

## Introduction

Bangladesh Atomic Energy Commission (BAEC) was founded in February 1973 through the promulgation of Presidential Order 15 of 1973 with the objective of promoting peaceful applications of nuclear energy in Bangladesh. By this time BAEC emerged as the largest organization for scientific and technological research especially in the field of nuclear energy in this country. The essentially goal-oriented research & development (R&D) programmes in physical sciences, biological sciences, engineering sciences and nuclear power field have been undertaken in the light of the overall need of the country so that the outcome of the activities can be directly contributed for socio-economic betterment.

Programmes of BAEC are chosen in a manner so that the priority, aspiration and needs of the country are amply reflected in their execution. Notable services of BAEC include modern nuclear medicine services to mass people, specially to the poorest section of the society, protection of public health and the environment through radioactivity monitoring of all imported food items, practice of safety culture against all kinds of radiation hazards, sterilization of medicine and medical equipment, food preservation, development of high quality polymer materials, chemical analysis of industrial products for QC purposes, chemical analysis of food and environmental samples for protection against pollution, industrial NDT and material testing services etc. In the last few years, the BAEC has undertaken the challenge of implementing the Rooppur Nuclear Power Project (RNPP) as one of its highest priority task.

The R&D programmes of BAEC are executed through its different institutes, centres and divisional laboratories equipped with state-of the-art facilities and installation. The major facilities include 3 MW BTRR, 3MV Tandem Accelerator Facility, 3MV Van de Graff Accelerator, Two Co-60 gamma irradiator, Central Radioactive Waste Processing and Storage Facilities, Nuclear apparatus and scanning devices in National Institute of Nuclear Medicine & Allied Sciences (NINMAS) and 14 Institute of Nuclear Medicine & Allied Sciences (INMAS) located at different district headquarters, Radioisotope Production Laboratory, Radioactivity Testing and Monitoring Laboratory, Beach Sand Minerals Processing Pilot Plant etc.

Apart from R&D activities, the following divisions of BAEC are playing vital role in executing various programmes undertaken by BAEC.

**International Affairs Division (IAD):** This division is playing a key role for maintaining liaison with many foreign countries and international organizations particularly International Atomic Energy Agency (IAEA) with a view of transferring the technology as well as developing human resources in the field of nuclear technology. This division is also in constant communication with IAEA in order to fulfill the country's obligation in matters related to Nuclear Safeguards and Non-proliferation of nuclear weapons. It also maintains liaison with other international bodies like RCA, FNCA etc.

**Planning and Development Division (PDD):** This division is responsible for planning, development and execution of different ADP and special R&D projects.

**Scientific Information Division (SID):** This division is responsible for selection, collection, processing and providing information to a wide range of stakeholders concerned with the R&D activities and different services of BAEC.

**Nuclear Safety, Security and Safeguards Division (NSSD):** This division is responsible for fulfilling the obligations rendered on operators under the signed international treaties, agreements, protocols and conventions related to safety, security, physical protection and safeguards of nuclear and radioactive materials.

R&D activities conducted during the period of July 2016 to June 2017 in the various fields of nuclear science & technology are described in this report.

## RESEARCH AND DEVELOPMENT ACTIVITIES

### I. PHYSICAL SCIENCES

#### ATOMIC ENERGY CENTRE (AEC), DHAKA

##### Accelerator Facilities Division (AFD)

##### Objective

The objectives of this Division are (a) to operate and maintain the 3 MV Van de Graaff Accelerator and its associated auxiliary systems (b) to develop ion beam experimental facilities (c) to utilize the accelerator ion beam for research and development works in the field of health, environment, agriculture, industry, etc. (d) to provide accelerator beam time to other users for research and service purposes.

##### Activities/Programme(s)

Accelerator Facilities Division of the Atomic Energy Centre, Dhaka operates and maintains the 3 MV Van de Graaff Accelerator and its associated auxiliary systems, which is capable of accelerating proton beam in the current range of nano to micro-amperes. The researchers of various groups are utilizing the proton beam with associated facilities of VDG Accelerator Laboratory widely for elemental analysis of environmental, health, biological, agricultural and industrial samples using IBA techniques Proton Induced X-ray Emission (PIXE) and Proton Induced Gamma Emission (PIGE). Besides this, this division has taken an initiative to establish an institute under the ADP project entitled as “Institute of Nuclear Medical Physics (INMP)”.

#### 1. Research and Development Work(s)

##### 1.1 Operation and Management of the 3 MV Van de Graaff Accelerator

M. J. Abedin, S. Akter, M. M. Ahasan and M. R. Mozumder

**Objective:** The main objective is to keep the accelerator operational, to produce and accelerate the proton beam for research and service purpose. Routine maintenance of the accelerator is also included in this programme.

**Current progress:** Now the accelerator is in operation. According to the user’s demands, the accelerator has been operated to produce and accelerate the proton beam for sample irradiation. For quantitative measurements of both the essential and toxic elements of fish samples of polluted lake, lake sediment samples, soil samples of Aila affected area, Cox’s Bazar Sea Beach area, medicinal plants, Industrial soils and vegetables have been collected, dried, grinded and prepared as pellets. Radionuclide detection of lake sediments and soil samples also have been done using newly developed Gamma Spectroscopy System. The researchers from different universities are doing their research works for MS, MPhil and PhD thesis using PIGE and PIXE techniques with the collaboration of Van de Graaff Accelerator laboratory of AECD.

##### 1.2 Elemental Analysis and Pollution Assessment of Some Soil Samples of Chittagong and Cox’s Bazar Sea Beach Area

M. J. Abedin, S. Akter, M. M. Ahasan and L. Jaman\*

**Objective:** The objective of the research work is to develop a methodology using the PIXE technique for the identification of the pollutant in Cox’s Bazar Sea Beach area of Bangladesh. The goal is to determine the exact quantification of essential and toxic elements of soil and to provide sufficient information to evaluate their impact on human health and the environment.

**Current progress:** Another 35 soil samples have been collected, dried, made fine powder and the pellets. The pellets have been irradiated by 2.4 MeV proton beam at the current ranges of 10 to 15 nA. IBA technique PIXE was applied for sample irradiation. Spectrum data acquisition is done by the software MAESTRO-32. The spectrum data have been analyzed using software GUPIX/DAN-32. A seminar was held on this research work at Physics Department of Jahangirnagar University. An international publication also published under

this research works. A PhD thesis will be submitted to the Dept. of Physics, Jahangirnagar University under this programme.

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\* Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh

### **1.3 Analysis of Elemental Concentration of Medicinal Plant using Ion Beam Analytical technique PIXE to Establish a Elemental Database**

M. J. Abedin, S. Akter, M. M. Ahasan and M. Z. Hossain\*

**Objective:** The main objective of the research work is to explore and identify the major and trace elements presence in medicinal plants grown in Bangladesh and to estimate the concentration of major and trace elements in plants or parts of the plants those are commonly considered as useful and efficient for various therapeutic purposes.

**Current progress:** Forty different medicinal plant samples have been collected, dried, grinded as fine powder and made pellets (7 mm dia. & 1mm thick). The pellet samples have been irradiated by proton beam of 2.4 MeV. A PhD thesis has been written using the research results and will be submitted under this programme to the department of Physics, Jahangirnagar University within 30 June 2017.

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\* Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh

### **1.4 Quantitative Analysis of Trace Element in Fishes and Sediments of Polluted Lakes in Dhaka City Using IBA Techniques and Radioactivity Measurement of lake Sediment**

M. J. Abedin, S. Akter, M. M. Ahasan and M. A. Rahman\*

**Objective:** The main objective of the research work is the elemental analysis of fish and sediment samples of lakes in Dhaka city, determination of heavy metal accumulation in fish and soil and to detect the radionuclide of lake sediment samples.

**Current progress:** Fifty five different fishes and fifteen lake sediment samples have been collected, dried, made fine powder, pellets have been made (7 mm dia. & 1mm thick). The pellets have been irradiated by proton beam of 2.4 MeV. Experiments have also been done using Gamma Spectrometry System for the detection of radionuclide. All the spectrum data have been analyzed using the GUPIX/DAN-32 software. A PhD thesis has been written under the research and will be submitted to the department of Physics, Jahangirnagar University within 30 June 2017.

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\* Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh

### **1.5 Assessment of Environmental Toxicity of Some Waterfall Areas Bangladesh by PIXE Technique and Radionuclide Detection using Gamma Spectrometry**

M. J. Abedin, M. M. Ahasan, S. Akter and M. Safiul Islam\*

**Objective:** The objective of this research work is to study the environmental toxicity and radionuclide accumulation in some waterfall areas of Bangladesh. This research work will provide the quantitative information regarding the elemental composition of the environmental ingredients and also the radiological environmental data of waterfall areas. This database will be helpful for the assessment of environmental quality of the waterfall areas as well as to assess the effect of the consequences on human health.

**Current progress:** Another 20 sediment and soil samples have been collected from different waterfall areas of Sylhet and Chittagong and preserved for nuclide detection using Gamma Spectroscopy System. A small portion of each of the sample has been taken for the elemental analysis by 2.4 MeV proton beam. Drying and grinding for fine powder and pellet making has been done. The pellets have been preserved for irradiation. Software MAESTRO-32 and GUPIX/DAN-32 will be used for data acquisition and spectrum analysis respectively. A PhD thesis will be submitted under this research programme to the department of Physics, Jahangirnagar University.

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\* Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh

### **1.6 Assessment of Elemental Concentration and Radioactivity of Baby Food Collected from Local Market using PIXE and Gamma Spectrometry Techniques**

M. J. Abedin, S. Akter, M. M. Ahasan and S. Roy\*

**Objective:** The main objective of this research work is to analyze the elements contain in the baby foods available in the local markets. The research work is also involved for the determination of any type of radionuclide contaminated with the baby food using Gamma Spectrometry System. The elemental and radiological data will be helpful to assess the quality of baby food.

**Current progress:** Different types of baby food have been collected from local market, dried, grinded and made as pellet (7mm diameter & 1mm thick). The pellets have been preserved in vacuum desiccators and will be irradiated by 2.4 MeV proton beam for elemental analysis. MS thesis will be submitted under this programme to the department of Computer Science and Telecommunication Engineering, Noakhali Science and Technology University.

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\* Department Computer Science and Telecommunication Engineering, Noakhali Science and Technology University, Bangladesh

### **1.7 Study of Medicinal Plants of Bangladesh with Anti Blood Pressure Potential using PIXE**

S. Akter, M. J. Abedin and M. M. Ahasan

High blood pressure is a common disease around the whole world. Stress, obese, lack of physical activity, older age, genetics, healthy food and soda are the main cause of blood pressure. Heart disease, stroke, kidney diseases may in the risk due to high blood pressure. Naturally occurring medicinal plants and herbs have hypotensive or antihypertensive potential. In this regards, some medicinal herbs and spices samples were collected from various places in Bangladesh. The samples were irradiated by 3 MV Van de Graaff Accelerator at Atomic Energy Centre, Dhaka (AECD) using Proton Induced X-ray Emission (PIXE) technique. The elements that were found to be present in these samples are: P (223 to 760), K (10537 to 47007), Ca (11239 to 50507), Mn (22 to 1128), Fe (202 to 918), Cu (7 to 63) and Zn (26 to 135) ppm. High blood pressure can be controlled by maintaining a proper lifestyle and healthy balanced diet.

### **1.8 Analysis of Spices Available in Local Market in Bangladesh using Ion Beam Analysis Technique**

S. Akter, R. Khatun, M. J. Abedin and M. M. Ahasan

Packed and unpacked spices may contain high level of lead that poses health threats. It may be due to soil contamination or artificial mixing of heavy elements to make the spices look brighter to attract customers. Some spices sample like turmeric and red chilli powder of local market in Bangladesh were collected to determine the toxicity present in them. The sample were dried and pressed to make pellet and irradiated by proton beam of 2.4 MeV and in the current range of 10 – 15 nA using 3 MV Van de Graaff Accelerator, Atomic Energy Centre, Dhaka and the IBA technique PIXE has been used for all of the experiments. Accuracy and precision of the technique were assured by analyzing certified reference material in the same experimental conditions. The elements that were found to be present in these samples are P, S, Cl, K, Ca, Mn, Fe, Zn. Among the investigated sample, one turmeric powder sample contains excess Pd which may affect human health. Proper care should be taken on processing the spices.

### **1.9 Establishment of the Institute of Nuclear Medical Physics**

M. M. Ahasan, S. Akter and M. J. Abedin

**Objective:** Quality cancer detection and treatment services will be given by providing Medical Physics Experts and Nuclear Medicine Technologists.

**Current progress:** The budget allocation of the last financial year (2016-17) for the project entitled as Establishment of “Institute of Nuclear Medical Physics” was forty hundred seventy seven lac and the implementation rate was 100%. The construction of Building has already completed. Tender processing for

Supply, Installation and Commissioning of a medical “Linear Accelerator (Linac)” with associate accessories and Supply, Installation and Commissioning of nuclear TOF-PET with faster scintillators integrated with 128 slice CT and related accessories have been completed.

## 2. Repair & Maintenance and Renovation Works

Repair and maintenance works have been done on a number of subsystems of 3MV Horizontal type Van de Graaff Accelerator.

## 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the Participant	Name of the event/topics	Organizer	Date	Place
M. M. Ahasan	Annual Conference of Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016)BSRO	BMPS	24-25 Sept. 2016	BIAM, Dhaka
	National Conference on Physics- 2017	BPS	05-07 Jan. 2017	AECD, Dhaka
	International Conference on Physics in Medicine and Clinical Nuroelectrophysiology	BMPA ECNES DU	10-11 March, 2017	DU
M. J. Abedin	National Conference on Physics- 2017	BPS	05-07 Jan. 2017	AECD, Dhaka
S.Akter	Annual Conference of Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016)	BSRO BMPS	24-25 Sept. 2016	BIAM, Dhaka
	National Conference on Physics- 2017	BPS	05-07 Jan. 2017	AECD, Dhaka
	International Conference on Physics in Medicine and Clinical Nuroelectrophysiology	BMPA ECNES DU	10-11 March, 2017	DU

## Chemistry Division (CD)

### Introduction

The Chemistry Division of the Atomic Energy Centre, Dhaka has been recognized both nationally and internationally as one of the leading Research Laboratory in the field of Analytical Chemistry. The objective of this Division is to make significant contribution towards socio-economic development of Bangladesh through different R&D programmes of the Bangladesh Atomic Energy Commission and analytical services to potential end users of the country. This Division is pursuing R&D activities in some selected branches of Chemistry (Advanced Analytical Chemistry, Atmospheric and Environmental Chemistry, Clinical/Medical Chemistry, Academic Training and Analytical Services) focusing the socio-economic development of the country. In collaboration with the Universities, Research Organizations and Medical Institutes, the Division carries out some specific research programmes and also provides academic training to the University student. Technical services in the form of Chemical Analysis of Materials, Consultants/Experts Services are provided to the different Organizations. The Division also participates in Coordinated Research Programmes under IAEA/RCA framework and Research Projects under MOST special grant programme, particularly in the field of Environmental Pollution, Nuclear Analytical Techniques in Material Analysis and Environmental Studies.

## Activities/Programme(s)

### 1. Research and Development Work(s)

#### Advanced Analytical Chemistry

##### 1.1 Evaluation of Blood Lead (Pb) Level as a Risk Factor in Children with Autism Spectrum Disorder

Y. N. Jolly, S. Akter, M. S. Ali\* and B. A. Begum

Autism is a devastating childhood condition that has emerged as an increasing social concern. Toxic level of heavy metals specially lead (Pb) have been suggested to play a critical role in the pathogenesis of autism spectrum disorder (ASD). In this study twenty five (25) patient of 3-16 years of age with Autism Spectrum Disorder (ASD) consider as case and twenty five (25) children of 3-16 years of age with any ASD consider as control were taken. The mean blood lead level in the case group was higher than the control group. There was no significant difference was found when blood lead concentration above the CDC's level of concern (10 mg/dl) was compared between case and control groups.

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\* Department of Pediatrics, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh

##### 1.2 A Study of the Commercial Feeding Effect on the Biochemical Composition of Thai Koi Fish (*Anabas testudineus*) and Various Analysis on Animal Model after Treating with Thai Koi

Y. N. Jolly, M. S. Rahman, J. Kabir, S. Akter, M. Munshi\* and M. Z. Amin\*

The present study was undertaken to analyze the proximate composition, biochemical analysis and heavy metal content in the edible parts of "Thai koi" (*Anabas testudineus*) fishes along with their corresponding feeding effect in Bangladeshi context. Proximate analysis revealed that the protein contents in the body of Thai koi fish varied between 41.26-57.69% by fresh basis. Fat contents in body and head were 36.41-50.01% and 27.59-38.57% respectively and the feed of the fishes contained 17.91 to 34.43% protein. Lead content of the fish and feed was lower than the standard level. Histopathological analysis of liver of animal models after treating with thai koi shows hydropic degeneration predominantly in midzone, whereas liver from control mice was in normal state with parenchyma and central vein (CV). Besides this, kidney section shows mild degenerative changes in the straight proximal tubules but kidney from control mice was in normal condition.

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\*Department of Genetic Engineering and Biotechnology, Jessore University of Science and Technology, Bangladesh

##### 1.3 Development of a Fast Track Method for the Facile Diagnosis of Wilson's Disease

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan and L. N. Lutfa

A fast-track diagnosis technique has been established for diagnosis of Wilson's disease using Atomic Absorption Spectrometric (AAS) technique. The proposed test method has been found simple, faster and accurate than the existing 24h urinary copper estimation. Advantages of the proposed test method have been confirmed by studying on 40 (forty) cases in Bangladesh. Cases have been selected considering age, urinary copper level and total urine volume etc.

##### 1.4 Development and Validation of a Method for the Determination of Cu in Urine

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. Z. Chowdhury, M. A. Maksud, S. R. Khan and L. N. Lutfa

For method validation according to the international guideline, working and linear ranges, limit of detection, limit of quantification, trueness (recovery) and precision (repeatability and reproducibility) have been assessed as performance criteria. The method LoDs for 7.0 µg/L, whereas, the method LoQs were obtained at 20.0 µg/L. Moreover, the recovery of the analyte was 94 – 102% and the RSD values for precision were 0.45 – 2.5 %. The method validation performance criteria indicate the method's suitability for Cu level quantification in urine.

### **1.5 Participation in Proficiency Testing (pt) for the Analysis of Fe and Zn in Wheat Flour Organized by Asia Pacific Laboratory Accreditation Cooperation (APLAC) and for Analyzing of Toxic Metals in Fish Organized by LGC Standard, UK**

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan and L. N. Lutfa

According to the standard of ISO/IEC 17025, testing laboratory has to participate routinely in Proficiency Testing (PT) for maintaining accreditation. As per the PT schedule, ACL has participated a PT programme through the quantification of Fe and Zn in wheat flour organized by APLAC. Obtained very good Z-Score  $< \pm 2$  and results considered very satisfactory. One fish based PT sample (LGC Standard, Scheme-QMAS, round MT 742) had received from UK and analyses of toxic elements had carried out using AAS techniques. The laboratory received very good Z-score indicating this laboratory able to produce very high quality test results.

### **1.6 Development of a Portable Device to Determine Potassium Level in Soil Sample**

S. B. Quaraishi, A. K. M. A. Ullah, M. Z. Chowdhury, M. A. Maksud, S. R. Khan, L. N. Lutfa, I. Kabir\*, Md. T. Hossain\*, M. A. Amin\* and J. A. Shupta\*

A UV-sensitive portable device has been developed to determine the concentration of Potassium in soil samples successfully under the research activity of “Development of portable device for measuring components in soils” by the Department of Electrical and Electronics Engineering, BRAC University, Dhaka. A satisfactory result has been observed with a comparative analysis of collected results from this Device with ACL laboratory established UV-Visible Spectrophotometric method. Therefore, this device can be used to identify the concentration of potassium in various samples by this invented portable device.

\* Department of Electrical and Electronics Engineering, BRAC University, Dhaka, Bangladesh

### **1.7 Development of Two Different Methods using GF-AAS and UV- Visible Spectrophotometry to Determine the Trace Level of Boron in Water Sample**

S. B. Quaraishi, A. K. M. A. Ullah, M. Z. Chowdhury, M. A. Maksud, S. R. Khan and L. N. Lutfa

Establishment of two different methods has been going on to determine Boron in water at trace level using GF-AAS and UV-Visible Spectrophotometer. At present experts are assuming that the accumulation of Boron in food chain through water is increasing so that utilizing this method, this issue will not only be confirmed but also help to do research as well as to provide service.

### **1.8 Development of an Analytical Method for the Determination of Selenium (Se) in Water using Graphite Furnace-Atomic Absorption Spectrophotometer (GF-AAS)**

S. B. Quaraishi, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan and L. N. Lutfa

Establishment of a precise, accurate analytical method for determining Selenium in different food samples at ultra trace level has been going on at trace level (ppb) using GF-AAS which will help to do research and provide services. By this time LOD and LOQ have been determined for this method. Experiments for checking recovery, repeatability and reproducibility are going on.

### **1.9 Development of an Active Method for the Analysis of Benzo [a] Pyrene by using GC-MS**

A. R. M. Tareq, S. Karmakar and R. Sultana

Polycyclic aromatic hydrocarbons, benzo [a] pyrene is a carcinogenic organic compound. The objective of the study was to develop a test method for routine laboratory analysis of benzo [a] pyrene. GC-MS analysis was performed using a Saturn 2200 mass spectrometer coupled with a Varian CP-3800 gas chromatograph fitted with a split-splitless injector 1177 and a VF-5 ms capillary column (30 m X 0.25 mm i.d., 0.25  $\mu$ m film thickness). Helium was used as a carrier gas at a flow rate of 1.0 ml/min. The injection port was maintained at 300 °C, and the split ratio was 20. Oven temperature programming was done from 50 °C hold at 1 min and then 50 °C to 320 °C at 10 °C/min and it was kept at 280 °C for 20 min. Ionization mode was electron impact ionization and the scanning range was from 40 amu to 500 amu. Method run time was 48 minutes. Benzo[a]pyrene was found at 25.85 minutes RT.

### **1.10 TiO<sub>2</sub> Nanoparticles: Facile Synthesis and Evaluation of Photocatalytic Activity**

A. K. M. A. Ullah, S. B. Quraishi, \*A. N. Tamanna, A. R. M. Tareq, R. Sultana and A. K. M. F. Kibria

TiO<sub>2</sub> is reported to be a catalyst having high reducing potential. In the present study, TiO<sub>2</sub> nanoparticles were synthesized through the reduction of titanium tetra isopropoxide (TTIP) with the extract of *Nyctanthes arbortristis*. The presence of reducing agents in the *Nyctanthes arbortristis* is confirmed with the Gas Chromatography-Mass Spectrometry (GC-MS) technique. The crystal structure and surface morphology were evidenced from the X-ray diffraction (XRD) and field emission scanning electron microscopy (FESEM) technique. Thermal stability and structural transformation were assessed using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) techniques. The photocatalytic activity will be assessed through the dye degradation activity.

\* Department of Physics, University of Dhaka, Bangladesh

### **Atmospheric and Environmental Chemistry**

#### **1.11 Dust Particle (PM<sub>10</sub> and PM<sub>2.5</sub>) Monitoring for Air Quality Assessment in Naryanganj and Munshiganj, Bangladesh**

B. A. Begum

The air samplings were done in four locations of Narayanganj and Munshiganj from 14 August to 7 September 2016 using same two Eco Tech Air samplers but in a cyclic order. All the samples were collected for 24h. It has found that the PM concentrations are significantly low in study areas. This is due to meteorological effect and as well as less anthropogenic activities in those areas. The Exceedance Factor (EF) levels of both PM<sub>2.5</sub> and PM<sub>10</sub> were within the limits of low pollution area.

#### **1.12 Particulate Matter Concentrations in the Air of Dhaka and Gazipur City During winter: A comparative Study**

M. M. Hoque<sup>1</sup>, B.A. Begum, A. M. Shawan<sup>2</sup> and S. J. Ahmed<sup>1</sup>

In order to compare the particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>) concentrations of Dhaka city and Gazipur city, the samples were collected from December 2013 to February 2014 using Air Metrics samples. The PM<sub>2.5</sub> and PM<sub>10</sub> concentrations at Joydeppur have been found higher than Farmgate during the sampling period. The daily average of PM<sub>2.5</sub> for both the cities exceeded the Bangladesh National Ambient Air Quality Standard (BNAAQs) which 65mg/m<sup>3</sup>. Brick kiln emission, indoor air pollution from cook stoves and long range transport may increase the concentrations of PM<sub>2.5</sub> in the air of Gazipur compared to Dhaka.

<sup>1</sup>Department of Physics, Dhaka University of Engineering and Technology, Gazipur, Bangladesh

<sup>2</sup>Department of Chemistry, Jagannath University, Dhaka, Bangladesh

#### **1.13 Thermal Performance and Emission Analysis of Available Metal and Non-Metal Improved Cook Stoves in Bangladesh and Development of a New Improved Cook Stoves with Thermo Electric Generator**

A. I. Sifal<sup>1</sup>, M. M. Uddin<sup>1</sup>, S. M. N. Shams<sup>1</sup> and B. A. Begum

The main objective of this research is to assess the thermal performance of the cook stove. After studying the thermal performance of improved cook stoves (ICS), the ICS is developed as TEG (Thermo Electric Generator). It consists of two materials placed in contact with each other via bridges. Electricity can then be generated if there is a temperature difference between the two materials and the heat begins to move from one side to the other. The heat dissipated from ICS is a potential source of heat which can be converted to electricity by using the principle of thermocouple.

<sup>1</sup>Institute of Energy, University of Dhaka, Bangladesh



### 1.14 Petrography and Geochemical Analysis of Sylhet Limestone

Y. N. Jolly, M. S. Rahman, J. Kabir, S. Akter, S. M. M. Ullah\* and M. S. Islam\*

Sylhet limestone formation of Eocene age has a great geo-scientific, educational and economical context. Petrography and geochemical analysis of Sylhet Limestone is studied by analyzing 28 samples from surface and subsurface of northeastern (Jaflong and Takerghat) and western (Joypurhat) part of Bangladesh. Geochemical results show that the samples are comprised high CaO with a significant amount of Fe<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, K<sub>2</sub>O, MgO, SiO<sub>2</sub> etc. Rather than oxides some trace elements like Sr, Zr, Zn, Sc, Co, V, Ba, Ni, Cu etc. has been found. Geochemical characteristics indicate that Sylhet limestone is deposited at a low energy shallow marine depositional environment. Petrography shows that the formation as ‘Highly Fossiliferous Nummulitic Limestone’ presenting an abundant and diverse foraminifer assemblages such as Nummulites, Discocyclina, Operculina, Assilina and a sparse but diverse ostracod assemblage.

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\*Department of Petroleum and Mining Engineering, Sylhet University of Science and Technology, Bangladesh

### 1.15 Status of Groundwater Quality and its Health Risk Assessment with the Special Emphasis on Arsenic Contamination: A Case Study

M. S. Rahman, S. Akther, M. J. Kabir, Y. N. Jolly, K. J. Fatema, H. Sushmita, B. A. Begum, S. B. Quaraishi, M. Asaduzzaman\* and M. E. Huda\*

A total of thirty-one groundwater samples have been collected from six upazilas of Comilla district in order to assess the processes controlling geochemical constituents of groundwater in the aquifer system. Irrigation water quality and health risk assessment is done to evaluate the suitability of groundwater for irrigation and drinking purposes. From piper diagram it is found that the major water type is Ca<sup>2+</sup>-Mg<sup>2+</sup>-HCO<sub>3</sub><sup>-</sup> in the study area. Gibbs plot suggesting that most of the samples fall within the rock-dominance zone. The suitability of water for irrigation is evaluated based on Sodium percent (Na%), Sodium adsorption ratio (SAR), Residual sodium bicarbonate (RSBC), Permeability index (PI), Magnesium hazard (MH) and Kelly’s ratio (KR). Na%, SAR, RSBC, PI and KR values indicate that groundwater is suitable for irrigation purposes. The values of HQ were found >1 in 90.32% samples, which employed highly potential health risk to local residents. In addition, average value for cancer risk of 8 per 1000 was found in study area. Arsenic is strongly correlated with HCO<sub>3</sub><sup>-</sup>, Mg<sup>2+</sup> and K<sup>+</sup>. This principal component analysis (PCA) suggests that As mobilize in the shallow aquifer through dissolution of carbonate minerals.

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### 1.16 Human Health Risk Assessment of Heavy Metals in Soil from the Proposed Site of Ruppur Nuclear Power Plant (RNPP), Bangladesh

M. S. Rahman, M. M. Ali\*, M. R. Zaman\*, M. E. Huda\*, S. Akther, M. J. Kabir and Y. N. Jolly

Concentration of 6 heavy metals (Pb, Cu, Zn, As, Cr, Co) were studied in the soils around to proposed site of Ruppur Nuclear Power Plant Pabna, Bangladesh. The concentration of Pb, Cu, Zn, and As were determine in the soil samples range from 61-863, 11-47, 93-165, and 7-12 mg/kg respectively. The concentration of Cr and Co are not found. Risk assessment indicated that the carcinogenic risk is completely insignificant but the cumulative non-carcinogenic risk tends to become significant, mainly for children, since it approaches unacceptable values.

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\* Department of Applied Chemistry & Chemical Engineering, University of Rajshahi, Bangladesh

### 1.17 Ecological Hazard Caused by Heavy Metals Pollution of Ship Breaking Yards in Sitakunda River, Chittagong

M. S. Rahman, S. Akther, M. J. Kabir, Y. N. Jolly, S. M. O. Faruque\* and M. B. Hossain\*

Mangrove ecosystem is very important as it plays a key role in nutrient cycling and provides shelter, food, breeding ground for several species. Surface sediment samples have been collected from 7 sampling points of

Sitakunda River, which is close to the ship breaking yards, and one surface sediment sample from the control site has also been collected, which is 10 km far away from the ship breaking yards of Sitakunda River. Corresponding to these six sampling stations, two most common aquatic plants: (1) *Avicennia alba* and (2) *Acanthus ilicifolius* have also been collected. Roots and leaves for both aquatic plant samples have been targeted to analysis for assessing the pollution status in the study area. The work is in progress.

\* Department of Fisheries and Marine Science, Noakhali Science & Technology University, Bangladesh

### **1.18 Status of Radionuclides and Toxic Metals in Samples from Sunamgonj Haor Areas**

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan and L. N. Lutfa

11 (Eleven) water, 05 (five) soil, 05 (five) sediment and 05 (five) water hyacinth and fish samples have been collected on 22 April 2017 from different locations of five areas of Sunamganj district named Dekhar Haor, Karchar Haor, Matian Haor, Tanguar Haor and Surma river. Quantitative analysis of various harmful heavy metals – Lead (Pb), Cadmium (Cd), Chromium (Cr), Copper (Cu), Nickel (Ni), Cobalt (Co), Arsenic (As), Mercury (Hg), Thorium (Th) and Uranium (U) have been carried and it has been observed that the amount of heavy metals in those samples are within the range of national & international guideline values. Therefore, it may be concluded that the harmfulness of the aquatic animals of Sunamgong Haor area were not for heavy metals and Uranium.

### **1.19 Pollution Status of Heavy Metals in Water of Halda River using Pollution Evaluation Indices**

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan, L. N. Lutfa  
and M. A. Islam\*

The pollution status of heavy metals in water of the Halda River, Chittagong was investigated based on the spatial variations. The mean values of heavy metal (Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Cd, Hg and Pb) pollution index (HPI) and pollution index (PI) were calculated. Comparison of the heavy metal concentrations in the water samples with different regulatory standard and background values revealed that Al, Co, Cu and Pb concentrations are higher than the regulatory standard values whereas concentrations for rest of the studied metals are below the regulatory standard values.

\*Institute of Nuclear Science & Technology, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh

### **1.20 Health Risk Assessment of Tourist in Saint Martin's Island, Bangladesh Due to Heavy Metals Exposure from Commonly Consumes Fish, Shrimp, Lobster and Crabs**

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan, L. N. Lutfa and J. Akhter\*

For the fish samples the metals concentration for Pb, Hg, Cr, Cd, and Zn were  $8.917 \pm 0.514$ ,  $0.074 \pm 0.003$ ,  $0.344 \pm 0.014$ ,  $14.09 \pm 0.096$ ,  $2.103 \pm 0.169$  mg/kg respectively. For the fishes (Mackerel, Blueing Angelfish), the mentioned metal concentrations were higher than the standard value of EU, 2006 and MOFL, BD, 2014. The highest Target Hazard Quotient (THQ) value was estimated for Cd (4.47699) in *P. sculptilis* shrimp that is very much consumed by the local people, Cd (2.07) in *H. Nigresceus* coral fish and Cd (1.18) in *M. victor* crab. Besides this, other species such as *R. kanagurta* has showed HI (Hazard Index) 0.22, *S. rubrum* 0.9 and *T. Jarboa*, *P. sanguinolentus*, *M. victor* Showed HI 0.25, 0.55 and 1.14 respectively that is also alarming. The Target Cancer Risk (TR) values for As, Cd, and Pb ranged from  $6.010 \times 10^{-7}$  to 0.0627 in the fish species  $6.01 \times 10^{-7}$  to 0.0156 in shrimp and lobster species and  $6.01 \times 10^{-7}$  to 0.05 in crab species respectively.

\*M.Sc Student, Department of Zoology, Jagannath University, Dhaka, Bangladesh

### **1.21 Potential Ecological Risk Assessment of Heavy Metal Contamination Around Ship Breaking Areas and its Impact on Vegetables Grown in that Area**

M. S. Rahman, Y. N. Jolly, S. Akther, M. J. Kabir, M. Rahman\* and M. B. Hossain\*

Five sampling points in the agricultural lands around the ship breaking yard and one sampling point as control (10 km far away from the ship breaking yard) have been selected for this study. Therefore, soil (6 inch depth) samples and five different types of most common vegetables: Red Amaranth, Spinach, Mustard Leaf, Taro, Cress leaf, Coriander leaf from the preselected six sampling points have been collected from the ship breaking area of Shitakunda, Chittagong. Heavy metal concentration in total 6 soil samples and in 30 vegetables samples have been determined using X-ray fluorescence (XRF) spectrometry. The work is in progress.

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\* Department of Fisheries and Marine Science, Noakhali Science & Technology University, Bangladesh

### **1.22 Management of Water Quality for TRIGA MARK-II Research Reactor with Special Emphasis on Corrosion Phenomena**

M. S. Rahman, M. F. Huq\*, R. Islam\* and M. R. Islam\*

TRIGA Mark-II Research reactor of BAECh uses AERE pump water as a secondary coolant. In our case study, in order to management of water quality several kinds of physical-chemical parameters were successfully implemented and distinguished with the collecting samples and the respective standards. Measured physico- chemical parameters were pH, EC, TDS, Salinity were in acceptable levels but in several points like (BOL,S-5), (WTPW ,S-6) parameters were little bit greater than normal values. The major cations were quite satisfactory level and we observed by Pearson`s correlation that to make an ionic balances all cations and anions were linked with each other.

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\* Department of Nuclear Engineering, University of Dhaka, Bangladesh

### **1.23 Risk Management Through the Best Trial and Error Approach on Nuclear Power Industry**

M. S. Rahman, M. F. Huq\* and S. Biswas\*

From the different risk analysis study, we found that the best trial-and-error approach contains five important concepts within a cyclical process of policy-making, including risk decision-making, risk decision evaluation, policy implementation, risk experience, and learning about risk. Each concept influences the others sequentially to aid in the development of better management policies. This study, through the investigation of various types of empirical data concerned with world nuclear energy technology, delineates the importance of proactive as well as reactive approaches in a nuclear risk management process, which adopts deliberative policy making through risk analysis to prevent the occurrence of unwanted events and the iterative policy correction of problems which are detected through experience.

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\* Department of Nuclear Engineering, University of Dhaka

### **1.24 Risk Assessment of Trihalomethanes (THMs) Formation in the Supplied Water of Dhaka City, Bangladesh**

M. S. Rahman, M. Bodrud-Doza\* and N. Chowdhury<sup>4</sup>

To identify the potential formation of THMs in supplied water, this research uses the Specific UV Absorbance (SUVA) indicator measuring the level of dissolved organic carbon (DOC) and UV-absorbance from water samples which are sourced from the surface water, treated and supplied by the water supply authority DWASA. Among the disinfection by-products (DBPs) and their levels of presence, THMs are the most common and indexed as carcinogenic. These are potentially formed by the reaction of the commonly used chemical disinfectants. If the level is beyond the threshold limit, people might be exposed to THMs through ingestion of drinking water as well as inhalation of indoor air due its volatile characteristic. Therefore the measurement of DBPs in the newly expanding supply water system should be cautiously monitored to avoid the upcoming threat of a slow-onset hazard from supply water.

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\*International Centre for Climate Change and Development, Independent University, Bangladesh

### **1.25 Characterization of Groundwater Quality using Water Evaluation Indices, Multivariate Statistics and Geostatistics: Central Bangladesh**

M. S. Rahman, M. A. H. Bhuiyan<sup>\*1</sup>, M. B. Doza<sup>\*1</sup>, F. Ahmed<sup>\*1</sup> and A. R. M. T. Islam<sup>\*2</sup>

This study investigates the groundwater quality in the Faridpur District of central Bangladesh based on preselected 60 sample points. The study reveals that EC, TDS, Ca<sup>2+</sup>, total As and Fe values of groundwater samples exceeded Bangladesh and international standards. Ground water quality index (GWQI) exhibited that about 47% of the samples were belonging to good quality water for drinking purposes. The heavy metal pollution index (HPI), degree of contamination (Cd), heavy metal evaluation index (HEI) reveal that most of the samples belong to low level of pollution. Principle component analysis (PCA) suggests that groundwater quality is mainly related to geogenic (rock-water interaction) and anthropogenic source (agrogeogenic and domestic sewage) in the study area. Subsequently, the findings of cluster analysis (CA) and correlation matrix (CM) are also consistent with the PCA results.

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<sup>\*1</sup>Department of Environmental Sciences, Jahangirnagar University, Savar, Dhaka, Bangladesh

<sup>\*2</sup>Department of Disaster Management, Begum Rokeya University, Rangpur 5400, Bangladesh

### **1.26 Groundwater Quality Assessment of Lakshimpur District of Bangladesh using Water Quality Indices, Geostatistical Methods and Multivariate Analysis**

M. S. Rahman, M. A. H. Bhuiyan<sup>\*1</sup>, M. B. Doza<sup>\*1</sup> and A. R. M. T. Islam<sup>\*2</sup>

A total of 70 groundwater samples have been collected from wells and the result reveals that 50 % of the water samples belong to good quality water. The degrees of contamination, heavy metal pollution index, and heavy metal evaluation index present diversified results in samples even though they show significant correlations among them. The results of principal component analysis (PCA) show that groundwater quality in the study area mainly has geogenic (weathering and geochemical alteration of source rock) sources followed by anthropogenic source (agrogeogenic, domestic sewage, etc.). The results of semivariogram models have shown that most of the variables have weak spatial dependence, indicating agricultural and residential/domestic influences. This study is an implication to show the multiple approaches for quality assessment and spatial variability of groundwater as an effort toward a more effective groundwater quality management.

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<sup>\*1</sup>Department of Environmental Sciences, Jahangirnagar University, Savar, Dhaka, Bangladesh

<sup>\*2</sup>Department of Disaster Management, Begum Rokeya University, Rangpur 5400, Bangladesh

### **1.27 Assessing Irrigation Water Quality in Faridpur District of Bangladesh using Several Indices and Statistical Approaches**

M. S. Rahman, A. R. M. T. Islam<sup>\*1</sup> and M. B. Doza<sup>\*2</sup>

This study reveals that the pre-collected water samples are mainly Ca-Mg-HCO<sub>3</sub> types. Based on irrigation water quality index (IWQ); it is observed that 68.33% of the water samples (41 locations) belong to high suitability water type, whereas 30% (18 locations) samples exhibit low suitability type for irrigation purposes in the study area. Results of the classification (EC, SH, Na%, SAR, PI, MH, and KR) indicate that groundwater in the study areas are mainly fit for irrigation uses. Besides the above finding, Na<sup>+</sup> and Cl<sup>-</sup> concentrations reveal the positively skewed and are regarded to be extreme. The spatial distribution of irrigation indices is carried out by geostatistical modeling. The results of semivariogram model show that most of the irrigation indices have weakly spatial dependence demonstrating agricultural and residential influences.

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<sup>\*1</sup>Department of Disaster Management, Begum Rokeya University, Rangpur 5400, Bangladesh.

<sup>\*2</sup>Department of Environmental Sciences, Jahangirnagar University, Savar, Dhaka, Bangladesh.

### 1.28 Industrial Metal Pollution in Water and Probabilistic Assessment of Human Health Risk

M. S. Rahman, M. B. Ahmed\*, N. Saha\*, J. L. Zhou\* and W. Guo\*

Concentration of eight heavy metals in surface and groundwater around Dhaka Export Processing Zone (DEPZ) industrial area were investigated, and the health risk posed to local children and adult residents via ingestion and dermal contact was evaluated using deterministic and probabilistic approaches. Metal concentrations (except Cu, Mn, Ni, and Zn) in Bangshi River water were above the drinking water quality guidelines, while in groundwater were less than the recommended limits. Estimations of non-carcinogenic health risk for surface water revealed that mean hazard index (HI) values of As, Cr, Cu, and Pb for combined pathways (i.e., ingestion and dermal contact) were  $>1.0$  for both age groups. However, the HI values for all the examined metals in groundwater were  $<1.0$ , indicating no possible human health hazard. Deterministically estimated total cancer risk (TCR) via Bangshi River water exceeded the acceptable limit of  $1 \times 10^{-4}$  for adult and children. Although, probabilistically estimated 95th percentile values of TCR exceeded the benchmark, mean TCR values were less than  $1 \times 10^{-4}$ . Sensitivity analysis identified exposure duration (ED) and ingestion rate (IR) of water as the most relevant variables affecting the probabilistic risk estimation model outcome.

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\*School of Earth Sciences, The University of Queensland, St Lucia, QLD 4072, Australia

### 1.29 Analysis of Heavy Metals in Soil and Plants of an Industrial Area

S. Akter, M. S. Rahman, J. Kabir, N. Sultana, \*A. Islam and Y. N. Jolly

12 (twelve) soil and 12 (twelve) vegetable samples were collected from industrially contaminated area of Sharishabari, Jamalpur and analysis for Heavy metals were done using X ray Fluorescence. Mg, Al, Si, P, K, Ca, Ti, Fe, Co, Cu, Zn, As, Rb, Sr, Y, Zr, Nb, Eu, Pb and Th were detected in soil samples and concentration of Ti, Fe, Rb and Pb were higher in soil compared to world average value whereas other elements were within the limit. On the other hand in vegetable samples the concentrations of K, Ca, Cr, Mn, Fe, Cu, Zn, As, Sr, and Pb were within the safe limit suggested by different agencies (National Research council; International Conference on heavy metals in Environment (1983)). Further works are in progress.

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\*Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh

### 1.30 Assessment of Chemical Pollutants from Water, Sediment and People Consumed Items Fish, Crabs and Molluscs from Naf River to Coral Ecosystem of Bay of Bengal, Bangladesh

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan, L. N. Lutfu and K. K. Sarker\*

This study has been conducted to determine the concentration of eight heavy metals (Pb, Cd, Cr, Cu, Ni, Zn, As and Hg) in water and sediment samples from Naf river to Saint Martin's Island of Bay of Bengal. Heavy metals concentrations were analyzed after treatment using atomic absorption spectrometer. Levels of Pb and Cd were found 3 to 4 times higher than the guideline values for Surface water.

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\*Department of Zoology, Jagannath University, Dhaka, Bangladesh

### 1.31 Health Risk Assessment for Population via Consumption of Vegetables Grown in Arsenic Contaminated Soils

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan, L. N. Lutfu and Z. H. Mollah

In this research, the concentrations of Cu, Zn, Cr, Pb, Fe, As and Mn in edible part of spinach grown in BAU farm soils and industrial contaminated soils have been determined. It has been found out that Target hazard quotients (THQ) values for As was almost same for both the soils at 15 ppm treatment but it increased proportionally with treatments at BAU farm soil and THQ values for Cr surpassed 1 and it was more than twice for industrial contaminated soils.

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\*Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Dhaka, Bangladesh

### **1.32 Determination of Food Traceability and Food Safety of Dairy Products**

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan, L. N. Lutfa and R. Haque\*

Ten water and ten milk samples from different coastal areas such as Shatkhira, Khulna, Bagerhat of Bangladesh have been collected and the concentrations of Pb, Cd, Cr, Cu, Ni, Co, Mn, Zn, Fe, As, Al, Sr have been determined. The metal concentration found in water within the permissible limit, whereas, in milk samples were found below the detection limit.

\*Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Dhaka, Bangladesh

### **1.33 Assessment of Some Trace Metals Concentration in Three Commercially Important Fishes Hilsailisha, Pampus Argenteus and Sardinella Logiceps Mainly Collected from Marine Water of Bangladesh**

S. B. Quaraishi, T. R. Choudhury, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan, L. N. Lutfa  
and M. S. Bristy\*

Three different fish species have been collected from Kuakata, Pathorghata, Rajshahi, Chapainawabgang, Balashighat, Pirojpur, Cox's Bazar, Kurigram, Nobogonga, Kustia etc. And analysis of Pb, Cd, Cr, Cu, Zn, Mn, Ni, As and Hg are carried out using Atomic Absorption Spectrometric method. Levels of Pb and Cd were found about 10 and 3 times respectively, higher than the guideline values for fresh water fish.

\*Department of Zoology, Jagannath University, Dhaka, Bangladesh

### **1.34 Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs): An Approach to Fish in Bangladesh**

A. R. M. Tareq, S. Karmakar, A. K. M. A. Ullah, R. Sultana and S. B. Quaraishi

Naphthalene, phenanthrene, anthracene, fluorine, pyrene, crycene, benzo[a]anthracene, and 2, 3-benzofluorene were determined in selected fish samples employing the Gas Chromatography-Mass Spectrometry (GC-MS) technique. A total of sixteen (16) fish samples with a variety of four different species were collected from four different markets of Dhaka city. Results showed that the highest concentration for naphthalene, phenanthrene, anthracene, fluorine, crycene, and benzo[a]anthracene were found to be 36.20, 2.02, 2.53, 147.70, 15.90, and 12.60 µg/kg respectively. The other two investigated PAHs compounds, pyrene and 2,3-benzofluorene were found below the detection limit <0.002 µg/kg. The spike recovery of the PAHs was found ranging from 60.33 to 93.79 %.

### **1.35 Phenol and Some Phenolic Derivatives: A Study of Some Fishes in Dhaka City Market, Bangladesh**

A. R. M. Tareq, S. Karmakar, A. K. M. A. Ullah, R. Sultana and S. B. Quaraishi

Phenol, 2-methyl phenol, 3-methyl phenol, and 2-methoxy phenol were determined in selected fish samples mostly consumed by the Dhaka city people employing by the Gas Chromatography-Mass Spectrometry (GC-MS) technique. A total of sixteen (16) fish samples with a variety of four different species were collected from four different markets of Dhaka city. All the samples were run through sequential treatment of dichloromethane-hexane (1:1) mixture and refluxed for four hours at 66 °C for the extraction of the Phenols. The extracted samples were then evaporated to 1mL and subjected to GC-MS analyses for the Phenols quantifications. Results showed that the highest concentration for phenol, 2-methyl phenol, and 3-methyl phenol were found to be 135.8, 16.60, and 62.20 µg/kg respectively. 2-methoxy phenol was found below the detection limit <0.001 µg/kg.

### **1.36 Study of Some Polycyclic Aromatic Hydrocarbons (PAHs) in the Sediments of Turag River**

A. R. M. Tareq, S. Karmakar, R. Khan and R. Sultana

A comprehensive study has been carried out to determine the PAHs (naphthalene, phenanthrene, anthracene, fluorene, pyrene, 2, 3 benzofluorene, benzo [a] anthracene and crysene) concentration in the sediments (A total of eleven sediment samples) of seriously polluted Turagrivier using GC-MS technique. Results showed that highest concentration of naphthalene, phenanthrene, anthracene, fluorene, pyrene, 2,3 benzofluorene,

benzo [a] anthracene and crysene found to be 135.7 µg/kg in S-3, 141.80 µg/kg in S-4, 134.30 µg/kg in S-4, 1803.60 µg/kg in S-2, 297.0 µg/kg in S-4, 195.80 µg/kg in S-9, 259.0 µg/kg in S-9, and 313.90 µg/kg in S-4 respectively. Spike recovery ranges from 49.0% to 105.12% clarify the accuracy and reliability of the applied technique.

### **1.37 Leaf Extract Mediated Synthesis of Silver Nanoparticles for Antibacterial Applications**

A. K. M. A. Ullah, S. B. Quraishi, \*M. F. Kabir, A. R. M. Tareq, R. Sultana and A. K. M. F. Kibria

There are numerous synthetic routes for nanoparticles synthesis and it is inevitable to synthesis nanoparticle through a green synthesis route which will be environmentally friendly and facile as well. In the present study silver nanoparticles were prepared through an environmental friendly green synthetic route using the leaf extract of mangifera indica. The formation of silver nanoparticles followed the reduction of silver ion with natural reducing agent. The presence of reducing agents was evidenced using the GC-MS Technique. The formation of nanoparticles was confirmed using XRD, FT-IR and UV-Visible Spectroscopy. The surface morphology was investigated using FESEM technique.

\* Department of Physics, University of Dhaka, Bangladesh

## **Clinical Chemistry**

### **1.38 Serum Zinc Concentration in Patients with Tuberculous Lymphadenitis**

S. B. Quaraishi, S. R. Khan and M. R. Kabir\*

This case control study included 25 freshly diagnosed tuberculous lymphadenitis patients as cases and 25 tuberculosis negative normal healthy subjects as controls as per inclusion and exclusion criteria. Serum zinc concentrations were estimated by using atomic absorption spectrophotometry before initiating anti-tuberculosis chemotherapy. Results are compared with the control group, the concentrations of serum zinc were significantly lower ( $P=0.034$ ) in tuberculous lymphadenitis group. This study indicates that tuberculous lymphadenitis patients have lower level of serum zinc concentrations.

\*MD student, Department of Internal Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

### **1.39 Association of Lead (Pb) in Maternal Serum with Fetal Neural Tube Defects**

S. B. Quaraishi, S. R. Khan and F. B. Kakon\*

Women with USG detected case of fetal neural tube defects with normal serum folic acid level were the case group and 30 women with USG detected normal fetus with normal serum folic acid level were the control group. Maternal serum was taken for measurement of Folic acid by automatic assay and Lead (Pb) by Graphite furnace atomic absorption spectrophotometer. Raised maternal serum level of Lead was diagnosed when the level was found  $\geq 5$  µg/dl. Data was processed and analyzed by using SPSS version 17. The raised value of serum Lead (Pb) was found in 6.67% subjects. Significant relationship of serum lead level was found with advanced age of cases. Actual distribution of NTD and mean value of lead among the respondents were found highly significant.

\*Department of Obs and Gynae, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

### **1.40 Determination of Arsenic Concentration in Scalp Hair by EDXRF and the Present Status of Arsenicosis Patient in Bangladesh**

Y. N. Jolly, M. S. Rahman, S. Akter, J. Kabir, K. M. Mamun, N. Sultana and B. A. Begum

Hair tissue is a good biological indicator for chronic arsenic exposure through which it excretes slowly. Therefore, by measuring the concentration of arsenic in scalp hair it is possible to have an accurate indication of arsenic exposure levels. Presently arsenic level in the scalp hair of suspected Arsenicosis patient from the period July 2016 to June 2017 has been reported. During this period, a total number of 128 patients came to determine arsenic concentration in scalp hair among them 64% was male and 36 % was female. According to

the investigation it was found that the arsenic affected patients were more prominent at the age group of 18 to 45 compared to the age group of 10 to 17 and 46 to 70 respectively. It is a regular routine analytical service of Chemistry Division.

#### 1.41 Determination of Blood Lead Level using EDXRF Technique

Y. N. Jolly, S. Akter, J. Kabir and B. A. Begum

An attempt was taken to determine Pb concentration using EDXRF technique in human whole blood as diagnosis purpose. After successful research, Chemistry division has been providing a routine analytical service to the nation recently for the quantitative and qualitative lead (Pb) determination in whole blood samples. Presently lead level in Human whole blood sample from the period July 2016 to June 2017 has been reported. During this period, a total number of seven (7) blood samples have been analyzed so far. It's a regular routine analytical service of the Division.

#### 2. Manpower Development/Training Programme(s)

Name of event/topics	Date	Place
Investigation of Heavy Metals Content in Fishes Available in Different Markets of Dhaka City	01 Oct., 2017	Atomic Energy Centre, Dhaka
“Wilson's Disease: Bangladesh Perspective”	16 Nov., 2017	Atomic Energy Centre, Dhaka
Regional Training on The Application, Maintenance and Trouble-Shooting of Atomic Absorption Spectroscopy (AAS) by the Analytical Chemistry Laboratory (ACL), Chemistry Division	17-22 Dec., 2016	Atomic Energy Centre, Dhaka
Drinking Water Quality in Distribution Systems: Impact and Management of Corrosion Byproducts	03 Nov., 2016	Atomic Energy Centre, Dhaka
Assessor Training course on ISO/IEC 17025:2005- General Requirements for the Competence of Testing and Calibration Laboratories	11-13 Apr., 2017	BAB, Dhaka, Bangladesh

#### 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the Participant	Title of the event	Organizer	Date	Place
Dr. B. A. Begum	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society (BCS)	BCS	31 March, 2017	Chittagong Port Auditorium,
	IAEA/RCA Workshop on Cultural Heritage and Applicability of Nuclear Analytical Techniques,	IAEA	12-16 June, 2017	Nay Pyi Taw, Myanmar
Dr. S. B. Quraishi	BAETE Accreditation Workshop for Engineering and technical Education	BAB	31 Oct., 2016	BAETE Secretariat, IEB, Ramna, Dhaka
	BAETE Accreditation Workshop for Faculty Members & Programme Directors	BAB	04 Jan., 2017	IEB HQ, Ramna, Dhaka



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	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society (BCS)	BCS	31 March, 2017	Chittagong Port Auditorium
	Seminar on “World Accreditation Day 2017: Delivering Confidence in Construction and the Built Environment”.	BAB and DCCI	09 June, 2017	Ministries of Industries, Dhaka
Dr. Y. N. Jolly	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
	Meeting and visit the Reference Plant of Rooppur Nuclear Power Plant in Russian Federation	GOB/Russian Federation	15-22 Jan., 2017	Moscow, Russia
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society (BCS)	BCS	31 March, 2017	Chittagong Port Auditorium, Chittagong
Dr. M. S. Rahman	Seminar on “Safe , Affordable Water for People and the Environment”	DHHE & WST, Australia	24 Oct., 2016	DPHE, Dhaka
	Seminar on "Safe water and Green Environment for Mankind"	MOI & WST,, Australia	25 Oct., 2016	Ministry of Industries (MOI), Dhaka
	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
	International Conference on “Physics in Medicine and Clinical Neuroelectrophysiology”	BMPS	10-11 March, 2017	Dhaka University, Dhaka
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society (BCS)	BCS	31 March, 2017	Chittagong Port Auditorium, Chittagong
	Seminar on “Networking of Swedish Institute (SI) Alumni in Bangladesh and Promoting Environmental Sustainability”.	D. U	04 May, 2017	Dhaka University, Dhaka
	Seminar on “World Accreditation Day 2017: Delivering Confidence in Construction and the Built Environment”.	BAB and DCCI	09 June, 2017	Ministries of Industries, Dhaka
	Conference and Workshop on “Quality Assurance for Nuclear Spectrometry”.	IAEA	19 to 23 June, 2017	Vienna, Austria
M. J. Kabir	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
T. R. Chowdhury	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society (BCS)	BCS	31 March, 2017	Chittagong Port Auditorium, Chittagong

	Seminar on “World Accreditation Day 2017: Delivering Confidence in Construction and the Built Environment”.	BAB and DCCI	09 June, 2017	Ministries of Industries, Dhaka
Engr. S. Akter	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society (BCS)	BCS	31 March, 2017	Chittagong Port Auditorium, Chittagong
A. R. M. Tareq	National Conference on Physics	BPS	05-07 Jan., 2017	Atomic Energy Centre, Dhaka
	38 <sup>th</sup> Annual Conference	BCS	31 March 2017	Chittagong
K. J. Fatema	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society (BCS)	BCS	31 March, 2017	Chittagong Port Auditorium, Chittagong
A. K. M. A. Ullah	1 <sup>st</sup> Symposium on Chemistry for Global Solidarity	Dept. of Chemistry, JU	14 Oct., 2016	Jagannath University, Dhaka, Bangladesh
	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Atomic Energy Centre, Dhaka
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society (BCS)	BCS	31 March, 2017	Chittagong Port Auditorium, Chittagong

BAB: Bangladesh Accreditation Board, DCCI: Dhaka Chamber of Commerce & Industries, MOI: Ministry of Industries, WST: Water Science Technology

#### 4. Collaboration Work(s)

This Division has collaboration work with the member state across Asia-Pacific region under IAEA/RCA framework. The collaboration area is given below:

- RAS/7/029 Project: Assess the impact of urban Air Particulate Matter on air quality
- RAS/1/012 Project: Characterizing and optimizing process dynamics in complex industrial system using radiotracer and sealed source techniques
- Coordinate Research Project (CRP) D52038 entitled, ” Food traceability and Food safety of Dairy Products as an example through the Nuclear Analytical Techniques

#### 5. Service Rendered

The Chemistry Division regularly provides analytical services in different area especially on Nutritional and Health-related environmental studies. During the reporting period, the analytical services rendered to various organizations are listed in Table 1.

**Table 1. List of Analytical Services Provided to Different Organizations**

Sl. No	Name of Organization	Types of sample	No. of sample	Total parameters
1	Hospitals and Clinics	Urine (Cu & Zn)	2010	2010
2	icddr,b	Water	100	1100
3	Hospitals and Clinics	Hair(As)	128	128

4	Ministry/Government organization	Gold	275	275
5	Ministry/Government organization	Silver	95	95
6	Bangladesh small and cottage Industries Corporation	Potassium Iodate	1	8
7	Avaynagar Thana, Jessore	Shimana Piller	2	18
8	Department of Civil Engineering, KUET	Dust sample	3	33
9	SMS feeds Limited	Fish feed sample	4	4
10	TSP complex Ltd.	Rock phosphate sample	2	8
11	Mr. Sajjad Parvez,	Cream	1	2
12	FIQC, Chittagong	Fish	27	27
13	Mr. Aminul Islam	Fish	1	3
14	Saidowla (Pvt) Enterprise Ltd	Fish	1	5
15	FIQC, Chittagong	Fish Feed	1	1
16	Saidowla (Pvt) Enterprise Ltd	Ice	1	5
17	A.P.C Pharmaceuticals Ltd.	Medicine	1	11
18	Police Headquarters	Rice	1	6
19	Chittagong Chemical Complex	Salt	1	5
20	Navana Batteries Worker	Serum	5	5
21	Patient	Serum	27	27
22	Apex Foods Limited	Shrimp	1	1
23	FIQC, Chittagong	Shrimp	1	1
24	Nirala Sea Foods Ltd	Shrimp	1	5
25	FIQC, Chittagong	Shrimp Feed	2	2
26	Beximco Pharmaceuticals Ltd	Water	2	10
27	Chemistry Division, BUET	Water	5	11
28	Eurocross Frozen Foods (Bd) Ltd	Water	1	5
29	Linde Bangladesh Ltd	Water	2	2
30	Mashud Fish Processing & Ice Complex	Water	1	5
31	Mr. S.M. Wahid Raza	Water	1	1
32	Nirala Sea Foods Ltd	Water	1	5
33	Riverain Fish & Food Processing Inds. Ltd.	Water	1	1
34	Saidowla (Pvt) Enterprise Ltd	Water	3	15
35	KUET	Essential oil	1	1
36	Jogonath University	Essential oil	1	1
37	Hospitals/Clinic/ Battery factory	Blood (Pb)	7	7

- **Citizen Charter**

Sl. No.	Name of the Service	Determinants	Current Service Rate (in Taka )
1	Determination of harmful elements in Serum sample by AAS	Cu, Zn, Se, Pb	1,500/- per element
2	Diagnosis of Wilson Disease by AAS	Cu	800/-
3	Determination of toxic/harmful elements	Pb/Cd/Cr/Na/K/Mg/Ca/Mn/Fe/	2,000/- per element

	in solid or liquid samples like fish, milk, vegetables, soil, sediment, meat, dairy and fish feed etc.	Ni/Co/Cu/Zn	
4	Determination of toxic/harmful elements in water samples by AAS	Pb/Cd/Cr/Na/K/Mg/Ca/ Mn/Fe/Ni/Co/Cu/Zn As/Hg	1,500/- per element 2,000/- per element
5	Determination of toxic/harmful elements in petroleum based Mineral Oils and other products by AAS	Pb/Cd/Cr/Na/K/Mg/Ca/ Mn/Fe/Ni/Co/Cu/Zn	5,000/- per element
6	Trace elemental measurements by XRF in the solid samples like soil, sediment, plastic, fertilizer, solid – waste, agricultural products, fish, vegetables etc.	Si, Al, K, Ca, Mg, Ti, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Zr, Cd, Pb, Hg, U	2,000/- for the first three elements & 200/- each for rest of the elements
7	Determination of different elements in liquids like water, serum, milk, fruit juice, edible oil, fuel oil etc. by XRF	Si, Al, K, Ca, Mg, Ti, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Zr, Cd, Pb, Hg, U	2,000/- for the first three elements & 200/- each for rest of the elements
8	Purity test of Gold & Silver medals by XRF	Purity and Weight	2,500/- for gold 2,000/- for silver
9	Measurement of As in Scalp Hair to help diagnose arsenicosis by XRF	As	1000/-
10	Anionic determination in liquid samples by UV-Visible Spectrophotometer	SO <sub>4</sub> <sup>-2</sup> , PO <sub>4</sub> <sup>-2</sup> , NO <sub>3</sub> <sup>-1</sup>	2,000/- per element
11	Determination of Water Pollutants	PH, EC, TDS, Salinity	500/- per element
		DO	1,200/-
		BOD	1,700/-
		COD	1,700/-
12	Measurement of Polycyclic Aromatic Hydrocarbons ( PAHs ) in fish and water samples by GC-MS/FT-IR method	Fluorine, Pyrene, Chrysene, Phenanthrene & Anthracene	5,000/- for the first three elements & 1,000/- each for rest of the elements
13	Measurement of Phenol in water by GC-MS/FT-IR	Phenol	5,000/-
14	Determination of Normal Hydrocarbons in water and jute based products by GC-MS/FT-IR	C <sub>10</sub> , C <sub>12</sub> , C <sub>14</sub>	5,000/-
15	Identification of Functional Groups in solid and liquid samples by GC-MS/FT-IR	-	1,500/-
16	Determination of different components in Natural Product/Essential Oil by GC-MS/FT-IR	-	5,000/-
17	Measure of Pb/As in air as particulate matter by GC-MS/FT-IR	Pb, As	10,000/-
18.	Particulate matter mass measurement in air sample	-	4,000/-
19	Measurement of Sulphate in air particulate matter by UV-Visible Spectrometer	SO <sub>4</sub> <sup>-2</sup>	4,500/-
20	Black Carbon measurement in air particulate matter	Black Carbon	1,500/-

21	Application of Tracer Technology in industrial pipelines	Flow Rate	Negotiable
22	Measurement of Pb in Human Blood using AAS/XRF	Pb	3,000/-
23	Establishment of new method: depends on demand of customer	-	25,000/-

### Electronics Division (ED)

#### Objective

Electronics Division has been providing services through repair and maintenance of various types of scientific, medical, analytical, nuclear instruments and solar energy belonging to all divisions of Atomic Energy Centre, Dhaka (AECD). The Division has also been developing embedded system, FPGA based system and PC based system to facilitate nuclear and analytical research at AECD.

#### Activities/Programme(s)

The Division has played a significant role in the development of indigenous capability for design and development of instrumentation and its maintenance at AECD. Main activities of the Division are in the following areas:

- Design and Development of Customized Electronic System
- Repair & Maintenance of Nuclear, Scientific, Medical & Industrial Equipments
- Training Programme
- Research Collaboration

#### 1. Research and Development Activities

##### 1.1 Area Radiation, Temperature and Relative Humidity Monitoring System Around TRIGA MARK-II Research Reactor at AERE, Savar

M. A. Rahman, S. Sattar, M. Begum and Y. Mawla

The aim of this work is to incorporate Area Radiation Monitoring System at several locations around TRIGA MARK-II Research Reactor, with the existing Temperature & Relative Humidity Monitoring System.

This is a PC based data acquisition system that will collect Environmental Radioactivity data together with Temperature and Relative Humidity from seven different locations around TRIGA MARK-II Research Reactor to a central control room. The entire system is divided into two parts- one is data acquisition unit (microcontroller based) and other is data monitoring & logging unit (PC based). Each data acquisition unit further divided into three parts: a. Microcontroller Module used for data acquisition, b. SHT-75 Sensor Module to sense temperature and relative humidity and c. GM Servo Meter Module to measure environmental radiation. RS-485 long distance serial communication topology is used for communication between microcontroller based data acquisition units and PC based data monitoring & logging unit. Last year two GM Servo meter module were installed at Reactor Top and Reactor Control Room. This year another GM Servo meter module is installed at Beam Port-1. Now seven SHT-75 Sensor Modules and three GM Servo meter modules are in working condition and the system is performing well.

##### 1.2 Design and Development of a Microcontroller based Access Control System using RFID-reader and RFID-tag

M. A. Rahman, S. Sattar, M. Begum and Y. Mawla

Entrance control of office, house or industry is a big issue of security system to avoid access of unauthorized people. For this purpose, Microcontroller based entrance control system by using RFID (Radio Frequency Identity) reader and RFID Tag has been designed where every authorized person has his own RFID Tag card to open the door.

The system is designed using Atmel AVR-series ATmega8 microcontroller, Grove-1.25kHz RFID Reader and 1.25kHz RFID Tag. RFID card information is read by RFID reader. Then the microcontroller receives the card information from RFID Reader using serial communication. After receiving the card information microcontroller performs an authentication process for legal card holder. For successful authentication the system generates a signal to operate a relay which turns on the magnetic door lock to open the door. The designed system is now on test condition.

### **1.3 Design and development of PC Based Employee Management and Access Control System using RFID-reader and RFID-tag**

M. A. Rahman, S. Sattar, M. Begum and Y. Mawla

Employee Management and Access Control System allows companies and organizations, requiring high level of security and access for better manage and monitor the employees of those organizations with protection of unauthorized access. For this purpose, a low cost PC Based Employee Management and Access Control System has been designed using RFID-reader and RFID-tag.

The Designed system is divided into two parts. PC site application software is designed using LabVIEW, MS-Access and LabVIEW Database Connectivity Toolkit. Employee information is inserted into the main database using individual RFID-tag. The other part is Access Control Terminal, designed using ATmega-8 microcontroller interfaced with a RFID-reader. In order to get access from the designed Employee Management and Access Control System, each employee should show individual RFID-tag at Access Control Terminal. PC site application software store enter and exit time records of all employees of the organization to the main database. Various search option is available to the PC site application software to find out quick status of all employees of the organization. PC site application software also provides previous status records of all employees from main database. Thus the Employee Management and Access Control System is capable of providing better manage and monitor the employees of any organization with low cost. The system is designed and tested in Laboratory and it is working properly.

### **1.4 Design and Development of Microcontroller Based Control System for Proper Utilization of 1.68KWp Solar Pumping Plant Installed at AECD**

M. A. Rahman, M. Begum, S. Sattar, A. Quader, M. U. Safia, Y. Mawla and D. K. Saha

At AECD campus, a 1.68KWp solar pumping plant has been installed to run 2.2HP water pump. This is an additional system to produce power in lieu of the normal electric power line and is used at daytime if the overhead tank water level falls below a certain limit. Objective of our entitled work is proper utilization of the unused power of the plant.

If the tank water is full then the solar power produced by the system remains unused. A survey was carried out by electronics division to observe the run time of water pump from solar energy. According to the survey, solar energy is used only 2-3 hours per day to run water pump and almost 5-6 hours per day, it is not utilized. We can exploit this unused solar power to charge a battery backup system that can be used to run some low power appliances at some significant locations of AECD. To achieve our goal we have designed a control system that uses the solar power to charge the battery backup system when the water pump is off. In the designed system ATmega8 microcontroller is used to monitor the pump status. A relay system is used to switch the solar power from pump controller system to battery backup system and vice-versa. This designed system will be helpful to save electricity. Implementation of the proposed work is going on.

### **1.5 Design and Development of a Microcontroller Based Light Intensity Measurement and Control System**

M. A. Rahman, S. Sattar, M. Begum and Y. Mawla

Main purpose of this design is to create artificial day-night effect as required by user for a selected area in order to enhance research activity.

In this proposed work a high speed and high sensitive silicon PIN photodiode (BPW34) will be used for light intensity measurement and a light dimmer circuit-designed using TRIAC-will be used as light intensity controlling system. This is an on-going work and hopes to complete next year.

### **1.6 Design and Development of a Nuclear Counting System using ATMEL $\mu$ C**

M. N. Islam, H. Akhter, M. Begum and Y. Mawla

Design and Development of a Nuclear Counting System (NCS) using ATMEL  $\mu$ C has been presented in this project. The NCS consists of a GM/Scintillation Detector, Detector Front-end Electronics Preamplifier-Amplifier-Shaper-Discriminator, high-performance, low-power Atmel AVR CMOS 8-bit microcontroller (ATmega8L) as the Processor, LCD display(16 ch, 2-line), low voltage power supply and high voltage power supply. An assembly language programme based on BASCOM AVR IDE has been developed to control the operation of the nuclear counting system.

The design and verification of the ATMEL  $\mu$ C based Nuclear Counting System (NCS) in Proteus 7.7 simulation platform has been completed. The performance test for the system in the same platform has been still going on. Thereafter, system would be tested in Hardware.

### **1.7 Study and Development of PIC Microcontroller-to-PC Communication via USB**

M. N. Islam, H. Akter, M. Begum and Y. Mawla

Study and Development of PIC Microcontroller-to-PC Communication via USB has been depicted in this project. The Microchip FSUSB Framework utilized the PIC18F4553 with 20MHz crystal. PortB pin RB<sub>4</sub> would be used as Bootloader and RD<sub>0</sub> & RD<sub>1</sub> as the status indicator. Moreover, RC<sub>5</sub> and RC<sub>4</sub> of PortC would be used as USB D+ and D-. Firmware tools consist of Mplab IDE, Mplab C18 Compiler, Driver, FSUSB Framework v2.6 and Microsoft Visual Studio (Visual C/C Sharp).

The demonstration and development/verification of the complete USB2.0 communication solution by using USB Device – CDC – BASICDEMO software in Proteus 7.7 simulation platform has been completed but continuous ignition in RD<sub>0</sub> instead of blinking in RD<sub>0</sub> & RD<sub>1</sub> alternately. For solving this problem/further investigation as well as hardware test of the PIC Microcontroller-to-PC Communication via USB, the PICDEM FS USB Demo Board (PIC18F4553/PIC18F45K50), Part Number DM163025-1 is under purchase process.

### **1.8 Front-end Electronics for Nuclear Detectors: Preamplifier-Amplifier-Shaper-Discriminator**

M. N. Islam, H. Akter, M. Begum and Y. Mawla

In this project, Front-end Electronics Preamplifier-Amplifier-Shaper-Discriminator for Nuclear Detectors has been described. The nuclear detector signal channel (NDSC) comprises of a charge-sensitive preamplifier, a gain amplifier, a CR-RC shaping amplifier and an integral discriminator. The charge-sensitive preamplifier, converts the charge into voltage, feedback circuit has 1M $\Omega$  resistor and 10 pF capacitor that gives its decay time constant ( $\tau$ ) of 10  $\mu$ s. The gain of amplifier used in this channel to amplify the input signal into 1 to 51 times. Shaping amplifier which is the combination of high pass and low pass filter with equal time constant ( $\tau_1=\tau_2=\tau$ ) of 5  $\mu$ s to increase the signal-to-noise ratio. The Single ended or integral discriminator function is to eliminate the system noise and pulse height discrimination.

The design and verification of the NDSC in Proteus 7.7 simulation platform has been completed. The performance test of the NDSC in the same platform for various pulse/sec (100Hz, 1 KHz & 10 KHz) situations has been completed successfully. And the simulation results show the good agreement with the electronic design of the nuclear detector signal channel (NDSC).

### **1.9 Study and Development of Microcontroller Based High Voltage Power Supply**

M. N. Islam, H. Akter, M. Begum and Y. Mawla

In this project, microcontroller based high voltage power supply (HVPS) has been presented. The HVPS consists of microcontroller based oscillator (high frequency, more than 80%D, 5V), transistor driver circuit,

ferrite core transformer and voltage multiplier circuit (quadrupler). The PIC16F84A  $\mu\text{C}$  with 20 MHz crystal generates high frequency, more than 80% D, 5V signal which has been used as a input for transistor 2N2222A driver coupled with HV X-former. Thereafter, the X-former's secondary voltage has been multiplied by a quadrupler circuit. A multi-turn potentiometer would be used to adjust the output voltage to a required level.

The design and verification of the complete high voltage power supply (HVPS) in Proteus 7.7 simulation platform has been going on. Thereafter, complete high voltage power supply would be tested in hardware.

The design and verification of the complete power supply in Proteus 7.7 simulation platform has been going on. Thereafter, complete high voltage power supply would be tested in hardware.

#### **1.10 Design and Development of a Microcontroller Based Nuclear Survey Meter**

M. N. Islam, H. Akter, M. Begum and Y. Mawla

Design and Development of a Nuclear Survey Meter (NSM) using ATMEL  $\mu\text{C}$  has been presented in this paper. The NSM consists of a GM Detector, Detector Front-end Electronics Preamplifier-Amplifier-Shaper-Discriminator, high-performance, low-power Atmel AVR CMOS 8-bit microcontroller (ATmega8L) as the Processor, LCD display(16 ch, 2-line), low voltage power supply and high voltage power supply. An assembly language programme based on BASCOM AVR IDE would be developed to control the operation of the nuclear survey meter (NSM).

The design and verification of the ATMEL  $\mu\text{C}$  based Nuclear Survey Meter (NSM) in BASCOM AVR and Proteus 7.7 simulation have been going on. Countrate to Doserate Conversion for this system has been also going on. Thereafter, the hardware test will be performed accordingly.

#### **1.11 Design and Development of a $\mu\text{C}$ Based Automatic Mains Changeover System**

M. N. Islam, H. Akter, M. Begum and Y. Mawla

Design and development of automatic electrical mains changeover system (EMCS) using PIC  $\mu\text{C}$  has been presented in this project. The EMCS consists of PIC microcontroller 16F84A with 4MHz crystal, two switching transistors, two relays and low voltage power supply. The electrical mains changeover control signal output at RB0 and RB2 of PortB actuate two switching transistors which drive two relays to operate two loads depending on the definite time interval (1h) availability of mains or choice of distinct loads. An assembly language programme based on MPLAB IDE would be developed to control the operation of the system.

The design and verification of the PIC  $\mu\text{C}$  based electrical mains changeover system (EMCS) in Proteus 7.7 simulation platform has been going on. Thereafter, system would be tested in Hardware.

#### **1.12 Design and Development of a Microcontroller Based Frequency Meter**

M. N. Islam, H. Akter, M. Begum and Y. Mawla

In this project, design and development of a microcontroller based frequency meter (FM) using ATMEL  $\mu\text{C}$  has been presented. The System consists of signal processing electronics integral discriminator, high-performance, low-power Atmel AVR CMOS 8-bit microcontroller (ATmega8L) as the Processor, LCD display (16 ch, 2-line) and low voltage power supply. An assembly language programme based on BASCOM AVR IDE would be developed to control the operation of the designed system.

The design and verification of the microcontroller based frequency meter (FM) in Proteus 7.7 simulation platform has been going on. Thereafter, system would be tested in Hardware.

#### **1.13 Design and Development of a Multi-channel Analyzer for Gamma-ray and X-ray Spectrometry using Low-Cost, Bus-Powered Multifunction DAQ for USB**

M. N. Islam, H. Akter, M. Begum and Y. Mawla

Design and Development of a Multi-channel Analyzer (MCA) for Gamma-ray and X-ray Spectroscopy has been presented in this project. For this system, Scintillation Detector NaI (Tl) followed by Preamplifier-



Amplifier-Shaper analog pulse processor, Low-Cost, Bus-Powered Multifunction DAQ for USB has been chosen as computer communication and gamma acquisition, LabVIEW as the user interface and gamma analysis. The charge-sensitive preamplifier, converts the charge into voltage, feedback circuit has 1M $\Omega$  resistor and 10 pF capacitor that gives its decay time constant ( $\tau$ ) of 10  $\mu$ s. The gain of amplifier used in this channel to amplify the input signal into 51 times. Shaping amplifier which is the combination of high pass and low pass filter with equal time constant ( $\tau_1=\tau_2=\tau$ ) of 5  $\mu$ s to increase the signal-to-noise ratio. 8 analog inputs at 12 or 14 bits, up to 48 kS/s, 2 analog outputs at 12 bits, software-timed, 12 TTL/CMOS digital I/O lines, One 32-bit, 5 MHz counter, Digital triggering, Bus-powered and high resolution ADC (8-12 bit, 5 MHz). The resolution of a digital spectrometer system and a classical spectrometer for different sources  $^{137}\text{Cs}$  and  $^{60}\text{Co}$  by NaI (TI) detector at low counting rates would be observed. The spectrum of  $^{137}\text{Cs}$  and  $^{60}\text{Co}$  at various counting rates would be applied. Energy spectrum and FWHM would be measured with the shaper  $\tau=5 \mu$ s NaI (TI) detector in eV.

The design and verification of the Preamplifier-Amplifier-Shaper analog pulse processor in Proteus 7.7 simulation platform has been completed. The user interface and gamma analysis by using LabVIEW in progress. Thereafter, system would be tested in Hardware.

#### **1.14 Neutron Imaging and Tomography with Medipix2 and Dental Microroentgenography: An Over View**

M. N. Islam, H. Akhter, M. Begum, Y. Mawla, K. Asaduzzaman\*, M. Hoq\*, T. Fujiwara\*\*, S. Kenji\*\* and H. Takahashi\*\*

An over view of Neutron Imaging and Tomography (NIT) with Medipix2 and Dental Micro-roentgenography have been presented in this project. This over view confined to semiconductor detector Medipix2, neutron radiography and tomography and dental microroentgenography. Medipix2 is a pixel-based detector technology employed to measure charge particles, photons (visible through gammas) and neutron. Neutron Beam for this technology are LVR-15 Research Reactor ( $10^7$  n/cm $^2$  s) and Spallation neutron source ( $3 \times 10^6$  n/cm $^2$  s). This technology has been verified with photograph and neutronogram of a relay and photograph and tomographic 3D reconstruction of a bullet cartridge, tooth and fishing thread. Comparison of spatial resolution among different imagers also has been presented.

An elaborate study about Neutron Imaging and Tomography (NIT) with pixel-based detector Medipix2 of high spatial resolution, single quanta counting digital imaging device for X-ray and neutron imaging has been presented. USB Readout adds portability, ease of use, significant reduction in interface electronics and no external power supply. Moreover, dental roentgenography high resolution microimaging device. Isotropic illumination by diffuse neutron source is also being investigated.

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\*\*Dept. of Nuclear Engineering and Management, UT, Japan

#### **1.15 Design and Development of a Single Channel Analyzer with Microcontroller Based Controlled Output**

M. N. Islam, H. Akhter, M. Begum, Y. Mawla, K. Asaduzzaman\*, M. S. Alam\*, M. A. S. Haque\* and M. Hoq\*

Single Channel Analyzer (SCA) is a most common device used in today's nuclear world. Therefore, A SCA with microcontroller based controlled output has been proposed in this article. The system comprises of Lower Level Discriminator (LLD), Upper Level Discriminator (ULD), wide dynamic range, Fast Processing and Hysteresis. The Comparator LM339N used as the key component that performs the main function of the proposed nuclear module. The multi-turn potentiometers have been used as LLD and ULD for the incoming linear pulses from shaping amplifier. The system has also employed the Hysteresis facilities so that oscillations due to stray feedback are not possible. A lower pin and less housing PIC microcontroller (P16F676) has been used to control the width and time delay of the output pulses.

A single channel analyzer (SCA) with microcontroller based controlled output has been presented in this research. The operating principle of the designed nuclear module has been analyzed graphically. And the figure for the input and output wave form of the SCA has been also presented. The system comprises of two distinct modes of operation and incurred with both positive and negative outputs. The system has LLD, ULD, wide dynamic range, Fast Processing and Hysteresis. The system is simple, reliable, efficient in operation and user friendly. The module can be used with any nuclear measurement chain, nuclear counting system, DAC and MCA applications successfully.

\*Institute of Electronics, AERE, Savar, Dhaka, Bangladesh

### 1.16 Design and Development of an Electricity Saving System using a PIR Motion Sensor

S. Sattar, M. A. Rahman, A. Quader, M. Begum, M. U. Safia and Y. Mawla

This is a PIR (Pyroelectric or Passive Infrared) sensor based system which is designed to save electricity by turning off the appliances in absence of users.

Bangladesh is a developing country. Development of a country depends on many parameters. One of the main parameter is availability of electricity. Electricity is the driving force of the industries as well as development. As power generation of our country is not up to the level of the electricity demand, we have to reduce the power wastage to ensure proper use of this energy. This proposed system is designed to lessen the electricity wastage. PIR comes from “pyroelectricity” which means: heat that generates electricity. Human body radiates IR at low level wavelength (9-10micro meters) which is detected by the PIR sensor. When the PIR sensor detects the presence of human at selected zone then it will generate an electric pulse to switch-on the appliances. In absence of human being it will switch-off the appliances. Thus the system will be helpful to reduce unwanted power wastage. The work is going on.

### 1.17 Design and Development of an Online Data Logger with Raspberry Pi

S. Sattar, M. A. Rahman and M. Begum

Raspberry Pi is a device to use it as an independent system as well as interfacing with microcontroller based systems to expand the scope of microcontrollers. With microcontroller it is difficult to transmit logging data by online/ internet. By using Raspberry Pi difficulties can be overcome.

The Raspberry Pi (Model B has 512MB RAM, 2 USB ports and an Ethernet port) is a credit-card sized mini computer that can be plugged into any display monitor/TV and a keyboard. This is a Linux processor based system. The Raspberry Pi has 17 GPIO pins brought out onto the header, most have alternated functions other than just I/O like as UART, I2C, SPI. All the pins can be used for GPIO with either INPUT or OUTPUT. In this work a data logger is designed. The Raspberry Pi does the data logging by using Python and can transmit the data by internet. Excel is used which collect data and save the output of the collection or analysis.

## 2. Repair & Maintenance and Renovation Works

During the period major instruments (scientific, industrial and nuclear) of AECD have been repaired. The major instruments include repair Gross Alpha/Beta Counter, Walk Through Metal Detector, Digital Projector, Gas Analyzer, Portable Air Sampler, Dehumidifier, On Line UPS, Electric Kettle, Micro Oven, Electronic Balance, Battery Charger, Power Supply, LCD TV, LED Monitor, CVT, CCTV, Colour Monitor, Computers, (System Unit with software installation), Printers, Intercom Systems. The Division has been successfully maintaining the Intercom Systems of AECD. The system contains Digital PBX-Board, Panasonic 16SLC having 96 lines and Panasonic D1232, having 16 lines.

**Table: Type and Number of Repaired Instruments**

Type of the instruments	Name of the user	Qty.
Scientific, Nuclear and Analytical	AECD	12
Computer (System Unit, with software installation),	AECD	15
Monitor	AECD	05

Printer	AECD	01
UPS (Uninterruptible Power Supply )	AECD	07
Intercom System (Line & Set)	AECD	14

### 3. Training Programme/Workshop/Seminar/Symposium/Conference Arranged

Name of event/topics	Date	Place	No. of Participant
Industrial Attachment Training Programme for the students of Ahsanullah Institute of Technical and Vocational Education and Training (AITVET), Dhaka	16 Aug., 2013- Nov., 2016	ED, AECD	12

### 4. Seminar/Symposium/Conference/ Workshop/Meeting Attended

Name of the participant	Name of event/topics	Organizer	Date	Place
M. Begum	National Conference on Physics - 2017	BPS	05-07 Jan., 2017	AECD
	National Seminar on Tissue Banking Activities in Bangladesh	BAEC	28 Feb., 2017	BEC
	National Conference on Electronics and ICT - 2017	BES	20 April, 2017	AECD
H. Akhter	National Conference on Physics - 2017	BPS	05-07 Jan., 2017	AECD
	National Seminar on Tissue Banking Activities in Bangladesh	BAEC	28 Feb., 2017	BAEC
	National Conference on Electronics and ICT - 2017	BES	20 April, 2017	AECD
M. N. Islam	National Conference on Physics -2017	BPS	05-07 Jan., 2017	Dhaka
	National Conference on Electronics and ICT	BES	20 April, 2017	Dhaka
A. Rahman	National Conference on Physics - 2017	BPS	5-7 Jan., 2017	AECD
	National Seminar on Tissue Banking Activities in Bangladesh	BAEC	28 Feb., 2017	BEC
	National Conference on Electronics and ICT – 2017	BES	20 April, 2017	AECD
S. Sattar	National Conference on Physics - 2017	BPS	05-07 Jan., 2017	AECD
	National Seminar on Tissue Banking Activities in Bangladesh	BAEC	28 Feb., 2017	BEC
	National Conference on Electronics and ICT – 2017	BES	20 April, 2017	AECD

#### • Citizen Charter

Course Offered	Type	Course Fee
National Training Courses	Microcontroller	6,000/- per participant
	LabVIEW	8,000/- per participant
Academic Training courses	Industrial Attachment Training Programme	Public and Private Polytechnic - 3000/- per student

## Experimental Physics Division (EPD)

### Objective

The key objective is to develop solar energy materials and advanced materials in thin film form for solar photovoltaic and different optoelectronic applications. These are summed up below:

- Development and characterization of elemental, binary, ternary and quaternary semiconducting materials in thin film form
- Fabrication of photo detectors and characterization
- Studies of the fundamental properties of solid state materials

### Activities/Programme(s)

- Development and characterization of fundamental properties of elemental, binary, ternary and quaternary semiconducting materials in thin film form
- Preparation and characterization of SnO<sub>2</sub>, Al doped SnO<sub>2</sub>, In doped GaAs, In doped SnO<sub>2</sub>, Cu doped ZnSe, CdSe, Cu doped CdSe, Zn doped CdTe deposited by Thermal evaporation
- Preparation and characterization of ZnO, Al doped ZnO deposited by Spin Coating
- Preparation and characterization of ZnS, CdS deposited by Chemical bath deposition
- Buffer Layers of Al doped ZnO (AZO) thin films
- Front contact layers of undoped and doped SnO<sub>2</sub> thin films
- n-type window layers of CdS thin films
- p-type absorber layers of CdTe thin films
- CdTe thin films study for nuclear detector application

### 1. Research and Development Work(s)

#### 1.1 Synthesis of Al doped SnO<sub>2</sub>(ATO)Thin Films for Photovoltaic Application

K. M. A Hussain, T. Faruque, J. Parvin and S. Ahmed

SnO<sub>2</sub> thin films were successfully deposited on glass substrate using thermal evaporation method with different doping concentration of Al (2%, 3%, 5%). The thicknesses of the films were measured around 300 nm. The substrate temperature was maintained at 150°C. The films were annealed at 200°C for 15 minutes. Maximum transmittance (87%) was obtained for 3% Al doped SnO<sub>2</sub> at wavelength about 1000 nm. The direct band gap was found from 2.6 eV to 3.96 eV for variation of doping concentration. Its grain size decreases with increasing the doping concentrations.

#### 1.2 Structural, Optical and Electrical Properties of Indoped SnO<sub>2</sub> (ITO) Thin Film

K. M. A. Hussain, T. Faruque, J. Parvin and S. Ahmed

2% In doped SnO<sub>2</sub> (300 nm) thin film was deposited on glass substrate by thermal evaporation method at various substrate temperature  $S_T = 270^\circ\text{C}$  and  $350^\circ\text{C}$ . Crystallinity of the film was increased with increasing substrate temperature. The maximum value of transmittance, T% was found 88% around the wavelength of 1900 nm for the film of  $S_T = 270^\circ\text{C}$ .

#### 1.3 Characterization of ZnS Thin Film Deposited by Chemical Bath Deposition (CBD) Method

K. M. A. Hussain, T. Faruque, S. Ahmed and J. Parvin

ZnS thin film was deposited using chemical bath deposition technique. In this deposition technique, the entire amount of Zn<sup>2+</sup> precursor (ZnSO<sub>4</sub>·7H<sub>2</sub>O) [0.15 mole/l] was firstly mixed with thiourea SC(NH<sub>2</sub>)<sub>2</sub> (0.60 mol/l) and heated at 60°-80° C. leading to the formation of [Zn(SC(NH<sub>2</sub>)<sub>2</sub>)<sub>n</sub>] complexes. Secondly an excess of ammonia (NH<sub>3</sub>) was then added to both the two solutions under constant stirring at the same experimental parameter except one without rinsed and one with rinsed. The XRD experiment showed an unknown phase

when the film was deposited without rinsing condition. This phase was successfully removed by rinsing. Its structural & optical characterizations were studied.

#### **1.4 Preparation and Characterization of Cdse Thin Films**

K. M. A Hussain, T.Faruqe, J. Parvin and S. Ahmed

CdTe thin films were successfully deposited on glass substrate at  $S_T = 100^\circ\text{C}$  using thermal evaporation method. The thickness of the films was measured by FTM5 Thickness Monitor. The measured thickness were 300nm, 350nm, 400nm, 450nm. XRD, UV-VIS-NIR measurement were completed. One MS thesis paper was submitted under this research work.

#### **1.5 Synthesis of Al doped ZnO(AZO)Thin Film by Spin Coating Method**

K. M. A Hussain, T. Faruqe, J. Parvin and S. Ahmed

The ZnO precursor solution was prepared by dissolving zinc acetate  $(\text{CH}_3\text{COO})_2\text{Zn}\cdot 2\text{H}_2\text{O}$  in solution of ethanol and di-ethanolamine (DEA) at room temperature. The molar ratio of DEA to zinc acetate was maintained at 1 and the concentration of zinc acetate was 0.1M. The solution was stirred to about one hour at  $60^\circ\text{C}$  until a clear and homogeneous solution was not obtained. The solution was kept for 24 hours at room temperature. Al doping was achieved by adding hexahydrate aluminum chloride  $(\text{AlCl}_3\cdot 6\text{H}_2\text{O})$  solution. After that the solution was stirred to about two hours at room temperature. After that 1% & 3% Al doped ZnO thin films were deposited on glass substrate at rpm 3000, 3500, 4000, 4500, 5000 for 30 Sec and annealed at  $300^\circ\text{C}$  for 15 min. Optical and structural characterization was completed. One MS thesis paper is submitted under this research work.

#### **1.6 Zinc Oxide (ZnO) Films Prepared by Sol-Gel Spin Coating**

K. M. A Hussain, T. Faruqe, J. Parvin and S. Ahmed

Zinc Oxide (ZnO) thin films were deposited by sol-gel spin coating method on glass substrates. Zinc acetate dehydrate, ethanol and diethanolamine (DEA) were used as a starting material, solvent and stabilizer, respectively. The molar ratio of DEF to Zinc acetate dehydrate was maintained at 1.0 and the concentration of zinc acetate was 0.8M. After preparing the coating solution, it was dropped onto glass substrate, which was rotated at 3000 rpm, 3500 rpm, 4000 rpm and 4500 rpm for 30s. After the deposition, the film was annealed at  $150^\circ\text{C}$  for 5 min. The same process was repeated for 3 times in order to make uniform films.

#### **1.7 Deposition and Characterization of Cu-doped Znse Films**

K. M. A Hussain, T.Faruqe, J. Parvin and S. Ahmed

Thermal evaporation technique was used to prepare 2% Cu-doped ZnSe thin film having substrate temperature of  $200^\circ\text{C}$ . Here the film thickness was measured 300nm. After the deposition, the film was annealed at  $100^\circ\text{C}$  for 1 hour. During this method a high vacuum coating unit was used for the preparation of thin film. Vacuum of the order of  $10^{-6}$ mbar was maintained in the chamber throughout the deposition. Its structural, optical and electrical properties are studied and one MS thesis paper is completed.

#### **1.8 Measurement of Different Parameters of Solar Cells**

K. M. A Hussain, T.Faruqe, J. Parvin and S. Ahmed

I-V data was studied at normal (100W) light and dark position for reverse & forward bias and further analysis such as Shunt resistance (RSH), Conversion efficiency, Maximum power output (P-max), Voltage at P max (V-max), Resistivity, Fill factor (ff), Series resistance (Rs) is going on.

#### **1.9 Structural, Optical, Electrical and Surface Properties of AZO/FTOGlass Thin Films using Thermal Evaporation**

K. M. A Hussain, T.Faruqe, J. Parvin and S. Ahmed

The 0.3% Al doped Zinc oxide (AZO) thin films was deposited on glass substrate by thermal evaporation showed high transmittance. It was found that the films deposited on glass substrate showed high conductivity from 150 to 200 nm and remain constant due to increase of thickness from 200 to 250 nm. The substrate

temperature was 200°C and the films were annealed at 350°C for 15 minutes. The highly conductive film was observed for the film deposited on FTO coated glass substrate.

### 1.10 Synthesis of CdS Thin Films on Different Layers of Glass Substrates

K. M. A Hussain, T. Faruqe, J. Parvin and S. Ahmed

The thermal evaporation method was used to deposit CdS thin films on FTO glass substrates and on Al doped ZnO layer at substrate temperature  $S_T = 70^\circ\text{C}$ . The film was annealed at  $100^\circ\text{C}$  for 15 min. The film showed different transmittance and reflectance due to different substrate layer of the film. The XRD data confirmed the crystalline nature of the film. The thickness of the film was measured as 90 nm.

### 1.11 Optoelectronic & Structural Characterization of ZnSe Thin Film Fabricated by Thermal Evaporation Technique

M. T. Chowdrury, K. M. A. Hussain, T. Faruqe, J. Parvin and S. Ahmed

ZnSe (300nm) thin film is deposited on glass substrate at substrate temperature  $300^\circ\text{C}$  and annealing temperature  $350^\circ\text{C}$  for 1 hour using thermal evaporation method. UV-VIS-NIR, XRD and SEM analysis are going on.

### 1.12 Study of CdTe Absorber Layer Thin Film

K. M. A Hussain, T. Faruqe, J. Parvin and S. Ahmed

The CdTe thin films were deposited on CdS/AZO/FTO glass substrate layer, CdS/FTO glass substrate layer and CdS/glass substrate layer using thermal evaporation method at substrate temperature  $S_T = 300^\circ\text{C}$  and Annealing temperature  $A_T = 100^\circ\text{C}$  for 1 hour. The film thickness was found 500nm measured by FTM5 Thickness Monitor. The different transmittance and reflectance were observed from the UV-VIS-NIR spectrophotometer. The XRD data confirmed the crystalline nature of the deposited films.

## 2. Repair & Maintenance

- Solution for the problem of high software floppy disk of UV-VIS-NIR machine is under process. The Problem is found and alternatively solved.
- Vacuum system is checked of the Vacuum Deposition Unit Model: Edward E-306A. To identify the deflection of current indicator during thermal evaporation, one connection point of 4 sources was checked and one fault is found. Performance of the machine is satisfactory and in working condition.

## 3. Seminar/Symposium/Conference/workshop/Meeting Attended

Name of the participant	Name of event/topics	Organizer	Date	Place
K. M. A. Hussain	National Conference on Physics Research and Education in Bangladesh	BPS	5-7 Jan., 2017	AECD Auditorium
T. Faruqe	National Conference on Physics Research and Education in Bangladesh	BPS	5-7 Jan., 2017	AECD Auditorium
J. Parvin	National Conference on Physics Research and Education in Bangladesh	BPS	5-7 Jan., 2017	AECD Auditorium

## 4. Collaboration Work(s)

The Division has good collaboration with teachers and research students of

- Department of Physics and Department of Electrical and Electronic Engineering, University of Dhaka
- Physics Department, Dhaka University of Engineering & Technology (BUET)
- Department of Glass and Ceramic Engineering (BUET)

- Physics Discipline, Khulna University
- Department of Physics, Shahjalal University of Science and Technology (SUST)
- Reviewer of Materials Science of Semiconductor Processing Journal

## **Health Physics Division (HPD)**

### **Objective**

The objective of this division is to protect life, property and environment from undue radiation hazard through: (i) Population exposure control (ii) Occupational exposure control (iii) Medical exposure control and (iv) Radiation protection services. Radiation and radioactivity in environmental samples & imported/exportable foods (except Chittagong Port) are being monitored as per requirement of the NSRC rules 1997 and BAER Act-2012. This division is the only provider of Individual Monitoring Services (IMS) of occupational workers throughout Bangladesh; this is mandatory as per NSRC rules 1997 and BAER Act-2012. Health Physics Division is one of the most important Technical Support Organization (TSO) of ongoing Rooppur Nuclear Power Plant (RNPP). This division has been provided nuclear and radiological emergency services in case of any incident or accident.

### **Activities/Programme(s)**

To fulfill the objective of this division various programmes have been taken on Research & Development (R&D) activities and Rendering service works on i) imported/exportable food stuffs ii) individual monitoring service and iii) gross alpha & gross beta measurement in water samples. National & International collaboration works and human resource development through academic programmes are also performed.

## **1. Research and Development Work(s)**

### **1.1 Survey of Background Radiation Levels Throughout Bangladesh**

S. F. Mahal, S. Yeasmin, M. S. Rahman, A. Islam, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and N. Hassan

**Objective:** To assess the external exposure of population due to natural and artificial radiation.

**Current progress:** During this reporting period, measurement of background radiation level has been carried out regularly in and around Dhaka city on monthly basis as a part of this work. In this study, calibrated beta-gamma survey meter was used with Global Positioning System (GPS) for pointing the location. The average background radiation level was found from (0.13 to 0.28)  $\mu\text{Sv h}^{-1}$ . It is observed that there is no change in background radiation level from the data of previous years.

### **1.2 Environmental Radioactivity Monitoring in the Rooppur Nuclear Power Plant Area**

S. F. Mahal, S. Yeasmin, M. S. Rahman, A. Islam, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and N. Hassan

**Objective:** To measure environmental radioactivity at 10 km area of the Rooppur Nuclear Power Plant Project before installation of NPP to meet up the regulatory requirement.

**Current progress:** Total 100 environmental samples (71 soil samples, 21 water samples and 08 vegetable samples) were collected from 71 locations (1km interval) around the Rooppur Nuclear Power Plant project site. 8 vegetable samples and 3 water samples have been counted using gamma spectrometry system. The rest of the environmental samples will be measured in the same procedure. The results of the monitoring study will be required as regulatory pre-requisites for the installation/operation of Rooppur Nuclear Power Reactor in future as a base line data.

### 1.3 Measurement of Environmental Samples of Sunamgonj Haor Area

S. F. Mahal, S. Yeasmin, M. S. Rahman, A. Islam, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and N. Hassan

**Objective:** To identify uranium radionuclide in soil, water, water-hyacinth samples and to calculate activity concentration of uranium radionuclide in those samples.

**Current progress:** 31 environmental samples (14 soils, 14 water and 03 water-hyacinths) were collected from 04 haors in Sunamgonj district. These samples were processed, prepared and measured by High-Purity Germanium Gamma spectroscopy system. The activity concentration of uranium of soil, water and water-hyacinth samples ranged from (6.72-23.39) Bqkg<sup>-1</sup>, (2.45-9.14) BgL<sup>-1</sup> and (0-39.44) Bqkg<sup>-1</sup> respectively. The environmental radiation level also measured in Sunamgonj haor area by survey meter and dose rate were ranged from (0.03-0.16) μSvh<sup>-1</sup>. This value is comparable to other parts of Bangladesh. All these obtained values are within the recommended values set by IAEA, WHO, UNSCEAR etc.

### 1.4 Workplace Monitoring of different Radiation Facilities of Atomic Energy Centre, Dhaka

S. F. Mahal, S. Yeasmin, M. S. Rahman, A. Islam, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and N. Hassan

**Objective:** The objective of workplace monitoring is to protect occupational workers from ionizing radiation.

**Current progress:** Five divisions of AECD, viz. Non Destructive Testing (NDT), Accelerator Facilities Division (AFD), Material Science Division (MSD), Chemistry Division and Health Physics Division (HPD) have been using radioisotopes and radiation producing equipments for research & development works. Radiation monitoring has been done on monthly basis in and around the above mentioned divisions by using β - γ survey meter. The radiation levels in front of isotope storeroom (corridor) of HPD, Cobalt-60 Irradiator Source room (corridor) of HPD and NDT Source storeroom were found (0.4 - 2.5) μSvh<sup>-1</sup>, (0.23 – 0.56) μSvh<sup>-1</sup> and (0.22 – 1.5) μSvh<sup>-1</sup> respectively. The control panel of AFD, XRD machine of MSD were found around background level. No significant change in dose level was observed.

### 1.5 Environmental Gamma Dose Measurement in AECD Campus by Thermoluminescence Dosimeter (TLD)

S. F. Mahal, S. Yeasmin, M. S. Rahman, A. Islam, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and N. Hassan

**Objective:** For the measurement of population dose, environmental gamma radiation is to be measured with TLD -100 chips.

**Current progress:** For this study, 10 monitoring post has been set up permanently in different locations in AECD campus. Elemental correction coefficient (ECC) and Reader calibration factor (RCF) has been calculated. The dosimeters get ready for field study.

### 1.6 Determination of Radioactivity in Rain Water

S. F. Mahal, S. Yeasmin, M. S. Rahman, A. Islam, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and N. Hassan

**Objective:** To determine the radionuclides and their concentration in rain water of AECD campus and Tongi area.

**Current progress:** During the reporting period, 26 rain water samples were collected from AECD campus Dhaka and Tongi area. The activity concentration of radionuclides <sup>226</sup>Ra, <sup>232</sup>Th and <sup>40</sup>K were determined by Gamma Spectrometry System consists of High Purity Germanium (HPGe) Co-axial detector coupled with multichannel analyzer. The activity concentration of <sup>226</sup>Ra of rain water samples were found (3.26 to 21.43) BqL<sup>-1</sup> with mean concentration 8.45 BqL<sup>-1</sup>. The activity concentrations of <sup>232</sup>Th in the rain water samples were varied from (2.87 to 18.53) BqL<sup>-1</sup> with mean concentration 8.77 BqL<sup>-1</sup>. The <sup>40</sup>K activity in these rain water samples were found (36.27 to 176) BqL<sup>-1</sup> with average 73.54 BqL<sup>-1</sup>. No artificial radionuclide was detected at any of the sample.



### 1.7 Radioactivity Concentration of Different Food Samples Imported from SAARC and other Countries

S. F. Mahal, S. Yeasmin, M. S. Rahman, A. Islam, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and N. Hassan

**Objective:** To monitor the level of radioactivity in different food samples imported from SAARC and other countries as a part of radioactivity monitoring surveillance programme.

**Current progress:** Thirty (30) imported food samples were collected from local market viz. Noya bazaar, Dhaka; Hatirpool bazaar, Dhaka and Kachpoo bazaar, Narayanganj. Different Food samples such as Anchor Beans, Dabli, Ginger, Garlic, Rice, Red Wheat, White Wheat, Lentils, Chhola, Palm Oil and Soybean oil were imported from different countries such as Australia, China, India, Pakistan, Maldives, Malaysia and Nepal. The samples were processed following the standard procedure and analyzed for gamma emitting radionuclides. The radioactivity range of  $^{232}\text{Th}$  series is found to be (0.19 - 23.8) Bqkg<sup>-1</sup> and that of  $^{238}\text{U}$  series is found to be (0.33 - 24.46) Bqkg<sup>-1</sup>. The radioactivity range of  $^{40}\text{K}$  is found to be (239- 529.82) Bqkg<sup>-1</sup>. No artificial radionuclide was observed.

### 1.8 Assessment of Radioactivity Level of Soil Samples in Pabna District of Bangladesh

S. Yeasmin, M. M. M. Siraz, M. R. Zaman\*, M. M. A. Mollah\* and M. S. Rahman<sup>#</sup>

**Objective:** To determine the activity concentrations of naturally occurring and man-made radiolucides in the soil of Ishwardi upazila of Pabna District, in the northwest of Bangladesh.

**Current progress:** A total of 15 soil samples were randomly collected from different locations of Ishwardi upazila. All the samples were processed following the standard procedures as per International Atomic Energy Agency guidelines. The detection and measurement of radionuclides in the samples were carried out by a gamma spectrometry system using a high-resolution HPGe coaxial detector coupled with a Silena Emcaplus Multichannel Analyzer. The mean activity concentrations of  $^{226}\text{Ra}$ ,  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in soil samples were found to be (37.5±3.7, 34.0±3.6, 59.3±4.0 and 315.1±27.2) Bqkg<sup>-1</sup> respectively. The mean Radium Equivalent Activity, External Hazard Index and Internal Hazard Index were estimated to be 146.5 Bqkg<sup>-1</sup>, 0.40 and 0.50 respectively. The mean outdoor Absorbed Dose Rate, Indoor Absorbed Dose Rate and total Annual Effective Dose Rate were calculated to be 68.9 nGyh<sup>-1</sup>, 82.6 nGyh<sup>-1</sup> and 0.49 mSvy<sup>-1</sup> respectively. All these obtained values were below the recommended value set by IAEA. No artificial radionuclide was found in these samples, so the study area seemed to be radiologically safe.

\*Environmental and Tracer Studies Laboratory, University of Rajshahi, Rajshahi; <sup>#</sup> Chemistry Division, Atomic Energy Centre, Dhaka, Bangladesh

### 1.9 Transfer Factor of Radionuclides from Soil to Grass and Mango of Sundarganj Upazila of Gaibandha District

M. S. Mondol\*, S. K. Das\*, M. M. M. Siraz and S. Yeasmin

**Objective:** The activity concentrations of naturally occurring and anthropogenic radionuclides in soil, grass and mango were measured with an aim to determine the transfer factors of radionuclides from soil to grass and mango collected from Sundarganj Upazila in Gaibandha district, Bangladesh.

**Current progress:** A total of forty samples including 10 mangoes, 10 grasses and 20 soil samples were collected from different locations of Sundarganj Upazila in Gaibandha district. The average activity concentrations of  $^{226}\text{Ra}$ ,  $^{238}\text{Th}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in soil were found to be (45.1±4.0, 38.7±3.9, 52.2±4.0 and 362.1±28.3) Bqkg<sup>-1</sup> respectively while in grass their values were (23.1±11.7, 25.2±612.6, 32.5±11.0 and 243.4±91.6) Bqkg<sup>-1</sup> respectively. The average activity concentrations of  $^{226}\text{Ra}$ ,  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in soil were found to be (47.2±3.7, 43.9±3.7, 64.5±3.9 and 421.6±27.3) Bqkg<sup>-1</sup> respectively while in mangoes their values were (26.2±6.1, 20.4±8.6, 16.4±4.8 and 312.8±54.8) Bqkg<sup>-1</sup> respectively. The average transfer factors (TF) from soil to mangoes were found to be 0.596, 0.446, 0.292, and 0.758 for  $^{226}\text{Ra}$ ,  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  respectively. On the other hand from soil to grass the TF values were found to be 0.504, 0.680, 0.556 and

0.701 for  $^{226}\text{Ra}$ ,  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  respectively. The transfer factors for grass are higher than those for soil to mangoes. All the obtained values are below the recommended values set by IAEA. No artificial radionuclide was found in these samples, so the study area seemed to be radiologically safe.

\*Department of Physics, Jagannath University, Dhaka, Bangladesh

### 1.10 Measurement of $^{238}\text{U}$ , $^{228}\text{Ra}$ , $^{226}\text{Ra}$ , $^{40}\text{K}$ in Foodstuffs Collected from North-Eastern Part of Bangladesh

S. Islam\*, S. K. Das\*, M. S. Mondol\*, M. M. M. Siraz and S. Yeasmin

**Objective:** The activity concentrations of  $^{238}\text{U}$ ,  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in different foodstuffs were measured by using High Purity Germanium (HPGe) gamma spectrometry with 20% relative efficiency.

**Current progress:** A total of sixteen food samples were collected. Activity concentrations of radionuclides were determined in samples of cereal (wheat, rice, corn, kaun rice), potatoes, pulses and powdered milk. The mean activity concentrations of  $^{238}\text{U}$ ,  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in foodstuffs were found to be varied from  $(2.40 \pm 6.22) \text{ Bqkg}^{-1}$  to  $(26.34 \pm 7.5) \text{ Bqkg}^{-1}$  with an average value  $(15.25 \pm 6.10) \text{ Bqkg}^{-1}$ ,  $(0.72 \pm 2.78$  to  $33.80 \pm 6.25) \text{ Bqkg}^{-1}$  with an average value  $(16.21 \pm 4.37) \text{ Bqkg}^{-1}$ ,  $(2.06 \pm 2.83$  to  $19.18 \pm 4.15) \text{ Bqkg}^{-1}$  with an average value  $(11.37 \pm 3.61) \text{ Bqkg}^{-1}$  and  $(59.93 \pm 37.33$  to  $409.45 \pm 47.97) \text{ Bqkg}^{-1}$  with an average value  $(177.60 \pm 36.10) \text{ Bqkg}^{-1}$  respectively. These values can be used to measure the daily intake of radiations according to how much food is eaten by a person. By measuring daily intake of radiations this study will be able to estimate the total absorbed dose for a person and can compare with that of the safe limit of radiation ingestion.

\* Department of Physics, Jagannath University, Dhaka, Bangladesh

### 1.11 Measurement of Activity Concentration of Radionuclides in Soil Samples Collected from Sundarganj Upazila in Gaibandha District, Bangladesh

M. S. Mondol\*, S. K. Das\*, S. Islam\*, M. M. M. Siraz and S. Yeasmin

**Objective:** To determine the activity concentrations of radioactive materials such as  $^{226}\text{Ra}$ ,  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  of twenty soil samples collected different locations of Sundarganj Upazila in Gaibandha district of Bangladesh.

**Current progress:** Soil samples had been measured using a Gamma-ray spectrometer with an HPGe detector with 20% relative efficiency. The mean activity concentrations of  $^{238}\text{U}$ ,  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in the soil samples were found to be  $(40.11 \pm 3.78) \text{ Bqkg}^{-1}$ ,  $(45.145 \pm 3.83) \text{ Bqkg}^{-1}$ ,  $(54.80 \pm 3.94) \text{ Bqkg}^{-1}$ , and  $(391.84 \pm 27.78) \text{ Bqkg}^{-1}$  respectively. The mean value of radium equivalent activity, external and internal hazards, outdoor absorbed dose rate, indoor absorbed dose rate and total annual effective dose rate were found to be  $153.68 \text{ Bqkg}^{-1}$ , 0.54, 0.42,  $72.48 \text{ nGyh}^{-1}$ ,  $86.98 \text{ nGyh}^{-1}$  and  $0.52 \text{ mSvy}^{-1}$  respectively. The total effective dose found in this study was lower than the average worldwide limit provided by UNSCEAR. Accordingly, the investigated soil zones can be considered to have normal levels of natural background radiation.

\* Department of Physics, Jagannath University, Dhaka, Bangladesh

### 1.12 Measurement of Indoor Environmental Gamma Radiation Doses at AECD Campus by In-Situ Method

M. S. Rahman, M. S. Hossain\*, A. Islam, S. F. Mahal, Z. Hossain and M. H. Ahsan\*

**Objective:** To identify natural and artificial radionuclides in the indoor environment and to measure environmental gamma radiation doses from natural and artificial radionuclides quickly.

**Current progress:** In-Situ Environmental gamma-ray dose rates were measured at 21 indoor locations of Atomic Energy Centre, Dhaka (AECD) Campus using portable HPGe detector (Model No. GEM25P4-83). The measurement time was 10,000 sec at each location. The dose rates were varied from  $(0.05861$  to  $0.1223) \mu\text{Gyh}^{-1}$  with an average of  $(0.09233 \pm 0.01663) \mu\text{Gyh}^{-1}$ . The population doses were also calculated from the measured dose rates. It was observed that the annual average population dose due to indoor terrestrial gamma radioactivity is comparable to other countries in the region.

\*Department of Physics, Shahjalal University of Science and Technology, Sylhet, Bangladesh

### 1.13 Measurement of Extremity Doses of Workers in Nuclear Medicine Facilities

M. S. Rahman, M. T. Islam\*, A. Begum\*\*, S. F. Mahal, A. Islam, Z. Hossain and M. A. Islam\*

**Objective:** Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses at extremity (especially fingers of the hands) comparing to other parts of the body. Therefore, it is required to measure extremity dose of workers in nuclear medicine departments.

**Current progress:** Eleven workers of NINMAS, Dhaka, six workers of INMAS, Rajshahi and three workers of INMAS, Bogra were monitored using 22, 12 and 6 ring dosimeters respectively. The monitoring period was varied from 1 to 3 months. Each worker was given two TLD chip embedded rings for wearing middle in the fingers of their both hands. The annual average equivalent doses of workers in three nuclear medicine departments were ranged from (0.26-10.00) mSv.

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\*Department of Physics, University of Rajshahi, Rajshahi, Bangladesh

\*\*Member, Planning, BAEC

### 1.14 Study on Outdoor Environmental Gamma Dose Rate by In-Situ Method

M. S. Rahman, S. Tazmin\*, S. F. Mahal, A. Islam, Z. Hossain and M. H. Ahsan\*

**Objective:** To measure real-time environmental gamma radiation doses from natural and artificial radionuclides.

**Current progress:** In-Situ Environmental gamma-ray dose rate was measured at 27 locations of Shahbag and part of Ramna Thana under Dhaka district using real-time environmental radiation measuring device (GAMMA-SCOUT GmbH & Co. KG). This device meets all European CE standards as well as the American “FCC 15 standard”. All the locations were marked out using global positioning system (GPS). The dose rate varied from (0.07-0.22)  $\mu\text{Sv h}^{-1}$  with an average of  $0.16\mu\text{Sv h}^{-1}$ . The annual effective dose of the population due to the environmental gamma radiation was also calculated and it was varied from (1.50 – 2.50) mSv.

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\*Department of Physics, Shahjalal University of Science and Technology, Sylhet, Bangladesh

### 1.15 Study on Outdoor Terrestrial Gamma Dose Rate by In-Situ Method

M. S. Rahman, S. Ahmed\*, A. Islam, S. F. Mahal, Z. Hossain and N. Ahsan\*\*

**Objective:** To identify natural and artificial radionuclides in the environment and to measure environmental gamma radiation doses from natural and artificial radionuclides.

**Current progress:** In-Situ environmental gamma-ray dose rate was measured at 04 locations of Atomic Energy Centre, Dhaka (AECD) Campus using portable HPGe detector (Model No. GEM25P4-83). The measurement time was 10,000 sec at each location. The dose rates varied from (0.281-0.421)  $\mu\text{Gy h}^{-1}$  with an average of  $(0.358 \pm 0.066) \mu\text{Gy h}^{-1}$ . The annual effective dose of the population due to the terrestrial gamma radiation were also calculated and it was varied from (0.208 - 0.627) mSv. It was observed that the annual average population dose due to outdoor terrestrial gamma radioactivity is comparable to other countries in the region.

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\*\*Department of Physics, University of Dhaka, Dhaka, Bangladesh

### 1.16 Participation of Inter-laboratory Intercomparison Test in Asia Pacific Region

M. S. Rahman, S. F. Mahal, S. Yeasmin, A. Islam, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and N. Hassan

**Objective:** To identify natural radionuclides in water, milk powder and calcium carbonate samples and to calculate activity concentration of natural radionuclides.

**Current progress:** Bangladesh participated inter-laboratory intercomparison exercise (Proficiency Test) in Asia Pacific Region organized by International Atomic Energy Agency (IAEA-TEL 2017). 24 Countries in Asia Pacific Region participated in this inter-laboratory intercomparison test. IAEA sent five samples (03water, 01 milk powder and 01 calcium carbonate) for this intercomparison test. These samples will be measured by High-Purity Germanium gamma spectroscopy system. Natural radionuclides  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  to be identified and activity concentration of each radionuclide to be calculated after measurement. Activity concentrations of those natural radionuclides will be reported to IAEA.

### 1.17 Renewal of Licenses of Atomic Energy Centre, Dhaka

M. S. Rahman, A. Islam, S. Yeasmin and S. F. Mahal

**Objective:** To perform services and R & D works related to the ionizing radiation in AECD, it is mandatory to get license from Bangladesh Atomic Energy Regulatory Authority.

**Current progress:** Five divisions of AECD are being used radiation generating equipment and radioactive sources for service and R & D works. AECD has two licenses; Class E and Combined license Class A & C. As per NSRC Rules-1997, every year these licenses have to be renewed by Director, AECD with cooperation of two RCOs. There are two licenses (A&C combined license, No. 2/1998(R-16/2017)/1716 and license E, No. 2736/2009(R-7/2016/1626) occupied by Atomic Energy Centre, Dhaka. “License A” for own, store, handle and use of radioactive materials; “license C” for own, store, handle and use of radiation generating equipment and “license E” for import and export of radiation generating equipment and radioactive materials. Licenses are to be renewed and prepared a report on radiation protection programme periodically, which are performed by the Radiation Control Officers (RCOs) and signed by the Licensee. Within the time period combined licenses A&C and E have been renewed, the next renew date of A&C due on 31 December 2017.

### 1.18 Assessment of Radioactivity in Metallic Radioactive Substances Recovered from Bochila, Mohammadpur

A. Islam, Samsuzzaman\*, A. Haydar\*, Z. Hossain, S. Yeasmin and S. F. Mahal

**Objective:** The recovery and safe interim storage of all the orphan radioactive materials is a crucial issue for the safety aspects of the workers and public.

**Current progress:** The occupational and public safety was verified by measuring the radiation dose levels with different types of radiation measuring equipment. The physical inspection and gamma spectral analysis of the samples (Three Metallic Pieces) confirms that the recovered Piece-2 is depleted uranium. Nevertheless the gamma spectral analysis of the recovered Piece-1 & Piece-3 was not performed but depending on the measurement of radiation dose levels it can be concluded that they are also radioactive. Accordingly, it is recommended by the technical team that under the approval of Bangladesh Atomic Energy Regulatory Authority (BAERA), the recovered radioactive substances have to collect, transport and safe interim storage at the Central Radioactive Waste Processing and Storage Facility (CWPSF) of HPRWMU, INST, AERE, Savar, Dhaka.

\*HPRWMU, INST, AERE, Savar, Dhaka, Bangladesh

### 1.19 Evaluation of High Doses of the Radiation Workers

M. S. Rahman, A. Islam, S. F. Mahal, S. Yeasmin, J. Ferdous, A. K. M. M. Rahman, M. Begum, M. M. M. Siraz, S. Pervin and Z. Hossain

**Objective:** To evaluation of high doses is to make aware and protect occupational workers from the high exposure of ionizing radiation.

**Current progress:** During the reporting period, dose of 38 dosimeters from 28 different organizations have been observed above investigation level (5 mSv for 3 months). The aggregated dose was 802.488 mSv with the highest value 83.15 mSv and the lowest value was 5.020 mSv. Letters for investigation have been issued to the relevant organizations. 46% (13 out of 28) organizations have replied. No organizations responded that the dose was received by the pertinent worker. 100% organizations replied that the TLDs were left in the

exposure room due to lack of cognizant. The accused 28 organizations swore that they will be more mindful about using the TLD badges.

### 1.20 Measurement of Radioactivity in Some Building Materials Used in Bangladeshi Dwelling

A. Khatun\*, J. Ferdous, Z. Hossain, M. M. Haque\* and S. F. Mahal

**Objective:** To analyze gamma-ray spectra and measure activity concentrations of natural radionuclides in some building materials used in Bangladeshi dwelling.

**Current progress:** As the part of Environmental Radioactivity Monitoring Programme, total 24 samples of natural and manufactured building materials (cement 5 samples; stone 5 samples; sand 5 samples, tiles 9 samples) were collected from the different areas of Bangladesh. The activity concentration of radionuclides  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  were determined by Gamma Spectrometry consists of High Purity Germanium (HPGe) Co-axial detector coupled with multichannel analyzer. The measured activity concentrations of  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$ , in the selected building materials, were found to be ranged from  $(7.9 \pm 4.6 \text{ to } 80.1 \pm 2.6) \text{ Bqkg}^{-1}$ ,  $(4.6 \pm 3.8 \text{ to } 59.0 \pm 5.3) \text{ Bqkg}^{-1}$  and  $(137 \pm 12 \text{ to } 803 \pm 17) \text{ Bqkg}^{-1}$ , respectively. The  $R_{\text{a,eq}}$  activities estimated for the studied samples did not exceed the criterion limit of radiation dose  $1.5 \text{ mSvy}^{-1}$ . Values of  $H_{\text{ex}}$  and  $H_{\text{in}}$  for all samples investigated are below unity.

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### 1.21 Study of Gamma, Gross Alpha and Gross Beta activity in Water Samples in Satkhira District of Bangladesh

M. A. Awal\*, J. Ferdous, Z. Hossain, M. R. Rahman\*, S. F. Mahal and A. Hoque

**Objective:** To assess the concentration of gamma, gross alpha and gross beta in water samples and its dose consequence.

**Current progress:** In this study, thirteen water samples were collected from different locations of Satkhira district. Measurement of gamma-emitters and gross alpha and gross beta activity in water samples were done using High-purity (HPGe) co-axial detector and ZnS(Ag) scintillation detector. The observed average activity concentrations of  $^{238}\text{U}$ ,  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in these water samples are  $(1.401 \pm 0.45) \text{ Bq L}^{-1}$ ,  $(0.0275 \pm 0.0071) \text{ Bq L}^{-1}$ ,  $(0.393 \pm 0.17) \text{ Bq L}^{-1}$  and  $(3.992 \pm 1.28) \text{ Bq L}^{-1}$ . The observed gross alpha and gross beta activity found in water samples are  $(2.89 \pm 0.71) \text{ mBq L}^{-1}$  and  $(32.02 \pm 7.65) \text{ mBq L}^{-1}$ . Artificial radionuclide  $^{137}\text{Cs}$  was not found in the water sample. These values are considerably lower than both the World Health Organization and International Commission on Radiological Protection limits.

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### 1.22 Determination of Radioactivity Concentration Levels in Tea Sample of Fatikchari, Chittagong

M. N. Nipa\*, J. Ferdous, Z. Hossain, M. R. Rahman\*, S. F. Mahal and A. Hoque

**Objective:** To estimate the activity concentration of gamma, gross alpha and gross beta in tea sample which produced in the Fatikchari tea garden for the protection of human health.

**Current progress:** In this study, the activity concentrations of  $^{232}\text{Th}$ ,  $^{238}\text{U}$  and  $^{40}\text{K}$  were measured in 13 tea samples from Fatikchari tea gardens using gamma spectrometry with an HPGe detector. The mean activity concentrations of  $^{232}\text{Th}$ ,  $^{238}\text{U}$  and  $^{40}\text{K}$  were found to be  $(8.7 \pm 2.0, 0.7 \pm 0.2, 325 \pm 29 \text{ and } 45.04 \pm 2.6) \text{ Bqkg}^{-1}$ , respectively. Measurements of gross  $\alpha$  and  $\beta$  activity concentrations in different tea samples were carried out by ZnS(Ag) scintillation detector. The average measurement for digestion is  $4.8 \text{ mBqL}^{-1}$  for gross  $\alpha$ ,  $89.00 \text{ mBqL}^{-1}$  for gross  $\beta$  in the tea samples. The present data are comparable with those found in other studies.

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### 1.23 An Evaluation and Comparison of Performance of two Dose Calibrators in Institute of Nuclear Medicine and Allied Sciences, DMCH, Dhaka, Bangladesh

A. K. M. M. Rahman, F. Reaz\*, S. F. Mahal, M. A. Hoque, S. Yeasmin, M. Begum, M. M. M. Siraz, S. Pervin, S. Reza\*\*, M. Rahman\*\* and R. Islam\*

**Objective:** To assess the performance of two dose calibrators which are used in the Institute of Nuclear Medicine and Allied Sciences, DMCH, Dhaka, Bangladesh.

**Current progress:** Major quality control tests were carried out using three standard Radio nuclides, Cs-137, I-131 and Tc-99m which were accuracy, constancy, linearity and geometry. Besides these, shielding efficiency, influences of the container of the source and response time were also studied. According to AAPM Report No. 181 and IAEA guideline, in case of diagnosis, measurement should not exceed  $\pm 10\%$  range of the prescribed one and when it is used for therapy it should not exceed  $\pm 5\%$  of the required dose. All results obtained from the study have been compared with the international standard. Accuracy of Capintec CRC-25R was found about 2.5%; which represents its suitability for both diagnosis and therapy. Measurements taken by Veenstra VDC-404 were about 6% deviated. Thus its use should be avoided in case of therapeutic measurement. It was found that both dose calibrators have satisfactory performance in case of linearity, constancy and geometry test.

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\*\* Institute of Nuclear Medicine and Allied Sciences, Dhaka, Bangladesh

### 1.24 Measurement of Radioactivity Concentration in NORM Samples of Different Gas Fields

M. Begum, S. F. Mahal, S. Yeasmin, M. M. M. Siraz, S. Pervin, Z. Hossain, N. Hassan and A. Begum\*

**Objective:** To determine the radioactivity concentration of Naturally Occurring Radioactive Materials (NORM) samples collected from different gas fields for radiation protection of occupational workers and the environment.

**Current progress:** Oil and gas production and processing operations sometimes accumulate naturally occurring radioactive materials (NORM) at elevated concentration in by-product waste streams. Five different type of water samples (Processed water, Water of three phase separator, Pond water, Deep-well water and Tube-well water) and two soil samples were collected from two different gas fields namely Sriyyl Gas Field, Comilla and Sundalpur Gas Field, Noakhali. In this study, the radioactivity concentration of NORM in the water samples were measured using a High Purity Germanium (HPGe) detector. The measured activity concentrations of  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in the water samples of gas fields varied from (3.24 to 14.80)  $\text{Bqkg}^{-1}$ , (3.29 to 9.32)  $\text{Bqkg}^{-1}$  and (0.0 to 27.19)  $\text{Bqkg}^{-1}$  respectively. The measured average activity concentrations of  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  in the soil samples were  $(27.90 \pm 1.41) \text{Bqkg}^{-1}$ ,  $(40.53 \pm 3.39) \text{Bqkg}^{-1}$  and  $(391.92 \pm 30.14) \text{Bqkg}^{-1}$  respectively. According to IAEA, more countries are adopting the  $1000 \text{Bqkg}^{-1}$  regulatory criterion for U, Th series. The values of  $^{238}\text{U}$  and  $^{232}\text{Th}$  are much below than regulatory criteria,  $1000 \text{Bqkg}^{-1}$

\*Member, Planning, BAEC, Dhaka

### 1.25 Analysis of Radon Concentration in Air at Different Locations of Dhaka City

A. K. Azad\*, M. A. Hoque, J. Ferdous, M. M. M. Siraz, A. Begum\*, S. Yeasmin and S. F. Mahal

**Objective:** To determine Radon Concentration in Air of Different Locations, Dhaka City

**Current progress:** Radon is a cancer-causing, colorless, odorless, chemically-unreactive inert, radioactive gas which is released from the normal decay of the elements uranium, thorium, and radium in rocks and soil. Long term exposure to radon can lead to lung cancer. According to, U.S. Environmental Protection Agency (US EPA), radon is the number one cause of lung cancer among non-smokers; overall, radon is the second leading cause of lung cancer. As a part of the environmental radiation and radioactivity monitoring programme, total eighteen rooms were surveyed from 2014 to 2016 for the determination of activity concentration of radon from various locations of Dhaka City. The maximum and average radon activity concentration found in Health Physics Division of Atomic Energy Centre Dhaka, Bangladesh University of Engineering and Technology, Lalmatia Mohila College and Desh Tower of Khilgaon, Dhaka were (50.14, 20.018; 32.27, 12.68; 24.9, 9.37; 30.225, 14.55)  $\text{Bqm}^{-3}$  respectively. According to IAEA Safety Standard,

General Safety Requirements (GSR) Part 3, annual average activity concentration due to  $^{222}\text{Rn}$  shall not exceed  $300 \text{ Bqm}^{-3}$  for dwellings and other buildings, with account taken of the prevailing social and economic circumstances, so the study area seemed to be radiologically safe. This study would be helpful for the establishment of a database of radon activity concentration so that Scientists may adopt necessary safety measures for reducing indoor radon level.

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### **1.26 Measurement of Indoor Radon Concentrations in Different Laboratory of AECD Campus by RAD7**

S. Pervin, S. F. Mahal, S. Yeasmin, A. Islam, J. Ferdous, M. Begum, M. M. M. Siraz, Z. Hossain, A. Begum<sup>#</sup> and A. Begum\*

**Objective:** Indoor Radon comes from the building materials which increase the indoor radon concentration inside the dwellings. This process leads to the increase concentration of radon daughter products, and intensifies the risk of lung cancer. Therefore it is important to determine radon concentration in air and calculate the radon dose from which we can calculate the effective dose. In this way the health detriment could be measured.

**Current progress:** The main source of radon in air is the decay products of uranium in soil and rocks. Radon and its daughter products are present in the atmosphere, especially in the places where the ventilation is poor. For this study, seven counting is completed at different laboratory in AECD Campus including 4 laboratories of Health Physics Division and 2 of Chemistry Division and 1 of Electronics Division using RAD7 which is a portable, easy to use and very sensitive device. For counting time we follow 2day and 1day test protocol. The work is on progress.

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<sup>#</sup>Member, Planning, BAEC, Dhaka

\*Department of Physics, Bangladesh University of Engineering and Technology; Dhaka.

## **2. Environmental Radiation & Radioactivity Monitoring**

- Measurement of background radiation levels throughout Bangladesh and assessment of population exposure
- Analysis of different radionuclides in environmental and biological samples both qualitatively and quantitatively
- Development and standardization of analytical methods for low level measurement of radioactivity in environmental samples
- Measurement of environmental gamma dose by Thermo-luminescent Dosimeter.
- Estimation of radioactivity concentration in Naturally Occurring Radioactive Materials (NORM) samples of different gas fields
- Measurement of environmental gamma doses by In-Situ method
- Assessment of Gross Alpha and Gross Beta activity in environmental samples
- Determination of the Radon concentration in environmental samples such as air, water and soil

## **3. Occupational Exposure Control**

- Control of occupational exposure by monitoring individual radiation exposure and workplace monitoring throughout the country
- Measurement of extremity doses of workers in Nuclear Medicine and Interventional Cardiology Department

#### 4. Medical Exposure Control

- Control of medical exposure by measuring of patient’s surface dose of cardiac patient during CAG and PTCA.
- Measurement of patient surface dose during CT examination.

#### 5. Quality Assurance Programme for Radioactivity Measurement

- Performance test of detecting system
- Participation in the inter-laboratory intercomparison exercise (Proficiency Test) in Asia Pacific Region organized by International Atomic Energy Agency (IAEA)

#### 6. Quality Assurance Programme of Individual Monitoring System

- Performance test of TL Dosimeter system through routine test and calibration
- Participation in the intercomparison programme of individual radiation monitoring (regional and international)

#### 7. Manpower Development/Training Programme(s)

- Follow-up Training Course (FTC): 5<sup>th</sup> Follow-up Training Course entitled “Environmental Radioactivity Monitoring Course” from 15 to 19 February, 2017 at Training Institute, AERE, INST, Savar, Dhaka Jointly Organized by Bangladesh Atomic Energy Commission (BAEC) and Japan Atomic Energy Agency (JAEA). This course was coordinated by Jannatul Ferdous, Principal Scientific Officer, HPD, AECD, Dhaka
- Follow-up Training Course (FTC): 5<sup>th</sup> Follow-up Training Course entitled “Nuclear and Radiological Emergency Preparedness Course at BAEC (NREPCB) -2017” from 26 February to 09 March, 2017 at Training Institute, AERE, INST, Savar, Dhaka Jointly Organized by Bangladesh Atomic Energy Commission (BAEC) and Japan Atomic Energy Agency (JAEA). This course was coordinated by Engr. Md. Ashraful Islam, Principal Engineer, HPD, AEC, Dhaka
- RTC on Search for Orphan Sources and Post-discovery activities, organized by IAEA, 18–22 July, 2016, Nepal, participated Engr. M. A. Islam
- Instructor Training Course on Environmental Radioactivity Monitoring, organized by IAEA, 20 June - 29 July, 2016, Japan, Participated M. Begum
- Training Course on radiation Protection for Radiation Workers and RCOs of BAEC & Others, organized by TI, AERE, 28 Aug., - 01Sept., 2016, participated M. Z. Hossain
- FTC on Environmental Radioactivity Monitoring Course, organized by BAEC & JAEA, 15-19 Jan., 2017, participated M. Z. Hossain

#### 8. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the Participant	Name of the event/topics	Organizer	Date	Place
S. F. Mahal	National Conference on Physics-2017	BPS	05-07 Jan., 2017	AECD, Dhaka
	International Conference on Physics in Medicine and Clinical Neuro Electrophysiology (PMCN-2017)	Society of Nuclear Medicine Bangladesh	10-11 Mar., 2017	Dhaka, Bangladesh
S. Yeasmin	Regional Workshop on Development of Radioactive Discharge Criteria and its Corrective Measures	IAEA	10-14 Oct., 2016	Kuala Lumpur, Malaysia



	National Conference on Physics-2017	BPS	05-07 Jan., 2017	AECD, Dhaka
	Visit the Reference Plant of Rooppur Nuclear Power Plant in Russian Federation	RNPP Project	15-22 Jan., 2017	Moscow, Russia
	International Conference on Physics in Medicine and Clinical Neuro Electrophysiology (PMCN-2017)	Society of Nuclear Medicine, Bangladesh	10-11 Mar., 2017	Dhaka, Bangladesh
	Strengthening National Capacity for the Protection of Workers Exposed to Ionizing Radiation and the Public	IAEA	08-12 May, 2017	IAEA, Japan
Dr. M. S. Rahman	Regional workshop to review and update national action plan to control public exposures	IAEA & BAPETEN	08-12 Aug., 2016	Jakarta, Indonesia
	Workshop for Development of Draft “National Radioactive Waste Management Strategies of Bangladesh	IAEA & BAEC	16-20 Oct., 2016	BAEC, HQ
	National Conference on Physics-2017	BPS	05-07 Jan., 2017	AECD, Dhaka
	Regional workshop on occupational radiation protection in high exposure operations	IAEA & BATAN	10-14 Apr., 2017	Yogyakarta Indonesia
	Scientific Visit under IAEA National Technical Cooperation Project (BGD9015), title: Strengthening National Capacity Build up in Radiation Protection of Workers and Public of Bangladesh	IAEA & JAEA	08-12 May, 2017	IAEA, Japan
	Coordinated Research Project on Alarm Assessment	IAEA	08-10 Aug., 2016	Thailand
	National Conference on Physics	BPS	05-07 Jan., 2017	DU & AECD, Dhaka
	Bilateral Meeting on Fuel Supply Contract regarding the Rooppur Nuclear Power Plant.	RNPP Project	04-09 April, 17	Moscow
J. Ferdous	Regional Workshop on Occupational Radiation Protection Programmes in line with the IAEA Safety Requirements (GSR Part 3) and Safety Culture	IAEA	22-26 Aug., 2016	Vienna, Austria
	National Conference on Physics	BPS	05-07 Jan., 2017	
	International conference on physics in Medicine and Clinical Neuroelectrophysiology, PMCN 2017,	Society of Nuclear Medicine, Bangladesh	10-11 Mar., 2017	Dhaka, Bangladesh
M. Begum	National Conference on Physics-2017	BPS	05-07 Jan., 2017	AECD, Dhaka

	Workshop on Monitoring during a Nuclear or Radiological Emergency	(IAEA)	22 May -02 June, 2017	Fukushima Prefecture, Japan
M.M. M. Siraz	Workshop for Development of Draft “National Radioactive Waste Management Strategies of Bangladesh	IAEA & BAEC	16-20 Oct., 2016	BAEC HQ
	Regional Workshop on the Revised Safety Requirements in Emergency Preparedness and Response (GSR Part 7)	JAEA	31Oct., - 4Nov., 2016	Fukushima, Japan,
	National Conference on Physics-2017	BPS	05-07 Jan., 2017	AECD, Dhaka
	International Conference on Physics in Medicine and Clinical Neuro Electrophysiology (PMCN-2017)	Society of Nuclear Medicine, Bangladesh	10-11 Mar., 2017	Dhaka, Bangladesh
S. Pervin	National Conference on Physics-2017	BPS	05-07 Jan., 2017	AECD, Dhaka

### 9. Collaboration Work(s)

To Implement radiation protection programme , HPD has been working in collaboration with IAEA, JAEA (Japan) as well as government of Bangladesh in different projects such as IAEA/RCA, IAEA/Non-RCA, IAEA CRP, ITC followed by FTC, ADP etc.

#### Collaboration Project with IAEA

- IAEA/TC project BGD/9/015- Strengthening National Capacity build-up for the protection of workers Exposed to ionizing Radiation and public
- RAS/9/064- Strengthening the Transfer of experience related to occupational Radiation Protection in the Nuclear Industry and other Applications Involving Ionizing Radiation
- RAS/9/069- Harmonizing Approaches and Measures for Radiation Protection of the public and the Environment in line with the International safety standards
- RAS/9/075-Strengthening Radiation Protection Infrastructure and Technical Capabilities for the Safety of Workers, Patients and the Public
- RAS/9/078- Strengthening Public and Environmental Radiological Protection in the Asia-Pacific Region
- RAS/9/080- Enhancing National Capabilities on Occupational Radiation Protection in Compliance with Requirements of the New International Basic Safety Standards
- IAEA Co-ordinated Research Project: “In-Situ Measurements for Rapid Environmental Mapping of Contaminated Sites” (IAEA Research Contract No. 18197)

To enhance knowledge on radiological science the senior scientists of HPD have been delivering theoretical lectures, preparing and editing question papers in the field of Medical Physics, Health physics & Radiation Protection in the following areas:

- M. Phil in Nuclear Medicine, Part-I students of Bangabandhu Sheikh Mujib Medical University
- FCPS Part-I, MD in Radiotherapy and Radiology course
- Question preparation, moderation of the question setting and evaluation of the Exam paper on Basic Physics part-I, paper-III of M. Phil (Nuclear Medicine) examination

## 10. Services Rendered

### • Services Rendered to Imported and Exportable Food Samples

During the reporting period, 2783 imported milk & milk products samples & other samples and exportable samples were tested in this division. The radioactivity level of  $^{137}\text{Cs}$  in all the samples was within the limit as per Nuclear Safety and Radiation Control Rules 1997.

**Table 1.** List of number of the sample per month for radioactivity testing of imported and exportable food items

Name of the month	Milk & Milk products (A)	Others (B)	Imported C = A+B	Domestic Product	Individual Product	Monthly Total
July'16	19	75	94		17	111
Aug'16	73	130	203	3	21	227
Sep'16	54	93	147		16	163
Oct'16	49	122	171	1	22	194
Nov'16	45	137	182		40	222
Dec'16	39	79	118	1	24	143
Jan'17	62	141	203		28	231
Feb'17	72	133	205		20	225
Mar'17	62	155	217		22	239
April'17	76	236	312		09	321
May,17	133	334	467	12	11	490
June'17	48	140	188		29	217
Grand Total = 2783						

### • Gross Alpha and Gross Beta Service Provided

During this reporting period, gross alpha and gross beta activity were tested in this division.

**Table 2.** List of gross alpha and gross beta service

Name of Organization	Type of sample	No. of sample	Total Parameters
Karnofuli Fertilizer company Ltd. Chittagong	Drinking water	2	2
Square Pharmaceuticals Ltd. (Dhaka)	Bore hole water	2	2
Beximco Pharmaceuticals Ltd. (Dhaka)	Portable water	6	6
SK-F Pharmaceuticals Ltd.(BD)	Portable water	3	3
Urban Builders Group	Bore hole Water	3	3
Total		16	16

### • Service Provided to New Organizations

During the reporting period (July 2016-June 2017), 512 new TLD badges have been issued to radiation workers of 234 new organizations which are shown in Table-3.

**Table 3.** Number of New TLD Badges Issued to Different New Organizations

Name of the month	No. of Organizations	No. of workers
July'2016	11	15
August'2016	14	39
September'2016	20	26
October'2016	16	25
November'2016	29	83
December'2016	21	54
January'2017	27	76
February'2017	24	43
March'2017	28	44
April'2017	16	49
May'2017	20	36
June'2017	08	22
Total	234	512

- **Service of Dose Measurement and Reporting**

During the reporting period, doses of 9460 TLD badges of 3135 organizations were measured quarterly. Evaluated values of effective doses were recorded in the database system and reported to the relevant organizations. Table 4 shows month wise number of dose measured TLD badges of radiation workers working in different organizations.

**Table 4.** Evaluated Number of TLD Badges with Number of Organization

Name of the month	No. of organizations	No. of measured TLD badges
July'2016	221	795
August'2016	278	916
September'2016	200	486
October'2016	292	856
November'2016	266	795
December'2016	248	709
January'2017	298	870
February'2017	225	679
March'2017	299	921
April'2017	283	963
May'2017	284	735
June'2017	241	735
Total	3135	9460

- **Individual Monitoring Service (IMS)**

This division, the only individual radiation monitoring service provider in Bangladesh, has been providing service all over the country to the occupational workers who have been working in the different radiation fields such as medicine, industry, agriculture, education and research. Till June 2017, the total number of organizations and radiation workers came under this service was 3659 and 8036 respectively. Table 5 shows the practice wise organization and workers.

**Table 5.** List of Individual Radiation Monitoring Service Provided to the Occupational Workers of Different Radiation Practices

Practices	No. of organizations	No. of radiation workers
Radiotherapy	11	254
Nuclear Medicine	18	464
Industrial Radiography	32	218
Diagnostic Radiology	3500	6390
Research	16	354
Others (Quality Control, Level Gauge etc)	82	356
Total	3659	8036

• **Citizen Charter**

Name of Service	Fee
Individual Monitoring Service (IMS) of radiation workers	For New TLD Badge –Tk. 5000/= (dosimeter fee); Tk.200/= (Processing fee each time for each TLD)
Radioactivity monitoring of imported food items and other materials	<ul style="list-style-type: none"> <li>• Milk and milk products:               <ol style="list-style-type: none"> <li>(a) 0.5% of the C&amp;F value; Up to Tk. 10,00,000/= but not less than Tk. 500/=</li> <li>(b) Tk. 5,000/= and 0.25% of the C&amp;F value for the amount exceeding Tk. 10,00,000/= (Tk. 10,00,001/= to Tk. 1,00,00,000/=)</li> <li>(c) Tk. 27,500/= and 0.15% of the C&amp;F value for the amount exceeding Tk. 1,00,00,000/= (Tk. 1,00,00,001/= to Tk. 2,50,00,000/=)</li> <li>(d) Tk. 50,000/= and 0.10% of the C&amp;F value for the amount exceeding Tk. 2,50,00,000/= (Tk. 2,50,00,000/= to Tk. 5,00,00,000/=)</li> <li>(e) Tk. 75,000/= and 0.05% of the C&amp;F value for the amount exceeding Tk. 5,00,00,000/= (Tk. 5,00,00,000/= to Tk. 10,00,00,000/=)</li> <li>(f) Tk. 1, 00,000/= and 0.01% of the C&amp;F value for the amount exceeding Tk. 10,00, 00,000/= (More than Tk. 10,00,00,000/=)</li> </ol> </li> <li>• Other food items (except the food items mentioned in no. 1): 50% of no. 1, but not less than Tk. 500/=</li> <li>• Re-examination of an item Tk. 1000/= for each sample</li> <li>• No fee will be applicable to the food items imported for relief and service purposes.</li> </ul>
Radioactivity monitoring of exportable food items and other materials	Testing fee 50% of imported food items
Radioactivity test of food items (Local Products) brought by persons	Tk. 1000/=
Determination of gross-alpha and gross-beta in drinking water	Tk. 5,000/= (each sample)

**Materials Science Division (MSD)**

**Objective**

Materials Science Division, Atomic Energy Centre, Dhaka carries out research in bulk and nano structural applications oriented materials, which have potential use in the different branches of i.e. nanotechnology, telecommunication, information technology and biotechnology. The division is involved with both synthesis

and characterization different kind of materials. MSD accomplished exhaustive research in the nanocomposite magnetic alloy systems which have potential applications in the miniaturization of electrical and electronic components. Crystallographic characterization and quantitative phase study of inorganic, organic, thin film and unknown materials are carried out by XRD and SEM. Large numbers of students are involved with this group through different academic programmes from various public and private universities under national and international collaboration. The division also provides supports and services to the industrial and research organizations.

### Activities/Programme(s)

#### 1. Research and Development Work(s)

- Development of spinel type soft ferrites using magnetite and commercial grade raw materials and study of their characteristic properties
- Synthesize, characterization and study of the biomedical application of nanometric scale ferrite/dielectric materials
- Development of ferrite permanent magnets from beach sand mineral magnetite extracted from Cox's bazar beach sand
- Study of the magnetic and structural properties of amorphous/ nanocrystalline materials
- Study of the structural and magnetic properties of perovskites
- Crystallographic characterization and quantitative phase study of inorganic, organic, thin film and unknown materials by XRD method
- In-situ high temperature phase transition study of binary alloys
- Study of the magnetic and electrical properties of microwave ferrite materials
- Mineralogical study of soil, rock, clay, terracotta and silt materials by XRD method

#### 1.1 Study of Hyperthermia of Folate Chitosan Coated Cobalt Ferrite Nanoparticles for Cancer Treatment

S. M. Hoque, S. I. Liba, A. Nahar, K. Islam and M. Anwaruzzaman\*

**Objective:** The objective of the work is to the Study of hyperthermia of folate chitosan coated cobalt ferrite nanoparticles for cancer treatment

**Current progress:** The ability of magnetic particle to absorb the energy of AC magnetic fields aroused numerous investigations aimed primarily at the development of the technology of local thermal therapy of malignant tumor. In this study cobalt ferrite nanoparticle has been synthesized through co-precipitation method. Chitosan was modified to add folate group into it. The nanoparticle then coated with folate chitosan to make it target specific for malignant cells. X-ray diffraction (XRD) result indicated the presence of single phase inverse spinel structure of  $\text{CoFe}_2\text{O}_4$  with a grain size of 11.58 nm and the lattice parameter was 8.311Å. The Actual size of the parcel was measured by Transmission electron microscope (TEM) and it was 10nm. Size of the coated particle was 19nm and this increment in size was a confirmation of successful coating. Vibrating sample magnetometry (VSM) result confirmed the ferromagnetic nature of the prepared cobalt ferrite nanoparticles. The measured magnetization was 50.4 emu/g with a coercivity of 147.527 Oersted. Elemental analysis was done by Energy dispersive X-ray (EDX) spectroscopy. EDX result confirmed the atomic ration was as it had been expected. Formation of sextet with slow relaxation in Mossbauer spectra analysis was also an indication of ferromagnetism of cobalt ferrite. The tetrahedral and octahedral site distribution of cations confirmed that the cations are almost uniformly distributed. Flame atomic absorption Spectroscopy (FAAS) result was in agreement with the EDX result. These two results assured the expected distribution of Co and Fe in the nanoparticles. Fourier transform Infra-Red (FTIR) spectroscopy result confirmed the presence of folate chitosan on coated sample. Dynamic light scattering technique (DLS) data showed that the hydrodynamic diameter of the coated particle was between 120nm to 190

nm with a PDI range of 0.25 to 0.35. This was a clear indication that this coated particle can be applied for biomedical purposes. Cytotoxicity of both the coated and uncoated particles was observed. Both the results confirmed the nontoxic behavior of the synthesized particle. Lastly hyperthermia study indicated that at a concentration of 2mg/ml, 52°C temperature was obtained which is sufficient for cancer cell destruction. From the high temperature response and nontoxic results it can be concluded that this synthesized nanoparticles can be effectively used to damage cancer cell through hyperthermia.

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### 1.2 Magnetization Behavior of Co-rich Nd-Fe-B Based Nanocomposite Magnets with Tb Substitution

S. M. Hoque, M. N. I. Khan, S. I. Liba, M. N. I. Khan, H. N. Das, A. Nahar, A. A. Begum, K. Islam\*, Z. Begum, A. Hossen and P. C. Karmaker\*

**Current progress:** A detailed study has been carried out on the multiphase nanocrystalline permanent magnetic materials based on Fe<sub>3</sub>B and Nb<sub>2</sub>Fe<sub>14</sub>B exhibit superior magnetic properties and significantly low material cost due to less amount of rare earth element. Terbium (Tb) substituted Co-rich Nd-Fe-B nanocomposite melt spun ribbons of composition Nd<sub>4-x</sub>Tb<sub>x</sub>Fe<sub>83.5</sub>Co<sub>5</sub>Cu<sub>0.5</sub>Nb<sub>1</sub>B<sub>6</sub> (x=0,0.2,0.4,0.6,0.8 and 1) and Nd<sub>4-x</sub>Tb<sub>x</sub>Fe<sub>71</sub>Co<sub>5</sub>Cu<sub>0.5</sub>Nb<sub>1</sub>B<sub>18.5</sub> (x=0,0.2,0.4,0.6,0.8 and 1) alloys have been fabricated by single roller melt spinning technique in an argon (Ar) atmosphere. The amorphous samples were characterized by X-ray diffractometer (XRD) with CuK $\alpha$  radiation and soft (Fe<sub>3</sub>B) and hard (Nd<sub>2</sub>Fe<sub>14</sub>B) phases are formed due to the samples annealed at different crystallization temperatures. For these nanocomposite melt spun ribbons the weight fractions of both the phases Fe<sub>3</sub>B and Nd<sub>2</sub>Fe<sub>14</sub>B in crystallization process were estimated by Mössbauer spectroscopy analysis. In the vacuum annealing process, a practically amorphous alloy as quenched starts to crystallize at 675°C and 600°C for based on composition of B<sub>6</sub> and B<sub>18.5</sub> respectively, but the crystallized grains are too fine to be observed with the X-ray diffraction method and Mössbauer spectroscopy. The Curie temperature (T<sub>c</sub>) for as-cast and annealed samples with the help of temperature dependence of magnetization measurement by vibrating sample magnetometer (VSM) have been determined. By using vibration sample magnetometer (VSM), the magnetization parameters were characterized of these ribbon samples for as-cast and annealed condition with applied magnetic field of 10 KG. Co-rich and Tb substitution has significantly enhanced the value of coercivity (H<sub>c</sub>) and maximum energy product (BH)<sub>max</sub> for both the compositions. The highest value of coercivity (H<sub>c</sub>) 5.3 kOe and the maximum energy product (BH)<sub>max</sub> 19.7 MGOe have been achieved. In this experiment, it can be stated that the values of coercivity (H<sub>c</sub>), remanent ratio (M<sub>r</sub>/M<sub>s</sub>) and maximum energy product (BH)<sub>max</sub> have been enhanced for most enhanced for most of the compositions than the high anisotropic Tb containing exchange spring ribbons.

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### 1.3 Investigation of the Influence of Annealing Temperatures on the Structural Properties of Magnesium Ferrite Nano Particle and Functionalization of Chitosan Coated Magnesium Nano particle for In Vitro Hyperthermia Application

S. M. Hoque, S. I. Liba, H. N. Das, A. Nahar, A. A. Begum, K. Islam and R. Mahub\*

**Objective:** The objective of the work is to investigate the influence of annealing temperatures on the structural properties of magnesium ferrite nano particle and functionalization of chitosan coated magnesium nano particle for in vitro hyperthermia application.

**Current progress:** Magnetic nanoparticles (MNPs) have been widely investigated as a hyperthermia agent for cancer treatment. Magnesium ferrite nanoparticles were synthesized employing co-precipitation method and were annealed at different temperatures 200°C, 400°C, 500°C, 600°C, 700°C, 800°C, 1000°C, 1200°C and 1400°C in air for 3 hours in order to vary the crystal size. X-ray diffraction (XRD) patterns of as-dried powder yielded single phase of spinel cubic. With the increase of annealing temperature, peak width decreases and becomes sharper which reflects the coarsening of particles. The crystallite size corresponding to the temperature at which it was annealed was calculated by the Scherrer equation up to a temperature of 800°C. It was found to be in the range of 1.5-27 nm. The constituent elements and chemical composition are analyzed using EDX spectrum. Magnetization measurements have been accomplished by vibrating sample

magnetometer (VSM). It was found that saturation magnetization ( $M_s$ ) increasing particle size but at larger particle size it starts to decrease. Other structural and magnetic properties such as chemical shift, quadruple splitting and hyperfine field were determined by Mössbauer Spectroscopy. Super paramagnetic/ferromagnetic transition with the increase of particle size has also been confirmed by this method. Fourier Transformation Infrared (FTIR) spectra of magnesium ferrites showed the formation of tetrahedral and octahedral peaks of the metal oxides. The magnesium ferrite nano particles were then coated with biocompatible chitosan material to form homogeneous suspension for the purpose of hyperthermia application. The hydrodynamic diameter and the polydispersity index (PDI) were analyzed by dynamic light scattering at the room temperature 25°C, physiological temperature of 37°C and hyperthermia temperature 45°C. Homogenous solution of varying concentrations such as 5 mg/ml, 2mg/ml and 1 mg/ml were prepared with coating and thermo-therapeutic applications of cancer treatment was examined by hyperthermia measurements. It has demonstrated that the required temperature for hyperthermia heating could be tuned by tuning the particle size, shape and magnetization and the concentration of solution. A cytotoxicity test was performed on Hela cell lines with various  $MgFe_2O_4$  concentrations ranging from 0.25 mg/ml to 2 mg/ml of particle size 17 nm. The result reveals the biocompatibility of magnesium ferrite nanoparticles to be a potential candidate for bio-applications.

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#### 1.4 Synthesis, Structural and Magnetic Properties of Barium Strontium Ferrites using Hematite of Analytical Grade and Magnetite from Cox's bazar Beach Sand

S. M. Hoque, S. I. Liba, M. N. I. Khan, H. N. Das, A. Nahar, A. A. Begum, K. Islam, A. Hossen and U. Habiba\*

**Objective:** The objective of the work is to the synthesis, structural and magnetic properties of Barium Strontium Ferrites using hematite of analytical grade and magnetite from Cox's Bazar beach sand.

**Current progress:** In this work represents the  $BaO.SrO.xFe_2O_3$  and  $BaO.SrO.xFe_3O_4$  ( $x=5,6,5,8,6$ ) hexaferrites have been prepared using hematite of analytical grade and magnetite from beach sand Mineral Exploitation Centre, Bangladesh Atomic Energy Commission, in order to carry out a structural and magnetic properties. All the samples are annealed at 1250°C. The formation of ferrite was confirmed by the X-ray Diffraction (XRD) which reveals that Ba-Sr-Ferrite of hexagonal structure has been formed in both the cases for all compositions. Porosity of the samples has been obtained from X-ray density and apparent density. The grain size of the samples has been determined by the scanning Electron Microscope (SEM) test. The Fourier Transform-Infrared Spectroscopy (FTIR) is used to identify organic materials in the samples. This technique measures the absorption of infrared radiation by the sample material versus wavelength. The magnetic characterizations have been determined by the Vibrating Sample Magnetometer (VSM) test. From this VSM test, we have obtained the hysteresis parameters of the M-H loop. The M-H curves were measured in the range of -2 to 2 Tesla. The Currie temperatures of those hexaferrites have been obtained from the temperature dependent magnetic moments measurements. The magneto caloric effect has been discussed for all the samples. The entropy change due to magnetic phase transition is measured to determine magneto caloric effect for each sample. The Mössbauer study provided the sextet pattern which confirms that the samples are in the ferromagnetic state. Different hyperfine parameters were also observed that provide the occupancy of  $Fe^{3+}$  ion in A-site and B-site.

\*Department of Applied Physics, University of Chittagong, Bangladesh

#### 1.5 Formation of Aluminum Microsphere by Utilizing Atomic Migration

F. M. Kamal\* and M. N. I. Khan

**Objective:** The objective of the work is to formation of micro and nano materials for electro-mechanical system.

**Current progress:** A technique using the sudden change in the geometrical shape of metal line is considered for effective accumulation of atoms, and therefore fabrication of micro/nano materials utilizing electromigration. The experimental sample of Al metal line is formed on a TiN layer and covered with a  $SiO_2$



passivation layer. Thereafter, the sample is placed on a ceramic heater under atmospheric conditions, and subjected to a constant direct current for fabricating micro/nano materials. Finally, microsphere was obtained at the specific location in the sample with a sudden change in geometrical shape where a hole was introduced in the SiO<sub>2</sub> passivation and Al layers. Therefore, the temperature distribution was observed along the metal line of the proposed Al sample structure. As a result of current applying, the sphere of a high aspect ratio was fabricated.

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\*Micro/Nano-Machining Research and Education Centre, Department of Nanomechanics, Tohoku University, Japan

### 1.6 Evaluation of Temperature Distribution in Micro Materials by Joule Heating

F. M. Kamal\* and M. N. I. Khan

**Objective:** The objective of the work is characterized of micro materials prepared by Joule heating.

**Current progress:** Hillock has been successfully formed by utilizing electromigration in the passivation Al thin film specimen. Microstructure has been studied by electron microscopy during passage of current. Aluminum atoms have been migrated along the sample strip from cathode to anode by utilizing electromigration. The experimental result shows that atoms are discharged through the hole. Evaluation of electromigration-induced micro materials is proposed by considering one dimensional and two dimensional distributions of the current density and temperature distribution. Finally, model and finite element analysis have been performed for current density and temperature distribution of the sample structure.

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### 1.7 Simplified Processes for the Fabrication of Nano Materials Utilizing Electromigration

F. M. Kamal and M. N. I. Khan

**Objective:** The main objective of this research work is to study the simplified processes for the fabrication of materials utilizing electrical and mechanical methods

**Current progress:** The present research aims to form nano materials based on physical phenomena, such as electromigration. Metallic materials have been attracted due to their potential applications based on the physical properties as a functional element in MEMS. Various metallic nano materials, such as nanobelts, nanospheres, nanotubes, nanowires, etc. have been studied. We proposed a sample structure that plays significant role in accumulating and discharging atoms at predefined position, and thus enhancement of fabricating nano metallic materials utilizing electromigration. The experimental sample of Si wafer was oxidized to form thick SiO<sub>2</sub> layer and then a thick TiN layer was deposited on the SiO<sub>2</sub> layer. Therefore, aluminum metal line was formed on a TiN layer which was covered with a SiO<sub>2</sub> as a passivation layer. A hole was introduced at specific position on the specimen to discharge the accumulated atoms. The experimental result shows that atomic flux of the sample plays important contribution for controlling temperature and current density, and thus developing to form hillock as well as nano materials. Therefore, considering the electro-thermal solution on the sample structure happened in the experiment for discussing the experimental results. Finally, it can be concluded that utilizing the new methodology for producing nano materials at the predetermined position.

### 1.8 Study of the Magnetic Properties of Strontium and Barium-Strontium Hexaferrite

F. M. Kamal, M. N. I. Khan, A. A. Begum, S. M. Hoque, D. K. Saha\* and M. Moniruzzaman\*\*

**Objective:** The main objective of the research work is to study of the magnetic properties of Strontium and Barium-Strontium Hexaferrite.

**Current progress:** Magnetic properties of Strontium and Barium-Strontium ferrite have been studied in the present investigation. SrFe<sub>12</sub>O<sub>18</sub> and BaSr<sub>2</sub>(Fe<sub>2</sub>O<sub>3</sub>)<sub>6</sub> samples have been prepared by double sintered ceramic method and both samples were sintered at 1250° C for 3 hrs. Phase identification and purity level of the

samples were confirmed by X-ray diffraction (XRD) method. Lattice parameters for all the hexagonal ferrite have been calculated from XRD data which is constant of all the hexagonal ferrite. The lattice parameters of Sr-Fe and Ba-Sr-Fe were found to 23.03 Å for the c-axis length and 5.848 Å for a, the width of the basal plane. Frequency dependent complex permeability of the toroid shaped samples at room temperature was measured with impedance analyzer at frequency range from 1kHz to 120 MHz. Field dependence of the magnetization has been measured by Vibrating Sample Magnetometer (VSM). Magnetic properties such as saturation magnetization, coercivity, initial permeability, and complex permeability were investigated. Both saturation magnetization and coercivity of the sample was observed to be increased slightly with the substitution of Ba in Sr ferrite. Finally, it is observed that Strontium ferrite possesses a magnetoplumbite structure.

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\*\* Department of Physics, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh

### 1.9 Development and Investigation of Artificial Sub-surface Cracks in Welded Plate using Magnetic Particle Inspection

F. M. Kamal, M. N. I. Khan and F. M. Mohee\*

**Objective:** The objective of this work is to investigate the artificial sub-surface cracks in welded plate using magnetic particle inspection.

**Current progress:** Defects of several types and orientations are found in different locations in steel equipment. Especially cracks in welding are very crucial for catastrophic failure of an industrial component. Materials are used under various conditions for stress, fatigue and undesirable environment, which may create additional defects or aggravate present ones. Different processes have been carried out for detecting surface and sub-surface discontinuities in ferromagnetic materials. The present research study has been carried out to study the optimum condition of generating artificial cracks in welded plate of steel materials. The experimental samples have been developed with artificial sub-surface defects. The equipment for the arc welding process consists of a power source, welding cable, electrode, electrode holder, and work clamp. After producing cracks to the desired location and depth, the welded plate was machined and polished to remove the dust or spatter. After finishing the welding, magnetic particle inspection was applied to evaluate the cracks generated. Finally, location and size of the cracks of the sample was found successfully. Defects have been evaluated in different stages of the development using different testing methods. The rapid cooling technique has been found to be effective method for generating artificial sub-surface cracks in mild steel welded plates.

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### 1.10 Effect of Cr<sup>3+</sup> Doping on Structural, Electrical and Magnetic Properties of Ni<sub>0.8</sub>Co<sub>x</sub>Cr<sub>x</sub>Fe<sub>2-x</sub>O<sub>4</sub> Ferrite

M. N. I. Khan, S. M. Hoque, F. M. Kamal, S. I. Liba, A. Parveen, A. A. Begum, K. Islam,  
N. Nahar and N. Das\*

**Objective:** The objective of the work is to the effect of Cr<sup>3+</sup> doping on structural, electrical and magnetic properties of Ni<sub>0.8</sub>Co<sub>x</sub>Cr<sub>x</sub>Fe<sub>2-x</sub>O<sub>4</sub> ferrite.

**Current progress:** A series of Ni<sub>0.8</sub>Co<sub>x</sub>Cr<sub>x</sub>Fe<sub>2-x</sub>O<sub>4</sub> were prepared by conventional double sintering ceramic method for x=0.00, 0.05, 0.10, 0.15 and 0.20 and sintered at 1100°C for 3 hours. The effect of Cr<sup>3+</sup> doping on structural, electrical and magnetic properties were studied and reported. X-ray diffraction (XRD) confirmed the single phase spinel structure of all the samples without any impurity peak. Lattice parameter, bulk density, X-ray density and porosity were studied with the variation of Cr<sup>3+</sup> concentration. Lattice parameter was found to decrease with increasing Cr<sup>3+</sup> content as Cr<sup>3+</sup> has smaller ionic radius than Fe<sup>3+</sup>. X ray density was found to increase with Cr<sup>3+</sup> doping while bulk density was decreased and porosity was found to increase. Microstructural and morphological study was done by Scanning Electron Microscope (SEM). Average grain size of the samples was found to decrease with increasing Cr content. Variation in dielectric constant, dielectric loss tangent, relative quality factor (RQF) was investigated with frequency. The dielectric constant

of the system is found to decrease with the increase in Cr content. Variation of resistivity was observed with frequency. The ac resistivity significantly changes by increasing with the increase of  $\text{Cr}^{3+}$  concentration. Permeability is found to change significantly with increase in Cr content. The value of magnetic loss tangent, relative quality factor changes with Cr concentration. Magnetic properties have been studied by measuring M-H plots using Vibrating Sample Magnetometer (VSM). From the M-H plot, it is seen that saturation magnetization decreases with increasing Cr content. Coercivity and anisotropy energy change significantly with  $\text{Cr}^{3+}$  concentration.

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### 1.11 Study the Structural, Electrical and Magnetic Properties of Iron Substituted Barium Titanate ( $\text{BaTiO}_3$ )

M. N. I. Khan, S. M. Hoque, M. M. Hoque, H. N. Das, S. I. Liba, A. Nahar, A. Parveen, N. Islam,  
J. Begum and S. Mahbub\*

**Objective:** The objective of the work is to the study the Structural, Electrical and Magnetic Properties of Iron substituted Barium Titanate ( $\text{BaTiO}_3$ ).

**Current progress:** The structural, electrical and magnetic properties Fe doped ferroelectric Barium Titanate ( $\text{BaTiO}_3$ ) with the general formula  $\text{BaTi}_{1-x}\text{V}_{0.05}\text{Fe}_x\text{O}_3$  (where  $x=0.00,0.05,0.10,0.15,0.20$ ) have been synthesized by a solid state reaction technique. In this study Barium Titanate is modified with vanadium pentoxide and in addition, doped with Fe ion at the B site of lattice. The main idea is to search for new characteristics for ferroelectric ceramics. Appropriate amount of starting material was thoroughly mixed, dried and pre sintered at  $700^\circ\text{C}$  for 3 hours and sintered at  $1250^\circ\text{C}$  for 3 hours. X-ray diffraction (XRD), a scanning electron microscope (SEM), impedance analyzer and a vibrating sample magnetometer (VSM) were used in order to study the effect of divalent substitutions and their impact on the crystal structure, grain size, microstructure and magnetic properties of the barium titanate based ceramics. X-ray diffraction pattern of the sample indicated single phase cubic perovskite structure. The lattice parameters are increased with increasing Fe contents. This is because of having higher ionic radius of  $\text{Fe}^{3+}$  ( $0.645\text{\AA}$ ) than  $\text{Ti}^{2+}$  ( $0.605\text{\AA}$ ). The density of the samples is found to decreases with the substitution of divalent ions. The microstructure of the samples shows that the grain growth is greatly changed by the addition Fe. Frequency dependence of dielectric is studied within the frequency range from 1KHz to 100MHz. It is found that Fe doping influence the properties of the poly crystalline material. In all sample, ac resistivity has been observed to be decreased with increasing frequency and then invariant at high frequency. The initial permeability of the samples is found to decrease with the substitution of Fe contents for the samples. Permeability in magnetic materials originates because of the spin rotation and domain was motion. The magnetic hysteresis has been also investigated by VSM at room temperature.

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### 1.12 Study of the Safety and Neutronic Parameters of Research Reactor using Evaluated Nuclear Data Libraries and Computer Codes

M. M. Haque, A. Parveen and M. M. Islam\*

**Objective:** The objective of the work is to the study of the safety and neutronic parameters of research reactor using evaluated nuclear data libraries and computer codes.

**Current progress:** A 3MW TRIGA MARK-II research reactor is custom-made at AERE, Dhaka, Bangladesh and deliberated for training, research and isotope production. The present work consists of a theoretical study of safety analysis of TRIGA-MARK-II research reactor using the evaluated nuclear data libraries. The data files of the evaluated nuclear data library cannot be used directly as input to neutronic or other applied calculations. These data files are to be converted to preprocessed files and then to post processed into multi-group files, which are then directed into specially formatted working libraries. These libraries are compatible with the neutronic codes. This subject involves development and validation of

computer software using knowledge of ENDF-6 formats, thermal effects, shelf-shielding factors in resolved and unresolved regions, transfer matrices of various Legendre orders etc. The preparation of updated working libraries for the codes NJOY99.0, WIMSD-5B and CITATION are important practical steps to use the updated nuclear data files, which cannot be used directly in thermal research and power reactor calculations. Joint Evaluated Fussion library JEFF-3.1.2 and Japanese Evaluated Nuclear Data Library JENDL-4.0, JENDL-4.0u were primarily chosen for this analysis. The basic evaluated nuclear data files of JEFF-3.1.2 and JENDL-4.0u associated with TRIGA reactor were processed successfully by using nuclear data processing code NJOY99.0. Different cross-sections of U-235 and U-238 were computed from the NJOY output of the evaluated nuclear data library. The 69 group cross-section libraries were engendered from the processed file for reactor code WIMSD-5B. From the generated 69-group cross-section library, the integral parameters of benchmark lattices TRX and BAPL were premeditated by using cell code WIMSD-5B. The calculated integral parameters were compared to the Cross Section Evaluated working Group, USA (CSEWG) Values as well as the consequences of Monte Carlo code MCNCP4. From the comparison of the integral parameters with the experimental values it is found that the obtained result between the two libraries are nearly alike with some uncertainties. But the degrees of uncertainties for the values of integral parameters of JEFF-3.1.2 library are comparatively less than JENDL-4.0u data library. Therefore JEFF-3.2.1 is the better library and selected as a more reliable data library for the neutronic calculation of TRIGA Mark-II research reactor at AERE, Savar, Dhaka, Bangladesh. The computation methods, tools and techniques, customization of cross section libraries, various models for cells and a lot of associated utilities were standardized and validated for the cross section library generated from basic evaluated nuclear data files of JEFF-3.1.2. 3-D diffusion code CITATION was used to perform the global analysis of the core study such as multiplication factor, neutron flux, power distribution, power peaking factors and control rod worth etc. In order to compare the neutron data libraries and reactor calculation codes, various reactor parameters of light water reactor were analyzed. It is found that the power peaking factors strongly depend on core configuration and must be calculated from case to case. Neutron data libraries and reactor calculation codes play an important role in the prediction of criticality of nuclear reactor. The computed value of the effective multiplication factor is 1.04147. The hot spot is found physically at the fuel position C4 with a maximum power density of 105.07 watt/cc. The calculated total peaking factor is 4.489. The results obtained from the neutronic analysis would be used to analyze the thermal hydraulic behavior and the safety margin of the core both for steady state and pluse mode operations.

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### 1.13 Investigation of Multiferroic Properties of Ni-Zn Based Ferrite and Ba-Ti Based Ceramic Composites via Standard Solid State Reaction Method

M. N. I. Khan, S. M. Hoque, F. M. Kamal, S. I. Liba, A. Nahar, A. A. Begum., A. Hossen, K. Hasan, N. Begum and I. N. Esha\*

**Objective:** The objective of the work is to the investigation of mltiferroic properties of Ni-Zn based ferrite and Ba-Ti based ceramic composites via standard solid state reaction method.

**Current progress:** In the present research work, five series of multiferroic composites,  $(1-x)\text{Ba}_{0.6}(\text{Ca}_{1/2}\text{Sr}_{1/2})_{0.4}\text{Ti}_{0.5}\text{Fe}_{0.5}\text{O}_3 + (x)\text{Ni}_{0.4}\text{Zn}_{0.45}\text{Cu}_{0.15}\text{Fe}_{1.9}\text{Eu}_{0.1}\text{O}_4$  where  $x=0.1, 0.2, 0.3, 0.4, 0.5$  along with the pure ferrite,  $\text{Ni}_{0.4}\text{Zn}_{0.45}\text{Cu}_{0.15}\text{Fe}_{1.9}\text{Eu}_{0.1}\text{O}_4$  and pure ferroelectric ceramic,  $\text{Ba}_{0.6}(\text{Ca}_{1/2}\text{Sr}_{1/2})_{0.4}\text{Ti}_{0.5}\text{Fe}_{0.5}\text{O}_3$  have been produced by conventional or standard solid state reaction method sintered for 3 hours at  $1200\text{C}^\circ$  in air. Structural and morphological studies have been preformed by X-ray diffractometer (XRD) and Scanning Electron Microscope (SEM) respectively. The XRD analysis reveals that lattice parameter decreases while X-ray and bulk density increases with increasing ferrite content. The microstructural studies have revealed that the substitution of ferrite makes a notable impact on the average grain size. The real part of dielectric constant,  $\epsilon'$  decreases whereas quality factor, Q increases with increasing ferrite content in the composites. A remarkable improvement in the complex initial permeability,  $\mu_i'$  and relative quality factor, RQF have been detected with the increasing ferrite constant. From the study of M-H loop, it has been observed that saturation

magnetization increases with decreasing coercive field for the increasing ferrite contents preserving the sum rule for composites. Both the resistivity at room temperature and activation energy increases. Hence, from the obtained results, it can be claimed that the composites can be a better alternatives for single phase multiferroics.

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#### 1.14 Structural Ferroelectric and Ferromagnetic Properties of $(1-x)\text{BaTiO}_3+x\text{Cu}_{0.1}\text{Co}_{0.9}\text{Fe}_2\text{O}_4$ Multiferroic Composite

M. N. I. Khan, D. K. Saha, S. M. Hoque, S. I. Liba, H. N. Das, A. Parveen, K. Hasan  
and M. A. Haider\*

**Objective:** The objective of the work is to the Structural Ferroelectric and Ferromagnetic properties of  $(1-x)\text{BaTiO}_3+x\text{Cu}_{0.1}\text{Co}_{0.9}\text{Fe}_2\text{O}_4$  multiferroic composite.

**Current progress:** Multiferroics with coexistence of ferroelectric and ferromagnetic orders has been attained worldwide attraction due to its significant technological promise in the multifunctional devices applications. In the present research five samples of  $(1-x)\text{BaTiO}_3+x\text{Cu}_{0.1}\text{Co}_{0.9}\text{Fe}_2\text{O}_4$ ; ( $x=0.0, 0.1, 0.3, 0.5$  and  $1.0$ ) composite were prepared by conventional solid state reaction method. The structural, ferroelectric and ferromagnetic properties are studied in details. Structural and morphological analysis are carried out by X-ray diffractometer and scanning electron microscope (SEM) respectively. The complex initial permeability, dielectric constant and ac resistivity have been measured using Wayne Kerr Impedance Analyzer 6500B. DC resistivity and activation energy are measured by Keithley 6514 electrometer. Magnetization as a function of applied magnetic field (M-H) hysteresis loop of the samples are carried out by micro sense vibrating sample magnetometer (VSM). The XRD analysis reveals the coexistence of both ferroelectric and ferrite phases in the composite with no other phases in the composites. There is a slight change in the lattice parameter of both ferrite and ferroelectric phases in the composite. For  $x=0.5$  sample structure becomes tetragonal because of the stress exerted by ferroelectric perovskite and spinel ferrite on each other and for this stress both ferroelectric and spinel ferrite experienced a strain and lattice parameter “a” changes. A significant enhancement of initial permeability, loss factor and relative quality factor has been observed with the increase of ferrite content in the composites. For  $x=0.5$  minimum loss tangent and maximum relative quality factor is observed. For  $x=0.5$  lower dielectric loss and higher quality factor is found. Large value of dielectric constant is observed for  $x=0.1$  sample. The saturation magnetization, remanent magnetization, coercivity and anisotropic energy have been calculated from the M-H hysteresis loop at room temperature. The saturation magnetization increases with increasing ferrite content. Remanent magnetization increases with ferrite content upon  $x=0.3$  then again decreases. Therefore,  $x=0.1$ ,  $x=0.3$  and  $x=0.5$  can be utilized for device based on ferroelectric, multiferroic and ferromagnetic properties respectively.

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#### 1.15 Effect of $\text{Eu}^{3+}$ Doping on Structural, Electrical and Magnetic Properties of $\text{Ni}_{0.4}\text{Zn}_{0.45}\text{Cu}_{0.15}\text{Fe}_{(2-x)}\text{Eu}_x\text{O}_4$ Ferrites

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and M. Al-Amin\*

**Objective:** The objective of the work is to the effect of  $\text{Eu}^{3+}$  doping on structural electrical and magnetic properties of  $\text{Ni}_{0.4}\text{Zn}_{0.45}\text{Cu}_{0.15}\text{Fe}_{(2-x)}\text{Eu}_x\text{O}_4$  ferrites.

**Current progress:** A series of Eu doped  $\text{Ni}_{0.4}\text{Zn}_{0.45}\text{Cu}_{0.15}\text{Fe}_{(2-x)}\text{Eu}_x\text{O}_4$  were prepared by conventional double sintering ceramic method with x varied from 0.00 to 0.15 and sintered at  $1200^\circ\text{C}$  for 3 hours. The effect of Eu doping on structural, electrical & magnetic properties were studied. X-ray diffraction and Scanning Electron Microscope (SEM) results confirmed the single phase spinel structures of all the samples. Lattice parameter, bulk density, X-ray density & porosity were studied with the variation of  $\text{Eu}^{3+}$  concentration. Variation in dielectric constant, dielectric loss tangent, quality factor & relative quality factor (RQF) were observed with

frequency. The dielectric constant of the system is found to decrease with increase in Eu content. And resistivity was observed with both frequency & temperature. The AC resistivity significantly changes with the variation of  $\text{Eu}^{3+}$  concentration. Room temperature DC resistivity changes significantly with Eu addition. Activation energy was studied from temperature dependent resistivity. Permeability is found to decrease with increase in Eu content. The values of magnetic loss tangent, quality factor, relative quality factor (RQF) change with Eu concentration. Magnetic properties have been studied by measuring M-H plot, it is seen that the saturation magnetization, coercivity & anisotropy energy change significantly with  $\text{Eu}^{3+}$  concentration.

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### 1.16 Study of the Structural, Electrical and Magnetic Properties of Calcium and Strontium Substituted Barium Titanate ( $\text{BaTiO}_3$ ) Ceramics

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**Objective:** The objective of the work is to the study of the structural, electrical and magnetic properties of Calcium and Strontium substituted Barium Titanate ( $\text{BaTiO}_3$ ) ceramics.

**Current progress:** The structural, electrical and magnetic properties of Ca and Sr doped ferroelectric Barium Titanate ( $\text{BaTiO}_3$ ) with the general formula  $\text{Ba}_{1-x}(\text{Ca}_{0.5}\text{Sr}_{0.5}\text{Sr}_{0.5})_x\text{Fe}_{0.5}\text{Ti}_{0.5}\text{O}_3$  (where,  $x=0.0,0.1,0.2,0.3$  and  $0.4$ ) have been synthesized by a solid-state reaction technique. In this study Barium titanate is modified with Ferric oxide and in addition, doped with calcium and strontium at the A-site of the lattice. The main idea is to search for new characteristics for ferroelectric ceramics. Appropriate amount of starting materials was thoroughly mixed, dried and pre-sintered at  $800^\circ\text{C}$  for 4 hours and sintered at  $1200^\circ\text{C}$  for 3 hours, X-ray diffraction (XRD), a scanning electron microscope (SEM), impedance analyzer and a vibrating sample magnetometer (VSM) were used in order to study the effect of divalent substitutions and their impact of the crystal structure, grain size, microstructure and magnetic properties of the  $\text{BaTiO}_3$  based ceramics. X-ray diffraction patterns of the samples indicated single phase cubic perovskite structure. The Lattice parameters are decreased with increasing Ca and Sr contents. This is because of having lower ionic radius of  $\text{Ca}^{2+}$  ( $r_{\text{Ca}} = 1 \text{ \AA}$ ) and Sr ( $r_{\text{Sr}} = 1.18 \text{ \AA}$ ) than Ba ( $r_{\text{Ba}} = 1.35 \text{ \AA}$ ). The density of the samples is found to increase where as porosity decreases with the substitution of divalent ions. The microstructure of the samples shows that the grain growth is greatly changed by the addition of CaO and  $\text{SrCO}_3$ . Frequency dependence of dielectric is studied within the frequency range from 1 KHz to 100 MHz It is found that Ca and doping influence the properties of the polycrystalline materials. In all samples, ac resistivity has been observed to be decreased with increasing frequency and the invariant at high frequency. The dc resistivity of the grown materials is studied with variation of temperature which was starting from room temperature by two-probe method. It is observed that all the dc resistivity decreases with temperature for all samples confirming the semi conductor behavior of the prepared ceramics. The initial permeability of the samples is found to decrease with the substitution of Ca, Sr contents for the samples. This decrease in permeability is co-related the grain size of the samples. Permeability in magnetic materials originates because of the spin rotation and domain wall motion. The magnetic hysteresis has been also investigated by VSM at room temperature.

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### 1.17 Synthesis of $(1-x)\text{BiFe}_{0.9}\text{La}_{0.1}\text{O}_3+x(\text{Ni}_{0.6}\text{Zn}_{0.4}\text{Fe}_{0.94}\text{V}_{0.06}\text{O}_4)$ Nanostructured Multiferroic Composites and Study of Its Structural, Magnetic and Electrical Properties

M. N. I. Khan, D. K. Saha, S. M. Hoque, S. I. Liba and M. R. Hassan\*

**Objective:** The objective of the work is to the synthesis of  $(1-x)\text{BiFe}_{0.9}\text{La}_{0.1}\text{O}_3+x(\text{Ni}_{0.6}\text{Zn}_{0.4}\text{Fe}_{0.94}\text{V}_{0.06}\text{O}_4)$  nanostructured multiferroic composites and study of its structural, magnetic and electrical properties

**Current progress:** The multiferroic composites  $(1-x)\text{BiFe}_{0.9}\text{La}_{0.1}\text{O}_3+x(\text{Ni}_{0.6}\text{Zn}_{0.4}\text{Fe}_{0.94}\text{V}_{0.06}\text{O}_4)$  are made with the combination of perovskite and ferrite materials. The nanoparticles are synthesized by using solid state reaction method and some mechanical dispersion techniques like magnetic stirring, ultrasonification and centrifugation, X-ray diffraction method with Rietveld refinement was established to see multiphase formation that consists with perovskite and ferrite compositions From Rietveld analysis, rhombohedral to

orthorhombic phase transition was found up to  $x=0.7$  and the pure cubic ferrite structure was found for  $x=1$  content. At  $x=0$ , the sample is in rhombohedral orthorhombic mixed phases but with the increasing in  $x$  (as ferrite content) the cubic phase is visible. At fully ferrite contents where  $x=1$ , there has no rhombohedral and orthorhombic phase has been visible but only cubic phase is formed. The goodness of fitting confirmed that the composites are made with well distribution of perovskite and ferrite materials. The results from Rietveld analysis show that increasing  $\text{Ni}_{0.6}\text{Zn}_{0.4}\text{Fe}_{0.94}\text{V}_{0.06}\text{O}_4$  (NZVFO) contents the ferrite phase fraction was increased whereas the perovskite phase fraction decreased. The Field emission scanning electron microscopy (FESM) has been used to understand the surface morphology of composites. The proportion and contribution of particles inside the composites have been found by EDX analysis. Initially, all prepared samples were heated at  $150^\circ\text{C}$  and the nanostructure was confirmed by FESEM photograph where the size of particles were about 20~30 nm and after increasing annealing temperature, increase in grain size is clearly observed. At  $300^\circ\text{C}$ ,  $450^\circ\text{C}$ ,  $600^\circ\text{C}$  and  $850^\circ\text{C}$  annealing temperatures the grain sizes are in between 30~40 nm, 50~80 nm, 160~260 nm and 800~1700 nm respectively. The magnetization, saturation magnetization and coercivity has been calculated by using Vibrating Sample magnetometer (VSM), where magnetization is lowest for pure  $\text{BiFe}_{0.9}\text{La}_{0.1}\text{O}_3$  (BLFO) perovskite phase and increased with increasing NZVFO ferrite contents. The magnetization is maximum for  $x=1$  which may be contributed by total of ferromagnetic contents. The temperature dependent magnetization was taken at 50E constant field for both of heating and cooling mechanism where the Curie temperatures have Curie temperatures are  $364^\circ\text{C}$  and  $350^\circ\text{C}$  for pure perovskite mixed phases ( $x=0$ ) and cubic ferrite phase ( $x=1$ ) respectively. The frequency dependent dielectric constant is maximum for Bismuth perovskite content but it was lower as ferrite content increased. On the other hand resistivity increasing ferrite content. Frequency dependent permeability was maximum for pure NZVFO content but in BLFO content, permeability become low.

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### 1.18 Synthesis and Comparative Study of Structural and Mechanical Properties of Hydroxyapatite ( $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ ) Nanoparticles using Different Precursor Substances and Varying Sintering Temperatures for Biomedical Applications

S. M. Hoque, H. N. Das, S. I. Liba, A. Nahar and M. S. Ishtique\*

**Objective:** The objective of the work is to the Synthesis and comparative study of structural and mechanical properties of Hydroxyapatite ( $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ ) nanoparticles using different precursor substances and varying sintering temperatures for biomedical applications.

**Current progress:** Synthesis, mechanical and structural properties of Hydroxyapatite ( $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ ) nanoparticles, prepared by wet chemical precipitation technique, were studied. Three sets of starting materials were chosen by varying the precursors of calcium nitrate tetrahydrate, calcium hydroxide, di-ammonium hydrogen phosphate acid for preparation of the samples in solution form. The solution was dried to form the pellets which were sintered at different temperatures from  $600^\circ\text{C}$  to  $1400^\circ\text{C}$ . X-ray diffraction (XRD) revealed that there is a secondary phase formation at temperature  $1400^\circ\text{C}$  when calcium nitrate tetrahydrate and calcium hydroxide react with di-ammonium hydrogen phosphate (HAP-3) respectability. But for second precursors set, HAP-2 (Calcium hydroxide and phosphoric acid), there was no such phase formation. All samples as-prepared and sintered showed hexagonal crystal structure of the nanoparticles. It was also found from XRD data that crystalline size (27-116 nm for HAP-1, 16-127 nm for HAP-2 and 11-92 nm for HAP-3) was increasing as temperature was increased while measurement porosity (62.8-12.9% for HAP-1, 52.1-11.3% for HAP-2 and 57.2-6.9% for HAP-3) had an opposite outcome. The transformation Electron Microscope (TEM) analysis confirmed the formation of needle shaped particles but Scanning Electron Microscope (SEM) micrographs showed large aggregate formation in all as-prepared samples. The functional group in the prepared samples were analyzed using Fourier Transform Infrared Microscopy (FTIR). The FTIR spectrum exhibited the formation of hydroxyl (OH), phosphate ( $\text{PO}_4^{3-}$ ) and carbonate ( $\text{CO}_3^{2-}$ ) groups. Hardness measurement of the sintered samples revealed that the Vickers hardness (276.4-2886.3 MPa for HAP-1, 234.1-3009.7 MPa for HAP-2 and 260.9-2944.7 MPa for HAP-3) of prepared samples was increasing as temperature was increased and above  $1200^\circ\text{C}$  the rate of increase of hardness is not same as it was when the

temperature was increased from 600°C to 1200°C. This may be caused by the recovery and recrystallization process at high temperature. These nanoparticles can be used as biomaterials for the application) inhuman hard tissue engineering and as re-mineralizing agent in dentistry.

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### 1.19 Study of the Magnetic and Transport Properties of $\text{Ba}_{1-x}\text{Sr}_x\text{Ti}_{0.5}\text{Mn}_{0.5}\text{O}_3$

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**Objective:** The objective of the work is to the Study of the magnetic and transport properties of  $\text{Ba}_{1-x}\text{Sr}_x\text{Ti}_{0.5}\text{Mn}_{0.5}\text{O}_3$

**Current progress:** Barium titanate is the first ferroelectric ceramics and a good candidate for a variety of applications due to its excellent dielectric, ferroelectric and piezoelectric properties. Barium titanate is a member of a large family of compounds with the general formula  $\text{ABO}_3$  which is called perovskite. In this study polycrystalline ceramics  $\text{Ba}_{1-x}\text{Sr}_x\text{Ti}_{0.5}\text{Mn}_{0.5}\text{O}_3$  with composition  $x= 0, 0.1, 0.2, 0.3, 0.4$  were synthesized by the conventional solid state ceramic sintering method. All the samples were sintered at 1250°C for four hours in air. The samples were characterized by X-ray diffraction (XRD), Vibrating Sample Magnetometer (VSM) techniques. Frequency dependent permeability, frequency dependent dielectric constant and temperature dependent resistivity of the samples were measured. The X-ray diffraction patterns clearly indicate that the crystal phases were distorted from cubic to tetragonal phases with Sr substitution. The saturation magnetization ( $M_s$ ) value increases from 1.125 to 4 emu/g with the increase in manganese content from 0 to 0.4. The value of  $M_s$  at room temperature for the parent sample is 1.125 emu/g. The permeability measurements have been carried out at room temperature on all the samples in the frequency range 1 kHz-120MHZ. The permeability becomes steady for the samples  $x=0- 0.4$  in the frequency range of 1 KHz – 10MHz. The real part of permeability and imaginary part of permeability decreases from  $x=0 - 0.3$  with frequency and then increases for  $x=0.4$ . The loss factor ( $\tan\delta$ ) is maximum for  $x=0.4$  and minimum for  $x=0$ . Both the heights value of quality factor (Q) and relative quality factor (QRF) are obtained for  $x = 0$  sample. The dielectric constant ( $\epsilon'$ ) is maximum at  $x=0.4$  composition. The dielectric constant increase in Sr content. The loss factor ( $\tan\delta$ ) is minimum for  $x=0.4$  composition. Relative quality factor (RQF) is maximum for  $x=0.4$  sample. Temperature dependent resistivity measurement shows that resistivity decrease with increasing temperature for all compositions of  $\text{Ba}_{1-x}\text{Sr}_x\text{Ti}_{0.5}\text{Mn}_{0.5}\text{O}_3$  ( $x=0- 0.4$ ) perovskite. The resistivity decreases with increase in Sr content. The activation energy also decreases with increase in Sr content. An influence of Sr doping on the structure, magnetic and dielectric properties were observed.

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### 1.20 Study of the Magnetic and Transport Properties of $\text{CaMn}_{(1-x)}\text{Ti}_x\text{O}_3$

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**Objective:** The objective of the work is to the Study of the Magnetic and Transport Properties of  $\text{CaMn}_{(1-x)}\text{Ti}_x\text{O}_3$

**Current progress:** Recently, ceramic materials have been given a lot of attention as candidates for Implanting materials as they possess certain highly desirable characteristics for thesis applications. Ceramics used for the repair and reconstruction of debased or damaged part of the body, are known as bioceramics. Ceramics have been used for some time in dentistry owing to their inertness to the body fluids, high compressive strength and good esthetic appearance. One problematic aspect of ceramic materials and of dental ceramics in particular is their low mechanical resistance and fracture toughness. Generally, in dental application, ceramics should have greater stiffness, higher elastic limits, better fracture resistance, and improved wear characteristics. The last point deserves special attention. The ceramic materials involved in association with CaO,  $\text{MnO}_2$  and  $\text{TiO}_2$  to form  $\text{CaMn}_{(1-x)}\text{Ti}_x\text{O}_3$  perovskite structure which have been prepared by solid state reaction method and sintered at 1200°C for 3 hours. The atomic compositions of undoped specimens are close to the stoichiometric value while  $\text{Ti}^{2+}$  doped specimens are deficient in Mn and O



respectively. The O deficiency may be responsible for comparatively higher electrical conductivity of  $Ti^{2+}$  doped specimen. The heat treatment produced significant compositional and structural modifications in the near surface regions. To study the domination of Ti on structural, magnetic and transport properties of Ca-Mn structure are the motives of this thesis. To understand the crystallization phase and phase and structural pattern of the perovskite have been justified by X-ray diffraction methods. The XRD data shows that there has no segregation, haziness and fluctuation of crystalline peaks which prove the homogeneity, purification and well mixing of samples. The sharp and well defined peaks provide the crystallization fitting at crystallization temperature. X-ray diffraction techniques were taken in account to  $Cu-\alpha$  radiation and there has no ambiguity between the peaks which confirms the purity of the samples. The lattice parameter was decreased with increasing Ti on Ca-Mn content which is resulted for the less ionic radius of Ti than Mn. The magnetic properties of the ferrites were characterized with high frequency (1KHz-13MHz) with the help of complex permeability and temperature dependent permeability measurements. The real part of permeability increase till 0.2 of Ti substitution but after increasing Ti content the permeability again decreased. The resistivity of the samples is decreased and conductivity is increased with increase of Ti content. The relative quality factor (RQF) for  $CaMn_{(1-x)}Ti_xO_3$  is found to be increased with the increasing the amount of  $Ti^{2+}$  inside  $CaMn_{(1-x)}Ti_xO_3$  due the ion exchange interaction between two lattice sites. The magnetic properties have been investigated by vibrating sample magnetometer (VSM) technique at room temperature. The saturation magnetization increased with the increasing of  $Ti^{2+}$  contents. The variation of the corresponding terms can be explained on the basis of cation distribution and exchange interactions between A and B sites.

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### 1.21 Preparation and Characterization of Al Substituted Ni-Cu-Zn Ferrites

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**Objective:** The objective of the work is to Preparation and characterization of Al substituted Ni-Cu-Zn ferrites.

**Current progress:** Traditional spinel NiZn (including Ni-Cu-Zn) ferrites are widely used in various high-frequency components and multilayer chip inductors (MLCIs) due to their high electrical resistivity, chemical stability, relatively low sintering temperature, and good electromagnetic properties. This work investigates the impact of Al substitution on the structural, morphological, magnetic and electrical properties of  $Ni_{0.25}Cu_{0.20}Zn_{0.55}Al_xFe_{2-x}O_4$  (0.00, 0.05, 0.10, 0.15 and 0.20) prepared by conventional solid state reaction method sintered at 1200°C 3 hours. X-ray diffractometer (XRD), field emission scanning electron microscopy (FESEM), vibrating sample magnetometer (VSM) and impedance analyzer were used to characterize the properties of the samples. The XRD study confirmed the cubic spinel structure with single phase for all the samples. The lattice constant, X-ray density and bulk density decrease while the grain size (as estimated from the FESEM micrographs) and porosity increase with the increase of Al content in the samples. The temperature dependence of the initial permeability has been measured in the temperature range from 30°C to 250°C. Curie Temperature ( $T_c$ ) has been estimated from the temperature dependence of the permeability spectra for all samples. The Curie temperature and initial permeability ( $\mu_i'$ ) decrease with the increase in Al substitution. The saturation magnetization measured at room temperature has found to decrease with the increase of  $Al^{3+}$  ions. The frequency dependence of the complex permeability of the samples has been measured for toroidal samples in the frequency range between 1 kHz and 120 MHz at room temperature. The decrease in initial permeability has been explained on the basis of variation in grain size and porosity. Dielectric constant, loss tangent and AC conductivity have been measured as a function of frequency at room temperature. Dielectric constant shows usual dielectric Dispersion at lower frequencies due to Maxwell-Wagner type interfacial polarization. Dc resistivity has been measured in the temperature range from 30°C to 300°C. The activation energies of the samples have been calculated from the Arrhenius plots.

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### 1.22 Effect of Rare Earth Metal Substitution on the Magnetic and Transport Properties of Ni-Zn Ferrites

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**Objective:** The objective of the work is to the effect of rare earth metal substitution on the magnetic and transport properties of Ni-Zn ferrites.

**Current progress:** The present work is focused on the influence of substitutions rare earth ions in Ni-Zn ferrites. Three series of ferrite samples of the compositions  $\text{Ni}_{0.60}\text{Zn}_{0.40-x}\text{La}_x\text{Fe}_2\text{O}_4$  [where  $x=0.05, 0.10$  and  $0.1$ ] and  $\text{Ni}_{0.60}\text{Zn}_{0.40-x}\text{Eu}_x\text{Fe}_2\text{O}_4$  [where  $x=0.05, 0.10$  and  $0.1$ ] were prepared by using solid state reaction technique. The phase identification was carried out by using the X-ray diffraction (XRD). The XRD analysis revealed that undoped rare earth in sample shows formulation of cubic spinel structure with no extra peak but other three RE (La, Y and Eu) doped samples show additional peaks other spinel structure and corresponding to a second orthoferrite phase. Lattice parameters of all three series slightly decrease with increasing  $x$ -content. A slightly increase in bulk density has been found with increasing RE content. The average grain size increases significantly with increasing RE content. The increase in density and grain growth of the samples may be attributed to the liquid phase at constant sintering temperature. A slight increase of Curie temperature,  $T_c$  and saturation magnetization  $M_s$  of  $\text{Ni}_{0.60}\text{Zn}_{0.40-x}\text{RE}_x\text{Fe}_2\text{O}_4$  [RE= La, Y and Eu] series with increasing RE in were observed. The change of  $M_s$  with the increase of RE substitution has been explained on the Neel's Collinear two sublattices magnetization model and Yafet-Kittels` non-collinear magnetization model. Initial permeability decreases with the increasing of RE ions. Quality factor signifies the merit of the material from the application point of view. The variation of the quality factor with frequency shows a similar trend for all three samples. From these three series of samples are seen that the real part of initial permeability almost constant up to 4MHz. The AC resistivity decreases with increasing temperature the dielectric constant is found to decrease continuously with increasing frequency frequency and remains almost constant at higher frequency range. The variation of electrical resistivity and dielectric properties is explained of  $\text{Fe}^{2+}/\text{Fe}^{3+}$  ionic concentration with affect RE ions as well as the electronic hopping frequency between  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  ions.

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### 1.23 Study of Microstructures, Mechanical and Electrical Properties of $\text{Al}_2\text{O}_3$ -30 wt.% $\text{ZrO}_2$ Composite Ceramics Doped with MgO

M. M. Haque, A. Parveen and M. B. Hossain\*

**Objective:** The objective of the work is to the Study of Microstructures, Mechanical and Electrical Properties of  $\text{Al}_2\text{O}_3$ -30 wt.%  $\text{ZrO}_2$  composite ceramics doped with MgO.

**Current progress:** The composite of Aluminum Oxide ( $\text{Al}_2\text{O}_3$ ) and Zirconia ( $\text{ZrO}_2$ ) is a hybrid ceramic possessing remarkably improved mechanical properties including hardness, toughness, bending strength etc. A number of experimental observations reveal that such excellent ceramic would be a potential candidate for many biomedical applications e.g. in dental applications etc. Mechanical properties of composite materials are greatly affected by their shapes, sizes, relative density of bulk –grains and in the same way these parameters are dependent on dipping condition, doping materials, sintering temperatures etc. In this work, the composite  $\text{Al}_2\text{O}_3$ -  $\text{ZrO}_2$  has been doped with magnesium oxide (MgO) at different wt%. The effect of addition of MgO is this composite in suppressing grain growth and enhancing fracture toughness by transforming the mechanism of crack growth (at nanoscale) is analyzed. The sintering temperature was kept fixed as 1650°C for each composite. Since MgO possesses low dielectric losses, besides mechanical and morphological studies, electrical properties (such as resistivity, conductivity and permeability) of these composites have also been observed. With the increase of the wt% of MgO, the resistivity is decreasing and the conductivity is increasing against frequency but the permittivity exhibits somewhat different behavior. Microstructural characterization of the sintered samples was made through the Scanning Electron Microscope (SEM). It is observed that the presence of MgO on the grain boundaries effectively limits a rapid grain growth of  $\text{Al}_2\text{O}_3$  and  $\text{ZrO}_2$ . Average grain size increases with the change of the additive wt% of MgO (i.e., Average size increased with the increase in doping content of MgO). The flexural strength and hardness of the sintered compositions tend to

increase with the variation of additive wt% of MgO. It is found that the maximum flexural strength of 174.8 MPa for the composition Al<sub>2</sub>O<sub>3</sub>-30wt% 3 SYZ +3 wt% MgO which is attributed to the homogeneity as well as the reduction in grain size and increase density, and the maximum Vickers hardness of 9.08 GPa for composition Al<sub>2</sub>O<sub>3</sub>-30wt% 3 SYZ +3wt% MgO.

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\*Physics Discipline Science, Engineering and Technology School, Khulna University, , Bangladesh

### 1.24 Physical Properties of Alumina and Zirconia Based Ceramics Doped with MgO and TiO<sub>2</sub>

M. M. Haque, A. Parveen and M. R. Hasan\*

**Objective:** The objective of the work is to the Physical Properties of Alumina and Zirconia Based Ceramics Doped with MgO and TiO<sub>2</sub>.

**Current progress:** Ceramics is an inorganic, non-metallic material which is composed of oxides, carbides, nitrides, borides having significant structural, mechanical, thermal and electrical properties. Ceramics materials have excellent biocompatible properties such as bioactive, bio-inert and biodegradable properties which are desirable in the progress and enhancement of human civilization. Now a day's the most widely used ceramics materials are alumina (Al<sub>2</sub>O<sub>3</sub>) and Zirconia (ZrO<sub>2</sub>) based ceramics. The current developments in ceramic materials science for dental applications led to high class mechanical strength materials which are represented by these materials. It has excellent biocompatibility and long-term potential durability. The main advantage of alumina is high hardness and wears resistance and Zirconia has higher strength and fracture toughness properties. Magnesium oxide and Titanium dioxide has also been considered the most useful material because of their excellent physical properties and biocompatibility. In addition of MgO and TiO<sub>2</sub> with Al<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub> composite play an important role to improve their physical properties (Microstructure, Mechanical, and Electrical properties). Several experimental observations reveal that composite of Alumina (Al<sub>2</sub>O<sub>3</sub>) and Zirconia (ZrO<sub>2</sub>) possess excellent mechanical properties including improved hardness, toughness, bending strength etc. Mechanical properties of composites are much affected by the shapes, sizes and relative density of bulk-grains, and these parameters are governed by doping condition, doping materials, sintering temperatures etc. In this work, the composite Al<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub> has been doped with Magnesium Oxide (MgO) and Titanium-Oxide (TiO<sub>2</sub>) at different wt%. The sintering temperature was kept fixed as 1650°C for each composite. Since MgO and TiO<sub>2</sub> possess low dielectric losses besides mechanical and morphological studies, electrical properties of these composites have also been observed. The result shows that the average grain size decreases with increase in additive different wt% of MgO and TiO<sub>2</sub>. The hardness and flexural strength of the composite tends to increase with the additive different wt%. And the electrical properties (dielectric constant, resistivity and conductivity etc.) also vary with the different wt% of MgO and TiO<sub>2</sub>

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\*Physics Discipline Science, Engineering and Technology School Khulna University, Bangladesh

### 1.25 Structural and Electrical Properties of Pure and Bismuth Doped Barium Titanate Ceramics

A. Nahar, S. M. Hoque, F. M. Kamal, M. M. Haque, M. N. I. Khan, H. N. Das, M. Al-Mamun, S. I. Liba, A. Parveen and A. A. Begum

**Objective:** The objective of the work is to the Structural and Electrical Properties of Pure and Bismuth Doped Barium Titanate Ceramics.

**Current progress:** Pure and Bismuth (Bi) doped Barium Titanate (BaTiO<sub>3</sub>) samples with a general formula Ba<sub>1-x</sub>Bi<sub>2x/3</sub>TiO<sub>3</sub> (where x=0.00, 0.01, 0.02, 0.03, 0.04, 0.05 and 0.06) are prepared by the standard solid state reaction method and the structural and electrical properties of samples are investigated. The tetragonal structures of the prepared samples are confirmed by X-ray diffraction (XRD). The Energy Dispersive X-ray spectroscopy (EDX) reveals the presence of Bi. It has been found from Scanning Electron Micrographs (SEM) that with the increase of doping concentration of Bi, grain size increases and the porosity decreases. From the resistivity versus temperature curves, the Curie temperature (T<sub>c</sub>), corresponding to the tetragonal to cubic transition of the sample, is measured. T<sub>c</sub> of the pure BaTiO<sub>3</sub> is observed to be around 135°C, which increases with the increase of doping concentration. Dielectric constant decreases with the increase of

frequency. In addition to this, the ac resistivity of the samples changes with the applied frequency, which are consistent with the obtained XRD and SEM results.

## 2. Seminar/Symposium/Conference/Workshop Attended

Name of the person	Name of the event/topics	Organizer	Date	Place
Harinarayan Das	Nuclear and Radiological Emergency Preparedness	TI, AERE, Savar, Dhaka	26 Feb., - 09 Mar., 2017	AERE, Savar, Dhaka
Samia Islam Liba	Foundation Course on Nuclear Energy-3	Department of Atomic Energy (DAE), India	9 Jan., - 17 Feb., 2017	Mumbai, India
Arijun Nahar	Foundation Course on Nuclear Energy-3	Department of Atomic Energy (DAE), India	9 Jan., - 17 Feb., 2017	Mumbai, India
	Basic Russian Language Course -3	TI, AERE, Savar, Dhaka	02 Oct., -03 Nov., 2016	AERE, Savar, Dhaka
	Nuclear and Radiological Emergency Preparedness	TI, AERE, Savar, Dhaka	26 Feb., - 09 Mar., 2017	AERE, Savar, Dhaka
	Basic Nuclear Orientation Course-2017	TI, AERE, Savar, Dhaka	09 April- 08 June, 2017	AERE, Savar, Dhaka

## 3. Lecture Delivered

Speaker	Name of the event/topics	Date	Place
Dr. S.M. Hoque	“Introduction to Nanotechnology”, Basic Nuclear Orientation Course	19 Oct., 2014	Bangladesh Atomic Energy Commission
Dr. M. M. Haque	Solid Properties of Carbon Molecules and their Hybrid Materials based on Carbon Nanotube”	23 Sept., 2014	Atomic Energy Centre, Dhaka

## 4. Collaboration Work(s)

To improve the research quality, Materials Science Division is involved with a collaboration work titled on Magnetic and structural properties of Ferrites, Nanocomposites and Perovskite Materials with International Programme for Physical Sciences (IPPS) under International Science Programme of Uppsala University, Sweden.

On the other hand, to help in the development of manpower, this division is involved with the preparation of question paper, evaluation of examination paper, evaluation of thesis paper in the level of M.S./M.Phil./Ph.D. at different public Universities in the country. This division is also involved with the collaboration research work with different public and private Universities in the country.

## 5. Service Renderd

### • Service Provided by SEM & EDX

Name of institutions/organizations	No. of samples
Dept. of Physics, KUET	08
Dept. of EEE, RUET	02
Dept. of Applied Physics, RU	10
Dept. of Chemistry, KUET	05
Dept. of Geological Science, JU	05
Total	30

- **Service Provided by VSM**

Name of institutions/organizations	No. of samples
Dept. of Physics, JU	02
Dept. of Physics, JU	02
Dept. of MME, BUET	05
Dept. of MME, BUET	02
Dept. of Physics, BUET	13
Dept. of Physics, BUET	04
Dept. of Physics, BUET	05
EEE,BUET	02
EEE,BUET	02
Dept. of Physics, BUET	13
Dept. of MME, BUET	02
Dept. of Physics, BUET	01
Dept. of MME, BUET	03
Dept. of Physics, BUET	04
Total	60

- **Citizen Charter**

Analytical System	Parameter Determinant	Service charge per sample* in Taka
X-ray diffraction (X-RD)	Characterization of known/unknown materials	4000
	Phase identification of materials	4000
Scanning Electron Microscope (SEM)	Morphology study	3000
	Quantitative elemental analysis by EDX	3000
	Both Morphology and quantitative elemental analysis	5000
Vibrating Sample Magnetometer (VSM)	Magnetic properties study at room temperature	1500
	Magnetic properties study at low and high temp. (-170 °C – 700 °C)	1500

\*All charges are 50% less in case of student

### Medical Physics Division (MPD)

#### Objective/Introduction

Medical Physics Division was established in 2014. The prime objective of this division is to provide training as well as service in the field of medical physics. Medical Physics Division in Atomic Energy Centre, Dhaka is working with the close cooperation of “Establishment of Institute of Nuclear Medical Physics (INMP)” Project at AERE, Savar, Dhaka.

## Activities/Programme(s)

### 1. Research and Development Work(s)

#### 1.1 Establishment of the Institute of Nuclear Medical Physics project

R. Khatun, S. Akter, M. F. Uddin, A. N. Monika\* and M. M. Ahasan\*

There was a long cherished desire that a well equipped Medical Physics Institute would be established in Bangladesh for quality cancer care and management by the use of medical physics technology. In developed countries, a medical physicist needs to be trained up from proper Institute. The scope of medical physics education in Bangladesh is rare. Hence, an ADP project entitled as “Establishment of Institute of Nuclear Medical Physics” has already been taken at AERE Savar. Medical Physics Division is giving necessary supports to implement this project. Medical Physics Division and this Institute would jointly work to make qualified medical physics professionals & technologists and to deliver quality services to the patients. Consequently, international standard cancer diagnosis and treatment facilities would be developed through medical physics technology. Construction works and other activities are nearly finished. Installation of Medical LINAC is going on. Final LC of TOF PET/CT has been completed. Hopefully the entire project work will be finished in due time.

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\* Nuclear Medical Physics Institute, AERE, Savar, Dhaka, Bangladesh

#### 1.2 Thyroid Uptake of $^{99m}\text{Tc}$ and its Agreement with $^{131}\text{I}$ for Evaluation of Thyroid Function

R. Khatun, S. Akter, M. F. Uddin, A. N. Monika and M. Ohiduzzaman\*

The main function of thyroid gland is the production of thyroid hormones. Thyroid hormones regulate the basal metabolic rate and also influence many bodily functions, such as physical growth and development, puberty, organ function, fertility and body temperature. Thyroid uptake and scintigraphy using  $^{99m}\text{Tc}$ -pertechnetate has proven to be more advantageous than with  $^{131}\text{I}$ -iodide, since the images have better quality, the procedure is faster and the patient is submitted to a lower radiation dose. The purpose of this study is to perform thyroid uptake using  $^{99m}\text{Tc}$  and  $^{131}\text{I}$ -Iodine, to make a comparison between them and hence to find out the agreement between them. The experiment is carried out at the Institute of Nuclear Medicine and Allied Sciences (INMAS), Bangladesh Atomic Energy Commission, Dhaka Medical College Hospital Campus, Dhaka-1000. In the present work, the study consists of 109 patients, 67.72% female and 30.28% male with ages ranging from 14 to 66 years and correlation between  $^{99m}\text{Tc}$  and  $^{131}\text{I}$  for euthyroid, hyperthyroid and hypothyroid patients were found. Good agreement could be seen except hypothyroid patients. In statistical analysis euthyroid and hyperthyroid are significant but hypothyroid is not significant. Number of hypothyroid patients is little. Further study and more patients should be included to better significant for hypothyroid patients.

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\*Department of Biomedical Physics and Technology, University of Dhaka, Bangladesh

#### 1.3 Site Planning of a Newly Installed LINAC at BAEC, Bangladesh

R. Khatun, S. Akter, M. F. Uddin, A. N. Monika\* and M. M. Ahasan\*

Radiotherapy is a multidisciplinary area which uses complex equipment and radiation sources for treatment. Radiotherapy programme is mainly based on site planning, constructing and staffing the radiotherapy facility by skilled personnel. Medical Physicists play a vital role in radiotherapy such as treatment plan verification, machine calibration, patient positioning etc. The construction of specialized bunkers (shielded rooms) for housing the treatment equipment is technically an engineering challenge and needs professional oversight to ensure long term structural integrity. A standard design is imperative to provide future requires and advances in technology. This study provides a basis for site planning of a newly installed radiotherapy facility (LINAC) construction. As LINAC is a highly sophisticated machine, it is not so easy to install like other equipments and it is very important to set up the facility with careful/perfect mode. So we have to consider various aspects such as location, socio-economic status, shielding, system components, regulatory requirements, etc. to setup/site planning of a newly installed LINAC. The present study will help understanding to obtain a brief guideline for the purchaser/user how to set up a new radiotherapy facility like Linac.

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\*Institute of Nuclear Medical Physics

#### **1.4 High Energy Medical Linear Accelerator Treatment-Room's Door Design**

S. Akter, R. khatun, M. F. Uddin, A. N. Monika\* and M. M. Ahasan\*

Medical linear accelerator (Linac) plays an important role in the treatment of cancer tumors. Radiation entered into the door of the treatment room because of scattering from room surface and the patient, and leakage transmission. Typical door size varies with the energy of the Linac. For low energy installations, typical door size is ~ (6 to 10) mm lead in 5 cm wood. High energy medical Linac requires door shielding for both photons and neutrons. For energy >10 MV big door is required in Linac treatment room with maze. In this case, a sandwich door of lead (~10 to 15 mm) and 5% borated polyethylene layer (~10 cm) placed in a steel frame is usually used. On the other hand, for direct shielded door i.e., without maze at high energy, bigger door is required, the sandwich door of lead (~8mm), and 5% borated polyethylene layer (~28 cm) and lead (~8mm) placed in a steel frame. Several studies shows that target, multi leave collimator, wedge filter, primary and secondary collimators are the main sources for photo neutrons production in a linac head. Flattering filter free photon beam caused significant decrease in neutron production. The study emphasis on the treatment-room's door with additional shielding for high energy medical Linac.

\* Nuclear Medical Physics Institute, AERE, Savar, Dhaka, Bangladesh

#### **1.5 Shielding Design for High Energy Linac Bunker**

M. F. Uddin, R. Khatun, S. Akter, A. N. Monika\* and M. M. Ahasan\*

The main objective of this research work is to measure primary and secondary barrier thickness required for radiation safety of human and environment and Bangladesh Atomic Energy Regulatory Authority (BAERA) requirement. High energy medical linac is used to treat cancer patients either in electron or photon mode depending on the position of the malignant tissue. As the particles energies are in MeV range, so special measures are taken into account for design consideration. Normally, photon energy is taken into account for shielding design consideration. Remaining two particles electron and neutron are less important for shielding calculation. According to BSS schedule and ICRP report 60, occupational annual dose limit is 20 mSv averaged over five consecutive years and 50 mSv in a single year. The main concept of designing protective barrier is to ensure that the equivalent dose received by an individual does not exceed the applicable maximum permissible value. Protection is required against three types of radiation such as, primary radiation (from the patient), scattered radiation (from the patient) and leakage radiation (from the linac head). To save the radiation worker from these three types of radiations, primary wall and secondary wall thickness, primary wall width, maze design and door shield are calculated. These calculation results were submitted to Bangladesh Atomic Energy Regulatory Authority as an official document to get license.

\* Nuclear Medical Physics Institute, AERE, Savar, Dhaka, Bangladesh

#### **1.6 Modality of Using Best Imaging Tools for Diagnosis of Normal Tissue and Cancer Tissue**

A. N. Monika\*, R. Khatun, S. Akter, M. F. Uddin, A. Rhaman\* and M. M. Ahasan\*

There is wide range of imaging device that used for tumour diagnosis. Multi-slice CT, MR with dynamic scanning, 3D ultrasound, Positron Emission Tomography and Single Photon Emission Computed Tomography; each of them has superiority on particular case. For cancer diagnosis, Multi-slice CT is required. CT Hounsfield units of CT machine convert into relative electron densities by calibration curves. Megavoltage beam produces Compton scattering during tissue interaction, directly proportional to electron density. Density data is used for radiation dose calculation. But soft tissues or organs are hard to see in CT image. Magnetic field based MRI imaging device is superior to produce detailed pictures of soft tissues and organs but cannot provides density calculation. Hydrogen nuclei (protons) are aligned in the magnetic field of MRI, as human body is equivalent to water. When field is turned off, protons gradually return to their normal spin, produce radio signal and measured by receivers of MRI and converts into image. If MRI image is fused with CT image, organ of risk or normal tissue can be avoidable during contouring and radiation dose is also calculated. MRI fuse CT images are the best data set that gives the details of internal body structure.

\* Nuclear Medical Physics Institute, AERE, Savar

**2. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the Participant	Name of the event/topics	Organizer	Date	Place
Dr. R. Khatun	Annual Conference of Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016)	BSRO BMPS	24-25 Sept., 2016	BIAM, Dhaka
	National Conference on Physics- 2017	BPS	05-07 Jan., 2017	AECD, Dhaka
	International Conference on Physics in Medicine and Clinical Neurophysiology	BMPA ECNES DU	10-11 Mar., 2017	DU
S. Akter	Annual Conference of Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016)	BSRO BMPS	24-25 Sept., 2016	BIAM, Dhaka
	National Conference on Physics- 2017	BPS	05-07 Jan., 2017	AECD, Dhaka
	International Conference on Physics in Medicine and Clinical Neurophysiology	BMPA ECNES DU	10-11 March, 2017	DU
M. F. Uddin	Annual Conference of Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016)	BSRO BMPS	24-25 Sept., 2016	BIAM, Dhaka
	National Conference on Physics- 2017	BPS	05-07 Jan., 2017	AECD, Dhaka
	International Conference on Physics in Medicine and Clinical Neurophysiology	BMPA ECNES DU	10-11 Mar., 2017	DU

**3. Service Rendered****Medical Physics Experts Services**

- To develop qualified medical physics professionals with instrumental and clinical knowledge.
- To provide medical physics expert services in hospitals over the country to manage cancer patients.
- Review and verify the treatment planning systems (TPS).

**Medical Equipment Services**

- Commissioning, Setup, Calibration, Acceptance testing, QA and QC
- Repair, Maintenance and Making technical specifications of medical equipments

**Patients Safety/Risk Management Services**

- Surveillance of medical devices and evaluation of clinical protocols to ensure the ongoing protection of patients

**Non-Destructive Testing Division (NDTD)****Objective**

Non-Destructive Testing (NDT) Division has been working as an excellent centre for R & D, acquisition & dissemination of knowledge and technology on NDT in the country. Since its inception, NDT Division has been working to develop and promote the science and practice on NDT and its application in industries throughout Bangladesh having the objective of reducing foreign dependency and to make Bangladesh self-reliant on NDT technology for facilitating its socio-economic development.



## **Activities/Programme(s)**

Considering the present industrial needs NDT Division has taken up the following programmes:

- Research & Development on NDT techniques those are useful to our industries
- Render valuable NDT services and consultancy to the local industries
- Training and Certification to develop expertise and proficiency of local NDT practitioners to meet international standard

### **1. Research and Development Work(s)**

#### **1.1 Development of Technical Working Procedures of NDT Methods**

M. F. H. Chowdhury, M. S. Alam, M. N. N. Alam and M. A. Habib

To control & maintain the quality of industrial products & to assure reliability to the users, it is required to use NDT applications in all stages of processes for the uninterrupted operation of the industrial components. Considering the demands of the industries & to make these industries benefit & productive, NDT Division is continuing its application based R&D programmes. For this purpose the details technical working procedures of both conventional & advanced NDT methods like Radiographic, Ultrasonic, Magnetic Particle, Liquid Penetrant & Remote Visual Inspection have been developed to solve various technical problems exists in industries.

Depending on the geometry, dimension, orientation of the components, service condition, anticipated defect nature in the component and applicable codes & standards, the working procedures were developed for the inspection of different equipment used in various industrial sectors viz. Steel Structure, Fertilizer Factory, Power Generating Equipment, Gas processing plant, Ship building Industries, Amusement park, Defense sector, High Rise Building Structures etc.

#### **1.2 Corrosion Evaluation and Wall Thickness Measurement in Insulated Pipes by Tangential Radiography**

M. F. H. Chowdhury, M. S. Alam, M. N. N. Alam and M. A. Habib

The scope of this work is to evaluate the corroded zones and to measure wall thickness of insulated pipes in order to make a correlation directly in assessing the remaining life time of power plants, petroleum and petrochemical industries etc. without removing specially insulations from the metal part so that the cause of accident due to fire & leaks, low production or unpredictable shutdown of plants can be minimized.

An attempt has been taken to develop a standard protocol for method validation to be utilized to determine remaining wall thickness of the pipe creating grooves of different depths on the external surface.

#### **1.3 Development of Eddy Current Testing Technique for Heat Exchanger Tube**

M. F. H. Chowdhury, M. S. Alam, M. N. N. Alam and M. A. Habib

Eddy Current Testing Method has been using as a quality control tool for the inspection of numerous engineering components particularly the ferro-magnetic and non-ferromagnetic Heat Exchanger Tubes, Feed Water Heater Tubes, Condenser Tubes, Air Conditioner Tubes etc. of Petrochemical Industries. A programme on the above topic has been taken whose objective is to interpret the signals arising from different known defects and finding the better response of a defect at a particular frequency by utilizing Multi Frequency Eddy Current Testing Equipment - MS 5800 with Multiview 6.0R software.

Few experiments have been performed with the MultiScan MS 5800 Multi Frequency Eddy Current equipment having options to use 4 frequencies simultaneously. For this investigation, Stainless Steel tube having artificial defects of different volume were analyzed experimentally.

### 1.4 Digital Industrial Radiographic Method for Industrial Practices

M. F. H. Chowdhury, M. S. Alam, M. N. N. Alam and M. A. Habib

The scope of this work is to make the digital image of an object onto the imaging plate by the ionizing radiation and processing the image with the aid of appropriate computer facility in order to enhance their contrast & spatial resolution and to sharpen and smoothen their edge definitions for analysis of object structures.

Using X-ray Source Digital image of welded plate and bullet proof vest were analyzed to assess the integrity by adjusting different parameters available in the I See! software.

### 2. Manpower Development/Training Programme(s)

#### • Arrangement of National Training Course on NDT

Name of the event/topics	Date	Place	No. of participant
74 <sup>th</sup> National Training Course on Ultrasonic Testing Level-1	17 July - 03 Aug., 2016	NDT Division, AECD	19
75 <sup>th</sup> National Training Course on Liquid Penetrant Testing Level-2	04 - 22 Dec., 2016	NDT Division, AECD	12
76 <sup>th</sup> National Training Course on Liquid Penetrant Testing Level-2	09 - 26 Jan., 2017	NDT Division, AECD	13
77 <sup>th</sup> National Training Course on Radiographic Testing Level-1	06 - 23 Mar., 2017	NDT Division, AECD	12
78 <sup>th</sup> National Training Course on Radiographic Testing Level-1	09 - 27 April 2017	NDT Division, AECD	12

#### • Arrangement of Customized Training Course on NDT

Name of the event/topics	Date	Place	No. of participant
Gas Pipeline Welding and NDT	26 Feb., - 02 Mar., 2017	NDT Division, AECD	13

### 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
Md. Faruque Hossain Chowdhury	IAEA/RCA Mid-Term Progress Review Meeting	IAEA	27 June - 01 July 2016	Bangkok, Thailand
Sanjoy Chandra Dey	Training Course on Radiation Protection for Radiation Workers and RCO's of BAEC & others	BAEC	28 Aug., - 01 Sept., 2016	AERE, Savar
Md. Saiful Alam	Regional Training Course (RTC) on "X-ray and Gamma ray based DIR for specialized NDT requirement in Industry.	IAEA	19 - 23 Sept., 2016	Kelaniya, Sri Lanka
Md. Nur Nazmul Alam	Regional Training Course (RTC) on "X-ray and Gamma ray based DIR for specialized NDT requirement in Industry"	IAEA	19 - 23 Sept., 2016	Kelaniya, Sri Lanka

Name of the participant	Name of the event/topics	Organizer	Date	Place
Sanjoy Chandra Dey	Basic Russian Language Course-3 (BRLC-3)/2016	BAEC	02 Oct., - 03 Nov., 2016	AERE, Savar
Md. Faruque Hossain Chowdhury	IAEA/RCA Project Design Meeting TC Cycle 2018-2019	IAEA	31 Oct. - 04 Nov., 2016	Viena, Austria
Md. Faruque Hossain Chowdhury	IAEA/RCA Expert Group Meeting, ,	IAEA	07 - 11 Nov., 2016	Indonesia
Md. Faruque Hossain Chowdhury	National Conference on Physics-2017	BPS	5 - 7 Jan., 2017	AECD
Md. Saiful Alam	National Conference on Physics-2017	BPS	5 - 7 Jan., 2017	AECD
Md. Ahasanul Habib	National Conference on Physics-2017	BPS	5 - 7 Jan., 2017	AECD
Sanjoy Chandra Dey	3 <sup>rd</sup> Foundation Course on Nuclear Energy (FCNE)	DAE, India	09 Jan., - 17 Feb., 2017	Mumbai, India
Sanjoy Chandra Dey	Follow up Training Course (FTC) on “Nuclear and Radiological Emergency Preparedness Course at BAEC-2017”	JAEA & BAEC	26 Feb - 09 Mar., 2017	AERE, Savar
Sanjoy Chandra Dey	Basic Nuclear Orientation Course-2017	BAEC	09 April - 08 June, 2017	AERE, Savar
Md. Faruque Hossain Chowdhury	Workshop on Developing Inspection Programme and QC and QA System for Construction of NPP	RNPP, BAEC	14 -17 May, 2017	AECD
Md. Saiful Alam	Workshop on Developing Inspection Programme and QC and QA System for Construction of NPP	RNPP, BAEC	14 -17 May, 2017	AECD

#### 4. Collaboration Work(s)

- **IAEA Projects**

NDT Division has been actively participating in all IAEA/RCA Programme on NDT for Asia & Pacific region. The objective of this project is to maintain a uniform quality level of standard so that the certification scheme can be recognized and harmonized mutually among the RCA member states.

During this reported period, the following IAEA/RCA projects on NDT were maintained:

“Building Capacity for Applications of Advanced Non-Destructive Evaluation Technologies for Enhancing Industrial Productivity (RAS/1/020)”. This Project has been started on January 2015.

- **Basic Training for BAF Officer’s**

During this reported period, the concerned persons of the NDT Division delivered theoretical lectures on different NDT methods to the 57<sup>th</sup> & 58<sup>th</sup> Flight Safety Officer's (FSO) Training Courses organized by the "Flight Safety Institute", Dhaka of Bangladesh Air Force (BAF). Besides the participants from Bangladesh Air Force, Bangladesh Navy & Bangladesh Army, 6 participants from Royal Jordanina, 2 participants from India, 2 participants from Srilanka & 1 participants from Pakistan Air force were present in these courses. The NDT Division also conducted day long practical demonstration class for the above courses. This collaboration is likely to be continued.

- **Practical Demonstration for University Students**

Within this reporting period, NDT Division of BAEC arranged Practical demonstration on different NDT Methods for 50 students of Level – 2, Term - 1 of Department of Materials and Metallurgical Engineering,

Bangladesh University of Engineering and Technology (BUET) on 18 & 25 May 2017 to provide application based knowledge on NDT methods of as a part of their curriculum activities.

### 5. Service Rendered and Revenue Income

No. of service given to the organization	Types/nature of services	Quantity of sample	Income (BDT)
12 Times to IPCO Development Bangladesh Ltd.	Ultrasonic Testing of Welding joints of Main Beam of 3 Star cum Retail Building & 5 Star Hotel Building	171.15 meters	2,72,405/-
	Liquid Penetrant Testing	1.2 meters	---
05 Times to Bangladesh Ordinance Factories	Digital Industrial Radiographic Testing of Mortar Shell	34 Nos.	34,000/-
01 Time to Western Marine Services Ltd.	Calibration of 02 Nos. Ultrasonic Thickness Gauge	2 Nos.	4,000/-
02 Times to BITAC, Dhaka	Ultrasonic Testing of Air Compressor Piston	1 No.	4,000/-
	Ultrasonic Testing of Journal Bearing	1 No.	
01 Time to Bangladesh Gas Fields Co. Ltd.	Ultrasonic Testing of Welding joints of Gas Pipe line	312 Nos.	2,02,545/-
02 Times to Chathweld Construction Co. Ltd.	Industrial Videoscope Inspection of 42" Header of Power Plant	2 No.	60,000/-
01 Time to Bangladesh Industrial X-ray	Calibration of 01 No. Ultrasonic Flaw Detector	1 No.	3,000/-
01 Time to Jamuna Fertilizer Co. Ltd.	Ultrasonic & Magnetic Particle Testing of High Pressure Steam Header Reducer Welding joint	1.11 meters	10,000/-
01 Time to Saj Engineering & Trading Company	Radiographic Testing of Welding joints of Pipe of Power Plant	78 Nos.	39,000/-
02 Times to Power Mech Projects Ltd.	Industrial Videoscope Inspection of Gas Turbine (M701F4) & Cartridge Filter, Top Hat, Main – A & B and Pilot of Gas Turbine of Bheramara CCPP (360 MW)	6 Nos.	80,000/-
01 Time to Solution NDT & Inspection Services	Calibration of 01 No. Ultrasonic Flaw Detector & 01 No. Ultrasonic Thickness Gauge	2 Nos.	5,000/-
02 Times to Advanced Technic & Inspection Co. Ltd.	Calibration of 02 Nos. Ultrasonic Flaw Detector & 02 Nos. Ultrasonic Thickness Gauge	4 Nos.	10,000/-
01 Time to I A & E, Gazipur Cantonment	Radiographic Testing of. Bullet Proof Jacket (Hard Armour Plate)	1 No	2,000/-
01 Time to Industrial Engineering Services	Calibration of 03 Nos. Ultrasonic Flaw Detector & 03 Nos. Ultrasonic Thickness Gauge	6 Nos.	15,000/-
01 Time to Bangladesh Petroleum Institute	Organization of Customized Training Course for BPI Personnel	1 No.	30,000/-
* Received Pending Service Charge			30,000/-
Total			8,00,950/-

- **Citizen Charter**

**Table 1. NDT Servicing Fee**

NDT Method	Types/nature of the Job	Rate of Service Charge
Radiographic Testing	Weld Testing (Plate and Pipe of dia. more than 90 mm)	Tk. 2,000 per meter
	Weld Testing (Pipe of dia. upto 90 mm)	Tk. 600 per joint
	Area Testing	Tk. 20,000 per sq. meter
Ultrasonic Testing	Weld Testing	Tk. 1,500 per meter
	Surface Testing	Tk. 12,000 per sq. meter
	Thickness gauging	Tk. 100 per Spot
	Shaft Testing (upto 200mm dia.)	Tk. 2,000 per meter
	Shaft Testing (above 200mm dia.)	Tk. 2,500 per meter
Magnetic Particle Testing	Weld Testing	Tk. 1,000 per meter
	Surface Testing	Tk. 10,000 per sq. meter
Liquid Penetrant Testing	Weld Testing	Tk. 1,000 per meter
	Surface Testing	Tk. 10,000 per sq. meter
Eddy Current Testing		Depends on type and size of the work
Digital Hardness Testing		Tk. 100 per Spot
Industrial Videoscope		Tk. 20,000 per day (for inspection) & Tk. 10,000 (for reporting)
Calibration Service	Ultrasonic Flaw Detector	Tk. 3,000 per equipment
	Ultrasonic Thickness Gauge	Tk. 2,000 per equipment
	Other equipment	Depends on the type of the work
Consultancy Service on NDT and Weld Quality Control		Tk. 2,500 per person deployed per day
Other Testing & Services (e.g. NDT Procedure Preparation, Special Investigations, NDT Equipment Testing and Installation)		Depends on type of the work

**Note: Minimum service charges**

- Tk. 2,000 for the service rendered at the NDT Laboratory, AECD
- Tk. 5,000 per deployment for the service rendered within and around Dhaka City
- Tk. 10,000 per deployment for the service rendered outside Dhaka

**Table 2. NDT Training Course Fee**

Course Offered	Type	Course Fee
National NDT Training Courses	Level-1	Tk. 10,000 per participant
	Level-2	Tk. 15,000 per participant
	NDT Foundation Course	Tk. 15,000 per participant
Other Customized Courses on NDT	Cost depends on type, duration and venue of the course	

**Table 3. NDT Certificate Renewal/Recertification Fee**

Type and validity of certificate	Fee
Certificate will be issued for the next 5 years w.e.f the date of issue of the first certificate (Condition: For the certificate already issued for 1 year and did not exceed a time period of 5 years)	Tk.3000
Certificate will be issued for the another next 5 years w.e.f the expiry date of first 5 years (Condition: For the certificate exceeds the time period of 5 years from the date of first issue)	Tk.5000
Re certificate will be issued for the another next 5 years w.e.f the date of passing the Practical Examination (Condition: For the certificate exceeds the time period of 10 years from the date of first issue) Note: If the recertification is applied for more than 12 months after expiry of the period of validity, a complete examination (general, specific and practical) for Level 1 and Level 2 and a main method examination for Level 3 shall again be passed successfully.	Tk.8000

**Plasma Physics Division (PPD)****Objective/Introduction**

The plasma physics division is the newest division of the Atomic Energy Center, Dhaka (AECDC) which is started to work in January 2016 to promote fundamental, advanced and applied research works in the related areas of plasma physics. The major objective of the plasma physics division is to build up capacity in the area of plasma research and plasma based technology development. The major areas of research and development are as follows: Theoretical, computational and experimental studies on the Space plasma, Astrophysical plasma, Industrial plasma, Fusion plasma, etc.

**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Optimization of Axial Current Sheath Velocity in a Dense Plasma Focus Device**

M. A. Malek and M. K. Islam

**Objective:** The objective is to design and develop a suitable dense plasma focus device for technological, industrial and field applications. Computer code based on Lee model is used to design the device.

**Current progress:** A dense plasma focus (DPF) is a high pulsed co-axial accelerator that produces a high-density, high-temperature plasma along with pulsed x-rays, neutrons, electrons, ions and Electro Magnetic Waves. The plasma focus device is composed with two sections: The first section is pre-pinch (axial) section and the second one is the radial pinch phase section. We already studied the axial velocities of plasma sheath with different operational parameters as well as tube parameters. Recently, we have studied the dependency of the axial current sheath velocity on the dimension of electrodes. In this study, the dimension of the electrodes is adjusted in such a manner that the discharge current approaches to maximum when the axial sheath reaches at the end of the anode length. Hence, the pinch starts and occurs at the top of the anode. Detailed consequences of the result on the performance of plasma focus device are understood.

**1.2 Study on the Excitation of Dust Modes in Magnetized Dusty Plasma**

M. K. Islam, M. S. Munir, A. Hossain, M. A. Malek, H. Shahina and Y. Nakashima

**Objective:** To help laboratory experiment of justifying dust modes, especially the dust lower hybrid (DLH) mode, it is important to clarify the conditions for excitation of different electrostatic dust modes in magnetized dusty plasma.

**Current progress:** The conditions for excitation of electrostatic dust modes in magnetized dusty plasmas with negatively charged dust grains are investigated theoretically. It is found that the plasma parameters, wave

propagation direction with respect to the applied magnetic field direction as well as the parameters related with dust grain impose conditions to excite different dust modes in magnetized dusty plasma. A crucial condition is found to excite dust lower hybrid (DLH) mode. Detailed analysis of the conditions to excite electrostatic dust modes in magnetized dusty plasma is given to help laboratory experiment to justify the different dust modes precisely.

## 2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Md. Khairul Islam	National Conference on Physics	BPS	05-07 Jan., 2017	AECD, Dhaka
M. A. Malek	Internet-based Numerical Experiments Workshop on Plasma Focus (NEWPF 2016)	Institute for Plasma Focus Studies Australia in association with ICPSA2016 and AAAPT	16 Sept. - 31 Oct., 2016	Internet-based

## 3. Collaboration Work(s)

For capacity building of the Plasma Physics Division, the division is collaborating with the Plasma Research Center, University of Tsukuba, Tsukuba, Japan. This division is also involved with the collaborative research work on the matters of common interest of the plasma physics group of different public and private universities in the country.

The division has close cooperation with teachers and research students (M. Sc., M. Phil., Ph. D.) of various universities concerning academic works.

## 4. Lecture Delivered

- “Research on the Plasma State of Matter”, Dr. Md. Khairul Islam, Atomic Energy Center, Dhaka, Bangladesh, 17 September, 2016
- “Plasma State of Matter and its Applications”, Dr. Md. Khairul Islam, basic nuclear orientation course 2017(BNOC 2017), TI, AERE, Savar, 24 May, 2017

## ATOMIC ENERGY RESEARCH ESTABLISHMENT (AERE), SAVAR

### CENTRE FOR RESEARCH REACTOR (CRR)

#### Introduction

The TRIGA Mark-II research reactor of Bangladesh Atomic Energy Commission (BAEC) is the only nuclear reactor in the country. It has a maximum steady state thermal power of 3 MW. The reactor achieved its first criticality on 14 September 1986. The reactor has so far been used in various fields of research and utilization such as, Neutron Activation Analysis (NAA), Neutron Radiography (NR), Neutron Scattering (NS), experimental reactor safety research, academic research, training of manpower (local and foreign) etc. Center for Research reactor (CRR) is responsible for the operation and maintenance of the reactor and its associated equipment associated with systems ensuring appropriate level of safety as delineated in the Safety Analysis Report (SAR). CRR is also responsible for the preparation of various Safeguards and Additional Protocol related reports for AERE facilities on routine basis. These reports are sent to the IAEA through Nuclear Safety, Security and Safeguards Division (NSSSD) and International Affairs Division (IAD) of BAEC.

#### Activities/Programme(s)

##### 1. Research and Development Work(s)

Nuclear safety is the most important issues in the nuclear installations. Some important reactor safety such as control rod worth, core excess reactivity, shutdown margin, loss of reactivity with power increases, power

defect, radiation dose measurement at different strategic points, fuel temperature reactivity coefficient, coolant temperature reactivity coefficient, void coefficients and thermal power calibration of the reactor parameters were measured during the reporting period by scientist/engineer of CRR. Study on these safety parameters of the nuclear reactor is very important for reactor safety and efficient operation. Reactor is operated for training, practical experiment related to safety, industrial attachment programme for students from different universities as well as for trainee from BAEC training institute.

Different groups of the Institute of Nuclear Science and Technology (INST) used the neutron beam of the reactor to carry out various Research and Development (R&D) activities. Neutron Activation Analysis technique is used to determine the trace elements present in soil, foodstuff, and vegetable samples. The Neutron Radiography group used the NR technique to detect voids, cracks, internal continuity in materials and determine water absorption behavior of jute plastic composites and various types of building materials e.g. bricks, tiles, etc. The High Performance Powder Diffractometer (HPPD) has been set up at the reactor to enhance the R&D facilities in neutron scattering technique. Structural studies of materials are being done by this technique to characterize materials crystallographically and magnetically. The micro-structural information is obtainable by neutron scattering method which is very essential for determining its technological applications. This technique is unique for understanding the magnetic behavior in magnetic materials. Ceramic, steel, electric and electronic industries can be benefited from this facility to improve their products and fabrication process. During the reporting period, the reactor was operated for a total of about 148.25 hours (257 MWh) at different power levels (50 W – 2.4 MW) in order to test HPPD, nuclear safety research, manpower training and irradiated different target samples for research and development (R&D) activities.

## 2. Repair & Maintenance and Renovation Works

Month	Type of work(s)
July	<ul style="list-style-type: none"> <li>• Installation of the obstruction signal light on the stack of the reactor</li> <li>• Secondary make up and service water supply underground pipe line maintenance: The damaged and corroded underground 2 inch pipeline and corresponding valves were replaced. Visual inspection of reactor pool liner by remote visual system using underwater camera and recorded the visual image data to identify any obvious defect or damage in the reactor tank</li> <li>• Ethernet cable wiring was established from Wi-Fi router to class room in the 2<sup>nd</sup> floor of the reactor extension building</li> </ul>
Aug.	<ul style="list-style-type: none"> <li>• Inspection test and maintenance of the water based fire protection system: Inspection and churn test (operable condition) of the electric driven fire pump and associated systems were performed to ensure fire pump reliability</li> </ul>
Sept.	<ul style="list-style-type: none"> <li>• Reactor pool water temperature channel of the data acquisition unit was made operable by replacing DRF-RTD omega module with action pack module.</li> <li>• New NLW was installed in reactor console system with the help of experts</li> <li>• Vibration monitoring: Primary and secondary pumps and motors vibration were measured to check the operating condition of the system</li> </ul>
Oct.	<ul style="list-style-type: none"> <li>• In-service inspection by NDT method: Reactor tank wall thicknesses were measured by ultrasonic thickness gauge</li> <li>• Vibration monitoring: Primary and secondary pumps and motors vibration were measured to check the operating condition of the system</li> <li>• Range selection switch on ROD control panel did not show actual range on UIT for few ranges. It was identified that BCD board connected to NMP-1000 module has several disconnected wires and ULN-2003 APG IC was damaged. All the circuits of BCD board were made operable by soldering those wires and</li> </ul>



	<p>replacing the ULN-2003 APG IC</p> <ul style="list-style-type: none"> <li>• SCRAM relay maintenance for proper operation of SCRAM circuit and continuous supply of magnet power maintaining safety</li> </ul>
Nov.	<ul style="list-style-type: none"> <li>• The emulator was made operational which will help to gain knowledge about the reactor operation for the beginners</li> <li>• Maintenance of the Cooling tower: Mechanical cleaning were undertaken as schedule to remove the deposited soft sludge and scale from the basin and secondary piping to minimize the fouling effect in secondary cooling system</li> <li>• One faulty relay of the DB-24R relay board was replaced with new one for maintaining “WD1 SCRAM” operational in the SCRAM circuit</li> <li>• Two seismic switches placed in control room and shield structure of reactor tank were configured according to the Safety Analysis Report. These two seismic switches were successfully installed and connected with the SCRAM loop of the digital console system for ensuring safety in emergency condition</li> </ul>
Dec.	<ul style="list-style-type: none"> <li>• Repair and maintenance of the 10 HP water pump: Seal and coupling spacer of the pump were replaced</li> <li>• Annual maintenance and surveillance activities were performed for the following mechanical systems: Primary pumps, secondary pumps, 250kVA &amp; 650 kVA Generators, water treatment plant ,fire pump, 10 HP pump, ventilation system etc.</li> </ul>
Jan.	<ul style="list-style-type: none"> <li>• Change Over switch is a very important part of sustainable electricity supply to reactor facility. One of the 400 A circuit breaker of change over switch was identified faulty and it was replaced by a similar kind of circuit breaker to ensure safe operation</li> <li>• BTRR facility has a 230/120 V transformer. Some important systems like reactor online purification pump are fed from this transformer. Low voltage problem was identified during operation period and preliminary maintenance was done by reactor personal to make it operational</li> </ul>
Feb.	<ul style="list-style-type: none"> <li>• For each start-up of digital console, some tests of NLW-1000 were fails. The problem was investigated and several communications were made with GA experts. According to their findings, GA sent a line driver kit along with the NLW-1000. The line driver kit was successfully installed</li> <li>• Maintenance of Relay board of Emergency Core Cooling System</li> <li>• All the magnetic isolators and electrical connections in the primary and secondary pump rooms were thoroughly checked and repaired</li> <li>• An old metal light shed made operable by replacing capacitor and installed on the roof top of heat exchanger room</li> </ul>
Mar.	<ul style="list-style-type: none"> <li>• The Low-count rate test shows irregular signal for each prestart check. According to the GA expert suggestions, all connection and continuity were checked. A new cable between NLW-100 and PA-1000 was installed replacing the old one for better performance</li> <li>• To ensure proper physical security of reactor facility, two new 100 W LED light shed are installed on the roof top of the south side security post.</li> <li>• One 125 W mercury light shed is installed in the roof top of 250 kVA generator room to enhance the physical security of reactor facility</li> </ul>
April	<ul style="list-style-type: none"> <li>• Physical inspection of distribution boards, LT panel, VCB, Change Over was performed. Necessary steps were taken to clean the panels accordingly</li> <li>• Battery Charger of 250 kVA diesel generator was replaced by a new inverter type battery charger</li> </ul>

May	<ul style="list-style-type: none"> <li>• Replacements of overload relay of online purification pump after proper diagnosis.</li> <li>• Checking battery and maintenance of solar system of CRR</li> </ul>
June	<ul style="list-style-type: none"> <li>• NFT-1000 at DAC was not working properly. A thorough investigation was made on the NFT-1000 module and one DRF-PR module was faulty. The faulty DRF-PR was replaced by a new DRF-PR from spare parts of digital console</li> <li>• A video surveillance system code made operable by installing software and configuring hardware</li> <li>• Problem identification and possible remediation process of hand foot monitor is going on.</li> <li>• To ensure proper physical security of reactor facility, two new 100 W LED light shed are installed on the roof top of the north side security post.</li> </ul>

### 3. Manpower Development/Training Programme(s)

Name of the event/topics	Date	Place	No. of Participant
Industrial Training [for Students of Level-4, Term-1, Mechanical Engineering Department, Bangladesh University of Engineering and Technology (BUET)]	09-29 Aug., 2016	CRR	05
Industrial Training [for the Students of EEE Department, Islamic University of Technology (IUT), Gazipur]	21- 22, 28- 29 Nov., 2016	CRR	97
Practical Class [for the Participants of Follow-up Training Course (FTC)]	02 Feb., 2017	CRR	16
Industrial Training [for the Students of Level-4, Term-1, Mechanical Engineering Department, Bangladesh University of Engineering and Technology (BUET)]	08-27 Feb., 2017	CRR	05
Practical Class [for the students of masters 4 <sup>th</sup> batch, Department of Nuclear Engineering, Dhaka University, Session 2015-2016]	09-11 Apr., 2017	CRR	19
Industrial Training [4 <sup>th</sup> year 1 <sup>st</sup> semester Students of Mechanical Engineering Department, Dhaka University of Engineering and Technology (DUET) ]	12 Apr., - 02 May, 2017	CRR	20
Practical Training [for the students of masters 5 <sup>th</sup> batch, Department of Nuclear Engineering, Dhaka University]	27 Apr., 2017	CRR	26
Training[for the Participants of Basic Nuclear Orientation Course (BNOC)-2017, TI, AERE]	11 May, 2017	CRR	26
Senior Reactor Operator (SRO) License Course	Apr. 1- Sept., 2016	CRR	05
Reactor Operator (RO) License Course	07 Feb., -27 Oct, 2016	CRR	04

## INSTITUTE OF NUCLEAR SCIENCE AND TECHNOLOGY (INST)

### Radioisotope Production Division (RIPD)

#### Objective

The objective of Radioisotope Production Division (RIPD) is to substitute the import of medical radioisotopes, Tc-99m cold kit and therapeutic radiopharmaceutical by indigenous production. To achieve the goal the production and supply of two medically important radioisotopes Tc-99m and I-131 are regularly done. RIPD is now meeting the entire demand of Mo-99/Tc-99m generator of 15 Nuclear medicine centers under the umbrella of Bangladesh Atomic Energy Commission and also supplies Mo-99/Tc-99m generators to some private and government run nuclear medicine centers. The Mo-99/Tc-99m generators produced at the cGMP compliant facility are comparable with the best quality generator available in the global market. The Mo-99/Tc-99m generators produced at the cGMP compliant facility are comparable with the best quality

generator available in the global market. I-131 produced by RIPD is also extensively used in the 15 Nuclear medicine centers of BAEC. Beside this, RIPD also conducts research in the field of medical radioisotopes and radiopharmaceuticals.

## Activities/Programme(s)

### 1. Research and Development Work(s)

#### 1.1 Study on Partial elution Problem of Tc-99m Generator

Partial elution of Tc-99m from  $^{99m}\text{Mo}/^{99m}\text{Tc}$  generator was reported from different nuclear medicine centers to RIPD. Several experimental works were performed which include use of different types of Aluminium oxide (acidic, basic and neutral), change of conditioning of  $\text{Al}_2\text{O}_3$ , addition of various amounts of oxidizing agent etc. to find out the reason and solve it. Inadequate oxidization process of oxidizing agent (NaOCl) caused the negative shifting in the yield of Tc-99m from column chromatographic  $^{99m}\text{Mo}/^{99m}\text{Tc}$  generator. Stable pertechnetate yield was found with 30%  $\text{H}_2\text{O}_2$  proportioned to  $\text{H}_2\text{O}$  as 3:7.

#### 1.2. Effect of Addition of Oxidizing Agent on Mo-99 Breakthrough for the Newly Imported Mo-99 from Indonesia

Relatively higher volume of supplied Mo-99 from Indonesia compared to previous supplier (Belgium) cause higher amount of Mo-99 breakthrough in the Tc-99m elute. NaOCl and  $\text{H}_2\text{O}_2$  were used separately as oxidizing agent during chemical process Mo-99 prior to loading to  $^{99m}\text{Mo}/^{99m}\text{Tc}$ . Use of 6-14% Cl active NaOCl reduces the Mo-99 breakthrough in the Tc-99m elute within the permissible limit.

### 2. Repair & Maintenance

- Operation & maintenance of the cGMP complaint computer controlled on-line Tc-99m generator
- Production facility at RIPD and I-131 Production Plant
- Maintenance of Non-pyrogenic Water Production Plant, Hot Air Sterilizer, Steam Sterilizer
- Operation and Maintenance of Lyophilizer
- **Operation & Maintenance of HPGe**

### 3. Manpower Development/Training Programme(s)

Name of the Participant	Name of the event/topics	Organizer	Date	Place
Dr. Md. Mustafizur Rahman	Regional Training Course on Security and Radioactive Material in Transport”	IAEA	3-7 Oct., 2016	Philippines
Dr. Md. Mustafizur Rahman	Regional Training Course on the Development and Clinical Application of Radiosynovectomy”	IAEA	14-18 Nov., 2016.	Philippines

### 4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
Md. Mahfujur Rahman	Regional Workshop on Radiation Safety and Emergency Preparedness	IAEA	31 Oct., - 8 Nov., 2016	KINS, Daejeon, South Korea
Momtaz Fatima Waheed	Workshop on the Signatures of Man-Made Isotope Production”	IAEA	San Carlos de Bariloche, Argentina	28 November to 2 December, 2016.
Dr. Md. Mustafizur Rahman	Regional Workshop on Preparation and Clinical Utilization of Radiolabeled Therapeutic peptides”	IAEA	Singapore	22-26 May, 2017

**5. Collaboration Work(s)**

IAEA TC Project BGD/6/022: “Producing Therapeutic Radiopharmaceuticals”.

To produce and supply of Therapeutic Radiopharmaceutical (Lu-177) to meet the local demand of these isotopes is under implementation.

**6. Service Rendered and Revenue Income**

Number of service given organization	Nature of service	Total number	Income (BDT)
21	Supply of Mo99/Tc-99m generator	820 Mo99/Tc-99m generators	6,56,00,000/-
16	Supply of I-131 radioisotope	1334.22 GBq	1,10,80,000/-
Total			7,66,80,000/-

**7. Lecture Delivered**

- The scientist of this division conducted full theoretical and practical courses of Radiopharmacy for the M. Phill course of BSMMU
- Three scientists also delivered lectures in the Basic Nuclear Orientation Course (BNOC)-2017 conducted by BAEC

**Nuclear and Radiation Chemistry Division (NRCD)****Objective/Introduction**

The objective of Nuclear and Radiation Chemistry Division (NRCD) is modification of materials to use in the fields of health, agriculture, water treatment and biodegradable packaging material by the application of nuclear technique especially gamma ray. Moreover, this division insures water quality of research reactor, provides analytical services to different institute of BAEC/other organizations of Bangladesh and study on environmental pollution of different matrix.

**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Preparation of Amidoxime Adsorbent by Radiation Induced Grafting of Acrylonitrile on Polyethylene Film and Its Application in Cr(VI) Removal**

N. Rahman, N. C. Dafader and A. R. Miah

Pre-irradiation technique was applied to graft acrylonitrile (AN) onto polyethylene film. The graft yield was optimized with respect to radiation dose, monomer concentration and reaction time. Effect of H<sub>2</sub>SO<sub>4</sub> as additive on graft yield was studied. Highest graft yield obtained was 120 % at 70 kGy radiation dose, 60% monomer concentration and 4 h reaction time using H<sub>2</sub>SO<sub>4</sub> as additive. The AN grafted films were modified with hydroxyl amine hydrochloride to prepare amidoxime adsorbent. The prepared adsorbent was characterized by FTIR, TGA and DMA. The prepared amidoxime adsorbent showed high affinity towards Cr(VI) adsorption. Adsorption capacity was studied under different conditions: contact time, pH and initial metal ion concentration. The highest adsorption capacity obtained was 200 mg/g after 72 h contact time at pH 1.5 and initial metal ion concentration 200 ppm. Pseudo-first-order and pseudo-second-order equations were used for interpretation of kinetic adsorption data. The equilibrium experimental data for the adsorption of Cr(VI) on amidoxime adsorbent were also fitted with Langmuir isotherm model. Desorption and reuse of the adsorbent film was studied. The adsorbent showed no significant loss of activity indicating that the film can be used repeatedly for Cr(VI) sorption from aqueous solution.

## **1.2 Preparation and Property Analysis of Biodegradable Packaging Film from Alginate, Starch and Citric acid**

N. Rahman, N. C. Dafader and Parvin Banu

In the present study alginate-starch blend films (thickness 0.08 mm) of different composition were prepared by casting and their mechanical properties were studied. Highest tensile strength was obtained for alginate: starch = 4: 1 of 70 MPa. To impart antimicrobial property to the alginate-starch films, citric acid of different composition were used and CaCl<sub>2</sub> treatment of this film was performed to improve the water resistance of the films. Then the films were further modified with monomer, methylacrylate (MA) and gamma radiation. The blend films were soaked in different formulations of methylacrylate (MA), in methanol and then irradiated by gamma radiation. Mechanical properties of the modified films such as tensile strength and elongation at break were studied. Thermal properties of films were characterized by dynamic mechanical analysis (DMA). The structural and morphological features of films were investigated using Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM).

## **1.3 Effect of Oligo-Chitosan and Bio-Fertilizer on Rice Plant**

S. Sultana, K. Pramanik and S. Nahar

A pot experiment was conducted at National Institute of Biotechnology (NIB), Savar to evaluate the effect of oligo-chitosan (o-chitosan) and bio-fertilizer separately on rice plant during August to November, 2016. The crop variety was BIRRI-29 and *Azospirillum sp* strain was used as bio-fertilizer (Associative N<sub>2</sub> fixing bio-fertilizer, Phosphate solubilizing Bacteria). Five milliliter of bio-fertilizer (10<sup>7</sup>~10<sup>8</sup> CFU/ml) was applied on each plant with one week interval up to 2.5 months. Different concentration of o-chitosan (50 and 100 ppm) was applied foliarly to rice plant and water level was maintained as per requirement. O-chitosan and bio-fertilizer separately showed some positive effects in terms of number of tillers and number of panicle per pot in compare to control.

## **1.4 Effect of Oligo-Chitosan on Growth and Yield of Maize (Zea mays L)**

S. Sultana, F. Khatun, J. Alam and M. Rahman

Field experiment (3m x 2m) was conducted at the Atomic Energy Research Establishment (AERE), Savar during the period from April to July 2016 to investigate the effect foliar application of oligo-chitosan (o-chitosan) on morphological values and seed yield of maize plants. The experiment comprised four levels of o-chitosan concentrations viz., 0, 50, 75 and 100ppm. O-chitosan was applied on maize plant after germination at every 10 days up to harvesting times and parameter was studied 15-20 days interval. Plant parameters such as cob length and breadth, cob weight, number of seeds cob<sup>-1</sup>, 100-seed weight, number of cob plot<sup>-1</sup> increased significantly with the increased concentration of o-chitosan up to 75 ppm. Therefore, foliar application of o-chitosan with 75 ppm gives the highest yield over control which is ~ 44%.

## **1.5 Management of Phomopsis Blight and Fruit Rot of Brinjal by Oligo-Chitosan**

S. Sultana, F. Khatun, J. Alam and M. Rahman

Fruit rot of brinjal caused by *Phomopsis vexans* is an important disease of eggplant inflicting heavy losses. It is reported that chitosan has antifungal activity and induced systemic resistance in plants. Therefore, it is necessary to study the management of disease through the use of chitosan. It has observed that oligo-chitosan applied at different concentration (from 1000-5000 ppm) significantly inhibited the mycelial growth of *Phomopsis vexans*. It was observed that with increasing the concentration of oligo-chitosan the mycelial growth of *Phomopsis vexans* extensively decreased. At 5000ppm oligo-chitosan, the inhibition percent of mycelia growth over control is 74.89. The results of bio-assay test indicate the effectiveness of oligo-chitosan in mycelial growth inhibition, which is a concentration dependent manner.

### 1.6 Effect of Oligo-Chitosan on Plant Diseases of Carrot (*Daucus Carrota L.*)

S. Sultana, F. Khatun, J. Alam and M. Rahman

Carrot (*Daucus carrota L.*) is one of the most popular and highly nutritious cool season root crops. The soil borne diseases is the major constraints to produce the carrot. The major diseases of carrot are: Crown rot and Canker caused by *Rhizoctonia solani* pathogen, Southern blight caused by *Sclerotium rolfsii*, *Alternaria* leaf blight caused by *Alternaria dauci*, Cavity spot caused by *Pythium* spp., Damping off caused by *Fusarium* spp., Sclerotinia rot caused by *Sclerotinia sclerotiorum*. Among them the southern blight of carrot caused by *Sclerotium rolfsii* pathogen is remarkable. This pathogen is very threats in carrot production both at seedling and mature stage in the field. It is reported that chitosan has antifungal activity and induced systemic resistance in plants. Oligo-chitosan against carrot root fungi was tested in vitro at four concentrations, i.e. 0, 2000, 4000 and 6000 ppm. It has observed that all tested concentrations have significantly reduced the mycelial growth of tested pathogen. The highest reduction was obtained with oligo-chitosan used at 6000 ppm which is 70.20% where the mycelial growth was reduced by up to 26.12% and 55.10% for 2000ppm and 4000ppm of o- chitosan respectively.

### 1.7 Determination of Uranium and Its Isotopic Ratio in Environment Samples Collected from North-East Part of Bangladesh Using Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)

M. F. Alam, G. Yang, M. Yamada, A. K. M. A. Ullah, M. I. Khalil, A. K. M. F. Kibria and N. C. Dafader

The sediment samples was collected from north-east part of Bangladesh to measure background levels of  $^{238}\text{U}$ , activity of trace  $^{236}\text{U}$  and  $^{236}\text{U}/^{238}\text{U}$  atom ratios by using ICP-QQQ. In order to measure trace  $^{236}\text{U}$  and  $^{236}\text{U}/^{238}\text{U}$  in environmental samples with a high matrix effect, a novel and simple method was established that makes the digestion and purification procedures compatible with advanced triple-quadruple inductively coupled plasma-mass spectrometry. A total dissolution of sample with  $\text{HF}+\text{HNO}_3+\text{HClO}_4$  was followed by chromatographic separation with a single resin column containing normal type DGA resin. The analytical accuracy and precision of  $^{236}\text{U}/^{238}\text{U}$  ratios were examined by using the reference materials IAEA-135. Finally, the developed method was successfully applied to measure  $^{236}\text{U}/^{238}\text{U}$  ratios and  $^{236}\text{U}$  activities in soil samples. The result found that the activity of  $^{238}\text{U}$  was 4.83 Bq/kg - 5.86 Bq/kg,  $^{236}\text{U}$  was  $2.63 \times 10^{-5}$  Bq/kg -  $4.70 \times 10^{-5}$  Bq/kg and  $^{236}\text{U}/^{238}\text{U}$  atom ratios was  $2.83 \times 10^{-8}$  -  $4.20 \times 10^{-8}$ .

### 1.8 Determination of Ultra-Trace $^{129}\text{I}$ in Environmental Samples by Triple Quadruple ICP-MS and Its Application to Coastal Sediment Samples of Bangladesh

M. F. Alam, G. Yang, M. Yamada, A. K. M. A. Ullah, I. Khalil, A. K. M. F. Kibria and N. C. Dafader

The aim of this study is to determine the ultra-trace  $^{129}\text{I}$  in the environmental sample. We have developed analytical procedures for the determination of  $^{129}\text{I}$  in sediment samples by triple quadruple ICP-MS. Tetra methyl ammonium hydroxide (TMAH) used as a chemical modifier and  $\text{CCl}_4$  for solvent-extraction to separate iodine from sediment. In this study, oxygen was used as a reaction gas for reducing the background intensity. The measured  $^{129}\text{I}/^{127}\text{I}$  ratios of Geological Reference Standard, JSD-3 are consistent with the certified value within the analytical error. In order to confirm the applicability of the method to the measurement of  $^{129}\text{I}/^{127}\text{I}$  ratios of sediment samples collected in the southern coastal region of Bangladesh, two samples were analyzed. The  $^{129}\text{I}$  was found from 1.04 – 1.26 mBq/kg and  $^{129}\text{I}/^{127}\text{I}$  was found from  $2.29 \times 10^{-7}$  -  $3.02 \times 10^{-7}$ . This method provides a powerful tool for investigating radioiodine contamination in the environmental sample.

### 1.9 Human Health Risk Evaluation Due to Cd in Groundwater in Damurhuda Union, Chuadanga, Bangladesh

S. Sultana, M. F. Alam, F. T. Ahmed, N. C. Dafadar, M. T. Hasan, M. S. Rahman and G. Ara

Groundwater in Damurhuda Union, Chuadanga, Bangladesh was collected to determine the level of Cd metal in drinking water of the study area and evaluate the health risk (hazard quotient, HQ) of adults and children with exposure to this element via oral ingestion and absorption through skin. The average value of concentration of Cd metal in groundwater of the study area is higher than the permissible limit. The  $\text{HQ}_{\text{oral}}$  &

HQ<sub>dermal</sub> for adult and child is greater than 1 in almost all the sampling sites indicating potential health risk to the people on consumption of the groundwater and these locations either have unusual geological enrichment or are under heavy anthropogenic influence showing adverse health threat.

### 1.10 Physico-Chemical Properties of Some Industrial Waste Water in Hazaribagh, Dhaka, Bangladesh

S. Sultana, M. F. Alam, F. T. Ahmed, N. C. Dafadar, M. S. Rahman and G. Ara

The waste water of tannery industries and its surrounding areas was collected for analysis. For this purpose, three tannery industries (Shahjalal, Superior and Lexco Tannery industries, Hazaribag, Dhaka), its adjacent river Buriganga and tube well water were selected. Water samples were collected from three leather industries, two different locations (Gazirghat and Jhauchar point) of the adjacent river Buriganga and a tube well. In this investigation, the pH of industrial waste water was found to be in acidic range (3.79-5.78) and EC value also found highest (2.89-75.3). The pH value of tube-well water and river water are of 7.15 and 7.19-7.34 respectively. The EC value of tube well water and river water are of 0.27 and 0.80-0.85 mS/cm respectively. The other properties such as Total Dissolved Solid (TDS), Phosphate (PO<sub>4</sub><sup>3-</sup>), Chloride (Cl<sup>-</sup>), Total Alkalinity (TA) and Total Hardness (TH) of tannery effluent, river and tube well water were found in the range of 0.185-40.95, 0.1920-2.3848, 0.8818-1878, 90-1332 and 110-654 mg/L respectively.

### 2. Manpower Development/Training Programme(s)

Name of The participant	Name of the event/topics	Organizer	Date	Place
Farah Tasneem Ahmed	Basic Nuclear Orientation Course-2017	BAEC	09 April- 08 June, 2017	TI, AERE
Shahnaz Sultana	64th Training programme of NITUB of UV-VIS and IR spectrophotometer	NITUB	08-13 April, 2017	Dhaka University
Shahnaz Sultana	Follow-up training course (FTC)-2017 on Reactor Engineering Course	BAEC and JAEA	29 Jan-16 Feb, 2017	TI, AERE
Shahnaz Sultana	Follow-up Training Course (FTC)-2017 on Environmental Radioactivity Monitoring course	BAEC and JAEA	15-19 Jan, 2017	TI, AERE
Dr. Nazia Rahman and Shahnaz Sultana	IAEA/RCA Regional Training Course on Advanced Characterization methods of Grafted Polymeric Matrix: Designing and Up Scaling of Radiation Grafting for Environmental and Industrial Application	IAEA	08-12 Aug, 2016	Kuala Lumpur, Malaysia.

### 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of The participant	Name of the event/topics	Organizer	Date	Place
Dr. N. C. Dafader, Dr. S. Sultana, Dr. N. Rahman and S. Shahnaz	National Conference on Physics-2017	BPS	05-07 January 2017	AEC, Dhaka, Bangladesh
Dr. Nazia Rahman	International Conference on Applications of Radiation Science and Technology	IAEA	24-28 April 2017	Vienna, Austria
Md. Ferdous Alam	Environmental monitoring of radionuclide's released from nuclear power plant accident by using ICP-MS	MEXT	26 Sep, 2016 – 03 March, 2017	Hirosaki University, Japan

Dr. Nirmal Chandra Dafader	IAEA/RCA Final Review Meeting of Extended RAS/1/014 Project	IAEA	28 Nov – 02 Dec, 2016	Takasaki, Japan
Dr. Salma Sultana	FNCA Joint Workshop on Bio-fertilizer Project and Electron Accelerator Application Project	FNCA	7-11 Nov, 2016	Hanoi, Vietnam.
Dr. Nirmal Chandra Dafader	Third Research Coordination Meeting on Application of Radiation Techniques in Development of Advanced Packaging Materials for Food Products	IAEA	11-15 July 2016,	Vienna, Austria

#### 4. Collaboration work(s)

- IAEA/RCA Project Title: Supporting Radiation Processing for the Development of Advanced Grafted Materials for industrial Applications and Environmental Preservation (RAS/1/014)
- FNCA Project Title: Application of Electron Accelerator, Radiation Processing of Natural Polymers
- IAEA CRP Project Title: Application of Radiation Techniques in Development of Advanced Packaging Materials for Food Products’ (Research Contract No. 17639/R0)

#### 5. Service Rendered

Number of services given organization/person/patient	Nature of sample/service	Total number/quantity of sample/person/patient
Center for Research Reactor (CRR)	Water quality analysis	Weekly and Yearly basis
Food Technology Division, IFRB, AERE	Trace elemental analysis	08
Reactor and Neutron Physics Division, INST, AERE	Toxic element analysis	12

#### Health Physics and Radioactive Waste Management Unit (HPRWMU)

##### Objective/Introduction

The objective of Health Physics and Radioactive Waste Management Unit (HPRWMU) is to ensure protection of human and the environment, at present and in future, from hazards & deleterious effects of ionizing radiations associated with Radioactive Wastes (RW) and Radiation Sources (RS). In order to achieve the above mentioned objective, the unit is conducting its activities in following four areas:

- Radiation Protection Service (RPS): Providing routine and emergency radiation protection service throughout the country
- Environmental Radiation Monitoring (ERM): Conducting assessment and control of radiation exposure to occupational workers and the public
- Secondary Standard Dosimetry Laboratory (SSDL): Performing Standardization of radiation monitoring equipment’s

Radioactive Waste (RW) Management: Working on safe management of RW and radiation source (RS) including their ultimate disposal



**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Distribution of Natural and Probable Artificial Radioactivity Sediment and Water Samples Collected from Low-Lying Areas of Savar Industrial Zone, Bangladesh**

M. L. Ali, M. A. Haydar, M. I. Ali, D. Paul and S. M. A. Islam.

Distribution of the natural radionuclides ( $^{238}\text{U}$ ,  $^{232}\text{Th}$ , and  $^{40}\text{K}$ ) and their specific activities in sands and sediments of the Brahmaputra (Jamuna) river of Bangladesh together with mineral characteristics has been studied to assess the radiation levels as well as to develop a baseline database for comparison in the future in case of any change in the area under study due to anthropogenic activities. The radiological parameters of natural radioactivity were assessed calculating the radium equivalent activity, hazard index, the absorbed dose rate, and annual effective dose. The average activity concentrations of  $^{226}\text{Ra}$  ( $^{238}\text{U}$ ),  $^{232}\text{Th}$ , and  $^{40}\text{K}$  in sand and sediment were found to be  $59 \pm 2$  &  $60 \pm 2$  Bq/kg,  $113 \pm 5$  &  $135 \pm 5$  Bq/kg, and  $983 \pm 42$  &  $1002 \pm 43$  Bq/kg, respectively. The calculated average absorbed dose rate and annual effective dose were found to be 150 nGy/h and 0.18 mSv/ year respectively. These high values are associated with mineral content of the sediment. X-ray diffraction peaks of sand and sediment samples identify quartz, feldspar, rutile, zircon, monazite, uranium fluoride, hematite, kyanite, and uranium arsenide minerals to be present in the samples.

**1.2 Measurement of flux-weighted average cross-sections and Isomeric Yield Ratios for  $^{103}\text{Rh}(\gamma, xn)$  Reactions in the Bremsstrahlung End-Point Energies of 55 and 60 MeV**

M. S. Rahman, K. Kim, G. Kim, H. Naik and et al.

They measured the flux-weighted average cross-sections and the isomeric yield ratios of  $^{99\text{m,g},100\text{m,g},101\text{m,g},102\text{m,g}}\text{Rh}$  in the  $^{103}\text{Rh}(\gamma, xn)$  reactions with the bremsstrahlung end-point energies of 55 and 60 MeV by the activation and the off-line  $\gamma$ -ray spectrometric technique, using the 100 MeV electron linac at the Pohang Accelerator Laboratory. The flux-weighted average cross-sections were calculated by using the computer code TALYS 1.6 based on mono-energetic photons, and compared with the present experimental data. The flux-weighted average cross-sections of  $^{103}\text{Rh}(\gamma, xn)$  reactions in intermediate bremsstrahlung energies are the first time measurement and are found to increase from their threshold value to a particular value, where the other reaction channels open up. Thereafter, it decreases with bremsstrahlung energy due to its partition in different reaction channels. The isomeric yield ratios (IR) of  $^{99\text{m,g},100\text{m,g},101\text{m,g},102\text{m,g}}\text{Rh}$  in the  $^{103}\text{Rh}(\gamma, xn)$  reactions from the present work were compared with the literature data in the  $^{103}\text{Rh}(d, x)$ ,  $^{102-99}\text{Ru}(p, x)$ ,  $^{103}\text{Rh}(\alpha, \alpha n)$ ,  $^{103}\text{Rh}(\alpha, 2p3n)$ ,  $^{102}\text{Ru}(3\text{He}, x)$ , and  $^{103}\text{Rh}(\gamma, xn)$  reactions. It was found that the IR values of  $^{102,101,100,99}\text{Rh}$  in all these reactions increase with the projectile energy, which indicates the role of excitation energy. At the same excitation energy, the IR values of  $^{102,101,100,99}\text{Rh}$  are higher in the charged particle-induced reactions than in the photon-induced reaction, which indicates the role of input angular momentum.

**1.3 Comparison of 3DCRT Dose Distribution in Radiotherapy for Lung Cancer Patient by using AAA PBC Algorithms**

M. M. Rana, S. M. A. Islam, M. M. Islam, M. S. Rahman, S. Alam and M. A. Bari

The Pencil Beam Convolution (PBC) algorithm in radiation treatment planning system is widely used to calculate the radiation dose distribution in radiotherapy planning. A new photon dose calculation algorithm known as Anisotropic Analytical Algorithm (AAA) by Varian Medical Systems is applied to investigate the difference of dose distribution by using AAA and PBC algorithms for the lung cancer with an inhomogeneity of its low density. In the present work, radiotherapy treatment planning of 10 lung cancer patients are designed with 6 MV photon beam using three-dimensional conformal radiation therapy (3DCRT) and dose distribution was calculated by the AAA and the PBC Algorithms. The dose distribution performance is evaluated by dose profile curve along transversal slice of PTV and Dose Volume Histogram (DVH) covered by the 95% isotope of PTV. The mean dose of organ at risks did not change significantly but the volume of the PTV covered by the 95% isotope curve was decreased by 6% within inhomogeneity due to the algorithms. The dose distribution and the accuracy in calculating the absorbed dose of the AAA algorithm of the Varian Eclipse treatment planning system is analyzed and discussed.

#### **1.4 Photonuclear Studies for the Isomeric Yield Ratios in the Production of $^{nat}\text{Fe}(\gamma, \text{xnp})$ $^{52m}\text{gMn}$ with 50-, 60- and 70-MeV Bremsstrahlung**

**M. S. Rahman, G. Kim, K. S. Kim, M. Lee and A. K. M M. H. Meaze**

The isomeric yield ratios in the production of  $^{nat}\text{Fe}(\gamma, \text{xnp})$   $^{52m}\text{gMn}$  have been measured with photonuclear reactions. The high purity natural Fe metallic foils were used and irradiated with bremsstrahlung beams of end point energy 50-, 60-, and 70-MeV. The bremsstrahlung beams are produced with high energy electron beam struck with 0.1 mm thin tungsten target. The activation method has been used and hence the induced activities in the irradiated foils were measured by off-line  $\gamma$ -ray spectrometric technique using HPGe detector coupled to a PC-based 4K MCA. The experimental values of isomeric ratios are compared with the theoretical values by statistical model code TALYS. The detail of the formation of isomers by photonuclear reactions together with the literature values of the investigated nuclides are compared and discussed.

#### **1.5 Elemental Distribution of Metals in Urban River Sediments Near an Industrial Effluent Source**

U. Tamim, R. Khan, Y. N. Jolly, K. Fatema, S. Das, K. Naher, M. A. Islam, S. M. A. Islam  
and S. M. Hossain

To study the compositional trends associated with the spatial and layer wise distribution of heavy metals as well as the sediment response towards the untreated chemical wastes. They have analyzed river sediments by INAA and EDXRF. In nine sediment samples 27 elements were determined where Na, Al, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Zn, As, Rb, Cs, La, Ce, Sm, Dy, Hf, Th and U were determined by INAA and Cu, Sr, Ba, Hg and Pb were determined by EDXRF. Pollution level and the origin of pollutants were evaluated by the aid of geo-accumulation index, enrichment factor, pollution load index and the inter-element correlation analysis. Major elements are somehow buffered even though the pollution level is severe while the trace metals seem to be highly responsive. Among the heavy metals, Cr is the dominant pollutant, though the pollution level varies systematically with the sampling depth and the distance from the contamination source. Positive linear correlation between Cr and Zn (0.94) ensures the similar anthropogenic source(s) for these two metals, but the sediments of this study respond differently depending upon their geochemical behavior.

#### **1.6 Conditioning of Disused Sealed radioactive Sources (DSRSs) in Bangladesh: Recent Experience and Lessons Learned**

M. I. Ali, D. Paul, A. M. Farsani and J. C. B. Navarro

Radioisotopes have found diversified and incremental applications in Bangladesh including medicine, industry, agriculture, research and education etc. As a result, a considerable number of DSRs have been generated in the country. Recently Bangladesh has completed the conditioning of Category 3-5 DSRs stored at CWPSF with the assistance of IAEA experts under RAS-9071 project. A total of 89 sources (which include both gamma and neutron sources) of about 2Ci total activity were conditioned and stored into 4 special type capsules (3 for gamma sources and 1 for neutron sources) designed and approved by IAEA. The capsules with gamma sources were kept in 2 cemented drums and the capsule with neutron sources was kept in a lead container with sufficient polyethylene shielding and finally stored at the interim storage area of the CWPSF. The national operators responsible for radioactive waste management (RWM) in the country got 'hands-on training' and gathered valuable experience during this 'first-ever' conditioning operation.

#### **1.7 Exploring Sustainability to Feed the World in 2050**

M. H. Rahman

The world population is expected to reach 9 to 9.3 billion by the year 2050. By 2050, demand of food will rise up to 70% henceforth need to produce more food. More food requires more water, more land and more energy. Sustainable use of natural resources is required because those resources will become scarcer in the future. There is no sustainability without decreasing hunger. The global food security challenge is not about the capability of world agricultural producers to produce enough food to feed the world, but rather is about ensuring that the poorest people in the world have the economic and physical access to the food they require

to meet their nutritional needs. Improving the global world food balance sustainably is of importance in order to prevent global food prices from increasing to a level that leads to increasing food insecurity and poverty for people who spend a high share of income on food. Future world food balance will not only depend on increase in overall production, reduction of waste and losses but also the sustainable consumption pattern. A sustainable food diet would give preference for reduced meat diets, organically, minimally processed, ecologically packed and tastefully prepared foods, diets that have low environmental impacts but provide the required amount of nutrients and energy to maintain good health, as well as foods traded fairly. Need more scientific research to increase investment to sustain productivity growth in technology, infrastructure and institutions, environmental services and sustainable resource management.

## 2. Seminar/Symposium/Conference/Workshop/Meeting Attended

No	Name of the participant	Name of the event/topics	Organizer	Date	Place
1.	Dr. Md. Shamsuzzaman	Annual Conference of Bangladesh Society of Oncologists & Bangladesh Medical Physics Society	BIAM	24 -25 Sept. 2016	Dhaka
2.	All Scientists of HPRWMU	Heavy Metal Removal Performances of Recycled Concrete and Cement Paste: A potential Method for Groundwater Treatment in Bangladesh	NMU	22 Nov. 2016	INST, AERE
3.	Dr. Debasish Paul Dr. M. Moinul Islam Dr. Shakilur Rahman Dr. M.H. Bhuyan Dr. Md. Shamsuzzaman	National Conference on physics	BPS	5 -7 Jan., 2017	AEC, Dhaka
3.	Dr. Shakilur Rahman Dr. M.H. Bhuyan Dr. Md. Shamsuzzaman Tanjim Siddiqua	International Conference on Physics in Medicine and Clinical Neuroelectrophysiology	BMPA	10-11 March, 2017	Dhaka University
4.	Dr. Shakilur Rahman	15 <sup>th</sup> Chittagong Conference on Mathematical Physics	Ctg. Univ.	16-03-2017	Chittagong

## 3. Service Rendered and Revenue Income

Name of sample/service	Total number/quantity of sample/person/patient	Income (BDT)
Radiation survey	16	96,900.00
Interim storage	2 (1 box)	1,22,960.00
Radiation measuring devices calibration, dosimetry	82	4,55,000.00
Total		6,74,860.00

### Others

- Numbers of environmental sample analysis (July 2016 - June 2017) by HPGe Detector are 340.
- Numbers of calibrated radiation measuring devices by SSDL of HPRWMU are 82.

### Reactor Physics & Engineering Division (RPED)

#### Objective/Introduction

The programme of the division is to conduct R&D activities using modern methods for the computational analysis of nuclear reactors, with particular emphasis on reactor physics, design and safety. Here we procure and implement computer codes related to reactor engineering and nuclear data processing with international

collaboration. The ultimate objective of the division is to support the development of infrastructure for nuclear power programme to meet the ever increasing demand of electricity.

### Activities/Programme(s)

Neutronics and Thermal Hydraulics calculations are needed for efficient utilization and safe operation of nuclear reactor. In these regard MCNP modeling of TRIGA and VVER type reactor is going on. Neutron beam design of TRIGA reactor has been studied and kinetic parameter calculation is under investigation. Neutronic benchmark calculation of VVER-1000 reactor is also under way. Thermal hydraulics and Transient analysis of TRIGA reactor has been performed with the code COOLOD-N2 and EUREKA-2/RR. TRIGA system modeling with RELAP-5 is going on. The division also supports Nuclear Engineering study programme of different local universities.

#### 1. Research and Development Work(s)

Description (150 to 200 words): RPED is engaged in developing and transferring technology/computer codes for overall design, analysis, in-core fuel management and safety studies of nuclear reactors. The following on-going research projects are highlighted to reflect the activity of the section:

- Nuclear engineering and nuclear data processing
- Radiation shielding technology
- Neutronics analysis of nuclear reactors
- Thermal hydraulics and Safety studies of nuclear reactors

#### 2. Manpower Development/Training Programme(s)

Name of the event/topics	Date	Place	No. of participant
Advance Simulation of Thermal Hydraulic Phenomenology with System Codes, RELAP5, TRACE and RELAP/SCDAP Training Course”	17-21 Oct, 2016	Barcelona, Spain	01
3 <sup>rd</sup> Foundation Course on Nuclear Energy (FCNE)	9 Jan.-17 Feb.2017	Mumbai, India	01
Reactor Engineering Course at BAEC (RECB-5)-2017	29 Jan.-16 Feb.2017	Training Institute, AERE	01
Nuclear Engineering practical course for the Dhaka University Nuclear Engineering students.	9-23 Apr. 2017	INST, AERE	19
Two Lectures delivered Basic Nuclear Orientation Course (BNOC)-2017	9 Apr.-8 Jun. 2017	Training Institute, AERE	

#### 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the Participant	Name of the event/topics	Organizer	Date	Place
Dr. Md. Jahirul H. Khan	Workshop on Research Reactor Network (RRN) Project and Neutron Activation Analysis (NAA) Project	MEXT	7-9, Dec., 2016	Sydney, Australia
Dr. Md. Jahirul H. Khan Dr. Badrun N. Hamid M. SayemMahmood Md. AltafHossen RashidaYasmeen	National Conference on Physics-2017	BPS	5-7, Jan. 2017	Dhaka
Dr. Badrun N. Hamid	International Conference on Topical Issues in Nuclear Installation Safety: Safety Demonstration of Advanced Water Cooled Nuclear Power Plants	IAEA	6-9 Jun. 2017	Vienna, Austria

#### 4. Lecture Delivered

Four Lectures delivered for “Nuclear Engineering Follow up Training Course (FTC)-2017”, TI AERE, 29 Jan.-16 Feb., 2017.

#### Tandem Accelerator Facilities Division (TAFD)

##### Objective/Introduction

The main objective of the Tandem Accelerator Facility is to provide analytical service: qualitative and quantitative analysis of elements in environmental samples, i.e. soil, water, air, food, blood, industrial materials, etc.

##### Activities/Programme(s)

###### 1. Repair & Maintenance

As the central AC was unoperational for long period of time, many parts of the accelerator was getting trouble. The troublesome parts are PIXE detector, striper motor inside the tank, one turbo-molecular pump and batteries of accelerator ups. Different types of initiative were taken for themaintenance.

###### 2. Manpower Development/Training Programme(s)

One scientist went for a scientific visit in SouthKoreaduringthe period 17 October – 19 November 2016.

###### 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

One scientist has participated in International Conference on Physics -2016, 10-12 March 2016. Bangladesh Physical Society (BPS).

#### Isotope Hydrology Division (IHD)

##### Objectives/Introduction

The Isotope Hydrology Division has set its aim to apply the isotope techniques in the following areas.

- Investigations of surface-water and groundwater resources: their origin, dynamics, interrelations and residence time
- Studying water resources contamination issues like pollution, source, and transport of contaminants
- Studying the recharge mechanism of groundwater, flow dynamics and hydraulics and possible interconnection between different aquifer systems using environmental tracers (stable isotopes  $\delta^2\text{H}$  &  $\delta^{18}\text{O}$  & radioactive  $^3\text{H}$  &  $^{14}\text{C}$ )
- Determination of groundwater parameters such as direction of groundwater flow, filtration velocity, vertical flow velocity, permeability, effective porosity and dispersion coefficient by single-well dilution technique

##### Activites/Programme(s)

###### 1. Research and Development Work(s)

The Isotope Hydrology Division, INST has been performing the daily and monthly sampling, collecting the meteorological & physicochemical parameter and shipping monthly samples to IAEA for stable isotope analysis since 2009. From 2015 to present, IHD has analyzed on an around 1000 nos. daily rainfall samples for stable isotopes ( $\delta^2\text{H}$  &  $\delta^{18}\text{O}$ ) in Isotope Hydrology Lab. The study investigates the factors that control the isotopic composition of tropical precipitation in Bangladesh. Precipitation samples collected from seven sites indicate seasonal and spatial variations in  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ , despite the relatively limited geographic coverage and low-lying elevation of each of the collection sites. The equation of LMWLs of monthly precipitations of all stations for the period 2009-2014 mostly follows the GMWL. The values of the estimated slopes and intercepts of LMWLs of monthly precipitations closely match that of Craig’s GMWL. The intercept values of LMWLs of daily precipitations of three locations, namely, Sylhet, Savar, and Barisal are lower compared to

GMWL. This low intercept reflects high relative humidity at the moisture sources of above three locations. The weak correlation between the precipitation  $\delta^{18}\text{O}$  and local precipitation amount at monthly scale exist for all the cases indicating that the rainfall amount effect is not responsible for seasonal variability of stable isotope. Values of  $\delta^{18}\text{O}$  are more depleted for samples collected during rainy (monsoon) seasons, while enriched values are associated to winter and summer (pre-monsoon seasons. Deuterium excess values in precipitation show higher values during rainy season. The moisture sources of three stations, namely, Sylhet, Dhaka, and Barisal, in four different seasons have been analyzed for 72 hours using HYSPLIT air masses back trajectories. The two years (2013 and 2014) isotope values are explained with respect to the sources of vapor obtained using the HYSPLIT model. During the pre-monsoon season, the main source of moisture is originated from the continent and partly from the Bay of Bengal, resulting in values of  $\delta^{18}\text{O}$  more enriched and higher values for “d-excess”, reflecting recycling of water over the continent. During the rainy season source of vapor in mostly located over the Bay of Bengal, resulting in heavy precipitation associated with depleted  $\delta^{18}\text{O}$  values than during summer season. This reflects over deuterium excess in groundwater, which is recharged during the wet season. The time scale of the positive d-excess in anomalies during the monsoon appears to be modulated by the monsoon intraseasonal oscillation. All cases, average air temperatures vary from 18-30°C. The seasonal variation of air temperature is not too much prominent indicating that the stable isotopes of the said three areas rainfall are not temperature dependent. As observed from the daily stable isotope plot, temperature and amount of precipitation have a rather weak influence on stable isotopes in precipitation, with the primary controls thought to be the relative humidity and the degree of air mass rainout moisture transport. The stable isotope of precipitation are enriched at the beginning of pre-monsoon and gradually depleted at the end of post-monsoon.

## 2. Repair & Maintenance

### Installation and Commissioning of New Tritium Enrichment Unit (TEU)

Isotope Hydrology Division (IHD) has procured a Tritium Enrichment Unit (TEU) from IAEA under the IAEA/TC project BGD/7/007. Large quantities of tritium were released into the atmosphere in the thermonuclear tests performed during the early 1960s. This isotope is used nowadays as a global transient tracer for studying dynamics of the hydrological cycle. In particular, environmental tritium is widely used in hydrology as an age indicator for young groundwaters. With decreasing levels of environmental tritium, there is a need for sensitive measurement techniques capable of quantifying these levels with sufficient precision. The method most widely used nowadays to measure concentrations of environmental tritium in water is electrolytic enrichment followed by liquid scintillation spectrometry. Isotope Hydrology Laboratory of International Atomic Energy Agency has developed a specific type of electrolytic Enrichment System to concentrate tritium in water and prepare samples for tritium analysis with Liquid Scintillation Counter (LSC). Under the above TC project, Isotope Hydrology Division (IHD) of INST has installed and commissioned with the aid of one expert sent from Isotope Hydrology Section of IAEA.

### 3. Manpower Development/Training Programme(s)

Name of the the event/topics	Date	Place
<ul style="list-style-type: none"> <li>• “Overview of Atomic Energy Research Establishment” (By Dr. Mubarak Ahmad Khan, Director General, AERE, Savar, Dhaka)</li> <li>• “The Institute of Tibetan Plateau Research, CAS and the Third Pole Environment International Programme” (By Prof. ZHANG Fan, Institute of Tibetan Plateau Research (ITP), Chinese Academy of Sciences (CAS), Beijing, China)</li> <li>• “ENSO effects on annual variations of precipitation stable isotopes in the Tibetan Plateau” (By Dr. GAO Jing, Institute of Tibetan Plateau Research (ITP), Chinese Academy of Sciences (CAS), Beijing, China)</li> </ul>	06 Dec., 2016	INST seminar room, AERE, Savar, Dhaka.

**4. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date
Md. Masud Karim	Eighth Regional Workshop on Hydrological, Geotechnical and Human-Induced Hazards Relevant to Nuclear Power Plant Site Safety and Seventh Annual Meeting of the ANSN Topical Group on Siting	Asian Nuclear Safety Network (ANSN), IAEA.	25-29 July 2016
Nasir Ahmed	Regional Workshop on the Interdisciplinary Application of Isotope Hydrology and Soil Related Isotopic Techniques for Flood Risk	International Atomic Energy Agency (IAEA)	20-24 March 2017
Nasir Ahmed	XVI World Water Congress (WWC) 2017	International Water Resources Association (IWRA), National Water Commission of Mexico (CONAGUA), and National Association of Water and Sanitation Utilities (ANEAS)	29 May – 2 June 2017
Nasir Ahmed	Implementation of Soil Related Nuclear Techniques Applicable for Flood Management in Watershed Case Studies	International Atomic Energy Agency (IAEA)	12-16 June 2017

**5. Collaboration Work(s)**

- **Complementing Conventional Approaches with Nuclear Techniques towards Flood Risk Mitigation and Post-Flood Rehabilitation Efforts in Asia (IAEA/RCA-5069)**

Under IAEA/RCA-5069 project, IHD, a field sample campaign has been conducted in Sangu Basin, Bandarban district. A total 84 nos. of soil samples have been collected from three sites namely disturbed, undisturbed and controlled with a depth variation from 0 to 45cm. To investigate the soil erosion and sedimentation, FRNs techniques (fallout radionuclides techniques) will be applied by measuring  $^{137}\text{Cs}$ ,  $^{210}\text{Pb}$  and  $^7\text{Be}$  from the collected samples. The analysis is under process.

- **Assessing Deep Groundwater Resources for Sustainable Management through the (IAEA/RCA-7030)**

The coastal area of Bangladesh is highly vulnerable to saline water intrusion. To investigate and assess the groundwater resource of the south central coastal area of Bangladesh an extensive field survey has been carried out by Isotope Hydrology Division, INST in the coastal district of Patuakhali and Barguna, Bangladesh. Geomorphologically the area is characterized by narrow flatlands along the coast characterized by numerous channels with swamps and mangrove forest. Groundwater occurs at very shallow depth in the upper shallow aquifers that are composed of fine to very fine sand. The intermediate aquifer (the lower shallow in other plains) is saline all along the coastline. The deep aquifer is composed of fine to medium sand with occasional coarse sand. The upper aquifers are unconfined to leaky confined whereas the deeper aquifer is confined. Thus in the coastal zone, the sequence of alluvial and deltaic sediments is divided into multiple aquifers and aquitards. The surface lithology of the area is of deltaic deposits which are composed of tidal deltaic deposits, deltaic silt deposits, and mangrove swamp deposits. The soils are nonsaline throughout the year over substantial areas in the north and the east, but they become saline to varying degrees in the dry season in the Southwest. Water type for the dry and wet season according to Piper diagram shows most of the water samples are Na-Cl type. Only two water samples are Mg-HCO<sub>3</sub> and 2 samples are Ca-HCO<sub>3</sub> type indicating the weathering of dolomite and calcite minerals. A good positive correlation between Na<sup>+</sup> vs Cl<sup>-</sup> is seen in the wet season with some exceptions. This may be due to the mixing of fresh water end member with the saline water. For this reason, around 65% of dry season water samples have less Na<sup>+</sup> and are plotted below the mixing line. On the other hand, in the wet season, the concentration of Na<sup>+</sup> is relatively higher than the dry season waters and about 64% of the total wet season waters are plotted above the mixing line indicating freshening of water. Based on the regional groundwater flow and geochemical profile, a conceptual water

type profile through north-south has been developed. In the profile, it is observed that fresh  $\text{CaHCO}_3$  type water is flowing from the northern part and saline  $\text{NaCl}$  water type water is from the south. About 10 km to 15 km away from the Bay of Bengal mixing between fresh and saline water is occurring. The presence of  $\text{NaHCO}_3^+$  type water in the north to central part indicates freshening of groundwater because of fresh recharge water flushing from the north. A precipitation monitoring station, covering the southern part of Bangladesh, has been established in Barisal for rainfall sampling. Isotopic Analysis of precipitation samples shows the relation between  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  with reference to the global meteoric water line and local meteoric water line. Based on isotopic values of rainfall it can be said that the groundwater in the study area is mainly recharge during a cooler period, probably the last glacial maximum period (Pleistocene period). Based on the Sodium Absorption Ratio (SAR) values, for the wet season, 58% of water samples are in excellent to permissible class and the rest of the samples are in doubtful to the unsuitable category for irrigation. Based on the result of the present study it can be concluded that in the south central coastal region of Bangladesh the groundwater aquifer is moderately potential while in the dry season most of the water is contaminated. Further detailed study with Tritium ( $^3\text{H}$ ) and Radiocarbon ( $^{14}\text{C}$ ) dating tools have been suggested.

- **ITP, CAS-INST, BAEC Joint Scientific Exchange Programme**

For measuring stable isotopes ( $\delta^2\text{H}$  &  $\delta^{18}\text{O}$ ), studying rainwater chemistry and understanding the moisture transport process from the Bay of Bengal to the Southern Tibetan Plateau, IHD, INST and ITP (Institute of Tibetan Plateau), CAS (Chinese Academy of Science) signed a Mo.U on 30 December 2014. IHD has been performing precipitation sampling and collecting the meteorological data from Savar station since 2014. A total 53nos. of samples have been shipped to ITP already. Further research and evaluation are going on.

## **Reactor and Neutron Physics Division (RNPD)**

### **Objective/Introduction**

Reactor and Neutron Physics Division (RNPD) is entrusted with the responsibility of utilization of the research reactor in the country for research and applications in nuclear techniques. RNPD has three major facilities namely, (i) Neutron Scattering, (ii) Neutron Activation Analysis and (iii) Neutron Radiography. All these facilities utilize neutrons generated in the TRIGA Mark II Research Reactor for specific research and discharging services in the nuclear technique. The programmes are mainly focused on characterization of essential materials, elemental analysis of toxic and heavy elements and studies of structural and building materials for defects and flaws.

### **Activities/Programme(s)**

#### **1. Research and Development Work(s)**

##### **Neutron Scattering**

##### **1.1 Structural Characterization of $\text{CoNiZn}$ Ferrite by Neutron Diffraction**

S. Aktar, A. K. M. Zakaria, T. K. Datta, I. Kamal and I. B. Elius

A series of ferrite composites with chemical formula  $\text{Co}_{0.2}\text{Ni}_x\text{Zn}_{0.8-x}\text{Fe}_2\text{O}_4$  (where  $x = 0.0, 0.2, 0.4, 0.6, \& 0.8$ ) were synthesized by standard solid state reaction technique. The formation of single phase ferrite was confirmed through powder X-ray diffraction. In order to structural characterization of prepared samples, neutron diffraction experiments were performed at room temperature. Rietveld refinement of neutron diffraction data showed cubic symmetry corresponding to the space group  $\text{Fd}\bar{3}\text{m}$ . On applying the full pattern fitting of Rietveld method using Fullprof programme, structural details such as lattice constant, oxygen position parameter and the distribution of cations over the spinel lattice have been deduced through neutron diffraction data analysis. Cation distribution result indicates that Zn and Ni ions exclusively occupy the tetrahedral (A) and octahedral (B) site respectively for all values of x. But with increasing nickel content from  $x = 0.4$ , Co ion distributed over both A & B sites. The refinement of neutron diffraction data also reveals the sublattices and net magnetic moments of all the samples. At room temperature, the magnetic structure of all investigated samples was found to be ferromagnetic.



## Neutron Activation Analysis

### 1.2 Assessment of Contamination and Nutritional Deficiency in Ready-made Baby Foods Available in Local Market using Neutron Activation Analysis Technique

K.Naher, M. A. Islam, R. Khan, S. Das, U. Tamim, M. A. Ali, M. A. Azam, I. Khalil and S. Islam

This study have been carried out for the determination of nutritional and toxic elements in some locally available baby food using nuclear reactor based neutron activation analysis (NAA) technique. For NAA, 15 samples having about 75 mg of each were prepared in two folds followed by the standard protocol of NAA. Two certified reference materials namely IAEA Soil-7, IAEA SL-1 and one standard reference material NIST-1633b were prepared in the same way. The standard and certified reference materials were used for quality control purpose. To determine the elemental concentration we use both short and long irradiation schemes and we found Al, Ca, Mg, Mn, Ti, V, Na, K, Fe, Cr, Th, U and Zn. In some cases lower nutritional values were obtained compared to the quoted values.

### 1.3 Assessment of Toxic and Essential Elements in Some Common Spices Available in Local Market of Bangladesh using Instrumental Neutron Activation Analysis Method

K. Naher, M. A. Islam, R. Khan, S. Das, U. Tamim, M. A. Ali, M. A. Azam, I. Khalil and S. Islam

In this study, the most three common brand and non-brand spices Chilli powder, Turmeric powder and Coriander powder used in Bangladeshi food menu were analyzed using INAA technique. Non-brand spices were collected from the village of Belnagor, Magura and Savar, Dhaka. The brand spices of Square Consumers and Archu food companies limited were collected from the local market. All the samples were analyzed using the 3 MW TRIGA Mark-II Research reactor based Neutron Activation Analysis (NAA) technique. To apply relative standardization approach, 3 standards: IAEA-Soil-7, IAEA-SL-1 and NIST 1633b Coal Fly Ash were used. The concentrations of Sm, Na, Br, As, Zn, Sc were found in the ranges of 0.01-0.11 µg/g, 93.2-835.92 µg/g, 0.01-9.45 µg/g, 87-190 µg/g, 0.20-0.40 µg/g, respectively. Other elements were found to be below the detection limit. Arsenic was found in Coriander powder collected from Savar open market and it was amounted as 8.44µg/g, which is much higher than the permissible limit of 1 µg/g. The experimental values of other elements were also compared with the values from different countries. The present experimental data will help to assess the current toxicity level of our spices as well as will be treated as a base line data to assess future contamination.

### 1.4 Study of Elemental Concentrations of Two Ceramic Industrial Waste Samples in Dhaka District of Bangladesh by Neutron Activation Analysis

K. Naher, M. A. Islam, R. Khan, S. Das, U. Tamim, M. A. Ali, M. A. Azam, I. Khalil and S. Islam

Elemental analysis has been carried out in eleven ceramic waste samples collected from two industries in Dhaka district, Bangladesh. The TRIGA reactor based neutron activation technique was employed to determine the metals and metalloids in the collected samples. The CRMs were used to quantify the wide number of elements as well as to control the quality of the analysis. A total of 19 elements like Na, Sm, La, U, K, Ce, Th, Cr, Cs, Hf, Sc, Fe, Eu, Ti, V, Al, Dy, Mn and Ba were determined and compared with the world reference values. Some elements Na, K, Cs, Th, Eu, Ce, U have higher concentration than world average value. Some elements Sc, Cr, La, Ti have comparable concentration and other elements with have lower concentration levels than world average values. The investigation of the present work can be treated as the baseline data and will help to assess further evaluation for the researchers in future.

## Neutron Radiography

### 1.5 The Signal Chain - how the Removal of an Image Intensifier at the AERE Reactor in Bangladesh Improves Neutron Imaging

B. Schillinger and S. Saha

Most beginners in neutron imaging, including the authors, will fall for the mistaken notion that a sensitive detector for neutron imaging must collect as much light as possible from a neutron sensitive scintillation

screen. In the case of AERE, the neutron imaging detector was manufactured by an external company according to exactly this task, employing an image intensifier to maximize the detected light. However, while the available neutron beam required exposure times in the order of a minute to collect sufficient neutron statistics for an image, the intensifier was so sensitive that the scintillation light caused by a few single neutrons was enough to saturate the attached cooled CCD camera. Removal of the intensifier solved the problem, since the camera alone was sensitive enough to record the emitted scintillation light. The presentation will use this example to illustrate the signal chain from detected neutrons through photons to photo electrons and digital units in the camera, and give a feeling for the design of a detection system.

### **1.6 Upgrade of the Neutron Imaging Facility at 3 MW TRIGA Reactor at AERE, Bangladesh**

S. Saha, B. Schillinger, M. N Islam and T. K. Datta

The 3 MW TRIGA Mark II reactor at Atomic Energy Research Establishment (AERE) in Dhaka, Bangladesh, was commissioned in 1987. At the time, a radiography facility for film was installed. Due to the low sensitivity of film, it was optimized for high flux, at the cost of beam collimation and image definition, with an L/D ratio of only 60. Today's sensitive CCD detectors for neutron imaging allow to sacrifice intensity for better collimation, so a new collimator was designed that improves the suppression of unwanted fast neutron and gamma radiation and increases the L/D ratio to 115.

### **1.7 Characterization of wound Healing Bandages made of Poly Vinyl Alcohol**

S. Saha and S. Sultana

Poly vinyl alcohol is used to synthesize wound healing bandages with kappa-carrageenan (KC) by NRCD of INST. Different types of wounds specially burning tissue can be healed early by this type of bandages. To measure the quality of these samples it is important to identify the internal structure as the constituted materials are homogeneously distributed or not. Neutron Radiography technique has been applied to investigate the quality with water absorption characteristics. While the thickness of the samples are 0.5 cm thick the appropriate irradiation time has been measured 4 mins and in most cases the ingredients inside the samples are uniformly distributed which refer to uniform water absorption. The water absorption characteristics are interesting to observe. The samples absorbed water very slowly.

### **1.8 Environmental Monitoring and Physiochemical Study of Corals Available in St. Martin Island**

S. Saha, R. Khan, M. A. Haydar and M. M. Karim

At present, considering the interest on blue economy of Peoples Republic of Bangladesh Government, this is becomes obvious to grow our research interest on the resources of the Bay of Bengal. There are very few coral islands are available in the world and we are very proud to have one of those few. There is a common problem among all these islands are they are shrinking in size. The coral stones are losing their varieties and abundance in the sea shores. This is why, we made an approach to investigate their varieties and abundance using Neutron Radiography, Neutron Activation Analysis and their background radiation from Health Physics and Radioactive Waste Management Unit of Institute of Nuclear Science and Technology. So far, Neutron Radiography technique has been applied to all the coral samples and sand stone samples. There are seven individual varieties among collected samples of corals and few of them are already going through massive bleaching and notorious algae overgrown.

## **2. Repair & Maintenance**

Due to power failure and unregulated power supply the control units of the High Performance Neutron Diffractometer, responsible for maneuvering the stepper motors of various parts of the machine, the NIM-BIN power supply units were damaged several times. They were repaired, replaced and reinstalled upon consulting the local specialists.

Besides the above mentioned, several other routine works are also done for several parts of the machine to ensure the best performance of the Diffractometer.

One of the HPGe detector systems at NAA laboratory was repaired due to problem in the high voltage unit.

**3. Manpower Development/Training Programme(s)**

Name of the participant	Name of the event/topics	Organizer	date	Place
Dr. M.A. Islam	Training workshop on Research Reactor Applications	IAEA	12-16 Dec., 2016	Vienna, Austria
Sudipta Saha	KOICA-IAEA Joint Training Programme on Fundamentals of Radioisotopes and Radiation Technology.	06-24 November, 2016	Seongnam & Daejeon, Republic of Korea.	03 (From Bangladesh)

The Division has also been playing a very important role to promote the higher education of the country. Many researchers/students of different universities and institutes utilize the laboratory facilities of this division for their academic research. The scientists of this division are engaged in guiding the students/researchers for higher academic degrees like M.Sc., M. Phil. and Ph. D. by utilizing the facilities of this division and contributing to the development of manpower in the field of nuclear science and technology. Besides, students from different universities are trained up regularly as a part of industrial attachment.

**4. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Rahat Khan	IAEA Regional workshop on safety and utilization aspects of experiments for research reactor	IAEA	6 - 10 Mar., 2017	Daejeon, Republic of Korea
Sudipta Saha	National Conference on Physics-2017	BPS	05-07 Jan., 2017	Dhaka

**5. Collaboration work(s)**

NAA group of RNPd actively participates in collaborative research work with IAEA, FNCA, FTC, IIT-Kharagpur etc.

**INSTITUTE OF ELECTRONICS (IE)****General Electronics Division (GED)****Objective**

This division deals with the design, development and fabrication of electronic and nuclear instruments which are mainly used for test and measuring purposes. A number of Nuclear Instruments have been designed in the General Electronics Division. These are Portable Radiation Dose Rate Meter (PRDM), Hand and Foot Radiation Monitor (HFRM) and Area Radiation Monitor (ARM). These Instruments have been supplied to different Institutes and Industries of the country.

**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Microcontroller based Portable Radiation Dose Rate Meter (MDGE)**

Microcontroller based Radiation Dose Rate Meter (MDGE) has been designed and developed with analog display and working satisfactorily in several institutes of BAEC and also outside BAEC. Development work of this project is going on.

**1.2 Microcontroller Based Hand and Foot Radiation Monitor:** In order to improve the nuclear safety features of the existing Hand and Foot Radiation Monitor, the Microcontroller-Based Hand and Foot Radiation Monitor project has been taken up. One Microcontroller based Hand and Foot Radiation Monitor

has been supplied to the Health Physics and Radioactive Waste Management Unit (HPRWMU), INST, AERE, Savar, Dhaka. The instrument is working properly. Development work of this project is going on.

### **1.3 Microcontroller Based Area Radiation Monitor (ARM)**

Area Radiation Monitors are used in nuclear installations to ensure radiation safety of the personnel. Design and Development of microcontroller based digital ARM has been completed in cooperation with Nuclear Electronics Division. Development work for inclusion of more channels is going on.

**1.4 Design and Development of Microcontroller Based Hot Plate for NRCD:** According to the demand of NRCD, AERE, Savar, one Microcontroller Based Hot plate has been designed and fabricated in this lab.

**1.5 Design and Development of Microcontroller Based Chiller Controller for VLSI:** Microcontroller Based Chiller Controller has been designed for VLSI Laboratory and working satisfactorily.

### **1.6 Software Development**

**Development of Microcontroller Based Instruments:** The software development of Microcontroller Based Instruments is going on.

## **2. Production Work(s)**

- Microcontroller based Portable Radiation Dose Rate Meter. Model No: MDGE-11, Serial No: 031601. Supplied to-Abul Khair Group, Chittagong, Bangladesh. M/S S.G.S Company
- Microcontroller based Portable Radiation Dose Rate Meter. Model No: MDGE-11, Serial No: 101601. Supplied to BSRM, Chittagong
- Microcontroller based Hand, Foot and Cloth Radiation Monitor, Model No: MHFCIE-11 Serial No: 071501. Supplied to HPRWMU, INST, AERE, Savar
- Microcontroller Based Hot plate. Supplied to NRCD, INST, AERE, Savar, Dhaka

## **3. Repair & Maintenance**

- Portable Radiation Dose Rate Meter Model: DRGE-31, Serial no-110301, User: NINMAS, Rajshahi,
- Portable Radiation Dose Rate Meter Model: DRGE-31, Serial no-090402, User: GSD, IFRB, AERE, Savar, March 2017
- Portable Radiation Dose Rate Meter, Model: DRGE-31, Serial no-060401, User: INM, AERE, Savar, Dhaka, April, 2017
- Portable Radiation Dose Rate Meter, Model: DRGE-11, Serial no-070401, User: INM, AERE, Savar, Dhaka, April, 2017

## **4. Seminar/Conference/Symposium/Workshop/Meeting Attended**

- The scientist of this division Participated in Conference on “National conference on physics” from 5-7 January 2017, organized by: Bangladesh Physical Society
- The scientist of this division Participated in Conference on “National conference on Electronics and ICT” 20 April 2017, organized by: Bangladesh Electronics Society
- Farhana Hafiz, PE, delivered a seminar lecture on “Nuclear Safety Consideration learned in the Workshop on Basic Professional Training Course”, at 17th November 2016, Institute of Electronics, AERE, Savar, Dhaka
- Farhana Hafiz, PE Participated in training course on “Joint Workshop on Basic Professional Training Course for Nuclear Safety” Daejeon, Republic of Korea, 29 August- 9 September 2016, Hosted by: Government of the Republic of Korea

- Fahmida Akter, Principal Engineer has participated in “3rd Foundation Course on Nuclear Energy (FCNE) Mumbai, India” from 09 January to 17 February, 2017 Organized by Nuclear Power Corporation of India Limited, DAE, Mumbai, India.

## **5. Lecture Delivered**

- The scientists of this division delivered lectures in the Industrial Attachment Training Programme from 16 August 2016 to 22 November 2016 held in Institute of Electronics for the students of different Polytechnic Institute of Bangladesh
- The scientists of this division delivered lectures in the Industrial Attachment Training Programme from 26 December 2016 - 12 January 2017 held in Institute of Electronics for the students of Military Institute of Science & Technology (MIST), Mirpur Cantt. Dhaka
- The scientists of this division delivered lectures in the Practical Course for Nuclear Engineering Students, Dhaka University from 13 April to 19 April 2017
- The scientists of this division delivered lectures in the BNOC-2017 Programme at 25<sup>th</sup> May 2017

## **Nuclear Electronics Division (NED)**

### **Activities/Programme(s)**

#### **1. Research and Development Work(s)**

##### **1.1 Design, Development and Fabrication of the Area Radiation Monitor**

Area Radiation Monitors are used in nuclear installations to ensure radiation safety of the personnel. Design and Development of microcontroller based digital ARM has been completed in cooperation with General Electronics Division. Development work for inclusion of more channels is going on.

##### **1.2 Design, Development of Educational Nuclear Counting System**

Nuclear counting system is used in many nuclear experiments. It is also a basic system to learn nuclear science and technology. The main objective of this project is to develop such system for education purpose. The system may also be useful for nuclear scientists. Design and development work of this system has been completed. The system consists of PIC microcontroller as the main component that lessens lots of conventional analog circuitry. The system has been designed with GM detector and locally designed & developed high voltage power supply. MPLAB IDE has been used to develop the Assembly Language programme for controlling the operation of the system.

##### **1.3 Design, Development of a Gamma Source control Console (GSC) for IFRB**

Gamma Source control Console (GSC) is a customized controller for 90kCi Co-60 Gamma irradiator of IFRB for its research and industrial application. The failure of BRIT supplied control console it stopped Research and industrial application related to the Irradiator. An emergency system has been setup to continue the Research and industrial application. A step has been taken to develop a control console that will control and displays Irradiation time of the Co-60 source along with Compressor ON time. Development work is going on.

##### **1.4 Design and Development of Microcontroller Based LCD Panel Meter**

Panel meters are used in different electronic instruments. A microcontroller based LCD Panel Meter design work is going on.

##### **1.5 Design and Development of Ultrasonic Humidity Controller**

It is a customized instrument for Insect Biotechnology Division of IFRB which is control the humidity of laboratory. One Ultrasonic Humidity Controller has been designed and supplied to IBD, IFRB. The development work of another unit of Humidity Controller is going on.

## 2. Production of Electronic Gazettes

One Ultrasonic Humidity Controller has been manufactured and supplied to IBD, IFRB.

## 3. Lecture Delivered

- The scientists of this division delivered lectures in the Industrial Attachment Training Programme from 16 August 2016 to 22 November 2016 held in Institute of Electronics for the students of different Polytechnic Institute of Bangladesh
- The scientists of this division delivered lectures in the Industrial Attachment Training Programme from 26 December 2016 to 12 January 2017 held in Institute of Electronics for the students of Military Institute of Science & Technology (MIST), Mirpur Cantt. Dhaka
- The scientists of this division delivered lectures in the Practical Course for Nuclear Engineering Students, Dhaka University from 13 April to 19 April 2017

## 4. Manpower Development/Training Programme(s)

Mohammad Abu Sayid Haque, Principal Scientific Officer has participated in “3rd Foundation Course on Nuclear Energy (FCNE) Mumbai, India” from 09 January to 17 February, 2017 Organized by Nuclear Power Corporation of India Limited, DAE, Mumbai, India.

### Production Division (PD)

#### Objective

The Production Division is mainly engaged with fabrication, assembling and repair of the electronic instruments in order to meet the requirement of different institutes of BAEC and other organizations of the country.

#### Activities/Programme(s)

##### 1. Production works

- **Production of Digital pH Meter: Quantity - 02**

**Specifications:** Measuring range: 0-14 pH, Resolution: 0.01 pH, Input Impedance:  $10^{12}$  Ohms, Accuracy:  $\pm 0.01$  pH, Type of pH electrode: Combination type, Temperature compensation : Manual  
Input Base current : 10 Pico Amp. (Approx.), Power requirement: 220 V AC, 50Hz, Readout: 3.5 digit display, Weight: 1.5 Kg (Approx.)

- **Production of A.C. Voltage Stabilizer: Quantity - 03**

**Specifications:** Upper cut-off voltage: 270V, Lower cut-off voltage: 120V, Time delay: Direct (No delay), 30 sec (For TV/Comp), 3 min (For Fridge), Stabilized output: 205-235V, Input voltage: 220VAC, 50Hz, Type: 160-250V, Weight: 8 Kg (Approx.)

- **Production of Drop-Out-Relay: Quantity - 10**

**Specifications:** Upper cut-off voltage: 250V, Lower cut-off voltage: 160V, Time delay: 3 min (Adjustable), Input voltage: 220VAC, 50Hz, Output (safe range): 160-250V, Weight: 1.8 Kg (App.)

##### 2. Repair & Maintenance

Following Instruments were repaired during this period:

- Repaired of Digital pH Meter: Quantity - 02
- Repaired of A.C. Voltage Stabilizer: Quantity - 02
- Repaired of Drop-Out-Relay: Quantity - 02

**Repair & Maintenance Division (RMD)****Objective**

This division has been providing services through repair, maintenance and installation of scientific, nuclear medical, industrial and nuclear instruments of different Institutes and Establishments of Bangladesh Atomic Energy Commission (BAEC) and outside the organization. In addition to this design, development, fabrication and up-gradation activities are being carried out in this division.

**Activities/Programme(s)****1. Repair & Maintenance and Installation**

About forty eight (48) instruments are repaired, maintained and installed during this time according to the requisition of the user. The main Instruments are : Water Bath, Computer CPU, Computer Monitor (CRT), LCD Computer Monitor, UPS, Inverter, Air culler Remote, Gamma Calibrator, Projector (Multimedia), Heating Mantle, Hot Plate, Amplifier, Orbital Shaker Machine, Ultrasonic cleaner, Heating Mantle, Telephone Set, Laser Printer, Gamma Calibrator (UPS), 10KVA online UPS, Inverted Microscope, TV, 40KVA Eaton UPS, Incubator, Voltage Stabilizer, Centifuge, Scanner & Adaptor, AC Circuit, etc. Approximate price of the repaired Instruments/Equipments is 50(fifty) Lac BDT.

**Robotics Instrumentation & Control Division (RICD)****Objective/Introduction**

The objective of the division is to develop Robotics and Remote handling tools for laboratories of Bangladesh Atomic Energy Commission (BAEC).

**Activities/Programme(s)****1. Research and Development Work(s)**

- Line following Bot: Development of a line following Bot to be used in the laboratories of BAEC is going on
- Server Room Temperature Control System: A programmable Room Temperature Control System for the Server room of Institute of Computer science has been designed

**2. Production of Electronic Gazettes**

- One Server Room Temperature Control System has been manufactured and delivered to Institute of Computer Science (ICS)
- A Sample Rotator Power Supply has been manufactured and delivered to Institute of Food & Radiation Biology (IFRB)

**3. Manpower Development/Training Programme(s)**

Name of the event/topics	Date	Place	No. of Participant
Industrial Attachment Training Programme for the Polytechnic Institutes.	16 Aug., – 22 Nov., 2016	Institute of Electronics, AERE, Savar, Dhaka	73
Industrial Attachment Training Programme for the Military Institute of Science & Technology MIST, Mirpur Cantonment, Dhaka.	26 Dec., – 12 Jan., 2017	Institute of Electronics, AERE, Savar, Dhaka	35

**4. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Shahana Sultana	Basic Russian Language Course-III.	TI, BAEC	2 Oct., -3Nov., 2016	TI, AERE, Savar, Dhaka
Md. Khalid Hossain	Regional School on Nuclear Security for Asia and Pacific Region	IAEA and BATAN	17-28 Oct., 2016	Indonesia

**5. Collaboration Work(s)**

Dye Sensitized Solar cell: In addition to the robotics development this division also involved in Energy Research in collaboration with Institute of Radiation and Polymer technology. Research work on Natural Dye Sensitized Solar cell going on.

**6. Repair & Maintenance Works**

A Stabilized Dual Power Supply (Farnell) has been repaired.

**VLSI Technology Division (VLSITD)****Objectives**

- Research on thin film technology on wafer and glass substrates
- Research on organic Materials
- Multi-layer Solar cell Simulation

**Activities/Programme(s)****1. Research and Development Works**

- Simulation of Hetero structure Solar Cell using different types of material
- Simulation of Hetero structure LED
- Measurement the conductivity of Aloe Vera Gel
- Fabrication of Nano Rod Using Zinc Oxide (ZnO)

**Solar Cell Fabrication and Research Division (SCFRD)****Objective/Introduction**

- To develop a good research team to conduct research in the field of renewable energy
- To adopt the solar cell fabrication technology
- To train and develop skilled manpower in the field of renewable energy
- To fabricate high efficiency single crystalline silicon solar cell
- To provide environment for conducting research in the field of solar cell fabrication technology
- To test solar cell that are imported, as a standard ‘testing laboratory for solar cell and solar panel’
- To provide research facilities to the university’s student on renewable energy
- To initiate research collaboration with home and foreign universities
- To help the government to achieve the Millennium Development Goal in the field of renewable energy



## **Activities/Programme(s)**

### **1. Research and Development Work(s)**

#### **1.1 Surface Reflectance Optimization for KOH-IPA Solution Based Textured Mono-Crystalline Silicon Wafer**

The present study deals with the optimization of surface reflectance by the formation of pyramidal microstructure on p-type mono-crystalline silicon substrate using Potassium Hydroxide-Isopropyl Alcohol (KOH-IPA) solution. To reduce the reflectance of silicon wafers a technique called texturing is most often performed upon silicon wafers. Texturing reduces reflection and enhances light absorption by creating uneven surface like forming pyramidal shape microstructure. After completing the cleaning process immersing the wafer samples in KOH: IPA: H<sub>2</sub>O solution (1 gram: 5 ml: 125 ml) for 10 min, 20 min, 25 min, 30 min, 35 min and 40 min at 70°C-80°C, pyramidal microstructure has been formed on every wafers surfaces. Subsequently, the pyramidal microstructures has been observed using Field Emission Scanning Electron Microscope (FE-SEM). Afterwards, reflectance of these samples has also measured and optimum reflection of 0.1% has been found for 20 min submerged in KOH-IPA solution samples.

#### **1.2 Investigation of Minority Carrier Diffusion Length and Lifetime of a Mono-crystalline Silicon Solar Cell Using Surface Photo-voltage Measurement Method**

Minority carrier lifetime and diffusion length are an important parameter for characterizing a solar cell. In this research, we have investigated the minority carrier diffusion length and lifetime of a fabricated mono-crystalline silicon solar cell using Surface Photo-voltage Measurement (SPV) method. For the investigation, at first a mono-crystalline silicon solar cell is fabricated using phosphorous diffusion technique. A simple, computer-controlled and normal incidence SPV measurement system is used to determine the minority carrier diffusion length and lifetime of Si solar cell. From the experimental result it is found that the minority carrier diffusion length and lifetime of our fabricated silicon solar cell are 86.41µm and 2.76µsec respectively which are compatible with high efficiency solar cell.

#### **1.3 Characterization of Doped Silicon Wafer using Four Point Probe Method**

Doping is an important term in semiconductor technology because it intentionally introduces impurities into an extremely pure semiconductor for the purpose of modulating its electrical properties. In this research, we have doped a p- type silicon wafer using phosphorous diffusion technique to form p-n junction. Phosphorous diffusion is done by high temperature diffusion furnace. Doped silicon wafer is characterized by four point probe method. The four point probe method is a simple table top system designed to measure the sheet resistance of an emitter layer of the wafer. The sheet resistance usually depends on both the resistivity and the thickness of the emitter layer. Sheet resistance can be measured after the diffusion to check whether the doping process is properly done or not. Initially, we took a p-type mono-crystalline silicon wafer with square shape 150×150 mm<sup>2</sup> in size, 200µm in thickness and which is a (100) oriented Czochralski Si wafer. Then Cleaning and texturing of the wafer is done using different chemical solutions. Then we have measured the sheet resistance of the wafer by four point probe and found 8.88kΩ/square which shows a very high resistance. Then phosphorous diffusion of the wafer is done by diffusion furnace to form p-n junction POC13. Finally, we have measured the sheet resistance of the doped silicon wafer by four point probe method and found 10.33Ω/square which shows a very low sheet resistance. The low sheet resistance of the doped silicon wafer indicates that doping process of our experiment is properly and uniformly done throughout the silicon wafer.

## **INSTITUTE OF COMPUTER SCIENCE, AERE**

### **Computer Training and Services Division (CTSD)**

#### **Objective/Introduction**

The main activities of Computer Training and Services Division (CTSD) are to provide services and conduct basic & applied research and training in the field of computer science and ICT. CTSD publishes several articles in the peer reviewed journal as well as it provides services to BAEC, such as software and web

application development, maintenance and up gradation of inter-network infrastructure of BAEC, broad band internet service, wireless network(Wi-Fi) manpower development, and collaborative work with the MOST(Ministry of science and Technology) in the field of Computer science. The near plan of CTSD are also to work with online learning management portal with moodle, establishing a data center and cyber security lab for ensuring offline security and overall network security management in BAEC and establishing a proper nuclear database system. The others motto of CTSD is to ensure services in network level and software level for making BAEC a Digital Organization.

## **Activities/Programme(s)**

### **1. Research and Development Work(s)**

#### **1.1 Research on computer network and Nuclear Cyber Security at BAEC**

M. S. Islam, M. H. Ali and M. D. Hossain

Bangladesh Atomic Energy commission (BAEC) is research organization where Scientist are working in various field. A internal network like LAN and Wi-Fi system are working in BAEC,AERE, AECD. There also many computers are using in different fields. So it is necessary to ensure security in both computer application level, network level, information level and data security area. So by research and establishing a nuclear cyber security lab, it will help To prevent, detect and respond to malicious or unauthorized acts directed at nuclear & radioactive material and providing high assurance that digital computer, communications system and networks are adequately protected against cyber attacks to computer base process & nuclear sensitive information. Currently a cyber security based documentation are prepared in baec and a cyber security lab establishment procedure is going on. Research are also in progress.

#### **1.2 Design and Development of E-learning Management systems in Nuclear Education in BAEC**

M. S. Islam, M. H. Ali and M. D. Hossain

Bangladesh Atomic Energy commission (BAEC) is research organization where different academic curriculum are running also with research. Like BAEC provides some specialized training, Industrial attachment training, different nuclear activity courses etc. so by developing and designing a web based learning portal where nuclear and ICT related coursers will be offered and will be easy for the administration, documentation, tracking, reporting and delivery of educational courses or training programmes. In this purpose a Moodle based e-Learning management system are configured in baec local network. A full basis working activities like coursed in different areas will be offered and thought in future. Working progress are going on.

#### **1.3 Research on Nuclear Knowledge Management System**

M. S. Islam, M. H. Ali and M. D. Hossain

Bangladesh Atomic Energy commission (BAEC) is research organization where various research are going on in different fields. So it is badly needed to preserve and sharing knowledge among the scientist .To identifying, acquiring, transforming, developing, disseminating, using, sharing, and preserving knowledge, relevant to achieving specified nuclear knowledge and by a Computer based automation will be helpful for the development for the nuclear knowledge for the BAEC. Documentation in this area and Research are in progress.

#### **1.4 Research on Physical Protection System and Information and Computer Security**

M. S. Islam, M. H. Ali and M. D. Hossain

Bangladesh Atomic Energy commission (BAEC) is research organization where various research are going on. In this purpose in many institutes many valuable research properties are reserved. On computer application level many important information are kept. It is very urgent to keep or maintain research how to save this properties under all time protection and monitoring. Research are very important for ensuring computer security. So research are covering physical protection system and maintain information and computer security within a large scale. Research on this field and working activities are going on.

**2. Manpower Development/Training Programme(s)**

Name of the event/topics	Date	Place	No. of participant
Industrial Attachment training Programme based on computer science	14 Aug-21 Nov, 2016	Institute of Computer Science	37
Training programme on e-filing system implementation at BAEC	19-22 Feb, 2017	BAEC HQ	20
Training of Trainers for the e-Filing System implementation	06-09 Feb, 2017	Hon'ble Prime minister's a2i office, Dhaka	01

**3. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Md Dulal Hossain	International Conference on Nuclear Security: Commitments and Actions Title of paper: "An Analysis of Regulatory Frameworks for Adopting Cyber DBT at Nuclear Facilities: Bangladesh Perspectives"	IAEA	5-9 Dec. 2016	Vienna, Austria
Dr. Md Dulal Hossain	Third International Conference on Nuclear Knowledge Management: Challenges and Approaches Title of paper: "Nuclear Knowledge Innovations Assimilation: The Impact of Organizational Knowledge Frames and Triple Helix Dynamics of Knowledge Base"	IAEA	7-11 Nov. 2016	Vienna, Austria

**4. Seminar Arranged**

"Introducing e-tendering system at BAEC" has arranged on 26 Jan, 2017 in the Institute of Computer Science, AERE, Savar, Dhaka.

**Computer Software and Development Division (CSDD)****Objective/Introduction**

The Computer Software Development Division is engaged to promote fundamental, advanced and applied research works in the related areas of software engineering and data science. Hence, the major objective of the division is to build up capacity in the area of need based system development and doing research work in the upcoming technologies. The major areas of research and development are as follows: Software engineering, data analysis and decision making, artificial intelligence and internet of things (IOT) etc

**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Introducing Text Editor for Formation of the Title and Abstract of Individual Articles of the Publication Warehouse Application**

M. N. Nobi, M. A. Habib and M. S. Ahmed

Scientists of Bangladesh Atomic Energy Commission (BAEC) publish research papers in various international/national journals and conference proceedings every year. Publication warehouse is an application having archived all these papers and publicly open to find these journals of different fields from the BAEC central web portal. Along with the storing facilities, there is a separate interface accessible for both Scientists of BAEC and general people to search published articles by its title, author, discipline, published year and by the name of the different institutes of the BAEC. Normally, article's abstract and titles contain differently formatted text, equation, the text of different size, chemical reaction etc. However, there was no option to store these texts as formatted as in the original article. This work introduces the facilities to store the title and abstract according to its original format.

## 1.2 Renovation of Foreign Visit Database System for the Improvement of Visiting History Management

M. N. Nobi, M. A. Habib and M. S. Ahmed

Bangladesh Atomic Energy Commission (BAEC) is a multidisciplinary research & development organization. From the very beginning of its formation, BAEC started R&D works in areas covering physical science, bioscience, engineering and nuclear medicine for human welfare and economic uplift of the country. Scientists of BAEC travel to abroad to attend in different events like seminars, symposium, and trainings etc. for different purposes. Foreign visit database application aims to store overall information of each and every visit of the scientists. There are features available to search list of event participation of any specific scientist or all the participants of any specific event. It is also possible to search participants or events of any specific month of any year. In any specific visiting history, it shows the name of the event, duration and participant's details including designation and institute. In the designation and institution field, it shows current designation and institution of the corresponding participants. It doesn't track the participant's designation and institution during the visiting time-frame. This enhanced phase of the system tracks designation and institution of any employee along with the event's details so that viewers can get accurate information about any participant like participant's designation during any event.

## 1.3 User Interface Restructuring of Foreign Visit Database and Publication Warehouse System

M. N. Nobi, M. A. Habib and M. S. Ahmed

Bangladesh Atomic Energy Commission (BAEC) is a multidisciplinary research & development organization. From the very beginning of its formation, BAEC started R&D works in areas covering physical science, bioscience, engineering and nuclear medicine for human welfare and economic uplift of the country. Scientists of BAEC work in a different domain and publish their outcomes in world's renowned journals, conferences proceedings etc. These published articles are stored in an internal e-Service of BAEC named as Publication Warehouse. This system is open to public to access articles published by the BAEC scientists. Scientists also need to travel to abroad to attend in different events like seminars, symposium, and trainings etc. for different purposes. Foreign visit database application, another internal eService of BAEC, aims to store overall information of each and every visit of the scientists. There are features publicly available to search list of event participation of any specific scientist or all the participants of any specific event. However, user interfaces, those are open to public, of these systems was not that much lucrative. This work restructures overall system to make it well-looked and better oriented.

## 1.4 Enhancement and Maintenance of BAEC Web Portal

M. A. Habib, M. N. Nobi and M. S. Ahmed

The BAEC Web Portal has been developed as National Web Portal ([www.bangladesh.gov.bd](http://www.bangladesh.gov.bd)) under national Web Portal Framework of A2I (Access to Information) of Prime Minister's Office; which is design using Desktop Application Content Management System Software.

## 2. Manpower Development/Training Programme(s)

Name of the event/topics	Date	Place	No. of Participant
Workshop on e-Filing system implementation at BAEC	19-22 Feb, 2017	BAEC HQ	20

## 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
Mohammad Nur Nobi	Training of Trainers for the eFiling System implementation	a2i centre, PM Office	06-09 Feb, 2017	Dhaka
Mohammad Nur Nobi	Refreshers training on eFiling	a2i centre, PM Office	08 Jun, 2017	Dhaka

**Computer System Division (CSD)****Objective/Introduction**

Computer System Division (CSD) is a division of Institute of Computer Science (ICS). The main objectives of CSD are to conduct basic & applied research in the field of computer science & engineering and ICT education. The main Services of CSD are Computer Hardware/Software maintenance, Management Information System (MIS), ID Card Prepared. CSD publishes several articles/technical reports as well as provide services, IT training and consulting services to BAEC.

**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Local Area Network (LAN) Design and MikroTik Router Installation and Configuration at NMPI, AERE**

Communication between remote parties can be achieved through a process called Networking, involving the connection of computers and networking devices. In order to design and build a well secured network, many factors must be taken into consideration, such as the topology and placement of hosts within the network, the selection of hardware and software technologies, and the careful configuration of each component. When we talk about networks, we need to keep in mind three concepts, distributed processing, network criteria and network structure. Networks are divided into two main categories: Local Area Networks (LANs). The internet is a structured, organized system. Each network requires a structured planning and designing before deployment it that requires internet access, Internet connectivity factors should be included into the plan, Includes a practical design of network internet connectivity backbone. Procedures of selecting equipments are added and planning designs their networks. The LAN of NMPI interconnects more than 30 computers will using various network media.LAN designed and using a Mikrotik Router, Switch and other network media. Configuring and Installation of Mikrotik Router and Currently internet service is smoothly running at NMPI, AERE. We are expected to have a concept to any of the common UNIX flavored operating systems. Every network requires a regular maintenance, such as storage maintenance, remote resource access, user management, log management and some other management. Monitoring is a regular task for all network system. It is mandatory when the system is dedicated to public service to make a user friendly and dependable monitoring system. As a result of this LAN network, NMPI, AERE is getting a high speed internet service.

**2. Repair & Maintenance (Assemble, Installation of Hardware & Software and Troubleshooting of Computer):** A number of new Computers Hardware/Software have been assembled/Installation for ICS as well as other Institute of BAEC. A list of these activities for the period is given below:

SL. No	Name of the Institute	No. of PC
1.	Institute of Nuclear Science and Technology (INST),Savar	03
2.	Institute of Food and Radiation Biology (IFRB) ,Savar	13
3.	Institute of Computer Science (ICS) ,Savar	05
4.	Central Engineering Facility (CEF) ,Savar	01
5.	Nuclear Mineral Unit (NMU) ,Savar	04
6.	Central Administrative Division (CAD) ,Savar	06
7.	Central Finance & Accounts Division (CF&AD) ,Savar	04
8.	Scientific Information Unit (SIU) ,Savar	01
9.	Institute of Radiation & Polymer Technology (IRPT) ,Savar	01
10.	Training Institute (TI), Savar	02
11.	GPF Branch (HQ BAEC)	01

### 3. Preparation of ID Card

The Official ID card for each employee working in BAEC is prepared by Computer System Division, Institute of Computer Science. ID cards prepared by Computer System Division for different Institutes/Divisions in BAEC from July 2016 to June 2017 are listed below.

SL. no	Name of the institute	No. of card
1.	Institute of Nuclear Science and Technology (INST), Savar	50
2.	Institute of Food and Radiation Biology (IFRB), Savar	45
3.	Institute of Electronics (IE), Savar	24
4.	Institute of Computer Science (ICS), Savar	21
5.	Central Engineering Facility (CEF), Savar	13
6.	Nuclear Mineral Unit (NMU), Savar	09
7.	Central Administrative Division (CAD), Savar	16
8.	Central Finance & Accounts Division (CF&AD), Savar	08
9.	Security Branch (SB), Savar	01
10.	Daily Basis Employee, AERE, Savar	20
11.	Student, AERE, Savar	72
12.	Atomic Energy Center, Dhaka	93
13.	BAEC Head Quarter, Dhaka	87
14.	Institute of Energy Science (IES), Savar	02
15.	Institute of Tissue Banking and Biomaterial Research (ITBBR), Savar	08
16.	Center for Research Reactor (CRR), Savar	12
17.	Scientific Information Unit (SIU), Savar	02
18.	Training Institute (TI), Savar	01
19.	Institute of Radiation & Polymer Technology (IRPT), Savar	04
20.	Driver (Outsider), AERE, Savar	01
21.	Contractor Employees, AERE, Savar	04
22.	Institute of Nuclear Medicine & Allied Sciences (INMAS), Dhaka	07
23.	Institute of Nuclear Medicine & Allied Sciences (INMAS), Rajshai	07
24.	Project, AERE, Savar	02
25.	Security Pass	56
26.	Visitor Pass	52
27.	Riskwa Driver (outsider)	31
28.	Contractor	04
29.	Driver (Outsider)	01

## **INSTITUTE OF ENERGY SCIENCE (IES), AERE**

### **Objective/Introduction**

Bangladesh Atomic Energy Commission is struggling on reinforcing its culture of innovation with unrelenting commitment to face the energy challenges of Bangladesh in the new millennium. Energy is the strategic input for sustainable development and the issue of energy security is considered like the individual security, social security and territorial security. Institute of Energy Science, the newly established institute in the Atomic Energy Research Establishment has been started functioning in 3 April 2008 to build a favorable infrastructure for sustainable energy research and to promote the technological know-how in both renewable and non-renewable energy fields. The planned research and development activities are diverse and broad and the main objectives are to

- build trained and skilled manpower in different areas related to energy production
- undertake and promote R&D activities in the respective fields
- develop new technology for efficient and cost-effective energy production
- perform R&D in renewable sources, including hydrogen energy

### **Activities/Programme(s)**

#### **1. Research and Development Work(s)**

- Engineering analysis of nuclear reactors, with particular emphasis on reactor physics, design and safety
- Development of methods, tools and techniques to investigate fission product inventory and to carry out decommissioning studies of nuclear reactors
- Atmospheric dispersion modeling and radiological safety analysis of nuclear reactors
- Setting up a heat transfer facility to study thermal hydraulics and safety parameters of LWRs
- Design study of innovative next generation nuclear reactors
- Nuclear fuel performance, core management and fuel cycle analysis
- Probabilistic safety assessment (PSA) of nuclear reactors

## **INSTITUTE OF RADIATION AND POLYMER TECHNOLOGY (IRPT), AERE**

### **Objective/Introduction**

Institute of Radiation and Polymer Technology (IRPT) is dedicated to research and development activities by the application of radiation technology. The institute was established in 2010 and has been able, through innovative research and technological achievements in polymer science and industrial application of gamma radiation sterilization process to contribute to the national effort for achieving economic self-sufficiency. The institute has the 350 kCi Co-60 gamma source which is the largest capacity source in Bangladesh.

The main objectives of the institute are as follows:

- Application of radiation processing technologies for the socio-economic development of the country
- Providing commercial gamma irradiation services for quality improvement of food items and sterilization of medical products, pharmaceutical raw and packaging materials etc
- To provide irradiation service to research organizations for R & D purpose
- To expand cooperation with other scientific organizations, universities, private and public sectors through mutual exchange of educational programmes, training, technical cooperation and expert services
- To develop human resources in the field of nuclear science and technology
- Transferring the technology to the entrepreneurs for industrial applications

**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Development of Different Polymeric Composite Materials for Structural Applications and Radiation Shielding**

Radiation technique is used to increase mechanical properties of different composite polymeric materials. Different natural and synthetic fibers have been used for the development of polymer composite. Research has been conducted for developing radiation shielding materials. Fabrication and Characterization of Jute Fabrics Reinforced Polymer based composite was done and comparative study between hand Lay-up and Compression Molding Technique was conducted. Effect of sand on mechanical properties of Jute Fabrics Reinforced Polypropylene based composite has been determined. Fabrication and characterization of Carbon Kevlar Reinforced Polypropylene based composite was done. Physico-mechanical property of unidirectional Jute Fiber Reinforced Polypropylene and Linear Low Density Polyethylene based composite was determined and effect of dye observed.

**1.2 Development of Advanced Materials for Biomedical, Environment Application**

Antibacterial and biodegradable facial tissue paper was fabricated and characterized using bio-based raw material. Different types of hydrogel were prepared for biomedical application and heavy metal removal.

**1.3 Use of Radiation, Chemical and Microbiological Tools for Water Treatment for Different uses**

Physico-chemical and microbiological quality assessment of surface water of Turag river, Buriganga river and different aquaculture pond in Savar, Dhaka were conducted. Gamma irradiation was used for the treatment of polluted river water. Research was conducted to investigate naturally occurring bacterial strategy in degrading or detoxifying heavy metals of the Buriganga River. Study was conducted in a view to removal of chromium and lead from paint industry effluent by naturally occurring bacteria. Biodegradation capability of pesticide resistant naturally occurring bacteria to breakdown the hazardous residual pesticide was also observed.

**1.4 Application of Chitosan as Food Preservative**

R & D works was conducted related to application of chitosan to use as a preservative coating on different tropical fruits and vegetables.

**1.5 Dye sensitized Solar Cells (DSSCs)**

DSSCs were constructed with TiO<sub>2</sub> and ZnO nanoparticles and the effect of gamma ( $\gamma$ ) radiation on them was determined.

**2. Repair & Maintenance and Renovation Works**

- Mechanical problem of IRPT Co-60 Gamma plant was solved and plant started its work properly
- A Demineralize water treatment plant was installed for IRPT Gamma source. The capacity of water treatment plant is 1000L/hr.
- A Process controller was installed for Twin Screw Extruder Machine of IRPT
- Repair and maintenance work was done for Heat Press Molding Machine of Composite Lab of IRPT. Hydraulic O ring, gasket, pressure bucket, hydraulic oil, hydraulic jack was replaced

**3. Manpower Development/Training Programme**

Sl. No.	Name of the event/topics	Date	Place	No. of participant
1	Development of Antibacterial and Anticancer Agent Speaker: Mr. Md. Abdur Razzak, SSO	14 Nov., 2016	IRPT, AERE, Savar, Dhaka.	15
2	Carbon Nanotube Reinforced Polyester Composite Speaker: Dr. A K M Moshiul Alam, SSO	28 Nov., 2016	IRPT, AERE, Savar, Dhaka.	12



3	Radiation Protection Programme (RPP) in Co-60 Gamma Irradiator, Speaker: Mr. Abu Hena Mostofa Kamal	5 Dec., 2016	IRPT, AERE, Savar, Dhaka.	19
4	Overview on Foundation Course on Nuclear Energy, Mumbai, India, Speaker: Mr. Md. Serajum Manir, SO	15 Dec., 2016	IRPT, AERE, Savar, Dhaka.	15
5	Fiber Reinforced Polymer Composites Speaker: Md. Saddam Hossain, Md. Niloy Rahman. Md. Mostafizur Rahman, M.Sc. Students, Applied Chemistry and Chemical Engineering, Dhaka University.	18 Dec., 2016	IRPT, AERE, Savar, Dhaka.	15
6	Nuclear/ Radiological Safety Culture analysis Speaker: Engr Md. Borhan Uddin, SE	20 Mar., 2017	IRPT, AERE, Savar, Dhaka.	15
7	Industrial Training Programme for the Mechanical Engineering Students of Dhaka University of Engineering Technology (DUET)	12 April -2 <sup>nd</sup> May, 2017	IRPT, AERE, Savar, Dhaka	18

#### 4. Seminar/Symposium/Conference/Meeting Attended

Name of participant	Name of the event/topics	Organizer	Date	Place
Dr. Ruhul Amin Khan	Working Group on Radioactive Source Security to be held at Vienna in Austria	IAEA	24-27 Apr., 2017	Vienna, Austria
Dr. Ruhul Amin Khan	The regional Workshop on Occupational Radiation Protection in High Exposure Operation	IAEA	10 -14 Apr., 2017	Yogyakarta, Indonesia
Mohammad Zahirul Islam Mollah	The International Conference on Application of Radiation Science and Technology (ICARST-2017)	IAEA	24-28 Apr., 2017	Vienna, Austria
Md. Borhan Uddin	LPG- An alternative Fuel in Bangladesh	IEB	07 July 2016	IEB Seminar Hall, Dhaka
Md. Borhan Uddin	Improving Quality Assurance in Engineering Education	IEB	25 Sept., 2016	IEB Seminar Hall, Dhaka
Abu Hena Mostofa Kamal	Tissue Engineering and the need for Smart Scaffolds	ITBBR AERE	19 Jan., 2017	INST auditorium, AERE

#### 5. Stakeholder Meeting

Several stakeholders meeting were held with different company e.g. Pran Agro Ltd., Square Food and Beverage Ltd. for promoting irradiation services to these stakeholders between July 2016 to June 2017 at IRPT.

#### 6. Service Provided and Revenue Income

The 350 kCi Co-60 gamma irradiator of IRPT is used to irradiate food items, medical and pharmaceutical products. Generally 25 kGy is used for sterilization purposes and up to 10 kGy is applied for food items. In this institute, different private companies take the services of irradiation of food items for exporting purposes. The irradiated food items are spices such as chili, turmeric, coriander, zinger, nut, spirulina, pet food, Mushroom etc. Different medical items and pharmaceutical raw materials are irradiated here e.g. syringe, surgical gauze, bandage, aluminium tube, specimen container, Eye drape, empty infusion set, petri dish, filter, family planning kits, eye ointment, mannitol, PEG-600, bacitracin Zn etc

Nature of service	Total quantity of irradiated sample	Income in BDT
Food irradiation	52.3 Ton	20,18,921

**INSTITUTE OF NUCLEAR MINERALS (INM)****Introduction**

Institute of Nuclear Minerals (INM) of Bangladesh Atomic Energy Commission (BAEC) is committed to utilize peaceful application of nuclear technology in the field of minerals exploration, exploitation and water resource development. INM is responsible to explore uranium/thorium bearing atomic minerals in different prospective zones of Bangladesh. Besides atomic minerals, the unit has been working to explore heavy minerals and coal as well as to delineate groundwater aquifer in different areas of Bangladesh. In addition, the unit is involved in site characterization for Nuclear Power Plant (NPP) and radioactive waste disposal through surface geophysical survey and different geophysical techniques.

The unit is also involved to determine the geochemical, mineralogical and petrographical characterizations of rocks and sediments in terms of their radioactivity and economic potentiality. Recent studies on marine radioactivity with the application of radio-analytical procedures and elemental analysis of materials from different origins are also conducted under the unit.

Moreover, the unit is also engaged in providing services to national, international mining companies, hydrological organizations and universities using the existing facilities.

**Activities/Programme(s)****1. Research and Development Work(s)**

- Exploration of uranium, thorium and other precious metals in potential areas of Bangladesh
- Siting at RNPP through geophysical logging service
- Providing borehole geophysical logging and surface resistivity survey (VES) to different national and International mining companies/organization
- Geochemical and mineralogical characterizations of radioactive and non-radioactive rock and sediment samples
- Studies of marine radioactivity with application of radio-analytical procedures
- Elemental analysis of materials from different origins

**2. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name/no. of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Mohammad Rajib	Follow-up training course (FTC) on Environmental Radioactivity Monitoring	BAEC and JAEA	15-19 Feb., 2017	Training Institute, AERE
	Follow-up training course (FTC) on Nuclear and Radiological Emergency Preparedness Course	BAEC and JAEA	26 Feb., - 9 Mar, 2017	Training Institute, AERE
	Joint Japan Geoscience Union (JpGU)-American Geophysical Union (AGU) Meeting	JpGU and AGU	20-24 May, 2017	Makuhari Messe, Chiba, Japan
Dr. Ratan Kumar	Processing of unconventional radioactive mineral resources	IAEA/RCA	11-14 July, 2016	Colombo, Sri Lanka
	Lessons Learned and Safety Improvements Related to External Hazards Based on the IAEA Fukushima Report"	IAEA	23-25 Nov., 2016.	Vienna, Austria

	Aus IMM Uranium Conference 2017	IAEA	6-8 June, 2017	Adelaide, Australia
	Project Appraisal Study	NAPD	28 Aug., - 01 Sept., 2016.	Ministry of Planning, Dhaka
	Training Course on Electronic Government Procurement (e-GP) System	Training Institute, AERE, Savar	18-22 Aug., 2016.	AERE
Farah Deeba	Training Workshop on Uranium Geochemistry in the Asia-Pacific Region	IAEA	16–19 May, 2017	Bangkok, Thailand
50 persons	Adsorption characterization of geological materials from a potential radioactive waste repository by water-rock interaction experiment	INM, AERE	20 March, 2017	INST, AERE

### 3. Collaboration Work(s)

Two projects have been successfully completed under Special Allocation from the Ministry of Science and Technology for the Financial Year 2016-2017 with approval of the BAEC

- Detailed Uranium Exploration at Fultala Area, Kulaura, Moulvibazar District
- Estimation of Surface Water Infiltration into Aquifer through Nuclear Techniques by Using Radon Detection at the South-West Coastal Area of Bangladesh

### 4. Service Rendered and Revenue Income

Number of service given to organization	Nature of service	Total number of service	Income (BDT)
02	Spontaneous Potential, Electric, Resistivity, Gamma	04	320000

#### • Citizen Charter

Sl No	Type of services	Approved fee by BAEC (in Taka)
1	Traditional logging service: (Gamma/SP/SPR/Resistivity) Parameter determination of one or more than one of Geophysical Bore-hole Logging by Gamma/SP/SPR/Resistivity.	50,000/- to 90,000/- (based on depth)
2	Nuclear Logging service (Gamma/Gamma-gamma/Density)	80,000/- to 1,10,000/- (based on depth)
3	Caliper logging (in addition to 1 or 2)	25,000/-
4	Temperature logging (in addition to 1 or 2)	25,000/-
5	Earth resistivity survey vertical electric Sounding(VES)	35,000/-
6	GIS-map preparation	10,000/-/ map
7	GIS data analysis	10,000/-/ data analysis map
8	Training on geophysical survey & borehole logging for three days	25,000/--participant
9	Petrological/Mineralogical analysis of geological sample	12,000/-/ participant
10	Elemental analysis of geological sample using XRF	5000/-/ sample

## BEACH SAND MINERALS EXPLOITATION CENTRE (BSMEC), COX'S BAZAR

### Introduction

Investigations on mineralogy and ore reserve calculations including preliminary laboratory scale mineral separation, pilot plant scale mineral separation and determination of conceptual flow sheets for future pilot plant work, physical separation of constituent valuable minerals and to find out working economics involved therein which would, in turn, be used in commercial plant to be set up in future, were among the primary objectives towards setting-up a pilot plant in BSMEC campus, Cox's Bazar by the BAEC. In line with the goals of the centre, considerable R&D works had been accomplished in the centre in the past.

### Description of Work(s)

Using the existing facilities of the pilot plant at BSMEC, five minerals- magnetite, garnet, ilmenite, rutile and zircon are being successfully separated from sands. All these five minerals have great scientific, technical and economic values.

**Zircon ( $ZrSiO_4$ ):** About 60% of all zircon production is used in foundry facing works, while 15% is consumed in the manufacture of zirconium metal, alloys and chemicals. Zircon is extensively used in refractory products and in the manufacture of glass. Zircon in the form of its flour (2-micron size) is widely used in ceramic industries as a opacifier in glazes for chemical and electrical porcelains, sanitary wares, semi vitreous dinner wares and wall tiles. It is also used as resistance to crazing and color stabilizer in ceramic products. Zirconium compound is used in tanning white leather, in dental cement and in high power light house lamp. Zirconium in the form of zirconium alloys is used as a cladding for fuel rods in nuclear power plants. Zircon serves as the only source of hafnium which is used in nuclear industries.

**Rutile ( $TiO_2$ ):** Rutile is used as a raw material in the pigment industry. This industry consumes about 66% of the total rutile production, while 18% is used in welding rod coatings, 15% in manufacturing of titanium metal and only 1% in all other uses. It is used in all types of paints and enamels including high gloss finishes and emulsion paints. Rutile is also used in the manufacture of light colored rubber goods of porcelain enamels to impart a cream color to bodies and glazes. It is used in the manufacture of electric insulators. In paper manufacture the rutile (titanium dioxide) is used for its high opacity, good retention in the pulp and color brightness. Titanium metal is used chiefly for military purposes in fighter aircraft, jet engines and in many part of naval craft.

**Magnetite ( $FeO, Fe_2O_3$ ):** Magnetite is used chiefly as a source of pig iron which is the primary material for the production of cast iron, wrought iron, malleable iron and the many varieties of ordinary and special steels. It is used in open hearth steelmaking as a media for carrying oxygen. Important use of magnetite is in the production of high density concrete for shielding radiations. Magnetite is also used in the drilling mud for its higher specific gravity. It is extensively applied in the manufacture of ferrite rods which are used in radio and other instruments. Red oxide and black oxide may also be produced from magnetite by applying chemical processes.

**Garnet ( $Fe, Al, Ca, Mg, Mn$ ) ( $SiO_4$ )<sub>3</sub>:** About 90% of the total garnet production is used in the manufacture of emery cloth, paper, wheel and grinding stones. Garnet is sometimes used as jewels in watches, also in meters and scientific apparatus. Loose garnet powder may be used for polishing marble, slate or soapstone and in some sand blast works. Recently a special quality of garnet gas found its use in lasers.

**Ilmenite ( $FeO, TiO_2$ ):** Ilmenite is a source of  $TiO_2$  which is used chiefly as a white pigment. Ilmenite is extensively used in the welding rod coatings. Presently ilmenite is being widely used as radiation shielding material.

It is comprehended that the marine and coastal environment of Bangladesh offers valuable resources including seabed minerals, which, if harnessed properly, could be a great basis for the socio-technical development of the country. It is also known that harnessing energy and minerals from the sea is an important part of 'blue economy'. BSMEC by utilizing its current facilities and through expanding its area of research and development activities could play a significant role towards developing science and technology as well as strengthening 'blue economy' - the new economic sector needed for achieving the sustainable development of Bangladesh.

However, during the reporting period necessary repair and maintenance works have been carried out with a view to keep the pilot plant operational. Besides, in addition to routine administrative work, the centre housed

couple of technical visits for the students and researcher of different institutes of the country. A meeting for the exchange of views as a part of the observance of ‘World Sea Day’ was also held during the period.

## **ATOMIC ENERGY CENTRE (AEC), CHITTAGONG**

### **Objective**

- Radioactivity Monitoring of Food and Environment
- Radiation Protection and Safety
- Education and Research

### **Activities/Programme(s)**

#### **1. Research and Development Work(s)**

##### **1.1 Coordinated Research Programme with International Organization**

- IAEA/RCA Project-RAS/7/028: Enhancing regional capabilities for marine radioactivity monitoring and assessment of the potential impact of radioactive releases from nuclear facilities in Asia-Pacific marine ecosystem.
- IAEA/CRP Project-JO2005: Improvement of the assessment of initial alarm of radiation detection instruments.

##### **1.2 Coordinated Research Programme with Universities and other Research Organizations**

- Assessment of heavy metal in some marine biotic components collected from Parkey Beach area, eastern coastal side of the Bay of Bengal of Chittagong region- Joint research work with CUET
- Assessment of spatial variability of Heavy Metal hazard in road deposited sediment using road network under Chittagong City Corporation - Joint research work with CUET
- Natural radionuclides and heavy metal content in Sand, Sediment and Water Samples of Parkir Chor beach and Anowara region of Chittagong area, Bangladesh - Joint research work with CUET
- Heavy element Contaminants and radioactivity levels of effluent discharge from different industries to Murari Khal, Patiya, Chittagong - Joint research work with CUET
- Investigation on mass concentration of radionuclides and heavy metals in coastal eco-system of Kutubdia Island, Cox’sbazar, Bangladesh - Joint research work with CUET
- Studies on the microbiological and physicochemical parameters of water and Shrimp from the river Karnafuli - Joint research work with CU
- Study on the concentration of heavy metals in some economical fish species, their eggs and water of the Karnaphuli river estuary, Chittagong, Bangladesh - Joint research work with CU

#### **2. Manpower Development and Training Programme**

##### **Masud Kamal (Chief Scientific Officer and Director)**

- 6<sup>th</sup> INTERPOL Counter Nuclear smuggling Workshop, Colombo, Sri Lanka 04 – 06 July, 2016
- Scientific foundations for Alarm Adjudication and Reachback Exchange, Karlsruhe, Germany, 12-15 July, 2016
- First research Coordination Meeting on Improved Assessment of Initial Alarms from Radiation Detection Instruments, Sri Lanka Atomic Energy Board, Colombo, Sri Lanka, 17 - 21 October, 2016

##### **Dr. Shahadat Hossain (Principal Scientific Officer)**

- Training on Assessment of Initial Alarms from Radiation Portal Monitors and other Radiation Detection Systems, arranged by IAEA and Bangladesh Customs, Chittagong Custom House, Chittagong, Bangladesh, 16 - 17 August, 2016.

**Dr. A K M Saiful Islam Bhuiyan (Senior Scientific Officer)**

- FTC on Reactor Engineering, arranged by Training institute, AERE, Savar, Dhaka, 29 January - 16 February, 2017.

**Shahadat Hossain (Scientific Officer)**

- Training on Assessment of Initial Alarms from Radiation Portal Monitors and other Radiation Detection Systems, arranged by IAEA and Bangladesh Customs, Chittagong Custom House, Chittagong, Bangladesh, 16 - 17 August, 2016.
- Training course on Radiation Protection for Radiation Workers and RCOs of BAEC and others, arranged by Training institute, AERE, Savar, Dhaka, 28 August - 1 September, 2016.
- FTC on Environmental Radioactivity monitoring, arranged by Training institute, AERE, Savar, Dhaka, 15 - 19 January, 2017.
- FTC on Reactor Engineering, arranged by Training institute, AERE, Savar, Dhaka, 29 January - 16 February, 2017.
- FTC on Nuclear and radiological emergency preparedness, arranged by Training institute, AERE, Savar, Dhaka, 26 February - 09 March, 2017.
- Basic Nuclear Orientation Course arranged by Training institute, AERE, Savar, Dhaka, 15 – 19 January, 2017.

**Mohammed Asraf Uddin (Experimental Officer)**

- FTC on environmental Radioactivity monitoring, arranged by Training Institute, AERE, Savar, Dhaka, 15 January - 19 January, 2016.

**Rashmi Roy (Sub-Assistant Engineer)**

- Training on Assessment of Initial Alarms from Radiation Portal Monitors and other Radiation Detection Systems, arranged by IAEA and Bangladesh Customs, Chittagong Custom House, Chittagong, Bangladesh, 16 - 17 August, 2016.

**3. Service Rendered and Revenue Income**

Month	A	B	C	No. of samples	Total income (in Taka)
July 2016	702	1	0	703	8694538.00
August 2016	1078	0	1	1079	12494388.50
September 2016	1227	0	1	1228	10287091.75
October 2016	1494	0	2	1496	14356398.25
November 2016	1364	0	0	1364	13955464.00
December 2016	1011	1	3	1014	13138585.00
January 2017	1556	0	5	1561	19929485.00
February 2017	1333	0	2	1335	17440565.00
March 2017	1390	0	1	1391	18504230.60
April 2017	1425	0	2	1427	19758678.00
May 2017	1321	0	1	1322	18470258.15
June 2017	931	0	3	934	16109584.00
Total	14832	2	21	14855	183139266.3

A: Radioactivity testing of samples of imported foods and allied materials, B: Radioactivity testing of samples of exportable foods and C: Radioactivity testing of miscellaneous materials

#### **4. Responsibilities**

- Radioactivity measurement of imported food and allied materials (Measurement of radioactivity in imported food and allied materials is a mandatory work of the laboratory to implement the Nuclear Safety & Radiation Control Rules-1997, SRO No. 205-Law /97, Bangladesh.)
- Radioactivity measurement of exportable food and allied materials
- Radioactivity measurement of miscellaneous materials
- Radiation protection services
- Radiation protection service during transportation of radioactive materials from Chittagong port to different destinations of Bangladesh
- Radiation survey of the exportable scrap materials at work-site of the ship-breaking yard
- Environmental radiation monitoring
- Workplace radiation monitoring
- Cooperation with other scientific organizations, universities, private and public sectors through mutual exchange of educational programmes, training, technical cooperation and expert services and
- Development of human resources in the field of nuclear science and technology

#### **RADIOACTIVITY TESTING & MONITORING LABORATORY (RTML), MONGLA, BAGERHAT**

##### **Objective/Introduction**

- Implementation of the “Bangladesh Atomic Energy Regulatory Authority Act 2012” and “Nuclear Safety and Radiation Control Rule 1997”
- Radioactivity testing of foods and other allied materials imported & exported through Mongla port
- Radioactive materials safety service to the port authority and customs department while inspection of special consignments that contain radioactive materials in it. Activities like nuclear security, safeguard and controlling illegal traffic of radioactive materials in the region
- Radioactivity analysis of environmental samples, harmful contaminated objects, radioactive material or any other sample requested for nuclear forensic investigation
- Radiation protection and safety service during transport of radioactive materials imported or exported through Mongla port. Safe handling of radioactive materials to and from the region
- Radiation protection and safety service to the public, hospitals, local industries, universities or research institutes and exploration companies etc
- Emergency service during nuclear and radiological incidents, accidents

##### **Activities**

###### **1. Collaboration Work**

Establishment of RTML, Mongla project director has organized several stakeholder meeting with port authority and custom department etc.

**2. Service Rendered**

Nature of service	Quantity of sample/equipment	Income (BDT)
Research collaboration through equipment supply to HPRWMU, INST, AERE, Savar, Dhaka.	10 Marinelli beakers	Free of charge

**II. BIO-SCIENCES****INSTITUTE OF FOOD AND RADIATION BIOLOGY (IFRB)****Agrochemical and Environmental Research Division (AERD)****Objective/Introduction**

Agrochemical and Environmental Research Division (AERD) is involved in research related to residues fate, distribution, degradation, translocation and impact of pesticides in environment and also engaged in elemental analysis and their impact on food & environment and in rendering services. The objectives are:

- To know the present status of residues of pesticides, heavy metals and trace elements in food and environment
- To generate and provide pesticide residue data for fixing National Acceptable Daily Intake (ADI) and Maximum Residue Limit (MRL) of Bangladesh
- To promote safe and effective use of pesticides for safe guarding human health and environment

**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Identification and Quantification of Pesticide Residues in Some Soils of Narshingdi Area**

M. A. Uddin, M. A. Z. Chowdhury, Z. Fardous and M. Hasanuzzaman

Soil samples collected from nine selected spots of high land vegetables and low land paddy fields of Narshingdi district were analyzed by GC & HPLC. Identification of the pesticide was carried out in relation to the retention time of the pure analytical standard supplied by International Atomic Energy Agency (IAEA), Austria. Quantification was made with a freshly prepared standard curve of the standard pesticide. Results of residual pesticides in soils of Narshingdi district showed that out of 9 samples, only two samples contained organochlorines, namely DDT and DDE ranging from 0-0.726 and 0.404-0.563 µg/kg respectively. While, organophosphorous, carbamate and pyrethroid residues were found below detection limit. However, the contamination level of DDT and its metabolites was lower as compared to the IAEA/FAO/Codex Alimentarius Guide line value.

**1.2 Assessment of Heavy Metals Contamination and Human Health Risk in Shrimp Collected from Different Farms and Rivers at Khulna-Satkhira Region, Bangladesh**

M. A. Z. Chowdhury, Z. Fardous and M. K. Alam

Shrimp is one of the most important protein source, its contamination can be dangerous to public health. Shrimp species were collected from various shrimp farms in Khulna and Satkhira area in Bangladesh. This study is aimed to assess the heavy metals contamination and health risk in Shrimp (*Macrobrachium rosenbergii* and *Penaeus monodon*) collected from Khulna-Satkhira region in Bangladesh. The results showed that the Pb concentrations (0.52–1.16 mg/kg) in all shrimp samples of farms were higher than the recommended limit. The Cd levels (0.05–0.13 mg/kg) in all samples and Cr levels in all farms except tissue content at Satkhira farm were higher than the permissible limits. The individual concentration of Pb, Cd, and Cr between shrimp tissue and shell in all rivers and farms were not statistically significant ( $P > 0.05$ ). Target hazard quotient (THQ) and



hazard index (HI) were estimated to assess the non-carcinogenic health risks. Shrimp samples from all locations under the current study were found to be safe for consumption, the possibility of health risk associated with non-carcinogenic effect is very low for continuous consumption for 30 years.

### 1.3 Investigation of Heavy Metal Contents in Cow Milk Samples from Area of Dhaka, Bangladesh

Z. Fardous and A. Z. Chowdhury

A total of 90 cow milk samples of Branded, Dairy and domestically produced milk were collected randomly from different sources of Savar Upazila in Dhaka area. Cadmium (Cd), chromium (Cr), lead (Pb), manganese (Mn), copper (Cu) and iron (Fe) contents in collected milk samples were determined using Flame Atomic Absorption Spectrometry (FAAS). To ensure quality control, one of the best quality control parameters i.e. recovery test; from eight various sample digestion methods were used. Among the six metals, only Cr showed to exceed the highest Estimated Daily Intake (EDI) rate (for brand cow milk: 0.413 mg/day, dairy farm cow milk: 0.243 mg/day, domestic cow milk: 0.352 mg/day), and the comparison percentages of calculated values per permissible values were as follows; 206.5 % for brand cow milk, 121.5 % for dairy farm cow milk and 176.0 % for domestic cow milk. Hazard Quotients (HQ) values and Carcinogenic Risk (CR) values were found within the acceptable level. Conclusion: Although, the metal content in sampled cow milks were within the safe limit, the potential human health risks cannot be neglected for the regular/long time consumption of heavy metal contained cow milk.

### 2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Md. Amin Uddin, Dr. M. Alamgir Z. Chowdhury	National Science Conference on "Biochemistry and Molecular	BSBMB	10 Dec., 2016	Dhaka

### 3. Service Rendered and Revenue Income

Number of service given to organization/person	Nature of service	Total number of sample analysis	Total Income (BDT)
02	Pesticide residues and Heavy metals analysis	72	8,57,300/-

### Food Technology Division (FTD)

#### Objective/Introduction

Food Technology Division is basically involved in carrying out research on improvement of food quality (nutritional, functional and microbiological quality) and storage condition through conventional and nuclear technology for food safety and security aspects. Research works of FTD also focus on development of convenience food and food additives from different kinds of food and food derivatives. Area-wise analysis of elemental and heavy metal in agricultural and dairy products through nuclear techniques is also in progress to develop a database for food traceability and authenticity.

#### Activities/Programme(s)

##### 1. Research and Development Work(s)

##### 1.1 Evaluation of Gamma Irradiation and Boiling Treatment on Antioxidant Status in Different Spices

A. Khatun, M. A. Hossain, M. Islam, M. K. Munshi, A. Akter, B. Rahman and R. Huque

The effects of gamma irradiation treatment (0.05 and 0.1kGy) and water boiling on the antioxidant markers (total phenol, and flavonoid content, antioxidant activity, and reducing power) of three spices (garlic, ginger, and turmeric) were investigated. Results indicated that the antioxidant quality of ginger has improved when treated with irradiation but irradiation treatment gradually decreased the antioxidant parameters with increasing dose in turmeric. For garlic, lower dose (0.05 kGy) was useful to retain antioxidant value after boiling than higher dose gamma radiation. In addition, boiling showed a significant loss of total phenol

content and DPPH radical scavenging activity as well as other antioxidant markers were observed for fresh ginger and garlic. But fresh turmeric showed reverse phenomena upon boiling. The changes of bioactive compound upon irradiation and boiling might contribute to antioxidant activity of studied spices.

### 1.2 Effect of Different Cooking Methods on Antioxidant Markers of Selected Green Leafy Vegetable

M. A. Hossain, A. Khatun, M. Islam and R. Huque

This study was designed to evaluate the effect of cooking on the vitamin C, total phenolics, total flavonoid and antioxidant properties like DPPH-free radical scavenging activity and reducing property of some tropical green leafy vegetables; *Spinacia oleracea* L, *Ipomoea aquatica* Forssk, *Amaranthus gangeticus* L and *Basella rubra* L. The results of the study revealed that cooking causes a significant ( $P < 0.05$ ) increase in the total phenol and flavonoid content, DPPH radical scavenging ability, and reducing power. Conversely, cooking decreases vitamin C contents in all the vegetables.

### 1.3 Effects of Ginger Extract on Preservation and Sensorial Quality of Raw Tilapia Fish at Refrigerator Temperature (4°C)

M. Islam, A. Hossain, A. Khatun, A. I. Bhuiyan, A. Rahman, M. A. Hossain and R. Huque

A study was conducted to determine the effect of ginger extract on shelf life extension of Tilapia fish (*Oreochromis shiranus*) at 4°C temperatures. The results revealed that the proximate thiobarbituric acid (TBA) value, Tyrosine value (TV) and Total Bacteria count (TBC) were increased with preservation time. Samples treated with ginger extract had lower TBA, TV and TBC than the control sample. The organoleptic results showed that samples treated with 15% ginger extract had the best acceptance.

### 1.4 Food Traceability and Food Safety of Dairy Products as an Example Through the Nuclear Analytical Techniques. Co-ordinated Research project Contract No: 18195/R0

R. Huque, M.K. Munshi, A. Khatun, M. Islam, A. I. Bhuiya, M. A. Hossain, A. Rahman and A. Hossain

Milk samples collected from three areas (Pabna, Shirajganj, Comilla, Shatkhira) were subjected to microbiological, biochemical, and elemental analysis procedure. Results showed that the average concentrations of lead, cadmium, chromium, copper, manganese and cobalt were below detection limit in cow milk from three farms of Pabna and two farms of Shirajganj. Milk from all sampling areas showed lower level of arsenic. Milk from Comilla and Sathkhira showed high concentration of lead and nickel. The total count of bacterial, coliform, Staphylococcal, and Listeria in raw milk varies widely among the samples collected. However, the results revealed that milk from all regions are safe in course of public health standard as all categories of microbial counts are lower than acceptable limit.

### 1.5 Assessment of Nutritional and Microbiological Quality of Sweet Curd (misty Doi) Collected from Different Region of Bangladesh

A. Rahman, A. Hossain, M. Islam, A. Khatun and R. Huque

Sweet curd samples collected from three different areas (Dhaka, Bogra and Jhenidah) of Bangladesh were subjected to microbiological and nutritional analysis. In case of moisture content curd from Dhaka showed maximum (76.11%) compared to Bogra (71.7%) and Jhenidah (70.05%). Inverse results were found in the case of total solid contents. Sweet curd from Dhaka contained highest amount of fat (4.02%) than those of two other areas. On the other hand, protein content found to be lower in curd from Dhaka. Curd from Jhenidah contained highest amount of acidity might be due to the presence of lactobacillus bacteria. Microbiological analyses of these sweet curds are going on.

## 2. Manpower Development and Training Programme

Name of the event/topics	Date	Place	No. of participant
National Workshop on TC Project Design using the Logical Framework Approach	13– 17 Mar., 2017	BAEC	3

RAS7026 - Supporting the Use of Receptor Binding Assay (RBA) to Reduce the Adverse Impacts of Harmful Algal Toxins on Seafood Safety Project Coordination Meeting and Workshop on RBA method validation and related statistical approaches	24-28 April 2017	Philippine Nuclear Research Institute, Manila	2
Basic Nuclear Orientation Course-2017	9 May-8 June 2017	Training Institute, AERE, Savar	1

### 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. R. Huque	IAEA CRP Project 18195/RO, Midterm Meeting	IAEA	3-7 Oct., 2016	Rabat, Morocco
Dr. A. Khatun	Antioxidant potential of <i>Sasa senanensis</i> leaves in the prevention of oxidative stress in mice	IFRB, AERE	30 May, 2016	IFRB, AERE, SAVAR
A. Rahman	Glycemic Response To BRRI (Dhan 28) among Non Diabetic and Diabetic Subjects.	IFRB, AERE	14 May, 2017	IFRB, AERE, SAVAR

### 4. Collaboration Work(s)

- **IAEA CRP Project**

**Title:** Food traceability and food safety of dairy products as an example through the Nuclear analytical techniques (**Code:** 18195/RO).

Food authentication is the process that verifies that a food is in compliance with its label description which may include the origin. Milk is a high value-added product, rich source of natural nutrients for human being which contains more than twenty different trace elements. Milk is most susceptible to be mislabeled and their country of origin can sometimes be in question. In this regard, the use of multi elemental analysis could be a good tool for origin authentication purposes. The main objective of this project to differentiate the milk according to geographical region in Bangladesh based on elemental composition.

- **IAEA RCA Project**

**Title:** Supporting the use of receptor binding assay (RBA) to reduce the adverse impacts of Harmful Algal toxins on seafood safety (**Code:** RAS7026).

Seafood tainted with natural algal toxins remains a major public health and socioeconomic problem in the Asia-Pacific regions including Bangladesh that rely in seafood as a major source of protein and economic growth. Harmful algae blooms (HABs) are increasing with the development of the industry and continuous use of agrochemicals (fertilizer) in Bangladesh. A number of pollutant materials from industry and different sources have led to nutrient enrichment which induced phytoplankton bloom. HABs can have a negative effect, causing severe economic losses to aquaculture, fisheries and tourism operations and having major environmental and human health impacts. Moreover, HABs produce toxins that can cause diseases such as amnesic shellfish poisoning, paralytic shellfish poisoning and diarrhetic shellfish poisoning etc. The detection and regular monitoring for algal toxins and the causative harmful algal blooms (HABs) are essential for the protection of aquatic lives, shellfish safety, drinking water quality, and public health. Our research has focused on some principal aspects of harmful algae and their toxins such as to strengthen harmful algal bloom (HAB) monitoring capabilities in the coastal regions through the use of the Radioligand Receptor Binding Assay (RBA), a nuclear technique for Ciguatera and Puffer fish poisoning- reduce environmental and socio-economic costs of harmful algal blooms - toxin monitoring capacity: strengthen skills and competencies; extend to new type of marine toxins – environmental assessment: land-based pollution; nutrient over-enrichments.

**5. Service Rendered and Revenue Income**

Total number/quantity of sample	Income (BDT)
14	Inter laboratory Service
4	4000/-
5	Inter laboratory Service
4	4,300/-
Total	8,300/-

**Gamma Source Division (GSD)****Objective/Introduction**

Gamma Source Division of IFRB has been rendering irradiation services since 1980 to different institutes/organizations and private companies using Co<sup>60</sup> panoramic gamma irradiator. GSD is the pioneer irradiation service provider in Bangladesh. Its main objective is to develop and utilize gamma irradiation techniques in research and commercial sectors for better quality products. GSD has provided irradiation services for research purpose to three different government (including institutes of BAEC, NIB, BARI and BSIR, Ishwardi) and private organizations at free of cost during this time period. During this time period, GSD has served irradiation to commercial products of 11 food industries and 26 medical & pharmaceutical companies of Bangladesh and earned 54,28,026/-revenue for the country. During this reporting period, the activities of the source were 71.72 kCi on 01/07/2016 and 63.54 kCi on 30/06/2017. At the same time, the dose rates were 3.11 kGy/hr.on 01/07/2016 and 2.74 kGy/hr. on 30/06/2017.

**Activities/Programme(s)****1. Research and Development Work(s)**

Preparation of Ceric-Cerous dosimeters of different concentration and tested with reference dosimetry systems. GSD-made Ceric-Cerous dosimeters showed consistent response to irradiation; however, further validation is required

**2. Service Rendered and Revenue Income**

Nature of service	Quantity of sample	Income (BDT)
Food irradiation	77.999 Ton	30,97,126/-
Medical and Pharmaceutical products irradiation	3489 cft 24 cft (free for R&D)	23,30,900/-
Total		54,28,026/-

**Insect Biotechnology Division (IBD)****Objective/Introduction**

This division is engaged in developing the methods of management of insect pests and Phytosanitary treatment using nuclear and biotechnological approaches. The R & D activities conducted for the reporting period are given below:

**Activities/Pogramme(s)****1. Research and Development Work(s)****1.1 Development of Gel based Larval Diet for Mass Rearing of Oriental Fruit Fly, *Bactrocera Dorsalis* (Hendel)**

M. Khan, N. Sultana, M. Momen, M. A. Bari, M. A. Hossain, K. Seheli and S. A. Khan

The efficacy of gel based larval diets using different gelling agents viz., agar, carboxy methyl cellulose, custard powder, guar gum, and κ-Carrageenan (sulfated plant polysaccharide) was evaluated for mass rearing of the Oriental fruit fly, *Bactrocera dorsalis* (Hendel). Diets were assessed in terms of pupal yield (number),

larval duration (days), pupal weight (mg), % sex ratio, % adult emergence, % fliers, and % egg hatch. Gel diet containing 0.5% agar outperformed other gel based larval diets especially in terms of pupal yield ( $1899\pm 256$ ), developmental time (6-10 days), and flight ability (76%).

### **1.2 Population Fluctuation Monitoring of the Tephritid Fruit Flies in Atomic Energy Research Establishment Campus using Different Types of lures**

M. A. Hossain, M. Momen, M. A. Bari, S. A. Khan, N. Sultana, K. Seheli and M. Khan

Fruit fly (Diptera: Tephritidae) is regarded as one of the most important global pest of quarantine importance. In Bangladesh, it causes serious damage to wide variety of fruits and vegetables. Accurate methods for fruit fly population surveys are prerequisites for effective decision making in area-wide control programmes aimed at pest suppression, as well as those attempting to establish fruit fly free or low prevalence areas. Population fluctuations of the economically important Tephritid fruit flies were assessed from October, 2016 to June 2017 in ten different sites of AERE campus using hawaii traps baited with three kinds of lures viz., Methyl eugenol, Cue-lure and Zingerone. During the experiments, population fluctuation of seven species, viz., *Bactrocera dorsalis*, *B. cucurbitae*, *B. tau*, *B. rubigina*, *B. zonata*, *B. correcta* and *Dacus longicornis* were recorded. Among the captured fruit flies the oriental fruit fly, *B. dorsalis* was by far the most numerous species (52%) followed by melon fruit fly, *B. cucurbitae* (19.09%), and pumpkin fruit fly, *B. tau* (18.33%). Remaining four species were less abundant in this area. The survey programmes are on going.

### **1.3 Rearing of Peach Fruit Fly, *Bactrocera Zonata* (Saunders) (Diptera: Tephritidae)**

M. Khan, N. Sultana, M. Momen, M. A. Bari, M. A. Hossain, K. Seheli and S. A. Khan

Investigation was conducted to establish a stable line of Peach fruit fly, *Bactrocera zonata* (Saunders) on artificial rearing media based on bran diet. Brewer's yeast was used as protein source in addition to wheat bran, sugar, anti-microbial agent (sodium benzoate). The diet (100 eggs/70gm diet) was assessed in terms of pupal yield (number), larval duration (days), pupal weight (mg), percent (%) of adult emergence, active fliers, sex ratio, and egg hatch. The mean ( $\pm$ se) number of pupae ( $350\pm 7.63$ ), larval duration ( $8\pm 1.2$  days), pupal weight ( $13.5\pm 1.0$  mg), adult emergence ( $88.83\pm 3.98\%$ ), fliers ( $73.17\pm 1.93\%$ ), male ( $61.12\pm 2.93\%$ ), egg hatch ( $87.50\pm 7.63\%$ ), were recorded for *B. zonata* developed from the diet and found satisfactory for future mass rearing under laboratory condition.

### **1.4 Mass Scale Rearing Optimization and Quality assessment of Melon fly, *Bactrocera Cucurbitae* (Coq.) for Field Release of Sterile Flies**

M. A. Bari, S. A. Khan, N. Sultana, M. Momen, M. A. Hossain, K. Seheli and M. Khan

This present work was conducted to scale up the mass rearing capacity of adult melon flies and concurrently to identify the obstacles in mass rearing system in the laboratory. The appropriate size of rearing trays, amount of eggs, amount of diet etc. were optimized in terms of cost benefit analysis. Three different sizes of trays were used for 250gm, 500gm and 1000gm diet seeded with 0.5 ml (~3500 eggs), 1 ml (~7000 eggs) and 2 ml (~14000 eggs) respectively. Various quality parameters such as percent egg hatch, larval duration, pupal recovery and adult emergences were not in consistence. Further works are on going.

### **1.5 Radiation-induced Sterility at 80 Gy for Pupal Stages of *Aedes Aegypti***

M. Momen, N. Sultana, S. A. Khan, M. A. Bari, M. A. Hossain, K. Seheli and M. Khan

The sterile insect technique (SIT) offers a promising strategy for mosquito-borne diseases prevention and control. For such a strategy to be effective, sterile males need to be competitive enough to fulfill their intended function by reducing wild mosquito populations in nature. We studied the effect of irradiation on sexual mating success of *Aedes aegypti* males. Immature and adult mosquitoes were reared in a climate-controlled room maintained at a temperature of  $27\pm 1^\circ\text{C}$  and 70-80% relative humidity; the light regime was LD 12:12 hrs photoperiod. Gamma radiation dose of 80Gy was applied to male pupae (48 h old) and the induced sterility was assessed by the hatch rate of eggs obtained from the females mated with males irradiated at pupal stage. Radiation dose of 80Gy to male pupae resulted  $97.38\pm 3.89\%$  sterility. Further works are on going.

**2. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Mahfuza Khan	Tephritid workers of Asia, Australia and Oceania (TAAO) pre-symposium workshop Fruit Flies of Economic Importance Diagnostics	TAAO	14 Aug. 2016	Putrajaya Malaysia
Dr. Kajla Seheli	RAS/5/066 IAEA Regional Workshop on Sterile insect Technique-based Approaches to control populations of mosquito disease vectors, with special reference to dengue, chikungunya and zika vectors	IAEA	5-9 Sept. 2016	Kuala Lumpur Malaysia
	National Conference on Biochemistry and Molecular Biology for life Sciences	BSBMB	10 Dec. 2016	Dhaka
Md. Aftab Hossain, Md. Abdul Bari and Mahfuza Momen	20 <sup>th</sup> National Conference and Annual General Meeting on Sundarbans biodiversity: Zoological perspectives	ZSB	31 Dec. 2016	Dhaka
Md. Abdul Bari	RTC on Free Open Source Software for GIS and Data Management Applied to Fruit Flies in Southeast Asia	FAO/IAEA	6-10 Mar. 2017	Bangkok Thailand
	30 <sup>th</sup> Annual Conference on Microbiology Education and Research for Sustainable Development	BSM	29 April 2017	Dhaka
Nahida Sultana	Basic Nuclear Orientation Course (BNOC) – 2017	BAEC	9 April - 8 June, 2017	Savar
Dr. Mahfuza Khan	3 <sup>rd</sup> International Conference on Area-wide Management of Insect Pests: Integrating the Sterile Insect and Related Nuclear and Other Techniques	FAO/IAEA	22-26 May 2017	Vienna Austria

**3. Collaboration Work(s)**

- Collaborative research work on “Species diversity of fruit flies (Diptera: Tephritidae) in Bangladesh” with Idaho University, USA and Hawaii University at Manoa, USA
- IAEA Co-ordinated Research Project, CRP No. 17011/R4, titled ‘Use of Symbiotic Bacteria to Reduce Mass-rearing Costs and Improve Mating Success of Selected Fruit Pests in Support of SIT Application
- IAEA RCA Project No. RAS/5066, ‘Promoting the sharing of expertise and infrastructure for dengue vector surveillance towards integration of the sterile insect technique with conventional control methods among South and South East Asian countries’ (under Regional TC Project RAS 5066 and INT5155)
- IAEA RCA Project No. RAS/5067, ‘Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in Southeast Asia’

- Collaborative Research Programme on ‘Area-Wide Integrated Pest Management (AW-IPM) and Sterile Insect Technique (SIT)’ with IBD, IFRB, AERE, and Regional Horticulture Research Institute, Chapainawabganj, 2016
- Collaborative Research Programme on ‘Oriental bamboo tephritids’, IBD, IFRB, AERE and Forschungsinstitute Senckenberg, Germany, 2016

## **Microbiology and Industrial Irradiation Division (MIID)**

### **Objective/Introduction**

This division is one of the pioneer divisions of IFRB. The division deals with microorganisms those are closely associated with the health and welfare of human being. MIID is basically involved in doing research and development work on different aspects of Radiation Microbiology. The R & D activities conducted for the reporting period are given below:

### **Activities/Programme(s)**

#### **1. Research and Development Work(s)**

##### **1.1 Disinfection of Archived Material by Radiation Processing Technology Keeping the Material Integrity**

M. K. Pramanik, A. B. Miah and M. K. Alam

The aim of the study is to preserve paper-based archived material for a long period of time using ionizing radiation/nuclear technique. To conduct this research, old note-pad samples were selected as tentative archived material. Samples were prepared and irradiated at a series of radiation doses e.g. 0, 2.0, 4.0, 6.0, 8.0, 10.0 and 14.0 kGy at a dose rate of 12.8 kGy/h from panoramic Batch type 80 kCi <sup>60</sup>Co source. After irradiation different quality parameters such as microbiological (Total Viable Bacterial Count, Total Fungal Count), mechanical (Tensile Strength, Percent of Elongation at Break and Elastic Modulus) and color properties (L-value, a-value and b-value) of samples were assessed to observe the immediate effect of ionizing radiation on this. Results showed that the total bacterial count of unirradiated (control) paper were  $4.0 \times 10^2$  cfu/g and radiation dose of 2.0 kGy was enough to eliminate the microbial load completely. Among mechanical properties, tensile strength (TS) of unirradiated sample was 16.23 MPa and it was gradually increased as the dose increased and finally reached upto 18.99 MPa at a dose of 14 kGy causing the TS-change above significant level ( $p < 0.05$ ). Though changes of percent of elongation at break (EB) due to irradiation was insignificant, elastic module (EM) increased as the radiation dose increased gradually. EM of non irradiated sample was  $381.85 \text{ N/m}^2$  and it started changing significantly from 6.0 kGy and finally reaches upto  $477.03 \text{ N/m}^2$  at 14.0 kGy. Results showed that L-value of colour parameter changed very slightly though a and b-value changed significantly from 6.0 kGy. From these findings it can be inferred that a radiation dose of 4.0 kGy might be used to conserve the cultural heritage including valuable paper-based archived materials.

##### **1.2 Effect of the Carrier Sterilization Methods on Viability of Rhizobium Etli**

M. K. Pramanik and M. A. Bathen

In this study, effect of different sterilization methods (viz, autoclaving and ionizing radiation) of carrier on the viability of Rhizobium etli was observed. Peat soil was used as carrier material of this strain. Two sets of peat soil for each sterilization method were sterilized for storing them in two different temperatures i.e, 8°C and 30°C. Sterilization of peat soil with autoclave was performed at 15 psi for 40min at 121°C. Radiation Sterilization of peat soil was performed with a Cobalt-60 gamma source at a dose of 40 KiloGray. Sterilized carrier was then inoculated with Rhizobium etli. After inoculation one set for each sterilization method was preserved at 8°C and the other set was preserved at 30°C. Viability of Rhizobium on this sterilized carrier was determined by spread plate technique on YMA medium at every 10 days of interval. Result showed that in both methods number of Rhizobium increased for few days after inoculation. Carrier material sterilized by gamma radiation could maintain higher number of cells than the carrier material sterilized by autoclave.

### 1.3 Synergistic Effect of Oligo-chitosan and Biofertilizer on Rice Plants

S. Sultana, M. K. Pramanik and S. Nahar

Pot experiment was carried out to observe the synergistic effect of plant growth promoter (oligo -chitosan as PGP) and Biofertilizer (BF) along with chemical fertilizer (CF) on rice plants. Rice plants (BIRRI-29) were treated with single different treatment (viz, Chemical Fertilizer, oligochitosan 50/100ppm and BF, separately) and combined treatment (viz. CF with/without urea+BF, CF with/without urea+oligochitosan-50/100 ppm and CF with/without urea + oligo chitosan50/100 ppm + BF). All of the single treatments showed positive effect in terms of leaf number, plant height, tiller and panicle number per pot in comparison to control. Among the single treatments, the highest leaf no. found in the pot treated with 100 ppm oligochitosan, the highest plant height found in the pot treated with 50ppm oligochitosan and the highest tiller and panicle no found in pot treated with BF.

Combined treatments with CF with/without urea + oligochitosan 50/100ppm showed positive effect in terms of plant height, tillers and panicle number with compare to control. In these combinations, the highest plant height was found in the pot treated with CF without urea+100 ppm oligochitosan. The highest tiller and panicle number were counted in the pot treated with CF with urea + 100ppm oligochitosan. Combined treatments with CF with/without urea + BF also showed better result with respect to all of the parameters in comparison to control. Both the combination treatments (CF with urea + BF and CF without urea + BF) produced same effect with respect to tiller and panicle number.

Combined treatments with CF with/without urea + oligochitosan50/100 ppm + BF also produced improved result in terms of all parameters with compare to control. In these combinations, highest no of leaves, tiller and highest plant height were found in the pot treated with combination of CF with urea + 100ppm oligochitosan + BF. Though these combined treatments (CF with/without urea + oligochitosan50/100 ppm + BF) rendered positive impact on rice plants in comparison to control, synergistic effect was found insignificant in comparison to other (single & combined) treatments. The work is ongoing as the yield of rice is not harvested yet. capability using Pikovskayar's media.

### 1.4 Effect of Gamma Radiation on the Treatment of Textile Wastewater of an ETP

T. Mumtaz, S. Khan and A. N. M. Fakhruddin

Wastewater samples collected from eight steps of a effluent treatment plant (ETP) in Savar were irradiated at a Co<sup>60</sup> facility located at Atomic Energy Research Establishment, Ganakbari, Savar, at 5kGy and 10 kGy doses. The impact of gamma radiation on the mesophilic wastewater natural contaminants was determined by means of total counts before and after irradiation. The characteristics such as pH, chemical oxygen demand (COD), colour removal, total dissolved solids (TDS) and Electric conductivity (EC) were also measured. It was observed that, colored wastewater become almost colorless after irradiation and it significantly improved with higher dose radiation. COD was decreased significantly because of the degradation of the organic solid particles. However, the change of pH, TDS and EC were found less or insignificant effects after application of gamma irradiation.

### 1.5 Assessment of *in-vitro* Probiotic Characteristics of Lactic Acid Bacteria Isolated from Raw Vegetables

A. A. Mahin, O. B. Mosleh and S. A. Mahmud

The aim of this study was to characterize the lactic acid bacteria isolated from raw vegetables and to investigate their potential technological properties as probiotic and charting their possible exploitation. A total of 150 single colonies were isolated from tomato, carrot and cauliflower based on their acid production capabilities. Among them, 21 lactic acid bacteria were preliminarily selected based on catalase and gram reaction. Then the isolates were assessed for *in-vitro* probiotic properties like acid and bile tolerance, surface hydrophobicity, resistance to simulated gastric juice and intestinal fluid, cholesterol assimilation, auto-aggregation, anti-microbial activity, antibiotic susceptibility and  $\beta$ -galactosidase activity. Finally, the isolates were checked for their safety level and identified using 16s rDNA sequencing. Taken all the *in-vitro* criteria together, 7 isolates (identified as *Leuconostoc lactis*, *Weissella cibaria*, *W.confusa*) were considered as



potential probiotics based on their technological and probiotic properties and one of them showed further potential to be inoculated in milk products of lactose intolerant individuals because of  $\beta$ -galactosidase activity. All the selected isolates were gelatinase-negative and non  $\beta$ -haemolytic. Moreover, all but four isolates did not possess any plasmid which further assures no chance of horizontal transfer of drug resistant gene by these isolates. In conclusion, raw vegetables may serve as the potential sources for the probiotic lactic acid bacteria which can be further exploited for several health-related benefits.

### **1.6 Enhanced Bioethanol Production from Potato Peel Waste Via Consolidated Bioprocessing with Statistically Optimized Medium**

A. A. Mahin, T. Hossain, A. B. Mia and S. A. Mahmud

We aimed to produce bioethanol from a no-value waste, potato peel waste (PPW), via consolidated bioprocessing (CBP) and the production was improved using response surface modeling. An extensive screening was undertaken to isolate some amylolytic yeasts producing sufficient  $\alpha$ -amylase and glucoamylase from soil, date palm juice, rotten potato, sawdust and compost. We evaluated bioethanol production from starch by the isolates through CBP and various physical parameters were optimized for enhanced ethanol production. Then, PPW was used as a carbon source and to obtain maximum ethanol production a fermentation medium containing the minimum number of ingredients was designed by response surface modeling. A total of 28 amylolytic yeast like microorganisms were isolated, among which 5 isolates were selected based on high  $\alpha$ -amylase and glucoamylase activities and identified as *Candida wagneriana*, *Hyphopichia pseudoburtonii* (2 isolates), *Wickerhamia* sp. and *Streptomyces drozdowiczii* based on 26S rDNA and 16S rDNA sequencing. *Wickerhamia* sp. showed the highest ethanol production (30.4 g/L) with the fermentation yield of 0.3 g ethanol/g starch at 30°C, pH 7 after 96 h. Then, PPW was used to produce ethanol by *Wickerhamia* sp. The effect of various medium ingredients was evaluated initially by Plackett-Burman design, where malt extracts, tryptone and  $\text{KH}_2\text{PO}_4$  showed significantly positive effect ( $p$ -value < 0.05). Using RSM, a medium consisting of 40 g/L (dry basis) PPW and 25 g/L malt extract was found optimum and yielded 21.7 g/L ethanol. Thus, it can be concluded that *Wickerhamia* sp. is a promising candidate for bioethanol production from PPW through consolidated bioprocessing.

### **1.7 Bioprotection of Lettuce and Beef Against Foodborne Pathogens by Locally Isolated Bacteriocinogenic Lactic Acid Bacteria**

A. A. Mahin, S. M. M. Mouna and I. Kabir Jahid

To evaluate the potency of locally isolated bacteriocinogenic lactic acid bacteria against foodborne human pathogens on lettuce and beef. Among 150 lactic acid bacteria isolated from raw vegetables, 37 were investigated for their antimicrobial activity against foodborne human pathogens by both agar spot and well diffusion tests. Their antimicrobial activities were further characterized and identified using 16S rDNA sequencing. The isolates having high antimicrobial activities were then checked for production of bacteriocin like substance (BLS) and ability to protect lettuce leaf and beef from pathogenic *Listeria monocytogenes* and *Salmonella enteritidis* respectively. Ten isolates showed strong antimicrobial activity and among them 4 produced bacteriocin like substances in culture supernatant. Most of them pertained to *Leuconostoc* and *Weissella* species. The isolate *L. lactis* 37, which produced heat stable BLS, successively eradicated *L. monocytogenes* on fresh-cut lettuce and reduced >80% *S. enteritidis* on beef after 2 days of incubation. The study concluded with the findings that the isolate *Leuconostoc* 37 could be used as a bioprotective agent for food items against food-borne pathogens.

**2. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Md. Kamruzzaman Pramanik	FNCA-workshop, (Biofertilizer project)	Japan	07-11 Nov, 2016	Hanoi, Vietnam
	International Conference on Applications of Radiation Science and Technology-2017	IAEA	24-28 Apr., 2017	Vienna, Austria
Dr. Tabassum Mumtaz	1st Int'l Conference on 'Women in Science without borders'	Egyptian Youth Academy of Science	21-23 March, 2017	Ramses Hilton Hotel, Cairo, Egypt.
Dr. Abdullah-Al-Mahin	Annual Conference 2017, Bangladesh Society of Microbiologists	Bangladesh Society of Microbiologists & department of Microbiology, Dhaka University	29 April, 2017	Dhaka, Bangladesh
	International Conference on Genomics, Nanotech and Bioengineering (ICGNB)-2017	North South University	14-16 May, 2017	Dhaka, Bangladesh

**3. Collaboration Work**

- The division is currently running S&T, CRP projects (Disinfection of archived materials by radiation) and FNCA (Biofertilizer) under the auspices of International Atomic Energy Agency (IAEA).
- It has active collaboration with Dhaka University, Jahangirnagar University, Jessore University of Science and Technology, Kushtia Islamic University etc. for academic and research purposes.

**4. Service Rendered and Revenue Income**

Number of service given to organization	Nature of service	Total quantity of sample	Income (BDT)
3	Sample: Food/Feed Service: Microbiological analysis	9	18600.00
4	Sample: Pharmaceutical Service: Microbiological analysis	6	27000.00
Total			45600.00

**Radiation Entomology and Acarology Division (READ)**

Radiation Entomology and Acarology Division (READ) concerns primarily to develop and apply nuclear and integrated pest control techniques for stored and agricultural insect pests.

**Activities/Programme(s)****1. Research and Development Work(s)****1.1 Field Application of Sterile Insect Technique (SIT) for Production of Safe and Quality Dried Fish**

Assurance of quality production of 10 lacs sterile flies (*L. cuprina*) on cost effective artificial diet for field release under blowfly SIT strategy fortnight in Sonadia and Nazirertek commercial marine fish drying yards at Cox's Bazar on a regular basis would hopefully suppress / control the wild blowfly population at the released site reducing usual damage of sun dried marine fish caused by infestation of blowfly and thus minimizing traditional use of harmful insecticides. Environmentally friendly SIT technique may emerge as a suitable and effective strategy for suppressing the blowfly, a serious pest of sun dried marine fish ensuring production of insecticide free more acceptable marine dried fish, saving natural environment and boosting the trade potential of sun dried marine fish in both domestic and international market.

### **1.2 Identification of a Parasitic Hymenoptera as an Effective Biological Control Agent Against Blowfly Pests in Sun Dried Marine Fish at Cox's Bazar**

Repeated field level study of the fly pest population in different season revealed that occurrence of *Lucilia cuprina*, *Chrysomya megacephala*, *Boettcherisca paregrina* and *Musca domestica* in fish drying areas like Sonadia and Nazirertek, Cox's Bazar. Out of which *L. cuprina*, a major pest of the sundried marine fish of Bangladesh is being tried to control using Sterile Insect Technique (SIT). The *Dirhinus* sp. is a large, black hymenopteran insect parasitizing pupae of both *L. cuprina* and *B. paregrina*. The *Dirhinus* sp. (Chalcididae: Hymenoptera) may be used as an effective biological agent to control fly population in natural environment where fly pest infest. Parasitization in the pupae of *B. paregrina* was first detected in our laboratory rearing of the fly pest. It was apparent that the parasite passes its pre-adult life stages in the pupal case of their host. The parasite thus develops causing gradual death of the fly host. Only one adult parasite was emerged from each of the parasitized host pupa. The larvae of the parasitoid subsist on the developing adult in host puparium resulting pre-adult death of the host fly. As a result, the adult parasitic hymenopteran insect comes out of the fly puparium instead of the adult pest fly. Thus the parasitoid is capable of reducing the population of pest fly in nature.

### **1.3 Study of the Life Cycle of *Chrysomya rufifacies* (Diptera: Calliphoridae)**

The green hairy maggot blowfly, *Chrysomya rufifacies* (Macquart) is recognized as a serious pest of marine fishes during the process of sun drying in Bangladesh. The life history of *C. rufifacies* was studied on tilapia fish in laboratory condition ( $25 \pm 5^\circ\text{C}$ ). There are three larval instars. Mating took place after 2 days of adult emergence and duration of copulation ranged from 2 to 9 minutes. The duration of pre-oviposition, oviposition and post-oviposition period were recorded as 11-20 days, 9-11 days and 2-6 days, respectively. Each female laid only two egg batches during adult life totaling  $358.4 \pm 16.21$  eggs. The incubation period was 10-13 hours. The elongated larvae are 12 segmented of which 2nd -and 3rd -instar larvae bear long tubercles or hairy spines from the 4th segment. The range of duration of larva, pre-pupa and pupa were 80-115 hours, 48-72 hours and 48-120 hours, respectively. Life cycle from egg to adult emergence was completed in  $10.2 \pm 2.39$  days. Adult longevity of female was always greater than male. On the other hand life spans of mated male and female adults were more than those of unmated ones

### **1.4 Population Structure of Pierid Butterflies in Different Areas of Savar**

The present study incorporates detailed field observations of family Pieridae in different areas of Savar during January to December, 2014. During the course of field study, 2665 specimens of Pierid butterflies belonging to 24 species under 11 genera were recorded and assessed their species status, flying period, species abundance and their annual fluctuation pattern. The *Eurema* and *Leptosia* were most dominating genus with recorded highest number of individuals and they occupied 42.10% and 25.40% of total genera respectively. Nine species occur throughout the year and rest of the species showed very short seasonal peaks and they are either absent or rare in other seasons. Study revealed that the Pierid butterfly populations and species showed bimodal annual fluctuations peaked in December and May in study sites and also showed the first peak formed in December was much higher as compared to the second peak occurred in May. Monthly occurrence of pierid butterfly population was lower from June to September. *Leptosia nina nina* and *Eurema hecabe hecabe* were recorded highest abundant species in study sites.

## **Veterinary Drug Residue Analysis Division (VDRAD)**

### **Introduction**

Veterinary drug residue analysis Division (VDRAD) deals with the screening of different veterinary drug residues in foods of animal origin as well as development of several analytical methods for the confirmatory analysis. Specifically, the aims of this division is to monitor and confirm the residues of veterinary drugs in foods of animal origin to protect the public health and to increase international trade through utilization of nuclear and allied analytical methods.

### **Activities/Programme(s)**

#### **1. Research and Development Work(s)**

##### **1.1 Screening of Veterinary Drug Residues in Animal Originated Food Stuffs by CHARM II Technique**

Screening of veterinary drugs residues in foods of animal origin is a significant interest because of potential human health hazard and great impact on international food trade. Veterinary drugs commonly antibiotics are used as feed additive or to protect the diseases for food producing animals including tetracyclines, sulfonamides, quinolones, aminoglycosides, chloramphenicols, macrolides. CHARM II test is one of the

significant and easy methods for screening the antimicrobial residues in food of animal origin and it exploits microbial or antibody receptor assay technology. By using this technique, we have screened different veterinary drug residues in milk, egg and chicken matrices collected from different local markets.

### **1.2 High Performance Liquid Chromatography (HPLC) Method Development for the Determination of Tetracyclines in Chicken Tissue**

Tetracyclines (TCs) are broad-spectrum antibiotics which are commonly used as veterinary medicine to prevent diseases as well as food additive for the food producing animals to promote growth. These are widely used in poultry and dairy cattle. The analytical procedures have to be sensitive and selective enough to determine the concentrations of TCs according to the maximal residual limit (MRL) recommended by European Union (EU) regulations. A confirmatory high performance liquid chromatographic (HPLC) method for determination of tetracyclines antibiotics in tissue of chicken was developed. In this procedure, tetracyclines antibiotic residues were separated from chicken tissue by extraction with succinate buffer and followed cleaned and purified by solid phase extraction using C18 cartridges. Finally, oxytetracycline, tetracycline, chlortetracycline, doxycycline were separated on a ZORBAX Eclipse plus C18, (100 mm × 4.6 mm, 3.5 µm) column by gradient elution with a mobile phase consisting of 0.01M oxalic acid, acetonitrile and were monitored at 300-450 nm through diode array detector (DAD).

### **Plant Biotechnology and Genetic Engineering Division (PBGED)**

#### **Introduction**

Plant Biotechnology and Genetic Engineering Division is a leading research oriented laboratory in the country. It initiated research on plant tissue culture and mutation breeding in the early eighties with micropropagation of forest trees and mutation breeding of jute. Later on the other crop plants like cereals, fruit, medicinal, ornamental, vegetable, spices etc. have been included in the programme. In the mid-nineties research on Agrobacterium-mediated genetic transformation has been initiated with the fiber crop jute and this technique is expanded gradually to other plants of economic importance viz. rice, sugarcane, banana, tomato and Papaya. Presently the scientists of this division are doing their research on mutation breeding to improve crop plants besides the previous programme.

#### **Objectives**

- To develop suitable protocol for disease free and high yielding plantlets production through in vitro culture
- To establish *in vitro* protocol for commercial production of forest, fruit, medicinal and ornamental plants
- To identify the desired tissue culture derived lines from seed, embryo and anther culture through observational trials and primary yield trials
- To develop Agrobacterium-mediated genetic transformation technique to improve crop plants
- To improve crop plants through mutation breeding using Carbon Ion beam and Gamma irradiations
- To molecular characterization of mutant lines

#### **Activities/Programme(s)**

##### **1. Research and Development Work(s)**

###### **1.1 *In vitro* Clonal Propagation of Chrysanthemum Morifolium Ramat Through Axenic Culture**

M. R. Islam, M. T. Jahan, P. K. Roy, M. H. Kabir and A. N. K. Mamun

Chrysanthemum created a great demand for the promotion of floriculture in Bangladesh. The climatic condition and soil of Bangladesh is very favorable for commercial cultivation of Chrysanthemum. But no significant works have been done yet on Chrysanthemum for its improvement either in agronomy or in *in vitro* aspects. Though few efforts were made earlier for commercialization of this plant using *in vitro* techniques in Bangladesh but it was not adequate. Considering its importance and to overcoming the mentioned constraints

there is a need to establish a sustainable protocol for the commercial propagation of Chrysanthemum using tissue culture techniques. Therefore, the present study aims to develop a simple, rapid, and efficient high frequency regeneration technique for potential application in large scale propagation of Chrysanthemum.

A reliable and rapid large scale micropropagation method has been established from the node and shoots tip explant of Chrysanthemum morifolium growing in in vitro. Experiments were conducted to standardize the culture media with plant hormone for multiple shoot proliferation and rooting for obtaining plantlets with uniform characteristics like mother plant in terms of growth and habits. Different concentrations and combinations of auxins (IAA) and cytokinins (BAP, Kin) were used in MS for the above purpose. Maximum shoot regeneration was found in MS treated with 2.0 mg/l BAP both in node and shoot tip explants. In the above combination, nodal explants produced 14-16 initial shoots. Shoot tip explants produced 10-12 shoots. For *in vitro* rooting, different concentrations of IBA and NAA were used. Higher rooting percentage was recorded on MS fortified with 0.5 mg/l IBA. The rooted plantlets were hardened and successfully established in the soil. About 85% of the regenerated plantlets survived in the natural condition.

### 1.2 *In Vitro* Clonal Propagation of Stevia rebaudiana Bertoni through Node and Shoot tip Culture M.T.

Jahan, M. R. Islam\*, P. K. Roy, A. N.K. Mamun and M. A. Islam

*Stevia rebaudiana* Bertoni is a rare medicinal herb belongs to the family Asteraceae. It is a special interest to Diabetics patient and diet conscious. Seed of stevia show a very low germination percentage and vegetative propagation is limited by lower number of individuals. Propagation by seed does not produce homogenous populations; resulting in great variability is important feature like sweetening level and composition.

The climatic condition, soil type of Bangladesh is very favorable for commercial propagation of this important plant. Considering its importance and to overcome the problem of its propagation through conventional methods, the present study was undertaken to develop a simple, rapid and economical protocol for the production of plantlets on a large scale from the node and shoot tip explants of *S. rebaudiana*.

A reliable rapid large scale micropropagation method has been established from the node and shoots tip explant of *Stevia rebaudiana* Bertoni. Experiments were conducted to standardize the culture media with plant hormone for multiple shoot proliferation and rooting for obtaining plantlets with uniform characteristics like mother plant in terms of growth and habits. Different concentrations and combinations of auxins (IAA) and cytokinins (BAP, Kin) were used in MS for the above purpose. Maximum shoot regeneration was found in MS treated with 2.0 mg/l BAP both in node and shoot tip explants. In the above combination, nodal explants produced 14-16 initial shoots. Shoot tip explants produced 10-12 shoots. For *in vitro* rooting, different concentrations of IBA and NAA were used. Higher rooting percentage was recorded on MS fortified with 0.5 mg/l IBA. The rooted plantlets were hardened and successfully established in the soil. About 85% of the regenerated plantlets survived in the natural condition.

## 2. Manpower Development and Training Programme

Name of the event/topics	Date	Place	No. of participant
Basic Nuclear Orientation Course (BNOC)	09 Apr., - 08 June, 2017	Training Institute, AERE.	03

## 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
All the Scientist of this Division	8 <sup>th</sup> International Plant Tissue Culture & Biotechnology Conference.	Bangladesh Association for Plant Tissue Culture and Biotechnology, Department of Botany, University of Dhaka.	03-05 Dec., 2016	Department of Botany, Dhaka University

#### **4. Collaboration Work(s)**

Plant Biotechnology and Genetic Engineering Division (PBGED) has collaboration with International Atomic Energy Agency (IAEA), Regional Cooperative Agreement (RCA) Austria and Forum for Nuclear Cooperation in Agreement (FNCA), Japan. At present Scientists of this division engaged in several projects, these are as follows:

- Coordinated Research Project (CRP) of IAEA (No. 13186/RBF) entitled “Improvement of Banana (*Musa spp.*) through in vitro mutagenesis and doubled haploids”
- Forum for Nuclear Cooperation in Asia (FNCA) project entitled ‘Induced mutation for higher protein, amylase and yield in salt tolerant rice landraces by gamma irradiation’
- (RAS/5/045) ‘Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology (RCA)
- RAS5056: “Supporting Mutation Breeding Approaches to Develop New Crop Varieties Adaptable to Climate Change (RCA)”.
- RAS5070: Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RCA)
- RAS5077: Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA)

#### **INSTITUTE OF TISSUE BANKING AND BIOMATERIAL RESEARCH (ITBBR)**

##### **Introduction**

Tissue donation and grafting has comprehensive and versatile role in the health care sector. Utilization of human tissues has been practicing in Bangladesh is somewhat new in the field of tissue banking activities to treat degenerative bone diseases, congenital deformities, bone fractures, gap non-union from traumatic accidents, dental defects, different type of burns, acid violence, leprotic ulcer, bedsore, traumatic open wound, diabetic wound etc. To rehabilitate and treat these sorts of health problems in our country, “Institute of Tissue Banking and Biomaterial Research” of Bangladesh Atomic Energy Commission is the only tissue bank regularly providing radiation sterilized amnion membrane and bone allograft to different hospitals and clinics that have been using successfully in different types of clinical disorders and injuries in Bangladesh. Besides banking of human bone and amniotic membrane, ITBBR launches nationwide public/professional awareness programmes to motivate people for tissue donation and to disseminate information of tissue transplantation among the medical professionals. At present, ITBBR is trying to develop allograft substitute for skin and bone tissue regeneration. For this purpose, it has started doing research on epidermal keratinocyte, hydroxyapatite, calf bone xenografts and fabrication of biocompatible scaffold for tissue engineering. Due to its ongoing success on tissue banking activities, the tissue banking laboratory has been upgraded as an independent institute named “Institute of Tissue Banking and Biomaterial Research (ITBBR)” at AERE in 2017.

##### **Activities/Programme(s)**

#### **1. Research and Development Work(s)**

##### **1.1 Processing and Preservation of Amniotic Membrane for Repair of Chronic Non-healing Wounds with Regeneration of Lost Tissues**

Human amniotic membrane is a trilaminar tissue composed of an avascular mesenchyme, basement membrane and internal epithelium. HAM is widely used as biological dressing material in reconstructive skin surgery, abdominal and vaginal reconstructions, plastic surgery and in ophthalmologic surgery. Both the cellular and acellular parts of the membrane have anti-inflammatory characteristics that could help speed wound closure. Amniotic epithelial cells secrete factors that inhibit the chemotactic properties of neutrophils and macrophages as well as T and B lymphocyte proliferation. In addition to these secretory properties, the

collagen matrix of the underlying stroma has been shown to bind T lymphocytes along with other leukocytes, thereby sequestering and preventing them from participating in the inflammatory process. For HAM allograft preparation, amniotic sacs were retrieved from seronegative donor after normal vaginal deliveries. Amnion was separated aseptically from chorion, washed several times (6-8 times) with sterile physiological saline, spread on sterile surgical gauze and oven dried at the temperature  $40\pm 1^{\circ}\text{C}$  for overnight. The dried membranes were cut into different standard sizes e.g., (20×10 cm, 10×10cm, 5×5 cm), triple packed in polythene envelopes, vacuum-sealed and labeled properly under laminar flow cabinet and sterilized by gamma irradiation at the dose of 25 kGy. During the reporting period, 1545 pieces of amniotic sacs were collected and amniotic membrane allografts were prepared for clinical use in rehabilitative surgery.

## **1.2 Procurement and Preservation of Cancellous Chips Allografts for Remodeling and Filling of Bony Voids**

An allograft is defined as any tissue harvested from one individual and implanted into another of the same species. Freezing or freeze-drying the allograft is crucial in minimizing this reaction. However, the fundamental properties of the material may be altered. In orthopedic surgery, autografts are the most effective as they are osteoconductive, osteoinductive and may have osteogenic cells but it has huge limitations, including donor site morbidity, inadequate amount and inappropriate form. Although the risk of disease transmission through implantation of allograft is rare, its existence is not inconsequential. By eliminating the need for an additional surgical procedure, allografts reduce the operating time and trauma associated with the acquisition of autografts. Allografts may be cancellous, cortical, or a combination of both. Cancellous bone allograft (CBA) alone or in combination with autologous bone precursor cells offers an appealing strategy for skeletal regeneration. To prepare CBA, bones (femoral heads and condyles) were collected from clinically acceptable live donors undergoing surgical treatment. Bone tissues were pasteurized, processed, radiation sterilized and preserved according to the protocol set by ITBBR based on guidelines of International Atomic Energy Agency (IAEA), the European Association of Tissue Banks (EATB) and the American Association of Tissue Banks (AATB). From July 2016 to June 2017, 833 raw bone tissues were collected from different hospitals and freeze dried radiation sterilized bone allografts were prepared for clinical use in orthopedic reconstruction.

## **1.3 Processing of Frozen Irradiated Massive Bone Allograft Used in Orthopedic Surgery**

Replacement of bone where there is none is one of the most challenging problems facing orthopedic surgeons today. In the case of tumor resection or trauma, massive bone defects must be filled with regenerate bone as quickly as possible in order to restore function. Current standards for bridging of massive bone defects in long bones generally follow a theme of filling the defect with bone autograft or allograft. In orthopedic surgery, Use of massive bone allografts has become common practice in limb salvage after giant cell tumor (GCT) resection and primary and revision total joint replacement. In certain special clinical situations associated with large bone loss, such as trauma, limb-length discrepancy repair or even infection, massive bone allografts can be successfully used. Cortical bones such as femur, tibia, fibula, cranial bone etc. were collected from seronegative live donor after total knee replacement (TKR) operation, corrective osteotomy, primary traumatic limb amputation surgery etc. and were preserved under frozen condition ( $-80^{\circ}\text{C}$ ) until processing began. For processing, the frozen long (massive) bones were thawed to room temperature and soft tissue were removed using sterile surgical instruments under aseptic condition. Then the bones were treated with providone iodine solution and washed several times with plenty of sterile distilled water, double packaged in polyethylene, vacuum sealed, wrapped with fabric and labeled with graft identification number, dose and date of gamma irradiation, preservation conditions, expiry date etc. Finally, the bones were packaged and vacuum-sealed in a third layer of polyethylene. The bones were then placed in an insulated cool box and the cool box was kept in deep freezer ( $-80^{\circ}\text{C}$ ). Cortical bones were sterilized by gamma radiation under frozen condition and were preserved at  $-80^{\circ}\text{C}$  and supplied to hospitals/clinics after sterility testing. During the reporting period, 3 massive bones were supplied for clinical use in limb salvage surgery.

#### **1.4 Processing of Demineralized Bone Granules for the Treatment of Oral and Maxillofacial Bone Defects**

Demineralization of bone is the first step during matrix breakdown, which improves accessibility of the growth factors that retain all or most of its osteoinductive potential. Demineralized bone matrix (DBM) is widely used in the repair of pathologies associated with skeletal defects and periodontal diseases. The property which sets demineralized bone matrix (DBM) grafts apart from other types of bone graft is its capacity to actively induce the formation of new bone. For demineralized bone granule preparation, pasteurized bones were cut into pieces (cortico-cancellous and cancellous bone pieces) and washed with sterile distilled water. The bone pieces were then treated with chloroform: methanol (1:1) solution for defatting, crushed, demineralized with 0.6 N hydrochloric acid (HCl) and washed with phosphate buffer solution (pH 7.0) to neutralize the activity of acid followed by washing again several times with sterile distilled water. The granules were then freeze dried at  $-50^{\circ}\text{C}$  for approximately 24 hours. Bone granules were then dispensed in 2 cc plastic vials; the vials were wrapped in polyethylene pouches (triple layered), labeled, and sterilized by gamma irradiation (25 kGy). During the period, 16 vial demineralized bone granule were prepared for clinical use in oral and maxillofacial surgery.

#### **1.5 Microbiological Quality Assessment and Sterility Assurance of Tissue Allografts for Safe Tissue Transplantation**

Preserved human connective tissue grafts such as bone, cartilage, tendons, skin and amnion used in reconstructive surgery has increased tremendously in several disciplines over the last several years. The highest demand is for musculoskeletal allografts which are commonly used for reconstructive surgery in orthopedics and traumatology. ITBBR strictly follows the guidelines of tissue banking setup by IAEA, EATB and AATB. To ensure desired quality of allografts and to protect prospective recipients from the risk of allograft associated infection, tissue procurement, processing, labeling, quality control practices were performed and were documented in accordance with approved standard operating procedure and instructions. All the tissue allografts processed at ITBBR were sterilized by 25 KGy gamma irradiation. After sterilization, sterility test was done using four different types of microbiological culture media (nutrient broth, thioglycollate broth, brain heart infusion broth, and sabouraud dextrose broth). In the reporting period, 1325 amnion samples from 41 batches and 843 bone samples from 31 batches were tested. All samples were found microbiologically safe.

#### **1.6 Processing and Preservation of Frozen Human Amniotic Membrane (HAM) for Ocular Surface Reconstruction**

Frozen HAM transplantation is currently being used worldwide for a continuously widening spectrum of ophthalmic indications because the basement membrane component of amniotic membrane is similar in composition to the conjunctiva. Various methods have been used to preserve amniotic membrane including “fresh” (or more appropriately hypothermic) storage, freezing, and freeze drying/ oven drying. Differences in preservation techniques can significantly influence the biochemical composition and physical properties of HAM, potentially affecting clinical safety and efficacy. For this, the objective of the study was to, (i) investigate the initial microbial load of unprocessed HAM; (ii) isolate and to identify the microbial contaminant associated with HAM; (iii) determine antimicrobial susceptibility pattern of the isolated microorganisms; (iv) formulate suitable antibiotic cocktail to eliminate the HAM associated microflora; and (v) develop suitable protocol for the processing and preservation of frozen amniotic membrane for the treatment of ocular disease. During this period, amniotic sac were collected and microbiological analysis was performed. HAM was processed using antibiotic cocktail which was formulated on the basis of the antimicrobial susceptibility pattern of the bacterial contaminants. Grafts were preserved using Dulbecco’s Modified Eagle Medium (DMEM) and glycerol at  $-80^{\circ}\text{C}$ .

#### **1.7 *In vitro* Growth and Maintenance of Human Epidermal Keratinocytes**

In the past few decades, the *in vitro* cultivation of human epidermal keratinocytes has significantly been improved owing to several developments in terms of media, growth factors and overall culture conditions. This development has exhibited great applicability in the treatment of burn and ulcer patients as allografts and



autografts, along with contributing in pharmacological tests, skin disorder study and most recently in iPSC technology. However in Bangladesh, human cell culture has not yet been advanced enough which urges extensive research. The present study, therefore, aimed to investigate an optimum culture condition for human epidermal keratinocytes (HEK). For this purpose, effects of substrate, donor age, serum concentration and growth factors on keratinocyte culture were evaluated. Keratinocytes were isolated from epidermal layer of human foreskin by cold trypsinization which yielded  $2.5 \times 10^6$  cells on an average from each foreskin with cell viability up to 90%. Compared to tissue culture plastic and medium-conditioned flasks, gelatin-coated substrate showed higher amount of cell attachment (35-50%). Serum concentrations of 10-15% yielded 2-4 folds more cell proliferation than lower or higher levels. Additional insulin supplementation at 5 $\mu$ g/ml gave better cell growth than serum (10%) or hydrocortisone supplement (0.4 $\mu$ g/ml) alone. However, the most significant cell growth was obtained in serum containing medium supplemented with both insulin (5 $\mu$ g/ml) and hydrocortisone (0.4 $\mu$ g/ml).

### **1.8 Synthesis of Nano-sized Hydroxyapatite from Eggshell and Its Characterization by X-ray Diffractometry**

Adult mammal bone is composed of mineral phase comprising ~69% of the total weight along with ~22% organic matrix and 9% water. Hydroxyapatite (HA) is the major inorganic phase among other minerals. Various techniques were developed and have been used to manufacture nano-HA (n-HA). Considering the ever-growing need to develop clean, non-toxic and environmentally friendly techniques, here we used chicken eggshells as raw materials to produce HA by wet chemical precipitation method. X-ray powder diffractometry was carried out using a two circle ( $2\theta$ - $\theta$ ) X-ray powder diffractometer, X'Pert PRO PW 3040 with Cu- $\alpha$ .

### **1.9 Fabrication of Biocompatible Bone Tissue Scaffold**

Hydroxyapatite (HA) based biomaterials have generated considerable interest in the regeneration of skeletal tissue due to its osteoconductive properties, non-toxic, non-immunogenic behavior and crystallographic similarity with natural bone minerals. HA derived either from natural sources (bovine bone, eggshell, coral, marine algae etc.) or from synthetic sources can form a strong chemical bond with host bone tissue but bovine HA are more osteoconductive than synthetic HA. Therefore, our aim is to prepare hydroxyapatite from bovine cortical bone to fabricate biocompatible scaffold for bone tissue engineering aiming to use as an alternative to bone allografts in the treatment of skeletal defects. HA was extracted from bovine cortical bone by both low (200-250 $^{\circ}$ C) and high (650-1250 $^{\circ}$ C) temperature sintering. XRD spectra of the sample sintered at 800-950 $^{\circ}$ C exhibited several high intensity peaks corresponding to various planes of pure HA i.e., 132, 210, 211, 213, 221, 222, 300 and 402 which were also the characteristic peaks of standard HA (Reference code: 01-086-0740). Above these temperature, decomposition of HA phase was observed and at low temperature HA was the major phase but there were some organic impurities. So, sintering at 800-950 $^{\circ}$ C temperature was found suitable for the extraction of pure, non-stoichiometric HA (crystal system: hexagonal, space group: P63/m). To find out a suitable sterilization approach, effects of gamma radiation on HA were also studied. Same X-ray diffraction pattern was obtained before and after gamma irradiation at 25 kGy. Using this HA, a series of HA/chitosan-gelatin (HA/Cs-Gel) composite scaffold with different HA content were fabricated by thermally induced phase separation (TIPS) technique and gamma radiation. Scanning electron microscopy of the HA/Cs-Gel composite scaffold depicted a continuous structure of irregular interconnected pores. Further work is being carried out to determine the cross-linking pattern, cytotoxicity, protein absorption capacity and biocompatibility of the scaffolds.

### **1.10 Characterization and Molecular Profiling of Multidrug Resistant Amniotic Membrane Associated Microflora with Their Radiation Sensitivity Pattern**

Amniotic membrane (AM), a well-established biological treatment tool has been using in ocular surgery, skin, abdominal and vaginal reconstruction and cosmetic surgery for many years. But the risk of infectious diseases transmission with tissue allograft is a major concern in the tissue banking practice. Moreover, the occurrence of multidrug resistant bacteria on amnion has also been reported. Therefore our aim is to investigate the level of bioburden on amniotic membrane, to determine the antibiotic sensitivity of membrane associated isolates

and then to investigate radiation sensitivity pattern of representative microbial isolates and then to determine radiation dose to eliminate the bioburden level effectively

## **2. Service Rendered**

From July 2016 to June 2017, 5323 pieces of radiation sterilized amnion membrane allografts (including eye grafts) and 13901 cc bone grafts (including 3 deep frozen massive bone allograft, 14 frozen cranial bone autograft and 16 vial demineralized bone granule) have been supplied to the different hospitals/clinics throughout the country. During this period, patients suffering from various types of skin loss due to burn (acid, fire and electric burn), leprotic ulcer, diabetic wounds, abdominal and vaginal complications and ophthalmic diseases were treated using amniotic membrane allografts. Using the bone allografts patients suffering from different orthopedic complications such as giant cell tumor, bone cyst, spinal defects, bone fracture, osteolytic lesion, fibrous dysplasia, gap-nonunion, osteosarcoma etc. were treated successfully.

## **3. Public and Professional Awareness Programme for Tissue Donation**

Tissue banking is a practice of collecting human cadaver and discarded tissue, their processing and preservation for clinical application and research. ITBBR links different occupational groups, medical professional health care staff by social networking to increase the capability and capacity within the health system to maximize donation and to build community awareness and stakeholder engagement across Bangladesh to promote organ and tissue donation. In Bangladesh the only tissue bank, ITBBR motivate and create public awareness by organizing seminars and presentations; displaying posters in medical / scientific conferences; publishing leaflets; establishing collaboration with national and international organ donation organization. To bring awareness to the critical need for more tissue donors and to explain the scientific ground of transplantation, one national seminar on “Tissue Banking activities in Bangladesh” was arranged at Dhaka.

## **NUCLEAR MEDICINE**

### **NATIONAL INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (NINMAS), SHAHBAG**

#### **Introduction**

National Institute of Nuclear Medicine & Allied Sciences (NINMAS) is the apex Nuclear Medicine facility in Bangladesh and it is located in Bangabandhu Sheikh Mujib Medical University (BSMMU) premise. The Institutes provides medical imaging using nuclear techniques and therapeutic treatment services.

#### **Objectives**

- To render specialized medical services to the people using nuclear technology
- To improve and upgrade Nuclear Medicine facilities in Bangladesh
- To conduct training of physicians, physicists, radiopharmacists and technologists in the field of nuclear medicine
- To conduct academic and research activities
- To coordinate and standardize the activities of all nuclear medicine establishments of BAEC

#### **Activities/Programme(s)**

##### **1. Clinical Services**

Clinical services are provided under the following divisions:

- PET-CT Division
- Scintigraphy Division
- Nuclear Cardiology Division
- Nuclear Nephrology Division

- Research and Development Division
- Thyroid Division
- *In-vitro* Division
- Ultrasound and Color Doppler Division

## **2. Diagnostic Activities**

- The Institute is equipped with PET-CT facility. PET-CT scan is very useful for early diagnosis and staging of cancer for the people of Bangladesh
- The institute is equipped with 3 SPECT facilities and one SPECT CT and one planar Gamma camera. The Scintigraphic studies are: Bone scan, Brain scan, Kidney (DTPA, DMSA), GFR, Hepatobiliary, HIDA, Lymphoscintigraphy, GI bleeding, Thyroid Scan, parathyroid, Salivary, Cardiac and Testicles, Lung Perfusion etc.
- Thyroid Imaging and Uptake
- BMD (Bone Mineral Densitometry) for early detection of osteoporosis/osteopenia
- Conventional and Power & Color Doppler ultrasound Imaging: At present there are 5 Color Doppler's including one 4D, one 3D and three 2D machines. All sorts of diagnostic USG, including normal B-scan of different organs, HRUS of superficial organs and Color Doppler of vascular system are routinely performed
- Hormone Analysis: All thyroids related hormones like T3, T4, TSH, FT3, FT4, LH, FSH, pituitary hormones, estrogen, progesterone, prolactin, testosterone, follicular stimulating and luteinizing hormones, Vitamin D, parathormone and Tumor Marker: Thyroglobulin, etc.

## **3. Therapeutic Activities**

- The therapeutic component of our activity is extensively in the treatment of thyroid cancer and hyperthyroid patients using I-131
- Strontium-90 for pterygium, corneal neovascularization and squamous cell carcinoma of the conjunctiva
- I-131 labeled MIBG for diagnosis and therapy of neuroendocrine tumors

## **4. Research and Development Work(s)**

### **In-house Research**

- Evaluation of PET-CT in gastrointestinal carcinoma- Dr. Shamim Momtaz, Dr Abu Bakker Siddique and coworkers
- Role of PET-CT in evaluation of treatment response in lung carcinoma- Dr. Shamim Momtaz and coworkers
- Experience of PET-CT in adult lymphoma- Dr Fatima Begum and coworkers
- Experience of PET-CT in breast cancer- Dr. Shamim Momtaz and coworkers
- Protocol development for the contraindication of stress myocardial perfusion study in main trunk stenosis in collaboration with cardiologists- Dr Shamim Momtaz, Dr Mostofa Shamim Ahsan, Dr Tapati Mandal and Dr Pupree Mutsuddy
- Followup for intervention adopted in reversible perfusion defect in MPI- Dr Shamim Momtaz, Dr Mostofa Shamim Ahsan, Dr Tapati Mandal and Dr Pupree Mutsuddy

- Correlation between parathyroid scintigraphy and ultrasonography in evaluation of parathyroid adenoma- Dr Mostofa Shamim Ahsan and Dr Sadia Salam
- DTPA renogram & USG of DM Patients more than 5yr -Dr Jasmine Ara Haque & co workers.
- Renal function tests of HTN patients more than 10 yrs by DTPA renogram - Dr Jasmine Ara Haque & co workers
- Evaluation of renal function by MAG 3 under 1yr age patient - Dr Jasmine Ara Haque & co workers
- Longterm Follow up of radioiodine treated thyroid carcinoma with lymphnodes metastases, Dr Fatima Begum, Dr Sharmin Quddus, Dr Farhana Haque, Dr Azmal Sarker, Dr Sharmin Reza Dr. Rahima Perveen and Dr Urnas Islam
- Role of posttherapy scan in evaluation of hidden lungs metastases in patients with differentiated thyroid carcinoma- Dr Sharmin Quddus, Dr Farhana Haque, Dr Azmal Sarker and Co-workers.
- Spectrum of thyroid dysfunction in children who are referred to NINMAS for thyroid function evaluation- Dr Simoon Salekin, Dr Urnas Islam and coworkers
- Metastases in unusual sites from differentiated thyroid carcinoma-Dr. Rahima Perveen, Dr Urnas Islam and co-workers
- Transvaginal folliculometry in infertile women- Dr Jasmine Ara Haque and coworkers
- Evaluation of postmenopausal uterus by transvaginal scan- Dr Jasmine Ara Haque and coworkers
- Biophysical profile on 32 weeks onwards pregnant women- Dr Jasmine Ara Haque and coworkers
- Duplex study of vertebral arteries in patients- Dr Fazlul Bari and coworkers
- Assessment of carotid vessels in DM and TIA - Dr Nasreen Sultana and coworkers
- Musculoskeletal ultrasonography of different limb joints and injury- Dr Fazlul Bari, Dr. Abu Bakker Siddique and coworkers
- Duplex study of uterine artery to predict pre- eclampsia. Case- control study. Dr. Abu Bakker Siddique and coworkers
- Duplex study of penile vessels in erectile dysfunction, (Pharmaceutical augmented). Dr. Abu Bakker Siddique, Dr Fazlul Bari and Dr Azmal Sarker
- Elastoscans of thyroid nodule- Dr Fazlul Bari and coworkers
- Elastoscans of Breast- Dr Jasmine Ara Haque and coworkers
- Less fetal movements and oligohydramnios associated with high S/D ratio of umbilical artery Dr Nasreen Sultana and co-workers

#### **5. Collaboration Work(s)**

The institute has a significant volume of both large and small projects and programmes under the auspices of Research and Development division.

#### **6. Current Research Projects at NINMAS**

##### **IAEA TC Project**

- IAEA TC Project BGD-6025, “Improving the Management of Oncological, Cardiovascular and Infectious Diseases, Particularly Tuberculosis”, Dr Shamim Momtaz
- IAEA TC Project BGD-2016003, “Improved Cancer Management through Capacity Building in Molecular Imaging and Radiation Oncology” (2018-19), Dr. Shamim Momtaz

**IAEA RCA Project**

- Optimizing the role of Nuclear Medicine techniques in the diagnosis and clinical management of childhood cancer and inborn diseases (RAS/6/075), Dr Sadia Sultana
- Preventing overweight and obesity promoting physical activity among children and adolescents (RAS/6/080), Dr Shamim Momtaz.
- Strengthening the effectiveness and extent of Medical Physics Education and Training (RAS/6/077), Dr Kamila Afroj Quadir and Mrs. Ferdoushi Begum.
- Improving Patients care & enhancing Government parties capacity in Nuclear Medicine Programmes in RCA Region (RAS 6083), Dr Jasmine Ara Haque
- Improving Quality of life of Cancer Patients through Steamline and Emerging Therapeutic Nuclear Medicine Techniques (RAS 6074), Dr Jasmine Ara Haque
- Building Capacity with Distance Assisted Training For Nuclear Medicine Professionals (RAS/6/064), Dr Kamila Afroj Quadir

**CRP Project**

- CRP Project E13043, “Evaluation of multimodality imaging in the assessment and diagnosis of early stage Alzheimer disease with and without comorbidities”, Dr Nasreen Sultana
- CRP Project E15021, “FDG PET/CT in the evaluation of Extra-pulmonary Tuberculosis and Response of Therapy”, Dr. Shamim Momtaz
- CRP Project E2.40.19, “Advances in Medical Imaging Techniques”, Dr Kamila Afroj Quadir & Md. Nahid Hossain
- CRP Project E-12017, “PET-CT in the management of pediatric lymphoma”, Dr. Fatima Begum

**Ministry of Science & Technology Project**

- Government ADP project, “Establishment of Positron Emission Tomography Computed Tomography (PET-CT) Technology with Cyclotron facilities”, Project Director: Dr. Md Nurul Islam
- Government ADP project, “Upgrading and strengthening the facilities at National Institute of Nuclear Medicine and Allied Sciences (Former INMU), Project Director: Dr. Faria Nasreen.

**7. Training/Workshop/Seminar/Conferences hosted at/by NINMAS**

Name of the event/topics	Date	Place	No. of Participants
Training of the in vitro laboratory technologists of NINMAS and Institute of Nuclear Medicine and Allied Sciences (INMAS) on Radioimmunoassay especially thyroid auto antibodies, thyroid peroxidase antibodies (TPOAb) and thyroglobulin antibodies (TgAB).	June 2016-Dec., 2016	Radioimmunoassay Laboratory, <i>In vitro</i> Division, NINMAS, Dhaka	14
Arrangement of Expert Mission Programme under IAEA Project (RAS 6083) Titel: Multidisciplinary Group Discussion and Awareness Programme in Clinical Application in PET/CT under IAEA project in the field of Cardiology, Neurology, Oncology & Thyroidology.	25-29 Feb., 2017	NINMAS, Shahbag Dhaka	80
Arrangement of one day workshop on Nuclear Cardiology under IAEA Project (RAS 6083) joint collaboration with Society of Nuclear Medicine	27 <sup>th</sup> April, 2017	IMMAS, Mymensingh.	60

**8. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the Participant	Name of the event/topics	Organizer	Date	Place
Prof. Dr. Mizanul Hasan	Operational and maintenance training on Siemen's Dual Head SPECT scanner	Project on "Upgrading & Stengthening the facilities at NINMAS"	18 Sept., - 1 Oct., 2016	Erlangen, Germany
Prof. Dr. Nurun Nahar	Operational Training of Mediso Imaging System	Project on "Upgrading & Stengthening the facilities at NINMAS"	06-12 Jan., 2017	Manila, Philippine
Prof. Dr. Shamim M F Begum	Operational and maintenance training on Siemen's Dual Head SPECT scanner	Project on "Upgrading & Stengthening the facilities at NINMAS"	18 Sept., - 1 Oct., 2016	Erlangen, Germany
Prof. Ferdoushi Begum	Operational and maintenance training on Siemen's Dual Head SPECT scanner	Project on "Upgrading & Stengthening the facilities at NINMAS"	30 Oct., - 12 Nov., 2016	Erlangen, Germany
Prof. Dr. Faria Nasreen	Operational and maintenance training on Siemen's Dual Head SPECT scanner	Project on "Upgrading & Stengthening the facilities at NINMAS"	18 Sept., - 1 Oct., 2016	Erlangen, Germany
Dr. Nasreen Sultana	IAEA sponsored fellowship in neuroimaging.	International Atomic Energy Agency (IAEA)	9-20 Jan., 2017	Utah university. USA
Md. Nahid Hossain	Operational and maintenance training on Siemen's Dual Head SPECT scanner	Project on "Upgrading & Stengthening the facilities at NINMAS"	18 Sept., - 1 Oct., 2016	Erlangen, Germany
Dr. Sharmin Quddus	Operational Training of Samsung Medison Co. LTD.	Project on "Upgrading & Stengthening the facilities at NINMAS"	21-23 Sept., 2016	Seoul, Korea
Dr. Tanvir Ahmed Biman	Operational Training of Mediso Imaging System	Project on "Upgrading & Stengthening the facilities at NINMAS"	06-12 Jan., 2017	Manila, Philippine
Dr. Tanvir Ahmed Biman	Training Programme on "Operation and Maintenance of Cyclotron and Radiochemistry Analyzer"	Project on "Establishment of Positron Emission Tomography – Computed Tomography (PET-CT) and Cyclotron Facilities"	06-17 March, 2017	Austin Hospital Heidelberg, Victoria, Australia
Dr. Mohammad Anwar-UI Azim	Training Programme on "Operation and Maintenance of Cyclotron and Radiochemistry Analyzer"	Project on "Establishment of Positron Emission Tomography – Computed Tomography (PET-CT) and Cyclotron Facilities"	06-17 March, 2017	Austin Hospital Heidelberg, Victoria, Australia
Dr. Rahima Perveen	Operational and maintenance training on Siemen's Dual Head SPECT scanner	Project on "Upgrading & Stengthening the facilities at NINMAS"	30 Oct., - 12 Nov., 2016	Erlangen, Germany
Dr. Urnas Islam	Basic Nuclear Orientation Course	Bangladesh Atomic Energy Commission	09 Apr., - 08 June, 2017	AERE, Savar, Dhaka

**9. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Prof. Dr. Mizanul Hasan, Prof. Dr. Raihan Hussain, Prof. Dr. Nurun Nahar, Prof. Dr. Shamim M F Begum, Prof. Dr. Sadia Sultana, Prof. Dr. Nurul Islam, Prof. Dr. Fatima Begum, Prof. Ishraque Hossain Ansari, Prof. Ferdoushi Begum, Prof. Ferdoushi Begum, Prof. Dr. Jasmine Ara Haque, Prof. Dr. Faria Nasreen, Prof. Dr. Faria Nasreen, Dr. Abu Bakkar Siddique, Dr. Mostafa Shamim Ahsan, Dr. A K M Fazlul Bari, Dr. Nasreen Sultana, Dr. Sharmin Quddus, Dr. Mohammad Anwar-Ul Azim, Dr. Azmal Kabir Sarker, Dr. Pupree Mutsuddy, Dr. Rahima Perveen, Dr. Tapati Mondal, Dr. Simoon Salekin, Dr. Urnas Islam, Md. Nahid Hossain and Dr. Jasmine Ara Haque	22 <sup>nd</sup> National Conference of Society of Nuclear Medicine, Bangladesh	Society of Nuclear Medicine, Bangladesh	24-25 Feb., 2017	Gazipur, Bangladesh
Prof. Ferdoushi Begum, Md. Nahid Hossain	International Conference on Physics in Medicine and Clinical Neuroelectrophysiology PMCN-2017	Bangladesh Medical Physics Association (BMPA)	10-11 Mar., 2017	Dhaka, Bangladesh
Dr. Nasreen Sultana	15 <sup>th</sup> Annual General Meeting of ARCCNM and the 7 <sup>th</sup> CJK conference on Nuclear Medicine	Asian Regional Cooperative Council for Nuclear Medicine (ARCCNM)	14-16 <sup>h</sup> July, 2006	Shenyang, China.
Dr. Jasmine Ara Haque, Dr. Nasreen Sultana	FNMB Examination	Asian school of Nuclear Medicine	17 July, 2016	Shenyang, China.
Md. Nahid Hossain	International Conference on Medical Physics (ICMP)	International Organization of Medical Physics (IOMP)	9-12 Dec., 2016	Bangkok, Thailand
Md. Nahid Hossain	International Conference on Advances in Radiation Oncology (ICARO2)	International Atomic Energy Agency (IAEA)	20-23 June, 2017	Vienna, Austria,
Md. Nahid Hossain, Dr. Tanvir Ahmed Biman, Dr. Mohammad Anwar-Ul Azim	National Conference on Physics-2017	Bangladesh Physical Society	5-7 Jan., 2017	AEC, Dhaka
Dr. Sharmin Quddus	2 <sup>nd</sup> Asian Nuclear Medicine Academic Forum 3 <sup>rd</sup> Rising Professional Challenge	Asian School of Nuclear Medicine (ASNM)	5-8 May, 2016	Shanghai, China

Dr. Mohammad Anwar-Ul Azim	The IAEA Technical Meeting (F1-TM-52895) on “Specific Applications of Research Reactors: Production and Use of Radiotracers”.	International Atomic Energy Agency (IAEA)	20-23 June, 2016	Vienna, Austria
Dr. Mohammad Anwar-Ul Azim	11 <sup>th</sup> International Conference on Radiopharmaceutical Therapy (ICRT)	World Association of Radiopharmaceutical and Molecular Therapy (WARMTH)	13-17 Nov., 2016	Cochin, India
Dr. Fatima Begum, Dr Shamim Momtaz, Dr Sadia Sultana	The 15 <sup>th</sup> Annual General Meeting of the ARCCNM and The 7 <sup>th</sup> CJK Conference on Nuclear Medicine	ARCCNM, Chinese Japan and Korea Society of Nuclear Medicine, Asian School of Nuclear Medicine	12-17 July, 2016	Shenyang China
Dr. Jasmine Ara Haque	Workshop & coordination Meeting in Nuclear Medicine Techniques in Neurological Disease	IAEA	26 -30 June, 2017	Osaka, Japan
Dr. Jasmine Ara Haque	Conference of Asian School of Nuclear Medicine 2017	Asian School of Nuclear Medicine	11-13 May, 2017	Shanghai, China

## 10. Academic Activities

- NINMAS is the only institute in the country where postgraduate degrees like M. Phil and MD (Nuclear Medicine) courses have been conducted for the medical graduates under Bangabandhu Sheikh Mujib Medical University (BSMMU). Nine students passed M Phil course in the year 2016-2017 and 10 residents were admitted for MD course of 5 years duration
- One IAEA fellow (Physician) has been doing his IAEA fellowship training in NINMAS
- During this period 8 students completed M Phil thesis supervised by the NINMAS personnel under BSMMU
- Thirteen students of Biomedical Physics and Technology Department, University of Dhaka completed one month internship as part of their M Sc programme at NINMAS
- Three doctors completed their six months training programme in the field of Nuclear Medicine & Ultrasound from this Institute
- Weekly journal review as continuous education programme was conducted on recent Nuclear Medicine & Allied Sciences related works regularly in this institute
- Scheduled lectures were delivered routine to post graduate students (MD, MS) of different disciplines of BSMMU, BIRDEM, NIKDU, NICVD, NSH, NICRH, NICDH and Heart Foundation and students are placed for 15-30 days for practical demonstration

## 11. Service Rendered and Revenue Income

Total no. of patient	Income (BDT)
72,830	5,87,36,505/-



## **INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), DHAKA**

### **Introduction**

Institute of Nuclear Medicine & Allied Sciences is one of the oldest Institute of Nuclear Medicine in this country and it was established in 1961 in the Dhaka Medical College premises. This institute was modernized on 2006. At present this institute included different technologies like Dual head & Single headed Gamma camera, thyroid scanner, 2D & 3D ultrasound scan, color Doppler scan, BMD and in vitro procedure etc. A considerable number of patients obtained health care services from this institute & regular basis.

### **Activities/Programme(s)**

#### **1. Diagnostic Services**

- **In Vivo Procedure**

Scintigraphic Studies of Brain, Bone, Liver, Hepatobiliary, Kidney (DTPA & DMSA), Cardiac, HIDA, Lymphoscintigraphy GI Bleeding, Thyroid, Parathyroid, Salivary and Testicles etc.

- **In Vitro Procedure**

Different types of hormone analysis i.e. T3, T4, TSH, FT3, FT4, Tg, FSH, LH, Oestrogen, Progesterone, Testosterone, Prolactin, PSA, Tg, Ca-125 and Calcitonin etc.

- **Ultrasound Services**

2D/3D scanning ultrasonography & Doppler Ultrasound plays an important role for diagnosis. Different types of organ like liver, kidney, pancreas, ovary, prostate, thyroid, testis, breast, mas skeletal ultrasound etc ultrasound routinely done here.

- **Color Doppler Imaging**

Different type of vasculorrities or blood vessel like- carotid, vertebral arteries, upper & lower limbs vessels, renal doppler, portal venous doppler A.V. fistula etc. are being performed regularly this institute.

- **Bone Mineral Densitometry**

For early detection of osteoporosis / osteopenia, this modality is very useful and is being routinely done in this institute.

#### **2. Therapeutic Service**

Radionuclide therapy services were applied to the different type of patients like, Thyroid cancer, Thyrotoxicosis, Pterygium, Onychomycosis, Bone Pain Palliation, Polycythaemia Vera and Painful Joint Disorders & Chronic Rh. Arthritis (Radiosynovectomy) etc. routinely being done. In addition to this treatment is being given to the patients of Hypothyroidism and IDD, simple goiter, thyroid nodule etc this institute provide the services at regular basis.

#### **3. Research and Development Work(s)**

Various Nuclear Medicine and Ultrasound related research works are being performed in this institute results were published in National and international journals. About 20 research papers have been published last year in National/International journals.

#### **4. Manpower Development/Training Programme(s)**

The following training were conducted in this institute in last fiscal year

- BGD/6024 on strengthening of oncology services in Bangladesh
- IAEA RCA project BGD/6071 on strengthening of radio nuclide therapy services in Bangladesh
- IAEA RCA project BGD RAS-6062 on supporting 3D image guided radiotherapy

- Different type of workshop and seminar are being done regularly in this institute. During last year, 9 doctors completed their long term training programme from this institute

## 5. Academic Activities

Weekly journal review /seminar and interesting case presentation on recent of Nuclear Medicine & Ultrasound related works are being done regularly in this institute. Scheduled lectures were delivered to both under graduate and post-graduate students of DMC, Scientists of this Centre have been delivering scheduled lectures to the post graduate students of M. Phil course in Nuclear Medicine” conducted by the Faculty of Post Graduate Medicine of Dhaka University. Two students completed their M.Sc thesis in this center.

## 6. Service Rendered and Revenue Income

Total no. of patient	Income (BDT)
41,845	2,42,35,030/-

## INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), MITFORD

### Introduction

INMAS, Mitford is situated in the old part of Dhaka City to serve specialized medical services to the people using nuclear technology. Our aim is to overall expansion of nuclear medicine procedures specially using news hybrid technology. This centre is already equipped by modern technology like SPECT/CT which improve accuracy of detection of disease.

### Activities/Programme(s)

#### 1. Manpower Development and Training Programme

Name of the event/topics	Date	Place	No of participant
Centre based training courses on application of nuclear medicine procedures	12-13 July/16	INMAS Mitford	5
Centre base training course on office manners	28 Dec/16	INMAS Mitford	30

#### 2. Seminar/Conference/Workshop/Meeting Attended

Name of the participants	Name of the event/topics	Organizer	Date	Place
Dr. Hosne Ara Rahman (PMO) Dr. Jesmin Ferdous (SMO) and Dr. Samira Sharmin (SMO)	RCA/IAEA TC Project (RAS 6083) IAEA Workshop on improving patient care and enhancing government parties capacity in nuclear medicine programmers in RCA region	BAEC	27-28 Feb., 2017	Dhaka
Dr. Mahbub ur Rahman (CMO) Dr. Hosne Ara Rahman (PMO) Dr. Jamiul Hossain (SMO) Dr. Jesmin Ferdous (SMO) Dr. Samira Sharmin (SMO) and Dr. Farida Yasmin (MO)	Weekly central CME of Sir Sallimullah Medical College	SSMC	16 April, 2017	Dhaka
Dr. Samira Sharmin (SMO)	Asian Nuclear Medicine Academic Forum	ASNMM	11-13 May, 2017	Shanghai China.

### 3. Academic Activities

- Lectures are delivered to M.Phil/MD students of different discipline.
- Regular weekly in-house meeting and Seminar is held which is jointly organized by INMAS, Mitford and SSMCH.

### 4. Service Rendered and Revenue Income

Total no. of patient	Income (BDT)
19370	1,051,4,450.00

## INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), CHITTAGONG

### Objective/Introduction

Institute of Nuclear Medicine & Allied Sciences, Chittagong is one of the oldest Nuclear Medicine Institute in Bangladesh and was established in 1970. With the vision to render specialized medical services to the people using nuclear technology for peaceful uses of atomic energy to achieve self-reliance for overall socio-economic development. This institute is presently functioning with facilities like Dual Head & Single Head SPECT Gamma Camera, CT Scanner, Thyroid Scanner, Ultrasonogram, Colour Doppler and *In-vitro* Laboratory for Radioimmunoassay (RIA) with Computerized Gamma Well Counter and other necessary facilities.

### Activities/Programme(s)

#### 1. Research and Development Work(s)

##### a1. Services

- Radionuclide imaging: Bone Scan, Renogram, Renal Scan, Thyroid Scan, Liver Scan, RBC Scan, parotid scan, testicular scan, parathyroid scan, HIDA scan etc
- Radionuclide Therapy  
Radio Iodine therapy for thyrotoxicosis and Ca-thyroid patients  
Radiation therapy after pterygium operation of eye
- Radioimmunoassay: T3, T4, TSH, FT3, FT4, & TG and also several other hormones like LH, FSH, Prolactin, Testosterone, Progesterone, Oestradiol, AFP and Cortisol etc.
- Ultrasound: General Ultrasound (Whole Abdomen, Lower/Upper Abdomen, Pregnancy profile, HBS, KUB etc.)  
High Resolution Ultrasound (Thyroid Scrotum Breast, Endocavitary Studies etc.)
- Colour Doppler: Lower Limbs, Upper Limbs, Carotid Arteries, Testis, Pregnancy etc.
- Thyroid Clinic: Thyroid cancer, hyperthyroidism, hypothyroidism patients came for treatment and follow up

#### 2. Ultrasonography Guided Percutaneous Ethanol Injection Therapy for Benign Thyroid Nodules: Continuing Prospective Study to Evaluate Sustained Effectiveness of Therapy (PEIT)

Thyroid nodule is one of the most frequently encountered thyroid diseases. High resolution USG and <sup>99m</sup>Tc thyroid scan are well established and inexpensive imaging modality for many thyroid disorders including nodules.

Our previous experience with cystic nodules in 12 consecutive patients seemed to be satisfactory (Nuclear science and applications, Vol. 24. No. 1&2. 2015), showed the entire group had a highly significant reduction in the initial cyst volume compared with the final volume at the late follow-up after completion of PEIT

( $P < 0.001$ ). Moreover, US-guided percutaneous ethanol injection is an effective, safe, well-tolerated and inexpensive outpatient procedure for the treatment of benign thyroid nodules.

After aspiration of cyst fluid, 99% ethanol was injected in each nodule under USG guidance. In case of solid nodule, aspiration may be required if liquefaction occur after a few session of PEIT.

The effectiveness of sclerotherapy was assessed by comparing the baseline volume and the volume at final follow up following ethanol injection measured by HRUS.

The aim of this study is to detect the sustained effectiveness of ethanol injection therapy (PEIT) in benign both cystic and solid thyroid nodules in a fairly large population (approximately 100 cases). We already have enrolled 15 more cases and the process is going on.

### 3. Manpower Development/Training Programme(s)

Name of the event/topics	Date	Place	No. of participant
Training on 4D Color Doppler Machine	23-29 Oct., 2016	India	01

### 4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Pabitra Kumar Bhattacharjee, Dr. Md. Sazzad Hossain	22 <sup>nd</sup> National Conference of the Society of Nuclear Medicine, Bangladesh	Society of Nuclear Medicine, Bangladesh	24-25 Feb., 2017	BRAC CDM, Rajendrapur, Gazipur, Bangladesh

### 5. Service Rendered and Revenue Income

Total no. of patient	Income (BDT)
38,353	2,31,69,550.00

## INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), MYMENSINGH

### Objective/Introduction

Institute of Nuclear Medicine and Allied Sciences (INMAS), Mymensingh as an organization of Bangladesh Atomic Energy Commission is committed to peaceful use of Atomic Energy in the field of medicine. INMAS, Mymensingh has been started its work in 1989 using Nuclear technology in the Department of Radiology of MMCH occupying 3 rooms only naming as Nuclear Medicine Centre. At present it stands in its own 3 storied building in the north-east corner of MMCH. All the major Nuclear Medicine investigations and Ultrasound imaging are done in this Institute. This Institute offer Nuclear Medicine therapy services in hyperthyroidism and thyroid cancer. All the investigations and therapy offered by the Institute in a subsidized cost as determined by the commission and adjusted time to time. This Institute is also a hub of radioimmunoassay performing about 26 types of hormone & cancer marker studies. A host of senior & junior qualified & skilled Doctors and technologists are working in this Institute. They are all dedicated to offer best therapeutic & investigation skill to the service of humanity.

All the necessary informations are in our own website [www.inmasmym.org](http://www.inmasmym.org).

### Activities/Programme(s)

#### 1. Services

- Medical services: Diagnosis of diseases and treatment of a number of diseases
- Developing facility to start post graduate MD residency course in Nuclear Medicine under BSMMU
- Provide attachment training to the Post graduate medical students in their MD, MS residency programme.

**2. Collaboration Work(s)**

IAEA RCA Project “ Strengthening Hybrid Imaging in Nuclear Medicine in Asia (RAS 6079)”

**3. Academic Activities**

- Series of lecture were arranged on SPECT-CT for doctors, scientist & scientific staff of INMAS, Mymensingh.
- Series of lectures on radiation control and safety were held on during this period for scientific staffs of INMAS, Mymensingh.
- Post graduate students of MD (Radiology & Imaging) and MS (Surgery, Pediatric surgery) of MMC attended in a series of classes in this Institute based of Nuclear Medicine

**4. Manpower Development/Training Programme**

Name of the event/topics	Date	Place	No. of Participant
Basic Nuclear Orientation Course-2017 (BNO-2017)	9 Apr.-8 June, 2017	Training Institute, AERE	01

**5. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Gazi Abul Hossain Dr. Mohammad Nasim Khan Dr. Ratan Kumar Chakraborty	National Conference of Society of Nuclear Medicine, Bangladesh (SNMB)	SNMB	24-25 Feb., 2017	BRAC-CDM, Gazipur

**6. Service Rendered and Revenue Income**

Total no. of patient	Income (BDT)
58358	3,74,70,600/-

**7. Others**

- The Institute provides research facility for post graduate students of MD, MS, M Phil & PhD programme
- Radioimmunoassay laboratory provide services to different research programmes of different discipline of medical sciences
- This Institute provides facility to perform research programme in association with other institutes such as MMC & BAU, Mymensingh

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), SYLHET****Introduction**

Institute of Nuclear Medicine & Allied Sciences, Sylhet is located at the North-East part of the country. It was established in the year of 1980 at Sylhet M.A.G Osmani Medical College campus. The institute provides both diagnostic and therapeutic services to the people of greater Sylhet division by using nuclear technologies & ultrasound system in order to help the improvement of quality of community health services. The institute also provides academic and research activities to upgrade the knowledge regarding nuclear medicine among the professionals.

**Activities/Programme(s)****1. Academic Activities**

- Post Graduate Residency Training in Nuclear Medicine for MS and MD students of Sylhet MAG Osmani Medical College
- Lectures given for the undergraduate medical students regarding Nuclear Medicine technologies and ultrasound

- The institute participates to the regular journal club of Sylhet MAG Osmani Medical College
- Scientific seminars on different publications and new cases take place time to time.

## 2. Manpower Development and Training Programme(s)

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Kamrun Nahar	22th National Conference	SNMB	24 - 25 Feb., 2017	BRAC CDM, Rajendrapur, Gazipur, Dhaka
Dr. Kamrun Nahar	Regional Workshop on the enhancement of Medical Doctors Competence for Radiological emergencies	IAEA	21-25 Nov., 2016	Phuket, Thailand

## 3. Service Rendered and Revenue Income

Total no. of patient	Income (BDT)
22,547	12,569,900/-

## INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), RAJSHAHI

### Introduction

Institute of Nuclear Medicine & Allied Sciences (INMAS), Rajshahi is located North West part of the country. This Institute provides services to the people of greater Rajshahi and nearby districts using nuclear technology and Ultrasound system and made a great impact in this region of the country for betterment of health services.

### Activities/Programme(s)

#### 1. Repair & Maintenance and Renovation works

- Replacement of AIMDR board at Detector-1 of Dual Head SPECT Gamma Camera carried out on 10-01-17
- Renovation works of old guest house, conference room, internal road construction Electric & sanitary works of INMAS, Rajshahi has been carried out

#### 2. Manpower Development/Training Programme(s)

Name of the event/topics	Date	Place	No. of Participant
4th year students of Department of Biochemistry and Molecular Biology of University of Rajshahi, placed here for their inplant training.	3-6 June, 2017	Seminar room, INMAS, Rajshahi	8
MD (Medicine) and MS (Surgery) Student of Rajshahi Medical College were placed here for carried out their theoretical and practical classes for 14 days.	15- 18 June, 2017	Do	3
4th year students of Institute of Health Technology, Prime Institute of Medical Technology, Rajshahi Institute of Medical Technology placed here for practical & theoretical classes.	2 Jul. 27 Aug., 2016	Do	75
Rajshahi Mohila polytechnic Institute were placed here for practical and theoretical classes in Nuclear Medicine & Ultrasonography.	16 Aug. 16 Nov., 2016	Do	15
Seminar on “Radiation protection in Radio-iodine Therapy”.	30 Apr., 2017	Do	12

**3. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Md. Kabiruzzaman Shah, Dr. Nasrin Begum, Dr. Md. Mosharraf Hossain, Md. Sariful Islam Chowdhury	22nd National Conference of SNMB	SNMB	24-25 Feb., 2017	Gazipur
Md. Sariful Islam Chowdhury	Initiation of Bangladesh Pilot Clinical Training in Medical Physics using AMPLE e-learning Software	NINMAS	28-30 July, 2016	NINMAS, Dhaka.

**4. Service Rendered and Revenue Income**

Total no. of patient	Income (BDT)
28888	1,71,32,000/-

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), DINAJPUR****Introduction**

Institute of Nuclear Medicine and Allied Sciences, Dinajpur was established in the year 1982 at Dinajpur Sadar Hospital campus to serve the endemic goiter zone of greater Dinajpur and Rangpur district. In the following four decades the Institute served a huge number of patients with Thyroid Disorders.

**Activities/Programme(s)****1. Diagnostic**

Both *In-vivo* and *In-vitro* techniques are used in this center for diagnosis of diseases.

***In-vivo* Procedure**

- Thyroid Scanner: This test is performed with thyroid scanner to determine the function of thyroid gland.
- Nuclear Imaging: Diseases of bone, brain, liver, kidney, thyroid gland etc. are detected by taking images of the respective organs with SPECT machine
- BMD: Bone Mineral Densitometry (BMD) is used to assess bone mineral content of the patient for detection of osteoporosis and osteopenia
- Renogram: This test is performed with SPECT machine to determine the functional status of kidneys

***In-vitro* Procedure**

- Thyroid related hormones (T<sub>3</sub>, T<sub>4</sub>, TSH, FT<sub>3</sub>, FT<sub>4</sub>, Tg and Antithyroid Antibody) are being estimated in the lab by Radio Immunoassay (RIA) technique with modern instruments

**Ultrasonogram with Color Doppler**

- Ultrasonogram both conventional and Color Doppler ultrasound available here.

**2. Therapeutic**

- Radioactive Iodine (I-131) is used for treatment of thyrotoxicosis and thyroid cancer.
- Sr-90 is used after Pterygium operation of eye.

**3. Service Rendered and Revenue Income**

Total no. of patient	Income (BDT)
8,666	47,76,200/-

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), RANGPUR****Introduction**

Institute of Nuclear Medicine and Allied Sciences, Rangpur is located in the northern part of the country in the premises of Rangpur medical College Hospital. The Institute provides diagnostic & therapeutic services to the people of Northern part of Bangladesh covering greater Rangpur, part of greater Bogra & Dinajpur using Nuclear technology & ultrasound system. Since inception in 1989 the Institute made a great impact in this region for the betterment of health services.

**Activities/Programme(s)****1. Diagnostic**

The following Diagnostic services are done in this **Institute**. a) Thyroid Studies b) Renal Studies c) Bone Scan d) Brain Scan e) Liver Scan f) Tubal Patency g) Ultrasonography of various organs & i) Radioimmunoassay of thyroid hormones, FT<sub>3</sub>, FT<sub>4</sub> & Prolactin.

**2. Therapeutic**

- Iodine-131 Therapy for Thyrotoxicosis
- Iodine-131 Therapy for Thyroid Cancer
- Beta Radiation Therapy for Pterygium, Vascularised Corneal Ulcer etc.

**3. Research and Development Work(s)**

By using *invivo* & *in vitro* nuclear techniques & ultrasound various R & D programmes are going in relation to hypothyroidism, thyrotoxicosis thyroid cancers, renal diseases foetal maturity & hepatobiliary diseases scientific discussions on journals collected through Internet are done time to time.

**4. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Md. Murshed Ali. Chip Medical Officer & Director	Regional Training Course on Hybrid Imaging and Therapeutic Nuclear Medicine Technologies and Its Applications in Thyroid Conditions Including Liver and Prostate Cancer Theragnostics to be held at Lahore.	IAEA	08-19 May, 2017	Faisalabad in Pakistan
Dr. Mrs. Sadia Afroz Choudhury Senior Medical Officer	Regional Training Course On the Development and Clinical Application of Radiosynovectomy Agents.	IAEA	14-18 Nov., 2016.	Quezon City in Philipines

**5. Academic Activities**

- The Institute is carrying out academic activities in Collaboration with the Department of Physiology, Endocrinology, Gynecology & Oncology Dept of Rangpur Medical College Hospital.
- Arranged scientific & technical discussions on Nuclear Medicine & Ultrasonography for our newly appointed doctors & scientists.



**6. Service Rendered and Revenue Income**

Total no. of patient	Income (BDT)
17,136	88,21,700/-

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), KHULNA****Objective/Introduction**

- To Provide diagnostic and Therapeutic services to the patients using nuclear technology and ultrasound system and to conduct academic and research activities
- To promote better understanding of nuclear medicine services among the medical professional
- To improve and upgrade nuclear medicine facilities concerning local perspectives  
To facilitate research and development works in the relevant fields

**Activities/Programme(s)****1. Research and Development Work(s)**

- Value of HRUS and RAUptake test of thyroid in the management of subacute thyroiditis
- Fetal assessment in high risk pregnancy using Color Doppler study

**2. Academic Activities**

- Post-graduate students and Internee doctors of Medicine Department, Khulna Medical College received training of Thyroid disease management from Thyroid Clinic
- Clinical students of Khulna Medical College, Students of Khulna University of Engineering and Technology and Khulna Polytechnique Institute were placed for theoretical and practical classes
- Arranged Seminar/Journal review on Nuclear Medicine, Ultrasound procedures and related subjects monthly

**3. Manpower Development/Training Programme(s)**

Name of the event/topics	Date	Place	No. of participant
In-house workshop on Reception management	29 Oct., 2016	INMAS, Khulna	06
In-house workshop on Radiation protection	11 Feb., 2017	INMAS, Khulna	07

**4. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	place
Dr. Ashoke Kumar Paul CMO & Director	22 <sup>nd</sup> National Conference of SNMB	SNMB	24-25 Feb., 2017	Dhaka
Dr. Ashoke Kumar Paul CMO & Director	6 <sup>th</sup> Khulna Divisional Medical Conference of BPMPA	BPMPA Khulna	4 March, 2017	Khulna
Dr. Ashoke Kumar Paul CMO & Director	5 <sup>th</sup> Divisional Scientific Conference of OGSB	OGSB Khulna	2-3 March, 2017	Khulna

**5. Service Renderd and Renew Income**

Total no. of patient	Income (BDT)
26,603	1,37,09,900/-

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), BARISAL****Introduction**

The Institute of Nuclear Medicine and Allied Sciences, Barisal is situated in the Campus of Sher-e-Bangla Medical College & Hospital. It was established in the year of 1989 with the objective to serve the people of the southern most part of the country. The Institute delivers its service mostly to the patients attending the Sher-e-Bangla Medical College Hospital and also to the people of the Barisal Division and as well as people of the neighbouring districts like Madaripur, Gopalgong, Pirojpur, Bagerhat etc. The Institute is equipped with one dual head SPECT and another single head gamma camera, one small organ scanner, thyroid uptake system and three ultrasonography machine and a RIA Laboratory.

**Activities/Programme(s)****1. Diagnostic Activities**

- **Ultrasonography & Color Doppler**

Ultrasonography is the main diagnostic tool of the Institute. Around 80% of patients are handled through this system. Sonography of abdominal organs, thyroid gland, pediatric brain, testes, mammary gland, eye ball etc. is highly popular among the referring physicians. Colour doppler study of the peripheral vessels, carotid arteries and other organs is being done routinely. Endocavitary scan and 4D Ultrasonography of fetus & different organs are also done here.

- **RIA laboratory**

Serum T<sub>3</sub>, T<sub>4</sub>, TSH, FT<sub>3</sub>, FT<sub>4</sub>, FSH, LH, Prolactin, Progesterone, Testosterone are confidently estimated weekly.

- **Nuclear Medicine**

Bone scan, Renal scan, Renogram, Thyroid scans whole body <sup>131</sup>I scan are routinely done.

**2. Therapeutic Activities**

- <sup>131</sup>I therapy: <sup>131</sup>I therapy is given to Hyperthyroid & Ca- thyroid patients.
- Follow-up: Toxic & Ca thyroid Patients are then followed up periodically for the rest of their lives.
- Beta-radiation: Beta-radiation is applied to Postoperative Pterygium patients using Sr-90 source.

**3. Research and Development Work(s)**

Outcome of well differentiated Ca thyroid patients after radioiodine therapy.

**4. Manpower Development/Training Programme(s)**

Name of the event/topics	Date	Place	No. of participant
Honorary training course on ultrasonography for doctors	July, 2016 to June, 2017	INMAS, Barisal	04

**5. Seminar/Symposium/Conference/workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Nafisa Jahan, Director & PMO Dr. Ferdous Sharmin, MO and Asaduzzaman, SA-1	22nd National Conference of Society of Nuclear Medicine Bangladesh (SNMB)	SNMB	24-25 Feb., 2017	Rajandrapur Gazipur
Mr. Das Shymol Kumar, Aco	Training Course on Service Conduct rules & Regulations	TI, AERE, BAEC	18-19 Dec., 2016	Savar, Dhaka

**6. Service Rendered and Revenue Income**

Total no. of patient	Income (BDT)
18416	94,18,600/-

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), FARIDPUR****Introduction**

Institute of Nuclear Medicine & Allied Science (INMAS), Faridpur was established along with other three institute in Mitford, Comilla and Bogra as a common project. The institute is situated in the premises of Faridpur medical college hospital. The foundation stone was led on 15 September 1995, construction was completed in early 1997 and the institute started running in October 1997. Patients from greater Faridpur district and adjacent areas usually attend the institute to receive nuclear medicine services.

**Activities/Programme(s)****1. Research and Development Work(s)**

- Doppler study of carotid arteries in normal individuals to determine normal range and variations
- Study of ovulation by ultrasound in in female infertility
- Detection and follow-up up to resolution in hepatic abscess
- Doppler study of pregnancy for early detection of IUGR

**2. Manpower Development/Training Programme(s)**

- Dr Tanima Biswas, Medical Officer got admitted in MD Radiology and Imaging course in 2016 in Dhaka Medical College and Hospital.

**3. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr Shankar Kr Dey	22th National conference of the “Society of nuclear medicine, Bangladesh”	SNMB	24-25 Feb., 2017	BRAC CDM, Dhaka

**4. Service Rendered and Revenue Income**

Total no. of patient	Income (BDT)
16996	93,11,250/-

## **INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), BOGRA**

### **Introduction**

The Institute of Nuclear Medicine & Allied Sciences, Bogra is a government institute of specialized and applicable research oriented health services. The government fund and labors are totally used here for public health service. The Institute is mainly involved with diagnosis and treatment of various human diseases using radiopharmaceuticals. Academic and research activities are also performed here. Gamma Camera, Thyroid Uptake System, Gamma counter, Pterygium Applicator, Ultra sonogram and other associated ultra-modern equipments are available in this Institute. At present, 39 officers and staffs are working here

### **Activities/Programme(s)**

#### **1. Diagnosis**

- Radioisotope Scan: Brain Scan, Kidney Scan, Liver- spleen Scan, Bone Scan, Hepatobiliary Scan, Thyroid Scan and Ranogram etc.
- Radio-immuno assay (RIA): T3, T4, TSH, FT3, FT4, Tg, Prolactin, FSH, LH.
- Ultrasonogram.

#### **2. Treatment/Therapy by Radioisotope**

- Radio-iodine ablation of post-operative therapy cancer and therapy of Hyperthyroidism.
- Beta-Radiation in postoperative pterygium to prevent recurrence of disease.

#### **3. Academic Activities**

Lecture/demonstration to the students of Shaheed Ziaur Rahman Medical College and Institute of Health Technology, Bogra about the role and procedures of Nuclear Medicine.

#### **4. Manpower Development/Training Programme(s)**

Internal Training is delivered regularly to the officer and staffs for human resource Development.

#### **5. Service Rendered and Revenue Income**

Total no. of patient	Income (BDT)
16032	Tk. 1,00,28,600/-

## **INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), COMILLA**

### **Objective/Introduction**

Institute of Nuclear Medicine & Allied Sciences (INMAS), Comilla is established in 1996 which located at Comilla Medical College Campus, Comilla. This institute, provides diagnostic and therapeutic treatment service by using nuclear medicine technique, Ultrasound & Color Doppler to the people of east part of Bangladesh including Comilla, Noakhali, Chandpur, Laxmipur, Feni Etc.

### **Activities/Programme(s)**

#### **1. Research and Development Work(s)**

This institute is equipped with one Dual Head SPECT camera, two RIA counter, Bone Mineral densitometry (BMD), two Conventional ultrasound and one Color Doppler Ultrasound machine. The institute also has facility of Radio-iodine therapy for Hyperthyroidism and Ca-thyroid and  $\beta$ -radiation in post surgery pterygium cases.

## 2. Repair & Maintenance and Renovation Works

Build two Cancer room for Ca-Cancer Thyroid Patient and two room for Doctor & Nurse.

## 3. Manpower Development/Training Programme(s)

- Dr. Md. Sayedur Rahman Miah has done Regional training course of hybrid imagine therapeutic nuclear medicine techniques and its applicants in thyroid conditions including liver and prostate cancer Theragnostics and peptide receptor dadiionuclide therapy (PRRT) in Lahore, 8-12 May, 207 and in Faisalabad, 15-19 May 2017.
- Md. Masud Parvej (SO) is doing 14<sup>th</sup> postgraduate educational course in radiation protection and safety of dadiation source (PGEC14-2017) to be held at kajang in Malaysia from 08 may – 03 November, 2017.
- Nur Aminur Hossain (SA-1), Nazmul Hoque (Tech-1) And Md. Jamal Hossain (Assistant) was complete Graduation course on Homeopathy.
- Harunur Rashid (Computer Typist) running BSc (Science) Course under Open University.
- Alamgir Hossain (GA) was complete one year Medical Technologist Course

## 4. Seminar/Symposium/Conferance/Workshop/Meeting Attended

One seminar was in Comilla Medical College Hospital Auditorium

## 5. Academic Activities

- Doctors of INMAS delivar lecture on nuclear medicine to under graduate level of Comilla Medical College.
- Delivar lecture to nursing Institute of Comilla.
- Arrange honorary training (6 Months) for 04 Doctors on nuclear medicine & Ultrasound in the intitite.

## 6. Service Renderd and Revenue Income

Total no. of patient	Income (BDT)
15326	8578150.00

## INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), COX'S BAZAR

### Objective

Institute of Nuclear Medicine & Allied Sciences (INMAS), Cox'sBazar is located in the South-eastern corner of the country within the Premises of Beach sand Mineral Exploitation centre, Cox'sbazar. It started to function from June, 2013, in a make shift Building which was modified from a residential Hotel. The Institute is placed in a tourist hotel-motel zone, away from the government hospitals and all the private clinics.

### Activities/Programme(s)

#### 1. Health Services

##### Diagnostic service

This institute is equipped with two single head Spect Gamma Camera. One RIA Counter, Two color Doppler Ultrasound machine, which are used for following diagnostics services:

- **Scientigraphy**

Thyroid scan, bone scan, kidney scan, Renal scan, Reno gram etc

- **Ultrasound & Color Doppler**  
Routine abdominal & Pregnancy.
- ***In-vitro***  
T3, T4, TSH, FT3, FT4, LH, Prolactin.
- **Therapeutic Service**  
Iodine-131 therapy for Thyrotoxicosis.  
Iodine-131 therapy for Thyroid Cancer.

**2. Service Rendered and Revenue Income**

Total no. of patient	Income (BDT)
3229	15,92,150.00

**III. ENGINEERING AND GENERAL SERVICES**

**ENGINEERING DIVISION, HQ, BAEC**

**Objective**

Bangladesh Atomic Energy Commission has been engaged in research and development (R & D) activities in the various fields of Nuclear Science and Technology in the country. Under the Charter of Bangladesh Atomic Energy Commission, Engineering Division (ED) has been entrusted with the responsibilities for installation, testing and operation of various scientific, nuclear and engineering facilities and building up & maintenance of physical infrastructures for smooth operation of R&D programmes of BAEC. This division is also actively involved in the implementation of 2400 MW Rooppur Nuclear Power Project (RNPP) at Pabna. Following activities have been performed by Engineering Division during 2016-2017 periods.

**Activities/Programme(s)**

**1. ADP Projects**

**Ongoing**

- Establishment of Positron Emission Tomography–Computed Tomography (PET-CT) with Cyclotron facilities
- Construction of Rooppur Nuclear Power Plant (First Phase)
- Establishment of Institute of Nuclear Medical Physics (INMP), AERE, Savar
- Modernization of Food and Radiation Biology Facilities, AERE, Savar
- Construction of Rooppur Nuclear Power Plant
- Capacity build-up of nano and nano-bio Technological laboratory, Material Science Division, AEC, Dhaka

**Completed**

- Establishment of Radioactivity Testing and Monitoring Laboratory at Mongla, Khulna
- Establishment of Institute of Nuclear Medical Physics, AERE, Savar
- Establishment of Positron Emission Tomography-Computed Tomography (PET-CT) with cyclotron facilities, NINMUS, Shahbagh, Dhaka

- Infrastructure development and capacity enhancement of Institute of Food and Radiation Biology (IFRB), AERE, Savar etc
- Establishment of Atomic Energy Centre (1st revision)” Chittagong
- Accomplishment of essential activities to implement 600MW (e) Rooppur Nuclear Power (RNP) project, Rooppur Pabna
- Upgrading of research and service facilities of Nuclear Medicine Centres Bogra, Barishal, Khulna, Mymensingh, Rangpur and production of TC-99 KIT”
- Strengthening of Atomic Energy Research Establishment, AERE, Savar, Dhaka
- Extension of Centre for Nuclear Medicine & Ultrasound Chittagong, Sylhet, Chittagong, Rajshahi and Dinajpur
- Modernization of Centre for Nuclear Medicine & Ultrasound, Sylhet, Rajshahi, Dinajpur and Chittagong
- National Institute of Biotechnology (NIB), a Project of Ministry of Science and Technology at Ganakbari Savar, Dhaka
- Bangladesh Atomic Energy Commission, head quarter complex project at Sher-e-Bangla Nagar, Agargaon, Dhaka-1207 Project
- Training institute and laboratories facilities project at AERE, Savar
- Modernization of Centre for Nuclear Medicine & Ultrasound, Mitford, Comilla & Faridpur Project
- Nuclear Medicine Centers, Barisal, Khulna, Rangpur and Mymensingh
- Extension and modernization of research facilities of Atomic Energy Centre, Dhaka, etc.

## **2. At BAEC HQ, Dhaka**

- Interior decoration, furniture, PA system, lighting system, sound system and other related works for conference rooms at canteen building (2nd Floor) of BAEC Head Quarter, Sher-E-Bangla Nagar, Agargaon, Dhaka
- Supply of office Furniture, Air Conditioners, PABX system & related other works at 3rd Floor of canteen building for planning and development division BAEC Head Quarter
- Access control system with related other works at BAEC HQ, Sher-E-Bangla Nagar, Agargaon, Dhaka
- Supplying & Installation of food grade plastic water tank on the roof of Dr. Anwar Hossain auditorium at BAEC, HQ, Agargaon, Dhaka
- Yearly maintenance For Digital Hipbath 3750 Siemens PABX Exchange system/intercom system at BAEC HQ
- Supply installation, testing and commissioning of lift spares including automatic rescue device (ARD) for modification of 630 KG Lift at HQ
- Supply, Installation, Testing & Commissioning of CCTV System, at BAEC HQ. paramanu Bhaban
- Request for expression of interest (EOI) for local consulting services for conducting Gap, analysis and developing necessary documents for selecting & engaging consultancy firm and certification body for obtaining integrated management system (IMS) [ISO 9001-2015, ISOI4001-2015& OHSAS 18001-2007] certification for HQ, BAEC, Dhaka
- Supplying, commissioning & testing tools for Bio-Science Division at BAEC, HQ, Dhaka
- Supplying of furniture for Planning & Development division and international Affairs Division at BAEC, HQ, Dhaka.

- Supplying of Electrical Goods for BAEC, (HQ). Dhaka
- Supply, Installation, Testing & Commissioning circuit of 7.5 Kw solar pump system at BAEC, HQ, Dhaka
- Manufacturing and supplying of senior executive table for office room of (Member Engineering) at BAEC HQ Dhaka
- Supply, installation, testing and running of Heavy Duty Paper Shredder Machine at BAEC HQ. paramanu Bhaban
- Supply, installation, testing and commissioning of PA system for committee Room at 2nd Floor, BAEC, (HQ)
- Supplying of the furniture for various division at BAEC, HQ, Dhaka
- Supply, installation, testing & commissioning of two unit 1.5 Ton split air conditioner at BAEC, HQ, Agargaon, Dhaka. (FOR acting director, Finance and Budget & Establishment division)
- Renovation and Modification Works of Room No 701 [6th Floor] At BAEC, Head Quarter, Dhaka

### **3. At BAEC Housing Colony, Banani, Dhaka**

- Cleaning & repair of sewerage line, providing uPVC pipe & making inspection pit at BAEC, housing colony, Banani, Dhaka
- Renovation/repair and maintenance Works of Flat No C-5, D-2, C-10, C-14, C-3, C-6, C-7, D-10, C-4, C-19, HB-9, C-2, D-5, HB-4, HB-3, C-18, D-8, D-16, C-15, D-11 and servant quarter 2, 3, 4, 5, 6, 8 at BAEC housing colony, Banani, Dhaka
- Construction of two over head water tank (new C-Type and D- Type building) as well as changing surface G-1 pipe and related other works at, BAEC housing colony, Banani, Dhaka
- Renovation/Repair and Maintenance works of Main Gate (Spaced Breaker) at - BAEC housing colony, Banani, Dhaka
- The execution of the works and Physical service named Renovation/repair and maintenance works of flat No C-17, HB-9 & Club at BAEC housing colony, Banani, Dhaka

### **4. Under RNPP Project**

- Construction of Meter Room for Connection of Electrical power to RNPP Project site, Irshordi, Pabna
- Supply, installation, testing & commissioning of 630KVA sub-station equipment, H.T & LT cable & 630 KVA diesel generators over holing and other related works for construction of RNPP Project (First Phase) at Pabna
- Supply, installation, testing & commissioning of PFI plant, earthing system, cable work, HT meter room and other related works for construction of RNPP Project (First Phase) at Pabna

### **5. At AECD, Ramna, Dhaka**

- Building, Administrative Building screening work and remaining sewerage line, [AFD, ENGS, Canteen building to RNPP building, west side boundary wall gate and other related works at AEC, Dhaka

### **6. At NINMAS & Different INMAS(s)**

- Repair and maintenance works for Spect Gamma camera room toilet above gamma camera room and director's room of INMAS, Sylhet
- Renovation/Repair and maintenance works of INMAS, Mitford, Dhaka



- Execution of the works and physical service named institute of Nuclear Medicine & Allied Sciences at Shaheed Sohowardy Chest & Hospital Campus, Mohakhali and Medical College Hospital Campus, Pabna, Kushtia, Jessore & Cox's Bazar.
- Execution of feasibility study of the project name patient service facilities and infrastructure development of institute of nuclear medicine & Allied sciences (INMAS) at Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Dinajpur and Rangpur.
- Renovation and maintenance works at INMAS, Faridpur.

**7. At AERE, Saver, Dhaka**

- Balancing, Modernization, refurbishment and Extension (BMRE) of safety systems of the 3 MW TRIGA MARK-11 Research Reactor Facility at AERE, Saver, Dhaka.
- Construction at animal House at institute of Tissue Banking and Biomaterial Research (TIBBR) at AERE, Saver, Dhaka,

**8. At various Institute/Center/Division Outside Dhaka**

- Supply & installation of Electro-Mechanical goods & hardware for nuclear industry information centre (NIIC), at Bangabandhu Sheikh Mujibur Rahman Novo Theatre, Bijoy Sharani, Dhaka
- Feasibility study of the project named Establishment of Atomic Energy Centre at Cox's Bazar
- Renovation/Repair and maintenance works of rest house building at Beach Sand Mineral Exploitation centre (BSMEC), Cox's Bazar
- Supply, testing & commissioning of air conditioning equipments and other related works for Beach Sand Mineral Exploitation centre (BSMEC), Cox's Bazar

**9. Other Services**

- Rendered various services related to Planning, Designing, Drawing and Sanitation work (civil, electrical, mechanical & sanitary) at various divisions /facilities of BAEC HQ, Agargaon, Dhaka
- Rendered various services related to Planning, Designing, Drawing, and Sanitation works (civil, electrical, mechanical & sanitary) at various facilities of Bangladesh Atomic Energy Center, Romna, Dhaka
- Rendered various services related to Planning, Designing, Drawing, and Sanitation works (civil, electrical, mechanical & sanitary) at various facilities of Bangladesh Atomic Energy Researches Establishment, Saver, Dhaka
- Rendered various services related to Planning, Designing, Drawing, Sanitation works (civil, electrical, mechanical & sanitary) at various facilities of BAEC Housing Colony, Banani, Dhaka
- Performed Planning & designing services (civil, electrical, mechanical and sanitary) contributed to various facilities at Bangladesh Atomic Energy Regulatory Authority (BAERA)
- Performed Planning & designing services (civil, electrical, mechanical and sanitary) contributed to various facilities of Dhaka INMAS
- Providing technical expert services in various Centers/institutes/different projects of BAEC and other National Projects outside BAEC like, High Tech Park etc. and Department of Environment

**10. Seminar/Symposium/Conference/Workshop/Training/Meeting Attended**

Name of the participant	Name of the event/topics	Organizer	Date	Place
Jafar Sadique	South Asia Industry Outreach Workshop	US State Department	10-12May, 2016	Washington D.C,USA
Jafar Sadique	25 <sup>th</sup> Meeting of the INPRO Steering Committee Vienna, Austria,	IAEA	31 Oct., -02 Nov., 2016	Vienna, Austria.

Engr. Md. Salahuddin Sheikh	Meeting on Site License Condition Precedence & Milestone Achievement regarding the Rooppur Nuclear Power Plant.	JEC Atomstroyexpot	19-24 May, 2017	Moscow, Russian.
Engr. Md. Salahuddin Sheikh	Electronic General Procurement System (e-GP) System.	Training Institute of BAEC	18-22Dec., 2016	Savar, Dhaka.
Md. Ohidul Islam	“Project Appraisal, EIA & Formulation of DPP”	Ministry of Planning	17 July–04 Aug., 2016	Nilkhet, Dhaka
Md. Ohidul Islam	Electronic General Procurement System (e-GP) System.	Training Institute of BAEC	18-22Dec., 2016	Savar, Dhaka.
Engr. Abu. Md. Ahsanul Karim	“Basic Russian Language Course”	Training Institute of BAEC	2Oct., - 3Nov., 2016	Savar, Dhaka.
Engr. Abu. Md. Ahsanul Karim	Department of Atomic Energy, 3q FCNE	NPCIL	9Jan., - 17 Feb., 2017	Mumbai, India.
Engr. Abu. Md. Ahsanul Karim	“Follow-up Training Course [FTC] on Reactor Engineering Course)”	Training Institute of BAEC	17–24 March, 2016	Savar, Dhaka.
B. B. Dhar	Electronic General Procurement System (e-GP) System.	Training Institute of BAEC	18-22Dec., 2016	Savar, Dhaka.

### 11. Preparation of Development Project Pro-forma (DPP)

This Division contributes for the preparation of Development Project Pro-forma (DPP) for various Development Projects of BAEC under Govt. ADP Programme.

### ENGINEERING AND GENERAL SERVICES DIVISION (EGSD), AECD

#### Objective

Engineering & General Service (E & GS) Division of AECD is directly involved with all other divisions by providing technical and utility services for research and development work. The objectives of this division are to provide all types of engineering and technical services in the Atomic Energy Centre, Dhaka as well as BAEC head quarter. E & GS division has six sections likely- Electrical, Refrigeration & Air Conditioning System, Plumbing, glass blowing and Mechanical Workshop to support divisional activities.

#### Programme

E & GS division also provides all utility services and maintenance work such as electricity, water supply, ventilation, air-conditioning (AC) system, civil works etc through the respective sections.

#### Facilities

- Electrical Equipment Repair & Re-winding Facility
- Heavy Machineries (Lathe, Shaper, Milling, Drill Machine etc.)
- Precision Tools
- A/C Maintenance Facility
- Surface Grinding Facility
- 11 KV (1000 KVA & 500KVA) Sub-station Facility
- Solar Energy Plant (2.2 KW) Power Supply Facility

### **Service Available**

Implementation of various repair, maintenance and services related works (civil, Electrical, Mechanical & sanitary) with various facilities of AECD. Planning & designing services ( Civil, Electrical, Mechanical and Sanitary ) contributed to various facilities (Institutes/ Establishment/Centre ) of BEAC. Taking necessary steps to find out technical problems in various facilities and taking of remedial measures.

### **Activities**

During the reporting period this Division performed lot of successful jobs different divisions of AECD as well as RNPP,BAEC HQ, AERE. Beside the routine jobs involving the operation & maintenance of all utility services were done as usual. Such as

- Electrical Section: During the period this section has received over 140 jobs requisition and completed all the jobs successfully
- Air-Conditioning Section: During the period this section completed 110 jobs. Installed & repaired many Air-conditioners of AECD as well as BAEC Head quarter building in addition to routine maintenance & servicing works
- Workshop Section: During the reporting period this section has received over 20 jobs requisition and has completed all the works satisfactorily
- Installation & Utility Section: During the period this section has received 50 jobs requisition and completed all the works satisfactorily
- Glass Blowing Section: This section has ability to perform glass pipe, glass rod and Lab related all glassware work

## **CENTRAL ENGINEERING FACILITIES (CEF), AERE, SAVAR**

### **Objective**

The fundamental works of Central Engineering Facilities (CEF) in Atomic Energy Research Establishment (AERE) are to help all its institutions by providing all kinds of equipments as well as providing helps in their installment, repair, replacement and maintenance needed in carrying out various R&D works. CEF has been taking care of the engineering facilities to needed in AERE campus. CEF is responsible for formulating all engineering related jobs as for example-designing, planning, installation, operation and maintenance of all facilities of AERE, the largest research complex of Bangladesh Atomic Energy Commission (BAEC).Power supply system, Gas system, water supply system, civil and sanitation system of AERE are the main lookouts of CEF. To fulfill the requirement of the R&D activities, the CEF is providing services for Design, Development, Construction, Technical support, implementation and maintenance of the infrastructures already developed at AERE.

There are five divisions in the CEF and activities of each division during the reporting period are narrated in the sub-section.

### **Activities/Programme(s)**

#### **1. Service(s)**

##### **Mechanical Maintenance section (MMS)**

- Repaired colony side 41HP centrifugal pump 3A
- Repaired office side 25HP centrifugal pump 2B
- Repaired colony side 25HP centrifugal pump 3C
- Repaired & Maintained of underground Water pipe line in AERE campus
- Painted fan , gates and other equipment in AERE office & residential area

- Supply drinking Water Which use in different laboratories to the area of the office and Residential area regularly
- Operated & maintained deep-well turbine pump & other pumps regularly

#### **Air-Condition Section (A-CS)**

- General servicing around 85 nos of window & split type A/C in all institute at AERE
- Around 25 nos of Refrigerator & fridge have been repaired in different institute at AERE
- Repaired Central air-conditioning plant in INST Auditorium(40 Ton)
- Replace around 20 nos compressor of fridge, window & Split type A/C in all institute at AERE
- Replace around 12 nos blowers of window & Split type A/C in all institute at AERE
- Repaired others Refrigeration system (Cooling incubator, Dehumidifier etc)
- Weekly operated & maintained Central A/C of INST Auditorium.

#### **Engineering Workshop Division (EWD)**

- Planned and designed for workshop related work
- Repaired and maintained regularly of the existing AERE facilities based on demand
- Taken necessary steps to find out technical problems and to give out appropriate solution
- Designed and developed items & accessories required for research activities
- Performed machining, welding, sheet-metal works, carpentry works etc
- Managed repair and maintenance works related to door, window, furniture etc of AERE Office & AERA Colony
- Drawing designed and fabricated a Rainfall Collector for Isotope Hydrology Division of INST
- Making contact for Mask using Thermal Evaporator for VLSI research
- Drawing designed and fabricated a trolley for Tandem Accelerator Facilities Division of INST, AERE
- Drawing, designed and fabricated 164 nos of Led-Pot for Isotope carrying in different Centre for Nuclear Medicine & Ultrasound from IHD, INST
- Drawing designed and fabricated Mold for Shielding materials of Reactor and Neutron Physics Division of INST
- During the reporting period, this division has successfully completed job request of 35 nos. of machining work, 42 nos. of welding, 26 nos. of sheet-metal and 158 nos. of carpentry works received from different institutes of AERE

#### **Electrical Engineering Division (EED)**

- Electrical Repair & Maintenance of IRPT at AERE, Savar, Dhaka.
- Electrical Repair & Maintenance of MII Division IFRB at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of FTD, IFRB at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of PBGED, IFRB at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of GSD, IFRB at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of VDRAD, IFRB at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of RNPd, INST at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of READ, IFRB at AERE, Savar, Dhaka

- Electrical Repair & Maintenance of NMU at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of TBBRU at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of IE at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of ICS at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of NRC, INST at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of RIPD, INST at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of HPRWMU, INST at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of IHD, INST at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of TAF, INST at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of EI at AERE, Savar, Dhaka
- Electrical Repair & Maintenance of Street light at AERE, Savar, Dhaka
- Refilling of Fire Extinguisher at AERE, Savar, Dhaka
- Facility of Industrial Training Programme (Electrical Technology) for the Diploma students.

#### **Civil Engineering Division (CED)**

- Repair, Maintenance and Painting work of AERE officers hostel and staff hostel
- Construction of Connecting Approach R.C.C Road in front of DG office
- Dismantling and shifting of Old Hot-Cell with related equipment at IRPD, INST
- Laboratory Renovation work of Room No-153 for Lu-177 Production Facilities at IRPD
- Skidding work of the roof of INST building (Partly) and painting works (Partly) at INST
- Construction of Connection R.C.C Security patrol road (Partly) 1260' length & 10' wide near south side boundary wall.
- Construction of security watch tower near HPRWMU
- Performed electrical wiring of room no 132 of IRPT at AERE Savar.

#### **2. Manpower Development and Training Programme(s)**

The facility has so far been used to train up a total of 47 personal from Dhamri Polytechnic Institute, Dhamri, Dhaka, Rajdhani Polytechnic & Textile College, Dhaka and Institute of Computer Science & Technology, Feni in different fields during the reporting period. The training fields are as follows.

<b>Name of participants institution</b>	<b>Name of trade</b>	<b>No. of student</b>	<b>Total</b>
Dhamri Polytechnic Institute	Electrical	37 (Thirty seven)	47 (Forty seven)
Rajdhani Polytechnic & Textile College	Electrical	05(Five)	
Institute of Computer Science & Technology, Feni	Refrigeration & Air-Conditioning	05 (Five)	

#### IV. INTERNATIONAL AFFAIRS DIVISION (IAD), HQ, BAEC

##### Introduction

International Affairs Division (IAD), Bangladesh Atomic Energy Commission (BAEC), has been maintaining assigned liaisons regularly with the international organizations and foreign countries since its inception. The liaisons are bordered normally to the nuclear technology transfer, enrichment of nuclear instrumentation, establishing nuclear power plants and development of human resources for the peaceful application of nuclear science & technology in the country. Under the supervision of BAEC, IAD directly communicates with international organisations to get international projects and simultaneously monitors the progress of the implementing projects. To strengthen the overall nuclear capability of the country, this division makes liaison for foreign trainings, fellowships and scientific visits for scientists, engineers, doctors, geologists, technicians and administration personnels. In the financial year 2016-2017, IAD has processed nominations of 313 participants for various international programme in different countries (except India & Russia). IAD also works to arrange expert missions, international meetings, workshops, seminars, trainings, etc. in BAEC as well as in the country. To enhance R&D (Research and Development) works, IAD plays an important role to execute bilateral and multilateral agreement with foreign countries. Moreover, to fulfill the international obligations related to nuclear safeguards and non-proliferation of nuclear weapons, IAD has also been in constant communication with the International Atomic Energy Agency (IAEA), United Nations Organization (UNO), etc. since the inception of BAEC. A brief description of the activities of IAD during the period of “July, 2016 – June, 2017” is presented below:

##### Activities/Programme(s)

- **Technology Transfer**

BAEC has been receiving technical assistances mainly from IAEA through Technical Cooperation (TC) Projects, Regional Cooperation Agreement (RCA) and Regional Cooperation Non-Agreement (Non-RCA) Projects, Coordinated Research Projects (CRP) and other special projects of IAEA. As the assigned liaison point of IAEA, IAD is liable to monitor the progresses and outputs of these projects, the reports and to submit the reports to the IAEA, to arrange expert visits, scientific visits, trainings and fellowships for the scientists involved with these projects. IAD also helps the project counterparts to organize training courses, seminars, meetings, etc. in the country.

- **Technical Cooperation (TC) projects**

In the financial year 2016-2017, IAD worked for Eight (8) ongoing TC projects and simultaneously to obtain new TC projects in different priority fields of development perspective of the country. The TC projects are covering the thematic areas on Establishing Nuclear Power, Nuclear Agriculture, Human Health (nuclear medicine), Environment and Water resources.

- **Regional Cooperative Agreement (RCA) Projects**

RCA is an intergovernmental agreement among IAEA member states of East Asia and Pacific region. The projects among the twenty two countries of this region are commonly known as RCA Projects. Such projects are involved in research, development and training activities in the related fields of nuclear science and technology through sharing of regional resources including facilities, equipment and expertise as well as pooling of knowledge. IAD performed liaison for fifteen (15) RCA projects covering different nuclear fields namely- Agriculture, Human Health, Industry, Environmental Protection and Water Resources.

- **Non- RCA Projects**

These projects are Asia Region Based projects supported by IAEA Technical Cooperation (TC). In these projects, countries from Middle East are also involved with the twenty two RCA countries. In the reported year, IAD made liaison for Fifty seven (57) Non-RCA projects covering- Nuclear power planning, Sustainability of Nuclear Institute, Nuclear Capacity Enhancement, Strengthening Radioactive Waste Management and Radioactive Exposure Control, Irradiation, Physical Protection, Strengthening Health Support, etc.

- **Coordinated Research Projects (CRPs)**

Bangladesh avails IAEA research supports through the Coordinated Research Projects (CRPs) too. Such research activities are normally conducted by the research institutes of both the developing and developed countries those are member of IAEA on the same research area of interest. IAEA funds a portion of the project's cost, IAD liaisons for a number of CRP projects covering the research area of Food and Agriculture, Human Health, Physical and Chemical Sciences, Nuclear Installation Safety, Nuclear Fuel Cycle, Nuclear Security Culture and Waste Technology Besides BAEC, scientific institutes and Universities of Bangladesh such as ICDDR'B, Dhaka University, Bangladesh Agricultural University (BAU), Radiation Oncology Department of the Hospitals Centre for Woman and Child Health, are involved with CRP's.

- **Projects of the Forum for Nuclear Cooperation in Asia (FNCA)**

IAD is the focal point to implement the FNCA projects. The framework of this forum specified to various vital nuclear fields such as: utilization of research reactors, utilization of radioisotopes in agriculture, application of radioisotopes and radiation for medical use, public information of nuclear energy and radiation safety and radioactive waste management, safety culture of nuclear energy, human resources development. The present members of this forum are Japan, Mongolia, Kazakistan, Australia, Bangladesh, China, Indonesia, Republic of Korea, Malaysia, Philippines, Thailand and Viet Nam. In the financial year 2016-2017, IAD made liaison for a number of FNCA projects in total 13 participants participated in various international programme in the said financial year.

- **Exchange of Experience and Expertise**

Exchange Programmes under the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and Nuclear Safety Research Association (NSRA) of Japan invite nuclear researchers from neighboring Asian countries to Japan and dispatches Japanese experts to other countries. As the focal point of this programme, IAD processed the necessities in favor of the selected scientists, engineers, doctors and technicians of BAEC. Both of these exchange programmes are helpful to gather state-of-the-art technical knowledge and to perform high grade research activities in Japan for contributing to build up and to strengthen nuclear base and nuclear safety works in BAEC.

- **Follow-up Training Courses (FTCs) and Instructor Training Courses (ITCS)**

During the reported period, three Follow-up Training Courses (FTCs) are conducted in Dhaka with the help of Japanese and Bangladeshi experts. Through the FTCs Sixty nine (69) participants are trained in different areas of nuclear science and technology. In addition five (05) participants for Instructor Training Course (ITC), one (01) participant for Nuclear Plant safety Course; one (1) participant for Nuclear Energy Official Course; one (01) participant for Site Preparation Public Relation Course; one (01) participant for Basic Radiation knowledge for School Education Course have completed the courses. These courses are successfully conducted in Japan.

- **Service Training**

In case of the appropriate set up/operation of procured new nuclear instruments specially, under ADP Projects, IAD works to complete the service training processes in order to avail them in the instrument manufactures.

- **Database of Foreign Visitors**

From July 2008, IAD has been maintaining database for the foreign visitors. Generally high officials have attended in various conferences and meetings namely RCA, Non-RCA, FNCA and IAEA annual conferences. On the other hand, scientists, engineers, doctors, geologists, technicians and administrative officials of BAEC, MoST and other organizations have attended in various meetings, conferences and workshops and have availed significant number of fellowships and trainings in the reported period under TC, RCA and FNCA projects.

**V. NUCLEAR POWER AND ENERGY DIVISION (NPED), HQ, BAEC****Activities/Programme(s)**

In recent times, there has been a growing trend worldwide of adopting alternative source of energy in policy framework in the context of diminishing reserve of fossil fuel as well as the detrimental impact of its burning on environment and human health. Renewable and environment friendly energy sources come into consideration to tackle future energy crisis. Renewable energy sources like solar energy, wind energy etc. cannot cope with the huge consumption demands of industrialization and urbanization. In this perspective, nuclear energy is considered as a suitable alternative, provided necessary safety measures are in place. Nuclear power plants are especially suitable for countries like Bangladesh having huge population and limited land area and resources. The prospect of nuclear energy had been recognized in policy plans of Bangladesh and necessary steps are being taken for early implementation of Rooppur Nuclear Power Project at Rooppur, Pabna. Having a nuclear power plant installed in the motherland - has been a dream of the people of Bangladesh since mid-60, a decade before the independence of the country. This dream will be implemented by the 2017 through the FCD (First Concrete Date) and the nation will get 2X1200 MW energy from this nuclear power plant by 2024 and 2025 respectively.

**1. Manpower Development/Training Programme(s)**

Name of the event/topics	Date	Place	No of participants
Workshop on developing inspection programme and QC and QA Systems for construction of NPP	14-17 May, 2017	AECD Auditorium	40
Training on “Document Management System (DMS)	17-19 April, 2017	AECD Auditorium	30
Workshop on “Developing inspection programme and QC and QA Systems for construction of NPP	14-17 May, 2017	AECD Auditorium	55

**2. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participant	Name of the Event/topics	Organizer	Date	Place
Md Jahangir Alam	IAEA Fellowship Program	Nuclear Power Institute	10 Oct.-04 Nov., 2016	Texas, USA
Md Jahangir Alam	Joint ICTP-IAEA School on Nuclear Knowledge Management	Jointly ICTP-IAEA	5-9 Sept., 2016	Trieste, Italy
AfsanaSharmin	Technical Meeting on Stakeholder Involvement and Public Information	IAEA	13-16 June, 2017	Vienna, Austria

**3. Stakeholder Meeting**

- Participation of establishing Rooppur Nuclear Power Plant at Power and Energy Mela organized by the Ministry of Power, Energy and Mineral Resources during the last 10-12 December 2016 to inform the general public about nuclear power.
- Art Competition and Photo Exhibition about nuclear technology were organized On March 28, 2016, at the Nuclear Industry Information Center located in the Novo Theater in Dhaka.
- On the occasion of the Eleventh National Rover Mute 2011, Father of the Nation Bangabandhu Sheikh Mujibur Rahman Government College and the Wahab School of Gopalganj, the exhibition of two Global Development Village (GDV), in the exhibition village, the Rooppur nuclear power Plant project participated in the banner of the Ministry of Science and Technology and free distributed the Nuclear Safety and Nuclear Security related books. Pen imbedded with the name of Roppur NPP nuclear power plant, T-shirts and smarties distributed among participants
- On the 29/03/2017 Rooppur Nuclear Power Plant Project organized the visit to Construction area for the overall progress of the Nuclear Power Plant of the University of Nuclear Engineering Department of



Dhaka University.

- Bangla New Year's Celebration and Ananda Rally were arranged with Rooppur High School, Ishwardi, Pabna students and local people. Leaflets, brochures, project name marked umbrellas and T-shirts were distributed among the participants and arranged a documentary shows about the progress and security of the project.

#### 4. Collaboration Work(s)

Name	Collaboration With	Title	Date	Place
MoU	India-Russia-Bangladesh	Trilateral MoU Between India-Russia-Bangladesh on Cooperation for successful implementation of Rooppur Nuclear Power Project	23 April, 2017	Committee room, Rooppur NPP Bhaban

## VI. NUCLEAR SAFETY, SECURITY AND SAFEGUARDS DIVISION (NSSSD), HQ, BAEC

### Objective/Introduction

- To fulfill the obligations under International Treaties, Agreements, Protocols and Conventions related to Nuclear Safety and Radiological Emergencies including Safeguards and Physical Protection of nuclear and radioactive materials and Illicit Trafficking;
- To maintain safeguards procedures of the State Systems of Accounting for and Control of Nuclear Material (SSAC).
- To ensure physical protection of nuclear material and radioactive sources and associated installations of the country.

On behalf of BAEC, this Division has been acting as the focal point of different well-known strategic partner namely International Atomic Energy Agency, U.S. Department of Energy, Japan Atomic Energy Agency, Forum for Nuclear Cooperation in Asia and emerging Asia-Pacific Safeguards Network for the issues of nuclear safeguards, safety, security and physical protection of radioactive materials and associated facilities

### Activities/Programme(s)

#### 1. Research and Development Work(s)

##### 1.1 Uranium speciation in the plausible precursors of Sherpur, Sunamganj and Moulvibazar Districts for Establishing a Dedicated Economical Database' Under the Special Allocation for Science and Technology

Bangladesh badly needs the exploration of uranium for expanding its nuclear technology and nuclear energy works. Lack of appropriate drive in past failed to deliver dependable database of uranium concentrations in the country. Recently, it has realized that rocks and sands of some locations of Sylhet and Moulvibazar districts consist of appreciable concentrations of uranium and thorium in compound forms. This finding fingers the importance of searching uranium further in the adjacent locations as well as the adjacent districts especially which are located to the Indian border. Considering above scientific point, this S&T project was proposed to quantify the uranium concentrations in the rock, soil and water of the some locations of the hilly areas of Sherpur, Sunamganj and Moulvibazar Districts. Samples were collected from different locations of the Districts and most of them were analyzed. Varying concentrations of uranium were observed in the samples. Some of them seem encouraging which are pointing to continue this R&D work.

##### 1.2 Others

Taka two lacs obtained from the Government to run the R&D work on Uranium.

## 2. Manpower Development/Training Programme(s)

Within the scope of the Basic Ordering Contract (BOC) No. 11968-AD8, Rev. 1 between BAEC and Battelle Memorial Institute (BMI) of U.S. Department of Energy, through the long discussion with the designated point of contact for the implementation of BOC in Bangladesh, NSSSD ensured a training programme in

Nepal for the responsible personnel of different facilities where security enhancement activities have been done.

Name of the event/topics	Date	Place	No. of participant
Physical Protection and Security Management Course	6-9 March, 2017	Kathmandu, Nepal	15

## 3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. A. K. M. Fazle Kibria	Regional Workshop on INSSP and NUSIMS	IAEA	18-21 Oct., 2016	Viet Nam
	Discussion on Operation and Maintenance and Fuel supply Contract of RNPP	RNPP	03-09 Apr., 2017	Russian Federation
	38 <sup>th</sup> Annual Conference of Bangladesh Chemical Society-2017	BCS	31 Mar., 2017	Chittagong
Dr. A. K. M. Fazle Kibria Dr. Abid Imtiaz H. M. Borhanul Alam	National Conference on Physics-2017	BPS	5-7 Jan., 2017	Dhaka

## 4. Collaboration Work(s)

Development of the Integrated Nuclear Security Support Plan (INSSP) for Bangladesh was finalized during this reporting period. Finally the Government of the People's Republic of Bangladesh has approved its INSSP with the Action Plan for the period of 2016-2018 on 5 December 2016. Through the follow-up discussions with the designated point of contact of IAEA, several activities of INSSP have been finalized to implement in 2017.

- 'Uranium speciation in the plausible precursors of Sherpur, Sunamganj and Moulvibazar Districts for Establishing a dedicated economical database' under the Special Allocation for Science and Technology.
- 'Development of the Application of Performance-Based Methodology to Design and Evaluate the Physical Protection of Radioactive Nuclear Material and Associated Facilities in Bangladesh' under the IAEA Coordinated Research Project (CRP) 'J02004' entitled 'Development of Nuclear Security Assessment Methodologies (NUSAM) for Regulated Facilities.
- 'Factors that Influence Culture for Safety, Organizational Culture and Human Performance at Nuclear and Other Facilities in Bangladesh' under the IAEA Coordinated Research Project (CRP) 'J02007' entitled 'Development of Nuclear Security Culture Enhancement Solutions.'
- Nuclear Security and Safeguards Project under the cooperation activities of Forum for Nuclear Cooperation in Asia (FNCA).
- Supervision of security enhancement activities including installation of Biometric Access Control, highly sensitive surveillance cameras, sensors, etc., at the nuclear and radiological facilities of AERE and in parallel to the governmental and private hospitals of the country having radiotherapy machines consisting of radioactive sources and concealed radioactive materials therein under the Basic Ordering Contract (BOC) No. 11968-AD8, Rev. 1 between BAEC and Battelle Memorial Institute (BMI) of U.S. Department of Energy.

## 5. Stakeholder Meeting

Name of the event/topics	Date	Place
12 <sup>th</sup> General Meeting of Bangladesh National Authority for Chemical Weapons Convention (BNACWC)	19 Dec., 2016	Armed Forces Division, Dhaka Cantonment, Dhaka

## VII. PLANNING AND DEVELOPMENT DIVISION (PDD), HQ, BAEC

As a premier research organization of the country, Bangladesh Atomic Energy Commission (BAEC) has been engaged in research and development activities in different disciplines of nuclear science & technology. BAEC contributes socio-economic development of Bangladesh through peaceful application of nuclear energy. In according National science and technology policy BAEC has been undertaking initiatives for upgrading and extension of different laboratories through development projects.

In this regard, 8(Eight) projects of Bangladesh Atomic Energy Commission (BAEC) were incorporated in the Annual Development Programme (ADP) of 2016-2017.

The total ADP allocation of the year 2016-2017 for implementation of ongoing project of Bangladesh Atomic Energy Commission was Tk. 372806.00 Lakh. Out of this granted allocation, Tk. 357998.46 Lakh had been spent up to 30 June, 2017 making an implementation rate of 96.03% 12 (Twelve) new projects, in total have been proposed for the FY 2017-2018 from BAEC to the concerned Ministry. The entire picture on the advancement of all the development projects are shown in Table-1.

**Table 1. Status of advancement of all the development on going projects of BAEC under ADP FY 16-17**  
(Taka in lakh)

Sl. No	Name of the Project with Implementation Period	Estimated Cost Total (F.E)	Cumulative Expenditure upto, June 2016 (F.E)	Revised Allocation for the FY 2016-17 (F.E)	Expenditure	Percentage of expenditure against allocation upto 30 June, 2017
1	2	3	4	5	7	9
1	Establishment of Positron Emission Tomography - Computed Tomography (PET-CT) with Cyclotron facilities, Oct., 2011 – Sept., 2018.	13800.00 (11645.00)	8627.00 (8123.00)	3542.00 (2500.00)	3542.00 (2500.00)	100% (100%)
2	Establishment of Radioactivity Testing and Monitoring Laboratory at Mongla, Khulna, July, 2012 – June, 2017	1938.00 (290.00)	1668.82 (290.00)	259.00 (0)	258.00 (0)	99.61% (99.81%)
3	Construction of Rooppur Nuclear Power Plant (First Phase) Mar., 2013 – June, 2017	508708.81 (442577.00)	461795.57 (32472.00)	21865.00 (0)	21853.87 (0)	99.95% (99.95%)
4	Establishment of Institute of Nuclear Medical Physics (INMP) at Atomic Energy Centre, Sept., 2013-June 2017	6230.00 (3450.00)	1684.00 (0)	4077.00 (3378.00)	4076.30 (3377.80)	99.98% (100%)
5	Upgrading and Strengthening the facilities at National	2475.00 (1800.00)	1133.70 (0)	1143.00 (683.00)	1136.14 (682.75)	99.40% (99.40%)

	Institute of Nuclear Medicine and Allied Sciences (Former INMU), January 2015 - June 2017					
6	Modernization of Food and Radiation Biology Facilities of AERE, Savar, April 2016 - June 2018	4767.00 (2276.00)	0 (0)	795.00 (531.00)	794.84 (531.00)	99.98% (99.98%)
7	Construction of Rooppur Nuclear Power Plant, April 2016 – December 2025	11309291.27 (10120000.00)	0 (0)	340971.00 (104300.0)	326183.31 (104300.00)	95.66% (99.98%)
8	Capacity build-up of nano and nano-biotechnological laboratory at Material Science Division Atomic Energy Centre Dhaka, October 2016 - June 2019	4829.00 (3875.00)	0 (0)	154.00 (0)	154.00 (0)	100% (100%)
		11852039.08 (10585913.00)	474909.09 (41708.18)	372806.00 (111392.00)	357998.46 (111391.55)	96.03% (99.98%)

**Table 2. Status of advancement of all the development proposed projects of BAEC under ADP**

Sl. No	Name of the project and implementation period	Approval status	Remarks
1	Development of Human Resources & Establishment of Residential Accommodation Facilities for the Radiation Testing and Monitoring Laboratory, Mongla, Bagerhat, July 2017 - June 2019.	approved	Project approved on 20-02-2017 in ECNEC.
2	Establishment of Institute of Nuclear Medicine & Allied Sciences at Shaheed Suhrawardy Medical College Hospital Campus, Sher-e-Bangla Nagar, National Institute of Diseases of the Chest & Hospital Campus, Mohakhali and Medical College Hospital Campus, Pabna, Kushtia, Jessore & Cox Bazar, July 2017-June 2020.	Unapproved	Weight for approved in planning commission
3	Patient Service Facilities and Infrastructure Development of Institute of Nuclear Medicine and Allied Sciences (INMAS) at Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Dinajpur and Rangpur (Phase – 1), July 2017-June 2020.	Unapproved	"
4	Balancing, Modernization, Refurbishment and Extension (BMRE) of Safety Systems of the 3 MW TRIGA Mark-II Research Reactor Facility at AERE, Savar, Dhaka, July 2017-June 2020.	Unapproved	"
5	Improvement of the laboratory Facilities of Institute of Electronics to support the Government's Digital Technology based Development Activities., July 2017-June 2020.	Unapproved	"
6	Site selection of Nuclear Power Plant at southern zone in Bangladesh	Unapproved	"
7	Establishment of Positron Emission Tomography-Computed Tomography (PET-CT) with Cyclotron facilities and upgrading patient service facilities at Institute of Nuclear Medicine & Allied Sciences (INMAS) Mymensingh, INMP, Savar, January 18 - June 2021.	Unapproved	"
8	Capacity buildup of Bangladesh Atomic Energy Commission Residential	Unapproved	"

	Area at Banani and Savar, July 2017-June 2022.		
9	Establishment of Nuclear Cyber Security & Information System' Innovations Research Laboratory at BAEC, July 2017-June 2019.	Unapproved	DPP Under processing
10	Establishment of Standard Calibration and Quality Assurance (QA) Laboratory for Radiotherapy, Diagnostic Radiology and Neutron Radiation, July 2017-June 2019.	Unapproved	DPP Under processing
11	Screening of Congenital Hypothyroidism in Newborn Babies (Phase 2), July 2017-June 2020.	Unapproved	DPP Under processing
12	Capacity building of Nuclear Minerals Unit (NMU) for R&D activities of geological prospects in Bangladesh, July 2017-June 2019.	Unapproved	DPP Under processing

### VIII. QUALITY MANAGEMENT DIVISION (QMD), HQ, BAEC

#### Introduction

The objectives of Quality Management Division (QMD) are as follows:

- To develop, implement, maintain, and manage the QMS within the BAEC.
- To advise the Commission on all issues related to overall Quality Policy of the BAEC.
- To develop BAEC central QMS Codes and Manuals.
- To facilitate the development of QA Manual and Procedures for each institute/department.
- To conduct periodic QA audit to ascertain the implementation of QA programme.
- To record results of QA audit along with nonconformities (if any) and submit a report to Commission together with the recommendations on general acceptability of the work and suggestion on rectification, if applicable.
- To evaluate the effectiveness of QMS programme and make suggestion from time to time on necessary modification/upgrade.
- To arrange necessary QA/QC training for developing in-house capability with the assistance of external consultants, if necessary.
- To keep records of important quality issues and monitor progress in resolving them.
- To help promote 'Quality Culture' within BAEC.
- To upgrade 'BAEC QMS' to 'IMS (Integrated Management System)' in future.

This year QMD was mainly engaged in the activities related to implementation of Integrated Management System (IMS) in the BAEC Head Office. Moreover, a substantial amount of time was dedicated to RNPP implementation associated activities.

#### Activities/Programme(s)

##### 1. Organizing Meeting Regarding Implementation of ISO 9001

A meeting regarding implementation of ISO 9001 was organized on 18-08-2016 with the Chairman of BAEC in the Chair. In the meeting Member (Planning), BAEC, Directors of different Divisions of BAEC Head Office, officers of QMD and a few consultants and experts on ISO 9001 were present. Two presentations on QMS/ISO/IMS were given in the meeting. In the meeting it was decided that to implement IMS in the Head Office of BAEC and obtain IMS certificate necessary actions will be undertaken through QMD.

#### Benefits of implementing the above standards and IMS

##### Key benefits of implementing ISO 9001

- Enhance customer satisfaction and improve customer loyalty leading to profitable business.
- Better control & continual improvement in the organization.
- Integration and alignment of internal processes leading to increased productivity and results.
- Provide confidence to interested parties as to the consistency, effectiveness and efficiency of the organization.
- Early detection of any discrepancy in the operation and/or service will be made possible through frequent checks.
- Appropriate corrective action helps prevent recurrence of faults.
- Make management more active.
- A great marketing tool: Buyers are more likely to do business with an ISO certified organization than non-certified one.
- Ensure quality to end users.
- Advice purchase of quality raw materials for better finished products.

**Key benefits of implementing ISO 14001**

- Control environmental pollution.
- Material savings through more complete product input processing, substitution, and recycling of by-products and waste.
- Reduce energy consumption.
- Reduce material storage costs.
- Reduce costs for emissions, discharges, waste handling, transport and disposal

**Key benefits of implementing OHSAS 18001**

- Identify, minimize and control health and safety risks.
- Ensure health and well-being of employees, sub-contractors and the public.
- Focus towards zero accidents.
- Ensure legislative awareness and compliance.
- Reduce information related security breaches.
- Reduce accident and incident rates by reducing and elimination workplace hazards and investigation.
- Increase employee motivation through greater participation and a safer workplace.

**Key benefits of IMS**

- Smoothly organize the processes of organizational activity
- Encourage risk management
- Meet deadlines
- Remain within the planned budget
- Reduce faulty work and waste to a minimum
- Avoid the disturbance of employee health and violations of environmental balance

- Raise stakeholder perception and satisfaction

## 2. IMS implementation Activities (Gap Analysis)

BAEC decided to establish an Integrated Management System (IMS) following ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007 international standards. BAEC has taken initiatives to appoint a consulting firm for designing, developing, documenting & implementing Quality Management System leading to certification of IMS standards. As part of this a gap analysis was conducted by a consulting firm to identify gaps in the Management System of the Head Office of Bangladesh Atomic Energy Commission (BAEC) and Analytical Chemistry Laboratory under Chemistry Division, AECD relating to Integrated Management System (IMS) [ISO 9001:2015 QMS, ISO 14001:2015 EMS & OHSAS 18001:2007] International Standards' requirements.

Under gap analysis the findings are based on the physical observations, key consultation and review of documents by the Consultants who visited the following 20 (Twenty) Divisions/Sections/Unit/Clinic of Bangladesh Atomic Energy Commission:

Name of the Department/Division	Date
Quality Management Division	29-11-2016
Planning & Development Division	29-11-2016
Scientific Information Division (SID)	29-11-2016
Engineering Division	30-11-2016
Business Development Unit (BDU) and Administration Division	30-11-2016
Security Branch	30-11-2016
Nuclear Safety, Security & Safeguards Division (NSSSD)	01-12-2016
Bio-Science Division	01-12-2016
Clinic	01-12-2016
Accounts & Audit Division	05-12-2016
Human Resource Division	07-12-2016
Physical Science Division	07-12-2016
Finance & Budget Division	07-12-2016
Establishment Division	07-12-2016
Nuclear Power & Energy Division (NPED)	12-12-2016
Analytical Chemistry Laboratory under Chemistry Division, AECD	12-12-2016
International Affairs Division	19-12-2016
Transportation Branch	19-12-2016
Legal Cell	19-12-2016
Procurement Branch	19-12-2016

Finally the report on the following topic was submitted

“GAP ANALYSIS RELATING TO INTEGRATED MANAGEMENT SYSTEM (IMS) [ISO 9001:2015 QMS, ISO 14001:2015 EMS & OHSAS 18001:2007] INTERNATIONAL STANDARDS' REQUIREMENTS FOR HEAD OFFICE OF BANGLADESH ATOMIC ENERGY COMMISSION, DHAKA”

The report concluded that Non-Conformances under the gap analysis might be discussed in the review meeting and corrective measures might be initiated. The report also provided Bangladesh Atomic Energy Commission (BAEC) with some recommendations.

### 3. Lecture Delivered

Director, QMD delivered a lecture on IMS on 10-04-2017 under ‘BNOC-2017’.

### 4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Name of the event/topics	Organizer	Date	Place
Dr. Md. Quamrul Huda, CSO & Director	Discussion on Appendices of General Contract and Additional Contracts for Construction of Rooppur Nuclear Power Plant	BAEC	25 - 29 Jul., 2016	Russia
	The bilateral meeting on Supplementary Contracts Operation & Maintenance Contract and Fuel Supply Contract regarding the RNPP	BAEC	26 Mar. - 2 Apr., 2017	Russia
Engr. K. M. Rezaur Rahman, PE	Technical Meeting of the INPRO Collaborative Project Roadmaps for Transition to Globally Sustainable Nuclear Energy Systems	IAEA	11 - 14 Oct., 2016	Austria
	Technical Meeting on Topical Issues in the Development of Nuclear Power Infrastructure	IAEA	31 Jan. - 3 Feb., 2017	Austria
	The Project Coordination Meeting for RC/UNOSSC Project on Electron Beam application for Value Addition to Food and Industrial Products and Degradation of Environmental Pollutants in the Asia Pacific Region (Phase 2)	IAEA	10 -11 May, 2017	Thailand

### 5. Collaboration Work(s)

Dr. Md. Quamrul Huda, CSO & Director was involved in the S&T project titled “Atmospheric Dispersion Modeling and Radiological Safety Assessment of TRIGA Research Reactor” as Associate Investigator in the fiscal year 2016-2017. Report regarding the project is yet to be finalized.

### 6. Others

- QMD was actively involved in the activities of RNPP through different committees.
- QMD Scientist continued to get involved in finalizing the draft of an updated organogram of BAEC.
- QMD personnel delivered duties as the members of some other committees formed by the authority.

## IX. HUMAN RESOURCES DIVISION (HRD), HQ, BAEC

### Activities

The concept of Human Resources Development and Management of an organization is the modern form of traditional Public Administration/Establishment. Modern Human Resources Management includes all the activities of Establishment plus organizational developmental activities such as leadership, motivation, developing organizational culture, communication of shared values, and so forth. The Human Resource Management approach remains integrated to the organization’s core strategy and vision. It seeks to optimize the use of human resources for the fulfillment of organizational goals. This strategic and philosophical context of Human Resources Development and Management makes it more purposeful, relevant, and more effective compared to the traditional Establishment approach. With this view, the Human Resources Division (HRD) is launched in BAEC. The HRD bears the prime responsibility for the enhancement of skills and management of human resources of BAEC. The major activities of HRD during the fiscal year 2016-2017 are as follows:



- Conduct all activities of ANSN (Asian Nuclear Safety Network) as a Member of the ANSN Steering Committee [Director, HRD].
- As the Chair of Working Group of RCA (Regional Cooperative Agreement) Human Resources Development (RCA-WG-HRD), all the activities of the Group were conducted according to the TOR (Terms of Reference). Survey of RCA Member States was conducted for HR Gap Analysis. Based on this Gap Analysis, the Strategic Plan to fill up the gaps was prepared and submitted to the IAEA and RCA and also presented at the 46<sup>th</sup> GCM. [Director HRD is the Chair of RCA-WG-HRD].
- Performed activities of the Non-RCA Project RAS/0073 “Supporting HRD and Nuclear Technology”.
- Successful implementation of the FNCA-HRD project.
- Organized to nominate and send 33 young BAEC Scientists to attend the 3<sup>rd</sup> Foundation Course on Nuclear Energy (FCNE) Organized by NPCIL, DAE Mumbai, India from 9 Jan- 17 Feb., 2017 under the bilateral cooperation agreement;
- On the basis of “Sachibalaya Nirdeshmala-2014” an In-house Training Program was developed by HRD which is continuously conducting by the Training Institute, AERE, Savar for the development of skill manpower.
- Contributed to IAEA INIR Mission, IWP (Integrated Work Plan with IAEA), JWG (Joint Working Group with Rosenergoatom, Russian Federation) for the development of nuclear infrastructures focusing on IAEA Mile Stones approach.
- Initiatives were taken to sign Memorandum of Understanding (MoU) with 3 universities, namely,
  - The Department of Nuclear Engineering, Dhaka University
  - The Military Institute of Science and Technology, Dhaka
  - The Daffodil International University, Dhaka
- Provided feedback on the following Draft MoUs received from the Ministry:
  - Cooperation in the Field of Maritime Transport between Bangladesh and Russia
  - Maritime Co-operation between Bangladesh and China.
- Notices were circulated requesting nominations of candidates and necessary actions taken to select the candidates for the following national and international training/seminar/workshop/committee, etc.:
  - Annual Competitions of the Royal Academy of Overseas Science of Belgium, Competitions 2016-2017 and 2017-2018
  - Consultative Council for the Implementation of the Strategy for Science, Technology and Innovation in Islamic Countries
  - Laboratories twinning of developed and developing laboratories of the member countries of the Netherlands-based international government organization OPCW to take the necessary steps to submit interest letter
  - FTC training programs (three) held from January-March, 2017
  - Thirteenth Training Course on Oceanography: Principles and Applications UNESCO/People’s Republic of China (the Great Wall) Co-Sponsored Fellowships Programme, 2017-2018 and UNESCO/Poland Co-Sponsored Fellowships Programme Engineering Cycle-2017
  - Training Course on ISO/IEC17025:2005 General Requirement for the Competence of Testing and Calibration Laboratories organized by Bangladesh Accreditation Board (BAB)
- Upon request from many national and international organizations, feedback was given for the following events:

- Possibility of recruiting students in BAEC who completed the MS course from the Department of Biomedical Physics and Technology, University of Dhaka, 2015
- The New Project on Climate change led by Australia under FNCA
- Report of training course for teachers to introduce Nuclear Science in Secondary School through Innovative approaches, Quezon City, Philippines. 22-26 August, 2016
- Possibility of conducting joint research between Indian Institute of Technology Kharagpur, West Bengal and Neutron Activation Analysis Laboratory, INST, AERE, Bangladesh Atomic Energy Commission
- The Draft law of (i) Bangamata Sheikh Fazilatunnesa Muzib University of Science and Technology- law, 2016 (ii) Sheikh Hasina University of Science and Technology-law, 2016 and (iii) Education law-2016
- Played an important role for successful implementation of the 39th RCA NR Meeting, 3-6<sup>th</sup> April, 2017, Cox's Bazar, Bangladesh.
- Solving a series of seniority related problems of BAEC employees.
- The important role played for publishing the BAEC Journal "Nuclear Science and Application".

## **X. SCIENTIFIC INFORMATION DIVISION (SID), HQ, BAEC**

### **Activities**

Access to information is an important precondition for ensuring sustainable development. Scientific Information Division plays the key role to collect, select, process and provide information to a wide range of stakeholders concerned with the R&D activities of BAEC. In addition, SID acts as an liaison between BAEC and the government on one hand and public, press etc on the other hand. The main tasks of SID are summarized in brief as follows.

- Compiling, Editing and Publishing Scientific Journals, Periodicals reports, Annual Reports, Popular scientific articles, Newsletter, Brochure, Proceedings, Souvenir etc. related to R&D works of BAEC.
- Collection, selection, processing for storage and dissemination of information in the field of scientific research and technological development of all branches of sciences with particular emphasis to the nuclear technology research and development.
- Maintaining liaison with the News media, TV, Radio etc. to disseminate news of scientific programmes, symposia, conference, seminar, workshop, training etc. under R&D and service activities of BAEC.
- Updating information/documents in the website.
- Selection, acquisition and distribution of Books, Journals, Magazines, Annual report, Scientific News Letter and other scientific documents.
- Providing assistance to scientists in establishing contact with the relevant authorities to exchange views & ideas regarding implementation of R&D projects.
- Processing nomination of BAEC scientists to attend various National Seminar, Symposium, Conference, Workshop etc. which are arranged nationally.
- Processing nomination of BAEC Scientists for award at home and abroad.
- Preparing reports and providing information for the National Assembly/Ministry of Science and

Technology and other relevant government authorities relating to BACE activities.

- Publishing tender/notification/press release of BAEC in the daily newspapers.
- Taking and displaying of photographs in different occasions of BAEC and documentation of printed photographs for further use etc.
- Compilation, Editing and Publication of diary/Telephone index/Guide books, Booklets etc.
- Collection and upgrade the abstract of published scientific papers in national and international journals by the scientists of BAEC in BAEC website ([www.baec.gov.bd](http://www.baec.gov.bd))

### Key Responsibilities

Sl. no.	Description of work	Quantity	Remarks
1	BAEC Annual Report July 2015-June 2016	300	Published, distributed and uploaded to the BAEC website
2	Scientific Journal “Nuclear Science and Applications” Vol.24 (1,2), June, December 2015	300	Published, distributed and uploaded to the BAEC website
3	Scientific Journal “Nuclear Science and Applications” Vol.25 (1,2), January, December 2016	300	Ready to publish
4	Published BAEC Brochure	1800	Published, distributed
5	Arranging science fair/digital fair	2	Successfully completed
6	BAEC Diary 2017	1100	Published and distributed
7	Pocket directory	200 small	Published and distributed
8	Tender/Advertisement etc. sent to the newspaper	35	Published in the 110 daily newspapers
9	Processing of bills (tender/advertisement etc.)	35	Successfully completed
10	Press release on training, workshop etc. conducted by BAEC	13	Published in the daily newspapers
11	Photographic service (processed, printed and supplied)	650	Distributed to the relevant divisions, organizations, etc.
12	Processed nominations of BAEC scientists to attend various scientific/technical/workshop/seminar etc. arranged locally by different academic/professional institutes.	260	Nomination letters were distributed to the relevant participants.
13	Processed applications of various Scientific Societies /Professionals seeking financial support/donation etc. from to establish transparency & accountability as well as to ensure access to information (a2i) as per the newly enacted “right to information Act”.	6	Successfully completed
14	Provide National Parliamentary questions and answers	7	Successfully completed
15	Provide Parliamentary Committee Report	7	Successfully completed
16	Provide BAEC information for Preparation of Ministry Annual Report	2	Successfully completed
17	Preparation of annual performance agreement 2016-2017 between BAEC with MOST & Different Inst./Centre/Unit with BAEC	31	Successfully completed
18	Preparing Different APA reports of BAEC	35	Successfully completed

19	Providing input for different bilateral contract/MoU/ international conference/meeting	10	Successfully completed
20	Preparing and providing inputs to different ministry	20	Successfully completed
21	Preparing and providing monthly report to MOST	12	Successfully completed
22	Preparing and providing Election manifesto report to MOST	12	Successfully completed
23	Preparing and providing inputs to the MOST	39	Successfully completed

## **XI. SCIENTIFIC INFORMATION UNIT (SIU), AERE, SAVAR**

### **Objectives**

The main responsibilities of the Scientific Information Unit (SIU) are to furnish documentation of the scientific achievements attained in different Institutes/Units of the Atomic Energy Research Establishment (AERE) and to collect and preserve scientific documents to be used primarily by the scientists of AERE conducting research and development (R&D) activities in nuclear science and technology. Another important involvement of the Unit is to extend required co-operation and coordination in documenting (both electronic and traditional) seminars/symposiums/workshops etc. held in AERE. In the domain of public relation the Unit gets involved in attending the official delegates both from home and abroad, and visitors and guests of AERE.

### **Activities/Programme(s)**

The activities/involvements of SIU during the period under report are as follows:

- Publication of AERE Technical Report, vol. 21: The major documentation activity within the reporting period involves publication of the AERE Technical Report, vol. 21 by the SIU. The report covers the activities and achievements of AERE in 2015. The Unit has published a number of internal reports of different institutes/units of AERE.
- Acquisition of Books and Journals: In the period under report, the Unit collected 40 books of different titles to be used by the scientists/researchers of AERE.
- Co-operation in Seminars/Symposium/Workshop held in AERE: The Unit extended technical co-operation (photography) in documenting the seminars/symposia/workshops held in AERE
- Attendance to Delegates/Visitors: During the period under report the Unit had to host as many as 67 groups of delegates and visitors from both home and abroad to AERE.
- E-journal Service: The Unit has been serving e-journals with the help of HINARI/AGORA/OARE from 2008. Users can download required articles from scientific books and journals from different publishers which are available in the net.
- Database Service: The Unit provides on-line database and e-catalogue searching facilities.
- Fax Service: Fax services are available at the Unit with the modern fax machine for receiving and sending official documents to and from AERE.
- Current Awareness Service (CAS) and Selective Dissemination Service (SDS): Books/journal's etc. are listed on the basis of recent collections to inform the scientists and researchers at AERE.
- News Clipping Compilation and Preservation: News concerning Bangladesh Atomic Energy Commission (BAEC), Rooppur NPP project and in general nuclear science and technology published in daily newspapers are clipped to the Notice Boards of different institutes/units of AERE for dissemination and awareness of scientists of AERE.
- Routine Services: The routine services rendered during the period under report include (i) photography and documentation service in different national day ceremonies/programmes (ii) photographic service to the officials/employees of AERE for official purpose and (iii) reprography service etc.

The SIU has always been trying to perform all the assigned duties and responsibilities accordingly and timely and is going smoothly to achieve the target

## XII. TRAINING INSTITUTE (TI), AERE, SAVAR

### Introduction

Training Institute (TI) of Bangladesh Atomic Energy Commission (BAEC) is located in Atomic Energy Research Establishment (AERE) campus, Ganakbari, Ashulia, Savar, Dhaka. It is housed in a four storied building having total floor area of 36,395 sq. ft. It has been built in the motivation to develop the skilled manpower in nuclear fields to meet up the future demand of BAEC and for the country. Bangladesh Government is going to establish a Nuclear Power Plant (NPP) at Rooppur in Pabna District. A good number of efficient manpower in different fields will be required in that plant. Considering all these requirements TI is conducting different training programmes since its establishment as per the approval of BAEC. TI organizes different kind of in-house training courses like- Basic Nuclear Orientation Course (BNOC), Follow-up Training Course (FTC) Supported by Japan Atomic Energy Agency (JAEA) and Language Course. TI also conducts selection procedure of BAEC employees for having suitable training from other reputed organizations of Bangladesh. Following activities have been performed in the reported period.

### Activities/Programme(s)

#### 1. Manpower Development/Training Programme(s)

Name of the event/topics	Duration	No. of participants	Training hours (man-hours)	Resource persons
In-house training course on office manners and general behavior -III	24-25 July 2016	26 (Staff)	10 (260)	Senior Scientists of BAEC and High Officials of MOST
Training Course on Radiation Protection for Radiation Workers and RCOs of BAEC & Others	28 Aug. – 01 Sept., 2016	22 (Officer)	25 (550)	Senior Scientists of BAEC
Basic Russian Language Course-III	02 Oct. - 03 Nov., 2016	16 (Officer)	82 (1312)	Ex. Director, INST, AERE
In-house training course on office manners and general behavior –IV	18-19 Dec., 2016	24 (Officer)	10 (240)	Senior Scientists of BAEC and High Officials of MOST.
Training Course on e-GP System	18-22 Dec., 2016	15 (Officer)	25 (375)	Experts from Dohatec New media, Dhaka
FTC on environmental Radioactivity Monitoring	15-19 January 2017	14 (Officer)	25 (350)	Scientists of BAEC and JAEA
FTC on Reactor Engineering	29 Jan. -16 Feb., 2017	12 (Officer)	75 (900)	Scientists of BAEC and JAEA
FTC on Nuclear and Radiological Emergency Preparedness	26 Feb. - 9 Mar., 2017	22 (Officer)	50 (1100)	Scientists of BAEC and JAEA
Basic Nuclear Orientation Course-2017	9 Apr. 1-8 June, 2017	26 (Officer)	168 (4368)	Senior Scientists of BAEC and High officials of MOST
Total		167	9455 man-hours	

**2. Seminar/Symposium/Conference/Workshop/Meeting Attended**

Name of the participants	Name of the event/topics	Organizer	Date	Place
Md. Nurul Islam	Annual meeting of the Topical Group Education and Training (ETTG) and Regional workshop on Talent Management	IAEA	17-21 Oct., 2016	Vietnam
	National Conference on Physics-2017	Bangladesh Physical Society	5-7 Jan., 2017	Dhaka
	Fukui International meeting on Human Resource Development for Nuclear Energy in Asia	WERC	8-10 Feb., 2017	Japan
	Implementation of General Contract (Joint Training Advisory) for CRNPP	CRNPP	22-26 Mar., 2017	Russia
A. K. Das	National Conference on Physics-2017	Bangladesh Physical Society	5-7 Jan., 2017	Dhaka

**3. Training Courses Arranged Outside the Training Institute for BAEC Employees**

Training Institute has performed the selection procedure for officers and staffs of BAEC for availing appropriate training from different organizations in Bangladesh during the reporting period. The training programmes were held in the following organizations-

- Rural Public Administration Training Center (RPATC), New Eskaton, Dhaka
- Bangladesh Institute of Management (BIM), 27 Dhanmondy, Dhaka and
- Institute of Diploma Engineers in Bangladesh (IDEB), Kakrail, Dhaka
- Bangladesh Association of Librarians, Information Scientists & Documentationalist (BALID) Dhanmondi, Dhaka

12 (twelve) officers and 17 (seventeen) staffs, total 29 (twenty nine) employees from different institutes/units/divisions of BAEC have had training from above mentioned organizations within 01 July 2016 to 30 June 2017.

**XIII. FINANCE AND ACCOUNTS DIVISION (FAD), HQ, BAEC****Activities****1. Revenue Budget Allocation (including fund release and source of fund)**

(in lac Taka)

Head of Accounts	Source of fund			
	Allocation from Govt.	Received from BAEC own income	From other sources	Total received
General grant	18967.72	1687.50	1216.54	21871.76
Special grant (RNPP)	362.75	--	--	362.75
Capital grant	1380.00	142.50	--	1522.50
Total	20710.47	1830.00	1216.54	23757.01
Service Charge Distribution	---	1220.00	---	1220.00
Grand Total	20710.47	3050.00	1216.54	24977.01

**2. Revenue Budget Allocation (Center/Institutewise)**

Name of the centre/institute	Revenue budget allocation (in lac Taka)
BAEC Head Quarter, Dhaka	3142.50
Works Branch, BAEC Dhaka	971.30
BAERA Dhaka	382.00
Atomic Energy Centre, Dhaka	1935.00
AERE Savar	6122.00
National Institute of Nuclear Medicine & Allied Sciences, Dhaka	895.00
Institute of Nuclear Medicine & Allied Sciences, Chittagong	235.50
Institute of Nuclear Medicine & Allied Sciences, Rajshahi	211.50
Institute of Nuclear Medicine & Allied Sciences, Dinajpur	171.00
Institute of Nuclear Medicine & Allied Sciences, Sylhet	149.00
Institute of Nuclear Medicine & Allied Sciences, Dhaka	400.00
Institute of Nuclear Medicine & Allied Sciences, Barisal	169.00
Institute of Nuclear Medicine & Allied Sciences, Khulna	209.00
Institute of Nuclear Medicine & Allied Sciences, Rangpur	234.00
Institute of Nuclear Medicine & Allied Sciences, Mymensing	273.00
Institute of Nuclear Medicine & Allied Sciences, Bogra	195.50
Institute of Nuclear Medicine & Allied Sciences, Comilla	150.00
Institute of Nuclear Medicine & Allied Sciences, Faridpur	149.00
Institute of Nuclear Medicine & Allied Sciences, Midford	281.00
Institute of Nuclear Medicine & Allied Sciences, Cox's Bazar	55.00
RTML Chittagong	196.00
BSMEC Cox's bazaar	123.50
RNPP Pabna	197.00
Pension & retirement benefit	4830.21
Foreign Exchange Branch, Dhaka	1080.00
Nuclera Power Plant Company Bangladesh Limited	1000.00
Service Charge Distribution	1220.00
Total	24977.01

## XIV. SUPERVISION OF THESIS

### ATOMIC ENERGY CENTRE (AEC), DHAKA

#### Accelerator Physics Division

1. Joint-supervisor: Dr. Md. JoynalAbedin, “Analysis of Elemental Concentration of Medicinal Plants Using Ion Beam Analytical Technique PIXE to Establish a Elemental database”, Ph. D. Thesis (Md. ZakirHossain), Department of Physics, Jahangirnagar University, June 2017.
2. Joint-supervisor: Dr. Md. JoynalAbedin, “Quantitative Analysis of Trace Element in Fishes and Sediments of Polluted Lakes in Dhakacity Using IBA Techniques and Radioactivity Measurement of Lake Sediment”, Ph. D. Thesis (Md. AtiqurRahman), Department of Physics, Jahangirnagar University, June 2017.

#### Chemistry Division

3. Co-supervisor: Dr. Bilkis Ara Begum, “Thermal Performance and Emission Analysis of Available Metal and Non-Metal Improved Cook Stoves in Bangladesh and Development of a New Improved Cook Stoves with Thermo Electric Generator”, M. Sc Thesis (Anwarul Islam Sifat and Md. Milon Uddin), Institute of Energy, University of Dhaka, October 2016.
4. Co-supervisor: Dr. Bilkis Ara Begum, “Study of the Carbonaceous Aerosol over Gazipur city: Identification and assessment of sources”, M. Phil Thesis (Mohammed Mozammel Hoque), Department of Physics, DUET, Gazipur, December 2016.
5. Joint-supervisor: Dr. Shamshad B. Quraishi, “Health Risk Assessment of Tourist in Saint Martin’s Island, Bangladesh due to Heavy Metals Exposure from Commonly Consumes Fish, Shrimp, Lobster and Crabs”, M. Sc Thesis (Jhuma Alhter), Department of Zoology, Faculty of Life and Earth Science, Jagannath University, Dhaka, September 2016.
6. Joint-supervisor: Dr. Md. Safiur Rahman, “Management of Water Quality for TRIGA Mark –II Research Reactor with Special Emphasis on Corrosion Phenomena”, M. S. Thesis (Mohammad Rafiqul Islam), Department of Nuclear Engineering, Dhaka University, November 2016.
7. Joint-supervisor: Dr. Md. Safiur Rahman, “Risk Management through the Best Trial and Error Model on Nuclear Power Industry”, M. S. Thesis (Shantanu Biswas), Department of Nuclear Engineering, Dhaka University, November 2016.
8. Co-supervisor: Dr. Bilkis Ara Begum, “Evaluation of Blood Lead Level as a Risk Factor in Children with Autism Spectrum Disorder: A case control study”, M. D. Thesis (Dr. Md. Shaheb Ali), Department of Pediatrics, Bangagabdh Sheikh Mujib Medical University, January 2017.
9. Joint-supervisor: Dr. Shamshad B. Quraishi, “Serum Zinc Concentration in Patients with Tuberculous Lymphadenitis”, M. D. Thesis (Dr Md Rashadul Kabir), Department of Internal Medicine, Bangabandhu Sheikh Mujib Medical University (BSMMU), May 2017.
10. Joint-supervisor: Dr. Shamshad B. Quraishi, “Portable UV-Spectrophotometer to Determine the Concentration of Potassium”, B. Sc. Thesis (Ifra Kabir, Md. Tashik Hossain, Md. Al-Amin and Jahanara Akhter Shupta) Department of Electrical and Electronics Engineering, BRAC University, Dhaka, May 2017.
11. Joint-supervisor: Dr. Shamshad B. Quraishi, “Association of Lead (Pb) in Maternal Serum with Fetal Neural Tube Defects”, FCPS Thesis (Dr. Fahmida Bayes Kakon), Department of Obs and Gynae, Bangabandhu Sheikh Mujib Medical University (BSMMU), January 2017.



12. Joint supervisor: Dr. Yeasmin Nahar Jolly, “Petrography and Geochemical Analysis of Sylhet Limestone”, B. Sc. Thesis (S. M. Mohammad Ullah), Department of Petroleum and Mining, Sylhet University of Science and Technology, May 2017.
13. Joint-supervisor: Dr. Md. Safiur Rahman, “Status of Groundwater Quality and Its Health Risk Assessment with the Special Emphasis on Arsenic Contamination: A case study”, M. S. Thesis (Md. Asaduzzaman), Department of Environmental Sciences, Jahangirnagar University, May 2017.

### **Experimental Physics Division**

14. Joint-supervisor: Kazi Md. Amjad Hussain, “Chemical Bath Deposition and Characterization of ZnS Buffer Layer for Thin Film Solar Cell”, B. Sc. (Hons) Project report (Md. SaifurRahman and IntiazHossen), Department of Electrical & Electronic Engineering, University of Dhaka, July 2016.
15. Joint-supervisor: Kazi Md. Amjad Hussain, “Synthesis Via Spin Coating and Characterizations of Al (at. 1%) Doped ZnO Nanostructured Thin Films for Opto-electronics Applications”, M. Sc. Thesis (Turja Nandy), Department of Electrical and Electronics Engineering, University of Dhaka, Declaration and submitted on August 2016.
16. Joint-supervisor: Kazi Md. Amjad Hussain, “Fabrication and Characterization of Al doped ZnO Thin Film Using Spin Coating Deposition System”, M. Sc Thesis (Tanusree Chakraborty), Physics Discipline Science, Engineering and Technology School, Khulna University, November 2016.
17. Co-supervisor: Kazi Md. Amjad Hussain, “Construction and Characterization of ZnS Thin Films Deposited by Chemical Bath Deposition Technique”, M. Sc Thesis (Md. Kamruzzaman), Department of Physics, University of Dhaka, April 2017.
18. Co-supervisor: Kazi Md. Amjad Hussain, “Structural, Optical and Electrical Properties of Vacuum Evaporated Cadmium Selenide (CdSe) and Copper (Cu) Doped CdSe Thin Films”, M. Sc Thesis (SadiaRahman), Department of Physics, University of Dhaka, April 2017.
19. Co-supervisor: Kazi Md. Amjad Hussain, “Effect of thickness on the Structural, Optical and Electrical Properties of Copper (Cu) dopd Zinc Selenide (ZnSe) Thin Films by Thermal Evaporation Method”, M. Sc. Thesis (Md. Mustafijur Rahman), Department of Physics, University of Dhaka, April 2017.

### **Health Physics Division**

20. Joint-supervisor: Dr. Mohammad Sohelur Rahman, “Measurement of Indoor Terrestrial Gamma Radiation Dose Rate at AECD Campus by In-Situ Technique”, M. S. Thesis (Shahadat Hossain), Department of Physics, SUST, October 2016.
21. Joint-supervisor: Dr. A. K. M. Mizanur Rahman, “An Evaluation and Comparison of Performance of Two Dose Calibrators in Institute of Nuclear Medicine and Allied Sciences, DMCH, Dhaka, Bangladesh”, M. S. Thesis (Fardous Reaz), Department of Nuclear Engineering, University of Dhaka, November 2016.
22. Joint-supervisor: Jannatul Ferdous, “Measurement of Radioactivity in Some Building Materials used in Bangladeshi Dwelling”, M. S. Thesis (Mst. Azmary Khatun), Department of Physics, University of Rajshahi, February 2017.
23. Joint supervisor: Selina Yeasmin, “Radioactivity Concentration in Soil and Transfer Factors of Radionuclides from Soil to Grass & Mango in Sundarganj Upazila in Gaibandha District, Bangladesh”, M. Sc. Thesis (Md. Shahjamal Mondol), Department of Physics, Jagannath University, March 2017.
24. Joint supervisor: Selina Yeasmin, “Measurement of  $^{238}\text{U}$ ,  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$ ,  $^{40}\text{K}$  in Foodstuff Samples Collected from North-Eastern Part of Bangladesh”, M. Sc. Thesis (Saiful Islam), Department of Physics, Jagannath University, March 2017.

### Material Science Division

25. Co-supervisor: Dr. M. M. Haque, “Physical Properties of Alumina and Zirconia Based Ceramics Doped with MgO and TiO<sub>2</sub>”, M. Sc. Thesis (Md. Razibul Hasan), Department of Physics, Khulna University, October 2016.
26. Co-supervisor: Dr. M. M. Haque, “Study of Microstructures, Mechanical and Electrical Properties of Al<sub>2</sub>O<sub>3</sub>-wt.% ZrO<sub>2</sub> Composite Ceramics Doped with MgO”, M. Sc. Thesis (Belal Hossain), Department of Physics, Science, Engineering and Technology School, Khulna University, October 2016.
27. Co-supervisor: Dr. Md. Nazrul Islam Khan, “Study of the Magnetic and Transport Properties of CaMn<sub>(1-x)</sub>Ti<sub>x</sub>O<sub>3</sub>”, M. Sc. Thesis (Sumya Nigar), Department of Physics, Govt. B. M. College, Barisal, December 2016.
28. Co-supervisor: Dr. Md. Nazrul Islam Khan, “Study of the Magnetic and Transport Properties of Ba<sub>1-x</sub>Sr<sub>x</sub>Ti<sub>0.5</sub>Mn<sub>0.5</sub>O<sub>3</sub>”, M.Sc. Thesis (Shahnaz Parvin), Department of Physics, Govt. B. M. College, Barisal, December 2016.
29. Co-supervisor: Dr. M. N. I. Khan, “Effect of Rare Earth Metal Substitution on the Magnetic and Transport Properties of Ni-Zn Ferrites”, M. Phil. Thesis (Alamgir Hossain), Department of Physics, Khulna University of Engineering & Technology, January 2017.
30. Co-supervisor: Dr. M. N. I. Khan, “Synthesis of (1-x)BiFe<sub>0.9</sub>La<sub>0.1</sub>O<sub>3</sub>+x(Ni<sub>0.6</sub>Zn<sub>0.4</sub>Fe<sub>0.94</sub>V<sub>0.06</sub>O<sub>4</sub>) Nanostructured Multiferroic Composites and Study of its Structural, Magnetic And Electrical Properties”, M. Sc. Thesis ((Md. Rabiul Hassan), Department of Physics, Khulna University of Engineering & Technology, February 2017.
31. Co-supervisor: Dr. M. M. Haque, “Study of the Safety and Neutronic Parameters of Research Reactor Using Evaluated Nuclear Data Libraries And Computer Codes”, Ph. D. Thesis (Md. Mominul Islam), Department of Physics, Jahanginagar University, Savar, Dhaka, March 2017.
32. Co-supervisor: Dr. Md. N. I. Khan, “Preparation and Characterization of Al substituted Ni-Cu-Zn Ferrites”, M. Phil. Thesis (Kazi Rumanna Rahman), Department of Physics, Chittagong University of Engineering & Technology, March 2017.
33. Co-supervisor: Dr. Engr. S. M. Hoque, “Investigation of the Influence of Annealing Temperatures on the Structural Properties of Magnesium Ferrite Nanoparticle and Functionalization of Chitosan Coated Magnesium Nanoparticle for In vitro Hyperthermia Application”, M. Sc. Thesis (Rawdah Mahbub), Department of Electrical and Electronic Engineering, University of Dhaka, April 2017.
34. Co-supervisor: Dr. M. N. I. Khan, “Investigation of Multiferroic Properties of Ni-Zn based Ferrite and Ba-Ti based Ceramic Composites via Standard Solid State Reaction Method”, M. Sc. Thesis (Iffat Nur Esha), Department of Physics, University of Dhaka, April 2017.
35. Co-supervisor: Dr. M. N. I. Khan, “Study of Structural, Electrical and Magnetic Properties of Calcium and Strontium Substituted Barium Titane (BaTiO<sub>3</sub>) Ceramics”, M. Sc. Thesis (Fatema Tuz Zohora Toma), Department of Physics, University of Dhaka, April 2017.
36. Co-supervisor: Dr. S. M. Hoque, “Synthesis and Comparative Study of Structural and Mechanical Properties of Hydroxyapatite Ca<sub>10</sub>(PO<sub>4</sub>)<sub>6</sub>(OH)<sub>2</sub> Nanoparticles using Different Precursor Substances and Varying Sintering Temperatures for Biomedical Applications”, M. Sc. Thesis (Md. Saif Ishtiaque), Department of Physics, University of Dhaka, April 2017.
37. Joint supervisor: Dr. Engr. S. M. Hoque, “Magnetization Behavior of Co-RICH Nd-Fe-B based Nanocomposite Magnets with Tb Substitution”, Ph. D. Thesis (Palash Chandra Karmaker), Department of Physics, Jahanginagar University, Savar, Dhaka, June 2017.

38. Co-supervisor: Dr. M. N. I. Khan, “Study the Structural, Electrical and Magnetic Properties of Iron Substituted Barium Titanate ( $\text{BaTiO}_3$ )”, M. Sc. Thesis (Shammi Mahbub), Department of Electrical and Electronic Engineering, University of Dhaka, June 2017.
39. Co-supervisor: Dr. M. N. I. Khan, “Effect of  $\text{Cr}^{3+}$  Doping on Structural, Electrical and Magnetic Properties of  $\text{Ni}_{0.8}\text{Co}_{0.2}\text{Cr}_x\text{Fe}_{2-x}\text{O}_4$  Ferrites”, M. Sc. Thesis (Nayan Das), Department of Electrical and Electronic Engineering, University of Dhaka, June 2017.
40. Co-supervisor: Dr. A. K. M. Hakim, “Study of the Crystallization Kinetics of Amorphous Magnetic Materials”, Ph. D. Thesis (Md. Masud Rana), Department of Theoretical Physics in partial of the requirements, University of Dhaka, July 2017.

#### **Medical Physics Division**

41. Co-supervisor: Dr Rajada Khatun, “Thyroid Uptake Of 99mTc and its Agreement with 131I for Evaluation of Thyroid Function”, M. S. Thesis (Md. Ohiduzzaman), Department of Biomedical Physics and Technology, University of Dhaka, May 2017.
42. Co-supervisor: Dr Rajada Khatun, “Study of Thyroid Uptake by Tc-99m and I-131 for Hyperthyroid Patient”, M. Sc. Thesis (Md. Kaiyum Rabbi), Department of Physics, Jagannath University, Dhaka, May 2017.
43. Co-supervisor: Dr Rajada Khatun, “Study of Thyroid Uptake by Tc-99m and I-131 for Euthyroid and Hypothyroid Patient”, M. Sc. Thesis (Md. Abu Bakar Siddique), Department of Physics, Jagannath University, Dhaka, May 2017.

#### **CENTRE FOR RESEARCH REACTOR (CRR), AERE**

44. Co-supervisor: Dr. Md. Abdul Malek Soner, “Nuclear Safety Assessment of the BAEC TRIGA Research Reactor,” Ph. D. Thesis (Md. AjijulHoq), Department of Physics, Jahangirnagar University, August 2016.
45. Co-supervisor: Dr. Md. Abdus Salam, “Study on Reactivity Parameters of the Nuclear Research Reactor”, M. Sc. Thesis (Md. Muntashir Mafiz), Department of physics, Jahangirnagar University, August 2016.
46. Co-supervisor: Anisur Rahman, “Calculation and Measurement of the Scintillation Detector Efficiency”, M. Sc. Thesis (Sugrib Chakma), Department of physics, Jahangirnagar University, August 2016.
47. Co-supervisor: Dr. Md. Abdul Malek Soner, “Measurement of Reactivity Coefficients of the BAEC TRIGA Research Reactor”, M. Sc. Thesis (Md. Al Amin Hossain), Department of Nuclear Engineering, Dhaka University, November 2016.
48. Co-supervisor: Dr. Md. Abdul Malek Soner, “Mesearment of control Rod Worth, Core Excess and Shutdown Margin With WCT of the BAEC TRIGA Research Reactor”, M. Sc. Thesis (Md. Saifur Rahman), Department of Physics, JagannathUniversity, March 2017.

#### **INSTITUTE OF RADIATION AND POLYMER TECHNOLOGY (IRPT), AERE**

49. Co-supervisor: Dr. Ruhul Amin Khan, “ Investigation of Naturally Occurring Bacterial Strategy in Degrading or Detoxifying Heavy Metals of the Buriganga River”, M. S. Thesis (Abdullah Al Mamun), Department of Microbiology, University of Chittagong, March 2017.
50. Co-supervisor: Dr. Ruhul Amin Khan, “Physico-Chemical and Microbiological Assessment of Surface Water Quality of Turag River in Dhaka, Bangladesh”, M. S. Thesis (Tahmina Begum), Department of Microbiology, University of Chittagong, March 2017.
51. Co-supervisor: Dr. Ruhul Amin Khan, “Removal of Chromium and Lead from Paint Industry Effluent by Naturally Occurring Bacteria”, M. S. Thesis (Tofa Begum), Department of Microbiology, University of Chittagong, March 2017.

52. Co-supervisor: Dr. Ruhul Amin Khan, “Assessment of Surface Water Quality of Aquaculture Ponds Located in Savar, Bangladesh”, M. S. Thesis (Amisha Chowdhury), Department of Microbiology, University of Chittagong, March 2017.
53. Co-supervisor: Dr. Ruhul Amin Khan, “Biodegradation of Hazardous Residual Pesticide by Pesticide Resistant Naturally Occurring Bacteria”, M. S. Thesis (Farjana Akter Koly), Department of Microbiology, University of Chittagong, March 2017.
54. Co-supervisor: Dr. Ruhul Amin Khan, “Dye sensitized Solar Cells (DSSCs) Constructed with  $\text{TiO}_2$  and  $\text{ZnO}$  Nanoparticles and the Effect of Gamma ( $\gamma$ ) Radiation on Them”, M. S. Thesis (Ridwan Nahar), Department of Physics, University of Dhaka, April 2017.
55. Co-supervisor: Dr. Ruhul Amin Khan, “Effect of Sand on Mechanical Properties of Jute Fabrics Reinforced Polypropylene based Composite”, M. S. Thesis (Md. Mostafizur Rahman), Department of Applied Chemistry and Chemical Engineering, University of Dhaka, April 2017.
56. Co-supervisor: Dr. Ruhul Amin Khan, “Fabrication and Characterization of Jute Fabrics Reinforced Polymer based Composite: Comparative Study Between hand Lay-up and Compression Molding Technique”, M. S. Thesis (Md. Sahadat Hossain), Department of Applied Chemistry and Chemical Engineering, University of Dhaka, April 2017.
57. Co-supervisor: Dr. Ruhul Amin Khan, “Fabrication and Characterization of Antibacterial and Biodegradable Facial Tissue Paper using Bio-based Raw Material”, M. S. Thesis (Khandaker Umaiya), Department of Applied Chemistry and Chemical Engineering, University of Dhaka, April 2017.
58. Co-supervisor: Dr. Ruhul Amin Khan, “Fabrication and Characterization of Carbon Kevlar Reinforced Polypropylene based Composite”, M. S. Thesis (Md. Saddam Hossain), Department of Applied Chemistry and Chemical Engineering, University of Dhaka, April 2017.
59. Co-supervisor: Dr. Ruhul Amin Khan, “Physico-mechanical Property of Unidirectional Jute Fiber Reinforced Polypropylene and Linear Low Density Polyethylene Based Composite: Effect of Dye”, M. S. Thesis (Md. Niloy Rahman), Department of Applied Chemistry and Chemical Engineering, University of Dhaka, April 2017.

## **INSTITUTE OF NUCLEAR SCIENCE AND TECHNOLOGY (INST), AERE**

### **Nuclear Radiation and Chemistry Division**

60. Supervision: Md. Ferdous Alam, “Hydrochemical Variation and Quality Analysis of Ground Water in Shaingair Upazila, Manikganj District, Bangladesh”, B. Sc. (Hons) Thesis (Sajin Sultana), Department of Environmental Sciences, Jahangirnagar University, January 2017.
61. Supervision: Md. Ferdous Alam, “Human Health Risk Assessment Due To Trace Element Contamination in Ground Water in Damurhuda Union, Damurhuda, Chuadanga, Bangladesh”, B.Sc. (Hons) Thesis (Md. Tareq Hasan), Department of Public Health and Informatics, Jahangirnagar University, October 2016.

### **Health Physics and Radioactive Waste Management Unit**

62. Co-supervisor: Dr. M. Moinul Islam, “Dosimetric Comparison with the Anisotropic Analytical Algorithm (AAA) and Pencil Beam Convolution (PBC) Algorithm for Radiotherapy Treatment Planning System”, Ph. D. Thesis (Muhammad Masud Rana) Department of Physics, Jahangirnagar University, June 2016.
63. Joint-supervisor: Dr. Md. Idris Ali, “Measurement of Natural Radioactivity in Environmental Samples in a Selected Zone of Bangladesh”. Ph. D. Thesis (Sheikh Shariful Islam), Department of Physics, Jahangirnagar University, June 2016.
64. Joint-supervisor: Dr. Md. Idris Ali, “Study of Radioactivity Levels in Different Kinds of Food Stuff Grown on The Bank of Rupsha River and Its Impact of Human Health”, M. Sc. Thesis (Mst. Nur Nahar), Department of Physics, Khulna University of Engineering & Technology, April 2016.

65. Co-supervisor: Dr. Shakilur Rahman, “Standardization of Photon and Neutron Calibration Fields for Characterizing Special Neutron Moderated Detectors and Digital Dosimeters”, M. S. Thesis (Jannatul Ferdous), Department of Physics, University of Chittagong, March 2016.
66. Joint supervisor: Dr. Debasish Paul, “Study on Probable Radionuclide Contents and Their Dose Assessment in Sand, Soil and Water Samples Collected from the Rupsha River, Khulna”, M. Sc. Thesis (Tuhina Islam), Department of Physics, Khulna University of Engineering & Technology, April 2016.
67. Joint-supervisor: Dr. Debasish Paul and Co-supervisor: Ms. Siddha Moutoshi Shome, “Characterization of Unsealed Solid Radioactive Wastes of Central Radioactive Waste Processing and Storage Facility (CWPSF)”, M. S. Thesis (Shoman Das), Department of Physics, University of Chittagong, November 2016.
68. Co-supervisor: Dr. Shakilur Rahman, “Dosimetric Characteristics and Output Factors of Small Field in External Beam Radiotherapy For 6 MV Photon Beam From Clinac With Various Detectors”, M. S. Thesis (Santunu Purohit), Department of Physics, University of Chittagong, November 2016.
69. Joint supervisor: Dr. Debasish Paul, Dr. Md. Idris Ali and Co-supervisor: Mr. Md. Abu Haydar, “Radioactivity in Environmental Samples Collected from Inani Beach and Inani canal: A Comparative Study”, M. S. Thesis (Md. Ikram), Department of Physics, University of Chittagong, November 2016.
70. Supervisor: Co-supervisor: Dr. Shakilur Rahman, Dr. Md. Shamsuzzaman, “Dosimetry of  $^{60}\text{Co}$  Teletherapy Units and Calibration of Some Ionization Chambers”, M. Sc. Thesis (Md. Ali Reza), Physics Discipline, Khulna University, October 2016.
71. Co-supervisor: Dr. Shakilur Rahman, “Calibration and Standardization of Ionization Chamber and Absorbed Dose to Water for Photon Beam by IAEA Dosimetry Protocols”, M. Sc. Thesis (Md. Rakibul Islam), Physics Discipline, Khulna University, October 2016.

#### **Reactor and Neutron Physics Division**

72. Co-supervisor: Dr. Md. Amirul Islam, “Study of Trace Element Contamination in Industrial Effluent By Research Reactor Based Neutron Activation Analysis Method”, M. Sc. thesis (Md. Harun Ur-Rashid), Department of Physics, Shahjalal University of Science and Technology, Sylhet, Bangladesh, January 2017.
73. Co-supervisor: Dr. Md. Amirul Islam, “Environmental Risk Assessment By Elemental Concentration in Sediment of The Rivers of Sundarban using Research Reactor Based Neutron Activation Analysis Method”, M. Sc. thesis (Abdullah Al-Mamun), Physics Discipline, Khulna University, December 2016.
74. Co-supervisor: Dr. Md. Rahat Khan, “Assessment of Elemental Background in Rampal by Instrumental Neutron Activation Analysis”, M. Sc. thesis (Md. Shohel Parvez), Physics Discipline, Khulna University December 2016.

#### **INSTITUTE OF FOOD AND RADIATION BIOLOGY (IFRB), AERE**

##### **Agrochemical and Environmental Research Division**

75. Co- supervisor: Dr. Md. Amin Uddin, “Pesticide Residue Analysis in Water of Some Selected Pond and Canals at Sadar Upazila of Lakshmipur District”, M. S. thesis (Nasid ul Abedin Chowdhury), Department of Biochemistry and Molecular Biology, Tejgoan College, National University, October 2016.
76. Co- supervisor: Dr. Muhammad Alamgir Zaman Chowdhury and Zeenath Fardous, “Efficiency of Trapa Biospinosa Roxb. and Salvinia Cucullata Roxb. in Waste Water Treatment”, M. S. thesis (Sadia Afrin Nitol), Department of Environmental Science, Jahangirnagar University, June 2016.
77. Co- supervisor: Dr. Md. Hasanuzzaman, “Pesticide Residues Contamination Analysis in Water Samples of Sreenagar Upazila in Munshiganj District and Malathion Effects on The Mortality Rate of Tilapia, Oreochromis Mossambicus (Peters, 1852)”, M. S. thesis (Md. Nasir Uddin), Dept. of Fisheries, Dhaka University, February 2017.

### **Insect Biotechnology Division**

78. Co-supervisor: Dr. Mahfuza Khan, ‘Effect of Solid Lure Plugs and Essential Oils with DDVP Insecticide Strips for Capture of Bactrocera Fruit Flies (Diptera:Tephritidae) and Non-target Insects in Field Trails’, M. Sc. Thesis (Amit kumar Neogi), Department of Zoology, Jagannath University, 2017.

### **Microbiology and Industrial Irradiation Division**

79. Co-supervisor: Dr. Md. Kamruzzaman Pramanik, ‘Disinfection of Archived Materials and Cultural Heritage Artifact By Radiation Processing Technology’, M. Sc. Thesis (Md. Shohel Rana), Department of Microbiology, Jagannath University, December 2016.
80. Co-supervisor: Dr. Abdullah-Al-Mahin, “Evaluation of *in-vitro* Probiotic Characteristics of Lactic Acid Bacteria Isolated From Raw Vegetables”, M. S. thesis (Orin BintehMosleh), Department of Biotechnology and Genetic Engineering, Jahangirnagar University, November 2016.
81. Co-supervisor: Dr. Abdullah-Al-Mahin, “Enhanced Bioethanol Production from Potato Peel Waste via Consolidated Bioprocessing with Statistically Optimized Medium”, M. S. thesis (Tahmina Hossain), Department of Biotechnology and Genetic Engineering, Jahangirnagar University, November 2016.
82. Co-supervisor: Dr. Abdullah-Al-Mahin, “Bioprotection of Lettuce and Beef against Foodborne Pathogens by Locally Isolated Bacteriocinogenic Lactic Acid Bacteria from Vegetables”, M. S. thesis (Syedzadi Mahbuba Monzur Mouna), Department of Microbiology, Jessore University of Science and Technology, October 2016.

### **INSTITUTE OF TISSUE BANKING AND BIOMATERIALS RESEARCH (ITBBR), AERE**

83. Joint supervisor: Dr. S. M. Asaduzzaman, “Enumeration and Characterization of Bacteria Isolated from Human Amniotic Membrane and Determination of Radiation Sensitivity of Isolates”, M. Sc. Thesis (UmmayTamimaTasnim), Department of Microbiology, Jessore University of Science and Technology, October 2016.
84. Joint-supervisor: Dr. S. M. Asaduzzaman, “Formulation and In Vivo Evaluation of Human Amniotic membrane and Aloe veraDerived Burn Healing Gel”, M. Sc. Thesis (Rashedul Islam), Department of Biotechnology and Genetic Engineering, JahangirnagarUniversity, November 2016.
85. Joint-supervisor: Dr. S. M. Asaduzzaman, “Fabrication and Characterization of Hydroxyapatite Based Biocompatible Composite scaffold for Bone Tissue Engineering”, M. Sc. Thesis (Poulomi Das), Department of Mathematics and Natural Sciences (MNS), BRAC University, March 2017.

### **INSTITUTE OF ELECTRONICS (IE), AERE**

#### **General Electronic Division**

86. Co-supervisor: Farhana Hafiz, “Design and Development of Microcontroller Based wireless Temperature Monitor”, M. Sc. Thesis (Mahmudun nabi), Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh, December, 2016.
87. Co-supervisor: F. Akter, “Design and Development of Microcontroller Based wireless Humidity Monitor”, M. Sc. Thesis (Jahedul Islam), Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh, December, 2016.
88. Co-supervisor: Farhana Hafiz, “Design and Implementation of Wireless Autonomous Information Robot for Nuclear Reactor Chamber”, B. Sc. Thesis (Navid Bin Ahmed), Department of EEE, Independent University, Bangladesh, June, 2017.

#### **Solar Cell Fabrication and Research Division**

89. Co-supervisor: Md. Abdur Rafiq Akand, “Optimization of Focal Flow Rate To Fabricate High Efficient Solar Cell”, M. S. Thesis (Tanvir Hasan Mojumder), Institute of Energy, Dhaka University, December 2016.

90. Co-supervisor: Md. Abdur Rafiq Akand, “Comparison of Texturing Effect on The Efficiency of Solar Cell”, M. S. Thesis (Mahadev Paul), Department of Physics, Khulna University, January 2017.

**TRAINING INSTITUTE (TI), AERE**

91. Co-supervisor: Dr. Md. Nurul Islam, ‘To Study Water Uptake in Roots and The Ripening Properties of Some Plant Pods By using Neutron Radiography Technique’, Ph. D. thesis (Md. Mustafizur Rahman), Department of Physics, Jahangirnagar University, December 2016.

**INSTITUTE OF NUCLEAR MINERALS (INM), AERE**

92. Co-supervisor: Dr. Ratan Kumar Majumder, “Hydrochemical Characterization and Identification of Groundwater Quality Zone Suitable for Drinking and Domestic Purpose in Rajshahi City Corporation Area Using GIS Techniques”, Ph. D. thesis (Md. Shomser Ali), Dept. of Geology and Mining, Rajshahi University, October, 2017.
93. Co-supervisor: Md. Jamal Uddin and Dr. Ratan Kumar Majumder, “Nutritional Status of Iodine Specially Emphasis on North Western Region of Bangladesh”, M. Sc. (Project work), Maliha Siddiqua, Department of Environmental Sciences, Jahangirnagar University, Dhaka, Bangladesh.
94. Co-supervisor: Dr. Ratan Kumar Majumder, “Arsenic Contamination in Groundwater Aquifers and their Hydrogeochemistry in Jhenaidah, South-western Part of Bangladesh”, M. Sc. Thesis (Sabrina Toma), Department of Environmental Sciences, Jahangirnagar University, Dhaka, Bangladesh, March 2017.

**NATIONAL INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (NINMAS), SHAHBAG**

95. Supervisor: Prof. Sadia Sultana, “Genetic Spectrum Analysis in Patients with Congenital Hypothyroidism in a Hospital Setting in Bangladesh”, M. Phil Thesis (Dr. Tasnia Kawsar Konika), BSMMU, May 2017.
96. Supervisor: Prof. Fatima Begum, “Follow up Study of Hyperparathyroidism Patients having Previous Positive Parathyroid Scan at NINMAS”, M. Phil Thesis (Dr. Shahanaz Begum), BSMMU, May 2017.
97. Supervisor: Prof. Raihan Hussain, “Role of Peak Systolic Velocity (PSV) of Inferior Thyroid Artery (ITA) with Technetium-99m Thyroid Scan in Differentiating diffuse toxic goiter from Sub-acute thyroiditis”, M. Phil Thesis (Dr. Khaleda Mushtar), BSMMU, May 2017.
98. Supervisor: Prof. Raihan Hussain, “Assessment of Agreement Analysis Between Pretest Probability Score and Summed Stress Score of Myocardial Perfusion Imaging in Suspected and Known Cases of Coronary Artery Disease”, M. Phil Thesis (Dr. Sharmin Rahman), BSMMU, May 2017.
99. Supervisor: Prof. Raihan Hussain, “To evaluate the role of Transient Ischaemic Dilation (TID) Ratio in Gated Stress SPECT Myocardial Perfusion Imaging using Pharmacological Agents”, M. Phil Thesis (Dr. Rezoana Ahmed), BSMMU, May 2017.
100. Supervisor: Prof. Fatima Begum, “Assessment of Thyroid Antibodies (TgAbs) Level As A Prognostic Factor To Evaluate The Outcome of Differentiated Thyroid Carcinoma”, M. Phil Thesis (Dr. Shamima Yeasmin), BSMMU, May 2017.
101. Supervisor: Prof. Sadia Sultana, “Assessment of bone mineral density in nonalcoholic steatohepatitis cirrhosis”, M. Phil Thesis (Dr. Afroza Begum), BSMMU, May 2017.
102. Supervisor: Prof. Shamim Momtaz, “Role of Lymphoscintigraphy Staging in the Evaluation of Lymphedema and Comparison with Clinical Staging”, M. Phil Thesis (Dr. Meheruba Jahan), BSMMU, May 2017.

103. Co-supervisor: Prof. Dr Nurun Nahar, “Short Survey of Quality of Life in Thyroid Carcinoma Patients Receiving Long term Calcium Supplement In Postoperative Hypoparathyroidism State”, B. Pharm (Kallol Bepari), ASA University, Bangladesh, May 2017.
104. Co-supervisor: Prof. Dr Fatima Begum, “Short Survey of Quality of Life in Thyroid Carcinoma Patients Receiving Longterm Levothyroxine Replacement”, B. Pharm (Md. Sohel Rana), ASA University, Bangladesh, May 2017.
105. External-supervisor: Prof. Shamim Momtaz, “A Study on the Association of Age, Gender and Dietary Intake with Bone Mineral Density as a Risk of osteoporosis and the Prevalence of Osteoporosis among the People”, M. Sc. Thesis (Ms Nusrat Tabassum), Department of Food & Nutrition, College of Home Economics, Dhaka, National University, November, 2016.
106. External-supervisor: Prof. Shamim Momtaz, “Factors associated with Bone Mineral Density among Urban and Rural subjects of Bangladesh”, MSc Thesis (Ummay Hafsa Nadia), Department of Food & Nutrition, College of Home Economics, Dhaka, National University, November, 2016.
107. External-supervisor: Prof. Shamim Momtaz, “A Study on The Factors Associated With Bone Mineral Density Among The Women During Menopause in Bangladesh”, M. Sc. Thesis (Syema Sultana Jui), Department of Food & Nutrition, College of Home Economics, Dhaka, National University, 2017.

### Reports

108. Co-supervisor: Prof. Ferdoushi Begum, “Internship on Nuclear Medicine”, M. Sc. Report (Shahidul Hasan Saikat), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
109. Co-supervisor: Prof. Ferdoushi Begum, “Internship on Nuclear Medicine”, M. Sc. Report (Mohammad Shahadat Hossain); Department Biomedical Physics & Technology, University of Dhaka, April 2017.
110. Co-supervisor: Md. Nahid Hossain, “Internship on Nuclear Medicine”, M. Sc. Report (Md. Sohel Rana), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
111. Co-supervisor: Md. Nahid Hossain, “Internship on Nuclear Medicine”, M. Sc. Report (Md. Moinul Islam), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
112. Co-supervisor: Md. Nahid Hossain, “Internship on Nuclear Medicine”, M. Sc. Report (Aynus Tazwar Haque), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
113. Co-supervisor: Md. Nahid Hossain, “Internship on Nuclear Medicine”, M. Sc. Report (Aninda Gopesh Bappy), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
114. Co-supervisor: Md. Nahid Hossain, “Internship on Nuclear Medicine”, M.Sc Report (Risat Jasmin), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
115. Co-supervisor: Md. Nahid Hossain, “Internship on Nuclear Medicine”, M. Sc. Report (Rashida Haque), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
116. Co-supervisor: Dr. Tanvir Ahmed Biman, “Internship on Nuclear Medicine”, M. Sc. Report (M. Arsullah Al-Imran), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
117. Co-supervisor: Dr. Tanvir Ahmed Biman, “Internship on Nuclear Medicine”, M. Sc. Report (Md. Abu Billal), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
118. Co-supervisor: Dr. Tanvir Ahmed Biman, “Internship on Nuclear Medicine”, M. Sc. Report (Md. Rakib Hasan), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.
119. Co-supervisor: Dr. Tanvir Ahmed Biman, “Internship on Nuclear Medicine”, M. Sc. Report (Salah Uddin), Department of Biomedical Physics & Technology, University of Dhaka, April 2017.



120. Co-supervisor: Dr. Tanvir Ahmed Biman, “Internship on Nuclear Medicine”, M. Sc. Report (Md. Mehedi Hasan), Department Biomedical Physics & Technology, University of Dhaka, April 2017.

#### **INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), DHAKA**

121. Co-supervisor: S. Reza, “Study of Thyroid Uptake using  $^{99m}\text{Tc}$  Pertechnetate Over I-131”, Msc thesis (Rezia Sultana), Jagannath University, Department of Physics, 2017.
122. Co-supervisor: S. Reza, Study of the Exposure Rate of Radio Pharmaceuticals Applied Patients attendant at INMAS, Dhaka. Msc Thesis (Md. Ohiduzzaman), Jagannath University, Department of Physics, 2017.
123. Co-supervisor: S. Reza, Determination of Effective Dose of Thyroid Gland in Nuclear Diagnostic During Thyroid Scan, Msc Thesis (Maryam Mumu), Ganna Bishabiddalay, Savar, Dhaka, Department of Physics, 2017.

### **XV. NATIONAL/INTERNATIONAL PUBLICATIONS**

#### **ATOMIC ENERGY CENTRE (AEC), DHAKA**

##### **Accelerator Facilities Division**

##### **International**

1. M. L. Hossen, M. J. Abedin and S. Akter, “PIXE for Elemental Analysis of Domestic Medicinal Plants in Bangladesh”, International Journal of Recent Advances in Physics, Vol. 5(¾), (2016), pp. 1-8.
2. M. Ahasan, S. Akter, R. Khatun, F. Uddin, A. N. Monika, M. Rahman and M. Khanam, “Image Noise Analysis of a Large Ring PET Scanner”, International Journal of Medical Physics, Clinical Engineering and Radiation Oncology, Vol. 6, (2017), pp. 208-215.

##### **Chemistry Division**

##### **International**

3. A. J. Atanacio, D. D. Cohen, B. A. Begum, B. Ni, G. G. Pandit, S. K. Sahu, M. Santoso, D. D. Lestiani, J. M. Lim, S. A. Rahman, M. S. Elias, D. Shagjamba, A. Markwitz, S. Waheed, N. Siddique, P. C. Pabroa, F. L. Santos, M. C. S. Seneviratne, L. Handagiripathira, W. Wimolwattanapun, T. B. Voung and A. Karydas, “The APAD and ASFID: Long-Term Fine and Coarse Ambient Particulate Matter and Source Fingerprint Databases for the Asia-Pacific Region”, Air Quality and Climate Change, Vol. 50, (2016), pp. 41-49.
4. M. B. Doza, A. R. M. T. Islam, F. Ahmed, S. Das, N. Saha and M. S. Rahman, “Characterization of Groundwater Quality Using Water Evaluation Indices, Multivariate Statistics and Geostatistics in Central Bangladesh”, Water Science Journal, Vol. 30(1), (2016), pp.19-40.
5. N. Saha, M. Z. I. Molla, M. F. Alam and M. S. Rahman, “Seasonal Investigation of Heavy Metals in Marine Fishes Captured from the Bay of Bengal and the Implications for Human Health Risk Assessment”, Food Control, Vol. 70, (2016), pp.110-118.
6. M. B. Doza, A. Ahmed, M. A. Hosain, M. A. Rakib, M. A. H. Bhuiyan and M. S. Rahman, “Geospatial Assessment of Greenhouse Gas Emissions in Savar Upazila, Bangladesh”, J. Nature Sc. Sust. Technol., Vol. 10(3), (2016), pp. 251-267.
7. G. M. R. Islam, M. R. Habib, J. L. Waid, M. S. Rahman, J. Kabir, S Akter and Y. N. Jolly, “Heavy Metal Contamination of Freshwater Prawn (*Macrobrachium rosenbergii*) and Prawn Feed in Bangladesh: A market-based study to highlight probable health risk”, Chemosphere, Vol. 170, (2017), pp. 282-289.

8. Ommi, F. Emami, N. Zikova, P. K. Hopke and B. A. Begum, “Trajectory-based Models and Remote Sensing for Biomass Burning Assessment in Bangladesh”, *Aerosol and Air Quality Research*, Vol. 17, (2017), pp. 465-475.
9. N. Saha, M. S. Rahman, M. B. Ahmed and J. L. Zhou, “Industrial Metal Pollution in Water and Probabilistic Assessment of Human Health Risk”, *Journal of Environmental Management*, Vol. 185, (2017), pp. 70-78.
10. A. K. M. A. Ullah, A. K. M. F. Kibria, M. N. I. Khan, A. R. M. Tareq and S. H. Firoz, “Oxidative Degradation of Methylene Blue using  $Mn_3O_4$  Nanoparticles”, *Water Conserv. Sci. Eng.*, Vol. 1(4), (2017), pp. 249-256.

#### **National**

11. B. A. Begum, “Comparison of a Traditional Cook Stove With Improved Cook Stoves Based on Their Emission Characteristics”, *Nuclear Science and Applications*, Vol. 24, (2015, published 2017), pp. 1-4.

#### **Book Chapter**

12. Y. N. Jolly, Roksana Huque, Ashraful Islam, Safiur Rahman, Shirin Akter, Jamiul Kabir, Kamruzzaman Munshi, Mahfuza Islam, Afifa Khatun and Arzina Hossain, “Toxic Elements in Rice and Possible Health Risk Assessment - Bangladesh Prospect”, *Breeding and Genetic Engineering: The Biology and Biotechnology Research*, Chaptered, ISBN: 978-1-922227-355, Editor: iConcept Press, (2016).

#### **Electronics Division**

##### **International**

13. M. N. Islam, A. Rahman, H. Akhter, M. Begum, Y. Mawla and M. Kamal, “Study of 12KW Solar Office System at Atomic Energy Centre Chittagong”, *Int. J. of Adv. Eng., Mgt. and Sci. (IJAEMS)*, Vol. 2(7), ( 2016), pp.1033-1036.
14. M. N. Islam, H. Akhter, M. Begum, K. Asaduzzaman, M. S. Alam, M. A. S. Haque and M. Hoq, “Design and Development of a Single Channel Analyzer with Microcontroller Based Controlled Output”, *Int. J. Adv. Eng., Mgt. and Sci. (IJAEMS)*, Vol. 3(6), ( 2017), pp.638-641.

##### **National**

15. M. A. Rahman, A. A. Mamun, S. Sattar, M. Begum and A. Begum, “Design and Development of a Temperature and %Rh Remote Monitoring System with Wireless Communication”, *Journal of Bangladesh Electronics Society*, Vol. 16(1-2), (2016), pp.51-56.

#### **Experimental Physics Division**

##### **International**

16. M. M. Rahaman, K. M. A. Hussain, M. Sharmin, C. Das and S. Choudhury, “Structure, Morphology and Opto-Electrical Properties of Nanostructured Indium Doped  $SnO_2$  Thin Films Deposited by Thermal Evaporation”, *European Scientific Journal*, Vol. 12(27), (2016), pp.263-275.
17. K. M. A. Hussain, I. M. Syed and Z. H. Mahmood, “Thickness and Substrates Effect of Vacuum Evaporated Al doped ZnO (AZO) Thin Films”, *Advan. Sci. Engr. and Medicine*, Vol. 8, (2016), pp. 918-923.

##### **National**

18. M. S. Islam, C. Das, M. Sharmin, K. M. A. Hussain and S. Choudhury, “Effect of Doping Concentration on The Optical Properties of Indium doped Gallium Arsenide Thin Films”, *J. of Bangladesh Acadmic Science*, Vol. 40(2), (2016), pp. 179-186.

## Health Physics Division

### International

19. M. T. Hassan, M. S. Rahman, A. Begum, M. A. Islam and N. Ahsan, “Seasonal Variation of Terrestrial Gamma Radiation Dose and Evaluation of Annual Effective Dose in AECD Campus, Dhaka, Bangladesh”, *International Journal of Scientific Research and Management*, Vol. 4(9), (2016), pp. 4478-4486.
20. M. S. Rahman, A. Begum, A. Hoque, R. K. Khan and M. M. M. Siraz, “Assessment of Whole-Body Occupational Radiation Exposure in Industrial Radiography Practices in Bangladesh during 2010-2014”, *Brazilian Journal of Radiation Sciences*, Vol. 4(2), (2016), pp. 01-17.
21. S. Hossain, M. S. Rahman, M. A. Islam and M. H. Ahsan, “Measurement of Indoor Terrestrial Gamma Radiation Dose and Evaluation of Annual Effective Dose at AECD Campus, Dhaka, Bangladesh”, Vol. 5(3), (2017), pp. 5233-5241.
22. M. S. Sultana, A. Rahim, J. Ferdous, A. Begum and M. A. Islam, “Investigation of Anthropogenic and Naturally Occurring Radionuclides in Soil Samples of Kurigram District, Bangladesh”, *Noble International Journal of Scientific Research*, Vol. 1(1), (2017), pp. 18-29.
23. M. Begum, A. K. M. M. Rahman, H. T. Zubair, H. A. A. Rashid, Z. Yusoff, M. Begum, M. Alkhorayef, K. Alzimami and D. A. Bradley, “The Effect of Different Dopant Concentration of Tailor-made Silica Fibers in Radiotherapy Dosimetry”, *Radiation Physics and Chemistry*, Vol. 141, (2017), pp. 73-77, <https://doi.org/10.1016/j.radphyschem.2017.06.008>.

### National

24. J. Ferdous, N. Sharmin, A. Begum and A. Begum, “Airborne Radioactivity in Hot Lab of Nuclear Medicine”, *J. Sci. Res.*, Vol. 9(2), (2017), pp. 159-166.

## Material Science Division

### International

25. S. M. Hoque, M. Tariq, S. I. Liba, F. Salehin, Z. H. Mahmood, M. N. I. Khan, K. Chattopadhyay, R. Islam and S. Akhter, “Thermo-therapeutic Applications of Chitosan- and PEG-coated NiFe<sub>2</sub>O<sub>4</sub> Nanoparticles”, *J. of Nanotechnology*, Vol. 27, (2016), pp. 285702-12.
26. S. M. Hoque, Y. Huang, E. Cocco, S. Maritim, A. D. Santin, E. M. Shapiro, D. Coman and F. Hyder, “Improved Specific Loss Power on Cancer Cells by Hyperthermia and MRI Contrast of Hydrophilic Fe<sub>x</sub>Co<sub>1-x</sub>Fe<sub>2</sub>O<sub>4</sub>”, *J. Contrast Media and Molecular Imaging*, (2016), DOI: 10.1002/cmml.1713.
27. S. Akhter, M. A. Hakim, S. M. Hoque and H. N. Das, “Sintering Temperature and Composition Dependence Magnetic Properties of Cu<sub>1-x</sub>Mg<sub>x</sub>Fe<sub>2</sub>O<sub>4</sub> Ferrite”, *J. of Applied Physics*, Vol. 8(6), (2016), pp.123-129.
28. H. M. Usama, A. Sharif, M. A. Aubair, M. A. Gafur and S. M. Hoque, “Structural Transition and Its Effect in La, Zr co-substituted Monodomain BiFeO<sub>3</sub>”, *J. of Applied Physics*, Vol. 120, (2016), 214106, doi: 10.1063/1.4969047.
29. M. S. Islam, M. F. Hossain S. M. A. Razzak, M. M. Haque and D. K. Saha, “Effect of Deposition Time on Nanostructure ZnO Thin Films Synthesized by Modified Thermal Evaporation Technique”, *J. of Nanoscience and Nanotechnology*, Vol. 16, (2016), pp. 9190–9194.
30. M. S. Islam, M. F. Hossain, S. M. A. Razzak, M. M. Haque and D. K. Saha, “Fabrication and Characterization of High-Crystalline Nanoporous ZnO Thin Films by Modified Thermal Evaporation System” *International Journal of Nanoscience*, Vol. 15, (2016), pp. 6.
31. M. M. Islam, M. M. Haque and S. M. A. Islam, “Comparison of JEFF-3.1.2 and JENDL-4.0u for TRIGA MARK-II Calculation Through the Benchmarking of Integral Parameter of TRX and BAPL Lattices of Thermal Reactor”, *International J. of Energy and Power Engineering*, Vol. 6(2), (2017), pp. 6-12.

32. M. A. Ali, M. M. Uddin, M. N. I. Khan, F. U. Z. Chowdhury and S. M. Haque, “Structural, Morphological and Electrical Properties of Sn-substituted Ni-Zn Ferrites Synthesized by Double Sintering Technique”, *J. of Magnetism and Magnetic Materials*, dx.doi.org/10.2016/j.jmmm. 10.027, (2016).
33. N. Jahan, F. U. Z. Chowdhury, A. K. M. Zakaria, M. N. I. Khan, M. S. Aktar and M. A. Hakim, “Manipulation of Magnetic Properties of Cr-Substituted Ni Ferrite Synthesized by Conventional Ceramic Technique” *J. of Superconden Magn*, Vol. 30, (2017), pp. 261–268.
34. M. K. H. Bhuiyan, M. A. Gafur, M. N. I. Khan, A. A. Momin and A. K. M. A. Hossain, “Correlations of Structural, Dielectric, Magnetic and Magnetoelectric Properties of  $Ca_{1-x}Sr_x(Fe_{0.5}Ta_{0.5})O_3$  Multi Ferroic Ceramics”, *J. of Materials Sciences and Applications*, Vol. 8, (2017), pp. 64-84.
35. M. I. Khalil, R. K. Majumder, M. Z. Kabir, F. Deeba, M. N. I. Khan, M. I. Ali, D. Paul, M. A. Haydar and S. M. A. Islam, “Assessment of Natural Radioactivity Levels and Identification of Minerals in Brahmaputra (Jamuna) River Sand and Sediment, Bangladesh”, *J. of Radiation Protection and Environment*, Vol. 39, (2017), pp. 204-211.
36. M. K. H. Bhuiyan, M. A. Gafur, M. N. I. Khan, A. A. Momin and A. K. M. A. Hossain, “Correlations of Structural, Dielectric, Magnetic and Magnetoelectric Properties of  $Ca_{1-x}Sr_x(Fe_{0.5}Ta_{0.5})O_3$  Multi ferroic Ceramics”, *J. of Materials Sciences and Applications*, Vol. 8, (2017), pp. 64-84.
37. M. A. Ali, M. M. Uddin, M. N. I. Khan, F. U. Z. Chowdhury, S. M. Hoque and S. I. Liba, “Magnetic Properties of Sn-substituted Ni-Zn Ferrites Synthesized from Nono-sized Powers of NiO, ZnO, Fe<sub>2</sub>O<sub>3</sub> and SnO<sub>2</sub>”, *J. of Chin Phys*, Vol. 7(26), (2017), pp. 077501.
38. F. M. Kamal and M. N. I. Khan, “Formation of Aluminum Microsphere by Utilizing Atomic Migration”, *J. of Electrical and Electronics Engineering*, Vol. 12(3), Ver. I, (2017), pp. 64-68.

#### **National**

39. F. M. Kamal and M. N. I. Khan, “Evaluation of temperature Distribution in Micro Materials by Joule Heating”, *J. of the Bangladesh Electronic Society*, Vol. 1-2(16), (2016), pp. 69-74.

#### **Medical Physics Division**

##### **International**

40. S. Akter, R. Khatun, M. M. Ahasan, M. J. Abedin, M. F. Uddin and A. N. Monika, “Analysis of Spices Available in Local Market in Bangladesh Using Ion Beam Analysis Technique”, *IOSR Journal of Environmental Science, Technology and Food Technology (IOSR-JESTFT)*, Vol. 10(9-II), (2016), pp. 44-47.
41. S. Akter, M. M. Ahasan, M. J. Abedin, R. Khatun, M. F. Uddin and A. N. Monika, “Medicinal Plants of Bangladesh with Anti Blood Pressure Potential – A PIXE Analysis”, *International Journal of Scientific & Engineering Research*, Vol. 8(2), (2017), pp. 547- 549.
42. R. Khatun, M. Rana, M. Ahasan, S. Akter, F. Uddin, A. N. Monika and M. Ohiduzzaman, “Site Planning of a Newly Installed LINAC at BAEC, Bangladesh”, *Universal Journal of Medical Science*, Vol. 5(1), ( 2017), pp. 8-12.

#### **CENTRE FOR RESEARCH REACTOR (CRR), AERE**

##### **International**

43. M. A. Salam, A. Haque, M. M. Uddin, M. B. Shohag and M. A. MalekSoner, “Thermal Power Calibration and Error Minimization of 3 MW TRIGA Mark-II Research Reactor”, *International Journal of Scientific & Engineering Research*, Vol. 7(5), (2016), pp. 710-716.
44. M. M. Rahman and M. B. Shohag, FLEX Strategy to Cope with Extended SBO for APR1400, *International Journal of Engineering Research & Technology*, Vol. 5(10), (2016), pp. 77-81.

45. M. AjjulHoq, M. A. M. Soner, M. A. Salam, S. Khanom and S. M. Fahad, “Estimation of Na-24 Activity Concentration in BAEC TRIGA Research Reactor”, *Journal of Results in Physics*, Vol. 7, (2017), pp. 975-979.

#### **National**

46. M. M. Rahman and S. K. Dey, “Time of maximum uptake of Technetium-99m Per technetate (TcO<sub>4</sub>) in the Thyroid Gland and its Correlation with Thyroid Functional Status”, *Bangladesh Journal of Medical Physics*, Vol.8, (2017), pp. 1-6, Available Online on March 09, 2017.

### **INSTITUTE OF NUCLEAR SCIENCE AND TECHNOLOGY AND TECHNOLOGY (INST), AERE**

#### **Nuclear Radiation and Chemistry Division**

##### **International**

47. M. M. Bhuyan, N. C. Dafader, K. Hara, H. Okabe, Y. Hidaka, M. Rahman, M. M. R. Khan and N. Rahman, “Synthesis of Potato Starch-Acrylic Acid Hydrogels by Gamma Radiation and Their Application in Dye Adsorption”, *Int. J. Polym. Sci.*, Vol. 2016, (2016), pp.1-12
48. N. Rahman, N. C. Dafader, M. S. Hossen, M. F. Alam, M. Kabir and M. R. Hasan, “Gamma Ray Induced Grafting of Binary Monomers (Acrylic acid/Methyl Methacrylate) onto Polyethylene (PE) Films for Heavy Metal Adsorption”, *J. Mater. Environ Sci.*, Vol. 7(11), (2016), pp.4096-4104.
49. N. J. Nitu, M. M. I. Masum, R. Jannat, S. Sultana and M. K. A. Bhuiyan, “Application of Chitosan and Trichoderma Against Soil-Borne Pathogens and Their Effect on Yield of Tomato”, *Int. J. Biosci.*, Vol. 9(1), (2016), pp. 10-24.
50. M. D. T. Islam, N. C. Dafader, P. Poddar, M. D. Noor, S. Khan and A. M. S. Chowdhury, “Studies on Swelling and Absorption Properties of The  $\gamma$ -Irradiated Polyvinyl Alcohol (PVA)/Kappa-Carrageenan Blend Hydrogels”, *J. Adv. Chem. Eng.*, Vol. 6(2), (2016), pp. 1-6.

##### **National**

51. S. Sultana, K. Habib, M. R. Islam, N. C. Dafader, M. E. Haque and A. F. M. M. Rahman, “Study on the Swelling Behavior of Gamma Radiation Induced Acrylamide/Carboxymethyl Cellulose Blend Hydrogel in Urea Solution”, *Dhaka Univ. J. Sci.*, Vol. 64(2), (2016), pp.105-108.
52. S. Sultana, N. C. Dafader, F. Khatun, M. Rahman and J. Alam, “Foliar Application of Oligo-Chitosan Improves Morphological Character and Yield in Rice”, *Nuc. Sci. and Appl.*, Vol. 24(1&2), (2015, published 2016), pp.51-53.
53. S. Sultana, N. C. Dafader, M. H. Kabir, F. Khatun, M. Rahman and J. Alam, “Application of Oligo-Chitosan in Leaf Vegetable (Spinach) Production”, *Nuc. Sci. and Appl.*, Vol. 24(1&2), (2015), pp.55-56.
54. R. Das, M. Shajahan, M. F. Alam and A. K. M. F. Kibria, “Hydrogen Generation Characteristics and Efficiency of a Pd 80 at. % of Ni Electrocatalyst in Alkaline Medium”, *Bang. J. of Nuc. Sci. and Appl.*, Vol. 24(1&2), (2015), pp. 45-50.

##### **Internal Report**

55. M. Sonar, M. F. Alam and et al. “Quality Assessment of Reactor Cooling Water”, CRR/AR-25/2015, December 2016.

#### **Health Physics and Radioactive Waste Management Unit**

##### **International**

56. M. M. Rana, S. M. A. Islam, M. M. Islam, M. S. Rahman, S. Alam and M. A. Bari, “Comparison of 3DCRT Dose Distribution in Radiotherapy for Lung Cancer Patient by Using AAA PBC Algorithms”, *International Letters of Chemistry, Physics and Astronomy*, Vol. 68, (2016), pp 54-60.

57. K. Fatema, S. Das, K. Naher, M. A. Islam, S. M. A. Islam, S. M. Hossain and et al., “Elemental Distribution of Metals in Urban River Sediments Near an Industrial Effluent Source”, Elsevier, Chemosphere, Vol. 155, (2016), pp. 509-518.
58. M. L. Ali, M. A. Haydar, M. I. Ali, D. Paul and S. M. A. Islam, “Distribution of Natural and Probable Artificial Radioactivity Sediment and Water Samples Collected from Low-Lying Areas of Savar Industrial Zone, Bangladesh”, Journal of Nuclear and Particle Physics, Vol. 6(2), (2016), pp. 25-34.
59. M. S. Rahman and et al., “Measurement of flux-weighted average cross-sections and isomeric yield ratios for  $^{103}\text{Rh}(\gamma, xn)$  reactions in the bremsstrahlung end-point energies of 55 and 60 MeV”, The European Physical Journal, Vol. 52, (2016), pp. 2-12.
60. M. H. Rahman, “Exploring Sustainability to Feed the World in 2050”, Journal of Food Microbiology, Vol. 01(01), (2016), pp. 7-16.
61. M. I. Ali, D. Paul, A. M. Farsani and J.C.B. Navarro, “Conditioning of Disused Sealed Radioactive Sources (DSRSs) in Bangladesh: Recent Experience and Lessons Learned”, IAEA-CN-242, pp. 55-60.
62. R.N. Sruti, M. M. Islam and M. M. Rana, M. M. H. Bhuiyan, M. A. Khan, M. K. Newaz and M. S. Ahmed, “Measurement of Percentage Depth Dose of a Linear Accelerator for 6 MV and 10 MV Photon Energies”, Nuclear Science and Applications, Vol. 24(1&2), (2015, published 2016), pp. 29.

#### **National**

63. M. S. Rahman and et al., “Responses of LiF Thermoluminescence Dosimeters to  $^{60}\text{Co}$  Teletherapy Beams”, Bangladesh Journal of Medical Physics, Vol. 8, (2015), pp. 14-21.

#### **Internal Report**

64. M. H. Bhuiyan, M. H. Rahman and M. Shamsuzzaman, “Report on Radiation Dose Measurement of Irradiated Soil Samples from IIT, India at Rabbit System of BAEC Center for Research Reactor (CRR)”, Report No. HPRWMU-18/2016, August-2016.
65. M. Shamsuzzaman, B. C. Sutradhar and M. H. Rahman, “Radiation Monitoring for the Occupational Safety during I-131 & Tc-99m at RIPD”, Report No. HPRWMU-19/2016, September-2016.
66. M. M. Islam, M. H. Bhuiyan and M. H. Rahman, “Report on “Inspection Report on "Disused/Spent Sealed Radioactive Source  $^{137}\text{Cs}$  at Chevron Block Twelve Ltd., Bibiyana Gas Field, Habigonj, Bangladesh”, Report No. HPRWMU-20/2016, August-2016.
67. M. M. Islam, M. H. Bhuiyan and M. H. Rahman, “Inspection Report on "Disused/Spent Sealed Radioactive Source  $^{137}\text{Cs}$  at Chevron Block Twelve Ltd., Bibiyana Gas Field, Habigonj”, Report No. HPRWMU-21/2016, August-2016.
68. M. M. Islam, M. H. Bhuiyan and M. H. Rahman, “Inspection Report on "Disused/Spent Sealed Radioactive Source H-3 and Neutron Generator Tube at Chevron Block Twelve Ltd., Bibiyana Gas Field, Habigonj." Report No. HPRWMU-22/2016, August-2016.
69. M. M. Islam, M. H. Bhuiyan and M. H. Rahman, “Inspection Report on "Disused/Spent Sealed Radioactive Source  $^{137}\text{Cs}$  at Chevron Block Twelve Ltd., Bibiyana Gas Field, Habigonj”, Report No. HPRWMU-23/2016, August-2016.
70. M. M. Islam, M. H. Bhuiyan and M. H. Rahman, “Inspection Report on "Disused/Spent Sealed Radioactive Source Am-Be 241 at Chevron Block Twelve Ltd., Bibiyana Gas Field, Habigonj”, Report No. HPRWMU-24/2016, August-2016.
71. M. M. Islam, M. H. Bhuiyan and M. H. Rahman, “Inspection Report on "Disused/Spent Sealed Radioactive Source Am $^{241}$  at Chevron Block Twelve Ltd., Bibiyana Gas Field, Habigonj." Report No. HPRWMU-25/2016, August-2016.
72. M. M. Islam, M. H. Bhuiyan and M. H. Rahman, “Inspection Report on "Disused/Spent Sealed

- Radioactive Source Am-241 at Chevron Block Twelve Ltd., Bibiyana Gas Field, Habigonj." Report No. HPRWMU-26/2016, August-2016.
73. M. H. Bhuiyan and M. Shamsuzzaman, "Report on IAEA/WHO Therapy Level Annual TLD Postal Dose Quality Audit-2016 for the Dosimetry System of SSDL" Report No. HPRWMU-27/2016, August-2016.
  74. D. Paul and B. C. Sutradhar, "Inspection Report on Disused Sealed Radioactive Co-60 Source of BSRM Iron & Steel Co. Ltd. 202-205, Nasirabad Industrial Area, Baizid Bostami Road, Chittagong", Report No. HPRWMU-28/2016, August-2016.
  75. D. Paul, M. I. Ali, M. A. Hayde and B. C. Sutradhar, "Radiation Protection Service Provided During the Retrieval Work of the Stuck Gamma Irradiation Source at the Co-60 Gamma Source Plant of the Institute of Radiation and Polymer Technology (IRPT), AERE, Savar", Report No. HPRWMU-29/2016, August-2016.
  76. M. Shamsuzzaman and M. A. Hayder, "Inspection Report on Sealed Radioactive Cs-137 of Chevron Bangladesh Block Seven Ltd", Report No. HPRWMU-30/2016, September-2016.
  77. Dr. Md. Shamsuzzaman and Md Abu Hayder, "Inspection Report on Sealed Radioactive Source Am-241-Be of Chevron Bangladesh Block Seven Ltd", Report No. HPRWMU-31/2016, September-2016.
  78. M. Shamsuzzaman and M. H. Bhuiyan, "Report on Calibration of Therapy Level Ionization Chambers of Khwaja Yunus Ali Medical College & Hospitals in terms of Absorbed Dose-to-water Calibration Coefficient (ND,W)", Report No. HPRWMU-32/2016, September-2016.
  79. M. H. Bhuiyan and D. Paul, "Training Course on Radiation Protection for Radiation Worker and RCO's of BAEC & Others, Training Institute, AERE, Savar, Organized by HPRWMU, 28 August-1st September 2016", Report No. HPRWMU-33/2016, September-2016.
  80. B. C. Sutradhar, "Safe Collection, Transport and Storage of Disused Sealed Radioactive Co-60 Source from BSRM Iron & Steel Co. Ltd. 202-205, Nasirabad Industrial Area, Baizid Bostami Road, Chittagong", Report No. HPRWMU-34/2016, September-2016.
  81. D. Paul and M. A. Hayder, "Report on the Radiation Protection Status of the Co-60 Teletherapy Unit of Ahsania Mission Cancer and General Hospital Uttara Model Town, Dhaka", Report No. HPRWMU-35/2016, October-2016.
  82. M. Shamsuzzaman, B. C. Sutradhar and M. H. Rahman, "Workplace Radiation Survey at the Strategic Location of the Radioisotope Facility for Occupational Safety", Report No. HPRWMU-36/2016, November-2016.
  83. D. Paul, M. I. Ali, M. A. Hayder and B. C. Sutradhar, "Report on the Disposal of the Biological Waste Sample (Rat) of HPRWMU, INST, AERE, Savar, Dhaka", Report No. HPRWMU-37/2016, November-2016.
  84. M. Shamsuzzaman, B. C. Sutradhar and M. H. Rahman, "Assessment of Occupational Radiation Safety During Production of I-131 and Tc-99m Radioisotopes at the RIPD", Report No. HPRWMU-38/2016, November-2016
  85. M. A. Hayder and B. C. Sutradhar, "Report on Radiation Protection Services During the Visit of Honorable Professor Dr. A. F. M. Ruhul Haque, MP and President of the Ministry of Science and Technology Related Permanent Steering Committee to Different Divisions of Atomic Energy Research Establishment (AERE)", Report No. HPRWMU-39/2016, November-2016.
  86. M. Shamsuzzaman, B. C. Sutradhar and M. H. Rahman, "Report on Radiation Safety Evaluation During Production of I-131 and Tc-99m Radioisotopes", Report No. HPRWMU-40/2016, November-2016.
  87. S. M. Some, M. I. Ali and D. Paul, "Report on IAEA-National Workshop on the Development of Radioactive Waste Management Strategies of Bangladesh", Report No. HPRWMU-41/2016,

December-2016.

88. M. H. Rahman, B. C. Sutradhar, K. Fatema and M. Shamsuzzaman, “Report on Verification of Radiation Safety During Production and Transportation of I-131 and Tc-99m Radioisotopes”, Report No. HPRWMU-42/2016, December-2016.
89. M. H. Rahman, B. C. Sutradhar and M. Shamsuzzaman, “Report on Strategic Workplace Radiation Monitoring to Estimate the Occupational Safety as per the ALARA Principle During Radioisotope Production at RIPD”, Report No. HPRWMU-43/2016, December-2016.
90. D. Paul, M. I. Ali and M. A. Hayder, “Report on The Radiation Protection Status of the Linear Accelerator (LINAC) Unit of Ahsania Mission Cancer & General Hospital, Uttara Model Town, Dhaka”, Report No.-HPRWMU-44/2016, December-2016.
91. D. Paul, M. I. Ali and M. A. Hayder, “Report on The Radiation Protection Status of the Linear Accelerator (LINAC) Unit of Enam Medical College & Hospital, Savar, Dhaka”, Report No. HPRWMU-45/2016, December-2016.
92. D. Paul, M. I. Al and M. A. Hayder, “Report on Radiation Protection Status of the CT Simulator Unit of Enam Medical College & Hospital, Savar, Dhaka”, Report No. HPRWMU-46/2016, December-2016.
93. K. Fatema and S. M. Some, “Report on Radiation Protection and Demonstration to the Visitors During Visit of the Health Physics and Radioactive Waste Management Unit (HPRWMU), INST, AERE”, Report No. HPRWMU-47/2016, December-2016.
94. M. H. Rahman, B. C. Sutradhar and M. Shamsuzzaman, “Report on Workplace Radiation Survey for the Occupational Safety During Radioisotope Production and safe transport of I-131 and Tc-99m Radioisotope at RIPD”, Report No. HPRWMU-48/2016, December-2016.
95. M. H. Rahman, B. C. Sutradhar and M. Shamsuzzaman, “Report on Workplace Radiation Survey for the Occupational Safety During Radioisotope Production and safe transport of I-131 and Tc-99m Radioisotope at RIPD”, Report No. HPRWMU-49/2016, December-2016.
96. M. H. Rahman, B. C. Sutradhar and M. Shamsuzzaman, “Report on Workplace Radiation Survey for the Occupational Safety During Radioisotope Production and safe transport of I-131 and Tc-99m Radioisotope at RIPD”, Report No. HPRWMU-50/2016, December-2016.
97. M. H. Rahman, B. C. Sutradhar, M. Shamsuzzaman and M. L. Ali, “Radiation Survey During Production of I-131 and Tc-99m Radioisotope to verify Occupational Safety at Radioisotope Production Division, RIPD, INST, AERE”, Report No. HPRWMU-01/2017, February-2017.
98. M. H. Rahman, M. L. Ali, S. M. Some, S. Paul, M. Begum and M. H. Bhuiyan, “Report on Radiation Dose Measurement of Irradiated Soil and Mongolian Coal Fly Ash Samples at Rabbit System of TRIGA Mark-II Research Reactor, CRR, BAEC”, Report No. HPRWMU-02/2017, March-2017.
99. M. H. Rahman, B. C. Sutradhar, M. L. Ali and M. Shamsuzzaman, “Radiation Safety Features for Production and Transportation of I-131 and Tc-99m Radioisotopes, RIPD, INST, AERE”, Report No. HPRWMU-03/2017, April-2017.
100. M. H. Bhuiyan, S. Paul and B. C. Sutradhar, “Report on Cleaning of Specimen Rack and Aluminum Housing of Lazy Susan Assembly of TRIGA Mark-II Research Reactor, CRR, BAEC”, Report No. HPRWMU-04/2017, April-2017.
101. M. Shamsuzzaman and M. A. Hayder, “Inspection, Collection and Safe Storage of  $^{252}\text{Cf}$  Radioactive Source of Nuclear Minerals Institute of AERE, Savar, Dhaka”, Report No. HPRWMU-05/2017, April-2017.
102. M. H. Rahman, S. Paul and M. H. Bhuiyan, “Radiation Dose Measurement of Irradiated Sediment Samples of Turag River at Rabbit System of TRIGA Mark-II Research Reactor, CRR, BAEC”, Report No. HPRWMU-06/2017, April-2017.



103. M. H. Rahman, B. C. Sutradhar, T. Siddiqua and M. Shamsuzzaman, “Report on Workplace Radiation Survey for the Occupational Safety During Radioisotope Production and safe transport of I-131 and Tc-99m Radioisotope at RIPD”, Report No. HPRWMU-07/2017, April-2017.
104. T. Siddiqua, M. Shamsuzzaman, M. H. Bhuiyan and M. S. Rahman, “Dosimetric Calibration Service of Multiple Photon Beams (6. 10, 15) of LINAC Machine of ENAM Medical College & Hospital Using SSDL Dosimetry System”, Report No.-HPRWMU-08/2017, April-2017.
105. K. Fatema, B. C. Sutradhar and M. H. Rahman, “Report on Radiation Dose Level of Irradiated Sediment Samples at at Rabbit System of TRIGA Mark-II Research Reactor, CRR, BAEC”, Report No. HPRWMU-09/2017, May-2017.
106. M. H. Rahman, B. C. Sutradhar and M. Shamsuzzaman, “Strategic Radiation Survey for the Occupational Safety During Production and Transportation of I-131 and Tc-99m Radioisotopes, RIPD, INST, AERE”, Report No. HPRWMU-10/2017, May-2017.
107. B. C. Sutradhar, K. Fatema and S. Paul, “Report on Radiation Dose Level of Irradiated Sediment Samples at at Rabbit System of TRIGA Mark-II Research Reactor, CRR, BAEC”, Report No. HPRWMU-11/2017, June-2017.
108. K. Fatema, “Report on Radiation Dose Level of Irradiated Sediment Samples at Rabbit System of TRIGA Mark-II Research Reactor, CRR, BAEC”, Report No. HPRWMU-12/2017, June-2017.
109. K. Asaduzzaman and M. A. Hayder, “Report on the Radiation Protection Status of the Linear Accelerator (LINAC) Unit of Apollo hospital, Dhaka”, Report No.-HPRWMU-13/2017, June-2017.
110. M. Shamsuzzaman and M. A. Hayder, “Assessment of Radioactivity in Metallic Radioactive Substances Recovered From The Construction Site at Rajdhani Preparatory School, Rayer Bazer, Washpur Kheaghat (Bosila), Mohammedpur, Dhaka”, Report No. HPRWMU & HPD-01/2017, June-2017.
111. M. Begum and S. Paul, “Report on Radiation Dose Level of Irradiated Turag River Sediment Samples at Rabbit System of CRR”, Report No. HPRWMU-15/2017, June-2017.

### **Reactor Physics and Engineering Division**

#### **International**

112. M. Asaduzzaman, S. M. A. Islam, M. J. H. Khan and M. S. Hossain”, Analysis of Individual Fuel Element Burnup and Core Burnup Lifetime of BAEC TRIGA Core Using TRIGAP Code”, International Journal for Research in Applied Science & Engineering Technology, Vol. 4 (VIII), (2016), pp. 473-479.
113. M. J. H. Khan, M. M. Rana and S. M. A. Islam”, Analysis of Power Peaking Factors of 3 MW TRIGA Mark-II Research Reactor using the Deterministic Diffusion Code SRAC-Citation”, International Journal for Research in Applied Science & Engineering Technology, Vol. 5 (VI), (2017), pp. 390-396.

#### **National**

114. M. M. Rana, M. J. H. Khan and M. M. Sarker, “A Study for Obtaining a Better Core Configuration of The TRIGA Mark-II Research Reactor”, Military Institute of Science and Technology (MIST), Journal of Science and Technology, Vol.4 (1), (2016), pp. 44-52.

#### **Internal Report**

115. R. Yasmeen, M. S. Mahmood, M. J. H. Khan, N. H. Badrun, M. H. Altaf and S. M. Shauddin, “Neutron and Photon Current Estimation at Different Beam Ports of TRIGA Reactor”, INST-142/RPED-40, November, 2016.

## **Tandem Accelerator Facilities Division**

### **International**

116. M. S. Uddin, K. S. Kim, M. Nadeem, S. Sudar and G. N. Kim, “Excitation Functions of Alpha Particle Induced Reaction on Natnifrom Threshold to 44 MeV”, *Eur. Phys. J., A* 53, (2017), pp. 100.
117. F. Tárkányi, F. Ditrói, S. Takács, J. Csiki, A. Hermanne, M.S. Uddin and M. Baba, “Activation Cross Sections of Proton Induced Nuclear Reactions on Palladium Upto 80 MeV”, *Appl. Radiat. Isot.*, Vol. 114, (2016), pp. 128-144.
118. M. S. Uddin and B. Scholten, “Excitation Functions of Alpha Particle Induced Reaction on Natti Upto 40 MeV”, *Nucl. Instr. Metod. Phys. Res., B*, Vol. 380, (2016), pp. 15-19.
119. M. R. Rahman, M. O. Rahman, M. A. Shariff, M. S. Uddin, M. M. Hasan and M. A. Shameem, “PIXE Analysis of Some Environmental Samples From Selected Saline Region of Bnagldesh”, *Int. J. Envir. Sci. Development*, 7(1), (2016), pp. 16-21.
120. M. R. Rahman, M. O. Rahman, M. A. Shariff, M. S. Uddin and M. M. Hasan, “Heavy Metal Contamination in Agricultural Soil of South-Western Seashore Area in Banglades”, *Int. Jour. of Agriculture and Environmental Research*, Vol. 3(2), (2017), pp. 2584-2599.

### **National**

121. M. S. Uddin, N. Afroz, M. A. Islam and M. K. Newaz, “Cross Section of the  $^{159}\text{Tb}(n,\gamma)^{160}\text{Tb}$  Reaction at 0.0536eV Energy, Nuclear Science and Applications”, Vol. 24 (1&2), (2015), pp. 5-8.

## **Reactor and Neutron Physics Division**

### **International**

122. M. A. H. Chowdhury, M. M. Hoque, S. M. Hossain, K. Naher, M. A. Islam, U. Tamim, K. M. S. Alam and R. Khan, “Analysis of Heavy Metals and Other Elements in Textile Waste Using Neutron Activation Analysis and Atomic Absorption Spectrophotometry”, *Journal of Environmental Science, Toxicology and Food Technology*, Vol. 11, (2017), pp. 14-23.
123. R. K. Majumder, M. I. Khalil, S. Karmaker, R. Khan, S. Das, M. A. Rahman and M. N. Zaman, “Uranium potentiality of sandstones collected from north-eastern part of Bangladesh”, *J. East China Univ, Technol.*, Vol. 39, (2016), pp. 25-31.
124. U. Tamim, R. Khan, Y. N. Jolly, K. Fatema, S. Das, K. Naher, M. A. Islam, S. M. A. Islam and S. M. Hossain, “Elemental distribution of metals in urban river sediments near an industrial effluent source”, *Chemospher*, Vol.155, (2016), pp. 509-518.

### **National**

125. F. Hossain, M. A. Islam, A. A. Mamun, K. Naher, R. Khan, S. Das, U. Tamim, S. M. Hossain, F. Nahid and M. A. Islam, “Assessment of trace contaminants in sediments of the poshur river nearby Mongla Port of Bangladesh”, *Nuclear Science and Applications* 25 (2014, published 2016), pp. 7-11.

## **INSTITUTE OF NUCLEAR MINERALS (INM), AERE**

### **International**

126. S. A.Simu, T. Sikder, M. J. Uddin, F. Deeba, M. A. Kashem, K. P. Mondal, M. Akter, M. Rahman and S. Banik, “Monitoring of heavy metal pollution and GIS derived land use changes in the major economic zone of Bangladesh”, *Sustainable Water Resources Management*, DOI 10.1007/s40899-017-0151-2, Springer International Publishing, AG 2017.
127. R. K. Majumder, M. I. Khalil, S. Karmaker, R. Khan, S. Das, M. A. Rahman and M. N. Zaman, “Uranium Potentiality of Sandstones Collected from North-Eastern Part of Bangladesh”, *Journal of East China University of Technology*, Vol. 39, (2016), pp. 25-31.

128. M. Rajib and C. T. Oguchi, “Adsorption of  $^{133}\text{Cs}$  and  $^{87}\text{Sr}$  on pumice tuff: A comparative study between powder and intact solid phase”, *Acta Geochimica*, doi:10.1007/s11631-016-0133-3 (2017).

## **INSTITUTE OF FOOD AND RADIATION BIOLOGY (IFRB), AERE**

### **Agrochemical and Environmental Research Division**

#### **International**

129. M. I. Muhib, M. A. Z. Chowdhury, N. J. Easha, M. M. Rahman, M. Shammi, Z. Fardous, M. L. Bari, M. K. Uddin, M. Kurasaki and M. K. Alam, “Investigation of heavy metal contents in Cow milk samples from area of Dhaka, Bangladesh”, *International Journal of Food Contamination*, Vol. 3, ((2016)), pp. 16, DOI 10.1186/s40550-016-0039-1, Springer.
130. T. Sarkar, M. M. Alam, N. Parvin, Z. Fardous, A. Z. Chowdhury, S. Hossain, M. E. Haque and N. Biswas, “Assessment of heavy metals contamination and human health risk in shrimp collected from different farms and rivers at Khulna-Satkhira region, Bangladesh”, *Elsevier, Toxicology Reports*, Vol. 3, (2016), pp. 346-350.

#### **National**

131. M. A. Uddin, M. A. Z. Chowdhury, Z. Fardous and M. Hasanuzzaman, “Quantification of pesticide residue in some soils in Norshindi area”, *The Bangladesh journal of scientific research*, Vol. 29(1), (2016), pp. 85-88.

### **Food Technology Division**

#### **International**

132. A. Khatun, A. Hossain, M. Islam, K. Munshi, A. Akter, B. Rahman and R. Huque, “Evaluation of gamma irradiation and boiling treatment on antioxidant status in different spices”, *Journal of Food Process Engineering*, (2016), pp. 1-7. DOI 10.1111/jfpe.12482.
133. A. Hossain, A. Khatun, M. K. Munshi, M. S. Hussain, M. Islam, A. Hossain and R. Huque, “Study on antibacterial and antioxidant activities of raw and fermented *Moringa Oleifera* lam. Leaves”, *Journal of Microbiology and Biotechnology Research*, Vol. 6 (4), (2016), pp. 23-29.
134. M. Islam, A. Hossain, M. K. Munshi, A. Khatun, M. A. Hossain, R. Noor and R. Huque, “Microbial status of street vended fresh-cut fruits, salad vegetables and juices in Dhaka city of Bangladesh”, *International Food Research Journal*, Vol. 23(5), (2016), pp. 2258-2264.
135. S. Sultana, M. A. Shariff, M. A. Hossain, A. Khatun and R. Huque, “Effect of Super water absorbent (SWA) hydrogel on productivity and quality of tomato”, *Archives of Applied Science Research*, Vol. 8 (10), (2016), pp. 5-9.
136. F. Mridha, R. Huque, A. Khatun, M. Islam, A. Hossain, M. A. Hossain and M. S. Kabir, “Effects of gamma irradiation on antioxidant markers, microbial population and sensory attributes of strawberry (*fragaria × ananassa* Duch.) cv. Festival”, *Plant Cell Biotechnology and Molecular Biology*, Vol. 18(5&6), (2017), pp. 208-218.
137. A. A. Sajib, M. A. I. Bhuiya and R. Huque, “A simple, efficient and rapid method for good quality DNA extraction from rice grains”, *Rice Science*, Vol. 24(2), (2017), pp. 119–122.
138. Madumita, P. C. Banik, R. Mondal, M. A. Rahman, M. A. M. Khan, “Assessment of nutritional status of a Government Girls Orphanage in Tangail district of Bangladesh”, *SMU Medical Journal*, Vol. 4(1), (2017), pp. 79-87.

## **Gamma Source Division**

### **International**

139. M. F. Mortuza, M. H. Rahman, M. H. Rahman, A. Nahar, M. R. I. Khan, A. K. M. M. Hasan and M. Rahman, “Isolation, biochemical and genetic characterization of extracellular protease producing cattle hide dehairing bacterium - A potential alternative to chemical dehairing”, *Ecological Genetics and Genomics*, Vol. 2, (2017), pp. 3-12.

### **Insect Biotechnology Division**

#### **National**

140. M. Hossain and M. Khan, “Effect of adult diets on the longevity of sterile oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) Establishment Campus, Ganak-Bari, Savar. Bangladesh”, *Bangladesh J. of Entomol.*, rVol. 26(2), (2016), pp. 29-35.
141. M. Khan, M. A. Bari, M. Hossain, D. Kovac, A. Freidberg, J. Royer and D. L. Hancock, “Preliminary Survey of Bamboo-Shoot Flies, (Diptera: Tephritidae: Acanthonevrini, Gastrozonini) with Four New Records from Bangladesh”, *TAAO (Tephritid workers of Asia, Australia and Oceania) Newsletter*, (October, 2016.), pp. 7-8.

### **Microbiology and Industrial Radiation Division**

#### **International**

142. J. P. Tan, J. M. Jahim, S. Harun, T. Y. Wu and T. Mumtaz, “Use of Corn Steep Liquor as an economical nitrogen source for biosuccinic acid production by *Actinobacillus succinogenes*”, *Earth and Environmental Science*, Vol. 36, Conference 1.
143. R. Begum, M. A. K. Sarker, M. A. Islam, M. K. Alam and M. K. Pramanik, “Isolation and Characterization of Lactic Acid Bacteria from Indigenous Dairy Product and Preparation of Starter Culture by Freeze-drying, *Bioresearch Communication*, Vol. 3(1), (2017), pp. 302-308.
144. K. M. Elsayed, M. R. Islam, A. A. Mahin, J. Nagao, T. Zendo and K. Sonomoto, “Lia RS reporter assay: A simple tool to identify lipid II binding moieties in lantibiotic nukacin ISK-1”, *J Bioscience and Bioengineering*, Vol. 123(3), (2017), pp. 398–401.
145. M. S. Hossain, A. A. Mahin, S. Momin, M. A. A. Rahman, M. S. Hussain and R. Islam, “Bioconversion of water-hyacinth to nutritionally enriched animal feed by solid state fermentation using *Pleurotus sajor-caju*. *Journal of Microbiology*”, *Biotechnology and Food Science*, Vol. 6(5), (2017), pp. 1165-1169.
146. H. M. Shamim, M. S. Hussain and A. A. Mahin, “Solid-state Fermentation of Coconut Coir by *Pleurotus sajor-caju* Increases the Anti-oxidant Properties and Nutritional Value”, *Biotechnology*, Vol.15, (2016), pp. 141-147.
147. A. A. Mahin, M. M. A. Khokon, M. Z. Hasan, Z. U. M. Khan, S. A. Mahmud and H. O. Rashid, “Radiation preservation of hog-plum (*Spondias pinnata*) in combination with chemicals”, *Am. J. Food Technol.*, Vol. 11, (2016), pp. 221-227.

#### **National**

148. M. F. Mansor, J. M. Jahim, T. Mumtaz, R. A. Rahman and S. A. Mutalib, “Development of a methane free, continuous biohydrogen production system from palm oil mill effluent (POME) in CSTR”, *Journal of Engineering Science and Technology*, Vol. 11(8), (2016), pp. 1174-1182.
149. M. K. Pramanik, A. B. Miah and M. K. Alam, “Disinfection of archived material by radiation processing technology keeping the material integrity”, *Bangladesh Journal of Microbiology*, Vol. 33(1), (2016), pp. 01-04.

## **INSTITUTE OF TISSUE BANKING AND BIOMATERIALS RESEARCH (ITBBR), AERE**

### **International**

150. M. S. Rahman, H. M. Jamil, N. Akhtar, R. Islam, M. M. Rana, S. M. A. Awal and S. M. Asaduzzaman, “Cancer Epigenetics and Epigenetical Therapy”, *Journal of Experimental and Integrative Medicine*, Vol. 6(3), (2016), International, Peer-reviewed, ISSN: 1309-4572.
151. S. Chatterjee, M. Haque, M. S. Rahman, H. M. Jamil, N. Akhtar, S. M. A. Awal, M. S. Rahman and S. M. Asaduzzaman, “Conservation Pattern, Homology Modeling and Molecular Phylogenetic Study of BMP Ligands”, *Trends in Bioinformatics*, Vol. 9, (2016), pp. 70-80, Doi: <http://dx.doi.org/10.3923/tb>.

## **INSTITUTE OF ENERGY SCIENCE (IES), AERE**

### **International**

152. N. Jahan, M. M. Rahman, M. Q. Huda and S. M. Seo, “Sub-critical measurement with source term for research reactor in inverse kinetics method”, *W. J. Nucl. Sci. Technol.*, Vol. 7, (2017), pp. 129-135.
153. N. Jahan, M. M. Rahman and M. Q. Huda, “Neutron flux signal acquisition from plant instrumentation channel of research reactor for reactivity calculation”, *W. J. Nucl. Sci. Technol.*, Vol. 7 (2017), pp. 145-154.
154. M. M. Rahman, J. Dongxu, M. S. Beni, H. C. Hei, W. He and J. Zhao, “Supercritical water heat transfer for nuclear reactor applications: A review”, *Ann. Nucl. Energy*, Vol. 97, (2016), pp. 53-65.

### **Internal Report**

155. N. Jahan, M. M. Rahman, M. Q. Huda and S. M. Seo, “Determination of Neutron Source Strength for Sub-critical Reactivity Measurement”, Report No. EI-27/NED-27, Nuclear Energy Division (NED), Institute of Energy Science, June 2016.
156. N. Jahan, M. M. Rahman, M. Q. Huda and S. M. Seo, “Digital Time-series reactivity measurement system for Reactor TRIGA Puspati”, Report No. EI-28/NED-28, Nuclear Energy Division (NED), Institute of Energy Science, June 2016.

## **INSTITUTE OF RADIATION AND POYMER TECHNOLOGY (IRPT), AERE**

### **International**

157. R. A. Khan, H. J. Salem, R. Korehei, M. Martinez and J. A. Olson, “Fractionation and Characterization of Bleached Pulp Fibres: Application on Sodium Alginate Films”, *Canadian Journal of Chemical Engineering*, Vol. 95( 1), (2017), pp. 33-38.
158. M. T. Islam Bosssunia, P. Poddar, M. M. Hasan, M. T. Hossain, F. Gulenoor, R. A. Khan and S. Chowdhury, “Gamma Irradiated Jute Reinforced Polypropylene Composites: Effect of Mercerization and SEM Analysis”, *Journal of Material Science and Engineering*, Vol. 5(4) (2016), pp. 1-6.
159. L. N. Hilary, I. Z. Luna, M. A. Gafur and R. A. Khan, “Preparation and Mechanical Characterization of Polyester Resin/China Clay Nano-composites”, *European Journal of Pure and Applied Chemistry*, Vol. 3(1), (2016), pp. 49-57.
160. M. Islam, M. Razzak, M. Karim and A. H. Mirza. “H-bond plays key role in the synthesis of stable hemiaminals”, *Tetrahedron Letters*, Vol. 58(15), (2017), pp. 1429–1432.
161. Z. A. Zianor Azrina, M. D. H. Beg, M. Y. Rosli., R. Ramli, N. Junadi and A. K. M. Moshikul Alam, “Spherical nano crystalline cellulose (NCC) from oil palm empty fruit bunch pulp via ultrasound assisted hydrolysis”, *Carbohydrate Polymers*, (2017), DOI: 10.1016/j.carbpol.2017.01.035.
162. A. K. M. M. Alam, M. H. Beg, R. M. Yunus, M. F. Mina, K. H. Maria and T. Mieno, “Evolution of Functionalized Multi-Walled Carbon Nanotubes by Dendritic Polymer Coating and their Anti-Scavenging Behavior during Curing Process”, *Materials Letters*, Vol. 167, (2016), pp.58–60.

163. A. K. M. M. Alam, M. H. Beg and A. R.M. Yunus, “Micro Structure and Fractography Of Multiwalled Carbon Nanotube Reinforced Unsaturated Polyester Nanocomposites” J Polymer Composites, (2016), DOI: 10.1002/pc.23911.
164. M. Bijarimi, S. Ahmad and A. K. M. M. Alam, “Toughening Effect of Liquid Natural Rubber on the Morphology and Thermo-Mechanical Properties of the Poly (Lactic Acid) Ternary Blend”, Polymer Bulletin, (2016), DOI: 10.1007/s00289-016-1889-7.
165. S. Jesmin, A. A. Jubayer, S. B. Eusuf, A. H. M. Kamal, J. M. M. Islam, F. Ferdoush, S. E. Kabir and M. A. Khan, “Gamma Radiation Treated Chitosan Solution for Strawberry Preservation: Physico-Chemical Properties and Sensory Evaluation”, International Letters of Natural Sciences, Vol. 60, (2016), pp 30-37.

#### **Book**

166. R. A. Khan, K. D. Vu and M. Lacroix, Book Chapter -16, Title: Biodegradable and Bioactive Polymeric Coatings and Films for Food Packaging: Preparation, Characterization and Application. Book Name: The Radiation Chemistry of Polysaccharides, International Atomic energy Agency (IAEA), Vienna, (2016), pp. 419-460.

### **INSTITUTE OF ELECTRONICS (IE), AERE**

#### **General Electronics Division**

##### **International**

167. M. Hasan, K. G. Martuza, T. S. Roy, A. Mehbub, H. Kabir, F. Hafiz, F. Akter, M. Hoq and M. A. M. Chowdhury, “Design and Development of Floor Contamination Monitor for Gamma Ray Measurement”, International Journal of Research in Electronics & Communication Technology, Vol. 4(6), (2016), pp. 23-30, ISSN Online: 2347-6109 , www.iaster.com

##### **Internal Report**

168. M. F. Pervez, F. Hafiz, F. Akter, M. A. S. Haque, M. Hoq and A. A. Mortuza, “Challenges in the measurement of Pico-current with microcontroller based LCD display”, Report No. IE-53/ GED-18, November 2016.
169. M. F. Pervez, A. A. Mortuza, M. K Hossain, F. Hafiz, F. Akter, S. Sultana, N.H. Mia, S. M. Rana, M. A. S. Haque and M. Hoq, “Software implementation of UART Transmitter General Purpose I/O Pin for Sensor Node”, Report No. IE-55/ GED-18, November 2016.

#### **Nuclear Electronics Division**

##### **International**

170. M. Hasan, K. G. Martuza, T. S. Roy, A. Mehbub , H. Kabir , F. Hafiz , F. Akter , M. Hoq and. M. A. M. Chowdhury, "Design and Development of Floor Contamination Monitor for Gamma Ray Measurement", International Journal of Research in Electronics & Communication Technology, Vol. 4(6), (2016), pp. 23-30, DOA: 03012017. IASTER 2016, www.iaster.com.
171. M. Firoz Pervez, A. A. Mortuza , M. H. Ali, M. A. S. Haque , H. K. Ghosh and M. Hoq, “Novel Scanning Technique for LED Dot-Matrix Display to Reduce Flicker”, Electrical and Electronic Engineering, Vol. 6(2), (2016), pp. 19-24, DOI: 10.5923/j.eee.20160602.01.

#### **Robotics Instrumentation and Control Division**

##### **International**

172. M. K. H. Jewel, M. N. Mostakim, M. K. Rahman, M. S. Ali, S. D. Hossain, M. K. Hossain and H. K. Ghosh, “Design and Development of a Versatile and Intelligent Home Security System”, International Journal of Engineering and Manufacturing, Vol. 4, (2017), pp. 60-72.

173. A. S. M. S. Hasan, M. K. H. Jewel, M. N. Mostakim, N. H. Bhuiyan, M. K. Rahman, S. D. Hossain and M. K. Hossain, "Smartphone Controlled Spy Robot with Video Transmission and Object Collector", *International Journal of Engineering and Manufacturing*, (2017), (Accepted).

#### **National**

174. M. K. Hossain, M. F. Pervez, M. N. H. Mia, A. A. Mortuza, M. S. Rahaman, M. R. Karim, J. M M. Islam, F. Ahmed and M. A. Khan, "Effect of Dye Extracting Solvents and Sensitization Time on Photovoltaic Performance of Natural Dye Sensitized Solar Cells", *Results in Physics*, Vol., 7, (2017), pp. 1516–1523, DOI: 10.1016/j.rinp.2017.04.011.

#### **Solar Cell Fabrication and Research Division**

##### **International**

175. G. Hashmi, M. A. R. Akand, M. K. Basher, M. Hoq and M. H. Rahman, "Fabrication of Crystalline Silicon Solar Cell in Bangladesh: Limitations and Remedies", *International Journal of Scientific & Engineering Research*, Vol. 07(5), (2016), pp. 581-586.
176. M. Asrafusjaman, K Uddin, G. Hashmi and M. A. R. Akand, "Mono-Crystalline Silicon Solar Cell Fabrication in Bangladesh", *International Journal of Research in Engineering and Technology*, Vol. 05(9), (2016), pp. 169-174.

##### **Internal Report**

177. M. K. Basher, M. A. R. Akand and M. Hoq, "Characterization of Doped Silicon Wafer Using Four Point Probe Method", Report No. IE-SFRD-1, April 2017.

#### **TRAINING INSTITUTE (TI), AERE**

##### **National**

178. M. M. Rahman, S. Saha, M. N. Islam, A. K. Das, A. K. M. A. Rahman, and S. M. A. Islam, "A Study of the Morphological Change in Plant Pod by Using Film Imaging Neutron Radiography Technique", *Jahangirnagar University Journal of Science*, Vol. 40(1), (2017), pp. 47-53.

#### **ATOMIC ENERGY CENTRE (AEC), CHITTAGONG**

##### **International**

179. S. Yasmin, B. S. Barua, M. U. Khandaker, M. T. Chowdhury, M. Kamal, M. A. Rashid, M. M. H. Miah and D. A. Bradley, "Investigation of ionizing radiation shielding effectiveness of decorative building materials used in Bangladeshi dwellings", *Radiation Phys. Chem.*, (2016), <http://dx.doi.org/10.1016/j.radphyschem>, 2016.11.017..

#### **NUCLEAR SAFETY, SECURITY AND SAFEGUARDS DIVISION (NSSSD), HQ, BAEC**

##### **International**

180. A. K. M. A. Ullah, A. K. M. F. Kibria, M. Akter, M. N. I. Khan, M. Maksud, R. A. Jahan and S H. Firoz, "Synthesis of Mn<sub>3</sub>O<sub>4</sub> nanoparticles via a facile gel formation route and study of their phase and structural transformation with distinct surface morphology upon heat treatment", *Journal of Saudi Chemical Society*, (2017), <http://dx.doi.org/10.1016/>.

##### **National**

181. R. Das, M. Shajahan, A. K. M. A. Ullah, H. M. B. Alam and A. K. M. F. Kibria, "Surface Reaction Characteristics and Oxygen Evolution Capability of a Pd<sub>80</sub>at.%Ni Electrode in 30wt.%KOH medium", *Nuc. Sci. Appl.*, Vol. 25(1&2), (2016), pp. 33.

**NATIONAL INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (NINMAS),  
SHAHBAG**

**International**

182. J. Ferdous, S. Hossain, F. Begum and M. A. Hoque, “Assessment of Activity Concentration and Effective Doses from Bioassay Sample of Occupational Workers in NINMAS, Bangladesh”, *International Journal of Radiology & Radiation Therapy*, Vol.1(2), (2016), pp. 8.
183. Y. Kitamura, T. Kozaka, D. Miwa, I. Uno, M. A. Azim, K. Ogawa, J. Taki, S. Kinuya and K. Shiba, “Synthesis and evaluation of a new vesamicol analog o-[<sup>11</sup>C]methyl-trans-decalinvesamicol as a PET ligand for the vesicular acetylcholine transporter”, *Annals of Nuclear Medicine*, Vol. 30 (2), (2016), pp. 122-129.
184. S. Sultana, S. Momtaz, F. Begum, N. Nahar and R. Hussain, “Initial experience of PET CT in differentiated thyroid carcinoma patients with high serum thyroglobulin and negative iodine whole body scan”, *Asia Oceania Journal of Nuclear Medicine & Biology*, Vol. 4, (2016), Suppl. 1, S51.
185. R. Hussain, S. Sultana, R. Parveen and M. S. Salekin, “Outcome of radioiodine therapy in Hurthle cell carcinoma of thyroid: a tertiary center experience”, *World Journal of Nuclear Medicine*, Vol. 15, (2016), Suppl. 1, S29.
186. F. Begum, L. Nisa, K. A. Quadir, S. M. F. Begum, R. Hussain, A. T. M. A. Rahman, Z. J. Khan and M. A. B. Siddique, T. Pascual and M. Hasan, “Evaluation of F-18 PET-CT in Pediatric Lymphoma- Preliminary Experience at National Institute of Nuclear Medicine and Allied Sciences”, *Asia Oceania Journal of Nuclear Medicine & Biology*, Vol. 4(1), (2016), Suppl. 1, S51.
187. S. Sultana, S. Momtaz, F. Begum, N. Nahar and R. Hussain, “PET CT imaging in differentiated thyroid carcinoma patients with rising serum Tg/Anti Tg antibody”, *World Journal of Nuclear Medicine*, Vol. 15, (2016), Suppl. 1, S32.
188. S. M. F. Begum, F. Begum, R. Hussain, A. k. Sarker and M. Hasan, “18F FDG PET-CT in the Diagnosis of Spinal Cord Involvement Secondary to NonHodgkins Lymphoma- A case Report”, *Asia Oceania Journal of Nuclear Medicine & Biology*, Vol. 4(1), (2016), Suppl. 1, S63.

**National**

189. M. Hasan and F. Nasreen, “Asian School of Nuclear Medicine - An Emerging Platform of Nuclear Medicine Education”, *Bangladesh J. of Nuclear Medicine*, Vol. 20(1), (2017), pp. 7-8.
190. A. Naznin, S. Sultana, K. Nahar, T. Sifat and P. Mutsuudy, “Evaluation of Skeletal Hot Spots in Carcinoma Prostate Patients by Scintimetric Method”, *Bangladesh J. of Nuclear Medicine*, Vol. 20(1), (2017), pp. 9-13.
191. T. Sifat, F. Begum, S. Sultana, P. Mutsuudy, A. Naznin and S. M. F. Begum, “Frequency and Site of Skeletal Metastatic Lesion Detected by Bone Scintigraphy in Newly Diagnosed Asymptomatic Cancer Patients”, *Bangladesh J. of Nuclear Medicine*, Vol. 20(1), (2017), pp. 14-18.
192. P. Mutsuddy, M. A. Azim, S. M. F. Begum, R. Hussain, S. Farhana, T. Sifat, S. Sharmin and Afroza Naznin, “Assessment of Agreement between Gates Method and Dual Plasma Sample Method for Measurement of Glomerular Filtration Rate”, *Bangladesh Journal of Nuclear Medicine*, Vol. 20(1), (2017), pp. 19-23.
193. S. Sharmin, J. A. Haque, M. M. U. Rahman, H. A. Rahman, J. Hossain, M. M. Uddin, J. Ferdous and F. Yasmin, “Correlation Between Bone Scan Findings and CA15-3in Patients with Carcinoma Breast”, *Bangladesh J. of Nuclear Medicine*, Vol. 20(1), (2017), pp. 24-26.
194. M. S. A. Mamun, N. Nahar, M. S. Salekin and M. M. Rahman, “Thyroid Hormonal Status in Newly Diagnosed Type2 Diabetes Mellitus” *Bangladesh J. of Nuclear Medicine*, Vol. 20(1), (2017), pp. 27-31.



195. S. M. F. Begum, N. Sultana, R. Perveen, K. B. Shamsuddin, M. Bashir and L. S. Banu, “Renal Manifestation in Patients with Primary Hyperparathyroidism: a Retrospective Analysis in a Tertiary Institute”, Bangladesh J. of Nuclear Medicine, Vol. 20(1), (2017), pp. 32-36.
196. S. Quddus, F. Begum, N. Sultana, R. Perveen, T. Mandal, U. Islam, M. S. Salekin, S. Sultana and N. Nahar, "Outcome of Fixed Dose of Radioiodine Therapy in Hyperthyroid patients at NINMAS ", Bangladesh J. of Nuclear Medicine., Vol. 20(1), (2017), pp. 37-40.
197. N. Sultana, S. Quddus, R. Perveen, M. S. Salekin, M. Bashir and N. Nahar, “Assesment of Inferior Thyroid Artery by Color Doppler Ultrasound in Diffuse Toxic Goiter- Experience at NINMAS”, Bangladesh J. of Nuclear Medicine, Vol. 20(1), (2017), pp. 41-44.
198. R. Hussain, “Hibernating Myocardium and Role of 18F FDG PET Cardiac Imaging- A Review”, Bangladesh J. of Nuclear Medicine, Vol. 20(1), (2017), pp. 45-50.
199. M. S. Islam, S. K. Das and T. A. Biman. “Measurement of Uptake by using Image Based Bio-distribution of 99mTc-DTPA amd 99mTc-DMSA for Kidney, Liver and Spleen”, J. of Bangladesh Acad. Sci., Vol. 41(1), (2017), pp.105-114.
200. R. Hussain, “188 Rhenium Generator- A Breakthrough in Therapeutic Nuclear Medicine”, Bangladesh J. of Nuclear Medicine, Vol. 19(2), (2016), pp. 87-88.
201. M. S. A. Chowdhury, S. Sultana, M. A. Awal, S. Sarmin and M. S. Salekin, “Assessment of Gonadal Function Following Single Dose of Radioiodine Therapy in Differentiated Thyroid Cancer Patients of Reproductive age”, Bangladesh J. of Nuclear Medicine, Vol. 19(2), (2016), pp. 92-97.
202. M. S. Rahman, S. Sultan and A. Nazneen, “Assessment of Thyroid Function in Early Pregnancy”, Bangladesh J. of Nuclear Medicine, Vol. 19(2), (2016), pp. 98-102.
203. S. Farhana, R. Hussain, P. Mutsuddy, J. Ferdous and S. M. F. Begum, “Role of Bone Scintigraphy in Modification and Finalization of the Pathological Staging of Carcinoma of Breast”, Bangladesh J. of Nuclear Medicine, Vol. 19(2), (2016), pp. 107-110.
204. K. Nahar, M. S. A. Prince, S. M. F. Begum, A. Nazneen, F. Rahman and S. Sultana, “Role of Baseline Bone Scintigraphy in the evaluation of Skeletal Metastasis of Newly Diagnosed Lung Carcinoma Patients”, Bangladesh J. of Nuclear Medicine, Vol. 19(2), (2016), pp. 111-115.
205. A. K. Sarker, R. Hussain, F. Nasreen, L. Nisa, M. Hoq, K. K. Nath, N. Khatun, S. Islam and F. Alam, “Assessment of agreement between Gated SPECT Myocardial Perfusion Imaging and Gated SPECT Blood Pool Imaging for measurement of Left Ventricular ejection fraction in Coronary Artery Disease”, Bangladesh Journal of Nuclear Medicine, Vol. 19(2), (2016), pp. 128-134.
206. S. M. F. Begum and M. A. S. Khan, “18F FDG PET-CT Imaging in Tuberculosis”, Bangladesh Journal of Nuclear Medicine, Vol. 19(2), (2016), pp. 135-141.
207. F. Begum and D. K. Bhowmick, “Pediatric Sedation During Imaging - A Short Review”, Bangladesh Journal of Nuclear Medicine, Vol. 19(2), (2016), pp. 142-145.

### **Case Reports**

208. S. M. F. Begum, F. Begum, P. Mutsuddy, L. S. Banu and R. Hussain, “Superficial Metastasis from Breast Cancer and Gall Bladder: Detected by 18F FDG PET-CT Scan”, Bangladesh J. of Nuclear Medicine, Vol. 20(1), (2017), pp. 56-58.
209. S. M. F. Begum, F. Begum, R. Hussain, A. K. Sarker and M. Hasan, “18F FDG PET-CT in the Diagnosis of Spinal Cord Involvement Secondary to Non Hodgkins Lyphoma – A Case Report”, Bangladesh J. of Nuclear Medicine, Vol. 19(2), (2016), pp. 146-148.

210. P. Mutsuddy, S. M. F. Begum, R. Perveen and M. S. Salekin, “Asymmetrical Uptake in <sup>99m</sup>Tc MDP Bone Scan in Upper Extremity in Patient with Prostate Cancer: an Interesting Case”, Bangladesh Journal of Nuclear Medicine, Vol. 19(2), (2016), pp. 135-141.

#### **INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), DHAKA**

##### **National**

211. S. Reza, “<sup>99m</sup>Tc Perchnetate Thyroid Uptake and Scintigraphy: Standardization in Euthyroid Subjects”, British Journal of medical and health Research, Vol. 4(1), (2017), pp. 33-41.
212. S. Reza, “Correlation of Serum T4, T3 and TSH Levels with Radioiodine Thyroid Uptakes, IOSR Journal of Nursing and Health Science, Vol. 6(1), (2017), pp. 13-16, www.iosrjournals.org.
213. R. Afrin, “Role of MDCT Scan in the Evaluation of Pancreatic Mass with Histopathological correlation”, BMRC Bulletin, Vol. 42(3), (2016), pp.120-124.
214. R. Afrin, “Role of Whole-Body Tc <sup>99m</sup>MDP Bone Scintigraphy for Evaluating Skeletal Metastasis in Patients with Lung Cancer”, BMRC Bulletin, Vol. 42(3), (2016), pp.132-137.
215. F. Rahman, “Evaluation of Carotid Intima-Media Thickness in Sub-clinical Hypothyroid Patients”, Bangladesh Journal of Nuclear Medicine, Vol. 19(2), (2016), pp. 123-127
216. S. Hossain, “Agreement between Thyroid Uptake of <sup>99m</sup>Tc Perchnetate and <sup>131</sup>I Hyperthyroid Patients”, Bangladesh Journal of Nuclear Medicine, Vol. 19(2), (2016), pp. 89-91
217. R. Afrin, “Role of Baseline Bone Scintigraphy in the Evaluating Skeletal Metastases of Newly diagnosed Lung Carcinoma Patients”, Bangladesh Journal of Nuclear Medicine, Vol. 19(2), (2016), pp. 111-115.
218. M. Hossain, “Comparison between Conventional SPECT and SPECT-CT in Detection of Parathyroid Adenoma or Hyperplasia”, Bangladesh Journal of Nuclear Medicine, Vol. 20(1), (2017), pp. 81.
219. R. Afrin, “Different imaging modalities for evaluating emphysematous pyelonephritis: a life threatening urological emergency-a case report”, Bangladesh Journal of Nuclear Medicine, Vol. 20(1), (2017), pp. 63,
220. S. Sharmin, “Role of Tc DTPA renal scintigraphy for evaluating renal parenchymal function in patients with ectopic kidneys. 6 months experience”, Bangladesh Journal of Nuclear Medicine, Vol. 20(1), (2017), pp. 89
221. A. Akter, “Role of <sup>99m</sup>Tc MDP Bone Scintigraphy for Evaluating of malignant mesenchymal bone tumor in a 65 years old male patient: a case report”, Bangladesh Journal of Nuclear Medicine, Vol. 20(1), (2017), pp.83
222. T. Sultana, “Papillary micro carcinoma within Hashimoto’s thyroiditis and lymph node metastasis-case report of a 9 years old girl”, Bangladesh Journal of Nuclear Medicine, Vol. 20(1), (2017), pp. 88.

#### **INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), MITFORD**

##### **National**

223. S. Sharmin, J. Hossain, M. Rahman, H. A. Rahman, J. Hossain, M. M. Uddin, J. Ferdous and F. Yasmin, "Correlation between bone scan finding and CA 15-3 in patient with carcinoma breast", Bangladesh Journal of Nucl. Medicine, Vol. 20(1), (2017), pp. 24-26.
224. J. Hossain, H. A. Rahman, S. Sharmin and J. Ferdous, "Maffucci's syndrome - a case report of rare connective tissue disorder", Bangladesh Journal of Nucl. Medicine, Vol. 20(1), (2017), pp. 67-69.
225. J. Ferdous, M. Rahman, H. A. Rahman, J. Hossain, S. Sharmin and F. Yasmin, "Efficacy of sonoelastography images in solitary cold thyroid nodule and compared with FNAC", Bangladesh Journal of Nucl. Medicine, Vol. 19(2), (2016), pp. 103-106.

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), FARIDPUR**

**National**

226. M A. Awal, M. S. A. Chowdhury and M. H. Rahman, “Development of Autoimmune hypothyroidism after interferon- beta 1a treatment in patients with multiple sclerosis: A case report”, Bangladesh J Nucl. Medicine, Vol. 19(2), (2016), pp.149-151.

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), RAJSHAHI**

**National**

227. M. M. A. Hossain, N. Begum, P. Ahmed, M. Hossain, K. Shah, S. Khatun, S. I. Chowdhury and F. F. Shimu, “Pattern of Renogram Findings in Patients Attending INMAS, Rajshahi”, Bangladesh J. Nucl. Med., Vol. 19(2), (2016), pp. 116.
228. K. Z. Shah, N. Begum, S. M. Badruddoza, P. Ahmed and M. Hossain, “Carcinoma of Stomach diagnosed by Trans abdominal Sonography and guided FNAC where Endoscopy was not conclusive – Three case reports”, The Journal of Teacher’s Association, Vol. 26, (2016). pp.

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), SYLHET**

**International**

229. M. Saha, K. Nahar, I. Parveen, M. Mahmuduzzaman, M. A. Hosen, P. Mutsuddy and M. H. Khan, “Sonographically detected Non-Alcoholic Fatty Liver Disease in Apparently Healthy Adults and Associated Factors”, Mymensingh Med J, Vol. 26(1), (2017), pp. 109-116.

**National**

230. K. Nahar, M. S. Alam, S. M. F. Begum, A. Naznin, F. Rahman and S. Sultana, “Role of Baseline Bone Scintigraphy in the Evaluation of Skeletal Metastases of Newly Diagnosed Lung Carcinoma Patients”, Bangladesh J. Nucl. Med, Vol. 19(2), (2016), pp. 111-115.
231. K. Nahar, A. Naznin and S. A. Mimi, “Role of High Resolution Ultrasonogram in the Evaluation of Palpable Breast Lumps and Correlation with FNAC reports”, The OMTAJ, Vol. 14(2), (2015), pp. 139-140.
232. A. Naznin, S. Sultana, K. Nahar, T. Sifat and P. Mutsuddy, “Evaluation of Skeletal Hot Spots in Carcinoma Prostate Patients by Scintimetric Method”, Bangladesh J. Nucl Med., Vol. 19(1), (2016), pp. 09-13.
233. F. Rahman, F. S. Haque, S. K. Biswas, R. Begum, S. Hossain, S. Sharmin, S. Hossain and K. Nahar, “Evaluation of Carotid Intima-media Thickness in Sub-clinical Hypothyroid Patients”, Bangladesh J. Nucl. Med., Vol. 19(2), (2016), pp. 123-127.
234. T. Sifat, F. Begum, S. Sultana, P. Mutsuddy, A. Naznin and S. M. F. Begum, “Frequency and Site of Skeletal Metastatic Lesion Detected by Bone Scintigraphy in Newly Diagnosed Asymptomatic Cancer Patients”, Bangladesh J. Nucl. Med., Vol. 19(1), (2016), pp. 14-18.
235. P. Mutsuddy, M. A. U. Azim, S. M. F. Begum, R. Hussain, S. Farhana, T. Sifat, S. Sharmin and A. Naznin, “Assessment of Agreement between Gates Method and Dual Plasma Sample Method for Measurement of Glomerular Filtration Rate”, Bangladesh J. Nucl. Med., Vol. 19(1), (2016), pp. 19-23.

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**National**

236. F. Sharmin, N. Jahan, N. Jahan and N. Zaman, “Enchondroma in Flat Bone: A Rare Case Report”, Bangladesh Journal of Nuclear Medicine, Vol. 19(2), (2016), pp. 155-156.

## XVI. PAPER PRESENTED IN SEMINAR/SYMPOSIUM/CONFERENCE/WORKSHOP

### ATOMIC ENERGY CENTRE (AEC), DHAKA

#### Accelerator Facilities Division

1. “High Energy Medical Linear Accelerator Treatment-Room’s Door Design-A short Review”, S. Akter, M. M. Ahasan, M. J. Abedin, R. Khatun, M. F. Uddin and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-48, 05-07 January, 2017, pp. 37-138.
2. “Shielding Design for High Energy Medical Linac”, M. F. Uddin, R. Khatun, M. M. Ahasan, S. Akter, M. S. I. Chowdhury and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, BMP- 04, 05-07 January, 2017, pp. 55.
3. “Versatility of Survey Meter for Radiation Monitoring”, M. F. Uddin, R. Khatun, M. M. Ahasan, S. Akter, M. S. I. Chowdhury and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, PP- 69, 05-07 January, 2017, pp. 147.
4. “Nuclear Medical Physics Institute-The First Institute in Bangladesh for Quality Cancer Care”, M. F. Uddin, M. M. Ahasan, R. Khatun, S. Akter and A. N. Monika, Annual Conference Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016), BIAM Dhaka, PP - 4, 24-25 September, 2016, pp. 24.

#### Chemistry Division

5. “An integrated Approach for Groundwater Pollution Evaluation of Dhaka City using Multivariate Statistical Analysis, Groundwater Pollution Indices, Geostatistical Modeling and Human Health Risk Assessment”, M. Bodrud-Doza, Y. N. Jolly, B. A. Begum, K. J. Fatema, M. A. H. Bhuiyan, S. B. Quraishi and M. S. Rahman, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 64.
6. “Evaluation of Blood Lead Level as a Risk Factor in Children with Autism Spectrum Disorder: A Case Control Stud”, M. S. Ali, B. A. Begum, S. Akter, M. M. Rahman and Y. N. Jolly, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 83.
7. “Assessing Risk to Human Health for Heavy Metal Contamination in Street Dust of The Capital City, Dhaka, Banglades”, M. D. H. Khan, M. A. Salam, Y. N. Jolly, M. J. Kabir, S. Akther and M. S. Rahman, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 66.
8. “Reducing Corrosion of Iron from Boiler Surface with Trisodium-Phosphate Treatmen”, M. Z. Chowdhury, R. Islam, M. F. Huq and M. S. Rahman, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, RP-09, 5-7 January, 2017, pp. 95.
9. “Assessment of Trace Metal Concentration in Sediment Samples of Selected Area of Sundarban Mangrove Forest, Bangladesh”, A. S. M. F. Rabbi, M. A. H. Bhuiyan, Y. N. Jolly, M. J. Kabir, S. Akther and M. S. Rahman, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-53, 5-7 January, 2017, pp. 140.
10. “Trace Metals in Fish and Shell Fishes Collected from the Karnaphuli River Estuary, Bangladesh and their Human Health Risk Assessment”, M. S. Rahman, Y. N. Jolly, S. Akther, M. J. Kabir, M. S. Hossain and M. K. Ahmed, 38th Annual Conference-2016 of Bangladesh Chemical Society, Chittagong, 31 March-1 April, 2017, pp. 57-58.
11. “Toxic Metal Concentration in Antidiabetic Herbal Preparation”, M. R. Zamir, M. A. Rahman, A. Amin, M. S. Rahman, 38th Annual Conference-2016 of Bangladesh Chemical Society, Chittagong, 31 March -1 April , 2017, pp. 38.
12. “Assessment of Radioactivity Level in Soil Samples of Pabna District in Bangladesh”, S. Yeasmin, M. M. Siraz, M. R. Zaman, M. M. A. Mollah and M. S Rahman, Int. Conf. on Physics in Medicine and

Clinical Neuroelectrophysiology, Dhaka, 10 – 11 March, 2017, pp. 45.

13. “Carbon Coated Iron Manganese Binary Oxide an Effective Agent for the Simultaneous Removal of As<sup>3+</sup> and As<sup>5+</sup>”, A. Azim, A. K. M. A. Ullah, M. J. Nime and S. H. Firoz, 1st Symposium on Chemistry for Global Solidarity, Jagannath University, Dhaka, Bangladesh, PP-03, 14 October, 2016, pp. 49.
14. “Oxidative Degradation of Methylene Blue Using Mn<sub>3</sub>O<sub>4</sub> Nanoparticles”, A. K. M. A. Ullah, S. B. Quraishi, M. N. I. Khan, A. R. M. Tareq, M. A. Maksud and S. H. Firoz, 1st Symposium on Chemistry for Global Solidarity, Jagannath University, Dhaka, Bangladesh, PP-04, 14 October, 2016, pp. 50.
15. “Urinary Copper/Zinc Ratio: As an adjunct tool for the diagnosis of Wilson disease in children”, S. Kadir, A. S. M. B. Karim, S. R. Khan and T. R. Choudhury, 38th Annual Conference-2016 of Bangladesh Chemical Society, Chittagong, 31 March - 1 April, 2017, pp. 33.
16. “Concentrations of Uranium and <sup>234</sup>U/<sup>238</sup>U, <sup>235</sup>U/<sup>238</sup>U, <sup>235</sup>U /<sup>238</sup>U Ratios in Soil Samples Collected Around the Fukushima Dai-Ichi Nuclear Power Plant Accident Area Using Triple-Quadrupole Inductively Coupled Plasma-Mass Spectrometry”, T. R. Choudhury, G. Yang , H. Tazoe and M. Yamada, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 140.
17. “Study of the Structure, Surface Morphology and Electric Properties of Mn Doped Barium Titanate Ceramic”, M. Jahan, P. Bala, D. K. Saha, A. R. M. Tareq, A. K. M. A. Ullah, M. Hasan, S. M. Hoque and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-07, 5-7 January, 2017, pp. 86.
18. “Synthesis of Mn<sub>3</sub>O<sub>4</sub> Nanoparticles via a Facile Gel Formation Route and Study of Its Phase and Structural Transformation with Distinct Surface Morphology upon Heat Treatment”, A. K. M. A. Ullah, A. K. M. F. Kibria, M. Akter and S. H. Firoz, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-08, 5-7 January, 2017, pp. 86.
19. “Enrichment of the Magnetic Properties of BaTiO<sub>3</sub> Based Ceramics with Calcium Substitution”, M. Farzana, S. M. M. A. Mamun, A. K. M. A. Ullah and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-01, 5-7 January, 2017, pp. 118.
20. “Influence of Microstructure on the Dielectric Properties of La Doped CaMnO<sub>3</sub>”, S. K. Saha, P. Bala, D. K. Saha, A. K. M. A. Ullah, M. Hasan and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-09, 5-7 January, 2017, pp. 121.
21. “Catalytic Degradation of Methylene Blue Using Mn<sub>3</sub>O<sub>4</sub> Nanoparticles”, A. K. M. A. Ullah, S. B. Quraishi, A. R. M. Tareq, M. A. Maksud and S. H. Firoz, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-30, 5-7 January, 2017, pp. 130.
22. “Food Toxicity: Bangladesh perspective”, S. B. Quraishi, T. R. Choudhury, A. K. M. A. Ullah, A. Maksud, S. R. Khan and L. Nahar, 38th Annual Conference of Bangladesh Chemical Society, Chittagong, Bangladesh, S2 (A)-IL-1, 31 March, 2017, pp.14.
23. “Oxidative Degradation of Methylene Blue using Mn<sub>3</sub>O<sub>4</sub> Nanoparticles”, A. K. M. A. Ullah, A. K. M. F. Kibria, S. B. Quraishi, M. N. I. Khan, A. R. M. Tareq and S. H. Firoz, 38th Annual Conference of Bangladesh Chemical Society, Chittagong, Bangladesh, S2 (A)-OP-05, 31 March, 2017, pp. 18.
24. “Cytotoxicity of Silver Nanoparticles: A brief review of invitro studies”, S. M. M. Hossain, A. K. M. A. Ullah and M. Akter, 38th Annual Conference of Bangladesh Chemical Society, Chittagong, Bangladesh, S2 (B)-OP-05, 31 March, 2017, pp. 22.
25. “Structure and Morphology Dependent Cytotoxicity of MnO<sub>x</sub> Nanoparticles on PC 12 Cell”, A. K. M. A. Ullah, A. K. M. F. Kibria, S. B. Quraishi, M. Akter, M. N. I. Khan and S. H. Firoz, 38th Annual Conference of Bangladesh Chemical Society, Chittagong, Bangladesh, S2 (B)-OP-08, 31 March, 2017, pp. 25.

26. “Mechanistic Study of Ag Nanoparticles Mediated Toxic Effect on PC 12 Cell”, A. K. M. A. Ullah, M. Akter and S. H. Firoz, 38th Annual Conference of Bangladesh Chemical Society, Chittagong, Bangladesh, S2 (B)-OP-09, 31 March, 2017, pp. 26.
27. “Development and Validation of a GF-AAS Method and Its Application for the Trace Level Determination of Pb, Cd and Cr in Fish Feed Samples Commonly Used in the Hatcheries of Bangladesh”, A. K. M. A. Ullah, M. A. Maksud, S. R. Khan, L. N. Lutfu and S. B. Quraishi, 38th Annual Conference of Bangladesh Chemical Society, Chittagong, Bangladesh, S1-PP-02, 31 March, 2017, pp. 53.
28. “Phenol and Some Phenolic Derivatives: A study of some fishes in Dhaka city market, Bangladesh”, A. R. M. Tareq, S. Karmakar, A. K. M. A. Ullah and S. B. Quraishi, 38th Annual Conference-2016, Chittagong, S3-PP-23, 31 March 2017, pp. 104.
29. “Characterization and Quantification of Various Volatile Compounds from Various Hog Plum (Spondias mombin) Peels by GC-MS”, A. R. M. Tareq, S. Karmakar, M. S. Rana, R. Sultana, M. E. Ahasan, M. M. Rashid and S. C. Mondal, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, ES-02, 5-7 January, 2017, pp. 61.
30. “Carcinogenic Polycyclic Aromatics Hydrocarbons (PAHs): An approach to fish in Bangladesh”, A. R. M. Tareq, S. Karmakar, A. K. M. A. Ullah, M. J. Kabir and S. B. Quraishi, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, BMP-13, 5-7 January, 2017, pp. 79.
31. “Impact of Structural Factors on Magnetic Properties of  $Ba_{1-x}Sr_xTi_xMn_{0.5}O_3$ ”, S. Parvin, T. I. Khan, A. R. M. Tareq, M. S. Mahmud, M. R. Hassan, M. A. Hakim, A. A. Begum, Z. Begum and M. N. I. Khan, National Conference on Physics -2017, Atomic Energy Centre, Dhaka, Bangladesh, PP.14, 05-07 January, 2017, pp.123.
32. “Catalytic Degradation of Methylene Blue Using  $Mn_3O_4$  Nanoparticles”, A. K. M. A. Ullah, S. B. Quraishi, A. R. M. Tareq, M. A. Maksud and S. H. Firoz, National Conference on Physics -2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-30, 05-07 January, 2017, pp.130.
33. “High Energy Medical Linear Accelerator Treatment-Room’s Door Design-A short Review”, S. Akter, M. M. Ahasan, M. J. Abedin, R. Khatun, M. F. Uddin and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-48, 05-07 January, 2017, pp. 37-138.
34. “Shielding Design for High Energy Medical Linac”, M. F. Uddin, R. Khatun, M. M. Ahasan, S. Akter, M. S. I. Chowdhury and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, BMP- 04, 05-07 January, 2017, pp. 55.
35. “Versatility of Survey Meter for Radiation Monitoring”, M. F. Uddin, R. Khatun, M. M. Ahasan, S. Akter, M. S. I. Chowdhury and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, PP- 69, 05-07 January, 2017, pp. 147.
36. “Nuclear Medical Physics Institute-The First Institute in Bangladesh for Quality Cancer Care”, M. F. Uddin, M. M. Ahasan, R. Khatun, S. Akter and A. N. Monika, Annual Conference, Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016), BIAM, Dhaka, PP - 4, 24-25 September, 2016, pp. 24.

### Electronics Division

37. “Study of Health and Safety at Nuclear Installations”, M. N. Islam, H. Akhter, M. Begum, Y. Mawla and M. Kamal, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-89, 05-07 January, 2017, pp.154.
38. “Design and Development of Microcontroller Based Control System for Proper Utilization of 1.68KWp Solar Pumping Plant Installed at AECD”, M. A. Rahman, M. Begum, S. Sattar, A. Quader, Y. Mawla and D. K. Saha, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 153.

39. “Design and Development of an Electricity Saving System Using a PIR Motion Sensor”, S. Sattar, M. A. Rahman, A. Quader, M. Begum and Y. Mawla, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 153.

#### **Experimental Physics Division**

40. “Synthesis of Al doped ZnO Thin Films Using Sol-gel Spin Coating Technique”, T. Chakraborty, F. Nahid, K. M. A. Hussain, T. Faruque, J. Parvin and S. Ahmed, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 108.
41. “Effect of Zn Concentration on CdTe Thin Films Deposited by Thermal Evaporation Method”, T. Faruque, K. M. A. Hussain, J. Parvin and S. Ahmed, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 110.
42. “Role of Substrate Temperature on the Opto-electrical Properties of Indium Doped Tin Oxide Thin Films”, M. M. Rahaman, K. M. A. Hussain, M. Sharmin, C. Das and S. Choudhury, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 110.
43. “Opto-electrical Properties of Nanostructured Indium Doped Tin Oxide Vacuum Evaporated Thin Films”, M. M. Rahaman, K. M. A. Hussain, M. Sharmin, C. Das and S. Choudhury, Bangladesh Academy of Sciences Young Scientists Congress, 27-28 October, 2016, pp. 9.

#### **Health Physics Division**

44. “Assessment of Radioactivity Level in Soil Samples of Pabna District in Bangladesh”, S. Yeasmin, M. M. Siraz, M. R. Zaman, M. M. A. Mollah and M. S. Rahman, International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN-2017), Dhaka University, Bangladesh, 10-11 March, 2017, pp. 45.
45. “Transfer Factors of Radionuclides from Soil to Grass and Mango in Sundarganj Upzila in Gaibandha District in Bangladesh”, M. S. Mondol, S. K. Das and S. Yeasmin, International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN-2017), Dhaka University, Bangladesh, 10-11 March, 2017, pp. 46.
46. “Extremity Dose Measurement for Occupational Workers Using Ring TLD”, M. T. Islam, M. M. Haque, A. Begum, M. S. Rahman and M. A. Islam, International Conference on Physics in Medicine & Clinical Neuroelectrophysiology (PMCN-2017), Dhaka University, Bangladesh, RDH-7, 10-11 March, 2017, pp. 49.
47. “A study of Naturally Occurring Radioactive Materials in Barapukuria coal Mine”, Dinajpur, Bangladesh, L. Rahman, M. M. Haque, A. Begum, J. Ferdous and M. A. Islam, International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN 2017), Dhaka University, Bangladesh, 10-11 March, 2017, pp. 44.
48. “Radioactivity in Some Building Materials Used in Dwellings of Bangladesh”, A. Tasnim, M. M. Haque, A. Begum, J. Ferdous and M. A. Islam, International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN 2017), Dhaka University, Bangladesh, 10-11 March, 2017, pp. 43.
49. “Natural Radionuclide Concentrations in the Seasonal Fruits of Bangladesh”, R. Mustakim, M. M. Haque, A. Begum, J. Ferdous and M. A. Islam, International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN 2017), Dhaka University, Bangladesh, 10-11 March, 2017, pp. 48.
50. “Determination of Radioactivity in Rain Water from Various Areas in Dhaka”, A. Islam, M. A. Hoque, S. F. Mahal, S. Yeasmin, M. S. Rahman, J. Ferdous, M. Begum, M. M. M. Siraz, S. Pervin, Z. Hossain and A. Begum, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, 05-07 January, 2017, pp.107.
51. “Study of Workplace Monitoring at Atomic Energy Centre, Dhaka”, A. Islam, M. A. Hoque, S. F.

- Mahal, S. Yeasmin, M. S. Rahman, J. Ferdous, M. Begum, M. M. M. Siraz, S. Pervin and A. Begum, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, PP-46, 05-07 January, 2017, pp. 137.
52. “Background Radiation Monitoring in Different Locations of Bangladesh”, M. Begum, M. A. Hoque, S. F. Mahal, S. Yeasmin, M. S. Rahman, A. Islam, J. Ferdous, M. M. M. Siraz, S. Pervin, N. Hassan, Z. Hossain and A. Begum, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, PP-50, 05-07 January, 2017, pp. 138.
  53. “Measurement of Activity Concentrations of Radionuclides in Soil Samples Collected from Sundarganj Upazila in Gaibandha District, Bangladesh”, M. S. Mondol, S. K. Das, S. Islam and S. Yeasmin, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, PP-47, 05-07 January, 2017, pp. 137.
  54. “Measurement of  $^{238}\text{U}$ ,  $^{228}\text{Ra}$ ,  $^{226}\text{Ra}$ ,  $^{40}\text{K}$  in Foodstuffs Samples Collected From North-Eastern Part of Bangladesh”, S. Islam, S. K. Das, M. S. Mondol and S. Yeasmin, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, 05-07 January, 2017, pp. 115.
  55. “Measurement of Indoor Terrestrial Gamma Radiation Dose Rate at AECD Campus”, M. S. Rahman, S. Hossain, M. A. Islam, M. A. Hoque and M. H. Ahsan, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, PP-49, 05-07 January, 2017, pp. 138.
  56. “Absorb Dose Rate and Transfer Factor from Soil to Plant in Chittagong Region of Bangladesh”, M. S. Bhuyan, J. Ferdous, A. K. M. R. Rahman and M. A. Hoque, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, 05-07 January, 2017, pp. 106.
  57. “A study of Gross Alpha and Gross Beta activity and Radionuclide Concentrations in the water Samples from a District in the Northern Region of Bangladesh”, A. Rahim, M. S. Sultana, J. Ferdous, A. Begum and M. A. Islam, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, 05-07 January, 2017, pp. 106.
  58. “A Study of Natural Radionuclide Concentrations in the Soil Samples of a District in the Northern Region of Bangladesh”, M. S. Sultana, A. Rahim, J. Ferdous, A. Begum and M. A. Islam, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, 5-7 January, 2017, pp. 135.
  59. “Analysis of Radon Concentration in Air of Different Locations, Dhaka City”, A. K. Azad, M. A. Hoque, M. M. M. Siraz, J. Ferdous and A. Begum, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, 05-07 January, 2017, pp. 116.

### Materials Science Division

60. “An Investigation on the Structural, Morphological and Dielectric Properties of La And Mn Co-Substituted Bismuth Ferrite Multiferroic”, M. S. Islam, A.T. M. K. Jamal, S. M. Hoque, S. I. A. A. Begum, A. Parveen and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, CM-11, 5-7 January, 2017, pp. 50.
61. “Nanotechnology in Biomedical Applications at the Molecular Level”, S. M. Hoque, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, IT-IVB, 5-7 January, 2017, pp. 37.
62. “Simplified Processes for the Fabrication of Nano Materials Utilizing Electromigration”, F. M. Kamal, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, NM-02, 5-7 January, 2017, pp. 70
63. “Interconnection Between Structural and Magnetic Properties of Nanocrystalline  $\text{Fe}_{75.5}\text{Nb}_1\text{Cu}_1\text{Si}_{13.5}\text{B}_9$ ”, M. M. Rasna, G. M. Bhuiyaqn, M. R. Hassan, S. I. Liba, M. N. I.Khan, S. M. Hoque, N. H. Dan and M. A. Hakim, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, NM-07, 5-7 January, 2017, pp. 73.



64. “Study of Correlation Between Hydrodynamic Diameter and Specific Loss Power (LSP) of Folate Chitosan Coated Cobalt Ferrite Nanoparticle for Cancer Treatment”, M. Anwaruzzaman and S. M. Hoque, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, NM-09, 5-7 January, 2017, pp. 73-74.
65. “Structural, Morphological and Optoelectronic Parameters Studies of Thermally Vacuum Evaporated Zinc Telluride Thin Film”, N. P. Begum, J. U. Ahmed and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, TF-06, 5-7 January, 2017, pp. 76-77.
66. “Complex Permeability of La, Y, Eu incorporation Ni-Zn Ferrites”, M. A. Hossain, M. N. I. Khan and S. S. Sikder, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-02, 5-7 January, 2017, pp. 84.
67. “Frequency Dependent Dielectric Behavior of Al-Substituted Ni-Cu-Zn Ferrite”, K. R. Rahman, F. U. Z. Chowdhury and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-03, 05-07 January, 2017, pp. 84.
68. “Effect of Sintering Temperature on the Microstructure of Mixed Spinal Mg-Cu Ferrites”, A. Podder, S. Hider, S. M. Hoque and S. S. Sikder, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-04, 05-07 January, 2017, pp. 84.
69. “Impact of Holmium Substitution on Structural and Electrical Properties of Cobalt Ferrites”, M. R. Hassan, R. Islam, F. S. Shanta, D. K. Saha and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-05, 05-07 January, 2017, pp. 85.
70. “Influence of Zn Substitution on the Structure and Magnetic Properties of Cu Ferrites”, S. Akhter, S. M. Mamun and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-06, 5-7 January, 2017, pp. 85.
71. “Study of the Structure, Surface Morphology and Electric Properties of Mn Doped Barium Titanate Ceramic”, M. Jaman, P. Bala, D. K. Saha, A. R. M. Tareq, A. K. M. A. Ullah, M. Hasan, S. M. Hoque and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-07, 05-07 January, 2017, pp. 85.
72. “Structure and Magnetic Properties of  $\text{La}_x\text{Ni}_{0.5}\text{Zn}_{0.5-x}\text{Fe}_2\text{O}_4$ ”, S. Barua, D. K. Saha, M. N. I. Khan, M. R. Hassan and J. Ahmed, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MM-10, 05-07 January, 2017, pp. 87.
73. “Exchange-spring Behavior of  $\text{Nd}_{4-x}\text{Tb}_x\text{Fe}_{71}\text{Co}_5\text{Cu}_{0.5}\text{Nb}_{1}\text{B}_{18.5}$  Nanocomposite Melt-spun Ribbons”, P. C. Karmaker, S. I. Liba, N. H. Dan, D. K. Saha, M. O. Rahman, P. Nordblad and S. M. Hoque, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MS-02, 05-07 January, 2017, pp. 99.
74. “Evaluation of Enhanced Magnetic Properties of  $\text{NiFe}_2\text{O}_4$  Using as-Synthesized Ultrafine Nanoparticles as the Starting Material of The Sintered Products”, S. I. Liba, M. Tareq, F. Salehin, R. Islam, Z. H. Mahmood and S. M. Hoque, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MS-03, 05-07 January, 2017, pp. 100.
75. “Synthesis and Characterization of Polycrystalline  $\text{Bi}_{0.9}\text{La}_{0.1}\text{Fe}_{1-x}\text{Eu}_x\text{O}_3$ ”, A. Kaiyum, M. A. Hossain, M. A. Hakim, S. M. Hoque, F. M. Kamal and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MS-04, 05-07 January, 2017, pp. 100.
76. “Structural, Dielectric Properties and Magnetoelectric Coupling Studies of Rare Earth Substituted  $x\text{Ba}_{0.95}\text{Sr}_{0.05}\text{TiO}_3-(1-x)\text{BiFe}_{0.9}\text{Re}_{0.1}\text{O}_3$  [where, Re=Gd And Dy] Multiferroic Ceramic”, M. J. Miah, M. N. I. Khan and A. K. M. A. Hossain, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, MS-04, 05-07 January, 2017, pp. 102.
77. “Enrichment of the Magnetic Properties of  $\text{BaTiO}_3$  Based Ceramics with Calcium Substitution”, M.

- Farzana, S. M. M. Al Mamun, A. K. M. A. Ullah and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-01, 05-07 January, 2017, pp. 118.
78. “Investigation of Structural and Magnetic Behaviors of Nanocrystalline Fe<sub>70.5</sub>Cr<sub>3</sub>Cu<sub>1</sub>Nb<sub>3</sub>Si<sub>13.5</sub>B<sub>9</sub> Amorphous Ribbons”, M. M. Rana, G. M. Bhuiyan, M. R. Hassan, S. I. Liba, M. N. Khan, S. M. Hoque and M. A. Hakim, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-03, 05-07 January, 2017, pp. 119.
  79. “Structural, Magnetic and Dielectric Properties of BFO-NCZFO Multiferroic Composites”, S. C. Mazumdar, M. N. I. Khan, A. K. M. A. Hossain, F. T. Zohra, R. Ferdousy, S. Akhter and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-04, 05-07 January, 2017, pp. 119.
  80. “Enhancement of Magnetoelectric Properties of Ca<sub>1-x</sub>Sr<sub>x</sub>(Fe<sub>0.5</sub>Ta<sub>0.5</sub>)O<sub>3</sub>”, M. A. Gafur, M. N. I. Khan, A. A. Momin and A. K. M. A. Hossain, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-08, 05-07 January, 2017, pp. 121.
  81. “Influence of Microstructure on the Dielectric Properties of La Doped CaMnO<sub>3</sub>”, S. K. Saha, P. Bala, D. K. Saha, A. K. M. A. Ullah, M. Hassan, M. F. Kabir and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-09, 5-7 January, 2017, pp. 121.
  82. “A Study on the Structure, Surface Morphology and Permeability of Multiferroic Composite”, M. A. Haider, I. M. Syed, Z. Begum and N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-10, 05-07 January, 2017, pp. 121.
  83. “Impact of Structural Factors on Magnetic Properties of Ba<sub>1-x</sub>Sr<sub>x</sub>Ti<sub>0.5</sub>Mn<sub>0.5</sub>O<sub>3</sub>”, T. I. Khan, M. S. Mahmud, M. R. Hassan, A. R. M. Tareq, M. A. Hakim, A. A. Begum, Z. Begum and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-14, 05-07 January, 2017, pp. 123.
  84. “Effect of Ti Substitution on Structural and Electrical Properties of Ca-Mn Ceramic”, S. Nagar, T. Khan, S. M. Hoque, F. Alam, M. R. Hassan, M. A. Hakim, M. Hasan, A. Parvin, N. Begum and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-16, 05-07 January, 2017, pp. 124.
  85. “Structure and Magnetic Properties of La<sub>x</sub>Ni<sub>0.5</sub>Zn<sub>0.5-x</sub>Fe<sub>2</sub>O<sub>4</sub>”, S. Barua, D. K. Saha, M. N. I. Khan, M. R. Hassan and S. J. Ahmed, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-18, 05-07 January, 2017, pp. 125.
  86. “Study of the Magnetic Properties of Strontium and Barium-Strontium Hexaferrite”, F. M. Kamal, M. N. I. Khan, S. M. Hoque, M. Moniruzzaman, A. A. Begum and D. K. Saha, National Conference on Physics, Atomic Energy Centre, Dhaka, Bangladesh, PP-20, 05-07 January, 2017, pp. 126.
  87. “Effect of Mg Substitution on Transport and Magnetic Properties of Zn Ferrites”, M. D. Hossain, M. A. Hakim, S. J. Ahmed, M. N. I. Khan and A. T. M. K. Jamil, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-21, 05-07 January, 2017, pp. 126.
  88. “Significance of Eu Doping on Structural and Electrical Properties of Ni-Zn Cu Ferrites”, M. A. Amin, I. N. Esha, F. T. Z. Toma, K. H. Maria and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-22, 05-07 January, 2017, pp. 126.
  89. “The impact of Microstructure on Magnetic Properties of Ni<sub>0.6-x</sub>Zn<sub>0.4</sub>Mn<sub>x</sub>Fe<sub>2</sub>O<sub>4</sub>”, M. M. I. Khan, D. K. Saha, M. N. I. Khan, S. J. Ahmed, M. R. Hassan, N. Begum and A. T. M. K. Jamil, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-23, 05-07 January, 2017, pp. 127.
  90. “Study the Structure, Surface Morphology and electric Properties of Sn Doped Cu-Zn Ferrites”, S. Islam, F. Alam, M. K. H. Bhuiyan, M. S. Mahmud and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-24, 05-07 January, 2017, pp. 127.

91. “Preparation and Characterization of Ba-ceramic with the Addition of Ca and Sr Oxides”, F. T. Z. Toma, M. Al-Amin, I. N. Esha, K. H. Maria and M. N. I. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-25, 05-07 January, 2017, pp. 128.
92. “Magnetic Properties and Microstructure of Exchange-Based Nd<sub>2</sub>Fe<sub>14</sub>B/Fe<sub>3</sub>B”, S. M. Hoque, P. C. Karmaker, S. I. Liba, D. K. Saha, N. H. Dan, M. O. Rahman and P. Nordblad, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-33, 05-07 January, 2017, pp. 131.
93. “Influence of Tb and Annealing Process On Magnetic Properties of Nd<sub>4-x</sub>Tb<sub>x</sub>Fe<sub>71</sub>Co<sub>5</sub>Cu<sub>0.5</sub>Nb<sub>1</sub>B<sub>18.5</sub> RE-lean Hard Magnetic Nanocomposites”, Tang, P. C. Karmaker, M. O. Rahman, S. M. Hoque, N. V. Thanh, N. M. Lam, N. V. Duong, P. T. Thanh, N. H. Yen, N. T. T. Huyen, L. T. Hung and N. H. Das, The 7th International Workshop on Advanced Material Science and Nanotechnology (IWAMSN), (2014), pp. 2-6.

### Medical Physics Division

94. “High Energy Medical Linear Accelerator Treatment-Room’s Door Design-A short Review”, S. Akter, M. M. Ahasan, M. J. Abedin, R. Khatun, M. F. Uddin and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, PP-48, 05-07 January, 2017, pp. 37-138.
95. “Shielding Design for High Energy Medical Linac National”, M. F. Uddin, R. Khatun, M. M. Ahasan, S. Akter, M. S. I. Chowdhury and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, BMP- 04, 05-07 January, 2017, pp. 55.
96. “Versatility of Survey Meter for Radiation Monitoring”, M. F. Uddin, R. Khatun, M. M. Ahasan, S. Akter, M. S. I. Chowdhury and A. N. Monika, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, PP- 69, 05-07 January, 2017, pp. 147.
97. “Thyroid Cancer Treatment in Bangladesh”, M. Ohiduzzaman, R. Khatun, S. Reza, M. K. A. Khan, S. Hossain, M. M. Ahasan, S. Akter, M. F. Uddin, A. N. Monika and R. Sultana, National Conference on Physics- 2017, Atomic Energy Centre, Dhaka, Bangladesh, BMP-18, 05-07 January, 2017, pp. 81.
98. “Assessment of Hyperthyroid Patients Using Tc-99m & I-131, M. K. Rabbi”, R. Khatun, S. Reza, M. K. A. Khan, S. Hossain, M. M. Ahasan, S. Akter, M. F. Uddin, A. N. Monika and M. A. B. Siddique, National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, BMP- 19, 05-07 January, 2017, pp. 82.
99. “Thyroid uptake of 99mTc and its agreement with 131I for evaluation of Thyroid Function at INMAS, Dhaka, BAEC “, M. Ohiduzzaman, R. Khatun, S. Reza, M. A. Kadir, S. Hossain, M. M. Ahasan, S. Akter, M. F. Uddin and A. N. Monika, International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN 2017), Dhaka University, Bangladesh, NM - 0, 10-11 March, 2017, pp. 67.
100. “Heel Effect in X-ray: A Short Review”, M. F. Uddin, M. M. Ahasan, R. Khatun, S. Akter and A. N. Monika, Annual Conference Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016), BIAM, Dhaka, Bangladesh, OP -18, 24-25 September, 2016, pp. 19-20.
101. “Study of Exposure Rates from Various Nuclear Medicine Scan”, M. Ohiduzzaman, R. Khatun, S. Reza, S. Hossain, A. K. M. Khan, M. M. Ahasan, S. Akter, M. F. Uddin, A. N. Monika and R. Sultana, Annual Conference, Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016), BIAM, Dhaka, Bangladesh, OP -19, 24-25 September, 2016, pp. 19-20.
102. “Nuclear Medical Physics Institute-The First Institute in Bangladesh for Quality Cancer Care”, M. F. Uddin, M. M. Ahasan, R. Khatun, S. Akter and A. N. Monika, Annual Conference Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016), BIAM, Dhaka, Bangladesh, PP - 4, 24-25 September, 2016, pp. 24.
103. “Comparison and Correlation of Tc99m over I131 in the Study of Thyroid Uptake”, R. Sultana, R.

Khatun, S. Reza, K. M. A. Khan, S. Hossain, M. M. Ahasan, S. Akter, M. F. Uddin, A. N. Monika and M. Ohiduzzaman, Annual Conference, Bangladesh Society of Radiation Oncologists & Bangladesh Medical Physics Society (ACBSROBMPS-2016), BIAM, Dhaka, Bangladesh, PP - 12, 24-25 September, 2016, pp. 28.

#### **Non-Destructive Testing Division**

104. “Integrity Assessment of Circumferential Weld in High Pressure Gas Pipeline by Analyzing Reflected Ultrasonic Signal From Weld Metal”, M. F. H. Chowdhury, M. S. Alam and M. A. Habib, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 118.

#### **Plasma Physics Division, AECD**

105. “Optimization of Axial Current Sheath Velocity in a Dense Plasma Focus Device”, M. A. Malek and M. K. Islam, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, 5-7 January, 2017 OPP-09, pp. 69.

#### **ATOMIC ENERGY CENTRE (AEC), CHITTAGONG**

106. “Assessment of Heavy Metals in Some Popular Farm Fishes and Corresponding Artificial Fish Feed of Chittagong Area and Evaluation of Health Risk through Their consumption”, N. S. Reshma, S. Hossain, N. Deb, M. T. Chowdhury, M. Kamal, M. S. Rahman, M. K. A. Patwary and A. K. M. H. Meaze. National Conference on Physics-2017, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp 61.
107. “Assessment of Heavy Metal Concentrations in Water, Sediment, Fish and Plant Samples of Halda River, Chittagong, Bangladesh”, S. Akther, M. M. H. Miah, S. Hossain, N. Deb and M. Kamal, National Conference on Physics-2017, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp 62.
108. “Study of Heavy Element Concentrations of tannery Effluents in Chittagong, Bangladesh”, A. A. Begum, M. M. H. Miah, S. Hossain, N. Deb and M. Kamal, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp 63.
109. “Analysis of Natural Radioactivity and Evaluation of Radiological Hazards By Gamma-Ray Spectrometry With Statistical Approach in Fly-Ash, Bottom Ash and Coal-Fired Brick Kilns”, M. J. Abedin, M. R. karim, M. Kamal, S. Hossain and M. H. A. Miah, 38<sup>th</sup> Annual Conference-2016, Bangladesh Chemical Society & Bangladesh Chemical Society, Chittagong Region, pp 23, 31 March, 2017.
110. “Assessment of Heavy Element in Soil, Sediment and Water Due to the Ship Breaking Activities on the Coastal Zone of Sitakunda, Chittagong, Bangladesh”, Bhowmik, A. K. M. R. Rahman, S. Hossain and N. Deb, National Conference on Physics-2017, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, PP-53.
111. “Distribution of Heavy Metals in Surface and Sub Surface Sediments of the Coast of Kutubdia Island, Cox’sbazar, Bangladesh”, N. Ud- Doulah, M. R. Karim, S. Hossain, N. Deb and Masud Kamal, 38 Annual Conference-2016, Bangladesh Chemical Society & Bangladesh Chemical Society, Chittagong Region, S1-PP-12, 31 March, 2017.
112. “Assessment of Some Heavy Metals Concentration in Different Parts of Broiler Chicken and Poultry Feeds and its Impact on Human Body”, M. J. Alam, M. E. Ali, S. Hossain, N. Deb and M. Kamal, 38 Annual Conference-2016, Bangladesh Chemical Society & Bangladesh

Chemical Society, Chittagong Region, S1-PP-12, 31 March, 2017.

113. “Study of The Pollution Status of Some Important Canals in Chittagong Metropolitan Area and Its Impact on The Environment of Mega City”, M. E. Ali, M. N. Sultana and S. Hossain, 38 Annual Conference-2016, Bangladesh Chemical Society & Bangladesh Chemical Society, Chittagong Region, S1-PP-15, 31 March, 2017.
114. “Study of Some Heavy Metals Concentration in Some Imported Fish and Its Impact on Common Food Stuff”, M. E. Ali, M. Akhter and S. Hossain, 38 Annual Conference-2016, Bangladesh Chemical Society & Bangladesh Chemical Society, Chittagong Region, S1-PP-17, 31 March, 2017.

#### **CENTRE FOR RESEARCH REACTOR (CRR), AERE**

115. “Coping Strategy for Extended Station Black Out of a Nuclear Power Plant”, M. M. Rahman, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 142-143.

#### **INSTITUTE OF NUCLEAR SCIENCE AND TECHNOLOGY (INST), AERE**

##### **Nuclear Radiation and Chemistry Division**

116. “Investigation of Cr(IV) Removal By The Iminodiacetate Group Containing Nonwoven Polyethylene Adsorbent”, N. Rahman, N. C. Dafader, S. K. Majumdar and M. M. Rahman, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 62.
117. “Application of O-Chitosan As Plant Growth Promoter on Maize (Zea Mays L) Plant”, S. Sultana, N. C. Dafader, F. Khatun, M. Rahman and J. Alam, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 62-63.
118. “pH and EC Measurement of Some Tea Infusion After Some Time Intervals”, S. Shahanaz, N. C. Dafader, N. Rahman and F. Alam, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 139-140.
119. “Preparation of Selective Hazardous Metal Ion Adsorbents from Acrylic Monomer Grafted PET Films”, N. Rahman, International Conference on Applications of Radiation Science and Technology (ICARST 2017), Vienna, Austria, 24 - 28 April, 2017, pp-403.

##### **Health Physics and Radioactive Waste Management Unit**

120. “Ingestion of Rice in Low-Lying Areas of Asulia, Savar”, M. A. Haydar, M. I. Ali, D. Paul and et al., National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 103.
121. “Radioactivity in Environmental Samples Collected from Inani Beach and Inani”, M. Ikram, M. A. Haydar, M. I. Ali, D. Paul and et al., National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 105.
122. “Experimental Study on Particle Sedimentation Behaviour and Bed Formation Characteristics During Sedimentation of Solid Particles used as Simulant Debris”, M. Shamsuzzaman, T. Horie, F. Fuke et al., National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 105.
123. “Experimental Investigation of Attenuation Property of Fiber Reinforced Polymer Based Composites and Wood materials for Neutron and Gamma Radiation Shielding”, M. Shamsuzzaman, M. M. H. Bhuiyan, M. S. Rahman and et al., National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January 2017, pp. 134.

124. “Study on Radioactivity in Soil and Sediment Samples of Inanai Canal, Cox’s Bazar, Bangladesh and Estimation of Radiological Hazard Indices”, M. Ikram, M. A. Haydar, M. I. Ali, D. Paul and etal., National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 134.
125. “Work Place Monitoring at Different Strategic Locations of BAEC TRIGA Mark II Research Reactor”, M. M. H. Bhuiyan, M. Shamsuzzaman, T. Siddiqua, M. S. Rahman and D. Paul. National Conference on Physics - 2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 135.
126. “Standardization of Neutron Radiation Field in Terms of Scattering Factors”, M. Shamsuzzaman, T. Siddiqua, M. S. Rahman, D. Paul and etal., International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN-2017), Dhaka University, Bangladesh, 10-11, March 2017, pp. 40.
127. “Calibration of Some Therapy Level Ionization Chambers and Dosimetry of High Energy Photon Beam from Medical Linear Accelerator Using Nk and N D, W Based Protocol”, M. R. Islam, M. N. Sharmin, M. S. Rahman, M. Shamsuzzaman, M. R. Rahman, F. Nahid and D. Paul, International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN-2017), Dhaka University, Bangladesh, 10-11 March, 2017, pp. 75.
128. “Photonuclear Studies for the Isomeric Yield Ratios in the Production of  $^{nat}\text{Fe}(\gamma, \text{xnp})^{52\text{m.g}}\text{Mn}$  with 50-, 60-, and 70-MeV Bremsstrahlung”, M. S. Rahman, G. Kim, K. S. Kim, M. Lee and A. K.M. M. H. Meaze, EPJ Web Conferences 106, 04008 (2016), pp. 01-10.

#### **Isotope Hydrology Division**

129. “Isotope-Based Assessment of Groundwater Resources and Soil Erosion for Sustainable Management in the South Central Part of Coastal Region in Bangladesh”, N. Ahmed and P. K. Aggarwal, XVI World Water Congress (WWC) 2017, Cancun, Mexico, 29 May - 2 June, 2017.
130. “Isotope-Based Assessment of Deep Groundwater Resources for Sustainable Management in the Coastal Areas of Bangladesh – Crisis in Overexploitation and Salinization”, N. Ahmed, Argonne, Illinois, USA, 20-24 March 2017.
131. “Assessment of Depth Distributed Fallout Radionuclide (FRN) and Soil Erosion/Deposition on A Hill Slope in Khagrachari and Bandarban Areas, Bangladesh”, N. Ahmed, H. Rahman, M. A. Tarafder, M. M. Karim and M. A. Q. Bhuiyan, Nanning, Guangxi, China, 12-16 June 2017.
132. “Atmospheric Control on the Precipitation Isotopes Over Bangladesh”, N. Ahmed, S. Terzer, S. A. Choudhury, S. M. Q. Hasan, M. S. H. Bhuiyan, M. A. Q. Bhuiyan and M. M. Karim, National Conference on Physics-2017, Atomic Energy Center, Dhaka, Bangladesh, 5-7 January, 2017, AP-11, pp. 112.
133. “Assessment of Hydrological and Geotechnical Hazards Relevant to Rooppur Nuclear Power Plant (RNPP) Site Safety”, M. M. Karim and A. K. M. R. K. Zoardar, Eighth Regional Workshop on Hydrological, Geotechnical and Human-Induced Hazards Relevant to Nuclear Power Plant Site Safety and Seventh Annual Meeting of the ANSN Topical Group on Sitting”, Jakarta, Indonesia, 25-29 July, 2016.

#### **Reactor Physics and Engineering Division**

134. “Analysis of Benchmark Fuel Assemblies Calculation for VVER-1000 Kalinin-1 Reactor Core using the Deterministic Code DRAGON5”, M. J. H. Khan, W. F. G. V. Rooijen, A. Hebert, M. S. Mahmood, S. M. Shauddin, R. Yasmeen, M. A. Hossen and N. H. Badrun, National Conference on Physics -2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp.93.
135. “Use of RELAP5 Code in Modeling TRIGA Research Reactor System for Thermal Hydraulic Analysis”, M. H. Altaf, N. H. Badrun, M. J. H. Khan, M. S. Mahmood, S. M. Shauddin and R.

Yasmeen, National Conference on Physics -2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 94.

136. “Neutron and Photon Flux Variation at Different Beam Ports of TRIGA Research Reactor”, R. Yasmeen, M. S. Mahmood, M. J. H. Khan, N. H. Badrun, M. H. Altaf and S. M. Shauddin, National Conference on Physics -2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 95.
137. “Use of Reliability Assessment Method to Quantity Probabilistic Safety of Reactor Thermal Hydraulic Parameters”, N. H. Badrun and M. H. Altaf. International Conference on Topical Issues in Nuclear Installation Safety: Safety Demonstration of Advanced Water Cooled Nuclear Power Plants, , Vienna, Austria, IAEA-CN-251-5, 6-9 June, 2017.

#### **Reactor and Neutron Physics Division**

138. “Impact of Ship Breaking Activities in The Mainland and in a Remote Island in Terms of Heavy Metals Abundances of Sand Samples”, S. Das, R. Khan, U. Tamim, S. Kabir, M. A. Islam, K. Naher, S. R. Chakraborty, A. K. M. R. Rahman, A. K. Deb and S. M. Hossain, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 85.
139. “Assessment of Elemental Background in Rampal By Instrumental Neutron Activation Analysis”, R. Khan, S. Parvez, U. Tamim, S. Das, M. A. Islam, K. Naher, M. H. R Khan, F. Nahid and S. M. Hossain, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 65.

#### **INSTITUTE OF FOOD AND RADIATION BIOLOGY (IFRB), AERE**

140. “Current Human Disease Vector Situation in Bangladesh”, S. A. Khan, M. Momen and K. Seheli, First Coordination Meeting on Sterile Insect Techniques for the Area-Wide Integrated Pests and Human Disease Vectors (INT5155) Tapachula, Mexico, 4-8 July, 2016.
141. “Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Management Programme in Southeast Asia”, M. Khan, 2nd RCM of IAEA Research Contract Project No. RAS-5067, Putrajaya, Malaysia, 19 August, 2016.
142. “Fruit Bagging Technology to Manage the Destructive Effects of Bactrocera Fruit Flies (Diptera: Tephritidae) in Mango Orchard at Chapainawabgonj, Bangladesh”. M. S. Uddin, M. H. Reza, S. A. Khan and M. Khan, Oral presentation at First Symposium of Tephritid workers of Asia, Australia and Oceania (TAAO), , Putrajaya, Malaysia, 15-18 August, 2016.
143. “Response of Solid Lure Plugs and DDVP Insecticide Strip for Detection and Male Annihilation of Bactrocera Fruit Flies (Diptera: Tephritidae) and Non-target Insects in Field Trials”, M. Khan, M. A. Bari, M. Hossain, A. K. Neogi, L. Leblanc and R. I. Vargas. First Symposium of Tephritid workers of Asia, Australia and Oceania (TAAO), , Putrajaya, Malaysia, 15-18 August, 2016.
144. “Gut Microbial Community on Adult Fitness and Larval Rearing of Bactrocera cucurbitae (Coq.) and Bactrocera dorsalis (Hendel)”, M. Khan, K. Seheli, M. A. Bari, S. A. Khan, M. A. Hossain, G. Tsiamis and K. Bourtzis, Vienna, Austria, 17-21 May, 2017.
145. “Recent Surveys of Fruit Flies (Diptera: Tephritidae: Dacinae) in Bangladesh”, L. Leblanc, M. A. Hossain and S. A. Khan, Pacific Branch Meeting and Conference, Entomological Society of America, , Portland, Oregon, USA, 2-5 April 2017.

#### **Microbiology and Industrial Research Division**

146. “Application of Gamma Radiation and Physicochemical Treatment to Improve the Bioactive Properties of Chitosan Extracted from Shrimp Shell”, J. Aktar, M. Z. Hasan, T. Afroz, H. Rashid and M. K. Pramanik, International Conference on Applications of Radiation Science and Technology (ICARST 2017), , Vienna, Austria, 24 - 28 April, 2017.

### **Plant Biotechnology and Genetic Engineering Division**

147. “*In vitro* Propagation of Pink Cassia (Cassia Renigera Wall. Ex Benth) An Exotic Ornamental Plant in Bangladesh”, M. R. Islam, M. T. Jahan, P. K. Roy, M. H. Kabir and A. N. K. Mamun, 8th International Plant Tissue Culture & Biotechnology Conference, Department of Botany, University of Dhaka, 03-05 December, 2016.

### **INSTITUTE OF RADIATION AND POLYMER TECHNOLOGY (IRPT), AERE**

148. “Molecular Investigation of naturally Occurring Bacterial Strategy in Degrading or Detoxifying Heavy Metals from Buriganga River, Dhaka”, A. A. Mamun, M. I. Hoq, R. A. Khan, A. H. M. Kamal, T. Begum and F. A. Koly, International Conference on Mechanical Engineering and Applied Science (ICMEAS-2017), MIST, Dhaka, Bangladesh, 22-23 February, 2017, pp. 81.
149. “Biodegradation of Hazardous Residual Pesticide by Pesticide Resistant Naturally Occurring Bacteria”, F. A. Koly, A. H. M. Kamal, M. I. Hoq, R. A. Khan, A. A. Mamun and T. Begum, International Conference on Mechanical Engineering and Applied Science (ICMEAS-2017), MIST, Dhaka, Bangladesh, 22-23 February, 2017, pp. 80.
150. “Variation in Water Quality Level with the Seasonal Changes by Determining Physicochemical and Microbiological Water Quality Parameter of Turag River, Dhaka, Bangladesh”, T. Begum, A. Chowdhury, S. Manir, A. H. M. Kamal, M. S. Rahaman, S. Sultana, M. Razzak and R. A. Khan, International Conference on Mechanical Engineering and Applied Science (ICMEAS-2017), MIST, Dhaka, Bangladesh, 22-23 February, 2017, pp. 77.
151. “Removal of Chromium and Lead from Paint Industry Effluent by Naturally Occurring Bacteria”, T. Begum, M. I. Hoq, R. A. Khan, A. H. M. Kamal, M. S. Rahaman, A. A. Mamun and F. A. Koly, International Conference on Mechanical Engineering and Applied Science (ICMEAS-2017), MIST, Dhaka, Bangladesh, 22-23 February, 2017, pp. 74.
152. “Fabrication Mechanical and Interfacial Properties of Jute Fabrics Unsaturated Polyester Resin-based composites, Kamrun Keya, Md Razzak”, R. A. Khan and M. S. Rahaman, International Conference on Mechanical Engineering and Applied Science (ICMEAS-2017), MIST, Dhaka, Bangladesh, 22-23 February, 2017, pp. 68.
153. “Water Quality Parameters of Padma River Water near Rooppur Nuclear Power Plant Site”, M. N. Salam, M. S. Rahaman, M. Razzak, H. A. Rashid, M. M. Haque, R. A. Khan, International Conference on Mechanical Engineering and Applied Science (ICMEAS-2017), MIST, Dhaka, Bangladesh, 22-23 February, 2017, pp. 68.

### **INSTITUTE OF NUCLEAR MINERALS UNIT (INM), AERE**

154. “Uranium Potentiality of Cenozoic Tipam Sandstones Exposed in North-Eastern Part of Bangladesh”, R. K. Majumder, M. I. Khalil, B. M. R. Faisal and M. N. Zaman, The AusIMM International Uranium Conference 2017, Adelaide, Australia, 2017.
155. “Background of Assessing Geological Materials For A Potential Low and Intermediate Level Radioactive Waste Repository in Bangladesh”, M. Rajib, C. T. Oguchi, G. Rasul, R. K. Majumder, M. I. Khalil, M. Z. Kabir, F. Deeba and M. Moniruzzaman, Joint JpGU-AGU International Meeting, Makuhari Messe, Chiba, Japan, 20-24 May, 2017.

### **INSTITUTE OF ELECTRONICS (IE), AERE**

#### **Robotics Instrumentation & Control Division**

156. "Optimization of Electrode Fabrication Parameters to Enhance the Efficiency of Natural Dye Sensitized Solar Cell", M. K. Hossain, M. F. Pervez, M. N. H. Mia, A. A. Mortuza, M. A. S. Haque, H. K. Ghosh, M. Hoq, F. Ahmed and M. A. Khan, National Conference on Electronics and ICT, Bangladesh Electronics Society, Dhaka, Bangladesh, 20 April, 2017, NC06, pp. 27-28.



157. "Natural Sensitizer Based Dye Sensitized Solar Cell: Optimization of Dye Extraction Parameters for Enhancement of Cell Efficiency", M. K. Hossain, M. S. Rahaman, A. A. Mortuza, M. A. S. Haque, H. K. Ghosh, M. Hoq, F. A. and M. A. Khan, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, RE-03, pp. 96-97.

#### **General Electronics Division**

158. "Design and Development and fabrication of Gamma Source Controller for Co-60 Gamma Irradiator of IFRB", F. Hafiz, F. Akter, M. A. S. Haque, A. A. Mortuza, H. K. Ghosh and M. Hoq, National conference on Electronics and ICT, 20 April, 2017, NC10, pp. 30.
159. "Design and Implementation of an Autonomous Wireless Information Transceiver Robot", N. B. Ahmed, S. Khan and F. Hafiz, National conference on Electronics and ICT, 20 April, 2017, NC12, pp. 31.

#### **Solar Cell Fabrication and Research Division**

160. "Comparative Study on the Surface Texturing Method for Crystalline Silicon Solar Cell", M. Asrafusjaman, G. Hashmi, T. Akter, M. A. R. Akand, M. K. Basher and K. Uddin, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January 2017, RE-05, pp. 98.
161. "Band Gap Measurement of P-Type Monocrystalline Silicon Wafer Using Spectral Response Measurement System", G. Hashmi, M. K. Basher, M. Hoq and M. H. Rahman, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January 2017, TF-07, Dhaka, Bangladesh, pp. 49.

#### **TRAINING INSTITUTE (TI), AERE**

162. "Metallurgical Observation of a Number of Metallic Artifacts extracted from old Forges in Japan", A. K. Das, M. N. Islam and T. Ohba, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 120.
163. "Designing a New Collimator and Preparation of Phantom for Neutron Radiography Facility in Bangladesh", S. Mistry, S. Saha, F. Nahid and M. N. Islam, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January 2017, pp. 115.

#### **NUCLEAR SAFETY, SECURITY AND SAFEGUARDS DIVISION, HQ, BAEC**

164. "Oxidative Degradation of Methylene Blue using Mn<sub>3</sub>O<sub>4</sub> Nanoparticles", A. K. M. A. Ullah, A. K. M. F. Kibria, S. B. Quraishi, M. N. I. Khan, A. R. M. Tareq and S. H. Firoz, 38th Annual Conference of Bangladesh Chemical Society-2017, Chittagong, 31 March 2017, S2(A), OP-05, pp. 18.
165. "Structure and Morphology Development Cytotoxicity of MnOx Nanoparticles on PC12 Cell", A. K. M. A. Ullah, A. K. M. F. Kibria, S. B. Quraishi, M. Akter, M. N. I. Khan and S. H. Firoz, 38th Annual Conference of Bangladesh Chemical Society-2017, Chittagong, 31 March 2017, S2(B)OP-08, pp. 25.
166. "Development Needs for Strengthening the Nuclear Security Regime of Bangladesh", H. M. B. Alam, A. Imtiaz and A. K. M. F. Kibria, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, RHP-02, pp. 103.
167. "Synthesis of Mn<sub>3</sub>O<sub>4</sub> Nanoparticles Via A Facile Gel Formation Route and Study of Their Phase and Structural Transformation With Distinct Surface Morphology Upon Heat Treatment", A. K. M. A. Ullah, A. K. M. F. Kibria, M. Akter, M. N. I. Khan, M. A. Maksud, R. A. Jahan and S. H. Firoz, National Conference on Physics-2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, MM-08, pp. 86.

**NUCLEAR POWER AND ENERGY DIVISION (NPED), HQ, BAEC**

168. “The Roadmap of First NPP Project in Bangladesh”, M. A. Razzaque, M. Khalaquzzaman, I. I. Choudhury, N. R. Kundu, M. K. Alam and S. Akbar, Conference for Nuclear Power in the Asia Pacific region, Manila, Philippines, 30 August – 02 September, 2016.

**NATIONAL INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (NINMAS), SHAHBAG**

169. “18 FDG PET-CT in Predicting Acute Respiratory Distress Syndrome: A Case Report”, M. S. Ahsan, S. M. F. Begum, P. Mutsuddy, T. Mandol and S. Salekin, Asian Nuclear Medicine Academic Forum (ANMAF 2017), Shanghai, China, 11-13 May, 2017.
170. “Is FDG PET an Over Burden Test For Breast Cancer Management? Not Really!”, J. A. Haque, S. M. F. Begum, A. B. Siddique and H. A. Rahman, Asian Nuclear Medicine Academic Forum (ANMAF 2017), Shanghai, China, May 11-13, 2017.
171. “PET CT Imaging in Differentiated Thyroid Carcinoma Patients With Rising Serum Tg/Anti Tg Antibody”, S. Sultana, S. Momtaz, F. Begum, N. Nahar and R. Hussain, 11th International Conference on Radiopharmaceutical Therapy (ICRT) in Kochi, Kerala, India, 13-16 November, 2016.
172. “Using Six Degrees of Freedom Motion Information to Correct Motion Induced Reconstructed SPECT data with algorithm, Md. Nahid Hossain, Kamila Afroj Quadir, Adnan Kiber and Roger Fulton”, International Conference on Medical Physics (ICMP-2016), Bangkok, Thailand, 09-12 December, 2016, pp, 509.
173. “Medical Physics Education and Training in Bangladesh- An overview”, M. N. Hossain, M. H. Rashid, T. A. Biman and K. A. Quadir; International Conference on Advances in Radiation Oncology (ICARO2), Vienna, Austria, 20–23 June 2017, pp. 83.
174. “TRIGA Mark - II Research Reactor Based Radioisotope Production in Bangladesh and its Prospective Application”, M. A. U. Azim, M. Hasan, K. A. Quadir and N. Hossain, The IAEA Technical Meeting (F1-TM-52895) on “Specific Applications of Research Reactors, Production and Use of Radiotracers”, Vienna, Austria, 20 - 23 June, 2016.
175. “Introduction of Radiobromine Labeled Benzovesamicol Analogue As A New and Prospective Neuroimaging Probe With The High Affinity For Sigma ( $\sigma$ ) -1 receptor”, M. A. U. Azim, T. Kozaka, I. Uno, D. Miwa, Y. Kitamura and K. Ogawa, 15th Annual General Meeting of ARCCNM in conjunction with 7th CJK Conference on Nuclear Medicine, , Shenyang, China, 15 July, 2016.
176. “Production and Therapeutic Application of iodine-131 in Nuclear Medicine of Bangladesh: Present Status and Future Plan”, M. A. U. Azim, M. Hasan, R. Hussain, I. H. Ansari, F. Nasreen, N. Hossain, T. A. Biman and S. Salekin, 11th International Conference on Radiopharmaceutical Therapy (ICRT), Cochin, India , 13-17 November, 2016.
177. “Recurrent Well Differentiated Thyroid Carcinoma - Prognosis and Clinical Outcome”, F. Nasreen, 11th ICRT (International Conference on Radiopharmaceutical Therapy), Cochin, India, 13-17 November, 2016.
178. “Simulation of Motion Induced SPECT Data using IDL Function With Developed Algorithm”, M. N. Hossain, A. Kiber, K. A. Quadir and R. Fulton, International Conference on Physics in Medicine and Clinical Neuroelectrophysiology (PMCN-2017), Dhaka, Bangladesh, 10-11 March, 2017.
179. “Treatment Monitoring in Multi Drug Resistance Tuberculosis using 18F FDG PET-CT”, S. M. F. Begum, F. Begum, M. A. S. Khan, S. Dey, K. K. Nath, N. Hossain, N. Sultana, R. Hussain and J. Bomanji, 22nd National Conference of Society of Nuclear Medicine, Bangladesh, Gazipur, 24-25 February, 2017, pp. 78.

180. "Assessment of Proton Therapy & New Proposed Plasma Therapy on The View of Bragg Effect", T. A. Biman, M. N. Hossain, A. U. Azim, R. Azad and M. Rabbani, National Conference on Physics- 2017, Atomic Energy Centre, Dhaka, Bangladesh, 5-7 January, 2017, pp. 54.
181. "FDG PET-CT in Detecting Tumor Recurrence not Evident in Whole Body <sup>131</sup>I Scan in Differentiated Thyroid Carcinoma", S. Sultana, F. Begum, S. M. F. Begum, N. Nahar and R. Hussain, 22nd National Conference of Society of Nuclear Medicine, Bangladesh, Gazipur, 24-25 February, 2017, pp. 79.
182. "PET-CT in Pediatric Patients with Lymphoma- One Year Experience at NINMAS, Dhaka", F. Begum, S. M. F. Begum, R. Hussain, S. Sultana, A. T. M. A. Rahman, L. Nisa, K.A. Quadir, T. Pascual and M. Hasan, 22nd National Conference of Society of Nuclear Medicine, Bangladesh, Gazipur, 24-25 February, 2017, pp. 80.
183. "Survival Outcome in Patients with Severe Left Ventricular Dysfunction Detected by Gated SPECT Myocardial Perfusion Imaging", A. K. Sarker, F. Nasreen, L. Nisa and R. Hussain, 22nd National Conference of Society of Nuclear Medicine, Bangladesh, Gazipur, 24-25 February, 2017, pp. 83.
184. "Effectiveness of preoperative Lympho Scintigraphy for the Detection of Cervical Lymphnode Metastasis in Patient with Oral Squamous Cell Carcinoma", M. A. Habib, Q. B. Rahman, R. Begum, S. M. F. Begum, P. Mutsuddy, A. K. Sarker and K. K. Nath, 22nd National Conference of Society of Nuclear Medicine, Bangladesh, Gazipur, 24-25 February, 2017, pp. 86.
185. "Routine FDG Production and Performance of Cyclotron in Terms of Saturation Yield Over Beam Current", M. K. Islam and N. Islam, 22nd National Conference of Society of Nuclear Medicine, Bangladesh, Gazipur, 24-25 February, 2017, pp. 88.
186. "Elastoscan to Differentiate Benign from Malignant Thyroid Lesions and Correlation with Cold Nodule in Thyroid Scan and Histopathology", A. K. M. F. Bari, G. R. Hawlader and S. Salam, 22nd National Conference of Society of Nuclear Medicine, Bangladesh, Gazipur, 24-25 February, 2017, pp. 90.

#### **INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), DHAKA**

187. "Flow Mediated Vasodilation (FMD) & Carotid Intima Media Thickness (IMT) For Evaluating Endothelial Dysfunction in Patients With Coronary Artery Disease", S. K. Biswas, A. W. Chawdhury, F. S. Haque, F. Rahman, M. Hossain and S. Hossain, International Conference on Integrated Medical Imaging in Cardiovascular Diseases (IMIC-2016), Vienna, Austria, 10-14th October, 2016.
188. "Agreement Between Thyroid Uptake of <sup>99m</sup>Tc Pertechnetate and <sup>131</sup>I", S. Hossain, 22th National Conference of Society of Nuclear Medicine, Bangladesh, BRAC CDM, Gazipur, Dhaka, 24-25 Feb, 2017.
189. "Thyrotoxicosis with Osteoporosis: A Case Report of A 16 Years Old Girl", M. Islam, 3rd Asian Nuclear Medicine Academic Forum, Shanghai, China, 11-13<sup>th</sup> May, 2017, pp. 142.

#### **INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), MITFORD**

190. "Imaging of Nuclear Medicine", S. Sharmin, Conference Hall, SMCH, Mitford, 16 April, 2017.

#### **INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), KHULNA**

191. "Sonographic Detection of Intravesical Foreign Bodies", A. K. Paul, 6th Khulna Divisional Medical Conference, BPMPA, 4 March, 2017.
192. "Treatment of Carcinoma-thyroid", A. K. Paul, Khulna Medical College Hospital, 16 January, 2017.
193. "Skeletal Scintigraphy: Diagnostic & Therapeutic Value", J. Das, Khulna Medical College Hospital, 11 August, 2016.
194. "Color Doppler Study in Liver Diseases", J. Das, Khulna Medical College Hospital, 27 October, 2016.

195. “Sonographic Evaluation of Pediatric Kidney Disease”, J. Das, Khulna Medical College Hospital, 12 January, 2017.

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), COMILLA**

196. “Effects of Thyroxine Withdrawal in Patient With Differentiated Thyroid Cancer”, M. S. R. Miah, M. R. Islam and M. M. Parvej, 11th International conference on Radiopharmaceutical therapy (ICRT), Cochin, Kerala, India, 13-17 November, 2016.
197. “Radiation Level of A Room Designed and Contracted For High Dose Radioiodine Therapy in Differentiated Thyroid Carcinoma-INMAS Comilla Model”, M. M. Hoque, M. S. R. Miah, R. Islam and M. M. Parvej, Asian Nuclear Medicine Academic Forum (ANMAF-2017), Shanghai, China, 11-13 May, 2017.

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), RAJSHAHI**

198. “Study of Radiation Dose Rate from Patients Undergoing Radionuclide Bone Scintigraphy”, S. I. Chowdhury, K. Z. Shah, R. Rahman, N. Begum, M. Hossain, P. Ahmed, M. M. A. Hosen, S. Khatun, M. F. Uddin and S. K. Mostaque, National Conference on Physics- 2017, Atomic Energy Centre, Dhaka, Bangladesh, 05-07 January, 2017, pp. 107.
199. “Evaluation of serum Thyrotropin and Urinary Protein Level Among The Pre-Eclamptic Pregnancies”, N. Begum, K. Shah, P. Ahmed, M. Hossain and S. I. Chowdhury, 3rd Asian Nuclear Medicine Academic Forum (ANMAF-2017), Shanghai, China, 11-13th May, 2017.

**INSTITUTE OF NUCLEAR MEDICINE & ALLIED SCIENCES (INMAS), DINAJPUR**

200. “Chronic Obstructive Pulmonary Disease”, Dr. B. K. Bose, 3rd International Conference, Australia 11 - 12 July, 2016.
201. “CHEST-SGP Congress”, Dr. B. K. Bose, Basel, Switzerland, 07-09 June, 2017.