3. RESEARCH SUPPORT FACILITIES

3.1 HIGH VACUUM LABORATORY

M. Archunan, A.Kothari, P.Barua, A. Mandal

Installation of new Low Energy Ion Beam Facility (LEIBF) has been the major activity of the group, this year. High Voltage deck, ECR source along with electronics, GP tube, beamline components, experimental facilities etc. have been installed. Wiring of the components to control console is in progress. Installation and alignment of LINAC cryostat chamber II and III was also done.

3.1.1. Installation of Low energy Ion Beam Facility

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A new Low Energy Ion Beam Facility (LEIBF) has been installed in a newly built Low Energy Ion Beam building. The facility can deliver various beams with wide range of energies ranging from a few KeV to a few MeV. A detailed layout was designed consisting of different optical elements, diagnostics, vacuum systems, etc. as per ion optic calculations. The entire facility can be divided into four different sections, which are

- High voltage (HV) deck with ECR source and Isolation transformer
- Accelerating section between deck and magnet.
- Analysing cum switching magnet.
- The three Beam lines.

The beamhall is L shaped. The ECR source sits on a 400 kV deck. The multiply charged positive ion beams from the ECR source are to be transported to analyzing cum switching magnet, which analyses and bends the ion beam into one of the three beam-lines at 75 degrees, 90 degrees and 105 degrees.

Vacuum System: A combination of getter pump and ion pump has been installed in accelerating section and all the beamlines. ECR and deck components are provided with a combination of turbo pump and dry scroll to take care of high outgassing load. An electromagnetic scanner has been installed in the material science line, for scanning over an area of 50 mm x 50 mm. For this purpose, intermediate section starting from end of the scanner magnet up to entrance of the target chamber has been widened to a diameter of 150 mm. So an additional turbo pumping system has been installed in this section to limit the gas loading from the chamber side into rest of the beamline. All monitoring and control equipments have been provided with necessary interlocks to prevent vacuum accidents.

Installation : The floor of the beam hall has been strengthened by embedding base plates on the floor at all the load bearing surfaces i.e. under the magnet, high voltage deck and under all the beamline stands and facilities. The beam axis height for this facility has been kept at 1.75 m from the floor. To install beamline components at this height, a complete support structure, consisting of beamline stands, channels, brackets and related accessoroies, were designed and fabricated. All these components were powder coated for better finish and life. The magnet was placed and aligned properly using LEICA theodolite. The accelerating section, deck (high voltage deck) components and all the three beamlines were installed step by step and aligned with reference to the ports of the magnet. All vital components like ECR source and electrostatic accelerator coloumn (GP tube), beam diagnostic components (BPM and Faraday cup), beam focussing/steering elements (quadrapoles, beam steerers and scanners) and beam slits have been installed precisely within an accuracy of ~ 0.5 mm. Reference points for beam height and beam axis have been transferred on the floor and on the walls at all the necessary points. All the controllers for beamline valve and Faraday cup and their interfacing units are modular based and are designed and fabricated in-house. These are very compact, easy to operate and provided with status readback, which facilitate easy diagnosis of faulty points. To meet various requirements of the facility most of the components were indigenously designed and developed. Some of the critical components developed are

- High Voltage Deck: The high voltage deck is a stainless steel, two storey deck (Figure 2). The deck sits on three storeys of insulators and has been tested to hold 400 KV potential. All the power to deck is supplied through an indigenously designed and fabricated two stage Isolation tranformer (400KV, 25 kVA capacity). A 400 KV high voltage Glassmann power supply is used to accelerate the beam from ECR through accelerating coloumn.
- ECR source stand.
- All the beamline stand, brackets and accessories.
- Electrostatic quadrapole doublet and triplet.
- Control panel console, instrument racks and cable trays.
- Experimental chambers.
- Electrostatic steerer and scanner.
- Vacuum pumping crosses and all intermediate chambers.
- Modular based pneumatic valve controllers and Faraday cup controllers.

- Interfacing control units between Indigenous Measurement and Control System (I-MACS) and device controllers.

Fig. 1. Beamline

Fig. 2. High Voltage Deck

3.1.2 Installation and Alignment of LINAC Cryostat II and III

LINAC Cryostat I has been in operation for a few years and the cryostats II and III were under fabrication at that time, so in their place, beam line elements like quadrapole and vacuum pumps were installed. Now LINAC Cryostat II and III are ready so the space for the installation was created by dismantling and removing existing beamline components. The cryostats chambers have been installed at their positions and aligned for height and axis. All the cavities hang from the top plate which rests on the cryostat chamber's top flange. First of all the levelling of the chamber was done, so that misalignment due to gravity pull is zero. The chambers were then aligned with beam axis within 0.5 mm accuracy. The reference plates are aligned and reference point was transferred on each of the plate. These points on the two plates then serve as reference for alignment of cavities, when the top plate assembly is kept on a separate stand, out of the cryostat. The plate caves in a bit when the cryostat chamber is put under vacuum. This shifts the reference points on the plates by 2 mm. Both the LINAC cryostats II and III have been connected with the beam line and isolation valves have been installed at appropriate places.

3.1.3 Installation of Magnetic Steerer between LINAC Cryostats

For the installation of electromagnetic steerers in between LINAC I and II and in between LINAC II and III, two brackets were designed, fabricated and installed. The design is simple and is made up of small components assembled together by bolts and nuts. The space at the place is very less so the support has been taken from LINAC chamber reinforcements. The bracket can be easily dismantled in future if required.

3.2 MAINTENANCE AND SERVICING OF POWER SUPPLIES AND MAGNETS

Rajesh Kumar, S.K.Suman, Mukesh Kumar, A.Mandal

Beam transport system group is primarily responsible for the breakdown and scheduled preventive maintenance of the beam transport system at IUAC Ion accelerator. The group has also taken additional responsibility of maintenance of different types of power supplies used in other facilities. Also the group has extended its repairing skills for different instruments other than power supplies.

3.2.1 Beam transport System

Breakdown Maintenance: Approximately 150 instruments of different types including magnets, power supplies, CAMAC based control modules, Magnetic field measuring instruments, beam line switchers are in round the clock operation. During beam time any malfunctioning in electronic sections and as well as in power sections are taken care immediately. In case of electronic card failure, faulty cards are replaced with spares and in case of power section failure repairing is done in-situ. No major breakdown occurred this year except a few operational problems because of power fluctuations and failures which were attended immediately.

Scheduled preventive maintenance: Preventive maintenance has been done during scheduled maintenance periods for smooth and efficient running of accelerator beam transport system. In case of power handling instruments such as power supplies and magnets, power dissipation management is very essential to avoid high temperatures which can lead to frequent failures and even major breakdowns. To ensure smooth operation during beam time following steps of preventive maintenance were carried out twice this year.

- Thorough operational/functional testing of power supplies using remote and local control.
- Output voltage ripple monitoring of all power supplies.
- Output current stability measurement of all bending magnets.
- Safety interlock testing by generating false interlock status.
- Temperature monitoring of water cooled components at full load.
- Checking for loose and corroded connections.
- Changing deteriorated cooling water hoses.
- Changing corroded water cooled heat sinks.
- Dust cleaning of electronic sections and power sections.

- Temperature monitoring of magnets and power supplies at full power to check for proper cooling.

Installation/Upgradation:

- Six old power supplies (100A/47V) of quadrupole magnets have been replaced with new power supplies. The old power supplies were 22 years old and having no spare backup and output current stability also deteriorated.
- Two magnetic steerers along with associated power supplies (4 nos., 10A, 15V) were installed in between cryostats I, II & III to have better control on beam tuning.

3.2.2 Maintenance of power supplies other then BTS

Target development Lab (TDL) power supplies: Following four type of High power High voltage supplies with different functionality are used at TDL. Two breakdowns attended this year.

- 6kW-Electron beam source power supply (6kV, 1A)
- Electron XY sweep controller
- 2kW-Electron beam source power supply (4kV, 0.5A)
- Fast Atom beam source power supply (100mA, 3kV)

High voltage detector bias supplies: Three types of indigenously developed power supplies (5kV, 3kV and Pre amplifier PS) were repaired and serviced when ever reported.

- **Service and repair of instruments other than power supplies**
- XRD controller (Mat. Sc.)
- AFM controller (Mat. Sc.)
- Cryogenic temperature hall probe
- Ph-2 A/C plant chiller controller.
- Event /turn counter of superconducting quadrupole coil winding machine

3.3 DETECTOR LABORATORY

A. Jhingan, P. Sugathan

Detector Laboratory at IUAC provides experimental support to various users in setting up charged particle detectors and readout electronics. New detectors and electronics have been designed and developed for new experimental facilities. Apart from various developmental activities, the group is intensively involved in various user experiments in nuclear reaction dynamics in HIRA, GPSC and Neutron Array using heavy ion beams. Detector lab provided training on experiential activities for Scientist Trainees, JRF students, and M.Sc orientation program students.

3.3.1 Detector system for transfer studies in GPSC

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A new detector setup comprising of two position sensitive MWPC and an ionization chamber (IC) has been developed to study transfer reactions in GPSC (Fig.1).The setup was tested off-line with ^{241}Am alpha source and used in user experiment using ^{28}Si beam on ^{90,94}Zr targets. One MWPC was placed in forward angle to detect target like particles and the other MWPC followed by IC was placed at backward angle to detect projectile like particles in coincidences. The MWPC provided time of flight as well as the positions (for angular distribution) and the IC provided the differential energy loss and and total energy for Z identification. Both MWPCs have an active area of 5cm x 5cm, and IC has an active area of 8cm x 4.5cm with an active depth of 21cm. A split anode geometry has been used in IC with 4 segments. All detectors use 0.5 micron thick mylar foil as entrance window.

The MWPC has a 4 electrode geometry where each electrode is fabricated using 20 micron diameter gold plated tungsten wires at 25 mil pitch. Anode is fabricated with 10 micron diameter wire. Positions are extracted using delay line technique. MWPC signals are extracted using fast timing amplifiers.

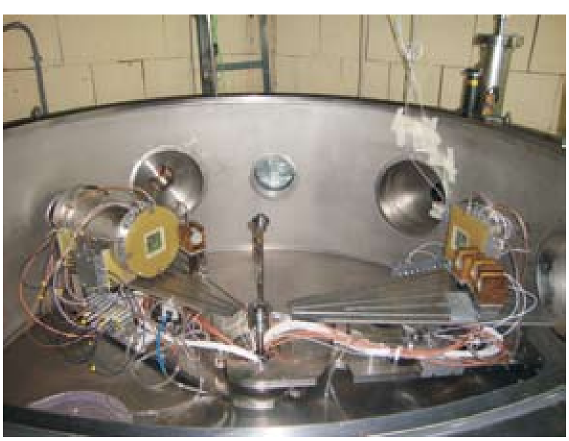

Fig.1. Experimental setup in GPSC

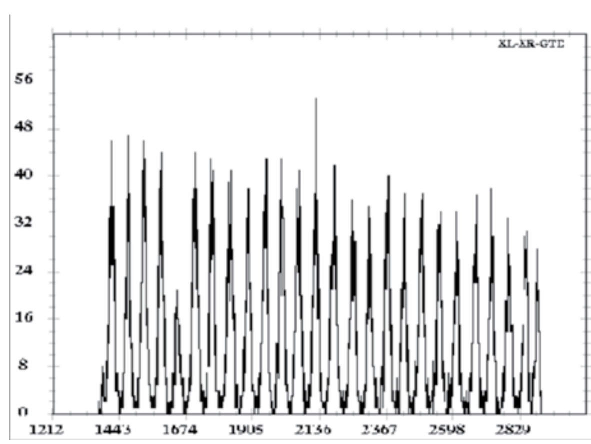

Fig.2. Masked position spectra

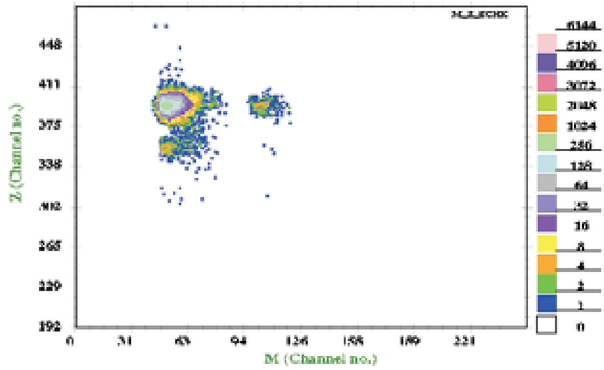

Fig.3. Plot of M/Z vs. Z

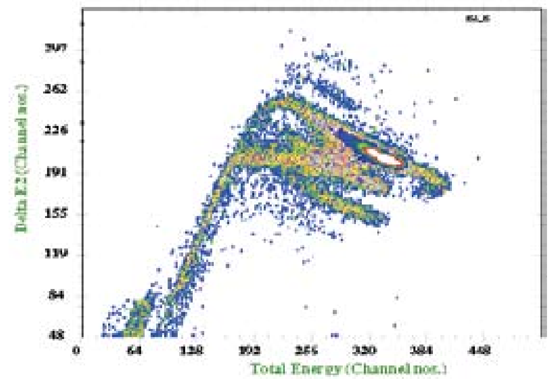

Fig.4. Z identification spectra

IC has a transverse field geometry with three electrodes: cathode, Frisch grid and a split anode (segmented into four parts along the beam direction). Frisch grid consists of 20 micron diameter gold plated tungsten wires at 1mm pitch stretched on a 3.2 mm thick printed circuit board. This design was preferred over the commercially available crossed wire mesh since it gives a better transmission and more uniform field as compared to later. An isolated guard ring was used with a uniform field gradient (using a resistive chain). Detector was operated with a single negative supply on cathode and anode grounded using high value resistors. The four anodes were read using charge sensitive preamplifiers (90 mV/MeV Si equivalent) placed in vacuum next to the detector to avoid degradation of the signal.

The detector was operated at 4 mbar isobutane for alpha test. A position resolution of 0.45 mm (fwhm) was observed (Fig.2). Rise times of the signals were close to 4 ns. Energy resolution of the IC was observed to be 110 keV (fwhm) for 5.486 MeV 241Am alpha. A mass resolution of 1 amu was desired in the experiment which could not be achieved owing to thick target and other experimental conditions. Fig.3 shows the plot of M/Z against Z. Mass M values were extracted applying momentum conservation using CANDLE software. A good Z separation was observed during the experiment using the IC (Fig.4).

3.3.2 Detector setup for HYRA focal plane

HYRA focal plane currently has a MWPC with an active area of 57mm x 57 mm followed by Silicon detector (50 mm x 50mm). It is planned to increase the active area of detection system by replacing the small MWPC with a large area MWPC (150mm x 50mm). Since the detector chamber in HYRA is routinely operated at very low pressures (~1Torr), a higher gain design will be desired. This can be achieved using a smaller wire pitch of 25 mils and reduced wire diameter of 10 micron for the anode. The active area of the silicon detector will also be increased by placing three detectors, each with an active area of 50mm x 50mm.

Three detectors are from CATE array used in RISING campaign at GSI. We would like to acknowledge Prof. H. J. Wollersheim (GSI) for providing these detectors. Efforts are on to develop readout of the detectors using home made preamplifiers followed by commercial shaping amplifiers. The setup is likely to be used in the coming experiments.

3.3.3 Detectors for Neutron array

New detectors for detecting fission fragments are currently being designed and fabricated. These detectors have been designed to pursue the mass gated neutron multiplicity measurements using heavy ion beam at LINAC energies. It is desired for the fission detectors to have a good time resolution < 500ps to exploit the fast timing capabilities of LINAC and at the same time good angular resolutions (~ 0.2 degrees) to measure the mass-angle correlations. The new detectors will have an active area of about 160 mm x 110 mm. The detector will have a four electrode geometry. We intend to use discrete inductor capacitor chips, in place of conventional DIP package, to extract the position information using the delay line technique. This allows reduced wire pitches with improved position resolutions. Two prototype frames have been fabricated with 1 ns/tap delay and tested using a time calibrator. Uniform time delay was observed as shown in fig. 5. The frames were designed to have a 25 mil wire pitch (20 micrometer gold plated tungsten wire). Such a design is expected to give a position resolution of ~ 0.5 mm. Frames are currently under fabrication with stretched wires. The detectors are likely to be used in future GPSC/NAND experiments.

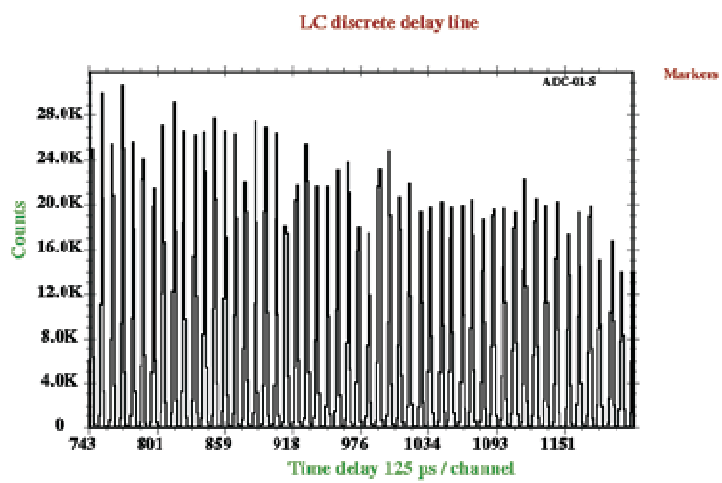

Fig. 5. Time delay

3.3.4 Charged particle detectors for slowed down beam campaign at PRESPEC

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In the scope of future slowed down beam campaign as a part of PRESPEC project at GSI, a test experiment was performed following off-line test with radioactive sources to study the feasibility of charged particle detector setup for secondary reaction studies at FRS / super FRS. The detection setup requires a beam tracking system preceding the secondary target and a particle identification system for identifying the secondary reaction products. The FRS beam slowed down in a degrader to Coulomb energies is cocktail in nature containing several radioactive species and have a poor quality in terms of energy spread (3 MeV/A to 10 MeV/A) and spot size (~ 5cm FWHM). The beam tracking detectors will determine trajectory and mass of these species using position information and time of flight (TOF) technique. The particle identification (*A, Z*) system requires position sensitive TOF and ΔE – E telescopes.

The detection system comprises of two position sensitive micro-channel plates (MCP) and a silicon strip detector and was set up in the experimental area after the UNILAC accelerator. All the detectors have an active area of 5 cm x 5 cm. Since a mass resolution of better than 1 a. m. u. (A~100 region @ 5 MeV/A) is desired, a time resolution of 100ps will be required by the TOF detectors. Thin totally depleted silicon detectors have an intrinsic time and energy resolution better than 100 ps and 50 keV (for 5.48 MeV ^{241}Am alpha) respectively. Thus they are an ideal choice for ΔE detector since they can give both differential energy loss (for *Z* identification) and fast timing (for *A* identification). For our test measurements, we used a 40 micron thick Silicon strip detector (design W) from Micron Semiconductors, UK. It has 16 strips on both front and back side in orthogonal direction. Position sensitive MCP is intended to be used as beam tracking detectors. They are read by fast current amplifiers, placed next to detector inside vacuum. To extract both good energy and timing simultaneously from the silicon detector, charge sensitive preamplifiers (for energy) were connected to the back side and fast timing amplifiers to front side. Two different combinations of these amplifiers were used. In one combination, energy is extracted using Mesytec charge sensitive preamplifiers followed by Mesytec Shapers. The timing is extracted using current amplifiers fabricated in GSI using monolithic microwave integrated transistors with a gain of about 0.5 mV/MeV. These transistors were placed on the mother board (inside vacuum) on which the detector is placed. In the second combination energy is extracted using charge sensitive preamplifiers which are custom built by IKP – Cologne for the LYCCA charge particle detector setup, and timing is extracted using a 32 channel timing amplifier, custom built by Mesytec using current feedback amplifiers, having a gain of 1mV/MeV. Further analog processing is done using standard NIM CFD and amplifiers. The data is digitized using a VME based data acquisition system. Off-line testing was performed using ^{252}Cf fission source and a mixed alpha source.

To evaluate the timing performance of the system, a test experiment was performed using 5.2 MeV/A ^{48}Ca beam from UNILAC on 150 μg/cm^2 Gold target. Scattered beam particles were detected in detection system placed at 15 degrees with respect to beam axis.

The TOF resolution observed for both MCP is 140 ps (FWHM). Silicon detector exhibited an average time resolution of 380 ps with rise times of about 3 ns with the GSI timing amplifiers. The Mesytec timing amplifiers gave an average time resolution of 530 ps with rise times of 10 ns. This is somewhat poor resolution due to high capacitance of the detector (~ 6 nF @ 400 pF/strip). The timing resolution can be improved by cooling the detector and modifying the readout electronics. In future, further tests will be performed with these modifications. It is also planned to explore the feasibility of using Multi Wire Proportional Counters in place of MCP as beam tracking detectors.

3.3.5 Axial Field annular Ionization Chamber

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An axial field annular ionization chamber (IC) has been developed by the UGC – DAE – CSR, Kolkata Centre in collaboration with IUAC. The detector has a three electrode geometry, namely an anode sandwiched between two cathodes (grounded). Inter-electrode distance is 10 mm. The electrodes have a circular geometry. The anode is segmented into 12 parts. Cathodes are made using the 20 micron diameter gold plated tungsten wires, and the anode using the commercially available grid. The detector is intended to be used in INGA campaign for transfer reaction studies.

3.3.6 Repair of damaged MWPC in NAND/GPSC

The two MWPC used for the detection of fission fragments in NAND were damaged in a vacuum accident during an experiment. The accident destroyed the cathode foils, X – position wire frames and entrance window. All the frames have to be remade. They are currently under fabrication. These detectors were replaced by the GPSC MWPC. One of these MWPC was found to break down with incident heavy ions. On inspection it was found that wires in X – position frame were sagging. This frame is also currently being fabricated.

3.4 TARGET DEVELOPMENT LABORATORY

D. Kabiraj, Abhilash S. R and D. K. Avasthi.

Target Development Laboratory at IUAC provides facilities to the users for the preparation of targets used for the experiments with IUAC Pelletron and other ion beam facilities. Several users have used the following facilities for the studies in Nuclear Physics, Atomic Physics, Materials Science and Bio Science: (i) a high vacuum evaporator, equipped with 2kW electron beam gun, evaporation setup by resistive heating, online thickness monitoring by quartz crystal thickness monitor. This evaporator is pumped by a diffusion pump with liquid nitrogen trap, with a base pressure of high $5x10^{-7}$ mbar. (ii) The oil free pumping system for the second evaporator includes a cryo-pump, a turbo molecular pump and a scroll pump, with a base pressure of $6x10^{-9}$ mbar. This evaporator is equipped with a 6 kW 4-pocket electron gun and evaporation setup by resistive heating method and a dual crystal thickness monitor and controller for online thickness monitoring and process control. (iii) A rolling machine for the preparation of thin foils by cold rolling method. (iv) A facility with wide atom beam source (ABS) has been used for the fabrication of composite thin films by sputtering method, making surface structuring on single crystal and amorphous materials.

This laboratory prepares isotopically enriched targets for the users related to nuclear physics and atomic physics experiments [1-6]. 130 $\mu g/cm^2$ thick targets of enriched ^{170}Er sandwiched in two C layers of 45 $\mu g/cm^2$ and 23 $\mu g/cm^2$ respectively, were prepared successfully [1]. Instead of depositing Er on self supporting C, floating the whole assembly of C-Er-C gave better efficiency. Optimization of substrate temperatures found out to be very crucial to achieve successful deposition and floating. $BaCl_2$, C, Er and C were deposited maintaining the substrate temperatures 280^0C for $BaCl_2$, 260^0C for first C, 240^0C for Er, and 220^0C for the next C. After the deposition was over, the temperature was maintained at 200^0C for an hour and then cooled very slowly. 100nm $BaCl_2$, 200 nm C, 150 nm Er and 100 nm C were deposited on glass-slide and floated to have sandwiched Er targets. To know the purity of the target, XRF was done and no high Z impurity was found.

Rolling technique was used for the fabrication of ^{160}Gd targets of ~1 mg/cm^2 thickness [2]. Gd tends to form oxide when in contact with oxygen present in the atmosphere. To minimize oxidation, which tends to spoil the foils when the surface area of the Gd foil significantly increases and the foil becomes very thin, an uninterrupted flow of Argon was maintained in between the rolls to create an inert environment. It was observed that foil catches fire suddenly and burn the foils. The oxidation of Gd is exothermic reaction, which causes such burning. In the precise observation it was noticed that, the burning of foil was taking place due to the spark in between the tip of forceps and foil while moving the foil. The spark was observed when foil thickness was less than ~10 mg/cm^2. Strong tendency of Gd to burn in air, accumulation of electric charge due to friction in rolling were the reasons. An antistatic wrist strap with uninterrupted flow of Argon was very effective in protecting the Gd foil from burning. A metallic clip was also attached to the antistatic wrist strap. The Gd foil, forceps, stainless steel folder and rolls were frequently earthed by the metallic clip and the wrist strap of antistatic wrist strap.

Thin self-supporting isotopic platinum (Pt) targets of 130–200 $\mu g/cm^2$ thickness have been prepared by evaporation technique, using selective etching and parting reagent methods [3]. The evaporation yield of the selective etching method was higher in comparison to the parting reagent method. To the best of our knowledge, the vacuum evaporation technique has not yet been employed for the fabrication of Pt targets successfully, due to alloying of Pt with the commonly used crucible materials like tungsten (W), molybdenum (Mo) and tantalum (Ta), etc, thus reducing the evaporation yield to a large extent. In order to avoid the alloying of Pt with the crucible material, a specially designed graphite crucible, prepared from 8 mm diameter high purity graphite rod, was used. The crucible was 8mm in height with a 5mm diameter and 3 mm deep drilled core as shown in Fig. 1. The purity of targets formed has been assessed by the Energy Dispersive X-ray Fluorescence (EDXRF) and Elastic Recoil Detection Analysis (ERDA) techniques. The analysis indicated that the targets prepared by the selective etching method contain 2 wt% of Cu. Contamination of C was found to be 2.5 wt% in the targets prepared by both of these methods.

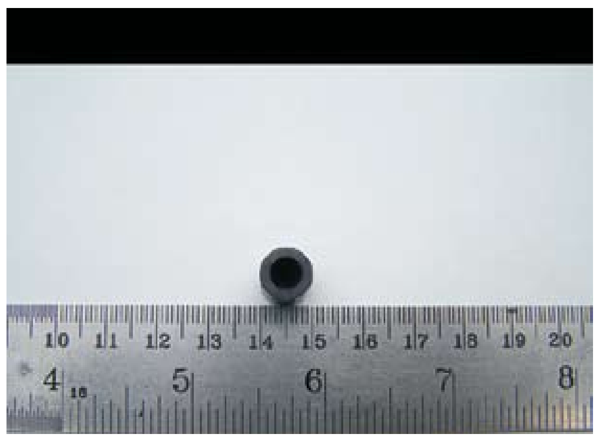

Fig. 1. Graphite crucible used for evaporation of Pt.

Several composite thin films (a few to quote are Ni-SiO_2, Pd-C, Pd-SiO_2 etc.) have been fabricated by co-sputtering technique using newly installed high current atom beam gun [7-9]. Figure 2 shows the RBS spectrum of ZnO-Tb co-sputtered thin film. The simulation of

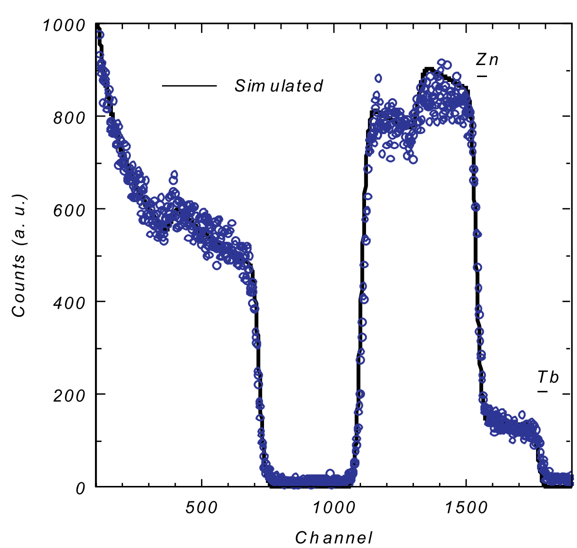

Fig. 2. RBS spectrum of ZnO-Tb co-sputterd thin film.

the spectrum indicates uniform distribution of Tb in ZnO matrix. Beam current of 35 mA and extraction voltage of 950 V is used during this deposition.

A new evaporator has been fabricated and is in the process of installation. An electron beam gun with special arc-suppression mechanism can operate at > 5 millibar of oxygen which will be installed in this evaporator. This multi-pocket electron beam gun will be useful for the preparation of oxide thin films and multi-layers thin films.

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3.5 RF & ELECTRONICS LABORATORY

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3.5.1 Multi-channel front end electronics

An 8-channel front end electronics system for multi-element solid state detector has been developed and successfully tested. The generic analog front end requirements such as preamplifier, shaping amplifier for energy spectroscopy and Low Level Discriminator (LLD) to generate corresponding ADC GATE logic are incorporated in a compact non-NIM standard cabinet in order to replace the existing electronics as close as possible to a multi-element detector system in an experimental area. Each circuit block has been assembled in a daughter card form and plugged into a mother board. Essential controls, test and interface connections are provided on the panels while minimizing the number of controls. The implemented electronics have all standard features and controls available in a setup using commercial modules.

Specificaions:

- Charge Sensitivity : -44mV / MeV (1pF) or -4.4mV / MeV (10pF) (Si. Equ.)
- Noise slope : ~40 eV/pF between 0-100pF with 0.5uS Ts constant.
- Shape : Positive, Unipolar Semi-Gaussian
- Time constant : 0.5 uS, T_{peak} = 1.0uS, 50% width: 1.3uS, 1% width: 3uS, with BLR
- Gain : Typical gain 12 (+10volt >> 20MeV, 200MeV)
- System Noise : ENC: 680electronics, ~6KeV FWHM (Si.)

3.5.2 Status of electronics for NAND array at IUAC

Technology transfer: Due to large scale requirement of PSD modules for various pulse shape discrimination applications in the country, a memorandum of understanding (MOU) has been signed between IUAC and M/s. ECIL, Hyderabad for technology transfer of PSD electronics module for commercial production in 2009. The prototypes developed at M/s. ECIL, based on the above know-how transfer have been inspected at IUAC, as per agreement and correction have been reported for final prototypes and evaluation with detectors at IUAC. The final prototypes are expected to be delivered to IUAC for evaluation.

3.5.3 Development of Time to Amplitude Convertor (TAC)

This project was undertaken to use with slow detectors such as CsI. It accepts TTL logic Start and Stop input pulses and generates an analog output pulse proportional to the time interval between the two inputs. This prototype has been made for 1uS time range corresponding to the dynamic range of 8V. Performance of the module was found to be satisfactory in terms of Resolution, INL, DNL and stability when compared with commercial TAC (Ortec 566) using NAND setup.

Based on the above experience another prototype was developed for 100nS Range. This accepts F/NIM input signals. Module showed comparable performance with commercial TAC with respect to resolution, INL and stability.

3.5.4 Development of SSB detector electronics module

A dual channel single width NIM module, containing shaping amplifier along with logic circuitry, has been developed to process energy signal coming from Silicon surface barrier detector. The energy output coming from charge sensitive preamplifier is fed to this module. Shaping amplifier is made with fixed 1uS time constant, fixed PZ for 50uS decay time and provides unipolar output. Its gain can be adjusted by two on board jumpers and a front panel 8 position binary coded switch to handle input signal in the range of 20 MeV to 200MeV. Timing information, i.e. Trigger_out and Gate (F/NIM), were generated from the signal extracted before shaping. This module has been used in nuclear physics experiments with LINAC beam in NAND experimental area.

3.5.5 Development of the Multi-harmonic buncher (MHB) for High Current Injector (HCI)

The Multi-harmonic buncher mainly has three different parts : the mechanical assembly, the tank circuits and the electronics. The mechanical assembly consists of a 14 inch side cubical vacuum chamber with six ports of which two have NEC type flanges and the other four have conflat flanges. Two additional view ports are also present in the chamber. This chamber houses the grid assembly which includes copper cones and cone extensions. Apart from these a copper box to house the tank circuit coils and capacitors also form a part of the mechanical assembly. A complete set of drawings were made for the entire mechanical assembly and its constituent parts. The fabrication work for the entire mechanical assembly is nearing completion. After the fabrication the vacuum tests will be conducted on the chamber. The Molybdenum grids required for bunching have already been procured. The vacuum variable capacitors for the tank circuits have been imported from Omnicor. The OFHC copper tubes are being ordered. The testing of the prototype MHB electronics in association with the BTS group is in progress and the designing and fabrication of a new MHB electronics will start shortly after studying the prototype modules.

3.5.6 High power solid state power amplifier development

A high power solid state radio frequency power amplifier capable of delivering 2kW (CW) at 97MHz has been demonstrated. This amplifier is built with in-house developed solid state power amplifiers (97MHz, 350 watts) and commercially available splitters and combiners. As shown in the figure, the RF input fed from signal generator is fed to a 1:2 quadrature splitter and its outputs are fed in phase to a set of four amplifiers. These amplifier outputs are combined in a four port in-phase combiner. The combined power outputs (in quadrature) are fed to a high power quadrature power combiner, to deliver more than 2kW (CW). The development work has been carried out to develop compact high power radio frequency amplifier using splitter, combiner technique for various on going projects at IUAC.

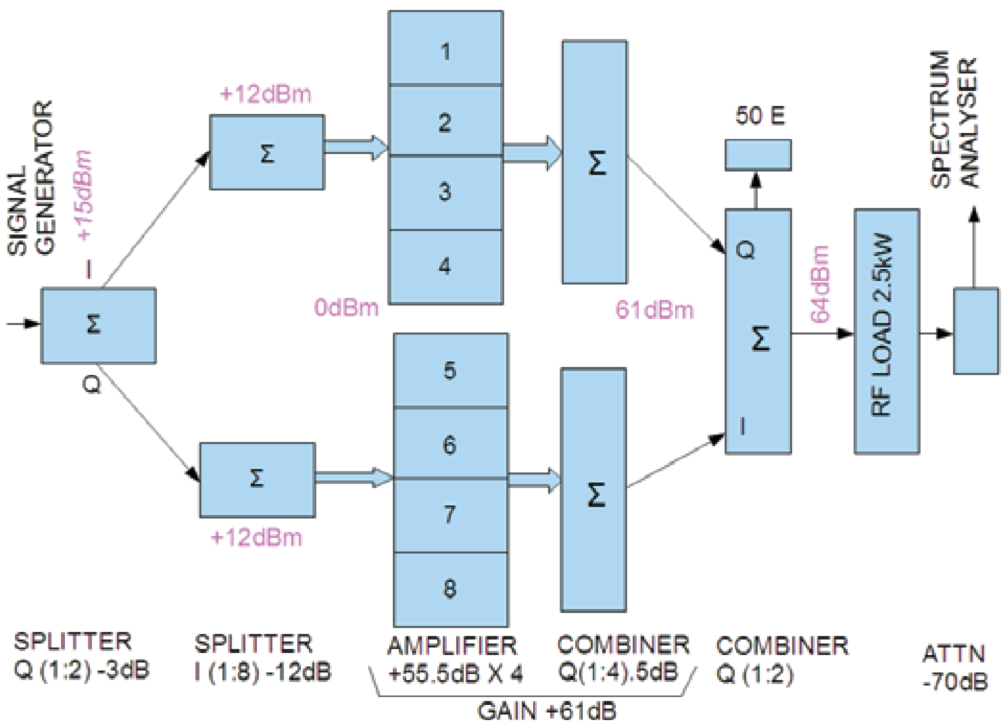


Fig. 1. Schematic diagram of 2kW solid state power amplifier

3.5.7 General Purpose Crate (GPC) for Control Applications

A General Purpose Crate (GPC) capable of handling digital and analog Inputs/ Outputs signals has been developed at Inter University Accelerator Centre (IUAC), New Delhi, for accelerator control system applications. The system includes back-plane bus with on board plugged-in single board computer with PC104 and Ethernet interface, running Linux operating system. The bus control logic is designed on the back-plane pcb itself, making the system more rugged. The various types of digital and analog input/output modules can be plugged into the back plane bus randomly with standard euro connectors, which provides highly reliable and dust free contacts. Maximum eight modules can be inserted into the crate. The total power consumption for various types of modules and back-plane controller is approximately 50 watts. The multi-output DC power supply from COSEL has been used in the crate. The general purpose crate is software compatible with the CAMAC crates used in the accelerator control system.

3.5.8 VMEDAC64 12-bit 64 Channel DAC for VME bus

A new VMEDAC64, a Versa Module Europa (VME) module, features 64 Analog Voltage Outputs, has been developed for control applications at Inter University Accelerator centre (IUAC) on a 6U VMEbus. The FPGA (Field Programmable Gate Array) is the module's core; it implements the complexity of control logic and VME bus slave interface. The low cost per channel or high density of 64 Analog Outputs on a single width 6U VME board is the unique feature of VMEDAC64 module which is not available in similar products at present. VME slave is implemented as a component in the firmware which can be used in the future designs without any change and hence speed up the prototyping. Control of analog output is as easy as writing the binary equivalent to a dedicated dual port register (per channel). Digital-to-analog conversion takes place automatically with total 7.040 ms (max.) output refresh time for 64 channels. Each channel has software controlled output switch which disconnects analog output from the field. The VME bus slave interface and control logic is implemented in a single FPGA chip to achieve a density of 64 channels in a single width, double height (6U) VME module. On-board DC/DC converters are incorporated for isolated power supply requirements.

3.6 ELECTRICAL GROUP ACTIVITIES

U. G. Naik, Raj Kumar

Electrical group primarily has a responsibility of maintaining the electrical installations of the institute. This group is also responsible for upgrading in electrical infrastructure take care to meet the requirement of scientific augmentation projects of the institute. It is a pleasure to put on record that the uptime achieved for electrical systems was close to 100%. This was possible with judicious maintenance schedules and monitoring arrangements. This group has also successfully completed the projects and works envisaged for the year F.Y.2010-2011.

MAINTENANCE:

3.6.1 Captive Power Installations

Institute has a captive power base of 860 KVA, having DG capacities from 100-320KVA. Group has successfully managed the power backup requirements with the captive power sets available. The group has always shown readiness in running the systems round the clock and within short notices smoothly.

A 750KVA DG Set for running the existing Helium plant as well as the new helium plant (to be installed soon) has been ordered. We have also made detailed plans to meet the present demand of emergency power by diverting the 2nos. of 320 KVA DG sets taken out of helium circuit.

3.6.2 Voltage Stabilisers

The group has managed to have another year of 100% uptime without a single break in the supply through 1MVA and 500 KVA stabilisers catering to major loads such as A/C plant-II, Helium Compressors, 15UD Pelletron & experimental areas.

3.6.3 UPS Installations

This year we planned, procured and put in to service 2X60 KVA UPS from Emerson Network for 1.7MeV Pelletron. Electrical group with the help of AMC of various suppliers/ manufacturers has maintained 2X300KVA UPS, 4X60 KVA UPS, 1X50 KVA UPS, dedicated to feed motor loads of Helium Compressors, High Current Injector systems respectively. About 20 nos. of UPS rated from 2-10kVA are looked after and maintained in house by the group. During the present year all UPS were very healthy and had 100% uptime.

3.6.4 Power Factor Compensation

Electrical group is very happy to declare that yet again we achieved average power factor almost near to unity throughout the year. Our system power factor without correction is about 0.85 and by raising it to near unity we saved around Rs.55 lakhs through the year from energy billing.

3.6.5 Communication Equipments

Electrical group maintains the hand held radio stations (Walkie-talkie) and base station. Till now we have 14nos. of hand held stations and one base station. The routine maintenance includes replacement of batteries, antennas, switches etc. These are always kept in working order. Any major repairs are required are got done through authorized service agents. The group takes the responsibility of getting the revalidation of license periodically from the Ministry of telecommunications.

3.6.6 Maintenance of Substation, Power and Lighting Installations of Office Complex and Residential Colony

Maintenance of electrical installations is managed through the AMC with an external agency; however, all the material required is supplied by us. This year we had freshly appointed an agency through open tendering and worked very hard in framing the specifications for the smooth operation. The electrical group is proud to declare here that during this year the installations have performed efficiently with uptime close to 100%. Few of the major yearly maintenance activities carried out are listed as below.

- Dehydration of transformer oil.
- Periodic maintenance of LT panels, Distribution boards and other accessories, Lighting, Fixtures, lighting and power circuits.
- Servicing of DG sets 60kVAX2nos, 2X 320 kVA, 1X 100 kVA-twice a year.
- Maintenance of street lighting and earthing.

3.6.7 Energy Saving

Energy savings measures taken earlier continued in the areas where we had installed the energy saving time switches and CFL lamps, T-5 lamps etc.

PROJECT WORKS:

3.6.8 UPS Systems

Group carried out exhaustive study in consultation with Pelletron group and framed the design specifications for the electrical part for the 1.7MeV pelletron at Engineering Building. The scheme involves a LT panel (input panel) with 2x630A electrically operated fixed type ACBs, 2X60KVA Online UPS in parallel redundant mode in modular configuration, output panel and batteries for UPS. The installation is put into operation since Dec 2010. The project completion cost was `15.75 lakhs.

Group has carried out detailed study in consultation with the experimental facility incharges and framed the design specifications for providing Uninterrupted and clean power in the Beam Hall –II area. For this we have planned 2X60KVA Online UPS in parallel redundant mode in modular configuration, Input panel and output panel alongwith UPS batteries for standard 10min. backup. UPS are already installed and waiting for its commissioning. The project completion cost would be 15.75 lakhs.

Both the sets were tested at factory in the presence of a member from this group to the entire satisfaction.

3.6.9 Electrical works for 1.7MV Pelletron

Group has planned, designed electrical power distribution scheme for providing uninterrupted power to the new pelletron with total power backup. This work includes set of electrical power distribution panels, copper and aluminum armoured/unarmoured cables, chemical type of electrical earthing, cable trays and lighting the lab. The work also included a 415/210volt 3phase, step down transformer in star/star configuration manufactured by a indigenous manufacturer. All the panels were tested at factory in the presence of a member from this group to the entire satisfaction. Testing of earth electrodes was done at site and results were recorded and were up to the satisfaction. The total work costed around `13 lakhs.

3.6.10 Electrical works planned for Helium plant-II (Linde)

Electrical Group has planned, designed electrical power distribution scheme for providing uninterrupted power to the new Helium plant-II with total power backup. This work includes set of electrical power distribution panels (outdoor/indoor both type), power factor correction panel, copper and aluminum armoured/unarmoured cables, chemical type of electrical earthing, cable trays etc. Existing UPS of 2X300 KVA shall be used for powering the new helium compressor. 750KVA DG set is also part of this project for providing the backup power. The status of the project is order has been placed on lowest bidder in 3rd week of Jan 2011 with a completion period of 4 months. DG set testing has been done at manufacturers place (factory) in presence of the group member and ready delivery. All the items required in the work are expected to at IUAC before end of March2011. Total work order value is `86 lakhs.

3.6.11 Electrical Energy management network

Electrical group had installed hardware and software with an intention to monitor and deliver good quality power the user in year 2000 through M/s Conzerv, a Banglore based firm. Now since the Firm has been merged with Schnieder Electric co. they were unable to provide support for expansion of the network as the software had no further license for addition. Therefore the group has ordered anew software from Schneider Electric that will work with the existing hardware and also has scope for increasing the size of network. Order value is 2.3lakhs.

3.6.12 Electrical Safety

As all the electrical installations of 1.7MeV pelletron are mounted on a steel platform at a height of 3mtr this has been insulated for electrical safety. As per the new standards, nominal 2.0 mm +/-10% thick insulated Synthetic Mat conforming to IS 15652: 2006 and meeting the requirements of IS 5216 (Part1, 2&3), IS 8437, IEC-479 Pub-1 along with suitable adhesive /chemibound, Pu resin, waterproofing compound and sealing material as per in service recommendation of Annexure 'A' Clause 'C' of IS 15652 and suitable for class-A up to 3.3KV without trolley movement have been procured and installed. This work has been completed at a cost of 2lakhs.

3.7 COMPUTER AND COMMUNICATIONS

S.Mookerjee, E.T Subramaniyam, S.Bhatnagar

The year has seen a number of major developments, including the commissioning of the High Performance Computing facility at the Centre, a complete overhaul and upgrade of the Centre's local area network, the integration of the Centre into the National Knowledge Network, and reorganization and upgrade of the central server pool.

3.7.1. High Performance Computing Facility

The Centre's high performance computing facility, funds for which were sanctioned by the Department of Science and Technology in 2008, was inaugurated on the 27th of April, 2010. The facility provides urgently needed supercomputing access to university users across the country, and also provides a big boost to the ion-solid, nuclear physics and atomic physics simulation programs at IUAC. The facility is targeted at computational chemists, physicists and biologists in the university system, working in the areas of materials science, atomic and molecular physics and chemistry, radiation biology and nuclear physics.

In its first phase, the facility consists of a 400 gigaflop SMP system, a 6 teraflop distributed memory cluster, and the power and cooling infrastructure to support more than 50 teraflops of distributed memory computing. The Sun Enterprise M9000 shared memory system is configured with 20 SPARC-VII CPUs (80 cores at 2.52 GHz), 256 GB of RAM, and 3 TB of directly attached storage. The MPI cluster consists of 96 Sun Fire X2200 nodes with dual quad core Xeon CPUs, a total of 768 cores at 3.0 GHz. Each node is configured with 16 GB of RAM and 500 GB of disk, with a 20 GB/s Infiniband interconnect. In addition, 10 TB of storage is available on a PVFS2 cluster, also connected to the Infiniband. Together, the facility is configured to take on a variety of scientific HPC applications, with different requirements of CPU and memory access.

A feature of the facility is the data centre housing the distributed computing cluster, which is notable for its efficient use of space and electrical power. With a capacity of 600 servers and associated networking equipment in a space of 50 m^2, this is one of the densest computing facilities anywhere. The high server density results in a very high heat density, making cooling a critical challenge. The cold water based in-rack cooling infrastructure in the data centre is one of the first such in the country, and is capable of cooling 20 kW per rack, at power efficiencies about 30% better than standard data centre precision air conditioning.

The data centre for the Kalki MPI cluster consists of 16 standard Rittal 19" 42U server/network racks, each attached to a Rittal LCP. The data centre is configured to handle the planned expansion in Phase II of the project. The LCPs work on chilled water, which is supplied through a system of 4 Kirloskar pumps, 4 Voltas 33 TR chillers, a 1000 litre expansion tank, and more than a kilometre of pipes with associated valves and gauges. Chilled water to each LCP is directed through a system of SS pipes running under the racks in the DC. Power to the cluster is supplied through 10 Rittal 50 kVA modular rack-mounted UPS systems. Electrical power in the data centre is supplied through two coupled bus bars. A fire alarm interfaced to a FM200 based fire suppression system has been installed. The fire warning system is additionally connected to a relay, which would switch off all electrical power to the DC in the event of a fire alarm. A monitoring system enables remote monitoring and limited remote control of the UPS, LCP and server parameters, and includes warnings and switch-off thresholds for air and server temperature, humidity, leaks and power conditions.

The use of water in a data centre which also carries 500 kVA of electrical power is fraught with safety implications and needs to be addressed thoroughly in both the design and implementation stages. The data centre construction therefore demanded a rigid insistence on compliance with every aspect of the original design and the list of approved makes of pipes and fittings; on factory and independent test reports to cross check quality of every pipe, cable and component; and the time-consuming monitoring of each of the more than 400 joints and welds in the systems of pipes from the pumps to the LCPs. The testing of the infrastructure was done before placing the servers in the racks, by putting an array of 20 1 kW heater elements and a fan array to simulate server air flow in each rack. The testing led to some additions to the monitoring and control systems. At the end of the test phase, all systems successfully handled both the electrical and heat loads. The involvement of the Centre's electrical, mechanical and civil engineering groups, at the design, implementation and testing phases, was instrumental in the successful setup of the data centre.

The 10 kW Sun Enterprise server requires much simpler infrastructure. IUAC's existing data centre has been partitioned to make room for the M9000, and a APC rack-mount UPS and redundant 3.5 TR split ACs with air flow directed to match the servers bottom-up air circulation suffice to meet power and cooling requirements.

The installation of the Kalki cluster was done using a standard Rocks 5/CentOS setup with Intel, OFED and PVFS2 rolls. The HPL benchmark results for the cluster was 6.2 teraflops, which is average at about 70% of peak efficiency. No special optimizations for the cluster hardware were made in running the benchmark. Since the inauguration, users from IUAC, universities and institutes have used the cluster, and successfully run public-license atomic physics, MD and DFT codes. The PARCAS and IMPACT ion-matter interaction MD codes have also been ported, and are running efficiently. The Solaris 10 OS and Sun Studio 12 compiler suites were installed on the Sun M9000 server. The HPL benchmark run with all 80 cores clocks in at 403 gigaflops. Users have installed and run the atomic physics GAMESS code, and a protein folding code.

Two workshops on high performance computing were organized as part of the training and outreach program of the new facility. The first, held in October 2009, was a one-day workshop on "Simulation Studies and Large Scale Computing" which focused on simulations in nuclear physics and ion-matter interactions. The second was a two-day workshop on "High Performance Computing" held in April 2010 to coincide with the inauguration of the new facility.

The first months of full operation have seen the facility used by computational chemists, biologists and physicists from eight universities and five institutes, besides IUAC users, a peak load of 95% and an average load of more than 60%.

3.7.2 IUAC LAN and servers

The local area network at IUAC was first set up in 1995, and was designed as a 10 Mbps 50-node LAN using hubs, a thick Ethernet backbone and 10base2 thin Ethernet cables to nodes. Over the years, as new buildings came up and the number of desktop PCs exploded, the network was expanded incrementally to seven networks with a total of 450 nodes, 100 Mbps UTP cabling, with a Cisco 3750 core switch and Cisco 2950 edge switches connected to the core through either fibre or 100 Mbps copper. In addition, as the number of desktops in each lab increased, users put in hubs and switches. The incremental additions, the 100 Mbps edge-to-switch bottleneck and the haphazard collection of managed and unmanaged hubs and switches had over time led to the network becoming unreliable and difficult to manage, besides becoming difficult to expand further to accommodate new buildings and users. This year, the LAN was overhauled to a single non-blocking 720-port 1 Gbps network, with fifteen Extreme X350 edge switches and two stacked Extreme X650 core switches, with 10 Gbps edge-to-core fibre connects. The main building cabling was re-laid to allow 1Gbps connectivity to the desktop. All IP addresses in the centre were changed to make up a single address space. With this, it is hoped that the network infrastructure has been laid out for the next few years, and will be able to accommodate the expected expansion. All central servers were also upgraded, and now are Xeon-based servers on Intel 1U platforms running Scientific Linux.

The centre was also connected this year to the National Knowledge Network, allowing fast access to Indian universities and institutes. This would ultimately allow effective resource sharing within the national education and research system, and is already useful for remote users of the high performance computing facility.

3.7.3 Data Acquisition System and Hardware development

Development of the next generation of data acquisition systems continued this year. In addition, the Global Event-identifier Module (GEM) [1] was successfully used in experiments, and the ASPIRE module developed for radiation biology experiments was further improved. The mass production and commissioning in experimental setups of the ADC814 14-bit 8-channel ADC was completed.

REFERENCES

[1] "Global Event-identifier Module: A distributed digital approach to event-of-interest identification logic for physics experiments", Kusum Rani and E. T. Subramaniam, Rev. Sci. Instrum. **81**, 075114 (2010)

3.8 AIR CONDITIONING, WATER SYSTEM AND COOLING EQUIPMENTS

P. Gupta, A. J. Malyadri, Bishamber Kumar

AC System

IUAC's Central Air Conditioning / Low temperature Cooling System of Phase-1 consisting of 400 TR Central AC plant performed with 100% uptime. Proper maintenance ensured that the safety record of the plant was maintained at 100% and the power consumption kept at optimum levels. The reciprocating compressors (1,3&4) have logged in approximately 96,000 hours each and the compressor#2 has logged 17,000 hours. Other rotary equipment except AHU#1-7 have logged in about 1,61,500 continuous run hours. The yearly maintenance costs have been maintained at approximately one-eighth the international standards of the installed project cost. Though, the plant has aged, yet the MTBF for all the equipment has shown a consistent rise over the years.

The Phase-II, Central AC Plant with a Centrifugal Chiller and with its installed capacity of 250 TR performed to an uptime of 100%. The plant catered to EBW, UPS, Beamhall#II and cryogenic activities. The highlight of the operation and maintenance of the above systems was the in-house responsibility and supervision provided to the contracts, thereby affecting substantial savings in the price paid for the operation and maintenance contracts.

The Phase-III, Central AC Plant with a Screw Chiller and with its installed capacity of 250 TR performed to an uptime of 100%. The pending works on Engineering building Air-washers were carried out by IUAC departmentally as CPWD expressed their inability to do the same.

Major work-highlights for changes affected in the above systems are as below:

To facilitate routine fumigation of Radiation Biology lab and to have a better dust environment, Central A/C was cut-off in the lab and four Nos. of 3.0 TR Split A/C's have been installed. Out of which only 2 units will be working at a time. A timer has been provided which will switch over to other unit as per the preset timing for round the clock operation.

Air-Conditioning was done in engineering building ground floor hall including under deck roof insulation for new 1.7 MV Accelerator. The A/C load was transferred on to the existing AHU#5 (23TR capacity) fed from Ph-3 A/C plant. Engineering building first floor

A/C was cut off from this AHU and local Window / Split A/C's have been provided in all the rooms.

A new lab, Atomic Absorption Spectrometry, has been set up in Beamhall#III first floor. For Air-Conditioning of this lab, 1 No. of 3.0 TR Split A/C has been provided.

The successful implementation of Ph-II & Ph-III Chilled Water Hook-up piping scheme has enabled us to take both the loads on either of the plants in the event of non-availability of minimum loads in any of the plants. This has also achieved huge electrical power savings. For six months period from Dec'09 to May'10, 1,87,879 KVA h units of electrical power was saved and the approximate savings were– 187879x5.2 = Rs. 9,76,970.80. The amount of money spent on the chilled water hook-up scheme (Rs. 6,44,965) was recovered with-in 4 months. Since December 2009, only one of the plant is running for both Ph-II & Ph-III loads and there-by effecting huge energy savings.

Ph-II 19 XL chiller micro processor LID buttons were not functioning and hence not able to run the machine. There was no option to run the chiller manually other than through LID. These buttons were not functioning because of the breakage of contacts. This problem was attended to in house by providing separate buttons on the existing LID. This has caused a savings of around Rs. 3 Lacks in replacement of the entire LID.

The equipment being into their twenty-second year of sustained operations **have far outlived their economic lives.** In the current year, plenty of repair activities were carried out. This was essential to reset the reliability of the equipment.

Water System

IUAC's centralized water system of Phase-I feeding low temperature cooling water of a total heat removal capacity of 115 TR, potable water supply and the gardening water supply performed to an operational uptime of 100%. This was possible due to the stringent maintenance practices that were followed over the years. The mechanical systems have already overshot 1,14,000 hours **beyond their expected life span.** A strict monitoring on the water quality ensured that the flow paths are in healthy condition.

IUAC's centralized water system of Phase-II feeding low temperature cooling water of a total heat removal capacity of 80 TR, Liquid Helium Cooling water of approx. 350 TR, potable water supply performed to an uptime of 100%.

IUAC's centralized water system of Phase-III feeding low temperature cooling water of a total heat removal capacity of 80 TR and potable water supply performed to an uptime of 100%.

Following changes were affected in the above systems:

- Process water SS Piping has been extended to Beamhall#II Store Extension Labs. Around 200 mts. of SS piping including thermal insulation has been been installed for the same and was connected on to the existing Ph-2 water system.
- Process water SS Piping has been extended to new 1.7 MV Accelerator facility. Around 200 mts. of SS piping including thermal insulation has been been installed for the same and was connected on to the existing Ph-III water system.

Cooling Equipment

Availability of equipment was recorded at around 99%.

New Works / Projects

Beamhall#III low side air-conditioning installation work has been inordinately delayed by CPWD. Lot of time was spent by us to co-ordinate the work with CPWD and to provide technical input for the same. It has finally taken a shape and is expected to be completed with in a month's time.

3.9 MECHANICAL WORKSHOP

B.B.Choudhary, S.K.Saini, R.Ahuja, S.Rao and J.Sacharias

The mechanical Workshop is serving as an in house machining and welding facility for the 15UD Pelletron accelerator laboratory, supporting various laboratories and large number of user community. Workshop has been involved in development activities of new system as well as a large-scale production of beam line components right from inception of IUAC. Most of the beam line components used for the new beam lines was fabricated in the IUAC Workshop. Workshop continues to assist the entire in house fabrication activities of LINAC, RFQ and DTL for HCI, INGA, HYRA, 1.7Mev Pelletron as well as the Cryogenic component developments.

The major facilities of the workshop are the Machine shop, Welding shop and the state of art Electron Beam Welding (EBW) machine facility.

The machine shop is equipped with a five axis Vertical Machining Centre and a CNC lathe. A Renishaw probing system is installed on the VMC. Apart from these, we have four conventional lathes, two milling machines and a radial drilling machine catering to the tool room jobs. Most of these machines are of HMT make, fitted with DROs for achieving higher accuracy and better productivity. Apart from these, we have cylindrical grinder, tool and cutter grinder, horizontal and vertical band saw machines, etc. for general requirements. One ITL make automatic vertical band saw machine has been added to the machine shop this year. We also have the CAD facility, Solid Works for the design and drafting purpose. We also have VISI CAM and PEPS for the CAM support for the Vertical Machining Centre and CNC lathe. A CMM is also installed in the workshop metrology section.

Welding shop is having high quality TIG welding machine and equipment. Some of the TIG machines can give pulsed arc for the thin section welding. Air plasma cutter with a capacity to cut up to 40mm thickness of stainless steel is used extensively. Aluminum welding and Oxy-acetylene cutting and brazing set ups are also available. We have a micro plasma machine from Air Liquide, France for very thin section welding.

The Electron Beam Welding facility is fully operational and fabrication of IFR-I resonators has been completed successfully. Workshop personnel are involved in almost all the major ongoing projects like spoke cavities and single cell cavities.

IUAC workshop is providing apprentice training for the ITI passed students in both welding shop as well as in machine shop. Basic workshop training is provided for the scientist trainees and Ph.D. students enrolled in IUAC.

Some of the major completed/ongoing projects :

- Radio frequency Quadrupole
- Drift Tube LINAC
- Electrostatic Quadrupoles
- Multi harmonic Buncher
- High current proton source for 2.45 Ghz source development program
- 50 keV Ion accelerator development work
- CCR movement system for XRD system
- ECR source stand and other assembly work
- LEIBF installation related work
- Spoke cavities
- Single cell cavities- etc.

3.10 HEALTH PHYSICS

S.P. Lochab, R.G.Sonkawade and Birender Singh

Health physics group involves in the field of radiation research, development and safety aspects. Recently patent has been filed from this group. Many university faculties and research scholars are using the facilities developed and maintained by this group. A few of the research scholars have completed their Ph.D. using the facilities and large numbers of research scholars are doing research available with this group. Electrochemical workstation for the development of the conducting polymers and nano particle composites deposition has been procured. Our group is working on the sensors using the conducting polymers and the same concept we would like to use for developing the radiation sensor.

Shielding blocks arrangement of research accelerator at BH-II with approval of commissioning of low energy 5SDH-2 Tandem Pelletron has been cleared by AERB. Recently colemanite powder having natural boron is converted into slabs using resin as binder and some excellent results are expected in this study. First time we used combustion method technique in the development of LiB4O7 nanocrystalline TL materials and we got good results. Work accepted in J. of Lumnsce. 2011. The radiation safety status of Pelletron accelerator in IUAC is maintained as per AERB regulations.

A Stepper Motor controller for exposures of samples with alpha has been designed and developed. Display of door interlock status in BH-I and BH-II was designed, fabricated and installed in the control room. A constant current battery charger was developed for search and secure system. Vacuum chamber for the energy loss measurement of alpha in the various gases/ medium was fabricated.

3.10.1 Radiation shielding door

On the basis of calculations by MCNP code and later on actual measurements done at Joint Institute for Nuclear Research (JINR), Dubna, Russia a sliding door for neutron and gamma radiation shielding is designed, fabricated and installed in HYRA area of BH-II.

A combination of HDPE, borated HDPE and lead+Iron in the ratio of 15:10:2 is calculated by MCNP code for estimating the sliding door thickness for beam hall-II.

Fe = 7.8g/cm^3; HDPE = 0.95g/cc; Boron Carbide = 2.54 g/cm^3, Pb = 11.4 g/cm^3

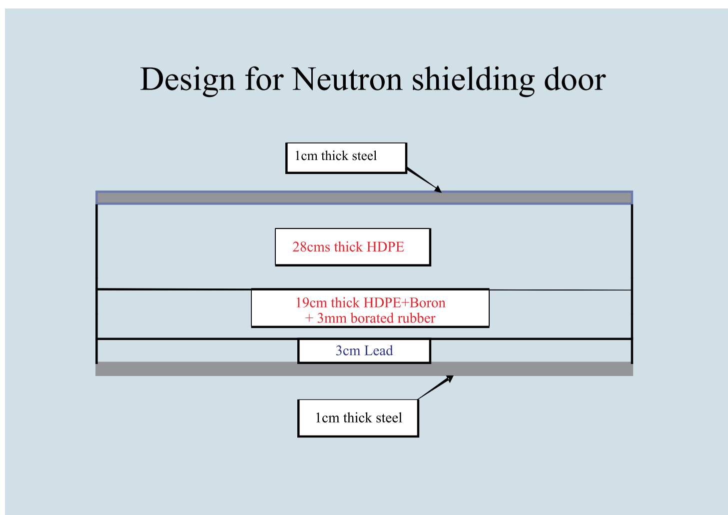
Average density for borated HDPE = 1.167 g/cm^3

Neutron Average Energy = 6 MeV,

Neutron fluence = 35×10^2 n/cm^2/sec at 1 meter.

The distance from the source where sliding door will be fitted is approx. 2 meter.

H, cm	Neutrons			
	Without Shielding		With shielding	
	(D0) µSv/h	(Φ0) n.cm2s-1	(Dn) µSv/h	(Φn) n.cm2s-1
0	1508	875	1508	875
2	1484	861	1373	870
7	1424	827	956	713
12	1369	795	575	458
17	1317	764	320	266
22	1268	736	168	144
29	1203	698	66	58
37	1134	658	22	20
47	1056	613	5	5



3.10.2 Gamma Chamber

Gamma Chamber model GC-1200 loaded with radioactive material (cobalt-60) of BRIT, Mumbai, is installed at IUAC. Gamma Chamber 1200 unit is designed to house up to 185 TBq (5000Ci) of Cobalt-60 source and the lead shielding provided is adequate enough to bring down the radiation leakage level on the exterior of the unit well below the accepted standards. It offers an irradiated volume of about 1200CC. The unit mainly consists of the following parts

a) Source and cylindrical source cage

b) Lead Flask as Biological shield

c) Central drawer with sample chamber

d) Mechanical driver system

e) External cabinet

Now IUAC is having irradiation facility of gamma and ion beams under one roof.

Gamma Chamber GC-1200

3.10.3 Synthesis and characterization of thermoluminescent $Li_2B_4O_7$ nanophosphor

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Lithium borate ($Li_2B_4O_7$) is a low Zeff, tissue equivalent material that is commonly used for medical dosimetry using the thermoluminescence (TL) technique. Nanocrystals of lithium borate were synthesized by the combustion method for the first time in the laboratory and its TL characteristics were studied and compared with those of commercially available microcrystalline $Li_2B_4O_7$. The optimum pre-irradiation annealing condition was found to be 300 ^{0}C for 10 min and that of post-irradiation annealing was 300 ^{0}C for 30 min. The synthesized $Li_2B_4O_7$ nanophosphor has very poor sensitivity for low doses of gamma up to 10^1 Gy whereas from 10^1 to 4.5×10^2 Gy this phosphor exhibits a linear response and then from 4.5×10^2 to 10^3 Gy it shows supralinearity. It shows low fading and a linear response over a wide range of gamma radiation from 1×10^2 to 5×10^3 Gy. Therefore the synthesized lithium borate nanophosphor doped with Cu may be used for high dose measurements of gamma radiations.

3.10.4 Thermoluminescence of Nanocrystalline $K_3Na(SO_4)_2$:Eu Irradiated With 75 MeV C^{6+} Ions

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Thermoluminescence of nanocrystalline $K_3Na(SO_4)_2$:Eu with grain size 17-37 nm prepared by coprecipitation method irradiated with 75 MeV C6+ ion-beam at different fluences in the range $1\times10^9 - 1\times10^{13}$ ions/cm^2 has been studied.

3.10.5 Luminescence characteristics of $Ca_{1-x}Sr_xS$:Ce nanophosphors

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Luminescence characteristics of $Ca_{1-x}Sr_xS$:Ce (x = 0, 0.25, 0.50, 1) nanophosphors have been investigated. XRD of all the samples show a single cubic phase of $Ca_{1-x}Sr_xS$:Ce. TEM micrographs exhibit the rod like structure of the samples with a decrease in diameter with decreasing amount of Ca. The results of TEM were found to be in good agreement with the XRD results. The PL emission spectrum has a main peak at 496nm with a shoulder at 551nm which may be due to the transition among 5d–4f levels of Ce in the mixed lattice. The red shift in the emission wavelength with increasing Ca content may be correlated with the change in crystal field of mixed host lattice for different Ca and Sr concentrations. We have also investigated TL response of $Ca_{1-x}Sr_x$:Ce to ^{60}Co γ- rays. All the samples with different Sr and Ca contents show different TL response. TL response for the sample with x = 0.75 shows the simplest TL glow curve with the maximum TL intensity, for which we have calculated the activation energy using glow curve deconvolution functions.

The thermoluminescence behavior of $Ca_{0.50}Sr_{0.50}S$:Ce nanophosphors have been investigated in the low (0.1–126 Gy) and high dose (1–6 kGy) range of gamma rays from ^{60}Co source at a heating rate of 10 K/s. The effect of different heating rates (5 K/s, 10 K/s and 15 K/s) on the TL glow curve has been investigated for the samples exposed to a dose of 1 kGy. All the samples with different Sr and Ca concentrations show different TL glow curves.

Thermoluminescence characteristics of UV irradiated $Ca_{1\_x}Sr_xS$: Ce as a function of x (0.25, 0.50, and 0.75) have also been investigated. TL glow curves of Ca_{1_x}SrxS: Ce (0.25,0.50, and 0.75) recorded after 450 mJ/cm^2 of exposure of UV radiations show almost similar structure except slight variation in the peak position. The trap parameters namely, activation energy (E), order of kinetics (b), and frequency factor (s) of $Ca_{0.75}Sr_{0.25}S$: Ce have been determined using Chen's peak shape method and GCD function suggested by Kitis for second order kinetics.

3.10.6 Synthesis and Characterization of doped Sulfide Nanoparticles

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We have synthesized Bi doped BaS and CdS nanocrystalline powder of average grain size 35 nm by solid state diffusion method using sodium thio-sulphate as a flux. During this work we have optimized the nature and amount of flux, amount the of dopant and temperature of firing for maximum yield of photoluminescence. The samples were characterized by X-ray powder diffraction (XRD) method, transmission electron microscopy (TEM), photoluminescence (PL) and UV- Visible techniques. The effect of dopant concentration on the photoluminescence of BaS:Bi nanocrystallites has been studied which is in agreement with the principle of concentration quenching. The energy band gap of bismuth doped BaS nanopowder has been calculated to be 4.25eV and is blue shifted in comparison to their bulk counterparts. The blue shift may be due to the quantum confinement in the particles. PL emission of CdS:Bi nanoparticles is at 413nmwith a shoulder at 438nmin addition to CdS peak at 550 nm. This may correspond to transition from 3P1 state to 1S0 states of Bi3+. Thermoluminescence and Raman studies have also been carried out on CdS nanophosphor. The Raman spectrum of CdS nanoparticles clearly shows first, second and third order LO Raman peaks when excited using the wavelength of 488 nm. The red shift of the Raman peaks in nanoparticles compared to that of bulk CdS may be attributed to optical phonon confinement. TL of Bi doped SrS nanocrystalline phosphors exposed to Cs137 gamma radiations has been investigated. The TL glow curve of _-irradiated SrS:Bi nanocrystallites consists of a glow maxima at 454K with small shoulders around 375K and 558 K. We have observed that the TL intensity increases with gamma dose, which may be explained on the basis of a high surface to volume ratio for the nanoparticles. These studies reveal that the 0.05 mol% of Bi3+ concentration is optimum for the maximum TL output. Further, the trapping parameters namely, activation energy (E), order of kinetics (b) and frequency factor (s) for SrS:Bi (0.05 mol%) have been determined using glow curve deconvolution (GCD) functions. Thermoluminescence of Ce doped SrS nanostructures exposed to Co-60 gamma radiations (0.1 Gy to7 kGy) has been investigated. TL glow curves for gamma doses in the range of 0.1–200 Gy, consist of a dominant peak at 386K with a very weak peak at 538 K. At higher doses (1–7 kGy), the peak at 386K shifts to the higher temperature of 421 K, while the other peak at 538K becomes more intense. This anomalous shifting of the first peak from 386K to 421K has been explained in the framework of Chen's peak shape method. Kinetic analysis of the experimental TL glow curve has been carried out using glow curve deconvolution (GCD) functions to determine the trapping parameters.

3.10.7 Thermoluminescence response of CaS:Bi^{3+} nanophosphor exposed to 200 MeV Ag^{+15} ion beam

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A study of the thermoluminescence (TL) parameters has been performed on swift heavy ion exposed Bi^{3+} doped CaS nanophosphors prepared by the chemical co-precipitation method. All the samples have been exposed to 200 MeV Ag^{+15} ions in a fluence range of $1 \times 10^{12} – 1 \times 10^{13}$ ions/cm^2. The prominent TL glow peak at 403 K (observed for the c-irradiated sample) appeared at the same position in the 200 MeV Ag^{+15} ion beam irradiated samples, while the other peak at 466 K disappeared and the broad peak normally measured at 534 K split into two peaks at 535 K and 582 K for the Ag^{+15} ion beam irradiated samples. The effect of different Bi^{3+} concentration has been investigated and it was found that the maximum TL intensity was measured for the 0.08 mol% sample. The effect of different heating rates on the TL response has also been determined. The trapping parameters (i.e. activation energy, frequency factor, order of kinetic) of all the individual peaks of the glow curves have been analysed by using Chen's formulae. The low fading and linear TL response in the range of $1 \times 10^{12} – 1 \times 10^{13}$ ions/cm^2 will be helpful to explore the potential use of this material for heavy ion dosimetry.

3.10.8 Radon & Thoron evaluation & analysis in water, soil and in environment using RAD7

R. G. Sonkawade

Natural radioactivity is wide spread in the earth's environment and it exists in various geological formations in soils, rocks, plants, water and air. Natural radioactivity in soils comes from ^{238}U and ^{232}Th series and natural ^{40}K. Uranium occurs in minerals such as pitchblende, uraninite etc. It is also found in phosphate rock, lignite and monazite sands.

In the present investigation the RAD7with RAD-Aqua and Soil gas probe is used for the evaluation & analysis of the radon, thoron concentration. RAD7 uses a solid state alpha detector which helps to distinguish radon from thoron and signal from noise. RAD7 was kept at various locations to find out the concentration of radon and thoron. A few prominent locations of Delhi such as, Bikaji cama place, Rajeev chowk, Kashmiri gate, AIIMS, etc., are studied. The concentration of radon and thoron in water samples were studied by using RAD-Aqua kit and the concentration of radon in the surrounding soil gas is measured by using soil probe. Thoron is associated with radon in soil.

The radon and thoron concentrations were found to vary from 11.1±2.3 Bq/m^3 to 65.5±5.7 Bq/m^3 and 9±2.7 Bq/m^3 to 69.8±7.6 Bq/m^3 respectively. The temperature was found to vary from 26 to 36.1^{0}C and relative humidity was found to vary from 19.6% to 42.8%. The influence of radon was found marginally higher near the bridges and around the building of concrete, which could be due to the high content of radon and thoron in the cement samples; however the concentration of thoron was slightly lower than that of radon. The influence of the traffic on the concentration of radon and thoron was also studied, the activity of radon and thoron was found maximum near the places of the heavy traffic. This influence of traffic on the activity concentration of ^{222}Rn & ^{232}Th was due to the presence of natural radioactivity in the fuels such as petrol, diesel, LPG, CNG etc., and another important factor is the attachment of the radioactive gases to the polluted air, which accumulates near the heavy traffic places. The concentration of radon found to vary from 1645Bq/m^3 to 3869Bq/m^3 in well water, the concentration of the radon was found to be inversely correlated with the Ph of water samples. Most of the values reported in the environment and water is well below the permissible limits.

3.10.9 An attempt to use polyaniline and conducting polymers as neutron sensor

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In this study polyaniline are irradiated with neutron at different fluences and studied for the radiation sensor properties using I-V, UV-Vis, Raman and XRD. X-ray diffraction of polyaniline irradiated with neutron at various fluences shows the change in crystalline behavior of polyaniline after irradiation. This may be due to the cross linking and formation of single and multiple helices. The UV-Vis spectroscopy was performed in the wavelength range 200-800 nm at room temperature for pristine and irradiated polyaniline. A shift of the absorption edge towards the visible region was observed for irradiated samples, which indicates a decrease in band gap after irradiation. Raman spectroscopy analysis of polyaniline were carried out in the range of 200-1800 cm-1 corresponding to the stretching modes of the different bonds, as well as to the rings C- H bending modes was studied before and after neutron irradiation. It was observed that only the intensity of particular functional groups varies. It is pointed that new small bands is formed for neutron irradiated polyaniline indicating cross-linking after irradiation.

Various other polymers were exposed with ionizing radiations such as gamma, neutron and ion beam with dose of 21.8625kGy-41.9375kGy, 6.87Gy-504.84Gy and 1E-11-1E-13 ions/sec respectively. Characterizations of these samples for structural, optical and electrical properties were investigated with a radiation weighting factors for all these radiations.

3.10.10 Synthesis and Characterization of ZnO Nano Particles

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Zinc oxide (ZnO), a versatile semiconductor material, has been attracting attention because of the commercial demand for optoelectronic devices operating at blue and ultraviolet regions. In the present study, a conventional chemical method that allows the direct preparation of nanocrystalline zinc oxide spheres with diameter ranging between 14 to 22 nm is reported. Simple and cost effective wet chemical route ZnO nanoparticles does require any surfactant, template and pre-seeding. Using solution of 0.45 M aqueous zinc nitrate, added drop wise (slowly for 40 min.) to 0.9 M aqueous solution of sodium hydroxide prepared in distilled water at a temperature of about 55 ºC under high speed stirring keeping same condition for 2 h, precipitated ZnO nanoparticles were cleaned with deionised water and ethanol then dried in air atmosphere at about 60 ºC. Optical characterization is being done using UV-Visible spectrometer and particle-size analysis by X-ray diffractrometer.

3.10.11 Experimental Condition induced variation in Texture coefficient of Crystal Planes in Cu and Ni nanostructures

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[2]Inter-University Accelerator Centre, New Delhi

In the present work, we found that synthesis of nanostructures to a large extent depends on the physical conditions of the experiment such as potential applied to the electrodes, temperature and pH of the electrolyte. For the synthesis of Cu nanostructures, we used polycarbonate track etched membranes of cylindrical shape with 100 nm as the pore diameter. A variation in the intensity of peaks in the XRD pattern is observed, as any of the above mentioned condition is changed during synthesis. The intensity of a peak in the XRD spectra is the direct reflection of orientation of a Miller plane in the crystal. Texture coefficient indicates that preferred orientation of crystal plane can be manipulated from experimental conditions to modify the material properties as per the requirement. Electrical conductivity of Cu nanowires varies with diameter of nanowires. However, keeping the diameter of nanowires constant, a variation in their electrical conductivity is observed after they were irradiated with gamma rays and neutrons. On the basis of I-V characteristics drawn at room temperature, decrease in the conductivity of Cu nanowires is observed, as compared to that of pristine nanowires.

Nanostructures of a typical ferromagnetic material, Nickel are fabricated by electro-deposition (in a DC mode) by the above method. Negative template method via two electrode potentiostatic arrangement in electrochemical cell has been used to synthesize the ordered array of one dimensional Ni nanostructures. Deposition has been carried out at 42 degree, 1.6 V and so formed one dimensional nanostructure has been obtained at a Cu substrate. The elegant approach of template synthesis has advantage that shape and diameter of one dimensional nanostructure can be varied as per the requirement, by using the templates of different pore shapes and diameters. Crystalline nature of one dimensional Ni nanostructures is confirmed by X-ray spectroscopy using Rigaku X-ray diffractometer. I-V characteristics have also been drawn using Keithley source meter, in order to check out the variation in electrical conductivity from bulk to nanoscale.

3.10.12 Study of optical and structural properties of CR-39 and PET polymers irradiated by 55 MeV C^{5+} ions

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CR-39 is a polycarbonate widely used as SSNTD for recording nuclear charged particles and in other applications. CR-39 and Polyethyleneterepthalate (PET) polymers foils were irradiated under vacuum with 55 MeV C^{5+} ions to the fluences varied from $1x10^{11}$ to $1x10^{13}$ ions/cm^2 from the 15UD Pelletron at Inter University accelerator Center, New Delhi. Ion induced optical, chemical and structural modifications were studied by ultraviolet, visible (UV–Vis) and Fourier transform infrared (FTIR) spectroscopy and X-ray diffractometer. The optical absorption spectra in the wavelength range of 200-800 nm were recorded for the pristine and ions irradiated polymers sample. A shift in the absorbance edge towards the longer wavelength region appeared in the UV-Vis spectra with increasing ions fluence, indicates a noticeable reduction in the band gap after SHI. The optical band gap decreases from 5.46 to 4.16 eV in CR-39 and 3.93 to 3.41 eV in PET. The correlation between the optical band gap and the numbers of carbon atoms (*N*) in a cluster with the modified Tauc's equation has been discussed in the case of CR-39. An XRD measurement shows a significant loss of crystallinity in PET as compare to CR-39 after the irradiation with SHI. At the low fluence crystallinity was found to increase but at higher fluence, it decreases which could ascribe to cross-linking and degradation mechanism. Particle size or grain size calculated using Sherrer formula, indicates a measureable changes in the irradiated samples.

3.10.13 Bulk etch rate estimation of LR-115 SSNTD using PHOENIX interface

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The bulk-etch rate estimation of cellulose nitrate (CN) SSNTD (commercially available in one of its forms as LR-115 type II, pelliculable or strippable film) using PHOENIX ((*Physics with Home-made Equipment & Innovative Experiments*) interface has been carried out. Bulk etch rate is one of the main parameters that controls track formation in an SSNTD. The thickness of the etched removed layer of the LR-115 detector during chemical etching at different concentrations of NaOH and KOH at constant temperature of 60$\pm$ 0.5^{0}C is measured by the instrument PHOENIX using

Am^{241} (α-source) kept in vacuum chamber. The bulk etch rates are found to vary from (1.44$\pm$ 0.07) to (3.90 $\pm$ 0.11) μmh^{-1} for NaOH and (1.74 $\pm$ 0.08) to (7.08 $\pm$ 0.14) μmh^{-1} for KOH with varying the etchant concentration from 1N to 3N respectively. The PHOENIX interface provides a suitable method for the estimation of bulk-etch rates or low thickness layer measurements.

3.10.14 Contribution of TENORM towards indoor radioactivity

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A Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) is a naturally occurring material that has been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing. In the present study some commonly used TENORMs viz; flyash, cement, wall putty etc. have been analyzed for radon concentration. The measurement of radioactivity has been carried out using "γ-ray spectrometry" and radon exhalation rates using "Canister Technique" from different materials. The radon exhaled by these materials has been estimated in terms of mass and surface exhalation rates. The alpha sensitive LR-115 Type II plastic track detectors commonly known as "Solid State Nuclear Track Detectors" have been used to measure the radon concentration. In the present study, the activity for ^{226}Ra, ^{232}Th and ^{40}K is found to vary from 31±3 Bq/kg to 152±8.9 Bq/kg, 11±0.5 Bq/kg to 180±4.3 Bq/kg and 245±3.7 Bq/kg to 1047±13.3 Bq/kg, respectively .The radon concentration in various samples varies from 236 to 1653Bqm^{-3} with an average of 821±174Bqm^{-3}. Based on the data the radon exhalation rates have been also calculated. The levels of radon in materials like fly ash, wall putty and snowcem have been found to be higher compared with others. Therefore, their use may enhance indoor radon levels when used as building materials.

Radioactivity and radon exhalation rates were estimated in soil samples collected from the vicinity of Kota Thermal Power Station, Kota, Rajasthan, India. In the studied soil samples, activity concentration of ^{226}Ra, ^{232}Th and ^{40}K varies from 38.2 $\pm$ 3.1 to 76.2 $\pm$ 7.6 Bq kg^{-1}, 44.2 $\pm$ 1.7 to 74.8 $\pm$ 2.9 Bq kg^{-1}, and 293.7 $\pm$ 4.0 to 477.4 $\pm$ 6.1 Bq kg^{-1}, respectively. The radon surface and mass exhalation rates vary from 336.4 $\pm$ 16.2 to 1869.2 $\pm$ 54.6 mBq m^{-2} h^{-1} and 13.0 $\pm$ 0.6 to 72.0 $\pm$ 2.1 mBq kg^{-1} h^{-1}. The estimated values for radium equivalent activity, gamma absorbed dose rates, indoor and outdoor effective doses of terrestrial, naturally occurring radio-nuclides viz., ^{226}Ra, ^{232}Th and ^{40}K, are found to vary from 126.7 to 195.7 Bq kg^{-1}, 58.1 to 89.1 nGy h^{-1}, 0.28 to 0.44 mSv, 0.7 to 0.11 mSv , respectively. The external hazard index, which must be less than unity in order to keep the radiation hazard insignificant, is found to vary from 0.34 to 0.53. The results obtained from the samples under investigation show that the natural radioactivity levels are well within the safety limits given by UNSCEAR (United Nation Scientific Committee on the Effects of Atomic Radiation) 2000.

In a further study, sand samples have been collected from the vicinity of Yamuna river while the soil samples have been collected from various locations of North-Eastern Haryana. The places are in the vicinity of Shivalik range of Himalayas. For the estimation of U, Th and K a non-destructive technique by a high resolution gamma-ray spectrometry with HPGe detector has been used. The radioelemental concentrations of uranium, thorium and potassium evaluated for the various soil samples in the study area are calculated. Alpha sensitive LR-115 type II plastic track detectors have been used for measuring the radon and radium concentration in different soil samples using “Can Technique”. Based upon the data, the mass and the surface exhalation rates of radon emanated from the samples have also been calculated. Also a correlation has been tested between uranium concentration measured with HPGe detector and the radon exhalation rates obtained using nuclear track detectors.

3.10.15 Estimation of radioactivity in tobacco

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Tobacco fields and plants also have higher concentration of uranium and consequently large contents of ^{210} Po and ^{210} Pb belonging to uranium and radium decay series. These radio-nuclides have long association with tobacco plants. ^{210}Pb and ^{210}Po, decay products of the uranium series get dissolved in water and are first transported into plants and subsequently to the human being. Uranium present in soil enters the plants through roots and gets distributed in various parts of the tobacco plants. This Phenomenon may cause high intake of uranium and its radioactive decay products leading to harmful effects in human being. In the present work Gamma spectrometry (HPGe detector of high-resolution gamma spectrometry system) has been used at Inter University Accelerator Center (IUAC), New Delhi, for the measurement of activity concentrations of ^{238}U, ^{232}Th and ^{40}K in some tobacco samples. The alpha radioactivity of the leaves of the tobacco plants was measured using plastic track detectors LR-115 Type-II manufactured by Kodak. Measurement of track densities (track cm^{-2} day^{-1}) shows a variation on the upper face and the bottom face of the leaves for the plants. The track density due alpha particles is higher at bottom face as compare to top face of the leaves.

3.11 CIVIL WORKS

M.K.Gupta

Works under Civil Section

- Major expansion Projects (Auditorium and Main Lab. Building vertical extension)
- Minor Projects
- Minor Works (additions, alterations, renovation in the existing Civil works)
- Civil Maintenance
- External Cleaning of the Campus
- Liaison with various Govt. and external agencies for statutory approvals and various civic problems
- Keys management of the Centre

Important Civil Activities during the Year 2010-11

- Following important Civil works were undertaken during the year 2010-11 in addition to routine Civil maintenance and minor works:
- Planning, design and drawings work in progress by M/S RITES for Auditorium & Lab. block Extn.
- Construction of M.S platform for 1.7 MV Pelletron Lab. in Engineering building for housing electrical equipments(UPS, Transformer, DB etc.)
- Civil works for establishment of AAS (Atomic Absorption Spectrometry) Laboratory located in Beam Hall-III

- P/F Aluminium sheet over floor and walls of High voltage area in LEIB building for electrical grounding
- Internal painting of Phase I housing and Flatlets
- Epoxy floor coating in 1.7 MV Pelletron Lab. in Engineering building
- Old fiberglass sheeting replacement at Main Gate car parking by new A.C. sheets
- Construction of new UPS room beside Beam Hall-II Stores
- Painting of Pipe rack steel structure around LEIB building and UB-III building.
- Covering of open drain in Phase II housing Playground by precast RCC covers

3.12 COMPRESSED AIR SYSTEM AND MATERIAL HANDLING EQUIPMENTS

K.K. Soni and Bishamber Kumar

The MG I Group is associated with the following activities:

i) **Compressed Air System**: Compressed air plant (Ph-I & PH-II) consisting of two nos. reciprocating compressors each of 60 M^3 /Hr and two nos. screw compressors each of 115M^3/Hr capacity, alongwith air dryers & filters with capacity of 3000 lpm @ 9.00 Kg/cm^2 have been maintaining uninterrupted air supply to tower, Beam Hall- I, Beam Hall -II and other associated lab areas round the clock. In order to further increase the reliability of the Compressed air supply at constant pressure, a 25 M^3 Storage tank is designed, fabricated and installed. It is installed in the Compressed air line on the roof of UB II. Pneumatic connections have been extended to all the labs.

A stand by screw compressor of 115 M^3/Hr capacity is added in PH I plant in order to meet any eventuality of break down of existing compressor. Further to ensure low dew point of the air, the compressed air is passed through two refrigerated type air dryers of 4300 LPM capacity. Ultra high filters of boro silicate and carbon filters are provided in different location of the compressed air to provide clean air free from dust and oil particles. The filter cartridges of Ultra high filters are changed once a year to maintain the quality of supply air.

Since Reciprocating compressors which are more power consuming and source of excess oil contamination in the compressed air, therefore, generally we do not operate the reciprocating compressors. Compressed air piping has been extended to Lab I, Lab II and New Workshop building.

ii) **Industrial Gases**: Various industrial gases required in different labs have been made available from time to time. Special gases like Iso Butane and mixture gases are also procured for labs.

iii) **Elevator**: Elevator has been running smoothly and monthly preventive maintenance of the same is carried out to minimize the operational break down.

iv) **Material Handling System** : Periodic maintenance / servicing of more then 14 nos E.O.T cranes and electric hoists of various capacity varying from 1 to 7.5 Tones are being carried out periodically and the same have been working smoothly. Two more cranes of 7.5 T capacities in BH III and 2 T Electrical Hoist in BH III has been added. All the cranes are put on remote control operation for safe handling of machines.

v) **Fire Extinguishers**: Annual refilling and periodic maintenance of all the fire extinguishers have been carried out. New fire extinguishers have been installed in newly constructed BH III, store area , Lab I and Lab II area, Workshop building. Some more sign boards including the "Escape route" is added in the building which shines even in darkness. .Demonstration for use of Fire extinguishers has been arranged and all the users and IUAC employees are trained to use the fire extinguishers.

New buildings under PH II part II have the newly added Fire safety norms which includes pressurized water hydrant system. It includes centralized pressurized water system connected to underground Water tank and water pumps which maintain continuous water pressure in the water hydrant line. This system is available in PH II Part II buildings. All the Labs and experimental areas have smoke detectors having display unit and sound alarm at Reception of Lab I which is attended round the clock by operator.

3.13 DATA SUPPORT LABORATORY

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Data Support Laboratory provides user support to various experimental groups setting up NIM & CAMAC modules for the data acquisition during the experiments. Data Room maintains two independent on-line data acquisition systems for data collection during accelerator beam experiments and two more workstations for off-line analysis. Apart from providing regular user support and maintenance of the setup, we have developed a few electronic modules and serviced a number of NIM and CAMAC modules. The lab had procured new modules and cables and connectors for data acquisition purpose.

3.13.1 Fabrication of Current Integrators

Current Integrator for measuring beam current from Pelletron Accelerator has been designed and developed at IUAC, in the year 2001. Three of such modules were fabricated and tested this year. This module includes important features like input current polarity indication, pre-selection of dose and overload protection etc.

Specifications

Input ranges	
Ampere / Coulomb meter	1nA/1nC – 30mA/3000C
Accuracy	
Ampere meter	< 1% of full scale
Coulomb meter	< 1% of reading
Input Impedance	
1nA to 300nA	< 1.5kΩ to 500Ω
1µA to 30mA	< 500Ω
Overload protection	Over voltage protection on the input and over current indication on front panel
Counter	Counter click, 10 clicks/sec at full scale
Polarity	Automatic adjustment to current polarity with LED indication on front panel
Output signals	
Analog voltage	0 to ±10Vfs, 10mA
Pulse output	0 to 10Hz fs, TTL
Mechanical dimensions	19 Inch rack mount (310mm x 135mm)
Power requirement	230V, 10VA

3.13.2 Fabrication of 4-Channel Tesla Meter Readout CAMAC Module

Single-width CAMAC module to read the magnet field values from the DTM- 151 Digital Tesla Meter has been designed and developed, last year. This module will read the Tesla meter and read back values are incorporated into the remote control system. It consists of Atmega16 Micro-controller and RS232 interface circuits built on a single board. As per the requirement from the users at IUAC, four such modules are fabricated and tested.

3.13.3 Design and Development of FPGA based Serial ADC with histogram CAMAC Module

The features and the capabilities of the Spartan 3 Family devices are optimized for high volume and low cost applications. By employing this Spartan family Xilinx device we designed and developed one 13 bit histogram CAMAC module with Peak stretching circuit using Serial ADC. This device is supporting in- system programming and supporting the lowest cost configuration solutions for serial and parallel flash memories for histogram. The functions of ADC, peak stretching circuits and CAMAC interface circuits are integrated into a single chip. The prototype has been built and being tested.

3.13.4 Fabrication of 2-Channel Fast Rate Divider modules

Single-width NIM modules (2nos), which incorporates two independent rate (frequency) dividers have been developed, last year. They were used in the Accelerator beam experiments at IUAC. To meet the requirements of such modules, two more modules were fabricated and tested this year.

Specifications

Range of n setting	Any integer between 1 and 1000
Maximum Input rate	50MHz
Propagation delay	Typically 13ns, Independent of n setting
Inputs	Negative Fast NIM
Impedance	50Ω
Minimum amplitude	-500mV
Minimum width	10ns
Outputs	Negative Fast NIM signal, source -16mA. Rise time and fall time less than 4ns.

3.13.5 Fabrication of Gate & Delay Generator modules

A NIM module to generate logic pulses for gating multi-channel analyzers/ analog to digital converters used in data acquisition applications has been designed and developed in the year 2007. This module accepts either polarity of logic pulses, providing an adjusted delay for each input pulse, and generates output pulses with both polarities that have an adjusted amplitude and width. It serves as a convenient interface between logic pulse origin and its end use. Two such modules were fabricated for the lab maintenance.

Specifications

Dimension	Single width NIM
Gate width	400ns to 20μs
Delay (3 position range switch + 10 turn potentiometer)	1.1μs (0.1 through 1.1μs) 11μs (1 through 11μs) 110μs (10 through 110μs)
Inputs	Positive & Negative NIM
Outputs	Delayed positive & negative
Dead time	Width + 0.2μs

3.13.6 Servicing and Maintenance

During the year a number of electronic modules have been serviced and added to the existing inventory of the electronics pool.

Following modules have been serviced

- Kinetic Systems CAMAC Power supply
- High Voltage Power supplies, EG&G Ortec model 556
- Charge Sensitive Pre-amplifiers, EG&G Ortec model 142IH
- Rate Divider modules, EG&G Ortec model RD2000
- NIM Bin Power supplies

Following modules are added to data acquisition resource pool

- EG&G Ortec 4001/4002E NIM Bins
- EG&G Ortec 556 High Voltage Power Supply
- Lecroy model MXs64-A, CRO