3. RESEARCH SUPPORT FACILITIES

3.1 SUPPORT LABORATORIES

3.1.1 High Vacuum Laboratory

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

The Beam hall III was made ready for the installation of high voltage deck. In the LEIBF GP tube shorting problems were taken up and an additional BPM has been installed after GP tube for accurate beam diagnosis. The 500 lps turbo pump was replaced with a 1000 lps turbo pump with a new pumping cross in the GP tube area of LEIBF. HCI High voltage deck installation was completed this year.

3.1.1.1 GP Tube shorting Problem in the Low energy Ion Beam Facility

In the new LEIBF, five GP tubes are installed between the high voltage deck and the ground potential. The inner electrodes are made of aluminium and their inner diameter is 100 mm. Three tubes were found completely short [< 5 ohms] and two were partially short. This could be due to sputtering of aluminium from the inner elctrodes due to hitting with beam during beam tuning by quadrupole doublet, placed before accelerating column.

As per manufacturer's suggestion the inner electrodes were removed and blasted with a mix of aluminium oxide and glass beads. All the tubes were cleaned in ultrasonic bath and baked at high temperature. Resistance of all the GP tubes were measured at 5kV using megger and all tubes showed resistance more than 5GΩ. To prevent similar problem in future two collimators of diameter 25 mm were designed and fabricated for installation in between GP. Two types of collimators were designed, one for the entry to first GP tube and the other to be used in between GP tubes. First collimator at the entry of GP tubes was machined from one piece of stainless steel with tantalum aperture in centre. Other collimator which was to be installed after two GP tubes was designed to fit in between the two tubes. Extra holes for pumping have been provided in such a way that beam does not pass through these to hit the tube electrodes. All the GP tubes and collimators were installed back.

3.1.1.2 Design, Fabrication and Installation of HCI High Voltage Deck

HCI High Voltage deck (100kV) is a huge structure and is mounted on insulators to isolate from the ground. ECR source, Bending Magnet, Beam diagnostic components, cooling equipments, etc. of approximate weight of 6-7 tonnes, are to be mounted on the Deck. The size of the deck is 4.5 m x 5.0m x 2.5m and the material to be used is non- magnetic. The whole platform is to be put on high Voltage 100kV.

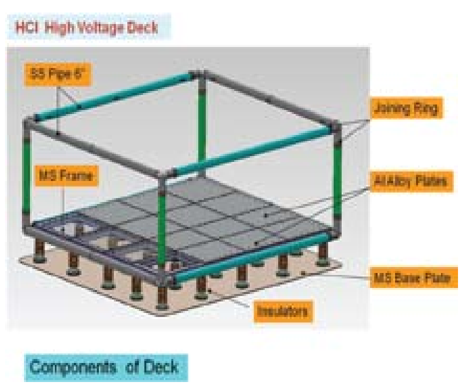

Fig 1: High Voltage Deck

On the basis of these requirements the deck structure was designed. A 3-D model was made using Solidworks. The top structure is a cuboid shape skeletal frame made of 150 mm OD stainless steel pipe. This is also modular and can be assembled and dis-assembled easily. This pipe structure is mounted on a MS Frame, with nuts and bolts from the frame side walls and welded plates, which is made of rectangular tubes of 142 mm x 82mm x 5.6 mm. The tubes are selected so as to take the high load of the deck components. The base of the deck, which holds the components, is made of high strength Aluminum alloy. There are sixteen aluminum alloy plates of 20 mm thickness designed to mount on the MS frame. MS frame sits on Insulators to maintain the deck potential. MS frame has 25 joints, where the rectangular tubes cross each other. A circular plate has been provided under the frame joints to couple it with the insulators. Similarly a coupling plate for insulator has been designed. The insulators would sit on a MS plate. A pair of mounting and alignment plate has been designed. A provision of 5 mm height has been kept in view of the replacement of insulators in case of breakage. Simulation studies were done for frame, torroid holding plate and aluminum plates as per their load requirements. All the components were within safe limits of stress.

The order for fabrication order was placed to outside fabricator after due diligence and technical discussions. Detail drawings of all the components were drafted and given to the vendor along with purchase order. A suitable insulator of LAPP make, for mounting the Deck was selected in view of the loads and high voltage conditions. A MS plate of size 4.5m x 5m x 10 was grouted at the actual HV platform site in the beam hall. The high voltage platform has been installed in the beam hall 3 with proper leveling and position.

3.1.1.3 *Fabrication* and installation of the new control Crate (IMACS) for LEIBF High voltage Deck

LEIBF control system was using two different control systems for measurement and control. Beam lines and facilities were running with Indigenous Measurement and Control System (IMACS) and PCLI software whereas the high voltage deck components i.e. ECR source and Electrostatic Quadrapole Doublet (EQD) were using field point system and Labview software. During beam runs the EQD stopped responding quite frequently and had to be switched off and on to make it work. So, a new IMACS Crate along with the Interfacing Crate has been installed in the HV Deck and the controls and measurement system of EQD power supplies have been transferred to IMACS for testing. After successful testing, the remaining equipments will be controlled by the same IMACS replacing existing Field Point system. The new interfacing Crate (Crate-3), consists of a total of 6 modules, 2 each of OR-IG, ADC and DAC Modules and will be used to control all the devices used in the HV Deck.

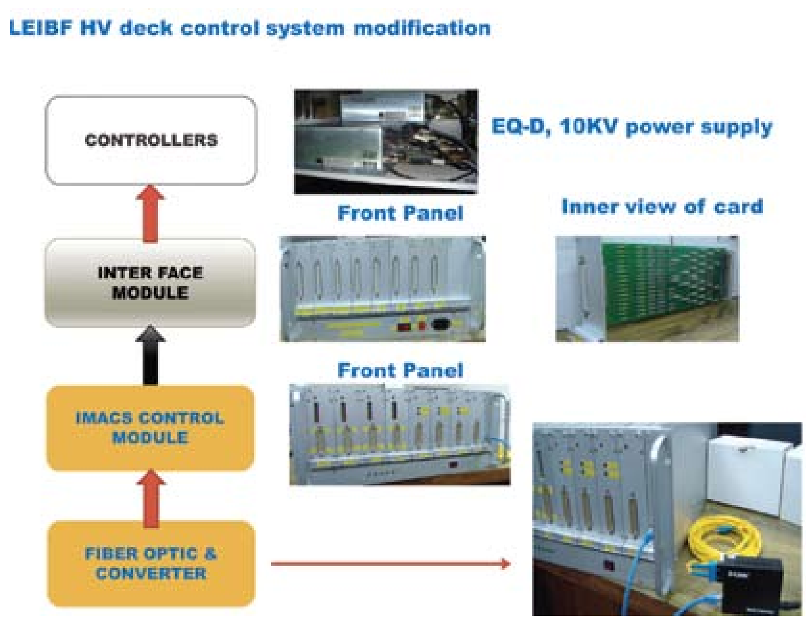

Fig.2: LEIBF HV Deck Control System

A new fiber optic to Ethernet media converter module along with a new fiber cable was installed between control system to HV deck. For performance testing of commercially available VME system in high voltage area we installed a VME crate for six months and interfaced EQD, high voltage for regular operation and it worked smoothly during beam runs.

3.1.1.4 Installation of the dedicated Vacuum Gauges for interlocking the Beam Line Valves in the LINAC beam line

The vacuum gauges in the LINAC beam line are used for interlocking of beam line valves (BLV). The same gauges are also used for LINAC chamber vacuum monitoring by the respective group. Many times the BLV interlocking signals got disturbed due to switching OFF gauge controllers unplugging of, interlocking signal cable, etc. These gauge controllers are installed in the back side rack, which is located behind the LINAC beam line causing difficulty in monitoring. So, separate and dedicated vacuum gauges for BLV interlocking were installed and the display was also brought to the front side for easy accessibility. Accordingly, 7 Full Range Hot Cathode Gauges, MKS make, were installed in the LINAC Beam line, in addition to the existing Pfeiffer penning Gauges. The locations are Super-Buncher, Diagnostic Box-1, LINAC-I, LINAC-II, LINAC-III, Diagnostic Box-2, and Re-Buncher. All the Gauge Controllers were installed at the same location in the DB-I area just before the LINAC-I. All the LINAC line BLV interlocking signals are taken from these controllers to interlock the respective BLV's through the fresh and new cables. Separate new cables were laid on the cable tray for this purpose.

Fig. 3: Vacuum interlocking Gauges for LINAC area

3.1.1.5 Installation of 2.45 MHz ECR Source Testing Set –up

A 2.45 MHz ECR source and corresponding beamline has been installed in old LEIBF room. The existing beamline from source to the analyzing magnet was dismantled to do the installation. The source was aligned with respect to the analyzing magnet. A BPM, Faraday Cup, Electrostatic steerer, Electrostatic quadrapole triplet [EQT] and a pumping cross were also installed and aligned. A turbo based vacuum pumping system was installed with necessary interlocks. After full installation leak check and vacuum establishment was successfully done.

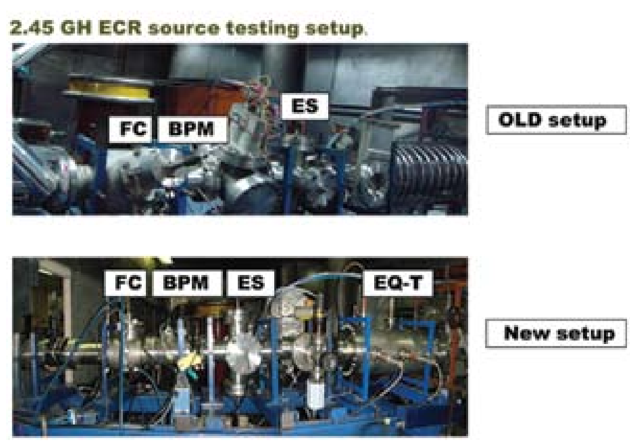

Fig. 3: Vacuum interlocking Gauges for LINAC area

3.1.1.6 Design, Fabrication and Installation of a vacuum interlocking system for new LEIBF HV deck

A Vacuum Interlocking System has been designed, developed and installed in the New LEIBF HV Deck. It works as a vacuum interlocking system to control the vacuum system of the HV Deck and also as a Beam Line Valve controller to control the BLV_0-1, which is located in the beam line inside the HV Deck. It's main features are :-

Vacuum Interlocking System: One Roughing Pump and a Turbo Pump can be controlled. It controls 4 valves i.e. roughing valve, backing valve, gate valve, and gas dosing valve. Only one of the roughing valves, backing valve and gas dosing valve can be opened at a time. There is a false alarm and blinking-LED (Opened Valve's Close Read Back) indication to indicate, if more than one, valve open switch, are activated. In such cases only one valve will be open and the other(s) will not open. At the same time the alarm and the LED blinking will be activated until someone acknowledges and rectifies the same. Set Point signals for roughing vacuum, backing vacuum and high vacuum are taken as status Read back from the external Gauge Controllers. All the Status Read Backs are provided in the front panel as LED indication. Power to the associate Controllers like, Turbo Controller and Gauge Controllers are provided within this System.

BLV Controller Part: It has local as well as remote modes of operation. In remote mode either potential free contact or +24Vdc signal is required to open the valve. The valve can be opened only if the vacuum interlock from both the side of the valve is O.K. That is NLK-A and NLK-B O.K. These status read backs are taken from the external gauge controllers. All the 4 status read backs, i.e., NLK-A and NLK-B O.K, Open and Close are provided in the front panel as LED indication.

3.1.2 Beam Transport System

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

Beam transport system (BTS) laboratory takes care of regular maintenance of beam transport instruments that are round the clock used in the IUAC accelerator system. Besides the maintenance, BTS laboratory also involved in indigenous development of instruments like magnets, power supplies and other instruments for the ongoing and upcoming research facility. Details of development and maintenance activities are summarized below.

3.1.2.1 Power Supply for HCI Steerer and low power Quadrupole Magnets

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

A compact and low cost air cooled magnet power supply has been developed for the upcoming HCI facility. It delivers DC power upto 300 Watt and has the facility to operate in unipolar as well as bipolar by a single onboard jumper. This is a linear current regulated power supply of load current tunability 0 to ±10 ampere with ±50V voltage compliance. Modular design approach has been adopted for electronics and power sections for fast servicing/ repairing in order to achieve high beam uptime for the experiment. Power supply contains local (front panel) as well as remote display for load current, load voltage, various status readbacks and controls. It can be remotely operated through standard CAMAC and Ethernet. The power supply has been tested with quadrupole magnet and achieved 100 PPM long term current stability and output ripple within 10mVpp. Fabrication for the mass requirement is in process.

3.1.2.2 Development of Magnet and associated Power Supply System for g – factor measurement set-up of nuclei

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

To measure g-factor of short-lived excited-states of nuclei an "External Magnetic field" is required to polarize the ferromagnetic Target. The required external magnetic field should be alternating bipolar with linear transition from one polarity to other with maximum transition time of one second and also having programmability for amplitude, duration and transition time. A compact 1400Gauss at 4A C-type dipole magnet with adjustable pole gap has been developed and powered by current regulated power supply. To generate the required magnetic field pattern of such functionality and programmability, a magnet power supply controller is designed. It generates bipolar square wave with variable amplitude (0-100%), transition time (200mS-2S) and pulse width (1min, 2min, and 3min). The magnet and power supply system have been used extensively, meeting all the functional and performance requirements. Instrument's programmable features contribute to satisfy all the required experimental conditions. Experimental data has been acquired at different amplitude and timing parameters.

3.1.2.3 Feedback Controller for Piezoelectric actuator based Phase locking of SCQWR

Rajesh Kumar, S.K.Suman, Mukesh Kumar, B.K.Sahu

In order to improve the dynamics of existing phase locking scheme of LINAC resonators and to improve the response time of the slow tuner control, piezoelectric actuators are used in close loop to deflect the bellow. A feedback controller has been developed to operate the piezoelectric actuator accurately for correcting the slow drifts caused during continuous operation thereby reducing the RF power required for phase locking. The phase drift error is generated by comparing the phase of RF pickup from cavity with the reference phase. An integral (only I) type feedback amplifier is used to have high gain at DC to minimize the steady state errors. The gain is rolled off to unity at 16 Hz to prevent excitation of resonances in cavity starting from 20 Hz up to several kHz. An additional function "Integral gain limit" is incorporated to prevent integrator output to swing to large value in case of large input errors which can cause cavity to oscillate. The signal obtained from this Integral controller is fed to a high voltage amplifier to provide an output of -20 to 110V to drive the piezoelectric actuator.

After successful off line testing and demonstration of the first prototype controller to correct the intentional generated frequency drifts of 160Hz within 12 millisecond time scale, four similar unit were fabricated and installed with the Piezoelectric actuator mounted cavities in third Linac module. These four units were used during two months beam acceleration using Linac and found to be working successfully as per design. This scheme working on a faster time scale has also reduced the load on the fast electronic tuner thereby reducing the average required power for phase and amplitude locking of the cavities. After successful testing of these controllers, production of 16 numbers of such controllers has been started at BTS laboratory for implementation the piezo based control scheme in remaining cavities of Linac.

3.1.2.4 Development of Multi Harmonic Buncher (MHB) Electronics

Rajesh Kumar, Abhijit Sarkar, A. Mandal

Over the last few years, significant efforts have been put on improving and maintenance of the control electronics of the MHB. Since, the old design was done more than two decades back in collaboration with ANL most of the components used in the design have become obsolete. Complete new electronics has been redesigned and rebuilt. The primary goal is to improve buncher RF field stability with redesigned control electronics for better bunch stability at the LINAC. Main emphasis in the new design is given to improve upon the dynamic range of the phase and amplitude correction feedback loops, programmable components for better optimization of operating parameters. Also new modularity and layout for simultaneous access to all the modules, for easy repair and service, have been done. The new design has been successfully implemented in the first prototype. A test setup is assembled to test the complete functionality and performance of the design. Individually each module tested successfully meeting all the design goals. The final integration to test the instrument as a whole is in progress. These results are encouraging and the designed controller will be useful in improving the buncher RF field stability for better bunch stability at the LINAC.

3.1.2.5 Temperature Controller for Thermoelectric cooler (TEC) module for Atomic Physics beamline

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

In one of the Atomic physics experiment very high resolution of the Si-surface barrier detector (SSBD) was needed to measure energy loss difference of the order of few tens of keV. To achieve such resolutions the detector has to be cooled to improve signal to noise by suppressing the detector thermal noise. The experimental chamber at Atomic physics beam line has space limitation, so the generally used compressor based cooling system is not highly desirable. Thermo-electric cooler (TEC) based system is chosen, because of its unique qualities such as it can heat and cool an object by simply reversing the current direction through it, without any moving parts and vibration, light weight and can be operated at any orientation in compact locations. Considering all these advantages a temperature controller based on proportional integral (PI) feedback loop has been design and developed. The system comprises of a controller and a detector holder whose temperatures can be accurately controlled over a range of temperature from -25°C to +100°C. The heating and cooling capacity of the controller is 25Watts and 2 Watts for ΔT 10ºC and 85ºC respectively. Using the developed controller the detector was cooled at -15°C and signal to noise ratio improved from 200 to 270. Eventually, this helped to improve the resolution of the Si-surface barrier detector from 24 keV at room temperature to 19 keV at cooled condition for the 5.486 MeV alpha of ^{241}Am, and thereby the four peaks of alpha have been resolved.

3.1.2.6 Development of Vacuum Tube based 10kW, 97MHz RF amplifier for Drift Tube Linac (DTL) cavities.

Rajesh Kumar, S.Venkataramanan, Ajithkumar B.P

This development work is taken up to explore the possibility of indigenous development of Vacuum Tube based Rf amplifiers of 10kW at 97MHz, to be used with the upcoming DTL (drift tube LINAC) RF cavities. The power amplifiers required to power various DTL RF cavities will be in the range of 10kW to 20kW. Initially a 10kW power amplifier unit, based on proven design will be developed and subsequent high power requirements such as 20kW or above will be generated with combined two 10kW identical units. The tube amplifier assembly is designed around a high amplification factor Triode tube (YU148) in 'grounded-grid' cathode driven configuration. The tube assembly consists of Vacuum tube mounting along with input output impedance matching networks and tank circuits. Most of the components of the tube assembly are locally developed and the integration is going on. Initial plan is to test the tube assembly along with existing power amplifier; thereafter the required biasing power supplies (Plate & Filament), control electronics consisting of metering circuits, overload circuits and safety interlocks will be taken-up in order to complete the development.

3.1.2.7 24-Channel High Voltage (-2kV/2.5mA) Power Supply for NAND facility.

S.K.Suman, Rajesh Kumar, J.Antony, S.Venkataramanan, P.Sugathan

Large numbers of high voltage detector bias supply (-2kV/3mA) are required in NAND facility at IUAC. To fulfill the NAND requirement, we developed a compact high voltage power supply by integrating various modules in a 19'' rack mountable 90mm instrument case. It contains 24 nos of 12V to -2kV DC-DC converter (HV module) which is controlled independently by Ethernet based control module. A 300W AC-DC converter of very low noise provides +12VDC to all 24 high voltage & control modules. All sub-assemblies assembled with negligible noise interference in between the modules by proper EMI shield and star connection in DC power distribution to all 24 channels. 3 such units have been assembled each having 24 high voltage modules. All have been tested at full load and achieved the output ripple ~0.007% and load regulation ~0.016%.

3.1.2.8 Maintenance Activities:

Beam transport system group is primarily involved in maintenance and servicing of different types of power supplies, magnets of various facilities like Beam Transport System of Accelerator, vacuum deposition unit power supplies for Target lab and high voltage power supplies for detectors.

3.1.2.8.1 Beam Transport System Maintenance

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

Large numbers of beam transport instruments (~175 instruments) are round the clock used in accelerator systems. It includes different types of electromagnets, highly stable power supplies and various associated instruments. For the best performance and uninterrupted operation of all these instruments, we have done scheduled and preventive maintenance.

Scheduled maintenance: Schedule maintenance of magnets, power supplies and other instruments has been done carefully twice this year. The schedule maintenance is very essential in order to achieve the best performance in terms of better beam stability with minimum breakdown. Some routine tasks carried out during the maintenance are:

- Locating and replacing degraded parts during scheduled maintenance.
- Proper cleaning (surface, cooling water paths, air filters) to maintain heat dissipation capacity.
- Output ripple and stability monitoring/measurement of power supplies and rectification by changing the leaking components from the various sections of power supply.
- Safety interlock calibration, testing and rectification.

Breakdown Maintenance: This type of maintenance has been done during beam time for any malfunctioning in power supplies, CAMAC Modules(remote control), magnetic field measuring instrument etc. 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.

3.1.2.8.2 Maintenance of power supplies/instruments other than BTS

Rajesh Kumar, S.K.Suman

BTS group has developed expertise in repairing and servicing of various type instruments (mainly in power electronics) and takes care of instruments used in various lab at IUAC as mentioned below.

Target development lab power supplies: Following power supplies are regularly used by Target Lab to make different kind of targets. These power supplies repaired/serviced whenever there is breakdown.

- 6kW-Electron beam source power supply
- Electron-gun XY sweep controller
- 2kW-Electron beam source power supply
- Fast Atom beam source power supply

Detector bias power supplies: Following high voltage power supplies for detectors have been serviced/repaired for the various lab at IUAC.

- Germanium detector bias supply

- ACS Detector bias power supply
- Pre-amplifier power supply

3.1.3 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, HYRA, 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.

3.1.3.1 Detector system for Quasi-elastic scattering studies in GPSC/NAND

It is planned to have a ring of four hybrid telescopes in GPSC/NAND for performing quasi elastic scattering experiments. The telescope will have an axial field ionization chamber as Delta E detector and Silicon PIPS/pin-diode detector as the stopping detector. Similar telescopes have earlier been used for studying the angular distributions of fission fragments and transfer reaction. The four telescopes will be arranged in a ring at 170 degree with respect to beam direction to detect back-scattered projectile like particles. The fabrication work is currently underway for the mechanical assembly of the detector setup. It is also planned to have a dedicated preamplifier system for the detectors to be placed in vacuum next to detector. The 8 channel preamplifier fabrication is also underway. The working setup is likely to be installed by the end of the first half of 2013.

3.1.3.2 Detector system for charge particle multiplicities in fission experiments

Developmental activities were initiated for carrying out investigation of charge particle multiplicity in fission experiments. It is proposed to perform mass gated light charged particle multiplicity experiments. For the same it is planned to have a pair of MWPC, for detecting complementary fission fragments, and an array of CsI Scintillators coupled to photo-diode for the detection of light charged particles such as alphas and protons. Currently designing and fabrication work is underway to have a 16 CsI detectors each with an area of 20 mm x 20 mm. Particle identification will be done using the pulse shape discrimination technique by processing the preamplifier signal through amplifiers with two different shaping times. It is proposed to have set up ready by the end of 2013 in GSPC/NAND.

3.1.3.3 Upgradation of MWPC in NAND/GPSC

New wire frames for the fission MWPC of GPSC/NAND were fabricated. The active area is kept identical to the previous one (200 mm x 100 mm). In the new configuration, the MWPC will be operated with four electrode geometry as against five electrodes in the previous configuration. The wire pitch has been reduced to 0.63 mm as against 1.27 mm. The reduced wire pitch is expected to improve the timing resolution. The new frames will replace the old frames in first half of 2013.

3.1.3.4 Annular PPAC for experiments in GDA & NAND

The annular PPAC setup developed for Coulex experiments in GDA was revived this year for carrying out experiments in Nuclear Physics in future. It is planned to perform Coulex experiments in GDA and ER gated neutron Multiplicity experiments in NAND. A new Aluminum chamber to house the electrodes was designed and is currently under fabrication at IUAC workshop. This will replace the previous SS chamber. New electrodes also have been fabricated. As compared to our previous design, the pitch of rings in theta electrode (anode) has been reduced to 1.27 mm from 2.54 mm. The fabrication and installation work will be completed by the end of the first half of 2013.

3.1.3.5 Installation of resistive anode detector at HYRA focal plane

Detector Lab – HYRA group

A stack of three resistive anode detectors, with area 50 mm x 50 mm were placed at HYRA focal plane for heavy ion detection. The detectors had on board pre-amplifier daughter cards for energy measurement with position signals (anode side) grounded in current configuration. The preamplfiers were operated in about 2 Torr Iso-Butane without any problem. The detector setup was placed behind MWPC at HYRA focal plane.

3.1.3.6 Differential drivers for multichannel preamplifer

Prototype differential driver module was designed and fabricated. The module has been realized as a single width NIM module. Motive is to convert the single ended signal to differential so as to drive them through inexpensive twisted pair cables. A single channel prototype was thoroughly tested with Silicon PIPS detector and Sodium Iodide detector. Encouraging results were observed. We plan to assemble 16 channel module and utilize them for the signal transmission of our future hybrid telescope detector array and CsI array for fission charge particle multiplicity experiment. We also plan to integrate the differential driver with the charge sensitive preamplifier daughter cards to eliminate the intermediate stage of NIM module

3.1.3.7 Preamplifier development

New preamplifiers, both charge sensitive as well as fast timing current sensitive, were developed this year. The fast timing version was used in Channeltron (Molecular Physics Group – LEIBF), & thin SBD (LINAC group) and proportional counters. Signals with rise times as fast as 1.5 ns have been observed. Timing resolution of 130 ps was observed with thin SBD for bunched beam from Super buncher (LINAC group). New versions of low gain and low power consuming charge sensitive preamplifier were also developed. Low gain versions are required in future with high energy heavy ion LINAC beams (~ 10 MeV/A), and with scintillators coupled to high gain PMT. Gains as low as 2.2 mV/pC have been used with Scintillation detectors.

3.1.4 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 for the studies in Nuclear Physics [1-10], Atomic Physics, Materials Science [11-22] and Bio Science have used: (i) high vacuum evaporator (ii) evaporator with oil free pumping system with a base pressure of 6×10^{-9} mbar (iii) rolling machine for the preparation of thin foils by cold rolling method (iv) atom beam source (ABS). More than 200 attempts were performed for target fabrication in different systems. In addition to IUAC Pelletron users, target lab provided target/thin film samples to universities, IITs, ISRO, VECC, TIFR and BARC. The ABS has been used for the fabrication of nano-composite thin films by sputtering method [11-13, 16, 18, 20, 22].

This laboratory prepares isotopically enriched targets for the users related to nuclear physics and atomic physics experiments. Following are such targets prepared during this period.

Fabrication of ^{148}Nd Targets

Ultra low density material Silica aerogel was used as backing material. Handling of highly fragile backing material, small amount of available material were the major constraints in the fabrication. A Tantalum crucible was used to minimize the solid angle of evaporation. The distance between source and substrate was optimized at 5cm after several trial attempts. The thickness of the target was ~500µg/cm^2. A gold layer of 20µg/cm^2 was also deposited to protect the target from the surrounding. *(K. Basu, IUC Kolkata)*

Preparation of ^{203,205}Tl Targets

^{203,205}Tl Targets were prepared successfully on a carbon backing of 25µg/cm^2.The thickness of ^{203,205}Tl targets were 200µg/cm^2. A tubular boat of Tantalum was used to restrict vapour flux to narrow cone. For fabricating 200µg/cm^2 of ^{203,205}Tl, only 40mg of material was consumed. The distance between the source and substrate was optimized to 11cm after several attempts. Extra care was taken during the fabrication as Tl was toxic material. Attempts for self- supporting targets were not successful as it was not getting separated while floating.

In addition to thin targets of Tl, thick targets were also fabricated by cold rolling technique. ^{203,205}Tl Targets of ~2.0mg/cm^2 were the requirement for the experiment. A Teflon sheet was used for the rolling of Tl foils. A continuous Nitrogen flow was also maintained between the rolls while rolling for providing the inert environment. *(Jagdish Gehlot and Golda KS, IUAC)*

Preparation of ^{204,206,208}Pb Targets

The thickness requirement was ~200µg/cm^2. Target lab had already delivered Pb targets (self-supporting and backing) to several users in the past. It was noticed during this work that self-supporting targets of Pb of thickness of <300µg/cm^2 were not having good stability for long duration. Several attempts were made before the final evaporation. Finally a thin carbon foil was opted as backing. 18 such targets were successfully fabricated by thermal evaporation technique. *(Ratnesh Pandey, VECC)*

Preparation of 184W Targets

^{184}W of 100µg/cm^2 on a thin backing of carbon were prepared. High melting point of the material and small amount of stock was the main constraints in this work. Though minimum distance between the source and substrate was preferable, it was optimized to 12cm to avoid degradation of releasing agent in the carbon coated slides. Trial evaporations were conducted using natural tungsten. Dissimilar behavior of enriched material as compared to natural one was major challenge at the last stage. *(Gayatri Mohanto, IUAC)*

Fabrication ^{94}Mo self-supporting targets from powder

The target requirement was of 3mg/cm^2 (self-supporting) and 1mg/cm^2 (on Gold backing). It was fabricated for an experiment in INGA at TIFR. The work involved: conversion of Mo powder in to a single pellet, melting of pellet to form a strong solid piece, conversion of solid piece in to a Mo foil by cold rolling, rolling of Au foil, evaporation of In on foils (Mo and Gold) to ensure the adhesion b/w the foils and rolling the foils together to form a single Mo target with Au backing. A target of ^{94}Mo of 1.5 mg/cm^2 with a Au backing of 10mg/cm^2 was made, which took a month to develop. *(Selvakumar, IIT Kharagpur)*

Fabrication, Inspection and Loading of stripper foils

Carbon stripper foils of thickness ~5µg/cm2 obtained from a German company. These carbon foils were grown by pulsed laser deposition (PLD) method on glass slides coated with copper and releasing agent. Separation of films from the glass slides, chemical etching of copper and mounting of self-supporting carbon films on stainless steel frame are done at IUAC. More than 300 carbon stripper foils were loaded during this period. In addition, 100 stripper foil of different thickness were prepared at target laboratory and installed at post accelerator assembly of Pelletron.

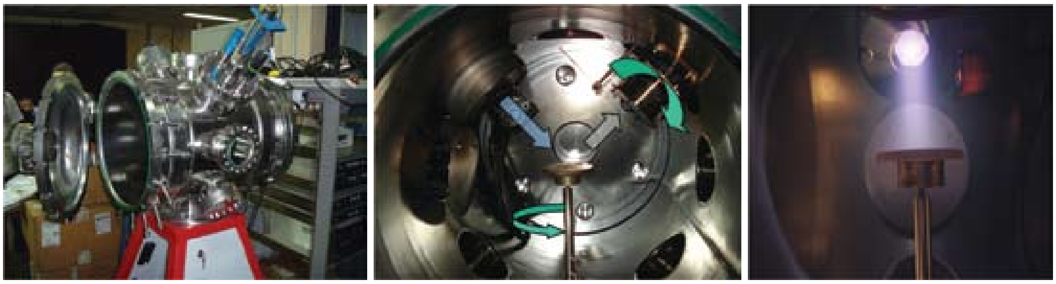

Fig. 1.

Composite thin films

Composite thin films are prepared by co-sputtering technique using Neutral Beam Facility as shown in Figure 1. In this facility neutral Ar beam of energy 600-1000eV are produced to prepare thin films by sputter deposition technique. As shown in the figure the beam is directed at an angle of 45o with respect to the sputter target and the sputtered species are collected on substrates placed at an angle of 45°. Substrate heater is provided with rotation and stutter with heating upto 500°C. Base pressure of the deposition chamber is maintained at better than 2x$^{10-6}$ mbar by oil free pumping. Deposition rate of 200nm/h is recorded for SiO_2 with beam energy of 800eV and current of 36mA.

DEKTAK Surface Profiler

The Dektak stylus surface profiler (Figure 2) is an advanced thin and thick film step height measurement tool. In addition to profiling surface, it can measure surface roughness. The profiler has vertical resolution of <1nm. It is very useful for accurate thickness measurement of thin films and 3D mapping is also possible using this instrument. Many users have already availed this facility for the measurement of thin film thickness.

Fig. 2.

IUAC School on Thin Films 2012

IUAC School on Thin Films 2012 was held from 11th to 13th Dec 2012. The school was scheduled as an yearly academic event of IUAC. The motivation for organizing the school was to impart basic knowledge on this film preparation to the researches and students, specially, in university system where exposure to the field of science and technology of thin film preparation is not adequate. To perform successful experiment to study material modification by ion beam irradiation in thin film form, it is important to prepare high quality thin films. This requires in depth knowledge of growth mechanism of thin films and the various techniques available to prepare such thin films. Total 80 participants registered for the school. Though there were much more request for participation, the total number was restricted to 90 as per the sitting capacity of the seminal hall. The inaugural lecture was delivered by Dr. Avasthi. The following speakers delivered the lectures. Prof. B. N. Dev IACS, Kolkata; Prof. B. M. Arora IIT, Mumbai; Prof. Apurba Laha IIT, Mumbai; Prof Shivaprasad JNCASR, Bangalore; Prof. Subir K. Das JNCASR, Bangalore; Prof. Arindo NUS, Singapore; Prof. S. Ghosh SPS, JNU, N Delhi; Prof. V. D. Vankar IIT, Delhi. An evening lecture, giving a flavor of real application of thin films, was delivered by Dr. Nyati, Moser Baer .

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3.1.5 RF & ELECTRONICS LABORATORY

A. Sarkar, S. Venkataramanan, B.K. Sahu, K. Singh, A. Gupta, M. Jain, P. Singh, D.K. Munda & B.P. Ajith Kumar

3.1.5.1 Front end and PSD electronics for NAND array at IUAC

The phase-I analog electronics requirements of both front end electronics such as PMT voltage divider network, charge sensitive preamplifier, preamplifier power supply and PSD (Pulse Shape Discriminator) electronic modules were successfully completed and delivered to users for commissioning with NAND detector array. The 50 channels of above electronics were in-house assembled, tested on bench and tested with actual source for performances. The electronics were warmed up for long duration for any performance defects, and rectified before delivery to user.

3.1.5.2 High power solid state power amplifier development

The development of solid state power amplifier 2000 watts CW in VHF band for in-house application is continued this year also with successful results. The in-house developed driver amplifier assembly containing various front-end building blocks such as pre-driver (1W), voltage controlled attenuator for Over Drive Control (OVD), intermediate driver amplifier (20W), and driver amplifier (~100 watts) and finally 4 port Wilkinson power splitter at 97MHz. This single unit broadband amplifier assembly is having power gain of >40dB, and 3dB bandwidth of 10MHz to 135MHz. This unit will drive four identical power core amplifiers capable of delivering 500 watts each. The driver amplifiers are wired around MRF151G in splitter, combiner configuration as explained earlier. At present a commercial 4 port Gysel power combiner is used to combine the power from 500 watts core units to obtain 2000 watts. The built-in directional coupler of Gysel combiner is used to measure forward power, suitably rectified with state of the art RF power detector chip, fed back to over drive control circuit to limit the maximum power output to desired level, in this case around 2000 watts. The unit is having other protection features such as over temperature cut-out, thermal compensated gate bias. The entire assembly is mounted on liquid cooled aluminium plate for reliable operation. The DC power supply is obtained from commercial 4 x 1500 watts SMPS assembled in a separate 19” chassis. The prototype unit is already tested with limited water cooling arrangement in our laboratory for assessing functioning of different features. The same unit is being readied for actual operation with sample DTL assembly in near future to assess its reliable performances.

3.1.5.3 Status Report of the Multi-harmonic buncher and associated jobs

The multi-harmonic buncher (MHB) was operated along with the low energy chopper (LEC) to provide 4 MHz pulsed beams to several Linac users continuously for 2½ months. Beams that were pulsed for the Linac operation included ^{19}F, ^{28}Si, ^{48}Ti and ^{58}Ni. The FWHM of the beam bunch varied from 1 ns to 2 ns. The users were Bivash Ranjan Behera (Punjab Univ.), S.S.Ghugre (UGC-DAE), Gopal Mukherjee (VECC), Rudrajyoti Palit (TIFR), Rahul Tripathi (BARC). A part of the beam time was also used for Linac tuning and several facility tests associated with Linac.

The system was also used to provide pulsed beams to several Pelletron users as well. The users were Jasmeet Kaur (Punjab Univ.), Rohit Sandal (Punjab Univ.), Maninder Kaur (Punjab Univ.).The beams that were pulsed included ^{12}C, ^{16}O , ^{18}O and ^{19}F . The FWHM varied from 1 ns to 1.5 ns.

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

The Mechanical Assembly:-

The 14 inch side cubical vacuum chamber with 6 ports with 2 NEC type flanges and 4 conflat type flanges, copper box to house the tank circuits, the grid assembly which includes the copper cones and cone extensions were fabricated last year. The top conflat flange on which the RF power feedthroughs (fluted insulators) are mounted was a real bottleneck as the dimensions of the feedthroughs are presently non-standard. We are in the process of getting these fluted insulators custom made for us. All required drawings for these feedthroughs along with the mounting flange have been made for fabrication. Indent raised, quotations received, order to be placed shortly.

The tank circuits:-

The tank circuit coils using OFHC copper tubes have been fabricated and mounted on the copper base plate. The vacuum variable capacitor holders are also mounted in place. The co-axial cooling arrangement in the coils including the manifold for water connection are made. Water flow to be tested shortly. This will be followed by the initial tuning of the tank circuits using dummy capacitive load. The final tuning will be done with the actual grids in place.

The Electronics:-

The new controller which was designed last year has been fabricated. The harmonic generator and distribution module, pick-up filters were thoroughly tested. These were found to work satisfactorily. This was followed by testing of the 12 MHz feedback control module. The harmonic generator and distribution, pick-up filter, control buffer including the panel meters were all hooked up with the 12 MHz feedback control module in a closed loop. The phase and amplitude locking were tested extensively and these loops were found to be working. Several problems were faced during the tests and with a very sincere effort these problems were solved to make the phase and amplitude lock loops working for the 12 MHz module. Several modifications had to be made in the 12 MHz feedback control board to make the circuit working. These modifications will be incorporated in the feedback control modules for 24 MHz, 36 MHz and 48 MHz and tested. Then all these modules will be integrated to give the final output.

3.1.5.5 Shaping Amplifier for HPGe Detectors

This is a single width NIM module which accommodates two independent channels of shaping amplifier, required to process the High Purity Germanium detector signals. The amplifier provides unipolar output and it's shaping time has been fixed to 3 μs. Potentiometers have been provided on the front panel to adjust Pole Zero and Base Line Restorer threshold voltage. Gain can be selected by a 8 position rotary switch in the range of ~(5 to 40). This module was developed last year in order to have some alternative of ORTEC make 571/572 shaping amplifiers. These modules were used in three nuclear physics experiments in GDA experimental area and users were quite satisfied. Based on this experience it was thought to provide more gain options and module design was modified to provide 16 gain options in the range of ~(10 to 80). Four modules have been fabricated and tested off-line with Clover detector using conventional electronics set up. Now we have planned to use these modules in the future experiments.

3.1.5.6 Improvements in the Control Scheme for Linac

The resonator control scheme for all the three cryostats are being installed and used for acceleration of heavy ion beams through Llinac using the three modules of Linac. Piezoelectric actuator based control scheme is implemented in four resonators of linac cryostat three. Three of them are used for beam acceleration and found to have improved the dynamics of the existing resonator control scheme. The controllers for the same have been developed in house. Positive position feedback (PPF) based control is also tested with piezoelectric control to improve the dynamics further to damp all the microphonics up to 50Hz level without exciting any higher modes of resonator. Electronic damping is also tested with positive position control feedback. The additional control electronics is designed for remote operation of piezoelectric based tuners from control room using CAMAC and tested successfully. The phase and frequency error readback are interfaced using in house USB based exp yes junior. The auto locking of the piezoelectric actuator based control scheme is tested successfully using the same with python based GUI.

A global phase shifter module is developed and integrated with existing Linac clock distribution system. This module makes the desired phase shift to the reference phase of all the resonators including buncher and super-buncher. This helps us to adjust the phase at the entrance of superbuncher in case of phase shift in beam pulsing system using MHB. The phase of all the resonators adjusted automatically without re-tuning the individual phase of the resonators.

3.1.6 COMPUTER AND COMMUNICATIONS

S.Mookerjee, E.T Subramaniam, S.Bhatnagar

The major activities this year include the expansion of the High Performance Computing facility at the Centre, expansion of the Centre's local area network, major enhancements to the Centre's enterprise computing and administration database package, and significant progress in the development of a DSP-based universal data acquisition system.

3.1.6.1 High Performance Computing Facility

The Centre's high performance computing facility, sanctioned by the Department of Science and Technology, 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 associated power and cooling infrastructure. Inaugurated in 2010, the facility has become one of the most significant and widely used supercomputing facilities in the country. The user base now consists of more than eighty research groups from universities and institutes across the country, for more than fifty of which this is the only available HPC facility. The facility also provides access to a wide range of software packages covering materials science, computational chemistry, bio-informatics, and atomic and molecular physics. This year, the software selection was enhanced with the installation of a number of widely used packages. This year also saw a significant increase in the number of publications resulting from the facility.

For some time, however, the facility has been overloaded, with an average of thirty jobs running at any time and a wait queue of another fifty jobs. This year, a major upgrade of the facility was undertaken to address this concern, and a new MPI cluster consisting of 200 compute nodes with 3200 Xeon cores and a total of 12 TB of RAM has been added. The new cluster is expected to be made available to users in May 2013. With a rated peak computing power of 61 teraflops, the cluster is expected to ease computing bottlenecks faced by userts in the last year, and enable the addition of new users.

3.1.6.2 IUAC LAN and servers

All central servers (mail, web, proxy, database, firewall, LTS and NIS) were upgraded this year to Scientific Linux 6.2, and a plan to ensure resilience and redundancy put into place. The mail server was enhanced with further security, anti-spam and mail throttling features, to keep pace with increased spam levels and security threats. The Spectranet internet access link was upgraded to 17 Mbps, and a second name server was configured to ensure redundancy. Incremental additions to the local LAN were made, and the gigabit network at IUAC now comprises a 48-port central switching system with nineteen edge switches, more than seven hundred wired LAN ports, and ten wireless access points across six buildings. A major augmentation of the administration database package was made, with integrated billing and inventory packages developed and tested.

3.1.6.3 NIAS Time Stamp unification Module (TsuM)

E. T. Subramaniam, Kusum Rani

A multi-hit, multi-channel, high resolution digital time recorder, with common start and stop has been designed and is being tested. The simulations have been completed. The back plane interface PCIeX1, is being developed, as it is planned as an add on card for any computer. A high speed universal serial bus interface is also planned. The same back plane will be used for high speed digital signal process based data acquisition systems. The output of the constant fraction discriminators, or the pre amplifier output directly (in case there is no considerable walk with respect to amplitude variations, i.e., rise time < 5 ns), are provided as inputs to this.

The time with the possible highest resolution (around 40 ps / 80 ps) is recorded. The system has an inter hit resolution up to 5 ns. This can be operated in common start / stop mode. Every event is also tagged by a 48 bit time stamp either generated locally (if master) or from a novel time stamping technique bus, as described in the paper http://link.aip.org/link/rsi/83/123508. The differential and integral non linearity studies are yet to be done.

3.1.7 HEALTH PHYSICS LABORATORY

S.P.Lochab, Birendra Singh & Debashish Sen

Health physics group is involved in the field of radiation safety, research and development. Many universities 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.

Newly developed TLD phosphors CaSO4:Dy and CaSO4:Dy,Mn studied and compared with CaSO4:Dy prepared by BARC. We used AAS setup to find out the ppm level of Mn in our CaSO4:Dy,Mn TLD material. Li2B4O7: Cu synthesized by combustion method and studied for its TL properties.

A new facility of electro-chemical workstation added for thin film deposition and few research scholars are doing work. Installed gamma chamber is in use by many universities and Institutions. Door interlock system for new radiation shielding doors in BH-II modified as per requirement. A radiation survey to check the shielding of newly fabricated sliding door in HYRA & Mat.Sc-II was done. The results are as per our expectations. Our lab is actively participating in NDMA meets.

3.1.7.1 Thermo-luminescence kinetic parameters of γ-irradiated $Sr_4Al_{14}O_{25}:Eu^{2+}$, Dy^{3+} phosphors

A.K. Bedyal[a], Vinay Kumar[a,b*], V.K. Singh[a], S.P. Lochab[c], Fouran Singh[c], O.M. Ntwaeaborwa[b] and H.C. Swart[b]

[a] School of Physics, Shri Mata Vaishno Devi University, Katra-182320, Jammu and Kashmir, India;

[b] Department of Physics, University of the Free State, P.O. Box 339, Bloemfontein 9300, South Africa;

[c] Inter-University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi 110067, India

In this report, we present a detailed investigation of the thermo-luminescence (TL) kinetics of the long afterglow phosphor, $Sr_4Al_{14}O_{25}:Eu^{2+},Dy^{3+}$, synthesized by the combustion method. Kinetic parameters such as the activation energy *(Eα)*, the frequency factor *(s)* and the order of kinetics *(b)* were calculated using Chen's formulism. The crystalline structure of the phosphor was examined using X-ray powder diffraction and transmission electron microscopy. The average particle size was found to be in the range of 45–52 nm. The optimum dopant concentrations were Eu (1 mol%) and that of Dy (2 mol%). The TL response of the phosphor was monitored after the samples were irradiated with a γ -dose using a ^{60}C° source in the 20-800 Gy range. A broad TL peak, (stretching from 328 to 410 K) with a maximum at 368K was observed. With increasing irradiation dose, the main peak shifts toward higher temperatures. Symmetry factor calculations show that the main TL glow peak obeys second-order kinetics, which could be attributed to the creation of deep level traps. This means that γ -ray irradiation greatly affects the distribution of traps in the $Sr_4Al_{14}O_{25}:Eu^{2+},Dy^{3+}$ phosphor. The phosphor showed a linear response with γ -dose.

3.1.7.2 Opto-Structural and dielectric properties of 80 MeV Oxygen ion irradiated natural phlogopite mica

Sukhnandan Kaur[a*], Surinder Singh[a], Lakhwant Singh[a] and S.P. Lochab[b]

[a]Department of Physics, Guru Nanak Dev University, Amritsar-143005, Punjab, India

[b]Inter University Accelerator Centre, New Delhi-110067, India

Ion beams of MeV energies produce latent tracks in most dielectrics. These ion tracks in turn produce various modifications in their structural, optical and dielectric properties. These modifications are monitored using various techniques such as Ultraviolet-visible spectrometry, X-Ray Diffraction, LCR meter and Fourier Transform Infra red spectroscopy in natural phlogopite mica. Thin sheets (~ 20 μm) of phlogopite mica were exposed to 80 MeV oxygen ions. A systematic decrease of the optical band gap with ion fluence was observed. An increase in the Urbach energy indicates an increase in the disorder in phlogopite mica. The dielectric constant was found to decrease with increasing fluence while measurements of tan δ, a.c. conductivity and dielectric loss show an increase. The measured data revealed that the value of a.c. conductivity depends linearly on the frequency, with slope n ranging between 0.62 and 0.77. X-Ray Diffraction analysis of pristine and irradiated phlogopite mica demonstrated that the crystallite size decreases while strain and dislocation density increases with increasing fluence. Fourier Transform Infra red spectra showed the shifting of the OH stretching band and the disappearance of Si-H bands due to irradiation. Different causes of these modifications are discussed here.

3.1.7.3 Thermoluminescence studies of tissue equivalent lithium fluoride nanophosphors

A. K. Sharma[1], R. Dogra[1], S. K. Mishra[2], S. P. Lochab[3], and Ravi Kumar[4]

[1]Department of Applied Physics, Beant College of Engineering and Technology, Gurdaspur 143521, India

[2]Department of Life Sciences, Jawahar Lal Nehru University, New Delhi 110067, India

[3]Inter-University Accelerator Centre, Aruna Asif Ali Marg, New Delhi 110067, India

[4]Centre of Material Science and Engineering, National Institute of Technology, Hamirpur 177005, India

Nanocrystalline lithium fluoride phosphors have been prepared by the chemical co-precipitation method at different pH values (7.0, 8.0 and 9.0). The formation of nanocrystalline structure has been confirmed by X-ray diffraction and transmission electron microscope. The thermolumniscence properties of lithium fluoride phosphors irradiated with gamma rays at different doses have been studied. The analysis of thermolumniscence glow curve has revealed the existence of two well resolved glow peaks, one low temperature peak at around 145 _C and other one at higher temperature around 375°C. The LiF nano-crystallites synthesized at 8.0 pH have been found to show maximum thermolumniscence sensitivity at studied gamma doses (0.1 Gy–15 Gy).

3.1.7.4 Swift heavy ion induced structural and optical properties of Y2O3:Eu3+ nanophosphor

S. Som [a], S.K. Sharma [a,*], S.P. Lochab [b]

[a] Department of Applied Physics, Indian School of Mines, Dhanbad 826004, India

[b] Inter University Accelerator Centre, New Delhi 110067, India

This paper reports the structural and optical modifications of Y_2O_3:Eu^{3+} nanophosphor induced by 150 MeV Ni^{7+} swift heavy ions (SHI) in the fluence range 1×10^{11} to 1×10^{13} ions/cm^2. The XRD, TEM and FTIR studies confirm the loss of crystallinity of the nanophosphors after ion irradiation. Diffuse reflectance spectrum shows a blue shift in the absorption band for SHI induced nanophosphors. An increase in the intensity of photoluminescence peaks without any shift in the peak positions was observed.

3.1.7.5 Pre-gamma dose thermoluminescence characteristics of muscovite mica

Navjeet Kaur [a], Lakhwant Singh [a], Mohan Singh [a], S.P. Lochab [b]

[a] Department of Physics, Guru Nanak Dev University, Amritsar, Punjab 143005, India

[b] Inter-University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi 110067, India

In the present research work, sensitization characteristics of the 180 ^{0}C thermoluminescence peak of muscovite mica have been studied. The sensitization factor (S/S0) as a function of post-irradiation heat treatment, pre-dose and duration of heat treatment has been investigated. A pre-dose of 2 kGy followed by heat treatment at 500 ^{0}C for 1 h is found to be the optimum condition for sensitizing the muscovite samples. The thermoluminescence glow curve structure of unsensitized and sensitized mica is nearly the same but a great improvement in the sensitivity has been observed after sensitization. The thermoluminescence response curves for unsensitized and sensitized mica samples exhibit linear behavior in the range 5–25 kGy. Analysis of the thermoluminescence glow curves and calculation of trapping parameters (activation energy and frequency factor) for individual deconvoluted peaks for 25 kGy gamma irradiated of unsensitized and sensitized mica have been done using glow curve deconvolution software.

3.1.7.6 Luminescence characteristics of Eu and Ti doped $LiNaF_2$ phosphor

S.P. Puppalwar [a], S.J. Dhoble [b], S.P. Lochab [c], A. Kumar [d]

[a] Kamla Nehru College, Sakkardara Square, Nagpur 440009, India

[b] Department of Physics, RTM Nagpur University, Nagpur 440033, India

[c] Inter University Accelerator Centre, Post Box-10502, New Delhi 110067, India

[d] National Environmental Engineering Research Institute, Nagpur 440020, India

Polycrystalline low Z phosphors (Zeff = 9.54) $LiNaF_2$:Eu and $LiNaF_2$:Ti prepared by standard solid state diffusion method are studied for their photoluminescence (PL) and thermoluminescence (TL) characteristics. The PL emission spectra of the phosphors suggest the presence of Eu^{3+} and Ti^{4+} in the host compound occupying two different lattice sites. The intense emission observed in the spectrum of Eu doped phosphor is assigned to electronic transitions $^5D_0 \rightarrow {}^7F_2$ in Eu^{3+} ions. In Ti^{4+} doped phosphor the observed emission in the range 350–390 nm attributed to Ti^{4+} ions. The TL glow curves of these $LiNaF_2$ phosphors exposed to γ-rays from ^{137}Cs for different exposures are discussed for the first time. The thermoluminescence (TL) response in the 0.1–5.3 Gy dose range increased linearly with the increase in radiation dose. The whole glow curve displays a remarkable stability upon storage at room temperature. The TL sensitivity of the phosphors is compared with standard commercial TLD phosphor $CaSO_4$:Dy and is found to be 5.37 times less in $LiNaF_2$:Eu and 9.25 times less in $LiNaF_2$:Ti phosphor.

3.1.7.7 Studies on luminescence properties and energy transfer in Ce/Dy co-doped CaS nano-phosphors

Geeta Sharma [a], S.W. Gosavi [a], S.P. Lochab [c], Nafa Singh [b]

[a] Department of Physics, University of Pune, Pune, India

[b] Department of Physics, Kurukshetra Institute of Technology and Management, Kurukshetra, India

[c] Inter University Accelerator Center, Aruna Asaf Ali Marg, New Delhi 110067, India

Luminescence properties of CaS:Ce co-doped with dysprosium has been studied. Ce/Dy co-doped CaS nanophosphors ($CaS:Ce_{0.25}Dy_{0.75}$, $CaS:Ce_{0.50}Dy_{0.50}$, $CaS:Ce_{0.75}Dy_{0.25}$) were synthesized using the solid state diffusion method. The phase purity of the samples was confirmed using XRD data. The particle size was calculated using Debye–Scherrer formula and was found to be varying between 50 and 60 nm for all the three samples ($CaS:Ce_{0.25}Dy_{0.75}$, $CaS:Ce_{0.50}Dy_{0.50}$ and $CaS:Ce_{0.75}Dy_{0.25}$). TEM image analysis of $CaS:Ce_{0.50}Dy_{0.50}$ shows nearly spherical particles with diameter varying between 50 and60 nm. One way energy transfer from Dy^{3+} to Ce^{3+} in CaS host has been investigated using photoluminescence studies. Thermoluminescence of these nanophosphors has been studied for 0.5 Gy–21 kGy dose of gamma rays and the dose linearity of $CaS:Ce_{0.50}Dy_{0.50}$ has been compared with $CaSO_4$:Dy (standard TL dosimeter). Linear behavior over a large dose range between 0.5 Gy and 21 kGy was found for $CaS:Ce_{0.50}Dy_{0.50}$ as compared to $CaSO_4$:Dy (nanocrystalline and microcrystalline) but it is found to be less sensitive than microcrystalline $CaSO_4$:Dy. To identify the peaks of Ce^{3+} and Dy^{3+} in CaS, the TL spectra of CaS, CaS:Ce, CaS:Dy and $CaS:Ce_{0.50}Dy_{0.50}$ were recorded. The addition of dopants does not add new peaks in CaS but aid to enhance the TL emission. The peaks in CaS may be associated to intrinsic traps in the host lattice.

3.1.7.8 Thermoluminescence of Eu activated LiF nanophosphors

Satinder Kumar[1], A.K. Sharma[2], S. P. Lochab[3] and Ravi Kumar[4]

[1]Department of Physics, Government College, Hamirpur – India (sksharma1564@gmail.com)

[2]Beant College of Engineering & Technology, Gurdaspur - India

[3]Inter-University Accelerator Centre, Aruna Asif Ali Marg, New Delhi – India.

[4]Centre of Material Science & Engineering, National Institute of Technology, Hamirpur-India

Nanocrystalline lithium fluoride (LiF) phosphors prepared by the chemical co-precipitation method at 8.00 pH value have been activated with Eu (0.01, 0.03, 0.07 and 0.1 %) as single dopants. The formation of nanocrystalline structure has been confirmed by X-ray diffraction. Thermolumniscence (TL) properties of LiF:Eu nano-phosphors irradiated with gamma rays at different doses of 100 Gy – 10 kGy have been further studied. There is only one main glow peak at around 122oC; which shifts to higher temperature with an increase in doping concentration at all studied irradiation doses. However, the glow peak shifts to lower temperature with an increase in irradiation dose from 100 Gy to 10 kGy. The LiF nano-crystallites synthesized at 8.00 pH and activated with 0.03 % Eu are found to have maximum TL sensitivity at studied gamma doses.

3.1.7.9 Pure LiF Nanophosphors for High Exposures of Gamma Rays

A.K. Sharma[1], Satinder Kumar[2], R. Dogra[1], S. P. Lochab[3] and Ravi Kumar[4]

[1]Beant College of Engineering & Technology, Gurdaspur - India

[2]Department of Physics, Government College, Hamirpur - India

[3]Inter-University Accelerator Centre, Aruna Asif Ali Marg, New Delhi – India.

[4]Centre of Material Science & Engineering, National Institute of Technology, Hamirpur-India

Nanocrystalline lithium fluoride (LiF) phosphors have been prepared by the chemical co-precipitation method at different pH values (7.0, 8.0, 9.0 and 10.00). The formation of nanocrystalline structure has been confirmed by X-ray diffraction and transmission electron microscope. Thermoluminescence (TL) properties of LiF phosphors irradiated with gamma rays at different doses of 10 Gy – 70 kGy have been further studied. The analysis of TL glow curve revealed the existence of three well resolved glow peaks, first low temperature peak at around 82°C, second at 125°C and third one at higher temperature around 303°C. The LiF nano-crystallites synthesized at 8.00 pH with maximum TL sensitivity at studied gamma doses ranging from threshold to high exposures are potential candidate for dosimetry applications.

3.1.8 DATA SUPPORT LABORATORY

V.V.V.Satyanarayana, R. Ruby Santhi and P. Sugathan

Data Support Laboratory provides support to users on data acquisition & nuclear electronics setup during experiments. In the data room, two on-line data acquisition based on CAMAC systems are maintained for data collection during in beam experiments and two desktop workstations for off-line analysis. The lab maintains the data acquisition computers & private LAN for data network. Apart from providing regular user support and maintenance of the setup, we also developed few electronic modules and serviced a number of NIM and CAMAC modules.

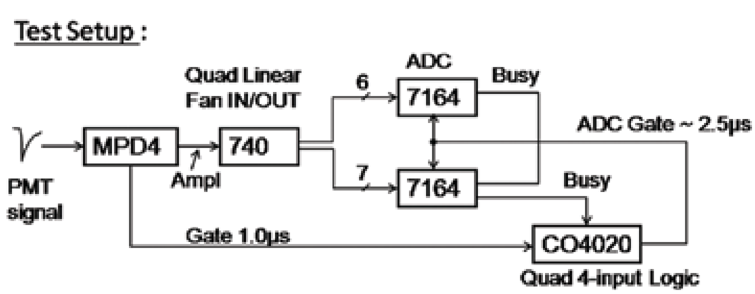
3.1.8.1 Development of NIM modules for NAND experimental facility

The upcoming Neutron detector array in Phase II beam hall required customized electronic modules and we have developed few such modules, tested and implemented them in the facility. A 16 channel NIM/ECL converter has been fabricated and tested. This has been used in converting the time of flight fast NIM signal from pulse shape discrimination module to ECL and fed to the VME TDC input. More such modules are being fabricated to meet the requirements of 100 time of flight channels. In order to feed the analog signal to VME ADCs, a multi channel adapter box containing LEMO to differential header has been fabricated and used in the setup.

3.1.8.2 *Freedom* DAS with CMC100 CAMAC crate controller

Kundan Singh, R. Ruby Santhi, P. Sugathan & B.P. Ajith Kumar

The existing data acquisition system based on the indigenously developed CAMAC crate controller and Freedom software has been running on an ISA bus based controller which require an ISA card to communicate with the personal computer (PC). Since the ISA slots in PC have become obsolete, we have developed an alternate solution using



2 ADCs; 32 channels assigned; 13 inputs Live

Trigger	Accepted Trigger after Logic		% Loss	
	Normal Mode	Q-Stop	N-Mode	Q-Stop
7.7K	5.3K	6.5K	31%	15%
42.9K	12.29K	21.0K	71%	50%

commercially available USB based crate controller CMC100. The CMC100 controller based data acquisition is found to be a very good replacement for the old system. The CMC100 is a USB2.0 compliant list processing CAMAC crate controller. The list processor program memory is 512 words. The CMC100 can read data from CAMAC modules at up to 30 Mbytes/sec. The existing 16 channel Phillips ADC can be read either in normal mode or Q-Stop mode (sparse data read) . In Q-Stop mode only those channels with data between an upper and lower threshold are read, starting with the highest numbered channel. Reading an empty buffer returns Q false. In other words sparse data read minimize data readout time. In order to implement these new features in data acquisition software, the front-end part of the Freedom software has been modified for both normal & Q-stop read modes of 7164 Phillips Peak ADC. For Q-Stop mode, new algorithm is written in the server program to sort data according to the user entered NAF list.

3.2 UTILITY SYSTEMS

3.2.1 ELECTRICAL GROUP ACTIVITIES

U. G. Naik, Raj Kumar

This group is primarily responsible for providing adequate electrical infrastructure for the scientific augmentation projects of the institute and maintains the electrical installations of the institute. 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.2012-2013. Brief of various activities are given below.

MAINTENANCE:

3.2.1.1 CAPTIVE POWER INSTALLATIONS

Institute has a captive power base of 1560 KVA, having DG capacities from 100-750 KVA. Group has successfully managed the power backup requirements with the captive power sets available. The group has shown ever readiness in running the systems round the clock and within short notices smoothly.

3.2.1.2 VOLTAGE STABILISERS

500 KVA stabilizer providing stabilized power to 15 UD Pelletron had developed fault in its control cards which were rectified. All other voltage stabilizers in various installations have delivered 100% up time.

3.2.1.3 UPS INSTALLATIONS

The institute has 5 sets of 2*60KVA UPS, 2*300KVA, 1*50KVA and around 20 nos. of 2-10KVA UPS systems maintained by electrical group. These were maintained properly with timely replacement of batteries and AMC through their respective manufacturers. UPS batteries worth of Rs. 10 lakhs were replaced during the year.

3.2.1.4 POWER FACTOR COMPENSATION

This year again we achieved an average power factor almost near to 0.95 lag throughout the year. Our system power factor without correction is about 0.85 and by raising it we saved around Rs.68 lakhs from energy billing.

3.2.1.5 COMMUNICATION EQUIPMENTS

Electrical group maintains the hand held radio stations (Walkie-talkie) and base station. Till now we have 14 nos. 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. The major repairs were done through authorized service agents. The group takes the responsibility of getting the revalidation of license periodically from the ministry of telecommunications.

3.2.1.6 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, whereas the material required is supplied by us. This year we had done a fresh exercise in appointing an agency by an 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%. A 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 and power circuits.
- Servicing of DG sets 2 X 60kVA, 2X 320 kVA, 1X 100 kVA-twice a year.
- Maintenance of street lighting and earthing.
- Gaskets replacement for 3nos. of 500KVA Transformers

3.2.1.7 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:

3.2.1.8 UPS SYSTEMS FOR 15UD PELLETRON

Group has planned, designed an uninterrupted electrical power system for 15UD Pelletron using 4*200KVA on line UPS and electrical panels at the input and output of the UPS with a total project cost of 100lakhs. The system is installed and put in to operation in March 2013.

3.2.1.9 BACKUP POWER TO 15UD PELLETRON & POWER TO HPC CENTRE

Group has planned, designed DG power backup of capacity 750 KVA to feed UPS systems of 15UD Pelletron. Project is delayed and the present status is 2*750KVA DG sets, one each for 15UD Pelletron and HPC Centre have been installed along with the exhaust piping and structure. Cabling and cable trays/ earthing etc are yet to be completed. The remaining works will need another 3 months time to get completed. Total project cost is 200 lakhs and around 130 lakhs has been paid till date.

Group has planned, designed a synchronization scheme to synchronize 3X750 KVA DG sets including the above mentioned 2nos. of 750 KVA DG sets and one more 750 KVA DG set of liquid He systems.

3.2.1.10 ELECTRICAL ENERGY MANAGEMENT NETWORK

Electrical group had successfully installed new power and energy monitoring software from Schnieder Electric co.

3.2.1.11 SPECIAL ELECTRICAL EARTHING

Electrical group has successfully executed 3nos. of electrical earthing inside the beam hall for the NAND experimental facility and its electronics. These were the special chemical earthing using copper electrode of 60mm diameter. Earth resistance measured at each electrode is within 0.5 Ohm.

3.2.1.12 WORKS FOR BEAM HALL-III

Electrical group has taken up electrical works partially for the first part of HCI in BH-III involving RFQ, DTL and few magnets besides 50 KVA of UPS power to the High voltage deck equipments.

3.2.2 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 1,02,000 hours each and the compressor#2 has logged in 21,500 hours. Other rotary equipment except AHU#1-7 have logged in about 1,75,000 continuous run hours. It is relevant to note that the Indian industrial norms specify ~25,000 run-hours for the life of compressors and ~50000 hours for other rotating equipment.

The Phase-II, centrifugal central AC plant with its installed capacity of 250 TR, catered to EBW, UPS, Beamhall#II and cryogenic activities. 19XL Chiller broke down and most of the rotating components were severely damaged. They were replaced by old used ones and the chiller was commissioned back in the month of February 2013. Though the Ph-2 Chiller was down, the ph-2 loads were diverted on Ph-3 chiller and the breakdown did not affect the research activities. OEM (Carrier) advised on replacing the chiller in-view of non-availability of critical spares, as this chiller model has become obsolete. It was decided to run this chiller to the extent possible. It was further decided, that in the event of any major subsequent failure of the chiller, no repair works will be taken up and it will be replaced summarily as it has overshot its commercial life.

The Phase-III, screw chiller based central AC plant with its installed capacity of 250 TR performed to an uptime of 100%.

The highlight of the operation and maintenance of the above systems was the in-house supervision provided to the contracts, thereby affecting substantial savings in the price paid for these.

The yearly maintenance costs have been maintained at approximately one-eighth of the national standards and one third of the world class industrial bench marks. Though, the plants have aged, yet the MTBF for all the equipment is within acceptable norms.

The equipment being into their twenty-fourth year of sustained operations has far outlived their economic lives. Maintenance ensured that the equipment still possessed high operational reliability.

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, which were followed over the years. The system has already overshot 1,28,000 hours beyond its expected life span.

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 heat removal capacity and potable water supply also performed to an uptime of 100%.

Further, 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%.

A strict monitoring on the water quality ensured that the flow paths are in healthy condition. The maintenance costs were kept significantly lower as compared to world class bench mark values.

COOLING SYSTEM

Availability of equipment was recorded at 99%.

PLANNED BUDGET WORKS

- Installation of 2 Nos., 200TR Screw Chillers in Ph-1 A/C Plant is nearing completion and is expected to be commissioned by March'31, 2013. This will replace the failed #4 and also help partly in picking up additional BH-3 loads.
- Replacement of: One AHU of Ph-2 A/C Plant, three air-washers at different locations, chilled water piping, valves, ducting, etc., have been completed. Replacement of AHU of Ph-2 plant (AHU#3) has been taken up and is expected to be completed shortly.
- Pelletron UPS room Air-Conditioning work of 16TR capacity has been taken up and is expected to be completed by April 2013.
- Ph-2 Kamadhenu housing drinking water main and branch headers were replaced by new GI pipes as the old MS pipes developed leakages at various places.
- Lab cooling supply water header to Gas Handling Room was replaced by new one as the old pipes developed leakages at various points.
- Additional cooling equipment were installed as per requirement.

RESEARCH ACTIVITIES OF THE GROUP

- A maintenance budget model was developed.
- Evaluation of realistic MTTR based on contextual criterion was modelled and validated.
- Diagnostic Tool for maintenance is under development.

3.2.3 MECHANICAL WORKSHOP (MG-III)

B.B.Choudhary, S.K.Saini, R.Ahuja, S.Rao & J.Zacharias

IUAC workshop is an ideal workshop equipped with modern machining and welding facilities to support Pelletron Accelerator, various laboratories and large number of user community. The major facilities of the workshop are the Machine shop and the Welding shop.

The Machine shop is equipped with a five axis Vertical Machining Centre and a CNC lathe. 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. We also have the CAD facility, Solid Works for the design and drafting purpose. We also have VISI CAM for the CAM support for the Vertical Machining Centre and CNC lathe. A portable CMM is also installed in the workshop metrology section.

Workshop has been involved in development activities of new system as well as a large-scale production of beam line components right from the inception of IUAC. Most of the beam line components used for the new beam lines were 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 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.

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 also 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
- High current proton source for 2.45 Ghz source development program
- 50 keV Ion accelerator
- LEIBF -II Beam line components
- Design of Monichrometic X-Y Allignment Stand
- Hexagonal High Temperature Ladder
- Mesh with rectangular Holes
- Target manipulator with Ball screw & stepper motor

3.2.4 CIVIL WORKS

M.K.Gupta & Harshwardhan

Works under Civil Section

- Major expansion Projects (right now construction of 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

- Liasion with various Govt. and external agencies for statutory approvals and various civic problems
- Key management of the Centre

Important Civil Activities during the Year 2012-13

Following important civil works were undertaken during the year 2012-13 in addition to routine civil maintenance and minor works:

- work for construction of Auditorium & Lab. block Extn in progress in association with M/S RITES (our Project management consultant)
- P/F Vitrified tiles on floors of rooms and replacement of glazed tiles on toilet walls in old Guest house flats and Nikunj Guest House
- Epoxy floor coating on the floor of Beam Hall III and R. N.125 in Beam Hall-II Extn. to make it dust-proof and durable
- Construction of Barbed wire fencing between Academaic & Residential Complex
- Internal painting of old Guest house & Hostel complex (including Dining Hall)
- Internal painting of Beam Hall-III
- Misc. renovation works in old Guest house Toilets & Kitchens (replacement of old plumbing & sanitary fittings, kitchen counters with Granite stones etc.)
- Covering of 5 no. balconies (Sumeru-I/4, Sumeru-I/1, sumeru-II/26, Kamdhenu-II/13&22) in Housing complex with MS glazed windows and fixed glazing
- Conversion of 5 no. kitchens into Toilets in old Guest house flats
- External painting of all buildings in IUAC (except Main building and buildings with Grit wash
- Replacement of 4 no. Security Porta cabins with new ones in the campus
- Modifications in Cryo entrance area to convert it into Plant Operators room
- Additions/Alterations & renovation of old Tea/pantry area in Beam Hall-II to convert it into Low Temp. Lab.
- Fabrication of few PVC storage Almirahs in Beam Hall-I & Beam Hall-II
- Spirit polishing of Main building wooden doors & partitions
- Making a PVC cabin with MS framework for operators in Beam Hall-III
- Renovation/additions/alterations in R.N. 240 & around (Main building) to convert it into Clean room for HPGe Detector repairs

3.2.5 COMPRESSED AIR SYSTEM AND MATERIAL HANDLING EQUIPMENTS (MG-I)

K.K. Soni and Bishamber Kumar

Group is associated with the following activities:

i) **Compressed Air System:** Compressed air plant (Ph-I & PH-II) consisting of three screw compressors each of 115M^3/Hr capacity, along with 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 breakdown of existing compressor. A storage tank of 1KL is added between compressor and Air dryer for smooth flow of compressed Air.

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:** The existing Elevator is running from last 23 years and now it needs thorough modification in order to match the current technology of low noise, low power consumption and enhance safety features. We have taken up the work for its modernization and hopefully to complete the same in next few months.

iv) **Material Handling System:** Periodic maintenance / servicing of more than 14 nos. E.O.T cranes and electric hoists of various capacities varying from 1 Tonne 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 important area 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, Lab II area and Workshop building. Some more sign boards including the “Escape route” are added in the building which shine 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.