3. RESEARCH SUPPORT FACILITIES

3.1 SUPPORT LABORATORIES

3.1.1 HIGH VACUUM LABORATORY

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

New Low Energy Ion Beam Facility (LEIBF) has been fully commissioned and is operational. Regular beams are being taken in the material science [90°] beamline. The installation continued from previous year and was completed in all respects. ASPIRE noise and sample pick up problem was solved and made operational.

3.1.1.1 COMMISSIONING OF LOW ENERGY ION BEAM FACILITY

P. Barua, A. Kothari, M. Archunan, S. K. Saini, R. Ahuja, R. Kumar, B.B. Choudhary, Kundan Singh, G.Rodrigues, C. P. Safvan, A. Mandal, D. Kanjilal

Installation of the facility was completed in all respects. The control electronics [designed and fabricated in house, Indigenous Measurement and Control System (IMACS)] were installed and all the devices were connected with their respective controllers. The working of all the devices was checked during beam test for proper working. Major activities are given below-

- **High Voltage Deck components:** Necessary high voltage safety interlocks were designed, fabricated and installed in the deck. ECR source along with RF power supply was installed. Two fibre optic devices were installed in the deck with fibre cable connection between deck and beamline. 400 kV GP Tube was installed between deck and beamline.
- **Beamline installations:** Magnetic Scanners were installed in the 90° beamline. A high speed Turbo Pump [Maglev, 1000 lps] near GP tube was installed to improve the vacuum by one order. Cooling system installed for high power Double Slit and Faraday Cup. A water flow switch is also installed which will be used for safety interlock purpose. The double slit was installed before the BPM during the installation, in the beamlines. Their position reversed for better beam control and diagnosis. Installation of 2" BPM in Material Science Line at the exit port of first chamber was done to diagnose the beam. Required vacuum was achieved at all the places.
- **Electronic Components:** Proper placement of the 19 inch instrument racks, magnet power supplies, and vacuum system controller was done. IMACS control system and all the beamline device controllers [fig 6.] were installed in the racks. Individual operation of the devices was checked for proper operation. Eleven Log amps. were installed in the beamline for Faraday cups and double slits and interfaced with the control system. There are five electrostatic quadrapoles which require 16 nos. of (0-10 kV) variable high voltage power supplies. All power supplies were installed with proper ground connections.
- **Control console design and fabrication:** Control Console Design, Fabrication and Installation: Control console was designed and combination of 4 number 19" rack was done. MDF board for side & top covering was used. New technology solid acrylic table top was used for durable & high finishing. Two number CCD cameras & 15" TFT installed on console for remote monitoring
- Successful beam test done.
  Beam = O 1+,
  RF Power = 20 watt
  Gas = 3.03 t ,
  Extractor = 15 kV
  BM (SW) = 0.5013 mT
  FC 01 current = 193 µA
  FC 2-2 current = 44 µA

Fig. 1. Beam Profile

Fig. 2. Control Console

3.1.1.2 INSTALLATION OF EXPERIMENTAL CHAMBERS IN LEIBF HALL

Installation of Material Science Chamber: A new chamber was installed and aligned in material science line. A complete vacuum pumping system with necessary controls, gauges and valves was installed on the chamber. A 12 inch linear motion drive and 360 degree rotary motion drive were installed on the chamber for sample movement. A hexagonal Liquid nitrogen cooled ladder was designed and fabricated for the chamber.

- **Installation of Auger Electron Spectroscopy [AES] chamber:** The AES chamber was installed in the Molecular Physics line [105°]. The chamber with the new stand is placed at its position and aligned with beam axis. It is a UHV chamber and is pumped by a Turbo Pump and an Ion Pump. It was integrated in to the beam line.
- **Installation of Atomic / Molecular Physics Chamber and Intermediate Beamline:** The existing molecular physics beamline was extended from AES chamber to the new atomic chamber and beyond. The entire beamline, stands and beamline components [two tubes having deflector plates, one Tee each for Ion Pump and turbo pump, manual Double Slit, BPM [Dan Physique], Isolation valve [6" OD], were installed.

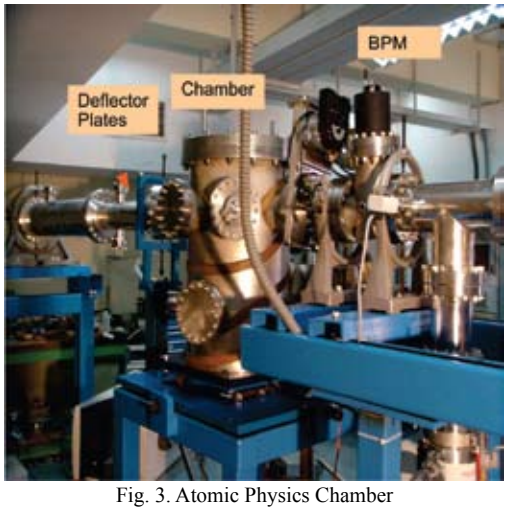


Fig. 3. Atomic Physics Chamber

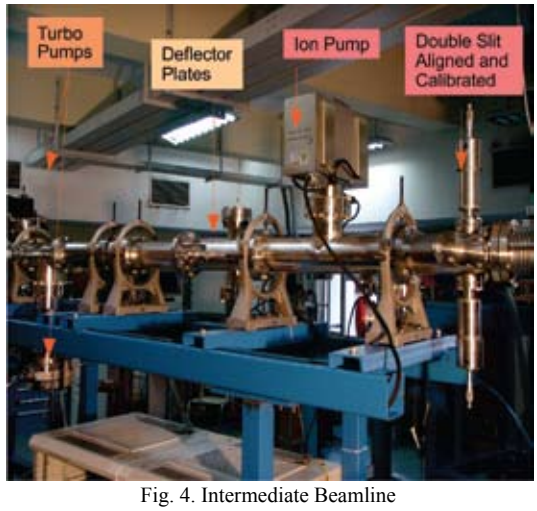


Fig. 4. Intermediate Beamline

3.1.1.3 DEVELOPMENT OF ELECTRONIC MODULES

New modular based controllers were designed, fabricated and assembled as per new control system IMACS [Fig 5.] for LEIBF. In total 14 nos. of modules were completed for controlling Faraday cups and beam line valves. Two new crates for interfacing of the devices with IMACS were also designed and fabricated.

The interfacing crate can accommodate 8 numbers of Interfacing Cards. The New LEIB Facility required at least two such Crates for controlling the whole beam lines. Crate-1 consists of 4 numbers of OR-IG, 2 ADCs and 2 DAC Modules and is used to control/measure 2 Turbo pumps, 8 BLVs and 4 Electrostatic Quadruples. Crate-2 consists of 4 numbers of OR-IG, 3 ADCs and 1 DAC Module and is used to control/ measure 6 Faraday Cups, 4 Ion Pumps, 4 Double Strippers, 1 Magnetic Scanner and 1 High Voltage Power Supply.

Fig. 5. IMACS

Fig. 6. BLV and FC Controllers

Fig. 7. LEIBF Control System

3.1.2 BEAM TRANSPORT SYSTEM

Beam Transport System laboratory takes care of regular maintenance of Beam transport instruments. BTS laboratory has been 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 SCANNING MAGNET POWER SUPPLY

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

A few 500 watt air cooled power supplies for scanning magnets are required in the accelerator system to replace the existing power supplies. The existing power supplies were developed in 1995 which were based on power opamp. It has power delivering capacity upto 150 watt which is not sufficient for scanning a bigger target. Also because of aging effect, it frequently gives operational problem.

In new design, we have used power transistors instead of power opamp to increase the load voltage as well as load current. This also has more protections associated with innovative control loops to drive inductive loads at high frequency for bipolar current regulated triangular wave outputs. The design is complete which includes circuits (control and power section), cabinet (modularity, front and back panel, module placement) and wiring and layout details. Design implementation is in progress.

3.1.2.2 CONTROL ELECTRONICS FOR PIEZO ACTUATOR BASED PHASE LOCKING OF SCQWR

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

There is a plan to implement piezoelectric based tuner mechanism for phase locking of the superconducting cavities in the Linac cryomodule -III to improve the dynamics of the overall resonator control scheme. Presently the fluctuations in resonant frequency are stabilized by dynamic I-Q based phase control along with helium gas flow based mechanical tuners. These mechanical tuners operate in a slow time scale. Because of slow response most of the dynamic fluctuations are taken care by electronic tuner by putting a substantial load on RF amplifiers. The piezoelectric based control is planned to operate in time scale of mili-seconds to improve the dynamics thereby reducing RF power. The control electronics for the same has been designed to operate in this time scale. The control module includes closed loop operation along with High voltage Amplifier and HV power supply. Design implementation is in progress.

3.1.2.3 HIGH VOLTAGE POWER SUPPLY (2KV/5MA) FOR NEUTRON/SILICON DETECTOR

Rajesh Kumar, S.K.Suman, P.Sugathan, A.Mandal

A compact high voltage module has been developed to be used with NAND array. This is a high performance 10W, 24VDC to HVDC (2kV) converter. It provides well regulated, low ripple and highly stable output. Linear and SMPS techniques are combined to minimize internal dissipation and generated EMI/RFI interference. In the next year, approximately 10 such modules will be housed in a 19" rack mountable 2U-cabinets with Ethernet based remote control and inbuilt 24V DC power source. Followings are the specifications and features.

- Input DC Supply : +24V/0.5A
- Output power :10W
- Output voltage : 0 to 2 kV
- Can be upgraded upto 10kV.
- 0 to 100% programmable output
- Voltage monitor (0 -10V F.S), Current monitor (0-10V F.S)
- Output Over current protection
- LCL & REM control, Remote shutdown

3.1.2.4 DEVELOPMENT OF BEAM LINE SELECTOR SWITCH FOR LEIBF-II FACILITY

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

A beam line selector switch has been developed for LEIBF-II facility. This basically switches a set of steerer power supplies from one beam line to the other beam line with interlocks and indications. Followings are the design features of this selector switch.

- Two power supplies are switched in between three beam lines.
- Only magnets of selected beam line are connected, while other beam line magnets are disconnected from power supplies.
- Power supplies get puts-off during the changeover.
- It is operated remotely or locally.

3.1.2.5 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.

3.1.2.5.1 BEAM TRANSPORT SYSTEM MAINTENANCE

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

A large numbers of instruments (approx. 175 nos) of different types including magnets, power supplies, CAMAC based control modules, Magnetic field measuring instruments, beam line switchgear are in operation round the clock. To achieve BTS uptime maximum, we have done scheduled and preventive maintenance.

Scheduled maintenance: Schedule maintenance of magnets, power supplies and other instruments has been done carefully and thoroughly twice this year to minimize breakdown/failure during the beam time.

Some routine tasks carried out during the maintenance are following-

- Locating and replacing degraded parts before failure 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.
- Safety interlock calibration and testing.

Breakdown Maintenance: This type of maintenance is done during beam time for any malfunctioning in electronic sections as well as in power sections. 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.

BTS Installation/Upgradation: Installation and testing of following BTS instruments have been successfully completed in new LEIBF-II facility. Indigenously developed power supplies are used for Steering and scanning magnets.

- Switching magnet power supply
- Steering magnets and power supplies
- Scanning magnet and power supplies
- Beamline selector switch for STPS

3.1.2.5.2 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. Now we have extended our skill in repairing and servicing of following instruments for various lab at IUAC.

Target development lab power supplies: Following vacuum deposition setups power supplies repaired/ serviced whenever there is breakdown.

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

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 (5kV,100uA)
- ACS Detector bias power supply (3kV, 10mA)
- Pre-amplifier power supply (±24V,1A ±12V 1A)

Tube base high power RF amplifier for DTL and RFQ: High power (2kW & 10kW) amplifiers are used in DTL testing. Following amplifiers have been repaired for multiple failures in RF section, DC power section and control electronics when ever reported. Amplifiers were made ready and used successfully for DTL testing.

- Indigenously developed 2kW, 97 MHz amplifiers
- 2kW RF 97 MHz amplifier “Hennry make”
- 10kW RF 97 MHz amplifier “DB Power make”

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, 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 FISSION ANGULAR DISTRIBUTION STUDIES IN GPSC

A. Jhingan, Sunil Kalkal (DU), Varinderjit Singh (PU), P. Sugathan, R. Sandal (PU), B. R. Behera (PU), S. K. Mandal (DU)

Hybrid telescopes, having combination of gas (DE) and Silicon detectors (stopping), have been developed for heavy ion detection & particle identification in nuclear physics experiments in GPSC facility at IUAC. The detector telescope has been used for studying the angular distributions of fission fragments. The detector system can also be used to identify projectile like fragments and thus can be used for studying transfer and breakup reactions.

The telescope consists of a gas ionization chamber, operating in axial field geometry mode, followed by a Silicon surface barrier detector (100 μm thick) from Canberra. The ionization chamber (IC) is composed of three wire frames of active diameter 1cm. The wire frames are a cathode, a central anode frame, and another cathode wire frame. The distance between adjacent wire frames is 10 mm. All wire frames are made from gold plated tungsten wires of 20 μm diameter stretched on a 3.2 mm thick printed circuit board. The separation between adjacent wires is 1 mm. The electrodes are housed inside a cylindrical SS tube. The detector is operated with Isobutane gas at pressures 10-200 mbar. Entrance foil used is 1 μm mylar. Anode is read using in-house fabricated charge sensitive preamplifier with charge sensitivity of 90 mV/MeV (Si equivalent) and the SSBD has a charge sensitive preamplifier of sensitivity 20 mV/MeV. For improved resolutions, the preamplifier was placed next to detector inside the vacuum chamber.

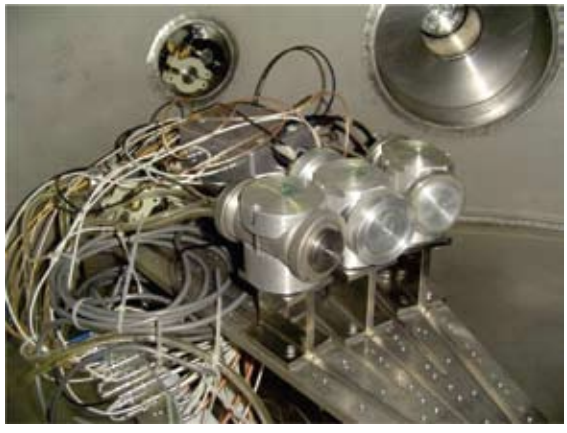


Fig. 1. Experimental setup in GPSC

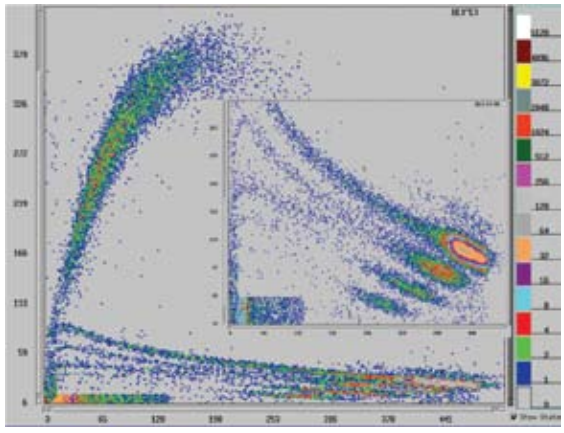


Fig. 2. Identification of various transfer products from on-line data.

The detector was tested off-line with ^{241}Am alpha source. The detector was operated at 100 mbar gas pressure with a bias voltage of +200 V. A resolution of 80 keV (fwhm) was observed for 600 keV loss in the active area of the IC. A detection efficiency of 100 % was observed for the IC with respect to Silicon detector following it. The detector setup was used for investigating the fission anisotropy of systems ^{19}F + ^{194,196,198}Pt and ^{16,18}O + ^{194,198}Pt. Three hybrid telescopes were placed at a distance of 30 cm from the target with angular separation of 12 degrees (fig.1). A clean separation was observed between projectile like particles & fission fragments. A clean separation between various projectile like transfer products was also observed (fig.2).

3.1.3.2 DETECTOR SETUP FOR HYRA FOCAL PLANE

Detector Lab – HYRA group

HYRA focal plane detector system was upgraded by replacing the existing MWPC with a large area MWPC (150mm x 50mm). To achieve higher gains at lower pressures, wire pitch in anode was reduced to 0.63 mm (from existing 1.27 mm) and a 10um diameter wire was used. The resistive anode detector was replaced by 16 x 16 strip detector (design W from Micron Semiconductors UK) having an active area of 5 x 5 cm2. The front end electronics include 32 channel preamplifier followed by two 16 channel units of shaping amplifiers from MESYTEC. The differential outputs from the preamplifier unit is driven to shaper amplifiers using 34 way round and twisted shielded cable to maintain the signal to noise ratio. The energy signals are read by Phillips ADC. The system was tested off-line and used in-beam experiments. In coming days we plan to add TDC and clock module for time stamping each event. To increase the active detection area, a new detector has been acquired from Canberra having 3 wafers of active area 4 x 4 cm2 having 4 resistive strips. Mounting these wafers together will yield an active area of 12 x 4 cm2 making it compatible to focal plane detector of DUBNA gas filled spectrometer.

3.1.3.3 REPAIR OF DAMAGED MWPC IN NAND & GPSC

The two MWPC destroyed in a vacuum accident in 2010 were repaired by replacing the entrance window foils, Aluminized cathode foils & X-position wire frames (10um gold plated tungsten wires at 0.63 mm pitch). The detectors were thoroughly tested off-line with ^{241}Am alpha and later used in experiment with LINAC beam for the system ^{28}Si + ^{204,206,208}Pb. One of the MWPC placed at forward angle (angular coverage 13 – 47 degree) had a count rate exceeding 500 kHz for elastics. No breakdown or deterioration in MWPC signals was observed at such high count rates during the entire run of 24 shifts.

The MWPC used for mass distribution experiments in GPSC showed sagging of wires and also blackening of wires in certain areas. This resulted in breakdown at lower voltages and reduced charge collection efficiency. Three wires frames of one of the MWPC were replaced with new ones. The detectors were used to carry out mass distribution experiments of ^{30}Si + ^{180}Hf, ^{18}O + ^{232}Th & ^{12}C + ^{238}U in GPSC.

3.1.3.4 TIME OF FLIGHT SYSTEMS FOR NAND/GPSC

We plan to have improved time of flight system (TOF) system for NAND & GPSC based on Multi wire proportional counters. The new system will have start-stop detectors with reduced wire pitch of 0.63 mm for all electrodes. Such frames with active area of 8” x 4” & 6” x 5” have been fabricated. The timing electrode uses 10 um wire and other electrodes uses 20 µm wires. For start detector timing electrode, we plan to have wire frame with 10 µm diameter wire at 0.3 mm pitch. A prototype electrode has been designed and fabricated. These will be assembled and tested in coming days. We intend to place the timing amplifiers in vacuum next to detectors to avoid timing degradation in long coaxial cables. The TOF systems will be used to carry out mass distribution & transfer reaction experiments.

3.1.3.5 TESTING OF RESISTIVE ANODE DETECTORS FROM CATE (GSI)

The three resistive anode Silicon detectors from CATE (Acknowledgement: Prof. H. J. Wollersheim, GSI, Darmstadt, Germany) were assembled on a common board with the provision of mounting on-board

preamplifier without any coaxial cables. Each detector has five readouts, thus a provision for mounting 15 preamplifiers has been made. The system was tested with ^{241}Am alpha source with only energy readout (without position) yielding an energy resolution of 75 keV (fwhm). Efforts are on to build custom made preamplifier for position readout from the resistive anode.

3.1.3.6 BALLISTIC DEFICIT CORRECTION IN RESISTIVE STRIP DETECTOR

Resistive strip detectors from Micron & Canberra were tested for different values of series termination resistors using ^{241}Am Alpha source. Depending upon the resistance of the strip the energy resolution is different and dependent on the position of the striking particle and value of series termination. A resolution of 50 keV (fwhm) was observed after applying ballistic deficit correction in software. More efforts are being made to improve upon this by playing with shaping time constants of amplifier & resistor values. We intend to achieve a value of ~ 30 keV (fwhm) for ^{241}Am Alpha.

3.1.3.7 HYBRID PREAMPLIFIERS FOR CSI & SILICON DETECTORS

New Hybrid preamplifier has been developed for extracting signals from CsI detectors and Silicon detectors. It is intended to use these hybrids in vacuum for improved energy & timing resolutions. Two versions thus have been developed: one for energy & one for timing. The energy version was tested with Silicon detector & showed an energy resolution of 20 keV (fwhm) for ^{241}Am alpha resolving the 5.48 MeV, 5.44 MeV & 5.39 MeV lines as shown in fig.3. The timing version yielded a rise time of 4 ns with a totally depleted Silicon detector having a 400 pF capacitance. It is intended to develop multichannel timing readout for Silicon strip detector to extract time of flight information for mass identification in GPSC.

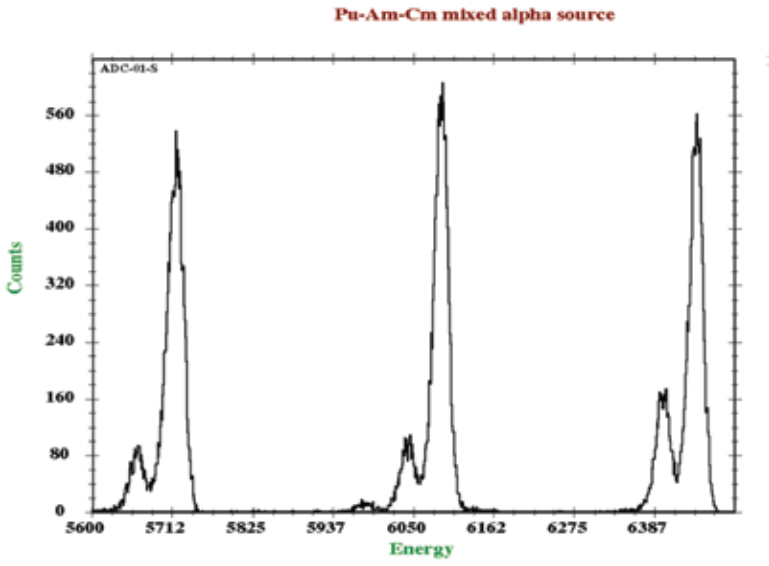


Fig. 3. Energy spectra from mixed source of Pu(5.15 MeV)Am(5.48 MeV)Cm(5.8 MeV)

Efforts are on to have a differential drivers for the energy signals to drive large number of signals of CsI/ Silicon array through inexpensive twisted pair ribbon cables. Extensive simulations have been carried out and work is in progress for developing the prototypes. The CsI array is intended to be used to study the mass gated pre-scission charge particle multiplicity in GPSC.

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, Atomic Physics, Materials Science and Bio Science have used: (i) high vacuum evaporator (ii) evaporator with oil free pumping system with a base pressure of $6x10^{-9}$ mbar (iii) rolling machine for the preparation of thin foils by cold rolling method (iv) atom beam source (ABS). More than

290 attempts were performed for target fabrication using the facilities mentioned above. The 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. Following are such targets prepared during this period.

^{116}Cd targets: Target development laboratory has successfully fabricated ^{116}Cd targets of ~1mg/cm^2 thickness by a small ^{116}Cd ingot of 194mg. One requirement of user was for a self- supporting target and another requirement was with a gold backing. Rolling technique was used for either target fabrication. The Cd ingot was initially rolled up to the thickness of 1.99mg/cm^2. The backing foil (gold foil) was separately rolled up to 5.84mg/cm^2. Finally the Cd and Au foil were rolled together and the final thickness of Cd and Au were 1.16mg/cm^2 and 5.5mg/cm^2 respectively. Many attempts were done with natural material before using isotopic material. These targets were successfully used in a nuclear physics experiment. *(Ish Mukul, IUAC)*

$^{180}HfO_2$ targets: $^{180}HfO_2$ target was prepared for a nuclear physics experiment in IUAC. The target requirement for the experiment was 150 µg/cm2 of $^{180}HfO_2$ on a thin carbon backing. In trial attempts, we experienced that the carbon foils of <50µg/cm2 were unable to withstand the force of vapour during evaporation. The powder of $^{180}HfO_2$ of 100mg was pressed into a Tantalum crucible of 3mm dia. The crucible was heated by electron beam bombardment technique in ultra-high vacuum evaporator. $^{180}HfO_2$ target was successfully used in the experiment. *(E Prasad, Calicut University)*

$^{50}Nd_2O_3$ targets: $^{50}Nd_2O_3$ target was prepared for a nuclear physics experiment in TIFR done by nuclear physics group of IUAC. The target requirement for the experiment was ~600 µg/cm^2 of $^{50}Nd_2O_3$ on a thick gold backing. The powder of $^{50}Nd_2O_3$ of 120mg was pressed into a Tantalum crucible of 3mm dia. The crucible was heated by electron beam bombardment technique in ultra-high vacuum evaporator. In order to avoid rapid oxidation, a thin gold layer of 20µg/cm^2 was also deposited on $^{50}Nd_2O_3$. This target was successfully used in the experiment. *(Dharmendra Singh, IUAC)*

^{196,198}Pt Targets: ^{196,198}Pt targets were successfully prepared for an experiment in IUAC. The film was deposited on carbon foils of 20µg/cm^2. The target material was placed in a graphite crucible. The heating of the material in the crucible was done by electron beam technique. Many trial attempts were done to perfect the method. Degradation of releasing agent at high temperature was the main challenge in this work. *(Varinderjit Singh, Punjab University)*

^{203,205}Tl Targets: ^{203,205}Tl Targets were recently 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 control the distribution of vapour flux. For fabricating 200µg/cm^2 of ^{203,205}Tl, only 20mg of material was consumed. *(Jagdish Gehlot, IUAC)*

^{120}Sn Targets: ^{120}Sn Targets were prepared successfully on a thick gold backing. The thickness requirement was 600µg/cm^2. A tubular boat of Tantalum was used to control the distribution of vapour flux. The target was successfully used in a nuclear physics experiment at IUAC. *(Jasmeet Kaur, Punjab University)*

Fabrication, Inspection and Loading of stripper foils: Carbon stripper foils of thickness ~5µg/cm^2 obtained from a Munich, Germany based company. The carbon foils are 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 200 carbon stripper foils were loaded during this period. In addition to regular stripper foil, target laboratory prepared and installed stripper foils of different thickness for post accelerator assembly.

Composite thin films: Composite thin films are prepared by co-sputtering technique using Neutral Beam Facility. The thin films prepared are Ni in ZnO matrix (ZnO:Ni), ZrO_2:Au, ZrO_2:Ag, TiO_2:Au, TiO_2:Ag, SiO_2:Zn, SiO_2:Ni, SiO_2:Au, SiO_2:Pd, SiO_2:Ag, SiO_2:Si, SiO_2:Fe/Co, Al_2O_3:Ge.

This source is also used for the purpose of surface modification of TiO_2 and graphite.

Improving the collection efficiency during evaporation

High cost and less availability of isotopically enriched materials are the major constrains for the preparation of targets of these materials. If the distribution of the vapor flux is not restricted within narrow solid angle, large amount of material get wasted without being collected on the substrates, as shown in the schematic diagram in figure 1. Thus minimization of material wastage is important in the case of fabrication of targets of expensive isotopes. In this laboratory, depending on the boiling point of the material either Joule heating or electron beam bombardment technique is used to evaporate materials under vacuum condition. Apart from commercially available crucibles, we fabricate suitable crucibles of tantalum and graphite. One such crucible made of graphite is shown in the figure 1 was used for the preparation of platinum target. It has a tapped cylindrical container where the material to be evaporated is kept and a top screw with a narrow hole. The crucible assembly can be heated both by Joule heating by a tungsten coil or by electron bombardment. Where in open source more than 100mg of material is required for making a target of thickness of 200µg/cm^2, using this special crucible only less than 5mg of material is consumed.

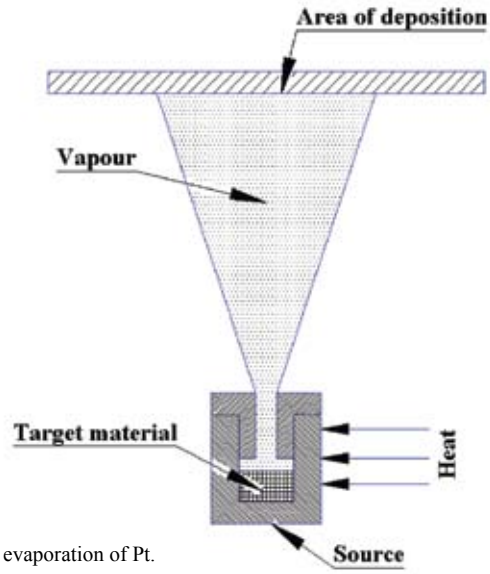


Fig. 1. Graphite crucible used for evaporation of Pt.

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 STATUS OF PSD ELECTRONICS FOR NAND ARRAY AT IUAC

We have the responsibility of fulfilling the various already developed front end electronics instrumentations required for National Array of Neutron Detector (NAND) at IUAC. We have already initiated the production of 25 numbers of Dual channel Pulse Shape Discriminator (PSD) modules for this purpose and this activity is to be completed soon. Required daughter cards like Shaping amplifier, and Time to Amplitude Converter (TAC) are being fabricated.

The PSD modules itself is a improved version of earlier developed and reported, in terms of components used to realize various blocks, availability of test points and provision of selective neutron or neutron plus gamma signals in order to reduce unwanted data collection.

3.1.5.2 VOLTAGE DIVIDER BASE FOR PHOTO MULTIPLIER TUBE (PMT) R4144

During this period we have initiated the development of voltage divider network for PMT R4144, which are to be used in NAND at IUAC. Initially, we had planned, developed and demonstrated three numbers of integrated PMT bases with built in compact high voltage power supply module as well as charge sensitive preamplifier to use with dynode signal for energy spectroscopy application. These networks were remotely controllable through LAN network. Due to various constraints, the design was abandoned and we have prototyped and successfully tested a new PMT base with voltage divider network and charge sensitive preamplifier for this application. This design is to be adapted and production of 50 PMT bases is taken up.

3.1.5.3 HIGH POWER SOLID STATE POWER AMPLIFIER DEVELOPMENT

We have been pursuing the development of a high power solid state radio frequency power amplifier capable of delivering 2kW (CW) or above at 97MHz. During this period, various power components developed for this application are 2 port Wilkinson power combiners, 3 port Gysel power combiners of both straight and folded configuration (Fig.1), 500 watts broadband VHF power amplifier core using MRF151G in splitter, combiner configuration (Fig.2). We intend to combine 500 watts VHF power amplifier core in a 4 port Gysel power combiner to realize a workable 2KW RF amplifier to experience various issues related to problems arising during assembly, integration and operation. At the same time, commercially available various pallet amplifiers using LDMOS devices are being tested for suitability for our application. The development work has been carried out to develop compact high power radio frequency amplifier using splitter, combiner technique for various ongoing projects at IUAC.

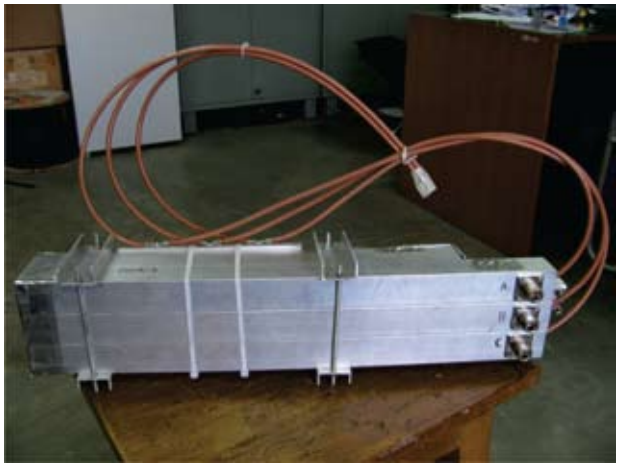


Fig. 1. 3 port Gysel RF power combiner at 97MHz

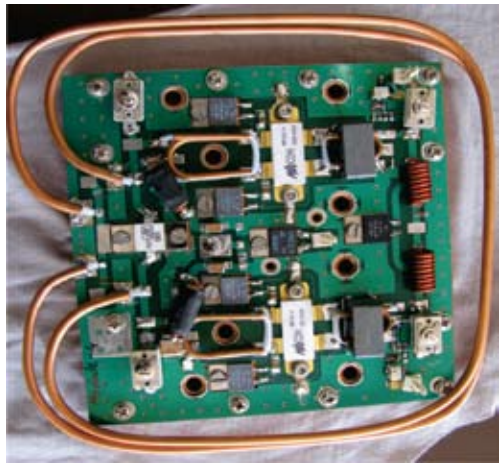


Fig.2. 500 watts VHF power core amplifier with Wilkinson splitter and combiner

3.1.5.4 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 1 month . Beams that were pulsed for the Linac operation included ^{19}F and ^{28}Si, ^{30}Si and ^{31}P. The FWHM of the beam bunch varied from 1 ns to 1.4 ns. The users were G. Mohanto (IUAC), Savi Goyal (Delhi Univ.), Varinderjit Singh (Punjab Univ.).

The system was also used to provide pulsed beams to several Pelletron users as well. The users were Jasmeet Kaur (Punjab Univ.)--2 runs, R.G.Thomas (BARC).The beams that were pulsed included ^{12}C and ^{18}O . The FWHM varied from 1 ns to 1.2 ns.

3.1.5.5 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 has been fabricated. The copper box to house the tank circuits and the grid assembly which includes the copper cones and cone extensions have been fabricated. The vacuum chamber has been thoroughly leak tested and no leaks were found.

The tank circuits:-

The OFHC copper tubes for the inductor coils and the vacuum variable capacitors have been procured. Fabrication work of tank circuits is in progress.

The Electronics:-

A completely new set of electronics has been designed to generate and control the saw-tooth voltage. The new design has not only replaced several obsolete components by new ones but also added new features for convenient operation,testing and trouble shooting. The design is complete on paper, the panels made ready, components ordered and pcbs made. Fabrication work to start shortly.

3.1.5.6 USB INTERFACE FOR CONTROL KNOBS HARDWARE TO PC

Hardware / Firmware :

The control knobs USB interface to PC is developed around a micro-controller. The micro-controller is working as a bridge with one end USART and other end parallel bus. The USB to USART converter chip is used to provide the final USB interface to PC. The firmware has been written in C-language, "m32knob.c", avr-gcc compiler is used to do the compilation and generate the HEX file (m32knob.hex), which will finally be uploaded into the program memory of the micro-controller using the SPI interface, through the parallel port. We have used ATmega32 micro-controller from Atmel corp. to load the firmware. The firmware basically emulates the parallel port of the PC. The hardware for USB to parallel bus emulator is shown in Fig.2. The schematic for shaft encoder knobs hardware is shown in Fig.1.

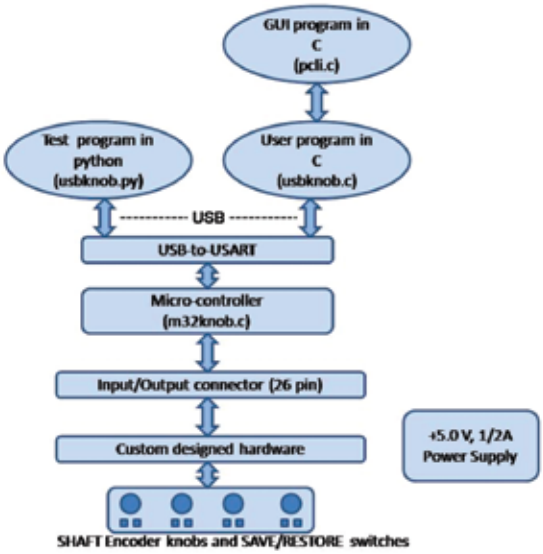


Fig. 1. Schematic for shaft encoder knobs hardware

Fig. 2. Hardware for USB to parallel bus emulator

3.1.5.7 NEW DEVELOPMENTS IN THE CONTROL SCHEME FOR LINAC

The resonator control scheme for all the eight resonators in the newly installed second cryostat module is being installed. At present the control is extensively used for acceleration of heavy ion beams through linac

using 19 cavities. The development for automation of the control scheme is going on. A new development to implement the electronic damping mechanism on the SC resonators is thought of to improve the locking performance of superconducting cavities at high field gradient. An extensive study was done to understand the microphonics related effect on resonators and various measurements and tests were done to damp the effect of microphonics for smooth linac operation with less RF power. This project is carried out with help of the Electronics Division, BARC and implementation plan will be carried out jointly in near future. In many of our earlier tests at IUAC we found that dynamics of the existing control scheme can be improved using a piezoelectric actuator based control. We are in the process of implementing this scheme in some of the linac resonators in the third cryostat module to understand the dynamics to its full extent. The mechanical arrangements and development of required electronics modules are being carried out for testing the same.

3.1.5.8 SILICON SURFACE BARRIER DETECTOR ELECTRONICS MODULE:

At IUAC we have developed a compact, single width NIM electronics module for processing signals from Silicon surface barrier (SSB) detectors commonly used in many nuclear physics experiments. The single width NIM module accommodates two independent channels, each containing shaping amplifier along with logic circuitry to generate the energy and timing information. The signal from SSB detector is fed to the input of the module through charge sensitive pre-amplifier and its input specifications are matched to accept signals from standard charge sensitive pre-amplifiers commonly used in charged particle spectroscopy. Shaping amplifier is made with fixed 1uS time constant, fixed Pole Zero (PZ) for ~50uS decay time and provides unipolar output. Timing information, i.e. Trigger_out and Gate (F/NIM), were generated from the signal extracted before shaping. Based on the experience of the first module the following modifications were incorporated in the new version:

- Front panel adjustable PZ
- More gain options to accommodate wide input signal range (5MeV to 400MeV)
- Gate (TTL)
- This module is being used in nuclear physics experiments with LINAC beam in Neutron array experimental area

3.1.5.9 GAMMA DETECTOR AMPLIFIER

At IUAC we use ORTEC make 571/572 amplifiers with HPGe detectors and at present most of these amplifiers are showing drift problem. In order to have an alternative we need an amplifier with the variable gain option. The amplifier is basically the spectroscopy amplifier of Clover electronics module, with the added variable gain feature. The single width NIM module contains two independent channels of shaping amplifier. The main features of the amplifier are 3uS shaping time constant (fixed), unipolar output and front panel adjustable PZ, base line threshold voltage & gain. Gain can be selected by an 8 position switch in the range of 5 to 40. The module was tested and compared with the Clover electronics module using conventional electronics set up. The following results were observed:

- Integral Non linearity error: Comparable (+/- 0.25KeV)
- Resolution: GDA (2.3KeV), Clover module (2.15 KeV)
- Stability: No significant shift was observed over a period of 60 hrs using Eu152 source.

Three modules have been produced.

3.1.6 COMPUTER AND COMMUNICATIONS

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

The major activities this year include the expansion of the user base of the High Performance Computing

facility at the Centre, expansion of the Centre's local area network, an upgrade and security fix of the central server pool, 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 the power and cooling infrastructure to support more than 50 teraflops of distributed memory computing. In addition, 10 TB of storage is available on a PVFS2 cluster.

This facility was inaugurated in April 2010, and the focus this year was on expanding the user base across universities and institutes, adding to the software available to users, and ensuring optimal utilization of the supercomputing resources. Significant success was achieved in meeting these goals. The user base now consists of sixty users based in forty two universities, colleges and institutes in the country. A comprehensive suite of public domain software for material science, computational chemistry, biology and atomic physics applications has been installed, tested and optimized. The usage of the Kalki cluster, as measured by the CPU core use, has been steady at 75-90 % of available cores. This makes it one of the most optimally used HPC systems in the country.

Key to the increase in usage has been the emphasis on providing user support. The appointment of two DST project scientists, Dr. Sajeev Chacko and Mr. Bhushan Awasarmol, to handle scientific software and system administration, has ensured the development of effective user support mechanisms. A dedicated web site (http://www.iuac.res.in/hpc) was set up to offer comprehensive information about the facility, from initial account creation procedures, through software installation and resource manager usage, to remote login processes and job and system status. With the increase in the number of users on the Kalki cluster, the need to reduce wait times for programs to start running became important. After an analysis of usage patterns, four resource manager queues with different CPU core count and run time constraints were set up. This considerably reduced wait times. On an average, the cluster now accommodates twenty simultaneous jobs from ten users, with a queue wait list of another five jobs and wait times of a day or two.

The emphasis on ensuring a reliable system and reduce downtime to a minimum. Efficient monitoring and preventive maintenance of both data centre and computer components are critical to reliability. A comprehensive SNMP-based software was developed to log and display in real time all parameters important for the operation of the facility. The software integrates into a single display all data centre parameters including UPS voltage and loads, chiller water temperatures and status, rack cooling unit status, and head, storage and compute node parameters. It also integrates into the display the queue, job, user and system status. The package provides for alarms to be generated on threshold values.

3.1.6.2 IUAC LAN AND SERVERS

The database server for the administration was replaced due to hard disk fault and was restored as well as upgraded to Scientific Linux 5.5. The proxy server was upgraded with automated backup by synchronizing the entire system on to another hard disk on the same system. This practice will be introduced for other servers also in a phased manner. The local area network at IUAC was overhauled last year to a single non-blocking 720-port 1 Gbps network, with fifteen Extreme X350 edge switches, two stacked Extreme X650 core switches, and 10 Gbps edge-to-core fibre connects. This year three more edge switches were added to accommodate the increase in number of desktop users and instrument interfaces. The old guest house building, which did not earlier have access to the network, was connected to the IUAC network through two switches and fibre connectivity to the core switch. The connectivity to the National Knowledge

Network was upgraded to its full configuration, with the installation of a new router and activation of the redundant fibre link. All remote logins to the IUAC LAN are now through this link. The Spectranet internet link, which provides internet and mail access for IUAC users and web page access for remote users, was upgraded to 16 Mbps.

3.1.6.3 NEW GENERATION INSTRUMENTATION & ACQUISITION SYSTEMS (NIAS):

As part of the development of a digital signal processing based data acquisition currently under way, prototype hardware capable of handling four channels was designed and tested. A novel technique for transmission of 48 bit time stamp was developed. As the "jitter" plays an important role in the resolution of the analog-to-digital converter, extreme care was taken to reduce the "jitter"; the CRO plot of the "jitter" is shown in Fig. 1, and it can be seen that the standard deviation is about 800 fs. A multi-tier data acquisition software package was also developed. The system is capable of: i) sampling up to 20 kilo events / signal / second; ii) handling 35 nano second to 6 micro seconds rise times; iii) energy resolution (> 30 us fall time) comparable with 13 bit conventional systems; iv) collecting all possible information from a signal: E, Q (at least 2), T (48 bit TS @ 10ns + CFD @ 150 ps for top 90 % of range), Rt, Z (Zero cross @ 150ps for top 90 % of range).

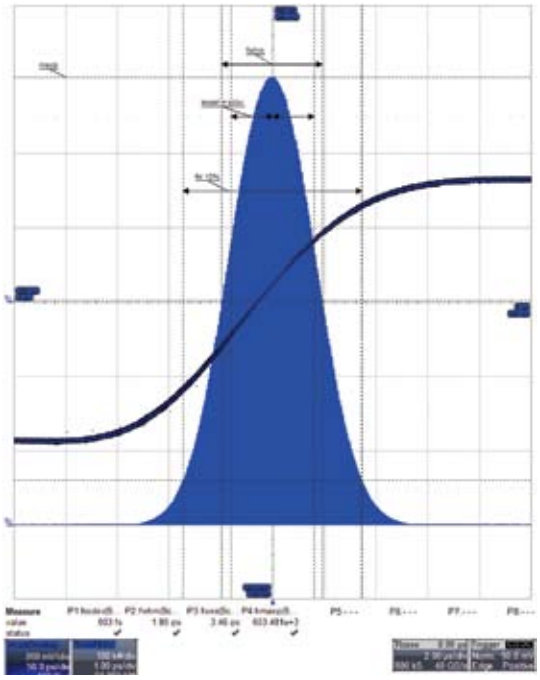


Fig. 1 : Jitter after the clock conditioner (~ 800fs)

The system was tested with two NaI detectors and a Co-60 source in the laboratory. The results are shown in Fig. 2. The system was installed in GDA during Dr. Rakesh Kumar's beam time, and was tested with Eu152 source as well as beam. The Eu-152 spectrum is shown in Fig. 3. We thank Dr. Kumar for providing space and time for testing the setup.

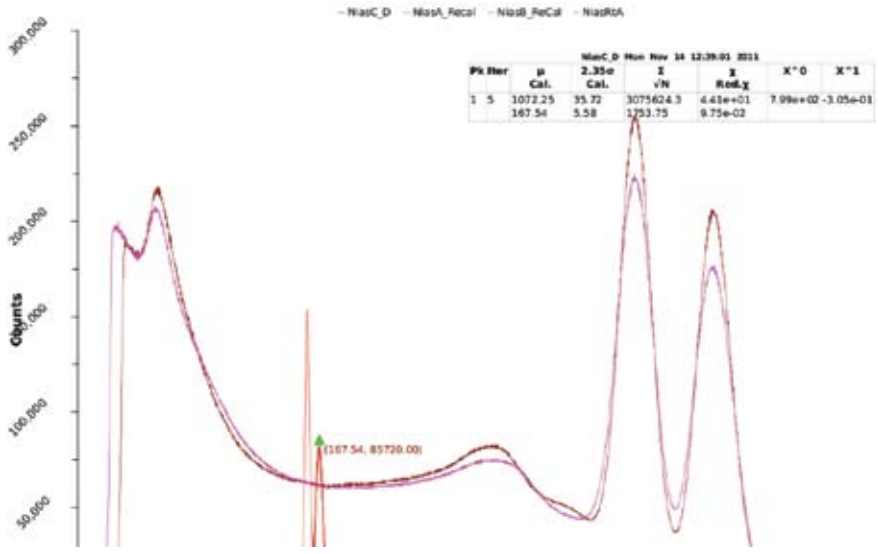


Fig. 2 : Spectrum of Co-60 using NaI detectors. It show four histograms (i),(ii) The two peaks after re-calibration (NiasA_Recal, NiasB_ReCal), (iii) the time difference between the two detectors (NiasC_D) and (iv) the rise time (NiasRtA).

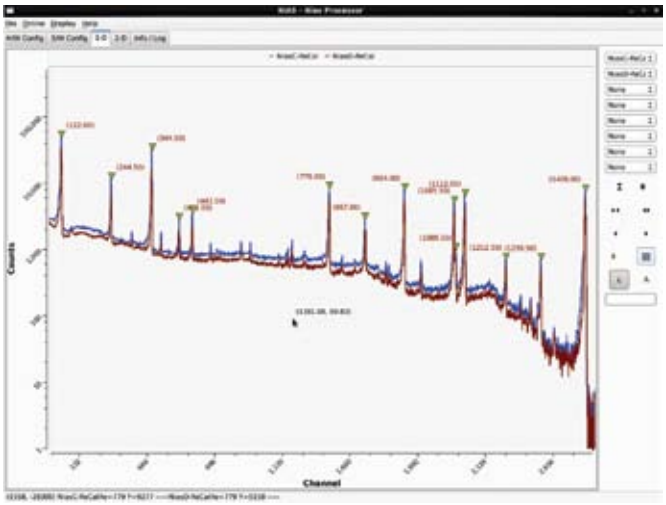


Fig. 3 : Spectrum with Eu-152 source using HPGe detectors of GDA, IUAC.

3.1.7 HEALTH PHYSICS LABORATORY

S.P. Lochab, Birendra Singh & Debashish Sen

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.

Two neutron and gamma shielding sliding doors are got fabricated and installed in beam hall-II after approval from AERB. Radiation level outside these doors were checked and found within permissible limits. Shielding blocks re-arrangement in Mat.Sc.-II area was completed. The radiation safety status of Pelletron accelerator in IUAC is maintained as per AERB regulation.

Water and rock samples were tested for lead, arsenic elements. 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 completed. Our lab is actively participating in NDMA meets.

3.1.7.1 RADIATION SHIELDING DOOR

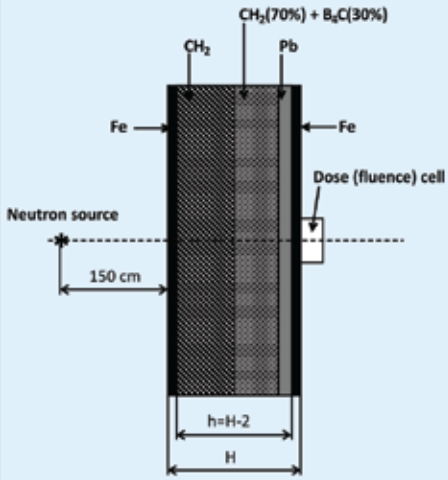
The calculated values and measured values of leakage radiation are very close in newly installed radiation shielding doors in BH-II. The calculated values outside shielding door for neutron is 5μSv/h whereas after installation of this door the measured neutron level is 4.2μSv/h. Both radiation shielding doors photos are shown in the photos. The trench of 1 foot depth is covered as shown in the photo.

Radiation shielding door in HYRA, BH-II

Radiation Shielding door in Mat.Sc.-II

Neutron Shielding –Sliding Door for BH-II (Calculations by NCNP Code)
Fe = 7.8g/cm³; HDPE = 0.95g/cc; Boron Carbide = 2.54 g/cm³, Pb = 11.4 g/cm³
Average density for borated HDPE = 1.167 g/cm³
Total thickness H, the ratio of HDPE: borated DHPE: Fe+Pb = 15:10:2
Neutron Average Energy = 6 MeV,
Neutron fluence = 35î 10^2 n/cm²/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	
	(D_0) µSv/h	(Φ_0) 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



3.1.7.2 GAMMA CHAMBER GC-1200

The cobalt-60 source strength was 4745Ci when source was loaded in Gamma Chamber model GC-1200. The dose rate measured on 8/3/2011 was 8.36kGy/hr. 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. We have many users from different universities and Institutions using gamma chamber for irradiating their samples.

3.1.7.3 CORRELATION BETWEEN ION INDUCED DEFECTS AND LUMINESCENCE PROPERTIES OF $K_3NA(SO_4)_2$: EU NANOPHOSPHOR

A. Choubey [a,*], S.K. Sharma [a], S.P. Lochab [b], D. Kanjilal [b]

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The $K_3Na(SO_4)_2$: Eu phosphor has been prepared by chemical co-precipitation method. X-ray diffraction studies show that $K_3Na(SO4)_2$: Eu phosphor exhibits hexagonal structure with average particle size of 42 nm. The samples were irradiated with 1.2 MeV Argon ions, with fluences varying between 10^{11} and 10^{15} ions/cm2. Monte Carlo SRIM-2008 Simulation was used for evaluating ion range, ion energy loss and ion induced atomic displacements. Ions having a range of 2.09 mm lose their energy mainly via electronic stopping, by creating large number of defects and activating different trap centers. This results in composite thermoluminescence (TL) glow curves. The growth of lower temperature peak at around 449 K which was linear in the whole studied dose range, might be attributed to the change in trap centers and luminescence centers populations. The observed variation in TL intensity of the higher temperature peak

at 533 K is the resultant effect of both increases in density of ion beam tracks and high ionization density. A photoluminescence (PL) emission peak is seen around 415 nm when excited by 310 nm light, due to transition from an excited state of 4f65d configuration to 8S7/2 state of Eu2þ ion. The higher concentration of defects that generate nonradiative states within the band gap is responsible for decrease in PL intensity after irradiation. The composite TL glow peaks were first deconvoluted with GlowFit program and then kinetics parameters of isolated prominent peaks were calculated by the thermoluminescence peak shape and various heating rate methods.

3.1.7.4 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 photoluminescence spectrum comprises of a main peak in the range 480–510 nm with a shoulder in the range 530–565 nm, which may be ascribed to transitions from 5d–4f levels of cerium in the mixed host 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.Wehave also investigated TL response of $Ca_{1-x}Sr_x$:Ce to ^{60}Co- 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.

3.1.7.5 LUMINESCENCE CHARACTERISTICS OF EU AND TI DOPED $LINAF_2$ PHOSPHOR

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Polycrystalline low Z phosphors (Z eff = 9.54) LiNaF2: Eu and $LiNaF_2$: Ti prepared by standard solid state diffusion method has been studied for their thermoluminescence (TL) and photoluminescence (PL) characteristics. The PL emission spectra of the phosphor suggests the presence of Eu^{3+} and Ti^{4+} in the host compound occupying two different lattice sites. The intense emission of the spectrum is assigned to electronic transitions 5D0 → 7F2 in Eu^{3+} ions. The TL glow curves of these $LiNaF_2$ phosphors exposed to γ-rays of 137Cs for different exposures at the rate of 118 milirad / hr are described and discussed first time here. The TL sensitivity of the phosphors has compared with standard $CaSO_4$: Dy and is found to be 5.37 times less in $LiNaF_2$: Eu and 9.25 times less in $LiNaF_2$: Ti phosphor.

3.1.7.6 ARGON IONS INDUCED THERMOLUMINESCENCE PROPERTIES OF BA0.12SR0.88 SO4 PHOSPHOR

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Thermoluminescence properties of barium strontiummixed sulfate have been studied by irradiation with Argon ions. The sample was recrystallized by chemical co-precipitation techniques using H2SO4. The X-ray diffraction study of prepared sample suggests the orthorhombic structure with average grain size of 60 nm. The samples were irradiated with 1.2 MeV Argon ions at fluences varying between 1011 and 1015 ions/cm2. The argon ions penetrate to the depth of 1.89 mm and lose their energy mainly via electronic stopping. Due to ion irradiation, a large number of defects in the sample are formed. Thermally stimulated luminescence (TSL) glow curves of ion irradiated Ba0.12Sr0.88SO4 phosphor exhibit broad peak with maximumintensity at 495 K composed of four overlapping peaks. This indicates that different sets of traps are being activated within the particular temperature range each with its own value of activation energy (E) and frequency factor (s). Thermoluminescence (TL) glow curves were recorded for each of the ion fluences. A linear increase in intensity of TL glow peaks was found with the increase in ion dose from 59 kGy to 5.9 MGy. The kinetic parameters associated with the prominent glow peaks were calculated using glow curve deconvolution (GCD), different glow curve shape and sample heating rate methods.

3.1.7.7 NANOCRYSTALLINE BASO4:EU FOR DOSIMETRY OF PROTON BEAMS

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[3] Department of Physics, Sri Venkateswara College, New Delhi-110021
[4] Joint Institute for Nuclear Research, Dubna - 141980, Russia

Nanocrystalline BaSO4 doped with Eu, was prepared by the Chemical Co-precipitation method. The particle size was calculated by the broadening of the XRD peaks using Scherrer's formula with particle size around 45 nm. Samples in the form of pellets were irradiated by 150 MeV proton beam with dose range of 0.1 Gy to 325 Gy. Thermoluminescence (TL) glow curves of the irradiated samples were recorded and studied. It has been found that there are two prominent TL glow peaks at 460 K and 495 K. The TL response is sublinear below 1 Gy, linear in the range 1Gy to 200 Gy and then becomes supralinear for higher doses. The wider linear TL response of nanocrystalline BaSO4: Eu and low fading makes it a superior candidate as a dosimeter to be used for detecting the doses of protons for its various applications in the field of space, therapy and research.

3.1.7.8 THERMOLUMINESCENCE STUDIES OF TISSUE EQUIVALENT LITHIUM FLUORIDE NANOPHOSPHORS

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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 8.00 pH have been found to show maximum thermolumniscence sensitivity at studied gamma doses (0.1 Gy–15 Gy).

3.1.7.9 THERMOLUMINESCENCE CHARACTERISTICS OF GAMMA IRRADIATED $LI_2B_4O_7$:CU NANOPHOSPHOR

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Tissue-equivalent lithium borate activated by Copper ($Li_2B_4O_7$:Cu) is found to be useful for their potential applications in medical dosimetry of gamma rays. In extension to our previous work [1], nanocrystals of the Li_2B4O_7:Cu were synthesized by combustion method using different concentrations of Cu. TL characteristics of the synthesized $Li_2B_4O_7$:Cu material doped with 1000 ppm and 2500 ppm concentration of Cu were studied and compared with each other. It is observed that $Li_2B_4O_7$:Cu doped with 1000 ppm Cu exhibits a linear response from $1x10^1$ Gy to $1x10^2$ Gy whereas $Li_2B_4O_7$:Cu doped with 2500 ppm Cu exhibits a linear response from $1x10^2$ Gy till $8x10^3$ Gy of gamma radiations. Finally the trapping parameters associated with the glow peaks were calculated using glow curve deconvolution (GCD) and peak shape method. It can be observed that the values of trap depth calculated by peak shape method shows a good agreement with the values of trap depth calculated from GCD method. Fading and reproducibility of phosphors are also studied and it is found that the $Li_2B_4O_7$:Cu doped with 2500 ppm Cu is quite suitable for radiation dosimetry.

3.1.7.10 THERMOLUMINESCENCE PROPERTIES OF NANOCRYSTALLINE $K_2CA_2(SO_4)_3$:EU IRRADIATED WITH GAMMA RAYS AND PROTON BEAM

A. Pandey[a], Shaila Bahl[b], Kanika Sharma[a], Ranju Ranjan[a], Pratik Kumar[b], S.P. Lochab[c], V.E. Aleynikov[d], A.G. Molokanov[d]

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[c] Inter-University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi 110067
[d] Joint Institute for Nuclear Research, Dubna 141980, Russia

Thermoluminescence properties of nanocrystalline $K_2Ca_2(SO_4)$:Eu prepared by ball milling technique have been studied and the nanophosphor's suitability as an effective gamma radiation and proton beam dosimeter material has been examined. It is found that the nanophosphor is suitable for dosimetry over a very wide range of doses ~1 Gy to 1 kGy for gamma radiation. And for proton beam the same nanophosphor shows a more or less linear response for the dose range 0.1–100 Gy. A comparative study of this nanophosphor with its corresponding microcrystalline form (prepared by solid-state diffusion method) as well as the nanocrystalline form prepared by (the more conventional) co-precipitation technique has shown that the nanophosphor prepared by the ball milling technique is in almost all respects better than the other two forms reported earlier.

3.1.8 DATA SUPPORT LABORATORY

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

Data Support Laboratory provides user support to various experimental groups in setting up the electronics (NIM & CAMAC) & data acquisition during the experiments. At the main data room two independent on-line data acquisition systems are maintained for data collection during Accelerator beam experiments and two more workstations for off-line analysis. The lab maintains the Data Acquisition computers & network at IUAC. Apart from providing regular user support and maintenance of the setup, we have developed few electronic modules and serviced a number of NIM and CAMAC modules.

3.1.8.1 UP-GRADATION OF DATA ACQUISITION NETWORK ROUTER

V.V.V. Satyanarayana & E.T. Subramaniam

The existing Data Acquisition network (192.168.3.0) router has been upgraded with an Intel core i7 processor PC(rack mounted) with two separate network cards with a tranfer rate of 1000MBPS. Data acquistion systems in Dataroom, beam hall-I and II are connected to this network.

To provide a centralized network server for candle data acquisition system, a new locally developed (Net boot) " tiny LINUX" (NIAS) using custom DHCP and TFTP settings has been configured and tested with scientific Linux 6.1 on this server. This server will be used to boot all the List Processor CAMAC Crate Controller (LPCC) connected to the data network using PXE. The Preboot eXecution Environment (PXE, also known as Pre-Execution Environment') is an environment to boot computers using a netwotk interface independently of data storage devices (like hard disks) or installed operating systems. The PXE protocol is a combination of Dynamic Host Configuration Protocol (DHCP) and Trivial File Transfer Protocol (TFTP). DHCP is used to locate the appropriate boot server or servers, while the TFTP used to download the initial bootstrap program and additional files.

3.1.8.2 FABRICATION OF FPGA BASED 8 CHANNEL 4K CAMAC ADC MODULES

A single width CAMAC module having eight channels of peak sensing ADC (12-bit) has been designed and developed in the year 2009. The module design is based on Hardware Descriptive Language (HDL) implemented on Xilinx 4010EPQ160 FPGA. Four of such modules have been fabricated. Testing of these module is in the process. This is a single width CAMAC module designed to measure uni-polar signals from pulse shaping amplifiers in the range of 0 to 10V. This module contains a 12-bit peak sensing ADC of successive approximation type and uses sliding scale technique to improve the differential non-linearity (DNL) inherent in the successive approximation type ADCs. Four of such modules have been fabricated for the lab maintenance.

Specifications

Packaging	Single-width CAMAC module
Number of channels	8
Resolution	12-bits
Sliding scale	7-bits
Input	0 to 10V Uni-polar or bi-polar from shaping amplifiers
Gate Input	Negative NIM < 1μs from Gate and Delay Generators
Conversion time	8 μs
Differential non-linearity	< ± 0.2LSB
Integral non-linearity	< ± 0.05%

3.1.8.3 DEVELOPMENT OF DATA ACQUISITION SYSTEM FOR RADIATION BIOLOGY FACILITY

The on-line Data Acquisition System through PC parallel port is developed in the year 2005 at IUAC. Similar system which accepts 0-10V Gaussian pulses from shaping amplifiers with 0.5μs – 3μs shaping time has been fabricated for on-line Energy analysis in the Radiation Biology experimental setup at IUAC. The input signal peak height (which corresponds to the energy information) will be converted into a 12-bit digital output using a Successive Approximation Register type analog to digital converter. Parallel port of the PC is used to transfer the converted data and stored and the histogram plotted. This unit is installed in the Radiation Biology data acquisition setup at IUAC.

3.1.8.4 DEVELOPMENT OF MICRO-CONTROLLER BASED STEPPER-MOTOR CONTROLLER

V.V.V Satyanarayana & B.P. Ajith Kumar

A stepper motor controller module using Atmega32 Micro-controller has been developed to characterize the electric field pattern of a given resonator using bead -pull technique. A program is written in Python language to control the movement of the bead within the resonator. User can control the distance and the direction of the bead. The program has to be modified to facilitate the GUI window options with features to vary the time delay between each step, distance for one step etc. This unit has been installed in the Drift Tube Linac (DTL) laboratory for DTL tanks characterization.

3.1.8.5 DEVELOPMENT OF NIM MODULES FOR NAND EXPERIMENTAL FACILITY

A large number of NIM modules for forth coming Neutron Array Detector experimental facility at IUAC are in the design and development stage. Modules like Octal Gate and Delay Generator, Current Integrator, Rate dividers are in the development stage and modules like Logic Fan-In Fan-out, 16-Channel NIM/ECL converter, Lemo-Header Adapter, Delay Unit are in the Design and development stage.

3.1.8.6 SERVICING AND MAINTENANCE

Following NIM electronics modules have been serviced in this year.

- Gate & Delay Generators, EG&G Ortec model 416A
- Shaping Amplifier, EG&G Ortec models 571 and 572
- Current Integrator, Danfysik model 556
- High Voltage Power Supply, EG&G Ortec model 556
- NIM Bin, EG&G Ortec model 4001C
- Homemade LPCC Crate controllers
- Quad CFD, EG&G Ortec model 934
- TAC/SCA, EG&G Ortec model 567
- Analog to Digital Convener, Canberra model 8075

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 maintaining the electrical installations 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:

3.2.1.1 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 shown ever readiness in running the systems round the clock and within short notices smoothly.

We have added 750KVA DG Set in this year for backup power arrangement of helium.

3.2.1.2 VOLTAGE STABILIZERS

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.

3.2.1.3 UPS INSTALLATIONS

This year we planned, procured and put in to service 2X60 KVA UPS from Emerson Network for Beam Hall –II and similar Systems for modular Lab-I and II. 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.

3.2.1.4 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.65 lakhs through the year 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 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 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.

3.2.1.6 MAINTENANCE OF SUBSTATION, POWER & LIGHTING INSTALLATIONS OF OFFICE COMPLEX & 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.

3.2.1.7 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

Group carried out exhaustive study in consultation with beam hall group. Procured and installed 2X60KVA Online UPS in parallel redundant mode in modular configuration, output panel and batteries for UPS.

Similarly group has carried out detailed study in consultation with the users in modular Lab-I and II 2X60KVA Online UPS in parallel redundant mode in modular configuration, output panel and batteries for UPS.

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

3.2.1.9 UPS SYSTEMS FOR 15UD PELLETRON

Group has planned, designed uninterrupted electrical power system for 15UD Pelletron and will be completed in the next financial year 2012-13 with a fund requirement of 122 lakhs.

3.2.1.10 BACKUP POWER TO 15UD PELLETRON

Group has planned, designed DG power backup of capacity 750 KVA to feed UPS systems of 15UD Pelletron. Order has been placed and the work will be completed in the next financial year 2012-13 with a fund requirement of 75 lakhs.

3.2.1.11 BACKUP POWER TO HPC CENTRE

Group has planned, designed DG power backup of capacity 750 KVA to feed UPS systems of HPC Centre. Order has been placed and the work will be completed in the next financial year 2012-13 with a fund requirement of 75 lakhs.

3.2.1.12 SYNCHRONIZATION OF DG SETS

Group has planned, designed a synchronization panel to synchronize and run 3X750 KVA DG Sets. Order has been placed and the work will be completed in the next financial year 2012-13 with a fund requirement of 30 lakhs.

3.2.1.13 ELECTRICAL ENERGY MANAGEMENT NETWORK

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

3.2.2 AIR CONDITIONING, WATER SYSTEM & 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 99,000 hours each and the compressor#2 has logged 19,250 hours. Other rotary equipment except AHU#1-7 have logged in about 1,68,250 continuous run hours. #4 Condenser tube plate was noticed to have severely corroded.

The Phase-II, Centrifugal Central AC Plant 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 Phase-III, Screw Central AC Plant with its installed capacity of 250 TR performed to an uptime of 100%. The plant was riddled with current imbalance problem. The Leakage on oil discharge line was fixed.

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 the operation and maintenance contracts.

The yearly maintenance costs have been maintained at approximately one-eighth of the international standards. Though, the plants have aged, yet the MTBF for all the equipment are within acceptable norms.

WORKS PLANNED IN THE ABOVE SYSTEMS ARE ENUMERATED AS BELOW:

Installation of 2 Nos., 200TR Screw Chillers in Ph-1 A/C Plant has been taken up. This will replace the failed #4 and also help in picking up part of additional BH-3 loads.

Replacement of: One no. AHU of Ph-2 A/C Plant, three nos. air-washers at different locations, chilled water piping, valves, ducting, etc., has been taken up.

The equipment being into their twenty-third year of sustained operations has far outlived their economic lives. Maintenance ensured that the reliability of the equipment was reset to acceptable norms.

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 system has already overshot 1,21,000 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, 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 to one-eighth of the international standards without compromising on the maintenance practices.

COOLING SYSTEM

Availability of equipment was recorded at 99%.

NEW WORKS EXECUTED

A new lab was set up in engineering building first floor. For Air-Conditioning of this lab, 2 Nos., 3.0 TR Split A/C's were provided.

Air-Conditioning of 2x60 KVA UPS for Lab1,2 and Engineering Building was done by extending the duct of AHU#4 of Ph-3 A/C plant.
Cooling water for new LHe compressor was provided. The system with heat removal capacity of 275 KW or 79 TR of cooling load was hooked to the ph-III water circuit. This system was successfully commissioned.

The pending works of Beamhall#III low side air-conditioning were carried out departmentally by MG-2. This was, after the consultants failed to execute the same. The system was successfully commissioned and is ready for use.

3.2.3 CIVIL WORKS

M.K.Gupta

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
- Keys management of the Centre

Important Civil Activities during the Year 2011-12

- Following important Civil works were undertaken during the year 2011-12 in addition to routine Civil maintenance and minor works:
- Appointment of contractor (M/S Apex construction) for construction of Auditorium & Lab. block Extn. through open tendering with the assistance of M/S RITES (our Project management consultant)
- Construction of M.S platform in Workshop area in Engineering building at mid height level for 50 KeV Ion Accelerator Lab., including side covering with aluminium partition and PVC flooring at bottom
- Epoxy floor coating on the floor of LEIBF Beam Hall to make it dust-proof and durable
- PVC partitions and doors in basement of Beam Hall-III basement for RF test area including epoxy floor coating in DTL test facility area
- Internal painting of Phase II housing Flats
- Internal painting of New Guest house block
- Construction of enclosure for Sand blasting machine with Aerocon concrete panels on W-side of Engineering building
- Side covering of 6 no. balconies in Housing complex with MS glazed windows and fixed glazing
- PVC partition and door for Gama chamber in Beam Hall-III basement
- Construction of 2 no. store rooms on west side of LEIB building for miscellaneous uses
- Replacement of damaged drain covers with new RCC covers throughout campus
- Construction of cable trenches with covers and PCC flooring around 750 KVA DG set on S-side of Generator building
- Construction of UPS room (for 2x60 KVA) near S-W corner of LEIB building for providing UPS power to LEIB building

3.2.4 COMPRESSED AIR SYSTEM & MATERIAL HANDLING EQUIPMENTS

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 two nos. reciprocating compressors each of 60 M^3 /Hr and three nos. 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. 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 modernisation 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 capacity 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 capacity 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 and Lab II area, Workshop building. Some more sign boards including the "Escape route" are 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.