3. RESEARCH SUPPORT FACILITIES

3.1 HIGH VACUUM LABORATORY

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

Installation and commissioning of Automatic Sample Positioning & Irradiation Equipment (ASPIRE) was completed this year in all respects. Installation of new LEIBF facility has been started and HV deck and switching magnet have been placed at required positions. Regular involvement with the Pelletron group in maintenance activities, scheduled and emergency, requiring vacuum operations, maintenance of vacuum pumps and installation of critical components were carried out.

3.1.1 Installation of new LEIBF Facility

An LEIBF facility is being installed in the new material science building. The plan is to install three beamlines. The switching magnet has been placed. As it is very heavy (about eight tons) and to prevent sagging of the floor, a 20 mm iron plate was fabricated to be used as base for this magnet and grouted on the floor with high strength cement. High voltage deck on three stories of insulators was placed on the floor. A new plate was fabricated as per mounting holes of Deck, and the insulators were mounted and bolted on it. Then all the three levels of insulators were aligned stepwise. Finally the deck was lifted and placed on the insulators. The remaining installation activities are in progress.

Fig. 1. Switching Magnet

3.1.2 Assembly and Commissioning of New Beam Diagnostic System for HCI

A new Beam Diagnostic system was designed last year. It has a BPM, a Double slit, a Faraday cup and a pumping port in a single unit to accommodate all the diagnostic components in limited space. The fabrication and assembly has been completed with all the individual modules mounted and tested completely. The system has been installed in the ECR beamline for beam diagnostics and online testing. The ECR beamline was also dismantled and it's components realigned and installed along with the Beam Diagnostic System.

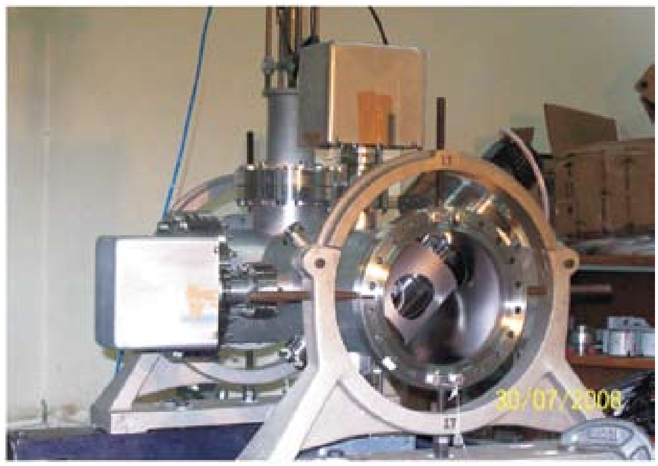

Fig. 2. Diagnostic System

3.1.3 Installation and Commissioning of ASPIRE (Automatic Sample Positioning and Irradiation Equipment) in Radiation Biology Line

M. Archunan, A. Kothari, P. Barua, ET Subramaniyam, Asiti Sharma

ASPIRE replaces the earlier setup used for irradiation of living cells / samples grown on circular dishes. It loads 20 samples simultaneously and irradiates each sample one by one within 30 minutes automatically. This set up eliminates the loading and unloading time required for each sample and reduces the experiment time by a factor of four. This project has been completed and experiments have been done using the system.

It has precisely controlled movements in all the three axes and additional components for handling samples. This system is fitted with all the required safety features. The control electronics and software to run this system as per the required logic was developed in house. The complete system is protected form dust with dust proof cover and cameras have been fitted at necessary points to monitor the process from remote location. It has been integrated with the beam line with necessary interlocks. Interfacing with camac is complete for remote control operation. Every mechanical, electronics and software (except the axis, motor and drive and few end components) have been indigenously developed and fabricated.

Fig. 3. ASPIRE

3.1.4 Other Installation Work

Installation of PPAC (Parallel Plate Avalanche Counter) set up in GDA experimental area at a particular position with respect to the foil was done and target ladder was also aligned with beam axis.

Offset Faraday Cup along with port aligner was installed in vault-I and accurately aligned with beam axis and offset position set as required.

3.1.5 Design and Fabrication of Electronic modules and Controllers

- Controller for operation of ASPIRE was designed and fabricated. It works in local as well as remote mode.

Fig. 4

- Design and fabrication of Target ladder controller for Radiation biology beam line are being carried out. There are two Target Ladders; one of them is in Vault – I area in which there are 3 positions of foil. The other one is in the beam line in which there are 2 positions, Quartz – In and Out. All these 5 positions are interlinked with the beam tuning as well as experiment. This controller makes sure that the beam always looks at either quartz or foil.

- Design and fabrication of 8-channel remote power controller was done. This controller is used to switch ON or OFF the 4 cameras and 4 Lamps either by local control or by remote control from Data Room.

Fig. 5

Modification in Installations

3.1.6 Shifting of Phase Detector From 06 Area (before LINAC) to 05 Area (before Superbuncher)

During operation of LINAC the user faced problem in getting proper signal for phase locking. So the Phase Detector from 06 area (before LINAC) was dismantled and installed just before Superbuncher in 05 area with proper alignment. New drift tubes were fabricated and installed as per the new arrangement.

3.1.7 Modification and Installation in Ion Source Test Bench

In the Ion Source Test Bench set up, the quadrupole was required to be shifted by 1500 mm away from magnet as per the new beam optics calculation. To accomplish the task all the beamline components had to be dismantled and beamline stands were also placed accordingly and grouted. All the components (Electrostatic quadrapole triplet, steerer II, BPM II and Faraday Cup) were reinstalled and aligned accordingly. The chamber and target ladder were also shifted and realigned. Calibration of double slit was also done.

3.1.8 Installation of Scanner Magnets in Material Science-II

Installation of the two scanner magnets X-X and Y-Y scanners in phase-II materials science beamline was done. Mounting and aligning fixtures were designed and fabricated for the installation work. Since the space was less, the entire assembly was dismantled and installed part-by-part and then assembled back.

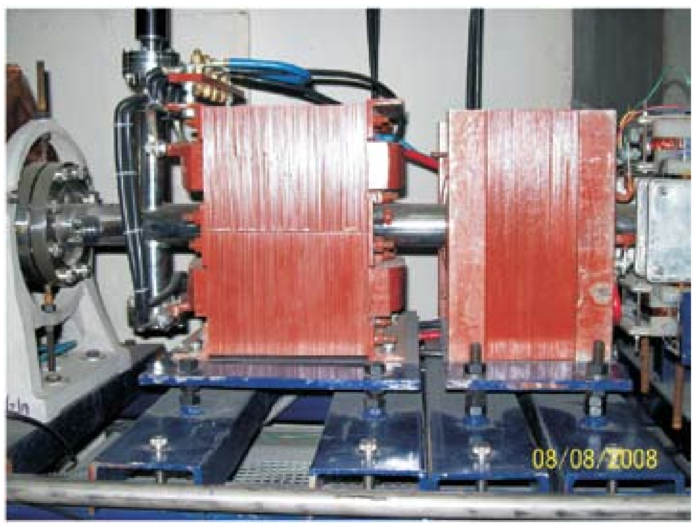

Fig. 6. Scanner Magnets

3.1.9 Pelletron and Beamline Related Maintenance

- Ion Pump of tank bottom (IP 03-1) had been running since installation of the Pelletron and its performance had degraded over the years. So it was replaced with a new Ion pump.
- A new Foil Stripper (50 foils) was installed in vault-I and properly aligned with beam axis. For this work the vault area had to be vented and beamline bellows were dismantled to access reference points. BPM -04 and mark on the wall near analyzer were taken as reference for alignment.
- Getter Pump 03-1, GP 03-2 and GP 04 were cleaned and cartridges were changed.
- A new BPM (2 inch scanning diameter) was installed just after second beamline valve of radiation biology beamline to eliminate beam tuning problems, experienced during beam run.

- HIRA beam line ion pump got contaminated. It was replaced with a new ion pump.
- HIRA beam line Getter Pump cartridge was replaced and thorough cleaning of the pump was carried out.
- Turbo pump (02 area) TP-02 was making loud noise so it was replaced with another 1600 l/s Turbo pump to avoid breakdown during experiment.

3.2 MAINTENANCE OF MAGNETS AND POWER SUPPLIES

S.K.Suman, Rajesh Kumar, Mukesh Kumar, A.J.Malayadri and A.Mandal

Beam Transport System laboratory takes care of regular maintenance of magnets, power supplies and other supporting instrument like CAMAC Modules, magnetic field measuring instruments, beamline selector switchgear etc. There are different types of magnets in the Pelletron accelerator and LINAC system. All these magnets are powered by highly stable power supplies. For smooth and round the clock running of all these instruments, we have done preventive as well as breakdown maintenance. The following major jobs have been done in this year.

3.2.1 Routine maintenance

Routine maintenance of all magnets and their power supplies are done twice in a year during which the following scheduled tasks are carried out:

- Output ripple monitoring of all power supplies and rectification.
- Stability measurement and rectification of magnet power supplies.
- Safety interlock testing.
- Calibration of control electronics.
- Functional testing of CAMAC modules for remote operation of magnet power supplies.
- Thorough observation of all power devices like power contactors, power transistors and water cooled heatsinks etc and changing the faulty ones.
- Dust cleaning from electronic cards and power supplies.
- Checking the connections for control signals in all power supplies.
- Checking the power connections for loose contacts.
- Checking of water leakage in the cooling systems and changing damaged hose pipes.

- Temperature monitoring of water cooled components like magnet's coil and transistor bank heatsinks to check the cooling efficiency at full load and cleaning the partially blocked coils.

No major breakdown occurred throughout the year. All BTS instruments performed with efficiency of 99.9%.

3.2.2 BTS repairing and installation works

This year the following BTS repairing and installation works were done:

- Beam line selector switch has been developed and installed to switch a common power supply set between Bio Sc beamline (MS_LX2) and zero degree beamline (MS_LX2).
- MQX_071 and MQY_071 quarupole power supplies repaired to avoid remote control data handshake problem.

3.2.3 Servicing and maintenance of power supplies besides BTS labs

BTS group also provides time to time service and maintenance support for following Target Lab power supplies and detector bias supplies.

- E-Beam source power supply (Model- TT3/6, Telemark)
- Atom Beam Source power supply (Model-850, Atomtech)
- e-Gun power supply (Model-922-0020, Varian)
- Quad 1kV Bias supply (Model-710,EG&G Ortec)
- 5kV Detector Bias Supply (Model-659 EG&G Ortec)
- 3kV Detector Bias Supply (Model-556, EG&G Ortec)

3.3 DETECTOR LABORATORY

A. Jhingan and 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 special training on experiential activities for Scientist Trainees, JRF students, and M.Sc orientation program students.

3.3.1 Large area position sensitive annular PPAC

A. Jhingan, R. Ahuja, S. Rao, T. Varughese, B. B. Choudhary, A. Kothari, P. Barua, R. Kumar, R. P. Singh, P. Sugathan, S. Muralithar, H. J. Wollersheim (GSI, Germany) and R. K. Bhowmik

A large area annular PPAC setup has been developed for Coulomb excitation experiments in GDA beam line. The design of the detector is based on two parallel electrodes geometry consisting a cathode foil and a anode made on printed circuit board. The cathode foil has been segmented into 16 parts to get azimuthal angles with a resolution of ~22 degrees. The anode is segmented into two parts and will give the polar angles using delay line technique. A conical stainless steel chamber was also fabricated which houses the target and the same is used for mounting the detector.

During the off line tests (Fig.1) with ^{241}Am alpha source, the delay line signals from anode showed capacitive pickup of cathode (foil) signals. This resulted in a poor quality spectrum from the delay lines. As a result, the detector could not be used in on-line Coulex experiment. For the experiment performed by users from GSI, an alternate arrangement was made using a similar annular PPAC from GSI. This detector during transit from GSI developed foil damage along with breakage of support wire frames for the foil.

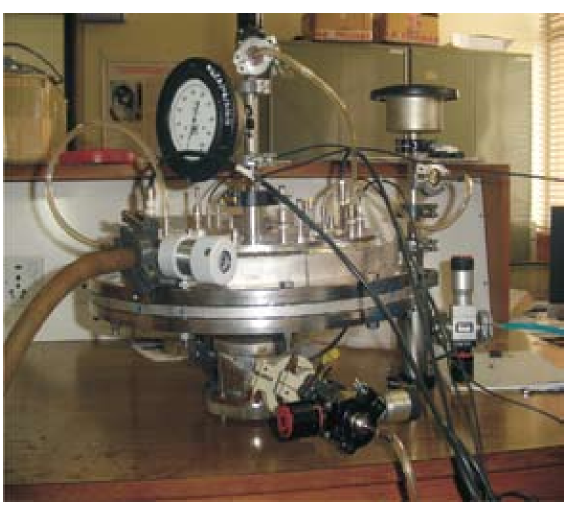

Fig.1. Annular PPAC during off line test in Detector Laboratory

Fig.2. Annular PPAC setup mounted in GDA beam line

The aluminum chamber housing the electrodes also had vacuum leaks. The faulty O rings and foil was replaced. Due to shortage of 2 micron foil, the experiment had to be carried out with a 10 micron polypropylene foil after a vacuum accident in GDA. Efforts are on to eliminate the capacitive pickup which may be due to large width of the individual rings and their variable lengths.

The GDA beam line was modified to accommodate the Coulex experiment setup. The Germanium detectors along with their Compton shield, target chamber and BGO mounting stands were removed. As shown in Fig.2, a new stand with a circular holding structure to support the target chamber and annular PPAC was specially designed and fabricated so as to fit into the GDA germanium detector holding structure. Since the Clover detectors were placed at 153 degrees with respect to the target, the target chamber was coupled to the main beam line using a annular perspex flange with glass tube (having KF25 coupling procured from MDC) to avoid gamma attenuation. A CF2.75" bellow was used for precision coupling with the main beam line. A makeshift Farady cup (also used as beam dump) was made with a KF40 blank off having a tantalum sheet over the active region exposed to beam. This was isolated from the main beam line using a Teflon KF40 adapter tube. Entire assembly was carefully aligned with the main beam line using theodolite by the beam transport group.

3.3.2 Fast timing preamps for MWPC readout

Two NIM modules, each housing eight channels of current sensitive fast timing preamps were fabricated. The modules were developed for readout of fast current signals from PPAC / MWPC. The modules were tested off line with gas detectors using 241Am alpha sources as well as with in beam experiments from Pelletron in HIRA and GPSC. For low pressure PPAC, rise times were as fast as 3.5ns.

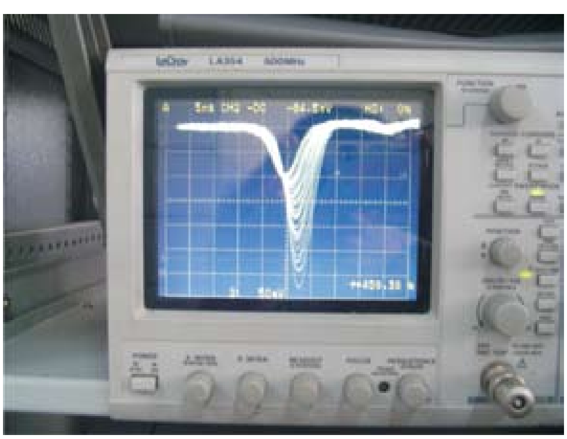

Fig.3. Timing signal from the cathode preamp (alphas from 241 Am)

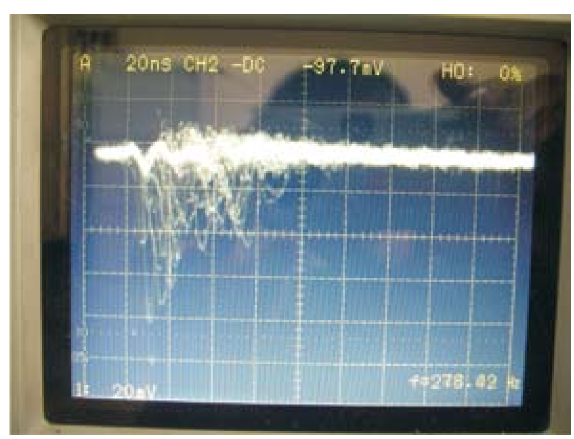

Fig.4. Delay line position signal triggered by cathode (fig.3)

3.3.3 MWPC at HYRA focal plane

HYRA group, E. Prasad Nair (Calicut Univ.), Sunil Kalkal (Delhi Univ.) and Gayatri Mohanto (IUAC)

The two dimensional position sensitive MWPC used in RIB experiment (S17 astrophysical factor measurement) and first INGA campaign at IUAC/NSC(Aug 2002) was revived for the detection of fusion products at HYRA focal plane. The detector has an active area of about 57mm X 57mm. The detector electrodes were cleaned up with isopropyl alcohol and the last cathode was removed, thus giving it a 4 electrode geometry (instead of original 5 electrode geometry). This is expected to improve the count rate handling capability as well the time resolutions. The detector was thoroughly tested with alphas from 241Am source. It was installed at HYRA focal plane. The detector was isolated from the HYRA gas filled separator by a ~0.5 micron polypropylene foil. The thin foil has been procured from GSI (*acknowledgement : Prof. H. J. Wollersheim*). Such thin foil was required for the detection of very low energy heavy residues (200 amu ~ .03MeV/A). The foil was stretched on a circular aluminum flange with an active area of about 120mm X 50mm and is supported by crossed ~ 0.7mm thick nylon wires at 1cm pitch. The detector has been used in HYRA test runs with the Pelletron. In coming days efforts are on to replace this detector with a larger area MWPC (active area 6"X 2"). This will be followed by a silicon strip detector for fusion implantation and its subsequent decay studies.

3.3.4 Fast timing MWPC as master trigger for NAND

A fast timing MWPC (transmission type) of active area 1.5" x 1.5" has been designed and fabricated. The electrodes are made of wire frames instead of aluminised mylar to avoid straggling of heavy fission fragments. It has four wire frames made of 20 micron thick gold plated tungsten wires. The entire assembly is mounted inside a square aluminum chamber milled from a 1 inch thick solid block. The active area is isolated from the vacuum by 1micron thick mylar foil at entrance as well as exit. The detector has been tested with 5.48 MeV alphas from 241Am at 4mbar isobutane inside GPSC. The anode pulses, after preamplification, exhibited a rise time of about 4ns with pulse heights ranging from 50 – 300mV. The detector is intended to be used as master trigger for NAND data aquisition providing a master start signal for time of flight measurements of fission detectors and neutron detectors in experiments to be performed with DC beams from pelletron.

3.3.5 Silicon Strip Detector setup for HYRA focal plane

A silicon strip detector is planned to be setup at HYRA focal plane behind the multiwire proportional counter. The detector will be used for the detection and implantation of fusion products and its subsequent decay within the detector. A strip detector from Micron semiconductors (design W) has been tested with 241Am alpha source. The detector has a total of 32 strips, 16 on front side and 16 on back side (orthogonal direction). The detector was tested using high density electronics from Mesytec. This comprises of a 32 channel preamplifier followed by two 16 channel Shaping Amplifiers cum discriminators. The shaped output is fed to 16 channel Phillips ADC via 34 pin twisted pair cables. Efforts are on to utilize the ECL outputs of discriminators by feeding them to TDC to get timing informations from individual strips. A custom made clock module and bit pattern module is also planned (to be developed by electronics group) to be integrated with the system for time stamping each event. We expect to install the entire system (along with large area MWPC) at HYRA focal plane by the end of 2009.

3.3.6 Charged particle detector array for INGA

A. Jhingan, P.Sugathan, J. Zacharia, S. Muralithar, R. K. Bhowmik

A charged particle detector array is planned for the future INGA campaigns. Currently the focus is on building a CsI array for the detection of protons and alphas produced in a nuclear reaction. A prototype spherical hollow chamber (~10" diameter) has been designed (Fig.5) for mounting the detector system. The chamber is segmented into three parts comprising of two hemispheres and one central cylinder. The chamber will be machined from Aluminum and will have a wall thickness of about 3mm to avoid gamma attenuation and scatterring.

The final array is likely to have about 72 CsI detectors which is likely to cover about 80% of the 4π. Each crystal is proposed to have an active area of 2cm X 2cm coupled to a 1cm X 1cm photodiode. This geometry is preferred to make it compatible with the proposed TIFR detector array. The detector mounting structure is currently being designed. The pulse shape discriminating properties of CsI have been demonstrated earlier. Efforts are on to make custom made high density readout electronics for the array. Digital signal processing is also being explored for the same along with conventional analog electronics.

We are also exploring the possibility of having charged particle detectors other than CsI for INGA. This includes gas detectors such as proportional counters (similar to CHICO), silicon detectors, ionization chambers for Coulomb excitation, fission and transfer induced spectroscopy etc.

3.3.7 Troubleshooting position sensitive silicon detectors in GPSC

Operational problems were observed and solved during a Nuclear Physics experiment (SINP, PU, DU, IUAC) while using position sensitive silicon detectors. The detectors were one - dimensional position sensitive detectors (from Ortec & Micron Semiconductors) and two dimesnional position sensitive strip detector from Micron Semiconductors (design X).

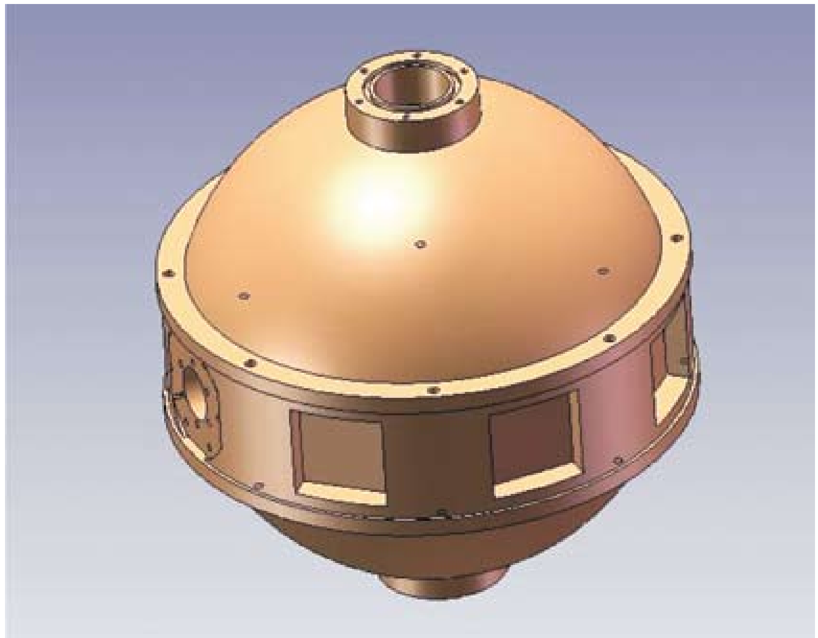

Fig.5. Design of the prototype chamber for CPDA

The Micron X detector was not taking bias, and at the same time was not giving position and energy information due to the faulty design of its mount. The detector has 16 strips, each strip being resistive to give position perpendicular to that of orientation of the strips. Each strip has to be read individually from both sides of the resistive chain to get position and energy. This means a total of 32 readouts (preamplifiers, shaping amplifiers, ADC) for one detector. Alternatively total energy is available from the back side also. To reduce the number of readouts, the back side was used to bias the detector as well as to get total energy. One side of each resistive strip was terminated using a 50 ohm resistor and the other end was connected to readout electronics. Thus in this fashion detector was operated smoothly with both energy and position information during the experiment. A new mount has been designed and fabricated to have readout from both ends of the individual strips as well as back side. This is likely to be tested in coming days. We acknowledge Dr. Subinit Roy (SINP) for providing the detector for off line testing.

A vacuum accident occured during the experiment after which the one dimensional position sensitive detector was neither taking bias nor giving any signal. After careful analysis it was found that thin wire connections from the bonding pad of the silicon wafer to the connectors (Energy and position signal) got misaligned, and were making contact with metal housing of the detector which is grounded. As a result the entire bias voltage and signals were grounded. This happend due to sudden venting of the GPSC (vacuum accident) resulting in change in the orientation of thin wires under stress. The metal housing was opened and the correct orientaion was restored. To avoid further such thing, small pieces of insulators were placed between the thin wires and metal housing of the detector.

3.3.8 Seconday Electron based detector for low energy heavy ions

At IUAC, the experiment with heavy ion fusion reaction involves the detection of heavy reaction products at low energy. Very often it is required to measure the time of flight and track the position of the heavy ions. For years we have been using low pressure Multi Wire Proportional Counters (MWPC) for position and time measurements. One of the main limitations of using gas detector for tracking measurements is the use of entrance window foil in the detector, which causes considerable energy loss and straggling in the foil. For very low energy, the particle may not even reach the second detector. It is therefore necessary to use thin detectors which do not cause considerable energy loss. Due to these considerations we have a plan to develop position sensitive detector based on the detection of secondary electron from thin foil placed on the ion trajectory. Thin foil detector using MCP for secondary electron detection are commonly used in such applications. However, commercially available MCP is of limited size and complicated to operate and maintain in high vacuum operation. In our plan, instead of MCP, we will use low pressure MWPC for electron detection. A design for a prototype detector setup has been made for this purpose. In this setup, a 0.5 micron thick, 5"x5" aluminised mylar foil will be intercepted by the ions. The secondary electrons emitted from the surface of the foil will be accelerated and focused to a similar sized MWPC using a combination of electric and magnetic fields. Electrons with energy of ~ 7 keV will be detected by MWPC. To measure the low level signals induced in MWPC, we propose to read out each individual wires using MANAS ASIC chip developed by high energy physics group at SINP, Kolkata.

3.4 TARGET DEVELOPMENT LABORATORY

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

Target Development Laboratory at IUAC provides facilities to the users for the preparation of targets used for the experiments with IUAC Pelletron and LEIBF facilities. Several users have used the following facilities for the studies in Nuclear Physics, Atomic Physics, Materials Science and Bio Science: (i) a high vacuum evaporator, equipped with 2kW electron beam gun, evaporation setup by resistive heating, online thickness monitoring by quartz crystal thickness monitor. This evaporator is pumped by a diffusion pump with liquid nitrogen trap, with a base pressure of high $5x10^{-7}$ mbar. (ii) The oil free pumping system for the second evaporator includes a cryo-pump, a turbo molecular pump and a scroll pump, with a base pressure of $6x10^{-9}$ mbar. This evaporator is equipped with a 6 kW 4-pocket electron gun and evaporation setup by resistive heating method and a dual crystal thickness monitor and controller for online thickness monitoring and process control. (iii) A rolling machine for the preparation of thin foils by cold rolling method. (iv) A facility with wide beam atom source has been used for the fabrication of composite thin films by sputtering method. This source has also been used for ion-beam milling to prepare free standing thin films. Starting with 3.4 mg/cm^2 Sn foil of area 10mmx10mm, 1.1 mg/cm^2 thick foil obtained after 5 hours of milling. There were several thin films prepared in this year, which includes carbon stripper foils of less than 5 μg/cm^2 thick used for IUAC Pelletron. Normally 200 stripper foils are loaded in every tank opening schedule. Some of the interesting and important thin films prepared this year are mentioned here.

Isotopically enrich chromium (^{50}Cr, isotopic abundance 4.35%) target has been prepared using 6kW electron gun. Only 100 mg metallic Cr was available. Apart from that, high cost and difficulty in availability required maximum collection of Cr vapor during deposition. A crucible of high purity graphite was fabricated to minimize material loss by containing the material in narrow cylindrical zone. During deposition the backing foil was kept at a distance of less than 10 cm from the source and finally a target of 600 μg/cm^2 was prepared using 75 mg of material. Similarly free standing isotopic ^{63}Cu target of thickness 650 μg/cm^2 was prepared using only 40 mg isotopically enriched copper.

Several composite thin films have been prepared by the process of co-sputtering and co-evaporation. Co-sputtering has been accomplished by the process of atom beam sputtering using 1.5 keV Ar beam from a composite target. Au–SiO_2 nanocomposite thin films, containing 10% Au, were prepared by cosputtering of Au and silica [1]. Transmission electron microscope (TEM) image of Au nanoparticles in as-deposited Si-rich silica matrix shows that the average diameter of nearly spherical nanoparticles is ~3.1 nm. Annealing has been found to result in the formation of core-shell nanostructures (average size ~4.6 nm) with amorphous Si nanoshells surrounding Au nanocrystals. The average volume fraction of these nanoshells has been found to be ~0.39±0.05. Energy dispersive x-ray studies on these core-shell nanostructures confirmed these nanoshells to be Si-rich.

A bi-functional (Ag and C_{70}) nanocomposite is prepared by co-evaporation from two sources (resistive heating). Metal concentration in the film was controlled by controlling the evaporation rates of Ag and C_{70}. Optical absorption studies revealed that surface plasmon resonance of Ag nanoparticles occurs at unusually large wavelength, which showed a regular redshift from 521 to 581 nm with increase in metal content from 4.5% to 28%. It is explained by the Maxwell–Garnett theory considering the absorbing nature of fullerene matrix. Rutherford backscattering and transmission electron microscopy were performed to quantify metal content and the particle size, respectively. A better detection of low intensity vibrational modes of C_{70} in Raman scattering is observed due to surface enhanced Raman scattering [2].

ZnO nano-wires have been grown by vapour–liquid–solid (VLS) process using metal nanoparticles (Au, Ti, Al and In) as catalysts. Nanoparticles were grown on substrate by evaporating 6 nm of the metal to be used as catalyst. Figure 1 shows the atomic force microscope (AFM) image of In nanoparticles. A quartz tube furnace was used as reaction chamber. The growth was performed at atmospheric pressure. Zn lump on a quartz boat was kept in the furnace zone having lower temperature and the substrates were kept at 950^{o}C. Initially only Ar gas was flown in the tube with flow rate 100 ml/minute. The flow of O_2 was subsequently started with flow rate 5.3 ml/minute after Zn evaporation. The processing temperature was 950°C for 35 minutes. The scanning electron microscope (SEM) image (Figure 2) shows that the ZnO nanowire were highly oriented with wurtzite hexagonal structure.

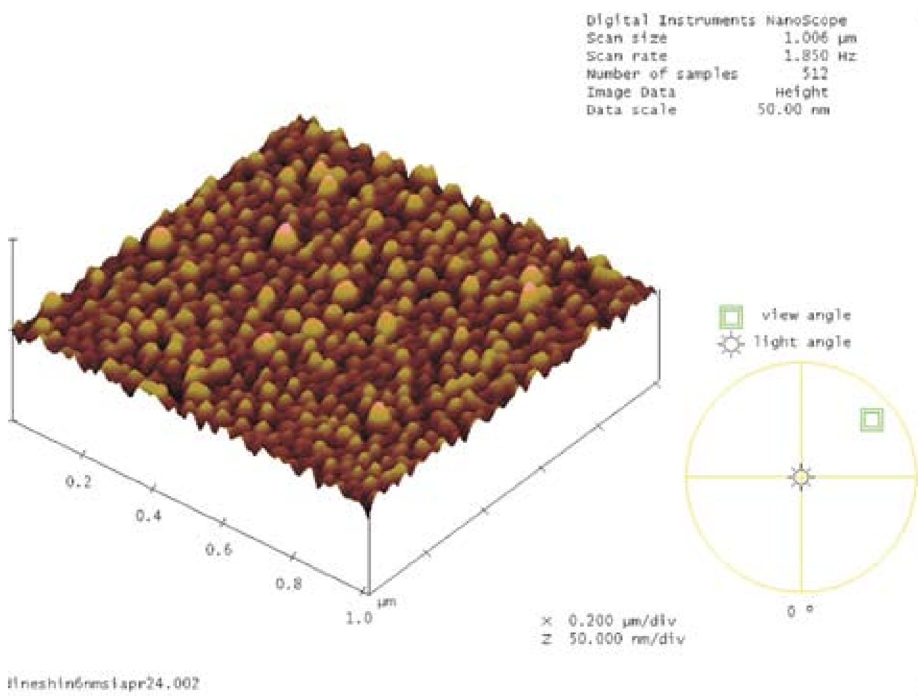

Fig. 1

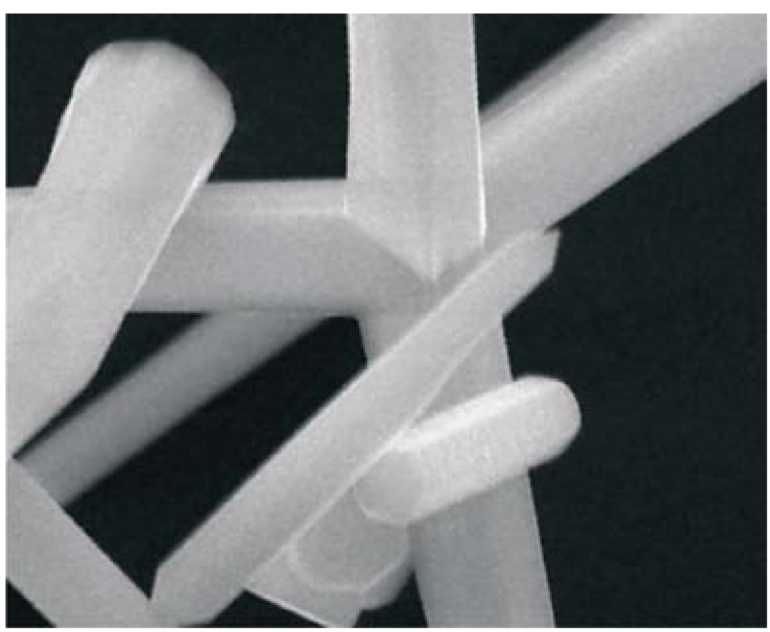

Fig. 2

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3.5 RF & ELECTRONICS LABORATORY

A. Sarkar, S. Venkataramanan, B.K. Sahu, K. Singh, A. Gupta, A. Pandey, P. Singh and B.P. Ajith kumar

3.5.1 Pulse Shape Discriminator (PSD) module for NAND array

Final batch of 10 nos. of PSD modules were fabricated and integrated with the existing 30 detector NAND array at Phase-II beam hall. The single width two channel NIM module [1] has been redesigned and tested for reproducibility. We have initiated the mass production of these modules for different neutron arrays in the country. In order to conserve space for front end electronics in a large array, efforts are made to accommodate as many as 10 such modules in a standard 200 watts NIM crate, with additional power supplies as shown in the figure. Meanwhile, remote control of various control parameters of this module is being planned.

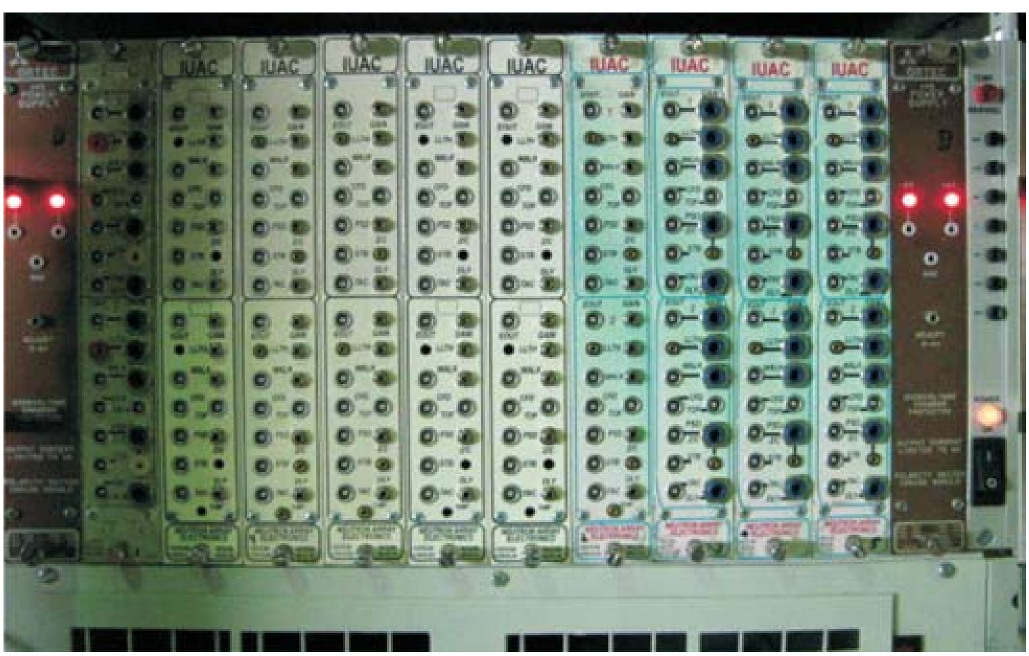

Fig. 1. PSD Module

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3.5.2 CAMAC Substitute Crate for Control Applications

The Tandam-LINAC accelerator control system at Inter University Accelerator Centre uses CAMAC standard for interfacing the devices to the computer. The devices are connected to CAMAC crates located at various locations around the machine. Each crate has several modules like ADCs (analog reads), DACs (analog writes), Input Gates (digital reads), Output Register (digital controls) etc. The high power consumption, weight and high cost of CAMAC Crate prompted us to develop a functional equivalent and modular compatible system to the existing system. This CAMAC Substitute Crate packs the functionality of a mini Crate (appx. 130 signals). The controller is designed with single board computer on the back plane PCB. Industrial standard EURO connector is used for the modules to be inserted on the back plane. The Crate is tested with the existing Pelletron Control System in client-server configuration.

3.6 ELECTRICAL GROUP ACTIVITIES

U. G. Naik and Raj Kumar

Electrical group has the responsibility to maintain the existing electrical installation and take up the new challenges required for the up gradation of the institute's expansion of the experimental facilities. We are happy 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.2008-2009.

Maintenance:

Captive Power Installations

Institute has a Captive power base of 860 KVA. Group has managed the emergency power requirements with the available power generating sets and also has plans for bigger sets to meet the demand in future plans. The group has shown ever readiness in running the systems round the clock and within short notices smoothly.

Power Stabilisers

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

UPS Installations

Electrical group with the help of AMC of various suppliers/ manufacturers has maintained 2X300KVA UPS, 4X60 KVA UPS, 1X50KVA UPS, dedicated to feed motor loads of Helium Compressors, High Current Injector systems, and many other critical installations, besides a previous base of about 20 nos. of UPS rated from 2-10kVA. Only the 5KVA and above capacity UPS are put on AMC with manufacturer and rest are all maintained by the group. During the present year all UPS were very healthy and had 100% uptime. Routine maintenance was carried out by the manufacturers authorized service centre and the faulty batteries were replaced.

Power Factor Compensation

Electrical group is very happy to inform that we achieved average power factor almost near to unity throughout the entire year. Our system power factor without correction is about 0.85 and by raising it to near unity we save around Rs.45 lakhs a year from energy billing.

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. These are working fine. The group takes the responsibility of getting the revalidation of license periodically from the Ministry of telecommunications.

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

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.

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:

Installation for Beam Hall-II

3ph. Power to 5 more Quadrupole magnets of ratings 300 amps capacity provided in HYRA experimental area.

UPS Systems

Group carried out exhaustive studies in consultation with Computer group and framed the design specifications for the electrical part of the computer DATA centre coming up at LEIBF building. The scheme involves a LT panel (input panel) with 2x1600A EDOCBs, 500kva UPS in modular configuration, output panel, power factor correction panel, bus ducts and batteries for UPS.

11 kV Compact substation

Group has planned, designed and ordered a ABB make Compact unitized substation with HT Vacuum circuit breakers in SF6 filled steel tank, 100kVA 11kV/433V transformer, multiple outgoings in LT panel with 300kVAR capacitors automatically controlled. This order is in execution stage most likely the entire erection and commissioning shall be over at the end of this financial year. This substation will cater for BH-II (HYRA) and BH-III. It also has expansion capability to feed another substation/transformer.

Phase-II Part-II Installations

Beam hall 3 (ECR) electrical works have been Co-ordinated.

3.7 COMPUTER AND COMMUNICATIONS

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

The year was marked by the sanction of a major new high performance computing facility at the Centre, and by developments on the group's ion-beam simulation software and data acquisition systems programs. Besides this, incremental expansion of the central server facility and network was taken up.

3.7.1 High Performance Computing Facility

A sum of Rs. 13.53 crores was approved by the Department of Science and Technology to set up a teraflop computing facility at the Centre. The purpose of the facility is two-fold: to enable large scale simulations of ion-matter interactions to support the Centre's experimental program, and to provide a supercomputing facility accessible to all university research groups in the areas of materials science, nuclear physics, atomic and molecular physics, and radiation biology and physics. The facility is to be set up in two phases, with the first phase to be commissioned in June 2009 and the second by the end of 2010.

The design of the facility and the data centre to house it was finalized this year, and orders for the first phase placed. The data centre has provision to house 550 1U servers, or a somewhat larger number of blade servers. In the first phase, systems will be put in place for a total power capacity of 400 KW and a cooling equivalent of 100 tonnes, which is expected to meet the second phase computing requirements as well. All civil, electrical and cooling work would be completed in the first phase itself, and only the expansion of the computing infrastructure is envisaged in the second phase. The cooling system will consist of chilled water based cooling modules coupled to the server racks. While this choice is necessitated by the very high power densities (20 KW per rack) needed to accommodate 550 servers in the small space (50 sq. m.) available for the data centre, the design is also expected to provide significant savings in cooling costs compared to conventional precision air-conditioning solutions. An integrated computer control of all data centre parameters, including rack power, temperature, fire sensors and alarms, and sensors for water leakage, is also envisaged. This would create a safe and efficient data centre, with power requirements of cooling modules and chillers continually adjusted to meet actual requirements of servers at different user loads.

The first phase computing system is to consist of a 600 gigaflop symmetric multiprocessing system and a 9 teraflop distributed memory cluster. The Sun M9000 Enterprise server with 20 SPARC-VII quad-core processors at a clock of 2.52 GHz has been selected for the SMP requirement. The distributed cluster would consist of 96 Sun Fire X2200 nodes with dual quad-core Xeon processors and a 20 GB/s non-blocking Infiniband interconnect. In addition, a parallel virtual file system would be implemented on 10 nodes of 1 TB each on Infiniband, to provide a central fast storage for the cluster. A dedicated 5-node parallel visualization system with a high-resolution tiled display is also being set up. A primary goal of the facility is to provide access to university users across the country. Initially, remote access would be possible through a dedicated 2 Mbps Internet link, which has been set up for the purpose. Over time, the possibility of linking up this resource with the National Knowledge

Network grid is being explored.

With the work on the data centre started, and the computer systems expected to arrive shortly, the new teraflop computing centre is expected to be open to users by the end of June, 2009.

3.7.2 Data Acquisition System and Hardware Development

Development activities for data acquisition system hardware and software included design of a new event-identifier module, a control system for radiation biology experiments, improvements and testing of the prototype DSP-based data acquisition system, bit pattern module hardware and software, a new multi-channel analyzer integrated with the existing data acquisition and analysis software, and mass production of ADC modules to meet the Centre's requirements and serve as spares for the INGA facility.

The new Global Event-identifier Module (GEM) consists of a bit pattern module, a 4-in-1 bit combiner, a trigger generator and reader, a clock module for multi-strobe usage, and a stretchable strobe for energy readouts. The entire configuration is completely programmable through CAMAC commands, without any jumpers. Simulations show better results with the module than with the existing NIM-based design.

A PC104 based control module ASPIRE was developed for radiation biology experiments, with options for calibration and scaler based automated dose per target.

Development of the signal processing system NIAS continued, with design modifications to incorporate high speed clock synchronization. The mass production of the ADC814 14-bit 8-channel ADC, which started last year, was continued to meet further requirements. Eighteen more modules are expected to be required, of which ten were completed. Testing of these modules and production of the other eight are in progress.

A software for readout of the bit pattern module has been developed, with various options for simulations, area-based charge distributions, and display. A single RPM package (NiasAllInOne.rpm) has also been put together to ease the installation and operation of software for the full range of the Centre's data acquisition and analysis software.

3.7.3 Simulations in Materials Science

First results from the IUAC-CIRIL-LIRIS collaboration studying target response to MeV ion beams were published this year [1]. The order of magnitude differences in sputtering yields between different initial energy distribution models emphasize the need to accurately simulate the electron-lattice energy transfer. They also indicate the importance of the sputtering yield in swift ion-matter collisions as a signature of this femto-second transfer process. The results point to the role of the radial energy transfer on ion impact in determining the sputtering yield.

Efforts to extend the IMPACT thermal spike-MD code to potentials other than the Lennard-Jones pair potential, and to amorphous target materials, were started this year. The objective is to simulate MeV ion interactions with targets relevant to the Centre's experimental program. Reuslts from this extension are expected next year, with Si and SiO_2 being the first targets to be studied.

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3.8 AIR CONDITIONING, WATER SYSTEM AND COOLING EQUIPMENTS

P. Gupta, A. J. Malyadri and 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 90,000 hours each and the new compressor#2 has logged 12,500 hours. Other rotary equipment have logged in about 1,48,000 **c**ontinuous run hours. The yearly maintenance costs have been maintained at approximately one-eighth the international standards of the installed project cost. Though, the plant has aged, yet the MTBF for all the equipment has shown a consistent rise over the years.

The vigil of MG#2 prevented a major disaster on #4 compressor due to timely intervention. The unit was completely refurbished during the year. Process of replacement of corroded AHU's has been initiated. This will be completed by 2010.

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

The Phase-II, Central AC Plant with a Centrifugal Chiller and with its installed capacity of 250 TR performed to an uptime of 100%. The plant catered to the cryogenic activities and was used extensively for picking up the Phase-I heat loads. This affected a huge energy saving, due to better IKW/Ton of this plant.

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

The newly built UPS system (300x2 KVA) had heavy heat dissipation leading to poor battery lives. To avoid this problem, the heat load was evaluated and a suitable cooling system was designed. The load was 22TR. The entire system was installed to the best of standards and no further problem has been reported till date.

The new A/C Plant, Phase-III, was **provisionally taken over** by IUAC on 03/04/2007. In-spite of our repeated perusals, CPWD/Blue Star is yet to carry out the plant load testing. The problem of high vibration still persists in the equipment.

CPWD had expressed their inability to carry out pending works on Air-washer. They have asked us to take up the same. Accordingly, MG#2 is planning to do pending works departmentally. The expenditure for the same will be intimated to CPWD to facilitate the appropriate deductions from their contractor's bills.

Water System

IUAC's centralized water system of Phase-I feeding low temperature cooling water of a total heat removal capacity of 115 TR, potable water supply and the gardening water supply performed to an operational uptime of 100%. This was possible due to the stringent maintenance practices that were followed over the years. The mechanical systems have already overshot 1,00,000 hours **beyond their expected life span.** A strict monitoring on the water quality ensured that the flow paths are in healthy condition. Numerous repair works were carried out. Some additional equipment was installed.

There were frequent water leaks due to bursting of rubber hoses. They have been replaced by thermo-plasic and multi purpose hoses. We are in the process of extending SS pipes in close proximity to the equipment. This will minimize the length of flexible hoses to avoid frequent water leaks and reduced friction head.

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

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

Cooling Equipment

Availability of equipment was recorded at around 99%.

New Construction

The construction works of Water System phase-III is nearing completion. The completion and testing of the system is expected shortly.

In-spite of our repeated persuasions, NO PROGRESS has been made on the low side air-conditioning works to be executed by CPWD. However, MG#2 has completed the high side works on the same, much ahead of schedule.

MG#2 has added on an additional piping network of ~300 meters. This will cater to additional areas brought under horticulture.

3.9 MECHANICAL WORKSHOP

B.B.Choudhary, S.K.Saini, Rajeev Ahuja, Sunder Rao and Jimson Zacharias

The Mechanical Workshop is serving as an in house machining and welding facility for the 15 UD Pelletron accelerator, supporting various laboratories and large number of researchers from all over India and abroad. Workshop has been involved in developmental activities of new systems 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 was fabricated in the IUAC Workshop during this year as well. Workshop continues to assist all the in house fabrication activities of LINAC, RFQ, DTL, HCI, INGA, HYRA, HIRA as well as the Cryogenic component developments.

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

The Machine shop is equipped with a five axis Vertical Machining Centre (VMC), a CNC lathe, four conventional lathes, two milling machines, cylindrical surface grinders and radial drilling machine. Most of these machines are of HMT make, fitted with DRO's for achieving higher accuracy and better productivity. Apart from these we have tool and cutter grinder, horizontal and vertical band saw machines, etc. for general requirements. We also have the VISI CAD-CAM facility and Solid Works for the design and the drafting purposes. A CMM will be added shortly for the inspection purpose.

Welding –shop has many high quality TIG welding facilities. 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 thick stainless steel is used extensively. Aluminium welding and Oxy-acetylene cutting and brazing set ups are also available. We have a micro –plasma machine from Air Liquid, France for very thin section welding.

The Electron Beam Welding (EBW) facility is fully operational. EBW of fifteen niobium quarter wave resonators are almost complete.

All the machines, mentioned above are working in good conditions because of timely maintenance and careful handling. Apart from five persons assigned to workshop, other academic personnel and students are also capable of handling the machines.

IUAC workshop is providing apprentice training for the ITI passed students in both welding shop as well as in machine shop. In return apprentices help the IUAC in fabricating various products. Basic workshop training is provided for the scientist trainees and PhD students enrolled in IUAC.

Some of the Major Activities of workshop

Prototype RFQ

Last year we assembled the ***straight vanes*** and completed the required testing of the prototype RFQ. We fabricated the ***modulated vanes*** as per our design after the testing of the straight ones. For assembling the modulated vanes, we removed all the straight vanes and vane posts from the chamber and assembled the modulated vanes on vane posts systematically.

Fig.1. Assembling of modulated vanes

After assembling the lines, water lines were laid according to the design plans. There are in total ten numbers of inlet ports and equal numbers of outlet ports. From the supply line water comes to the distribution manifold and from there it goes to the different points of the vane post. After assembling all the water cooling accessories we tested by circulating water at a pressure of 4 bar and found the performance satisfactory.

Fig.2. Assembling of water cooling accessories in progress.

After the test we dismantled all the vanes and vane posts and the Chamber was sent for the electro plating with copper. Copper plating on SS 304 grade steel is quite difficult and vendor has made special set up to carry out the operation.

Fig. 3. Various stages of Copper electro-plating of RFQ chamber

Electrostatic Quadrapoles

Six sets of quadruple are under fabrication. Out of six, four are triplet quadrupoles and two are doublet quadruples. Four triplet and one doublet are required for the LEIBF and one doublet is required for the ion source test bench.

Fig.4. Electrostatic Quadruples UHV chambers after Fabrication

Fig. 5. Electrostatic Quadrupoles inner components after fabrication

Gas Cell Absorber set up for AMS

It is used to stop the ^{10}B(Isobars of ^{10}Be) in ^{10}Be AMS experiments.

Fig. 6. Chamber for the gas cell absorber

Fabrication of Annular PPAC and conical target chamber for GDA with stand and foil flange

As we see in fig 7(a) and 7(b), one conical flange is fabricated and held independently in the beam line with the help of mounting frame and stand. It seems to be a small job but it was a very tedious job. Firstly making a conical flange is very difficult and then holding independently is again difficult.

Fig.7. Conical target chamber for GDA with stand and foil flange

Slow tuner development

This year we have developed two dozen slow tuner fixtures (Fig. 8) of new version and leak tested. This fixture will go to the Module #2 and module #3 LINAC. Certain Design changes were made to further improve the various requirements. Total 11 units installed last year are working fine without any problem.

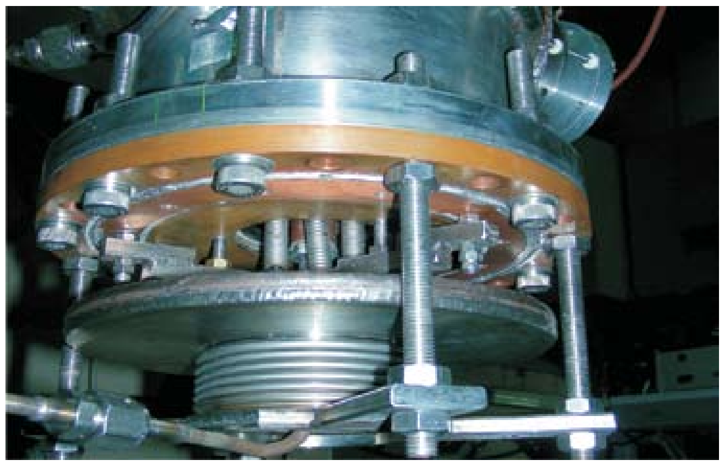

Fig.8. Slow Tuner

RF drive coupler Linear Motion

This year we have developed two dozen RF drive couplers of new version and tested. These drives (Fig. 9) will also go to the Module #2 and module #3. Certain design changes were made to further improve the various requirements. Total 11 units installed last year are working fine without any problem.

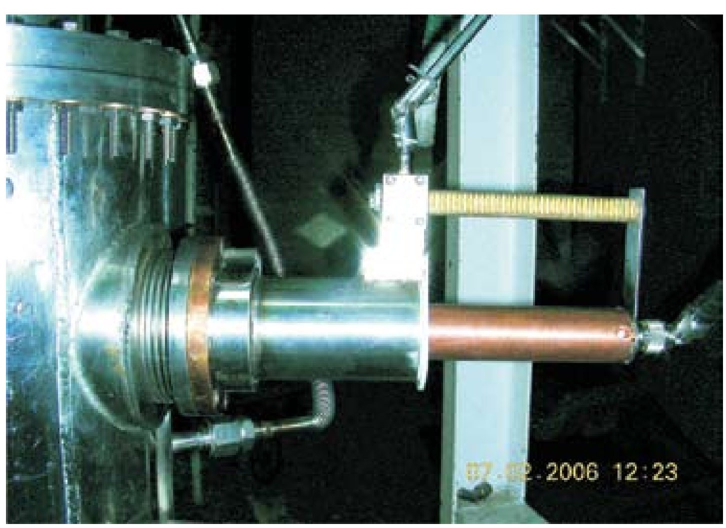

Fig.9. Drive Coupler

Drift Tube LINAC Project.

This project is very challenging job in terms of design as well as of engineering skill. In this project most of the work was done in IUAC workshop. Following are the major works done to complete this work.

Last year we successfully completed the DTL Tank and tested for leak. This year we designed the Stem and ridges for the DTL. Drafting work for the stems, ridges & Chamber were carried out in Solidworks software. Solid modeling and assemblies of the total DTL structure was made. Assemblies were made which conform to the geometrical tolerances and fits. Individual component drawings were made for all parts of the first tank of the DTL. These solid models were converted to the CAM software. Necessary changes were made for the CAM design for manufacturing. A lot of time was put in VISI CAD and VISI CAM software. We developed programming for the stems and did several trials in Nylon as well

Fig.10. Stem machining in progress

Fig. 11. Stem prototyping in progress

as in Aluminum. Sample were made and electroplated with silver. We went to VECC and CMERI Durgapur for vendor Development. We started making the ridges and stems on house using our VMC. All prototype stems and ridges are ready, assembled and checked for the geometrical accuracy. Bead Pull was done and results were satisfactory and presented at INPAC 2009 conference at Indore. Meanwhile a lot of efforts to find a suitable Cu platter vendor and trials are being done.

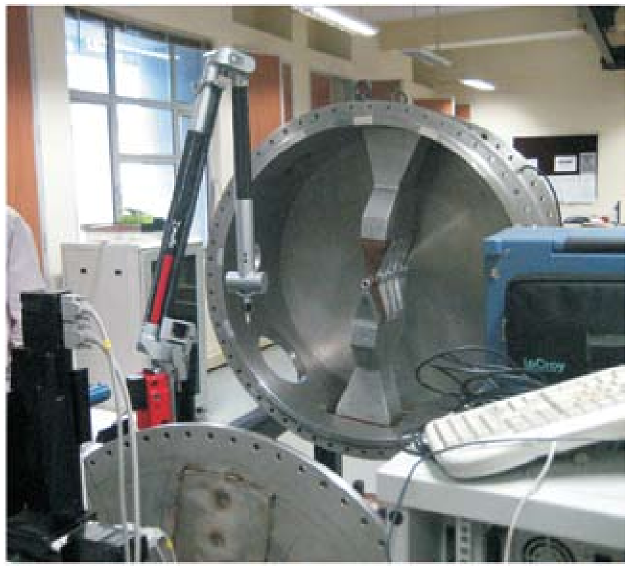

Fig.12. DTL parts are being assembled and tested.

3.10 HEALTH PHYSICS

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

Health physics group activities in the centre are mainly related to radiation safety and radiation research in environment, its interdisciplinary and regulatory aspects. A few research scholars have completed their doctor of philosophy (Ph. D) by using partially or fully the facilities available with this group. There are a few research scholars directly involved under this group. The concerned group members are approved as a supervisor or co-supervisor in the various universities. This group has given excellent academic support towards radiation research and safety in many interdisciplinary research activities.

Presently, there are around 20 universities, working with the health physics group on various interdisciplinary research activities, 6 research scholars are doing their research under co-supervision of this group at various universities. Around 15 research scholars are presently associated with them from various universities. The universities associated with this group are from all over the country. We are putting our best efforts to make these activities par excellence in co-ordination with the Atomic Energy Regulatory Board (AERB) and the various universities involved with the health physics group.

A few of the recent activities towards the development of radiation shielding with 30% borated High Density Polyethylene (HDPE) slabs are tested for neutron attenuation. Calculation by MCNP code was done for the combination of HDPE, borated HDPE and Iron+lead in the ratio of 15:10:2. Study of HDPE for its composition was done by Elastic Recoil Detection Analysis (EDRA) technique to find out the percentage of boron in borated polyethylene and to find out attenuation factor theoretically. We are studying and developing shielding material using up to 25% of fly ash with cement for both the neutron and gamma radiation shielding. The same has been simulated with the MCNP code. Main theme of this is to utilize fly ash without compromising much on the attenuation properties. Utilization of fly ash will definitely help in the ecological aspects. Nano phosphors for thermoluminescence dosimetry are developed and tested for ion beams. Conducting polymers as a radiation sensor, environmental radiation, etc, are the part of the research activities.

In addition to these activities our technical staff is involved in the installation of PLC based door interlock system for Beam Hall-II and Vault-II. This work was completed under our supervision, so that radiation safety aspects should be as per the norms of AERB. Interlock system in the control room for proton beam has been upgraded and beam line selector for BH-II is also incorporated.

3.10.1 Thermoluminescence of silica-based materials irradiated by thermal neutrons

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This work describes the thermoluminescence (TL) response of silica-based materials irradiated with thermal neutrons. These materials have the compositions (mol %): $(60 + x)$ SiO_2–$(30 − x)Na_2O$–$5MgO$–$5Al_2O_3$, where $x = 0$, 5, 10 and 15. The irradiation was carried out in the fluence range $1 \times 10^{14} – 1 \times 10^{17}$ neutron cm^{-2}. These glassy materials gave two TL glow peaks at around 473 and 643 K. The intensity ratio of these peaks is found to vary with varying SiO_2/Na_2O ratios. The peak at 473K is more prominent at the ratio SiO_2/Na_2O = 75/15, while the intensity of the other one at 643K increases by decreasing the value of this ratio. The former peak is attributed to both 'AlO4' hole centres and non-bridging oxygen (NBO) ion centres induced by neutrons irradiation, while the latter one could be ascribed to (NBO) ion centres introduced by the network modifiers, Na+ ions. The TL response against the neutron beam fluences of the material having the ratio SiO_2/Na_2O = 75/15 is found to show sublinearity in the above-mentioned range of fluence (using the area under the curve method). The other features such as high sensitivity and simple glow curve structure might be good indicators for this material to be used as a dosimeter in several applications such as thermal neutrons or in food irradiation.

3.10.2 Nanocrystalline $Ba_{0.97}Ca_{0.03}SO_4$:Eu for Ion Beams Dosimetry

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Nanoparticles of $Ba_{0.97}Ca_{0.03}SO_4$:Eu have been irradiated by 48 MeV Li^{3+}, 75 MeV C^{6+} and 90 MeV O^{7+} ion beams with a fluence range of 1×10^9-1×10^{13} ion/cm^2. The thermoluminescence (TL) glow curves along with the response curves of this nanophosphor have been investigated and compared with those of the corresponding microcrystalline samples. TL glow curve of the nanophosphor exposed to γ-rays has also been included in the letter with the aim of reporting some of the comparative measurements. The glow curves of the ion-beams irradiated nanomaterials are similar in their shapes to those induced by gamma rays, with a shift in the peak positions to the higher temperature side by around 30 K. The TL intensity of the ion beams irradiated nanomaterials is found to decease, while going from low to high atomic number (Z) ions (i. e. $Li^{3+} \rightarrow O^{7+}$). Similar trend was also observed in the linearity of the TL response curves. The response curve of Li ions irradiated nanomaterials is sublinear in the whole range of fluences studied. Carbon ion has also a more or less similar response, while the oxygen ion has a sublinear response over a shorter-range of 1×10^9-1×10^{12} ion/cm^2, and above this range the response saturates. These results for the nanomaterials are much better than that of the corresponding microcrystalline sample irradiated by Li^{3+} ions. The curve was sublinear up to the fluence 1×10^{10} ion/cm^2 and then saturates at higher fluences. The wider sublinear TL response of the nanocrystalline $Ba_{0.97}Ca_{0.03}SO_4$:Eu makes it superior to its corresponding micro form and thus makes it a suitable candidate as a dosimeter to be used for detecting the doses of ions, especially the lithium and carbon ions for their application in cancer radiotherapy and radiation biology.

3.10.3 Thermoluminescence of $BaSO_4$:Eu irradiated with 48MeV Li^{3+} and 150MeV Ag^{12+} ions

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The effects of irradiation by 48MeV Li^{3+} and 150MeV Ag^{12+} ion beams on the thermoluminescence (TL) of $BaSO_4$:Eu phosphor are studied. Samples in the form of pellets were exposed to different fluences in the range 1×10^9–5×10^{11} ions cm^{-2}. The modifications in TL glow curves of the materials irradiated by lithium (Li) and silver (Ag) beams are essentially similar to those induced by γ -ray irradiation. There is a significant variation in the relative intensity between the main glow peak at 497K and the small shoulder at 465 K. This variation is more dominant in the samples irradiated by Ag ions. This has been attributed to the change in the population of the luminescent/trapping centres (LCs/TCs) during the bombardment by high-energy heavy ions. The relative TL efficiency values of $BaSO_4$:Eu to 48MeV Li and 150MeV Ag ion beams have been measured relative to 0.662MeV γ -rays of 137Cs and are found to be 0.374 and 0.0017, respectively. It is found that $BaSO_4$:Eu phosphor is suitable for recording irradiation from light ions (Li) as well as heavy ions (Ag) as it shows linearity in its TL responses over wide ranges of fluences of ion beams. It is linear in the ranges 1×10^9–1×10^{11} and 1×10^9–1×10^{10} ions cm^{-2} for Li and Ag ion beams, respectively. This property along with its low fading make $BaSO_4$:Eu phosphor a good candidate to be used as a dosimeter for cosmic rays and medical applications.

3.10.4 Nanorods of LiF:Mg,Cu,P as Detectors for Mixed Field Radiations

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Nanocrystalline powder of LiF: Mg,Cu,P phosphor has been synthesized by the chemical coprecipitation technique. Shape and size of these nanomaterials were observed by transmission electron microscope and atomic force microscope. The particles are of rod shapes having diameters from 50 to 80 nm and lengths varying within the range 0.4–0.7 μm. Pellets of these nanorods were irradiated by 48 MeV $_7Li^{3+}$ ions at different fluences in the range 1×10^{11} –1×10^{14} ions/cm^2 (with corresponding doses in the range 0.679–679 kGy and their thermoluminescence (TL) properties have been studied. The TL glow curves are observed to have prominent peaks at around 588K along with smaller one at around 410 K. The TL intensity of the former is found to increase with increasing the fluence, while that of the latter decreases. These behaviors are in contrast with those of the peaks induced by 137Cs γ-rays. This modification in case of irradiation by ion beam has been attributed to the change in population of the luminescent/trapping centers due to the use of highly energetic ions. From these results, it is suggested that the nanorods of LiF:Mg,Cu,P might be used as detectors for mixed fields radiations such as space radiations.

3.10.5 Nanoparticles of $BaSO_4$:Eu for heavy-dose measurements

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Nanoparticles of $BaSO_4$:Eu with grain size in the range 30–50 nm have been prepared by the chemical co-precipitation method and characterized by UV–visible spectrometry and X-ray diffraction (XRD). Shape and size of the prepared nanomaterials were observed by a scanning electron microscope (SEM). The optical energy band gaps of the micro- and nanocrystalline $BaSO_4$:Eu were determined and are found to be 3.39±0.014 and 3.48±0.014 eV, respectively. The thermoluminescence (TL) glow curve of $BaSO_4$:Eu nanoparticles has been studied and compared with that of the corresponding microcrystalline powder. It has been observed that the TL glow peak at 497 K, seen prominently in the microcrystalline sample, appeared as a small peak in nanocrystalline powder, while that observed as a shoulder in the former at 462 K dominates in the latter. The observed TL sensitivity of the prepared nanocrystalline powder is less than that of the microcrystalline sample at low doses, while it is more at higher doses. This nanophosphor exhibits a linear/sublinear TL response to γ-radiation over a very wide range of exposures (0.1 Gy to 7 KGy), which is much wider compared to that of the microcrystalline counterpart (0.1–10 Gy). This response over a large span of exposures makes the nanostructure form of $BaSO_4$:Eu useful for its application to estimate low as well as high exposures of γ-rays.

3.10.6 Synthesis and the luminescence studies of Ce doped SrS nanostructures

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Cerium doped strontium sulfide nanostructures have been synthesized by solid state diffusion method in the presence of sodium thiosulphate. XRD confirmed the single phase rocksalt structure of synthesized samples and the average grain size using Debye Scherrer's relation is calculated to be 55 nm. TEM micrograph reveals the agglomerated whisker like morphology with a diameter of 55-60 nm and length of several nanometers which is in close agreement with XRD results. Effect of dopant concentration on photoluminescence (PL) intensity has been studied. PL emission for SrS:Ce (0.5 mol%) is at 481 nm with a shoulder at 530 nm at an excitation wavelength of 430 nm, which is attributed to the transitions from 5d state to 4f (2f7/2, 2f5/2) states of Ce3+. Ultraviolet and visible (UV-VIS) spectroscopy shows band to band absorption at 273 nm (4.54 eV) which is blue shifted in comparison to the band gap of bulk SrS (4.2 eV) which may be due to quantum confinement. Effect of high energy ball milling on the grain size and PL intensity has also been investigated for the first time in doped SrS system. PL emission wavelength is blue shifted by 3 nm but emission intensity decreases unexpectedly as the milling time increases, though there is size reduction which is evident from XRD peaks broadening of milled samples. This may be assigned to surface defects generated by ball milling which act as killing centers, quenching the photoluminescence.

3.10.7 Monitoring of radon and its progeny in the environment of vertical 15UD Pelletron accelerator facility

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Environmental radioactivity due to radon and its progenies present in the ambient air of vertical 15UD Pelletron accelerator facility at Inter University Accelerator Centre, New Delhi, India, was evaluated and analyzed so as to calculate the annual effective dose to the workers and users due to natural background radiation as a part of their total effective dose from ionizing radiation, including the component from artificial sources. Activity concentration of radon was measured by using active monitor. Activity concentrations of radon progeny were measured simultaneously using grab aerosol sampling and absolute beta counting. The effect of in-situ meteorological parameters like temperature and relative humidity along the height of the Pelletron tower, on the activity of radon and its progenies has been studied. The measurements were carried out in winter and rainy season. The values of temperature, relative humidity (%), radon activity concentration, radon equilibrium equivalent concentration (EEC) annual exposure, annual inhalation and annual effective dose varied between 16.1-21.7 ^{0}C, 39-62 %, 9.0±0.42-20.3±0.30 Bq/m^3, 1.3±0.20-5.3±0.29 Bq/m^3, (5.8-23.6)×10^{-3} WLM, 0.03-0.11 mSv, and 0.02-0.09 mSv, respectively, for locations with air conditioning in winter season, between 21.5-27.0 ^{0}C, 43-52.5 %, 9.0±0.71-32.5±0.75 Bq/m^3, 1.5±0.20-2.5±0.21 Bq/m^3, (6.7-11.1)×10^{-3} WLM, 0.04-0.05 mSv, and 0.03-0.04 mSv, respectively, for locations with air conditioning in rainy season and between 20.3-28.0 ^{0}C, 44-61.5 %, 9.0±0.10-50±0.80 Bq/m^3, 0.4±0.14-3.8±0.97 Bq/m^3, (1.8-16.9)×10^{-3} WLM, 0.01-0.08 mSv, and 0.01-0.07 mSv, respectively, for locations without air conditioning in rainy season. The ^{218}Po, ^{214}Pb, ^{214}Bi, radon and EEC activity concentrations were found to decrease with the height and relative humidity and increase with the temperature. The dose levels observed in the facility were below the ICRP and UNSCEAR recommendations, even for general public (1.2 mSv).

3.10.8 Comparative study of natural radioactivity levels in soil samples from the Upper Siwaliks and Punjab, India using Gamma Ray Spectrometry

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Natural radioactive materials under certain conditions can reach hazardous radiological levels. So, it becomes necessary to study the natural radioactivity levels in soil to assess the dose to the population in order to know the health risks and to have a baseline for future changes in the environmental radioactivity due to human activities. The natural radionuclide (^{226}Ra, ^{232}Th, and ^{40}K) contents in soil were determined for 26 locations around the Upper Siwaliks of Kala Amb, Nahan and Morni Hills, Northern India, using high-resolution gamma-ray spectrometric analysis. It was observed that the concentration of natural radionuclides viz., ^{226}Ra, ^{232}Th and ^{40}K, in the soil varies from 28.3 ± 0.5 to 81.0 ± 1.7 Bq kg^{-1}, 61.2 ± 1.3 to 140.3 ± 2.6 Bq kg^{-1} and 363.4 ± 4.9 to 1002.2 ± 11.2 Bq kg^{-1} respectively. The total absorbed dose rate calculated from activity concentration of ^{226}Ra, ^{232}Th and ^{40}K ranged from 71.1 to 162.0 nGy h^{-1}. The radium equivalent (R_{eq}) and the external hazard index (H_{ex}), which resulted from the natural radionuclides in soil, were also calculated and found to vary from 149.4 to 351.8 Bq kg^{-1}and from 0.40 to 0.95 respectively. These values in Upper Siwaliks area were compared with that from the adjoining areas of Punjab. The radium equivalent activities in all the soil samples were lower than the limit (370 Bqkg^{-1}) set in the Organization for Economic Cooperation and Development (OECD) report and the dose equivalent was within the safe limit of 1 mSv y^{-1}.

3.10.9 Study of neutron induced modification on optical band gap of CR-39 polymeric detector

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Neutron- irradiation effects on optical absorption of solid state nuclear track detector, CR-39 was studied for the various fluences ranging from $2.38x10^6$ to $2.7x10^8$ $n/cm^2/sec$ by ultraviolet-visible (UV-Vis) spectroscopy. The optical absorption spectra in the wavelength range of 200-700nm were recorded for the pristine and the neutron irradiated samples in the above fluence range. The UV-visible spectra show a shift in the absorbance edge towards the higher wavelength, which can be correlated to the transition involved in the CR-39 polymer and variation in the band gaps (E_g) using Tauc's expression. Both the indirect and direct band gap in pristine and neutron irradiated CR-39 have been studied. It is interesting to note that the values of indirect band gap is found to be lower then the corresponding values of the direct band gap. Indirect and direct bandgap of pristine and exposed CR-39 was found increasing with increasing fluences. However values of the indirect band gap are found to be lower than that of direct band gap. A decrease in the optical energy gap with increasing fluence can be discussed on the basis of neutron-irradiation defects in CR-39. The number of carbon atoms in a cluster was determined from UV-visible spectra of the neutron irradiated samples, using Tauc's expression.

3.10.10 Neutron dosimetry with Linear Energy Transfer (LET) and the Proton Recoil Track counting Method

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There is a need of standardizing neutron dosimeters above tens of MeV, as there is a growing interest of high energy accelerators for various applications such as Accelerator Driven Systems (ADS), Radioactive Ion Beam Facility (RIBF) etc. where tens of MeV neutrons are expected to be present. The long-term stability of latent tracks and insensitivity to gamma-rays along with the high capacity for registering recoil-proton tracks initiated the study of CR-39 as a neutron dosimetry material. Personnel neutron track detectors (PNTDs) are directly used to measure LET distributions of neutron-induced high-LET particle components, such kind of approach was initiated by space radiation dosimetrist having a very

long history, where different types of PNTDs utilized for measuring the LET distributions of high-LET components in space radiation. The measurement of LET distributions of secondary heavy charged particles for ≥ 4 keV/ µm-water induced by the neutrons with CR-39 plastic nuclear track detectors are discussed. Neutron dose equivalents were calculated from the LET distributions of the obtained tracks and using the ICRP60 Q-L relation. There was an extremely good correlation found with the LET and proton recoil track counting method. This paper presents the comparative study of both the technique.

3.10.11 Characterization and synthesis of conducting polymers for radiation dosimetry

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Semi-conductor radiation detectors are known in which excitation by radiation of electron-hole pairs in the depletion region of a semi-conductor device results in an electric current flow. However, such detectors give a transient response (i.e. representative of the instantaneous rate of irradiation) rather than a cumulative response (i.e. representative of the total amount of radiation over a particular interval) and further electronic apparatus is required to enable a cumulative reading to be obtained. Considering similar aspect, conducting polymers are tested for radiation sensor applications. So far the neutron dosimtery is done using the CR-39 foils, our attempts have shown conducting polymers may be used as a radiation sensor, our studies on electrical and structural properties of the irradiated polymers were investigated by measuring V-I using four probe set-up and X-Ray diffraction (XRD) using Bruker AXS, X-ray power diffractometer. V-I measurements show an increase in the conductivity of the film. XRD pattern of the polymer shows that the crystallinity improves after the irradiation with Swift Heavy Ions (SHI), which could be attributed to cross linking mechanism. Same concept has been used for the radiation dosimetry for gamma and neutron, it was observed that there is a linearity of I-V characteristics with the exposed doses with SHI & gamma.

3.11 CIVIL WORKS

M.K. Gupta

Civil section is associated with the following activities:

- Major expansion Project (right now Beam Hall III completion and planning for Auditorium)
- 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.

Important Civil Activities during the Year 2008-09

Following important Civil works were undertaken during the year 2008-09 in addition to routine Civil maintenance and minor works:

1. Complete renovation of IUAC Canteen by changing flooring, service area and kitchen counter stones, wall tiles, plumbing and sanitary fixtures and furniture.
2. Civil works for establishment of IFR Lab. in old Workshop area(UB-II) by necessary additions, alterations and replacements.
3. Silicone painting on red stone shaft walls of Main Lab. Building.
4. Construction of Stage in IUAC playground.
5. Construction of foundation for Packaged Substation near Beam Hall-III on E-side of storm water canal.
6. Provision of labour eating area on W-side shaft of IUAC Canteen by necessary additions & alterations.
7. Epoxy floor coating in 300 KVA UPS room (old Welding store room).
8. PVC flooring in R.N. 224 (Main Building), R.N. 405 (UB-I).
9. PVC partitions and enclosures in R.N. 225 and R.N.106 in Main Building.
10. Replacement of ceramic tile flooring in Gents toilet in Lounge area in Main Building.
11. Construction of road behind Engineering Building upto Sumeru-III (by CPWD).

3.12 COMPRESSED AIR SYSTEM AND MATERIAL HANDLING EQUIPMENTS

K.K. Soni and Bishamber Kumar

The group is associated with the following activities:

i) Compressed Air System: Compressed air plant (Ph-I & PH-II) consisting of two nos. reciprocating compressors each of 60 M^3 /Hr and two nos. screw compressors each of 115M^3/Hr capacity, 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.

Further to ensure 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.

Since Reciprocating compressors are more power consuming and source of excess oil contamination in the compressed air, therefore, the two reciprocating compressors are replaced by one Screw Air Compressor of 2208 lpm capacity. Compressed air piping has been extended to Lab I, Lab II and New Workshop building. An additional GA-15 FF air compressor is added to the system to meet the increased requirement of compressed air and also to make the system more reliable.

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

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

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

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

New buildings under PH II part II have the newly added Fire safety norms which includes pressurized water hydrant system. It includes centralized pressurized water system connected to underground Water tank and water pumps which maintain continuous water pressure in the water hydrant line. This system is available in PH II Part II buildings.

3.13 DATA SUPPORT LABORATORY

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

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

3.13.1 Fabrication of Octal Gate & Delay Generator

Single-width NIM module to generate logic pulses for gating analogue to digital converters (ADCs) used in data acquisition applications has been designed and fabricated. It provides a compact solution to gating problems in high-density experiments. It contains eight independent Gate & Delay generator channels and each channel accepts NIM-standard, fast negative logic pulses and produces two NIM-standard, fast negative logic pulse outputs, and one positive TTL output. It serves as a convenient interface between logic pulse origin and its end use. This year we have fabricated eight such modules.

Specifications:

Input	-	NIM standard, fast negative logic
Output	-	Two NIM outputs (-800mV in a 50Ω load)
	-	One TTL output (+4V into 50Ω load)
Delay	-	Adjustable from 70ns to 1000ns or, 0.4μs to 10μs
Pulse width	-	Adjustable from 70ns to 1000ns or, 0.4μs to 10μs
Dead time	-	Delay + Pulse width + 20ns
Delay Jitter	-	<0.04% of the selected delay

3.13.2 Design and development of FPGA based 8 channel 4K CAMAC ADC module

A single width CAMAC module having eight channels of peak sensing ADC (12 bit) has been designed and fabricated. The module design is based on Hardware Descriptive Language (HDL) implemented on Xilinx 4010EPQ160 FPGA. One channel is tested. 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. One channel of the module has been completed and tested for its performance.

Specifications of ADC:

*Single width CAMAC module
*12-bit peak sensing ADC with 7-bit Gatti circuit enabled
*Analog Input - 0 to 10V uni-polar or bi-polar from shaping amplifiers
* Conversion time – 8µs

Measured Performance:

Differential non-linearity < 0.03%
Integral non-linearity < 0.05%

3.13.3 On-line data acquisition system for PKDILS set-up at IUAC

On-line data acquisition system has been installed at PKDELIS setup at IUAC for local data collection. The system contains a CAMAC crate, home made crate controller along with a PC. CAMAC crate used is a Byra Systems made along with a 220V/110V step-down transformer. In-house developed 'Freedom' data acquisition software is installed for data collection. This system is running successfully since 8 months.

3.13.4 Fabrication of High Voltage Power supply control module for Atomic Physics set-up at IUAC

This is a Single width CAMAC module containing two channels of 16 bit Digital to Analog converters to control the output voltage of the High voltage power supplies through CAMAC. There is a read back facility to cross check. The module generates an output voltage in the range of 0 to 10V, which can be given to the power supplies control input terminal to set their output voltage.

3.13.5 Fabrication of CAMAC Crate controller with Embedded PC for Magnet lab at IUAC

For the local stand alone data acquisition system at magnet laboratory of IUAC, one CAMAC Crate Controller with Embedded Computer has been fabricated and tested. This is a double width CAMAC module which occupies the 24 and 25 stations of the CAMAC crate. Using this module, all the IGOR modules and ADC, DAC modules can be tested. The on board Embedded PC can either operate from the local flash disk or boot from a remote

Linux Server. All the required programs and operating system are loaded into the Flash disk which is mounted on the embedded computer. Since the only control link required is the Ethernet cable, the system can be used on high voltage platforms with fiber optic Ethernet link. A commercially available single board computer is integrated into the crate controller. The PC104 connector provides the interface between the computer and other components of the board. The board is placed in such a way that the Ethernet port is accessible from the front side. The controller circuit communicates to the computer through eight bytes in the PC I/O address space. For control system applications we need to run Operating system on each Crate Controller. The BIOS of the embedded computer has been modified to include the "Turbo C" program for the on board interface. On startup, the system loads the operating system through the network from a central computer.

3.13.6 Development of Prototype Tesla meter Readout with CAMAC Interface

The DTM-151 Digital Tesla meter offers extremely accurate and, high precision Hall Effect instruments for Magnetic Fields. Its resolution is 1 part in 600,000 and Maximum field is 3 Tesla. It has the option to read with seven digit display and either RS232 or IEEE488/GPIB communications. We have developed a prototype CAMAC interface card for reading the magnetic field values and incorporating this read back into remote control system. The system is based on the Atmega16 Micro controller chip and RS232 interface circuits built on a single width CAMAC card. The micro controller is programmed in such a way that it will accept the serial data from Tesla meter and convert to parallel data. The data will be stored in the registers and read by CAMAC commands. The Tesla meter reading can be read by 16 bit resolution with CAMAC interface.

3.13.7 Servicing and Maintenance

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

Following modules have been serviced.

1) Pre-amplifier, EG&G Ortec model 142A
2) Timing Filter Amplifier, EG&G Ortec model 474
3) NIM Bin power supplies
4) Home made crate controllers

Following Electronic module are added to data acquisition resource pool

IUAC made 8 Channel Gate & Delay generator modules
Canberra 2037A Timing Single Channel analyzers
EG&G Ortec 142-IH Pre-amplifiers
SHV, BNC and LEMO connectors and Cables