4. EXPERIMENTAL FACILITIES IN BEAM HALL

4.1 NEUTRON DETECTOR ARRAY PROJECT FACILITY

V.V.V. Satyanarayana, S.K. Suman, T. Varughese, Rajesh Kumar, P. Barua, J. Antony, S. Venkataramanan, J. Zacharias, R. Ruby Santhi, Kundan Singh, K. Saneesh, K.S. Golda, A. Jhingan and P. Sugathan.

The first phase of the DST funded project, National Array of Neutron Detectors is currently being installed at the phase II beam hall of IUAC accelerator facilities. The first phase of the project will have 50 neutron detectors, 5"x5" liquid scintillator of type BC501A each coupled to a 5" photomultiplier multiplier tube. The mechanical structure has already been built and installed at the beam hall. The mechanical assembly to mount 100 detectors is a metallic geodesic dome structure with hubs and links built using mild steel. Detectors will be mounted at a flight length of 175 cm from the target. A 100 cm diameter spherical vacuum chamber has also has been installed in the beam line. The vacuum chamber has provisions for mounting MWPC and other charged particle detectors at variable angle and distance.

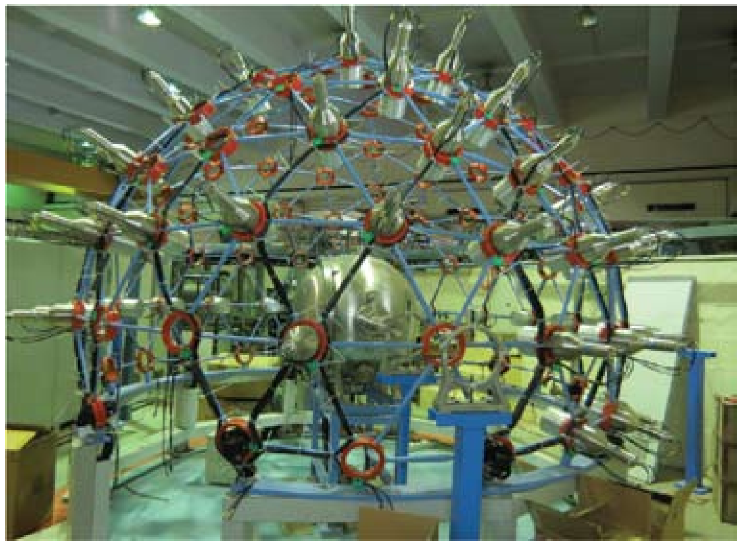

Fig.1. Detectors mounted on mechanical structure

All 50 detectors for the first phase has been tested in the laboratory and mounted on the structure. The test was carried out using homemade electronics for n- γ pulse shape discrimination (PSD) and timing performance characteristics with standard gamma ray as well as neutron sources. Though the detectors and PMTs are all identical, the operating voltage varied slightly among detectors. Nominal operating voltage on each detector was determined by keeping the anode signal amplitude for ^{137}Cs gamma rays around 450 mV for best timing & zero-cross separation. The custom made PSD module contains the integrated electronics for n-γ discrimination, time of flight and energy. It is a single width NIM module having two independent channels that can accept signals from two detectors. For each detector, the anode and dynode (through a charge sensitive pre amplifier) signals are fed to the inputs of the PSD module which process them and provide energy, constant fraction timing and a time to amplitude signal corresponding to zero-crossing time distribution

Fig. 2. High voltage power supply

for n -γ separation at its outputs. Other logic signals and monitoring signals are also provided on its front panel. Total 50 channels of PSD modules have been fabricated and tested for its performance.

The PMTs are normally operated below -2000 volt. To operate the tubes, homemade voltage divider bases have been fabricated, which contains the high voltage resistive divider circuit compatible to R4144 tube. The base also contains an integrated charge sensitive pre-amplifier for dynode signals. To take care of the large number of high voltage channels required for the full array, custom made compact high voltage power supply has been made at IUAC. The high voltage (-2000 V) is generated using commercial DC-DC high voltage converter chip (PICO make) mounted on a control board that can be controlled over a private Local Area Network. The digital section of this board consists of a microprocessor and an Ethernet controller where as the analogue section contains one 12-bit digital to analog converter. Each board has its own unique MAC and IP address that can be specifically selected at a time for read and write operations. A 19" rack mount 2U box houses 24 channels of high voltage power. Total three such boxes has been fabricated that will be used for biasing all the detectors in the initial stage. A graphical user interface developed in Qt framework as well as LabView is used to control the high voltages over the network.

The electrical signals from all detectors are routed to data room through BNC coaxial cables. Cabling for all the 100 detector setup has been completed. At the data room, the NIM electronic modules and VME data acquisition system are mounted in 19" racks. The VME data acquisition system has been tested with LAMPS (A. Chatterjee, TIFR) software on CAEN PCI-optical link controller and 32 channels analog ADC and TDCs. The initial tuning of each detector channel is currently going on.

Fig. 3. PMT bases

The work and support by other lab members are duly acknowledged.

4.2 GAMMA DETECTOR ARRAY (GDA) FACILITY

S. Muralithar, R.P. Singh, Rakesh Kumar, Indu Bala, R.K. Gurjar, and Kusum Rani

The users of INGA and GDA facilities have published prolifically this year contributing over ten contributions in DAE 2012 and six communications in international journals. As Indian National Gamma Array (INGA) experimental campaign is in TIFR few experiments were done using GDA facilities.

4.2.1 Experiments and detector maintenance

The experiments were done using GDA with CPDA for incomplete fusion dynamics, 'l' distribution experiment in fusion-fission reactions, g-factor measurement facility in-beam test and quadrupole moment measurement using perturbed angular distribution system.

As the HPGe and Clover detectors are damaged, by neutron in fusion evaporation reaction, continuously over the years, they need periodic servicing cum annealing. Servicing of Clover detectors showing vacuum leaks or noisy preamplifier was done this year by service engineers of supplier Canberra in IUAC and recovered three detectors while the rest three Clovers will be sent to factory for repaire.

4.3 HEAVY ION REACTION ANALYZER (HIRA) & HYBRID RECOIL MASS ANALYZER (HYRA) FACILITY

N. Madhavan, S. Nath , J. Gehlot, T. Varughese, A. Jhingan

HIRA

HIRA facility was used in an experiment looking for changes in angular momentum distribution in Evaporation Residues (ERs) from same Compound Nucleus (CN), ^{80}Sr, at similar excitation energies but formed in asymmetric and symmetric projectile-target combination. ER-tagged gamma multiplicity method was used in this experiment by using 14-element BGO multiplicity array at the target site of HIRA to study the two fusion-evaporation reactions, ^{16}O + ^{64}Zn and ^{32}S + ^{48}Ti. In addition, partial and/or total cross-section of ERs was taken up by mass identification at the focal plane. The experiment was part of a student's (Panjab university) thesis work.

Prior to the experiment, conditioning of ED1 and ED2, maintenance work on magnets and power supplies and, testing and calibration of focal plane detectors were carried out. The second part of the experiment which involves angular distribution of ERs and extraction of ER transmission efficiency of HIRA for the two reactions will be taken up in a separate experimental run.

HYRA

HYRA facility (gas-filled mode) was used in experiments involving measurements of fusion excitation function and/or spin distribution and in microsecond isomer decay measurements at the background-free, focal plane in reactions populating heavy CN. In addition, few experimental runs were carried out using TIFR 4π spin spectrometer and High energy Gamma Ray Spectrometer (HIGRASP) to study GDR built on excited states, using the HYRA beam-line.

In the earlier experiments up to November 2012, beams from Pelletron accelerator were used. Later, the experiments carried out between December 2012 and February 2013 made use of beams further accelerated by all three modules of superconducting LINAC accelerator. Special efforts were taken to clear the pending experiments in HYRA which required LINAC beams during this period.

The launch of isomer decay experiments in HYRA and the corresponding modification in the HYRA focal plane detection system and electronics this year has opened up a new breed of experiments in gas-filled mode of HYRA. The excellent results obtained with moderate gamma detector configuration and limited beam intensities has further confirmed the utility of HYRA and enthused new user groups.

To carry out the microsecond isomer decay experiments, the focal plane of HYRA gas-filled stage had to be modified. A large (~ 7.5" I.D.) re-entrant cup was used at the exit port of focal plane chamber with ~ 1 mm stainless steel (SS) sheet separating the vacuum (inside the chamber) from atmosphere. The attenuation of gamma rays in the SS sheet had to keep as small as possible without compromising on the strength and the vacuum holding capability. The SS sheet is welded to a flange which is bolted to the re-entrant cup with o-ring as the sealant. Such a design would help in modifying the material or thickness of the sheet in certain experiments as per requirement. A three-wafer, 2D position-sensitive silicon detector setup was used to cover the full focal plane of HYRA. For detection of delayed gamma rays, a HPGe clover detector was mounted close to the silicon detector with just the SS sheet of re-entrant cup separating the two.

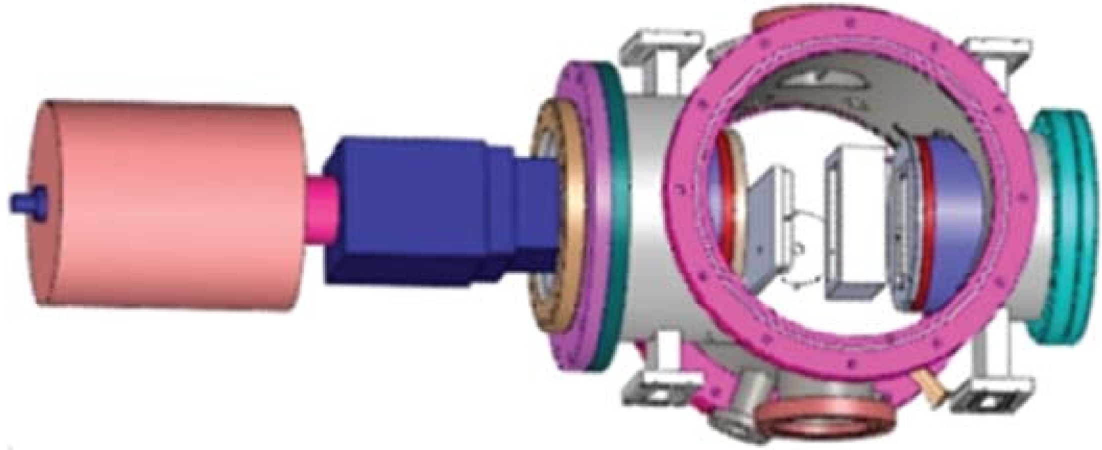

Fig. 1. Focal plane isomer decay setup - Clover HPGe detector close to Silicon detector(s)

Signals from the four individual crystals of the clover detector were processed separately to use the clover detector as four individual detectors for delayed gamma-gamma coincidence. This idea has helped immensely as gamma-gamma coincidence could be recorded while maximizing the solid angle of acceptance (and hence the efficiency) of the gamma detector(s) with just one clover detector. The heavy ERs under study are mostly deformed and the energy levels of excited states (and hence the gamma transition energies) are usually low. Hence, as anticipated, use of individual clover crystals as independent detectors worked out well. The ratio of coincident ER-gamma detection (of the focal plane silicon detector and combined clover detector) to ER detection was found to be nearly 3% for an average gamma multiplicity of nearly four below the isomeric state. Another clover detector was used near the target chamber for identification of populated ERs and the same was used for ER-Prompt gamma coincidence measurements too. The data acquisition trigger was an 'OR' of focal plane MWPC detector, silicon detector(s) and the clover detector(s) which allowed ER, alpha decay and delayed gamma events to be recorded separately. The time difference between ER detection in MWPC and delayed gamma detection in clover detector(s) was used to get the lifetime of the isomeric state(s). In ^{194}Bi (VECC led experiment) it has been observed that there are two isomeric states (one long-lived of the order of few microseconds and the other of shorter half-life of ~ 750 ns) with the longer lifetime state lying above the shorter lifetime state. As the fusion-evaporation reaction chosen feeds higher angular momentum states (above the long-lived isomeric state) strongly, the short-lived isomeric state could also be studied well at the focal plane though the flight time of the ERs was close to 1.8 microseconds (i.e. ~ 2.5 half-lives of short-lived isomeric state which would have otherwise made more than 80% of it to decay in transit through HYRA).

The experiments taken up in HYRA facility/beam-line are:

- measurement of ER excitation function in ^{16,18}O + ^{192,194,198}Pt to look for effect of shell-closed CN (Student expt., PU, CU-Kerala, IUAC),
- measurement of ER excitation function in ^{48}Ti + ^{140,142}Ce to look for effect of neutron shell closure in target (PU, IUAC),
- isomeric state decay in ^{192,194}Bi ERs (VECC, IUAC, UGC-DAE-CSR-Kolkata, TIFR),
- isomeric state decay in ^{189}Tl ERs (TIFR, IUAC, VECC, UGC-DAE-CSR-Kolkata)
- GDR decay from excited states in CN formed by ^{28}Si + ^{116}Cd fusion-evaporation reaction (Facility test/Actual expt., IUAC/JNU student).

One experiment on isomeric decay in ^{212}Fr (UGC-DAE-CSR-Kolkata, IUAC, VECC, TIFR) had to be postponed due to problems in beam delivery.

A new, compact aluminium chamber with increased angular acceptance (matching with HYRA's maximum angular acceptance) has been designed and is under fabrication. The lower lid of this chamber will have monitor detector mounts machined out at appropriate angles (with respect to the beam direction) and orientation for the mounting of normalization detectors. Once ready, this new chamber will be used in future experiments involving HYRA and TIFR 4p Spin spectrometer or INGA. The same could also be used in HIRA with BGO multiplicity array.

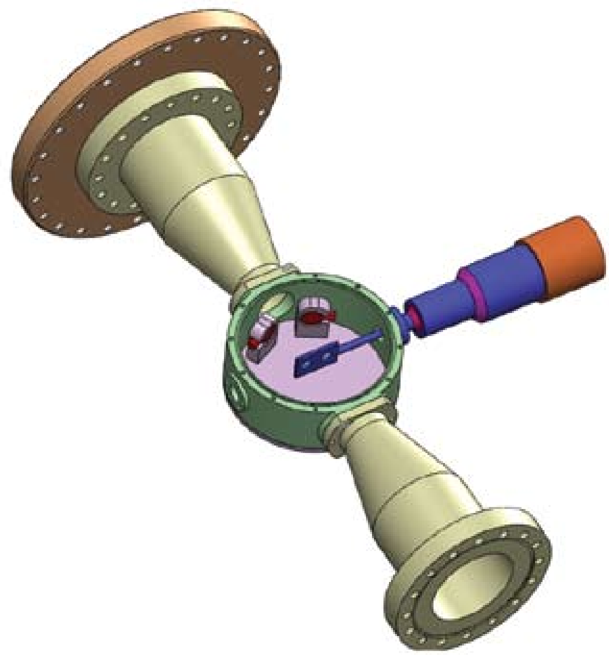

Fig. 2. New, compact aluminium chamber designed for HYRA to be used in ER tagged gamma measurements (with TIFR 4p Spin Spectrometer or INGA array)

A temporary I-section (~200 mm O.D. and ~ 1.1 m long) with its support/alignment mechanism has been fabricated to be used in place of the superconducting quadrupole magnets (which are under development), for initial experiments. After final testing and field measurements of the superconducting quadrupole magnets, the same may initially used in the second stage replacing the I-section. After perfecting the use of superconducting quadrupole doublet in the second stage in some experiments, it will be shifted near the target position as the first ion-optical element of HYRA. Several experiments carried out this year with HYRA gas-filled mode, both with stand-alone Pelletron beams and Pelletron-LINAC beams, required focal plane detector setup to be undisturbed and constantly upgraded too. We plan to take a break in experiments, preferably after pending experiments are over, so that the focal plane detector system can be removed to get the alignment direction for the second stage installation.

The superconducting, super-ferric quadrupole doublet being developed by the Cryogenics laboratory of IUAC is nearing completion. The magnetic yoke of both the magnets have been interconnected and have been placed inside the liquid helium vessel and welded, after taking the leads out. This part has subsequently been given cold-shock with liquid nitrogen and checked for leak afterwards. The outer copper shield has been positioned and the two cryo-cooler assemblies have been independently set up. The final welding of the outer vessel, insertion of vacuum chamber, alignment assembly, tests, etc. will be carried out in the coming weeks. More details of the assembly may be found in the Cryogenics section of this report.

FUSION14 International Conference: The international conference FUSION14 is proposed to be held at Delhi during February 24 – 28, 2014 with IUAC taking the lead role in organising this important event. A two-day satellite school on "Nuclear reactions around the Coulomb barrier" on Feb. 21 – 22, 2014 is also planned for the benefit of young researchers entering the field.

4.4 MATERIALS SCIENCE FACILITY

A. Tripathi, K. Asokan, V.V. Sivakumar, Fouran Singh, S.A. Khan, P. K. Kulriya, I. Sulania, P. Barua, A. Kothari and D.K. Avasthi

The materials science facilities support the research programmes of a large number of users from different universities and institutions. This year there have been a total of 56 user experiments in materials science beamline with energetic ion beams. These were spread over 146 shifts and were performed without any major beam time loss due to facility break down. The swift heavy ion (SHI) irradiation and related experiments are mostly performed in the irradiation chamber in the materials science beamlines in beamhall-I, though 4 experiment running over 12 shifts were performed in materials science beamline in beamhall-II. Besides this, low fluence irrdiation experiments are also performed in general purpose scattering chamber (GPSC) in beamhall I and this year the facility was used in 3 runs spread over 12 shifts. Experiments are being done in different areas of SHI induced materials modification and characterization and the details of the research programmes are given in Section 5.2.

The materials synthesis techniques: RF sputtering system, microwave plasma system, ball milling system, box furnace and tubular furnaces are being extensively used by users for preparing samples. The off-line characterization facilities: XRD, UV-Vis, SPM, SEM, micro-Raman and transport measurement facilities continue to be used by a large number of users.

4.4.1 Irradiation chamber maintenance

A. Tripathi, S. A. Khan and P. Barua

The irradiation chamber in materials science beamline was used in more than 132 shifts of irradiation experiments from 52 users. The system has been running without any problem. There was a minor disruption due to UPS related electrical power problem but it was solved without any delay in scheduled experiment. The servicing of lifting arrangement system was also done.

4.4.2 Scanning Probe Microscope

I. Sulania, S. Gupta* and A. Tripathi,
(* I P University, Delhi)

Multi Mode SPM with Nanoscope IIIa controller acquired from Digital/Veeco Instruments Inc. is extensively used in user experiments. There was a computer related problem when the SMPS power supply of the computer failed. The system was operational throughout the year and more than 450 samples were studied in AFM and MFM modes.

4.4.3 *In-situ* X-ray Diffractometer

P. Kulriya

The XRD is extensively used by the most of material science users to confirm crystal structure of their as deposited as well as ion irradiated samples. This year offline XRD system has been used for characterization of around 500 samples. Most of the samples are either in thin films or nanoparticle form where slow scan is required to get good statistics. One of the highlights of offline XRD results is experiments related to exposure of Pd and Pd-alloy nanoparticles to hydrogen gas at various temperature and pressure which were performed in collaboration with a research group from IIT Delhi. The results have been analyzed and compared with previous investigation on the Pd thin films.

In facility up gradation, low temperature in-situ XRD and in-situ XRR facility with ion beam have been tested in collaboration with research group from BARC, Mumbai and IUAC-DAE-CSR, Indore, respectively and the details of experimental results are discussed in following sections. Some regular maintenance work such as (a) cleaning of x-ray tube water filter, (b) changing the water of the chiller, (c) cleaning of the tank of chiller (d) cleaning the surface of gobble mirror, (e) work related to high voltage knob (f) alignment of the x-ray diffractometer, have been carried out this year. Other than regular maintenance work, some breakdown maintenance work like (a) water leakage problem in pump of the chiller, (b) problem in DC power supply of detector controller, and (c) problem in door of XRD system, was also done.

4.4.3.1 Testing of *In-situ* x-ray reflectivity (XRR) using XRD system

A. Gupta*, S. Poddar*, R. Gupta*, P. Kulriya
(*UGC DAE-CSR, Indore)

The *in-situ* x-ray reflectivity is very useful technique for investigation of swift heavy ion induced interface mixing in multilayer nanostructures. In multilayer x-ray monochromators, a controlled modification of interface roughness is needed in order to reduce the higher harmonic content. Such controlled modification of interfaces can be conveniently achieved using swift heavy ion irradiation. In the facility test experiment, *in-situ* XRR measurements were carried out to monitor the evolution of interfaces in the $[W10Å/Si15Å]_{30}$ and $[W7Å/Si10Å]_{30}$ multilayer under irradiation with 120 MeV Ag ions [Fig. 1] . Inter-diffusion lengths down to 0.1nm can be determined conveniently using this technique. Such a high precision in measurement allows one to study subtle effects of internal stresses on intermixing. In another set of samples, ion beam induced sputtering in 20nm Pt thin films deposited on the Si substrate was investigated using same facility. The decrease in the FWHM of the XRR profile confirmed the sputtering by swift heavy ion.

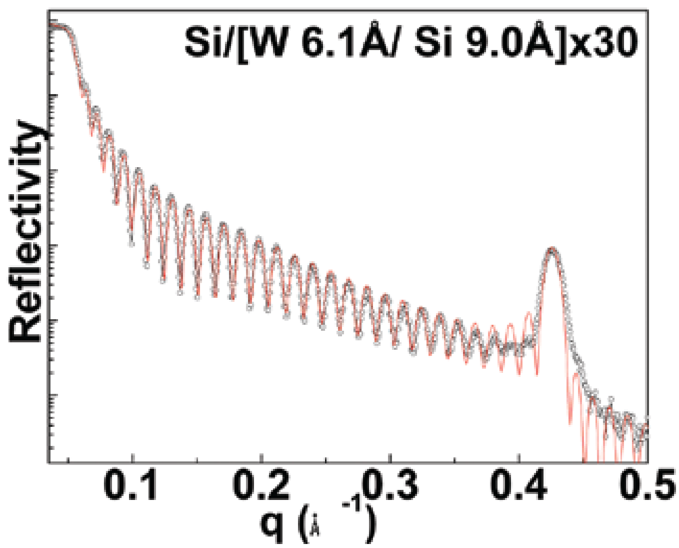

Fig. 1. In-situ XRR spectrum of the as-deposited multilayer thin film of [W6.1Å/Si9.0Å]x30

4.4.3.2 Testing of closed cycle refrigerator CCR with beam

P. Kulriya, R. Ahuja, D.K. Avasthi

A closed cycle refrigerator (CCR) based sample cooling was integrated with existing XRD system last year. In current academic year, we have performed facility test to investigate effect of temperature on the ion beam induced amorphization in $BaTiO_3$ by irradiating it at 25K and 300K using 100 MeV Ag ion. The *in-situ* XRD study showed that the intensity of the diffraction peak decreased with increase in ion fluence. The sample becomes completely amorphous at the fluence on $3x10^{13}$ions/cm^2 when it is irradiated at 300K. Similarly, *in-situ* XRD investigations are performed on $BaTiO_3$ samples at the 25K using same ion beam parameters. The ion fluence required to amorphize it, was $1x10^{14}$ions/cm^2, which clearly indicates that damage cross section is higher for the sample irradiated at 300K. The low temperature *in-situ* XRD is the only way to examine the irradiation induced structural transformations of the low temperature phase like rhombohedral phase of $BaTiO_3$ as investigated in the present experiment.

4.4.4 Fabrication and installation of high temperature target ladder

P. Kulriya, Renu and D.K. Avasthi

The high temperature ion irradiation facility has been installed and tested using UHV substrate heater that can work in vacuum. In test experiment, it was able to achieve a temperature of 1000^0C.

The temperature was quite stable within $\pm 5^0$C. A photograph of the high temperature target ladder installed in high vacuum chamber in materials science beam line of LINAC accelerator is shown in figure 2(a) and its view at 1000^0C in vacuum is shown in figure 2(b). The test of the high temperature irradiation facility was performed by keeping pyrochlore ($Gd_2Zr_2O_7$ and $Gd_2Ti_2O_7$) samples at 1000^0K temperature and irradiating them at same temperature using 120 MeV Au ions at different fluences. The crystal structure of the as-deposited, samples irradiated at room temperature and elevated temperature are compared. Room temperature investigations were performed using *in-situ* XRD during irradiation. At high temperature irradiations, both the samples showed significant crystalline nature at the fluence where they got amorphized at room temperature irradiation. The present experiments show that defect annealing process at 1000K is quite significant in pyrochlores.

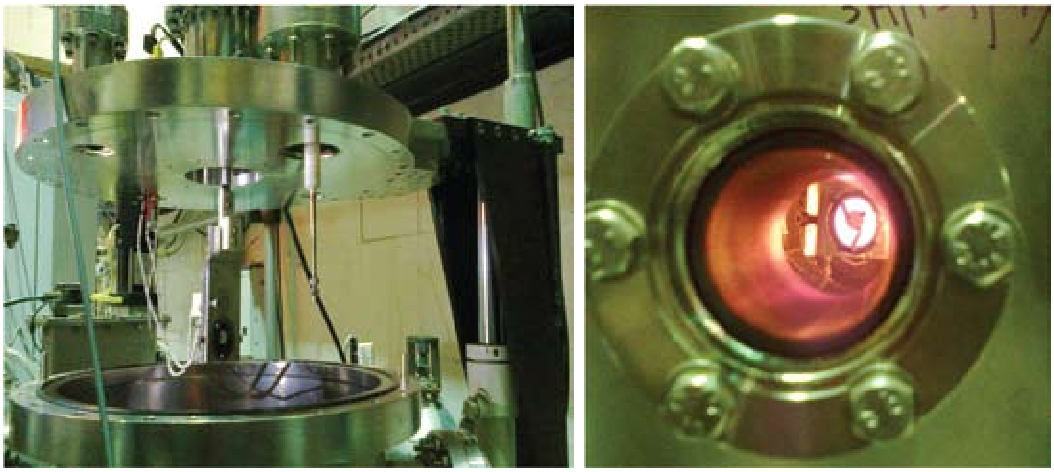

Fig. 2(a) High temperature target ladder installed in high vacuum chamber in materials science beam line of LINAC accelerator

2(b) View of target ladder at 1000^0C in vacuum, through a view port.

4.4.5 Plasma based systems for thin film deposition.

V.V. Siva Kumar

The multi-target DC sputtering system was completed and tested with thin film deposition of Cu and Fe films. A base vacuum of 8 x 10^{-6} torr was achieved using a Turbo pump. For the Fe film deposited with 80 watts DC power at 40 mtorr pressure, the deposition rate was found to be 4 nm / min.

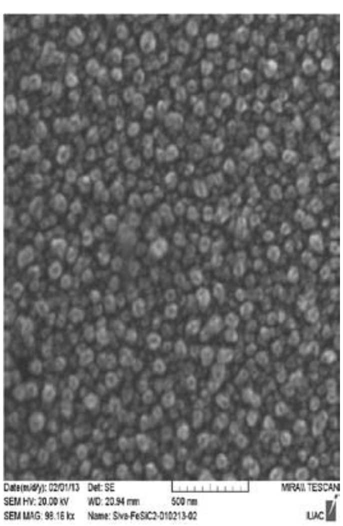

Fig. 3. Fe film on Si

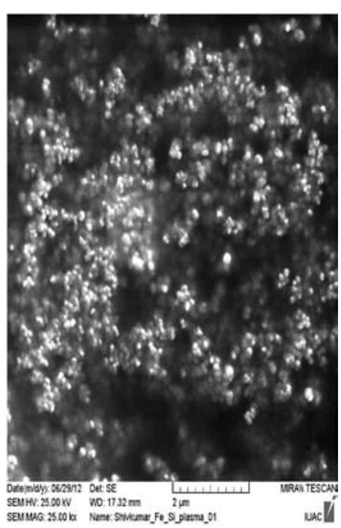

Fig. 4. Nanostructured Fe film

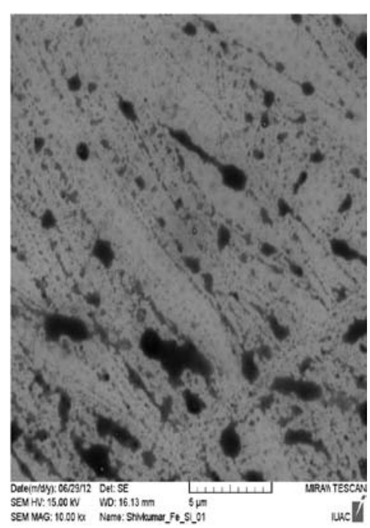

Fig. 5. Nanostructured C film

The rf sputtering system was operational and used for thin film depositions of users. Thin films of TiO_2, SnO_2, Fe doped SnO_2, Metglass, AlN, $YMnO_3$, Ag/Ca Phosphate, Ge doped SiO_2, Al_2O_3, $CoFe_2O_4$, Co doped TiO_2, ZnO and ZnMgO were prepared using the rf sputtering system for ion beam studies on these materials. Ag, N doped ZnO thin films with p-type conductivity, confirmed by Hall measurements, were also grown using rf sputtering.

A substrate heater (up to 900°C) with provision for dc bias was installed in the microwave plasma CVD system. Deposition of thin films of Carbon with methane as carbon source was done by microwave plasma CVD on annealed and plasma treated Fe films with dc bias to substrate holder. SEM measurements show that the initial Fe film (Fig 3) got modified into a nanostructured Fe film with aggregation of iron nanoparticles (Fig 4) due to the plasma treatment and annealing, and Carbon film with circular nanometric surface structure (Fig 5) is formed on the modified Fe film. Further experiments for growth of vertically aligned CNT are planned using C_2H_2 gas as the carbon source.

For the upgradation of the microwave plasma CVD system to ECR plasma system, sector magnets were assembled into ring magnets which produced the required magnetic field (875 gauss) and the ECR plasma chamber is being fabricated.

4.4.6 Field emission scanning electron microscope (FE-SEM)

A. Tripathi

The field emission scanning electron microscope (FE-SEM) from TESCAN, MIRA II LMH CS is regularly being used to boost research activities in nanomaterials and other systems. This year the system has been used for studying surface morphology of nearly 282 samples from 56 users besides elemental analysis of 114 samples in EDS mode.

The source got shut down twice due to interruption in UPS power. The issue was solved with help of electrical group and efforts are made to avoid any power related problem in future. On one occasion after the power problem, the system required baking for which the company engineer was called. As the FE source has run more than three years its tuning was also undertaken twice this year. The software problem in EDS system was solved and sample stage calibration was also undertaken.

4.4.6.1 Cross sectional SEM

Surbhi*, S. Kumar, S.A. Khan, A. Tripathi

(*DEI, Agra)

Efforts were made to initiate layer thickness measurements using SEM. The cross sectional SEM of ZnO/CuO sample on ITO substrate was done to obtain information about sample layer thickness and composition. The sample was sandwiched between two copper foils and cut with a sharp knife for the purpose. The elemental mapping of the samples was also done using EDS mapping. The SEM morphological and EDS elemental mapping images are shown in figure 6 below.

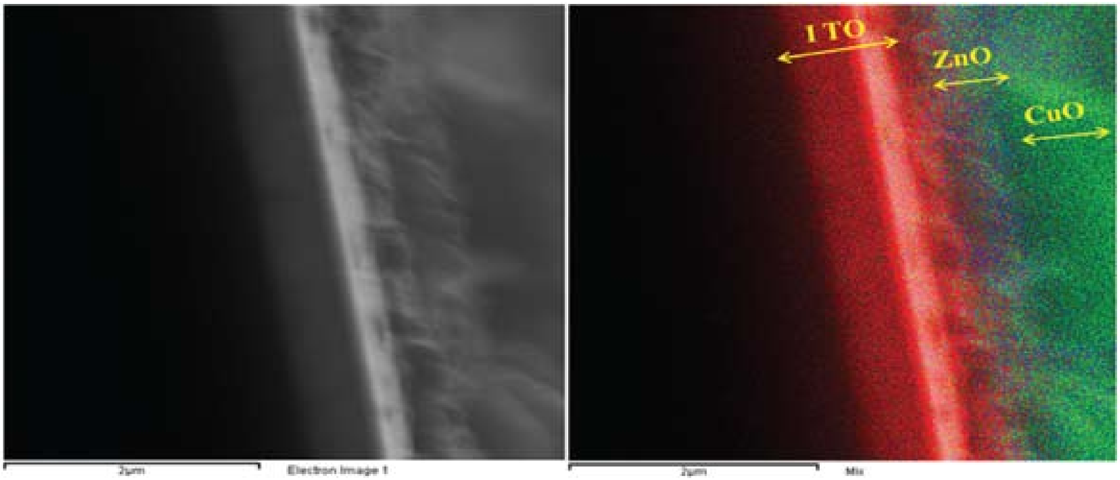

Fig. 6. SEM morphological (left) and EDS elemental mapping (right) images for ZnO/CuO sample on ITO substrate

4.4.6.2 Spectroscopy facilities

Fouran Singh, Vinod Kumar, I. Sulania, and S.K. Gautam

Micro-Raman spectroscopy setup is being heavily used for ex-situ experiments and about 600 spectra were recorded on various types of samples. Custom designed stage for the fibre optic probe is installed and setup is tested for the insitu measurements. Testing during the ion beam irradiation is awaited.

PL and FTIR are under maintenance for the regular operation.

4.4.7 Materials Synthesis

Gagan Dixit, K. Asokan

This facility provides the opportunities to the user community for various sample preparation methods. Samples can be prepared from solid state reaction for bulk synthesis, sol gel for nanoparticles preparation and spin coating for thin films. Pellets can be prepared with the help of Hydraulic press. Muffle furnace up to 1000° C, programmable furnace from Nabertherm up to 1400° C and a tubular furnace up to 1400° C are available for sample preparation and annealing including vacuum annealing.

4.4.8 Low Temperature and Transport measurement facilities

Gagan Dixit, K. Asokan

The electrical characterization techniques like dielectric measurement, resistivity measurement, Hall Effect measurement (room temperature) and 1/f noise measurements are routinely used by users. Dielectric measurements can be performed in the temperature range ~77 K – 450 K and in the frequency range from 20 Hz -1 MHz with the help of low frequency LCR meter 4284A Hewlett Packard and from 75 KHz – 30 MHz with the help of LCR meter 4285A Agilent. C-V measurements can also be performed with the help of these LCR meters. Room temperature as well as temperature dependent I-V measurements and temperature dependent resistivity measurements can be carried with 2612A dual channel Keithley source meter. All these experimental set up are interfaced with the computers through Lab view programming.

Hall Effect measurements can be carried out with HMS-3000 at room temperature and liquid nitrogen temperature. The set up is very good for metals and semiconductors.

Apart from these facilities, two new setups, delta mode setup and an instrument from Cryo head of

Oxford instruments with high vacuum for resistivity and dielectric measurements are also available. Noise measurement experiments can also be performed from liquid nitrogen to room temperature with the help of dynamic signal analyzer (HP – 35665A). Attempts are being made to develop these characterizations available down to liquid helium temperature.

A power supply for superconducting 8T magnet meant for magneto transport setup has been purchased. Once it is suitably placed close to He accessible location, it will be made available to users. A low temperature lab has been set up with closed cycle cryostat which will be used for resistivity measurements. We also intend to build ac susceptibility in coming year.

4.5 RADIATION BIOLOGY FACILITY

A. Sarma, IUAC, New Delhi

The **ASPIRE** [Automated sample positioning and irradiation system for radiation biology experiments] system is updated to its automatic status where irradiations can now be done with a set of preset doses. It is being successfully utilized for irradiating biological samples. The uniformity over a field of 40 mm diameter is having 2 % standard deviation. The mean fluence is within 1 % of the electronically measured value at the centre of the field.

The characterization of the system has also been done using irradiating SSNTD [CN 85]

The radiation biology laboratory is having the following equipments to facilitate the sample preparation and post irradiation treatments:

- Two CO2 incubators, Two biosafety cabinets, one small laminar flow bench for cell culture
- Field Inversion Gel electrophoresis, Normal gel electrophoresis, protein gel electrophoresis set up
- Image based cell counter Countess [Invitrogen] which also gives information about cell viability and Beckman-Coulter Z2 cell counter
- PCR machine, a crude gel documentation system, UV-Vis Spectrophotometer and a Fluorescence microscope.
- Perkin Elmer Multimode Plate Reader, Eppendorf and Plastocraft Refrigerated Centrifuge and a Biotek micro-plate washer.

The laboratory section has independent Split AC supply isolated from the central AC system. The CO2 supply to the twin incubators is done from outside the lab area, which facilitates the replacement of empty cylinder without disturbing the laboratory environment.

Regular work is going on in the laboratory on

- Analytical procedures involving gen expression studies, Western Blot, Flurescence Immunostaining studies etc by the University Users
- Synthesis of gold nano-particles [AuNPs] of different sizes and functionalization with different agents like Glucose, Folic acid and PEG.
- Internalization of such particles by cancer cells and study of radiation interaction on them.

4.6 ATOMIC PHYSICS FACILITY

4.6.1 Noise reduction technique

K. Haris[1], Rajesh Kumar[2], Hala1, S. K. Suman[2]and T. Nandi[2]

[1]Dept. of Physics, Aligarh Muslim University, Aligarh 20 2002, India.
[2] Inter-University Accelerator Centre, JNU New Campus, New Delhi 11 0067, India.

The electrical and thermal noises restrict the resolution of any detector and the control over them is always a big challenge for the most experiments. The noises are of different origin such as, electrical, thermal and acoustic etc; however, at the end all of these will attain a conversion to electrical form. The major contribution originates from the original system injected electrical noises;and the root cause of its propagation is mainly due to limitation of a clean ground system and hence the floating ground bed will inject a lot of noise into detecting system. The thermal noises are of lesser contribution and can be greatly abated by cooling the detector. Thus, many times, if electrical noise is under control, thermal noise limits the detector resolution considerably.In particular, the heavy ion detection demands thermal cooling for the detectors.

In order to reduce the electrical noise we have used a totally electrically isolated platform for the detector system. The Lemo feedthrough to SSBD was housed within a Teflon jacket and thereby no electric contact with the vacuum chamber. We have drawn ground free electric power for the cooling system and the detector, later the clean ground was added to it. The impedance of the clean ground used was 0.2 Ohms. This helps us to obtain significant reduction of noise level of the system from 200mV to 30 mV, and hence to achieve good S/N ratio. To reduce the existing thermal noise, the cooling of detector was necessary.There are many techniques available for this, such as use of cryogen, thermoelectric cooling (TEC), mechanical cooling, adiabatic demagnetization etc., however, finding a handy, uninterrupted, low power consumption and cost effective technique is very desirable.

Recently, an experimental challenge was to measure the surface Wakefield effect on energy loss [1] and thermoelectric cooling (TEC) system as shown in Fig. 1 came to play its important role. The TEC as associated with a controller enabled us to cool the detector at least rate of cooling (max. 3.5°C/sec) and down to the lower temperature set point -25°C. We observed that cooling the detector @ -15°C would further reduce the noise level of amplifier output within 5 - 10 mV. Recently, this TEC has been used offline to see the performance of particle detection from ^{241}Am source and four α components were resolved clearly @ -10 to -25°C as shown in Fig.2. The set up is always ready for measuring heavy ions with cooled Silicon Surface barrier detector with lowest possible electrical noise.

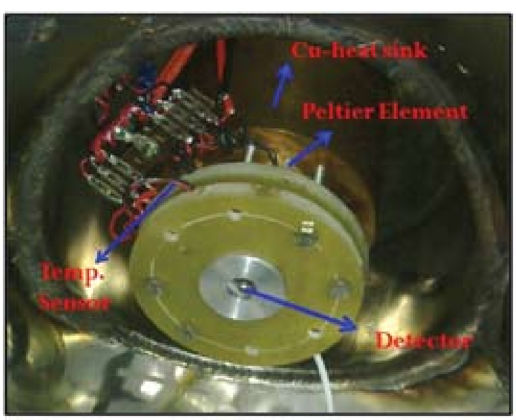

Fig. 1. A View from inside the chamber cooling flange with Silicon surface barrier detector (SSBD)

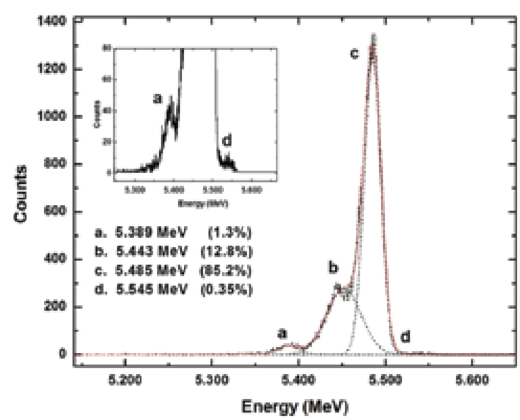

Fig. 2. Alpha spectrum of ^{241}Am taken with help of SSBD Cooled at -15°C using a TEC system

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4.7 ACCELERATOR MASS SPECTROMETRY

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Accelerator Mass Spectrometry (AMS) facility for ^{10}Be and ^{26}Al measurement is in operation using 15UD Pelletron Accelerator. A new facility is being set up for ^{14}C AMS measurements. The clean chemistry laboratory is extensively being utilized by various users for the chemical treatment and extraction of ^{10}Be from their samples. A brief of the activities performed in last year are as:

1. Chemical processing and ^{10}Be measurements of sediments samples from the Bay of Bengal:

Sediment samples from a 4.12 meter marine sediment core collected from the Bay of Bengal were chemically processed and analysed for 10Be concentration measurements using AMS facilities at IUAC. The aim of the study is to date the cores using ^{10}Be radioisotope and to correlate it with the paleo-climatic studies already performed on the cores. Sediments are important carriers of trace metals in the hydrological cycle and because metals are partitioned with the surrounding waters, they reflect the quality of an aquatic system. Geochemical characteristics of the sediments can be used to infer the weathering trends, climatic changes from past to present (glacial to interglacial) and the sources of pollution. Environmental Magnetism (like susceptibility) is capable of providing important data for studies of global environmental change, climatic process and the impact of humans on the environment. Total of 16 samples including one blank were processed and measured for 10Be concentration. (User: P.V. Lakshminarayana, Andhra University, Vizag)

2. Chemical processing of sediments samples from Arctic Ocean:

To determine the production rate of ^{10}Be in Arctic Ocean area, the surface sediments samples were collected. These samples were chemically processed for ^{10}Be extraction and other geochemical analysis at IUAC clean chemistry laboratory. ^{10}Be is produced in the upper atmosphere by spallation reaction of secondary cosmic rays on the N and O. After their production they get attached to aerosol/ dust and reaches earth surface mainly through rain, snow and dry deposits. The production rate of the isotopes varies from place to place depending on the intensity of the cosmic rays and earth's magnetic field. Polar Regions have higher cosmic ray flux and therefore production of radioisotope is also high. Radioisotope's concentration measurement in surface sediment sample can provide the production rate in recent time. Total 15 surface samples have been chemically processed and the ^{10}Be measurements will be carried out soon. (User: Pankaj Kumar, IUAC)

3. Chemical processing of sediment samples from Pacific Ocean:

Under the collaborative research proposal entitled "Reconstruction of the chronostratigraphy of IODP 322, site NT1-01 (Hole C0012A), and NT1-07 (Hole C0011B) sediment core (subtropical Pacific Ocean), using ^{10}Be dating", total 26 samples were chemically processed at IUAC, New Delhi during July to August, 2012. The sediment samples have been collected from the subduction front of Nankai Trough, in subtropical Pacific Ocean. Site C0012A recovered the sediment from 0 to 530 meter below sea floor (mbsf) and site C0011B recovered the sediment from 340 to 876 mbsf. Both site C0012A and C0011B sediment deposition characterized by the hemipelagic to turbidite sequences in nature during early to mid Miocene time. Turbidite sequence to both the sites shows very rare or barren preservation of the microfossils during the middle and lower part of the coring section. This lack of preservation of microfossils provides the ambiguity to the reconstruction of precise age model.

Despite the reconstruction of age model based on the biostratigraphy (nannofossils and Planktonic Foraminifera) and paleomagnetism data, attention required to provide the precise age model based on the chronostratigraphy ^{10}Be dating. In the absence of detailed biostratigraphy, beryllium isotopes have been used to provide essential time information. To decipher palaeo-environmental implications the proposed study is to be undertaken on the core catcher sediments. Therefore, a precise dating tool is required to establish the geological time period based on ^{10}Be chronostratigraphy for the above mentioned site and strengthen the scientific results. In addition, the concentration of rapid variations of the ^{10}Be production -on decadal to centennial timescales (attributed to solar magnetic variability) become strongly damped in the marine records. The proposed study will also allow us to reconstruct the ^{10}Be concentration and solar magnetic variation within the Miocene time scale from subtropical Pacific Ocean. (User: Dr. Pawan Govil, BSIP-Lucknow)

4. ^{14}C AMS system:

A new ^{14}C AMS facility is being established at IUAC. This facility will fulfill the demand of Indian researchers for ^{14}C measurements in frontier areas of science such as climate change, biomedicine and forensic sciences, archeology and human heritage and ocean current study. The key features of this facility are; 500kV ion accelerator with two ion sources and an automated graphitization system. The ^{14}C AMS facility is supported by the Ministry of Earth Sciences, Govt of India.

In addition to the ^{14}C measurements, the proposed system can perform ^{10}Be and ^{26}Al measurements also with better precision than using existing 15UD Pelletron accelerator.

For ^{14}C AMS measurements, samples containing carbon are chemically converted into graphite powder. This process is called graphitization. We are developing an automated graphitization unit in collaboration with ETH, Zurich.