4. EXPERIMENTAL FACILITIES IN BEAM HALL

4.1 GENERAL PURPOSE SCATTERING CHAMBER (GPSC) & NEUTRON ARRAY FACILITY (NAND)

M. Archunan, A. Kothari, P. Barua, K.S. Golda, A.Jhingan, P. Sugathan and R.K. Bhowmik

The GPSC facility has been used extensively for many user experiments in various fields of Physics viz. Nuclear Physics, Material Science, and Atomic Physics. In nuclear physics, the facility has been used in a few experiments measuring fission fragment angular distribution and mass distribution in order to study the dynamics of heavy ion induced fusion-fission reactions. Time of flight setup using two large area MWPC for detection of fission fragment along with 5 liquid scintillators for neutron detection has been used in these experiments.

The existing neutron detector array facility has been used in a series of successful user experiments using the accelerated beams from the first module of LINAC plus Pelletron accelerator. Experiments measured the average number of neutrons emitted before (pre-scission) and after (post-scission) fission of the heavy compound nucleus produced in the reaction. This was achieved by detecting the neutrons in coincident with the fission fragments using an array of 24 liquid scintillators and two multi-wire proportional counters (MWPC). The home made electronics and data acquisition system has been upgraded to process and collect data from the array.

4.1.1 Novel Method for Neutron TOF Data Analysis

Golda K.S. and R.K. Bhowmik

The study of fusion-fission dynamics in heavy ion induced nuclear reactions is a topic of great interest in recent years. Neutron Time of Flight (TOF) spectrometers have been extensively used since early eighties to study the fusion-fission dynamics as a 'Clock' for establishing the time scale for nuclear processes [1]. Precise measurement of neutrons which are emitted at different stages of reaction between heavy ions in conjunction with the heavy fragments provide exclusive data and a unique possibility to explore the complex nuclear processes involved in heavy ion collision. The disentanglement of time scales of quasi-fission from fusion fission reactions from the shape of the pre-scission neutron multiplicity distribution has added a new dimension to our understanding on reaction dynamics [2].

To be able to acquire such high precision exclusive data, a large array of neutron detectors is currently under development at Inter University Accelerator Centre. It consists of around one hundred 5” (diameter) × 5” (length) liquid scintillators at 1 meter flight path [3]. Usually large flight path and neutron detectors of short length are used to obtain good spectral resolution. A disadvantage of such facilities is the low efficiency of the detecting system. Since the primary objective of our facility is to measure high-fold neutron-fission coincidences with high statistics to extract the higher moments of the fold-distribution, the geometry of the array has been optimized for high efficiency and good granularity.

A new approach in the analysis of the neutron TOF experimental data has been developed to extract good spectral resolution from high efficient TOF spectrometers with limited flight path. This method will allow performing measurements with higher efficiency owing to the large detector thicknesses and larger solid angles.

The energy of neutrons emitted in a typical heavy ion induced reaction follows a Maxwellian distribution. Hence the experimentally measured neutron TOF spectrum has a continuous distribution without significant structure. In the conventional data analysis method the experimental TOF data are first binned as per the spectral resolution of the detecting system and thereafter converted into energy by applying proper Jacobian. The energy dependent intrinsic detector efficiency correction is applied to these discrete energy points to construct the final energy distribution. This method can give rise to incorrect shape of the energy distribution if the thickness of the detector is large in comparison with the flight path. As the pre-and post-scission multiplicities are extracted by fitting the energy distribution using moving source approximation [4], an incorrect shape in the energy distribution is a matter of great concern.

In the new method, the experimental TOF data have been binned to get a set of representative points and the errors of these individual points have been adjusted to reproduce the best χ^2 fit to the experimental data. These representative data points have been converted into energy by considering proper Jacobian. A cubic spline fit to the obtained energy points gives a continuous energy distribution. This energy distribution has been folded back to get TOF data by adjusting the ordinate to reproduce the experimental TOF spectrum. The incorporation of detector resolution as a result of the finite thickness and response function of the detector are included in the de-convolution procedure. The flowchart of the procedures followed is given in Fig. 1.

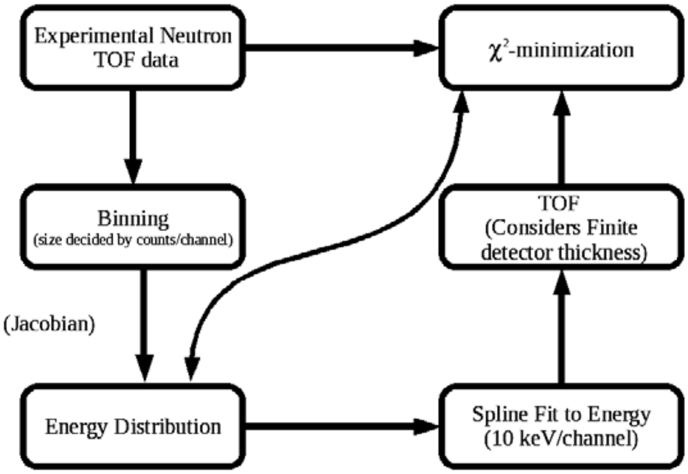

Fig. 1. Flow chart of the data analysis method adapted

To establish the new data analysis method we have made use of the experimentally measured neutron TOF data from the fusion-fission processes induced by ^{12}C+ ^{196}Pt systems at 82 MeV. The data collected at 1 meter and 2 meter flight path by 5” × 5” liquid scintillator detectors, which were placed at the same angles with respect to the respective fission detectors, were compared. The time resolution of the detecting system was obtained from the width of the gamma peak. Fig. 2 compares the folded back TOF distribution with the experimentally obtained ones for each of these detectors. We have optimized the initial TOF bin sizes for different flight paths based on the statistics of the data for generating the representative points. The folded back TOF distribution, within statistical uncertainty, very well represents the experimentally measured one.

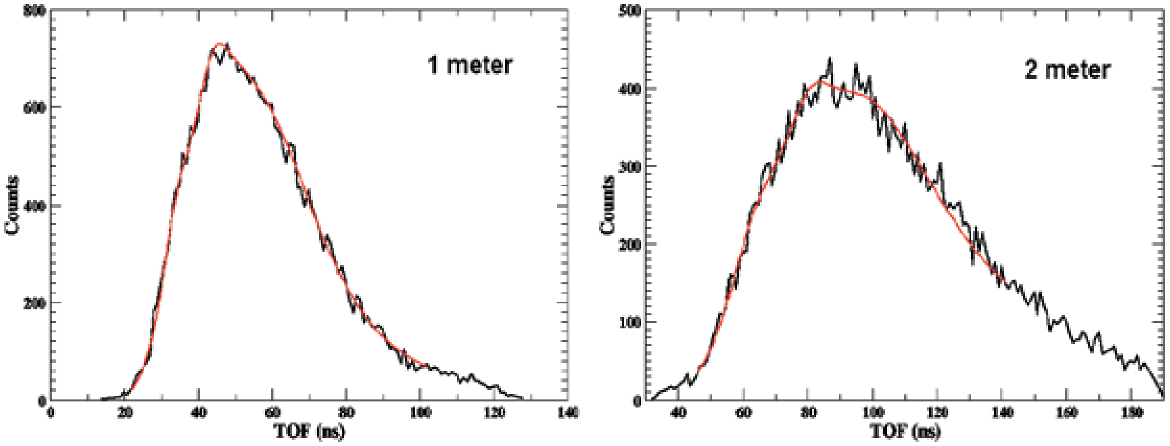

Fig. 2. Experimental time of flight spectra at 1m (left) and 2 meter (right) flight paths. The red curves are the folded back TOF spectra calculated from deconvoluted energy spectra

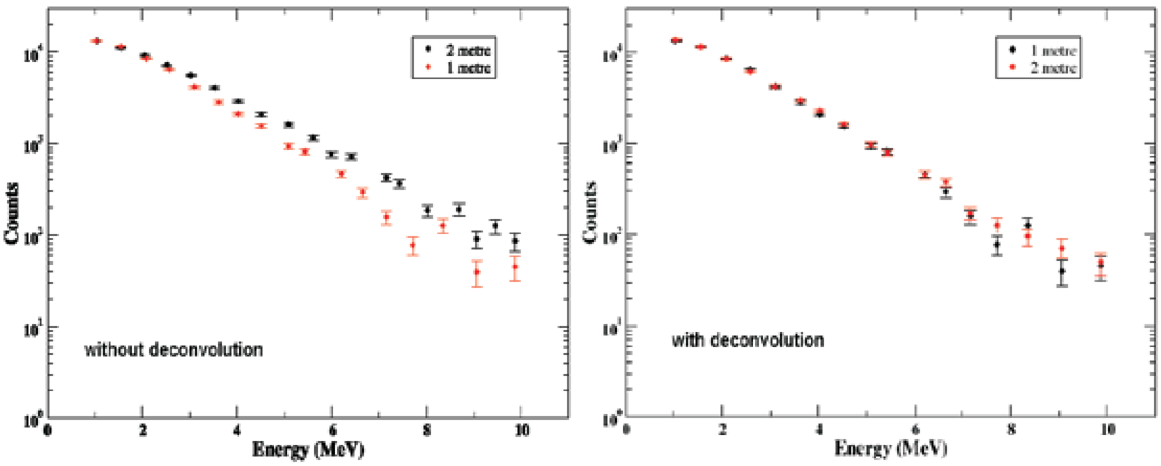

Fig. 3. Neutron energy distribution extracted from 2m & 1m flight path TOF data (left) before deconvolution (right) after deconvolution

The energy distributions obtained from the time of flight data, without taking into account the finite thicknesses of the detectors and time resolution, show significant differences at higher neutron energies (fig 3 left). The deconvoluted energy distribution obtained from both the detectors match well within the experimental error as shown in Fig.3 right. This shows the importance of taking into account the effect of instrumental resolution in extracting the neutron energy distribution.

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4.2 GAMMA DETECTOR ARRAY FACILITIES

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The users of GDA facilities have published prolifically this year, contributing over twenty three papers in DAE 2010 symposium and fifteen papers in international journals from the data obtained by using GDA and INGA related facilities.

4.2.1 Indian National Gamma Array (INGA)

The Clover detectors, of IUAC, UGC-DAE-CSR, SINP and TIFR, which were used in INGA campaign at IUAC, were moved to TIFR during the end of last year. After setting up, first cycle of five experiments were conducted at BARC-TIFR Pellteron. The experiments used beams from the Pelletron alone (without augmentation of energy by the LINAC).

4.2.2 New Recoil Distance Device for Indian National Gamma Array

Lifetimes of in the range of about a pico-second to a nano-second could be measured using a Recoil Distance Device, also called a Plunger. This is a crucial range for nuclear structure studies. Here we report on the new Plunger developed for the Indian National Gamma Array (INGA) at IUAC.

The new plunger shown in fig 1 has three fixed stainless steel rods to support the stopper foil and three movable rods which support the target foil. The movable rods can be independently moved using DC linear actuators. These are ultra-high resolution linear actuators providing linear motion up to 25 mm with sub-micron resolution. The Plunger is equipped with read-outs from the target and stopper foils to enable distance calibration using the capacitance method [1]. It also has a 5 mm collimator and a Faraday cup for beam alignment and current measurement.

Fig.1. New Plunger for INGA; Foil holders and the cones could be seen in the foreground

The details of the various parts of the plunger were reported in [2]. Figure 2 shows the plunger in the INGA beam line for the first in-beam test. Figure 3 shows a typical curve for the distance calibration. We are planning a full plunger in-beam test in this year. It also has provision to be coupled with the mass spectrometer along with INGA.

Fig. 2. Plunger mounted in INGA beam line showing the (left) front and (right) back views

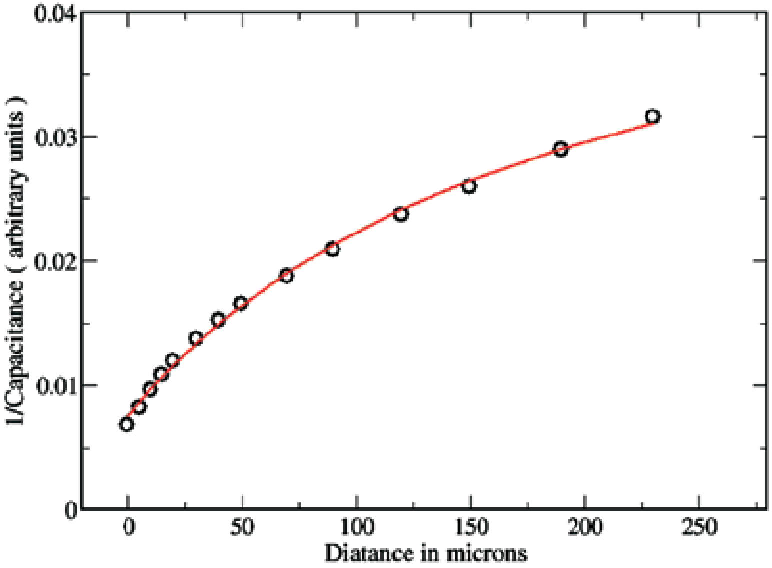

Fig. 3. Distance calibration curve for the new plunger during lab test

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4.2.3 Detector Maintenance

As the HPGe and Clover detectors have been used continuously over the years, they needed periodic servicing cum annealing. Six detectors were evacuated while eight detectors were annealed to restore the FWHM of the detectors. Efforts to fix the problems of the detectors showing vacuum leaks or noisy preamplifier would be taken up this year after receiving funds from DST-INGA project. The faulty Clover detectors have to be sent back to the manufacturer for repair.

4.2.4 Nuclear Physics using LINAC

A workshop on “Nuclear Physics using LINAC” was organized at IUAC on January 21-22, 2011. The experimental ideas were presented and discussed with requirements for feasibility. Participants came from various institutes and Universities.

4.2.5 Experiments using GDA related facilities

The GDA facilities were used in a number of experiments for studying Incomplete fusion mechanism, perturbed angular distribution for Electromagnetic moments measurements, Fission hindrance and entrance channel effects in fusion reaction.

4.3 RECOIL MASS SPECTROMETERS

N. Madhavan[1], S. Nath[1], T. Varughese[1], J. Gehlot[1], A. Jhingan[1], G. Mohanto[1], I. Mukul[1], I. Mazumdar[2], D. A. Gothe[2], P. B. Chavan[2], M. B. Naik[3], S. Kalkal[4], E. Prasad[5], A. K. Sinha[6]

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[6]UGC-DAE-CSR, Kolkata Centre, Kolkata

4.3.1 Heavy Ion Reaction Analyzer (HIRA)

Last year, some of the experiments pending in HIRA beam line could not be taken up due to lack of time, as a large number of nuclear physics measurements requiring LINAC energies were conducted in beam hall II with HYRA and NAND facilities. These experiments would be scheduled during the later part of 2011 when LINAC module 2 and 3 installation would be carried out. HIGRASP set up has been moved from HIRA area and set up at HYRA target site for experiments using HYRA - spin spectrometer combination. Two more experiments have recently been sanctioned in the recent (December 2010) AUC meeting.

Results from some earlier experiments using stand-alone HIRA or HIRA-INGA combination have been published this year. They have also been presented in INPC and DAE symposium on Nuclear Physics and selected for presentation in FUSION11.

4.3.2 HYbrid Recoil mass Analyzer (HYRA)

HYRA was used to carry out fusion studies around barrier in $^{16}O + {}^{194}Pt$ system with some of the earlier measurements cross-checked using pulsed beam. The nickel entrance window foil was replaced with carbon (~ 200 $\mu g/cm^2$ thick) to reduce multiple scattering effects and beam energy loss. Care was taken to carry out beam tuning on target with helium gas in HYRA in order to increase the longevity of the window foil. The change-over to mounting monitor detectors from the top lid with signals too taken through the lid helped in ease and accurate mounting of normalization detectors.

HYRA has recently been coupled with TIFR 4π spin spectrometer and HIGRASP set up at IUAC (fig. 1-3). This powerful combination paves the way for spin and/or evaporation residue (ER) gated GDR decay built on the excited states in heavy nuclei and to probe the limits of angular momentum in heavy ERs surviving fission.

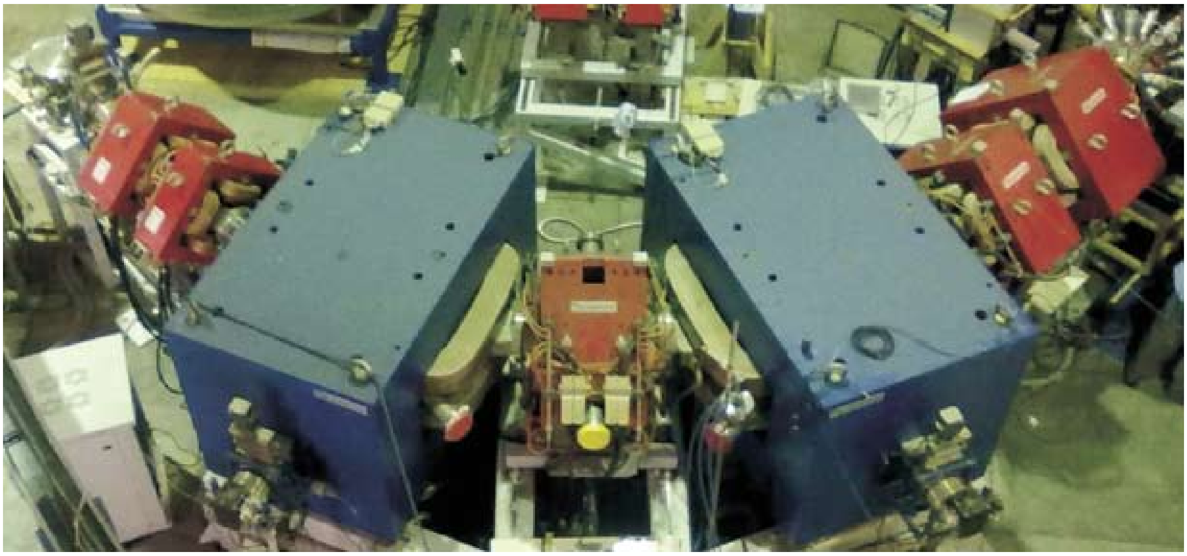

Fig. 1. HYRA gas-filled stage coupled with TIFR 4π spin spectrometer (seen in top right corner)

Fig. 2. Spin spectrometer and support structure at HYRA target site

Fig. 3. HYRA gas-filled stage coupled with spin spectrometer and HIGRASP high energy gamma ray detection system

The TIFR 4π spin spectrometer is a 32-element gamma multiplicity/sum energy detector array consisting of 20 hexagonal and 12 pentagonal sodium iodide crystals with an inner, spherical clearance of about 200 mm diameter. The total efficiency of the complete array is nearly 84% at 660 keV with each hexagonal and pentagonal detector having efficiency of about 3 % and 2 %, respectively. The two halves of the array are mounted independently on two plates with the possibility of locking them together in the final position. The parts of the array were shipped from TIFR to IUAC in April 2010. In order to allow proper alignment at HYRA target site, to use the same foot-print as the previous stand-alone HYRA target chamber and to be within the constraints imposed by Indian National Gamma array (INGA) platform assembly, a special mounting/alignment structure was designed and fabricated at IUAC in consultation with TIFR group. Several provisions, to align the two halves with respect to the beam direction/target centre and to allow sideways movement of the halves to access the target chamber, were incorporated. Precise, reproducible movement of the halves is achieved using Linear Motion (LM) guide rails and bearing assemblies.

The small aluminum chamber, initially used with HIRA, was adapted for use with this combined facility. Modifications to the bottom lid were made (fig. 4) to incorporate helium gas-inlet and the mounting of two monitor detectors at forward angles (~ 24°). The beam-line between INGA and HYRA target locations was replaced with a telescopic arrangement to gain increased access to the chamber.

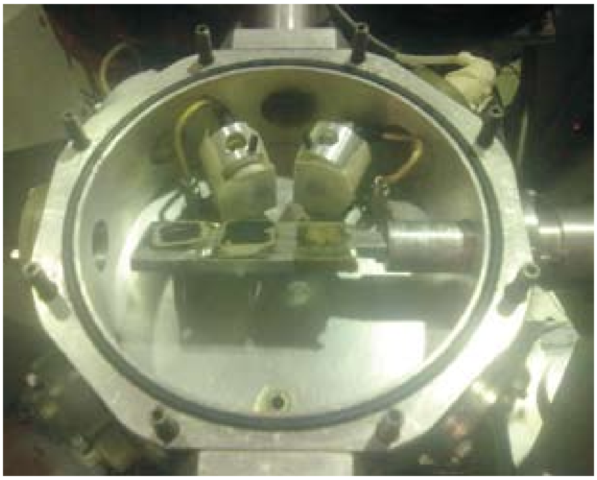

Fig. 4. Target chamber with modifications for the HYRA-Spin spectrometer coupled system

In the experiments using 4π spectrometer, up to 29 detectors were used with two pentagons removed for beam entrance and exit and a hexagon removed for target ladder movement or HIGRASP detector. The forward most detectors were very close to the entrance quadrupole (Q1) coils due to which the gains of these PMTs were affected when Q1 was energized. However, covering the PMTs with μ-metal shield allowed their use with no gain related problems even at 80% of maximum field value of Q1. This suggests that use of the INGA detectors (with clover detectors at 90° and back angles and at larger distances from Q1) should not be significantly affected by Q1 field when INGA and HYRA are coupled.

Three experiments following a calibration experiment have been undertaken with the combined facility. The spin spectrometer was initially calibrated with standard gamma sources for efficiency and cross-talk estimation and threshold for each detector was adjusted to about 100 keV. GDR decay (spin and/or ER gated) from excited states in ^{196}Hg* CN and its ERs has been initiated by TIFR group. Angular distribution and excitation energy dependence are planned for this system. The raw gamma fold spectrum is heavily contaminated up to second fold (Coulomb excitation and other inelastic excitations) and moderately contaminated up to even seven fold (from fusion of oxygen with carbon entrance window). However, ER gating cleans up the gamma fold and the time-of-flight (TOF) spectrum with HIGRASP as start and beam RF as stop (fig. 5).

The gas-filled mode of HYRA was used in all the above experiments, namely, fusion-evaporation in ^{16}O + ^{180}Hf → ^{196}Hg*, ^{16}O + ^{208}Pb → ^{224}Th*, ^{30}Si + ^{170}Er → ^{200}Pb* and ^{16}O + ^{184}W → ^{200}Pb* (calibration system). In the first system looking for GDR decay from excited states, ER gating cleaned up the gamma fold spectrum in coincidence with high energy gamma detected in HIGRASP. By taking the ratio of ER gated gamma fold counts to the respective counts in the raw spectrum in the high fold region, we could establish the average transmission efficiency for all ERs through HYRA. The transmission efficiency for this system by this novel method was found to be close to 7.5 % (fig. 6). The lower folds in the raw spectrum are contaminated by Coulomb excitation and fusion evaporation reaction involving ^{16}O and carbon (window foil).As the ER cross-sections for the other two systems have been measured elsewhere, extraction of transmission efficiency could be done easily.

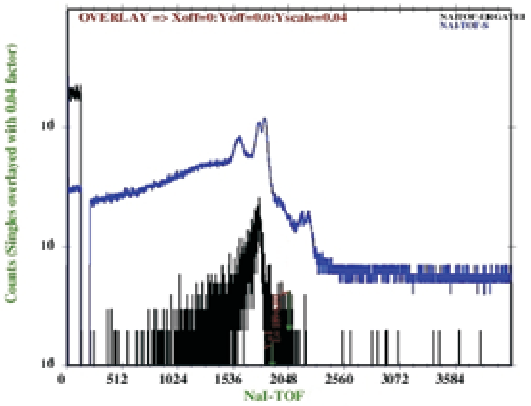

Fig. 5. Tagging with ER cleans up the NaI-RF TOF spectrum eliminating neutrons and gamma background from fission fragments, and products from fusion of oxygen beam with carbon window foil and upstream collimators

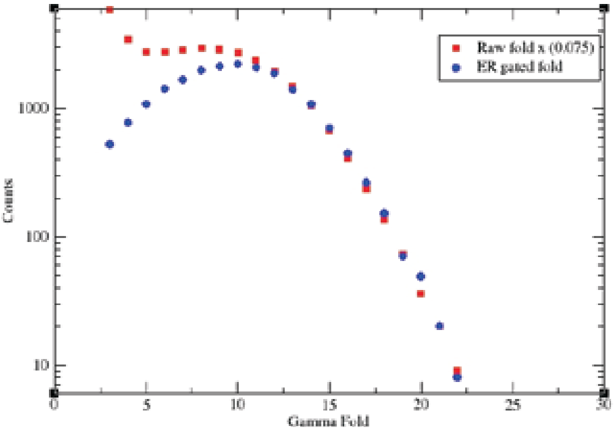

Fig. 6. ER gated and raw gamma fold counts (in coincidence with HIGRASP signal) with raw fold spectrum scaled down to 7.5 %, which is the transmission efficiency for ERs as seen by the matching of higher fold events

HYRA facility related activities and initial experiments have been presented at International Nuclear Physics Conference held at University of British Columbia, Canada in July 2010, at DAE symposium on Nuclear Physics held at BITS, Pilani in December 2010 and has been selected for oral presentation in FUSION11 international conference to be held at Saint Malo, France in May 2011.

The entrance to HYRA area is being provided with a sliding, radiation shielding door. The civil work of making a trench to embed the rail structure and other associated mechanical jobs has held up installation of second stage of HYRA. The high voltage handling capability of electrostatic dipole (ED) assembly being sensitive to dust, the installation of ED and other second stage magnetic components will be taken up after the radiation shielding door is commissioned.

All coils for the superconducting quadrupoles Q1-Q2 have been wound and are being tested at liquid helium temperature by passing currents up to 100 A. Three coils have been tested successfully and the remaining five coils will be taken up for testing in the near future. Spare coils are planned for both quadrupoles. The installation of the coils, poles and yoke inside the cryostat will be followed by the final welding of the cryostat at the site. Cryo coolers are planned to be used with the quadrupole doublet to maintain the liquid helium temperature.

A two-day workshop “Nuclear Physics using LINAC booster at IUAC” was held at IUAC on January 21 and 22, 2011. There were 25 participants from the user community. The workshop had invited talks followed by an open house. Various aspects related to proposals in idea stage, facility requirements and user collaboration were discussed.

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 continue to support the research programmes of a large number of users from different universities and institutions. There have been a large number of experiments in materials science with energetic ion beams, without any beam time loss due to major facility break down. The swift heavy ion (SHI) irradiation and related experiments are performed in the two irradiation chambers in the two materials science beamlines in beamhall I and beamhall II, and in general purpose scattering chamber (GPSC) in beamhall I. The experiments using on-line/in-situ facilities in materials science beam lines, which have unique features, are given emphasis. Besides that many experiments were carried out using low energy ion beams using LEIBF facility and atom beams using atom beam sputtering set up. The off-line facilities are also being used by many users for preparing and characterizing samples. 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.

XRD, FTIR, PL, UV-Vis SPM, micro-Raman and transport measurement facilities continue to be used by a large number of users. The materials synthesis techniques: RF sputtering system, ball milling system, box furnace and tubular furnaces are being extensively used by users for preparing samples. The microwave plasma based deposition system has become operational and the installation of in-situ micro-Raman set up in the beam line is in progress.

4.4.1 Irradiation chamber maintenance

A. Tripathi, S A Khan, VVV satya, P Barua

The irradiation chamber in materials science beamline is used in most of the irradiation experiments and ERD studies. The operation of the chamber with the two existing sample ladders was tested to ensure its trouble free operation. An additional gauge was mounted on the chamber and integrated to the vacuum interlock system to avoid disruption in beamtime due to gauge contamination. A dedicated power supply for electron suppressor has been acquired. A dedicated current integrator for materials science beamline has been fabricated by data support group.

4.4.2 Scanning Probe Microscope

A. Tripathi, I. Sulania

Multi Mode SPM with Nanoscope IIIa controller acquired from Digital/Veeco Instruments Inc. was extensively used in user experiments in the beginning of the year. Later on, its controller developed a problem which could not be solved by the company engineer at IUAC. The controller is sent back to the company and a replacement for the same has been ordered.

4.4.3 In-situ X-ray Diffractometer setup

P. K. Kulriya

In-situ *x*-ray diffractometer system in the materials science beam line of pelletron accelerator is being extensively used by many researchers from Indian universities and institutes for offline as well as in-situ characterization of their samples including nanoparticle, thin films as well as powders. The system has been running smoothly except for a few problems. The motherboard of the computer used for interfacing and data collection was damaged. Hence, it was replaced with a new system and all the softwares were re-installed. The DC power supply was also damaged, probably due beamhall environment. This year more than 725 samples are studied including 560 which were in thin film/nanoparticle. There were three experiments using in-situ XRD set up.

4.4.3.1 Installation of cryostat for in-situ XRD

P. K. Kulriya, M. Bharadwaj, R. Ahuja and D.K. Avasthi

It is well established that the ion beams having special features like spacial selectively, very good focusing and very high energy is a very excellent tool for structural modification of nanomaterial by creating defects in a controlled fashion. To get more accurate and reliable diffraction spectrum of ion irradiated materials, a GM based closed cycle refrigerator was funded by nano mission of DST, New Delhi to cool the sample down to 10K. The system has been tested and installed with existing x-ray diffractometer, as shown in figure 1. The mechanical fixture to attach the CCR with the in-situ XRD set up is designed, fabricated and tested. It is used for fine movement of the cryostat in forward and backward direction. The cooling curves in test measurements of cryostat are recorded without load, with Cu block as a load and with sample mounted on the Cu block are shown in figure 2. It shows that a temperate of 20K can be achieved at the cold head within 2hrs. A XRD spectrum of test sample is also recorded. The effect of vibration of CCR on was not observed and diffraction pattern was very good. The in-situ XRD experiment with ion beam using the close cycle refrigerator is to be performed in near future.

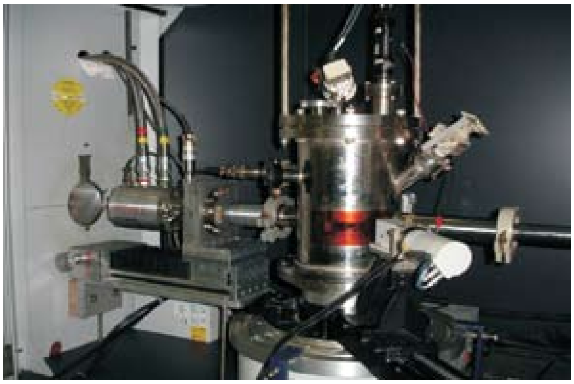

Fig. 1. Photograph of the closed cycle refrigerator installed with XRD system

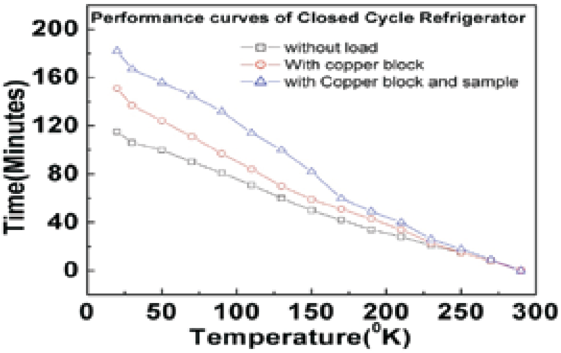

Fig. 2. Cooling curves in test measurements of cryostat

4.4.4 Plasma based systems for thin film deposition

V.V. Siva Kumar

For plasma based synthesis of thin films, an rf sputtering system and a microwave plasma CVD system are available. The rf sputtering system is being used for thin film depositions of users and the microwave plasma system is being used for studying DLC thin film deposition by CVD. A substrate heating arrangement is being made in the MW-CVD system to deposit carbon nanophase thin films requiring high substrate temperature. A multi-cathode sputtering chamber having 3 target holders for 2 “ dia targets and rotating sample holder with heater (upto 750°C) was procured from M/s Excel Instruments, Mumbai and installed and leak tested.

The rf sputtering system was operational for thin film deposition. Thin films of Strontium Barium Niobate, CeO_2, MgB_2, nanocomposite ZnO / porous silicon, MgO, SnO_2 and NiZnCe Ferrite were prepared for ion beam studies on these materials. Provision for water cooling of the rf sputtering chamber was made to reduce the heating of o-rings of the chamber due to substrate heating. Provision for clamping the target to the target holder is being made.

DLC films were deposited using the microwave plasma system (Fig 1). The films were deposited at different deposition conditions obtained by varying the substrate dc bias, deposition pressure and microwave power. Initially the substrate was heated using the ions from the plasma for 20 mins and then the thin film deposition was done. Ar / H_2(2 %) and methane gases were used for growing the DLC films. The deposited films were annealed in high vacuum at temperatures of 200, 400 and 600 °C to study the influence of annealing on the DLC films. Raman spectra (Fig 2) of the deposited and annealed films showed the presence of D band (~1380 cm^{-1}) and G band (~ 1558 cm^{-1}) which confirmed DLC formation in the films. Also a shift in position and change in intensity of D and G bands is observed in the annealed films.

Fig. 1. MW- CVD system.

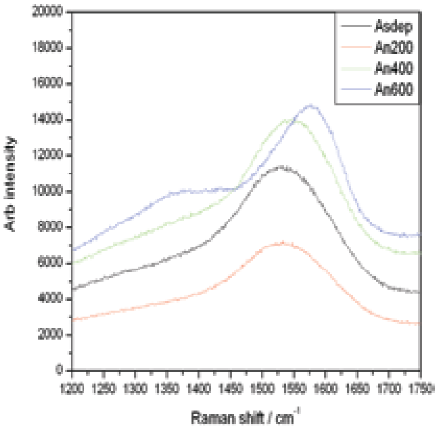

Fig. 2. Raman spectra of the thin films

4.4.5 Field emission scanning electron microscope (FE-SEM)

A. Tripathi, D.K. Avasthi

The field emission scanning electron microscope (FE-SEM) from TESCAN, MIRA II LMH CS is regularly being used to boost research activities in nanomaterials, in a project funded under Nano Initiative program of Department of Science and Technology. The SEM has a high brightness Schottky emitter electron gun with accelerating voltage variable from 200 V to 3 kV. The system also has an attachment for energy dispersive X ray spectrometer from OXFORD (Inca pentfetx3) with 133 eV resolution for elemental analysis.

Regular maintenance is being carried for the system. The problem in automatic sample chamber venting was rectified and sample position calibration was carried out. There was a problem in communication between the EDS computer and the microscope which was also rectified. The system has been used this year for studying more than 250 samples from 50 users.

4.4.5.1 Sputter Coater system for FE SEM

A. Tripathi, D.K. Avasthi

To improve the performance and applicability to different types of samples, Q150T-S High Vacuum Turbo pumped Sputter Coater system from Qoram Technologies was acquired. The system has been installed and is regularly being used to coat the samples with gold, carbon and chromium.

Fig. 3. Q150T-S High Vacuum Turbo pumped Sputter Coater system

4.4.6 Online ERDA Set up

S.A. Khan

The system is being used by many users and the system was modified this year by installing MKS gas flow meter with controller and Baratron gauge. The following five beamtimes utilized the ERDA facility last year.

- Ion beam synthesis of doped and un-doped ZnS nanocrystals in host matrices (Shiv Poojan Patel)
- Hydrogen Content And Depth Profile In Metal Hydride By ERDA (Pragya Jain)
- A Study On The Influence Of Energetic Ions On The Stability Of Bonded Hydrogen In Semiconductors (Nageswara Rao)
- Hydrogen Sensing Studies On Nanostructured Thin Films Using Elastic Recoil Detection Analysis (Ramesh Chandra)
- Electronic Sputtering in Fluoride thin films (Avinash Chandra Pandey)

4.4.7 Spectroscopy facilities

F Singh

IUAC has spectroscopic techniques for materials characterizations like photoluminescence (PL), ionoluminescence (IL), FTIR and micro-Raman. These facilities are all running smoothly and being used heavily by many users for the characterization of energetic ion irradiated samples. Last year about 175 PL, 430 FTIR and 480 micro-Raman spectra were recorded for various users. The activities for the in situ Raman facility test are on the way and a target ladder is designed and fabricated in the workshop for doing the in situ measurements at LN_2 temperature.

4.5 RADIATION BIOLOGY FACILITY

4.5.1 Status of the Molecular Radiation Biology Laboratory

A. Sarma

The laboratory is designed to extend user support to the best possible way during experiments. The experiments that are undertaken recently require suitable inhouse facilities for relevant protocols. The laboratory facility includes autoclave, biosafety cabinet, two CO_2 incubators, and other normal equipment like microbalance, oven, refrigerated centrifuge, PCR machine, Gel Doc, FIGE system and Semi dry transblotter, -80 C Ultra Freezer [Heto] and a -20 C Deep Freezer [Vest Frost]. and a large capacity 4 C freezer.

In addition we also have a fluorescent microscope [Carl Zeiss] to facilitate the experiments based on FISH and immunofluorescent assays.

For accurate cell counting, a Coulter Cell Counter [Beckman Coulter] is installed in the laboratory. This equipment would drastically enhance the speed and accuracy of post irradiation cell plating during the beam time, and thus save a lot of time. In addition we also have procured an image based cell viability measurement system Countess from Invitrogen.

A system for Drop Shape Analysis using Contact Angle Measurement of the liquid -substrate interface has been procured from Kruss, GmbH.

The laboratory has been provided with dedicated split air conditioners in order to separate itself from central air conditioning system. The contamination problem has been reduced to a great extent.

Both the incubators are provided CO_2 gas from a single cylinder kept outside the laboratory area using PVC piping. This would enable replacement of gas cylinder without contaminating the laboratory.

4.6 ATOMIC PHYSICS FACILITY

T. Nandi

Atomic physics research experiments with Pelletron accelerator are done in general purpose scatting chamber (GPSC) and in a dedicated beam line in beam hall II. Two Doppler tuned spectrometers have been made ready for high resolution x-ray spectroscopy experiments. However, there was an acute problem with the absorber foil changing system. Now proper equipments have been procured and there is a plan to install it soon. Further, innovative experiments in the broader line of atomic and nuclear physics have been initiated this year in GPSC again and some exciting results have been reported in section 5.4. In the mean time for further progress on the experimental facilities in beam hall II, equipments required for experiments with gaseous target and post collisional charge state analysis have been procured.