1. ACCELERATOR

1.1 PELLETRON

1.1.1 Operational Summary

S Chopra, R Joshi

Performance of 15 UD Pelletron accelerator was quite satisfactory, from April 2012 to March 2013. There were total three tank opening maintenances, two scheduled and one unscheduled, during this period. The details of all three tank opening maintenance are mentioned in maintenance section. LINAC was also used to boost the energies of beams from Pelletron and delivered to users for experiments in phase – II beam hall. Duration of beam runs, with LINAC as a booster, was of three months from December 2012 to February 2013. The operational summary of the accelerator from April 2011 to March 2012 is mentioned below.

Total No. of Chain Hours	=	6791 Hours
Total Beam utilization	=	3927 Hours
Machine breakdown	=	0156 Hours
Accelerator Conditioning	=	0869 Hours
Beam Change Time	=	0012 Hours
Tank opening maintenance	=	1694 Hours
Beam tuning time	=	0228 Hours
Experimental setup time	=	0078 Hours
Accelerator set up time after maintenance	=	0154 Hours

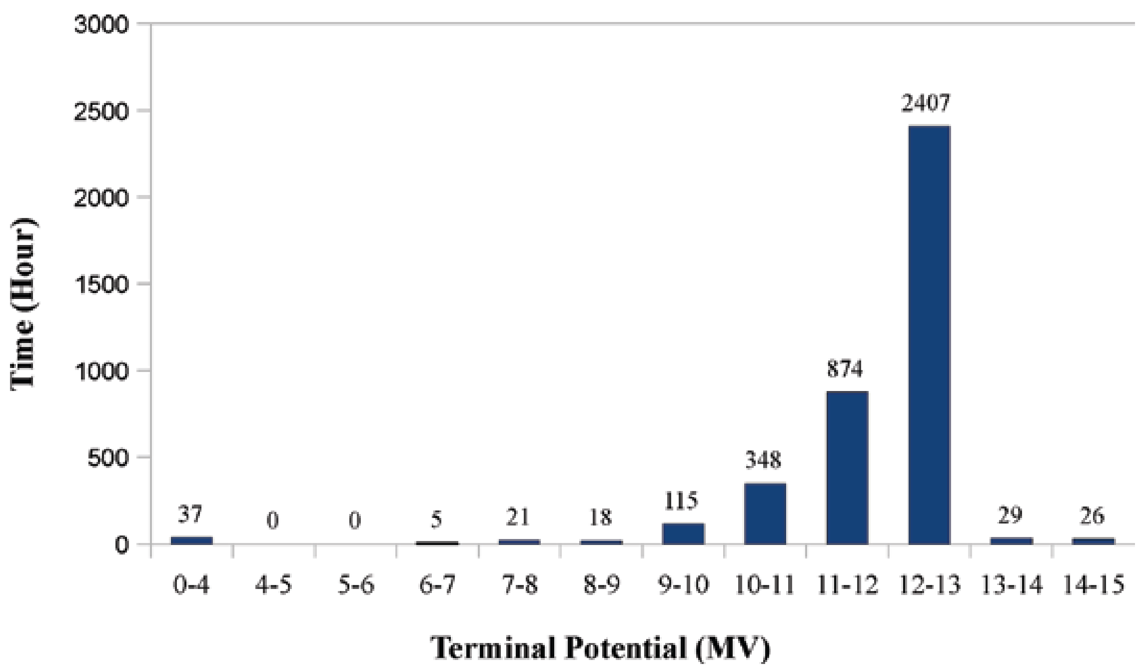


Fig. 1. Terminal Potential vs. Hour Graph

Total number of 491 shifts was used for experiment during mentioned period. Out of these 491 shifts, 201 shifts were used for pulsed beam users. The machine up time for this period is 97.70% and the beam utilization is 57.83%. The voltage distribution graph of Terminal Potential used for different experiments during above mentioned period is shown in figure 1. ^{16}O, 6^{+}, 100 MeV dc beam and ^{107}Ag, 13^{+}, 200 MeV dc beam were delivered to user at maximum terminal potential 14.24 MV and ^{1}H, 1^{+}, 7.2 MeV dc beam at the minimum terminal potential of 3.51 MV. Maximum terminal voltage achieved during conditioning in this year was 14.91 MV.

Accelerator performance, in the form of Pi-chart, is shown as below in figure 2.

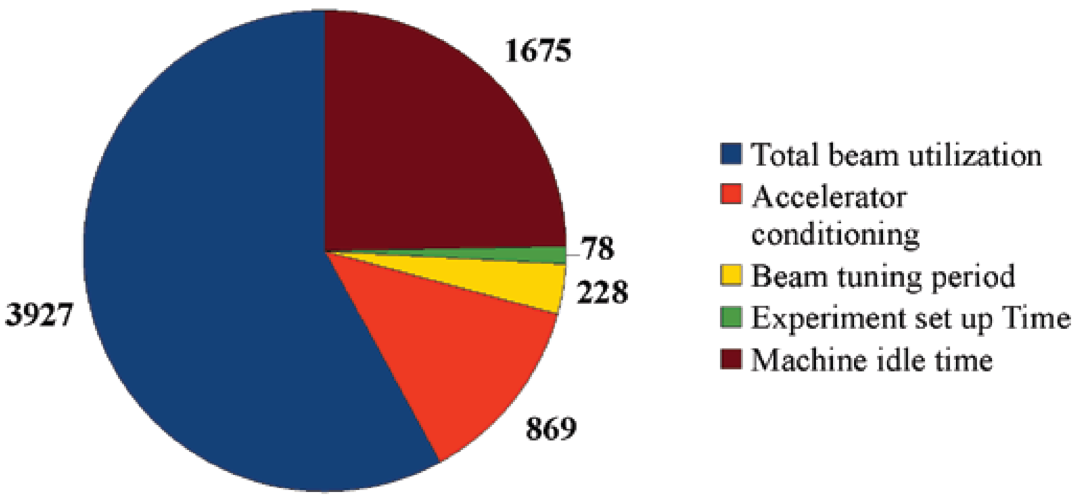


Fig. 2. Chain Hours Utilization

The total duration of beam run for mentioned period is 3927 hrs. Duration of run time in percentage for different ions is shown in table 1.

Table 1

Beam Delivered	Utilization (%age of total time)
^{1}H	0.95%
^{7}Li	1.17%
^{9}Be	0.79%
^{10}B	3.14%
^{11}B	0.46%
^{12}C	7.53%
^{16}O	12.38%
$^{17}(OH)$	0.25%
^{18}O	1.21%
^{19}F	5.80%

Beam Delivered	Utilization (%age of total time)
^{28}Si	27.13%
^{30}Si	4.64%
^{32}S	1.53%
^{48}Ti	7.74%
^{56}Fe	1.11%
^{58}Ni	7.65%
^{107}Ag	8.75%
^{127}I	0.96%
^{197}Au	6.81%

Pi- chart in figure 3 shows the distribution of delivered beam species during beam run from 1st April 2012 to 31st March 2013.

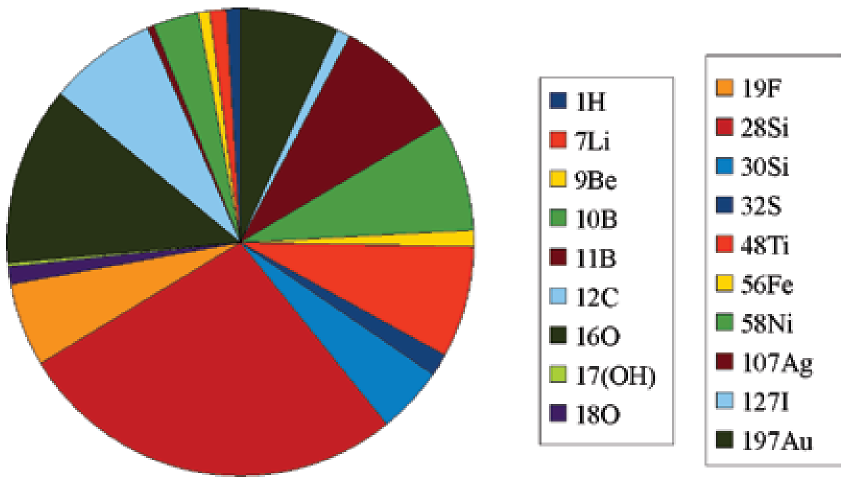


Fig. 3. Distribution of delivered ion beams

1.1.2 MAINTENANCE AND DEVELOPMENT ACTIVITIES

S Chopra, R Joshi, S Gargari, M Sota, S Ojha, V P Patel, R P Sharma, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar, Pranav Singh, D Kabiraj, Abhilash, P Barua and A Kothari

There were three tank opening maintenance in the mentioned period. The first tank opening maintenance was unscheduled resulted due to damage of fiber optic cables in high energy section. This maintenance was from 7th April to 13th April 2012. Remaining two scheduled maintenance were from 11th September to 18th October 2012 and 15th February to 12th March 2013. Routine maintenance jobs like, terminal foil stripper loading, column support post and accelerating tube resistors maintenance, in tank ion pump maintenance and maintenance of rotating parts inside tank, were carried out in both scheduled maintenance. Apart from routine maintenance jobs few major maintenance jobs were also carried out, which are listed below.

Major maintenance jobs during scheduled tank opening maintenance:

1. Testing performed before September 2012 scheduled tank opening maintenance

a) Testing of earthquake RAMs

The working of earthquake RAMs was tested. Both the chains, both the rotating shafts and blower motor was kept running during this testing. The tank pressure is ~89 psi and the earthquake RAMs were charged with SF_6 gas up to pressure of ~200 psi. The maximum operating pressure of these earthquake RAMs is 125 psi. The box of earthquake sensor, installed in control room, was opened. Three sensors are installed for three directions Vertical (V), Longitudinal (L) and Transverse (T). The top of earthquake sensor was hit by a mallet very lightly which activate a signal from longitudinal sensor. This signal fired the earthquake RAMs and all four RAMs moved inside towards terminal. At the same time all the motors (2 chain motors, 2 rotating shaft motors and a blower motor) got tripped as all of them all interlocked with earthquake RAM activation. The signal of earthquake sensor was reset from control room and then all the RAMs were retracted back.

b) *Testing of TPS electronics*

During regular run of accelerator, it was noticed that the terminal stabilization was difficult. The problem could be either in TPS or corona probe controller or corona probe itself. Therefore, it was decided to check full TPS along with corona probe controller electronics in simulated mode. To simulate terminal voltage, GVM amplifier output was disconnected from TPS and DC voltage was applied in its place. To simulate corona probe, the corona probe HV cable was disconnected from corona probe and connected to HV power supply. The conditions were simulated and total TPS system was checked. It worked satisfactorily.

2. Maintenance of Annular Service Platform (ASP)

During September 2012 scheduled maintenance, maintenance work of ASP was carried out. During installing ASP, a loud scratching sound was heard. On inspection, it was observed that grease on the rails of ASP counterweight got dried up. Lots of greasy dust was also seen on these rails. All the dried grease was first cleaned with diesel properly and then fresh grease was applied. Alignment of ASP was also done.

3. Charging system maintenance

The charging system #1 was rebuild during January 2012 as charging chain #1 broke in December 2011. During the first schedule maintenance, condition of charging system #1 was assessed. It was noticed that the position of charging chain #1 motor pulley, with respect to tank bottom, got lowered. This gap was measured and found that the gap got reduced by ~20 mm as compared to January 2012 measurement. This confirmed the elongation in charging chain #1 during routine operation of accelerator. A pellet was cut from chain #1 to take care of this elongation in September 2012 maintenance. Now total numbers of 620 pellets are there in charging chain #1. Both the charging systems were tested electrically to check their performance.

During the routine operation of 15 UD Pelletron, from October 2012 to February 2013, fluctuation in charging current of charging chain #1 was observed. This problem was looked into in second scheduled maintenance in February 2013. The problem was located on doubler side of charging system #1. The doubler inductor was opened and two elevations, of mounting bolt size, were noticed on the inner surface of removed doubler inductor. This was resulted due to tightening of mounting bolts. Therefore the doubler was replaced by new inductor. The suppressor inductor, of charging system #1, was replaced by another inductor as the inner surface of this inductor was also damaged. The terminal pulley of charging system was also oiled. The charging system was again. Fluctuations in current got reduced.

The routine maintenance of charging system #2 was also carried out. Semiconductor band of both the pulleys of both the charging systems were oiled with TP oil to reduce the friction between pulley and chain. Alignments of few idler wheels were also adjusted. Both the charging systems were ran for few overnights to check its mechanical performance. Tightening of all the mounting bolts, in terminal and tank bottom, was assured for both the charging systems. Both the chains were properly cleaned and checked thoroughly.

4. Maintenance of Rotating parts inside accelerator tank

Thorough maintenance of all the rotating parts, such as charging chain motors, rotating shaft motors, rotating shafts and blower motor was done. All these rotating parts play important role for the operation of accelerator. Rotating shafts are used to generate local power for devices in both dead sections and terminal. Separator boxes are used for mounting of these rotating shafts.

All the rotating parts inside tank were checked thoroughly for maintenance. In first scheduled maintenance, bearings of total number of fourteen separator boxes were replaced, six in low energy side and eight in high energy side. In second scheduled maintenance, total number of ten separator box assemblies, seven in low energy side and three in high energy side, were opened for maintenance. Bearings of these assemblies were replaced by new bearings. All the repaired separator box assemblies were installed back after maintenance. A separator box assembly in high energy side (between units #25–26) was replaced by new box from NEC as it was beyond repair. All the motors inside tank were properly greased.

5. Newly shorted Column Support Post Gaps

During first scheduled maintenance, total nine new column support post gaps were shorted, seven in low energy side and two in high energy side. During second scheduled maintenance, total four new column support post gaps were shorted, two in low energy side and two in high energy side. All these gaps were shorted because these gaps measured resistance of few hundred Mega Ohms. Apart from their low resistance value, cracks were also observed across these gaps. Therefore both of these gaps were shorted to avoid their further damage.

Now total 26 gaps are shorted in low energy side and 15 gaps are shorted in high energy side of accelerator.

6. Corona probe maintenance

During the routine operation of Pelletron, corona probe was positioned for proper operation of Terminal Potential Stabilizer (TPS) and a stable beam was delivered to user. Suddenly the terminal voltage started falling down due to a loss of charge. Sum of up charge was more than down charge of charging system. To investigate the reason of this charge loss, the probe was taken out to its extreme end and the charge loss disappeared. On pushing the probe in, loss of charge was again noticed. This loss of charge increased as the probe was pushed nearer to the terminal while there was no probe current. This indicated that some charge was leaking to ground through probe. Three nylon insulators are used to mount the corona probe and also insulate probe from ground. In September 2012 maintenance, all those three nylon insulators were taken out and cleaned thoroughly in ultrasonic bath and then installed back. This was done to avoid the leakage current through these insulators. During regular operation of Pelletron, after this maintenance, the problem of leakage current disappeared.

7. Accelerating tube gaps cleaning

A number of accelerating tube electrodes in entire machine were cleaned thoroughly with scotch brite and alcohol as they were dirty with lots of spark marks.

8. Stripper foil loading in terminal, HEDS and post acceleration section (before analyzer magnet)

Fresh stripper foils were loaded in terminal, HEDS and in post acceleration section (before analyzer magnet). Stripper foils, before analyzer magnet will be used exclusively to increase the charge state. These higher charge states beams will be used to boost the energies further using LINAC.

9. Welding of hoop screw bracket in equipotential ring

In September 2012 maintenance, a threaded bracket which holds the hoop screw, broke from its welding, during terminal upper shell movement, and got detached from equipotential ring in unit

#15. The bracket which got detached is from 19th ring on P-2 side. This bracket was TIG welded.

Maintenance during unscheduled tank opening maintenance:

The only unscheduled tank opening maintenance took place in April 2012. The reason for this maintenance was the failure of fiber optic cables. On 7th April 2012, none of the devices in terminal and HEDS could be operated and controlled from main control console. Investigation of problem concluded that all three bunches of fiber cables, responsible to carry control signals for devices in terminal and HEDS, got damaged. This led to unscheduled tank opening maintenance. The tank was opened and all the damaged bunches of fiber optic cables were replaced by new bunches. This unscheduled tank opening maintenance lasted for a week.

Other maintenance outside Pelletron Accelerator Tank

1. Maintenance of Vacuum related components

Routine maintenance of all ion pumps and sublimator pumps along with their controller was done. Two ion pump controllers were repaired. Apart from these few maintenance work was also carried out which are mentioned below.

a) Modification of ion pump controller

A relay card for ion pump controller was developed. This relay card has four DPDT relays and used as a contact closure for set point option in ion pump controller. These Set Point contact closures can be used to interlock the operation of any device, such as Beam Line Valve etc. This modified set point relay card is installed in most of the ion pump controllers.

b) Vacuum recovery in 02 area

During September 2012 maintenance, an ion pump (IP 02-2) in area between injector magnet and accelerator tank, installed above pendulum valve, was not holding vacuum. As soon as it was put ON, its HV dropped down to 500 V. The vacuum of the area between MHB valve and tank top was of the order of 10^{-2} T. Leak detector was connected and the leak detection was done for this area. No leak was found. This ion pump was tested, at its HV connector, with megger at 1 kV, it was measuring short due to bad vacuum. A turbo pump pumping station was installed and connected to the roughing port above IP 02-2. The vacuum of this area improved and the IP 02-2 now could be operated. BLV 02-3 (pendulum valve) was also opened after bypassing its NLKs, with turbo pump connected at the roughing port. The vacuum of pumping area between Multi Harmonic Buncher and terminal also improved.

After February 2013 scheduled maintenance, it was noticed that vacuum read by ion pump in LEDS, IP D-1, was in the order of 10^{-7} T and it was not improving. The vacuum read of IGC 02-1 was in the order of 10^{-6} T. With pendulum valve BLV 02-3 in closed condition, the vacuum of IP D-1 was deteriorating to as bad as 10^{-5} T range. To investigate this problem, leak check in 02 area, with BLV 02-3 in closed condition, was done. A leak in bellow of pendulum valve (BLV 02-3), towards low energy side of Pelletron, was noticed. This leak disappeared as soon as BLV 02-3 was opened. This confirms the leak in bellow of BLV 02-3 pendulum valve in closed condition. Therefore, BLV 02-3 was kept permanently open.

A pumping arrangement is also installed at the roughing port of pendulum valve, with roughing port closed. This is done to connect the external pumping system by opening the roughing port, if required.

c) *Replacement of Ion Gauges (IGC 01-1 and IGC 01-2)*

Two ion gauges (IGC 01-1 and IGC 01-2), in February 2013 maintenance, in area between ion source HV deck and injector magnet were not operating. Interlock points provided by these gauges were bypassed for routine operation. These ion gauges are now replaced by full range gauges from MKS Technology. Their controllers were also installed and all the bypass points were also restored back.

1.1.3 ION SOURCE ACTIVITIES

S Chopra, R Joshi, S Gargari, M Sota, S Ojha, Pankaj Kumar, V P Patel, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar and Pranav Singh

MC - SNICS was modified by its manufacturer, NEC, USA, few years back. This modification was done on the basis of working experiences and development carried out by different AMS labs around the world. The problems such as shorting of einzel lens and General Purpose tube (GP tube) during operation, difficult handling of cesium while loading cesium into cesium reservoir and contact problem due to floating type cathode connection, has been properly taken care in modified design of MC – SNICS. The old MC-SNICS was replaced by the new modified MC – SNICS in the month of March 2012. These modified 40 samples MC-SNICS uses only solid samples. The ion source operation was quite satisfactory from April 2012 to March 2013.

During the mentioned period, MC-SNICS was opened twice for routine maintenance. First time the source was opened in the 1st week of October. All the electrical connections of ion source were removed and the source was vented and the cesium was kept in Argon environment. The source was removed from line and taken out from deck for maintenance. The source was dismantled and all of its parts were cleaned. After cleaning of all the parts, the source was assembled again and the alignment was done with the help of alignment jig. The ionizer along with its few ceramic components was also replaced as those were dirty. The source was then put on HV deck and installed. All the electrical connections were restored back. The efficiency of this modified source is quite good. Consumption of cesium, for same kind of beam currents, is quite low as compared to earlier version of MC - SNICS. The cesium, which was loaded at the time of installation, has been continuing for almost last one year. This was the first maintenance after installation of the new modified MC-SNICS. So the source was tested again for different elements and the result was satisfactory. Second time the source was opened in the month of March, 2013 for routine maintenance. The usual routine maintenance was carried out. The new 5 g. cesium ampule has been loaded this time after one year of operation. In one year of operation there was no breakdown in the source.

Thorough cleaning of HV deck, multiplier stack and filter stack of HV power supply was carried out. Apart from this, Conditioning of HV deck was also done. For smooth and effective operation of MC-SNICS source, the cathode wheel had been loaded for regular and AMS runs, whenever required.

1.1.4 BEAM PULSING SYSTEM

R Joshi, M Sota, S Ojha, V P Patel, N S Panwar, S M Nishal and A Sarkar

Operation

1606 hours of beam time was used for pulsed beam runs using multi harmonic buncher (MHB) along with low energy chopper and traveling wave deflector. Out of 1606 hours of pulsed beam time 1136 hours were utilized for LINAC operation. Out of these 1136 hours, 394 hours were used for LINAC tuning and for remaining 742 hours beams were delivered to users, after boosting beam energies using LINAC. Energies of ^{19}F, ^{28}Si, ^{30}Si, ^{48}Ti and ^{58}Ni were boosted by using LINAC. The third stripper, before analyzer magnet, was used effectively to increase the beam charge state for many LINAC runs.

For the remaining 470 hours, pulsed beam from Pelletron, was utilized by users to perform experiments in different experimental lines. The beam bunched for these 388 hours were ^{12}C, ^{16}O, ^{18}O, ^{19}F and ^{32}O. All the pulsed beam runs were quite stable. Traveling Wave Deflector (TWD) was used to get different repetition rates of pulsed beam, whenever needed.

Maintenance

a) Chopper maintenance

During one of the LINAC runs, in January 2013, chopper amplifier broke down. This faulty chopper amplifier was replaced by another 100 W, 4 MHz. buncher amplifier. This buncher amplifier is used to power Light Ion Buncher (LIB) of old pulsing system.

Maintenance of the faulty 100 W, 4 MHz. chopper amplifier was carried out during February 2013 maintenance. The problem was rectified by replacing the AC mains receptacle box with fuse. The contacts of this receptacle box were damaged. The output cable, from chopper amplifier to chopper tank circuit, was not making proper connection. The output cable used is RG – 8 cable. N – Connectors from both the ends of this cable were removed and new connectors were made at the both ends of cable. After this maintenance work, 50 Ω pure resistive dummy load was connected at the output of amplifier and output stage of amplifier was tuned for maximum power transfer. The output of amplifier was then disconnected from dummy load and connected to tank circuit of chopper and chopper tank circuit was tuned for maximum power transfer from chopper amplifier. The chopper tank circuit could be tuned to get maximum forward power of ~20 W with reflected power of ~0.5 W. The chopper amplifier was kept ON for two days to check its stability which was up to the mark.

b) Traveling Wave Deflector (TWD) maintenance

The routine maintenance of TWD was also carried out. In this maintenance, all the control electronics and switching amplifier electronics was checked. The performance of TWD electronics was satisfactory.

1.1.5 DEVELOPMENT ACTIVITIES

S Chopra, R Joshi, S Gargari, M Sota, S Ojha, K Devarani, V P Patel, R P Sharma, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar and Pranav Singh

The development activity done during mentioned period is mentioned below.

a) Magnetic field read back of dipole magnets

Magnetic field read back of dipole magnets in 15 UD Pelletron accelerator was incorporated in control system so that they can be directly read in the computer and can be used for automation purpose. A CAMAC card was developed which reads data send by Gauss meter using RS232 port and format it to display the magnetic field value in existing control system. Cabling and necessary modification in database of control system was done. Presently, magnetic field, for analyzer and switcher magnets, are being monitored using these CAMAC cards and for injector magnet field will be installed soon.

b) Installation of new headers for compressed air line distribution

A new header is installed to new compressed air line for the distribution of compressed air to all pneumatic devices in ion source room (seventh floor). A ball valve is added for each pneumatic device so that each device can be isolated from main compressed line individually, which is quite useful in case of maintenance of individual pneumatic device.

1.2 LOW ENERGY ION BEAM FACILITY (LEIBF)

P. Kumar, Kedar Mal, Sarvesh Kumar, P. S. Lakshmy, Y. Mathur, U. K Rao, Chanderpal, M. Archunan, A. Kothari, P. Barua, S. K. Suman, Mukesh Kumar, Rajesh Kumar, Raj Kumar, R. Ahuja, S. K. Saini, B. B. Chaudhary, Sunder Rao, A. J. Malyadri, B. K. Garg, C. P. Safvan, G. Rodrigues, A. Mandal, and D. Kanjilal

1.2.1 Operation

The installation of new low energy ion beam facility (LEIBF), an upgraded version of old system has been completed in October 2011. Since then, this facility is being used regularly for user experiments in two beam lines viz. Materials Science (MS) at 90^0 and Atomic & Molecular Physics (ATMOL) at 105^0. In third line (at 75^0), we aim to decelerate highly charged ions up to zero kinetic energy (soft landing setup- SLS) to study ion-surface interactions influenced only by the potential energy. A few simulation studies have been done using SIMION ion optical code. The experimental chamber has been placed in line and beam tests need to be done. 10 GHz electron cyclotron resonance ion source (ECRIS) on high voltage platform (400 kV) and experimental beam lines are shown in figure 1.

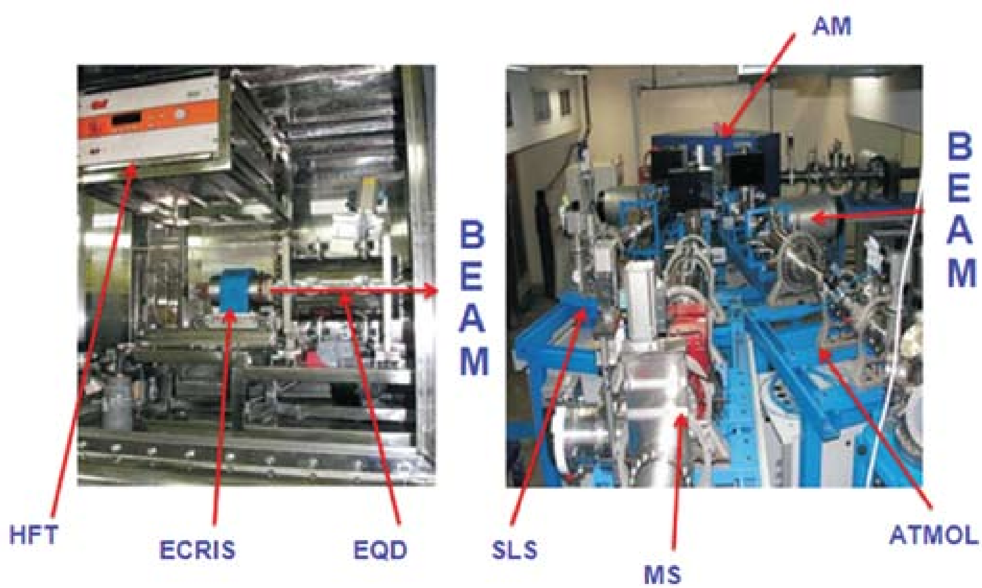


Fig. 1. All permanent-magnet-ECR source along with peripheral electronics on high voltage platform and view of the beam hall. HFT and AM stands for high frequency transmitter and analyzer magnet respectively. Others abbreviations used in the figure are already explained.

Research proposals (67 in number) approved in last workshop held on 22-23 October 2011 were reviewed critically and beam time allocation was done in terms of numbers of shifts. Excluding maintenance and dead time, 480 shifts were available and 471 sifts were allocated to users. The users are being invited regularly based on the grades given to their proposals. So far, we have completed 28 experiments and beams of various charge states (only from gaseous species viz. H, H_2, He, C, O, O_2, N, N_2, Ne, Ar, Kr, Xe) in the energy range of 60 keV to 800 keV were delivered. Extracted beam currents (hundreds of micro-amp for first few charge states) were quite satisfactory and we could process the samples/films with quite high ion fluences (~ 10^{18} ions/cm^2) as required for nano-patterning on semiconductor surfaces. A typical profile of 500 keV Xe^{+2} beam is shown in figure 2. Natural isotopic abundances are clearly visible in X profile (peaks at right hand side). The beam spot on the target was ~ 4 mm for 1 micro-amp beam current.

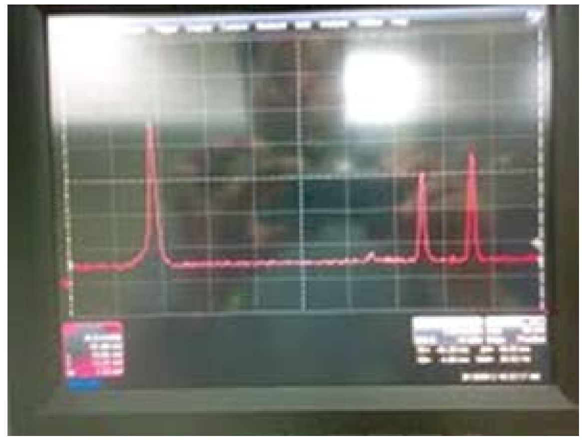


Fig. 2. A typical profile of 500 keV Xe^{+2} beam

Figure 3 shows the charge state distribution (CSD) of argon ECR plasmas at E/q = 212 kV (platform voltage = 200 kV and extraction voltage = 12 kV) and two different power levels - 2 and 70 watt. At 70 watt of RF power, we could populate up to + 9 charge state of argon which was limited to +7 for 2 watt power. Beam current for first few charge states are limited to tens of micro-amp due to the fact that we have used apertures (1 inch in diameter) in the first and third units of accelerating column to avoid the beam hitting and sputtering of the guard rings which caused deposition of metallic layer between two high voltage ring electrodes. Simulations show that only 13% beam will be allowed through accelerating column.

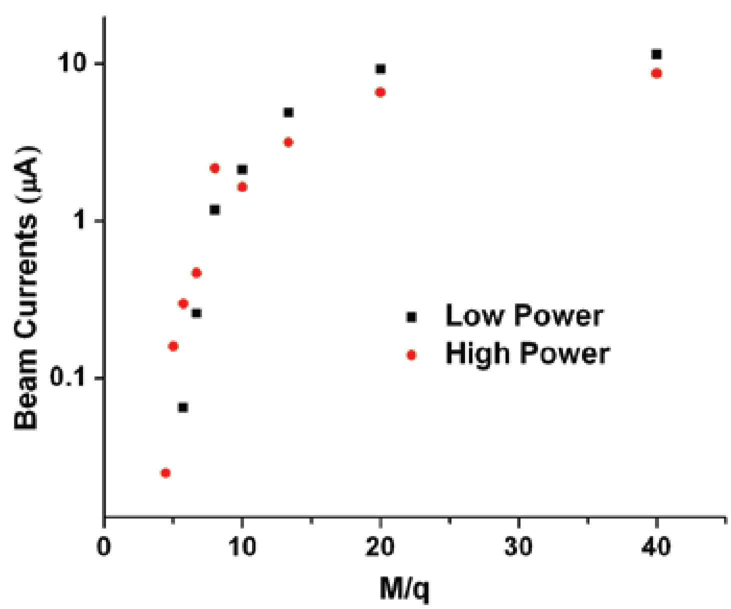


Fig. 3. Charge state distribution (CSD) of argon at E/q = 212 kV and two power levels (2 and 70 watt).

The LEIBF has been utilized fully by research community and system output has been quite well in this academic year. A student from IIT, Delhi studied formation of semiconductors on insulator (SOI) in great details using ion-cut process and completed his PhD. Three more users are about to submit their thesis on the research work completed using LEIBF. In past six months (July 2012 to February 2013), 13 research articles (known figure to us) were published in referred international journals.

1.2.2 Maintenance

Major maintenance work in this academic year includes dismantling of 400 kV accelerating column from beam line & its re-installation after sand blasting of its inner surface and repairing of 400 kV power supply. 400 kV accelerating column consists of 5 units (10 gaps in each unit). Due to quite high beam current through accelerating column, we could see signature of sputtering of metallic guard rings placed inside accelerating column which further caused deposition of metallic layer between insulating gaps and we could not raise high voltage beyond certain limit. Accelerating column was taken out of beam line for removal of deposited metallic layer. To avoid such problem in future, two apertures (at unit 1 and 3 from source side) were attached to the column before installing it again in the beam line. With aperture, total and analyzed beam currents reduced drastically but were sufficient for typical experiments proposed with LEIBF. Inner view of an accelerating unit is shown in figure 4.

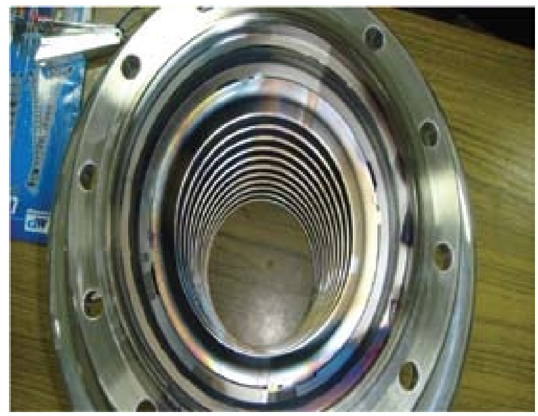


Fig. 4. Inner View of an accelerating unit. Beam marks on guard rings are clearly visible.

400 kV, 12 mA power supply procured from Glassman High Voltage Inc. suffered from voltage fluctuations during source operation. Also, we could not polarize the platform with more than 200 kV. Old 300 kV, 2 mA power supply was used to continue the source operation and user experiments. 400 kV power supply was shifted to ion source room of 15 UD Pelletron accelerator for maintenance. The power supply is repaired recently and test results with load are satisfactory. The other maintenance works include repairing of 10 GHz, 200 W travelling wave tube amplifier, magnetic scanner for beams at target and magnetic steerer power supplies.

1.2.3 Development

Indigenously developed interface crate, IMACS (indigenous measurement and control system) was installed on high voltage platform to control the source parameters through control computer (see details in section 3.1.1-- High Vacuum Laboratory). Voltage on the electrodes of electrostatic quadrupole doublet (EQD), previously controlled using field point modules, is being controlled now using IMAS and it has really made life comfortable in terms of beam tuning. Other major development work includes installation of BPM at the exit of accelerating tube, installation of new vacuum interlock system on high voltage platform and replacement of 2 inch travel Faraday cup by 4 inch cup in material science line.

ATMOL line was completed during this year. The cylindrical mirror analyzer was made operational in the surfaces sciences chamber using “Phoenix” data acquisition system. The time of flight system with position sensitive detector was also made operational. One user experiment on the dissociation of naphthalene molecules was successfully conducted. Pulsing of the low energy beam was also demonstrated using a high voltage pulser under an Indo-French collaborative project.

1.3 PELLETRON ACCELERATOR RBS-AMS SYSTEMS (PARAS)

1.3.1 Operation

Sunil Ojha

1.7 MV Pelletron accelerator and RBS facility was fully operational and performed quite well from April 2012 to March 2013. Around 1700 samples from 30 different Institutes, Universities and colleges were analyzed in this period. Main feature of this year's operation was increase in channeling measurements of single crystals to analyse ion beam induced amorphization and recrystallization. Channeling measurements were also carried out to confirm presence of impurities/dopants of low mass in high z substrate which is not possible by conventional RBS. Oxygen resonance measurements were carried out to analyse presence of oxygen on the surface of substrate. Composition analysis of nuclear physics targets were performed using RBS facility. The targets were in the form of thin films. Special target holder was fabricated for mounting these films.

Hydrogen profiling work with helium beam was initiated in this period. These measurements are done by placing targets in glancing angle and detector at forward angle. A Mylar foil in front of detector stops recoiled helium and allow hydrogen to reach detector.

1.3.2 Maintenance and Development

Sunil Ojha, S Gargari, R Joshi, M Sota, Bishamber Kumar, R P Sharma, V P Patel, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar, Pranav Singh, Ksh. Devarani Devi, S. Chopra and D Kanjilal

RBS facility is equipped with Rb charge exchange ion source. In the academic year 2012-13 maintenance of ion source was carried out thrice. These maintenances were carried out due to chocking of ion source by compounds of rubidium which is used for charge exchange purpose. All the parts of ion source were dismantled, cleaned properly and installed back. Rubidium was loaded in the end. Average lifetime of such ion source is 1200 – 1400 Hours.

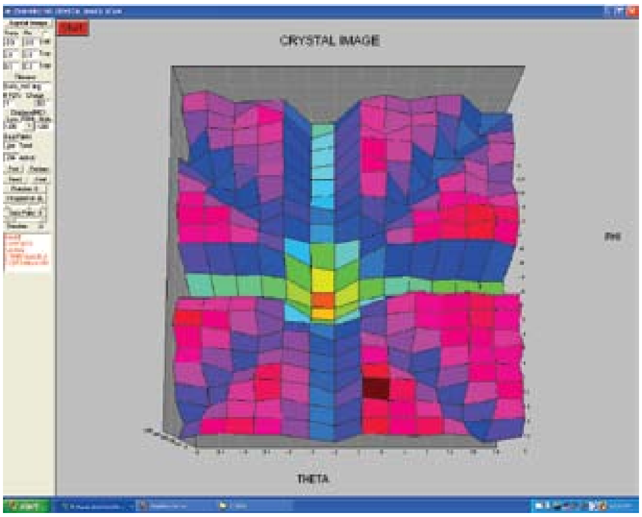


Fig. 1. Channeling image scan of GaAs (100) crystal

There was a breakdown in the power supply of switcher magnet due to overheating. An alternative power supply was provided by Beam Transport System (BTS) which ensured that RBS facility did not stop functioning. The power supply was repaired in house by BTS group and was made operational.

A leak had developed in one of the connectors joining helium bottle and ion source due to which we were losing helium gas. A filled bottle, which lasts for 3-4 months, got emptied within a week. Nothing appeared when we used soap bubble test to find leak location. Leak location and rate was found using helium leak detector in the sniffer mode. The leak rate was found to be in the order of 10e-4 torr-liters/sec. The connector was cleaned thoroughly and tightened properly, the leak rate dropped down and since then we have not witnessed any unusual drop in the pressure of helium bottle.

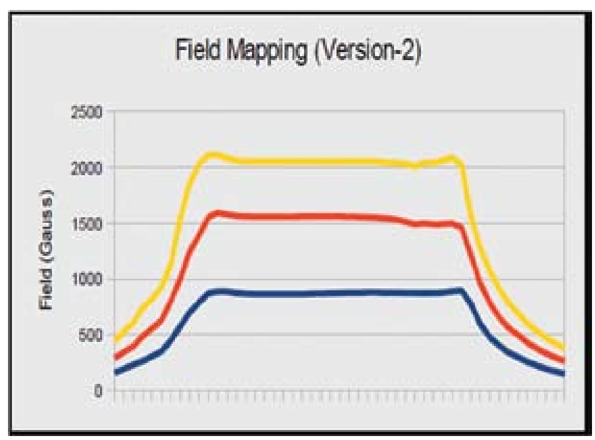
Power to the accelerator and accessories is provided via 3 phase step down transformer since all instruments adhere to American standards of voltage rating. During installation of accelerator a transformer was procured from local vendor which used to get heated up very fast. We had to provide extra cooling from outside by placing the transformer adjacent to the accelerator tank. Therefore we replaced this transformer with newly purchased one of ACME make. No external cooling is required in this transformer and it has been positioned appropriately.

1.4 DEVELOPMENT OF 50 KEV ION ACCELERATOR

Raj Kumar, R. Ahuja, C. P. Safvan

PERMANENT MAGNET BASED BENDING MAGNET

The bending magnet for 50 keV Accelerator has been re-designed and assembled using 50x25x10 mm permanent magnet pallets of 4 kG surface flux density. The new design uses 25 mm thick MS plates and a common hand wheel to vary the field in place of individual bolts for field variation. Shorting plates around the poles mounted on a common plate have been used to vary the field. The magnet has beam pipe of cross section 60x75 mm across the magnet with a bending radius of 200 mm. A maximum field of 2110 Gauss is achieved with this design which can be varied down to 900 Gauss by moving the hand wheel. Field mapping is carried out and found to have quite homogeneous field throughout the region between the poles as shown in the figure below.



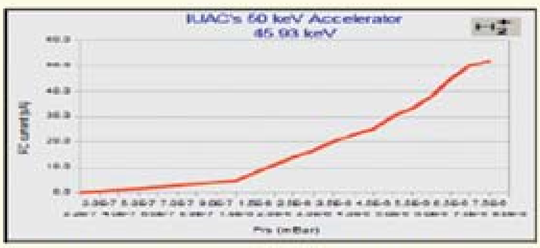
COMPLETION OF 50 keV ION ACCELERATOR

With development of new bending magnet & electrostatic quadrupole triplet etc the different components are assembled on a common stand. Penning ion generator is mounted at the inlet flange of quadrupole itself. The vacuum pumps, power supplies etc are installed, wired and tested. PLC based controller was assembled for controlling the electrostatic quadrupole. Complete Ion Accelerator with a gate valve & small experimental chamber is tested. Hydrogen & helium gas is used to produce beams. Performance tests are carried out at complete range of energy & current as shown in the figure. The long time stability tests are also performed.

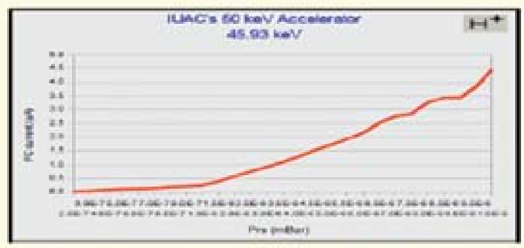
Front View

Back view

50 keV Ion Accelerator – Performance Curves

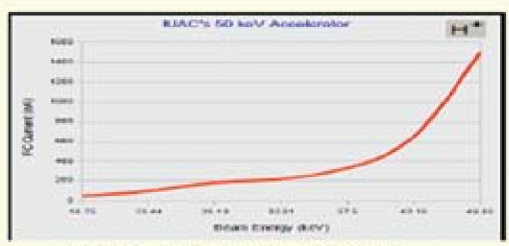


Beam Current Vs Source Prs. At 49 kV, 1721 G

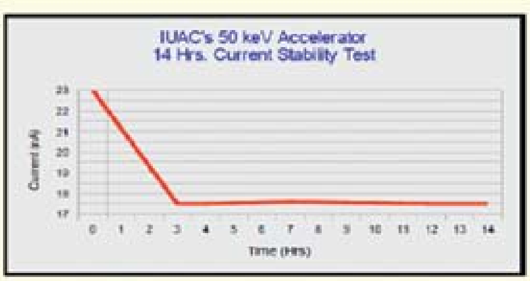


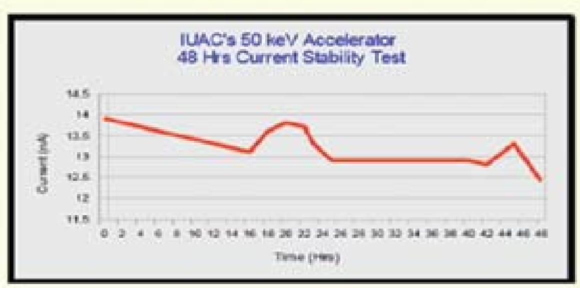
Beam Current Vs Source Prs. At 49 kV, 1230 G

Beam Energy Vs Current at fixed Prs.



Beam Energy Vs Current at fixed Prs.





Beam Current Stability Tests

General Specifications of 50 keV Ion Accelerator

Physical size without experimental chamber: 1600X700X1400 mm (WXDXH)

Weight: 500 kg

Power requirement: 900 watts peak at 240 VAC, 50 Hz

Vacuum pump requirement: 400 LPM Turbo pump with rotary pump.

Beam	Energy (keV)	Field (Gauss)	Current
H^{+}	45.93	1230	4.45 uA
H^{2+}	45.93	1721	52 uA
He^{+}	33.75	2110	43.5 uA
He^{2+}	91.86	1748	160 nA