1. ACCELERATOR

1.1 PELLETRON

1.1.1 Operational Summary

R Joshi

Performance of 15 UD Pelletron accelerator was quite satisfactory, from April 2013 to March 2014. There were total three tank opening maintenance, two unscheduled and a scheduled. The details of all three tank opening maintenance are mentioned in the maintenance section. The operational summary of the accelerator from April 2013 to March 2014 is mentioned below.

Total No. of Chain Hours	=	6807 Hours
Total Beam utilization	=	3811 Hours
Machine breakdown	=	0449 Hours
Accelerator Conditioning	=	0284 Hours
Beam Change Time	=	0012 Hours
Tank opening maintenance	=	1764 Hours
Beam tuning time	=	0181 Hours
Experimental setup time	=	0040 Hours
Accelerator set up time after maintenance	=	0052 Hours

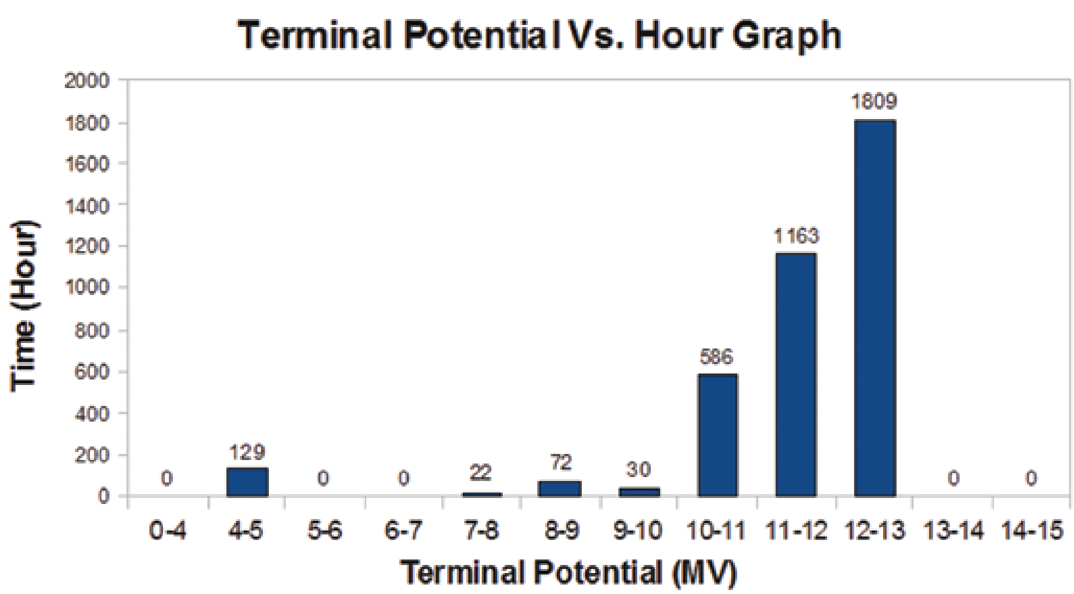

Fig. 1.

Total 477 shifts (1 shift = 8 hours) were used for experiment during the mentioned period. Out of these 477 shifts, 114 shifts were used for pulsed beam users. The machine up time for this period is 93.4% and the beam utilization is 55.99%. The voltage distribution graph of Terminal Potential used for different experiments during the above mentioned period is shown in figure 1. ^{32}S, 9^+, 127.6 MeV pulsed beam was delivered to user at maximum terminal potential 12.79 MV and ^{7}Li, 3^+, 20 MeV dc beam at the minimum terminal potential of 4.96 MV. Maximum terminal voltage achieved during conditioning in this year was 13.92 MV.

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

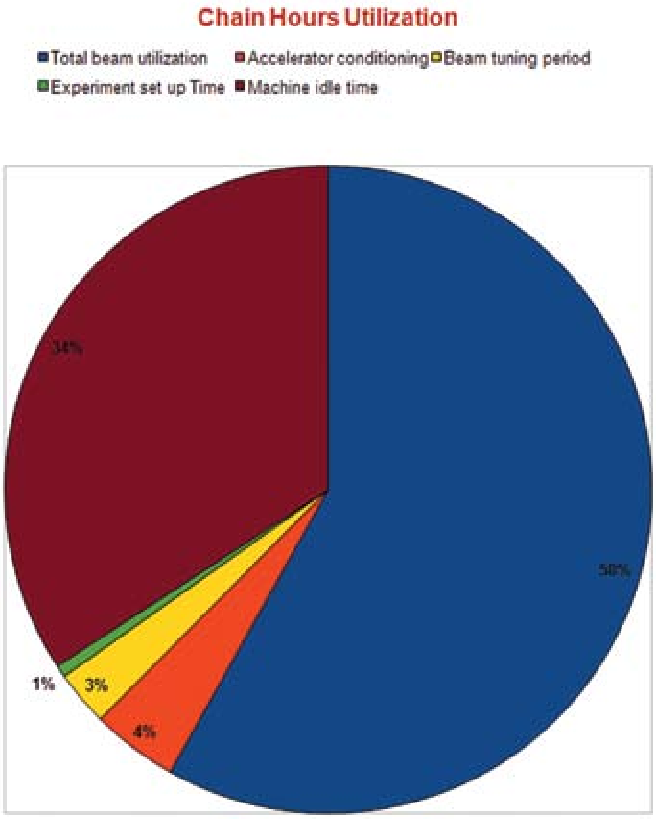

Fig. 2. Chain Hours Utilization

The total duration of beam run for mentioned period is 3811 hrs. Duration of run time in percentage for different ions is shown in table 1.

Table 1

Beam Delivered	Utilization (%age of total time)	Beam Delivered	Utilization (%age of total time)
^{7}Li	6.09%	^{30}Si	2.94%
^{10}B	1.64%	^{32}S	1.87%
^{11}B	3.27%	^{48}Ti	0.85%
^{12}C	9.53%	^{56}Fe	3.27%
^{13}C	0.50%	^{58}Ni	10.99%
^{16}O	17.87%	^{63}Cu	0.94%
^{18}O	2.09%	^{107}Ag	14.56%
^{19}F	11.48%	^{197}Au	9.91%
^{28}Si	2.19%		

Pi- chart in figure 3 shows the distribution of delivered beam species during beam run from 1st April 2013 to 31st March 2014.

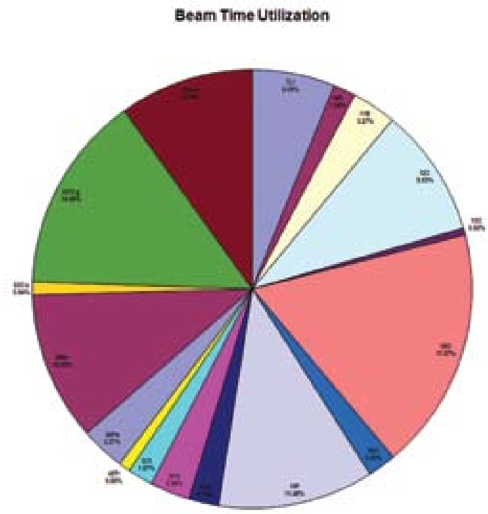

Fig. 3.

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, Rajveer, Abhilash, P Barua and A Kothari

There were three tank opening maintenance in the mentioned period. The first two tank opening maintenances were unscheduled. The reason for first unscheduled maintenance (from 25th April to 13th May 2013) was the fluctuations in charging system which resulted in beam instability. The second unscheduled maintenance, from 17th July 2013 to 22nd July 2013, resulted due to failure of all the devices installed in Low Energy Dead Section (LEDS) and in upper half terminal area (T-1). The last and third maintenance was started on 11th February 2014 and still continuing. Routine maintenance jobs like, foil stripper loading in terminal and High Energy Dead Section (HEDS), column support post and accelerating tube resistors maintenance, in tank ion pump maintenance and maintenance of rotating parts inside tank, were carried out in this scheduled maintenance. Apart from routine maintenance jobs, a few major maintenance jobs were also carried out, which are listed below.

Major maintenance jobs during scheduled tank opening maintenance:

Some problems also occurred during routine operation of machine which are mentioned below :

1) At the initial stage itself, unit #1 had to be shorted as sparking in this unit was observed from view port.
2) No current read back from column current in High Energy Section (HES).
3) Ion pump in HEDS (IP D-2) was not working.
4) Leaky pendulum valve in 02 area (BLV 02-3).
5) Vault BPM (BPM #5) was not working.
6) Terminal voltage was not going up properly and restricting at ~11 MV.

The major maintenance jobs carried out are listed below:

1. Testing performed before February 2014 scheduled tank opening maintenance

Analysis of all 30 accelerating units of 15 UD Pelletron

Towards the end of cycle, terminal was not holding potential higher than ~8 MV at CPS = 12 kV. Therefore, the testing of every unit, in adding mode, was done. At the time of testing units on high energy side, initially only unit #16 was kept alive and unit #17 to 30 were shorted with SS rods. Both the chains were put ON and unit #16 could able to hold >1 MV. Each and every unit was added one by one and tested after every addition. It was observed that up to unit # 26 addition of ~1 MV was observed in terminal voltage, but when unit #27 was added terminal voltage could not be increased by ~1 MV. This indicated that the problem was in unit #27. This testing continued for two days.

2. Column Support post (CSP) resistor network related problem

A few CSP resistor network values were quite different in unit #27 to 29. They measured between 200 Mega ohms to 600 Megs ohms. Also, these gaps could able to hold only 5 to 6 kV. These measurements justified the observations made during unit wise testing before opening the accelerator tank.

3. Charging system maintenance

Routine maintenance for both the charging systems was carried out. The terminal was shorted to ground potential and all the mounting nuts and bolts, of both the charging systems were checked and were tightened, if required. The condition of all the inductors, pick off wheels and pulleys, for both the charging systems, were in good shape.

Both the chains were run and condition of all idler wheels for both the charging system was checked. One of the idler wheels in the idler bracket of up – charge side for charging chain #1 was found to be out of shape completely. One of its edges got chipped off. This idler wheel was changed by a new one and aligned. Thereafter, both the charging systems were switched ON and checked. Charging chain #1 was touching only one idler wheel and charging chain #2 was touching two idler wheels in running condition occasionally. Both the charging systems were kept ON for two nights to check its mechanical performance. No idler dust was observed after these two overnight runs. Both the chains were properly cleaned and checked thoroughly. Semiconductor band of all the pulleys of both the charging systems were oiled with TP oil to reduce the friction between pulley and chain. This completed the charging system maintenance.

4. Maintenance of Rotating parts inside accelerator tank

Thorough maintenance of all the rotating parts, such as charging chain motors, rotating shaft motors, separator box assemblies for rotating shafts and blower motor was done. 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. Bearings of total number of sixteen separator boxes were replaced, eight in low energy side and eight in high energy side. Bearings of these assemblies were replaced by new bearings. All the repaired separator box assemblies were installed back after maintenance. Rubber coupler of a separator box assembly in high energy side (between unit #27 – 28) was found in broken condition, this rubber coupler was replaced by a new one.

Breaking of rubber coupler box of separator box between unit #27 – 28 caused discontinuation of rotating shaft drive from RS-2 motor. This resulted in failure of power generation from alternator in HEDS and therefore IP T-2 was not operating towards end of the operation cycle. All the motors inside tank were properly greased.

5. Replacement of Column Support Posts (CSP)

Before this scheduled maintenance, total number of twenty seven CSP gaps were shorted in Low Energy Side (LES) and fifteen gaps were shorted in High Energy Side (HES). These were shorted because some of them measured resistance of a few Gega ohms and others measured only hundreds Mega Ohms. Apart from their low resistance value, cracks were also observed across these gaps. Shorting of such kind of gaps, prevents their further damage. As one and a half unit, out of 15 units, got shorted in LES, it was decided to replace the CSP. Column support posts, whose gap resistors were in Mega ohms range were replaced. Gap resistance of all the CSPs, whose gaps were shorted, were measured for analysis and total number of TEN Column Support Posts (CSP) were replaced by new CSPs. Out of these ten, eight were in LES and two were in HES.

After replacement work, all CSPs were tested and all CSP resistors were mounted. After this replacement of CSPs, now the number of CSP gaps shorted in LES is only eleven and in HES it is only ten.

6. Corona probe maintenance

The condition of all seven corona probe needles was bad. Therefore all these needles were replaced by new needles.

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

Fresh stripper foils were loaded in terminal, and in High Energy Dead Section (HEDS). In terminal, 132 number of Laser Plasma ablated (LPA) foil strippers and 34 IUAC made stripper foils were loaded. HEDS were loaded by IUAC made stripper foils of thickness ~10 $\mu g/cm^2$. Whereas ~4 $\mu g/cm^2$ thickness stripper foils were loaded in terminal area.

8. Replacement of Pendulum valve by a manual valve

During routine operation of accelerator, vacuum of pre acceleration area (02 area) was going bad, to the order of 10^{-5} T, whenever pendulum valve (BLV 02-2) was closed. A leak was detected in the bellows of pendulum valve in closed condition. Therefore pendulum valve was kept open permanently for routine operation of accelerator. A turbo pump, of 250 l/s capacity, was also installed at the lower port of BLV 02-2 to take care of this leak. This temporary remedy held the vacuum of 02 area in the order of 10^{-7} T.

Pendulum valve BLV 02-2 was positioned between tank top and 02 area. This valve is also used to isolate pre acceleration (02) area and Low Energy Side (LES) of accelerator for maintenance purpose. Now, as BLV 02-2 has a leaky bellow it has to be removed from the beam line. In order to provide a valve between pre acceleration area and LES, it was decided to install a manual type 100 CF Ultra High Vacuum (UHV) Valve in place of BLV 02-2.

For this purpose a drift tube of proper length was fabricated, so that this drift tube and UHV valve could be accommodated in place of BLV 02-2. This newly fabricated drift tube was vacuum checked. The pendulum valve (BLV 02-2) was removed and drift tube along with the HV valve was installed in its place. After installation the leak check was done after baking. No leak was detected.

9. Replacement of equi-potential rings screws

Resistance was recorded between hoop screw and equi-potential rings was done from unit #1 to 9 and from unit #22 to 30, as the access to other units was not available. Total number of 154 hoop screws had higher resistance value, out of which 138 hoop screws had resistance in the range of kilo ohms, 15 had resistance in the range of Mega ohms and 1 screw was measuring infinity. Out of these high valued hoop screws around 50 were replaced by new screws. The remaining replacement will be done in future. All these hoop screws were replaced by new one after cleaning the hoop threads.

Maintenance during unscheduled tank opening maintenance:

There were two unscheduled tank opening maintenance during mentioned period. Both resulted due to breakdown of accelerator. These maintenance are mentioned below.

1. First unscheduled tank opening maintenance:

This maintenance took place in April 2013 and lasted for 19 days. The reason for this maintenance was beam instability. During one of the runs in April 2013, it was noticed that the beam could not be locked at FC 04-1 even for a few minutes. The reason for this was the fluctuation in chain #1 current from ~13 micro amp to 26 micro amp and sometimes even going up to as high as 32 micro amp. This fluctuation was appearing only whenever beam was being injected into the Pelletron accelerator. Without beam, the settling time of chain #1 current was quite high.

The problem was investigated thoroughly. Charging system #1 was cleaned thoroughly and its related capacitive gaps were checked. A minor improvement was observed in chain #1 current. Charging chain #1 was behaving normal without doubler. Doubler circuit was checked and it was found that the pick off wheel, related to doubler circuit, touched chain #1 in static condition and touches once in a while in running condition of chain. The position of this pick off wheel was adjusted and pushed near to chain #1 by couple of mm. This adjustment of pick off wheel position solved the current fluctuation problem in chain #1.

Apart from this another problem related to gas stripper operation was also encountered. The gas stripper valve was not operating properly. The replacement of card, which controls the opening and closing of gas stripper valve, solved the problem.

Rotating shaft in unit #4 got severely damaged due to spark. This rotating shaft was also replaced by a new one. Bearings for two numbers of separator box assemblies, for rotating shafts, between unit #4 – 5 and #5 – 6 were also replaced.

2. Second unscheduled tank opening maintenance:

This maintenance took place in July 2013 and lasted for 6 days. The reason for this maintenance was the failure of all devices installed in LEDS and terminal. Gas stripper was being used in a routine beam run on 17th July 2013. During this run, three in tank ion pumps (IP D-1, IP T-1 and IP T-2) and gas stripper in terminal stopped working. Also terminal voltage started falling down. As the three in-tank ion pumps were not pumping during gas stripper run, terminal might got discharged due to bad vacuum. The problem was thoroughly investigated which indicated that all the devices, for which power is driven from RS-1 shaft, were not working. Working of RS-1 motor was checked by measuring the load current, which was satisfactory. These results concluded that the problem is located inside the accelerator tank. Hence, the second unscheduled tank opening maintenance started on 17th July 2013.

After opening the tank it was noticed that rubber coupler, which connects the RS-1 to alternator in LEDS, broke into two pieces and Low Energy Dead Section (LEDS) was full of black dust generated from broken rubber coupler. This, broken rubber coupler, totally disengaged portion of shaft RS-1, between LEDS and terminal from RS-1 motor. Consequently, LEDS and T-1 alternator could not produce power for devices housed in LEDS and T-1 areas which resulted in the interruption of beam run. This broken rubber coupler was replaced to solve the problem.

In this tank opening, problem related to voltage read back of Electrostatic Quadrupole at LEDS (EQ D1-1) was also solved by replacing a light link card. Apart from this, gap #17 of column support post in unit #3 was also shorted, as the resistance value across this gap was low. A severe crack was also noticed in the ceramic of this gap.

Other maintenance jobs outside Pelletron Accelerator tank

1. Replacement of Beam Profile Monitor (BPM)

During a beam run, towards end of the cycle, Beam Profile Monitor (BPM), installed in vault area near image point of analyzer magnet (BPM #5), stopped working. This created problem in tuning the beam at vault faraday cup (FC 04-1). Although motor of this BPM was operating, but no fiducial signal was coming. Investigations lead to conclusion that vacuum bearing of this BPM got stuck causing no movement in BPM scanning wire. The head assembly of this BPM was replaced by new head assembly. As the alignment of its scanning wire was not proper, the scanning wire broke. On operating BPM #5, fiducial signal was appearing but there was no beam signal.

During scheduled tank opening maintenance, BPM #5 head assembly was opened again and new scanner wire was installed.

2. Maintenance of Vacuum related components

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

a) Maintenance of Sublimator pump in pre – acceleration section (SP 02-2)

Thorough maintenance of sublimator pump installed in pre – acceleration area (SP 02-2) was carried out. Inner wall of its body was properly cleaned and all of its three titanium cartridges were replaced by new cartridges. SP 02-2 was installed back, baked and leak tested. No leak was found.

b) Replacement ion pump for Multi Harmonic Buncher (MHB).

An ion pump of 320 l/s capacity is installed in 02 area. This ion pump is installed exclusively to take care of gas load which may have caused due to operation of MHB. During the routine operation, it was observed that this ion pump was not working. The resistance of the pump was measured with multimeter at its HV port and it measured a few ohms and with megger it was showing dead short. The magnets of pump were removed and its filaments were baked so that shorting track formed may get evaporated. Continuous baking of pump for around two days did not solve the problem. Hence it was decided to replace this pump.

As 320 l/s pump was not available, a recycled pump of 240 l/s capacity was tested and installed in the place of this faulty pump. The replaced pump and area was then baked and leak checked. No leak was found and the pump is now able to produce vacuum in the range of 10^{-7} T.

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

The ion source operation was quite satisfactory from April 2013 to March 2014 with only one breakdown. During this one year operation the new modified MC-SNICS was opened twice, once for breakdown maintenance and once for routine maintenance.

During a beam run, in last week of September 2013, it was noticed that the immersion lens assembly was not holding potential. This is the first break down of modified MC–SNICS source after one and half year of its installation. All the power supplies, related to ion source, were checked and all of them were working fine. Hence, it was decided to open the source for maintenance.

All the electrical connections of ion source were removed and the source was vented. 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 it was noticed that the ceramic studs holding the immersion lens had been shorted with the source body due to cesium deposition on the ceramic surface. All the parts of source were cleaned properly and the ceramic studs were replaced with the new ones. After this maintenance, the source was assembled again and its alignment was done with the help of alignment jig. The source was then put on HV deck and installed. Same cesium which was kept under argon atmosphere was loaded back. All the electrical connections were restored back. Thereafter source performed well with good efficiency.

The source was opened second time in the month of March 2014, for routine maintenance. This time also all the electrical connections of ion source were removed and the source was vented. The cesium was kept in Argon environment. Again the source was dismantled and all of its parts were cleaned thoroughly. The source was assembled, aligned and installed back after cleaning. New cesium ampule of 5 gm has been loaded after one year of operation.

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

911 hours of beam time was used for pulsed beam runs using multi harmonic buncher (MHB) along with low energy chopper and traveling wave deflector. All the pulsed beams from Pelletron, were utilized by users to perform experiments in different experimental lines. The beams bunched for these 911 hours were ^{7}Li, ^{11}B, ^{16}O, ^{19}F, ^{30}Si and ^{32}S. 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

Routine maintenance of chopper was carried out. 50 Ω pure resistance 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. Chopper tank circuit was then 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 were 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, Rajveer Sharma, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar, Pranav Singh, P Barua, A Kothari, M Archunan, Chandra Pal, Raj Kumar, U G Naik, A J Malyadri, Kundan Singh, D Munda, K K Soni, R Ahuja, S K Saini, B B Chaudhary and Sunder Rao.

The development activity done during mentioned period is mentioned below

Designing, installation, testing and commissioning of Negative Ion Implanter Facility at IUAC

Another useful facility, **Negative Ion Implanter Facility (NIIF)** is designed and installed at IUAC. This is totally new facility and can deliver energized negatively charged (from Lithium to Gold) particles having energy varying from 30 keV to 200 keV . First of all the total beam optics from negative ion source up to experimental chamber was calculated by using GICOSY software. Ion optics simulation had been performed for variable energies and ion masses. Simulation showed that transmission is improved only when the first quadrupole triplet after the accelerating tubes is in use. Nevertheless, there is a loss in transmission of the ion beam at the analyzer magnet. This beam optics is shown in figure 4.

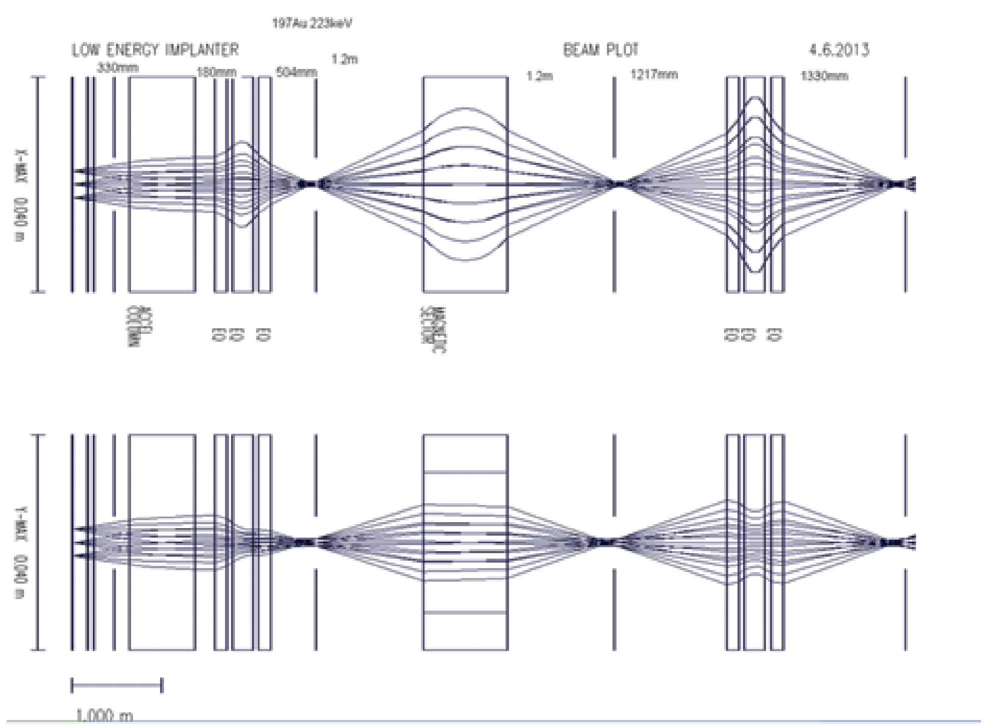

Fig. 4.

This facility is equipped with a sputter negative ion source called MC-SNICS (multi cathode source of negative ion By Cesium sputtering). 15UD Pelletron facility is now using a new modified MC-SNICS ion Source. The old MC-SNICS ion source, which was used earlier for Pelletron, has been used for this NIIF along with its electronics. High Voltage deck and analyzer magnet used in this facility are from old LEIBF. The components such as two numbers of electrostatic Quadrupole triplets, two numbers of electrostatic steerers and experimental chamber are designed and developed in IUAC. Three Faraday cups, a double slit, a single slit and three Beam Profile Monitors (BPM) have been procured from NEC, USA. Controllers, such as faraday cup controllers, Beam Line Valve (BLV) controllers, Mixer stage for electrostatic quadrupole triplets and electrostatic steerers are developed at IUAC.

The control system used for its operation is indigenously developed and named as Indigenous Measurement And Control System (IMACS). The facility has been tested with ^{12}C, ^{28}Si and ^{197}Au ion beam. The ion optics match with the simulated optics. The transmission of the ion beam improves with increase in energies of the ion beam. The maximum transmission observed was 90.66% with ^{197}Au negative ion beam at 100keV energy.

The features of Negative Ion implanter includes

1. Ion Implantation energies ranging from 30 KeV to 200 KeV
2. Negative, singly charged ions from sputtered negative ion source
3. Ion beam current up to 10uA (varies for different ion species)
4. Ion beam spot size is ~ 5mmX 5mm (variable with different energies)
5. Room temperature, high vacuum implants

The beam currents observed are as follows:

Species name	12C	28Si	197Au
Beam current (μA)	7.5	8	13

The detailed layout and installation of this facility is explained in the High Vacuum Lab section of this annual report.

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 air 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, U. K. Rao and D. Kanjilal

1.2.1 Operation

The performance of new low energy ion beam facility (n-LEIBF) in terms of ion beam development and delivery for user experiments has been very good in this academic year (2013-2014). About 80% of the lab time has been utilized to develop various ion beams for ion-collision experiments mainly in 90°

and 105° beam lines. Almost all sanctioned research proposals (~68) for the beam time allotment in the previous LEIBF workshop are completed in this year. The research findings of the experiments carried out using LEIBF are being published regularly in the refereed journals. To test the feasibility of new proposed experiments in various energy domains, charge state distribution studies of electron cyclotron resonance (ECR) plasma is extremely important. At moderate platform voltage and RF power, various ion beams of different charge states extracted from the ECR plasma are listed in Table 2.

Apart from the user support in the LEIBF, a few experiments on the ECR plasma diagnostics were conducted. Influence of the wave frequency on the shapes of oxygen and argon beams has been studied. The frequency was tuned around 10 GHz for which the cavity was designed. The oxygen beam shapes at the injection of different frequencies are shown in figure 5. The bigger shapes are for total beam and smaller one are for the analyzed beam (O^{+5}). The source parameters were optimized to maximize the analyzed currents.

The charge state distribution of xenon plasma was studied in correlation with anomalous effect observed in mixed oxygen, nitrogen and carbon ECR plasma. The ion source parameters were optimized for Xe^{+8}. The isotopic intensity ratio of xenon for different charge states is shown in figure 6. The anomalous effect was completely missing up to +13 charge state. Similar trends were noticed with oxygen mixing. However, a small influence of oxygen mixing on beam intensity of xenon beyond +8 charge state was noticed.

Ions\ Q	1+	2+	3+	4+	5+	6+	7+	8+	9+
H	47								
He	150	18							
B	4.5	1.5	0.2						
C	15	7		0.5					
N	45	23	6.5	2	0.4				
F	11	7	3.5	1.3	0.3				
O	70	32	9		1	0.2			
Ne									
Ar	50	36	17	7		4	2	1.5	0.3

Table 2: Intensity of various ion beams of different charge states extracted from the ECR plasma at moderate platform voltage and RF power

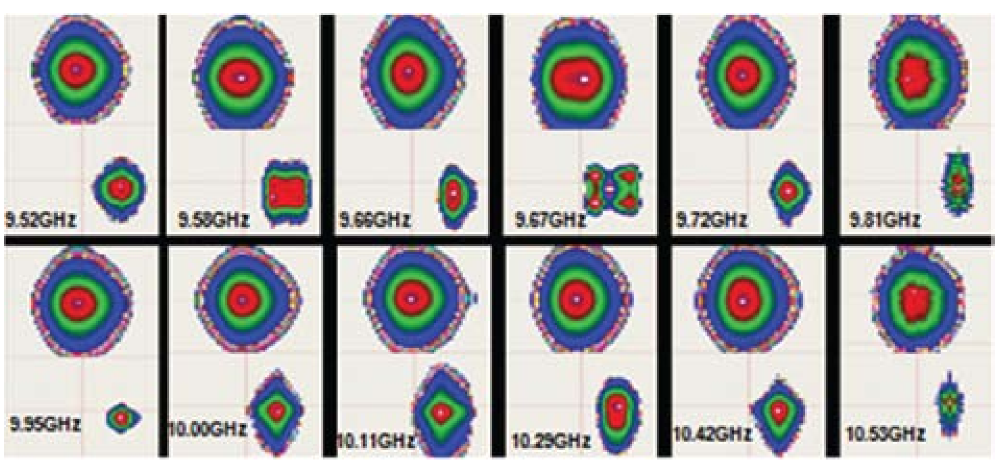

Fig. 5 The shapes of total and analyzed oxygen beams at the injection of different frequencies. The smaller shapes are of the analyzed beam (O^{+5}).

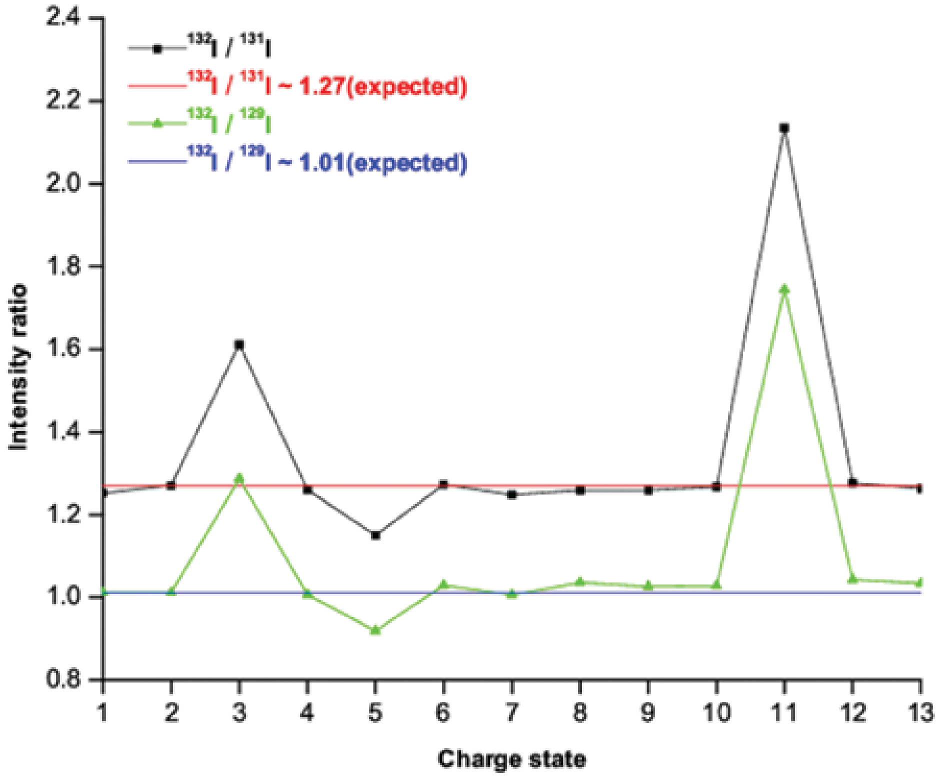

Fig. 6 Intensity ratio of xenon isotopes (I^{132}/I^{131} and I^{132}/I^{129}) for different charge states. The red and blue curves are expected ratios of I^{132}/I^{131} and I^{132}/I^{129} in the natural xenon.

1.2.2 Maintenance

In this academic year, electrostatic quadrupole doublet (EQD) installed after the extraction system was replaced with an Einzel lens. The EQD acts as a strong steer if beam deviates from the central trajectory. Due to this, post beam line components viz. guard rings of the accelerating column, aperture of beam profile monitor etc were getting exposed to the beam causing beam loss and instabilities. With Einzel lens, which provide gentle focusing effects, this problem has been minimized. Further, beam transmission was found to increase from ~ 37% to ~ 60%. The view of ECR ion source on the high voltage platform along with extraction and focusing system is shown in figure 7.

Fig. 7 Inside view of high voltage platform. The EQD (shown in left side image) has been replaced with Einzel lens (Right side image)

Other small maintenance work includes replacement of two subsections (total 5 sections) of the accelerating column, repairing of the gas dosimeter valve, replacement of the wave guide connector at the injection port, repairing of the RF amplifier, repairing of the 10 kV power supply etc. The ion source was opened twice in this academic year for thorough cleaning.

1.2.3 Development

The installation of 75^0 beam line is almost complete. Two experimental chambers have been already positioned. However, the polarization of the experimental chamber for deceleration of ion beams needs to be done. To promote research in ion beam induced nanostructuring of thin metallic films, a plasma coating unit (shown in figure 8) has been tested successfully. With this facility, thin films of Au, Cu and Ag can be prepared at present. A dedicated table for mounting the plasma coater is planned.

Fig. 8 Plasma coater for thin metallic film deposition

1.3 PARAS

1.3.1 Operation

1.7 MV Pelletron accelerator and Rutherford backscattering facility was in regular operation all year round. More than 2400 measurements were performed for users from 26 different Universities, colleges and institutes. Channeling measurements were performed on single crystals like silicon, germanium and gallium arsenide to measure beam induced defect generation and recrystallization.

RBS with $^4He^+$ ion beams, in many cases, is ineffective for light element (like C, N, O, ...) analysis due to overlapping signals and small scattering cross section. In such case nuclear reaction or elastic nuclear resonance (non-RBS or resonant RBS) scattering technique can be used to analyse the light elements. Elastic nuclear reaction is extensively used for the analysis of C, N or O in different samples of various IUAC users at 1.7 MV Pelletron Accelerator RBS lab. The alpha particle energy, chosen for the analysis of C, N and O, are 4.27, 3.69 and 3.05 MeV respectively. The backscattered alpha particles were detected by a surface barrier detector with scattering angle of 165° from the incident beam direction.

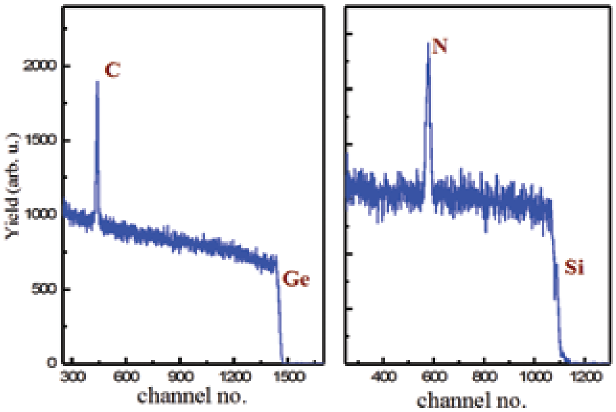

Fig. 9 Typical resonant RBS spectra for the analysis of C and N in different samples.

1.3.2 Maintenance

1.3.2.1 Ion Source Maintenance

1.7 MV Pelletron accelerator-RBS facility gas RF Charge exchange ion source produces negative helium ions. Average lifetime of such ion source is 1100 to 1400 hours. Regular maintenance is performed for upkeep of ion source. Last year ion source maintenance was performed twice (July-2013 and Jan-2014).

1.3.2.2 RBS facility maintenance

DUTEC400, the interface box which connects RBS end station to the data acquisition computer stopped functioning all of the sudden. It was observed that one of the transformers in the box was burnt. This transformer was providing power to various components in the interface box. Initially the facility was made operational by providing external power supplies. Facility was operational in such set up for some time. Later suitable transformer was procured and installed.

1.3.3 Development

1.3.3.1 Installation of an electron suppressor

An electron suppressor is designed and installed in the existing scattering chamber of 1.7 MV Pelletron Accelerator RBS lab. The bias to the suppressor has been optimized by recording the spectra with various bias voltages. After the installation of the suppressor a test run was made using Si samples and the backscattering yield from Si samples showed a good agreement with the collected charge. This setup has improved the quality of the ion beam analysis. The testing of suppressor and the recorded RBS spectra are shown in the Fig. 10

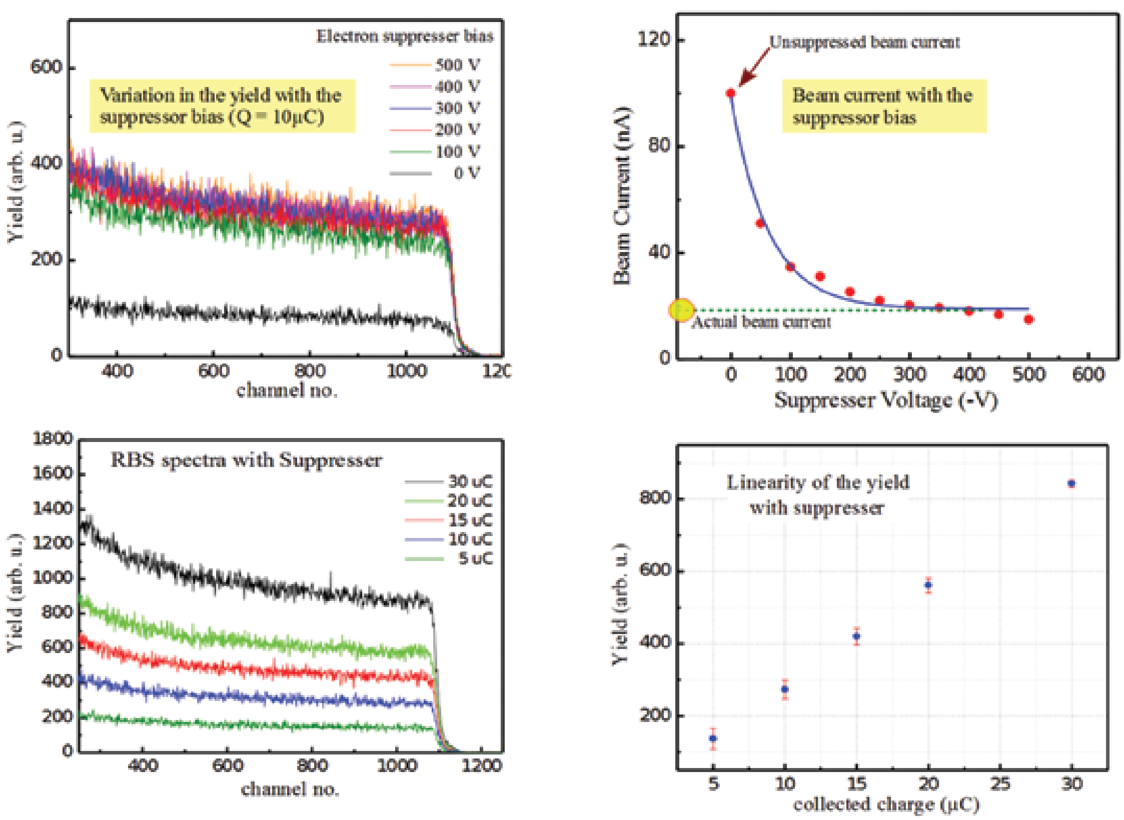

Fig. 10 Testing of electron suppressor and RBS spectra using Si samples.

1.4 DEVELOPMENT OF 50 KEV ION ACCELERATOR

Raj Kumar, Rajeev Ahuja C P Safvan

The development and improvement of the 50 keV accelerator has been continued. It was originally designed for producing Hydrgen and Helium ions at 30-50 kV. The ion source and extraction system were modified to enable the use of lower acceleration voltages. This included the modification in the high voltage divider chain and the installation of an einzel lens. The magnetic field was also increased by the addition of magnetic pallets.

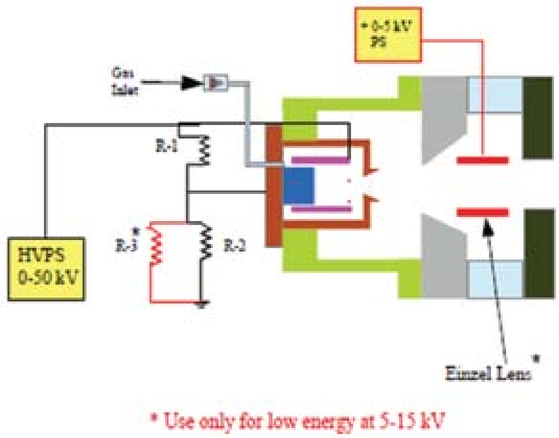

Fig. 11 Schematic diagram of PIG Ion Source

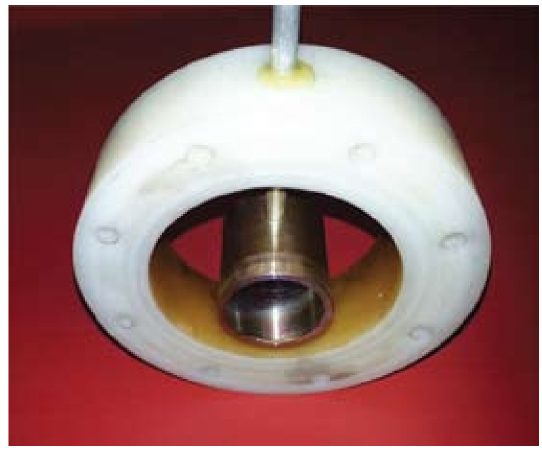

Fig. 12 Einzel Lens

By doing the above modifications we have successfully delivered low energy beams in the energy range of 6 – 12 keV of Nitrogen, Oxygen & Neon. The low energy beams have been used by various users as shown in user's list for creating ripples at surface & studying optical properties etc.

Beam Energy Range & Beam Current		
Beam	**Energy Range (keV)**	**Max. Current (μA)**
H^+	23 – 47	4.45
H_2^+	14 – 47	52
He^+	14 - 34	43.5
N^+	12	1.5
O^+	12	1.5
Ne^+	6.8	8

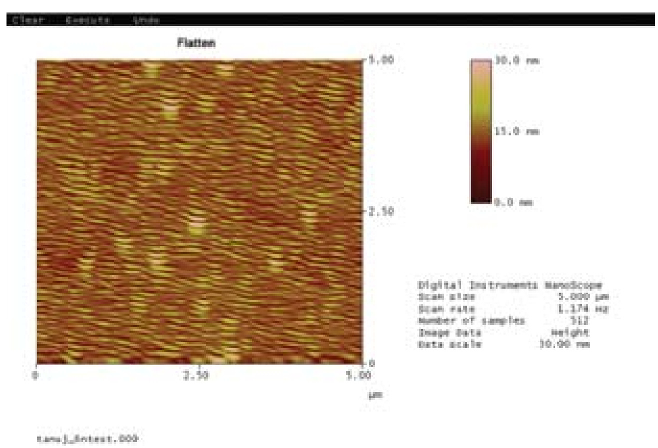

Fig. 13

List of Users

S. No.	Date	Name of User	Affiliation	Beam	Target
1	14/08/13	Ms. Manju Bala	IUAC/ JNU	31.5 keV, H^+	PbTe on Quartz
2	15/08/13	Ms. Manju Bala	IUAC/ JNU	31.5 keV, H^+	PbTe + 5% Ag
3	17/12/13	Tanuj	IUAC/JNU	6.5 keV, N^+	Silicon 100
4	02/01/14	Tanuj	IUAC/ JNU	8.5 keV, Ne^+	Silicon 100
5	15/01/14	Saif	IUAC	8.5 keV, Ne^+	FTO coated glass
6	22/01/14	Indra Sulania	IUAC	8.5 keV, Ne^+	(InP)100, (Ge)100
7	06/02/14	Saif	IUAC	8.5 keV, Ne^+	Quartz
8	13/02/14	H Arul	VIT Vallore	42.35 keV, H^+	LHM, ZNO, $BiMnO_3$, 17 samples
9	18 to 21/03/2014	K. Phaneendra	IUAC	43.5 kV, H^+	M2B2 6 samples
10	25/03 to 02/04/2014	Tanuj	IUAC	7 keV, Ne^+	Silicon 100 Ar^+ (2 Samples)
11	11 to 21/04/2014	Tanuj	IUAC	7 keV, Ne^+	Silicon 100 (4 samples)
12	21 to 24/04/2014	Tanuj	IUAC	7.76 keV, Ne^+	Silicon100 1 sample
13	24 to 26/04/2014	Tanuj	IUAC	8.47 keV, Ne^+	Silicon100 2 samples
14	01/05/14	Anitha A. C.	Alagappa University, Tamilnadu	12 keV, N^+	Tungsten Trioxide on Glass & Silicon 100