

1. ACCELERATOR

1.1 PELLETRON

1.1.1 Operational Summary

R Joshi

Performance of 15 UD Pelletron accelerator was quite satisfactory, from 1st April 2014 to 31st March 2015. There was only one scheduled tank opening maintenance, during the mentioned period. The details of scheduled tank opening maintenance are mentioned in maintenance section. The operational summary of the accelerator from April 2014 to March 2015 is given below.

Total No. of Chain Hours	=	7759 Hours
Total Beam utilization	=	5081 Hours
Machine breakdown	=	0124 Hours
Accelerator Conditioning	=	0612 Hours
Beam Change Time	=	0017 Hours
Tank opening maintenance	=	0881 Hours
Beam tuning time	=	0316 Hours
Experimental setup time	=	0049 Hours
Accelerator set up time after maintenance	=	0148 Hours

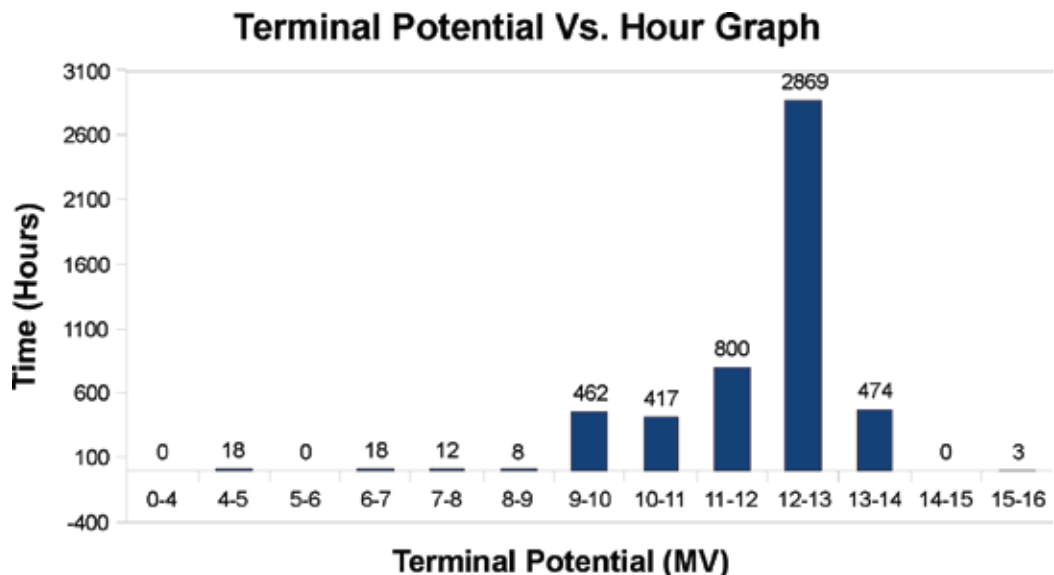


Fig. 1.1.1 Terminal potential vs. hour graph

Total numbers of 636 shifts were used for experiments during mentioned period. Out of these 636 shifts, 241 shifts were used for pulsed beam users. The machine up time for this period is 98.4% and the beam utilization is 65.49%. The voltage distribution graph of Terminal Potential used for different experiments during above mentioned period is shown in figure 1.1.1. ^{19}F , 9^+ , 121.5 MeV DC beam was delivered to user

at maximum terminal potential 13.5 MV and ^{12}C , 4+, 25 MeV DC beam at the minimum terminal potential of 4.99 MV was delivered to user. Maximum terminal voltage achieved during conditioning in this year was 15.4 MV. ^{16}O , 6+, 105 MeV DC beam was also tuned up to vault area, at Terminal Potential of 15 MV, for testing. The beam for this testing was quite stable for ~4 hours. Figure 1.1.2 shows the Chain hours utilization for mentioned period.

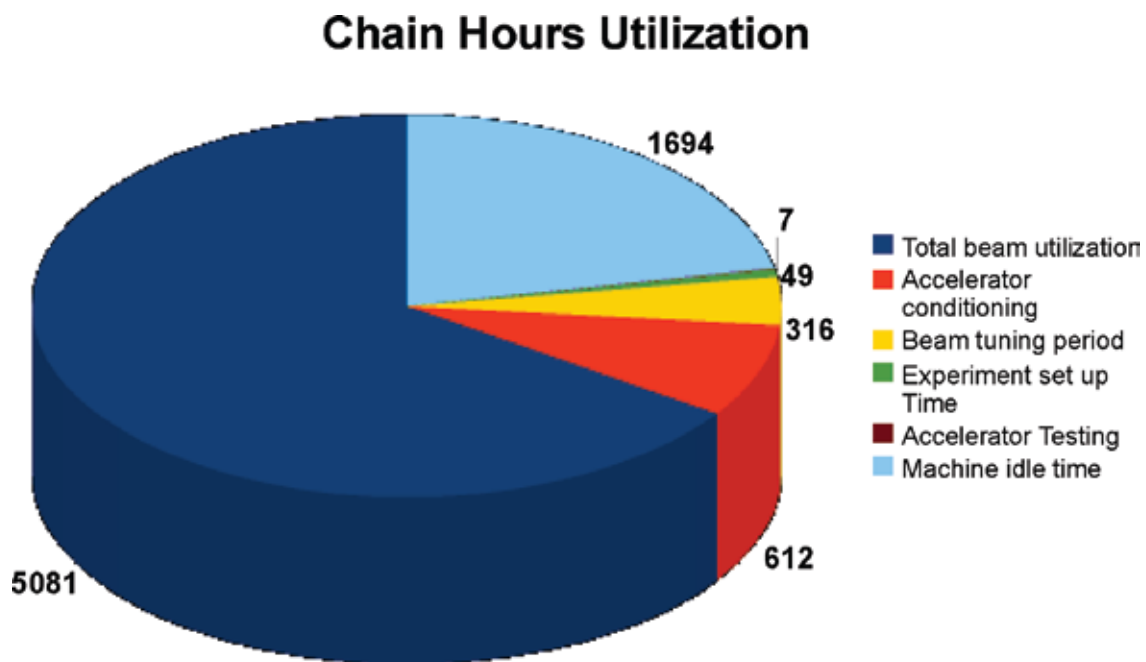


Fig. 1.1.2 Chain hours utilization

Duration of beam run time in percentage, for different ions species, is shown in table 1.

Table 1

Beam Delivered	Utilization (%age of total time)	Beam Delivered	Utilization (%age of total time)
^7Li	2.24%	^{48}Ti	8.75%
^{10}B	0.74%	^{51}V	0.80%
^{11}B	5.90%	^{56}Fe	0.52%
^{12}C	6.19%	^{58}Ni	6.74%
^{13}C	0.79%	^{79}Br	0.79%
^{14}N	0.24%	^{107}Ag	14.69%
^{16}O	11.93%	^{120}Sn	1.70%
^{18}O	3.12%	^{127}I	0.18%
^{19}F	12.92%	^{184}W	0.37%
^{28}Si	12.94%	^{197}Au	6.55%
^{30}Si	1.93%		

Pi- chart in figure 1.1.3 shows the distribution of delivered beam species during beam run from 1st April 2013 to 31st March 2014.

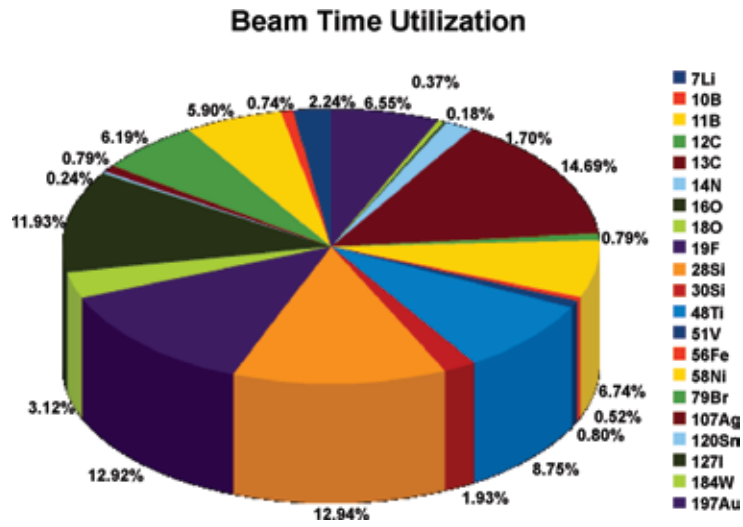


Fig. 1.1.3 Beam Time Utilization

1.1.2 MAINTENANCE AND DEVELOPMENT ACTIVITIES

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 Sharma, Pankaj Kumar, Abhilash, P Barua, A Kothari, S Chopra and D. Kanjilal

There was only one scheduled tank opening maintenance during 1st April 2014 to 31st March 2015. The 15 UD tandem was operational for users, from 24th April 2014 to 1st December 2014. During this period it operated satisfactorily and accelerator was stopped for maintenance on 3rd December 2014. This maintenance was performed from 3rd December 2014 to 2nd January 2015. On 7th April 2014, the tank was closed after last tank opening maintenance (from 11th February 2014 to 7th April 2014). Therefore, from 1st April 2014 to 7th April 2014, was the period of last year's scheduled tank opening maintenance and duration from 8th April 2014 to 23rd April 2014 was utilized for high voltage conditioning of terminal.

Terminal potential stabilization Control system (TPS 5.5) was tested before tank opening and its performance was satisfactory. Routine maintenance jobs like, foil stripper loading in terminal, 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 few major maintenance jobs were also carried out, which are listed later.

Few other maintenances listed below were also performed as operational problems occurred during routine operation.

- 1) Ion pump in Low Energy Dead Section (LEDS), IP D-1 was not working.
- 2) Beam Profile Monitor in pre-acceleration section was not working.
- 3) Data saving problem in Shaft Encoder – 2 (SE-2) at control console.

Apart from above mentioned problems, further elongation of charging chain #1 (if any), had to be looked into.

The major maintenance jobs carried out are listed below:

1. 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, as required. The condition of all the inductors, pick off wheels and pulleys, for both the charging systems was checked. Although both the chains were cleaned, the condition of chain #1 is still not good. An appreciable amount of idler dust was seen on the surface of chain #1.

To check the elongation of charging chain #1, the position of chain #1 w.r.t. tank bottom, was measured in both ON and OFF conditions. These readings were compared with earlier readings and found that position of chain #1 got lowered by ~7 mm. However, for removal of a chain pellet, it has to be lowered by minimum ~18 mm. Therefore, a pellet cannot be removed from chain #1.

Both the chains were run and condition of all idler wheels for both the charging system was checked. In case of charging system #1, one of the idler wheels in the idler bracket of up – charge side in unit #18, one idler wheel in the idler bracket of up – charge side in unit #22 and One of the idler wheels, in the idler wheel bracket for chain #1 on down – charge side in unit #18 were found to be out of shape completely. The edges of idler wheels in up – charge side got chipped off. Both of these idler wheels are on the same line. It seems that these idler wheels are responsible for the generation of idler dust. All three damaged idler wheels, in charging system #1, were replaced by new idler wheels and aligned. After replacement of these wheels, chain #1 was operated. It was observed that none of the idler wheels were touching the chain #1 in running condition but charging chain #2 was touching two idler wheels. The movement of all the idler wheels was smooth.

Both the charging systems were kept ON for four overnights to check its mechanical performance. No idler dust was observed. Both the chains were properly cleaned and checked thoroughly. As the cleaning condition of chain #1 was not good (idler wheel material got stuck on chain #1 pellets), chain #1 had to be cleaned many times. Semiconductor band of all the pulleys of both the charging systems were oiled with TP oil to reduce the friction between pulley and chain. Pillow blocks and chain motors of both the charging systems were properly greased. All of these steps completed the charging system maintenance.

2. 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.

All the rotating parts inside tank were checked thoroughly for maintenance. Bearings of total number of eight separator boxes, five in low energy side and three in high energy side, were replaced. Bearings of these assemblies were replaced by new bearings. All the repaired separator box assemblies were installed back after maintenance.

3. Generating Voltmeter (GVM) maintenance

GVM motor was switched ON for testing. It was observed that the GVM motor was rotating with dry bearing sound. The GVM assembly was taken out and this faulty motor was replaced by another repaired one. The GVM assembly was installed back after its maintenance. The GVM motor was rotating at 2997 RPM instead of 3000 RPM. The running of GVM motor was tested and it worked satisfactorily.

4. Corona probe maintenance

The condition of all seven corona probe needles was good. Therefore, none of the corona needles were replaced.

5. Stripper foil loading in terminal

Fresh stripper foils were loaded in terminal. This time only IUAC made stripper foils were loaded in terminal area and their thickness was $\sim 4 \mu\text{g}/\text{cm}^2$.

6. Maintenance of offset quadrupole power supply

Problem was encountered while testing the offset quadrupole +X power supply (+EQX T-1). All other three power supplies related to offset quadrupole were working satisfactorily. The output of +XkV power supply of offset quadrupole was not going beyond $\sim 22\text{kV}$ whereas this power supply must vary from 0 kV to 60 kV. This power supply plays important role during double stripper operation (in terminal and HEDS). The problem was analyzed and found that the power supply itself was faulty. This power supply was replaced by another repaired power supply and tested. The power supply worked satisfactorily and later on this faulty power supply was repaired.

7. Repairing of Column Support Post (CSP) gaps

The condition of CSP and accelerating tubes should be good for stable operation of tandem accelerator. Each and every CSP and accelerating tube ceramic gaps must have high insulation (in the order of hundreds of gega ohms) and be able to handle rated high voltage without breakdown. If the condition of any of the these gaps is not good, the high voltage field, which accelerates the ion beam, will not hold.

During inspection, it was found that total number of four CSP gaps were not in good condition. Four of the CSP gaps, two in LES and two in HES, were measuring lower insulation across their gaps. These gaps were in unit #2, 11, 27 and 28. None of these gaps could be repaired, hence were shorted. At present, total numbers of 25 CSP gaps have been shorted (13 in LES and 12 in HES).

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. An ion pump controllers was repaired. Apart from these, few maintenance works were also carried out which are mentioned below.

a) Maintenance of Sublimator pump in pre – acceleration section (SP 02-1)

Thorough maintenance of sublimator pump installed in pre – acceleration area (SP 02-1) was carried out. The titanium cartridges of SP 02-1 were also replaced. Its controller was checked thoroughly and high ripple was found in the power supply. Its filter capacitor was replaced to take care of ripple.

b) Replacement of Ion Gauges

Three ion gauges, one in ion source area (IGC 01-1), one in pre-acceleration section (IGC 02-1) and one in post-acceleration section (IGC 03-1), were replaced by new gauges along with their controllers. Necessary corrections, in data base, were also incorporated for their proper pressure read back. Functioning of all these IGCs were checked and its found to be satisfactory.

2. Problems related to ion source functioning

a) G P Tube sparking problem

Sparking problem in the G P Tubes, at 200 kV, in ion source room restricted the functioning of ion source. This problem was looked into and found that the fifth gap of third G P Tube, from ion source deck side, was sparking. Thorough cleaning of this ceramic gap and its corresponding resistance was done. This improved the voltage holding capacity and G P Tube could hold 250 kV.

b. Problem related to cathode position change

The cathode position of MC-SNICS could not be changed remotely. The problem was located in the spark protection card. This card was replaced to solve the problem.

3. Problem related to Beam Profile Monitor (BPM)

One of the BPM station selectors was not functioning properly. Rotary switch (1-Pole 4-Way) of this BPM selector was replaced to solve the problem.

Beam Profile Monitor before injector magnet (BPM 01) stopped working. Its motor was replaced to solve the problem.

4. Maintenance of SF₆ gas reservoir tanks

The condition of all five SF₆ reservoir tanks was bad. The surfaces of all these tanks were rusting from many places. It was decided to paint these tanks along with their supporting structures, after proper surface treatment. The painting work of all these tanks and their structures was completed.

1.1.3 ION SOURCE ACTIVITIES

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

The ion source operation was quite satisfactory from April 2014 to March 2015. There was no breakdown of ion source during this period.

The source was opened in the month of December 2014, for routine maintenance. 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 was not loaded and continued with the old cesium.

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.

1.1.4 BEAM PULSING SYSTEM

R Joshi, M Sota, V P Patel, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar, Pranav Singh, A Sarkar and Sarvesh Kumar

Operation

A total of 1928 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 1928 hours were ^{11}B , ^{16}O , ^{18}O , ^{19}F , ^{28}Si , ^{30}Si and ^{48}Ti .

^{16}O beam was used for the testing of MHB along with chopper for 17 hours. 499 hours of pulsed beam was utilized for LINAC operation. Out of these 499 hours, 189 hours were used for LINAC tuning and remaining 310 hours beams were delivered to users, after boosting beam energies using LINAC. Energies of ^{28}Si and ^{48}Ti beams were boosted by using LINAC.

Remaining 1412 hours, pulsed beam from Pelletron, was utilized by users to perform experiments in different experimental lines. The beams bunched for these 1412 hours were ^{11}B , ^{16}O , ^{18}O , ^{19}F , ^{28}Si and ^{30}Si .

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. A 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. The 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 was checked. The performance of TWD electronics was satisfactory.

1.1.5 Low Energy Negative Ion Implanter Facility

K Devarani, M Sota, 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, Kundan Singh, D Munda, S Gargari, S Ojha, R Joshi and S Chopra,

This newly installed facility had performed well. It can deliver wide varieties of ion beam from ^7Li to ^{197}Au having energies 30keV to 200keV. Initially, the ion beams (^7Li to ^{197}Au) were accelerated to energies upto 200keV to test its feasibility in various energy domains. The ion beam energies for the higher masses (eg. ^{197}Au) were restricted at 100keV as the existing analyzer magnet could not handle more than 76% of its maximum magnetic field (1.4Tesla). A survey on radiation level had been conducted when ^{12}C , 200keV ion beam was accelerated with its maximum output (FC-011 current=22uA). The maximum radiation level was observed as 600uR/hr at FC-011 and that of the magnet entry as 400uR/hr. After getting clearance from the Health physics group, this facility had been put into operation for regular ion implantation process. During the academic year (2014-2015), 460 samples were implanted with ion fluences varying from 1×10^{10} to 5×10^{17} ions/cm². The ion beam delivered to user during this year were ^7Li , ^{11}B , ^{12}C , ^{16}O , ^{28}Si , ^{31}P , ^{56}Fe , ^{58}Ni , ^{59}Co , ^{107}Ag , ^{197}Au and SrF_3 . The energies of the ion beam were of 40 to 200 keV. The user community comprises of 18 different colleges, universities and institutes.

Apart from the ion implantation, a few ion beams (Pb, Tb, Ge) had been tried to develop. ^{74}Ge could be developed.

In regular routine maintenance, the ion source was opened once for thorough cleaning. There was a breakdown in ion source due to blockage of cesium passage pipeline. The blockage had to be drilled and then, the cesium passage was cleared. The air circulation in the high voltage room is not good. During the rainy season, due to moisture capture, the accelerating tubes suffered from lowering its holding capability of higher voltage. There were minor breakdown in control system. This had been rectified from time to time.

1.1.6 Utilization of Beam runs using 15 UD Pelletron Accelerator & LINAC

The utilization of beam time by different users, using facility at IUAC, New Delhi is mentioned below. Field wise utilization and user wise utilization of beam time are shown in figure 1.1.4 and figure 1.1.5 respectively. List of users from different universities, colleges, IITs etc. are tabulated in table 2.

Fieldwise Breakup of Utilized Beam Time

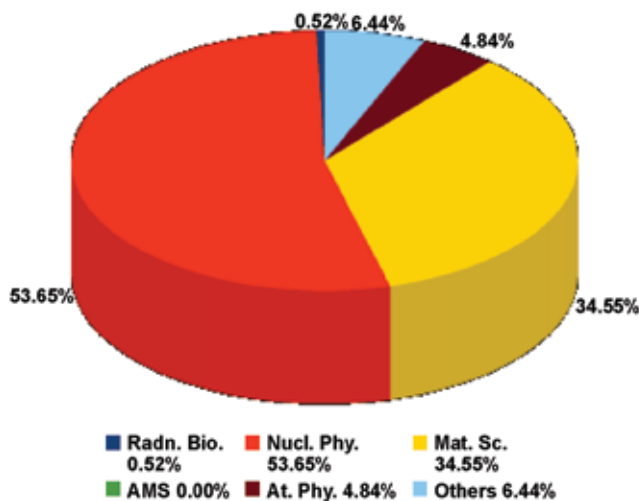


Fig. 1.1.4 Fieldwise breakup of utilized beam time

Userwise Breakup of Utilized Beam Time

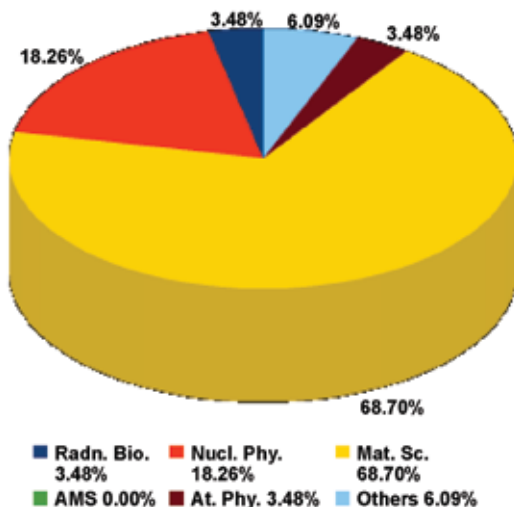


Fig. 1.1.5 Userwise breakup of utilized beam time

Table 2. User List : April 2014 to March 2015

Sr. No.	University / Institute / College	Shift Utilized
1.	Alagappa University, Karaikudi	2
2.	Allahabad University	2
3.	Aligarh Muslim University	47
4.	Anna University, Chennai	9
5.	ASE, Bangaluru	3
6.	Bangalore University	3
7.	BARC, Mumbai	10
8.	Chennai University	2
9.	DA University, Indore	4
10.	DTU, New Delhi	3
11.	Delhi University	53
12.	Devi Ahilya University, Indore	4
13.	Dr. BAMU, Aurangabad	7
14.	FLNR, Russia	19
15.	G B Pant University	3
16.	Guru Nanak Dev University, Amritsar	2
17.	Gauhati University, Assam	16
18.	GGSIPU, Delhi	2
19.	GNGC, Ludhiana	18
20.	Gujrat University	3
21.	Guru Nanak Girls College, Ludhiana	19
22.	Himachal University, Shimla	2
23.	HNBG, Tehri Garhwal	7
24.	Hyderabad University	6
25.	IIT, Allahabad	3
26.	IIT, Rajasthan	3
27.	IIT, Roorkee	1
28.	IIT, Delhi	3
29.	IPR, Gandhinagar, Gujrat	11
30.	Indian School of Mines, Dhanbad NIMS, Japan	6
31.	ISRO, Bangalore	5
32.	IUAC	98
33.	IUAC (students)	95
34.	Jamia Milia Islamia University, New Delhi	6
35.	Calicut University, Kerala	12
36.	KIIT University, Bhubneshwar	2

37.	Lalbag College, Kolkata	12
38.	Maharshi Dayanand University, Rohtak	3
39.	Manav Rachna University, Faridabad, Haryana	4
40.	MNIT, Jaipur	9
41.	Bombay University, Mumbai	3
42.	NIT Srinagar, Jammu and Kashmir	4
43.	Osaka University, Japan	3
44.	PRL, Ahmedabad, Gujrat	7
45.	Pune University, Pune	2
46.	Punjab University, Chandigarh	62
47.	S K University, Anantpur	5
48.	Saurashtra University, Rajkot	1
49.	St. Petersburg Polytechnic University, Russia	4
50.	Tezpur University, Assam	3
51.	M S University, Baroda	5
52.	VECC, Kolkata	18

1.2 LOW ENERGY ION BEAM FACILITY

1.2.1 ECR source based positive ion facility

The Electron Cyclotron Resonance ion source based facility continued to provide ion beams throughout the year for scheduled experiments. All the beam times requested by the users as part of the AUC 56 and AUC 57 were successfully delivered. During this year, there were a few minor maintenance jobs performed. As part of major facility improvements, the ion source was re-aligned with other beam line components, especially the magnet which required removal and re-installation of beam line components. At the same time DC bias tube, which is placed at injection side of the ion source has been replaced by a new one. The function of DC bias tube is to confine the electron density and populate high charge states. The length of old DC bias tube was significantly reduced due to sputtering by high energy electrons. After putting this new bias tube, there is no need to put more power inside the source to populate high charge state of high intensity. Due to large output beam current, the sputtering of aperture of the electrostatic quadrupole triplets (EQT) resulted in electrical shorting of the insulating gaps placed between poles and body of EQT above 7kV. Two new EQTs were installed, each in the main line and in the 90 degree line with cone shape apertures, to prevent further sputtering.

Another major development was the installation of a dehumidifier in the shielded high voltage area of the source. The new dehumidifier maintains humidity between 35 to 45 %. High humidity in the source area was causing blackening of the accelerator tubes. These tubes were cleaned by sand blasting and reconditioned. This has resulted in stable operation of the source and an improvement in the stability of high voltage power supply beyond 300kV. In brief, the overall operation of the facility was good. About 82% of the beam time was used to provide experimental beam time and about 14% was used for development activities like testing of the ECR source, development of new beams and the commissioning of the decelerator setup in the 75 degree line.

In addition, the composite ECR plasma was studied in detail. The charge state distribution of krypton plasma was studied in correlation with anomalous effect observed in mixed oxygen, nitrogen and carbon ECR plasma. Last year, we studied ECR plasma of Kr isotopes and found that the intensity ratios were

decreasing with charge state up to charge state 13+ for mass 82 and 83. The ion source parameters were optimized for Kr+8. The isotopic intensity ratio of krypton for different charge states is shown in following figure.

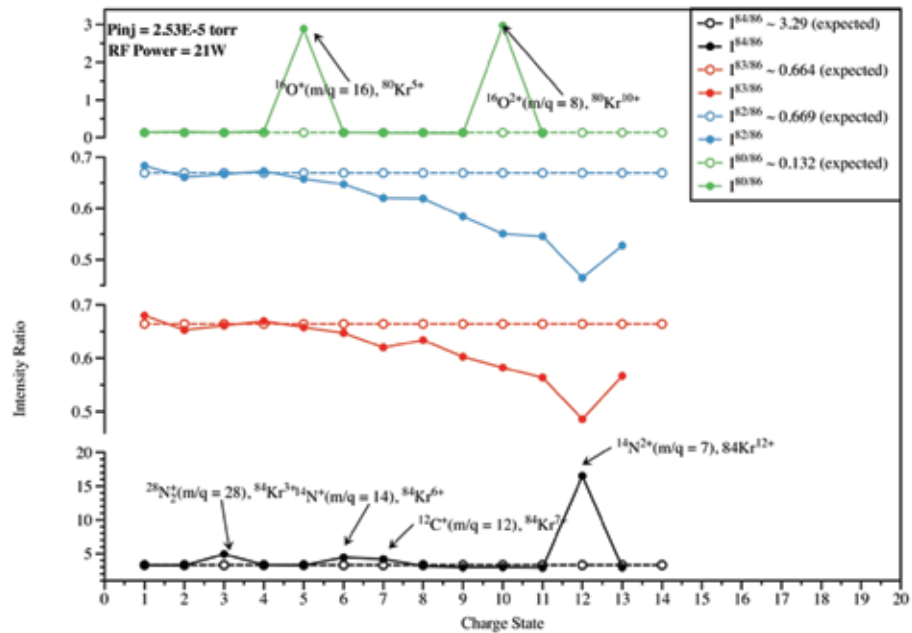


Fig.1.2.1 Intensity ratio of krypton isotopes (I_{80}/I_{86} , I_{82}/I_{86} , I_{83}/I_{86} , and I_{84}/I_{86}) for different charge states. The dotted curves are expected ratios of I_{80}/I_{86} , I_{82}/I_{86} , I_{83}/I_{86} , and I_{84}/I_{86} in the natural krypton

1.2.2 Atomic and molecular physics activities at LEIBF

Pragya Bhatt, Ajit Kumar, T. Sairam, Kedar Mal, Jyoti Rajput, C. P. Safvan

Electrostatic analyzer modification

A new parallel plate electrostatic analyzer (ESA) (Fig. 1.2.2) is designed and developed to study the post collision projectile beam in 105° beam line at LEIBF. For this study, a 1 meter long drift tube is mounted at the ion beam exit port of the experimental chamber; the projectile ions after colliding with free gas atoms/molecules are dispersed in space according to their energy by the ESA and are detected by a channel electron multiplier placed at the end of the drift tube.

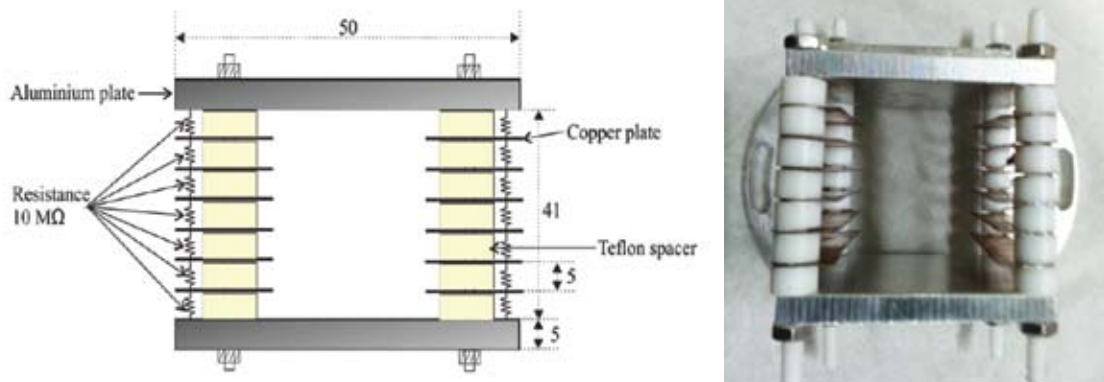


Fig.1.2.2 Schematic diagram of the ESA (left): lengths are in mm; photograph of the ESA (right)

Commissioning of decelerated beams at 75° beam line

In 75° beam line at LEIBF, a new deceleration lens system has been installed and successfully tested for very low energy highly charged ions [8 to 500 eV/q Ar^{q+} ($q=1-7$) and C^{q+} ($q=1,2,4$)]. A retarding plate analyzer (RPA) is used to measure the energy of the incident ion beam. A characteristic curve for ion current (I) and retarding voltage (V_{rel}) applied at RPA for Ar^{6+} ions produced in the ECR ion source is shown in Fig. 1.2.3 (left). The first derivative of I - V_{rel} curve gives the plasma potential for Ar^{6+} as 11 eV.

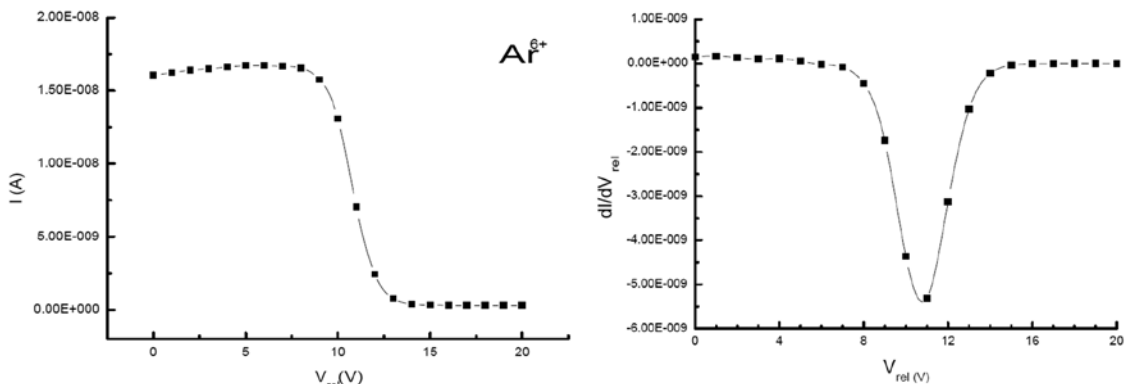


Fig. 1.2.3 Typical I-V characteristic curve for Ar^{6+} ions from the ECR source

1.2.3 Experiments conducted at LEIBF in atomic and molecular physics 105° beam line

- (a) The experiments for 240 keV Kr^{8+} ion interaction with CO_2 are performed at LEIBF in 105° beam line. The recoil ion momentum spectrometer is used to detect the produced ions in these collision events. The newly developed ESA (see, Fig. 1) is used to detect the energy analyzed projectile ions after the collision. Typical time-of-flight spectra obtained in these experiments for ionization and electron capture reactions is shown in Fig. 1.2.4.

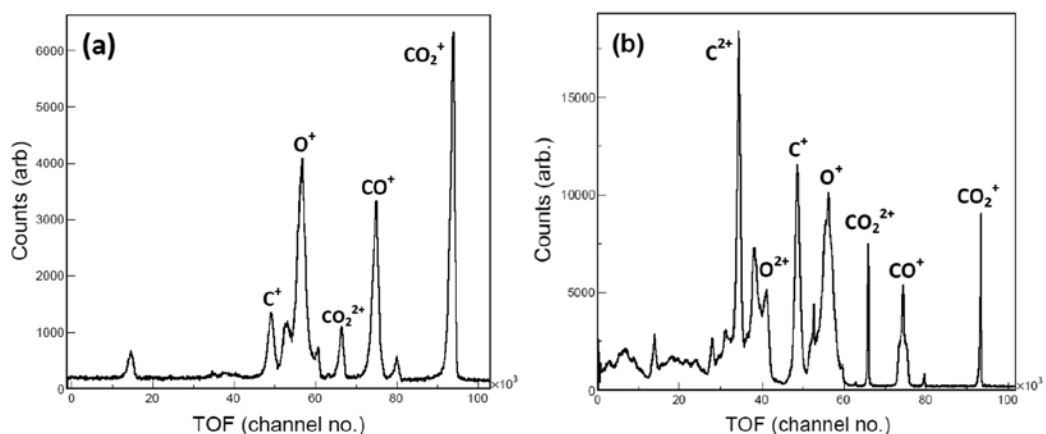


Fig. 1.2.4 Time of flight spectra generated in 240 keV Kr^{8+} collisions with CO_2 using trigger by (a) Kr^{7+} (single electron capture) and (b) ejected electrons.

- (b) The angular distribution of fragment ions of nitrogen molecules in collisions of 450 keV Xe^{9+} ions is studied. These distributions are obtained for different dissociation channels of N_2^{q+} ions and are compared with the Monte Carlo simulations. A typical result is shown in Fig. 1.2.5.

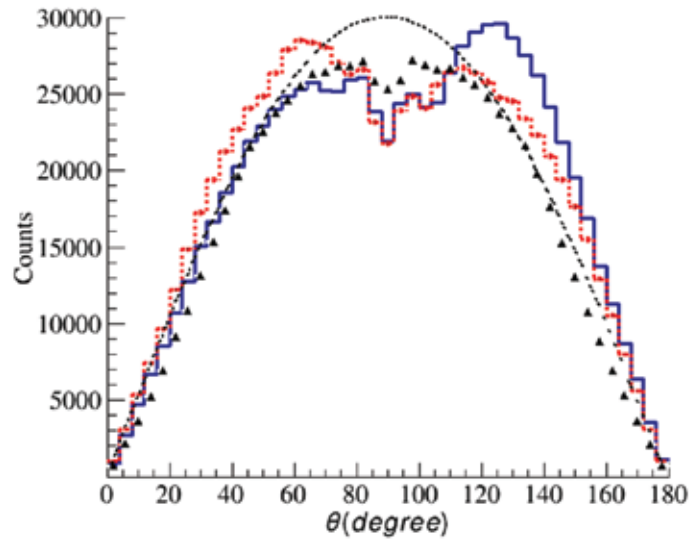


Fig. 1.2.5 Angular distribution of fragments observed in the dissociation channel $N_2^{3+} \rightarrow N^{2+} + N^+$ with respect to projectile direction (θ). The blue and the red curve represent the angular distribution of N^{2+} and N^+ fragments, respectively. The smooth dotted curve and the small black triangles represent the isotropic and simulated results, respectively.

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 1800 measurements of 71 users from 37 Universities, colleges and institutes were carried out. Channeling measurements were performed on TiO_2 single crystal on different axis (111 and 110) to understand defect generation mechanism due to implantation. Nitrogen resonance measurement was performed for the first time on nitrogen implanted silicon crystal. Measurements were performed on thin targets to be used in nuclear physics experiments to analyse their purity and thickness. Few measurements were performed on geological samples to analyze their constituents. Measurements were also performed on implanted polymers for various users.

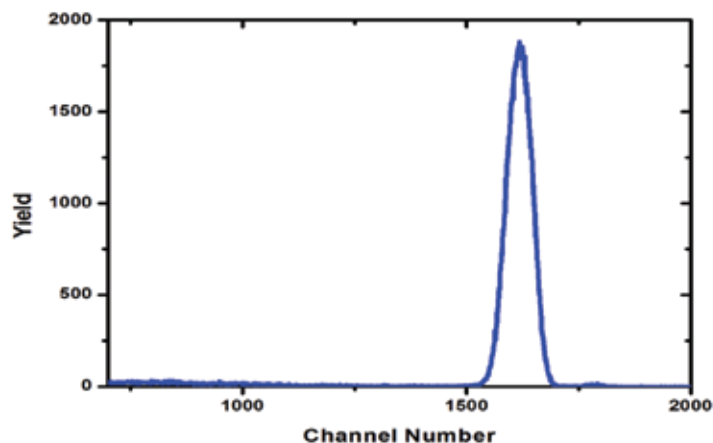


Fig. 1.3.1 RBS spectra of ^{154}Sm thin target

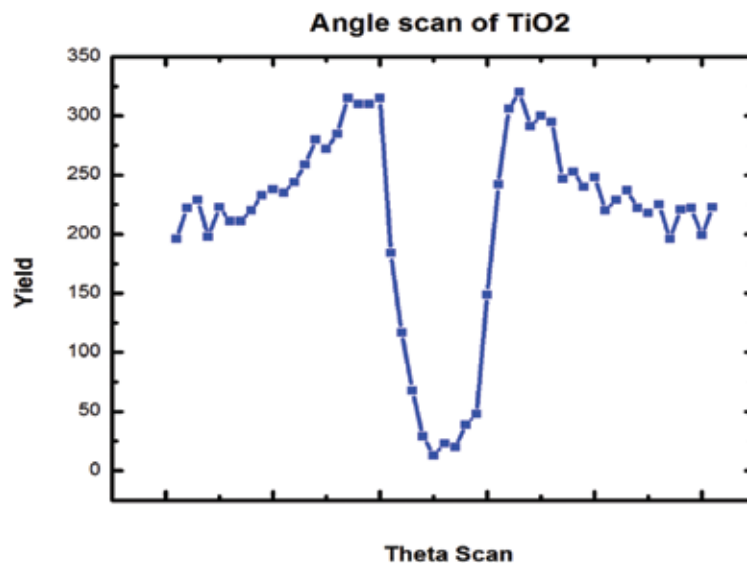


Fig.1.3.2 Angle Scan of TiO₂ single crystal

1.3.2 Maintenance

1.3.2.1 Ion Source Maintenance

Average lifetime of RF Charge exchange ion source is around 700-800 hours. Lifetime is limited by choking of source due to oxidization of rubidium. Maintenance was performed twice last year for RF ion source.

1.3.2.2 RBS facility maintenance

There were two major breakdown in the facility last year. A leak developed in one of the bellows at low energy side of Pelletron accelerator, due to which pressure was not going below 1×10^{-6} torr. The location of leak was pinpointed and sealed using a sealant. We plan to replace the bellow as early as possible.

Second major maintenance was performed on turbo pump after pelletron accelerator. The turbo pump stopped working after a power glitch. This was old turbo pump supplied along with the accelerator. The Turbo pump was replace and electronic modifications were made to interface it with existing controllers.

1.4 DEVELOPMENT OF NEW MAGNET FOR 50 KV ION ACCELERATOR

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The permanent magnet based bending magnet for 50 kV Accelerator has been re-designed. The new magnet will have entry and exit angles of 26.5 Deg for no focusing of beam in X plane as the existing magnet is over focusing in X plane. Extruded poles have been incorporated in new magnet to achieve better field. Field shunting plates have been redesigned for better force distribution for smooth movement.

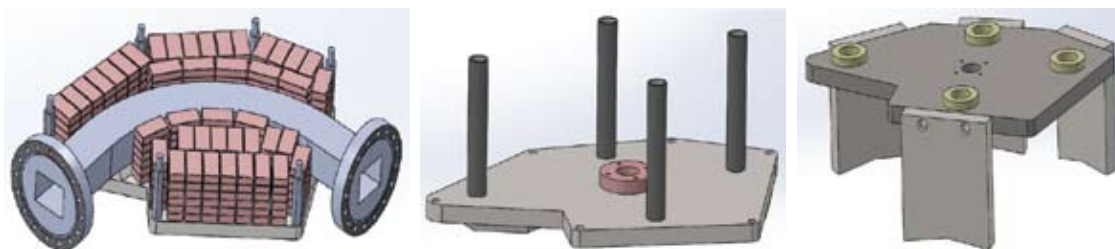


Fig. 1.4.1 (a) Lower assembly

(b) Upper pole assembly

Beam Energy Range with R=250 mm, Field: 1300 – 1800 G		
Element	Mass	Energy Range (keV)
H⁺	1	50 - 240
H₂⁺	2	25 - 120
He⁺	4	13 - 60
C⁺	12	4 - 20
N⁺	14	3.5 - 17
O⁺	16	3.2 - 15
F⁺	19	2.5 - 13
Ne⁺	20	2.5 - 12
S⁺	32	1.6 - 7.5
Cl⁺	35	1.5 - 6.5
Ar⁺	40	1.3 - 6

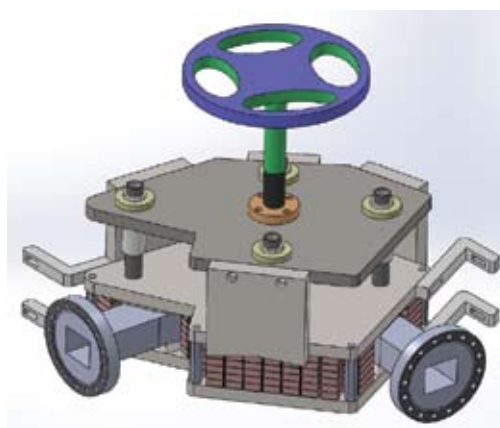


Fig. 1.4.2 Complete assembly of bending magnet

It will be assembled by providing 43 stacks of permanent magnets having 6 pallets each as shown in the figure. New design is expected to provide 1300 – 2800 Gauss variable field at 250 mm radius. The main poles of the magnet shall be fixed and the field shall be shunted by moving vertical plates just at the outside edges of main poles to achieve variable field.

1.5 DEVELOPMENT OF 20 KV ION ACCELERATOR FOR HIGHER MASS

New ion accelerator for higher mass has been designed to provide beam from helium to argon up to 20 kV Acceleration. This will have a focusing element of 4 gap einzel lens and above mentioned bending magnet.

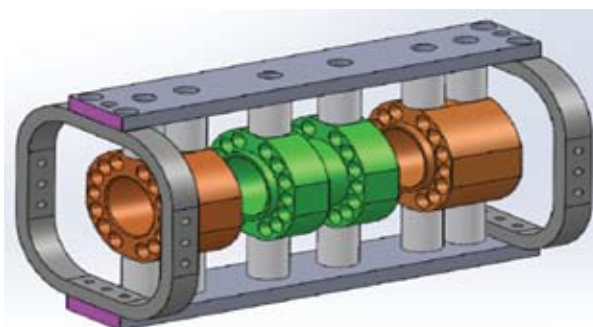
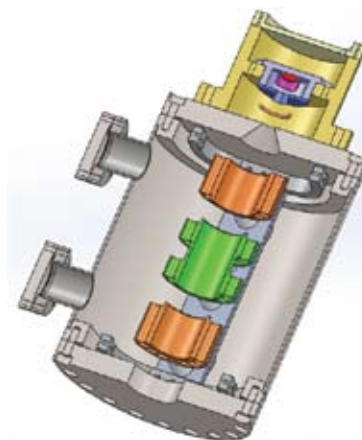


Fig. 1.5.1 (a) Inner assembly of einzel lens



(b) Einzel lens with ion source

The einzel lens has two main poles of 40 mm aperture with 4 gaps to focus the beam. The inner assembly of einzel lens and isometric view of einzel lens with ion source is shown in fig. 1.5.1.

This 20 kV ion accelerator is designed to have already developed penning ion source, above einzel lens and bending magnet and will be assembled in vertical configuration to have minimum floor space as shown. An experimental chamber and beam scanner is also designed for the same. The beam scanner shall be mounted inside the inlet port of the experimental chamber. The expected energy table and 3D assembly is shown here (fig. 1.5.2) for new accelerator.

Footprint: 580X1100 mm,
Height: 1800 mm
Weight: 550 kg
Power: 200 W, 1 Ph, 50 Hz
Portable design

Beam Energy Range with R=250 mm		
Element	Mass	Energy Range (keV)
He ⁺	4	13 – 20
C ⁺	12	4 – 20
N ⁺	14	3.5 – 17
O ⁺	16	3 – 15
F ⁺	19	3 – 13
Ne ⁺	20	3 – 12
S ⁺	32	3 – 7.5
Cl ⁺	35	3 – 6.5
Ar ⁺	40	3 – 6



Fig. 1.5.2 IUAC's 20 kV Ion Accelerator