Chapter 1

ACCELERATORS

1.1 15UD Pelletron

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1.1.1 Operational summary

The 15 UD Pelletron was in regular efficient operation during 1^{st} April, 2024 to 31^{st} March, 2025. The accelerator was under scheduled maintenance during May, 2024 – July, 2024.

A total of 429 shifts of beamtime were delivered to 55 users from 37 different Universities / Colleges / Institutes. Maximum terminal potential at which the beams were delivered was 13.03 MV and maximum terminal potential attained during conditioning (without beam) was around 13.06 MV. Figure 1.1(a) shows the voltage distribution graph of Terminal Potential (MV) used for beam runs for the mentioned period.

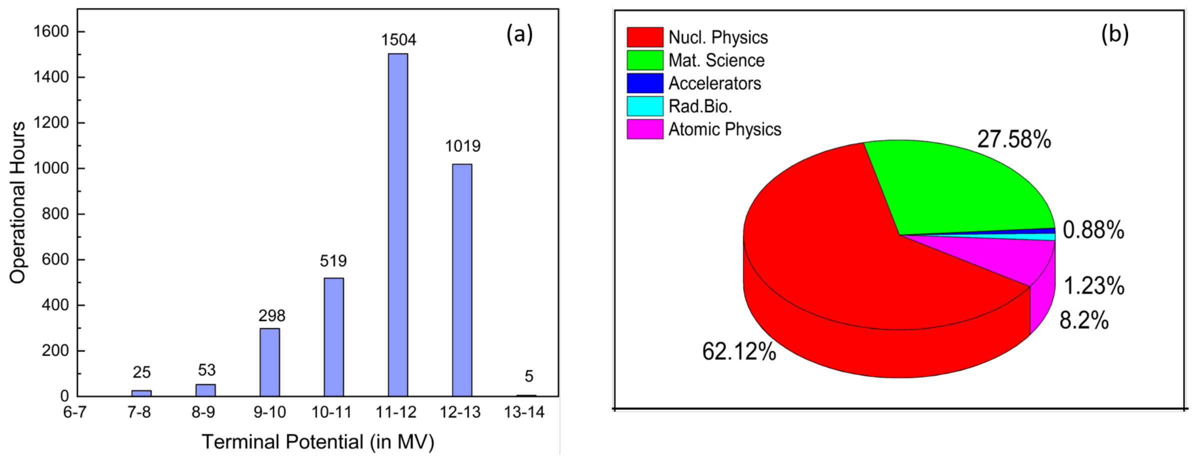

Figure 1.1: (a) Voltage distribution graph in hours. (b) Experimental field-wise breakup of delivered beamtimes.

^{7}Li, ^{10}B, ^{11}B, ^{12}C, ^{14}N, ^{16}O, ^{19}F, ^{28}Si, ^{30}Si, ^{32}S, ^{35}Cl, ^{48}Ti, ^{56}Fe, ^{58}Ni,^{63}Cu,^{79}Br, ^{107}Ag,^{127}I, ^{197}Au beams were delivered to the users for their experiments. The operational summary of the accelerator from 1^{st} April, 2024 to 31^{st} March, 2025 is shown below.

- Total chain hours : 5165 Hours
- Total beam utilization : 3429 Hours

- Breakdown during operation: 107 Hours
- Accelerator conditioning : 1589 Hours

For various nuclear physics experiments, ^{11}B,^{12}C, ^{14}N, ^{16}O, ^{28}Si, ^{30}Si and ^{35}Cl beams were pulsed for different time periods ranging from 250 ns to 4 μs and about 227 shifts of pulsed beam was provided to the users for their experiments in the HIRA and the NAND beamlines.

Out of total 429 shifts, 267 shifts were utilized by the users of nuclear physics facilities, 119 shifts by users of materials science, rest by users from the fields of atomic physics, radiation biology and accelerator physics groups. Fig. 1.1(b) shows the distribution of beamtime with respect to different experimental fields.

No linac run was performed during the period, April 2024 to March 2025.

There were major tank sparks in months of May and August 2024 in the Pelletron accelerator facility. Intermittently the beam times were stopped for various other reasons like pulsing system check-up, beam line components probelms in faraday cups, beam line and fast valves, BPM, analyser magnet and quadrupoles check-up, water leakage problem, resolving problems in ion pump IP041 and other ion pump controller problem etc. In all, a total of 104 hours of beamtime was affected due to all these works. Additionally, the Pelletron was shut down for dehumidifier maintenance from the first week of January 2025 until the third week of March 2025.

1.1.2 Maintenance

A scheduled tank maintenance was performed from May, 2024 – July, 2024. Last tank maintenance was done in December 2023. Due to tank sparks in 1st week of February 2024, units 14 and 15 in upper tank side near terminal had to be shorted. In May 2023, major tank spark due to nylon rod breakage in unit 1 further limited operation terminal voltage to around 11 MV. Tank was opened to resolve this issue and to perform routine maintenance work. Work related to carbon foil loading in terminal and dead section foil strippers, corona probe needles replacement, charging system maintenance and inspection and repairing of accelerating tubes and column support posts, rotating shaft maintenance were carried out.

1.1.3 Ion source activities and maintenance

The 40 cathode MC SNICS source was operational throughout the year. Cathode loading was performed five times in the academic year to provide various beams to the users. Ion source maintenance was done in July 2024. Cathode and immersion lens were cleaned to resolve shorting problem between them. Focus readback problem was resolved with ORA and OTA card replacement. Now focus can easily hold 1kV voltage. Einzel lens resistances were restored to Giga ohm range after sandblasting, cleaning, and proper alignment. Cs oven heater was replaced by new one.

1.2 Linac and superconducting resonator fabrication

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1.2.1 Linac maintenance

After the successful completion of the superconducting linac on 1st April, 2024 three resonators from the second module, with poor performance (E_a < 2.5 MV/m @ 4W), were removed for additional surface treatment. This was a part of the long-term plan to improve the overall energy gain from the accelerator. The processing recipe for individual resonator was decided after a thorough scrutiny of their past performance histories. Based on this, two of the three resonators R25 (i.e. the fifth cavity in the second cryomodule) and R28 were processed and are now ready for re-installation in the cryomodule. R25 was also cold tested in the test cryostat, after processing. A significant improvement of 89 % was observed in the accelerating gradient @ 4W which increased to 3.6 MV/m from a value of 1.9 MV/m achieved during the last linac operation. The quality factor curves for the QWR, before and after surface treatment, are shown in Fig 1.2. Even if a 10 % degradation of performance is assumed, when moving the cavity from the test cryostat to the linac, it is still expected to operate at 68 % higher gradient than the last linac run.

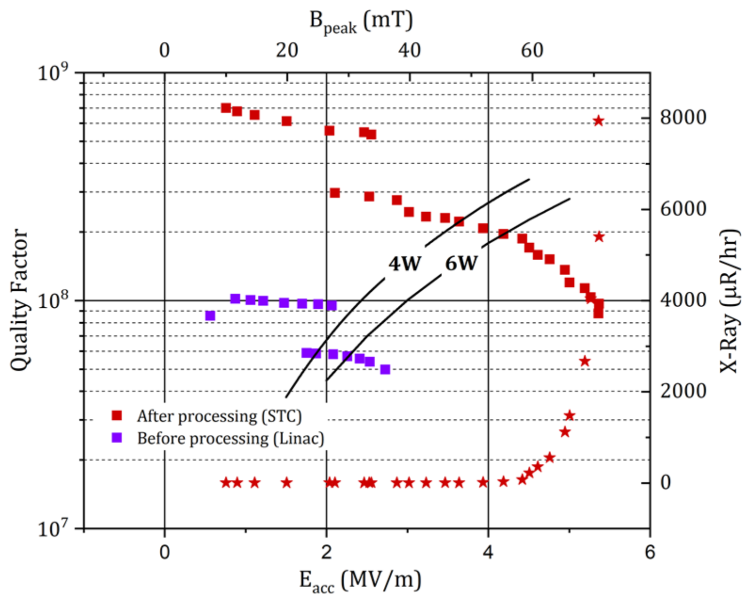

Figure 1.2: Quality factor curves for R25 pre- and post-processing.

The third cavity, R21, will be processed during the first week of May when the linac vault area will be accessible. The re-installation of the three cavities in the cryomodule along with their accessories will be carried out during the third and fourth weeks of May, 2025. This will be followed by evacuation, leak test and low temperature baking of the module. Thereafter, the linac will be ready for beam acceleration. An offline cold test of the second module has also been planned prior to the beam acceleration. This is however, subject to the operation of the LHe plant after its scheduled maintenance.

1.2.2 Electronics developments in linac

A microcontroller based resonator protection circuit was designed and successfully tested with one of the resonators during the linac operation. The circuit, which is directly connected to the backplane of the resonator controller, provides an additional layer of protection by switching off the phase and the amplitude feedback loops in the event of the cavity going out of lock. It thus prevents the power cable from getting damaged due to the excessive power drawn for phase control of the cavity in such a scenario. After a successful test of the circuit fabrication of more such units is under way for all the linac resonators.

1.2.3 Superconducting resonator fabrication

1.2.3.1 Fabrication of spare QWRs and slow tuners for SC linac

The SS jacketing work for the six spare QWRs for linac was started at the IUAC workshop in the last week of May 2024 after all the components, tooling and fixtures were shifted to IUAC from the external vendor's site. In a little over six months, the fabrication of all the six resonators was completed and they were pressure leak tested successfully. They are now ready for a final round of surface processing after which they can be cold tested for performance in the test cryostat. This performance tests will be done once the liquid helium plant is operational after maintenance. Meanwhile, the electron beam welding of the fourteenth niobium bellows of the mechanical tuner (which is the last in the lot) has also been completed. The spare QWR project, which has been pending since last several years, has been successfully concluded. Fig. 1.3 shows the pictures of the completed QWRs and tuner bellows.

1.2.3.2 Fabrication of 5-Cell 650 MHz β= 0.61 niobium cavities in collaboration with VECC

The fabrication of the first five cell cavities is now in its final stages. All the major sub-assemblies, *viz.*, the end groups attached with the niobium half cells and the four niobium dumbbells are ready after EBW after the RF tuning at VECC, Kolkata. Two out of the total five equator welds have also been successfully

Figure 1.3: The completed spare resonators and slow tuner bellows.

completed joining four dumbbells together. These are shown in Fig. 1.4 along with the remaining EBW work in the first cavity which is expected to be complete by the end of May 2025. The fabrication of the second cavity will be taken up thereafter and is targeted for completion in this academic year.

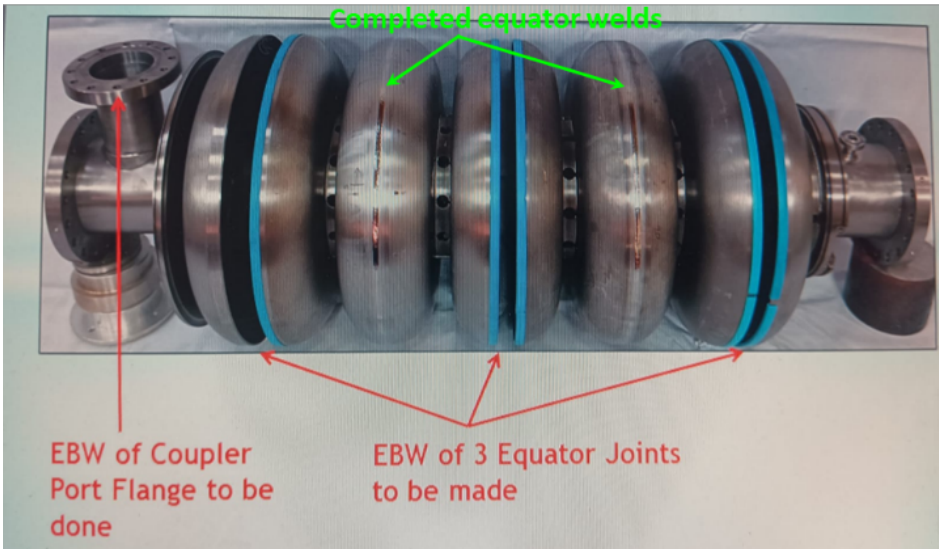

Figure 1.4: The sub-assemblies of the first 650 MHz five cell cavity along with the remaining EBW joints.

1.3 1.7 MV tandem accelerator-based ion beam analysis facility

G. R. Umapathy, Jaswant Singh, Pranav Singh, Suraj Kumar, Mohan Nishal, N. S. Panwar, Jagdish Prasad, Vijay P. Patel, Mukesh Sota, Sunil Ojha and S. Gargari

1.3.1 Operation

The 1.7 MV Tandem accelerator, for Ion Beam Analysis Techniques: Rutherford Backscattering Spectrometry (RBS), Resonance-RBS, and Elastic Recoil Detection Analysis (ERDA) measurements for hydrogen, is in continuous operation. In the year 2024-25 total 900 measurements of 31 users from 17 Universities, colleges and institutes were performed. The facility was operational throughout the year.

Fig. 1.5(a) shows comparative RBS measurements with normal RBS and Oxygen-resonance RBS for Au on glass. Au target was partially roughened for dual-element calibration. Fig. 1.5(b) shows the RBS spectrum of a commercial solar cell measured at 2 MeV and 3.045 MeV. It shows comparative RBS measurements with normal RBS and Oxygen-resonance RBS.

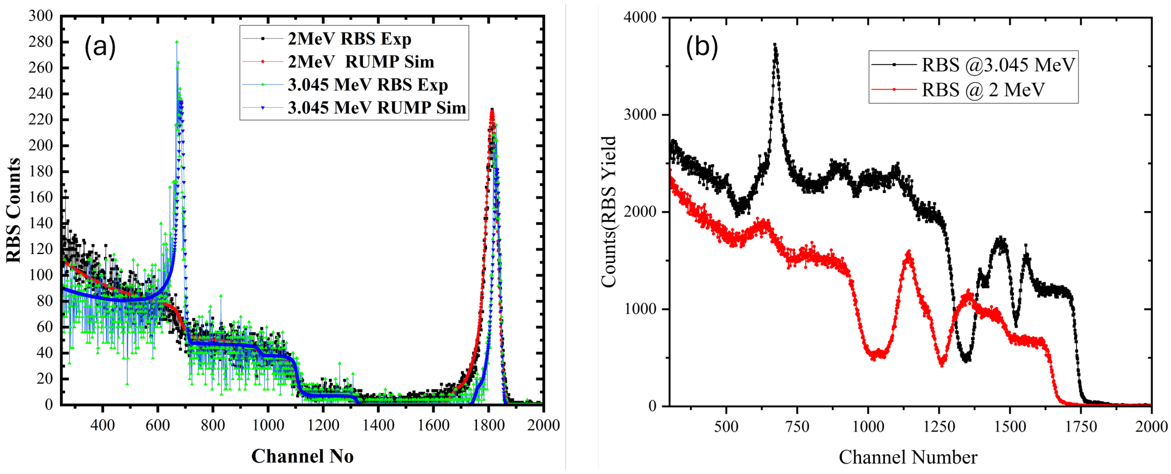

Figure 1.5: (a) Comparative RBS measurements with normal RBS and Oxygen-resonance RBS for Au on glass and a commercial solar cell. Au target was partially roughened for dual-element calibration. (b) RBS spectrum of a commercial solar cell measured at 2 MeV and 3.045 MeV. It shows comparative RBS measurements with normal RBS and Oxygen-resonance RBS.

1.3.2 Maintenance

1.3.2.1 Ion source maintenance

The RF charge exchange ion source underwent two maintenance activities—first in August and then in March. During the first intervention in August, routine procedures were carried out. These included the safe disposal of leftover rubidium, thorough cleaning of the ion source components, and ion source reassembly followed by leak testing. The quartz tube was refurbished in-house using the standard protocol. Notably, only 5 grams (1 ampule) of rubidium was loaded instead of the usual 10 grams. After maintenance, the ion source operated continuously and stably, although the beam current remained relatively low, at approximately 100 nA. The second maintenance was prompted by a sharp decline in beam current from the charge exchange source. The ion source assembly, up to the bias lens, was dismantled for inspection. The following observations were made:

1. No choking or deposition was observed at the aperture or along the beam path.
2. Rubidium had migrated and accumulated in the extended portions of the ion source structure.
3. Block-like deposition was observed on the extractor side of the quartz tube.

Following these observations, the source was cleaned thoroughly and the assembly was realigned and reassembled.

1.3.2.2 The 5SDH-2 Pelletron and end-station maintenance

The rotary pump in the high-energy section was producing excessive noise and was subsequently replaced with assistance from the Vacuum Lab. A gradual but continuous decline in SF_6 pressure was observed. Leak detection tests identified the source of the leak at the chain current feedthrough port. The SF_6 gas was refilled to 60 psi in preparation for the upcoming accelerator operation cycle.

In the end-section chamber, the 4-axis motorized goniometer's readback signal was not getting recognized by the control system. However, manual operation remained functional, allowing the system to continue operation without interruption.

1.4 Low energy ion beam facility

S. A. Khan and C. P. Safvan

After a long maintenance break in the last academic year, the Low Energy Ion Beam Facility at IUAC was made operational with old deck high voltage power supply. Beam tests were conducted upto 200 kV on the deck with this power supply before scheduling of the beamtimes of the users from May 2024. A total of 139 shifts were allocated to 26 users in addition to 24 shifts dedicated to facility testing over the academic year.

In the last week of January 2025, a vacuum leak was detected in the cross-shaped vacuum chamber located in the zero-degree area of the facility. This problem was resolved within a week with the timely help from the vacuum lab and IUAC workshop personnel. Another urgent maintenance task arose in the last week of February 2025, when oil contamination was noticed in the 25 kVA DC isolation transformer with the ECR ion source. The combined efforts of the electrical and ion source groups successfully resolved this issue within a month, ensuring the facility was fully operational for beamtime scheduling by the academic year's end.

1.5 AMS and geochronology facilities

1.5.1 Accelerator mass spectrometry

Gyan R Swain, Mahesh More, Chaitya Aswal, Megha Prakash, Praveen Chakrawarti, Rajeev Kumar, Leema Saikia, Pavitra V. Kumar, Anit Dawar, Abhishek Kumar, Prem Kumar, Ragini Vishwakarma, Jaswant Singh, Pranav Singh, Vijay Patel, Mukesh Sota, Rajveer Sharma, Madhav K Murari, Pankaj Kumar, S. Ojha, S. Gargari, S. Chopra and A. C. Pandey

An Accelerator Mass Spectrometry facility for the measurement of ^{14}C, ^{10}Be and ^{26}Al, based on a 500kV Pelletron accelerator (XCAMS) is in operation since March 2015. Carbon sample pre-treatment and graphitization are performed in a graphitization laboratory while ^{10}Be and ^{26}Al samples are processed in a clean chemistry laboratory

1.5.1.1 Graphitization laboratory

This laboratory is equipped with three Automated Graphitization Equipment (AGE) which are coupled with three elemental analysers (EA) for the graphitization of organic samples and one carbonate handling system (CHS) for the graphitization of carbonate samples. During April 2024-March 2025, 1313 samples have been pre-treated and graphitized by 61 users from different universities and institutes for their research work.

1.5.1.2 Clean chemistry lab for ^{10}Be and ^{26}Al sample preparation

^{10}Be/^{26}Al samples are processed in a 10000-class clean chemistry laboratory. During April 2024-March 2025, 92 samples for 04 users from different universities and institutes were processed for CRN measurements using AMS. Major renovation work was carried out during September 2024-December 2024 which included removal of existing wooden cabinets and tables and replacing those with new FRP material-based panel and granite tables. The HEPA filters in two fume hoods and wall mounted AHU unit were also changed. The air flow system of fume hoods and connected exhaust were repaired. The lab became functional in January 2025 and opened for research work after performing different quality checks of laboratory environment and background values

1.5.1.3 XCAMS facility

AMS measurements: The compact ^{14}C Accelerator Mass Spectrometer eXtended for ^{10}Be and ^{26}Al (XCAMS) is routinely utilized for the measurement of ^{14}C, ^{10}Be and ^{10}Be. Total 1542 samples of ^{14}C and ^{10}Be have been measured in the period from 1st April 2024 to 31st March 2025 of the 77 users from different institutes. Total 21 research paper are published in the peer reviewed journals using the data produced from AMS facility of IUAC in the mentioned duration. Other than the routine maintenances in ion sources (S1 and S2), roughing pump, ionizer, oven heater were replaced with new further, one amplifier in detection system, one vacuum gauge and degrader foil (75nm) were also replaced with newer ones.

During the last academic year, maintenance activities related to MC-SNICS ion source, magnet power supply, GVM, gap lens etc. were carried out.

1.5.2 National geochronology facility

Chaitya Aswal, Megha Prakash, Praveen Chakrawarti, Rajeev Kumar, Gyan R Swain, Mahesh More, Ragini Vishwakarma, Surabhi Tiwari, Leema Saikia, Pavitra V. Kumar, Anit Dawar, Abhishek Kumar, Prem Kumar, Deeksha Khandelwal, Rajveer Sharma, Madhav K Murari, Pankaj Kumar, S. Ojha, S. Gargari, S. Chopra and A. C. Pandey

1.5.2.1 High resolution secondary ion mass spectrometer

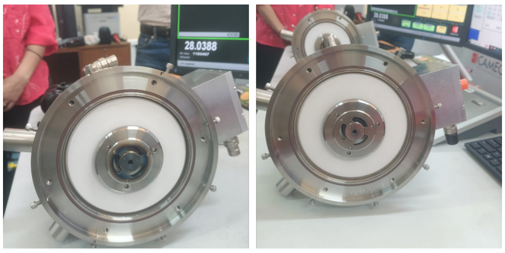

Figure 1.6: The old ion source (left) is replaced by the new one (right).

Large forward geometry High-Resolution Secondary Ion Mass Spectrometer (HR-SIMS) (model: CAMECA IMS 1300-HR3) has been operational at IUAC since December 2021. HR-SIMS facility has been routinely utilized for the U-Pb and oxygen isotope studies in zircon, depth profiling studies in multi-layered materials and study of Al-Mg isotope systematics in Ca-Al-rich inclusion (CAls) in meteorites. 1293 measurements in samples from 9 users from 8 universities and institutes have been completed during last one year. Maintenance activities carried out, included replacement of the oxygen ion source (Fig. 1.6), addressing sample high-voltage (HV) board failure, resolving issues related to compressed air gas line disruptions, stabilizing NMR performance, maintaining and replacing cold cathode gauges, repairing the coolant system of the oxygen ion source, replacement of the ultra-high vacuum (UHV) gauge (Fig. 1.7) in the analysis chamber, and rectifying deflector fluctuations.

The HR-SIMS sample preparation laboratory at IUAC is equipped with various instruments for grain size reduction and heavy mineral separation. For grain size reduction, a jaw crusher, a rotary mill, and a vibratory disc mill are in place. An automatic sieving machine has also been installed to sieve the powdered samples. To wash the samples and separate heavy minerals, a Wilfley table is used, along with a magnetic separator. Additionally, a heavy liquid separation facility is available, utilizing bromoform (2.89 g/cc) and diiodomethane (3.32 g/cc) for precise density separation. For grain identification and mount preparation, advanced polarized light and binocular microscopes are employed. An automatic polishing machine is utilized for the polishing process during sample preparation. More than 40 samples of diverse geological formation and rock types are processed for the zircon separation and 15 mounts have been prepared for the 10 users from different universities/ institutes during last year (Fig. 1.8).

Figure 1.7: The old CC1 and CC2 gauges.

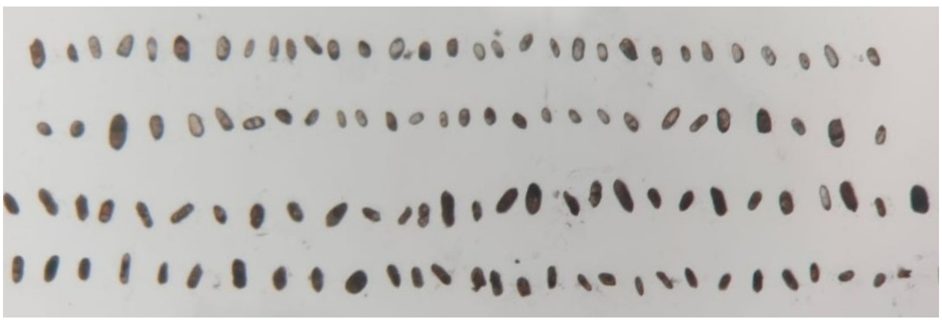

Figure 1.8: Binocular microscope image of Zircon grains.

1.5.2.2 Inductively coupled plasma spectrometers

Quadrupole- Inductively Coupled Plasma Mass Spectrometer (Q-ICPMS) and High-Resolution magnetic sector Inductively Coupled Plasma Mass Spectrometry (HR-ICPMS) are available under NGF at IUAC. Both these mass spectrometers can be operated as standalone units for liquid samples analysis, and they can also be coupled with existing femtosecond laser ablation system. Q-ICPMS is used for elemental analysis of samples with detection limit as low as 0.1 ppb. This technique helps in a wide range of applications like of chemical identification of geological, environmental, biological samples; quality analysis of ground water; toxic metal contamination in soil and water, etc. During April 2024 – March 2025, this facility was used for analysis of about 2417 samples for 61 users from different institutions. While, coupling Q-ICPMS with laser ablation system exhibits in-situ REE and elemental analysis of samples. Coupling of HR-ICPMS with Fs laser unit has been widely used for in-situ U-Pb chronology in several accessory minerals including zircon, appetite etc. HR-ICPMS experienced major breakdown due to the multiple components failure and those are being addressed.

1.5.2.3 Field emission–scanning electron microscope

The FE-SEM (Field Emission Scanning Electron Microscope) is used to facilitate the visualization and analysis of microscopic entities across various research domains of science. Equipped with Energy Dispersive X-ray Spectroscopy (EDS) and Cathodoluminescence (CL), the FE-SEM provides researchers with the capability to explore intricate structures at a microscopic level. The integrated Cathodoluminescence system allows for detailed imaging of zircon grains, a crucial component in mineral micro-area compositional analysis and U-Th-Pb dating. 19 Users from 11 Universities/ Institutes with 82 samples from all over the India have been utilized the facility under National Geochronological Facility. Major breakdown occurred related to the failure of vacuum board of FE-SEM is being solved

1.5.2.4 Wavelength dispersive X-ray fluorescence spectrometer

A Panalytical make WD-XRF spectrometer was installed in 2018 under NGF at IUAC and since then it is being used continuously by different users across the country. New protocols are developed for sediments and limestone and several new standards are included for precise measurement of major oxides from various sediment types and Limestone samples. New SBC was installed in the XRF spectrometer as the data collector software 'SuperQ' was failed to connect to the instrument. Further, during the pellet preparation, the Di-cap and the thread of the beamline of Pellet Press was broken. The thread was fixed, and a new Di-cap was prepared in the mechanical workshop at IUAC

1.5.2.5 X-Ray diffractometer

A Panalytical make X-ray diffractometer has been installed in 2017 under NGF at IUAC. Various sample types such as bulk material, separated clay fraction, nuclear targets, doped material etc. are studied using XRD during the year. From April-2024 to March-2025, 286 samples of 15 users from 9 different universities and 3 institutes, were measured using XRD. Faulty detector fan and X-ray tube, of which life was exhausted, were replaced with new ones.

1.6 Low energy negative ion implanter facility

Ksh.Devarani Devi, Deeksha Khandewal, Ritu Rani, Pradeep Kumar, Prena Tiwari, GR Umapathy, Sunil Ojha, G Raturi, Jawant Singh, Pranav Singh, Suraj Kumar, Mohan Nishal, N.S. Panwar, Tarun Chaudhary, M.P. Singh, Rakesh Kumar, Jagdish Prasad, Chandra Pal, Ashok Kothari, P Barua, Deepak Kumar Munda, Kundan Singh, VP Patel, M. Sota, R.K. Gujar, Mukesh Kumar, S. Gargari and Sunil Ojha.

1.6.1 Operation

The overall operational status and ion beam delivery of the implanter accelerator had been smooth. Ion beams of various species were accelerated in the energy range of 40 keV to 200 keV and employed in ion implantation and irradiation experiments. The accelerator, however, faced occasional failures in the ion source, beamline, and vacuum system. Those were resolved. Researchers from different colleges, universities and institutes made use of the beam time. In addition, few users accessed the facility through the Director's Direct Quota (DDQ). The operational statistics of the facility are provided below:

- Total no. of users: 17
- Total number of samples implanted: 460
- Ion beams delivered: ^{11}B, ^{12}C, ^{16}O, ^{27}Al, ^{31}P, ^{56}Fe, ^{58}Ni, ^{59}Co, ^{63}Cu, ^{107}Ag and ^{197}Au
- Energy range: 40 keV to 200 KeV
- Ion fluence range: 1×10^{14} to 5×10^{17} ions/cm^2

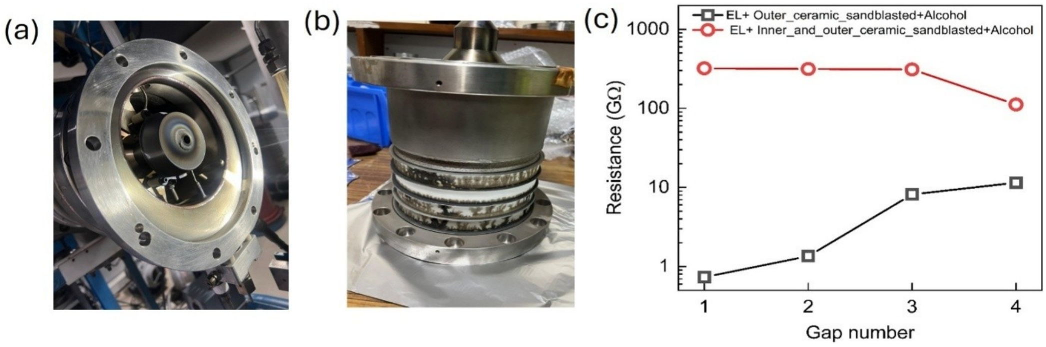

Figure 1.9: (a) Ion source before cleaning, showing accumulated contaminants or deposits on the surface, (b) einzel lens assembly with visible ceramic gaps, illustrating the condition before treatment and (c) variation of resistance (in GΩ) across the ceramic gaps of Einzel lens after sandblasting and alcohol dipping overnight, followed by heating in an oven at 100°C for 1 hour. The resistance measurements indicate a significant improvement in insulation when both inner and outer ceramic surfaces are treated, compared to treating only the outer surface.

1.6.2 Maintenance

To ensure the accelerator operated smoothly, both preventive and breakdown maintenances were carried out. As a preventive measure, in regular intervals, Cockcroft Walton voltage multiplier, ion source (external), general purpose accelerating tubes (external), high voltage room and high voltage decks were cleaned to avoid any discharge paths formed due to dirt. There were few breakdowns in ion source, beam line components and vacuum system. Below is a list of maintenance activities conducted on the respective devices:

Ion source: The ion source experienced cesium flooding twice and was restored by baking continuously for nearly two days each time. The accelerator was then operated under conditional runs, leading to stable performance. Later, an attempt to extract a sulfur ion beam caused contamination, degrading ion source performance and requiring disassembly and cleaning. Over time, increased currents in the cathode and Cs focus were observed due to cesium buildup and the use of high-vapor-pressure species like sulfur, which tend to poison the source. To address this, the ion source was opened for thorough cleaning. The gate valve to the GPT was closed, electrical connections removed, and the cesium reservoir safely detached in an argon environment. Subsequentially, ion source assembly was detached from the injector beam line. Fig. 1.9(a) shows the ion source before cleaning, with visible surface deposits and disassembled components. Fig. 1.9(b) highlights dirt-covered ceramic gaps in the Einzel lens. Key parts—including the Cs focus electrode, insulation studs, and Einzel lens ceramics—were cleaned via sandblasting, while the ionizer was cleaned separately with alcohol to protect the filament. All components were then soaked overnight in alcohol to remove residual contaminants. To assess cleaning effectiveness, resistance across the Einzel lens ceramic gaps was measured before and after treatment using a Megger. Fig. 1.9(c) shows a marked improvement in insulation, especially when both inner and outer ceramic surfaces were treated, following sandblasting, alcohol soaking, and heating at 100° C. After cleaning, the ion source and the Einzel lens were reassembled, realigned, reinstalled, evacuated, and all electrical connections restored for safe operation. Stable accelerator operation at -200 kV was achieved after conditioning.

Beam line components: There was compressed air leakage in the solenoid of FC-011, causing it not properly coming out from the beam path in "OUT" command. The solenoid was replaced.

Vacuum system: Overall, the vacuum system is functioning smoothly except for few faulty MKS vacuum controller and gauges. It has been decided to replace these components with newly procured Pfeiffer and Edward make vacuum controllers and gauges. The necessary fittings, including Zero-length adapters and Tee - adapters have been fabricated and tested for any vacuum leak.

Target station: The illumination of the target wafer was enhanced by fabricating a light mounting frame and installing it onto the chamber port.

1.6.3 Development activities

Development of new beams: Recent researches on material science involving ion implantation and irradiation in low energies demanded varieties of ion beams with high intensities. Despite the ion source functioning properly, it struggled to produce high-intensity ion beams of few ion species such ^{7}Li, ^{11}B, ^{120}Sn, ^{27}Al at lower energy regime, particularly between 30 keV and 60 keV. An improvement in the beam current intensities of these tough ion species, except for ^{120}Sn beam, could be achieved by preparing the cathodes with fresh materials and also packing the cathode materials densely into the cathode capsules.

The cluster ion beams of C_n^-, Al_n^- and Si_n^- at 70 keV were successfully developed using this facility. The experiment demonstrated the feasibility of delivering carbon clusters ranging from C^- to C_{10}^-, with beam currents varying between 1 μA and 10 nA. Aluminium clusters up to Al_5^- were detected using a Faraday cup, with beam currents ranging from 2 μA to 20 nA. Similarly, silicon cluster beams up to Si_5^- were measured, with beam currents ranging from 3 μA to 1 nA. These cluster ion beams can be made available to users in the future based on specific experimental requirements.

Research in materials Science: Multifunctional bimetallic gold-nickel (AuNi) nanoalloys of sizes, 5 nm–45 nm, embedded in fused quartz matrix were synthesized using sequential ion implantation and post annealing at 90°C for 1 hr in Argon environment. The nanoalloys exhibited both optical response with an intense surface plasmon resonance (SPR) peak at a wavelength, 540 nm and magnetic properties with ferromagnetic response at 10K and diamagnetic at room temperature. The study provides a way to synthesize a single system with multiple properties. In another study, 30 keV Ag^- ion implantation on Au thin film, 5 nm, deposited on glass substrates produced partially embedded bimetallic AuAg alloy nanostructures. Without the need for a probe, the SPRs of the bimetallic AuAg alloy nanostructures could detect sucrose solutions effectively, showing a noticeable blue shift (approx. 11 nm) to 1 nM sucrose solution.

1.7 Tabletop accelerators

Raj Kumar and C. P. Safvan

IUAC had designed, developed and installed 30 kV and 60 kV tabletop accelerators in-house. Both of them were in regular use in the last academic year. There was no breakdown during the year. Regular maintenance, mainly in the ion source, was carried out. Table 1.1 summarizes the usage of the accelerators during the last year.

Table 1.1: Operational summary of the tabletop accelerators.

	60 kV accelerator	**30 kV accelerator**
No. of runs	4	7
No. of samples implanted	40	65
Beams provided	H_2^+, He^+	N^+, Ar^+
Energy range	20 - 90 keV	10 - 27 keV