

Particle Accelerators of IUAC: Current and Future Facilities

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Inter University Accelerator Center (IUAC) is one of the major accelerator facilities in India and caters the need of the experimental physicists in the areas of Nuclear Physics, Materials Science, Atomic/Molecular Physics, Radiation Biology, etc. IUAC is equipped with seven particle accelerators which are operational at present. These are the 15 UD Pelletron Accelerator, the Superconducting Linear Accelerator (SC-Linac), the 1.7 MV Pelletron Accelerator for Rutherford back scattering, channeling etc., the 500 keV Pelletron for Accelerator Mass Spectrometry, the Low Energy Ion Beam Facility (LEIBF) having an electron cyclotron resonance ion source on the high voltage platform, the Negative Ion beam facility (NIBF), and the table top low energy accelerator. Another few particle accelerators are also coming up and will be fully operational shortly. Among them, High Current Injector (HCI) which will replace the Pelletron accelerator as the injector to the SC-Linac, 6 MV Tandem Accelerator at the National Geochronological facilities at IUAC, and the Free Electron Accelerator using a RF photocathode-based electron gun are noteworthy.

The 15 UD Pelletron accelerator using compressed geometry tubes is in continuous operation since 1990 and has been providing energetic ion beams in the range of a few tens to a few hundreds of MeV for scheduled experiments in the beam hall 1 and the beam hall 2. The energy of the Pelletron accelerator is further augmented by Niobium Quarter Wave Resonator based SC-Linac and the ion beams with enhanced energies are being delivered for scheduled experiments in beam hall-2. The ion beams either from Pelletron accelerator and/or SC-Linac are being mostly utilized by the Experimental facilities in Beam Hall-1 like Heavy Ion Reaction Analyzer (HIRA), General Purpose Scattering Chamber (GPSC), Gamma Detector Array, Material Science Experimental facilities and Radiation Biology facilities. In the beam hall-2, the ion beams are used to perform various experiments by using the facilities of Hybrid Recoil Analyzer (HYRA), Indian National Gamma Array (INGA), National Array of Neutron Detectors (NAND), Materials Science Experimental facility and Atomic physics experimental facility.

In last year, around 595 shifts of beamtime were delivered to 55 users from 30 different Universities/Colleges/Institutes. Maximum terminal voltage of the Pelletron accelerator reached was 14.8 MV without beam and 13.7 MV with beam. In the lower potential side, the beam was delivered to the user at 6.33 MV, but Pelletron has been successfully operated at 4.0 MV to test beam transmission, charge state distribution and available energies for ⁷Li beam. The Proton beamline facility was recommissioned recently and 25 MeV proton was delivered with 50 nA current for scheduled experiments.

SC-Linac operation was also performed in last year and 152 shifts of beamtime were delivered from Pelletron and Linac combination to perform the experiments in NAND, HYRA and INGA. In 2021, two accelerating modules were operational as the third one developed a cryogenic problem. The maximum energy gain from the two modules was measured as 6.1 MeV/charge state. A maximum energy gain of 9.6 MeV/charge state was obtained in 2019-20 from the SC-Linac and the maximum energy delivered from the combination of Pelletron and SC-Linac was 280 MeV (145+135) and 210 MeV (120+90) for ⁴⁸Ti¹⁴⁺ and ³⁰Si¹¹⁺ beams from Pelletron + Linac respectively. Currently, effort is dedicated to improve the field gradient of a few superconducting resonators.

High Current Injector (HCI) is designed to produce energetic ion beam of 1.8 MeV/u having mass to charge ratio (A/q) ≤ 6 and will be the injector to the existing SC-Linac. A major milestone has been achieved recently by accelerating N⁺⁵ ions having $A/q = 2.8$ to the desired energy of 1.8 MeV/u. With this test, the validation of the design parameters of HCI has been completed. The further tests of the beam acceleration with higher A/q ratio and of integrating the HCI beam line with the existing SC-Linac accelerator are underway.

The performance and the status of the various accelerators of IUAC will be presented in the symposium.

