Status of 3.0 MV Pelletron Accelerator at National Centre for Accelerator based Research at GGV, Bilaspur

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Introduction

Low energy high current Accelerators have attracted wide spread attention as an interdisciplinary tool for Research & Development in different fields of science and technology including Nuclear Physics, Material Science, Biology, nanotechnology, Bio-medical, agriculture, food processing, etc. This is due to the fact that ion beam energies (keV-MeV range) available from such accelerators have potential to induce physical, chemical and bio-chemical processes that can be controlled by changing the ion fluence, ion species and charge state of the ion beam. Apart from the use of accelerator for studying ion-solid interaction in terms of irradiation induced effects, ion beam analysis and ion implantation, availability of high current makes it exciting for neutron generation that has emerged as an important field in recent years. This is due to growing applications of neutron as important tool including Neutron Activation Analysis (NAA) -a versatile technique for the measurement of neutron induced reaction cross-sections and is capable for filling up the wide gap existing in the neutron cross section data, important for the design and development of new generation of reactors.

The Accelerator facility at NCAR, Bilaspur is in an advanced stage of commissioning after having completed installation.

Important Features of the Accelerator

A 3.0 MV Tandem Accelerator (Pelletron 9SDH-4) based facility at NCAR has been installed and will be commissioned soon. It will be possible to deliver energies up to 6 MeV protons and ions covering almost the periodic table. The accelerated positive ions from the Pelletron can be delivered to one of three beam lines after the switching magnet. The analyzing magnet has ports with the specifications as (i) 0^o port (ii) $\pm 10^o$ ports with ME/Z^2 = 310 amu-MeV, and (iii) $\pm 20^o$ ports with ME/Z^2 = 78 amu-MeV as detailed out in Figure 1.They are (i) MeV ion implanter at the end of the -10^0 beam line and (ii) an RC43 RBS End Station, PIXE, NRA, ERDA and channeling detectors for ion beam analysis as well as ion irradiation facilities at the 20^o port of the switching magnet. The two beam lines have been installed now and vacuum tested.

For the ion implantation beam lines, typically Silicon targets would be used for implantation. For ion beam analysis beam lines, targets can vary from light targets like Carbon to much heavier ones depending on the application.

A third beam line at the 0^o port of the switching magnet for low energy high current proton beam for neutron generation will be installed in the second phase.

In the low energy Pelletron accelerator two types of ion sources (SNICS-II and TORVIS) are available to produce negative ions for the acceleration in accelerating tank. The TORVIS source is planned to be used for production of protons and alpha particles with relatively high beam current. The high proton beam current available ~ 50 µAmp at 6 MeV for protons, in fact is the highest in the country and will open up many new avenues for research in low energy Nuclear Physics, especially for neutron generation.

Present status of Machine:

The facility is a flagship program for providing state of the art research facilities on the campus in the areas of Nuclear Physics, Material Science Nanotechnology, Environmental Sciences, Life Sciences, Biotechnology, Radiation Biology etc.

As shown in Fig.1 ion sources, accelerator tank, beam lines, and SF6 transfer facilities have already been installed. The air handling (HVAC) system has already been installed. Compressed air system and chilled water distribution system are also tested. The stabilized power for the ACPC and control panel comes through 325KVA capacity UPS. The input electrical power is fed through the isolation transformer and a capacitor panel insuring the stable power. 125 kVA DG set is kept in automatic mode which provides uninterrupted power. The safety system which include safety interlocks, fire fighting system are already in place. X-ray, γ-ray and neutron monitors have been installed. For the safety system a PLC panel has been installed and is working well. Ion sources, beam lines and pelletron tank have been tested for vacuum and a vacuum of 10(-7) has been achieved. Our next step is to go ahead with beam trials.

Fig. 1 Present status of Accelerator set up at GGV

The center has made consistent efforts to have synergy with the leading Accelerator Centers of the country and have already identified 40 users' proposals through national workshops, the last being organized under the aeges of Indian society of particle accelerators (ISPA). In this interdisciplinary center, presently two target stations have been installed. The high energy implanter beam line would be used to deliver high intensity positively charged ion beams (up to 10^{14} particles per second depending on the ion species and charge state) on a variety of targets. The second beam line would be dedicated for Ion Beam Analysis using Rutherford Backscattering (RBS), Forward Recoil Spectroscopy (FRS), Nuclear Reaction Analysis (NRA), Channeling and Particle Induced X-ray Emission (PIXE). The accelerator will provide opportunities to researchers from all over country to perform researches in multidisciplinary fields.

Extension of Facility: Neutron Generation

As stated the third beam line which is going to be installed is planned for neutron generation due to its importance in neutron-induced cross-section data. A dedicated neutron facility is gaining considerable interest due to their potential applications in nuclear technology, nuclear medicine, industry apart from the Nuclear Physics. Nuclear reaction cross-section measurements are extremely important for the advancement in reactor technology. These tasks require improved nuclear data and higher precision cross-sections for neutron induced reactions. Keeping this in view, the extension of research facility for neutron generation has been decided at the Centre and the zero degree beam line will be extended for measurement of various neutron induced reaction cross-sections.

In the facility possibly ^{7}Li (p, n) reaction will be mainly used for generating nearly mono energetic source of neutrons to produce high neutron flux. The iron and aluminium route or neutron production may also be considered.

The present accelerator is capable of producing high neutron flux (4.5×10^{9} neutrons/cm^{2}/sec) as it has high proton beam current of ~50μAmp. This provides the unique opportunity for neutron-activation cross sections measurements especially in low energy region where very limited information are available. Further, this facility will provide platform for low energy nuclear physics community for extensive studies in the areas related to nuclear astrophysics, neutron-induced reactions, measurements of neutron scattering cross sections, sub-barrier fusion reactions in future.

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