Delhi Penning Trap Setup For Experimental Study of Electron-Impact Ionization Cross-Section in Relativistic regime

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The Delhi Penning Trap (DPT)[1] has been developed as a dedicated facility for controlled studies of electron–ion interactions, with the long-term objective of investigating EII cross-section at relativistic electron energies. The cryogenic cylindrical Penning trap enables confinement and manipulation of ions under ultra-high-vacuum conditions, providing a low-background environment for precision measurements.

The DPT incorporates both destructive and non-destructive detection approaches for characterizing trapped ions and ionisation products. Non-destructive detection allows ions to be monitored without removing them from the trap, whereas destructive detection involves extracting the ions for subsequent identification based on their mass-to-charge ratio. During the initial commissioning of the facility, Electron-Ion interaction were performed using a 1 keV electron gun with helium, nitrogen, and argon as test gases. The ionisation products were extracted from the trap and analysed using a time-of-flight (TOF) technique, providing mass-to-charge-dependent identification of the produced ions.

The obtained TOF measurements are used to validate the ion trapping, electron-beam interaction, ion extraction, and detection systems. The facility is ultimately intended to measure EII cross-section into the 1–8 MeV energy range generated using FEL(Free Electron Laser)[2] based electron source, enabling experimental investigation of relative ionisation cross-section in the relativistic energy regime. We are going to measure relative cross-section not absolute because to measure it we need density of target gas and length of interaction region which is impossible to calculate in our experiment setup.

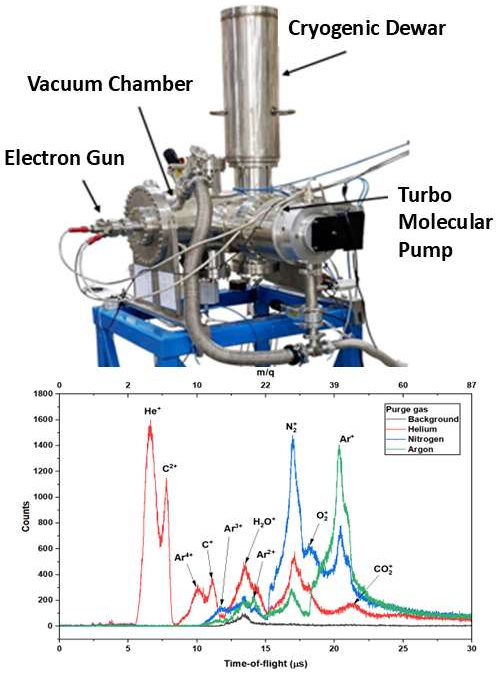

Figure 1. Delhi Penning Trap setup and graph of TOF of He,N_2 and Ar gas.

References

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