



Time-of-flight low-energy analyzer for Aditya-U Tokamak

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Abstract: The Time of Flight Low Energy Analyzer (TOFLEA) is an energy analyzer which is used for estimating plasma ion temperature in Tokamak fusion devices. Time of flight based analyzers are very useful for energy analysis of low energy neutrals as compared to stripping gas cell [1] or thin foil based neutral particle analyzers. The efficiency of stripping cell drastically reduces below 100 eV and thin foil based techniques are useful for energies greater than 1000 eV[2]. In a TOFLEA, the neutrals escaping from the magnetic confinement of the plasma are first mechanically chopped and after traversing a long flight path, they fall on the detector. An arrival time distribution (ATD) profile of neutral flux is obtained which enables the plasma ion temperature estimation. The design of the time-of-flight low-energy analyzer (TOFLEA) for Aditya-U Tokamak is discussed in this paper. The TOFLEA system contains a slotted rotating chopper disc in a chopper chamber, a long flight tube and a detector housing chamber. An ultrafast rotating chopper mechanically chops the neutral flux escaping the plasma, the short bunches of neutral flux traverses a long flight tube and then made to incident on a Cu-Be plate based secondary emission surface kept along the flight path, the secondary electrons thus emitted are registered by detector. The components of the TOFLEA system are designed to work in ultra-high vacuum (UHV) environment. UHV condition in the TOFLEA system reduces the scattering of low energy neutrals during their flight within the system. Vacuum grade slot less brushless DC motor with low outgassing material and ceramic hybrid ball bearings is specially chosen to ensure UHV compatibility of chopper's motor. A light sensing circuitry based on a He-Ne laser and a photodiode provides a trigger signal for start time information. Photons will overtake the neutrals during their flight time and hence photon signal can be eliminated from the neutral signal in time domain. Chopper's rotation frequency (round per minute) is the most critical parameter which decides the energy resolution of the TOFLEA system. The Charge-exchange neutral particle flux is estimated for TOFLEA system for Aditya-U tokamak and it is found that gating time of few micro-seconds is sufficient for obtaining detectable signal. The arrival time distribution is estimated, based on the present design of TOFLEA. The described TOFLEA is proposed for estimating the core ion temperature on the Aditya-U tokamak.

References

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