

Seminar

Institute for Plasma Research

Title: Development of a Time of Flight Diagnostic for energy analysis of Neutral Particles in ADITYA-U Tokamak

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Date: 21st November 2025 (Friday)

Time: 10:30 AM

Venue: Seminar Hall, IPR

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Abstract

Neutral particles escaping from a tokamak contain valuable information about ion temperature, impurity behavior and plasma heating. To study these particles in ADITYA-U tokamak, a Time-of-Flight (TOF) diagnostic is being developed to provide a direct way to measure the energy of fast neutrals.

In this method, a fast-rotating chopper disc slices the continuous neutral flux into short pulses (of the order of few μs). These pulses travel through a drift tube and their arrival time at the detector is recorded. Since fast particles reach the detector earlier and slow particles arrive later, the measured flight times can be directly converted into an energy spectrum. The short gate time of the chopper (few μs) compared to the long flight time of neutrals (tens of microseconds) gives adequate energy resolution, especially for low-energy particles in the 20–150 eV range.

A major advantage of this TOF system is that it avoids the use of a gas stripping cell, whose efficiencies below 100 eV falls drastically (typically $<10^{-3}$). Instead, the detector uses a Cu–Be target to produce secondary electrons that are amplified by an electron multiplier, giving much higher sensitivity for low-energy neutrals. The method also provides natural time-separation between VUV radiation peaks and the true neutral signal. With these benefits combined, the TOF system allows reliable detection of low-energy neutral flux that conventional techniques cannot measure effectively. In this work, the TOF system was conceptualized, and its design parameters were established through analytical estimates and modeling. A slab-model calculation was carried out to estimate expected neutral flux. This was followed by the engineering design of the full setup in CAD and addressed vacuum requirements and electronics. Another part of the work

involved designing an in-house hot-filament ion source and running detailed SIMION simulations to optimize ion focusing from 20 eV to 2000 eV. This source will be used later to calibrate the TOF system. Procurement of major components is currently in progress, and the hardware assembly will follow as the next step.

References

1. Voss, D. E., & Cohen, S. A. (1982). Low-energy neutral atom spectrometer. *Review of Scientific Instruments*, 53(11), 1696-1708.
 2. Ray, N. R. (1998). A time-of-flight low-energy analyzer (TOFLEA) of neutral atoms. *Journal of Physics D: Applied Physics*, 31(9), 1071.
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