

Seminar

Institute for Plasma Research

Title: X-ray Calibration Source Development for Core Rotation Measurement in the ADITYA-U Tokamak and other Spectroscopic Diagnostics Development

Speaker: Dr. Gaurav Shukla
Institute for Plasma Research, Gandhinagar

Date: 12th May 2026 (Tuesday)

Time: 11:30 AM

Venue: Seminar Hall, IPR

Join the talk online: URL: <https://bharatvc.nic.in/viewer/5992138016>

(Conference ID: 5992138016; Password: 232142)

Abstract

The measurement of plasma rotation and ion temperature is of importance to fusion research, plasma rotation is fundamentally linked to the suppression of turbulent transport and the stabilization of magneto-hydrodynamic (mhd) instabilities. This talk explores the investigation of core rotation of C^{5+} ions in the ADITYA-U plasma using passive charge exchange line (PCX) observed by high resolution visible spectroscopy diagnostics and the development of the calibration source for X-ray crystal spectrometer, which will provide the core rotation using Doppler shifted He-like Ar X-ray line.

The spontaneously generated core toroidal rotation in Aditya-U Ohmic plasmas is analyzed by examining a broad set of discharges. The analysis reveals that core rotation is more fundamentally correlated to core soft X-ray (SXR) emission, but no such dependency was observed with the total heating power or stored energy. To further validate these line-integrated PCX measurements and bridge the diagnostic gap, a tangential X-ray Crystal Spectrometer (XCS) has been installed on Aditya-U tokamak, which may allow for direct cross-diagnostic validation of core velocities. However, high-precision wavelength calibration of the crystal spectrometer is needed to ensure the accuracy of these measurements. In this work, conceptual design of a custom, in-house X-ray source has been made. By proposing a Rhodium-on-Copper anode architecture, this source targets the specific 3.14 keV energy range required to validate measurements of highly ionized Argon (Ar^{16+}) spectral lines.

In addition to that, optimization of the conceptual design of a Charge Exchange Recombination Spectroscopy (CXRS) has been done by considering different NBI beam energies and powers. The proposed diagnostic utilizes the heating neutral beam as a donor source for C^{5+} impurity emission at 529 nm. The design is based on beam attenuation and emissivity, proposing a high-throughput optics and a tangential periscope geometry to maximize core photon collection. Synthetic modelling indicates that this configuration is capable of resolving the Doppler shifts and broadening necessary for accurate ion temperature and rotation measurements at high temporal resolution.
