Seminar

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Institute for Plasma Research

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Title: Modelling of induced vessel currents in SST-1 tokamak

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Date: 17th March 2026 (Tuesday)

Time: 10:00 AM

Venue: Seminar Hall, IPR

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Abstract

The tokamak follows the magnetic confinement principle for the realization of nuclear fusion. The presence of time-varying magnetic fluxes in the tokamak vessel observed induced currents (IC). These IC impacts plasma formation time-scales, ohmic and vertical field flux penetration, magnetic measurements, plasma equilibrium, localized heating, and structural stresses. Hence, the understanding of the IC is required on time to plan any experiment.

The project aims to give the operator a first-hand view of possible IC scenarios before the experiment as a limited operational window exists for most successful discharges, by predicting IC for a given set of input condition would be beneficial . The SST-1 is considered for this study due to its continuous vessel configuration and available diverse experimental data sets. The IC modelling has been performed for the complete discharge, not specific to a particular plasma phase. ICs are modelled in the COMSOL Multiphysics platform (Finite Element Analysis) while exploiting the 2-D axisymmetric toroidal symmetry character of the SST-1 design, resulting in a reduced computational burden.

At the first phase, the ICs are modelled for the SST-1 tokamak for different operational configurations, including ohmic, vertical field, and plasma current. The modelling results (induced voltages) are compared with the experimental data obtained from 23 flux loops installed at different locations within the SST-1 (11 internal and 12 external), which are in fair agreement. Additionally, the COMSOL simulation allowed visualizing induced currents on walls restricted both experimentally and analytically. In the second phase, a large data bank for a range of SST-1 configurations is being built, which will serve as the training data for a comprehensive machine learning model for the IC prediction. The proposed methodology provides a computationally efficient and physically consistent tool for supporting a data-driven safe operation of SST-1. Once we get satisfactory results from current model then this work may be extended to other tokamaks also.