Seminar

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Institute for Plasma Research

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Title: Deep learning assisted microwave-plasma interaction based technique for plasma density estimation

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Date: 1st March 2024 (Friday)

Time: 03:30 PM

Venue: Committee Room No. 3, IPR

Abstract

The electron density is a key parameter to characterize any plasma. Most of the plasma applications and research in the area of low-temperature plasmas (LTPs) are based on the accurate estimations of plasma density and plasma temperature. The conventional methods for electron density measurements offer axial and radial profiles for any given linear LTP device. These methods have major disadvantages of operational range (not very wide), cumbersome instrumentation, and complicated data analysis procedures. The article proposes a deep learning (DL) assisted microwave-plasma interaction-based non-invasive strategy, which can be used as a new alternative approach to address some of the challenges associated with existing plasma density measurement techniques. The electric field pattern due to microwave scattering from plasma is utilized to estimate the density profile. The proof of concept is tested for a simulated training data set comprising a low-temperature, unmagnetized, collisional plasma. Different types of symmetric (Gaussian-shaped) and asymmetrical density profiles, in the range 10^{16}–10^{19} m^{-3}, addressing a range of experimental configurations have been considered in our study. Real-life experimental issues such as the presence of noise and the amount of measured data (dense vs sparse) have been taken into consideration while preparing the synthetic training data-sets. The DL-based technique has the capability to determine the electron density profile within the plasma. The performance of the proposed DL-based approach has been evaluated using three metrics- structural similarity index, root mean square logarithmic error, and mean absolute percentage error. The obtained results show promising performance in estimating the 2D radial profile of the density for the given linear plasma device and affirms the potential of the proposed machine learning-based approach in plasma diagnostics.