Seminar

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Institute for Plasma Research

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Title: Design and Development of High Power RF Antennae for the Pre-ionization and RF-Assisted Wall Conditioning Experiments in SST-1 and Characterization of RF Plasma Discharge in Multi-Cusp Plasma Device.

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Date: 21st November 2022 (Monday)

Time: 11:00 AM

Venue: Seminar Hall, IPR

Abstract

The RF-assisted Glow Discharge Cleaning (GDC) system having Three and Half Turn (THT) type high power antenna has been developed and mounted inside the Steady-State Superconducting Tokamak (SST-1) successfully for the Wall Conditioning at the possible lowest pressure. The antenna is designed according to the space constraint of the available SST-1 port and simulated using CST-MWS. The simulation and measurement results showed that the antenna naturally resonates at ~184.1 MHz and 173 MHz with ~12 dB and ~18 dB of return loss respectively which are in very close agreement. A fixed frequency (13.56 MHz) RF source along with the external L-Type matching network with variable vacuum capacitors and fixed value inductors is used to supply 2.5 kW of power to the RF antenna under matched conditions along with ~210 V DC and ~2.3 A current at the GDC electrodes. Dense plasma with helium discharge is obtained in the initial test experiment for the gas-filled pressure from 3.3e-3 Torr to 1.6e-4 Torr which may help in achieving the efficient SST-1 wall conditioning at low pressure down to ~ 1e-5 Torr in the next campaign.

In the characterization of RF Plasma discharge in a Multi-Cusp Plasma Device (MPD), the RF Plasma is produced along the 1.5 m long vacuum chamber (Multi-Cusp Plasma Device) using a high-power four-turn planer spiral antenna at 13.56 MHz in the power range of 0 to 1000 W and Argon gas–filled pressure between 2×10^{-3} mbar to 1×10^{-2} mbar. The input impedance of the spiral antenna along with the vacuum chamber, vacuum shield flange and RF shielding is measured using a VNA and is found to be ~0.37 + j80 Ω which is in very close agreement with the simulated result (0.3 + j0.88 Ω). The antenna is matched to resonate at 13.56 MHz using an external L-type matching network with variable capacitors and fixed value inductors under vacuum conditions with a base pressure of 5×10^{-3} mbar. The antenna resistance is then measured experimentally using the Rogowski coil under the matched condition and is found to be ~0.27 Ω which is in good agreement with the VNA readings. Finally, the characterization of Argon plasma is performed under the Multi-Dipole Line Cusp Magnetic Field (B_0) and it is observed that when RF power increases, the plasma density (n_e) moves to a maximum (3.2×10^{17} /m^3) value for large B_0 of 800 Gauss. In addition, the plasma resistance is also measured experimentally using a Rogowski coil and is found to be ~0.55 Ω which shows the coupling efficiency of RF power with the plasma is ~68 %.

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