Plasma Characteristics and Wave Propagation near Helicon Plasma Source in PISCES-RF

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The helicon plasma-based linear device PISCES-RF has been developed, and the plasma in the target region has been characterized using a reciprocating RF-compensated Langmuir probe (RFLP) [1]. The radial profile of ion flux, Γ_i, near the target typically peaks at the center of the plasma column in the helicon mode of operation. The radial variation over the plasma-exposed area (22 mm diameter) of the standard PISCES target is not more than ~20%. To make a flatter radial profile of Γ_i near the target, which is more preferable for PMI experiments, we have investigated plasma generation and transport processes by characterizing the plasma near the helicon source.

For this purpose, two reciprocating probe systems developed at the University of Tsukuba were newly installed at axial locations z ~ 0.50 m and ~ 0.75 m downstream from the helicon source exit (z = 0 m). Note that the PMI target is located at z ~ 1.28 m. A combined probe tip consisting of a B-dot probe and an RFLP was employed at each location to explore RF wave propagation together with plasma parameters.

In this experiment, measurements were performed in deuterium plasmas while varying the gas pressure (1 – 6 mTorr), RF input power (≤ 18 kW), and external magnetic field configuration. To study wave propagation, we take a relative amplitude, defined as a ratio of the magnetic fluctuation amplitude in the axial direction at 13.56 MHz to that at 27.12 MHz. While Γ_i at the center slightly decreases from 2.1×10^{23} $m^{-2}s^{-1}$ at z ~ 0.50 m to 1.9×10^{23} $m^{-2}s^{-1}$ at z ~ 0.75 m, the relative amplitude decays by a factor of ~2 – 3 at the center. At the edge of the plasma column, the wave is still observed at z ~ 0.50 m, whereas no significant wave activity is detected at z ~ 0.75 m. With increasing RF power, the peak value of Γ_i at z ~ 0.50 m increases up to 4.3×10^{23} $m^{-2}s^{-1}$ at 18 kW. Correspondingly, the relative amplitude at the plasma center also increases. In this workshop, we will discuss characteristics of the plasma near the helicon source based on probe measurements and RF wave propagation simulation.

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