Measurement of Single Pass EC Absorption Using Transmitted Waves in Heliotron J

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The EC power absorption is usually estimated by heat transport analysis using a power modulation technique in ECH and ECCD. Although this method gives the reliable power absorption profile and total absorption rate, it is not easy to apply it to every plasma shot. In this paper, we present a simple diagnostic system for measuring the single pass EC power absorption rate using transmitted waves and its experimental results in Heliotron J plasmas. Plasma production and heating is routinely performed in the helical-axis heliotron device, Heliotron J [1] using a 70GHz 400kW ECH system [2]. A Gaussian beam with controlled polarization is injected from the top of the torus at the straight section where the B contour has a saddle type shape. The injected waves cross the magnetic field obliquely due to inherently 3D magnetic field structure. The single pass absorption of the 2nd X-mode is estimated by measuring the transmitted waves. Previously the transmitted waves were measured by rotating one detector [3]. However, this method required some shots to determine the polarization, and the signal was fluctuated in time due to density change. In order to improve the situation, a corrugated waveguide and a miter bend have been set up on the bottom ports facing the ECH launcher at the same poloidal cross section. A power monitor with two multi-hole arrays is installed on the miter bend, which detect two polarized waves transmitting through plasmas simultaneously. While each detector signal oscillates depending on the electron density due to the X-mode absorption and the phase change between the O- and X-modes, the summation of the detector signals is kept constant, giving the total single pass absorption rate and its time evolution. The single pass absorption of the second harmonic X-mode is experimentally estimated to be around 90 % at $n_e \sim 0.5\times10^{19}$ m^{-3} and $T_e \sim 500$eV. This absorption efficiency is in good agreement with a ray tracing calculation result using the TRECE code [4]. The dependence on electron density, polarization of launched waves and magnetic field conditions are shown.

References

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