§24. Measurement of Power Deposition Profile by Heating Power Modulation of 2.45 GHz Microwaves in CHS

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A new transport simulation based on the concept of "dimensional similarity" using a low temperature and density helical plasma is currently underway in the CHS [1]. Previous experiment showed that an over-dense plasma was produced by 2.45 GHz microwaves of which power was absorbed in the inaccessible region for electron cyclotron waves [2]. This result suggests a possibility of the mode conversion to electron Bernstein wave (EBW).

Recently, power modulation method was used in order to derive more detailed absorption profiles and clarify the possibility of absorption of mode-converted EBW. This method is often used to measure power absorption or study of heat transport in high temperature plasmas. This method is also applicable to low temperature and over-dense plasmas. In these plasmas, responses in electron temperature (T_e), electron density (n_e), and space potential to modulated heating power are measured simultaneously by a triple-Langumir probe. In this experiment, microwave power is injected from two microwave sources (#1, #2). In order to investigate effective excitation of EBW, microwaves are launched by two different ways: one is perpendicularly injected to the toroidal field for #1 source, and the other obliquely injected for #2 source. Polarization of launched wave is typically selected to be X-mode for the perpendicular injection and O-mode for oblique one, respectively. Figure 1 shows time evolutions of modulated microwave power from #1 source (P_1), steady microwave power from #2 source (P_2), line averaged density ($<n_e>$), and T_e, n_e and electron pressure (P_e) measured at $\rho = 0.3$ at the toroidal field $B_{t0} = 613$ G in the magnetic configuration of $R_{ax} = 97.4$ cm. In this experiment, the modulation frequency and amplitude are selected to be 1 kHz and about 5 kW, respectively. Power spectral densities (PSD) of T_e, n_e and P_e at $\rho = 0.3$ and 0.7 are shown in Fig. 2(a). The time window for FFT analysis is 55ms from 110 ms. PSDs of T_e at $\rho = 0.3$ and 0.7 are comparable level, while PSDs of n_e and P_e at $\rho = 0.3$ is much larger than ones at $\rho = 0.7$. Figure 2(b) shows radial profiles of T_e, n_e and P_e and these of modulated amplitudes (δT_e, δn_e and δP_e). δT_e profile has the maximum around $\rho \sim 0.4$ and spreads widely from core to edge region. On he other hand, δn_e and δP_e increase rapidly from $\rho \sim 0.5$ and have the peak around $\rho \sim 0.3$. Figure 3 illustrates the radial profiles of characteristic frequencies in the equatorial plane of the horizontally elongated section where microwave is injected perpendicularly for the toroidal field from #1 source. As seen from the δP_e profile shown in Fig. 2, most of heating power is expected to be deposited in the region beyond the inaccessible region of O-mode and X-mode powers. This result indicates that EBW converted at upper hybrid resonance layer is absorbed in over-dense region of the plasma core. We are studying whether the modulation frequency is high enough for the characteristic frequency of electron heat transport to derive the power deposition profile straightforwardly.

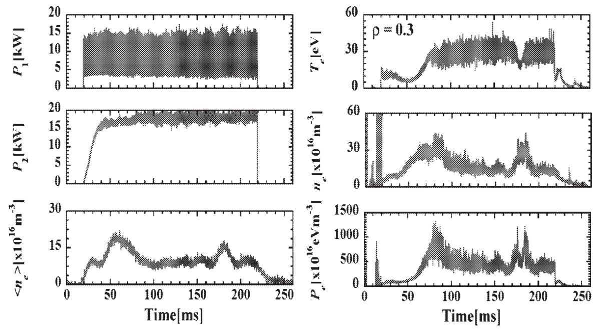

Fig. 1 Time evolutions of microwave powers (P_1, P_2), line averaged density ($<n_e>$), T_e, n_e and P_e at $\rho = 0.3$, where the modulation frequency of P_1 is 1 kHz and $B_{t0} = 613$ G.

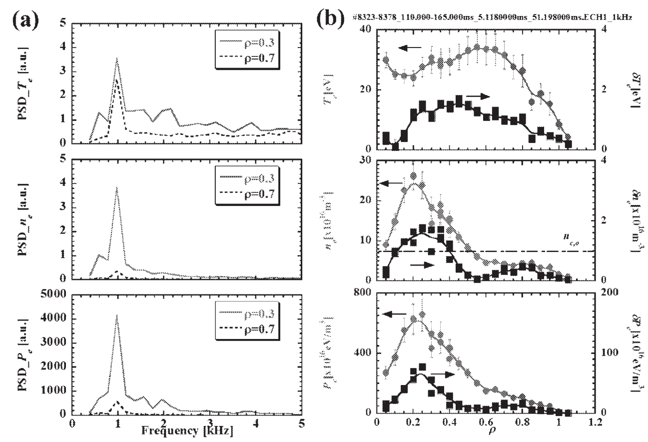

Fig. 2 (a) Power spectral densities of T_e, n_e and P_e at $\rho = 0.3$ and 0.7. (b) Radial profiles of T_e, n_e, P_e and those modulated amplitudes.

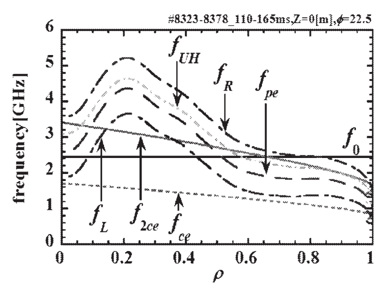

Fig. 3 Radial profiles of characteristic frequencies in the equatorial plane of the horizontally elongated section. The frequency f_0 is 2.45 GHz, f_{pe} is plasma frequency, $f_{R,L}$ are right and left hand cutoff frequency, f_{UH} is upper hybrid frequency, $f_{ce,2ce}$ are fundamental and 2nd harmonic electron cyclotron frequency.

[1] K. Toi *et al.*, 29th EPS on Plasma Physics and Controlled Fusion, Montereux, 2002, paper No.P4-06.
[2] R. Ikeda *et al.*, J. Plasma Fusion Res. **81**, 478 (2005).