§6. Measurement of Power Deposition Profile of 2.45 GHz Electron Bernstein Waves by Power Modulation Technique on CHS

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Production of over-dense plasmas by launching 2.45 GHz microwaves under very low field conditions has been successfully demonstrated on CHS. In the experiment, microwaves systems were arranged to aim at taking place mode conversion of launched electron cyclotron wave (ECW) effectively into electron Bernstein wave. One system (ECH#1) is launched nearly perpendicularly to the toroidal field, where FX-B mode conversion scenario is expected. The another (ECH#2) is launched obliquely for O-X-B mode conversion scenario. This experiment aims at clarifying the excitation, propagate and absorption of mode converted EBW. Power deposition profiles in produced over-dense plasmas were measured directly by using power modulation technique at various magnetic configurations where electron cyclotron resonance (ECR) and upper hybrid resonance (UHR) layers were scanned in space widely[1].

Figures 1 and 2 are radial profiles of electron temperature T_e, electron density n_e and electron pressure p_e. This figure also shows the response in p_e to ECH#1 or ECH#2 source δp_e, and the coherence γ_{pe}^2 and phase difference between δp_e and the modulated ECH power Φ_{pe}, at B_t/B_{res} = 100% and 70% (B_{res} = 0.0875T), respectively. Electron densities exceed O-mode cutoff density (n_{co} ~ 7.5x10^{16}m^{-3}) in both cases. Power deposition profile corresponds to δp_e-profile and the peak position is in over-dense region. Similarly, it was investigated in the cases of B_t/B_{res} = 50% and 20%. In the case of 50%, power deposition profile is similar to 100%. The reason may be that ECR layer such as 1st ECR or 2nd ECR passes through the plasma center in both cases and those conditions are similar each other. In the case of 20%, the peak of power deposition profiles is near plasma edge region. There are cutoff layers and UHR layer of ECWs near LCFS. The 4th–6th ECR layers are also between edge and central region. EBW mode-converted near LCFS may be absorbed at the more higher harmonic ECR layers. Moreover, electron-ion collision frequency is fairly high (ν_{ei}/ω ~ 10^{-5}–10^{-4}) in a whole plasma region. Collisional damping may also play a role in power absorption.

EBW is converted from ECWs at the UHR layer. The power-deposition profile may sensitively respond to a change in the n_e-profile. In order to test it, the n_e-profile was modified by gas puffing at B_{t0}/B_{res} = 70 % as shown in Fig. 3. The absorbed powers are obviously concentrated in the over-dense plasma region. The deposition region decreases or increases by moving the position of the UHR layer with the change of the line averaged electron density <n_e>. For example, the region becomes narrow around t ~ 120 ms and again broad around t ~ 200 ms, responding to the position of UHR layer. Since EBW will exist in the region inside of the UHR layer, this result clearly suggests the propagation and absorption of EBW.

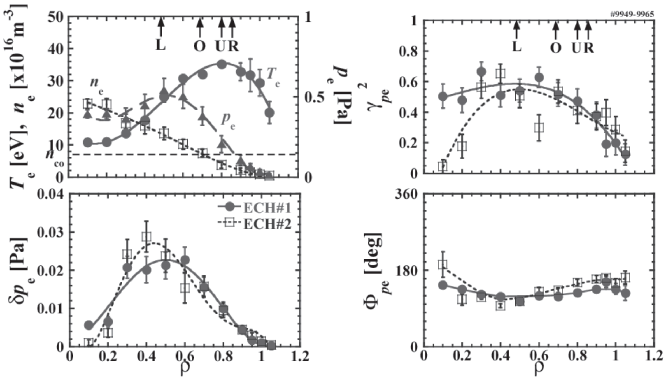

Fig.1 Radial profiles of T_e, n_e, p_e, δp_e, γ_{pe}^2 and Φ_{pe} at B_{t0}/B_{res} = 100%. The positions of R, L, O and U indicate the right hand, left hand and O-mode cutoff layers, and upper hybrid resonance layer, respectively.

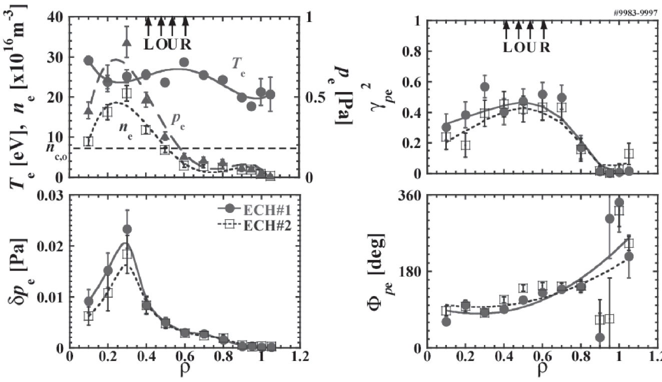

Fig.2 Radial profiles at B_{t0}/B_{res} = 70%.

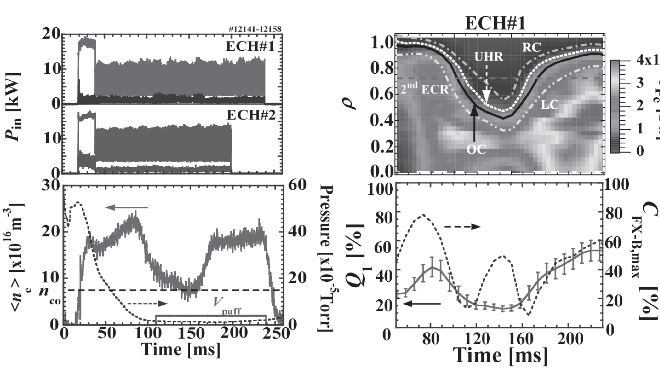

Fig.3 Time evolutions of ECH powers and <n_e>, contour plots of δp_e, the positions of various cutoff and resonance layers for ECH#1, the absorption rate Q_1, and maximum FX-B conversion efficiency, $C_{FX\text{-}B,max}$.

[1] R. Ikeda et al., to be published in Phys. Plasmas (2008).