§36. Effect of the Edge Plasma Profile Control on the Absorption Profiles in Oblique ECH Power Injection from the High Magnetic Field Side

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Since the 8th experimental campaign, electron cyclotron heating (ECH) by electron Bernstein waves (EBWs) has been tried with toroidally oblique injection of the extraordinary (X) waves from the high magnetic field side (X-B method). If the injected X-waves reach the UHR layer, they excite EBWs via the mode conversion process. As shown in Fig.1, obliquely injected beam of electromagnetic waves can approach the upper hybrid resonance (UHR) layer from the high field side. However, power absorption as electromagnetic (EM) mode of X-waves can take place at the fundamental electron cyclotron resonance (ECR) layer before the injected waves reach the UHR layer. Because X-mode waves which propagate obliquely to the external magnetic field, can be strongly absorbed at the fundamental ECR layer if the electron temperature and the electron density are certain levels there. Previous experimental results have suggested that power absorption as EM waves and as EBWs take place in parallel. Discrimination between power absorption as X-waves and power absorption as EBWs is required.

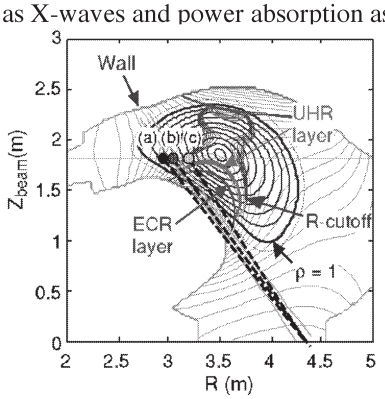

Fig.1: Contours of flux surfaces (ρ = 0.1, 0.2~ 1.0), positions of the UHR layer, the ECR layer, right handed (R) cutoff, and the target position of the injected beam for each case of (a), (b) and (c).

In the latest 10th experimental campaign, with use of the local island diverter (LID) coils and head insertion, we tried to cut down the plasma density and temperature profiles around the ECR layer in the edge region. In an experimental configuration where the position of the magnetic axis, R_{ax}=3.6m and the magnetic field at the axis B_{ax}=2.75T, about 400kW EM waves are injected with 39Hz, 100% modulation into the target plasma sustained by 4.5MW tangential neutral beam injection (NBI). The target position of the injected beam is changed shot by shot as shown in Fig.1. The central electron density was 1 x $10^{19}m^{-3}$. Profiles of 39Hz perturbation amplitude and phase of the electron temperature are obtained by FFT analysis of electron cyclotron emission (ECE) signals as shown in Fig.2 and Fig.3, for each case without and with LID application. The region where the peak of the amplitude and the bottom of the phase coincide indicates the power deposition region.

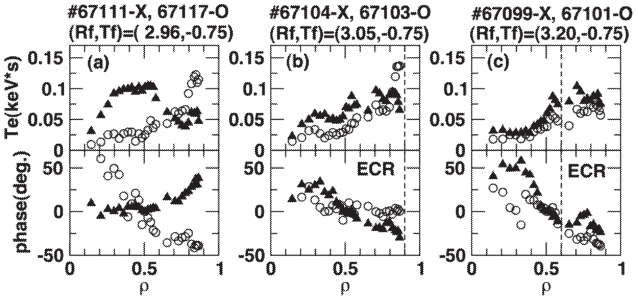

Fig.2 : Profiles of the perturbation amplitude and phase of the electron temperature for the case of X-wave injection (black triangles) and O-wave injection (white circles). (a), (b) and (c) indicate the beam target position (a), (b) and (c) shown in Fig.1. LID coils were not used and the LID head was not inserted (without LID application).

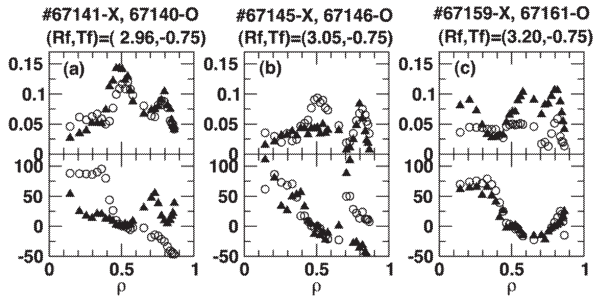

Fig.3 Profiles similar to those of in Fig.2. LID coils were used and the LID head was inserted (with LID application).

The amplitude and phase profiles are different without and with LID application. In the case of (c), since the bottom of the phase is clearly seen around ρ =0.6, absorption as EM modes may occur near the ECR layer. Peaks around ρ =0.2 and 0.8 are clearly seen only in the case with LID application, however clear bottoms of the phase is not seen. In the case of (b), power absorption as EM modes may occur near the ECR layer around ρ =0.8 in both of the cases without and with LID application, in both cases of X and O-wave injection since a set of the peak and the bottom can be seen there. A set of the peak and the bottom can be seen around ρ =0.5 in both cases of X and O-wave injection with LID application, and in the case of X-wave injection without LID application. There is a possibility that power absorption as EBWs takes place in these cases. There might be some X-wave components in the injected waves even in "O-wave" injection setting since the polarization is set on the assumption that EM modes couple with the propagation modes in plasma (X and O-waves) at ρ =1.0 although they couple in a different point. In the case of (a), at least power absorption around ρ =0.5 takes place in the case of X wave injection without LID application and in both cases of "X" and "O" wave injection setting" with LID application. There is a possibility that absorption as EBWs occurs at Doppler shifted ECR layer. More precise analysis with use of ray-tracing calculation is required to explain why the sharp peaks appear in amplitude profiles with LID application.