§1. Survey of the O-X Mode Conversion Window with Steering the Antenna Aiming

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In the LHD, the aiming of the quasi-optical launching antenna of the electron cyclotron wave used for electron cyclotron resonance heating (ECRH) can be steerable during the discharge. It allows an effective survey of the O-X mode conversion window with monitoring the emission by radiometer installed in the branch of the transmission line. In this experiment, a steering antenna installed in the lower port (1.5L port) was used for the survey. The radiometer that is originally installed for collective Thomson scattering measurement was used to detect the emission. In the left graph in Fig.1 contours of the O-X mode conversion ratio are plotted as a function of aiming point on the mid-plane (z=0). The O-X mode conversion rate was calculated theoretically with use of the experimental data. Trajectories of the steered aiming during one discharge are plotted in the same graph. When the trajectory “A” was selected, the emission intensity did not increase during the steering although the electron temperature obtained by Thomson scattering measurement increases with time. On the contrary when the steering trajectory of “B” was selected, the increase of emission near 77GHz range was observed. When the start time of the steering was delayed for 0.4 sec., the start time of the increasing is also delayed for about 0.4 sec. Therefore, this increase may be due to the change of antenna aiming and not due to the increase of electron temperature. However, this trajectory is apart from the predicted O-X mode conversion window where high O-X mode conversion ratio is expected. The trajectory that crosses the predicted mode conversion window could not set because of the hardware restriction of the steering.

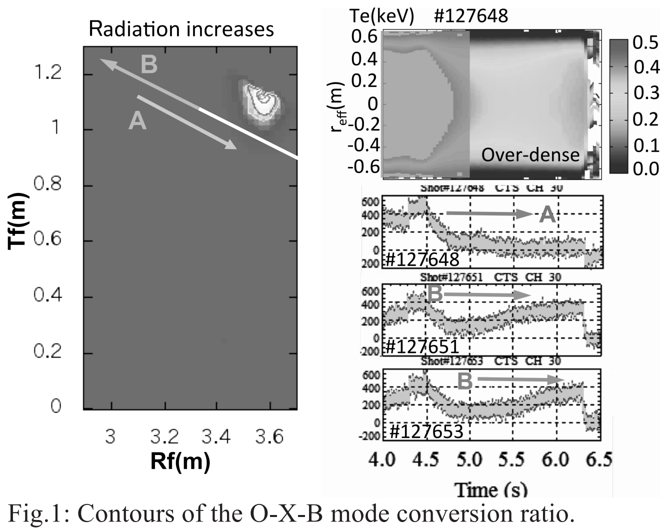

Fig.1: Contours of the O-X-B mode conversion ratio. Trajectories of antenna aiming steered during discharges (left). Change of electron temperature profile obtained by Thomson scattering measurement with time (right upper). Changes of the emission intensities with time for each case of steering trajectory (right lower).

We examine a possibility that the electron cyclotron emission in under-dense region is detected. Fig.2 shows the profiles of electron density and temperature. The plasma cutoff is located near the last closed flux surface (LCFS) near r_{eff} = 0.6 m however, the density and the temperature distribute even outside the LCFS. With using the dielectric tensor of the hot plasma, we calculate the wave trajectory and power absorption by ray-tracing including the area outside the LCFS. Fig. 3 shows the case of aiming with that the increase of the emission was observed. The ray reaches the ECR layer drawn with red line in the plasma boundary region where the electron temperature is several ten eV. Precise calibration of the emission intensity for obliquely propagating wave is required to examine the consistency of this analysis.

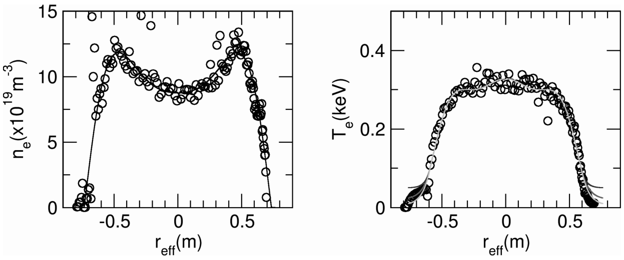

Fig. 2: Profiles of electron density (left) and temperature (right) obtained by Thomson scattering measurement.

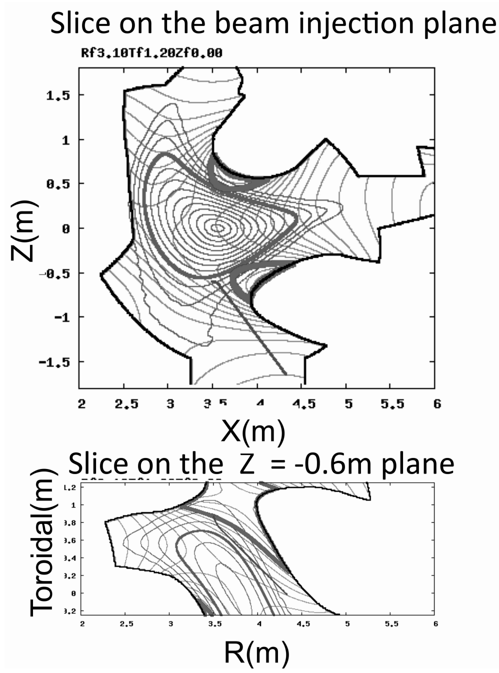

Fig. 3: Projection of the ray trajectory (green) when the aiming (R_f,T_f,Z_f) =(3.10m, 1.20m, 0.00m) was set. Contours of the flux surfaces are drawn by blue lines. The position of the ECR layer is drawn by red line.