§54. ECE Measurement Using Heterodyne Radiometer in LHD

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To obtain the ECE intensity profile (the 1st harmonic of the O-mode and the 2nd harmonic of the X-mode), two radiometers have been used in the 3rd experimental campaign on LHD. The schematic view of our radiometer system is shown in Fig.1. The ECE radiation is collected by an ellipsoidal mirror, which is mounted in an inner port of LHD, and is transferred to radiometers. The ECE is mixed with 132 GHz or 70 GHz local oscillator in each radiometer. Two filter banks consisting of 16 and 32 bandpass filters (bandwidth = 1 GHz) cover frequency ranges of 53-87 GHz and 115-149 GHz. Thus, we can measure the 1st and the 2nd harmonics of ECE from the inboard side of the LHD plasma in the high field operation ($B_0 \geq 2.75$ T).

The core plasma usually has enough optical depth (τ) for both modes in LHD. In contrast, the optical depth in the edge region ($\rho \geq 0.8$) depends strongly on electron temperature (T_e) and electron density (n_e). Figure 2 shows the T_e and n_e dependencies of $\tau=1$ and 4 boundaries at $\rho \sim 0.8$. As shown in this figure, the 1st harmonic of the O-mode is optically thin when $T_e < 1$ keV. On the other hand, the 2nd harmonic of the X-mode is optically thick when $n_e \geq$ 2-3 $\times 10^{-19}$ m^{-3}. From the point of view of optical depth, the high density plasma is favorable. However the cutoff phenomena prevent the ECE from propagating to the antenna if the density exceeds the cutoff value. The cutoff density for the 1st harmonic of the O-mode and the 2nd harmonic of the X-mode at $\rho \sim 0.8$ are 4.1×10^{-19} m^{-3} and 8.2×10^{-19} m^{-3}, respectively. Thus, the ECE measurements using the 1st harmonic of the O-mode is not available for the high density plasma, such as the pellet injected plasma. Typical time evolutions of ECE intensity during pellet injection are shown in Fig. 3.

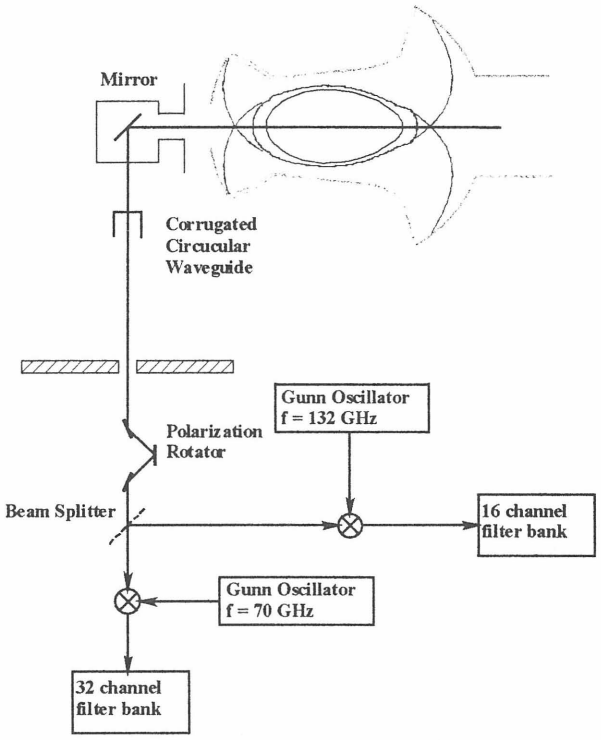

Fig. 1. Schematic view of radiometer system

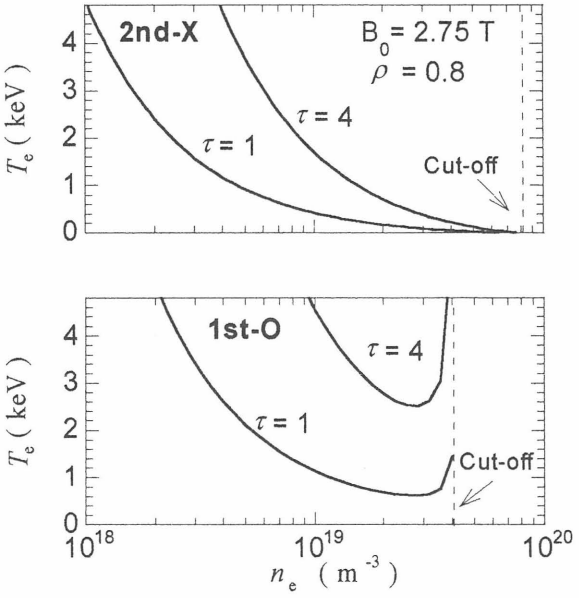

Fig. 2. Contour plots of optical depth.

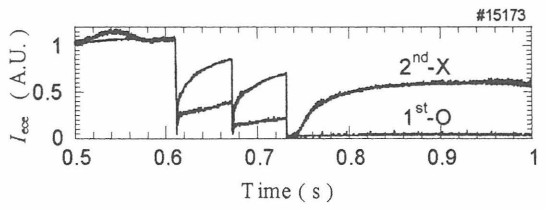

Fig. 3. Time evolutions of ECE intensity.