§51. ECE Studies in the Second Cycle Experiment on LHD: the Radiometer

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The heterodyne radiometer is used to study the electron cyclotron emission (ECE) from LHD plasmas. Our heterodyne radiometer system can measure the ECE radiation with a temporal resolution of less than 10 μs.

The intensity of the ECE radiation from plasma is proportional to the electron temperature, if the plasma is optically thick. Figure 1 shows the optical thickness with respect to the second harmonic X mode radiation from a typical LHD plasma. For this calculation, the temperature and density profiles are given by the Thomson scattering system and FIR laser interferometer, respectively. The typical plasmas (the average density is higher than 10^{19} m^{-3} and the central temperature is higher than 1 keV) produced in the second experimental campaign on LHD were optically thick except for the edge region, as shown in Fig. 1. Thus, the ECE measurements could determine the electron temperature with a high temporal resolution.

The ECE signals are calibrated by using the electron temperature measured by Thomson scattering system. The typical time evolution of the electron temperature is shown in Fig 2(a). When one of the neutral beams is turned off, the electron temperature decreases. The temperature in the core region ($\rho > 0.8$) decreases faster compared to one in the edge region, and thus the radial profile flattens. The typical radial profile of electron temperature is shown in Fig. 2(b).

From the point of view of the electron temperature diagnostic, the cut-off phenomenon is important. When the average density exceeds about 2×10^{19} m^{-3}, the cutoff layer appear at the edge region. Then the ECE radiation, which comes from the cutoff layer, decreases significantly. The location of the cutoff layer and its time evolution are found by the ECE measurements and agree with the density diagnostic.

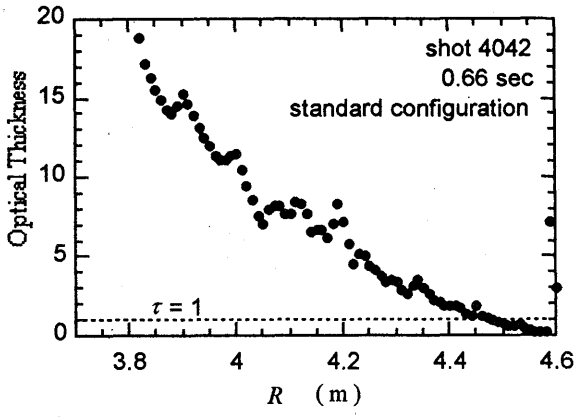

Fig. 1. Radial profile of the optical thickness τ of a typical LHD plasma. R is the major radius. The plasma is optically thick when $\tau >> 1$.

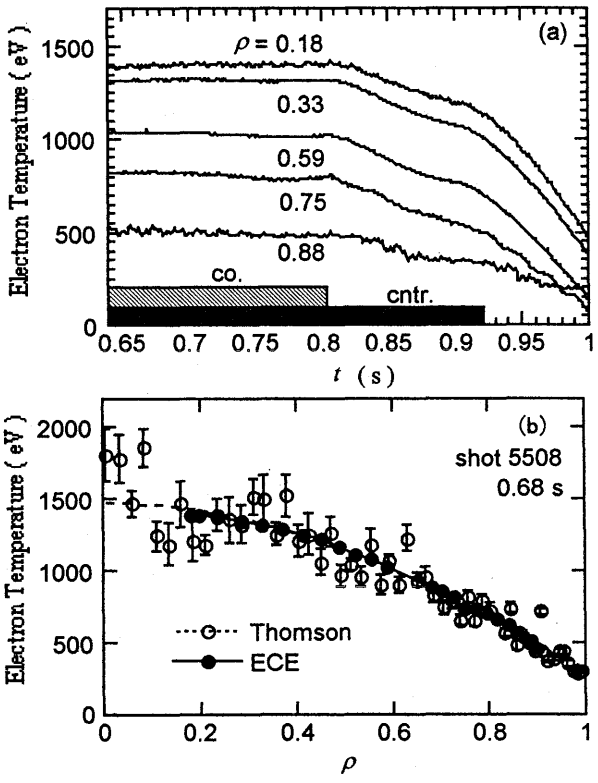

Fig.2. (a) The time behavior of the electron temperature measured by using ECE. Here, ρ is the normalized average radius. (b) Radial profile of electron temperature. The profile measured by Thomson scattering system is also shown in this figure.