§11. Electron Bernstein Emission Measurement in Second Harmonic with a Transmission Line for ECH

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In highly dense operation in the LHD generated by hydrogen pellet injection, the position of the ordinary-extraordinary-electron Bernstein wave (EBW) (O-X-B) mode conversion of the second harmonic electron cyclotron (EC) wave is near the plasma core. Therefore power deposition in the core region where heating by neutral beam injection is difficult can be expected. The optimum launching condition to excite the EBW via the O-X-B mode conversion process can be looked for by measurement of the emission originated thermally emitted the EBW.

For this purpose a heterodyne radiometer to measure the second harmonic EC wave was initially prepared to be installed one of the transmission line that is connected to the horizontal antenna. However after the planning the installation of a new 154GHz gyrotoron in the same transmission line was determined and the radiometer had to be move to another transmission line that is connected to the lower port antenna. Since the transmission line is used for launching 84GHz EC wave in the long pulse experiment evacuation of the transmission line is required. Therefore for the switching between the emission measurement and the power injection a gate valve and a vacuum window that was originally used for the power injection of the 84GHz EC wave were installed. A quasi-optical receiving system, a mixer and the first IF amp were installed near gyrotrons. Via the RF cable, the output of the first IF amp was input the second IF amp that was located apart from the gyrotrons.

However, it was derived that the signal noise (S/N) ratio of the thermally emitted signals was not good because the transmission efficiency is poor for the second harmonics range in this transmission line. More, the parasitic oscillations of the 77GHz and 154GHz gyrotron came to be mixed in the emission signals during the modulated power injection. It was confirmed that the power level of the parasitic oscillation can be reduced by setting the receiving system apart from the gyrotron. However, increase the transmission efficiency is not possible unless the transmission components are replaced for second harmonic wave transmission.

For the case of the measurement with the lower port antenna, the range of the aiming that allows the excitation of the EBW via the O-X-B mode conversion process that is "O-X-B mode conversion window" was estimated in two ways. In Fig. 1 the electron density profile used for the estimation is shown. The cutoff of the 153GHz EC wave is near the plasma core. Fig. 2 is obtained with the assumption that the launched wave propagates along the injection vector without refraction until it reaches the plasma cutoff. For wide range of the aiming in the toroidal direction, high O-X-B mode conversion rate is obtained. While if the effect of the refraction inside plasma is taken into account with use of the ray-tracing calculation the O-X-B mode conversion window shifts and the decreases in width as shown in Fig. 3. However this method might be improvable, for example by introduction of the full wave calculation to increase the accuracy.

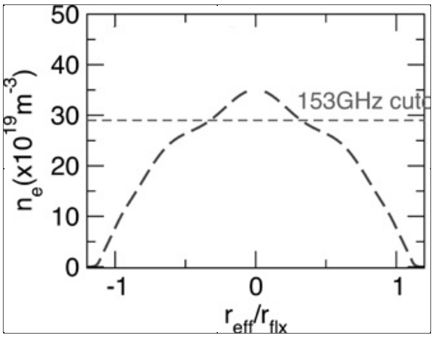

Fig 1 Electron density profile used to estimate the O-X-B mode conversion rate for the second harmonic EC wave

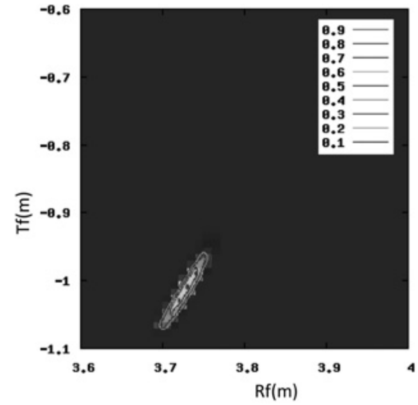

Fig. 2 Contours of the O-X-B mode conversion rate plotted as function of the aiming point on the equatorial plane. Refraction inside the plasma is not taken into account.

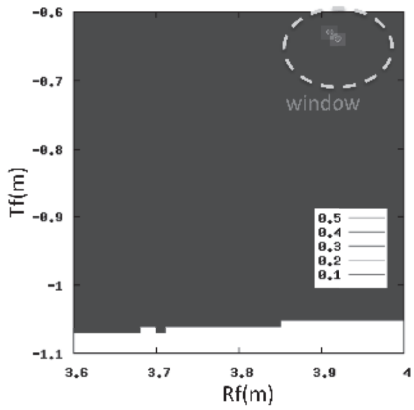

Fig. 3 Contours of the O-X-B mode conversion rate. Refraction inside the plasma is taken into account with use of the ray-tracing.