§39. Electron Bernstein Wave Measurement in Consideration of Finite Beam Width

Igami, H.,
Nagasaki, K., Sano, F., Mizuuchi, T., Ohshima, S., Minami, T., Yamamoto, S., Kobayashi, S., Okada, H., Nakamura, Y. (IAE, Kyoto Univ.),
Volpe, F. (Columbia Univ.),
Kubo, S., Shimozuma, T., Yoshimura, Y., Takahashi, H., Mutoh, T.

In this collaboration research program, we are developing a radiometer system in Heliotron J to measure emissions originated from the electron Bernstein wave (EBW) and emitted via the EBW-extraordinary-ordinary (B-X-O) mode conversion process for comparison with theoretically predictions about wave propagation, mode conversion and power absorption with taking into account of the finite beam width of the beam. In this fiscal year, we have installed a radiometer system as shown in Fig.1. In the system, via a waveguide switch installed on the way of the transmission line constructed of oversized corrugated waveguides used for electron cyclotron resonance heating (ECRH), emissions of *26-42 GHz* is collected with a Gaussian optics antenna and input into a mixer. The wave from the local oscillator of *24 GHz* is input into the mixer and the intermediate frequency (IF) output is amplified and divided in quarters, then input into Schottky diode detectors through band-pass filters (BPFs). The outputs of the detectors are input into the data acquisition system via buffer amplifiers. When the waveguide switch was set for ECRH to pass the 70 GHz second harmonic EC wave to the antenna, leakage fundamental electron cyclotron emissions of *28-29 GHz* and *31-32 GHz* bands were measured. Therefore we confirmed that this system can measure the emissions with a significant sensitivity.

Fig. 2 shows contour plots of the O-X-B mode conversion ratio (T_{OXB}) versus the toroidal and poloidal injection (detection) angles for different magnetic field configurations and central electron densities. The region of inside which a finite T_{OXB} is obtained (O-X-B mode conversion window) is located near the wall of the vacuum chamber port. It is required to reduce the magnetic field strength so that the mode conversion window can be aimed from the antenna widely.

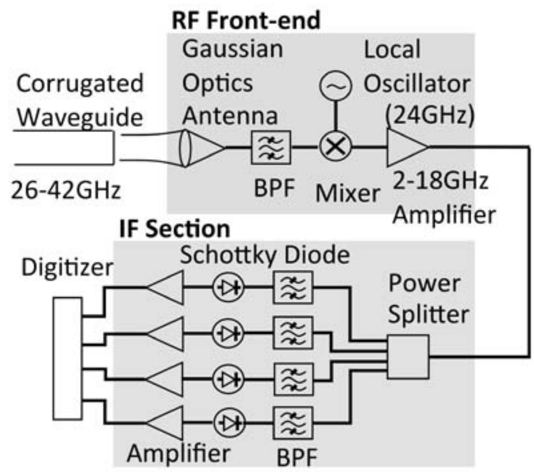

Fig. 1: Multi-channel radiometer system installed in Heliotron J

Contours of Fig. 2 are obtained with use single ray-tracing and the finite beam width has not been taking into account yet. Fig. 3 shows an example of comparison between the contour plots of T_{OXB} obtained by single and multi ray-tracing calculations. With taking into the beam whose waist size is *30 mm*, the width of the high T_{OXB} region becomes narrow, however, the region where $T_{OXB} < 20\ \%$ is comparable to that obtained by single ray calculation. Similar tendency can be expected to predict T_{OXB} in Heliotron J.

Here the influence of the density fluctuation to the mode conversion ratio is not considered. For the parameters of Heliotron J, 40% decrease of the efficiency with density fluctuation of 16 % for the density around the plasma cutoff is predicted. Validity of this prediction should be checked with comparison of the measurement in plasmas of different fluctuation level [1].

[1]. K. Nagasaki, et al., “Heating and Diagnostic Using Electron Bernstein Waves in Heliotron J”, Joint 19th ISHW and 16th IEA-RFP workshop, Padova, September 16-20, 2013, K6 (Poster)

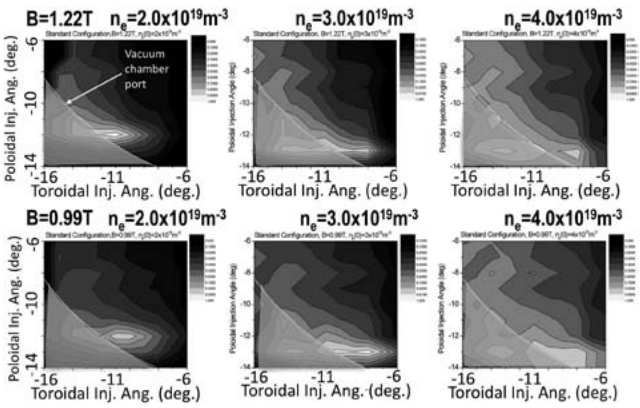

Fig. 2: Contours of the O-X-B mode conversion ratio for different magnetic field configurations and central electron densities. The region the vacuum chamber port prohibits the line of sight is hatched.

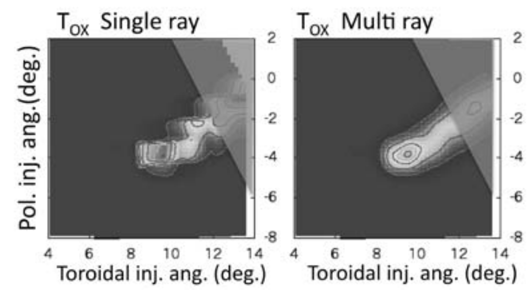

Fig. 3: Contours of the O-X-B mode conversion ratio calculated with use the single ray-tracing (left) and multi ray-tracing calculations. A helium discharge performed in a magnetic configuration (R_{ax}, B_t) = (*3.75 m, 2.4 T*) is considered.