§30. Scattering Measurement from Gyrotron

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Electron cyclotron heating system on LHD adapts a highly focused quasi-optical launching antenna. This antenna is designed so that the power deposition profile becomes as narrow as possible and position of power deposition can be changed to study local heating effect. This launching antenna is also attractive from the view point of scattering diagnostic tool. Since it uses high power gyrotron as a power source, one need not to prepare separate probing beam source. The two sets of U-port antennas on LHD have two sets of launcher systems for 84 and 168GHz. Once 168 GHz gyrotron is replaced by a scattering power detector, this system turns out to be the Brag back scattering measurment system. One gyrotoron beam can be used both as heating and as probing beam for scattering measurement by the plasma density fluctuations. The other antenna set can be used only for receiving the scattered part of the first beam. The scattering will take place from the volume, organized by cross section of the two beams in the plasma column. For the used 84 GHz gyrotrons beam frequency and present geometry of antenna sets as shown in Fig. 1, the scattering angle will correspond to the fluctuation wave number $K=10\text{-}15\ cm^{-1}$. By steering the receiving antenna in poloidal plane we can shift the location of scattering volume along the major radius from core to edge region in the plasma.

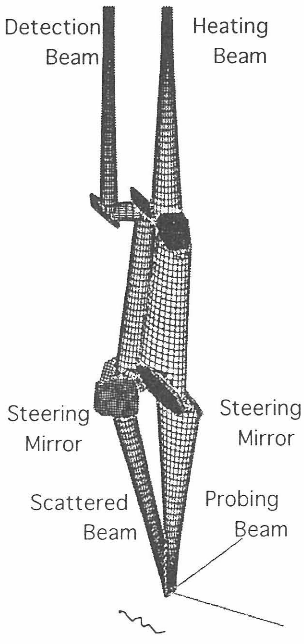

Fig.1 Scattering geometry

Fig.2 shows the transmission line for the probing and detection beam. One of the miter bend mirrors of 168GHz gyrotron transmission line is replaced by a simple microwave detector. Due to the high level of stray radiation from probing beam, this simple configuration forms homodyne detection system.

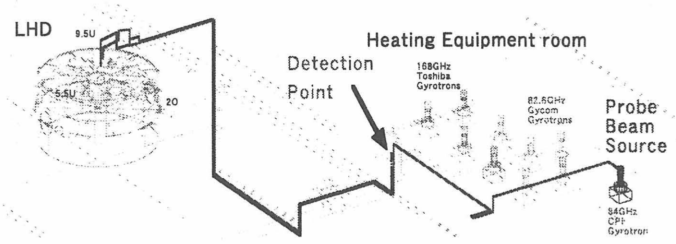

Fig.2. Transmission line for the probing and detection beam.

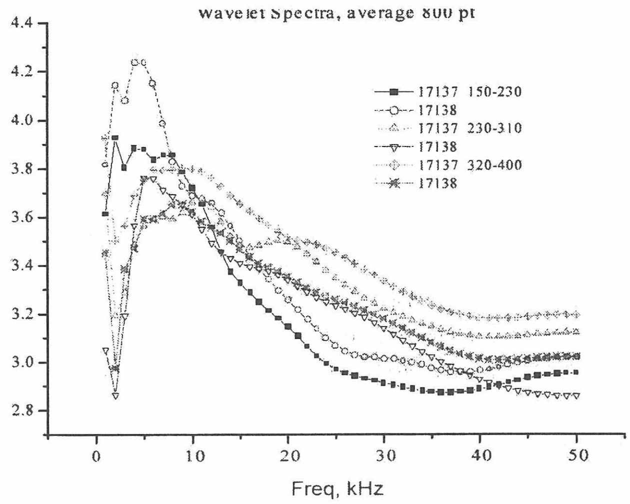

Fig.3 Example of the power spectrum by wavelet analysis.

During the third experimental campaign, the test measurement using the proposed method of scattering diagnostic was carried out on LHD. Since the detection line shares the transmission line for 168 GHz and the absorption of 84 GHz is high near the second harmonic operation, this trial experiment is limited to the 1.5 T operation of LHD. The local scattering signals were obtained with homodyne and heterodyne receiver. Fig. 3 shows an example of the result of wavelet analysis of the heterodyne signals. The spectrum region in frequency and in wave number imply that the density fluctuations are originated from drift-dissipative or trapped-electron instabilities[1], that can be excited in LHD plasma with ECH. This preliminary results show that the detected power corresponds to that scattered by density fluctuations in the scattering volume, but, further check of the system is necessary to discuss the characteristics of density fluctuations in LHD in detail. Next step measurements including the dependence on the locations of scattering volume, plasma parameters and their profiles, detection polarizations, etc. are planned in the forth experimental campaign.

Reference

1) G.M. Batanov et al.,Plasma Phys. Report **19** (10), October, 1993, p628.