§9. Gyrotron Scattering Measurement Test on LHD

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We tested a gyrotron scattering measurement system to investigate electron density fluctuations with wavelengths on the order of electron Larmor radius and with a wavenumber in the range of electron temperature gradient driven instabilities ($k \sim 3.4$ mm^{-1}).

The system utilizes a gyrotron, transmission lines and antennas of the electron cyclotron heating (ECH) system for LHD[1] and electron density fluctuations were measured by backward scattering. Millimeter-wave from a 82.7-GHz gyrotron was injected into a plasma. Scattered waves by electron density fluctuations were received with an antenna for 168 GHz and transmitted to a detector through 80-m long corrugated waveguide.

In the case of backward sacttering measurements, stray waves are generated by reflection of penetrated wave at inner walls of the vacuum vessel. Stray waves travelling in the plasma can be scattered and be received by the anntena. Thus an apparent scattering signal was produced by the scattering of stray waves, which overlapped the local scattering signal.

We tried to reduce the stray waves by placing a scattering volume in front of a resonance layer, which absorbs penetrating wave by the electron cyclotron resonance absorption as shown in Fig. 1. We compared the scattering signal by varying the scattering volume with almost reproducible shots. The scattering volume was varied by scanning the receiving antenna in the toroidal direction. The stray waves were monitored with a sniffer probe.

The result of the toroidal scan is shown in Fig. 2. The thick and thin lines represent the observed signals normalized to the line averaged density in the frequency range of (0.1 – 0.5) MHz and (0.5 – 0.8) MHz, respectively. The solid and dotted lines signify that the scattering volume was the maximum and zero, respectively. The scattering signal was observed to become stronger with increasing scattering volume, in particular, in the frequency range of (0.1 – 0.5) MHz, while the stray waves monitored with the sniffer probe were almost comparable. Accordingly the local scattering signal from the scattering volume was confirmed to be detected. The signal to noise ratio, however, was less than unity. Hence physical discussions were hard to make from the scattering signal. A beam dump is required to raise the signal to noise ratio.

1) Shimozuma, T. *et. al.*, Fusion Engineering and Design 53 (2001) 525

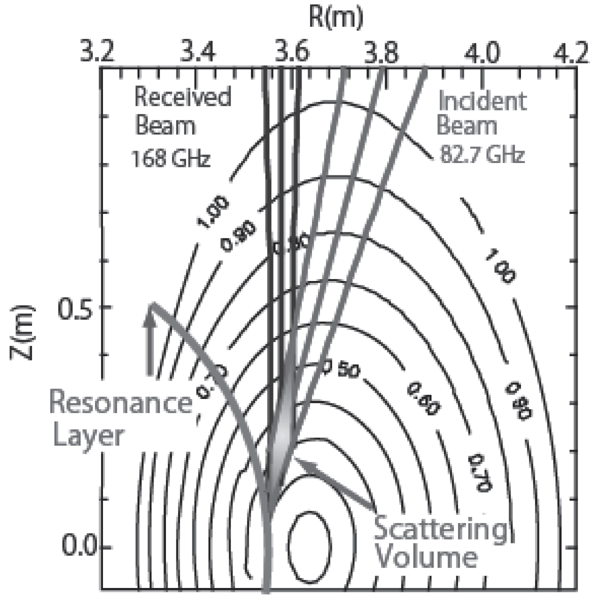

Fig. 1 Illustration of scattering geometry

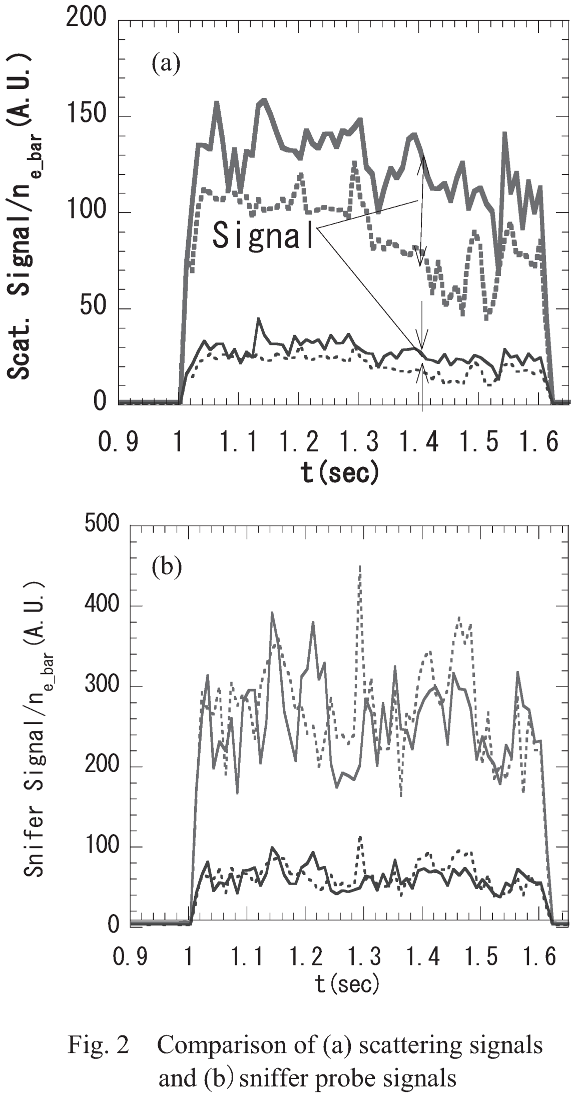

Fig. 2 Comparison of (a) scattering signals and (b) sniffer probe signals