§54. Fine Spectrum Measurement of Collective Thomson Scattering in the Large Helical Device

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One of capabilities for the collective Thomson scattering (CTS) diagnostics is to measure the ratio of ion species in confined plasmas [1, 2]. Since the CTS diagnostics is sensitive to the ion Bernstein waves (IBWs) and the ion cyclotron motions, the feature is appeared in the CTS spectrum as a fine structure. Then one can detect the fine structure in the CTS spectrum under a specific condition that the fluctuation wave vector k^{δ} is perpendicular to the magnetic field. The fine structure has the multiple peaks related to the harmonics of the ion cyclotron frequency $n\omega_{ci}$. Therefore the frequency resolution of the CTS receiver system is required to be less than $\omega_{ci}/2\pi$. In 14th campaign of LHD experiment, we introduced a fast sampling and wide bandwidth oscilloscope and demonstrated it for CTS diagnostics in LHD plasma discharges.

Fig.1 shows the schematic diagram of the receiver system for measuring the fine structure of CTS spectrum. The scattered radiation with the frequency range from 74 to 80 GHz is converted to that from 0 to 6 GHz by the mixer. It is separated to the conventional broad band receiver with 32 channels [3, 4] and the fast oscilloscope (TDS6604B) in the intermediate frequency (IF) line. The oscilloscope was prepared for the measurement of ion species ratio, and has the sampling frequency of 20GS/s and the bandwidth of 6GHz. The specification covers the full range of the broad band receiver with 32 discrete channels. Fig.2 shows the CTS spectra measured by the broad band receiver and the fast sampling oscilloscope.

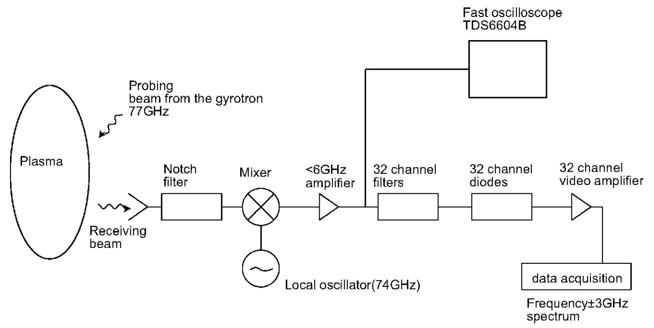

Fig. 1. Schematic diagram of the receiver system with the 32 channel broad band receiver and the fast sampling oscilloscope for CTS diagnostics.

The scattering volume is located at the plasma edge. The spectrum shapes in both methods agree with each other. In this case, since the fluctuation wave vector k^{δ} is not perpendicular to the magnetic field, the IBWs are not detected. However, this result is a good demonstration to measure the fine structure of CTS spectrum for the forthcoming campaign.

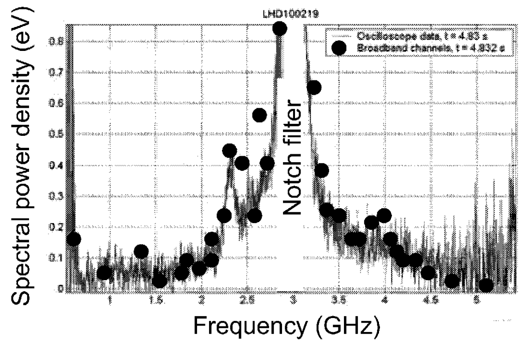

Fig. 2. Comparison between CTS spectra acquired by the receiver system with the 32 channel broad band receiver (closed circles) and the fast sampling oscilloscope(solid line).

In addition to the above purpose, the fast sampling oscilloscope can measure the gyrotron frequency, as is shown in Fig. 3. The main frequencies of 76.9298, 76.7758, and 76.979 GHz are located within the rejection band of the notch filter. Other sharp peaks outside that of the notch filter are also observed on the spectra. These lines have to be suppressed by a gyrotron operation and filter insertions. It leads to the suppression of parasitic oscillation of gyrotrons and the clean probing beam.

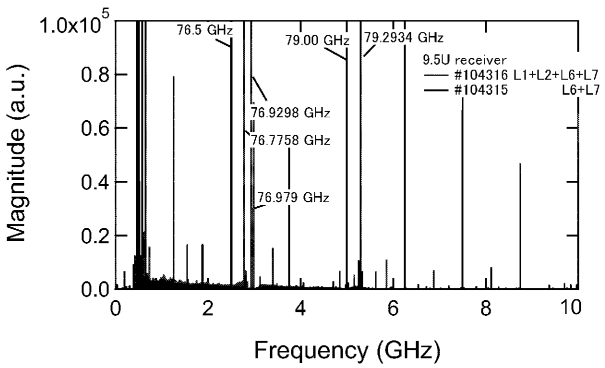

Fig. 3. The CTS spectra in LHD shots #104315 and #104316. The abscissa axis corresponds to the IF frequency. The frequency of 3GHz corresponds to the gyrotron frequency of 76.95GHz. L1, L2, and L7 indicate the transmission lines for 76.95 GHz gyrotrons. L6 corresponds to 84 GHz gyrotron.

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4) Nishiura, M., *et al.*, Journal of Physics: conference series **227** (2010) 012014.