§69. Spectrum Analysis of Collective Thomson Scattering in Neutral Beam Injected Plasmas in the Large Helical Device

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Fast ion physics are major concern in fusion plasmas. One of possible methods to diagnose confined fast ions is to use a collective Thomson scattering (CTS) technique with a millimeter wavelength and a mega-watt power. In the LHD campaign of 2011, we have made progress on the CTS diagnostic in the Large Helical Device (LHD). Three major points are improved in the hardware and the data analysis. We have installed a fast digitizer for high frequency resolution CTS spectra. Another is the fast scanning antenna system with the synchronization to a common trigger signal. The last one is the code preparation for the comparison between measured and simulated CTS spectra. The progress in the data analysis is reported here.

The probing beam is provided by the 77 GHz gyrotron with ~ 500 kW. The scattered radiation is resolved into 32 channels at the receiver system. Fig.1 shows the schematic diagram of the receiver system for measuring the 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. In the LHD shot#97496 at t = 4.6 s, only the perpendicular neutral beam #4 is injected into the plasma. At the time frame, fast ions have been simulated by the MORH code, which can track the fast ions originated by neutral beams for plasma heating. The result is shown in Fig. 2.

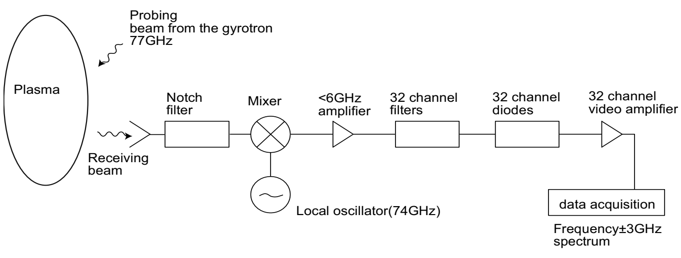

Fig. 1. Schematic diagram of the receiver system with the 32 channel broad band receiver and the fast sampling oscilloscope for CTS diagnostics.

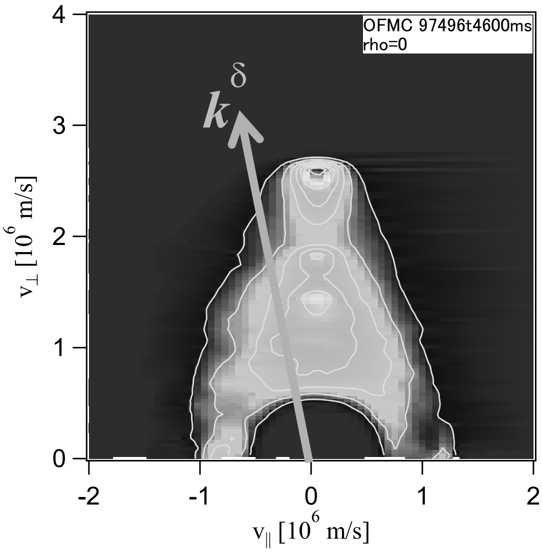

Fig. 2. Fast ion distribution on the velocity space ($v_\parallel$, $v_\perp$) is simulated by MORH code in the case of LHD shot#97496 at t = 4.6 s. The fluctuation wave vector k^δ is indicated as the arrow.

The scattering volume is located at the magnetic axis. The fluctuation wave vector k^δ is nearly perpendicular to the magnetic field, as indicated in the figure. Therefore it is considered that the observed CTS spectrum is mainly dominated by the trapped particles. The CTS spectrum from simulated fast ions is compared with the observed one in Fig. 3. The intensities of both spectra are relatively plotted. The measured CTS spectrum has still included large error bars in the fast ion region. The signal to noise ratio must be improved for the accurate discussion.

In any case, the geometrical effect on the angle between the magnetic field and the sightline will be handled, when the parallel fast ions are injected. On the other hands, the influence of perpendicular fast ions on the geometrical effect will be studied as well.

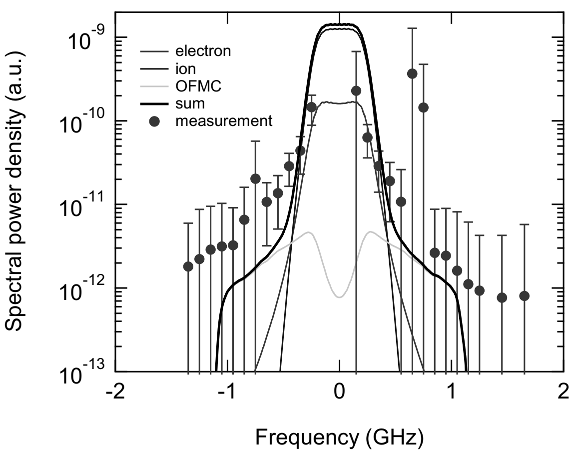

Fig. 3. Comparison between the measured CTS spectrum (closed circles) and the simulated one (thick solid line), which consists of the sum of the thin solid lines with the components of electron, bulk ions, and fast ion.