§19. Time Resolved Spectrum of Collective Thomson Scattering diagnostic in the Large Helical Device

Nishiura, M. (Univ. Tokyo),
Kubo, S., Tanaka, K., Seki, R., Ogasawara, S., Shimozuma, T., Mutoh, T., Kawahata, K., Watari, T., Okada, K., Kobayashi, S., LHD Experiment Group, Saito, T., Tatematsu, Y., Yamaguchi, Y. (FIR, Univ. Fukui)

Fast ion physics are major concern in fusion plasmas as well as bulk ion one. One of possible methods for diagnosing confined bulk and fast ions is to use a collective Thomson scattering (CTS) technique with a millimeter wave and mega-watt power. As other options, the fuel ratio of D/H, the ion temperature, and the flow velocity have also reported in TEXTOR and ASDEX-Upgrade using this method. In this fiscal year, we have made major progresses on the data analysis 1) of the CTS diagnostic in the Large Helical Device (LHD). Here we report the analyzed results and a newly developed IC chip detector for the CTS diagnostic.

Fig. 1 shows the time evolution of the CTS spectrum measured by the filter bank receiver at *t* = 4.496, 5.296, 5.416, 5.496, and 5.896 s. The CTS spectra at each time window are selected from the CTS spectrogram in Fig. 2 during the discharge. To compare the measured and theoretical CTS spectra, the spectrum is calculated by using the CTSsp for T_i = 1 and 2 keV with $n_e = n_i = 1.5 \times 10^{19}$ m^{-3}. The fast-ion components are not included to verify the bulk-ion effect. The broadening of the CTS spectrum is sensitive to increases in Ti but not influenced much by changes in T_e for this temperature range. Thus, the measured CTS spectrum reflects the ion features as expected. When Ti from the Ar Doppler broadening is used, the broadening of the calculated CTS spectrum is wider than that of the measured CTS spectrum. One of possible reasons might be the difference between the integrated line and the local measurement. To clarify this discrepancy, Ti estimated from the CTS diagnostic will be compared with Ti from charge exchange recombination spectroscopy (CXRS) in the near future.

The IC chip detector is newly developed to enhance the signal to noise ratio and the endurance from an intense spurious noise from gyrotrons at the CTS receiver. The IC chip detector is integrated into the printed board, and can detect a RF signal at the level of more than – 60 dBm. The time resolution of the output signal achieves ~ 400 ns, which can capture an MHD activity in LHD plasmas. The IC chip detector can be directly connected into the data acquisition card without any additional amplifier. The CTS receiver uses the filter bank system, which resolves the CTS signal into 40 channels to construct the frequency spectrum. It is attractive that the new detectors can reduce the interference between channels, because those detectors have the independent signal lines. This new system will be installed into the CTS receiver for forthcoming campaign.

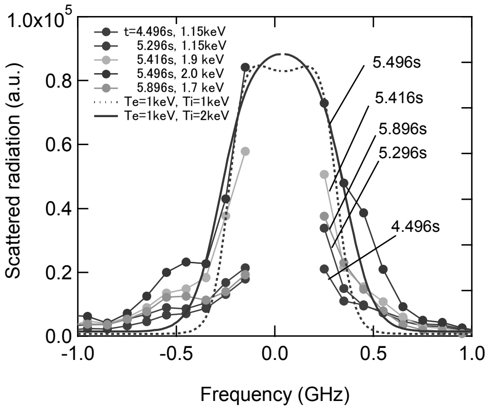

Fig.1 Temporal behavior of CTS spectrum. Red dotted line and solid line are calculated for Ti=1 and 2keV, respectively. The temperature on the right column indicates the ion temperature measured by the x-ray line of Ar XVII.

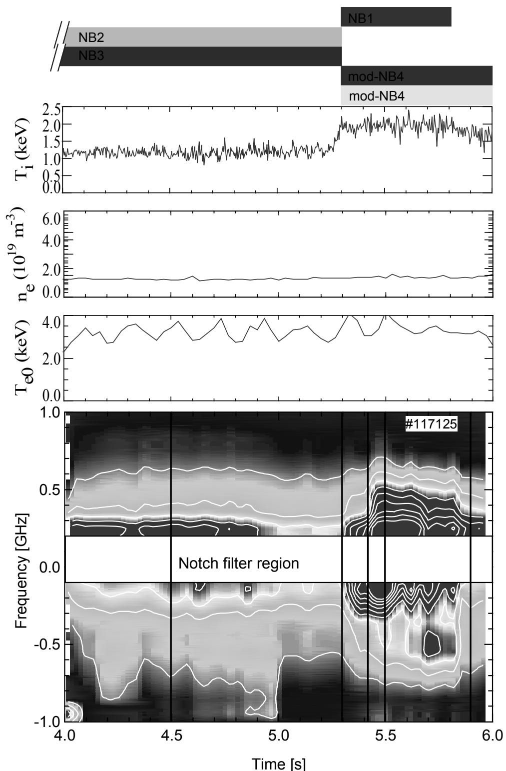

Fig. 2 CTS spectrogram in the LHD discharge #117125, in which is plotted the time evolution of frequency, as well as parameters Ti, ne, and Te0. The vertical lines at t = 4.496, 5.296, 5.416, 5.496, and 5.896 s indicate the time window for the CTS spectra in the next figure.

1) Nishiura, M., Kubo, S., Tanaka, K. *et al.* : Nucl. Fusion **54**(2014) 023006.