§2. Measurements of Electron Density Fluctuations in CHS Plasmas by Using YAG Laser Imaging Method with Folded Beam

Matsuo, K. (Fukuoka Institute of Technology),
Iguchi, H., Okamura, S., Matsuoka, K.

We applied a YAG laser imaging method with a folded beam to obtain information on electron density fluctuations and spatial distributions in compact helical system (CHS) plasmas. Recently, we have achieved an increase in spectral resolution by applying a maximum entropy method (MEM) with polar coordinates to the stored fluctuation data. In this study, the MEM was used to perform a spectral and spatial analysis to measured data during shot with the edge transport barrier (ETB) of a CHS discharge.

Figure 1 shows a schematic diagram of the laser beam path and the corresponding CHS cross section. The YAG laser (λ_I = 1.064 μm, 1.2 W) beam is transported by a polarization-maintaining (PM) optical fiber to near the CHS plasma. The radiation beam from the fiber is expanded and collimated, and injected into the plasma. The transmitted beam is then reflected by a mirror with a λ/4 waveplate and passes through the plasma a second time. This beam is then passed through a polarizer and imaging optics, and is finally detected by a one-dimensional 16-fiber array connected to Si photo-detectors. Two-dimensional spatial measurements at the detecting plane can also be performed by rotating the detector array in a step-wise manner during shots under the fixed operating condition. The measurable frequency range determined by the frequency response of the detector is 20 kHz to 1 MHz. The measurable wavelength determined by the beam width and the number of detector channels ranges from 2 to 47 mm.

Plasma was initially produced and heated by electron cyclotron heating (ECH) and then further heated by neutral beam injection (NBI). The spectrum of the density fluctuations is broadly distributed between 20–200 kHz.

The time history of the spatial distribution of density fluctuations during the shot with the ETB is shown in Fig. 2. This result is obtained by using MEM for spatial analysis and FFT for time analysis. Fluctuation of the ion diamagnetic direction is observed between about pre-15 ms in which ETB does generation (t = 57 ms). The fluctuation rapidly weakens at t = 57 ms, forming the ETB after it gradually moves to the edge. The fluctuation of the ion diamagnetic direction does not increase even in afterwards time zone. The fluctuation of the electron diamagnetic direction increases more gradually after the transition at the inside position than the ion component. Figure 3 shows the change of the fluctuation intensity of the electron and ion diamagnetic direction. It can be seen that the fluctuation of the ion diamagnetic direction grows before the transition, as was shown in Fig. 2, and weakens during the transition. Subsequently, following the transition, the fluctuation of the electron diamagnetic direction gradually increases.

In future work, we hope to determine it is correspondent to data such as behavior of observed fluctuation and density and temperature distribution of the plasma and electric field, and it will be sustained to the synthetic understanding.

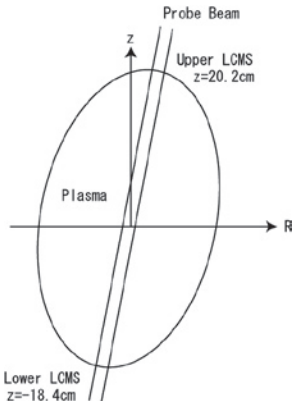

Fig. 1 Laser beam path and cross section in CHS. LCMS(Last Closed Magnetic Suface) is at z = 20.2 cm and z = -18.4 cm along the bream path.

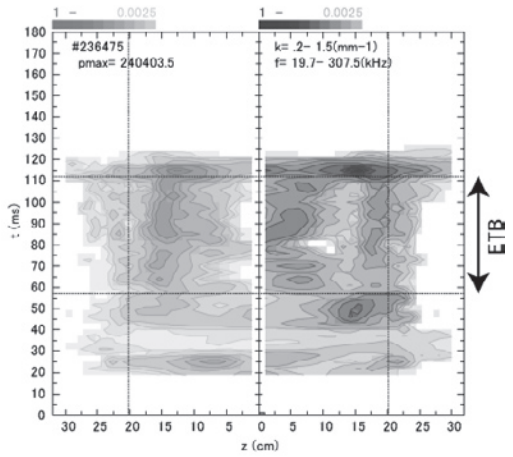

Fig. 2 Time history of spatial distribution of density fluctuation during the shot with the ETB. The left side shows the electron diamagnetic component and the right side shows ion diamagnetic component of the propagation direction.

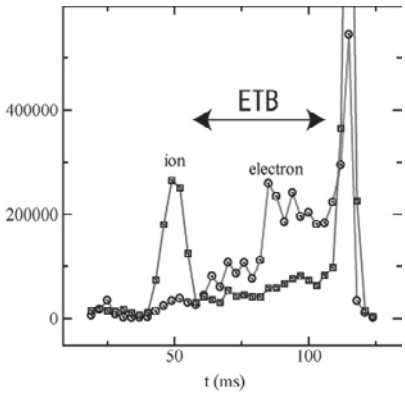

Fig. 3 Time variation of the fluctuation intensity of electron and ion diamagnetic direction during the shot with the ETB (upper side, z > 0).

1) Rev. Sci. Instru. Vol. 79, No. 10, 2008, pp. 10F514 1-4
2) 25th JSPF Meeting 2008, 4aC22P