§9. Development of an Advanced Data Analysis Technique for Density Fluctuation Measurements by the Laser Phase Contrast Method

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

We developed a laser phase contrast (LPC) method with a folded beam to obtain information concerning the spatial distribution of electron density fluctuations in magnetically confined plasmas. The LPC produces real images of the fluctuations, so it is possible to use standard signal analysis tools. However, the characteristics have blocked researchers from exploiting the full potential of the LPC with the standard analytical methods alone. The authors have carried out investigations of a 2-dimensional maximum entropy method (MEM) with polar coordinates as a means of analyzing data that is appropriate for the LPC. The MEM in particular is anticipated to provide a high spectral resolution, in spite of the low number of data. Therefore, we have developed an analytical technique which can reduce the deterioration of the resolution, especially in a low wavenumber range by formulating the MEM using polar coordinates. [1)] In this fiscal year, by enlarging the range of the regularization parameter in MEM, the optimized analysis of the fluctuations was performed with enhanced spatial resolution.

Figure 1 shows the LPC optical system for the CHS. The measurable frequency range is 20 kHz to 1 MHz. The measurable wavelength ranges are from 2 mm to 47 mm. Measuring plasma was initially produced and heated by ECH and further heated by NBI with the ETB (Edge Transport Barrier). Figure 2 shows the distribution of the frequency of measured fluctuations before the formation of the ETB. The analysis was carried out to reduce the regularization parameter for high resolution in spite of the deterioration of stability. It was found that there are components which appear to extend to the opposite LCMSs beyond the center of the plasma along the probing beam pass before the ETB transition, in addition to the components having higher frequency as the tip. There is a possibility that the frequency rises in response to the Doppler shift due to the influence of the electric field, as it has been pointed out in previous studies, and it also affected the propagation direction of the fluctuation. We are currently proceeding its verification.

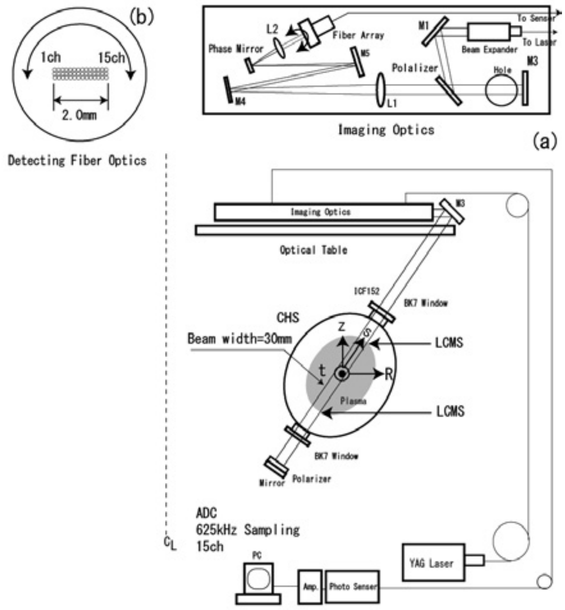

Fig.1 LPC optical System The light from the YAG laser was guided by an optical fiber, expanded in a beam expander, injected into the plasma via a port in the upper part of the CHS, reflected by a mirror, injected again into the plasma from a port in the lower part of the CHS, and then introduced into the optical detection system.

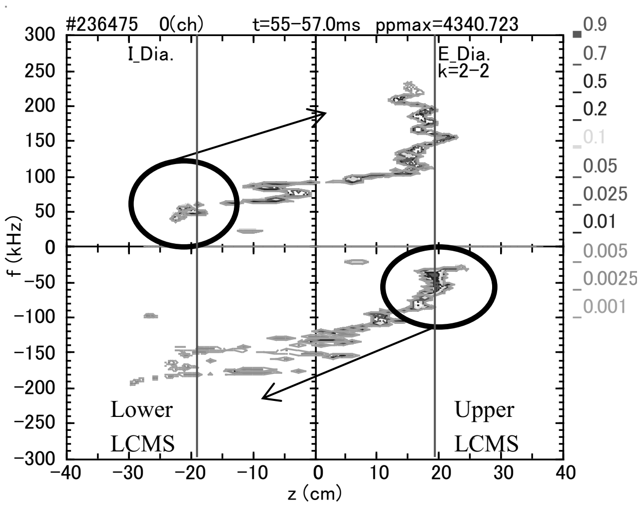

Fig.2 The spatial distribution of the measured density fluctuations before ETB transition as a function of frequency. The ETB transition happened at t=57ms.

In addition, we plan to compare this with turbulences in other confinement devices and discuss the validity of this measurement system for other devices.

1) K. Matsuo, H. Iguchi, S. Okamura, K. Matsuoka, Rev. Sci. Instrum. (2012)**83**(013501) 1-9.