§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)]

Figure 1 shows the LPC optical system for the CHS. The YAG laser (λ_i= 1.064 μm, 1.2 W) beam is transported by a PM optical fiber near the CHS plasma. The beam is then transmitted through focusing and imaging lenses along with a phase mirror, and then received by a one-dimensional 15-fiber array connected to low noise detectors. 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 number of detector channels ranges 2 mm to 47 mm.

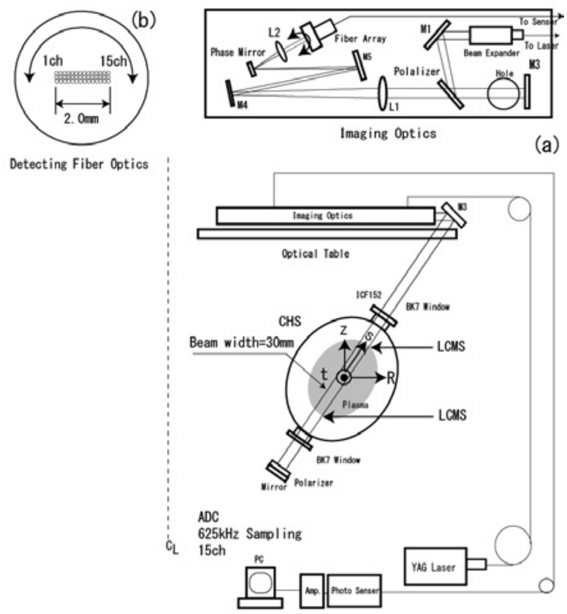

Fig.1 LPC optical System The light from the YAG laser was guided by an optical fiber, expanded in a beam expander, injected into the plasma via a port in the upper part of the CHS, reflected by a mirror, injected again into the plasma from a port in the lower part of the CHS, and then introduced into the optical detection system. The CHS operating conditions were fixed during measurements, and the 1D detectors, whose central channel was ch8, were rotated in increments of 15◦ to obtain a series of 12 shots.

Plasma was initially produced and heated by ECH and further heated by NBI. The ETB (Edge Transport Barrier) was observed in the NBI plasma on the CHS. Figure 2 shows the distribution of phase velocity of measured fluctuations before the formation of the ETB. Figure 2 indicates there are layers in which the velocity changes largely to the opposite direction near LCMSs.

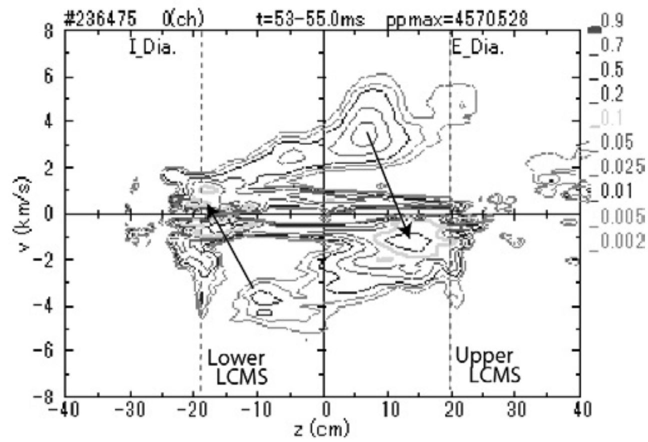

Fig.2 An example of the phase velocity of the measured density fluctuations. The phase velocity changed strongly near the LCMSs as shown by the arrows.

We will proceed with the analysis to allow a comprehensive understanding of whether such data will be compatible with the electric field of the plasma density and temperature distribution and behavior of the fluctuations observed in the CHS. 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.