§5. Measurements of Electron Density Fluctuations in CHS Plasmas by Using YAG Laser Imaging Method

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We have applied a novel technique of a YAG laser imaging method for obtaining information on electron density fluctuations, including the spatial distribution in CHS plasmas.. In this fiscal year, i) a double path optical system developed for increasing further the signal intensity was applied to CHS, and ii) by the system the density fluctuations were measured during discharge with edge transport barrier (ETB).

Figure 1 shows the optical system for CHS. The YAG laser (λ_i= 1.064 μm, 1.2 W) beam is transported by a PM optical fiber near the CHS plasma. A radiation beam from the fiber is expanded and collimated by a beam-expander, and injected into the plasma. Transmitted beam is reflected by a mirror with λ/4 waveplate and passes through the plasma again. This beam penetrates a polarizer toward imaging optics. The beam is then transmitted through focusing and imaging lenses along with a phase mirror, and then received by a one-dimensional 16-fiber array connected to low noise detectors. In addition to the one-dimensional spatial measurements, two-dimensional spatial measurements at the detecting plane were performed by making the detector array to rotate a shot by shot under the condition of fixed operation to observe 2D image equivalently. 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.

Plasma is initially produced and heated by ECH and further heated by NBI. The spectrum of the density fluctuation distributes broadly between 20 kHz – 200 kHz, and decreases as the frequency increases. Figure 2 shows examples of 2D distribution of the power densities as a function of wavenumber (k_x and k_y) at t=40-53.5ms (before the transition) and at t=60-73.5ms (after the transition) by the contour lines. The k_x and k_y approximately show the components which propagate in major radius and toroidal directions respectively. In this method, spatial positions of the density fluctuations are identified by the correspondence of observed propagational direction with direction of magnetic line of force because the observed micro-turbulence generally propagates toward perpendicular direction to a magnetic filed. According to the correspondence in Fig. 2, the 1st and 2nd quadrants show the upper half region and 3rd and 4th quadrants show the lower half region along the probe beam path in the plasma cross section. As shown in Fig. 2(a), the fluctuations mainly propagate at four directions which correspond to near plasma edge. Compared with Fig. 2(a) and (b), the density fluctuations were depressed after the transition.

Analyzing the detail spatial distribution of the density fluctuation is in progress.

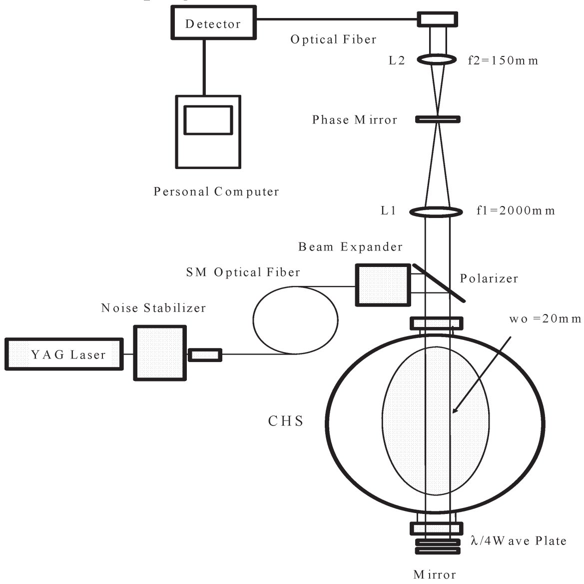

Fig. 1 Laser Imaging System for CHS.

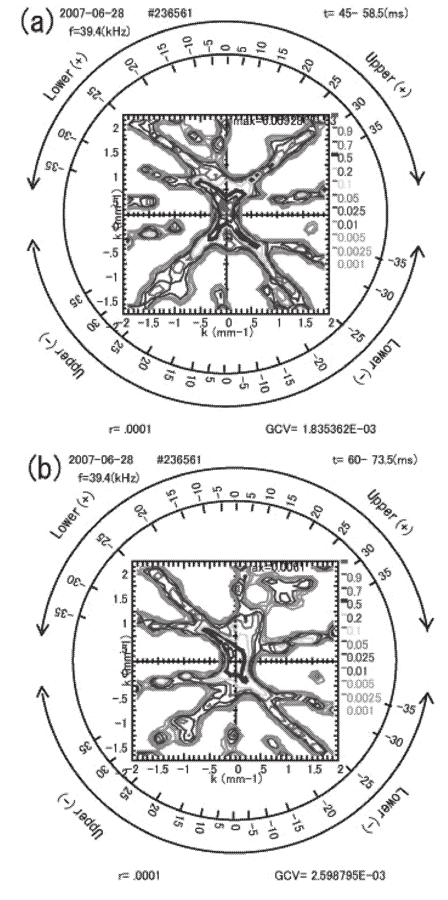

Fig. 2 Examples of the 2D distribution of the power spectra as a function of the k_x and k_y.