§29. Measurements of Electron Density Fluctuation in CHS Plasmas by Using Laser Imaging Method

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We have designed a laser imaging system for measuring electron density fluctuations in CHS plasmas. Guidelines for design of the system are listed below, i) minimum detectable fluctuation intensity is less than $\Delta n_e L = 1 \times 10^{16} m^{-2}$ (where $n_e = 1 \times 10^{18} m^{-3}$, width of density fluctuation L=100 mm, and $\Delta n_e / n_e = 10\%$ are assumed), ii) wavenumber-frequency spectra can be measured, iii) a probing visible or near-infrared laser can be applied, iv) spatial distribution of the fluctuations along the beam axis can be obtained.

Figure 1 shows the optical system designed according to the above guidelines for CHS. As a probing beam, we selected a YAG laser (λ_i= 1.064μm), because there is an applicable stabilizer to the lasers and an SM fiber for transport of the laser beam to the plasma, and it can supply the power the laser makes, SNR>1, under the above conditions. A radiation beam from the SM fiber is expanded and collimated with a width of 50 mm by a beam-expander, and passes through the plasma. After the plasma, the probe beam is transmitted through focusing (L1) and imaging (L2) lenses and a phase plate, and received by a 16 or 32-channel fiber array connected to low noise detectors.

Table 1 shows the measurable parameter regions of the designed system. The measurable frequency range, which is decided by the frequency response of the detector, is 2 kHz to 1 MHz. The measurable wavelength range, which is decided by the beam width and number of detector channels, is 1 mm to 60 mm. Further, spatial resolution was studied in the laser imaging technique utilizing magnetic field structure (change of pitch angle of the magnetic field) of

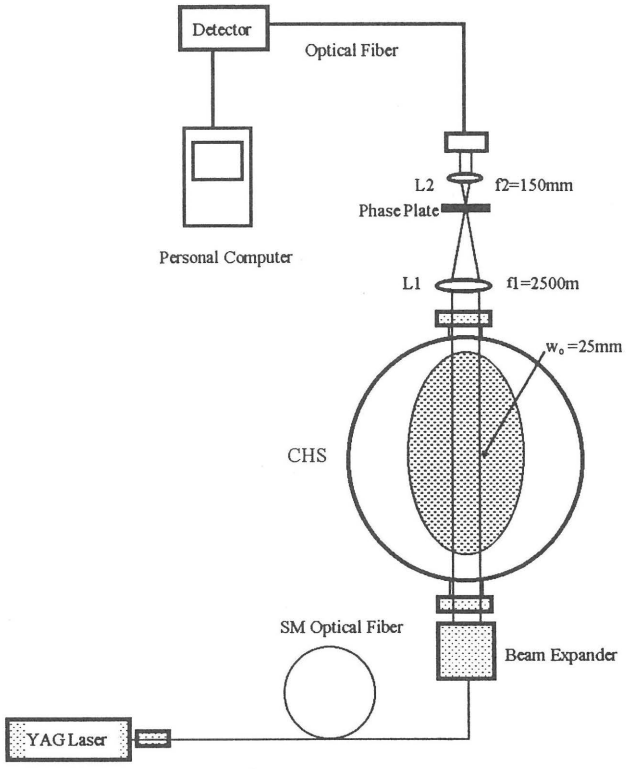

Fig. 1 Optical arrangement of laser imaging system for CHS.

parameters of fluctuation	measurable region
frequency	2 kHz～1 MHz
wavelength	1 mm～60 mm
spatial resolution (at $k=1mm^{-1}$)	10 mm(r=200 mm) 34 mm(r=0 mm)

Table 1 Measurable parameter regions

CHS and the character of density fluctuations in the magnetically confined plasma. We calculated the pitch angle of the magnetic field along the laser beam axis and obtained the angle of -40 deg to 40 deg. From the calculated pitch angle, we estimated a spatial resolution of about 10 mm at $k=1\ mm^{-1}$ around the plasma edge.

Based on the above studies, we will setup the YAG laser imaging system with CHS and measure the density fluctuations in the next fiscal year.

Reference

1)Kado, S. et al.: Jpn. J. Appl. Phys. 34(1995) 6492