

§4. Development of Electron Density and Temperature Measurements for Plasmoid Using Laser Thomson Scattering

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In ITER, control of transient heat and particle loads due to ELMs and its impact to divertor materials will be an important issue. For the assessment of the transients, it is necessary to characterize the high density plasmoid, and it is thought that laser Thomson scattering diagnostics will be the best tool for the characterization. For Thomson scattering diagnostics, laser transmission mirrors and a neodymium - doped yttrium aluminum garnet (Nd:YAG) laser at 1064 nm will be used for future fusion devices. In this study, the design of the laser Thomson scattering diagnostics was done for the plasma gun device developed in Nagoya University and the Rayleigh scattering signal was obtained using nitrogen gas. In addition, laser induced damage thresholds for the optics of the laser transmission mirrors are assessed^{1,2)}.

The measurement system of the laser Thomson scattering system was installed in the divertor simulator NAGDIS-II. In Fig. 1, a schematic of the experimental setup is shown. A Nd:YAG laser at the wavelength of 532 nm was used for the laser, and Brewster windows are used for the injection of the laser beam to the chamber to reduce the stray light. A viewing dump was installed in the opposite side of the field of view in the vacuum vessel, and the scattering light was collected with a optical fiber array thorough a lens. For the detector, image intensified charge coupled device (ICCD) (Princeton instruments, PIMAX-IV) was used. The spectrometer used has focal length of 300 mm, and the core diameter of the fiber was 0.23 mm. The numerical aperture of the fiber was 0.22 and the number of the array was 23 channels. With using a $1/2\lambda$ wave plate, the polarization of the laser beam was rotated so that the scattering signal can be collected by the collection optics.

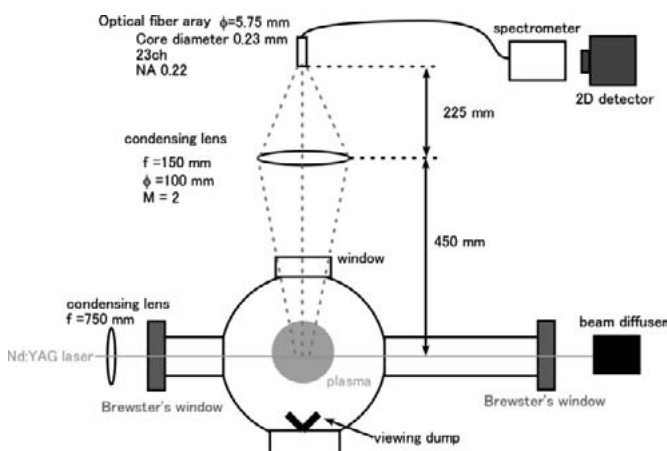


Fig. 1 Schematic of the experimental setup for the Thomson scattering measurement in the divertor simulator NAGDIS.

Figure 2 shows the nitrogen gas pressure dependence of the signal intensity without plasma. The signal contains the Rayleigh signal and stray light. The signal was detected using the imaging mode of the ICCD, and the central part of the image corresponding 12 ch was used to obtain the intensity. The intensity increased with the gas pressure linearly indicating the component is Rayleigh signal. The intercept of the fitting line corresponds to the stray light level. From Fig.2, it is seen that the Rayleigh signal was clearly obtained after eliminating stray light using baffles, beam dump, viewing dump, etc.; the Thomson scattering signal has not been obtained. By further decreasing the stray light level, and improve the detection systems, it is expected for future work that the Thomson scattering signal is successfully obtained.

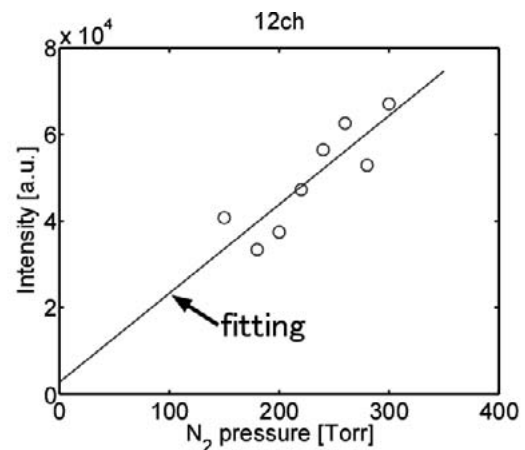


Fig. 2 Signal intensity as a function of the gas pressure.

- 1) M. Sato, S. Kajita, R. Yasuhara, et al., "Assessment of multi-pulse laser-induced damage threshold of metallic mirrors for Thomson scattering system", Optics Express, Vol. 21 (2013) pp.9333-9342.
- 2) S. Kajita, R. Yasuhara, M. Sato, et al., "Enhancement of multi-pulse laser induced damage threshold on Cu mirror under vacuum condition", Optics Express, Vol. 21 (2013) pp. 17275-17284.