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LHD偏光マルチパストムソン散乱計測システムの開発
Development of the polarization multi-pass Thomson scattering system in LHD

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Thomson scattering (TS) diagnostics is one of the most reliable methods for determining the local electron temperature (T_e) and density (n_e) in fusion plasmas. However, due to the small Thomson scattering cross-section, TS measurements are challenging for low densities plasmas. To increase the scattering probability at low densities, a multi-pass TS scheme is effective, which allows a laser pulse to be focused several times into the scattering volume, thus increasing the scattering photon number. In addition to improving the signal-to-noise ratio, a multi-pass TS system can be used to improve the time resolution and expand the measurable range of T_e.

Multi-pass TS systems are demonstrated at many institutes. TEXTOR group has demonstrated the improvement of signal to noise ratio by use of multi-pass TS system which uses a pair of concave mirror for recycling photon [1]. JT60 TS group has constructed a double pass system by the use of a phase conjugate mirror [2]. Although previous multi-pass systems have increased the reliability, they are also limited by the optical system, e.g., as each laser beam pass is different in a concave-mirror-type TS system (the TEXTOR system), the scattering volume should be set so that it is near the focal point of the concave mirror, else it is necessary to calibrate the system for each different beam pass. The phase conjugate mirror system, however, requires purity in the laser bandwidth.

In this study, we propose a newly scheme of multi-pass TS system by the use of a polarization optics. This scheme can be modified from the basic single pass TS system by adding the high reflection mirror for cavity mirror, lenses used for image relaying the laser beam and polarization control devices of a Faraday rotator and a Pokel's cell. It has a collinear beam line in the multi-pass cavity. The system design is carried out by polarization analysis by Jones matrix and optical ray trace.

To evaluate the effect of the multiplication of the scattering light, a multi-pass system without a polarization control device was installed in the GAMMA 10 system. As the result, the integrated scattering signal of the double-pass configuration is about 2 times larger than that of the single-pass configuration.

Now, we are constructing this system for the LHD TS system. Laser light is focused into the plasma by the first convex lens via 4-O port laser window. After interaction with the plasma, laser light is emitted from the 4-I port window, which has an anti-reflection coating, and is collimated by the second convex lens. After that, Laser light is reflected by a mirror for the second pass and again focused into the plasma. Figure 1 shows the Rayleigh scattering signals at the double pass configuration of the LHD TS system. We can confirm two peaks of Rayleigh scattering signal from the first pass and the second pass.

In this presentation, we show the results of the detailed design and experimental data of the new TS system configuration.

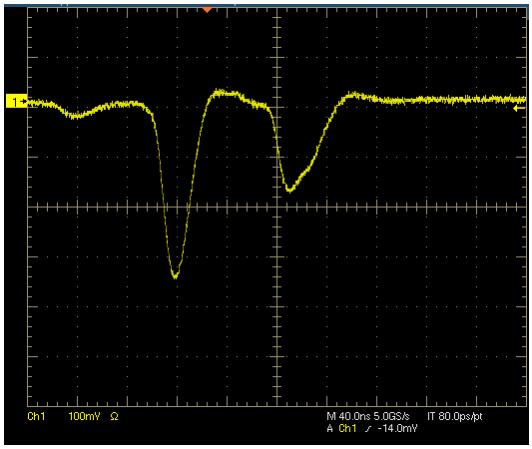

Fig.1 Rayleighen scattering signal at the double pass configuration of the LHD TS system

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[2]. T. Hatae, O. Naito, M. Nakatsuka, and H. Yoshida, Rev. Sci. Instrum. 77, (2006) 10E508.