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ヘリオトロンJにおける Nd:YAG トムソン散乱計測システムを用いたプラズマ分布の時間発展計測

Time evolution measurements of plasma profiles using a Nd:YAG Laser Thomson scattering system in Heliotron J

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Time evolution measurements of plasma density and temperature profiles provide indispensable information on the physics of transport barrier formation relating to improved confinement modes. In Heliotron J, spontaneous transition phenomena to improved confinement modes, which are similar to the H-mode, have been experimentally observed [1]. A Thomson scattering system with Nd:YAG lasers has been developed to obtain profile data with high time and spatial resolution in Heliotron J [2].

The system has 25 measurement points with a spatial resolution of ~10 mm in a radial direction. Two Nd:YAG lasers of 550 mJ (oscillation frequency: 50 Hz) were employed to obtain enough amount of scattering light in the profile measurements for low electron densities $\overline{n_e} \sim 0.5\times10^{19}$ m^{-3}. We have completed to develop a laser timing controller, a laser transmission system, and a data acquisition system. A novel laser timing controller, which can provide a high time-resolution for the Thomson scattering system, has been developed to precisely control the injection timing of the laser pulses to a plasma discharge [3]. Precise control of laser timing for two lasers can make a measurement with the minimum interval of 0.1 μs, which is sufficiently short compared to the expected characteristic time of the transport barrier formation. This feature is crucial for transport physics studies including spontaneous transition to the improved confinement mode. The laser beam is transmitted and focused on the plasma center in order to improve the S/N ratio avoiding the damage of the optical components due to the beam power concentration. Scattered light is collected by a large concave mirror (D = 800 mm, f/1.31) with a solid angle of ~ 50 mstr and guided to a set of interference filter polychromators through optical fiber bundles. The APDs of the polychromators provided with temperature compensation circuits enable to detect the scattering light at a constant sensitivity independently of their own temperature. Signals for the scattered light are digitized with fast-gated integrators (CAEN V792 32 Channel Multi-event QDC). The data are acquired by a VME-based system with a real-time operational capability. The system is constructed on the VME bus whose throughput and CPUs are 30 Mbyte/sec and Motorola 68060 with 60 MHz clock rate respectively. A LINUX computer analyzes the data immediately following a plasma discharge after getting them via a LAN.

In this experimental campaign, we measure the Heliotron J plasma using the Nd:YAG Laser Thomson scattering system.

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