**A fast Thomson scattering system for the transient plasma physics phenomena in LHD**

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Laser Thomson scattering system is one of the most realizable diagnostics tools for the evaluation of electron temperature and density profiles in fusion plasma. However, the high pulse energy laser system required as a probe light for the Thomson scattering system has a repetition rate of only a few 10 Hz to 100 Hz due to the limitation of heat generation in the laser medium. Therefore, it was not possible to measure transient changes in the spatial distribution of electron temperature and electron density in the plasma on the order of milliseconds, such as the melting of hydrogen pellets, plasma collapse, and rapid heating of the plasma by the heating system.

For this, we have overcome the problem of thermo-optical effects such as thermal lensing caused by heat generation in solid-state lasers by ‘the Pulse burst laser’ that can be make the ultrahigh repetition rate laser operation in a time shorter than the thermal diffusion time of the laser medium. As a result, Thomson scattering measurements with a high temporal resolution upto 20 kHz repetition rate were realized [1]. This measurement system is very powerful and has successfully measured various high-speed phenomena such as hydrogen pellet ablation dynamics[2] and a partial plasma collapse phenomena[3]. In the future, we plan to challenge repetition rates of 100 kHz or higher by improving the power supply, increasing the thermal shock resistance of a laser medium, and increasing the efficiency of the pump source.

**References**

1. H. Funaba, R. Yasuahra, et al. . et al. Electron temperature and density measurement by Thomson scattering with a high repetition rate laser of 20 kHz on LHD. Sci Rep 12, 15112 (2022).
2. A. Matsuyama, R. Sakamoto, R. Yasuhara, et al., Enhanced Material Assimilation in a Toroidal Plasma Using Mixed H2+Ne Pellet Injection and Implications to ITER, Phys. Rev. Lett. 129, 255001 (2022).
3. N. Kenmochi, K. Ida, T. Tokuzawa, R. Yasuhara, et al. Preceding propagation of turbulence pulses at avalanche events in a magnetically confined plasma. Sci Rep 12, 6979 (2022).

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