§4. Laser System for the LHD YAG Thomson Scattering

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YAG Thomson scattering is considered to be the most suitable for the measurements of electron temperature and density of plasmas with high temporal resolution. A multi-point high repetition rate Thomson scattering system has been designed for LHD. In this report, the YAG laser system and beam transport are described.

We use ten Nd:YAG lasers with the repetition rate of 50 Hz (20 msec^{-1}) and the pulse energy and width of 0.6 J and ~10 nsec respectively. We select various operational modes by adjusting the fire timings. The standard mode is the repetition rate of 500 Hz and the pulse energy of 0.6 J. In the measurements for low density plasmas, in which high laser power is needed, all ten lasers are fired simultaneously as a powerful single laser with the pulse energy of 6 J. When higher temporal resolution is required, for example, start up of plasma heating, pellet injection and L- to H-mode transition, the ten lasers are fired successively with a time interval as short as 20 μs, which is determined by the read-out time of ADC. In order to merge the ten laser beams, we have developed a beam merging mirror. This is a dielectric 14x20 mm^2 elliptic mirror formed at different position for each laser on an AR-coated glass of 4' in diameter. The method of the beam merging is illustrated in Fig.1.

The YAG lasers are located in the underground diagnostic room to avoid the damage due to neutron and x-ray radiations. The transport length is about 40 m. Then, high pointing stability (<0.5 mr) and low beam divergence (<0.1 mr) are required for the lasers. In addition, precision mirror steering system is also needed for accurate and stable beam transport. All seven steering and ten beam merging mirrors are controlled by computer-aided high precision linear actuators. For the merging and at least two steering mirrors, ultra-precision actuators with the resolution of 0.1 μm and acceleration up to 2500 mm/sec^2 are used. The laser beams are transmitted in an evacuated tube to avoid the deflection due to the temperature gradient of the air.

The YAG laser system has been partly used in the new CHS YAG Thomson scattering. Preliminary test and study on the optimization of the mirror steering system for the LHD Thomson scattering are in progress.

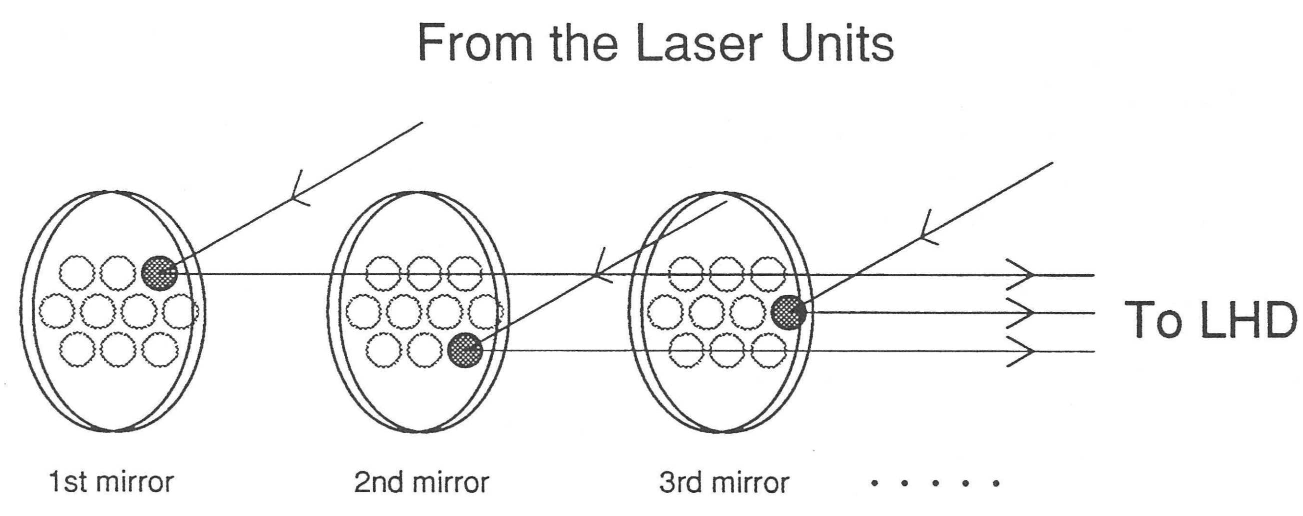

Fig.1. Schematic diagram for the beam merging method.