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JT-60SAトムソン散乱計測のレーザー開発状況と伝送系の設計
Development of a laser for the JT-60SA Thomson scattering diagnostic and design of its laser transfer system

東條寛[1], 波多江仰紀[1], 椿本孝治[2], 吉田英次[2], 佐久間猛[1], 濱野隆[1], 伊丹潔[1]

Hiroshi Tojo[1], Takaki Hatae[1], Koji Tsubakimoto[2], Hidetsugu Yoshida[2], Takeshi Sakuma[1], Takashi Hamano[1], and Kiyoshi Itami[1]

量研機構[1], 阪大レーザー研[2]
QST, Osaka Univ. ILE

Thomson scattering diagnostic in JT-60SA is now designed and developed for forthcoming plasma operations. A YAG laser (probe laser, 1064 nm), which has been used from JT-60U experiments, shows a peaked profile after a few meters from the output. It may cause laser induced damages on vacuum windows and mirrors to be located in a beam path from a laser room to the torus hall. Peaked and distorted amplification profile of the laser rod, which arise from focused light from flash lamps and thermal distortions, distort beam wavefront and cause an unexpected focal point (peaking) during the beam transfer. To cope with the problems improving wave front surface of the laser beam is necessary. Wavefront at different locations in the laser system will be measured using a Shack-Hartmann sensor. Then, we are planning to install deformable mirrors after the laser output for suppressing the distortion.
An optical design of the laser transfer system is also necessary to transfer a good beam profile from the laser room to the torus hall. If two wavelength lasers (YAG and ruby laser) can be transferred through the optics, it would be beneficial for calibration. In-situ relative calibration method, which is essential under harsh radiation conditions can be performed using the two lasers. Thus, the optical design should suppress chromatic aberrations between 1064 nm (YAG) and 694 nm (ruby). In particular, difference in their beam focal points in the plasma should be suppressed within 0.4 m. Otherwise, it will require larger cross-section of the scattered area than that of the case using only YAG laser, which enhances level of measured background light from the plasma, which degrades signal-to-noise ratio in the measured signal. Figure 1 shows an overview of optical design. Two image relays using two lenses each transfer the image in the laser room to the vacuum window. Use of three doublet lenses using silica and F2 (Schott Inc.) enables suppressing the focal point difference less than 1 mm.
Another issue in the laser transfer is stray light generated by scattering in the vacuum window. The light enter the vacuum vessel and spread out. Collection optics for measuring Thomson scattered light capture the stray light as background light (noise). One traditional but effective way is to equip baffle boards in the long-pipe connecting to the vacuum vessel. A simulation using ray tracing newly found that the baffles spaced at a geometric series, i.e., 40% of unit length, would significantly reduce the stray light. The amount can be reduced to ~ 6% using only three baffles compared with the case of no-baffles.

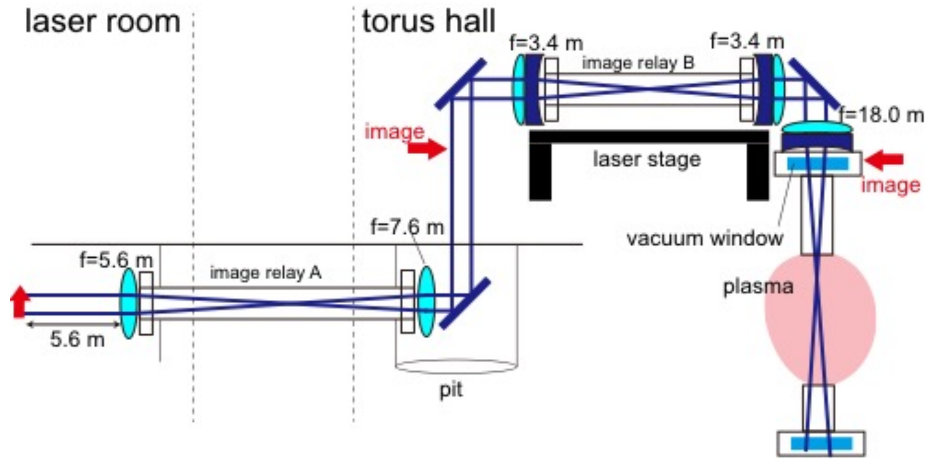

Fig. 1 Schematic of Laser transfer system for JT-60SA from the laser room to the torus hall.