§9. Development of the Multi-pass Thomson Scattering System in the GAMMA 10 Tandem Mirror

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In the GAMMA 10 tandem mirror, typical electron density is comparable to the peripheral plasma of torus type fusion devices. Then the effective concept for increasing of Thomson scattering (TS) signals is required for improvement of signal quality. We have been developing the multi-pass TS method of a polarization based system based on the GAMMA10 yttrium-aluminium-garnet (YAG)-TS. Last fund year, we constructed the polarization based double pass TS system. This fund year, we constructed the multi-pass TS system and carried out the Rayleigh scattering experiments [1]. Then integrated scattering signals increased about three times larger by the multi-pass system.

A schematic diagram of the newly multi-pass method of the polarization based system is shown in the Fig. 1. This system is based on the GAMMA10 double-pass TS system. Horizontal polarized laser light from the YAG laser is focused onto the plasma center by the first convex lens from the down side port window after passing a short pass mirror, the two Faraday rotators for isolator, a half wave plate, mirrors, a polarizer, a pockels cell and iris. After the interaction with plasma, the laser light emits from the upper side port window and collimated by the second convex lens. A pair of lenses is a key component of this optical system. It makes the image relaying optical system from iris to reflection mirror to maintain the laser beam quality during the multi-pass propagation. Laser light reflected by the reflection mirror for the second pass and focused again onto the plasma. A pockels cell is used for a polarization control device. It switches horizontal polarization to vertical at the second pass traveling of laser light. Vertical polarized laser light is reflected by the mirror. Then the multi-pass system is constructed.

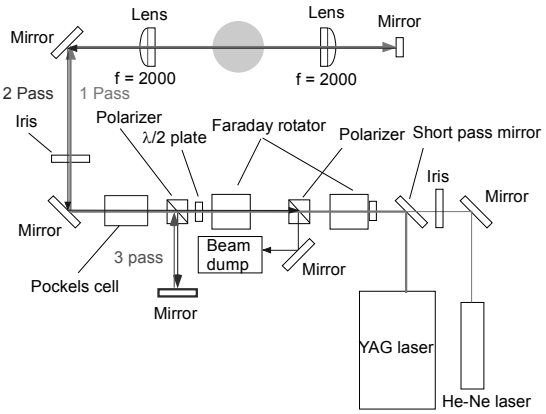

Fig. 1. Schematic diagram of the multi-pass TS system.

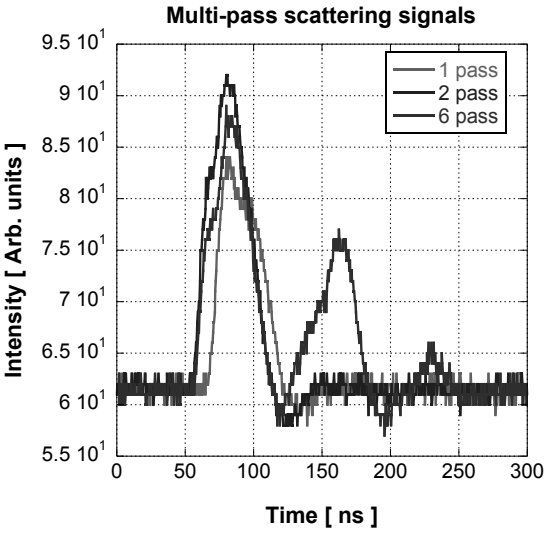

Fig. 2. The multi-pass TS system signal.

We carried out the Rayleigh calibration experiments for setting and stray light in the evaluation of the multi-pass system. Figure 2 shows the typical signals of polychromator of a single pass, double pass, and six pass configurations. The total integrated signal of six pass is about three times as large as that of single pass. We have successfully constructed the multi-pass TS system. We have to check the damage of the optical systems in the multi-pass laser configuration and optimize the optical system.

1) M. Yoshikawa, et al.: Rev. Sci. Instrum. **83**, (2012) 10E333.