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

Yoshikawa, M., Nagasu, K., Shimamura, Y.,
Kohagura, J., Shima, Y., Imai, T., Sakamoto, M.,
Nakashima, Y. (Univ. Tsukuba),
Minami, T. (Kyoto Univ.),
Yasuhara, R., Kawahata, K., Yamada, I., Funaba, H.

In the GAMMA 10 tandem mirror, typical electron density is comparable to the peripheral plasma of 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 multi-pass TS system and obtained the Rayleigh scattering signals of 1st to 6th passing signals. This fund year, we carried out the Raman scattering experiments with the normal operated YAG-laser power which is equal to the normal Thomson scattering experiments. Moreover, we obtained the Thomson scattering signals of 1st to 4th passing signals in the GAMMA 10 plasma experiments. 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 configuration is constructed.

We carried out the Rayleigh and Raman calibration experiments for setting and stray light in the evaluation of the multi-pass system. Figure 2 shows the typical polychromator output signals of a single pass, double pass, and six pass configurations in Raman scattering experiments. The total integrated signal of six pass is about three times and a half as large as that of single pass. We have successfully constructed the multi-pass TS system. Then we applied the multi-pass TS system to the GAMMA 10 plasma experiments. Figure 3 shows the mutli-pass TS signal of 1st to 4th passing. The electron temperature is about 28±2 eV. Them we obtained the multi-pass TS signals for the first time.

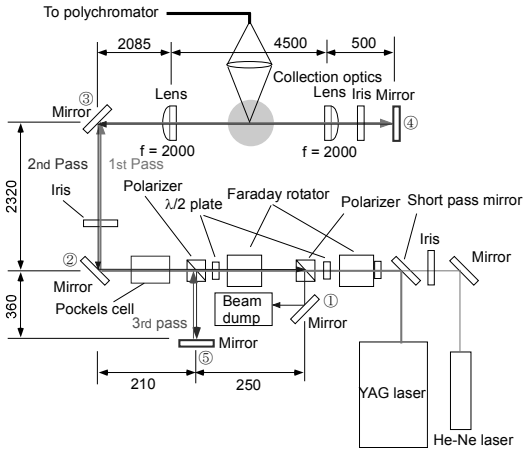

Fig. 1. Schematic of the multi-pass TS system.

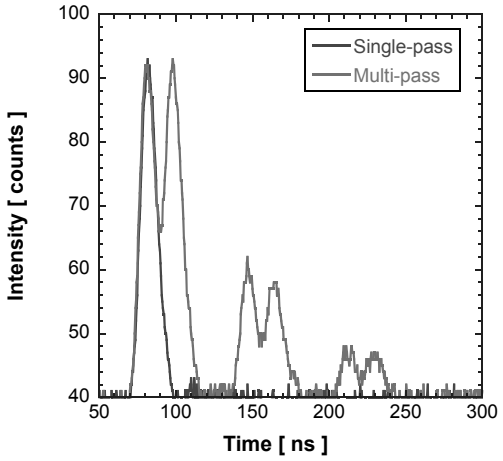

Fig. 2. Single (green line), double-pass (blue line) and multi-pass (red line) Raman scattering signals of CH. 1.

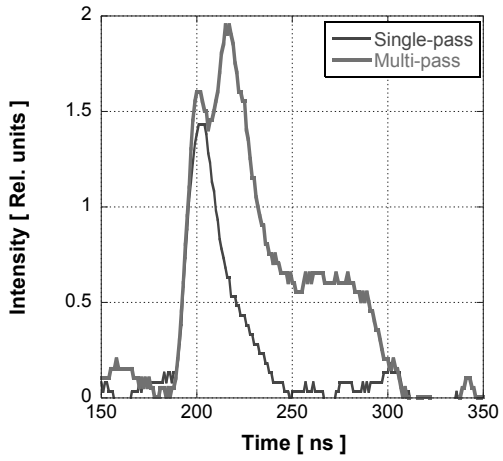

Fig. 3. Single and multi-pass TS signals.