§6. Development of Two Dimensional Thomson Scattering Measurement System

Ono, Y., Ito, S., Nonaka, H., Sumikawa, T., Yamada, T., Inomoto, M. (Univ. Tokyo, Dept. Frontier Sciences), Nakanishi, H., Narihara, K., Nagayama, Y.

The Thomson scattering is the most reliable electron temperature measurement and its two dimensional (2-D) measurement will contribute significantly to solving electron transport in LHD as well as magnetic reconnection in TS-4. We have developed a new cost-effective 2-D Thomson scattering system using multi-reflection of a single laser light and its time-of-flight effect and will be used for SINET data linkage. Novel points for our system is as follows: (1) multiple laser light reflection to cover m x n (2-D) measurement points on r-z plane, (2) usage of time-of–flight to save the number of polychromators and detectors, and (3) flexible usage of laser path length to control those numbers and delay times of scattering signals. They enable us to develop a low-cost 2-D Thomson scattering system using a single Laser and polychromators equivalent to the 1-D system, because the scattering lights from n measurement points are measured by a single polychromator.

In 2008, we completed the 2-D (3x3) measurement system and started for the first time the 2-D Thomson scattering measurement using three polychromator, collecting lens system and optical fiber system completed last year. Its laser beam was reflected three times by the mirror to cover the center area of out TS-4 spherical tokamak (ST) plasma, as shown in Fig. 1(top). A single low temperature ST was produced on the mid plane for the initial test of the 2-D system. The Thomson scattering signals from the three points were successfully measured by each collecting optics and polychromator system. It was observed that the three Thomson scattering signals were measured with equal time intervals of 50nsec corresponding to laser flight length of 15m. In Fig. 1(bottom), an example of Thomson scattering signals at r=360mm, Z=0mm are plotted as a function of wavelength to calculate the electron temperature by Gaussian fitting. Finally, 2-D contour of electron temperature were obtained as shown in Fig. 1(middle). This successful result supports the validity of our 2-D Thomson scattering measurement by multiple reflection and time of flight of laser. The remaining problem is 1) suppression of plasma light and 2) improvement of laser beam quality along the long laser beam path. In 2009, we will check the upper limit of reflection number of laser beam. The 2-D experiment will be analyzed by NIFS and U. Tokyo using the super SINET tool.

1) S. Ito , T. Sumikawa , E. Kawamori , Y. Ono, “Development of Multipoint Thomson Scattering Measurement System Using Multiple Reflections and Time-of-Flight of Laser Light, IEEJ Trans. Fun. Mat. 128-A, (2008), p.499.

2) Y. Ono et al., “Transient and Intermittent Magnetic Reconnection in TS-3 / UTST Merging Startup Experiments”, Fusion Energy 2006, EX/P7-12, (2007).

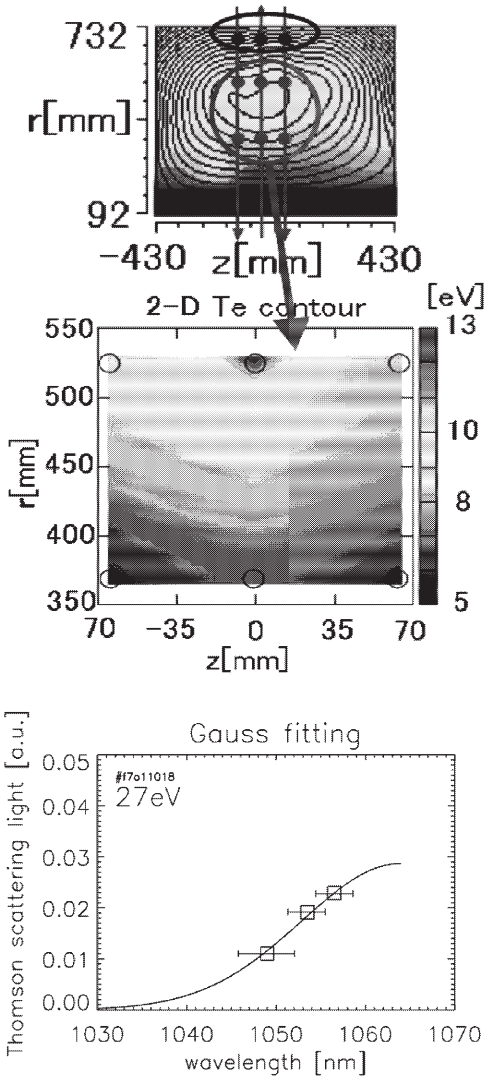

Fig. 1. The laser beam path and measurement points for the present 3x3 2-D Thomson scattering measurement in the poloidal flux contour of ST plasma (top), the measured 2-D contour of electron temperature (middle) and the Thomson scattered lights as a function of wavelength for Gaussian fitting (bottom).