§6. Development of Two Dimensional Thomson Scattering Measurement System

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The Thomson scattering is the most reliable electron temperature measurement and its extension to two dimensional (2-D) system will contribute significantly to solving electron dynamics 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. As shown in Fig. 1, 2-D profiles of electron temperature and density are measured at m x n measurement points covered by the YAG laser reflection on the r-z plane. 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 polychromaters 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 2007, we finished constructing the first 1-D measurement system and started for the first time the 1-D Thomson scattering measurement using the single 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 ST plasma, as shown in Fig. 1. The collecting optics and polychromator system detected for the first time the Thomson scattering signals from the three points, as shown in Fig. 2 top. It was clearly observed that the three Thomson scattering signals were measured with equal time intervals of 50nsec corresponding to laser flight length of 15m. This successful result supports the validity of our time of flight measurement. Figure 2 bottom shows the axial electron temperature profile obtained finally from the measured signals of single polychromator. The remaining problem is 1) reduction of cross-talk signals between each Thomson scattering signals and 2) improvement of laser beam quality along the long laser beam path. In the third year 2008, we are planning to extend the present 1-D system to the 2-D 3x3 Thomson scattering measurement using two sets of polychromators, collecting lenses and optical fibers arranged in 2007.

1) K. Yamashita, Y. Ono, K. Narihara et al., 3rd Plasma Conf. IEEJ (Kanazawa, Jan. 07.)
2) T. Sumikawa, Y. Ono et al., "Development of 2-D Thomson Scattering Measurement Using Multiple Reflection and the Time-of-Flight of Laser Light", Plasma and Fusion Research No. 2, S1108 (2007).

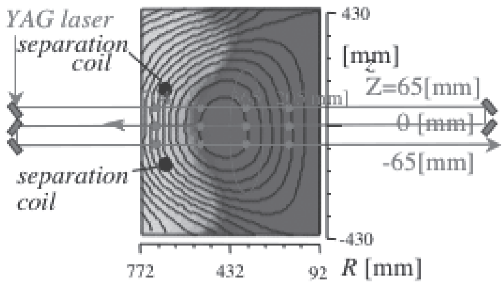

Fig.1 The laser beam path and measurement points for the present 2-D Thomson scattering measurement in the poloidal flux contour of ST plasma in TS-4 device.

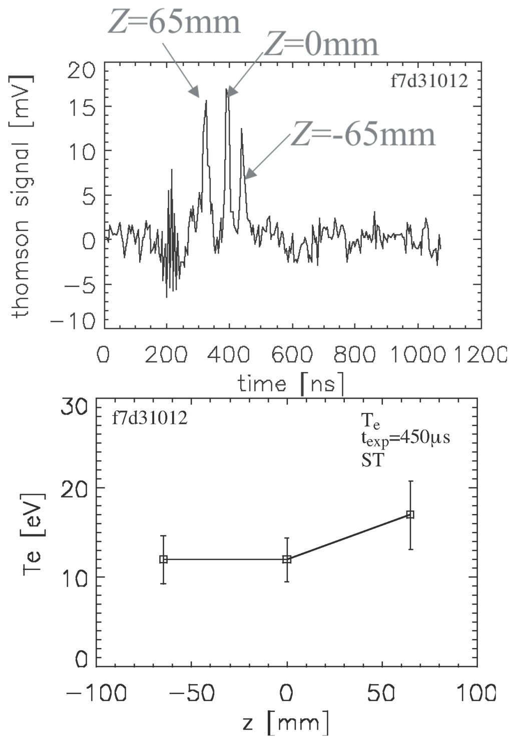

Fig. 2 Thomson scattering signals from three axial measurement points shown in Fig. 1 (top) and the measured electron temperature profile of ST plasma in the axial direction (bottom).