§24. Development of Two Dimensional Thomson Scattering Measurement by Use of Multiple Reflection of Laser Light

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The Thomson scattering method is the most reliable diagnostics for electron temperature measurement and its two dimensional (2-D) measurement is useful for magnetic reconnection experiment in TS-4 and electron transport study in LHD experiment. We have developed a new cost-effective 2-D Thomson scattering measurement system using multi-reflection of a single laser light and its time-of-flight effect[1]. A new characteristics for our system are as follows: (1) multiple reflections of laser light to increase the scattered light and to cover m x n (2-D) measuring points on r-z plane, (2) usage of time-of–flight of laser light to save the number of polychromators and detectors, and (3) flexible usage of laser path length to control the delay times of scattering signals from those measuring points. 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 scattered lights from n points are measured by a single polychromator.

In 2012, we tested the idea of multiple reflections using a part of new 7 channel system on the midplane in addition to the old 3x3 system on the R-Z plane. As shown in Fig. 1, the 2-D (3x3) + 1-D (7channnel) system has several multi-reflection channels to increase their scattering lights. The top panel of Fig. 2 shows the scattered light signals obtained from three times reflections of YAG laser light. We can clearly identify that the scattered light increases by factor of three due to the reflection of laser light by three-times. We used this technique for several edge channels with low scattered light to complete the 2D Thomson scattering system with high-resolution on the midplane mainly for laboratory study of magnetic reconnection. The scattered light signals from the new 5 point system were shown in the top panel of Fig. 2. It successfully measured the scattered light signals that increased by factor 3. Each three scattered light signals were measured as time series signals with interval time of 30nsec. The Gaussian fittings of those signals are used to calculate the electron temperature. Finally, 2D profiles of electron temperature were obtained as shown in the bottom right panel of Fig. 2 [1,2].

1) Y Ono, H Tanabe, et al., Plasma Phys. Control. Fusion 54, 124039 (11p), (2012),
2) Y. Ono, H. Tanabe et al., Fusion Energy 2012, EX/8-2 (2013).

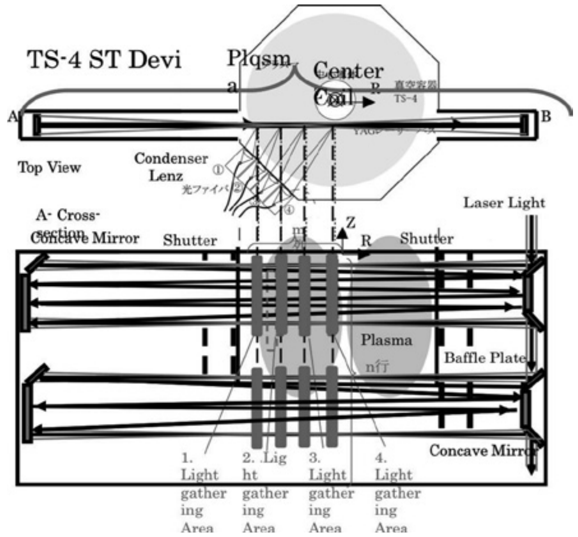

Fig. 1 The present experimental setup of 2-D Thomson scattering measurement by multiple laser-light reflections and its time of flight. The 3x3 scattered lights are transformed into 2D electron temperature profile on the R-Z plane using the Gausian fitting to those signals.

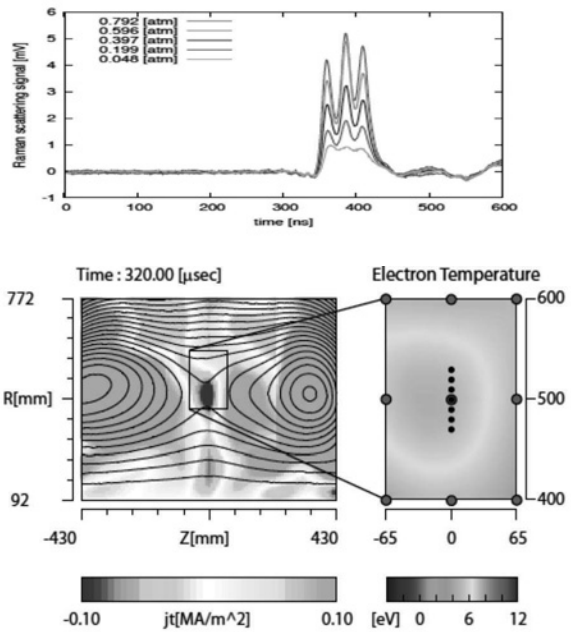

Fig. 2 Time evolutions of five-channel scattered signals on the midplane when YAG laser light was reflected for three times (top) and the polodal flux contour of two merging ST plasma with toroidal current density (by orange and blue colors) (bottom left) and R-Z contour of measured electron temperature for R=0.4-0.6m Z=-0.1-0,1m on the midplane.