Development of 2D Thomson Scattering Measurement System Using Multiple Reflections and Time-of-Flight of Laser Light

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We are developing a cost-effective two-dimensional (2D) Thomson scattering measurement system using multiple reflections and time-of-flight of a single Nd:YAG laser [1, 2] for 2D elucidation of electron heating/acceleration of magnetic reconnection. Its key ideas are to cover the 2D measurement area by the multiple reflections of laser light and to save the number of polychromators using the time of flight of laser light.

Figure 1 shows our experimental setup. When the Nd:YAG laser light is reciprocated between ϕ25 concave mirrors, its backscattered light collected by a concave mirror is guided to polychromators through optical fibers. The scattered lights from 2D (20 x 7) measurement points are detected by 1D (20) polychromators. Since the distance between mirrors is about 3.485m, time of the round trip flight: $(3.485\times2)/(3.0\times10^8)$ s = 23 ns is almost equal to intervals of pulses. However, the measured pulse duration of Raman scattering light was longer than expected. Figure 2 (a) implies signals from adjacent return paths are difficult to be separated. On the other hand, Figure 2 (b) shows numerical sums of signals from the first and the third return paths, indicating signals from every other return path can be separated. As we succeeded 1D measurement and the noise was not too large to separate signals, we will be able to introduce our 2D data.

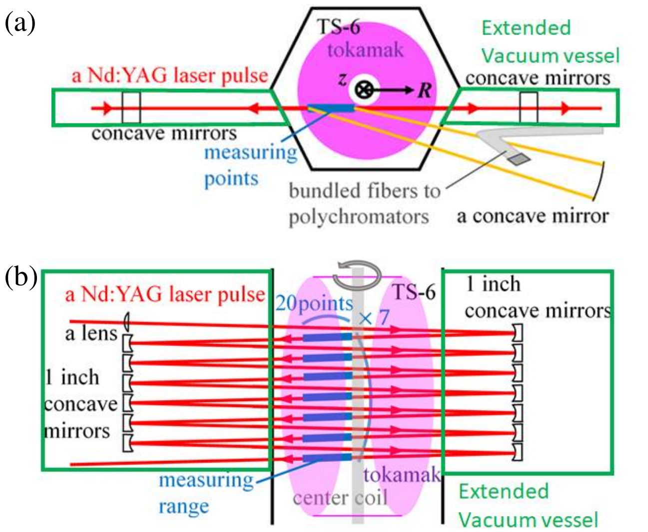

Figure 1. (a) The vertical and (b) the horizontal cross section of the experimental setup.

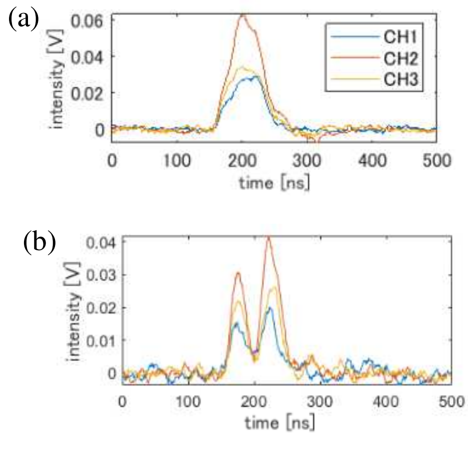

Figure 2. (a) Measured Raman scattering signals from return paths 1st, 2nd, and 3rd. (b) Numerical sums of Raman scattering signals from return paths 1st and 3rd without 2nd.

[1] S. Ito et al., IEEJ Trans. FM, 2, 132, 574 (2012).
[2] S. Kamiya et al., 35th annual meeting of JSPF, Osaka (2018).

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