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Development of Double Filter Polychromator System for Cost-Effective One-Dimensional Thomson Scattering Diagnostics

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We designed a new type of polychromator for Thomson Scattering using angular dependence of incidence to interference filter. While Existing polychromators use one interference filter to detect one wavelength, this polychromator enables us to reduce the number of interference filters to less than half.

We have been studying magnetic reconnection of two merging tokamaks as a new powerful initial heating method. It is important to measure the electron temperature profile without touching the plasma, Thomson scattering has been the most reliable method for measuring electron temperature and electron density.

Figure 2 shows our One-Dimensional Thomson Scattering Diagnostic System. When two antiparallel magnetic lines get closer, magnetic lines reconnect at the X-point due to finite electrical resistance. This phenomenon, called Magnetic Reconnection, accelerated plasma to the downstream, causing plasma heating.

At each measurement point, a polychromator is needed to separate the scattered light. In Fig. 2, we designed 20 measurement points to measure electron temperature and electron density. Therefore, it indicates that 20 polychromators are needed. Since each polychromator is expected to separate more than 5 wavelength ranges using 5 filters, the total number of interference filters is 5*20=100.

The wavelength, detected by scattered light, is in the 1050 nm ~ 1059 nm region, and the filter for short-wavelength can cover high-temperature regimes. It is a key issue to make polychromators cost-effective because the interference filter costs over 1000 dollars each, therefore.

The new type of polychromator uses an angular dependence of incidence to interference filter. The wavelength transmitted through the interference filter shifts toward the shorter side as the angle of incidence of the light entering the interference filter is increased. This polychromator enables us to reduce the number of interference filters needed to 1/2 or 1/3.

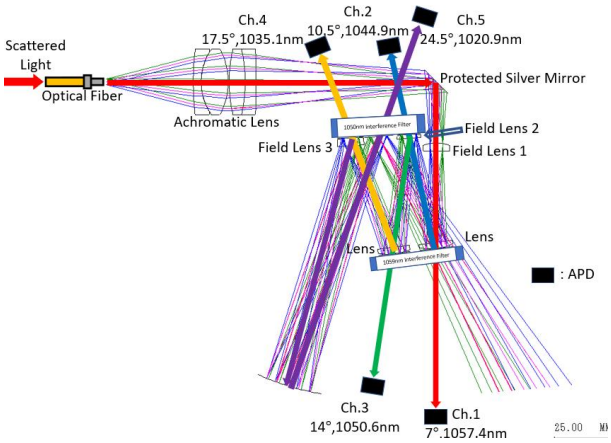

Fig.1 Schematic of our new type of polychromator system using angular dependence of incidence to interference filters. Each channel has different incident angle and detection wavelength range, as described below the number of each channel.

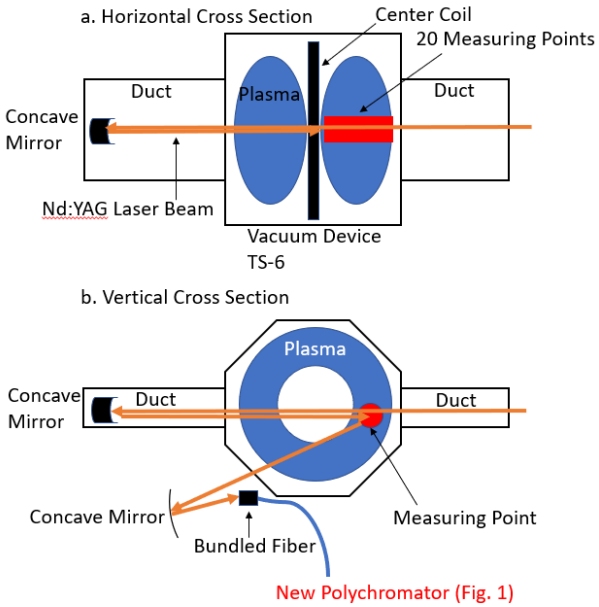

Fig. 2 Schematic of our 1-D Thomson Scattering diagnostic system.