Investigation of Thomson Scattering Measurement System for Long-Duration Discharges with a hot wall on the QUEST Spherical Tokamak

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The QUEST spherical tokamak is equipped with temperature-controllable plasma-facing metal walls (called hot walls) for studies of particle recycling during long-duration discharges [1]. The temperature of the hot walls can be controlled from room temperature to 673K. In the future, long-duration discharges for about six hours at the wall temperatures from 573 to 673 K is planned. The Thomson scattering (TS) measurement system for long-duration discharges in QUEST was introduced in 2022, and electron density and temperature profiles can be measured at 10 Hz for 15 seconds, which is repeated every minute, using oscilloscopes under the wall temperature of 473K [2]. For the accurate and continuous TS measurement during several-hour discharges, the following two developments are in progress. The first is the automatic alignment system for the YAG laser path. The laser spots are constantly monitored at the final mirror of the injection beamline and at the mirror positioned after passing through the plasma by three cameras as shown in Figure 1, and the misalignment is automatically corrected by motor-driven mirrors. The second is the development of a data acquisition system for long-duration discharges. Switched capacitor ADCs capable of continuous data acquisition is in preparation. In addition, it was found that the temperature control of the glass vacuum window is necessary for applying the TS system to long-duration discharges at the wall temperature of 573 K. The temperature of the window surface rises due to the radiant heat from the hot walls and plasma, while the surrounding flange is water-cooled. The temperature difference between the window and the flange may cause damage to the glass windows. One of the solutions is to install a remotely controllable light-shielding shutter. The above development will allow us to measure the electron density and temperature in the long-duration discharges with high-temperature plasma-facing walls, only during the periods when the shutter is open.

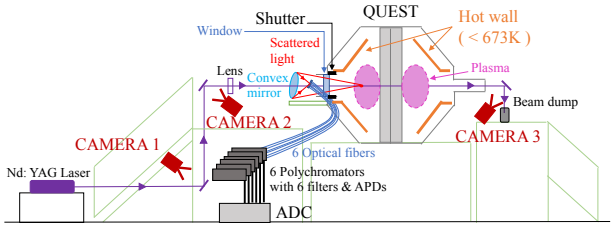

Figure 1. Conceptual diagram of TS measurement in long-duration discharges with a hot wall.

[1] M. Hasegawa, *et al.,* Plasma Fusion Res. **16** (2021) 2402034.

[2] K. Kono, *et al.,* Plasma Fusion Res. **18** (2023) 1405012.

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