Experimental study on in-situ calibration of spectral transmission of Thomson scattering in harsh environments

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Incoherent Thomson scattering system determines electron temperature and density from the spectrum of light scattered by electrons. Calibrating the spectral transmittance of the optical system is essential for electron temperature and density measurements. The spectral transmittance of the Thomson scattering system at ITER changes due to various factors. The main factors are the deposition of impurities on the plasma-facing mirror, and the irradiation of the vacuum window, lenses, and optical fibers. Implementation of a mirror cleaning system is also planned to remove impurities and restore the reflectivity of the plasma-facing mirror. The spectral transmittance, which decreases and increases, must be calibrated frequently. Smith proposed an *in-situ* calibration method of the spectral transmittance during the plasma discharge using two lasers with different wavelengths [1]. Yatsuka considered applying this method to the ITER edge Thomson scattering system (ETS) [2]. In ITER, an edge pedestal of several keV is expected to form. As the main probing laser, it was assumed to use the Nd:YAG laser (wavelength 1064 nm), and a suitable second laser was examined. In general, it is important that the Thomson scattering spectra generated by the two lasers overlap and that the two spectra span the entire measured wavelength range. A ruby laser is promising as the second laser. The core plasma of Large Helical Device (LHD) has an electron temperature of 1-10 keV. Therefore, the LHD Thomson scattering system was used to demonstrate the applicability of the *in-situ* calibration technique using Nd:YAG and ruby lasers to the ITER ETS. In the first trial, the Nd:YAG laser and the ruby laser were coaxially injected with a time difference of 11 ms. The electron temperature obtained from the Thomson scattering spectra of Nd:YAG laser and ruby laser alone with known spectral transmittance and the electron temperature obtained by analyzing the two Thomson scattering spectra together with unknown spectral transmittance were in good agreement. At this time, five wavelength channels were used for measurement, one of which was unavailable due to stray light from the Nd:YAG laser, so 9 signals were used for analysis. On the other hand, there were seven unknowns: electron temperature, density, and spectral transmittance of each wavelength channel. After this trial, the time difference between the two lasers was shortened to 0.5 ms, and the filters of the polychromator were improved, including cut-off of stray light. Data were accumulated using 6 wavelength channels (12 data). The presentation will explain the usefulness of the calibration method using two lasers.

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