Development of a Thomson scattering system in the TST-2 spherical tokamak

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Electron temperature is one of most important parameters in all fusion devices, including spherical tokamaks (STs). STs can generate high pressure with a smaller magnetic field compared with conventional tokamaks. However, STs are characterized by MHD events which cause significant distortion in the temperature profile[1].
Thomson scattering measurement is a highly reliable measurement of electron temperature, and many devices are equipped with a system. Recently the system in TST-2 was upgraded and more accurate and new results are reported in this paper.
This system consists of the following three components, incident optics, light collection optics, spectroscopic system. We use a compact Newtonian mirror system consists of a primary spherical mirror of diameter 254 mm and a small secondary flat mirror for the collection optics[2]. The system has large solid angle (88 msrad). For incoherent Thomson scattering, we use Nd:YAG laser with a wavelength of 1064 nm, with a pulse width of 10 ns, with a repetition rate of 10 Hz. The former low energy (0.45 J) laser has been replaced by a new high energy (1.6 J) laser, and the signal to noise ratio was improved from 5 to 10. The Calibration method of the polychrometar was modified, and the wavelength resolution was improved from 2.5 nm to 0.24 nm as a result. Recently, we introduce an 8-channel high speed oscilloscope, and thus all 5 wavelength channels can be recorded simultaneously, and fitting becomes more accurate.
Rayleigh scattering is used for the calibration of density, and multi spatial point density (and temperature) measurement is possible. We measured intensity of scattering light and stray light in the calibration.
Typical results are show in the following. The typical central electron temperature and the electron density are 150 eV and 1.5×10^{19} m^{-3}, respectively. The temperature profile has a maximum and flat near the center of the plasma, the density profile also has an maximum near the center. When instability is observed in the radiation signal, the temperature becomes low. Dependence of the temperature on other parameter will be reported.

[1] I. Semenov, et al. Phys. of Plasmas **10**, 664 (2003).
[2] S. Kainaga, et al. Plasma Fusion Res. **3** (2008) 027.