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LHDトムソン散乱装置の測定温度領域の拡大
Extension of the Measurable Temperature Range of the LHD Thomson Scattering System

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The large helical device (LHD) Thomson scattering system measures electron temperature (T_e) and density (n_e) profiles along the LHD major radius. The LHD Thomson scattering system was designed for the electron temperature range of T_e = 50 eV-10 keV. [1] The data quality becomes worse rapidly in higher temperature region, $T_e \geq 10$ keV. It is originated from the fact that the Thomson scattering spectrum becomes wider than the wavelength region observed by our polychromator. In order to obtain reliable and accurate T_e data in high-T_e plasma experiments, we tried several methods: guasi-simultaneous laser firing of three lasers and raw data summing methods. They have been successfully applied. [2] However, these methods have disadvantages too. For example, many lasers are needed for the guasi-simultaneous laser firing method, and many fixed plasma discharges (experiment time) are required for a raw data summing method. Therefore, we consider other methods to obtain reliable T_e and n_e data from a plasma discharge by using a laser.

We are planning to extend the measurable T_e range by following two methods. First we have installed one more wavelength channel that observes shorter wavelength region in polychromators. Next a forward scattering configuration, in which the Thomson scattering spectrum becomes narrower than current backward scattering configuration, is another candidate. We estimate the data quality by using mock Thomson scattering signal data when the two methods are applied. The mock data take some LHD plasma parameters into account, and Thomson scattering spectrum are calculated by using Selden's formula. [3] Both of them will provide more accurate T_e data in high- T_e region of $T_e \geq 10$ keV. The T_e error will be reduced from 52 % to 10 % at T_e = 30 keV by using the new polychromators as shown in Fig. 1. When applying a forward scattering configuration, the T_e error will be reduced from 52 % to 4 % at T_e = 30 keV, and will be further reduced to 3.5 % when both the methods are simultaneously applied.

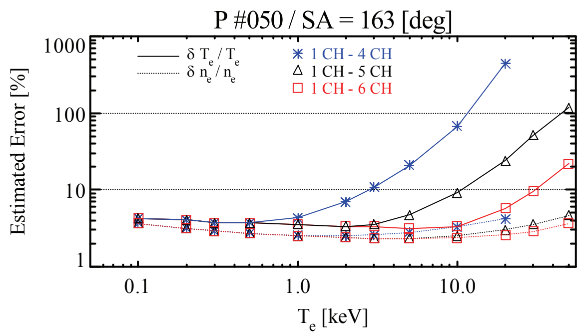

Fig. 1. Estimated T_e (solid curves) and n_e (dashed curves) errors. Crosses, triangles, and squares show T_e and n_e errors when wavelength channels #1-#4, #1-#5, and #1-#6 are used respectively.

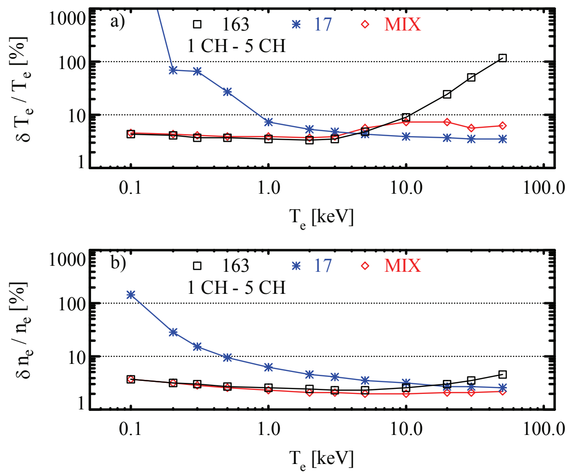

Fig. 2. Estimated T_e and n_e error when the wavelength channels #1-#5 are used for the backward scattering configurations, squares and forward scattering configurations, crosses.

[1] I. Yamada *et al.*, Fusion Sci. Tech., 58, 345 (2010).
[2] I. Yamada *et al.*, Rev. Sci. Instrum., 81, 10D522 (2010)
[3] A. C. Selden, Phys. Lett. A, 79A, 405 (1980).