§2. On the Influence from High-Energy Electrons on Electron Temperatures Measurements by the LHD Thomson Scattering System

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In the Large Helical Device (LHD) electron cyclotron resonance heating (ECRH) experiments, high-temperature plasmas whose electron temperature (T_e) exceeds 15 keV have been generated.[1] In such high-T_e ECRH plasmas, the electron distribution function may consist of two components: lower energy bulk component and high energy electron (HEE) component.[2] Thus, electron temperature measured by Thomson scattering diagnostics will be affected by the contribution from HEEs when considerable amount of HEEs are generated. Therefore, we estimated the influence from HEEs.

The LHD Thomson scattering system[3] mainly observes Thomson scattered light by lower temperature bulk electrons, and that by HEEs is hardly detected.[4] On the other hand, millimeter-wave (MMW) interferometer[5] observes both bulk electrons and HEEs. Therefore, comparison of electron densities obtained from the two diagnostics is expected to provide useful information of HEE component. Figure 1 show the comparison of line densities from MMW and Thomson scattering diagnostics. The second and third figures show electron temperature and density around the plasma center. Plasma stored energy is also plotted in the bottom figure. The highest $T_e(0)$ was 12.8 keV, and $n_e(0)$ was ~0.3×10^{19} m^{-3}. After t=2.0 sec, line densities obtained from MMW and Thomson scattering diagnostics show clear difference. The difference may be originated from extremely low-energy electrons that the Thomson scattering system cannot detect. Indeed, both $T_e(0)$ and plasma stored energy also disappeared after t=2.0 sec. Similar difference is expected to be observed if considerable amount of HEEs are generated around the time when $T_e(0)$ reaches the maximum. However, no clear evidence of the generation of HEEs is seen in the experiment. Since the spectral resolution of the polychromators is poor for accurately observing the HEE component, it will be difficult to obtain accurate information on HEEs by Thomson scattering system.

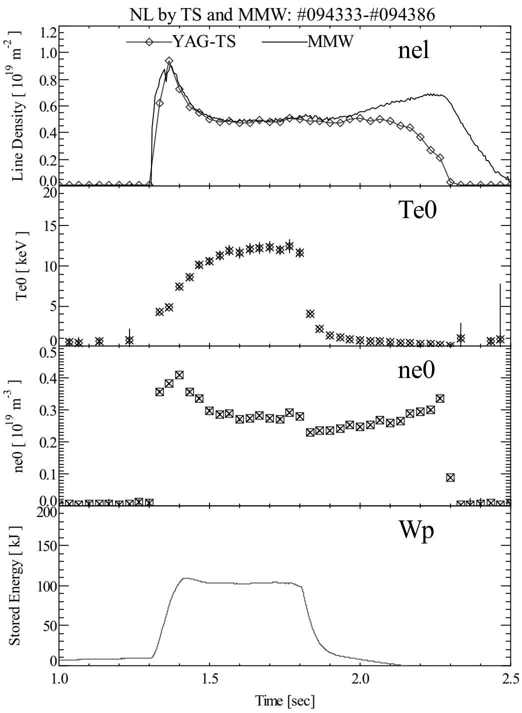

Fig.1. Comparison of line electron densities measured by MMW interferometer and Thomson scattering system. Te and ne around the plasma center, and stored energy are also plotted.

Still, considering the influence of HEEs on T_e measured by Thomson scattering diagnostics is important. We estimated T_e under the assumption that the temperature of HEEs is 69 keV and the population range is 0 %-50 %. An example is shown in Fig. 2. The upper figure shows T_e profiles at the HEE population of 0, 20 and 50 %. As expected, T_e by Thomson scattering diagnostics decreases as the population of HEEs increases. In other words, bulk electron temperatures by Thomson scattering diagnostics under the assumption that no HEEs exist are overestimates. However the error caused from ignoring HEE effect is estimated to be small in this work. Even when the population of HEEs is assumed to be 50 %, the error is 14 %. When accurate and reliable information on HEEs is provided from another diagnostics and/or theoretical calculation, more practical data analysis taking into account the effect of HEE will be possible.

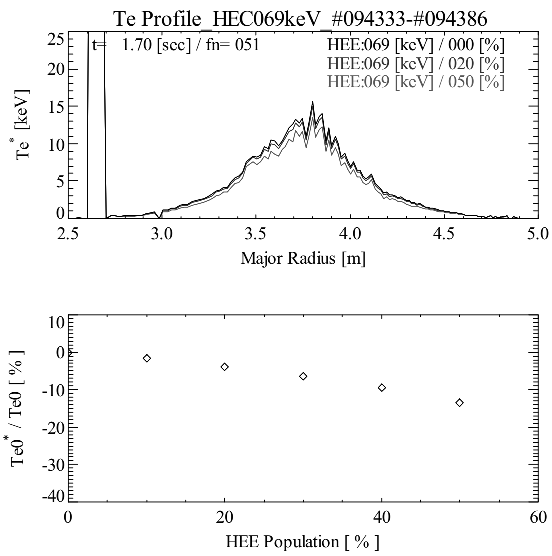

Fig.2. Comparison between electron temperature profiles that takes HEE effects into account, T_e*, and difference between $T_e(0)$* and $T_e(0)$.

1) Takahashi, H. *et al.*, IAEA 2010, Korea, (2010).
2) Muto, S. *et al.*, Rev. Sci. Instrum., **74**, 1993 (2003).
3) Yamada, I. *et al.*, Fusion Sci. Tech, accepted, (2010).
4) K. Kawahata *et al.*, Rev. Sci. Instrum., **70**, 695 (1999).