§13. Expansion of High T_e Regime in 14th Experimental Campaign on LHD

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In the LHD, an ECRH system with seven gyrotrons, whose frequencies are 77, 82.7, 84 and 168 GHz, has been operated for plasma generation and heating. Of these, the high power 77-GHz gyrotrons with the output power of more than 1 MW have been operated since the 2007 experimental campaign.[1)] In the present state, three 77 GHz gyrotrons are operational for plasma experiments. The total injection power of ECRH to the plasma significantly increased due to the installation of the 77 GHz tubes and reached a value of 3.7 MW. In the research, we tried the expansion of the high electron temperature regime of the LHD plasmas using the high power ECRH system.

In order to focus the high-power 77 GHz EC wave on the plasma centre, the experiments were carried out under the magnetic configurations of R_{ax} = 3.53 m/ B_t = 2.705 T and R_{ax} = 3.60 m/ B_t = 2.705 T. Figure 1 shows the typical time evolution of (a) the line-averaged electron density n_{e_fir}, (b) the central electron temperature T_{e0}. The target plasma was produced using the 82.7 GHz and 84 GHz ECRH (0.36 MW) and was sustained by the three-line 77 GHz ECRH (3.36 MW). As can be seen from fig. 1, T_{e0} of 8.7 keV at the electron density of $1x10^{19}$ m^{-3} was attained. In the research, the challenge for achievement of the new record of T_e was also performed for the lower collisionality plasmas. Figure 2 shows the radial profile of T_e with the averaged electron density of $0.2x10^{19}$ m^{-3}. In order to improve an accuracy of T_e data, we carried out 17 discharges with the fixed parameters such as T_e and n_e and three YAG lasers firing all together to increase the intensity of the Thomson scattered light. As can be seen from fig. 2, T_{e0} of 20 keV was realized and the value exceeded ~15 keV, which was obtained in 2009 experimental campaign.[2)]

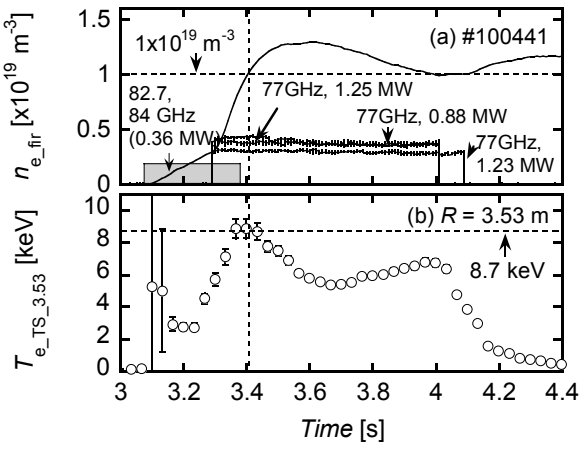

Fig. 1. The typical time evolution of (a) the line-averaged electron density n_{e_fir}, (b) the central electron temperature T_{e0}

Figure 3 shows the map of simultaneously attained T_{e0} and n_{e_fir} for ECRH discharges in several magnetic configurations. The open and the solid symbols represent the data obtained previous and 2010 experimental campaign, respectively. As shown in the figure, the plasma parameter regime with regard to the electron was successfully expanded both in the low and high density conditions.

1) Takahashi, H., et al.: Fusion Sci. Technol. **57**, 19 (2010).
2) Takahashi, H., et al.: IAEA FEC EXC/P8-15, Daejeon 2010.

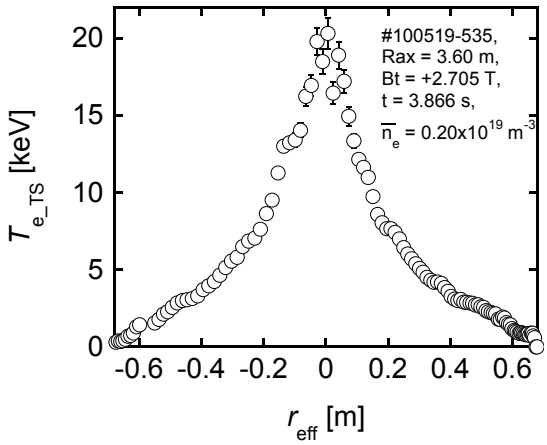

Fig. 2. The radial profile of T_e with the averaged electron density of $0.2x10^{19}$ m^{-3}

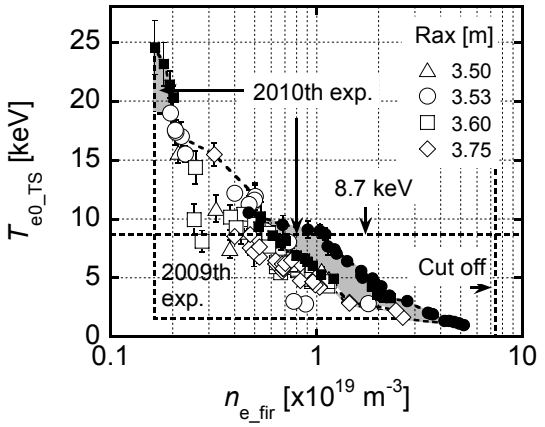

Fig. 3. The map of simultaneously attained T_e and n_{e_fir} obtained in ECRH discharges in several magnetic configurations