§4. Behavior of e-ITB Foot Points during ECRH Discharges

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A mechanism of e-ITB formation relating with a lower order rational surface has been studied in LHD.[1, 2] Most of the previous e-ITB experiments were carried out using centre-focused ECRH overlapping to NB sustained plasmas. There were always effects of inductive return current against NB driven current on the profile of the rotational transform because the relaxation time of the return current in LHD is several seconds, which is generally longer than the plasma sustainment time.[3] We carried out e-ITB experiments by using perpendicularly-injected ECRH alone. It becomes possible to investigate the dynamics of e-ITB formation and the relation between the foot point and the lower-order rational surfaces without the effect of return current

Figure 1 shows the time evolution of (a)-(d) T_e and n_e profile, (e) the radial position of the foot point of the e-ITB, (f) T_e gradient at r_{eff} = 0.078 m and (g) T_e slightly inside the rational surface of $\iota/2\pi = 0.5$ under R_{ax} = 3.53 m, B_0 = 2.705 T. The rotational transform profile for a vacuum condition is attached in (a)-(d) and the rational surface of $\iota/2\pi = 0.5$ is located at r_{eff} ~0.25 m. ECRH was injected perpendicularly during t = 0.21-0.71 s with P_{ECRH} = 2.63 MW. Highly accurate T_e profiles were successfully obtained by the accumulation of the intensity of Thomson scattered light through 20 discharges with the three YAG lasers all injected together. At the beginning of the discharge, a flat T_e profile with a small bump was observed and a peaked T_e profile was formed at t = 0.5 s. After that the foot point of the e-ITB moved to outward with increasing T_{e0}. As can be seen from Fig. 1 (a)-(d), steep gradient of T_e formed in the vicinity of the rational surface, which was larger than that in the e-ITB region. Fig. 1 (e), (f) shows that T_e at the core region increased with the foot point moving outward and the e-ITB growing. On the other hand, T_e just inside the rational surface (at r_{eff} = 0.21, 0.24 m) gradually decreased as shown in Fig. 1 (g) leading to the increase of T_e gradient at the core region and to the decrease of that around the rational surface. Finally, the T_e gradient at the e-ITB region equated with that around the rational surface indicating that (i) the foot point of the e-ITB reached to the position of the rational surface of $\iota/2\pi$ = 0.5 and (ii) the e-ITB plasma with only one folding point in its T_e profile was formed. We also observed same T_e profile behavior in higher density plasmas with $n_e < 0.73\times10^{19}$ m^{-3}.

1) Y. Takeiri *et al.*, Fusion Sci. Technol. **46**, 106 (2004).
2) T. Shimozuma *et al.*, Nucl. Fusion **45**, 1396 (2005).
3) K. Ida *et al.*, Phys Rev. Lett. **100**, 045003 (2008).

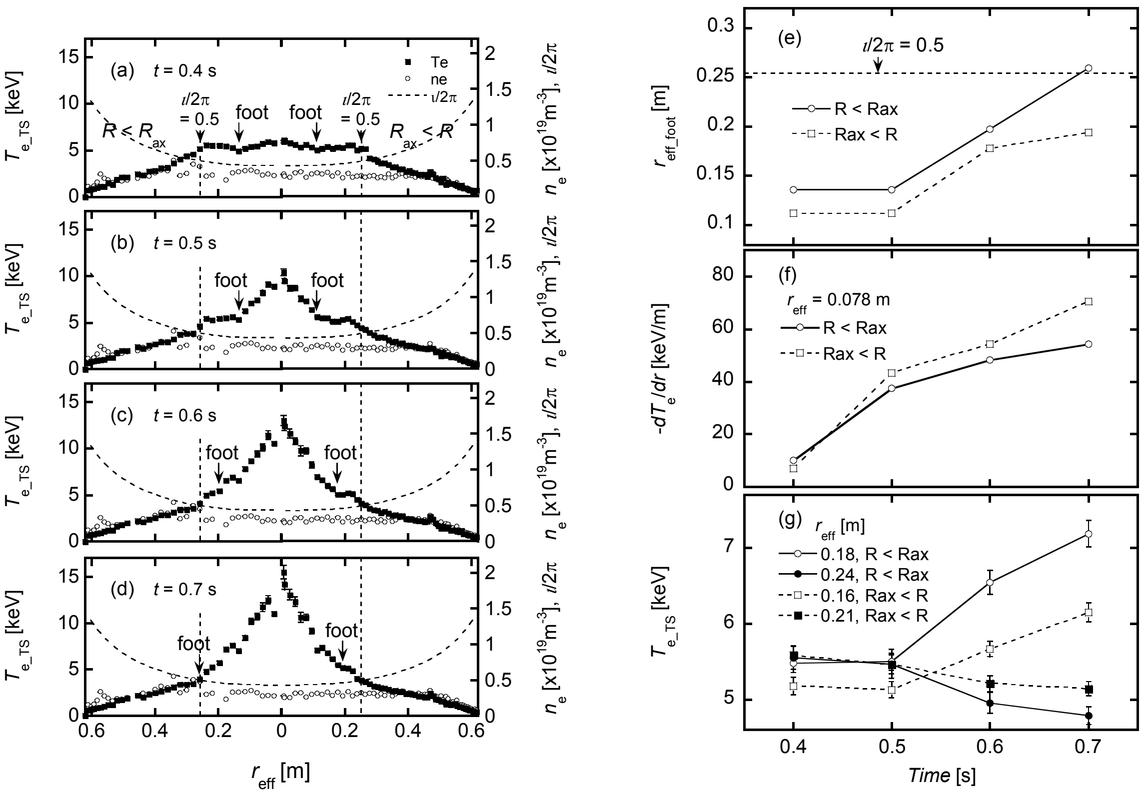

Fig. 1. The time evolution of (a)-(d) T_e, n_e profile, (e) the radial position of the foot point of the e-ITB, (f) T_e gradient at r_{eff} = 0.078 m and (g) T_e slightly inside the rational surface of $\iota/2\pi$ = 0.5.