§ 3. Electron ITB Formation with Combination of NBI and ECH

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The electron internal transport barrier (ITB) has been observed in the Large Helical Device (LHD) [1,2], which is formed with centrally focused ECRH microwaves injected into the NBI-heated plasmas. At an inward-shifted configuration of the magnetic axis, R_{ax}=3.5m, a high T_e, exceeding 10 keV in a low density, is achieved in the formation of the electron ITB, and the improvement of the core electron transport is confirmed. The electron-ITB is characterized by the neoclassical electron root with a positive radial electric field (E_r) determined by the neoclassical ambipolar flux. The T_e threshold for ITB formation depends on $n_e^{0.4}$ [1], which is consistent with the theoretically predicted transition to the electron root with a strong positive E_r [3].

The magnetic axis position is correlated with the transport properties in LHD. In the inward-shifted configurations, where the helical ripple is smaller than that in the standard one of R_{ax}=3.75m, the confinement properties are superior and the transport is dominated mainly by anomalous transport. On the other hand, in the outward-shifted configurations, where the helical ripple is larger, the ripple transport is dominant, leading to an enhanced transport. This variation of the transport properties with the magnetic axis position should influence the electron ITB formation, which is theoretically predicted by the threshold for the transition to the electron root from the ion root [3].

The electron ITBs were observed in various configurations of R_{ax}=3.6, 3.75, and 3.9m, as shown in Fig. 1, in the second-harmonic heating by ECH with frequencies of 82.7 and 84GHz, which was applied to NBI target plasmas with a resonance magnetic field strength of around 1.5T on the axis. Although the T_e itself cannot be compared directly as the heating power is not the same, differences in the T_e profile shape and the threshold density to form the electron ITB are recognized. The NBI-driven current also has an influence on the formation of the electron ITB [1]. The rotational transform profile is changed with the beam-driven current, and the rational surface seems to be correlated with the foot-point of the electron ITB profile. Although the ion transport is expected to be improved in the neoclassical electron root, no apparent increase in the ion temperature has been observed yet.

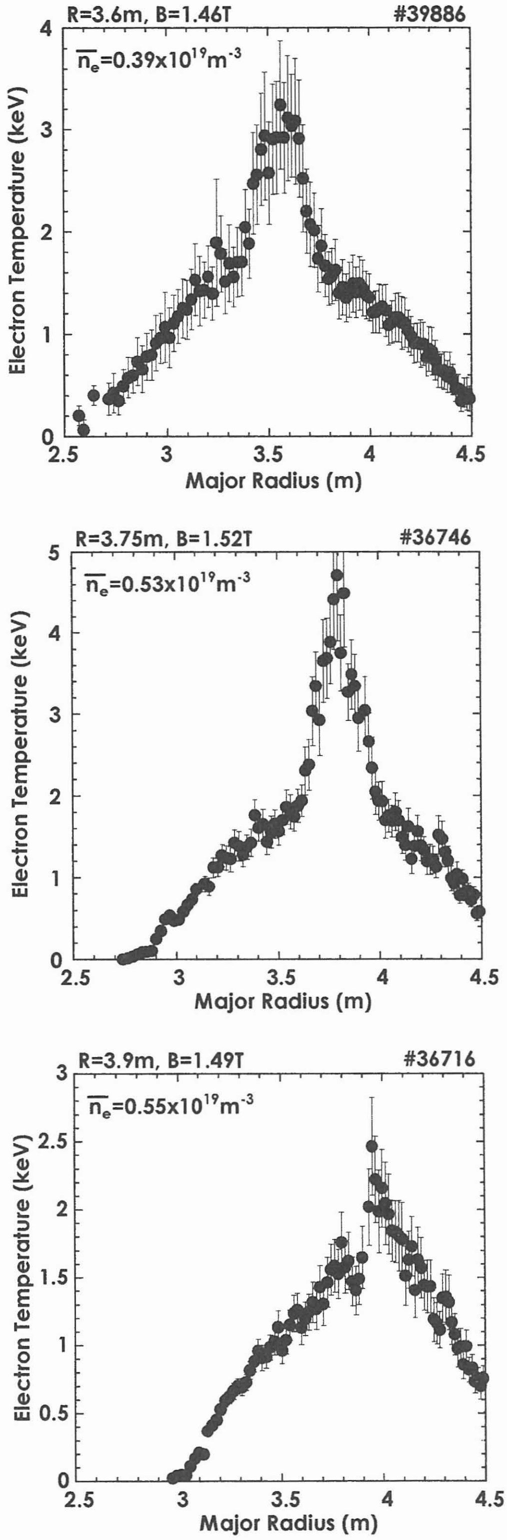

Fig. 1 Examples of the electron ITB profile observed at various R_{ax} positions of 3.6, 3.75, and 3.9m.

References
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