§4. Behavior of Electron Temperature Profile with e-ITB during Long Pulse ECRH Discharge

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The mechanism of an electron internal transport barrier (e-ITB)[1] formation has been investigated in the LHD. In the 2009 experimental campaign, the spontaneous formation of the e-ITB was observed in the ECRH plasmas. The foot point of the e-ITB moved outward during the discharge and was close to reaching the rational surface of $\iota/2\pi$ = 0.5.[2] However, the behavior of the electron temperature profile after the foot point of the e-ITB approached to the rational surface could not be clarified due to the limitation of the ECRH pulse duration. Thus the longer pulse discharge with enough heating power is necessary in order to investigate whether the e-ITB foot point stop the outward moving at the rational surface or not. From 2009 to 2010, it became possible to operate 77 GHz gyrotrons with higher electric efficiency due to the flexible control of the anode voltage. In addition to that, the conditioning of these tubes progressed steadily and the output energy of the gyrotrons in the high power operation significantly increased as shown in fig.1.

Figure 2 shows the time evolution of (a)-(d) T_e and χ_e profiles (e) r_{foot}, r_{in} and r_{out}, where χ_e, r_{foot}, r_{in} and r_{out} are the electron thermal diffusivity, the radial position of the e-ITB foot point, the inner and the outer boundary position of the local flattening in the T_e profiles, respectively. The experiment was carried out under the configuration of R_{ax} = 3.53m/ B_t = +2.705 T. The target plasma with the averaged electron density of 0.3x10^{19} m^{-3} was sustained for ~3 seconds by two lines of perpendicularly injected ECRH (1.34 MW). At the beginning of the discharge, a flat T_e profile was observed and a peaked T_e profile was formed at t = 0.9 s. After that r_{in}, which corresponds to the foot point of the e-ITB, moved outward. On the contrary, r_{out} shifted inward and the local flattening gradually shrunk. It was found that r_{in} reached slightly inside position of the rational surface of $\iota/2\pi$ = 0.5 and then the local flattening around the rational surface disappeared. After the healing of the local flattening, r_{foot} stopped outward moving, namely the foot point of the e-ITB did not move across the rational surface. In addition, the degradation of the T_e gradient was observed at the plasma core region in the latter phase of the discharge. The detailed verification of the role of the lower-order rational surface to determine the e-ITB structure and the study of the topology change in the magnetic surface during the e-ITB growing are the future works.

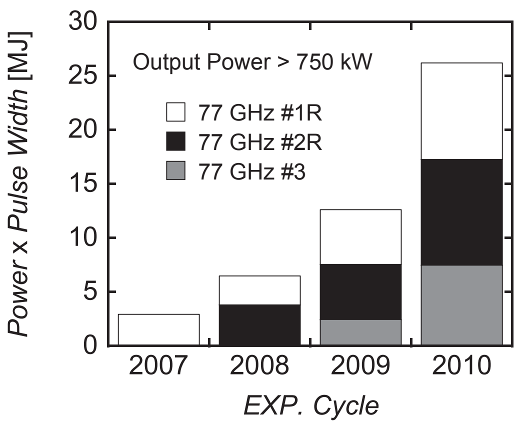

Fig. 1. The output energy of 77 GHz gyrotrons in the high power operation since 2007 experimental cycle

1) Ida K. et al., Phys. Rev. Lett. **91** (2003) 085003.
2) Takahashi, H., et al.: IAEA FEC EXC/P8-15, Daejeon 2010.

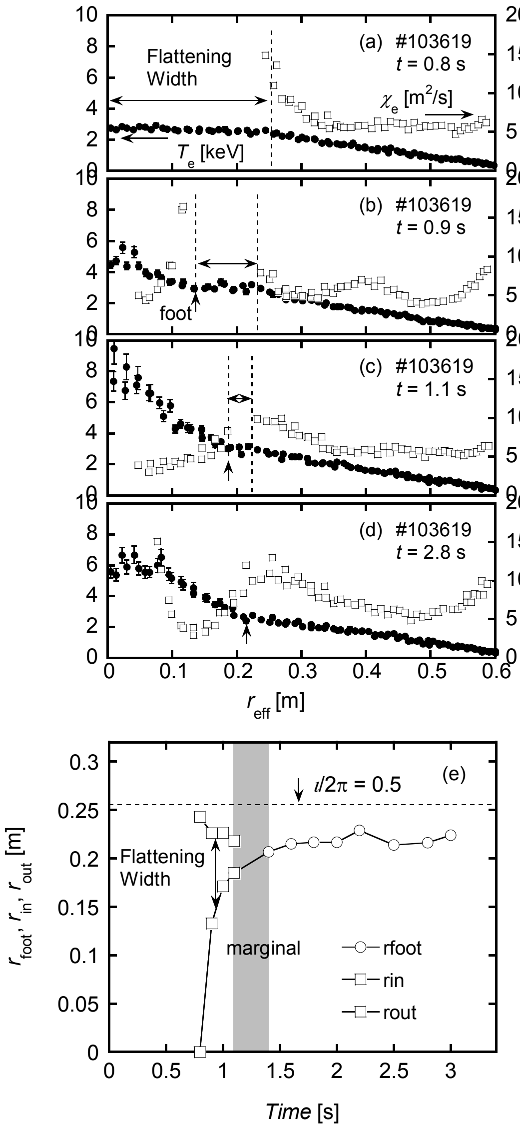

Fig. 2. The time evolution of (a)-(d) T_e and χ_e profiles (e) r_{foot}, r_{in} and r_{out}