§9. Effects of Applied Resonant Helical-Field Perturbations on ETB Formation

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The local island divertor (LID) coils can generate helical field perturbations resonate with the rational surface of $\iota/2\pi=1$ near the edge in LHD [1]. The Poicare plot of field structure is shown in Fig.1 for the case that the LID field is applied to expand the m/n=1/1 magnetic island. In this magnetic configuration, ergodic layer exists outside the sizable m/n=1/1 magnetic island.

In a shot shown in Fig.2(a) where the line averaged electron density was ramped up by gas puffing, the L-H transition occurred at $<n_e>\sim 2\times10^{19}$ m^{-3} and $<\beta_{dia}>\sim 1.8\%$ [2,3]. In this shot, small LID field was applied to diminish m/n=1/1 magnetic island induced by small error field and the electron temperature profile did not have any obvious island structures near the edge. When strong LID field was applied to expand the size of m/n=1/1 magnetic island near the edge as shown in Fig.1, the transition was triggered at the lower electron density ($\sim 1.3\times10^{19}$ m^{-3})(Fig.2 (b)) [3]. The ETB was formed outside the island separatirix which slightly moves outward from the location calculated in the vacuum field due to finite beta effect, and extends in the ergodic layer, as shown in Fig.2(c). In this case, formation of modest electron temperature pedestal may be caused by the transition at lower electron density which was realized by application of strong field perturbations. However, the sizable m/n=1/1 island degrades core plasma confinement and leads to the decline of $<\beta_{dia}>$. A reason why the transition is triggered at lower $<n_e>$ in the case with a sizable m/n=1/1 island is not clarified yet. This is left for an interesting and important issue in future. It should be noted that if the $<n_e>$ dependence in the ITER scaling law of power threshold is taken into account, the threshold power normalized $<n_e>^{0.64}$ increases slightly with the increase in the LID coil current.

As seen from Fig.2(b), ELM like activities in Hα emission were clearly suppressed by application of large LID field. Moreover, amplitude of coherent m/n=2/3 edge MHD mode was also suppressed. The cause of suppression of ELM like Hα fluctuations and m/n=2/3 edge MHD mode may be caused by slight reduction of the pressure gradient at the rational surface $\iota/2\pi=3/2$ due to expansion of sizable magnetic island. In this experimental campaign, steep pressure gradient region moves outward, but it does not excite other edge MHD modes such as m/n=1/2 of which rational surface resides in further outer edge.

[1] A. Komori et al., Proc. 15th IAEA Conf. Plasma Phys. Control. Fusion Res. (seville, 1994) Vol.2 (Vienna, IAEA)p773.
[2] K. Toi, S. Ohdachi, S. Yamamoto et al., Phys. Plasmas **12**, 020701 1 (2005)
[3] K. Toi, F. Watanabe, S. Ohdachi et al., Plasma Phys. Control. Fusion **48**, A295 (2006).
[4] J.A. Snipes and ITPA Conf. and H-mode Threshold Database working Group, 19th IAEA Fusion Energy Conf., Lyon, 2002, paper No. CT/P-04

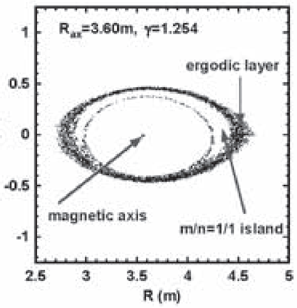

Fig.1 Poincare plot of the field topology in the case that the LID field is applied to expand m/n=1/1 magnetic island near the edge.

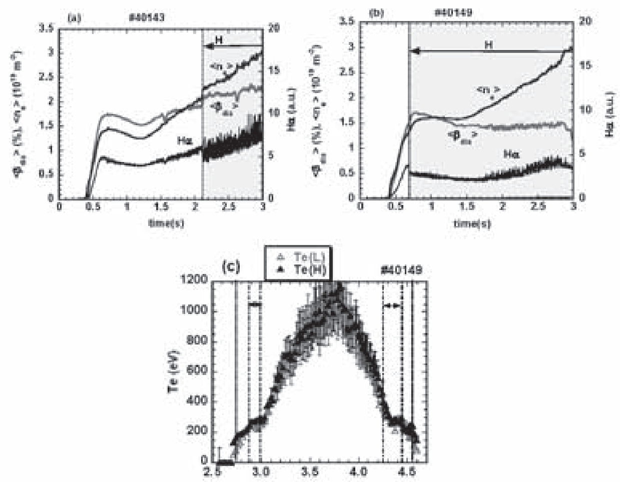

Fig.2(a) Time evolution of Hα emission, $<\beta_{dia}>$ and line averaged electron density $<n_e>$ in an ETB plasma where m/n=1/1 magnetic island is diminished with small LID field. (b) Time evolution of an ETB plasma in the case that the island was expanded by excessive LID field. (c) Radial profiles of electron temperature just before (t=0.669 s) and after (t=0.769s) the transition in the shot shown in Fig. (b). Dotted vertical lines indicate LCFS in the vacuum field. Two zones defined with a horizontal arrow and two vertical dash-and-dot lines correspond to the expanded m/n=1/1 island region generated in the vacuum field.