§10. Experiments on *m*/*n*=2/1 Magnetic Island Dynamics Based on ECCD

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The phenomenon of island healing/growth in helical plasmas can have profound consequences on plasma transport and stability. Since local plasma current densities can be externally driven and are expected to affect the island dynamics, experiments with electron cyclotron resonance current drive (ECCD) have been performed in the LHD heliotron in configurations with O-point and X-point of the $\iota/2\pi = 1/2$ resonance surface in the ECCD deposition zone. Low density plasmas (~ $1\times10^{19}m^{-3}$) were tried in order to increase ECCD for the given EC-power. Figure 1 shows the Poincaré plot of the magnetic configuration with *m*/*n*=2/1 magnetic island. The ECCD position on the O/X-point can be controlled by changing the polarity of the resonant magnetic perturbation (RMP) field even though the ECCD position does not change in the laboratory frame. The behavior of the magnetic island can be detected by the magnetic diagnostics. Shown in Fig. 2 are the waveforms of the *m* = 2 amplitude of the plasma response field $\Delta\Phi^r_{m=2}$ and the phase difference between the RMP field and the plasma response field $\Delta\theta_{m=2}$. Here, the behavior of the magnetic island can be distinguished by the $\Delta\theta_{m=2}$: the island grows (is healed) when $\Delta\theta_{m=2} = 0$ ($\Delta\theta_{m=2} = \pm\ \pi/2$). In case of the X-point ECCD (Fig.2 left), the $\Delta\theta_{m=2}$ approaches to 0.5 πrad (Fig. 2 (b)), which means that the magnetic island tends to be healed. On the other hand, in case of the O-point ECCD (Fig. 2 right), the $\Delta\theta_{m=2}$ rather closer to 0 than 0.5 πrad (Fig. 2 (d)), which means that the magnetic island tends to be enlarged. From the viewpoint of the plasma response field, it is found that the O-point ECCD makes the magnetic island enlarge while X-point ECCD tends to heal it. In spite of the significant difference of the $\Delta\theta_{m=2}$ that can be seen, the electron temperature profiles do not show the remarkable difference. If the electron temperature profile reflects the magnetic configuration structure, the local flattening should appear when the configuration has the magnetic island. In Fig. 3, however, both profiles are similar. The change of T_e gradient at *R*~3.4 m and ~4.0 m can be seen. In particular, it seems that the magnetic island is not completely healed in X-point ECCD case (Fig. 3 (a)). If the phase difference is strictly $\Delta\theta_{m=2}$ =0.5 πrad, the magnetic island should be healed completely. When a statistical analysis is done on a large number of Thomson Scattering profiles, more tendency to T_e-profile flattening is found in O-point ECCD cases as expected from Fig. 2 and as suggested in Fig. 3 around *R*~3.4 m. As mentioned, the result is not conclusive and the significance of these findings is presently under study. This work is supported by NIFS/NINS under the project of Formation of International Scientific Base and Network.

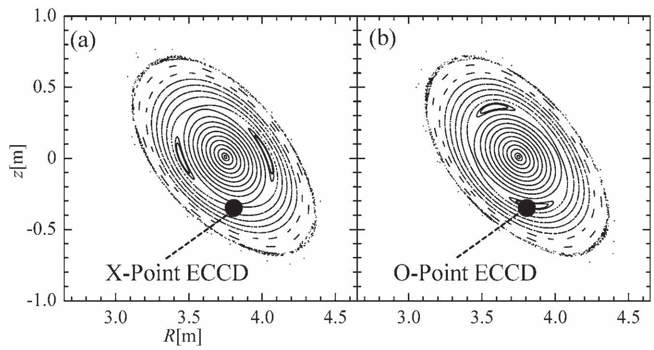

Fig. 1 Poincaré plot of magnetic configuration with *m*/*n*=2/1 magnetic island. Black dot indicates the position of ECCD at (a) X-point and (b) O-point.

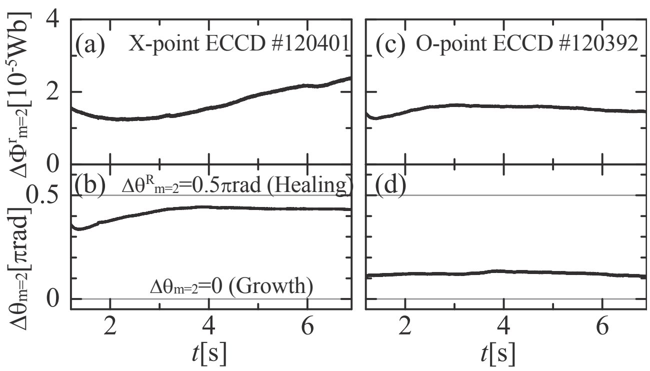

Fig.2 Time evolution of (a, c) plasma response field with *m*/*n*=2/1 mode and (b, d) phase difference between RMP and plasma response field. (Left) X-point ECCD. (Right) O-point ECCD

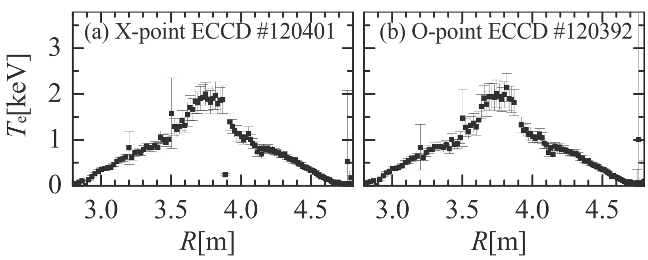

Fig.3 Major radial profile of electron temperature. (a) X-point ECCD. (b) O-point ECCD