§30. Observation of Magnetic Island Dynamics in Nonsteady State

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The dynamics of magnetic island in the Large Helical Device (LHD) have been studied [1] in which the static magnetic island with *m*/*n* = 1/1 (here, *m*/*n* is the poloidal/toroidal Fourier mode number) is produced by the perturbation coils. In the steady state condition, the stability of the magnetic island depends on beta (β) and collisionality (ν_h*) as shown in Fig.1. The gray (white) circles mean the growth (healing) of the magnetic island. The bold gray solid line indicates the boundary between the growth and healing. The magnetic island shows the transient behavior around the boundary. To observe the detail of this non-linearity at the transition around the boundary, we produce the plasma with temporally transition of the island from the stabilizing (healing) to the destabilizing (growth). The typical two discharges are also plotted in Fig.1, in which those discharges (shown by squares and triangles) trace the same trajectories and go into the growth regime at critical beta β_c = 0.31[%]. During the transition, these plasmas are in the ion-root [2] which implies that there is a possibility both of stabilizing and destabilizing[3]. The time evolution of the $\Delta\theta_{m=1}$ and plasma parameters (β and ν_h*) are shown in Fig.2, in which the time (*t*) is defined as *t* = 0 when the β starts to decrease. The $\Delta\theta_{m=1}$ means the differential poloidal angle of the X-point of the magnetic island from that of the seed island and

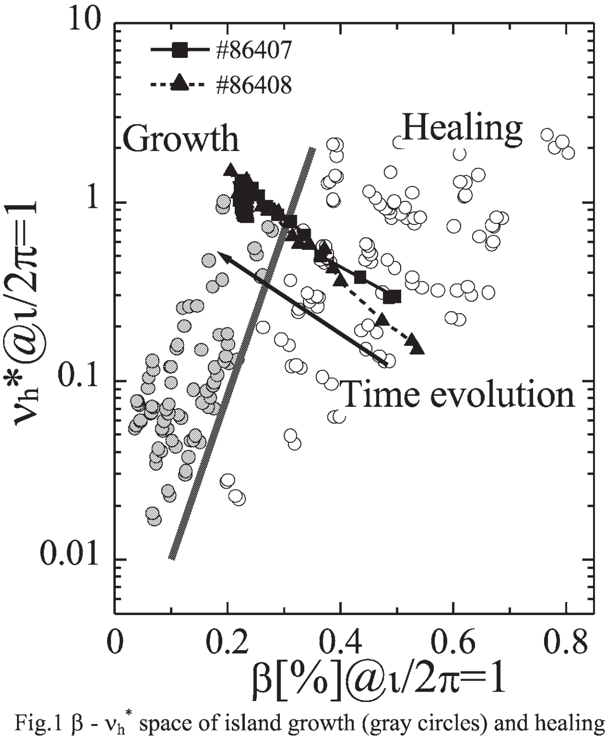

Fig.1 β - ν_h^* space of island growth (gray circles) and healing (white circles) in steady-state. Trajectories of single shots are plotted by squares and triangles which go into growth regime at critical beta β_c = 0.31[%].

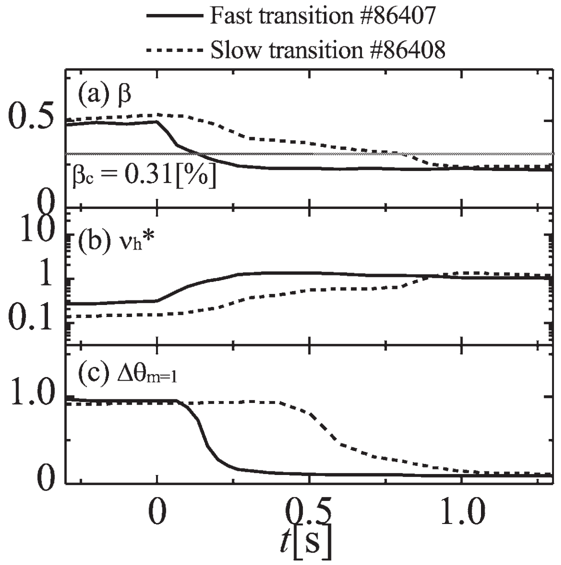

Fig.2 Wave form of (a)T_e, (b)n_e and (c)$\Delta\theta_{m=1}$. Critical beta β_c is indicated by gray solid line in (a).

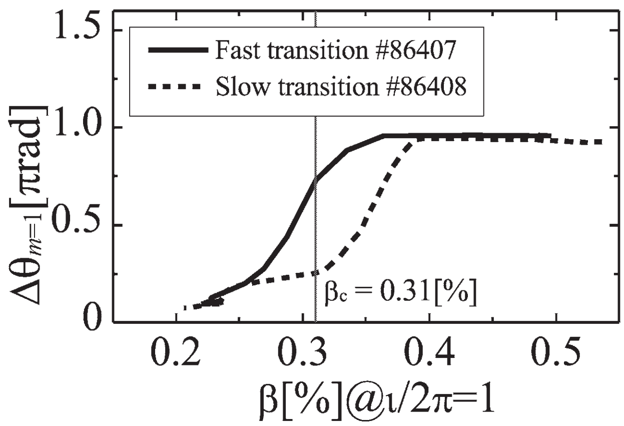

Fig.3 β dependence of $\Delta\theta_{m=1}$. Critical beta β_c is indicated by gray solid line.

is estimated by the perturbed magnetic field structure originating from plasma its self. The $\Delta\theta_{m=1}$ goes half around poloidally in the electron-diamagnetic direction when the magnetic island is destabilized. For the solid line discharge, the $\Delta\theta_{m=1}$ and β changes at the same time while the $\Delta\theta_{m=1}$ remains during the β goes down at *t* = 0 to 0.4[s] for the dashed line one. Figure 3 shows the β dependence of the $\Delta\theta_{m=1}$, in which the critical beta is β_c = 0.31[%]. When the beta goes down, which is consistent to the time evolution, the $\Delta\theta_{m=1}$ changes around β_c for the "Fast transition" discharge (solid line). On the other hand, the $\Delta\theta_{m=1}$ changes at β = 0.3 to 0.4[%] ($\beta > \beta_c$) for the "Slow transition" discharge (dashed line). It has reported that the hysteresis of the magnetic island behavior has been observed in the LHD [4]. These observations imply that the transition behavior depends on not only the plasma parameters but also the time, which remain unnoticed in the steady state.

1) Y. Narushima, et al., NF **48** (2008) 075010
2) M. Yokoyama, et al., NF **42** (2002) 143
3) K. Itoh, et al., PoP **12** (2005) 072512
4) K. Ida, et al. , Phys. Rev. Lett., **100**, (2008) 045003