§26. Measurement of Magnetic Field Accompanied by Varying Magnetic Island in LHD

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Magnetic islands sometimes play important roles in toroidal plasma confinement from a viewpoint of MHD stability. For example, a seed island triggers a NTM in Tokamaks. On the other hand, it is possible that the island flattens the pressure profile at the resonant surface, contributing to the stabilization of the pressure-driven resonant MHD mode. In the LHD experiment, a seed island width changes larger or smaller during the plasma discharge[1,2], which is accompanied by the change of the perturbed magnetic field $\tilde{b}_1$. Because the magnetic diagnostics measuring the profile of the field ($\tilde{b}_1$) originating from the island motion is an effective method to obtain its structure, a toroidal array of magnetic flux loops is set at the outer ports in LHD as shown in Fig.1. Each flux loop has total cross-sections of about NS=12m^2, which leads to enough electromotive force voltage to detect the slow (few 100ms) and small (few Gauss) change of the magnetic field. The shapes of the flux loops at the toroidal angles ϕ=-162, -54, 54, 90, and 162 are planar (solid line in Fig.1) that we use here. The detected magnetic fluxes Φ^{R}s are normalized by the total cross section NS to $\tilde{b}_1$ whose component is in the major radial direction. The 4-pairs of perturbation coils placed at the top and bottom of LHD around $\phi=\pm 90$[deg] (bold line in Fig.1) produce a seed island with the structure of m/n=1/1 mode. The typical discharge with a seed island ($w_{\rm vac}\simeq$150[mm]) is shown in Fig2 in which the island width w grows from 150 to 200[mm] as shown in Fig.2(d). The magnetic field $\tilde{b}_1$ varies with time (Fig.2 (e)). The $\tilde{b}_1$ profiles are shown in Fig.3. At t=0.48[s], ($w=w_{\rm vac}$) the flux loops detect zero field $\tilde{b}_1$. At t=1.73[s], (w=200[mm]) the finite field $\tilde{b}_1$ appears. The fitting curve $\tilde{b}_1(\phi) = \tilde{b}_1^{n=1}\cos(\phi - \phi_{n=1})$ well expresses the $\tilde{b}_1$ profile which has the dominant toroidal mode n=1. Here, $\tilde{b}_1^{n=1}$ and $\phi_{n=1}$ are the maximum amplitude and its toroidal angle respectively. We carry out the magnetic diagnostics of non-rotational magnetic island in LHD. It is confirmed that the finite magnetic field appears with a change of the magnetic island width.

References
1) K.Narihara et al., Phys. Rev. Lett.87,135002 (2001)
2) N.Ohyabu et al., Phys. Rev. Lett. 88,055005 (2002)

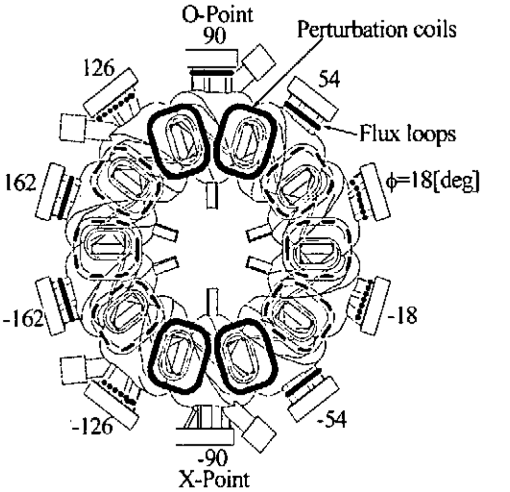

Fig. 1: Top view of the vacuum vessel of LHD.

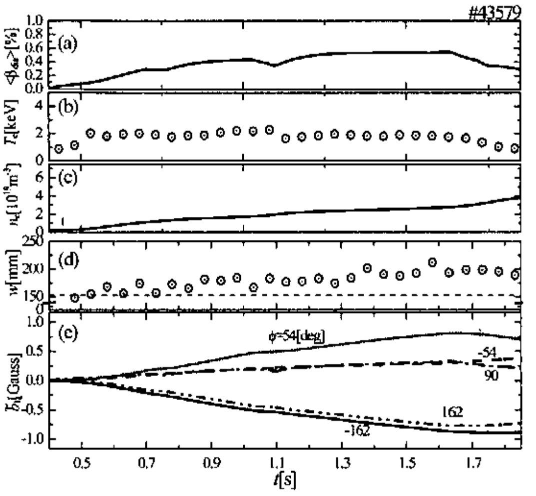

Fig. 2: Time evolution of (a)averaged beta $<\beta>_{\rm dia}$ (b)electron temperature at centre T_e (c)averaged electron density n_e (d)island width w (e)perturbed field $\tilde{b}_1$

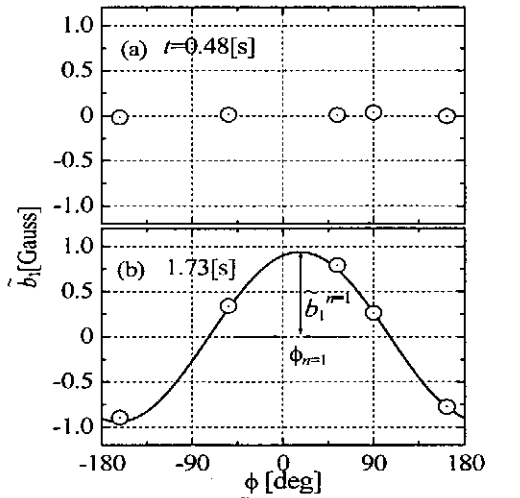

Fig. 3: Toroidal profile of $\tilde{b}_1$ at (a)t=0.48[s], (b)1.73[s]