§9. Development of Magnetic Island Detector by Magnetics Measurement

Okada, H., Yamamoto, S. (IAE, Kyoto Univ.),
Sakakibara, S., Suzuki, Y.

In magnetically confined plasmas, a magnetic island, which disturbs the structure of nested magnetic flux surface, would lead to the degradation of plasma confinement. The m=2/n=1 and m=1/n=1 (n and m are toroidal and poloidal mode number) magnetic islands generated by miss alignment of helical coil winding are observed in LHD plasmas due to the profile measurement of electron temperature. High performance plasmas are archived by the shrinkage of low-n magnetic islands using the external perturbation coil named as LID coil. However, the physics of magnetic islands and its effect on plasma confinement have little understanding. The aim of our study is to develop the magnetic island detector using flux loops having high spatial and time resolution and to clarify the physics and effect of magnetic island in helical plasmas. We are developing an island detector in Heliotron J, which is smaller and more flexible device than LHD. In the first fiscal year of this study, we developed the numerical scheme combined with HINT2 [1] MHD equilibrium solver and JDIA external magnetic field solver [2] to optimize the location and shape of magnetics, and the resonant magnetic perturbation (RMP) coil to control m=2/n=1 magnetic island.

In order to check the effectiveness of the RPM coil, we experimentally investigate magnetic field produced by RPM coil using toroidal array of magnetic coils, as shown in figure 1. In figure 1, the solid line and closed circle respectively denote calculated and observed magnetic field strength, and the color indicates the RPM coil current. The magnetic field strength of experimental result agrees well with that of calculated one. This result indicates that the perturbation magnetic field with m=2/n=1 is successfully produced in vacuum chamber of Heliotron J. Moreover, the penetration time of magnetic filed τ~5 (ms) enough in comparison with Heliotron J plasma discharge duration τ > 200 (ms).

We applied the RPM to plasma experiment. In this experiment, we set the magnetic configuration having rational surface of m=2/n=1, which is rotational transform is 0.5. Figure 2 shows the time evolution of the observed magnetic field obtained from the toroidal array of magnetic probe where the color indicates the RPM coil current. It seems that amplitude of observed magnetic field depends on the RPM coil current. It is difficult to investigate island width and location from this experimental result because the "existing" toroidal array of magnetic coil is not optimized for our study. We designed new saddle coil type magnetics using the numerical scheme mentioned above and RPM experiment result. Optimized new magnetics consists of two coil sets locating a different toroidal section in order to measure the asymmetry of magnetic field by Pfirsch-Schlüter current caused by existence of m=2/n=1 magnetic island. Figure 3 shows the new saddle coils and the poloidal cross section of Heliotron J. We plan to measure the magnetic island obtained using the new saddle coil in next experimental campaign.

1) Y. Suzuki, et al., Nucl. Fusion, **46**, L19 (2006).
2) T. Yamaguchi, et al., Plasma Fusion Res., **1**, 011-1 (2006).

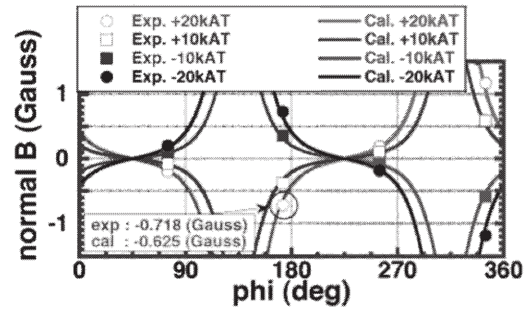

Fig. 1. Calculated and observed magnetic field of RP]

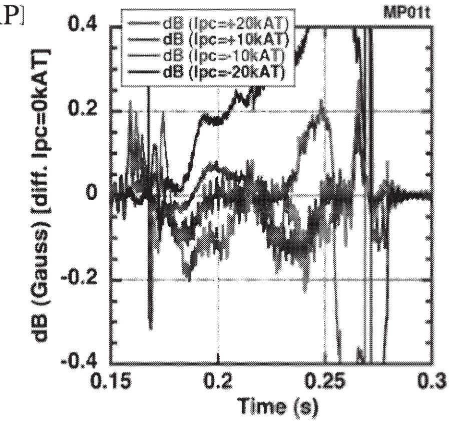

Fig. 2. Time evolution of observed magnetic field in plasma experiment with RPM

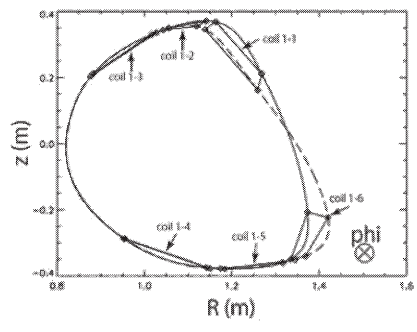

Fig. 3. Optimized saddle coil.