§5. Development of Magnetic Island Detector by Magnetics Measurement

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In magnetically confined plasmas, a magnetic island, which interrupts the structure of nested magnetic flux surface, would lead to the degradation of plasma confinement. 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 magnetic measurement (magnetics) having high spatial and time resolution and to clarify the physics and effect of magnetic island in helical plasmas. We study in Heliotron J, which is smaller and more flexible device than LHD. The resonant magnetic perturbation (RPM) coil, which locates at outside vacuum chamber and can control m=2/n=1 magnetic island have been installed and checked on its performance. The detector system which consists of 12 saddle loop coils has been installed in the chamber of Helitoron J. One set of the detectors consists of six soils. They are installed in a cross section at the same toroidal angle. The other set is installed in the toroidally opppoite cross section. Since the confinement field is changed slightly during a discharge, the signal of the one coil is subtracted from the signal of the toroidally opposite coil in order to generate net signal which corresponds to the field component from the generated island.

For the first of all, the signal in the configuration without a rational surface (no island) is observed. Since Pfirsh-Schlüter current is distributed equally at the symmetrical toroidal positions in this case, there is no net signals estimated using a pair of coils. For the configuration with the normalized rotational transform of 0.5, the magnetic flux surface is calculated with the RPM coil current as shown in Fig. 1. Upper two figures correspond to the magnetic surfaces at the two saddle coil sections in the case of the RPM coil current of 20 kA. The lower corresponds to the magnetic surfaces of -20 kA case. By changing RPM current direction, the poloidal position of the island can be changed by $\pi/2$,

The experimental condition is as follows; 70 GHz, ECH (~0.3 MW) and NBI (~0.6 MW) heating plasma, line-averaged density, $2\times10^{19}\ \mathrm{m}^{-3}$. The RPM coil current is changed shot by shot as shown in Fig. 2. The left column shows the diamagnetic signals, which is almost same for the change of the RPM coil current. In the right column, the signals from one pair of coils are presented, which correspond to the asymmetric component of the Pfirsh-Schlüter current. The signals

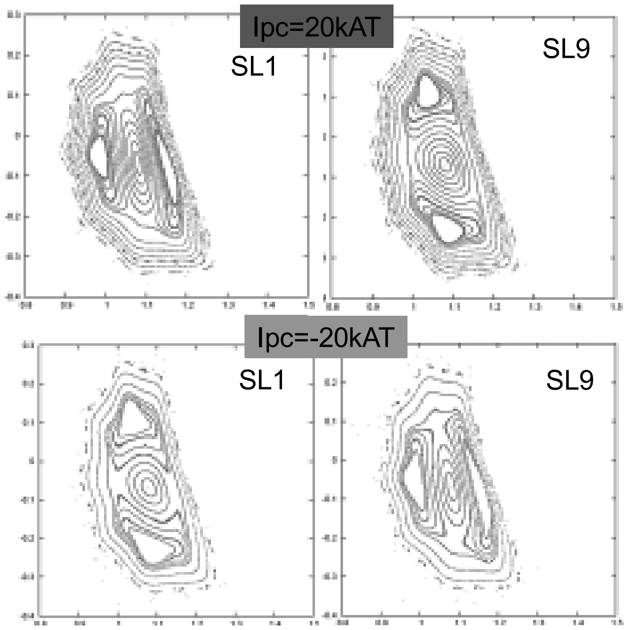

Fig. 1 The magnetic flux surface at the positions (SL1 and SL9) of the saddle loop coils when the RPM coil is activated in the configuration of $\iota/2\pi$=0.5. The RPM coil currents are 20kAT (top) and -20kAT (bottom).

changes gradually with the RPM coil currents. This means the effectiveness of this detector system of the island. It is noted that there is a signal without RPM

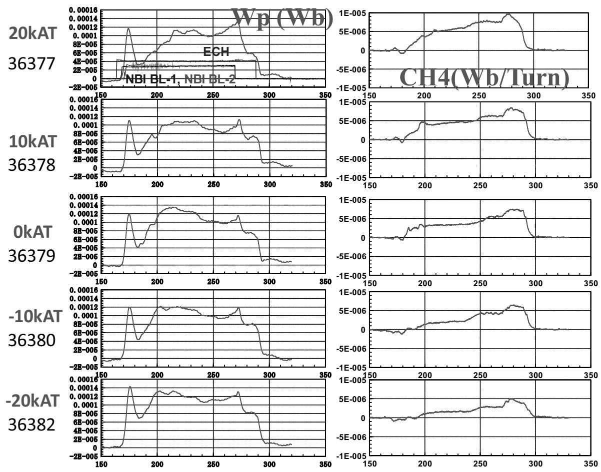

Fig. 2 Diamagnetic signal (left) , saddle loop coil signal(right). The results correspond to the cases for the RPM coil current of 20 kAT, 10 kAT, 0 kAT, -10 kAT, -20 kAT, respectively.

current. It is possible that there exists a island instead of no RPM coil current.

1) S. Yamamoto, et al., "Development of magnetic island detector by magnetic measurement in Helical plasmas", 19th International Toki Conference, Dec. 8-11, Toki (2009) P1-16.