§15. Study of Shielding Effect of Resonant Magnetic Perturbation and the Interaction with MHD Instabilities

Okamoto, M. (Ishikawa National College of Technology),
Ohno, N., Hayashi, Y. (Nagoya Univ.),
Sakakibara, S.

In several toroidal plasma confinement devices, the plasma response with resonant magnetic perturbation (RMP) fields is researched. In ITER, RMP coils are expected to reduce the heat load to the diverter plates during ELM[1]. In addition, the stabilization of resistive wall mode (RWM) by using feedback control coils was reported[2]. Therefore, it is one of important issues to investigate the penetration and propagation processes of RMP fields into the plasma in order to understand interaction between RMP fields and magnetic confinement plasmas. In this study, the profile of radial magnetic fluctuation is measured in HYBTOK-II tokamak plasma with m/n= 2/1 RMP fields, where m and n are the polodial and toroidal mode numbers.

We installed the RMP coils to HYBTOK-II tokamak like Figure 1. The coils are put outside the vacuum vessel (stainless-steel with 2 mm thickness) and the coil turn is 10. The coils are powered by two bipolar power supplies with a phase difference of 90° in order to rotate the RMP fields to the toroidal direction. In this experiment, the RMP frequency is set to 1 kHz and coil current is 150 A/turn. The radial magnetic field fluctuation profile in the plasma can be measured by a magnetic probe array, which is composed of 10 small magnetic pick-up coils and inserted vertically from the bottom of the vacuum vessel at the section with the RMP coils. In addition, another magnetic probe array is also installed to measure poloidal component of magnetic field for evaluation of q profile.

Figure 2 shows measurement results of the magnetic probe arrays. From Fig. 2(c), the resonant surface of q = 2 exists at r = 8 cm. In the vacuum, the amplitude of RMP field at edge region is 5 Gauss and is decreased toward the core region. In the plasma without RMP field, radial magnetic field fluctuation is larger than RMP field in the vacuum because magnetic island is grown by tearing mode. In the plasma with RMP field, it is found that the magnetic fluctuation is increased by RMP and is changed by the rotational direction of RMP. The cross-correlation function $C(\tau)$ and coefficient $R(\tau)$ between the RMP coil current I_{RMP} and radial magnetic field B_r fluctuation are estimated by following equations,

$$C_{I_{RMP}B_r}(\tau) = \lim_{T\to\infty}\frac{1}{T}\int_{-T/2}^{T/2} I_{RMP}(t)B_r(t+\tau)dt$$

$$R_{I_{RMP}B_r}(\tau) = \frac{C_{I_{RMP}B_r}(\tau)}{C_{I_{RMP}}(0)C_{B_r}(0)} = \frac{C_{I_{RMP}B_r}(\tau)}{\sqrt{\overline{I_{RMP}^2}}\sqrt{\overline{B_r^2}}}$$

where T is time range for the correlation. From Fig. 2(b), the profile of $R(\tau)$ is almost flat and the cross-correlation between tow signals is very high in the vacuum. In the plasma, the profile and value of R(t) slightly change compared to the vacuum. Therefore, it is considered that RMP field is penetrated in the core region.

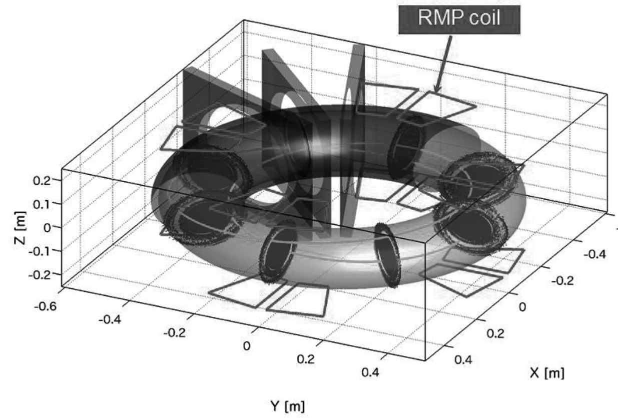

Fig. 1 m/n= 2/1 RMP coils structure in HYBTOK-II.

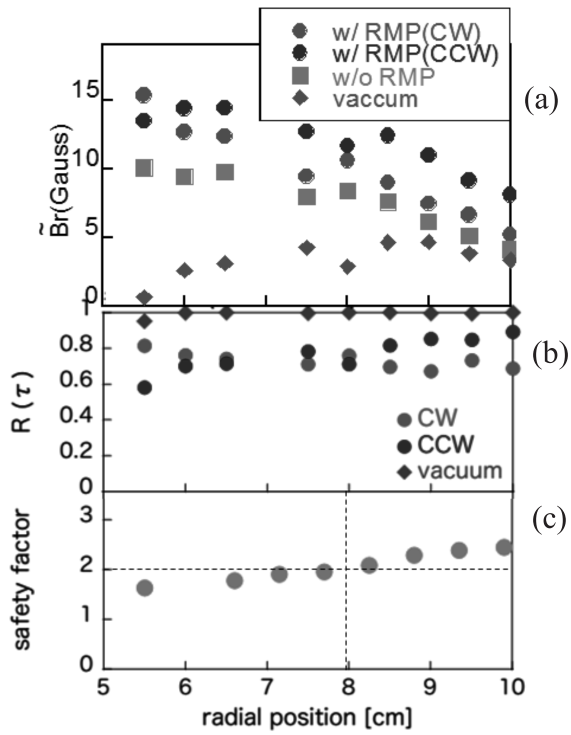

Fig. 2. Profile of the radial magnetic fluctuation amplitude (a), the peak amplitude of cross-correlation coefficient function (b) and safety factor (c).

1) Schmitz O., et al.: J. Nucl. Mater. **438** (2013) S194..
2) Okabayashi M., et al.: Nucl. Fusion **45** (2005) 1715.