## §6. Optimization of the Coil Current Configuration of Local Island Divertor Coils for Minimizing Magnetic Islands Induced by the Error Field

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Magnetic surface measurement in high magnetic fields showed the presence of the poloidal mode number $m$=1 and 2 magnetic islands induced by an error field.1) We successfully reduced the magnetic islands using twenty Local Island Divertor (LID) coils as previously reported in Ref.1. The currents of the LID coils are controlled by three power supplies A, B1 and B2. The LID coils installed in 4.5 and 9.5 ports are connected to the power supply A, and the coils installed in 3.5, 5.5, 8.5 and 10.5 ports are connected to the power supply B1. Other coils are connected to the power supply B2.

It has been expected that the plasma confinement property in helical systems is improved by minimizing the magnetic islands. Therefore, further reduction of the islands can improve the confinement property in LHD plasmas; we tried to find the optimized configuration of LID coil currents for minimizing the islands. For evaluating the error field quantitatively, we introduced the parameter $R$. This parameter ($R$) quantify the stochasticity of the magnetic field lines in the vicinity of a fixed point at which a magnetic field line returns to an initial position after a number of toroidal circulation.2) In torus magnetic field line configurations, an O or X-point corresponds to a fixed point. We calculated the parameter ($R$) around the O-points in the $m$=1 and 2 magnetic islands.

For confirming the usefulness of this parameter ($R$), we investigated the dependence on the horizontal displacement of the central axis of an upper OV coil. It is numerically found that the width of the islands and the error field increase with the displacement. Figure 1 shows the parameters ($R$) of the $m$=1 and $m$=2 magnetic islands. Two $R$ are calculated at the two O-points in the $m$=2 island. The value of the parameter ($R$) increases linearly with the displacement, guaranteeing the usefulness of the parameter $R$ for evaluating the error field.

We estimated the error field which can explain the experimental results of the magnetic surface measurement. Using the error field and the parameter $R$, we searched the optimized LID coil current configuration in which the summation of the three parameters ($R_{m=1}$, $R_{m=2}^{(1)}$ and $R_{m=2}^{(2)}$) is minimized. For simplicity, we set the output current of the power supply A to be equivalent to that of the B1. Figure 2 (c) illustrates the contour plot of the summation as a function of the output current of the power supplies. The value of the summation is minimized in the case of $I_A$~ -40 kA and $I_{B2}$~ 18 kA. Figure 2 (b) shows the magnetic surfaces in the optimized LID coil current configuration calculated by a magnetic field analysis code (HSD).3) The islands are significantly reduced compared to those in a non-optimized configuration shown in Fig. 2 (a).

Finally, we have discovered the optimized LID coil current configuration for minimizing the magnetic islands. We may find a further optimized configuration of LID coil currents by changing the combination of the LID coils and the power supplies.

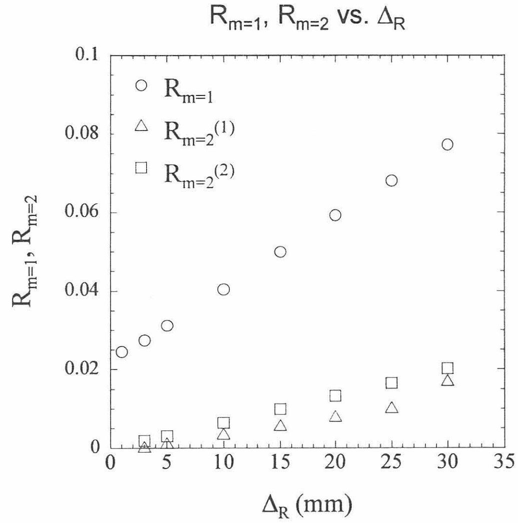


Fig.1. Dependence of the parameter ($R$) of the $m$=1 and 2 magnetic islands on the horizontal displacement of the central axis of an upper OV coil.

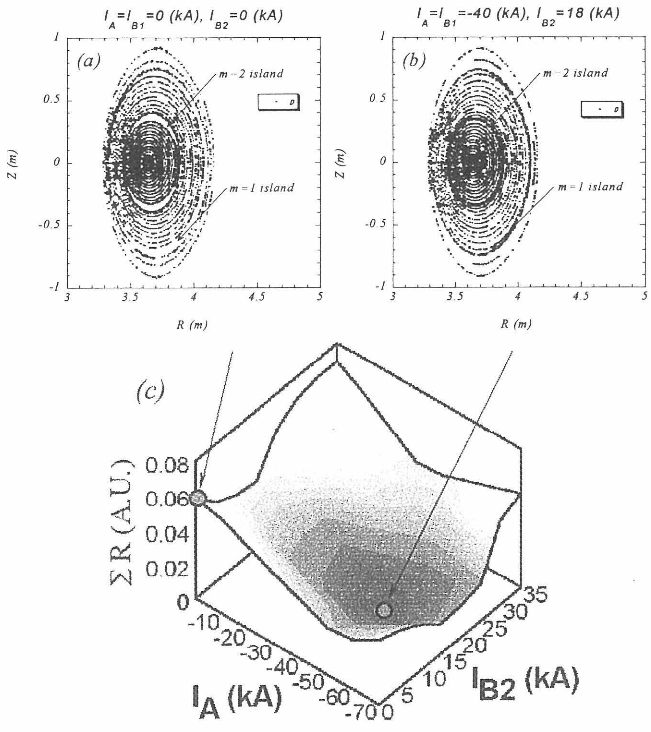


Fig.2. Contour plot of the summation of the parameter ($R$) as a function of the output currents of the power supply A and B2.


Reference

1) Fujiwara, M. et al., Proc.26th EPS Conf. on Contr. Fus. and Plasma Phys. (1999).
2) Green, J. M., J. Math. Phys. 9, (1968) 760.
3) Yamazaki, K. et al., Fusion Eng. and Des. 20, (1993) 79.