23Pa45

準軸対称ステラレータ CFQS の平衡制御の検討
Equilibrium control of quasi-axisymmetric stellarator CFQS

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A quasi-axisymmetric stellarator CFQS is under construction in Chengdu, China by a joint project (NSJP) of NIFS and Southwest Jiaotong University (SWJTU) [1,2]. The device is optimized with 16 modular coils to generate a QA configuration with low shear and weak magnetic well. It is designed to allow the physical properties of the magnetic surface to be changed by adding other control coils. Taking advantage of this feature, we plan to experimentally investigate the effects of rotational transform and the characteristics of high-beta and divertor configurations. In this presentation, we will explain the relationship between the control coil and the magnetic surface.

Fig 1 shows the configuration of the control coil. The control coil consists of 4 types of 16 modular coils (MC), 2 types of 4 poloidal coils (PFC), and 3 types of 12 toroidal coils (TFC). They will be controlled by a separate power supply for each type, a total of 9 power supplies. A TFC is a simple coil that winds a cable around a vacuum vessel. It takes a long time to cool down with natural air cooling, so it is necessary to limit the time of energization for one shot to reduce the temperature rise.

Plasma equilibrium control is planned to be performed mainly by the PFC due to engineering constraints of the TFC. Fig 2 shows the relation between the PFC current and the magnetic surface, where (0) is the value on the magnetic axis and (a) is the value on the last closed flux surface. The vacuum magnetic surface is calculated for about 100 combinations of IV and OV currents, and contour lines of the rotational transform and the average major radius are plotted in a figure. From the figure, it can be seen that the rotational transform and the major radius can be controlled independently. Since the magnetic field of the magnetic axis is almost inversely proportional to the major radius, the constant major radius condition is the same as the constant magnetic field condition.

In Fig 2, Iota(0) < 0.4 and Iota(a) > 0.33 (Area with white background) is a region where large magnetic islands cannot be formed, and the metal limiter configuration is formed as shown in Fig 3 (S),(A) and (B). Experiments are planned primarily in this area. As shown in Fig 3(C), large islands may be created in the plasma with Iota(a) < 0.33 or Iota (0) > 0.4. By controlling the rotation transform, we can create the magnetic island near the plasma surface as shown in Fig 3 (L1) and (L2), which is called bundle divertor. The divertor configuration with toroidal mode number of 2 and poloidal mode number 7 or 6 will be created.

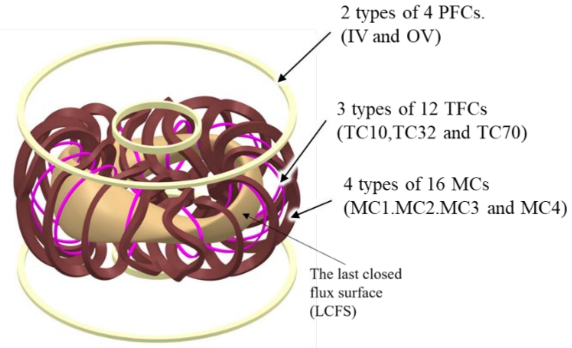

Fig 1 Coil system and magnetic surface

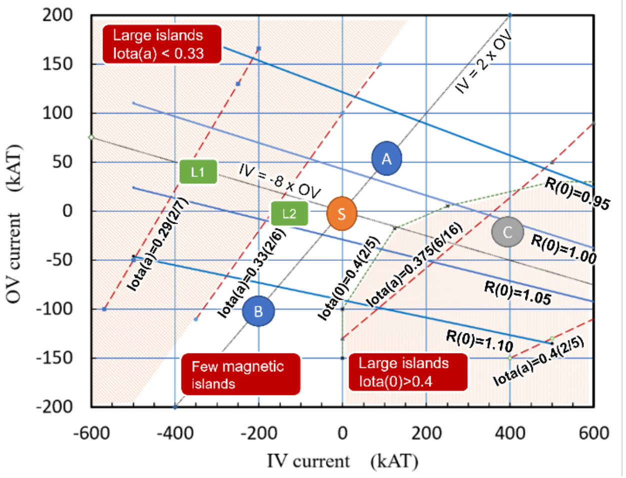

Fig 2 Magnetic surface control by PFC

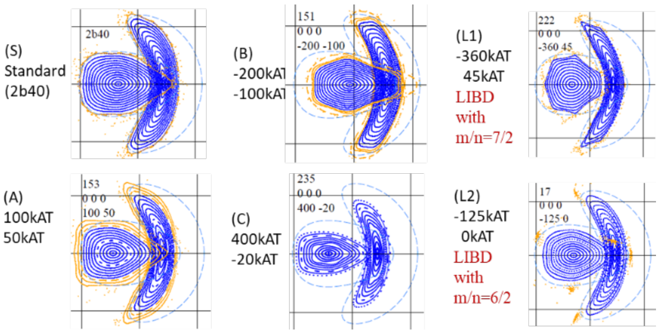

Fig 3 Example of the magnetic surfaces

[1] M. Isobe *et al*., Plasma Fusion Res. **14** (2019) 3402074.
[2] S. Kinoshita *et al*., Plasma Fusion Res. **14** (2019) 3405097