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準軸対称ステラレータＣＦＱＳにおける磁気面計測のための磁場配位の検討

Examination of the magnetic field configuration for measuring magnetic surfaces in the CFQS quasi-axisymmetric stellarator

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The quasi-axisymmetric stellarator CFQS is being constructed under the international joint project of the National Institute for Fusion Science (NIFS) and the Southwest Jiaotong University (SWJTU) in China. The magnetic coils in CFQS consist of modular coils (MCs), poloidal field coils (PFCs), and toroidal field coils (TFCs). After the construction, magnetic surface measurement using a fluorescent method is planned in a low toroidal magnetic field of 0.1 Tesla, in which an electron beam is launched along a magnetic field line from a movable electron gun. A poloidal cross-section of the magnetic surfaces is observed as luminescent spots on a mesh installed at a toroidal position. The distribution of the spots is detected with high-sensitive cameras, which provides the poloidal cross-section of the magnetic surfaces. It has been found that the magnetic structures in the standard magnetic configuration are not significantly affected by the error magnetic fields caused by the displacement of the MCs. While this property is advantageous for maintaining magnetic surfaces, it can prevent the detection of the error fields.

A special magnetic configuration for the magnetic surface measurement is proposed, in which the rotational transform crosses 1/3 in the plasma confinement region by optimizing the electric current of the PFCs. In this configuration, the magnetic islands are formed, which shape is quite sensitive to the error fields. Figure 1 shows the calculations of the poloidal cross-section of the magnetic field lines when one MC is radially displaced by 0, +10, and +5 mm at the mesh position. The magnetic field lines are traced from the electron gun which position is vertically changed by 5 mm to calculate the radial profile of the magnetic surfaces. For no coil displacement, up-down symmetric magnetic islands are formed (figure 1 (a)). For a coil displacement of +10 mm, asymmetric magnetic islands are produced (figure 1 (b)), which can be identified by careful measurements of the magnetic field lines at the island edge. For a small coil displacement of + 5 mm, the up-down asymmetry of the magnetic islands is not obvious, which can be difficult to be identified by the measurement. A method to detect the error fields due to the small coil displacement will be presented in this annual meeting.

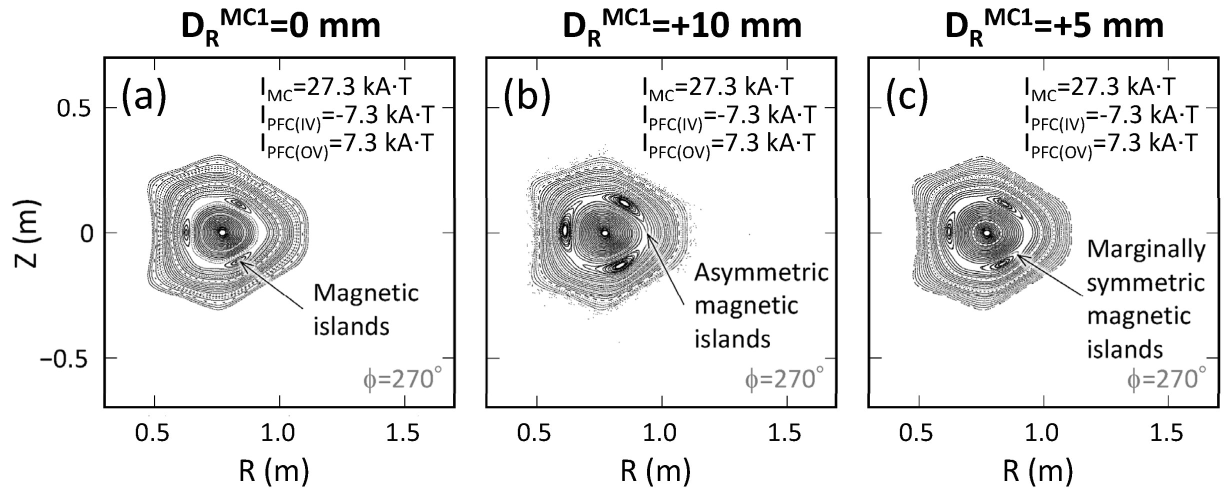

Figure 1: The calculations of the poloidal cross-section of the magnetic field lines for no radial displacement of one MC (a), a radial displacement of +10 mm (b), and a displacement of + 5mm (c).