

Design of auxiliary coils for divertor operation of quasi-axisymmetric stellarator CFQS

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An international joint project NSJP is in progress with the collaborations of National Institute for Fusion Science, Japan and Southwest Jiaotong University, China[1]. The target of this project is to construct a new advanced stellarator device CFQS in China and to make plasma confinement experiments based on the new concept of stellarator magnetic configuration with the quasi-axisymmetry[2]. In addition to the new concept of stellarator magnetic field configuration, this device will have a new divertor configuration with a clear separatrix structure between core and peripheral regions[3]. The magnetic structure of diverter legs between null points of the separatrix and the divertor target plates is also very unique compared to the existing stellarator designs.

This divertor configuration is, in principle, a kind of the island divertor and the islands at the edge region of the plasma are created by changing the rotational transform value at the edge so as to cross a low-order rational value, namely, 0.4. For this purpose, we designed auxiliary coils in addition to the main modular coils for the quasi-axisymmetric stellarator configuration. These auxiliary (toroidal) coils give simple toroidal field to modify the rotational transform.

In this paper, we discuss about the engineering design of these auxiliary toroidal field coils and discuss the variation of the divertor magnetic configuration (in vacuum) depending on currents in the toroidal field coils. Because the auxiliary toroidal field created by these coils is not purely axisymmetric, the additional ripple components are produced in addition to the quasi-axisymmetric field. The effects of these ripples on the neo-classical transport are also discussed.

[1] M. Isobe, et al., Plasma Fus. Res. 14 (2019) 3402074.

[2] A. Shimizu, et al., Plasma Fus. Res. 13 (2018) 3403123.

[3] S. Okamura, et. al., EPS conference 2018, paper P5.1034.