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Advanced shape design with F2EQ code in CFETR

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The Chinese Fusion Engineering Test Reactor (CFETR) is the next device in the roadmap for the realization of fusion energy in China, which aims to bridge the gaps between the fusion experiment ITER and the demonstration reactor (DEMO) [1]. CFETR will be operated in two phases: Steady-state operation and self-sufficiency with a modest fusion power of up to 200MW in Phase I, and DEMO validation with 1GW fusion power in Phase II[1]. A key challenge facing high-power steady-state operations and self-sufficiency is to maintain a fusion plasma with adequate performance while preventing damage to the vessel walls, especially divertors. Except the plasma detachment from a divertor target methods, other solutions that optimize the magnetic field topology in the divertor region have been proposed to reduce the power loads [2.3]. These advanced configurations will be a potential choice for CFETR.
In order to optimize the advanced plasma divertor shape, a new tool dubbed the F2EQ code was developed to fit CFETR shape design. F2EQ is a MATLAB toolbox with a series of scripts and functions, which can be used to solve the fixed-boundary and free-boundary plasma equilibrium problems. It provides the flexibility to set multiple plasma configuration, especially the advanced diverted configuration, like snowflake-plus. Starting from a conventional single null configuration, second order null constraint and multiple first order null constraint on X-points was enforced to obtain the desired advanced plasma shape. In order to satisfy the different concepts and ideals in concept design phase, multiple divertor coils inside or outside the vessel with optimized currents are considered. It is easy to switch any coil on or off with any desired plasma equilibrium in different shape and other parameters, like and . Based on a series calculation with F2EQ code, the optimized plasma equilibrium with two in-vessel divertor coils with modest current in snowflake-plus configuration gives factor 4 flux expansion then the used case with two external DC coils [4].

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Eligible for student paper award?

No

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