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トカマク原型炉における先進ダイバータ磁場配位とコイル配置の検討

Investigation of Advanced Divertor Magnetic Configurations and Coil Arrangements for Demo Tokamak Reactor

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Handling of an extreme exhausted power to the divertor is the most important issue for the fusion reactor design. Recently, *advanced divertor* was proposed to reduce the target heat load by increasing connection length ($L_{//}$) and magnetic flux expansion (f_{exp}) in the divertor. In this presentation, magnetic configuration and divertor geometry of super-X divertor (SXD) and snowflake divertor (SFD) for a Demo reactor were investigated.

Equilibrium calculation code, TOSCA, was developed for SXD design by introducing two parameters, i.e. radial location of the SX-null (R_{SX}), and magnetic flux ratio of the SX-null ($f_{SX} = [\Psi_{SX} - \Psi_{ax}]/[\Psi_s - \Psi_{ax}]$). Figure 1(a) shows an example, where the outer divertor is modified from the conventional divertor to SXD: R_{SX} = 6 m, f_{SX} = 0.95, and the outer target location is extended outboard from a reference conventional divertor design (shown by the green line). Due to a restriction of the poloidal field coil (PFC) current in the superconducting coils, the main divertor coils are installed inside TFC (inter-TFC). SXD has an advantage to increase $L_{//}$, which is increased to 54 m (1.4 times) compared to comparable size of the conventional long-leg divertor (41 m) as shown in Fig. 2. $L_{//}$ is further increased to 77 m (1.8 times) with increasing f_{SX} to 0.99. On the other hand, increases in f_{exp} at the target and the wet area are relatively small (<1.4 times).

SFD equilibrium was produced by arranging locations of three divertor coils appropriate for the same triangularity plasma shaping as shown in Fig. 1(b). Modification of the PFC current distribution including central solenoid (CS) coils is required. Shallow divertor with a wide opening is appropriate for the magnetic configuration. $L_{//}$ is largely increased near the SF null, thus the compact design is expected. On the other hand, larger PFC currents are required, and control scenario for the SF-null and the high plasma shaping should be developed. SF-pulse and SF-minus configurations are also investigated.

For the Demo advanced divertors, engineering issues such as neutron and thermal shielding for superconducting PFC, structure strength of the PFC feedthrough design, and divertor cassette design are increased. Advantages and issues of the Demo advanced divertor are summarized.

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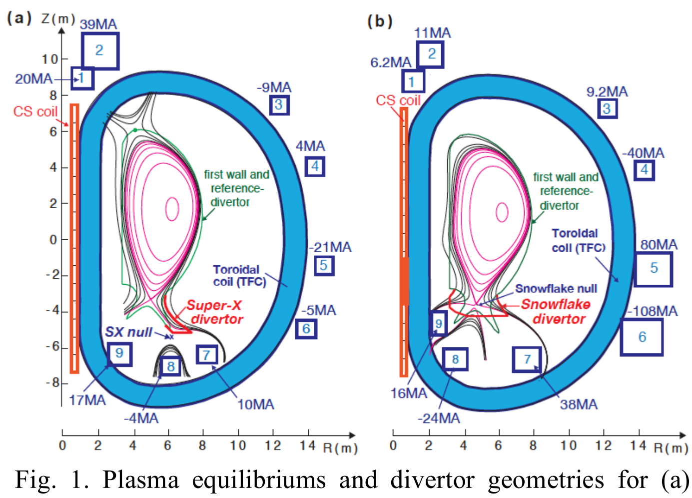

Fig. 1. Plasma equilibriums and divertor geometries for (a) super-X divertor (SXD) with R_{SX} = 6.0 m, f_{SX} = 0.95, and (b) snowflake divertor (SFD). Locations of three divertor coils are arranged inside TFC. PFC current distributions are described.

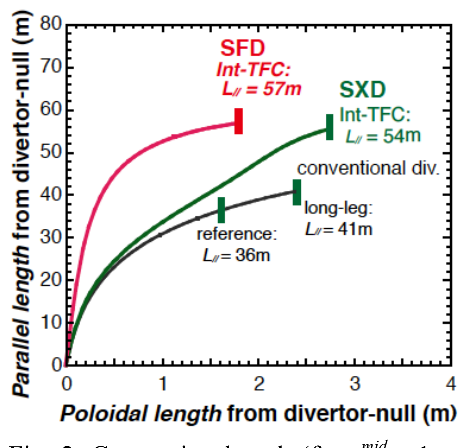

Fig. 2. Connection length (for r^{mid} = 1 mm) from the divertor null to the outer target as a function of poloidal length for the conventional, SX and SF divertors.