Maintenance Approaches for ARIES-CS Power Core

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The configuration and maintenance approaches for a power plant based on a compact stellarator are very different than for one based a tokamak. Compared to a tokamak, the replacement of the power core in a stellarator is considerably more challenging because the access to the blanket is strongly limited by the shape of the modular coils. The engineering effort during the first phase of the ARIES-CS study has focused on scoping out different compact stellarator design configurations and maintenance schemes to determine the key issues and better understand the parametric design windows and the engineering constraints. Three possible maintenance approaches for the ARIES-CS compact stellarator have been considered during this scoping phase:

1. Field-period based replacement including the disassembly of the coil system.
2. Modular replacement approach through maintenance ports arranged between each adjacent pair of modular coils.
3. Modular replacement through a small number of designated maintenance ports using articulated booms.

Individually, these different schemes impose different constraints on the physics configuration of the compact stellarator; for example, the field-period based replacement scheme tends to be more suited for configurations with three (e.g. NCSX) or more field periods and the modular replacement approach through maintenance ports arranged between each adjacent pair of modular coils requires adequate port space between the coils and tends to be better suited for a two-field period configuration. However, as a whole, these choices of maintenance schemes provide a sufficiently broad range of possibilities to accommodate the physics optimization on the machine configuration and size (including the number of coils and number of field periods).

The key issues associated with the three maintenance approaches have been identified and addressed, and the layout of coil system, coil supporting structure, cryostats, vacuum vessel and maintenance ports have been conceptually defined. These are summarized in this paper. Blanket concepts compatible with the three maintenance approaches have been investigated, and will be reported in separate papers. State-of-art CAD tools have been used in this study to verify clearances for blanket movements during maintenance operation and to determine the size of the blanket modules based on the available space for module removal.