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Development and applications of Magnets module for SYCOMORE CEA system code

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In the framework of prospective activities for a demonstration power plant, DEMO will be the next step for fusion energy following ITER tokamak. Some of the key design top-level questions can be addressed using macroscopic system-level codes. Those system codes aim to model the whole plant with all its subsystems and identify the impact of their interactions on the design choices. The SYCOMORE code is a modular system code developed to address key questions relevant to tokamak fusion reactor design by giving a global view in technology and physic domains. Among all components, SYCOMORE provides a representation of the magnet system, which is of importance regarding some factor of merits, e.g. fusion power or cost. SYCOMORE is ultimately coupled with an optimizer, scanning a high number of operation configurations and ranking them along selected merits. This scanning requires fast computation for each scanned point, so the magnets modelling must meet a trade-off between simplicity and accuracy. In this paper we describe the way Toroidal Field (TF), Central Solenoid (CS) and Poloidal Field (PF) systems modelling was chosen taking into consideration the driving design criteria used in usual magnets design method (temperature margin, copper maximum temperature during quench, mechanical resilience in stainless steel structural parts, etc⋯). The specificities of the reduced magnet representation chosen approach will be shown with the benchmarking of the simplified model of the two main systems (TF and CS) applied on ITER and DEMO reactors configurations and compared with output of more sophisticated design processes (detailed analyses, finite elements analyses etc ⋯), together with a discussion on the limits of this approach. PF system implementation being in early stage the principles will be exposed. Parametric explorations of DEMO operation domains will be reported along different conceptual choices related to the magnets (e.g. superconductor material and performances, structure resilience limits⋯) or on system requirements (e.g. burn duration, net electric power⋯) and the impact on the magnet system main design features will be exposed. In the other way round, an overall discussion will also be led on the machine performances sensitivity to baseline choices for magnet systems. Finally some general recommendations will tentatively be provided.

Eligible for student paper award?

No

Author: ZANI, Louis (CEA-IRFM)

Co-authors: Dr REUX, Cédric (CEA-IRFM); Dr ARTAUD, Jean-François (CEA-IRFM); Dr DUCHATEAU, Jean-Luc (CEA-IRFM); Mr HERTOUT, Patrick (CEA-IRFM); Mr BOUTRY, Arthur (CEA-IRFM); Mr SAID, Julien (CEA-IRFM); Mr DI GALLO, Luc (CEA-IRFM)

Presenter: ZANI, Louis (CEA-IRFM)

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