SYCOMORE: a modular system code for DEMO reactor design

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Demonstration power plants are the next step for fusion energy following ITER. Key design questions remain before a design is to be chosen. Some of these questions can be addressed by simulation through system codes.

The SYCOMORE code is a modular system code developed to address the key questions relevant for tokamak fusion reactor design. It aims at modeling all elements of a fusion reactor with software modules integrated in a global calculation workflow and to provide a global view of the plant, from technological elements to physics-oriented issues. This ranges from magnets, structures, tritium breeding blankets, power flow balance to heating systems, core plasma and divertor physics. Modules are connected through the European Integrated Modelling (ITM) infrastructure in a graphical workflow. Thus modules can be taken out of the workflow and be replaced by more sophisticated codes provided inputs and outputs are identical. The use of a single code with interconnected modules enforces the global consistency of the design with respect to the physical and technological assumptions or the radial build. SYCOMORE is also coupled to an optimization framework to be able to specify designs using figures of merit (cost of electricity, major radius,...) and constraints on some of the design parameters.

The present version of SYCOMORE contains the following modules: plasma physics (based on the Helios 0-D code), divertor physics, tritium breeding blankets, TF and PF magnets, power flow, thermodynamics. The models used in these elements will be presented in this article.

Preliminary tests with SYCOMORE have started. It shows a global consistency with respect to usual assumptions on reactor design and radial build. Preliminary benchmark with present ITER design shows qualitative agreement. Other benchmark activities with other system codes (JAPAN, UK) have started with SYCOMORE. It shows the overall consistency of the models chosen and the interaction between them.

New additions to the SYCOMORE module library are under way, as well as refinement for existing modules including divertor physics, magnets and power flow calculation, with the aim at providing a set of consistent design points for DEMO in the near future.