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P3.218 MIRA: a high fidelity system/design code for advanced fusion reactor system analysis

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Fusion systems codes are essential computational tools aimed to simulate the physics and the engineering features of a fusion power station. The main objective of a system code is to find one (or more) reactor configurations, which simultaneously comply with the physics operational limits, the engineering constraints and the net electric output requirements.
As such simulation tools need to scope many design solutions over a large parameter phase space, they rely on rather basic physics and engineering models (mostly at zero or one-dimensional level) and on a relatively large number of input specifications. With reference to the ongoing EU-DEMO conceptual design workflow, the systems codes are interfaced to the detailed transport codes and engineering platforms, which operate in much larger time scales. As a consequence, a design feedback to the system codes is unlikely to take place fast and efficiently.
In light of such a challenging frame of reference, a new high fidelity fusion system/design code, referred to as Modular Integrated Reactor Analysis (MIRA), has been recently developed at Karlsruhe Institute of Technology. MIRA incorporates, into a unique computing environment, a mathematic algorithm for the utmost tokamak fusion problems, including: (i) 2D free-boundary magnetic equilibrium, (ii) neutron, photon and charged particles poloidal wall loadings, (iii) radial neutron/gamma transport in core reactor components and (iv) full 3D engineering characterization of the toroidal and poloidal field coils.
To elucidate the capabilities of the full package, this work comprises a glance on the architecture and functional logics of MIRA, together with an applicative example on the EU-DEMO 2015 baseline. Accordingly, the major deviations from basic zero-dimensional system analysis approach and the implications on the reactor design are illustrated. Finally, a sensitivity study on the reactor build, intended as the radial and vertical thickness of the key core reactor components, is also presented.

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