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Toward a better coupling scheme for the co-simulation with 1-d conductor models in thermal contact to the FEM meshes of solid structure

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Since dependable conductor models can be based on 1-D thermal-hydraulic problems, coupled simulation scheme has established itself as a practical approach to evaluate the design of large-scale superconducting magnets. By integrating well-established numerical models around the core of superconducting magnet, i.e. the conductors, such a concept of coupled solution, known as co-simulation technique, has been used in common for most of present platforms, such as SuperMagnet, 4C and TACTICS. Thus, their coupled operations are simply driven by controlling the computational steps of each simulator so as to wait for the update of interface values from the counterpart. Against such a background of the basic architecture, some applications have raised the issue of numerical stability, as identified in terms of implicit solution scheme at the interfaces, and a new approach based on the interface Jacobian was brought to recover the loss of implicit condition in the particular case of hydraulic volumes connected to the conductor model. As an extension of this approach, the interface problem in thermal contact is explored by representing the logical essence of a quench simulation in a CICC, which has emerged as a technical issue of THEA-Cast3M coupling in the TACTICS model. Drawing each numerical step with tangible objects written in FreeFEM++, a partial matrix evaluation is proposed as a core of computational steps on the interface Jacobian. The actual coupling scheme then takes shape in detail as a numerical interface along the conductor model coupled to the 2-D or 3-D model of thermal meshes, intended to be applied to THEA-Cast3M coupling in TACTICS model, as well as to THEA-HEATER coupling in SuperMagnet model.

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