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A novel 1D - 3D coupled model for the thermal-hydraulic simulation of the gravity support of the Divertor Tokamak Test toroidal field coils

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The Divertor Tokamak Test (DTT) facility is a fully superconducting tokamak currently being built in the ENEA Frascati laboratories (Italy) to study the power exhaust issue in EU DEMO perspective.
The massive Toroidal Field (TF) magnets require a robust Gravity Support (GS) to sustain their weight. The GS is a stainless steel column in thermal contact at the bottom to the cryostat base at ambient temperature and at the top to the TF magnet casing at 4.5K. A parasitic static heat load is therefore conducted through it to the TF coil casing and must be carefully evaluated to assess the magnet performance by means of detailed thermal-hydraulic (TH) analyses.
To reduce the parasitic heat load to the magnet, the GS will be actively cooled by Thermal Anchors (TAs), where part of the heat is extracted by helium flowing in pipes suitably attached to or drilled in the GS. While the GS can be easily modelled, from the thermal point of view, as a 1D object, the TA requires a more detailed 3D analysis, exploiting computational-fluid-dynamic (CFD) tools.
In this work the effectiveness of this cooling solution is assessed coupling a 1D thermal model solving the heat conduction in the GS solids with a local 3D CFD TH model of the TA. This minimizes the computational cost, still describing with high fidelity the cooling of the TA.
The novel 1D+3D TH model is based on python programming language and on the commercial CFD software STAR-CCM+, coupled by a Functional Mock-up Interface.

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