MODELING OF W7-X SUPERCONDUCTING COIL COOL-DOWN

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The Wendelstein 7-X (W7-X) stellarator is under construction at IPP Greifswald, Germany [1, 2]. The magnetic confinement of the plasma during the operation of W7-X will be based on 50 non-planar coils (NPCs); additionally, 20 planar coils (PLCs) surround the NPCs, allowing field adjustment and modification of the magnetic configuration. All W7-X coils are superconducting and based on NbTi.

The cold test of all W7-X coils has been carried out in the CEA Saclay cryomagnetic test facility, requiring the cool-down from room temperature to the operating temperature T_{op} ~ 4.5 K provided by the supercritical helium coolant.

At any time during the cool-down transient, temperature differences between any two points of the coil are requested to stay below 40 K, in order to minimize thermo-mechanical stress. In the actual cold test of a coil, the temperature difference between coolant inlet and outlet is monitored, as well as three casing temperatures [3], but the limited nature of this measurement cannot fully guarantee that *any* two points of the coil satisfy that constraint.

In order to verify if this can be an issue, we apply here the recently developed 4C thermal-hydraulic code [4] to the analysis of the cool-down of an NPC. 4C implements a model of the cryogenic circuit feeding the coil, while the compressible 1D supercritical helium flow in the winding and in the case cooling channels is coupled with 2D heat conduction over suitable cross sections of the solid structures, resulting in a quasi-3D model.

The results of 4C are compared with previous simplified analysis [2].

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