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Validation of the cryogenic circuit module in the 4C code against SHe closed loop data

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The Cryogenic Circuit Conductor and Coil (4C) code has been recently developed for the simulation of thermal-hydraulic transients in the ITER magnets and cryogenic circuit [1]. The code validation was started against different types of transients ranging from (fast) safety discharge [2] to (slow) cool-down [3], but it did not include, so far, the cryogenic circuit module.
Very recently, the Cryogenics Modelica library has been developed by the authors as the basis for the 4C cryogenic circuit module, and the 4C results have been compared with those of a publicly available demo of the Vincenta code, showing very good qualitative agreement [4].
In this paper we validate the newly developed cryogenic circuit module of 4C against data collected in the Helios SHe cooling loop, at CEA Grenoble, France [5]. The main components of the Helios loop are: a cold circulator; heat exchangers to a saturated helium bath equipped with a resistive heater; pipes simulating the cooling channels of the ITER TF magnet casing and equipped with resistive heaters; control and bypass valves [6]. The computed evolution of temperature, pressure and mass flow rate at different circuit locations will be compared with the measurements.

[1] L. Savoldi Richard, et al., “The 4C Code for the Cryogenic Circuit Conductor and Coil modeling in ITER”, Cryogenics 50 (2010) 167-176.
[2] R. Zanino, et al., “Validation of the 4C Thermal-Hydraulic Code against 25 kA Safety Discharge in the ITER Toroidal Field Model Coil (TFMC)”, to appear in IEEE Trans. Appl. Supercond. (2011).
[3] R. Bonifetto, et al., “Modeling of W7-X superconducting coil cool-down using the 4C code”, to appear in Fus.
Eng. Des. (2011).
[4] R. Bonifetto, et al., “Dynamic modeling of a SHe closed loop with the 4C code”, presented at Cryogenic Engineering Conference, Spokane (WA) USA, June 2011.
[5] R. Vallcorba, et al., “ITER cryogenic system validation tests at Helios facility”, presented at Cryogenic Engineering Conference, Spokane (WA) USA, June 2011.
[6] C. Hoa, et al., “Forced flow SHe in a closed heat transfer loop submitted to pulsed heat loads”, presented at
Cryogenic Engineering Conference, Spokane (WA) USA, June 2011.

Author: ZANINO, Roberto (Politecnico di Torino)

Co-authors: CASELLA, Francesco (Politecnico di Milano); SAVOLDI RICHARD, Laura (Politecnico di Torino); BONIFETTO, Roberto (Politecnico di Torino)

Presenter: ZANINO, Roberto (Politecnico di Torino)

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