

Dynamic simulation of the first cool down of the JT-60SA cryo-magnet system

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In framework of the Broader Approach research and development for fusion activities, involving Japan and Europe, the JT-60SA tokamak has been jointly constructed in Naka, Japan to support the operation of ITER and to study advanced plasma scenarios for future fusion power plants.

The integrated commissioning of the tokamak started mid 2020 with a Japanese and European team, composed of QST, F4E and Eurofusion. CEA, as member of Eurofusion consortium, has brought expertise and support in the operation of the cryo-magnetic system.

The JT-60SA superconducting magnet system is composed of 18 Toroidal Field coils, 4 Central Solenoid coil modules and 6 Equilibrium Field coils with a total mass of around 700 tons. The magnets and structures are cooled at 4.5 K by circulation of supercritical helium supplied by a powerful cryogenic system.

The cool-down from 300 K to 4.5 K took more than one month with limitation on the cool-down speed of the magnets, but also on the thermal gradients between the different coils and between coils and thermal shields surrounding coils. To avoid emissivity degradation of the Thermal Shield surfaces by condensing impurities, the Thermal Shields shall follow the magnet cool-down at a warmer temperatures.

Dynamic simulations were performed during the cool down to support the operation and to optimize the process and the magnet cool-down. The first cool-down of the JT-60SA magnet system is presented and compared with simulation results obtained with Simcryogenics models. Simcryogenics is the simulation library developed by CEA (Departement of Low Temperature Systems) on a Matlab/Simulink platform for modelling cryogenic processes. Dynamic simulation models had been developed for the JT-60SA integrated commissioning activities.

Keywords

JT-60SA, Commissioning, cool-down, cryogenic, magnets

Category

Tools to support commissioning and operation phases of superconducting magnet systems

Primary author: MICHEL, Frederic (CEA - Commissariat à l'énergie atomique et aux énergies alternatives)

Co-authors: HOA, Christine (CEA - Commissariat à l'énergie atomique et aux énergies alternatives); ZANI, Louis (CEA - Commissariat à l'énergie atomique et aux énergies alternatives); LOUZGUITI, Alexandre (CEA - Commissariat à l'énergie atomique et aux énergies alternatives); Mr WANNER, Manfred (F4E - Fusion For Energy); Mr HAMADA, kazuya (QST - National Institutes for Quantum and Radiological Science and Technology); Mr FUKUI, Kazuma (QST - National Institutes for Quantum and Radiological Science and Technology); Mr NASTUME, Kyohei (QST - National Institutes for Quantum and Radiological Science and Technology)

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