THERMO-HYDRAULIC BEHAVIOUR OF THE ITER TF SYSTEM DURING A QUENCH DEVELOPMENT

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The toroidal field (TF) system of the ITER tokamak comprises 18 Nb_3Sn superconducting coils. In each coil, 14 Cable In Conduit Conductors (CICC) are wound in 7 double-pancakes and carry a nominal current of 68 kA, which corresponds to an electromagnetic stored energy of about 40 GJ for the whole TF system. In order to ensure the safety of the magnets, a regular quench detection system is foreseen to be based on compensated voltage. In addition, a secondary quench detection could rely on signals of thermo-hydraulic nature.

As a matter of fact, the development of a quench in a CICC leads to significant variations of pressure and mass flow at the quenched pancake extremities and in the nearby external cryogenic loop. The TF system operating in DC mode, such a quench detection could be more adapted to the TF magnet than to the other ITER superconducting magnets, where transient phenomena in normal plasma operation can generate similar thermo-hydraulic signals.

Analyses of the quench development have thus been performed using the coupled GANDALF and FLOWER codes. This tool allows to simulate the thermo-hydraulic behaviour of one CICC with a model of the external cryogenic circuit.

The study has focused on the first seconds of the quench development, before the magnet fast discharge. As thermo-hydraulic features such as the quench propagation or the maximum pressure, for instance, are very dependent on the quench ignition characteristics, notably the location and the length of the initial quenched zone, several cases have been selected and simulated. Results are discussed in term of impact on the sensors located on the external cryogenic circuit, in view of providing alternative signals for the possible secondary quench detection of thermo-hydraulic nature.