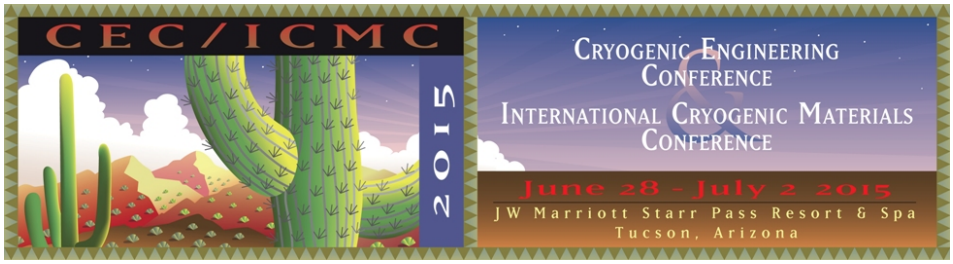

Contribution ID: **247** Type: **Contributed Oral Presentation**

Experimental characterization of the ITER TF structure cooling in HELIOS test facility

Wednesday, 1 July 2015 14:00 (15 minutes)

During ITER plasma operation, large thermal loads are generated in the stainless steel Toroidal Field (TF) coil casing. To avoid the increase of the TF conductor temperature in Cable in Conducts (CICC), cooling channels are implemented in between conductors and casings inner side, in particular in the plasma facing wall where the most stringent operating conditions in term of magnetic field, temperature and strain are located.
The cooling pipes in stainless steel are inserted in rectangular grooves filled with a charged resin, characterized by a good thermal conductivity.
To assess the efficiency of the cooling pipes and its thermal coupling with the charged resin, experimental characterizations have been performed. First of all, thermal resistance variation with respect to the temperature has been measured on material samples in a cryogenic bench. Further characterizations of the TF cooling scheme at cryogenic temperature have been performed on a dedicated mock-up in HELIOS test facility at CEA Grenoble. The mock up consists of a TF casing heated uniformly on its surface, a cooling channel implemented in the grooved filled with the charged resin, the filler, the insulation, the radial plate and a CICC. Both the cooling pipe and the CICC are cooled by supercritical helium flow at 4.4K and 5 bar. Temperature, pressure and mass flow are measured in different locations to investigate the repartition of the heat flux in both cooling pipe and CICC. Stationary as well as transient operating modes have been tested to assess the thermal efficiency of the case cooling design. The knowledge of this heat flux repartition will help refining the thermal hydraulic models in order to be more realistic in the analyses of the plasma disruption for example. The experimental tests are presented and the results are discussed and analyzed.

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Session Classification: C3OrF - Superconducting Magnets Cryogenic Systems II

Track Classification: CEC-06 - Superconducting Magnet Systems