Assessment of the performance of a 20 kA REBCO current lead

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Most of the large fusion devices like W7-X, JT-60SA and ITER use or will use High Temperature Superconductor (HTS) current leads (CL). In all cases the HTS material Bi-2223 embedded in a AgAu matrix is used. In the meantime, laboratories worldwide are investigating the design of a high current HTS CL composed of REBCO. The Karlsruhe Institute of Technology (KIT) has developed a 20 kA HTS current lead based on the JT-60SA CL design but replacing the Bi-2223 tapes by brass-stabilized REBCO tapes, poloidally distributing 24 REBCO stacks on a stainless steel support. The REBCO CL has been recently tested in the CuLTKa facility at KIT to investigate the steady state and transient performance in comparison to the Bi-2223 CL and to demonstrate the applicability of REBCO in CL for future devices.

The thermal-hydraulic CURLEAD code developed at KIT, recently updated in a collaboration between KIT and Politecnico di Torino and validated in both steady state and transient (pulsed) operation, was applied predictively, i.e. before the tests were performed, to support the test strategy of the REBCO CL. For instance, the prediction of the optimal HX mass flow rate to get to the desired target temperature was used to define the set point for the steady state tests both with and without current, while transient simulations were used to define the number of current pulses needed to reach periodic operation conditions for given current waveforms. A preliminary comparison between predictions and experimental results will also be presented, with particular reference to the GHe mass flow rate, temperature profile, and heat load at the cold end.

Primary author: ZAPPATORE, Andrea (Politecnico di Torino)

Co-authors: Dr HELLER, Reinhard (Karlsruhe Institute of Technology);   Prof. SAVOLDI, Laura (Politecnico di Torino);   Prof. ZANINO, Roberto (Politecnico di Torino)

Presenter: Dr HELLER, Reinhard (Karlsruhe Institute of Technology)

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