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Design and manufacturing of a KIT sample for a Quench Experiment on HTS Cable in Conduit Conductors

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Compared to low temperature superconductor (LTS) based fusion conductors, the use of high temperature superconductors (HTS) offers the possibility to increase the magnetic field strength in future fusion reactors, allowing higher flux swing or even more compact fusion reactors. REBCO, the most promising HTS material, is commercially available as coated conductor tape. Opposed to LTS wires, HTS "macro strands"are formed from HTS tapes. One such macro strand is the HTS CrossConductor (HTS CroCo), in which HTS and intercalated copper tapes of two different widths are combined to a cross-shaped stack embedded in a round solder matrix. Several of those macro strands are assembled to a HTS cable in conduit conductor (CICC).

Due to the fundamentally different geometry of HTS cables and the temperature dependency of material parameters, the electrical, thermal and mechanical properties differ between HTS and LTS CICC. This leads to a drastically different behavior during quench incidents, e.g. a slower normal zone propagation velocity. Through this, local hot spots can develop, which may not be detectable with common voltage-based quench detection devices. Therefore, investigations on the quench behavior of HTS CICC are of great interest for future HTS-based fusion magnet concepts.

This work describes the sample design, manufacturing procedure and pre-test results of the KIT sample for a Quench Experiment on HTS CICC. The Helium-cooled conductor consists of a copper stabilized HTS CroCo triplet, targeting for operation around 15 kA at 6 K in a magnetic background field of 11 T. It features multiple sensors to record voltage drop, as well as the coolant, jacket and strand temperatures. The purpose of this sample is to observe and understand quench propagation in HTS fusion conductors and to provide experimental data to qualify and improve thermal-hydraulic models of quench in HTS CICC for fusion applications.

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