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Design and analysis of HTS subsize-conductors for quench investigations towards future HTS fusion magnets

High Temperature Superconductors (HTS) are promising materials for future fusion magnets as they allow operating magnets at higher fields and/or higher temperatures and can offer significantly higher temperature margins compared to state-of-the-art low-temperature-superconductor solutions.
The high critical temperature results on the other hand in drastically different behavior of the superconductor in case of quench, e.g. a slower quench propagation velocity. Additionally, the promising HTS material Rare Earth Barium Copper Oxide (REBCO) is only available as flat tape in long length, and many high-field high-current cable concepts for fusion magnets base on the formation of so-called macro-strands, which are subsequently cabled to the final fusion conductor. Thus, the number and size of strands are additional quantities, which are significantly differing between LTS and HTS.
In this work, the design of HTS sub-size conductors for quench investigations will be presented. The samples are designed for a critical current of approx. 15 kA at operating conditions (T >= 4.5 K, B ~ 12 T) with forced flow supercritical Helium cooling. Such critical currents can be achieved for example by a triplet of HTS CroCo macro-strands. Different designs of such triplets will be discussed and analyzed by modeling with respect to the temperature and voltage evolution in the conductor in case of quench. The total stabilizer cross-section in the conductor, different thermal and electrical resistances between the individual macro-strands, helium and the jacket, and different layouts of the individual macro-strands will be considered. The software THEA will be used to calculate the quench performance of these designs under relevant operating conditions.

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