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Fri-Af-Po.02-07: The D0 prototype HTS conductor: Advancing Quench Detection for High-Temperature Superconducting Magnets for SupraFusion

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Suprafusion is a French exploratory program focusing on the development of high-temperature superconductors (HTS) to meet tomorrow's energy and societal challenges, using fusion needs as a vector for this research. In particular, the program aims to design, manufacture and test a large-scale HTS demonstrator magnet. To meet this goal, the program will follow a stepwise development plan with smaller mockups and prototypes to qualify the main demonstrator key technological bricks.
One important risk in the demonstrator development will be ensuring its safety against quench. Indeed, due to their slow normal zone propagation velocities, quench in HTS magnets are hard to detect and can totally damage a coil by the joule power deposited. To address this challenge, the first prototype (called D0) build in the framework of the SupraFusion program will aim to study the quench detection of HTS copper stabilized insulated coil.
The D0 prototype HTS conductor will be first wound as a one-layer spiral on a stainless steel mandrel with a bending radius of 60 mm. Then, the mandrel will be assembled with large copper pieces soldered to the conductor and ensuring a good electrical connection to the busbars. To ensure a homogeneous thermal map and allow parametric studies, the whole device will be actively cooled by forced flow supercritical helium. Finally, the D0 prototype coil will be inserted in a 9 T solenoid background field magnet called OPTIMIST. The design target is to operate this prototype and perform quench studies at 10 kA, 4.5 K under a field of nearly 10 T. Once under operation, this prototype will allow us to qualify several key aspects of our technology: the propagation quench velocity, the conductor hot spot temperature, the quench protection system sensitivity, the conductor critical current, etc. This poster will present the main design aspects of this D0 prototype including: magnetic field and load line margin computations, thermoelectric studies on the electrical connections, cooling strategy and thermal map, mechanical behavior under load, integration of the prototype in the MATTRCIS cold test facility.

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