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Review on progresses of the homemade 15T LTS solenoidal background magnets using for material testing facility and ultra-high magnet fabrication : Magnet Design, Manufacture and Testing

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High-field magnets play a crucial role in various research fields, contributing to the exploration of material properties under extreme conditions and advancing knowledge in biology, chemistry, geology, and more. The Comprehensive Research Facility for Fusion Technology (CRAFT) project aims to establish a comprehensive laboratory with functionalities related to superconducting materials, AC loss, structural materials, thermal hydraulic, non-destructive detection, and high voltage research. Within the CRAFT project, a key focus is the development of a background field superconducting magnet for the critical current test system of superconducting materials. The specifications include a central field strength not less than 19 T, a cold hole diameter larger than 70 mm, a test sample temperature range of 4.2-80 K, and an operational temperature control accuracy of up to 30 mK@10 K. The 19 T/70 mm magnet comprises two main parts: a 15 T/150 mm Nb3Sn+NbTi all-superconducting background field magnet and a 5 T/70 mm REBCO high-temperature superconducting insert magnet. Since 2019, the project has implemented a step-by-step plan to overcome challenges in low-temperature superconducting magnet technology for various apertures. The goal is to achieve key technology research for the 19 T/70 mm high and low temperature hybrid superconducting magnet by 2024.

The group involved in the project has successfully designed and prepared the 15 T/70 mm aperture low-temperature superconducting hybrid magnet in the initial stages. Significant experimental experience and key technologies have been accumulated. Currently, the focus is on the design and preparation of the 15 T/150 mm aperture low-temperature superconducting magnet.

This report primarily addresses scientific challenges and experimental verification methods encountered during the design and preparation of the 15 T low-temperature all-superconducting magnets. It also outlines the upcoming research plan of the ultra-high field magnets in our group.

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