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High Performance and Cost Effective Superconducting Accelerator Magnet R&D at IHEP

High-field superconducting accelerator magnets are pivotal components for next-generation high-energy accelerators such as the Super Proton-Proton Collider (SPPC) and the Future Circular Collider (FCC-hh). Enhancements in field strength are directly correlated with increases in center-of-mass energy, as well as reductions in size and cost of the accelerators. Initiated in 2014, the Institute of High Energy Physics (IHEP) has focused its research and development (R&D) endeavors on high-field superconducting magnet technology, addressing critical scientific and technical challenges. The goal is to achieve a dipole field exceeding 20 T (Tesla) by the 2030s, while maintaining a field quality of 10-4 and feasible costs for mass production. The R&D activities span three primary dimensions: 1. Advancement of high-performance, cost-effective High-Temperature Superconductors (HTS): The research is directed towards novel fabrication techniques and mechanisms that yield advanced HTS materials with superior overall performance suitable for high-field applications, particularly increasing the current-carrying capacity (Je) and mechanical properties of both Iron-Based Superconductors (IBS) and REBCO (Rare Earth Barium Copper Oxide) wires. 2. Development of compact, high-current HTS cables: Exploration of innovative structures and manufacturing processes for HTS superconducting cables suitable for using in accelerator magnets. 3. Exploration of novel technologies for high-field superconducting magnets: advanced coil structures, stress management strategies, and quench protection methods, particularly for the progression of HTS and high-field model magnets characterized by incremental improvements in field strength, field quality, and operational stability.

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