Project Summary/Abstract

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Project Title:	A Hybrid HTS/LTS Superconductor Design for High-Field Accelerator Magnets
Topic No: 33	Superconductor Technologies for Particle Accelerators
Subtopic: (b)	Superconducting Magnet Technology

Abstract:

Proposed designs for a Future Circular Collider (FCC) to collide protons with a center-of-mass energy of 100 TeV call for dipoles with fields up to 20 Tesla (T). This is significantly beyond the present technology and requires using High Temperature Superconductors (HTS). The recent Particle Physics Project Prioritization Panel (P5), organized by the U.S. Department of Energy (DOE), strongly supports the U.S. maintaining its leadership in superconducting magnet technology. This STTR proposes to design, build and test a proof-of-principle hybrid dipole that uses HTS in its highest-field regions and less-expensive low-temperature superconductors, Nb_3Sn and NbTi, where they suffice. During Phase I, a coil block with ReBCO tape with Kapton insulation was fabricated and tested, confirming that winding had no measurable degradation. A major concern in the magnets built with ReBCO is the large field errors associated with the conductor magnetization in the tape geometry. The major discovery during Phase I was finding a solution to reduce those errors considerably. Based on this and work performed under previous SBIR/STTRs and other programs, HTS coils will be designed and built in Phase II and then integrated with the existing Nb_3Sn common coil dipole. This provides a unique opportunity to test the concept in a proof-of-principle hybrid magnet with field approaching 15 T. A 20 T hybrid dipole design will also be developed with the goal of satisfying the requirements of accelerator magnets and reducing cost.

Commercial Applications and Other Benefits: Since the cost of HTS superconductors is high and likely to remain so, it is important to minimize HTS usage. Commercial spin-offs in the areas of energy technologies (SMES, wind turbines), medical accelerators, security screening, and motors or generators for direct-drive wind turbines can be enabled by this technology, just as the development of NMR and MRI magnets was enabled by magnet R&D for previous generations of high-energy-physics accelerators. The knowledge gained from this program will provide valuable feedback to the conductor manufacturers in their efforts to improve these conductors to better meet the needs of the magnet community.

Key words: High temperature superconductors, Accelerator magnets, HTS magnets

Summary for Members of Congress: To build upon the discovery of the Higgs boson by the Large Hadron Collider requires higher-field magnets feasible only with high-temperature superconductors (HTS). This STTR will design and build a proof-of-principle magnet to meet these high field requirements at minimum cost. The HTS magnet technology developed will be valuable for other areas of research, in medical devices, energy technology and national security.