Project Summary / Abstract

Company Name: Particle Beam Lasers, Inc.

Project Title: Overpass/Underpass coil design for high field dipoles

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Topic Number/Subtopic Letter: 33b

Abstract: We propose a "Proof-of-Principle" demonstration of an ~11 T Nb_3Sn dipole based on the novel overpass/underpass (also called cloverleaf) end design for high field block coil dipole magnets. Block coil dipole designs are appealing for their simplicity in the body of a magnet, but less so in the ends where, to clear the bore tube, cable in certain blocks must be lifted or bent in the hard direction to clear the beam tube. To avoid excessive strain, particularly for brittle conductor such as Nb_3Sn or HTS, this bend must be very gradual, making the ends very long and inefficient. The overpass/underpass end geometry keeps ends short without introducing excessive bending strain.

This Phase II proposal is built upon the considerable progress in Phase I, where we carried out magnetic, mechanical, and preliminary engineering designs of the overpass/underpass geometry, work that extended well beyond the conceptual design promised by the Phase I proposal. In addition, a practice coil with unreacted Nb_3Sn Rutherford cable also was wound.

Phase II proposes a proof-of-principle demonstration of this design for pole coils in a 2-in-1 common-coil dipole. Such a demonstration is possible within the budget of a Phase II SBIR, thanks to the unique design and capabilities of BNL's dipole DCC017, with its large, easily accessible open space in which new coils can be inserted and tested as an integral part of the magnet without any need for disassembly and reassembly.

The Phase II work plan includes further magnetic and mechanical design of this proof-of-principle dipole, which will be tested to reach ~11 T. Once the design is successfully demonstrated, the overpass/underpass end geometry is likely to be used in other block coil designs beyond just the common coil. CERN already is considering this design for their 20 T HTS magnet design, with Roebel cable. PBL has partnered with General Atomics (GA) for future industrialization and commercialization analysis of this design.

Commercial Applications and Other Benefits: The overpass/underpass design, if successfully demonstrated for block coil dipoles, will reduce both the stored energy and length of the magnet. This will improve performance in machines such as the Future Circular Collider (FCC), which offers a market of several billion dollars. The design can also be used for testing of the high current cables at high field for High Energy Physics (HEP) and Fusion Energy Sciences (FES) purposes.

Key words: Block coil dipoles, high field dipoles, common coil dipoles, Nb_3Sn dipole magnets.

Summary for members of Congress: The next generation "atom smashers" will require dipole magnets of very high magnetic field. This proposal will explore innovative block coil designs that can be used to make magnets shorter and more reliable.