Project Summary/Abstract

Company Name and Address: Particle Beam Lasers, Inc., 18925 Dearborn Street Northridge, CA 91324-2807
Principal Investigator: Ronald M. Scanlan
Project Title: Innovative Design of a High Current Density Nb_3Sn Outer Coil for a Muon Cooling Experiment
Topic No: 66 Advanced Concepts and Technology for High-Energy Accelerators
Subtopic: (b) Technology for Muon Colliders and Muon Beams

There is much interest within the accelerator physics community and DOE's Division of High Energy Physics for the development of a Muon Collider machine. A key challenge to realizing a Muon Collider is producing intense muon beams with small transverse emittances. For this project, we propose to explore a system which could deliver a muon beam with an emittance as low as 25 pi mm-mrad, sufficiently low to permit the operation of a high-luminosity Muon Collider. The approach taken in this proposal is to stage the final steps of the cooling process with an array of high-field solenoids culminating in a solenoid with a magnetic field in the range of 40 T to 50 T. The demonstration of a large bore 15T Nb_3Sn based solenoid would represent an important step toward establishing a stand-alone 40-T, all superconducting solenoid system. Such a high-field (40T) magnet has been shown to be a possible solution for a final cooling scheme
[http://indico.fnal.gov/getFile.py/access?contribId=12&sessionId=5&resId=0&materialId=slides&confId=3474]. The role of such a system was noted recently by the reviewers of the national Muon Acceleration Program (MAP) who commented on the importance of this high-field solenoid system to the eventual success of the Muon Collider program [Ref http://indico.fnal.gov/getFile.py/access?resId=0&materialId=16&confId=3474. Earlier SBIR work at PBL, Inc. was aimed at developing the HTS inner coils necessary to reach 40-50 T. Two Phase I proposals were granted, and they were followed by two Phase II grants that are now in progress. The innovative features in these previous SBIRs were designs of the inner high-field HTS coils, whereas the outer coils used the same design and technology employed in the NHMFL hybrid system. Due to the operational requirements of fast discharge and heat input, the NHMFL coils used a cable-in-conduit design that provided for helium flow through the coils and thus very good cooling. However, this is accomplished at the expense of overall current density, and the result is a large and expensive coil system. The PBL team believes that this large and expensive coil system can be replaced with a less expensive system utilizing a much higher overall current density by adopting a new technology developed for high field dipole magnets. The Phase I SBIR being proposed here is part of the overall strategic plan by PBL to develop a complete high-field solenoid for a muon collider cooling channel, including high current density Nb_3Sn outer solenoids. The SBIR Phase II work would build on this and prior work and result in a prototype Nb3Sn outsert solenoid with the ultimate goal that three (two from prior work and one from this work) can be assembled and nested together as a single solenoid having a field of ~40T.

Commercial Applications and Other Benefits: The primary benefit is the development of high-field solenoids for final cooling of muons for a muon collider. Commercial applications include muon radiography for medical and Homeland Security applications.

Key Words: High-Field Solenoid, Muon Cooling, Muon Colliders

Summary for Members of Congress:

A successful outcome of this study would result in a viable method for producing an intense cold muon beam which will have applications beyond those of a Muon Collider. Commercial applications include muon radiography for medical and Homeland Security applications. The use of intense sources of muons in condensed matter studies, nanotechnology, and other technologies have potential commercial application as well.