Project Summary

Company Name: Particle Beam Lasers, Inc., Northridge CA 91324-2807

Project Title: A Muon-Collider Final-Cooling Scheme: Cooling Simulations and the Design, Fabrication & Testing of Coils to Advance the Technology for a 50-Tesla Magnet

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Topic Number 49: Advanced Concepts and Technology for High Energy Accelerators

Subtopic Letter (b): Novel Devices and Instrumentation Development

A muon collider with center of mass energy of 1.5-4 TeV would probe physics at energies well above the CERN Large Hadron Collider, or proposed International Linear Collider. Muons, unlike electrons, have sufficiently mass to yield negligible synchrotron radiation, and can be circulated, thus decreasing the machine footprint and cost. The beams must have small transverse emittance to achieve high luminosity. Phase I simulations achieved the required ~25 pi mm-mrad emittance with final-stage cooling in 50 T solenoids.

Phase I has demonstrated that generating such a field should be feasible with a hybrid system with a 14 T superconducting magnet identical to that in the 45-T system at the National High Magnetic Field Laboratory at Tallahassee, but such a magnet would consume ~34 MW. Phase I designs replaced successive resistive coils by superconducting ones: first a Nb_3Sn operating below 2 K, then HTS (either YBCO or Bi 2212) for the rest.

Phase II proposes to build and test two test insert coils: 1) using Bi-2212 coil, and 2) using YBCO. Each coil would be first tested inside a ~10 T outsert YBCO coil (being designed and fabricated under another active SBIR), generating fields of ~15-20 T. Subsequently, one or both of the new coils, together with the YBCO outsert would be tested inside the background field of from a 19 T Bitter coil at the NHMFL, generating 35-40 T. The phase II proposal includes the design and construction of the needed quench protection for these tests. Using the experience from these tests, the Phase II will study magnet and quench protection designs for 40-50 T systems, and will continue the design and simulation of the cooling, matching, phase rotation and re-acceleration using both 50 and 40 T magnets.

Commercial Applications and Other Benefits: The motivation for Phase II is the development of high-field solenoids for the final cooling of muons for a collider. Commercial applications include muon radiography for medical and homeland-security applications. Intense sources of muons in condensed matter studies, nanotechnology, and other technologies may have commercial application as well. The research of this Phase II SBIR should help advance the frontier field of nuclear magnetic resonance magnets.

Key Words: High-field solenoid, muon cooling, muon colliders, Bi-2212, YBCO, quench protection

Summary for Members of Congress:
This scheme for cooling muons should facilitate muon colliders, muon radiography for medical and homeland security applications, and condensed matter studies, nanotechnology, and other technologies. The advancement of superconductor technology should extend the field range of nuclear magnetic resonance magnets.