Phase II Proposal **Project Summary/Abstract**

Company Name: Particle Beam Lasers, Inc., Northridge, CA 91324
Project Title: Development of a 6-Dimensional Muon Cooling System Using Achromat Bends and Design, Fabrication and Test of a Prototype High Temperature Superconducting (HTS) Solenoid for the System
Principal Investigator: Dr. Alper A. Garren
Technical Topic 31: Advanced Concepts and Technology for High Energy Accelerators
Subtopic Letter b): Novel Device and Instrumentation Development

The use of muon particle beams have possible commercial applications in the fields of biotechnology, medicine, and nanotechnology as well as in basic "physics science" engaged in the study and commercialization of advanced accelerator technologies, in this case, the study of acceleration, containment and storage of muon beams for both science and commercial applications. A major obstacle for building a case for future muon colliders or neutrino factories has been the lack of an experimental demonstration of the principle of ionization cooling of muons and in particular 6-D cooling and emittance exchange. Past work by our company in this area has focused on lattice design, simulation studies and magnet design for a compact gas-filled storage ring for 6-D cooling of muon beams. Based on this previous work, we considered in Phase I an extension of those design results to allow credible injection and extraction of the beam. The basic new idea is the incorporation of extended straight sections between achromats in the lattice. Both open and closed systems (i.e. ring) were studied. Although more work needs to be done, the Phase I feasibility studies made advancements as some beam cooling was observed under two of the five cases studied. In this current work we use wedge coolers unlike the high pressure gas from before.

The Phase II project will continue the refinement and optimization of the preferred lattice of a 6-D muon cooling system using achromat bends. Work will continue to define and develop a credible beam injection/extraction scheme. A high temperature superconducting (HTS) solenoid, a crucial sub-system of the 6-D muon cooling machine, will be designed, built, and tested during this phase. Further investigation of applications for cooled muon beams outside the high energy physics community will also be made. Project X proposed at FNAL would provide vast numbers of muons that could be used with rings like the one proposed here for commercial applications.

Commercial Applications and Other Benefits: Cooled beams of muon particles for use in elementary particle physics experiments are needed to advance mankind's understanding of the fundamental nature of energy, the elementary constituents of matter and the forces that control them. A robust, simple and economical cooling system to cool ion and particle beams have use in ion lasers, biotech, medical, and nanotechology applications. Development of HTS magnet technology may revolutionize future medical and accelerator facilities. Various magnets in muon colliders, hadron colliders, facilities for rare isotope beams (FRIB) benefit significantly from the ability of HTS to produce high fields and ability to handle and economically remove large energy depositions.

Key Words: 6-Dimensional Cooling of Muon Beams

Summary for Members of Congress: The Phase II project proposed is a continuation of initial work to develop a 6-Dimensional muon cooling system using achromat bends. The ultimate goal is to design, build, test and operate such a system at a national accelerator site or commercial ion laser facility. High Temperature Superconducting magnet technology is expected to make future accelerator facilities highly energy efficient.