Project Summary

Company Name: Particle Beam Lasers, Inc.

Project Title: Quench Protection for a Neutron Scattering Magnet

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Topic Number/Subtopic Letter: 18a

Abstract. Neutron scattering experiments would benefit from magnets with fields at least 50% more intense than the ~16 Tesla presently available from conventional low-temperature superconductors (LTS). A high temperature superconductor (HTS) , operating at ~4 K as a high field superconductor, is essential, because commercial LTS has insufficient current capacity at high fields. For neutron diffraction measurements, Particle Beam Lasers, Inc. (PBL) and Brookhaven National Laboratory (BNL) have invented a split-solenoid design capable of providing viewing access that is simultaneously broad axially, radially and circumferentially. The PBL/BNL team has a Phase I SBIR (Grant Number DE-SC0019722) focused on designing a magnet to meet the requirements for neutron scattering. However, the complete development of such a high field magnet technology, with its multitude of key technical issues, is well beyond the financial constraints of a single SBIR/STTR. PBL has experience addressing these key issues one at a time in separate proposals, to help develop the necessary components of high field magnet technology. One critical issue for developing high field HTS magnet technology is the quench protection. The SBIR proposed here will focus on the quench protection issues that are essential for the development of a very high field neutron scattering solenoid. This will include protection of HTS/LTS hybrid solenoids and quench initiation of solenoid sections to prevent overstressing these sections during quench. The LTS and HTS coils in a hybrid design have different quench initiation and propagation characteristics, and it is a challenge to design a protection system to guarantee against overheating or high offset forces. The quench velocity in HTS coils tends to be very low, which presents a major challenge in protecting HTS magnets from damage during a quench. We will develop an integrated approach encompassing several techniques to address this issue, including metal-insulation and no-insulation coils, as well as copper disc inserts that will accelerate the dispersal of stored energy. A key component of this effort will be the use of an advanced quench detection system that has been used in prior PBL/BNL SBIR projects. PBL has over 30 HTS coils which were wound under previous programs. This provides a significant leverage in a limited budget proposal, because the HTS coils are expensive. The PBL/BNL team will use these coils to perform certain quench experiments at 4K in Phase I itself.

Commercial Applications and Other Benefits: The advances in high field magnet quench technology sought by this proposal are essential not only for neutron scattering spectroscopy, but also for many other applications: magnets for research in chemistry and biology (e.g., nuclear magnetic resonance), high energy and nuclear physics, condensed-matter physics, medicine (e.g., proton and ion beam therapy) and wind-power applications.

Key Words: HTS magnets, quench protection, magnet design

Summary for Members of Congress: A new generation of high field magnets utilizing high temperature superconductors are being developed for applications such as neutron scattering spectroscopy. The project will investigate an innovative approach to protecting high field magnets from damage that can occur when the superconductors lose their superconductivity due to heating.