

Project Summary / Abstract

Company Name: Particle Beam Lasers, Inc.
Project Title: A new medium field superconducting magnet for the EIC
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Topic Number/Subtopic Letter: 37(g)

Abstract: The length of most accelerator magnets is much greater than the diameter, and therefore the loss in effective length from the ends (about a coil diameter in dipoles) is relatively small. However, for short magnets, such as some envisioned for the Interaction Region (IR) of the Electron Ion Collider (EIC), the end effects of the conventional *cosine theta* design will result in a relatively large reduction in magnetic length.

This proposal is for developing an alternate *optimum integral design* which significantly reduces the loss of effective length due to the ends. In the *optimum integral design* approach, the ends become an integral part of the magnet in optimizing the cosine theta current distribution, thereby creating a higher integral field for the same coil length. The more compact design is critical when available space is limited as in the EIC. As a part of Phase I, we ported and further developed the codes for optimizing the *optimum integral design*.

The lower cost of *direct wind* technology allowed us to design, build, and successfully test a proof-of-principle 1.7 T, 114 mm aperture, 600 mm long, 2-layer superconducting dipole based on the *optimum integral design*, a significant feat for a Phase I program.

The goal of Phase II will be to demonstrate the *optimum integral design* for EIC IR dipole B0ApF. This will be a 3.8 T, 114 mm aperture, 600 mm long superconducting dipole, which is well beyond what has been demonstrated with direct wind technology so far. The magnet will also meet the field quality requirements. It is an ambitious goal for an SBIR/STTR program but one that we believe can be achieved based on the strong performance of Phase I. Finally, we will examine the applicability of the *optimum integral design* to other EIC magnets and for other applications, such as medical and accelerator beam lines where compact, medium field superconducting magnets are required.

Commercial Applications and Other Benefits: A *direct wind* magnet based on the *optimum integral design* will create higher quality fields and have lower adverse end effects than conventional designs making it ideal for uses wherein space is at a premium. Demonstration of the *direct wind* magnet based on the *optimum integral design* is expected to provide a superior technical solution and reduce the cost of developing and building such magnets. These magnets should find widespread use in particle accelerators for research and medical applications.

Key words: Compact superconducting magnets, direct wind technology, electron-ion collider, optimum integral design

Summary for members of Congress: The proposed electron-ion-collider will need several short, medium field superconducting magnets. This proposal will not only reduce the cost and increase the reliability of magnets for the EIC but will also demonstrate a new type of efficient magnet design and construction applicable to various accelerator, medical and other applications.