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: Most superconducting accelerator magnets are presently based on a conventional "cosine theta" design. Typically, the magnet length vastly exceeds the aperture, and the loss in effective length from the ends (about a coil diameter in typical dipoles) is relatively small. However, for relatively short magnets such as those envisioned for the Interaction Region (IR) of the Electron Ion Collider (EIC) the end effects of the conventional design will result in a large relative reduction of the integrated field.

To reduce the cost of EIC IR magnets, use of "*direct wind technology*" is being considered. Though the "*direct wind technology*" has been used in several low field magnets, it is yet to be demonstrated for a combination of high fields and large aperture magnets, such as those required in the EIC. A loss in magnetic length from the conventional ends increases the requirement of the field in the body of the magnet and hence the cost and technical risk of the magnet program.

We propose to develop and demonstrate a medium field "*direct wind*" dipole with an "o*ptimum integral design*" approach that promises to have essentially no loss in effective length due to the ends. In the "*optimum integral design*" approach, the ends become an integral part of the magnet body - creating an effective azimuthal integral cosine theta distribution of the current density.

This proposal will examine the "*optimum integral design*" for the ~3.3 T B0APF EIC IR dipole, which has a coil i.d. of 120 mm and a coil length of about 600 mm. In this case the estimated savings in effective length, about one diameter, is about 20%.

During Phase I, a preliminary engineering design of the medium field EIC IR dipole B0APF with "*optimum integral design*" will be developed. This will include magnetic and mechanical analysis and a support structure likely consisting of stainless-steel tubes. Phase I will also demonstrate a short length (~150 mm), intermediate field (~2 T) proof-of-principle dipole with an aperture which will be close to the B0APF contemporaneous specifications. During Phase II, a proof-of-principle, full field dipole will be built and tested.

Commercial Applications and Other Benefits: The optimum integral design makes very short length superconducting dipole, quadrupole and other higher order multipole magnets possible that are not possible by other designs. This opens up new possibilities in the fields of accelerator, medical, defense and other applications. Demonstration of the "*optimum integral design*" with "*direct wind technology*" for short medium field superconducting magnets essentially eliminates the cost of expensive tooling such as needed for typical each conventional cosine theta magnets.

Key words: compact superconducting magnets, optimum design, electron-ion collider

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 superconducting magnets for the EIC but will also demonstrate a new type of efficient design for various accelerator, medical and other applications.