1.0 Experimental Studies of Optics schemes at CEBAF for Suppression of Coherent Synchrotron Radiation (CSR)

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Project Status

During the first quarter of the fiscal year, we were resource limited due to planned critical-path work on Project E and MEIC. After reworking the AWP and adjusting the staffing profile, we started executing the project mid-February 2015 and are back on track to complete this LDRD.

The goal of this LDRD is to conduct all the necessary studies for an eventual experiment at CEBAF. The first part of the plan, which consisted in narrowing down which beam parameters were required for measuring the CSR suppression, has been accomplished. We also designed the lattices specifically for CEBAF and determined the optimal experimental layout. Simulations were carried out to assess the feasibility and yielded promising results. The existing CEBAF injector setup was investigated for high charge transport. In its current state , the CEBAF injector is designed to transport fractions of picocouloumbs. Our studies indicate we will need up to 40 pC with a beam momentum around 500 MeV. We determined that there is a need to shorten the injector in order to achieve this. We believe, from our experience at the FEL Driver that it is doable.

Diagnostics were also examined, more specifically, the use of transverse phase space tomography to characterize the emittance growth due to CSR. Several of us [1] did such an experiment in the FEL a few years ago and are confident we can adapt this technique for the CSR experiment.

We are presenting some of our early results at the IPAC2015 conference. A poster and accompanying paper was prepared.

Project Plan

What remains to be done can be broken down into several categories:

Firstly, a new injector design needs to be studied. This will utilize a 350 keV gun and be installed in front of the injector linac. As a starting point we are using the gun design and layout used in the FEL Driver and believe one can install a temporary injector for the purpose of this experiment at CEBAF with reasonable labor costs. While such installation is outside the scope of this LDRD, assessing the feasibility is not. Carrying out this study requires massive amounts of simulations via the use of genetic algorithms [2] and GPT [3] but we have the expertise to do so. We have also coordinated with Bas van der Geer, the author of GPT, to come to Jefferson Lab to provide training after the IPAC2015 conference.

In order to support this work, we are requesting the reallocation of funds from labor to procurements in order to purchase a 96 CPU server to be hosted by the computer center. Preliminary estimates are of the order of 15-30K.

Secondly, the optic lattices have to be optimized further for the CEBAF experiment. In particular, the longitudinal matching has to be studied to find the optimal balance between accelerating in the injector linac and accelerating in the main linac and the various longitudinal bunch manipulations. The linac itself must be evaluated for high bunch charge transport.

Thirdly, the beam macro structure will be different from the nominal CEBAF beam in order to fit within the radiological envelope. Preliminary studies indicate that one will need to use at 31 MHz laser (instead of 499 MHz) as well as alter the tune mode macrostructure to reduce the duty cycle. We are planning to investigate this in collaboration with the injector group and the radiological safety group.

Budget

At the current pace, we are spending around 13K per month in labor (overhead included) However, we anticipate that we might need to consult outside experts at the lab for some parts of this LDRD (such as the radiological envelope for this particular beam structure) and expect they might charge some of that labor.Together with reprogramming some money towards purchasing a computational server, we should be on track to use most of our allocated funds.

References

[1] C. Tennant, Y. Roblin, *First results of transverse phase space tomography in the Jefferson Laboratory FEL upgrade driver*, JLAB-TN-09-21

[2] Alicia Hofler, Balša Terzić, Matthew Kramer, Anton Zvezdin, Vasiliy Morozov, Yves Roblin, Fanglei Lin, and Colin Jarvis, *Innovative applications of genetic algorithms to problems in accelerator physics*, Phys. Rev. ST Accel. Beams 16, 010101

[3] http://www.pulsar.nl/gpt

Publications

IPAC2015 abstract submitted.

Workshops/Conferences

Y.R. Roblin, *Experimental studies of optics schemes at CEBAF for suppression of coherent synchrotron radiation induced emittance growth*, MEIC collaboration meeting, Newport News, March 30-31, 2015.