1.0 Generation and Characterization of Magnetized Bunched Electron Beam from a DC Photogun for JLEIC Cooler

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Project Description

To maintain ion beam emittance and extend luminosity lifetime, the Jefferson Lab design of the Electron Ion Collider includes a bunched magnetized electron beam cooler as part of the Collider Ring. This 3-year (FY16/17/18) project aims to generate and characterize magnetized electron beams using a 350 kV inverted-insulator DC high voltage photogun. Measurements of beam magnetization at different bunch charge as a function of laser beam size and magnetic field at the photocathode are planned. The magnetized beam will be transformed into a flat beam using three skew quadrupoles and the transverse emittance ratio will be measured. Results will be compared to particle tracking code simulations. Photocathode lifetime at beam current up to 32 milliamperes will be compared to beam lifetime with no magnetization, to explore the impact of the magnetic field on photogun operation. Combined, these measurements and simulations will benchmark our design tools and provide insights on ways to optimize the electron cooler and choose the appropriate electron source and injector layout.

Accomplishments

We finished Year 1 (FY16) demonstrating non-magnetized beam at maximum current of 1 mA and started implementing a long list of improvements to the gun and diagnostic beamline. The cathode solenoid was mapped, installed and commissioned. Photocathode preparation chamber, gun HV chamber, cathode solenoid and fully instrumented beamline were all upgraded, commissioned and fully functional. Finally, we were ready to start the experimental measurements outlined in this project. **The highlight of Year 2 (FY17) was the demonstration of magnetized beam**.

- Delivered 4.5 mA magnetized beam for 6 hours with the gun HV at 300 kV and cathode solenoid magnetic field of 1511 Gauss on the photocathode.
- Measured beam rotation using the slit and view screen method and these values were used to calculate beam magnetization.
- Developed magnetized beam simulation tools and found good agreement between prediction and measurement.
- Designed a new non-invasive technique to measure beam magnetization that relies on a TE011 RF cavity to be tested with magnetized beam in FY18.

Publications

None

Workshops/Conferences

R. Suleiman, M. Poelker, J. Benesch, F. Hannon, C. Hernandez-Garcia, Y. Wang and S. Zhang, *Magnetized Bunched Electron Beam from DC High Voltage Photogun*, Physics of Photocathodes for Photoinjectors (P3) Workshop, Newport News, VA, October 17–19, 2016.

https://www.jlab.org/indico/event/124/

Questionnaire

Question	Answer
Will follow-on funding (post-LDRD project) be applied for?	Yes
Source of support for follow-on funding?	DOE SBIR *
Has follow-on funding been obtained?	Yes
Amount of follow-on funding ($K)?	970
Number of Post Docs supported by LDRD project?	1
Number of students supported by LDRD project?	0
Number of scientific staff/technical staff hired with LDRD funding?	0
Number of copyrights filed (beyond publications)?	0
Number of invention disclosures filed?	1
Number of patent applications filed?	0

* *A Magnetized Electron Source for Ion Beam Cooling* - Xelera Research - Phase II Proposal DE-SC001518.