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EIC Detector R&D Progress Report

Project ID: eRD26
Project Name: Compton Polarimetry
Period Reported: from Sep 2020 to Mar 2021
Project Leader: Ciprian Gal (ciprian.gal@stonybrook.edu)
Contact Person: Ciprian Gal (ciprian.gal@stonybrook.edu)

Project members
Abhay Deshpande (Stony Brook University), Ciprian Gal (Stony Brook University), Dave Gaskell (Jefferson Lab), Caryn Palatchi (University of Virginia), Kent Paschke (University of Virginia), Shukui Zhang (Jefferson Lab)

Abstract

We have received the funds allocated for the first year of the project, identified the needed components and expect to be able to meet our commitments by the end of the funding cycle. We have updated our simulations to the new IR location and expect to have an estimate of the sync light background by the time of the next report.

Past

What was planned for this period?

For this period we expected to be able to purchase the components needed for the lower power laser system and set up the laboratory space at Stony Brook University for initial commissioning and proof of principle testing. These tests consist of :

- Assembling a pulsed laser system that can be triggered based on a an external gate up to the highest frequency (100MHz) needed to individually measure each electron bunch
- Show that this system could be used for variable frequencies all the way down to 78kHz (the frequency of an individual bunch around the EIC ring)
- Show that with the introduction of a phase one could shift the overlap of the laser beam with different bunches in the electron beam to allow for simultaneous measurements of a fraction of the beam. This would be needed to allow for detector technologies where the recovery time would be relatively slower than the bunch frequency.

Additionally, taking into account the suggestions of the review committee we planned to investigate the rates and backgrounds at the photon and electron detector locations.

What was achieved?

Laser system construction:

eRD26 funding was provided only for the components of the laser system at a level of 69% of the request. Based on the award we have reduced the components that we planned to purchase this funding cycle to the bare minimum that would allow us to achieve the goals listed above.

For the laser system we have identified the main components (see Table I below) and obtained quotes from vendors. We expect that this will allow us to assemble the system and perform the tasks set out for this funding cycle.

Component	Sub-component	Cost/Quote	Component ID	Vendor
Laser diode		12500	QLD106G-6410	Cybel
Pulse generator		20000	EPG-210B-0030-S-P-T-A	Cybel
Controllers		4370.67	ITC4002QCL	Thorlabs
Preamp		7956.75	YDFA100P	Thorlabs
Fiber optics	Fiber isolator	518.34	IO-G-1064	Thorlabs
	Power meter display	1140.55	PM100D	Thorlabs
	Power meter diode	352.78	S121C	Thorlabs

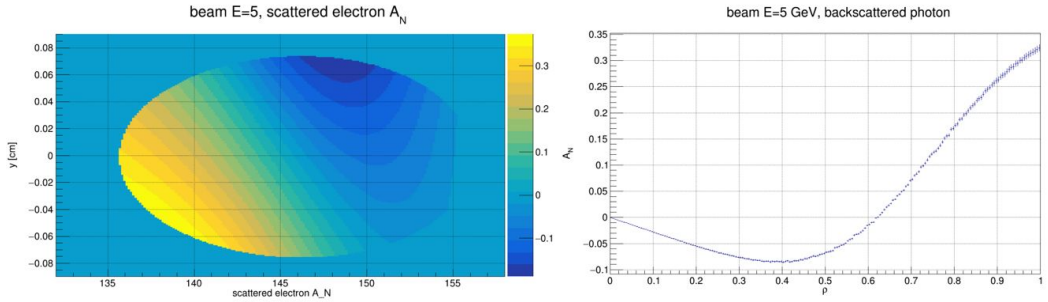
	Total	**46839.09**		

We estimate to complete the order for the components by mid March to allow for possible contributions from additional collaborators.

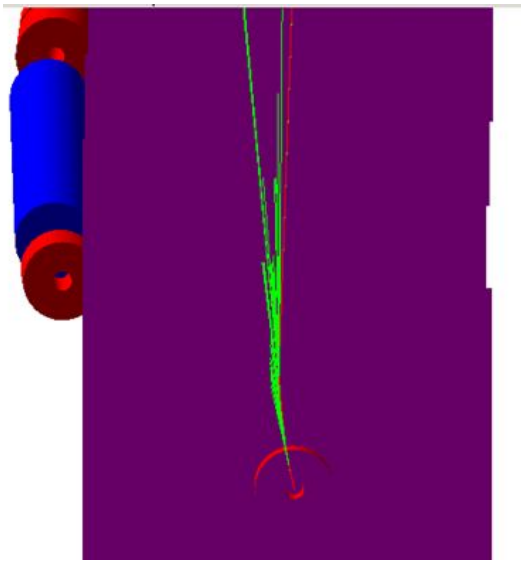
Simulations revisited and additions:

We were informed that the EIC project leans towards having the Compton polarimeter close to IR6 rather than at the IP12 location for which simulations were performed in our original proposal. Due to the difference in polarization direction at the two locations the analysis from IP12 cannot be directly ported to this new location. While the IP12 location required a high precision measurement of the transverse polarization component and a cross check of the longitudinal components, the IR6 location requires precision in both components due to a mix of longitudinal and transverse components.

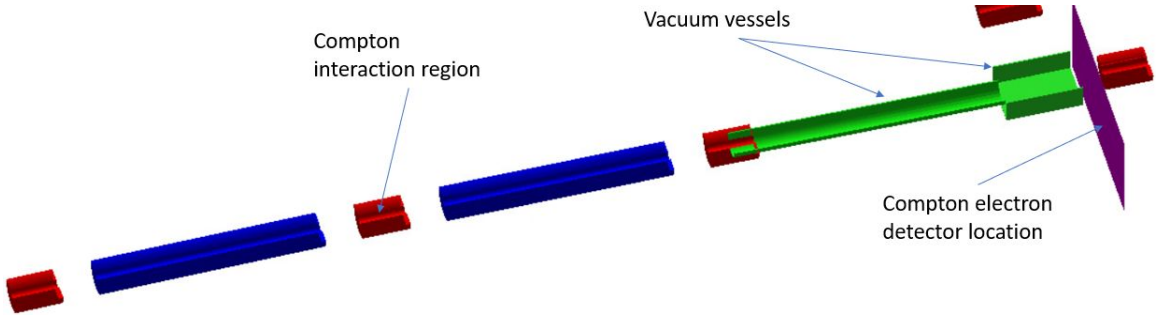
We have started with the simulation framework designed by Zhengqiao Zhang and have updated the software to take into account the analyzing powers of the Compton scattering. The figure below shows the analyzing power (on the color axis) for the scattered electron (left) and the analyzing power as a function of the maximum photon energy (right) for the backscattered photons. Due to the mixed longitudinal and transverse polarization direction at this location we are presented with a mix of spatial and energy dependent analyzing powers.



Furthermore, we have embarked on a detailed study of the synchrotron background at the electron detector locations (as was shown by eRD15 this was a critical issue for the JLEIC design which is not significantly different from what is planned at the EIC). As a first step we have verified that the Geant4 synchrotron radiation implementation provides consistent results with analytical calculations. Secondly, the physics models were embedded in the IR6 Compton simulation and confirmed sync-light photons were produced and recorded appropriately. The figure below shows Compton scattered electron (red line), the backscattered photon (green line going straight from the interaction point) and sync-light photons (other green lines) through the dipole after the Compton interaction.



The main source of background for the eRD15 setup were optically reflected photons from the surface of vacuum beam pipes and vessels, which Geant4 can easily address. We have created initial estimates (see figure below) for these enclosures and will evaluate their impact as our next step.



What was not achieved, why not, and what will be done to correct?

We expected that by this point we would have been able to obtain the components and start assembly. The delay was mainly caused by the 4 month timeline needed to access the eRD funds. We do not expect additional delays for the rest of the funding cycle.

How did the COVID-19 pandemic and related closing of labs and facilities affect progress of your project?

The 4 month timeline conceivably was this long due to remote work of support personnel at SBU and BNL.

How much of your FY20 funding could not be spent due to pandemic related closing of facilities?

We expect to fully exhaust the FY20 eRD funds.

Do you have running costs that are needed even if R&D efforts have paused?

No.

Future

What is planned for the next funding cycle and beyond? How, if at all, is this planning different from the original plan?

We expect to continue with the project as presented in the original proposal. The next step is the purchase of a high power amplifier that will allow us to test this system at powers close to the ones needed for the operation at the polarimeter.

We further plan to refine the simulation and evaluate the requirements for both the electron and photon detector systems. We will engage with interested parties and evaluate the performance of proposed detector systems. While this task was not in our original proposal we agree with the committee assessment that this aspect needs to be carefully considered so have added this task to our list.

What are critical issues?

The reason for this proposal is to show that a high power system with variable pulse frequency (as needed by the EIC) is feasible at the parameters needed for the EIC. As far as the authors are aware no such system has been employed at an accelerating facility before.

Additional information:

Manpower

Include a list of the existing manpower and what approximate fraction each has spent on the project. If students and/or postdocs were funded through the R&D, please state where they were located, what fraction of their time they spend on EIC R&D, and who supervised their work.

- Ciprian Gal: 10%
- Caryn Palatchi: 20%
- Kent Paschke: 5%
- Dave Gaskell: 5%
- Shukui Zhang: 2%

External Funding

Describe what external funding was obtained, if any. The report must clarify what has been accomplished with the EIC R&D funds and what came as a contribution from potential collaborators.

We are exploring the possibility of purchasing some of the diagnostic equipment using university sources.

Publications

At this stage of the project no publications were foreseen.