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EIC Detector R&D Progress Report

Project ID: eRD20
Project Name: Developing Simulation and Analysis Tools for the EIC
Period Reported: from July 13 2019 to December 31 2019
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Abstract

Developing the physics program for the EIC, and designing the detectors needed to realize it, requires a plethora of software tools and multifaceted analysis efforts. Many of these tools have yet to be developed or need to be expanded and tuned for the physics reach of the EIC. Currently, various groups use disparate sets of software tools to achieve the same or similar analysis tasks such as Monte Carlo event generation, interaction region and detector simulations, track reconstruction, and event visualization to name a few examples. With a long-range goal of the successful execution of the EIC scientific program in mind, it is clear that early investment in the development of well-defined interfaces for communicating, sharing, and collaborating, will facilitate a timely completion of not just the planning and design of an EIC but ultimate delivery of the physics capable with an EIC.

Past

What was planned for this period?
In FY20, we will continue our work on common physics and detector simulations for the EIC community with a focus on **Geant4 Simulations** (i.e., maintaining the Geant4 physics list tuned for EIC needs and contributing to the development of Geant4 hadronic models), **Interfaces and Integration** (i.e., unifying to a large extent presently disconnected event simulation and reconstruction pieces of code used by our various communities), and **Monte Carlo Event Generators for the EIC**.

What was achieved?

Geant4 Simulations EIC detector simulations rely on the Geant4 toolkit. We organized with the Geant4 Collaboration a Technical Forum on the EIC, which was held on September 24, 2019, as part of the EIC Software and Geant4 Collaboration meetings at Jefferson Lab. In the Technical Forum, we shared the status of the detector R&D for the EIC, as well as recent news on Geant4. We also discussed the physics list for the EIC that is maintained by the EIC Software Consortium and made requests for improved photo-nuclear and electro-nuclear reactions that have recently been included in Geant4 version 10.6.

Interfaces and Integration In June 2018, the EIC User Group (EICUG) formed a software working group with its conveners chosen from the EIC Software Consortium to "*build on the considerable progress made within the EIC Software Consortium (eRD20)"* (from working group announcement). From the start, the EIC Software Consortium has been the core of the software working group. The EICUG Steering Committee and the EICUG in general appreciate the efforts of the software working group. A tutorial for fast simulations at the EICUG meeting in July 2019 was very well received and allowed many users to get started with EIC simulations. This is reflected in the email from the EICUG Steering Committee announcing the EIC Physics and Detector Conceptual Development/ Yellow Report efforts: *"and simulations should be carried out using the EICUG developed software tools"*. Further tutorials have been announced for January and February 2020, with a tutorial on detector full simulations being scheduled prior to the EIC Generic Detector R&D meeting. The detector full simulations being presented will be a major step towards *"a simple lite setup with a well defined geometry description standard that is easy to use"* (T. Ullrich) that has been requested for the EIC Generic Detector R&D program.

Monte Carlo Event Generators (MCEGs) We are initiating a project with the Monte Carlo communities in the US and Europe (MCnet) to work on MCEGs for the EIC, requiring MCEG for polarized ep, ed, and e^3He as well as eA measurements. The MCEG initiative is connecting the MCEG efforts in NP and HEP and is encouraging a strong interplay between experiment and theory already at an early stage of the EIC. As an initial step, we have started a workshop series on "MCEGs for future ep and eA facilities" where the third workshop was held in November 2019 at the Erwin Schrödinger International Institute for Mathematics and Physics in Vienna, Austria.

During the workshop, we reviewed the theory for physics with light and heavy ions and discussed the modifications needed on the general-purpose MCEGs to simulate unpolarized observables also for eA where a precise treatment of the nucleus and its breakup is needed. There were presentations about pioneering MCEG projects for eA (BeAGLE, spectator tagging in ed, Sartre), as well as on the ongoing development of the eA adaptation of JETSCAPE and the Mueller dipole formalism in Pythia8. We also summarized the status of MCEG-data comparisons in HZTool/Rivet that are critical to tune MCEGs to existing DIS and heavy ion data as well on the ongoing work of verifying MCEGs for TMDs with TMD theory / phenomenology.

What was not achieved, why not, and what will be done to correct?
We are on track to achieve our FY20 goals.

Future

What is planned for the next funding cycle and beyond? How, if at all, is this planning different from the original plan?
We have reached the consensus that the optimal way forward on EIC simulations and software framework is to begin work on a greenfield solution that frees us from the legacy of existing options while leveraging the experience of everyone working on one team. In the future, the EICUG Software Working Group will focus on software support of the EICUG, in particular simulation support for the Yellow Report efforts, while the EIC Software Consortium will focus on the greenfield solution.

What are critical issues?
A workflow environment for the EIC can only grow with user input. The further development of simulation tools requires strong support from the community and will depend on how the community organizes itself and collaborates together.

Additional information:
None.

Manpower

The members of the EIC Software Consortium work on a best-effort basis. The eRD20 funds are presently not used to pay any positions. There are no PostDocs on our project.

External Funding

None.

Publications

None.