

# 1. Nuclear gluons with charm at EIC

---

**Principal Investigator:** C. Weiss (Theoretical and Computational Physics Center, 1.757.269.7013)

## Project Status

Project execution started October 1, 2015 as planned. Regular group meetings were scheduled (including the external collaborators through videoconferencing) and a public project Wiki was set up for communication and documentation at [https://wiki.jlab.org/nuclear\\_gluons/](https://wiki.jlab.org/nuclear_gluons/). Weiss (20% FTE) and Higinbotham (10% FTE) have been working on the project at planned levels of effort; Furlotov's effort was at 10% FTE in the first 5 months due to Hall D running but sufficient to achieve project objectives. An experimental physics graduate student (Dien Nguyen, U. Virginia) has been contracted and is presently working for the project (3 months at 100%). Results obtained so far (see [public Wiki pages](#) for details)

- Developed/tested simulation tools for heavy quark production at EIC: (a) Fast standalone code implementing leading-order QCD cross sections for heavy quark production on nuclei, for analytic rate estimates; (b) adapted HVQDIS Monte-Carlo code (HERA) to EIC kinematics.
- Calculated charm production rates at EIC (including region  $x \gtrsim 0.1$ ) and mapped kinematic dependence. Results show that physics measurements with open charm will be feasible with EIC if charm reconstruction can be done with overall efficiency at the level of  $\sim$ few %.
- Simulated open charm reconstruction at EIC using the  $D^*$  decay channel (does not require particle ID); surveyed advanced charm reconstruction methods and made high-level assessment of their efficiency and detector requirements (particle ID, tracking)
- Demonstrated sensitivity of measured charm cross sections to the nuclear modification of gluons and planned quantitative physics impact studies (reweighting of parton density fits)
- Implemented MC generator for semi-inclusive pion and kaon production in nuclear DIS with EIC, for studies of flavor decomposition of nuclear modifications. Testing in progress.

Results were disseminated in presentations at conferences/workshops with different audiences (JLab nuclear physics community, EIC collaboration, international deep-inelastic scattering community, APS; see below). Written conference proceedings are in preparation.

Results obtained so far show that measurements of charm production with a high-luminosity EIC are feasible up to  $x \sim 0.1$ , and that the overall objective of direct measurement of the nuclear gluon density at  $x \gtrsim 0.1$  can most likely be achieved. Developing advanced charm reconstruction methods with an overall efficiency of  $\sim$ few%, using the unique EIC detector capabilities (particle ID), will be essential to achieve this goal.

## Project Plan

R&D for the remainder of FY16 will focus on: (a) extending/refining the assessment of charm reconstruction at EIC (comparing decay channels, maximizing efficiency, quantifying errors, incorporating vertex detection); (b) developing a schematic model of the EIC detector performance for charm reconstruction (pion/kaon identification, resolution); (c) implementing/testing simulation tools for quark flavor decomposition with semi-inclusive pi/K at EIC; (d) setting up the parton density reweighing formalism to enable quantitative physics impact studies of charm and pion/kaon measurements; (e) testing and documenting the simulation tools.

The summer work of Prof. Hyde (consultant, EIC detector performance) has been planned and scheduled, as well as the visits of the senior theory collaborators (Stratmann, Strikman). A postdoc, Dr. Zhihong Ye (Argonne National Lab, Group of John Arrington), will support the development of the semi-inclusive pi/K simulation tools in the remainder of FY16, working as a consultant at JLab at 3-4 weeks full-time effort. His effort will be replace the graduate student in the remainder of FY16 and be covered from theses funds. Dr. Ye has unique first-hand experience in the semi-inclusive simulation tools and can accomplish the task in 3-4 weeks of effort.

## Budget

Budget: The LDRD staff will provide a graph of budget progress after you submit your report. It will become an appendix to your report, and be on a separate page

Note: Absent a complex project re-plan, the project Status and Plan material should sum to of order one page.

## Workshops/Conferences

Current updated and slides available on [public Wiki pages](#)

- C. Weiss, "Charm and Beauty production at an Electron-Ion Collider," abstract accepted at BEACH 2016, XIIth International Conference on Beauty, Charm, and Hyperons in Hadronic Interactions, 12-18 June 2016, George Mason University, Fairfax, VA, <http://beach2016.gmu.edu>
- Yu. Furletova, C. Weiss, "Probing nuclear gluons with heavy flavors at an Electron-Ion Collider" (presented by R. Yoshida), 24th International Workshop on Deep-Inelastic Scattering and Related Subjects (DIS2016), Hamburg, Germany, April 11-15, 2016, <https://dis2016.desy.de>
- C. Hyde, "Nuclear Gluons with Charm at EIC," Workshop on Next Generation Nuclear Physics at JLab12 and EIC, Florida International University, Miami, FL, 10-13 Feb 2016, <https://www.jlab.org/indico/event/121/>
- C. Weiss, "Nuclear gluons with charm at EIC," EIC User Group Meeting, UC Berkeley, 09 Jan 16, <http://portal.nersc.gov/project/star/jthaeder/eicug2016/index.php?id=0>
- S. Furletov, "Gluons at high x in Nuclei at EIC," APS DNP Fall Meeting, Santa Fe, 28 Oct 15