

1. Nuclear gluons with charm at EIC

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Project Status

Project work continued in FY17 with the same arrangements as for FY16 (regular meetings of local and external collaborators, public project Wiki at https://wiki.jlab.org/nuclear_gluons/). Weiss (20% FTE) and Higinbotham (10% FTE) have been working on the project at planned levels of effort; Furlletov's effort was at ~10% FTE average because of Hall D running but sufficient to achieve project objectives. Efforts focused on simulations of charm measurements with JLEIC (charm reconstruction, vertex detection) and study of the physics impact. Results obtained in FY17 so far:

- Tested/optimized event generators for charm production in deep-inelastic scattering by comparing PYTHIA 6, HERWIG 6/7, and QCD cross section codes (HVQDIS); set up Root/C++ based charm reconstruction and analysis program.
- Estimated charm reconstruction efficiency for exclusive and inclusive D-meson decay channels using momentum and vertex smearing. This level of simulations accounts for the expected JLEIC detector coverage (acceptance), expected vertex resolution, and particle identification performance.
- Implemented GEANT4 model of JLEIC central and vertex detector geometry and set up framework for track fitting and vertex reconstruction by adapting standard tools (GENFIT, RAVE), including interfacing with Root for physics analysis. This framework will enable next-level simulations of charm reconstruction including detector response, tracking, and vertex reconstruction efficiency.
- Developed computer codes for quantifying the impact of charm observables on nuclear gluons using reweighting of parton density fits (Python codes, available on github). First studies based on inclusive F2charm pseudodata have shown significant impact on large-x nuclear gluons.
- Tested/refined Monte-Carlo generator for semi-inclusive pion and kaon production in nuclear DIS with EIC, for studies of the flavor decomposition of nuclear quark/antiquark densities.

Results were disseminated in several conference presentations; a journal publication is being planned. Results obtained so far show that (a) a charm reconstruction efficiency of ~5-10%, as needed for the physics objectives, can likely be achieved with the projected JLEIC detector capabilities; (b) the planned charm measurements will have a significant impact on the determination of the nuclear gluon density at large x.

Project Plan

R&D for the remainder of FY17 will focus on: (a) next-level simulations of charm reconstruction with JLEIC, including effects of detector response, tracking, and vertex reconstruction efficiency, using the recently developed GEANT4-based setup; (b) optimization of the planned charm measurements through physics impact studies using parton density reweighting (effects of pseudodata coverage, errors, types of observables) ; (c) extension of the charm measurements to photo production and high- p_T charm pairs (rare processes with distinctive signal); (d) quantitative simulations of measurements of the nuclear quark flavor decomposition with semi-inclusive π/K at JLEIC and their impact; (e) documentation and publication of the results; (f) initiating a broad discourse with theorists regarding the interpretation of nuclear modifications of quarks/gluons at large x and its connection with nucleon interactions in QCD.

The summer work of Prof. Hyde (consultant, JLEIC detector performance) has been planned and scheduled (4 weeks at 100% FTE). To support the studies of charm photoproduction and quark flavor separation we plan to involve a postdoc, Dr. Florian Hauenstein (ODU), for 4 months at 50% FTE, in the remainder of FY17. His labor will be covered by funds originally projected for the effort of JLab collaborators (Furletov, Higinbotham), which have not been/will not be used because of the demands of the 12 GeV program. Dr. Hauenstein is well qualified for the task and has relevant expertise in nuclear measurements with JLab12. His involvement will ensure that the project objectives are achieved within the FY17 period. His effort will partly replace that of Dr. Zhihong Ye (ANL), whose availability in the remainder of FY17 will be limited.

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

- R. Yoshida, “High x at EIC” (includes LDRD project results), 25th International Workshop on Deep-Inelastic Scattering and Related Subjects (DIS2017), Birmingham, UK, April 3-7, 2017, <https://indico.cern.ch/event/568360/>
- C. Weiss, “EIC and ultraperipheral collision physics” (includes LDRD project results), Probing QCD in Photon-Nucleus Interactions at RHIC and LHC: the Path to EIC, Workshop at Institute for Nuclear Theory, University of Washington, Seattle, February 13-17, 2017, www.int.washington.edu/PROGRAMS/17-65w/
- C. Weiss, “Short-range correlations and large-x nuclear partons with EIC,” Quantitative challenges in EMC and SRC Research and Data-Mining, MIT, Boston, December 2-5, 2016 http://web.mit.edu/schmidta/www/src_workshop/
- Yu. Furletova, “Probing nuclear gluons with heavy flavors at an Electron-Ion Collider,” Joint CTEQ Meeting and POETIC 7 (7th International Conference on Physics Opportunities at an Electron-Ion Collider), Temple University, Philadelphia, November 14-18, 2016, <https://phys.cst.temple.edu/poetic-cteq-2016/>

Current updates and slides available on public Wiki at: https://wiki.jlab.org/nuclear_gluons/

Publications

- E. Chudakov, D. Higinbotham, S. Furletov, Yu. Furletova, D. Nguyen, M. Stratmann, M. Strikman, C. Weiss, “Heavy quark production at an Electron-Ion Collider,” J.Phys.Conf.Ser. 770 (2016) no.1, 012042, JLAB-THY-16-2354, arXiv:1610.08536, DOI dx.doi.org/10.1088/1742-6596/770/1/012042, <https://arxiv.org/abs/arXiv:1610.08536>, <https://inspirehep.net/record/1494805>