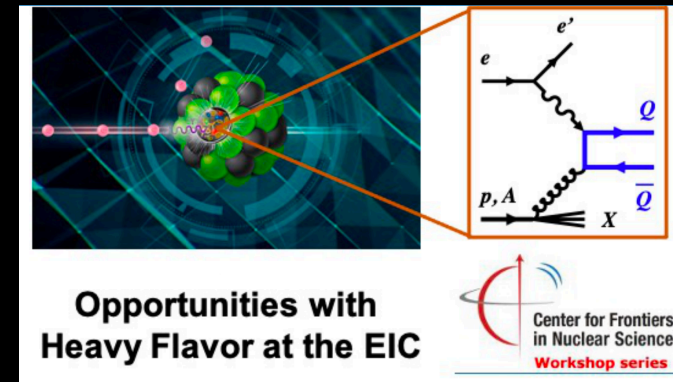


# Welcome to the Opportunities with heavy flavor at the EIC workshop

Nov 4<sup>th</sup> to 6<sup>th</sup>, 2020, online



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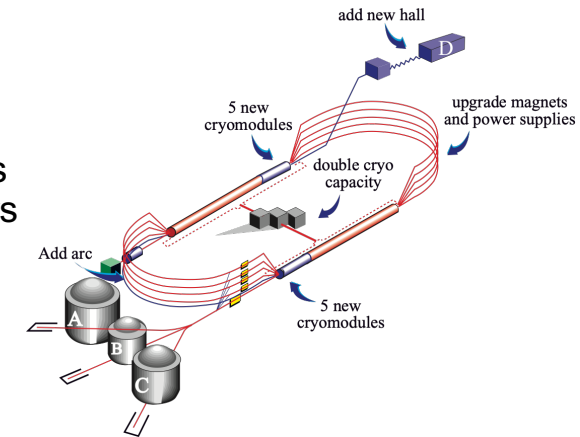
*CFNS – Stony Brook  
November 4-6, 2020*



# High-energy electromagnetic probes

## JLab 12 GeV

- Operating since 2018, first physics results, program for ~10 years
- Extensive data on hadronic final states from large-acceptance detectors CLAS12, GlueX, high-resolution spectrometers, recoil/breakup detectors
- Proposed detector upgrades SOLID, Moller, ...

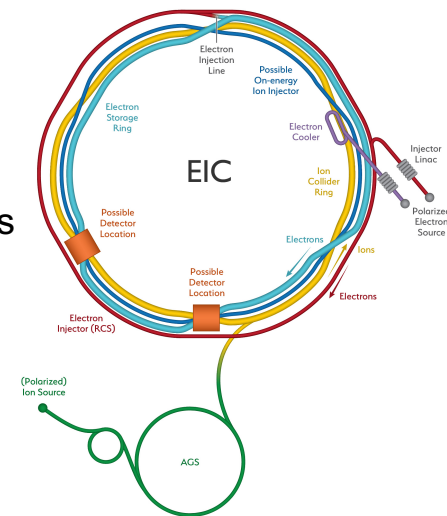


## COMPASS muon beam at CERN

- Hadron structure program continuing

## Electron-Ion Collider at BNL

- DOE Project: CD0 2019, CD1 planned 2021-Q2; CD4 expected 2030
- Accelerator and IR/detector development advancing rapidly
- Vigorous community effort in physics and detector development: Yellow Reports
- Open to new physics ideas beyond approved program
- Forward detection of nucleons/ions/nuclear breakup



## (HERA ep collider at DESY)

- Extensive results from 1992-2007 operations
- Archived data available for further physics analysis

# High-energy hadronic probes

## RHIC

- Started operation in 2000, flexible CM energies, polarized and unpolarized beams, pp, pA, AA collisions
- Discovered jet quenching, the strongly-coupled regime of QGP, flow effect in small systems, gluon helicity contribution to nucleon spin
- Research program continues with STAR and the new sPHENIX experiment till 2025



## LHC

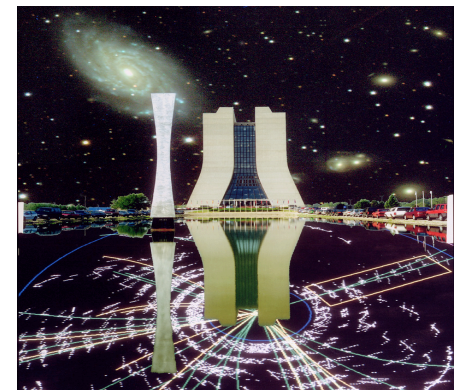
- Operational since 2010, world's highest energy collisions, pp, pA and AA programs
- Discovery of the Higgs 2012
- New insights into heavy flavor, top quark physics, heavy ions



## Fixed-target: J-PARC, PANDA

### (Tevatron)

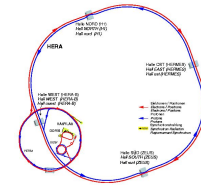
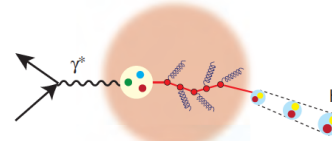
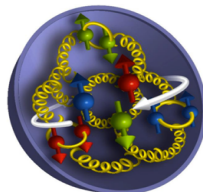
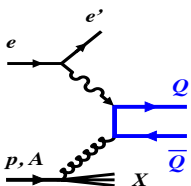
- Facility active 1983 – 2011, Discovery of the top quark 1995
- Discovery of the  $\Omega_b$ , Excluded high mass Higgs
- Important insight into quarkonia, the birth of NRQCD



# Heavy flavor workshop: Scope

**Nucleon and nuclear structure:** At the EIC, heavy quarks are produced from gluons carrying a large relative fraction of the nucleon's momentum  $x_B$ . They can help pin down the poorly known strange, charm, bottom, and gluon content of nucleons and nuclei at moderate and large Bjorken- $x$ . Such advances are not only central to Quantum Chromodynamics (QCD), but also necessary to ensure percent level precision in the evaluation of backgrounds for Beyond the Standard Model searches at collider experiments.

**Energy loss and hadronization:** Heavy flavor production is also an essential part of the e+A program at the EIC. It can provide insights into the space-time picture of hadronization that are simply not possible with light hadrons. Measurements of open heavy flavor modification can place tight constraints on the opacities of nuclear matter and transport properties of large nuclei.



**Lessons from HERA and the Hadron colliders:** The physics program at the EIC will greatly benefit from the lessons learned at HERA and the tremendous expertise of the DIS community. At the same time the LHC and RHIC have brought about new theoretical and experimental developments. Our intent is to summarize those advances, explore the synergies with the EIC, and use them as a stepping stone to ensure maximum impact of open heavy flavor measurements.

**Instrumentation and detector requirements:** Instrumentation at mid and forward rapidities at the EIC is absolutely critical for the precise measurements of heavy flavor mesons, baryons, and jets. In this workshop, we will have a dedicated session to discuss and refine the detector requirements for the future heavy flavor and jet measurements at the EIC, improve existing simulation tools, and forge collaborations.

# Heavy flavor workshop: Program

## **Wednesday 4 Nov: Overview of heavy flavor production, lessons from HERA and the LHC, role of heavy flavor in (n)PDF analyses**

- R. Thorne, A. Geiser, S. Sekula, P. Nadolsky, J. Rojo, V. Guzey, S. Moch, A. Mitov
- Discussion

## **Thursday 5 Nov: Heavy flavor and final-state interactions, lessons from RHIC and LHC, quarkonia and exotic heavy flavor states**

- O. Evdokimov, I. Schienbein, E. Aschenauer, V. Greco, Z. Liu, W. Brooks, Y. Makris, T. Skwarnicki
- Discussion

## **Friday 6 Nov: Detector technology for heavy flavor measurements, R&D toward the EIC, software tools**

- C. Haber, D. Morison, Y. Furltova, C.P. Wong, X. Dong, Z.E. Meziani, M. Posik, C. Gal
- C. Pinkenburg + Discussion
- We will have extensive discussions — after the presentations and in the discussion sessions. Everyone should participate.  
Speakers of the day should be available for questions. Please suggest topics/questions for discussion!
- We are coming together as researchers from different communities. Do not hesitate to ask basic questions or request explanations.