

# **EIC opportunities for Snowmass**



## **Report of Contributions**

Contribution ID: 1

Type: **not specified**

## 3D proton tomography at the EIC: TMD gluon densities

*Tuesday, 26 January 2021 11:50 (15 minutes)*

We present explorative analyses of the 3D gluon content of the proton via a study of (un)polarized twist-2 gluon TMDs, calculated in a spectator model for the parent nucleon. Our approach encodes a flexible parametrization for the spectator-mass density, suited to describe both moderate and small- $x$  effects. All these prospective developments are relevant in the investigation of the gluon dynamics inside nucleons and nuclei, which constitutes one of the major goals of new-generation colliding machines, as the Electron-Ion Collider (EIC).

**Primary authors:** BACCHETTA, Alessandro (University of Pavia and INFN); CELIBERTO, Francesco Giovanni (ECT\*/FBK Trento & INFN-TIFPA); RADICI, Marco (INFN - Sezione di Pavia); TAEELS, Pieter (Ecole Polytechnique)

**Presenter:** CELIBERTO, Francesco Giovanni (ECT\*/FBK Trento & INFN-TIFPA)

**Session Classification:** Hadron tomography at EIC and HEP

Contribution ID: 2

Type: **not specified**

## **Gluon saturation and spin physics: a window into axion-like dynamics**

We discuss a novel effective action that captures the interplay of hadron spin and gluon saturation in the Regge limit of QCD . In particular, we discuss an emergent axion like dynamics that is mediated by sphaleron transitions. This indicates a window in the strong interactions with formal connections to axion dynamics in dark matter and radiation, and to the role of sphaleron dynamics in B+L violation in the early universe.

**Primary authors:** VENUGOPALAN, Raju (BNL); Dr TARASOV, Andrey (OSU & CFNS)

**Presenter:** VENUGOPALAN, Raju (BNL)

**Session Classification:** Gluon saturation at EIC

**Track Classification:** Gluon saturation

Contribution ID: 3

Type: **not specified**

## Removing flat directions in SMEFT fits: how polarized electron-ion collider data can complement the LHC

*Monday, 25 January 2021 11:50 (10 minutes)*

We study the potential of future Electron-Ion Collider (EIC) data to probe four-fermion operators in the Standard Model Effective Field Theory (SMEFT). The ability to perform measurements with both polarized electron and proton beams at the EIC provides a powerful tool that can disentangle the effects from different SMEFT operators. We compare the potential constraints from an EIC with those obtained from Drell-Yan data at the Large Hadron Collider. We show that EIC data plays an important complementary role since it probes combinations of Wilson coefficients not accessible through available Drell-Yan measurements.

**Primary author:** WIEGAND, Daniel (Northwestern University/Argonne National Lab)

**Presenter:** WIEGAND, Daniel (Northwestern University/Argonne National Lab)

**Session Classification:** EW & BSM

**Track Classification:** EW & BSM

Contribution ID: 4

Type: **not specified**

## Light-front holographic $\rho$ -meson parton distribution functions

*Tuesday, 26 January 2021 12:50 (15 minutes)*

We present the leading-twist parton distribution functions (PDFs) of the  $\rho$ -meson in the light-front holographic model which are found to be in accord with the Nambu-Jona-Lasinio (NJL) model and the light-front quark model predictions. We further study the QCD evolution of the PDFs. The positivity bounds on the PDFs are also discussed.

-- WITHDRAWN --

**Primary authors:** DAHIYA, Harleen (Dr. B.R. Ambedkar National Institute of Technology, Jalandhar); Ms KAUR, Satvir (Dr BR Ambedkar National Institute of Technology, Jalandhar); Dr MONDAL, Chandan (Institute for Modern Physics, Chinese Academy of Sciences, Lanzhou)

**Presenter:** Ms KAUR, Satvir (Dr BR Ambedkar National Institute of Technology, Jalandhar)

**Session Classification:** Hadron tomography at EIC and HEP

**Track Classification:** Hadron tomography

Contribution ID: 5

Type: **not specified**

## Improved constraints on nPDFs with nCTEQ

*Tuesday, 26 January 2021 11:20 (15 minutes)*

As we strive for higher precision Standard Model predictions, a detailed knowledge of the PDFs is critical to interpret hadronic processes at LHC and EIC. New data from both proton and heavy ion beams can impose improved PDF constraints, as well as provide insights as to the optimal means to organize the QCD expansion. The recently released updates of the nCTEQ15 nPDFs reflect some of these advances. These efforts, together with complementary approaches such as Lattice QCD, will contribute toward incisive comparisons of data with theory as we validate our understanding of the Standard Model and search for deviations which might signal evidence of “new physics.”

**Primary author:** OLNNESS, Fredrick (SMU)

**Presenter:** OLNNESS, Fredrick (SMU)

**Session Classification:** Hadron tomography at EIC and HEP

**Track Classification:** Hadron tomography

Contribution ID: 7

Type: **not specified**

## EIC Impact Study on the Tensor Charge using TMDs from a Global Analysis of SSAs

*Tuesday, 26 January 2021 12:20 (15 minutes)*

The tensor charge is one of the fundamental charges of the nucleon and, arguably, the least known. This quantity sits at the intersection of three key areas of nuclear physics: 3-dimensional tomography of the nucleon, searches for beyond the Standard Model physics, and lattice QCD. In this talk I will report on a recent study of the impact of the Electron-Ion Collider (EIC) on the phenomenological extraction of the tensor charge from a QCD global analysis of single transverse-spin asymmetries (SSAs). We generated EIC pseudo-data for the Collins effect in semi-inclusive deep-inelastic scattering for proton and He-3 beams across multiple center-of-mass energies. We find a significant reduction in the uncertainties for the up, down, and isovector tensor charges that will make their extraction from EIC data on SSAs as or more precise than current lattice QCD calculations.

**Primary authors:** PITONYAK, Daniel (Lebanon Valley College); GAMBERG, Leonard (Penn State); KANG, Zhongbo (UCLA); PROKUDIN, Alexei (Penn State Berks); SATO, nobuo (Jefferson Lab); SEIDL, Ralf (RIKEN)

**Presenter:** PITONYAK, Daniel (Lebanon Valley College)

**Session Classification:** Hadron tomography at EIC and HEP

**Track Classification:** Hadron tomography

Contribution ID: 8

Type: **not specified**

## Probing the structure of exotic hadrons at the EIC

*Tuesday, 26 January 2021 11:35 (15 minutes)*

The EIC will provide a powerful tool for discriminating between various models of exotic hadron structure. Exotics that hadronize inside the nucleus must pass through nuclear matter, where they can interact with other partons and be disrupted. The magnitude of this disruption is expected to depend on the radius/binding energy of the state. Thus, the nucleus can act as a filter that preferentially suppresses extended states, while allowing compact states to pass through relatively unscathed. We will present a brief discussion of these effects and early projections for suppression of the exotic tetraquark candidate X(3872).

**Primary author:** DURHAM, Matt (Los Alamos National Laboratory)

**Presenter:** DURHAM, Matt (Los Alamos National Laboratory)

**Session Classification:** Hadron tomography at EIC and HEP

**Track Classification:** Hadron tomography



Contribution ID: 9

Type: **not specified**

## J/Psi and Psi(2s) production as a probe of low x evolution

We investigate photo-production of vector mesons J/Psi and Psi(2s), based on both HERA and LHC data, using 2 fits of unintegrated gluon distributions. The latter are subject to non-linear Balitsky-Kovchegov evolution (Kutak-Sapeta gluon; KS) and linear next-to-leading order Balitsky-Kuraev-Fadin-Lipatov evolution (Hentschinski-Sabio Vera-Salas; HSS gluon) respectively. Apart from extending previous studies to the case of radially excited charmonium Psi(2s), we further use an improved set of charmonium wave functions and provide an estimate of the uncertainties associated with the HSS gluon. While we observe that the difference between linear and non-linear evolution somehow diminishes and a clear distinction between both HSS and KS gluon is no longer possible using the currently available data-set, we find that the differences between both gluon distributions are enhanced for the ratio of the photo-production cross-sections of Psi(2s) and J/Psi vector mesons.

**Primary author:** Prof. HENTSCHINSKI, Martin (Universidad de las Americas Puebla)

**Presenter:** Prof. HENTSCHINSKI, Martin (Universidad de las Americas Puebla)

**Session Classification:** Gluon saturation at EIC

**Track Classification:** Gluon saturation

Contribution ID: 10

Type: **not specified**

## Dijet photoproduction in lepton-nucleus scattering at the EIC

*Wednesday, 27 January 2021 13:05 (10 minutes)*

We calculate the cross section of inclusive dijet photoproduction in electron-nucleus scattering in the kinematics of the EIC using next-to-leading order (NLO) perturbative QCD and nCTEQ15 and EPPS16 nuclear parton density functions (nPDFs). We establish kinematic reaches in the distributions in the dijet average transverse momentum, the average rapidity, the observed nuclear and photon momentum fractions and also examine the sensitivity of the calculated dijet cross section to nuclear modifications of nPDFs.

**Primary authors:** GUZEY, Vadim (Petersburg Nuclear Physics Institute); Prof. KLASSEN, Michael (University of Münster)

**Presenter:** GUZEY, Vadim (Petersburg Nuclear Physics Institute)

**Session Classification:** Jets at EIC

**Track Classification:** Jets

Contribution ID: 11

Type: **not specified**

## Leading jets and energy loss at the EIC

*Wednesday, 27 January 2021 13:15 (10 minutes)*

The energy loss mechanism of jets plays a central role in nuclear and high energy physics. We propose direct measurements of the energy loss of leading jets and perform a calculation at next-to-leading logarithmic (NLL') accuracy in the vacuum. The formation of leading jets can be described by jet functions which constitute probability densities and thus allow for a perturbative calculation of the average the energy loss. We identify the following three criteria for a direct measurement of jet energy loss at the cross section level. *i)* We measure a well defined object, the leading jet, where the formation process can be expressed in terms of a probability density. *ii)* In addition, we need a measurement of a hard reference scale with respect to which jet energy loss is defined. *iii)* At leading logarithmic accuracy, we require that the jet energy loss can be identified with parton energy loss. We discuss suitable observables at the Electron-Ion Collider and present numerical results including threshold corrections by making use of a parton shower Monte Carlo approach.

**Primary authors:** RINGER, Felix (UC Berkeley/LBNL); NEILL, Duff (LANL); SATO, nobuo (Jefferson Lab)

**Presenter:** SATO, nobuo (Jefferson Lab)

**Session Classification:** Jets at EIC

**Track Classification:** Jets

Contribution ID: 12

Type: **not specified**

## Cold Nuclear Matter effect on jet production at electron-ion colliders

*Wednesday, 27 January 2021 12:55 (10 minutes)*

Jet production and jet substructure at the electron-ion collider play an essential role in revealing the nuclear structure and the evolution of parton showers in cold nuclear matter. We present the theoretical study of inclusive jet cross section and jet charge with the cold nuclear matter effects at the EIC in the framework of soft-collinear effective theory with medium interactions. For the inclusive jet cross section we present the modification in electron-gold collisions in relative to electron-proton collisions, as well as its  $R$  dependence. We also provide the predictions of average jet charge for up-quark jet and inclusive jets. We demonstrate theoretically how to disentangle the effects from nuclear parton-distribution functions and the ones from strong interactions between cold nuclear matter and jet.

**Primary authors:** LI, Haitao (NU & ANL); VITEV, Ivan

**Presenter:** LI, Haitao (NU & ANL)

**Session Classification:** Jets at EIC

**Track Classification:** Jets

Contribution ID: 13

Type: **not specified**

## Heavy meson tomography of cold nuclear matter at the electron-ion collider

*Friday, 29 January 2021 11:50 (5 minutes)*

An important part of the physics program at the future electron-ion collider is to understand the nature of hadronization and the transport of energy and matter in large nuclei. Open heavy flavor production in deep inelastic scattering provides a new tool to address these critical questions. We present the first calculation of D-mesons and B-meson cross sections in electron-nucleus collisions at the EIC by including both next-to-leading order QCD corrections and cold nuclear matter effects. Our formalism employs generalized DGLAP evolution to include the contribution of in-medium parton showers, and is based on methods developed in soft-collinear effective theory with Glauber gluons that describe inclusive hadron production in reactions with nucleons and nuclei. The comprehensive study summarized here allows us to identify the optimal observables, center-of-mass energies, and kinematic regions most sensitive to the physics of energy loss and hadronization at the EIC.

**Primary author:** LIU, Zelong (LANL)**Co-authors:** Dr LI, Haitao; Prof. VITEV, Ivan**Presenter:** LIU, Zelong (LANL)**Session Classification:** Heavy flavor at EIC**Track Classification:** Heavy flavor

Contribution ID: 14

Type: **not specified**

## Open heavy flavor and jet studies for the future Electron-Ion Collider

*Friday, 29 January 2021 11:20 (5 minutes)*

The proposed high luminosity high energy Electron-Ion Collider (EIC) will provide a clean environment to precisely study the nuclear modification of the nuclear parton distribution functions (nPDFs) and hadronization processes within a wide  $x$ - $Q^2$  phase space. Heavy flavor hadron and jet measurements at the future EIC will allow us to better determine the nPDFs in the poorly constrained high Bjorken- $x$  region and provide enhanced sensitivities to the nuclear transport properties in medium. Studies of flavor tagged hadrons or jets and their correlations at the EIC provide a unique path to explore the flavor dependent fragmentation functions and energy loss in heavy nuclei, which can constrain the initial state effects for previous and ongoing heavy ion measurements at Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC). We will present recent results of heavy flavor hadron and jet reconstruction in simulation and the corresponding physics projection such as the flavor dependent hadron nuclear modification factor in electron+nucleus collisions. Initial design and performance of a proposed forward (proton/nuclei going direction) silicon tracking detector, which is essential to carry out these measurements at the EIC will be shown as well.

**Primary author:** Dr LI, Xuan (Los Alamos National Laboratory)

**Co-author:** WONG, Cheuk-Ping (LANL)

**Presenter:** Dr LI, Xuan (Los Alamos National Laboratory)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor

Contribution ID: 15

Type: **not specified**

## QCD evolution of the gluon Sivers function in heavy flavor dijet production at the EIC

*Friday, 29 January 2021 12:10 (5 minutes)*

Using Soft-Collinear Effective Theory, we develop the transverse-momentum dependent factorization formalism for heavy flavor dijet production in polarized-proton electron collisions. We consider heavy flavor mass corrections in the collinear-soft and jet functions, as well as the associated evolution equations. Using this formalism, we generate a prediction for the gluon Sivers asymmetry for the charm and bottom dijet production at the future Electron-Ion Collider. Furthermore, we compare theoretical predictions with and without the inclusion of finite quark masses. We find that the heavy flavor mass effects can give sizable corrections to the predicted asymmetry.

**Primary authors:** KANG, Zhongbo (UCLA); TERRY, John (UCLA); Dr SHAO, Dingyu (UCLA); Mr REITEN, Jared (UCLA)

**Presenter:** Dr SHAO, Dingyu (UCLA)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor

Contribution ID: 16

Type: **not specified**

## A self-consistent determination of proton and nuclear PDFs at the Electron Ion Collider

*Tuesday, 26 January 2021 11:05 (15 minutes)*

We quantify the potential impact of unpolarized lepton-proton and lepton-nucleus inclusive DIS cross sections measured at the Electron-Ion Collider (EIC) on the unpolarized proton and nuclear Parton Distribution Functions (PDFs). To this purpose we include neutral- and charged-current DIS pseudodata in a coherent set of global PDF determinations based on the NNPDF methodology. We find that the EIC could reduce the uncertainty of the light quark PDFs of the proton at large values of the momentum fraction  $x$ , and, more significantly, of the quark and gluon PDFs of nuclei, especially of heavy ions, at small and large  $x$ . We illustrate how the improved precision of nuclear PDFs can impact predictions for the interaction of ultra-high energy cosmic neutrinos with matter.

**Primary author:** ROJO, Juan (VU Amsterdam)

**Presenter:** ROJO, Juan (VU Amsterdam)

**Session Classification:** Hadron tomography at EIC and HEP

**Track Classification:** Hadron tomography



Contribution ID: 17

Type: **not specified**

## **Gluon saturation and spin physics: a window into axion-like dynamics**

*Thursday, 28 January 2021 13:10 (10 minutes)*

We discuss a novel effective action that captures the interplay of hadron spin and gluon saturation in the Regge limit of QCD . In particular, we discuss an emergent axion like dynamics that is mediated by sphaleron transitions. This indicates a window in the strong interactions with formal connections to axion dynamics in dark matter and radiation, and to the role of sphaleron dynamics in B+L violation in the early universe.

**Presenter:** VENUGOPALAN, Raju (BNL)

**Session Classification:** Gluon saturation at EIC

Contribution ID: **18**

Type: **not specified**

## Introduction

*Thursday, 28 January 2021 13:00 (10 minutes)*

**Presenter:** MUKHERJEE, Swagato (BNL)

**Session Classification:** Gluon saturation at EIC

Contribution ID: **19**

Type: **not specified**

## **Spin at small x**

*Thursday, 28 January 2021 13:20 (10 minutes)*

**Presenter:** KOVCHEGOV, Yuri (The Ohio State University)

**Session Classification:** Gluon saturation at EIC

Contribution ID: 20

Type: **not specified**

## J/Psi and Psi(2s) production as a probe of low x evolution

*Thursday, 28 January 2021 13:30 (10 minutes)*

We investigate photo-production of vector mesons J/Psi and Psi(2s), based on both HERA and LHC data, using 2 fits of unintegrated gluon distributions. The latter are subject to non-linear Balitsky-Kovchegov evolution (Kutak-Sapeta gluon; KS) and linear next-to-leading order Balitsky-Kuraev-Fadin-Lipatov evolution (Hentschinski-Sabio Vera-Salas; HSS gluon) respectively. Apart from extending previous studies to the case of radially excited charmonium Psi(2s), we further use an improved set of charmonium wave functions and provide an estimate of the uncertainties associated with the HSS gluon. While we observe that the difference between linear and non-linear evolution somehow diminishes and a clear distinction between both HSS and KS gluon is no longer possible using the currently available data-set, we find that the differences between both gluon distributions are enhanced for the ratio of the photo-production cross-sections of Psi(2s) and J/Psi vector mesons.

**Presenter:** HENTSCHINSKI, Martin (Universidad de las Americas Puebla)

**Session Classification:** Gluon saturation at EIC

Contribution ID: 21

Type: **not specified**

## The impact of gluon saturation in forward dijet/dihadron measurements at the EIC

*Thursday, 28 January 2021 13:40 (10 minutes)*

Inclusive measurements of back-to-back dijets/dihadrons in deeply inelastic scattering (DIS) present a promising channel to access signatures of gluon saturation inside nuclear matter at the future Electron Ion Collider (EIC). While most phenomenological studies have been performed within the powerful TMD factorization framework, there are important kinematic (perturbative power) and genuine saturation corrections that must be resummed for more controlled phenomenological predictions. The Color Glass Condensate (CGC) is a suitable framework that resums both kinds of contributions.

In this talk, I will present our results for inclusive diparton production in proton and nuclear DIS at leading order in the CGC. Our numerical results are compared to the TMD framework for a wide range of kinematics accessible at the future EIC. We find that both kinematic and genuine saturation corrections are significant and could be accessed in dijet and dihadron measurements.

**Presenter:** SALAZAR, Farid (Stony Brook University)

**Session Classification:** Gluon saturation at EIC

Contribution ID: 22

Type: **not specified**

## Deeply Virtual Compton Scattering at Small-x

*Thursday, 28 January 2021 13:50 (10 minutes)*

**Presenter:** YUAN, Feng (Lawrence Berkeley National Laboratory)

**Session Classification:** Gluon saturation at EIC

Contribution ID: 23

Type: **not specified**

## Prospects for diffraction at the EIC

*Thursday, 28 January 2021 14:00 (10 minutes)*

**Presenter:** STASTO, Anna (Penn State University)

**Session Classification:** Gluon saturation at EIC

Contribution ID: 24

Type: **not specified**

## **Overview of other topics in LOI and discussion of writing process**

*Thursday, 28 January 2021 14:20 (40 minutes)*

**Presenter:** SCHENKE, Bjoern (BNL)

**Session Classification:** Gluon saturation at EIC



Contribution ID: 25

Type: **not specified**

## The impact of gluon saturation in forward dijet/dihadron measurements at the EIC

Inclusive measurements of back-to-back dijets/dihadrons in deep inelastic scattering (DIS) present a promising channel to access signatures of gluon saturation inside nuclear matter at the future Electron-Ion Collider (EIC). While most phenomenological studies have been performed within the powerful TMD factorization framework, there are important kinematic (perturbative power) and genuine saturation corrections that must be resummed for more controlled phenomenological predictions. The Color Glass Condensate (CGC) is a suitable framework that resums both kinds of contributions.

In this talk, I will present our results for inclusive diparton production in proton and nuclear DIS at leading order in the CGC. Our numerical results are compared to the TMD framework for a wide range of kinematics accessible at the future EIC. We find that both kinematic and genuine saturation corrections are significant and could be accessed in dijet and dihadron measurements.

**Primary authors:** SALAZAR, Farid (Stony Brook University); SCHENKE, Bjoern (BNL); Dr MÄNTYSAARI, Heikki (University of Jyväskylä); MUELLER, Niklas (Brookhaven National Laboratory); BOUSSARIE, Renaud (Los Alamos National Lab)

**Presenter:** SALAZAR, Farid (Stony Brook University)

**Session Classification:** Gluon saturation at EIC

**Track Classification:** Gluon saturation

Contribution ID: 26

Type: **not specified**

## Exotic Spectroscopy @ EIC studies from JPAC

*Friday, 29 January 2021 12:40 (5 minutes)*

The EIC provides exciting new possibilities to study heavy exotic candidates in photoproduction. Here I provide a summary of current JPAC work to provide estimates of production rates of key exotic candidates such as the X(3872) and Y(4260) at EIC kinematics.

**Primary author:** WINNEY, Daniel (Indiana University)

**Presenter:** WINNEY, Daniel (Indiana University)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor

Contribution ID: 27

Type: **not specified**

## Studies of Open Charm Hadron Reconstruction at the EIC and Implications for Charm Structure Functions

*Friday, 29 January 2021 11:30 (5 minutes)*

The heavy-flavor program for the future Electron-Ion Collider (EIC) at Brookhaven National Laboratory offers many potential measurement opportunities probing the nucleon structure and cold nuclear medium effects with electron-proton(ion) collisions. Among many other interesting topics, a particular expected achievement is the improvement to the gluon nuclear parton distribution function from the measurement of the charm structure functions. In this presentation, we will present the studies of open heavy-flavor hadrons in a wide kinematic region using simulated electron-proton collisions in PYTHIA with detector performance based on a silicon-based tracker for the future EIC detector. We study the reconstruction of open charm hadrons and the effects of using secondary vertex reconstruction to suppress backgrounds including the impacts of primary vertex resolution. The impact of the expected statistical precision on charm structure functions with the nominal projected integrated luminosity will be discussed.

**Primary author:** KELSEY, Matthew

**Presenter:** KELSEY, Matthew

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor

Contribution ID: 28

Type: **not specified**

## Charm as a probe for strangeness at the EIC

*Friday, 29 January 2021 11:40 (5 minutes)*

We explore the feasibility of the measurement of charm-jet cross sections in charged-current DIS at the EIC. This channel provides clean sensitivity to the strangeness content of the nucleon in the high- $x$  region. We show the expected sensitivity to various strange PDFs, and hence this measurement will be key to future QCD global analyses.

**Primary authors:** ARRATIA, Miguel (University of California, Riverside); FURLETOVA, Yulia (Jefferson Lab); HOBBS, Timothy (Southern Methodist University and EIC Center@JLab); OLNESS, Fredrick (SMU); SEKULA, Stephen (SMU)

**Presenter:** OLNESS, Fredrick (SMU)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor

Contribution ID: 29

Type: **not specified**

## $\Lambda_c$ baryon production at future EIC

*Friday, 29 January 2021 12:00 (5 minutes)*

In high energy collisions, heavy quarks (c, b) are predominately produced in the initial hard scattering process. The relative ratio of different heavy flavor hadrons species serves as a tool to study charm quark hadronization mechanism. Recently, data from  $p+p$ ,  $p+A$ , and  $A+A$  collisions at RHIC and LHC showed that the  $\Lambda_c^+/D^0$  ratio is considerably larger than the fragmentation baseline. The high luminosity e+p and e+A collisions in the future Electron-Ion Collider (EIC) at Brookhaven National Laboratory would allow us to systematically investigate the  $\Lambda_c$  production over a broad kinematic region, which will shed detail insights on charm hadrochemistry and charm-quark hadronization. In this talk, I will present the reconstruction capability study for  $\Lambda_c^+$  baryons at the future EIC experiment utilizing an all silicon tracker based on next generation MAPS technology. Physics projections on the measurement of  $\Lambda_c^+/D^0$  ratio in e+p collisions in the future EIC will be presented.

**Primary author:** JI, Yuanjing (BNL)**Presenter:** JI, Yuanjing (BNL)**Session Classification:** Heavy flavor at EIC**Track Classification:** Heavy flavor

Contribution ID: 30

Type: **not specified**

## Search for Charged Lepton Flavor Violation at the Electron-Ion Collider

*Monday, 25 January 2021 11:30 (10 minutes)*

In the Standard Model of Physics (SM) associated with every conservation law there exists a symmetry. While no such symmetry associated with conservation of charge lepton flavors (CLF) has been identified, we still have not observed its experimental violation. Evidence for CLF violation (CLFV) would hence mean existence of physics Beyond the SM (BSM) and is of high interest. The recently approved Electron-Ion Collider (EIC) at BNL with 100-1000 times higher high luminosity than HERA (at DESY, German) will provide a unique new opportunity for such a search. In contrast with the CLFV transition between the  $e$  and  $\mu$  for which very stringent limits exist, there is still relatively large discovery space for the CLFV transition between the  $e$  and  $\tau$  within EIC's reach. With the modern detector designed for the EIC,  $\tau$ s created in e-p scattering at the EIC are expected to be identified with high efficiency. In this talk, we will present results from an ongoing study of sensitivity possible for  $e \rightarrow \tau$  conversion in e-p scattering at the EIC.

**Primary author:** ZHANG, Jinlong (Shandong University)

**Presenter:** ZHANG, Jinlong (Shandong University)

**Session Classification:** EW & BSM

**Track Classification:** EW & BSM

Contribution ID: 31

Type: **not specified**

## Toward a universal definition of TMD Fragmentation Functions

*Tuesday, 26 January 2021 12:35 (15 minutes)*

In semi-inclusive deep-inelastic scattering (SIDIS), the observables can be written in terms of two contributions: nucleon structure (i.e. the way partons are arranged in nucleons, encoded in the Transverse-Momentum Dependent Parton Distributions - TMD PDFs) and the mechanism of hadronization (encoded in the TMD Fragmentation Functions - TMD FFs). A reliable extraction of the former requires a detailed knowledge of the latter. In this regard, one of the cleanest processes from which we can gather information about TMD FFs is single hadron production in  $e^+e^-$  annihilation, with the jet axis being reconstructed. Unfortunately, the usual TMD factorization cannot be directly applied to this process. We present a factorization scheme that allows to write a proper factorization theorem for such cross section, restoring the possibility to perform global phenomenological studies of TMD physics by providing a framework in which SIDIS and  $e^+e^-$  data can be combined together.

**Primary author:** SIMONELLI, Andrea (University of Torino and INFN Torino)

**Co-author:** BOGLIONE, Mariaelena (University of Turin)

**Presenter:** SIMONELLI, Andrea (University of Torino and INFN Torino)

**Session Classification:** Hadron tomography at EIC and HEP

**Track Classification:** Hadron tomography

Contribution ID: 32

Type: **not specified**

## Measuring gluon polarization in the nucleon via open charm production at the EIC

*Friday, 29 January 2021 11:10 (5 minutes)*

To understand gluon polarization inside a polarized nucleon is one of the most important physics goals of the future EIC proposed at Brookhaven National Laboratory. In addition to the extraction of such information by a QCD fit on the polarized  $g_1$  structure functions, another direct measurement on gluon polarization via double spin asymmetries in the open charm production through photon-gluon fusion process is proposed. In this talk, the idea of such measurement and simulation studies at the EIC will be presented.

**Primary author:** Dr ZHAO, Yuxiang (Institute of Modern Physics, Chinese Academy of Sciences)

**Presenter:** Dr ZHAO, Yuxiang (Institute of Modern Physics, Chinese Academy of Sciences)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor



Contribution ID: 33

Type: **not specified**

## Welcome and summary of Snowmass aims

*Tuesday, 26 January 2021 11:00 (5 minutes)*

**Presenter:** Prof. LIN, Huey-Wen (Michigan State University)

**Session Classification:** Hadron tomography at EIC and HEP

Contribution ID: 34

Type: **not specified**

## Discussion toward Snowmass proceedings

*Tuesday, 26 January 2021 13:15 (30 minutes)*

**Primary authors:** VICINI, Alessandro (University of Milano); PROKUDIN, Alexei (Penn State Berks); FAZIO, Salvatore (Brookhaven National Laboratory); HOBBS, Timothy (Southern Methodist University and EIC Center@JLab)

**Presenter:** HOBBS, Timothy (Southern Methodist University and EIC Center@JLab)

**Session Classification:** Hadron tomography at EIC and HEP

Contribution ID: 35

Type: **not specified**

## Extraction of the $\Lambda$ Polarizing Fragmentation Function from Belle $e^+e^-$ data

*Wednesday, 27 January 2021 13:25 (10 minutes)*

We present a phenomenological analysis of the experimental data from Belle Collaboration for the transverse polarization of Lambda's measured in  $e^+e^-$  annihilation processes, both for the case of associated and inclusive (plus a jet) production. We extract for the first time, within a TMD approach, the quark polarizing fragmentation function for a Lambda hyperon, a distribution giving the probability that an unpolarized quark fragments into a transversely polarized spin-1/2 hadron. Similar analyses in  $eP \rightarrow e\Lambda + X$  processes at the EIC will be crucial for understanding the universality and evolution properties of the TMD polarizing FF.

**Primary authors:** Prof. D'ALELIO, Umberto (Università degli Studi di Cagliari & INFN); Prof. MURGIA, Francesco (INFN); ZACCHEDDU, Marco (Università degli studi di Cagliari & INFN)

**Presenter:** ZACCHEDDU, Marco (Università degli studi di Cagliari & INFN)

**Session Classification:** Jets at EIC

**Track Classification:** Jets

Contribution ID: 36

Type: **not specified**

## Quark and Gluon quasi-PDFs at low- $x$

Quasi parton distribution functions (PDFs) are related to the matrix elements of bilocal operators with space-like separation. The possibility to calculate these objects on the lattice has attracted much attention in the QCD community. I will present the behavior of quark and gluon quasi-PDFs at low- $x$ .

**Primary author:** CHIRILLI, Giovanni Antonio (University of Regensburg)

**Presenter:** CHIRILLI, Giovanni Antonio (University of Regensburg)

**Session Classification:** Gluon saturation at EIC

**Track Classification:** Gluon saturation

Contribution ID: 37

Type: **not specified**

## Introduction

Contribution ID: **38**

Type: **not specified**

## **Introduction**

*Friday, 29 January 2021 11:00 (10 minutes)*

**Session Classification:** Heavy flavor at EIC

Contribution ID: **39**

Type: **not specified**

## **Introduction**

*Wednesday, 27 January 2021 11:00 (10 minutes)*

**Presenter:** NADOLSKY, Pavel (Southern Methodist University)

**Session Classification:** Jets at EIC

Contribution ID: 40

Type: **not specified**

## **Jets at the EIC**

*Wednesday, 27 January 2021 11:35 (25 minutes)*

**Presenter:** RINGER, Felix (UC Berkeley/LBNL)

**Session Classification:** Jets at EIC



Contribution ID: 41

Type: **not specified**

## **Jets for longitudinal spin physics**

*Wednesday, 27 January 2021 12:00 (25 minutes)*

**Presenter:** PETRIELLO, Frank (Northwestern University)

**Session Classification:** Jets at EIC

Contribution ID: 42

Type: **not specified**

## summary and plan

*Wednesday, 27 January 2021 13:35 (20 minutes)*

**Presenter:** KANG, Zhongbo (UCLA)

**Session Classification:** Jets at EIC

Contribution ID: 43

Type: **not specified**

## TMD structure at the EIC using jets

*Wednesday, 27 January 2021 12:45 (10 minutes)*

The understanding of the fragmentation process is important as it will provide us with a deep insight into the elusive mechanism of hadronization. In recent years, observation of hadron inside jets has become important observable to understand and extract fragmentation functions. In this flash talk, I will demonstrate the usefulness of studying hadron distribution inside jets and how its framework can be generalized to include polarization.

**Presenter:** LEE, Kyle (LBNL)

**Session Classification:** Jets at EIC

Contribution ID: 44

Type: **not specified**

## Probing gluon distributions with heavy quark pairs at the EIC

*Friday, 29 January 2021 12:20 (5 minutes)*

Heavy quark production in deep inelastic scattering proceeds via the Boson Gluon Fusion process and thus provides constraints to the gluon distributions inside the nucleon/ion probed. Measurements of charm and anti-charm hadron pair production in deep inelastic scatterings can be used to probe the gluon transverse momentum dependent distributions (TMDs) in the nucleon/ion. In this talk we will discuss open charm hadron pair reconstruction studies with an all silicon detector design for a future Electron Ion Collider (EIC) experiment, and utilizing them for measuring the TMDs. Statistical uncertainty projections for physics observables in both polarized and unpolarized collisions at the EIC will be discussed.

**Primary author:** RADHAKRISHNAN, Sooraj (Kent State Univ./Lawrence Berkeley National Laboratory)

**Presenter:** RADHAKRISHNAN, Sooraj (Kent State Univ./Lawrence Berkeley National Laboratory)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor

Contribution ID: 45

Type: **not specified**

## In-medium fluctuations in the GLV formalism

*Friday, 29 January 2021 12:30 (5 minutes)*

Droplets of quark-gluon plasma produced in heavy-ion collisions rapidly evolve expanding and cooling. During considerable part of this dynamics the system can be described within relativistic hydrodynamics. Recently, there were some attempts to include effects of the medium motion to the jet energy loss and jet modification calculations in a variety of models. Here we will present the first principle consideration of the medium motion effects on the jet broadening and soft gluon radiation within the GLV approximation. We will show that the developed formalism can be also applied to derive the effects of in-medium fluctuations on a wide range of the jet observables at EIC.

**Primary author:** SADOFYEV, Andrey (Los Alamos National Laboratory)

**Presenter:** SADOFYEV, Andrey (Los Alamos National Laboratory)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor

Contribution ID: 46

Type: **not specified**

## Design and Performance of an All-Silicon Tracker for the Electron Ion Collider

*Friday, 29 January 2021 12:50 (5 minutes)*

State-of-the-art detectors are required to fulfill the challenging physics program of the future Electron-Ion Collider (EIC). Specifically, a hermetic, low-material-budget, compact tracker with excellent momentum and pointing resolution capabilities is needed. The experience gained with semiconductor detectors in previous colliders indicates that this technology is one of the best options to satisfy the EIC tracking requirements. We have designed and studied an all-silicon tracker prototype using the GEANT-based Fun4All simulation package. This tracker is hermetic for  $|\eta| < 3.5$  and satisfies the projected material-budget requirements for an EIC tracker. Resolutions were studied by generating different particles from the nominal interaction point over the entire detector acceptance and up to momenta of 25 GeV/c and reconstructing them with the detector concept embedded in 1.4 and 3.0 T solenoidal magnetic fields. Jets resolutions were also studied from electron-proton collisions using the PYTHIA 8 event generator. We compared the momentum-resolution performance of the tracker with the requirements outlined by the EIC physics working groups and identified phase-space regions where the tracker out-performs the requirements. In regions where the requirements are more stringent than the tracker performance, we studied potential options to enhance the performance.

**Primary author:** Dr CRUZ TORRES, Reynier (Lawrence Berkeley National Laboratory)

**Presenter:** Dr CRUZ TORRES, Reynier (Lawrence Berkeley National Laboratory)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor

Contribution ID: 47

Type: **not specified**

## Discussion and Summary

*Friday, 29 January 2021 13:00 (30 minutes)*

**Session Classification:** Heavy flavor at EIC

Contribution ID: 48

Type: **not specified**

## Probing the structure of exotic hadrons at the EIC

The EIC will provide a powerful tool for discriminating between various models of exotic hadron structure. Exotics that hadronize inside the nucleus must pass through nuclear matter, where they can interact with other partons and be disrupted. The magnitude of this disruption is expected to depend on the radius/binding energy of the state. Thus, the nucleus can act as a filter that preferentially suppresses extended states, while allowing compact states to pass through relatively unscathed. We will present a brief discussion of these effects and early projections for suppression of the exotic tetraquark candidate  $X(3872)$ .

**Primary author:** DURHAM, Matt (Los Alamos National Laboratory)

**Presenter:** DURHAM, Matt (Los Alamos National Laboratory)

**Session Classification:** Heavy flavor at EIC

**Track Classification:** Heavy flavor



Contribution ID: 49

Type: **not specified**

## Prospects for Dark Photons at EIC

*Monday, 25 January 2021 11:40 (10 minutes)*

Dark Photons have been proposed across a variety of mass scales in order to address anomalies in precision measurements and to provide a window into the dark sector. Over the past decade, many experiments have probed and ruled out dark photons in the most promising regions of the parameter space for simple models. However, the majority of these searches rely on hadronic production modes which, in some models, are significantly suppressed. The EIC's asymmetric beam energies offer a unique collision kinematics to mount a search for dark photons through purely leptonic production and decay modes. I will discuss the prospects for this measurement and a brief review of other related studies that can be undertaken at the EIC.

**Primary author:** CORLISS, Ross (SBU)

**Presenter:** CORLISS, Ross (SBU)

**Session Classification:** EW & BSM

**Track Classification:** EW & BSM

Contribution ID: 50

Type: **not specified**

## Overview of LOI contributions

*Monday, 25 January 2021 11:10 (20 minutes)*

**Presenter:** GAL, Ciprian (Stony Brook University)

**Session Classification:** EW & BSM

Contribution ID: 51

Type: **not specified**

## Introduction

*Monday, 25 January 2021 11:00 (10 minutes)*

**Presenter:** LEE, Yen-Jie (Massachusetts Institute of Technology)

**Session Classification:** EW & BSM

Contribution ID: 52

Type: **not specified**

## **Plans for proceedings**

*Monday, 25 January 2021 12:00 (20 minutes)*

**Session Classification:** EW & BSM

Contribution ID: 53

Type: **not specified**

## High dimensional jet measurements

*Wednesday, 27 January 2021 11:10 (25 minutes)*

**Presenter:** NACHMAN, Benjamin

**Session Classification:** Jets at EIC

Contribution ID: 54

Type: **not specified**

## Quarkonium production and gluon TMDs at the EIC

*Tuesday, 26 January 2021 12:05 (15 minutes)*

**Primary author:** TAELS, Pieter (Ecole Polytechnique)

**Presenter:** TAELS, Pieter (Ecole Polytechnique)

**Session Classification:** Hadron tomography at EIC and HEP

Contribution ID: 55

Type: **not specified**

## Update on Gluon Saturation in EIC Yellow Report

*Thursday, 28 January 2021 14:10 (10 minutes)*

**Presenter:** LAPPI, Tuomas (University of Jyvaskyla)

**Session Classification:** Gluon saturation at EIC