Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

FY2024 NPP LDRD Type B Pre-Proposal

EpIC CGC – Monte Carlo for exclusive processes at the EIC

2/8/2023

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FY2024 NPP LDRD Type B Pre-Proposal

Proposal title: EpIC CGC – Monte Carlo for exclusive processes at the EIC

Primary Investigator: Bjoern Schenke

Other Investigators: Kemal Tezgin (BNL), Elke Aschenauer (BNL), Heikki Mäntysaari (Jyvaskyla Uni) Pawel Sznajder (NCBJ-Warsaw)

Indicate if this is a cross-directorate proposal. Yes ___ No_X_

If yes, identify other directorates/organizations:

Not eligible for DOE ECA proposals

Proposal Term: From: 10/2023 To: 9/2025

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EpIC CGC – Monte Carlo for exclusive processes at the EIC

Develop a Monte-Carlo event generator for exclusive processes of deeply virtual Compton scattering (DVCS) and J/psi leptoproduction that are sensitive to the dense gluon regime inside nuclei. With the EpIC event generator, various GPD models can currently be simulated. Despite this, EpIC cannot effectively account for saturation effects due to its limited sensitivity to the small x region. We propose to implement CGC-based approaches into EpIC. This will allow to

1) Generate event-by-event results from CGC and apply detector acceptance simulations to obtain pseudo-data
2) Compare GPD and CGC approaches on the same footing, and open up communication between two communities
3) Explore background to DVCS, such as the Bethe-Heitler process

Program: NP

Return on Investment: Potential future funding from DOE Office of Science, Nuclear Theory. Seeds expertise in Monte-Carlo event generators at BNL and the US in general. Supports planning of EIC detectors, especially a potential 2nd detector (at IP8)

Broader impact on the activities at the laboratory: Will provide simulations, predictions, physics interpretation, needed by the EIC

Total planned funding per year in FY24 and FY25 $200,000 per year

Description of the LDRD Pre- Proposal

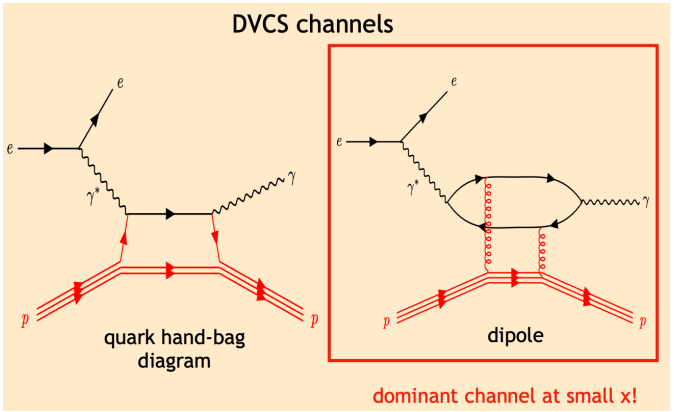
We have expertise here at BNL on

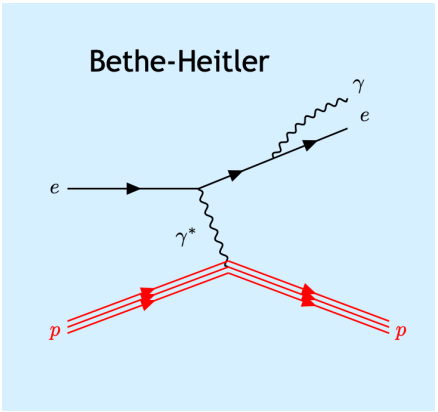
1. Color Glass Condensate calculations (NT group)
2. Monte Carlo event generators based on generalized parton distribution functions (GPDs) (Cold QCD group)

- It would be a wasted opportunity not to join efforts
- In the long run, a general Monte Carlo simulator for any process at the EIC, sensitive to small x is needed
- A natural starting point is to focus on exclusive processes, such as Deeply Virtual Compton Scattering (DVCS) and diffractive vector meson production

Description of the LDRD Pre- Proposal

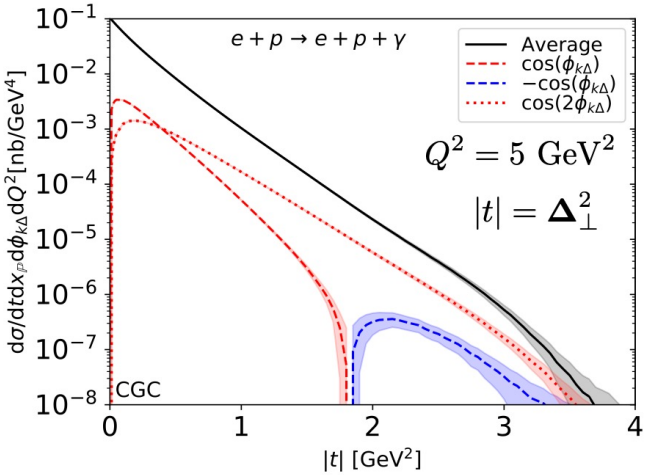
DVCS:





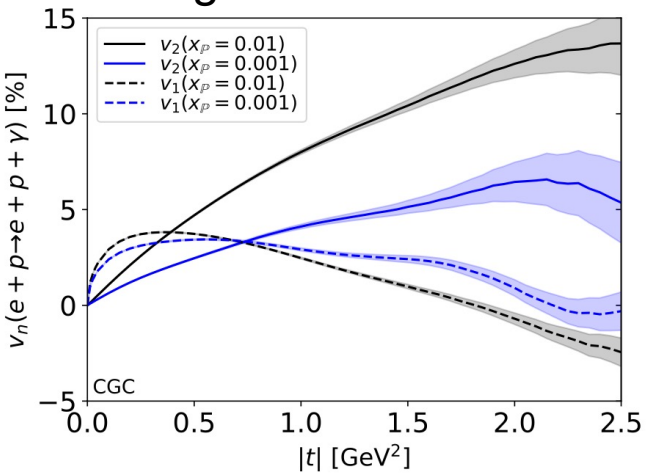
Gluon imaging using azimuthal correlations in diffractive scattering at the Electron-Ion Collider
Heikki Mäntysaari, Kaushik Roy, Farid Salazar, Björn Schenke, Phys.Rev.D 103 (2021) 9, 094026

Cross sections from the CGC



Significant contribution from large dipoles even at large Q^2 due to $z \to 0,1$

Angular correlations



Predict dependence of v_n on |t| and $x_{\mathbb{P}}$
Evolution decreases anisotropies

Description of the LDRD Pre- Proposal

Analogously, also studied exclusive J/ψ production.
Angular correlations contain information on correlations in the multi-gluon distribution *Hatta, Yuan, Xiao. arXiv:1703.02085*
Mäntysaari, Roy, Salazar, Schenke. arXiv:2011.02464

Is it measurable? What statistics are needed? How does it compare to the BH background? How do the results compare to GPD frameworks? We don't know.

Entering - EpIC:

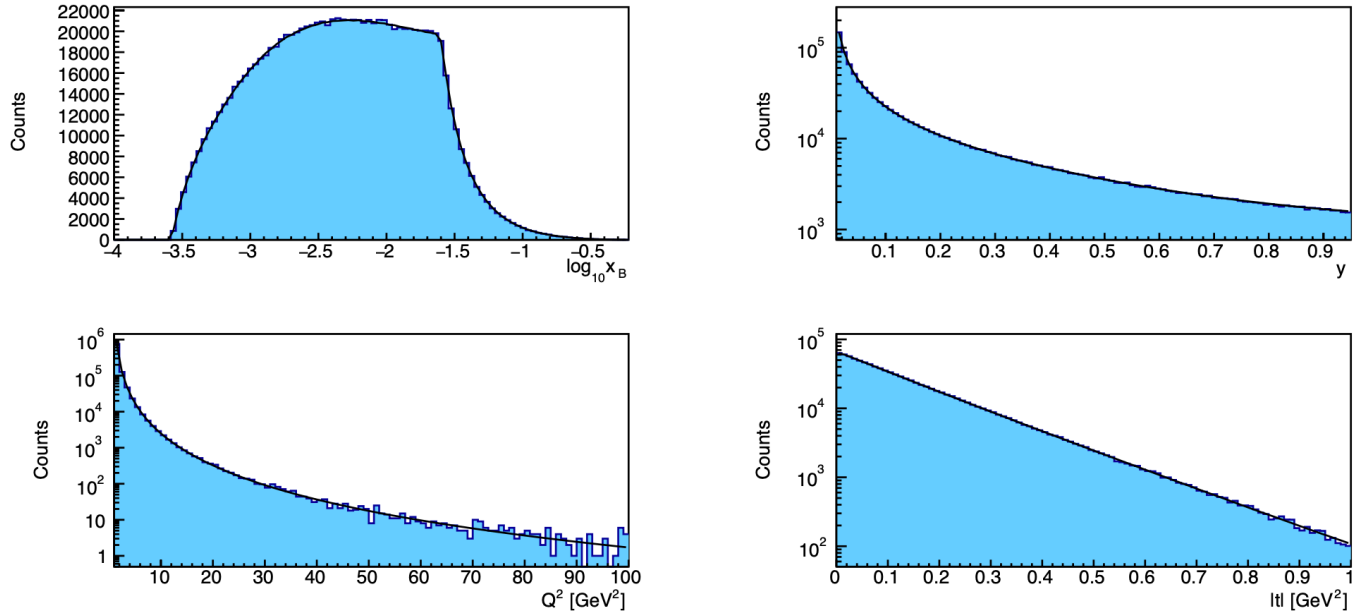
EpIC: novel Monte Carlo generator for exclusive processes
E.C. Aschenauer, V. Batozskaya, S. Fazio, K. Gates, H. Moutarde, Eur.Phys.J.C 82 (2022) 9, 819

We need to sample CGC cross sections, generate events, compare to BH (also work out interference), compare to GPD framework already in EpIC. Also helps in extending EpIC to e+A collisions

Description of the LDRD Pre- Proposal

EpIC is an event generator for exclusive processes:

1. Can generate events by using various GPD models
2. Has a flexible architecture for adding new models
3. Multi-channel analysis: DVCS, TCS and DVMP
4. Can generate events with QED radiative corrections



Distribution of unpolarized DVCS events using the Goloskokov-Kroll GPDs in EpIC

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Summary Slide

- Join forces between Cold QCD and NT groups
- Build a Monte-Carlo generator based on EpIC and the CGC to study exclusive processes at small *x*
- Compare GPD and CGC frameworks: This will also initiate interactions between otherwise distinct communities
- Couple to detector simulations and determine requirements to measure small-x cross sections and angular correlations
- The setup and expertise gained from this will allow to include more and more processes: e.g., exclusive and inclusive dijets and dihadrons