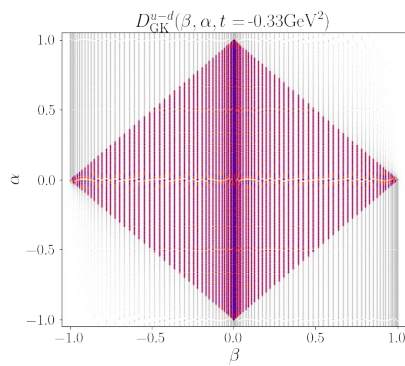
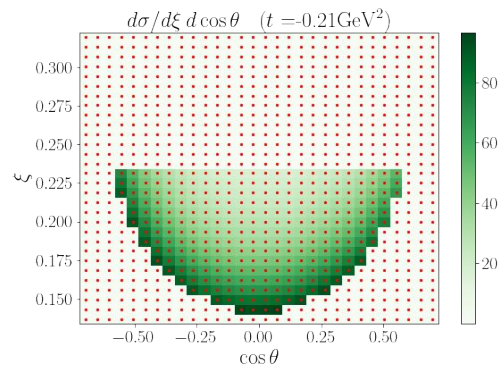


LD2406 Q2 - GPDs from polarization asymmetries with photoproduction in Hall D: **highlights**

Objective Number	Milestone	FY23				FY24			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Develop numerical codes for GPD evolution in Pytorch								
2	Calculate and implement LO hard cross sections in pQCD								
3	Simulate $\gamma N \rightarrow \pi \gamma N'$ observables at Hall D kinematics using existing GPD models								
4	Develop the GPD extraction toolkit for $\gamma N \rightarrow \pi \gamma N'$ observables using ML								
5	Calculation of NLO hard cross sections in pQCD								
6	Extend the framework to include pQCD NLO corrections								
7	Execute closure tests to validate the reconstruction of the x -dependence of GPDs								
8	Explore the sensitivity of extracting GPDs as a function of beam polarization and energy dependence at Hall D kinematics								

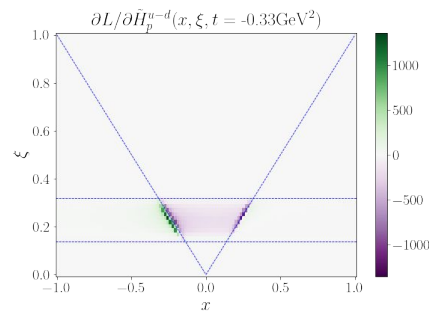
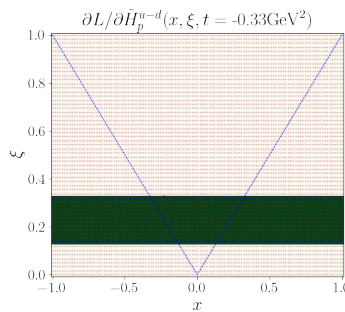
- **#1:** Matrix based evolution has been completed.
- **#3:** Dedicated study of GlueX sensitivity to $\gamma p \rightarrow \gamma \pi^0 p$ in progress. Need to complete study of detector acceptance and potential backgrounds with existing data and Geant4 simulations by August.
- **#4:** Issues with pixels optimization. We have confirm that all the pixels associated with the physical observables have non-zero gradients.
- A solution to isolate only the tunable GPD pixels was developed which saves significant computing resources for the GPD inference.
- **#5:** *Calculation of the NLO short-distance matching coefficients for this exclusive process is still in progress. Not only we need to evaluate over 500 uncut loop diagrams, we have to deal with end point singularities for exclusive processes even at the leading power, which is much more challenging than anticipated. We are developing numerical approaches to estimate the relative size of NLO to LO before getting the full NLO contribution analytically.*



Dots: sampled grid points;
Shaded: physical region.

Gray: sampled DD points;
Red: $|\alpha| + |\beta| \leq 1$
Blue: gradients nonzero

22.5% of pixels satisfy physical bounds
 2.27% of pixels are tunable



- Test of simple quadratic loss function
- Starting with GPD $t \in [-1, 0]$ GeV², $\xi \in [0, 1]$
- Physical cuts: $|t| \leq 0.4$ GeV², $q_T \geq 1$ GeV
- 7.33% of pixels are tunable (in physical range)

LD2406 - GPDs from polarization asymmetries with photoproduction in Hall D: financial report

Objective Number	Milestone	FY23				FY24			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Develop numerical codes for GPD evolution in Pytorch								
2	Calculate and implement LO hard cross sections in pQCD								
3	Simulate $\gamma N \rightarrow \pi \gamma N'$ observables at Hall D kinematics using existing GPD models								
4	Develop the GPD extraction toolkit for $\gamma N \rightarrow \pi \gamma N'$ observables using ML								
5	Calculation of NLO hard cross sections in pQCD								
6	Extend the framework to include pQCD NLO corrections								
7	Execute closure tests to validate the reconstruction of the x-dependence of GPDs								
8	Explore the sensitivity of extracting GPDs as a function of beam polarization and energy dependence at Hall D kinematics								

PI 5%

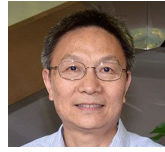
Co-PI



NS



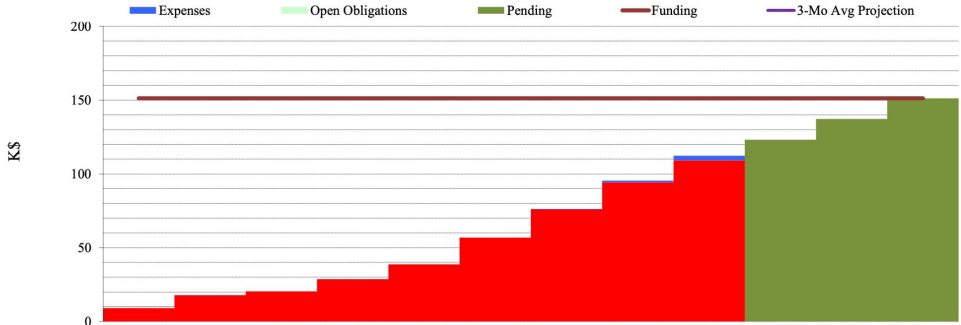
W. Melnichuk



J. W. Qiu



J. Stevens



	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24
YTD Spending	9	18	20	29	39	57	76	95	112	123	137	151
Pending	0	0	0	0	0	0	0	0	0	123	137	151
Open Obligations	0	0	0	0	0	0	0	0	0	0	0	0
Expenses	0	0	0	0	0	0	0	1	3	0	0	0
Labor	9	18	20	29	39	57	76	94	109	0	0	0
Funding	151	151	151	151	151	151	151	151	151	151	151	151
3-Mo Avg Projection												

theory



Z-Y. Li

scidac



A. Freeze

FY24 pdoc



Z. Yu

FY24 grad



S. Arrigo

Publications

Single Diffractive Hard Exclusive Processes for the Study of Generalized Parton Distributions

Phys. Rev. D 107 (2023)

Qiu, Yu

Extraction of the Parton Momentum-Fraction Dependence of Generalized Parton Distributions from Exclusive Photoproduction

Qiu, Yu,

Phys. Rev. Lett. 131 (2023)

Extracting Transition Generalized Parton Distributions From Hard Exclusive Pion-Nucleon Scattering

Qiu, Yu,

Phys. Rev. D 109 (2024)

New paper “A new frame for deeply virtual Compton scattering”

Qiu, Sato, Yu,

In preparation

New paper “Azimuthal modulations and extraction of generalized parton distributions”

Qiu, Sato, Yu,

In preparation

Conferences

QCD Factorization of Hard Exclusive Processes and Tomographic Image of Proton. “CTEQ Spring Meeting 2024” [6/4/2024]

Z. Yu

New Physical Processes for Extracting GPDs with a Better Sensitivity to Partonic Structure. “From Quarks and Gluons to the Internal Dynamics of Hadrons (CFNS workshop)” [5/16/2024]

Z. Yu

QCD Factorization of Hard Exclusive Processes and Tomographic Images of the Proton. “APS April Meeting 2024” [4/5/2024]

Z. Yu

Exclusive Diphoton Mesoproduction at J-PARC for Probing QCD Tomography with Enhanced Sensitivity. “Fourth International Workshop on the Extension Project for the J-PARC Hadron Experimental Facility (HEF-ex 2024)” [2/21/2024]

Z. Yu

Exclusive Photoproduction Reactions for Nucleon Structure (GPDs). “Workshop on Polarized Target Studies with Real Photons in Hall D” [2/21/2024]

Z. Yu

Single Diffractive Hard Exclusive Processes for Studying Generalized Parton Distributions (GPDs). “Workshop on GPDs for Nucleon Tomography in the EIC Era” [1/18/2024]

Z. Yu

Single Diffractive Hard Exclusive Processes for Studying Generalized Parton Distributions (GPDs). “The 2023 Fall Meeting of APS DNP and JPS” [11/27/2023]

Z. Yu

Explore Nucleon's Quark/Gluon Structure without Breaking it.

Nuclear physics seminar, Physics Department, University of Illinois at Urbana-Champaign

J. Qiu

