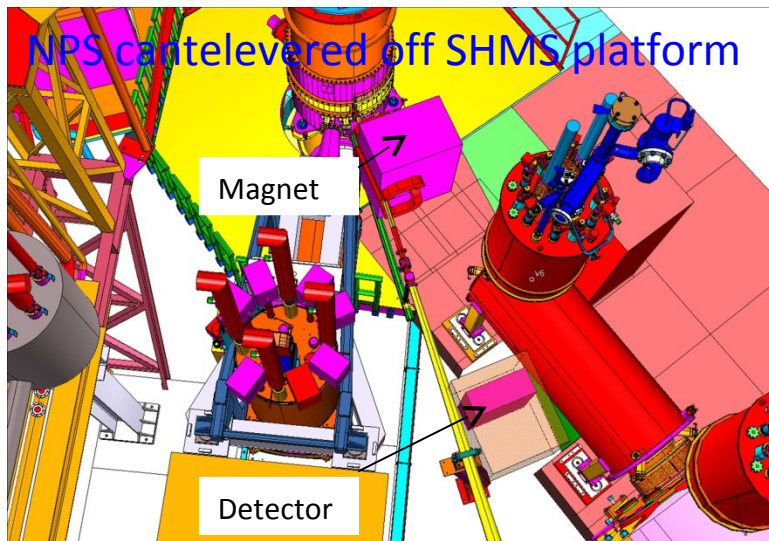
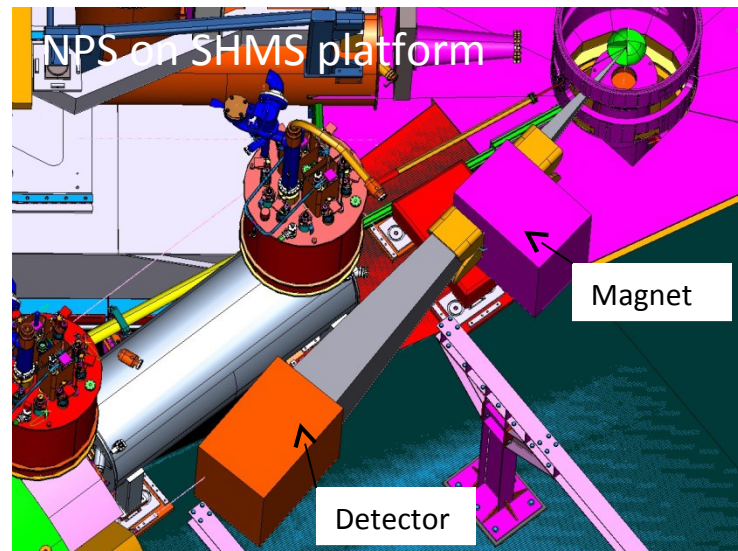


The Neutral-Particle Spectrometer (NPS)

The NPS is envisioned as a facility in Hall C, utilizing the well-understood HMS and the SHMS infrastructure, to allow for precision (coincidence) cross section measurements of neutral particles (γ and π^0). The NPS will be remotely rotatable off the SHMS platform.



NPS angle range: 5.5 – 30 degrees



NPS angle range: 25 – 60 degrees

The large interest for such a device can be exemplified by the PAC-approved program:
E12-13-007 – Measurement of Semi-inclusive π^0 production as Validation of Factorization
E12-13-010 – Exclusive Deeply Virtual Compton and

Neutral Pion Cross Section Measurements in Hall C

(E12-13-007 & E12-13-010 can run as one run group – first run group in Hall C)

E12-14-003 – Wide-angle Compton Scattering at 8 and 10 GeV Photon Energies

E12-14-005 – Wide Angle Exclusive Photoproduction of π^0 Mesons (runs as run group with E12-14-003)

E12-14-006 – Initial State Helicity Correlation in Wide-Angle Compton Scattering

EXP. NO.	Hall	Title	Spokespersons	Institutions	Beam Days	Rating	PAC	Run Group
E12-13-007	C	Measurement of Semi-Inclusive π^0 Production as Validation of Factorization	R. Ent	JLab	25	A-	40	A
			T. Horn	CUA				
			H. Mkrtchyan	Yerevan				
			V. Tadevosyan	Yerevan				
E12-13-010	C	Exclusive Deeply Virtual Compton and Neutral Pion Cross-Section Measurements in Hall C	C. Munoz Camacho	IPN Orsay	53	A	40	A
			R. Paremuzyan	IPN Orsay				
			T. Horn	CUA				
			C. Hyde	ODU				
			J. Roche	Ohio U				
E12-14-003	C	Wide-angle Compton Scattering at 8 and 10 GeV Photon Energies	B. Wojtsekhowski	JLab	18	A-	42	B
			D. Hamilton	Glasgow				
			S. Sirca	Ljubljana				
E12-14-005	C	Wide Angle Exclusive Photoproduction of π^0 Mesons	D. Dutta	Miss. State	18	B	42	B
			M. Amaryan	ODU				
			H. Gao	Duke				
			M. Kunkel	ODU				
			S. Sirca	Ljubljana				
			I. Strakovsky	GWU				
E12-14-006	C	Initial State Helicity Correlation in WideAngle Compton Scattering	D. Keller	UVa	15	B	42	C
			D. Day	UVa				
			J. Zhang	UVa				

Approved PAC days

129

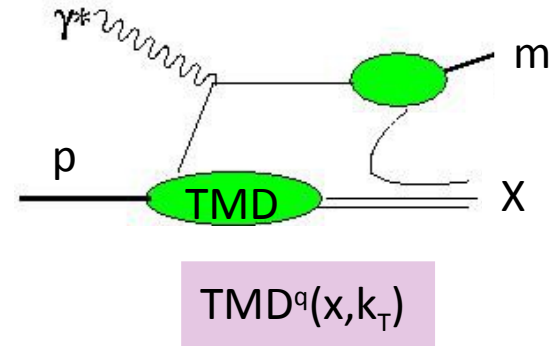
Run Group days

86

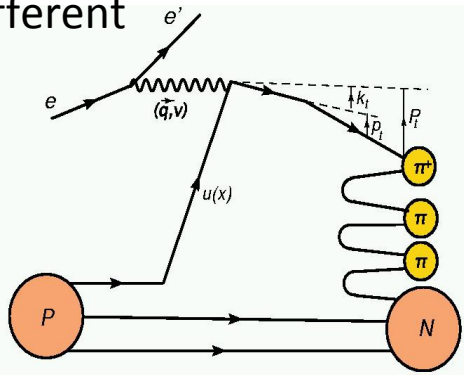
Hall C SIDIS Program – basic $(e, e' \pi)$ cross sections

Linked to framework of *Transverse Momentum Dependent Parton Distributions*

- Validation of factorization theorem needed for most future SIDIS experiments and their interpretation
- Need to constrain TMD evolution w. precision data
- Questions on target-mass corrections and $\ln(1-z)$ resummations require precision large- z data



Transverse momentum widths of quarks with **different flavor (and polarization)** can be different



$$P_T = p_t + z k_t + O(k_t^2/Q^2)$$

E12-13-007 goal: Measure the **basic SIDIS cross sections** of π^0 production off the proton, including a map of the P_T dependence ($P_T \sim \Lambda < 0.5$ GeV), to validate^(*) flavor decomposition and the k_T dependence of (unpolarized) up and down quarks

() Can only be done using spectrometer setup capable of % type measurements (an essential ingredient of the global SIDIS program!)*

Requires new ~ 25 msr Neutral-Particle Spectrometer

Advantages of $(e, e' \pi^0)$ beyond $(e, e' \pi^{\pm})$

- Many experimental and theoretical advantages to validate understanding of SIDIS with neutral pions
- Can verify: $\sigma^{\pi^0}(x, z) = \frac{1}{2} (\sigma^{\pi^+}(x, z) + \sigma^{\pi^-}(x, z))$
- Confirms understanding of flavor decomposition/ k_T dependence

PAC: “the **cross sections** are **such basic tests of the understanding of SIDIS** at 11 GeV kinematics that they will play a **critical role** in establishing the entire SIDIS program of studying the partonic structure of the nucleon.”

Towards the 3D Structure of the Proton

Simplest process: $e + p \rightarrow e' + p + \gamma$ (DVCS)

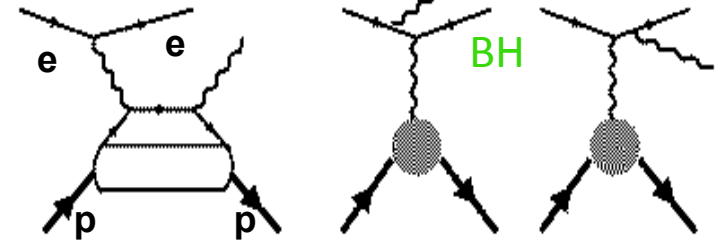
E12-13-010 DVCS measurements follow up on DVCS measurements in Hall A:

- Scaling of the Compton Form Factor
- Rosenbluth-like separation of DVCS:

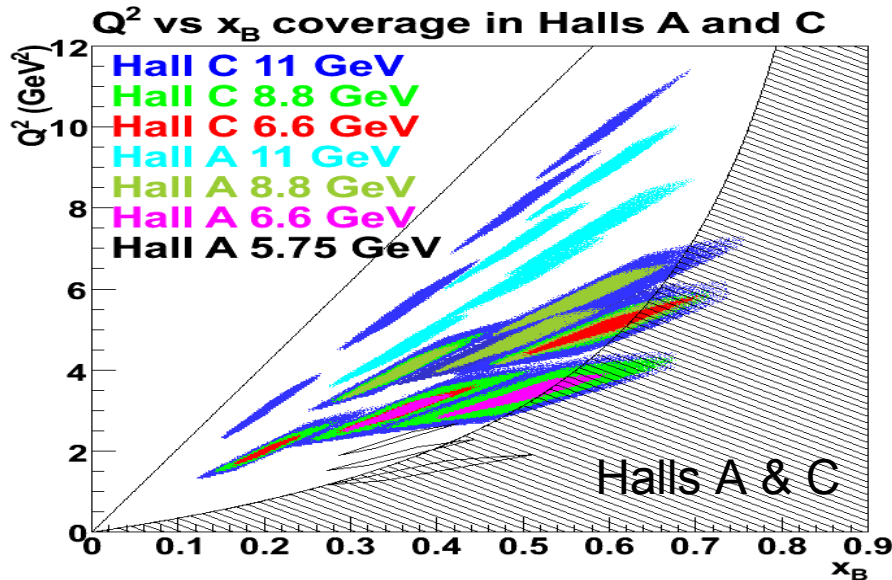
$$\sigma = |BH|^2 + \text{Re}[DVCS^\dagger BH] + |DVCS|^2$$

$$\sim E_{\text{Beam}}^2 \quad \sim E_{\text{Beam}}^3$$
- L/T Separation of π^0 production

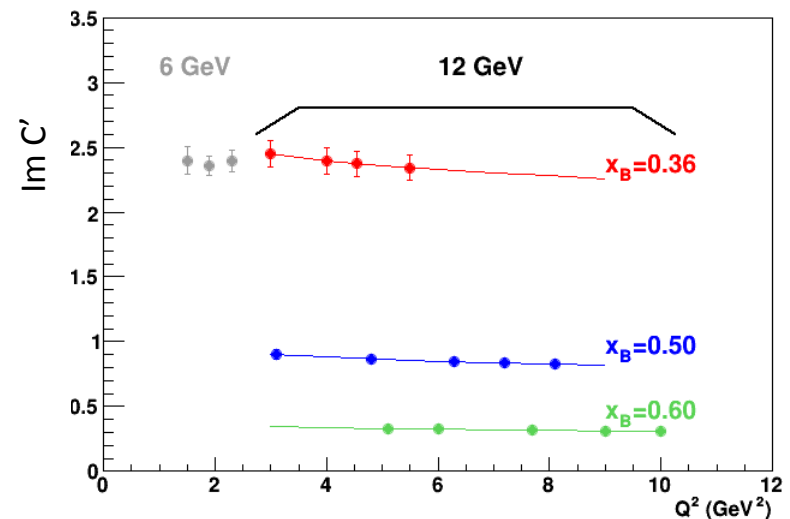
DVCS



Hall A data for Compton form factor (over *limited* Q^2 range) agree with hard-scattering

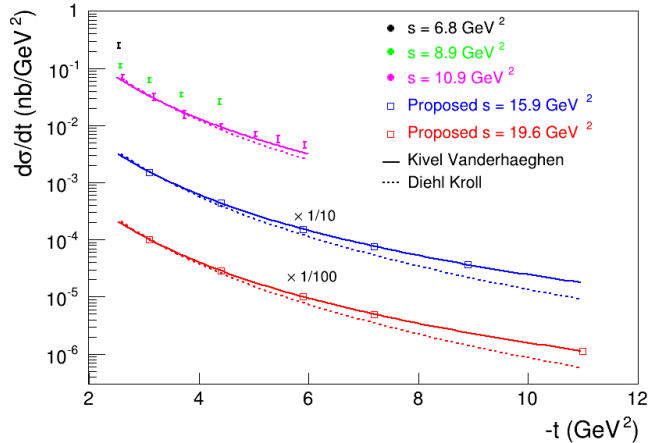


12 GeV projections: confirm formalism



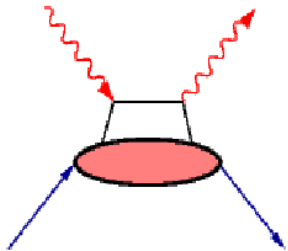
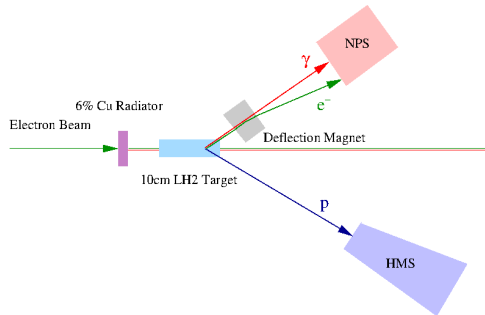
Extracting the real part of CFFs from DVCS requires measuring the cross section at multiple beam energies (DVCS²-Interference separation)

WACS - the process of choice to explore factorization in wide-angle processes



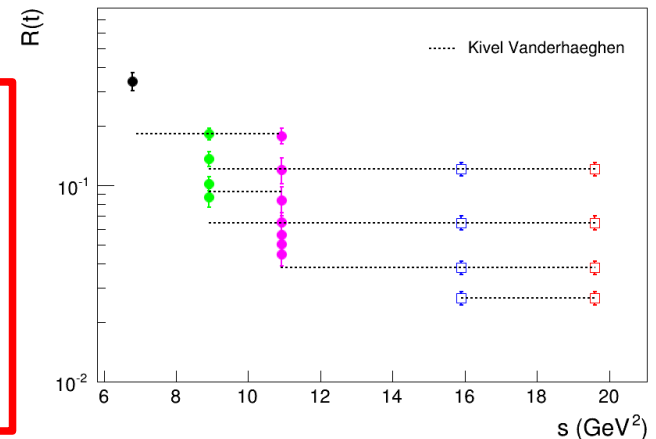
- WACS is a powerful but under-utilized probe of nucleon structure, for which there have been several theoretical approaches developed in recent years.
- Recent developments within the Soft Collinear Effective Theory (SCET) have demonstrated how important future WACS data for interpretation of a wide variety of hard exclusive reactions.

- Jlab Hall A data suggest factorization of the reaction mechanism into hard and soft-collinear parts (but limited in $-t$).
- E12-14-003 will use the Hall C HMS and the new **Neutral Particle Spectrometer** to measure the differential cross section with 18 days beam-time.



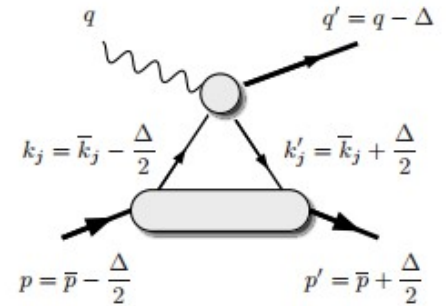
Two main goals of E12-14-003:

- Four fixed $-t$ scans will allow for a rigorous test of factorization.
- The t -dependence of the Compton form factor will allow us to gain valuable insights into proton structure at high momentum transfer.

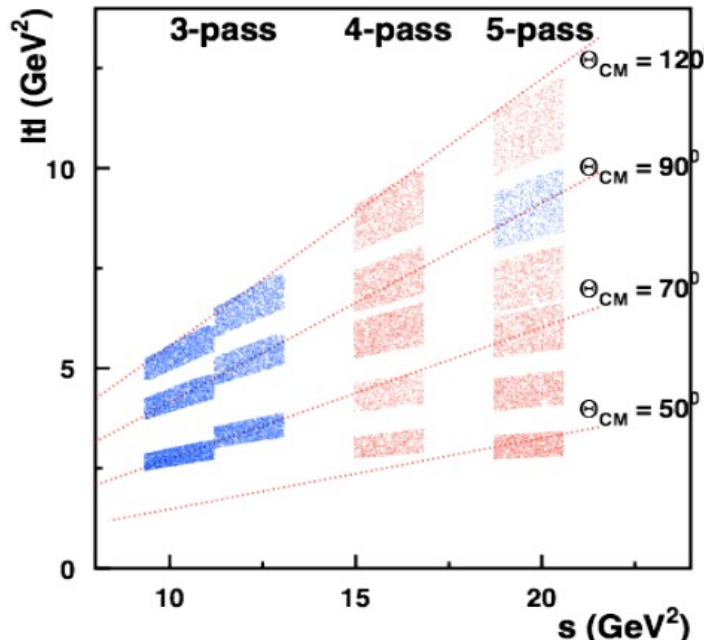


Wide angle exclusive photo-production of π^0 mesons

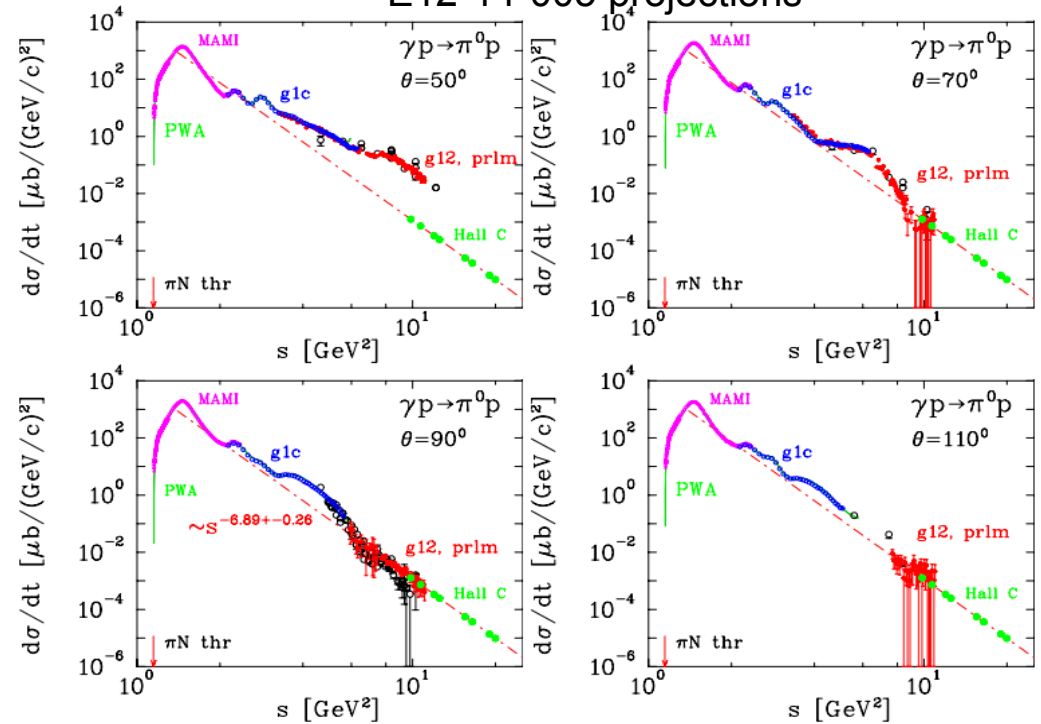
The next simplest reaction after Compton scattering.
But model prediction disagree with data by orders of magnitude!



Using the NPS E12-14-005 will cover a large range in $|t|$ and s



E12-14-005 projections



NPS data will help confirm scaling and provide wide angular coverage for testing models based on the dominance of handbag mechanism. Also help extract Regge trajectories.