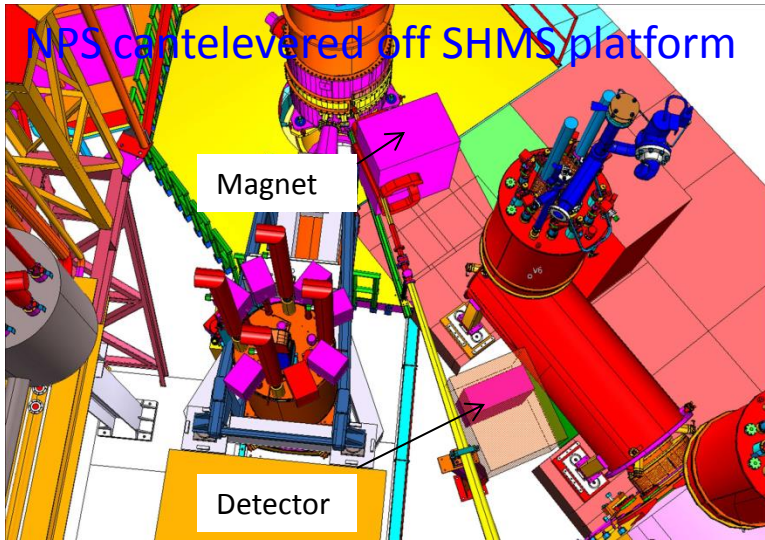
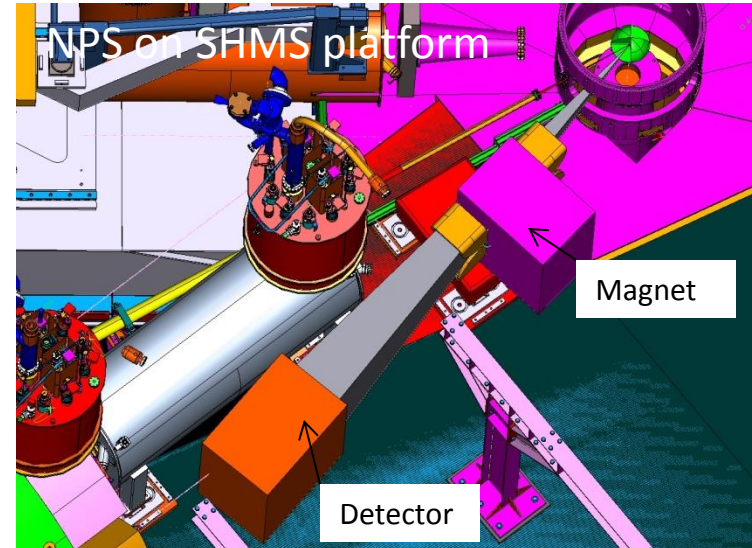


# The Neutral-Particle Spectrometer (NPS)

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 ( $\gamma$  and  $\pi^0$ ). 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  $\pi^0$  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  $\pi^0$  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 $\pi^0$ 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 $\pi^0$ 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

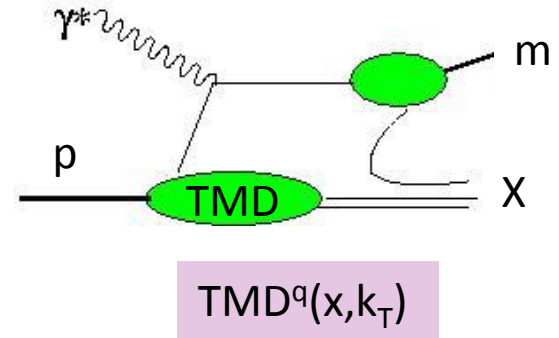
Run Group days

86

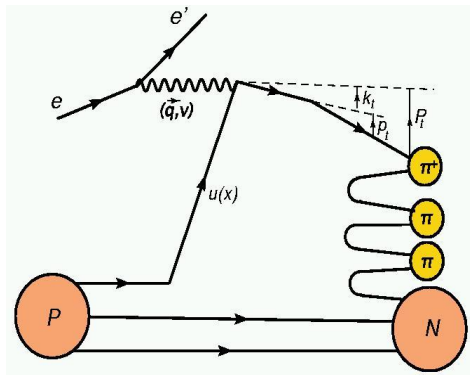
# Hall C SIDIS Program – basic $(e,e'\pi)$ cross sections

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  $\pi^0$**  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  $\sim 25$  msr Neutral-Particle Spectrometer

Advantages of  $(e,e'\pi^0)$  beyond  $(e,e'\pi^{+/-})$

- 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.”

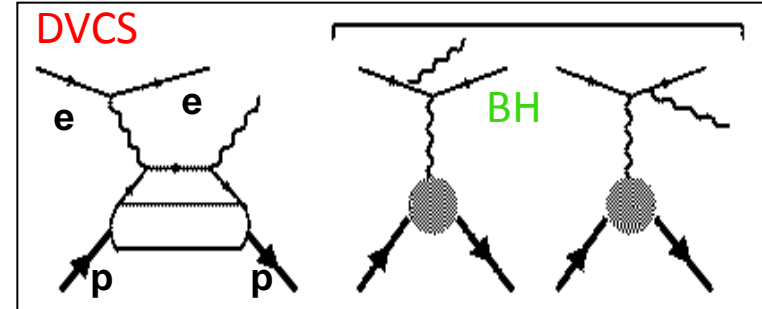
# Towards the 3D Structure of the Proton

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

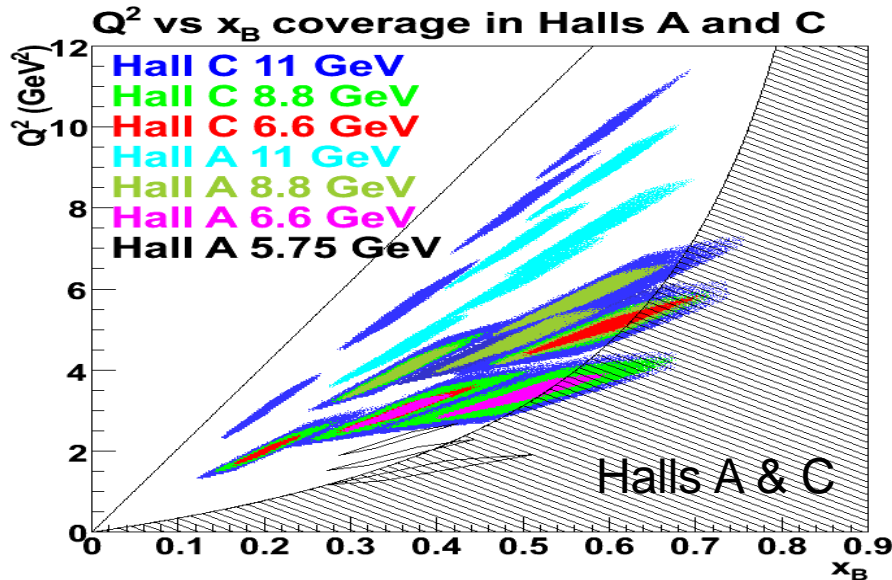
E12-13-010 DVCS measurements follow up on DVCS measurements in Hall A:

- Scaling of the Compton Form Factor
- Rosenbluth-like separation of DVCS:
 
$$\sigma = |BH|^2 + \text{Re}[DVCS^\dagger BH] + |DVCS|^2$$

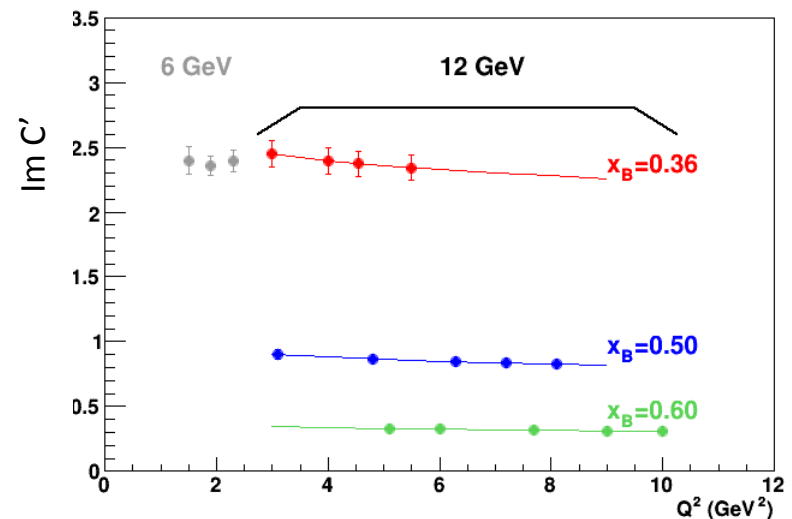
$$\sim E_{\text{Beam}}^2 \qquad \sim E_{\text{Beam}}^3$$
- L/T Separation of  $\pi^0$  production



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 (DVCS $^2$ -Interference separation)