



Deeply virtual Compton scattering cross sections at high Bjorken x

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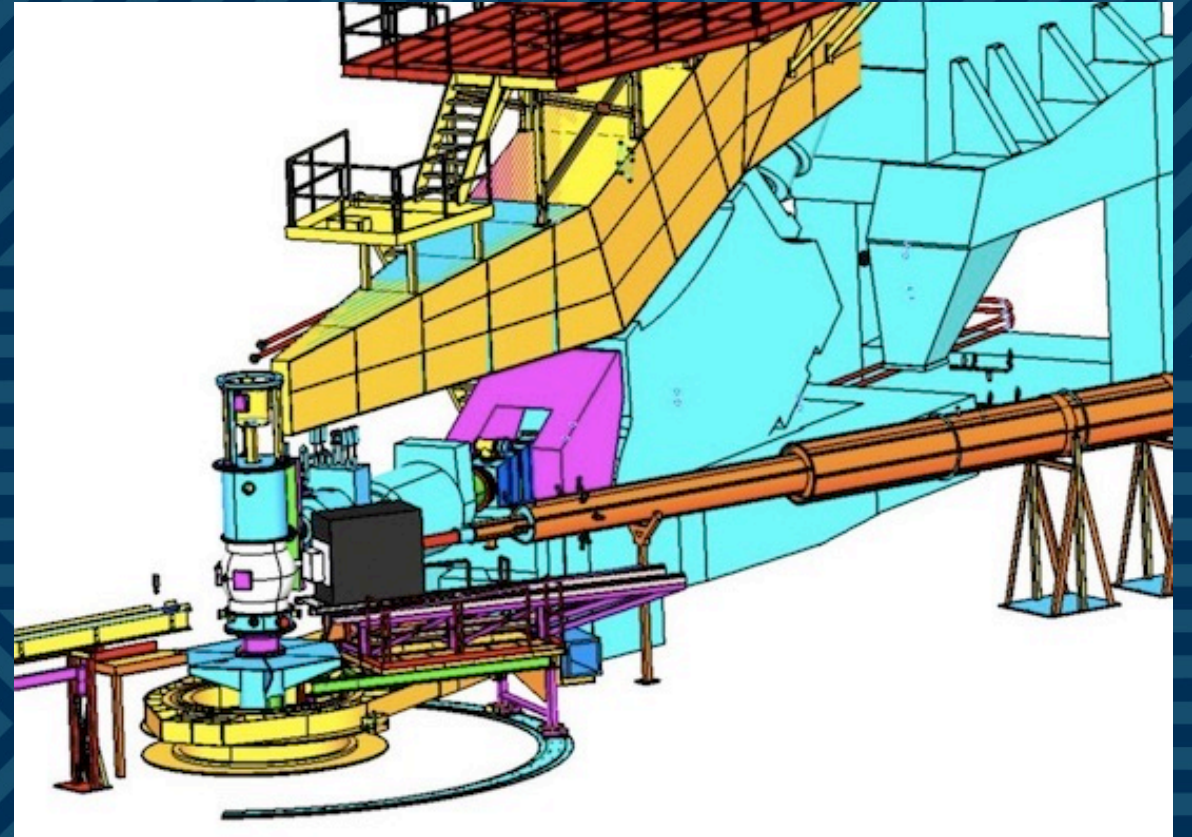
*For the JLab Hall A, E12-06-114, Collaboration
F. Georges et al., PRL in press*



OLD DOMINION
UNIVERSITY

Hall A DVCS Experiment at 11 GeV: 2014-2016

- $H(e, e'\gamma)p$ & $H(e, e'\pi^0)p$
- Cryogenic H_2 target
- Electron in Hall A Spectrometer
- PbF_2 calorimeter for gamma-rays
 - Cherenkov only, fast signals for pileup rejection.
 - 1 Ghz Digitizer
- Exclusivity by missing mass

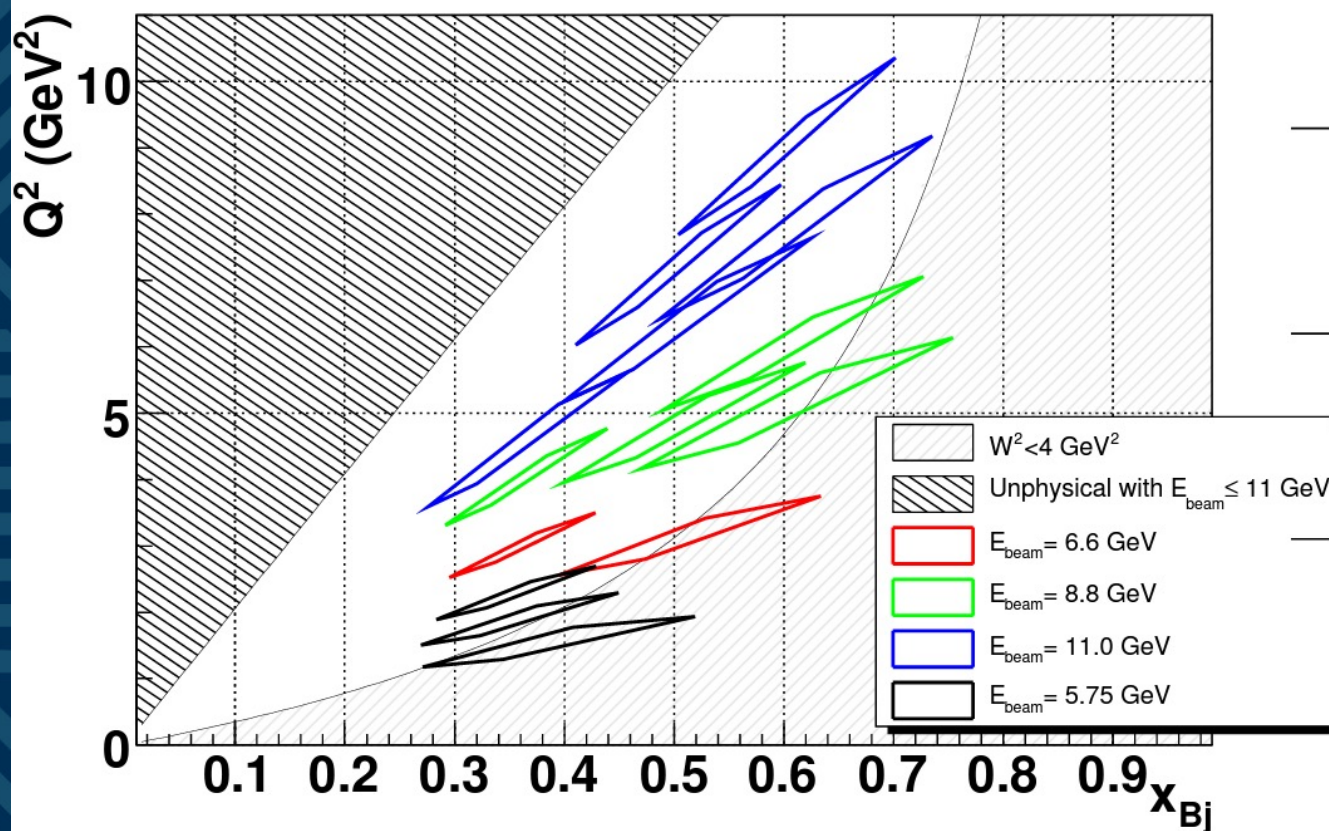


Kinematics and Beamtime (proposed)

JLab12 with 3, 4, 5 pass beam

(6.6, 8.8, 11.0 GeV beam energy)

DVCS measurements in Hall A/JLab



Q^2 (GeV ²)	Beam time (days)		
	0.36	0.50	0.60
3.0	3		
4.0	2		
4.55	1		
3.1		5	
4.8		4	
6.3		4	
7.2		7	
5.1			13
6.0			16
7.7			13
9.0			20
Total	6	20	62

88 days
250k events/setting

Total = 100 PAC days approved (88+12 days of calibration),



JLab Hall A DVCS, Actual Physics Run: 2014-2016

Setting	Kin-36-1	Kin-36-2	Kin-36-3	Kin-48-1	Kin-48-2	Kin-48-3	Kin-48-4	Kin-60-1	Kin-60-3
x_B	0.36			0.48				0.60	
E_b (GeV)	7.38	8.52	10.59	4.49	8.85	8.85	10.99	8.52	10.59
Q^2 (GeV ²)	3.20	3.60	4.47	2.70	4.37	5.33	6.90	5.54	8.40
E_γ (GeV)	4.7	5.2	6.5	2.8	4.7	5.7	7.5	4.6	7.1
$-t_{min}$ (GeV ²)	0.16	0.17	0.17	0.32	0.34	0.35	0.36	0.66	0.70
$\int Q dt$ (C)	1.2	1.7	1.3	2.2	2.2	3.7	5.7	6.4	18.5
# data bins	672			912				480	

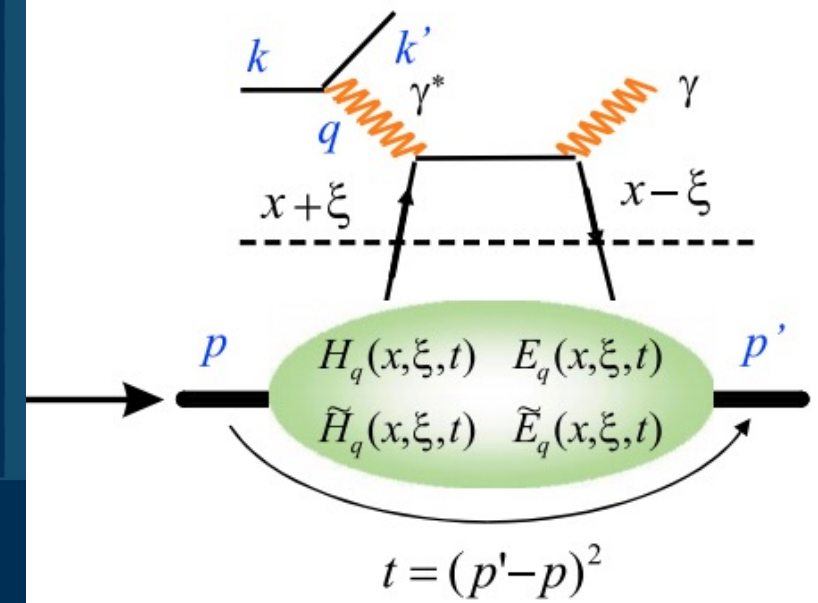
E12-06-114, 50 “PAC days”

- Exclusive π^0 production published in M. Dlamini et al., PRL **127** (2021) 152301



Longitudinal & Transverse Coordinates

- DIS defines a unique light-cone direction from q^μ & p^μ
- DVCS coordinate system is ambiguous up to order t/Q^2
- Light-cone from
 - q^μ & p^μ DIS
 - $(q+q')^\mu$ & $(P+P')^\mu$ Symmetrized
 - q^μ & q'^μ V. Braun *et al.*

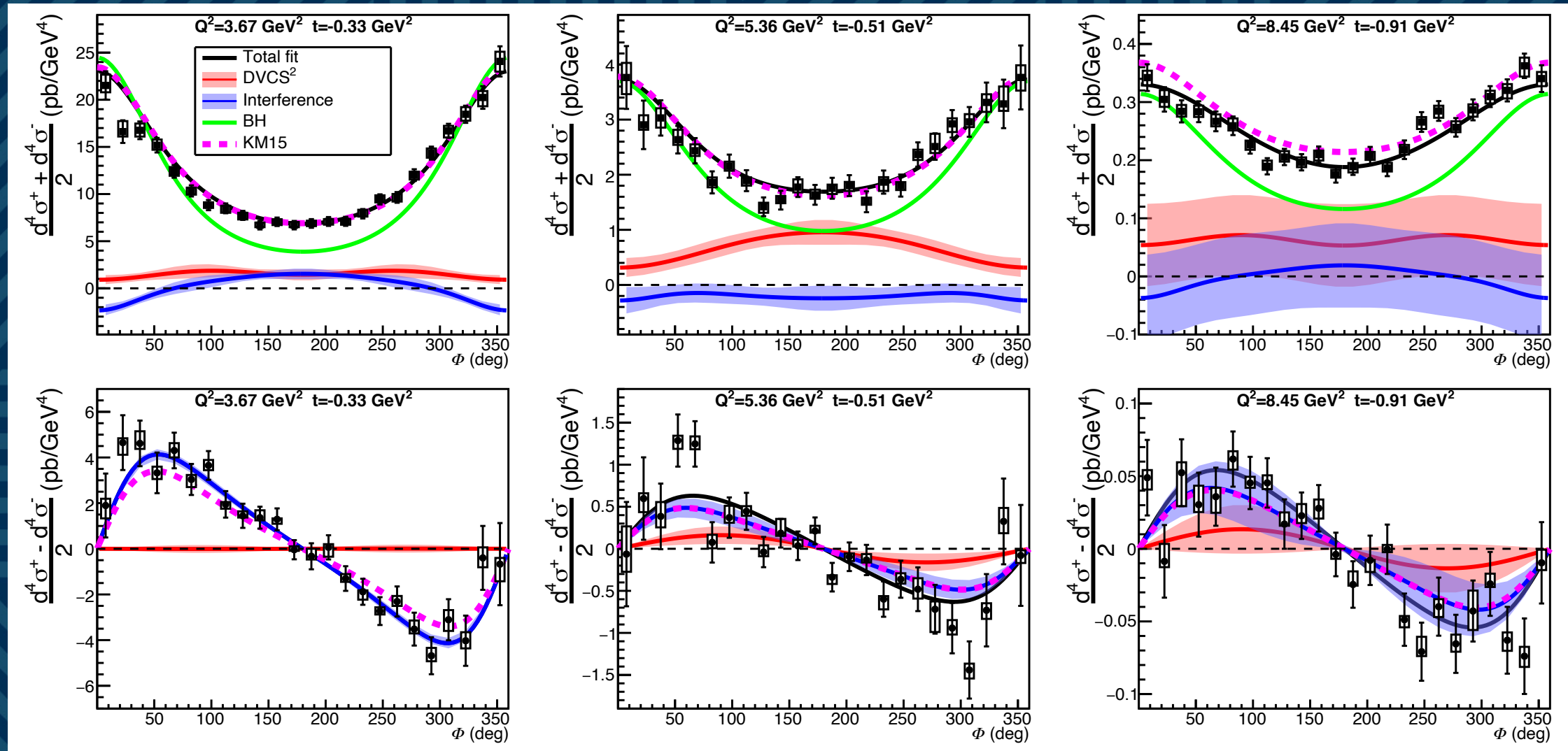


Cross Sections

$x_B=0.36, Q^2=3.7\text{GeV}^2, t=-0.33\text{GeV}^2;$

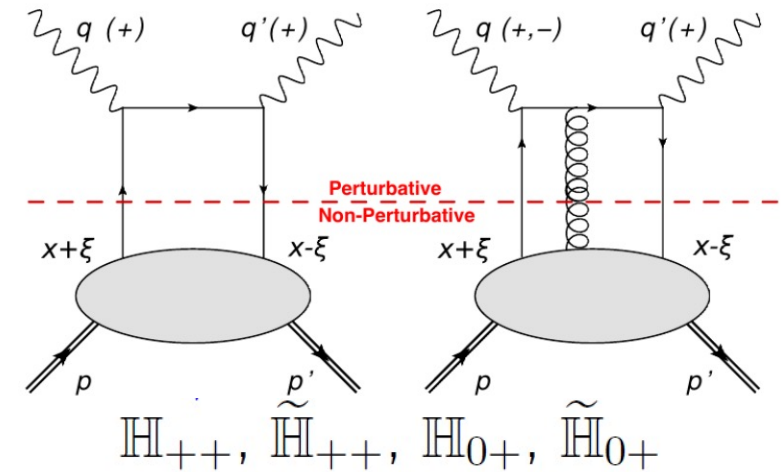
$x_B=0.48, Q^2=5.4\text{ GeV}^2, t=-0.33\text{ GeV}^2;$

$x_B=0.6, Q^2=8.4\text{ GeV}^2, t=-0.91\text{ GeV}^2$

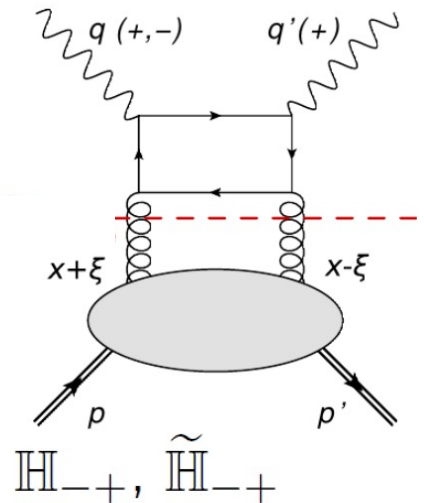


Braun, et al formalism

- Includes kinematic higher twist
- 12 complex CFFs
- $H_{\lambda,\lambda'}$, $\tilde{H}_{\lambda,\lambda'}$, $E_{\lambda,\lambda'}$, $\tilde{E}_{\lambda,\lambda'}$
 - $(\lambda,\lambda') = (+,+), (0,+), (-,+)$
- Each kinematic coefficient has different E_e , Q^2 , x_B , t -dependence
- Our analysis:
 - At fixed (x_B, t) global fit to all 12 CFFs (neglecting QCD evolution)



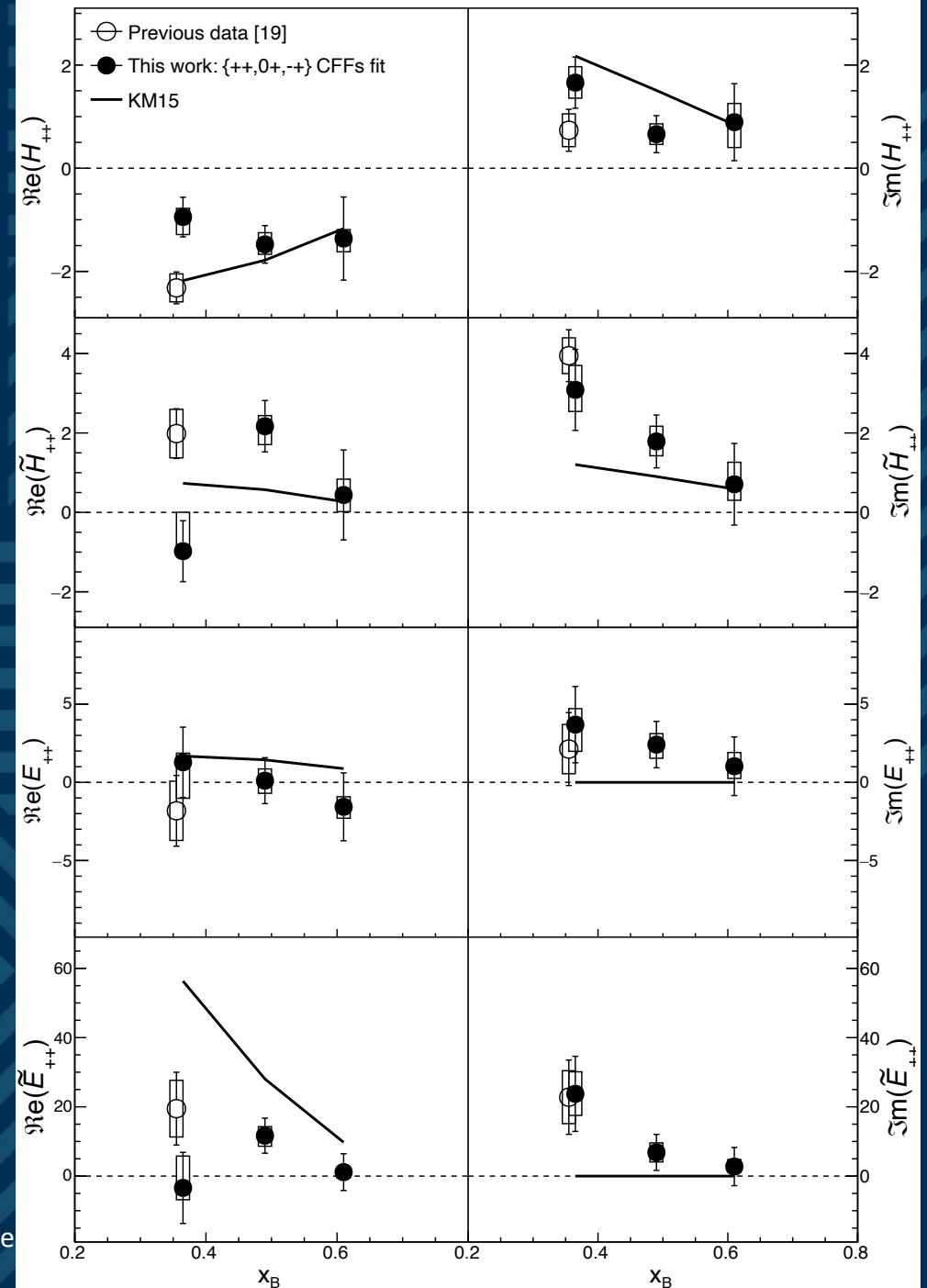
Helicity-flip (1 unit) CFFs
Same Q^2 -dependence
as higher-twist



Helicity-flip (2 units) CFFs
Same Q^2 -dependence
as NLO

CFF Extraction

- x_B -dependence of t -averaged results for Re & Im parts of ALL four helicity conserving Compton Form Factors
- Helicity flip amplitudes included in fit, statistically consistent with zero, but necessary for realistic uncertainties.
- $\text{Im}[E_{++}]$ and $\text{Im}[\tilde{E}_{++}]$ arbitrarily 0 in KM15 model



Conclusion and Outlook

- Realistic DVCS formalism essential for precision extraction of CFFs.
- 2023: Neutral Particle Spectrometer (NPS) DVCS run (tentative)
 - New PbWO_4 calorimeter: improved M_x^2 resolution
 - Sweep magnet to maintain low background in calorimeter
 - Higher momentum range of Hall C HMS allows full range of CEBAF kinematics
- Complete E12-06-114 Kinematics, and include multiple (2 or 3) incident beam energies at fixed (Q^2, x_B) : E12-13-010
 - L/T separation of Deep Neutral Pion Production
 - Improved precision on extraction of Re-parts of CFF.

