

# **HERA DVCS Results**

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#### On behalf of HERMES, H1 and ZEUS

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Electromagnetic Form Factors: transverse charge and current densities.

GPDs: longitudinal momentum and transverse space information.

 $\delta z_{\perp}$ 

x

 $b_{\perp}$ 

 $f(\mathbf{x}, b_{\perp})$ 

хp

х



Parton Distribution Functions: longitudinal momentum densities.







 $(x \pm \xi)$  : parton longitudinal momentum fractions,  $\xi$  : fraction of the momentum transfer, t : invariant momentum transfer to the nucleon

DVCS and Bethe-Heitler have the same initial and final states and are indistinguishable.

 $d\sigma(eN \to eN\gamma) \propto |\mathcal{T}_{BH}|^2 + |\mathcal{T}_{DVCS}|^2 + \mathcal{T}_{BH}\mathcal{T}_{DVCS}^* + \mathcal{T}_{BH}^*\mathcal{T}_{DVCS}$ 



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## HERA at DESY



- Part of the DESY facility in Hamburg, Germany.
- 920 GeV proton beam and 27.5 GeV electron/positron beam.
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	HERMES	ZEUS	H1
	Fixed Target	Collider	Collider
x <sub>B</sub> Bjorken scaling variable	0.03< x <sub>B</sub> < 0.35	x <sub>B</sub> < 0.01	x <sub>B</sub> < 0.01
Q <sup>2</sup> virtuality of exchanged photon (GeV <sup>2</sup> )	1 < Q <sup>2</sup> < 10	1.5 < Q <sup>2</sup> < 100	6.5 < Q <sup>2</sup> < 80
W invariant mass of hadronic (GeV)	W > 3	40 < W < 170	30 < W < 140
t squared momentum transfer at the proton vertex (GeV <sup>2</sup> )	t  < 0.07	0.08 <  t  < 0.53	t  < 1



The e<sup>±</sup>p sample is used to extract the  $\gamma^* p$  DVCS cross section, presented as a function of Q<sup>2</sup>.



- Cross section decreases with Q<sup>2</sup>.
- The n values from ZEUS and H1 are in agreement.



The e<sup>±</sup>p sample is used to extract the  $\gamma^* p$  DVCS cross section, presented as a function of W.



- The DVCS cross section increases with W.
- Due to the increasing gluon density with decreasing  $x_{\rm B}$ .



The e<sup>±</sup>p sample is used to extract the  $\gamma^{r} P$  DVCS cross section, presented as a function of W.



The e<sup>±</sup>p sample is used to extract the  $\gamma^* p$  DVCS cross section, presented as a function of Q<sup>2</sup>, |t| and W.

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• H1 b =  $(5.41 \pm 0.14 \pm 0.31)$  GeV<sup>-2</sup>, ZEUS b =  $(4.5 \pm 1.3 \pm 0.4)$  GeV<sup>-2</sup>.

• t-dependence of the DVCS cross section provides information on the transverse spatial distributions of protons.



A fit of the form  $d\sigma/dt \sim e^{-b|t|}$  is performed to the extracted inelastic DVCS events taking into account the statistical and correlated systematic errors.



• No b dependence on W.

 Corresponds to parton density described by sea quarks and gluons at low x.



The use of both e<sup>+</sup>p and e<sup>-</sup>p collision data allows, for the first time at a collider, the measurement of the beam charge asymmetry.









The comparison of the proton and deuteron values of the BCA, shown as a function of -t,  $x_B$  and  $Q^2$  and combined over all kinematics.







Sensitive to the imaginary part of GPD H





Theoretical work on constraining GPD models using global DVCS data has begun. It is obvious that the two different fits provide results which are rather different in the large-x region, but approach each other at smaller x.

Large differences in the fits when including different JLAB kinematics indicate that BSA measurements can be described with two qualitatively different GPD model scenarios.



#### **DVCS** is the simplest interaction used to investigate GPDs.

HERA has provided important results in this area. HERMES data with the recoil detector will provide new asymmetry results with the recoil proton from the DVCS interaction detected.

Future collaborations with theorists to constrain GPD models will provide new insights into nucleon structure.

Summary