

# Deeply Virtual Compton Scattering and its Beam Charge Asymmetry in $e^\pm p$ collisions at HERA

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On behalf of



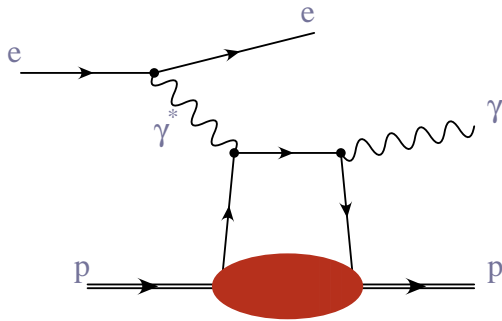
DIS10 - Florence - 19-23<sup>th</sup> of April 2010

## Content

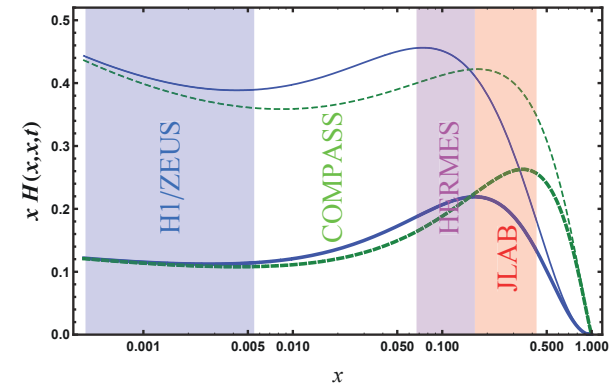
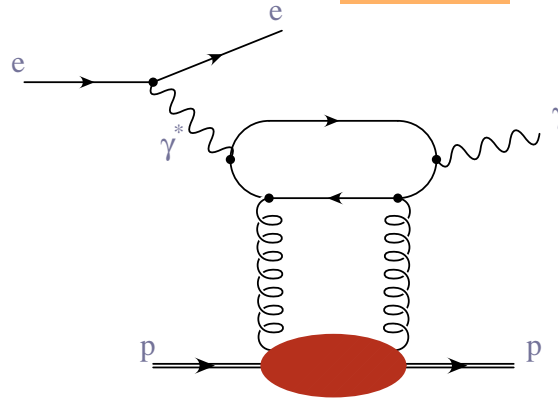
- Data  $e^\pm p$  HERA II - 2004-07
- integrated lumi of  $162 \text{ pb}^{-1}(e^+)$  and of  $144 \text{ pb}^{-1}(e^-)$
- Finalized cross section results
- Phys. Lett. B 681 (2009) 391.

# DVCS - Introduction

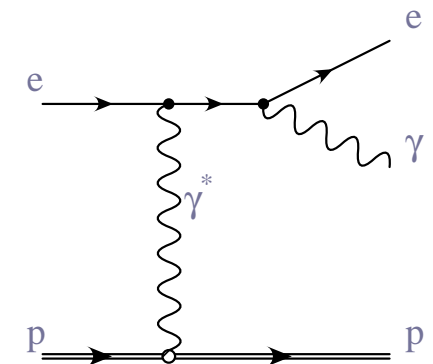
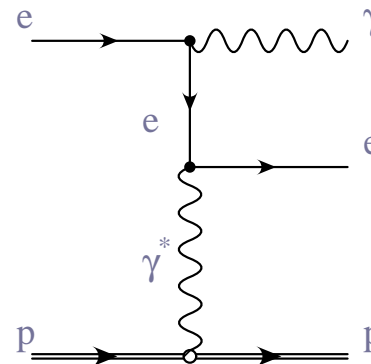
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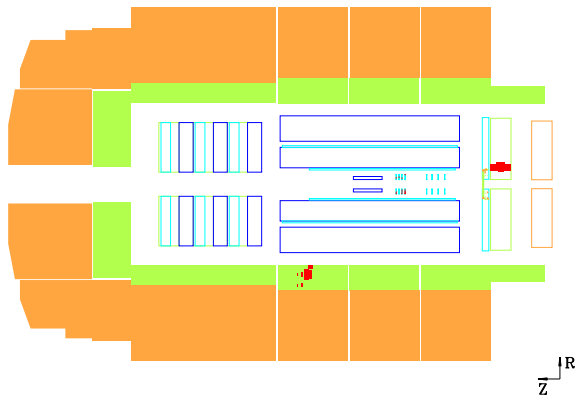
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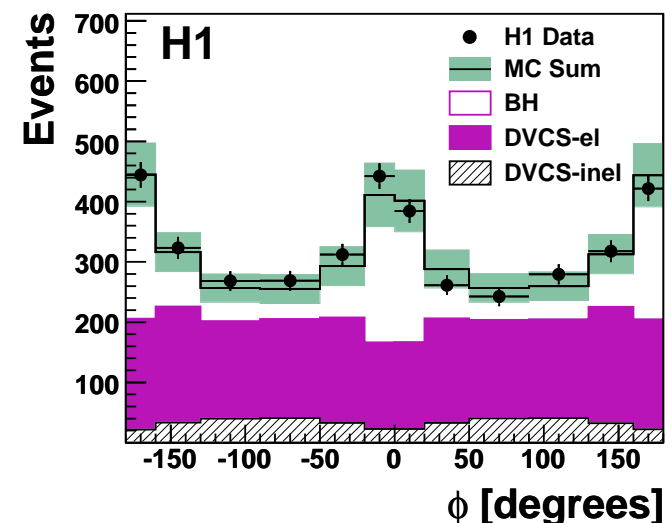
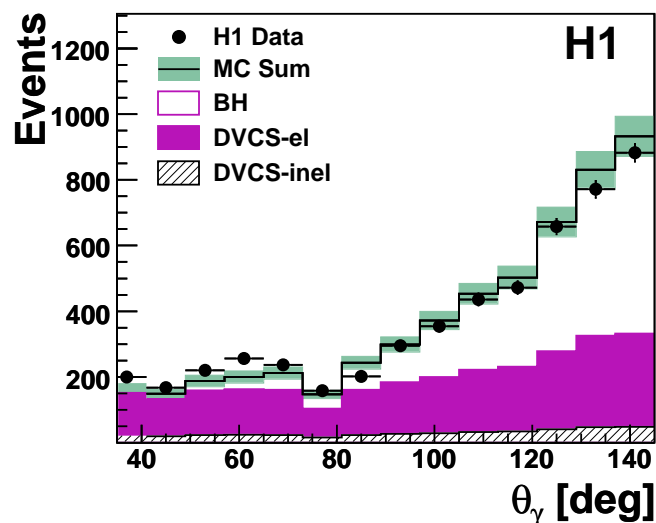
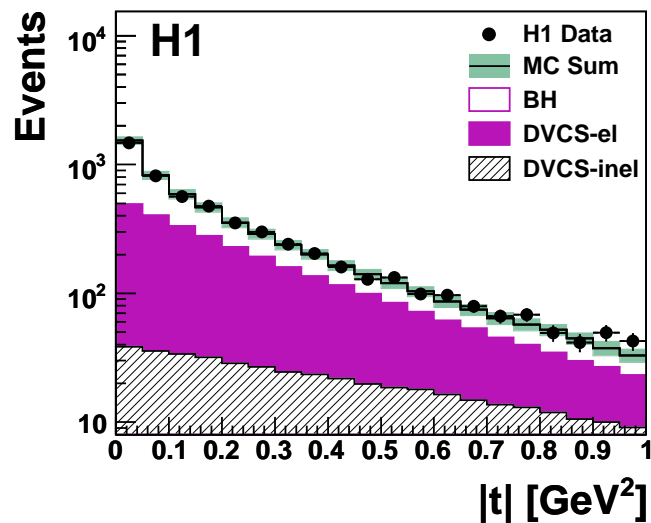
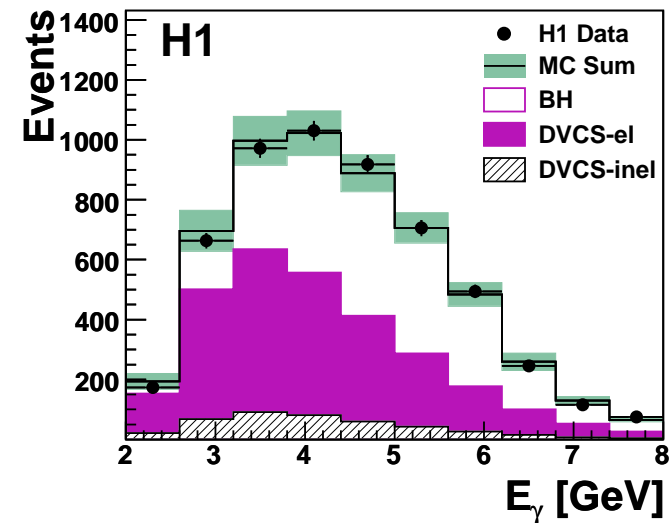
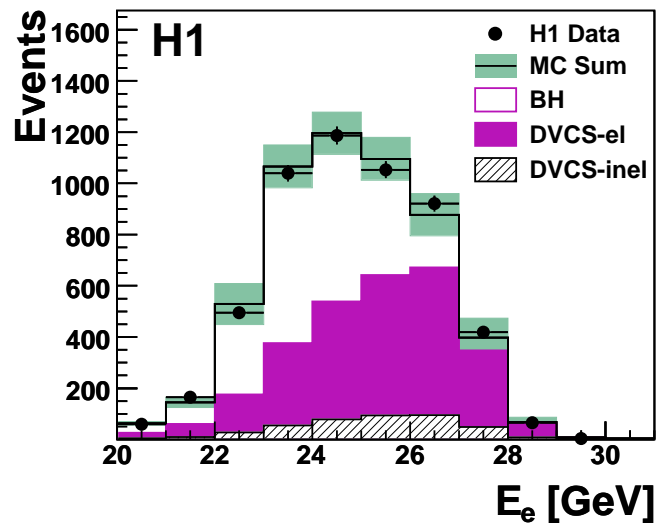
- **HERA (ep)**: wide range in  $Q^2$  (2 – 100 GeV<sup>2</sup>),  $W$  and  $t$  accessible at high  $Q^2$  and low  $x$
- Sensitivity to GPD (gluons, saturation?)
- Bethe-Heitler Process (Background + Interference)
- $\sigma_{DVCS} \simeq \sigma_{BH} \Rightarrow$  DVCS **cross section** measurement and high interference term sensitivity (**asymmetry** measurements)



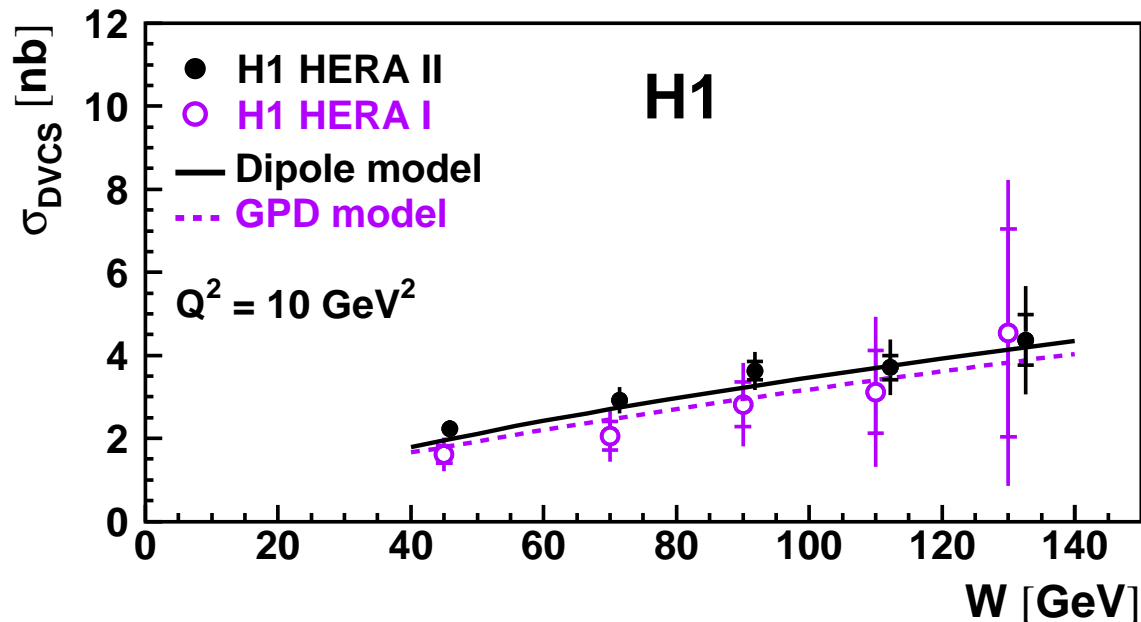
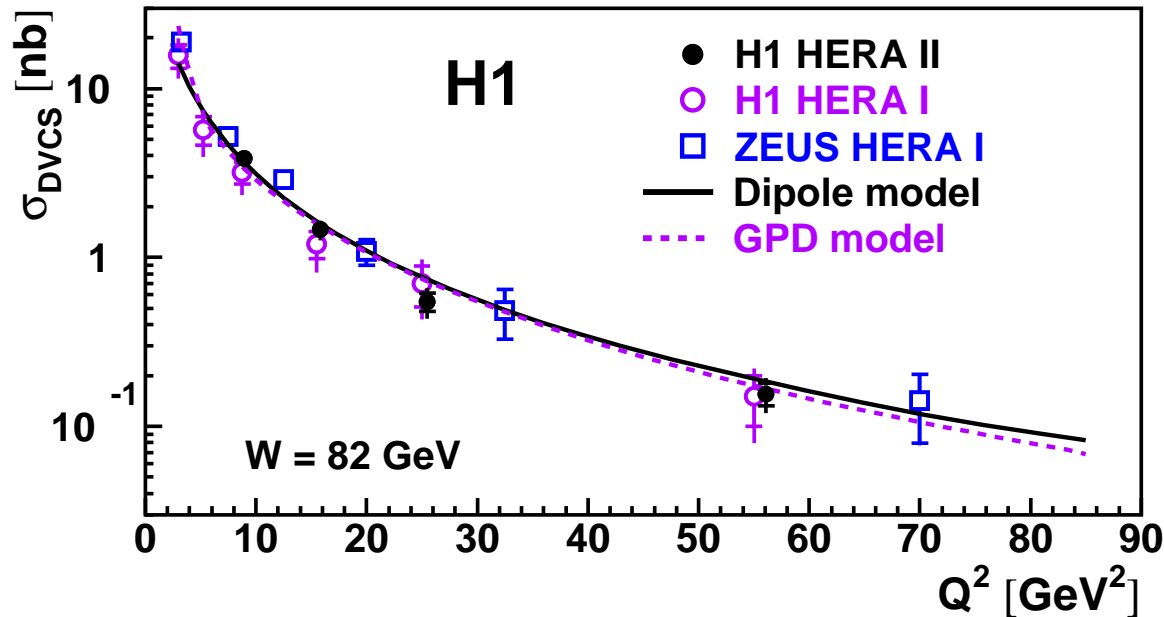
# H1 DVCS+BH Events



H1  $e^\pm$  data 2004-07  
Int. lumi =  $306 \text{ pb}^{-1}$   
5437 events.



# Cross section measurements



After subtraction of Bethe-Heitler contribution,

$$\frac{d^3\sigma_{ep \rightarrow e\gamma p}}{dW dQ^2 d|t|} =$$

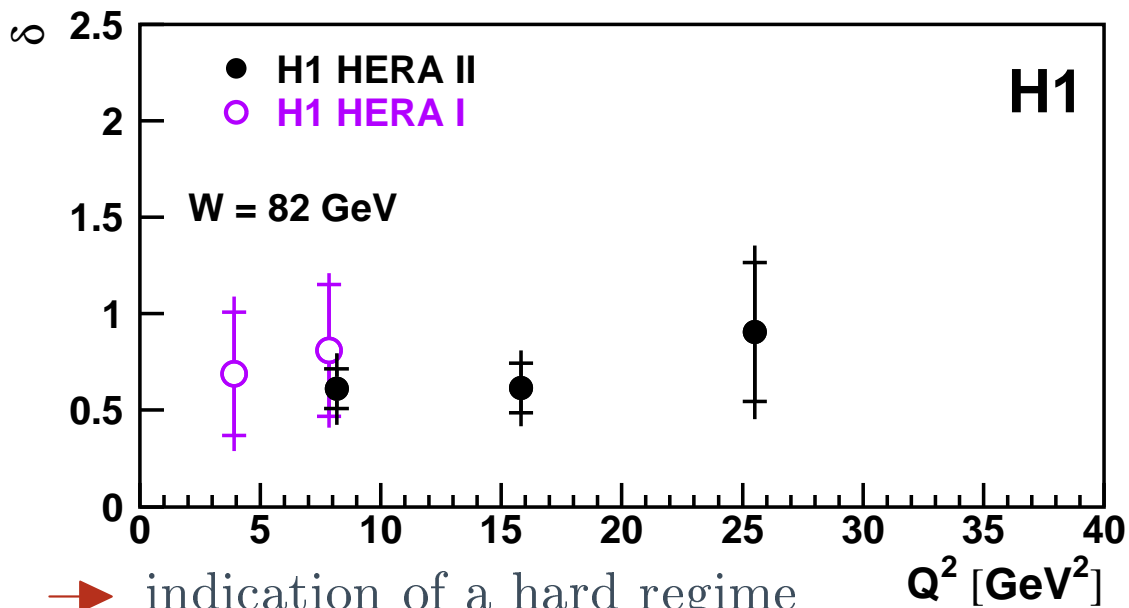
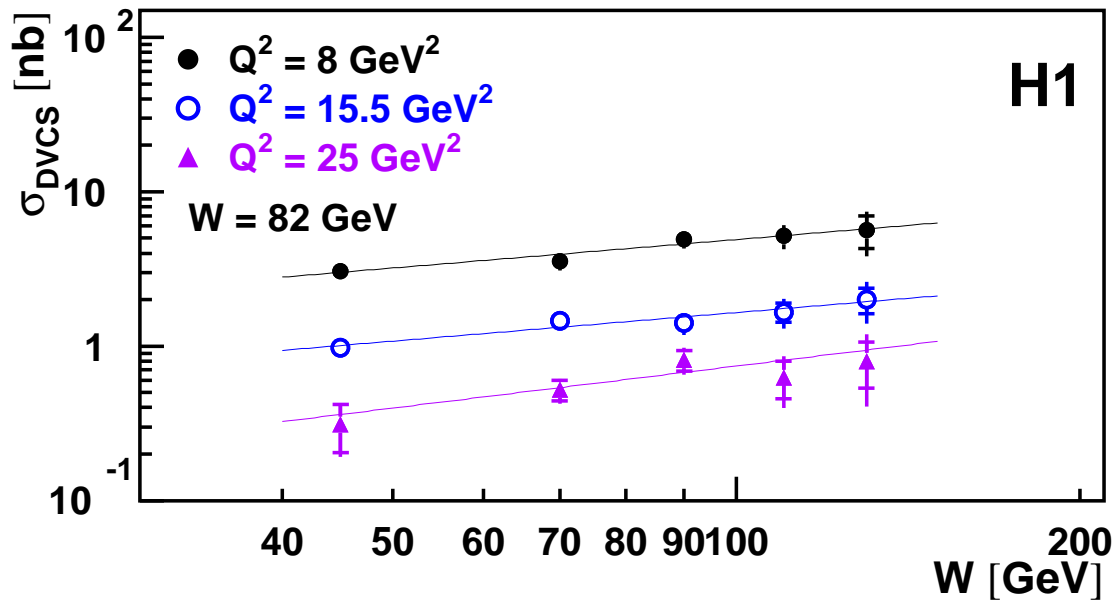
$$\Gamma(W, Q^2) \frac{d\sigma_{DVCS}}{d|t|}(W, Q^2)$$

→ in agreement with previous results

→ improved precision

- Dipole model: C. Marquet, R. Peschanski and G. Soyez [hep-ph/0702171] (geometric scaling extended to off-forward)

- GPD model: K. Kumerički and D. Müller (fit to previous HERA meas.)



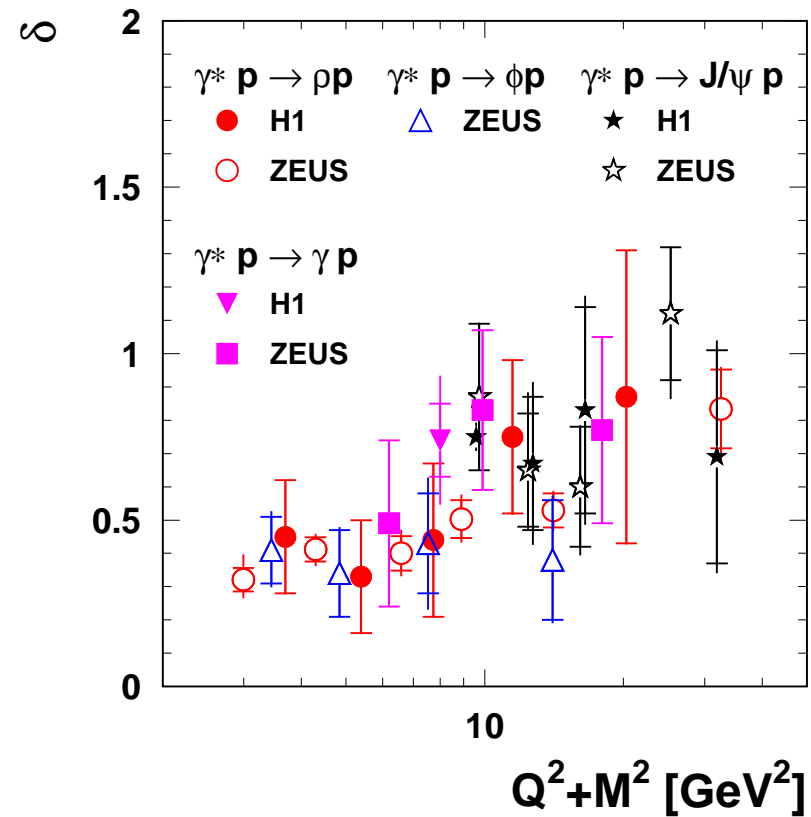
- ➔ indication of a hard regime
- ➔ no  $Q^2$  dependence
- ➔ in agreement with VM production

$W$  dependence for three  $Q^2$  values

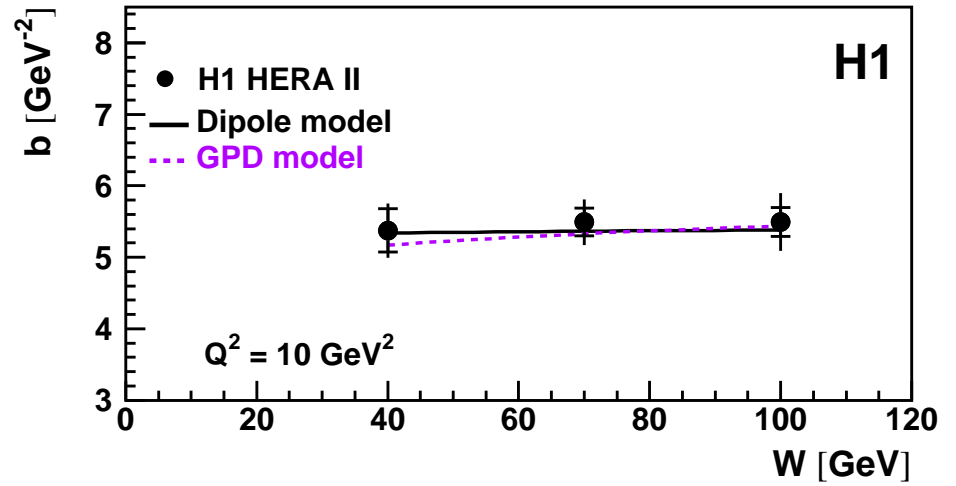
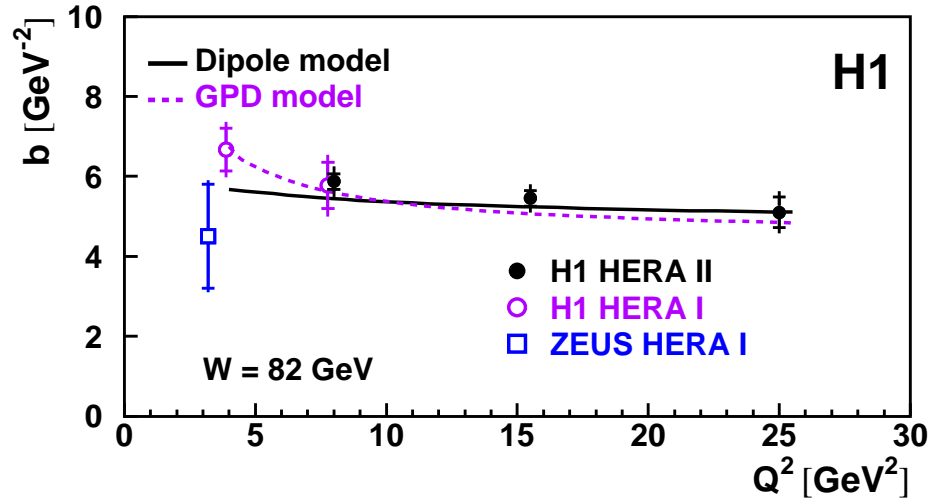
➔ Fit  $W^\delta$ :

Total sample gives:

$$\delta = 0.63 \pm 0.08 \pm 0.14$$

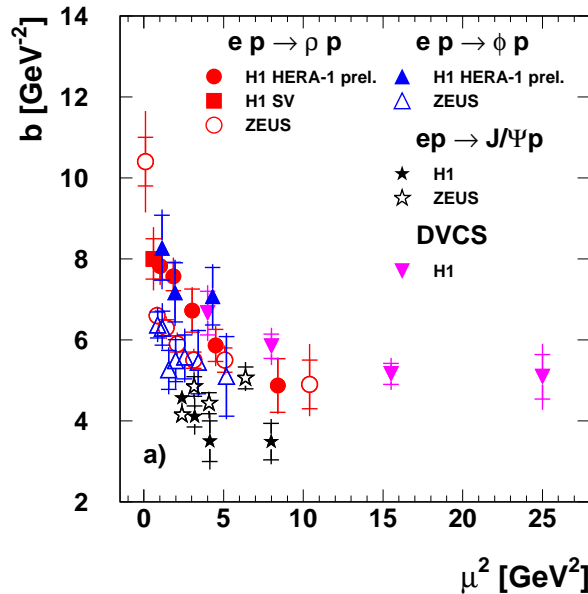
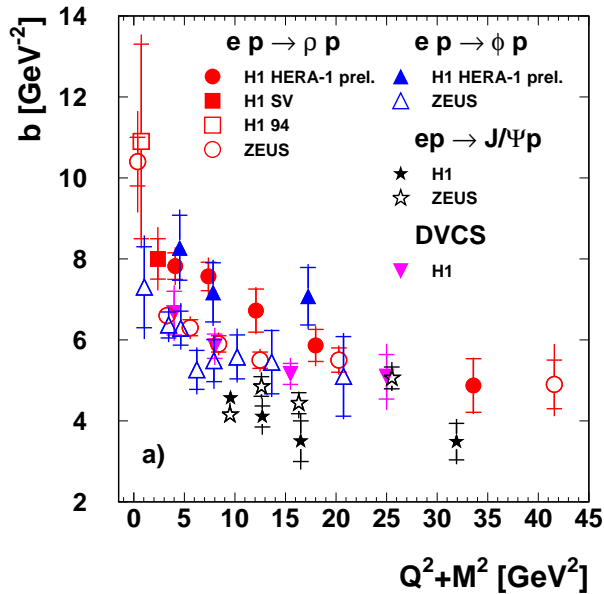


# $t$ slope



$$\frac{d\sigma}{dt} \sim e^{-b|t|} \quad b(Q^2) = A (1 - B \log(Q^2/2))$$

• no  $W$  dependence



$$\text{for VM: } \mu^2 = \frac{Q^2 + M_X^2}{4}$$

$$\text{for DVCS: } \mu^2 = Q^2$$

# DVCS: QCD interpretation

- correct  $Q^2$  dependence of the propagator and of  $b$  in the cross section:

$$S = \sqrt{\frac{\sigma_{DVCS} Q^4 b(Q^2)}{(1 + \rho^2)}}$$

- **skewing** factor: around 2

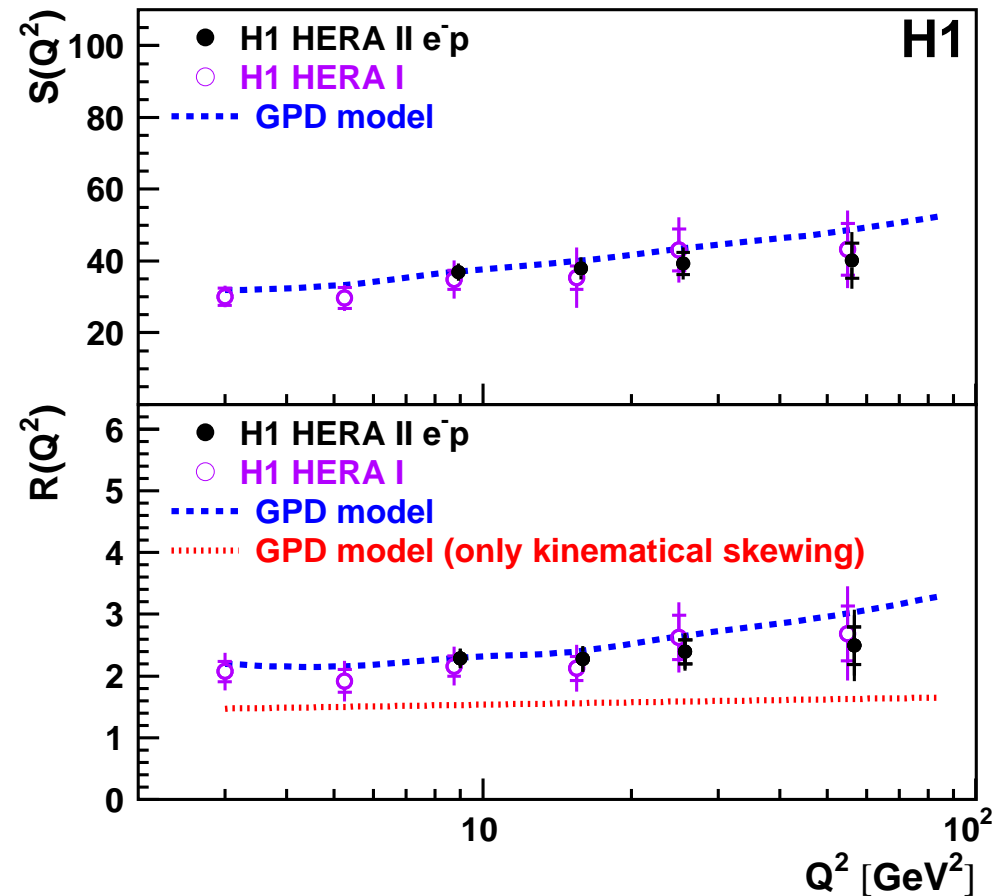
$$R = \frac{\text{Im} A(\gamma^* p \rightarrow \gamma p)}{\text{Im} A(\gamma^* p \rightarrow \gamma^* p)}$$

$$= \frac{4 \sqrt{\pi \sigma_{DVCS} b(Q^2)}}{\sigma_T(\gamma^* p \rightarrow X) \sqrt{(1 + \rho^2)}}$$

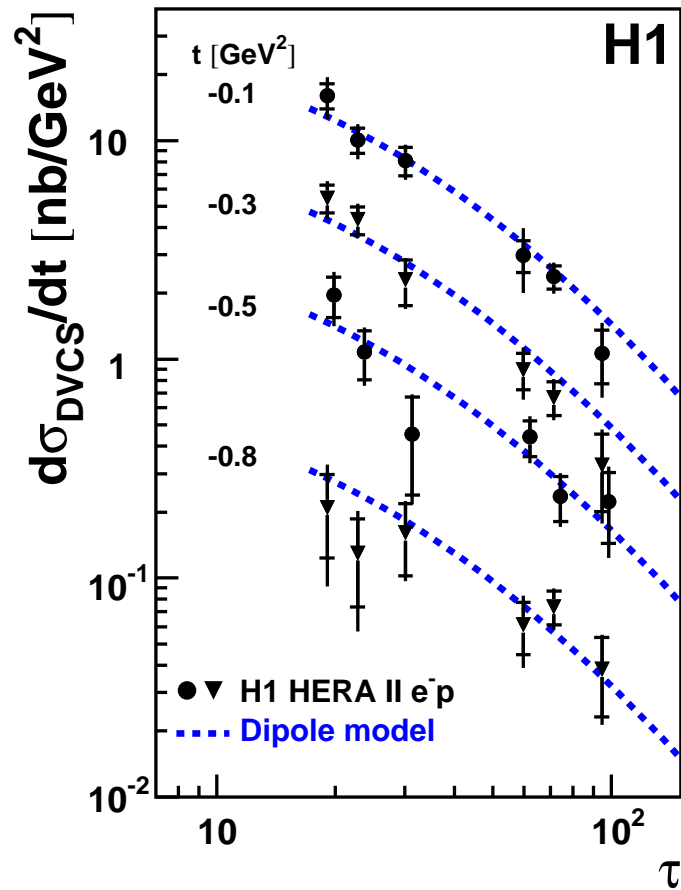
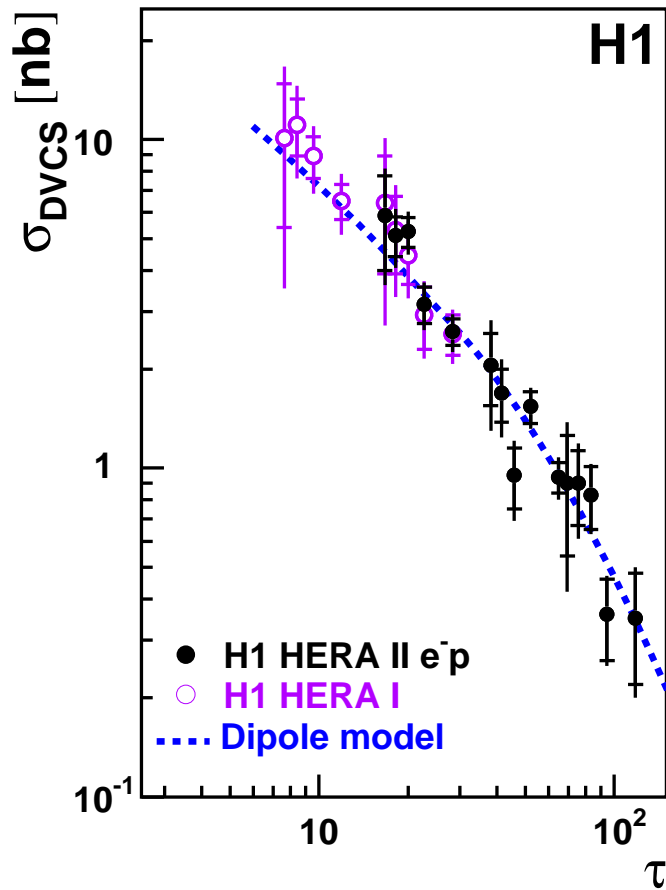
$-\sigma_T(\gamma^* p \rightarrow X)$  taken from QCD analysis of inclusive DIS H1 measurement.

⇒ important skewing factor

⇒  $Q^2$  evolution close to the one of DIS (pure DGLAP)



# Dipole approach



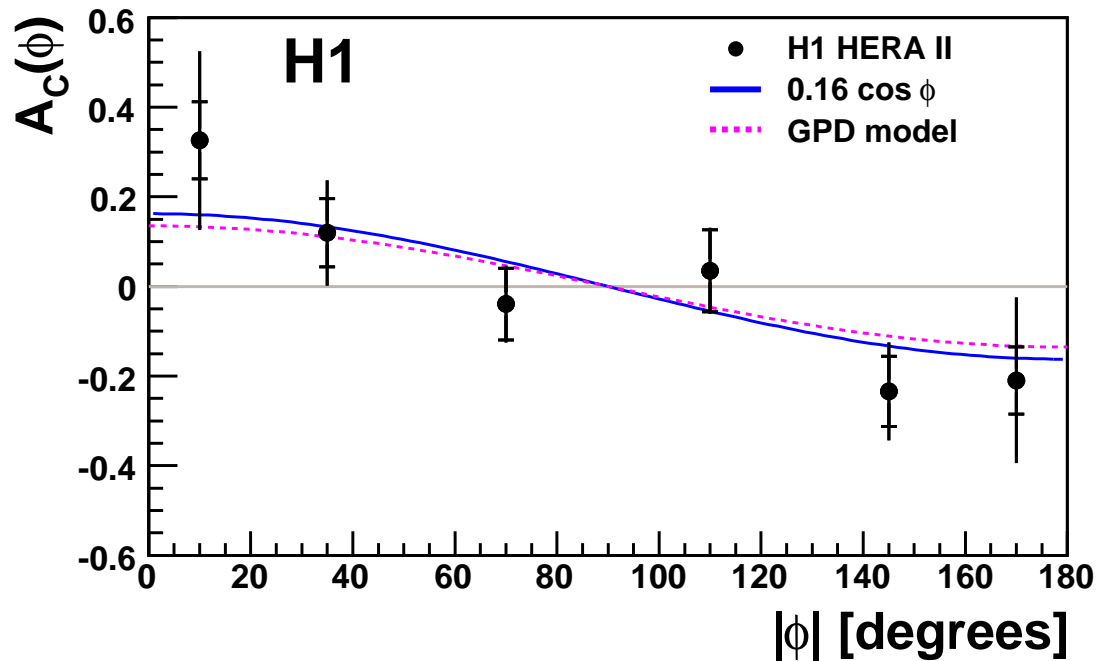
- here lower  $Q^2$  points from previous H1 publication [hep-ex/0505061] are included.

- Data globally described by the geometric scaling approach
- compatible with a saturation scale independent of  $t$



# Beam Charge Asymmetry

First BCA measured at HERA: based on HERA II data ( $e^+$  and  $e^-$ ).



$$BCA \equiv \frac{\sigma(e^+p) - \sigma(e^-p)}{\sigma(e^+p) + \sigma(e^-p)}$$

$$\sim p_1 \cos(\Phi)$$

$$p_1 = 0.16 \pm 0.04 \pm 0.06$$

$$p_1 = 2A_{BH} \frac{\text{Re}A_{DVCS}}{|A_{DVCS}|^2 + |A_{BH}|^2}$$

$$\rho = \frac{\text{Re}A_{DVCS}}{\text{Im}A_{DVCS}} = 0.20 \pm 0.05 \pm 0.08$$

Indep., we expect from dispersion relation  $\rho = \tan\left(\frac{\pi\delta(Q^2)}{8}\right) = 0.25 \pm 0.03 \pm 0.05$

$\Rightarrow$  in agreement

Obs.: low  $x$ :  $\text{Re} A_{DVCS}$  positive (H1)

larger  $x$ :  $\text{Re} A_{DVCS}$  negative (HERMES, CLAS)

# Conclusions

DVCS cross sections as a function of  $Q^2$ ,  $W$  and  $t$  have been measured with full HERA-II statistics  $e^-$  and  $e^+$  data.

- improved precision achieved in the  $t$  slope and the  $W$  dependence measurements.
- first BCA at collider
- very important impact on GPD determination (gluon and sea)
- measurement of both Re and Im amplitudes
- connects exclusive process (DVCS) to inclusive process (DIS)
- in agreement with various dipole model predictions, which are also describing inclusive diffraction.

⇒ DVCS plays a key role in the understanding of strong interaction dynamic in DIS