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

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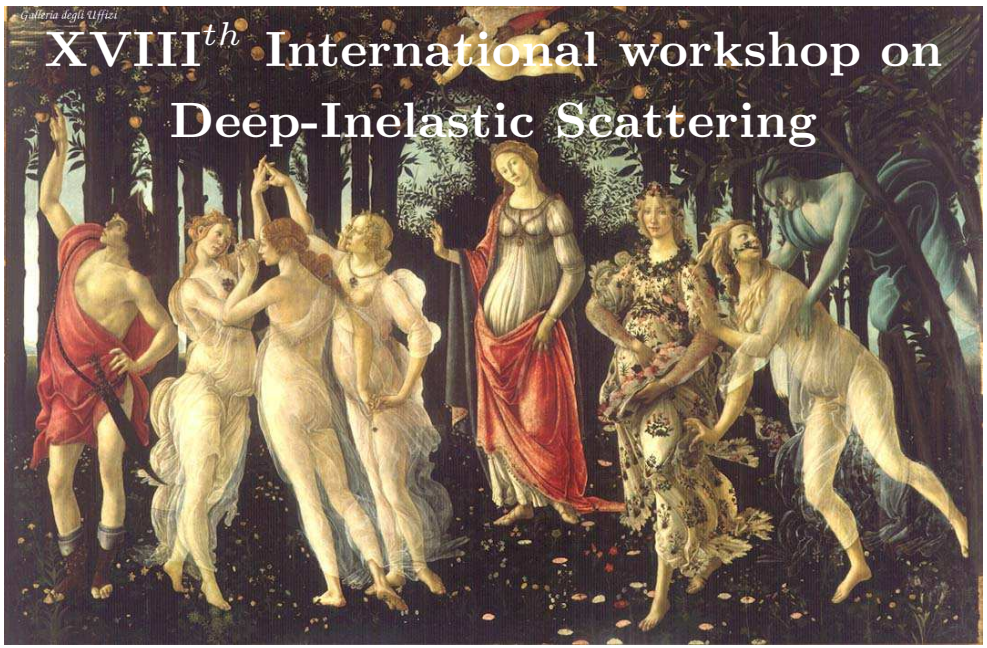
On behalf of



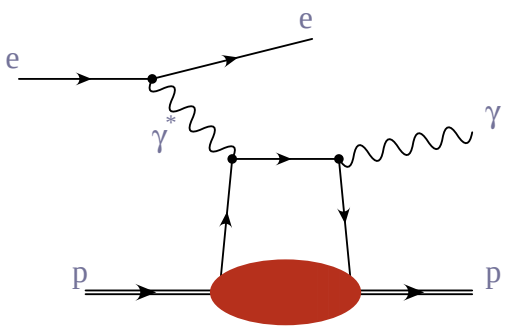
DIS10 - Florence - 19-23$^{\text{th}}$ of April 2010

Content

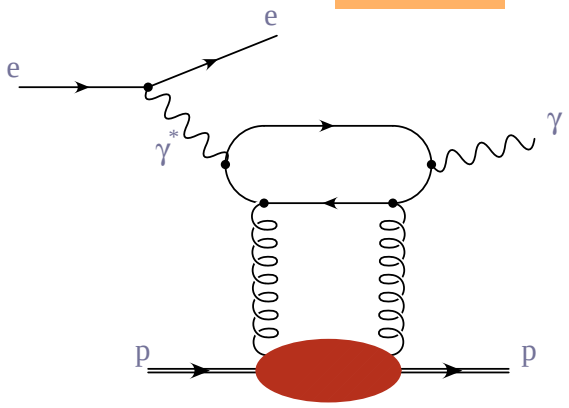
- **Data $e^{\pm}p$ HERA II - 2004-07**
- **integrated lumi of 162 pb^{-1}(e^{+}) and of 144 pb^{-1}(e^{-})**
- **Finalized cross section results**
- **Phys. Lett. B 681 (2009) 391.**

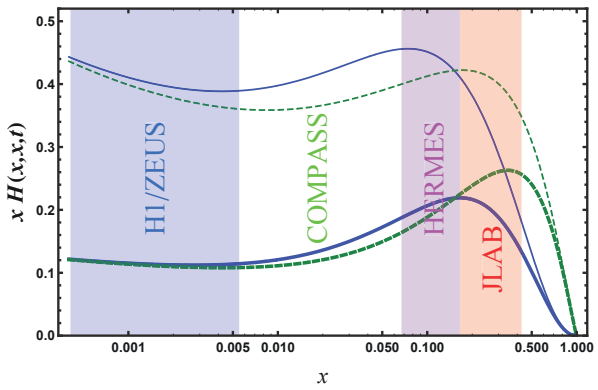
DVCS - Introduction

LO

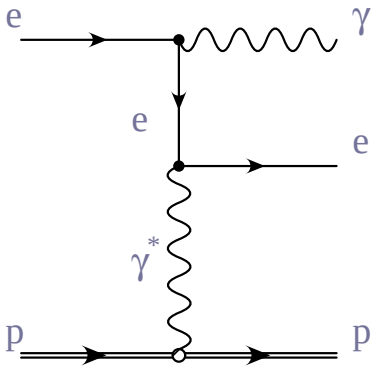


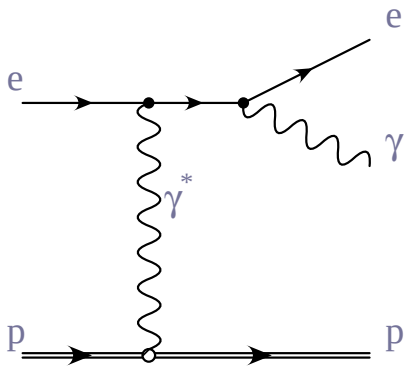
NLO



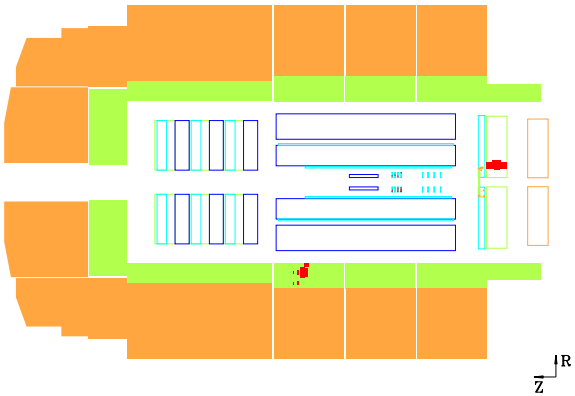


- HERA (ep): wide range in $Q^2(2-100\ \mathrm{GeV}^2)$, W and t accessible at high Q^2 and low x
- Sensitivity to GPD (gluons, saturation?)
- Bethe-Heitler Process (Background + Interference)
- $\sigma_{DVCS} \simeq \sigma_{BH} \Rightarrow$ DVCS cross section measurement and high interference term sensitivity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

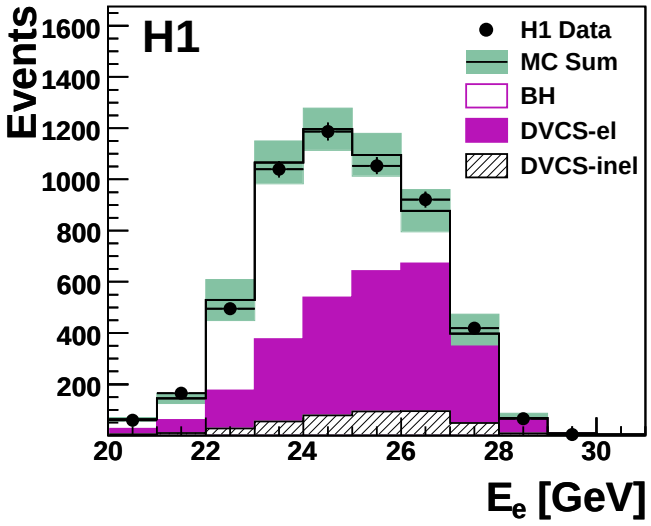


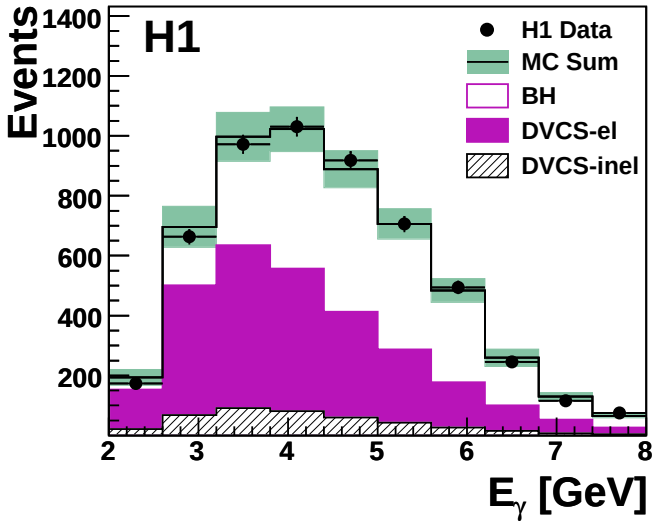


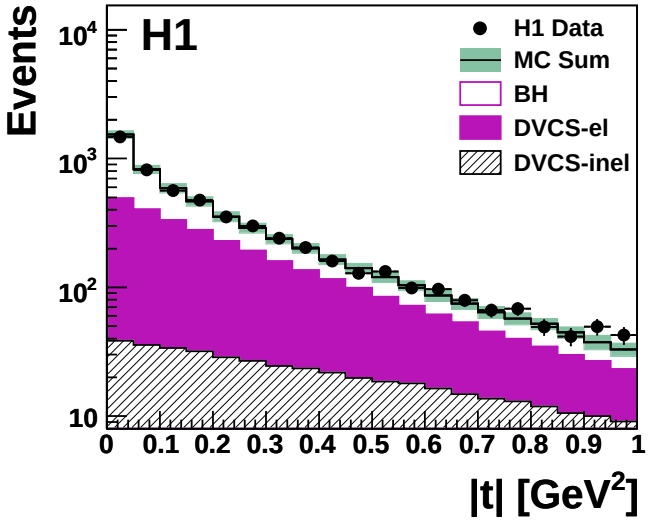
H1 DVCS+BH Events

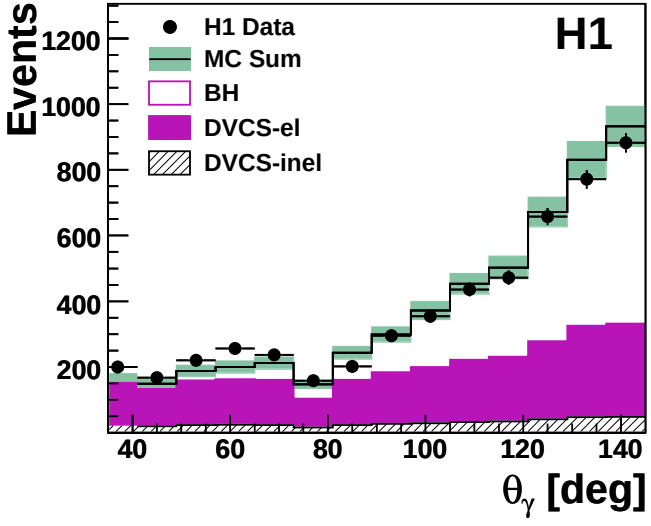


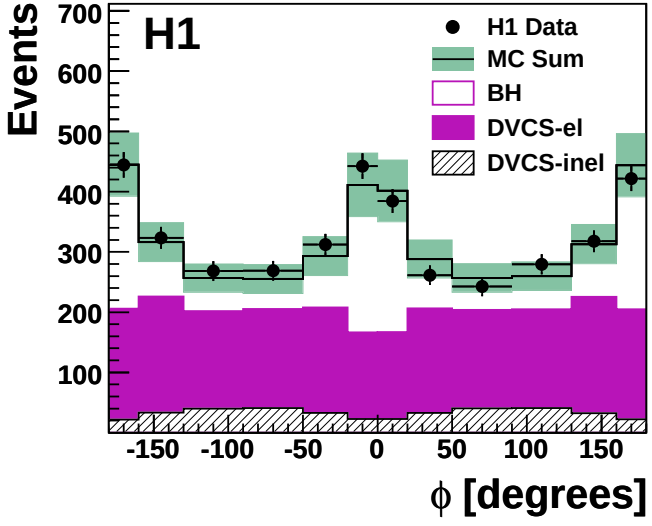
H1 $e^{\pm}$ data 2004-07
Int. lumi = 306 pb^{-1}
5437 events.



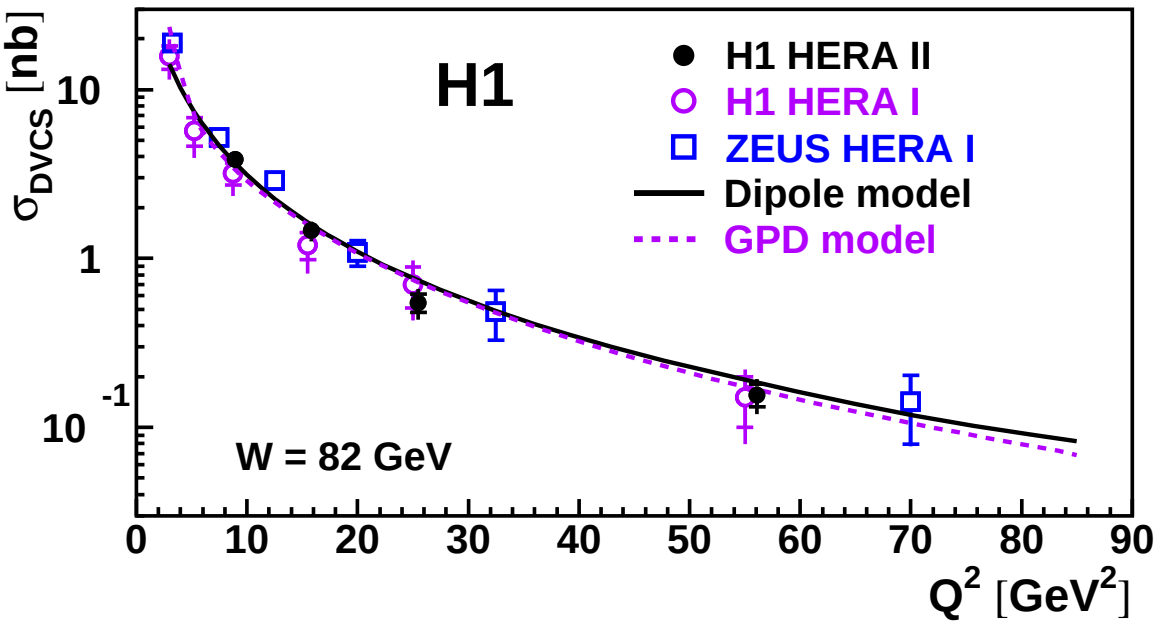


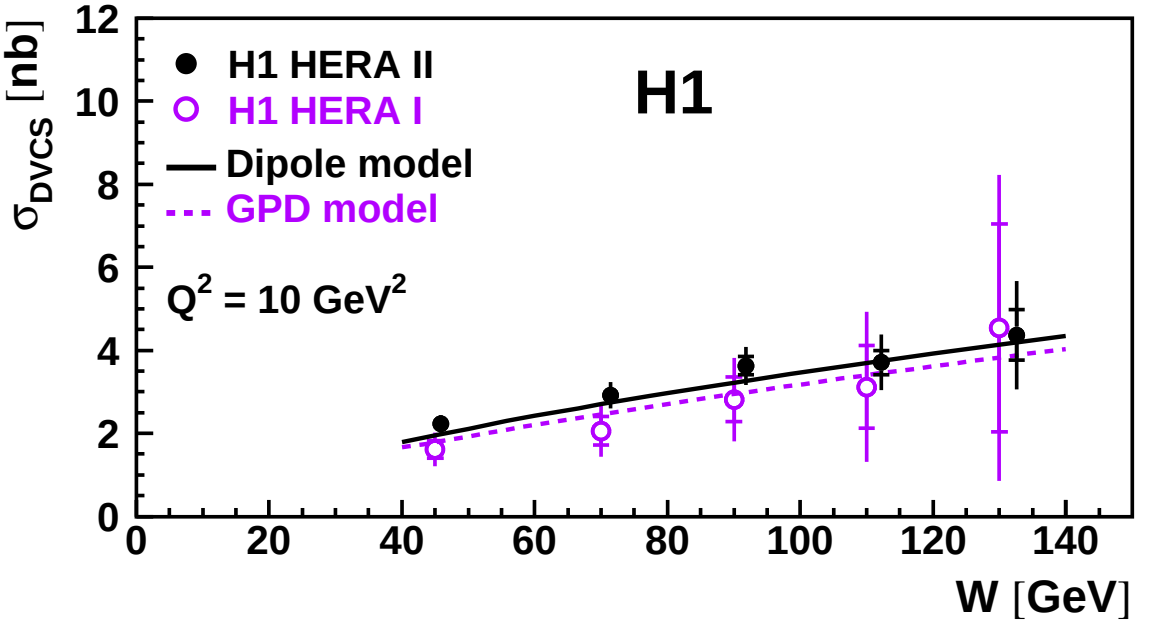






Cross section measurements





After subtraction of Bethe-Heitler contribution,

$$\frac{\mathrm{d}^3\sigma_{ep\to e\gamma p}}{\mathrm{d}W\,\mathrm{d}Q^2\mathrm{d}|t|} =$$

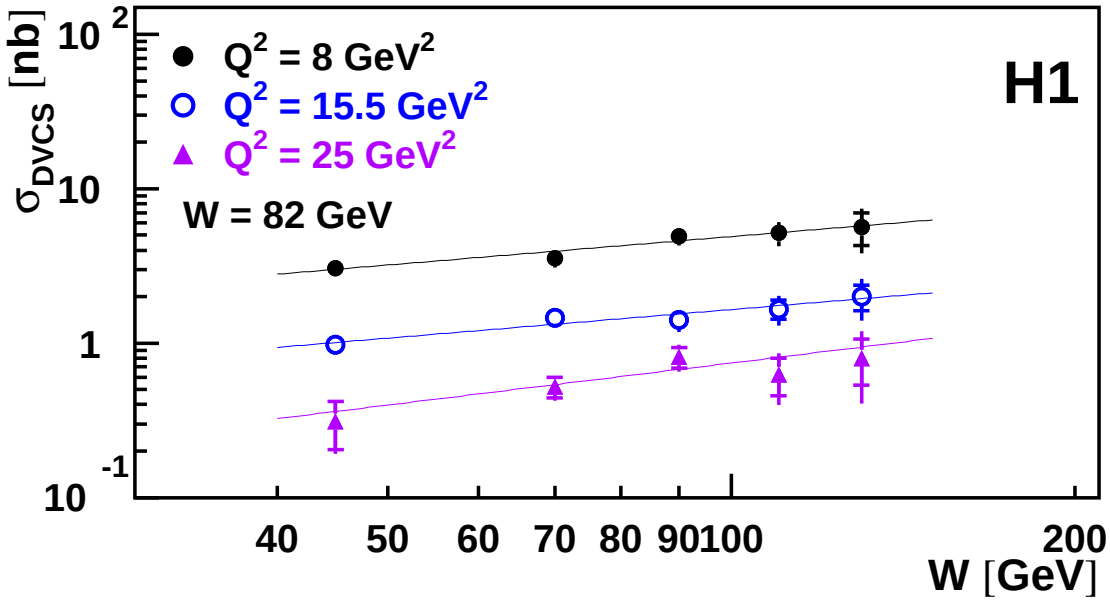
$$\Gamma(W,Q^2)\,\frac{\mathrm{d}\sigma_{DVCS}}{\mathrm{d}|t|}(W,Q^2)$$

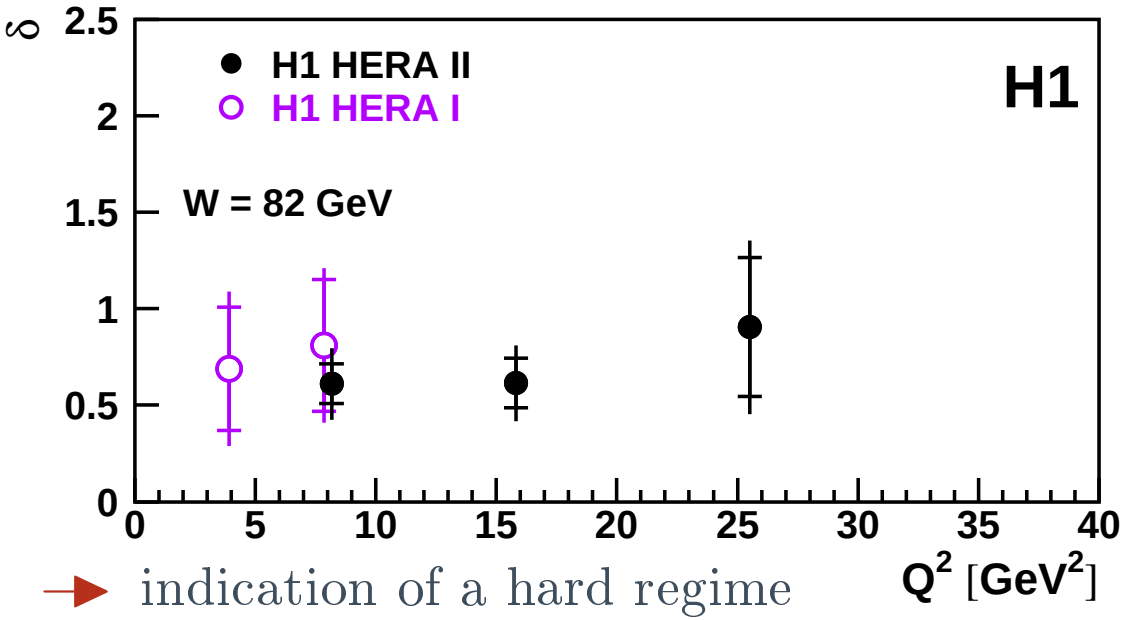
→ in agreement with previous results

→ 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.)



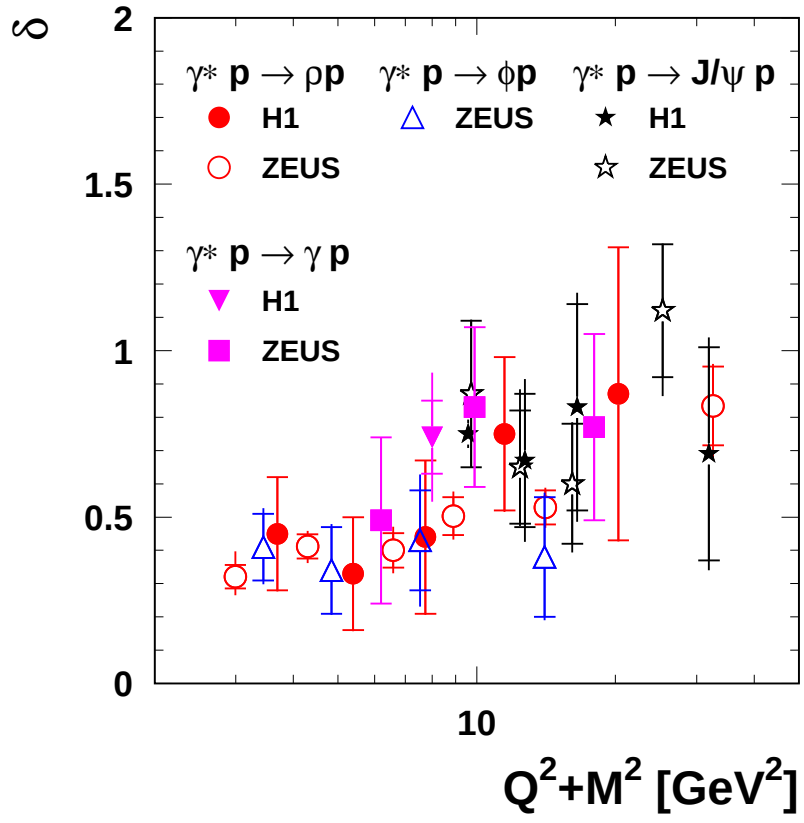


W dependence for three Q^2 values

→ Fit W^δ:

Total sample gives:

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

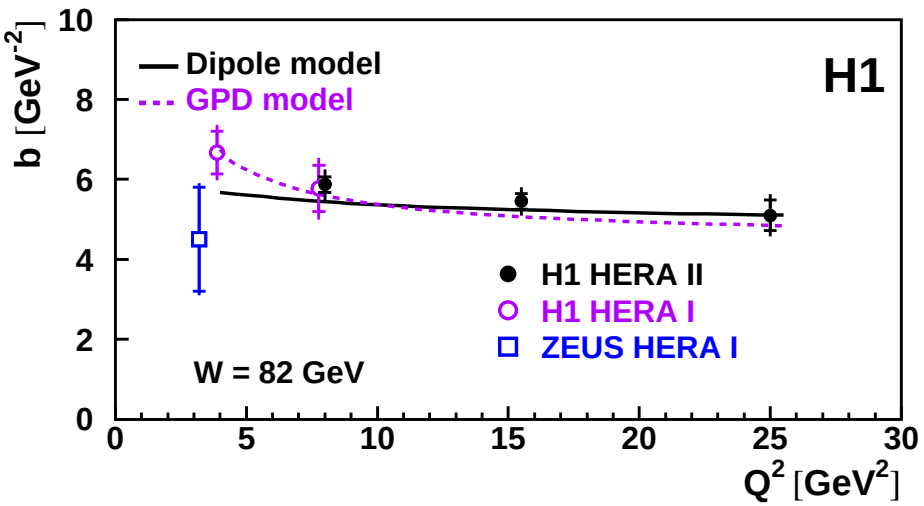


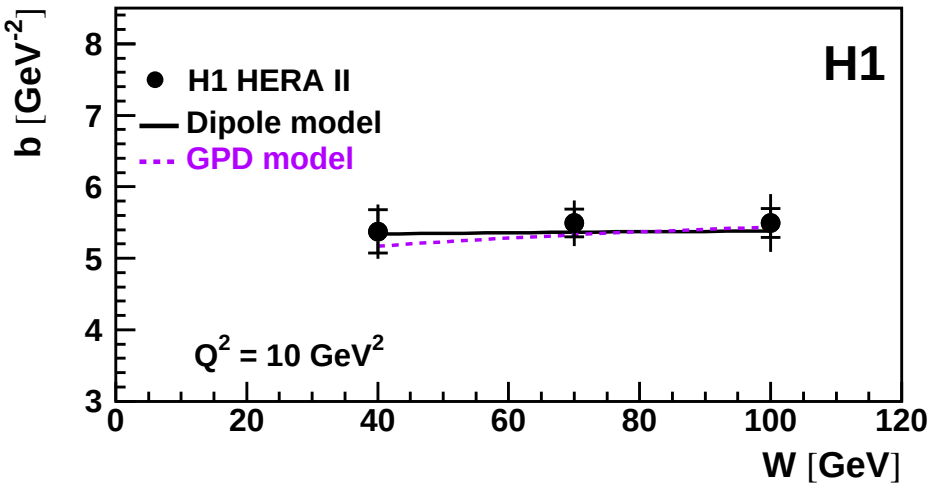
→ indication of a hard regime

→ no Q^2 dependence

→ in agreement with VM production

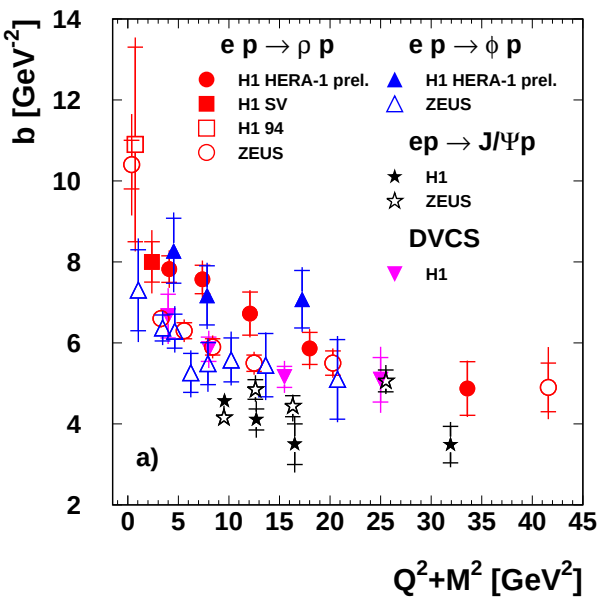
t slope

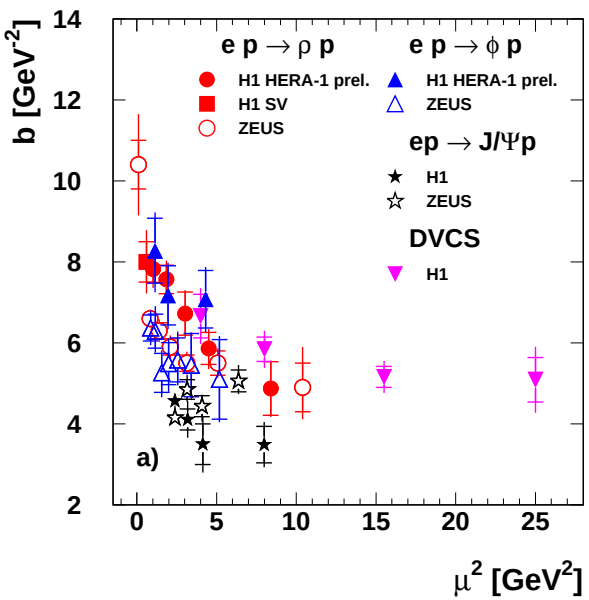




$\frac{d\sigma}{dt} \sim e^{-b|t|}$ $\quad b(Q^2) = A\left(1 - B\log(Q^2/2)\right)$

- no W dependence





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

for DVCS : $\mu^2 = Q^2$

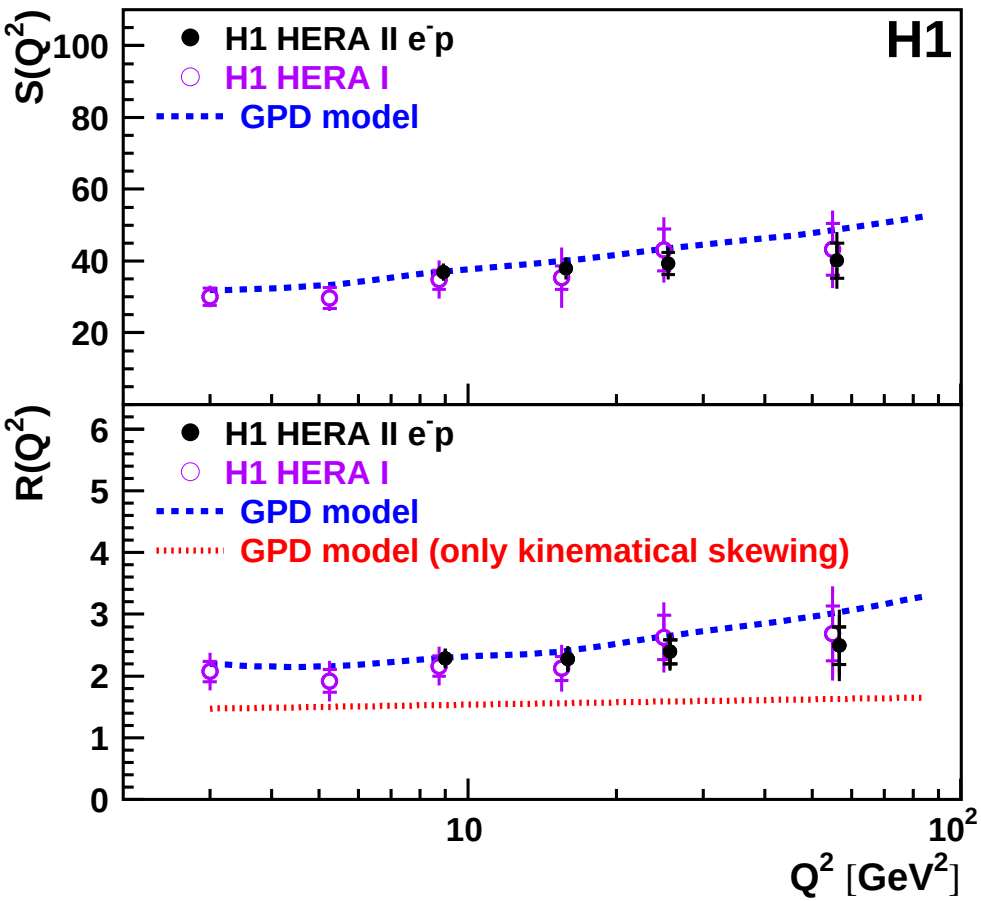
DVCS: QCD interpretation

• 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

$$R = \frac{\mathcal{I}m\ A(\gamma^* p \to \gamma p)}{\mathcal{I}m\ A(\gamma^* p \to \gamma^* p)} = \frac{4\sqrt{\pi\ \sigma_{DVCS}\ b(Q^2)}}{\sigma_T(\gamma^* p \to X)\sqrt{(1+\rho^2)}}$$

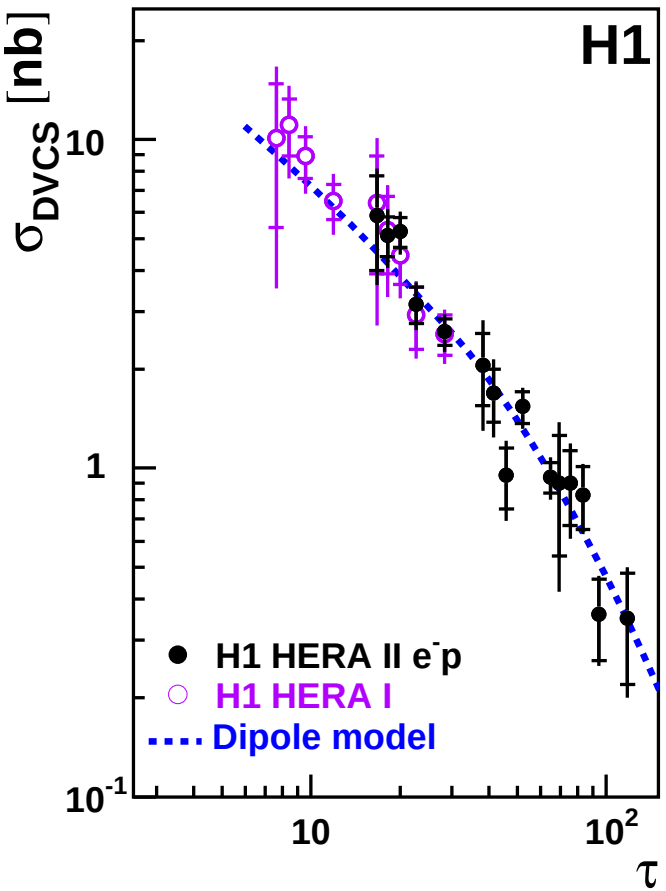


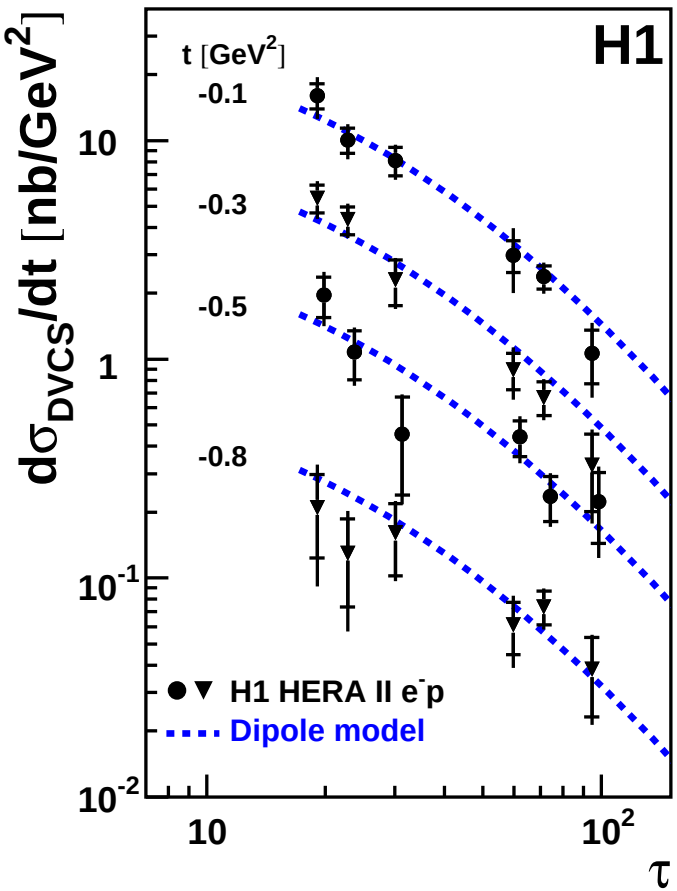
-$\sigma_T(\gamma^* p \to X)$ taken from QCD analysis of inclusive DIS H1 measurement.

$\Rightarrow$ important skewing factor

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

Dipole approach





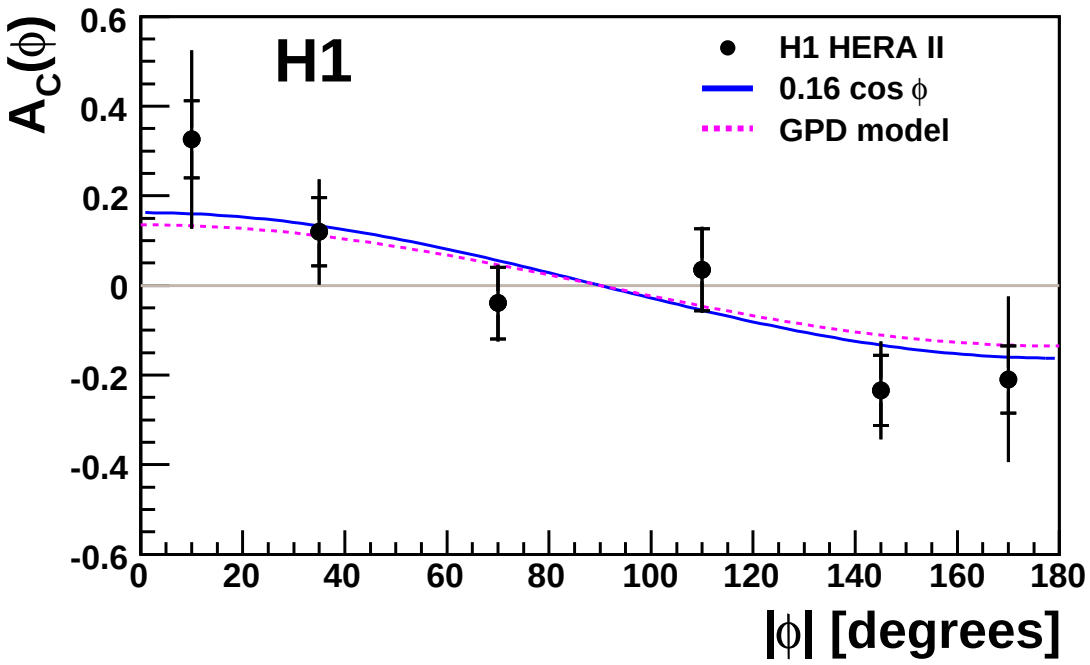
- here lower Q^2 points from previous H1 publication [hep-ex/0505061] are included.

→ 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^-).



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

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

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

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

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

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: Re A_{DVCS} positive (H1)

larger x: 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 imporant 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.

$\Rightarrow$ DVCS plays a key role in the understanding of strong interaction dynamic in DIS