DVCS and its t-dependence at HERA-II

$\mathcal{L}$. *Favart*

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On behalf of

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Deep-Inelastic Scattering

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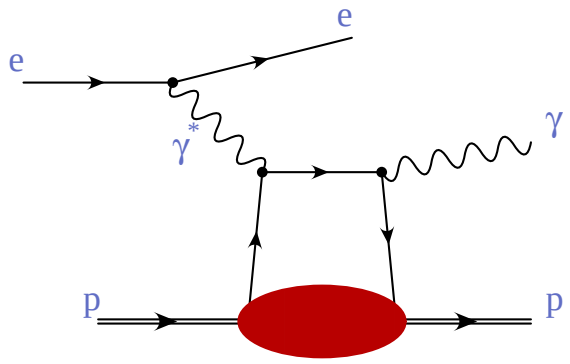
Content

- **Data e^- HERA II - 2005-06**
- **integrated lumi of 145 pb^{-1}**
- **Finalized cross section results**
- **Phys. Lett. B 659 (2008) 796.**

DVCS - Introduction

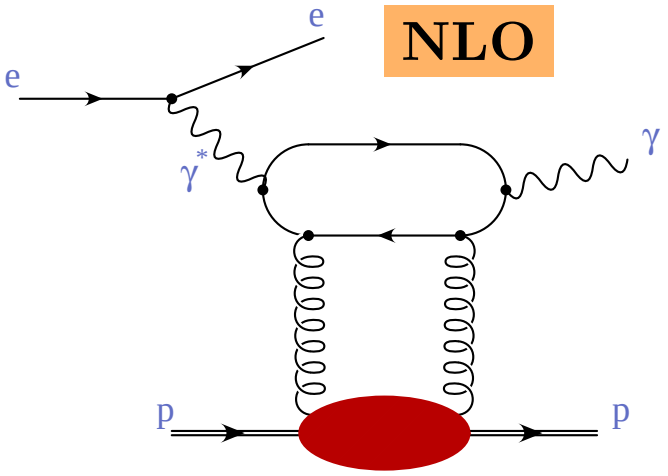
fact. $\longrightarrow$

LO



H1, ZEUS
HERMES, CLAS

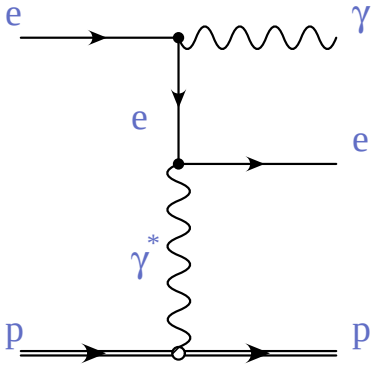
NLO

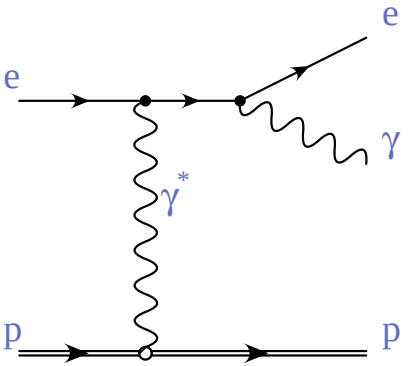


H1, ZEUS
COMPASS

- HERA (ep): wide range in Q^2, W and t accessible

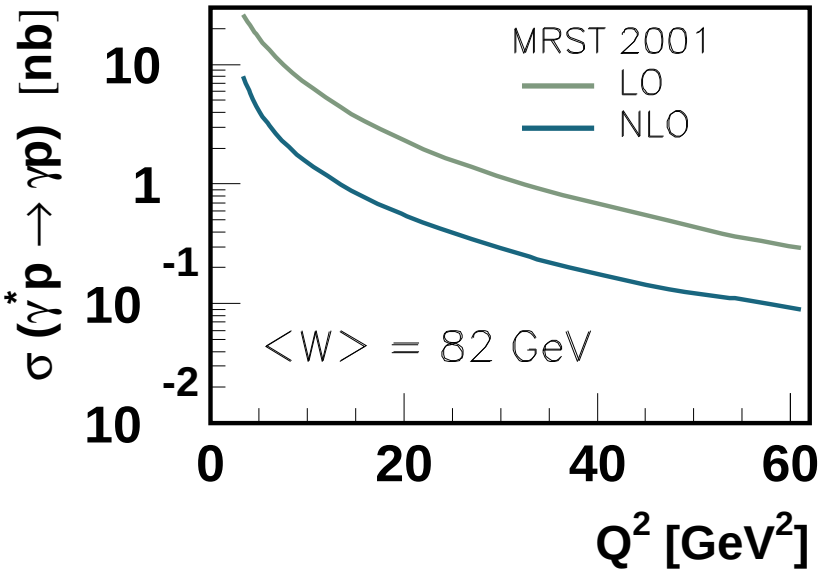
  at high Q^2 and low x
- Sensitivity to GPD (gluons)
- Bethe-Heitler Process (Background + Interference)
- interference term $\rightarrow \mathcal{A}_{DVCS}$ (asymmetry measurements)





QCD predictions

- Fully calculable in QCD
- NLO leading twist (+ twist three) calc. by A. Freund and M. McDermott Eur.Phys.J. **C23** (2002) 651
- Only input: GPDs



$b = b_0(1 - 0.15\log(Q^2/2))\,\mathrm{GeV}^{-2}$

GPD input:

DGLAP region: $|x| > \xi$

$\mathcal{H}^q(x,\xi,t;\mu^2) = q(x;\mu^2)\,e^{-b|t|}$ q singlet

$\mathcal{H}^g(x,\xi,t;\mu^2) = x\ g(x;\mu^2)\,e^{-b|t|}$ gluons

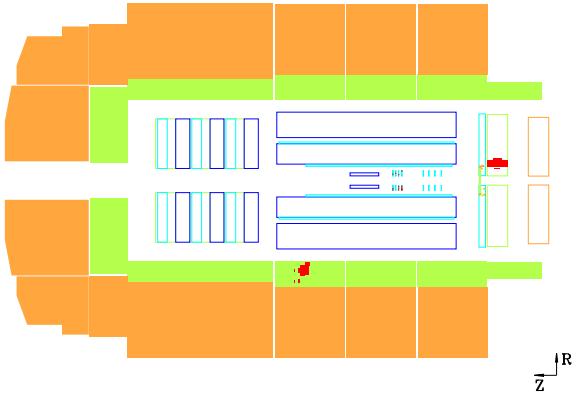
MRST2001 and CTEQ6

ERBL region: $|x| < \xi$

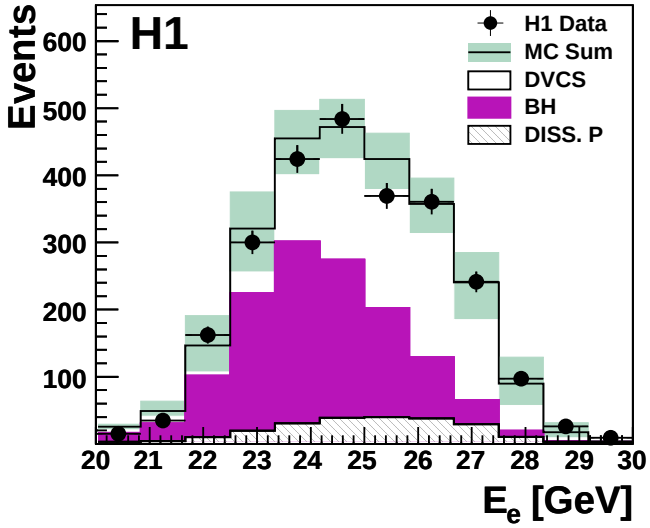
simple analytic function

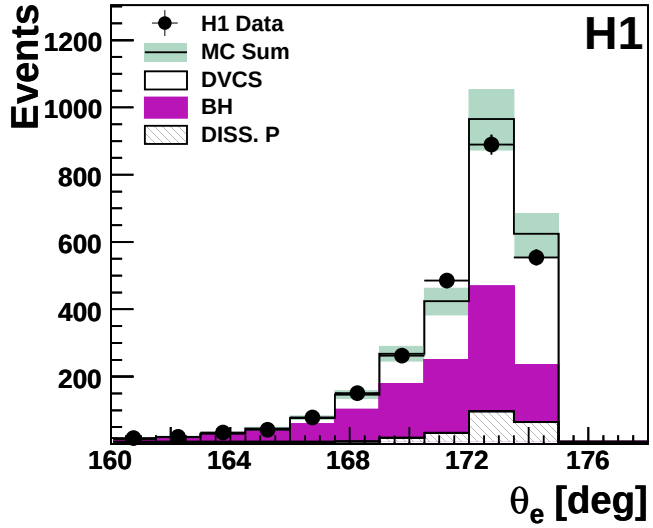
- implemented MC MILOU.

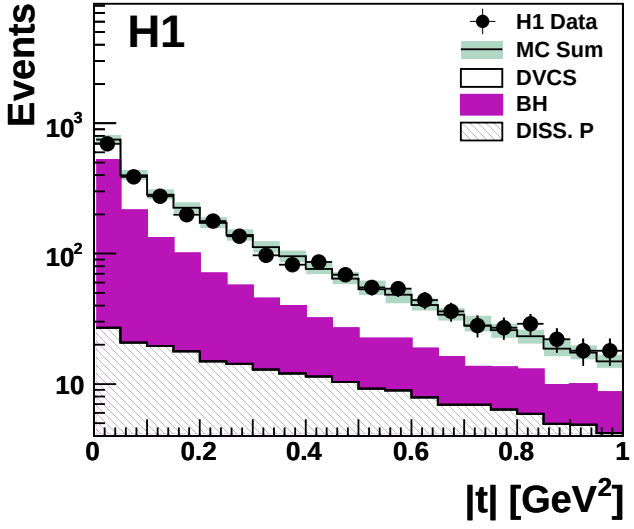
DVCS H1 Events

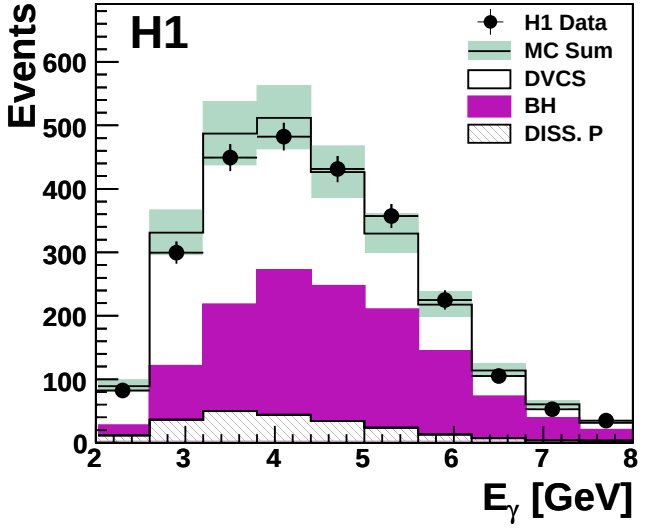


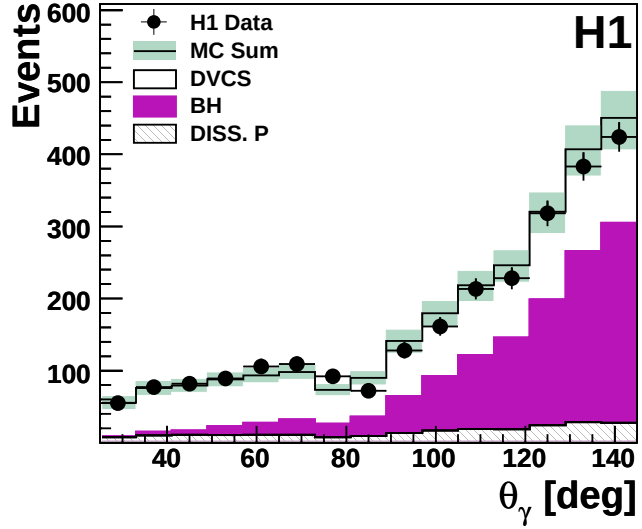
H1 e^- data 2005-06
Int. lumi $= 145$ pb^{-1}
2538 events.



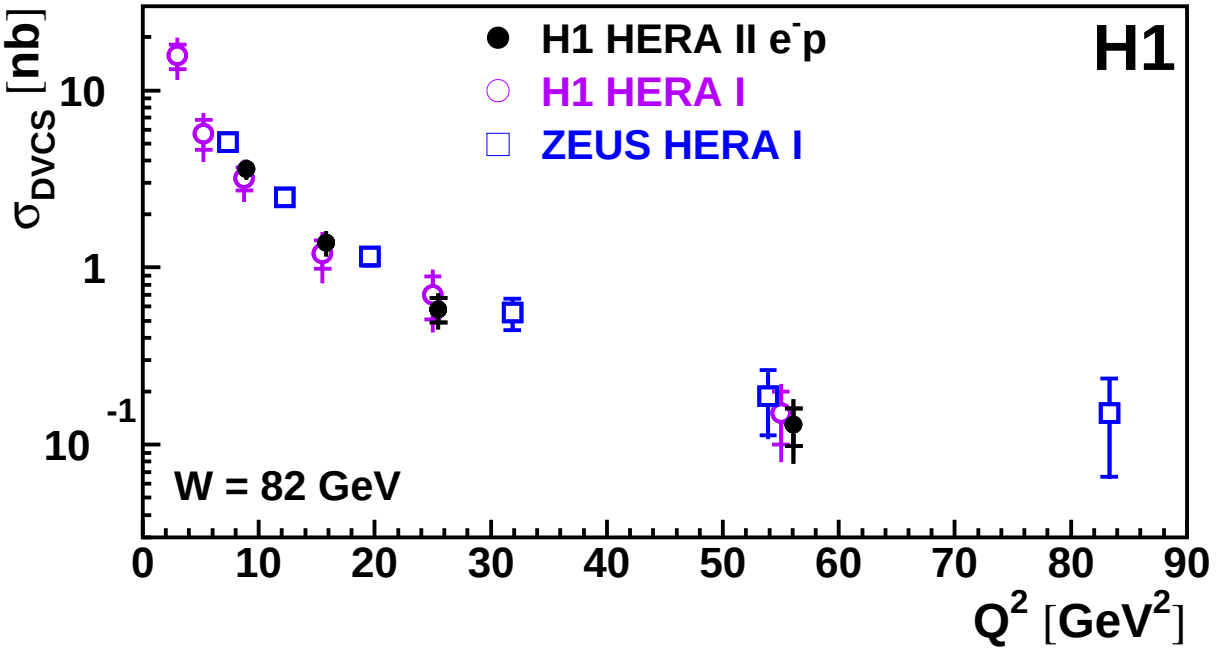


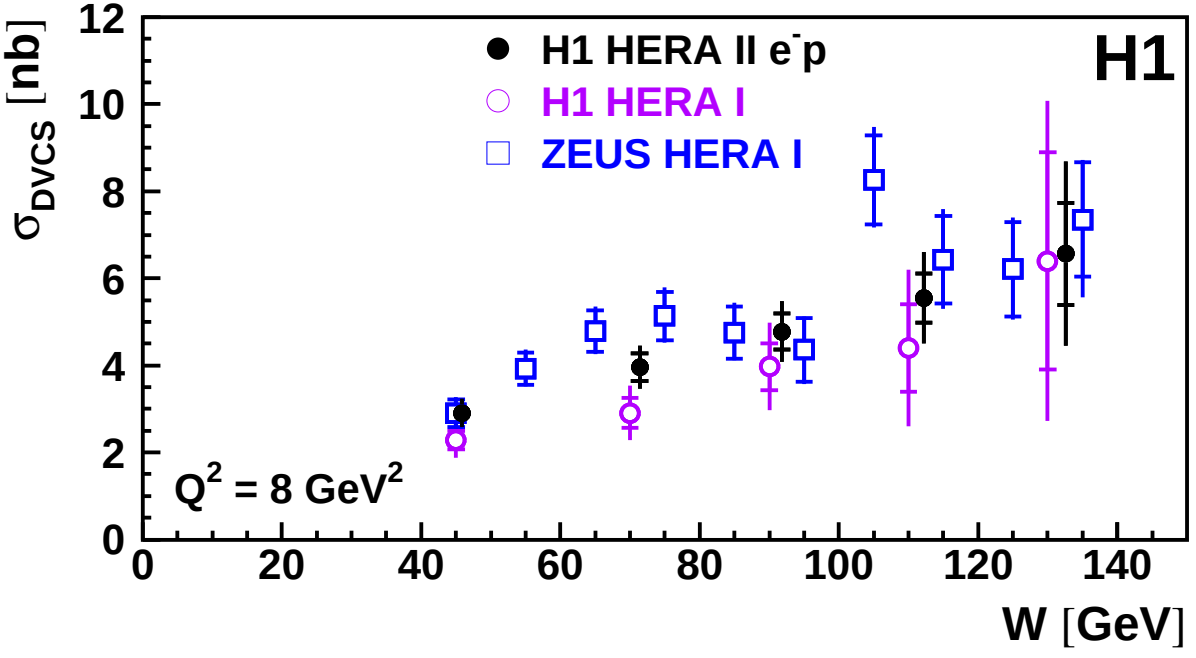






Basic Cross section measurements





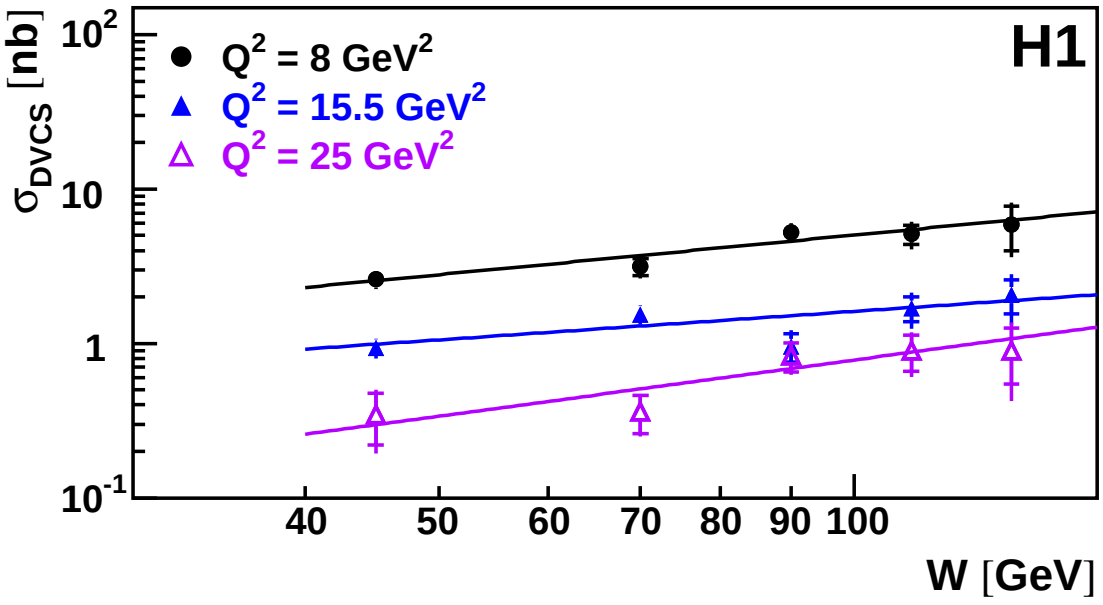
After subtraction of Bethe-Heitler contribution,

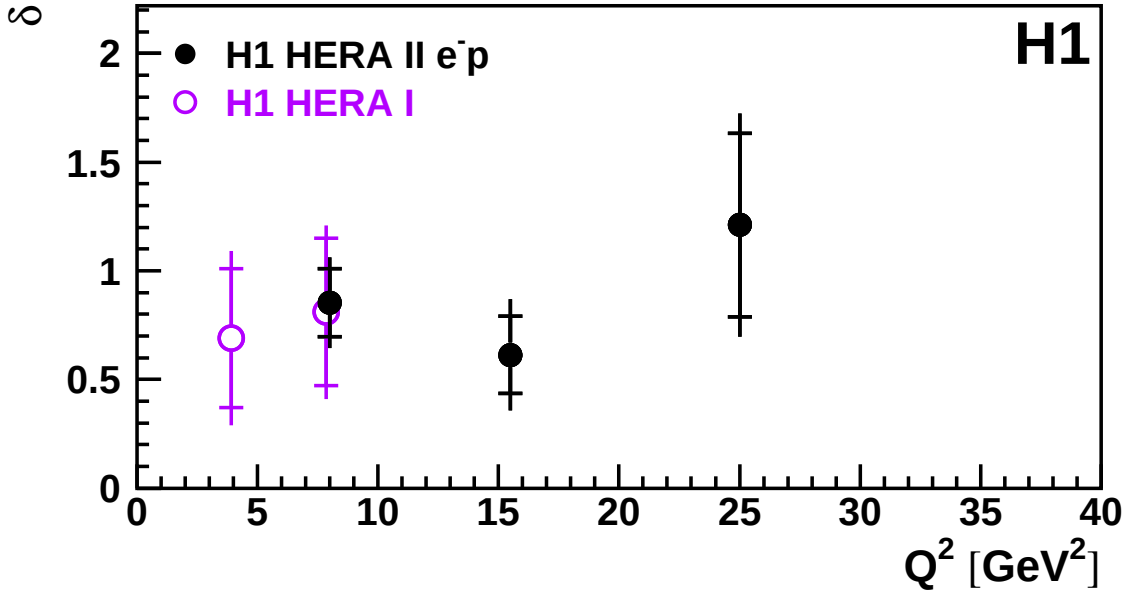
$$\frac{\mathrm{d}^3\sigma_{ep\to e\gamma p}}{\mathrm{d}W\,\mathrm{d}Q^2\mathrm{d}|t|} =$$

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

→ in agreement with previous results

→ improved precision

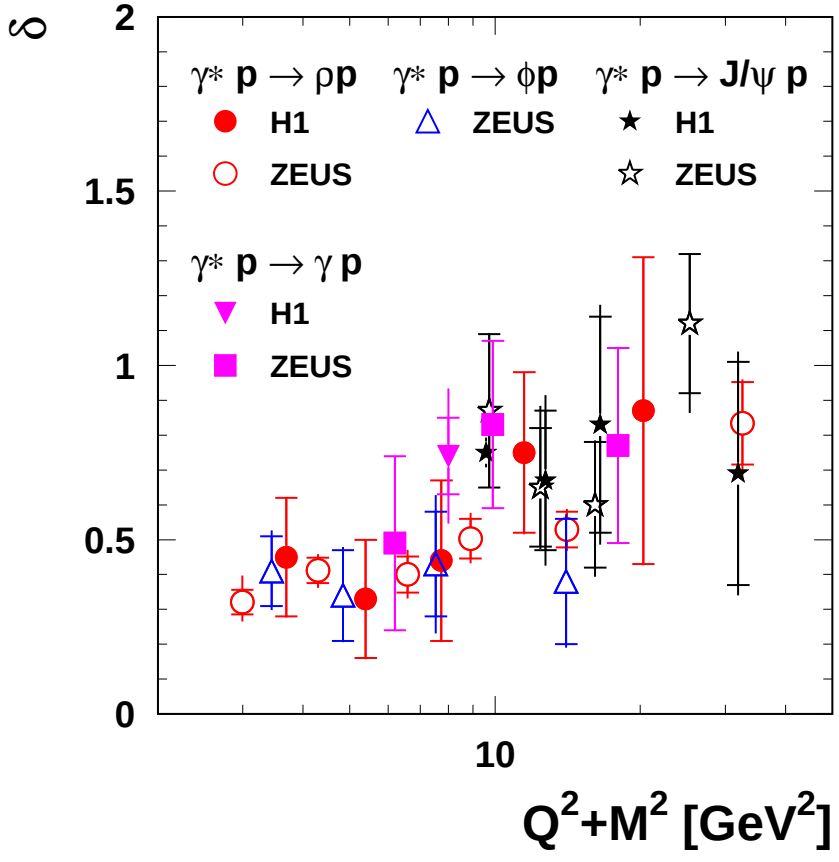




W dependence for three Q^2 values

→ Fit W^δ:

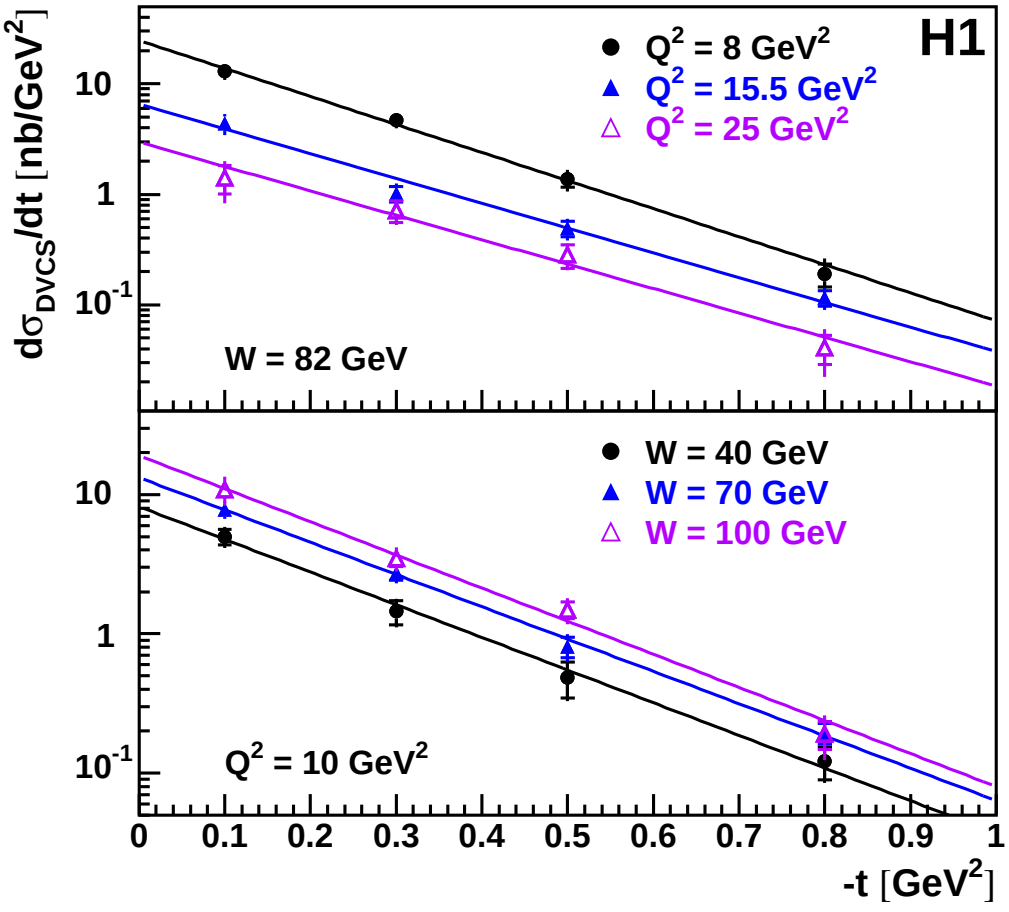
Total sample gives:
$\delta = 0.74 \pm 0.11 \pm 0.16$

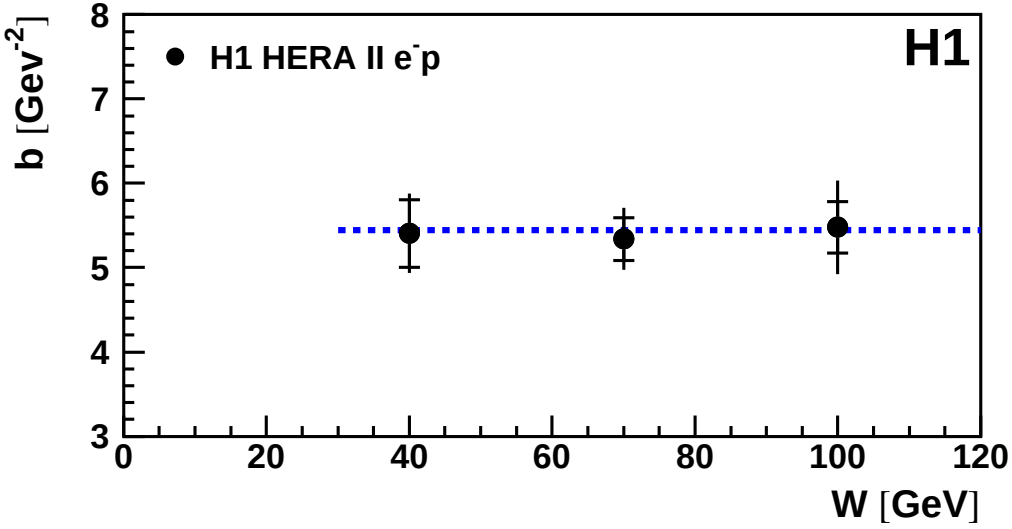


→ indication of a hard regime

→ in agreement with VM production

t slope

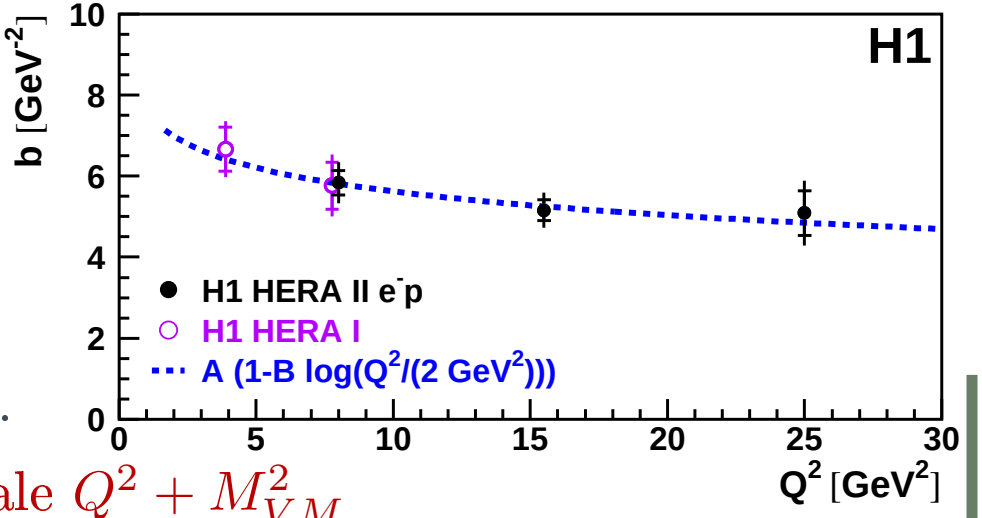




- First t slope measured vs W

$\Rightarrow$ no W dependence

$$b(Q^2) = A\left(1 - B\log(Q^2/2)\right)$$



A and B fitted to:

$A = 6.98 \pm 0.54$ GeV^{-2} $\qquad B = 0.12 \pm 0.03.$

$\Rightarrow$ Similar behaviour with VM using the scale $Q^2 + M_{VM}^2$

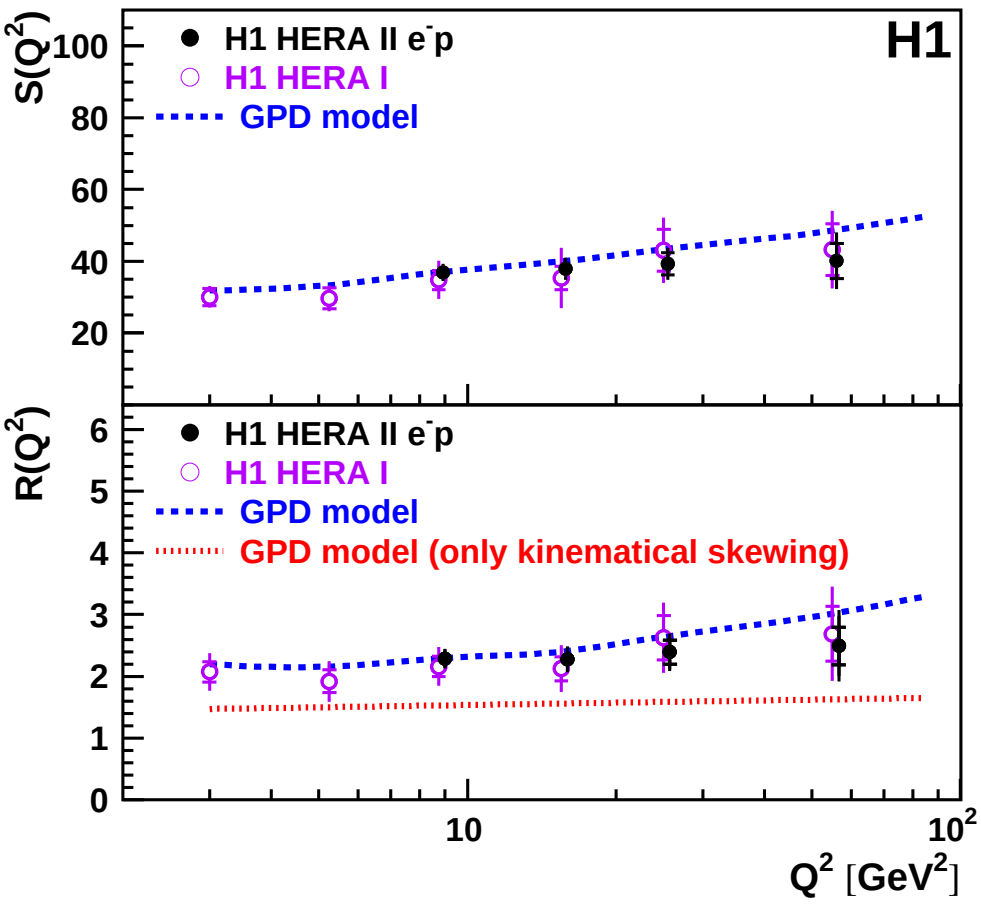
DVCS: QCD interpretation

• 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

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



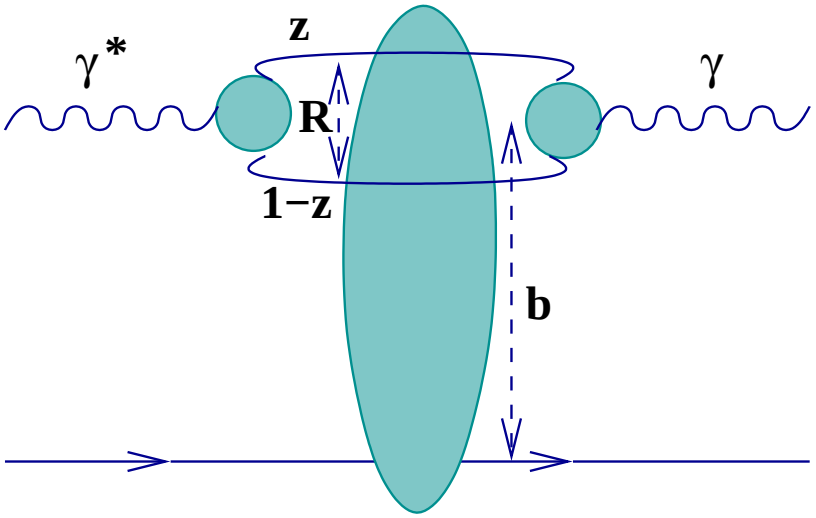
-$\sigma_T(\gamma^* p \to X)$ taken from QCD analysis of inclusive DIS H1 measurement.

$\Rightarrow$ important skewing factor

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

Colour Dipole Models

In the proton rest frame



- γ^* fluctuates in $q\bar{q} + q\bar{q}g + ...$

$$\mathcal{A} = \int dR^2\, dz\, \psi^{in}\, \sigma_{\rm dipole}\, \psi^{out}$$

- ψ^{in} and ψ^{out} calculable

- $\sigma_{\rm d}$ is modeled

- many models for $\sigma_{\rm d}$ exist.

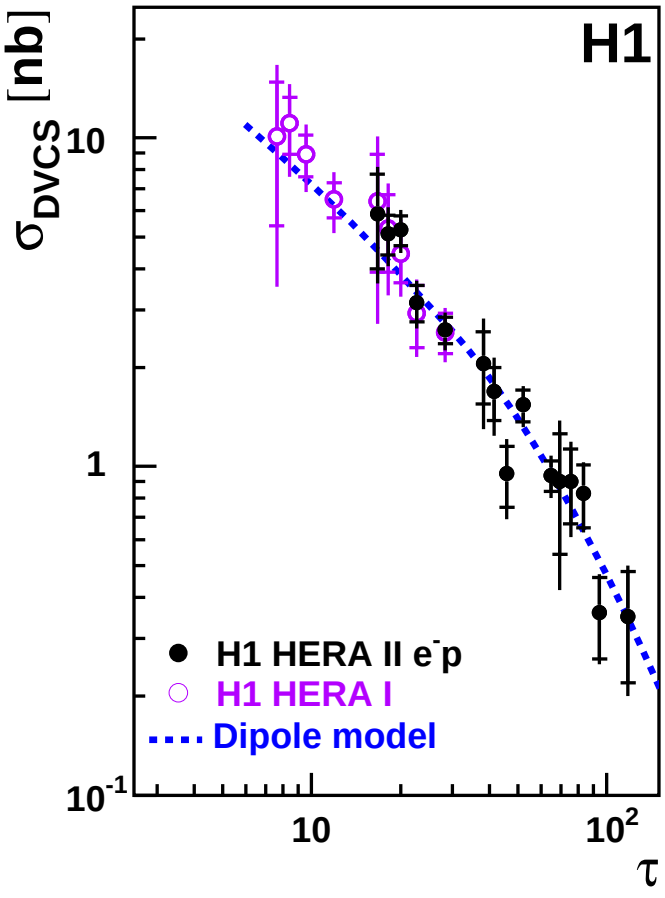
C. Marquet, R. Peschanski and G. Soyez: [hep-ph/0702171]

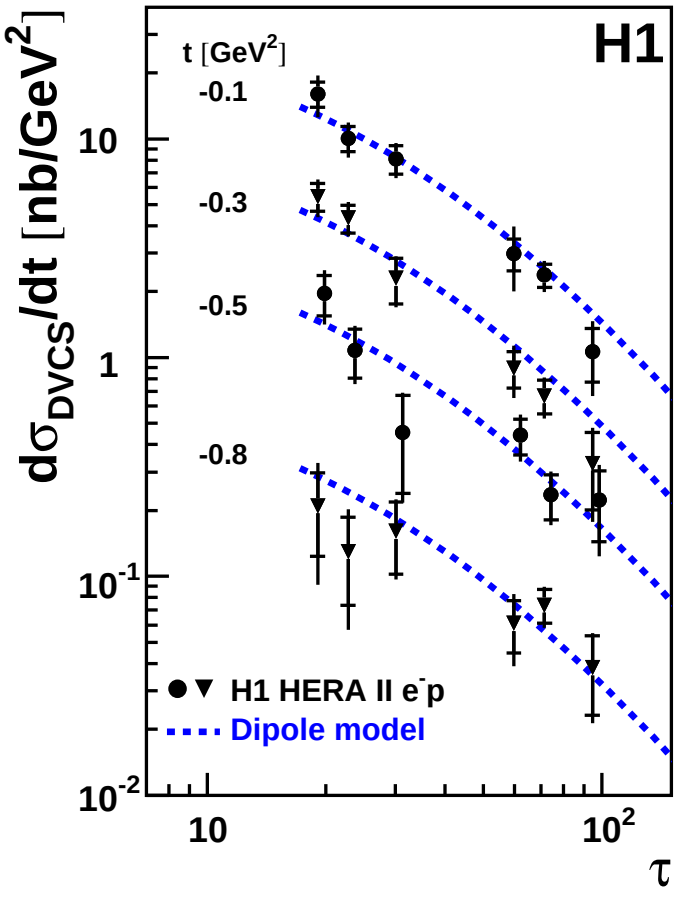
- includes saturation given by the geometric scaling extended here to the off-forward case ($|t| > 0$)

$$\sigma_{DVCS}(x, Q^2) = \sigma_{DVCS}(\tau), \quad \text{with} \quad \tau = \frac{Q^2}{Q_s^2(x)}.$$

$Q_s(x) = Q_0(x_0/x)^{-\lambda/2}$ using $Q_0 = 1$ GeV, $\lambda = 0.25$ and $x_0 = 2.7\ 10^{-5}$

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

Conclusions

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

- int. luminosity used increased by factor 4 w.r.t. H1 HERA-I data
- improved precision achieved in the t slope and the W dependence measurements.
- First measurement of the W dependence of the t slope
- in good agreement with NLO QCD predictions, based on GPD model: no intrinsic skewing needed.
- set constraints on gluon and sea GPDs.
- in agreement with various dipole model predictions.
- in particular with geometric scaling: no t dependence observed in the saturation scale.

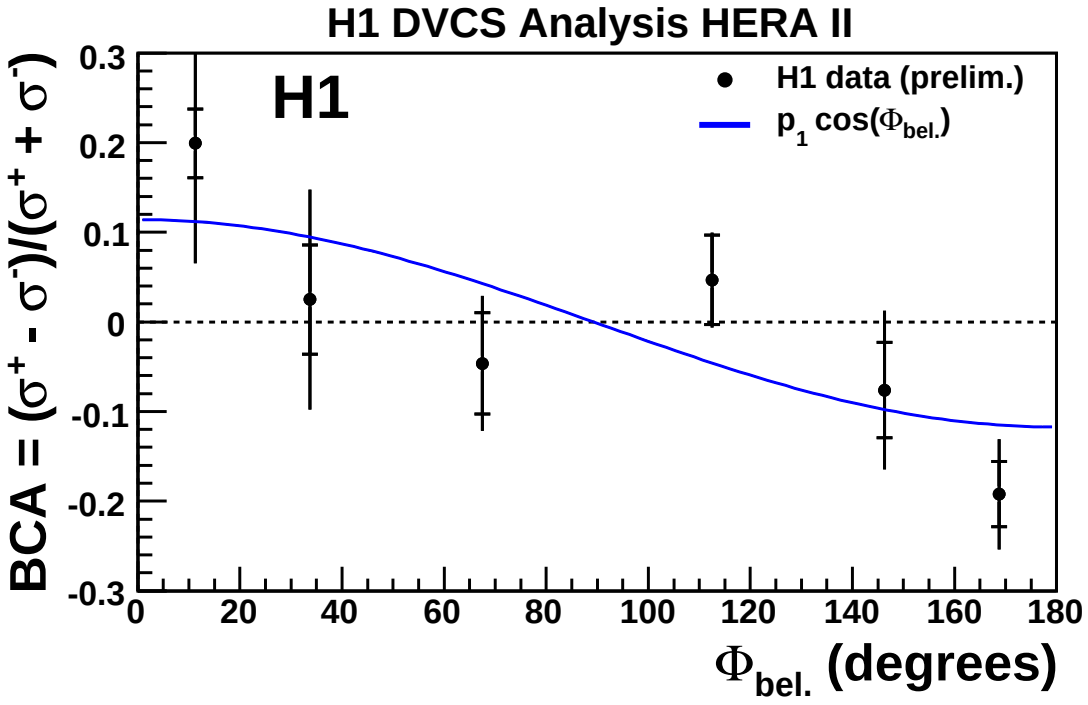
Back-up Slides

Beam Charge Asymmetry

New H1 measurement based on 291 pb^{-1} of HERA II data (e^+ and e^-).

- First DVCS BCA measured at HERA.

$$BCA \equiv \frac{\sigma(e^+p) - \sigma(e^-p)}{\sigma(e^+p) + \sigma(e^-p)} \sim p_1 cos(\Phi)$$



$0.05 < |t| < 1$ GeV^2 - before deconvolution by the ϕ resolution.