

DIS 2004

XII International Workshop on Deep Inelastic Scattering

Štrbské Pleso

14-18 April 2004

Deeply Virtual Compton Scattering at HERA (H1 results)

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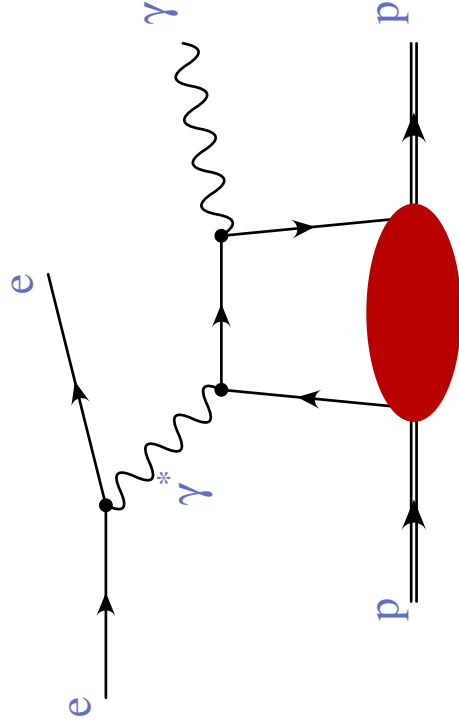
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Belgium

On behalf of the
H1 Collaboration



DVCS - Introduction

LO

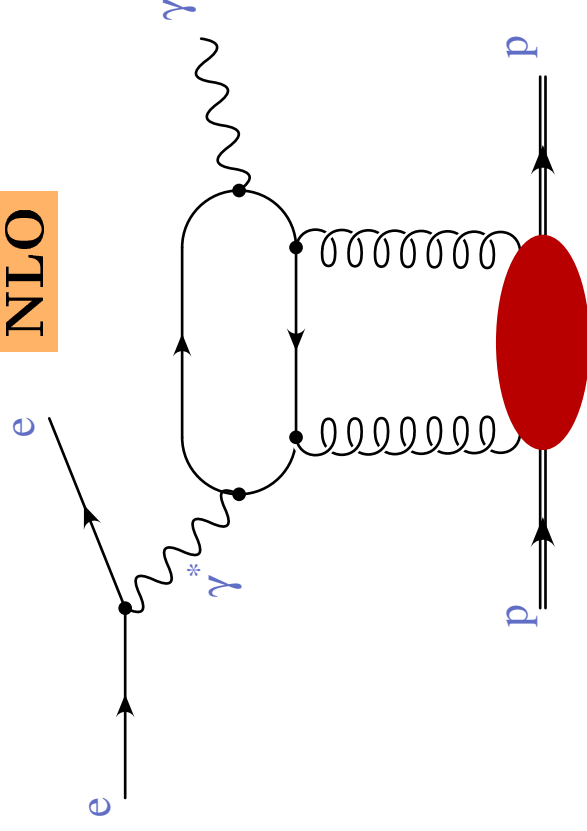


fact. \longrightarrow

H1, ZEUS

HERMES, CLAS

NLO

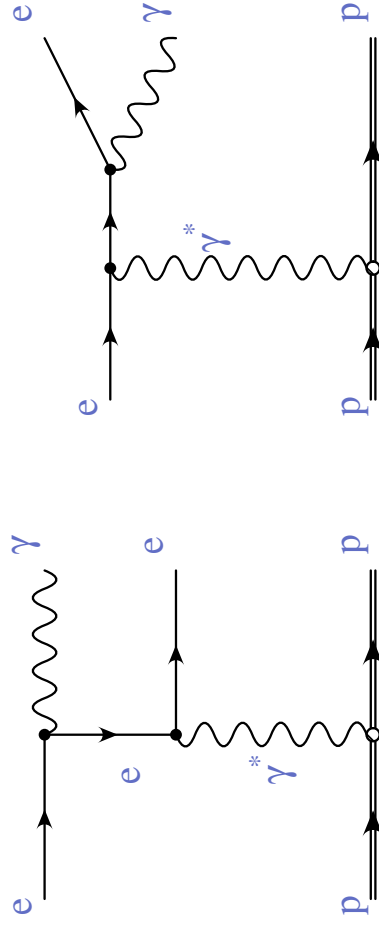


H1, ZEUS

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

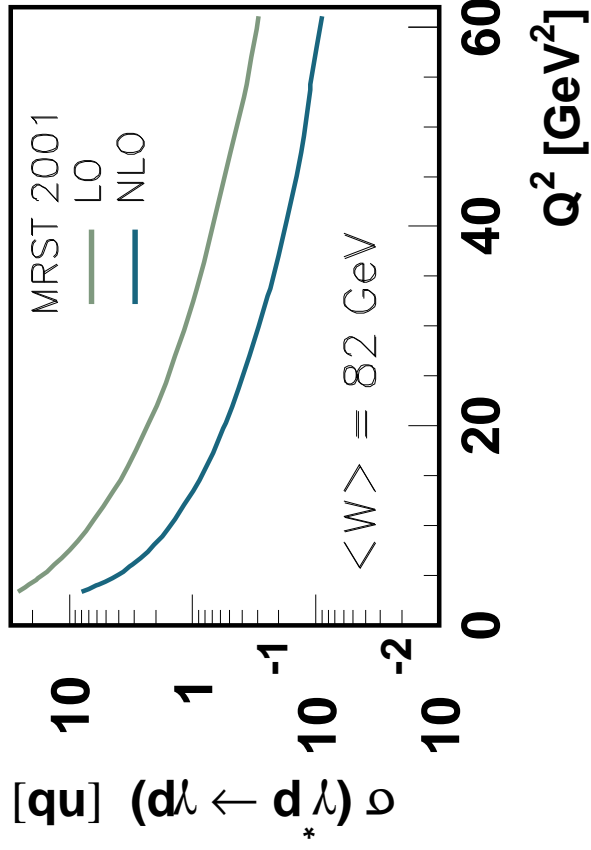
at high Q^2 and low x

- 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**



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

GPD input:

DGLAP region: $|x| > \xi$

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

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

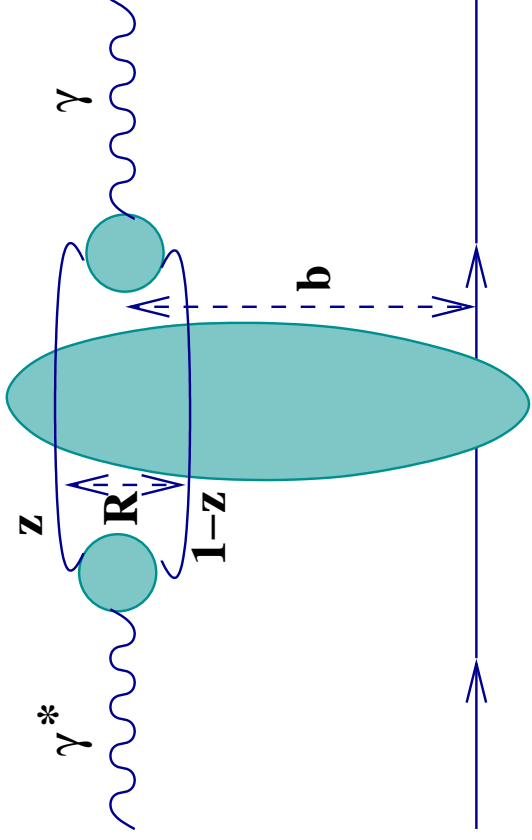
MRST2001 and CTEQ6

ERBL region: $|x| < \xi$

simple analytic function

Colour Dipole Models

In the proton rest frame



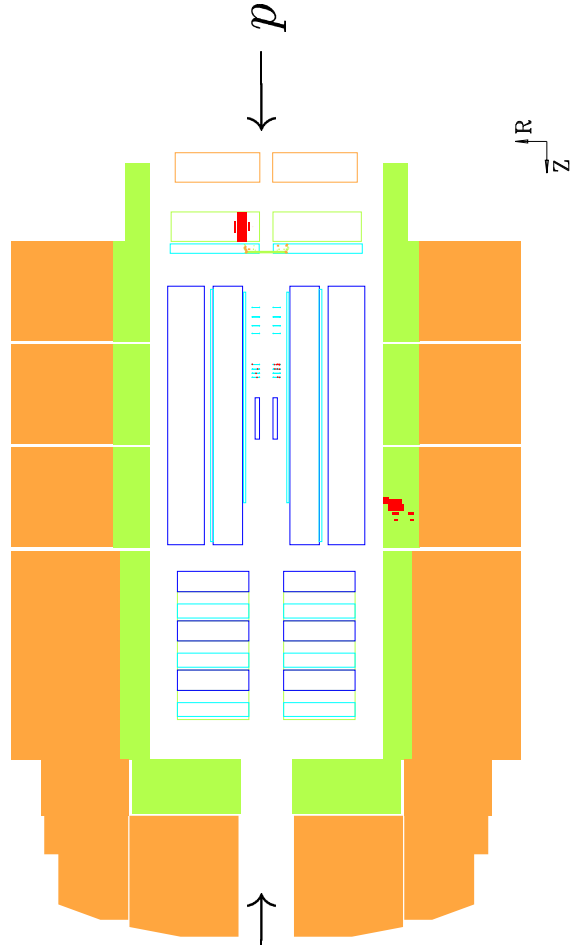
- γ^* fluctuates in $q\bar{q} + q\bar{q}g + \dots$
- $A = \int dR^2 dz \psi^{in} \sigma_{\text{dipole}} \psi^{out}$
- ψ^{in} and ψ^{out} calculable
- σ_d is modeled

Donnachie-Dosch: hard + soft \mathbb{P}
 Phys.Lett. B502 (2001) 74

Favart-Machado: GBW saturation model applied to DVCS (with and without
 DGLAP evolution: BGBK)

Eur.Phys.J. C29, 365 (2003) \rightarrow see talk

Analysis strategy



• DVCS

$e^+ \longrightarrow$

$\longleftarrow p$

\uparrow R
 \downarrow Z

H1

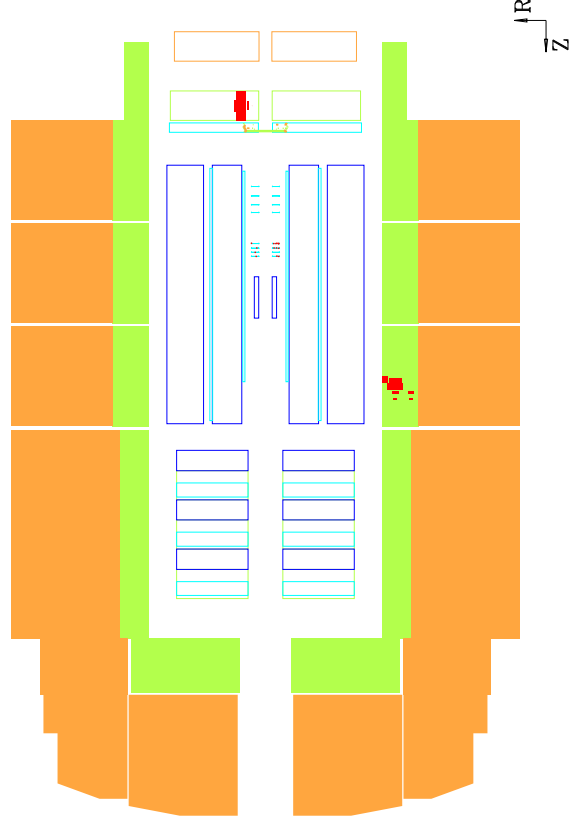
$E_1 > 15 \text{ GeV}$

$p_{T2} > 2 \text{ GeV}$

$E_3 < 0.5 \text{ GeV}$

elast. no track, Fwd

γ -sample

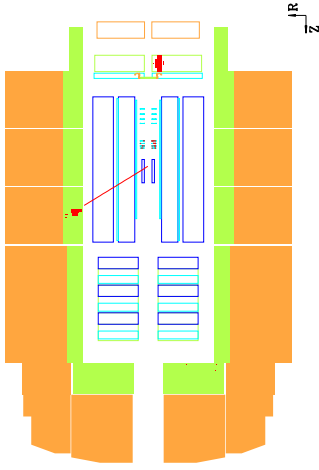


e^+ -sample

\uparrow R
 \downarrow Z

• Bethe-Heitler

H1 - Control by e^+ sample

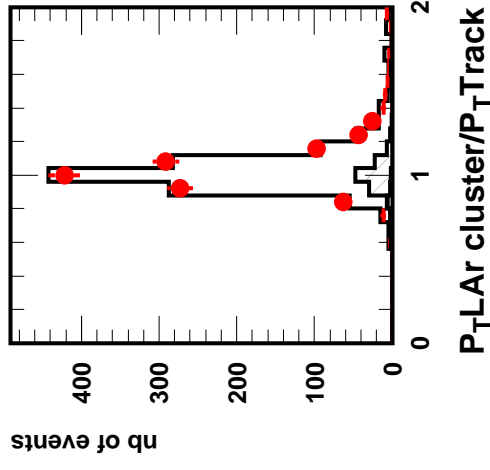
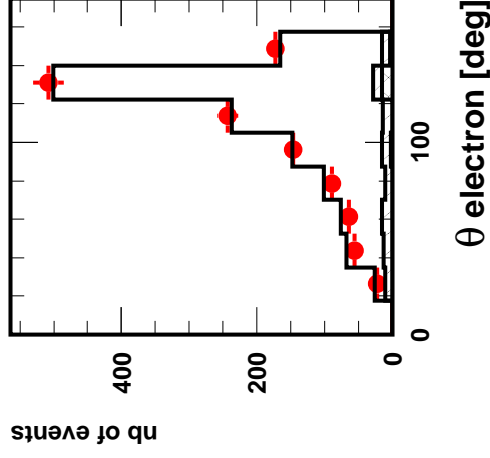
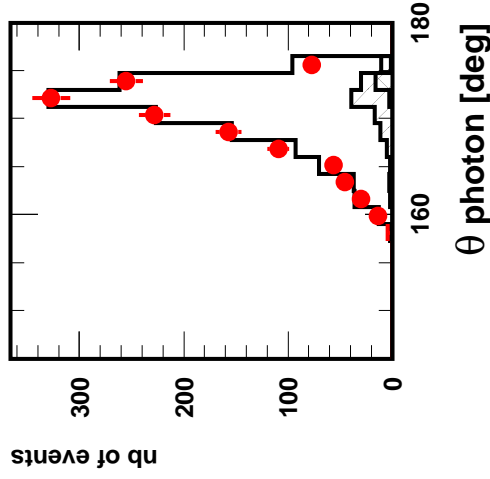
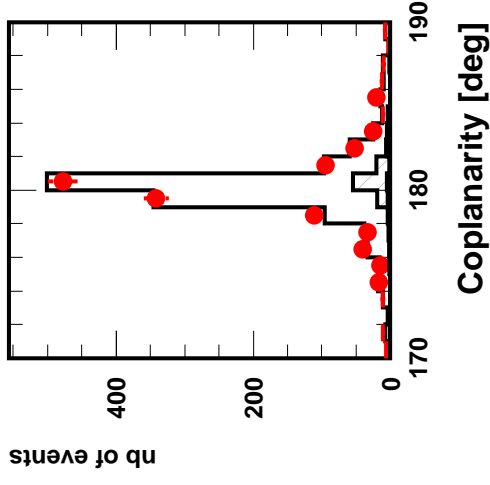
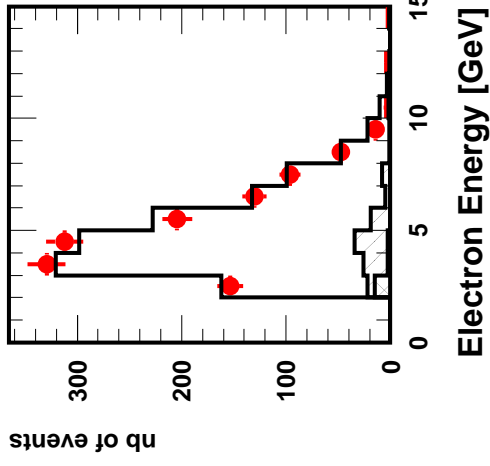
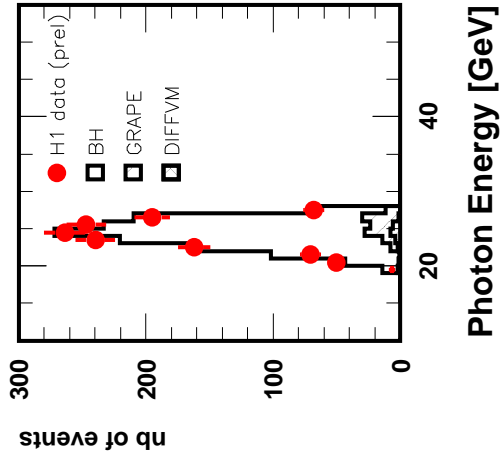


H1 data 2000

$$\int \mathcal{L} = 26 \text{ pb}^{-1}$$

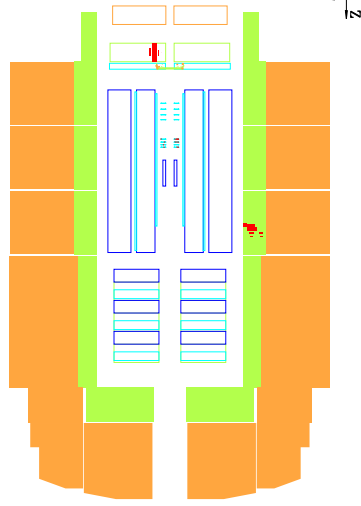
Well known cross section

H1 preliminary



\Rightarrow detector response is understood

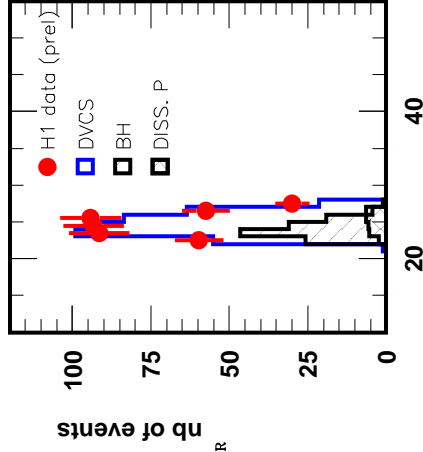
DVCS Candidate Sample



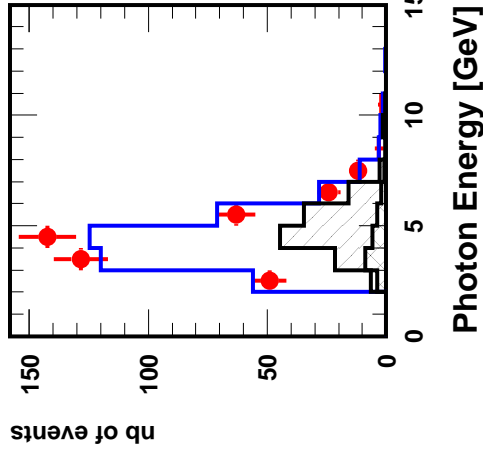
H1 data 2000

MC: FFS prediction (LO approximation - $b=7 \text{ GeV}^2$)

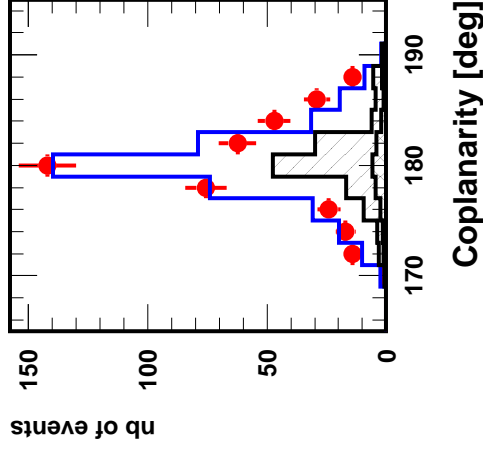
H1 preliminary



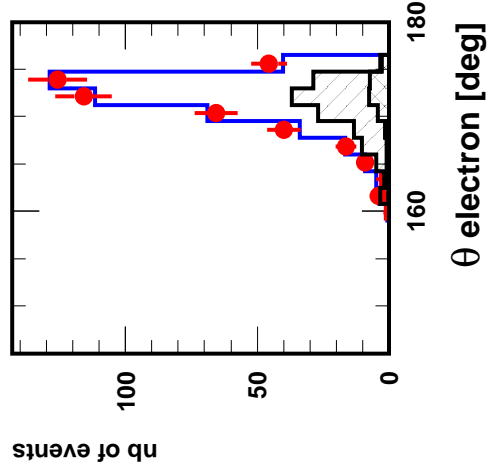
Electron Energy [GeV]



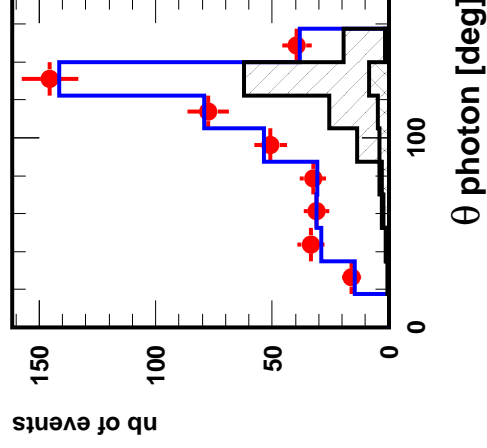
Photon Energy [GeV]



Coplanarity [deg]



θ electron [deg]

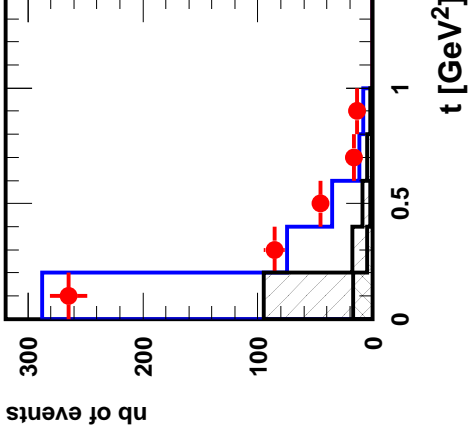
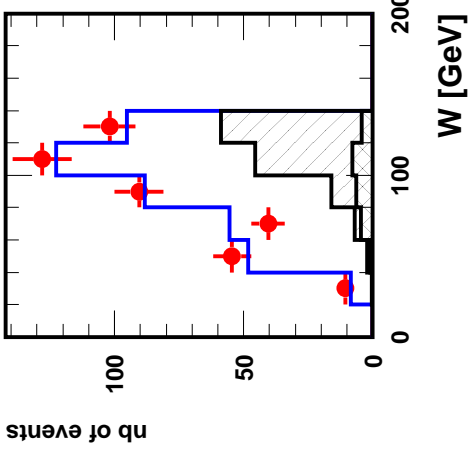
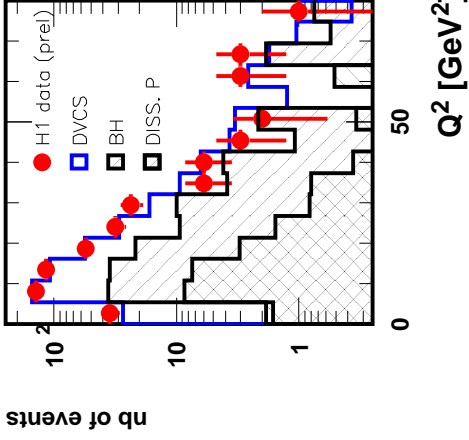


θ photon [deg]

Cross Section Measurement

$4 < Q^2 < 80 \text{ GeV}^2$
 $30 < W < 140 \text{ GeV}$
 $|t| < 1 \text{ GeV}^2$

H1 preliminary



- $e - p$ Cross Section extraction

$$\frac{d\sigma_{bin}}{dQ^2} = \frac{(N_{bin} - N_{backg.} - N_{p.dis.})}{\epsilon \cdot A \cdot \Delta Q^2 \cdot \mathcal{L}} \cdot (1 + \delta_{rad}) \quad \text{idem in } dW$$

- $ep \rightarrow \gamma p$ Cross Section (BH subtraction and photon flux factor)

- Main corrections and systematics:

- Proton diss background: $11 \pm 6 \%$ • Δ acceptance & bin cent. corr: 7%
- $\Delta\theta_e/\theta_\gamma$ (1.3/3 mrad): $5/5 \%$ • Energy scale uncertainty: 5%
- uncert. t slope ($b \pm 2 \text{ GeV}^{-2}$): 4% • QED rad corr: ($1 + \delta_{rad}$): 3%

NLO QCD

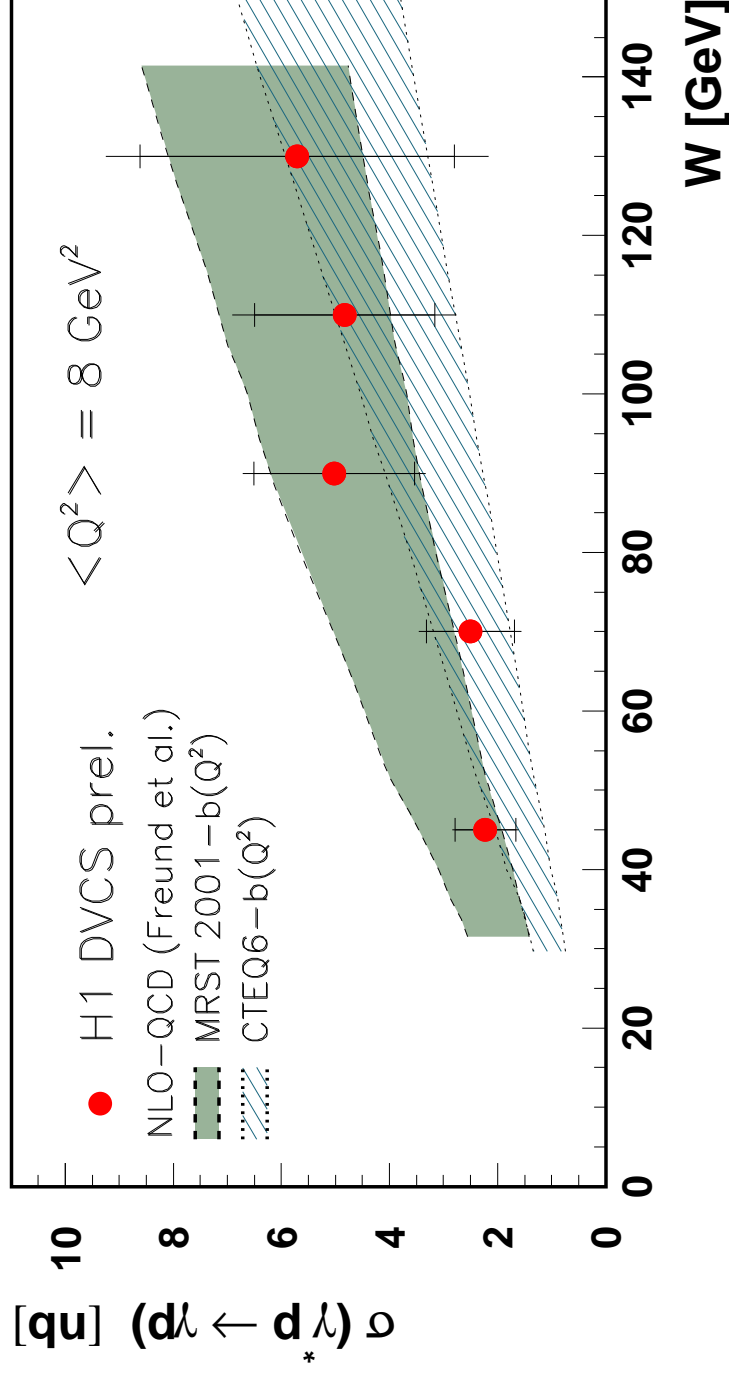
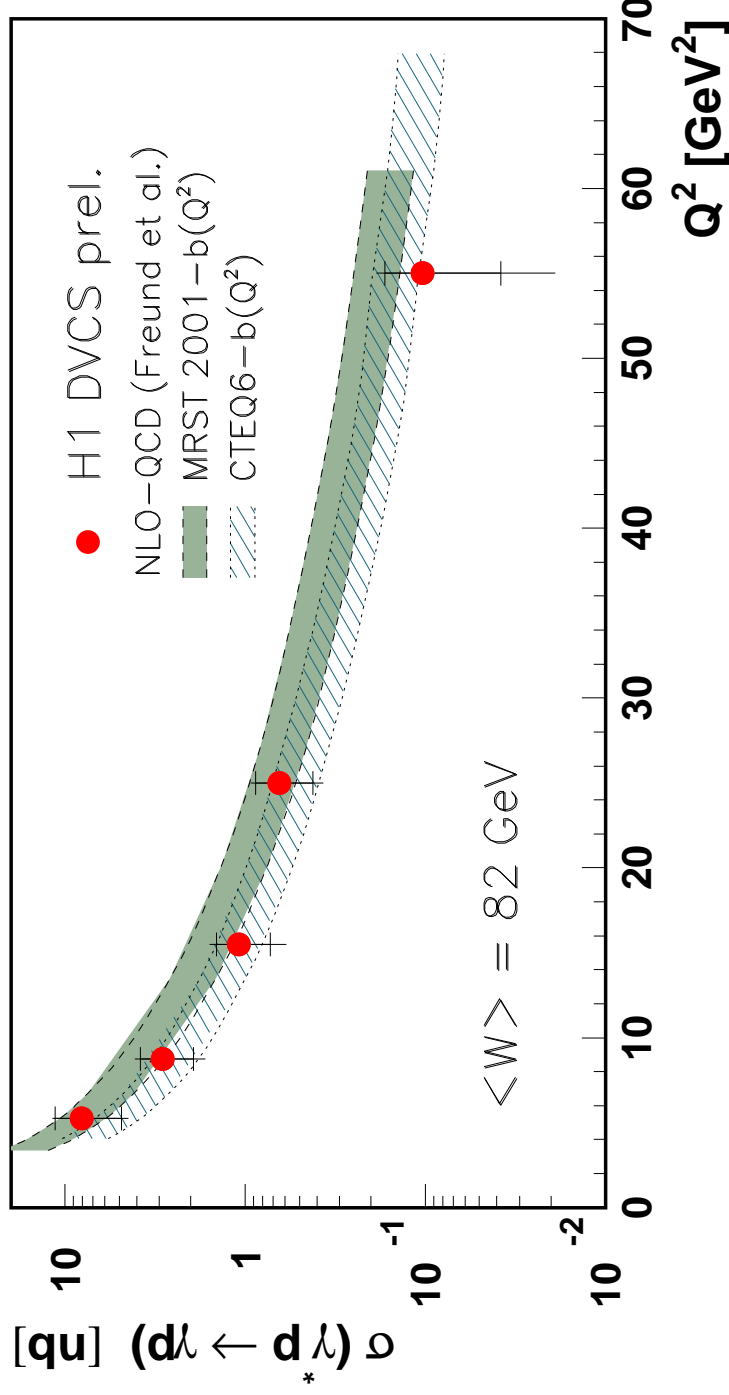
band:

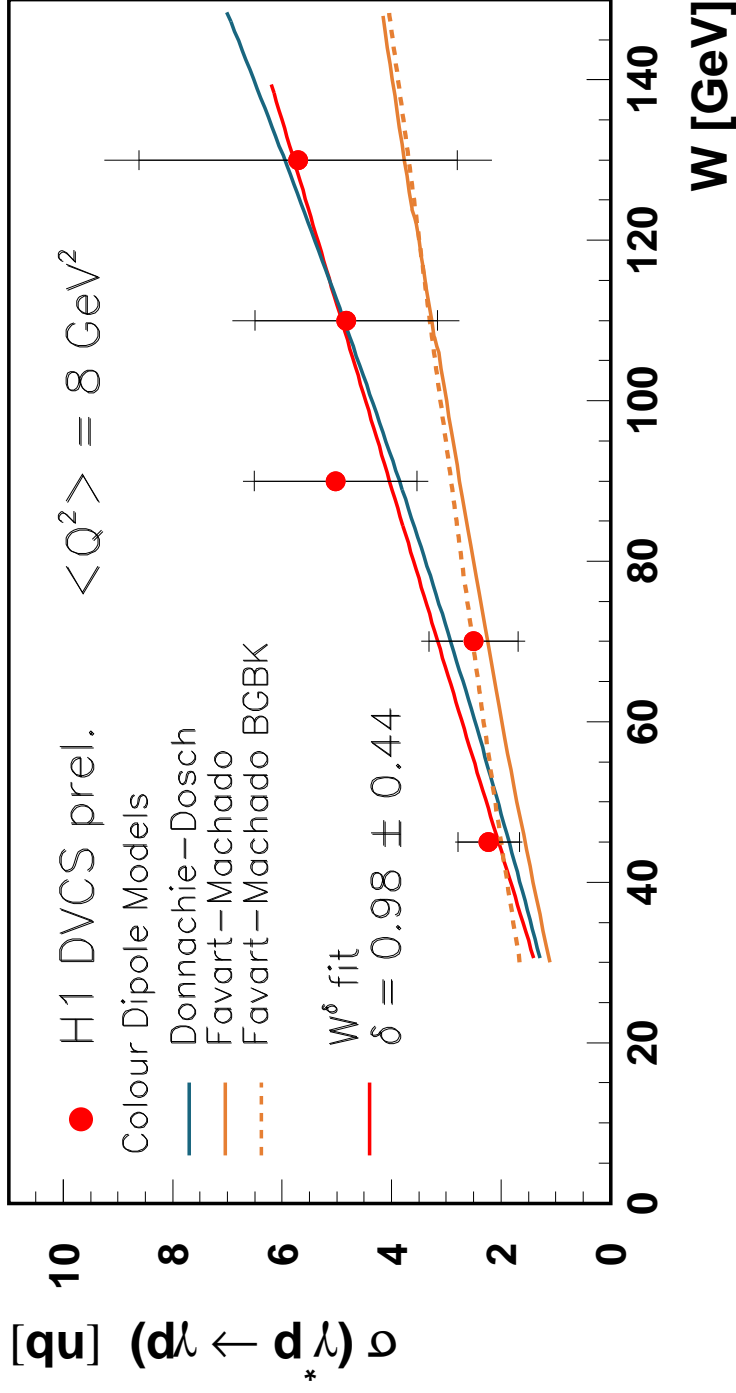
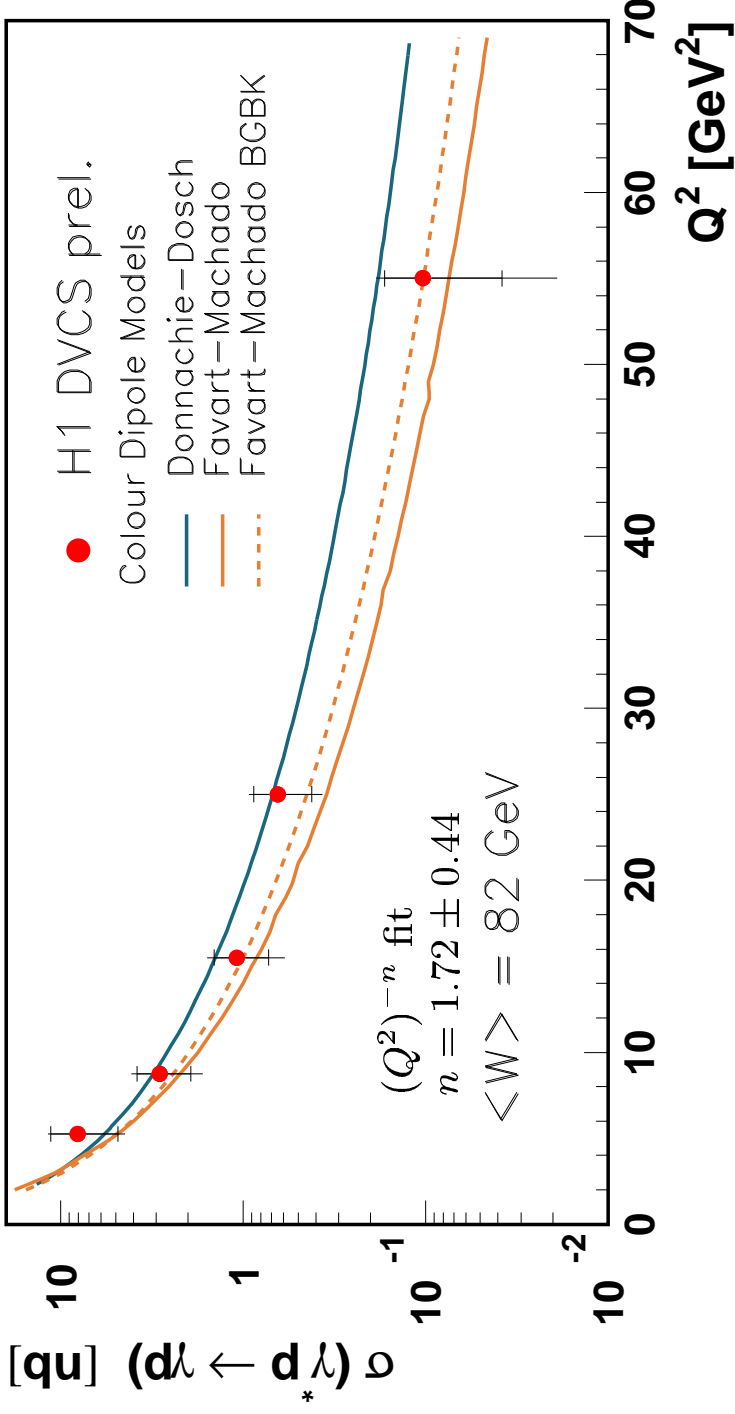
$$5 < b_0 < 9 \text{ GeV}^{-2}$$

⇒ Good description by QCD - NLO calculations

⇒ high sensitivity to the ERBL region param.

⇒ Need to measure t dependence





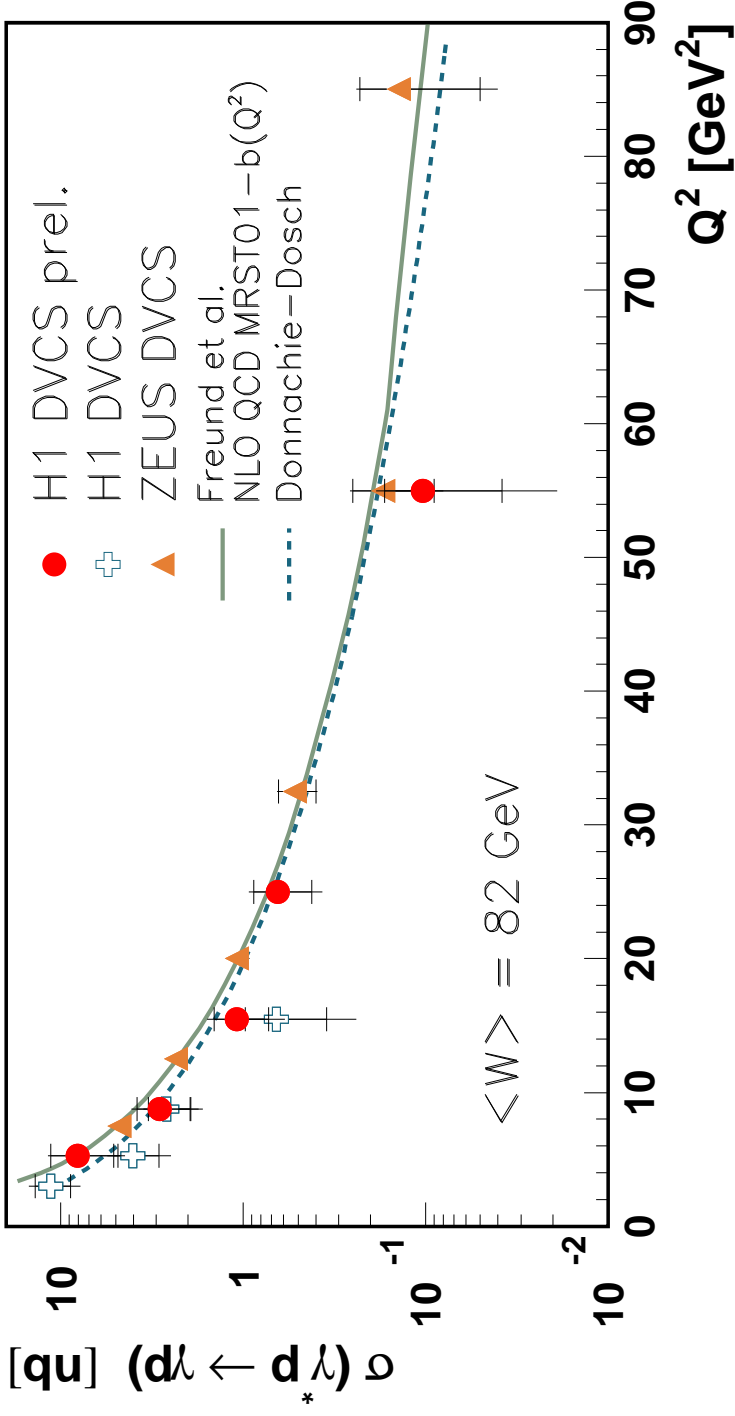
Dipole Models

$$b = 7 \text{ GeV}^{-2}$$

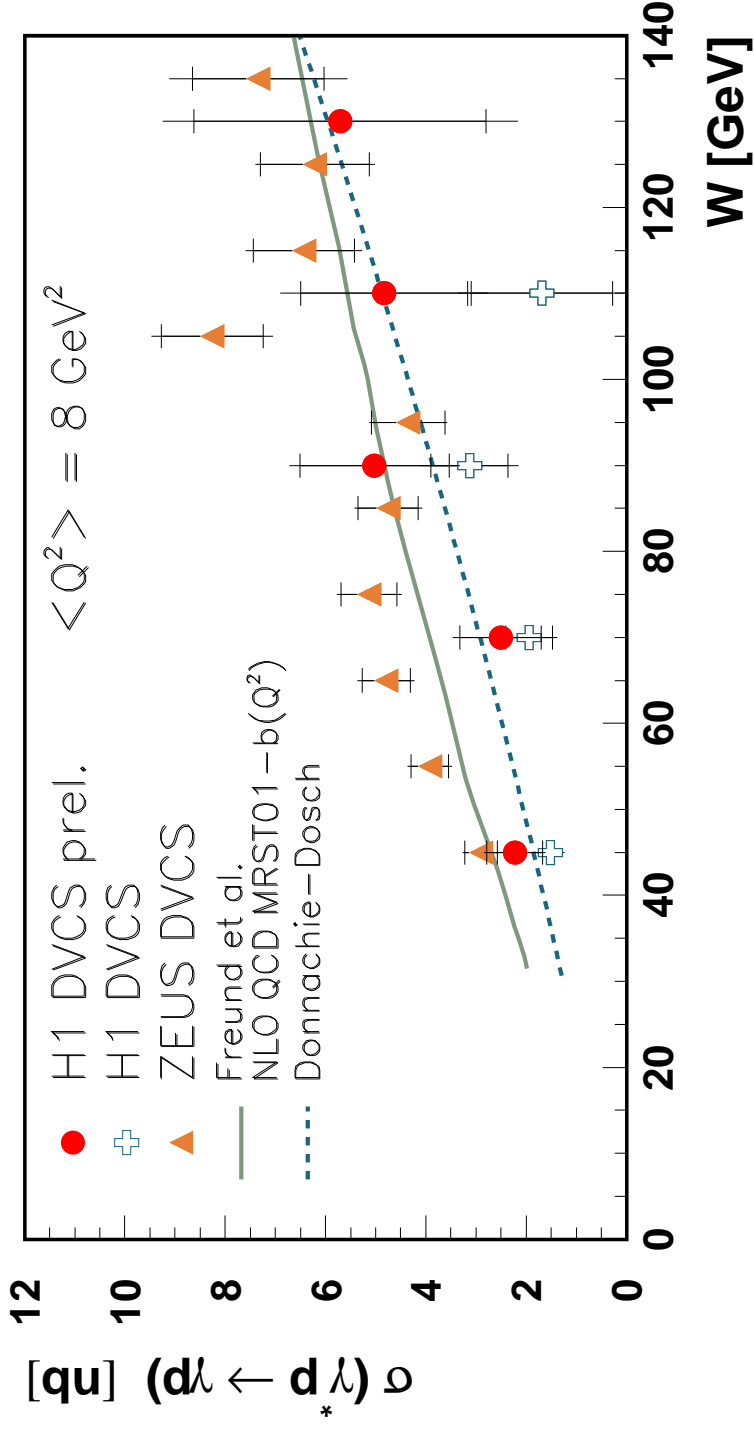
$\Rightarrow n$ smaller than for VM ($n(\rho) = 2.60 \pm 0.04$)
 $\Rightarrow \delta$ indication of a hard regime

\Rightarrow Both Dipole models in agreement with data. W slope better described by Donnachie-Dosch.

H1-ZEUS



$$b = 7 \text{ GeV}^{-2}$$



⇒ Good agreement between H1 results

⇒ Fair agreement between H1-prel and ZEUS results except for $W \sim 70 \text{ GeV}$: H1 lower by 2σ

Conclusion and Perspectives

- HERA using colliding beams is a very favorable place to study the diffraction of photons:
 - as a diffractive process in terms of pQCD
 - to access GPD (in part. gluons)
 - in a wide kinematic range.
- DVCS cross sections as a function of Q^2 , and as a fct. of W have been measured with higher precision within H1.
 - in agreement with different dipole models and QCD predictions, and provide first constrains on GPDs.
 - in agreement with previous H1 results and with ZEUS results
 - exhibit sensitivity to ERBL region.
- HERA II:
 - much higher statistics (goal: 1 fb^{-1})
 - higher precision : no p diss with (new) proton tagging (\rightarrow see VFPS talk)
 - asymmetry measurements (charge and helicity).