Studies of DVCS and high $|t|$ photon production with the H1 Detector

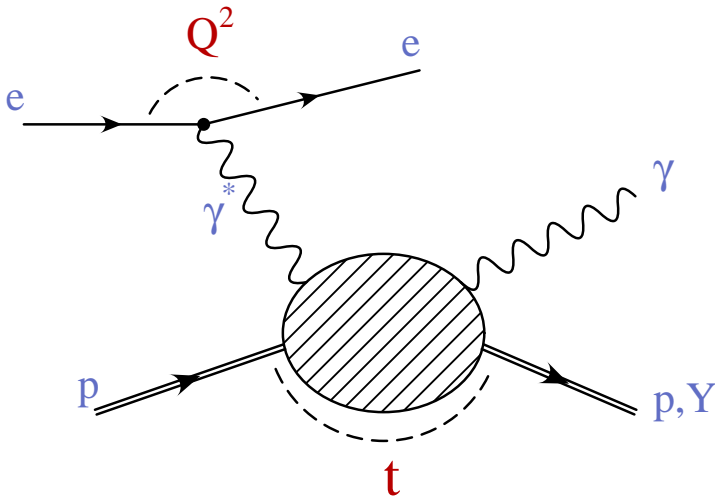**Laurent Favart**

I.I.H.E., Université Libre de Bruxelles

On behalf of the

H1 Collaboration

Introduction

photon diffraction off proton

- simplest QCD process
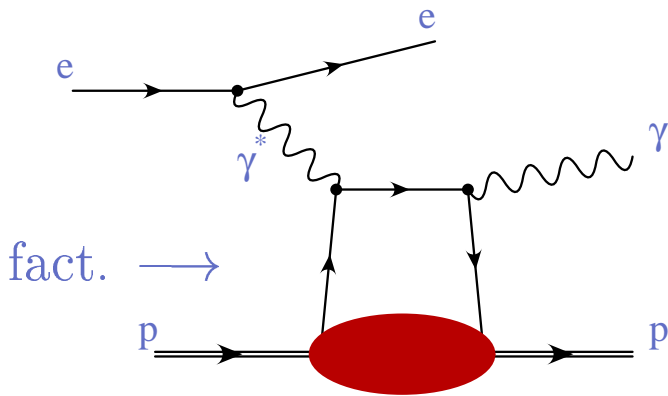
- fully calculable in pQCD
  hard scale Q^2 or t

DVCS

high t photon

- New measurement of DVCS

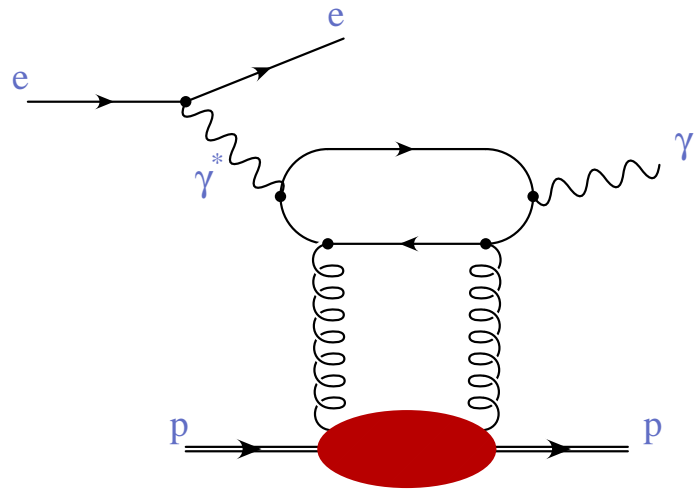- First observation and cross section measurement
  of high t photons

DVCS Introduction

QCD

LO   **NLO**

fact. $\longrightarrow$
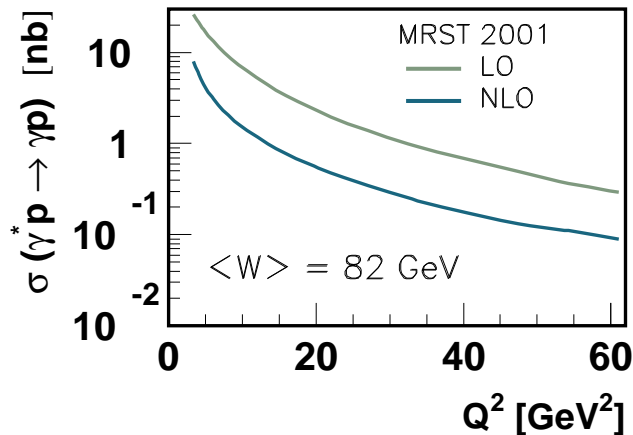
H1, ZEUS

HERMES, CLAS

H1, ZEUS

NLO leading twist calc. by A. Freund and M. McDermott
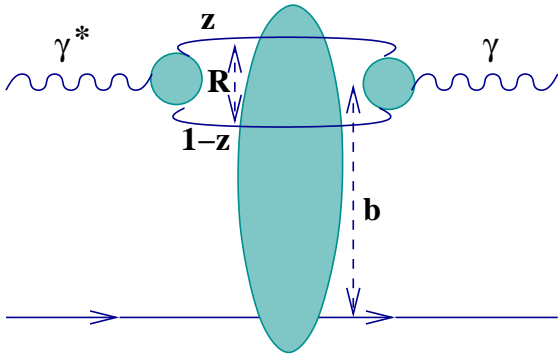
Eur.Phys.J. **C23** (2002) 651

Input: GPD

GPD modeling Freund [hep-ph/0306012]

$$GPD(x, \xi, Q^2, t) \sim \frac{PDF(\frac{x-\xi/2}{1-\xi/2}, Q^2)}{1-\xi/2} \times e^{-b\,|t|}$$

PDF: MRST2001 and CTEQ6

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

Colour Dipole Models : in the proton rest frame

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

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

- ψ^{in} and ψ^{out} calculable
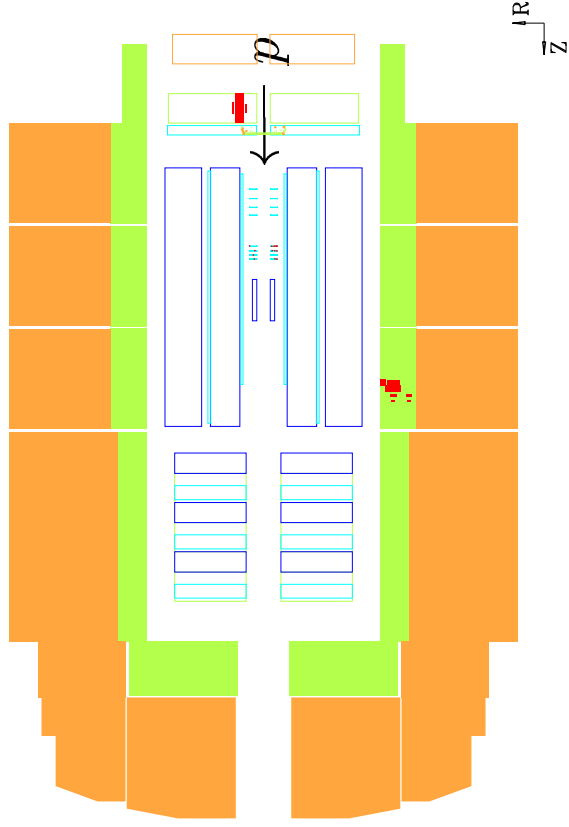
- σ_{d} is modeled

Donnachie-Dosch: hard + soft $I\!\!P$
Phys.Lett. B502 (2001) 74

Favart-Machado: GBW saturation model applied to DVCS
(with and without DGLAP evolution: BGBK)
[hep-ph/0302079] to appear in EPJ

DVCS Analysis

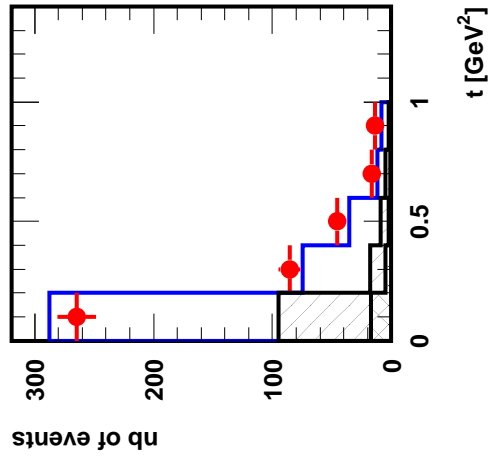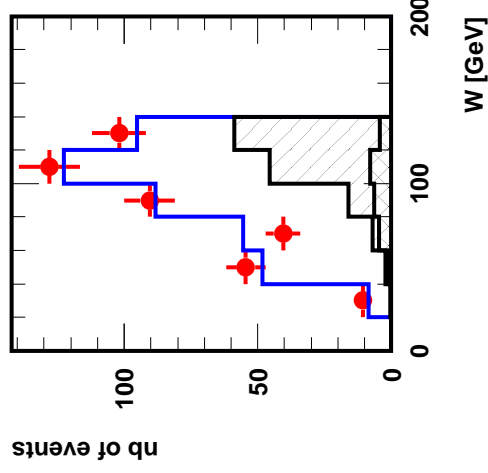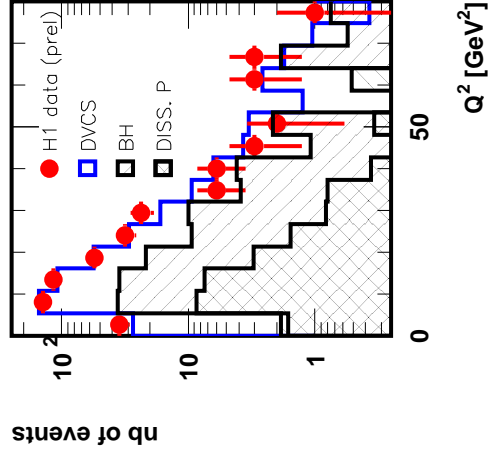H1 data 2000 $\int \mathcal{L} = 26\,\text{pb}^{-1}$

$E_e >$ 15 GeV

$E_\gamma >$ 2 GeV

$E_3 <$ 0.5 GeV

elast. no track, Fwd

H1 preliminary

p

$e^+ \longrightarrow$

R

z

nb of events

300

200

100

0

t [GeV^2]

1

0.5

0

nb of events

100

50

0

W [GeV]

200

100

0

H1 data (prel)
DVCS
BH
DiSS. P

nb of events

10^2

10

1

Q^2 [GeV^2]

0

50

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

H1 Results
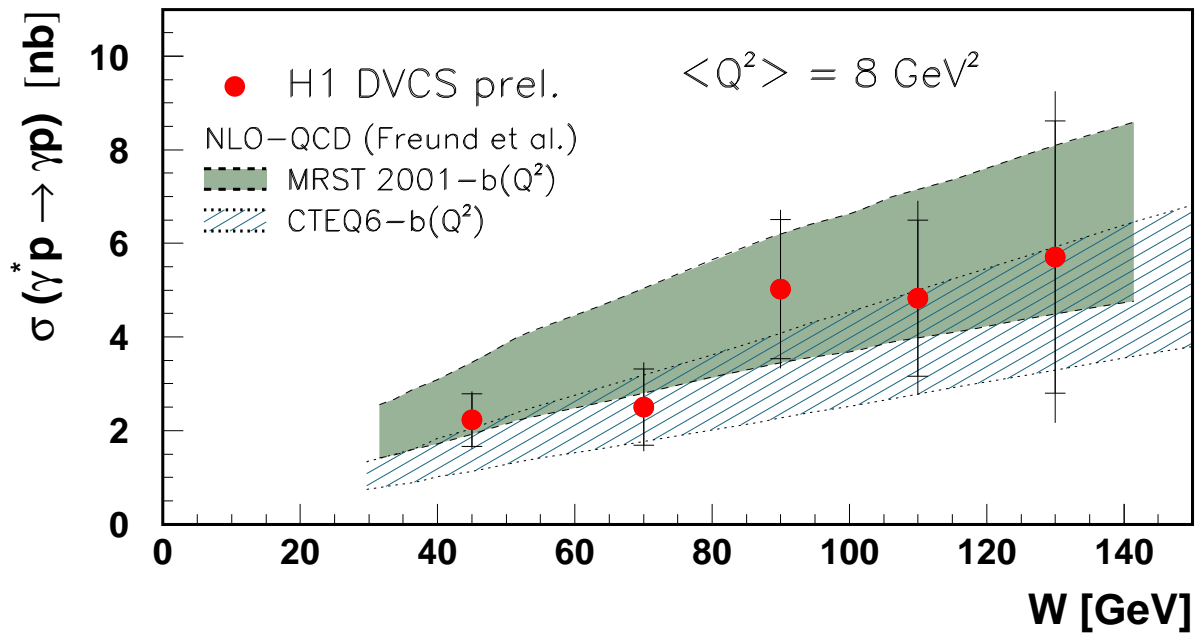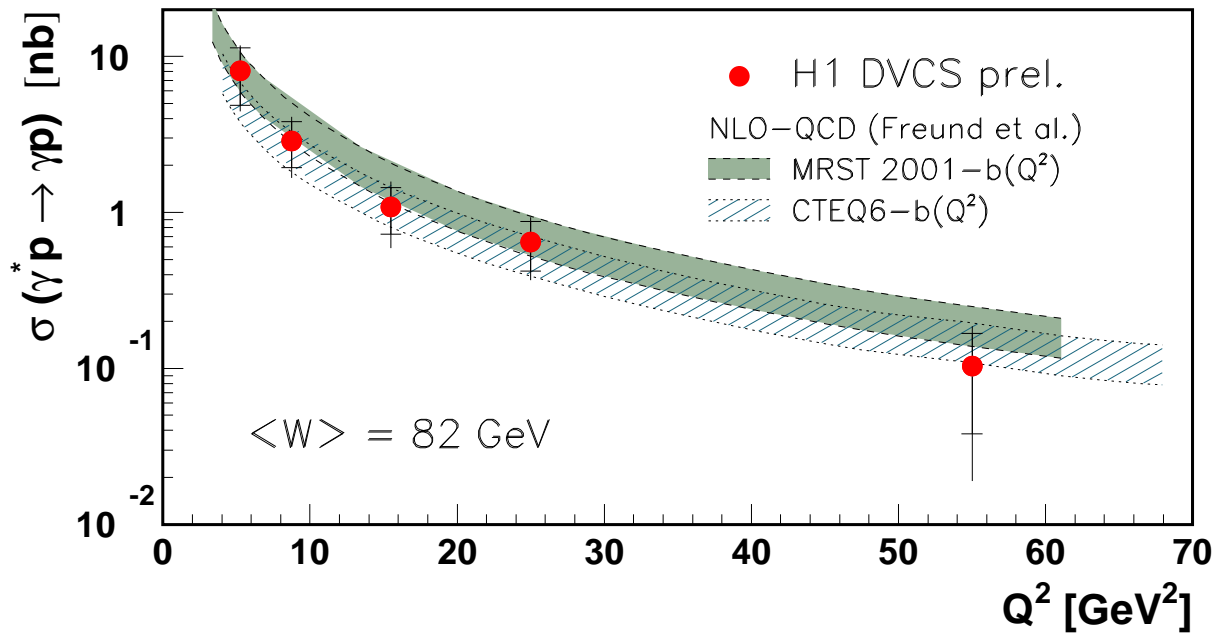
$5 < b_0 < 9\,\text{GeV}^{-2}$

$\Longrightarrow$ Good description by QCD - NLO calculations

$\Longrightarrow$ Need to measure t dependence

H1 Results

σ($γ^*p → γp$) [nb]

H1 DVCS prel.

Colour Dipole Models
Donnachie−Dosch
Favart−Machado
Favart−Machado BGBK

$(Q^2)^{-n}$ fit
$n = 1.72 \pm 0.44$

$<W>$ = 82 GeV

Q^2 [GeV^2]

σ($γ^*p → γp$) [nb]

H1 DVCS prel. $<Q^2>$ = 8 GeV^2

Colour Dipole Models
Donnachie−Dosch
Favart−Machado
Favart−Machado BGBK

W^δ fit
$\delta = 0.98 \pm 0.44$

W [GeV]
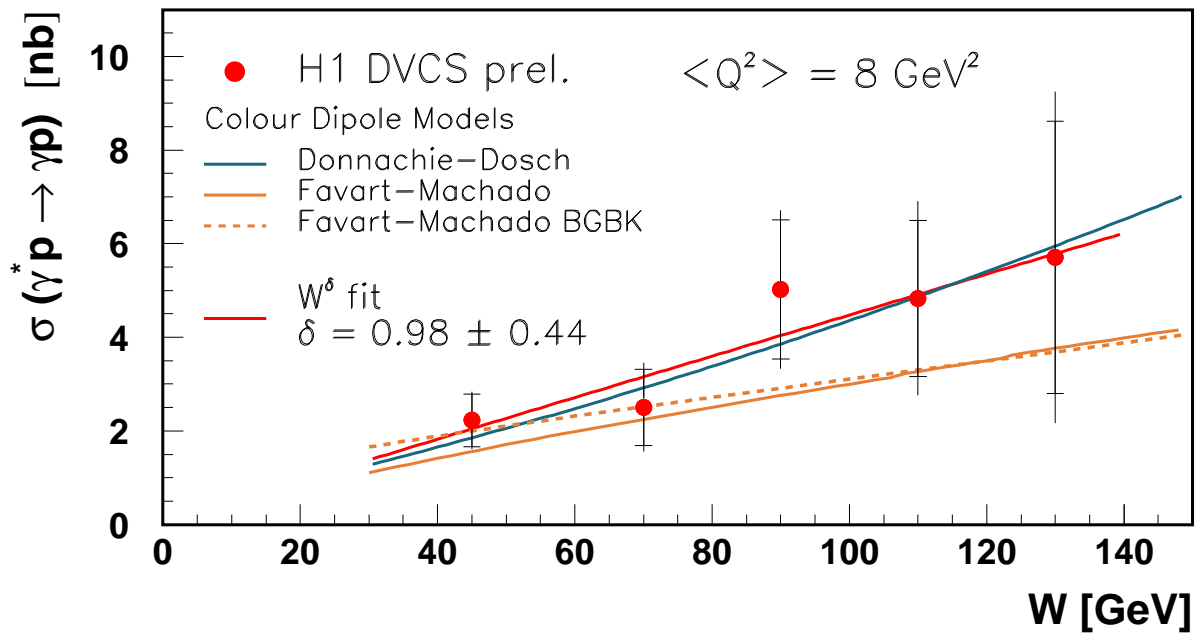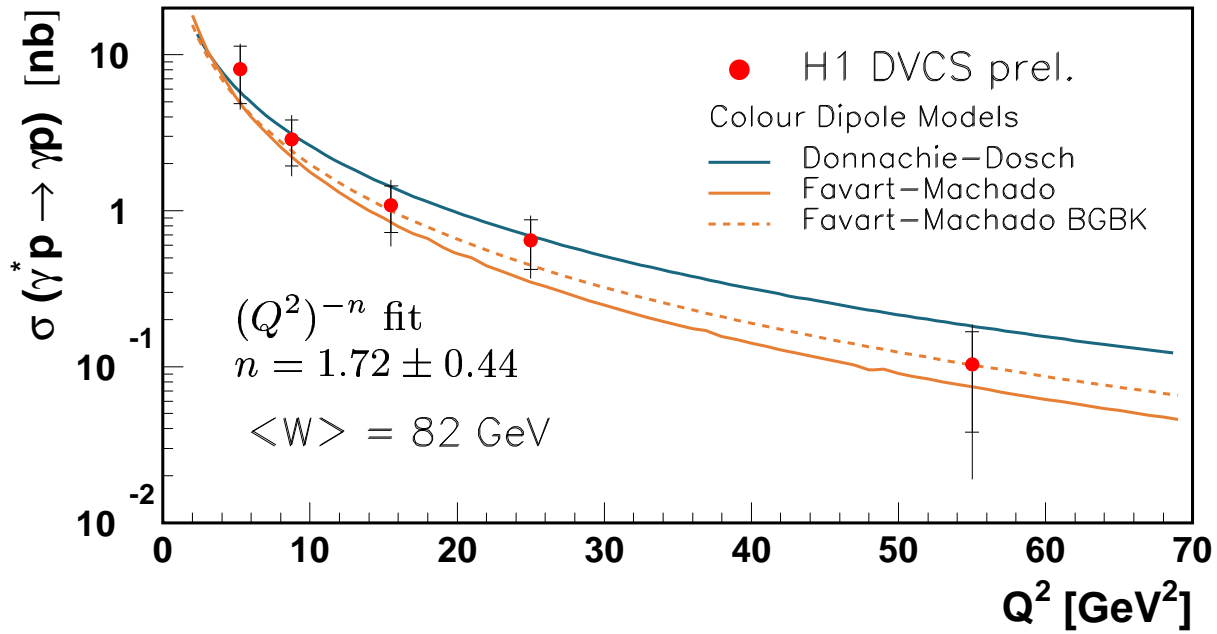
$b = 7\,\mathrm{GeV}^{-2}$

$\implies n$ small than for VM $(n(\rho) = 2.60 \pm 0.04)$

$\implies \delta$ indication of a hard regime

$\implies$ Both Dipole models in agreement with data.
W slope better described by Donnachie-Dosch.
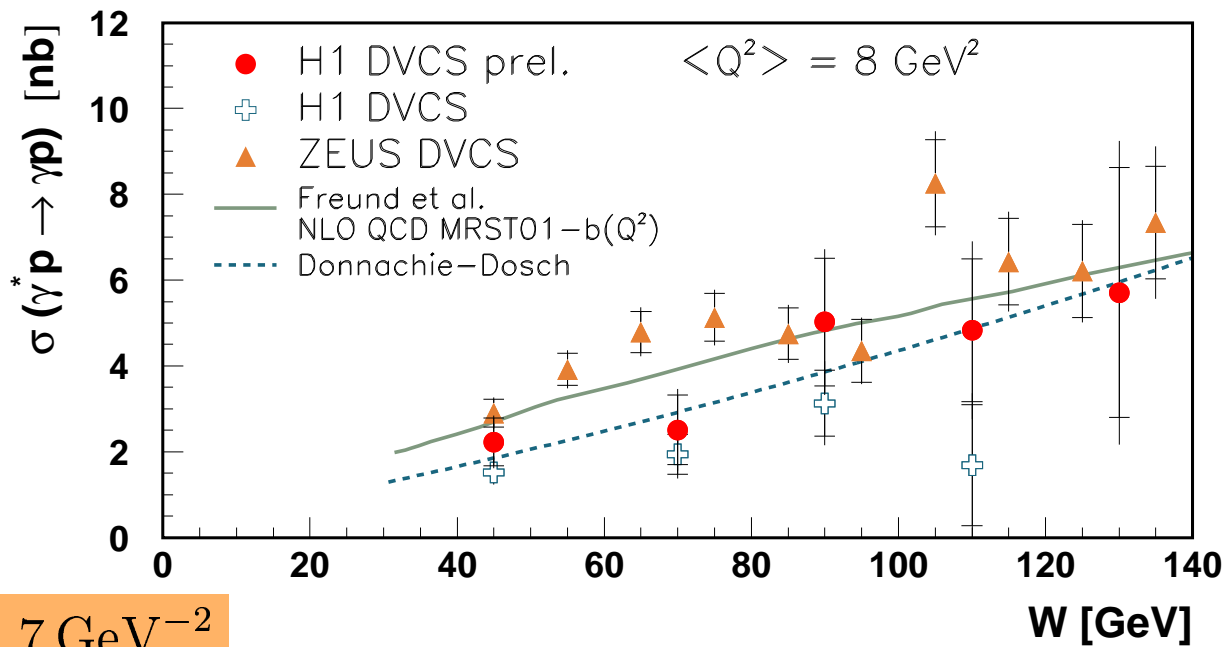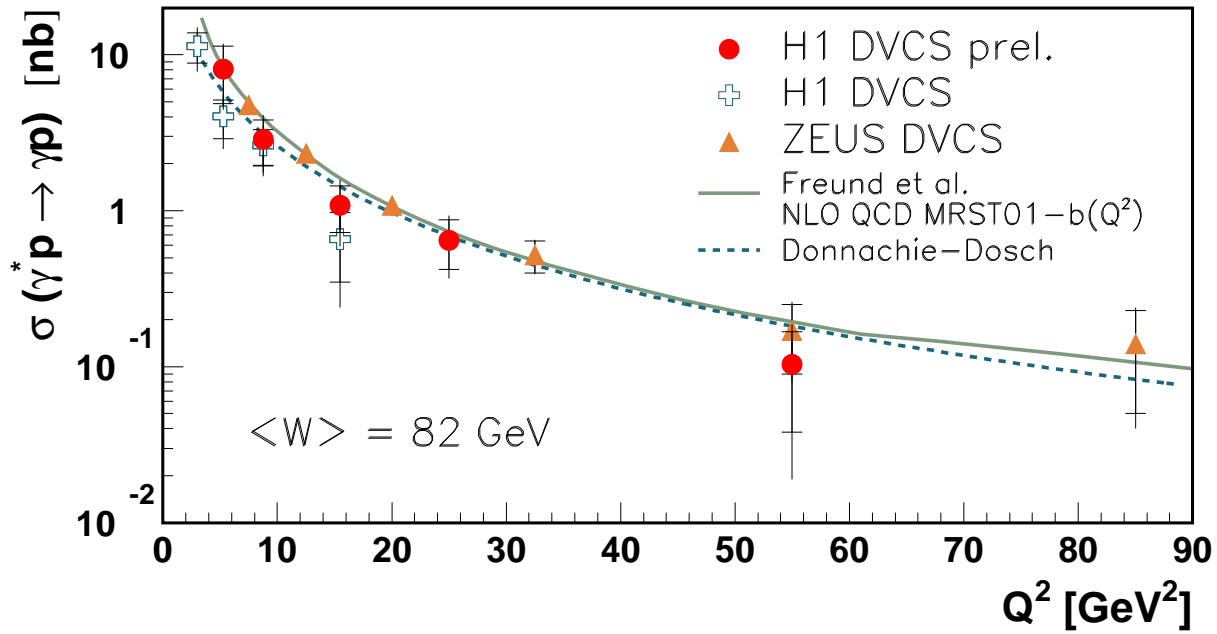
$b = 7\,\mathrm{GeV}^{-2}$

$\Longrightarrow$ Good agreement between H1 results

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

First Measurement of Diffractive high t photons
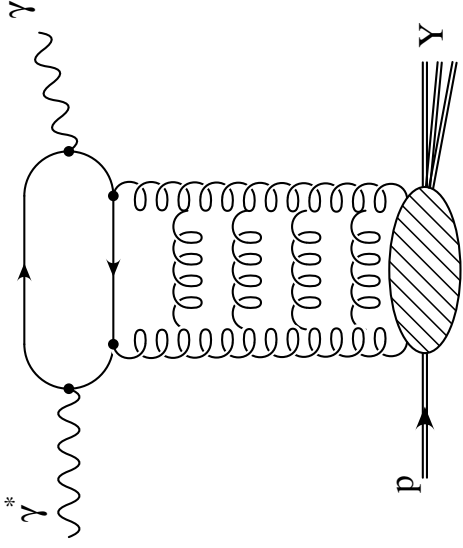
- photoproduction $Q^2 < 0.01$ GeV^2
- high t and low $x \to$ BFKL prediction
- dominated by p dissociation
- Bethe-Heitler kinematically suppressed

data 1999-2000 $\int \mathcal{L} = 40$ pb^{-1}
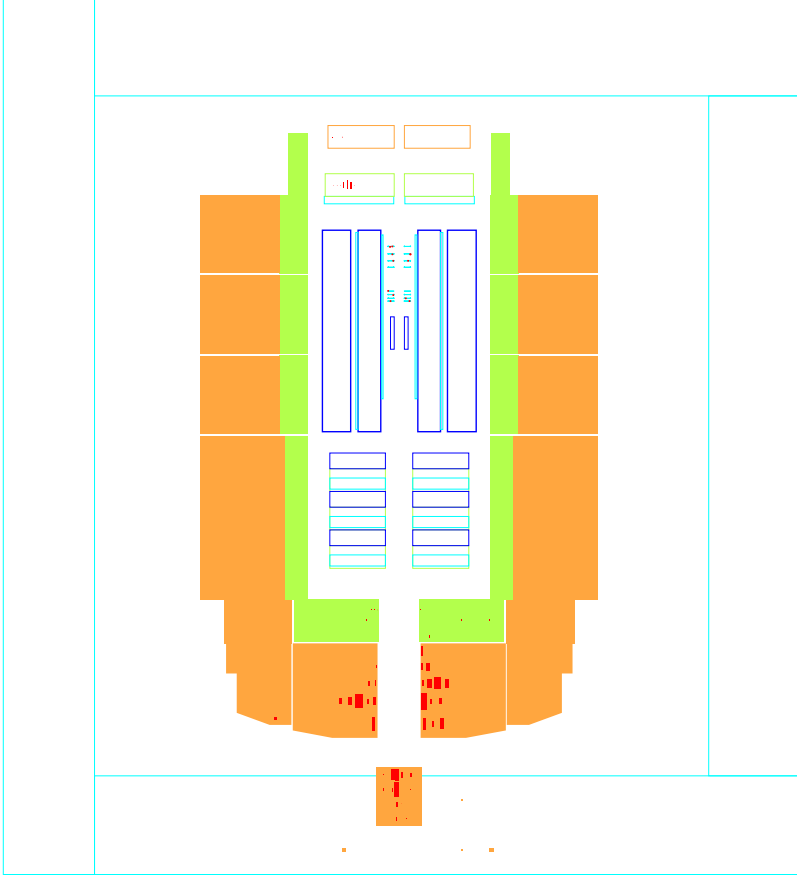
Tagged photoproduction
($0.3 < y < 0.6$)

Photon in Bwd Calo

$E_\gamma > 8$ GeV $p_\gamma^T > 2$ GeV

Y system in Fwd Calo

$y_{I\!P} = \frac{\sum_{Fwd}(E-P_z)}{2\,E_\gamma} < 0.018$
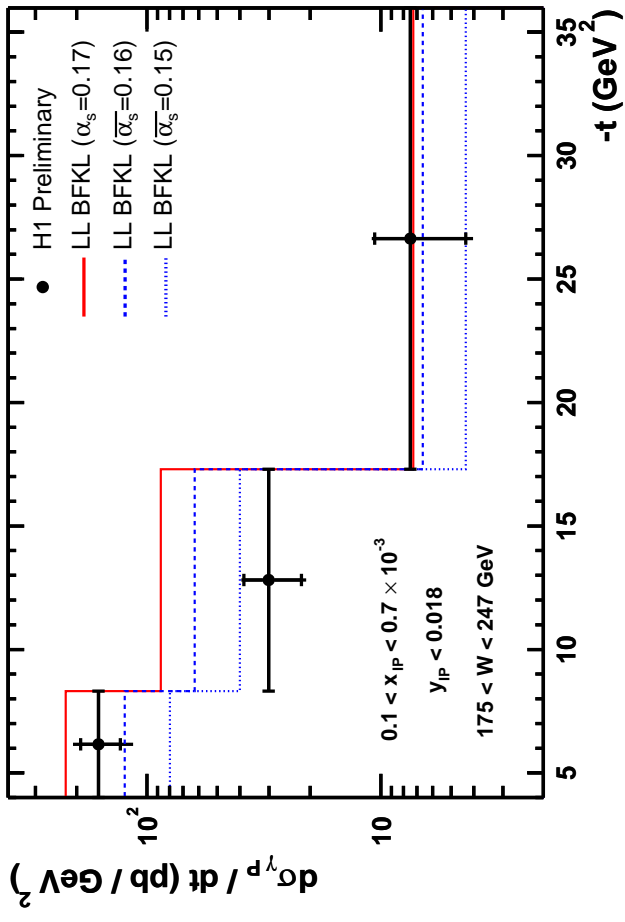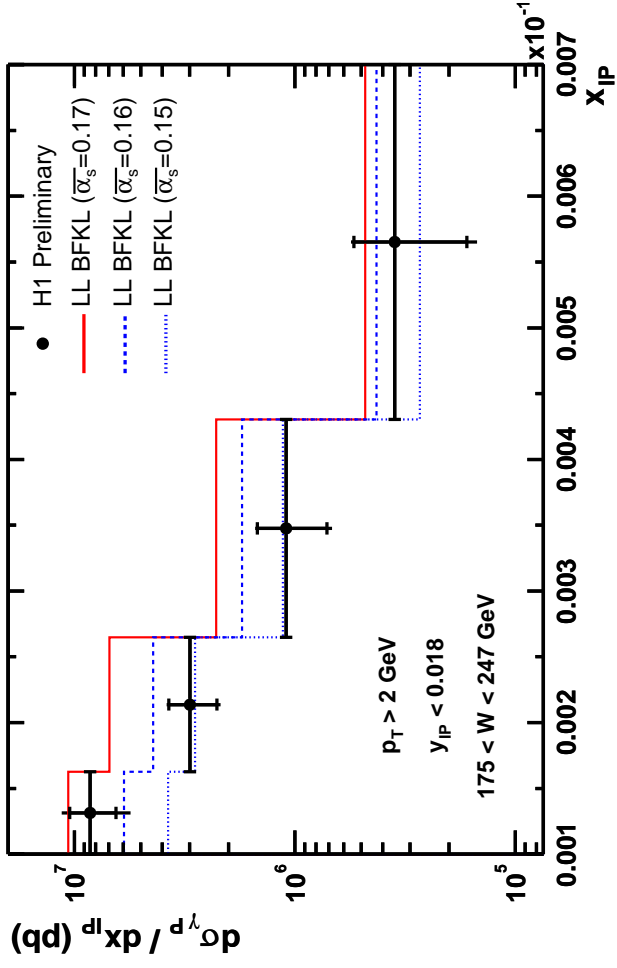
$\Delta\eta > 2$

$$|t| \simeq (p_\gamma^T)^2 \qquad x_{I\!P} \simeq \frac{(E-P_z)_\gamma}{2\,E_p}$$

Diffractive high t photons

data 1999-2000 $\int \mathcal{L} = 40 \text{ pb}^{-1}$

- Cross section basically described in shapes and Norm. by LL BKFL ($\bar{\alpha}_s \sim 0.15 - 0.17$).

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

- First observation and σ measurement of high t photons, in basic agreement with LL BFKL predictions

- HERA II:
  - much higher statistics (1 fb^{-1})
  - higher precision : no p diss with (new) proton tagging
  - asymmetry measurements (charge and helicity).