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Deeply Virtual Compton Scattering at HERA

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On behalf of the

ZEUS and H1 Collaborations

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- ZEUS first observation
- H1 cross section measurement
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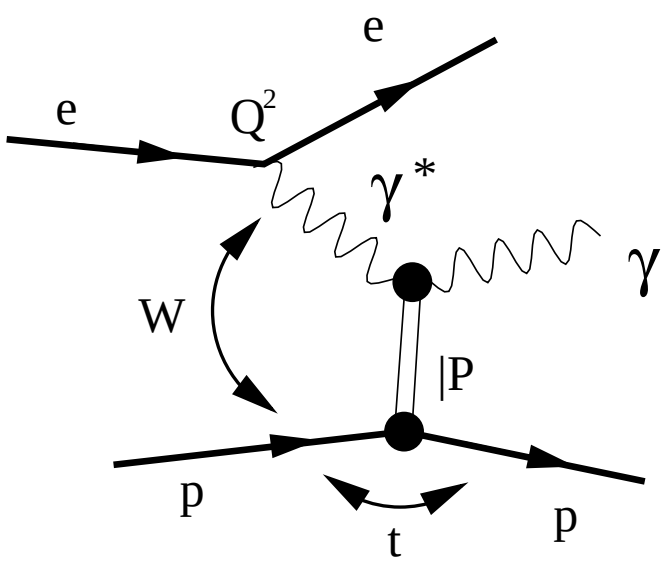
Motivation

- investigation of the nature of diffraction
- DVCS : $ep \longrightarrow e\gamma p$

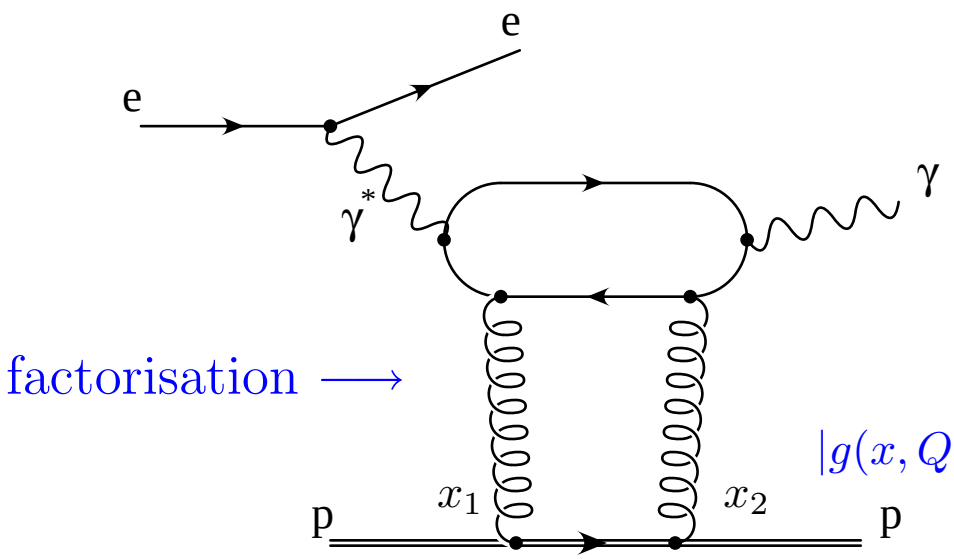


- HERA: wide range in Q^2 and W accessible

$\Rightarrow$ detailed studies of scattering mechanism

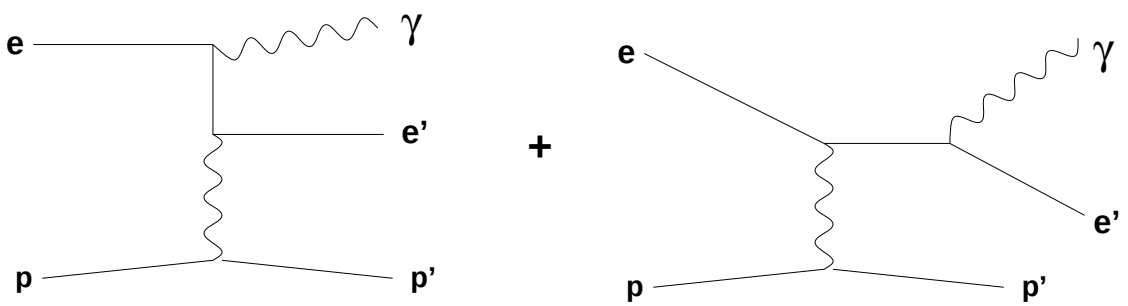
Motivation (Cont.)

- QCD interpretation of DVCS process



⇒ comparatively "clean" QCD process (w.r.t. VM)

- Bethe-Heitler process



⇒ Direct contribution + interference

- LO QCD calculation by L. Frankfurt, A. Freund and M. Strikman (FFS)

Many others: I. Balitsky, A. V. Belitsky, M. Diehl, X. Ji, E. Kuchina, D. Müller, L. Niedermeier, A. V. Radyushkin, A. Schäfer, ...

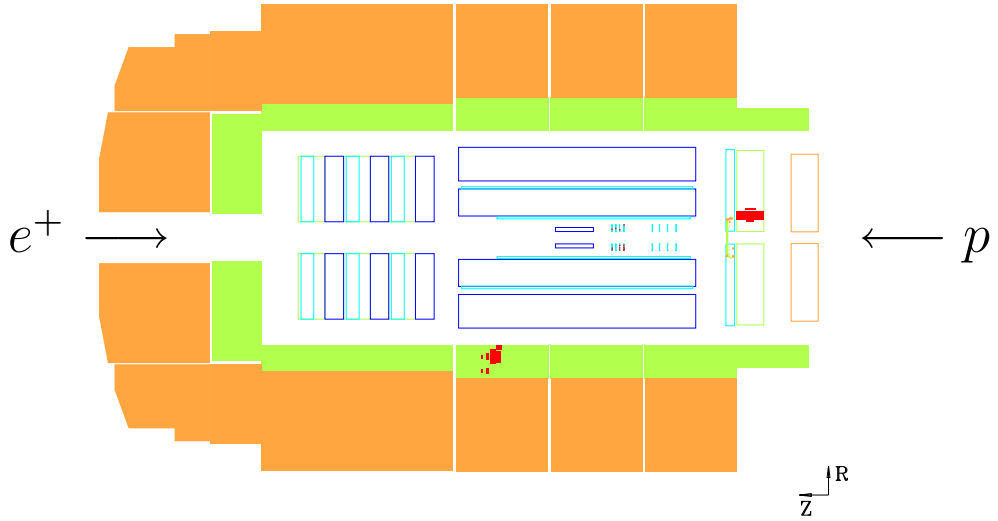
⇒ Implemented in two independent MC for H1 and ZEUS

- access to real part of the QCD amplitude

⇒ access to skewed parton distributions

Analysis strategy

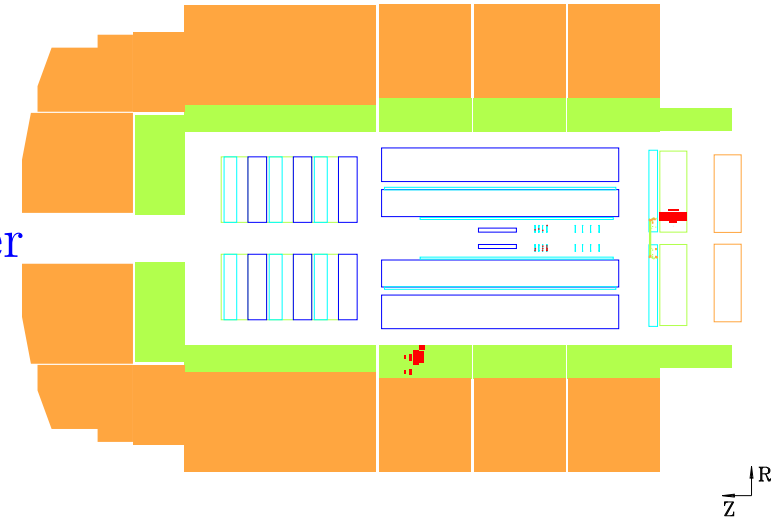
- DVCS

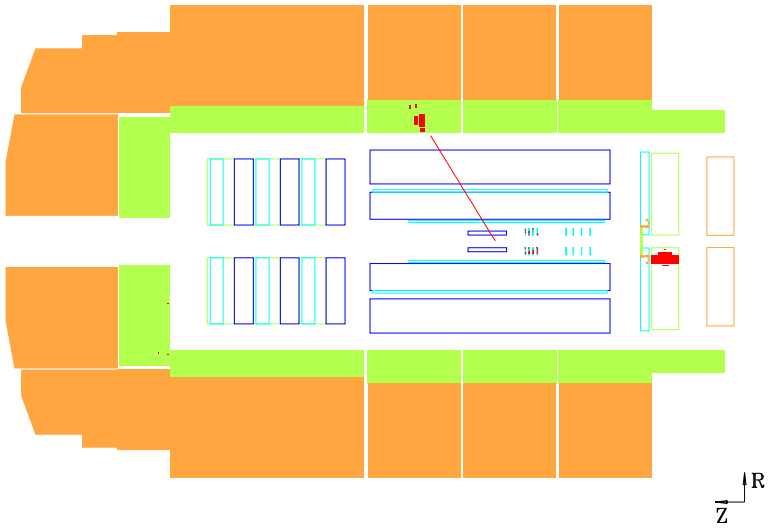


γ–sample

e^+–sample

- Bethe-Heitler

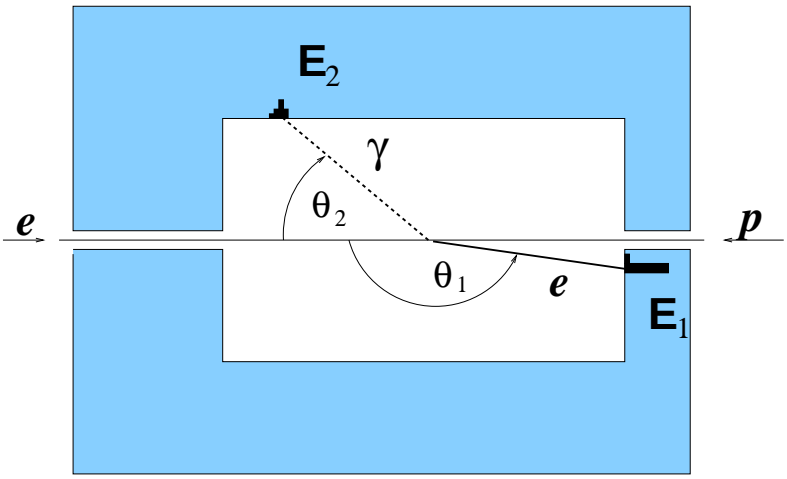




ZEUS - first observation of DVCS

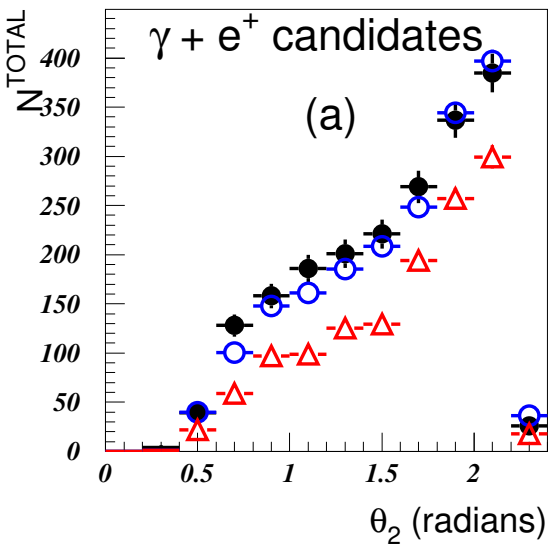
- selection criteria:

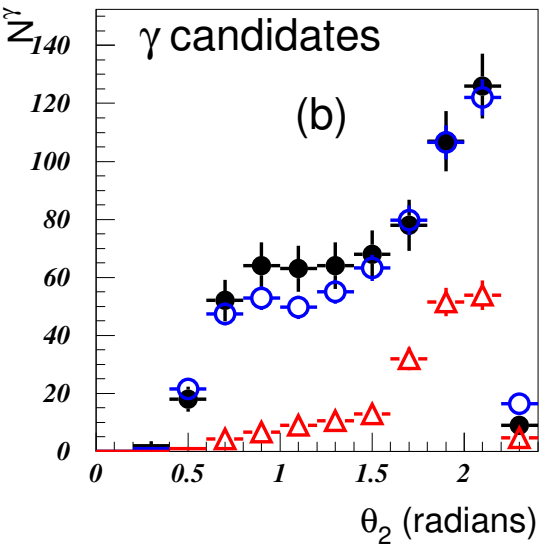
$\theta_1 > 160^o,\ E_1 > 10$ GeV
$\theta_2 < 137^o,\ E_2 > 2$ GeV
$|\theta_2 - \theta_1| > 45^o$
$Q^2 > 6$ GeV^2

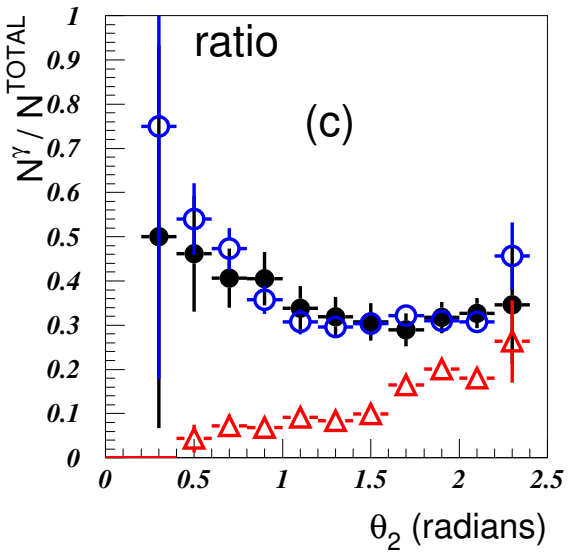


$\int L = 37 \mathrm{pb}^{-1}$
MC : t–slope $= 4.5\,\mathrm{GeV}^{-2}$

ZEUS 1996/97 Preliminary



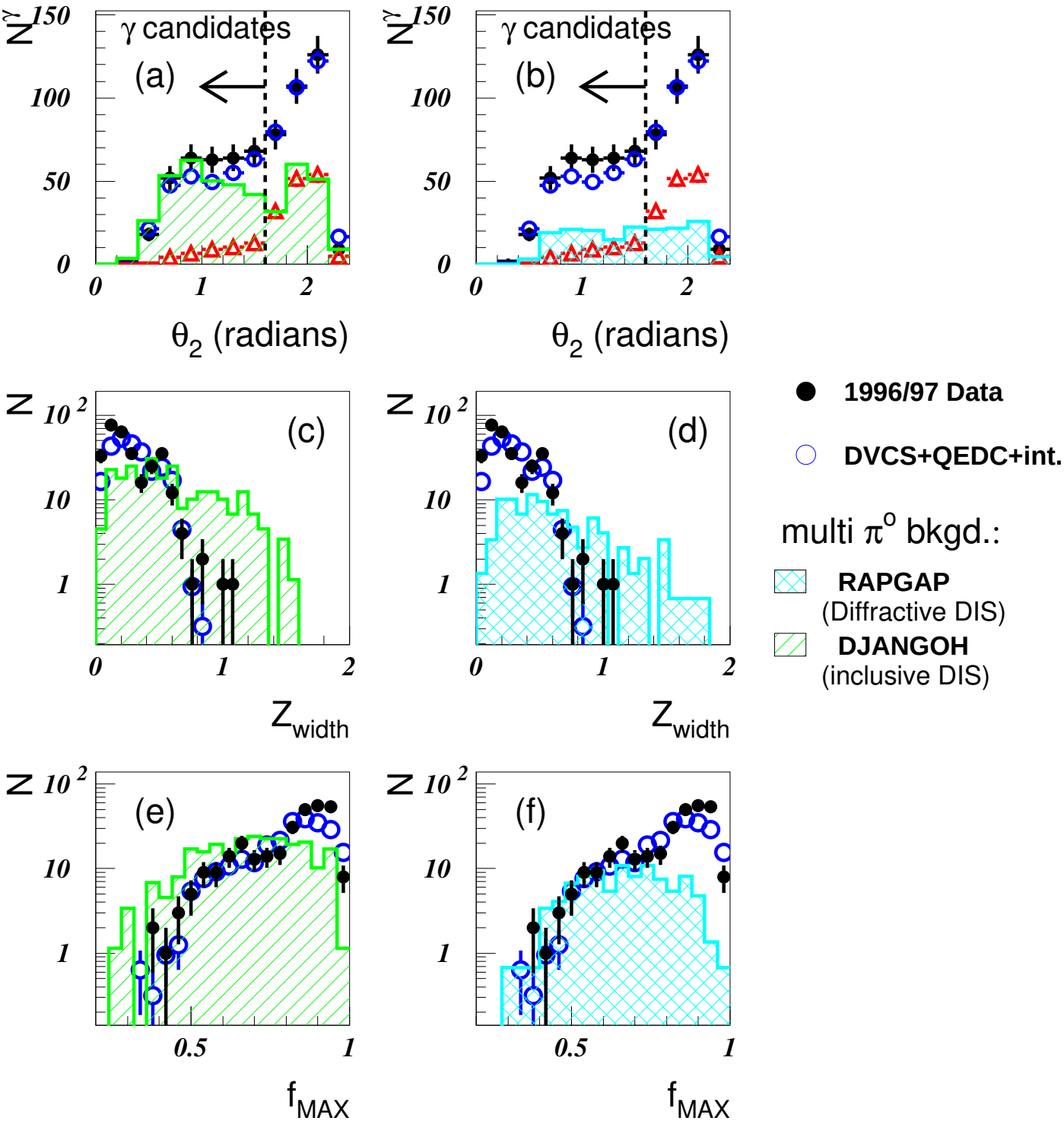




- **1996 - 1997 Data**
  (no acceptance correction)
- **GenDVCS DVCS+QEDC+int.**
  (detector-level)
- **Compton2.0 el. only**
  (detector-level)

ZEUS - first observation of DVCS (Cont.)

ZEUS 1996/97 Preliminary

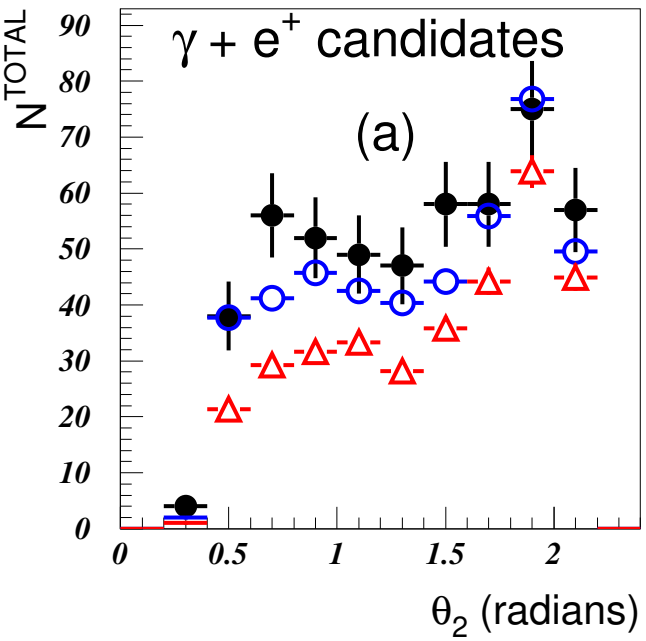


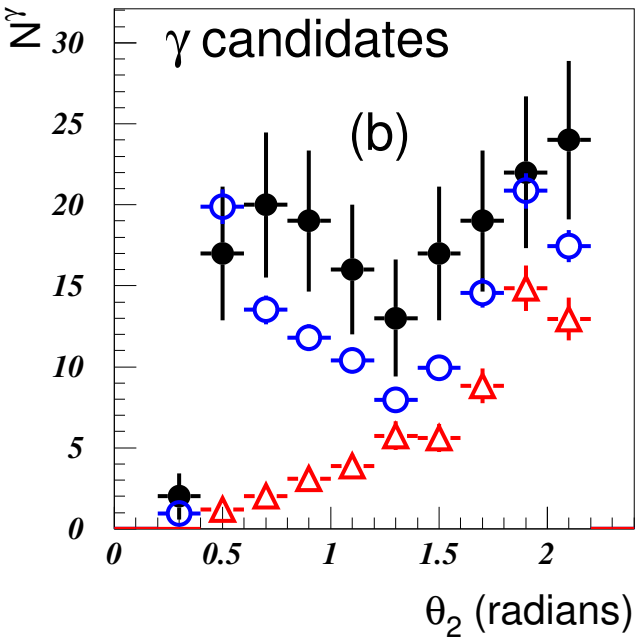
- DJANGOH and RAPGAP (high-mult. MC) are not reliable for low multiplicities.
- Cluster shape analysis $\Rightarrow$ Excess is photon signal

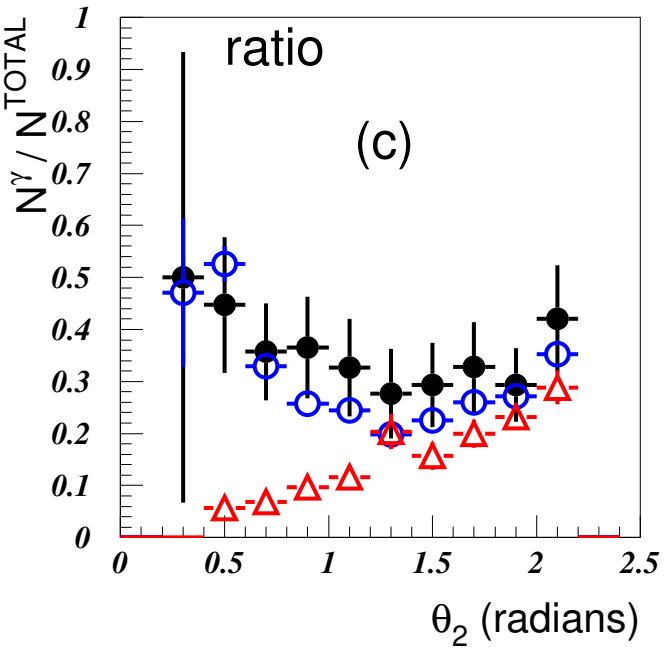
ZEUS first observation of DVCS (Cont.)

$E_2 > 5$ GeV : Signal persists

ZEUS 1996/97 Preliminary







- **1996 - 1997 Data** (no acceptance correction)
- **GenDVCS DVCS+QEDC+int.** (detector-level)
- **Compton2.0 el. only** (detector-level)

H1 - Analysis

- electromagnetic cluster in backward calorimeter (SpaCal)
  $E > 15\,\mathrm{GeV}$

- electromagnetic cluster in central calorimeter (LAr)
  $p_T > 1\,\mathrm{GeV}$

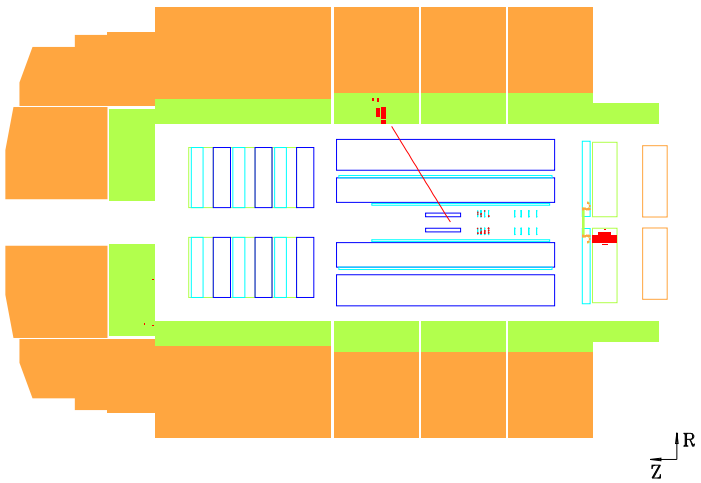
- 0 or 1 reconstructed track associated to the cluster in the central calorimeter

- elastic selection:
  $E_3 < 0.5\,\mathrm{GeV}$
  empty forward detectors

- kinematic selection
  - $\sum E - p_z > 45\,\mathrm{GeV}$
  - $2 < Q^2 < 20\,\mathrm{GeV}^2$
  - $30 < W < 120\,\mathrm{GeV}$
  - $|t| < 1\,\mathrm{GeV}^2$

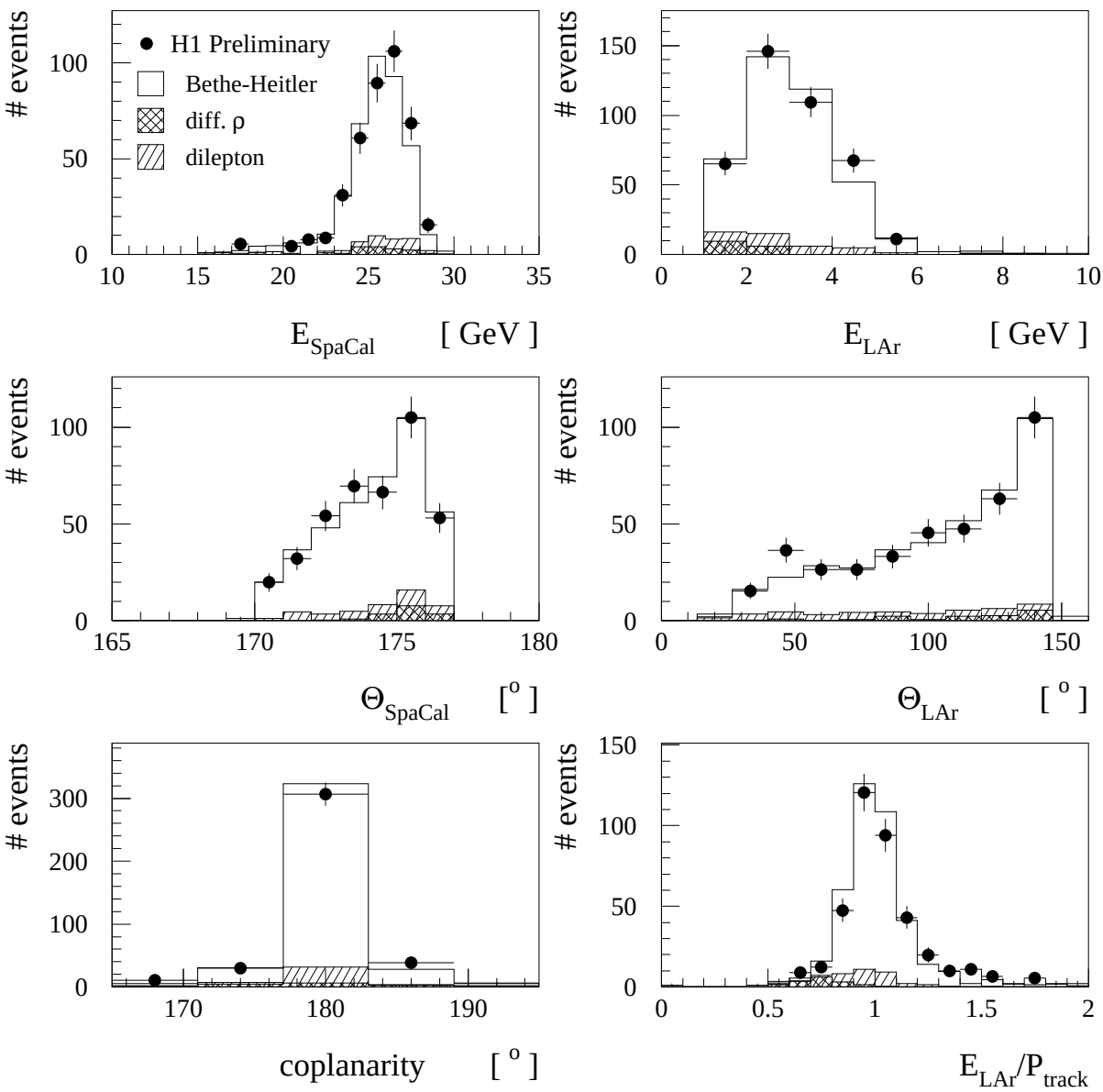
$\int L = 8\,pb^{-1}$

H1 - Control by e^+ sample



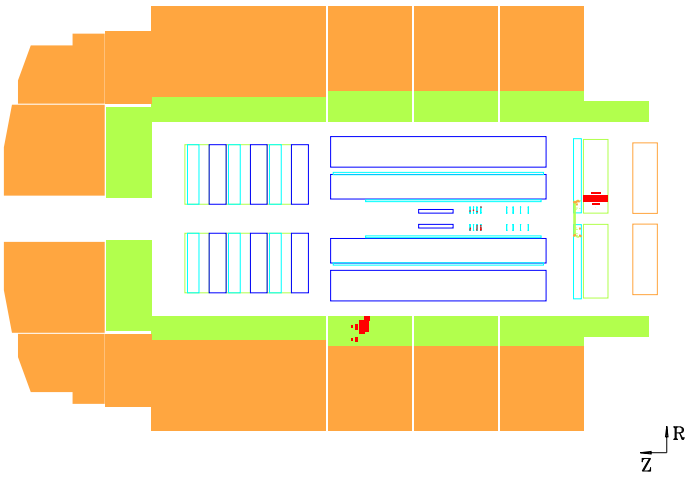
- $E_{\mathrm{SpaCal}} > 15\,\mathrm{GeV}$
- $p_{T\,\mathrm{LAr}} > 1\,\mathrm{GeV}$
- $E_3 < 0.5\,\mathrm{GeV}$
- empty forw. detectors

- $\int L = 8\,pb^{-1}$

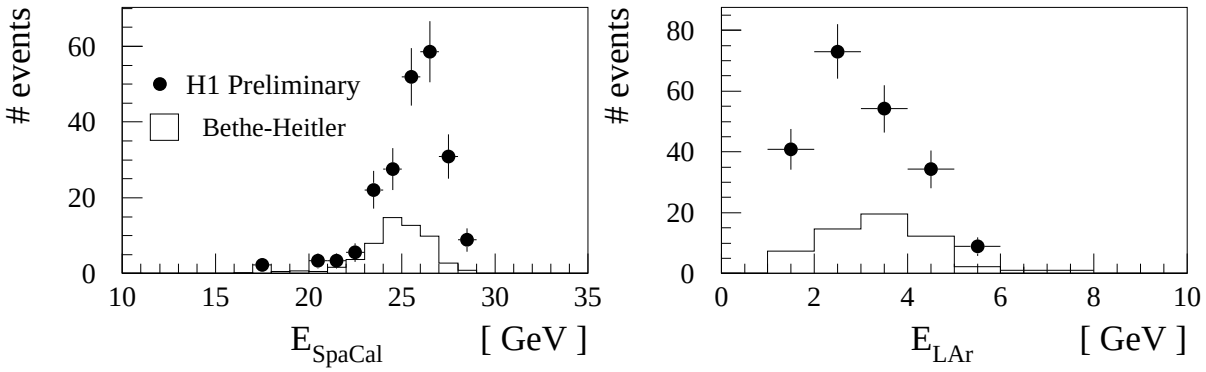


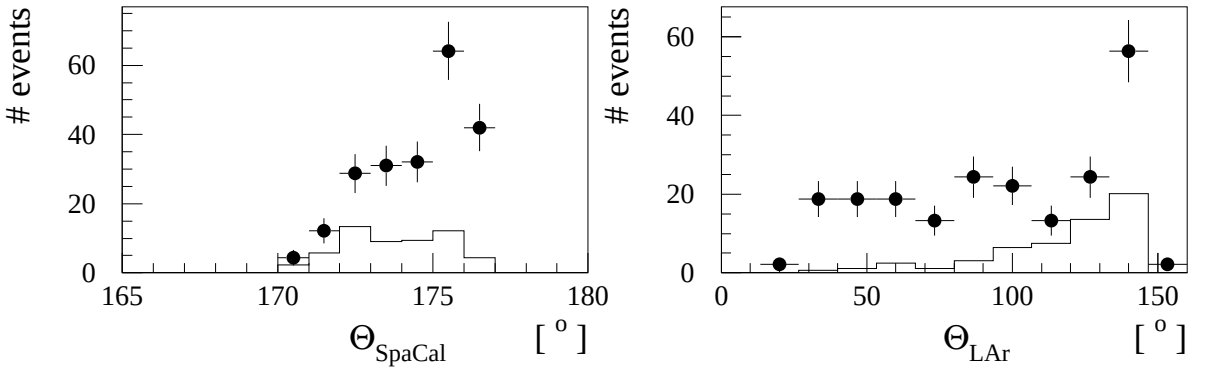
⇒ detector response is understood

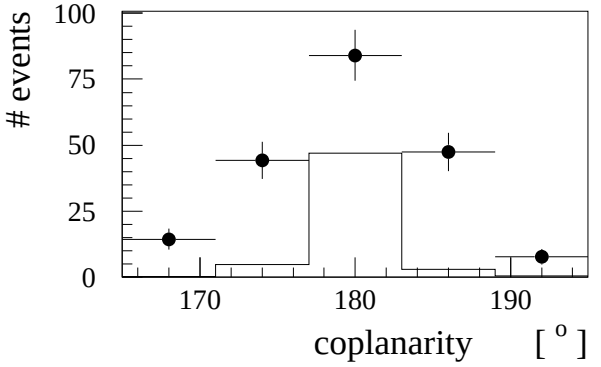
H1 - DVCS observation



- $2 < Q^2 < 20\,\mathrm{GeV}^2$
- $30 < W < 120\,\mathrm{GeV}$
- $|t| < 1\,\mathrm{GeV}^2$



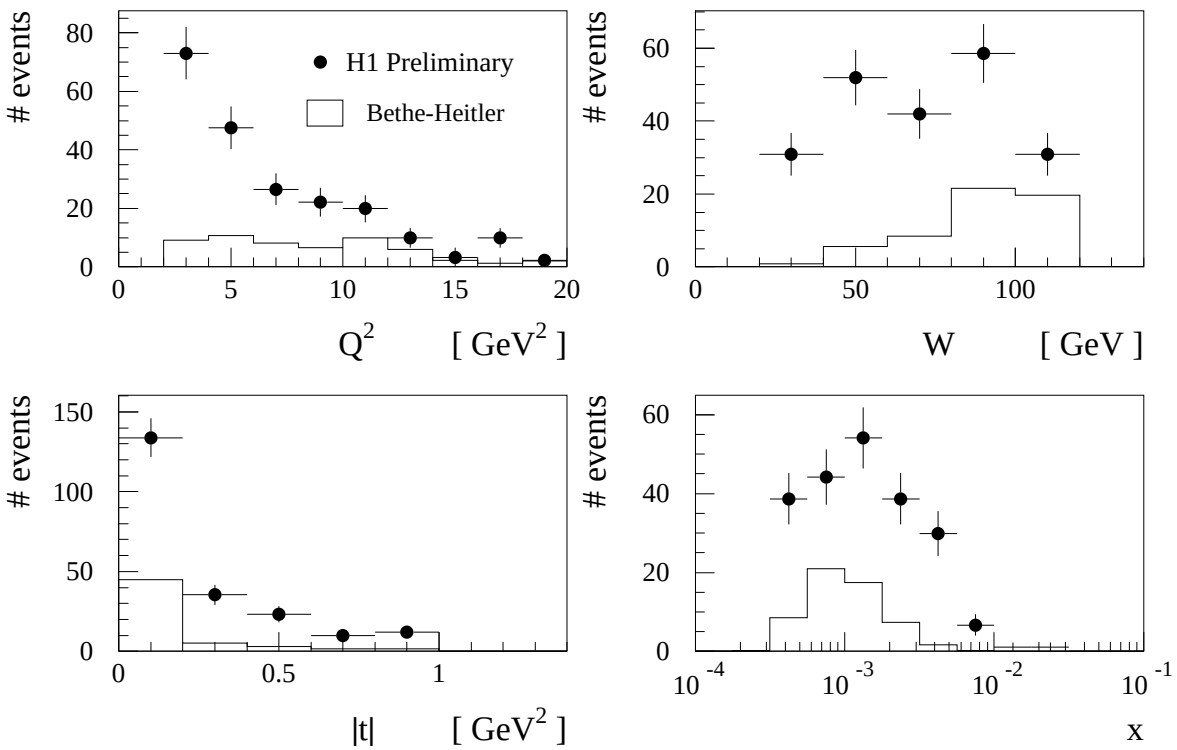




$\Rightarrow$ large excess of data above the Bethe-Heitler can be observed

H1 - DVCS observation (Cont.)

- kinematic distributions (uncorrected)



⇒ differences in shape and in normalisation can be observed

H1 - Cross section measurement

- kinematics is reconstructed by using the double angle method

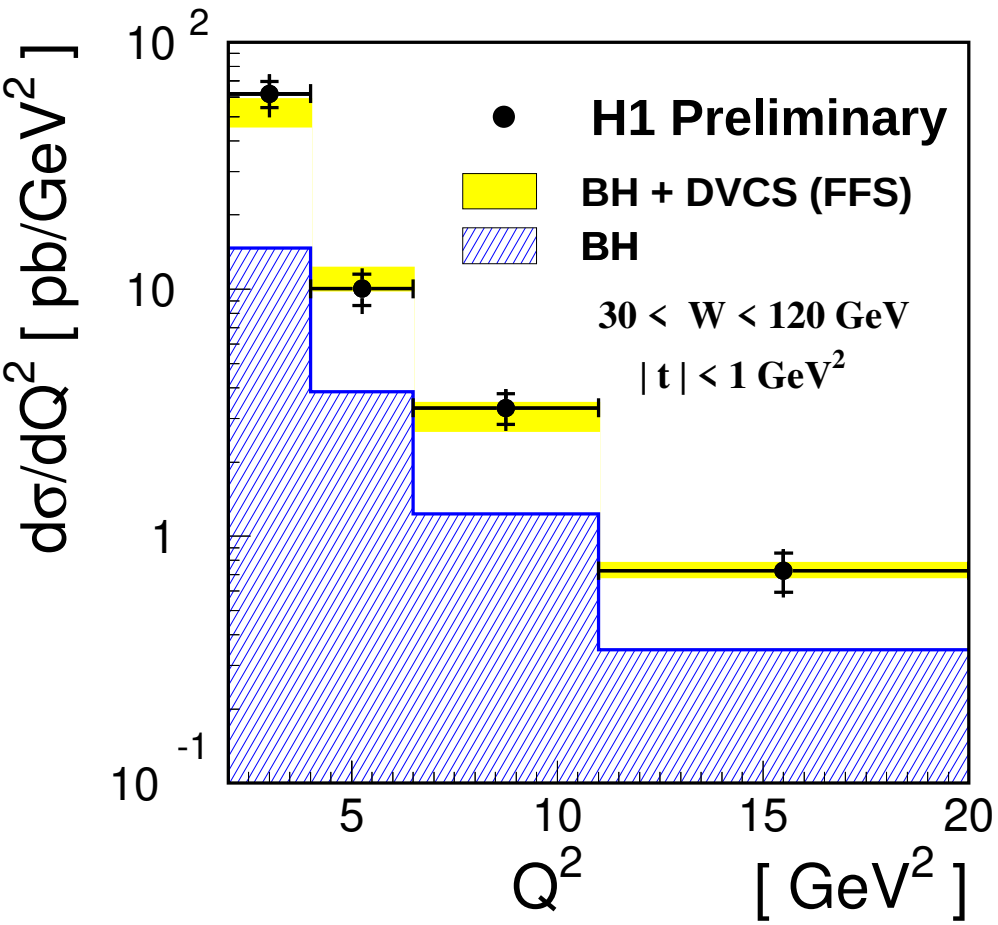
- data are corrected for
  - detector effects
  - acceptance (using DVCS MC)
  - QED ISR
  - proton dissociative background (10%)

$\Rightarrow$ elastic cross section

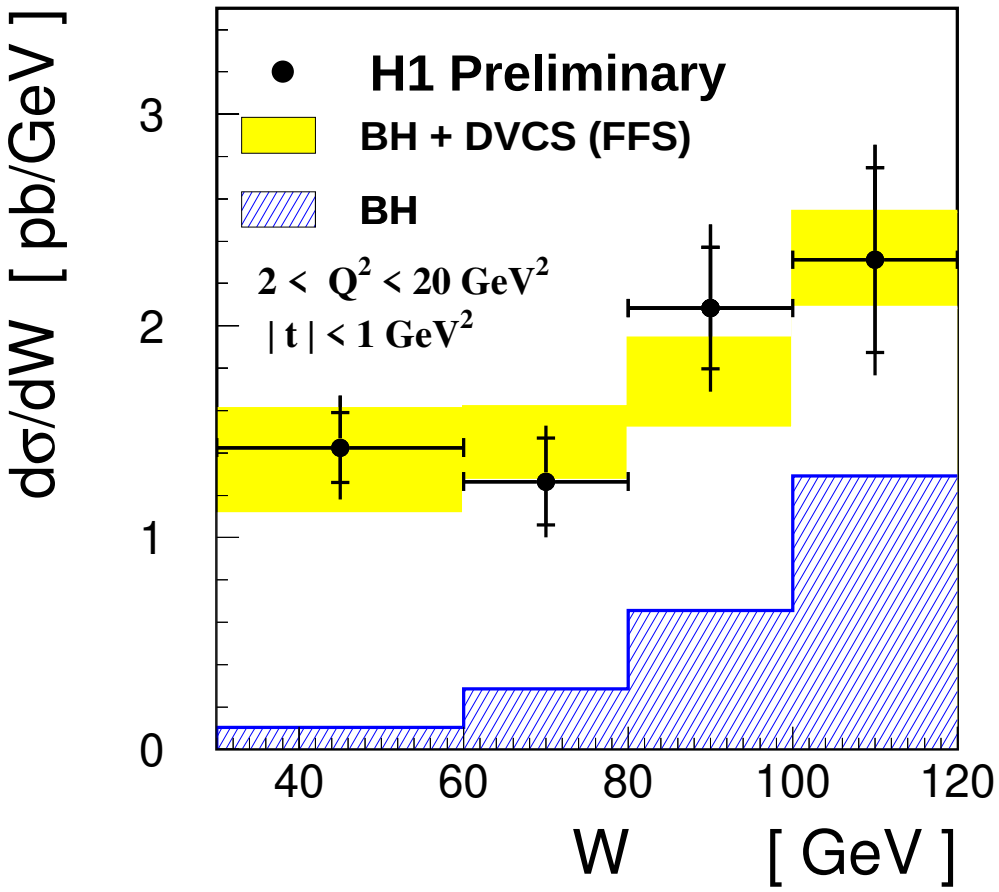
- main systematic errors
  - measurement of angle 5 - 10 %
  - dissociative background substraction 5 %
  - acceptance corrections 10 %

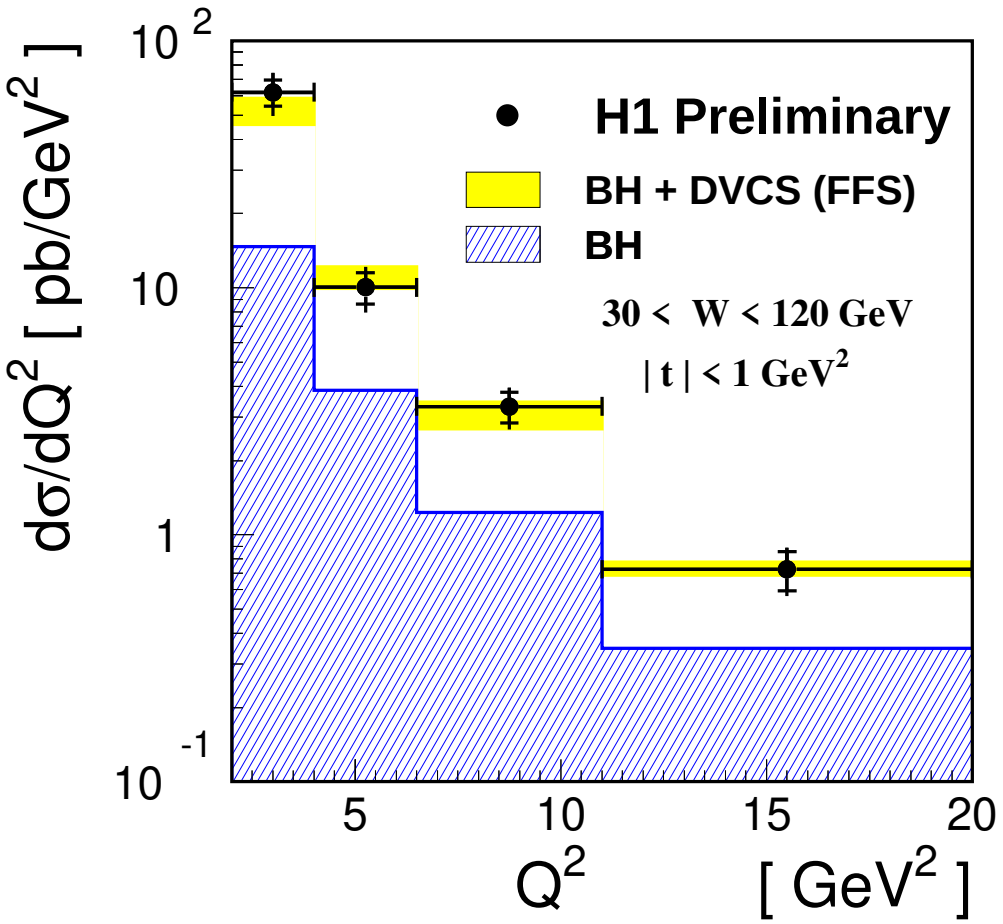
- MC : t–slope $7 - 10\,\mathrm{GeV}^{-2}$

H1 V


H1 Preliminary
BH + DVCS (FFS)
BH
30 < W < 120 GeV
| t | < 1 GeV^2
$d\sigma/dQ^2$ [pb/GeV^2]
Q^2 [GeV^2]
10^2
10
1
10^{-1}
5
10
15
20

H1 Cross section measurement (Cont.)





Conclusions

- Deeply Virtual Compton Scattering is a new laboratory to study diffraction in terms of pQCD.
  - pQCD calculable
  - access to nonforward gluon density
  - wide kinematic range accessible at HERA
- DVCS has been observed at HERA.
- Cross sections, $\frac{d\sigma}{dQ^2}$ and $\frac{d\sigma}{dW}$, have been measured for the first time.
- Measurements are in agreement with predictions by Frankfurt, Freund and Strikman.