DIS 2001
Bologna
April 27^{th} - May 1^{st}

Deeply Virtual Compton Scattering at HERA

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H1 Collaboration

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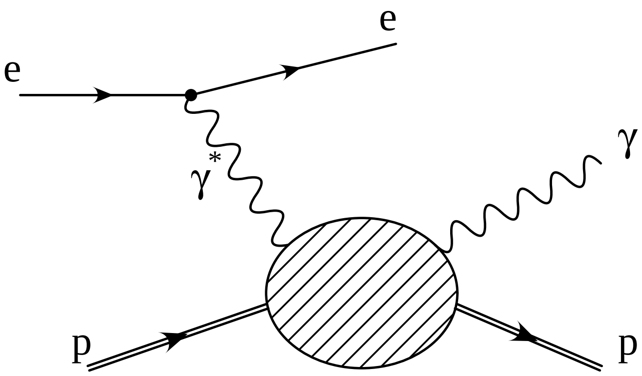
On behalf of the

ZEUS and H1 Collaborations

DVCS - Introduction

diffractive scattering of a virtual photon off a proton

$$e\,p \longrightarrow e\,\gamma\,p$$



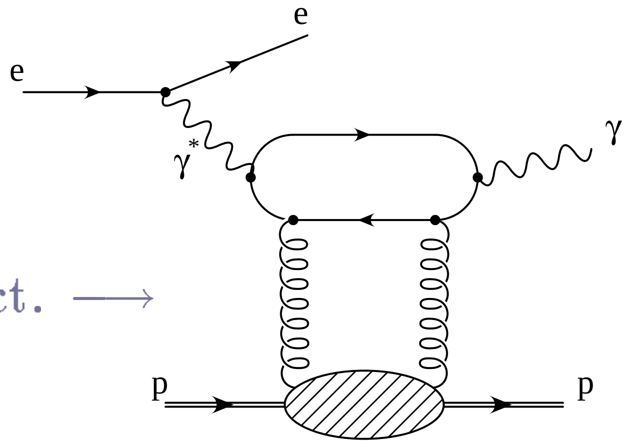
- large Q^2, large W and small t
- HERA: wide range in Q^2 and W accessible

Interest:

- comparatively "clean" QCD process (w.r.t. VM)
- particulary suitable channel to access skewed partons distributions

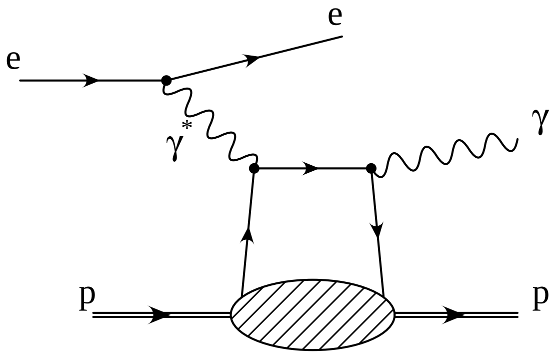
$\Rightarrow$ first cross section measurement

Introduction (QCD interpretation)



fact. $\longrightarrow$

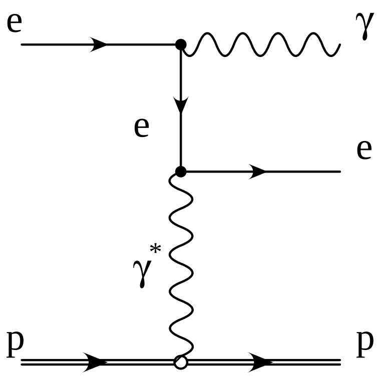
$G(x_1, x_2, Q^2)$

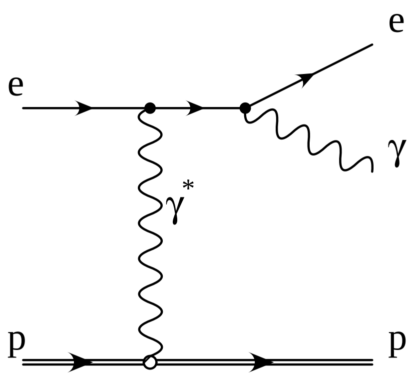


- Q^2 evolution calculable in pQCD
- process: nonforward nature

$\Rightarrow$ access to skewed partons distributions

- Bethe-Heitler process





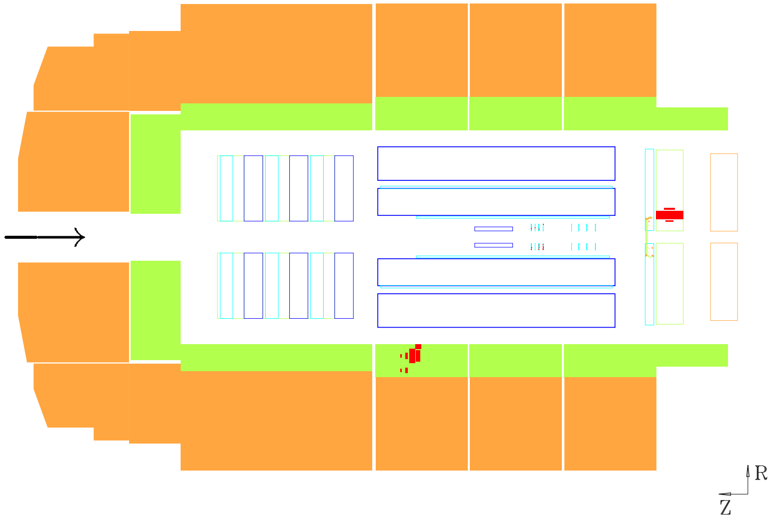
$\Rightarrow$ Direct contribution + interference
- intereference term $\rightarrow$ linear dep. in SPD
- access through the asymetric ϕ distribution

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

$\Rightarrow$ Implemented in two independent MC for H1 and ZEUS

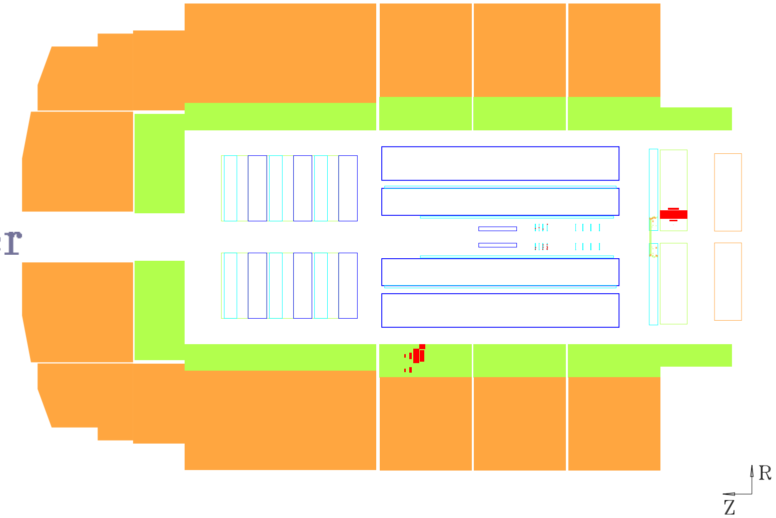
- Many others: I. Balitsky, A.V. Belitsky, M. Diehl, A. Donnachie, H. G. Dosch, X. Ji, E. Kuchina, D. Müller, L. Niedermeier, A.V. Radyushkin, A. Schäfer,...

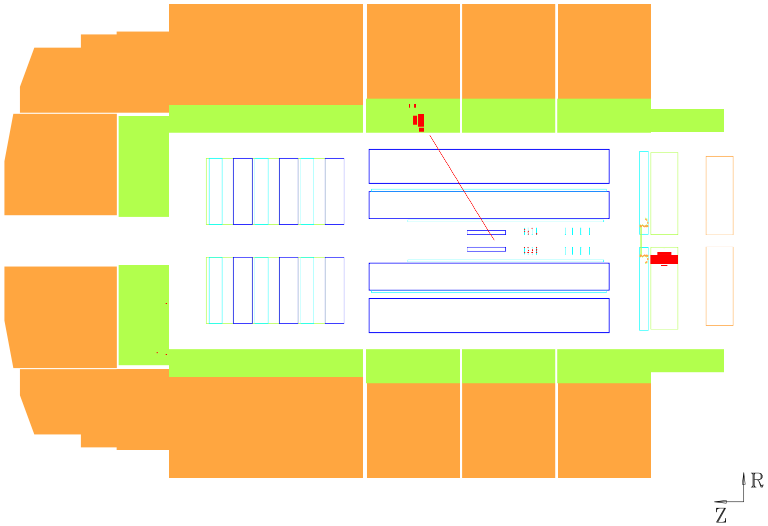
Analysis strategy

- DVCS $e^+ \longrightarrow$  $\longleftarrow p$

γ–sample e^+–sample

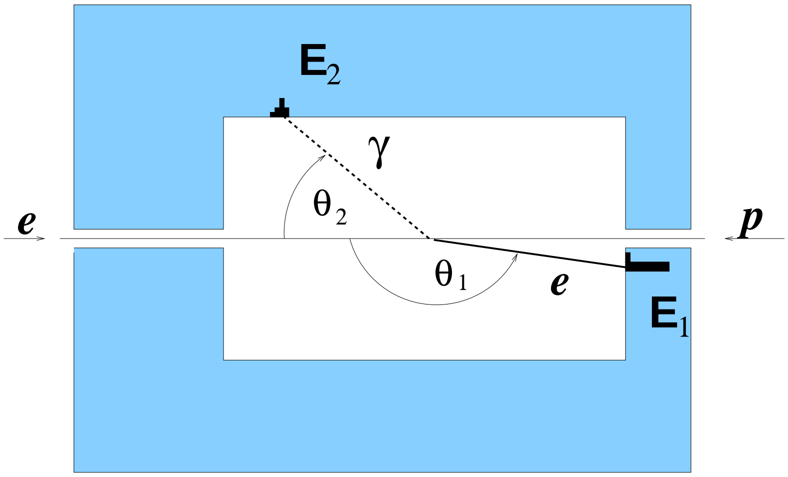
- Bethe-Heitler





ZEUS - first observation of DVCS

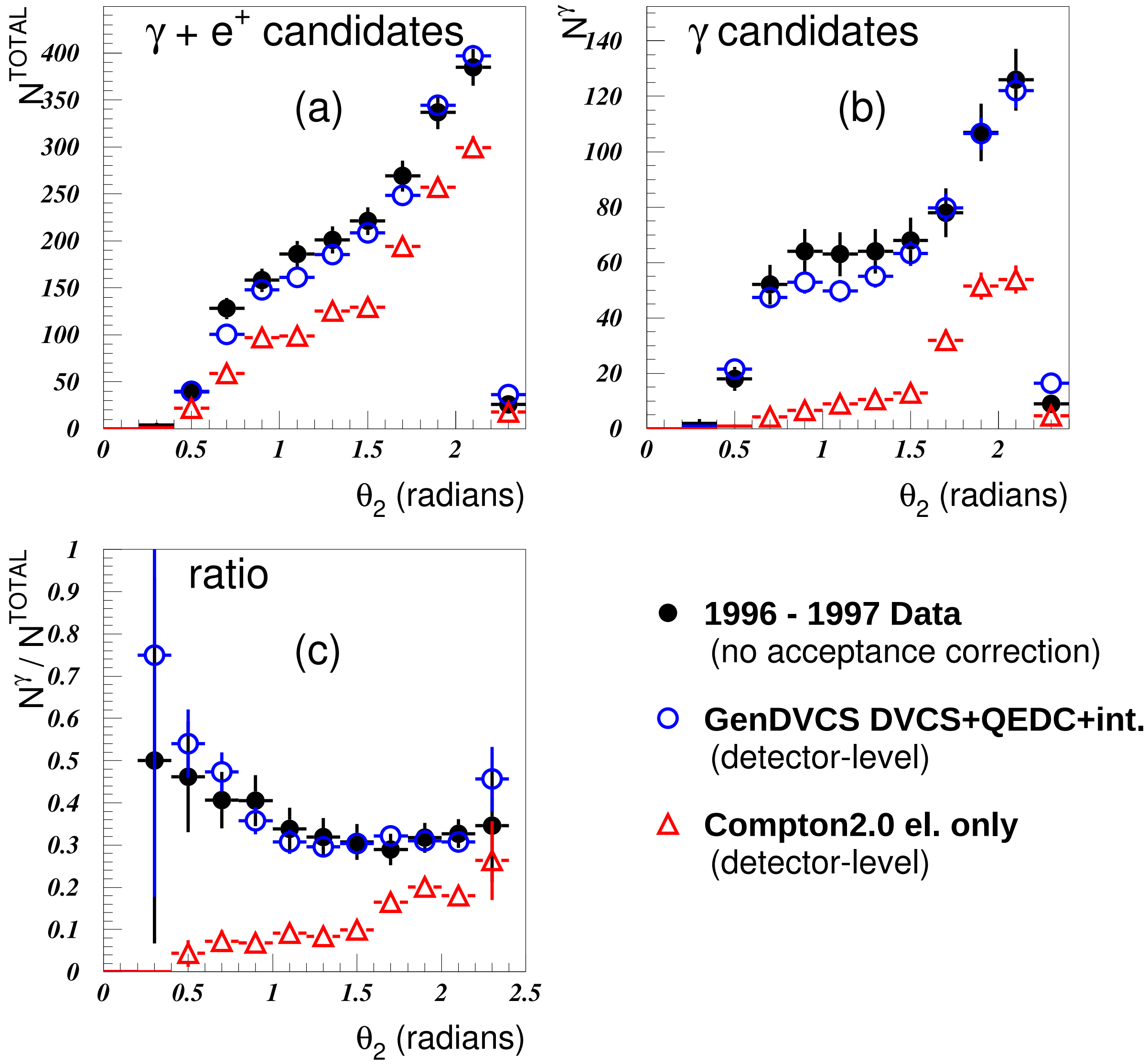
- selection criteria:



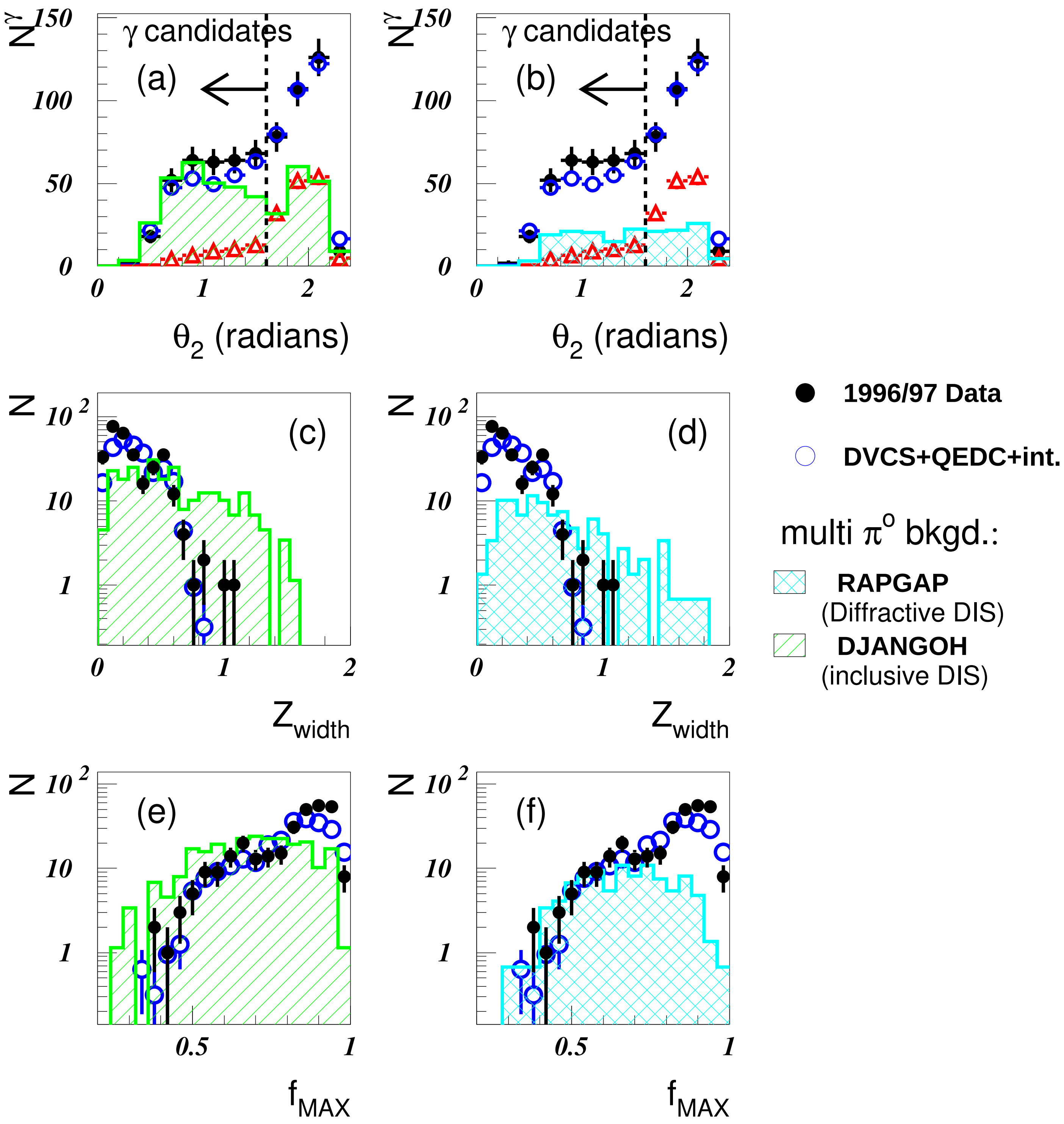
$$\theta_1 > 160^0,\ E_1 > 10\ \mathrm{GeV}$$
$$\theta_2 < 137^0,\ E_2 > 2\ \mathrm{GeV}$$
$$|\theta_2 - \theta_1| > 45^0$$
$$Q^2 > 6\ \mathrm{GeV}^2$$

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

ZEUS 1996/97 Preliminary



ZEUS 1996/97 Preliminary

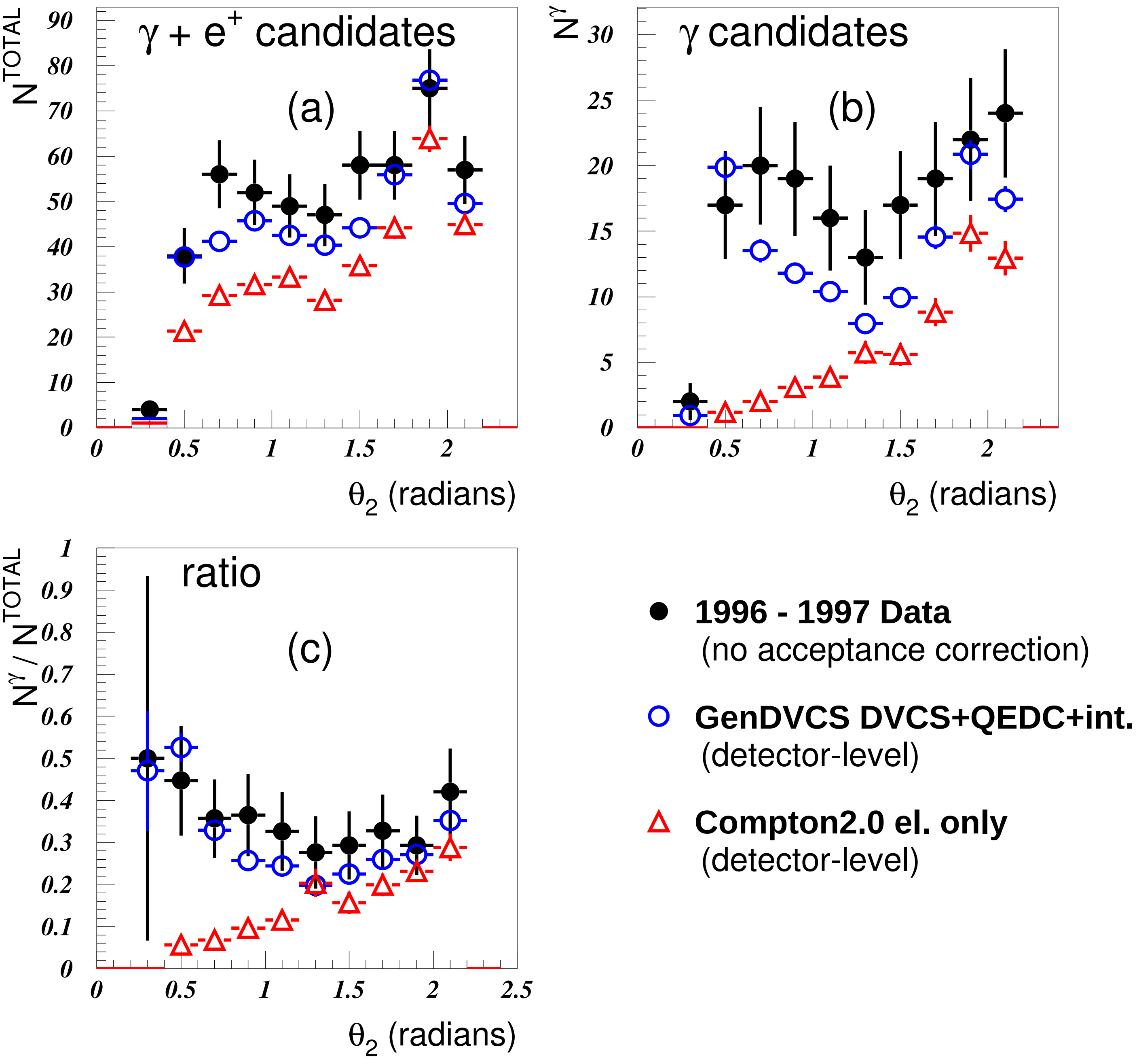


• DJANGOH and RAPGAP (high-mult. MC) are not reliable for low multiplicities.

Shower shapes ⇒ excess is photon signal

$E_2 > 5$ GeV : Signal persists

ZEUS 1996/97 Preliminary



H1 - Analysis

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

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

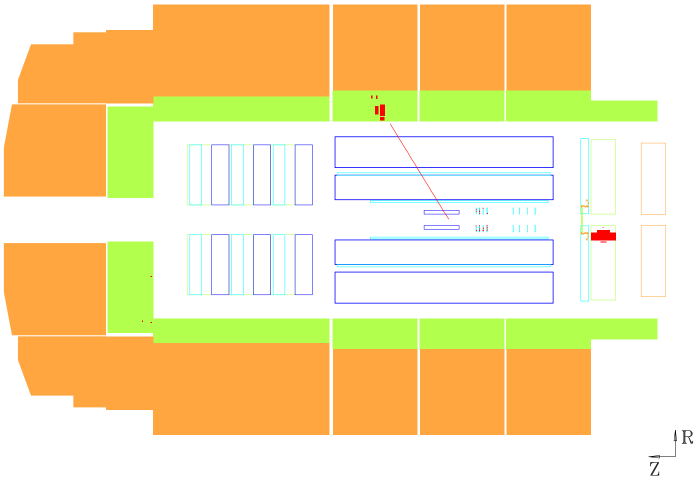
- 0 or 1 reconstructed track associated to the cluster in the central calorimeter

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

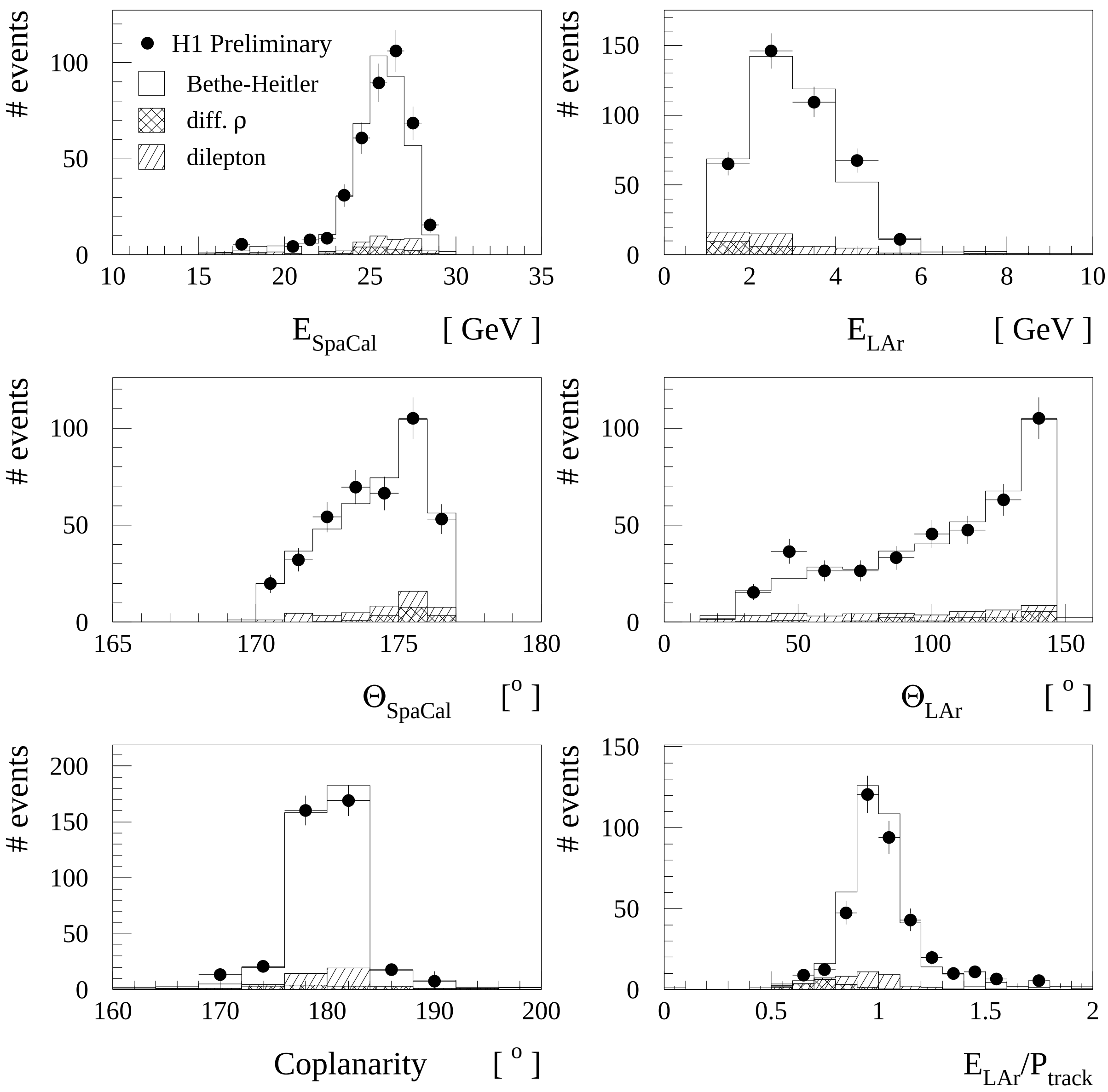
- kinematic selection
  - $\sum E - p_z > 45\,\mathrm{GeV}$
  - $2 < Q^2 < 20\,\mathrm{GeV}^2$
  - $30 < W < 120\,\mathrm{GeV}$
  - $|t| < 1\,\mathrm{GeV}^2$

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

H1 - Control by e^+ sample

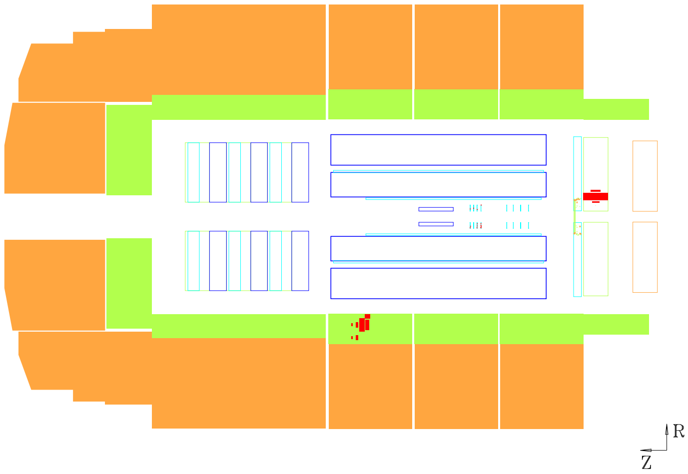


- $E_{\mathrm{SpaCal}} > 15\,\mathrm{GeV}$
- $p_{T\,\mathrm{LAr}} > 1\,\mathrm{GeV}$
- $E_3 < 0.5\,\mathrm{GeV}$
- empty forw. detectors
- $\int L = 8\,pb^{-1}$



⇒ detector response is understood

H1 - DVCS observation



- $2 < Q^2 < 20\,\mathrm{GeV}^2$
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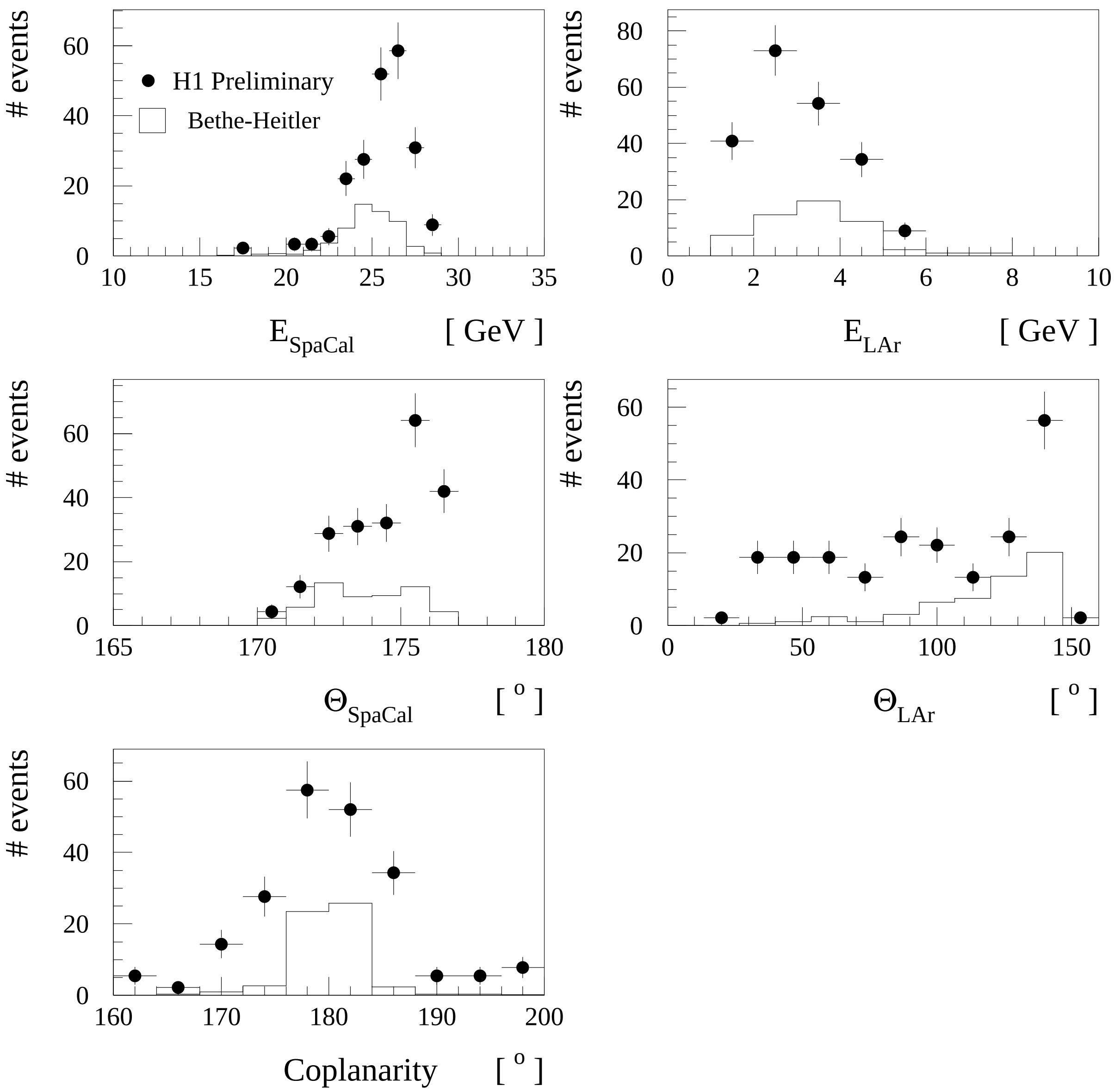
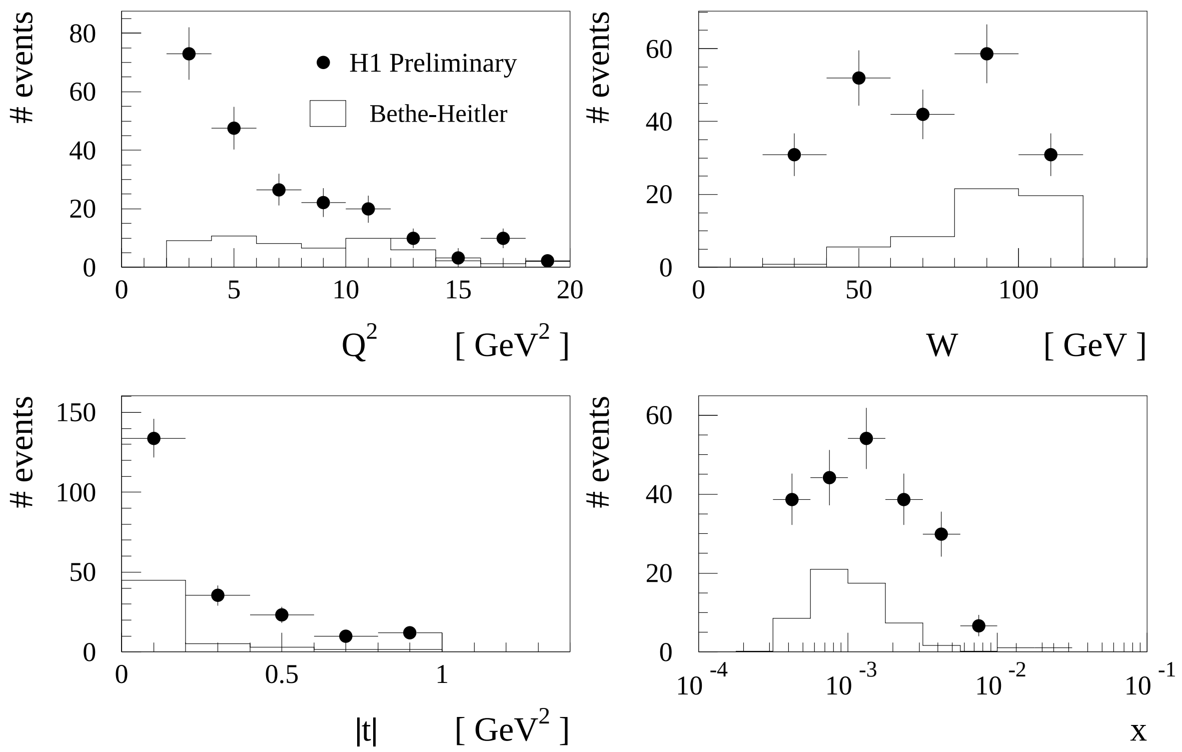


⇒ large excess of data above the Bethe-Heitler can be observed

H1 - DVCS observation (Cont.)

- kinematic distributions (uncorrected)



$\Rightarrow$ differences in shape and in normalisation can be observed

H1 - Cross section measurement

- kinematics is reconstructed by using the double angle method

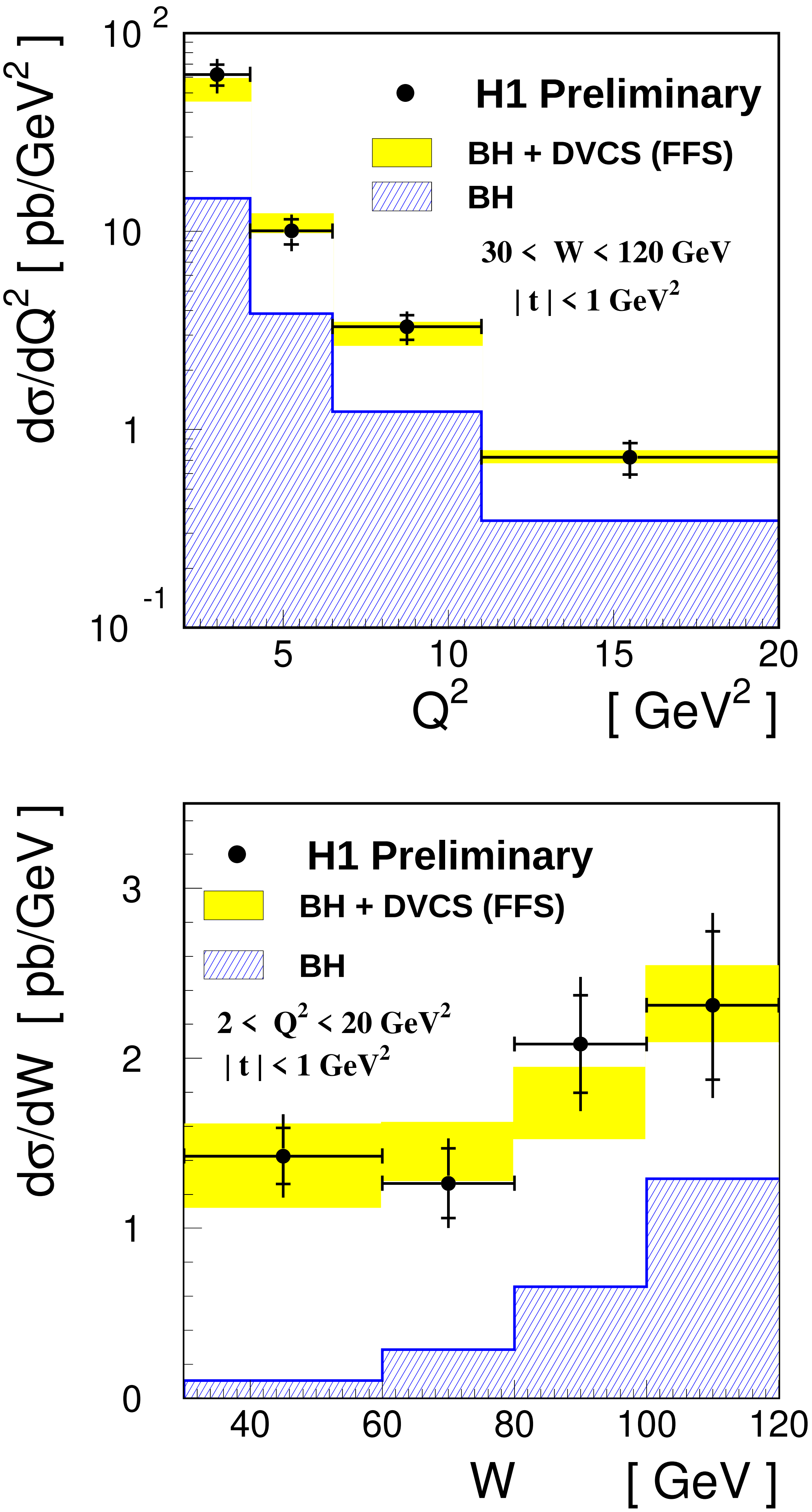
- data are corrected for
  - detector effects
  - acceptance (using DVCS MC)
  - QED ISR
  - proton dissociative background (10%)

$\Rightarrow$ elastic cross section

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

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

H1 Cross section measurement (Cont.)



Conclusion

- Deeply Virtual Compton Scattering is a new laboratory to study diffraction in terms of pQCD
  - pQCD calculable
  - access to skewed partons distributions
  - wide kin. 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 LO QCD predictions by Frankfurt, Freund and Strikman.