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Deeply Virtual Compton Scattering at HERA

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H1 Collaboration

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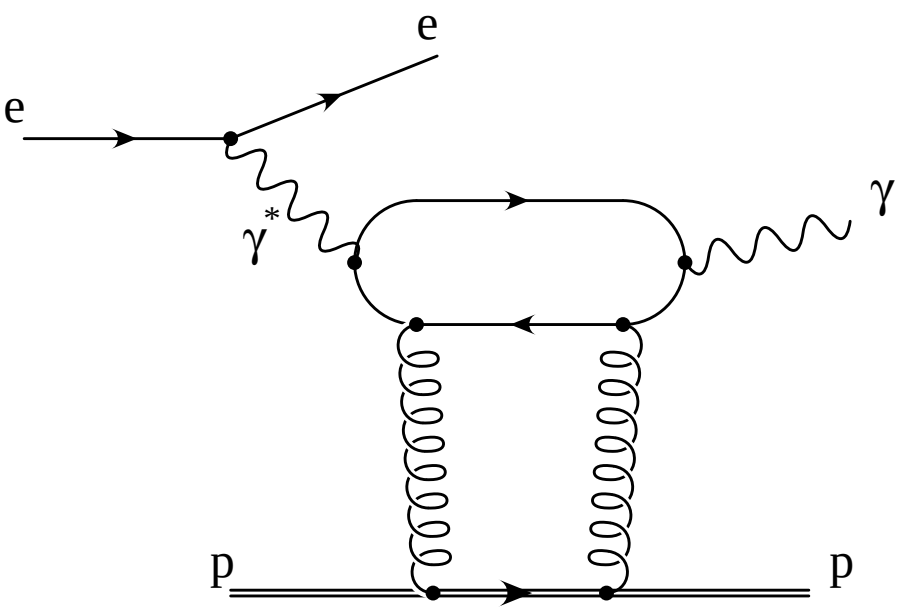
On behalf of the

ZEUS and H1 Collaborations

DVCS - Introduction

$$e\,p \to e\,\gamma\,p$$



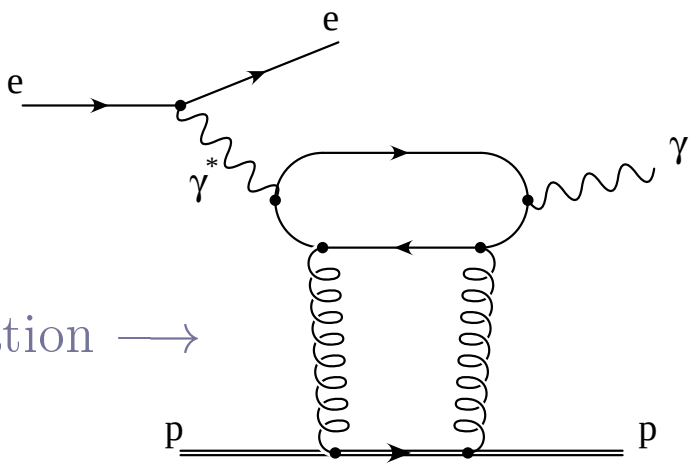
- comparatively "clean" QCD process (w.r.t. VM)
- process: nonforward nature

$\Rightarrow$ access to skewed partons densities

- HERA: wide range in Q^2 and W accessible
- detailed studies of scattering mechanism

$\Rightarrow$ first cross section measurment

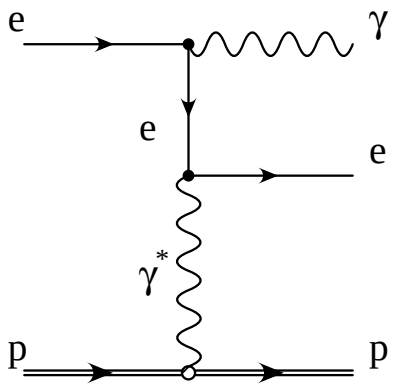
• DVCS process

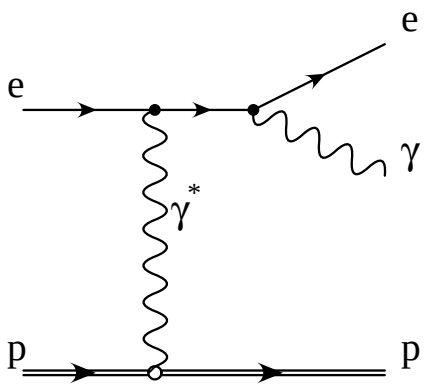


factorisation $\longrightarrow$ $G(x_1, x_2, Q^2)$

$\Rightarrow Q^2$ evolution calculable in pQCD

• Bethe-Heitler process





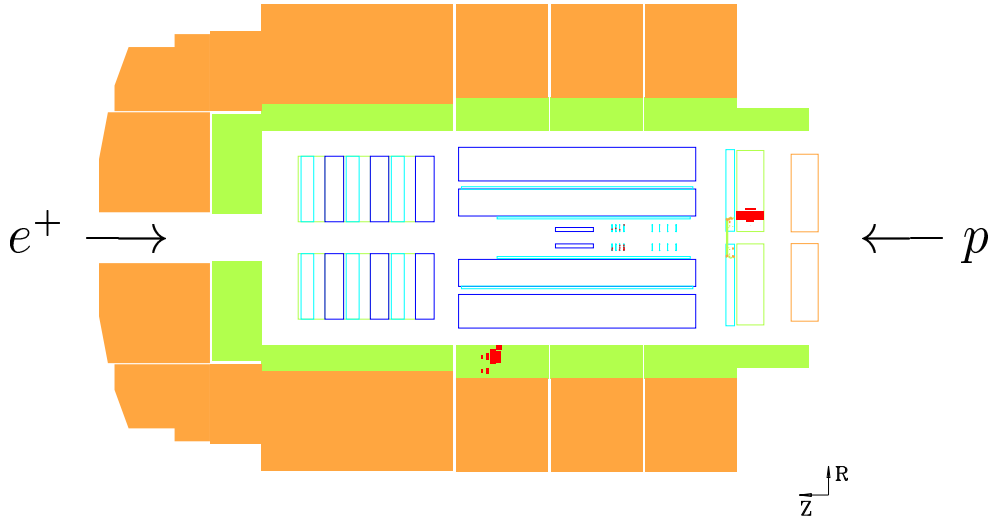
$\Rightarrow$ Direct contribution + interference

• 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, X. Ji, E. Kuchina, D. Müller, L. Niedermeier, A.V. Radyushkin, A. Schäfer,...

Analysis strategy

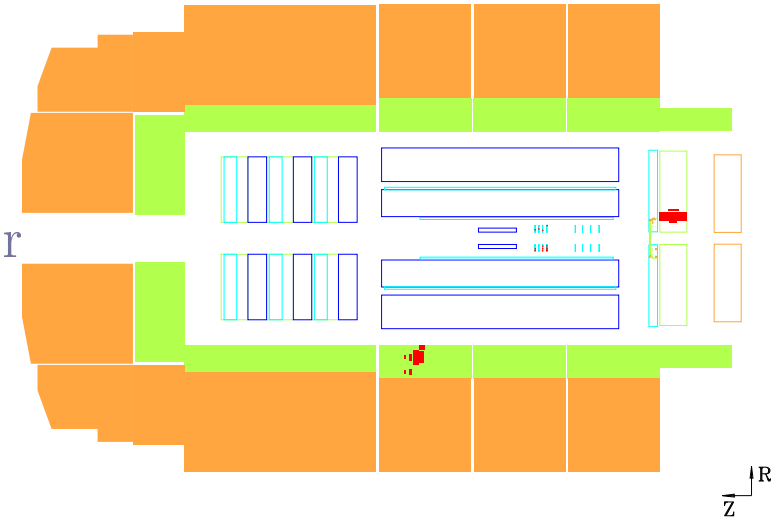
- DVCS

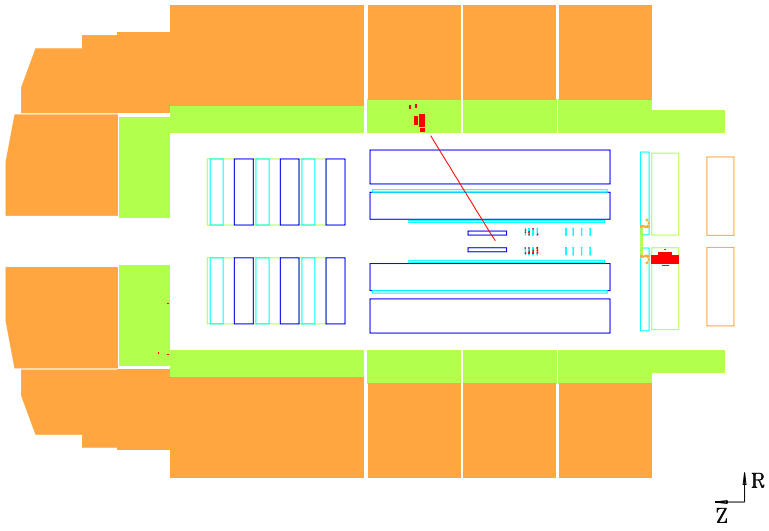


γ–sample

e^+–sample

- Bethe-Heitler

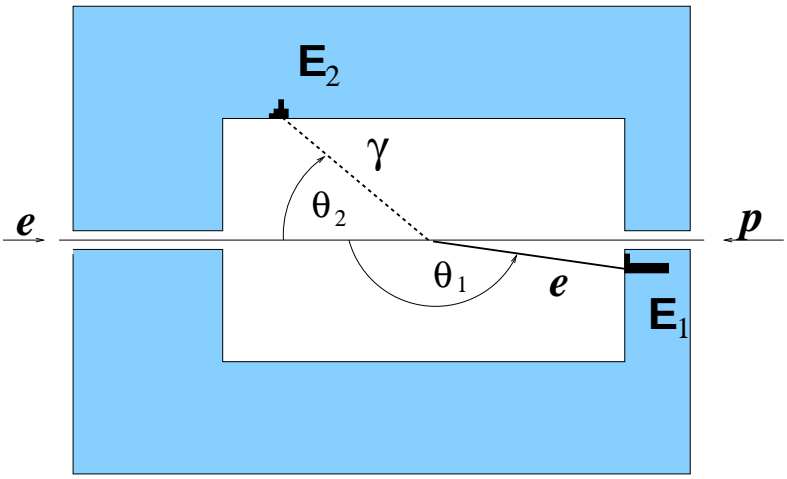




ZEUS - first observation of DVCS

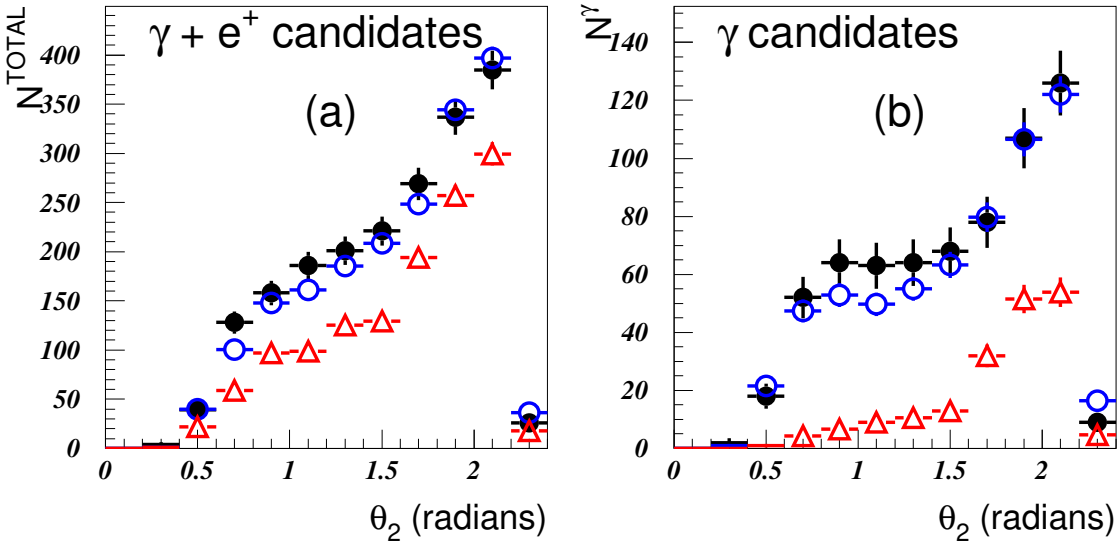
- selection criteria:

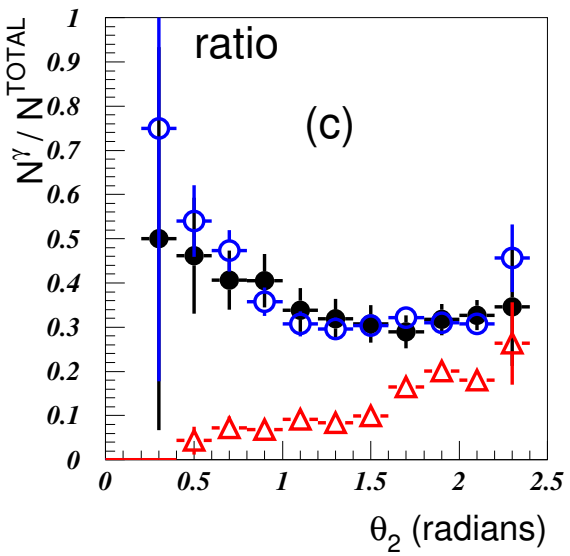
$\theta_1 > 160^0,\ E_1 > 10$ GeV
$\theta_2 < 137^0,\ E_2 > 2$ GeV
$|\theta_2 - \theta_1| > 45^0$
$Q^2 > 6$ GeV^2



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

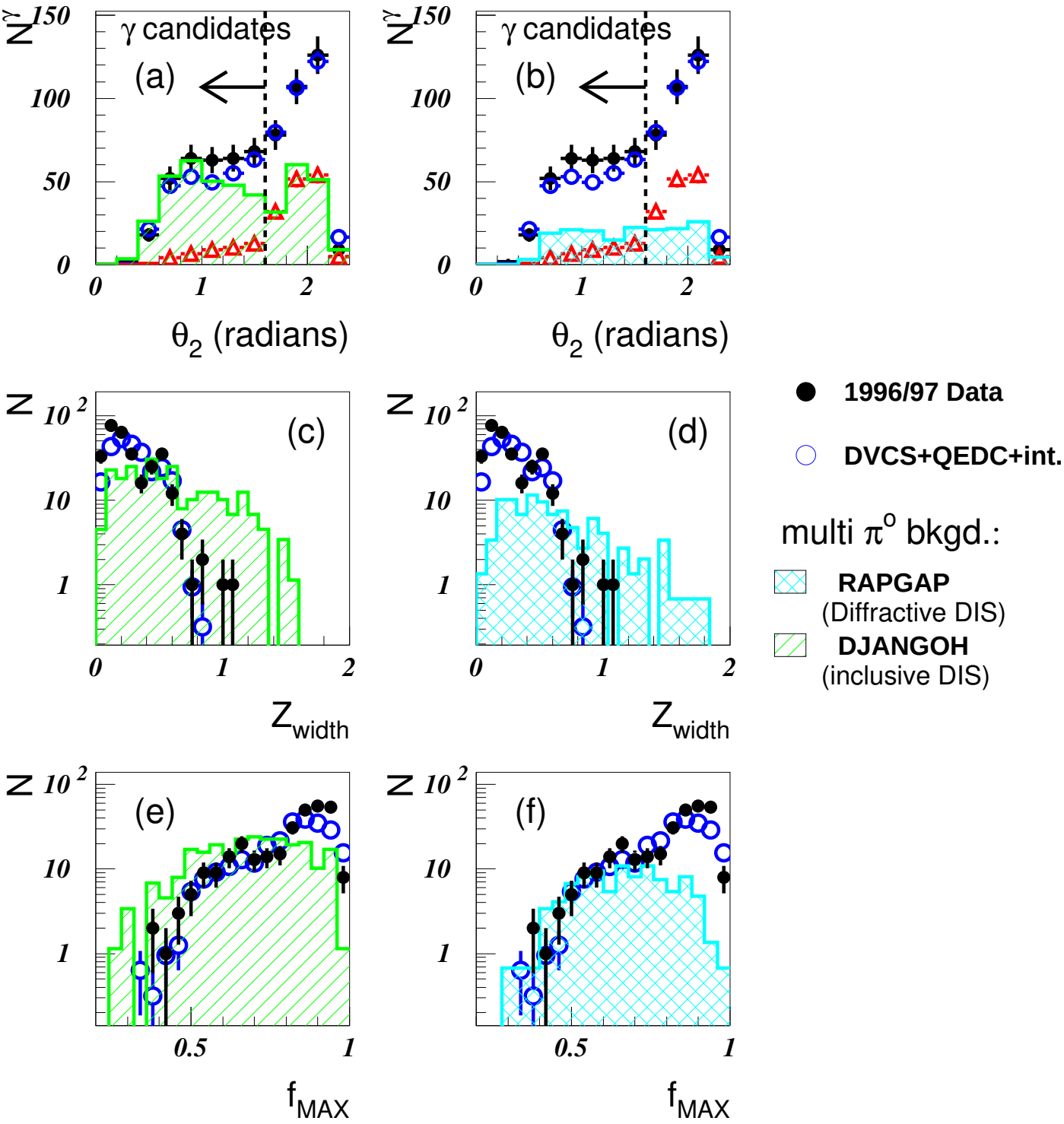
ZEUS 1996/97 Preliminary





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

ZEUS 1996/97 Preliminary

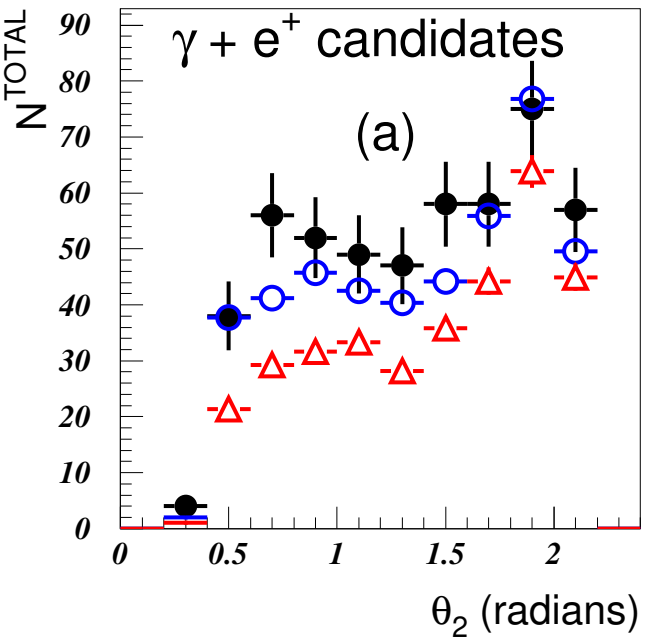


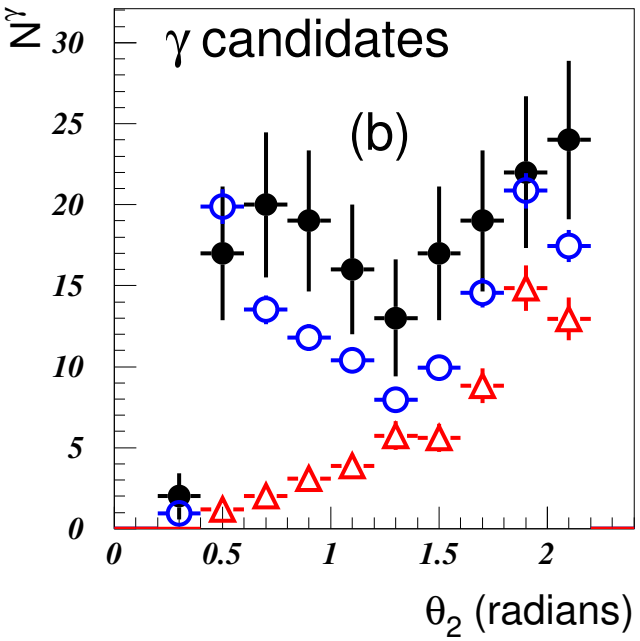
• DJANGOH and RAPGAP (high-mult. MC) are not reliable for low multiplicities.

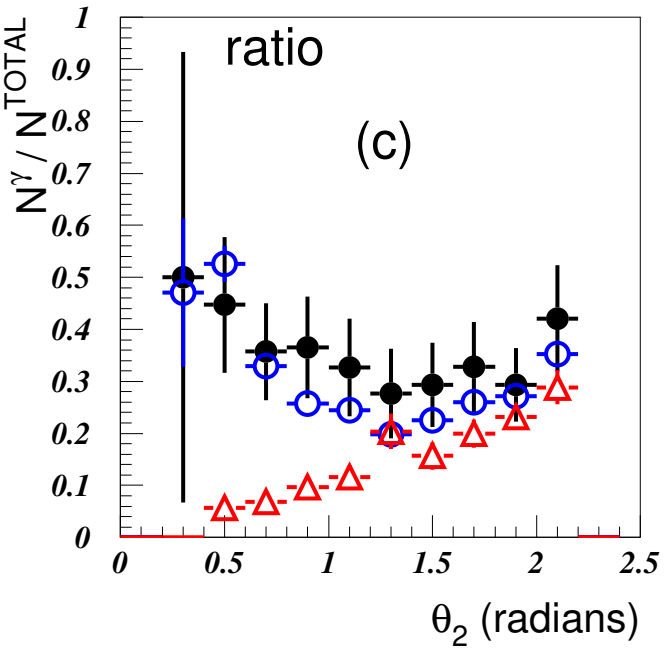
Shower shapes ⇒ excess is photon signal

$E_2 > 5$ GeV : Signal persists

ZEUS 1996/97 Preliminary







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  (no acceptance correction)
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  (detector-level)
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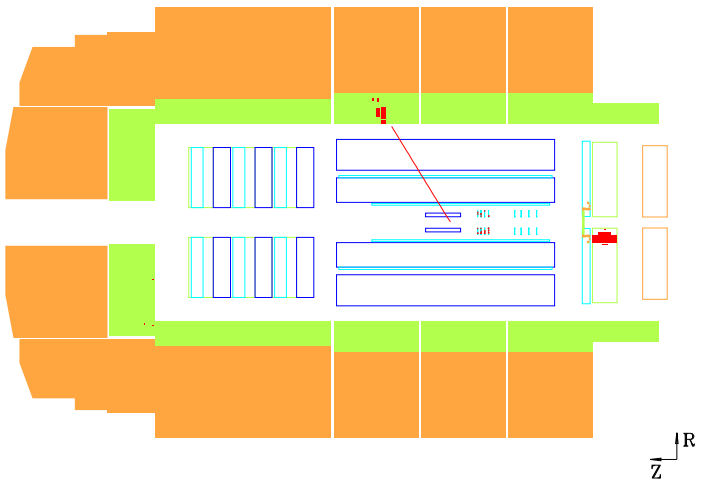
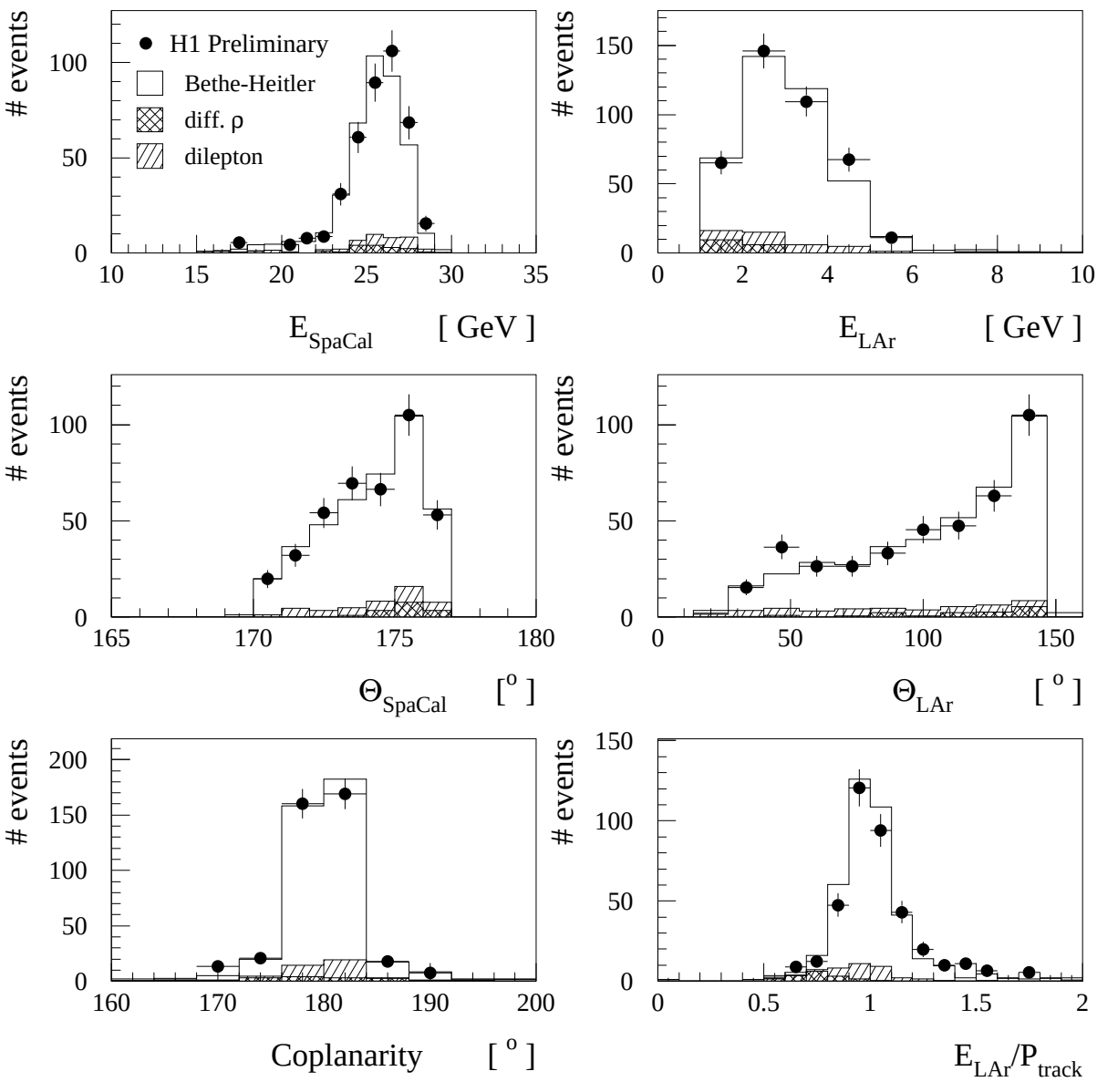
H1 - Control by e^+ sample



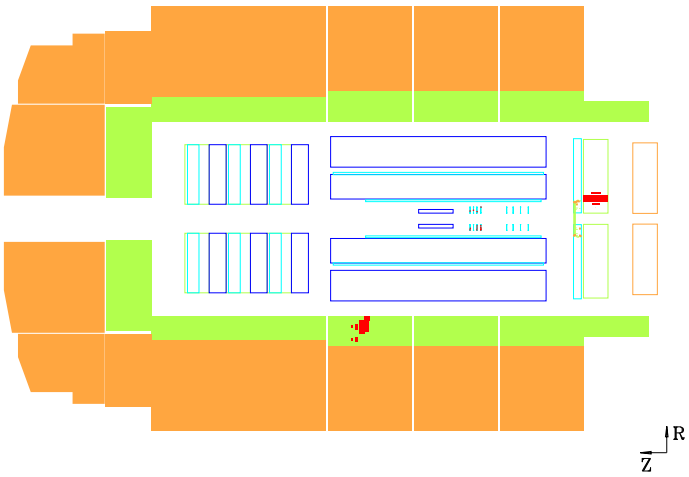
- $E_{\mathrm{SpaCal}} > 15\,\mathrm{GeV}$
- $p_{T\,\mathrm{LAr}} > 1\,\mathrm{GeV}$
- $E_3 < 0.5\,\mathrm{GeV}$
- empty forw. detectors

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

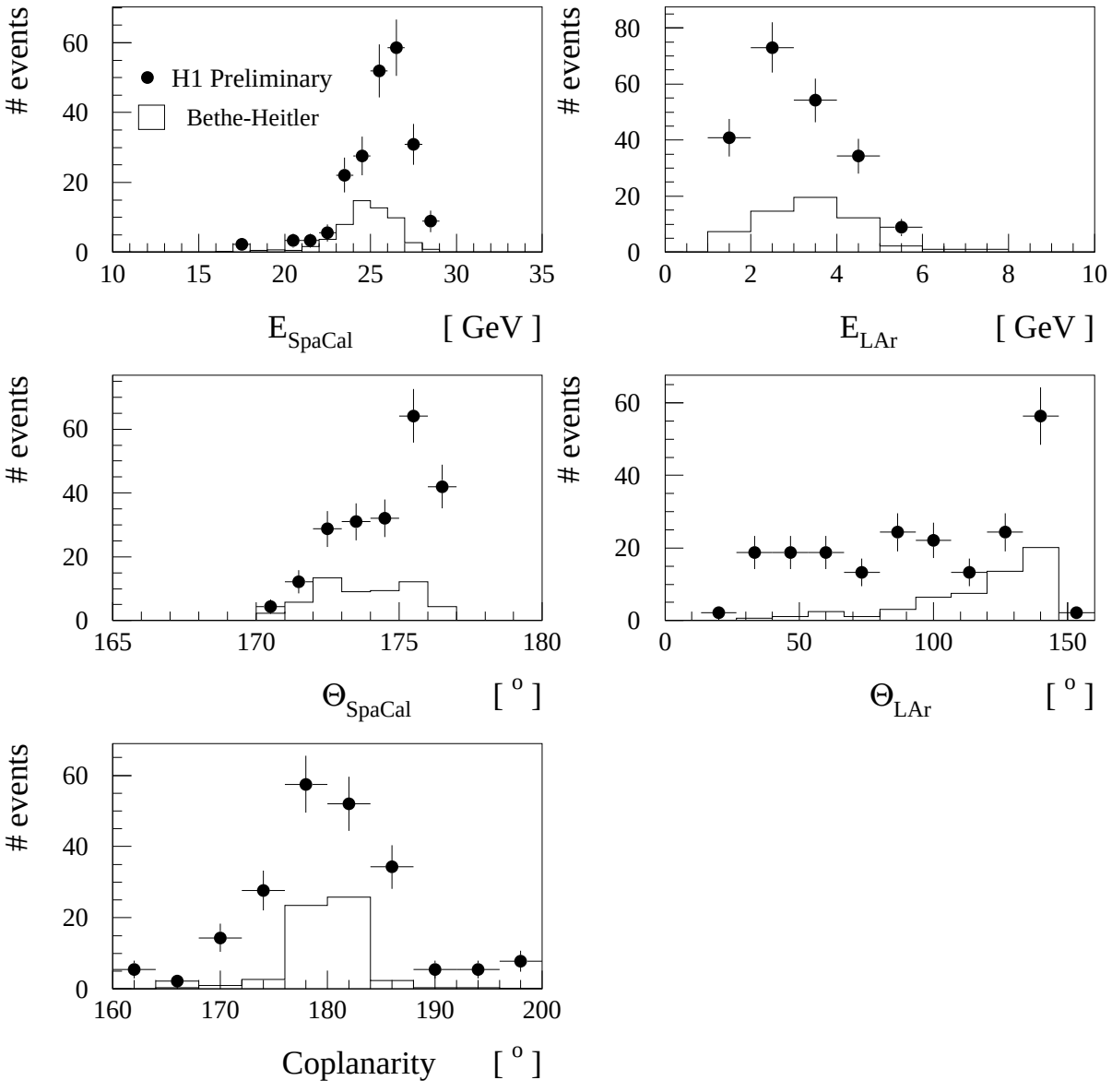


⇒ detector response is understood

H1 - DVCS observation



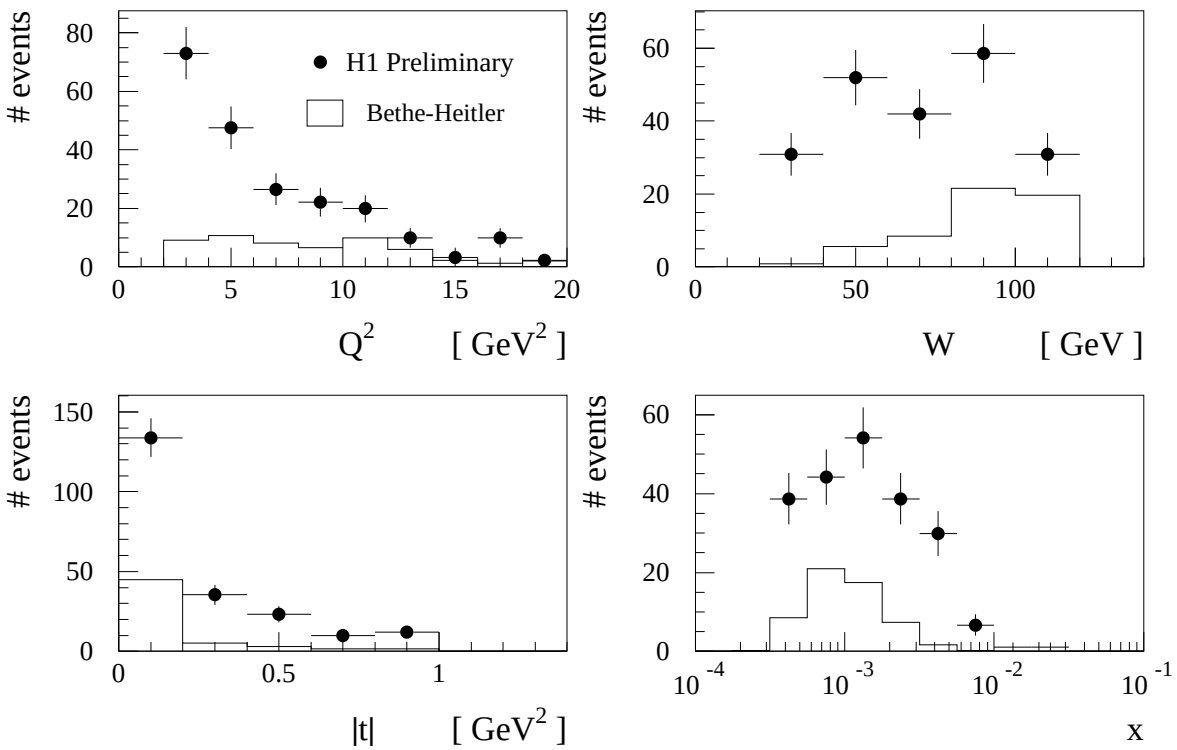
- $2 < Q^2 < 20\,\mathrm{GeV}^2$
- $30 < W < 120\,\mathrm{GeV}$
- $|t| < 1\,\mathrm{GeV}^2$



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

H1 - DVCS observation (Cont.)

- kinematic distributions (uncorrected)



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

H1 - Cross section measurement

- kinematics is reconstructed by using the double angle method

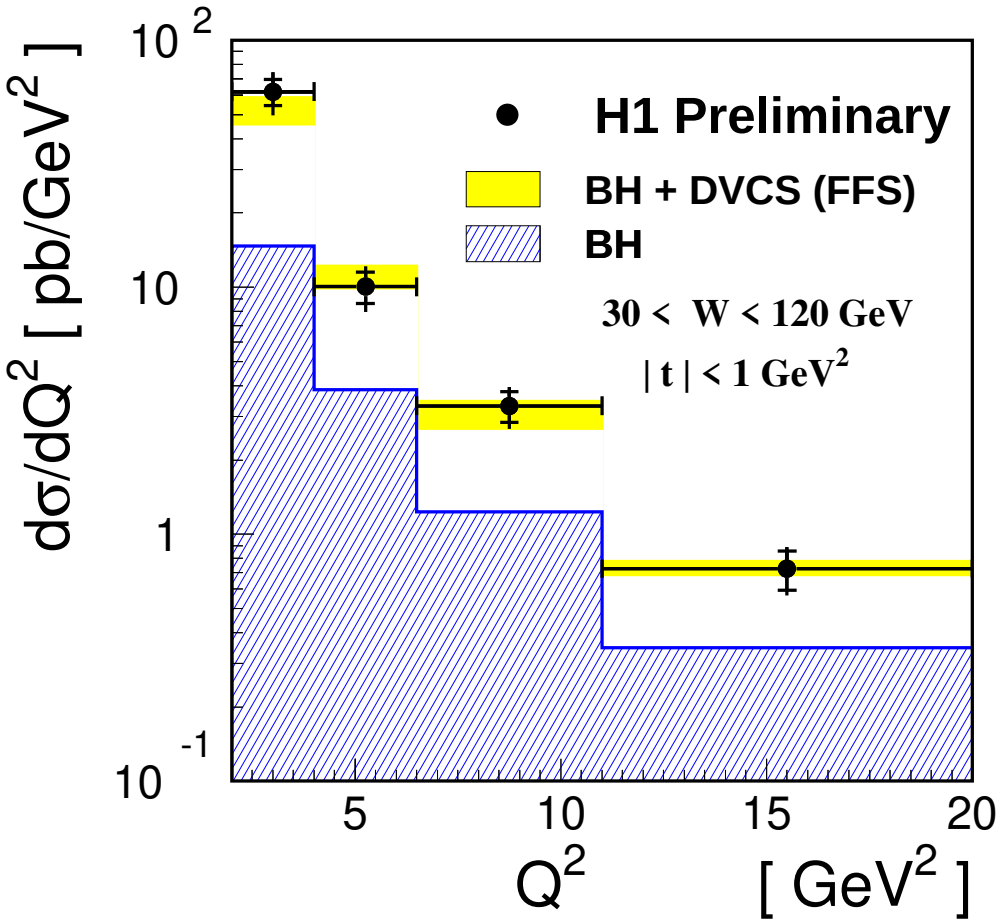
- data are corrected for
  - detector effects
  - acceptance (using DVCS MC)
  - QED ISR
  - proton dissociative background (10%)

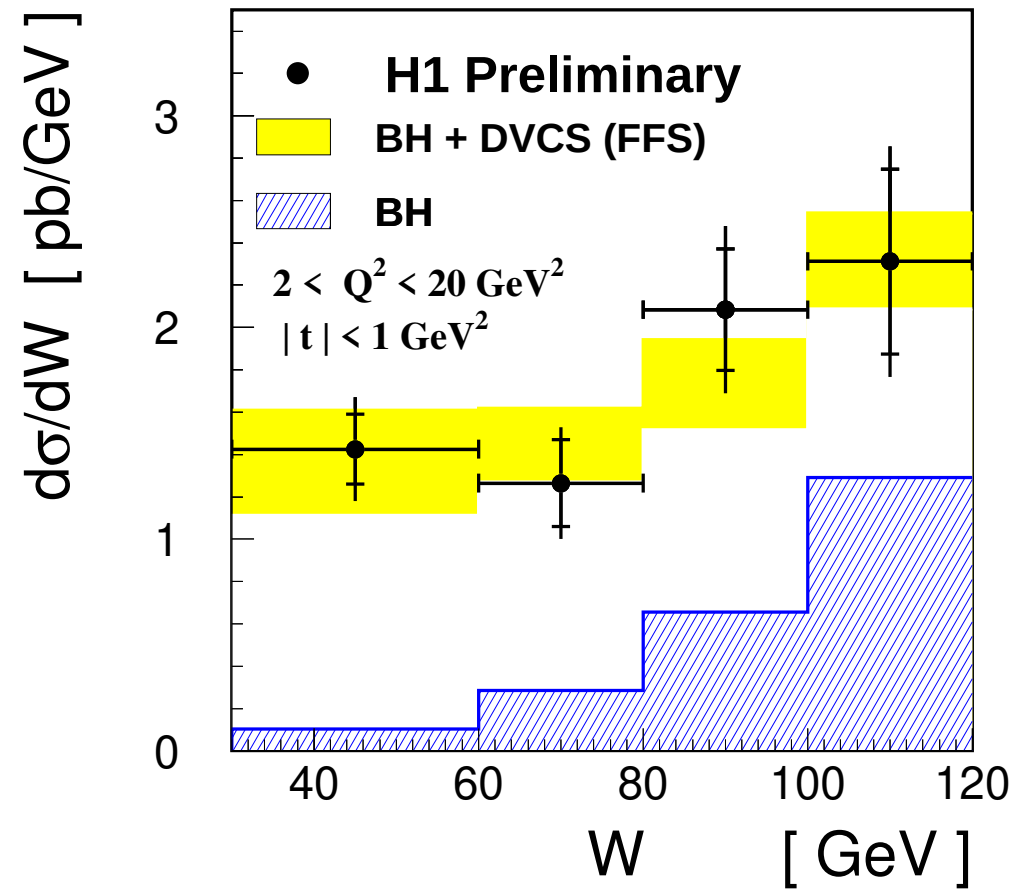
$\Rightarrow$ elastic cross section

- 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 nonforward gluon density
  - 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.