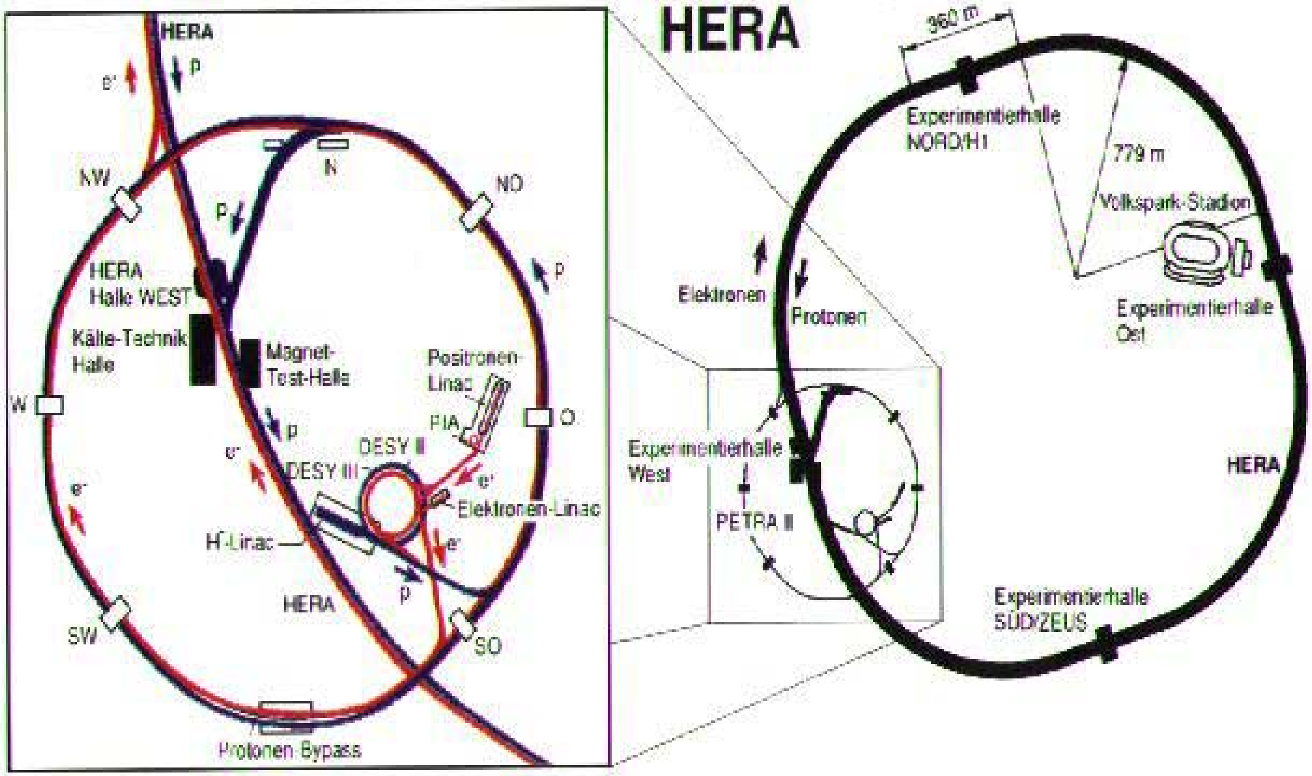
Nicolas Keller, Univ. ZH, 5.10.00

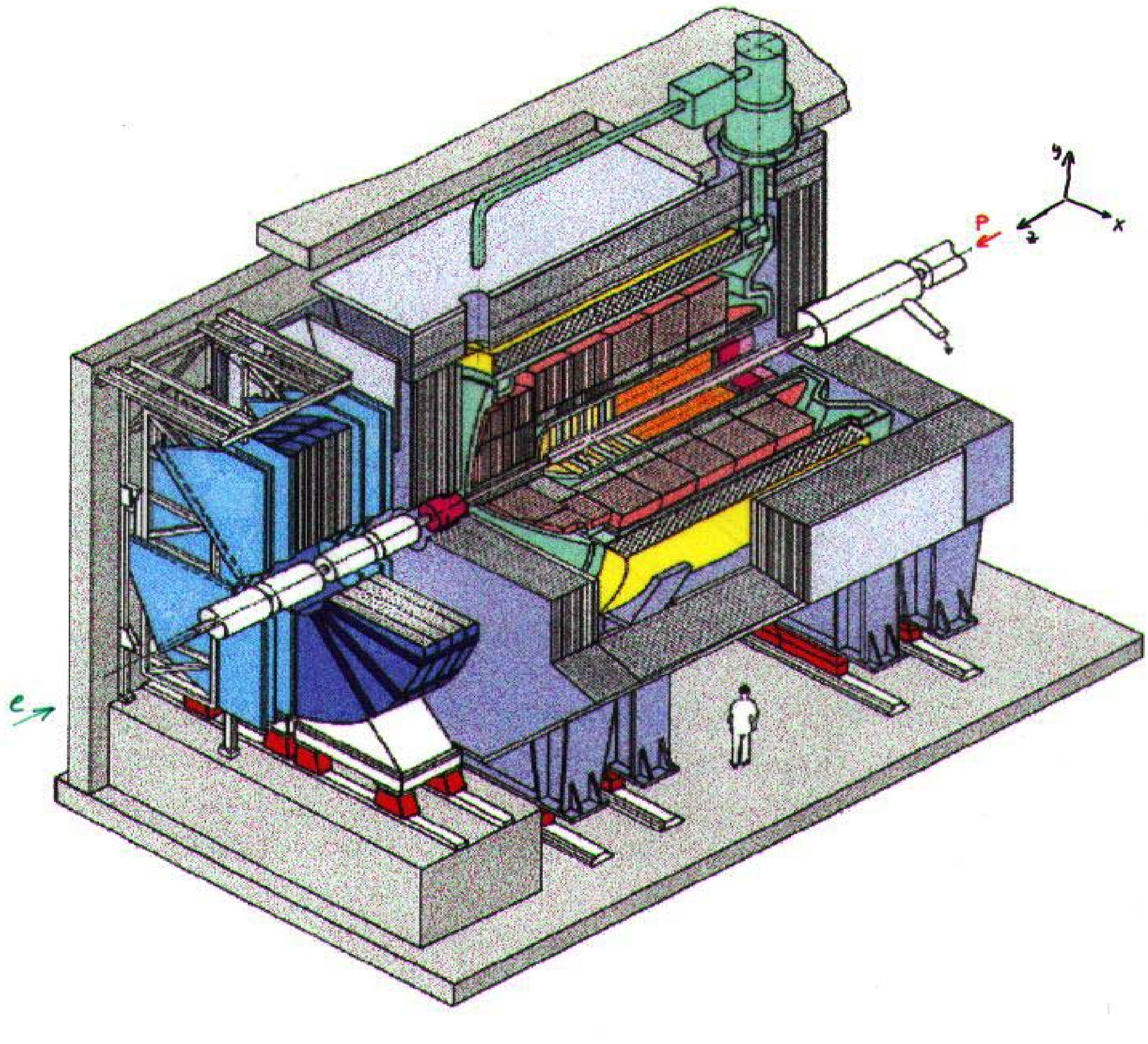
QED-Compton events in H1

- overview HERA / H1
- the QED-Compton process
- calibration
- photon content of the proton
- analysis aspects

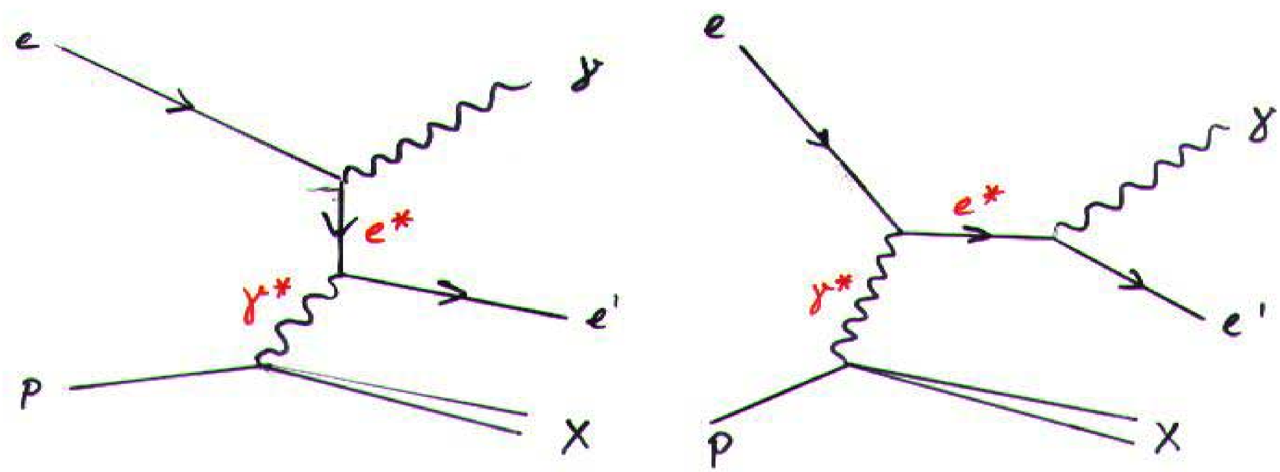


HERA
HERA
e'
p
NW
N
NO
p
p
HERA
Halle WEST
Kälte-Technik
Halle
Magnet-
Test-Halle
Positronen-
Linac
W
O
PIA
p
e'
DESY II
DESY III
e'
e'
Elektronen-Linac
H⁻-Linac
e'
p
HERA
SW
SO
Protonen Bypass
360 m
Experimentierhalle
NORD/H1
779 m
Volkspark-Stadion
Elektronen
Protonen
Experimentierhalle
Ost
Experimentierhalle
West
PETRA II
HERA
Experimentierhalle
SÜD/ZEUS

H1



allgemeiner Graph für radiative e-p-Streuung



Def.: $q^2(e^*) = \begin{cases} (p_\gamma - p_e)^2 \\ (p_\gamma + p_{e'})^2 \end{cases}$

$q^2(\gamma^*) = (p_X - p_P)^2$

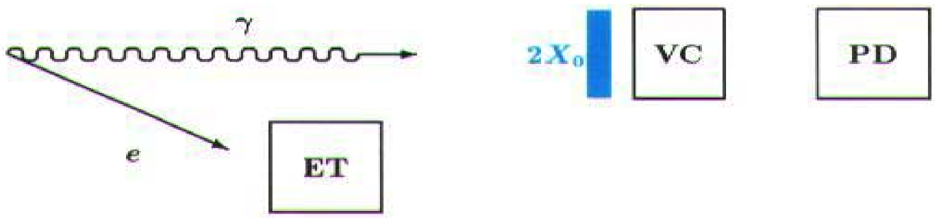
Matrixelement: $dM \sim \frac{dq(e^*)}{q^2(e^*) - m_e^2} \cdot \frac{dq(\gamma^*)}{q^2(\gamma^*)}$

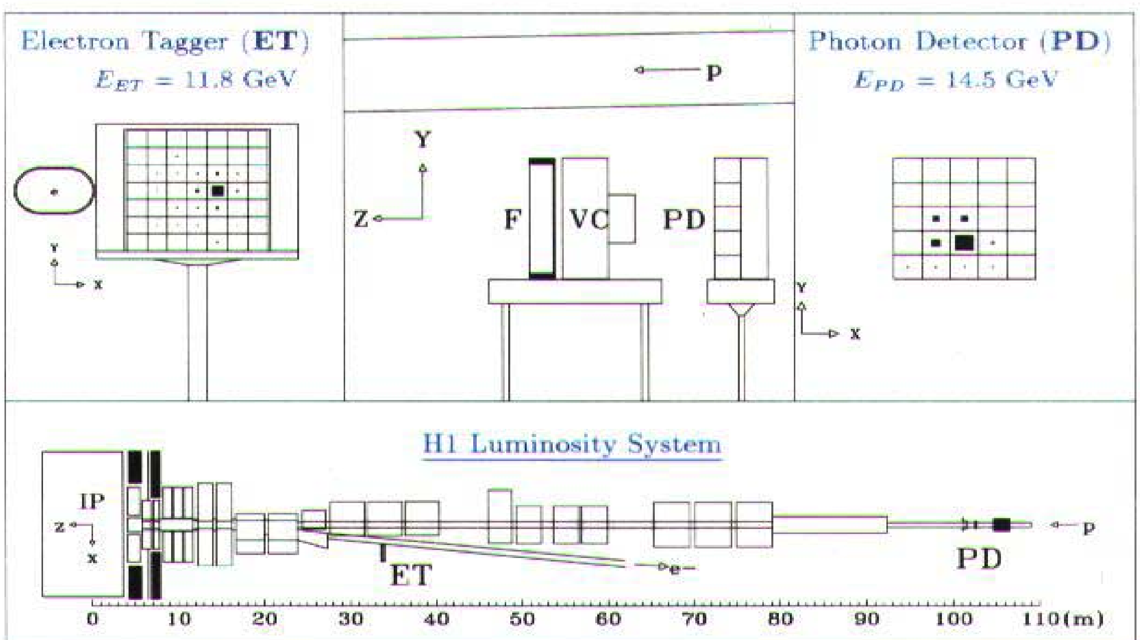
$\lvert q^2(e^*)\rvert$	$\lvert q^2(\gamma^*)\rvert$	
$\simeq 0$	$\simeq 0$	Bremsstrahlung
$\simeq 0$	> 0	radiative DIS
> 0	$\simeq 0$	QED-Compton-Streuung

Luminosity Measurement

Based on the bremsstrahlung process:

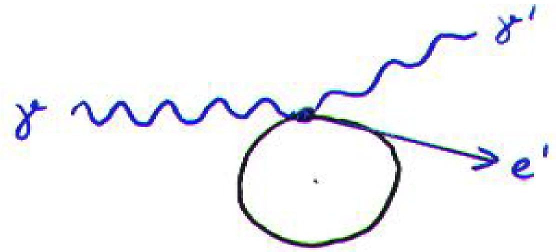
$$ep \rightarrow e\gamma p$$





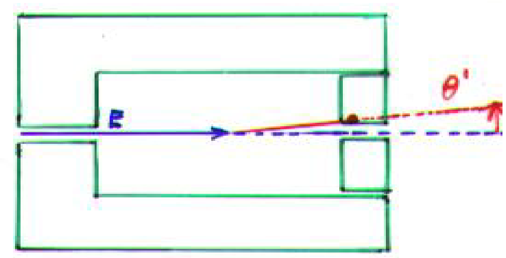
QED - Compton scattering

remember: classical Compton scattering



$$\gamma + e \longrightarrow \gamma' + e'$$

HERA / H1:



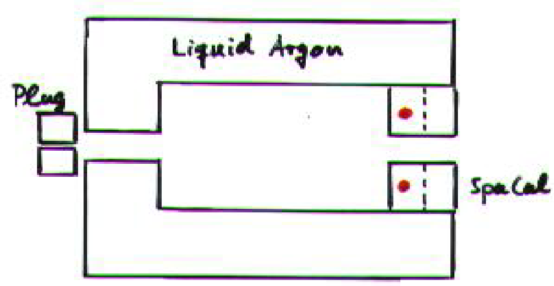
$$|q^2(e^*)| \gtrsim (E \cdot \theta')^2 \simeq 3{,}5 \text{ GeV}^2 \gg q^2(\gamma^*)$$

γ^* is quasi-real in $\gamma^* + e \rightarrow \gamma + e'$

$\Rightarrow$ small momentum transfer to the proton

$\Rightarrow$ proton (remnant) near / in the beampipe

Event signature:

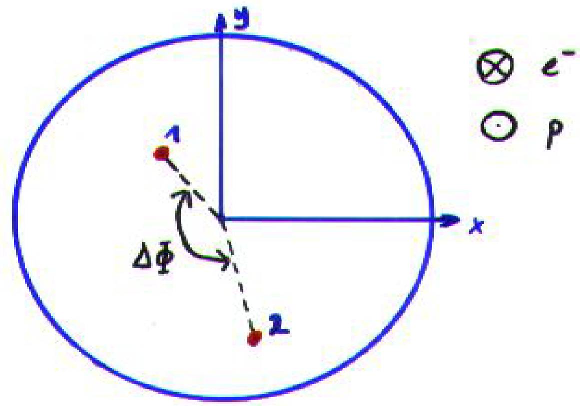


2 electromagnetic clusters

calibration I - energy

6 variables : electron $\theta_{e'}, \Phi_{e'}, E_{e'}$ } over-
photon $\theta_\gamma, \Phi_\gamma, E_\gamma$ } determined

define acoplanarity:



$$\Delta\Phi = |\Phi_1 - \Phi_2|$$

$$\vec{p}_T^{\,e'} \simeq -\vec{p}_T^{\,\gamma}$$

$\Rightarrow \Phi_{1,2}$ correlated

relation polar angle - energy:

$$E_{e'} = \frac{2E_e \cdot \sin\theta_\gamma}{\sin\theta_{e'} + \sin\theta_\gamma - \sin(\theta_{e'}+\theta_\gamma)}$$

"double angle method"

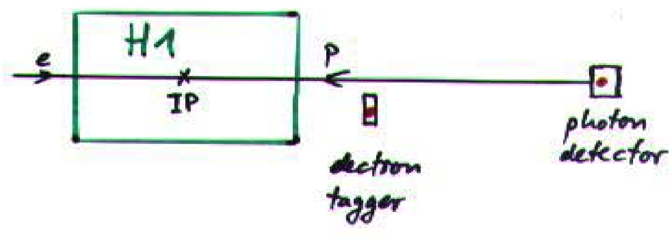
$$E_\gamma = \frac{2E_e \cdot \sin\theta_{e'}}{\sin\theta_{e'} + \sin\theta_\gamma - \sin(\theta_{e'}+\theta_\gamma)}$$

$\Rightarrow$ calorimeter calibration by comparison $E_{DA} \leftrightarrow E_{reconstructed}$

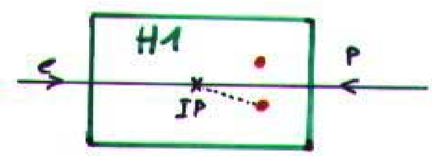
calibration II - luminosity

$$L = \frac{N}{\varepsilon \cdot \sigma}$$

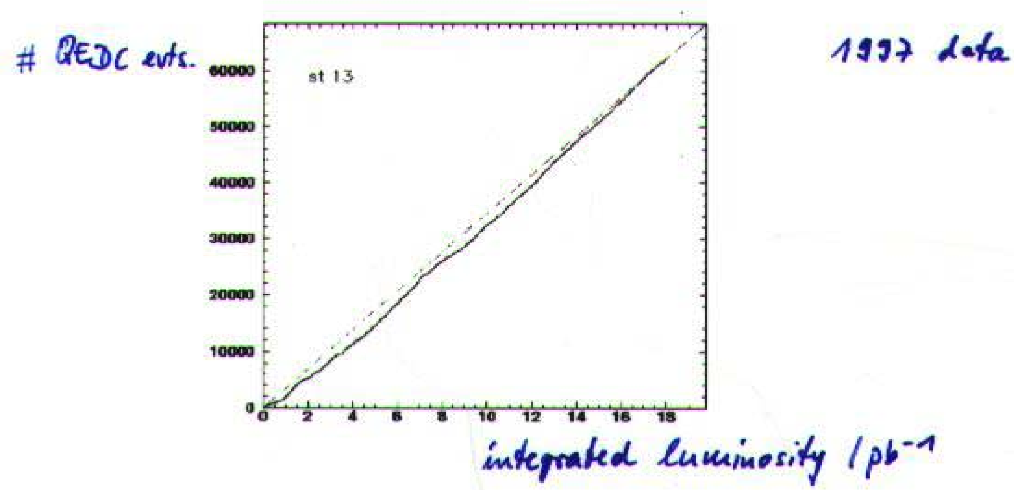
Bremsstrahlung



QED-Compton

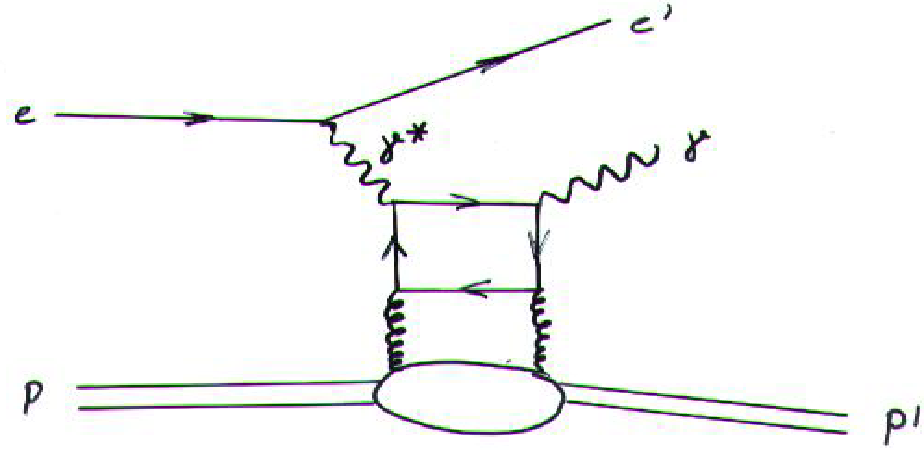


„internal" measurement, same systematics as in other processes



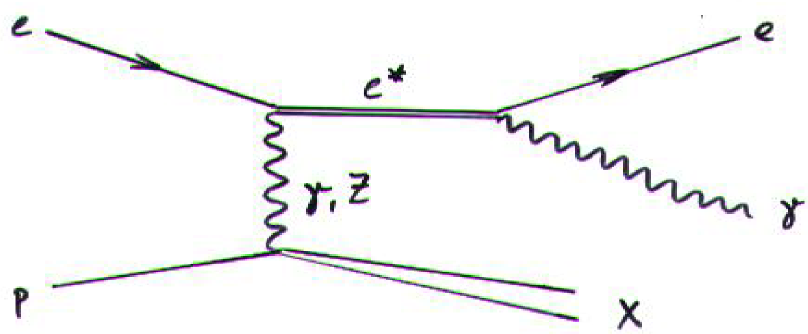
QEDC als Untergrund anderer Prozesse

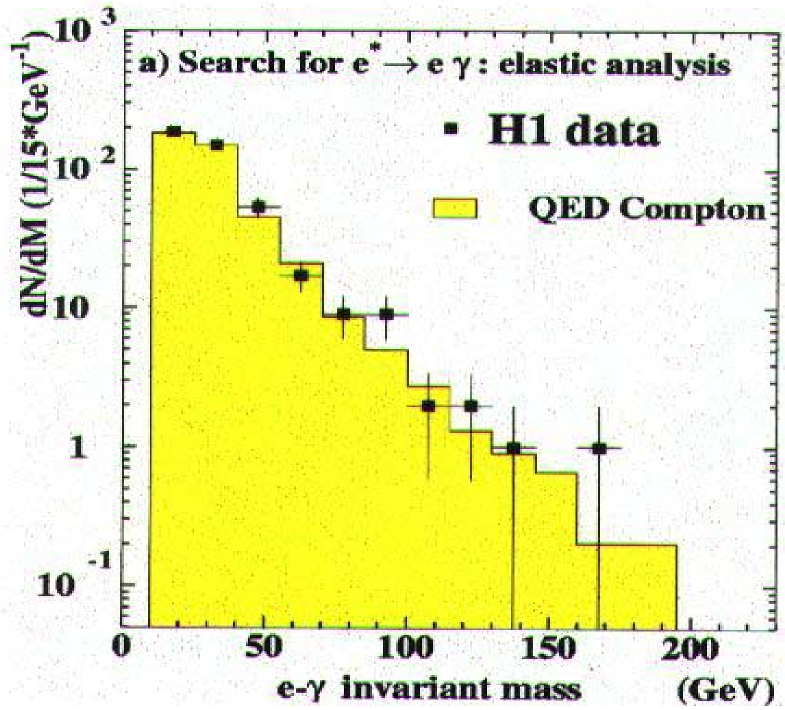
I DVCS (Deeply Virtual Compton Scattering)



- in pQCD berechenbar (Frankfurt, Freund, Strikman)
- Bestimmung von „Skewed Parton Distributions" (SPDs)

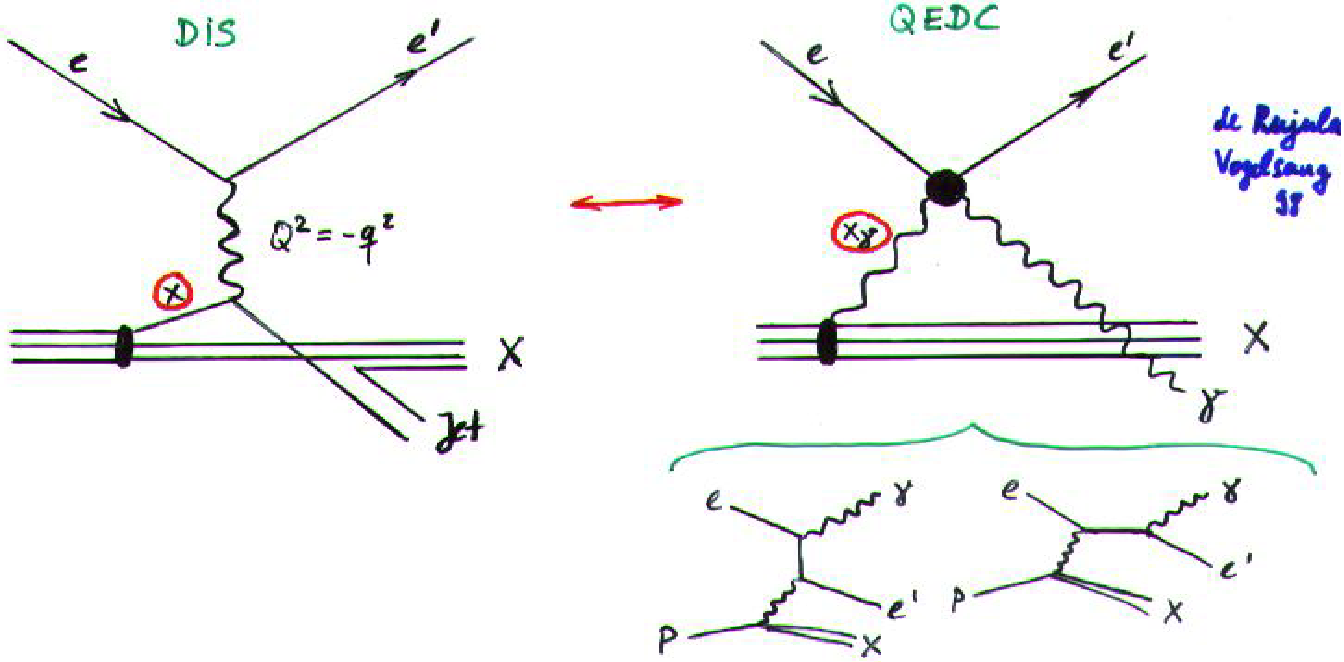
II angeregte Elektronen





a) Search for $e^* \rightarrow e\,\gamma$: elastic analysis
H1 data
QED Compton
dN/dM (1/15*GeV^{-1})
e-γ invariant mass (GeV)

Measurement of the photon content



virtual photon – virtual electron
quark – quasi-real photon
jet – real photon

$q = p_e - p_{e'}$ $\quad Q^2 = -q^2$ $\quad x_\gamma = \frac{Q^2}{2Pq}$ $\quad y = \frac{Q^2}{x_\gamma \cdot s}$

→ Deep Inelastic Compton Scattering (DICS)

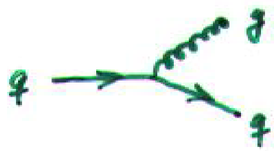
→ photon density $\boxed{\gamma(x, Q^2)}$

(longitudinal momentum distribution)

Comparison $\gamma(x, Q^2) \leftrightarrow g(x, Q^2)$

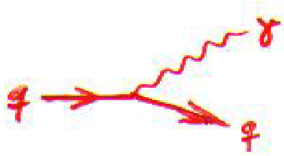
QCD gluon evolution equation:

$$\frac{d\, g(x, Q^2)}{d \ln Q^2} = \frac{\alpha_s(Q^2)}{2\pi} \int_x^1 \frac{dy}{y} \left[\sum_q \frac{4}{3} \underline{P_{gq}} \left(\frac{x}{y}\right) \cdot \left[q(y, Q^2) + \bar{q}(y, Q^2) \right] + \right.$$
$$\left. + \underline{P_{gg}} \left(\frac{x}{y}\right) \cdot g(y, Q^2) \right]$$



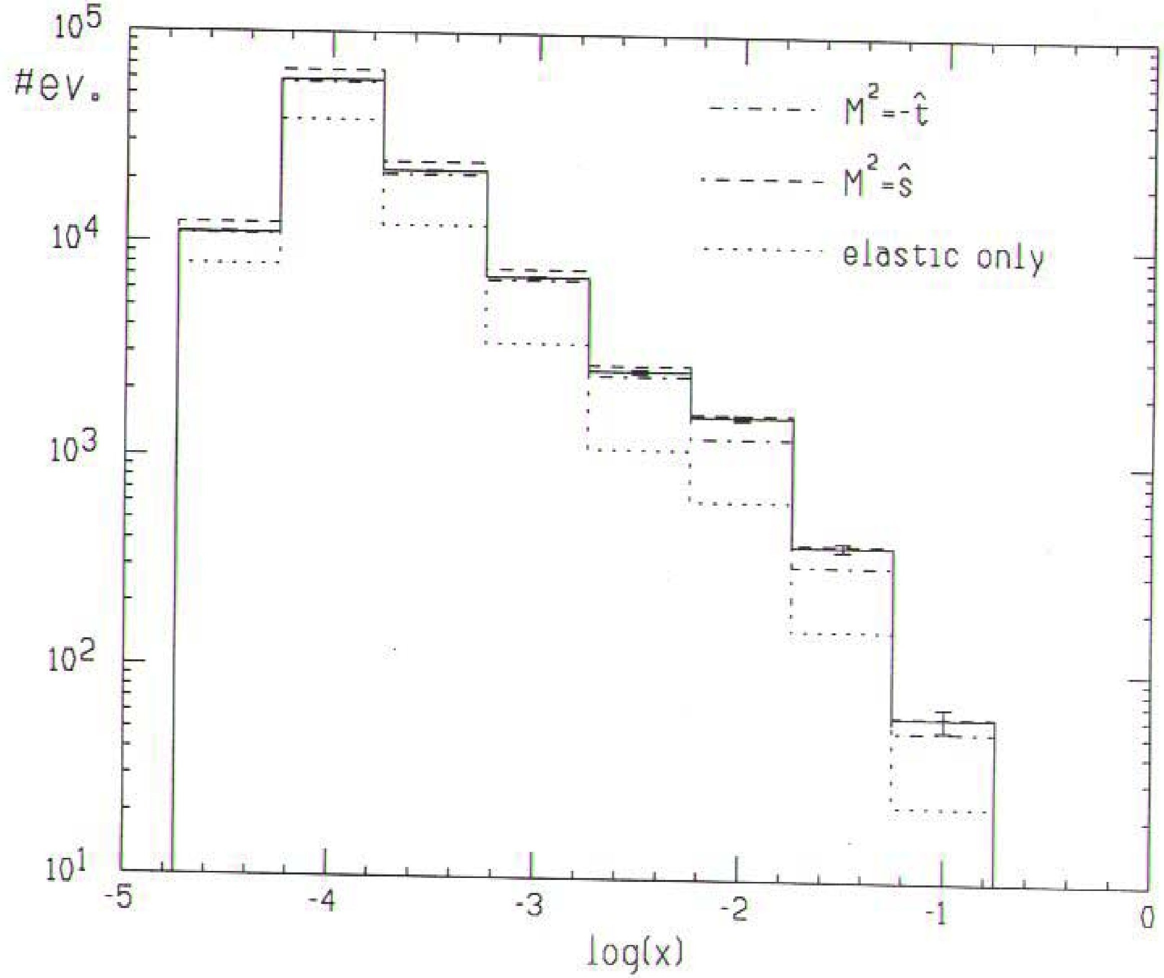
„QED evolution equation":

$$\frac{d\, \gamma(x, Q^2)}{d \ln Q^2} = \frac{\alpha_{em}}{2\pi} \int_x^1 \frac{dy}{y} \sum_q \underline{P_{Aq}} \left(\frac{x}{y}\right) \left[q(y, Q^2) + \bar{q}(y, Q^2) \right]$$



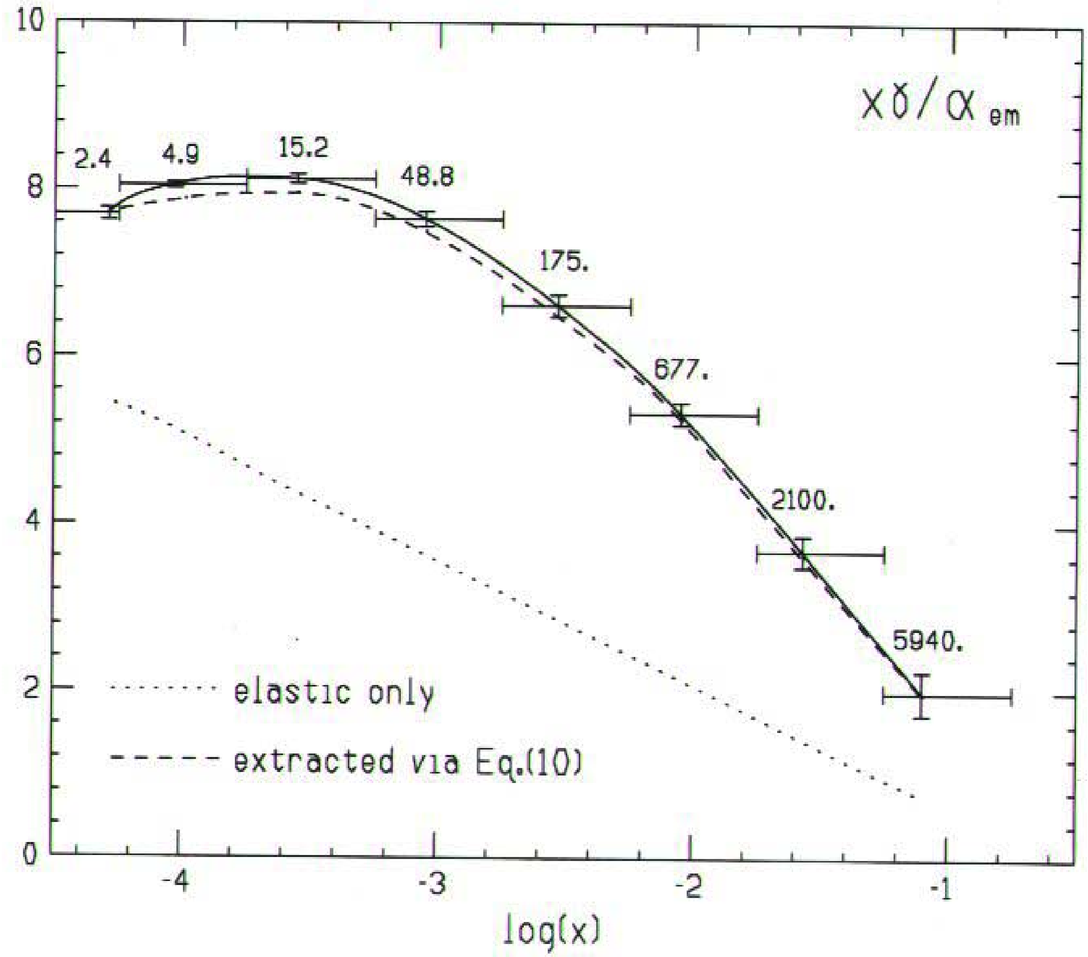
→ expect different Q^2 dependence

erwartete Ereignisraten bei HERA / 36,5 pb^{-1}



de Rujula, Vogelsang

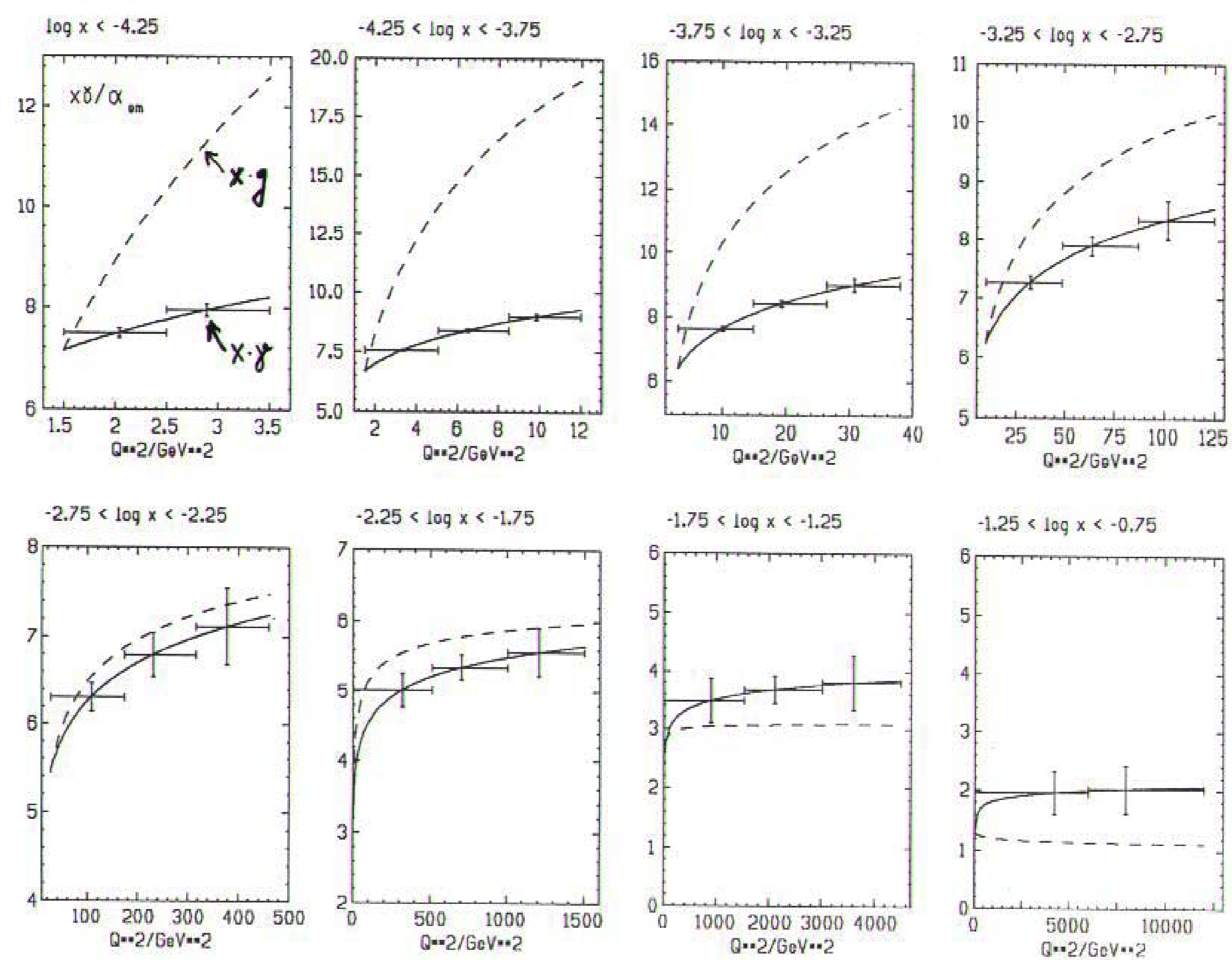
erwartete Messung von $\gamma(x, Q^2)$



de Rujula, Vogelsang

$$\gamma = \frac{\#\text{ev, Daten}}{\#\text{ev, MC}[\gamma_{toy}]}\,\gamma_{toy}$$

theoretische Erwartung $\gamma(x, Q^2) \longleftrightarrow g(x, Q^2)$



Conclusion, prospect:

- QED Compton events are useful for calibration + proton structure
- photon content of the proton: theoretical interesting test of QCD/QED, gluon ↔ photon
- electron / photon differentiation necessary for $\gamma(x, Q^2)$ ↔ high γ shower rate
- exploit all track / hit information in backward region
- trigger efficiencies for level 1 and 2
- Monte Carlo development: implementation of hadronic final state in COMPTON2.0