Measurement of the proton structure function F_2 at low Q^2 in QED Compton scattering at HERA.

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H1 Collaboration

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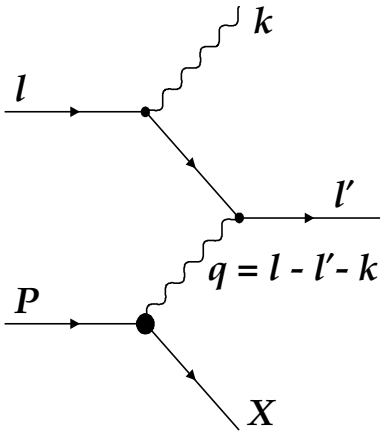
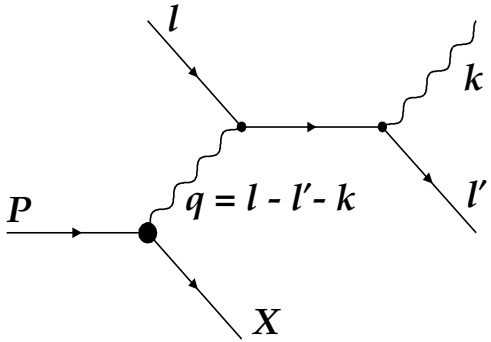
- Introduction
- Data analysis
- Results of F_2 measurement
- Summary

QED Compton

$q^2 \sim 0 <=> \vec{q} || \vec{P}$

Compton scattering of a quasi real photon off an electron





$Q^2 = -q^2 = -(l - l' - k)^2, \qquad x = \frac{Q^2}{2P \cdot (l - l' - k)}$

Inelastic QEDC – p breaks, cross section expressed by F_2 and F_L, since y small $\Rightarrow$ F_L negligible.

H1 Backward Detectors

SpaCal Calorimeter

- $153^o < \Theta < 177^o$
- lead - scintillating fibers
- 1192 square cells
- calibration accuracy:

$\sim 0.3\%$ at 27.6 GeV (DA meth.)

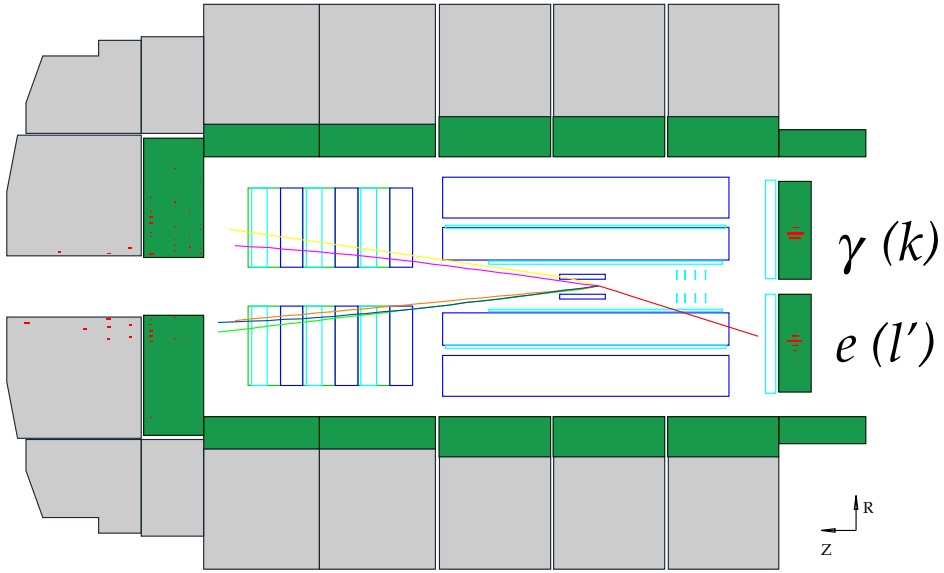
$\sim 2\%$ at 7 GeV (SpaCal-BST match.)

Backward Silicon Tracker

- $171.5^o < \Theta < 176.5^o$
- Θ resolution 0.3 mrad

Backward Drift Chamber

- $153.^o < \Theta < 176.5^o$
- Θ resolution $\sim$ 1. mrad



Background

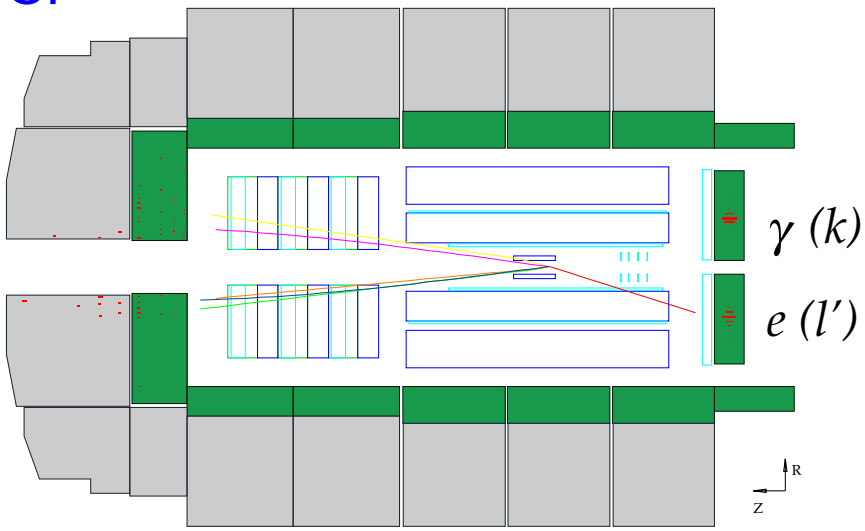
Main sources of background:

- inclusive DIS events with π^o faking outgoing photon. This background at high y (where the hadronic final state lies mostly in the backward region) dominates $\Rightarrow$ analysis restricted to low y region.
- elastic QEDC events – when noise in LAr calorimeter misidentified as hadronic activity $\longrightarrow$ 0 - 2%
- Deeply Virtual Compton Scattering (DVCS)
  - elastic $\longrightarrow$ negligible,
  - inelastic $\longrightarrow$ 5.5%
- elastic and inelastic dielectron production $\longrightarrow$ 0.5 - 2%
- inclusive photoproduction < 0.5%
- diffractive photo- and electroproduction of vector mesons $\longrightarrow$ 3%

Event selection

Requirements for event selection:

- Experimental signatures of QEDC:
  - two elm. clusters in SpaCal
  - clusters back-to-back in azimuthal plane
  - at least one track
  - vtx in central region



- Selection of inelastic QEDC:
  - some (above noise level) activity in LAr cal.
- Background suppressions:
  - limitation to low y region to suppress DIS background
  - shower shape estimators cuts to avoid hadrons faking electrons or photons
  - cut on residual energy in elm. SpaCal to suppress DIS, γp etc.

QEDC – event kinematics

Low y region used in the analysis,
resolution of electron and photon 4-momenta deteriorates as $1/y$
$\Rightarrow \Sigma$ method used to determine kinematic variables,

$$\Sigma = \sum_{i=1}^{N_h} (E_i - p_{z,i})$$

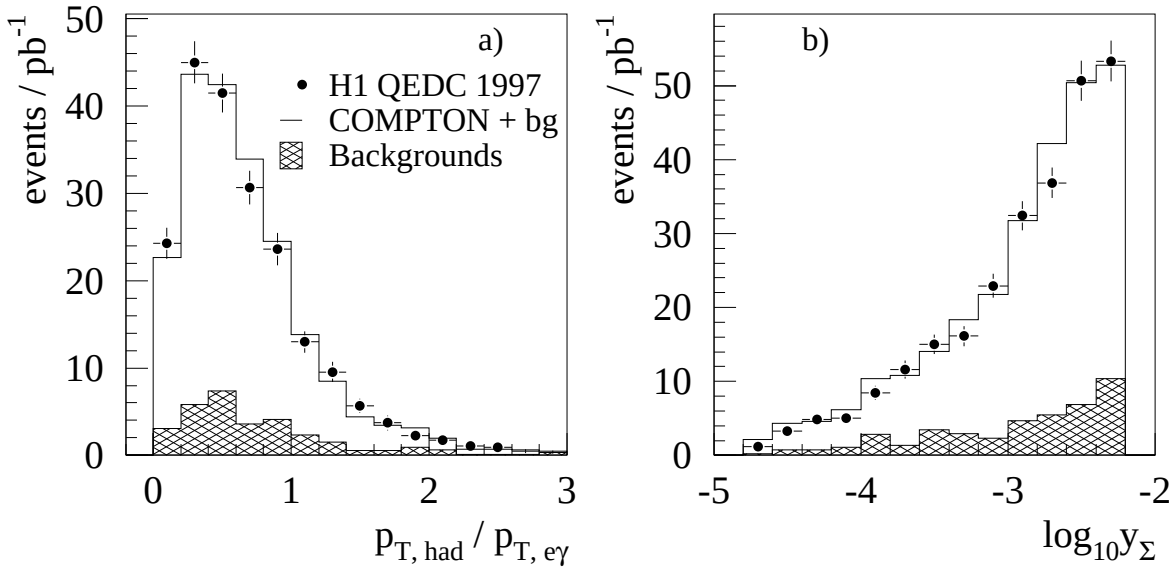
$$y_\Sigma = \frac{\Sigma}{\Sigma + E_{e'}(1 - \cos\Theta_e)} \qquad Q^2_\Sigma = \frac{E^2_{e'} \sin^2\Theta_e}{1 - y_\Sigma} \qquad x_\Sigma = \frac{Q^2_\Sigma}{2\Sigma E_p}$$

Hadronic final state in original COMPTON MC not sufficiently good described $\Rightarrow$ new version of COMPTON MC developed with SOPHIA package used to describe low Q^2 and low W region and QPM with Lund string fragmentation in the high Q^2 and high W region.

QEDC – MC simulation

SOPHIA MC for low Q^2 or low W:

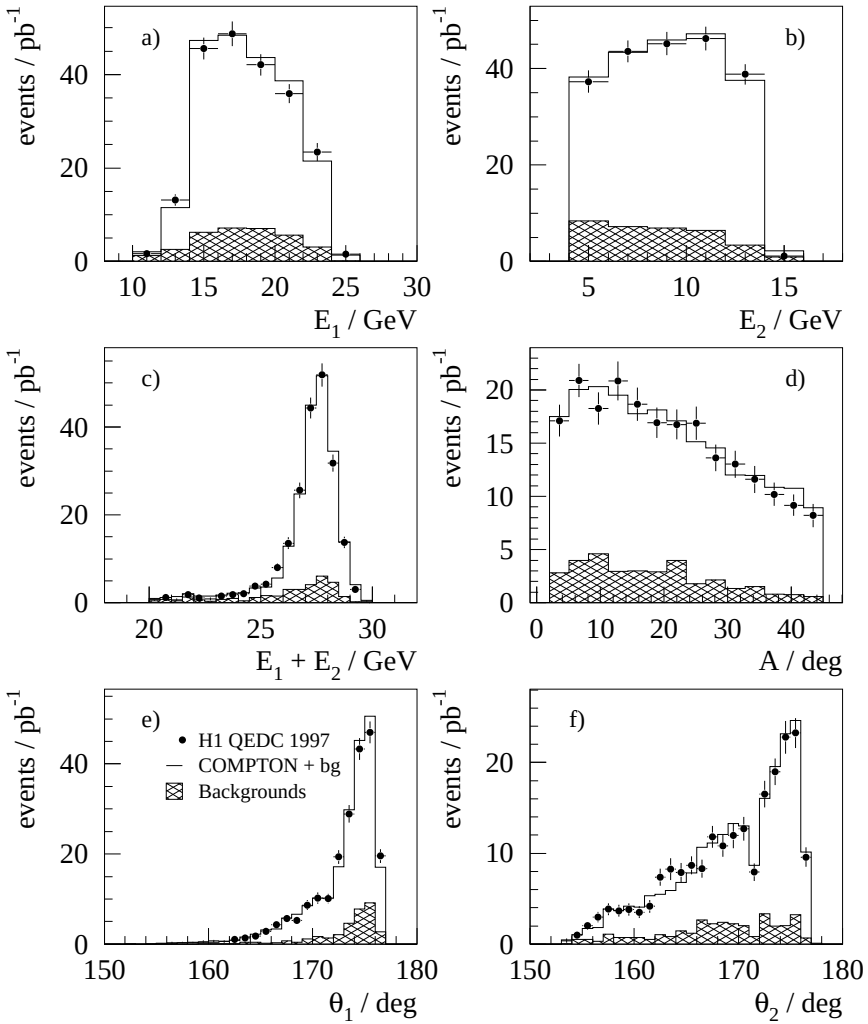
- precise description of γ hadron interactions reproducing large set of available data.
- includes: major baryon resonances, direct π production, diffractive production of light vector mesons, multiparticle production based on Dual Parton Model with Lund string fragmentation.



Good description of hadronic final states in forward direction by the COMPTON MC which implements SOPHIA package.

$e\gamma$ Control Plots

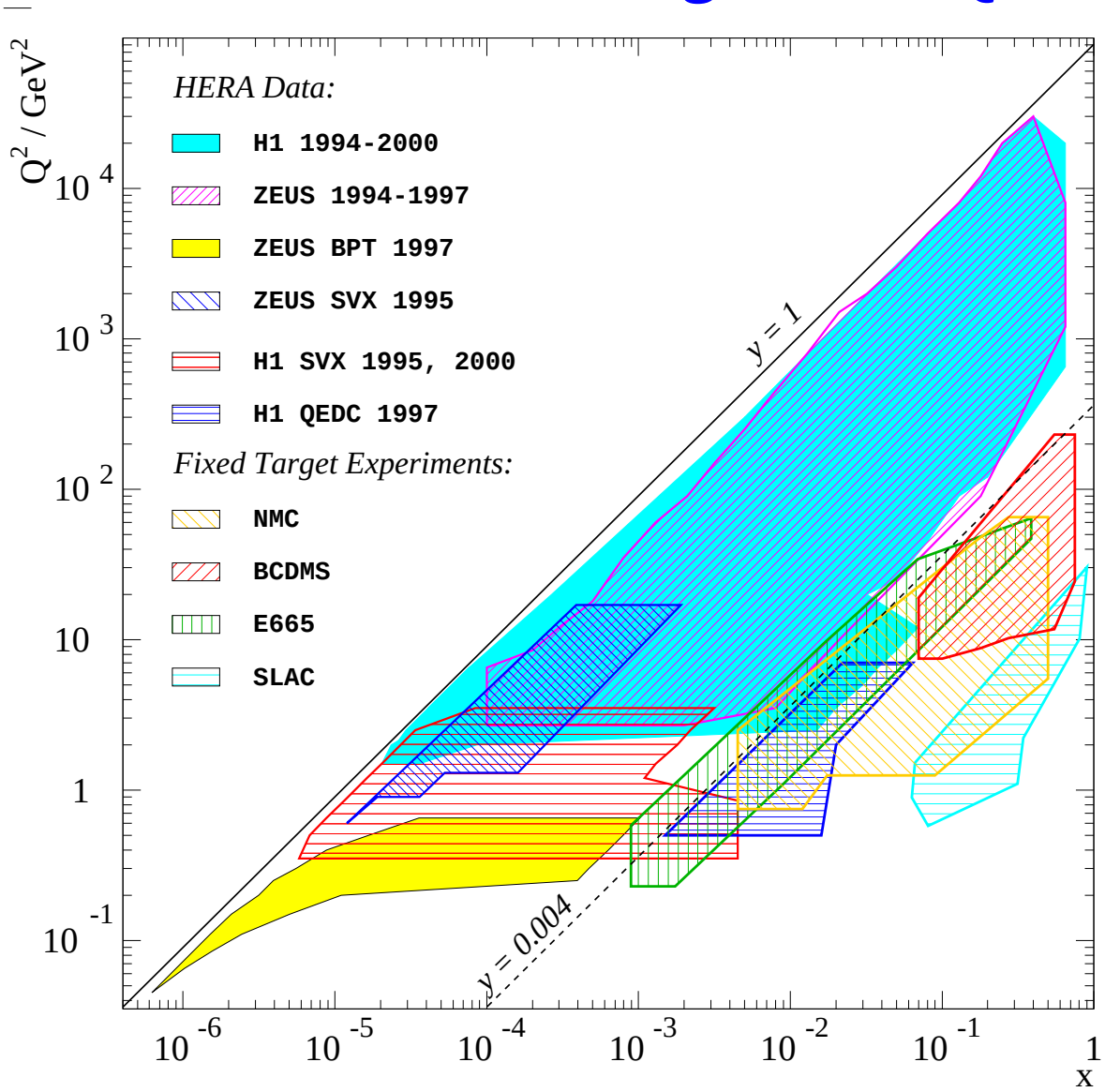
Control distributions for the measured e and γ in events used in the analysis.



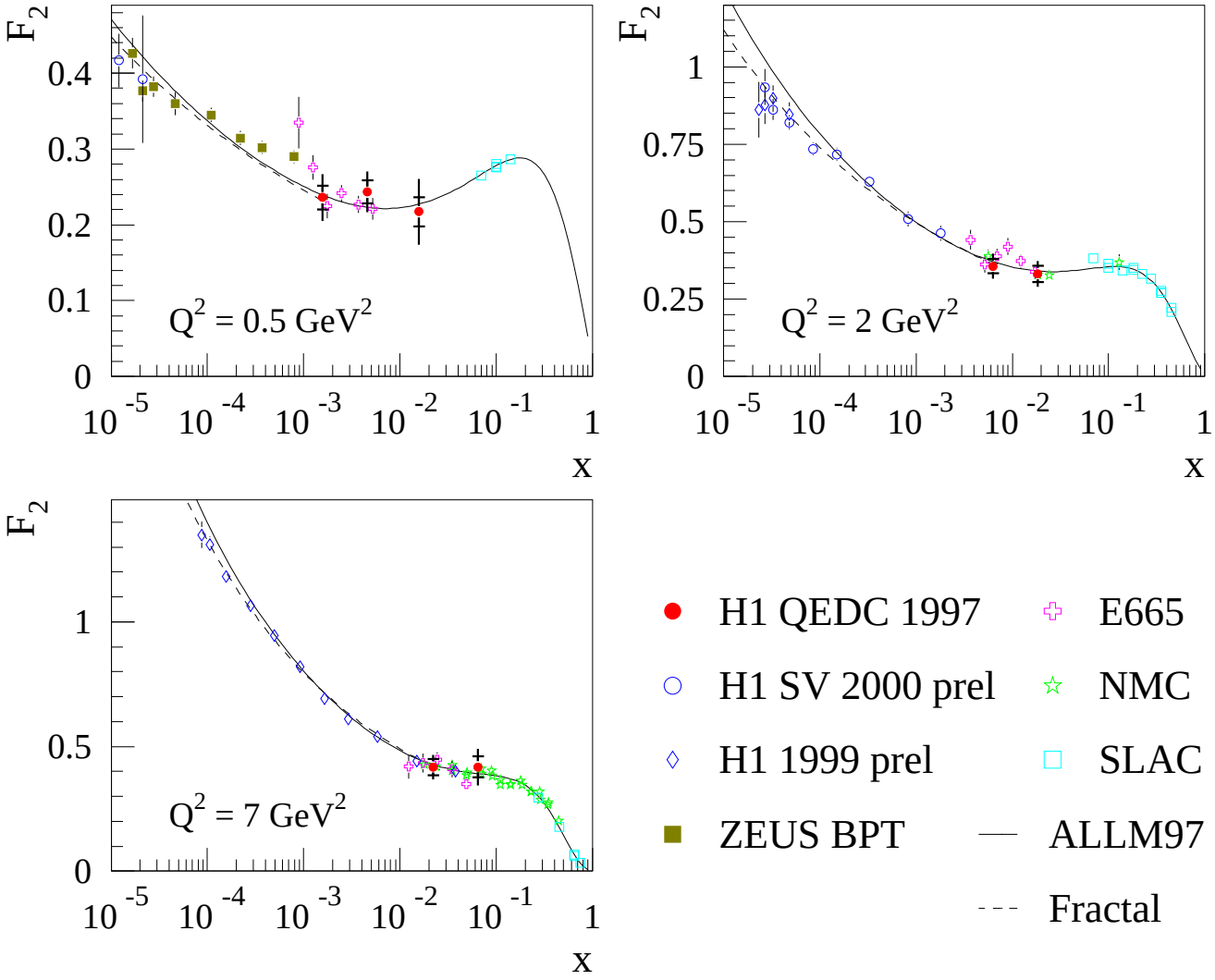
Good description of the electron-photon final state with the MC.

Kinematic region of QEDC

- F_2 with QEDC can be measured in the medium-high x region
- low Q^2 region can be accessed
- overlap with the fixed target measurement area

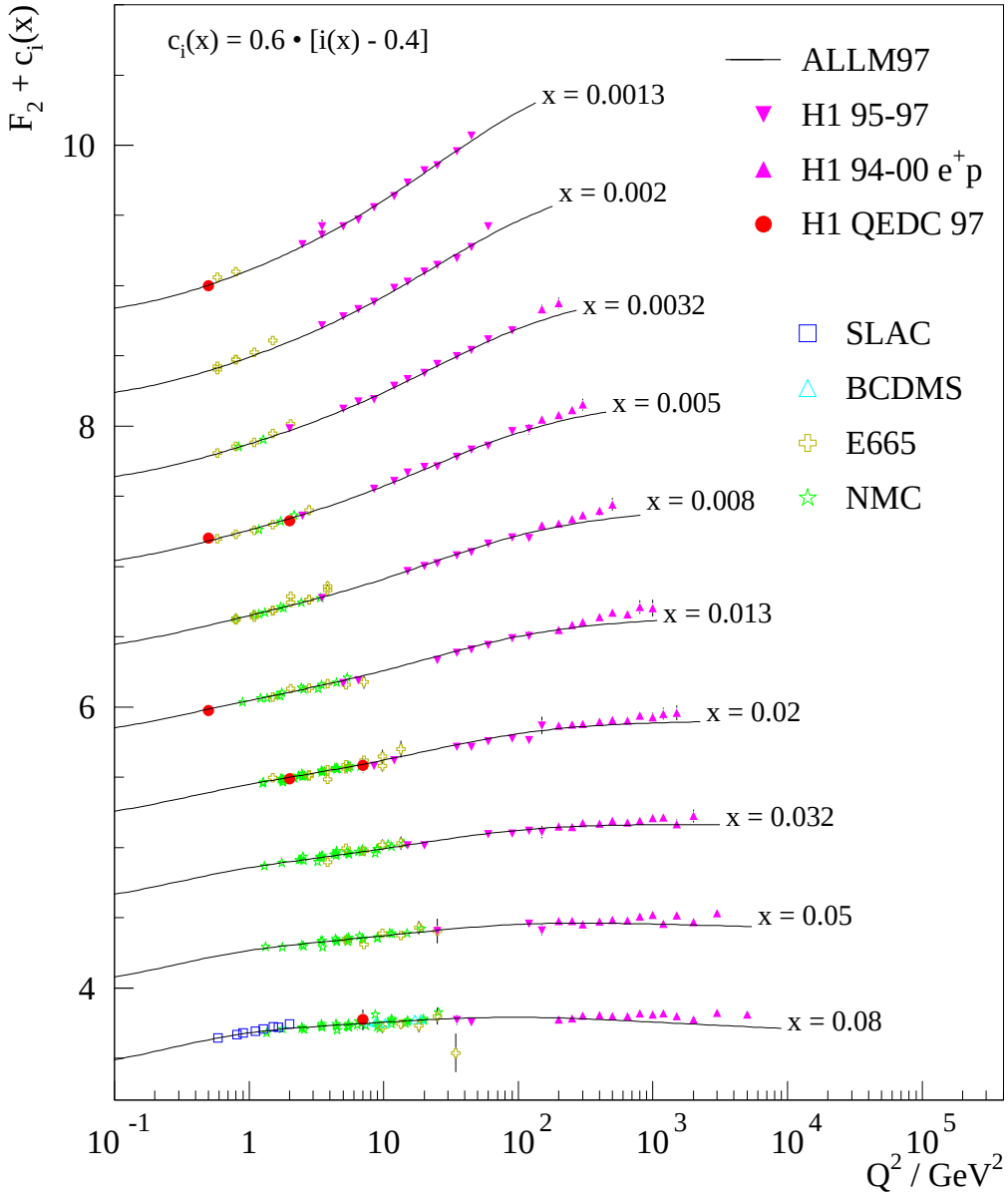


F_2 measurement with QEDC



Good agreement with fixed target data.

F_2 measurement with QEDC



Summary

- F_2 measured for the first time with a new method based on the analysis of QED Compton events
- F_2 with QEDC measured at Q^2 0.5 – 7 GeV^2 and x between 0.001 and 0.06.
- The kinematic domain of HERA is extended into the medium-high x region complementing standard inclusive F_2 measurements.
- Good agreement with the fixed target data.