New H1 Results at High Q^2

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On behalf of the

H1 Collaboration

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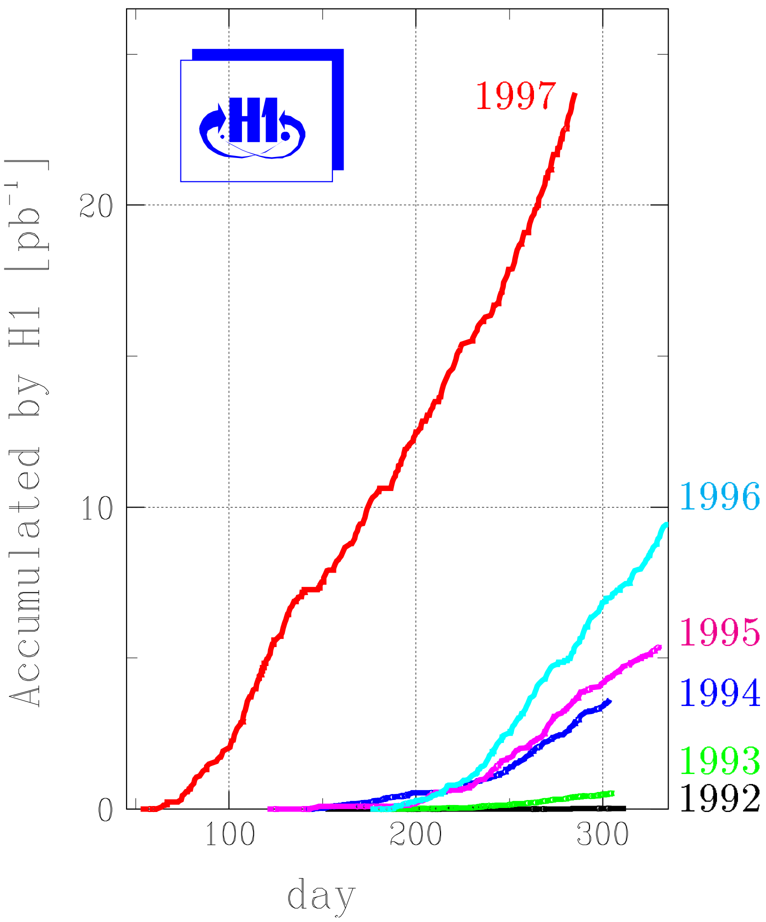
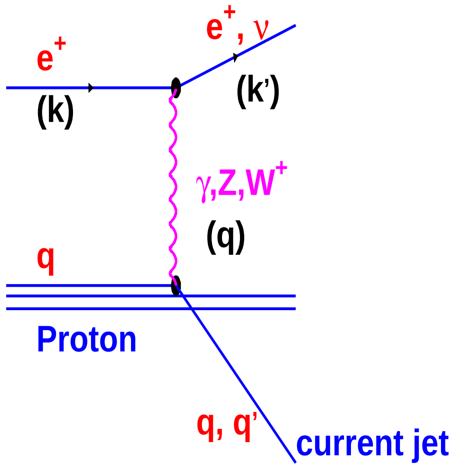


- Calibration of the Liquid Argon Calorimeter
- Events at Very High Q^2
- Results on Searches for
  - Leptoquarks
  - Excited Leptons
- Neutral Current-Cross Section Measurements at High Q^2 and High x

High Q^2 Physics at HERA

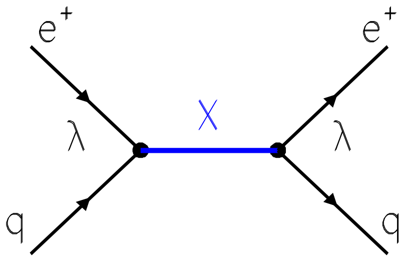
- Probe the proton at very small distances ($\geq 10^{-18}$m)
  via t-channel exchange of virtual gauge bosons



$$Q^2 = -(k-k')^2 = sxy$$
$$x = \frac{Q^2}{2(P.q)}$$
$$y = \frac{(P.q)}{(P.k)}$$
$$M = \sqrt{sx}$$

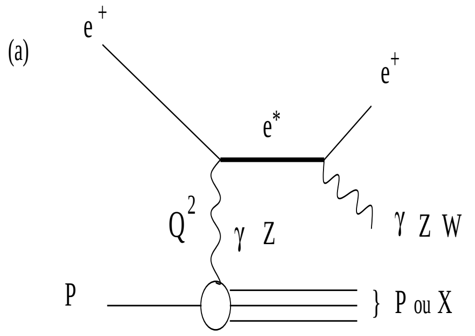
$\Rightarrow$ proton Structure Functions and pQCD tests
$\Rightarrow$ EW propagators

- Search for s-channel production of new particles
  with Yukawa couplings (λ) to e-q system



$M_X \leq 300$GeV
e.g. leptoquarks
leptogluons

- Search for excited fermions:



e.g. $e^* \to$ e γ
$\nu^* \to$ e W $\to q\bar{q}$

The Standard DIS Model

Neutral and Charged Current (NC,CC) cross-sections are determined using perturbative QCD and Electroweak theory

- Description of the proton in terms of scale dependent structure functions (SF).
- Parton density parametrizations extracted from global fits to SF measurements from HERA and fixed target also including inclusive lepton and direct photon measurements.
- Parton densities are evolved to high Q^2 using Next-to-Leading Order DGLAP equations.
- Couplings as given in the Standard Strong-Electroweak Model $SU(3)_c \otimes SU(2)_L \otimes U(1)_Y$
- At high x and high Q^2 the NC cross-section is dominated by the u valence quark density, the CC by the d quark.

The Standard DIS Model

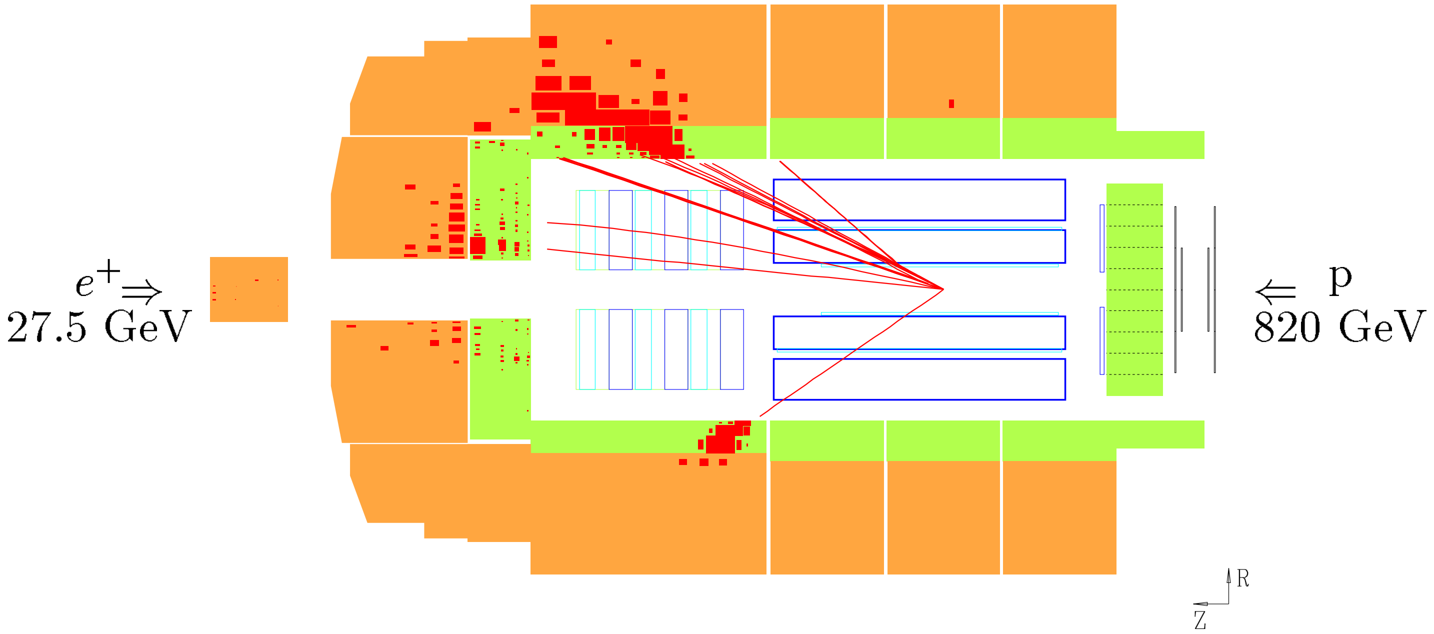
The uncertainty on the expectation comes from

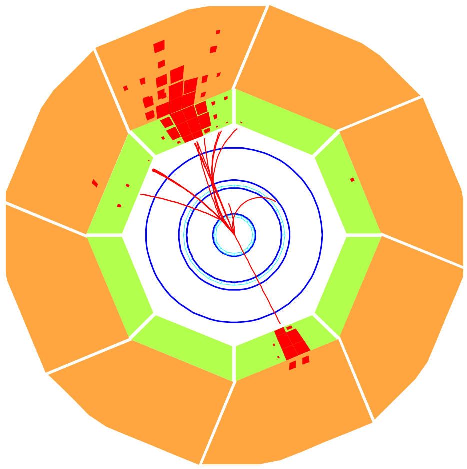
- The parton distributions which are determined $\pm 5\%$
  a) Input data (e.g. BCDMS at high x and low Q^2)
  b) Assumed shape of the distributions at the evolution starting point.
- The uncertainty on α_S which translates into a $\pm 4\%$ uncertainty at high Q^2.
- Higher Order QED corrections $\rightarrow \pm 2\%$.

NC DIS cross-section predictions at high x, Q^2 is accurate to $\simeq 7\%$

NC DIS Event

$\boldsymbol{Q^2 = 16950\ \mathrm{GeV}^2,\quad y = 0.44,\quad M = 196\ \mathrm{GeV}}$





Liquid Argon Calorimeter:

44000 Cells

$$\sigma(E)/E(em) \simeq 12\%/\sqrt{E/\mathrm{GeV}} \oplus 1\%$$

$$\sigma(E)/E(had) \simeq 50\%/\sqrt{E/\mathrm{GeV}} \oplus 2\%$$

$$\Delta E/E_{em} = 1 - 3\%$$

$$\Delta E/E_{had} = 4\%$$

$$\Delta\theta_e = 2 - 5\ \mathrm{mrad}$$

measured quantities:

e^+: energy E
polar angle θ

hadrons: $\Sigma = \sum_{hadrons}(E_h - p_{z,h})$
$\tan\gamma/2 = \Sigma/p_{t,h}$

Kinematic Reconstruction

- Electron Method: $y_e = 1 - \frac{E'_e}{E_e}\sin^2\frac{\theta_e}{2}$ $\qquad Q^2_e = 4E'_e E_e \cos^2\frac{\theta_e}{2}$
  - most precise at high y / low x
  - degrades severely at low y
- Hadron Method: $y_h = \frac{\Sigma}{2E_e}$ $\qquad Q^2_h = \frac{p^2_{t,h}}{1-y_h}$
  - low precision, but only method for charged current
- Σ Method: $y_\Sigma = \frac{\Sigma}{\underbrace{\Sigma + E'_e(1-\cos\theta_e)}_{2\cdot \mathrm{E_{Incident\ Electron}}}}$ $\qquad Q^2_\Sigma = \frac{E'^2_e \sin^2\theta_e}{1-y_\Sigma}$
  - precise over the whole kinematic range
  - independent of QED initial state radiation
- Double Angle Method:

$$y_{DA} = \frac{\tan\gamma/2}{\tan\gamma/2+\tan\theta/2} \qquad Q^2_{DA} = 4E^2_e\frac{\tan\theta}{2}\frac{\cot\theta/2}{\tan\gamma/2+\tan\theta/2}$$

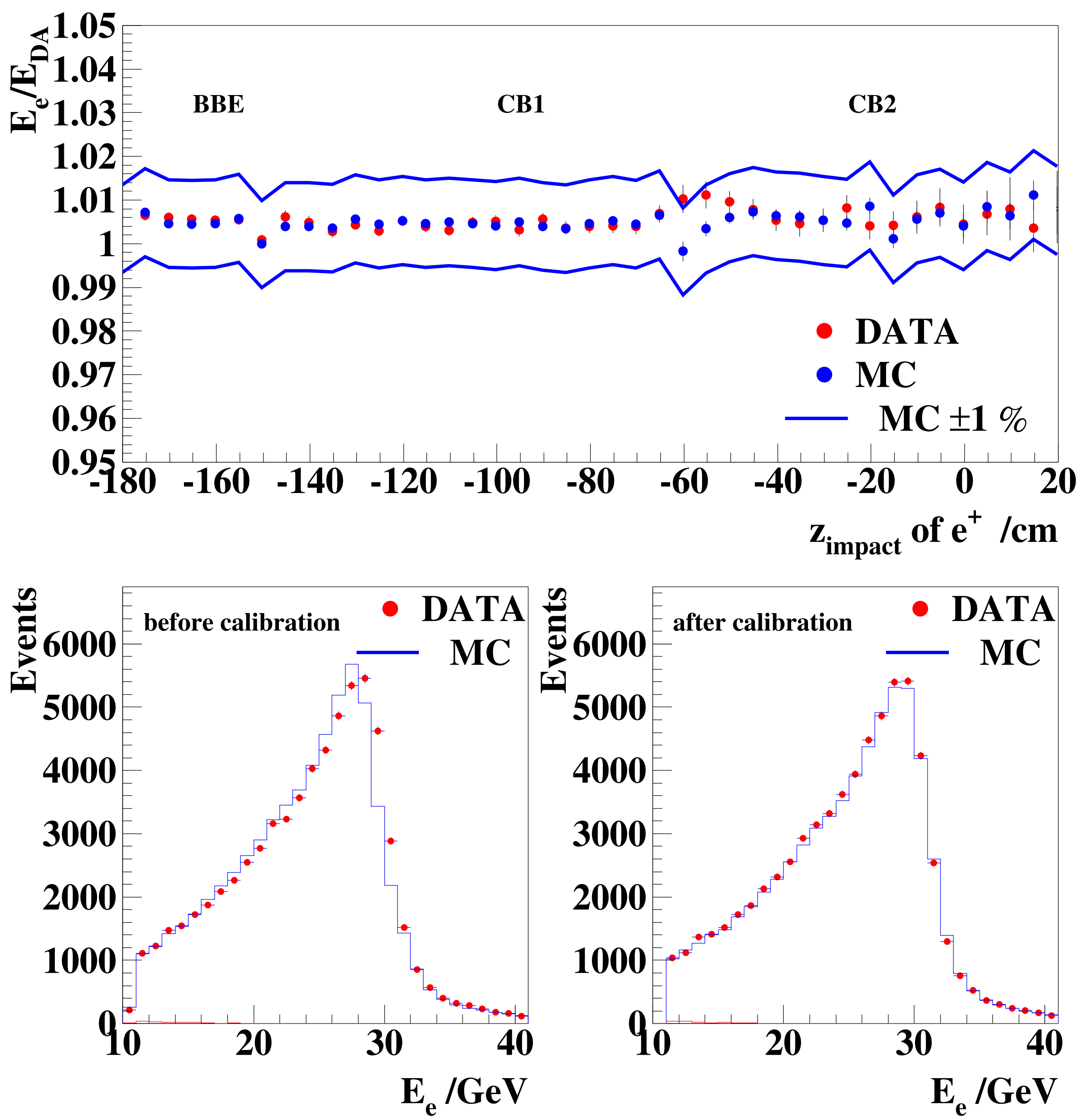
  - high precision at high Q^2, but sensitive to QED radiation
  - independent of energy scale $\Rightarrow$ used for calibration
- ω Method: calibrates Σ after solving the energy momentum conservation equations (asuming $\frac{\delta\Sigma}{\Sigma} = \frac{\delta p_T}{p_T}$)

$$(1-y_e)\frac{\delta E}{E} + y_h\frac{\delta\Sigma}{\Sigma} = y_e - y_h$$
$$-p_{T,e}\frac{\delta E}{E} + p_{T,h}\frac{\delta\Sigma}{\Sigma} = p_{T,e} - p_{T,h}$$

  - identification/correction of radiative events
  - determination of kinematics/calibration on an event by event basis

Electron Energy Calibration

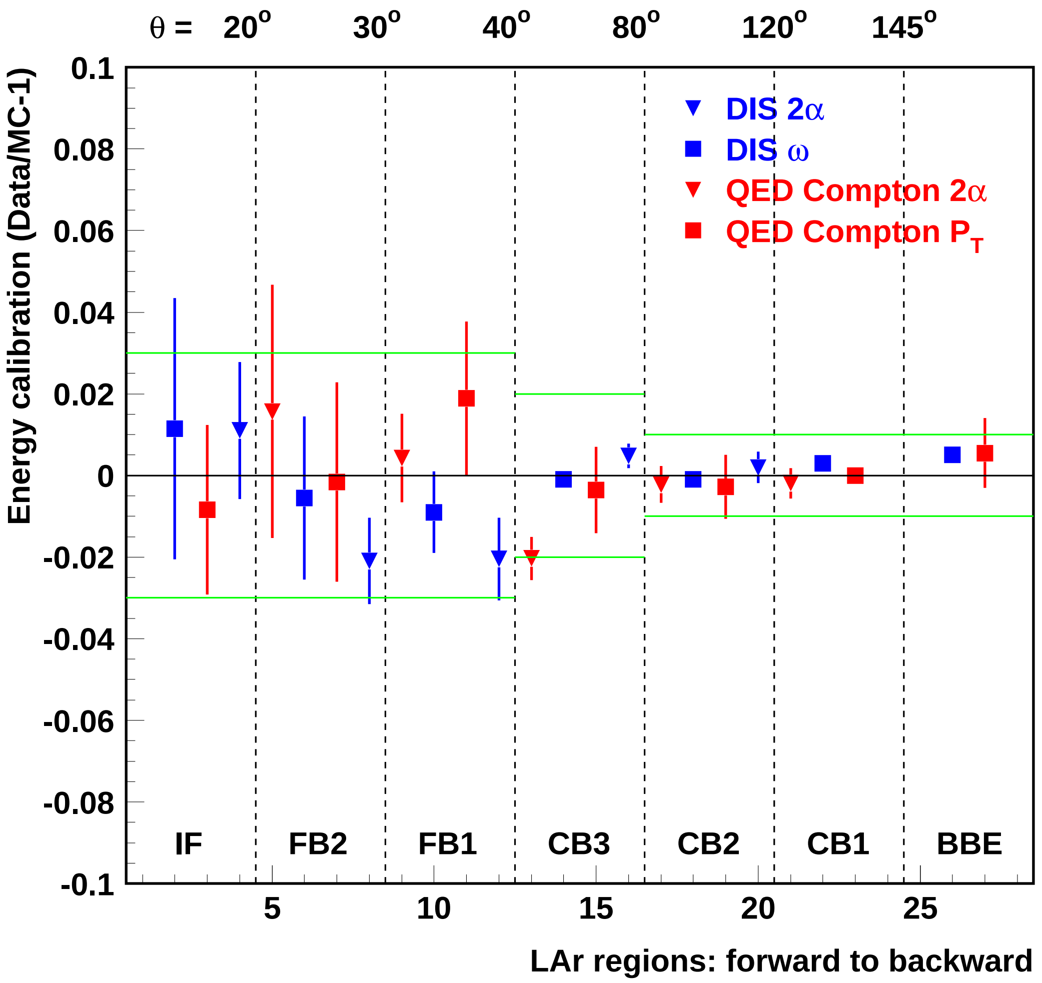
- Detailed calibration performed:
  - at low y using the Double Angle method
  - year by year
  - cm-wise in z and octant by octant in ϕ



- After calibration, fiducial cuts for z-cracks (e.g. -55,-65 cm) to maintain the precision below 1 %

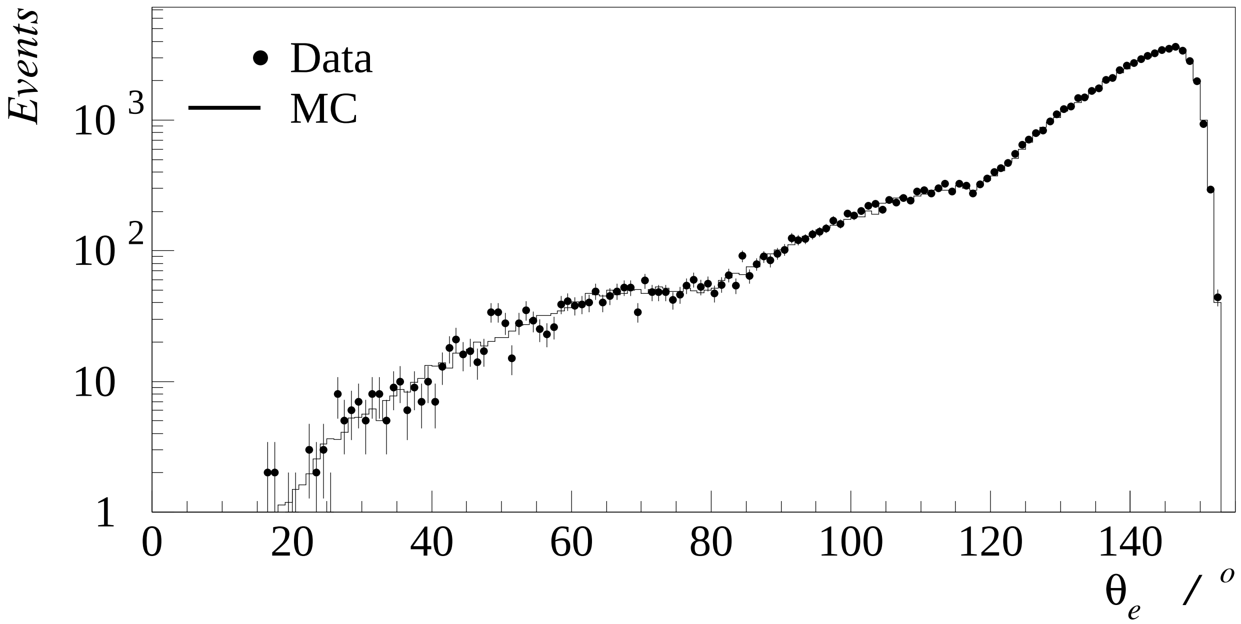
Electron Energy Calibration

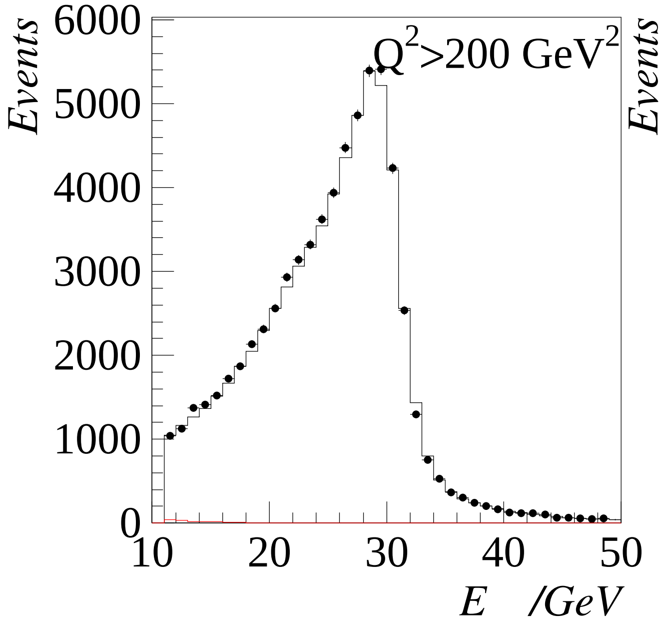
- **In situ** calibration now achieved for the LAr_{em} wheels using :
  Double-angle method and ω-method for NC DIS
  Double-angle method and P_T balance for QED Comptons

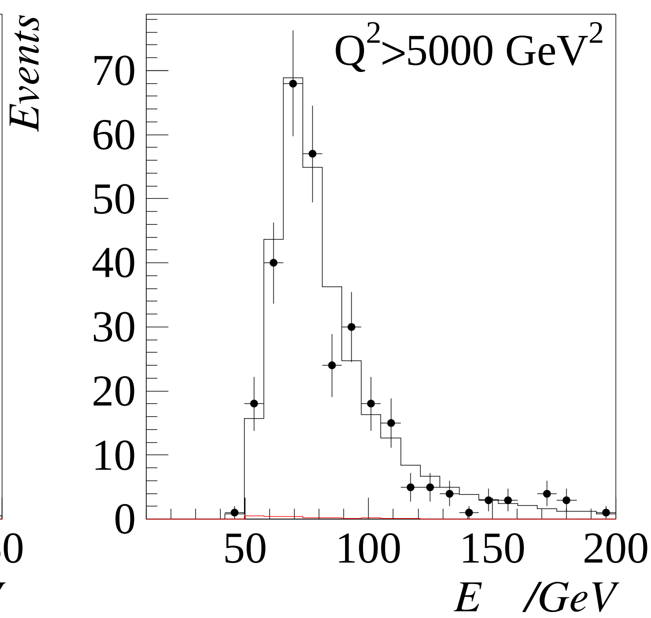


- e-calib. well within originally quoted $\pm 3\%$ syst. for central LAr wheels
  $\Rightarrow$ 1% precision for θ between 80° to 150°
- In the forward LAr wheels:
  consistency from various methods using NC DIS and QED
  $\Rightarrow$ calibration scale improved.
  Uncertainty at the 3% precision level only limited by statistics

Electron Polar Angle and Energy

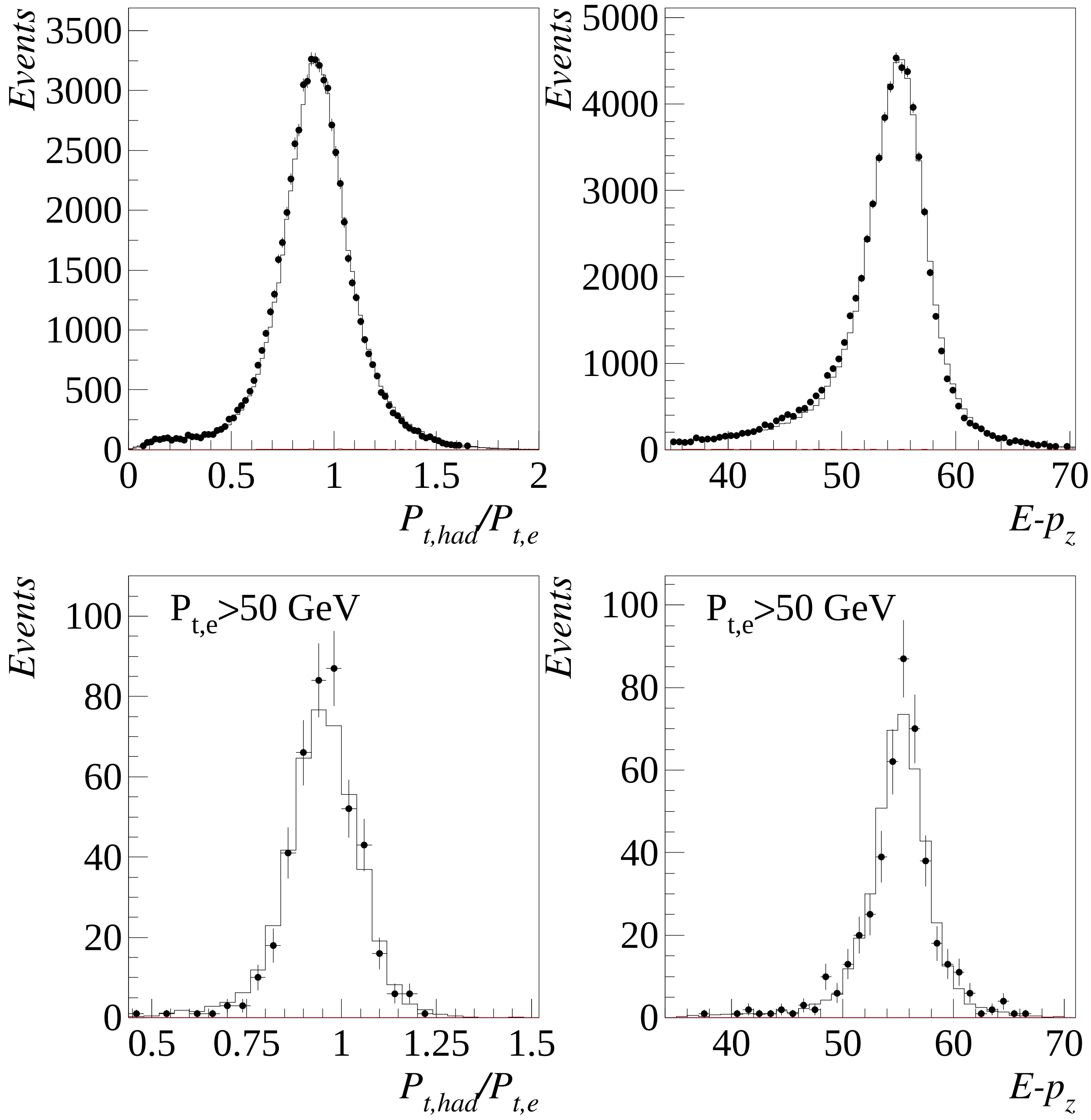






- Polar angle well described over the full Q^2 range ($\delta\theta \simeq 3$mrad)
- Energy spectrum under control for search ($Q^2 > 2500$ GeV^2) and cross-section ($Q^2 > 200$ GeV^2) analyses

Hadronic Energies



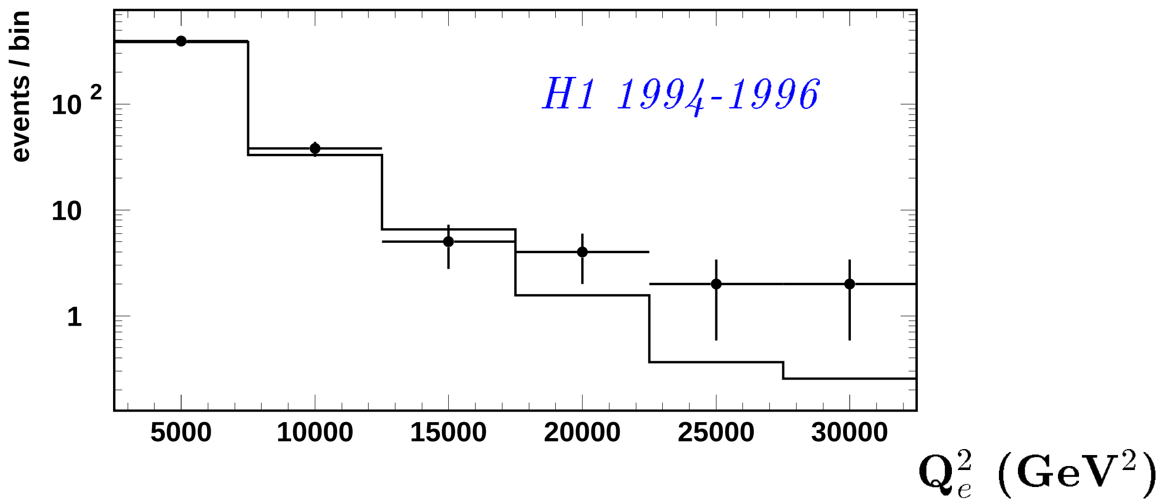
- hadronic scale is being precisely calibrated using the electron as reference
- width and scale of the hadronic distributions well described within the quoted error($\pm$ 4%)

Excess of High Q^2 Events at HERA

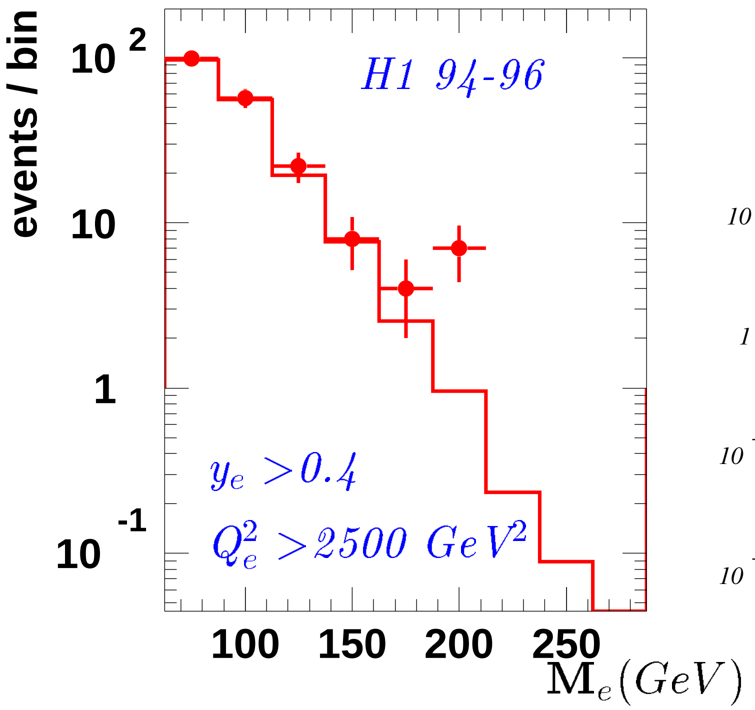
first publications:

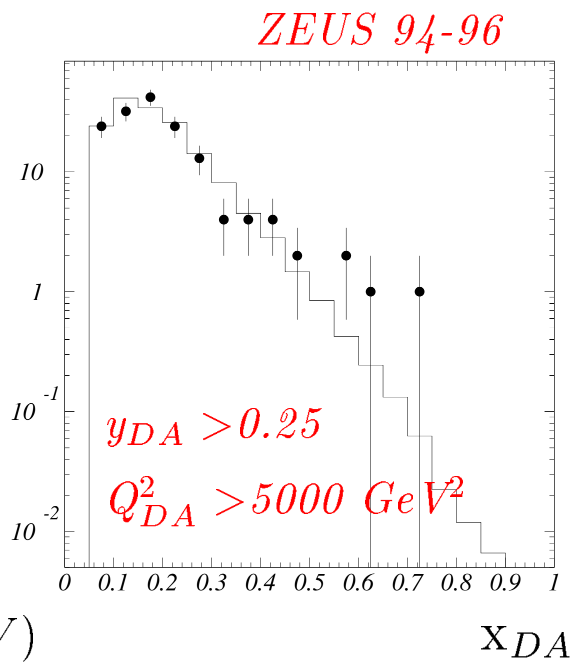
H1: 14.2 pb^{-1} Z.Phys **C74** (1997) 191

ZEUS: 20.1 pb^{-1} Z.Phys **C74** (1997) 207



$Q_e^2 > 15000$ GeV^2: N_{obs}=12 $\Leftrightarrow$ N_{exp}=4.71, $\mathcal{P} = 6 \times 10^{-3}$





M_e=200±12.5 GeV $y_e > 0.4$:

N_{obs}=7 $\Leftrightarrow$ N_{exp}=0.95

$x_{DA} > 0.55$ $y_{DA} > 0.25$:

N_{obs}=4 $\Leftrightarrow$ N_{exp}=0.91

Event Selection for High $\boldsymbol{Q^2}$ Searches

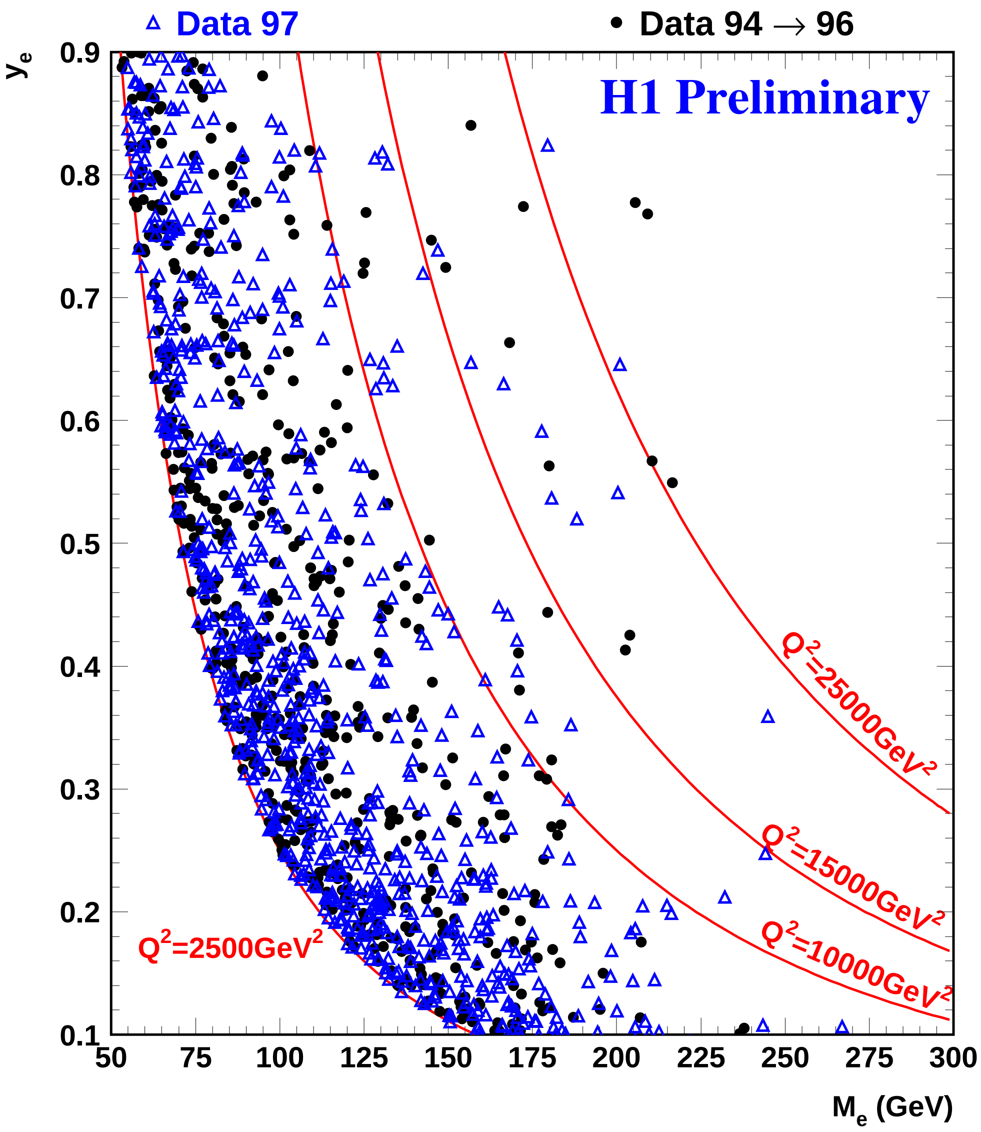
NC-like Events

H1 Z.Phys.C74(1997)191	H1 New Selection
Interaction Vertex	
$\mid Z_{vertex} \mid < 35$ cm	$\mid Z_{vertex} \mid < 40$ cm
Electron Identification	
Shower shape analysis	
Isolation in $\eta - \phi$ cone $(R < 0.25)$	
Cluster-track matching for $\Theta_e > 10°$	
Energy-momenta Conservation	
$43 < \sum E - P_z < 63\text{GeV}$ $(P_{T,miss}/\sqrt{E_T} < 3\sqrt{GeV})$	$40 < \sum E - P_z < 70\text{GeV}$ $(P_{T,miss}/\sqrt{E_T} < 4\sqrt{GeV})$
Kinematics	
$E_{T,e} > 25\text{GeV}$	$E_{T,e} > 15\text{GeV}$
$0.1 < y_e < 0.9$	
$Q_e^2 > 2500\text{GeV}^2$	
1994-96 data: $\Rightarrow$ 443 events	$\Rightarrow$ 544 events

CC-like Events

$P_{T,miss} > 50\text{GeV}$	
$(E_T - P_{T,h})/E_T < 0.5$	Background finders
$\Rightarrow$ 31 events	

NC Data Sample in the M-y Plane



H1 NC candidates $\mathcal{L} = 37.04 \pm 0.96\ \mathrm{pb}^{-1}$

$Q_e^2 > 5000\mathrm{GeV}^2$ $0.1 < y_e < 0.9$

Obs. $= 322 \Leftrightarrow$ Exp. $= 336 \pm 29.6$

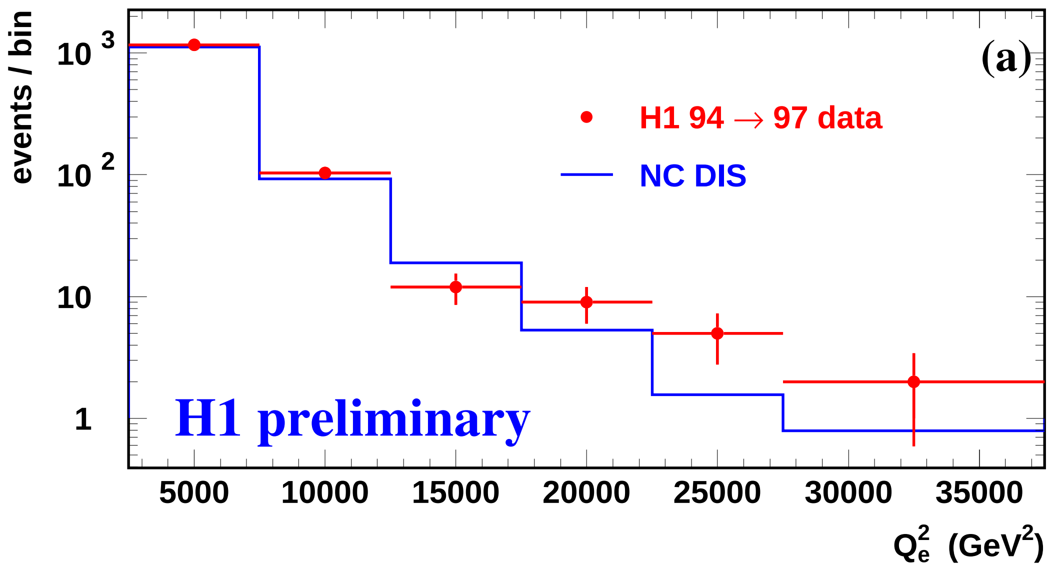
$(N_{exp}/N_{gen} \gtrsim 80\%$ within kine. range)

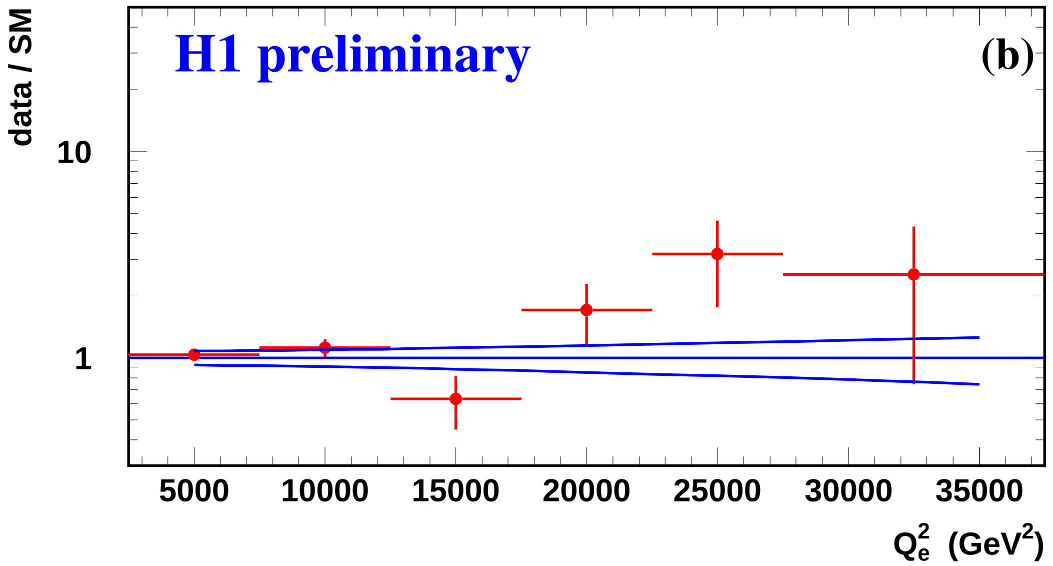
$Q_e^2 > 15000\mathrm{GeV}^2$

Obs. $= 22 \Leftrightarrow$ Exp. $= 14.7 \pm 2.1$

Q^2 Dependence, 1994-97 Data

- New E_e calibration
- Slightly modified selection cuts

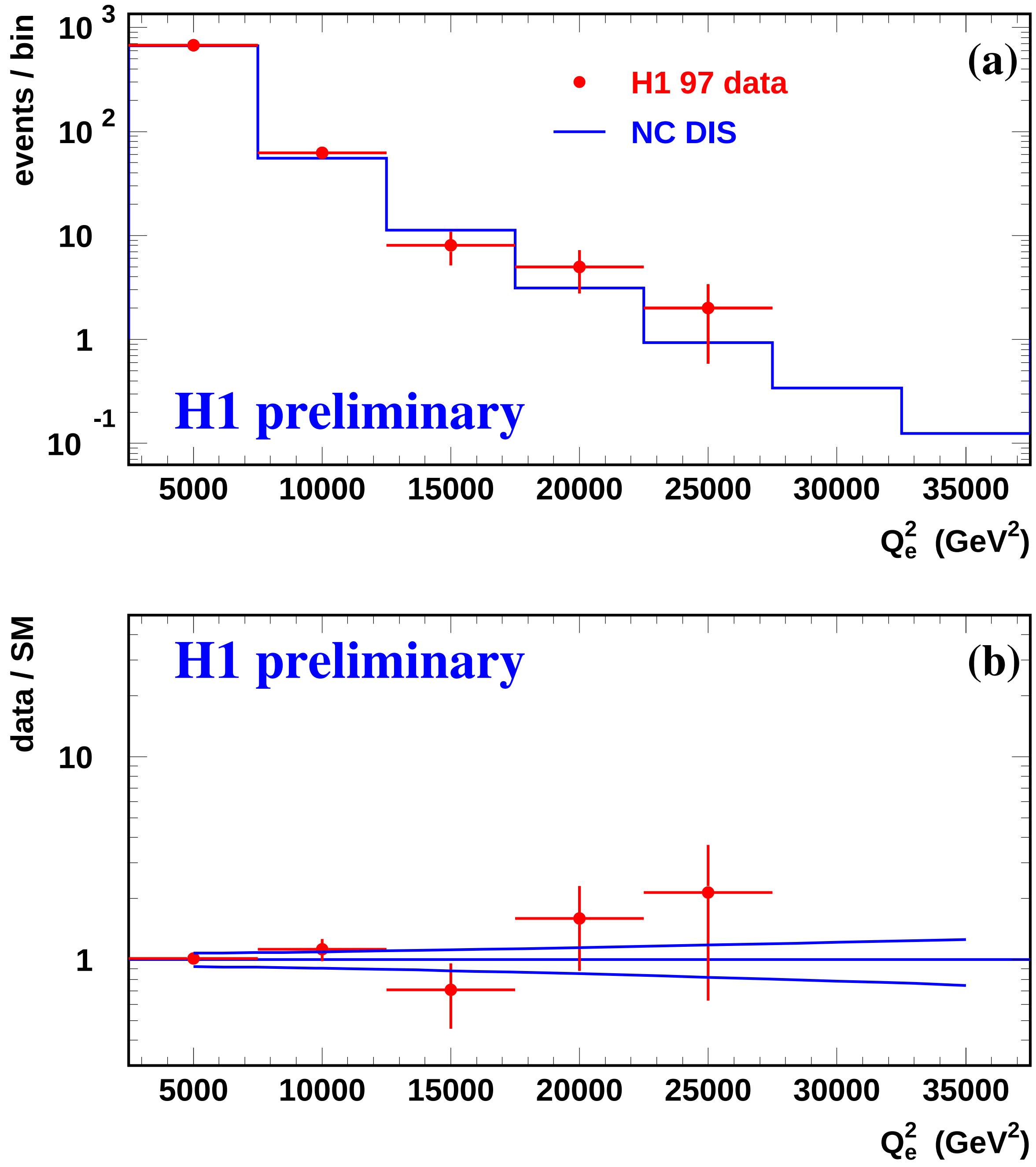




- Slight deviations from SM expectation observed for $Q_e^2 \gtrsim 15000 \mathrm{GeV}^2$
- Excess at highest Q_e^2 less significant than with 1994→96 data only

Q^2 Dependence, 1997 Data Only

- New E_e calibration
- Slightly modified selection cuts



- Good agreement with SM expectation for 1997 data
- Only marginal deviations observed for $Q_e^2 \gtrsim 15000\,\mathrm{GeV}^2$

Q^2 Integrals

1997 Data, H1 Preliminary						
Q^2_{min}/GeV^2	2500	5000	10000	15000	20000	25000
N_{obs}	753	178	31	10	4	2
N_{DIS}	758 ±57.9	199.7 ±17.6	32.7 ±3.8	8.77 ±1.26	2.61 ±0.43	0.94 ±0.17
$\mathcal{P}(N \geq N_{obs.})$	53%	83%	59%	38%	27%	24%
All 1994-97 Data, H1 Preliminary						
Q^2_{min}/GeV^2	2500	5000	10000	15000	20000	25000
N_{obs}	1297	322	51	22	10	6
N_{DIS}	1276 ±98	336 ±29.6	55.0 ±6.42	14.8 ±2.13	4.39 ±0.73	1.58 ±0.29
$\mathcal{P}(N \geq N_{obs.})$	42%	56%	60%	5.9%	1.8%	0.64%

Systematic errors dominate for every Q^2_{min}

- Significance of "anomaly" decrease including 1997 data
- Excess in integrated spectra at $Q^2 \gtrsim 15000\mathrm{GeV}^2$ remains

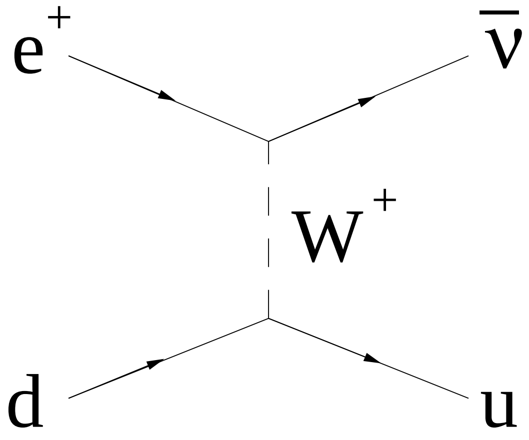
... but only **marginally** supported by 1997 data alone !

- Translation as cross-section corrected to Born level :

σ_{Born} (pb) for $Q_0^2 > Q^2_{min}$ and $y_0 < 0.9$			
Q^2_{min}	SM (MRSH)	H1 (EPS-97)	H1 Preliminary
5000	9.03	$8.86^{+1.02}_{-1.02}$	$8.69^{+0.77}_{-0.77}$
15000	0.38	$0.78^{+0.22}_{-0.20}$	$0.59^{+0.15}_{-0.13}$
25000	0.040	$0.210^{+0.112}_{-0.091}$	$0.168^{+0.083}_{-0.060}$

Improved acceptance (and statistics !) since EPS 97

Charged Current Deep Inelastic Scattering



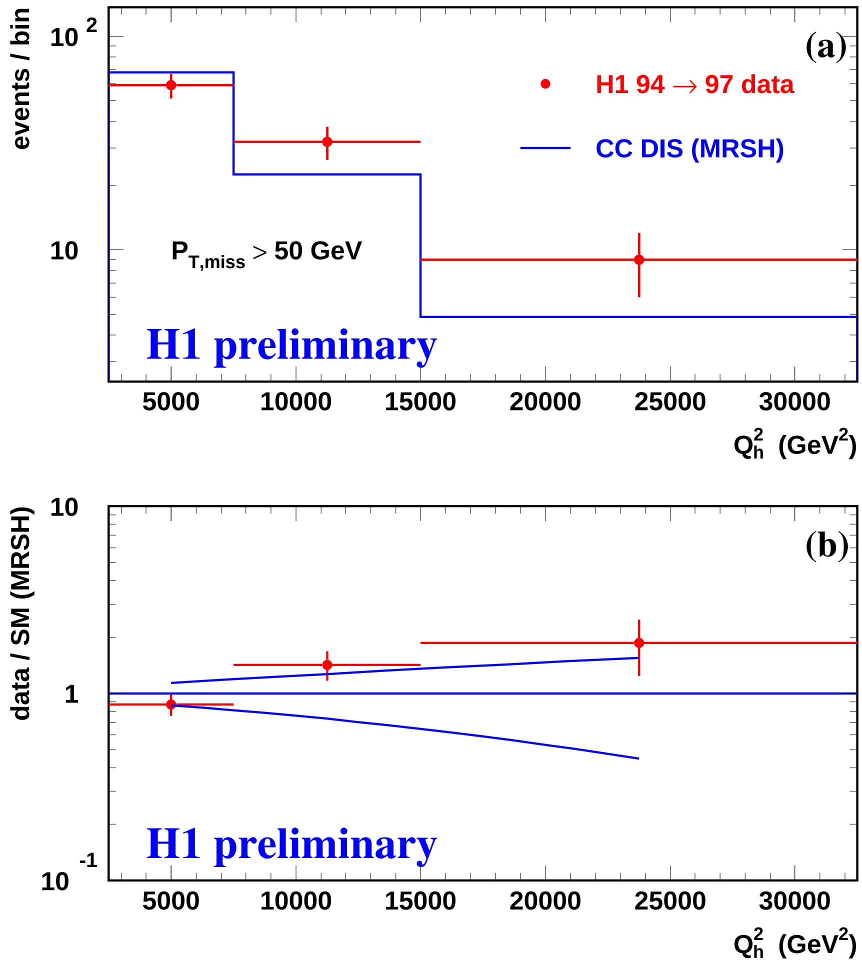
Cross Section for $e^+p \longrightarrow \bar{\nu}X$:

$$\frac{d^2\sigma_{CC}}{dxdQ^2} = \frac{G_F^2}{2\pi}\frac{1}{(1+Q^2/m_W^2)^2}\left(\bar{u}+\bar{c}+(1-y)^2(d+s)\right)$$

- For e^+p scattering the dominating contribution to the cross section comes from the d quark
  $\Rightarrow$ Largest theoretical error arises from uncertainty of the d quark density
- The main experimental uncertainty is the hadronic energy scale of the calorimeter

Update of Charged Current Rates

Q_h^2 Spectrum :



Q_h^2 Integrals:

CC DIS, 1994 - 97 Data, H1 Prelim.				**94-96**
Q^2_{min}/GeV^2	2500	7500	15000	15000
N_{obs}	100	41	9	4
N_{DIS}	95.3 $\pm$16.7	27.6 $\pm$8.4	5.07 $\pm$2.8	1.77 $\pm$0.4

- Systematic errors dominate for every Q^2_{min}
- Excess in integrated spectra for $Q^2 \gtrsim 7500\mathrm{GeV}^2$
  ... but compatible with SM within errors

NC Events at Large Masses

Mass Windows at large y_e:

Most significant deviation from SM expectation observed with the 1994-96 data alone for masses $M_e \simeq 200$GeV at large y_e :

$$N_{obs} = 7 \text{ within } M_e = 200 \pm 12.5 GeV$$
$$\text{for } N_{exp} = 0.95 \pm 0.18$$

$\rightarrow \mathcal{P} \simeq 1\%$ to observe an equal or larger deviation within kine. range in a random Monte Carlo experiment

Including the 1997 data:

$$N_{obs} = 8 \text{ within } M_e = 200 \pm 12.5 GeV$$
$$\text{for } N_{exp} = 3.01 \pm 0.54$$

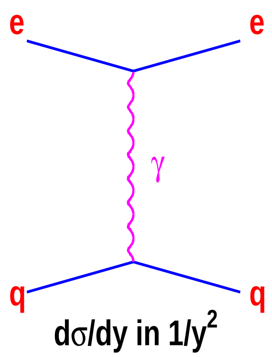
$\Rightarrow$ **The 1997 data alone do not confirm the observation of a "clustering" of events around** $M_e \simeq 200 GeV$

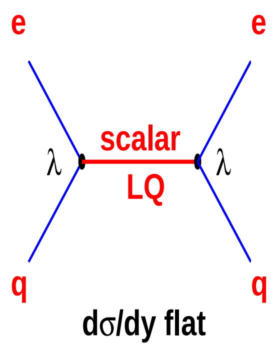
Integrated rates at large masses ($\geq$ 180 GeV^2):

1994-97 data: $N_{obs} = 10$ for $N_{exp} = 5.61 \pm 1.03$ for $y_e > 0.4$
$N_{obs} = 8$ for $N_{exp} = 2.94 \pm 0.42$ for $y_e > 0.5$

1997 data alone: $N_{obs} = 4$ for $N_{exp} = 3.33 \pm 0.62$ for $y_e > 0.4$
$N_{obs} = 4$ for $N_{exp} = 1.75 \pm 0.25$ for $y_e > 0.5$

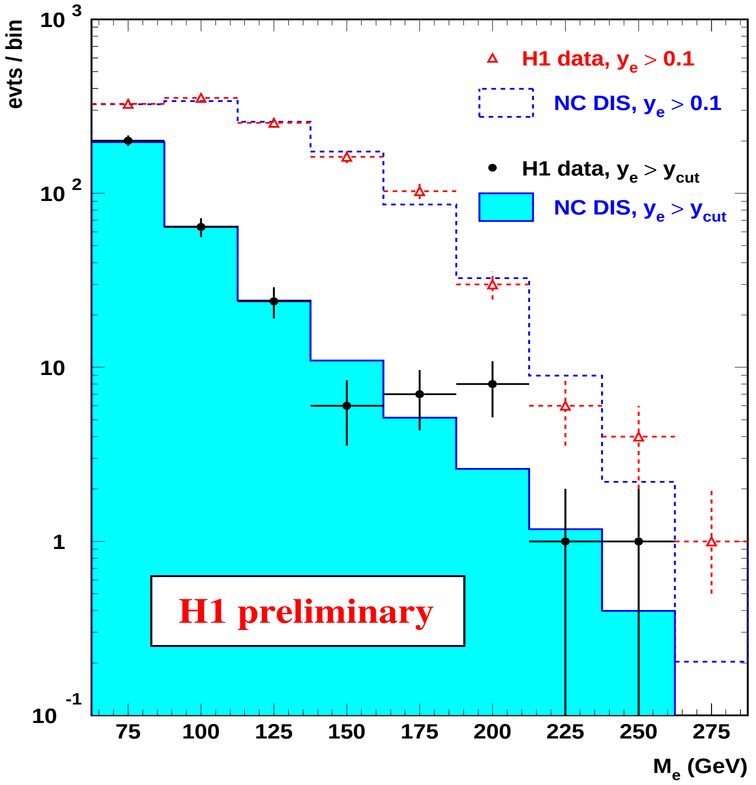
Setting Constraints for Leptoquarks





$\Longrightarrow$ optimized cut $y > y_{cut}$ which maximizes ratio signal / background

$y_{cut} \downarrow$ when $M_e \uparrow$ (e.g. $\simeq 0.4$ at $M_e \simeq 200\mathrm{GeV}$)



Mass spectrum for $y > y_{cut}$ used to constrain $\sigma(eq \to LQ \to eq)$

Parameters :

- LQ mass M_{LQ}
- Yukawa coupling λ

$(\sigma(eq \to LQ) \propto \lambda^2 \times q(x))$

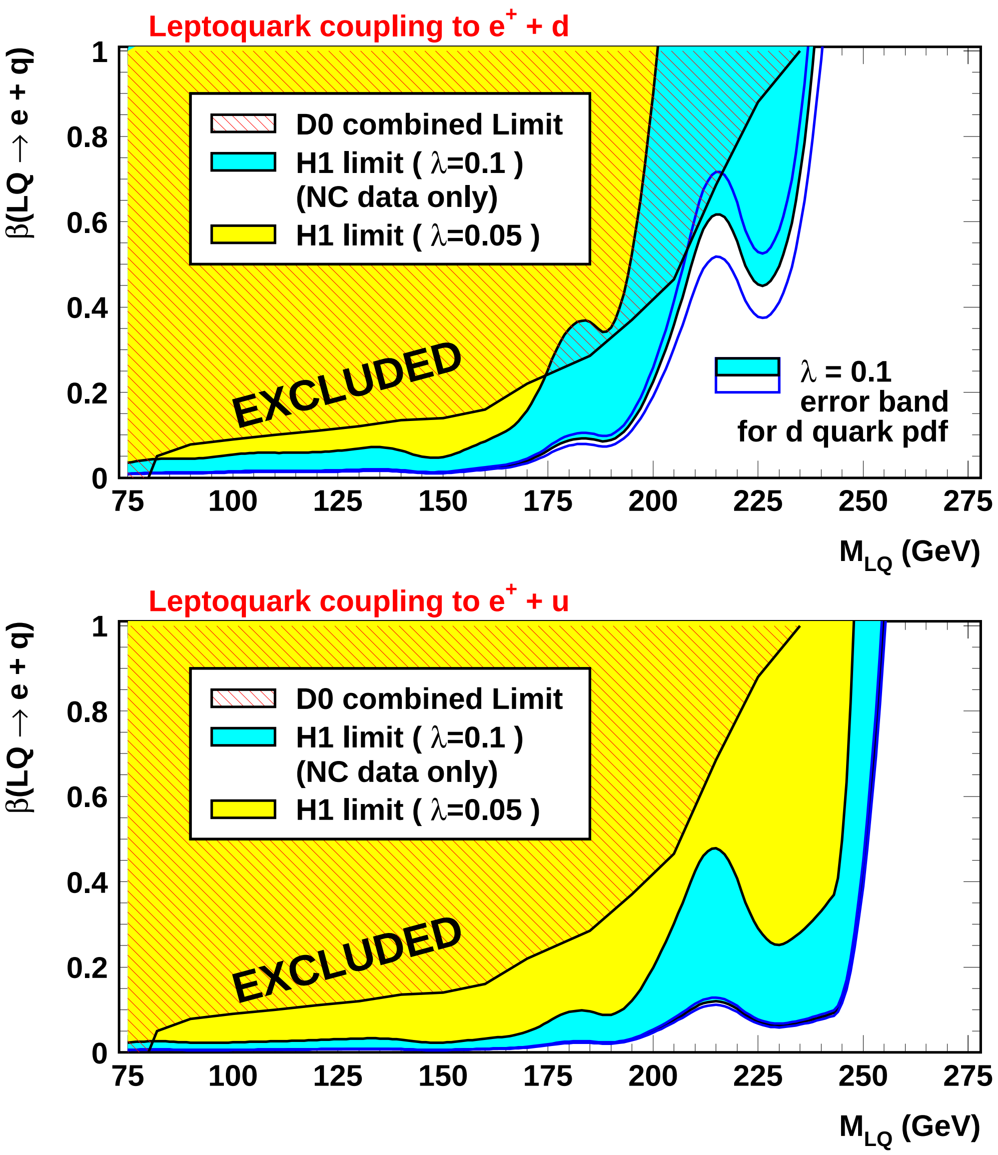
- $\beta = BR(LQ \to eq)$

- either fix λ and set constraints in plane β versus M_{LQ}
- or constrain λ vs M_{LQ} in specific models (β known)

Method : sliding mass window procedure, Poisson statistics
(H1 Collab., Phys. Lett. B369 (1996) 173.)

Constraints vs. β for Leptoquarks

H1 Preliminary



Sensitivity drop on β for $M_{LQ} \simeq 210\mathrm{GeV}$:

- new calibration $\Rightarrow \simeq +6\mathrm{GeV}$
- M_e underestimates M_{LQ} by $\simeq 4\mathrm{GeV}$

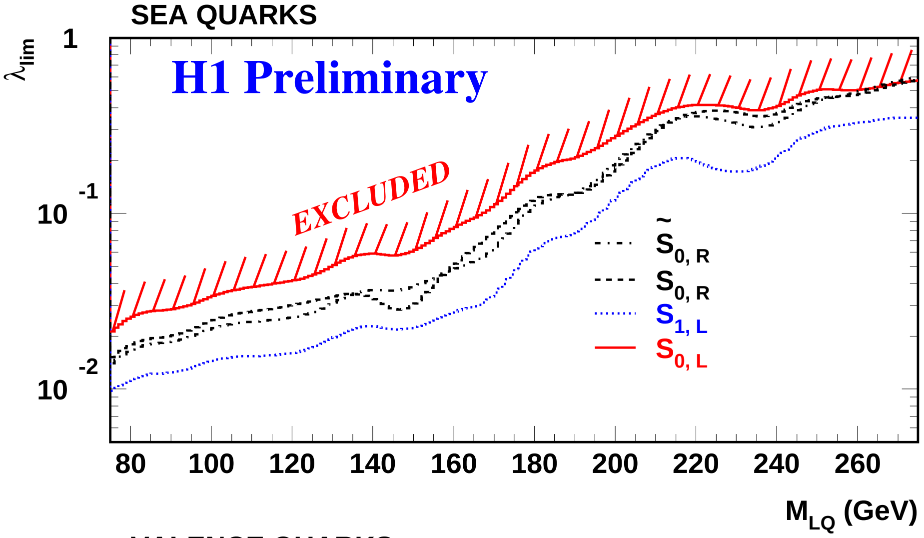
- Unexplored domain covered by H1, even for LQ coupling to e^+d
- Competition with TeVatron ($\lambda = 0.1$ corresponds to $\simeq 1/10 \times \alpha_{em}$)
- Still a high discovery potential at HERA, provided that $\beta << 1$

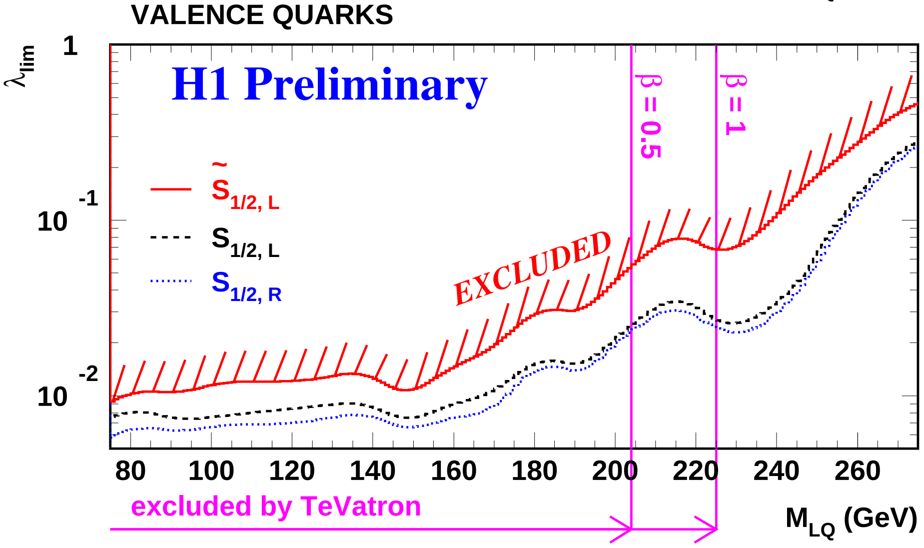
Mass-Coupling Constraints for Leptoquarks

Constraints on a specific LQ model (Buchmüller/Rückl/Wyler)

pure chiral coupling
β=1 or 1/2
LQ $\to$ e + q, or ν + q, or both

$\Longrightarrow$ 7 scalar LQ types

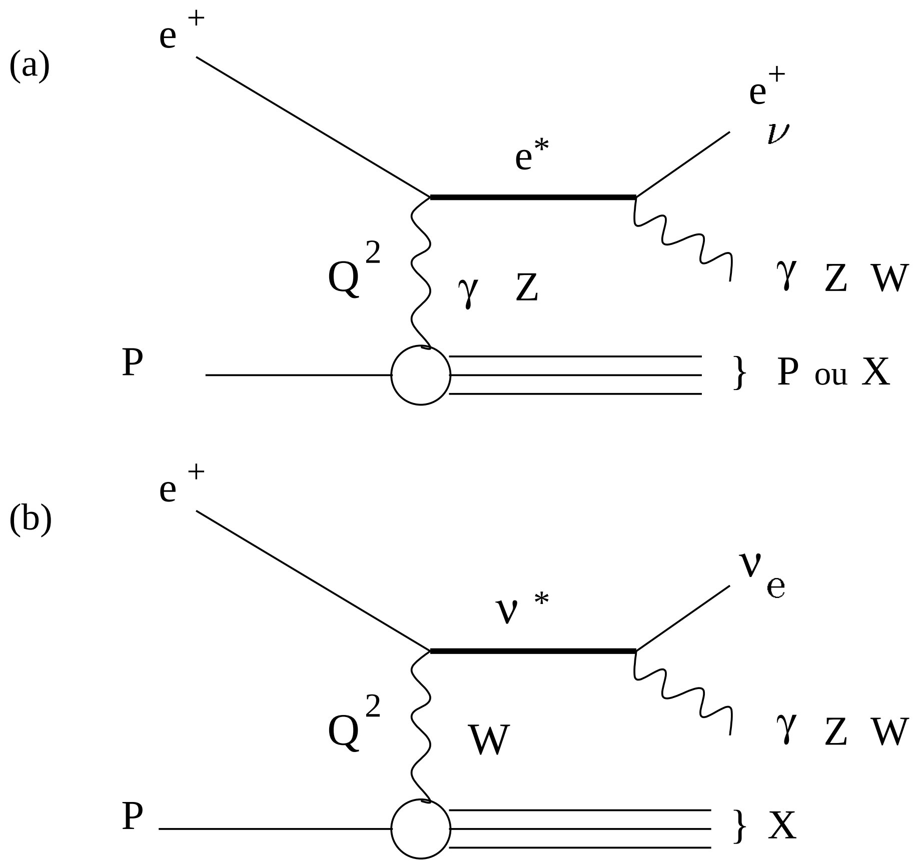




Stringent limits from TeVatron, BUT :

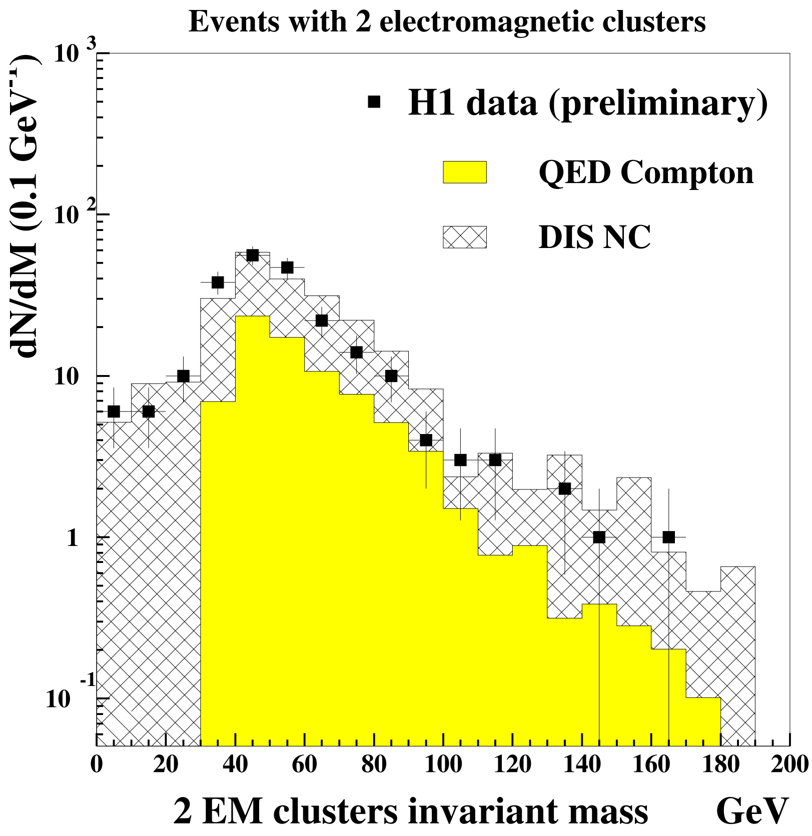
- For $\lambda \simeq \alpha_{em}$: $M_{LQ} > 275\text{GeV}$ at 95% C.L.
- Improvement by a factor $\simeq 3$ compared to earlier published results

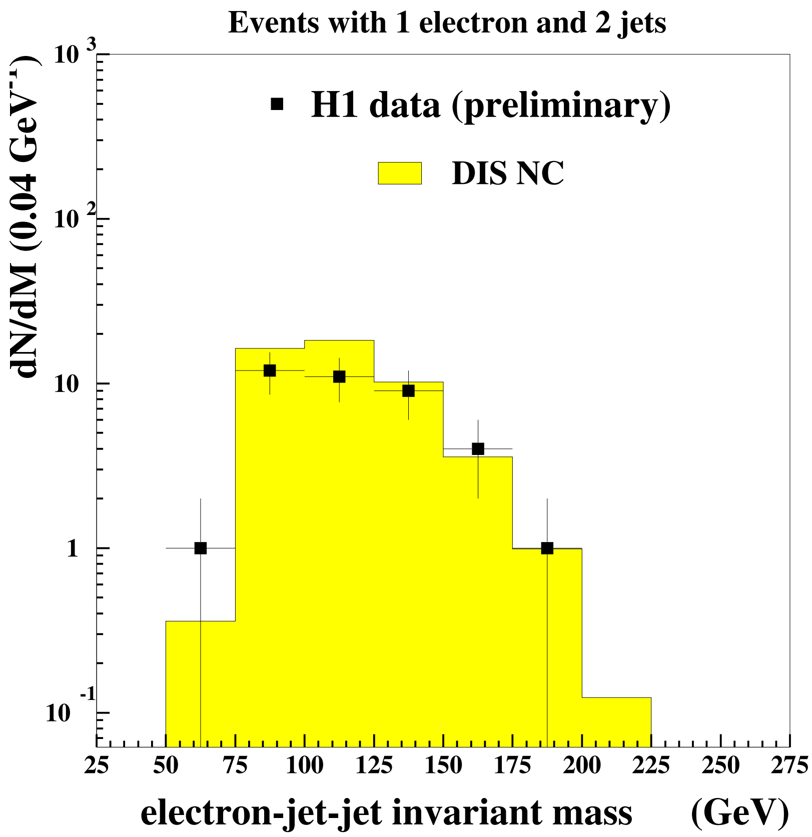
Excited Leptons Search



Channel	Selection	Data	SM exp.	Efficiency
$e^* \to e\gamma$	2 EM clusters	223	239 ± 7	85 %
$e^* \to eZ \hookrightarrow ee$	3 EM clusters	3	1.4 ± 0.3	78 %
$e^* \to eZ \hookrightarrow \nu\bar{\nu}$	1 electron + P_t^{miss}	1	3.6 ± 0.7	70 %
$e^* \to eZ \hookrightarrow q\bar{q}$	2 jets + 1 electron	38	48 ± 3	41 %
$e^* \to \nu W \hookrightarrow e\nu$	1 electron + P_t^{miss}	1	3.6 ± 0.7	70 %
$e^* \to \nu W \hookrightarrow q\bar{q}$	2 jets + P_t^{miss}	3	3.8 ± 0.5	40 %
$\nu^* \to \nu\gamma$	1 photon + P_t^{miss}	0	1.3 ± 0.8	38 %
$\nu^* \to \nu Z \hookrightarrow ee$	2 electrons + P_t^{miss}	0	0.38 ± 0.2	40 %
$\nu^* \to \nu Z \hookrightarrow q\bar{q}$	2 jets + P_t^{miss}	3	3.8 ± 0.5	40 %
$\nu^* \to eW \hookrightarrow e\nu$	2 electrons + P_t^{miss}	0	0.38 ± 0.2	40 %
$\nu^* \to eW \hookrightarrow q\bar{q}$	2 jets + 1 electron	38	48 ± 3	41 %

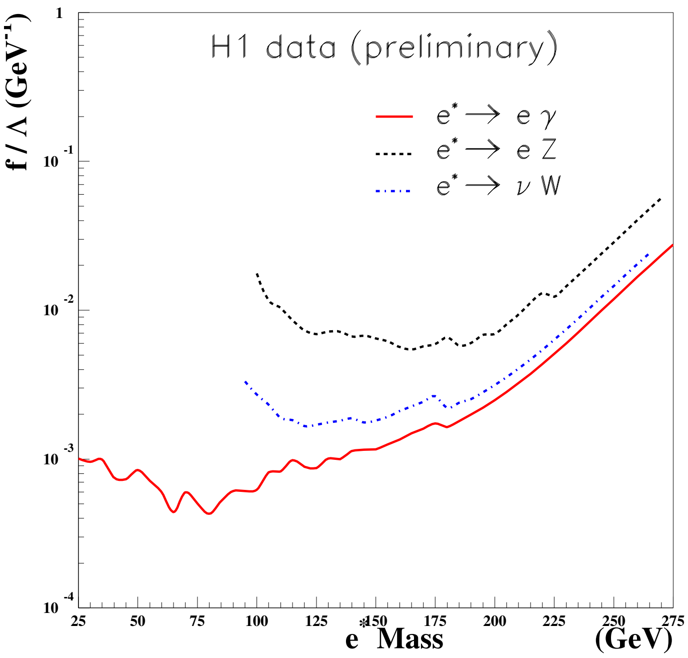
Invariant Mass Spectra

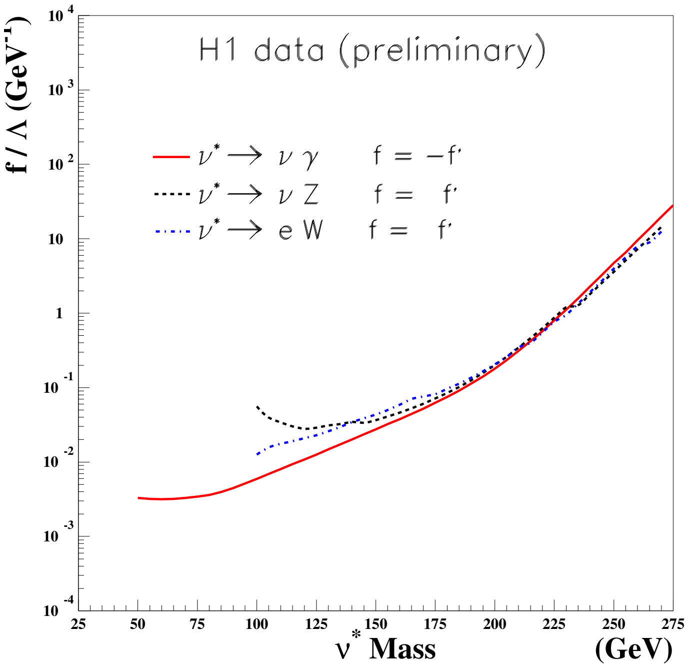




Rejection Limits

- e.g. based on the model of Hagiwara et al.
- better limit than previously published at HERA ($\geq$ factor 2)
- sensitivity extends beyond the LEP mass reach





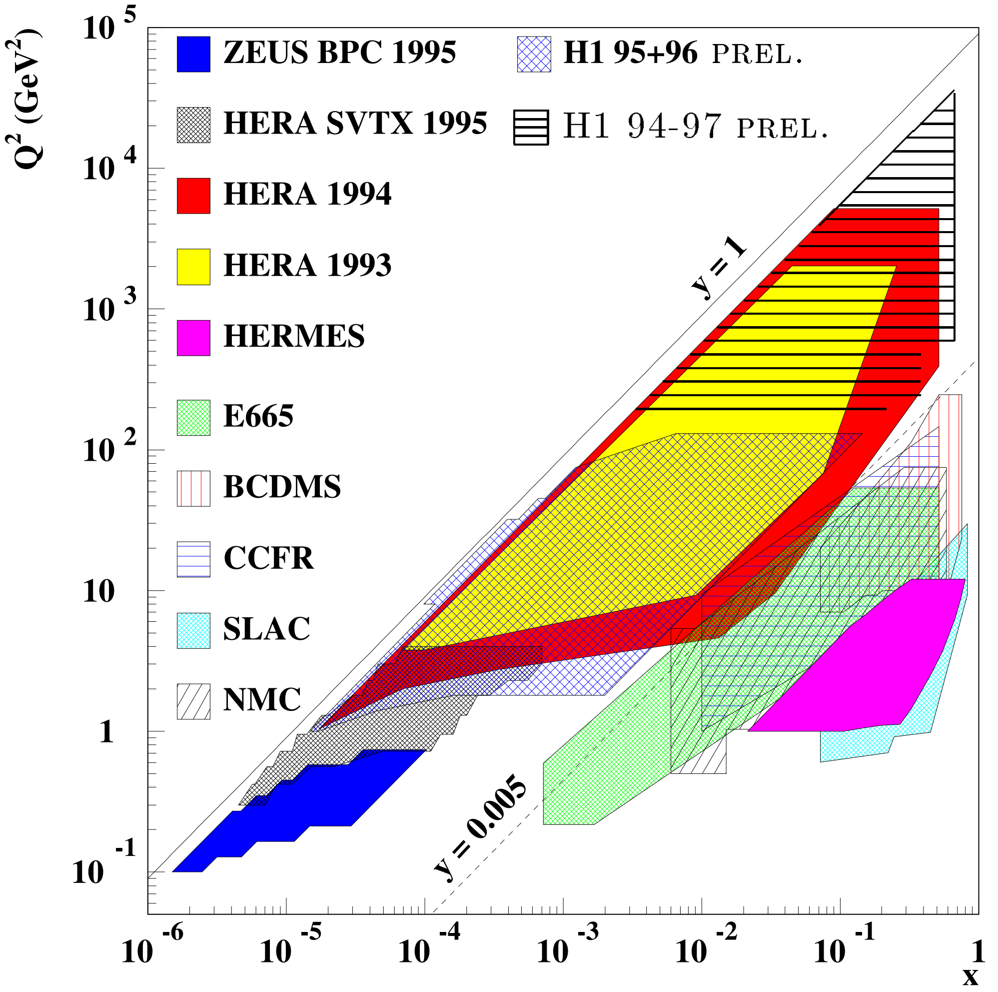
Cross-Sections at High Q^2

Event Selection:

- Calorimetric based trigger ($\epsilon > 99.5\%$)
- $E_e > 11$ GeV $y_e < 0.9$ $\theta_e \leq 150°$
- $\mid Z_{vertex} \mid < 35$ cm
- $E\text{-}P_z > 35$ GeV

$\Rightarrow$ Data sample $\simeq$ 75000 events
$\Rightarrow$ Background $< 1\%$

- Both positron and hadrons are used for kinematic reconstruction



Cross-Sections at High Q^2

Kinematic Domain: $200\ \mathrm{GeV}^2 \leq \mathrm{Q}^2 \leq 30000\ \mathrm{GeV}^2$

$0.005 \leq x \leq 0.65$

$$\frac{d^2\sigma}{dx\, dQ^2} = \frac{2\pi\alpha^2}{xQ^4}\left[Y_+ F_2(x,Q^2) - y^2 F_L(x,Q^2) - Y_- xF_3(x,Q^2)\right]$$

$$Y_\pm(y) = 1 \pm (1-y)^2$$

F_2: generalized structure function
F_L: longitudinal structure function
F_3: parity violating term from Z° exchange

$$F_2 = F_2^{em} + \frac{Q^2}{(Q^2+M_Z^2)} F_2^{int} + \frac{Q^4}{(Q^2+M_Z^2)^2} F_2^{wk} = F_2^{em}(1+\delta_Z)$$

F_2^{em}: photon exchange
F_2^{wk}: Z° exchange
F_2^{int}: γZ° interference

$$\frac{d^2\sigma}{dx\, dQ^2} = \frac{2\pi\alpha^2 Y_+}{xQ^4} F_2^{em}(1+\delta_Z-\delta_3-\delta_L)$$

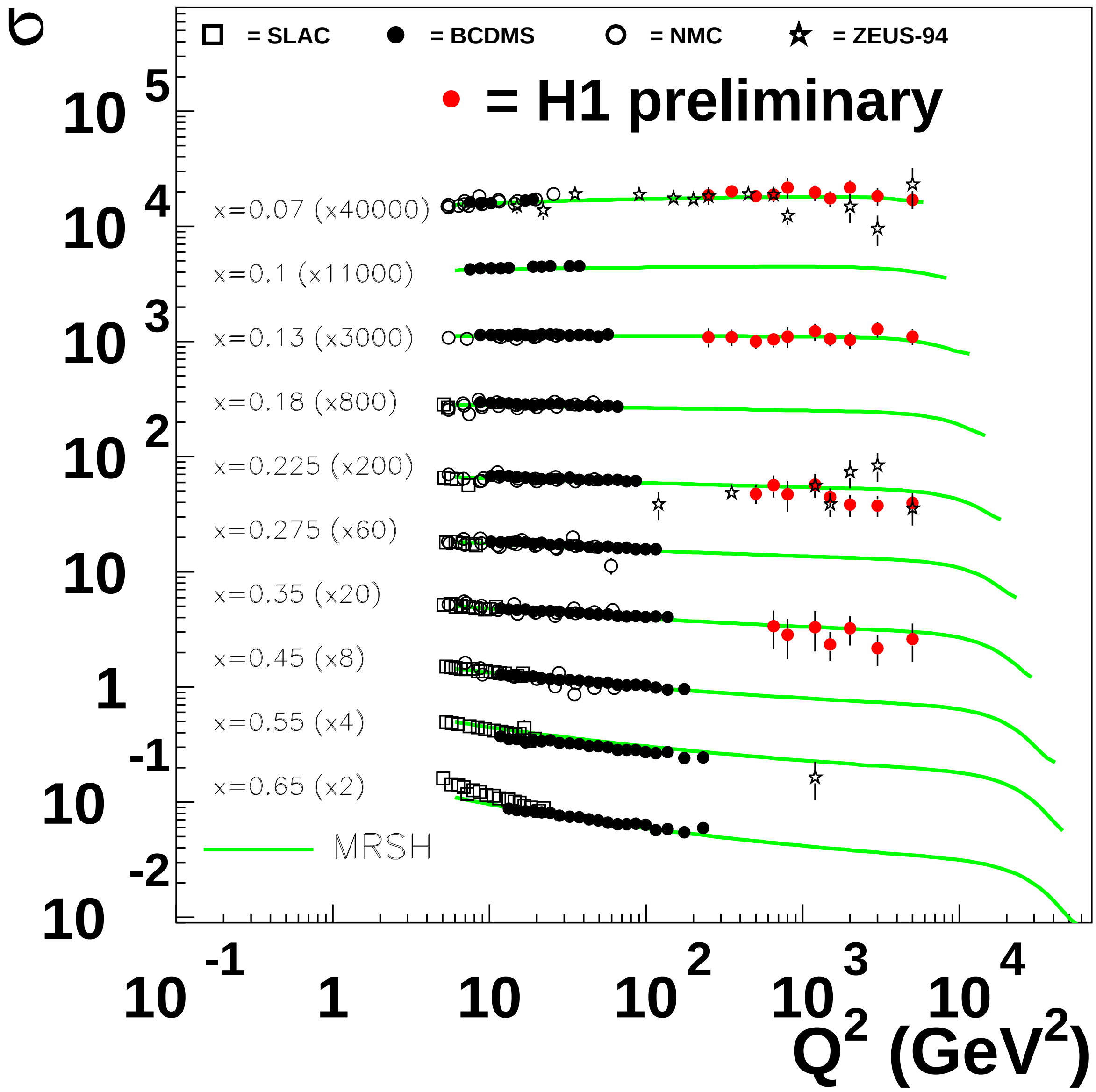
$\delta_Z - \delta_3$: $< 1\%$ at $\mathrm{Q}^2 < 1500\ \mathrm{GeV}^2$
$\approx 10\%$ at $\mathrm{Q}^2 = 5000\ \mathrm{GeV}^2$ and x=0.08
δ_L: negligible at $y < 0.5$
$\approx 5\%$ at $y = 0.9$

In the following we will use the Reduced Cross Section:

$$\sigma(e^+p) \equiv \frac{xQ^4}{2\pi\alpha^2}\frac{1}{Y_+}\frac{\mathrm{d}^2\sigma}{\mathrm{d}x\mathrm{d}Q^2}$$

Reduced Cross Section (presented at EPS'97)

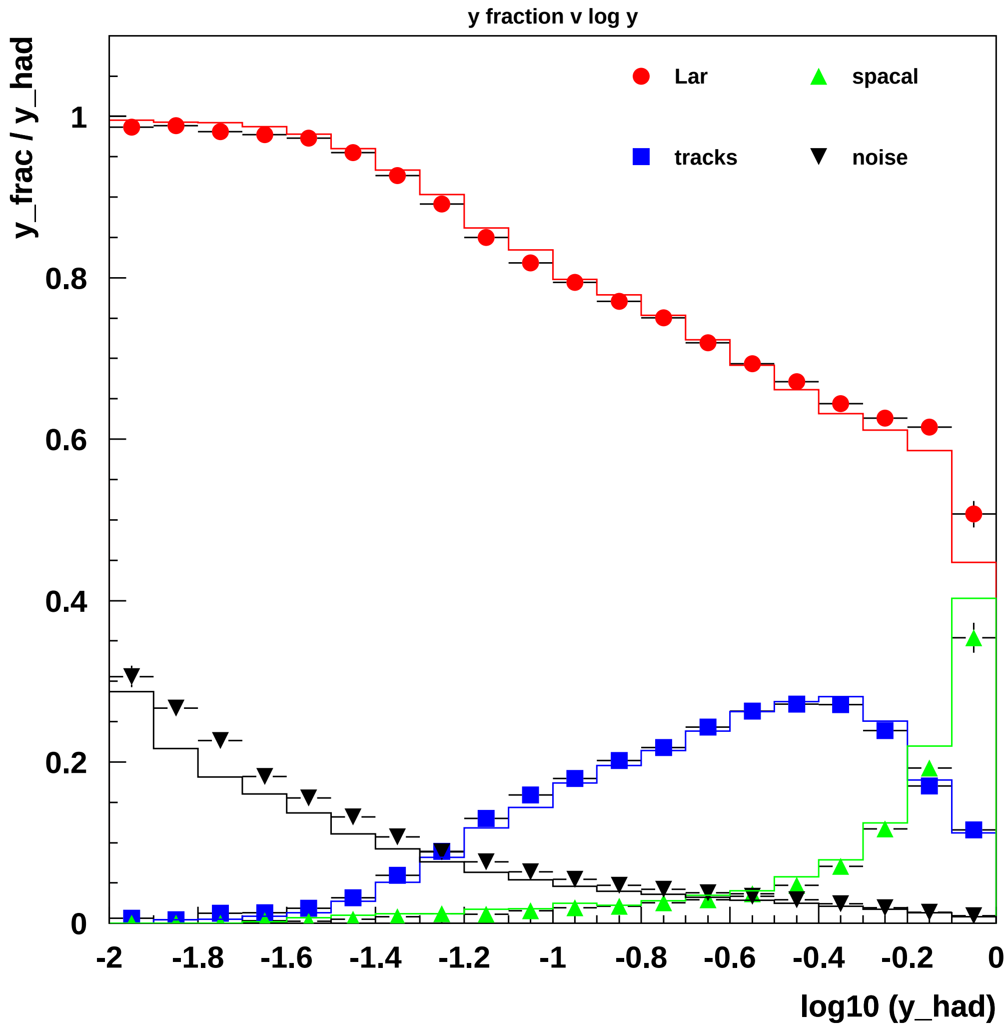
$$\sigma(e^+p) = \frac{xQ^4}{2\pi\alpha^2}\frac{1}{Y_+}\frac{\mathrm{d}^2\sigma}{\mathrm{d}x\mathrm{d}Q^2}$$



- Improvement of experimental techniques enable H1 to reach higher x values
- Higher statistics $\Rightarrow$ Higher Q^2

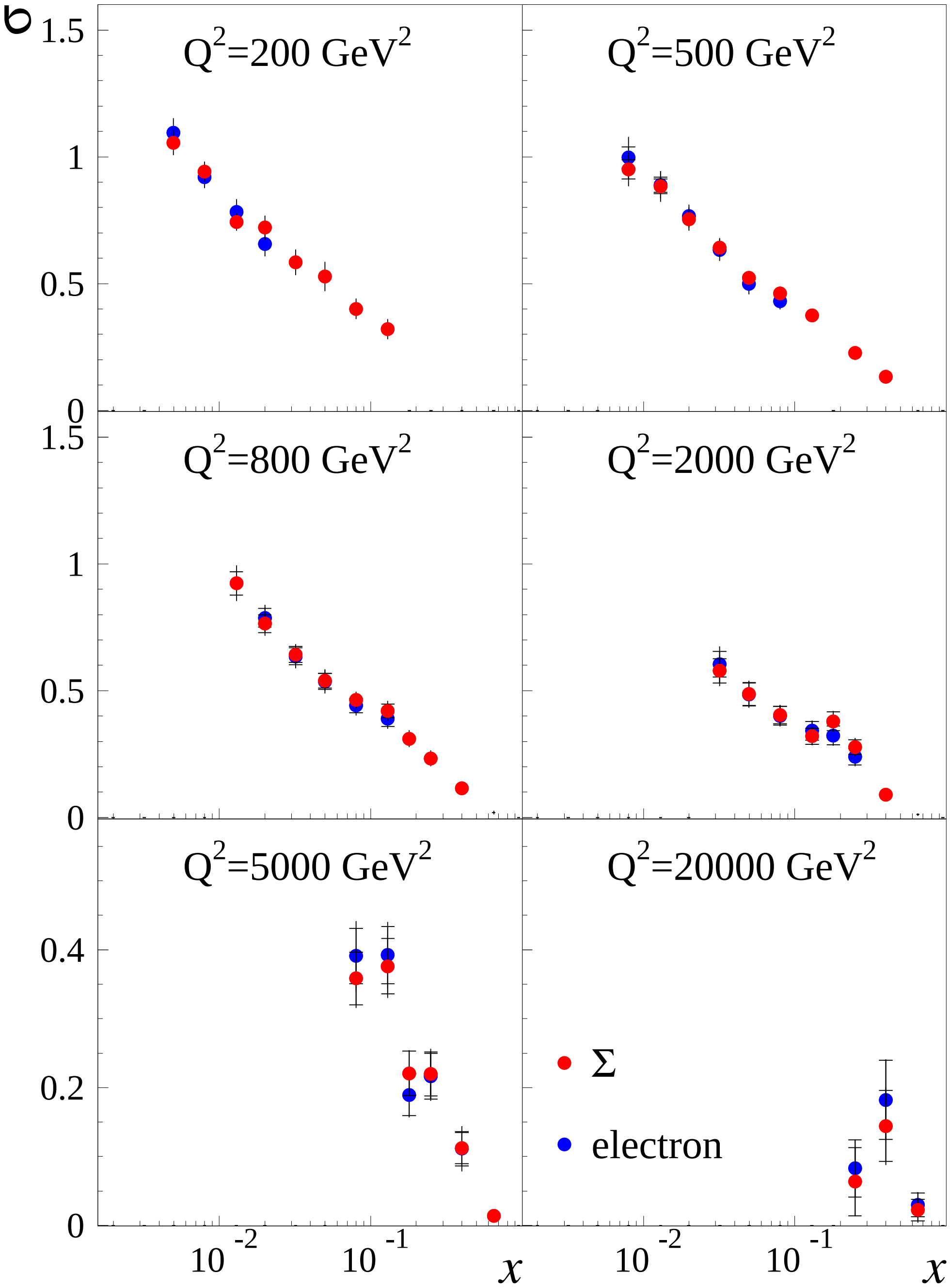
Measuring at High x

- Necessity to reduce the "noisy" cells at low y
  $\Rightarrow$ electronic noise
  $\Rightarrow$ backscattering in the beam-pipe
- Topological noise suppression improves y_h resolution at high x:



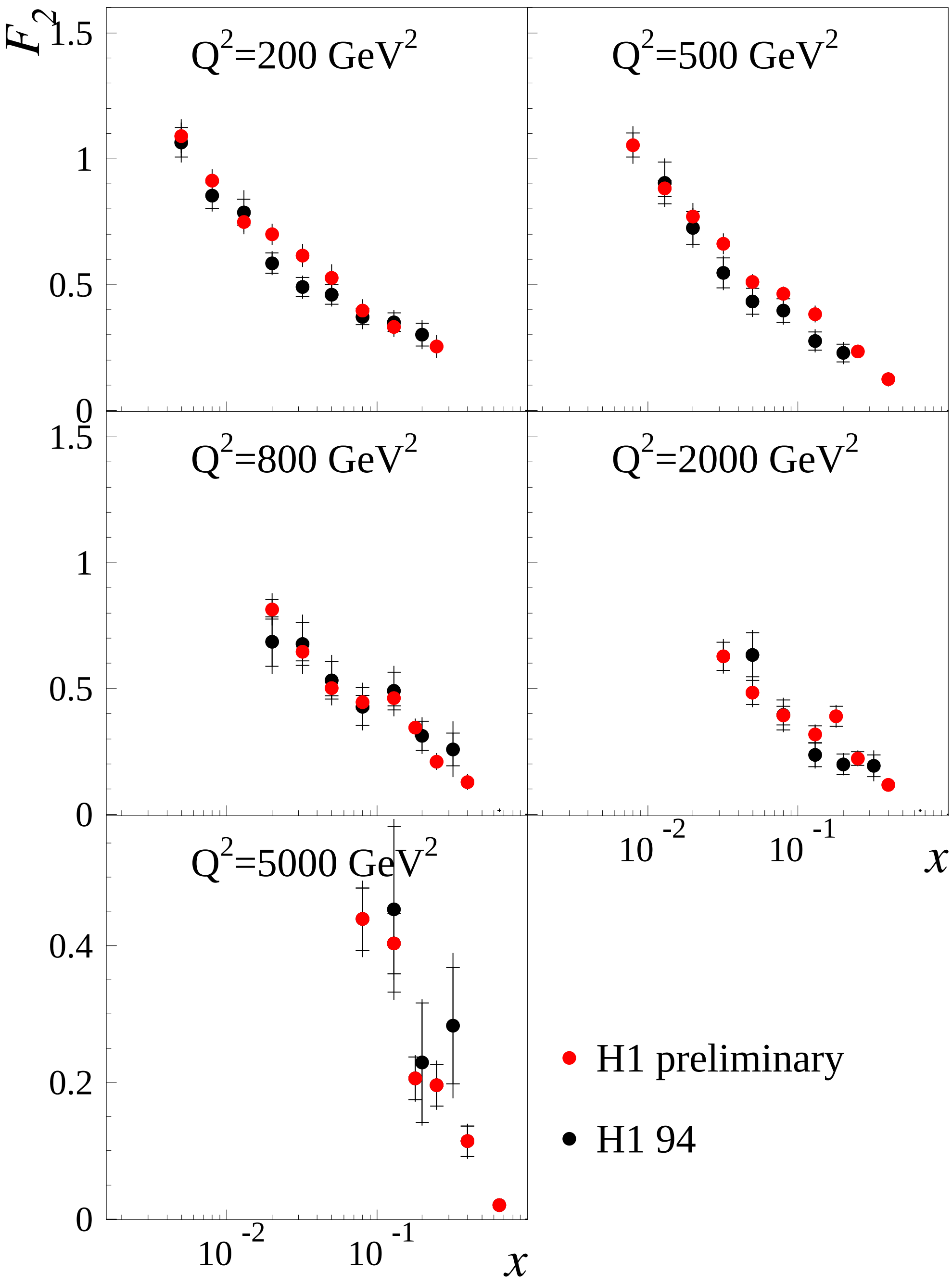
- systematic error on the noise supression:
  $\pm$ 25 % of the subtraction

Comparison of e and Σ Method



- Opposite systematic shift for electron energy error $\Rightarrow$ energy calibration check
- Different behaviour for radiative corrections
- For final result we use the $e\Sigma$-method (x_Σ, Q_e^2) which has a good stability in the full kinematic plane (cf DESY-97-137).

Comparison to 1994 Data



- Total errors improved by about a factor 2.
- $\delta \mathrm{F}_2/\mathrm{F}_2 \simeq 8\%$ over the full x and Q^2 range.

NLO QCD Fits

- Use NLO DGLAP equations to evolve:
  - $xu_{val}(x,Q^2)$, $xd_{val}(x,Q^2)$
    $xg(x,Q^2)$, $xSea(x,Q^2)$
  - Treat charm and bottom as massless partons

  $\Rightarrow$ more appropriate description for high Q^2

  $$c(x,Q^2) = 0 \text{ for } Q^2 < 1.5 \text{ GeV}^2$$
  $$b(x,Q^2) = 0 \text{ for } Q^2 < 5 \text{ GeV}^2$$

  - Assume $\bar{u} = \bar{d} = 2\bar{s}$ and
    $Sea = 2(\bar{u} + \bar{d} + \bar{s} + \bar{c})$ at Q_0^2
  - Take $\bar{c} = 0.02 \times xSea$
  - Use QCDNUM program from M. Botje

- Parton densities parametrised at Q_0^2:

  $$f_j(x) = A_j x^{B_j}(1-x)^{C_j}(1 - D_j x + E_j\sqrt{x})$$

  $\rightarrow$ parameters adjusted by fitting procedure

- Momentum and flavour sum rules applied

NLO-QCD Fits

- Datasets and Cuts:
  - NMC/BCDMS p+d F_2 data
  - H1 94 and preliminary H1 95/96 F_2 data with $Q^2 \leq 120$ GeV^2
  - H1 preliminary 97
    Use reduced cross-section data
    $\rightarrow$ no assumptions for F_L or xF_3
  - Require $Q^2 \geq 4$ GeV^2 and $W^2 \geq 10$ GeV^2
  - Require $x \leq 0.5$ for $Q^2 \leq 15$ GeV^2

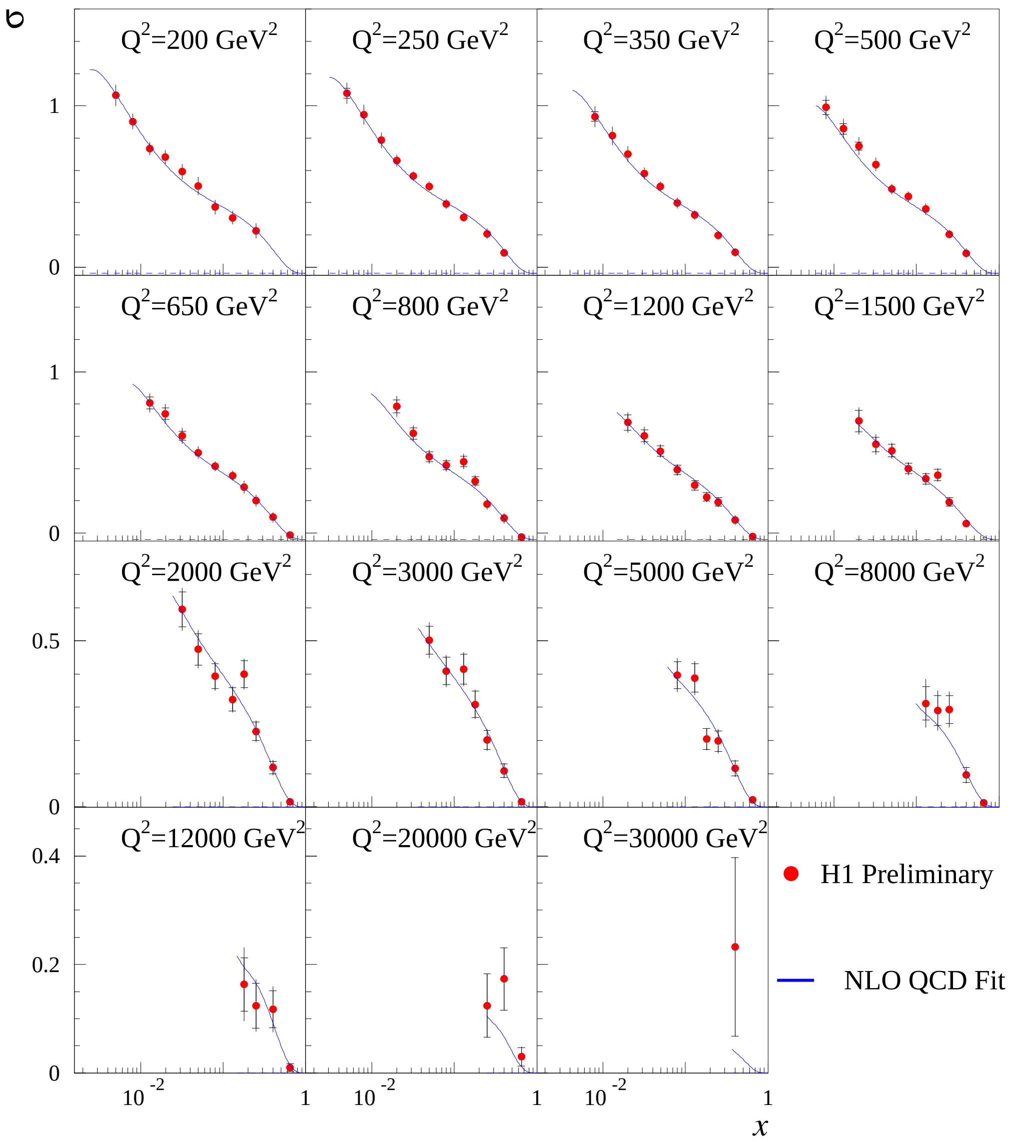
- Parameters:
  - starting scale: $Q_0^2 = 4$ GeV^2
  - $\alpha_s(M_Z^2)$=0.118 (fixed)

- Results:
  - Fit statistical $\oplus$ uncorrelated syst. errors

  1 Fit only data with $Q^2 \leq 120$ GeV^2
  then extrapolate to high Q^2

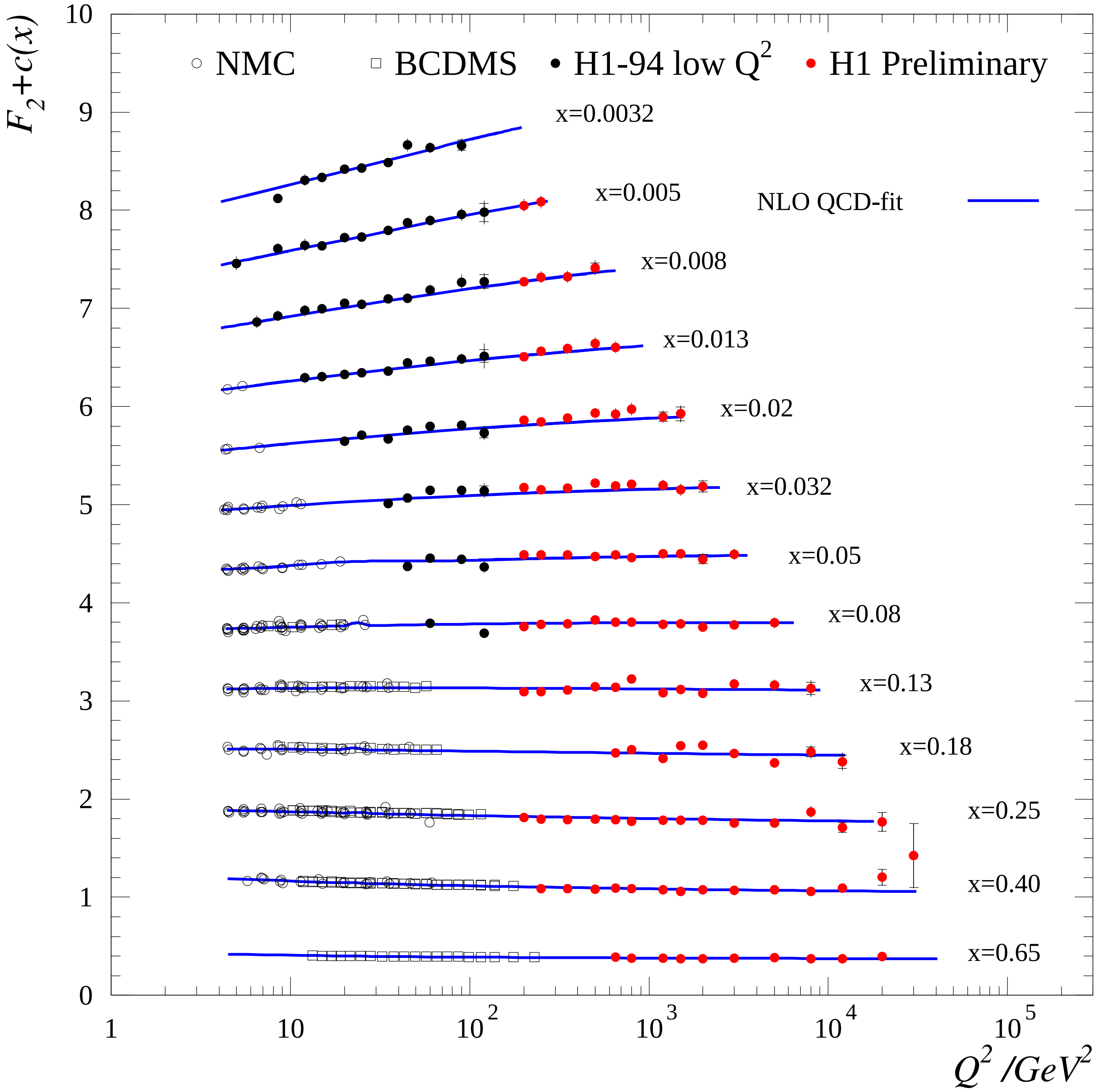
  2 Fit all data with $Q^2 \leq 30000$ GeV^2
  - Both fits have χ^2/ndf ≈ 1.2

Reduced Cross Section



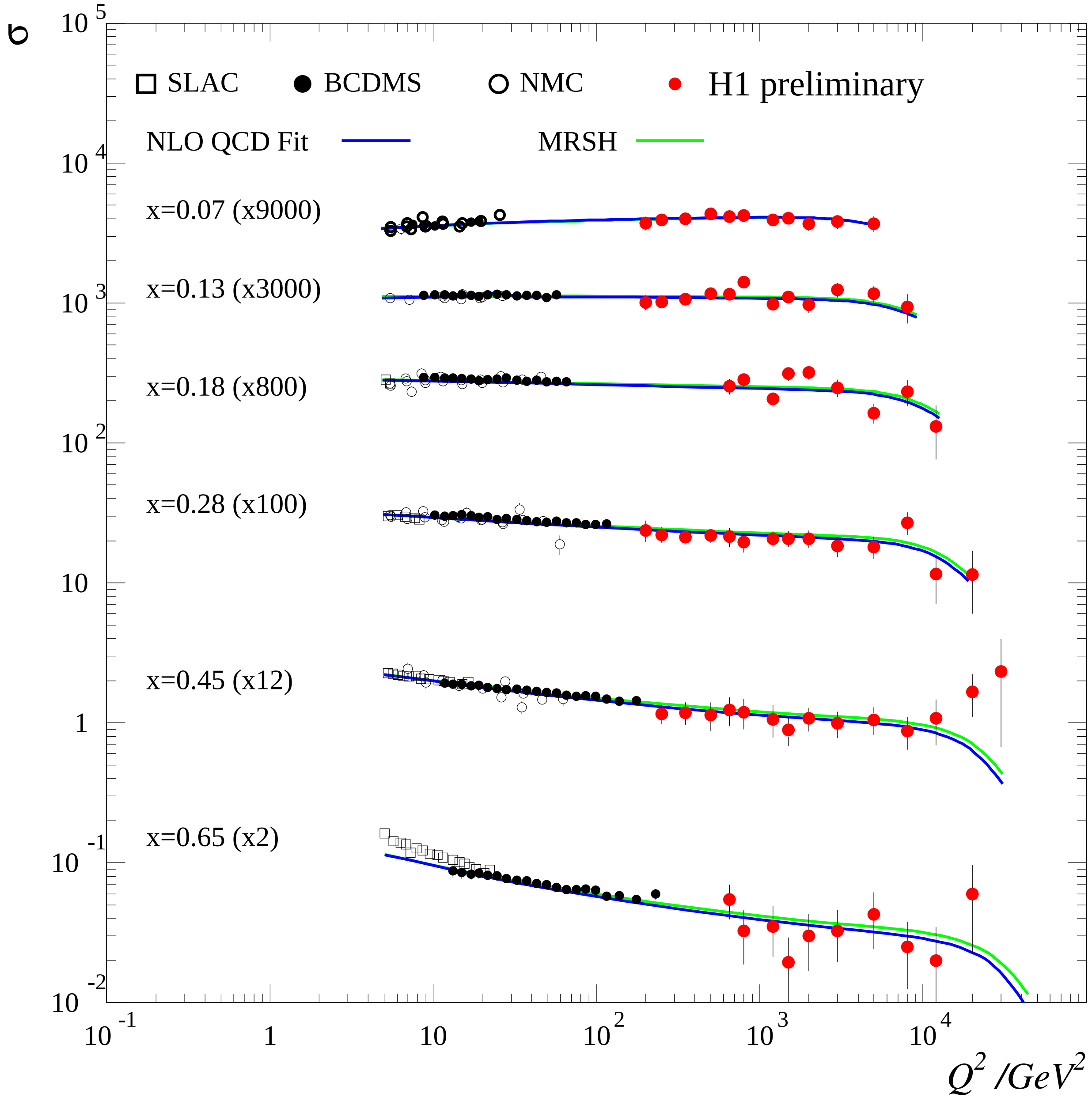
- Measurement from $Q^2 = 200$ to 30000 GeV^2. Up to $x = 0.65$ for $Q^2 \geq 650$ GeV^2
- NLO QCD fit gives good description of the data in the whole Q^2 and x range

F_2 - scaling violations



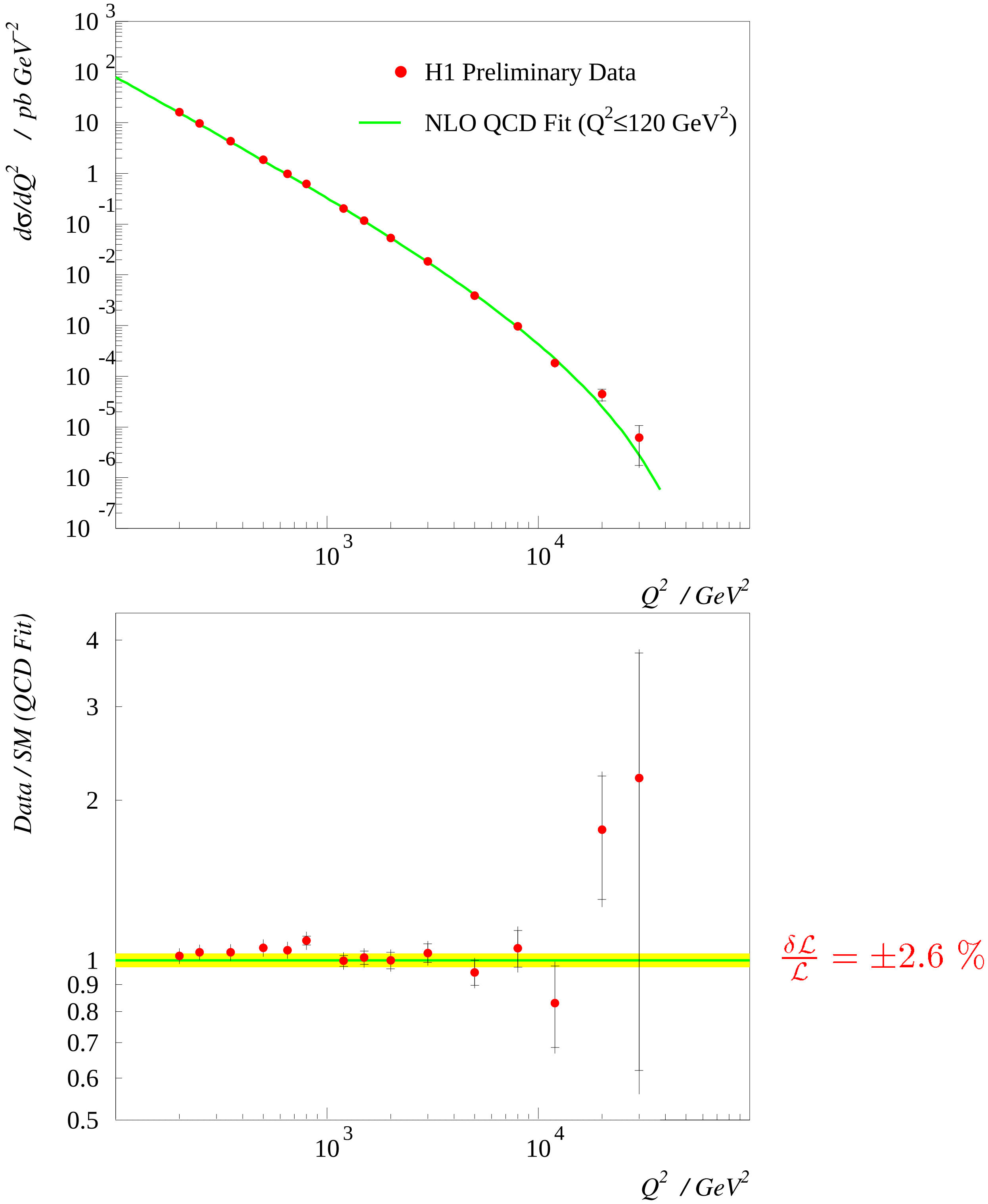
- F_2 derived from $\frac{d^2\sigma}{dxdQ^2}$ assuming F_L and xF_3 from MRSH
- access to valence quark region
- approaching overlap to the fixed target data at high x

Reduced Cross-section at High x



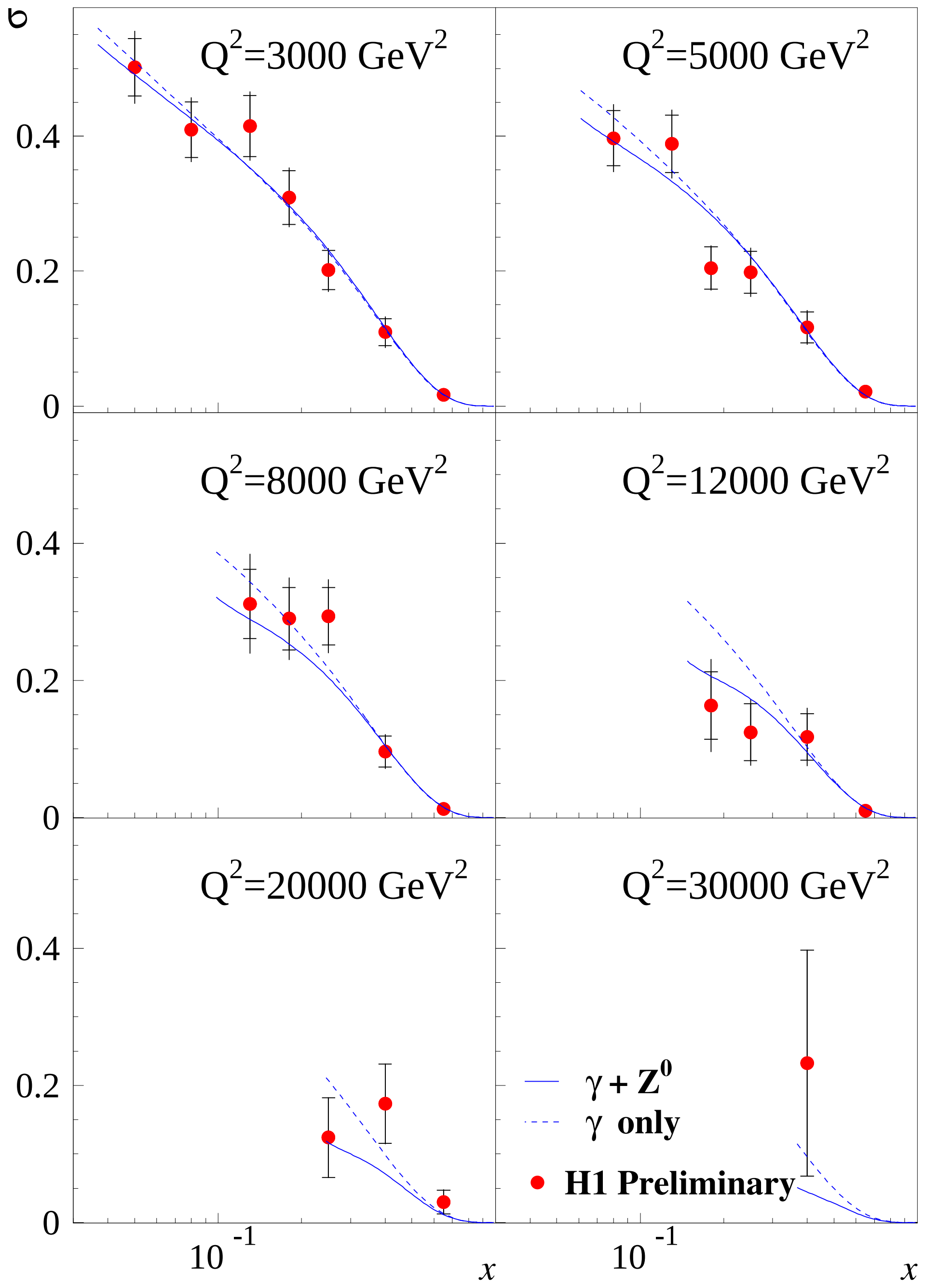
- Difference visible in the QCD fit when the high Q^2 data is or is not included.
- High Q^2 HERA data now also have an influence at high x.

Single Differential Cross-Sections



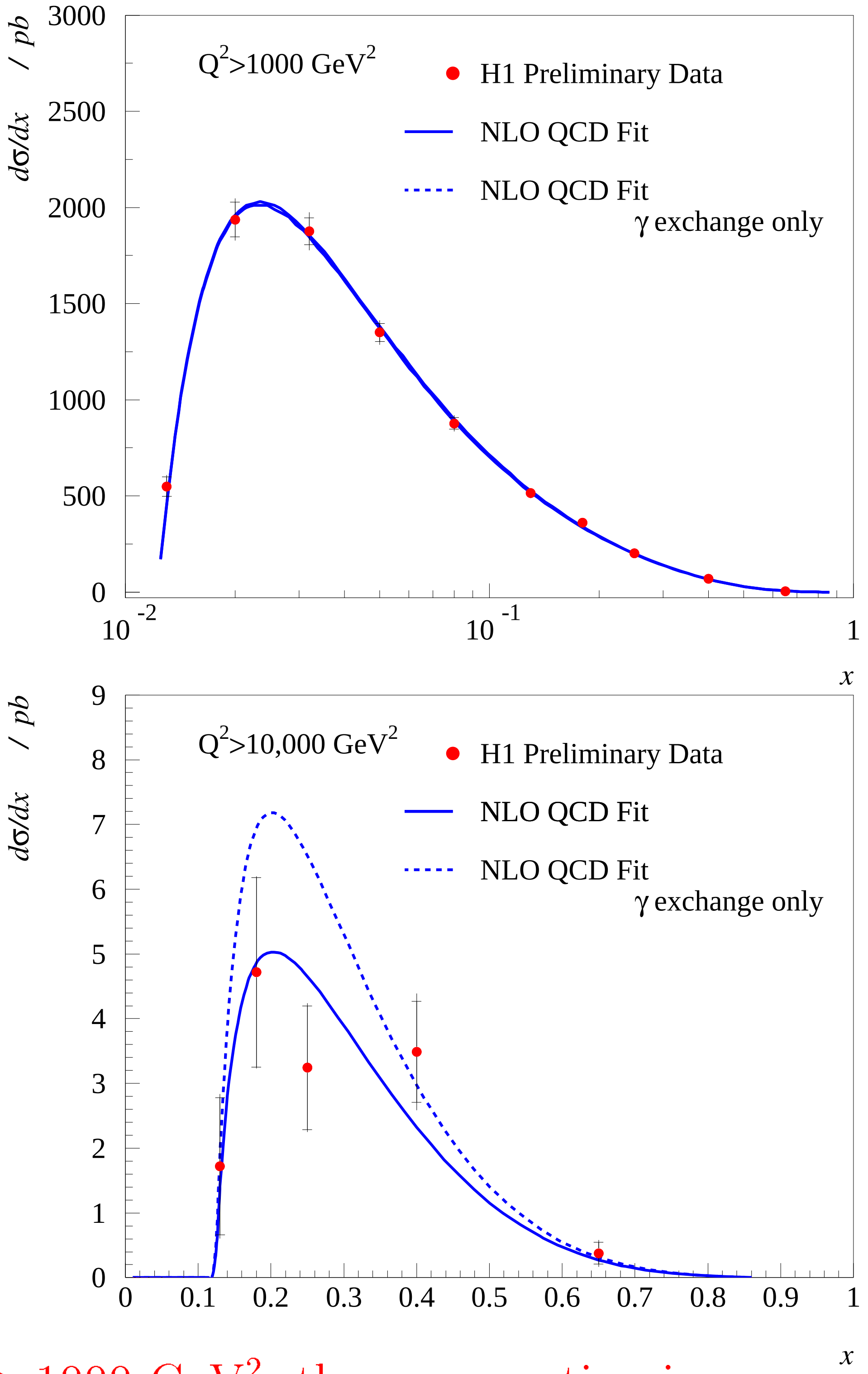
- High Q^2 data are compatible with a NLO QCD fit to all low Q^2 data ($\leq 120\mathrm{GeV}^2$) evolved over two orders of magnitude.
- Slight Excess visible at $Q^2 \geq 15000$ GeV^2.

Sensitivity To Electroweak Processes



- Effects are visible at $Q^2 \geq$10000 GeV^2
- Greater sensitivity can be gained from single differential distributions

$\mathbf{d}\boldsymbol{\sigma}/\mathbf{d}\boldsymbol{x}$ at $\boldsymbol{Q^2} > \mathbf{1000, 10000}$ GeV$^{\mathbf{2}}$



- For $Q^2 \geq 1000$ GeV^2, the cross-section is still dominated by low x partons.
- For $Q^2 \geq 10000$ GeV^2 the valence quarks contribute.
- The data are in good agreement with the electroweak Standard Model.

Summary

Searches:

- The excess of neutral current events observed at high Q^2 in the 94-96 data is still present, but with a lower significance ($\simeq 2\sigma$ at $Q^2 \geq 15000$ GeV^2 for the data taken from 94 to 97).
- In the mass window around 200 GeV the number of events observed in 1997 is comparable to expectation $\Rightarrow$ no confirmation of an accumulation of events at this mass value.
- Stringent limits have been determined for scalar leptoquarks. $\lambda \geq$ e.m. coupling strenght are excluded for masses up to 275 GeV. HERA still has a discovery potential for general ($\beta \ll 1$) leptoquark searches.

Cross-Sections:

- Single and double differential cross-sections have been measured for Q^2 from 200 to 30000 GeV^2, in the valence region up to $x = 0.65$ with a precision comparable to the low Q^2 HERA data.
- These cross-section measurements are very well described over two orders of magnitude in Q^2 by perturbative QCD, as shown by a Next to Leading Order QCD fit based only on low Q^2 (≤ 120 GeV^2) data.
- At $Q^2 \geq 15000$ GeV^2 a slight excess of events over expectation is also visible in the double differential cross-section.
- At high Q^2 (≥ 10000 GeV^2), the single differential $d\sigma/dx$ cross-section favours the Standard Model expectation of a suppression of the cross-section due to $\gamma - Z^0$ interference.