Structure Function Measurements and QCD Analysis at Medium Q^2

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On behalf of the

H1 Collaboration

DIS 99

The 7th International Workshop on Deep Inelastic Scattering and QCD

DESY Zeuthen, April 19-23 1999

Outline

- DIS 98 H1 DATA 94-96
- This talk H1 DATA 97

  * $2 < Q^2 < 120$ GeV^2

  * *statistical precision* 1%

  * *better acceptance,new tracker* $-$ *BST*

- Event Selection
- F_2 Measurement
- QCD fits
- Conclusions

DIS crossection at medium Q^2

$$\frac{d^2\sigma(lp)}{dxdQ^2} = \frac{2\pi\alpha^2}{Q^4 x}[Y_+ F_2(x,Q^2) - y^2 F_L(x,Q^2)]\ (1+\delta_r)$$

Reduced Cross Section

$$\sigma_r = \frac{d^2\sigma}{dxdQ^2}\frac{Q^4 x}{2\pi\alpha^2 Y_+} = F_2(x,Q^2) - \frac{y^2}{Y_+}F_L(x,Q^2)$$

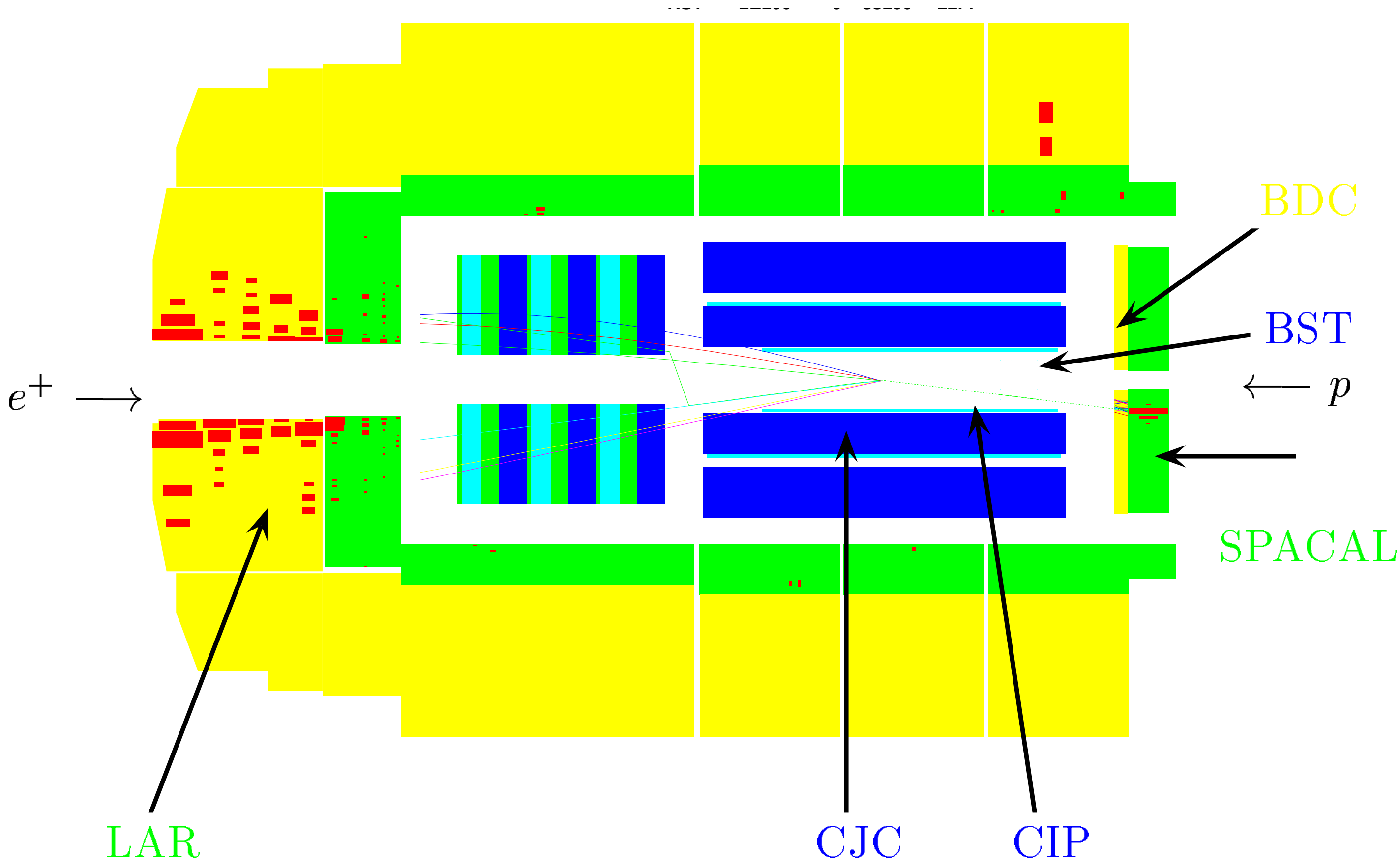
- y, Q^2 calculated by electron method $y > 0.15$
  or Σ method $y < 0.15$
- small influence of F_L , $\sigma_r \simeq F_2$ for $y \leq 0.6$
- F_L determination at high y - see talk of V.Arkadov

DATA 97 comprises two samples:

- nominal runs , $\mathcal{L}$= 15 pb^{-1} , $10 < Q^2 < 120$ GeV^2
- dedicated run ,$\mathcal{L}$=2 pb^{-1}, $2 < Q^2 < 10$ GeV^2

$\mathcal{L}(1997) \doteq 2{\star}\mathcal{L}(1994{+}1995{+}1996)$

Event Selection



- backward calorimeter SPACAL, backward drift chamber BDC
- backward silicon tracker BST,$172^o < \theta_e < 177^o$
- central inner prop. chamber CIP,central drift chamber CJC
- liquid argon calorimeter LAR

Systematic errors

Sources of systematic errors

- Precision of luminosity measurement: 1.5 %
- Angular precision $\delta\theta_e$: 0.5 mrad
  beam inclination vsrt z-axis, alignment of the chamber BDC and the Si-tracker BST
- Precision of the calibration of em. SPACAL :
  low energies 3 % , high energies 0.5 %
  double angle method checked with Compton events and kinematic peak position
- Accuracy of the hadronic energy scale :
  4/5 % for LAR/ SPACAL
  p_T balance between $e^{+'}$ and hadrons
- Noise suppression in the central(forward) LAR
  isolated cells with E $<$ 400(800) MeV excluded
  $\Rightarrow$ better y resolution at $y \sim 0.01$
- Accuracy of trigger efficiencies : 0.5 % – 1 %

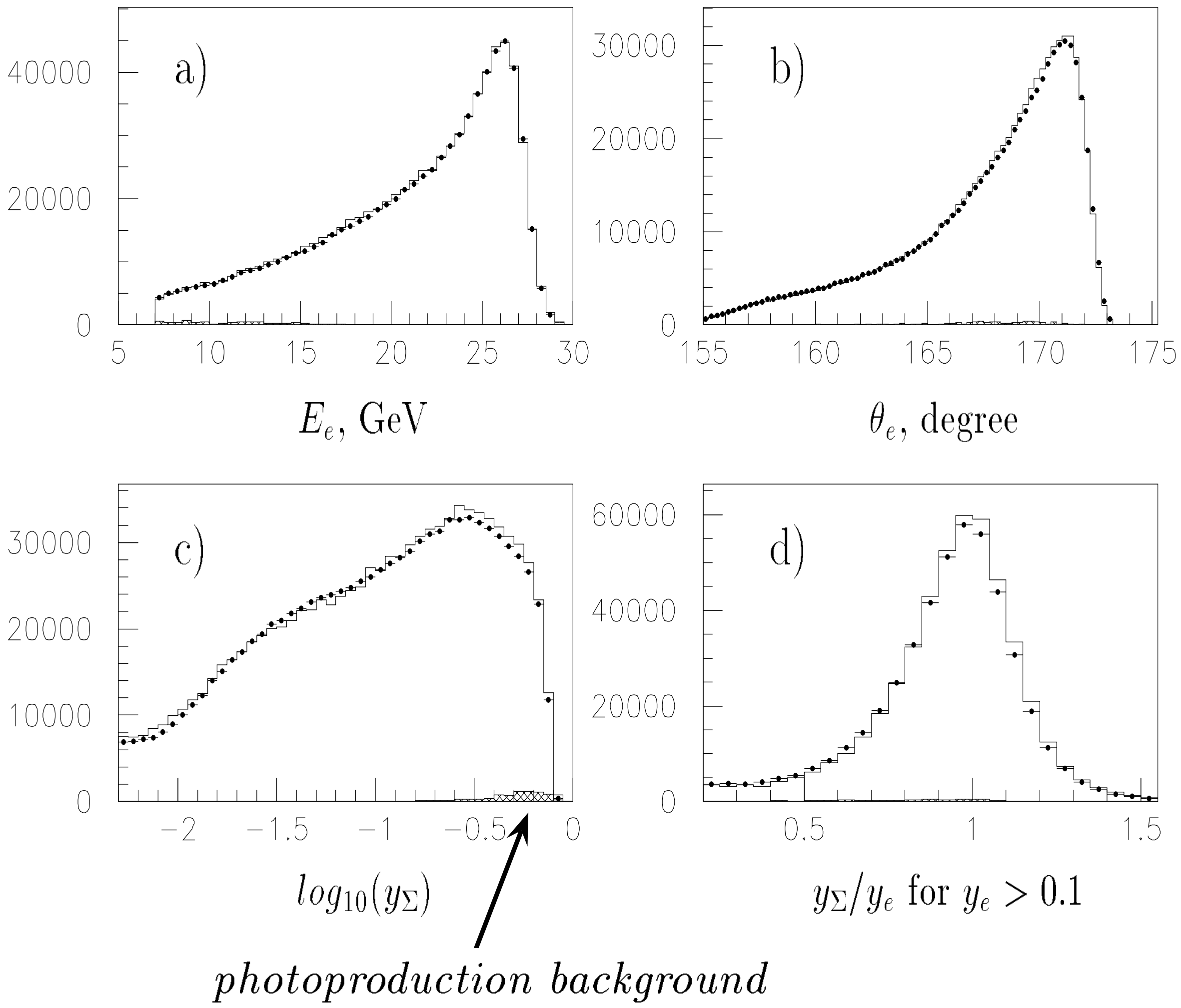
- Accuracy of the positron identification: 1-2 %
  Spacal cluster with max p_t or with max E
- Uncertainties of the BST efficiency 1–2 %
- Uncertainties of the vertex efficiency $\sim$ 1 %
- Radiative corrections are small due to the cut
  $\sum_h (E_i - p_{z,i}) + E_e - p_{z,e} > 35GeV$, h – $hadrons$

source	error [%] of σ_r
vertex efficiency	1-2
BDC efficiency	0.5
BST efficiency	1-2
trigger efficiency	0.5 - 1
positron identification	0.5-2
noise rejection in LAr	< 3 at $y < 0.02$
radiative corrections	1-2
photoproduction background	< 8 at high y
CJC-SPACAL link efficiency	2

Total systematic: mostly 3-4 %

at the edges of y-range up to 8 %

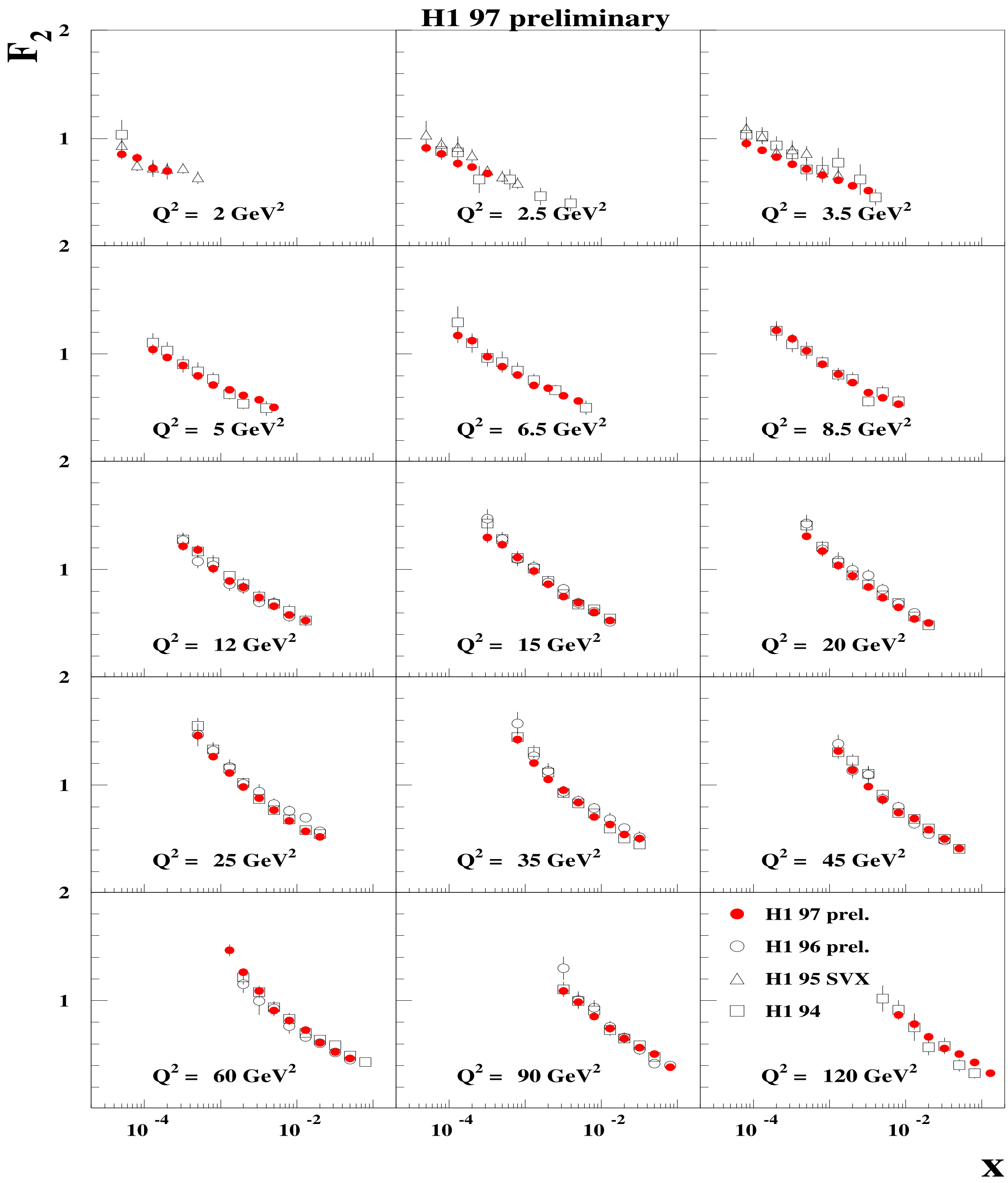
Comparison data-simulation



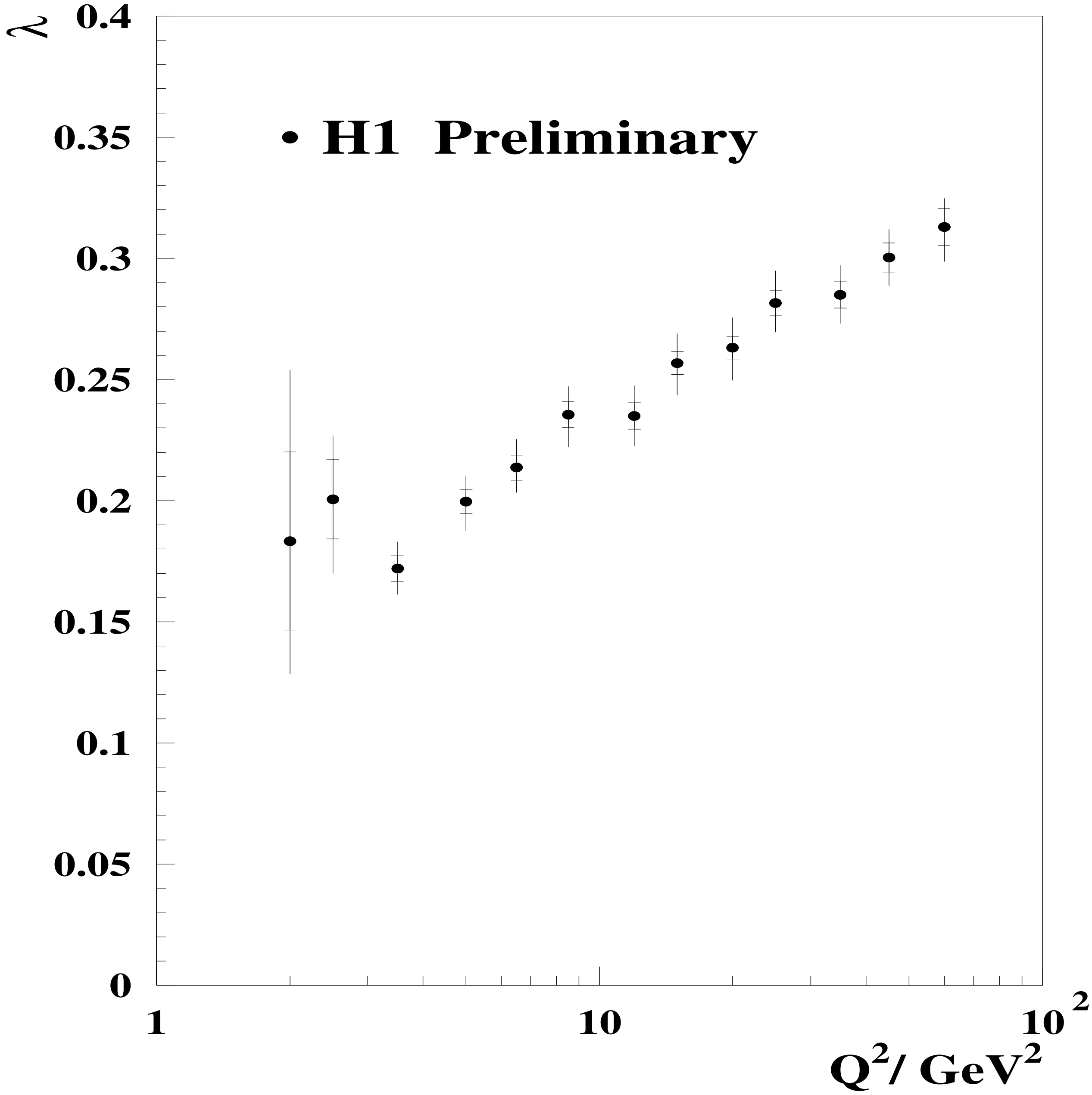
□ simulation DIS + photoproduction

• data 1997 - nominal runs

simulated distributions normalized to $\mathcal{L}$ of data


H1 97 preliminary
F_2
2
1
$Q^2 = 2\ GeV^2$
$Q^2 = 2.5\ GeV^2$
$Q^2 = 3.5\ GeV^2$
$Q^2 = 5\ GeV^2$
$Q^2 = 6.5\ GeV^2$
$Q^2 = 8.5\ GeV^2$
$Q^2 = 12\ GeV^2$
$Q^2 = 15\ GeV^2$
$Q^2 = 20\ GeV^2$
$Q^2 = 25\ GeV^2$
$Q^2 = 35\ GeV^2$
$Q^2 = 45\ GeV^2$
$Q^2 = 60\ GeV^2$
$Q^2 = 90\ GeV^2$
$Q^2 = 120\ GeV^2$
H1 97 prel.
H1 96 prel.
H1 95 SVX
H1 94
10^{-4}
10^{-2}
x

$$y < 0.6$$



Parameter λ from $F_2 \propto x^{-\lambda}$

inner bars – statistical errors , outer bars – total errors

QCD analysis

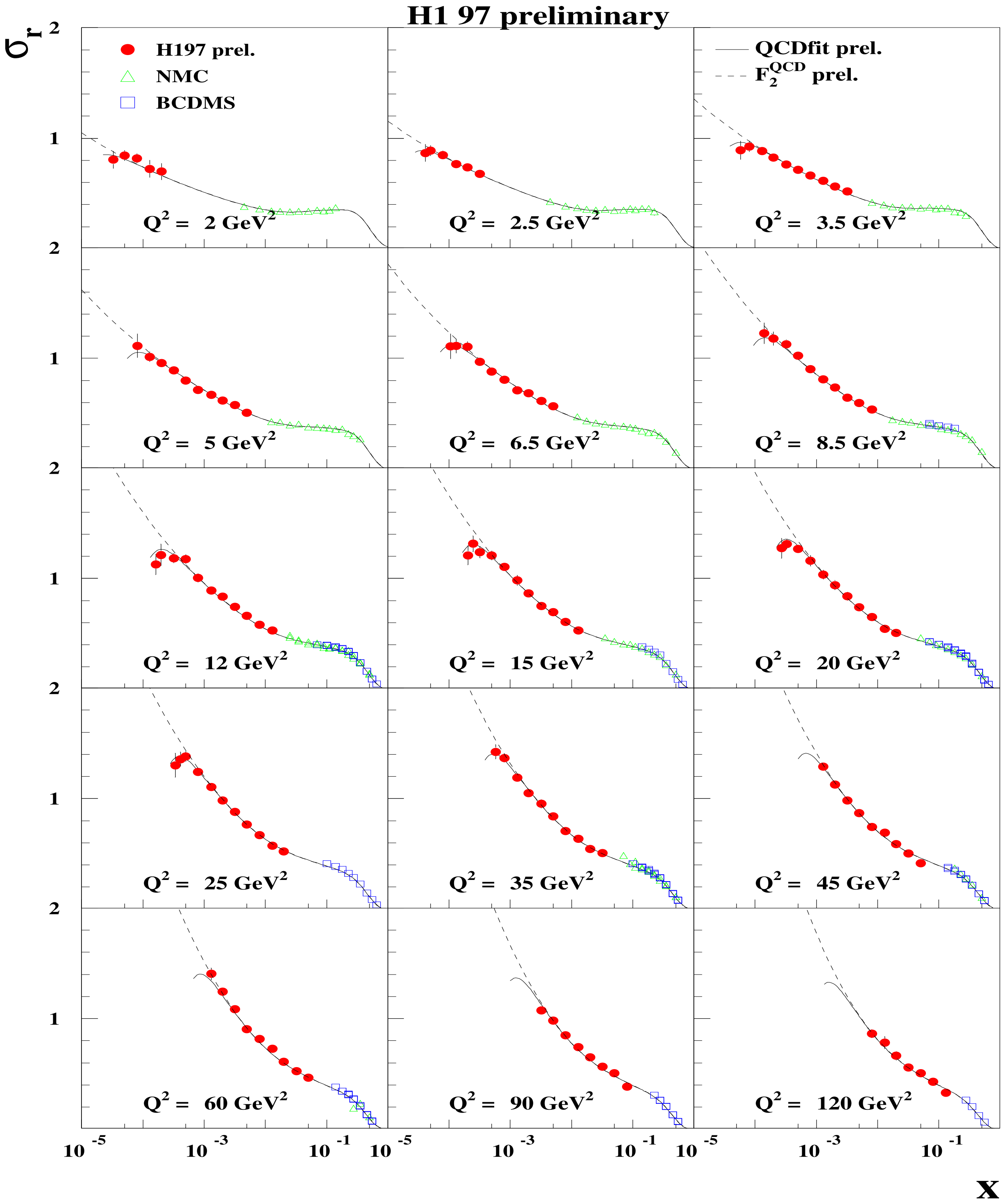
- NLO QCD fit to σ_r , $\overline{MS}$ scheme
  DGLAP evolution equations
  both F_2 and F_L icluded in the fit
- **Input** Parametrisations at $Q_0^2 = 2\ \mathrm{GeV}^2$:

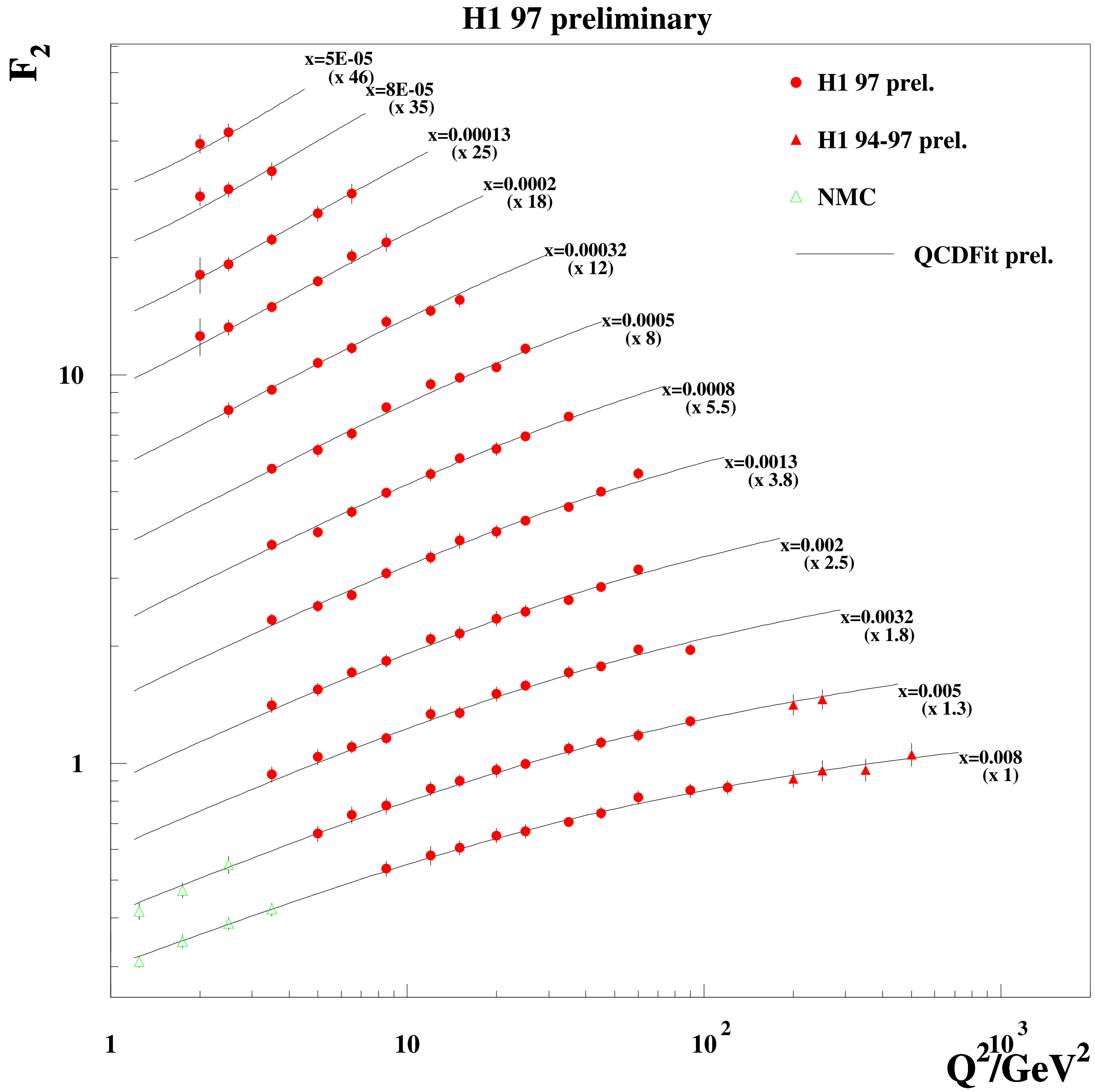
$$
\begin{aligned}
xg\ \ (x) &= A_g x^{B_g} (1-x)^{C_g} (1 + D_g x) \\
xu_v(x) &= A_u x^{B_u} (1-x)^{C_u} (1 + D_u x + E_u \sqrt{x}) \\
xd_v(x) &= A_d x^{B_d} (1-x)^{C_d} (1 + D_d x + E_d \sqrt{x}) \\
xS\ (x) &= A_s x^{B_s} (1-x)^{C_s} (1 + D_s x + E_s \sqrt{x})
\end{aligned}
$$

- S $= \bar{u} = \bar{d} = 2\ \bar{s}$
- Momentum sum rule fixes A_s
- Quark Counting rules fixe A_u, A_d

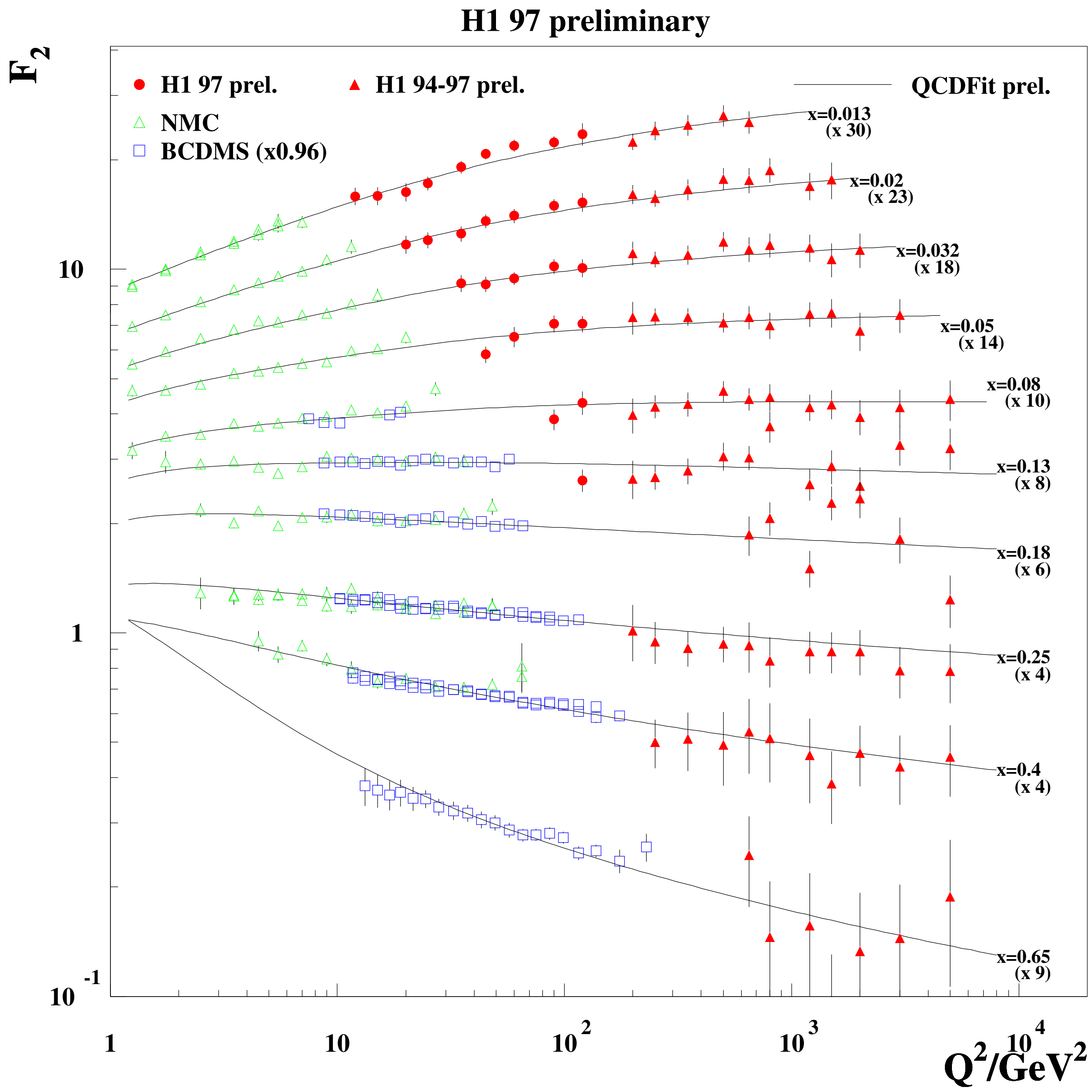
QCD analysis

- $F_2 = F_2^{n_f=3} + F_2^c$
- **c** from NLO γg fusion
  $m_c = 1.5$ GeV, $\mu^2 = Q^2 + 4m_c^2$
- $\alpha_s(\mathrm{M}_Z^2) = 0.118$
- **Data:**
  - **NMC+BCDMS:** p+d
    excluded BCDMS : $x > 0.5$ for $\mathrm{Q}^2 < 15$ GeV^2
  - **H1:** 97 data , $Q^2 \in (2{,}120)$ GeV^2
    94-97 data , $Q^2 \in (120{,}30000)$ GeV^2
  - normalization of H1 data fixed
- χ^2 of the fit: 1495 for 1095 data points


H1 97 preliminary
σ_r
H197 prel.
NMC
BCDMS
QCDfit prel.
F_2^{QCD} prel.
$Q^2 =$ 2 GeV^2
$Q^2 =$ 2.5 GeV^2
$Q^2 =$ 3.5 GeV^2
$Q^2 =$ 5 GeV^2
$Q^2 =$ 6.5 GeV^2
$Q^2 =$ 8.5 GeV^2
$Q^2 =$ 12 GeV^2
$Q^2 =$ 15 GeV^2
$Q^2 =$ 20 GeV^2
$Q^2 =$ 25 GeV^2
$Q^2 =$ 35 GeV^2
$Q^2 =$ 45 GeV^2
$Q^2 =$ 60 GeV^2
$Q^2 =$ 90 GeV^2
$Q^2 =$ 120 GeV^2
x



data points from the range $y < 0.6$



data points from the range $y < 0.6$

Conclusions

- DATA 97 made possible to measure F_2 with improved precision in the extended kinematic range towards low y due to the higher events statistics and the new backward silicon tracker

- stat.errors reached $\sim 1\%$, system.errors $\sim$ 3-4 %

- NLO DGLAP works down to $Q^2 \sim 2\ \mathrm{GeV}^2$ good description of H1 data in the range

$$2 < Q^2 < 120\ \mathrm{GeV}^2$$
$$3 \cdot 10^{-5} < x < 0.13$$

  and NMC and BCDMS data

- The rise of F_2 towards low x at fixed Q^2 is well interpreted by QCD

- QCD fit gives a good description of the data at the highest Q^2 too