Measurements of inclusive DIS cross section at low Q^2

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DIS Workshop 2005, Madison
27th April 2005

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Deep Inelastic Scattering

- DIS double-differential cross-section at low Q^2

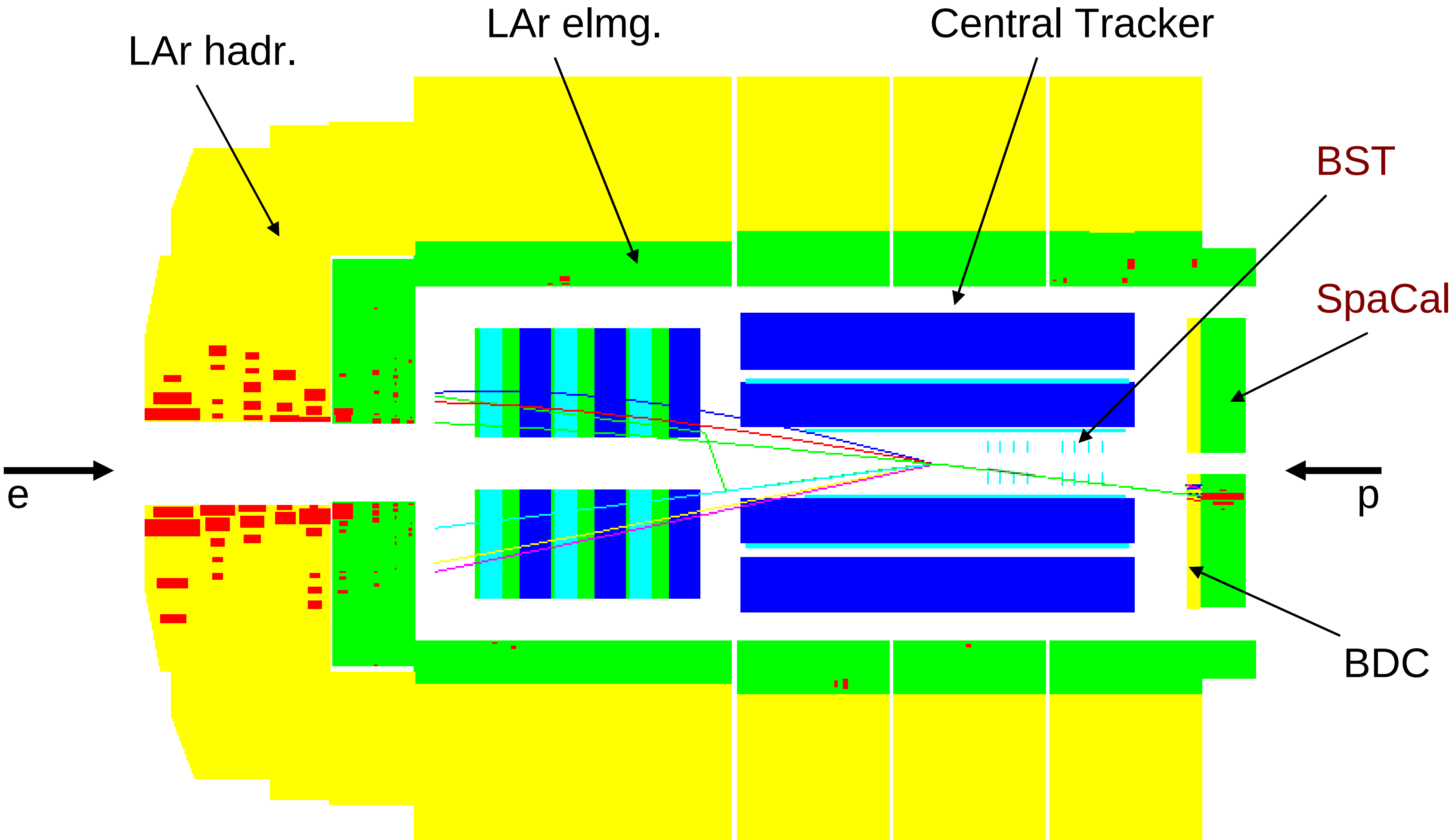
$$\frac{Q^4 x}{2\pi\alpha^2 Y_+} \cdot \frac{d^2\sigma}{dx dQ^2} = \sigma_r = F_2(x, Q^2) - \frac{y^2}{Y_+} \cdot F_L(x, Q^2)$$

  - Inelasticity $y = Q^2 / sx$ is a fraction of the lepton's energy loss and $Y_+ = 1 + (1-y)^2$
  - Center-of-mass energy squared of the lepton-nucleon system $s = 4E_e E_p$
  - For $y < 0.6$ the contribution of F_L is small
- The proton structure function in QPM

$$F_2 = \sum_i e_i^2 x[q_i(x) + \overline{q}_i(x)]$$

  - Expressed as a sum of the (anti)quarks momentum density distributions $q_i(x)$ weighted with their electric charge squared
  - $F_L = 0$ in QPM however $F_L \sim$ gluon density in NLO QCD

Low Q^2 event at H1 detector



Backward detectors of H1

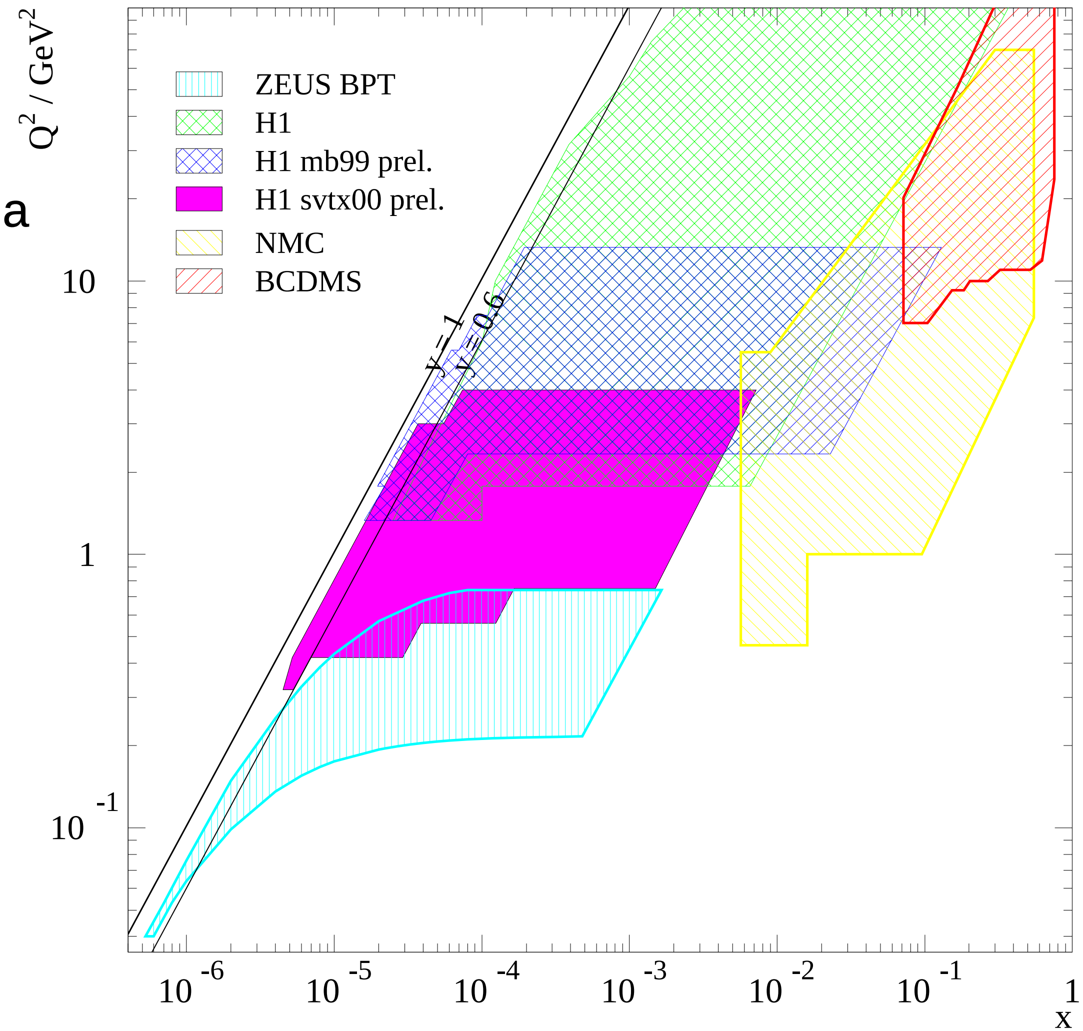
- SpaCal
  - Energy resolution $= 7.5\%/E^{1/2} \oplus 2\%$
  - Acceptance: $153^0 < \Theta < 177^0$
  - Equipped with scintillating fibers
  - Made from 1192 squared cells
  - Calibration accuracy: ~0.3% at 27.5 GeV (DA meth.)
- Backward Silicon Tracker
  - Angular resolution ~0.1 mrad
  - Acceptance: $161.5^0 < \Theta < 176.5^0$
  - Consist of 8 planes and 16 sectors
  - Track reconstruction efficiency: ~95%
  - Hit resolution ~20 μm
  - Alignment accuracy ~0.2 mrad

Kinematic plane

Special runs (with open triggers for inclusive DIS events) :

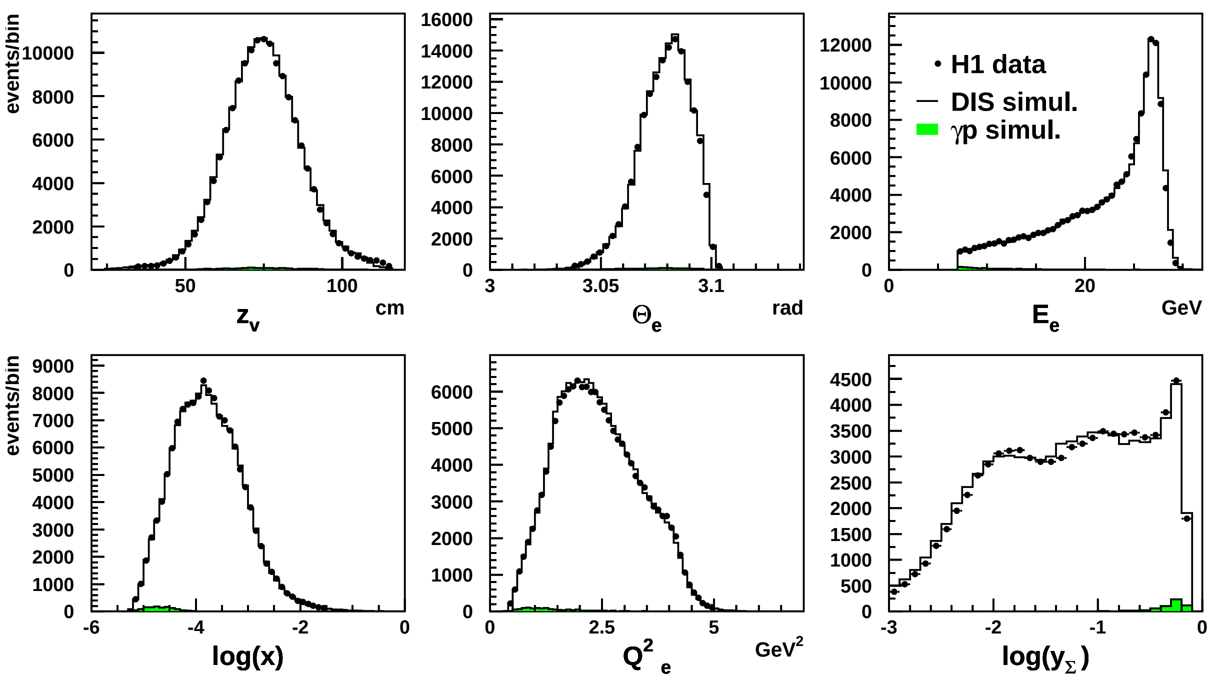
- Nominal vrtx mb99 data access high y region
- Svtx 2000 data to access low Q^2

- The contribution of F_L to cross section is not negligible at measured values of y extended up to 0.9



Measurement of Cross Section

- Event selection
  - Luminosities: $L_{99} = 2.7\text{pb}^{-1}, L_{00} = 0.6\text{pb}^{-1}$
    (also for ISR events)
  - Require a BST reconstructed vertex inside of interaction region
  - Require a SpaCal cluster
  - BST track matching this Spacal cluster



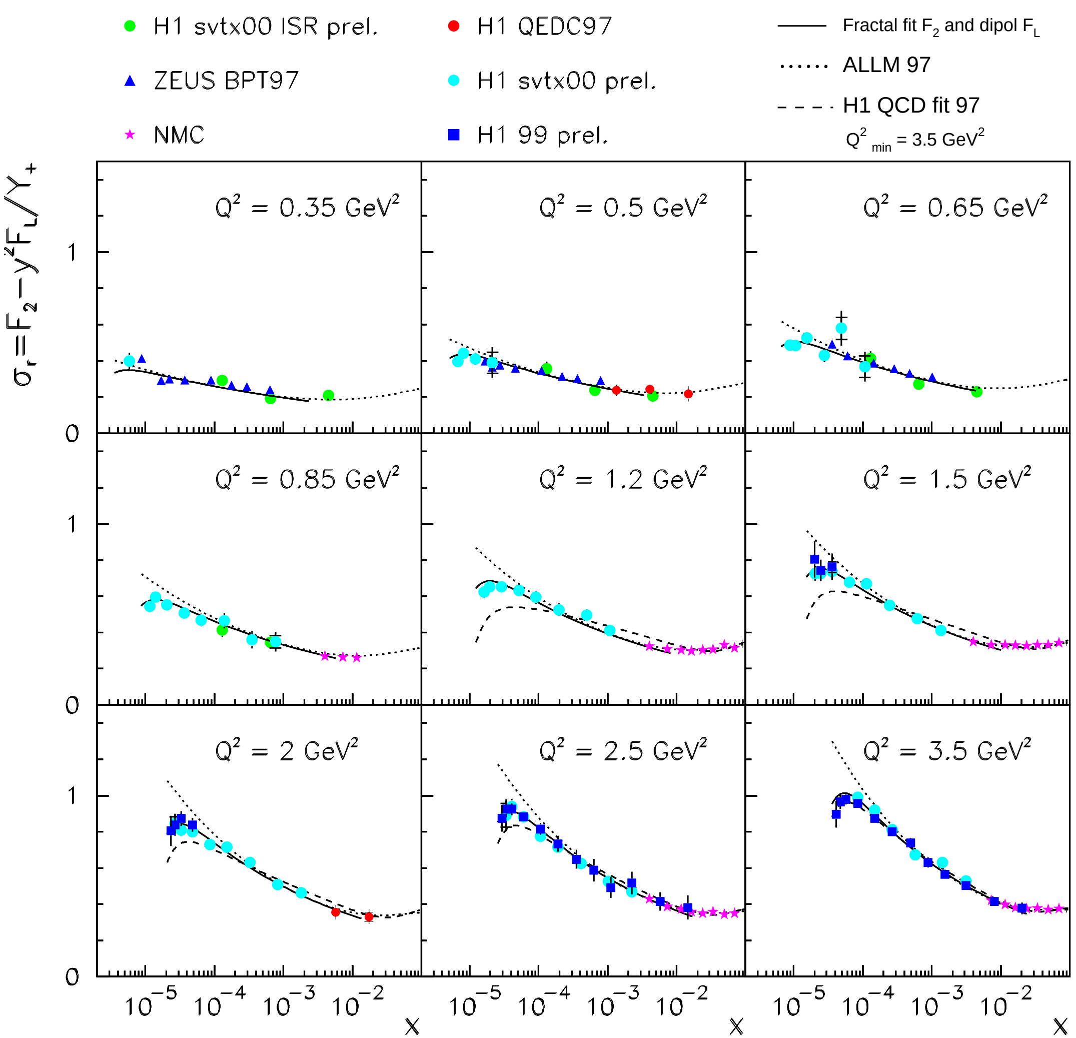
ISR measurement method

- If a photon is emitted from the incoming positron (ISR) the e^+ beam energy is reduced
- For the current analysis the method uses ISR without requirement for the radiative photon to be measured in the photon detector
- The incoming electron energy and kinematics are solely reconstructed from the final state excluding the photon, using the sigma method and energy momentum conservation:
  the incoming electron energy E_e is determined by
  $2E_e = \Sigma + (E - p_z)_{el}$ where $\Sigma = (E - p_z)_{had}$
- Because E_e for radiative events is reduced larger values of $x = x_R$ are reached:

$$x_R = \frac{Q^2_\Sigma}{y_\Sigma \cdot 4E_e E_p} = \frac{Q^2_\Sigma}{2\Sigma E_p}$$

Reduced Cross Section

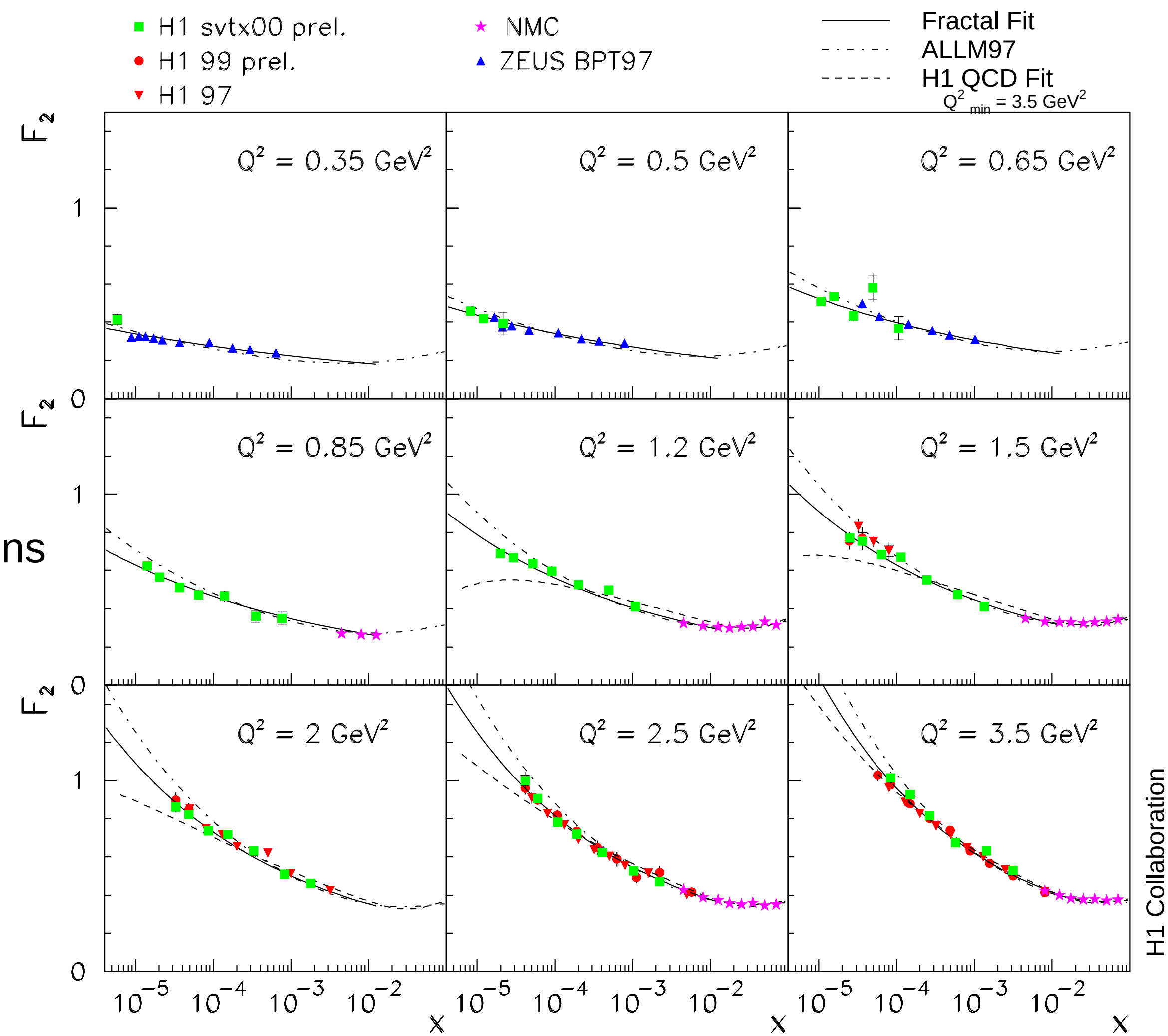
- The precision of measurement is ~2-3% in bulk region
- H1 svtx'00 ISR extends measurement to high x and QEDC'97 even to higher value of proton momentum fraction



Structure function F_2

- F_2 rises towards low x for all measured Q^2 bins

- The preliminary H1 results are in a good agreement with H1'97, ZEUS and NMC data in the overlapping regions



Rise of F_2 towards low x

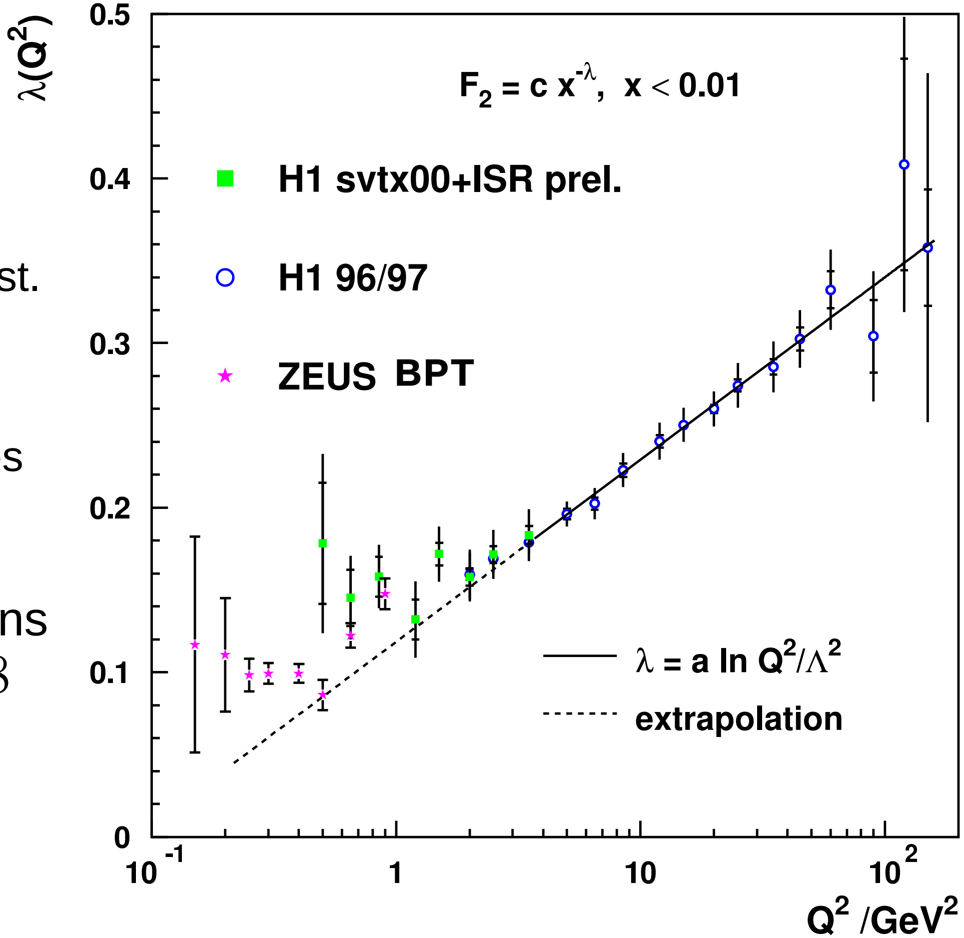
- F_2 used to fit x-dependences in Q^2 bins for x<0.01 and W>12 GeV:

$$F_2 = c(Q^2) \cdot x^{-\lambda(Q^2)}$$

- $\lambda \sim \ln(Q^2/\Lambda^2)$ and $c(Q^2)$~const. for $Q^2 > 3.5\,\mathrm{GeV}^2$

- Around $Q^2 = 1\,\mathrm{GeV}^2$ λ deviates from log-dependence

- From soft hadronic interactions it is expected that $\lambda \rightarrow 0.08$ for $Q^2 \rightarrow 0$

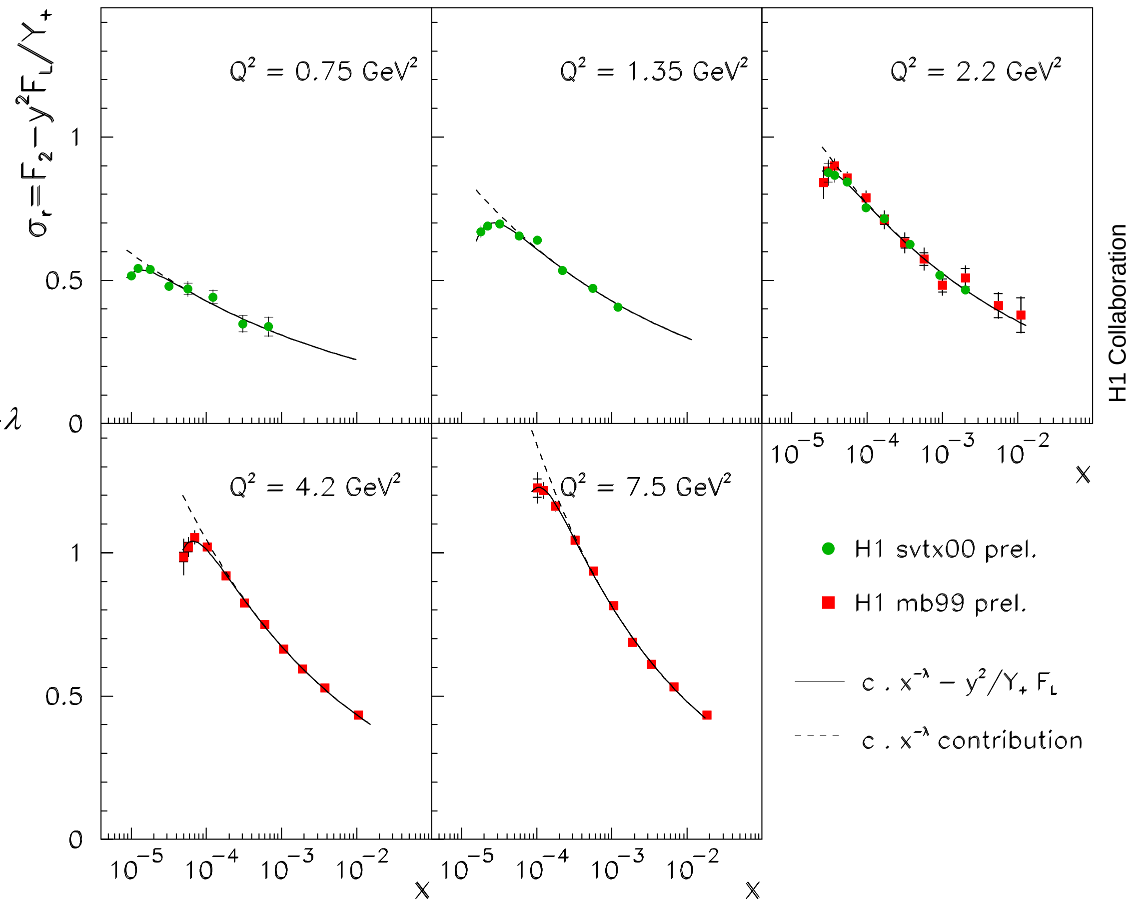


F_L at low Q^2 – 'shape' method

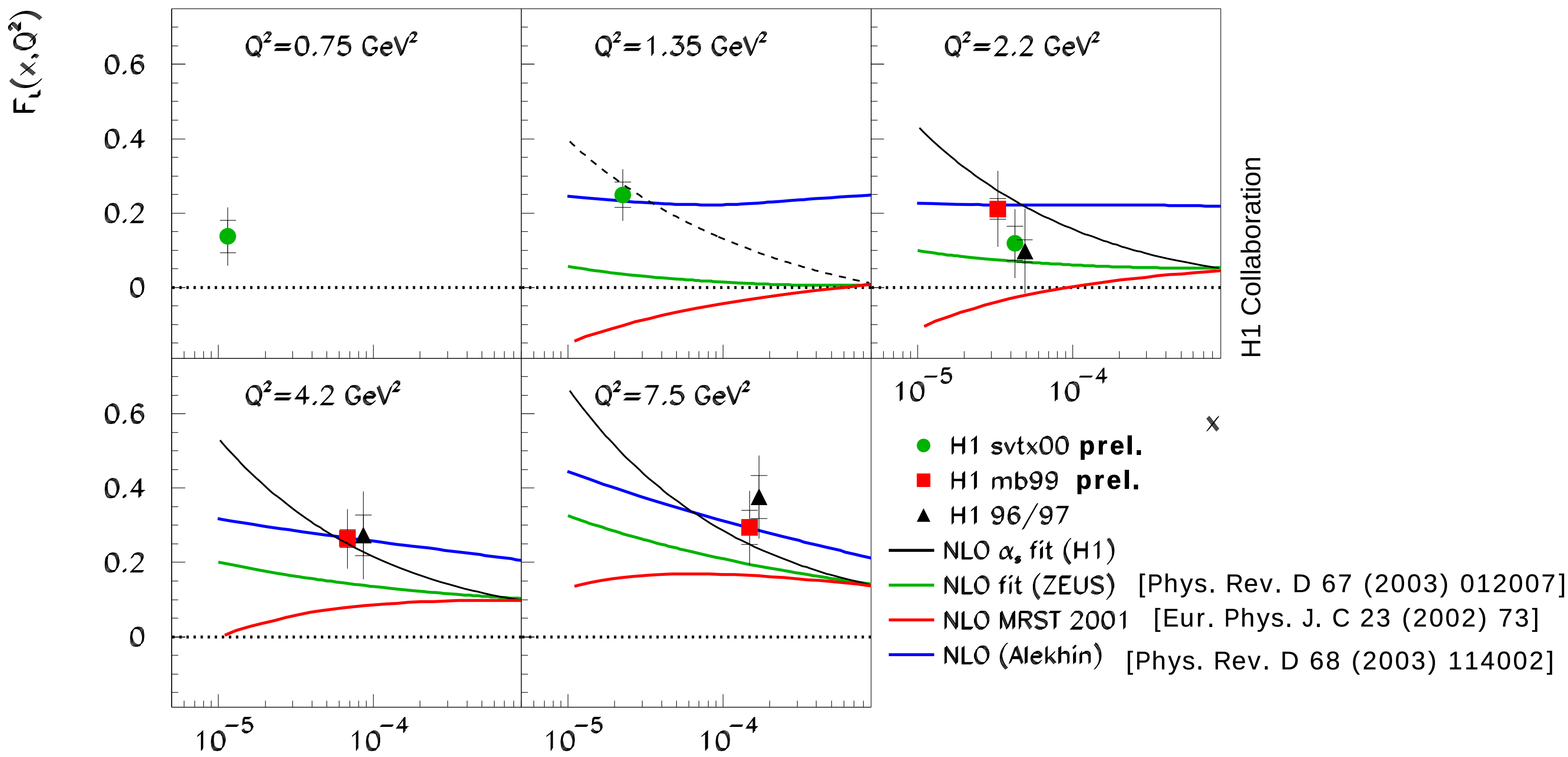
- Difference in the shape between σ_r and F_2 vs x is driven by y^2/Y_+ mostly (F_L variation is small) :
  - One F_L bin per Q^2
  - Fit in Q^2 bins:

$$\sigma_{fit} = F_2 - \frac{y^2}{Y_+} F_L \ , \ F_2 = c \cdot x^{-\lambda}$$

- Model dependent determination

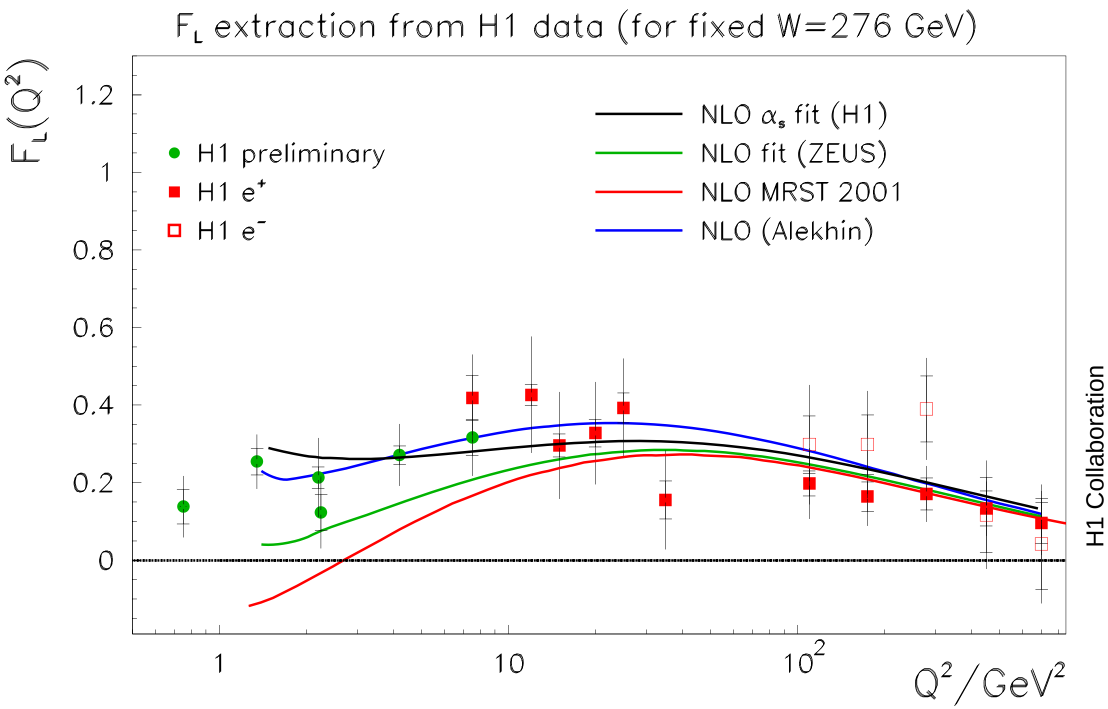


FL extraction



- Extracted FL is greater than 0 for all bins in Q^2
- With small enough errors it is able to constrain theoretical predictions

F_L extraction

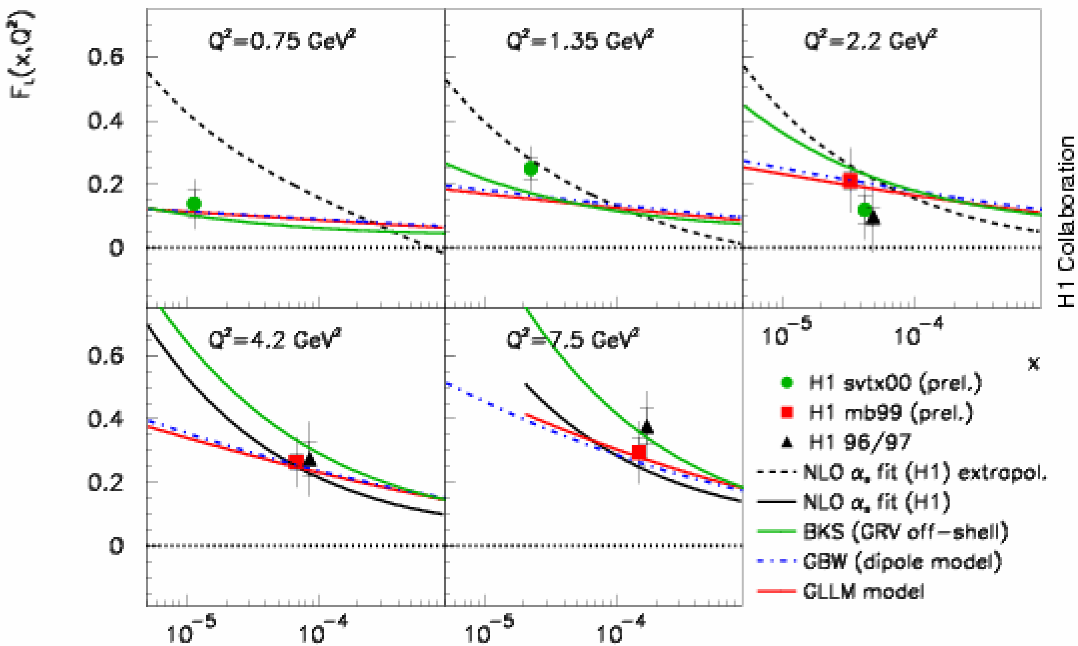


- H1 NLO QCD fit is consistent with the data for wide Q^2 range
- Alekhin fit is in agreement with the data
- MRST and ZEUS NLO fits tend to be low at low Q^2

Summary

- *Preliminary F_2 results with a high precision at low Q^2*
- *The ISR data of H1 extend the region to larger x and allows the rise of F_2 to low x to be determined for Q^2 below 1 GeV^2*
- *F_L extracted with the 'shape' method allows to distinguish between different PDF determinations*

F_L results



- BKS (GRV off-shell) – B. Badełek, J. Kwieciński, A. Staśto *Z. Phys.* C74, 297 (1997)
- GBW (dipole model) – K. Golec-Biernat, M. Wüsthoff *Phys. Rev.* D59, 014017 (1999)
- (GLLM model) – E. Gotsman, E. Levin, M. Lublinsky, U. Maor *Eur. Phys. J.* C27, 411 (2003)