New Measurement of F_2 at low Q^2 with Initial State Radiation Data

A. Petrukhin (H1 Collaboration)

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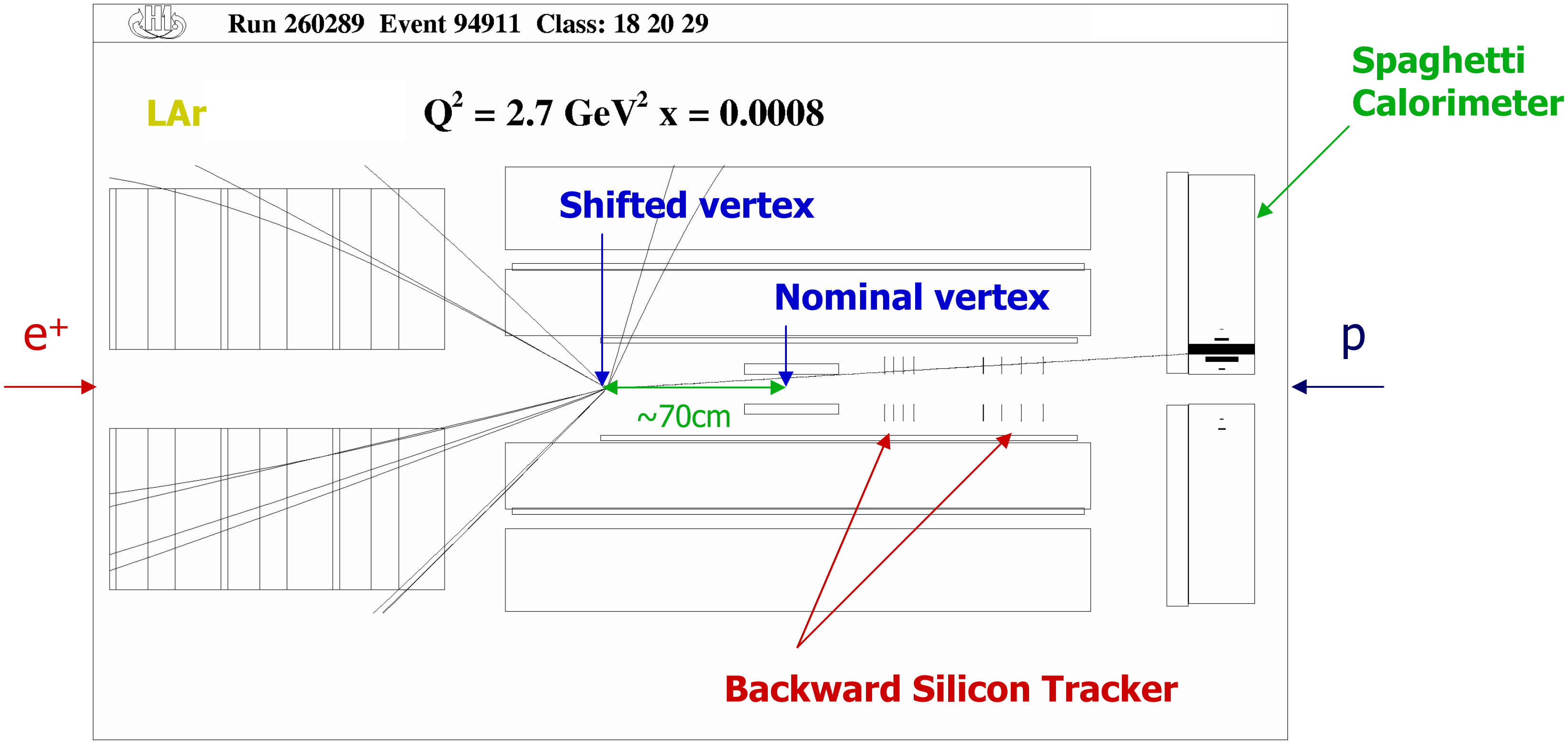
Shifted Vertex 2000 Data

- Special minimum bias trigger running in August 2000.
- Vertex shifted by +70cm in order to access $Q^2 \leq 1 GeV^2$
- Total luminosity: 583 nb^{-1}
- Preliminary analysis presented previously.

- The data were taken with nominal beam energies $\rightarrow$ limited acceptance below $1 GeV^2$ at low y.

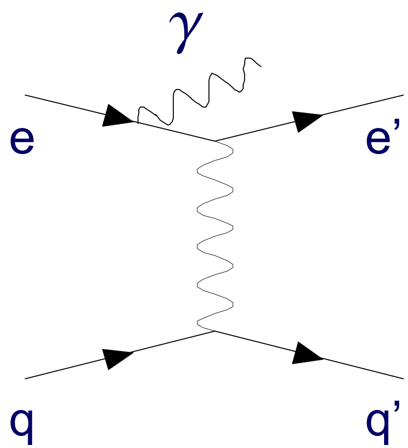
- Extend the kinematic range by using ISR events.

H1 Detector at HERA



- High precision reconstruction:
  - SpaCal: $\Delta E'_e/E'_e$=0.3% at kinematic peak
  - BST: $\Delta\theta$ = 0.2 mrad, suppression of neutral γp background
  - LAr: $\Delta E_h/E_h$ = 2% from p_t^h/p_t^e calibration.
- Shifting vertex opens detector acceptance at low Q^2.

ISR Measurement Method



- If a photon is emitted from the incoming positron effectively the e^+ beam energy is reduced.
- This can be utilized to access larger $x=Q^2/(ys)$, at a given Q^2, as was previously done in ISR F_2 data analyses.

- However, in these analyses the radiated photon is to be tagged which introduces an acceptance and measurement limitation.

- Here a new method is introduced which uses ISR but does NOT require the photon to be detected.

- The kinematics and the incoming electron energy are solely reconstructed from the final state, excluding the photon, using the sigma method and energy momentum conservation.

‘Sigma’ Method - reminder

- Sigma method:

$$Q^2_\Sigma = \frac{E'^2_e \sin^2\theta_e}{1 - y_\Sigma} \qquad y_\Sigma = \frac{\Sigma}{\Sigma + E'_e(1-\cos\theta_e)}$$

where $\Sigma = (E - p_z)_{had}$

- The incoming electron energy is determined by

$$2E_e = \Sigma + (E - p_z)_{el}$$

which is generally valid for both radiative and non-radiative events.

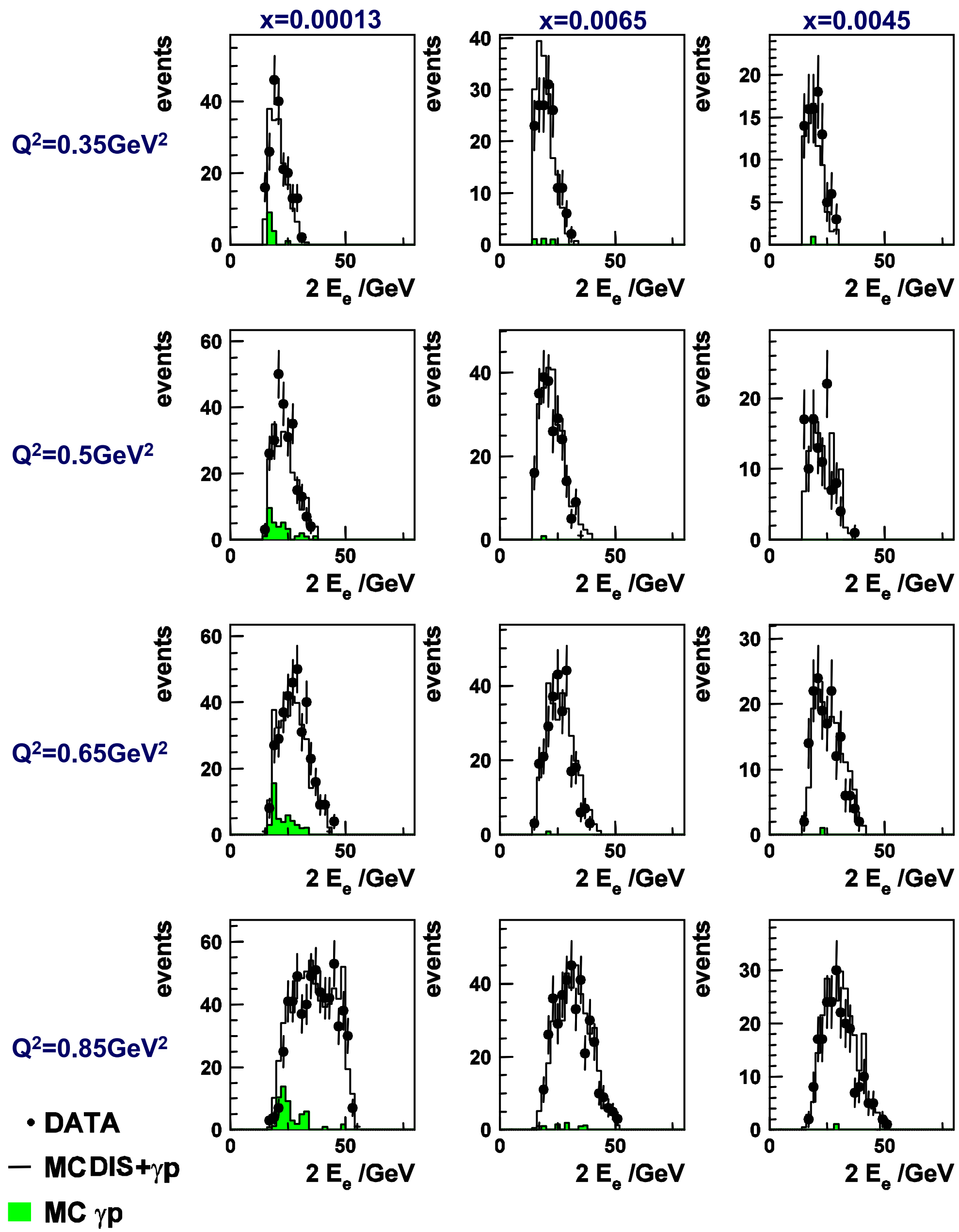
- This analysis determines Bjorken x as

$$x_R = \frac{Q^2_\Sigma}{y_\Sigma . 4E_e E_p} = \frac{Q^2_\Sigma}{2\Sigma E_p}$$ which is independent of E_e.

E_e reconstruction

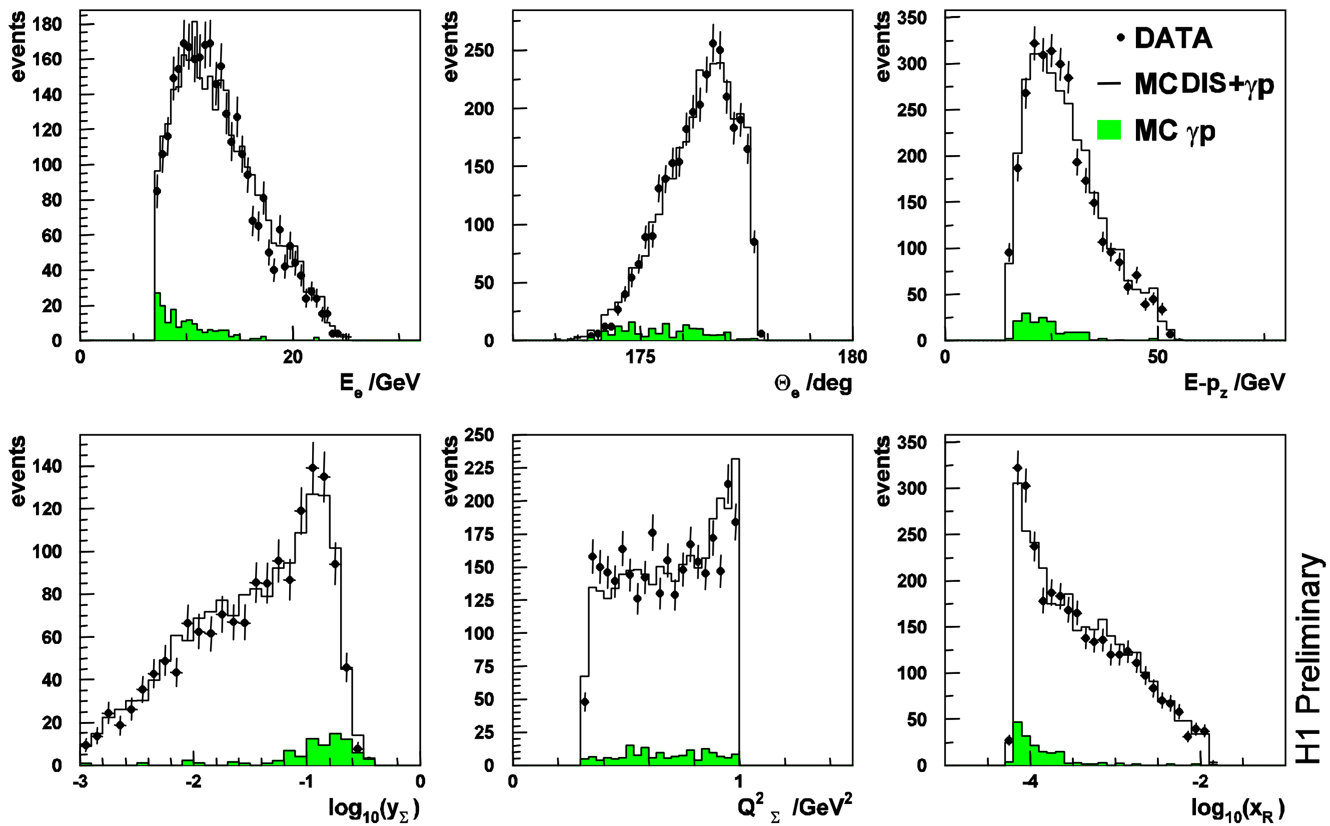
- $2E_e = \Sigma + (E-p_z)_{el}$
- The reduced incoming electron energy is well measured by the final state particles.
- Because $2E_e$ for radiative events is much reduced larger values of $x=x_R$ are reached.

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



Control Distributions

- DIS simulation – DJANGO using Fractal Model for F_2. Normalized to luminosity.
- γp – PHOJET normalized to tagged positron events.



Systematic Uncertainties

- Correlated systematic uncertainty
  - electron energy (0.3% at 27.6 GeV, 2% at 7 GeV)
  - electron angle (0.2mrad, measured by Backward Silicon Tracker)
  - hadronic calibration (5% SpaCal, 2% LAr and tracks)
  - LAr noise contribution to $E\text{-}p_z$ and P_t (10%)
  - Photoproduction background (20% PHOJET normalisation)
- Uncorrelated systematic uncertainty
  - MonteCarlo statistics
  - trigger (0.5%)
  - BST reconstruction (2%)
  - radiative corrections (3%, not applied)
- Total cross section uncertainty is ~10%.
- Uncertainty of the luminosity measurement: 1.8%

  (hereafter not included in measurement errors)

Cross Section – ISR alone

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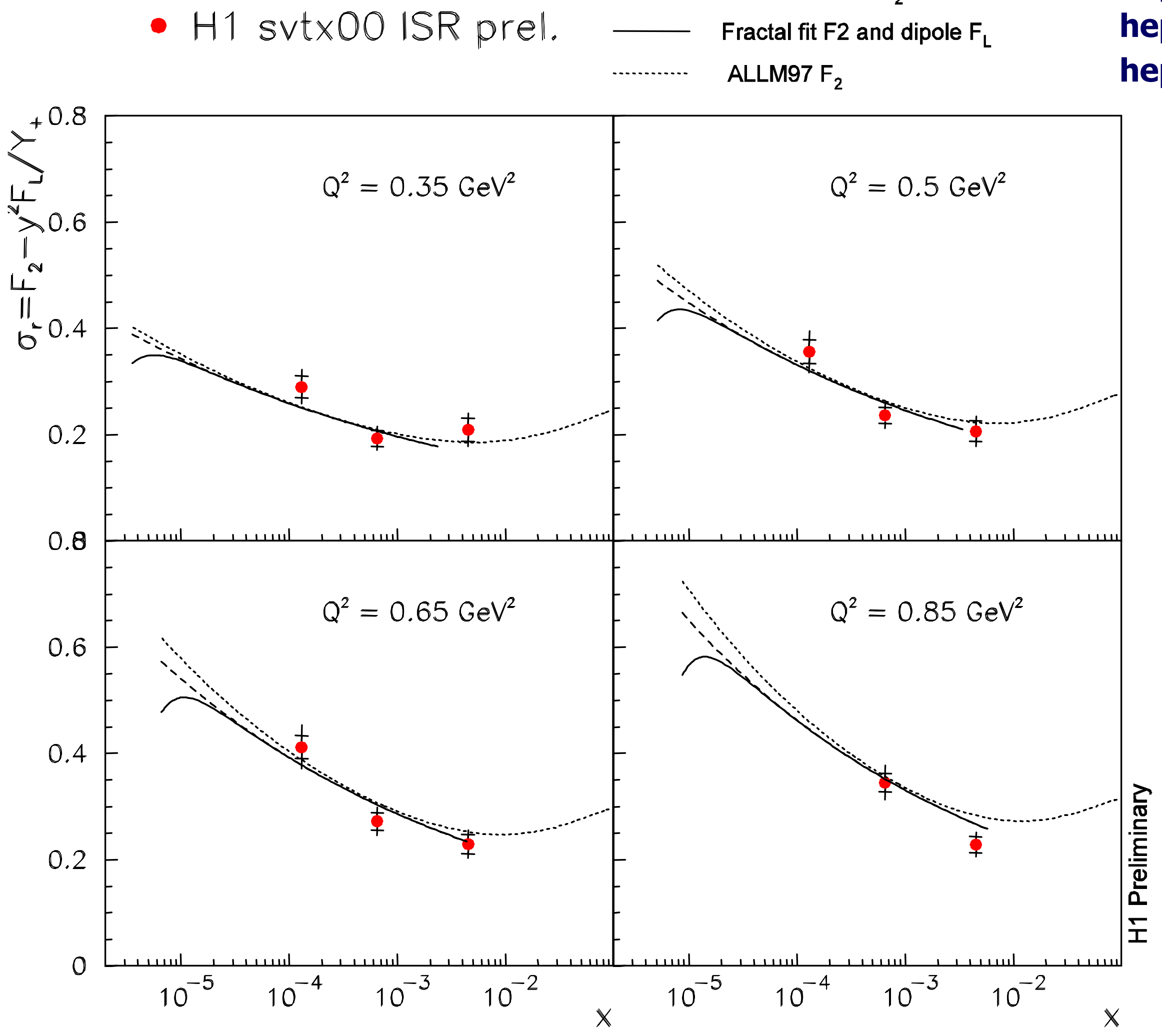
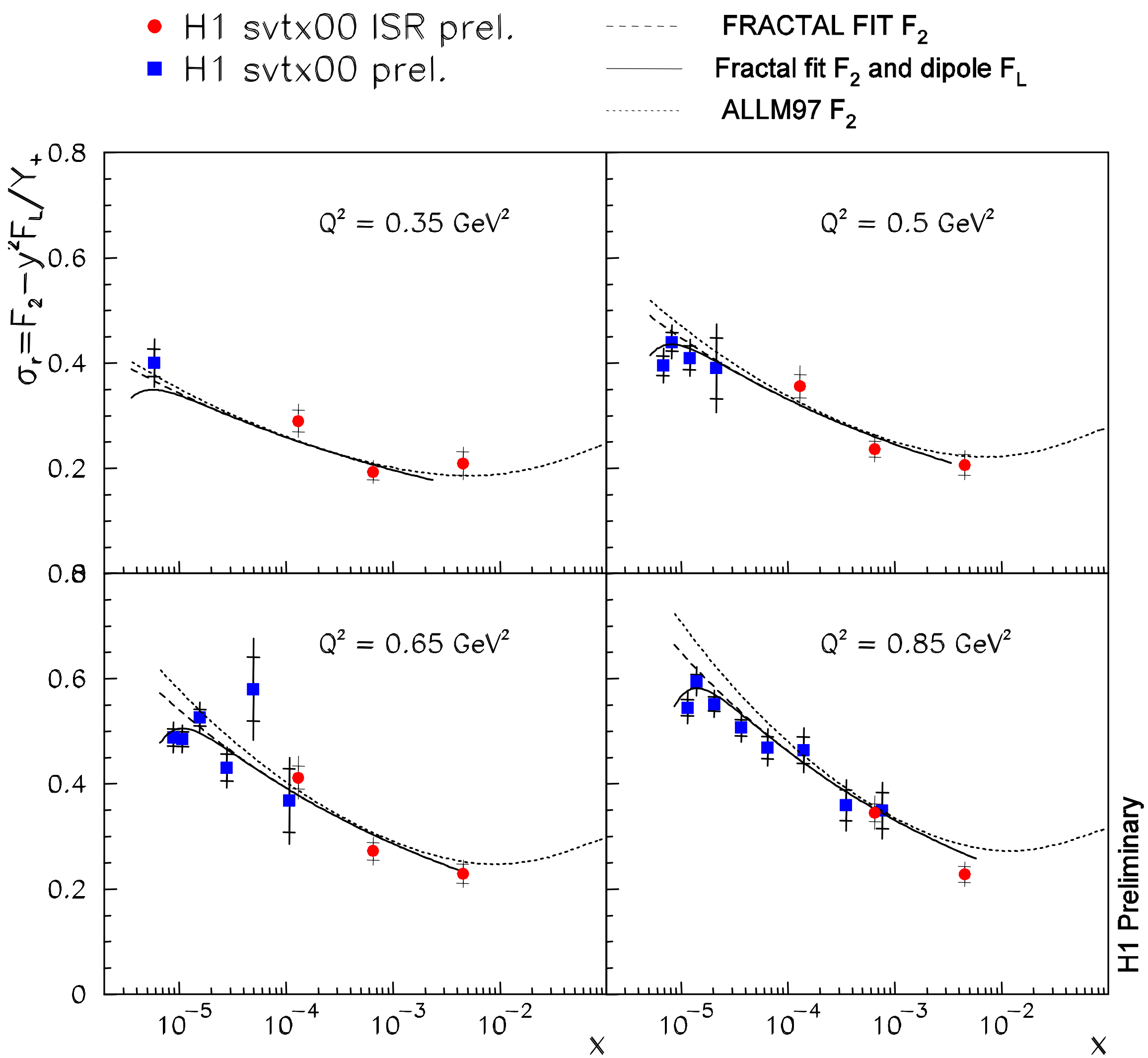
hep-ph/0207031
hep-ph/9712415

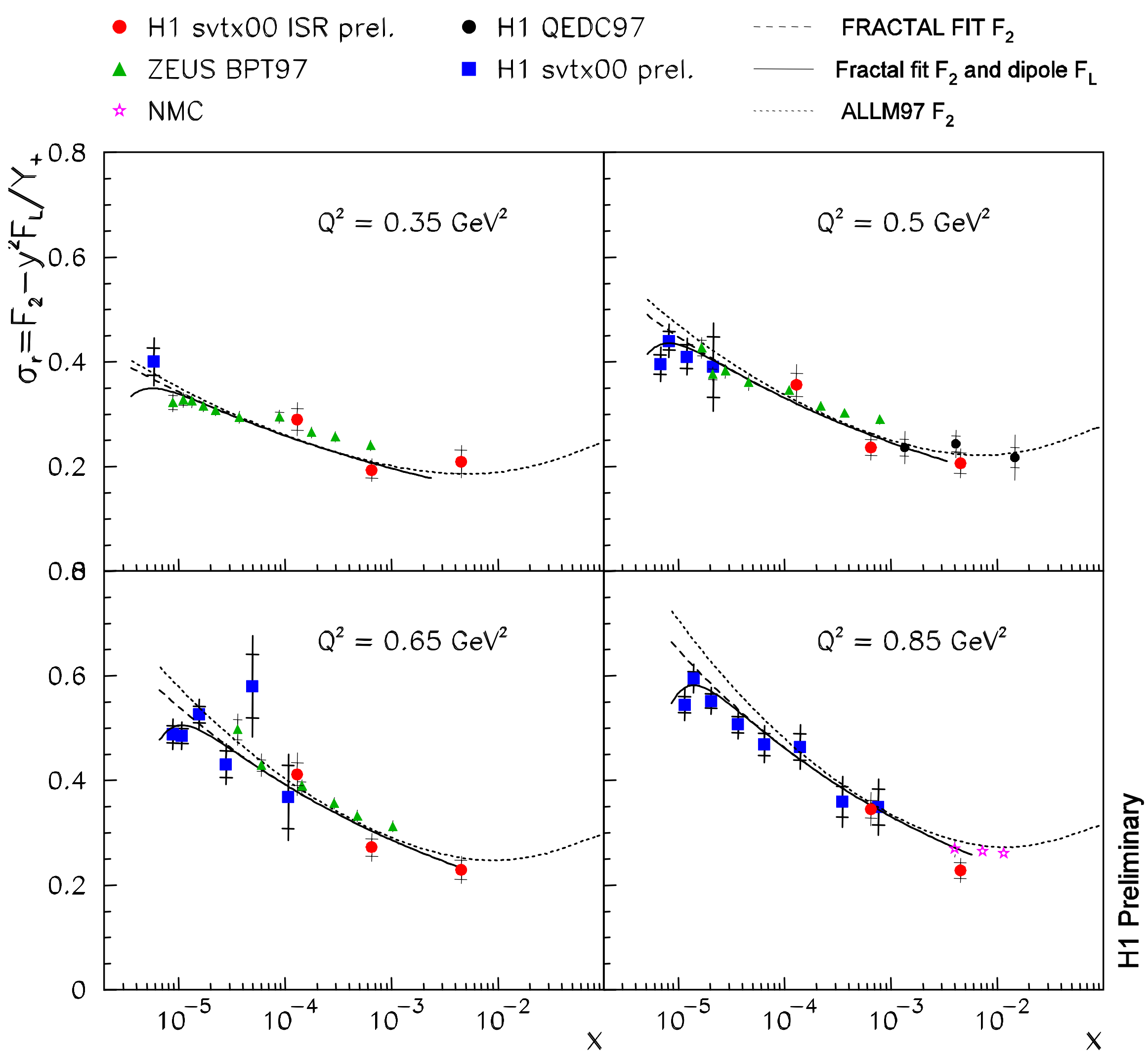


Cross Section – svtx00 & ISR



- ISR method complements svtx data by accessing large x at low Q^2.

Low Q^2 Cross Section Measurements



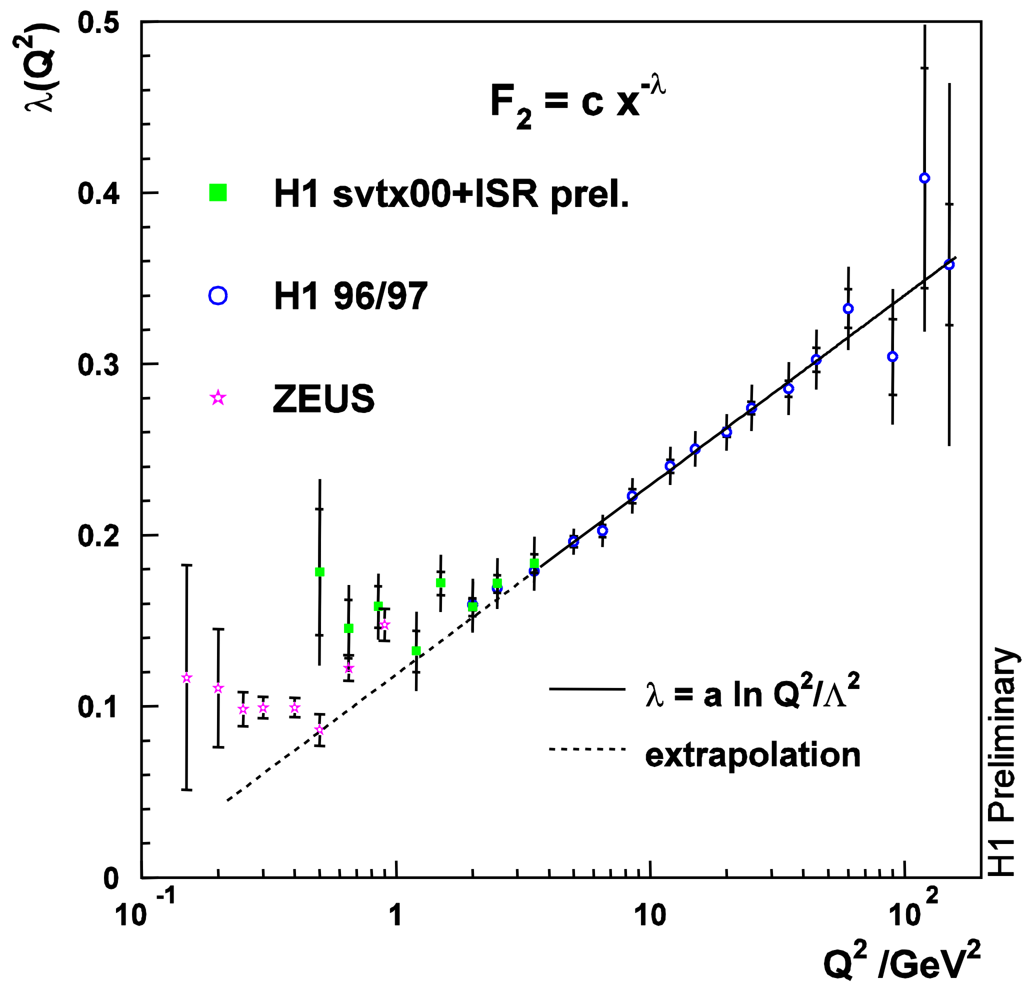
- ISR data consistent with data from ZEUS BPT,
  H1 QEDC and NMC in the respective regions of overlap.

Rise of F_2 towards low x

- Presented svtx00 ISR data are combined with the measurement of non-ISR svtx00 data.
- F_2 data used to fit x-dependecies in Q^2 bins for x<0.01 (and W>12GeV) :

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

- Bridge Q^2 gap between BPT and data from standard detector and analysis.
- From soft hadronic interactions it is expected that $\lambda \rightarrow \sim 0.08$ for $Q^2 \rightarrow 0$.



Summary

- The region of large x at low Q^2, below 1 GeV^2, is shown to be accessible using a new reconstruction method using ISR events without an explicit detection of the radiated photon.

- The obtained cross section is consistent with other data in the regions of overlap and with phenomenological expectations. The accuracy of this preliminary analysis is about 10%.

- The ISR data extend the region to larger x allowing the rise of F_2 to low x to be determined for Q^2 below 1GeV^2 in the H1 data.