

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

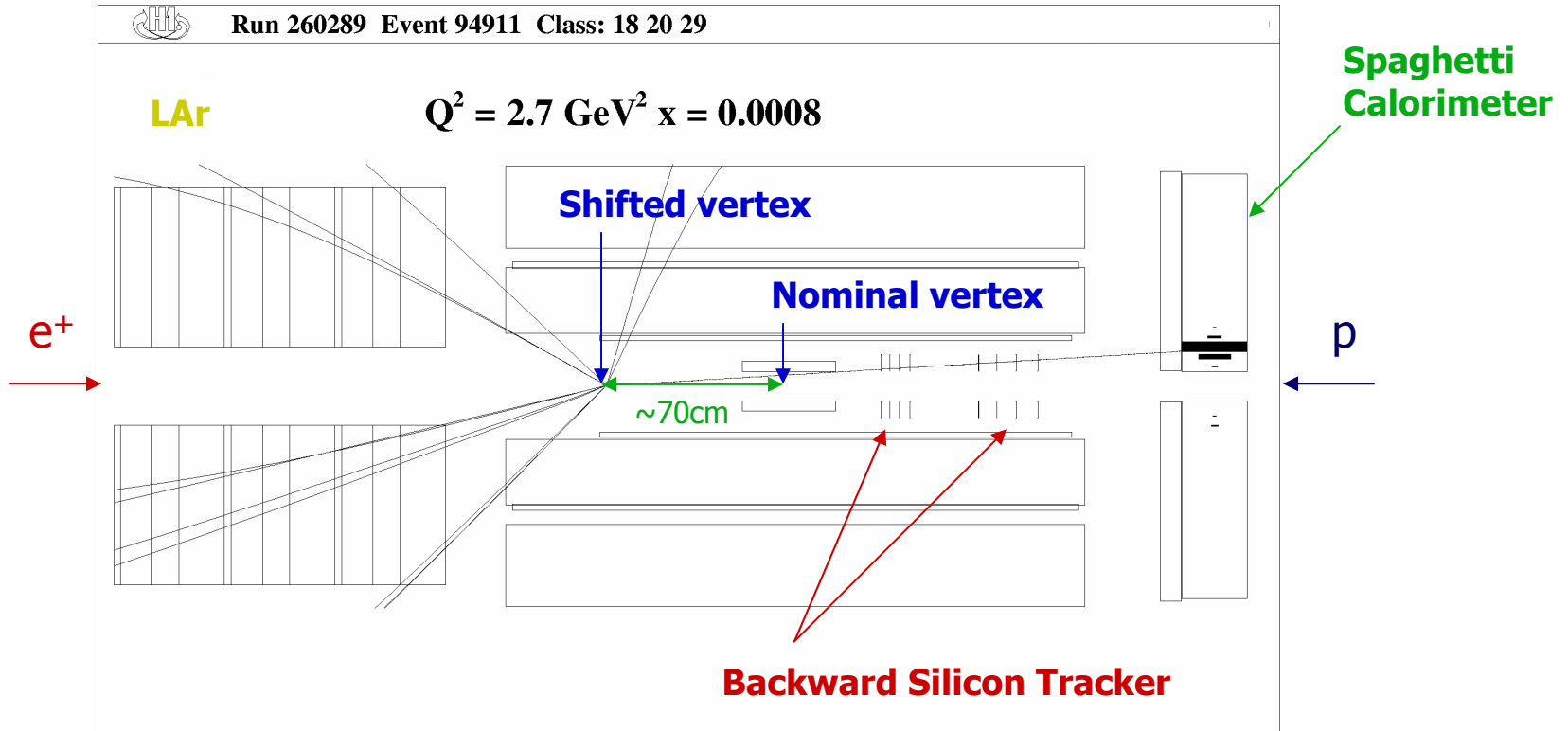
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DIS 2004, Štrbské Pleso, Slovakia
April 14, 2004

Shifted Vertex 2000 Data

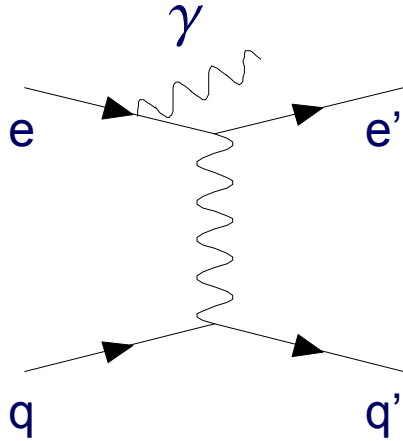
- Special minimum bias trigger running in August 2000.
 - Vertex shifted by +70cm in order to access $Q^2 \leq 1\text{GeV}^2$
 - Total luminosity: 583 nb^{-1}
 - Preliminary analysis presented previously.
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- The data were taken with nominal beam energies → limited acceptance below 1GeV^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: $\Delta\theta = 0.2 \text{ mrad}$, 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:

$$Q_{\Sigma}^2 = \frac{E_e'^2 \sin^2 \theta_e}{1 - y_{\Sigma}} \qquad y_{\Sigma} = \frac{\Sigma}{\Sigma + E_e'(1 - \cos \theta_e)}$$

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.

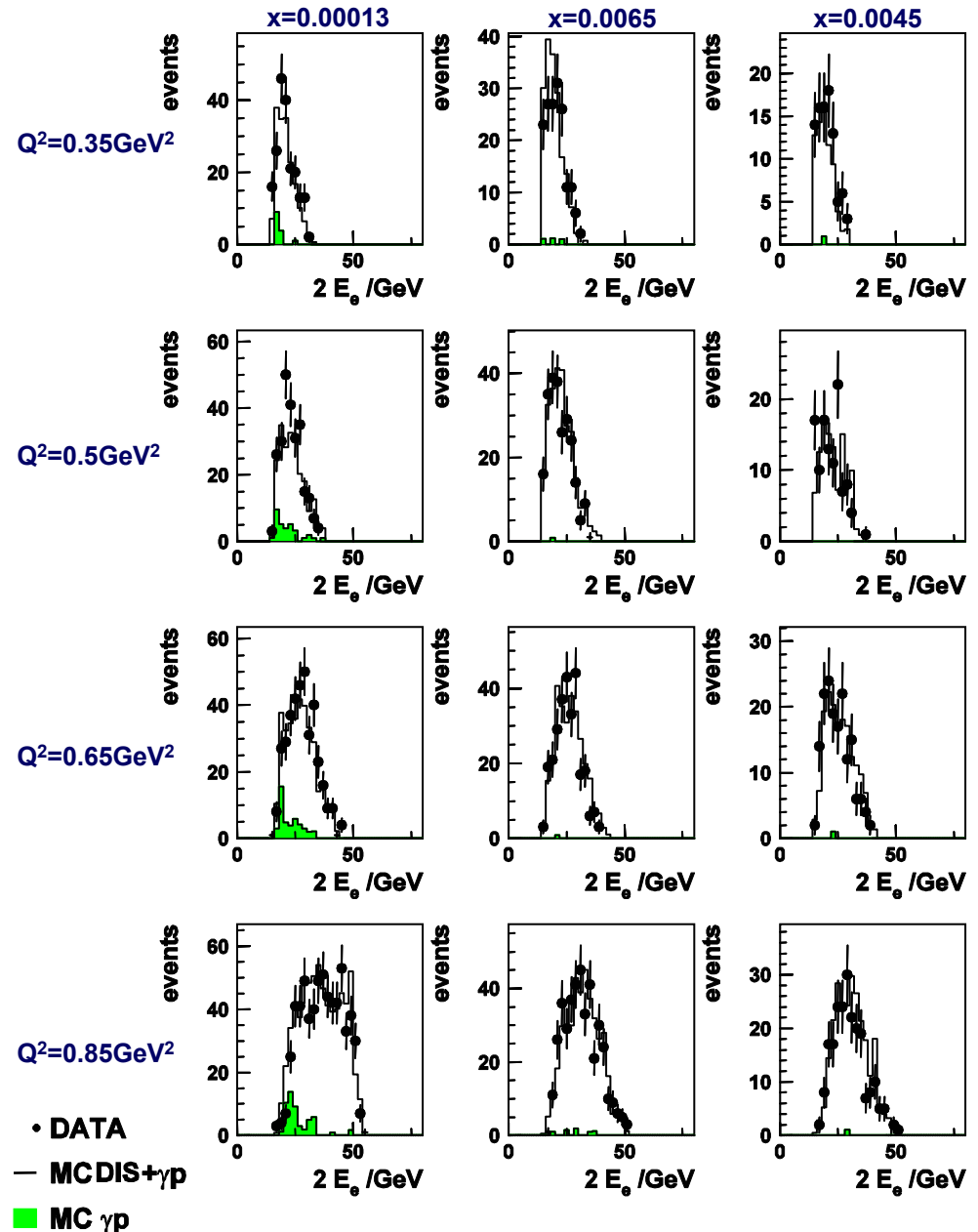
- This analysis determines Bjorken x as

$$x_R = \frac{Q_{\Sigma}^2}{y_{\Sigma} \cdot 4E_e E_p} = \frac{Q_{\Sigma}^2}{2\Sigma E_p} \quad \text{which is independent of } E_e.$$

E_e reconstruction

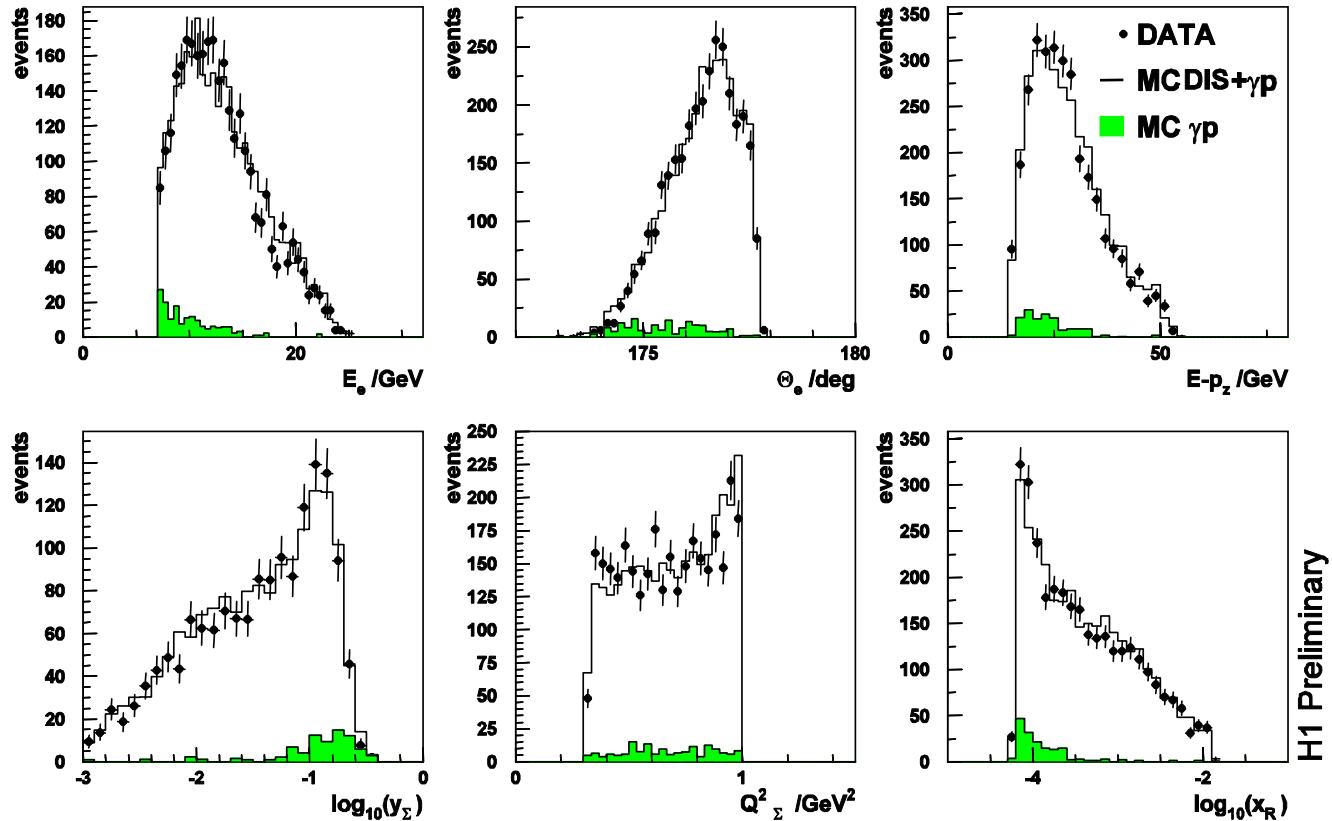
- $2E_e = \Sigma + (E - p_z)_{el}$
- The reduced incoming electron energy is well measured by the final state particles.
- Because $2E_e$ for radiative events is much reduced larger values of $x = x_R$ are reached.

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



Control Distributions

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



Systematic Uncertainties

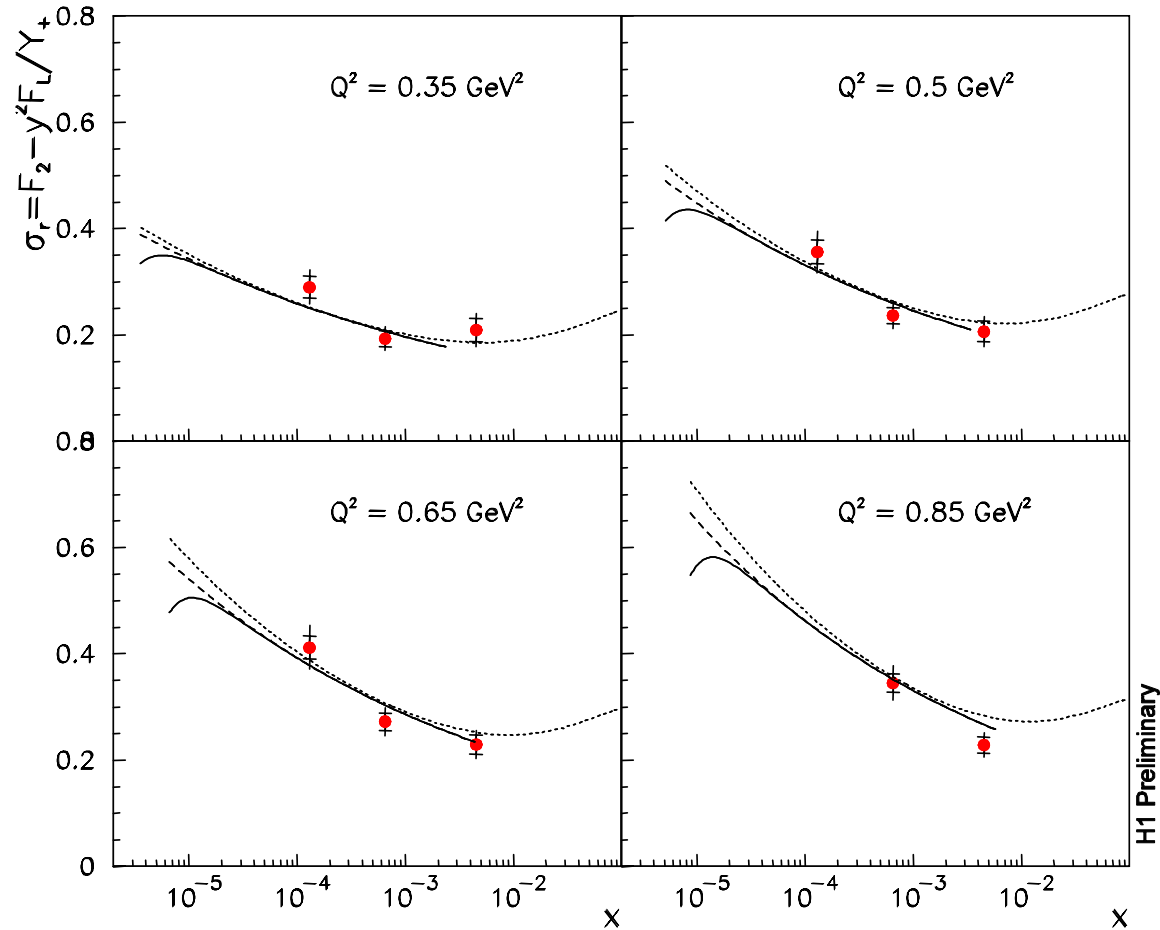
- Correlated systematic uncertainty
 - electron energy (0.3% at 27.6 GeV, 2% at 7 GeV)
 - electron angle (0.2mrad, measured by Backward Silicon Tracker)
 - hadronic calibration (5% SpaCal, 2% LAr and tracks)
 - LAr noise contribution to $E-p_z$ and P_t (10%)
 - Photoproduction background (20% PHOJET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

Cross Section – ISR alone

● H1 svtx00 ISR prel.

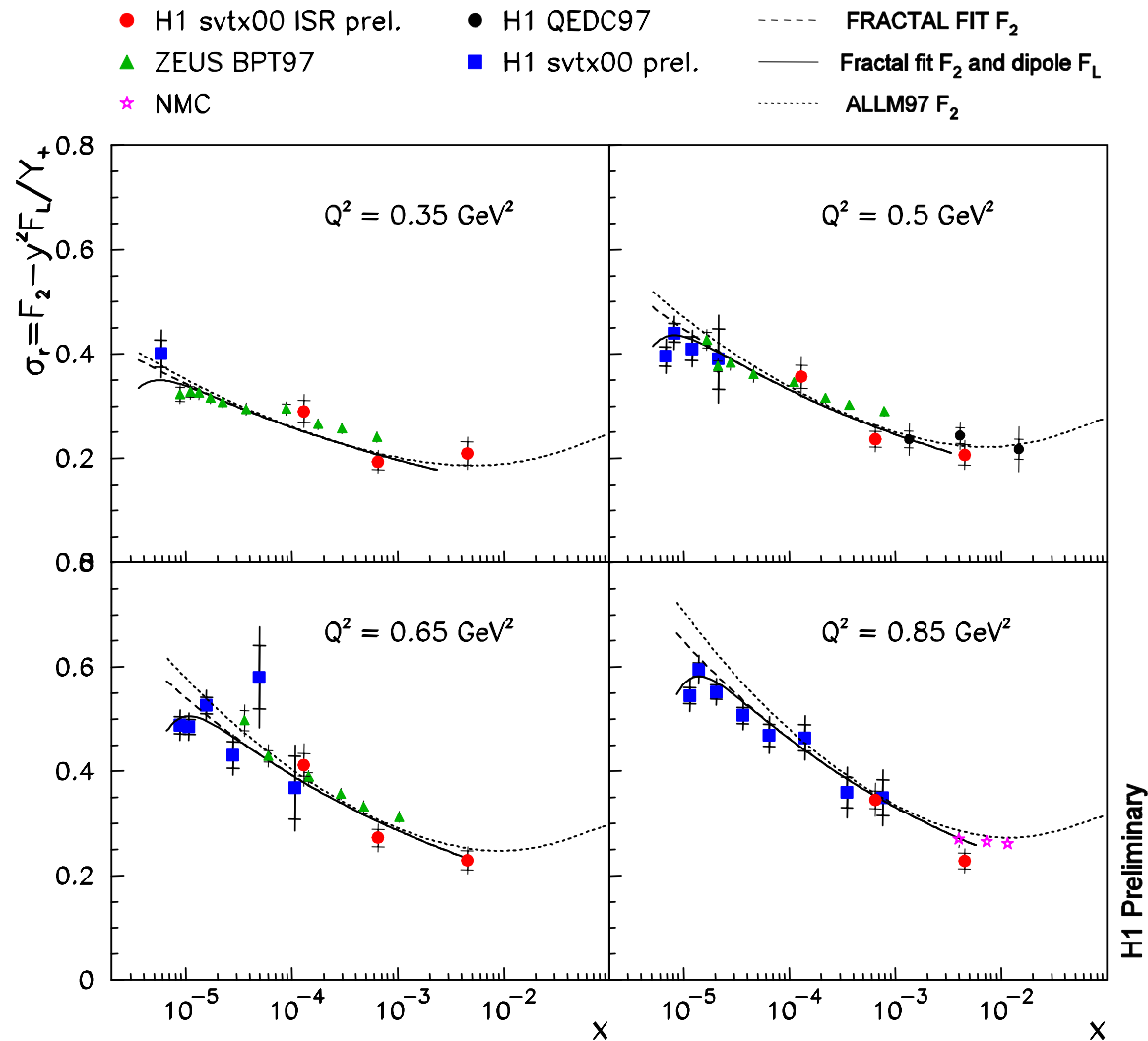
----- FRACTAL FIT F_2
—— Fractal fit F2 and dipole F_L
..... ALLM97 F_2

hep-ph/0203260
hep-ph/0207031
hep-ph/9712415



H1 Preliminary

Low Q^2 Cross Section Measurements



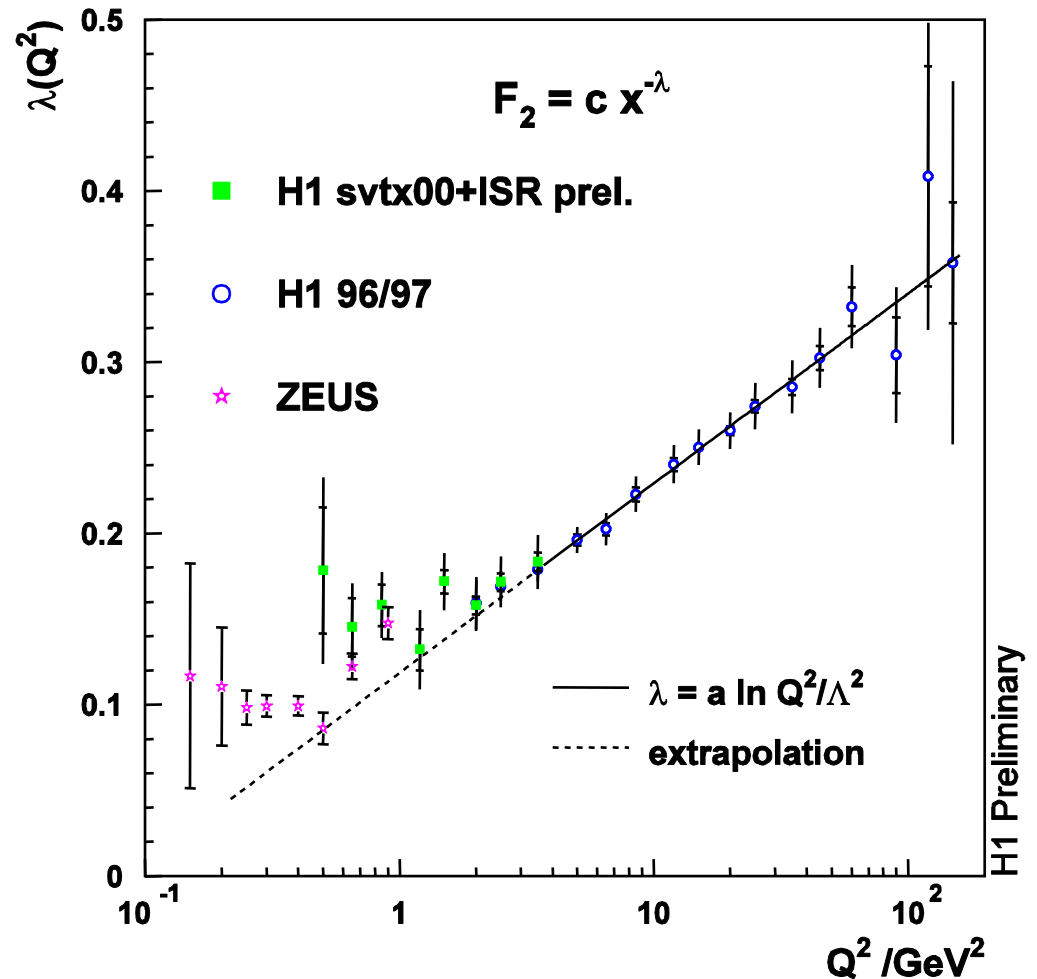
- ISR data consistent with data from ZEUS BPT, H1 QEDC and NMC in the respective regions of overlap.

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 -dependencies in Q^2 bins for $x < 0.01$ (and $W > 12\text{GeV}$):

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

- 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 1 GeV^2 in the H1 data.