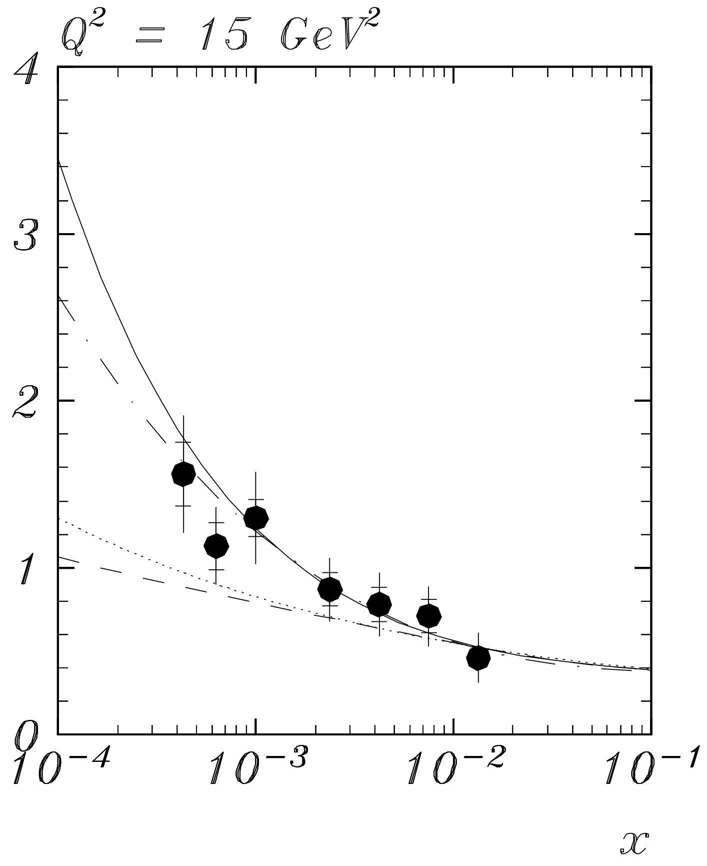
Rise of F_2

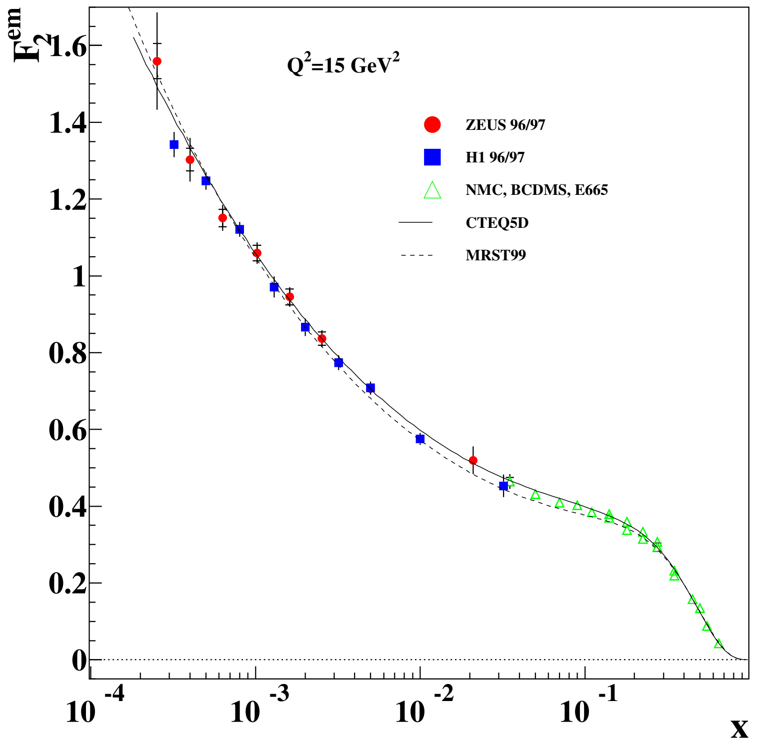
Jörg Gayler, DESY
for H1

1993



$\longrightarrow$

2000



Introduction (cont'd.)

strong rise of F_2 discussed in QCD frame long before observation :

1974: (De Rujula, Glashow, Politzer, Treiman, Wilczek, Zee)

(**1994**: (Ball, Forte))

double asymptotic limit: rise faster than any power of $\log(x)$, nearly like power in x.

1976 - 1978 (Balitsky, Fadin, Kuraev, Lipatov)

BFKL theory expects power behaviour $F_2 \sim x^{-\lambda}$

1981, 1983 (Gribov, Levin, Ryskin)

1986 (Mueller, Qiu)

saturation effects due to increasing gluon densities

Recent years (Buchmüller, Gehrmann, Hebecker ; Golec-Biernat, Wüsthoff ;......)

discussion of colour dipole models $\gamma^* \to q\bar{q}, q\bar{q}g \quad \times$ dipole-p cross section

non-perturbative interaction with proton colour field,

saturation at large radii, i.e. small Q^2, p_t^2

reached at smaller x_{Bj} already at smaller radii, i.e. at larger Q^2, p_t^2.

Empirical parameterisations, (e.g. log-dependence, Haidt)

Precision of present data allows to study rise of F_2 locally

Procedure

study rise of F_2 locally for different fixed Q^2 as function of x:

$$\lambda = -(\partial \ln F_2 / \partial \ln x)_{Q^2}$$

(suggested by Navelet, Peschanski, Wallon, 1994)

use published F_2 data: hep-ex/0012053

$$1.5 \leqq Q^2 \leqq 150 \text{ GeV}^2$$

and preliminary data (see talk of Tomas Lastovicka)

$$0.5 \leqq Q^2 \leqq 3.5 \text{ GeV}^2$$

λ is evaluated taking error correlations and x spacing corrections into account

Comparisons with NLO QCD fit

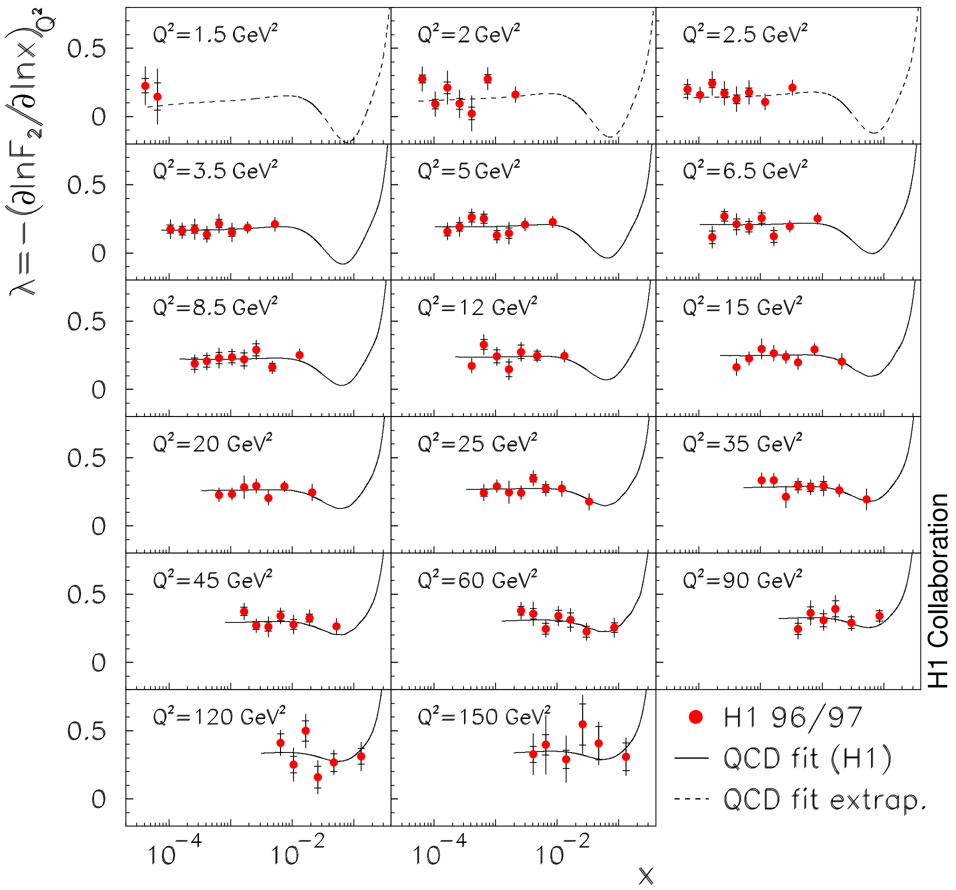
(hep-ex/0012053), using data at $Q^2 \geqq 3.5$ GeV^2)

at low Q^2 with the "fractal" fit

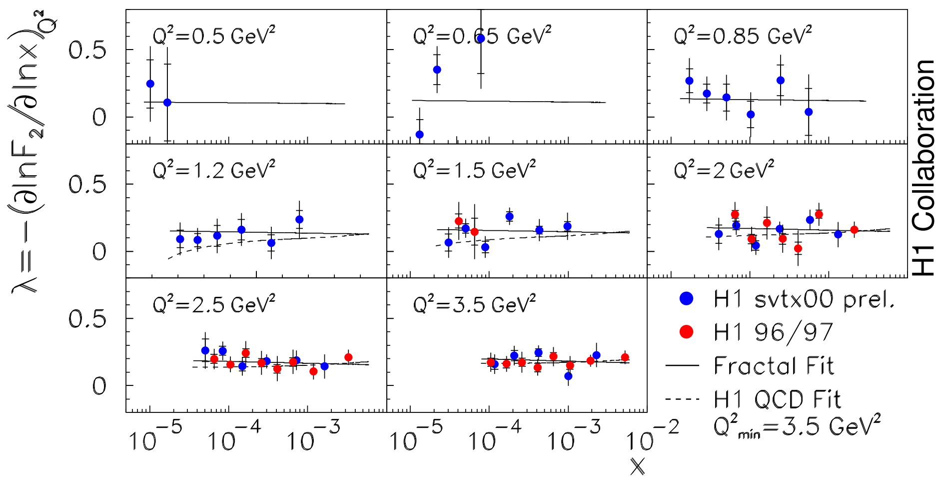
(see talk of Tomas Lastovicka)

x dependence of λ

nominal vertex data



shifted vertex data (+ nominal)

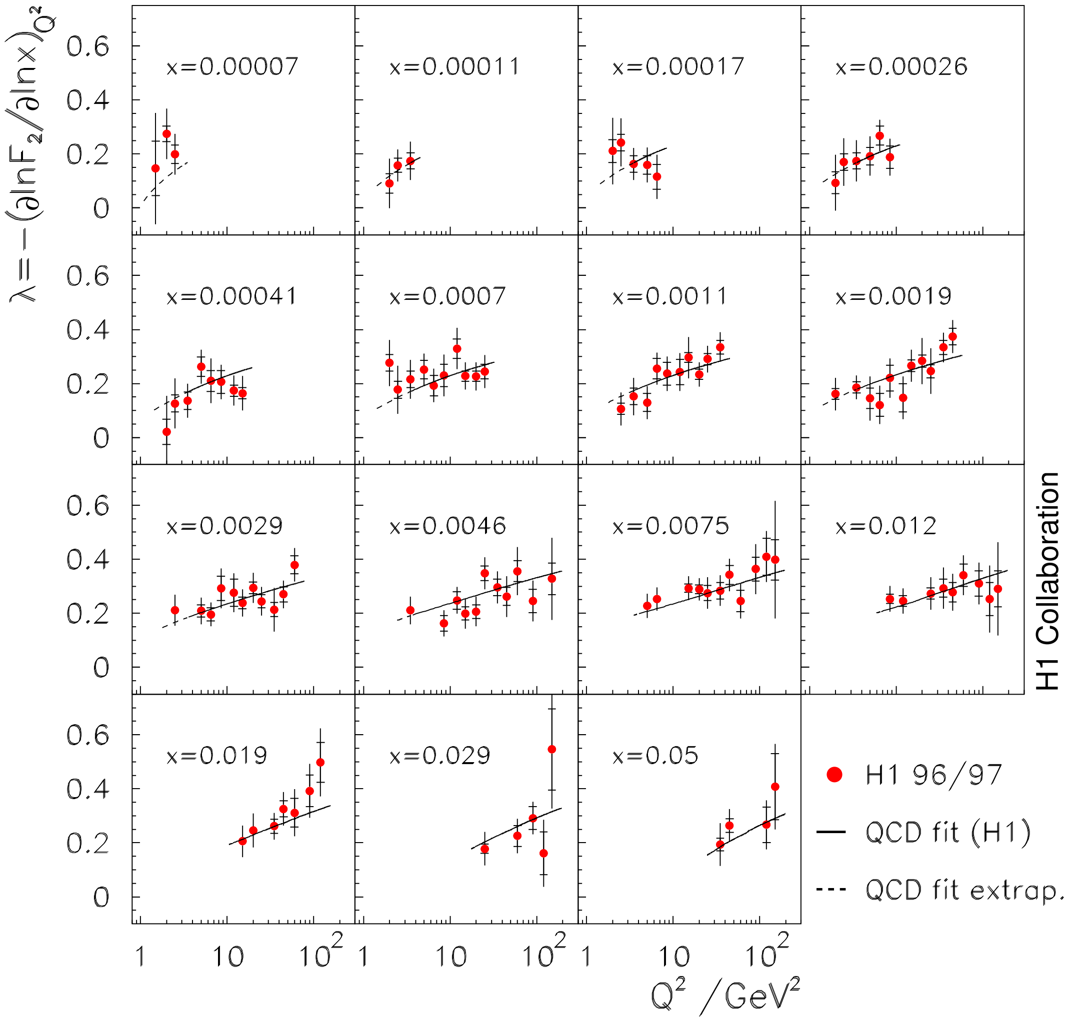


fixed Q^2, $x < 0.01$: $\lambda \approx$ const

$\Rightarrow F_2 \sim x^{-\lambda(Q^2)}$

no taming of rise visible yet for $0.5 \lesssim Q^2 \lesssim 150$ GeV^2

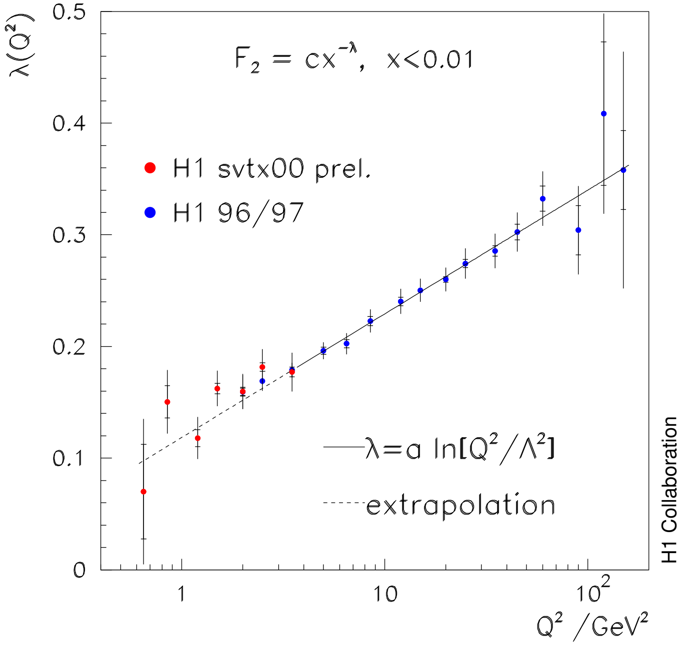
Q^2 dependence of λ in different x bins

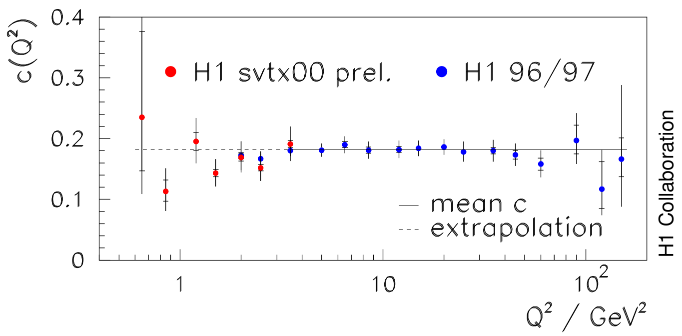


data consistent with linear rise

$\boldsymbol{\lambda \sim \ln Q^2}$

fit F_2 data for $x < 0.01$





assuming λ independent of x

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

$\longleftarrow$ fits for each Q^2 bin

fit $\boldsymbol{\lambda}$ results for $\boldsymbol{Q^2 \geqq 3.5}$ GeV^2 with :

$$\boldsymbol{\lambda(Q^2) = a \cdot \ln[Q^2/\Lambda^2]}$$

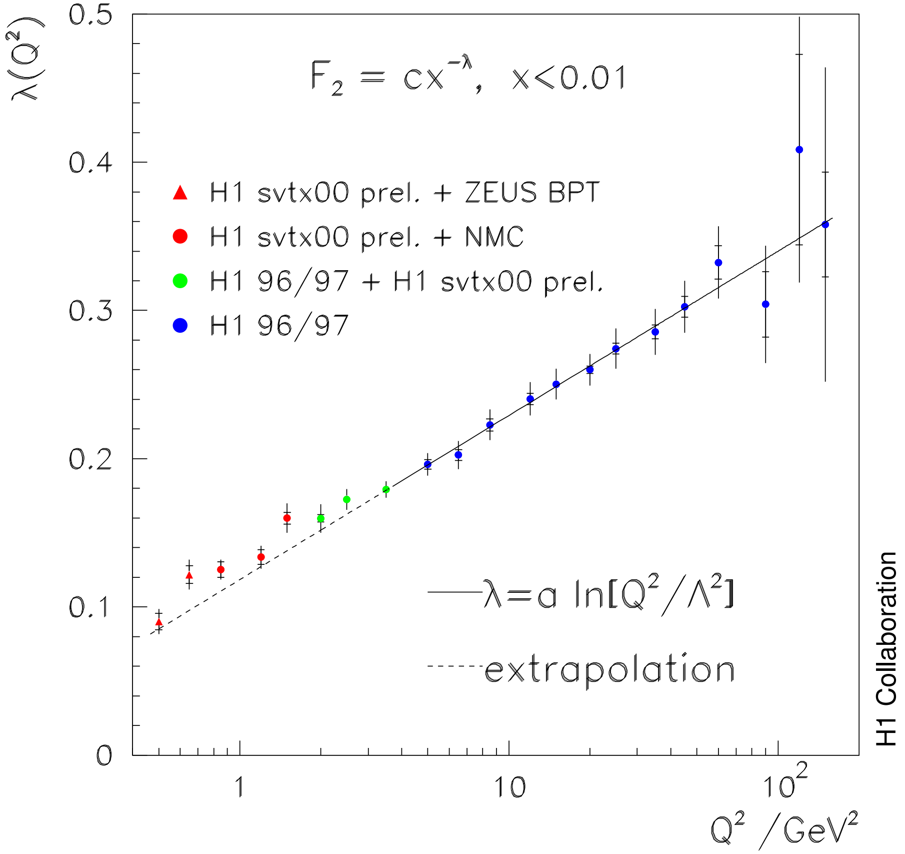
$$\Rightarrow \boldsymbol{a = 0.0481 \pm .0013 \pm .0037}$$

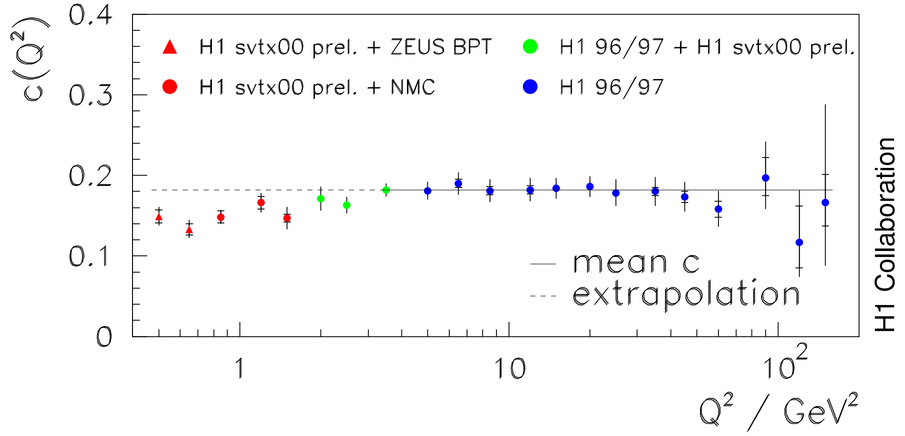
$$\boldsymbol{\Lambda = 292 \pm 20 \pm 51 \text{ MeV}}$$

$\boldsymbol{c}$ decreasing for small $\boldsymbol{Q^2}$ $(\boldsymbol{F_2 \rightarrow 0}$ for $\boldsymbol{Q^2 \rightarrow 0})$

very simple parametrisation for $\boldsymbol{x < 0.01}$, $\boldsymbol{Q^2 \gtrsim 3}$ GeV^2

Transition to small Q^2 — H1 combined with other experiments





for $Q^2 \lesssim 3$ GeV^2 :

deviation from log-dependence,

decrease of c

$$\sigma_{tot}^{\gamma^* p} = 4\pi\alpha^2/Q^2\ F_2 \ \sim x^{-\lambda}/Q^2$$
$$s = W^2 \sim Q^2/x$$

Hadronic interactions at high energy:

Regge theory: $\sigma_{tot} \sim s^{\alpha_{I\!P}(0)-1}$

$\alpha_{I\!P}(0) - 1 \approx 0.08$ (Donnachie, Landshoff)

$\rightarrow$ expect

$F_2 \sim x^{-(\alpha_{I\!P}(0)-1)} \approx x^{-0.08}$, $\lambda \approx 0.08$

$Q^2 \lesssim 1$ GeV^2 :

rise compatible with soft hadronic interactions

Conclusions on rise of F_2

- for $x < 0.01$ consistent with
  $\lambda \equiv -(\partial \ln F_2/\partial \ln x)_{Q^2}$ independent of x
- $\lambda \sim \ln(Q^2)$ for $Q^2 \gtrsim 3$ GeV^2 (pQCD region)
- here very simple parametrisation
  $F_2 = cx^{-\lambda}$ with $\lambda = a \ln(Q^2/\Lambda^2)$
- covered range extended to $Q^2 = 0.5$ GeV^2
- at low Q^2 ($Q^2 \lesssim 1$ GeV^2) rise similar
  as in soft hadronic interactions