H1 Highlights for ICHEP 02

DESY Seminar 23/07/02

Rainer Stamen

Universität Dortmund

New Results in 2002

Structure Functions:

- F_2 at low Q^2
- QCD Analysis of F_2 data

Diffraction

- Inclusive Diffraction at low Q^2
- Diffractive Parton Densities
- Diffractive Dijet Photoproduction
- ρ Meson Production at high Q^2
- $\psi(2S)$ Production
- Diffractive Dissociation in Photoproduction

Final States

- D Meson Production
- Prompt Photon Production
- D* Muon Correlations
- Forward π^0 Production
- Forward Jet Production
- Inelastic J/ψ Production in DIS and Photoproduction

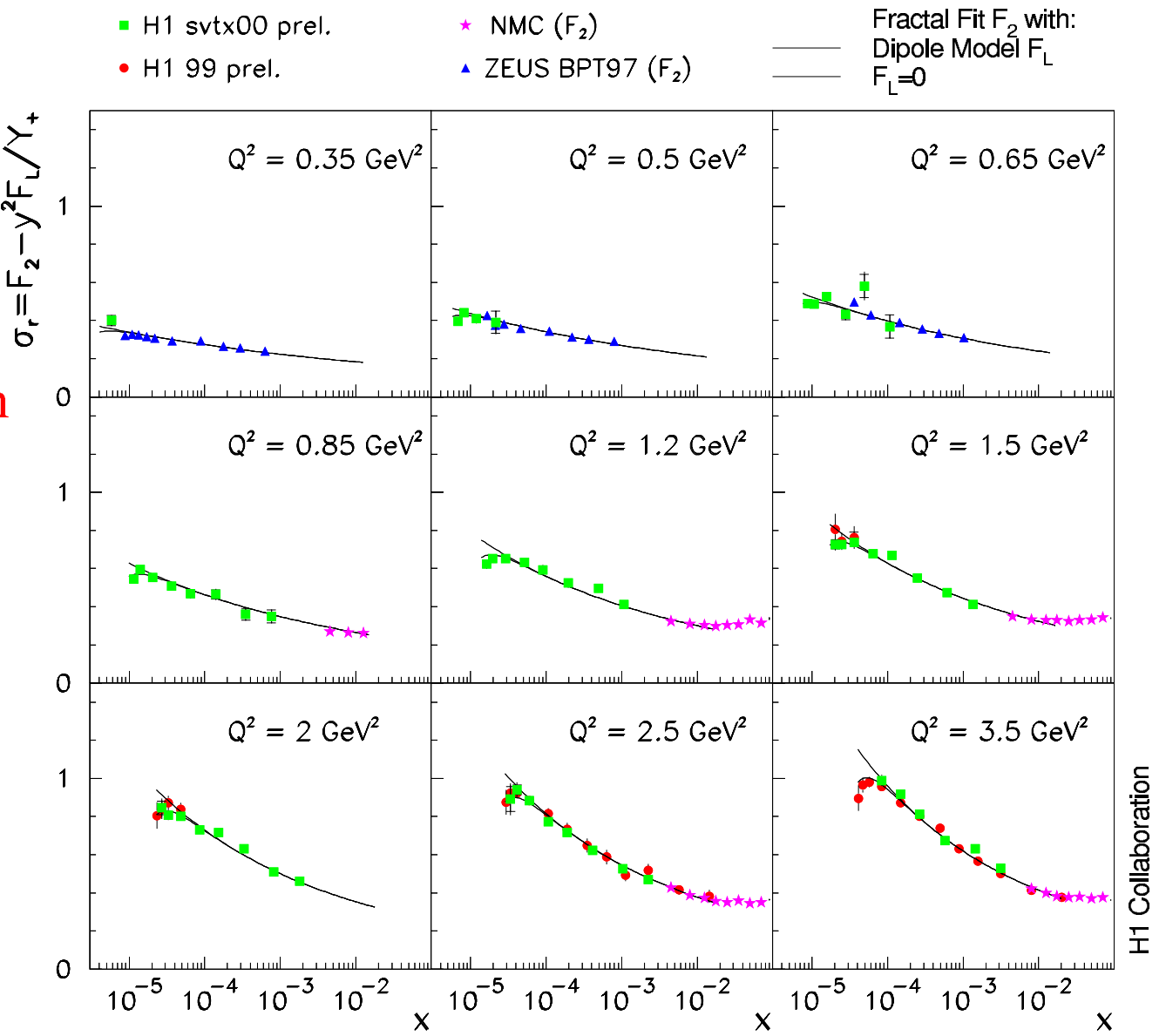
Beyond the Standard Model

- Multilepton Production
- Search for Double Charged Higgs
- W Production
- Single Top Production
- Contact Interactions
- Excited Electrons
- Leptoquarks

Reduced Cross Section at low Q2

vertex shifted: 0 –> 70 cm
=> access to lower values of Q2

=> data fill the gap between perturbative and non–perturbative region



Local Derivatives of F_2

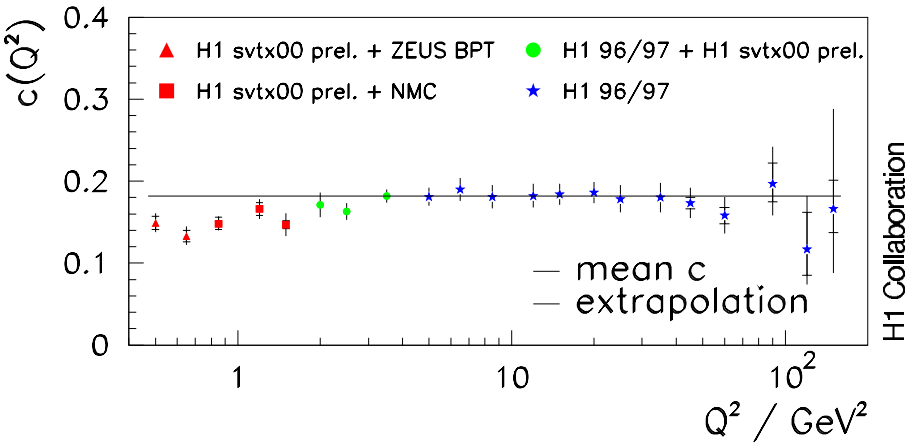
F_2 can be parametrised as

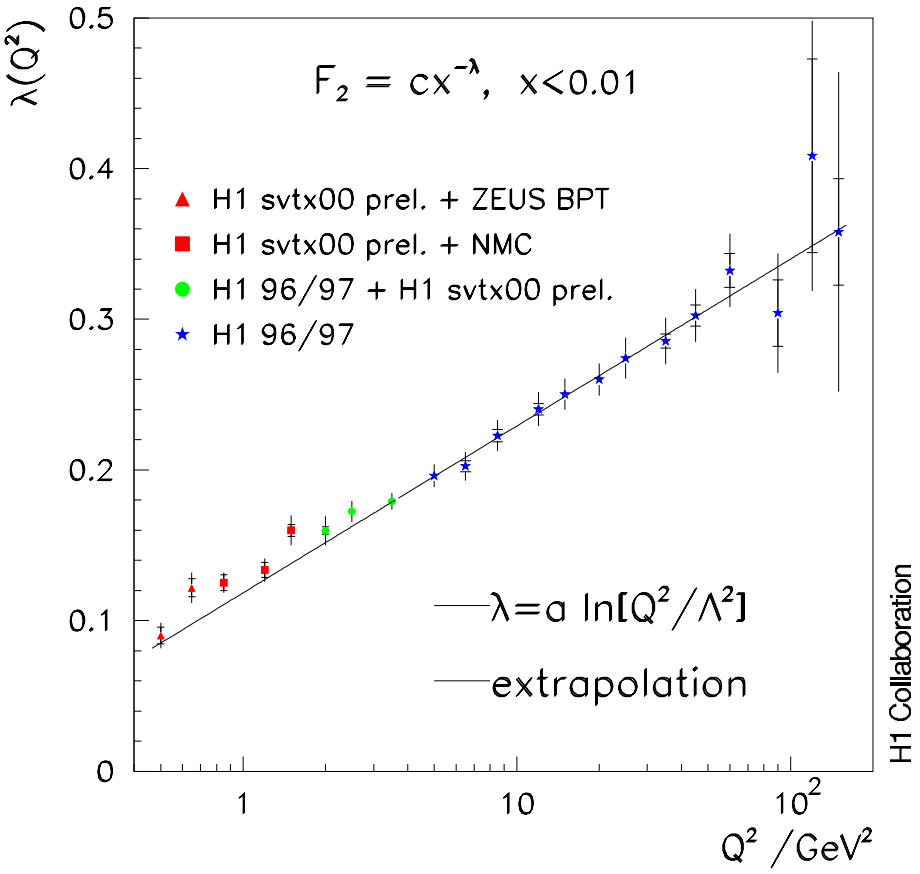
$$F_2 = c \cdot x^{-\lambda}$$

at small x for fixed values of Q^2.

λ does not change with x

-> Extraction of λ and c





QCD Analysis

QCD Analysis of high and low Q^2 data: new method

$$U = u + c \qquad D = d + s \qquad \Rightarrow \qquad d_v = D - \bar{D}$$
$$\bar{U} = \bar{u} + \bar{c} \qquad \bar{D} = \bar{d} + \bar{s} \qquad\qquad u_v = U - \bar{U}$$

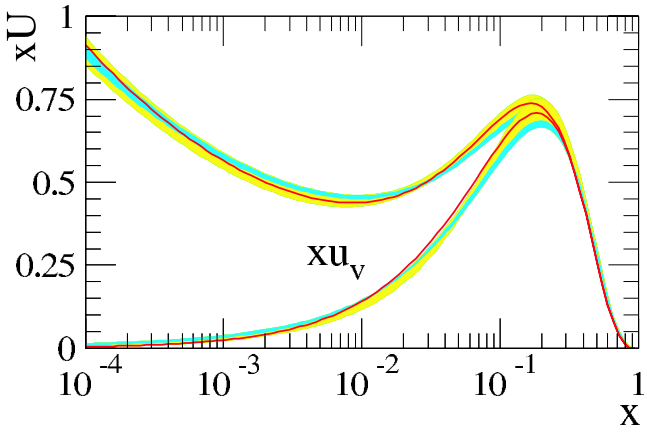
-> measurement is sensitiv to this kind of combination

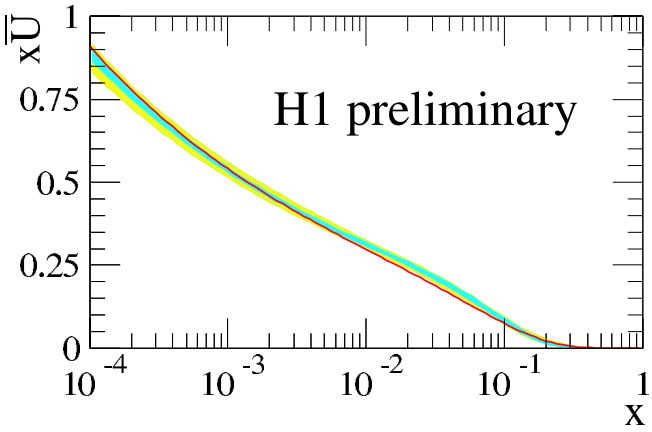
Charged Current $\qquad \Phi^{+}_{CC} = x\bar{U} + (1-y)^2 xD \qquad\qquad \Phi^{-}_{\bar{C}C} = xU + (1-y)^2 x\bar{D}$

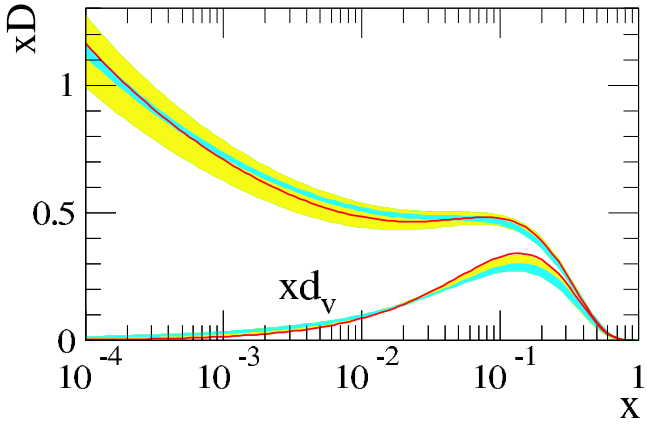
Neutral Current: $\qquad F_2 = \frac{4}{9} \cdot (xU + x\bar{U}) + \frac{1}{9} \cdot (xD + x\bar{D})$

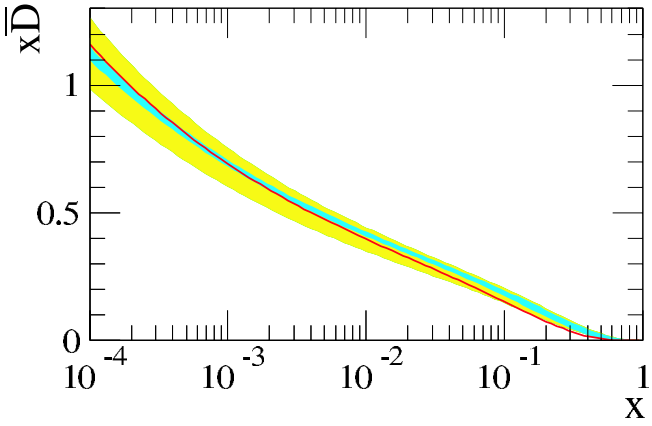
$$xF_3^{\gamma Z} \sim x\left[2(U - \bar{U}) + (D - \bar{D})\right] \qquad \text{(high } Q^2\text{)}$$

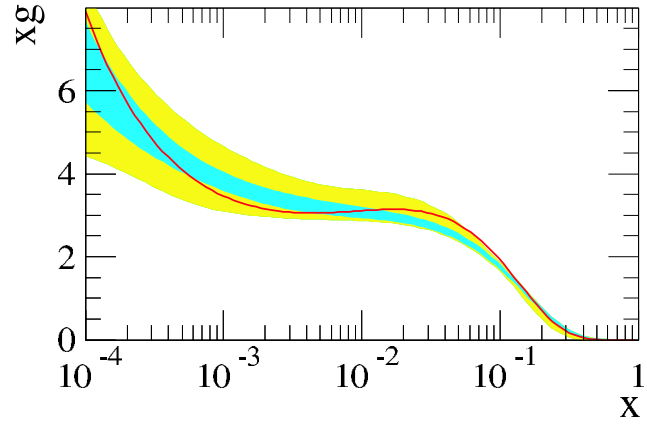
H1 Parton Distributions











Prel. H1 2002 PDF Fit

Fit to H1 + BCDMS data

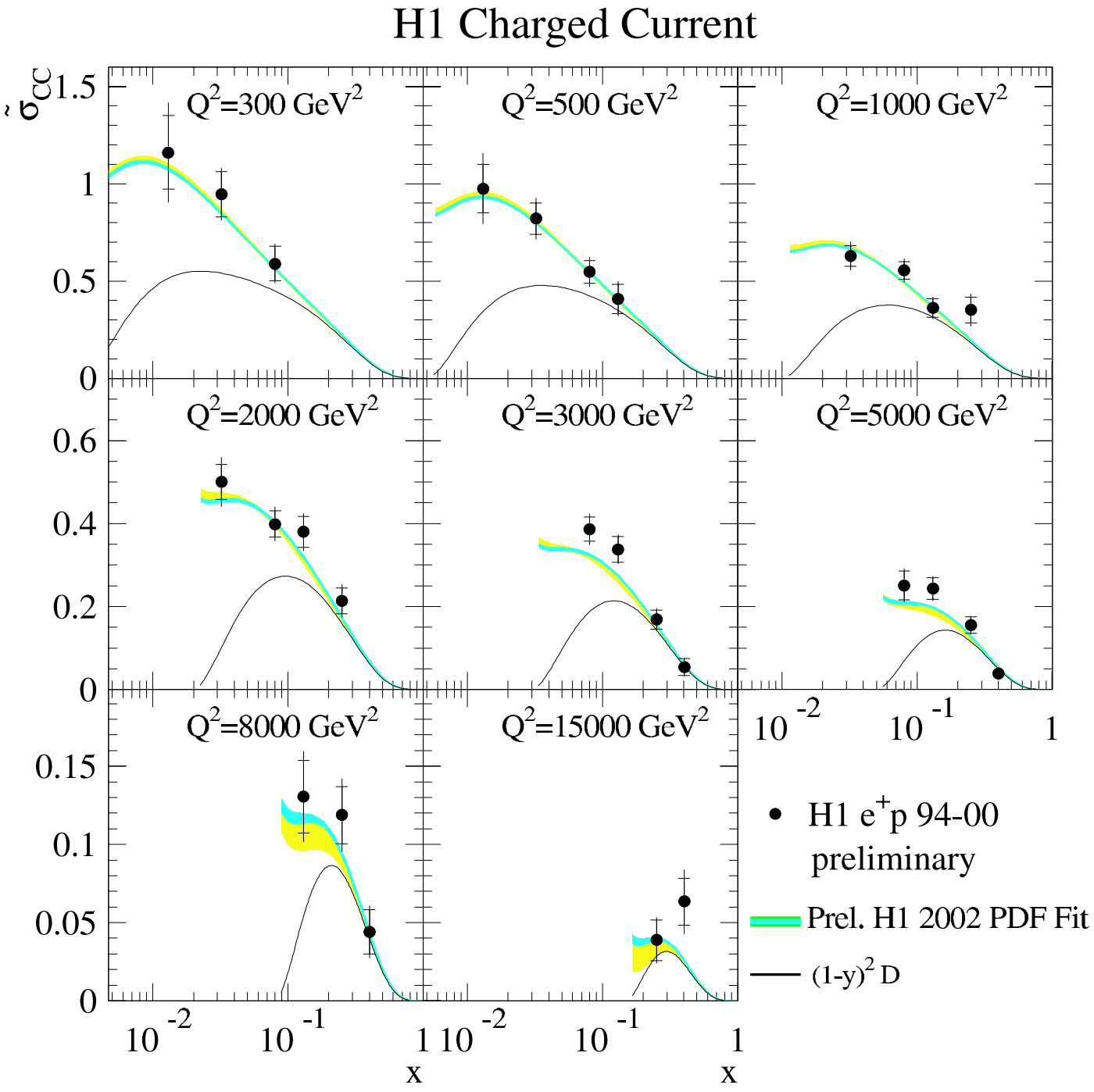
experimental errors

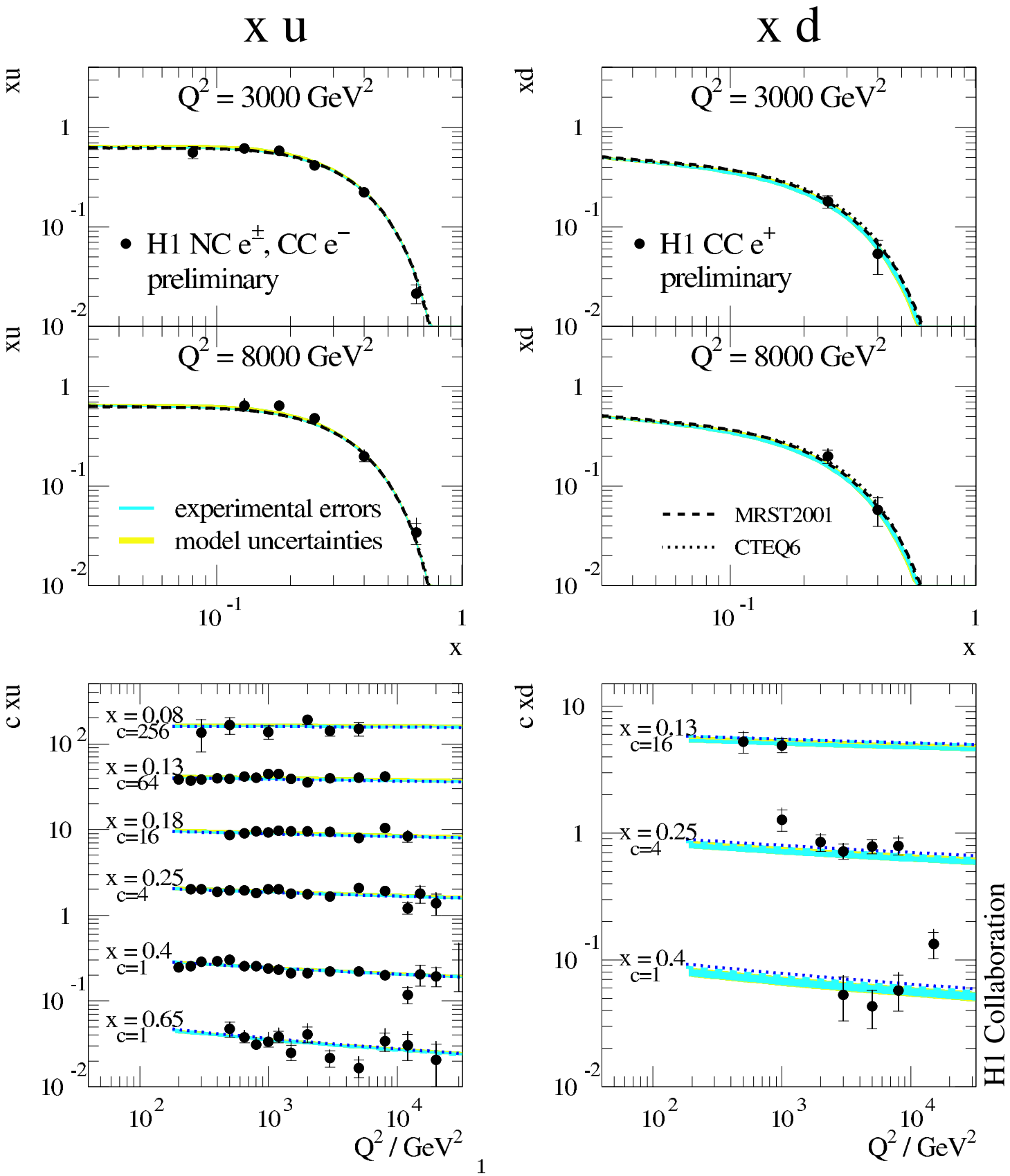
model uncertainties

Fit to H1 data

central value

$Q^2 = 4\ \mathrm{GeV}^2$

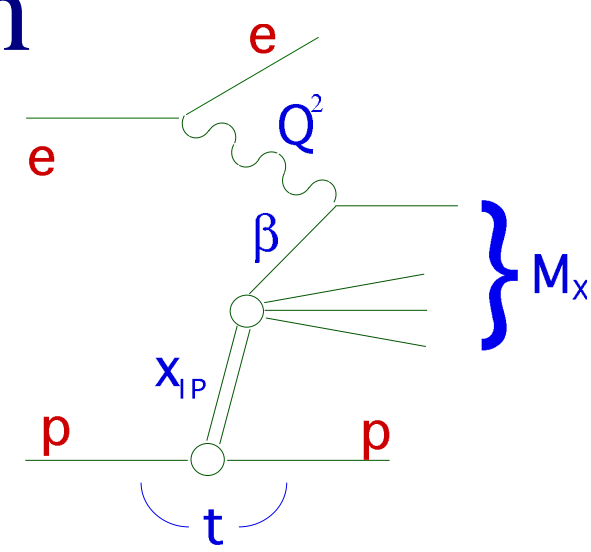

H1 Charged Current
$\tilde{\sigma}_{CC}$
Q^2=300 GeV^2
Q^2=500 GeV^2
Q^2=1000 GeV^2
Q^2=2000 GeV^2
Q^2=3000 GeV^2
Q^2=5000 GeV^2
Q^2=8000 GeV^2
Q^2=15000 GeV^2
x
H1 e^+p 94-00
preliminary
Prel. H1 2002 PDF Fit
$(1-y)^2$ D


x u
x d
xu
xd
$Q^2 = 3000$ GeV^2
$Q^2 = 8000$ GeV^2
H1 NC e$^{\pm}$, CC e$^-$
preliminary
H1 CC e$^+$
preliminary
experimental errors
model uncertainties
MRST2001
CTEQ6
x
c xu
c xd
x = 0.08 c=256
x = 0.13 c=64
x = 0.18 c=16
x = 0.25 c=4
x = 0.4 c=1
x = 0.65 c=1
x = 0.13 c=16
x = 0.25 c=4
x = 0.4 c=1
Q^2 / GeV^2
H1 Collaboration

Inclusive Diffraction

QCD hard scattering factorisation (Collins '97):

$$\frac{d^2\sigma\left(x,Q^2,,x_{I\!P},t\right)^{\gamma^* p \longrightarrow p' X}}{dx_{I\!P}dt} = \Sigma_i \int_x^{x_{I\!P}} d\xi \hat{\sigma}^{\gamma^*}\left(x,Q^2,\xi\right) \cdot f_i^D(\xi,Q^2,x_{I\!P},t)$$



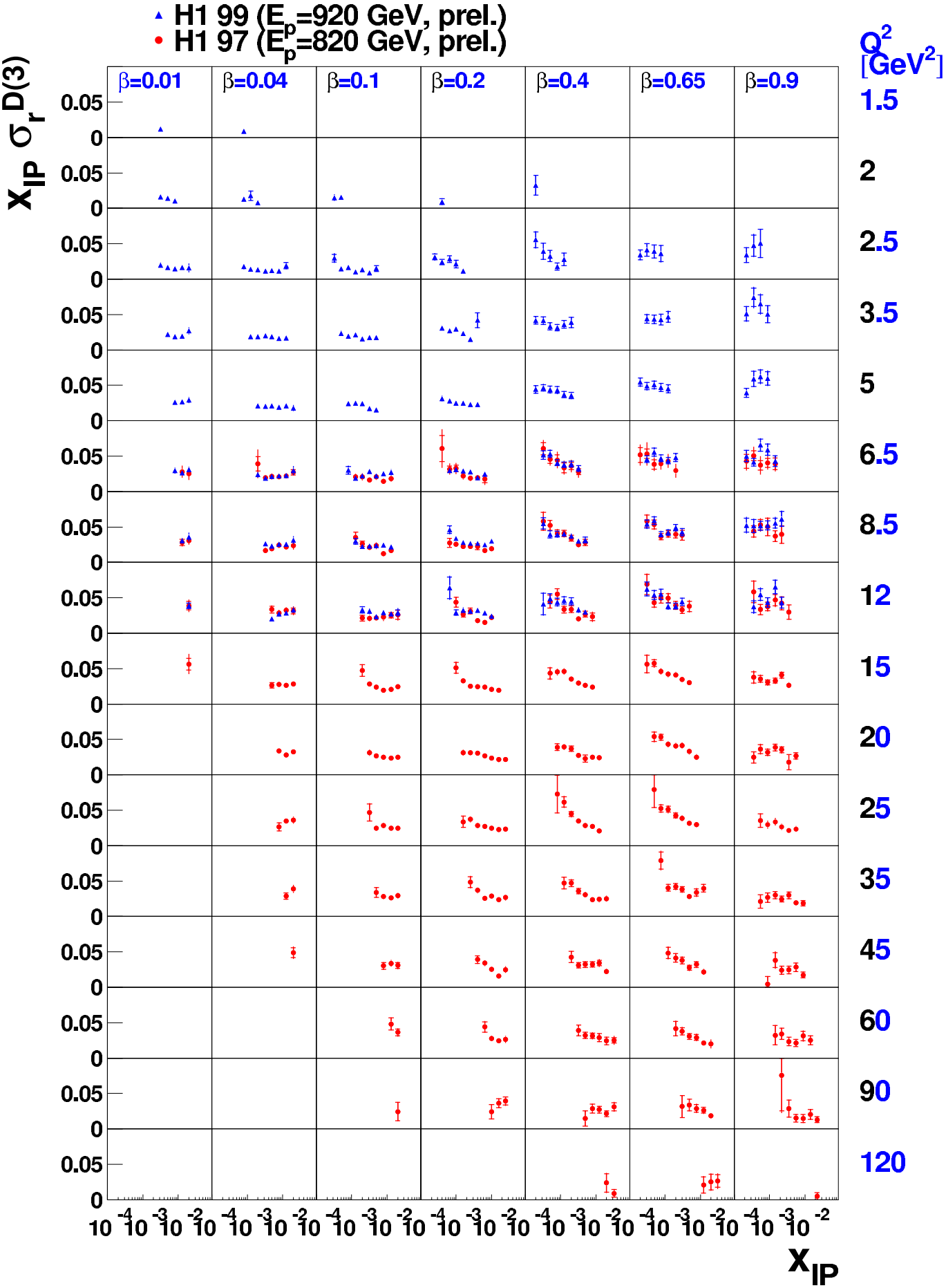
Diffractive Parton Densities obey DGLAP evolution

–> LO and NLO QCD Analysis

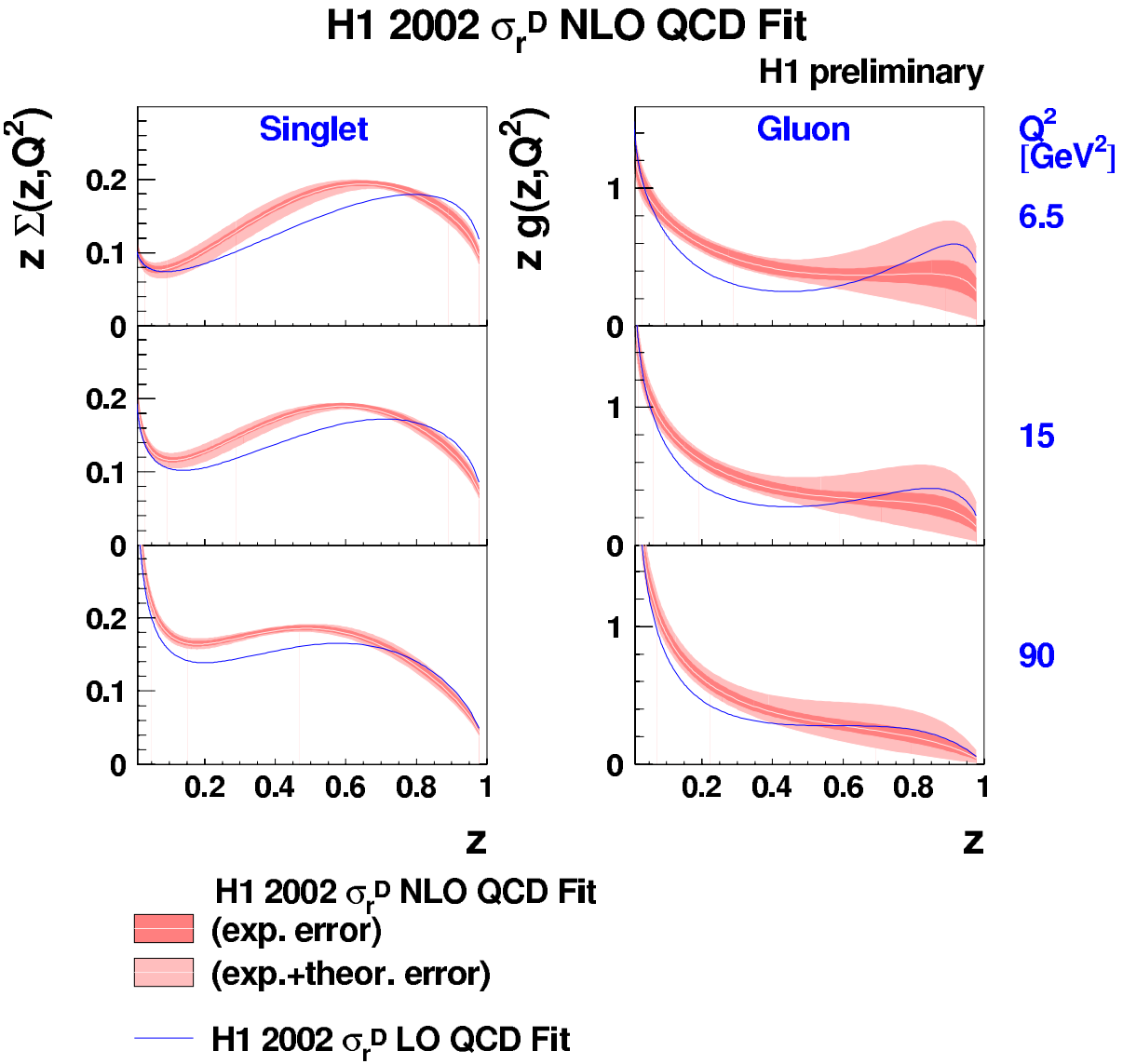
Additional Assumption:

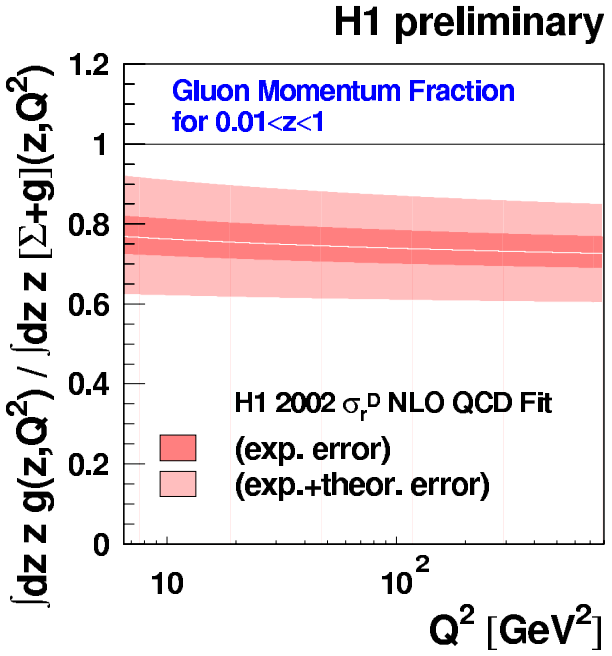
$$f_i^D(\xi,Q^2,x_{I\!P},t) = f_{x_{I\!P}/P}\left(x_{I\!P},t\right) \cdot f_i^{x_{I\!P}}\left(\beta = x/x_{I\!P},Q^2\right)$$

''flux factor'' *''structure function''*


H1 99 (E_p=920 GeV, prel.)
H1 97 (E_p=820 GeV, prel.)
$x_{IP}\,\sigma_r^{D(3)}$
Q^2 [GeV^2]
β=0.01
β=0.04
β=0.1
β=0.2
β=0.4
β=0.65
β=0.9
1.5
2
2.5
3.5
5
6.5
8.5
12
15
20
25
35
45
60
90
120
0.05
0
10^{-4} 10^{-3} 10^{-2}
x_{IP}

Diffractive Parton Density Functions



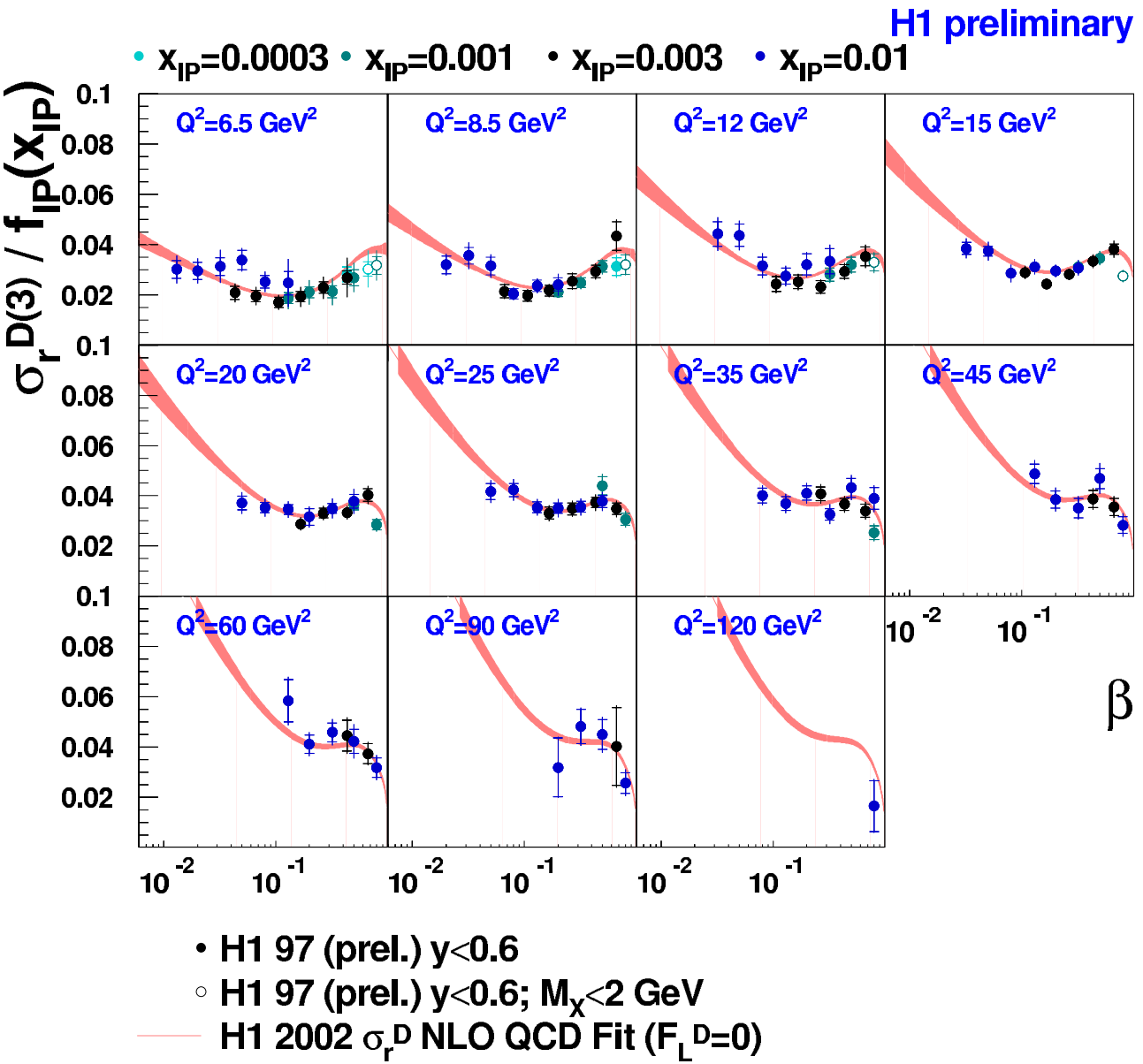


—> large gluon content
up to high values of z

Inclusive Diffraction

reduced cross section divided by x_{IP} dependence

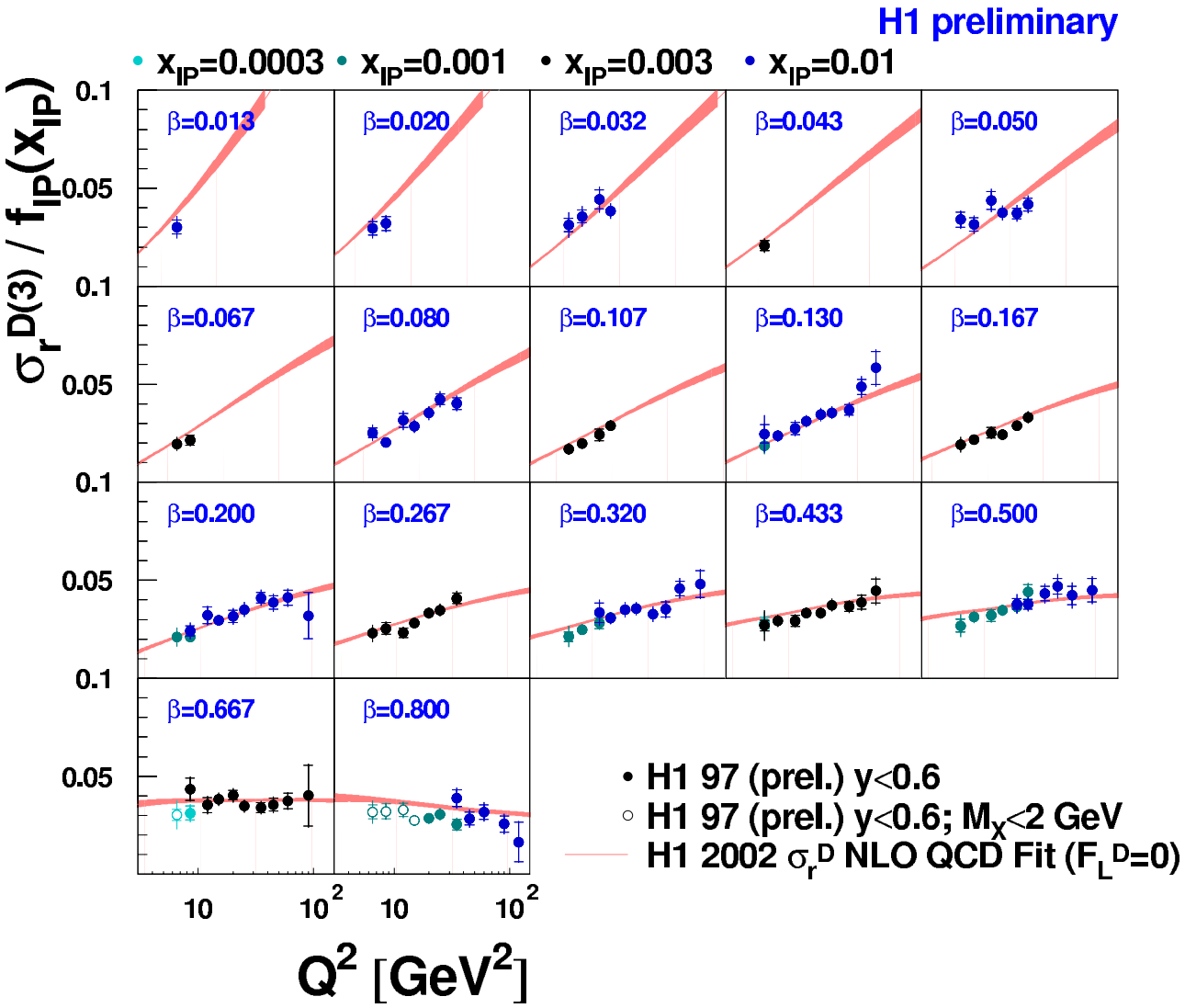
–> factorisation justified



Inclusive Diffraction

–> strong positive scaling violations

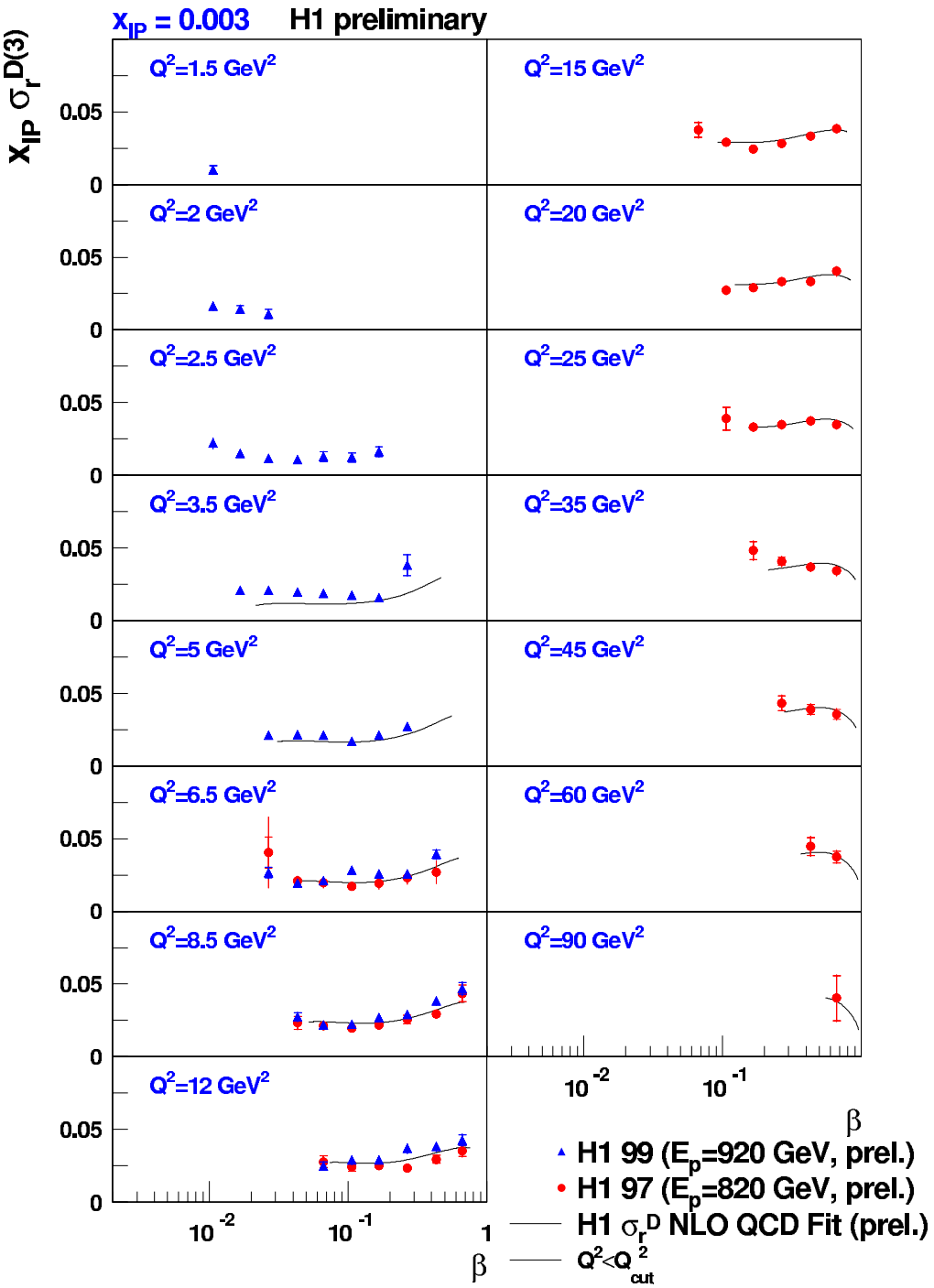
–> large gluon contents

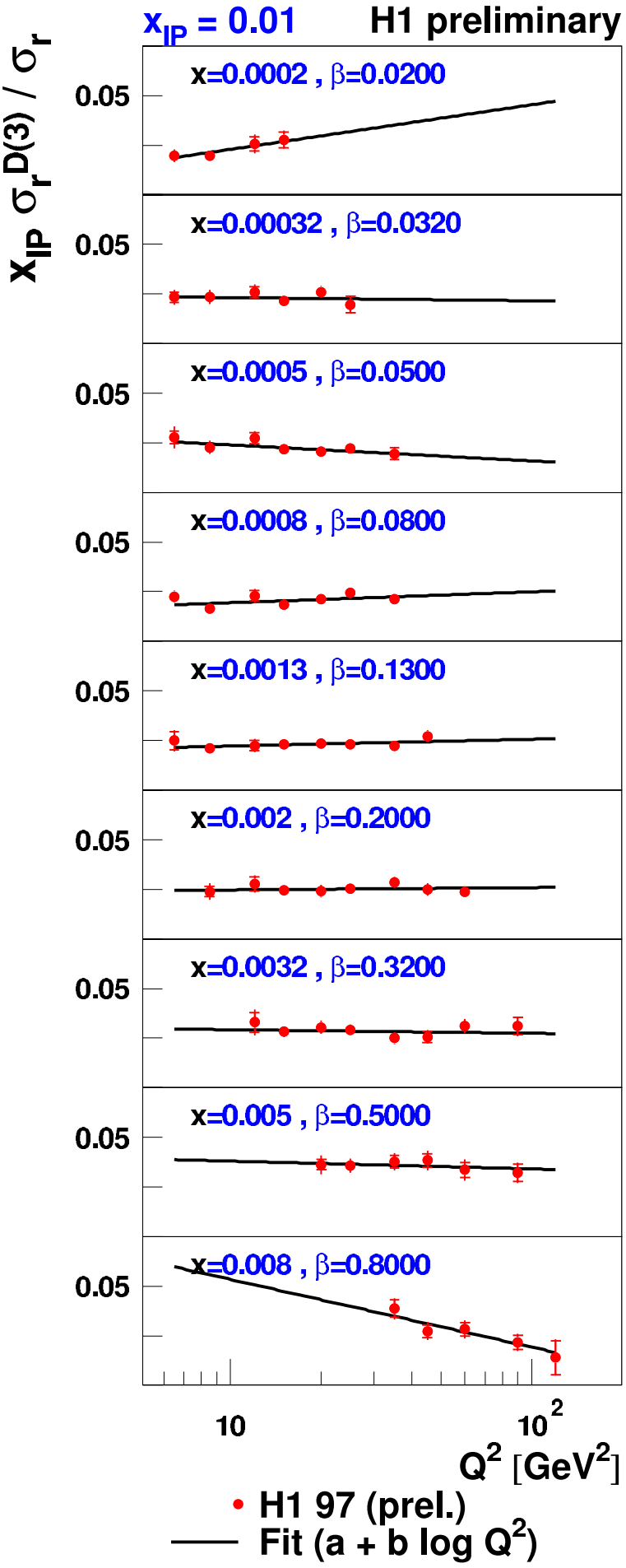


Comparison to low Q^2 data

–> Extrapolation of fit to smaller values of Q^2

–> good agreement



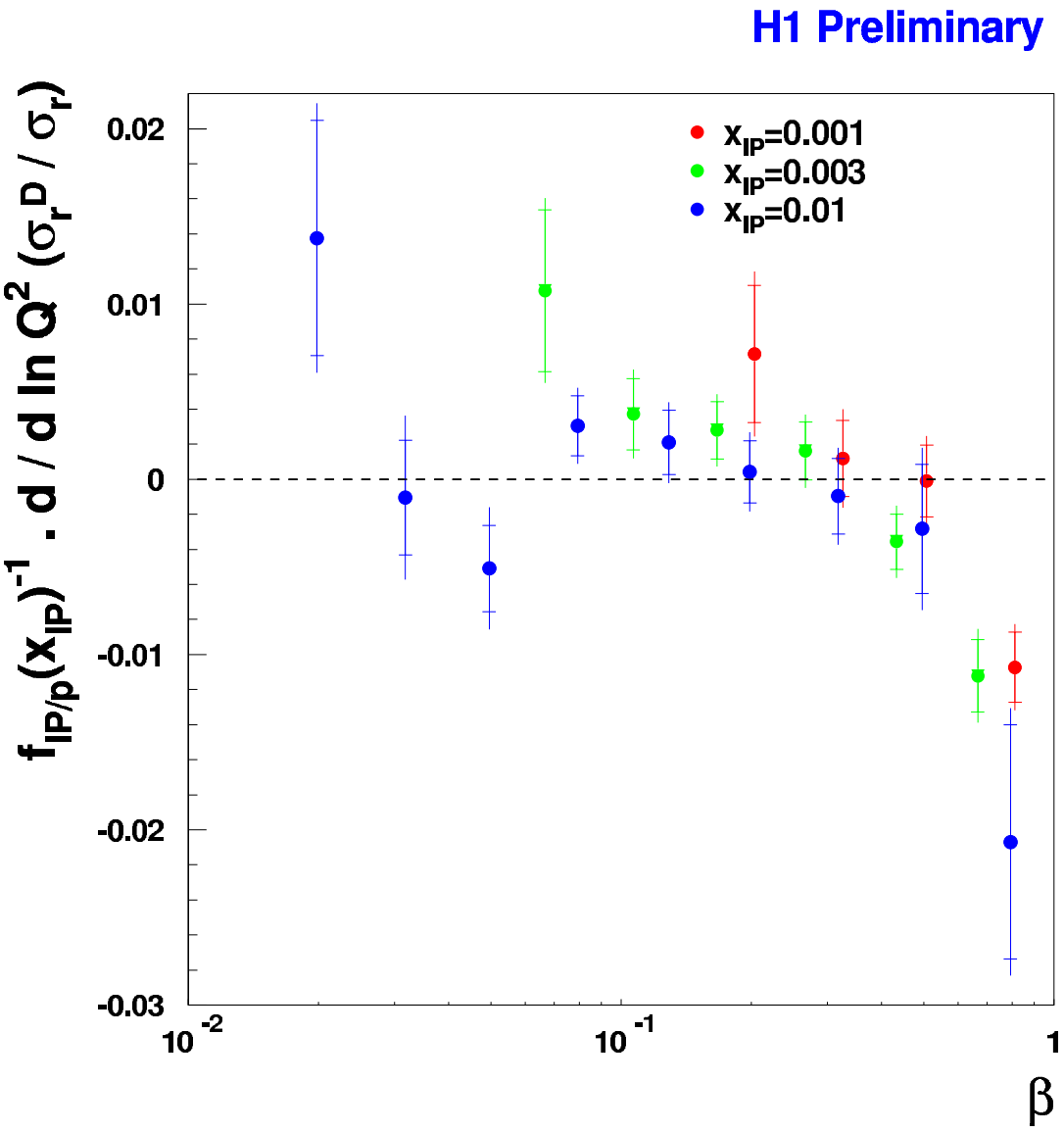

x_{IP} = 0.01
H1 preliminary
$x_{IP}\,\sigma_r^{D(3)} / \sigma_r$
x=0.0002 , β=0.0200
x=0.00032 , β=0.0320
x=0.0005 , β=0.0500
x=0.0008 , β=0.0800
x=0.0013 , β=0.1300
x=0.002 , β=0.2000
x=0.0032 , β=0.3200
x=0.005 , β=0.5000
x=0.008 , β=0.8000
0.05
10
10^2
Q^2 [GeV^2]
H1 97 (prel.)
Fit (a + b log Q^2)

Ratio Diffraction/Inclusive

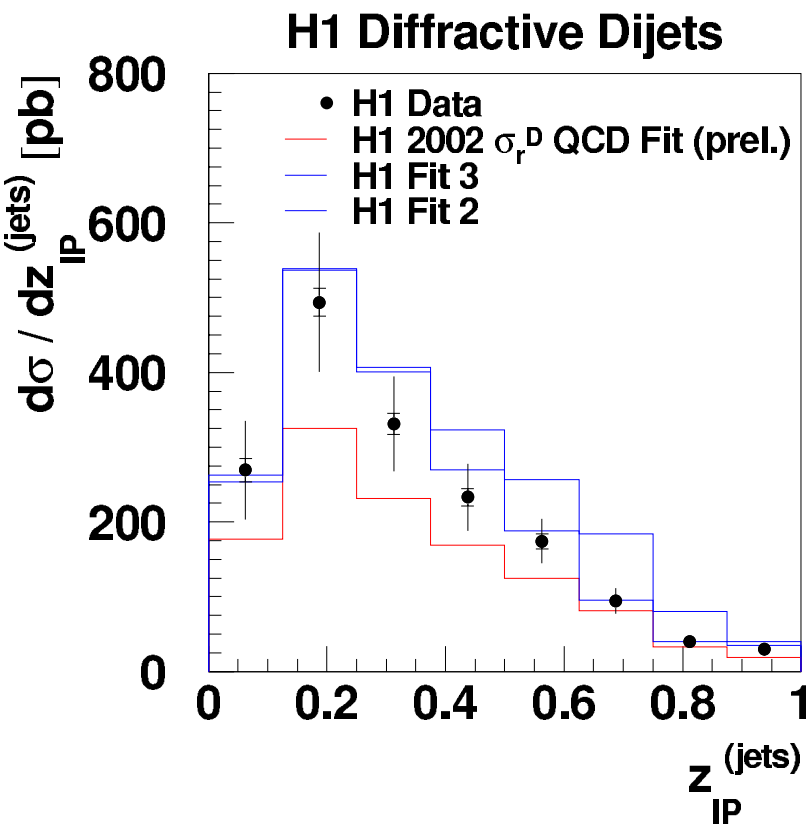
$$\frac{\sigma_r^D}{\sigma_r} \sim A + B \ln Q^2$$

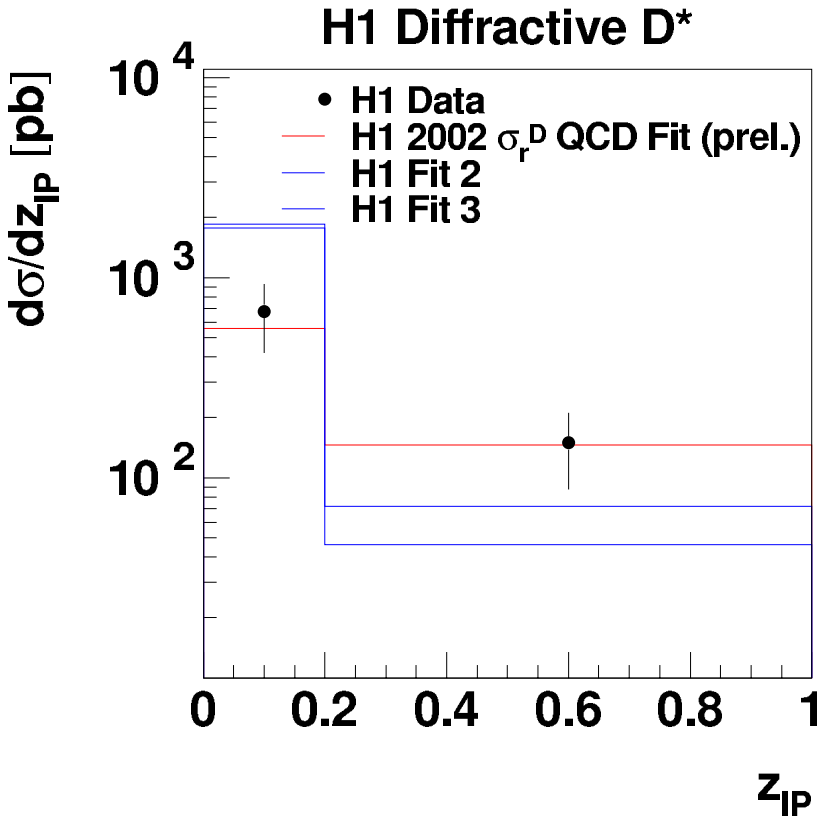
–> ratio is flat

Similar QCD dynamics underly proton and colour singlet exchange structure



Test of Diffractive Factorisation in DIS



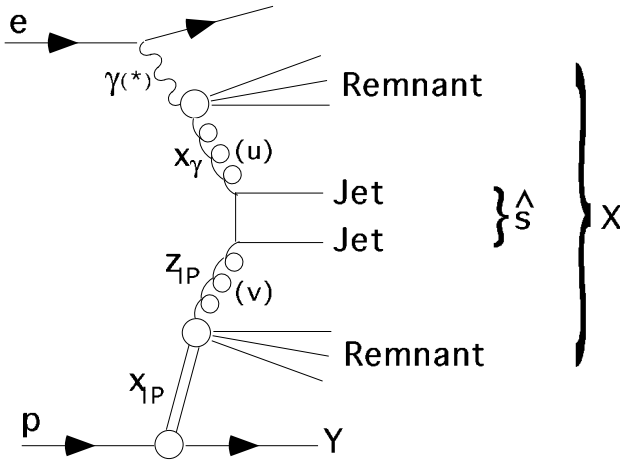


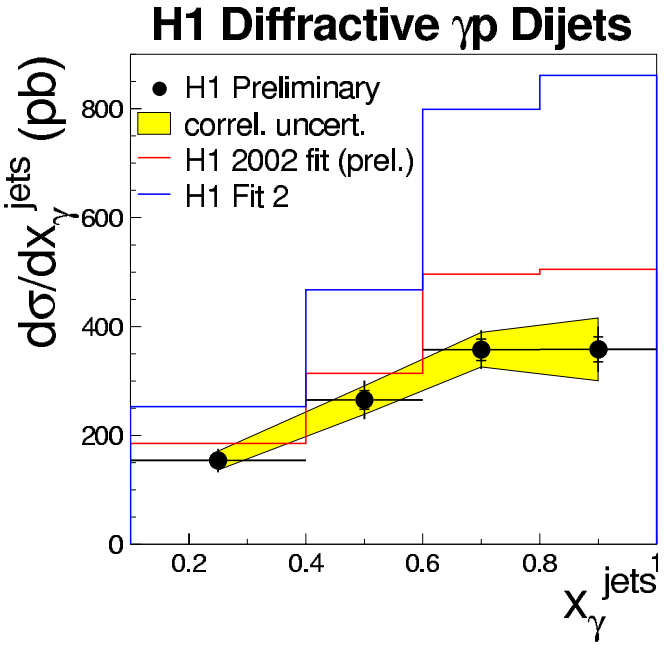
LO fits used to predict jet and charm production

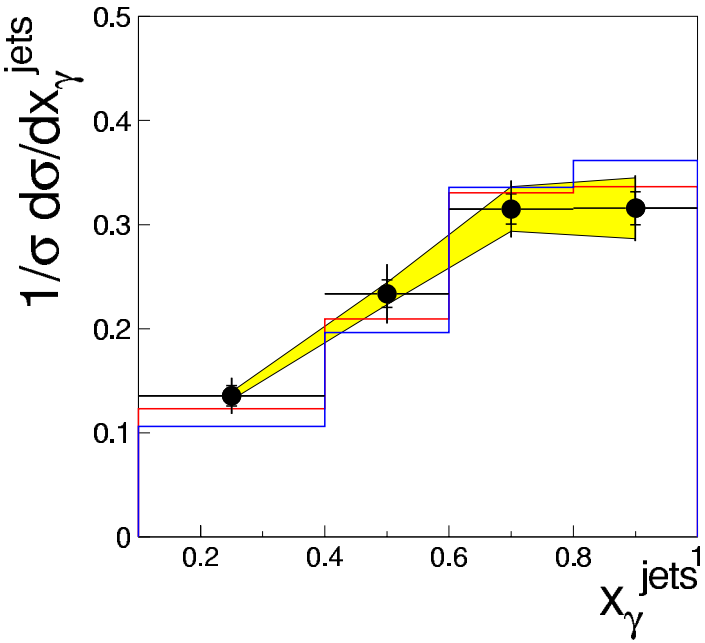
(NLO effects, scale uncertainties, pdf uncertainties)

–> H1 internal consistent picture: factorisation holds

Diffractive Dijets in Photoproduction





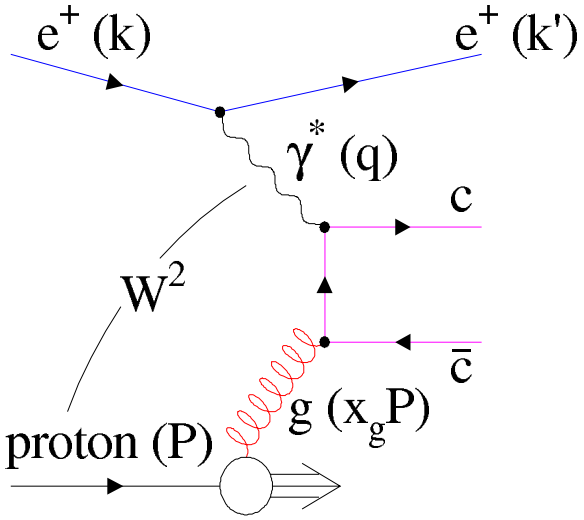


–> only small suppression factor needed

–> any factorisation breaking is small and x_g independent

–> factorisation breakdown at Tevatron not yet understood

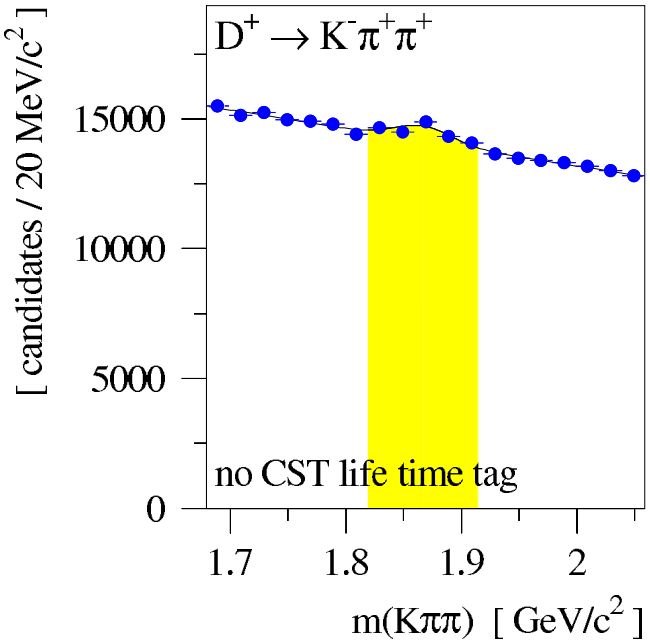
D meson production

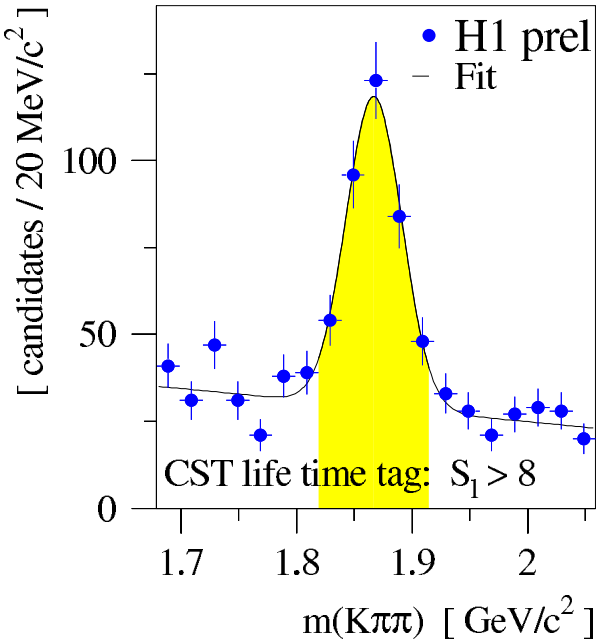


- charm production
- charm fragmentation

- improved vertex reconstruction using silicon detectors

–> lifetime tag





$D^{*+} \longrightarrow (K^- pi^+)\pi^+$
$D^0 \longrightarrow K^-\pi^+$
$D_S^+ \longrightarrow (K^+K^-)\pi^+$
$D^+ \longrightarrow K^-\pi^+\pi^+$

(first time at HERA)

D meson production

Ratios of D cross section used to extract
charm fragmentation factors and ratios

$$R_{u/d} = 1.26 \pm 0.20(stat) \pm 0.13(syst) \pm 0.04(theory)$$ *World average:* 1.00 ± 0.09

$$\gamma_s = 0.36 \pm 0.10(stat) \pm 0.01(syst) \pm 0.08(theory)$$ *World average:* 0.26 ± 0.07

$$P_V = \frac{VM}{PS+VM} = 0.693 \pm 0.045(stat) \pm 0.004(syst) \pm 0.009(theory)$$

World average: 0.601 ± 0.032

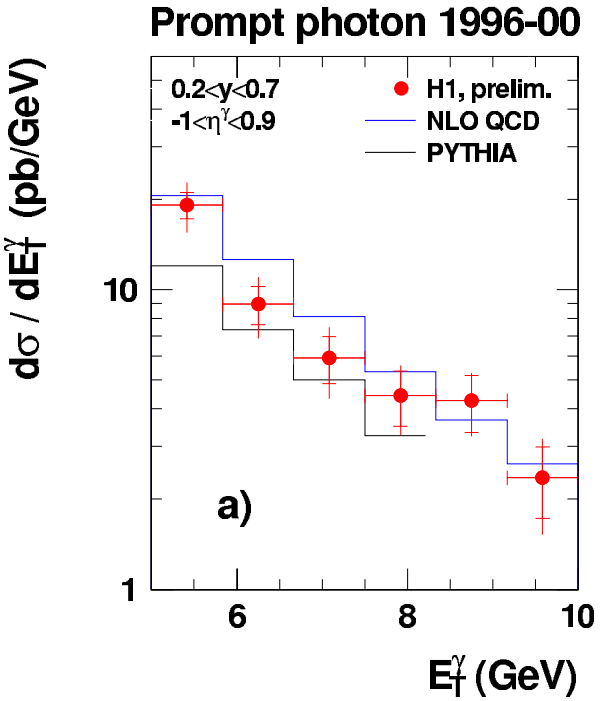
–> Errors not far from world averages

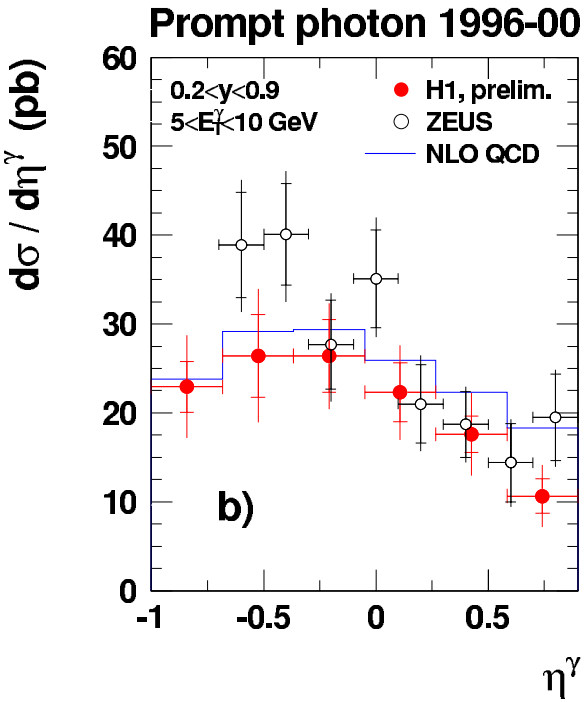
–> universality of charm fragmentation

Prompt Photons in Photoproduction

Studying QCD without fragmentation or jet finding issues

Signal extracted by shower shape analyis

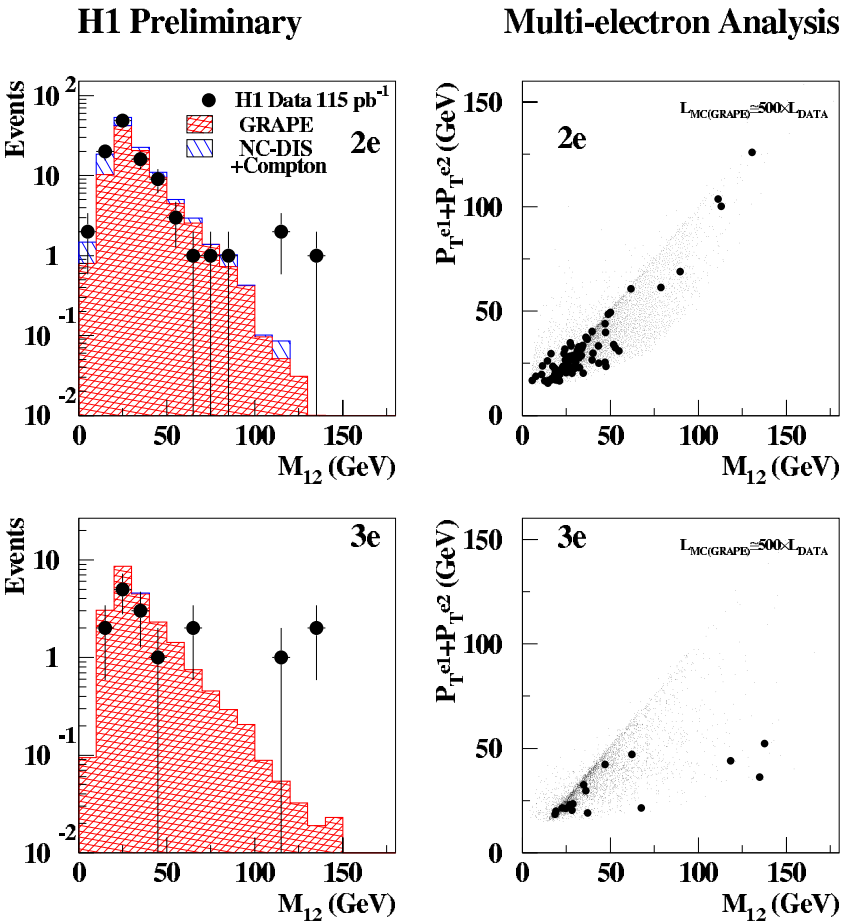


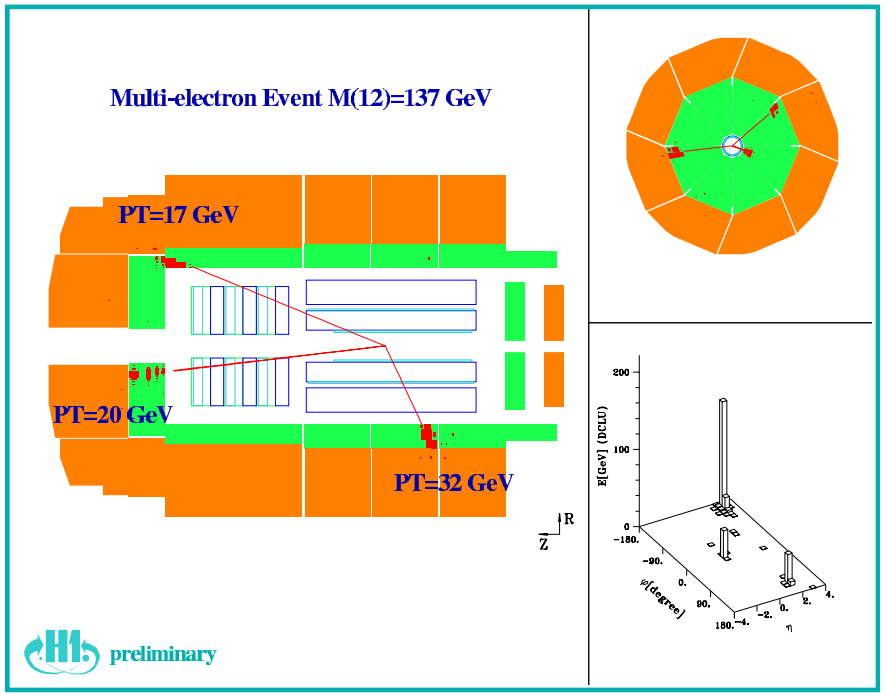


–> well in agreement with ZEUS results

–> well reproduced by NLO QCD

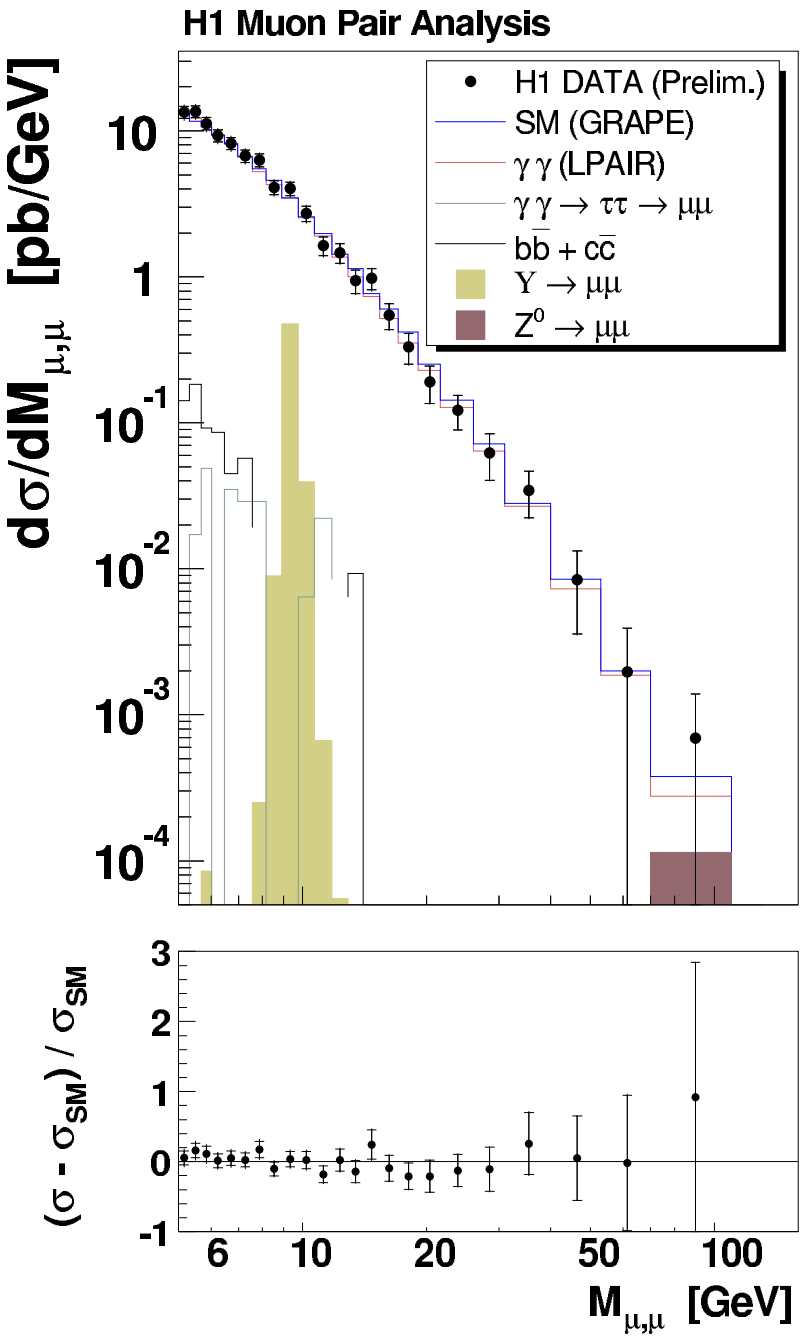
Multi Electron Analysis





M > 100 GeV

	Data	SM
2e	3	0.25 +– 0.05
3e	3	0.23 +– 0.04



Multi Muon Analysis

require 2 muons in central region

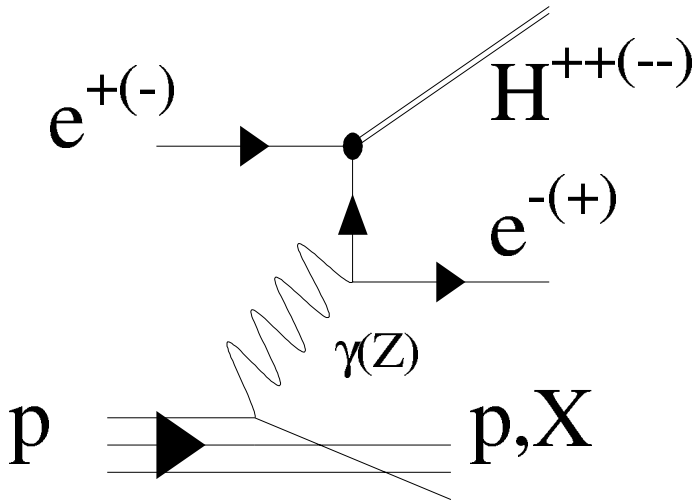
No event for: M > 100 GeV
(reduced lumi and efficiencies)

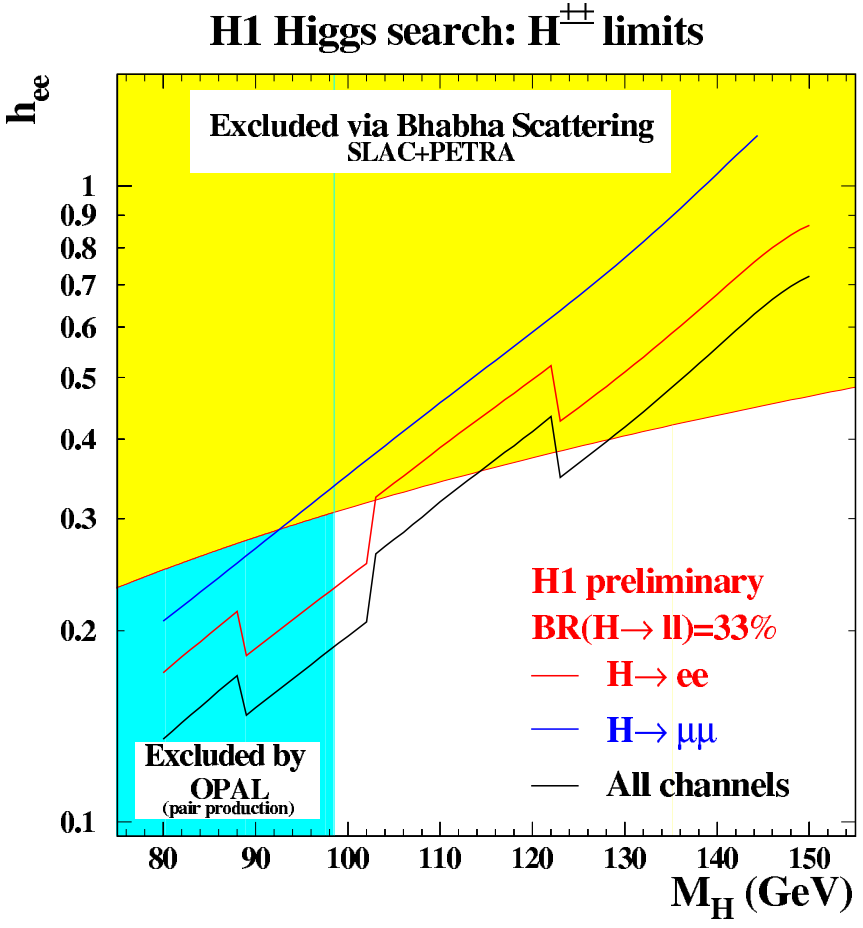
Good overall agreement with SM

Extrapolation from 2–electron events:
–> expect ~1 event with M > 100 GeV

–> not yet conclusive

Double Charged Higgs Analysis



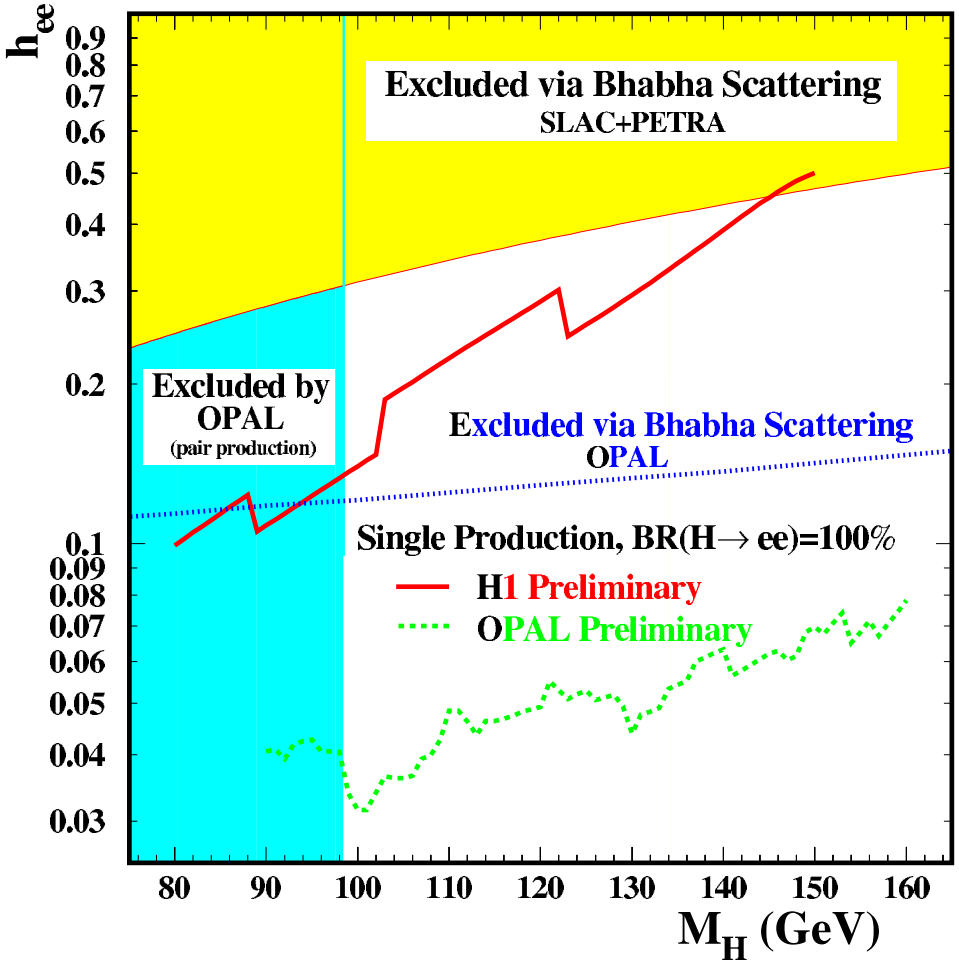


–> tighter cuts: transverse momentum charge

(reduction of background, high efficiency for double charged higgs)

–> only 1 dielectron event survives

H^{++} Experimental Results and Interpretion



- H^{++} interpretation disfavoured by H1
- H^{++} interpretation also disfavoured by new (more sensitive) OPAL results

→ Excess of 6 multi–electron events remains unexplained