Highlights from DIS 2001 - Experimental Results

Frank-Peter Schilling / DESY

- Structure functions
- α_s and $g(x)$ from jets
- Heavy quarks (F_2^c, b cross section)
- Spin (incl. DVCS)
- Diffraction
- Isolated Leptons Update

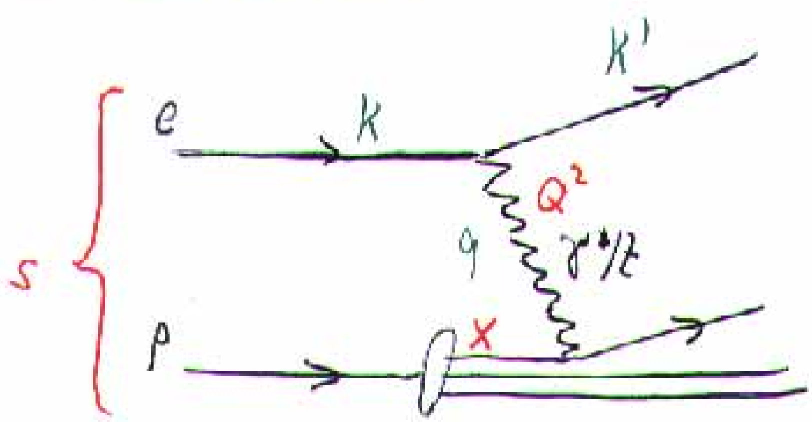
DESY Seminar, 08/05/2001

Structure Functions

- Final 1996/97 $F_2(x, Q^2)$ at medium Q^2 [ZEUS,H1]
- NLO QCD fits to determine α_s and $g(x)$ [H1,ZEUS]
- New high E_T Tevatron jet cross sections [D0]
- New $F_2(x, Q^2)$ data at very low Q^2 via ISR [H1]
- Longit. structure function F_L at low and high Q^2 [H1]
- New F_2^ν data at low x, Q^2 [CCFR]
- Photon Structure:
  - New LEP data [Opal]
  - High E_T dijets in photoproduction [H1]

Inclusive DIS at HERA

Neutral Current:



$$Q^2 = -(k-k')^2$$

$$x = \frac{Q^2}{2p\cdot q}$$

$$y = Q^2/sx$$

$$\frac{d^2\sigma^{e^\pm p}}{dx\,dQ^2} = \frac{2\pi\alpha^2}{xQ^4}\left[Y_+ F_2 \mp Y_- xF_3 - y^2 F_L\right]$$

$$\left(Y_\pm = 1 \pm (1-y)^2\right)$$

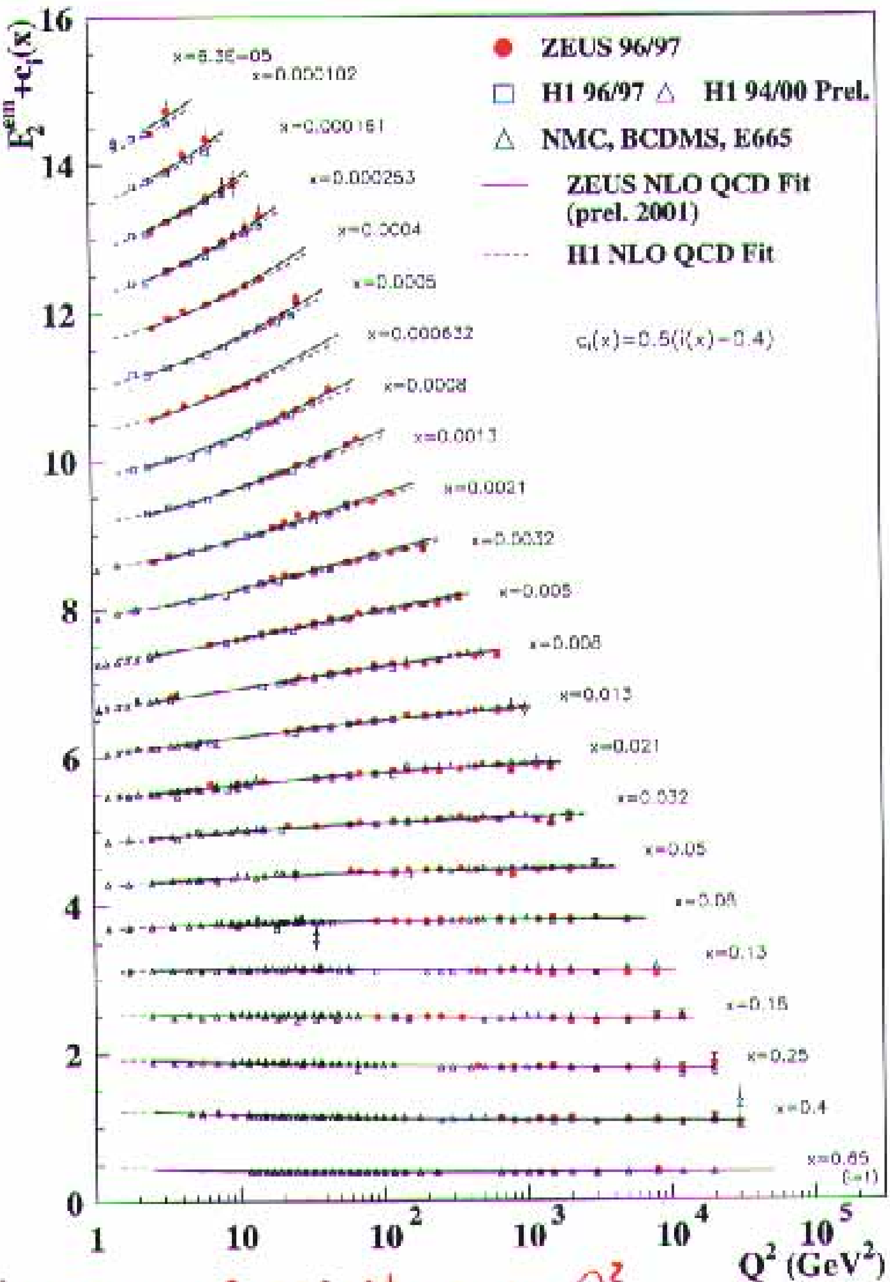
$F_2 = x\sum_q A_q(q+\bar{q})$ [in QPM]

$F_3 = x\sum_q B_q(q-\bar{q})$ [parity-violating, high Q^2 only]

F_L: Longit. Structure Function

- DGLAP equations describe evolution with Q^2

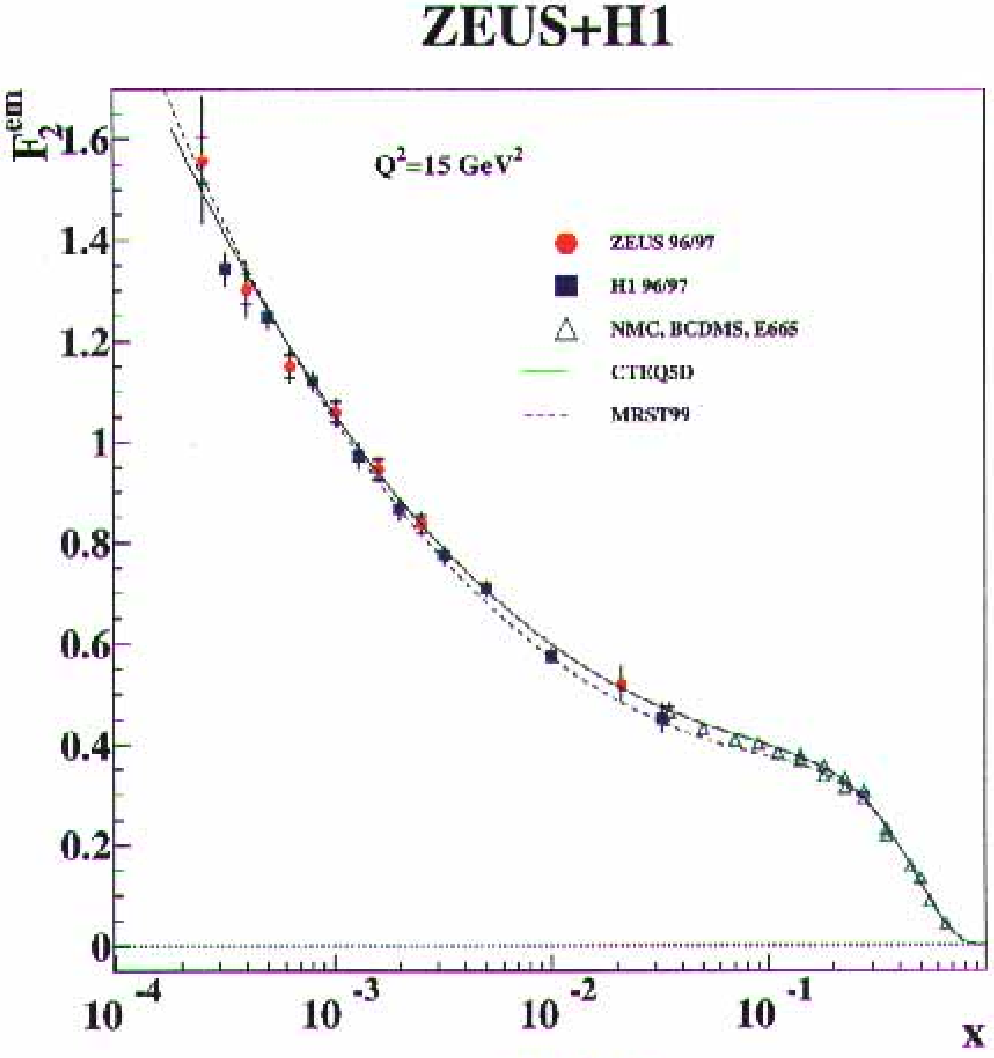
ZEUS/H1 final 1996/7 $F_2(x, Q^2)$ data



• 4 orders of magnitude in Q^2
• $x = 6 \cdot 10^{-5} \ldots 0.6$

=> Good agreement ZEUS - H1

ZEUS/H1 final 1996/7 $F_2(x, Q^2)$ data



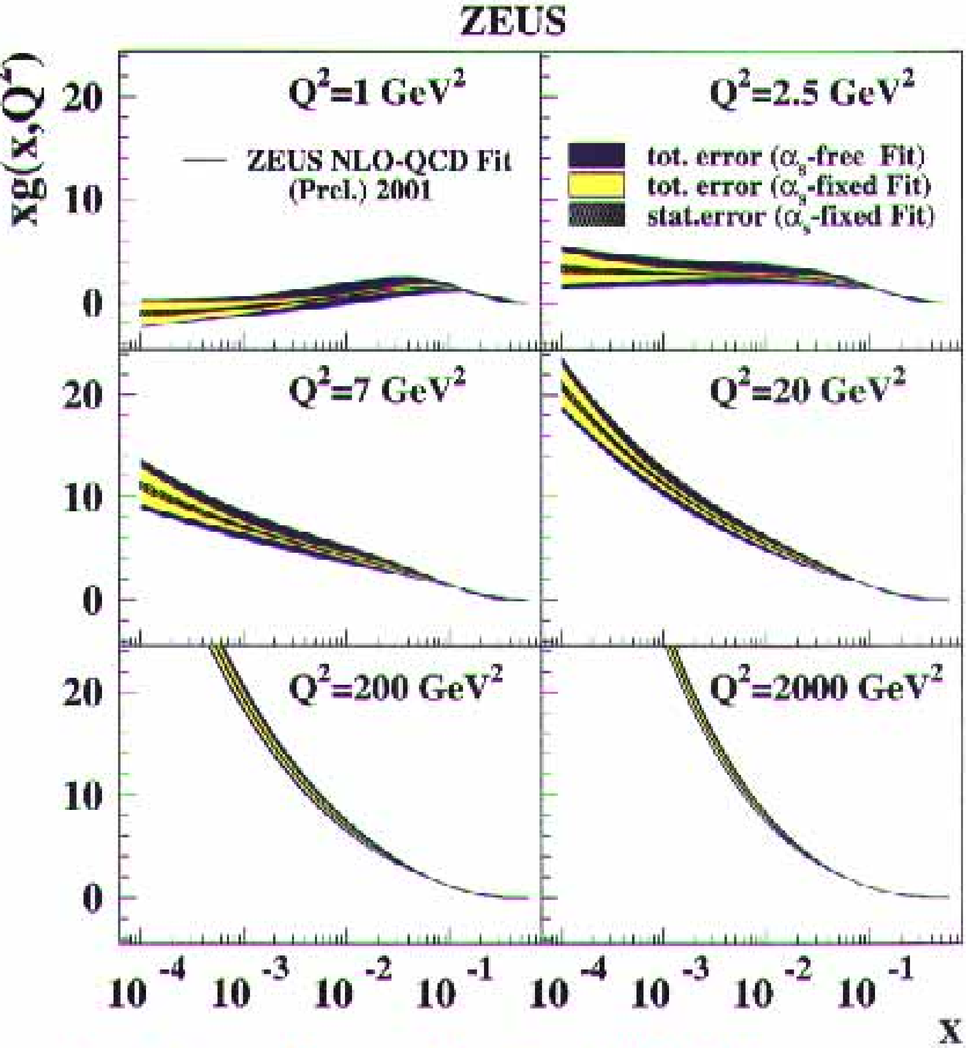
- stat. uncertainty $\mathcal{O}(1\%)$ → systematics dominate
- steep low-x rise
- small x: $\left.\frac{\partial F_2}{\partial \ln Q^2}\right|_x \sim \alpha_s P_{qg} \otimes xg(x)$

⇒ determine α_s, $g(x)$!

H1 and ZEUS NLO QCD fits

H1 [published]	ZEUS [preliminary]
– use lepton-proton target data only: H1, H1+BCDMS	– use ZEUS, BCDMS(P+d), E665, NMC (p+d), CCFR (xF3)
– parameterize xg, V(x), A(x) (effective valence and sea)	– parameterize xg u_v, d_v, xS, $x(d-u)$
– 5/4 parameter $xg(x)$ (H1+BCDMS / H1 alone)	– 3 parameter $xg(x)$
– $Q_0^2 = 4\ \mathrm{GeV}^2$	– $Q_0^2 = 7\ \mathrm{GeV}^2$
– $\alpha_s = 0.115$	– $\alpha_s = 0.1172$
– FFN(3) massive heavy quark scheme (PGF)	– VFN (Thorne/Roberts) heavy quark scheme
– Careful treatment of point-to-point correlated syst. errors (Pascaud-Zomer)	– Careful treatment of point-to-point correlated syst. errors (Pascaud-Zomer)
– Systematic offsets determined by fit	– Systematic offsets NOT modified by fit
– Scale dependence computed ± 0.005	– No scale dep. evaluated yet

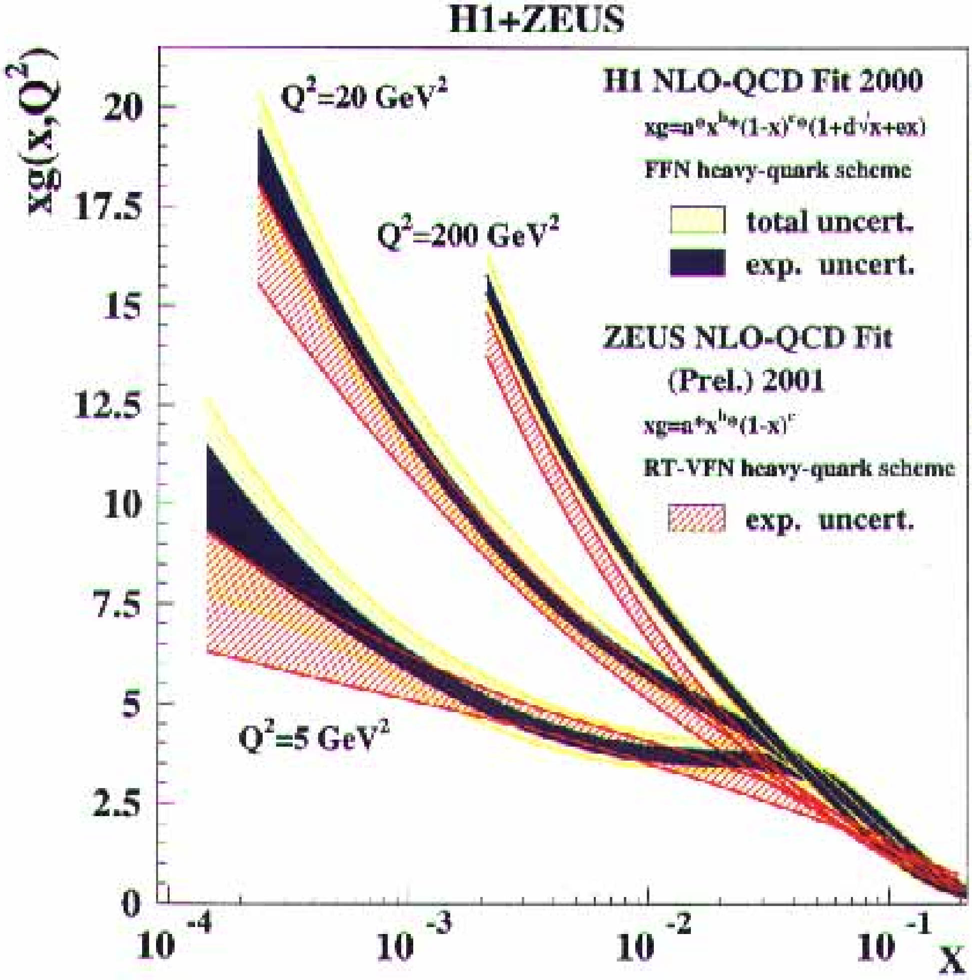
ZEUS $xg(x)$ (Preliminary)



- at $Q^2 = 1$ GeV^2 valence-like gluon

[R. Wallny]

Comparison: ZEUS and H1 $xg(x)$



$\alpha_s = 0.115$
$Q_0^2 = 4\ GeV^2$
5 param. g(x)

$\alpha_s = 0.117$
$Q_0^2 = 7\ GeV^2$
3 param g(x)

- For similar model assumptions ($g(x)$ param., HQ, α_s, Q_0^2), H1 and ZEUS gluons very similar!
- H1 error smaller [treatment of correl. syst. errors?]

[R. Wallny]

α_s from NLO QCD fits (H1/ZEUS)

[$\alpha_S(M_Z) = 0.1184 \pm 0.0031$ world average S. Bethke]

	ZEUS	H1
α_S	0.1172 prelim.	0.1150
errors:	$\pm$ 0.0008(stat) $\pm$ 0.0054(syst)	$\pm$ 0.0017 (exp) $^{+0.0009}_{-0.0005}$ (model)
sum:	0.0055	0.0020
scales:	?	$\approx$ 0.005

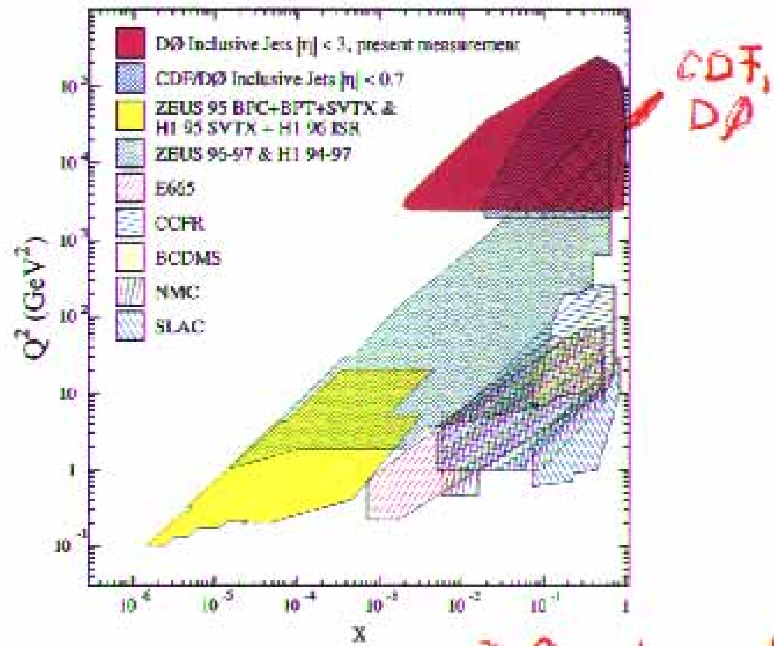
- Exp. errors: World average precision!
- Dominating uncertainty: Theory (scale)
  In NNLO: $\Delta_{scale} \sim 0.001$-2 [A. Vogt]
  ⇒ Available 2001!
- HERA II: syst. error ↘ 0.001

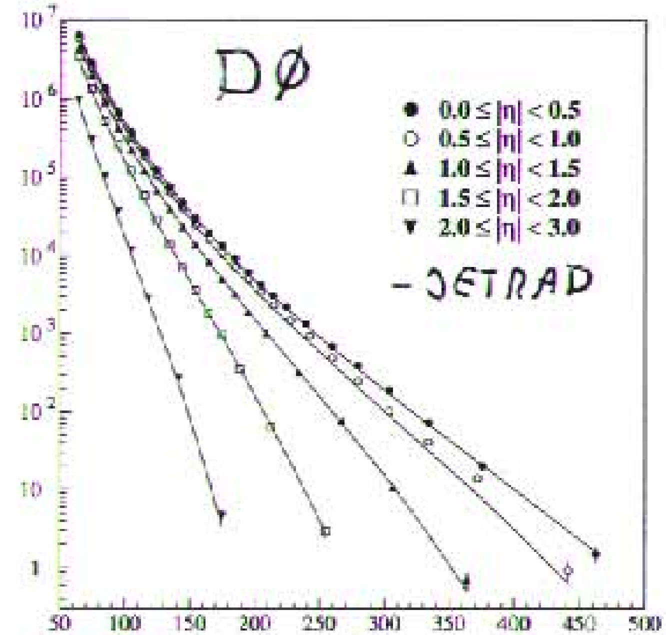
⇒ High precision QCD

⇒ "Need HERA WG's!" [R. Cashmore]

[hep-ex/0011036]

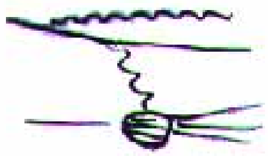
High E_T jets in pp (D0)





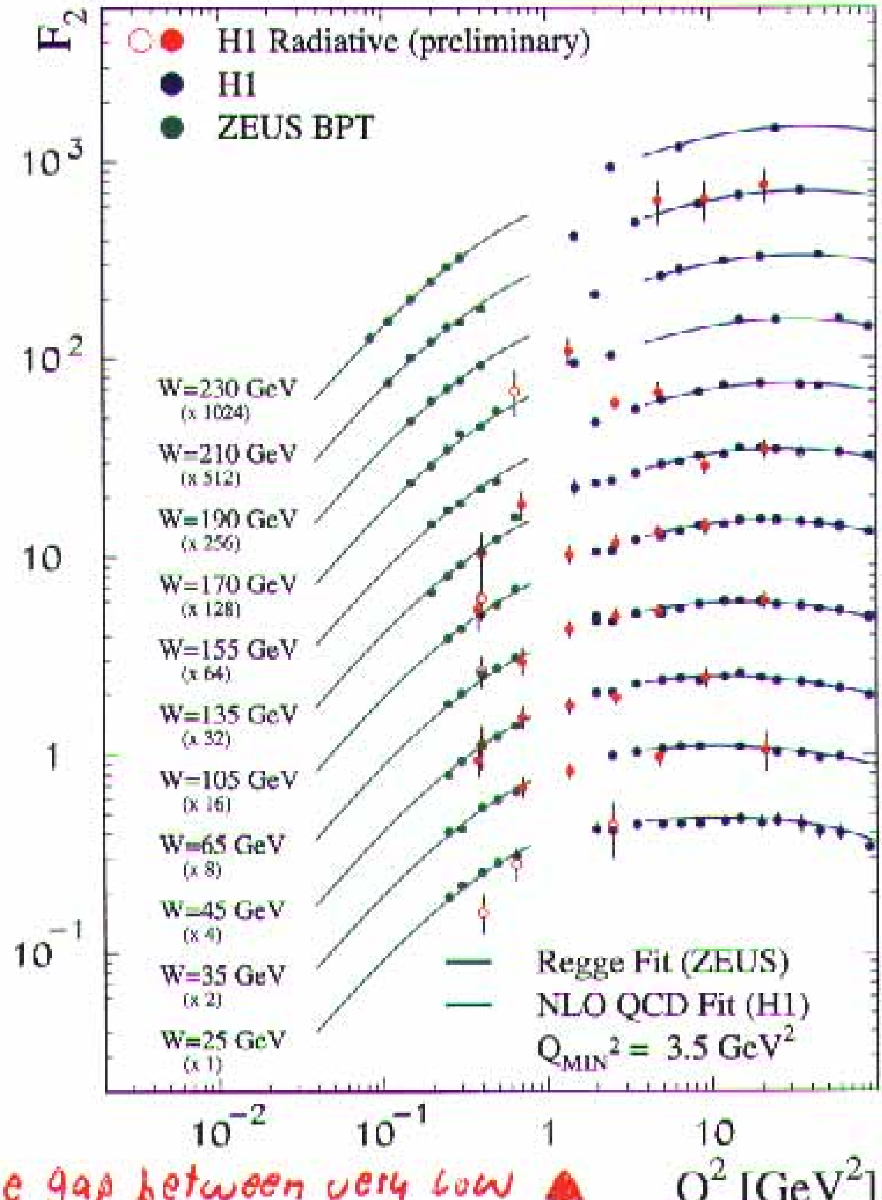
⇒ Constrain high x gluon

⇒ Being implemented in global fits



Initial state Radiation
⇒ smaller s ⇝ smaller Q^2 @ same θ_e,

New $F_2(x, Q^2)$ data at very low Q^2 (H1)



- close gap between very low and medium Q^2

⇒ access to interesting transition region ~ 1 GeV²

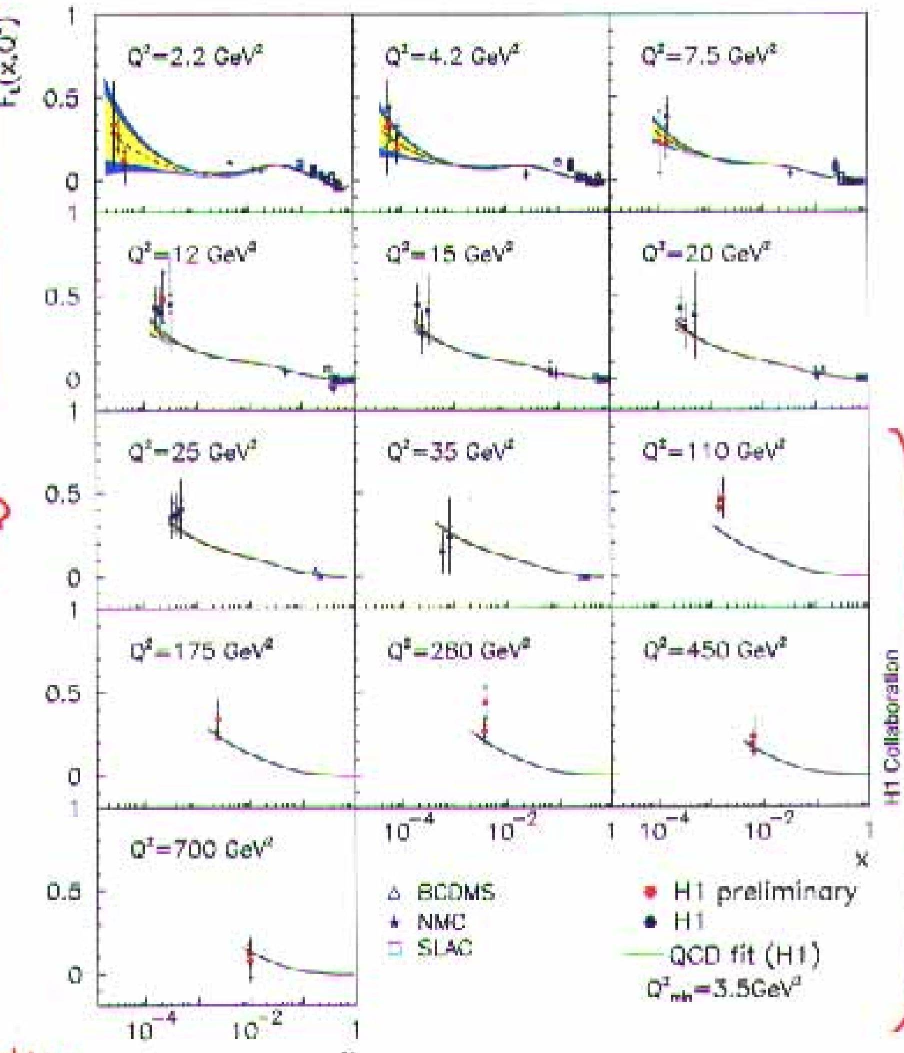
Longitudinal Structure Function

$$F_L \sim \frac{\alpha_s}{\pi} \beta_L \otimes x g(x)$$

New F_L measurements at low/high Q^2 (H1)

NEW
2.2–12 GeV²
y < 0.9
(E'_e > 3 GeV)
· Upgraded Backward Detectors

Agreement with NLO QCD fit



NEW
110–700 GeV
y < 0.75
1st F_L @ hi Q

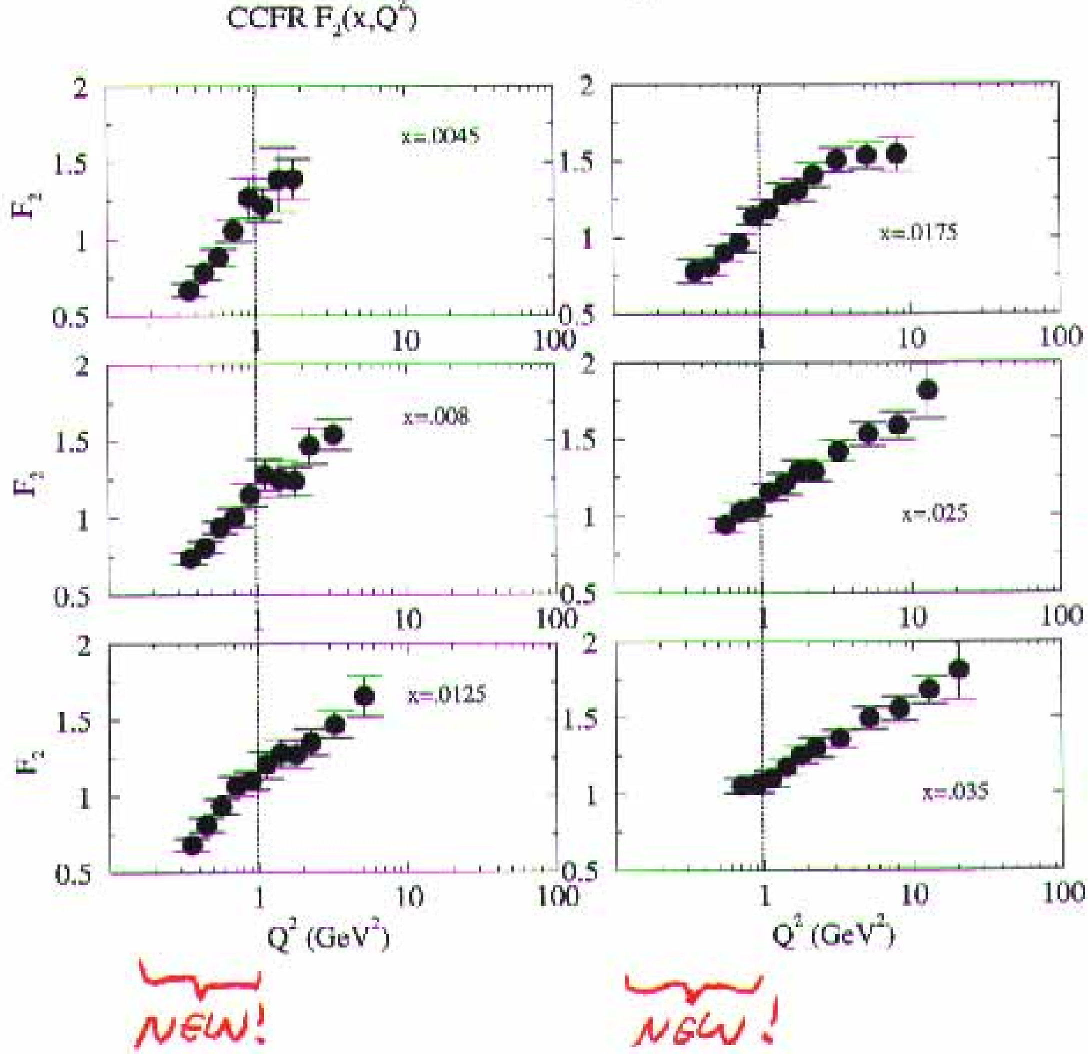
F_L extraction

- high Q^2: "Extrapolation method" $\sigma_r = F_2 - \frac{y^2}{Y_+} F_L$
- small Q^2: "Derivative method"

$$\left.\frac{\partial \sigma_r}{\partial \ln y}\right|_{Q^2} = \left.\frac{\partial F_2}{\partial \ln y}\right|_{Q^2} - \frac{2y^2(1-y)}{Y_+^2} F_L - \frac{\partial F_L}{\partial \ln y} \cdot \frac{y^2}{Y_+}$$

New data $F_2^\nu(x, Q^2)$ at low x, Q^2 (CCFR)

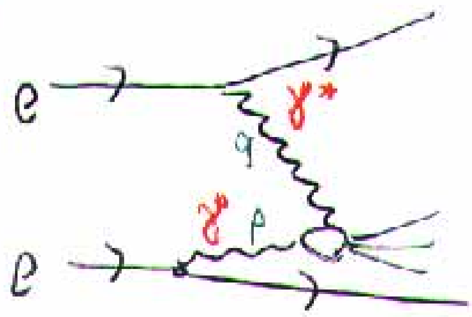
[hep-ex/0011094]



- New measurement at low x and Q^2
- Now agreement $F_2^\nu \Leftrightarrow F_2^\mu$ [NMC, E665] for $x > 0.0125$

Photon structure at LEP and HERA

LEP

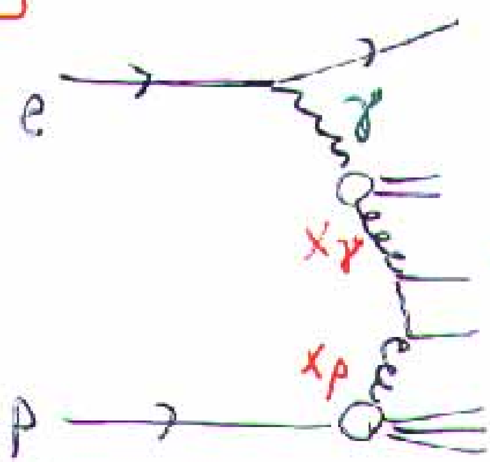


$p^2 \approx 0$ GeV^2

$Q^2 \gg p^2$

⇒ constrains q_γ

HERA



$Q^2 \approx 0$ GeV^2

} high P_T jets

⇒ constrains $q_\gamma + g_\gamma$!

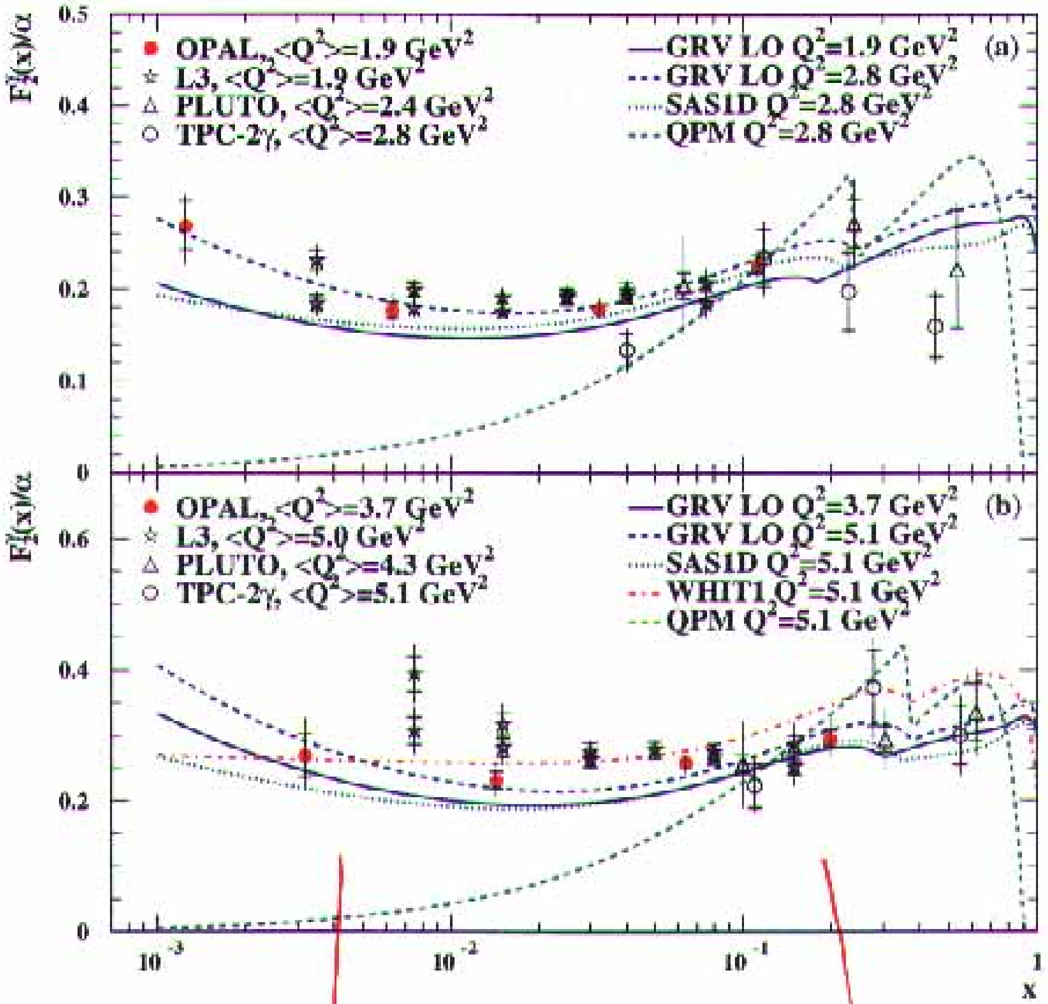
$F_2^\gamma = F_2^{point} + F_2^{hadr.}$

$\gamma^{(*)} \to q\bar{q}$ — pert.

$\gamma \to V\ (J^{PC} = 1^{--})$ — non-pert.

Photon Structure: New LEP data

$\frac{1}{\alpha} F_2^\gamma$



hadronic — point-like

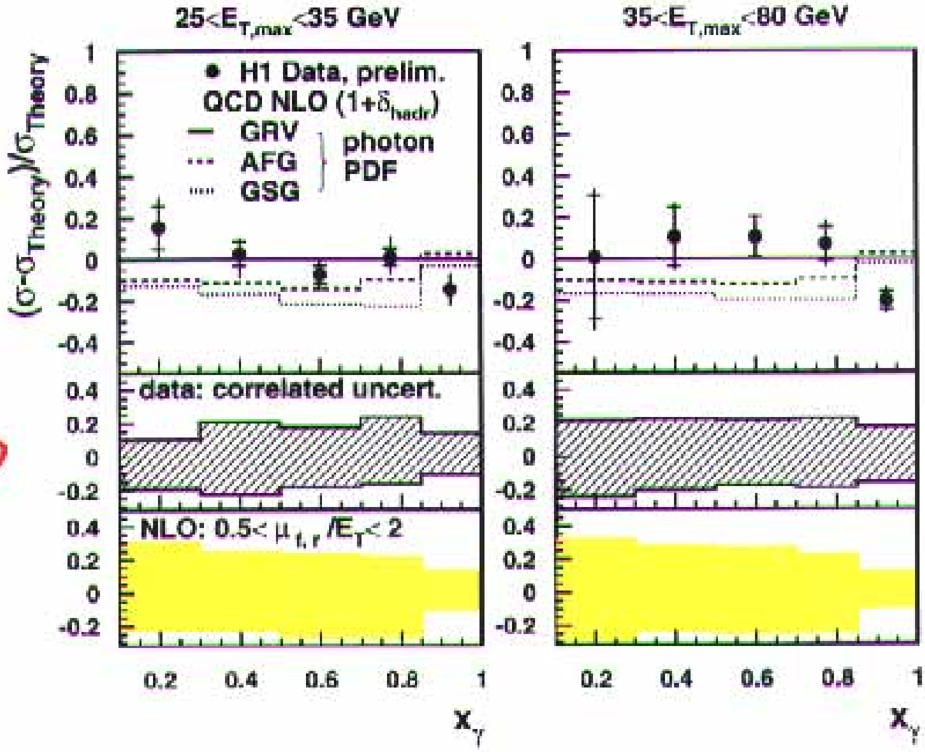
- Consistent with GRV/SaS
- Indication for low-x rise (?)
- Sizeable spread between datasets

[S. Ferron]

High E_T Dijets in γp (H1)

Measurement of $\frac{d\sigma}{dx_\gamma}$

Difference between data and theory:



Upper plot: only uncorrelated part of the systematic errors are shown.

NLO predictions describe the x_γ distribution

(no confirmation of earlier ZEUS observation)

DIS 2001, S. Ferron, Ecole Polytechnique 10

⇒ Fight to reduce Energy scale uncertainty!

α_s and $g(x)$ from Jets

- New result:
  - 3-Jet cross sections in DIS [H1]
- New result:
  - α_s from subjet multiplicities [ZEUS]
- Gluon density from jets [H1]
- α_s measurements summary [ZEUS,H1]

Jet production in DIS:

Sensitive to $\alpha_s \otimes g(x)$

Either: Input $g(x)$, extract α_s

Or: Input α_s, extract $g(x)$

Observables:
- Inclusive Jets
- Dijets
- 3-Jets
- Subjet mult.
- ...

$Q^2 = 5 \ldots 5000$ GeV^2
$M_{3jet} > 25$ GeV

[M. Wobisch]

3-Jet Production in DIS (H1)

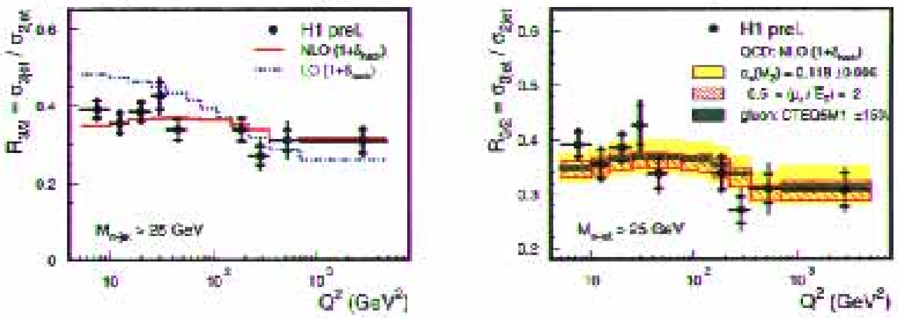
NEW
NLO available ($O(\alpha_s^3)$)

Ratio of 3-Jet and 2-Jet Cross Section: $R_{3/2} \propto \alpha_s$

measurement with same cut: $M_{n-jet} > 25$ GeV
probe PDFs at same x ⇒ cancellation of PDF uncertainties

comparing data with leading order and with next-to-leading order pQCD

Theory progress needed ⇒



⇒ Sensitivity to α_s

⇒ NLO: significant change of shape + good agreement with data

!! ⇒ small renormalization scale dependence over whole Q^2 range !!

M. Wobisch, DESY — Three-Jet Production in DIS — 10

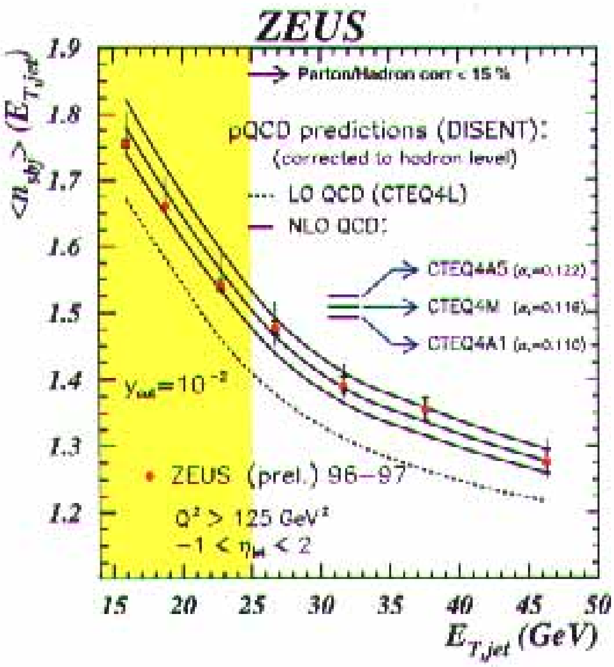
[O. Gonzales]

α_s from subjet multiplicities (ZEUS)

15

Comparison of the DATA with NLO QCD predictions (2)

$Q^2 > 125$ GeV^2
$E_T > 15$ GeV
incl. k_T alg.



- The measurements are sensitive to α_s

We extract α_s using the data with $E_{T,jet} > 25$ GeV

[Small hadronization corrections]

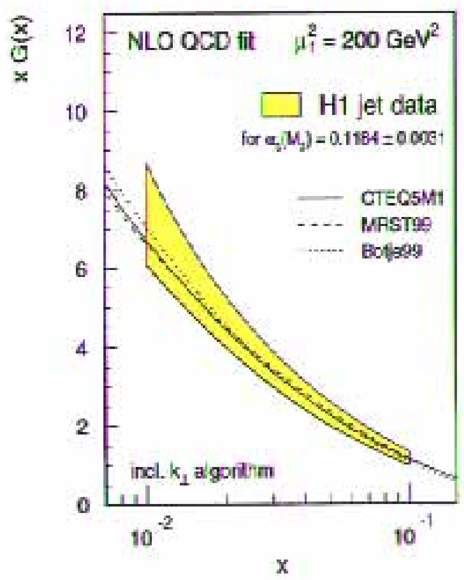
Oscar González (ZEUS Coll., UAM) DIS Workshop 27-IV-2001

$$\alpha_s(M_Z) = 0.1185 \pm 0.0016(\text{stat.})^{+0.0067}_{-0.0048}(\text{syst.})^{+0.0089}_{-0.0071}(\text{theo.})$$

[G. Grindhammer]

$g(x)$ from jets in DIS (H1)

Determination of $xg(x)$

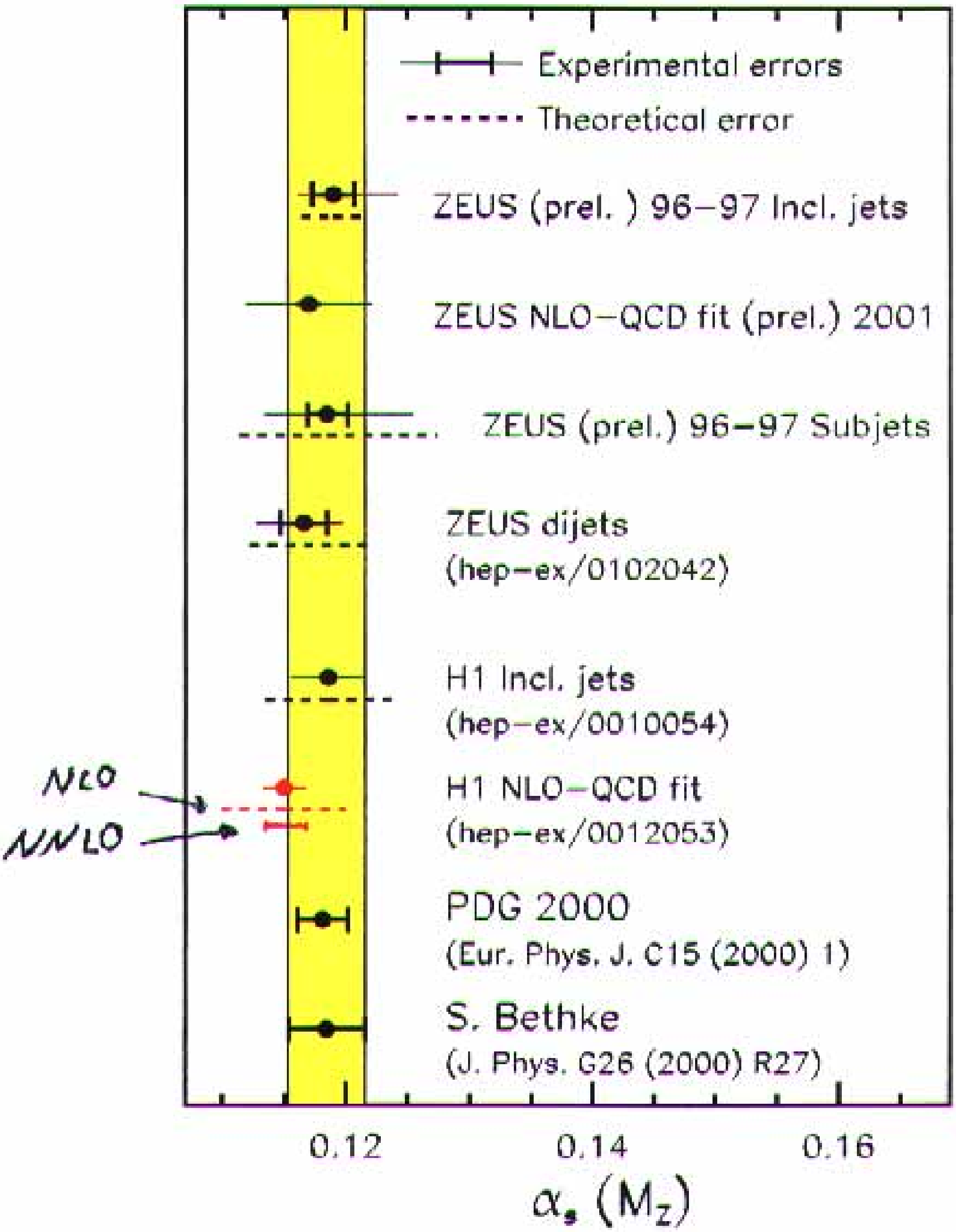


- Jet cross sections directly sensitive to $xg(x)$ and $xq(x)$
- Inclusive DIS (F_2) directly sensitive to $xq(x)$ only
- $\alpha_s(M_Z) = 0.1184 \pm 0.0031$

Direct determination from jets at $0.01 < x < 0.1$ is consistent with results from global fits

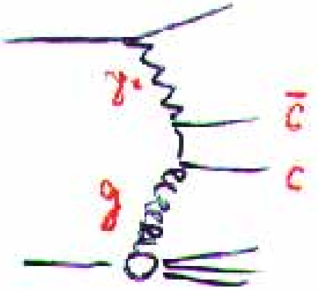
Günter Grindhammer, MPI Munich — α_s and xg from Jets in DIS — 11

α_s summary (ZEUS,H1)



Heavy Quarks

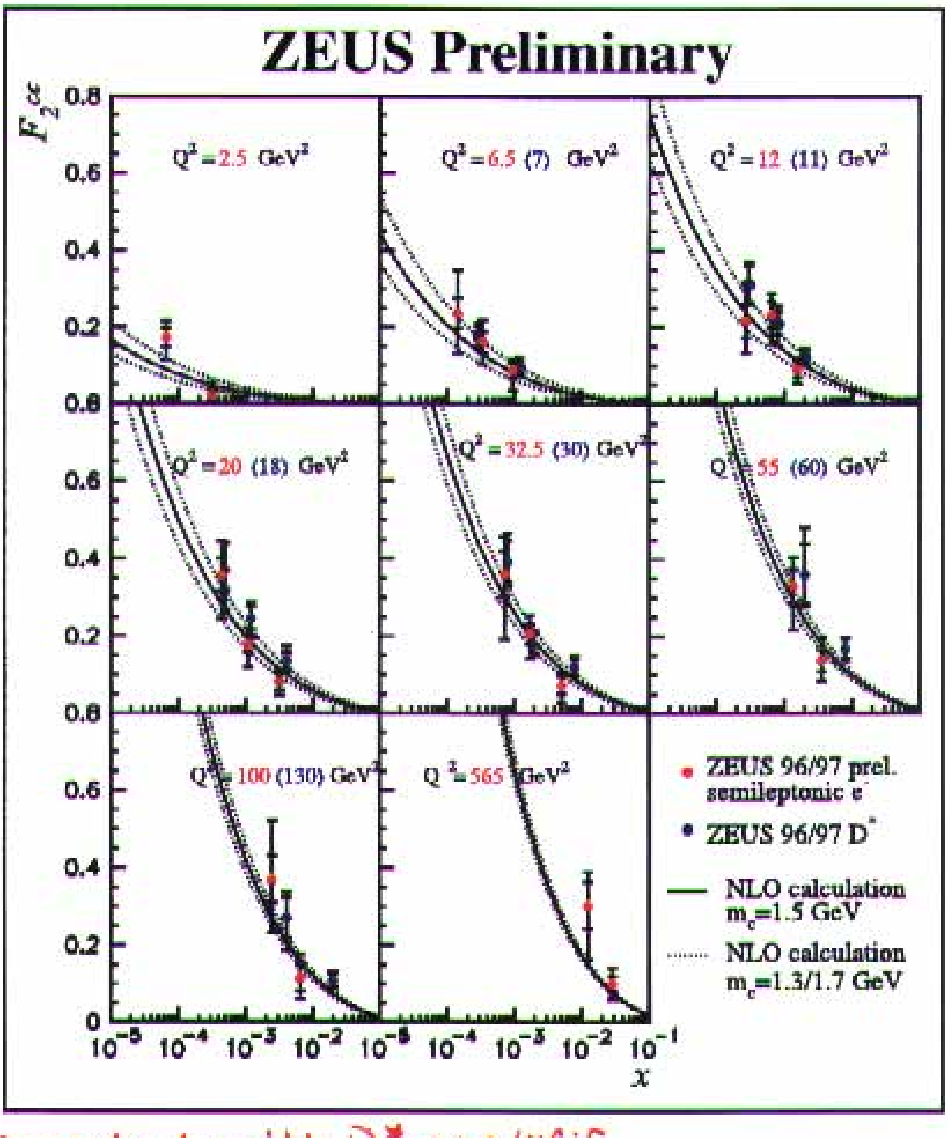
- D^* cross sections and F_2^c measurements [ZEUS,H1]
- b cross section at LEP [L3,OPAL]
- b cross section in photoproduction and DIS [H1,ZEUS]



Boson-Gluon Fusion

F_2^c (ZEUS)

New measurement using semileptonic decays:



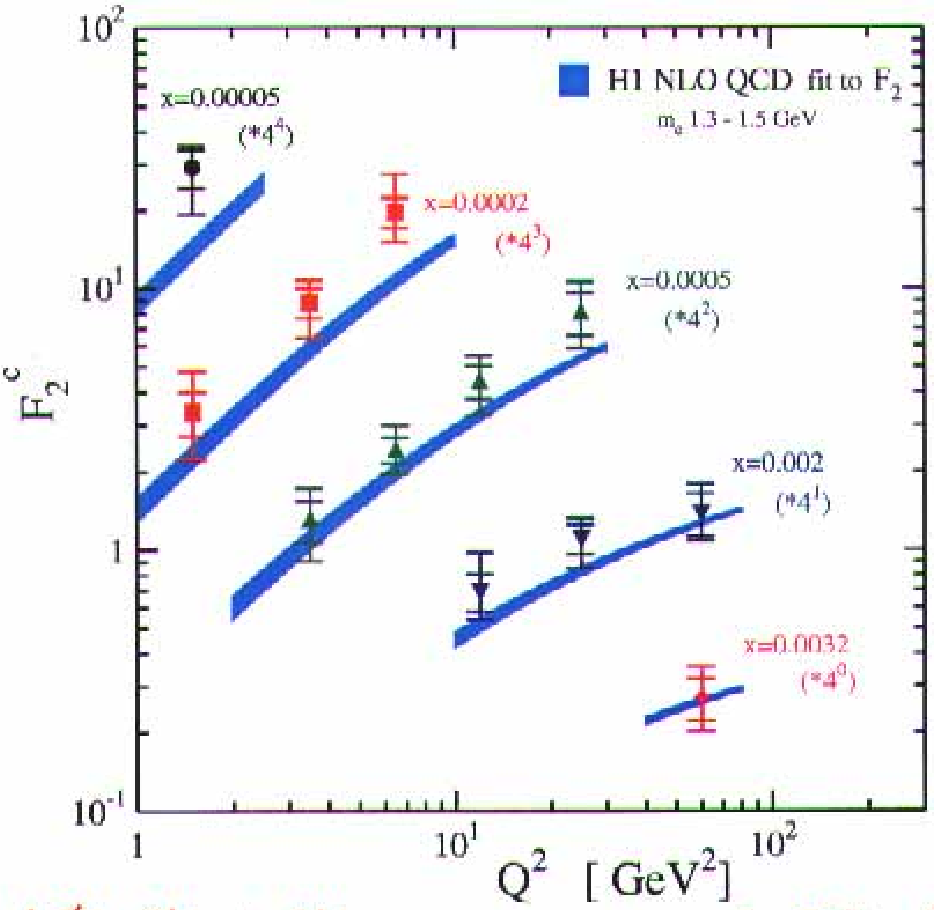
- Consistent with D* analysis
- Described by NLO DGLAP

F_2^c (H1)

[F_2^c not an observable! Need extrapolation from σ_{vis} !

F_2^c in the NLO DGLAP scheme

H1 96-97

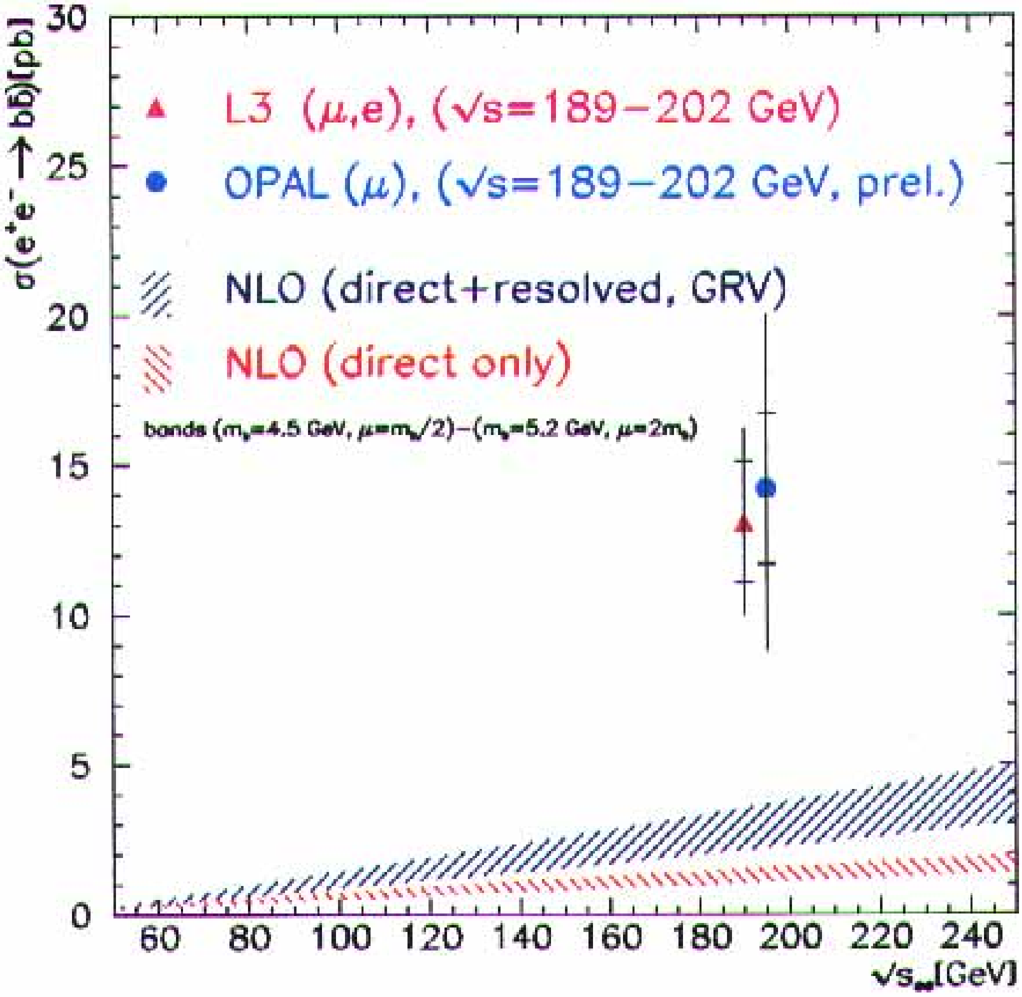


- H1 data show stronger scaling viol. @ small x than predicted by NLO DGLAP
- Better described by CCFM (angular ordering) [L. Loennblad]

- No discrepancy H1-ZEUS if same kinematics regions are compared!

b cross section at LEP

$$\gamma\gamma \longrightarrow b\, X$$

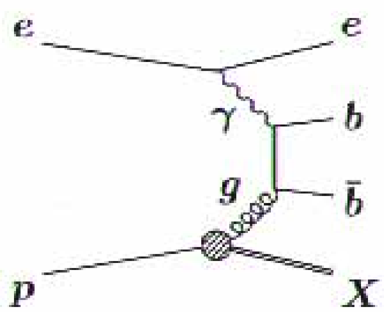


- NLO QCD too low by factor 3
- 2/3.5 standard deviations

[Similar at Tevatron]

[J. Kroseberg]

Production of Open Beauty at HERA



- necessary ingredient to **understand proton structure**
- b mass provides hard scale, i.e. good **testing ground for pQCD**

QCD calculations available in NLO
$p_t \approx m_b \rightarrow$ **'massive' approach**
(b produced dynamically in hard subprocess)

- γp: **'FMNR'** (Frixione et al.)
- **DIS: 'HVQDIS'** (Harris, Smith)

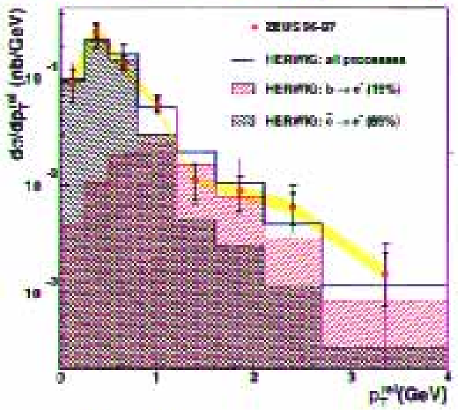
NLO corrections large in both cases

[J. Kroseberg]

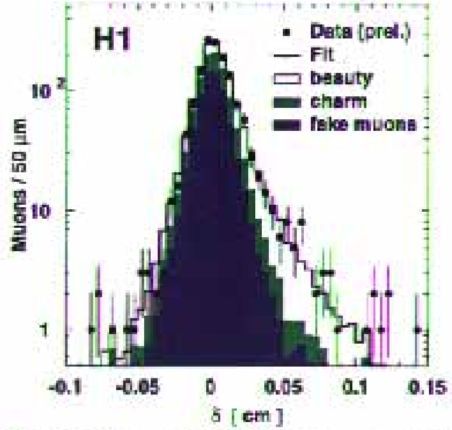
Open Beauty at HERA(I) : Photoproduction Cross Sections

new data and new methods → γp results confirmed and improved

ZEUS: electron p_t^{rel} analysis



H1: muon lifetime + p_t^{rel} analysis



parton level cross section

$\sigma_{ep\to e^+ bX} = (1.6 \pm 0.4 \,^{+0.3}_{-0.5}\,^{+0.2}_{-0.4})$ nb

[NLO QCD: $\sigma = (0.64 \pm \,^{+0.14}_{-0.10})$ nb]

visible cross section (comb. with publ. result)

$\sigma_{vis}^{ep\to b\bar{b}X\to\mu X'} = (170 \pm 25)$ pb

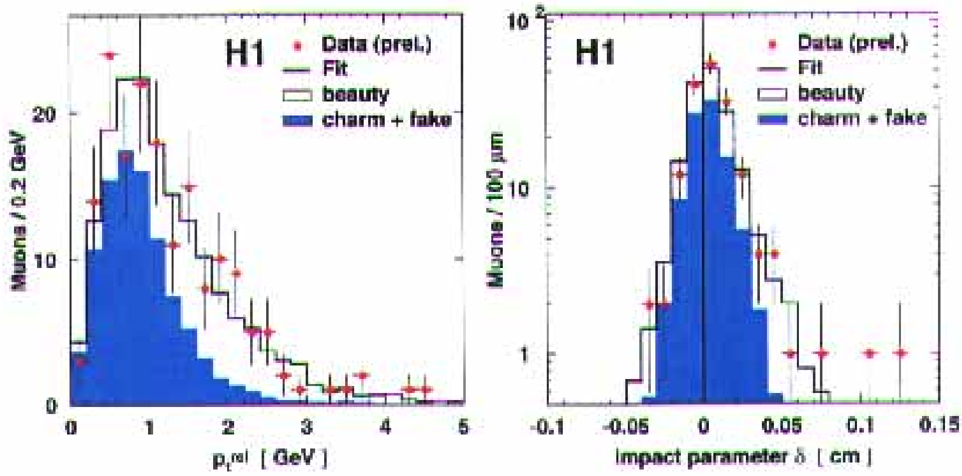
[NLO QCD: $\sigma = (104 \pm 17)$ pb]

[J. Kroseberg]

Beauty production in DIS (H1)

Open Beauty at HERA (II)

- **first measurement in DIS:**



$ep \to b\bar{b}eX \to \mu X'$ cross section in visible range:

$$\sigma_{vis} = [39 \pm 8\ (stat.) \pm 10\ (syst.)]\ \text{pb}$$

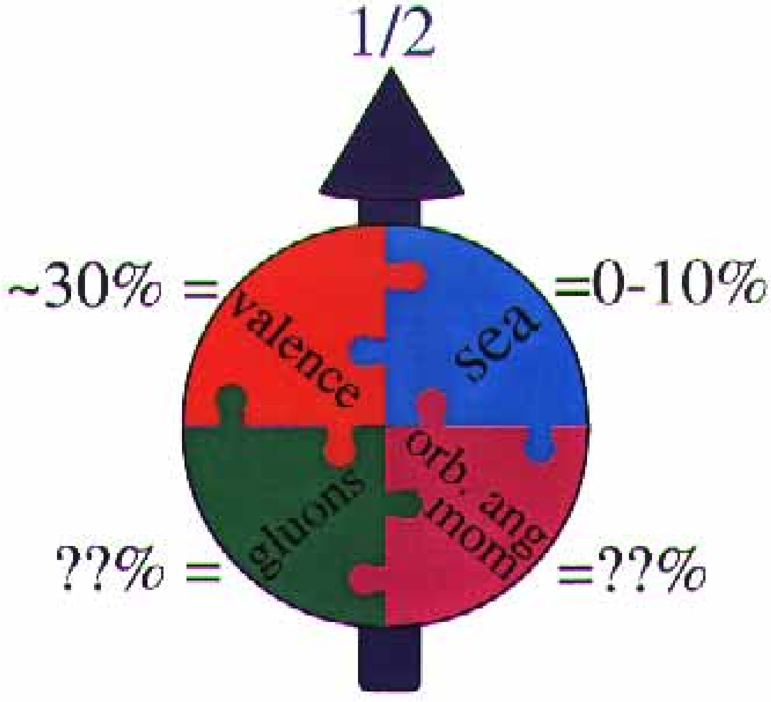
NLO QCD: $\sigma = (11 \pm 2)$ pb

- **all measured cross sections above NLO QCD**
  - → discrepancy theory ↔ data further established
  - → now seen in ep, γp, $\gamma\gamma$ and $p\bar{p}$ interactions

J. Kroseberg *Open Beauty Production at HERA* DIS2001 17

Spin

- Status of g_1
  - HERMES low x data [HERMES]
  [valence / sea decomposition]
- Transversity [HERMES]
- DVCS [H1,ZEUS,HERMES]



Spin: Introduction

Quark number density: $q(x)$

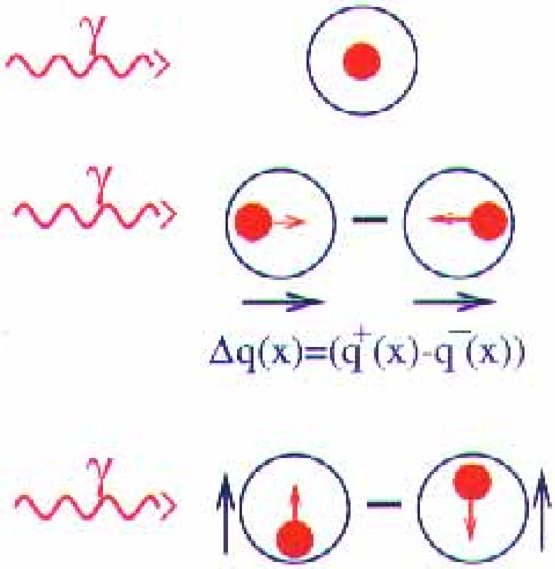
$$F_1(x) = 1/2 \sum_q e_q^2 (q(x)+\bar{q}(x))$$

Quark helicity: $\Delta q(x)$

$$g_1(x) = 1/2 \sum_q e_q^2 (\Delta q(x)+\Delta\bar{q}(x))$$

Quark transversity: $\delta q(x)$

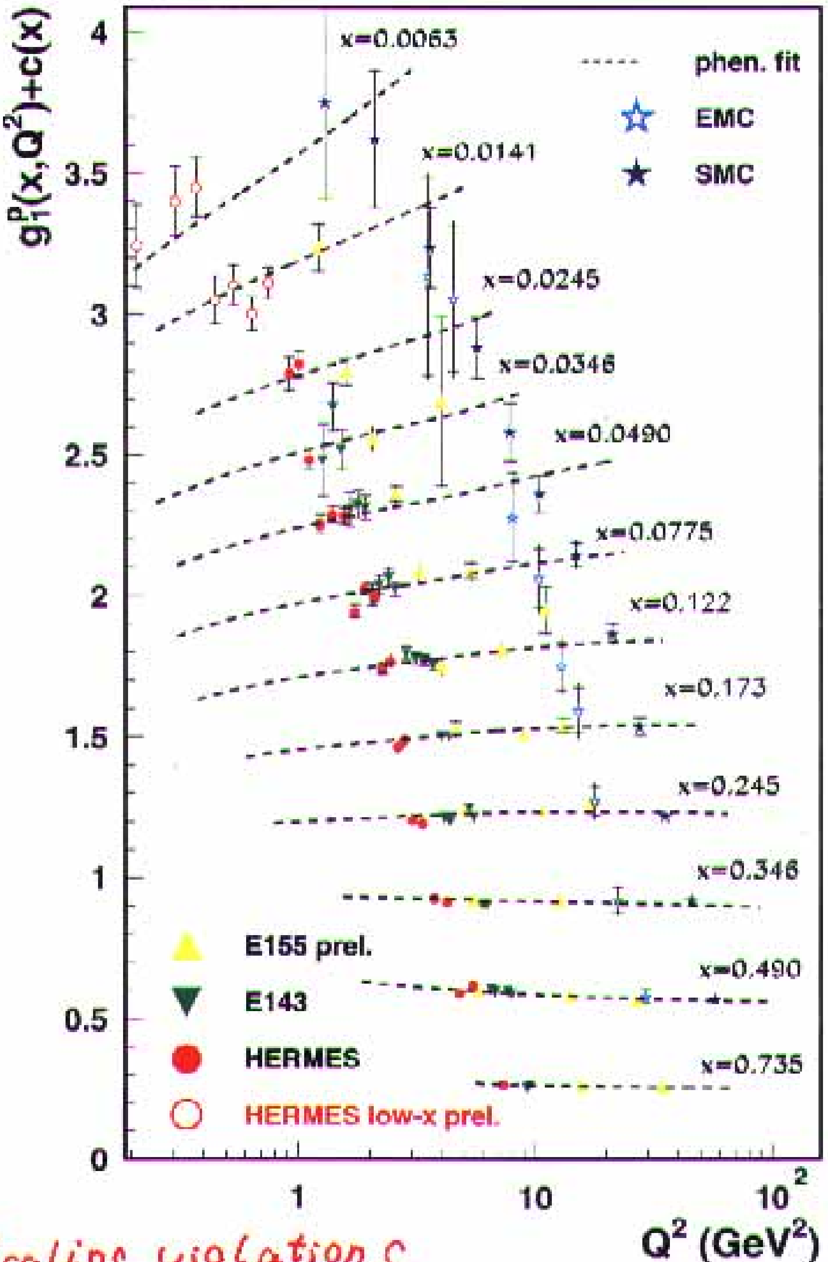
$$h_1(x) = 1/2 \sum_q e_q^2 (\delta q(x)+\delta\bar{q}(x))$$



Transversity:

- $\boldsymbol{\delta q}$: distr. of transverse quark spin in transversely polarized nucleon
- $\boldsymbol{\delta q \neq \Delta q}$ due to relativistic and spin orbit effects
- $\boldsymbol{h_1}$ never measured so far, chiral-odd !

g_1: New HERMES low x data



→ Scaling violations

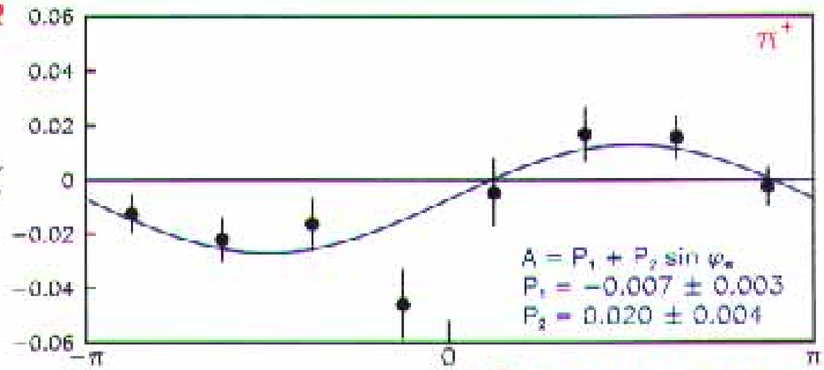
[M. Vincter]

Transversity: First results

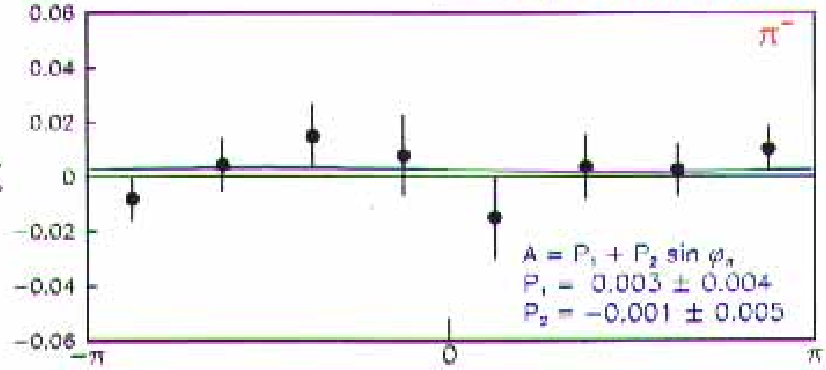
Single spin asymmetry with long. polarized target also sensitive to $\delta q(x) H_1^{\perp(1),q}(z)$ Collins Function (Transv. pol. frag. func.)

$$\vec{e} \,||\, \vec{p} \neq \vec{\gamma}^* \,||\, \vec{p}, \quad S_T \sim 15\%$$

Spin dependence of azimuthal distr. of leading pion

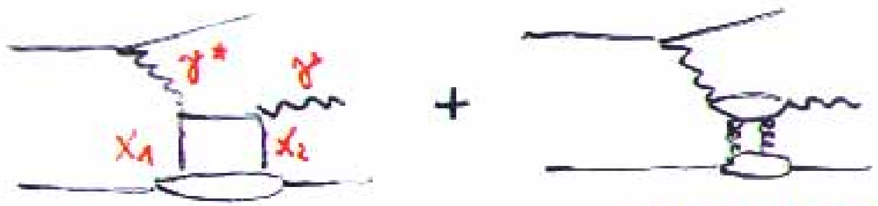


φ [of π around γ* direction]



- non-zero asymmetry for π^+, π^o; difference to π^- predicted by Collins (u-quark dominance in valence region)

⇒ Major physics topic in HERMES run II!



$\gamma^* p \to \gamma p$

- clean process
- NLO calc. available [A. Freund]

DVCS (ZEUS and H1)

$x_1 \neq x_2$

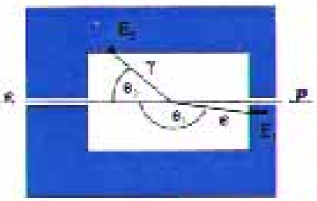
⊳ Access to generalized (skewed) PDF's

[see review M. Diehl]

ZEUS - first observation of DVCS

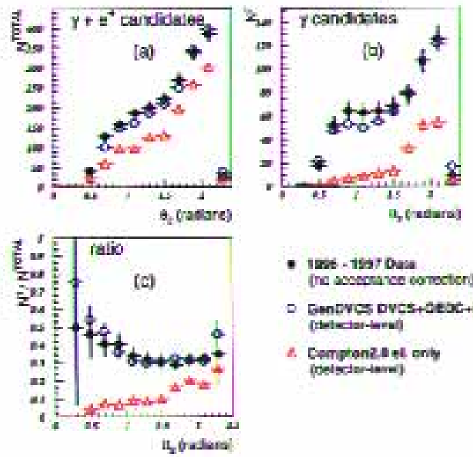
- selection criteria:

$\theta_1 > 160^\circ$, $E_1 > 10$ GeV
$\theta_2 < 137^\circ$, $E_2 > 2$ GeV
$|\theta_2 - \theta_1| > 45^\circ$
$Q^2 > 6$ GeV^2

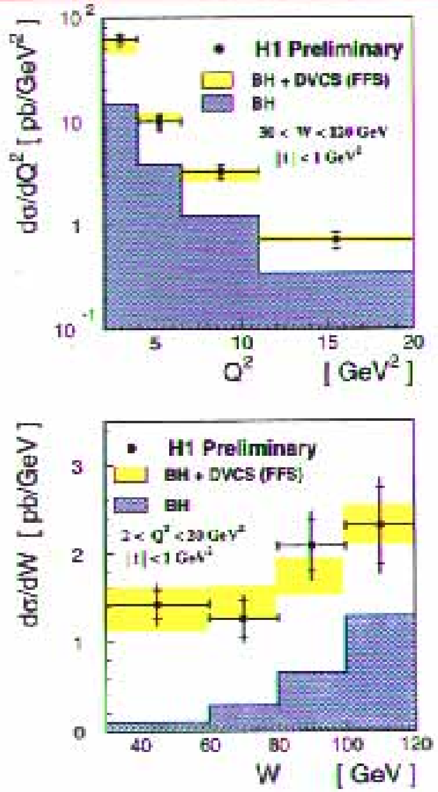


$\int L = 37$pb^{-1}
MC : t slope = 4.5 GeV^{-2}

ZEUS 1996/97 Preliminary



H1 Cross section measurement (Cont.)

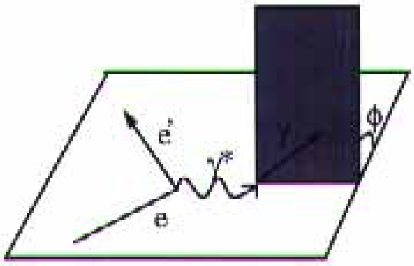


$\sigma \sim |DVCS|^2 + |BH|^2 + |BH \cdot DVCS|$

⇒ Exp. access to amplitude via φ asymmetry!

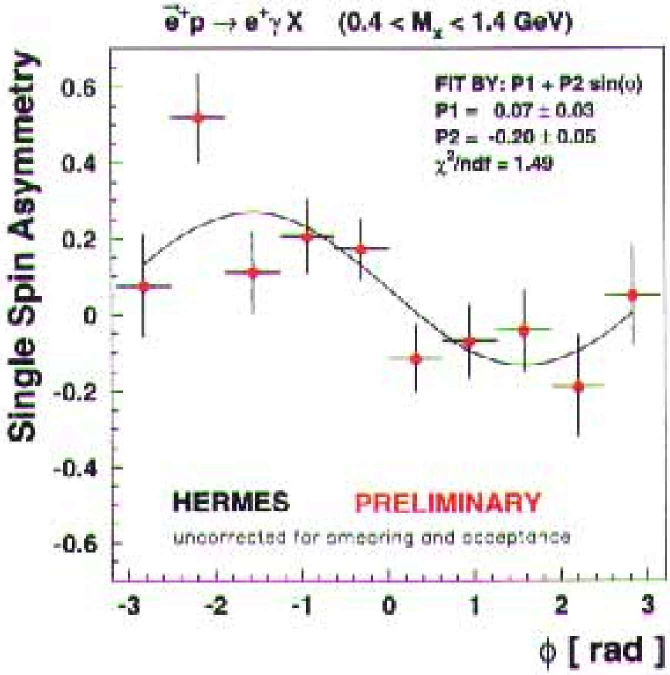
DVCS (Hermes)

[M. Vincter]



$$A_{LU}(\phi) = \frac{2 \cdot (N^+(\phi) - N^-(\phi))}{\langle |P_l| \rangle \cdot (N^+(\phi) + N^-(\phi))}$$

$N^{\pm}$ are the normalized yield of events with positive and negative lepton beam helicity states.

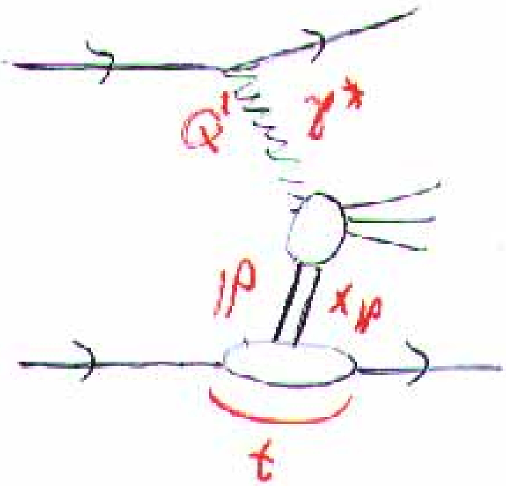


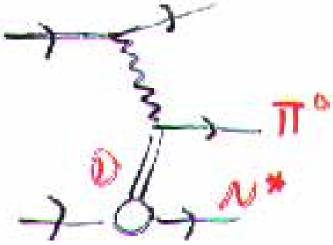
[no asymmetry observed if $M_x \neq m_p$]

⇒ Hot topic for HERMES run II!

Diffraction

- Odderon [H1]
- Factorization breaking?
  a) p-diss. ρ meson production [H1]
  b) Leading baryon production [ZEUS,H1]
- Hard Diffraction in DIS:
  – Event shapes [ZEUS]
  – Dijet production [H1]
  – 3-Jet production [ZEUS]
- Diffraction at the Tevatron [CDF,D0]





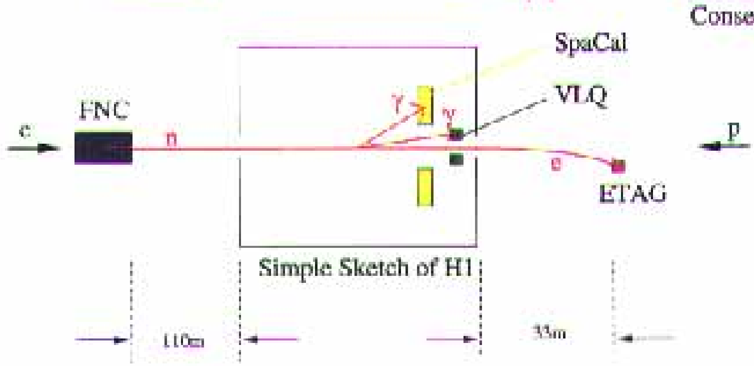
Searching the Odderon (H1)

THE SIGNATURE

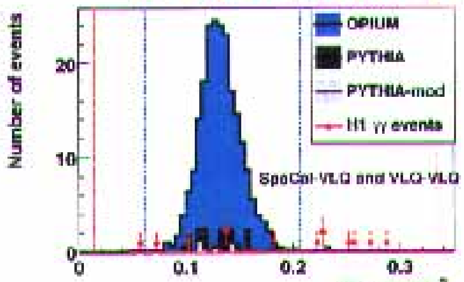
$ep \rightarrow e\,\pi^0 N^*$

$N^* \rightarrow n\,X$ $\qquad$ $\pi^0 \rightarrow \gamma\gamma$

Background Reduction
- No Bethe–Heitler
- No Tracks
- Energy–Momentum Conservation



Model: MSV (Stochastic vacuum)
[Dosch, Nachtmann, Berger]



$\sigma_{\gamma p \xrightarrow{O} \pi^0 N^*} < 39$ nb (H1 preliminary)

$\sigma_{\gamma p \xrightarrow{O} \pi^0 N^*} = 400$ nb (MSV prediction)

Model of the Stochastic Vacuum

restricted to the visible t range: $0.02\ \mathrm{GeV}^2 < t < 0.3\ \mathrm{GeV}^2$
$0.3 < y < 0.7$ and $Q^2 < 0.01\ \mathrm{GeV}^2$
$W_{\gamma p} = 210$ GeV
neutron tagged and extrapolated via Clebsch Gordan formalism

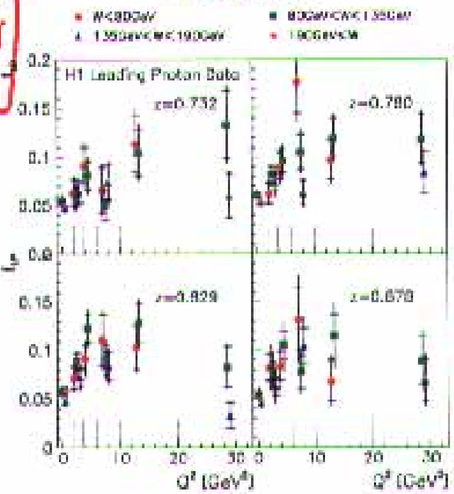
⇒ <u>This</u> O ruled out!

Factorization breaking in Diffraction? (H1,ZEUS)

Leading Baryon Production:

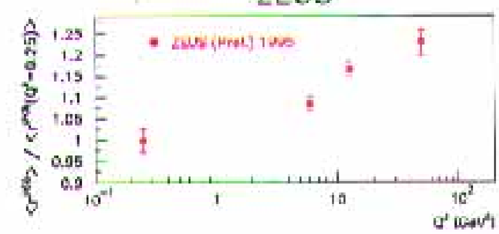
Fraction of leading p/n

H1 FPS:



Q^2

ZEUS LPS:



Q^2

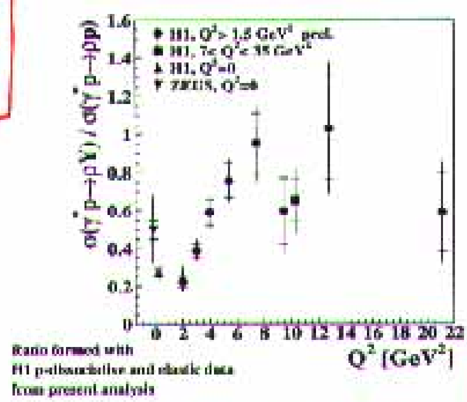
ZEUS FNC:

Q^2

Proton dissociative ρ production (H1):

$\gamma^* p \to \rho^0 Y$ **Ratio p-Diss./Elastic**

p-diss. / elastic



Ratio formed with H1 p-dissociative and elastic data from present analysis

Q^2

Strong rise for $Q^2 \lesssim 5$ GeV^2

- Breaking of Regge factorization !?
- Not observed such pronounced before

[T. Yamashita]

Event shapes in Diffraction (ZEUS)

Event shapes in diffractive DIS

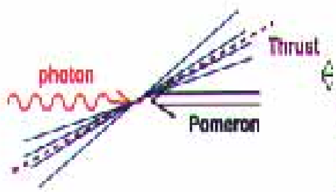
Proton is tagged using Leading Proton Spectrometer (LPS)

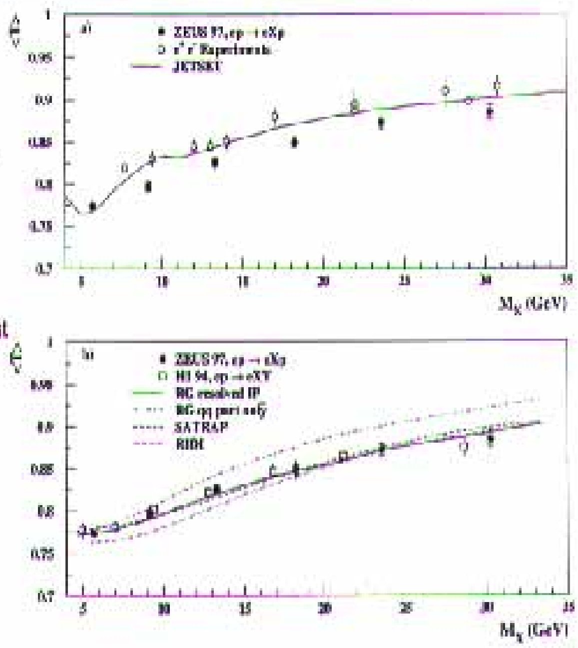
$4 < Q^2 < 150$ GeV^2,	$70 < W < 250$ GeV
$0.0003 < x_{I\!P} < 0.03$,	$4 < M_X < 35$ GeV
13.8 pb^{-1},	CMS of hadronic system (X)

Mean thrust value ($< T >$) as a function of M_X

$$T(\hat{n}) = \frac{\sum_i |\hat{n} \cdot p_i|}{\sum_i |p_i|}$$

($\hat{n}$: max $T(\hat{n})$)



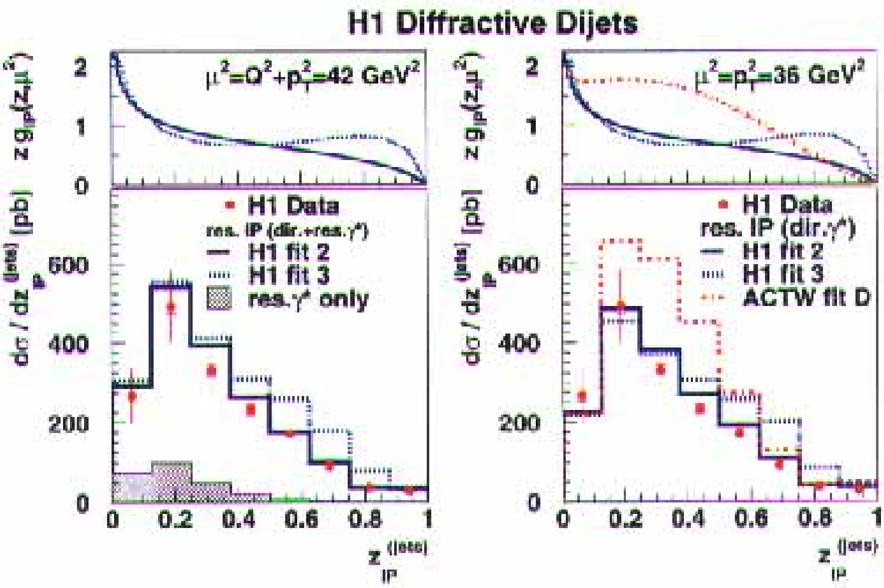


- $< T >$ now agrees with H1
  $\Leftarrow$ Definition of HFS changed such that short life time particles such as D+ are decayed.
- $< T >$ becomes larger as M_X increases
- $< T >$ in diffraction is smaller than in e+e-
- Resolved pomeron model (RAPGAP) describes data
  $q\bar{q}$ part only is too narrow $\sim$ e+e-
  $\Rightarrow$ Importance of $q\bar{q}g$ contribution in diffraction

Dijets in Diffractive DIS (H1)

Diffractive Gluon Distribution

Dijets directly constrain shape <u>and</u> normalization of g^D:



[res. γ^*, $\mathbb{R}$ and quark contributions small]

- H1 fit 2: very good agreement with data
- H1 fit 3: overshoots at high $z_{\mathbb{P}}$
- ACTW-D: too high

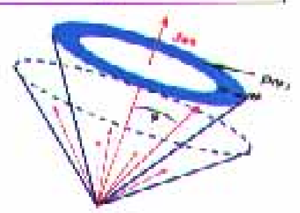
⇒ Strong support for fully factorizable diffr. PDF's in DIS which are gluon-dominated with momentum distr. flat in z

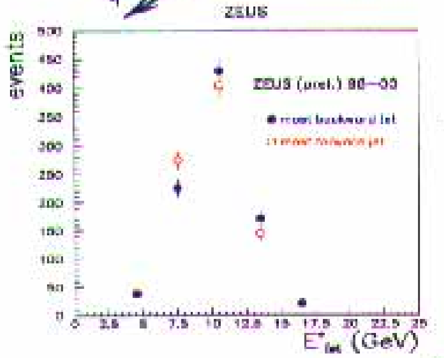
Proton rest frame picture: $q\bar{q}g \gg q\bar{q}$ states

[T. Yamashita]

3-Jets in Diffractive DIS (ZEUS)

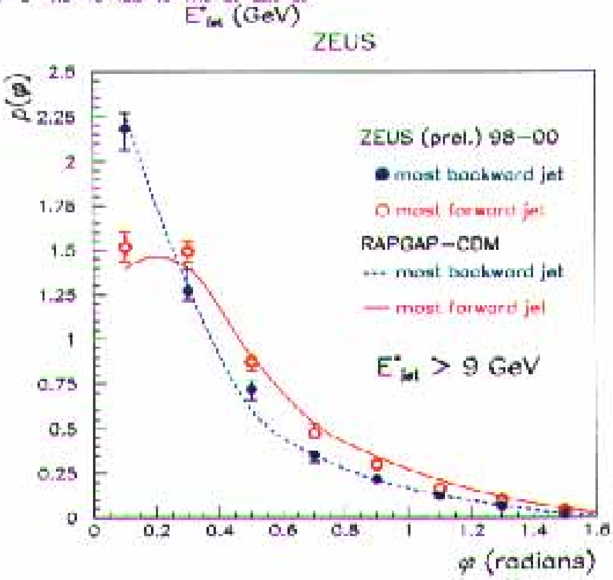
Jet shape in diffractive DIS 3jet events





$$\rho(\varphi) = \left\langle \frac{1}{\delta\varphi} \frac{E^{\rm jet}(\varphi \pm \delta\varphi/2)}{E^{\rm jet}} \right\rangle$$

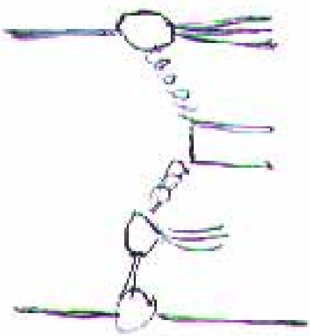
~ Same $E_{\rm jet}$ distribution most forward / backward jet

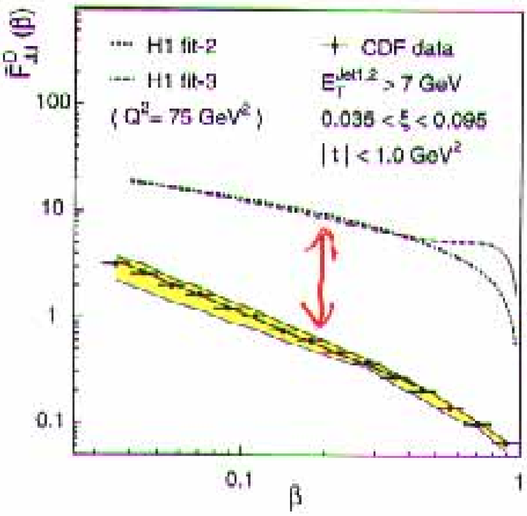


- Most forward jet is broader than most backward jet
- Data are described by the model where g is emitted to the $I\!P$ side and one of q is emitted to the γ side.
  ⇒ Supports the picture

Diffraction at the Tevatron

Diffractive dijet production:

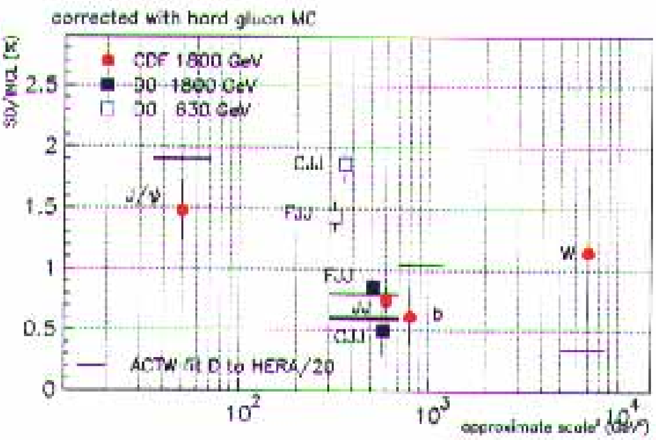




$\frac{1}{10}$ of HERA extrapolation!

Tevatron Summary:

$\frac{\text{diffr.}}{\text{non-diffr.}}$ [%]

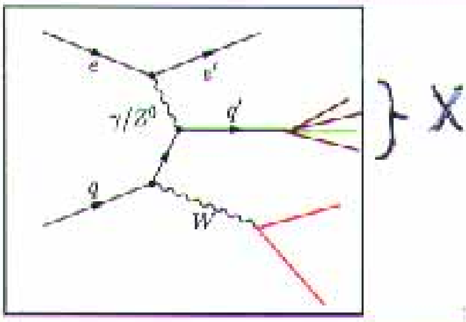


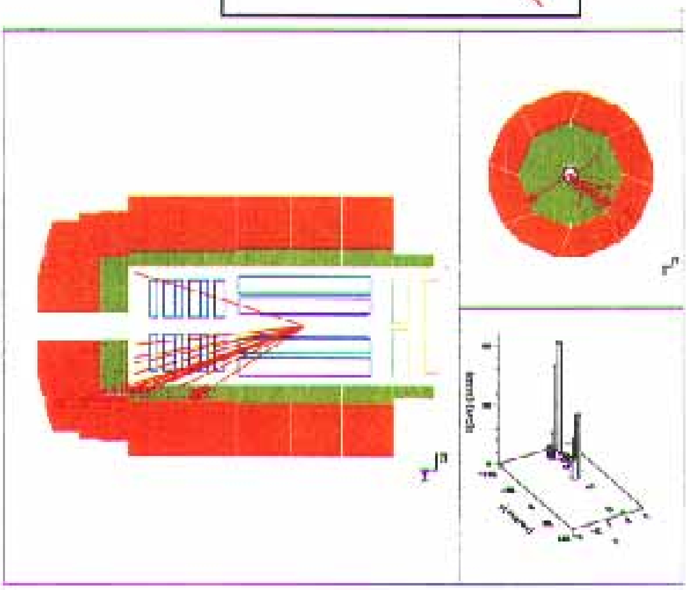
μ^2

HERA <> TEVATRON: Factorization badly broken!

Isolated Leptons Update

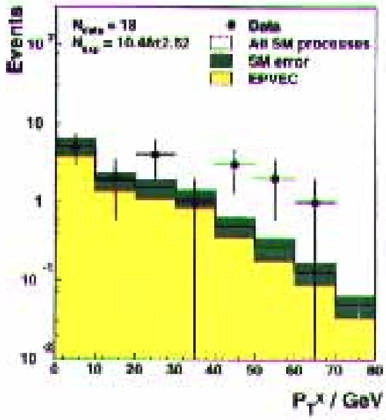
Standard Model $\ell + P_T^{miss}$ events





- W mostly photo-produced → low(ish) P_T
  P_T^W is measured from hadrons $= P_T^X$
- Standard Model (QCD LO) $\sigma(ep \to eW^{\pm}X) \simeq 1.2pb^{-1}$
- HERA experiments accumulated 120 pb^{-1}/exp.
  ~ 30 events already produced in each detector

Isolated Leptons Update (H1)



Combined e+μ

New Data since Osaka: extra 20 pb^{-1} e^+p @ $\sqrt{s} = 320$ GeV
4 new W candidates in e-channel (1e^+ @ $P_T^X > 25$ GeV)

e^+p

H1 94-00 e+p 101.6 pb^{-1}	Electrons	Muons	e+μ combined
$P_T^X > 0$ GeV	10 / 7.9 ± 1.9 6_{Osaka}	8 / 2.6 ± 0.7	18 / 10.5 ± 2.5 (only W 8.2)
$P_T^X > 12$ GeV	5 / 2.6 ± 0.7 4_{Osaka}	8 / 2.6 ± 0.7	13 / 5.1 ± 1.3 (only W 4.2)
$P_T^X > 25$ GeV	4 / 1.3 ± 0.3 3_{Osaka}	6 / 1.5 ± 0.4	10 / 2.8 ± 0.7 (only W 2.3)
$P_T^X > 40$ GeV	2 / 0.4 ± 0.1 2_{Osaka}	4 / 0.6 ± 0.2	6 / 1.0 ± 0.3 (only W 0.93)

⇐ 1 new event at $P_T > 25$

@ high $P_T^X > 25$ GeV : 10/2.82±0.73			
94-97 data	36.5 pb^{-1}	5 events	5μ ($2^+, 2^-, 1^?$)
99-00 data	65.1 pb^{-1}	5 events	4 e^- and 1 μ^+

e^-p

H1 98-99 e^-p (13.6 pb^{-1}) Data: 0	SM: 1.78
	(e:1.46 ± 0.30 μ:0.32 ± 0.09)

Isolated Leptons Update (ZEUS)

ZEUS prel. 1994-00 $e^{\pm}p$ 130 pb^{-1}	Electrons Observed/Expected (W)	Muons Observed/Expected (W)
$P_T^X > 25$ GeV	$1 / 1.14 \pm 0.06$ (1.10)	$1 / 1.29 \pm 0.16$ (0.95)
$P_T^X > 40$ GeV	$0 / 0.46 \pm 0.03$ (0.46)	$0 / 0.50 \pm 0.08$ (0.41)

⇒ • H1 still sees excess
• ZEUS does not

⇒ upward or downward fluctuation?

⇒ HERA II

Personal Highlights

- New F_2, F_L datasets at medium Q^2 $\Rightarrow g(x), \alpha_s$
- low $Q^2 \sim 1\ \mathrm{GeV}^2$ data $\Rightarrow$ transition region
- Jets: - 3 Jets
  - Subjets

  $\Rightarrow \alpha_s$

NNLO

- b cross sections
- Vertex factorization breaking in diffraction

DISclaimer / Acknowledgements

- It was impossible to cover everything!
- Not covered today:

  – Vector mesons
  – High Q^2 NC/CC cross sections
  – RP-SUSY, Leptoquarks, excited fermions, extra dimensions,...
  – ...

- Sorry to all whose results were not shown
- Thanks to all who helped by providing plots / transparencies
- Special thanks to:
  – Halina Abramowicz
  – Rosario Nania
  – Peter Schleper
  – Manuella Vincter
  – Jim Whitmore

  – and the organizers of DIS 2001 !