Recent results from the H1 Experiment

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On the way to final publications

ANSWERS EXPECTED FROM HERA

- Precision: proton structure functions and α_s
- Understanding of QCD: hadronic final state, fragmentation, diffraction
- Searches for new phenomena

WHAT MAKES IT POSSIBLE AT H1

- Statistics: HERAI + HERAII Luminosity ~ 500pb^{-1}
- Systematics: improvements in reconstruction and simulation

HERA COMBINED

Combination groups of H1 and ZEUS provide better precision results

Since last PRC

Publications:

- DESY-07-147 Measurement of Isolated Photon Production in DIS at HERA
- DESY-07-200 Three- and Four-jet Production at Low x at HERA
- DESY-08-009 A Search for Excited Neutrinos in ep Collisions at HERA

Preliminary Results:

- Direct measurement of F_L at medium Q^2
- HERA I combined PDF fit
- Multijets at high Q^2 and measurement of α_s
- Multijets at low Q^2 and measurement of α_s
- Strangeness at low Q^2
- Prompt photons in photoproduction
- Diffractive dijets in photoproduction
- Inelastic J/Ψ photoproduction
- Diffractive production of ρ and ϕ-mesons
- D* production in DIS
- D* production in photoproduction
- Charm fragmentation
- D*p resonance search
- Searches for Leptoquarks
- Searches for Lepton Flavour Violation

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- **Searches for Lepton Flavour Violation**

Direct measurement of F_L at H1

Longitudinal structure function directly sensitive to the gluon density:

$$F_L \sim \sigma_L$$
$$F_2 \sim (\sigma_T + \sigma_L)$$

QCD: $$F_L = \frac{\alpha_s}{4\pi} x^2 \int_x^1 \frac{dz}{z^3} \left[\frac{16}{3} F_2 + 8 \sum_q e_q^2 (1 - \frac{x}{z}) z g(z) \right]$$

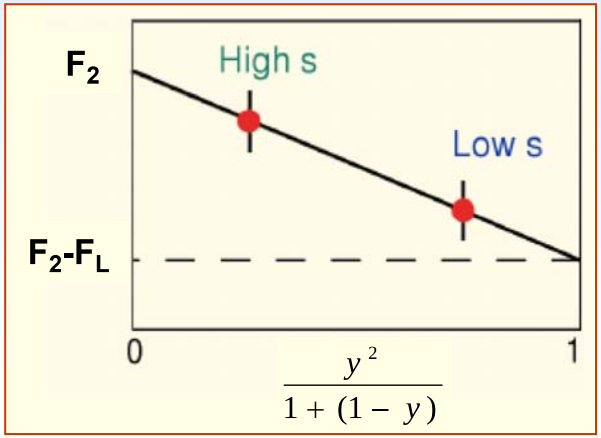
Reduced cross section:

$$\sigma_r = F_2(x,Q^2) - \frac{y^2}{1+(1-y)} F_L(x,Q^2), y = 1 - \frac{E_{e'}}{E_e}$$

Method: measurement of σ_r for same (Q^2,x) at different y (different $\sqrt{s}$)

Rosenbluth plot:

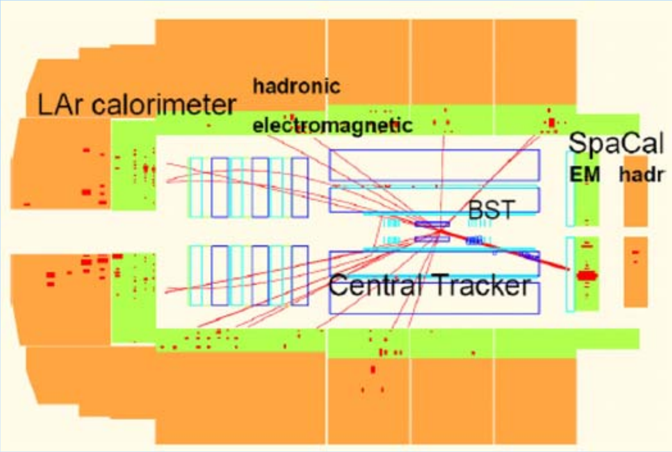
at same (x,Q^2)



H1 data 2007 e^+p

Lumi	E_p
21.9 pb^{-1}	**920 GeV**
6.2 pb^{-1}	**575 GeV**
12.4 pb^{-1}	**460 GeV**

Direct measurement of F_L at H1

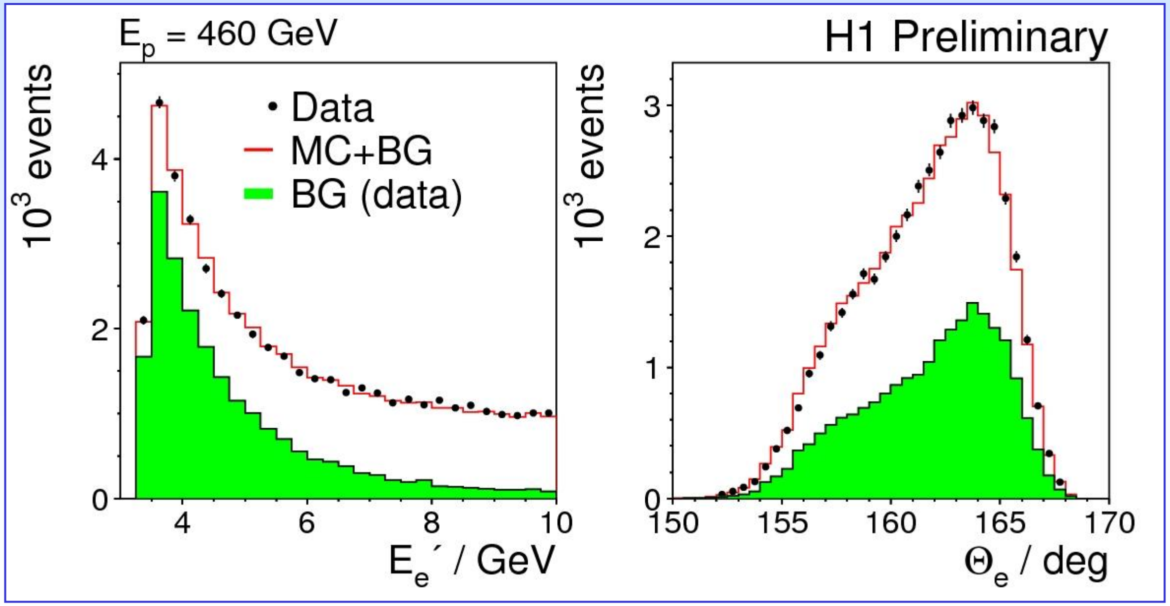


Experimental challenge at high y:

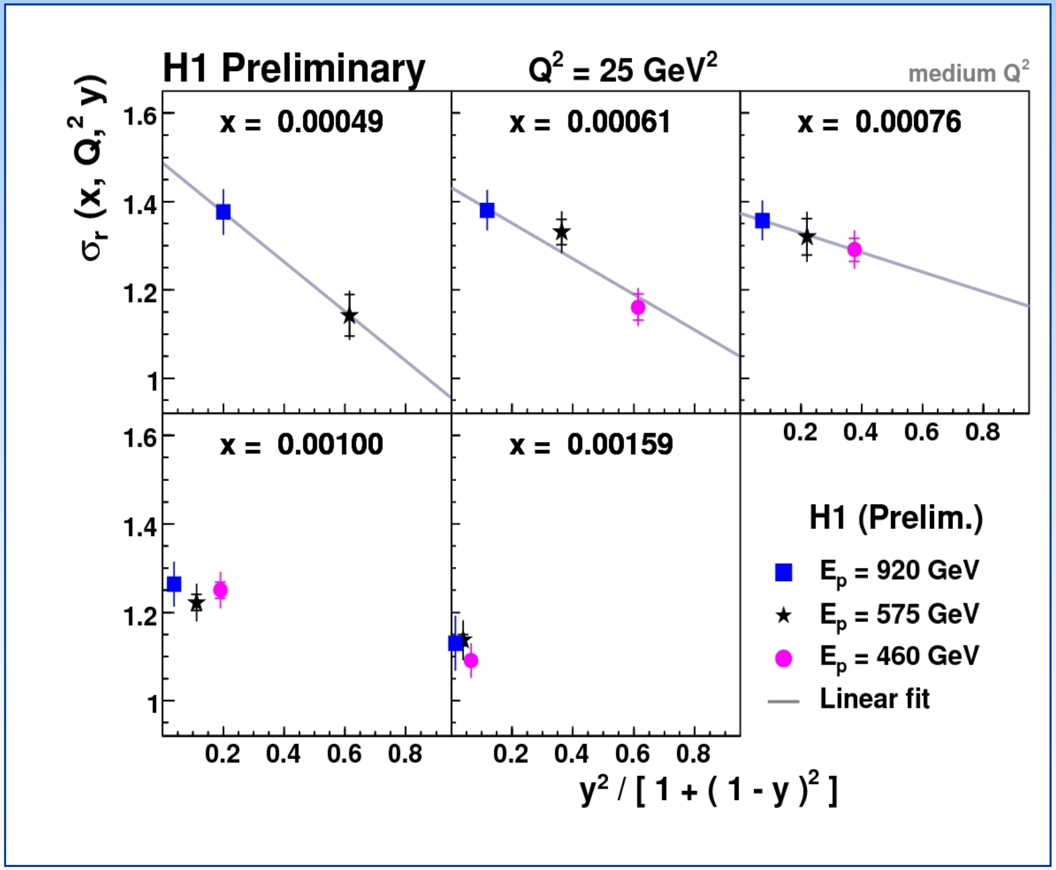
- reconstruct electron with small energy
- high γp background

background estimated from data

- Efficient electron reconstruction down to 3.3 GeV
- Data well described by the simulation



Extraction of F_L

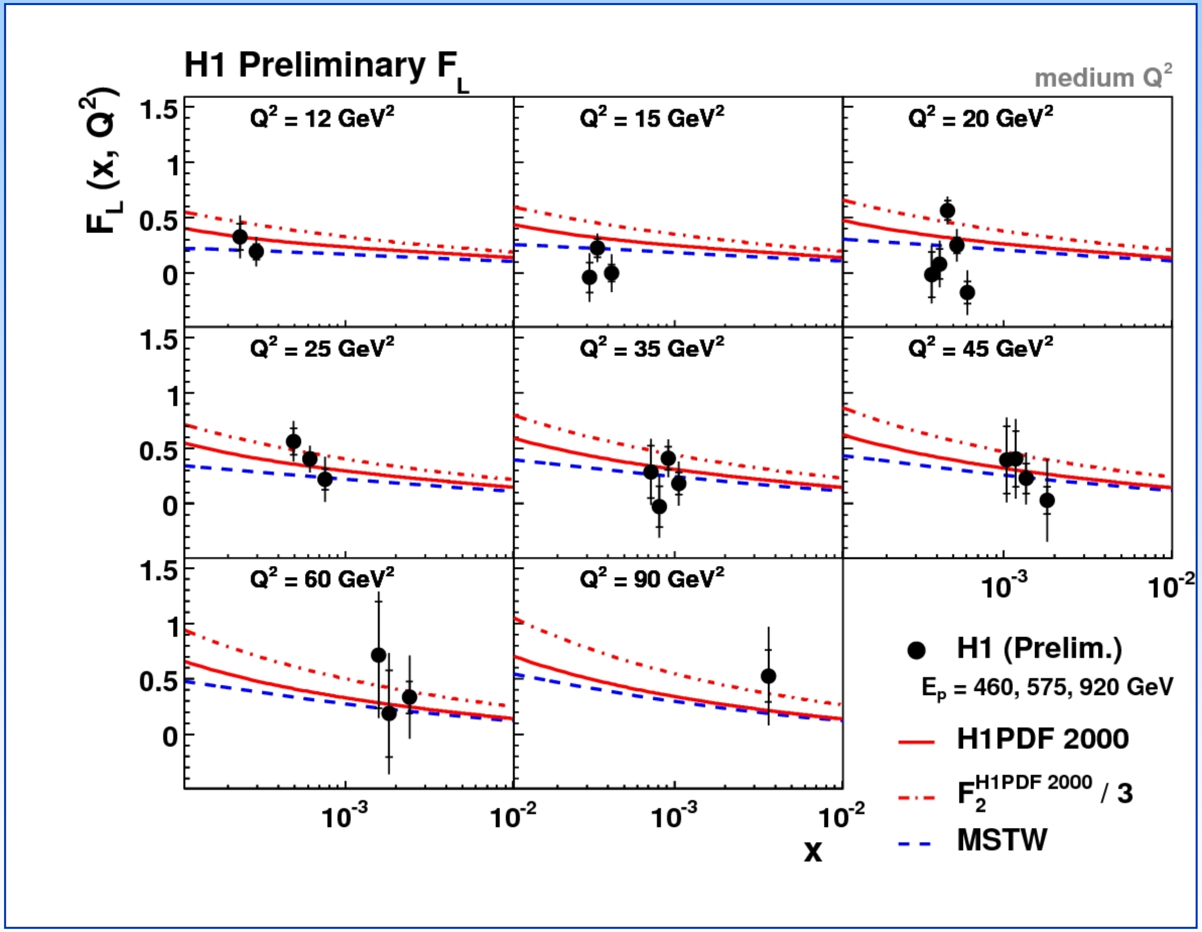


Linear fit to σ_r at different $\sqrt{s}$:

$$\sigma_r = F_2(x,Q^2) - \frac{y^2}{1+(1-y)}F_L(x,Q^2)$$

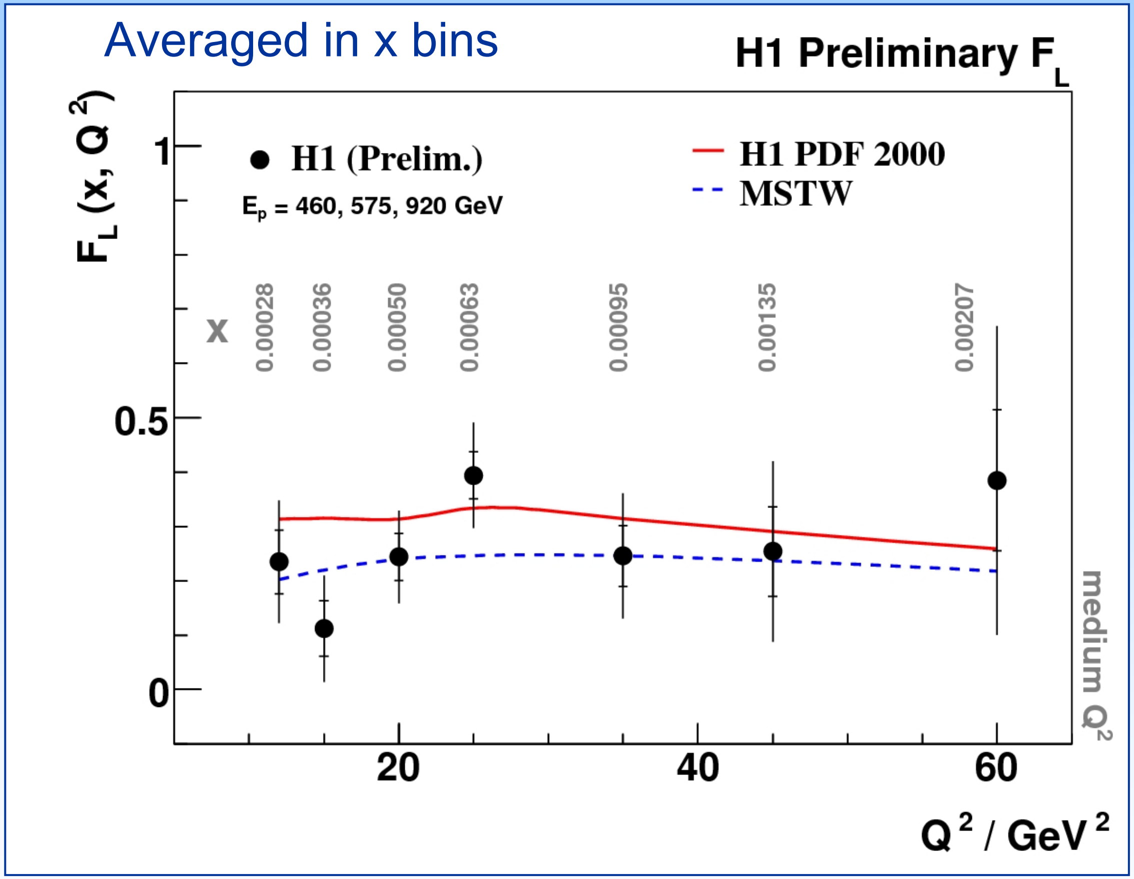
- slope: F_L
- intercept at y=0: F_2

First direct measurement of F_L at low x at HERA



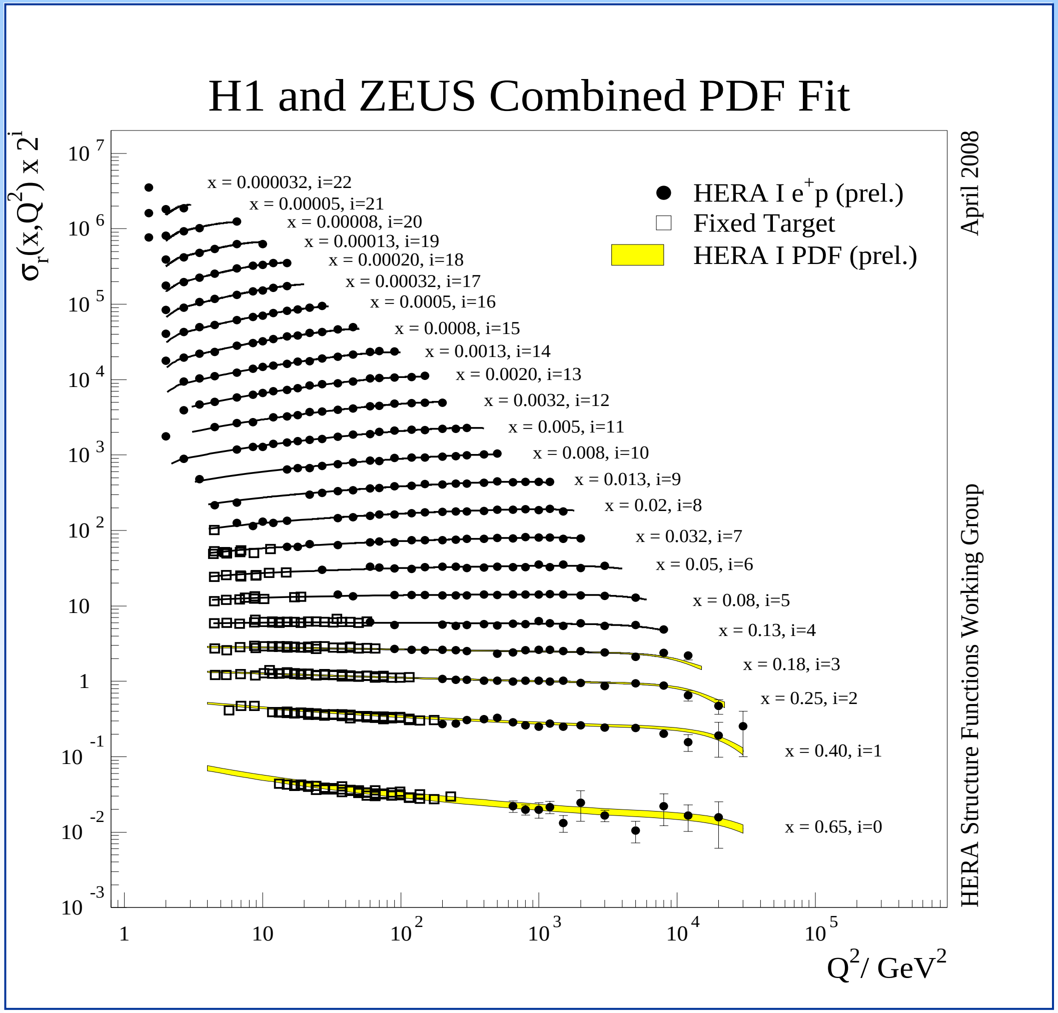
Analyses on the way: F_L at high Q^2 (aimed for DIS 2008), F_L at low Q^2

First direct measurement of F_L at low x at HERA



Directly measured F_L consistent with QCD predictions using gluon distribution obtained from scaling violations in inclusive measurements

HERA combined F_2 and HERA I PDF



Combined PDF fit performed on the preliminary combination of H1 and ZEUS data

Scheme:

Zero Mass VFNS

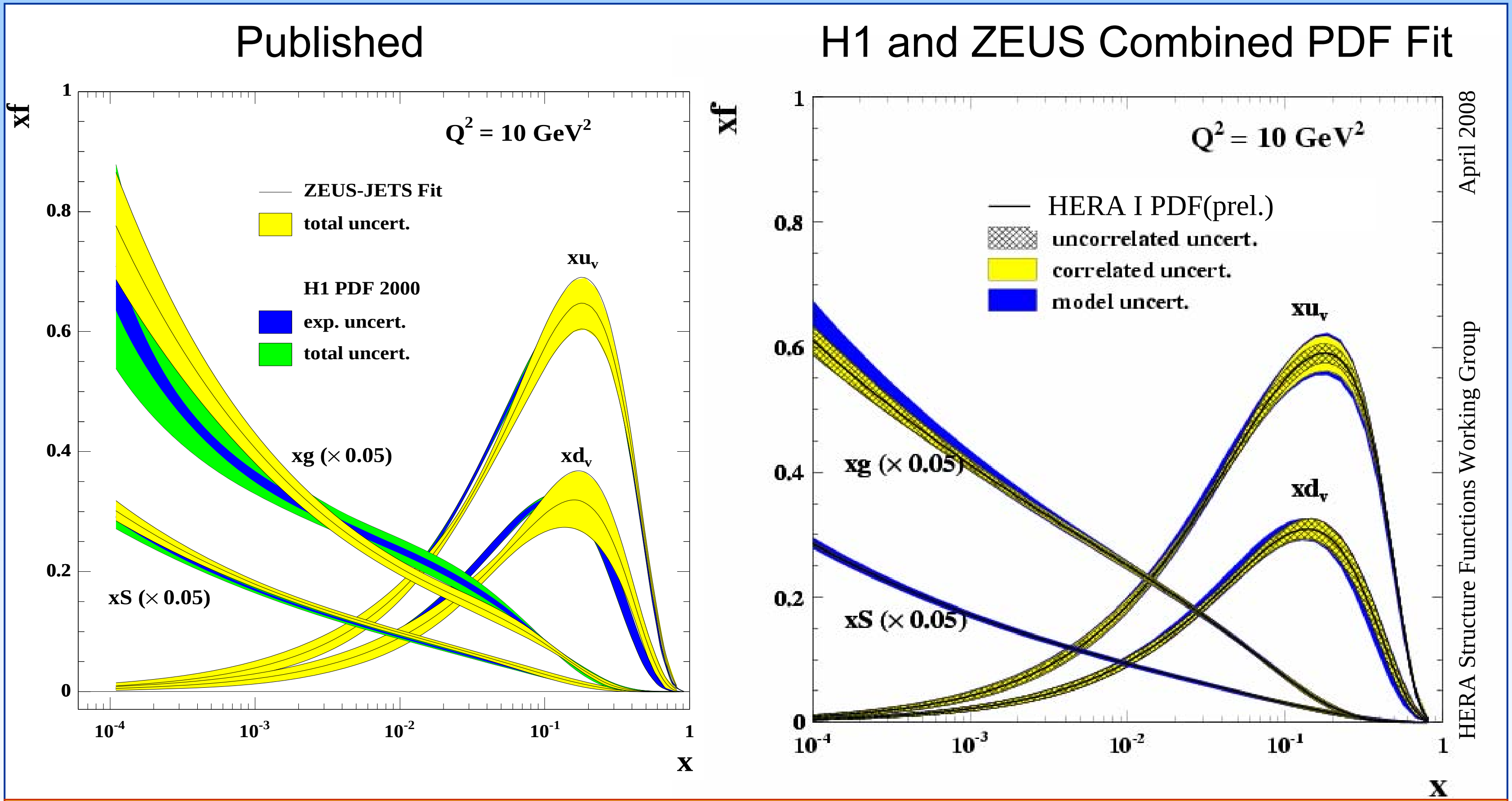
Fitted values:

gluon, u_v, d_v,

$U_{bar}=u_{bar}+c_{bar}$,

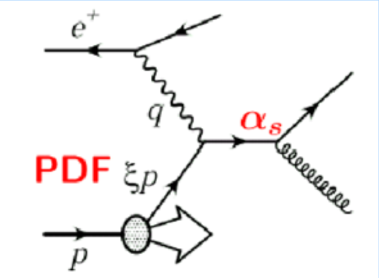
$D_{bar}=d_{bar}+s_{bar}+b_{bar}$

HERA I combined PDF Fit



- Combined fit in good agreement with H1 and ZEUS individual fits
- Much improved uncertainty on the gluon distribution: increased precision constrains gluon better at low and high x → gluon precise even without jets

H1 α_s measurement via multijets at high Q^2



Direct sensitivity to α_s

Observables: normalized jet cross sections

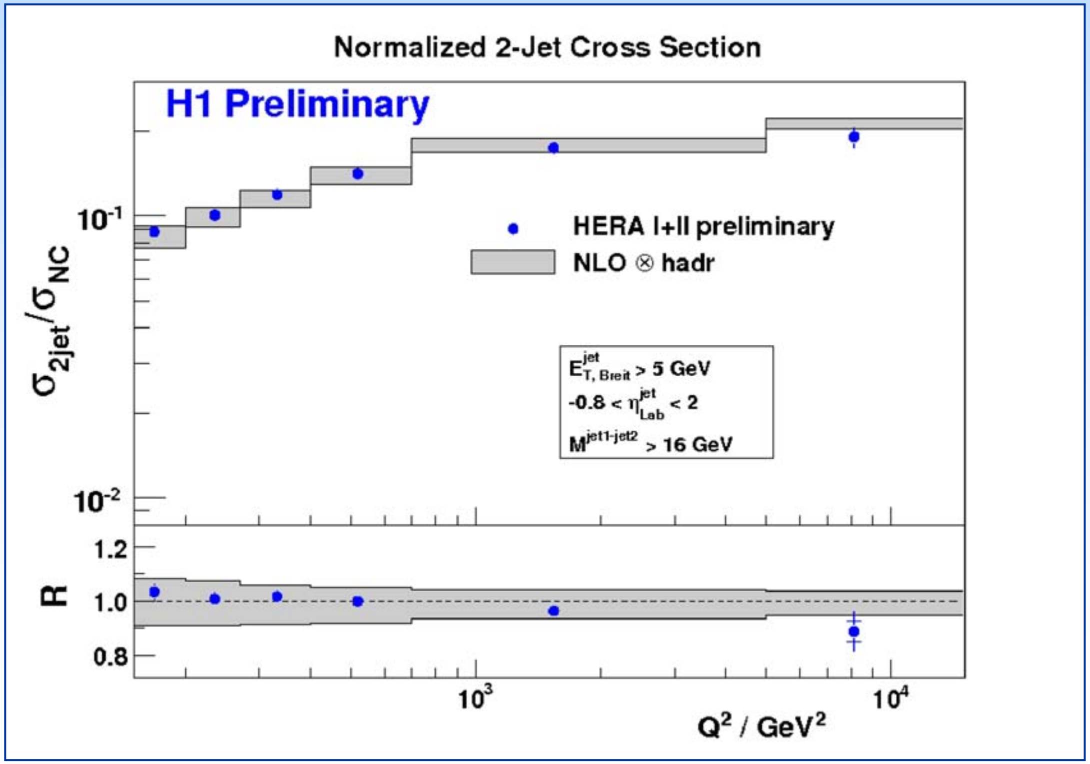
Inclusive: $\sigma^{jet}/\sigma(NC)$

Multijets: $\sigma^{multijet}/\sigma(NC)$

NLO and fits:

Scale : $\mu_r = \mu_f = Q$;

PDF: CTEQ6.5



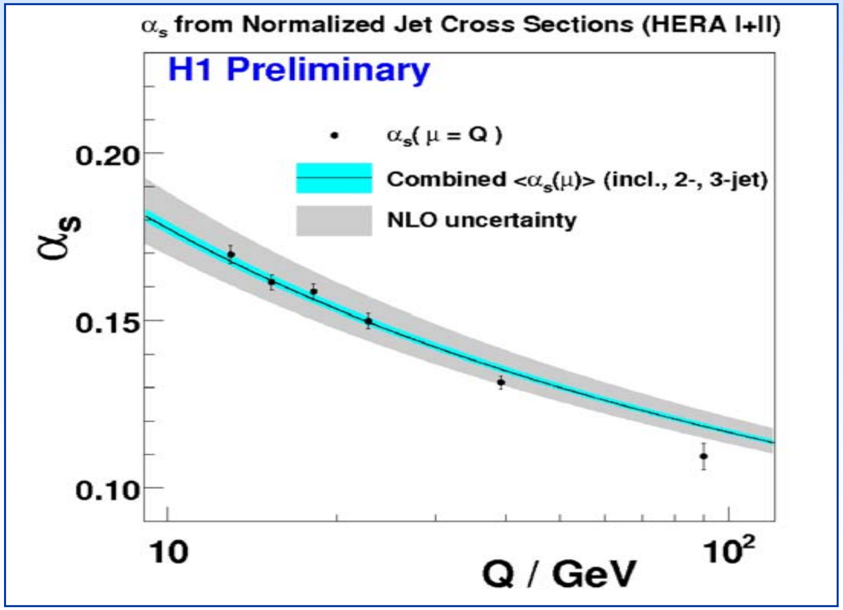
H1 α_s measurement via multijets at high Q^2

Method	α_s (M_Z)	Exp. error	Scale error	PDF error	X2/NDF
$\sigma_{jet} / \sigma_{NC}$	0.1196	0.0010	+0.0049 -0.0036	0.0019	26.84/23
$\sigma_{2jet} / \sigma_{NC}$	0.1171	0.0010	+0.0048 -0.0036	0.0018	28.12/23
$\sigma_{3jet} / \sigma_{NC}$	0.1179	0.0014	+0.0056 -0.0034	0.0009	4.53/5
Combined	0.1182	0.0008	+0.0041 -0.0031	0.0018	54.79/53

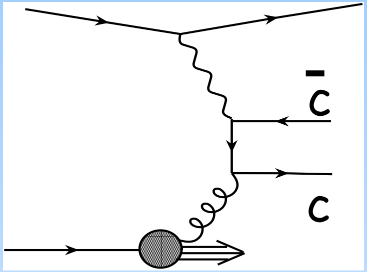
α_s extracted from $\sigma_{2jet} / \sigma_{NC}$

Combined fit of α_s:

Experimental uncertainty < 1%!

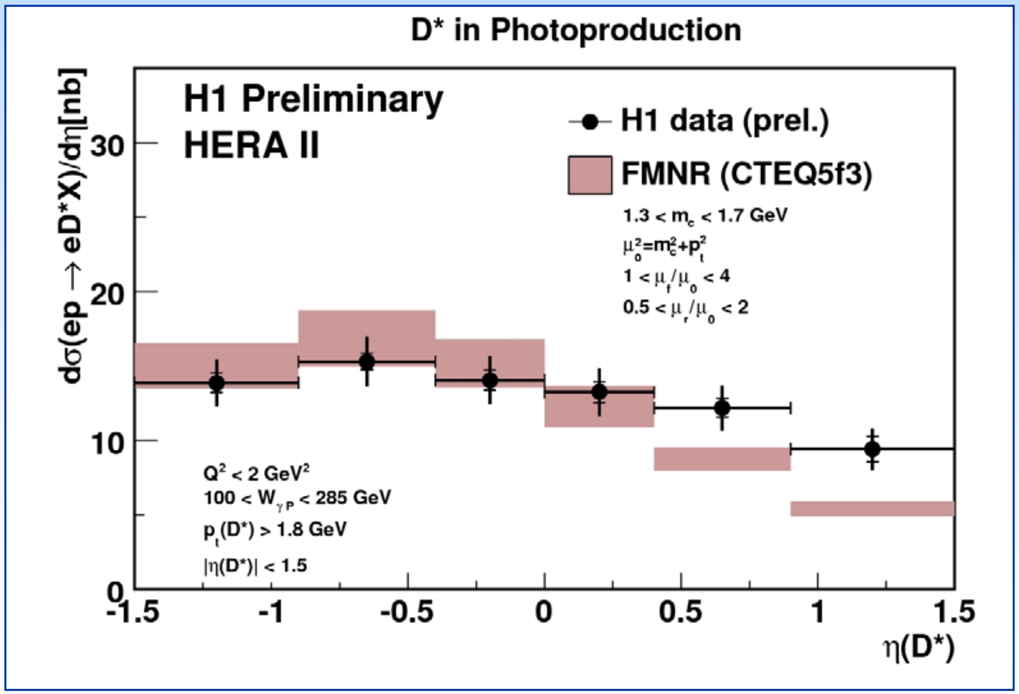


Open charm at H1: D* production in DIS and γp



BGF: direct sensitivity to the gluon density via

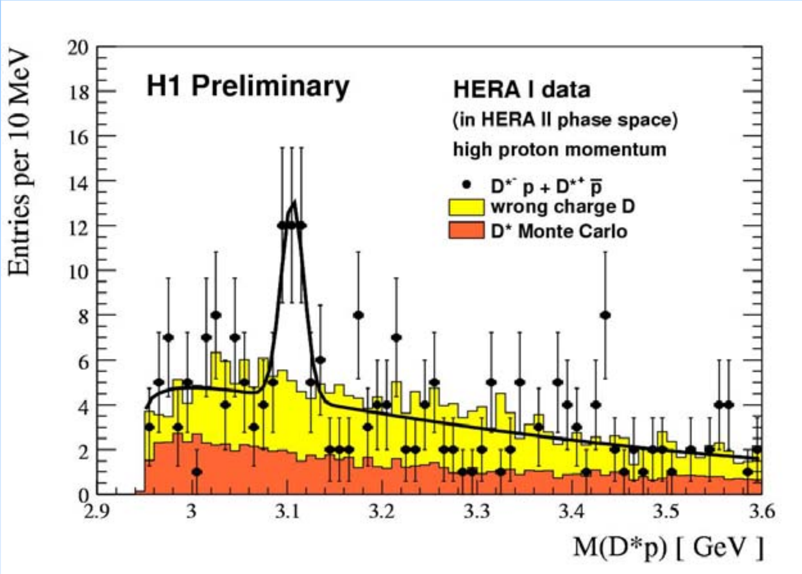
$\sigma(ep\rightarrow D^* X) \sim \gamma\ PDF \otimes g(x,Q^2) \otimes \sigma_{\gamma g\rightarrow cc} \otimes D^c_{D^*}(z)$

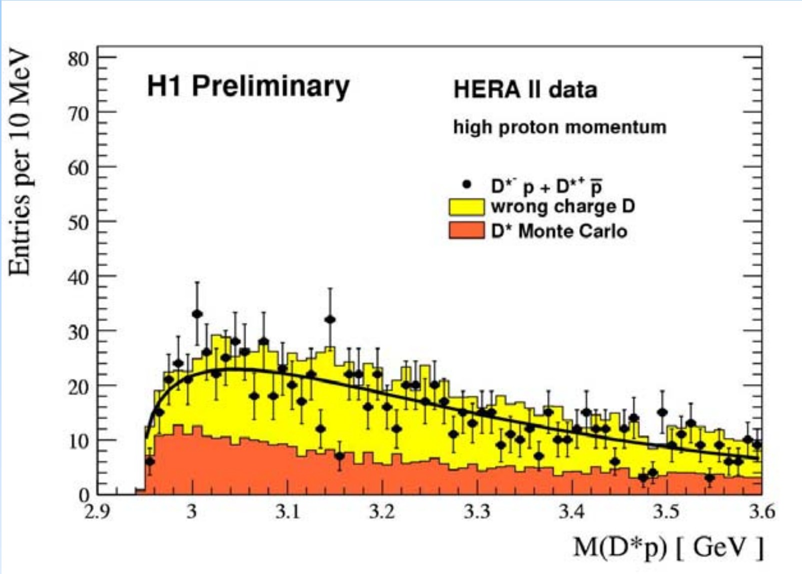


This became possible

due to the Fast Track Trigger !

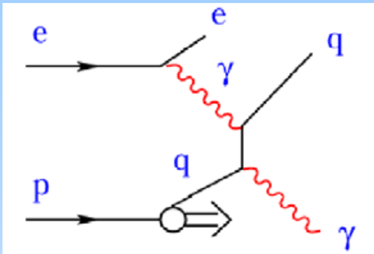
Analysis of D*p resonance





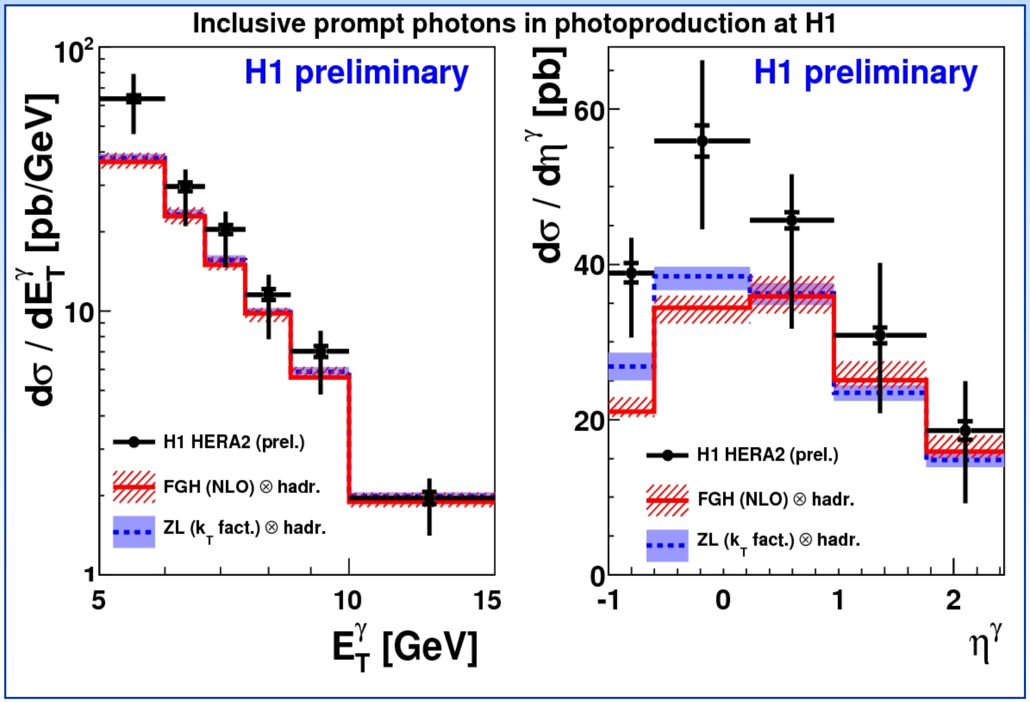
- Data of HERA I reanalyzed in the HERA II phase space for p(p)>2 GeV
- Published HERA I D*p resonance reproduced
- No indication for a resonance in HERA II data, p(p)>2 GeV
- Limits on N(D*p)/N(D*) = 0.1%

Prompt photons in photoproduction



Photon appears directly from hard interaction:

access to both photon and quark densities



Data agree with models:

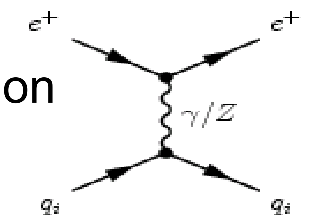
- ZL: based on k_t factorization
- FGH (NLO collinear):
- includes contribution from

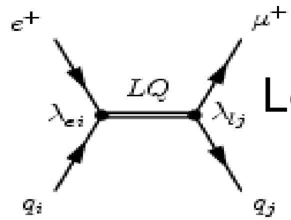
$\gamma g \to \gamma g$ and $q \to \gamma$ fragmentation

May help understanding of the background for $H \to \gamma\gamma$ at the LHC

Beyond the Standard Model Searches

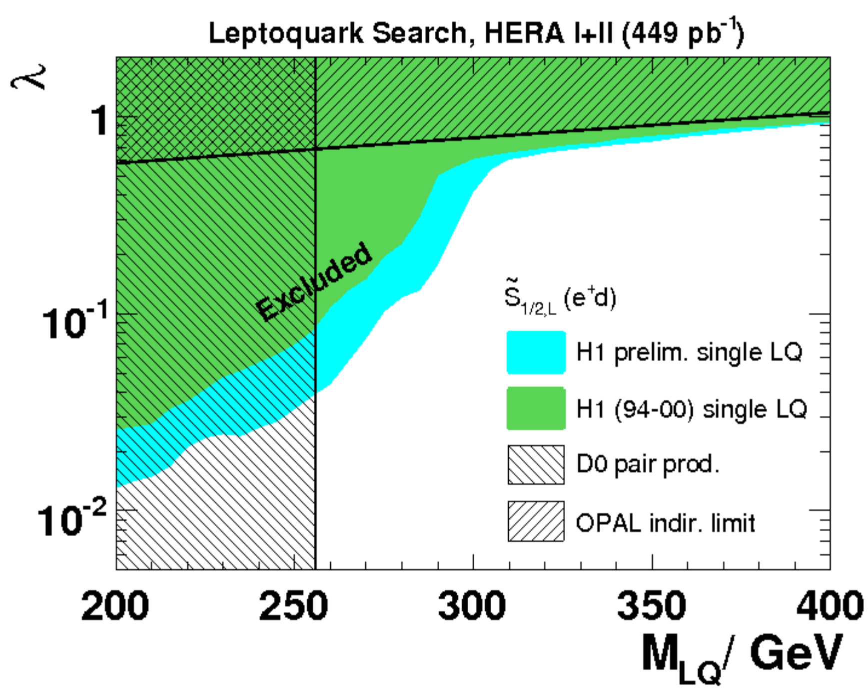
Leptoquark production (s-channel)



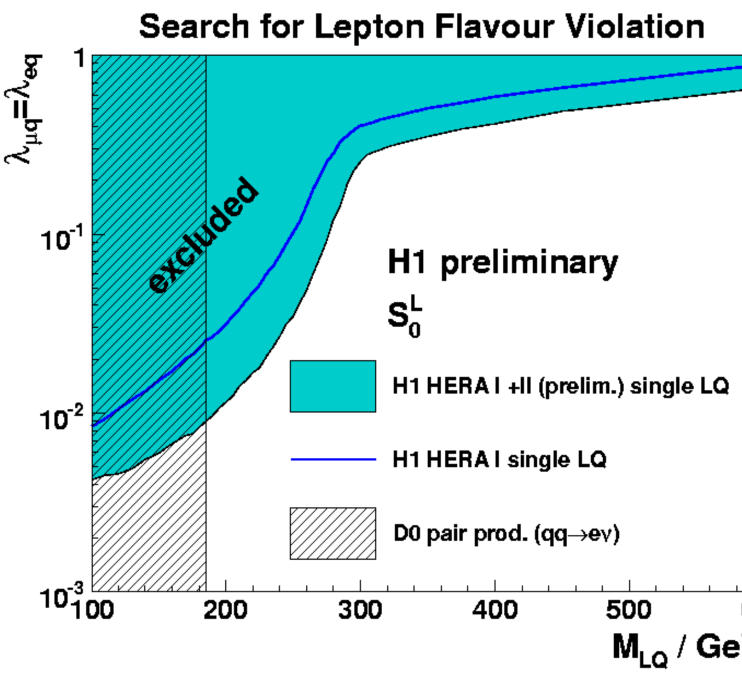


Lepton Flavour Violating Leptoquark decay

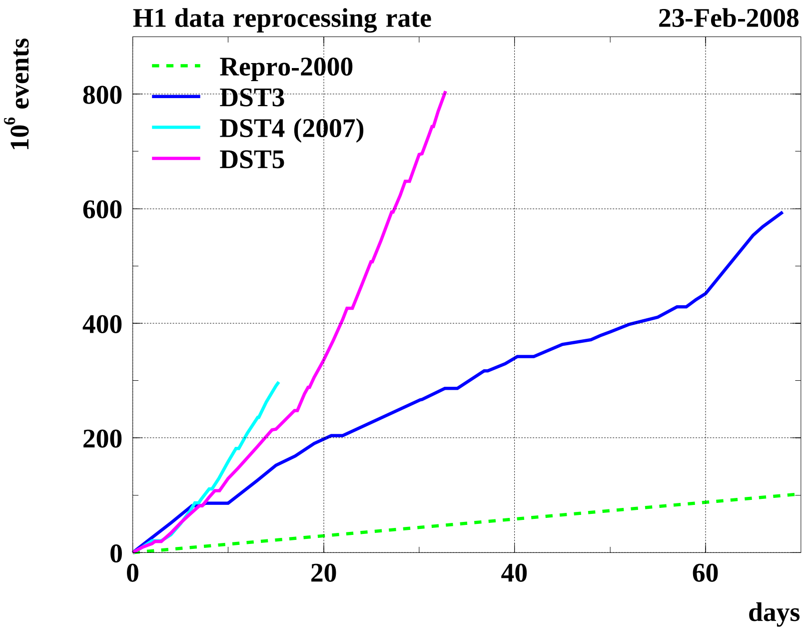
Exclusion Limits: Leptoquarks



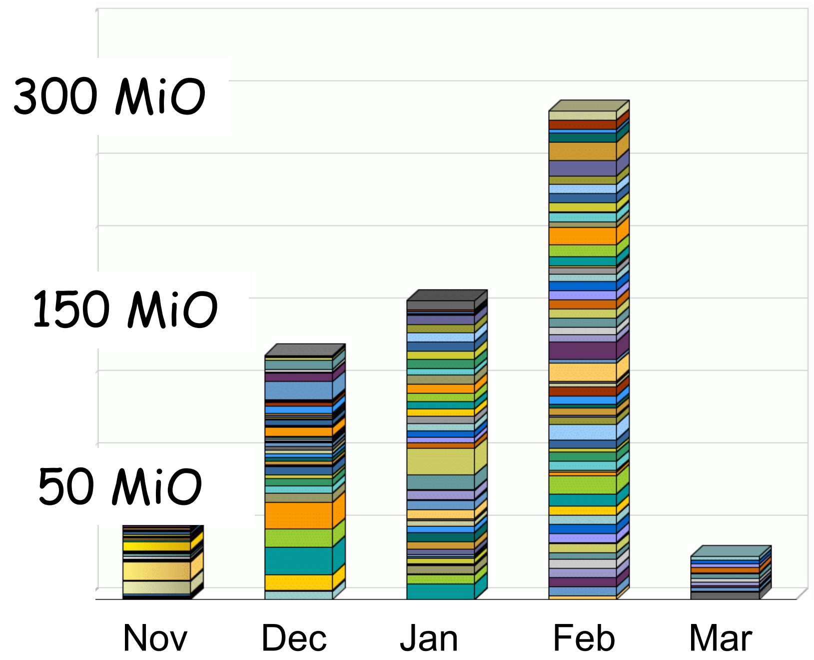
Lepton Flavour Violation LQ Couplings



Status of the reprocessing and simulation



- Reprocessing of full HERA data (800 Mio events) ready within 1 month
- New developments for the new reprocessing foreseen fall 2008



Monte-Carlo on the GRID:

- average speed: 100 Mio / month
- peak: >200 Mio / month

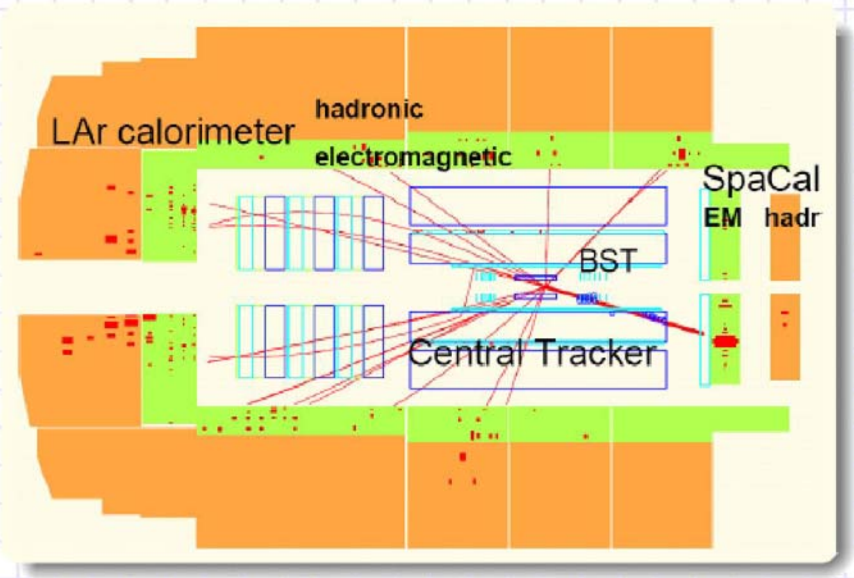
Summary

- Many new results from HERA II:
  - First direct measurement of F_L at low x
  - Significantly improved precision: inclusive + final state data
  - Many results on searches in the publication procedure
- Impressive precision of the first combined HERA I PDF fit
- Analysis efficiency improved due to fast data reprocessing and simulation

Backup

Presented Moriond 2008

Analysis Strategy



Electron method:

$$Q_e^2 = 4E_e E'_e \cos^2(\frac{\theta_e}{2})$$

$$y_e = 1 - \frac{E'_e}{E_e}\sin^2(\frac{\theta_e}{2})$$

$$x_e = \frac{Q_e^2}{s y_e}$$

- Scattered electron produces isolated and compact energy deposition
- Identified using shape and size of e/m shower profile

"High Y"

- High background contribution
- Require track link, higher R_{SpaCal}
- Estimate background from wrong charged tracks

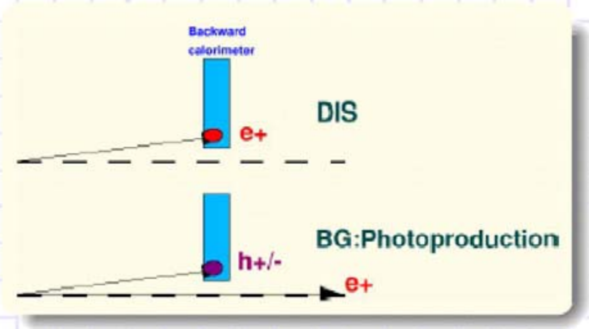
"Low Y"

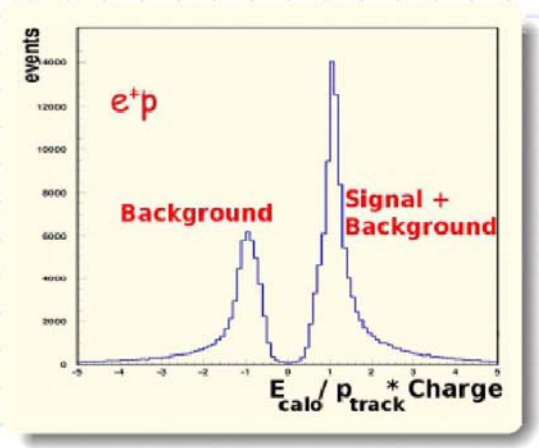
- Background free area
- $R_{SpaCal} > 20$ cm. Do not require track match
- γp MC to estimate residual background

Presented Moriond 2008

Background Determination

- At high y there is a large photoproduction background in which hadronic final state can mimic the signature of the scattered lepton with low energy





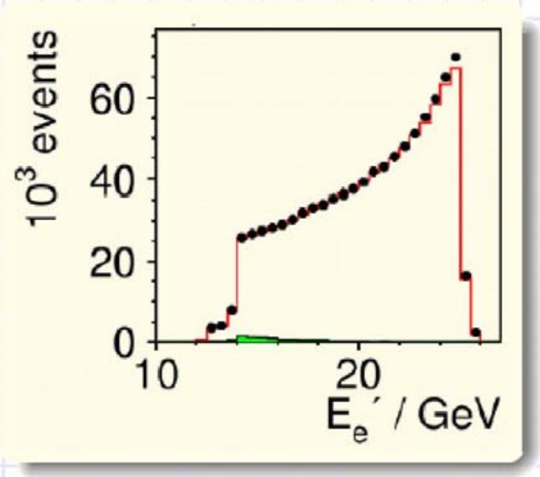
- Background is measured using data events with the charge opposite to lepton beam charge
- A small charge asymmetry ($\approx 5\%$) at low energies is generated by the difference of pA and $\bar{p}A$ cross sections
- Background charge asymmetry is determined using e^+p and e^-p 2003-07 data

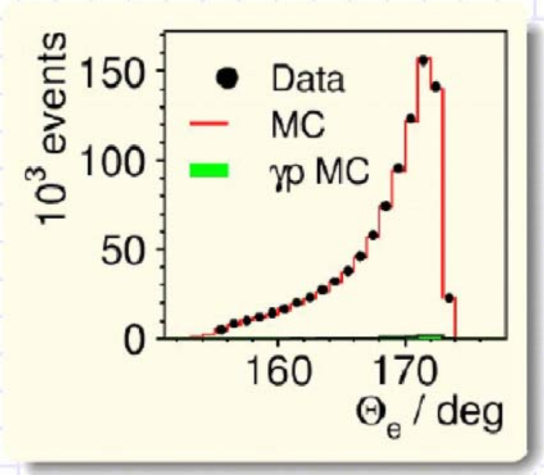
$$N^{signal} = N^+ - kN^-$$

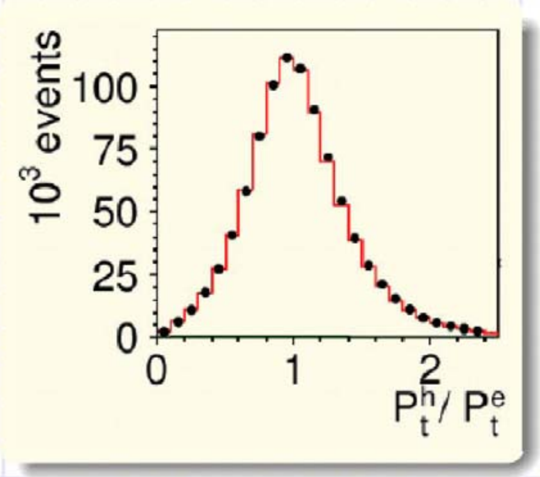
Charge asymmetry factor: $k = \frac{N^+_{bkg}}{N^-_{bkg}}$

Presented Moriond 2008

Low y Control Plots: $E_p = 920$ Data







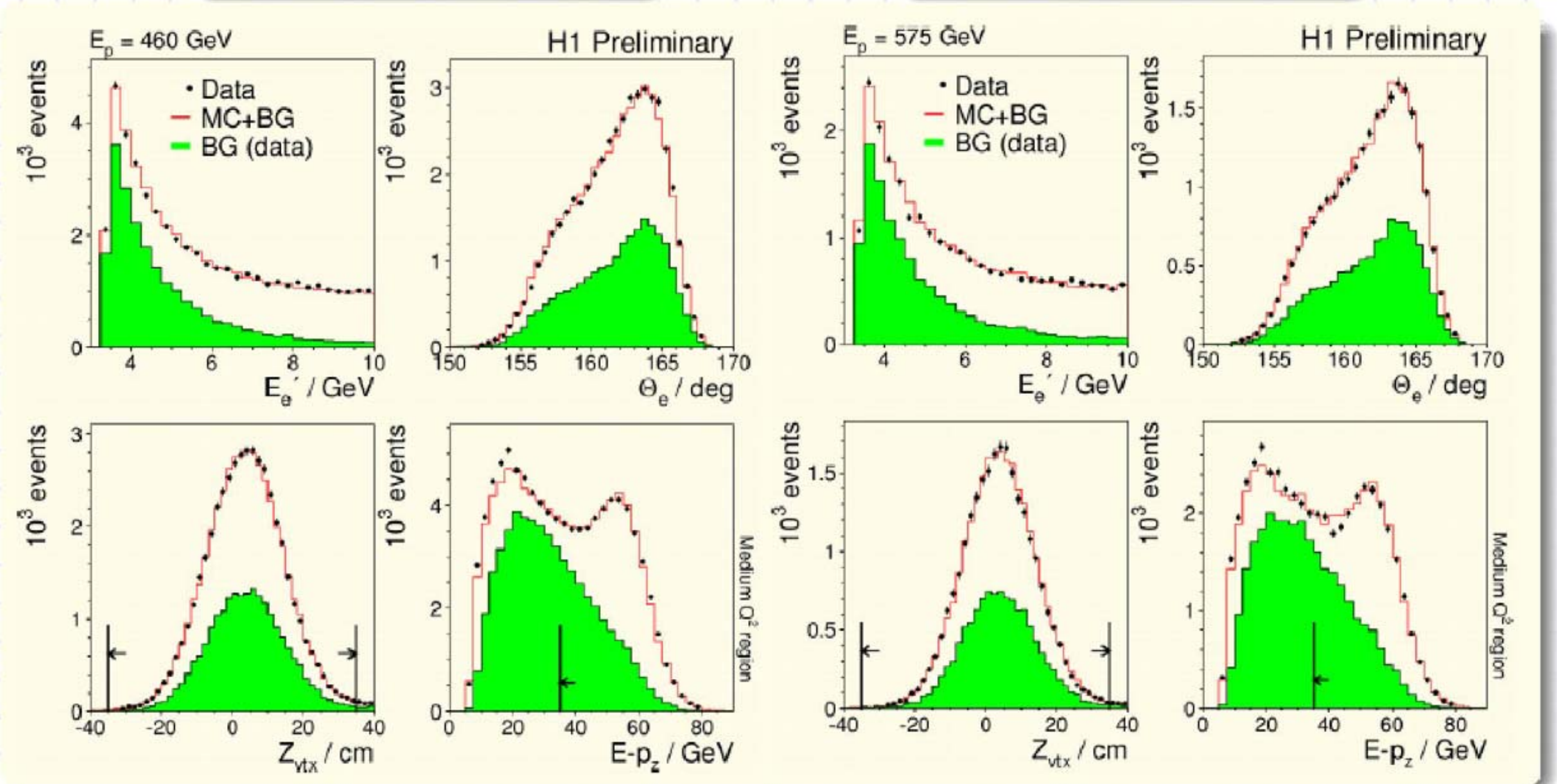
- Low background contribution
- Good control on the e/m and hadronic energy scales
- Electron energy (E_e'), scattering angle (θ_e), etc. are well described by MC

Presented Moriond 2008

High *y* Control Plots

$E_p = 460$ Data

$E_p = 575$ Data



- Good description of the data by MC

Presented Moriond 2008

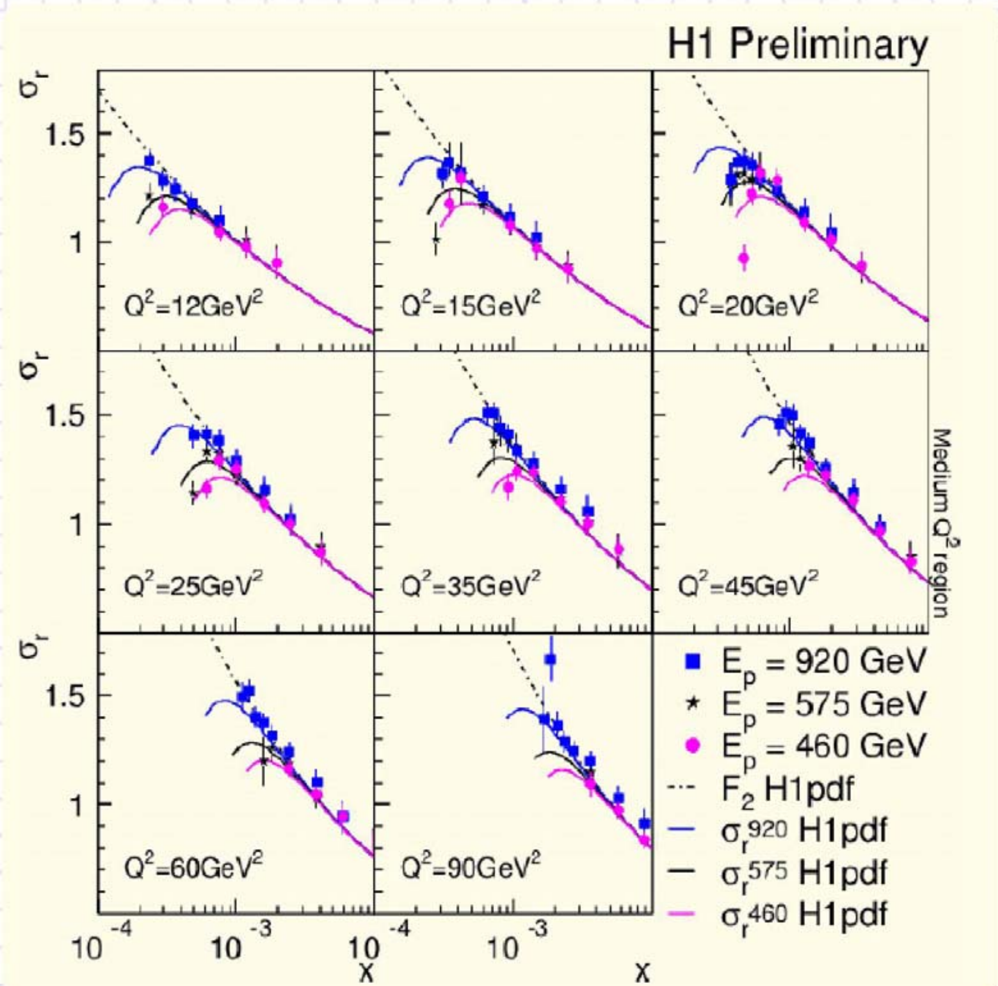
Double Differential Cross Sections

Same Q^2, x range, different CME $\rightarrow$ different y ranges

$$y = Q^2/(xs)$$

lower $s \rightarrow$ higher y

σ_r turns over at low x due to F_L



PDF Fits: Theoretical framework

NLO DGLAP evolution

Factorisation and renormalisation scales Q2

Zero-mass variable flavour number heavy quark scheme

Model assumptions

Which will be varied to assess model uncertainty

$Q_0^2 = 4\ GeV^2$ input scale

$Q^2_{min} = 3.5\ GeV^2$ minimum Q2 of input data

fs = 0.33D strange sea fraction, means s=0.5d

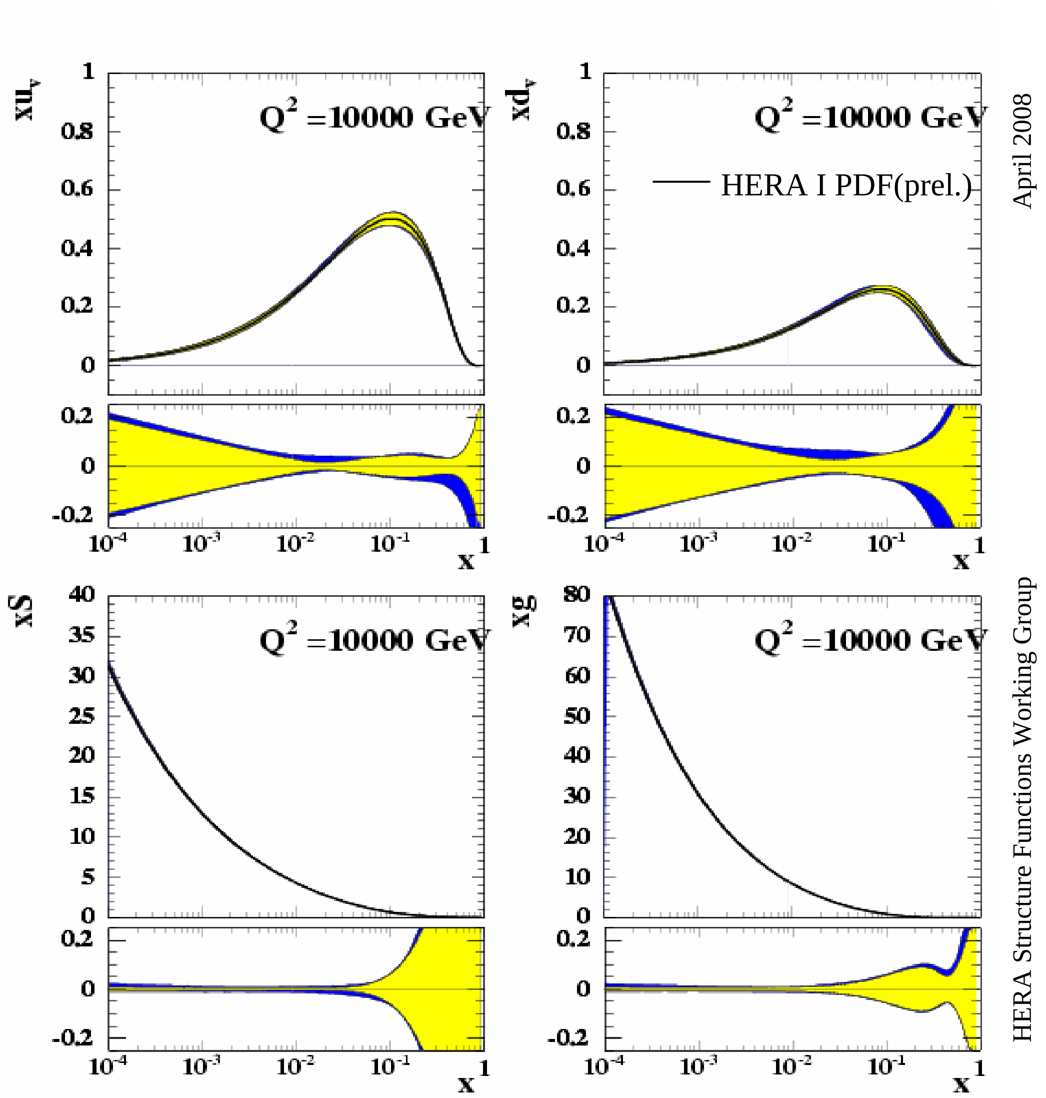
fc = 0.15U charm sea fraction, means c=0.176u

mc=1.4 mass of charm quark

mb=4.75 mass of beauty quark

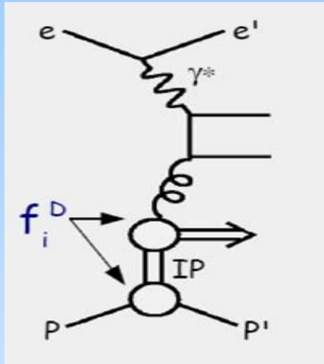
$\alpha_s(Mz) = 0.1176$ (PDG2006 value) Not included in Model Uncertainty

H1 and ZEUS Combined PDF Fit

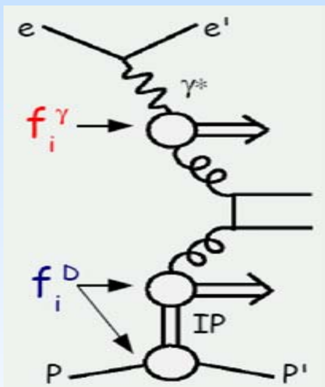


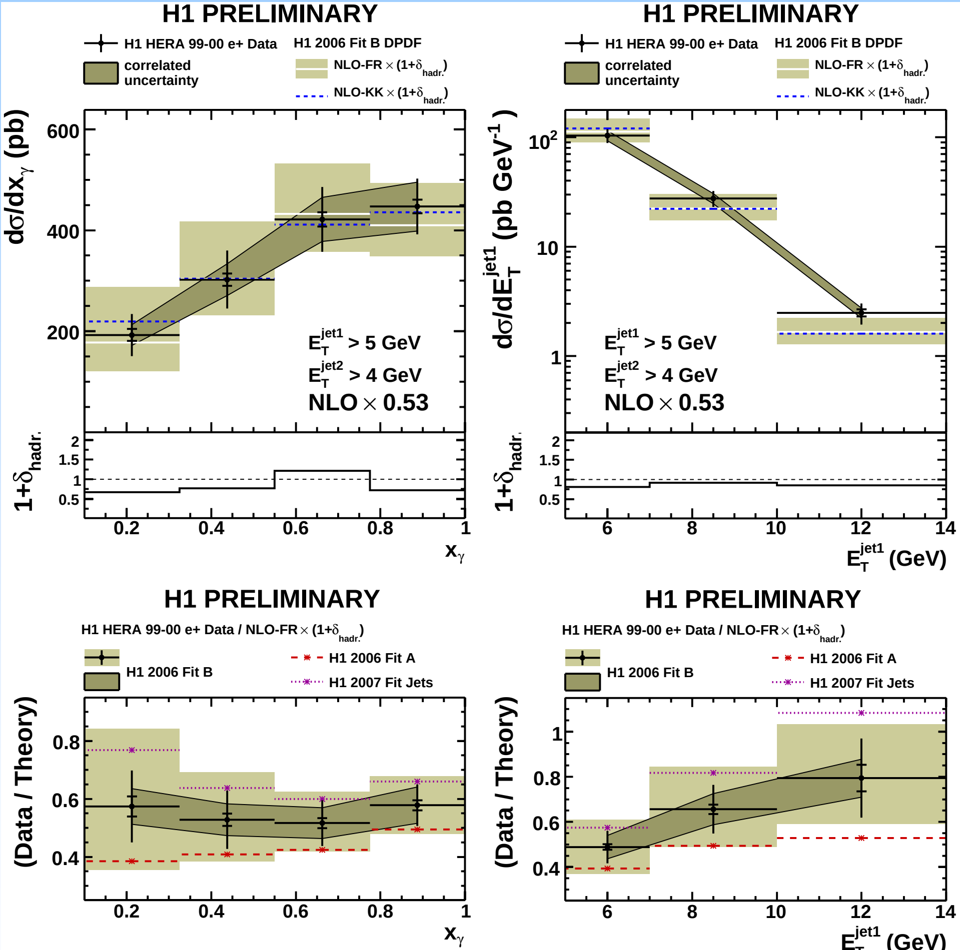
Diffractive dijets in photoproduction (HERA I)

Direct:
pointlike γ



Resolved:
hadronlike γ



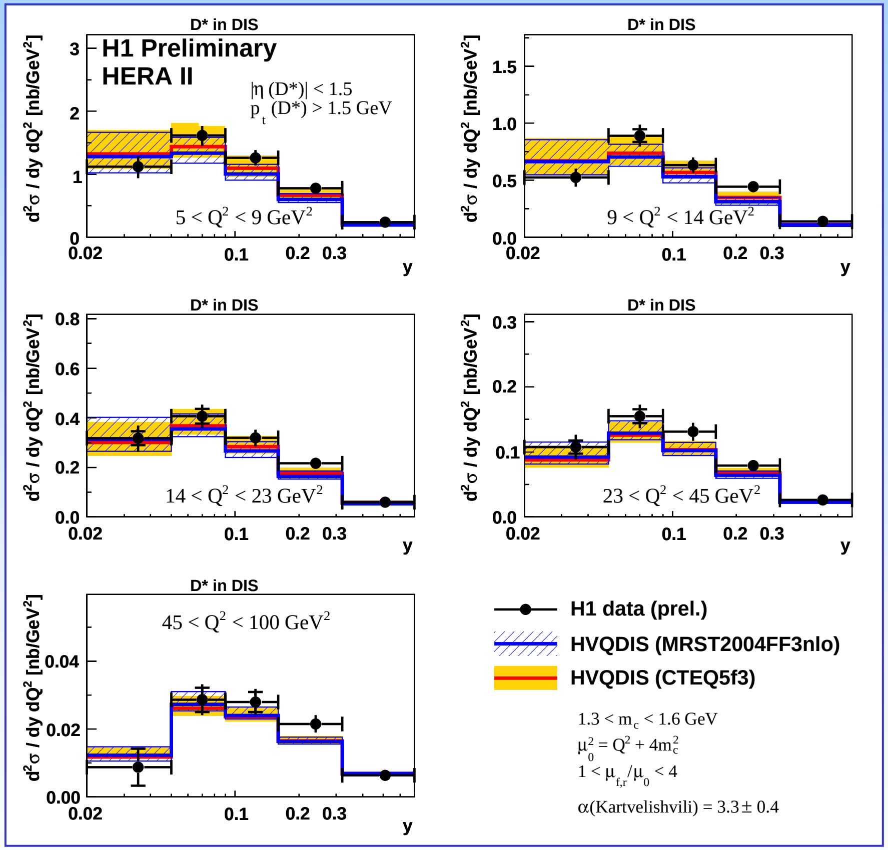


Factorization breaking:

- suppression factor same for direct and resolved processes
- dependent on E_T of the leading jet : consistent with ZEUS result

D* in DIS (HERA II)

Double-differential cross sections:



Precision will improve further

High precision points out NLO deficits