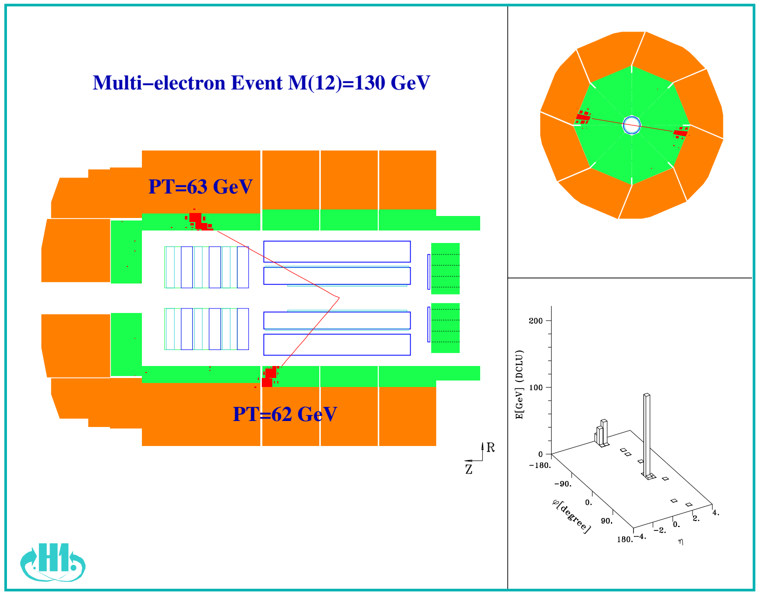
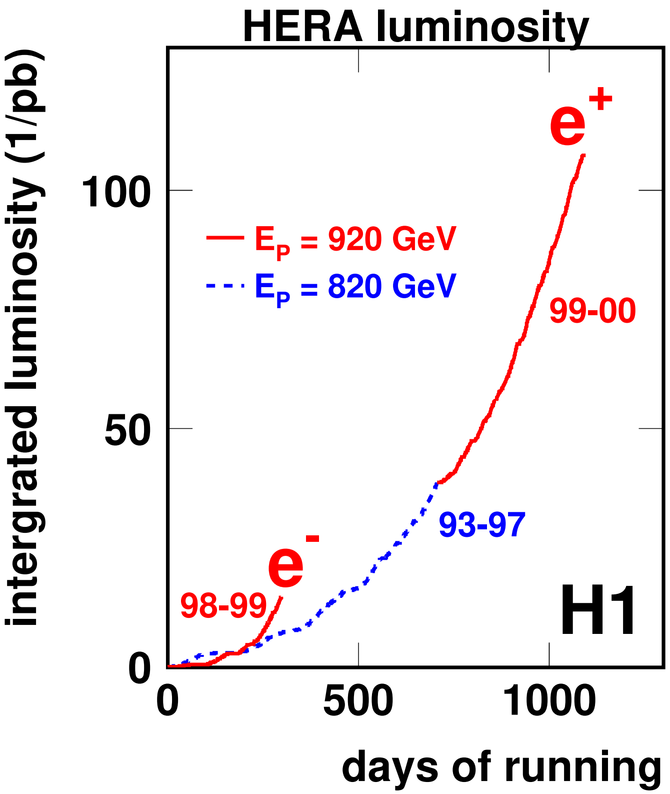
H1 Highlights for EPS03

Paul Newman   Birmingham University



- High Q^2 Cross Sections and PDFs
- QCD Tests with jets and heavy flavours
- Low x Physics
- Searches for new Physics

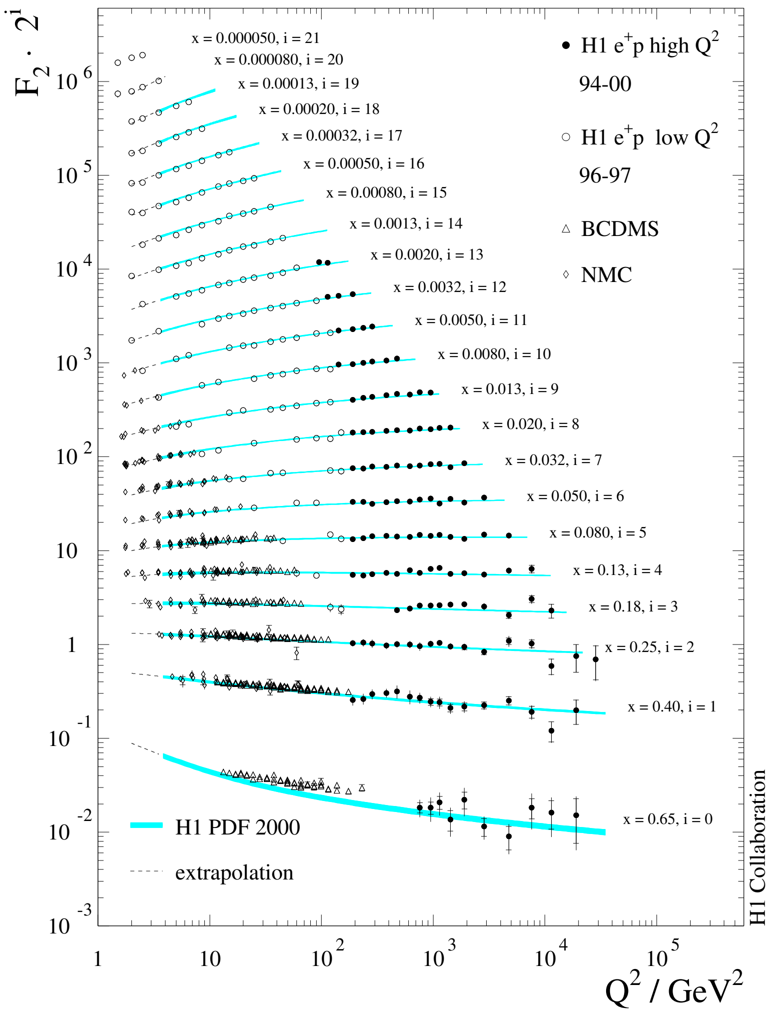


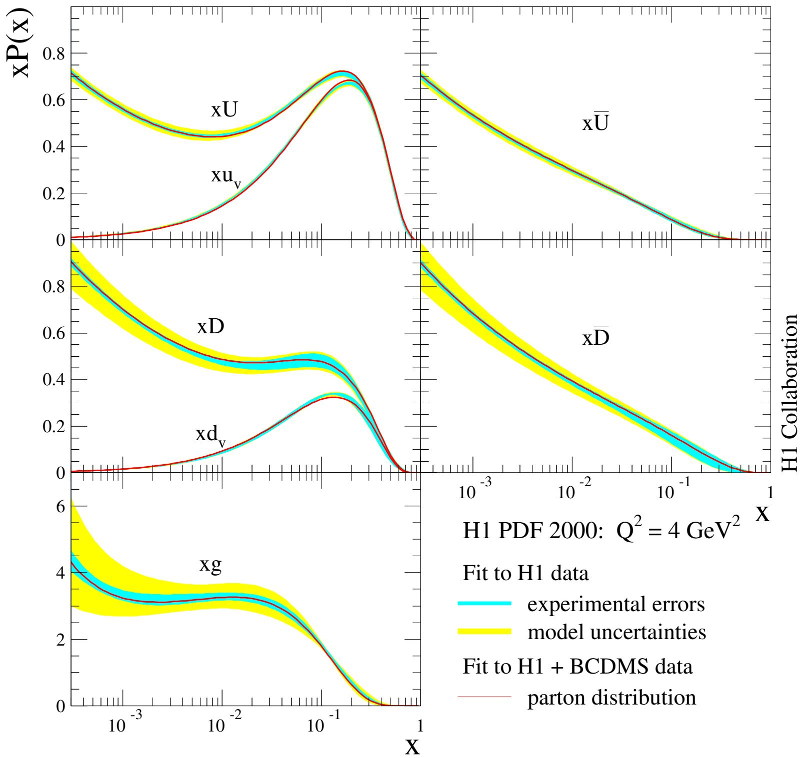
Results to Be Shown for the First Time at a Major Conference

- Final high Q^2 NC & CC xsecs / pdfs
- New method and data on F_L at low Q^2
- F_2 from QED-Comptons
- F_2^D at high Q^2
- $\gamma p \to \gamma Y$ at high $|t|$
- Deeply-Virtual Compton Scattering
- NLO Treatment of Diffractive Final States
- Elastic J/ψ photoproduction
- High $|t|$ J/ψ
- D^* photoproduction
- D^* $(+$ jet) in DIS
- $b \to \mu$ Photoproduction
- 2, 3-jet event shapes at high Q^2
- Dijets at low x
- Prompt Photons with Associated Jets
- Inclusive η, ρ^0, f_0, f_2 photoproduction
- General Search for new Phenomena
- R-parity Violating SUSY (full data)
- Search for Superlight Gravitino
- Search for magnetic monopoles
- Multi Electron Production
- Contact Interactions

53 papers submitted to conference, summarising work of last 2 years

High Q^2 NC & CC Cross Sections and Fits



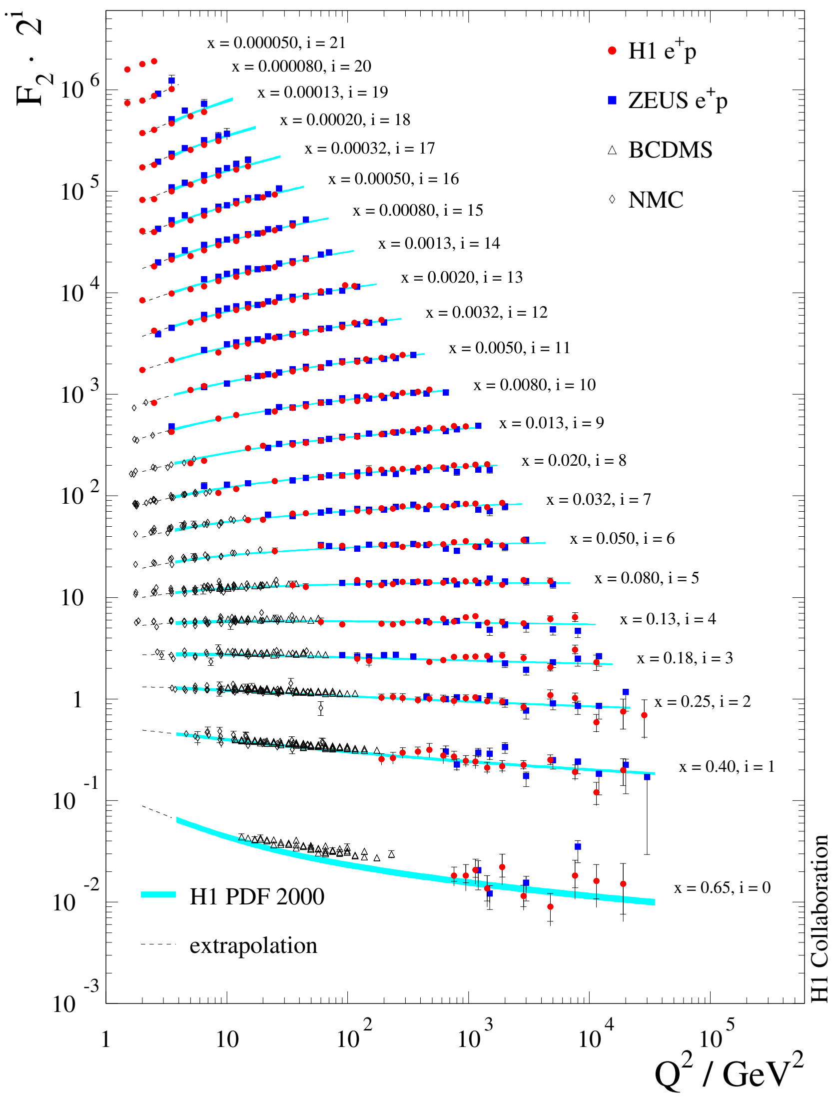


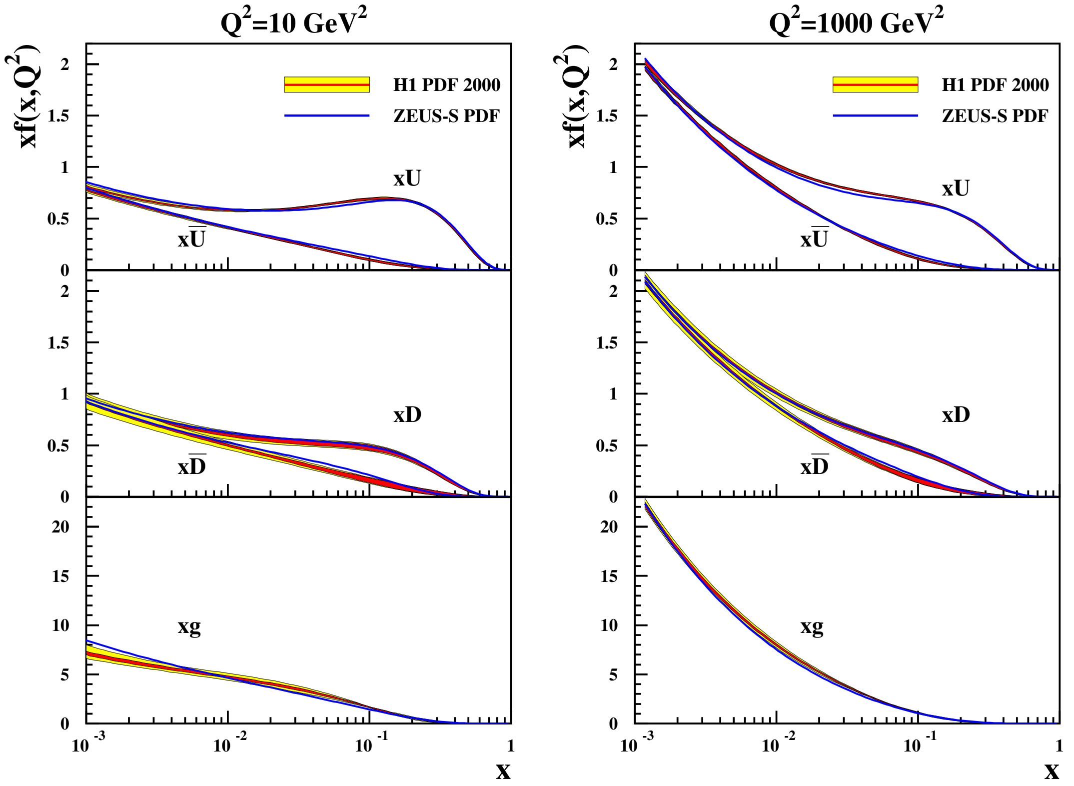
Beautiful summary of 10 years of high Q^2 inclusive measurements

Parton densities from *H1 data alone!*

$U = u + c$ etc

NC Comparison between H1 and ZEUS

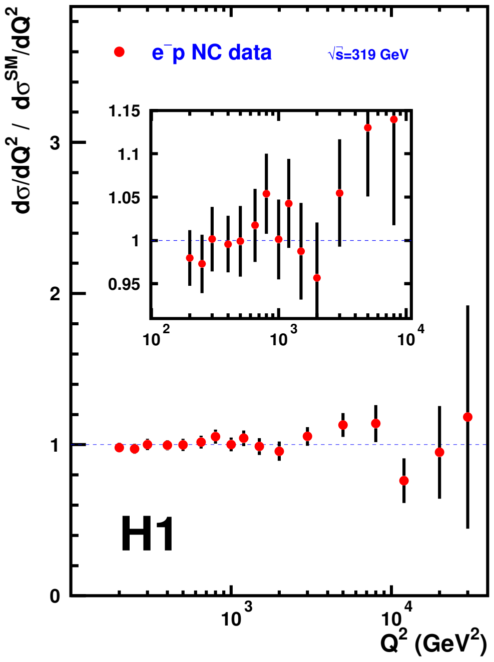


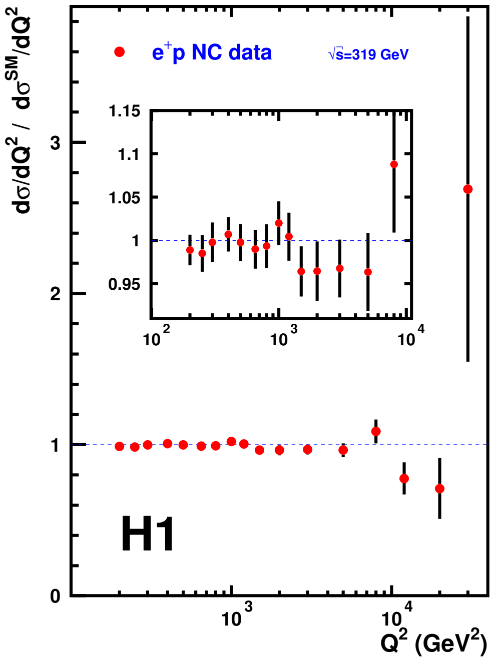


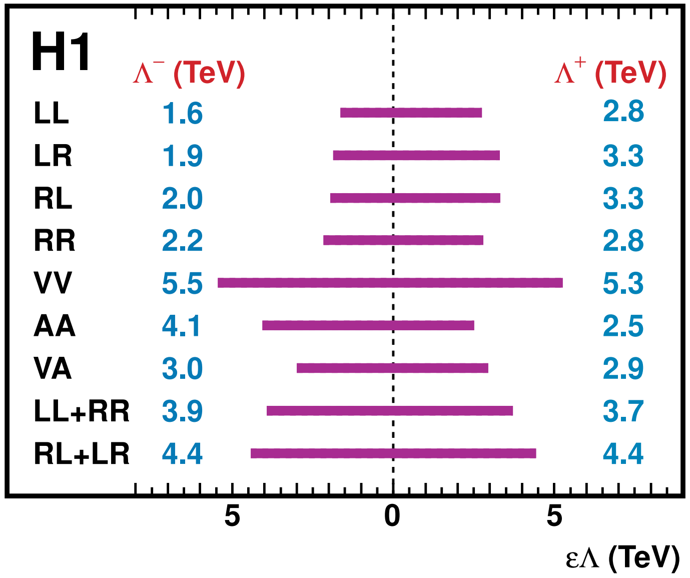
Consistency between experiments in data

Reasonable consistency in pdf’s

Search for Contact Interactions







H1 NC data consistent with Standard Model (CTEQ partons) up to highest Q^2

Competitive limits on compositeness scales, LQ, SUSY, large extra dimensions

Quark radius constrained to $R_q < 10^{-18}$ m

Differential 2-jet and 3-jet Event Shapes at high Q^2

New differential measurements in extended Q^2 range

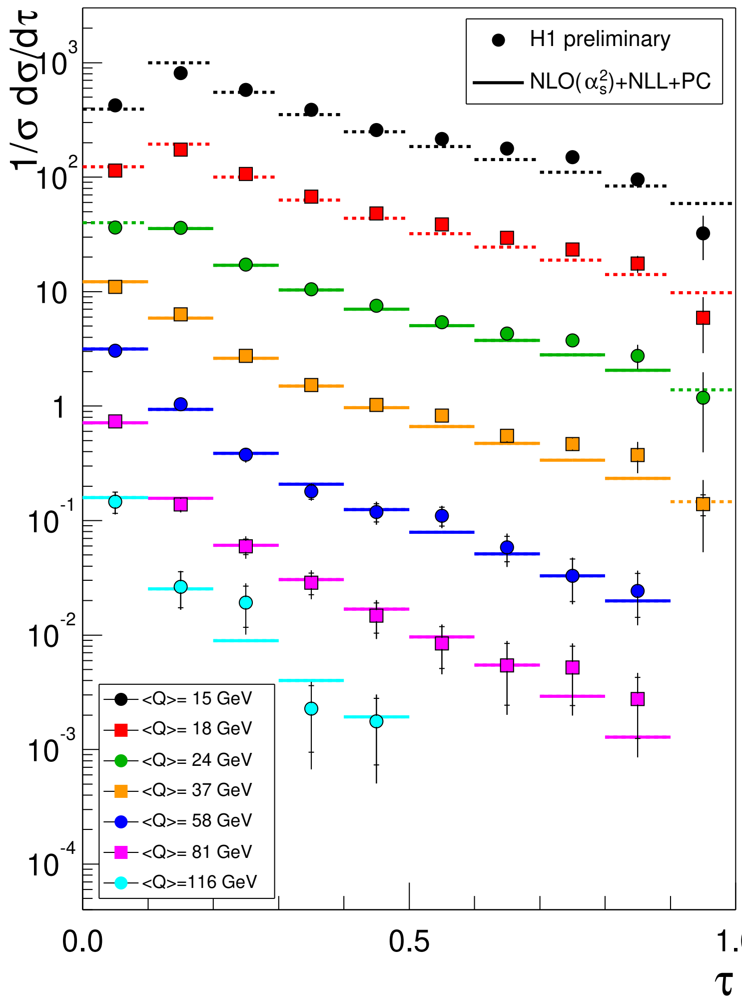
2 jet shapes: τ B τ_C C ρ_0

3 jet shapes: K_{out}/Q χ

Jet rates: $y2_{\mathrm{kt}}$ $y3_{\mathrm{kt}}$ $y4_{\mathrm{kt}}$

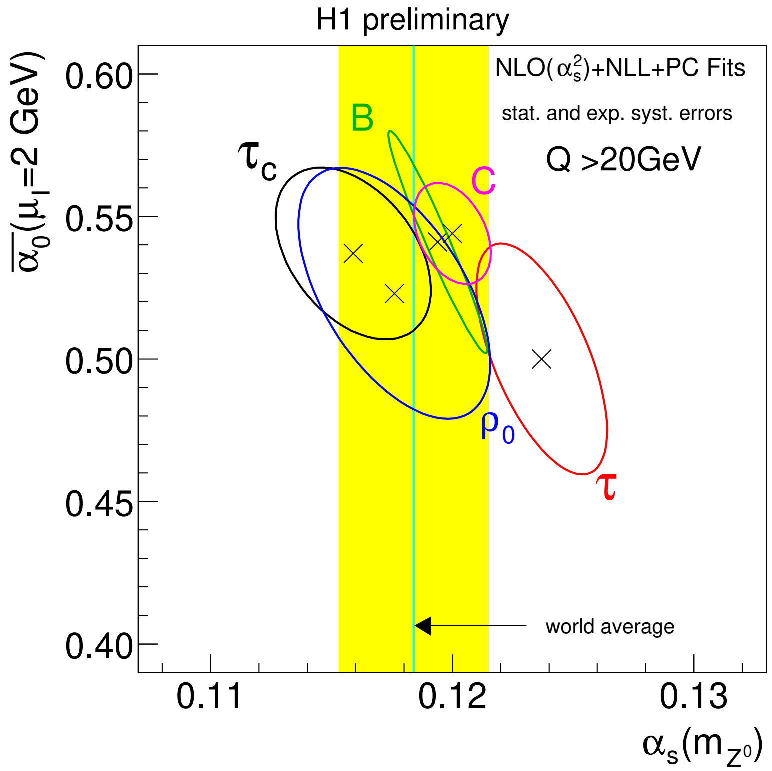
2 jet shapes: Fits using NLO QCD $\otimes$ new resummed calculations $\otimes$ power corrections

e.g. $\boldsymbol{\tau = 1 - \mathrm{Thrust}}$

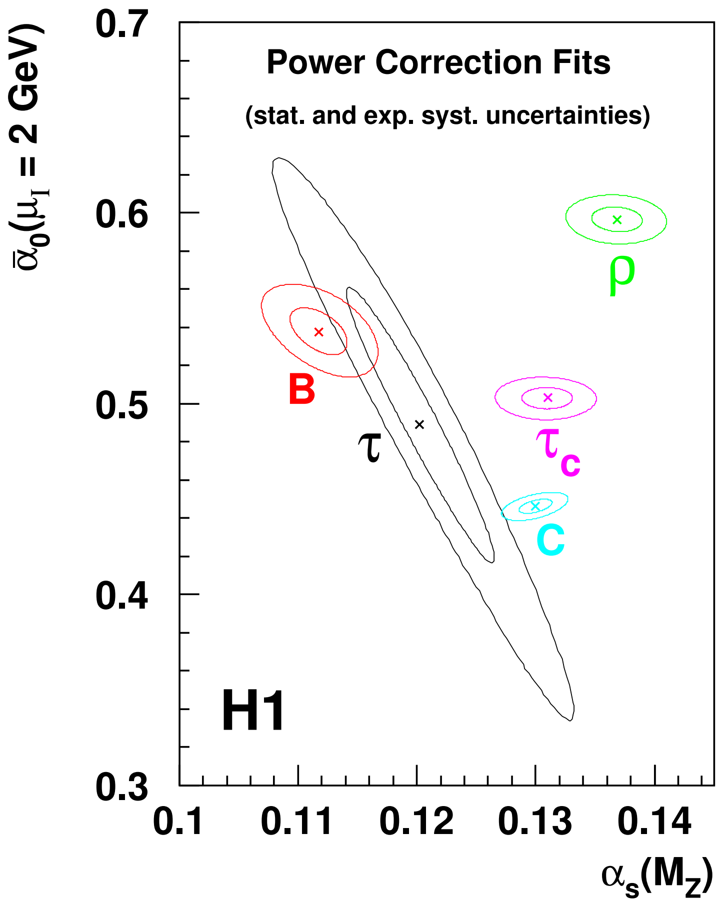


Impact of New Measurements

95-00 data, resummed, fit distributions

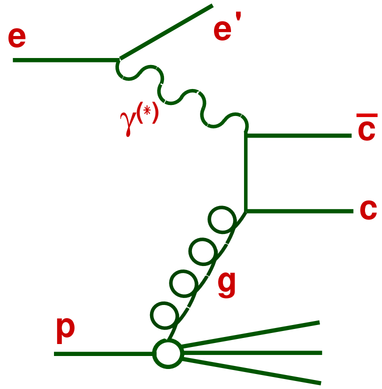


94-97 data, non-resummed, fit means



More consistent picture results for α_s and

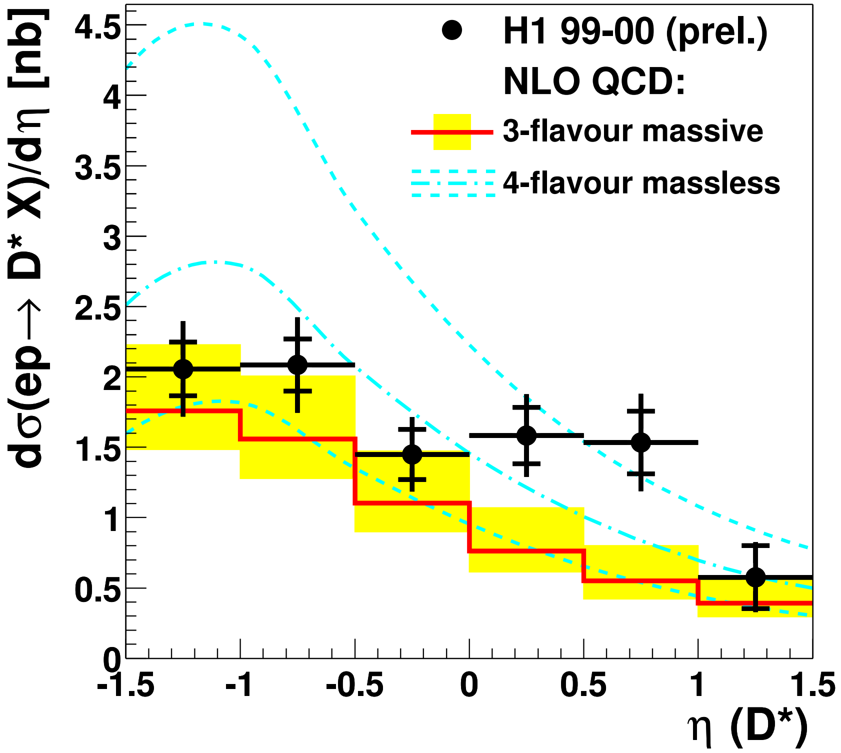
power correction parameter α_0

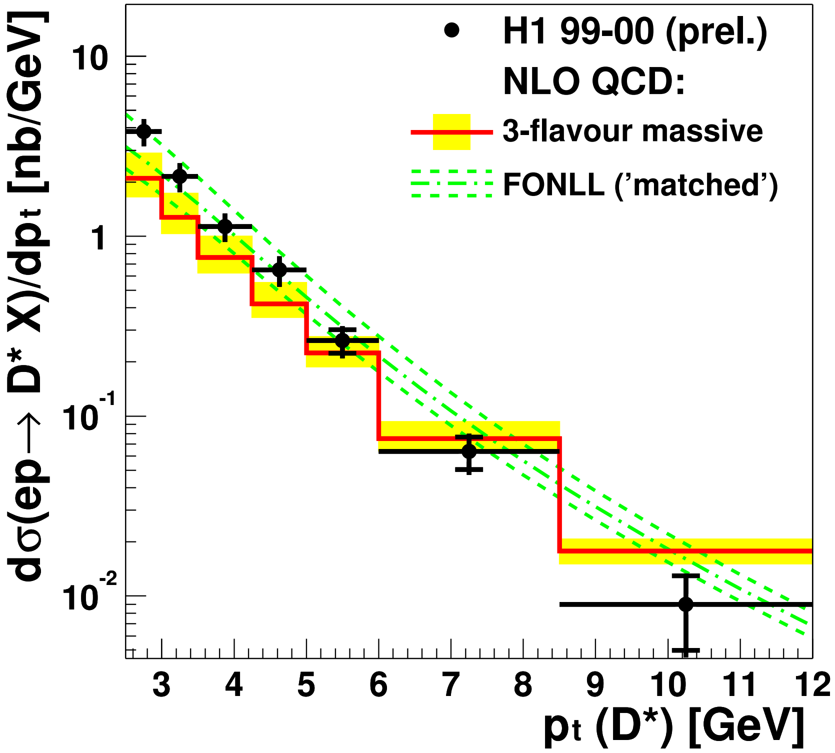


D^* Photoproduction

D^* data in tagged γp ...

Testing MC models and NLO theory



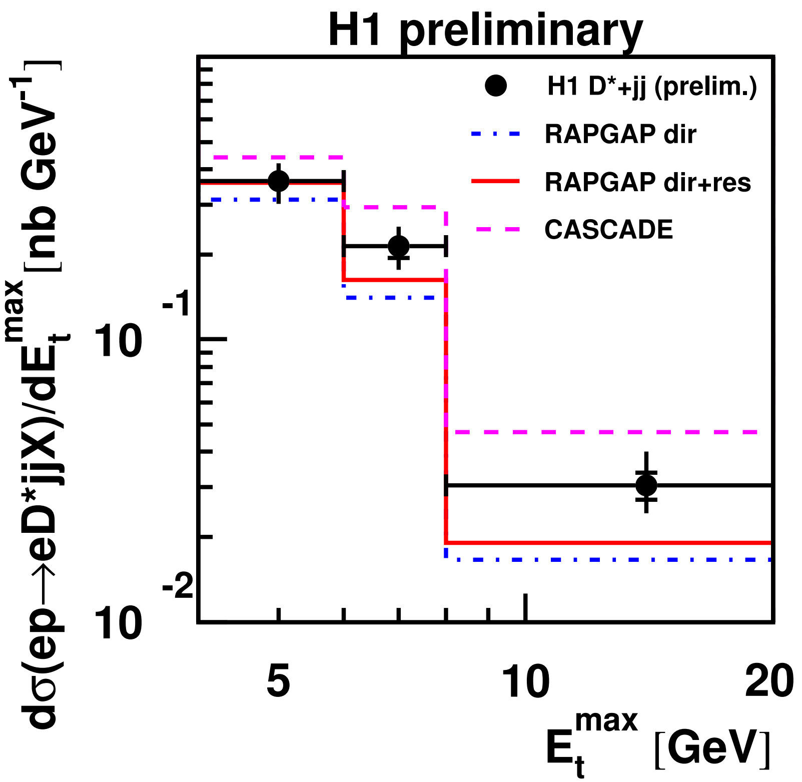


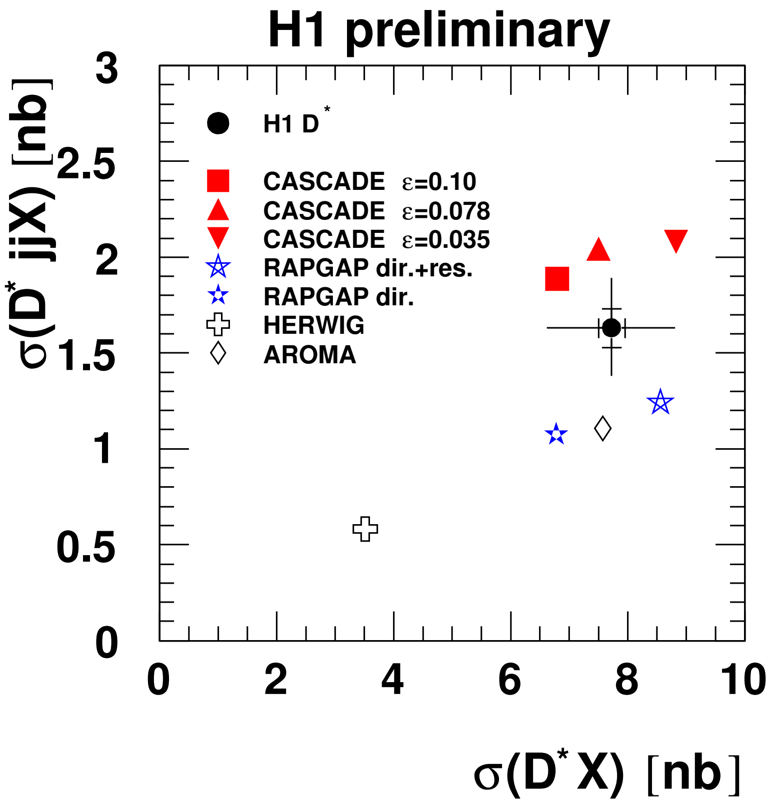
Not fully described by MC models or "massive" theory

Massless, Matched FONLL better?

Important data to constrain large theory uncertainties

D^*+ Dijets in DIS



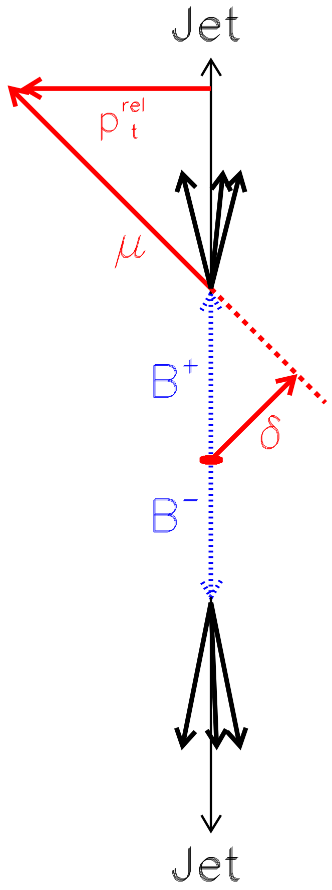


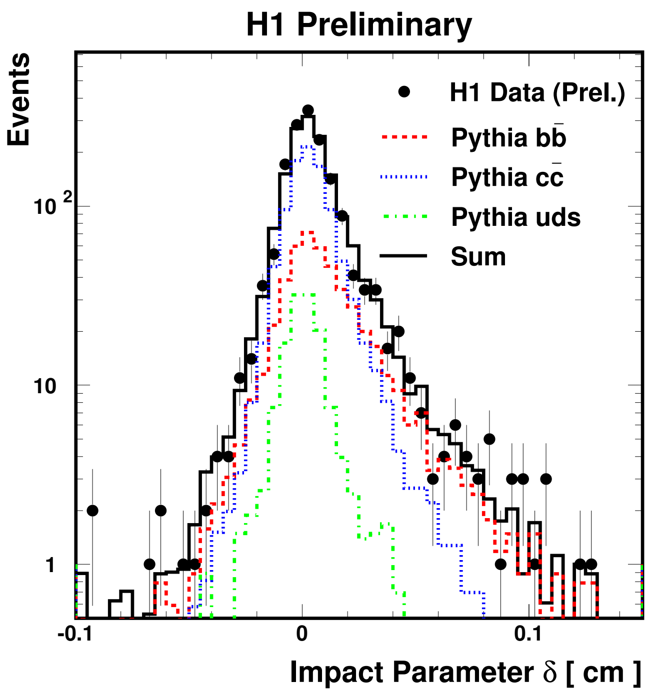
DIS Results for Inclusive D^* and D^*+ dijets

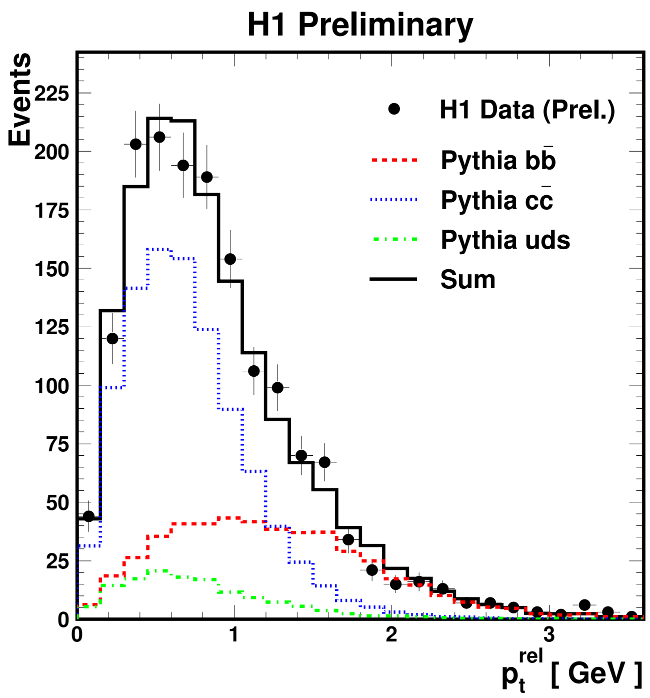
New insights with jet requirements

LO MC models describe inclusive data well, but dijets bring sensitivity to extra effects

$\sigma(ep \rightarrow eb\bar{b}X \rightarrow ejj\mu X)$ in γp







Measure b cross sections for dijet events with muon associated with one jet

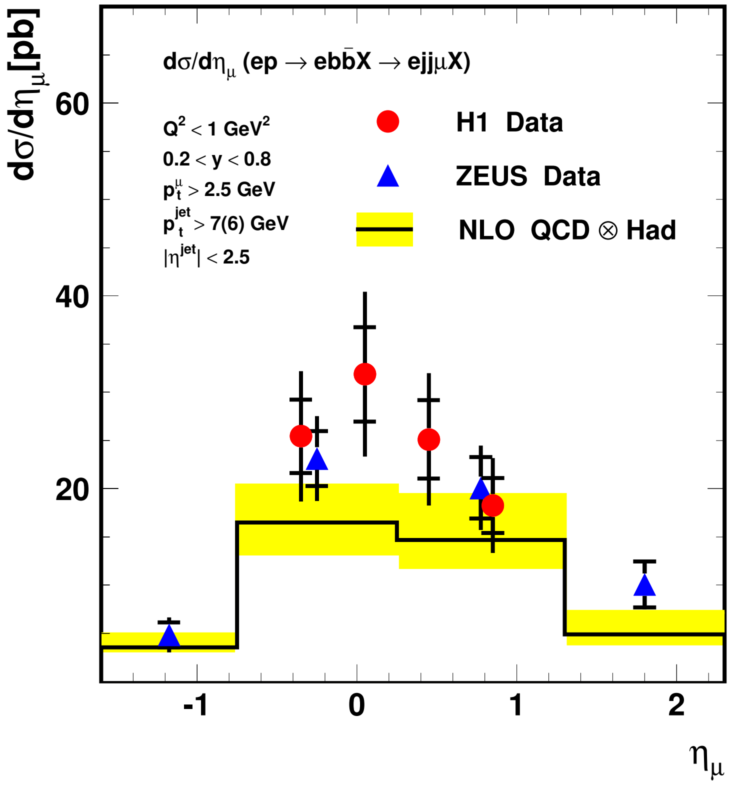
Two observables to separate b, c and background

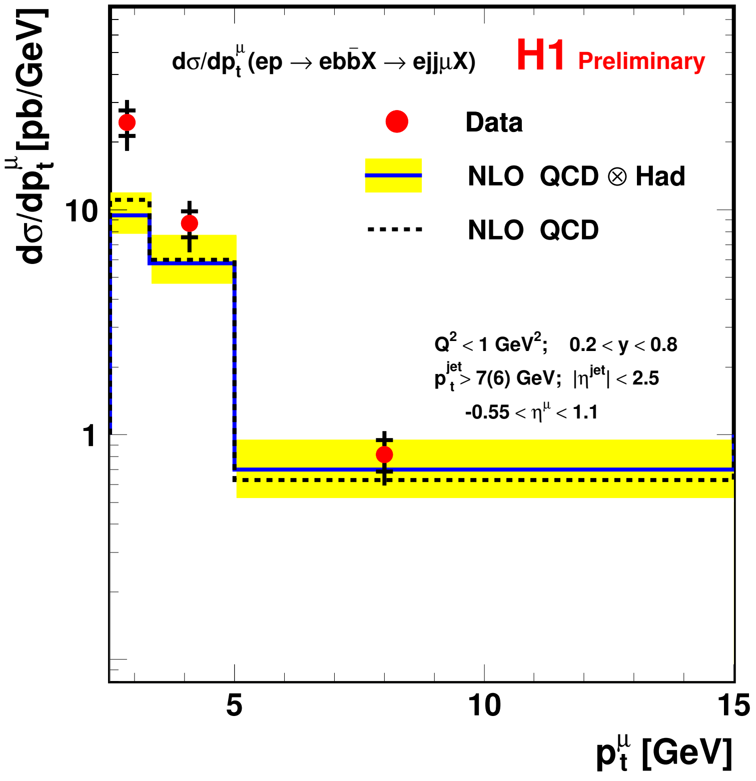
Simultaneous 2D fit

1) Track impact parameter δ from Silicon

2) $p_T^{\rm rel}(\mu - jet)$

Beauty Photoproduction Cross Sections





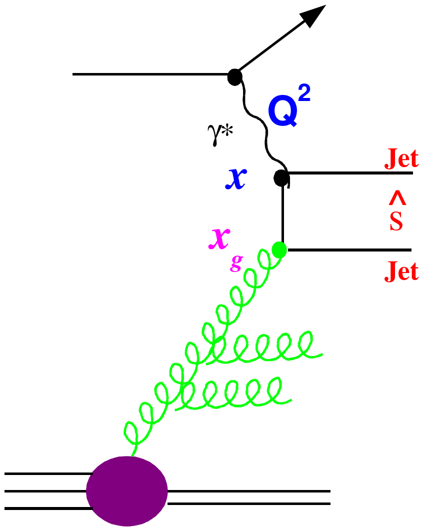
H1 and ZEUS in good agreement

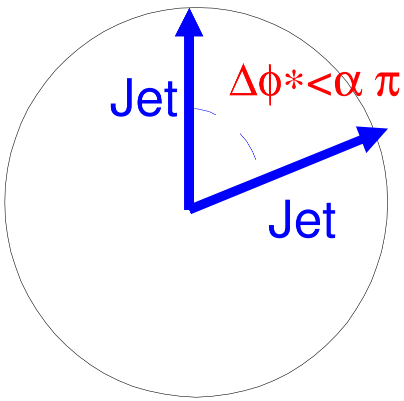
Comparisons with NLO QCD (fixed order massive)

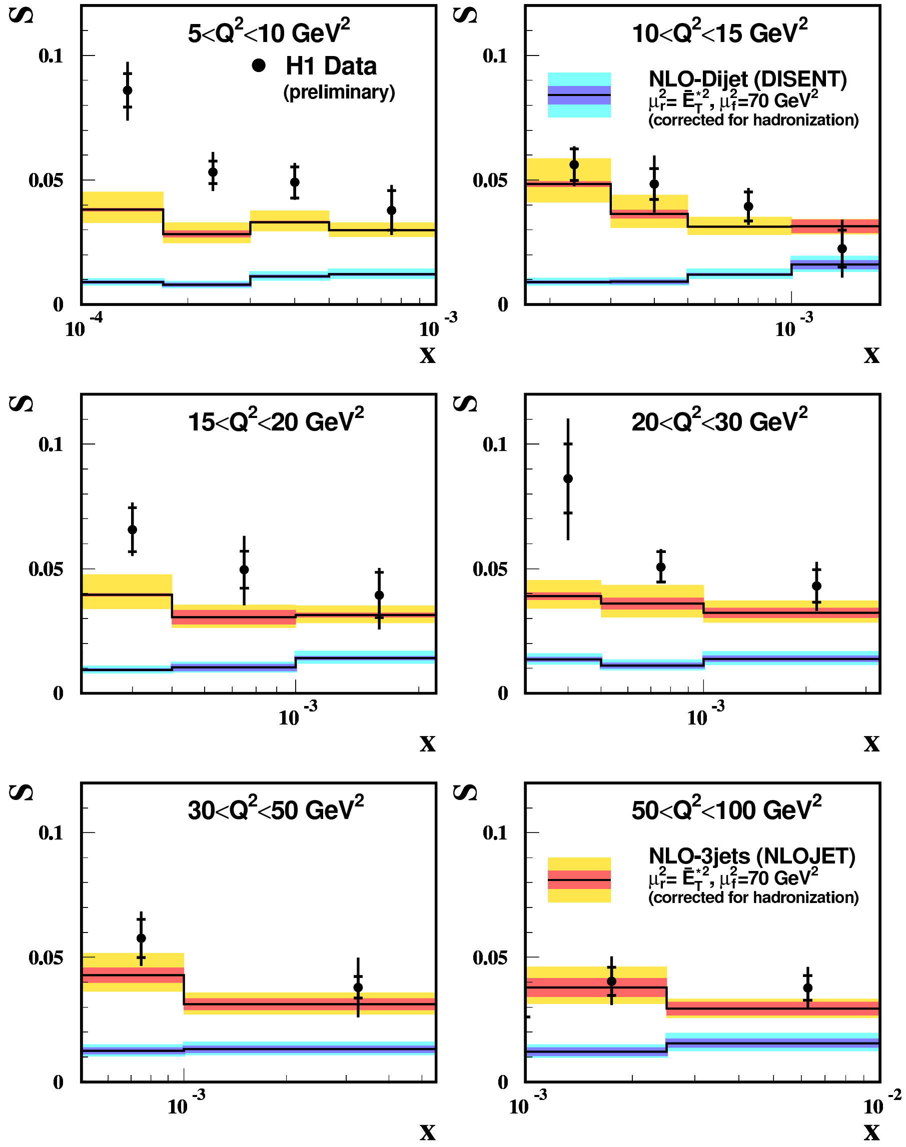
$\sigma(ep \rightarrow eb\bar{b}X \rightarrow ejj\mu X)$: Data / NLO ~ 1.8 (1.5σ) for measured range

Discrepancy increases as p_T decreases . . .

Dijet Production at Low x







Azimuthal decorrelation between jets in $\gamma^* p$ CMS

sensitive to higher order effects, incoming k_T

Measure S = Pr (2 leading jets have $\Delta\phi^\star < 120°$)

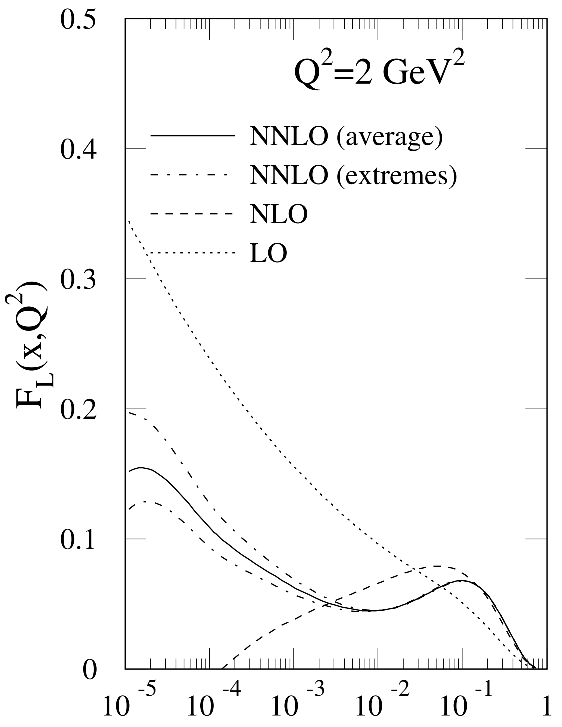
Mostly well described by NLO 3-jet theory

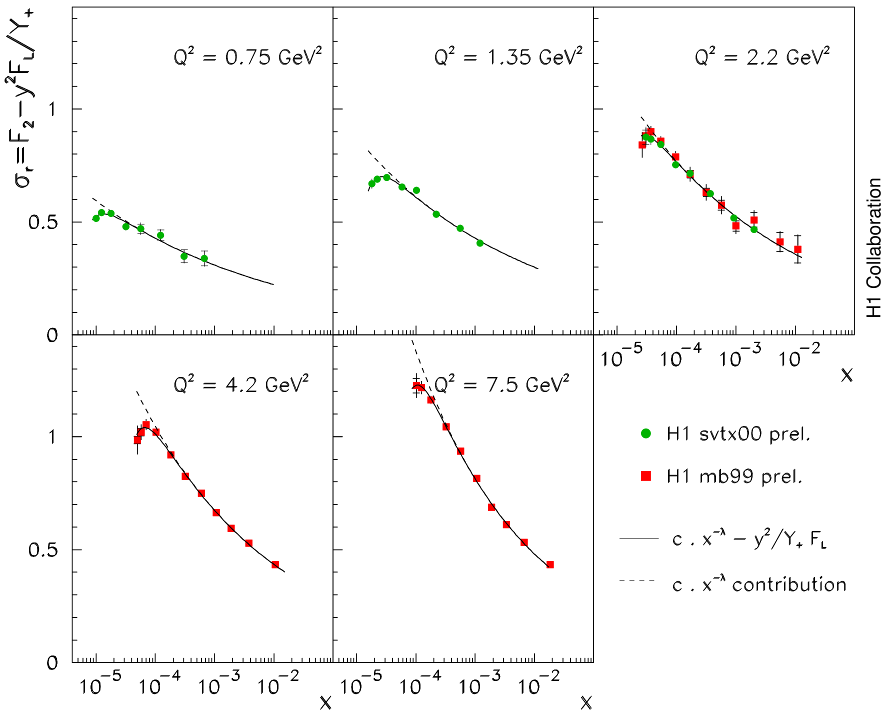
Still missing contributions at lowest x, Q^2 !...

Determination of F_L at Low Q^2

F_L is the ideal observable to study the low x gluon

F_L at low Q^2 (MRST) - huge changes from LO, NLO, (NNLO)





Sensitivity at highest y ($E'_e > 3\,\mathrm{GeV}$)

New data at lowest Q^2 from SV00 run.

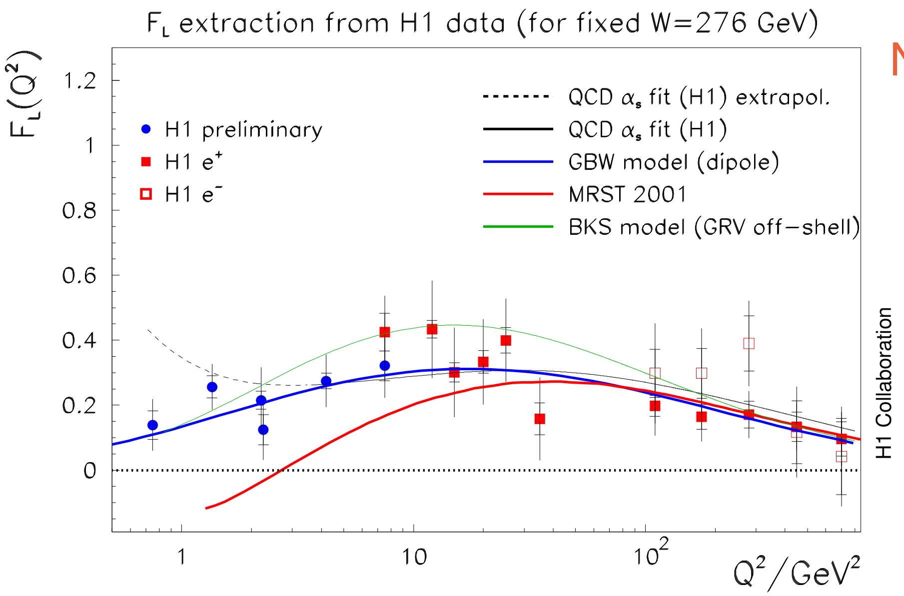
New method introduced: Fit σ_r at fixed Q^2:

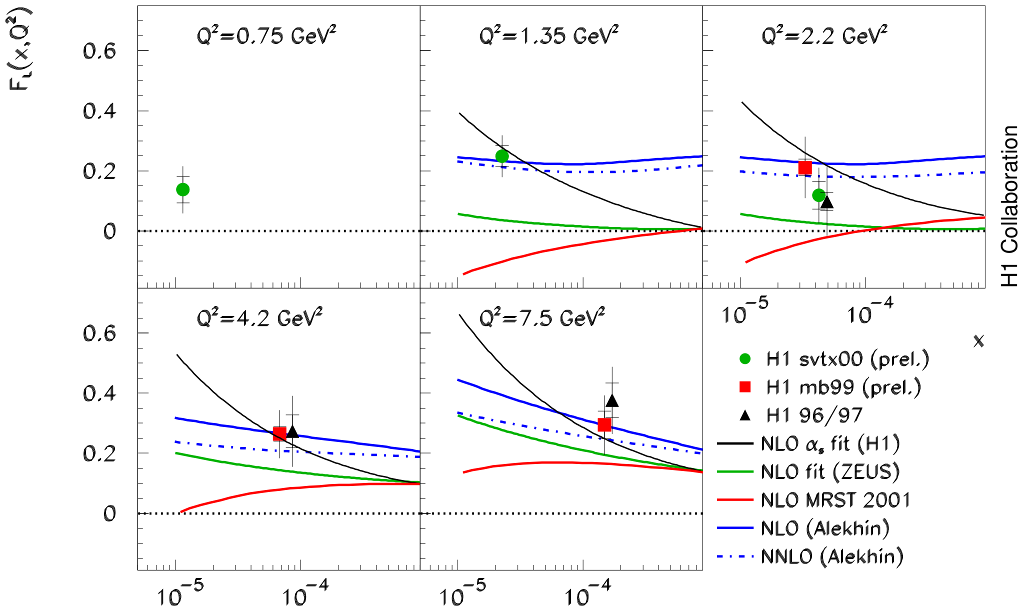
$$\sigma_r = c \cdot x^{-\lambda} - y^2/Y_+ \cdot F_L$$

F_L at Low Q^2

But models that can get the Q^2 dependence right can still be wrong

No substitute for measuring x dependence . . .





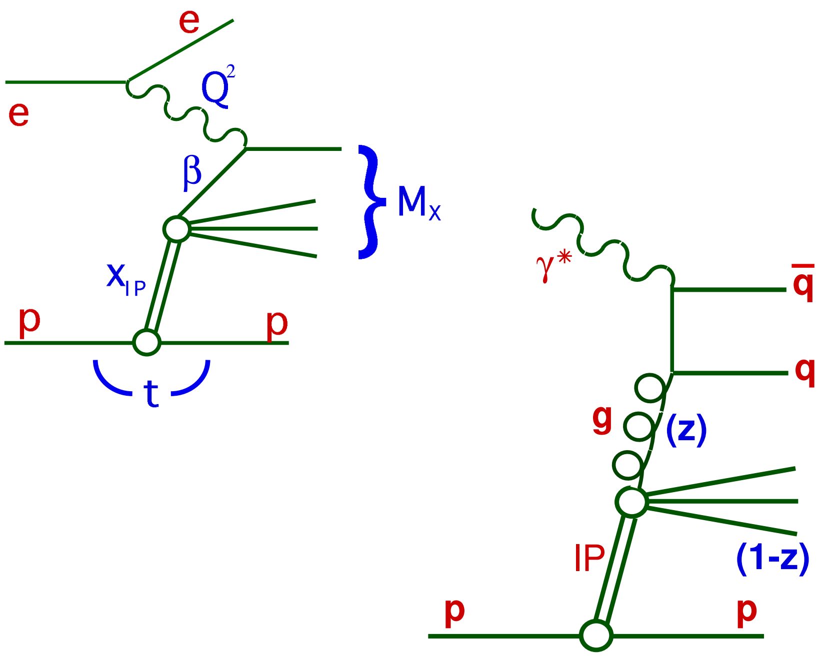
H1 F_L determination now spans 3 orders of magnitude in Q^2

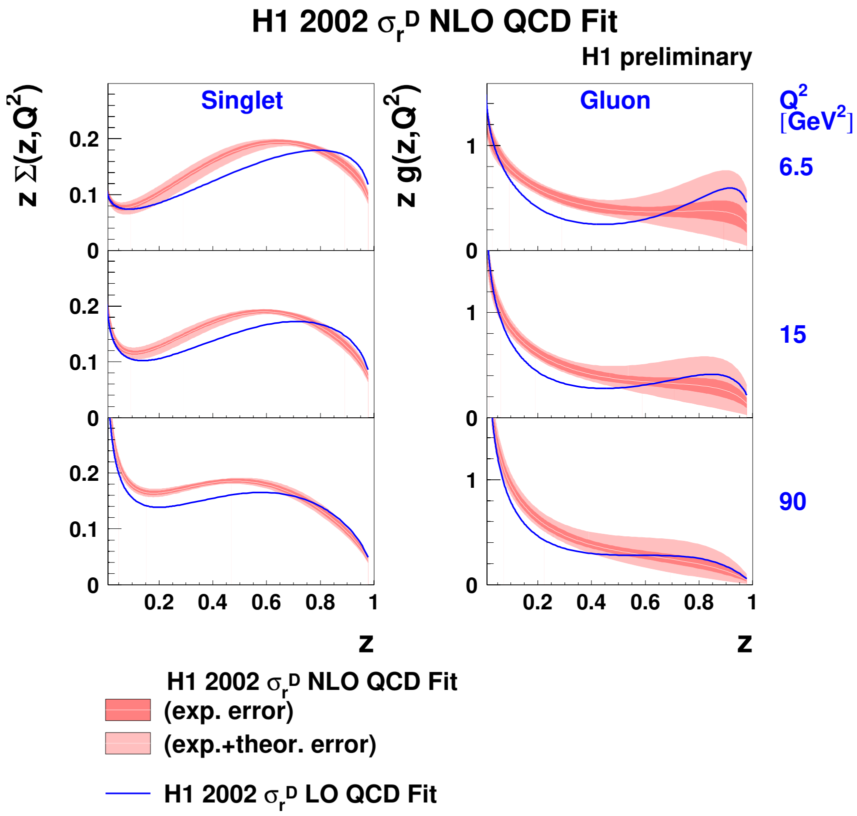
Distinguishes between models!

QCD Hard Scattering Factorisation for Semi-Inclusive DIS

Hard scattering factorisation established for diffractive DIS

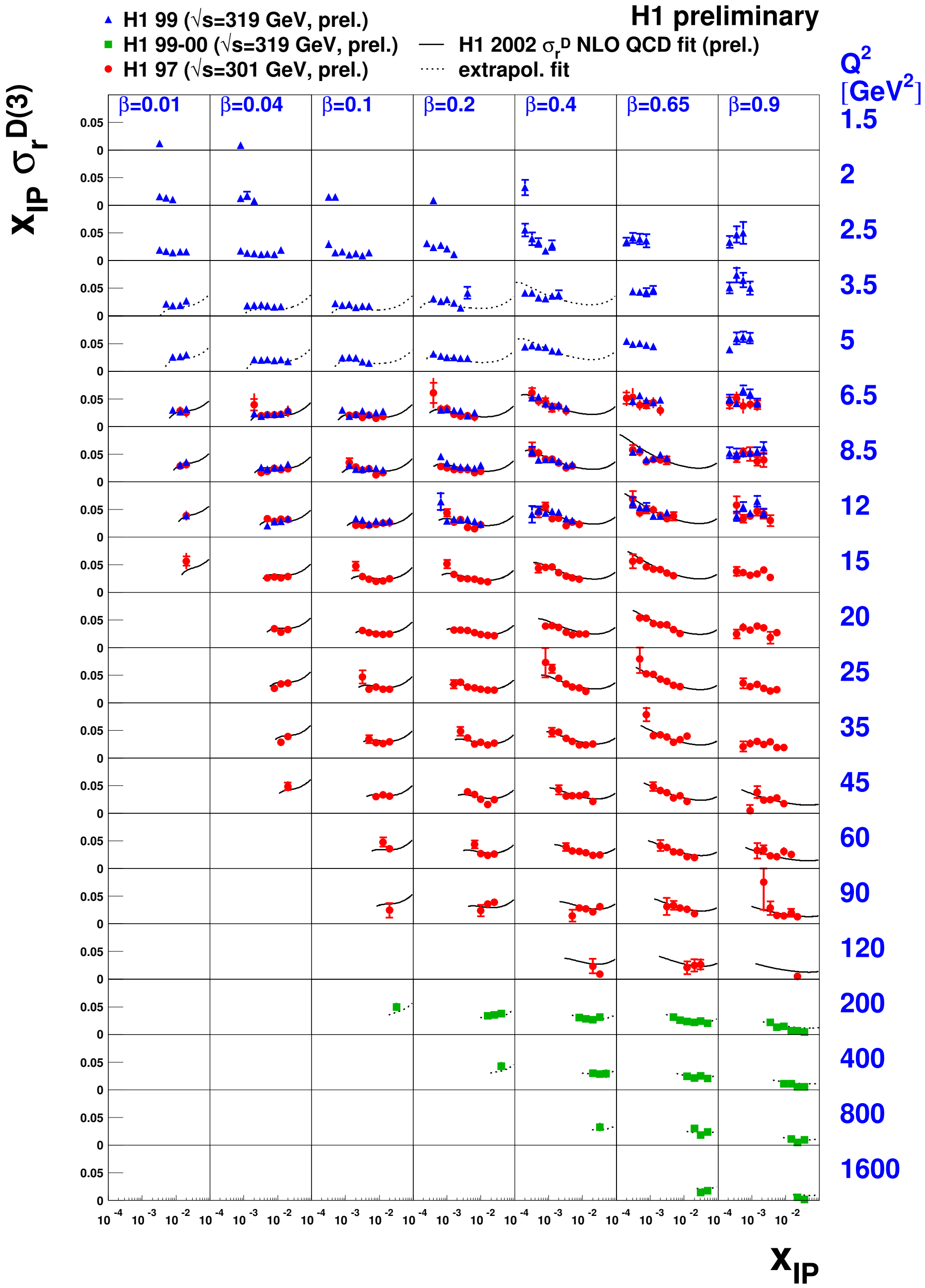
Diffractive parton densities extracted from H1 diffractive data with $6.5 < Q^2 < 90\ \mathrm{GeV}^2$

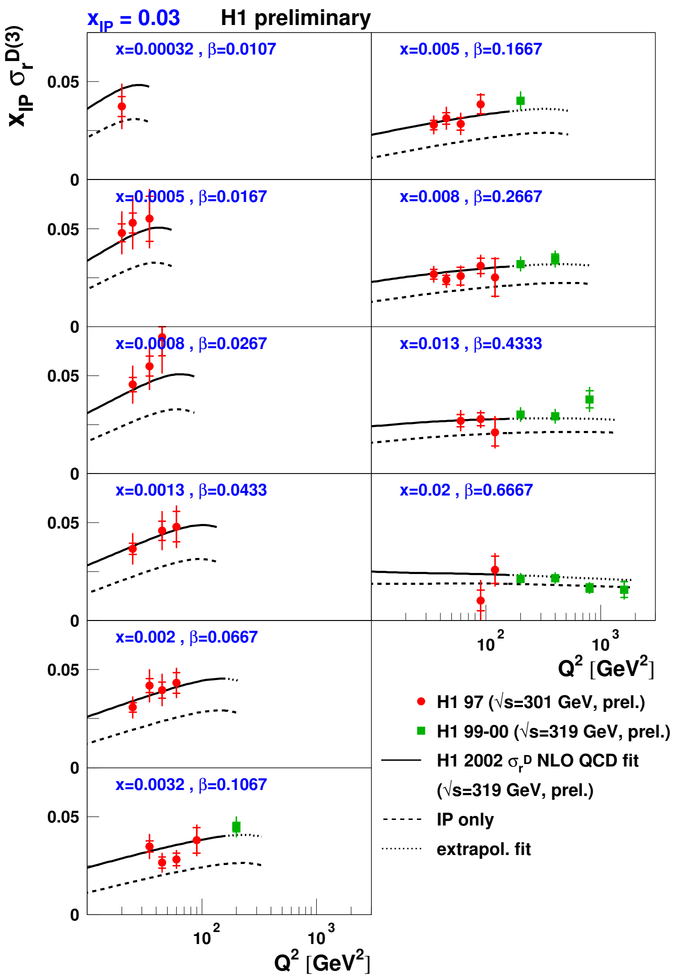




Test partons at higher Q^2 and in final state data

Diffractive DIS at High Q^2



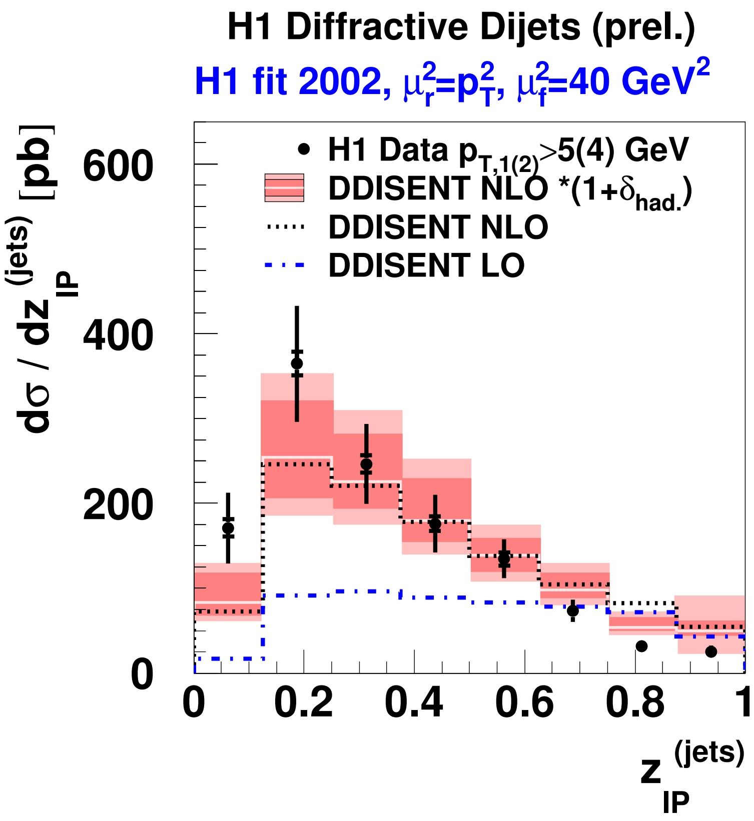


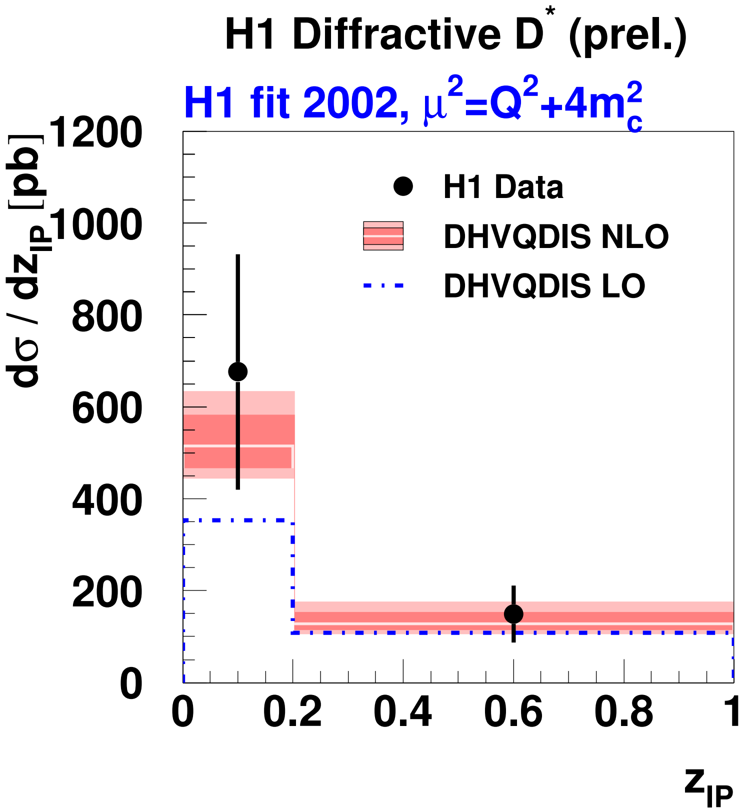
H1 F_2^D data now cover 4 orders of magnitude in Q^2

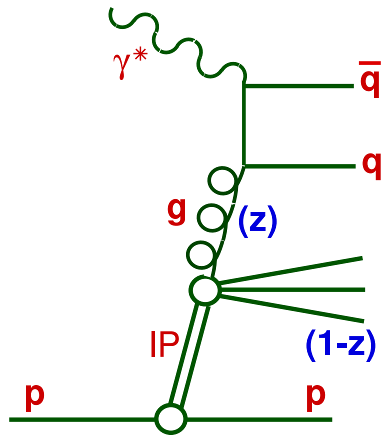
QCD fit to medium Q^2 data for diffractive parton densities describes new data well.

NLO treatment of diffractive final states

Calculations for previous H1 data using diffractive DISENT and HVQDIS.







Description

beyond LO+PS

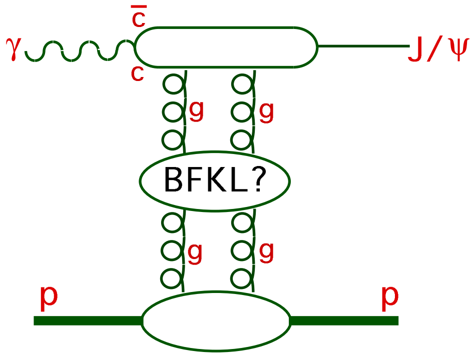
Low scales . . . large scale and hadronisation uncertainties

Data well described

Consistent description of diffractive DIS

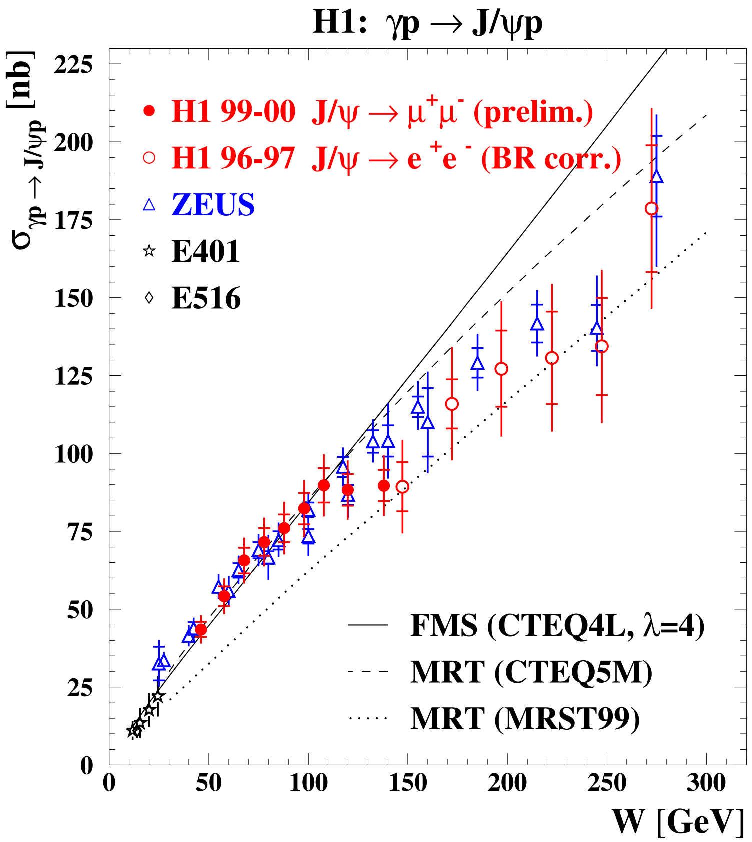
Diffractive hard scattering factorisation works!

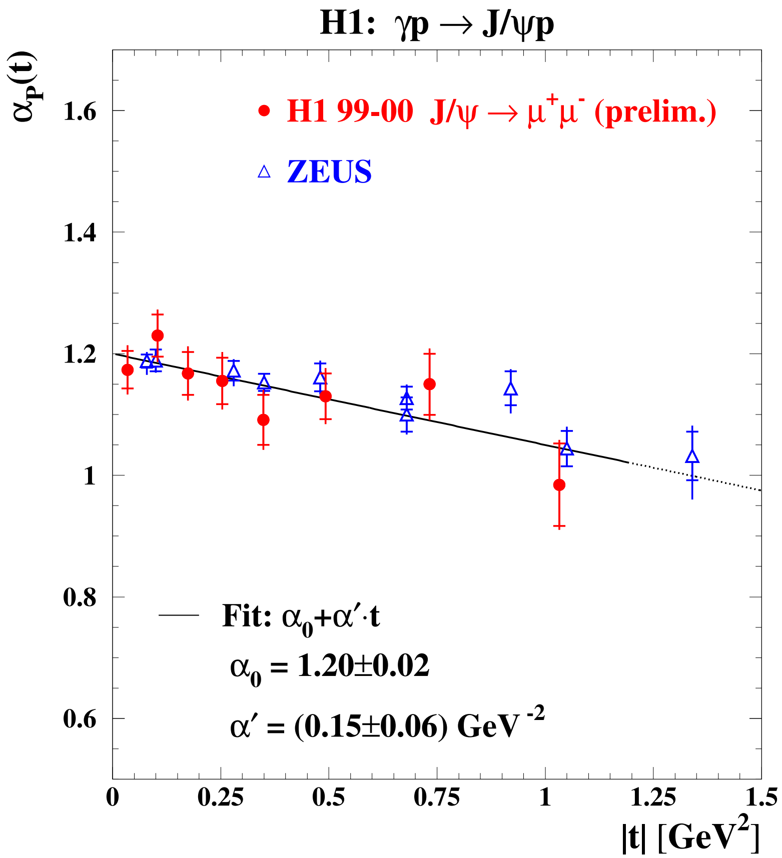
Diffractive $J/\psi \to \mu^+\mu^-$ Photoproduction



Elastic $J/\psi \to \mu^+\mu^-$ at low $|t|$ ...

$\mathrm{d}\sigma/\mathrm{d}t \propto (W^2)^{2\alpha(t)-2}$

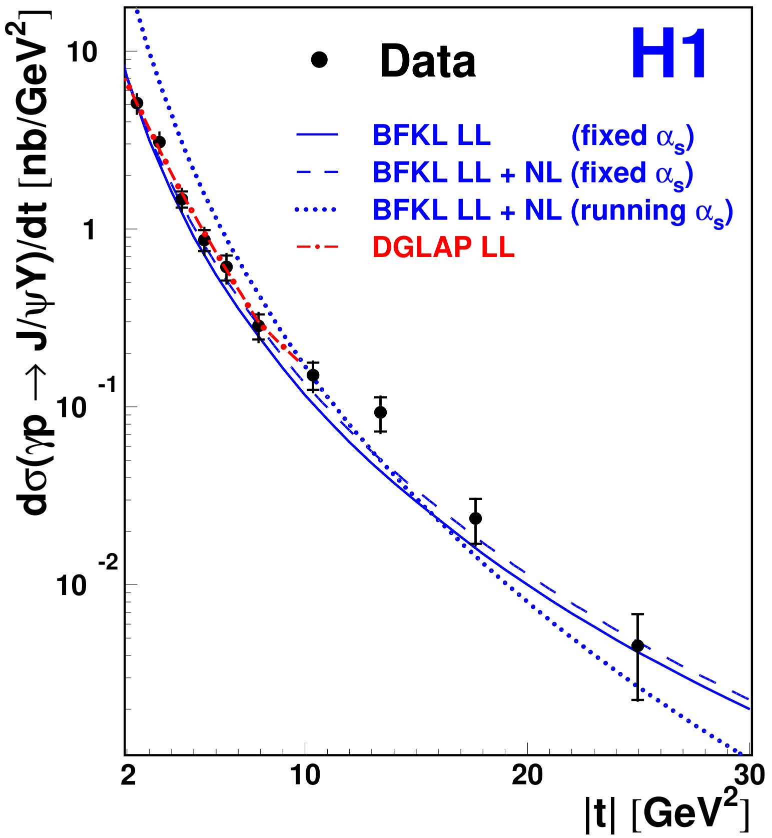


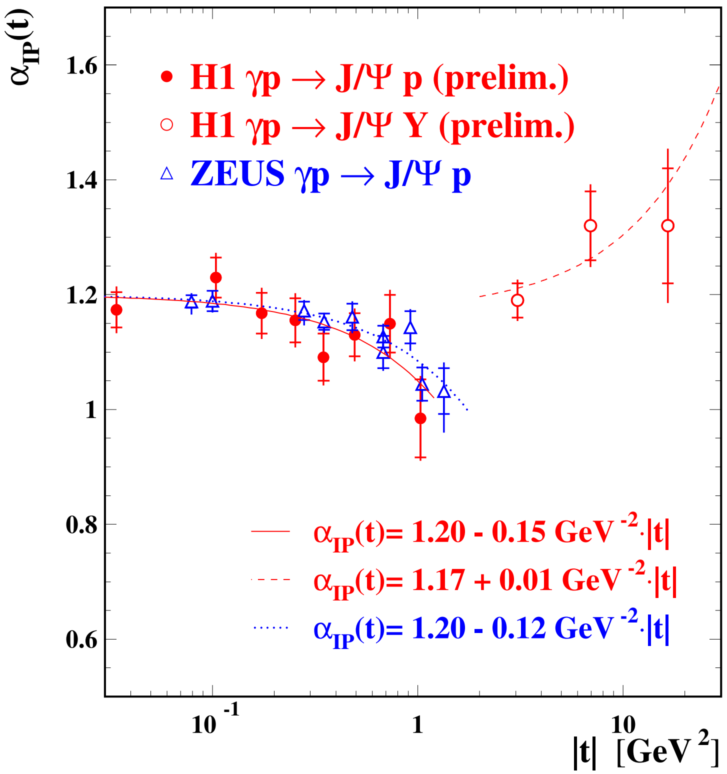


Hard energy dependence $\sigma \sim W^{0.70\pm0.08}$

Some shrinkage: $\alpha' = 0.15 \pm 0.06\,\mathrm{GeV}^{-2}$

High $|t|$ Diffractive J/ψ Photoproduction





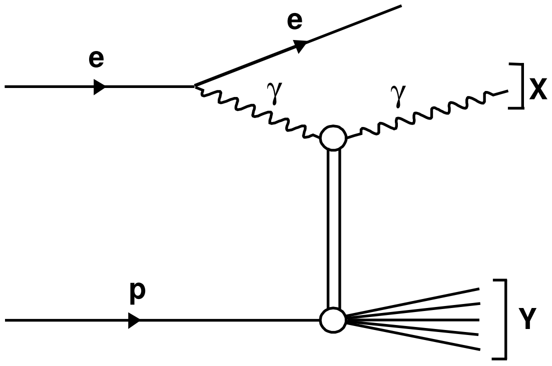
Unprecedented t range for VM

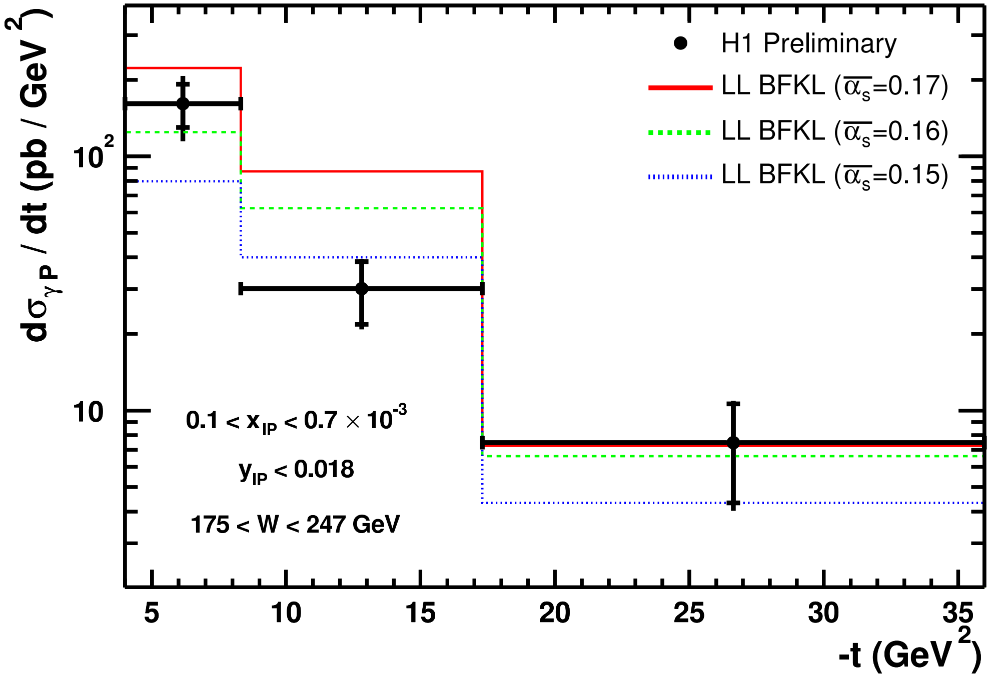
BFKL and DGLAP models describe most aspects of data

Trajectory incompatible with low $|t|$ elastic J/ψ

Evidence for new low x dynamics?

Diffractive Photoproduction of Photons at high $|t|$



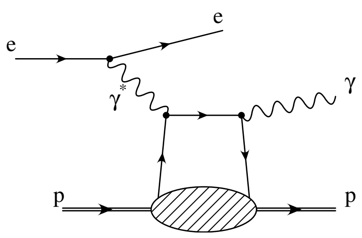


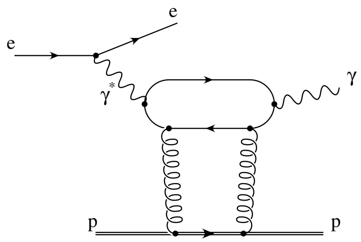
First observation of new process

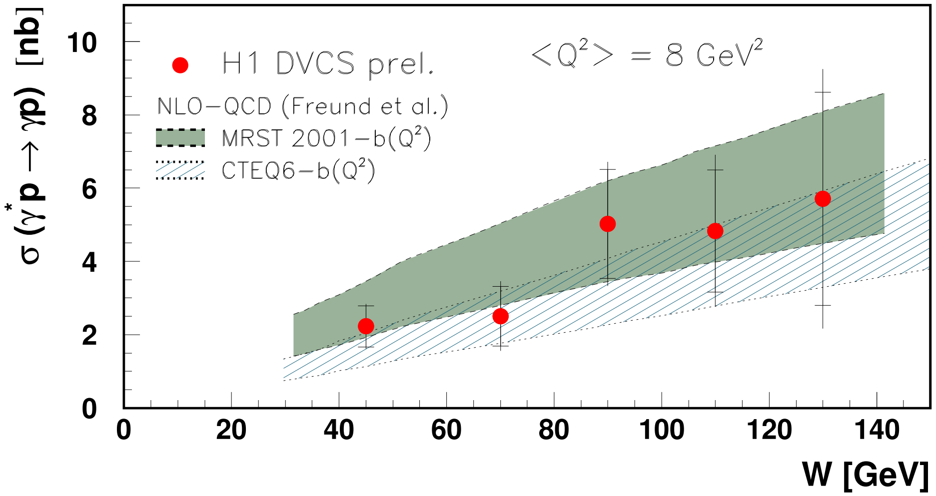
Lower statistics than high $|t|$ J/ψ, but no uncertainty due to VM wavefunction

Data reasonably described by LL BFKL model with reasonable $\bar{\alpha_s}$

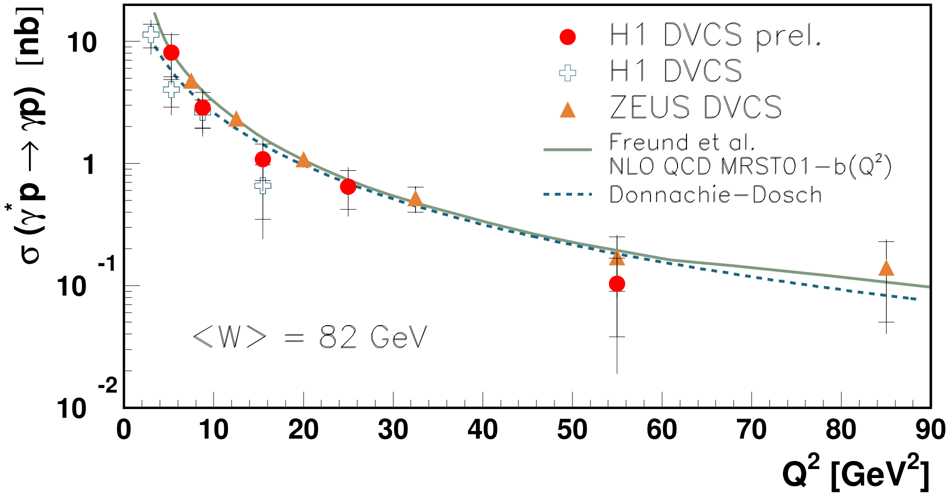
Deeply Virtual Compton Scattering







New measurement $\to$ higher Q^2



Leading twist NLO calculation using

GPDs (Freund, McDermott)

Data described with $\mathrm{d}\sigma/\mathrm{d}t \sim e^{bt}$,

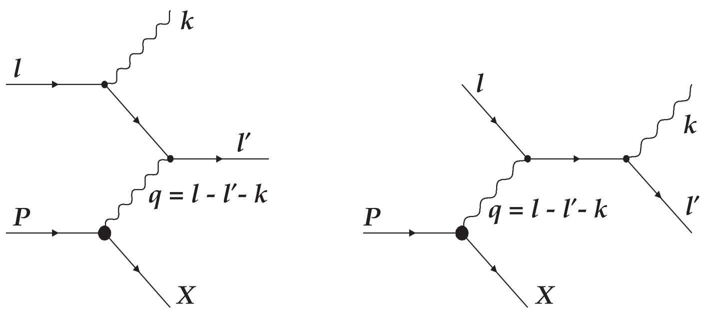
$b = 7[1 - 0.15\log(Q^2/2)]\ \mathrm{GeV}^{-2}$

parameterised from ρ data

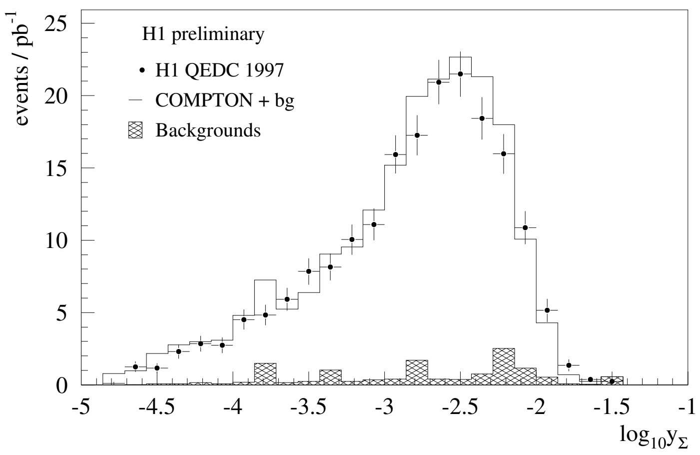
Sensitivity to choice of GPD

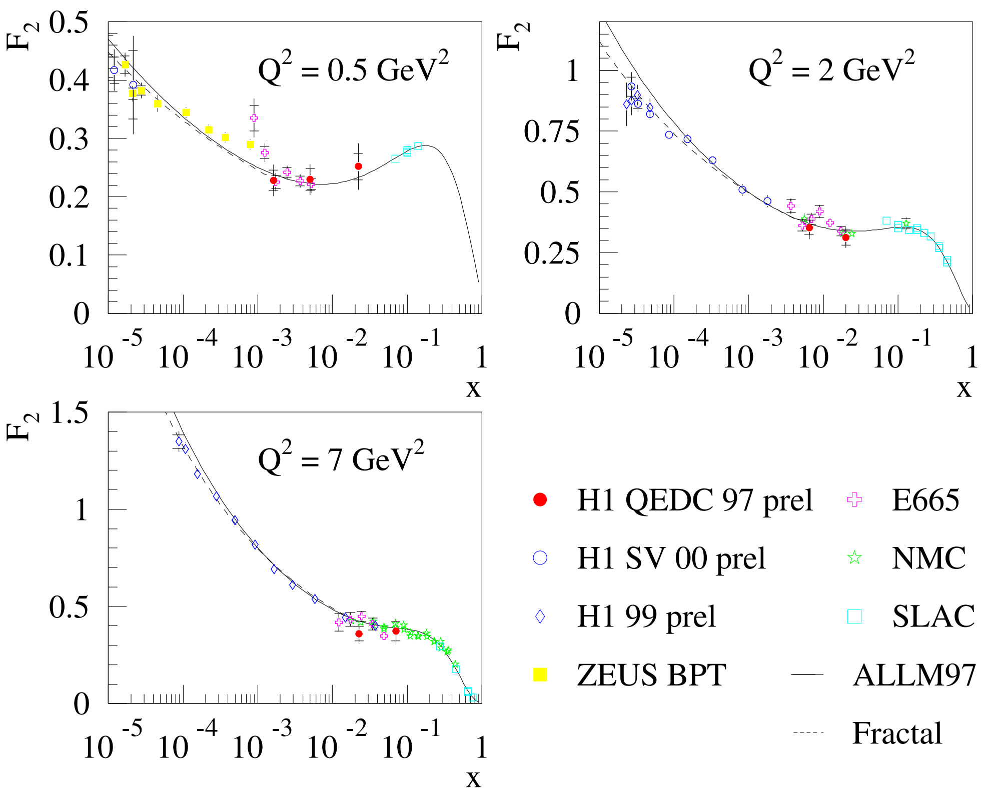
HERA measurements consistent

F_2 at High x, but Low Q^2

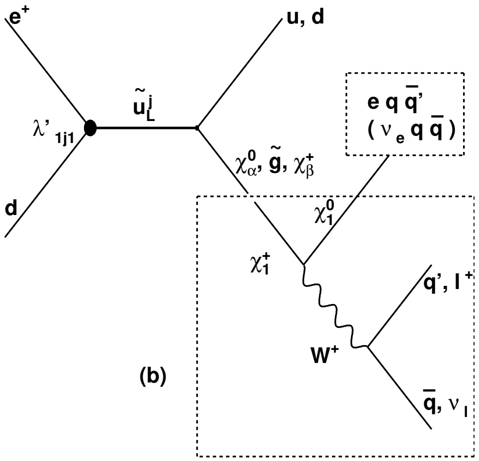


Use QED-Compton events and new models for the low W region



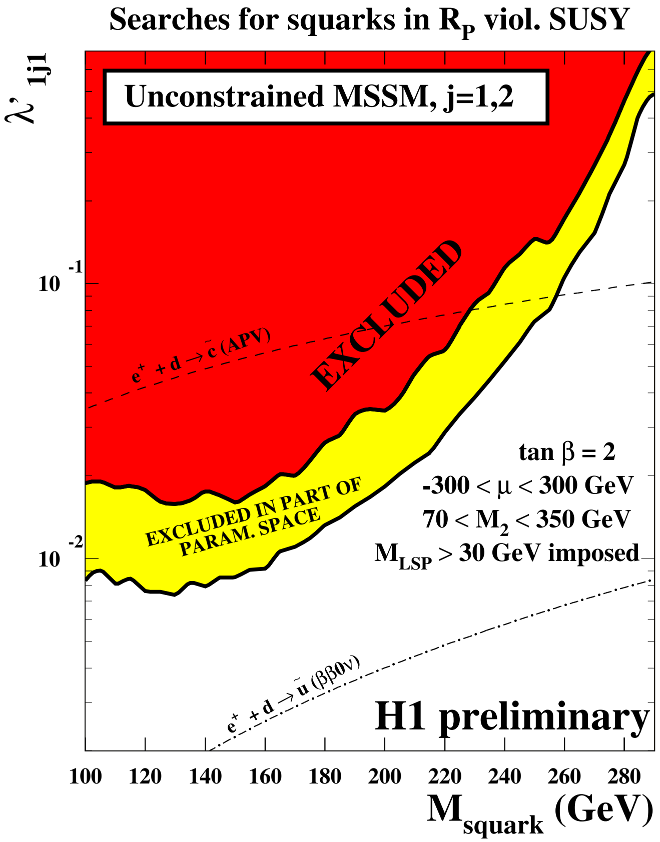


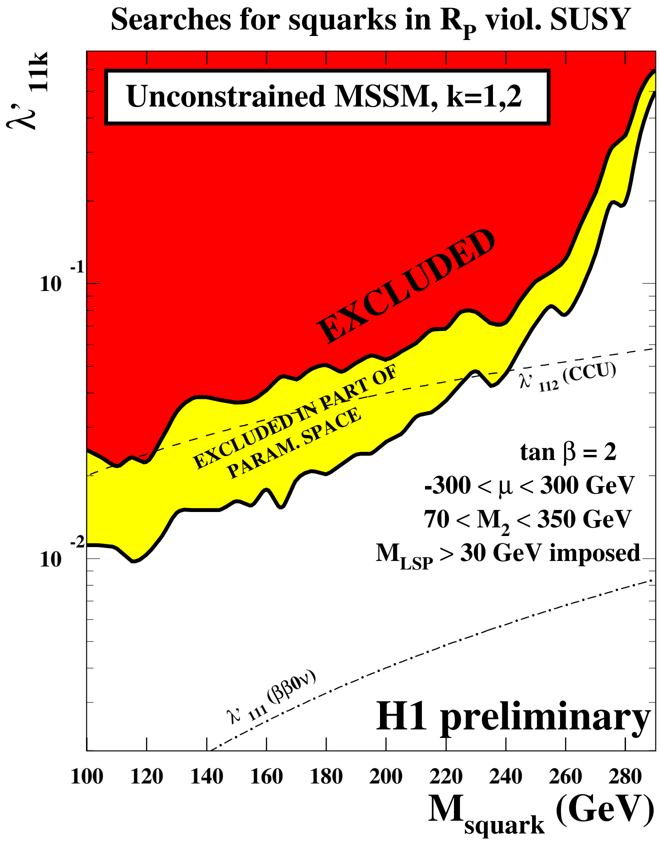
Search for $\tilde{q}$ in $\not{R}_p$ Supersymmetry



e.g. $e^+d \rightarrow \tilde{u}_L \ldots$

e.g. $e^-u \rightarrow \tilde{d}_R \ldots$





Study several

leptons + jets channels

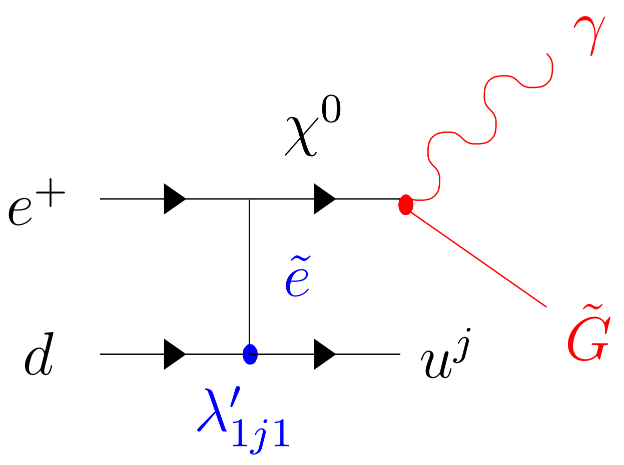
No significant

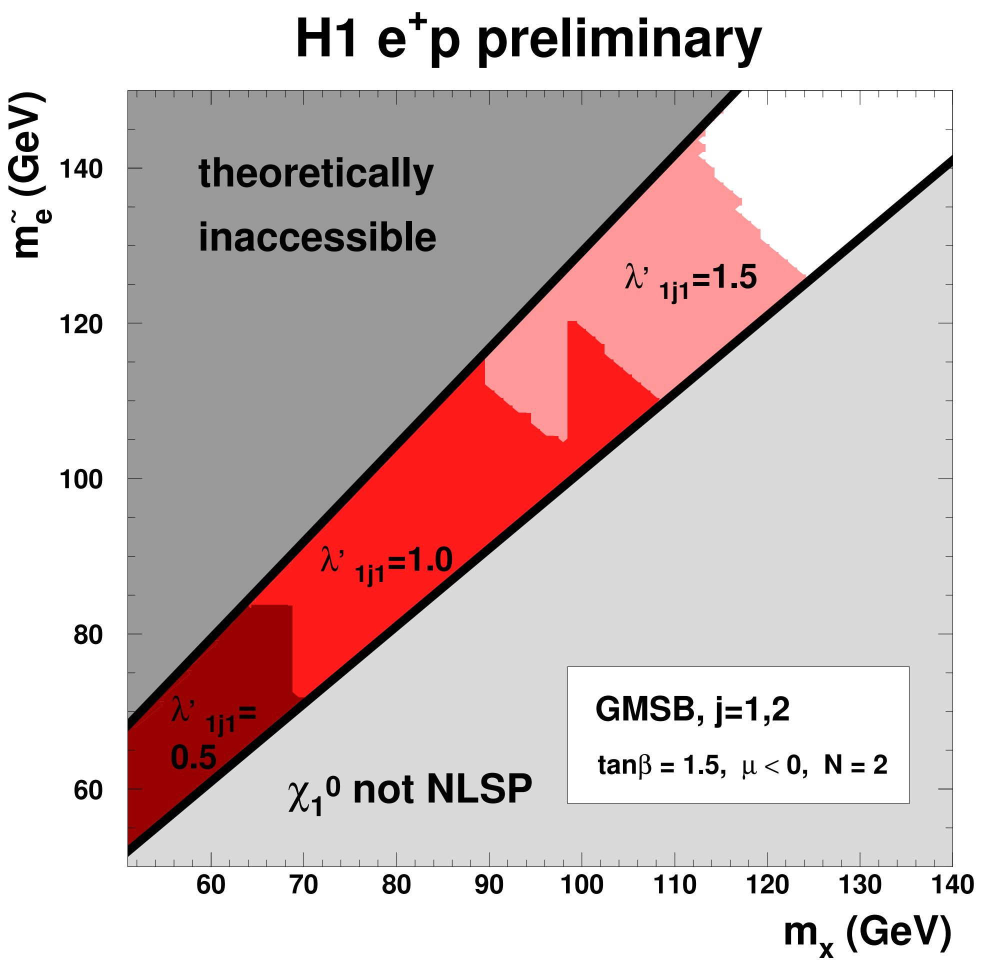
deviations from

expectations

$m_{\tilde{q}} < 275\ \mathrm{GeV}$ excluded in large part of parameter space for λ' of electromagnetic strength

Search for Superlight Gravitino



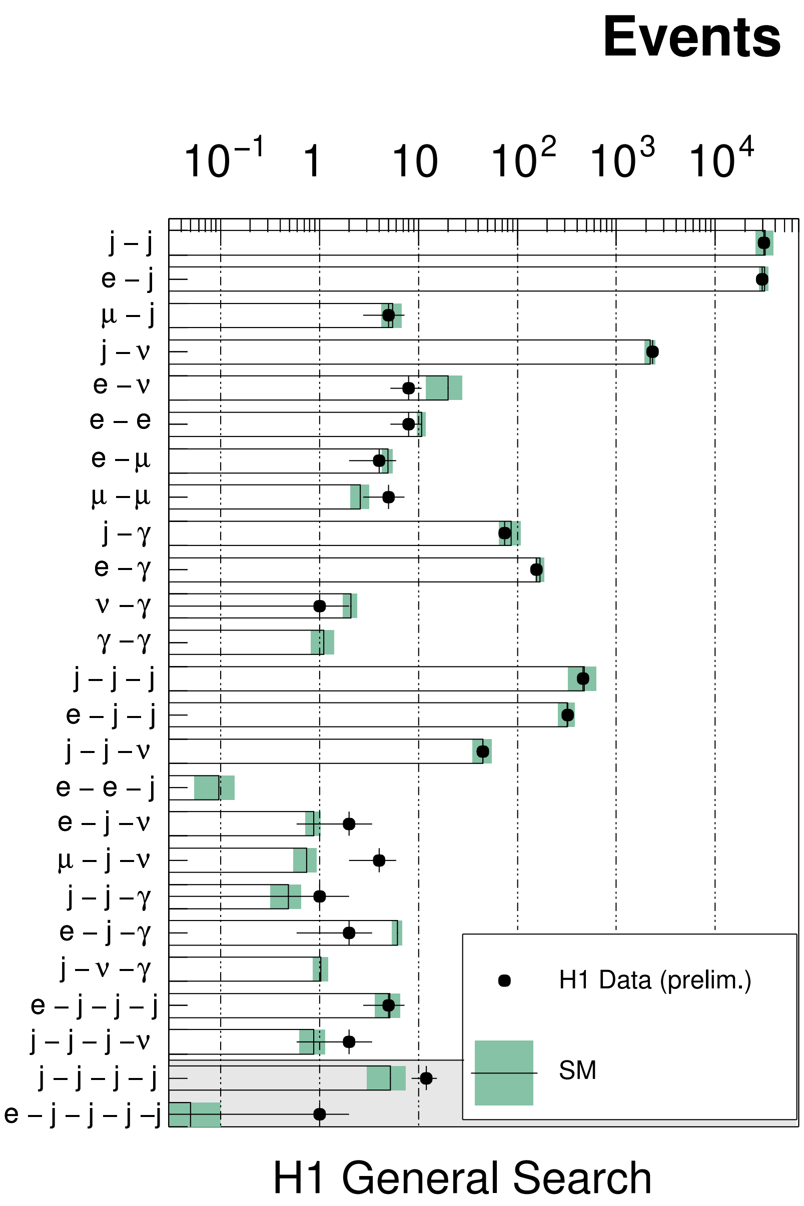


If $\tilde{G}$ is LSSP, produce $\tilde{\chi}^0$ via $R\!\!\!/_p$ t-channel exchange of $\tilde{e}$. Then $\chi^0 \rightarrow \tilde{G}\gamma$

Signature $\gamma + p_T^{\rm miss}$

Limits set in GMSB scenario

General Search for New Physics



How compatible is H1 data with the Standard Model overall?

Investigation of all multi-object final states with $j, e, \mu, \gamma, p_T^{miss}$ ...

...isolated

... $p_T > 20$ GeV

... $10° < \theta < 140°$

23+2 channels!

Compare with Standard Model up to $\mathcal{O}(\alpha_s)$+PS in QCD (many MC's!)

Impressive agreement for most channels

Differential Analysis in Σp_T and M_{all}

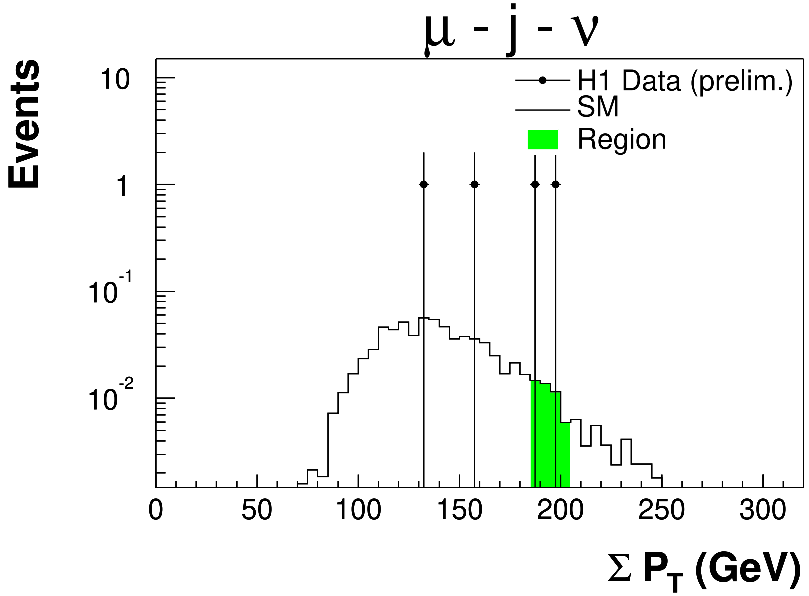
Novel statistical algorithm to quantify level of agreement . . .

For each channel, scan all possible connected regions in Σp_T and M_{all} to find most significant deviation

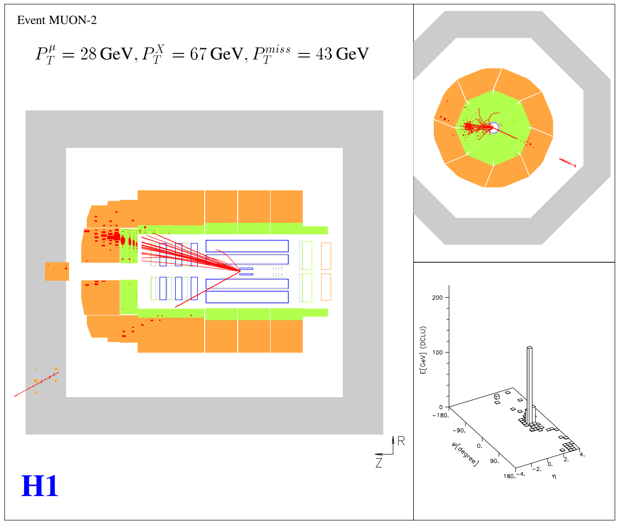
Use MC experiments to determine probability $\hat{P}$ of finding a more significant excess somewhere in distribution

Most significant effect from Σp_T scan for $\mu j \nu$ events . . .

Corresponds to already reported "isolated leptons with missing p_T" channel



$e^+p \rightarrow \mu^+X$



Overall Compatibility with Standard Model

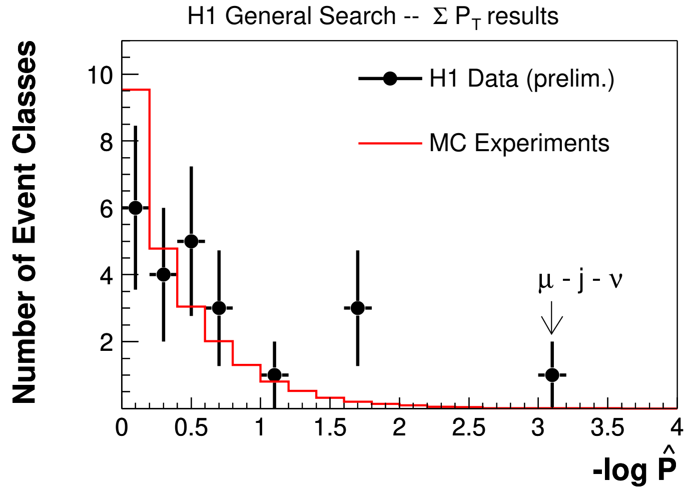
Probability of isolated lepton excess at high p_T was estimated at 10^{-3}

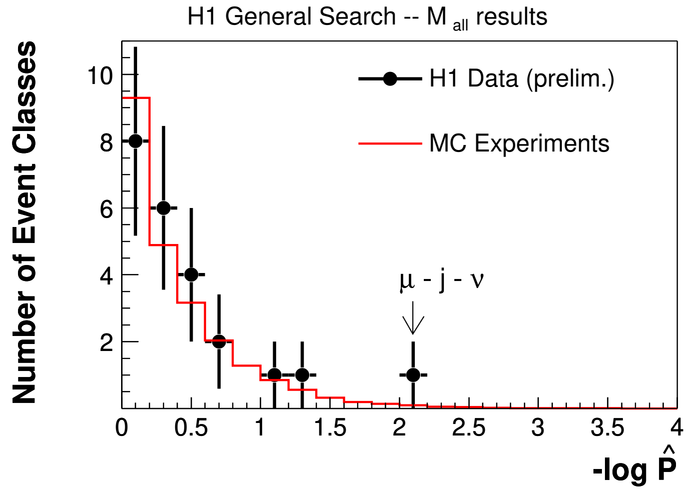
Probability that one of the 23 studied channels would give a more significant excess in $\Sigma p_T \sim 2\%$

For $M_{\rm all}$ analysis, 25% probability for larger excess

. . . Analysis confirms existing excess

No new deviations found





Summary

- Many new H1 results for EPS03 - HERA-I analysis still going strong!
  - Final HERA-I results in many areas
  - Old topics revisited with improved precision
  - Extended kinematic range
  - Several new and completely original topics
- Significant contributions to several areas of our field
  - Competitive sensitivity to new physics
  - Improved parton densities and tests of QCD
  - Unique constraints on low x Physics

Thanks and Congratulations to all in H1 who worked on the new data!