JETS IN ep AND γp INTERACTIONS AT HERA

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on behalf of ZEUS H1

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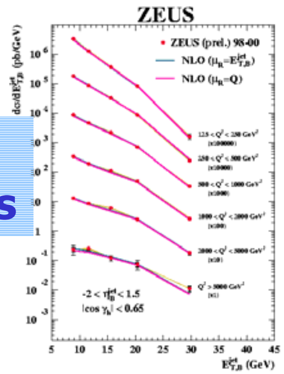
Warsaw University

PHOTON2005
31.08-4.09.2005, Warsaw

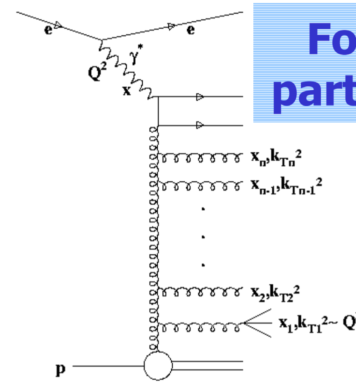
MOTIVATION AND OUTLINE

... from "simple" to more and more complex

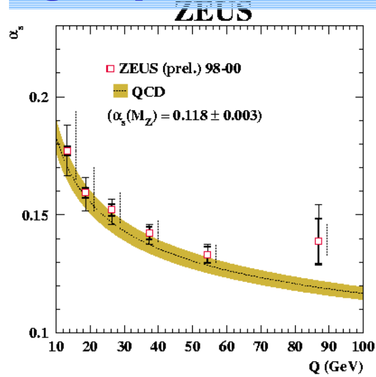
Cross-section measurements

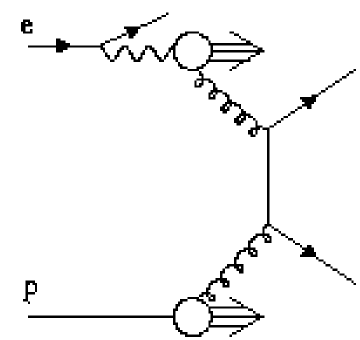


Forward jets, parton evolution



Extraction of QCD parameters





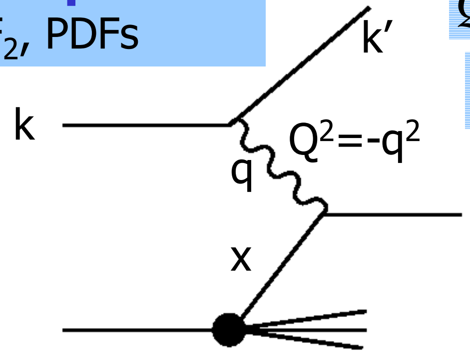
Jets at low Q^2,x Photon structure

I will mainly concentrate on new results since ICHEP04.

JET PHYSICS AT HERA

The basic processes, kinematics

QPM process
→F_2, PDFs



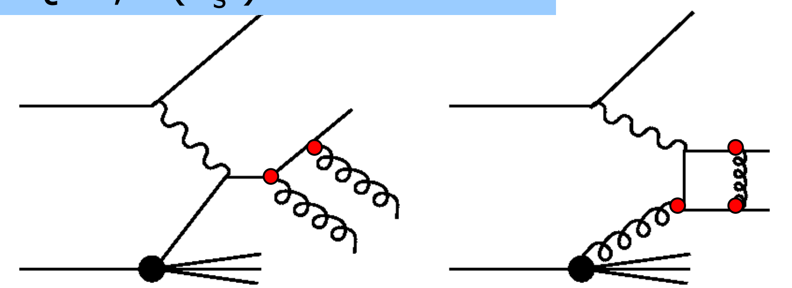
$$Q^2 = -(k-k')^2$$

$$x = Q^2/2Pq$$

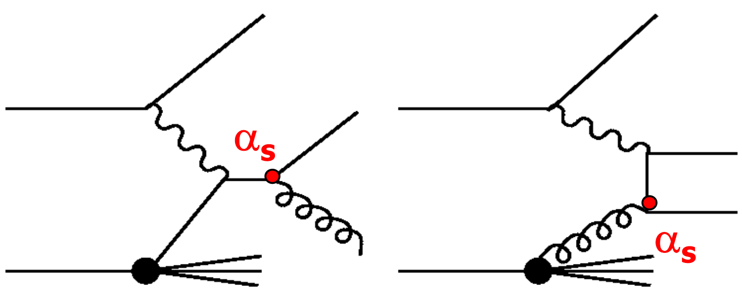
$$y = 1 - E'/E$$

$$Q^2 = xys$$

Real+virtual corrections:
NLO QCD, O(α_s^2)

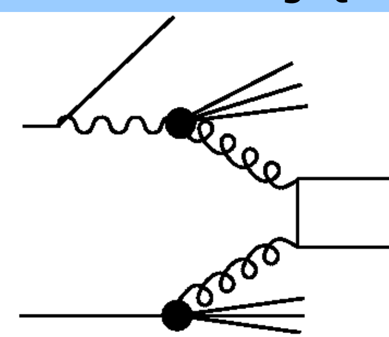


QCD-C and BGF processes:
Leading-order QCD, O(α_s).



$$\sigma \sim \hat{\sigma}_{\gamma i} \otimes f_{i/p}$$

Resolved photon contributions:
Suppressed with increasing Q^2



$$\sigma \sim f_{i/\gamma} \otimes \hat{\sigma}_{ij} \otimes f_{j/p}$$

JET ANALYSES AT HERA

General comments

- **Jet reconstruction and analyses**
  - almost always with inclusive $k_\perp$ algorithm on calorimeter cells or energy flow objects (cells+ tracks ➔ improved resolution).
  - DIS analyses mostly performed in Breit frame → select events with QCD coupling.
  - Data correction using LO MC models (acceptance, efficiency, hadronisation, QED)

- **Main experimental uncertainty: hadronic jet energy scale:**
  - know to between 1-3%! Typical effect on measurements: 5-10%.

- **Theoretical predictions for jet physics at HERA:**
  - LO MCs + models for parton radiation (PYTHIA, RAPGAP, ARIADNE): good for soft, small-angle phenomena, does not provide normalisation, includes detector simulation, hadronisation etc.
  - Fixed-order QCD calculations (up to NLO, DISENT, JetViP, FMNR etc.) describes hard physics well, no hadronisation, detector simulation, QED effects
- **Theoretical uncertainties dominate many measurements.**

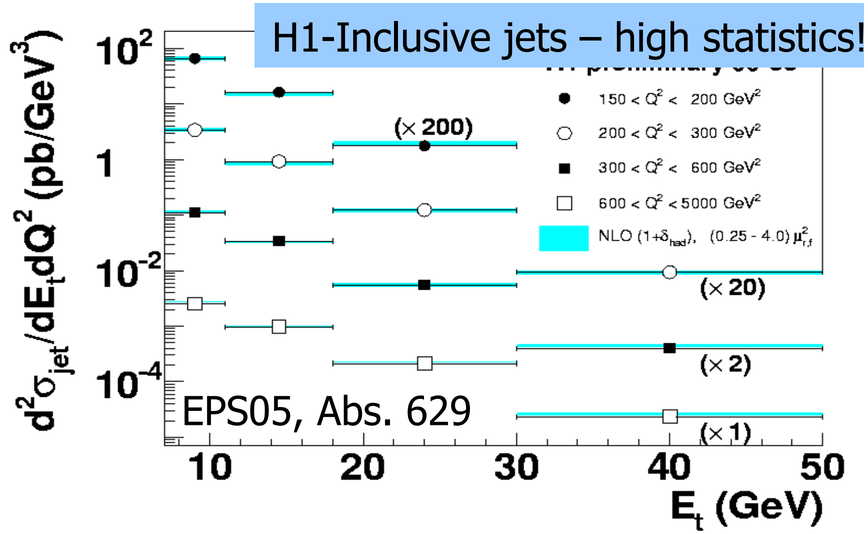
INCLUSIVE, 2, 3 JETS AT HIGH Q^2

Well understood phase-space with high scales → pQCD!

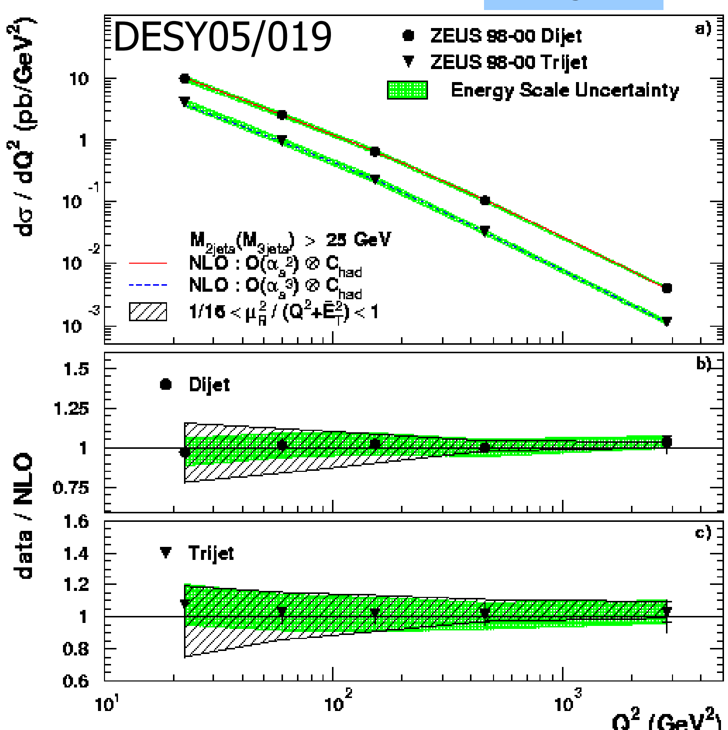
Typical scenario:

-- $Q^2 > 125$ GeV^2, $E_{T,jet} > 8$ GeV
-- Measurements dominated by theoretical uncertainties (scale)!
-- Full HERA-I data sets (80-120pb^{-1})

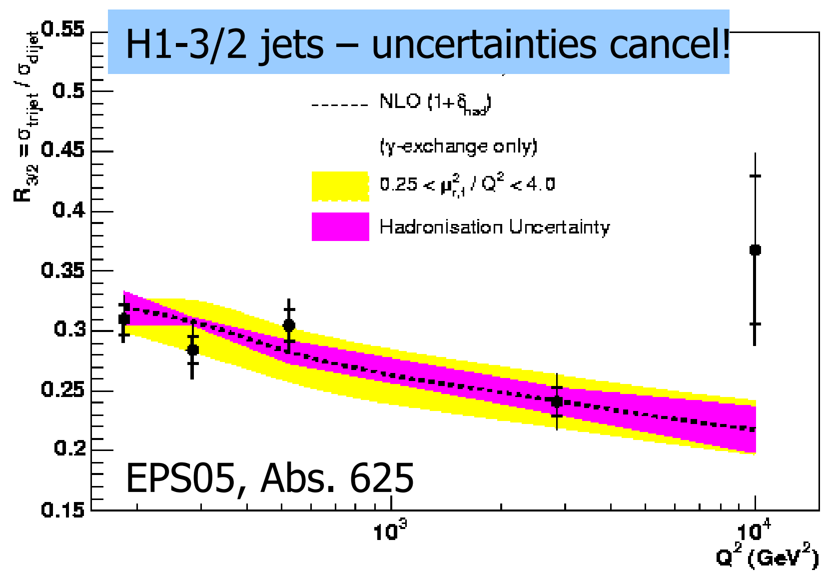
H1-Inclusive jets – high statistics!



ZEUS 2,3 jets



H1-3/2 jets – uncertainties cancel!



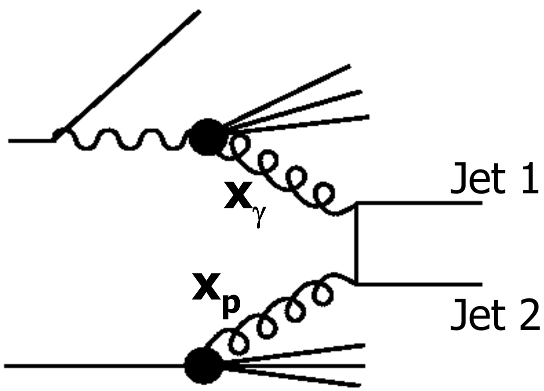
2 JETS IN PHOTOPRODUCTION (H1)

Further constraining the PDFs?

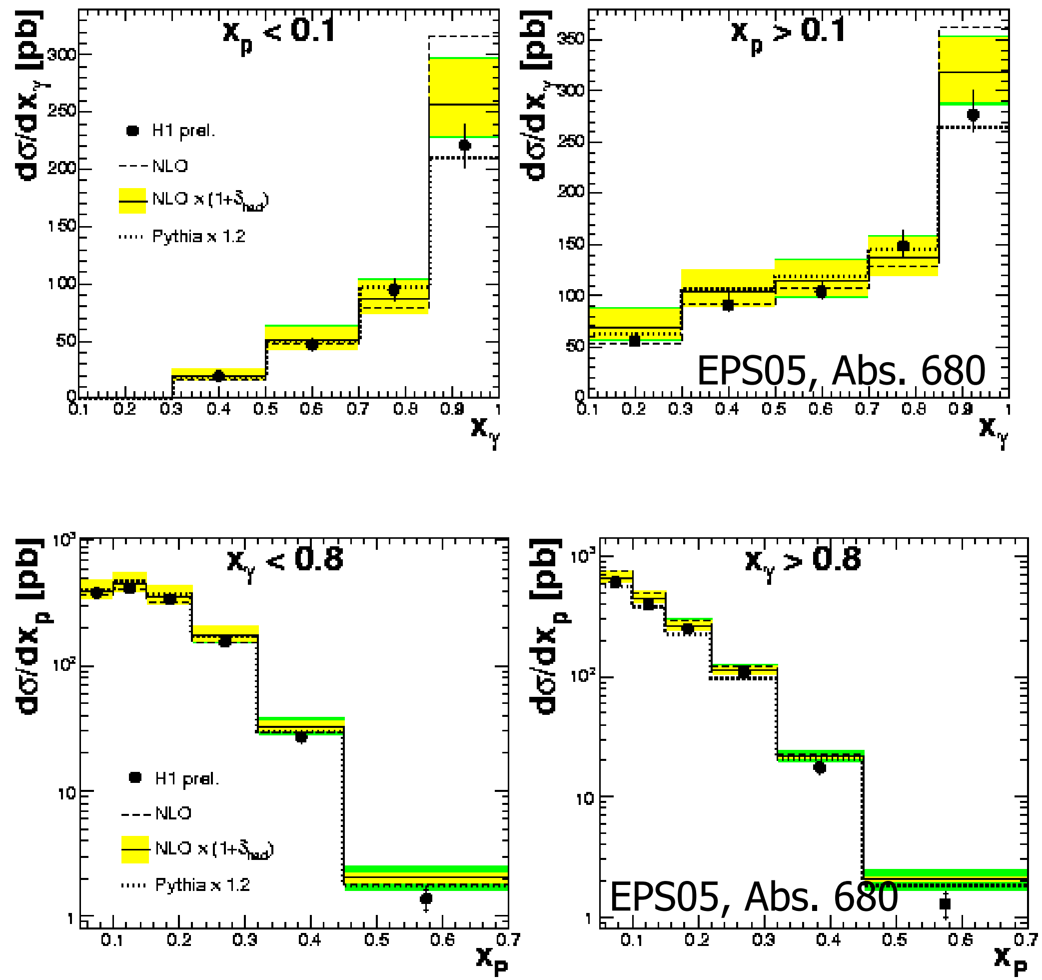
Emphasis on x_γ and x_p:

➔ learn something about PDFs, especially gluon at high x

$$x_\gamma = \left(\sum_i E_{T,i} \exp(-\eta_i)\right) / 2yE_e$$



$$x_p = \left(\sum_i E_{T,i} \exp(+\eta_i)\right) / 2E_p$$



Good description of data over wide kinematic range by both the MC and NLO calculation.

Data give access to proton PDF (used by ZEUS in QCD fits)

α_s FROM JETS AT HIGH Q^2

The Method

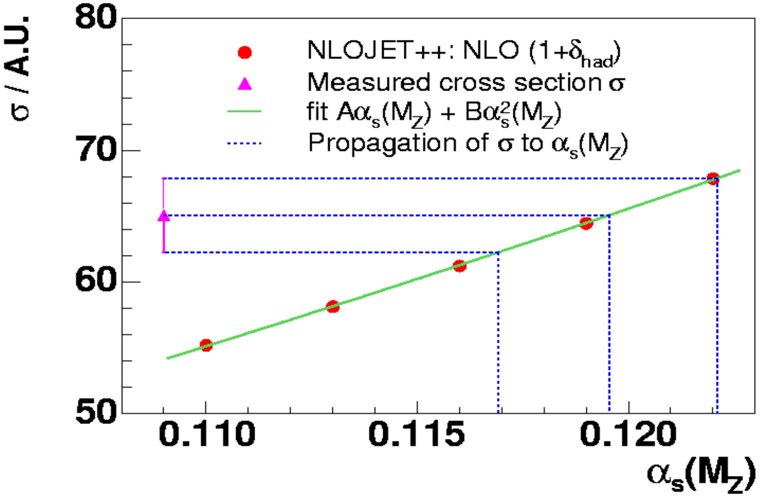
- **Determine dependence of cross-section on $\alpha_s(M_Z)$ in each bin using NLO calculations with different input $\alpha_s(M_Z)$ values.**
  -- use, for example, MRST or CTEQ4 (3/5 different α_s values, 0.110 to 0.122).

- **Functional dependence on $\alpha_s(M_Z)$ then approximated by the function**

$$\sigma_i(\alpha_s(M_Z)) = A_i \cdot \alpha_s(M_Z) + B_i \cdot \alpha_s^2(M_Z)$$

  -- A_i, B_i determined in the fit.

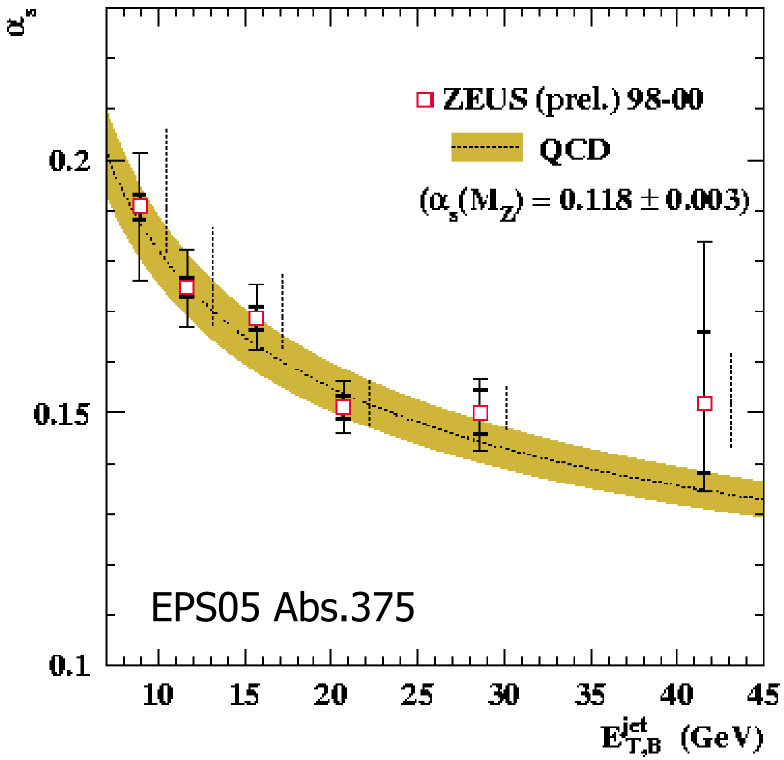
- **Use function to map measured cross-section to value of $\alpha_s(M_Z)$.**
  - evolve to correct scale
  - combine various data points, using, for example, a χ^2 fit.



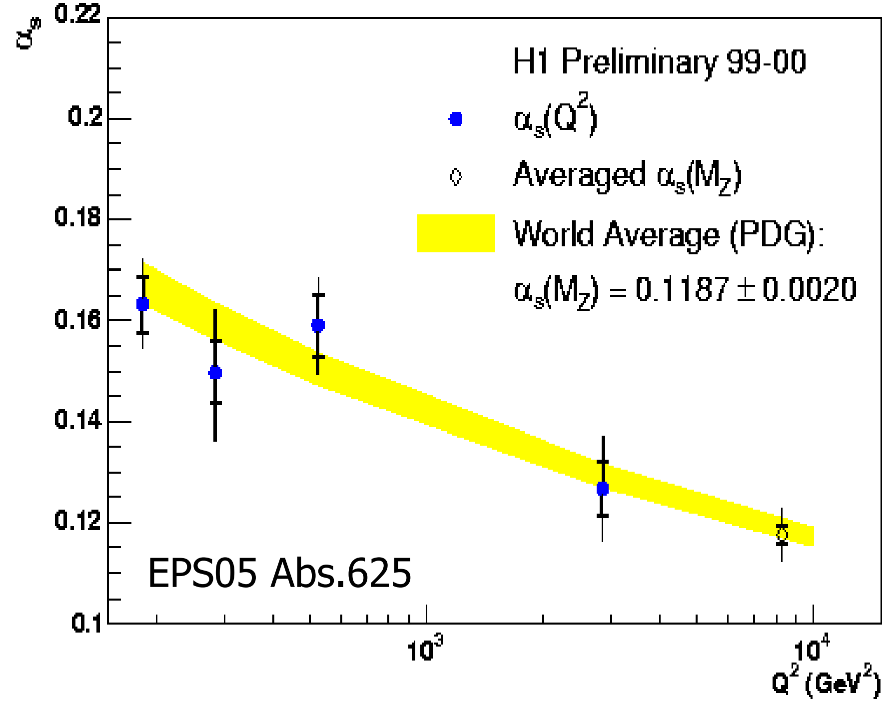
α_s FROM JETS AT HIGH Q^2

Results

α_s from inclusive jets:
small theoretical uncertainty!



α_s from ratio $\sigma_{3jet}/\sigma_{2jet}$ → some uncertainties cancel out!

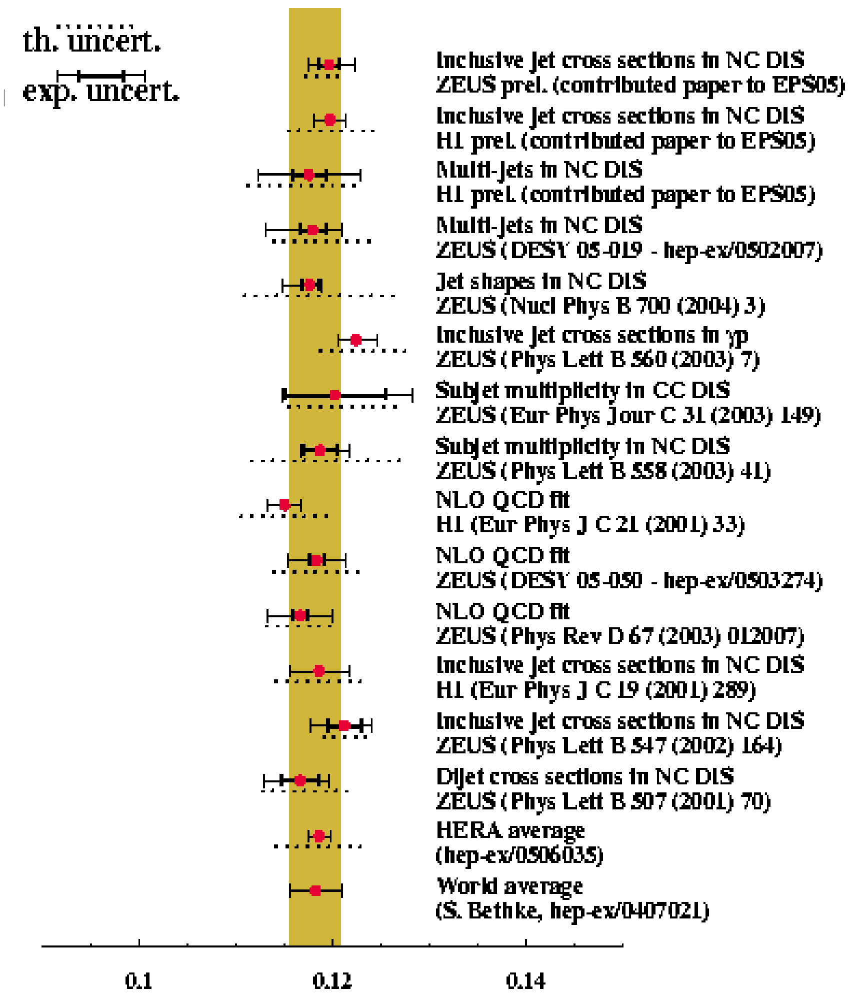


World average: $\alpha_s(M_Z) = 0.1187 \pm 0.0020$
H1 inclusive jets: $\alpha_s(M_Z) = 0.1197 \pm 0.0016(\text{exp}) \pm 0.0047(\text{theo})$
H1 3/2jet ratio: $\alpha_s(M_Z) = 0.1175 \pm 0.0053(\text{exp}) \pm 0.0061(\text{theo})$
ZEUS inclusive: $\alpha_s(M_Z) = 0.1196 \pm 0.0025(\text{exp}) \pm 0.0023(\text{theo})$

Nice agreement!
Errors going down!

α_s FROM JETS AT HIGH Q^2

Summary plots for HERA measurements



(C. Glasman, hep-ex/0506035)

Many consistent results

➔ nice QCD test!

Typical errors:

theoretical: 4-8%

experimental: 3%

HERA average:

$\alpha_s(M_Z) = 0.1186 \pm 0.0011 \pm 0.0050$

Ratio $\sigma_{exp}/\sigma_{theo}$:

0.0011 / 0.0050 !!!!

Errors of world / HERA average are becoming comparable!

GLOBAL QCD FITS

Supplement inclusive F_2 data to improve on q(x), xg(x)

- **Usual global QCD fits:**
  Only inclusive input data ➔ large uncertainty in gluon density at high x (basically only constrained by Tevatron jets data): 15% at x=0.3, 200% at x=0.5.

- **Jet data sensitive to high x,**
  but use in fits difficult (CPU time: 10h/50M events)

- **Idea: Use grids in x, μ_F^2 in which PDFs are approximately flat:**

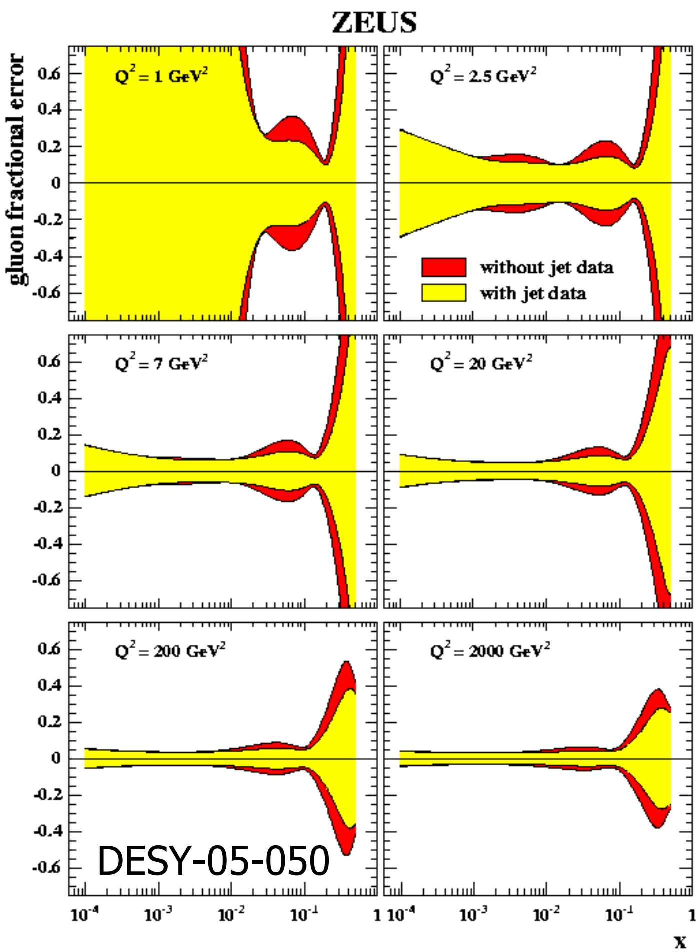
$$\sigma = \sum_{m=1}^{2} \alpha_s^m(\mu_r) \sum_{a=-5}^{5} \int dx \cdot f_a(x, \mu_f) \cdot \hat{\sigma}(x_{Bj}/x, \mu_r, \mu_f)$$

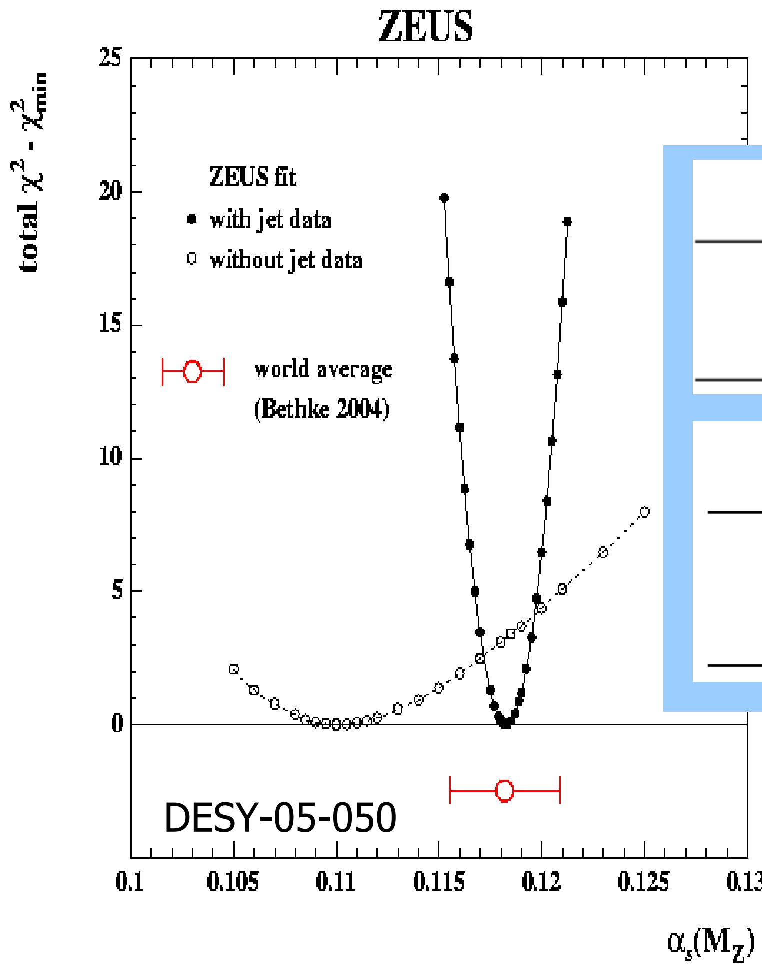
$$\sim \sum_{m=1}^{2} \alpha_s^m(\mu_r) \sum_{a=-5}^{5} \sum_i \sum_j f_a(x_i, \mu_{f,j}) \cdot \int dx_i \cdot \hat{\sigma}(x_{Bj}/x_i, \mu_r, \mu_{f,j})$$

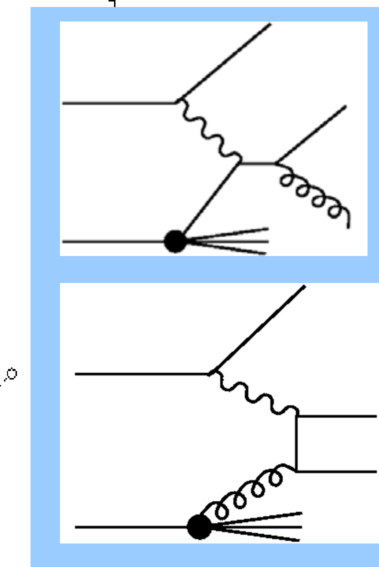
- **Derivation of total cross-section:**
  Sum over PDF × pre-calculated integrals over matrix elements for all x, μ_F^2 bins.
  ➔ calculation time reduced from 10h to 0.01s ➔ usable in fits!!!

GLOBAL QCD FITS

Results, comparison with H1, extraction of strong coupling







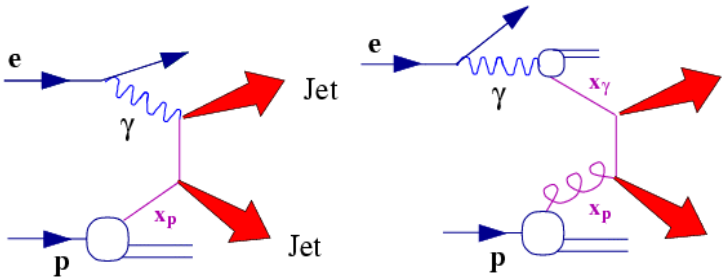
Large effect on gluon density at medium / high x – even with limited HERA1 data.

Great improvement of value and error! Problem: Correlation of xg(x) and α_s.

FROM PHOTOPRODUCTION TO DIS

The regime of low Q^2 (and low x)

- **For $E_T^2 > Q^2$ parton "resolves" hadronic photon structure**

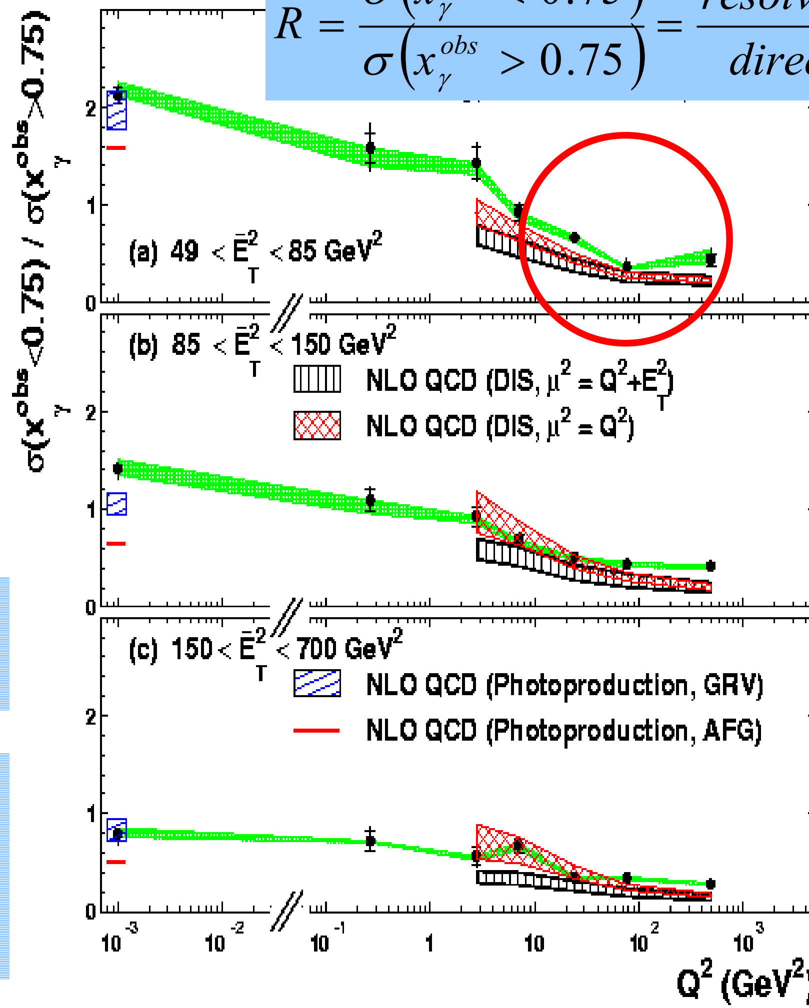


$x_\gamma = 1$ "direct"	$x_\gamma < 1$ "resolved"

- ZEUS (DESY-04-053): Quantify amount of resolved photon as function of Q^2, E_T!

- γp NLO fine; MC+PS+resolved okay!
- Resolved relevant for $Q^2 > 100\ \mathrm{GeV}^2$. Question of renormalization scale?

$$R = \frac{\sigma\left(x_\gamma^{obs} < 0.75\right)}{\sigma\left(x_\gamma^{obs} > 0.75\right)} = \frac{resolved}{direct}$$

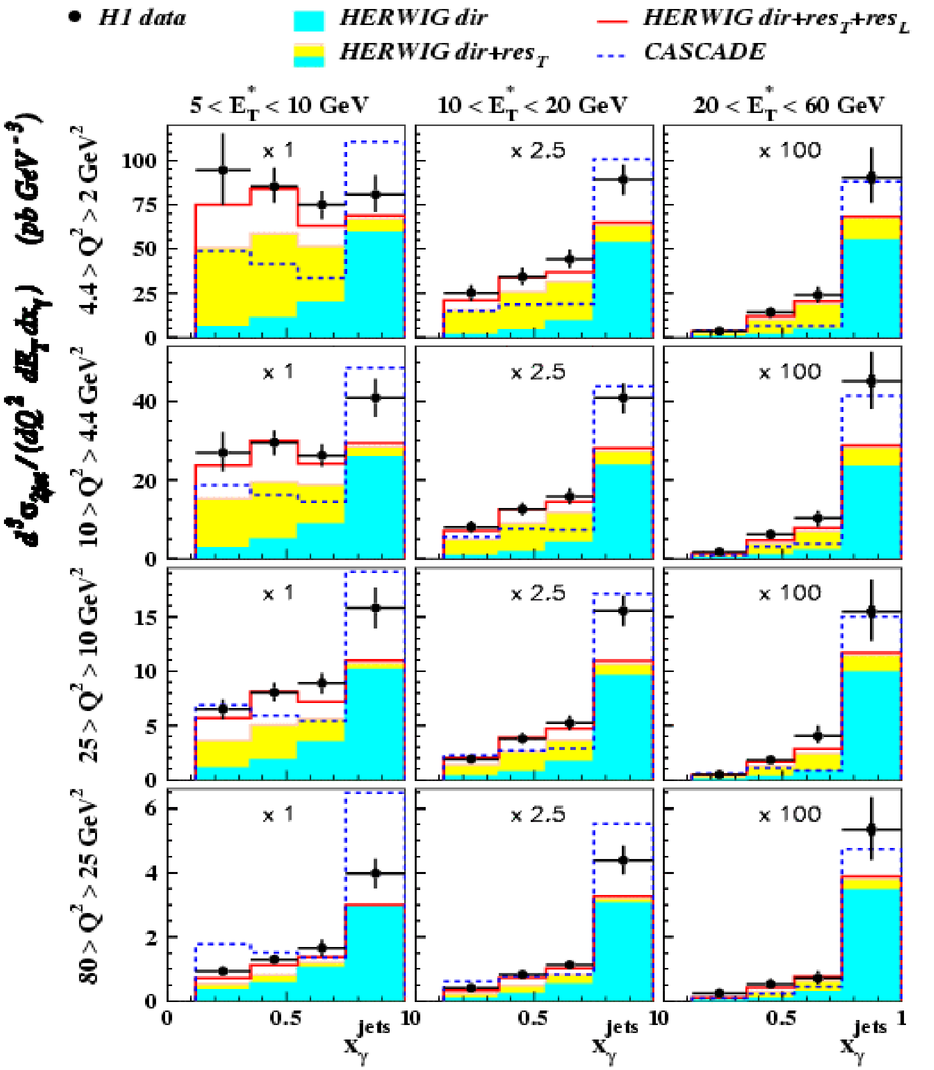


FROM PHOTOPRODUCTION TO DIS

The regime of low Q^2 (and low x)

- **H1 triple-differential cross-section in x_γ, Q^2 and p_T**
  -- DESY-03-206
  -- $2 < Q^2 < 80\ GeV^2$.
- Study interplay of Q^2 and E_T^2 **(photon PDF ⇔ proton PDF)**

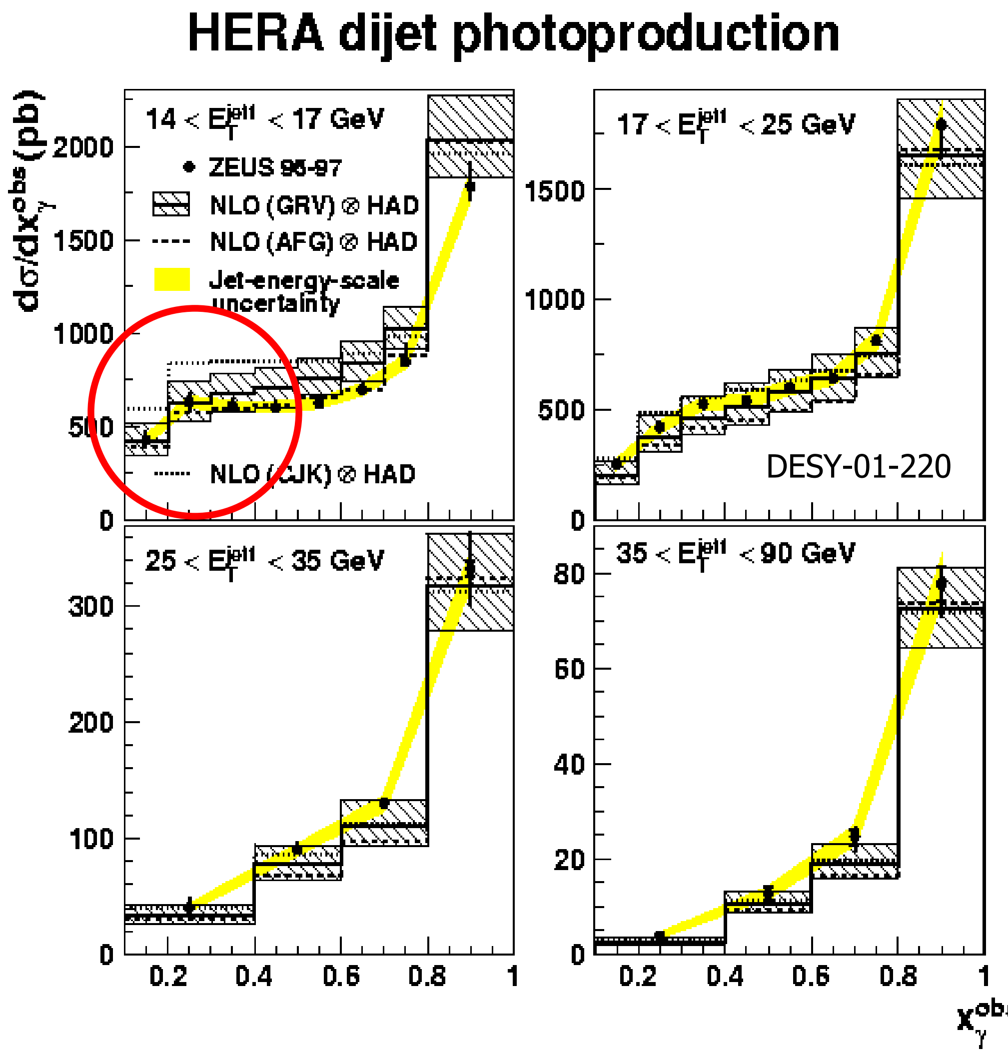
- **Direct AND resolved NLO QCD not enough at low x_γ.**
- In LO MC (HERWIG) need parton shower, direct and resolved photons (longitudinal and transverse polarization).
- CASCADE (CCFM, later) without k_T-ordering best at medium Q^2 (does it mimic resolved contributions?)



PHOTOPRODUCTION JETS

Sensitivity to the photon's PDFs?

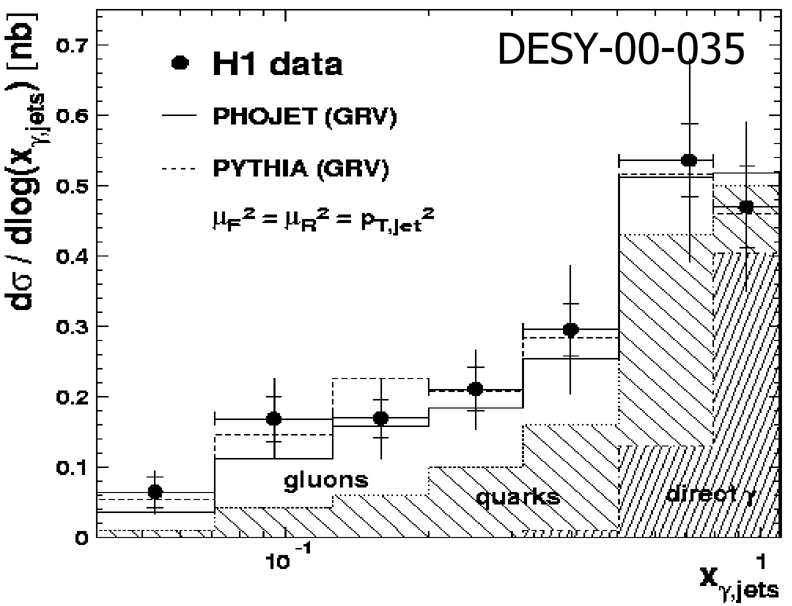
- **ZEUS dijet measurement in photoproduction:** Cross-sections as functions of x_γ in 39pb^{-1} from 1996/97
- For high x_γ (direct!) NLO QCD fine → cross-check of gluon as extracted from DIS analyses.
- At low x_γ and for low E_T^{jet}: **sensitive to γ structure! But difficult to exploit!** (see next slide)



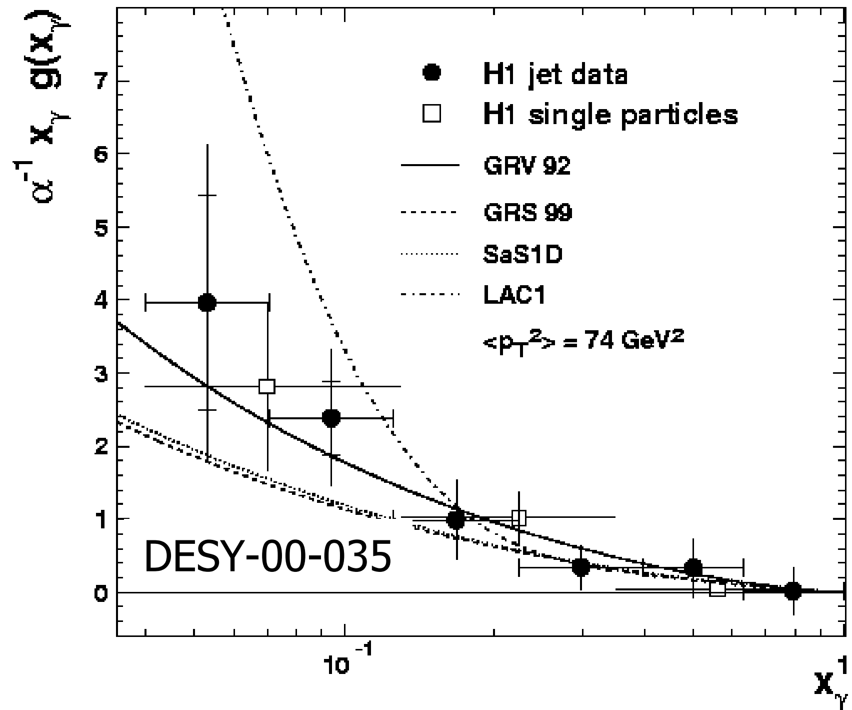
JETS AND PHOTON STRUCTURE

Low E_T jets and the photon's PDFs

- **Low E_T jets (4/6 GeV) sensitive to gluon content in photon.**



- Low E_T: Large contributions from underlying events; soft/hard transition ➔ subtraction procedure.
- Size of correction depends on model! ➔ large uncertainties!



Gluon density in the photon from H1 dijet data in photoproduction:

Agreement with other deter-minations; but very large errors. ➔ Need to improve on this!

FORWARD JETS

Hunting for signs of BFKL evolution

- **DGLAP approximation: Resum terms $\ln Q^2$ for parton evolution**
  ➔ works very well for most of HERA regime (F_2!)

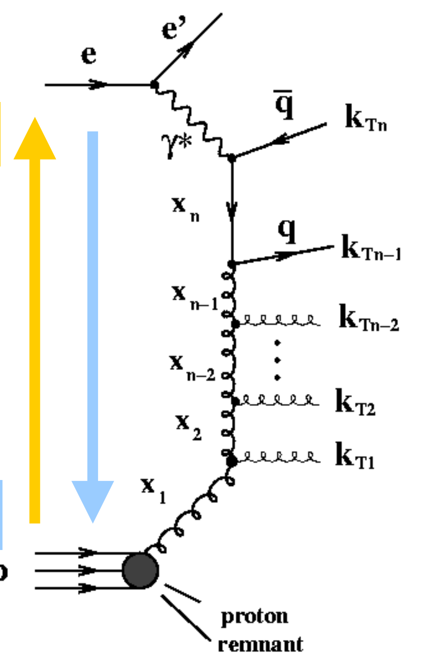
- **breakdown expected at very low x since terms $\ln 1/x$ neglected!**
  -- can we distinguish the onset of BFKL-like evolution?
  BFKL: resum terms $\ln 1/x$; “η democracy”. CDM has BFKL-like features
  CCFM evolution as a bridge between DGLAP and BFKL?

k_T large

DGLAP: k_T ordering!

BFKL: x ordering!

x large



Design phase-space to suppress DGLAP and enhance BFKL:

- forward region: $\eta > 2$ (close to proton)
- jet $E_T^2 \sim Q^2$ (suppressed in DGLAP)
- large $x_{jet}=E_{jet}/E_{proton}$ (realized in BFKL)

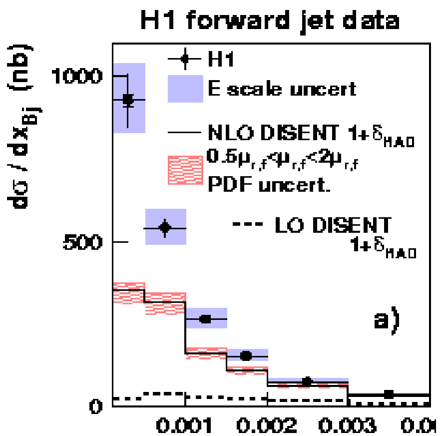
➔ Mueller-Navelet / “forward” jets

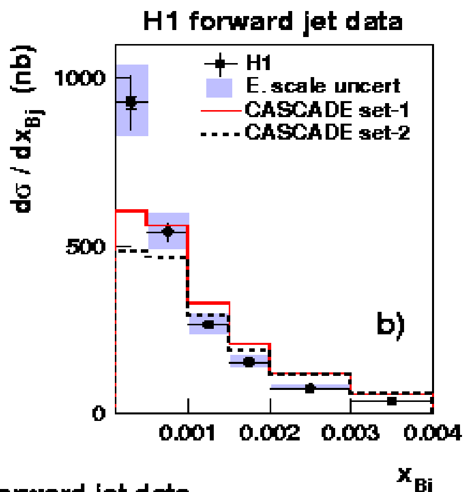
All results: Problems at low x! NNLO? Resolved? Evolution?

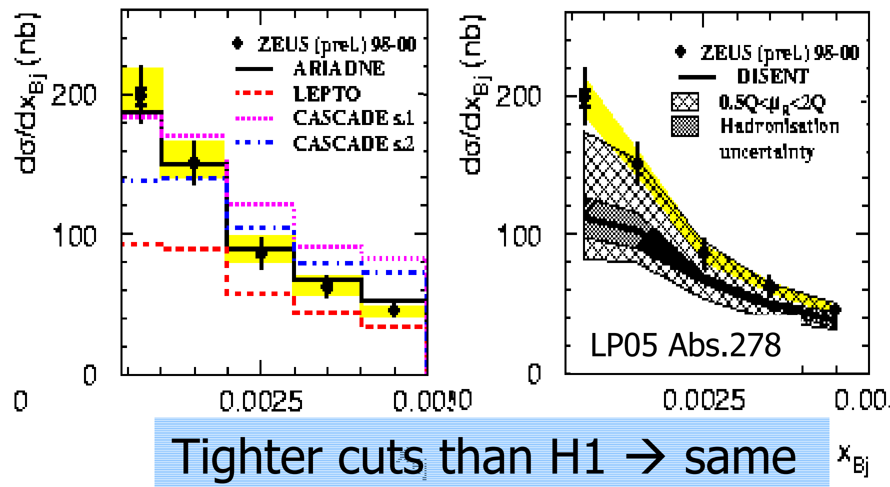
H1 AND ZEUS FORWARD JETS

as functions of x – spot problems in evolution?

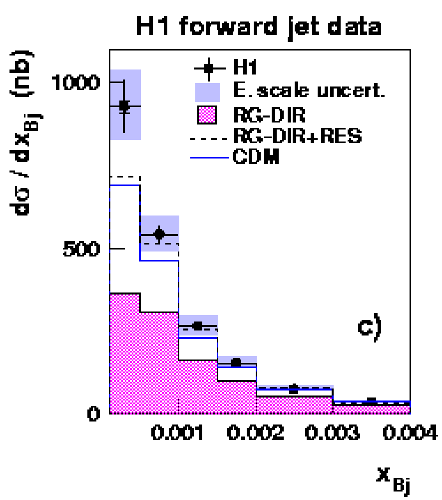
- only 1997 data, $13.7 pb^{-1}$
- $5 < Q^2 < 85$ GeV^2, $\mu_R = E_T$







Tighter cuts than H1 → same statistics from $72 pb^{-1}$. $\mu_R = Q$.



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All models below data at low x.

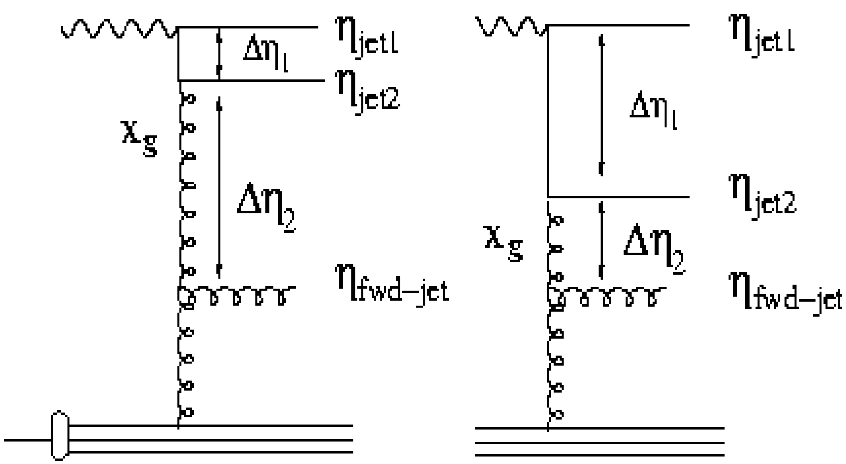
-- CCFM unclear
(PDFs, missing g→qq terms?)
-- resolved photons better
-- ARIADNE/CDM (BFKL-like) good

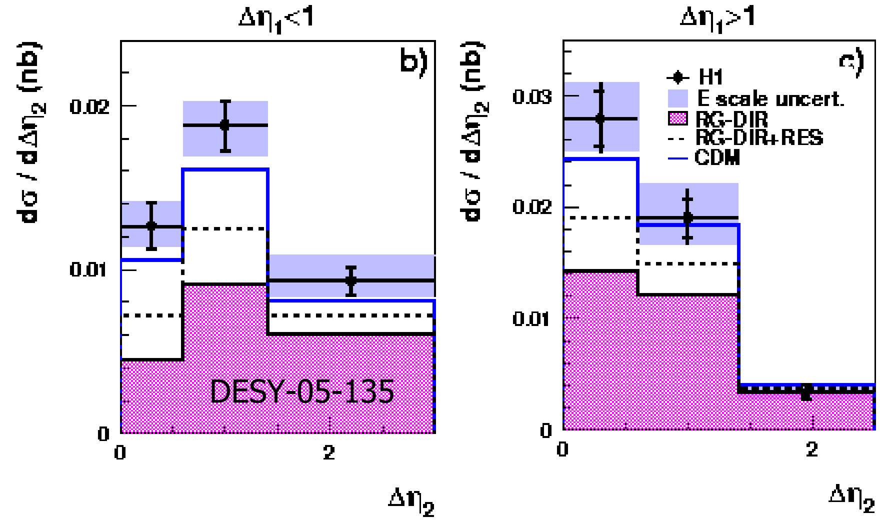
CONCLUSION: UNCLEAR!

FORWARD JET+CENTRAL DIJETS

Further constraining the phase-space (H1)

Request dijets in central detector
(same E_T > 6 GeV for all jets →
no k_T-ordering → DGLAP suppressed):





Choice of $\Delta\eta_1$, $\Delta\eta_2$ selects specific evolution scenarios:
-- $\Delta\eta_2$ small → no PS for BFKL radiation
-- $\Delta\eta_1$ large → BFKL between jet1, jet2?
-- 'BFKL' region: $\Delta\eta_1<1$, $\Delta\eta_2>1$
-- But: correct ordering of jets?

- **resolved LO MC fails!**
- **CDM (BFKL-like) close to data**
- **CCFM does not describe shapes.**

CONCLUSION: UNCLEAR!
But clearly more k_T-unordered necessary than in resolved γ.

SUMMARY AND OUTLOOK

Jet physics at HERA delivers many nice results!

- **Many measurements and QCD tests performed with jets. Interesting areas (transition DIS-photoproduction, forward jets)**

  -- Detailed Xsections and α_s / PDF measurements make jets at HERA a precision QCD laboratory; input crucial for LHC physics (QCD background).

  -- Many analyses contributing to better understanding of QCD fundamentals!

- **Many measurements dominated by theoretical uncertainties; progress relies especially on theoretical advancements:**

  - NNLO: splitting functions already available!
    Effect: More reliable cross-section prediction, reduction of scale uncertainty

  - MC@NLO program (S. Frixione) with NLO matrix elements and parton showers attached already implemented for pp; work on ep has started.
    Effect: Simultaneous description of small-angle and large-angle phenomena; reliable estimates of hadronisation corrections and detector effects.

- **HERA lumi aim until 31/07/2007: 700pb^{-1}; 10$\times$ HERA1 statistics!**

  -- Improve existing measurements and stay open for the unexpected!

NOT COVERED IN THIS TALK

Too many interesting subjects!

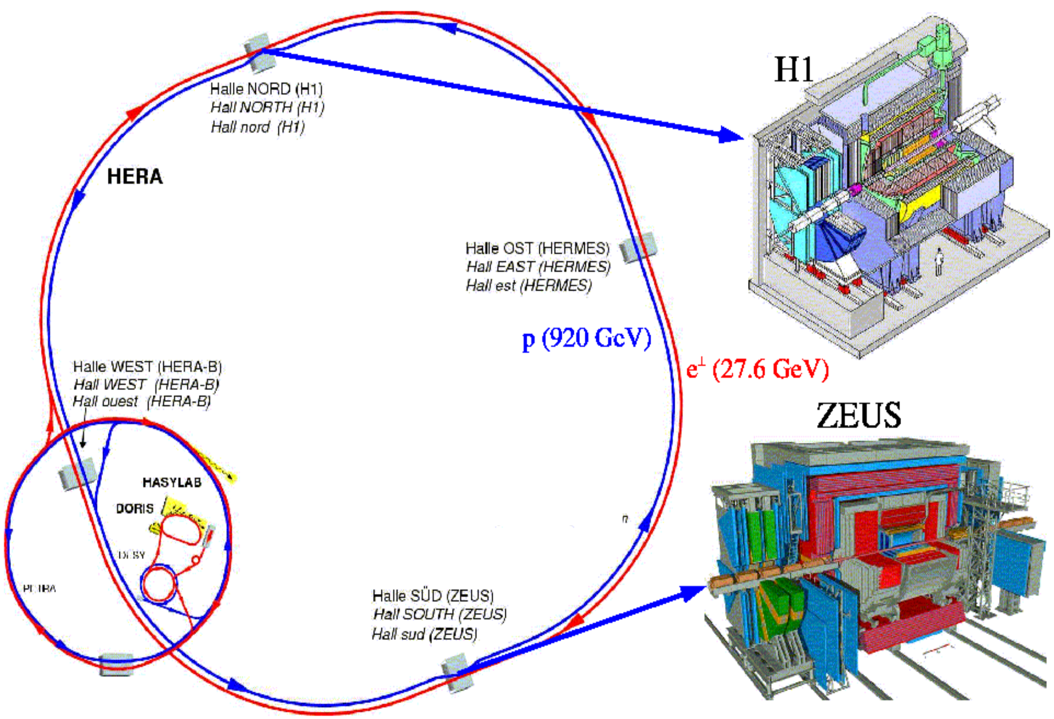
- Subjet measurements in photoproduction (ZEUS) → QCD radiation pattern
- QCD color structure analysis using three-jet angular correlations (ZEUS)
- Interjet energy flow and the question of high-p_T color-singlet exchange (ZEUS)
- Event and jet shapes.
- Forward neutral pions (same questions as for forward jets).
- More results on the hadronic final state (multiplicities etc.).
- …

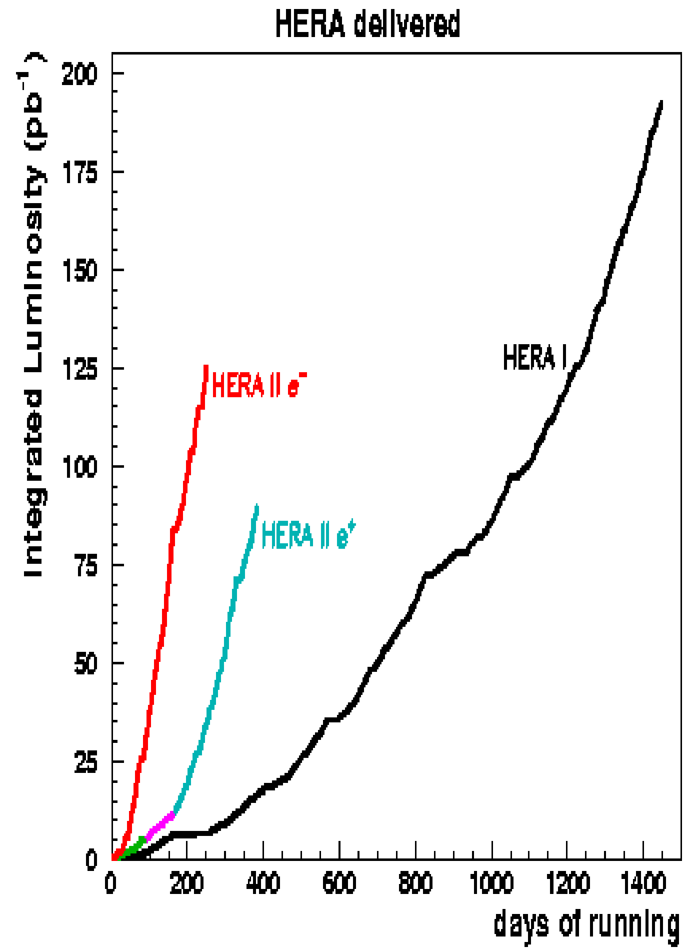
BACKUP SLIDES

EXPERIMENTAL ENVIRONMENT

HERA, H1 and ZEUS

- p(920 GeV) on e(27.5 GeV)
- CMS energy: 318 GeV
- H1 and ZEUS: ~400 physicists

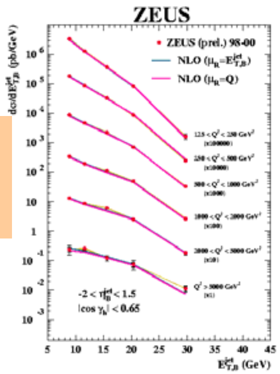


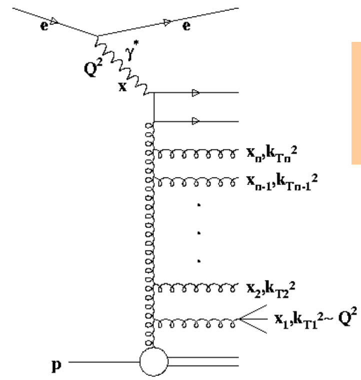


MOTIVATION AND OUTLINE

... from "simple" to more and more complex

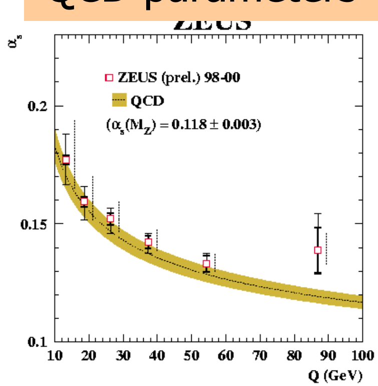
Cross-section measurements

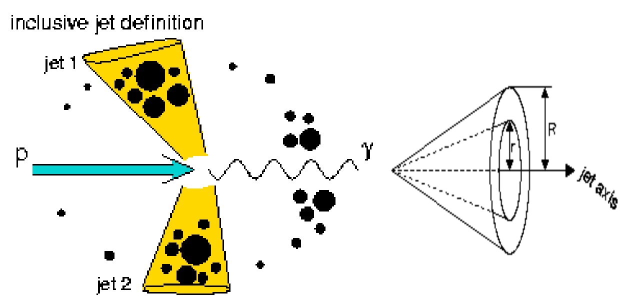




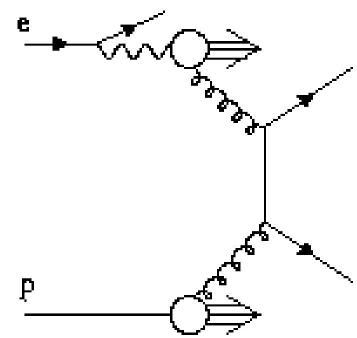
Forward jets and parton evolution

Extraction of QCD parameters





More fun with jets

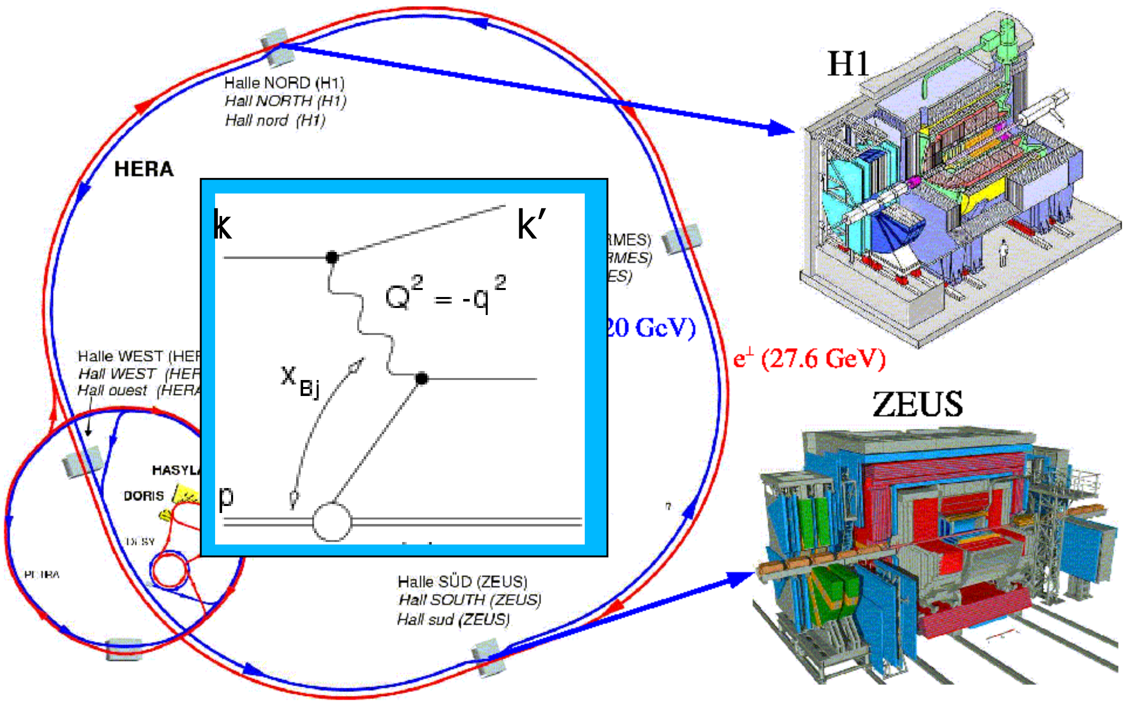


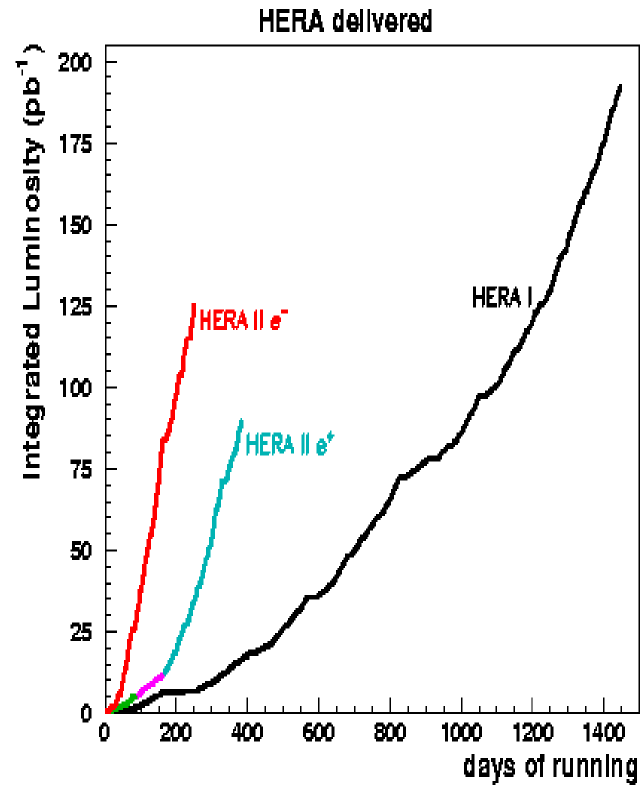
Jets at low Q^2,x

I will mainly concentrate on new results since ICHEP04.

EXPERIMENTAL ENVIRONMENT

HERA, H1 and ZEUS, kinematics of ep physics





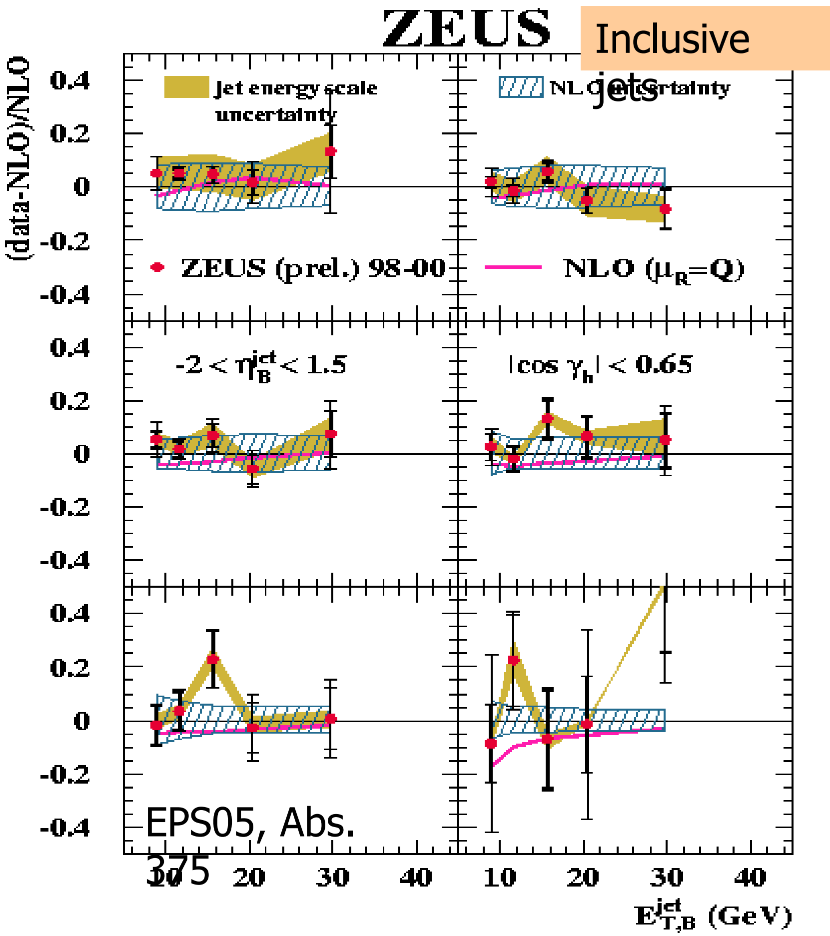
Momentum transfer	Proton momentum fraction in scattering	Energy transfer
$Q^2 = -(k-k')^2$	$x = Q^2 / 2Pq$	$y = 1 - E'/E$

At given CMS energy only two kin. variables independent: $Q^2 = xys$

Lumi summary:
- HERA-I (ZEUS): 91.7pb^{-1}
- HERA-II (e+) : 40.6pb^{-1}
- HERA-II (e-) : ~100pb^{-1}

INCLUSIVE, 2, 3 JETS AT HIGH Q^2

Well understood phase-space: $Q^2 > 125\ GeV^2$, $E_{T,jet} > 8\ GeV$

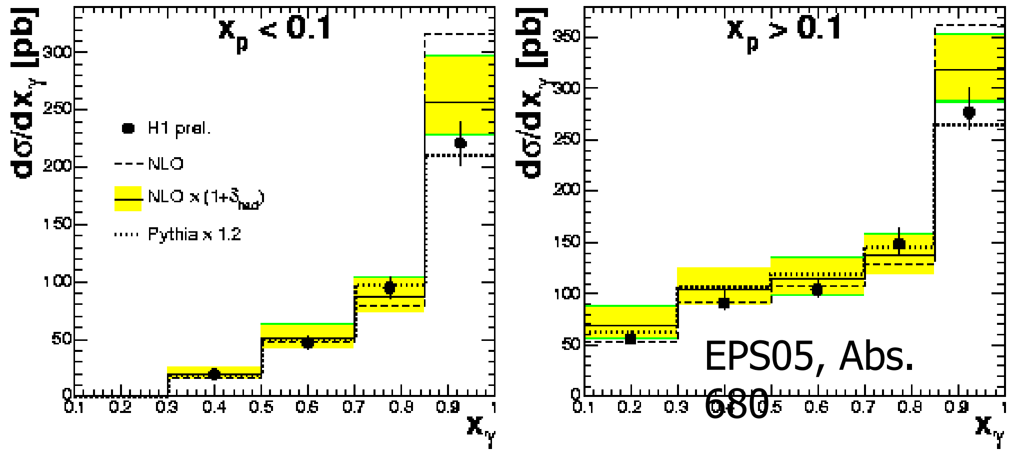


Excellent description of data by NLO QCD calculations.

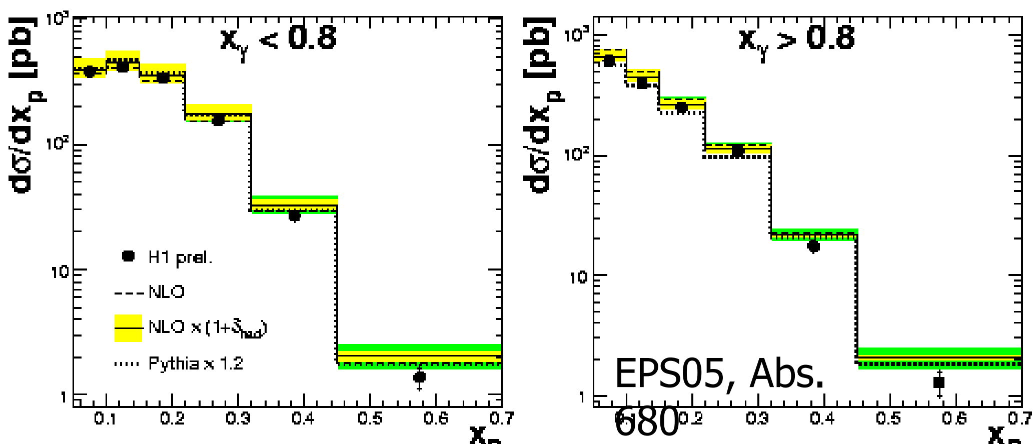
2 JETS IN PHOTOPRODUCTION (H1)

Further constraining the gluon in the proton

- 67pb-1, 99/00
- $Q^2 < 1$ GeV^2, $0.1 < y < 0.9$
- $p_{T1,2} > 25,15$ GeV (asymmetric cut ➔ safe NLO region)
- Results compared to LO MC and NLO calculations.



Special emphasis on x_γ and x_p (momentum fractions of photon and proton participating in the interactions ➔ learn something about PDFs, especially xg(x)?

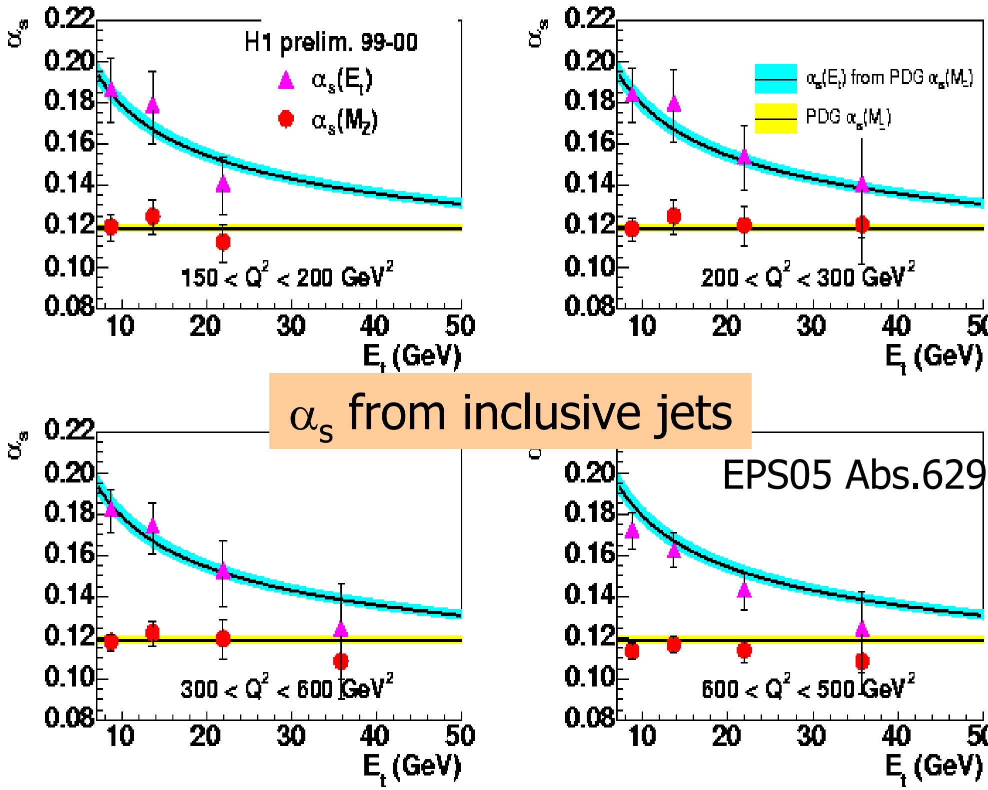


Good description of data over wide kinematic range by both the MC and the NLO calculation.

Use direct part of these data in PDF fit (as done by ZEUS - see later)?

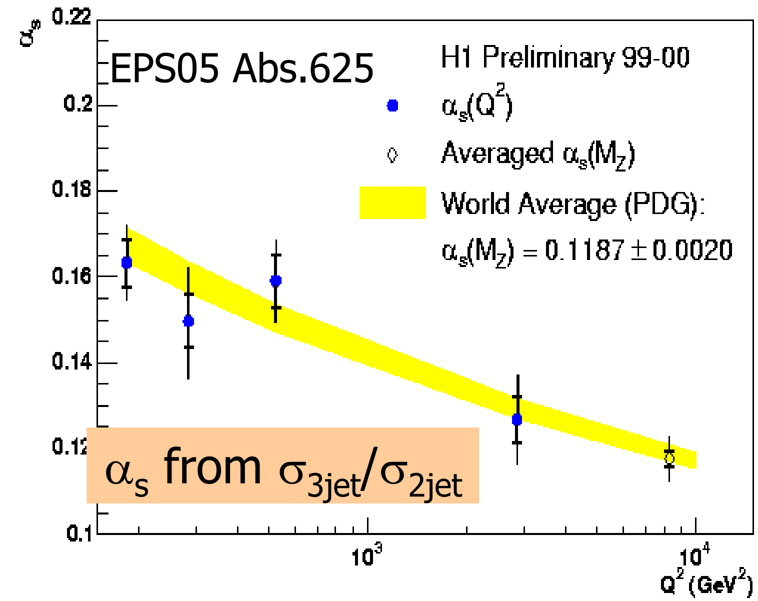
α_s FROM JETS AT HIGH Q^2: H1

Results



α_s from inclusive jets

15 data points in χ^2 fit with χ^2/dof =1.44



α_s from $\sigma_{3jet}/\sigma_{2jet}$

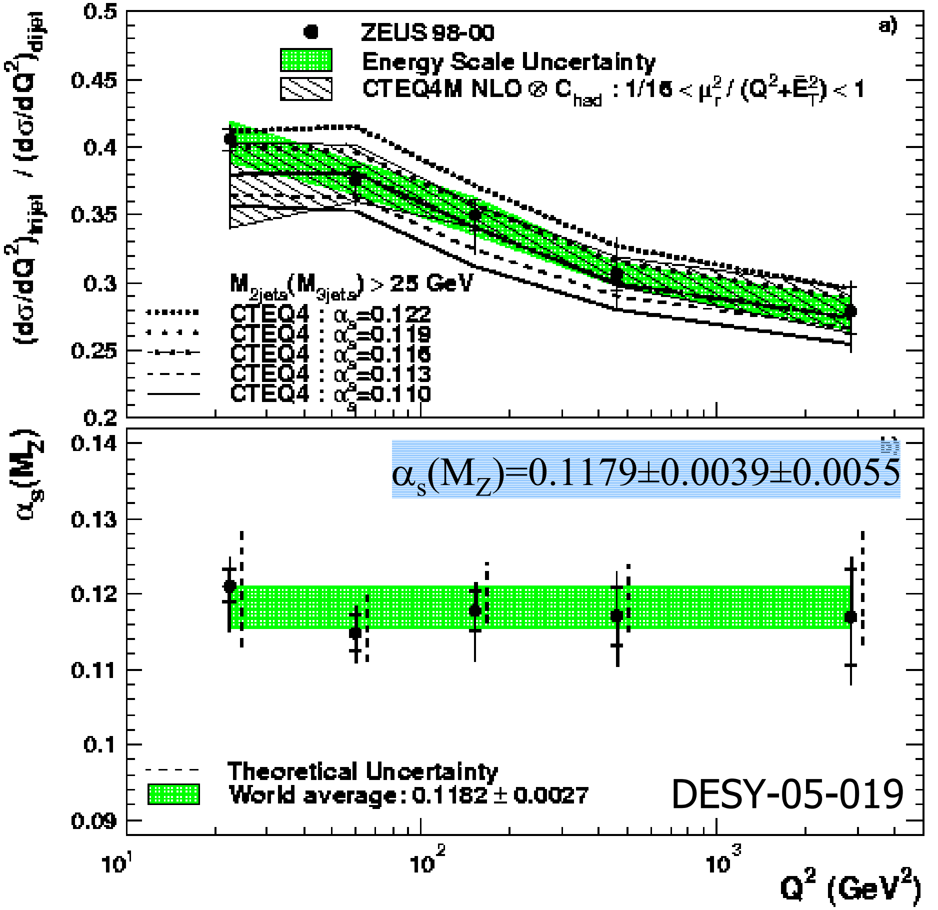
World average: $\alpha_s(M_Z) = 0.1187 \pm 0.0020$
H1 inclusive jets: $\alpha_s(M_Z) = 0.1197 \pm 0.0016(\text{exp}) \pm 0.0047(\text{theo})$
H1 3/2jet ratio: $\alpha_s(M_Z) = 0.1175 \pm 0.0053(\text{exp}) \pm 0.0061(\text{theo})$

Very nice agreement!
Errors coming down!

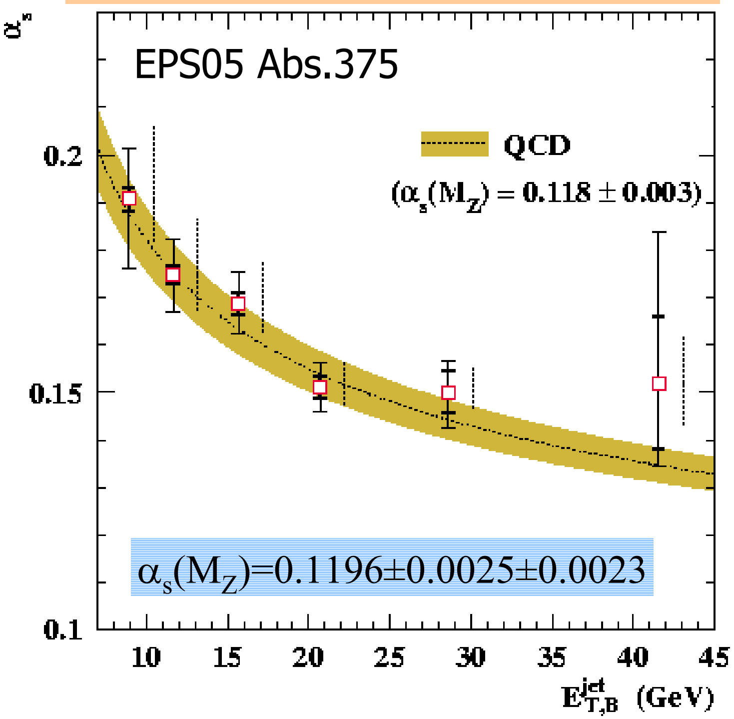
α_s FROM JETS AT HIGH Q^2: ZEUS

Results

α_s from ratio $\sigma_{3jet}/\sigma_{2jet}$ ➔
some uncertainties cancel out!



α_s from inclusive jets:
small theoretical uncertainty!

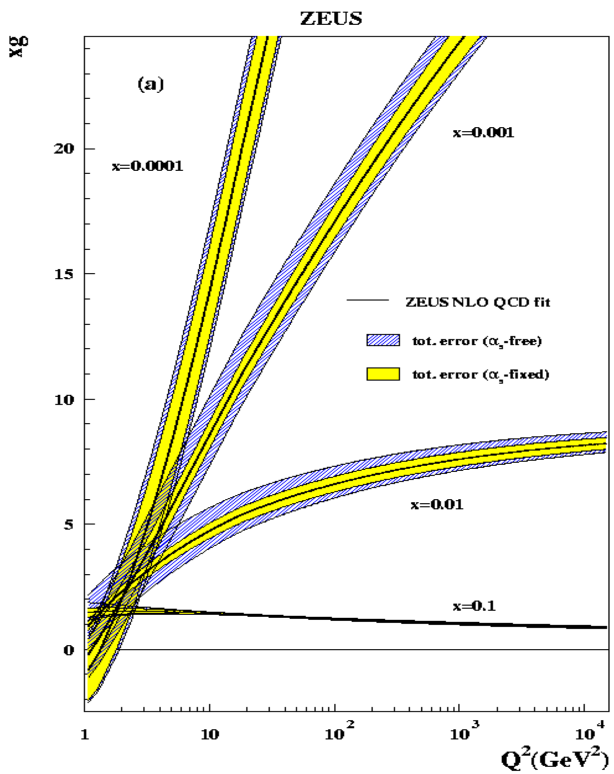


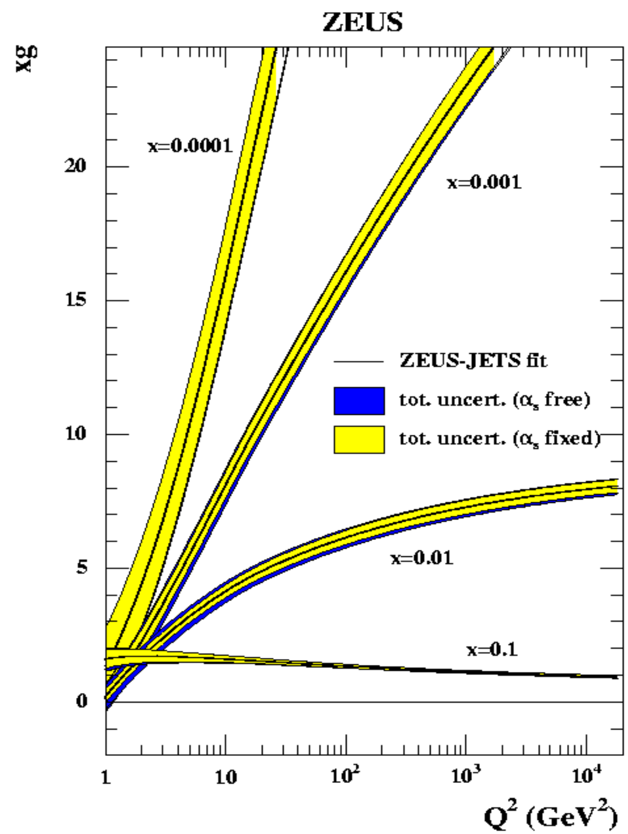
GLOBAL QCD FITS AND α_s

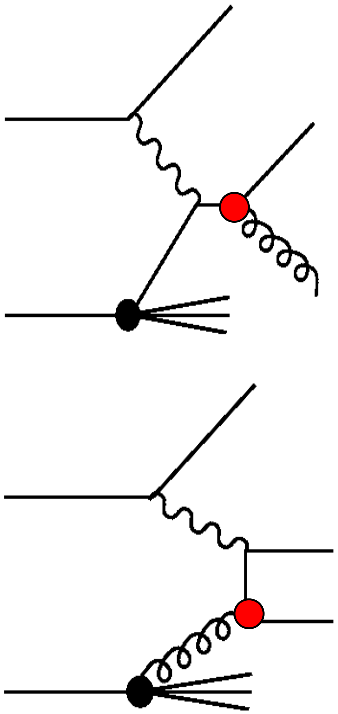
Effect on gluon uncertainty

Strong correlation between α_s and the gluon density for inclusive F_2 data

➔ large increase in gluon uncertainty when α_s free!







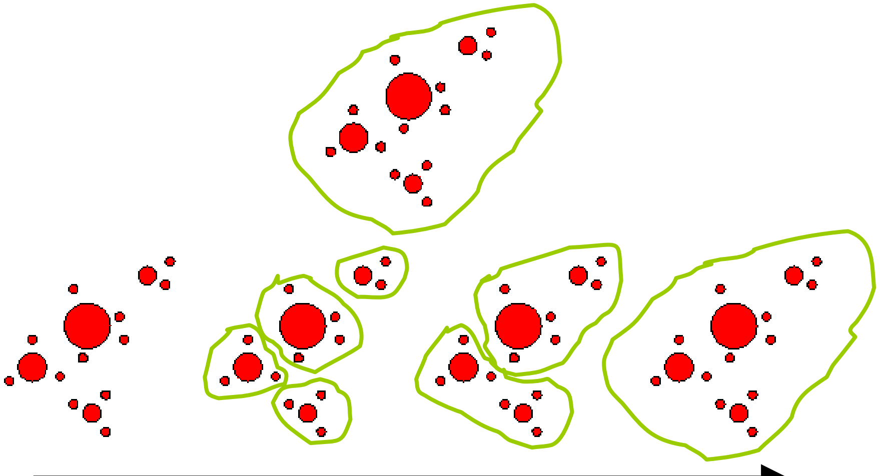
Jet cross sections directly sensitive to α_s via $\gamma^*g \to$ qqbar (coupled to gluon) and via $\gamma^*q \to qg$ (NOT coupled to gluon)

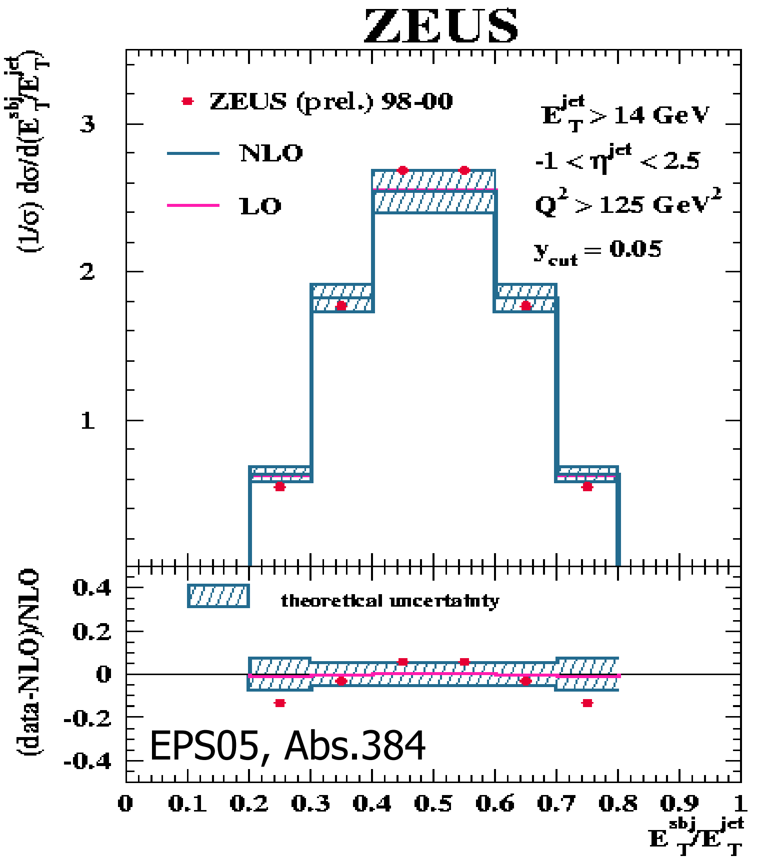
➔ α_s NOT as strongly correlated to gluon

SUBJET DISTRIBUTIONS

in high-Q^2 DIS – study QCD radiation pattern / jet structure

- Subjets are resolved by applying $k_\perp$ algo to objects of one jet as function of distance measure $d_{cut}=y_{cut}\cdot E_T^2$. Chosen here: Jets with two subjets at $y_{cut}=0.05$!





- Basically tested variables E_T^{sub}/E_T^{jet}, $\eta^{sub}-\eta^{jet}$, $|\phi^{sub}-\phi^{jet}|$ and orientation of subjets in η-ϕ space with respect to proton beam.

- All distributions nicely described by NLO QCD within 10%.

QCD COLOR DYNAMICS

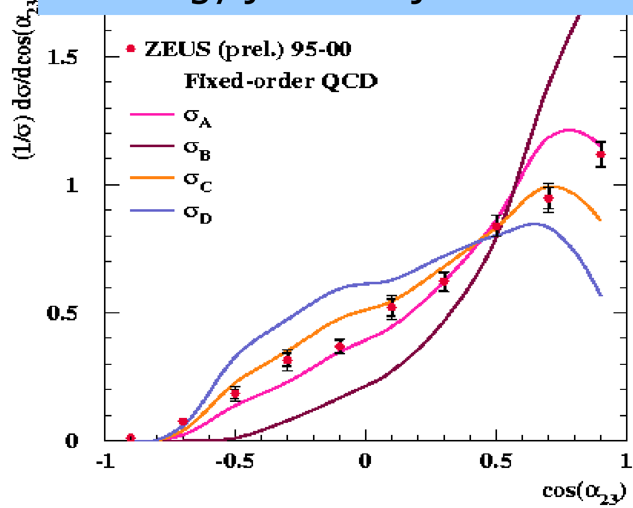
3-Jet angular correlations and the underlying gauge group

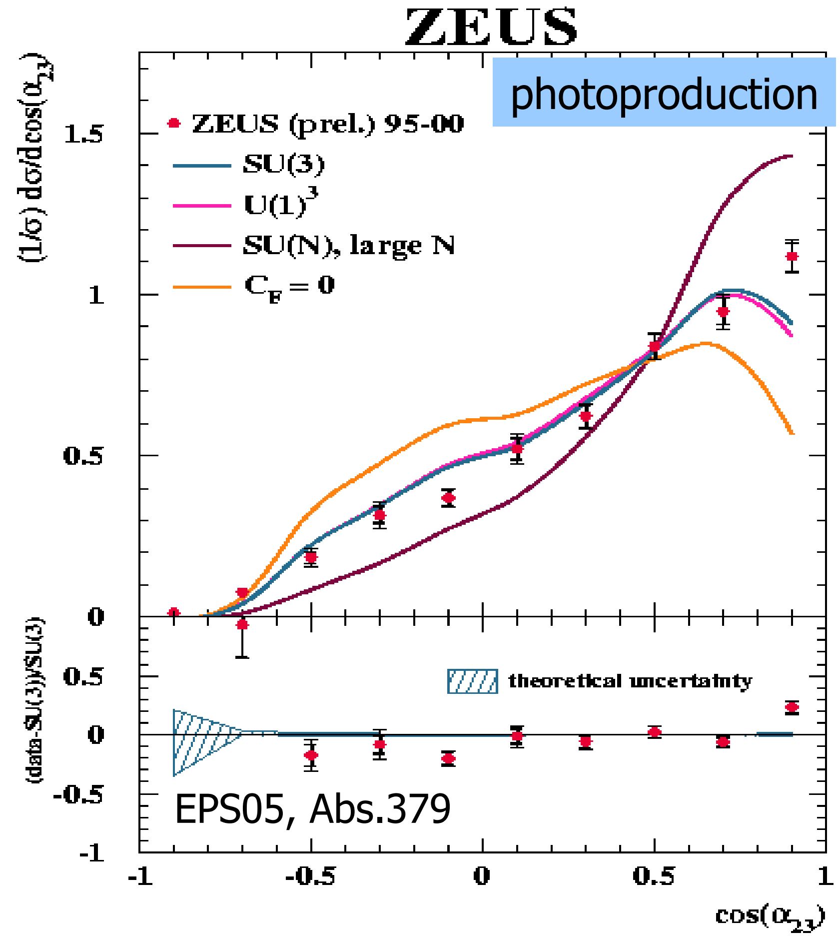
Aim: Investigate color dynamics and underlying gauge group using color factors C_F, C_A, and T_F of QCD.

The 3jet Xsection is sensitive to various color factor combinations:

$$\sigma_{ep\to 3\,jets} = C_F^2 \cdot \sigma_A + C_F C_A \cdot \sigma_B + C_F T_F \cdot \sigma_C + T_F C_A \cdot \sigma_D$$

α_{23}: angle between two lowest-energy jets in 3-jet events!





SU(3) favoured, but $U(1)^3$ not excluded!
CF=0 and SU(N) (N large) excluded!

QCD COLOR DYNAMICS

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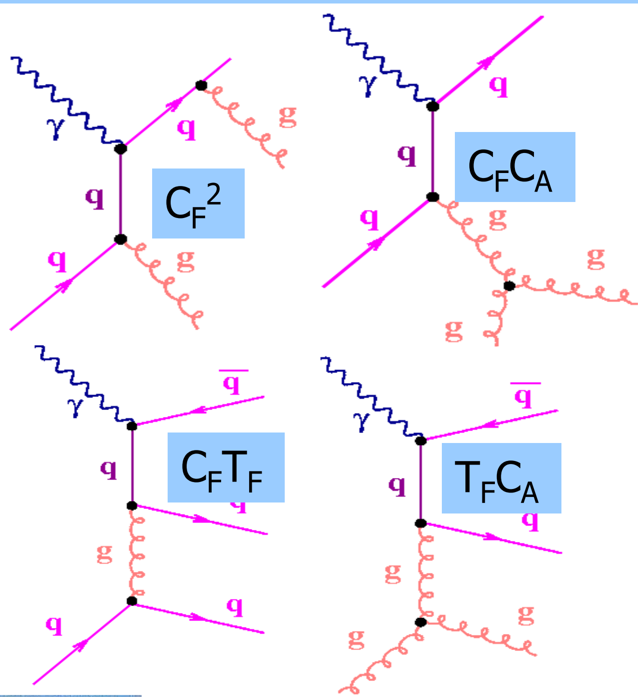
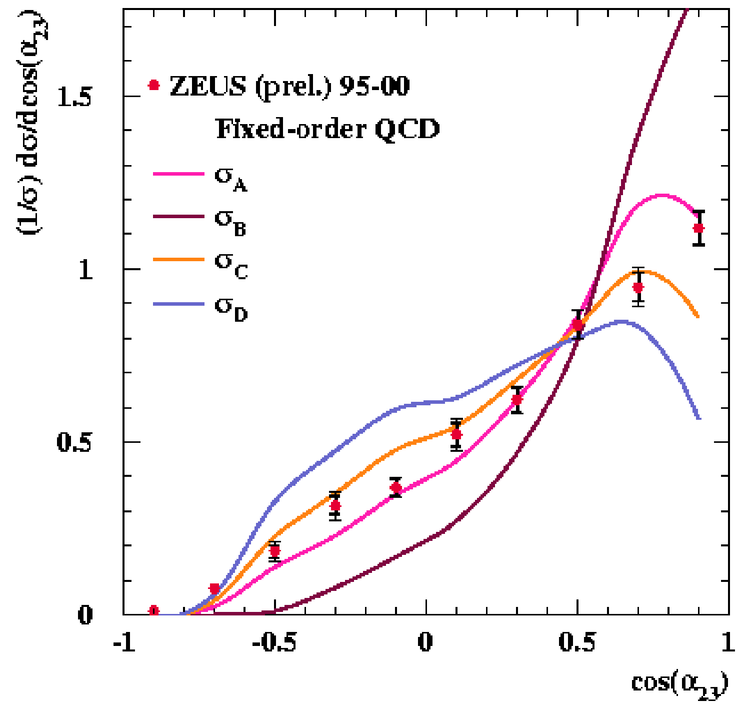
Aim: Investigate color dynamics and underlying gauge group using color factors C_F, C_A, and T_F of QCD.

At LO 3jet Xsection sensitive to various color factor combinations:

$$\sigma_{ep\rightarrow 3\,jets} = C_F^2 \cdot \sigma_A + C_F C_A \cdot \sigma_B + C_F T_F \cdot \sigma_C + T_F C_A \cdot \sigma_D$$



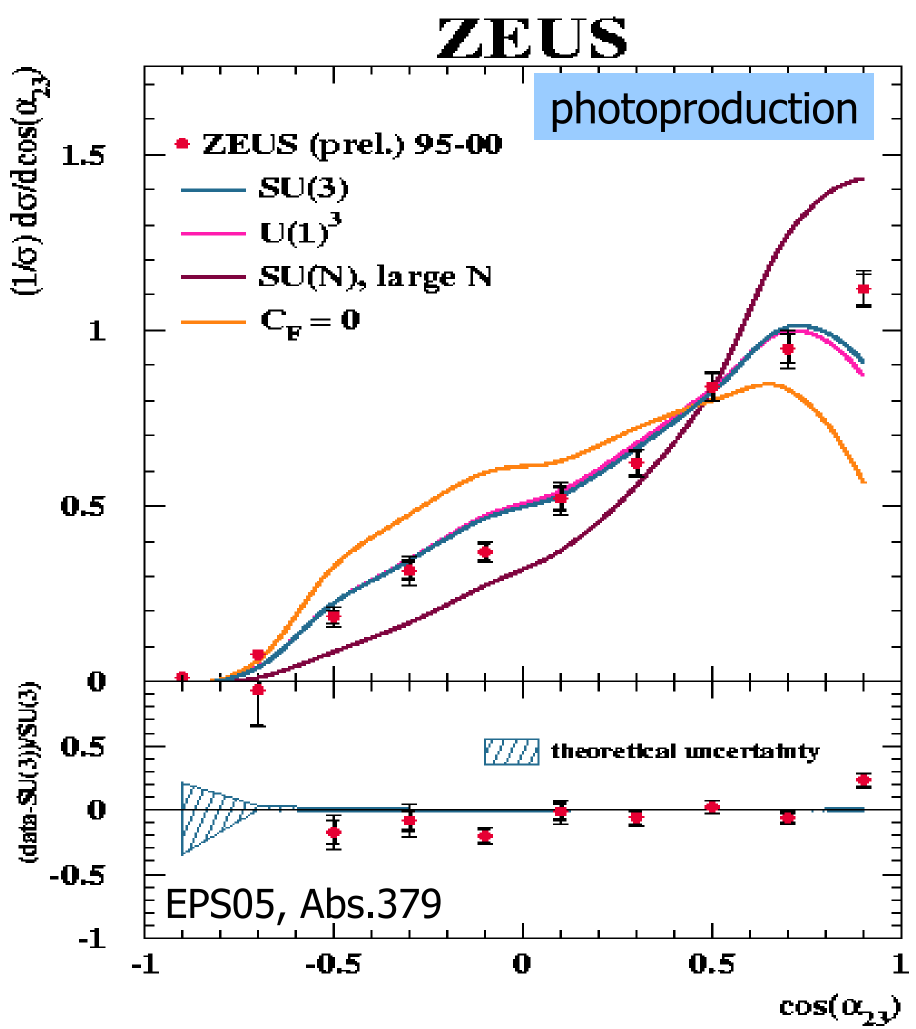
α_{23}: angle between two lowest-energy jets in 3-jet events!

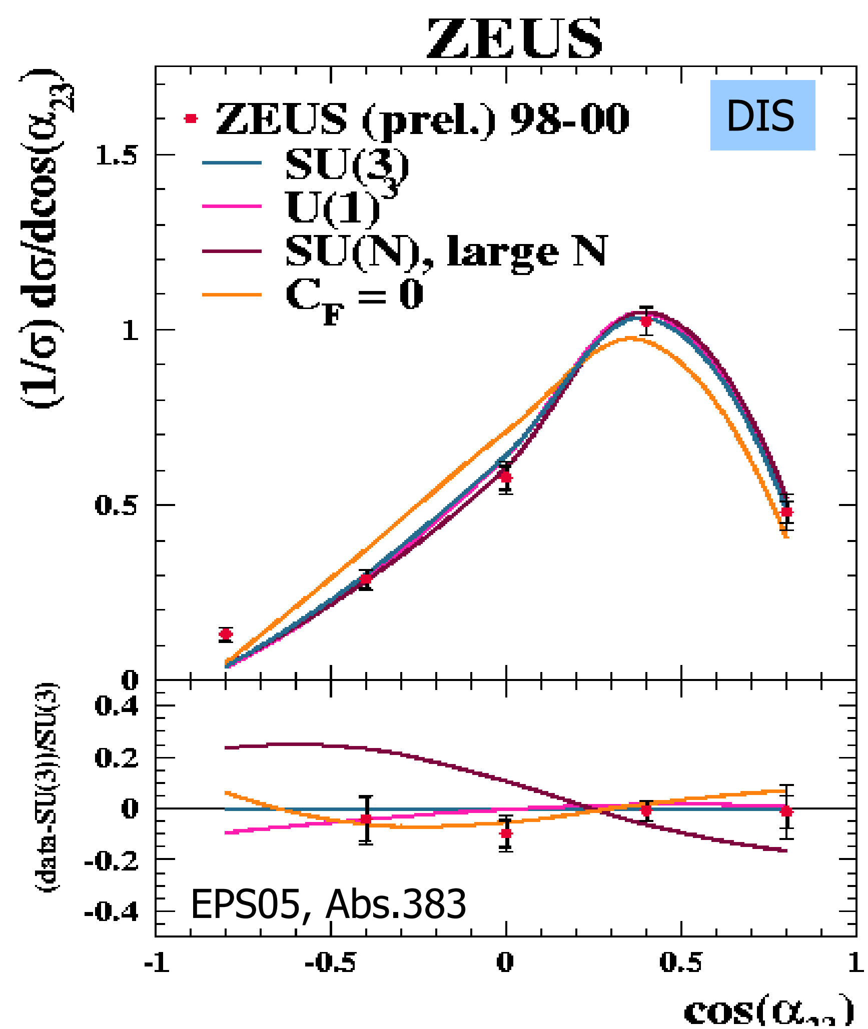


Sensitivity to different contributions!

QCD COLOR DYNAMICS

3-Jet angular correlations and the underlying gauge group





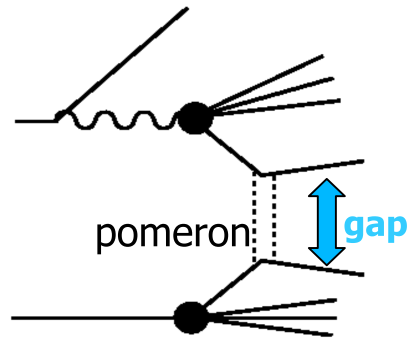
SU(3) favoured, but $U(1)^3$ not excluded!

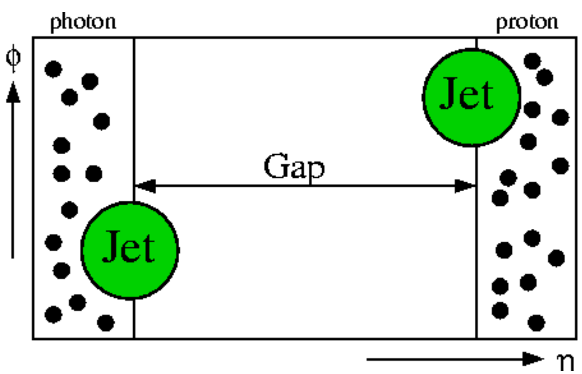
$C_F=0$ excluded!

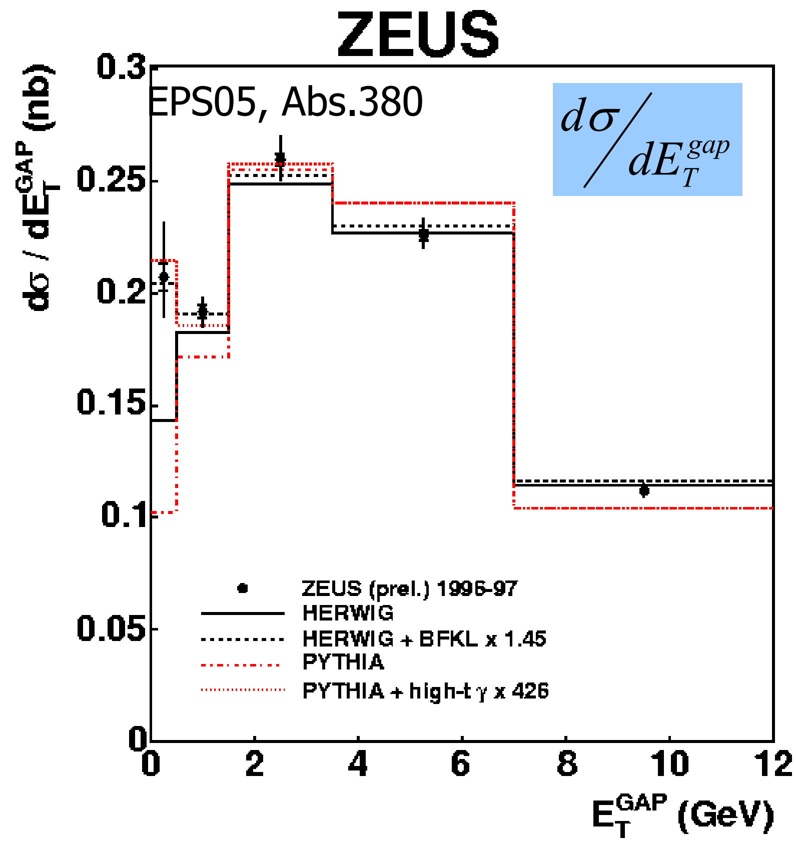
INTERJET ENERGY FLOW

in photoproduction dijet events with large rapidity gap

- Study color-singlet exchange with large momentum transfer by looking for rapidity gap dijet events.







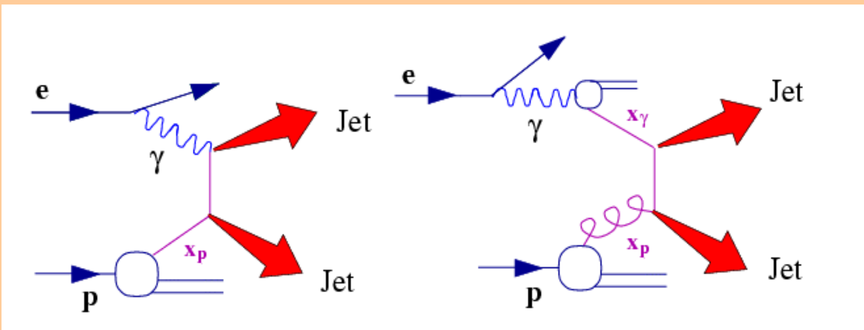
- Compare data to MC models with(out) CS contribution:
  -- PYTHIA: high-t-γ exchange;
  -- Herwig: BFKL-Pomeron.

- 3-4% CS exchange necessary to account for small E_t^{gap} cross-section. Amount depends on rapidity separation of jets.

FROM PHOTOPRODUCTION TO DIS

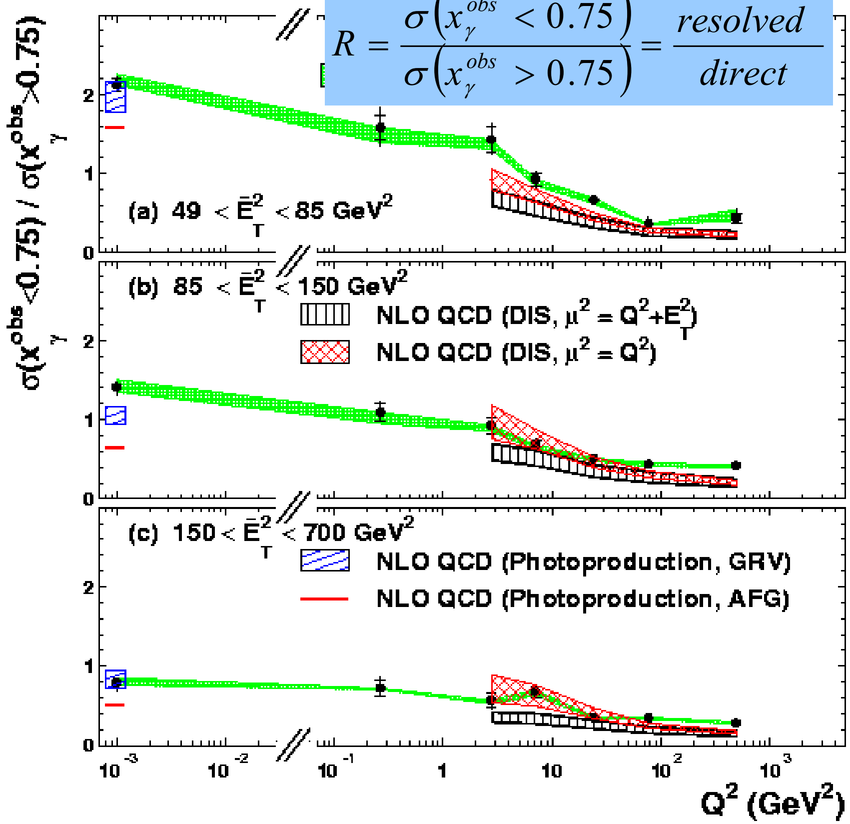
The regime of low Q^2 (and low x)

- For $E_T^2 \geq Q^2$ parton can probe resolved hadronic structure of photon; Resolved photon contributes to hadronic final state.



- Structure suppressed with increasing Q^2.
- x_γ quantifies the amount of the photon's energy that enters the hard scattering: resolved: $x_\gamma<1$, direct $x_\gamma=1$.
- Test influence of resolved photon contribution to the DIS dijet cross-section as function Q^2 using the ratio of resolved- over direct-enriched events ($x_\gamma<>0.75$).

$$R = \frac{\sigma\left(x_\gamma^{obs} < 0.75\right)}{\sigma\left(x_\gamma^{obs} > 0.75\right)} = \frac{resolved}{direct}$$



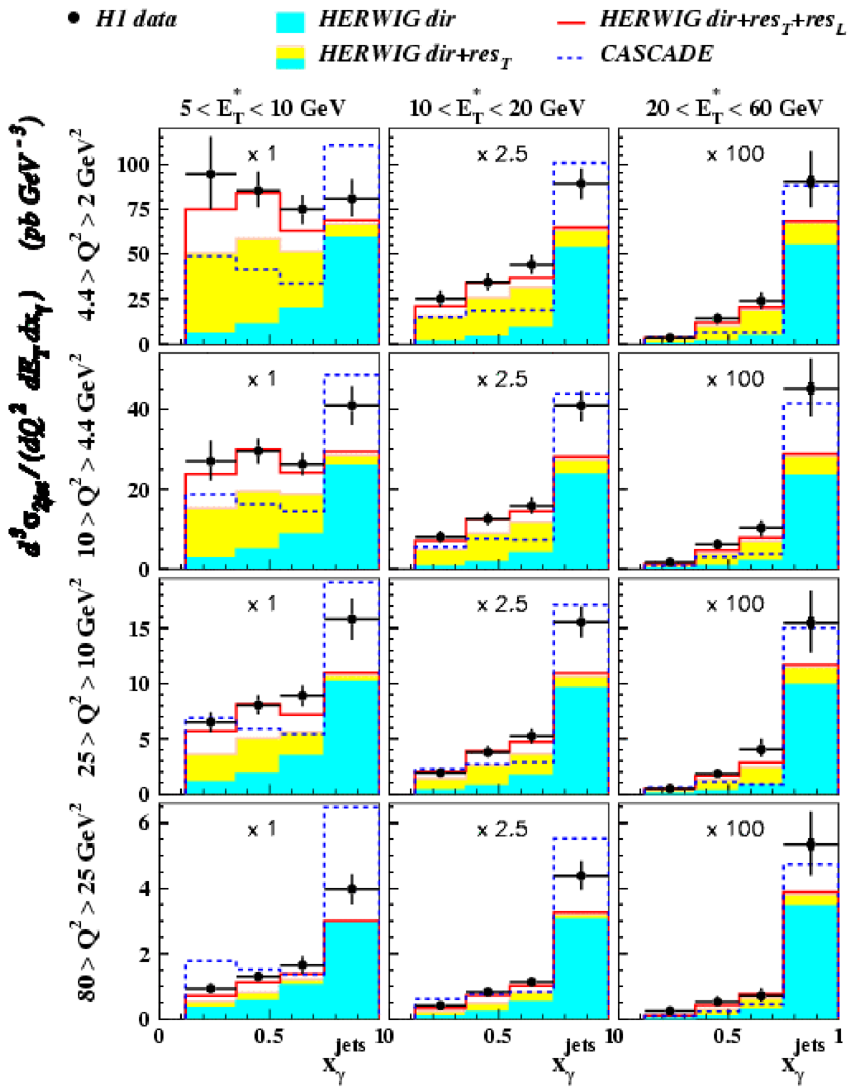
-- Resolved relevant for $Q^2>100$ GeV^2!

-- Direct NLO for low $E_T \sim 8$ GeV even at $Q^2 = 5$ GeV^2 not enough!

-- NNLO? Resummed?

FROM PHOTOPRODUCTION TO DIS

The regime of low Q^2 (2-80 GeV^2) – H1 triple-diff. cross-sections



- not shown: direct NLO fails at low Q^2, resolved decreases with Q^2 increasing. Also JetViP with resolved cannot cover!
- Full LO MC (HERWIG) with resolved contribution reproduces all features of the data (problems at high x_γ).
- Parton shower necessary to describe data at low Q^2 and x_γ!

- Some interplay between resolved (mimicking k_T-unordered!) and CCFM evolution – also CASCADE does a reasonable job (sensitivity to PDF!!!!)

Older study of dijets with small azimuthal separation: 2(3)jet NLO cannot account for the data completely; k_T-non-ordered models (CCFM) do a better job.

FROM PHOTOPRODUCTION TO DIS

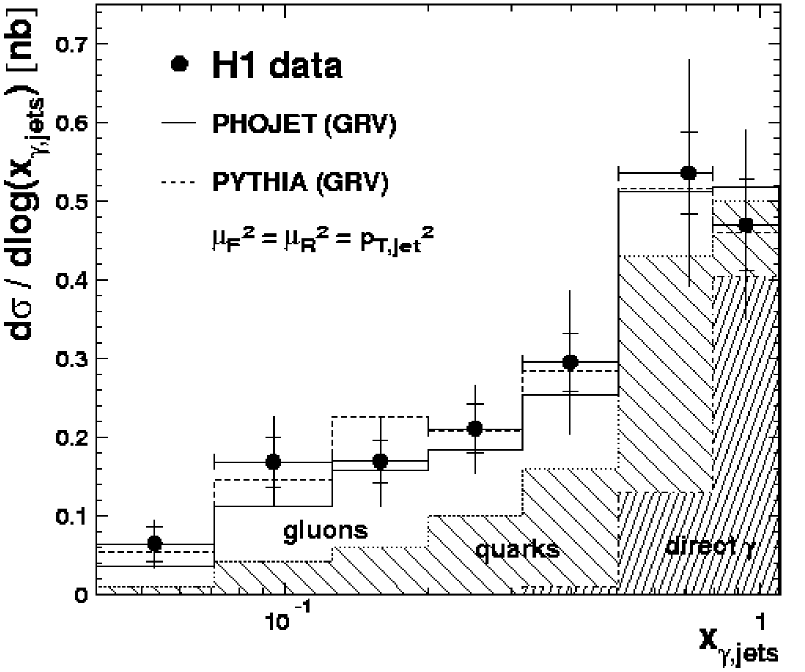
The regime of low Q^2 (and low x)

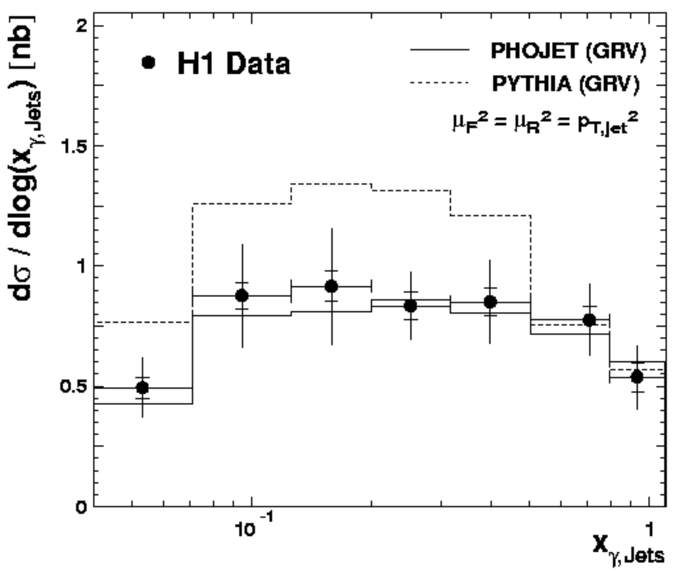
Say something about the S measurement from H1.

FROM PHOTOPRODUCTION TO DIS

Low E_T jets and the photon's PDFs

- Low E_T jets (6 GeV) are sensitive to the gluon content in the photon.
- Large contributions from underlying events
  ➔ subtraction procedure, amount of subtracted energy depends on model!
  ➔ large uncertainties!



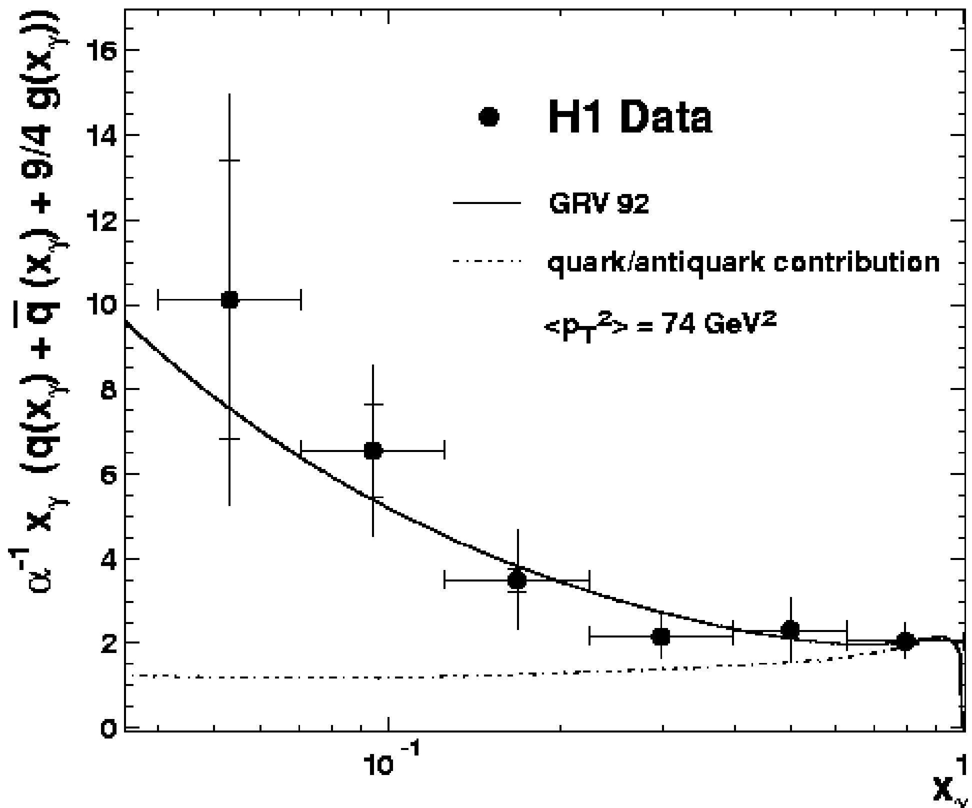


PHOTOPRODUCTION JETS

Low E_T jets and the photon's PDFs

Effective parton distribution

$$f_{\gamma,eff} = \left(q(x_\gamma) + \bar{q}(x_\gamma)\right) + \frac{9}{4} g(x_\gamma)$$



FORWARD JETS

Hunting for signs of BFKL evolution

- Perturbative expansion of evolution equations $\sim \sum_{mn} A_{mn} \ln(Q^2)^m \ln(1/x)^n$

  -- canno[…] calculated t[…]

  DGLAP: $\sum(\alpha_s \ln Q^2)^n$ BFKL: $\sum(\alpha_s \ln 1/x)^n$ CCFM: ln(Q^2) and ln(1/x)

- DGLAP approximation scheme for parton evolution works very well for most of HERA regime (F_2!)

  -- breakdow[…] w x since terms ln1/x neglected!

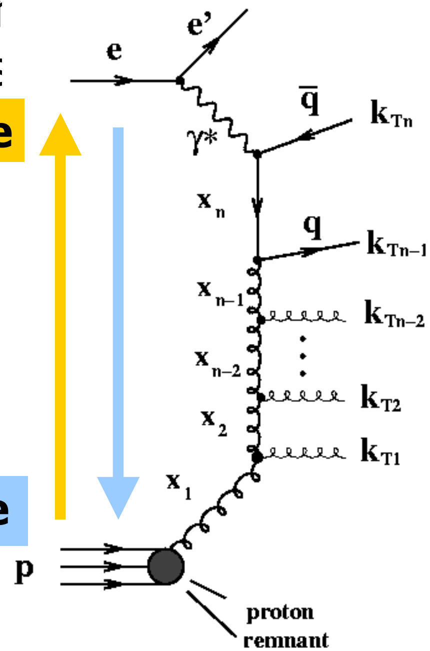
  -- can we dis[…] f Bl[…]

k_T large

DGLAP: k_T ordering!

BFKL: x ordering!

x large



Suppress DGLAP, enhance BFKL:

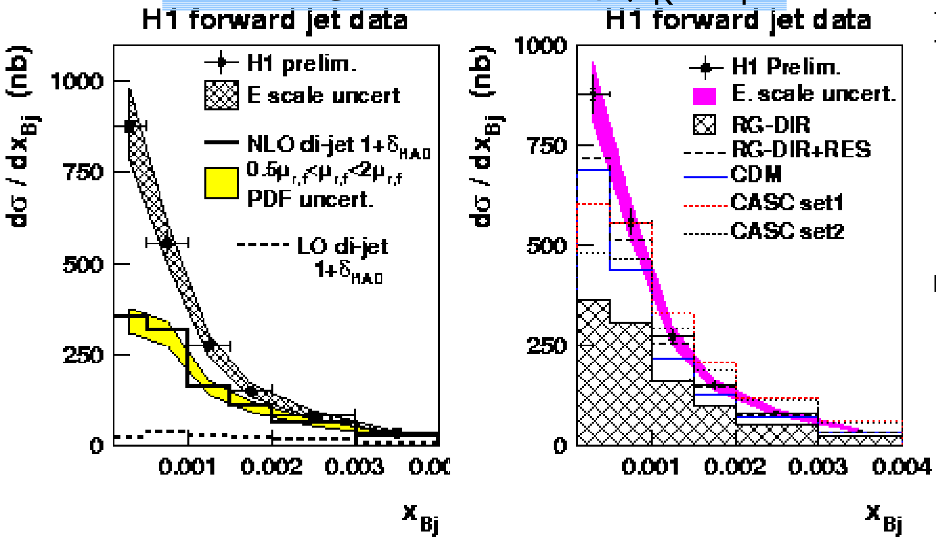
- forward region: η > 2 (close to proton)
- jet $E_T^2 \sim Q^2$ (suppressed in DGLAP)
- large $x_{jet}=E_{jet}/E_{proton}$ (realized in BFKL)

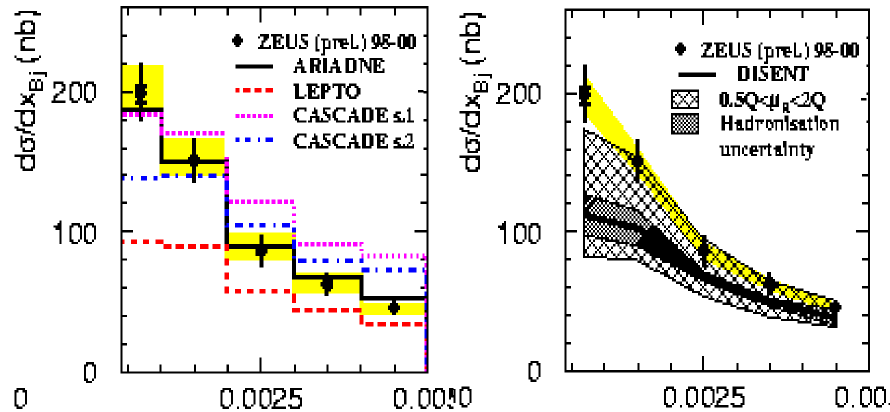
All previous results: Problems at low x!
-- NNLO? At all orders all schemes work
-- Resolved? May mimic higher orders
-- Evolution? Is it really BFKL?

H1 AND ZEUS FORWARD JETS

as functions of x – spot problems in evolution?

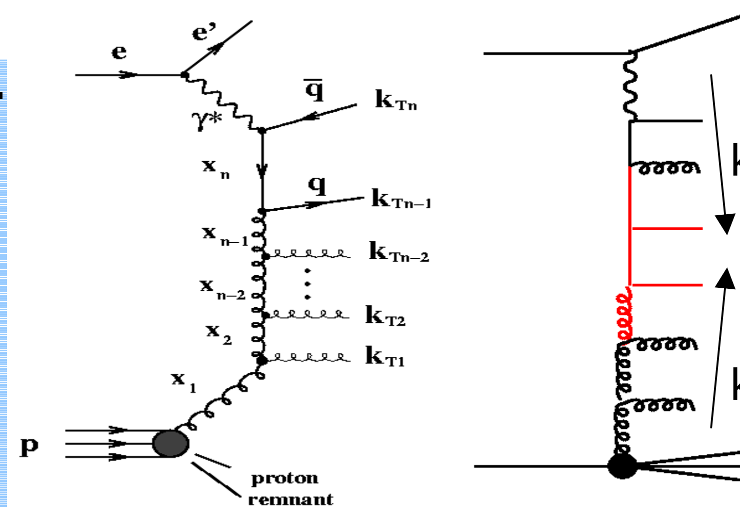
- only 1997 data, 13.7pb^{-1}
- $5 < Q^2 < 85$ GeV^2, $\mu_R = E_T$





Tighter cuts than H1 → same statistics from 72pb^{-1} of data. μ_R=Q.

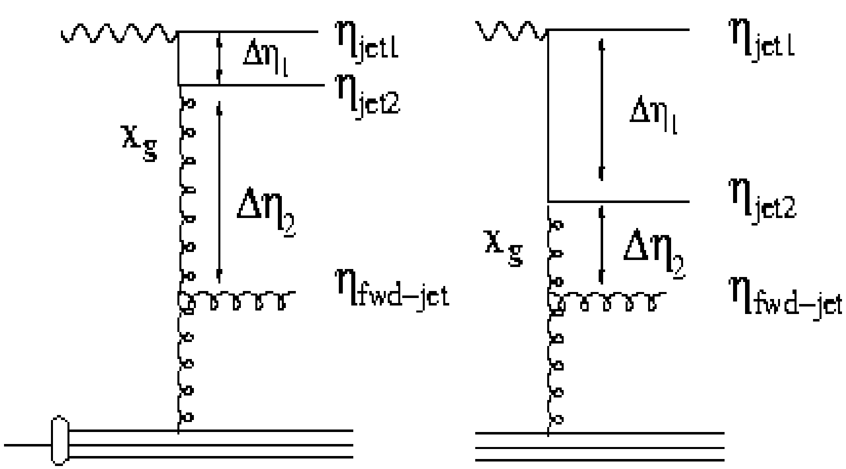
- All models below the data at low x values.
- CCFM unclear (PDF dependence!)
- resolved photons / ARIADNE (BFKL-like) better / good
  - is it non-k_T-ordered contribution? But why then CCFM not better?
  - is it mimicking higher orders (NNLO)?
  - is it a photon or a proton feature?

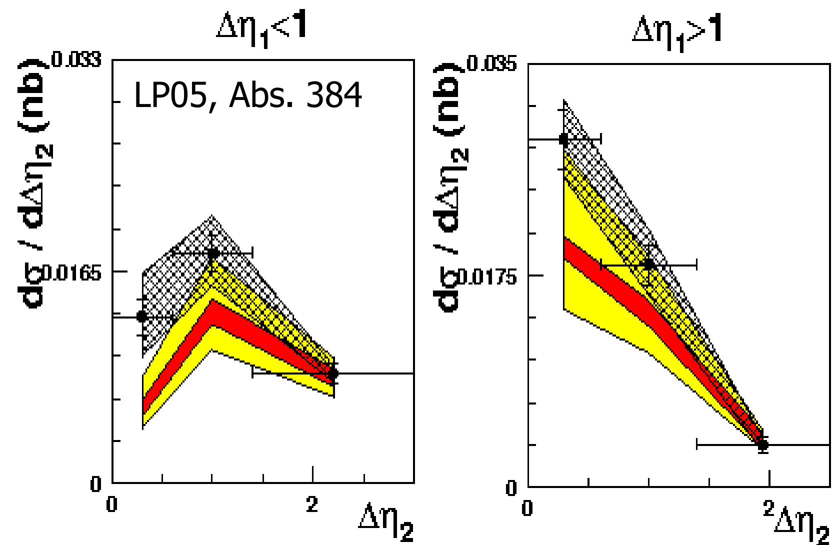


FORWARD JET+CENTRAL DIJETS

Further constraining the phase-space (H1)

H1 then requests dijets in central detector (demand same E_T > 6 GeV for all jets → no k_T-ordering → DGLAP suppressed):





Choice of $\Delta\eta_1$, $\Delta\eta_2$ selects specific evolution scenarios:
-- $\Delta\eta_2$ small → no PS for BFKL radiation
-- 'BFKL' region: $\Delta\eta_1<1$, $\Delta\eta_2>1$
-- $\Delta\eta_1 > 1$: resolved photon picture
-- But: correct ordering of jets?

- resolved LO MC describes $\Delta\eta_1 > 1$
- CDM (BFKL-like) better for $\Delta\eta_1 < 1$ than for $\Delta\eta_1 > 1$
- CCFM PDF set 2 describes 'BFKL' region

CONCLUSION: UNCLEAR!