Measurement of Dijets in DIS

and

Comparison to NLO Calculations

DIS'97 – Chicago

April 14 - 18, 1997

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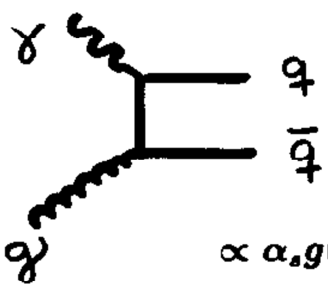
Method in a Nutshell

[calculated differential dijet cross section] = [measured differential dijet cross section]

- corrected to parton level (measured side)
- adjust input gluon density, xg(x), until the measured and calculated cross sections agree (calculated side)

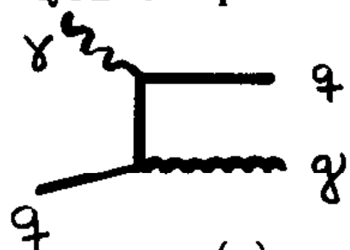
The LO Picture of DIS Dijet Production

PGF



$\propto \alpha_s g(x)$

QCD Compton



$\propto \alpha_s q(x)$

◇ Select small Q^2:

PGF dominant
Assume q(x) known
Assume $\alpha_s(Q)$ known: PDG: $\alpha_s(M_Z) = 0.118 \pm 0.003$

◇ Fraction of the proton's momentum, ξ, carried by the gluon:

- $\xi = x_{BJ}(1 + (q + \bar{q})^2/Q^2)$

Data

◇Kinematic cuts:

$7 < Q^2 < 100$ GeV^2

$y_{BJ} > 0.04$

$E_{e'} > 10$ GeV

(+ data quality cuts)

◇Jet Finding:

CONE

in LAB frame

cone radius = 1

K_T

in Breit frame

scale = Q^2

d_{cut}=0.5
(resolution parameter)

◇Jet Selection Cuts: TWO JETS!

in LAB

P_t(CORRECTED) > 4.0 GeV/c

$\eta < 2.0$

in HCM

P_t(CORRECTED)>4.0 GeV/c

New Jet Energy Corrections

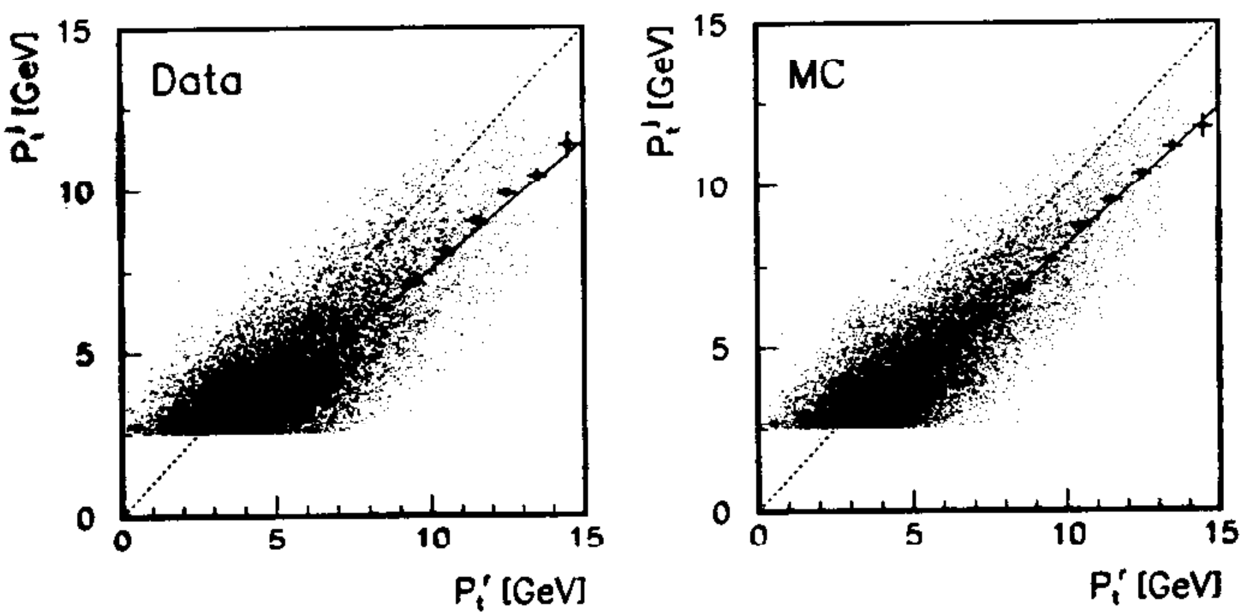
DOES NOT RELY ON CORRECT MC SIMULATION OF DETECTOR

METHOD:

- **Select DIS one jet events (with Cone)**
- **Calculate**
  - P_T^j = **transverse momentum of jet**
  - P_T^h = **transverse momentum of hadronic system excluding jet**
  - P_T^r = **sum of transverse momenta of scattered electron (electron energy presampler corrected) and** P_T^h
- **To obtain jet energy correction factors, require that**

$$P_T^r = C_F * P_T^j \, .$$

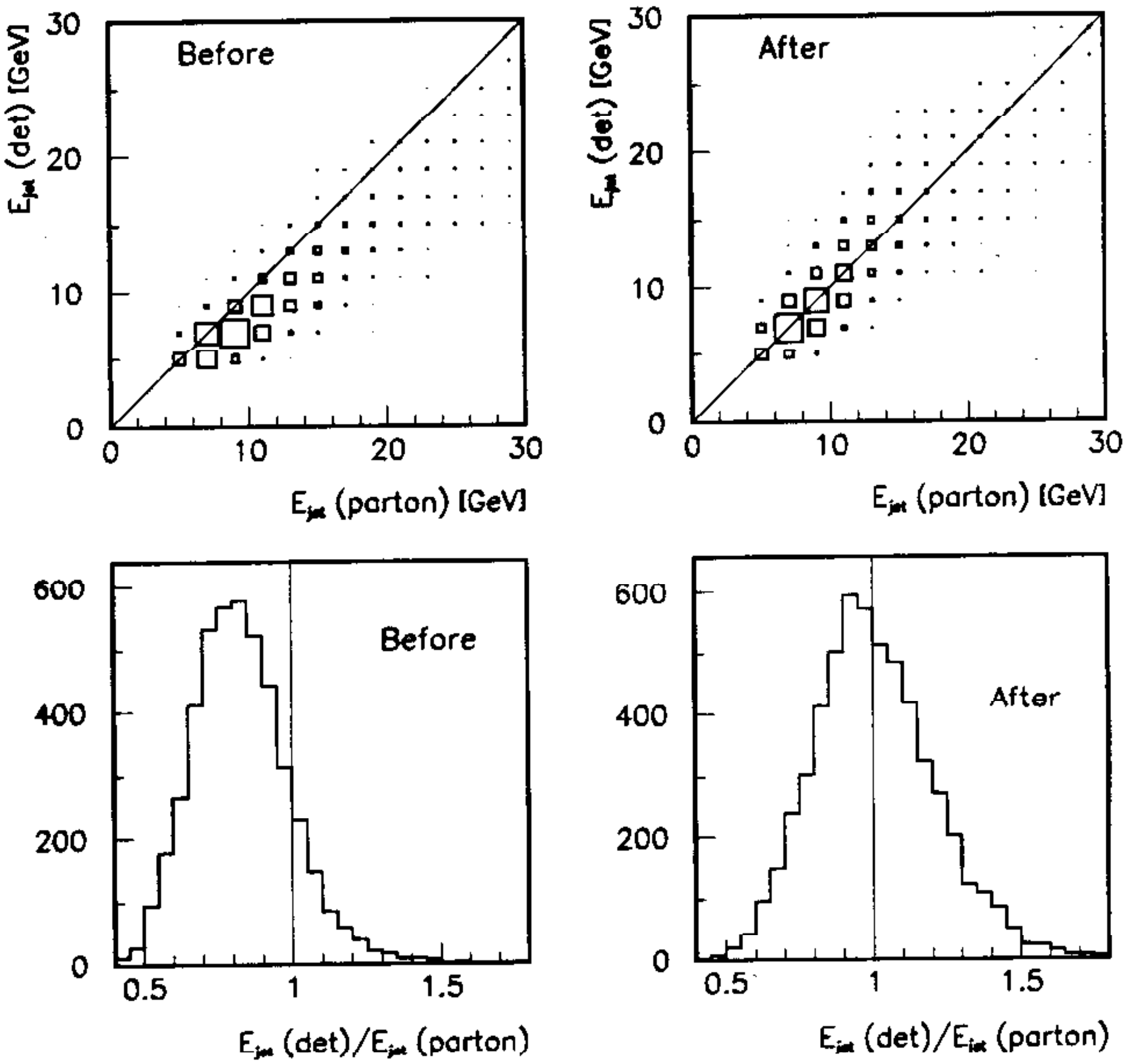
- **Cut on the uncorrected hadronic momentum,** P_T^h
  observation: correction factors independent of this cut



Cross check of Jet Energy Corrections

Using Monte Carlo

Matching jets on parton/detector level R 0.2



Correction Factors: data to parton level

◇ **To correct measured differential dijet cross section**

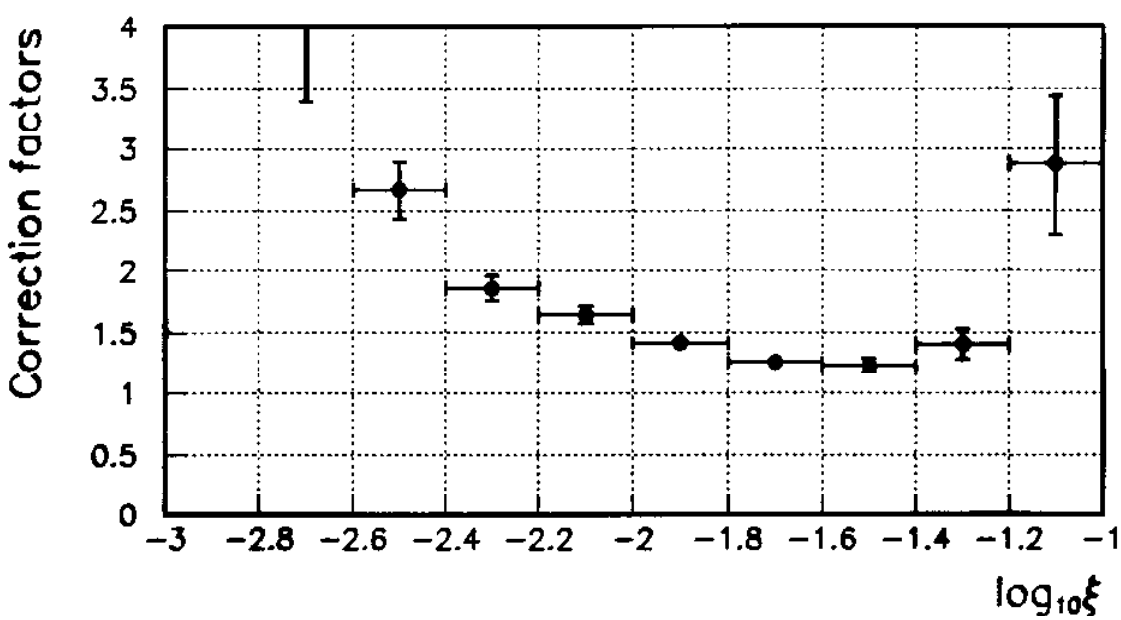
- **for detector acceptance**
- **for hadronization**

◇ **Correction factors obtained from Lepto 6.3**

◇ **Calculated as:**

- **(parton level dijet events)/(cell level dijet events)**

where the parton level events pass the kinematic cuts and the cell level events pass the kinematic and data quality cuts.



Calculation

◇ two programs

- MEPJET (Mirkes and Zeppenfeld)
- DISENT (Seymour and Catani)

◇ NLO dijet production calculated from pQCD matrix elements

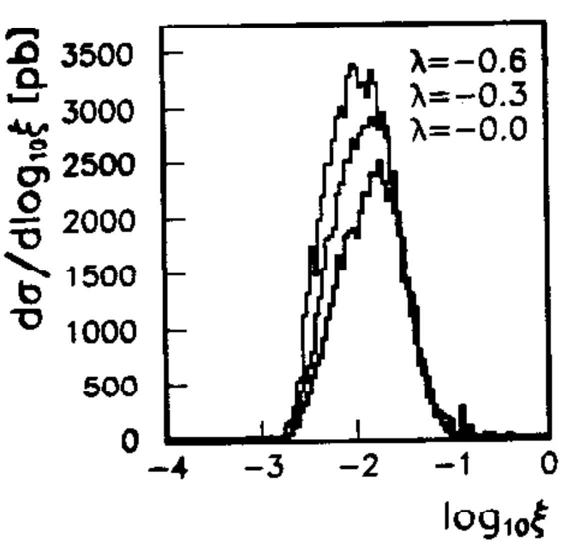
◇ apply jet finder to momentum four vectors of outgoing partons

◇ we used:

- Q^2 as factorization/renormalization scale
- the MRSA parton distribution function
- MRSA gluon parametrized as:

$$g(x, Q_0^2) = A_g x^{\lambda}(1-x)^{\beta}(1+\eta x) \text{ at } Q_0^2 = 4 \text{ GeV}^2$$

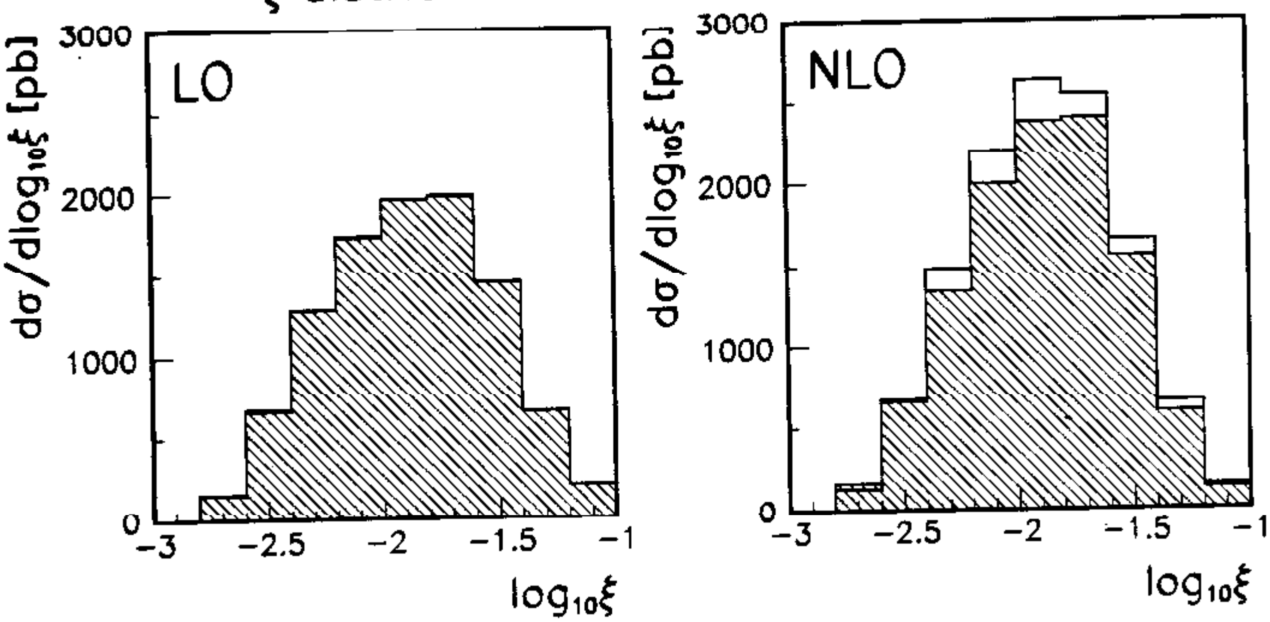
Variation of Calculated Dijet Cross Section with λ



The value of λ effects the total rate and the shape of the distribution.

Comparison of MEPJET and DISENT:

ξ distribution



Disent LO = 2.04 ± 0.01 nb   Disent NLO = 2.25 ± 0.08 nb

Mepjet LO = 2.03 ± 0.00 nb   Mepjet NLO = 2.41 ± 0.05 nb

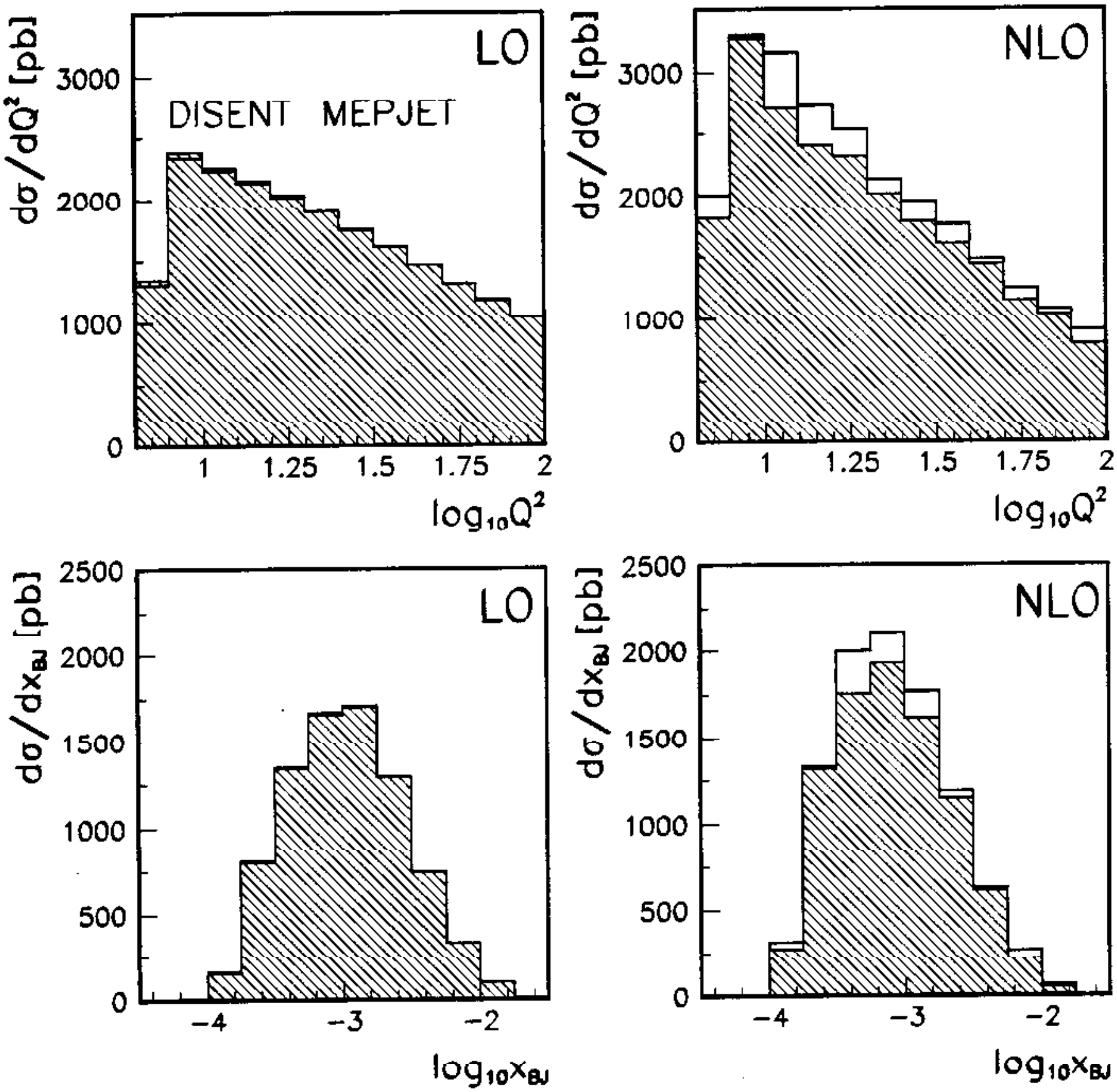
same input parameters
for both programs

α_{QED} = fixed

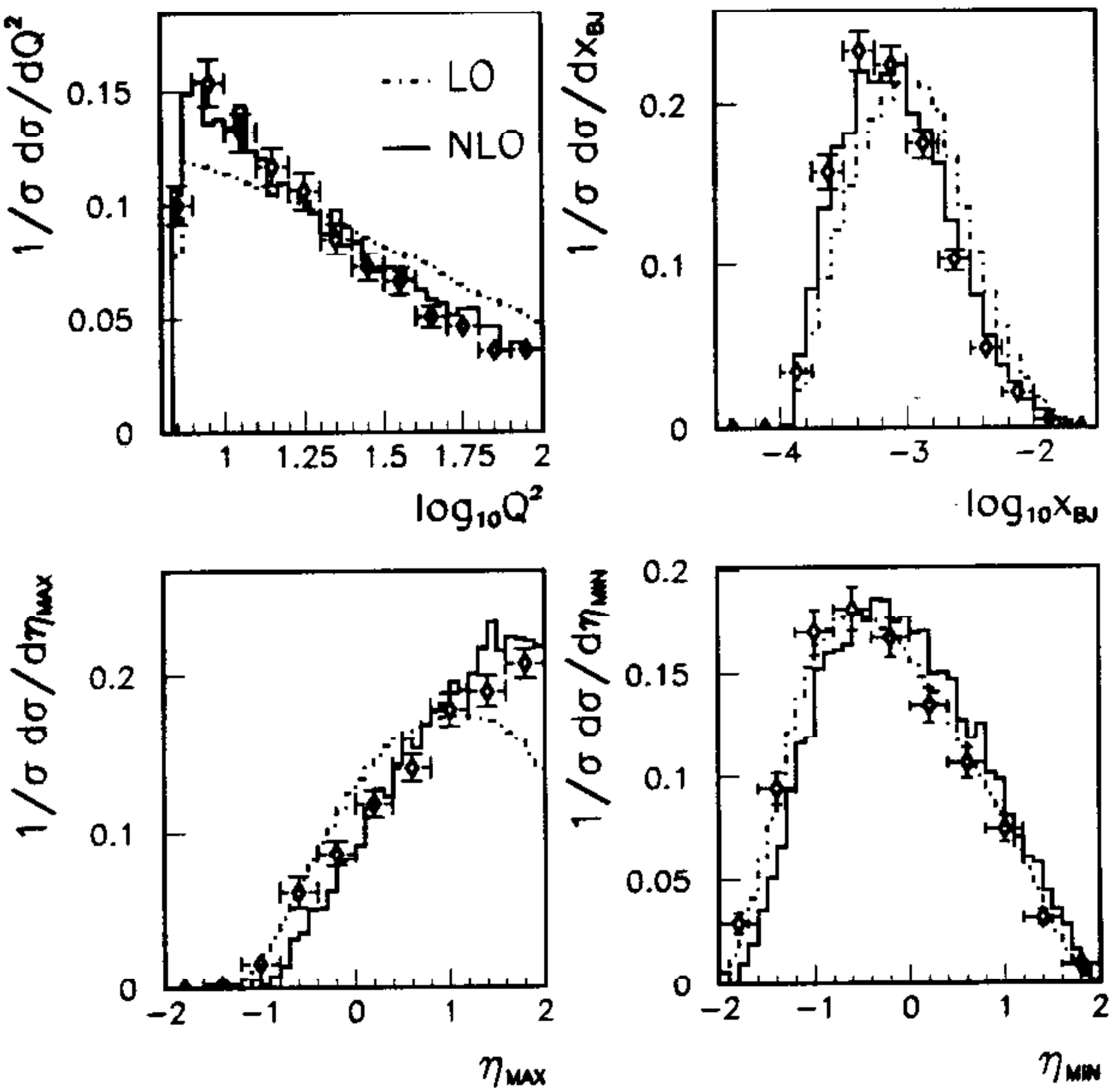
α_s(LO) = 2loop

Comparison of MEPJET and DISENT

Q^2 and x_{BJ} distributions

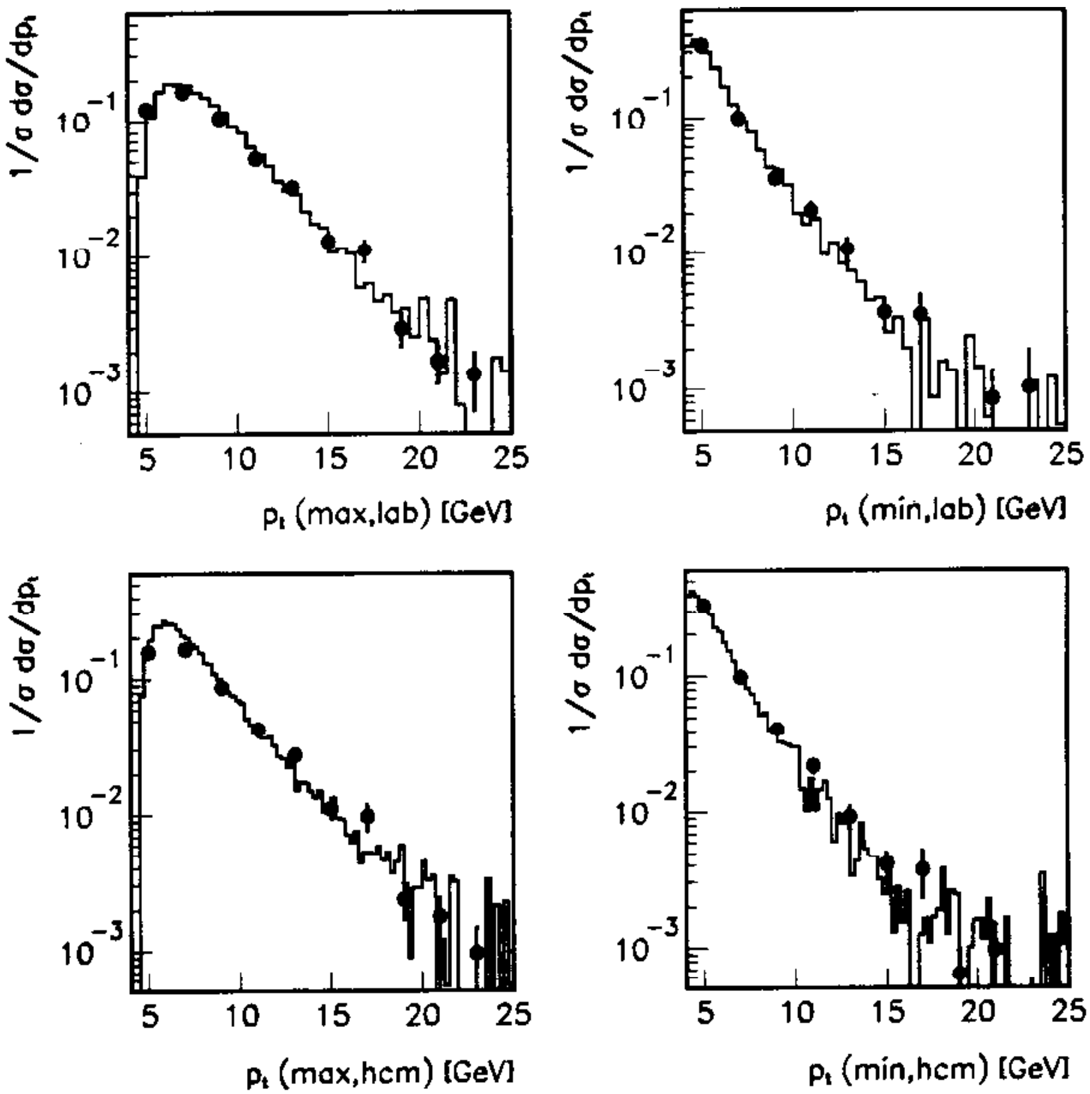


ZEUS 1994 - Preliminary



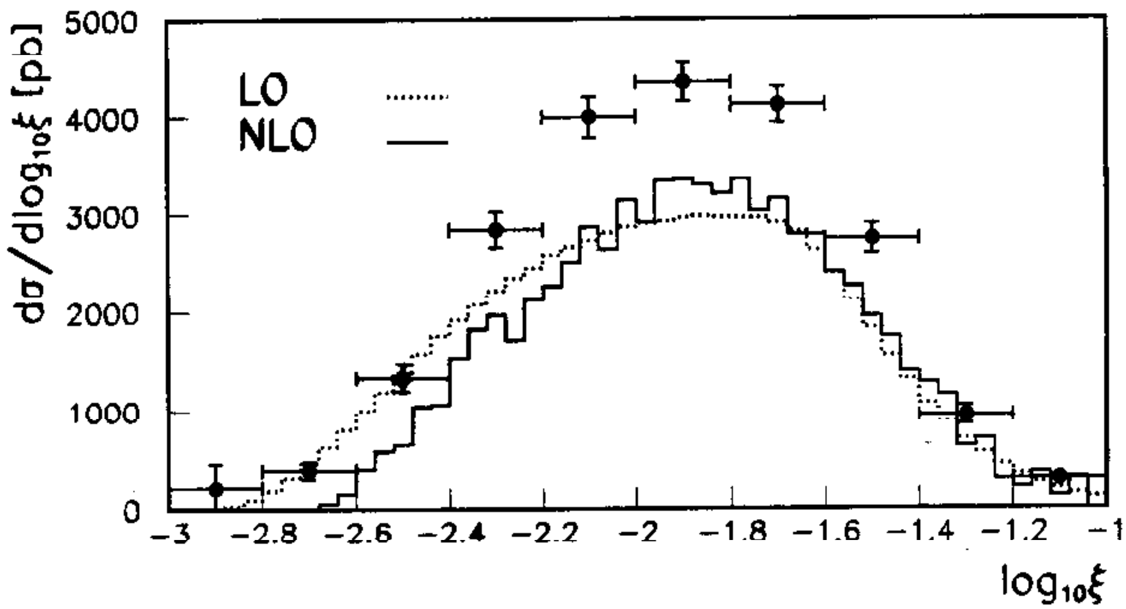
Comparison of data with Mepjet

ZEUS 1994 Preliminary



Comparison with Mepjet (NLO)

Measured and Calculated Dijet Cross Sections



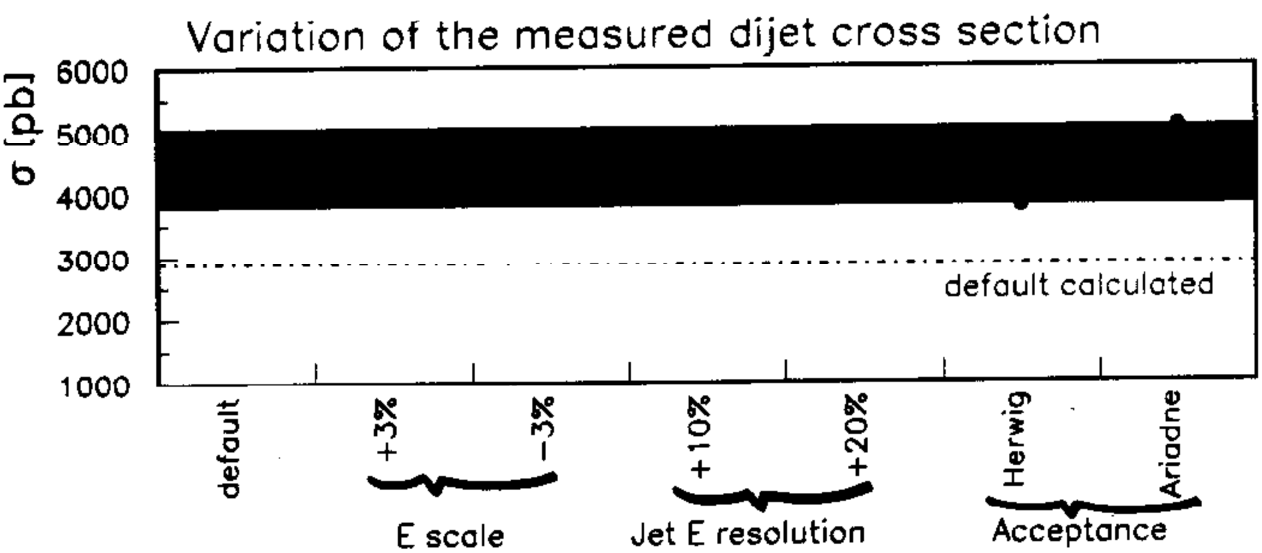
→ The NLO calculation describes well the shape of the measured cross section, but the calculated cross section is approximately 34% smaller than the measured one.

What we varied
in the measurement:

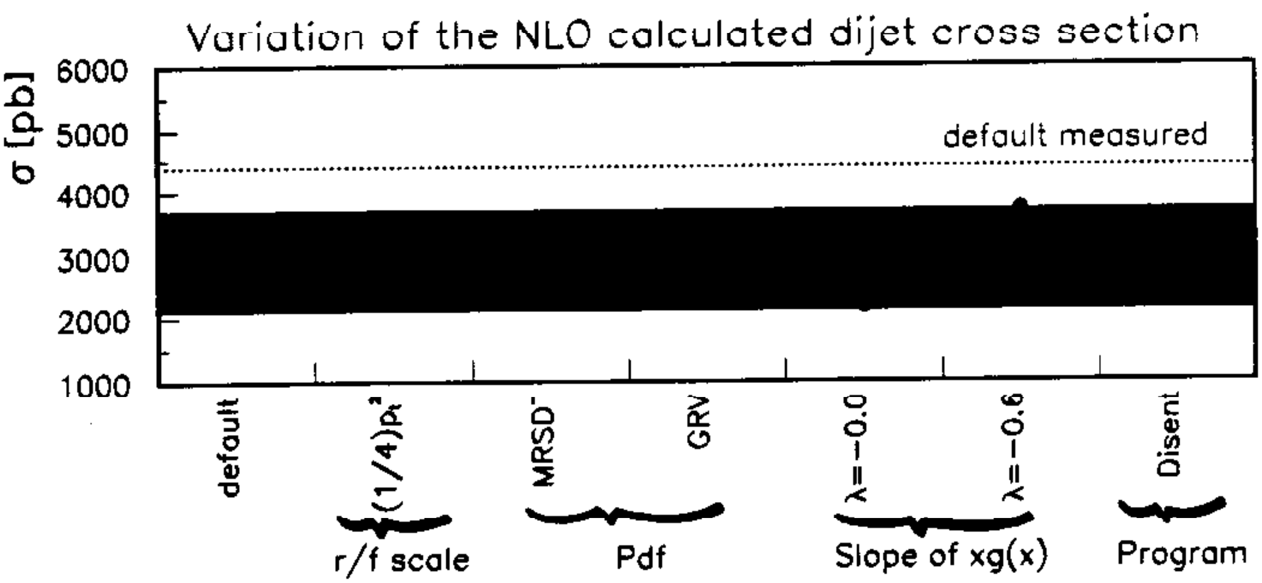
- calorimeter energy scale(±3%)
- jet energy resolution(10% 20%)
- Monte Carlo (Herwig Ariadne)

What we varied
in the calculation:

- factorization/renormalization scale(P_T)
- input P.D.F.s (GRV,MRSD$^-$)



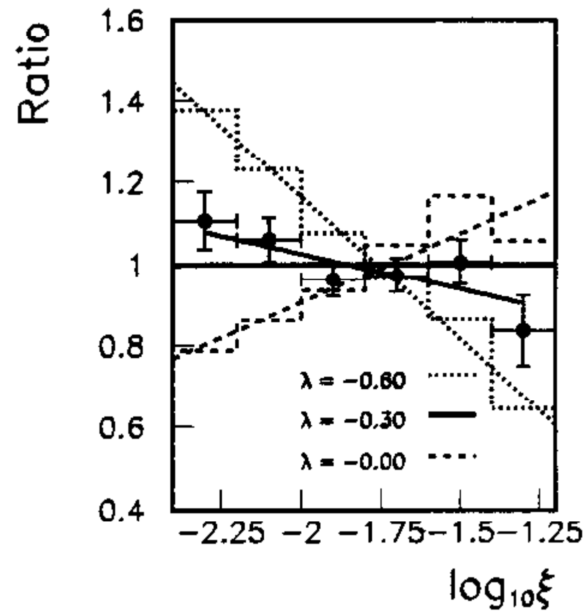
Variation of the measured dijet cross section
σ [pb]
6000
5000
4000
3000
2000
1000
default calculated
default
+3%
-3%
+10%
+20%
Herwig
Ariadne
E scale
Jet E resolution
Acceptance



Variation of the NLO calculated dijet cross section
σ [pb]
6000
5000
4000
3000
2000
1000
default measured
default
(1/4)p_t^2
MRSD-
GRV
λ=-0.0
λ=-0.6
Disent
r/f scale
Pdf
Slope of xg(x)
Program

ZEUS 1994 - Preliminary

Extract λ from shape of cross section



$$\text{Ratio} = \frac{\sigma_{NORM}(\text{data}, \lambda=0.0, -0.3, -0.6)}{\sigma_{norm}(\lambda=-0.3)}$$

$$\lambda_{meas} = 0.38 \pm 0.04 \pm 0.18$$

at $Q^2 = 4\ \text{GeV}^2$

Summary and Conclusions

- ◇ **Measurement of differential dijet cross sections**

  $7 < Q^2 < 100 \text{ GeV}^2$
  $y > 0.04$
  $E'_e > 10 \text{ GeV}$

- ◇ **Comparison to NLO calculations**

  Mepjet
  in reasonable agreement
  Disent

- ◇ **Shapes of differential cross sections**

  Q^2, x_{BJ}, η_{max}, η_{min}, p_t, ξ
  Well reproduced by calculation

- ◇ **Absolute Rate**

  Data significantly above NLO calculation
  Discrepancy can not easily be explained
  by systematic uncertainty of data and/or
  NLO calculation

- ◇ **Extraction of slope of $xg(x)$**

  $\lambda = 0.38 \pm 0.04 \pm 0.18$