W. Giele

S

α_s-EXTRACTION FROM TEVATRON DATA.

* THIS IS STILL A UNDERDEVELOPED SUBJECT, BUT IT WILL BE QUICKLY DEVELOPING.
* MAIN PROBLEM IS THE PDF'S. IN THIS TALK WE'LL TAKE MRSA' WITH VARIABLE α_s.
* WE WILL LOOK AT.

1. CROSS SECTION RATIO'S $\frac{V+\geq n \text{ JETS}}{V+\geq (n-1) \text{ JETS}}$

   (SEE TALK T. JOFFE-MINOR: W/Z + JET PRODUCTIO AT THE TEVATRON)

2. SINGLE JET INCLUSIVE CROSS SECTION $\frac{d\sigma}{dE_T^{JET}}$ ($30\,\text{GeV} \leq E_T \leq 500\,\text{GeV}$; $\sqrt{\hat{s}} \simeq 2E_T$; $x \simeq E_T/900\,\text{GeV}$)

   * SINGLE FIT TO SHAPE: α_s THROUGH PDF SLOPE = EVOLUTION RATE.

   * MEASURE α_s FOR EACH E_T-BIN (OR $\sqrt{\hat{s}}$)
     → "RUNNING OF α_s" FROM $\sqrt{\hat{s}} = 60\,\text{GeV} - 1\,\text{TeV}$
     $\ell_0 = 0.1\,\text{FM} - 0.01\,\text{F}$

3. EXTRACTING α_s.

← MEASURING α_s IN PRINCIPLE EASY

$$\underset{\text{DATA}}{\mathcal{O}} = \alpha_s^n(\mu)\,\big(1 + \alpha_s(\mu)\,\underbrace{a_1^{(n)}} + \alpha_s^2(\mu)\,\underbrace{a_2(\mu)} + \dots\big)\,\underbrace{a_0}_{\text{THEORY}}$$

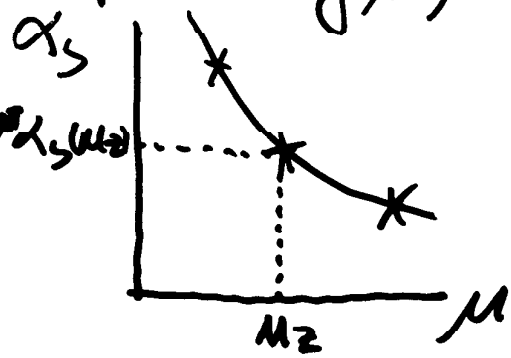
LO: SOLVE $\mathcal{O} = \alpha_s^n(\mu)\, a_0 \quad \Rightarrow \alpha_s^{LO}$

$\mathcal{O} = \alpha_s^n(\mu)\,(1+\alpha_s(\mu)\,a_1(\mu))\,a_0 \Rightarrow \alpha_s^{NLO}(\mu$

$\vdots$

$\alpha_s(\mu) \xrightarrow{\text{EVOLVE}} \alpha_s(M_Z)$ (independent of μ)

$\alpha_s(M_Z)$ SHOULD BE INDEPENDENT OF μ-choice.



IF WE HAVE INITIAL STATE COLLIDING HADRONS WE HAVE PDF'S. THE PDF'S WERE DETERMINED and evolved ASSUMING A CERTAIN VALUE OF α_s. THIS COMPLICATES α_s-EXTRACTION SLIGHTLY.

METHOD 2: ONE JET INCLUSIVE TRANSVERSE ENERGY DISTRIBUTION

* Most basic DISTRIBUTION IN HADRON COLLIDERS

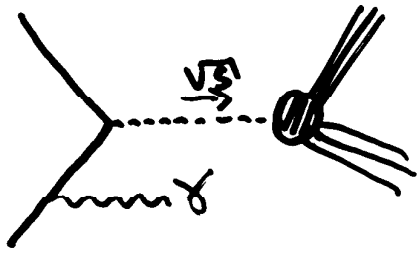
* LARGE RANGE OF E_T: $45\ \text{GeV} \lesssim E_T \lesssim 500\ \text{GeV}$

$\Rightarrow 90\ \text{GeV} \lesssim \sqrt{s} \lesssim 1000\ \text{GeV}$

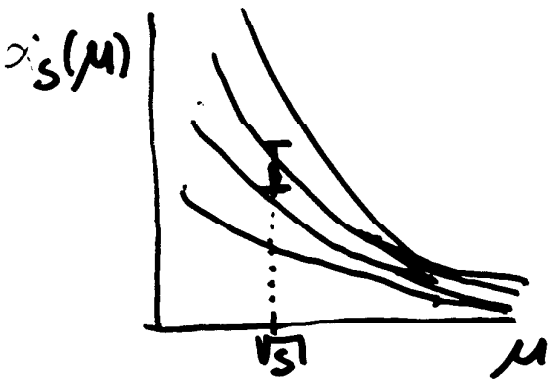
* THE e^+e^--EQUIVALENT WOULD BE MEASURING

α_s IN E.G. σ_{HADRONIC} FOR $\sqrt{s} = 90\ \text{GeV} \rightsquigarrow \sqrt{s} = 1\ \text{TeV}$

OR USE A $\sqrt{s} = 1\ \text{TeV}$ COLLIDER AND USE INITIAL STATE PHOTON EVENT TO "LOWER" HADRONIC FINAL STATE INVARIANT MASS.



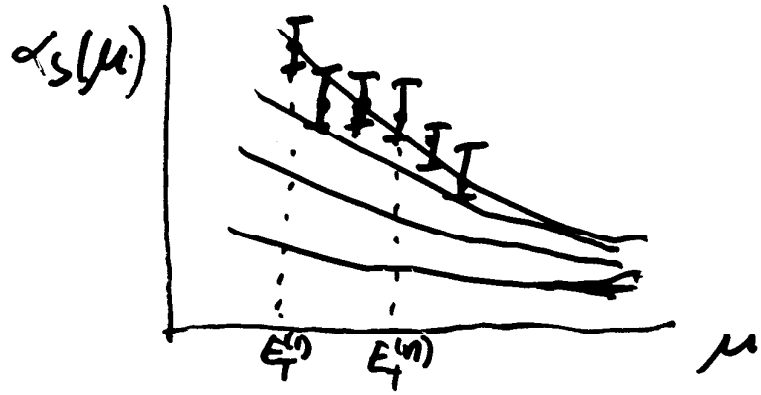
e^+e^-



FIXED $\sqrt{s}$

→ α_s DETERMINED BASED ON EVENT RATE

$p\bar{p}$



VARIABLE $\sqrt{s} \propto E_T$

→ α_s DETERMINATION BASED ON BOT NORMALIZATION (= EVENT RATE) AND EVOLUTION RATE. THESE TWO ARE CLOSELY CORRELATED (SHAPE & NORMALIZATION OF ONE JET INCLUSIVE DISTRIBUTION

⇓

GIVES SEVERE CONSTRAINTS ON CONSISTENCY OF DATA WITH QC

* THE DEPENDENCE OF THE ONE-JET INCLUSIVE TRANSVE ENERGY DISTRIBUTION ON α_s IS QUITE COMPLICATEI TWO (COMPETING) EFFECTS:

1) α_s CHANGES THE NORMALIZATION
2) α_s CHANGES THE EVOLUTION RATE OF THE PDF'S (IE A SMALLER α_s GIVE MORE VALENCE QUARKS FOR HIGH Q: (FIG 8).

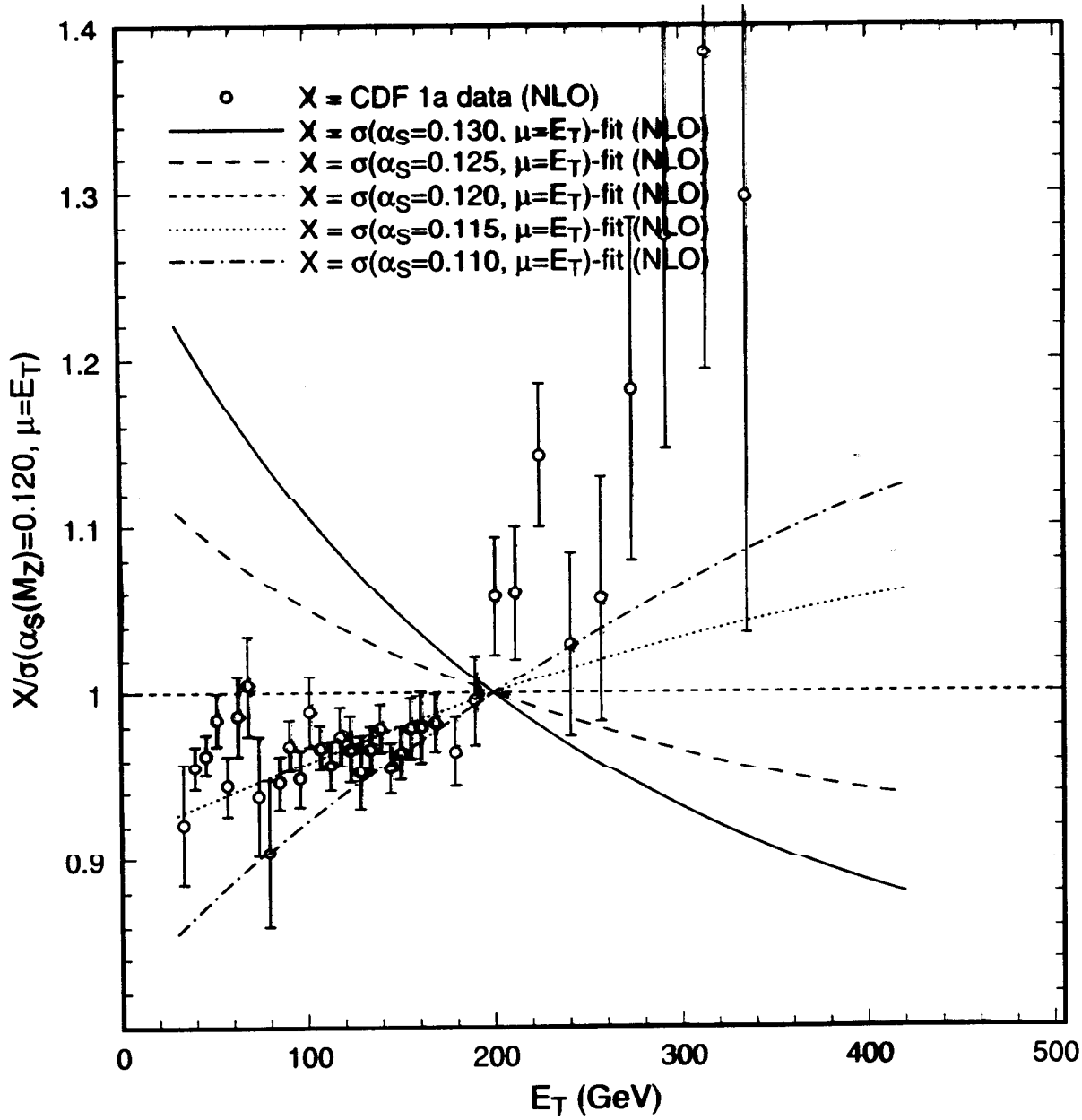
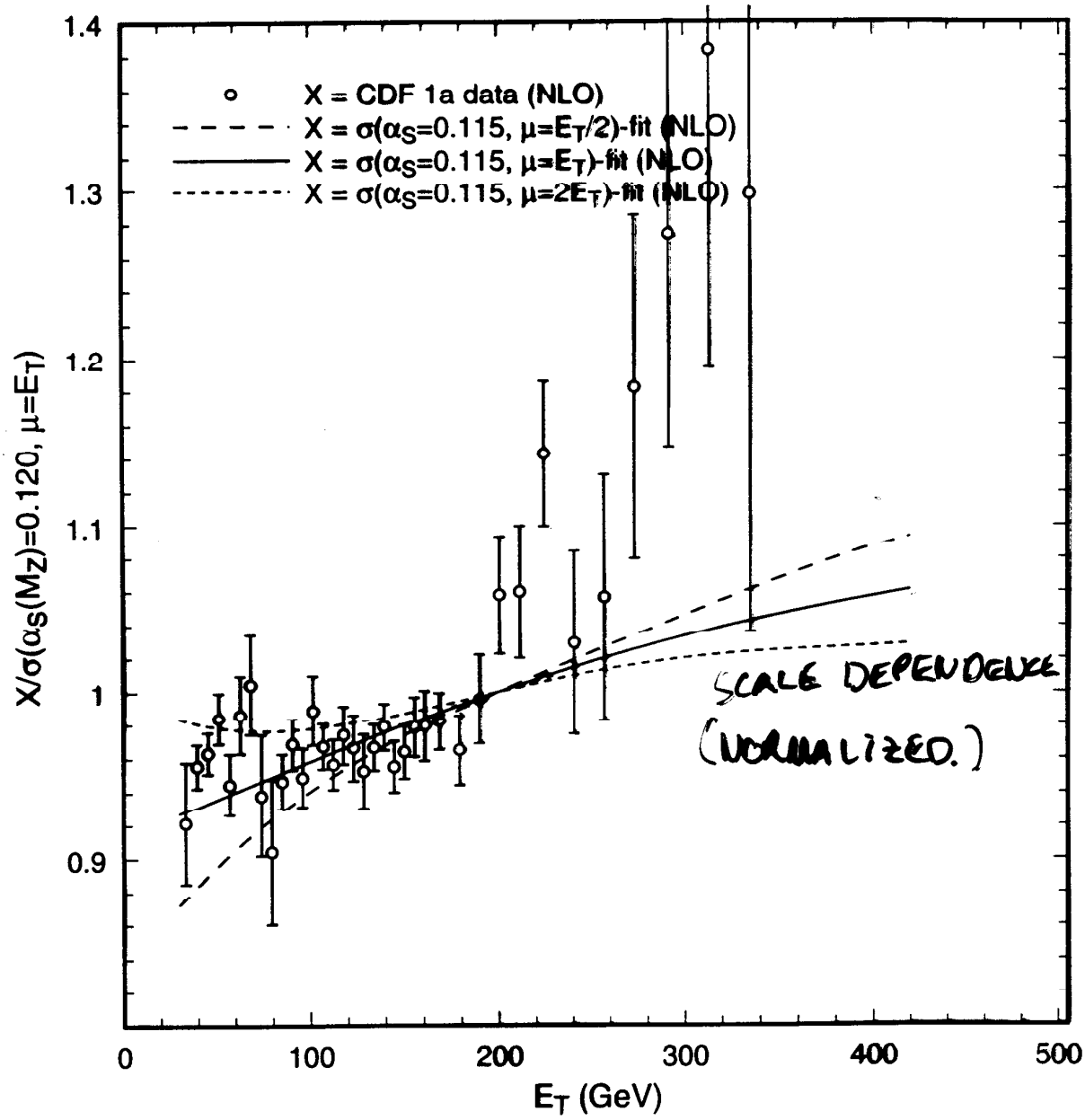
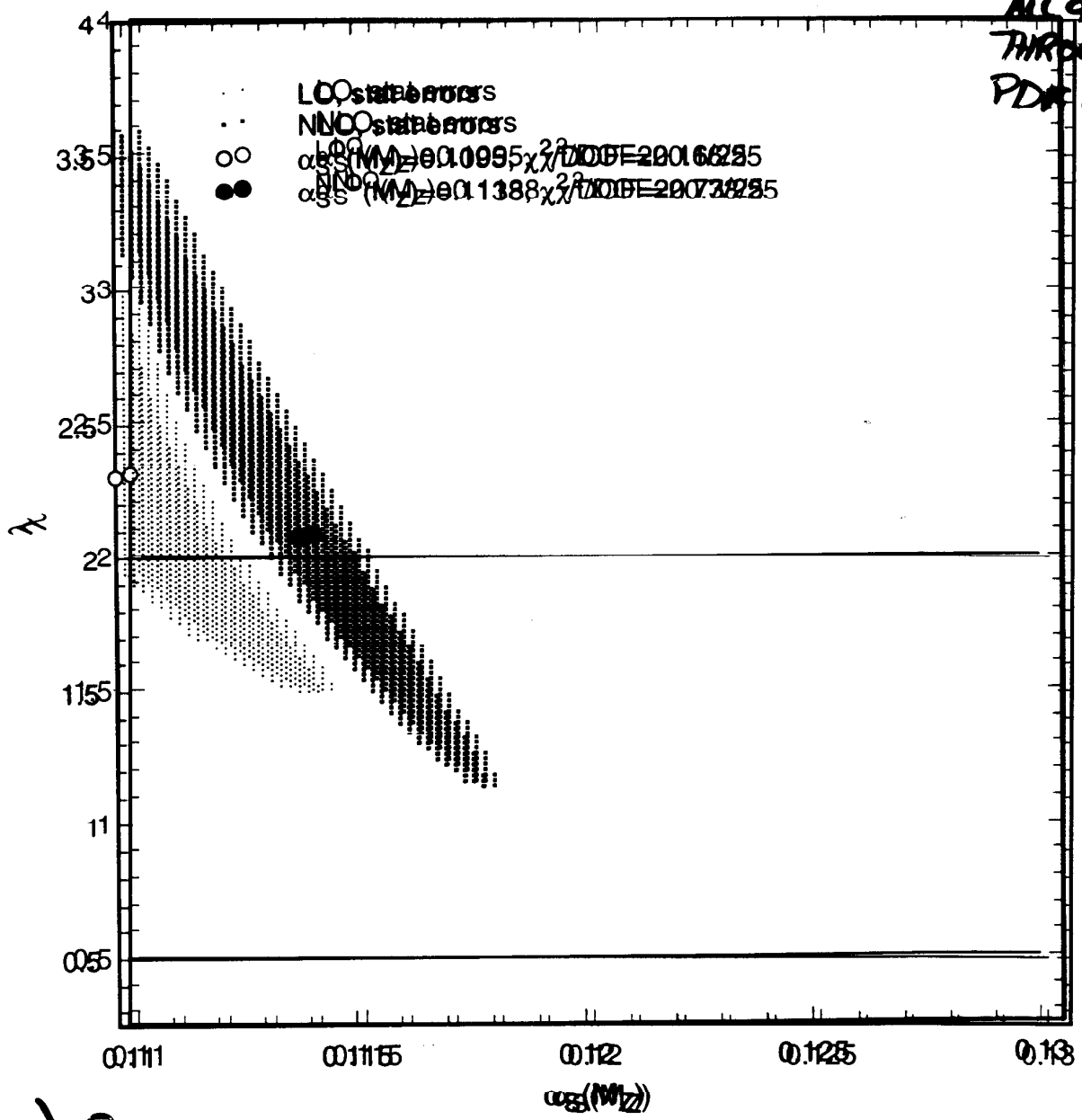

X = CDF 1a data (NLO)
X = σ(αS=0.130, μ=ET)-fit (NLO)
X = σ(αS=0.125, μ=ET)-fit (NLO)
X = σ(αS=0.120, μ=ET)-fit (NLO)
X = σ(αS=0.115, μ=ET)-fit (NLO)
X = σ(αS=0.110, μ=ET)-fit (NLO)
X/σ(αS(MZ)=0.120, μ=ET)
ET (GeV)
1.4
1.3
1.2
1.1
1
0.9
0
100
200
300
400
500

Fig 2.


X = CDF 1a data (NLO)
X = σ(αS=0.115, μ=ET/2)-fit (NLO)
X = σ(αS=0.115, μ=ET)-fit (NLO)
X = σ(αS=0.115, μ=2ET)-fit (NLO)
X/σ(αS(MZ)=0.120, μ=ET)
ET (GeV)
1.4
1.3
1.2
1.1
1
0.9
0
100
200
300
400
500
SCALE DEPENDENCE
(NORMALIZED.)

FLOATING NORMALIZATION! $\frac{1}{\sigma}\frac{d\sigma}{dq} \sim A + \alpha_s B$

ALL α_s-DEPE
THROUGH
PDF EVOLUTIO

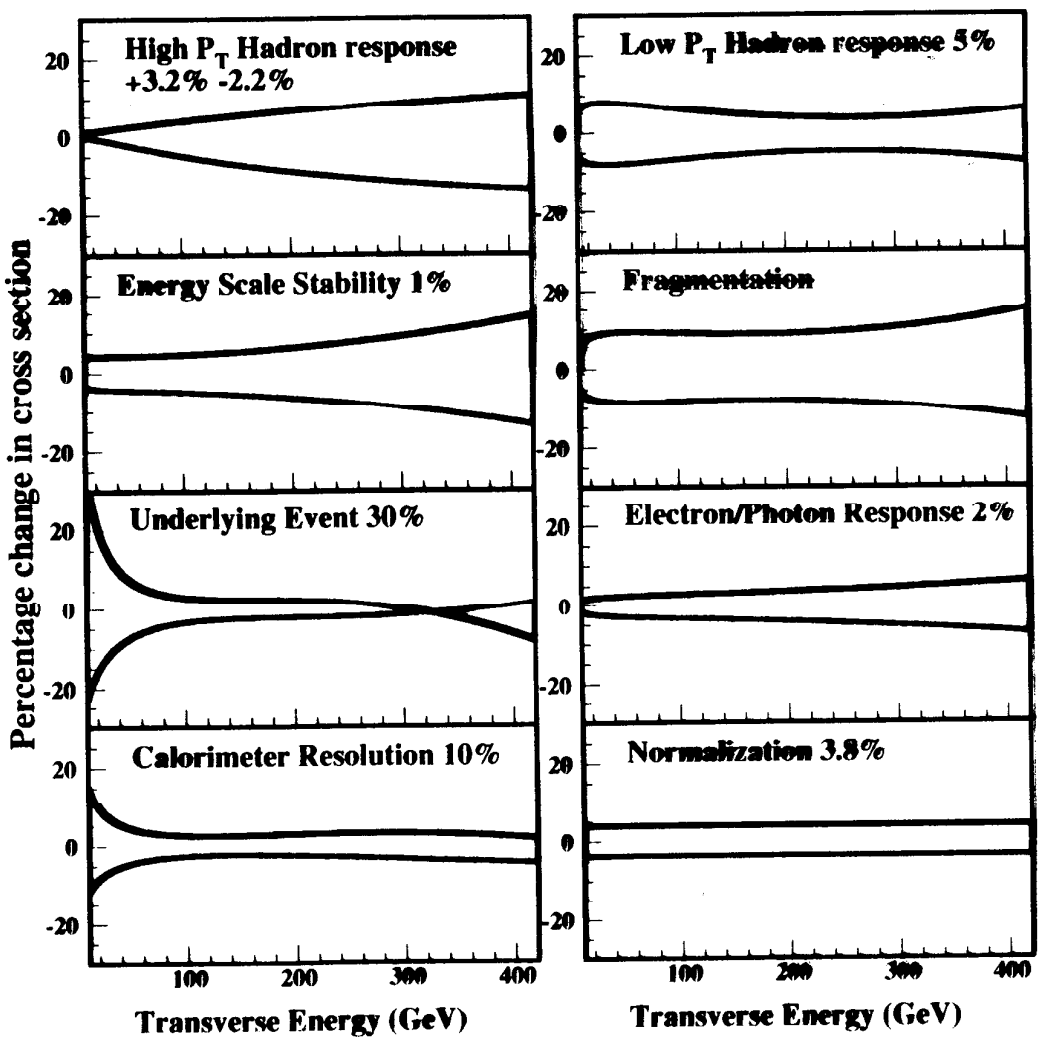


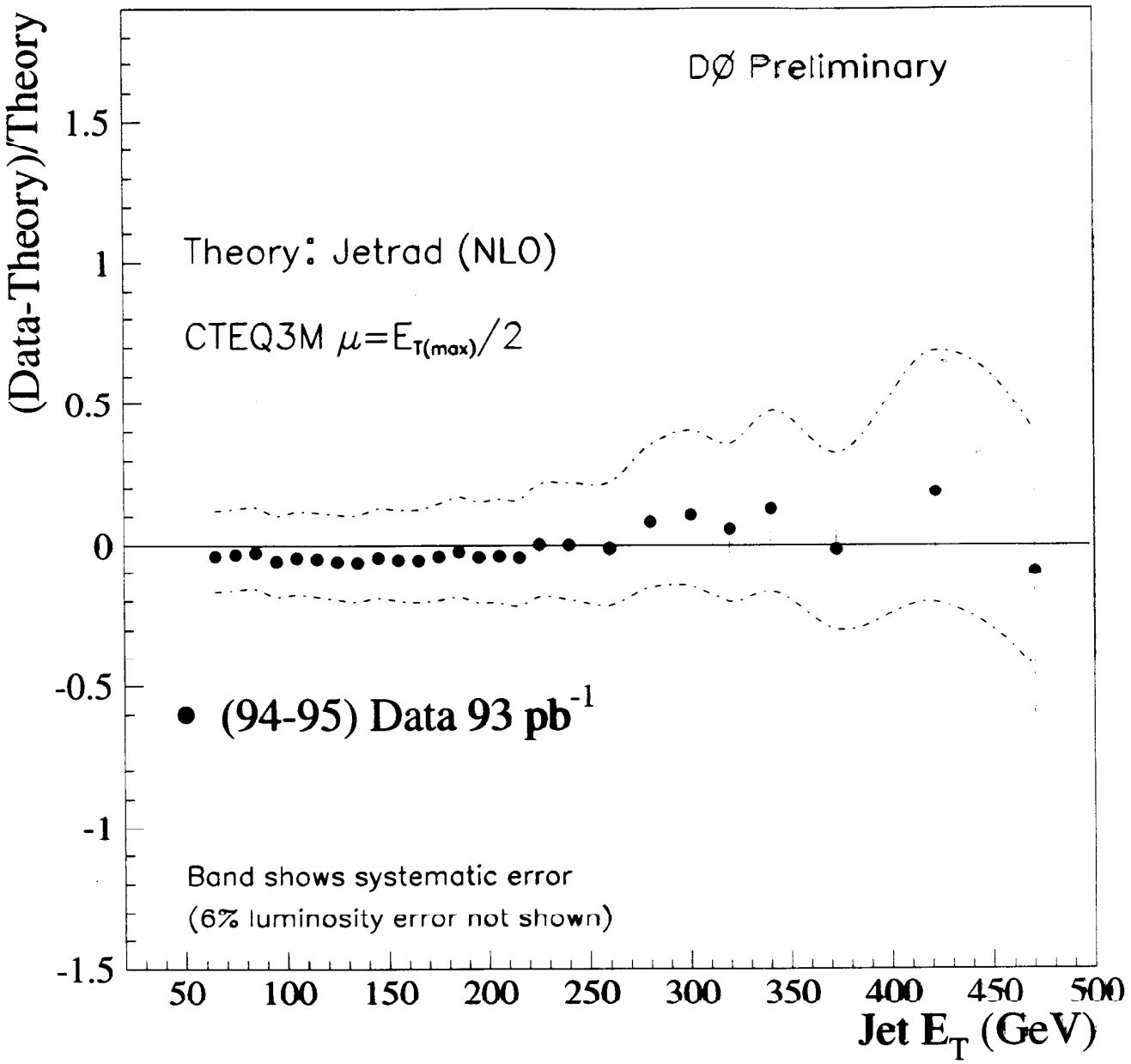
$\mu = \lambda E_T$.

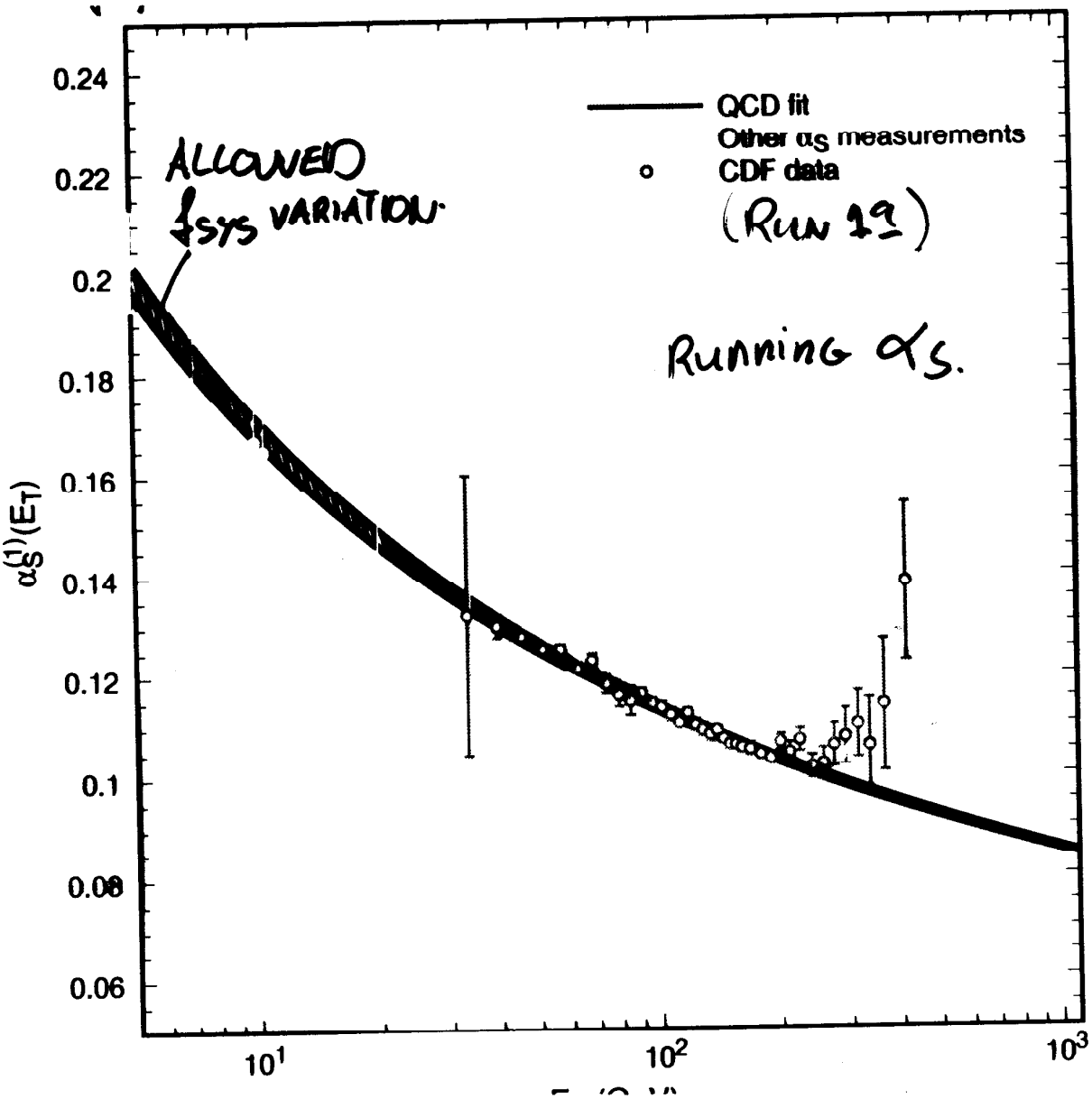
$30\,\text{GeV} < E_T < 200\,\text{GeV}$

Systematic Errors

1)Evaluate change in Response Functions
2)Use new Response Functions to derive New Physics curve
3)Compare to "Standard Curve"




DØ Preliminary
Theory: Jetrad (NLO)
CTEQ3M $\mu = E_{T(max)}/2$
(94-95) Data 93 pb^{-1}
Band shows systematic error
(6% luminosity error not shown)
(Data-Theory)/Theory
1.5
1
0.5
0
-0.5
-1
-1.5
50
100
150
200
250
300
350
400
450
500
Jet E_T (GeV)



$\alpha_S(M_Z) = 0.11$ [redacted] ± 0.0003 (STAT) [redacted] (SYS).

Ref.

FIG. 8