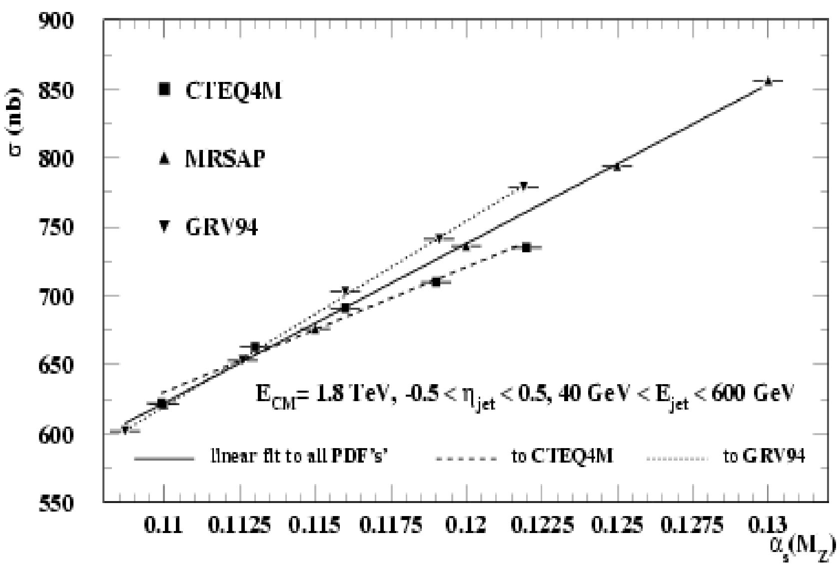
α_s from jet production at hadron colliders

Hasko Stenzel

HERA-LHC workshop – October 11-13, 2004

Outline

- Introduction
- single inclusive jet cross section
- α_S dependence of the total cross sections
- sensitivity of differential jet cross section α_S
- parameterisation of the differential cross section
- extraction of α_S
- systematic uncertainties
- Conclusion



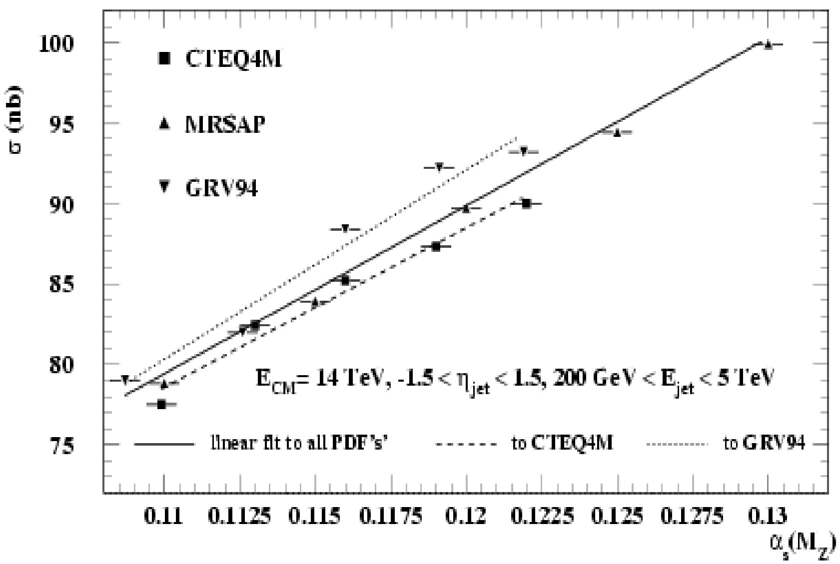
Introduction

Master Formula:

$$\sigma(pp) \to jets + X =$$

$$\sum_{a,b} \int dx_1 dx_2 f_a\left(x_1, Q^2, \alpha_s\right) f_b\left(x_2, Q^2, \alpha_s\right) \hat{\sigma}_{ab}\left(x_1 p_1, x_2 p_2, Q^2, \alpha_s\right)$$

$$\hat{\sigma}_{ab} = a \cdot \hat{\sigma}_{LO} \cdot \alpha_s^2 + b(\mu) \cdot \hat{\sigma}_{NLO} \cdot \alpha_s^3$$

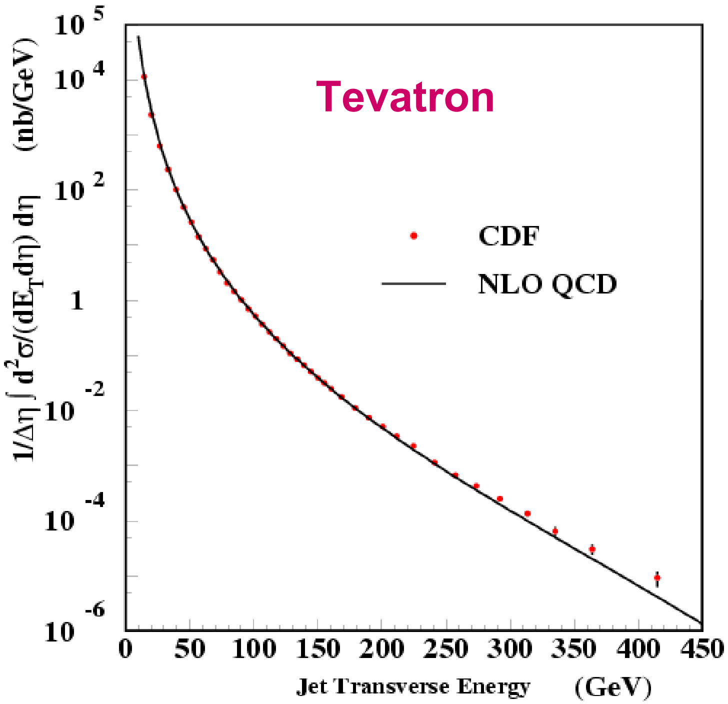


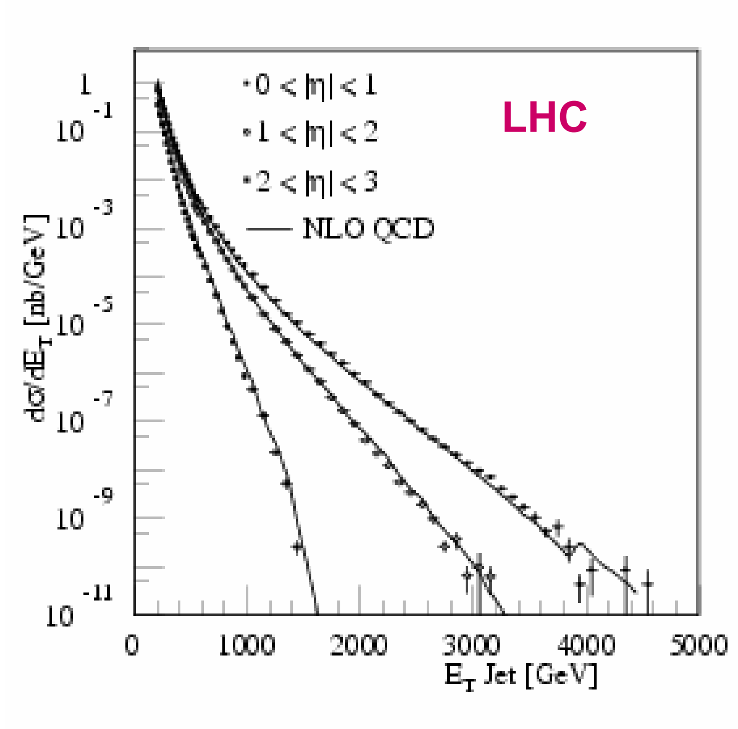
For cross section calculations the same value of α_s should be taken in PDFs and in σ(partonic).

The total cross section exhibits a clear and almost linear dependence on α_s.

➔ sensitivity to α_s !

Single inclusive jet cross section

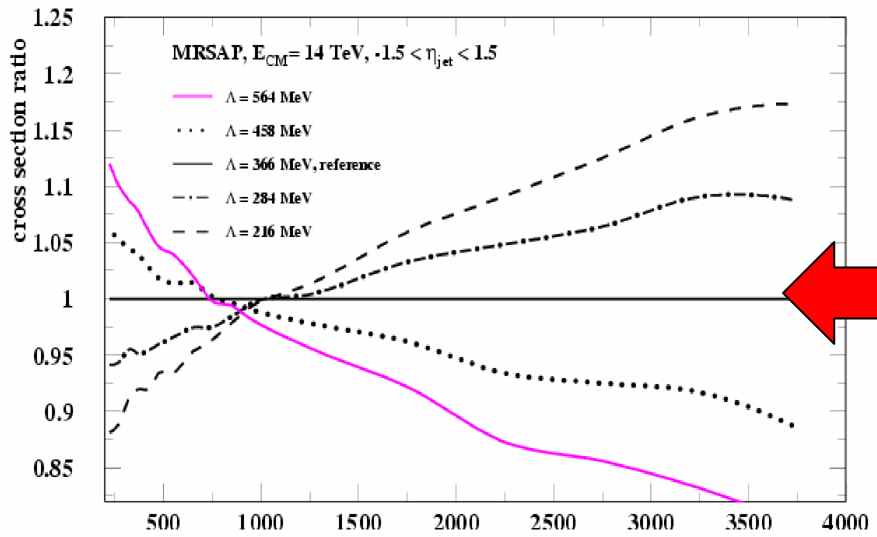


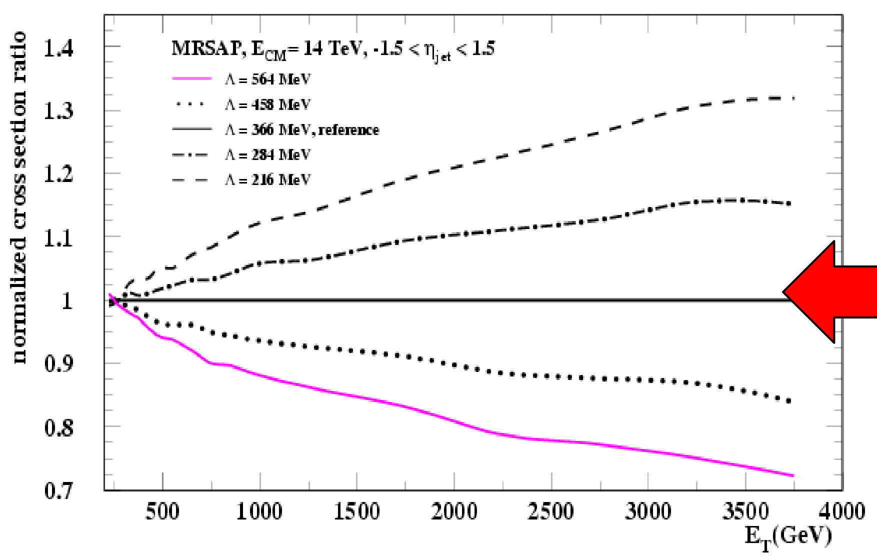


Jet finding: Cone algorithm R=0.7

Theoretical calculation: DYRAD NLO and $\mu_R = \mu_F = E_{T,jet}$

Sensitivity of differential jet cross section to α_s





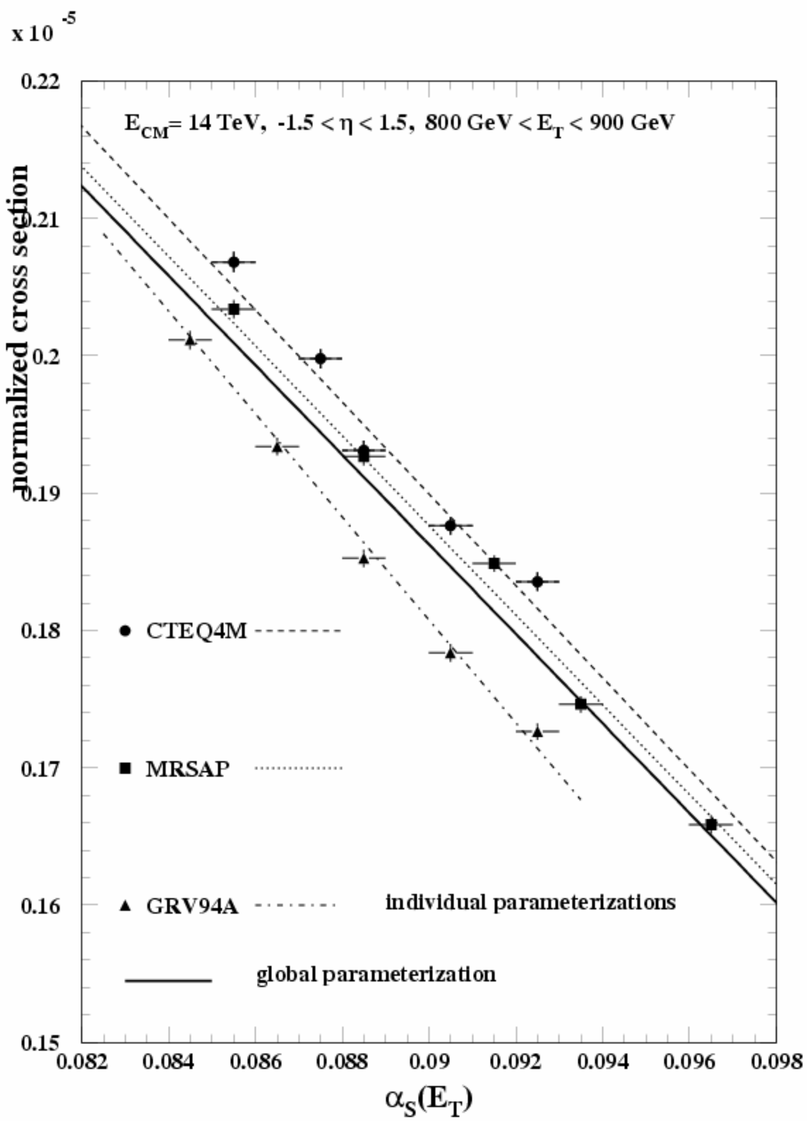
Ratio of cross sections for different Λ , MRSAP case

Region of weak sensistivity to α_s between 700 and 1100 GeV!

Consider normalised cross section choosing integrated cross section as normalisation point.

Experimental uncertainty on luminosity cancels!

Parameterisation of normalised cross section



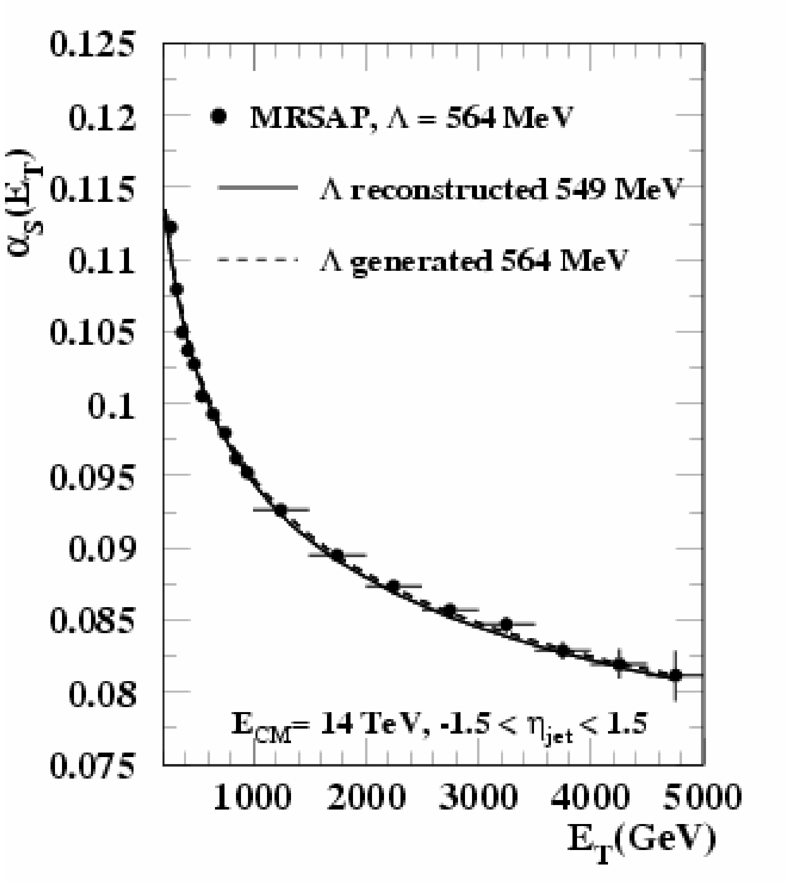
Linear parameterisation in each bin of E_T

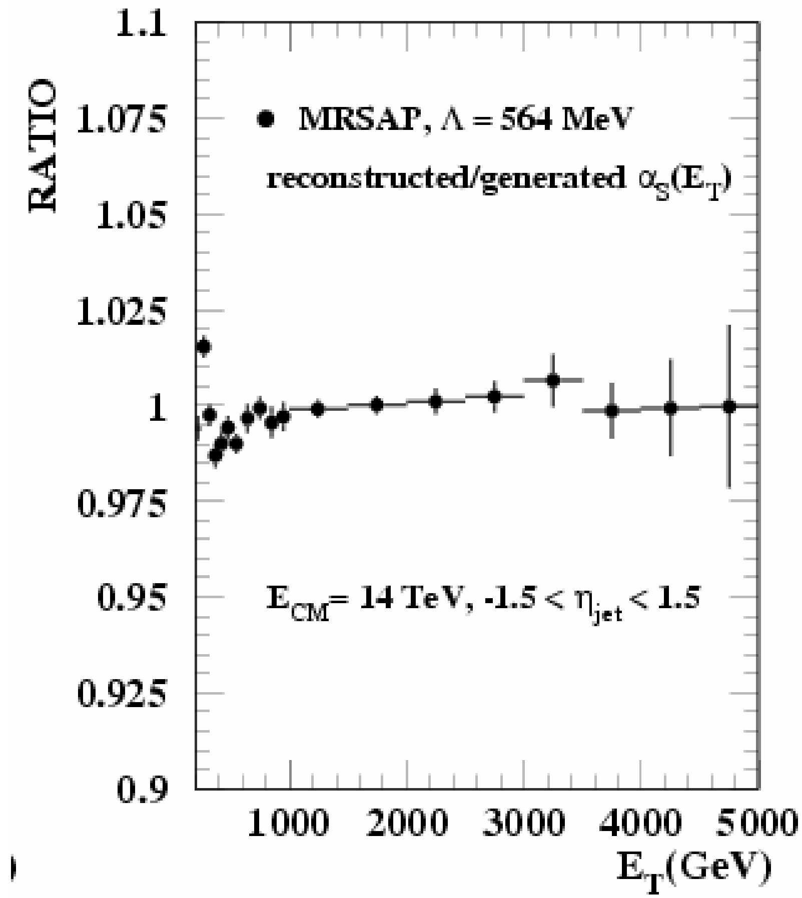
$$\sigma_{jets}(E_T, \alpha_s) = A(E_T) + B(E_T) \cdot \alpha_s$$

Extraction of α_s from a given cross section measurement

$$\alpha_s(E_T) = \frac{\sigma_{jets}(E_T) - a(E_T)}{b(E_T)}$$

Test of the parameterisation: extraction of α_s





Global parameterisation used to extract $\alpha_s(E_T)$ from MRSAP 'data'

Ratio of extracted/generated (PDF)Λ

Systematic uncertainties for α_s : PDF

PDF	TEVATRON 0.1<|η|<0.7	LHC 0.0<|η|<1.5
CTEQ4M	+0.0020	+0.0023
GRV94	-0.0015	-0.0028
MRSAP	-0.0011	+0.0006

Systematic uncertainty related to the functional form

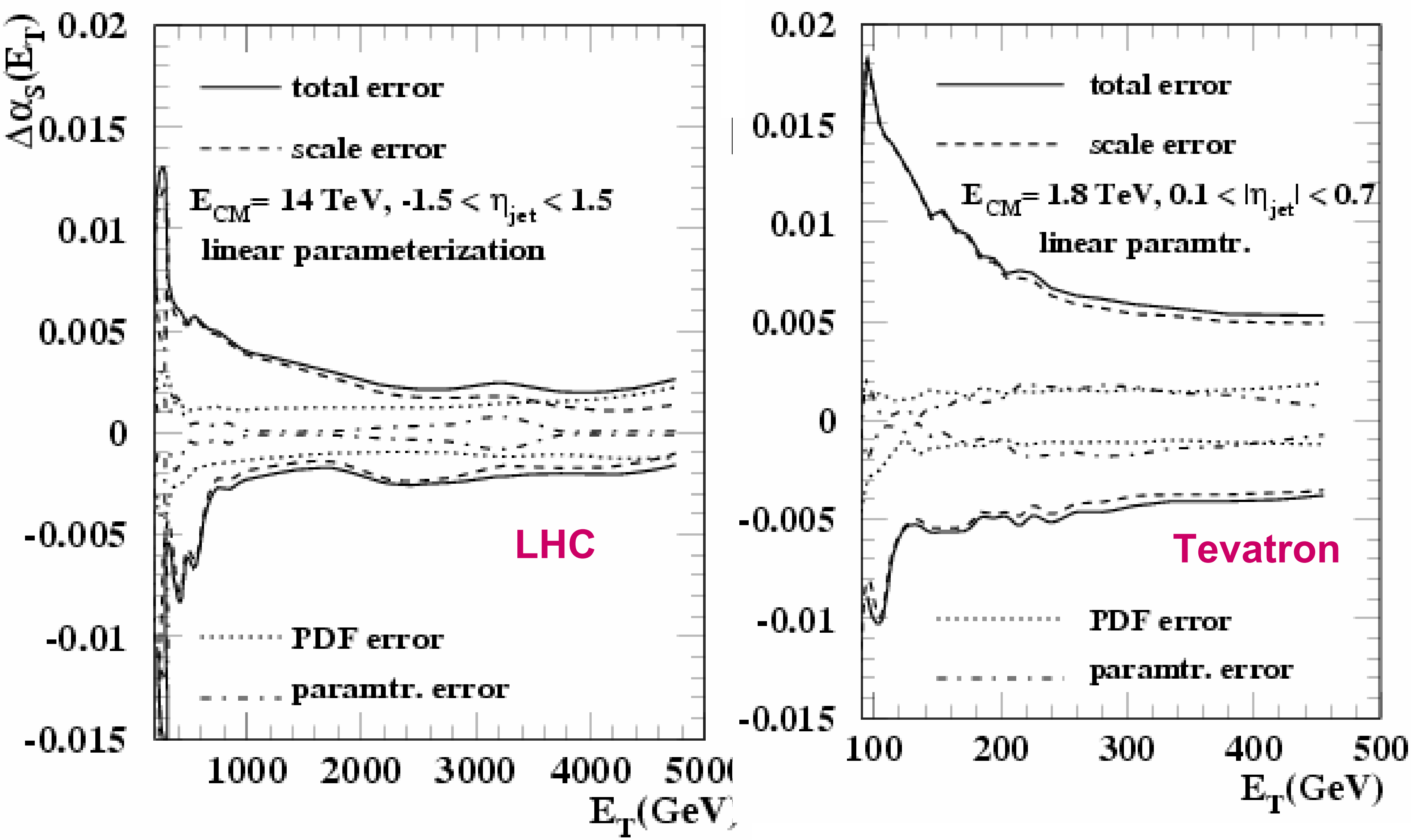
CTEQ4M	0.0009	0.0002
GRV94	0.0014	0.0002
MRSAP	0.0011	0.0006

Systematic uncertainties for α_s : scales

Variation of renormalisation scale (μ_R) and factorisation scale (μ_F)

Scale	TEVATRON $0.1<\|\eta\|<0.7$	LHC $0.0<\|\eta\|<1.5$
$x\mu_R = x\mu_F = 2.0$	-0.0020	+0.0013
$x\mu_R = 2.0$ $x\mu_F = 0.5$	+0.0098	+0.0068
$x\mu_R = 0.5$ $x\mu_F = 2.0$	-0.0059	-0.0035
$x\mu_R = x\mu_F = 0.5$	+0.0018	-0.0007

Summary of systematic uncertainties

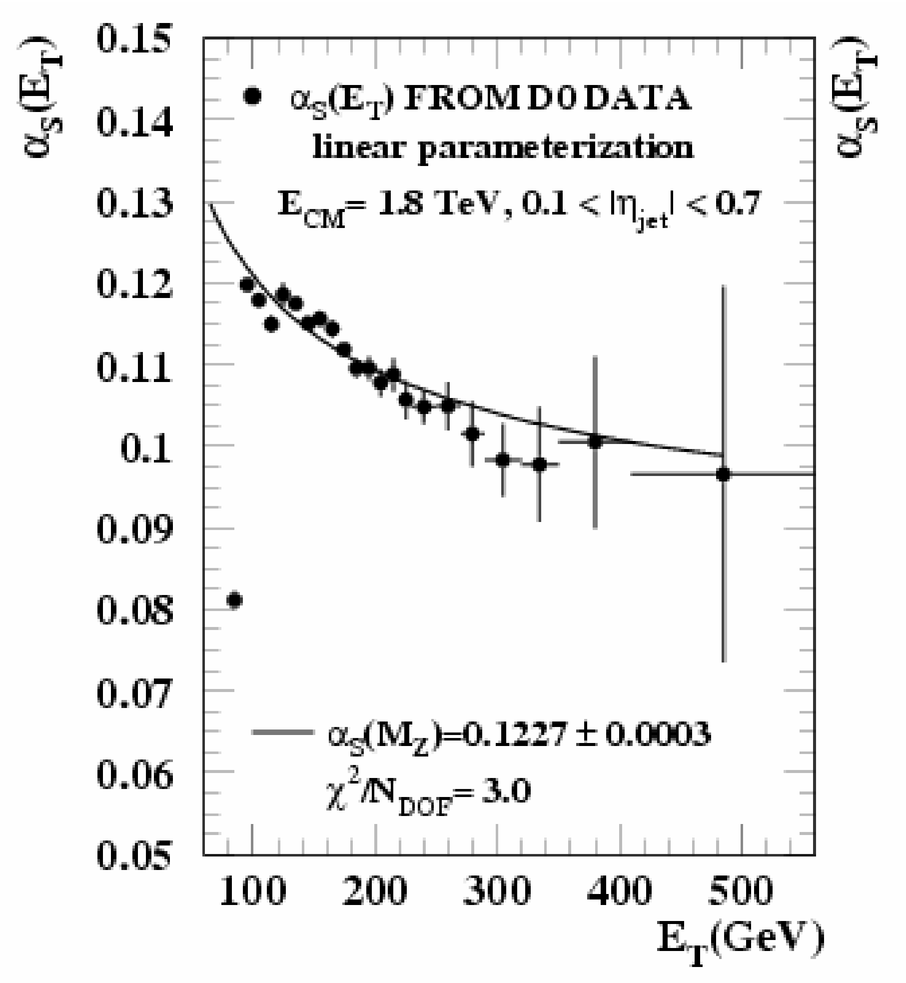


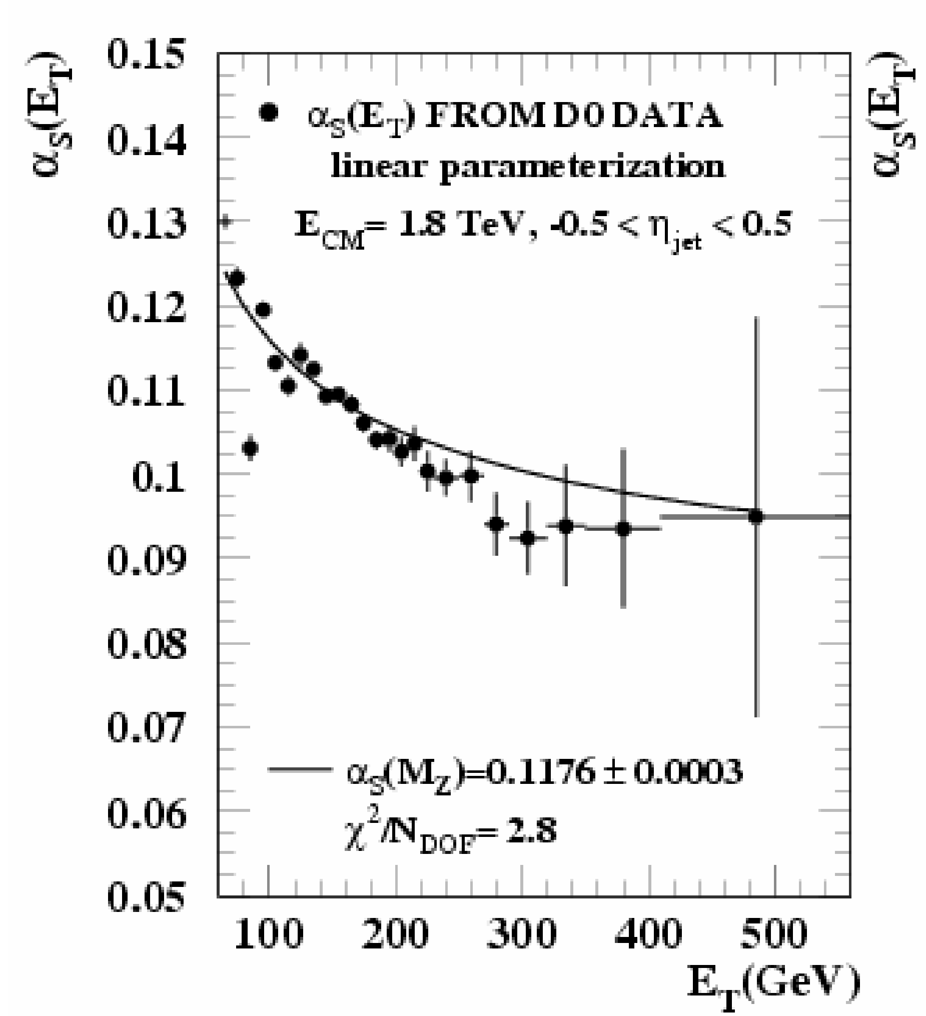
Summary of systematic uncertainties for α_s

Variation of renormalisation scale (μ_R) and factorisation scale (μ_F)

Source	TEVATRON 0.1<|η|<0.7	LHC 0.0<|η|<1.5
PDF	+0.0020 -0.0015	+0.0023 -0.0028
parameterisation	±0.0014	± 0.0006
scales	+0.0098 -0.0059	+0.0068 -0.0036
Total	***+0.0101 -0.0059***	***+0.0072 -0.0045***

Application to TEVATRON data





Test of the method with D0 data from RUN1

Conclusions & Prospects

- Parameterisation of jet cross setions as function of α_s
- Requires PDFs with variable α_s
- Extraction of α_s from normalised differential cross section measurement
- Systematic uncertainties at LHC 5-10%, scale dominated
- Hadronisation corrections to be investigated
- Experimental uncertainty (energy scale, jet algorithm,…) to be evaluated
- Observation of the running of from 300 GeV to 3 TeV