

The CTEQ6 parton distribution functions and jet production at the Tevatron

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.... *Preliminary results*; intended (when finished) for a paper on jet production by a group of CTEQ co-authors (Huston, Kuhlmann, Lai, Owens, Pumplin, Stump, Tung).

The CTEQ6 parton distribution functions ...

... fit, simultaneously,

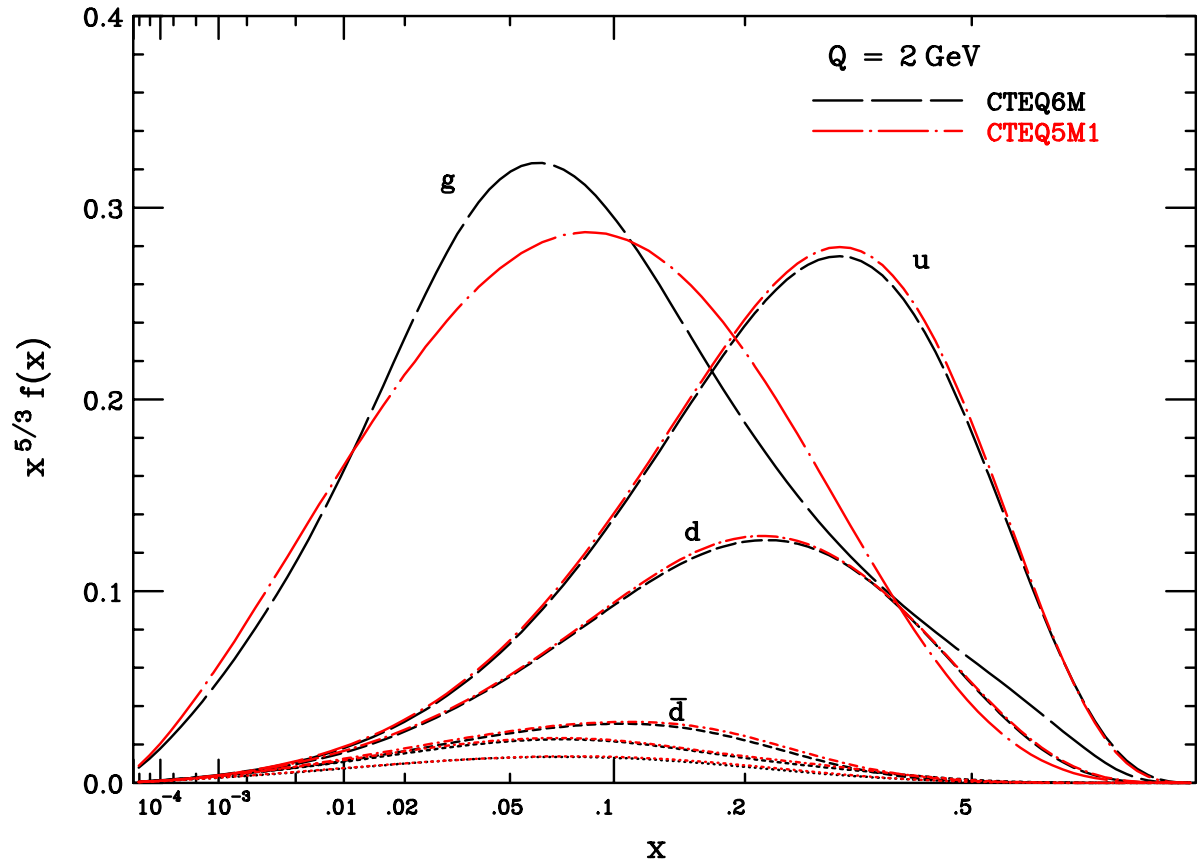
- DIS
- DY
- the inclusive jet cross section

$$\left(\frac{d^2\sigma}{dy dp_T} \right)_{\text{Tevatron}}$$

Ref: Pumplin, *et al*, JHEP07 (2002)

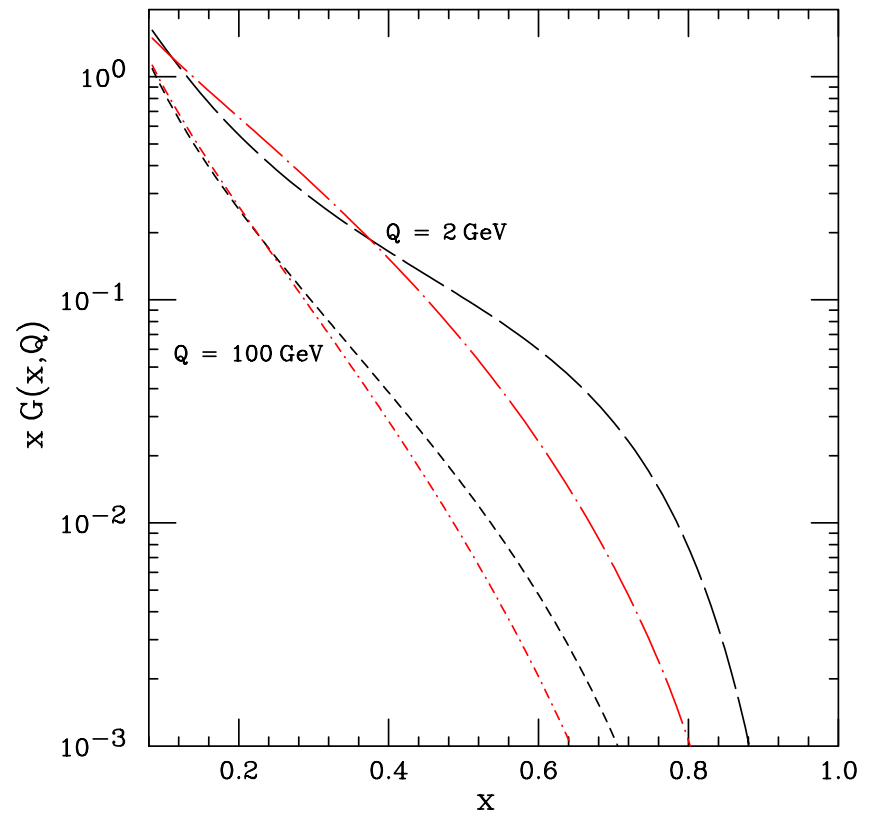
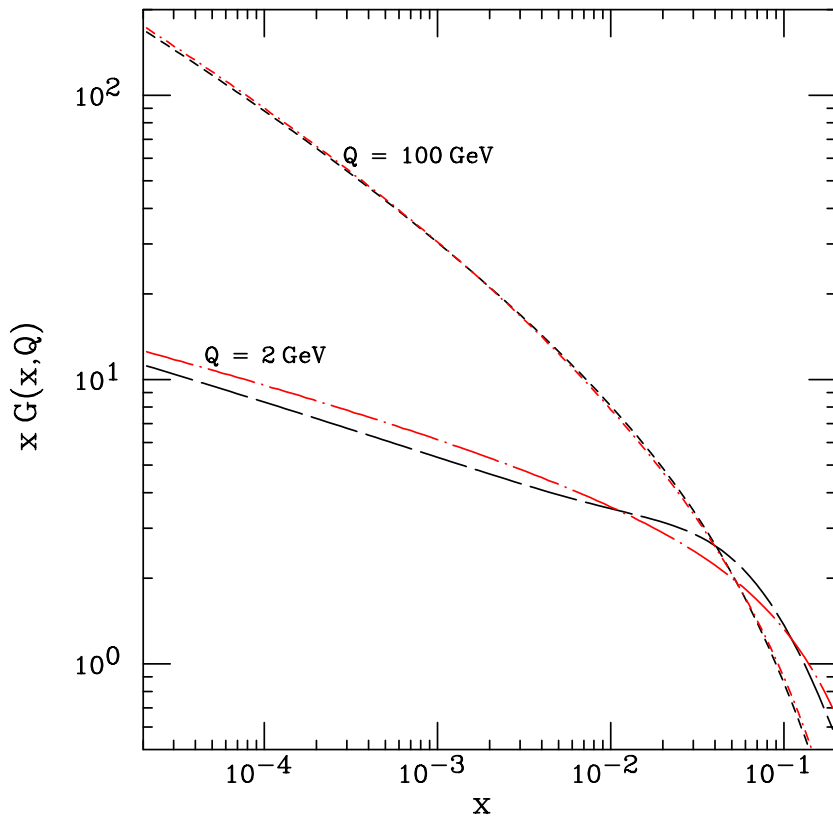
process	data set	χ_e^2/N_e
DIS μp	BCDMS p	378/339
DIS μd	BCDMS d	280/251
DIS ep	H1a	99/104
DIS ep	H1b	129/126
DIS ep	ZEUS	263/229
DIS μp	NMC F2p	305/201
DIS μd	NMC F2d/p	112/123
$p\bar{p} \rightarrow \text{jet}$	DØ jet	69/90
$p\bar{p} \rightarrow \text{jet}$	CDF jet	49/33
process	data set	χ_e^2/N_e
DIS $\nu \text{ Fe}$	CCFR	150/156
DY pp	E605	95/119
DY pd/pp	E866	6/15
$p\bar{p} \rightarrow W$	CDF W	10/11

Comparison of CTEQ5 and CTEQ6

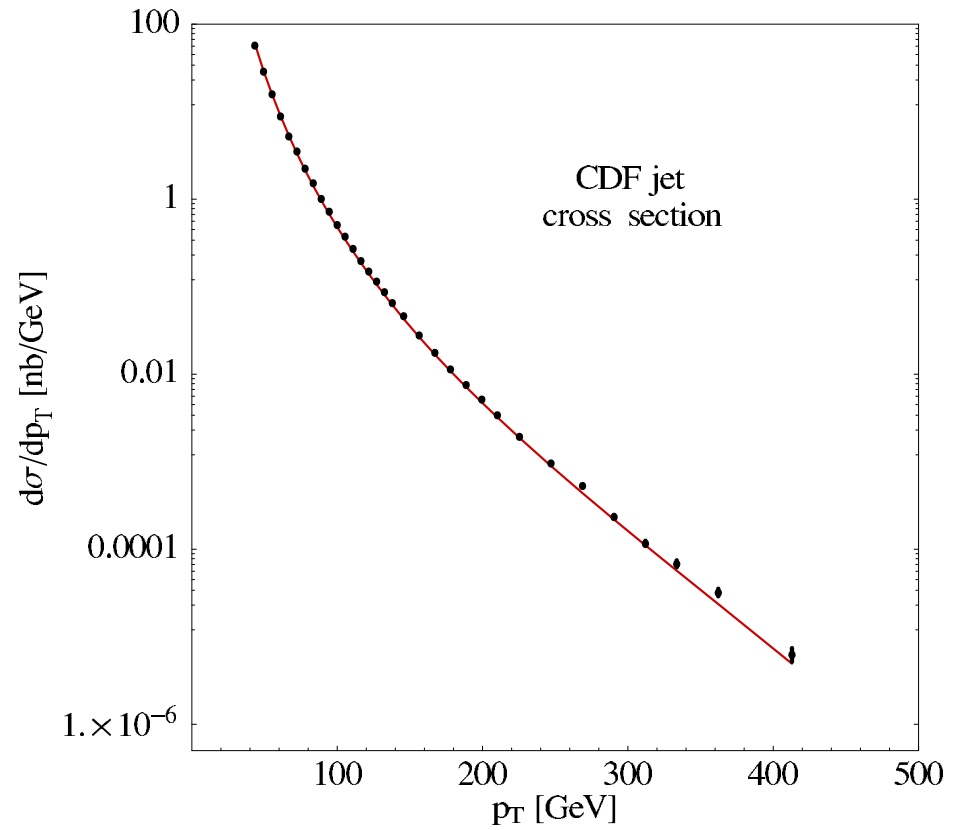
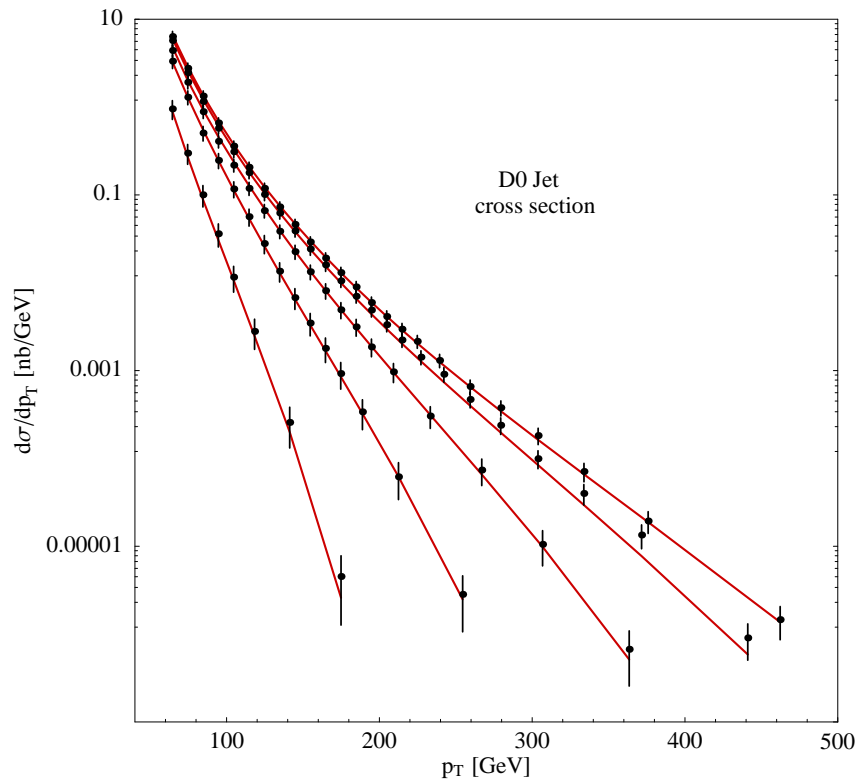


The quarks have not changed much.
The gluon distribution is larger at large x .

The gluon distribution function on a log scale

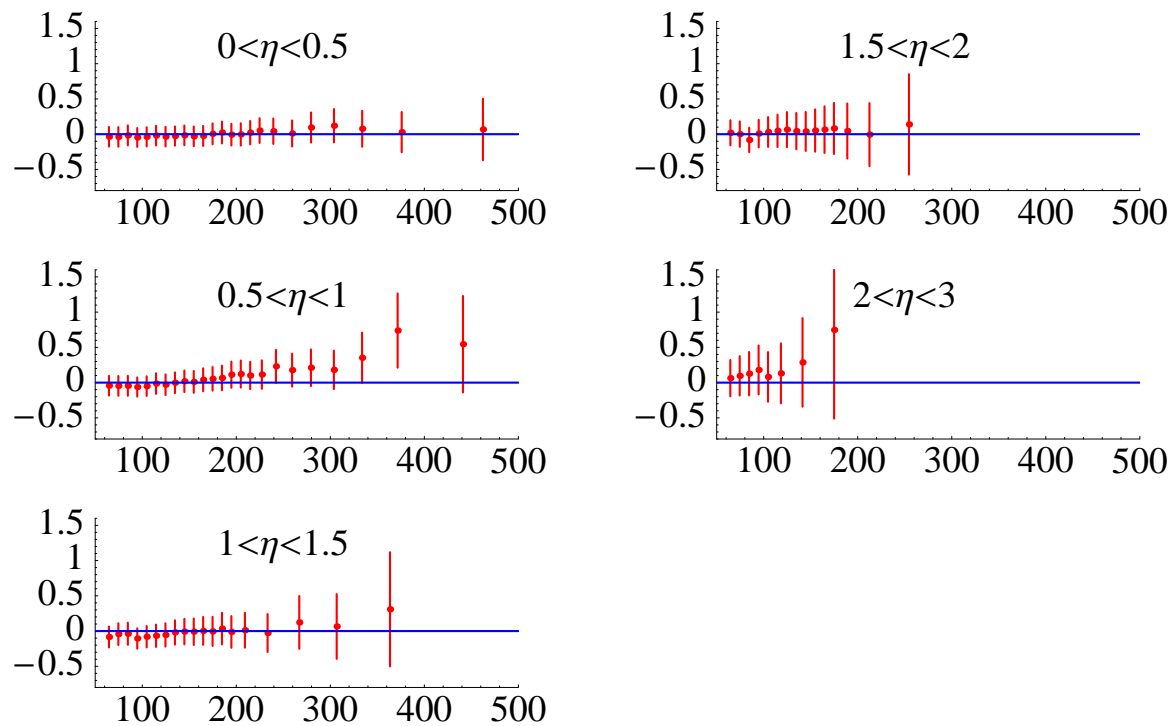


CDF and DØ measurements of jet production

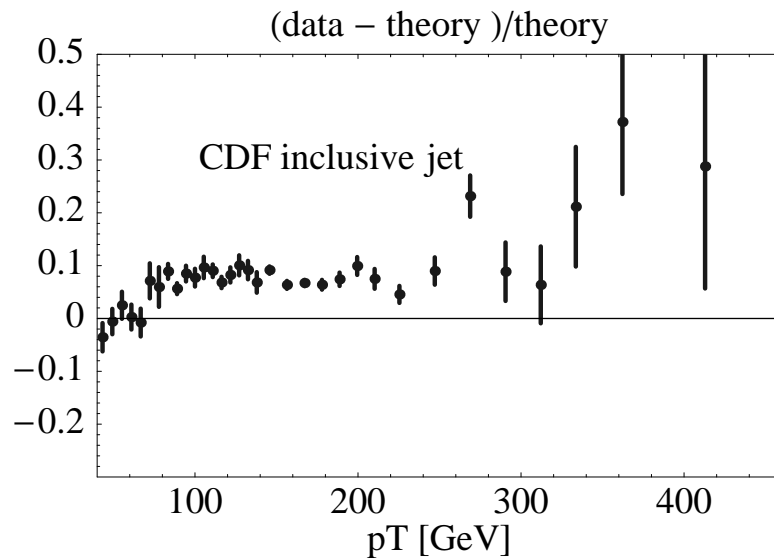


A closer look at the DØ data — the fractional difference between data and theory

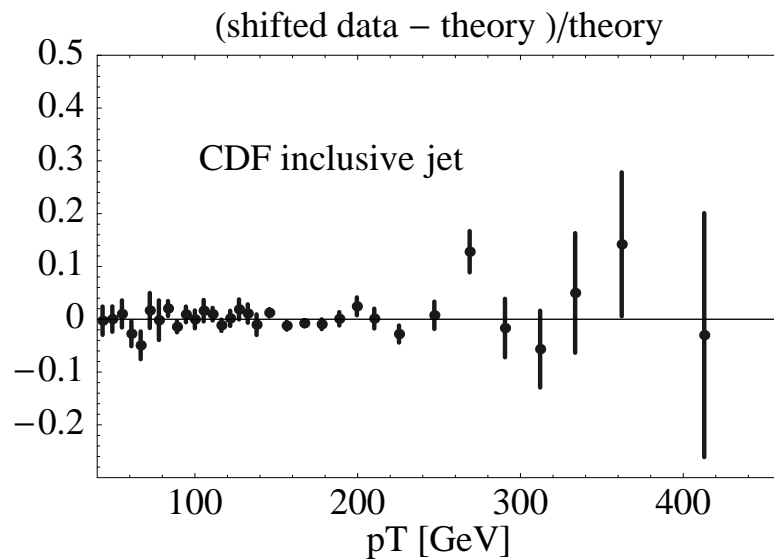
(data–theory)/theory versus p_T [GeV]



A closer look at the CDF measurements



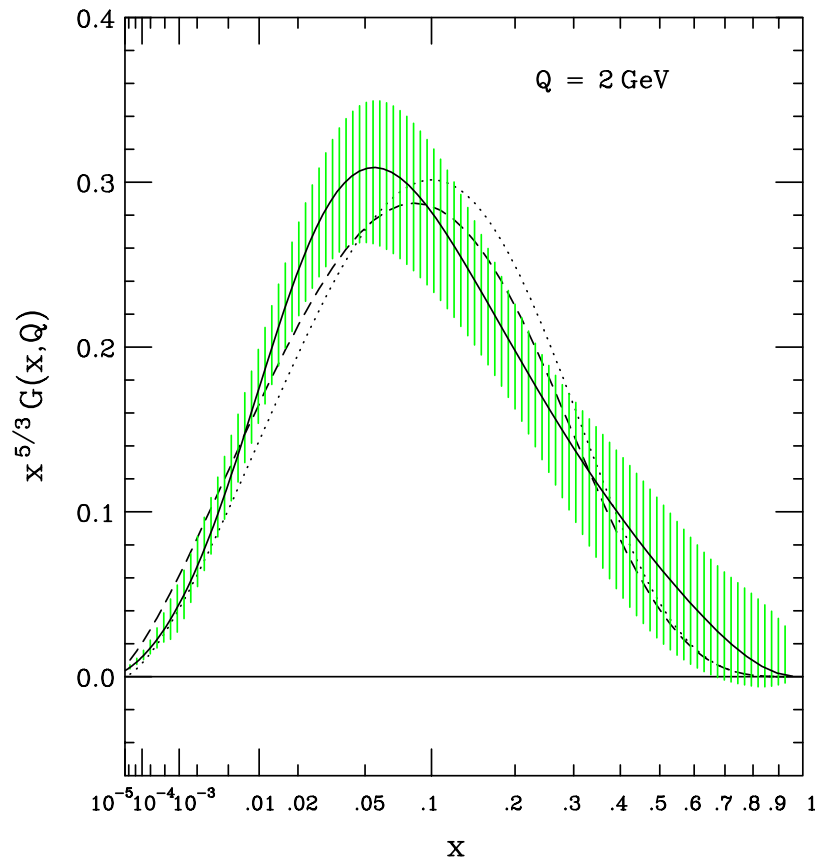
Comparing data and theory for CTEQ6 partons.



Comparing data shifted by the optimal systematic errors.

(statistical error bars)

The gluon uncertainty band



The shaded region is the envelope of possible variations of $G(x, Q)$.

Curves:
CTEQ6, CTEQ5, MRST2001

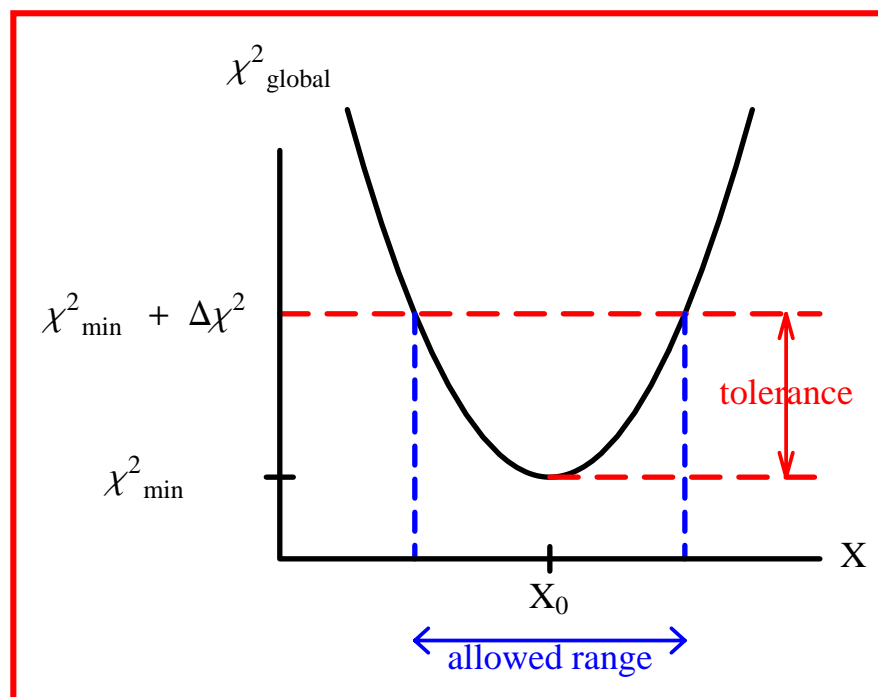
PDF uncertainty[†]

Our methods

- χ^2 minimization w/ fitting of systematic errors
- Diagonalization of the Hessian
- **The tolerance**

$$\chi^2 \leq \chi_0^2 + T^2$$

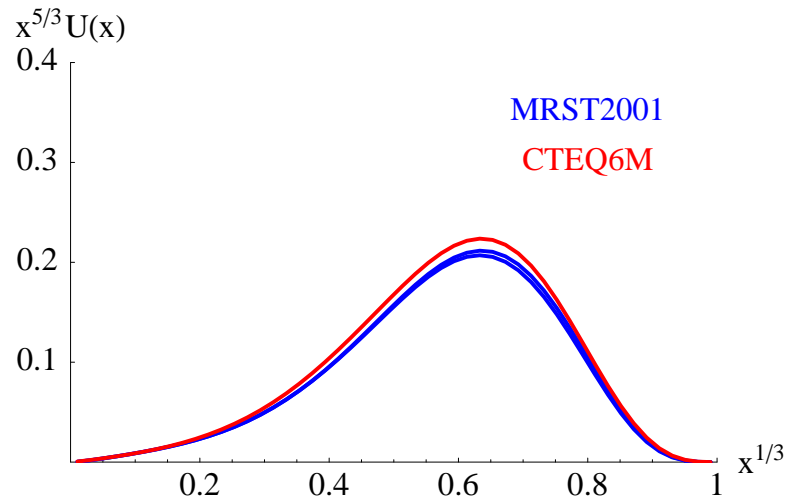
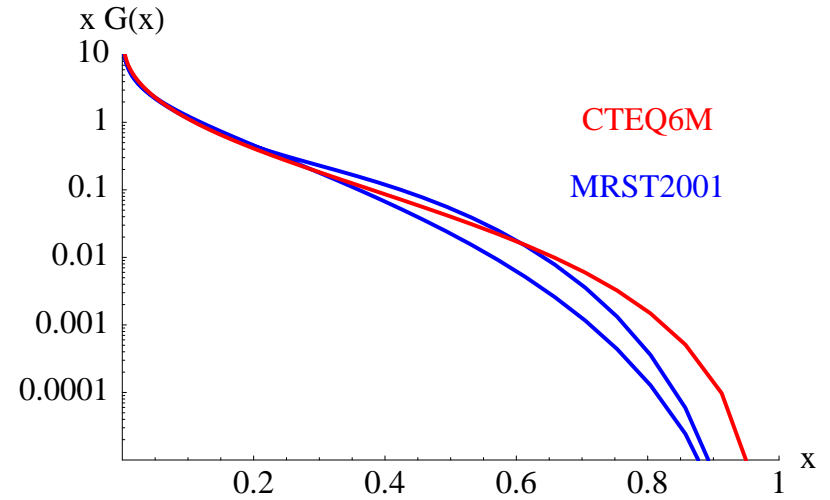
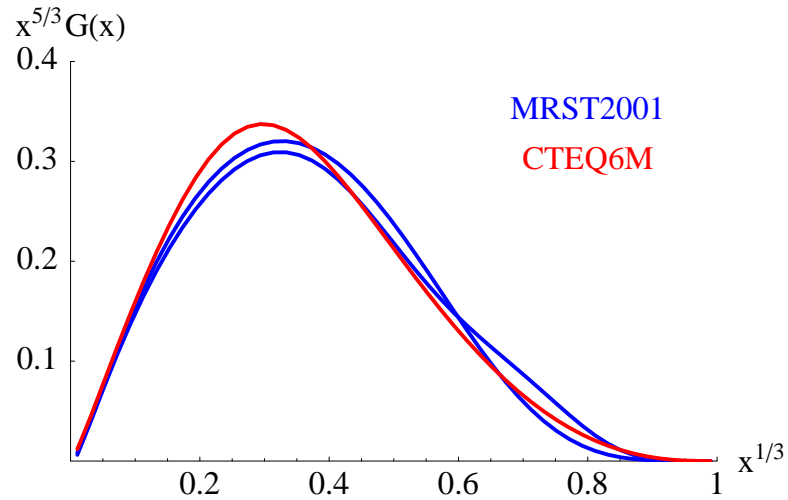
with $T \sim 10$



- Eigenvector Basis Sets
- Lagrange multiplier method

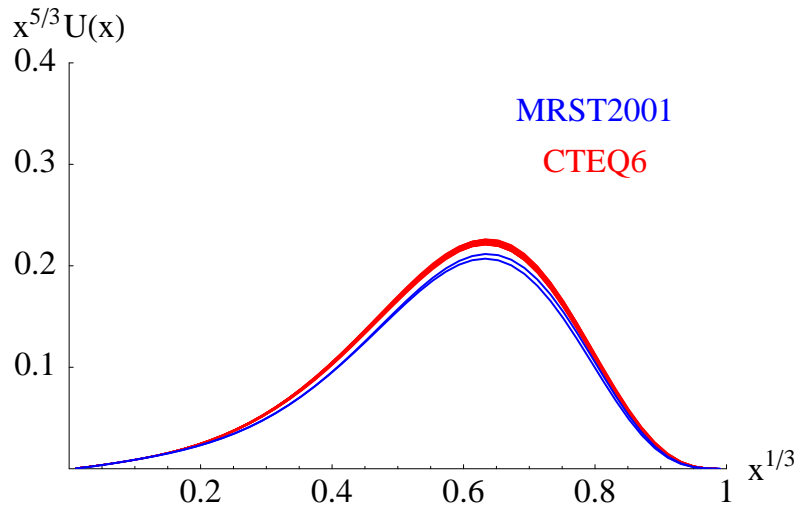
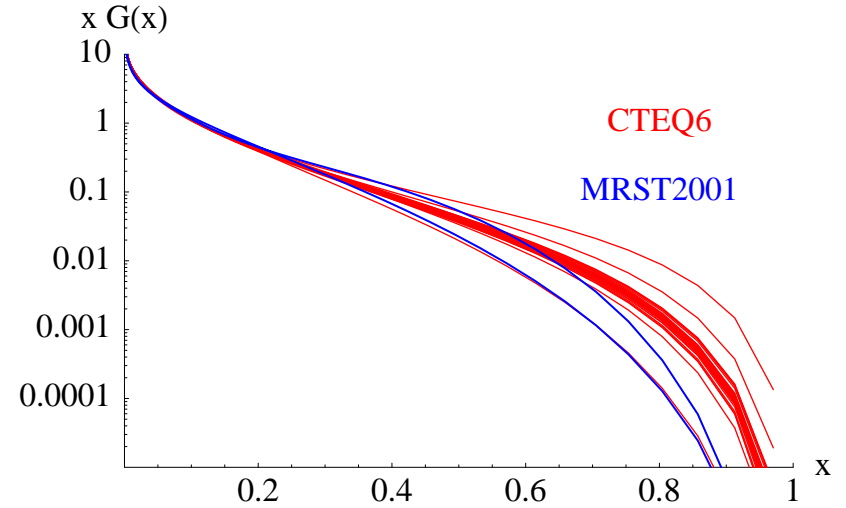
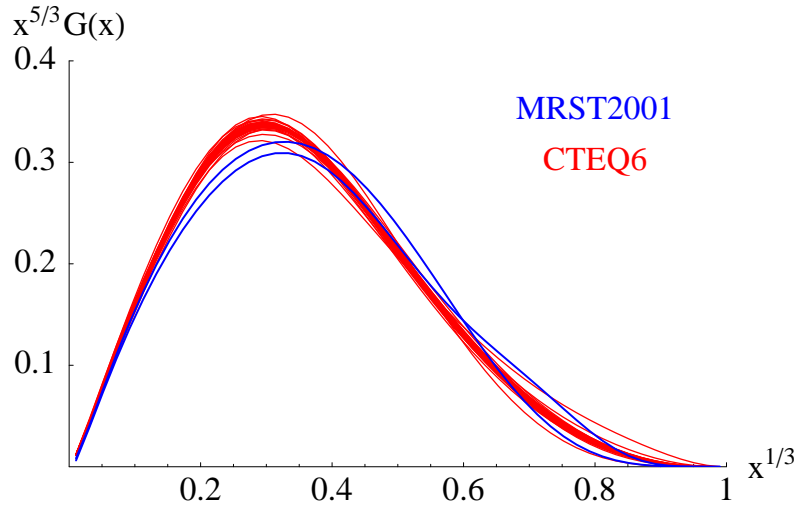
[†] due to propagation of experimental errors

Comparison of CTEQ6 and MRST2001



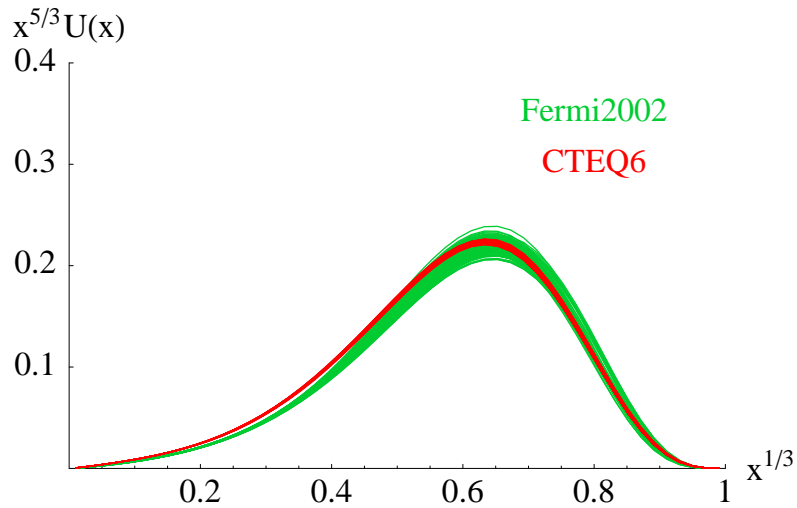
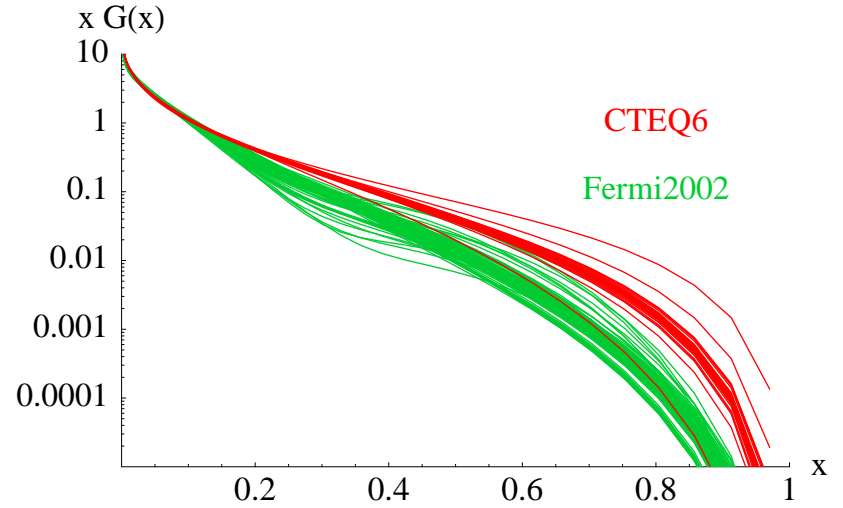
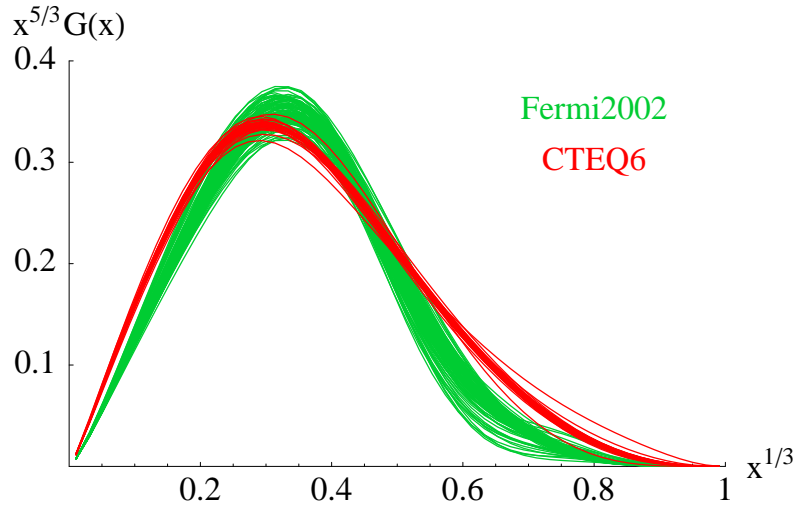
These plots show $G(x, Q)$ for $Q = 10$ GeV.

Comparison of CTEQ6 and MRST2001



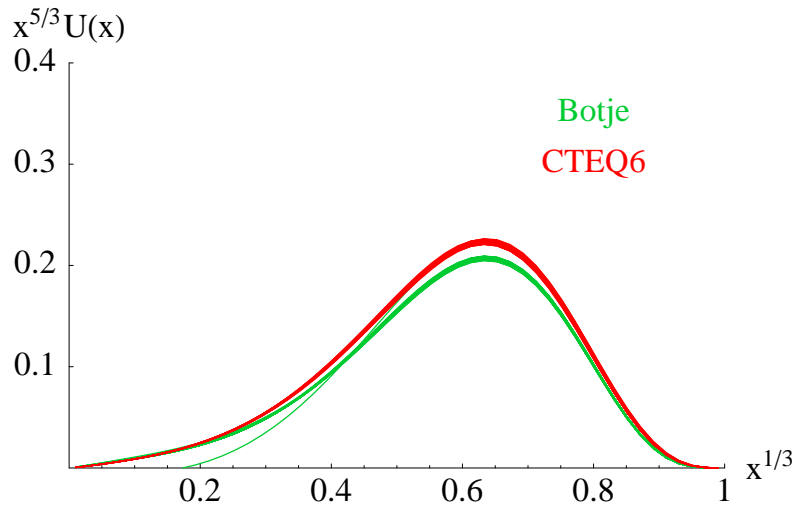
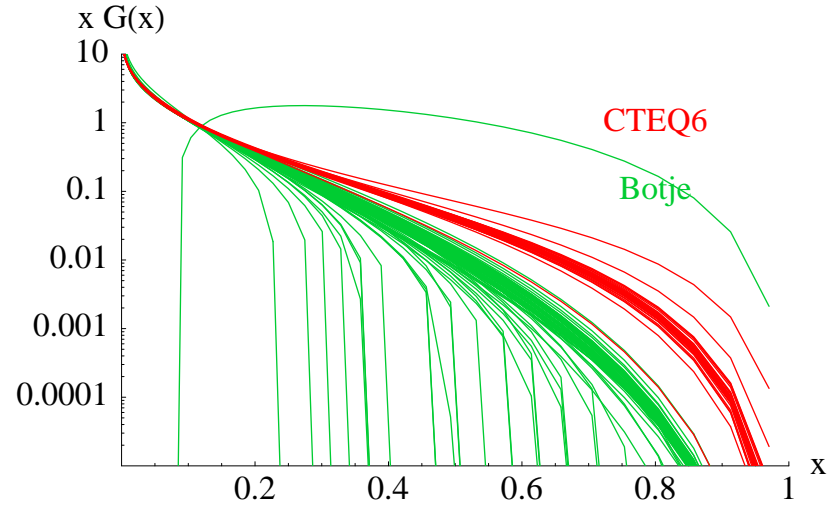
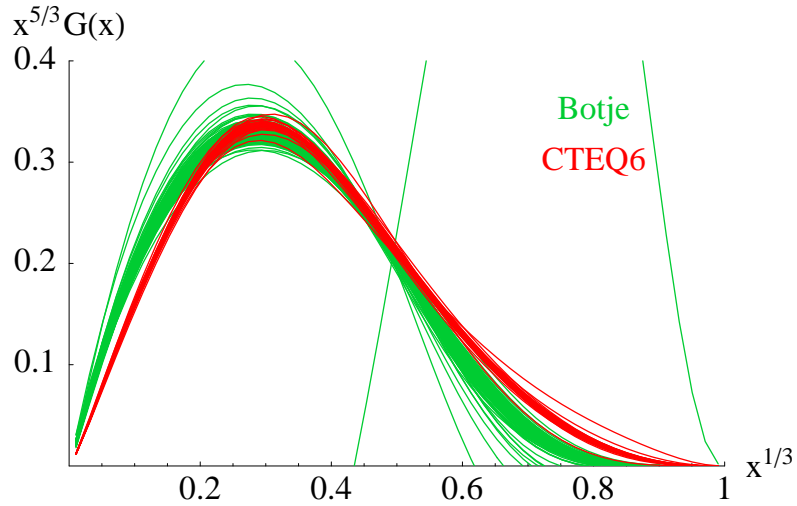
$Q = 10 \text{ GeV}$

Comparison of CTEQ6 and Fermi2002



$Q = 10 \text{ GeV}$

Comparison of CTEQ6 and M. Botje PDF's



$Q = 10 \text{ GeV}$

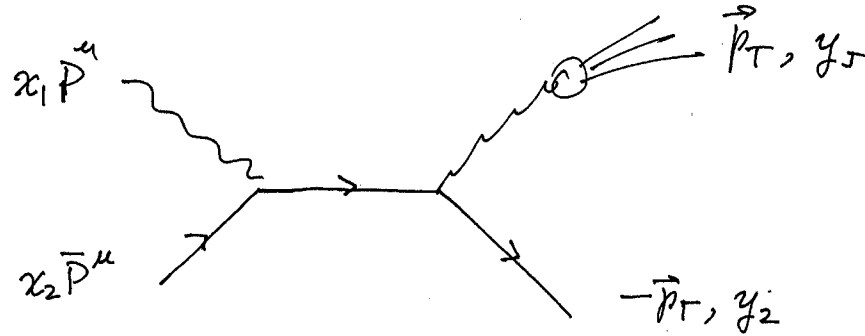
The hard gluon distribution of CTEQ6 comes from fitting the Tevatron jet cross section.

Why?

What is the uncertainty?

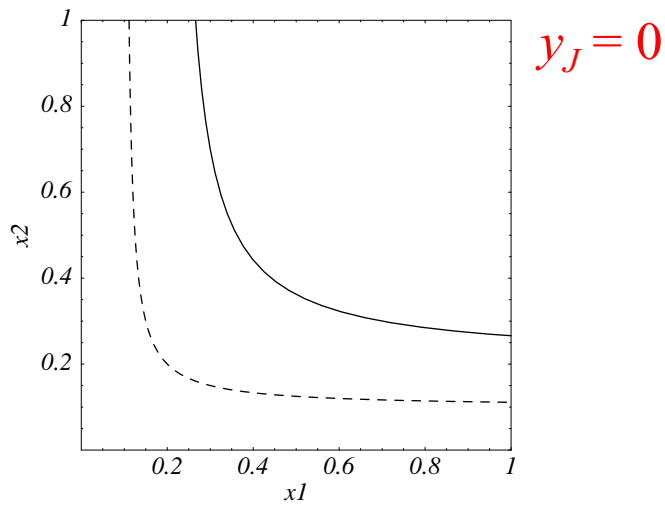
Predictions for Run 2.

What domain of momentum fraction is relevant to jet production for given y_J and p_T ?

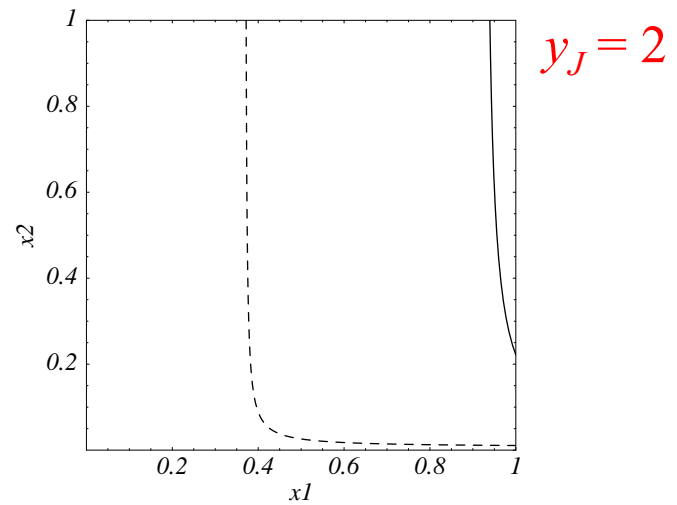


$$x_1 = \frac{p_T}{\sqrt{s}} \left(e^{y_J} + e^{y_2} \right)$$

$$x_2 = \frac{p_T}{\sqrt{s}} \left(e^{-y_J} + e^{-y_2} \right)$$

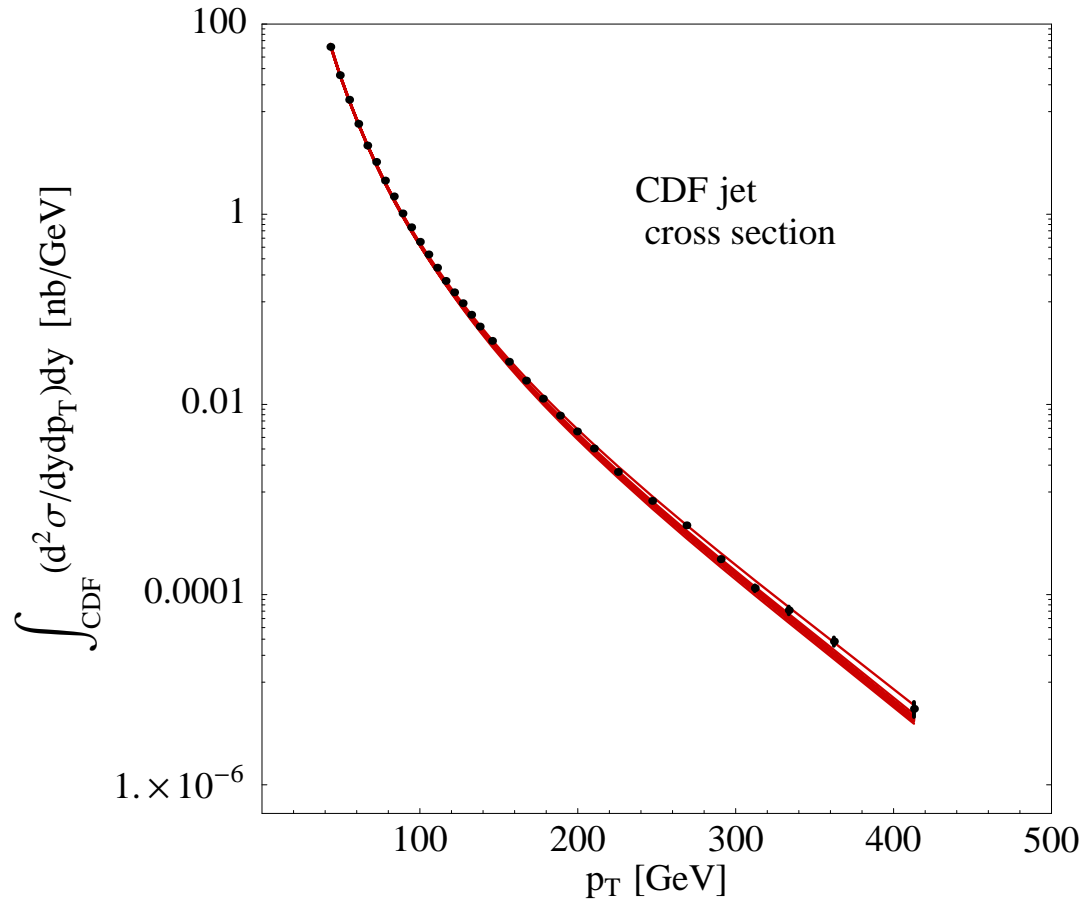


Solid : $p_T = 412$ GeV
 Dashed : $p_T = 200$ GeV



Solid : $p_T = 250$ GeV
 Dashed : $p_T = 100$ GeV

PDF uncertainty of the jet cross section

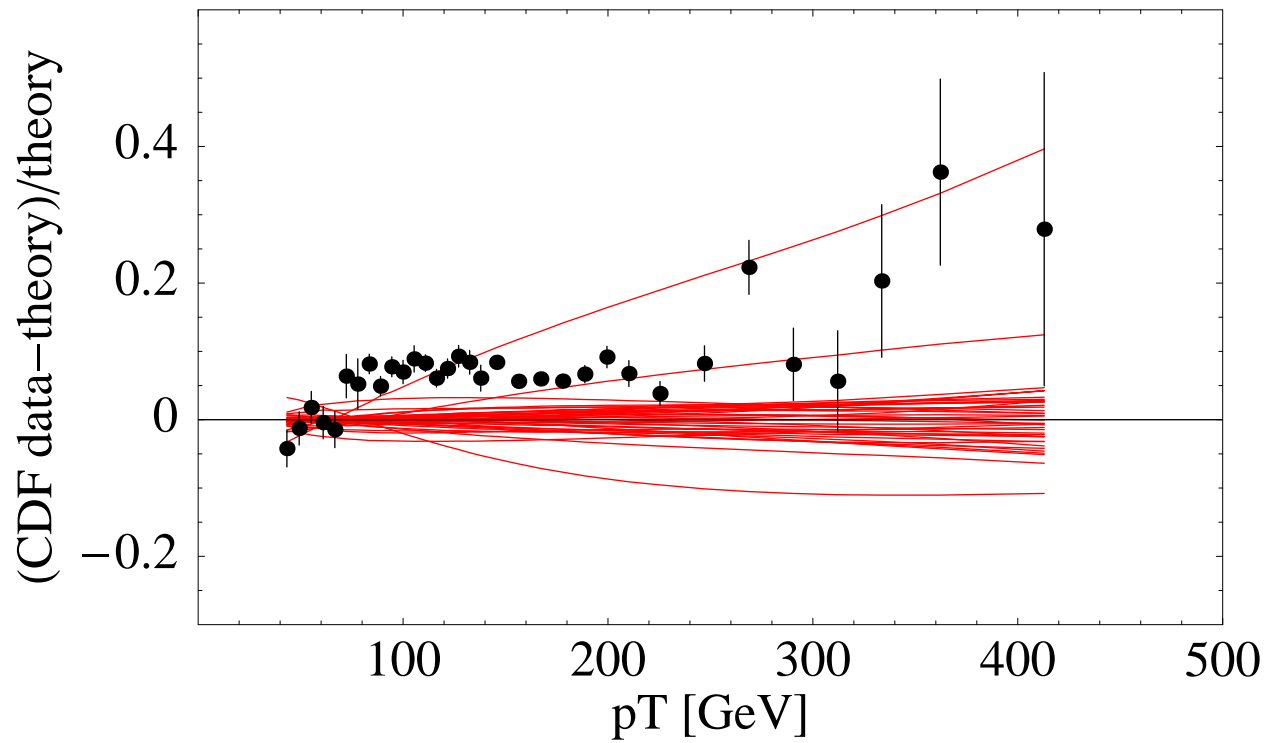


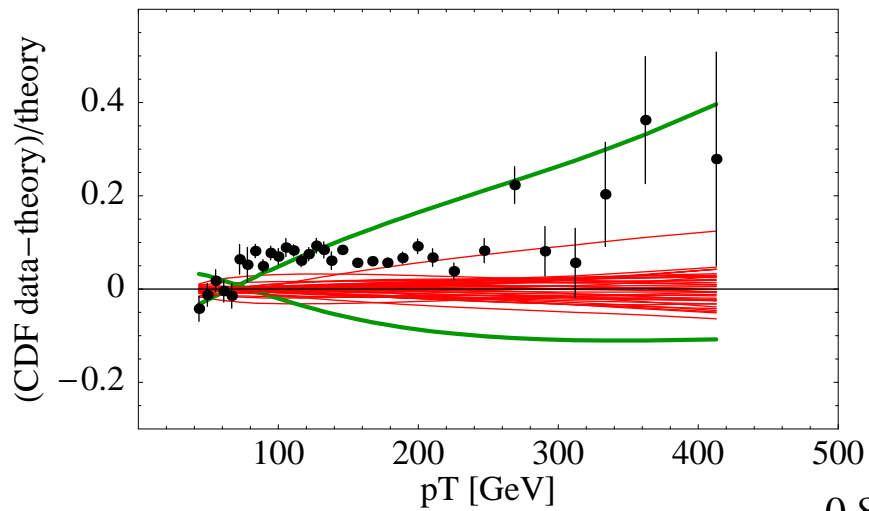
The CDF jet cross section for the 40 Eigenvector Basis Sets

The 40 sets need some improvement.

Simplest use — 40 independent alternatives to the standard CTEQ6.

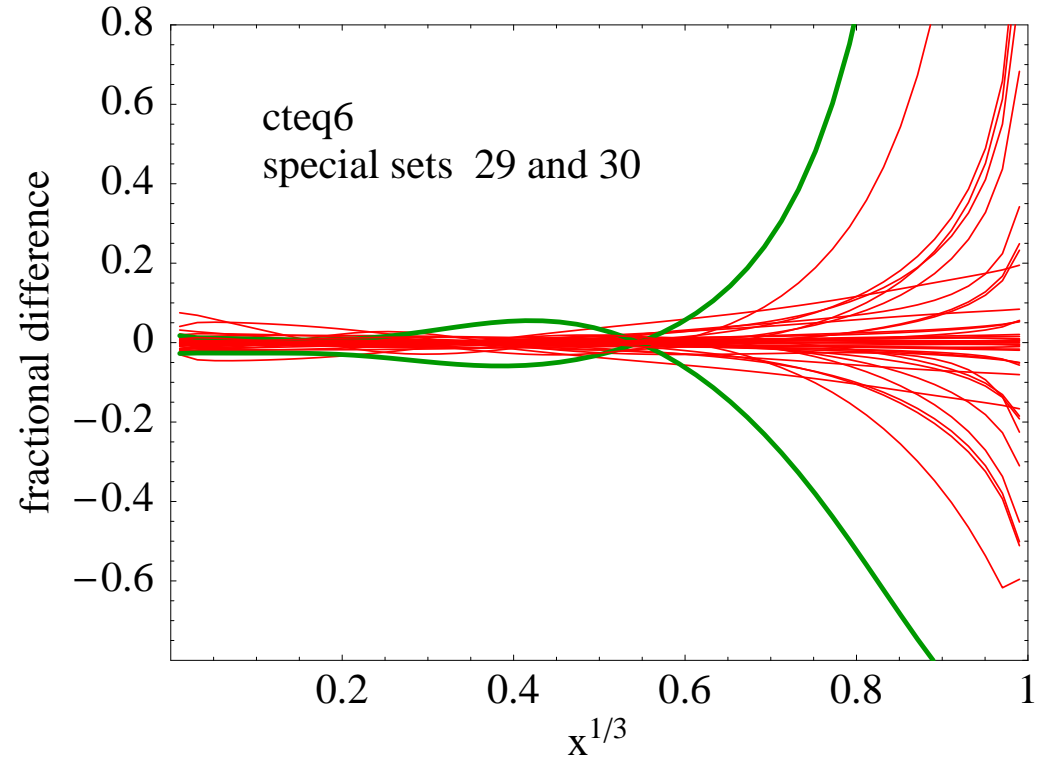
The CDF jet cross section — fractional differences compared to the standard CTEQ6



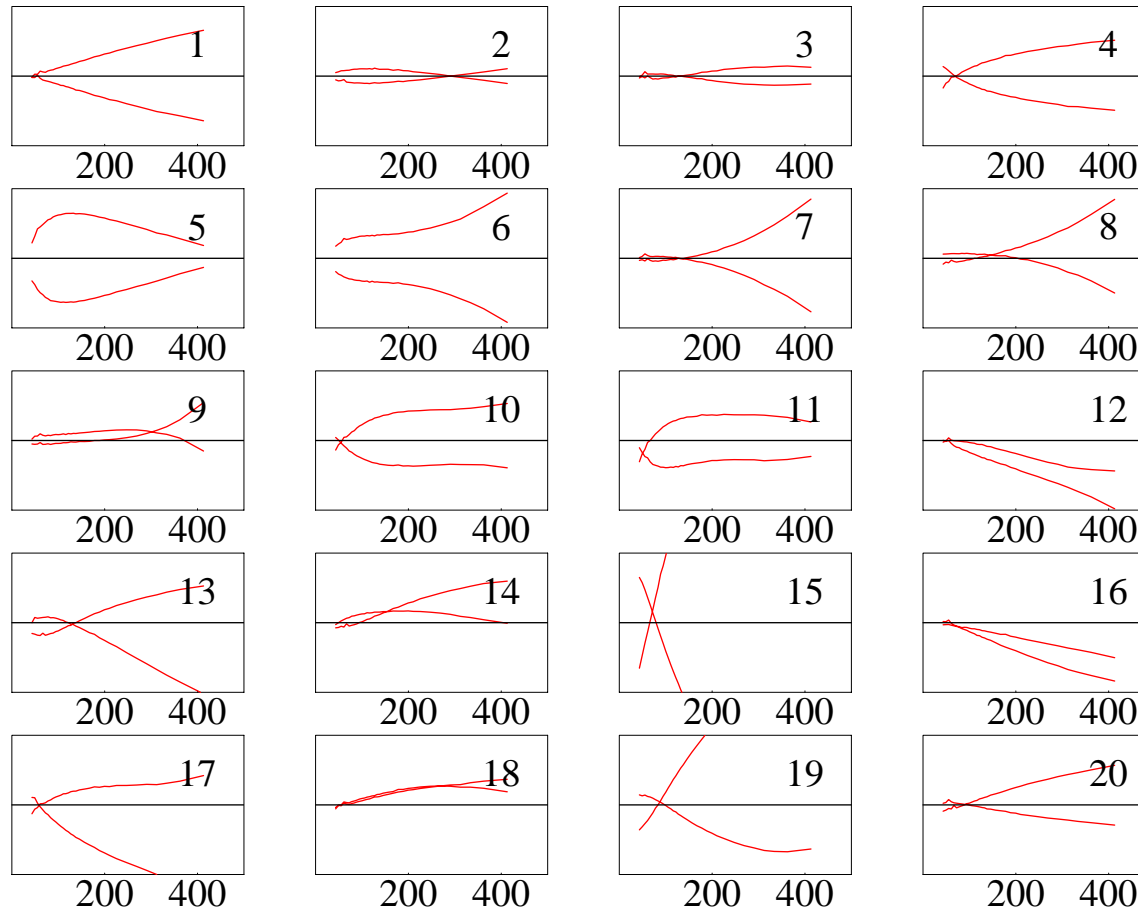


Eigenvector 15

The PDF sets *cteq6m_29* and *cteq6m_30* are the most extreme variations of the gluon.



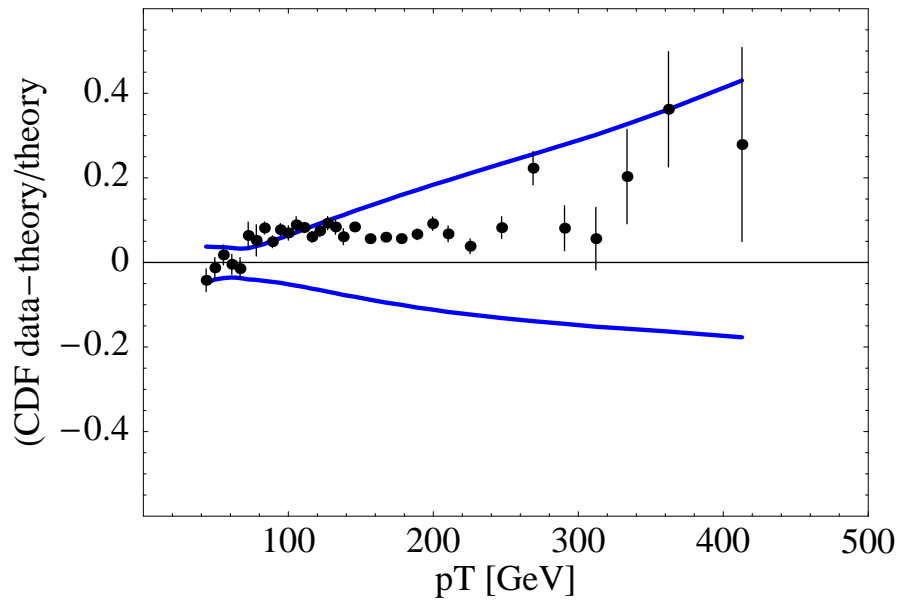
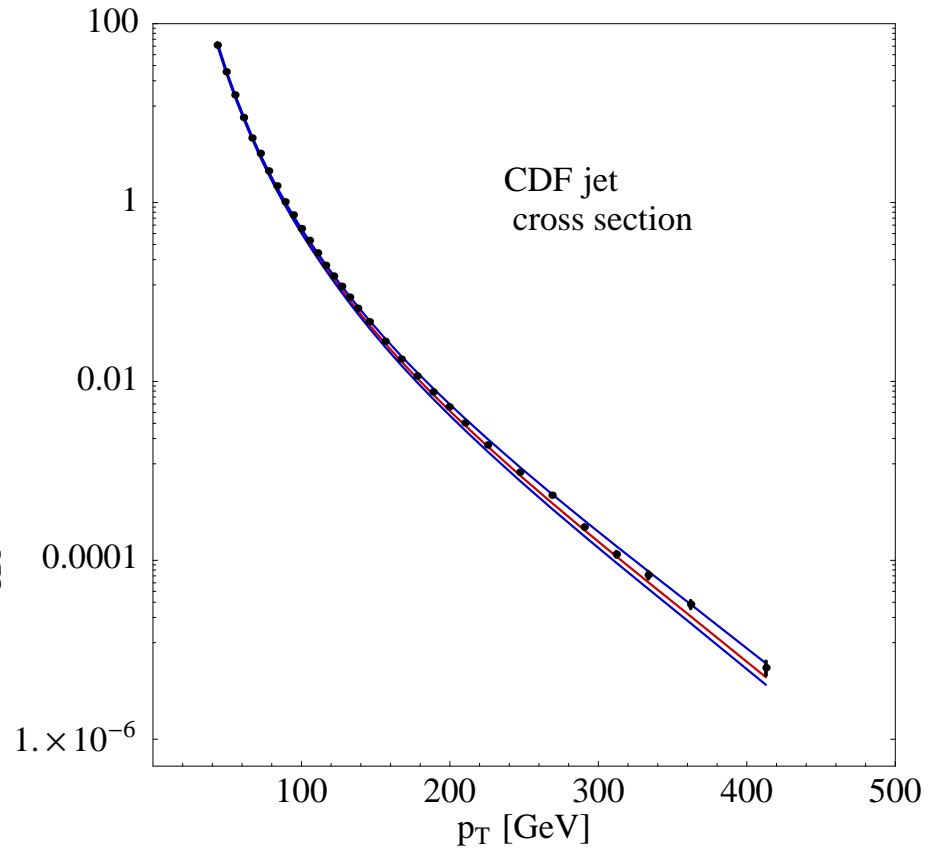
All eigenvectors (ordinate range -0.04 to 0.04)



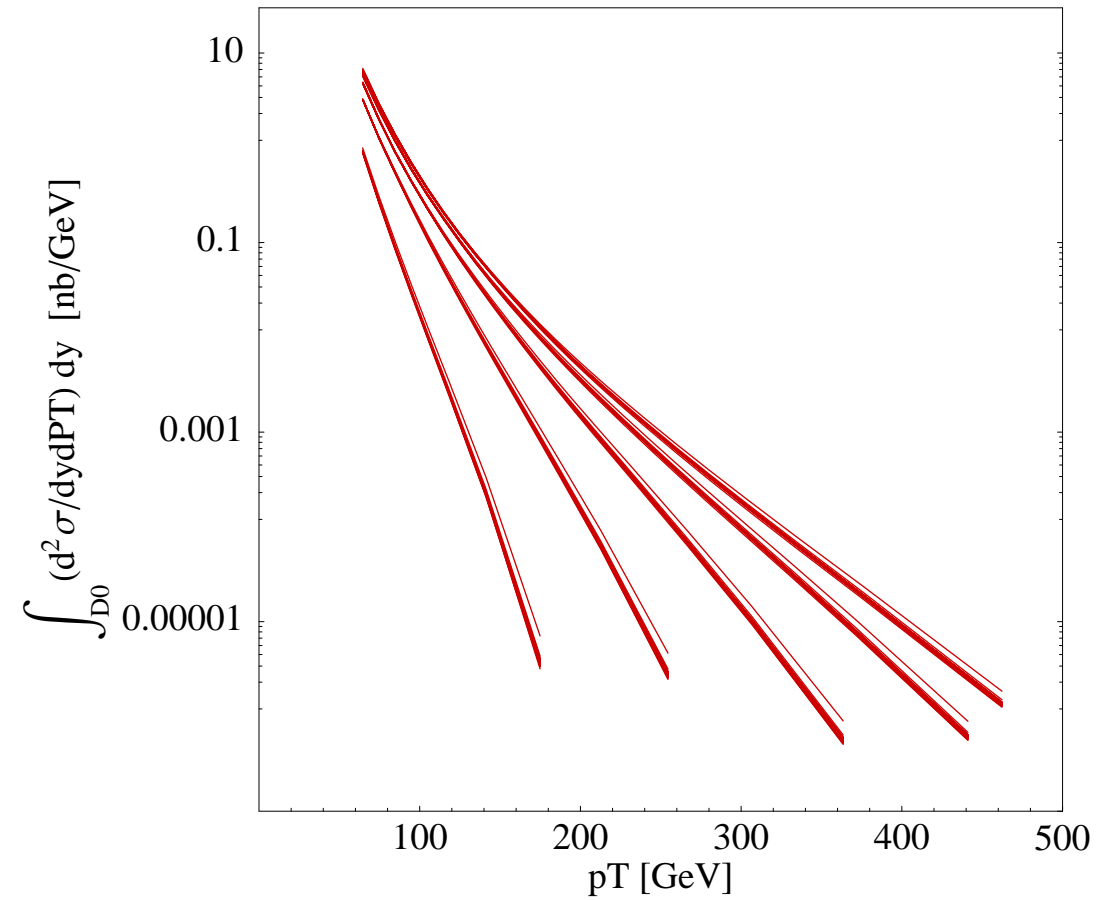
The total uncertainty band from the Master Formula

(Preliminary!)

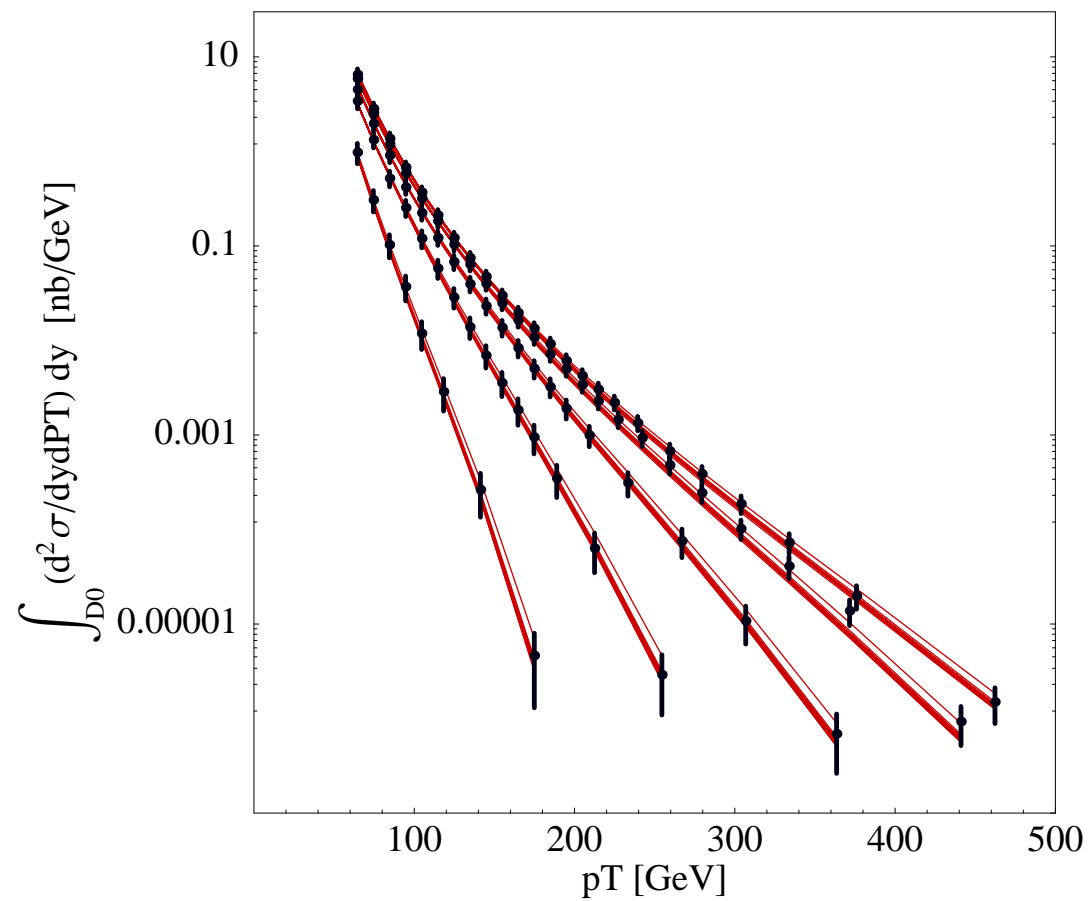
$$\int_{\text{CDF}} (d^2\sigma/dydp_T)dy \text{ [nb/GeV]}$$



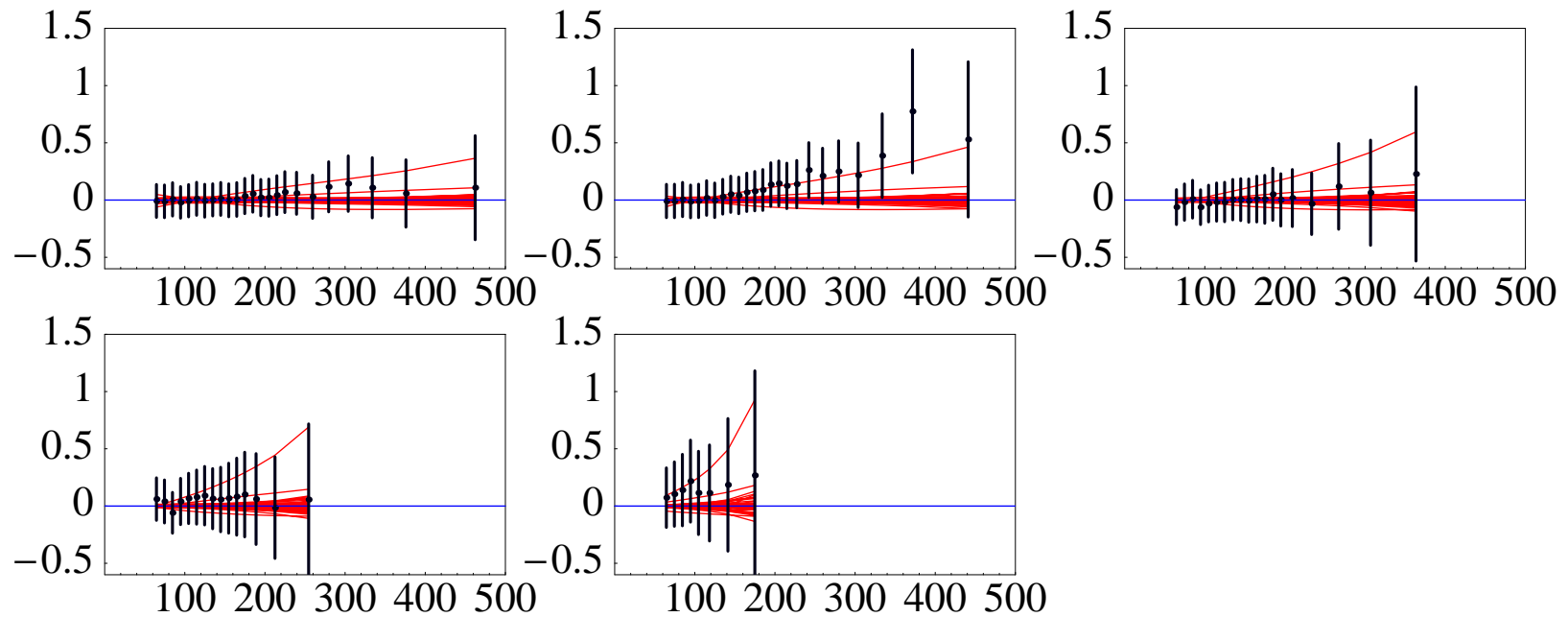
The $D\bar{D}$ jet cross section for the 40 Eigenvector Basis Sets



The $D\bar{D}$ jet cross section for the 40 Eigenvector Basis Sets



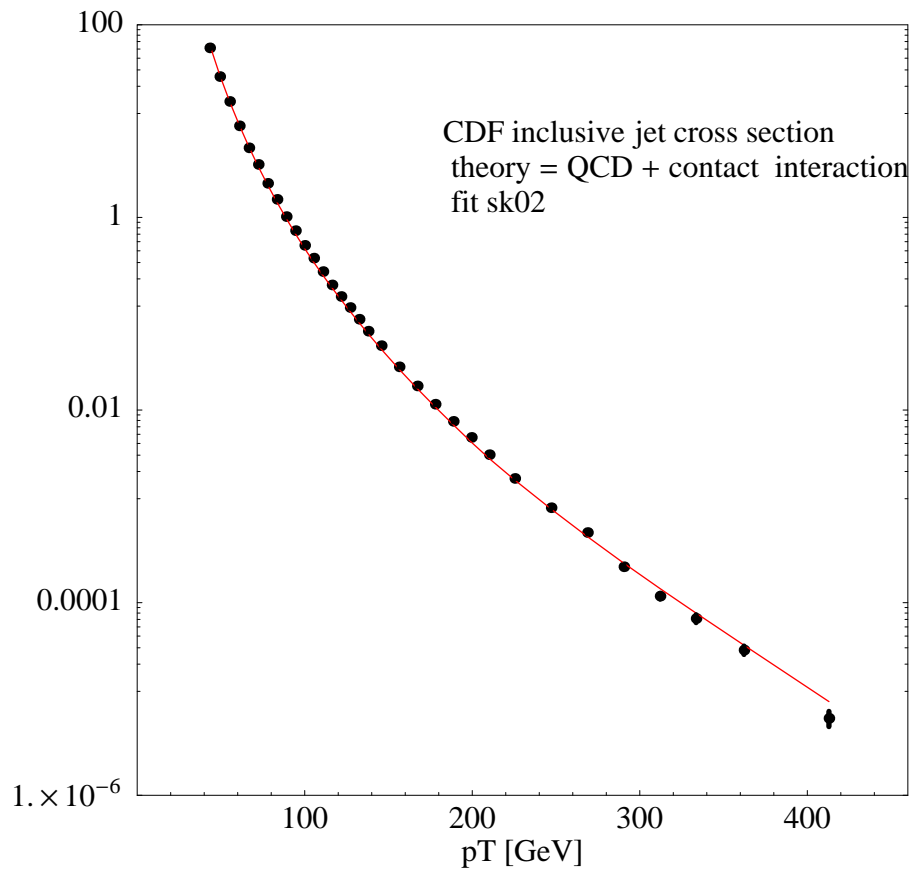
The $D\bar{D}$ jet cross section — fractional differences compared to the standard CTEQ6 ...



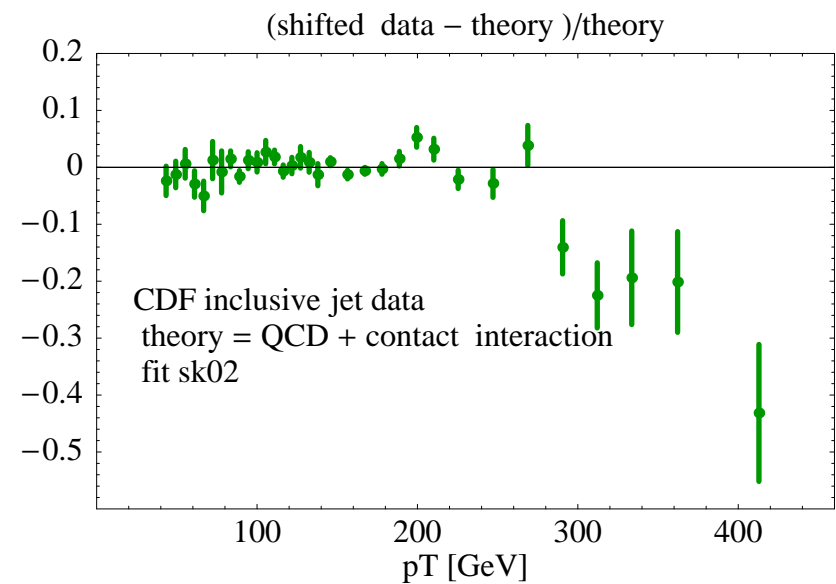
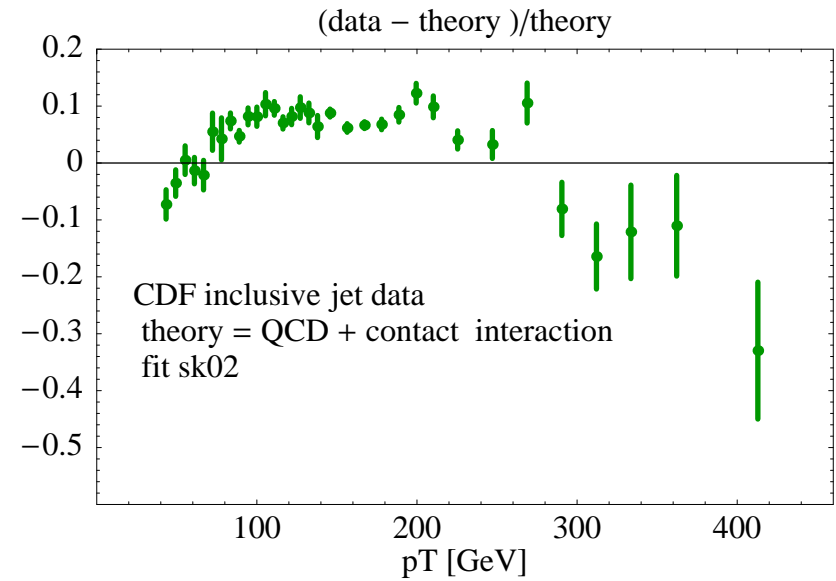
... versus p_T in GeV for 5 η bins

Is there room for new physics in the jet data?

CDF jet data versus theory for Steve Kuhlmann's contact interaction, with the *sk02* PDF's



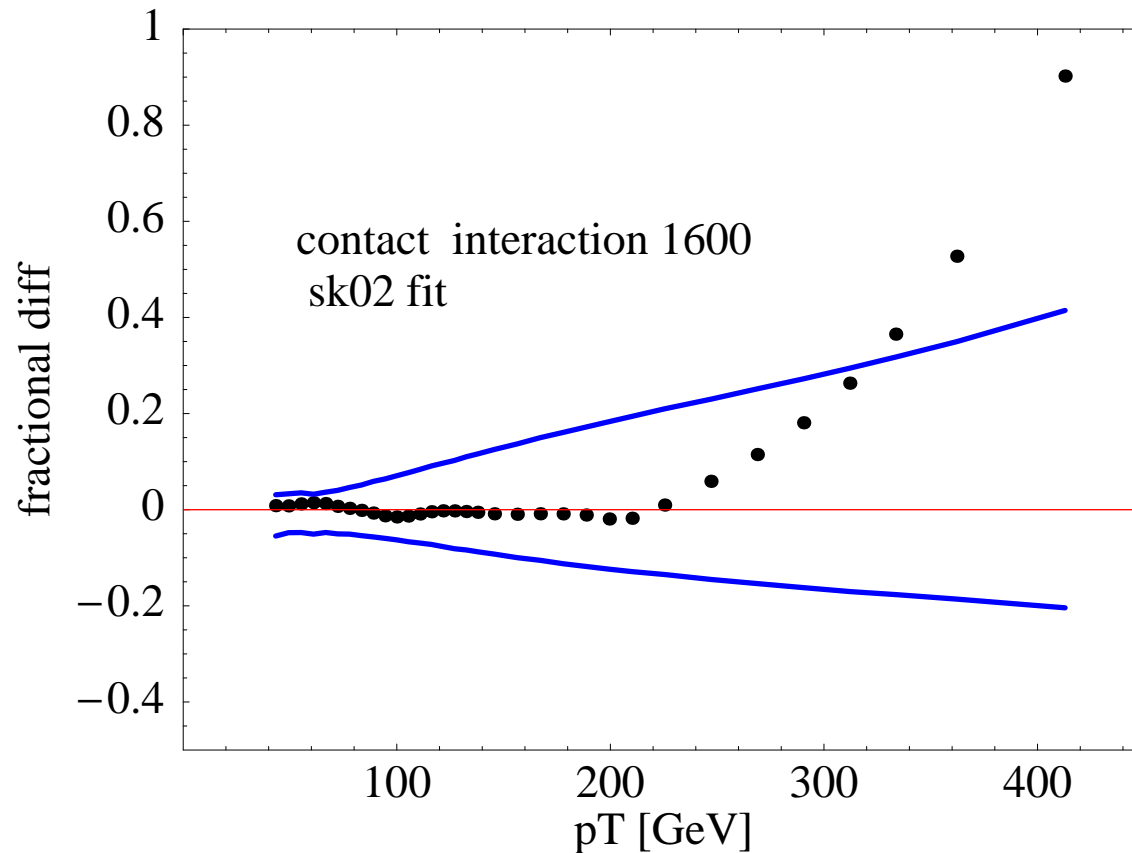
UC Riverside meeting



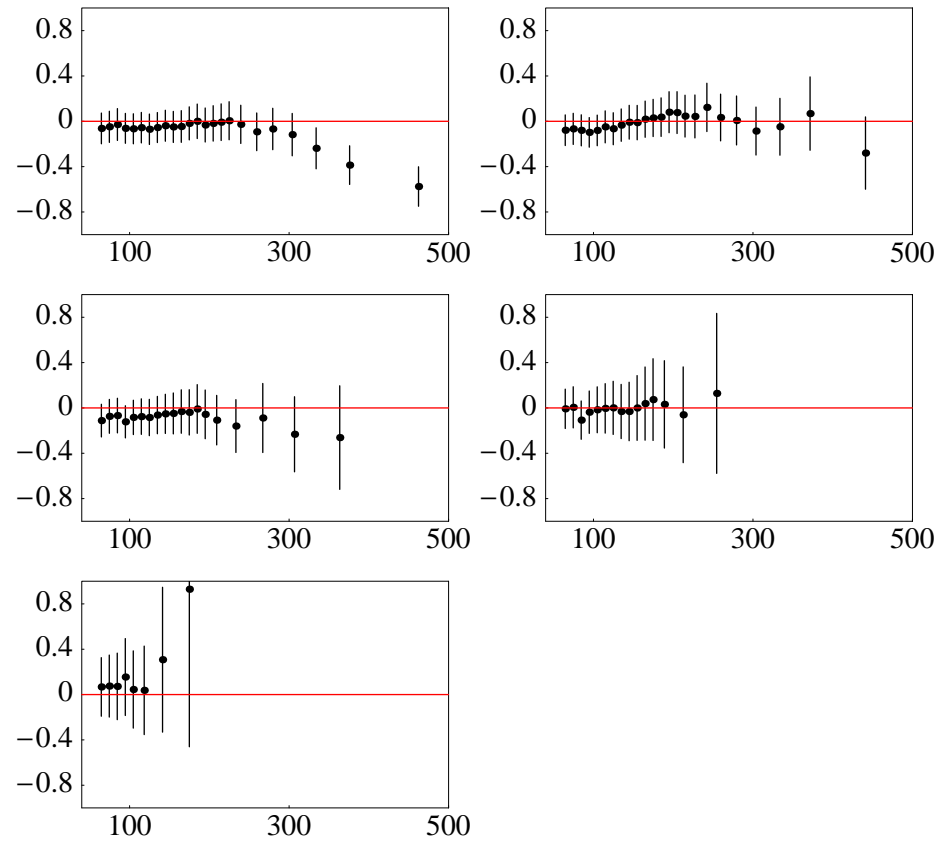
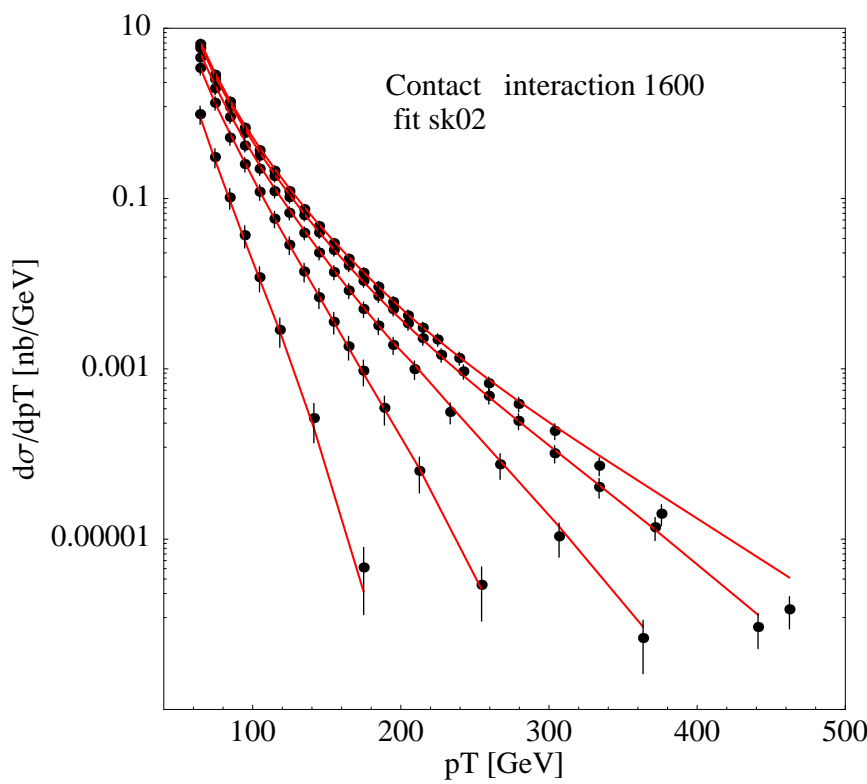
E2

Points: predicted cross section with SK's contact interaction and *sk02* PDF's, compared to pure QCD with standard *cteq6* PDF's.

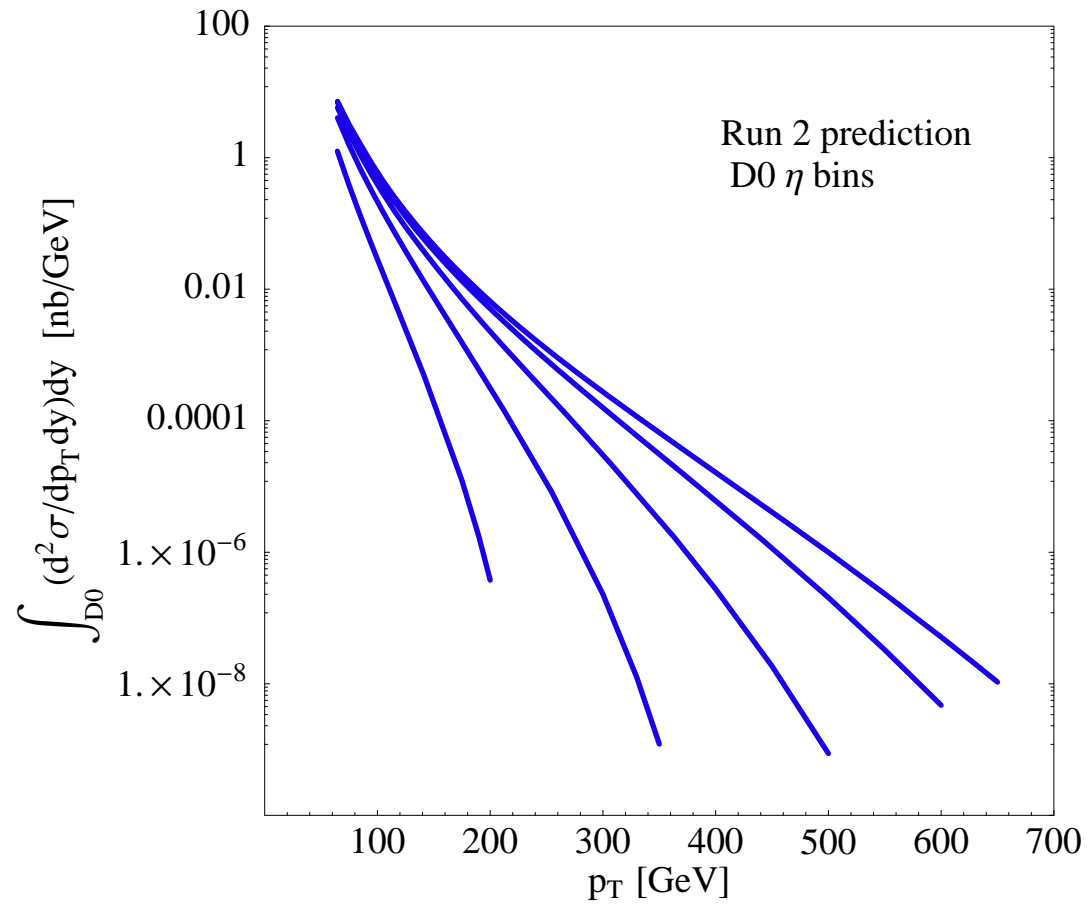
Curves: the uncertainty band for pure QCD and *cteq6*.

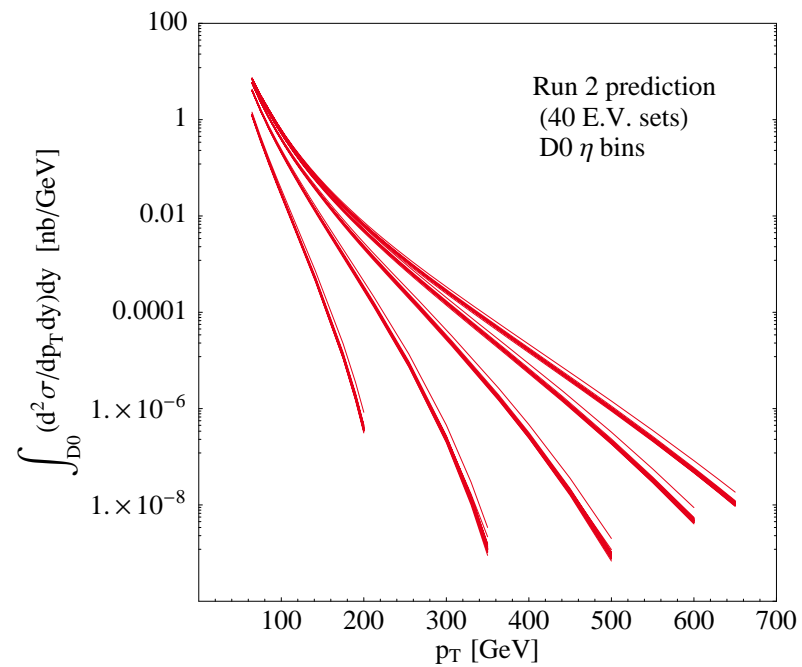


DØ jet data versus theory for Steve Kuhlmann's contact interaction with the *sk02* PDF's

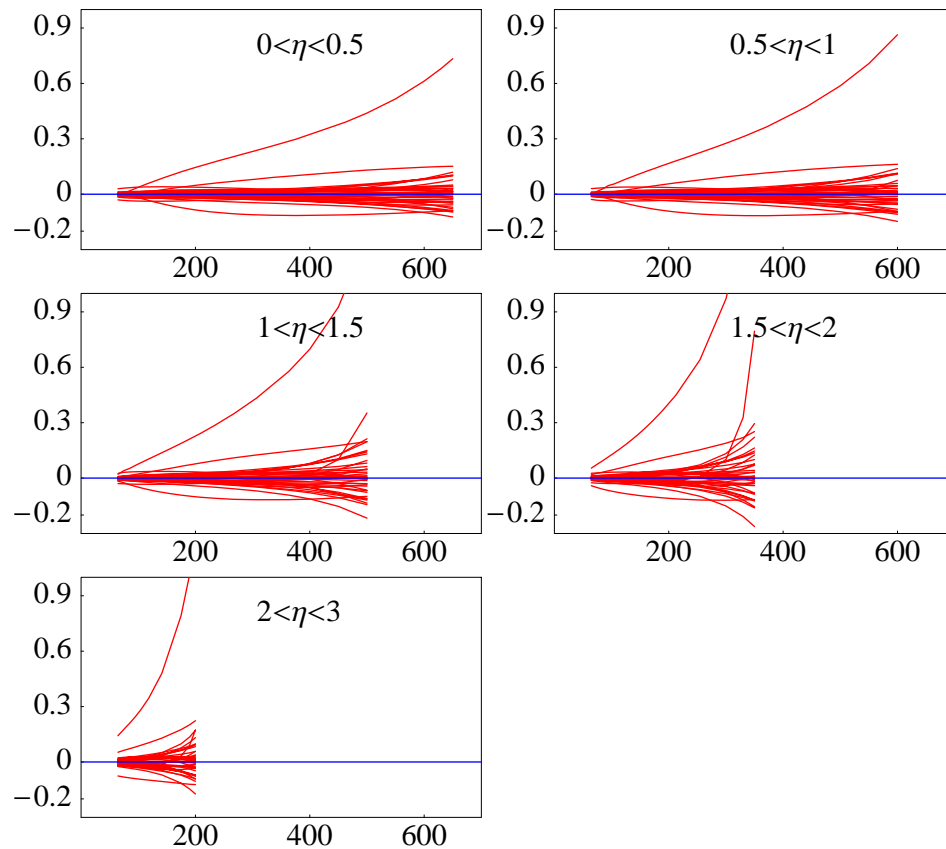


Predictions for Run 2 — DØ η bins

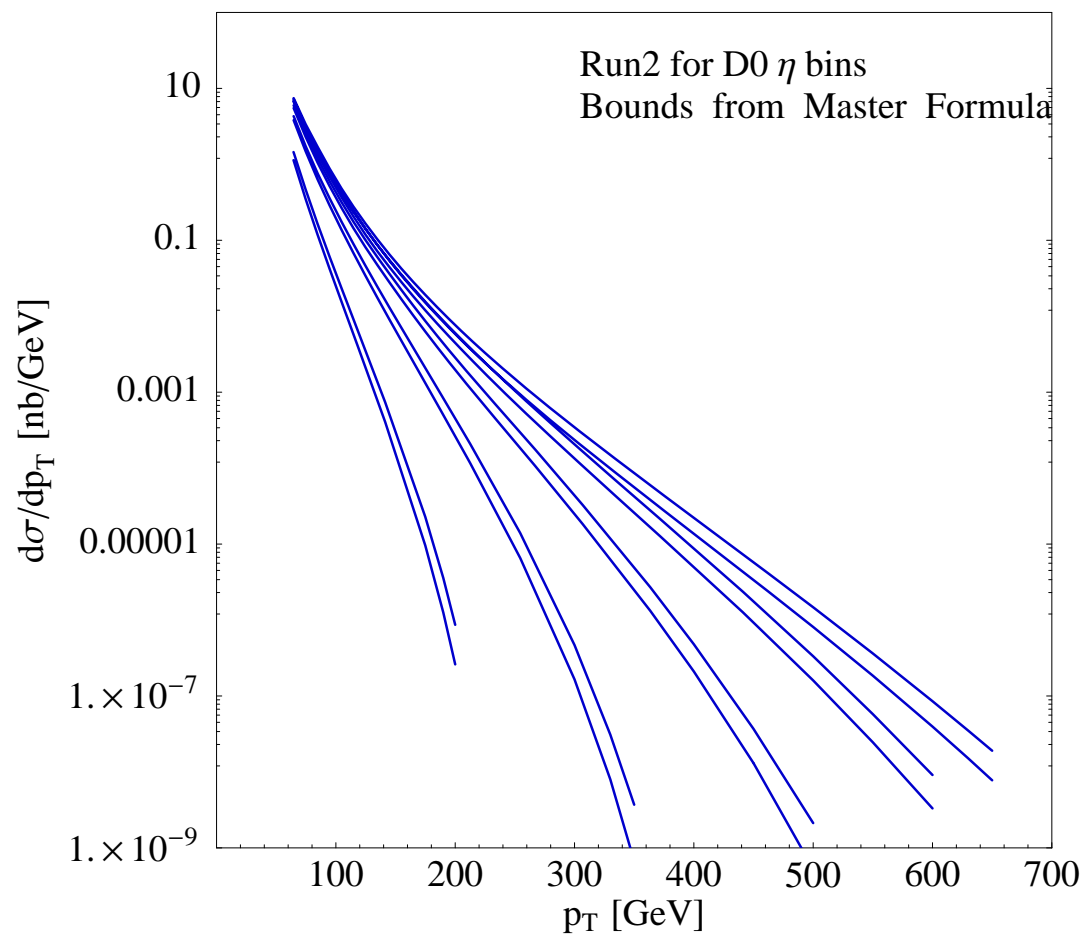


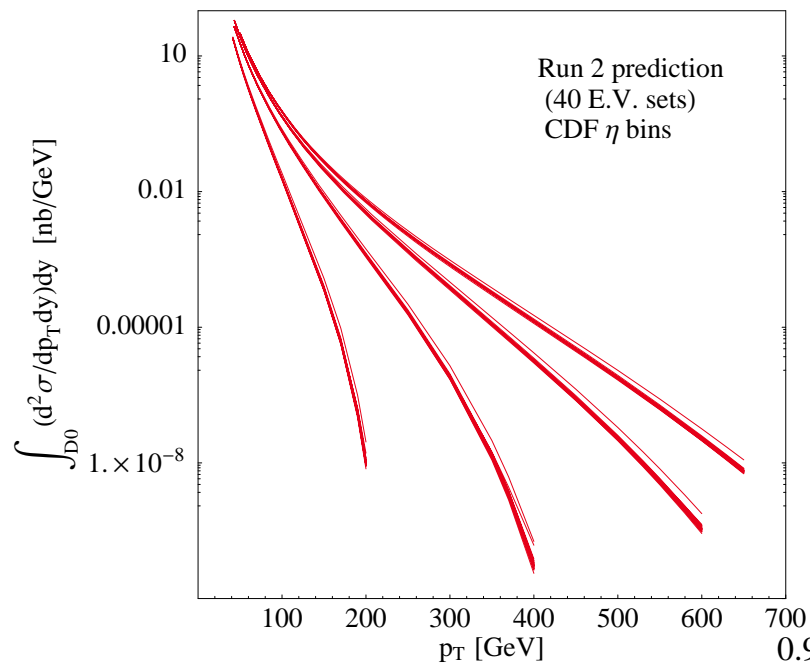


Predictions for Run 2 — D0 η bins



Predictions for Run 2 — bounds from the Master Formula (Preliminary!)





Predictions for Run 2 — CDF η values

