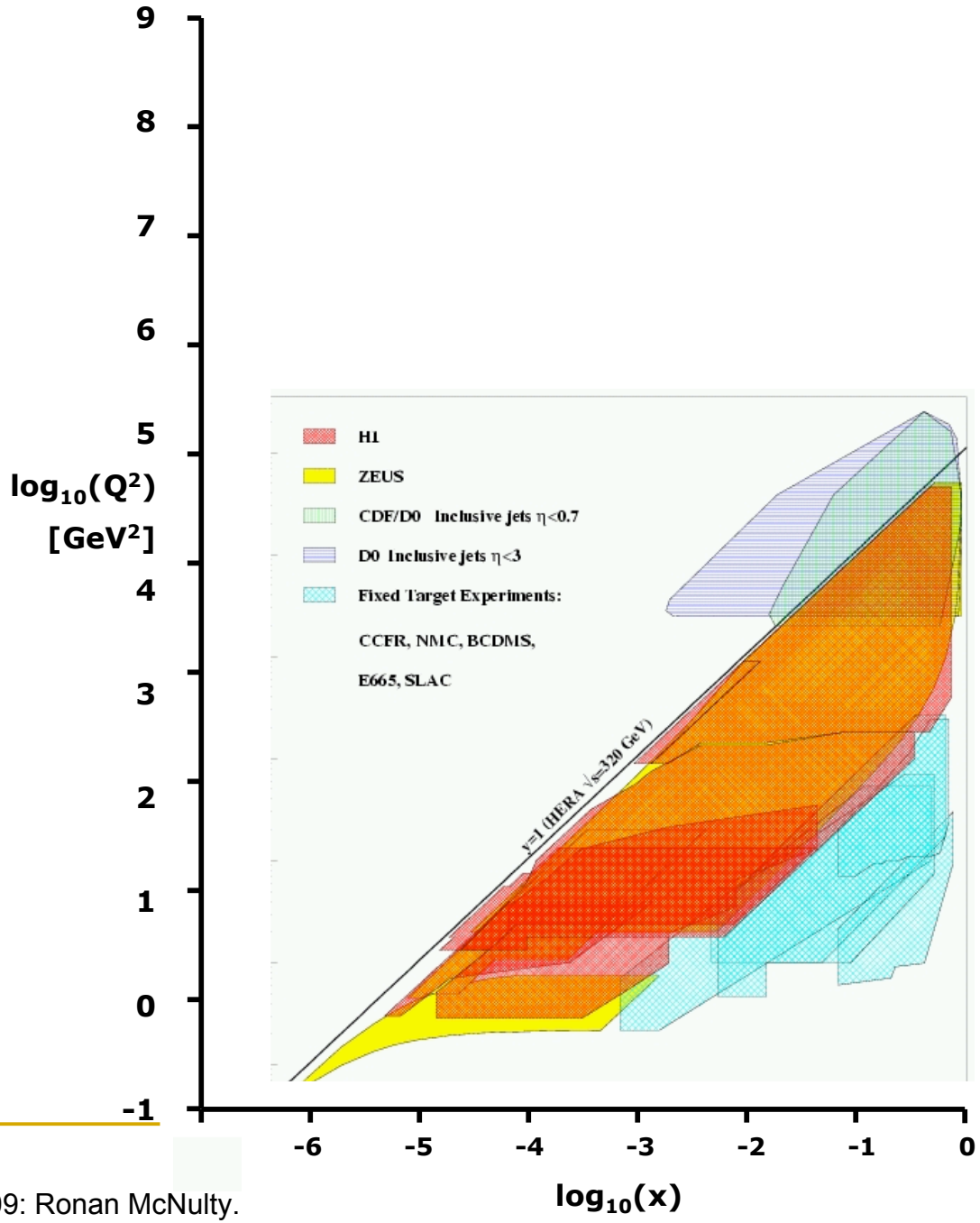
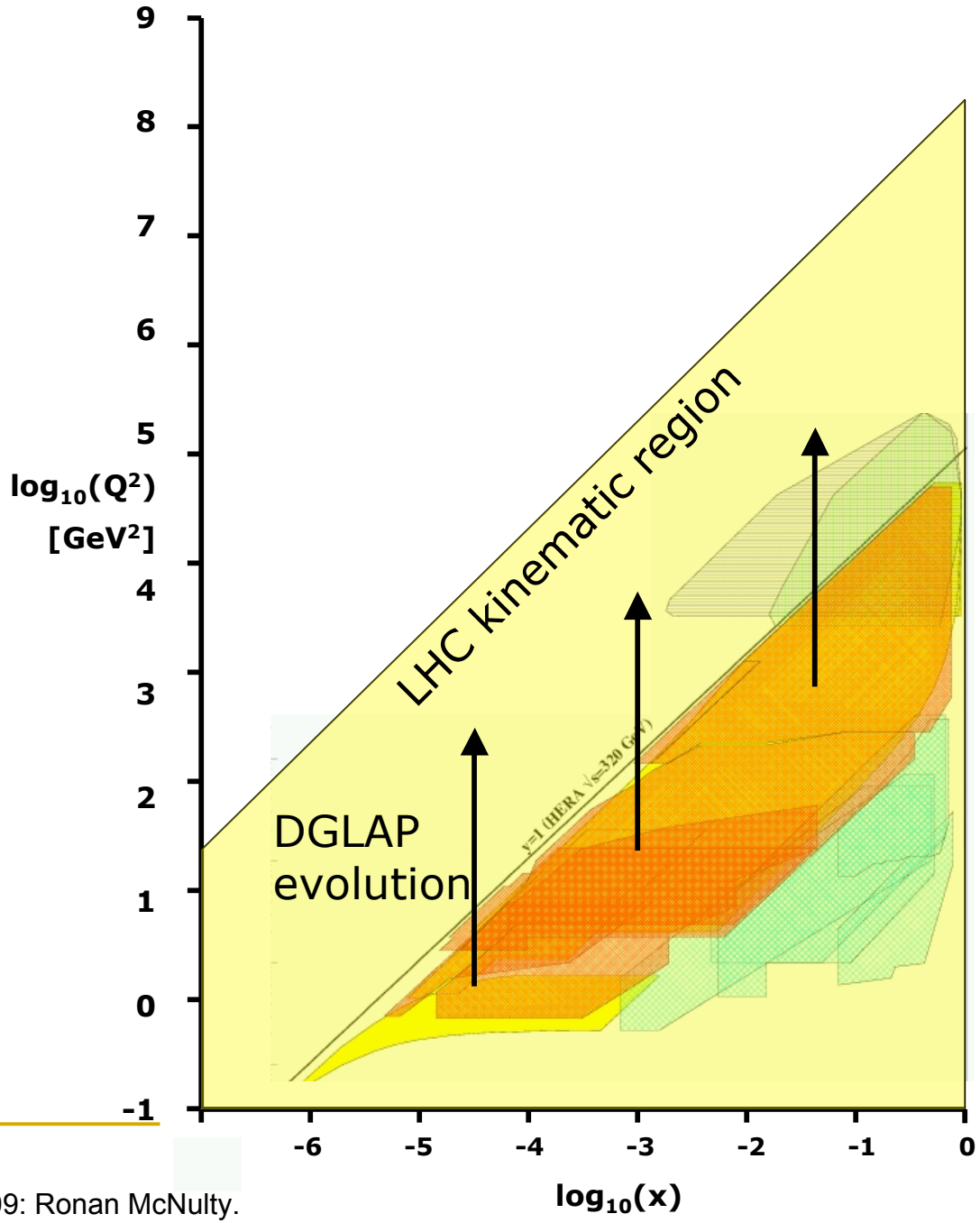
Inclusive jets & exclusive central particle production at the Tevatron

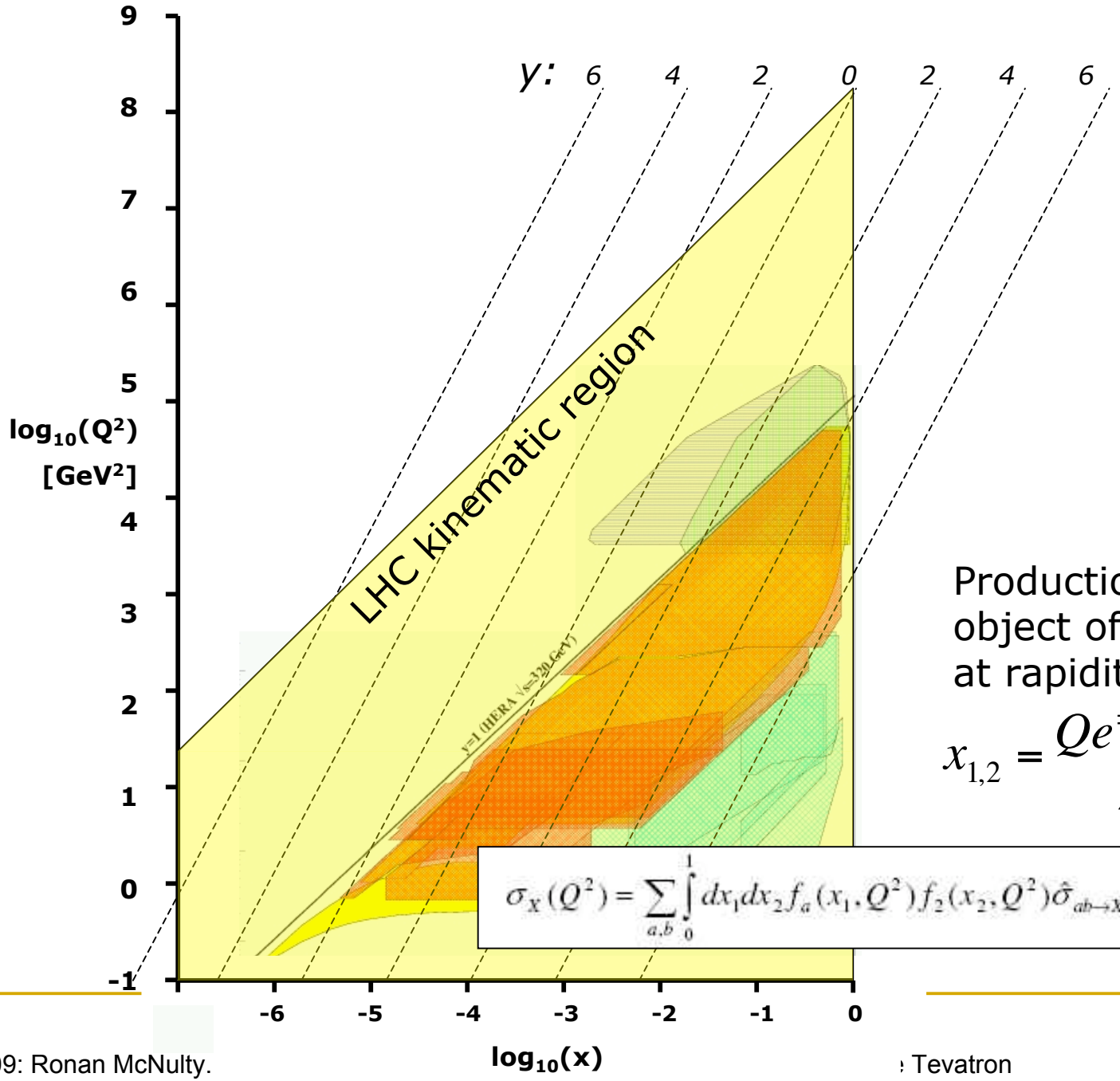
Ronan McNulty
(University College Dublin)
on behalf of the CDF collaboration.

Inclusive Jets (see also talk by M.Martinez-Perez)

- Constraining the PDFs (high-x gluon)
  - To describe Standard Model physics
  - To discover New Physics
- How to measure at the Tevatron
  - kT algorithm (1.1fb^{-1} of data)
  - midpoint cone algorithm (1.0 fb^{-1} of data)
- What it says about PDFs.


H1
ZEUS
CDF/D0 Inclusive jets η<0.7
D0 Inclusive jets η<3
Fixed Target Experiments:
CCFR, NMC, BCDMS,
E665, SLAC
y=1 (HERA √s=320 GeV)
log10(Q2) [GeV2]
log10(x)
9
8
7
6
5
4
3
2
1
0
-1
-6
-5
-4
-3
-2
-1
0

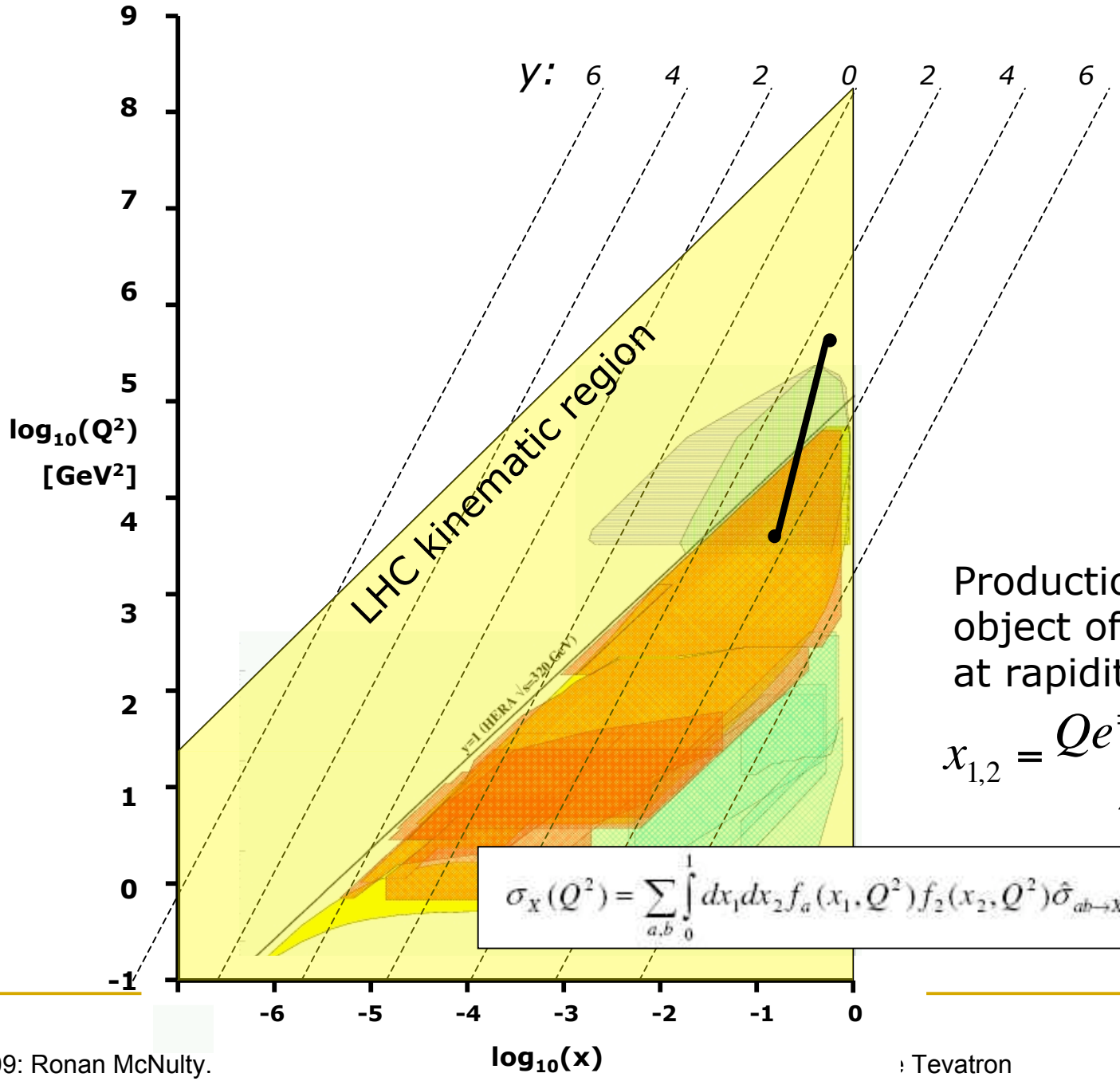

LHC kinematic region
DGLAP evolution
log10(Q2) [GeV2]
log10(x)
9
8
7
6
5
4
3
2
1
0
-1
-6
-5
-4
-3
-2
-1
0



Production of object of mass Q at rapidity *y*

$$x_{1,2} = Qe^{\pm y} / \sqrt{s}$$

$$\sigma_X(Q^2) = \sum_{a,b} \int_0^1 dx_1 dx_2 f_a(x_1, Q^2) f_2(x_2, Q^2) \hat{\sigma}_{ab \to X}(x_1, x_2, Q^2)$$



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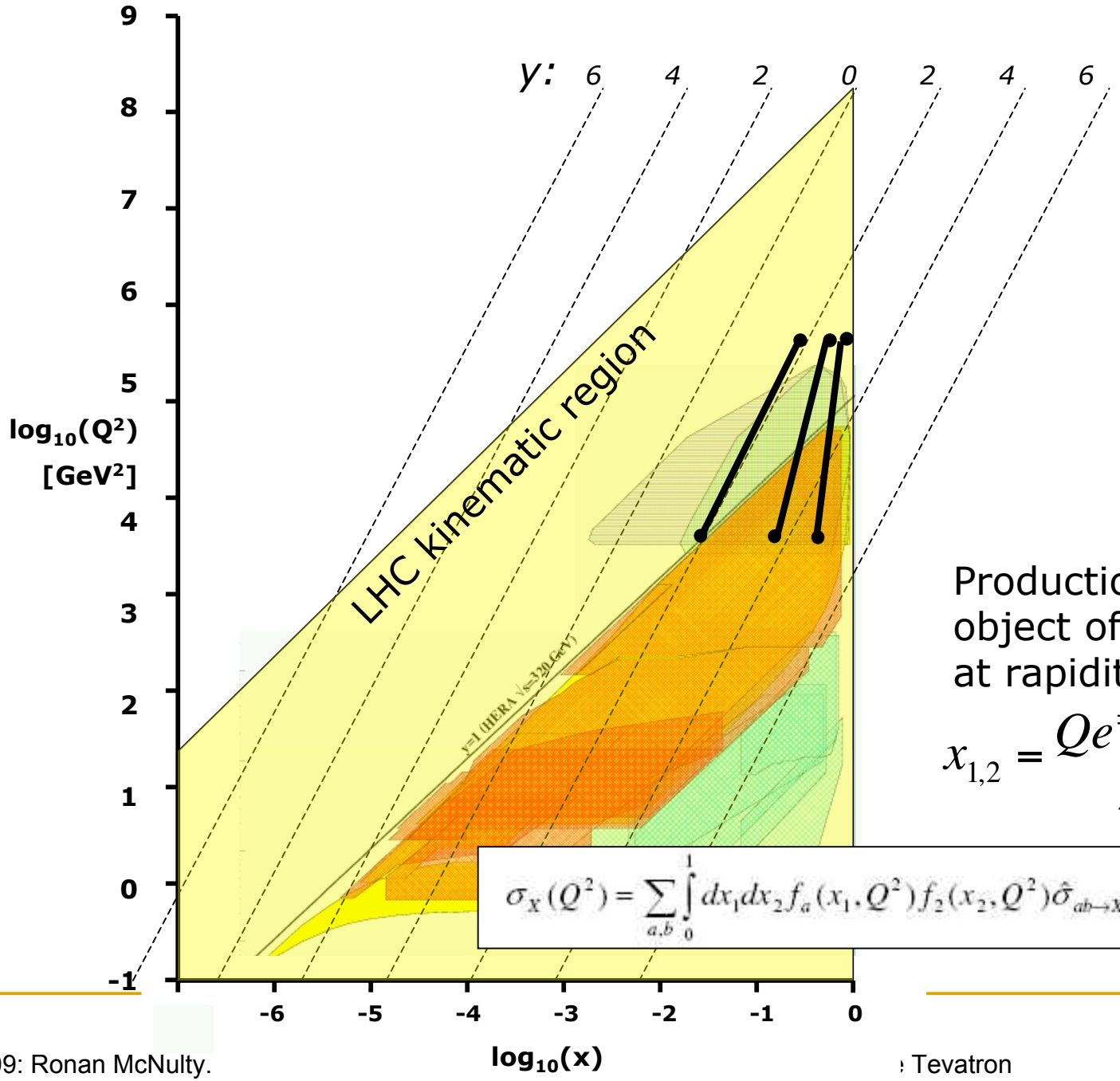

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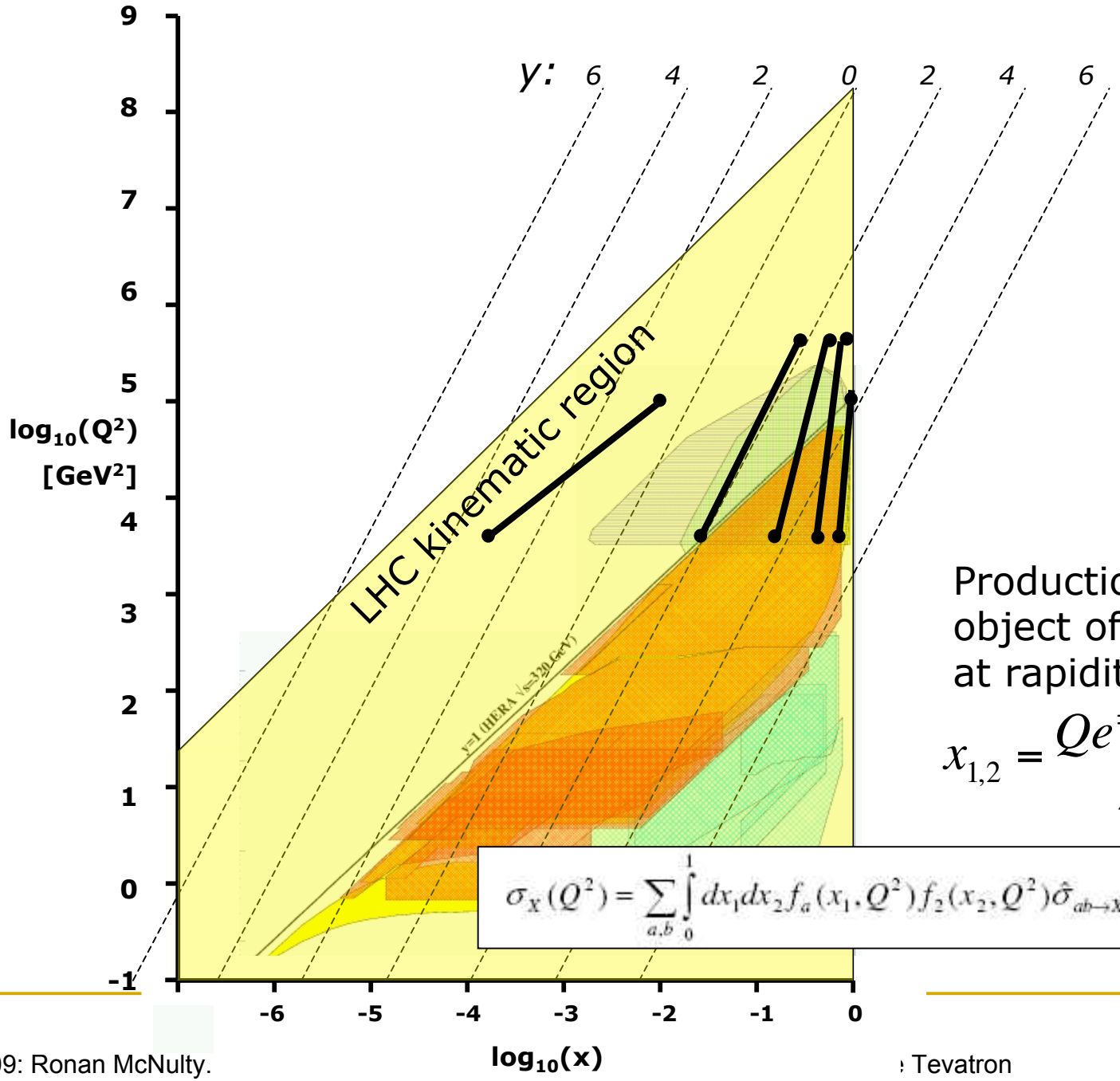

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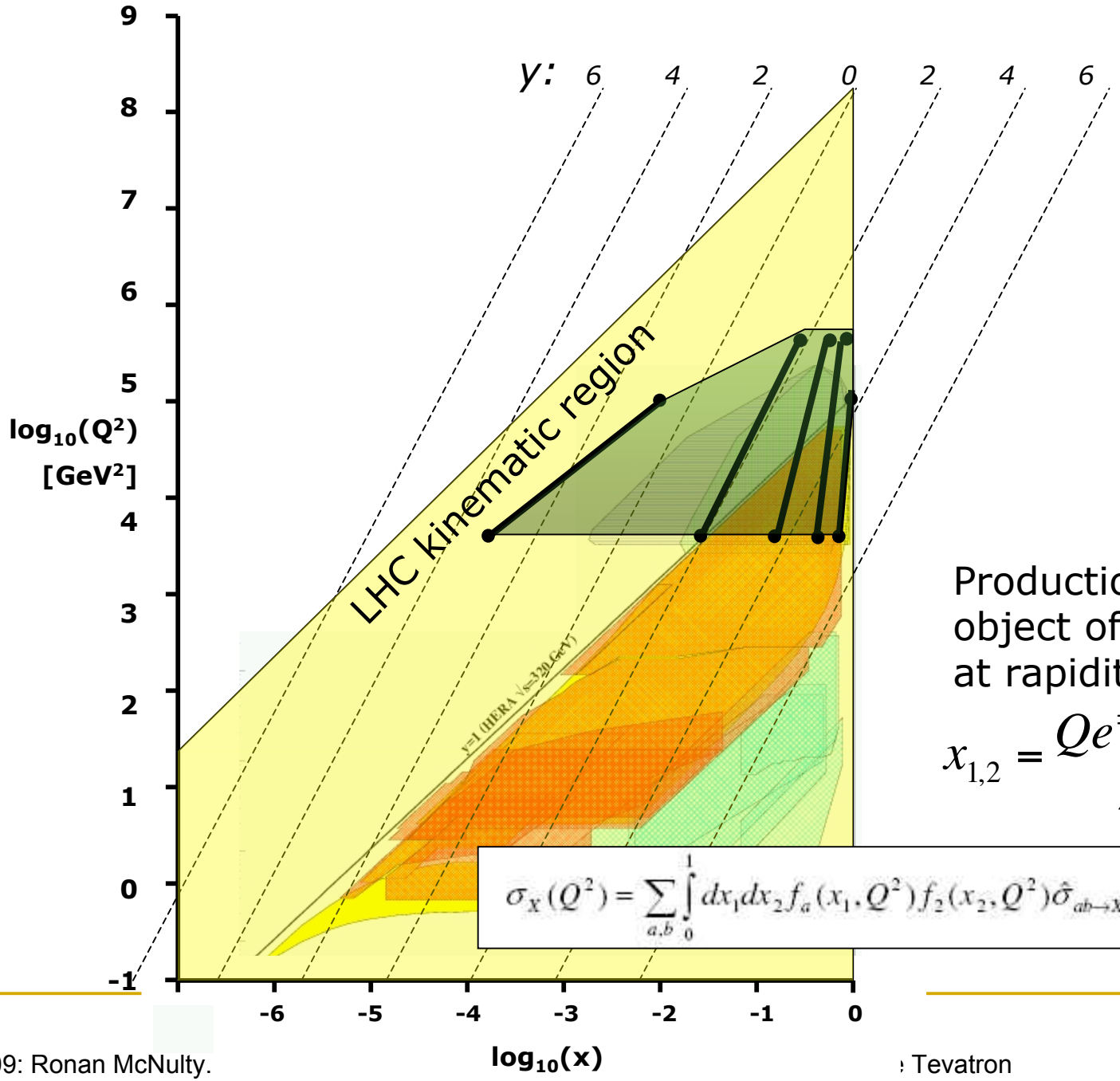

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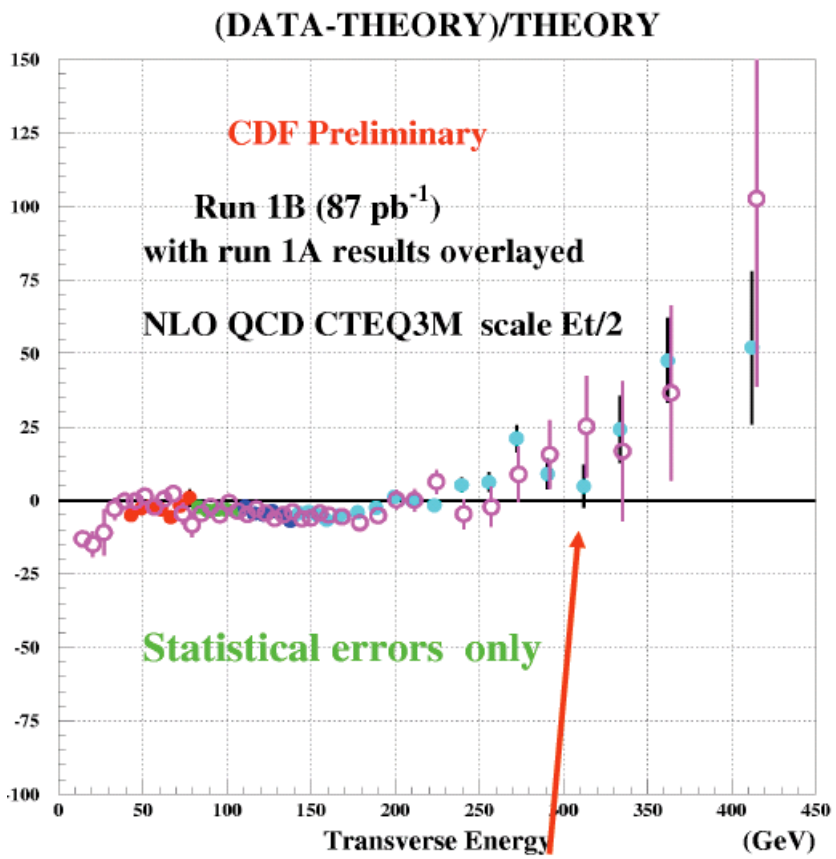
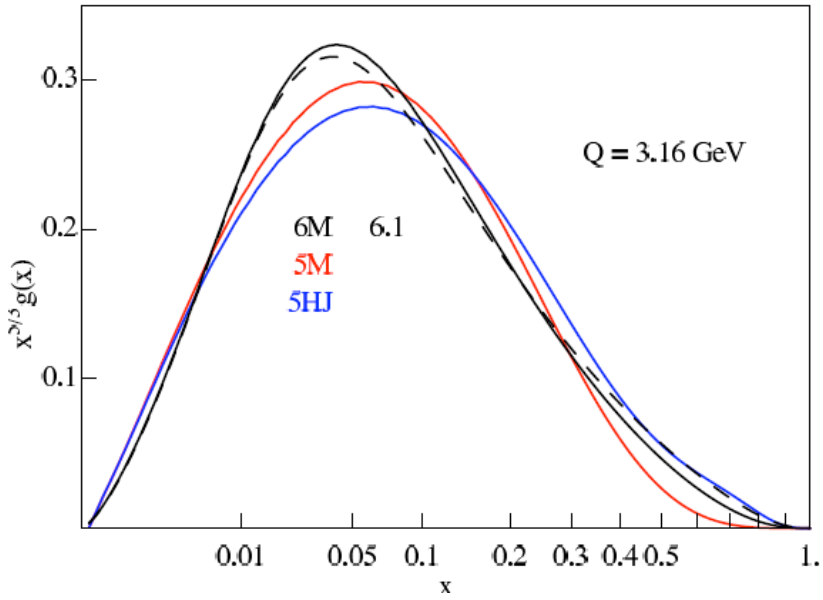
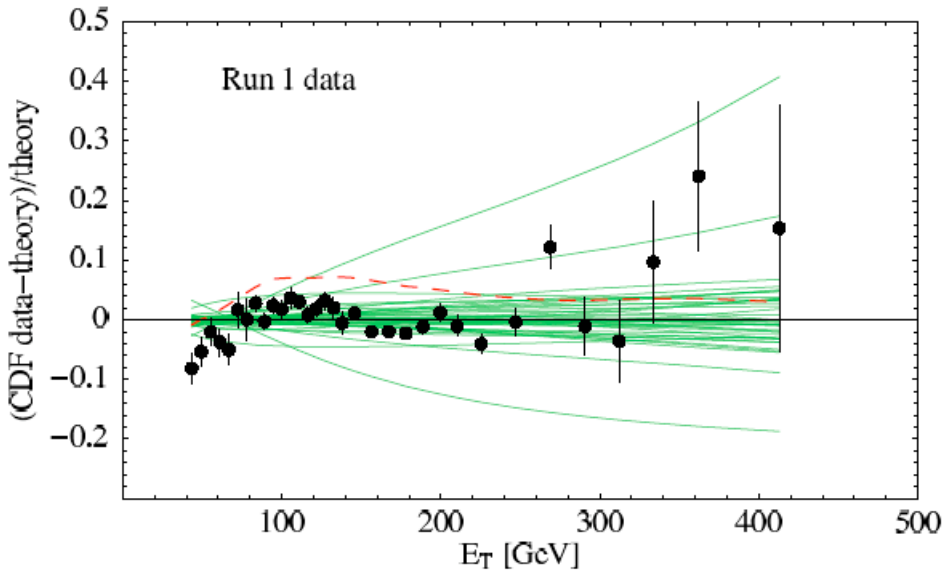
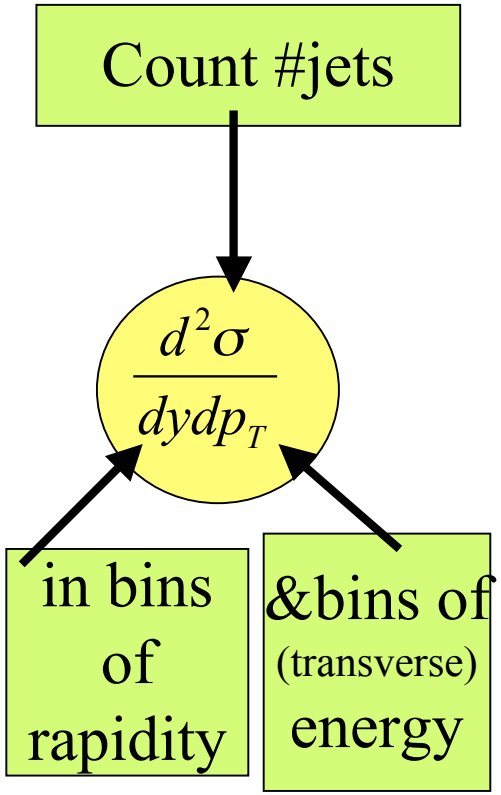


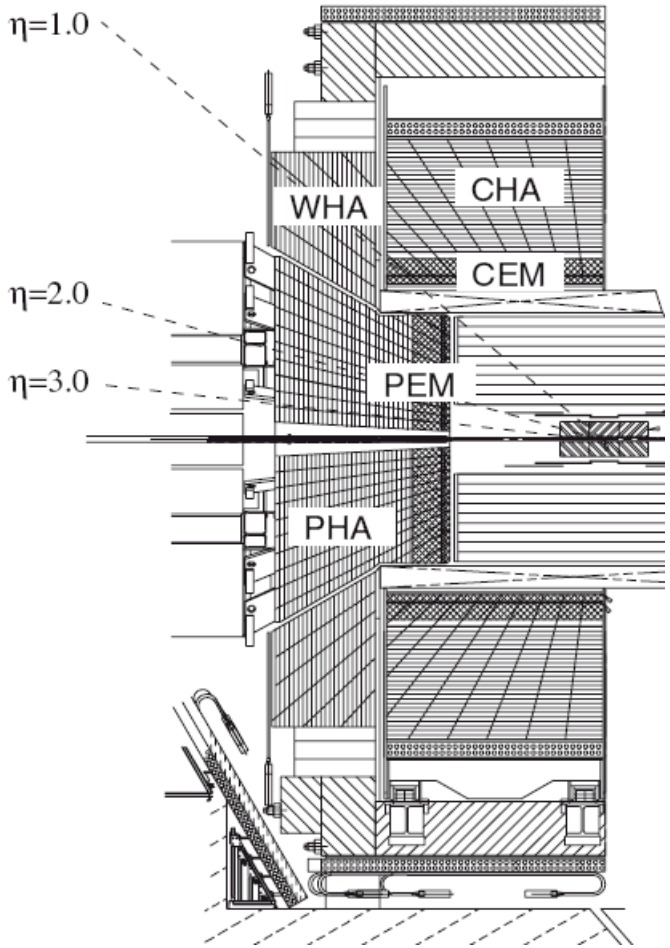
Was this new physics?

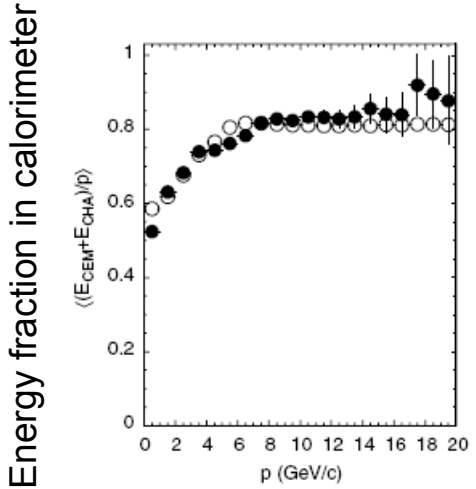




Methodology



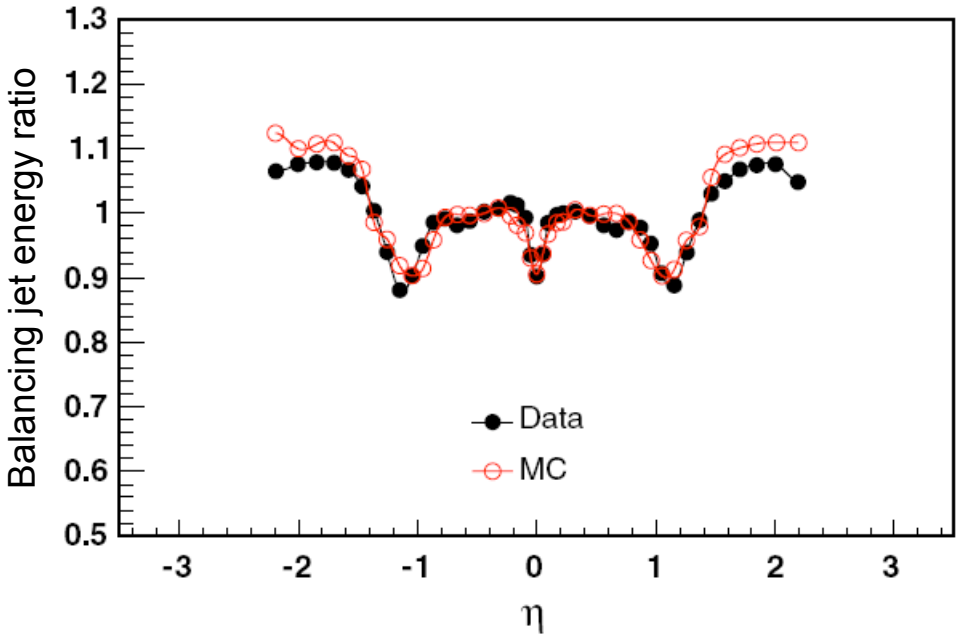




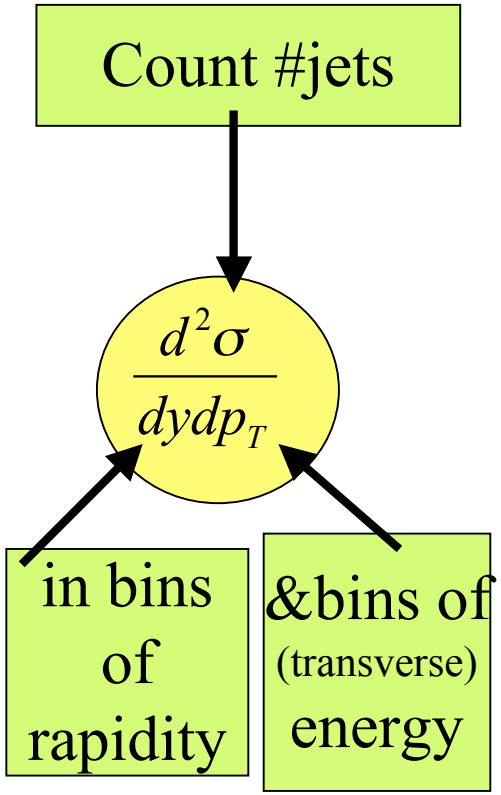
- data
- mc

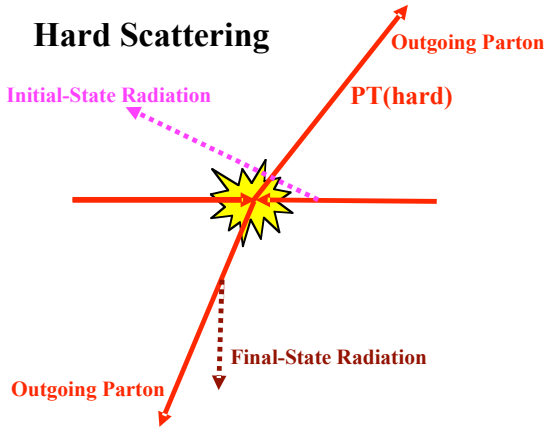
2-3% systematic

single track momentum



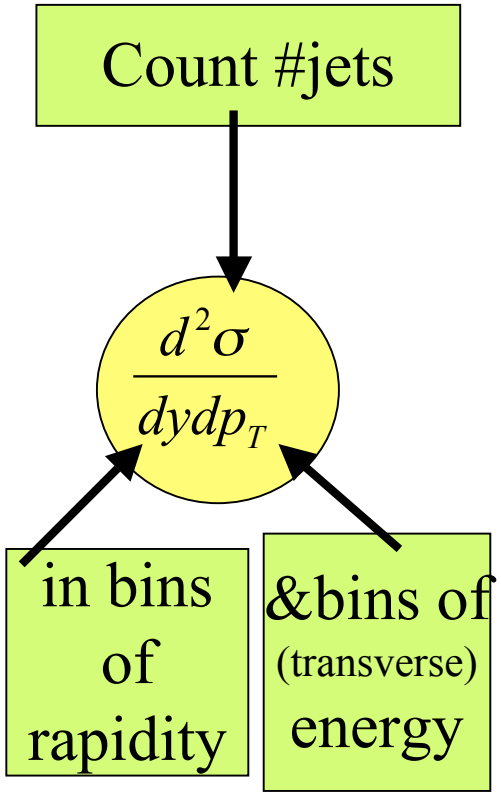
Methodology

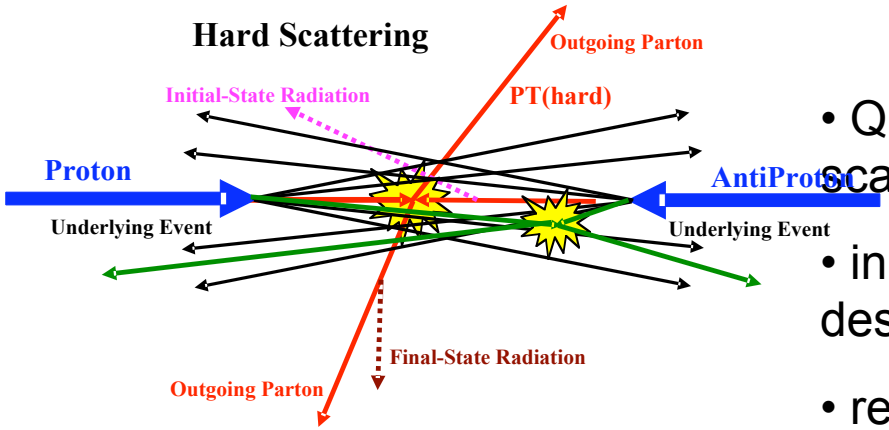




- QCD predicts hard scatter

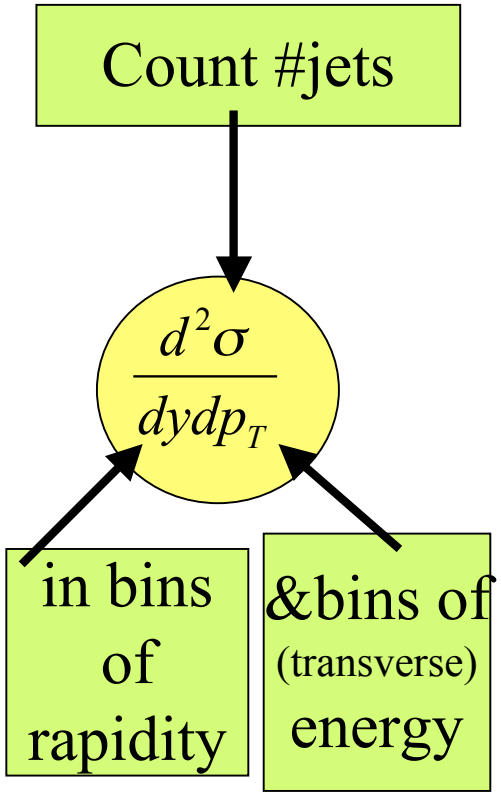
Methodology

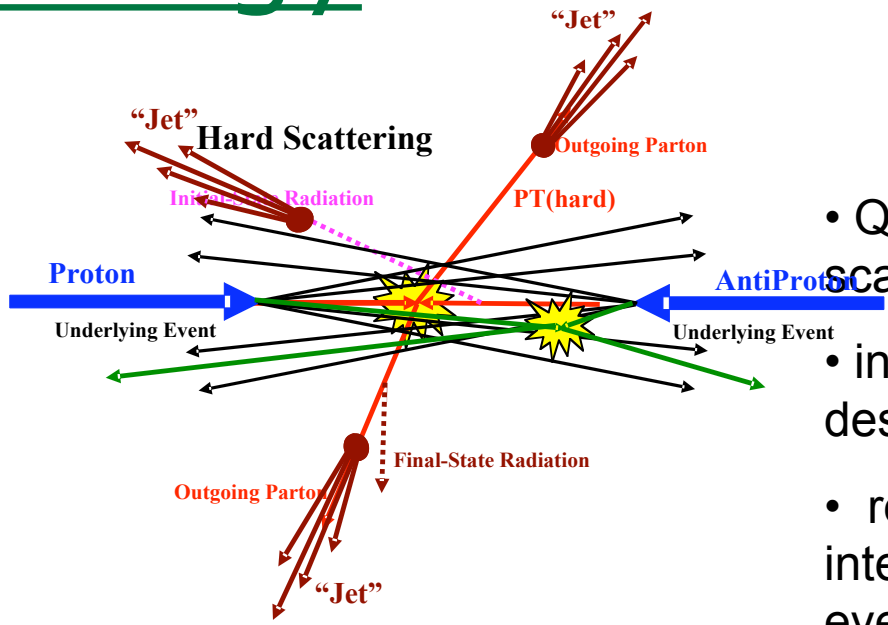




- QCD predicts hard scatter
- initial parton in proton described by PDF
- remaining partons interact (underlying event: proton remnants and mpi)
- multiple pp interactions

Methodology





- QCD predicts hard scatter
- initial parton in proton described by PDF
- remaining partons interact (underlying event: proton remnants and mpi)
- multiple pp interactions
- Partons hadronise
- We measure energy
- Collect it into jets

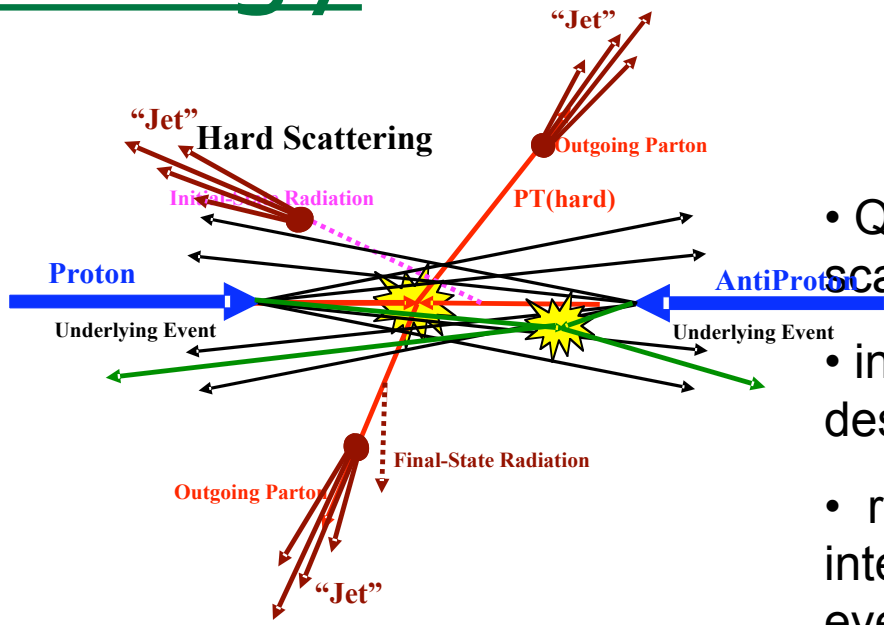
Methodology

Count #jets

$$\frac{d^2\sigma}{dydp_T}$$

in bins of rapidity

&bins of (transverse) energy



PRD 75, 092006 (2007)

k_T algorithm

PRD 78, 052006 (2008)

Midpoint cone algorithm

- QCD predicts hard scatter
- initial parton in proton described by PDF
- remaining partons interact (underlying event: proton remnants and mpi)
- multiple pp interactions
- Partons hadronise
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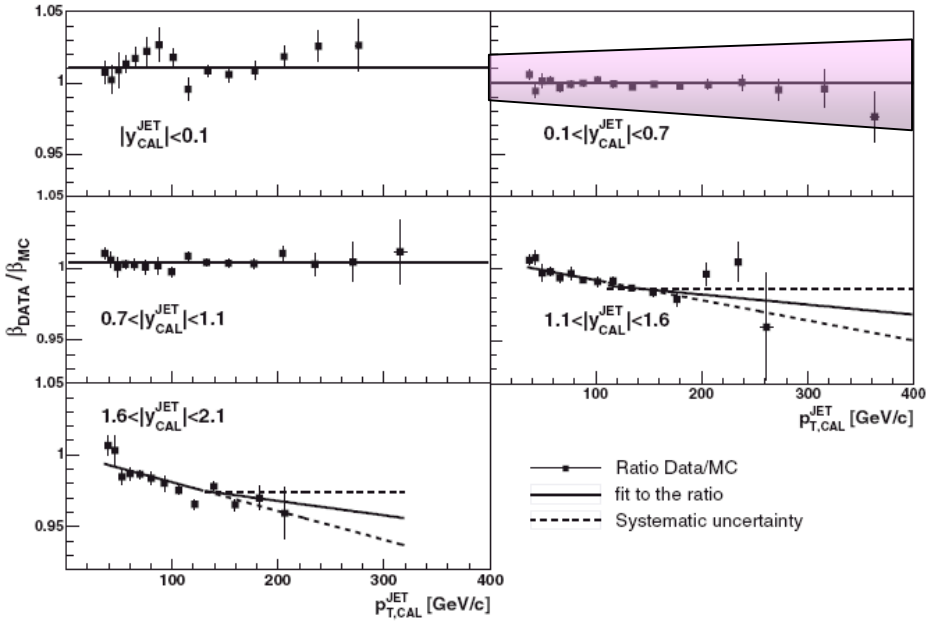
- Collect it into jets

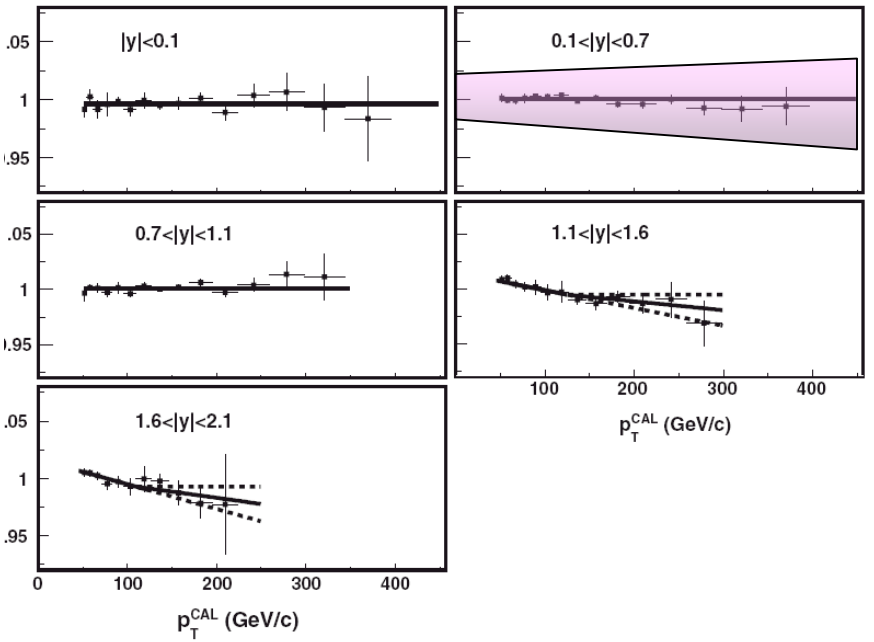
k_T algorithm

Calorimeter response

Midpoint cone algorithm

Jet Energy Scale: Nucl. Inst. Meth. 566 (2006) 375–412





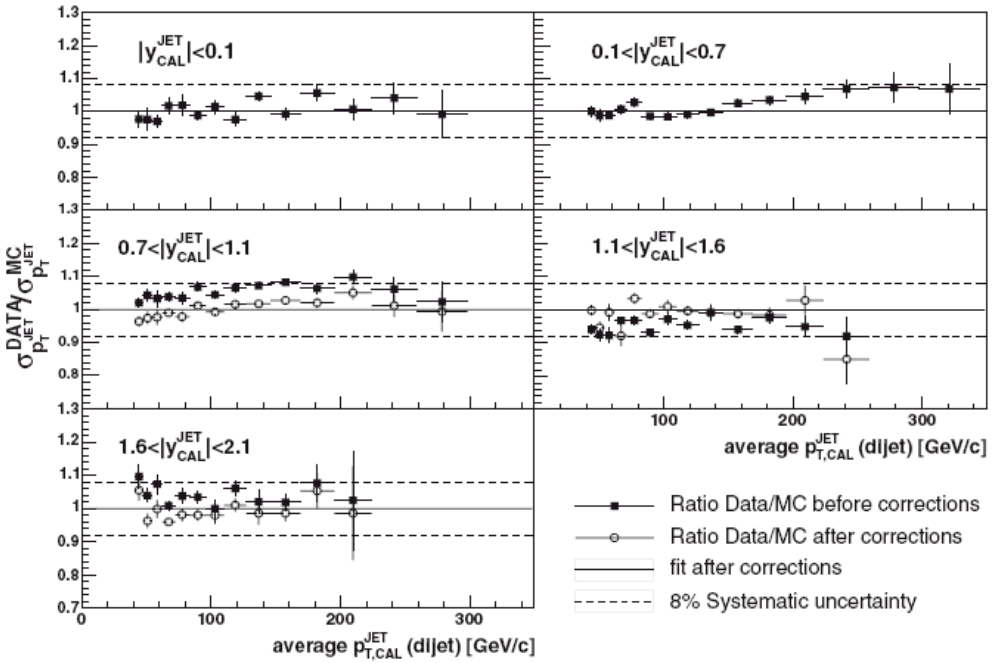
Systematic: 10% -> 60% on cross-section measurement.

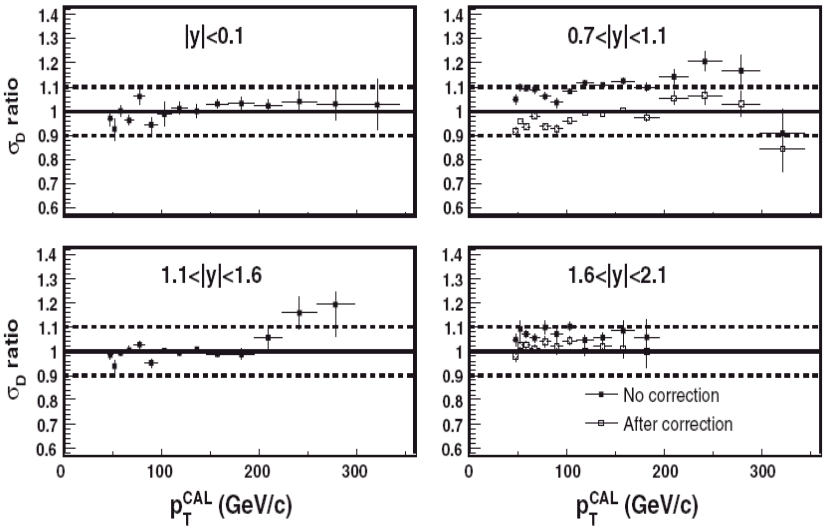
(larger at high pt)

k_T algorithm

Calorimeter resolution

Midpoint cone algorithm





σ(CEM)=14%/$\sqrt{}$ E+2%
σ(CHA)=50%/$\sqrt{}$ E+3%

Systematic: 10% -> 2% on cross-section measurement.

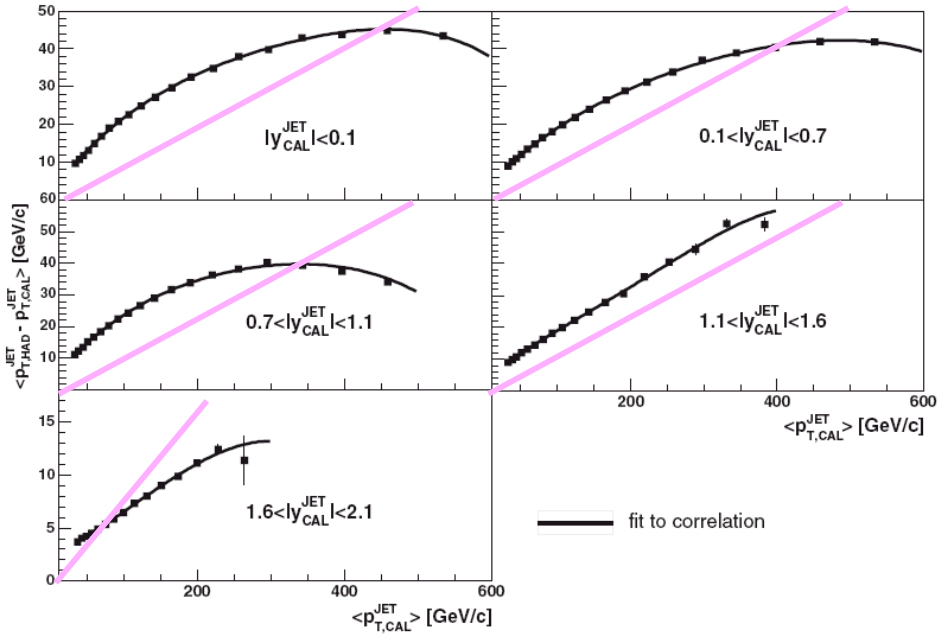
(smaller at high pt)

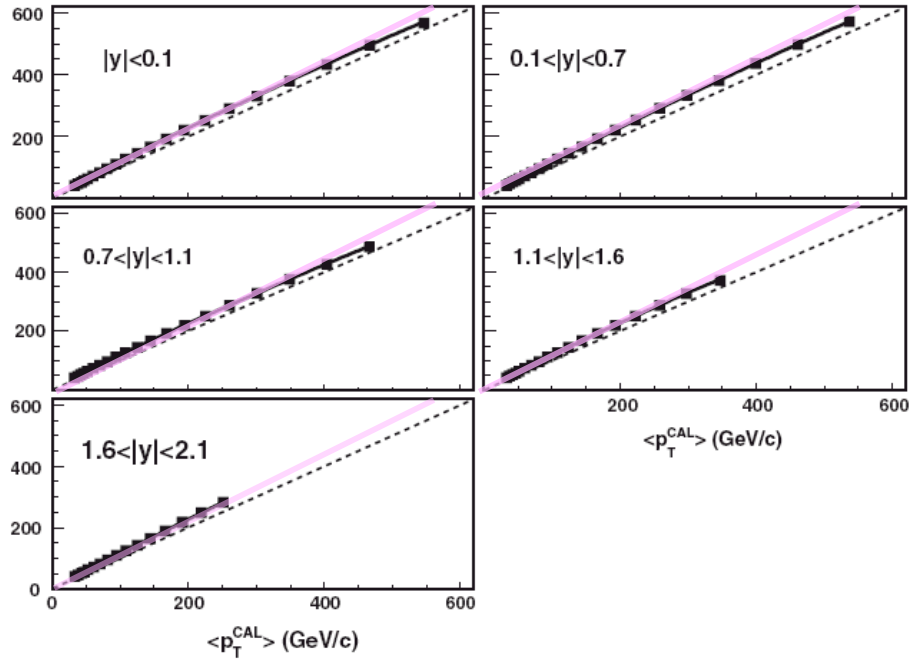
k_T algorithm

Unfolding to hadron level

Midpoint cone algorithm

Correct for energy missing from defined jet (calorimeter response / out-of-cone energy)





Systematic: 1% -> 10% on cross-section measurement.

k_T algorithm	Pile up	Midpoint cone algorithm

<Nv>=1.5 although N=5.9 at $1.6 \times 10^{32} cm^{-2} s^{-1}$

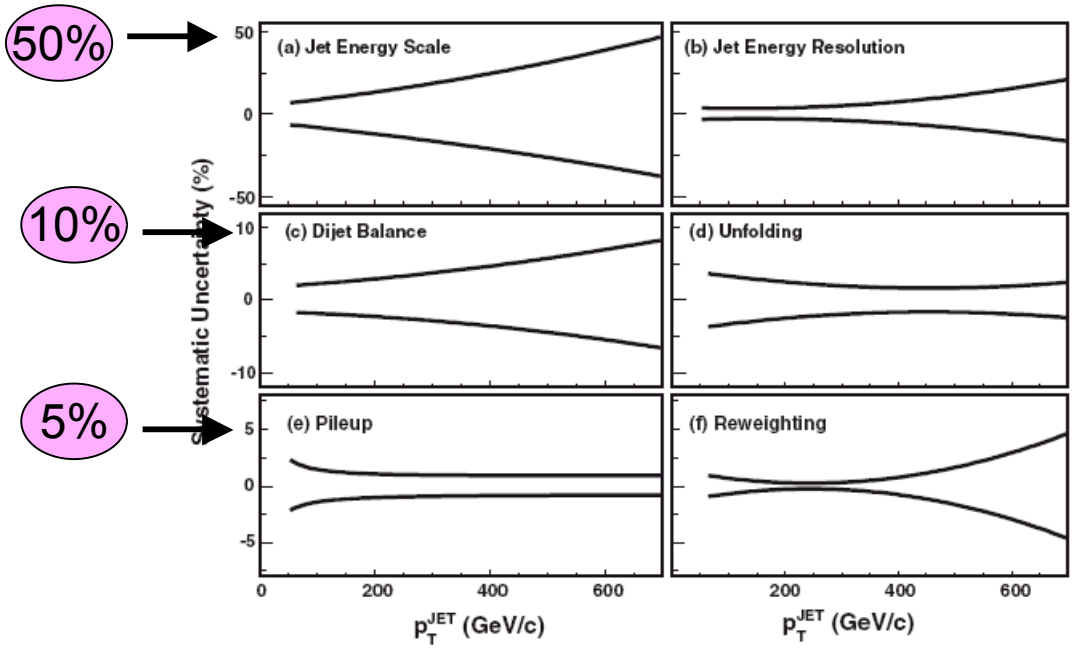
$-1.86*(N_v-1)$ GeV	$-0.97*(N_v-1)$ GeV

Systematic: 0.5%->2% on cross-section measurement

k_T algorithm

Systematic Overview

Midpoint cone algorithm

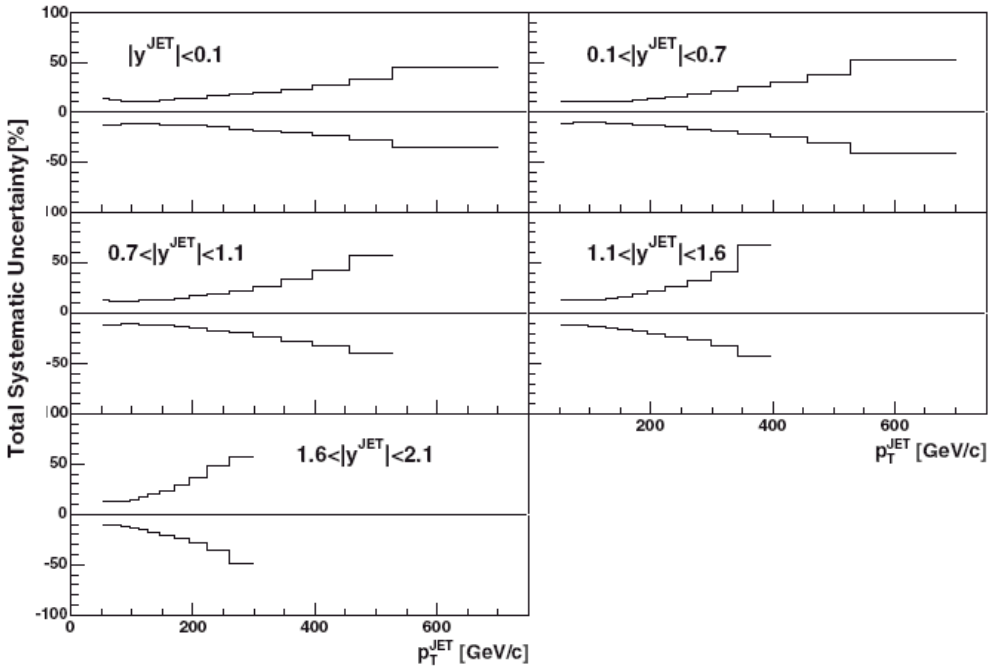


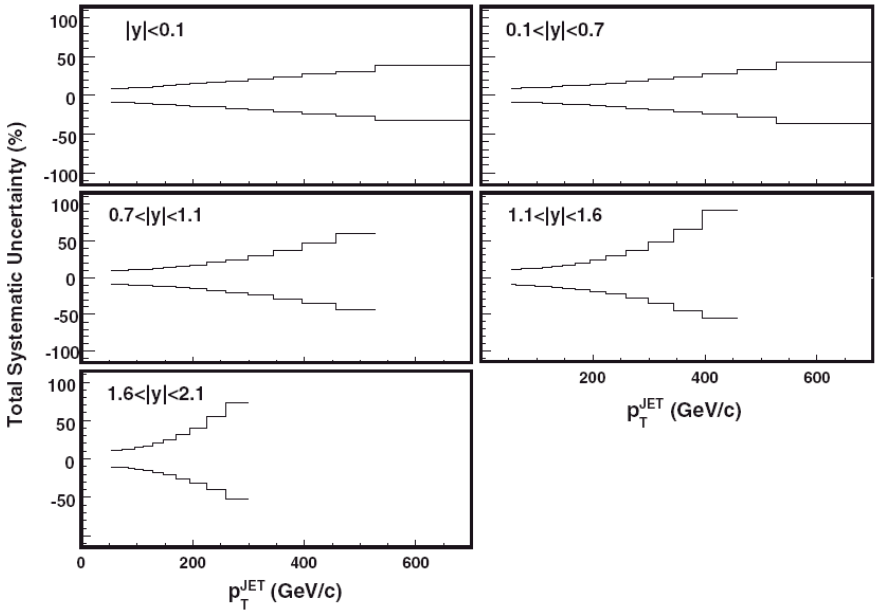
Jet energy scale dominates

k_T algorithm

Total Systematics

Midpoint cone algorithm





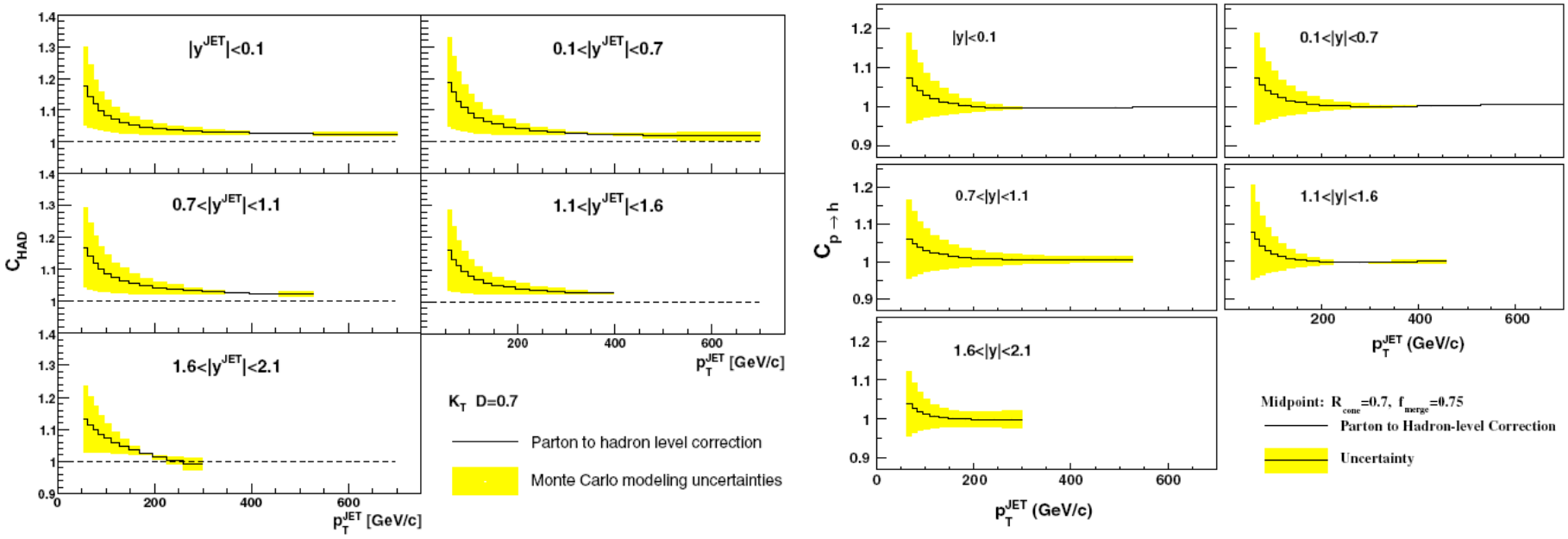
Total Systematic: Typically 10% at low pt; 50% at high.

k_T algorithm

Theory prediction at hadron level

Midpoint cone algorithm

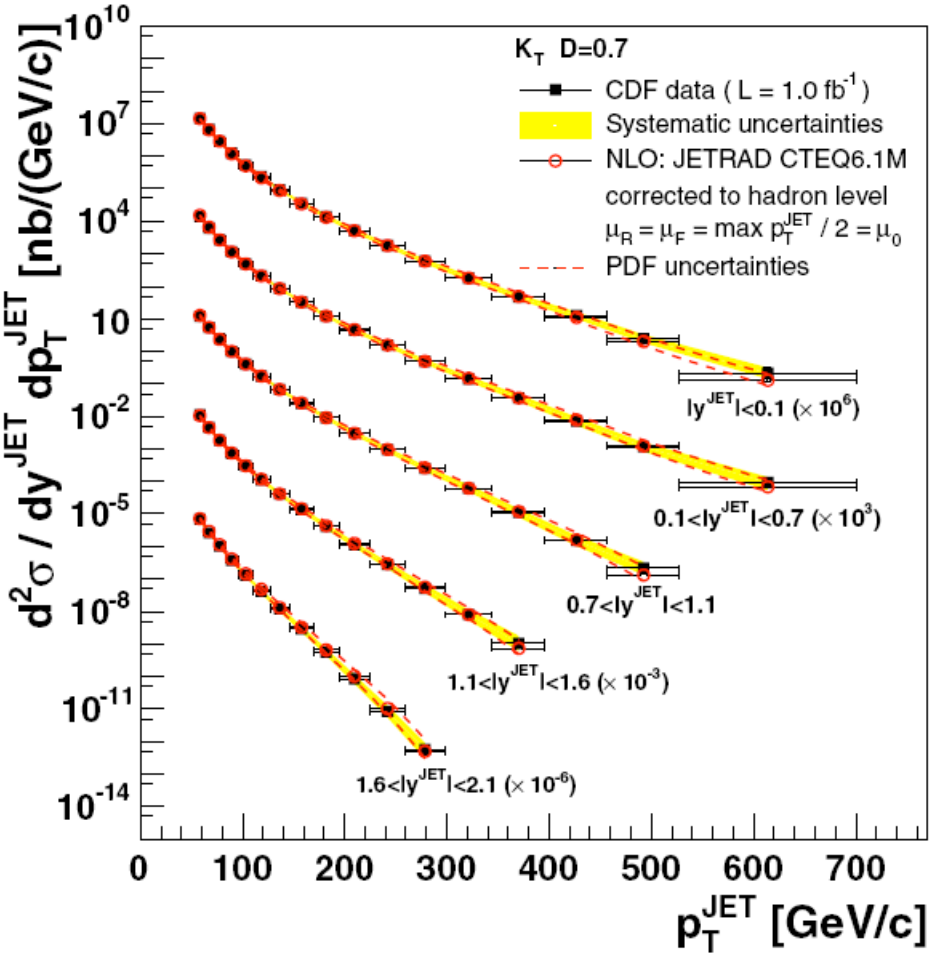
(Partons with underlying event and hadronisation added)

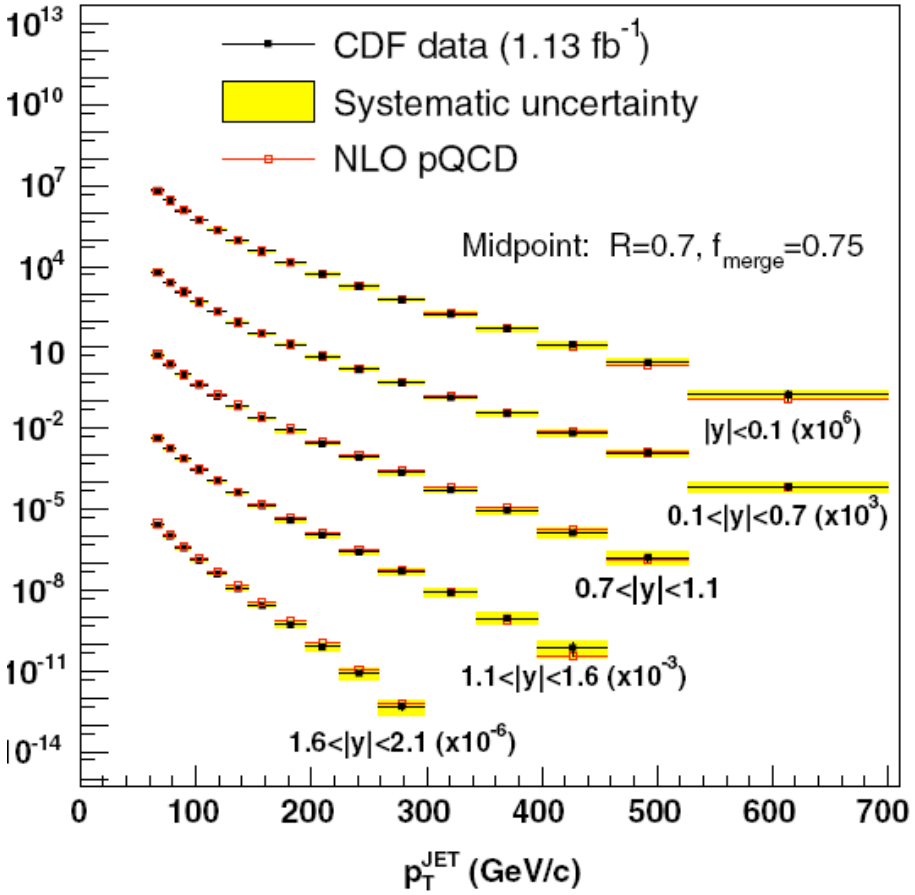


k_T algorithm

Data/Theory comparison

Midpoint cone algorithm





k_T algorithm

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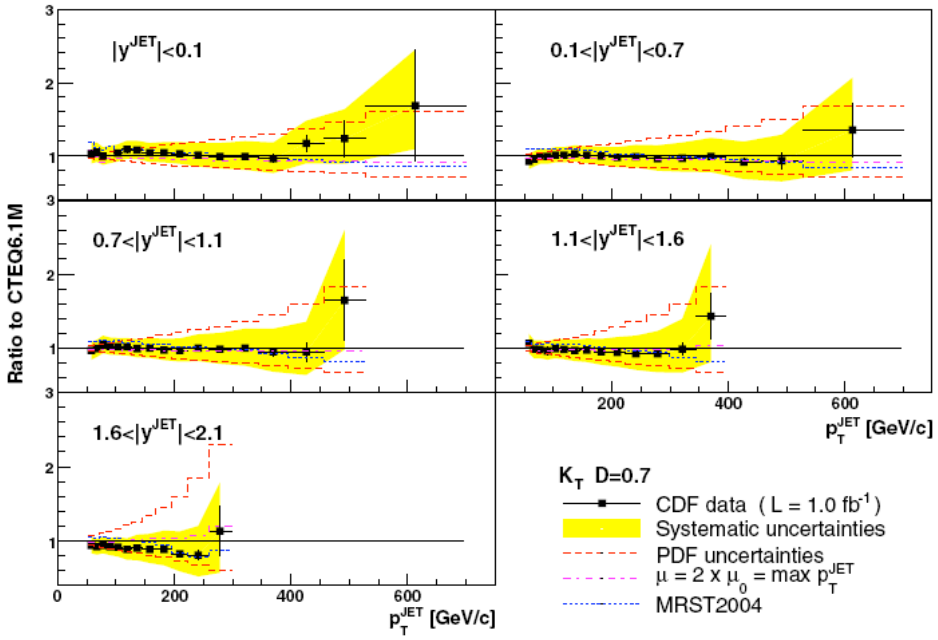
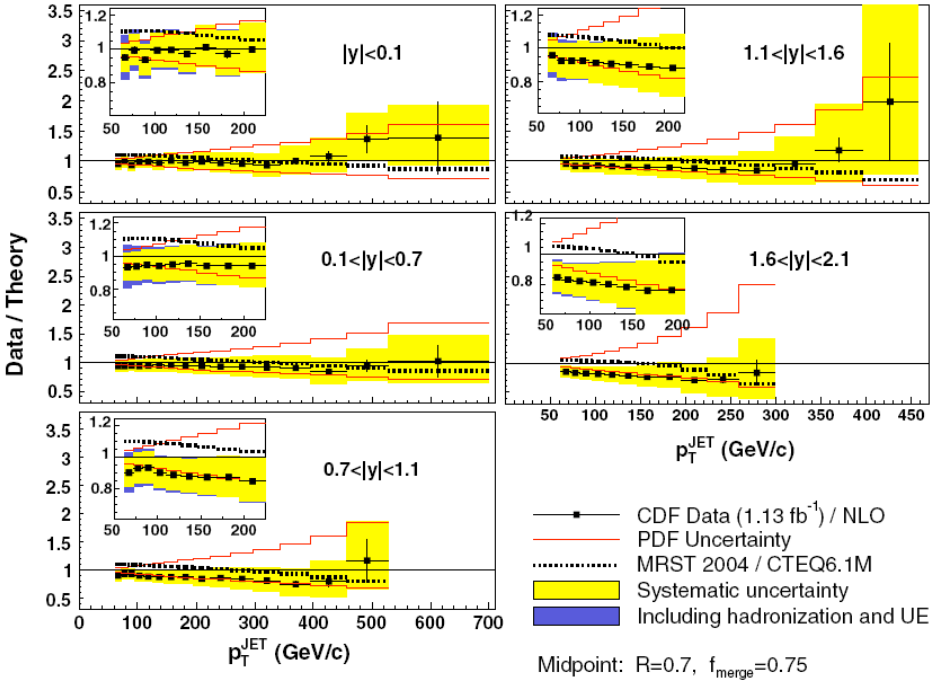
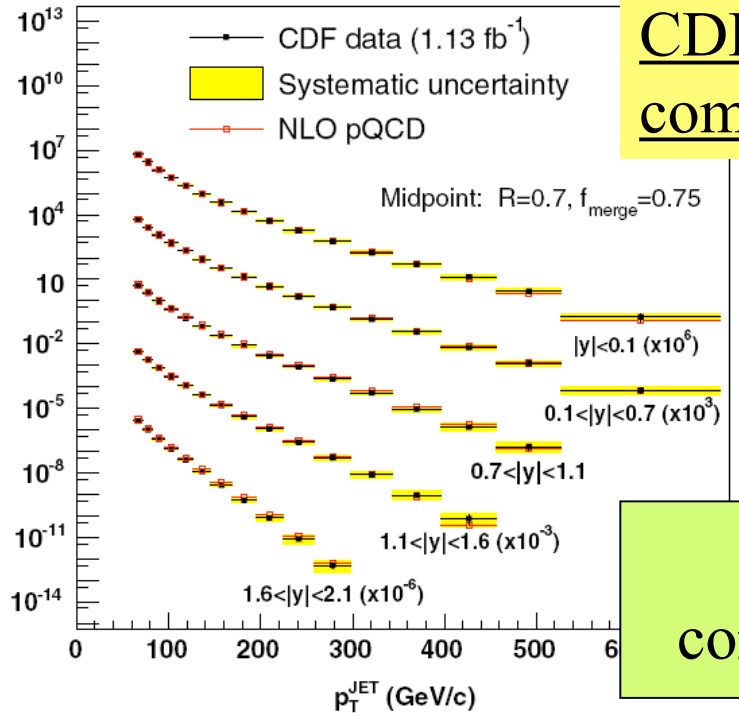
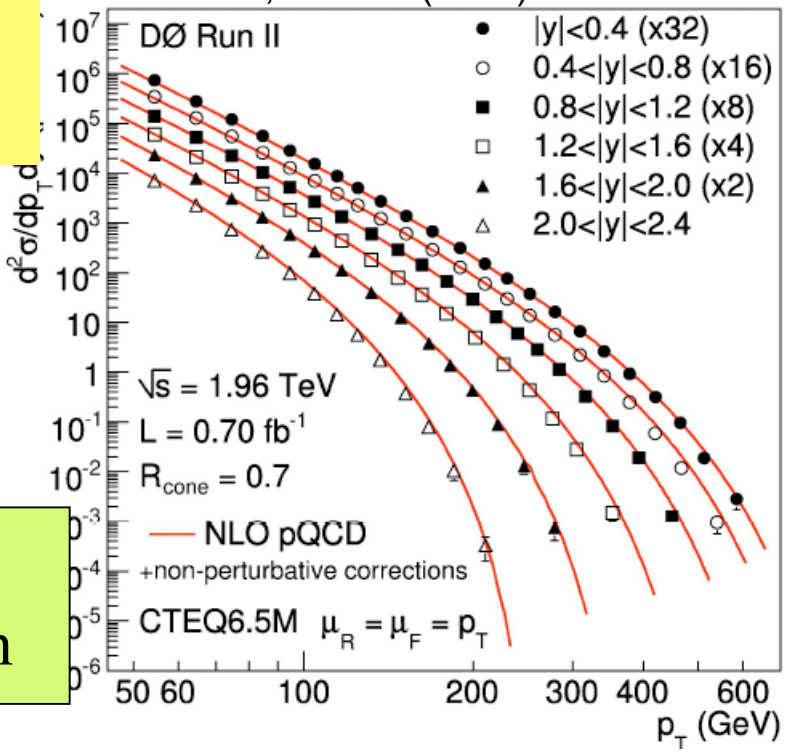




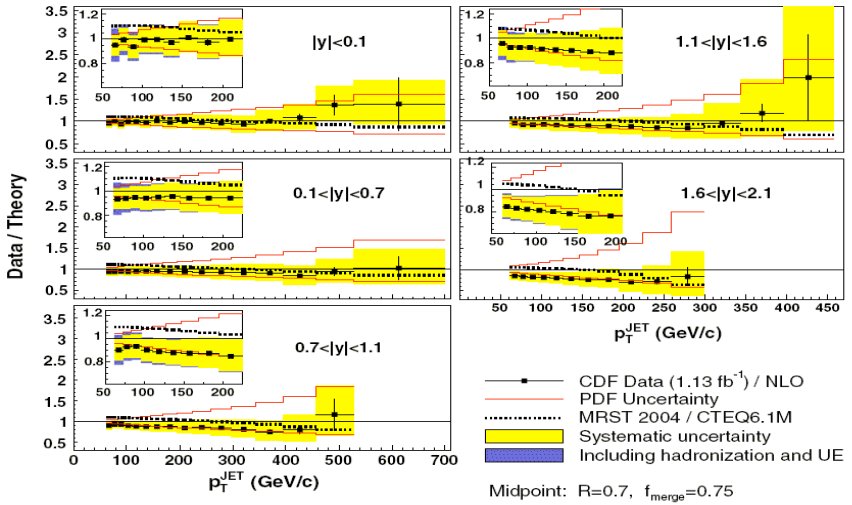
CDF/D0/theory comparison

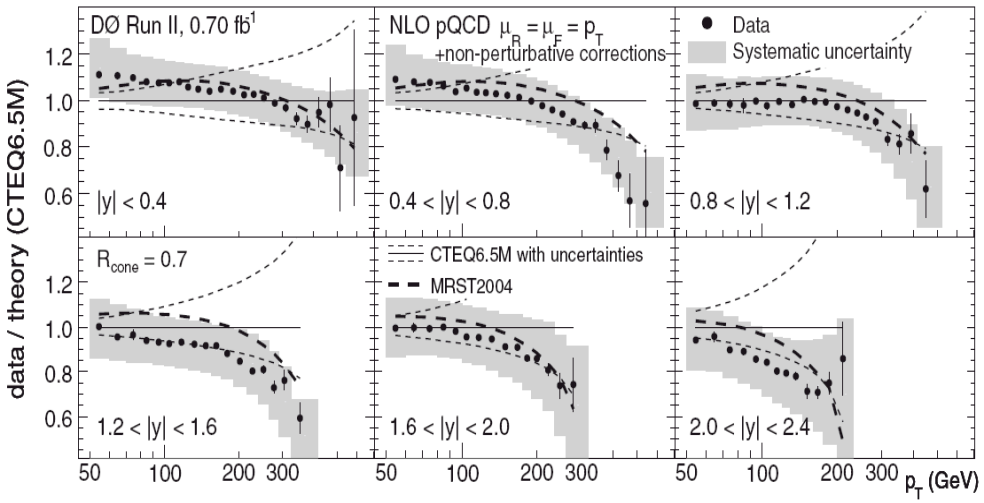
PRL 101, 062001 (2008)





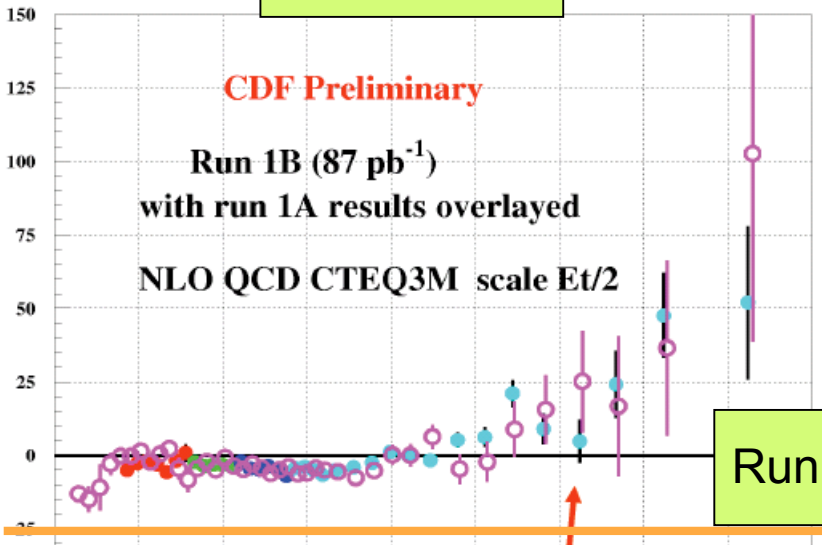
Midpoint cone algorithm

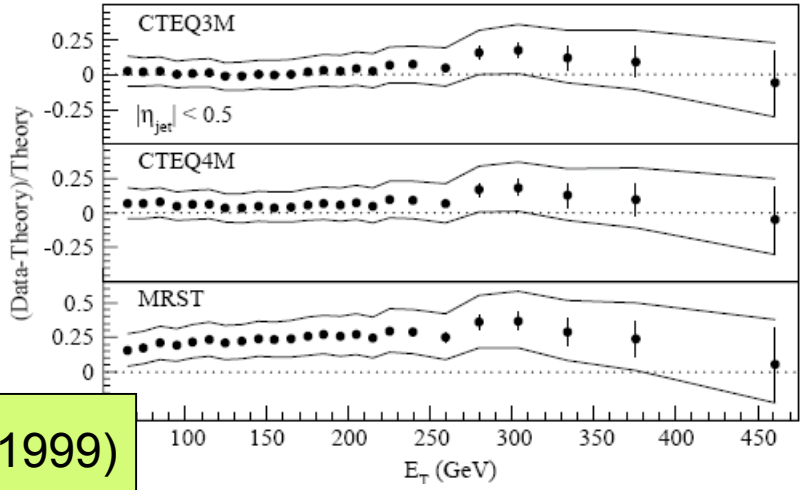




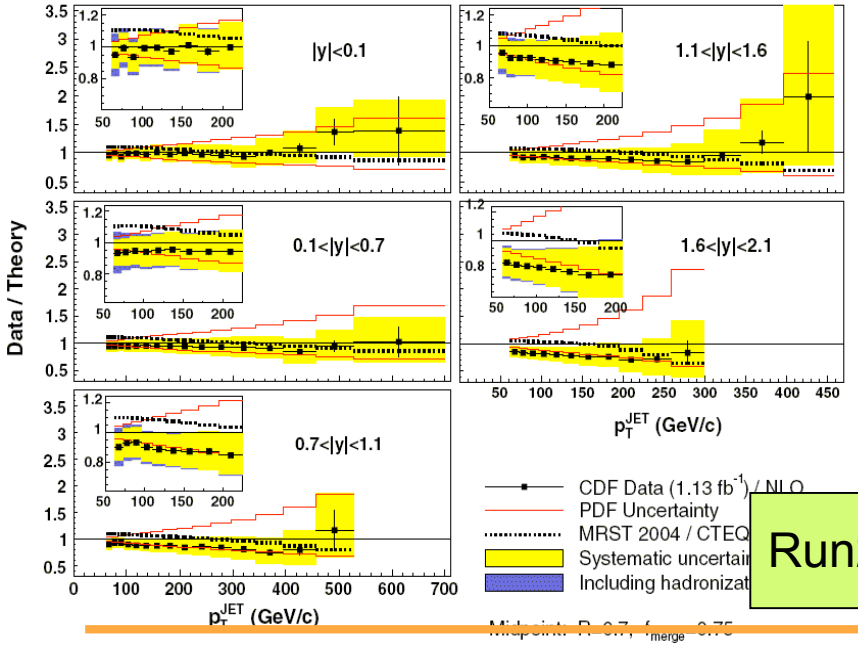
CDF

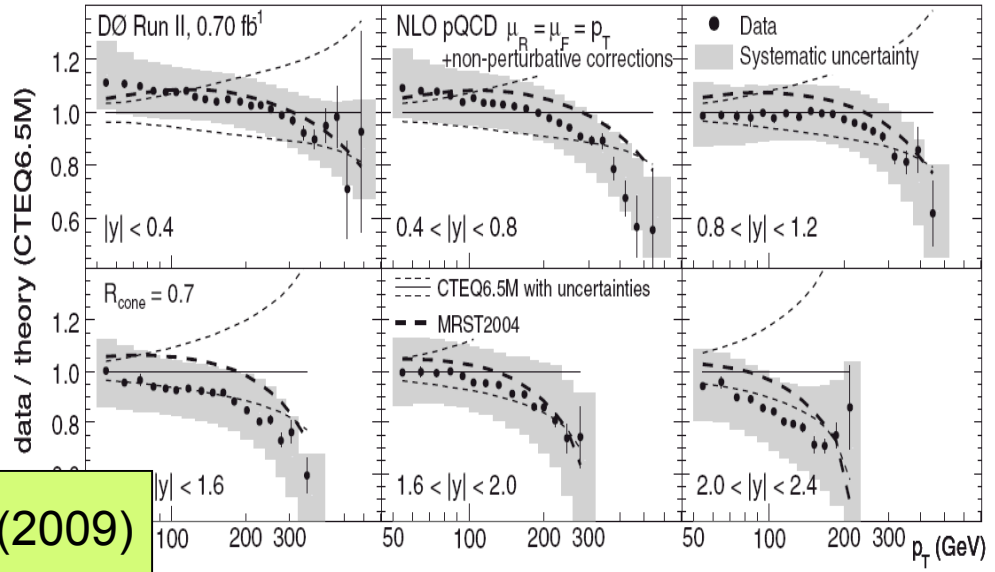
D0





Run1 (1999)

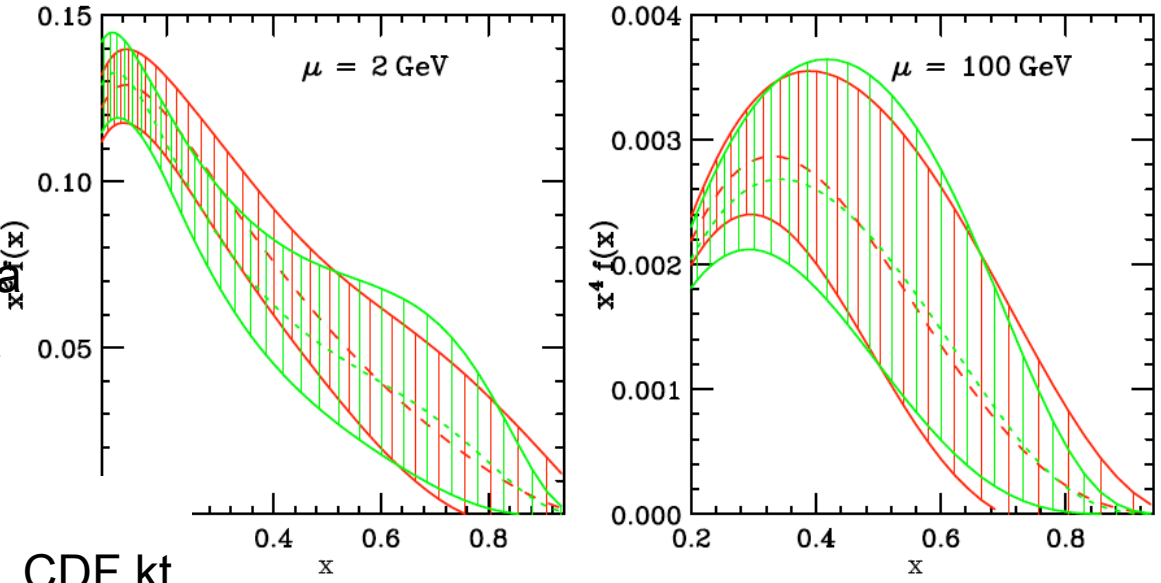




Run2 (2009)

Effect on gluon PDF: MSTW and CTEQ

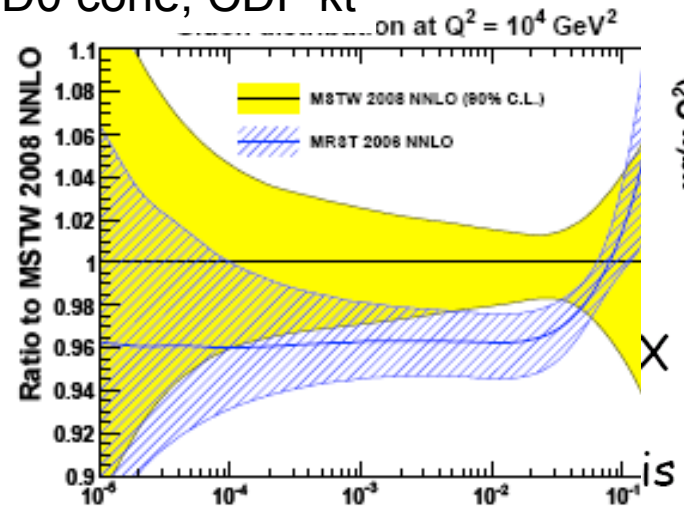
Run1 CDF,D0
Run2 cone data

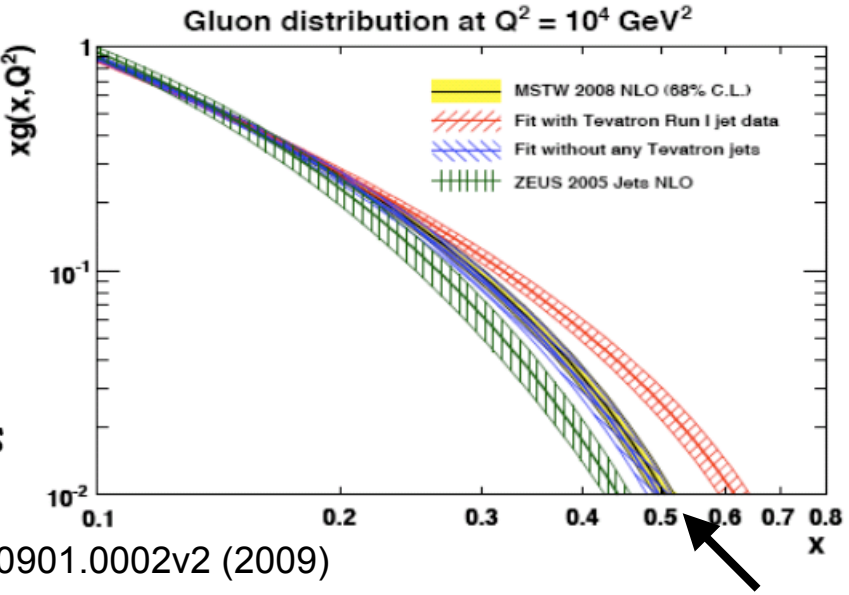


CTEQ6.6
CT09G

J. Huston,
Wshop on first physics
from LHC,
UCL, March 2009

Run2 D0 cone, CDF kt

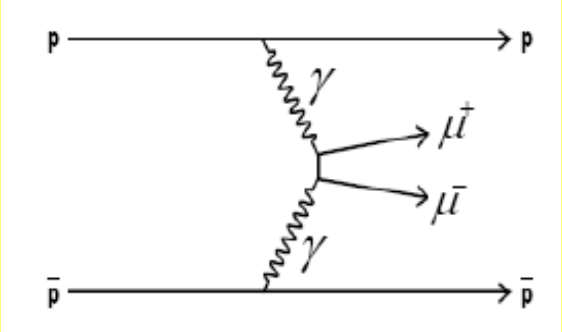




hep-ph 0901.0002v2 (2009)

Exclusive Dimuon Production (see also talk by J.Pinfold)

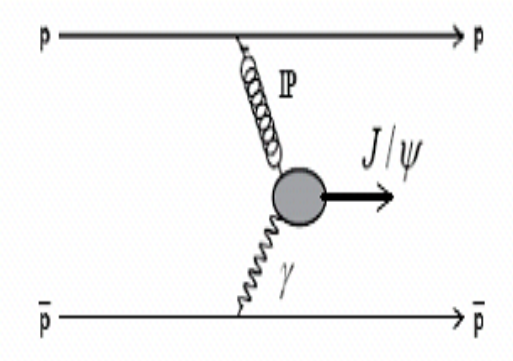
hep-ex 0902.1271v3 (2009)



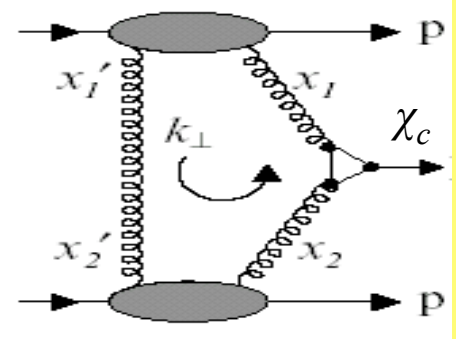
QED process: theory prediction <1%

Luminosity candidate for LHC

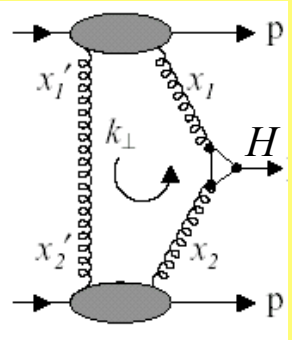
(See F.DeLorenzi's talk)

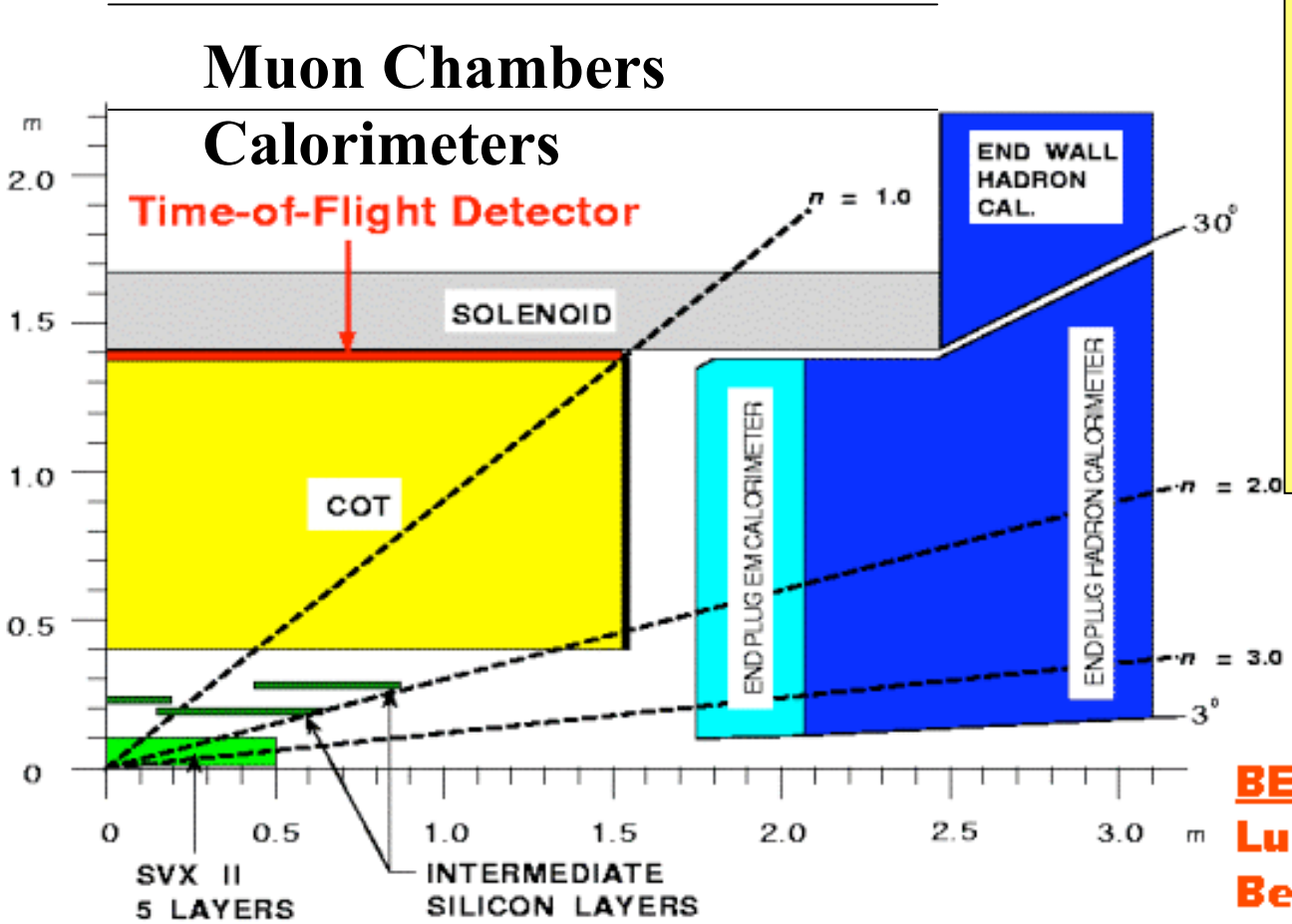


Possible odderon contribution



Calibrate of diffractive Higgs

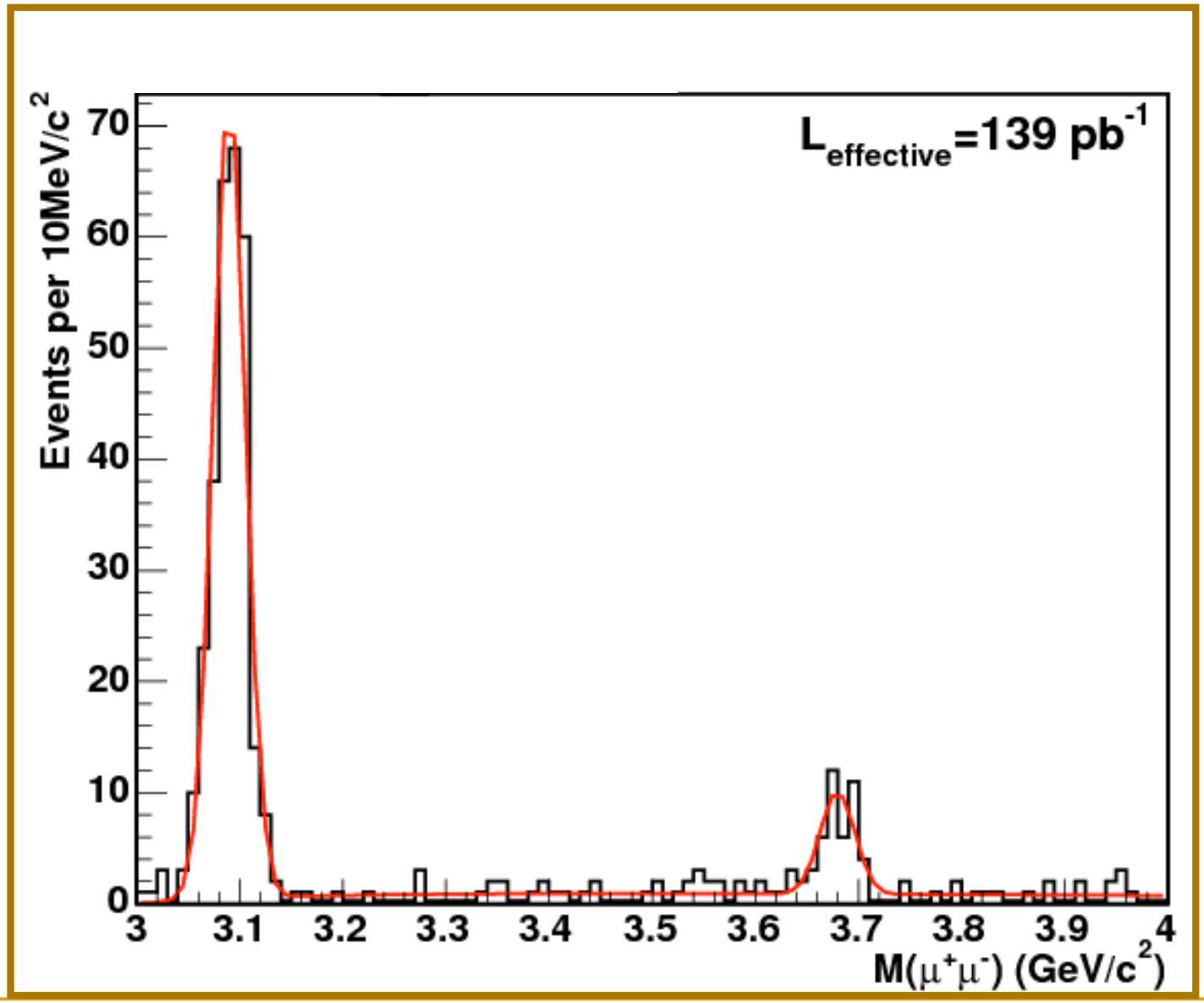




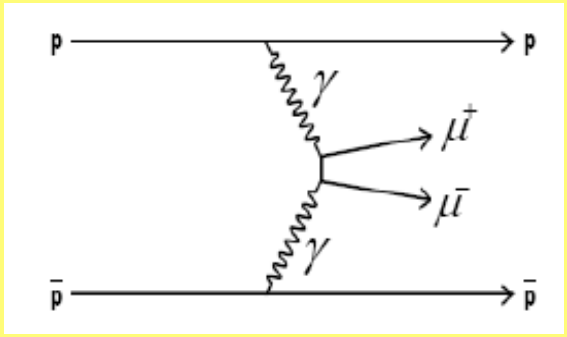
Trigger:
One muon, pT>1.4GeV
Nothing in BSC

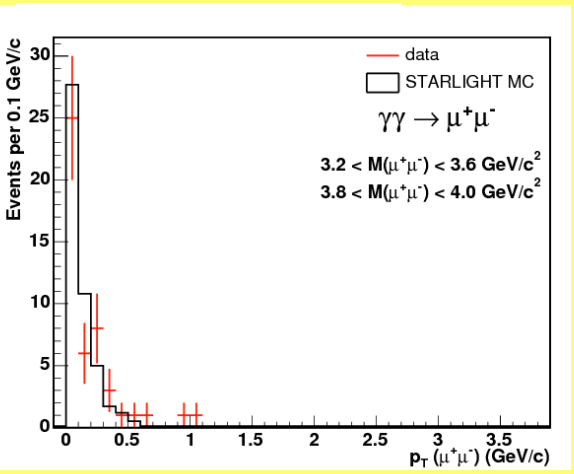
Reconstruction:
Two central muons
Nothing else or
1 EM shower>80MeV

BEYOND 3 deg:
Luminosity Counters
Beam Shower Counters
Roman Pots


$L_{effective}$=139 pb^{-1}
Events per 10MeV/c^2
0
10
20
30
40
50
60
70
3
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4
M($\mu^+\mu^-$) (GeV/c^2)

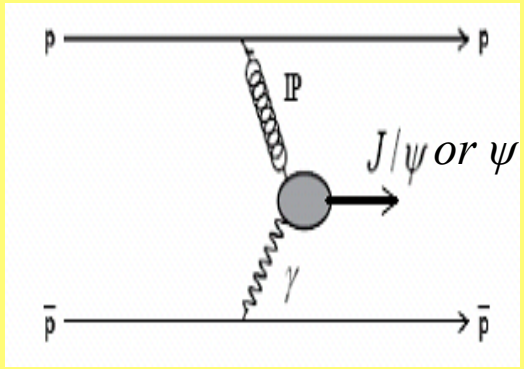
Exclusive Dimuon Production

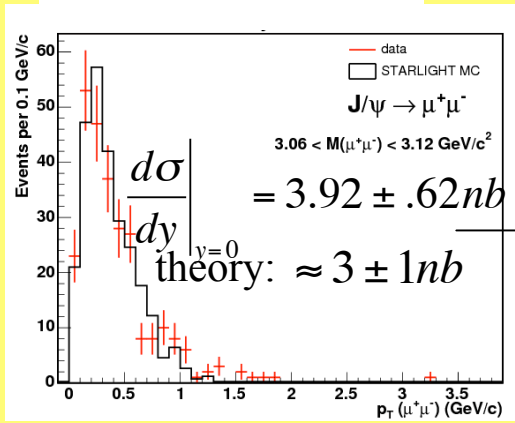




$\sigma = 2.7 \pm .5 nb$

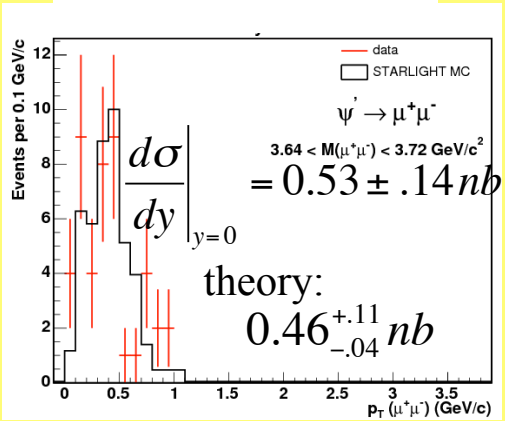
theory: $\sigma = 2.18 \pm .01 nb$





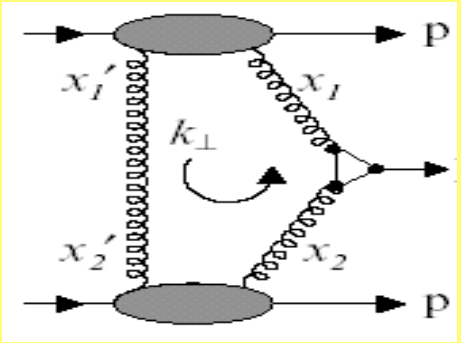
$\left.\frac{d\sigma}{dy}\right|_{y=0} = 3.92 \pm .62 nb$

theory: $\approx 3 \pm 1 nb$



$\left.\frac{d\sigma}{dy}\right|_{y=0} = 0.53 \pm .14 nb$

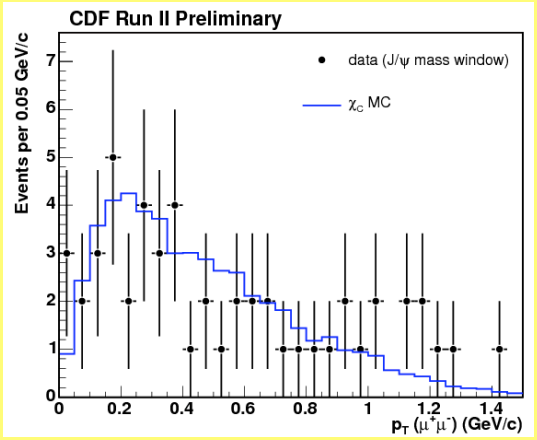
theory: $0.46^{+.11}_{-.04} nb$



65 have photon too

$\left.\frac{d\sigma}{dy}\right|_{y=0} = 76 \pm 14 nb$

consistent with theory



Conclusions

- Jet cross-section measurements for CDF and D0 agree with each other and with NLO QCD
- Exclusive dimuons in the continuum are in agreement with QED
- Exclusive J/psi, psi' and Chi_c have been observed.