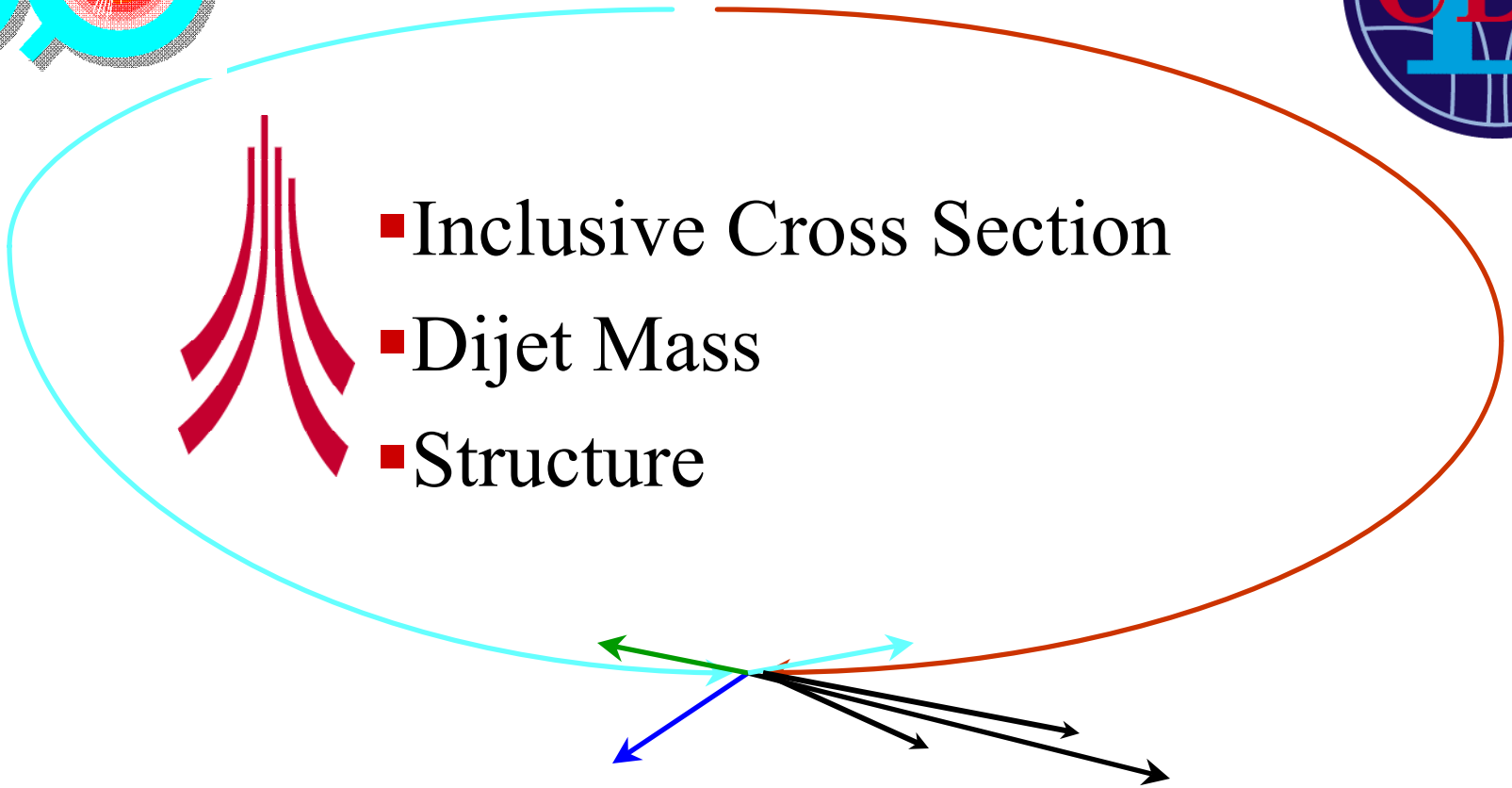
Run 2 Jets at the Tevatron

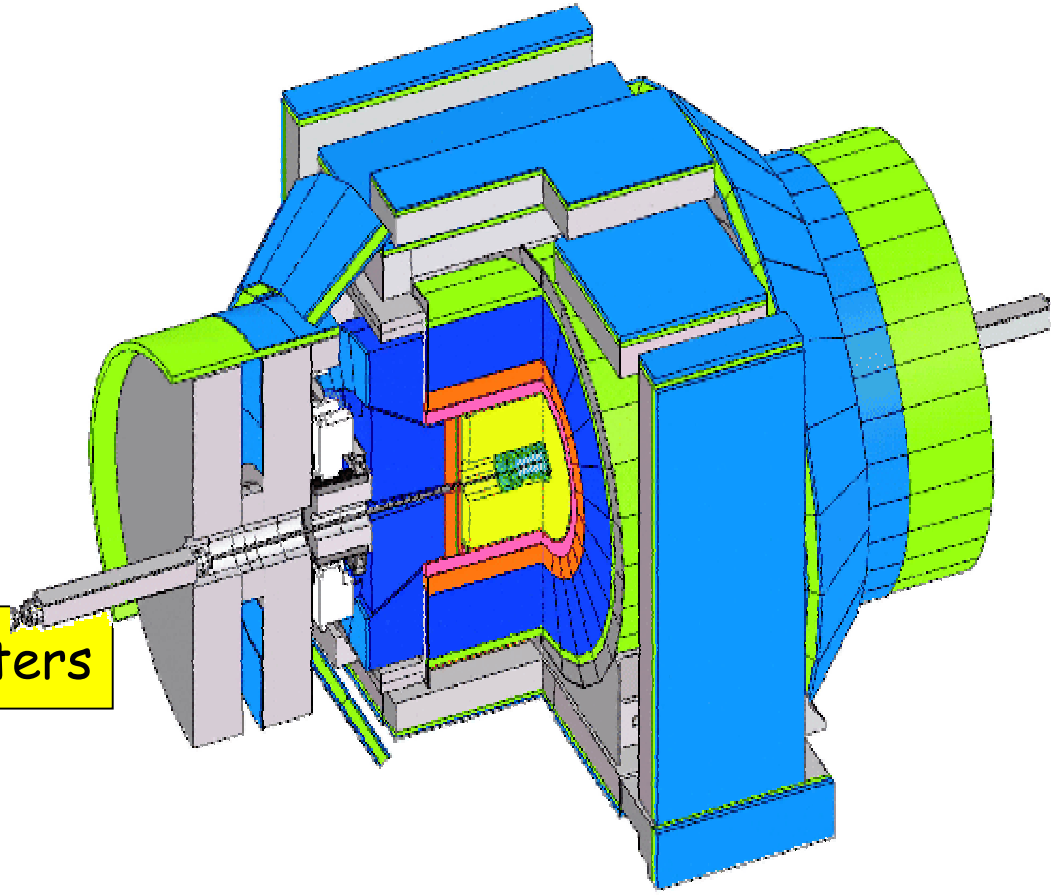
Iain Bertram
Lancaster University/DØ Experiment
PIC2003



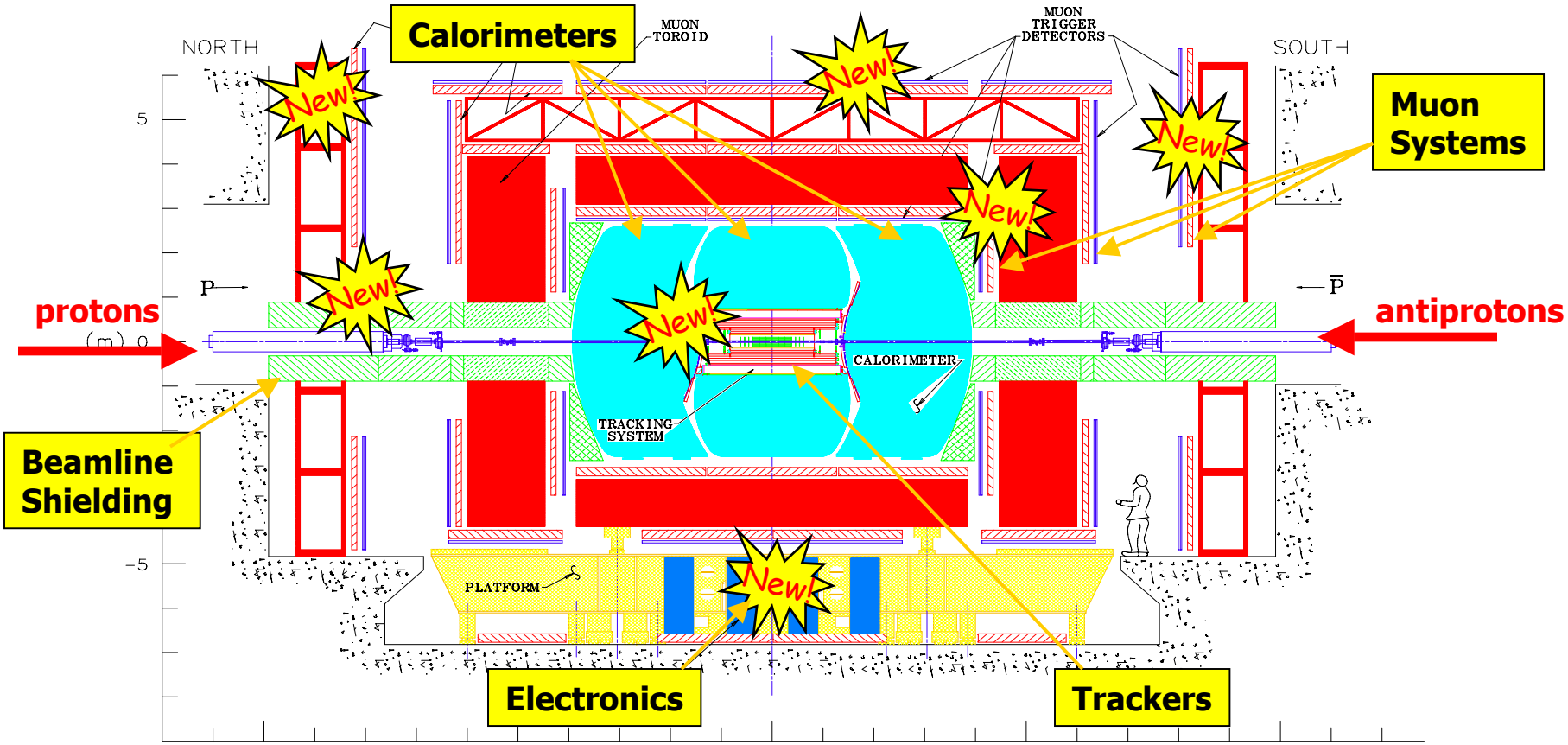
- Inclusive Cross Section
- Dijet Mass
- Structure

CDF II Upgraded Detector

- Upgraded Muon Detectors
- New TOF Detector
- New Plug Calorimeters
- New Drift Chamber
- New Silicon Tracking
- New Mini-Plugs Calorimeters
- New DAQ System

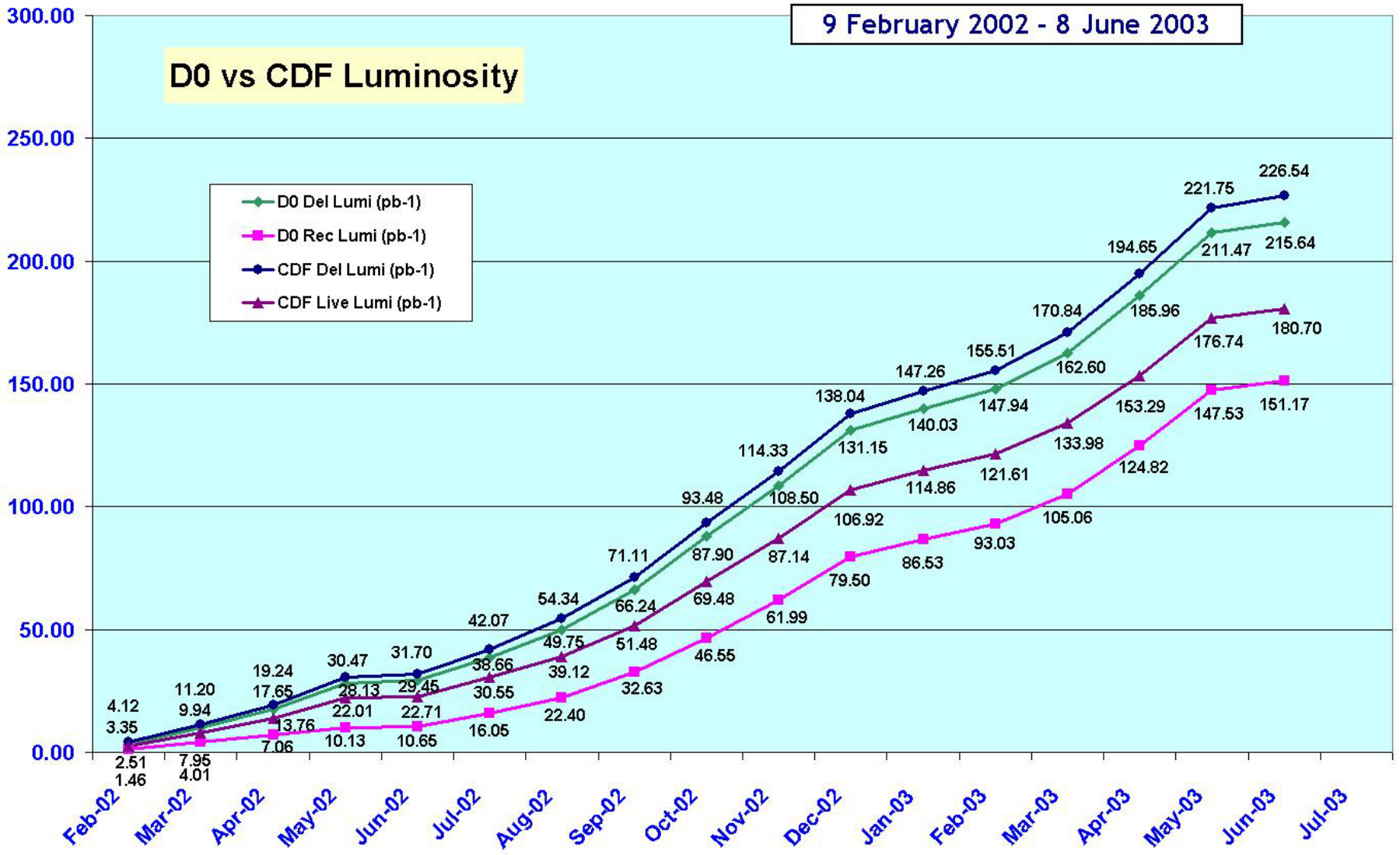


The Run 2a DØ Detector



- Silicon Microstrip Tracker (SMT)
- Central Fiber Tracker (CFT)
- Superconducting Solenoid
- Central/Forward Preshowers (PS)
- Inter-Cryostat Detectors (ICD)
- Muon central and forward scintillator
- Muon central propotional drift tubes (PDT)
- Muon forward mini-drift tubes (MDT)
- Forward Proton Detector (FPD)
- Shielding
- Front-end readout electronics, trigger, DAQ,…

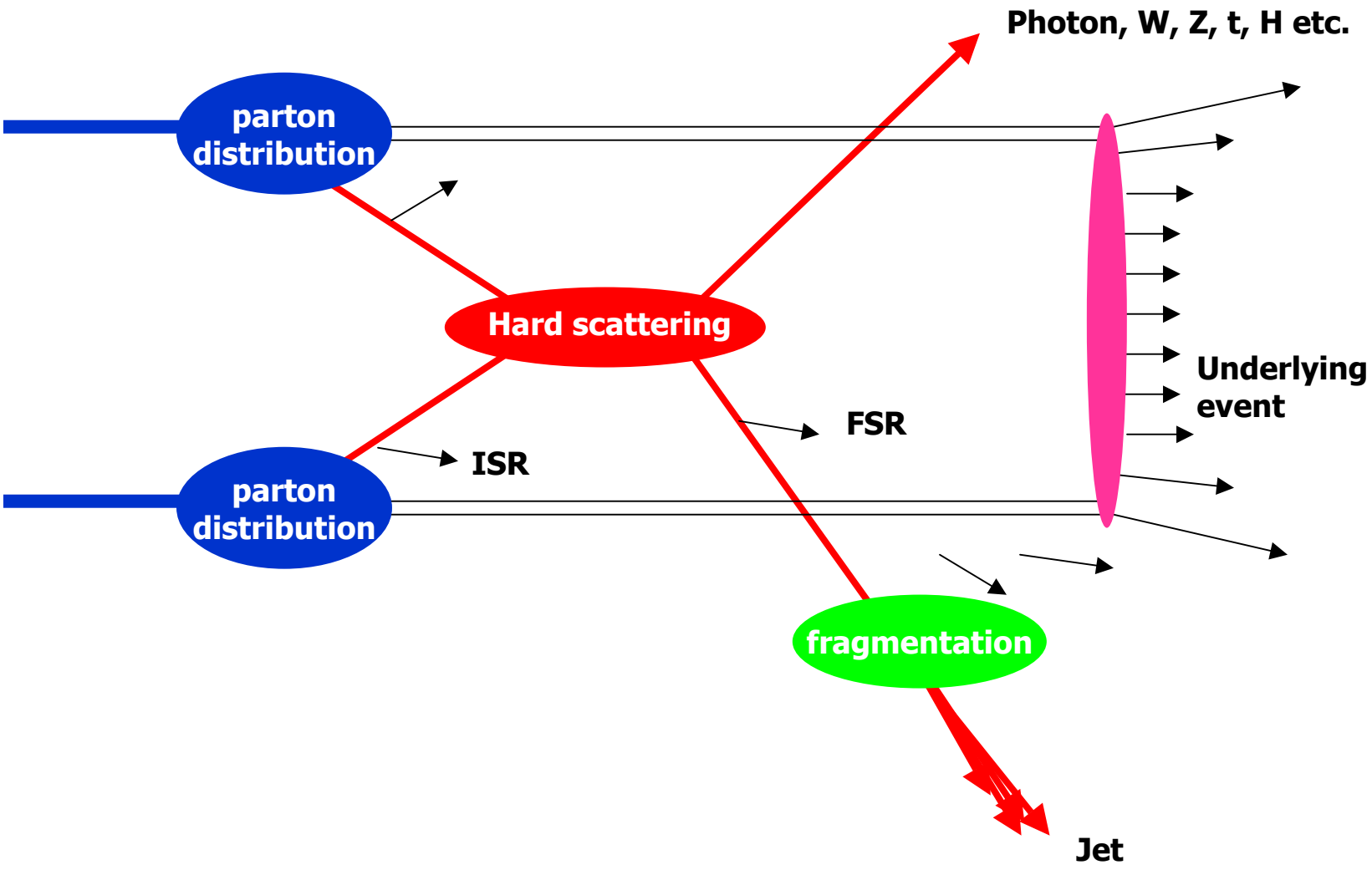
Luminosity


9 February 2002 - 8 June 2003
D0 vs CDF Luminosity
D0 Del Lumi (pb-1)
D0 Rec Lumi (pb-1)
CDF Del Lumi (pb-1)
CDF Live Lumi (pb-1)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
4.12
3.35
2.51
1.46
11.20
9.94
7.95
4.01
19.24
17.65
13.76
7.06
30.47
28.13
22.01
10.13
31.70
29.45
22.71
10.65
42.07
38.66
30.55
16.05
54.34
49.75
39.12
22.40
71.11
66.24
51.48
32.63
93.48
87.90
69.48
46.55
114.33
108.50
87.14
61.99
138.04
131.15
106.92
79.50
147.26
140.03
114.86
86.53
155.51
147.94
121.61
93.03
170.84
162.60
133.98
105.06
194.65
185.96
153.29
124.82
221.75
211.47
176.74
147.53
226.54
215.64
180.70
151.17

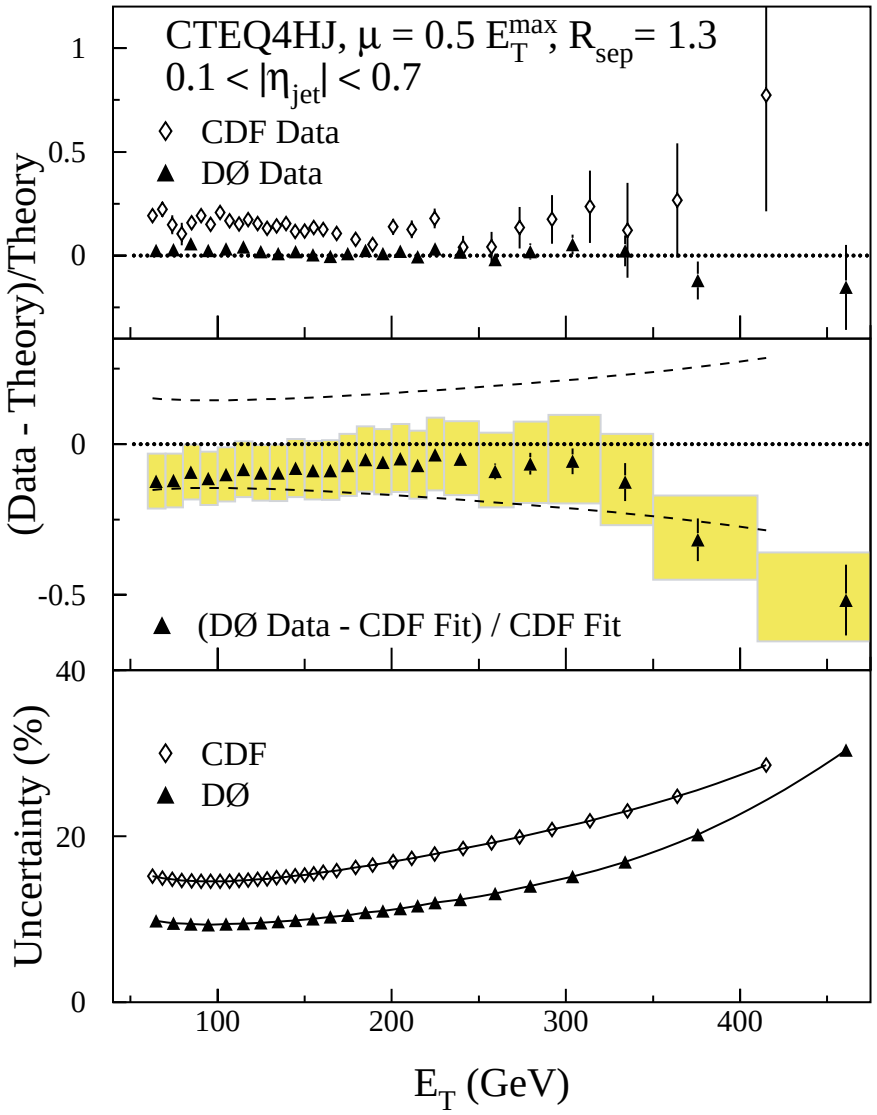
Luminosity II

- DØ Moriond Data Sample
  - Results presented $\mathcal{L}$ = 34 pb^{-1}
  - Summer Conference (EPS/LP) $\mathcal{L}$ = 120+ pb^{-1}
- CDF Winter Conference Sample
  - Results presented $\mathcal{L}$ = 85 pb^{-1}
  - Summer Conferences $\mathcal{L}$ = 160+ pb^{-1}

Hadron-Hadron Collisions



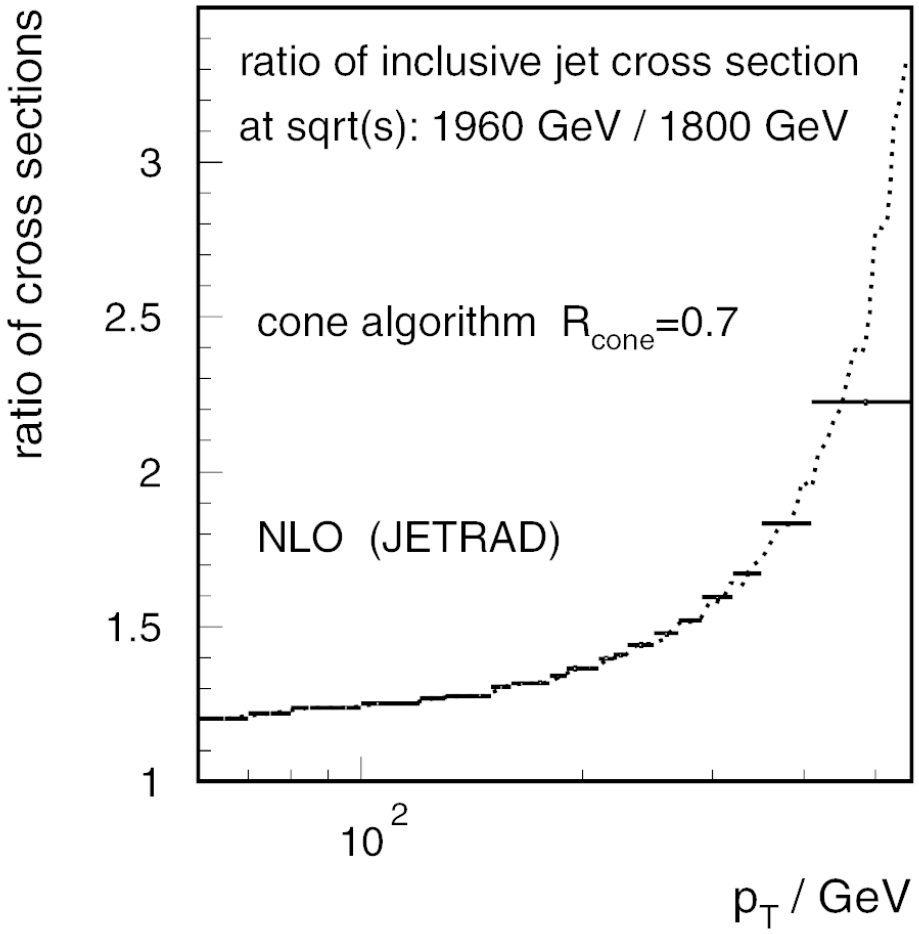
Why Do We Care? Run 1



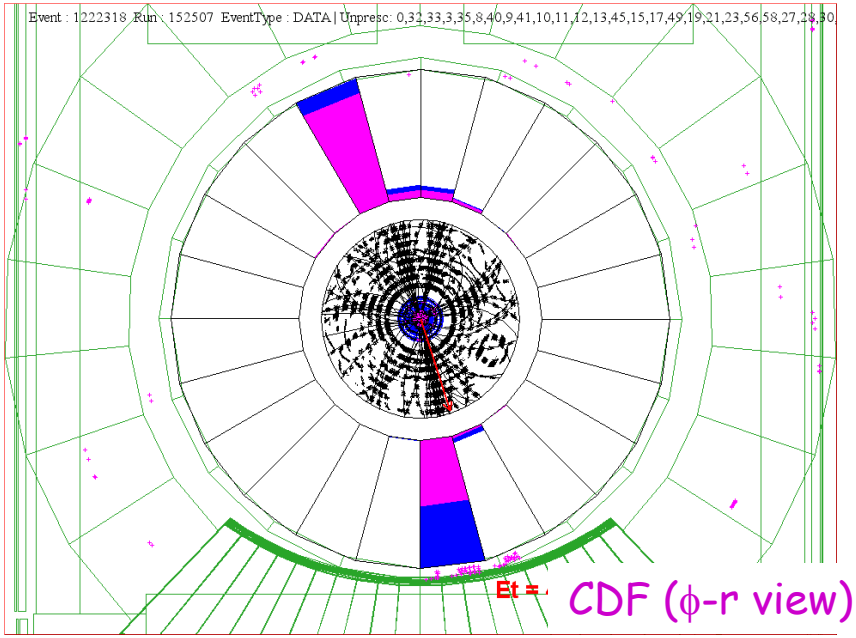
- Compare DØ and CDF for 0.1 < |η| < 0.7.
- **Data sets agree χ^2 = 32.1/24 d.o.f. for comparison of CDF fit and DØ data.**
- PDF's adjusted to give good agreement
- Change in √s gives new handle

Inclusive Jet Cross Sections

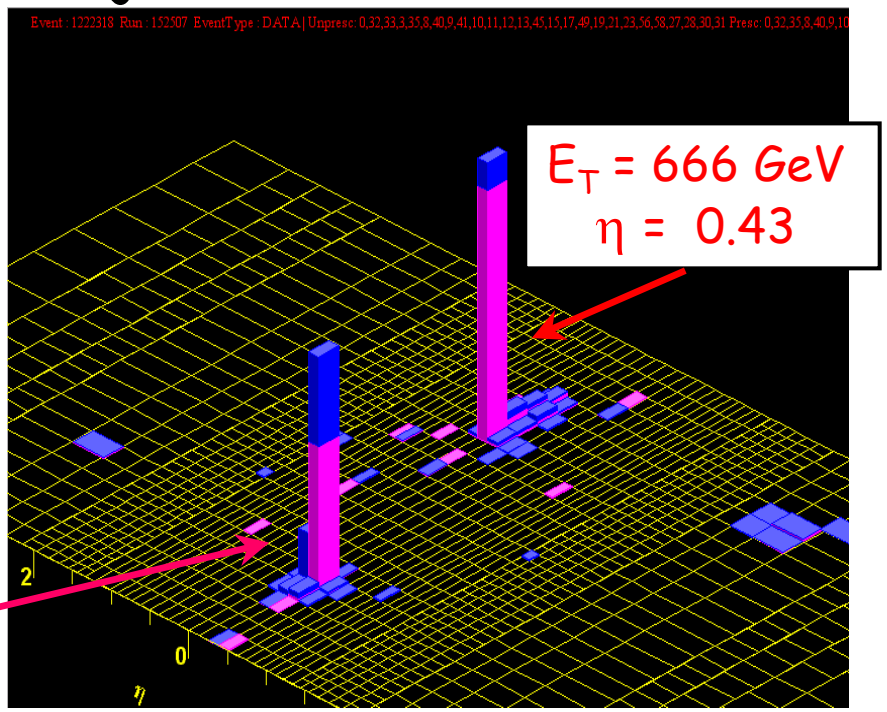
- Expect significant increase in cross section from Run 1 to Run 2.
- Factor 2 @ 400 GeV
- Eventually expect much higher luminosity



CDF's Highest Mass Dijet Event



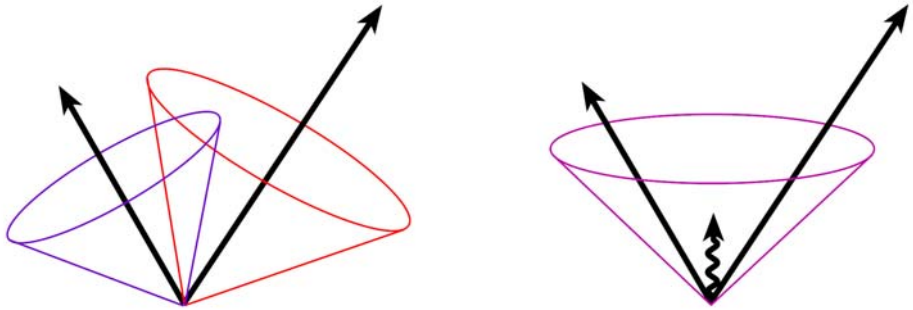
Dijet Mass = 1364 GeV



Much Higher p_T than Run 1 already

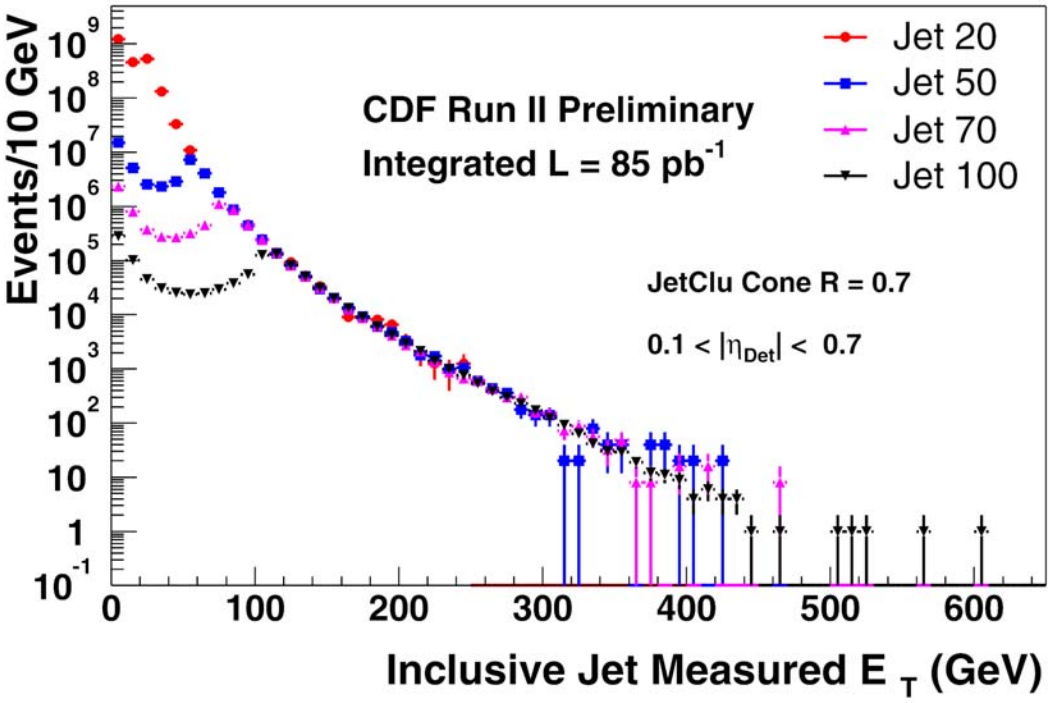
Jet Algorithms

- Modified Cone Algorithm!
  - Midpoint seeds
  - Massive jets and rapidity
  - aka: Improved Legacy Cone Algorithm
  - Infra-red safe at NNLO
- CDF/DØ use common algorithm
  - $\mathcal{R}$ = 0.7
  - Split/Merge if share > 0.5 Jet energy
  - Ref: hep-ex.....



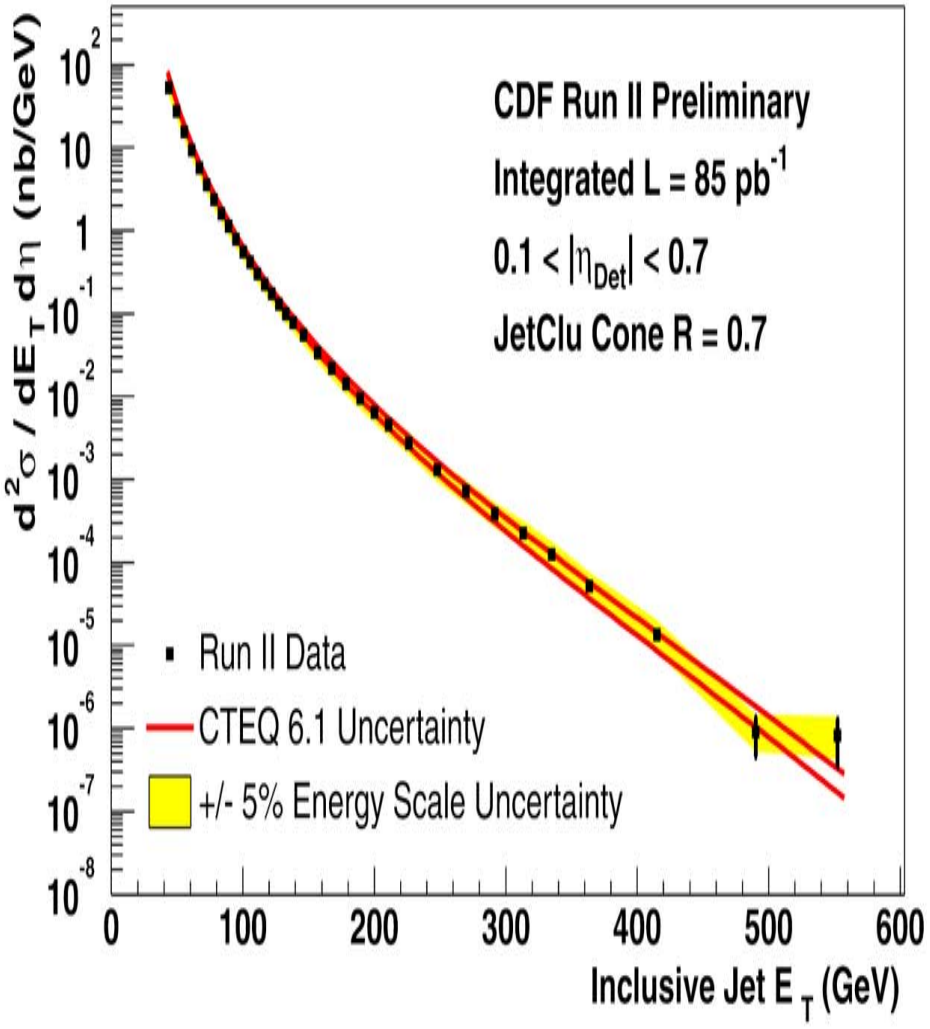
CDF Inclusive Jet

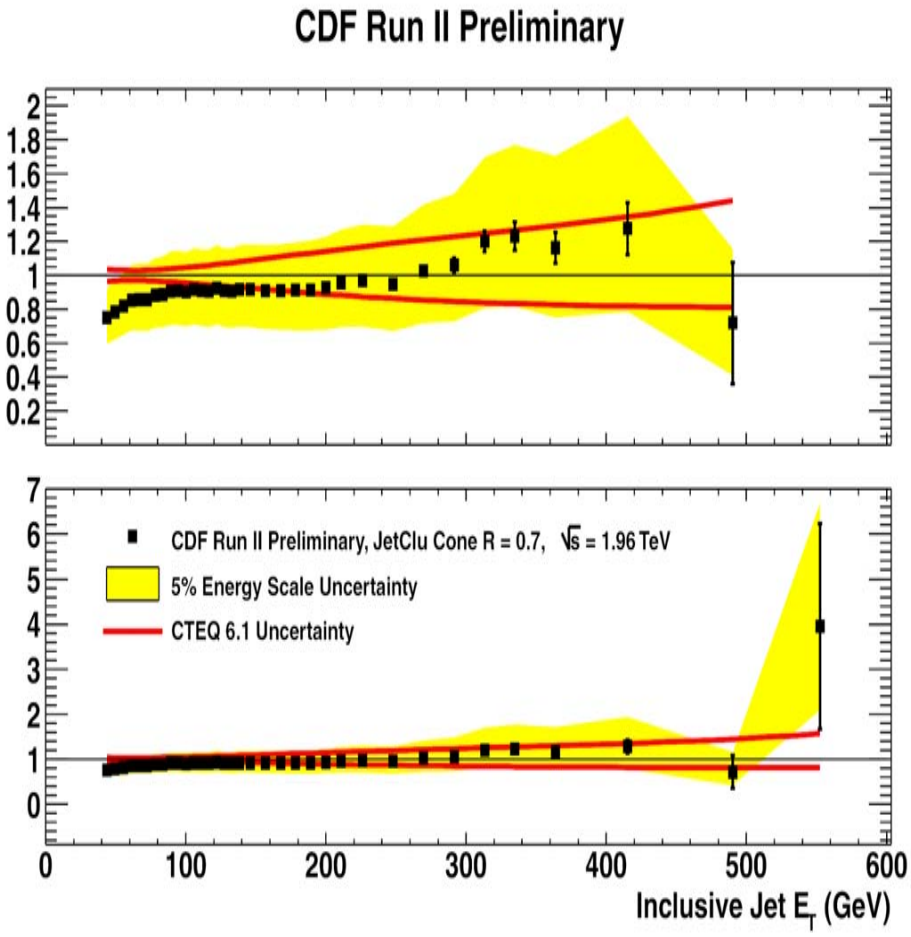
- Luminosity
  $\mathcal{L}$ = 85 pb^{-1}
- Rapidity:
  0.1 < |y| < 0.7
- Event Vertex
  |z| < 60 cm
- Clean-up using missing E_T and event scanning
- Four Triggers



Good Match between triggers

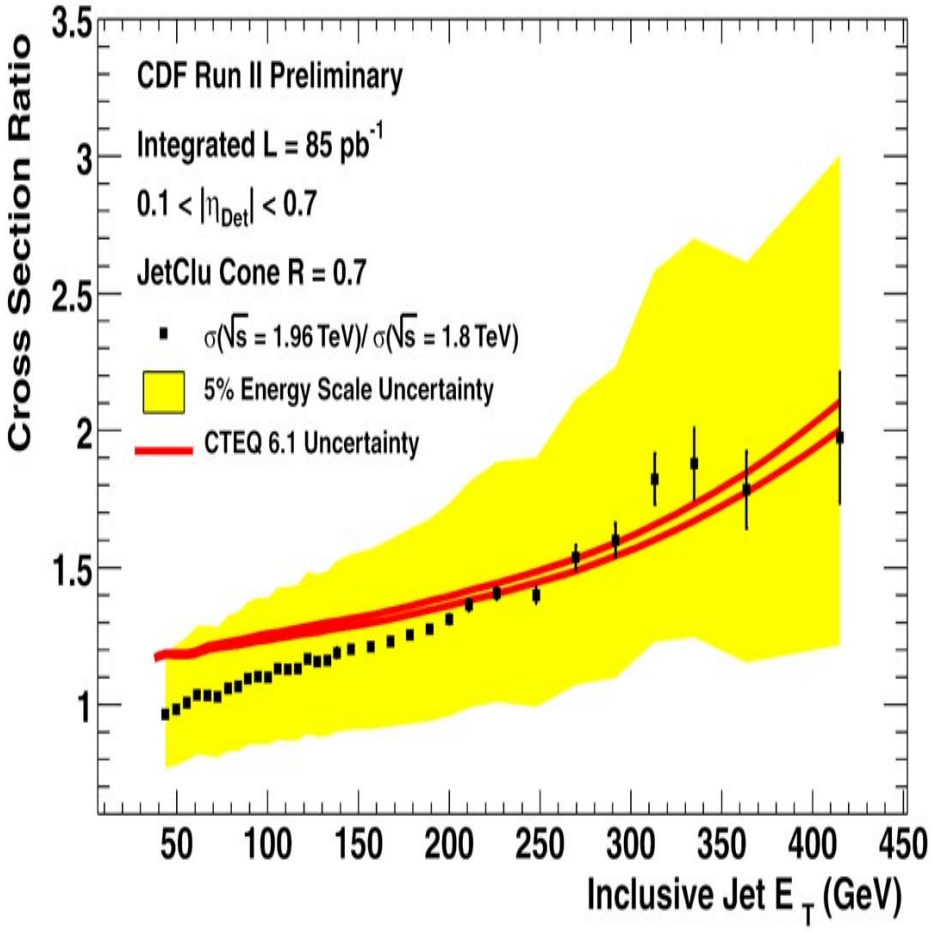
CDF Theory Comparison



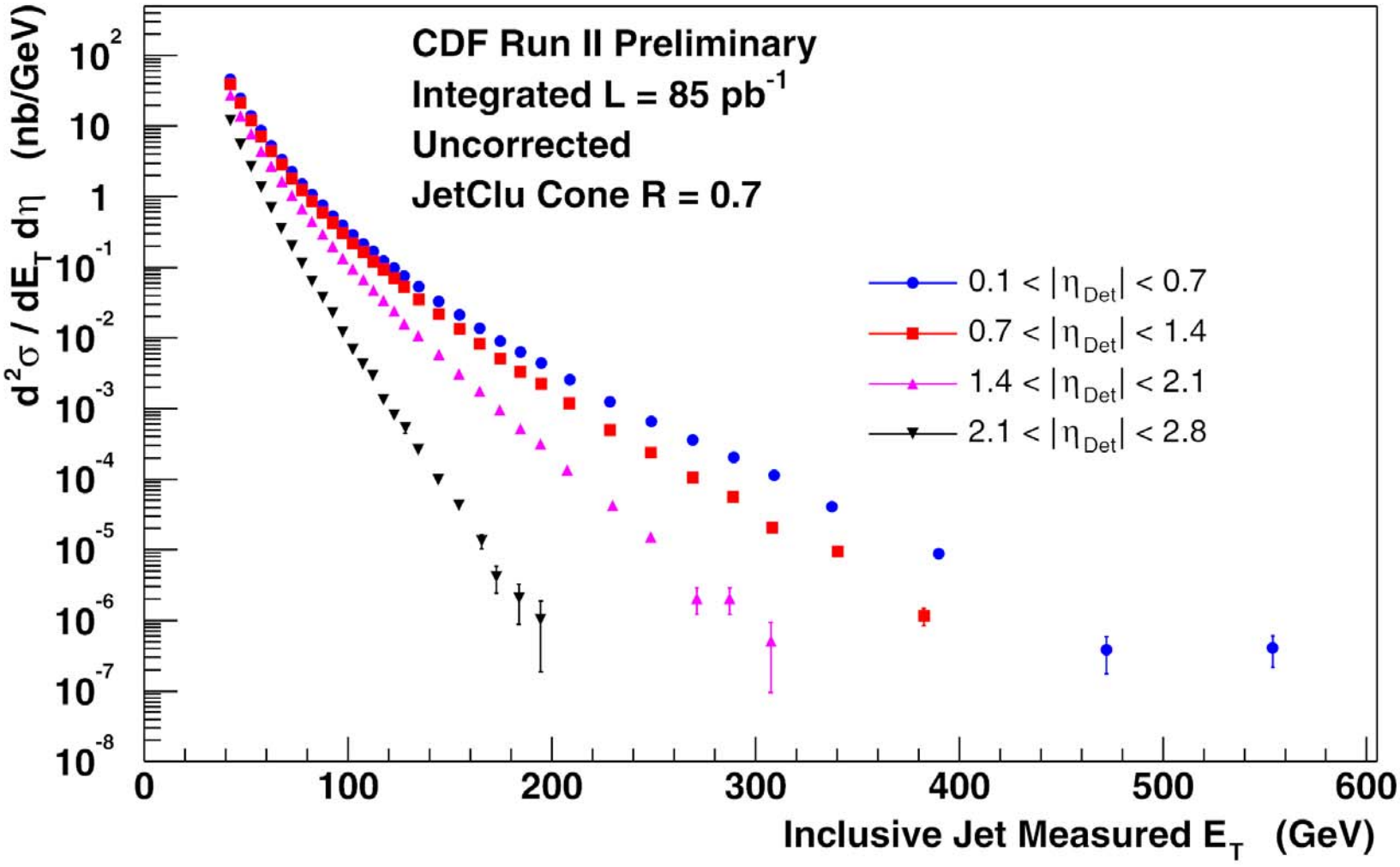


Comparison with Run 1

- Change in cross section from $\sqrt{s}$ =1.8 to 1.96 TeV
- Should have large cancellation of systematic uncertainties

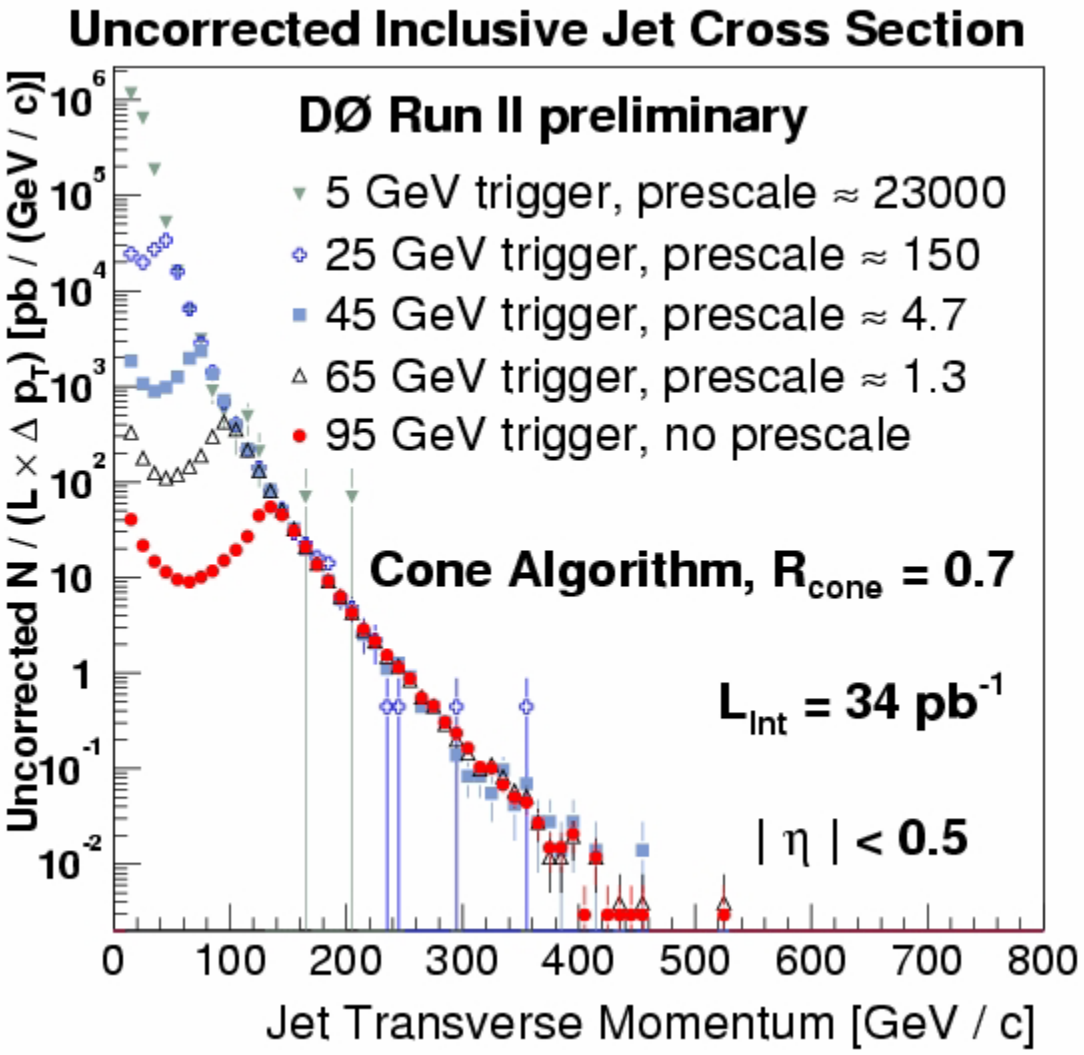


Rapidity Dependence

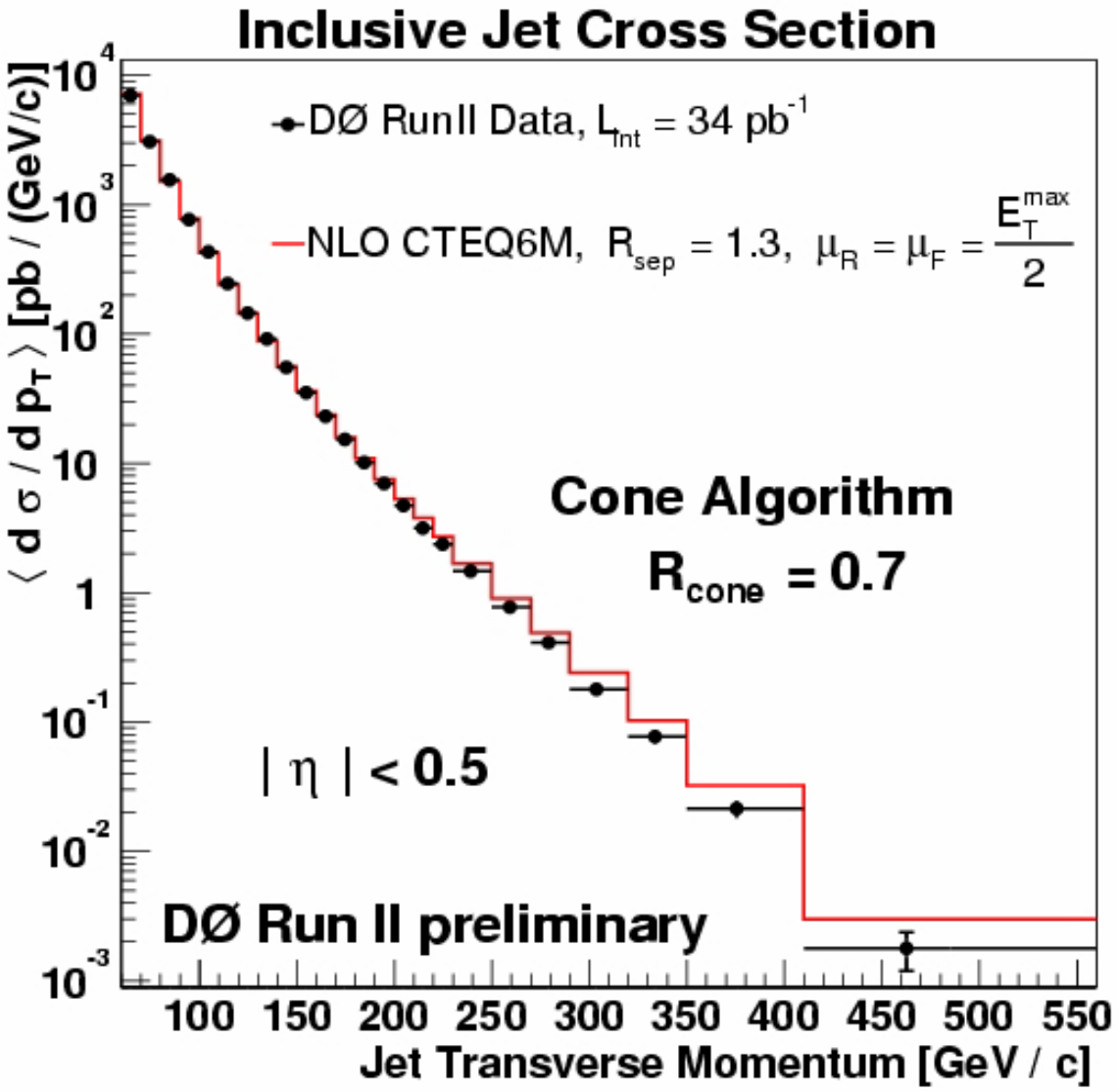


DØ Inclusive

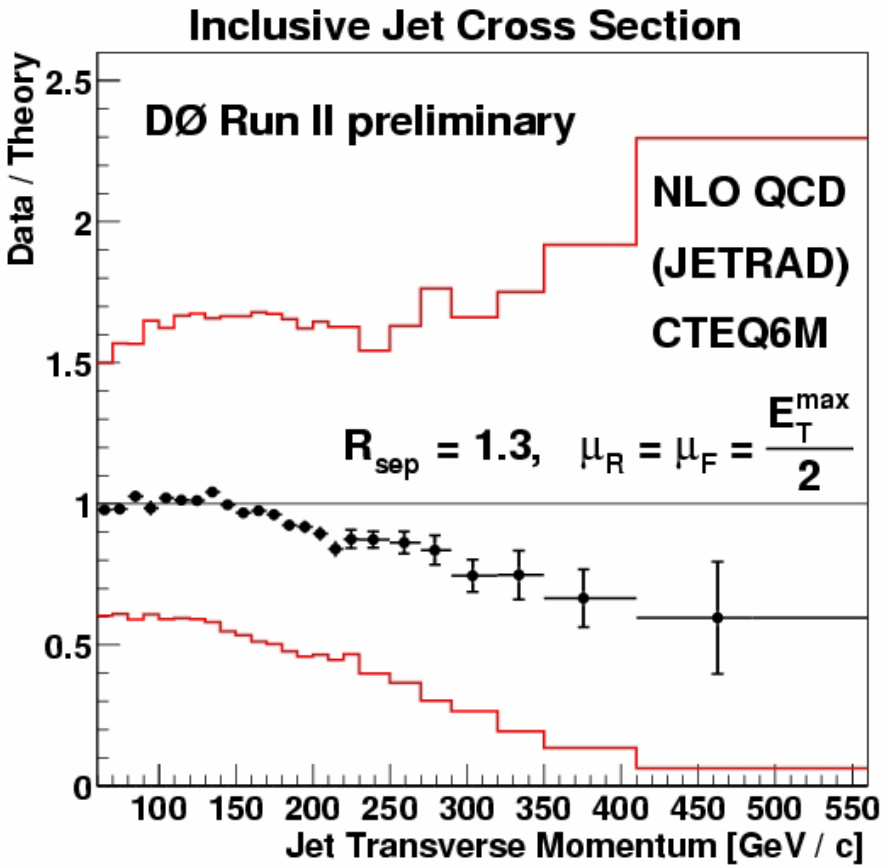
- Luminosity
  $\mathcal{L}$ = 34 pb^{-1}
- Rapidity:
  |y| < 0.5
- Event Vertex
  |z| < 50 cm
- Event Quality:
  Missing E_T/P_T[1] < 0.7
  Shower Shapes
- Four Triggers

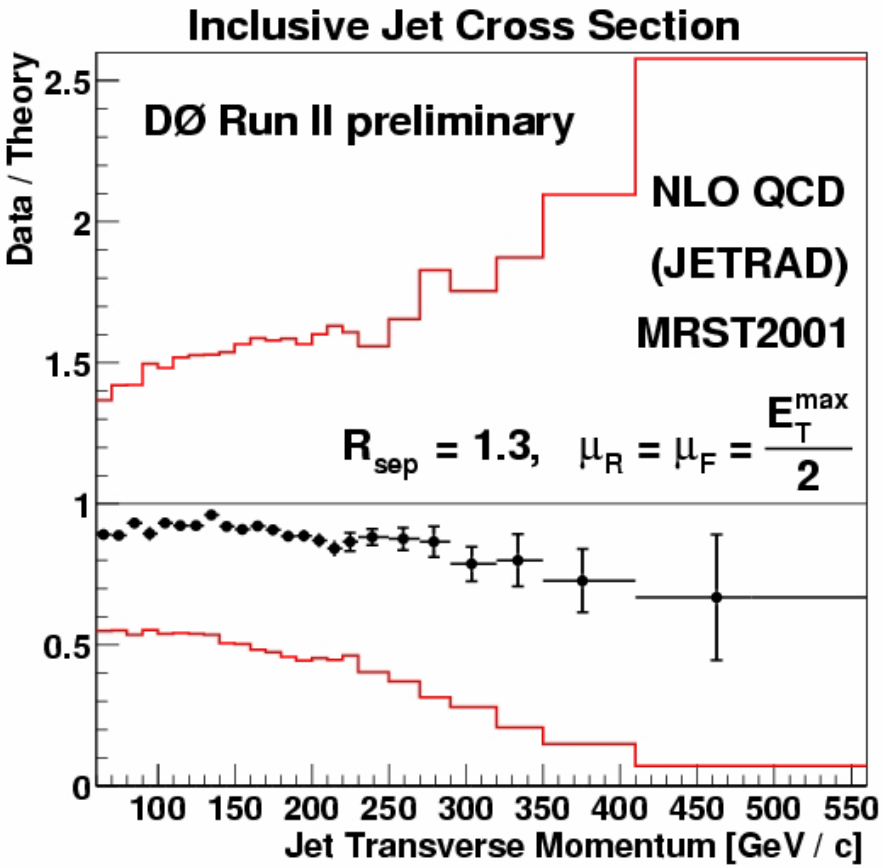


Corrected Cross Section



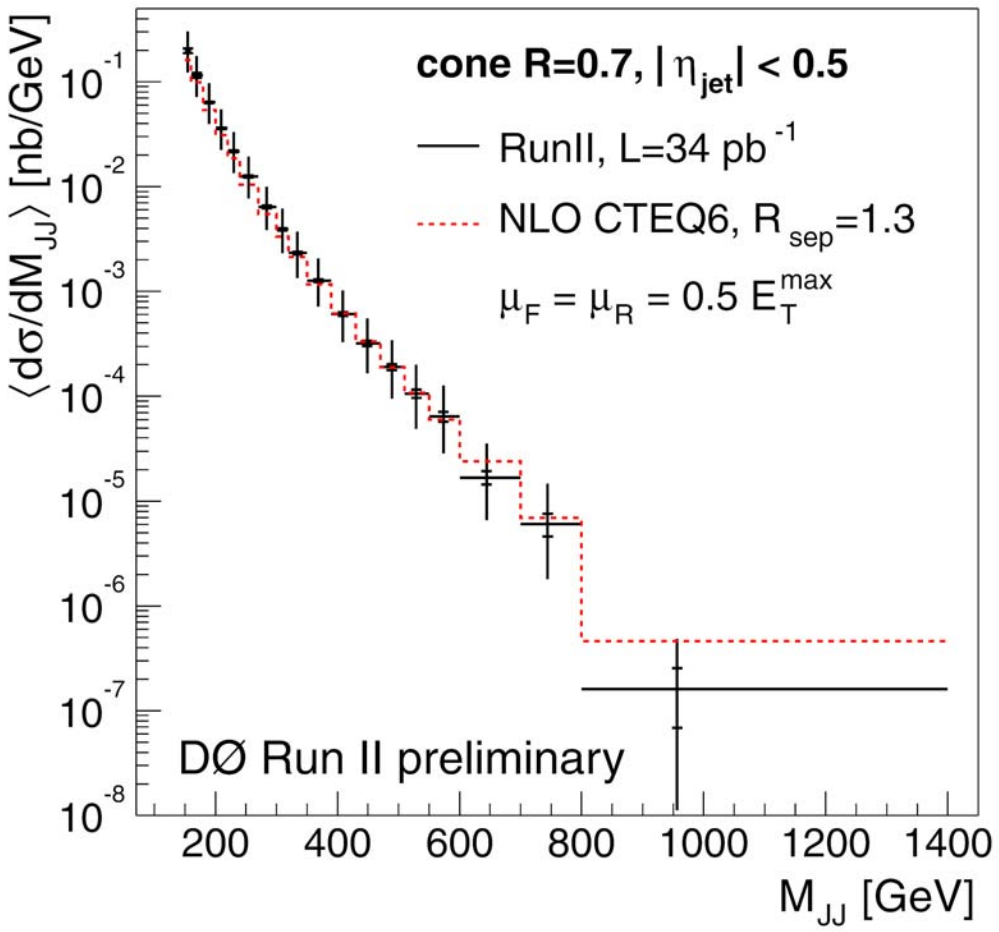
Comparison with Theories

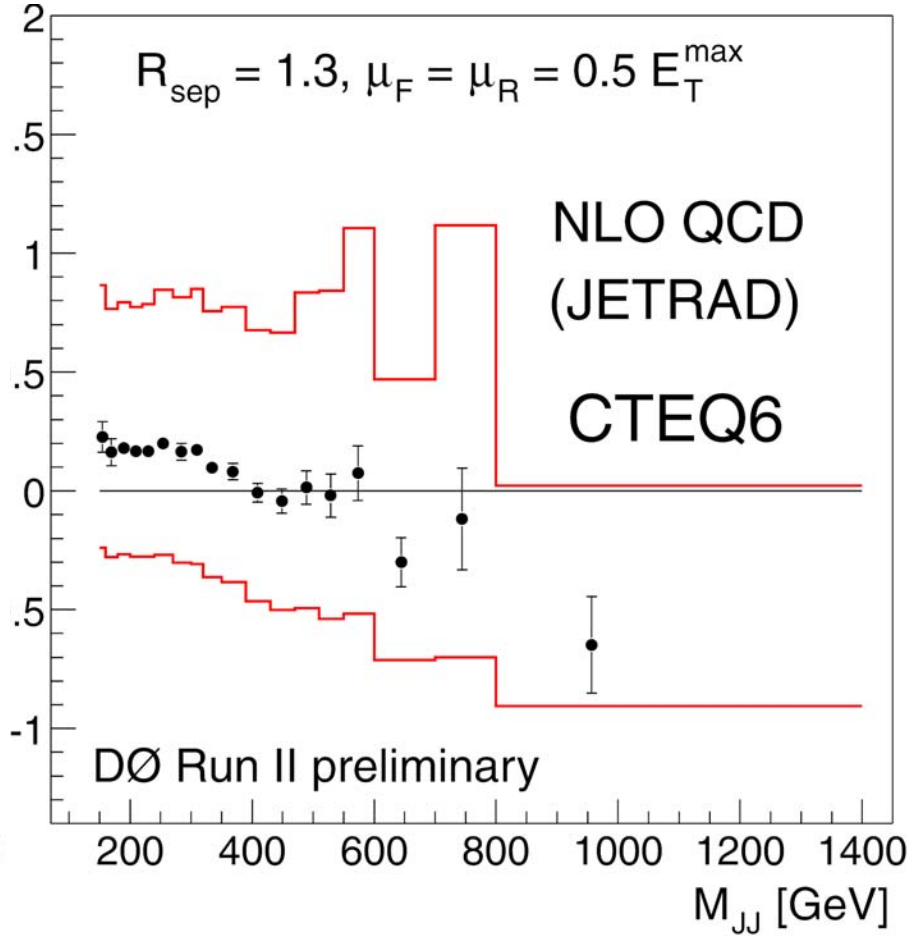




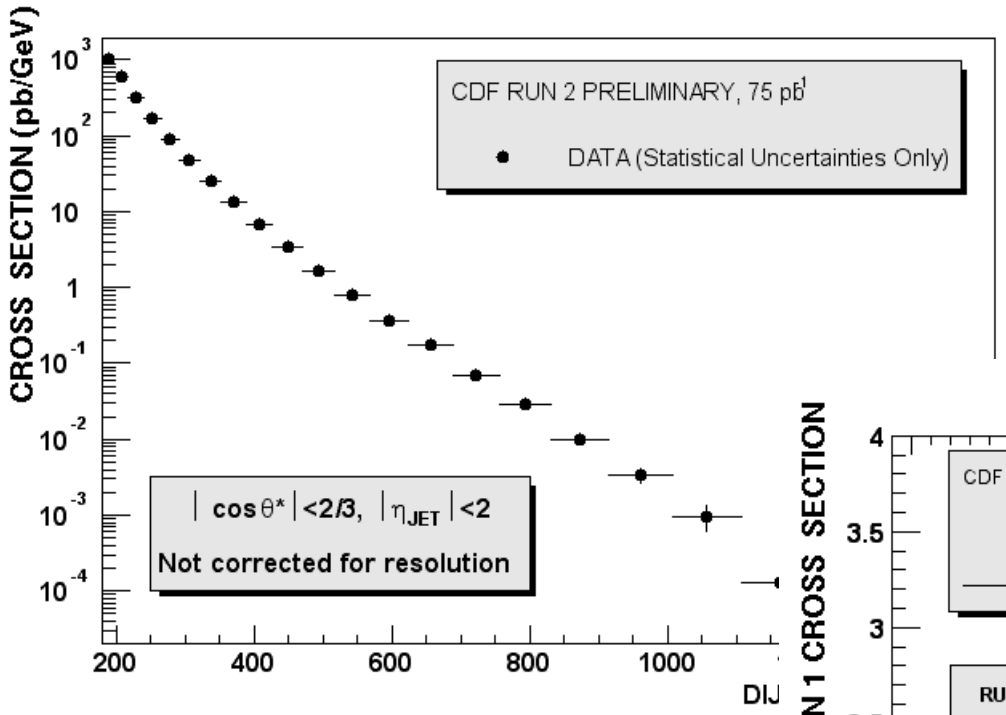
Expect 50% reduction in JES uncertainty for summer results

DØ Dijet Mass



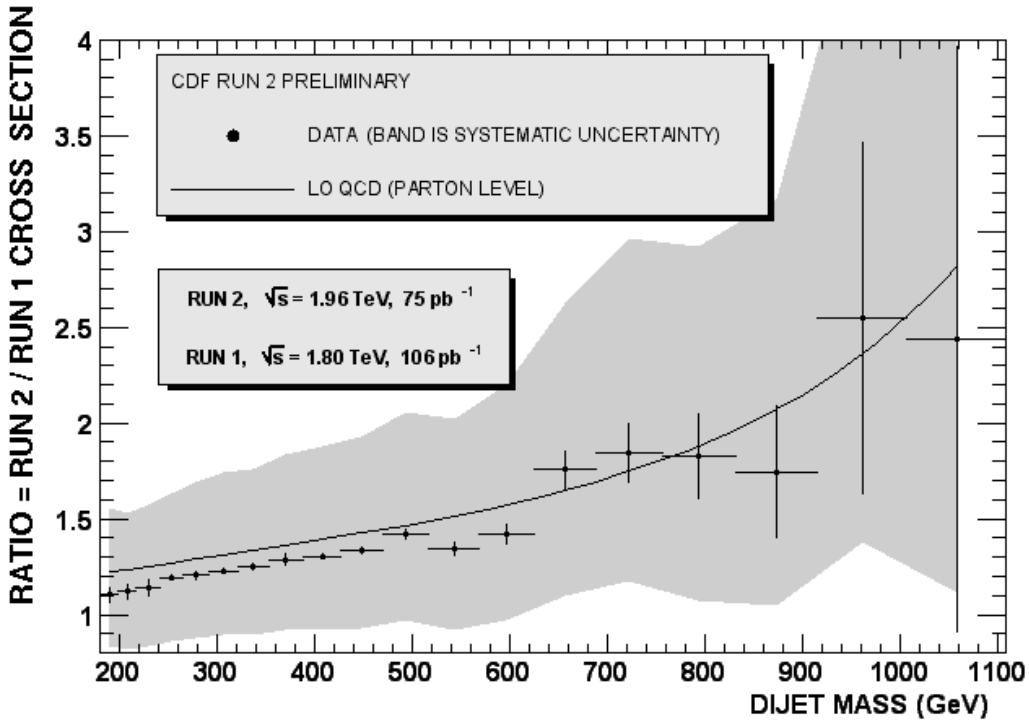


CDF Dijet Mass

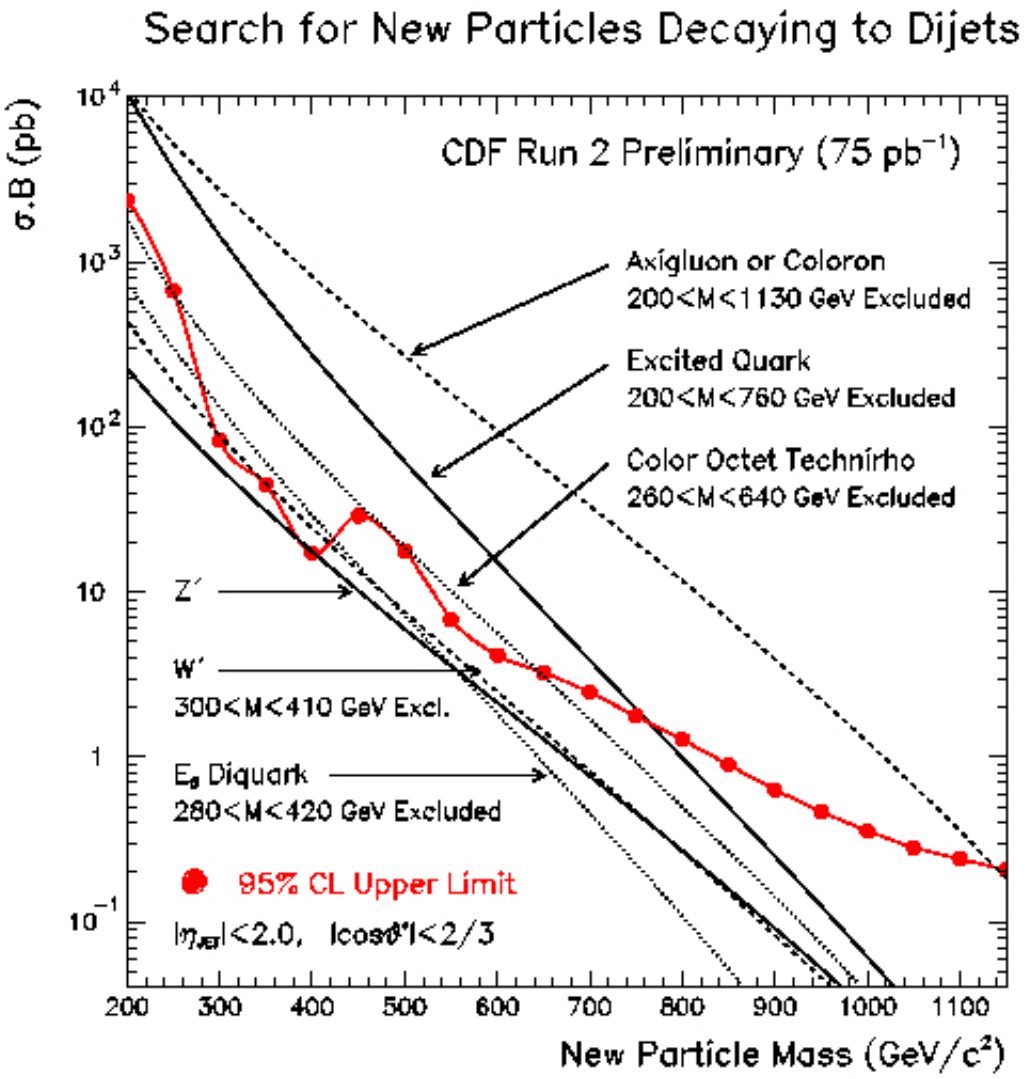


Fit to data to hunt for bumps.

No comparisons with theory



Limits on New Physics



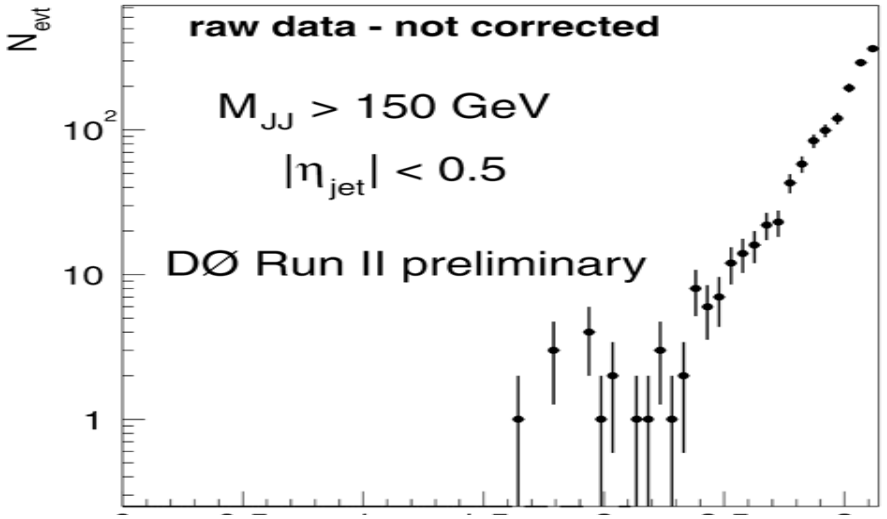
Exclude excited quarks with mass between 200 and 760 GeV.

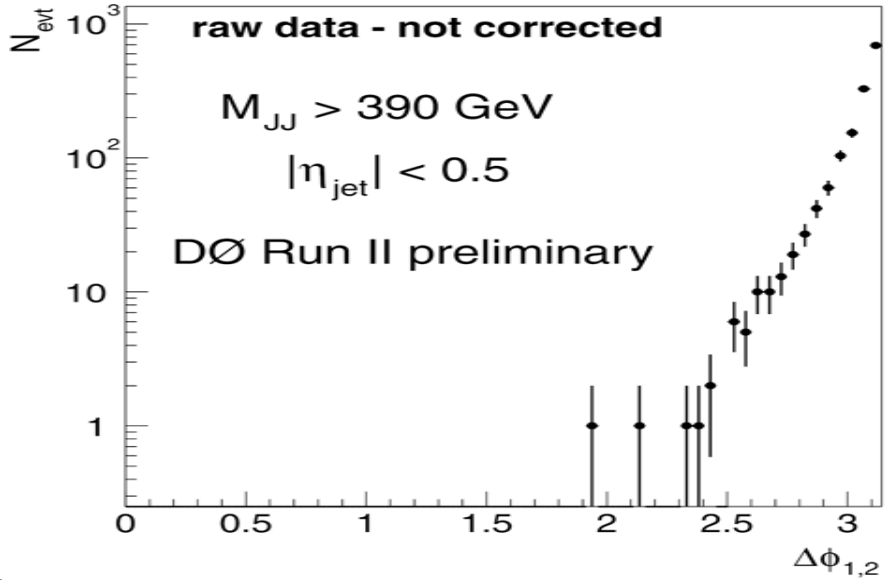
Run 1 exclusion between 200 and 570 GeV and between 580 and 760 GeV

DØ Run I > 775 GeV

DØ ΔΦ Distributions

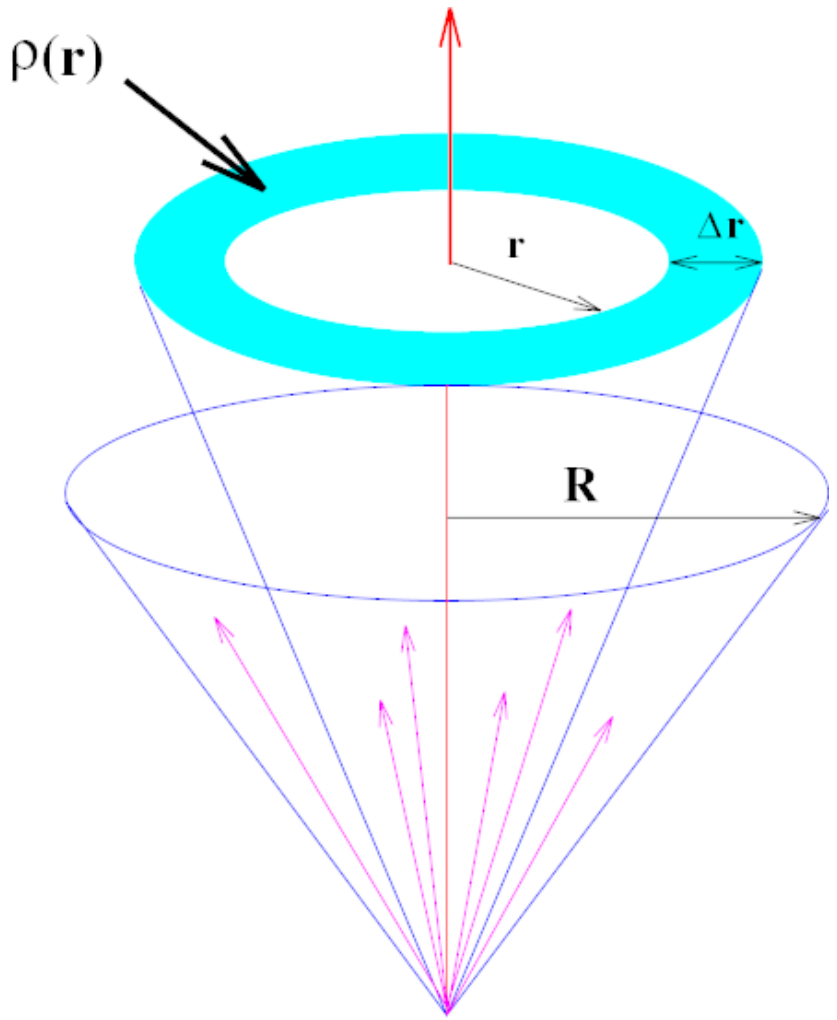
- $\Delta\Phi_{12}$ distribution is sensitive to additional jet activity in event
- Uncorrected Distributions
- Better Balanced at High Mass





Jet Shape and Energy Flow

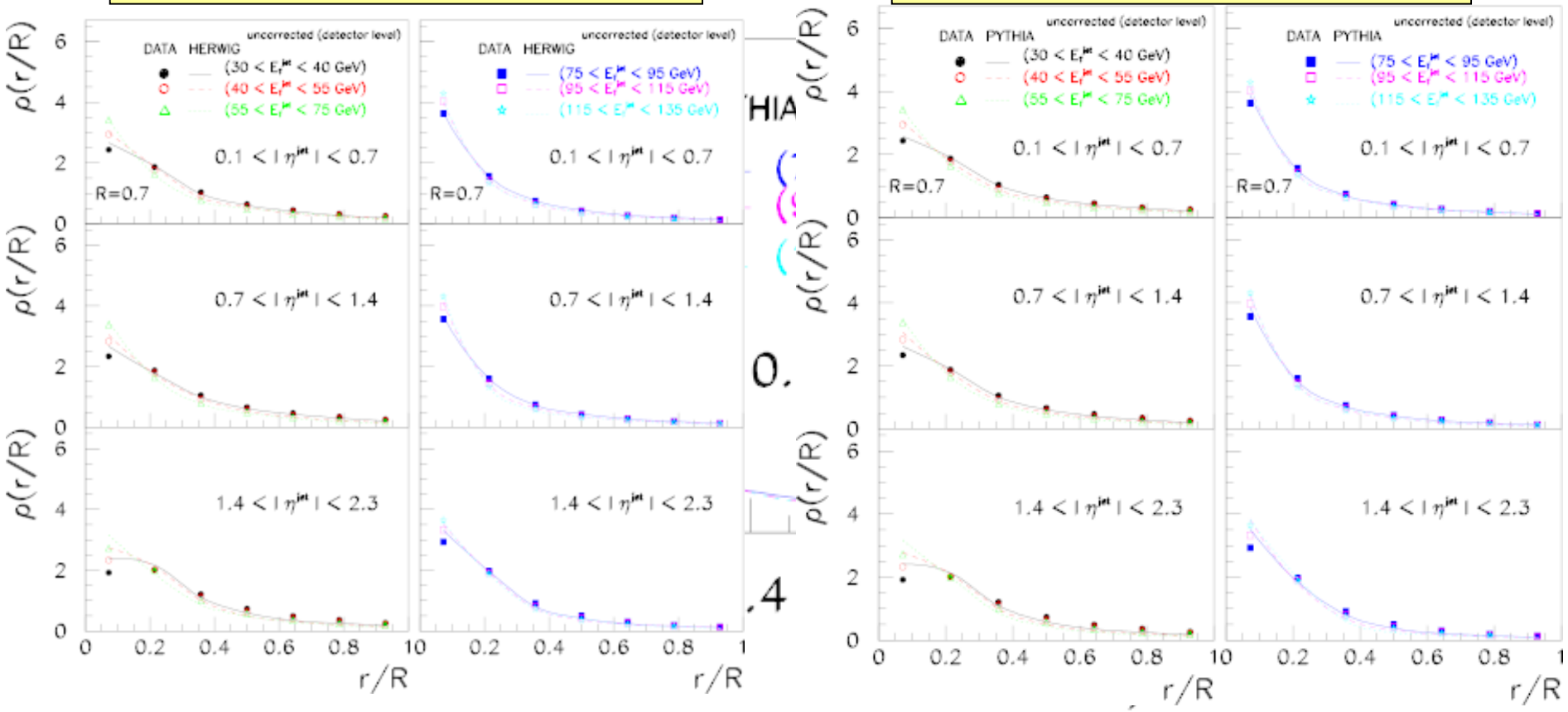
- Internal structure of jet
- Test pQCD/ parton shower models
- Hadronization/fragmentation, essential for jet energy determination
- Compare with Herwig/ Pythia



Jet Shape – CDF Preliminary

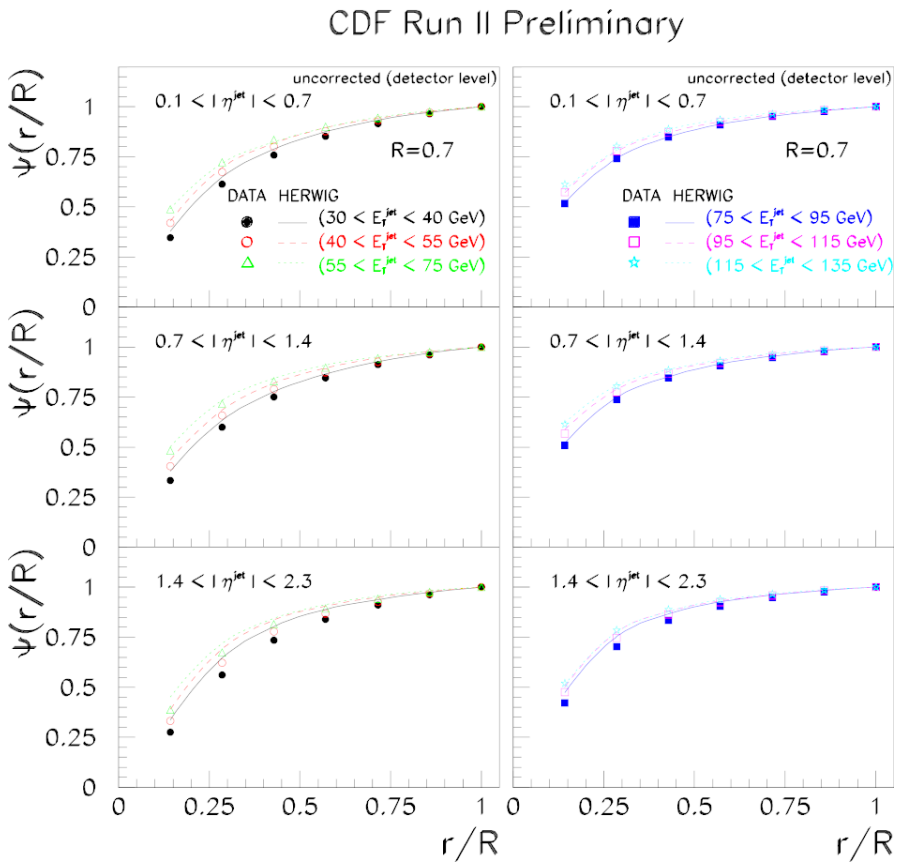
Herwig after detector simulation

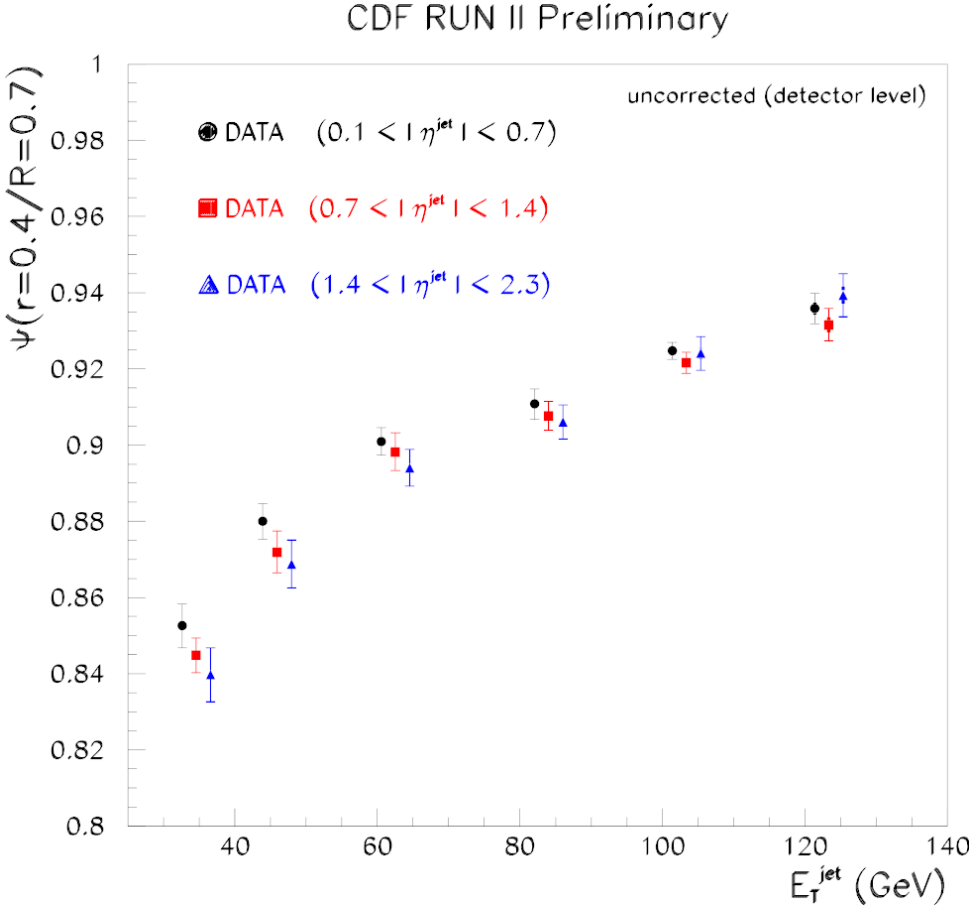
Pythia after detector simulation



Good agreement with Herwig and Pythia in central region
Slightly wider jets in forward region at low E_T

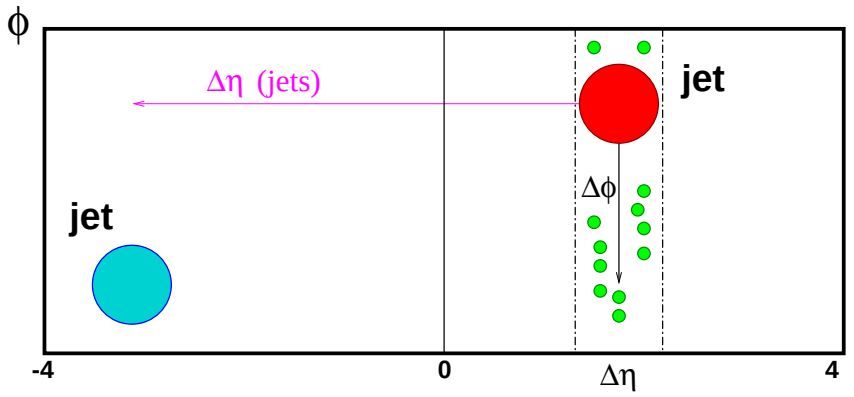
Energy Flow within a Jet



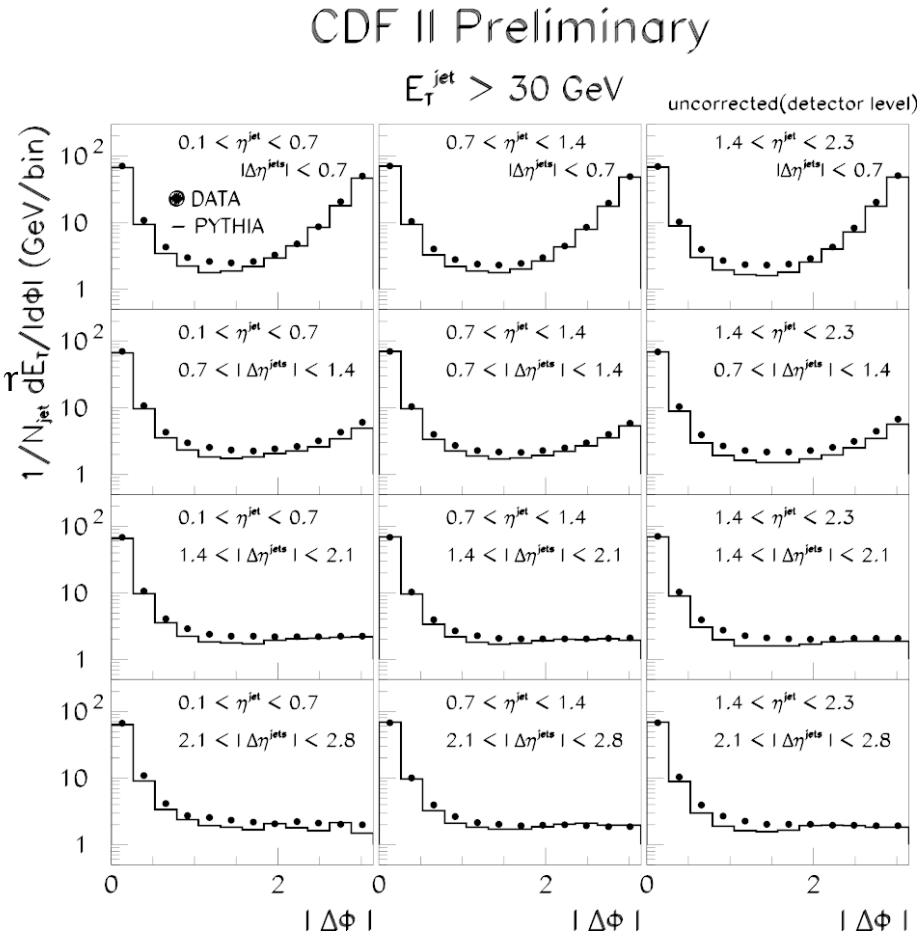


Jets become narrower as their Et increases.
Smaller fraction of energy in R=0.4 as η of the jet increases.

Event Energy Flow



- Reconstruct jet
- Measure transverse energy along φ direction within $\Delta\eta$ for various separations between two leading jets.
- Compare with Pythia/Herwig prediction after detector simulation.



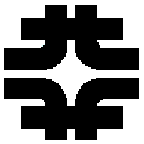
Good agreement between data and Pythia/Herwig (Parton Shower+ Underlying Event)

Conclusions

- Improved analysis around corner
  - Reduced Uncertainties
  - Bigger Samples
  - Stay Tuned
  - More Analyses

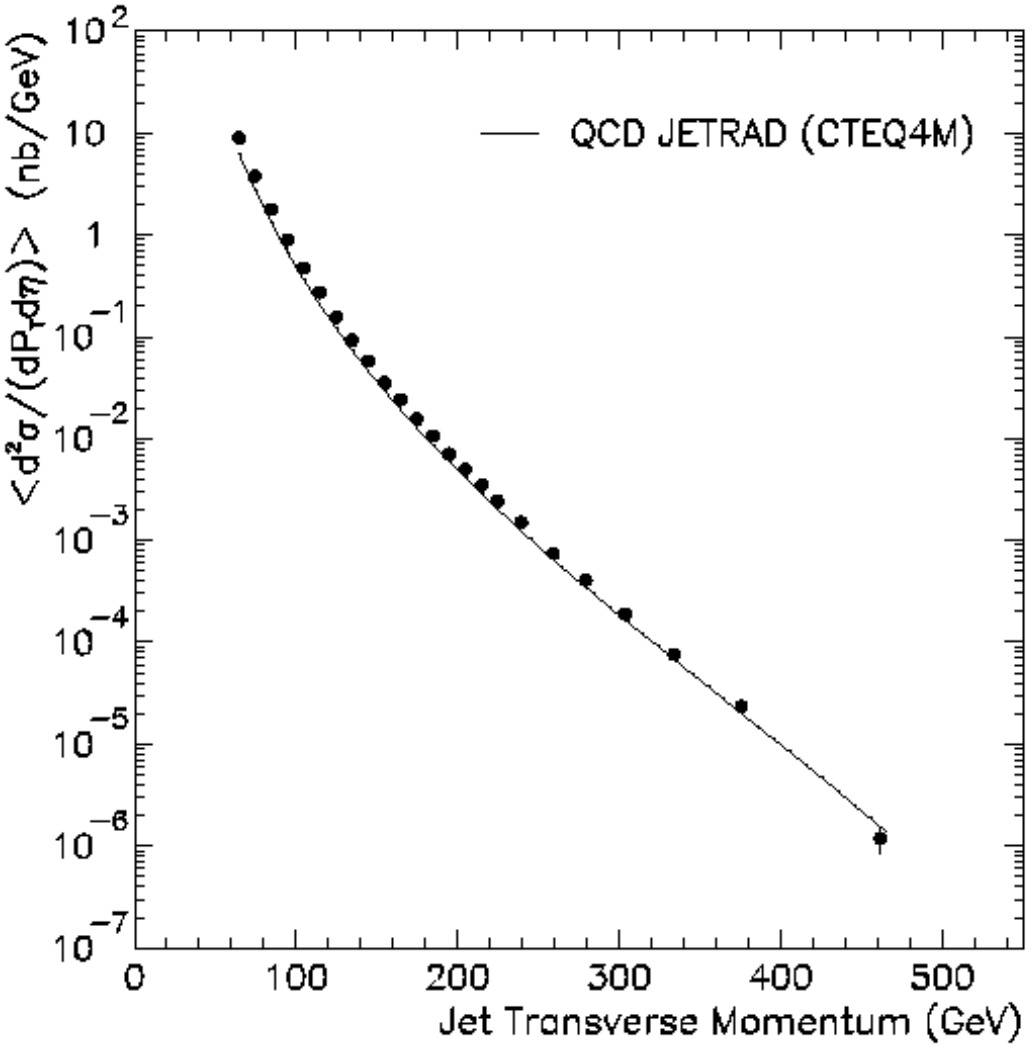
- Current results Look similar to Run 1
  - No k_T as yet.
  - No big surprises!
  - Need more data

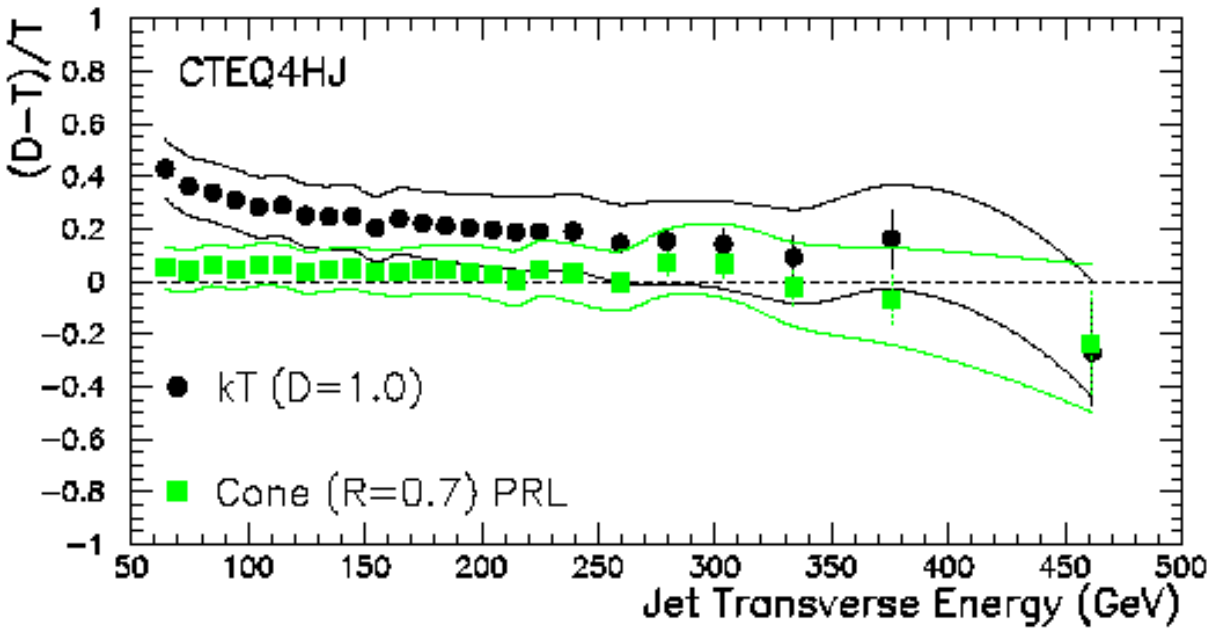
Backup Slides



DØ K_T Inclusive Jet Cross Section

- Phys.Lett. B525 (2002) 211-218
- $-0.5 < \eta < 0.5$
  D = 1.0
  (Match Cone at NLO)
- Predictions IR and UV safe
- Merging behavior well-defined for both exp. and theory



Jet Cross Section using K_T

- K_T with D=1.0, equals NLO cross section with Cone R=0.7
- Energy difference between KT and cone causes difference in cross section
- 1-2 GeV Difference caused by
  - Hadronic Showering effects (parton to particle)
  - Underlying Event
  - Showering