La Thuile
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Jet studies at CDF in Run II

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for the CDF collaboration

Outline

Motivation

- **Inclusive jet cross section**
- **Dijet mass**
- **Jet shapes**

Summary

Motivation

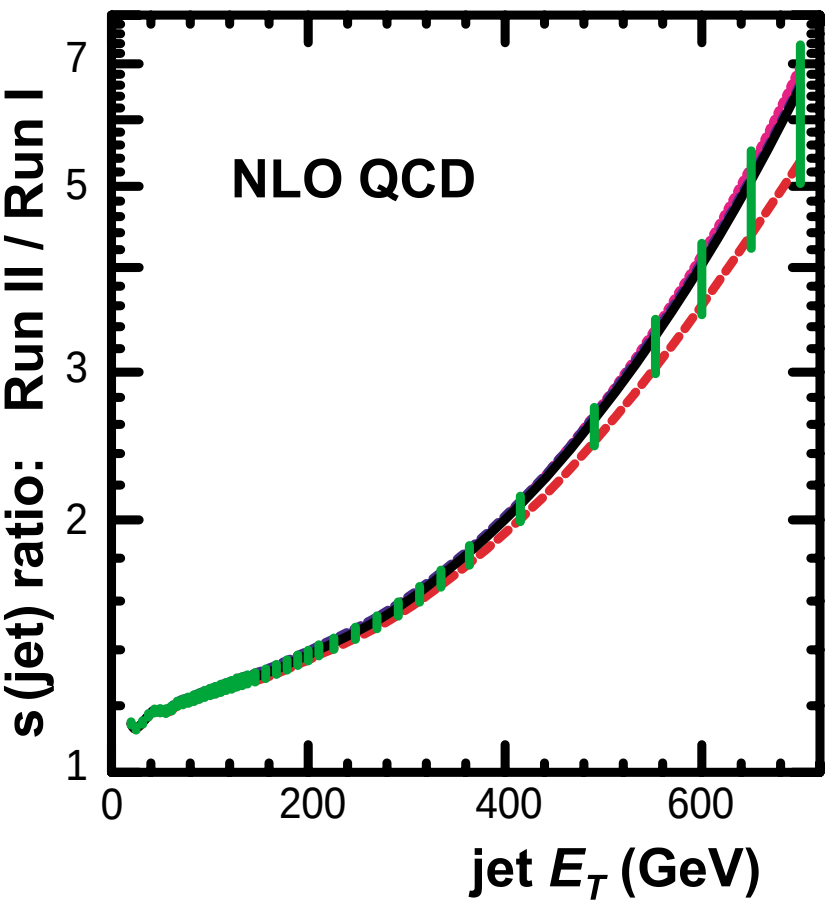
- Tevatron = jet factory
- Probe highest energy scales
  - Higher $\sqrt{s}$ → higher s (factor 3 for $E_T > 500$ GeV)
  - Already more jets than in Run I
- Test fixed-order QCD
  - look for deviations → new physics
- Constrain PDFs
- Analyses:
  - Inclusive jet cross section (counting jets)
  - Dijet Mass (bump hunting)
  - Jet Shapes & Energy Flow

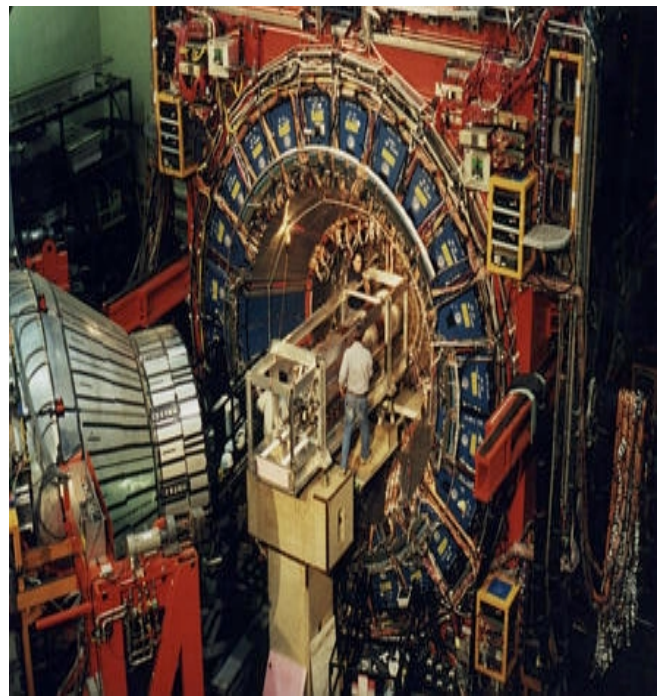
Tevatron & CDF

Upgraded Tevatron at Fermilab

vs = 1.8 TeV ➔ 1.96 TeV

Higher s (jet)





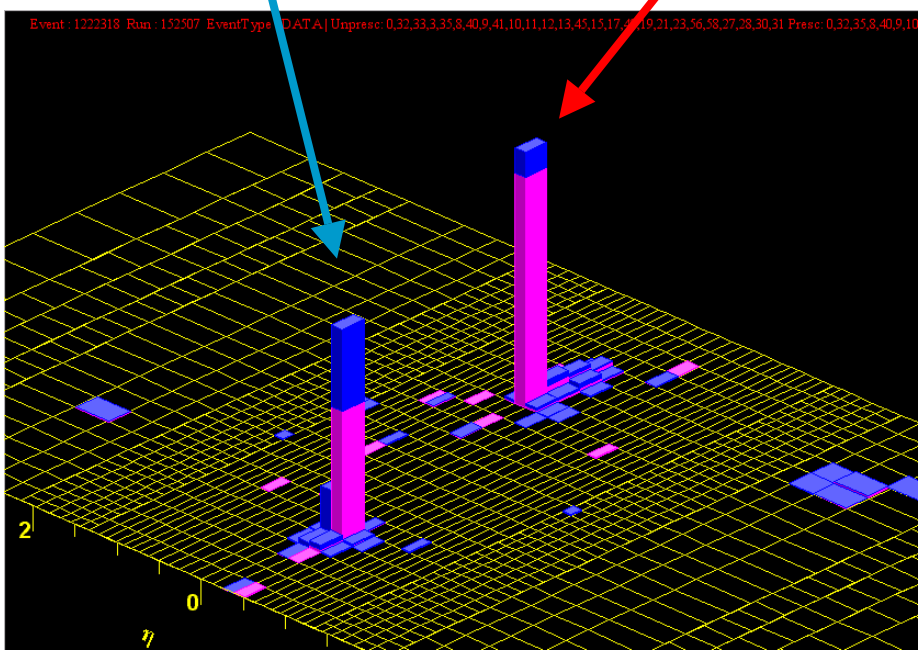
Collider Detector at Fermilab (CDF)

- New plug calorimeter ($1.1 < |\eta| < 3.6$)
- New tracking system
- Upgraded trigger

Highest Energy Jets in Run II

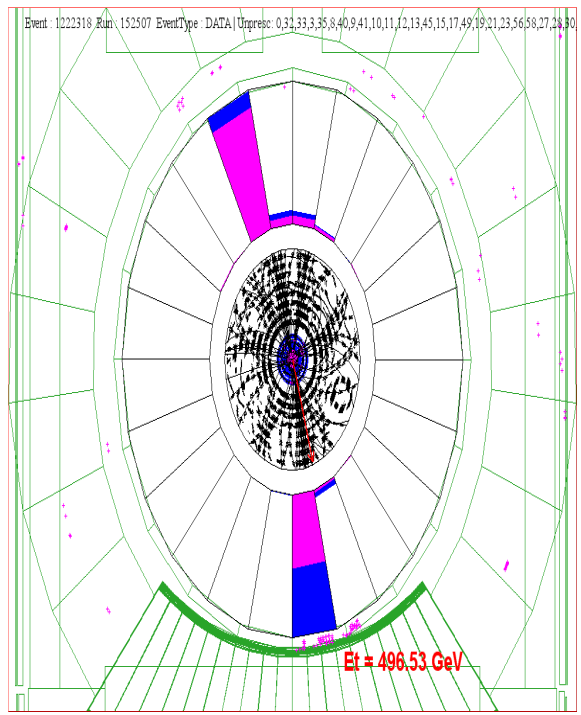
Jet 2
E_T = 546 GeV (raw)
η_{det} = -0.30

Jet 1
E_T = 583 GeV (raw)
η_{det} = 0.31



CDF Run II Preliminary

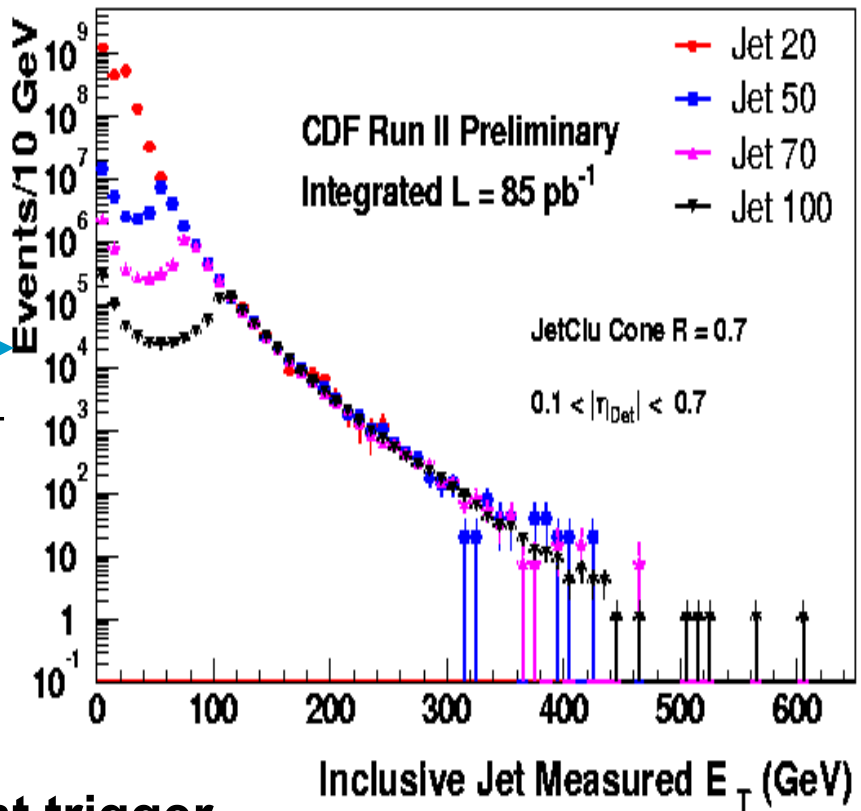
Run 152507 Event 1222318
Dijet Mass = 1364 GeV (corr)



Inclusive Jet Cross Section

- **Repeat Run I analyses**
  - **Use CDF cone jet algorithm with R = 0.7 (JetClu)**
- **Event selection cuts**
  - **$|z_{vertex}| < 60$ cm**
  - **? $E_T < 1500$ GeV**
  - $E_T^{missing} / \sqrt{\sum E_T} < 2 \text{ to } 7$

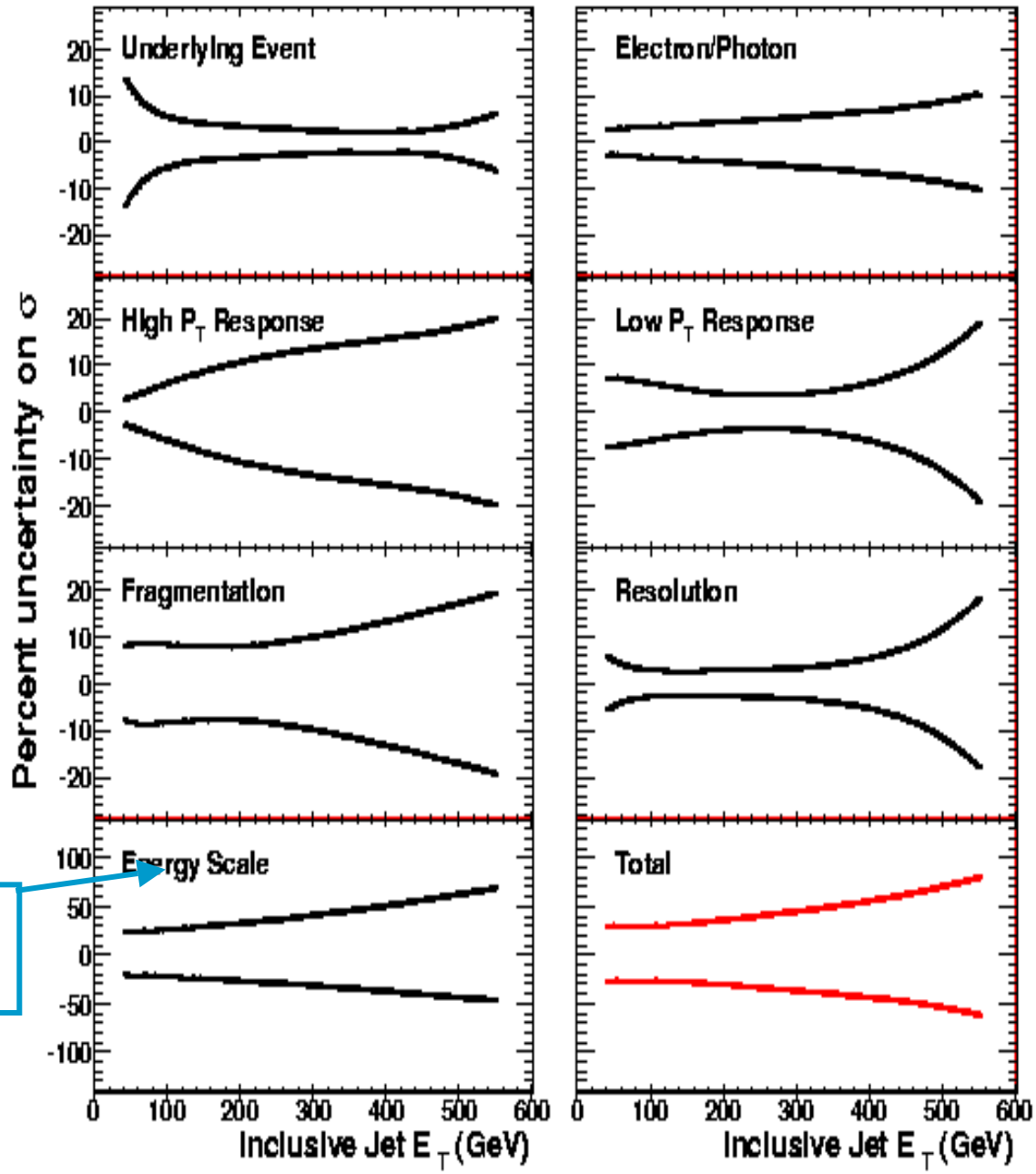
$$\frac{d\sigma}{dE_T} = \frac{N}{\varepsilon L \Delta E_T \Delta \eta}$$



- **Require fully efficient trigger**
- **Apply jet energy corrections (same as in Run I)**

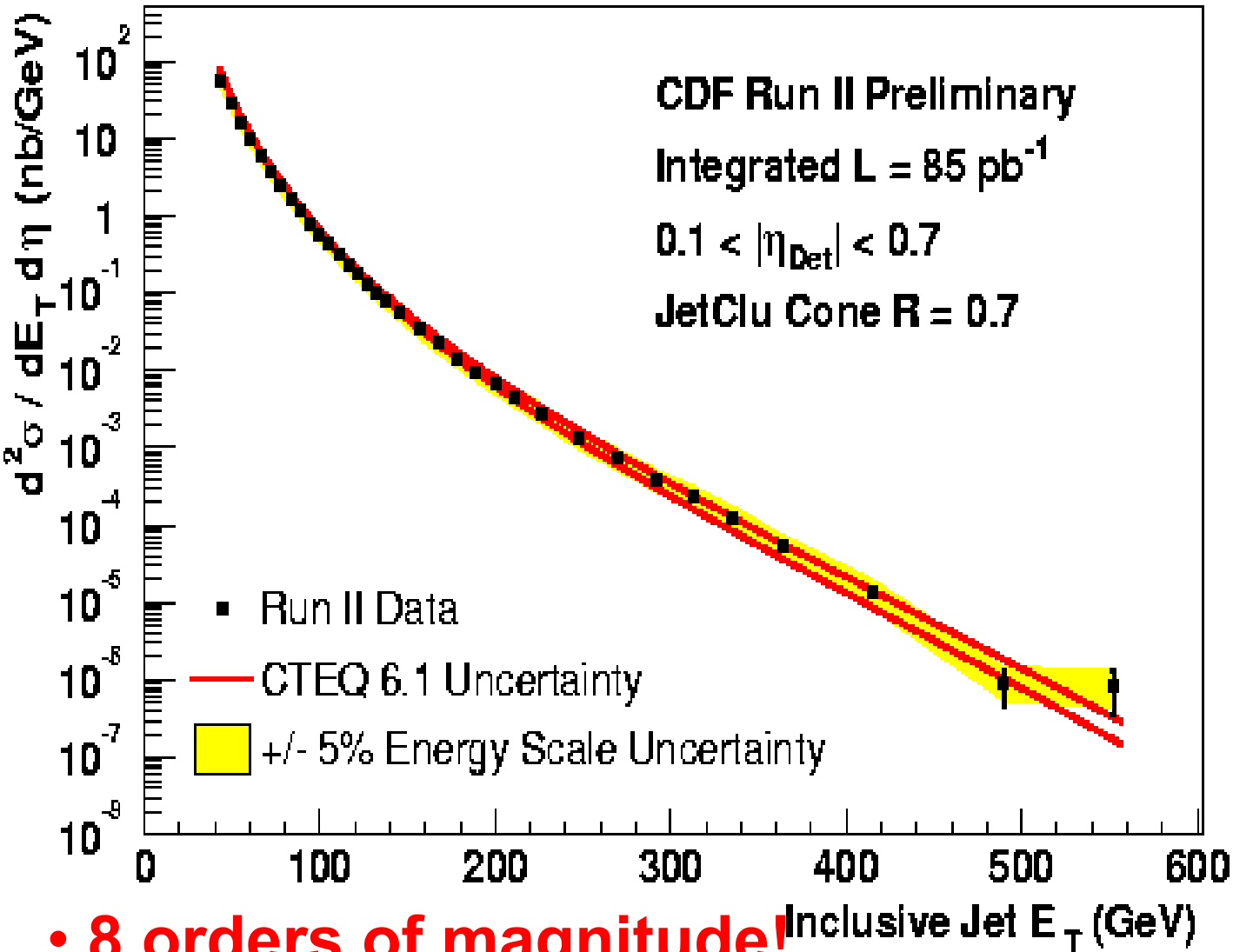
Systematic Uncertainties

Luminosity uncertainty = 6%



Largest uncertainty

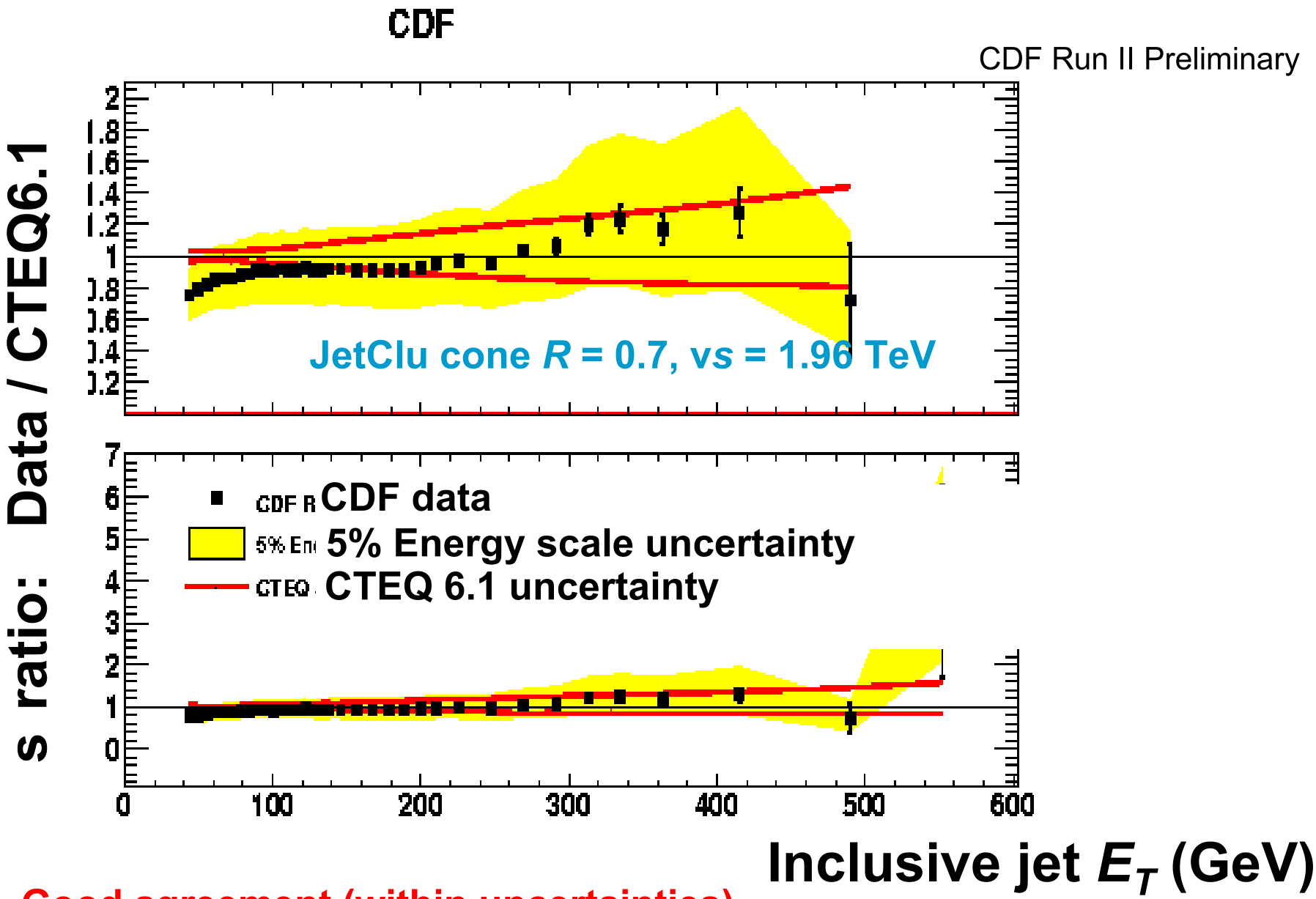
Corrected: Log



- 8 orders of magnitude!
- Highest E_T jets ever!

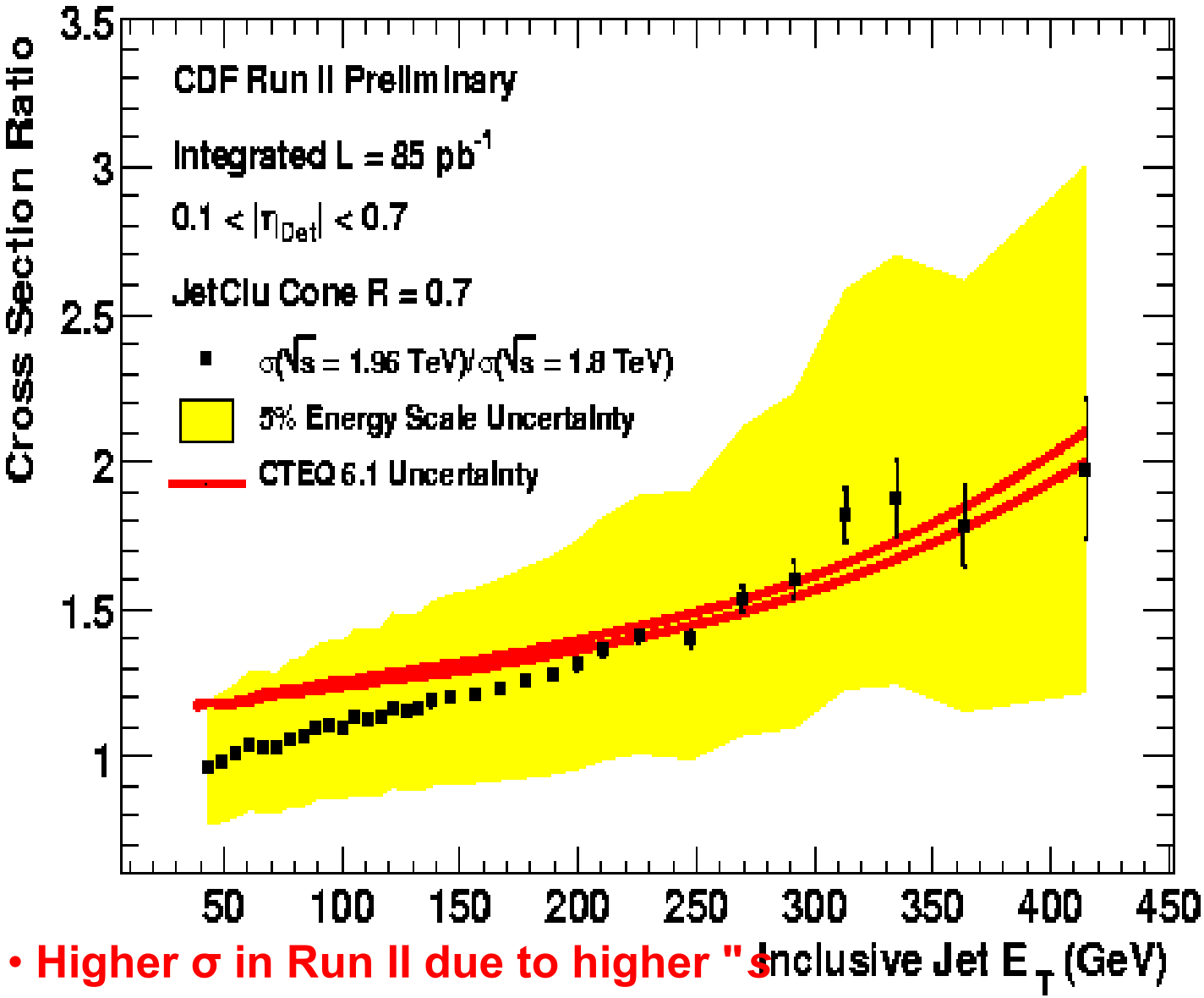
CTEQ 6.1: hep-ph/0303013

Corrected: Linear



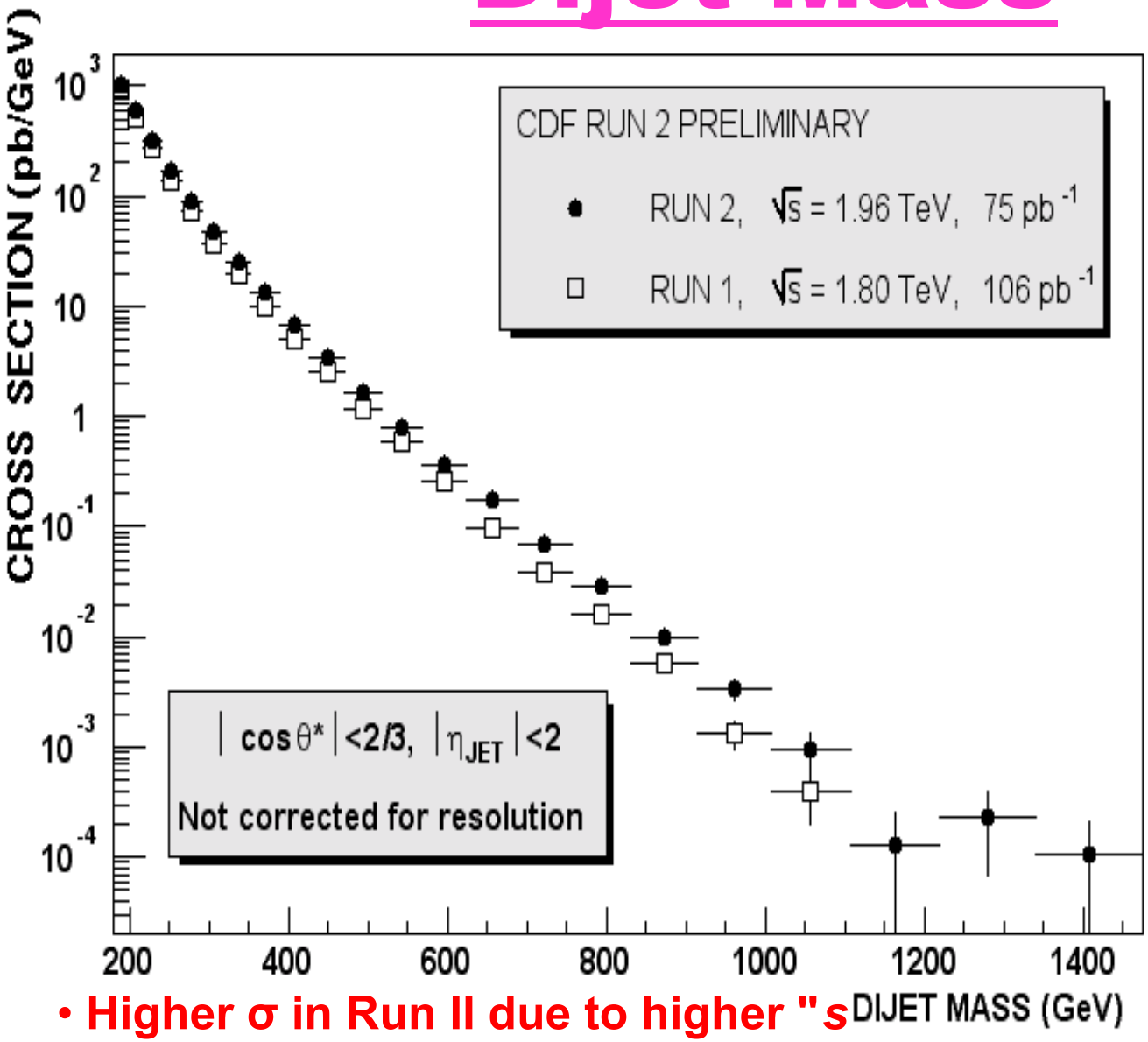
Good agreement (within uncertainties)

Run II & I



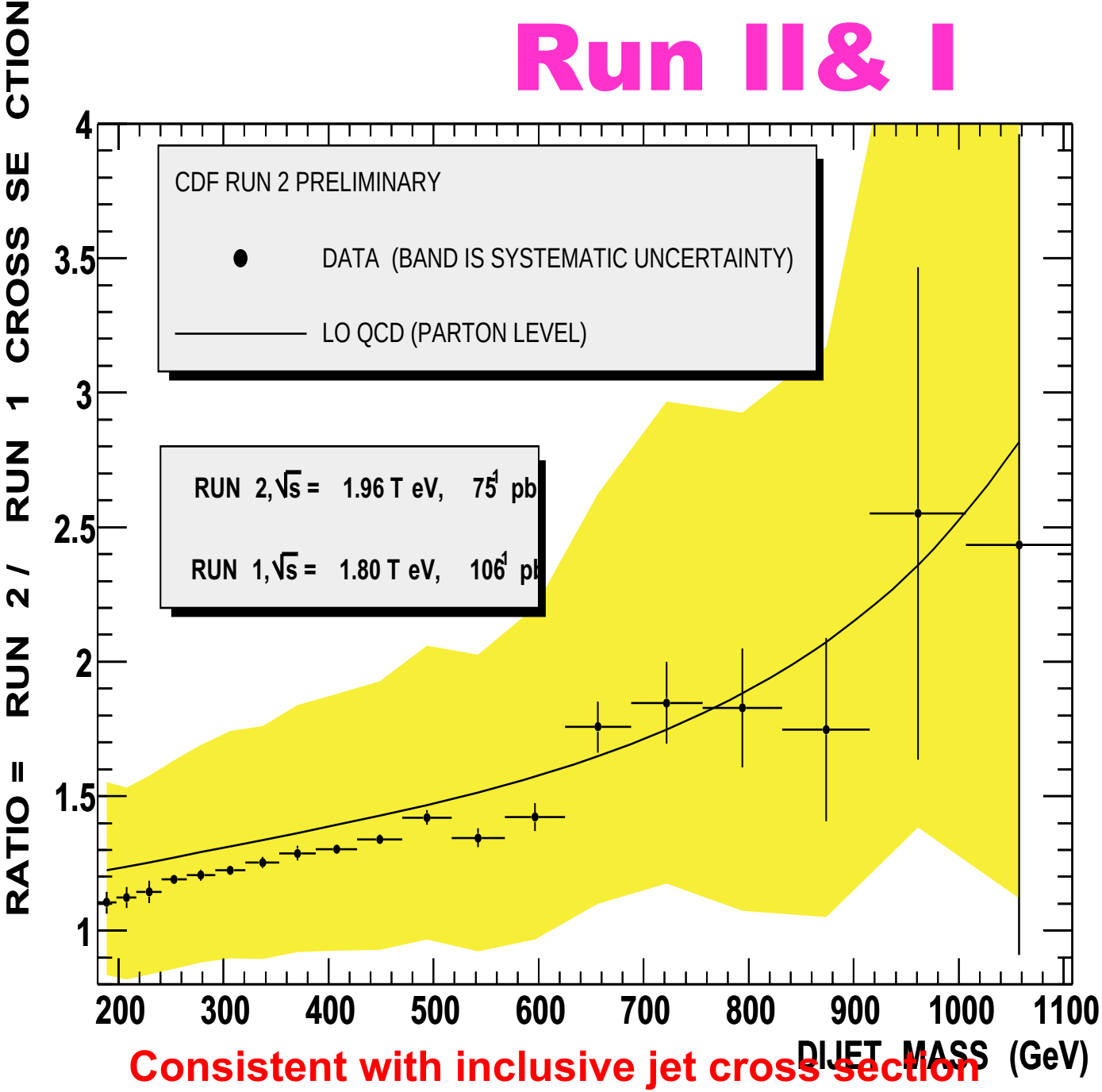
- Higher σ in Run II due to higher "s
- Many uncertainties cancel in the ratio

Dijet Mass



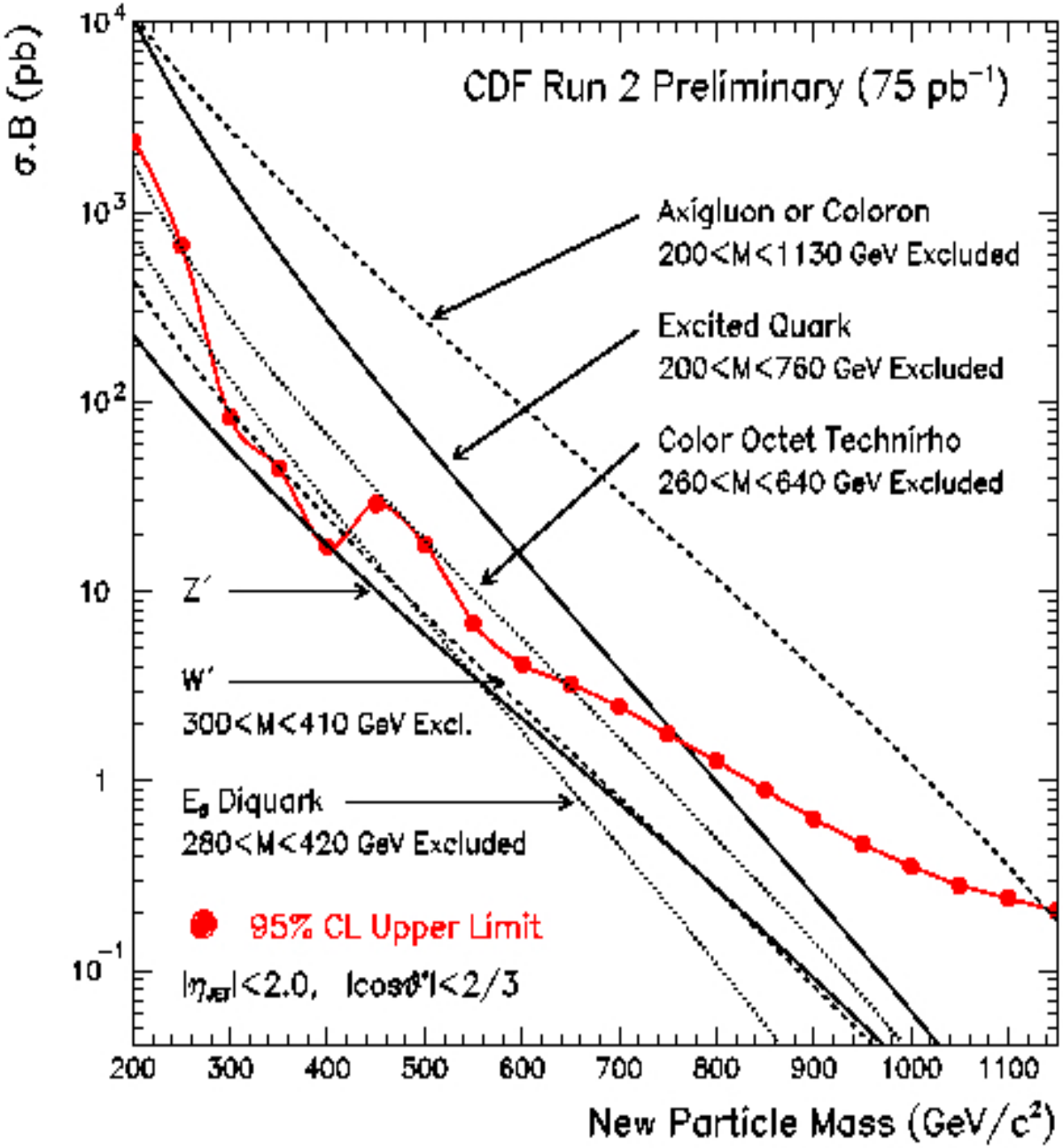
- Higher σ in Run II due to higher "s
- 3 more bins at high dijet mass!

Run II& I

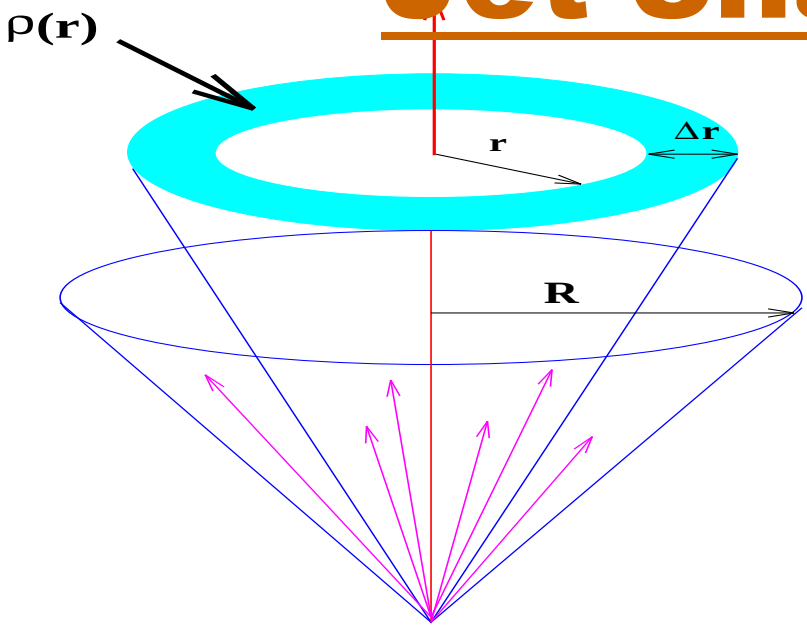


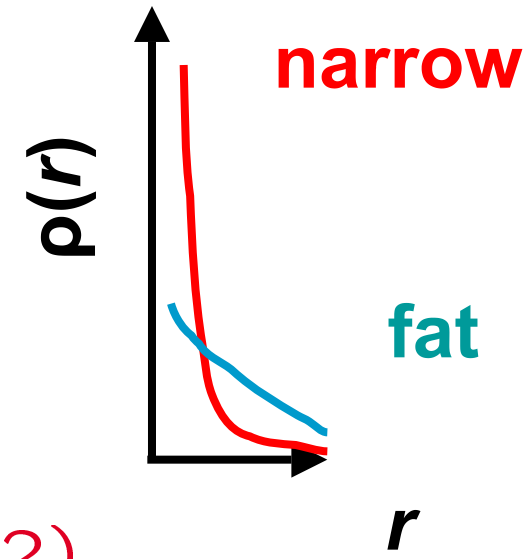
Consistent with inclusive jet cross section

Limits


CDF Run 2 Preliminary (75 pb^{-1})
σ.B (pb)
New Particle Mass (GeV/c^2)
Axigluon or Coloron
200<M<1130 GeV Excluded
Excited Quark
200<M<760 GeV Excluded
Color Octet Technirho
260<M<640 GeV Excluded
Z′
W′
300<M<410 GeV Excl.
E$_6$ Diquark
280<M<420 GeV Excluded
95% CL Upper Limit
$|\eta_{jet}|<2.0$, $|\cos\theta^*|<2/3$

Jet Shapes





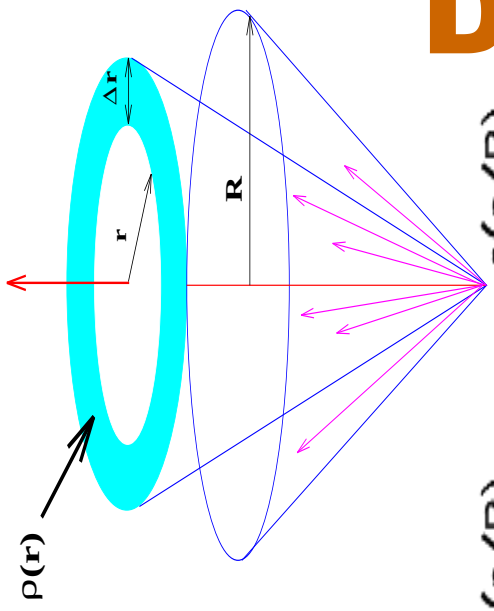
Differential jet shape definition

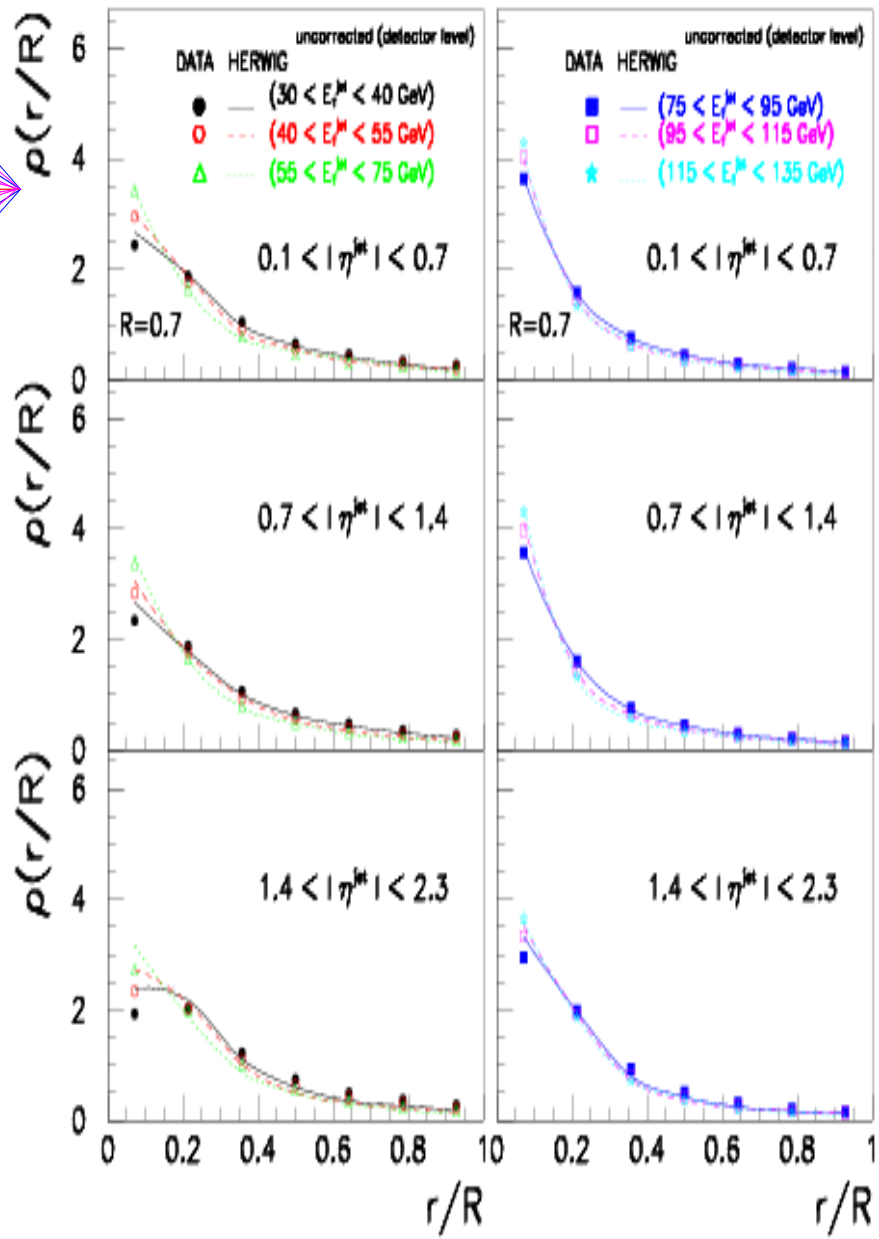
$$\rho(r) = \frac{1}{N_{\text{jets}}} \frac{1}{\Delta r} \sum_{\text{jets}} \frac{E_T(r \pm \Delta r/2)}{E_T^{\text{Jet}}(0, R)}$$

$$\Sigma_{r=0}^{R} \; \Delta r \cdot \rho(r) = 1$$

$\Rightarrow$ Jet Shape computed using CAL towers
$\Rightarrow$ Plots ARE NOT corrected to the hadron level

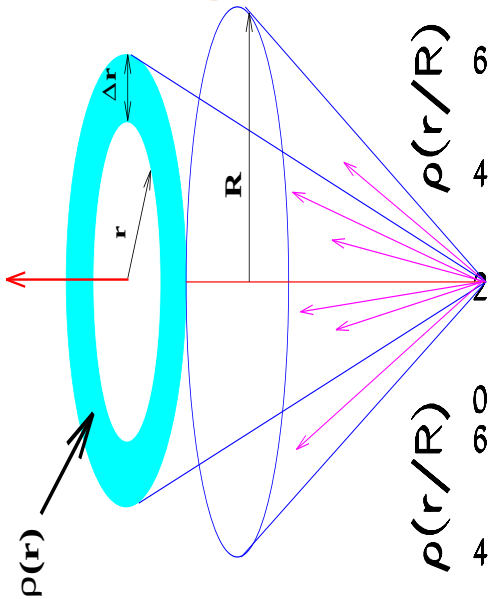
Data & *HERWIG*

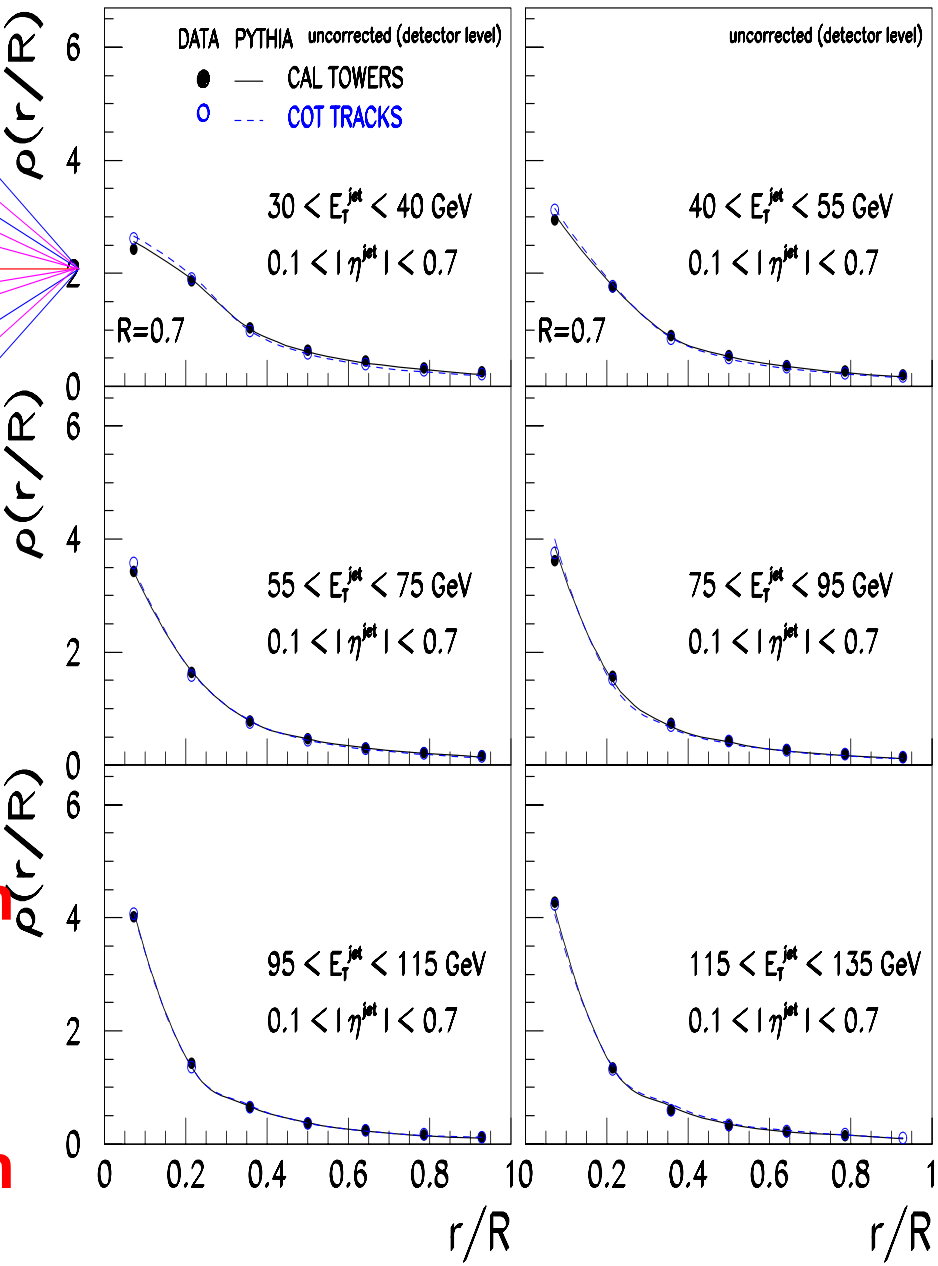




- **Narrower jets at high E_T & low η**
- ***HERWIG* agrees well with data**

Calorimeter vs. tracking

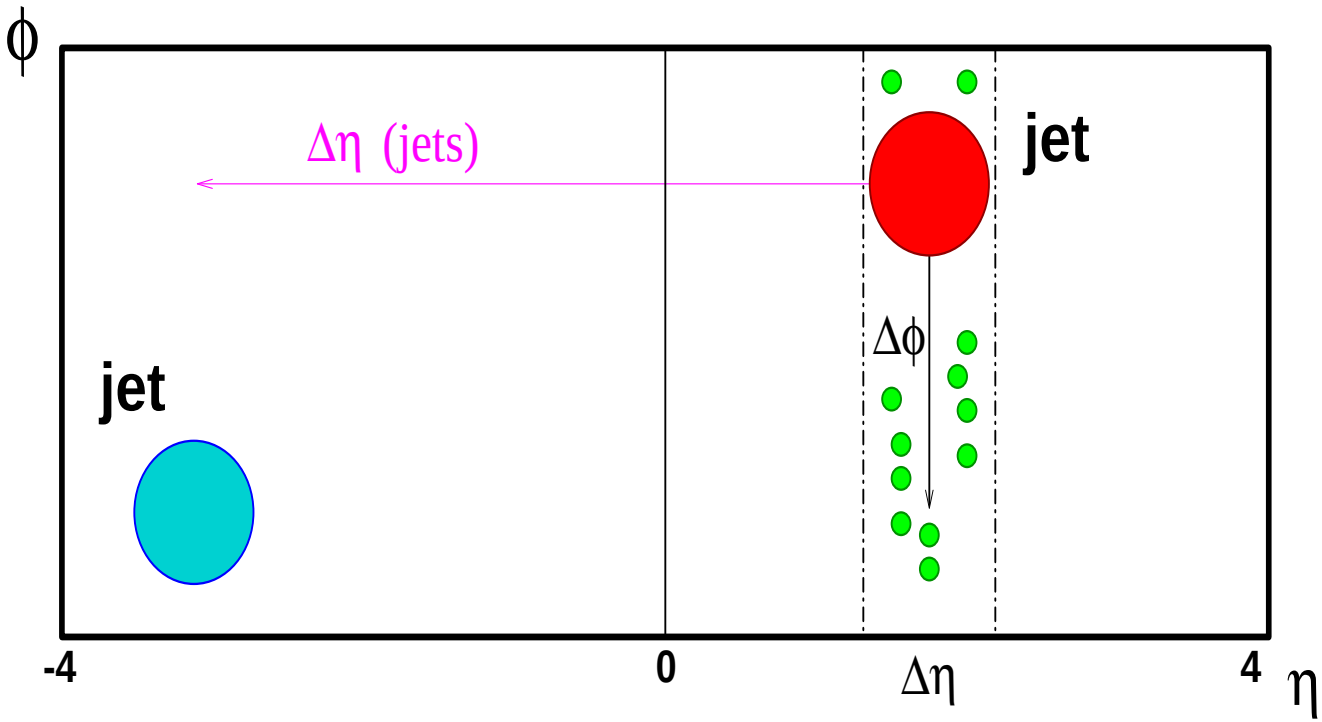




CDF Run II Preliminary

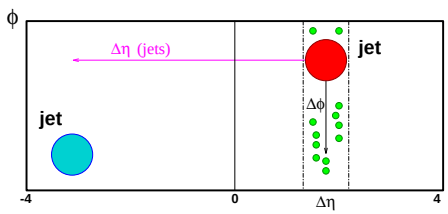
- **Use COT tracks with $p_T > 0.5$ GeV**
- **Agrees with calorimeter-based shape**
- **Agrees with *PYTHIA***

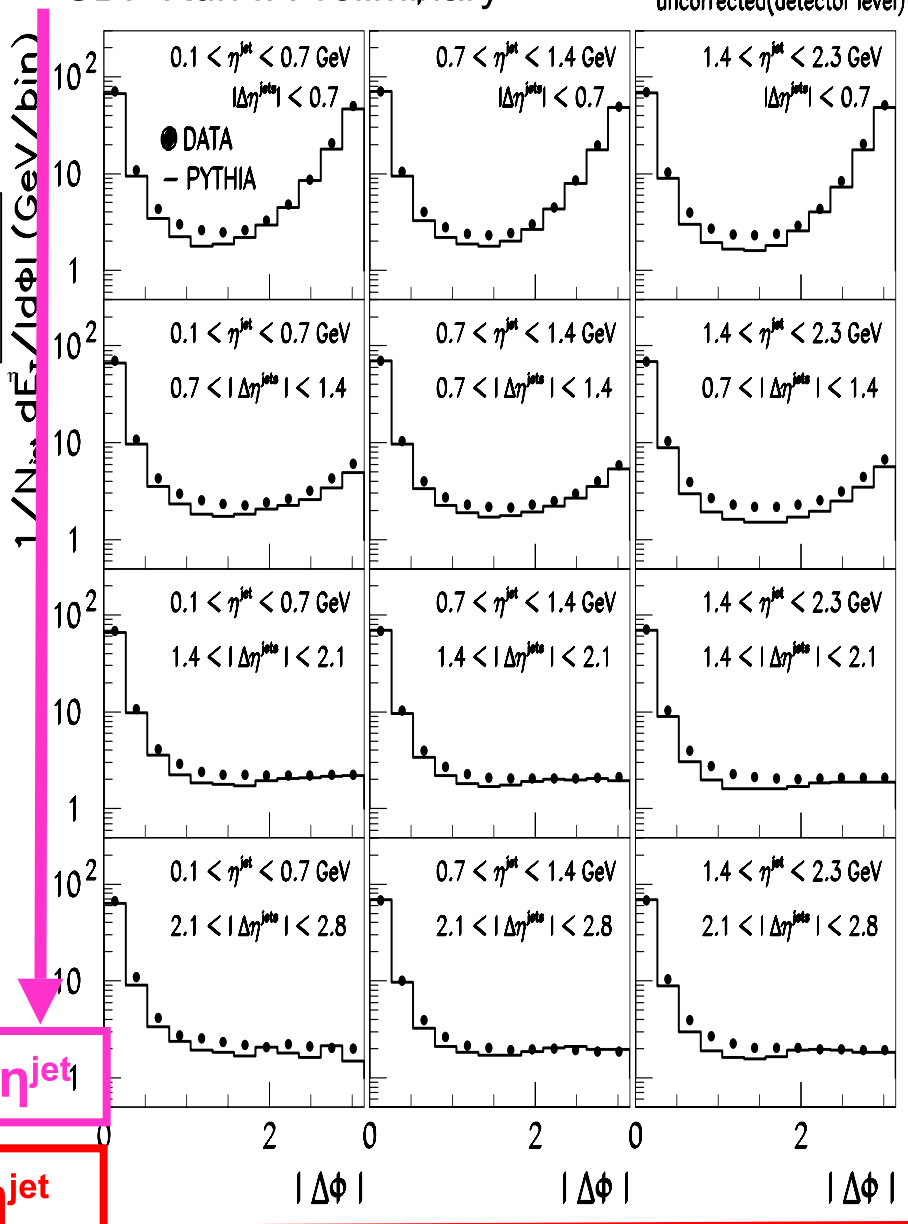
Energy flows



- Look *outside* the jet
- Probe the underlying event

Energy flows



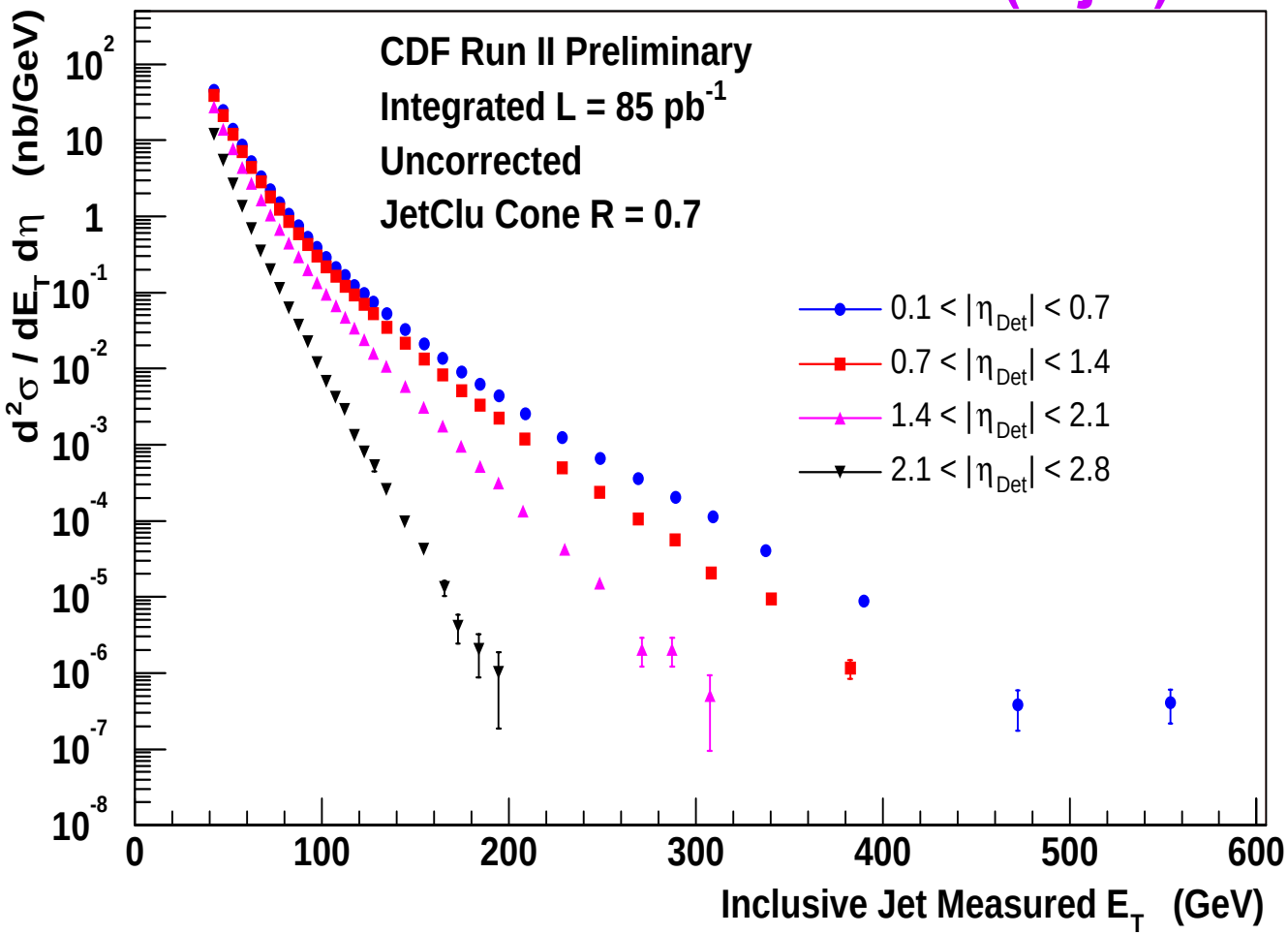


Increasing $\Delta\eta^{jet}$

Increasing η^{jet}

Summary

- CDF has preliminary measurements in Run II
  - Inclusive jet cross section
  - Dijet mass
  - Jet shapes & energy flow
- Higher vs → more jets at high E_T
- Data samples w/ higher statistics than Run I
- Dominant systematic: jet *E*-scale
- General agreement w/ fixed-order QCD calculations & Monte Carlos

Outlook

- Reduced systematics
- More data
- Forward jets
- Different jet algorithms
- Other jet analyses
  - Dijet angular distribution
  - s (*b*-jet)