Dijet Azimuthal Decorrelation

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Outline

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- $\Delta\varphi$ decorrelation studies at CMS
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Motivation

- At LHC, QCD will be probed at energies never achieved in previous experiments.
- Dijet azimuthal decorrelation probes the dynamics of QCD radiative processes.
- An accurate description of QCD radiative processes in event generators is important for precision measurements and searches for new physics (Higgs boson, SUSY).

$\Delta\varphi$ Decorrelation

- An important aspect of pQCD and MC event generators is to accurately account for the radiation of quarks and gluons.
- The azimuthal angle between the two leading jets in an event is sensitive to the effect of this radiation.

$$\Delta\varphi = |\varphi_{jet1} - \varphi_{jet2}|$$

  - At leading order the two leading jets have equal transverse momentum and correlated azimuthal angle ($\Delta\varphi = \pi$).
  - Higher order corrections cause azimuthal decorrelations. Soft radiation causes small deviations from π, while values significantly lower than π indicate the presence of hard radiation.

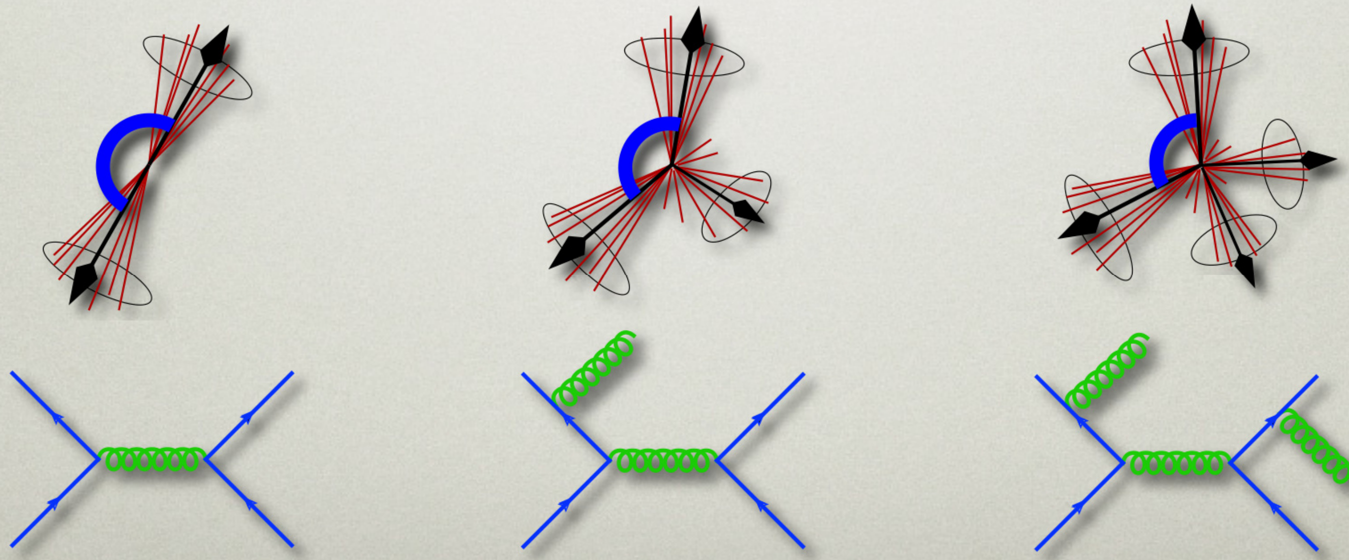
Δφ Decorrelation

Δφ distributions:

- provide a test of pQCD over a wide range of jet multiplicities without the need to reconstruct the additional jets
- offer a tool to study the transition between soft and hard QCD processes

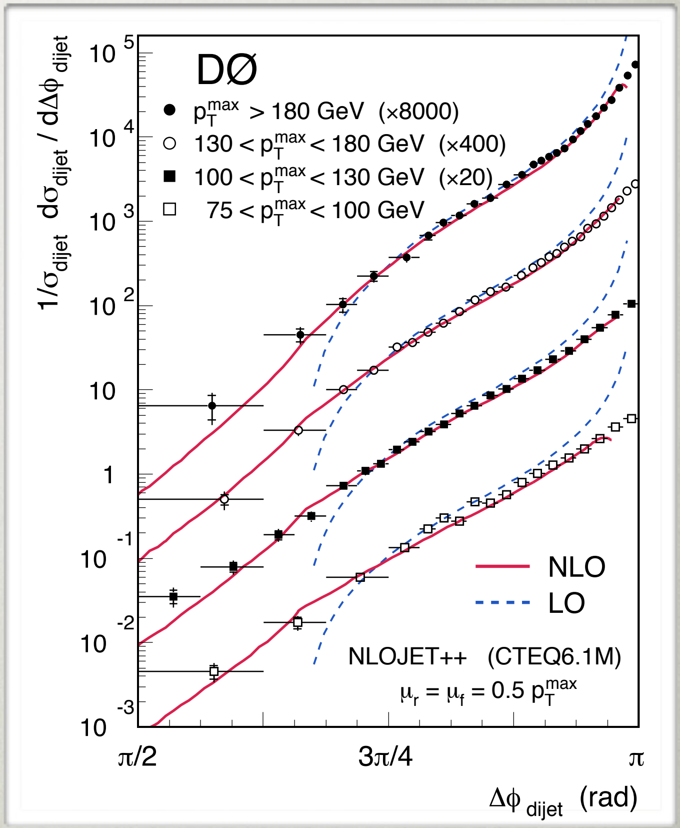
The observable

$$\frac{1}{\sigma} \cdot \frac{d\sigma}{d\Delta\varphi}$$

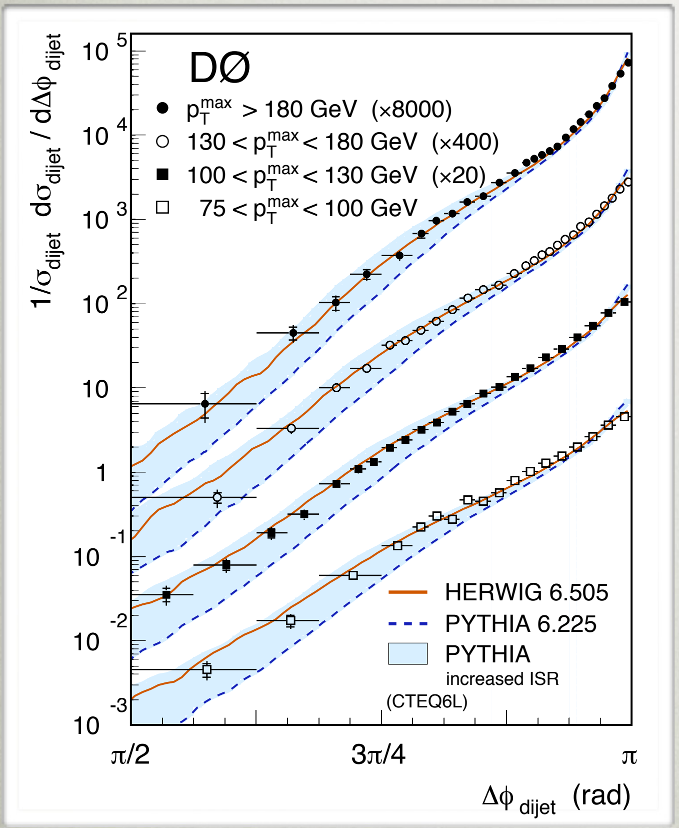


DØ Results

- Data were collected with the DØ detector in Run II using $p\bar{p}$ collisions at $\sqrt{s} = 1.96\ \mathrm{TeV}$
- Jets were reconstructed using a seed-based cone algorithm with radius R = 0.7
- The events were selected using single jet triggers with multiple thresholds. The p_T bins were defined such that the trigger efficiency is greater than 99%
- The p_T of the second jet was required to be greater than 40 GeV. Both jets have |y| < 0.5
- NLO pQCD provides a good description of data, while the LO calculation has a limited applicability



DØ Results



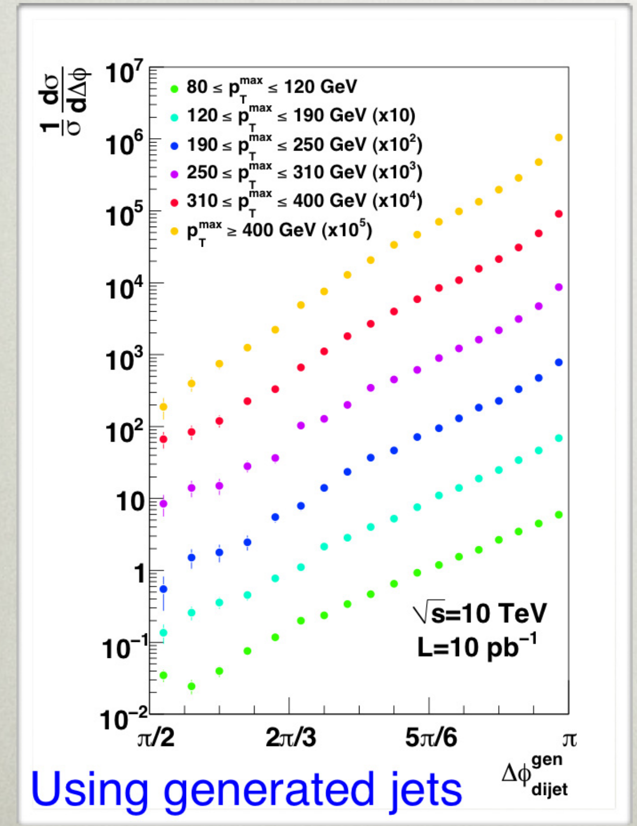
- HERWIG describes the data well over the entire $\Delta\varphi$ range.
- PYTHIA with default parameters does not perform that well. The distribution peaks higher at π and lies significantly below the data over most of the $\Delta\varphi$ range.
- However, by increasing the initial state radiation (ISR), PYTHIA can be tuned to better describe the data.

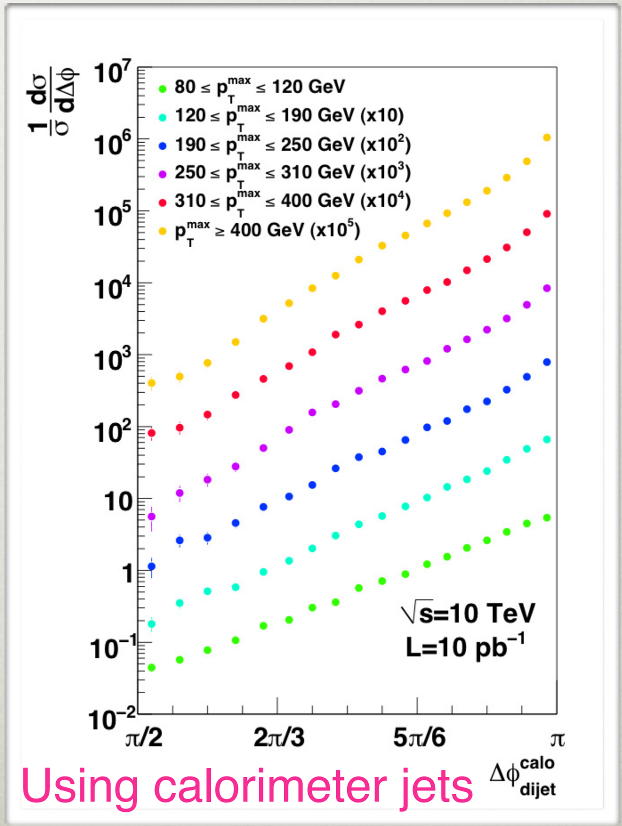
$\Delta\varphi$ Studies at CMS

- Performed with MC samples generated using PYTHIA and GEANT for 10 pb^{-1} and 10 TeV (iCSA08)
- Jets are reconstructed using a seedless infrared safe cone algorithm (SISCone) with radius R = 0.5
- The events are selected using single jet triggers with different thresholds
- Six p_T bins of the leading jet are defined such that the triggers are fully efficient
- No p_T requirement on the second jet
- Both jets are restricted to central rapidity region, $|y| < 1.1$

Δφ Distributions

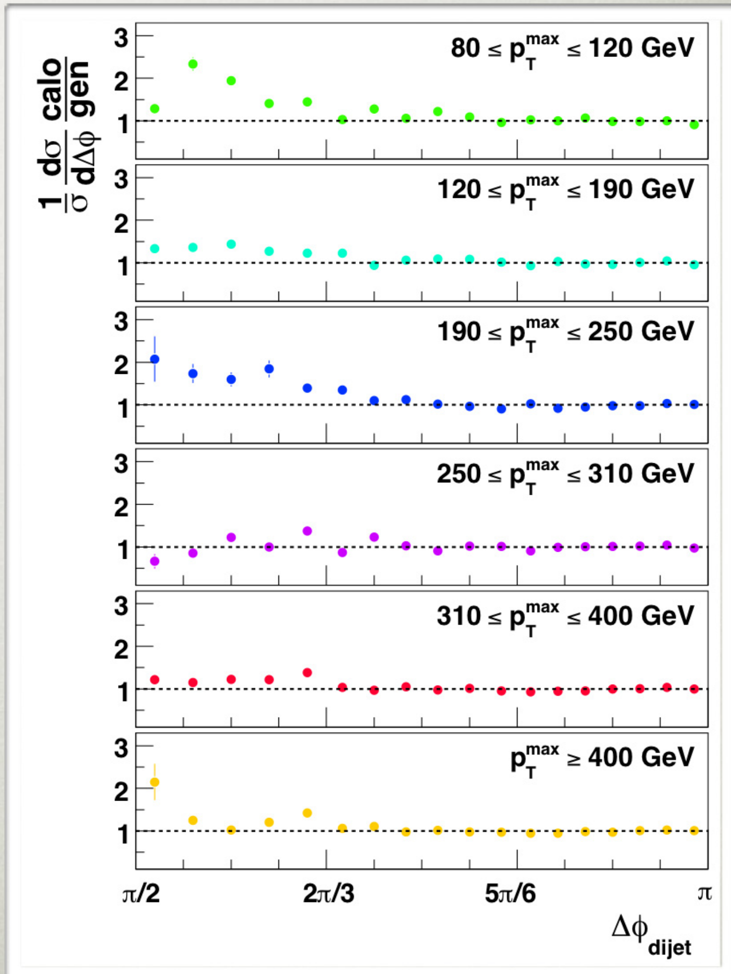
- For higher p_T bins the Δφ distributions peak higher at π; more correlated jets



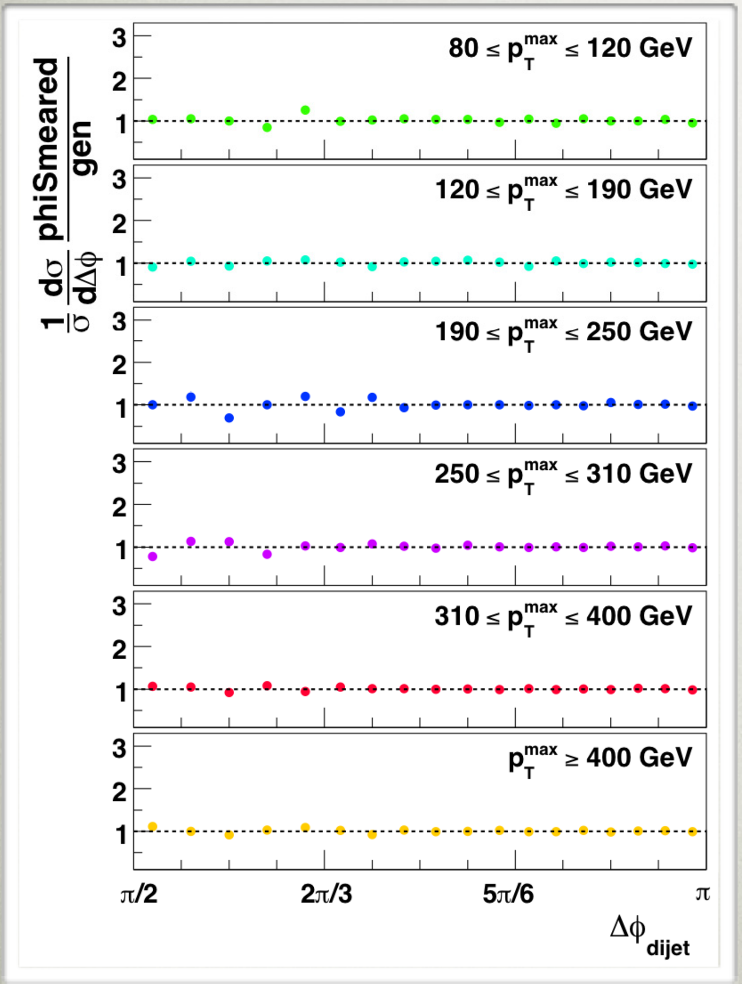


Detector Effects

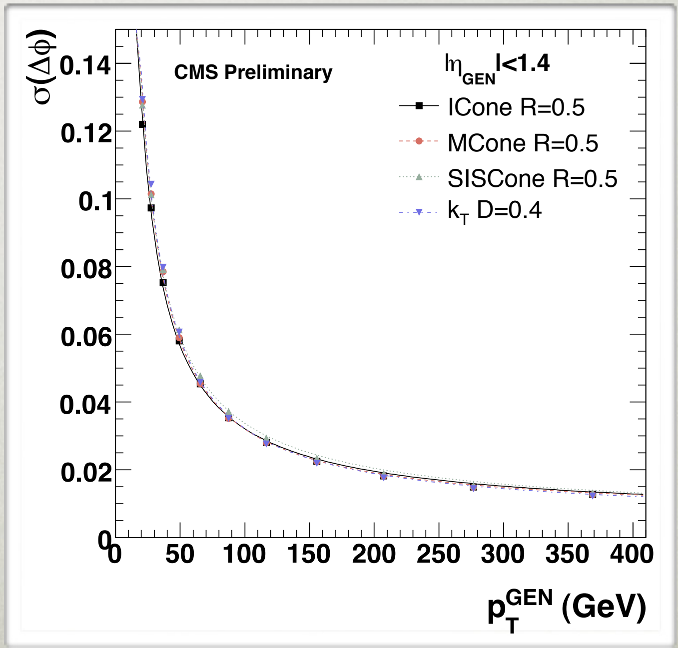
- Detector effects such as jet energy and position resolution, jet energy scale, etc., can affect the $\Delta\varphi$ distributions
- The magnitude of these effects can be evaluated by taking the ratio between reconstructed and generated $\Delta\varphi$ distributions
- For $\Delta\varphi > 2\pi/3$ the detector effects are relatively small
- Below $2\pi/3$, the detector effects are more visible, especially for lower p_T bins



Jet Position Resolution Effect



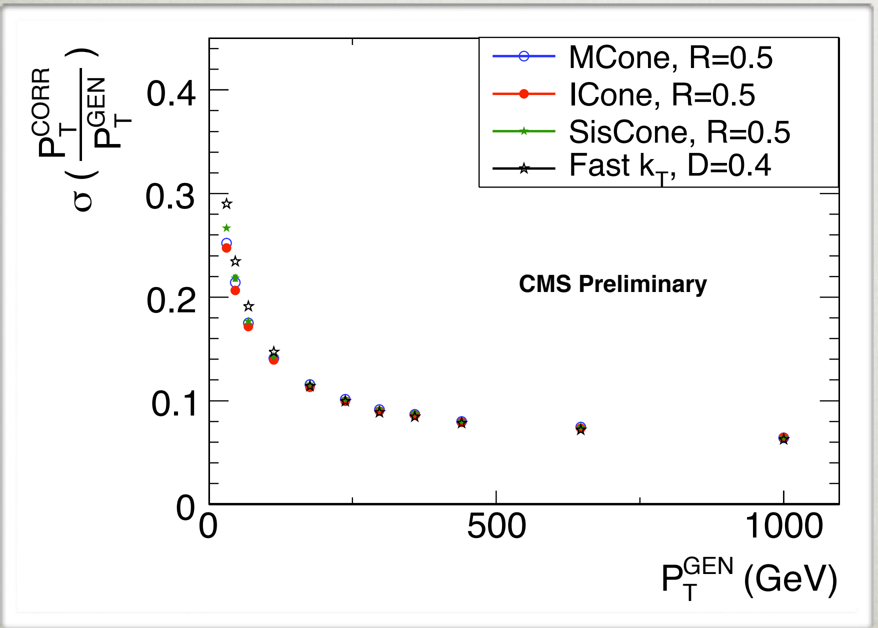
- Generated jets are smeared in φ using the MC position resolution function
- **Insensitive** to jet position resolution

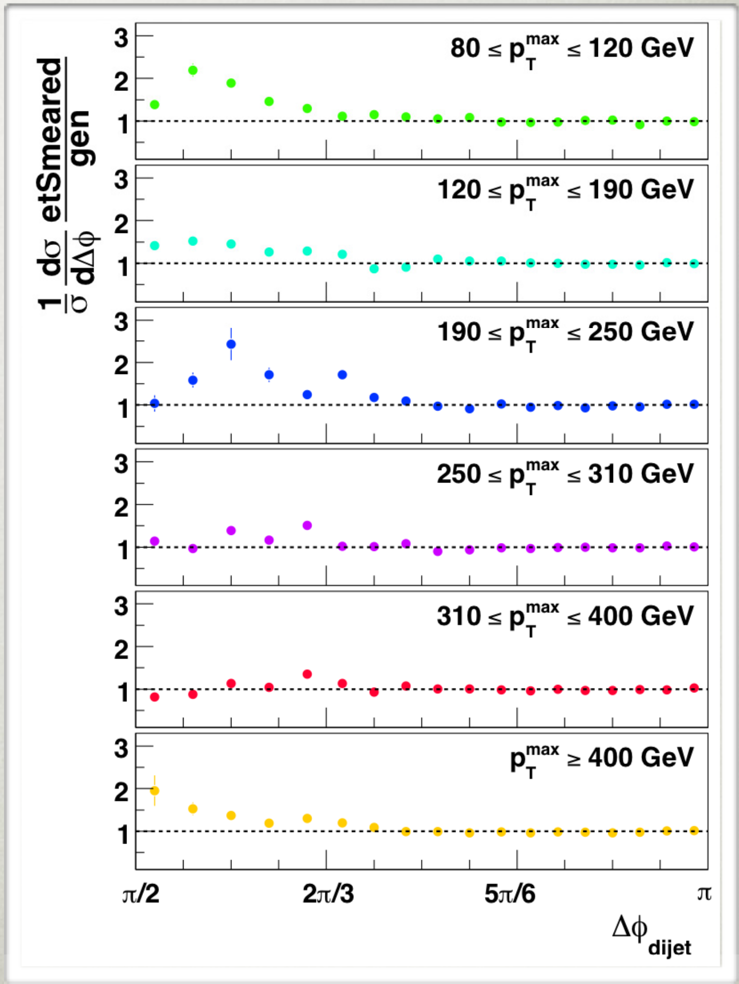


Jet Energy Resolution Effect

- Generated jets are smeared in p_T using the energy resolution function

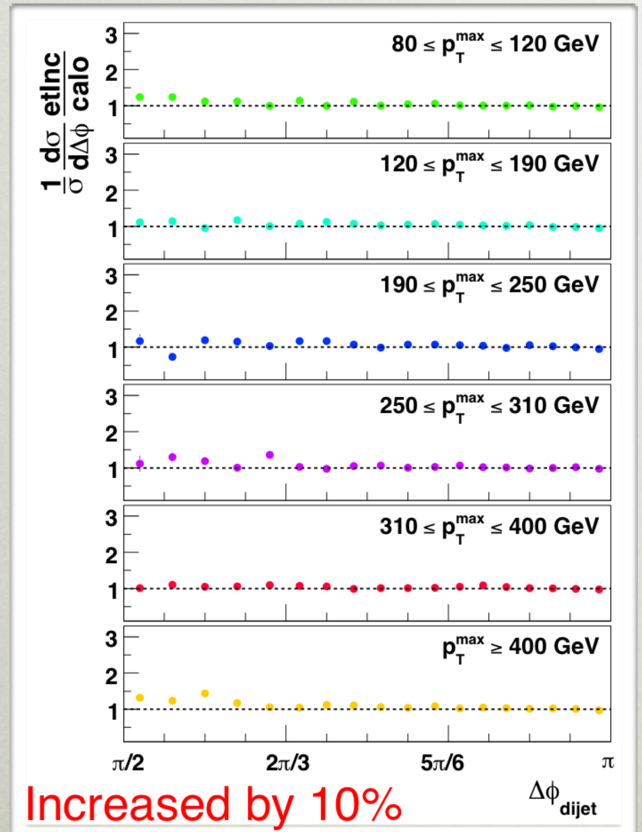
- **Sensitive** to jet energy resolution

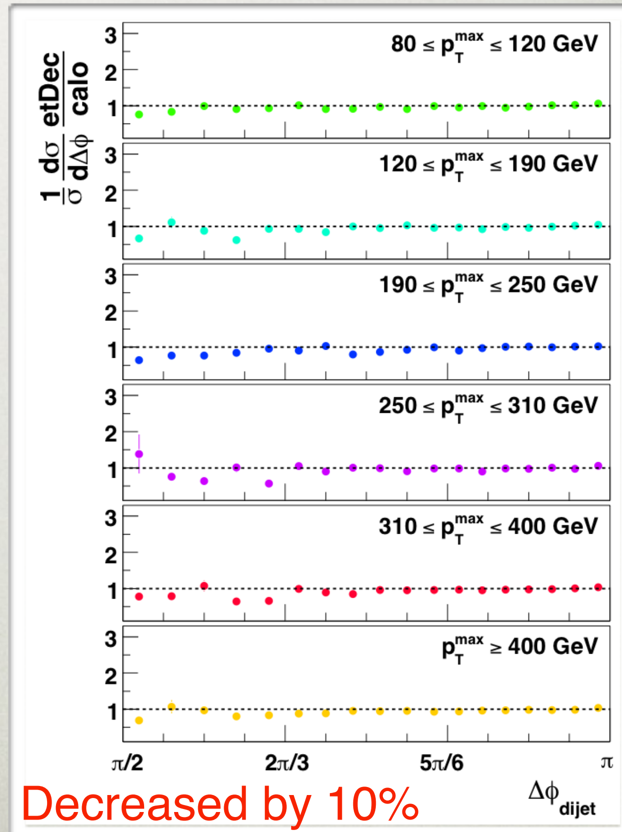




10% JES Uncertainty Effect

- Small effects seen for $\Delta\varphi < 2\pi/3$





Summary

- Dijet azimuthal decorrelation is sensitive to high order radiation without explicitly measuring the radiated jets
- Study the transition between soft and hard QCD processes
- NLO pQCD provides a good description of Tevatron data
- Insensitive to jet position resolution and jet reconstruction efficiency
- Sensitive to jet energy resolution. Explains the difference between reconstructed and generated jets
- JES uncertainties have negligible impact
- Can be done with early data !!!