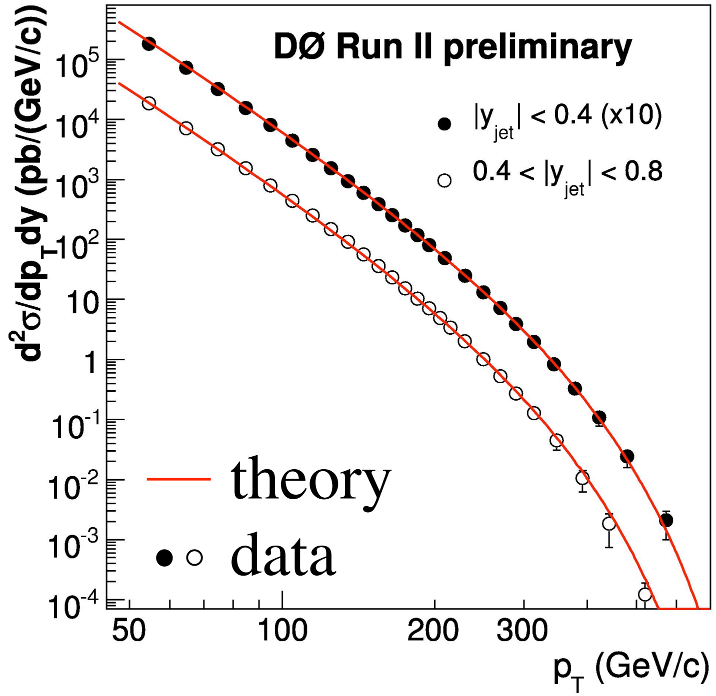
D0 results on inclusive jet production



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for the D0 collaboration

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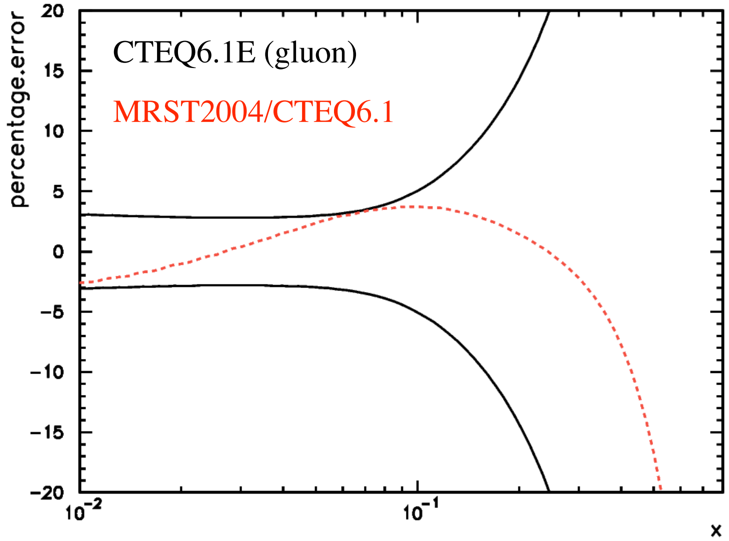
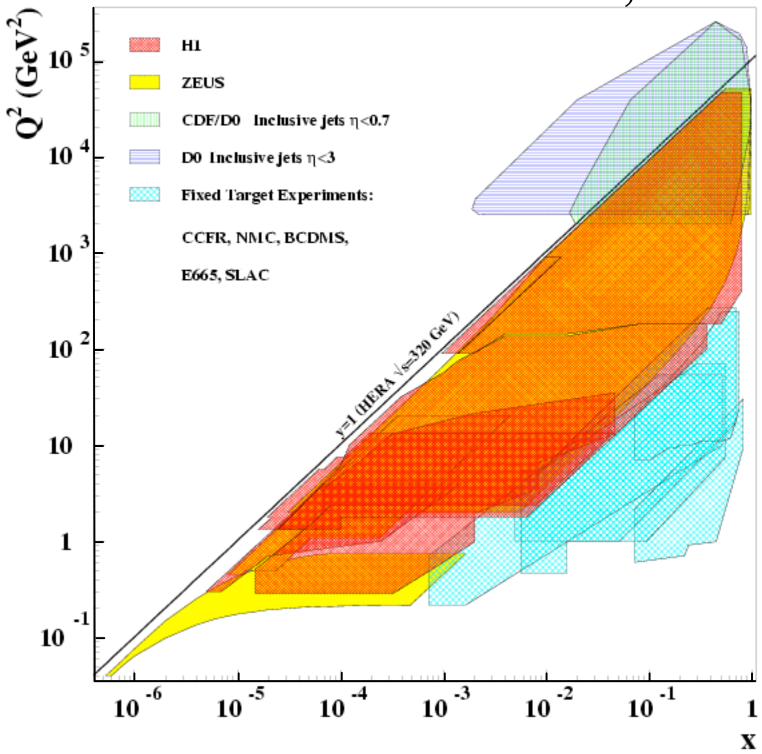
Introduction

- The Fermilab Tevatron is performing wonderfully
  - best place right now to study QCD
  - $\sqrt{s}$ = 1.96 TeV, L = 2.9×10^{32} $cm^{-2}s^{-1}$

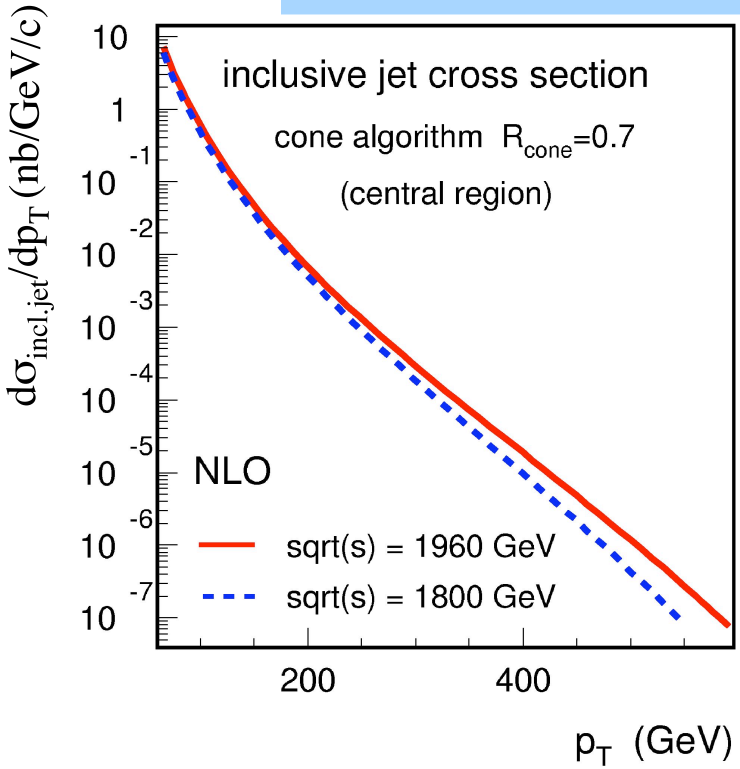


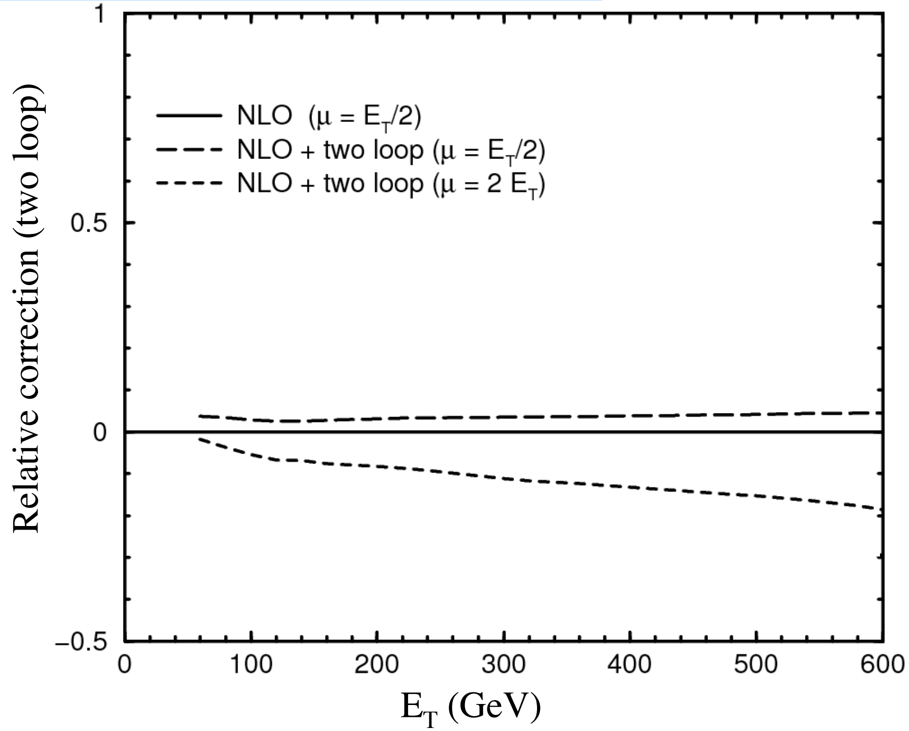


- Inclusive jet cross section:
  - precision test of perturbative QCD over ten orders of magnitude
  - sensitive to gluon PDF's in unconstrained areas
  - sensitive to non-standard physics like quark compositeness

Theoretical prediction

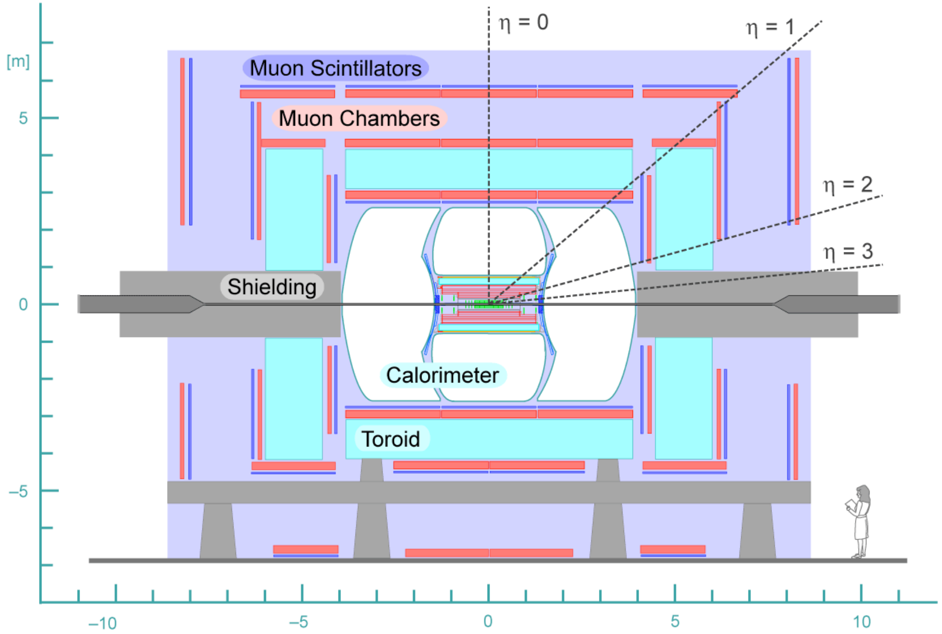
[N.Kidonakis, J.F.Owens, Phys. Rev. D63, 0504019 (2001)]

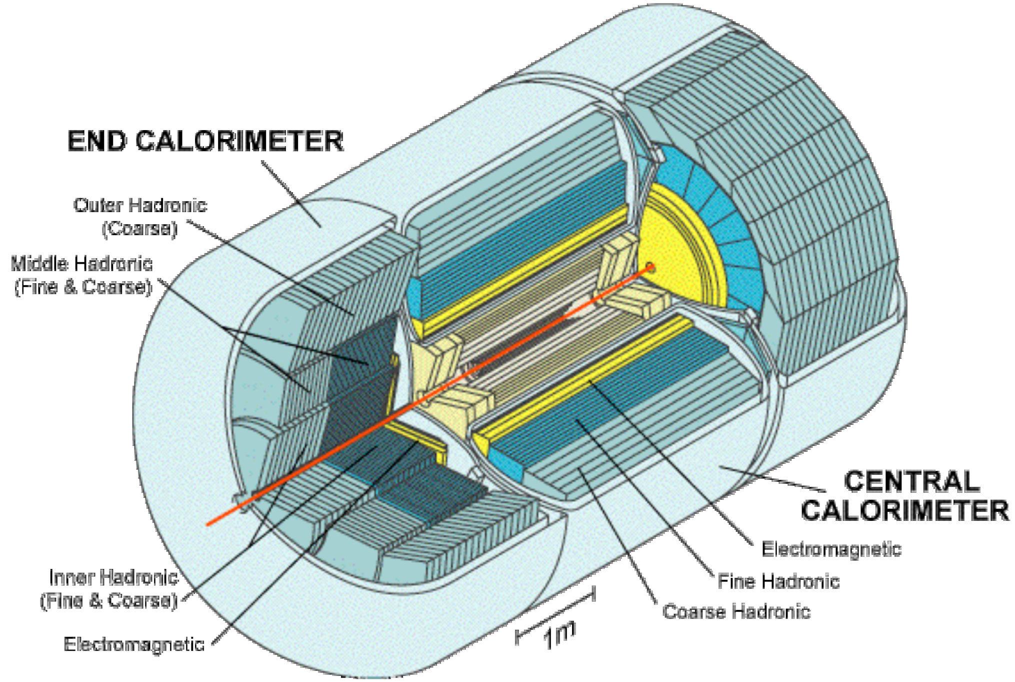




- NLO with NNLO-NNL corrections up to two-loop accuracy
- MC generated using fastNLO
- Hadronization corrections applied (based on Pythia)
- Using CTEQ6.1M PDF’s
- Renormalization- and factorization scales set to jet p_T

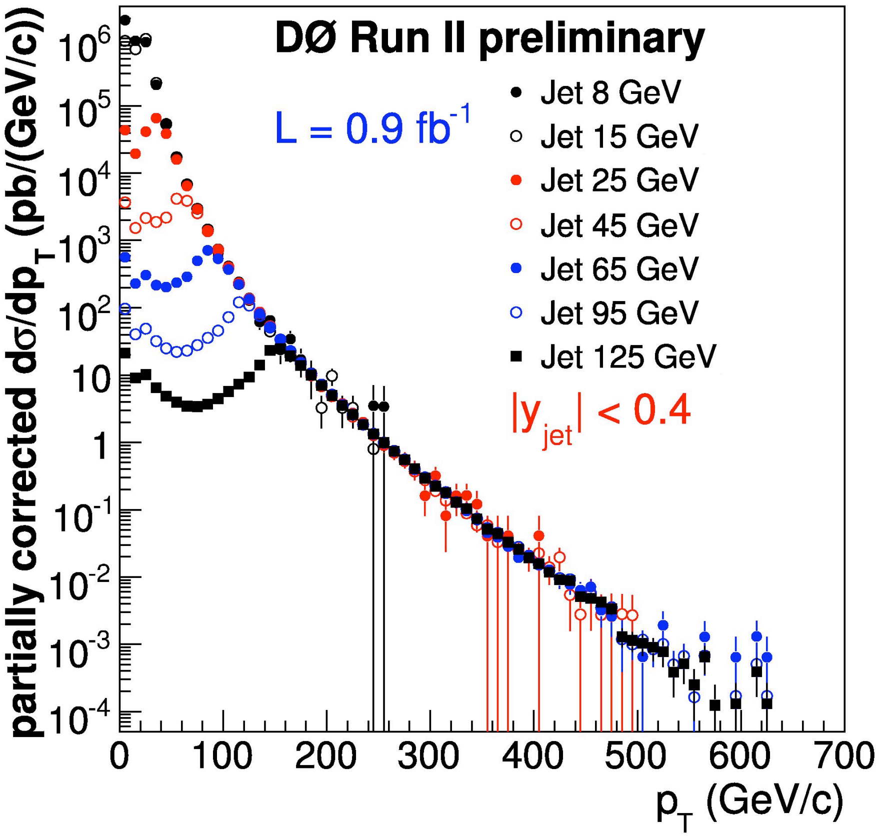
The D0 detector





- General purpose detector with LAr/Uranium calorimeter
- Fine segmentation:
  - $\Delta\eta \times \Delta\phi \approx 0.1 \times 0.1$
  - segment size halved in third EM cal layer to 0.05 x 0.05 (shower maximum)

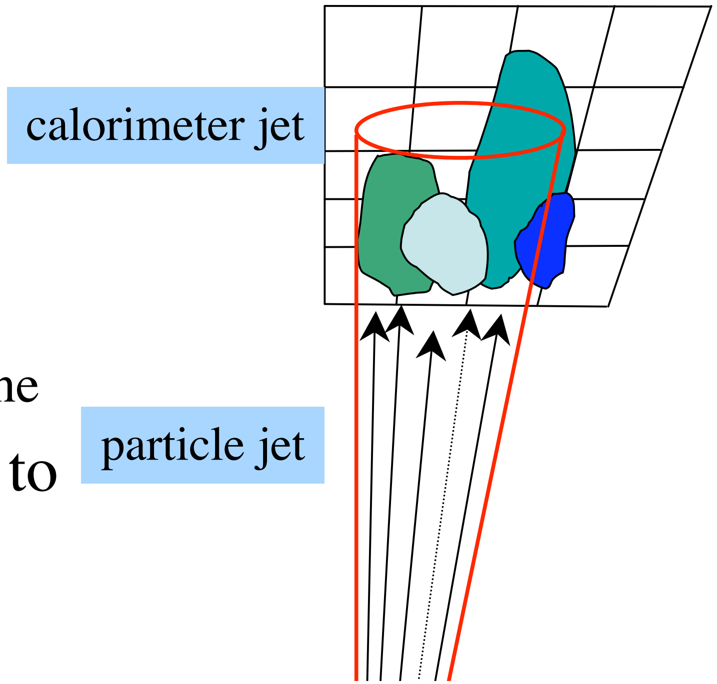
Data selection



- Data taken using single-jet triggers with different p_T thresholds
- Tevatron RunII data taken from 2002 - 2005
- Extensive data quality cuts
- Integrated luminosity: $883 pb^{-1} \pm 6\%$

Jet energy calibration

- Jets reconstructed using a R = 0.7 cone algo
- Correct measured jet energy to particle level
  - offset energy and underlying event
  - detector response
  - correct for shower development outside the jet cone
- Photon+jet events are ideal, use di-jet events to increase statistics
- Preliminary jet energy scale determined on ~150pb^{-1}



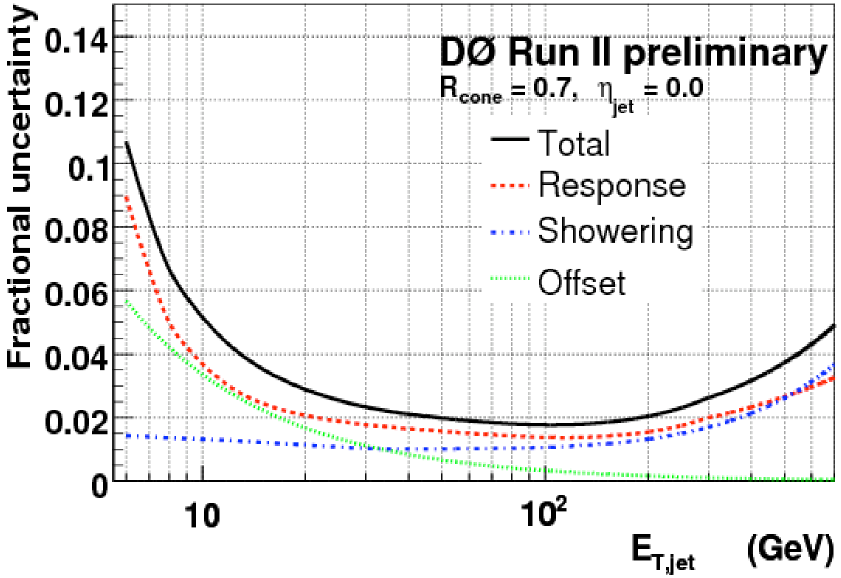
Much effort being put into the final, and much improved energy scale determined on 1fb^{-1}

Jet energy calibration (cont'd)

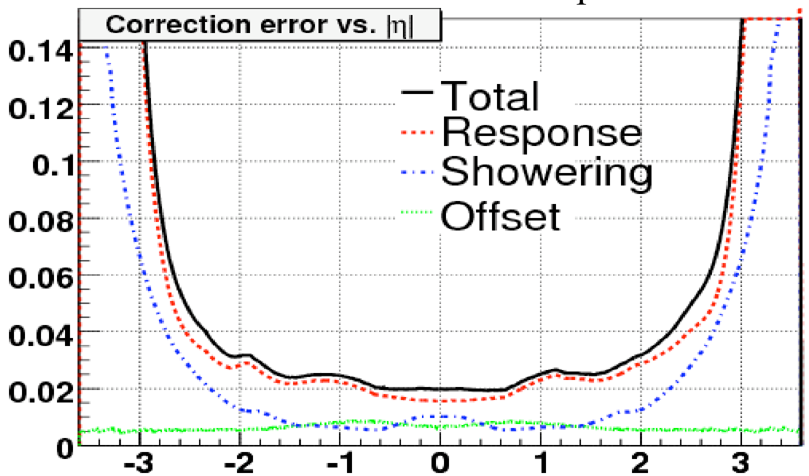
$$E_{jet}^{ptcl} = \frac{E_{jet}^{cal} - O}{R \cdot S}$$

- Offset: determined from minimum-bias and zero-bias data
- Response: use the inherent pT balance in back-to-back photon+jet events to relate the jet response to that of the photon
- Showering: estimated in data from energy density profiles around the jet axis

At high pT statistically limited



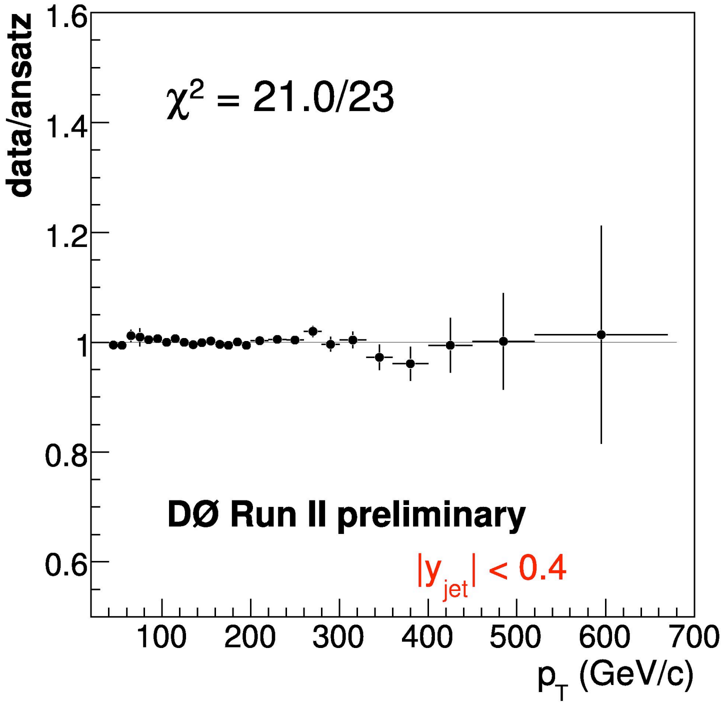
E_T = 50GeV



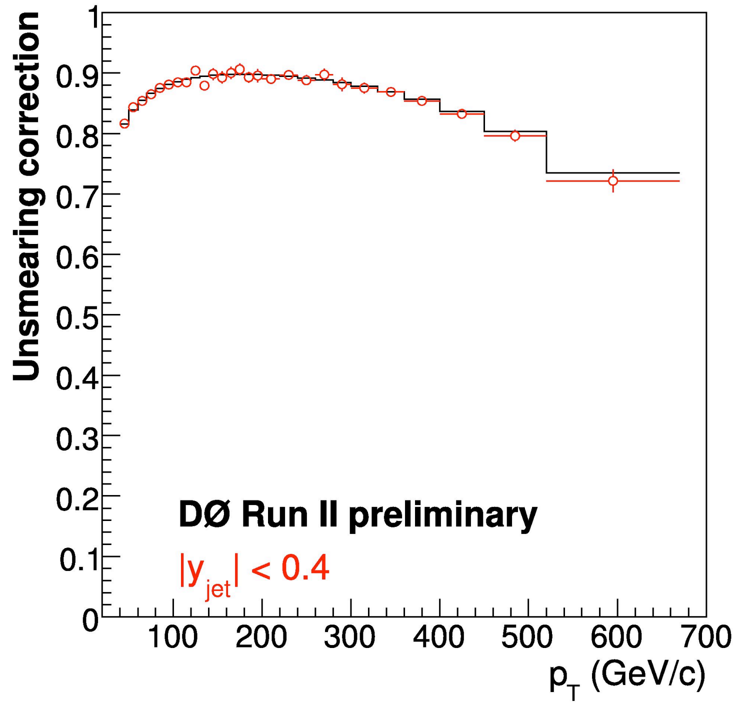
Resolution unfolding

- Data corrected for jet energy scale, trigger- and jet id efficiencies
- Two methods:
  - fit data with Ansatz functions smeared with Gaussian p_T- and η resolutions from data and use fit results to unfold data
  - fold resolutions into Pythia MC

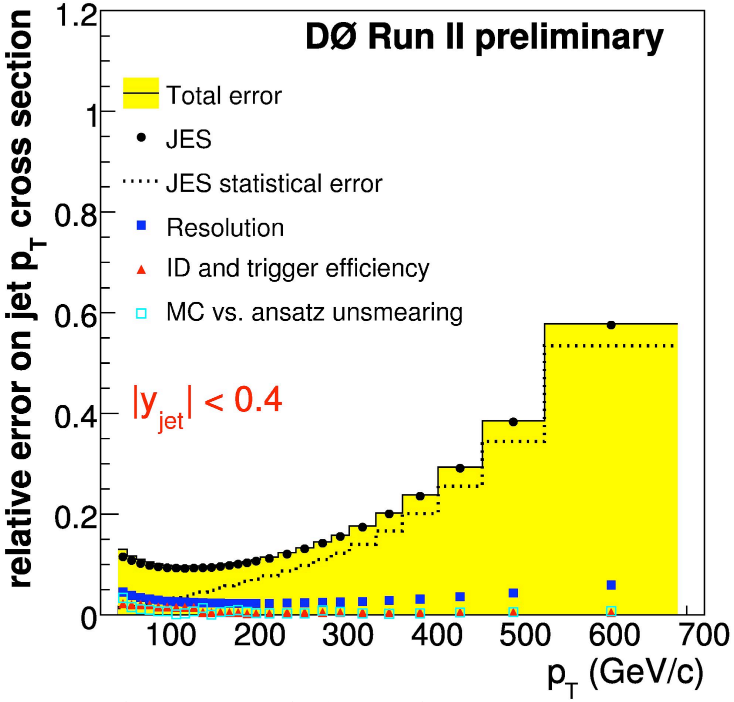
Ansatz fit result

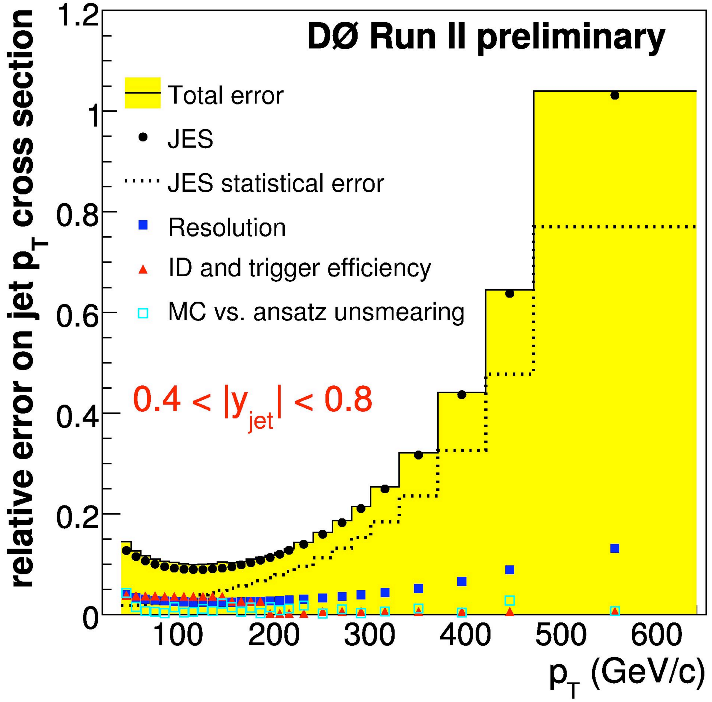


Pythia- and Ansatz unsmearing functions



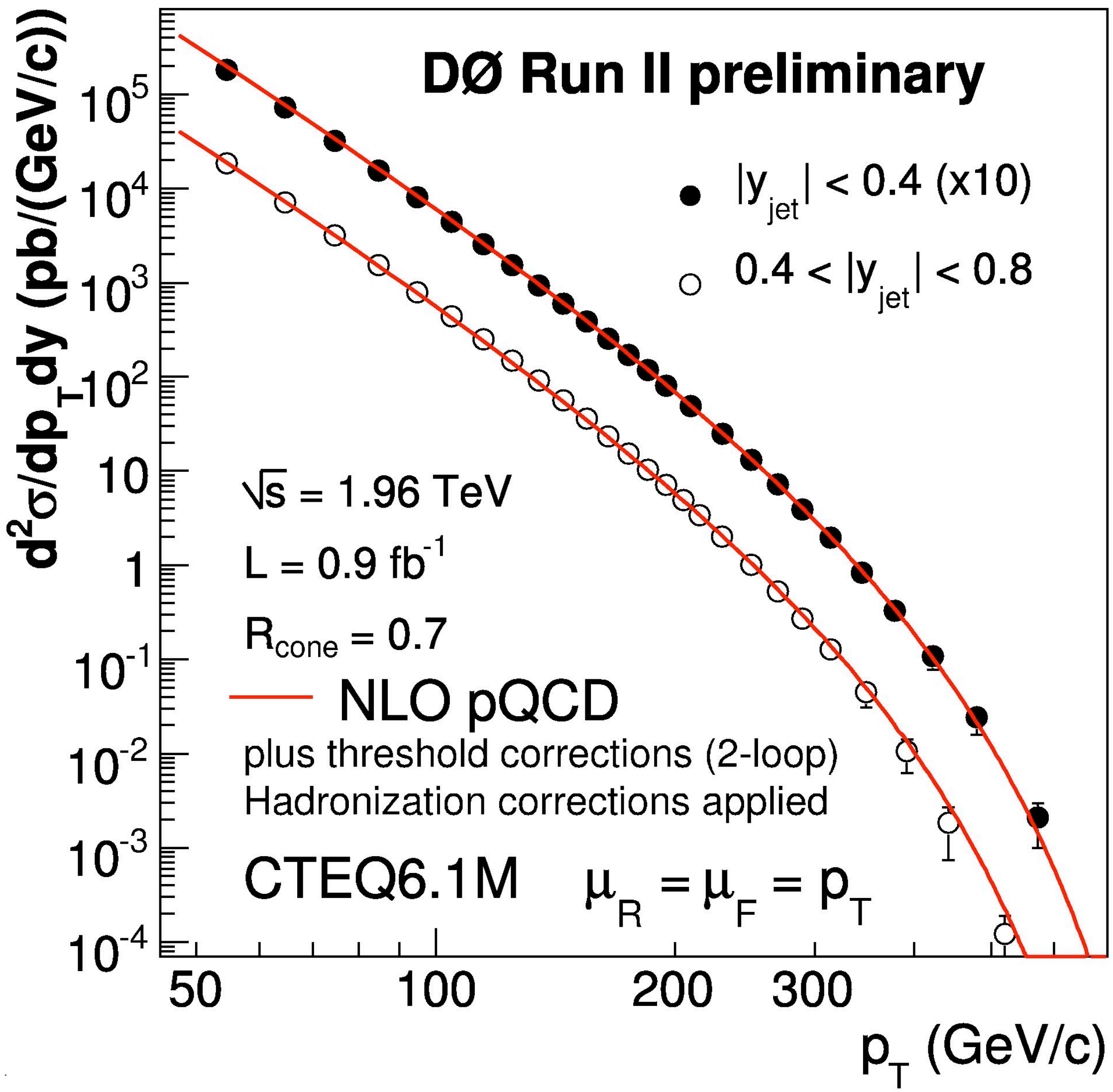
Uncertainties

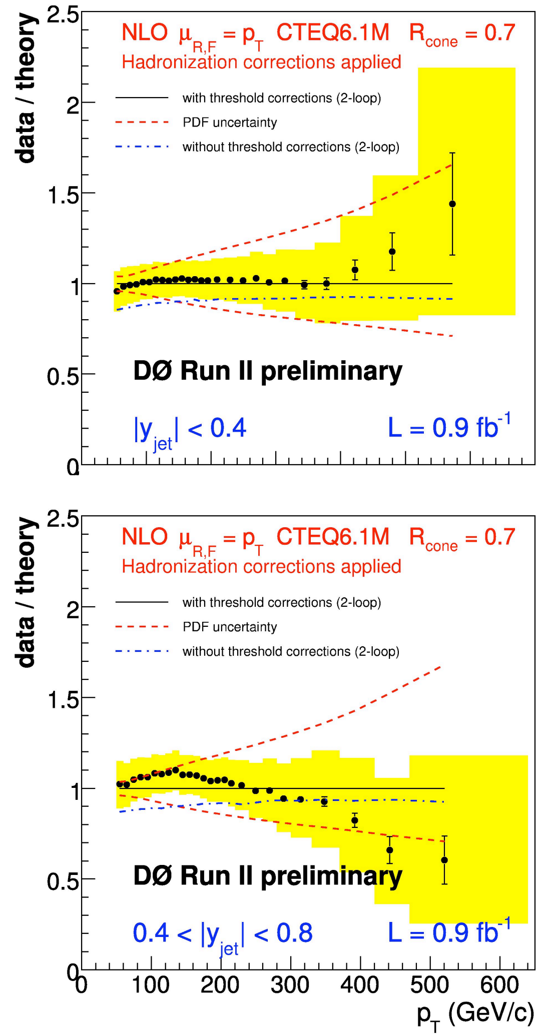




- Dominated by jet energy scale
- JES in turn limited by statistics (small photon+jet sample just does not contain too many high-p_T jets)
- Not shown: 6% luminosity uncertainty

Inclusive jet production cross section





Conclusion

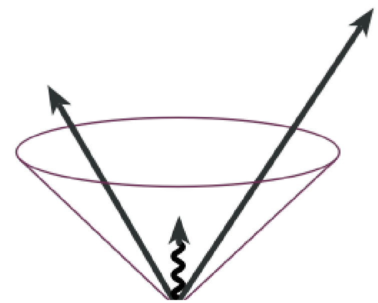
- This preliminary result is based on ~1fb^{-1}
  - we have already recorded >3fb^{-1} and are expecting >6fb^{-1}
- A much improved jet energy scale is under review

We're anticipating a very strong finale for the D0 experiment the next couple of years!

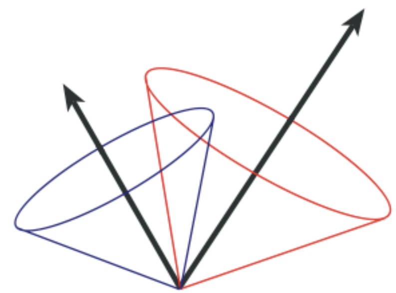
Backup slides

‘Run II midpoint cone algorithm’

- ‘Particle’ can be calorimeter tower, stable MC particle or parton
- Iterate over seed particles with $p_T > 0.5 GeV/c$
  - add all particles with $p_T > 1 GeV$ in a cone with $\Delta R = \sqrt{(\Delta\eta^2 + \Delta\phi^2)} < 0.3$
  - recompute cluster axis and repeat until stable

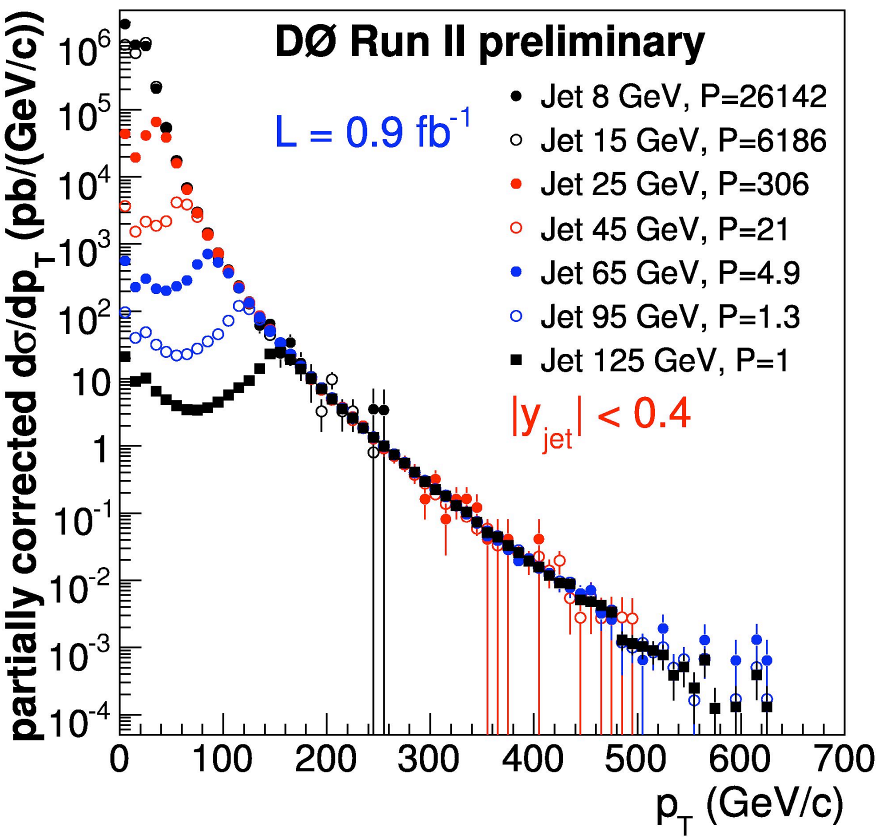


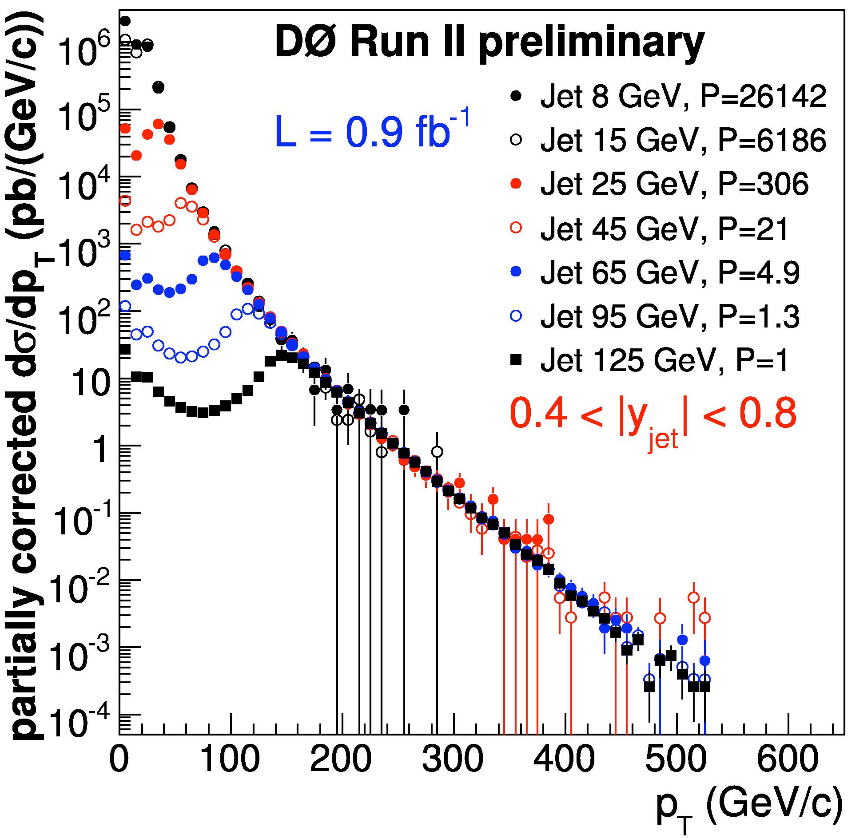
- Infrared safety: repeat above procedure for all jet-pair midpoints
- Remove duplicates and clusters with $p_T < 1 GeV$
- For each ‘proto-jet’ cluster:
  - add all particles in a cone with $\Delta R = \sqrt{(\Delta y^2 + \Delta\phi^2)} < 0.7$
  - recompute centroid and repeat until stable



- Remove duplicates and treat overlaps:
  - if the overlap is larger than 50% of the energy of the lowest-pT jet: merge (combine jets and recompute centroid)
  - otherwise assign each overlap particle to the closest jet in ΔR
- Remove jets with $p_T < 6 GeV$

Different triggers





Jet energy calibration (cont'd)

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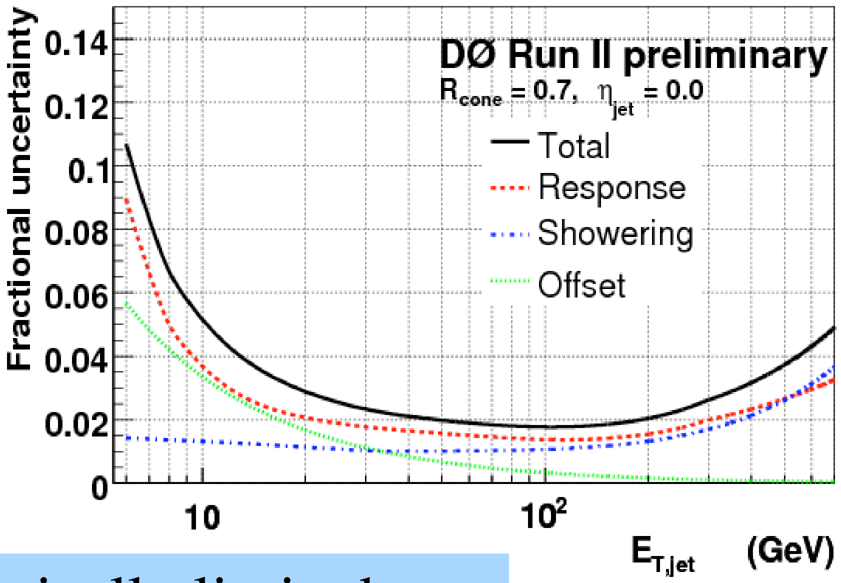
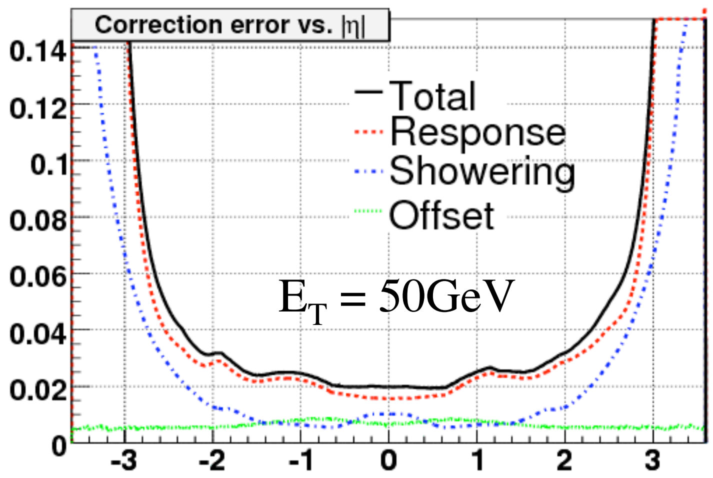
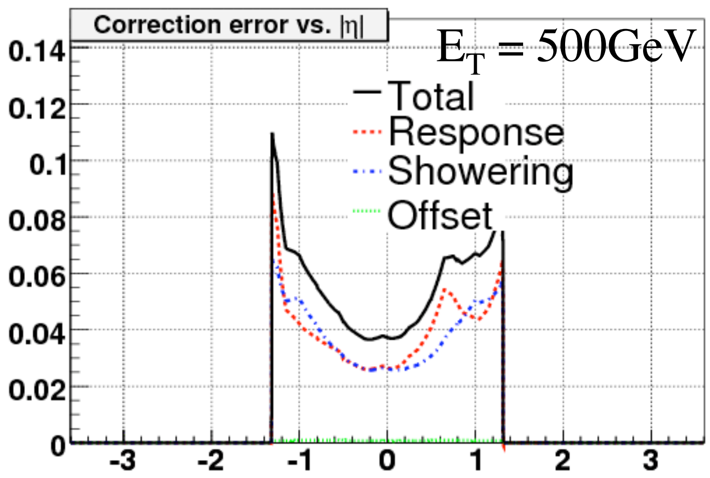


At high pT statistically limited

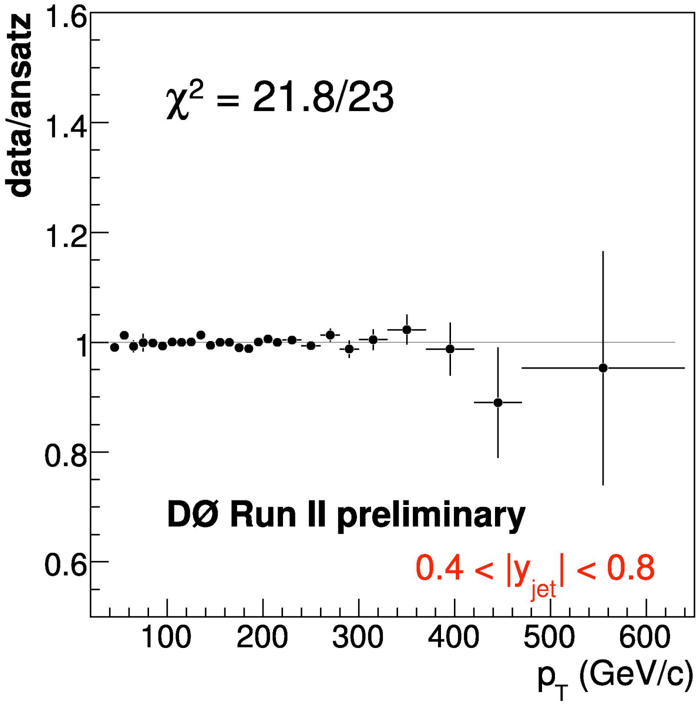


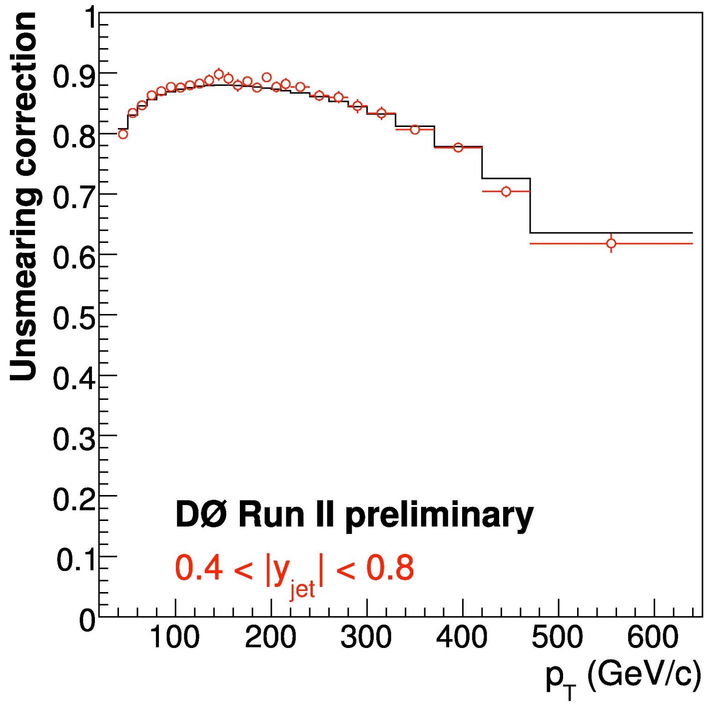


Ansatz function

$$f(N,\alpha,\beta,\gamma) = N\left(\frac{p_{\mathrm{T}}}{1\mathrm{GeV/c}}\right)^{-\alpha}\left(1-\frac{2\cosh{(y_{\mathrm{bin}})}p_{\mathrm{T}}}{\sqrt{s}}\right)^{\beta}\exp{-\gamma p_{\mathrm{T}}}$$

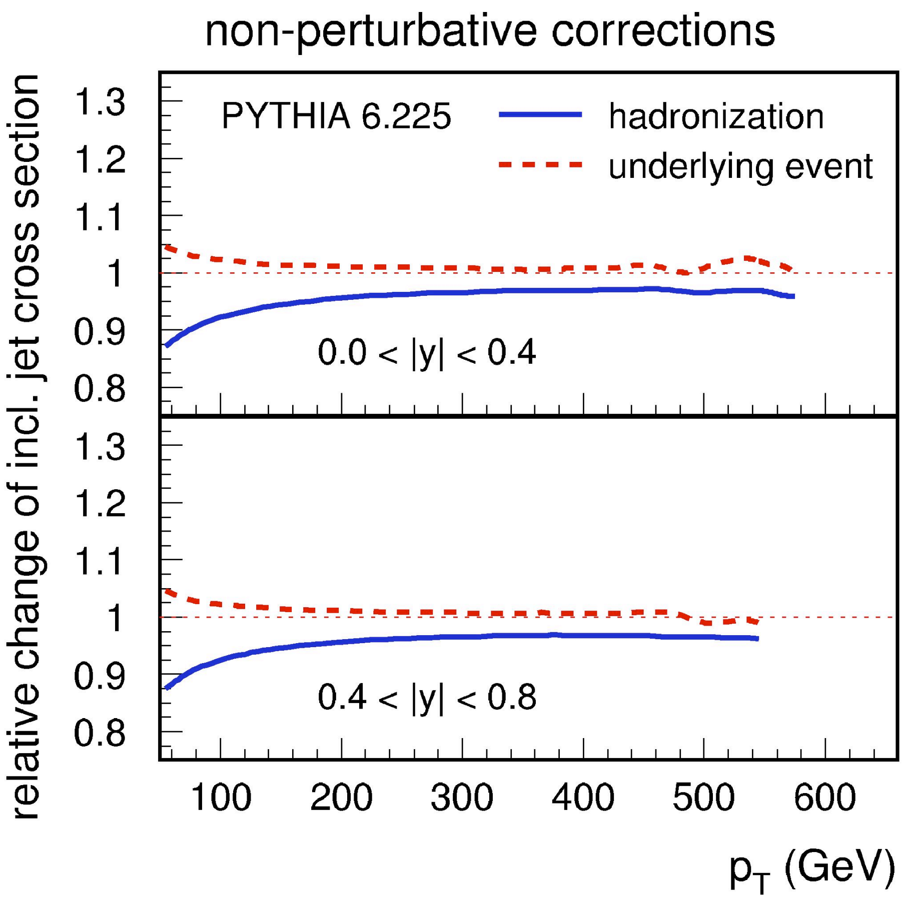
y_{bin} is the lower rapidity bin limit (0.0 or 0.4)



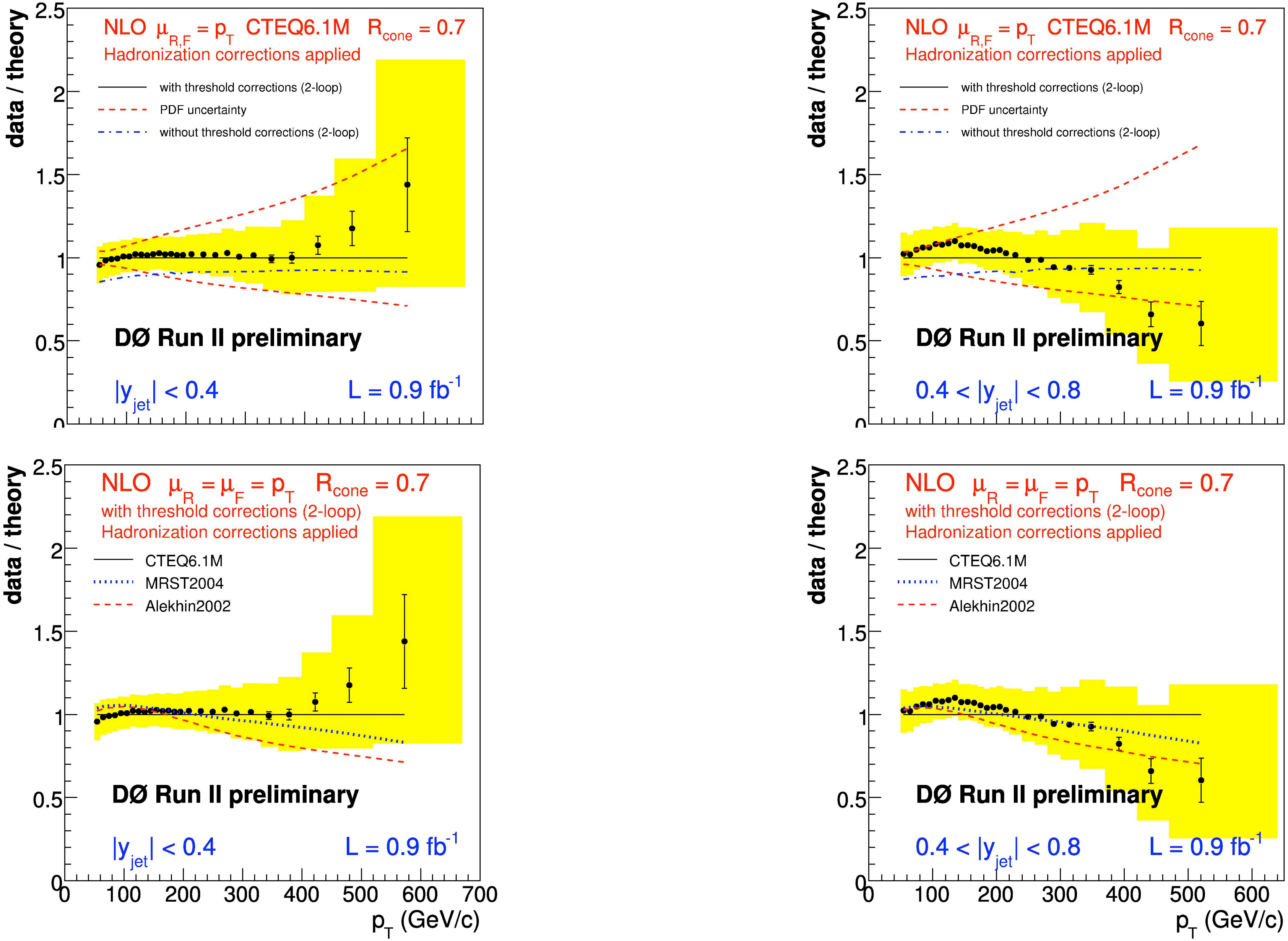


Hadronization corrections

- Data corrected for underlying event by jet energy scale
- Remove soft, non-perturbative contributions to jet production from MC:
  - hadronization corrections: ratio of jet cross section before/after hadronization
  - estimated using Pythia
- Repeating procedure with the Herwig generator gives compatible results



PDF sensitivity?



Scale variations