Inclusive high p_T jet cross section measurement at DØ

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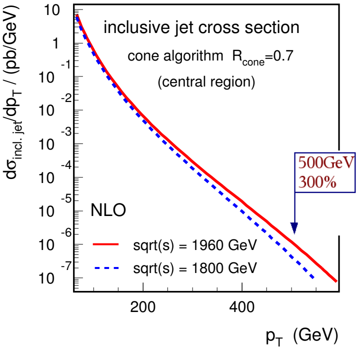
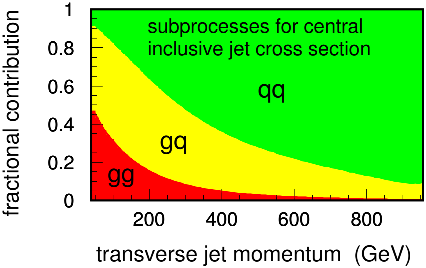
Outline

- Introduction: why measure the inclusive jet cross section?
- Tool: DØ Detector
- Basic idea: how to measure the inclusive jet cross section?
- Event selection and cuts
- Jet energy scale, unfolding data
- Preliminary results
- Systematic study and comparison with theory

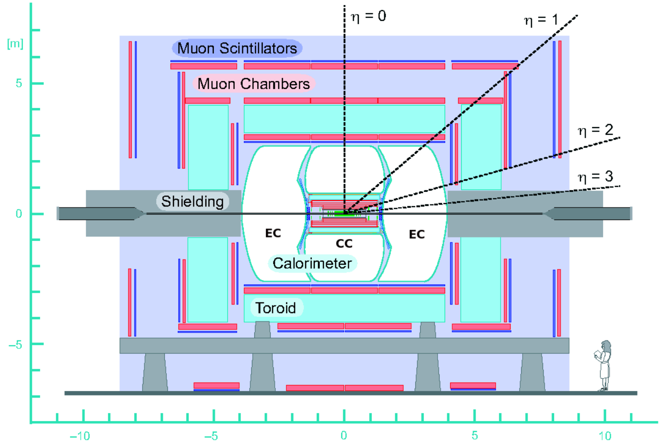
Introduction: why measure it?





- In theory, jet production can be explained by QCD
- Jets at DØ Run II: jet cone algorithm with radius of 0.7 in $y - \phi$ space
- Can explore subprocesses for jet production (above)
- Increased integrated luminosity will allow to test pQCD in unexplored energies
- Sensitive to parton density functions (PDFs), potential deviation may indicate new physics beyond SM
- To get the better constraint of fractions of subprocesses (right)

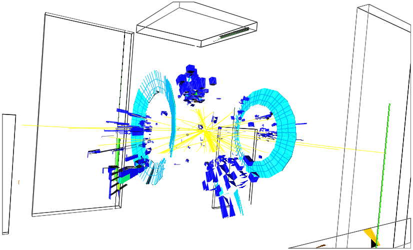
DØ Detector System

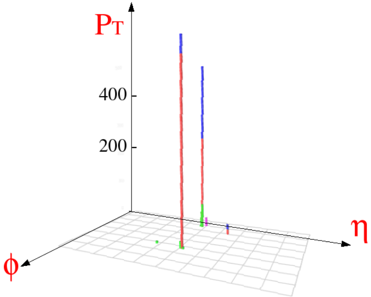


Cross section view of the DØ detector

- Components: central tracking, preshowers, calorimeters, muon system
- Calorimeter: central calorimeter (CC) and end caps (ECs)

Inclusive jet event with the highest p_T





	1st jet	2nd jet
p_T (GeV/c)	624	594
y_{jet}	0.14	-0.17
ϕ_{jet}	2.10	5.27
M_{jj} (TeV/c^2)	1.22	

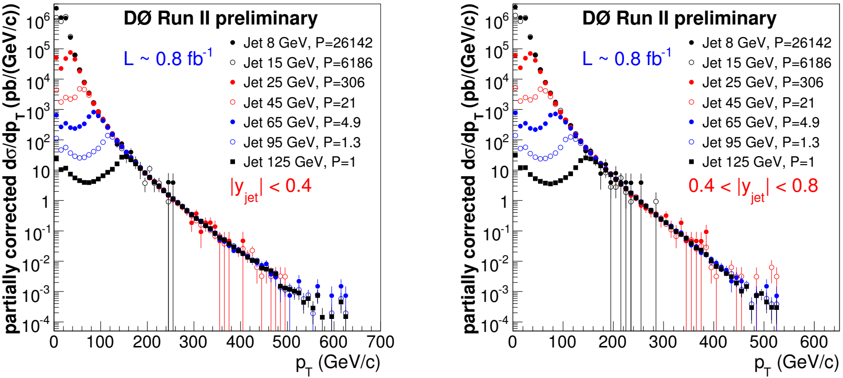
Basic idea: how to measure the inclusive jet cross section?

In each bin of $p_T - y$, the differential cross section:

$$\frac{d^2\sigma}{dp_T dy} = \frac{N_{jet}}{\Delta p_T \Delta y \cdot \epsilon \cdot \int \mathcal{L} dt}$$

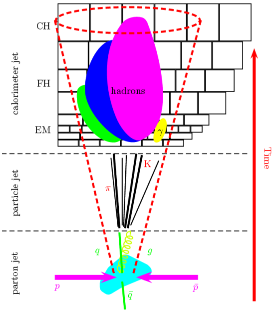
- N_{jet}: the number of jets observed in a bin
- $\Delta p_T \Delta y$: the $p_T - y$ bin size; in this analysis, two bins of jet rapidities are used: $|y_{jet}| < 0.4$ and $0.4 < |y_{jet}| < 0.8$; p_T is corrected for **jet energy scale (JES)** and **unfolded** due to finite p_T resolution
- ϵ: total overall efficiency for inclusive jets and event selection:
  $\epsilon = \epsilon_{trigger} \cdot \epsilon_{jetID} \cdot \epsilon_{vtx} \cdot \epsilon_{MET}$
- $\int \mathcal{L} dt$: integrated luminosity

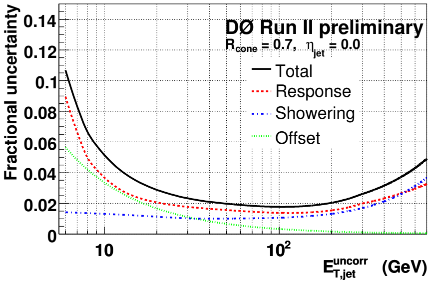
Data sample; event and objects selection



- Data sample:
  - Luminosity: $\sim$0.8 fb^{-1} taken between 2002 and 2005 (DØ Run II a)
- Selections: good jet selections, good quality primary vertex, cut on ratio of p_T to missing E_T, normalization condition

Jet energy scale (JES)





$$E_{jet}^{ptcl} = \frac{E_{jet}^{raw} - E_{offset}}{R_{jet} \cdot S}$$

- Offset correction: remove all energy not associated with the hard scatter
- Response scaling: scale jet energy to γ response
- Showering correction: for jet out-of-cone showering effects

Unfolding of measured inclusive jet p_T spectra (1)

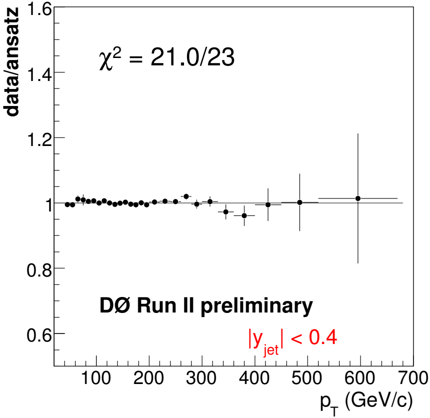
- Aim of unfolding: remove effect induced by the finite jet resolution on measured jet spectra

Cross section Ansatz function:

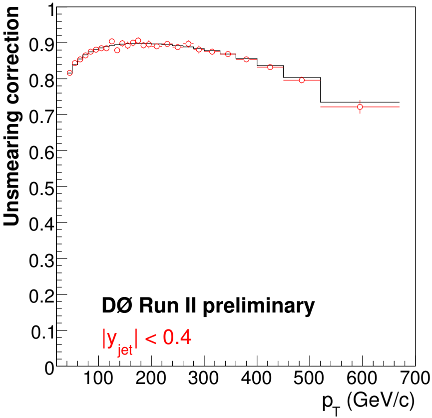
$$f(N,\alpha,\beta) = N(\frac{p_T}{p_{T0}})^{-\alpha}(1 - \frac{2\cosh(y_{min}p_T)}{\sqrt{s}})^{\beta}\exp(-\gamma\frac{p_T}{100})$$

- Unfolding methods:
  1. Fit the data by the function above smeared by the resolution obtained from data
  2. Smear particle MC jets (Pythia) with jet p_T and angular resolution to derive unfolding correction (for cross checking)

Unfolding of measured inclusive jet p_T spectra (2)

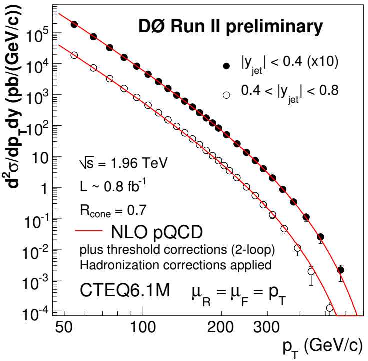


Relative difference between data and smeared ansatz function



Comparison of unfolding corrections between data (solid line) and MC (○)

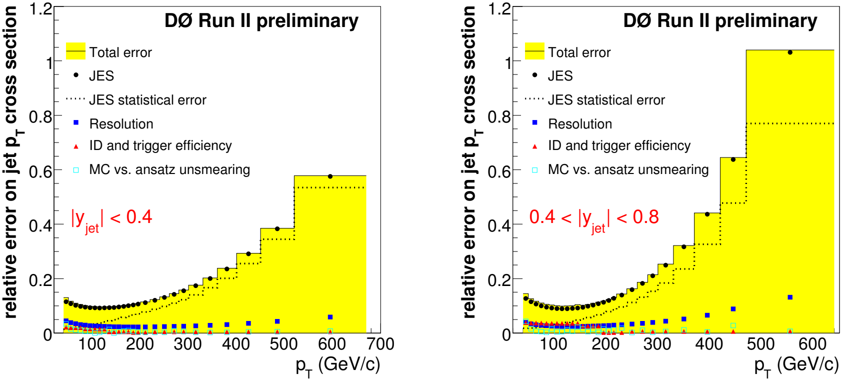
Preliminary results: measured cross section



- Theoretical predictions: NLO pQCD + threshold correction (2-loop)
- Also corrected for underlying events (by JES) and hadronization effect (by Pythia)
- Data scaled to theory at $p_T = 100$ GeV in the $|y| < 0.4$ bin to remove luminosity uncertainties

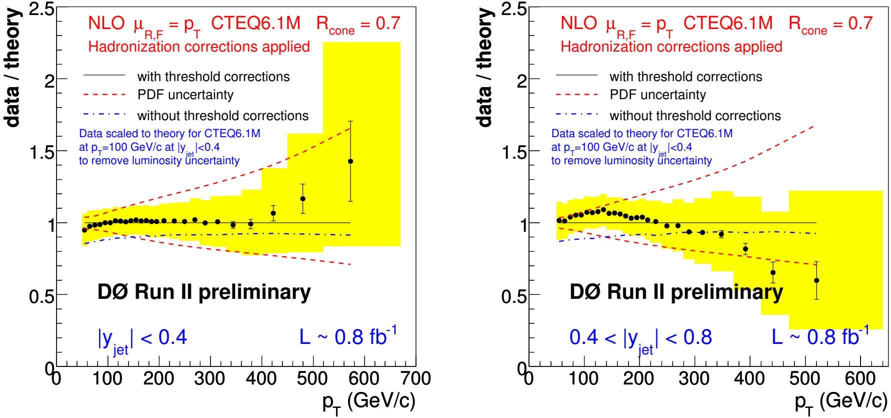
- Preliminary results (points) show good agreement with the predictions from NLO pQCD
- Inclusive jet cross section measurements in each rapidity region similar behavior

Systematics on cross section measurement



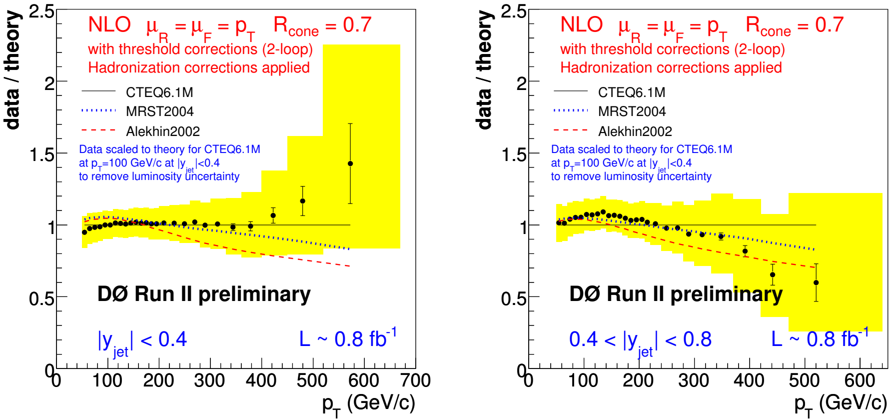
- Jet energy scale (•) (∼5% change in JES causes >50% change in inclusive jet cross section). The dominant contribution to the JES uncertainty is from statistics
- Jet p_T resolution (■); Trigger efficiency (▲); Unfolding uncertainty (□)
- Comparable precision to DØ Run I

Comparison with NLO pQCD



- Ratio of measured inclusive jet cross section to theory
- Systematic exp. uncertainty: shaded band
- Uncertainty from proton PDFs: dashed lines
- Reached required sensivity to constrain the PDFs

Comparison with NLO pQCD



- Ratio of measured inclusive jet cross section to theory
- Systematic exp. uncertainty: shaded band
- NLO predictions for MRST2004 and Alekhin2002 PDFs
- Sensitive to different PDFs used

Conclusion

- Preliminary inclusive jet cross section results were shown
- Results were compared with theoretical predictions
- Results are nearing the accuracy needed to constrain PDFs
- Significant improvements soon using an improved jet energy scale