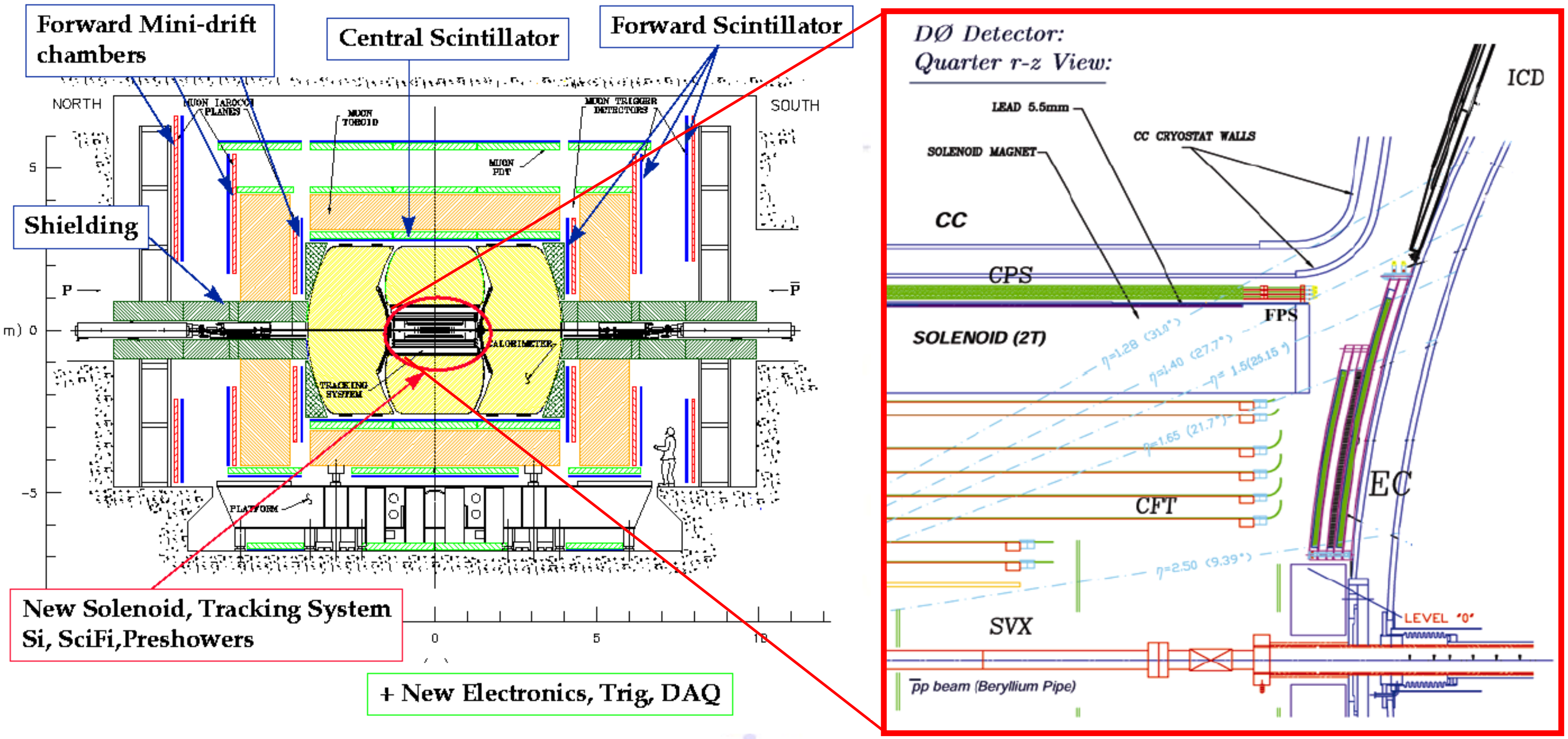
QCD Results from D0

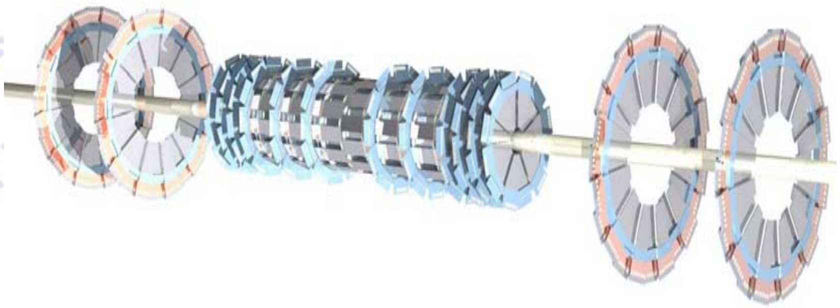
- Run II D0 Detector
- Run II Jet Physics
- Run II Jet Algorithms
- Jet Energy Scale and Resolution
- Inclusive Jet Cross Section
- Dijet Mass Cross Section
- Summary and Outlook

Run II D0 Detector



Run II D0 Detector

- New magnetic inner tracking system
  - 2T superconducting solenoid
  - 800k channel silicon strip detector
  - scintillating fiber tracker
  - preshower detectors
- Faster calorimeter readout electronics for shorter bunch spacings
- Upgraded muon system
  - new forward muon detectors
  - additional scintillation counters in central
  - Increased shielding
- Forward proton detector
- New trigger & DAQ system
  - 10 kHz accept rate at L1
  - 1 kHz accept rate at L2
  - 50 Hz accept rate at L3



Run II Jet Physics

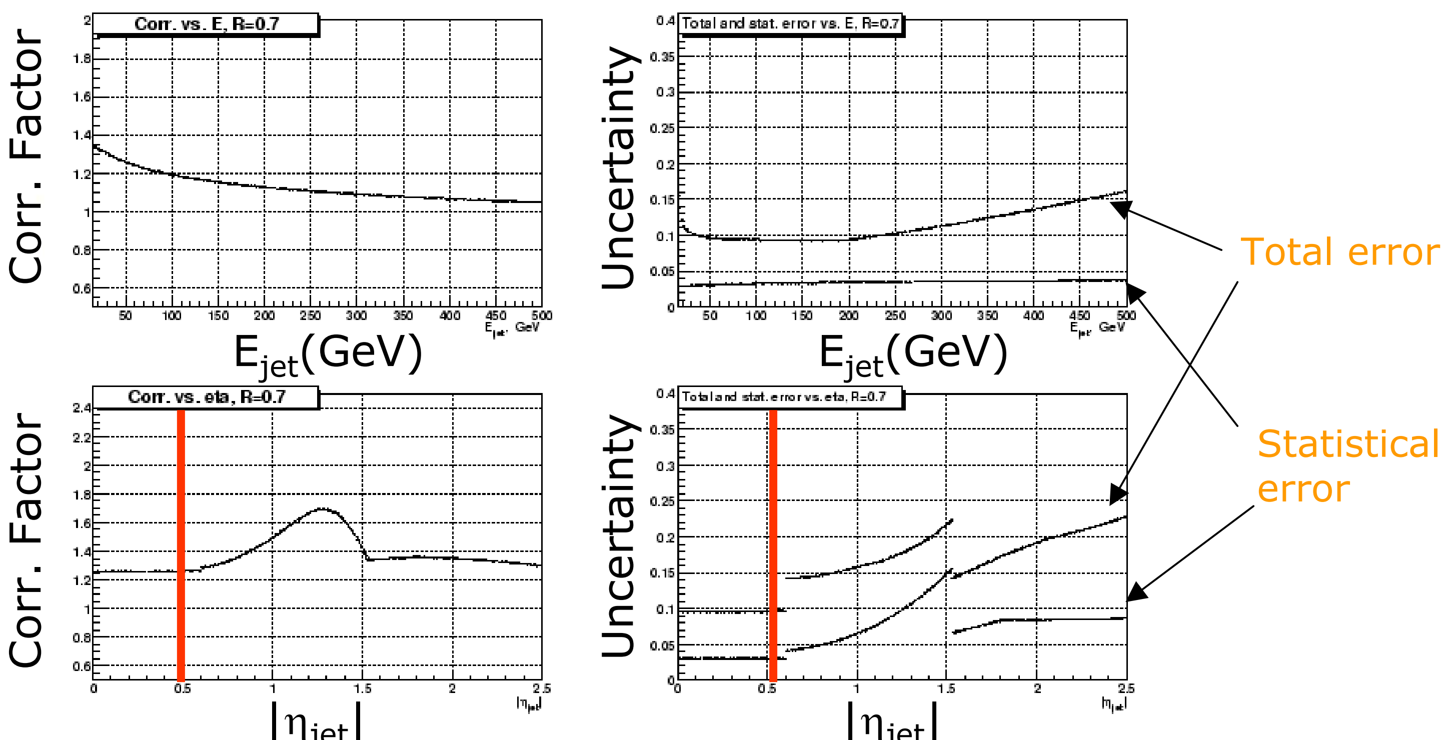
- Tevatron energy increased from 1.8 TeV to 1.96 TeV
  - Inclusive jet cross section increases by 20% at p_T=100GeV and by 100% at p_T=500GeV
- Tevatron will collect 4-8 fb^{-1} of data by 2009
  - Extend jet measurements to higher jet energies
    - Proton structure at large x (~0.5)
      - Also there will be improved PDF measurements with W asymmetry and Drell-Yan.
    - Searches for new physics
- Tevatron experiments will use Run II jet algorithms
  - Better comparison with higher order theoretical calculations

Run II Jet Algorithms

- Agreed at the Workshop on "QCD and Weak Boson Physics in Run II, 1999"
- Cone Jet Algorithms (Improved Legacy Cone Algorithm)
  - $R_{cone} = 0.7$ in $\eta \times \phi$
  - Recombination in E-scheme
    - 4-vector sum with true p_T and massive jets
  - Seeds + midpoints
    - Approximate seedless algorithm
    - Infrared and collinear safe
    - Split/merge jets with >50% overlap
- k_T Jet Algorithms

Jet Energy Scale

- Jet Energy Scale
  - From the back-to-back γ+jet events
  - Current analyses are for $|\eta|<0.5$
  - Results for $|\eta|>0.5$ later

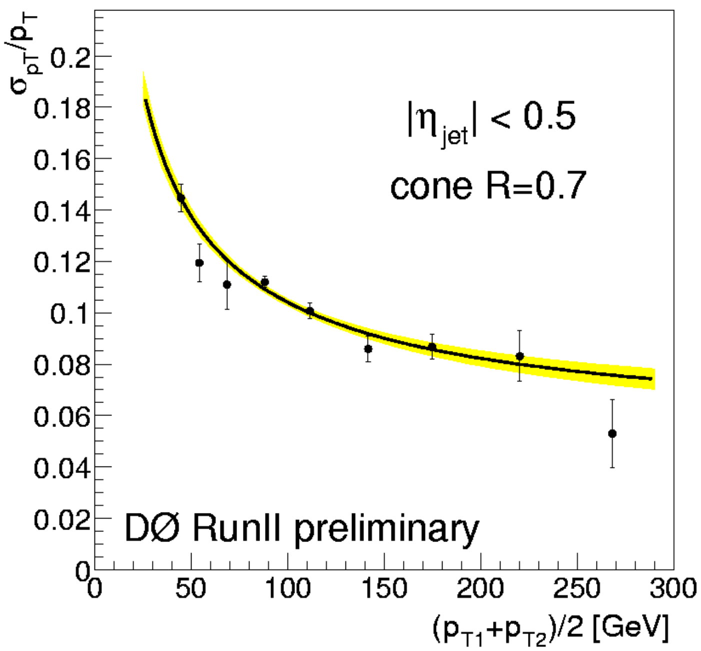


Jet p_T Resolution

- Jet p_T Resolution
  - From the pT imbalance in the back-to-back dijets

$$\mathcal{A} = \frac{p_T^{jet1} - p_T^{jet2}}{p_T^{jet1} + p_T^{jet2}}$$

$$\frac{\sigma_{p_T}}{p_T} = \sqrt{2} \cdot \sigma_{\mathcal{A}} = \sqrt{\frac{N^2}{p_T^2} + \frac{S^2}{p_T} + C^2}$$



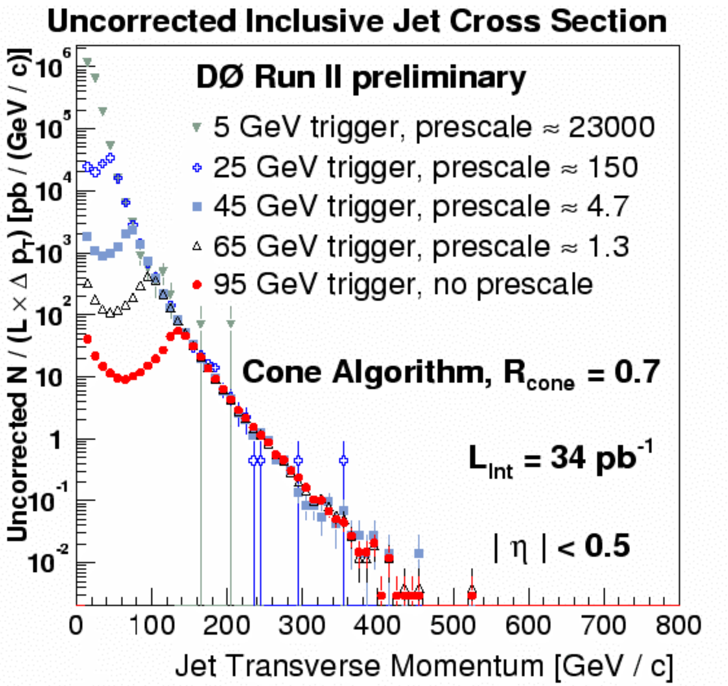
Inclusive Jet Cross Section

- Test of QCD at the highest energy
- Probe the gluon distribution at large x

Triggers

- Jet Triggers
  - Level 1
    - Hardware trigger with $\Delta\phi x \Delta\eta = 0.2x0.2$ towers
    - Fast calorimeter readout
    - Coverage $|\eta|<2.4$
    - Ability to prescale the trigger
  - Level 2
    - Software trigger running on special processor
    - 3x3 or 5x5 trigger towers
  - Level 3
    - Software trigger

- Reconstruction code optimized for speed using precision readout
- No split and merge



Data Sample

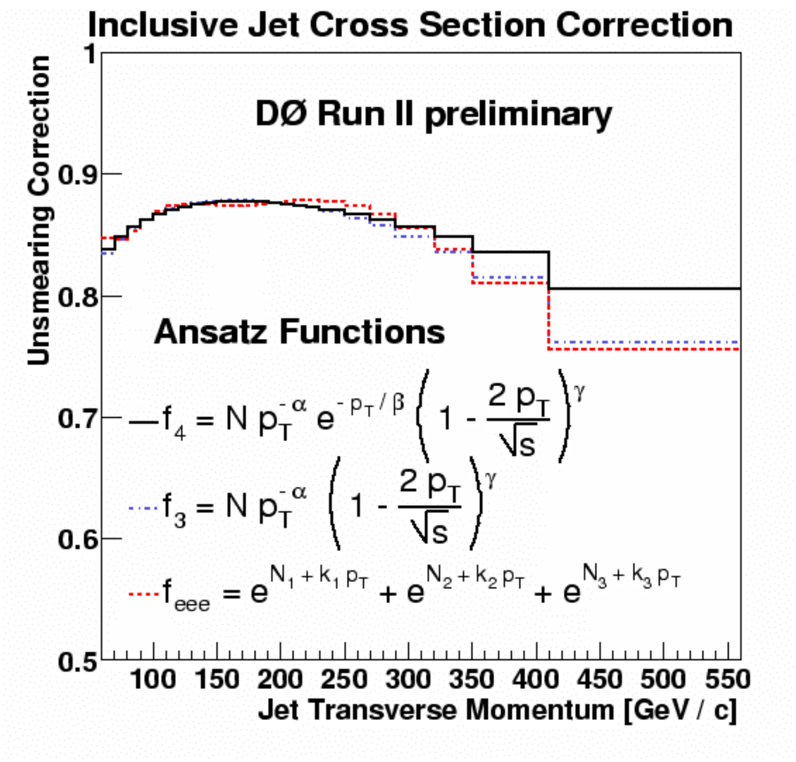
- Run Selection
  - Reject runs with
    - Not enough events
    - Problems in tracking detectors
    - Noisy calorimeter
    - Hot cells in calorimeter
- L3 Trigger requirement
  - Simple cone jet at L3
    - p_T calculated assuming $z_{vtx}=0$.
  - Offline p_T cut to ensure trigger is 100% efficient

trigger	p_T(GeV/c)
25 GeV trig	60 – 100
45 GeV trig	100 – 140
65 GeV trig	140 – 180
95 GeV trig	> 180

- Vertex requirement
  - N_{tracks} for vertex $\geq$ 5
  - $|z_{vtx}|<50$ cm
- Missing Energy requirement
  - MET < $0.7*p_T^{max}$
- Jet Selection
  - γ/e rejection
  - Fake jets due to noises and hot cells removed

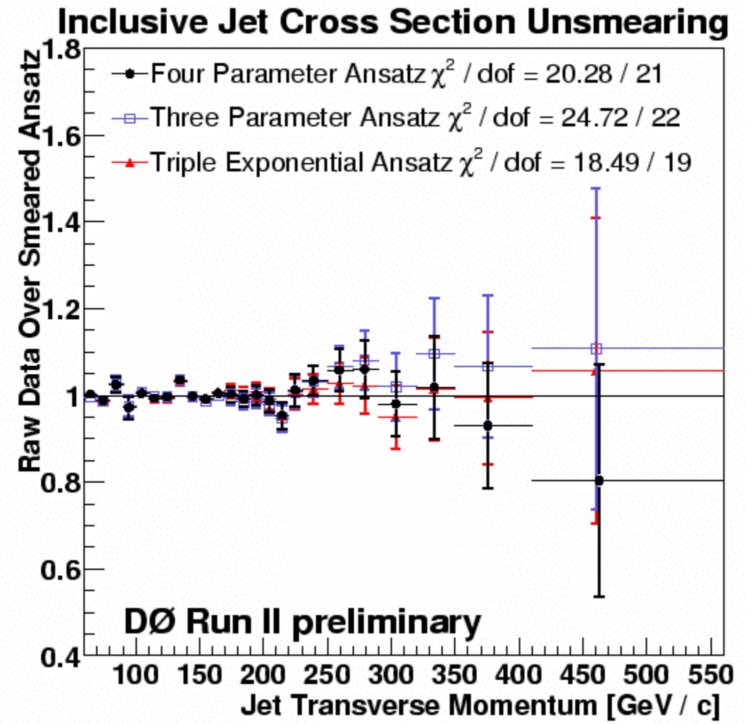
Unsmearing

- In order to compare the experimental data and theoretical predictions, the detector resolution has to be taken into account.
- Method
  - Assume that the correct inclusive jet cross section can be described by an analytic function (ansatz funciton) f_n.
  - The ansatz functions are smeared according to the jet p_T resolution.



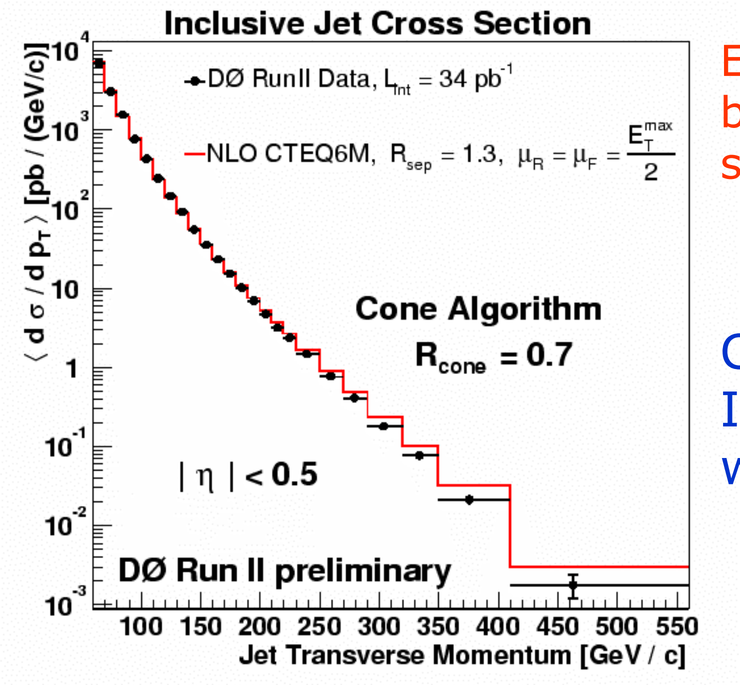
Unsmearing

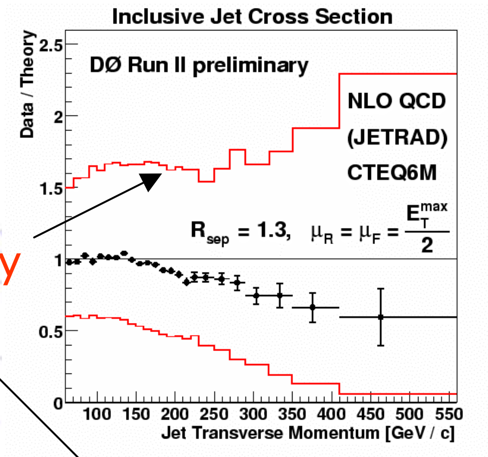
- The smeared functions are fitted to the data distribution.
- The ratio of the unsmeared and the smeared ansatz funtions gives the correction factors.



Inclusive Jet Cross Section

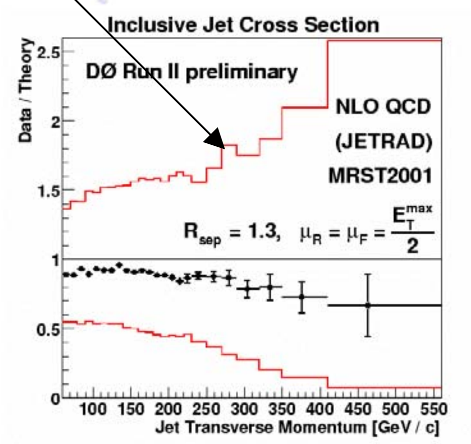
$$\langle \frac{d\sigma}{dp_T} \rangle = \frac{N_{evt}}{\mathcal{L} \times \Delta p_T^{bin}} \cdot \prod_i \frac{1}{\epsilon_{eff,i}} \times C_{unsmear}$$





Error dominated by current energy scale error

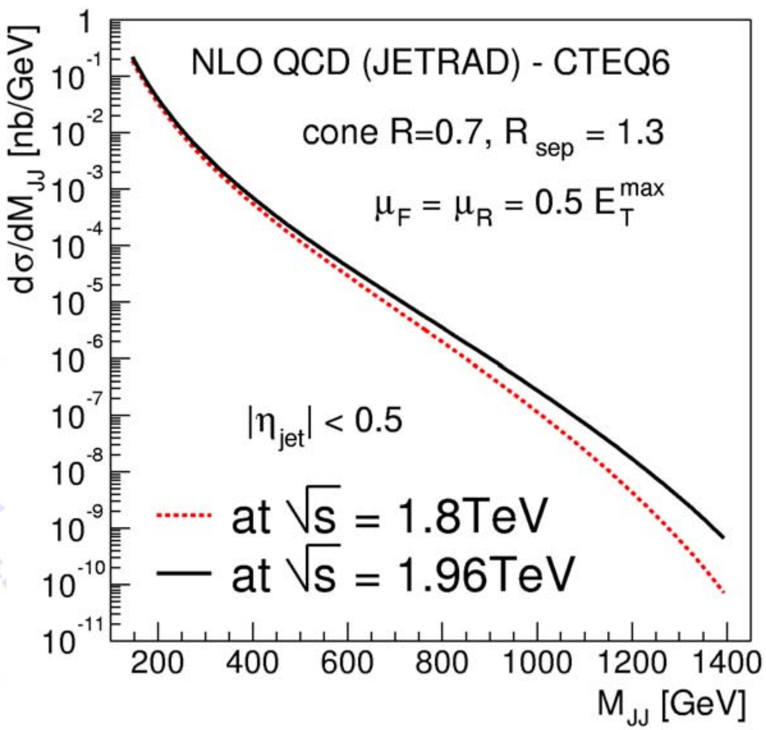
Current result Is consistent with both PDFs.



Agreement in 7 order of magnitudes!

Dijet Mass Cross Section

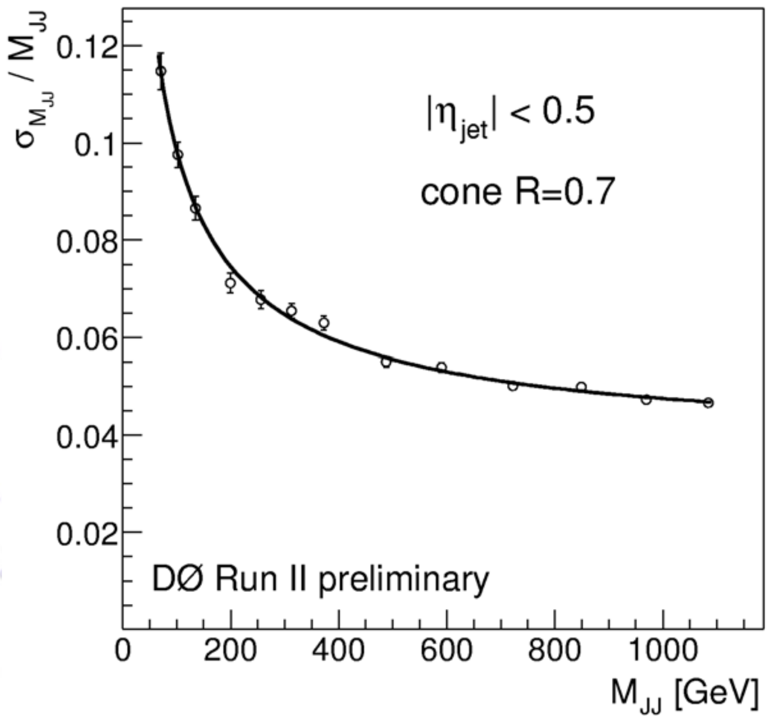
- Probe the proton structure at large x
- Searches for new physics (quark compositeness, excited quarks, Z', W', and other exotic particles)



Dijet Mass Resolution

- PYTHIA dijet events smeared using the measured jet pT resolution.
- The original mass compared to the smeared mass.

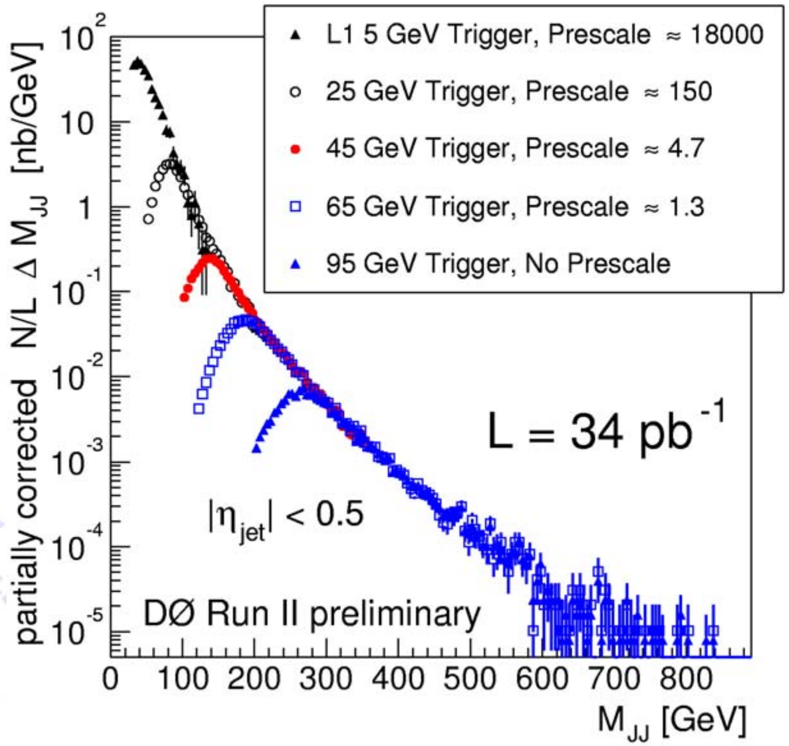
$$\frac{\sigma_{M_{jj}}}{M_{jj}} = \sqrt{\frac{N^2}{M_{jj}^2} + \frac{S^2}{M_{jj}} + C^2}$$



Data Sample

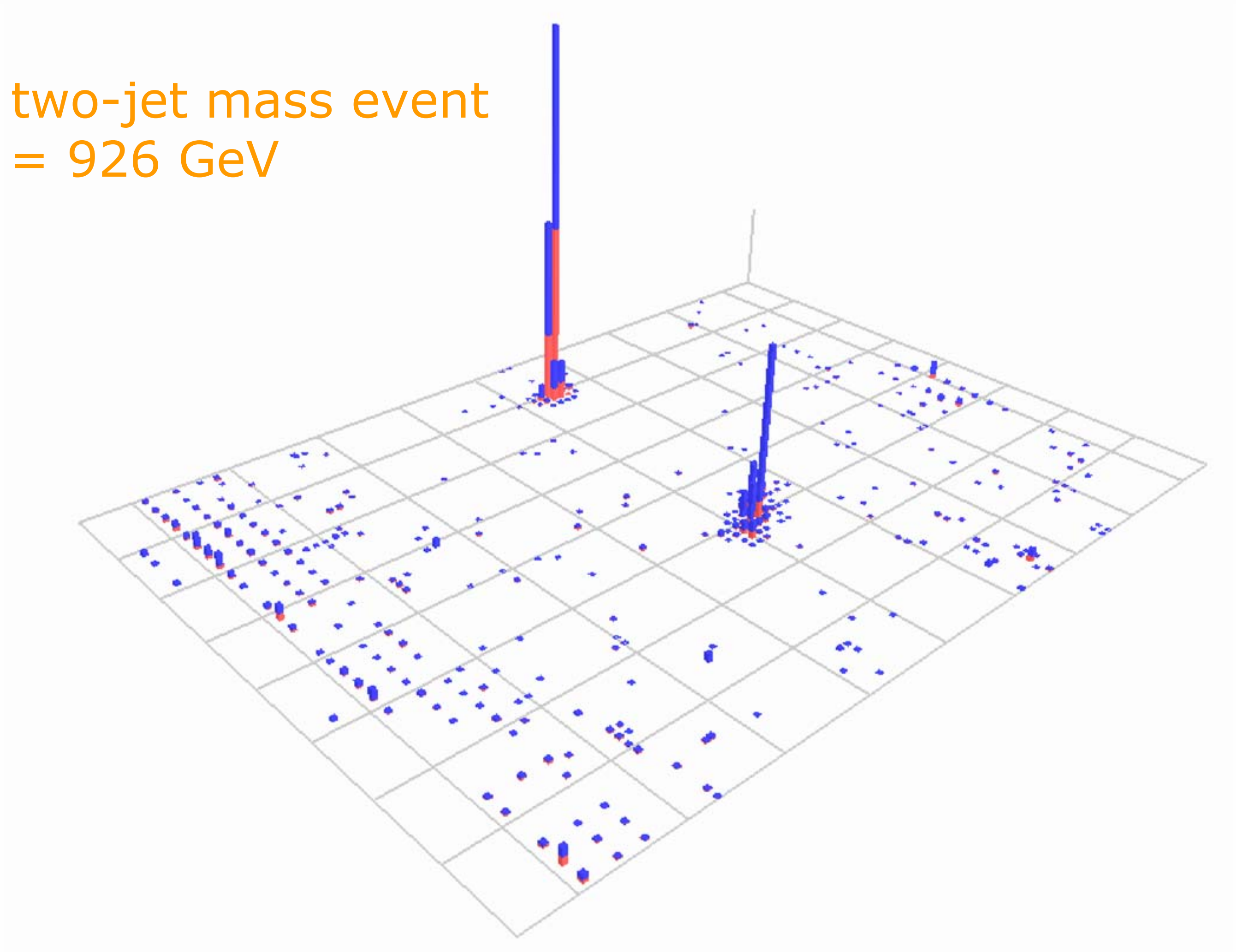
- The same data sample as the inclusive jet cross section.
- Dijet mass requirements for triggers to be 100% efficient.

trigger	M_{jj}(GeV)
25 GeV Trig	150 - 180
45 GeV Trig	180 – 300
65 GeV Trig	300 – 390
95 GeV Trig	390 - 1400



Event Display

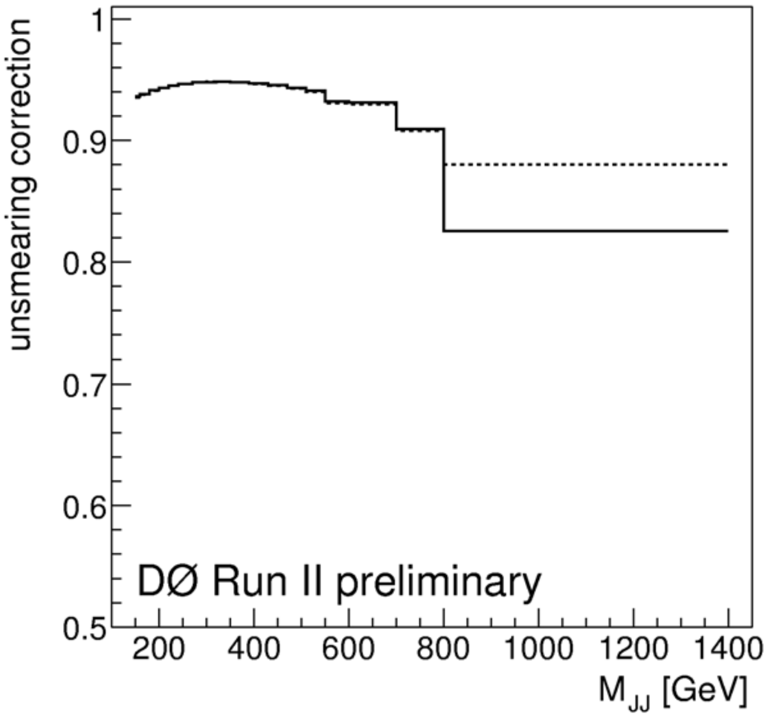
Highest two-jet mass event with M_{jj} = 926 GeV



Unsmearing

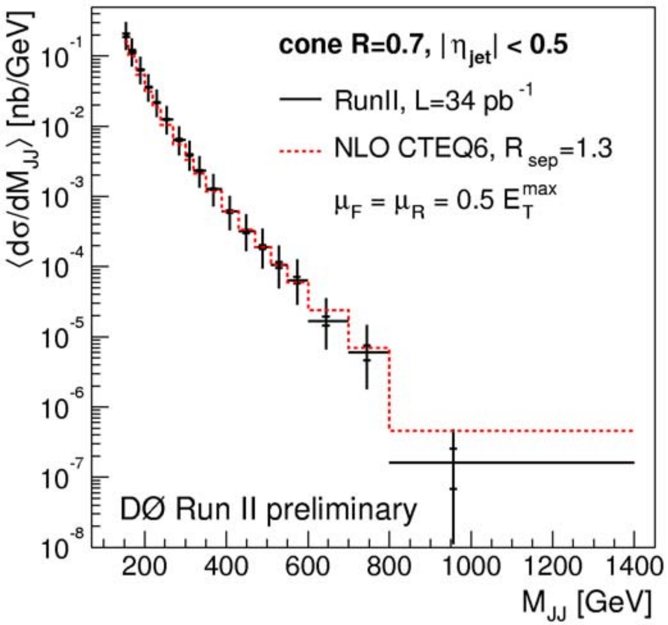
- The same method as in the inclusive jet cross section
- The ansatz function:

$$f(M_{JJ}|N,\alpha,\beta) = N M_{JJ}^{-\alpha}(1 - \frac{M_{JJ}}{\sqrt{s}})^{\beta}$$

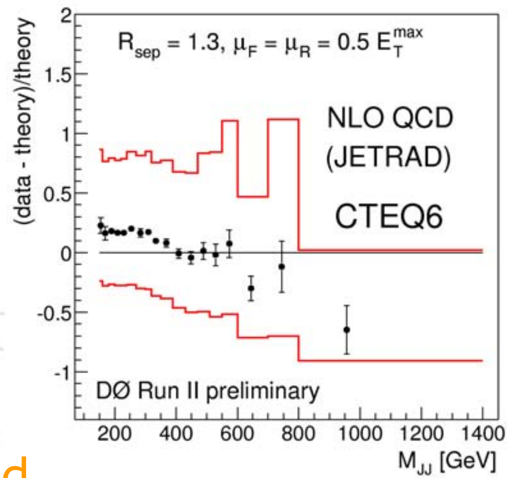


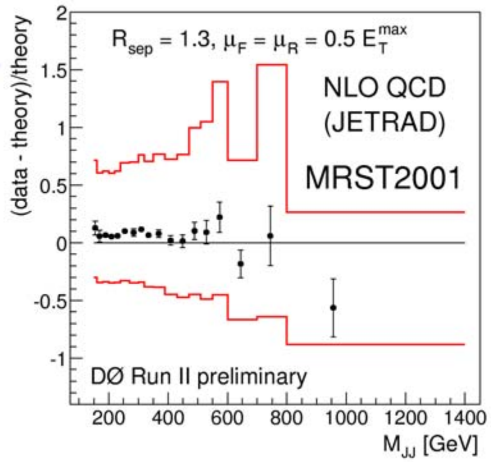
Dijet Mass Cross Section

$$\langle\frac{d\sigma}{dM_{jj}}\rangle = \frac{N_{evt}}{\mathcal{L}\times\Delta M_{jj}}\cdot\prod_i\frac{1}{\epsilon_{eff,i}}\times C_{unsmear}$$



Good agreement
Between data and
QCD predictions





Summary and Outlook

- Preliminary results on the inclusive jet p_T cross section and the dijet mass cross section are presented for $|\eta|<0.5$.
- Analyses with the increased data sample ($>120pb^{-1}$) will be presented in the winter conferences.
  - η coverage will extend to 2.4.
  - The highest M_{jj} will reach ~1.3 TeV.
- Some of other planned analyses
  - Inclusive cross section ratio in η:
    - tests of QCD with less systematic uncertainties.
  - Cross section measurements with k_T algorithm.
  - Three jet cross section