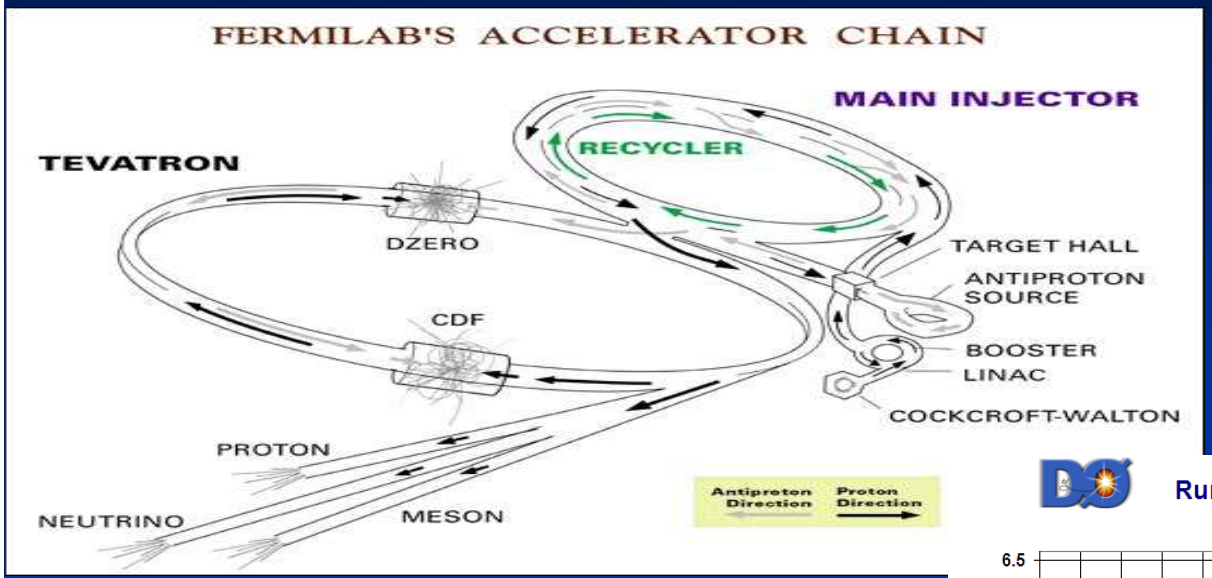
Measurement of the Differential Dijet Mass Cross Section at the Tevatron

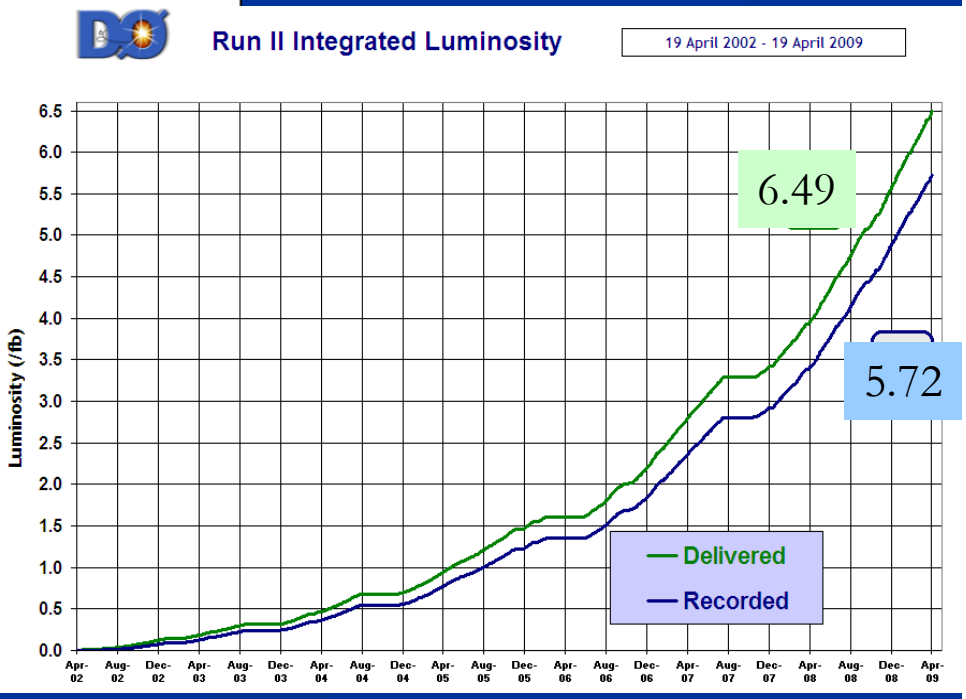
Mandy Rominsky
University of Oklahoma

On Behalf of the DZero Collaboration

Tevatron

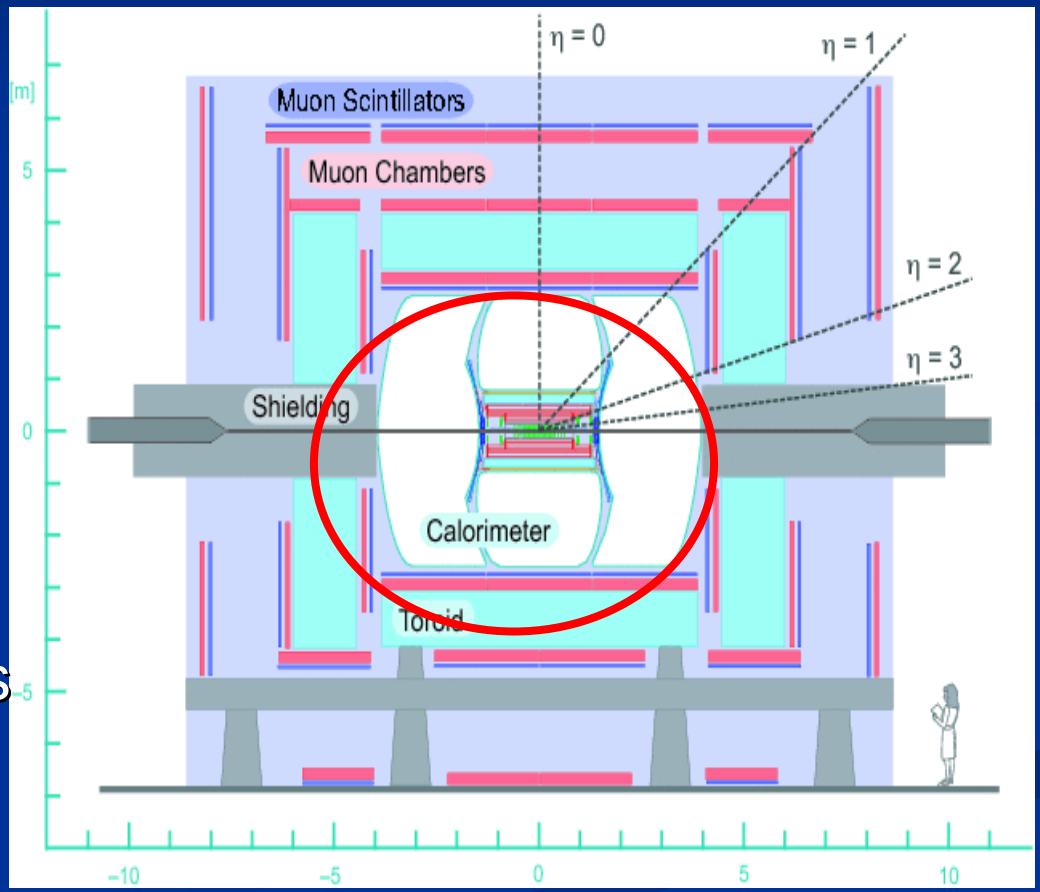


- DZero has ~5 fb^{-1} on tape
- ~ 2 fb^{-1} recorded in 2008 alone
- Current data-taking efficiency ~ 90%



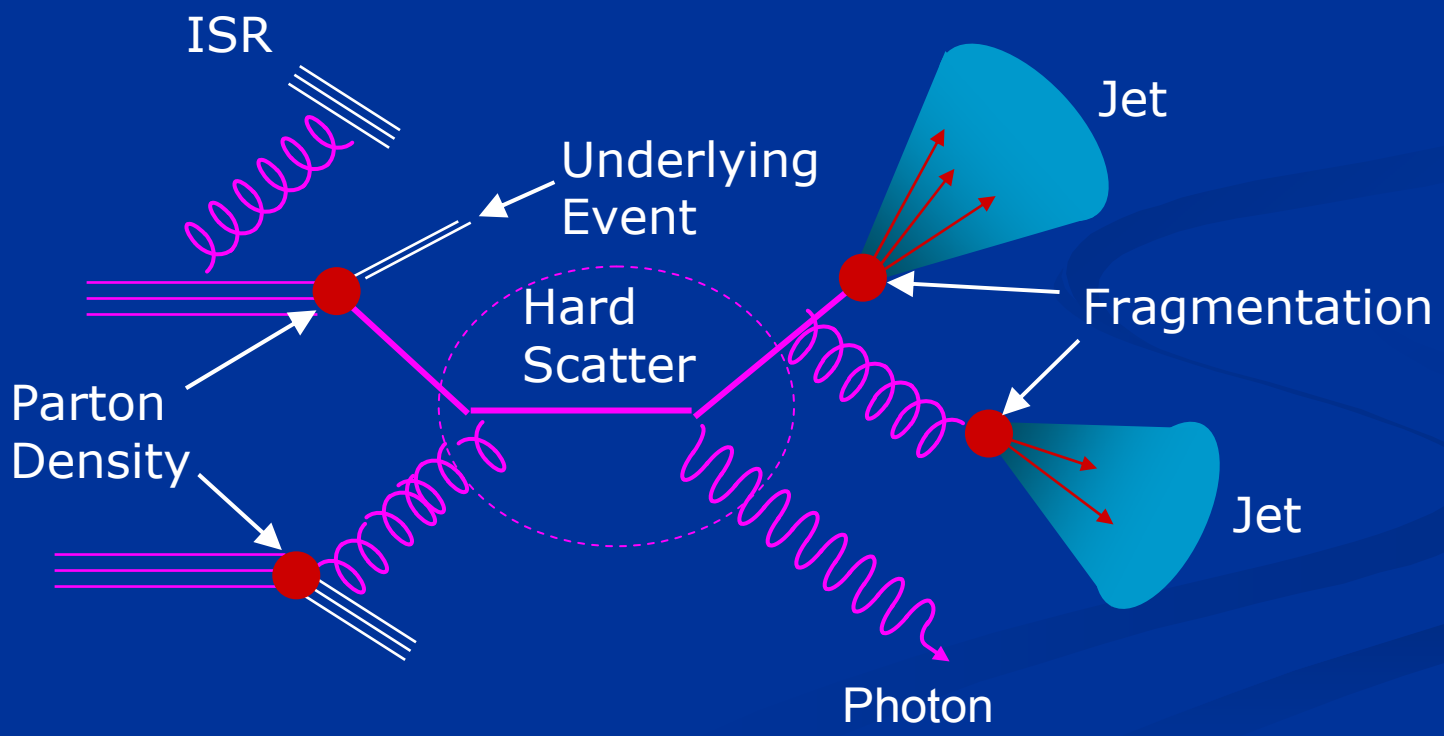
DZero Experiment

- Multipurpose detector
  - Silicon microstrip and scintillating fiber tracker
  - 2 T superconducting solenoid magnet
  - Liquid argon-uranium calorimeter (electromagnetic and hadronic)
  - Muon detectors
- Calorimeter most important for this analysis
  - Full coverage: $|\eta| < 4.2$ ($\theta \approx 2^{o}$), λ_{int} ~7.2 (total)
  - Finely segmented



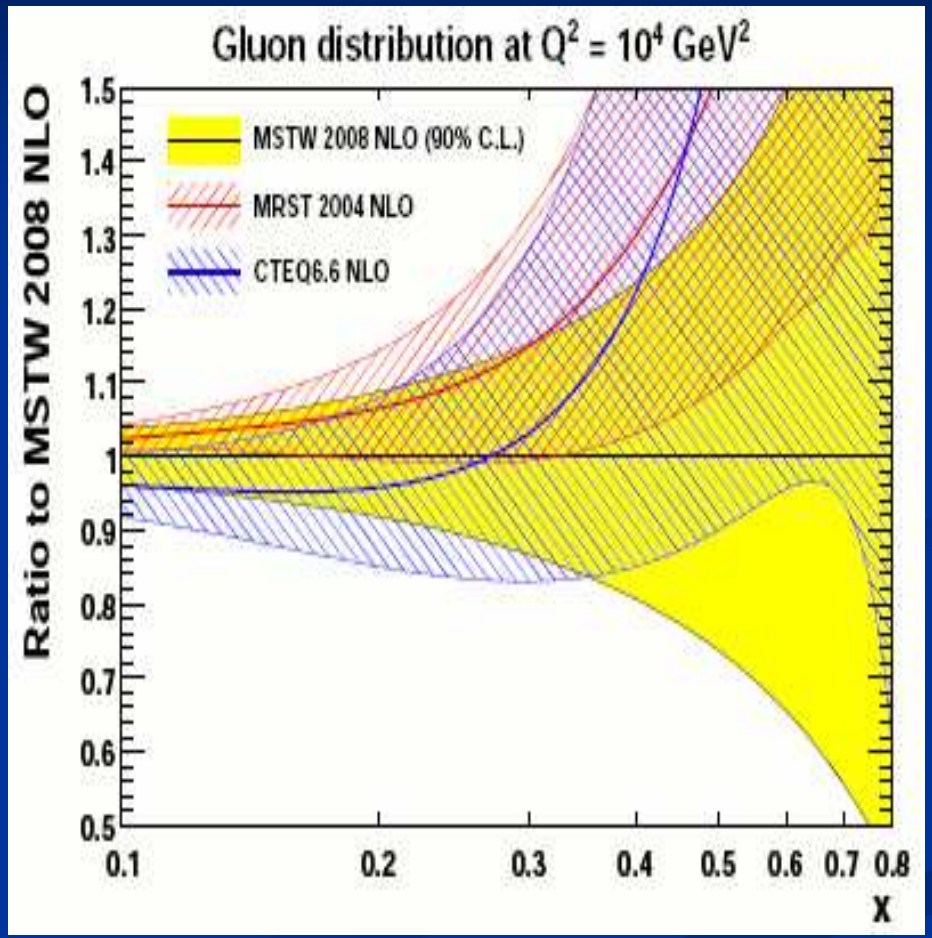
Dijet Mass Measurement

- Jets of particles formed from hard scattering of hadrons
- Jets were reconstructed with D0 Run II cone algorithm
- Use the standard invariant mass formula ($M^2 = E^2 - p^2$)



Motivation

- Measuring jets has many benefits
  - Study parton distribution functions (PDFs), especially high x gluon
  - Look for new physics that decays to 2 jets



Data/ Event Selection

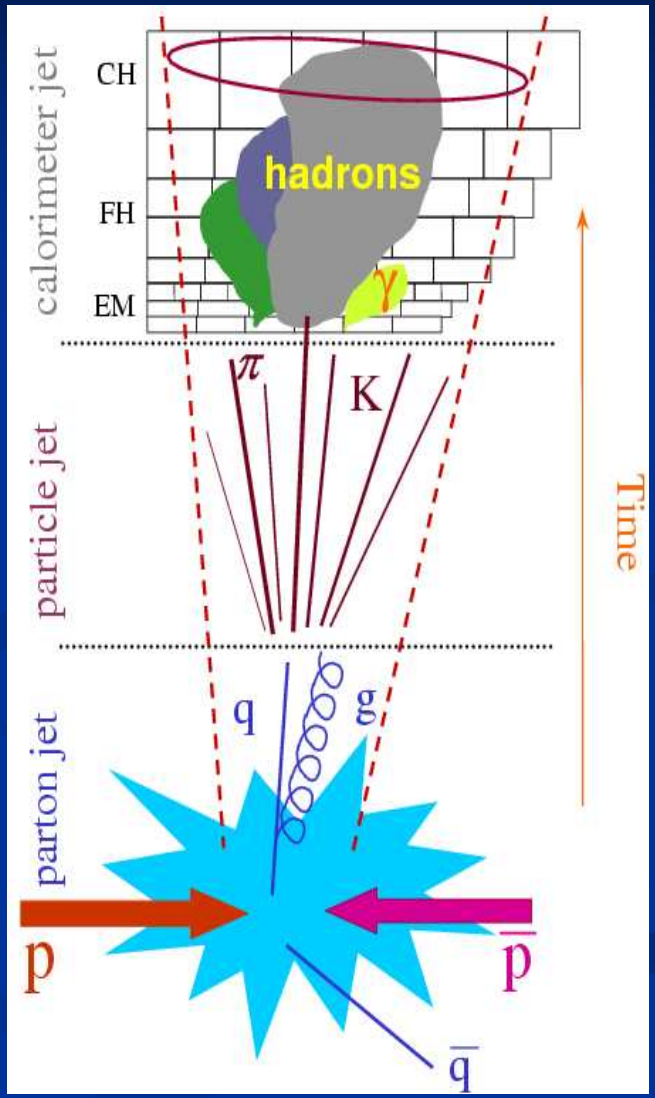
- L = 0.7 fb^{-1}
  - Well understood data set with a small jet energy correction uncertainty
- Events must have 2 or more jets that pass event and jet quality cuts
- Bin according to most forward jet
  - Central: $|y| < 0.4$ and $0.4 < |y|_{max} < 0.8$
  - ICR: $0.8 < |y|_{max} < 1.2$ and $1.2 < |y|_{max} < 1.6$
  - EC: $1.6 < |y|_{max} < 2.0$ and $2.0 < |y|_{max} < 2.4$
- Both jets must have a $p_T > 40$ GeV

Jet Energy Scale

- Jet Energy Scale returns the measured calorimeter jet energy to the particle level

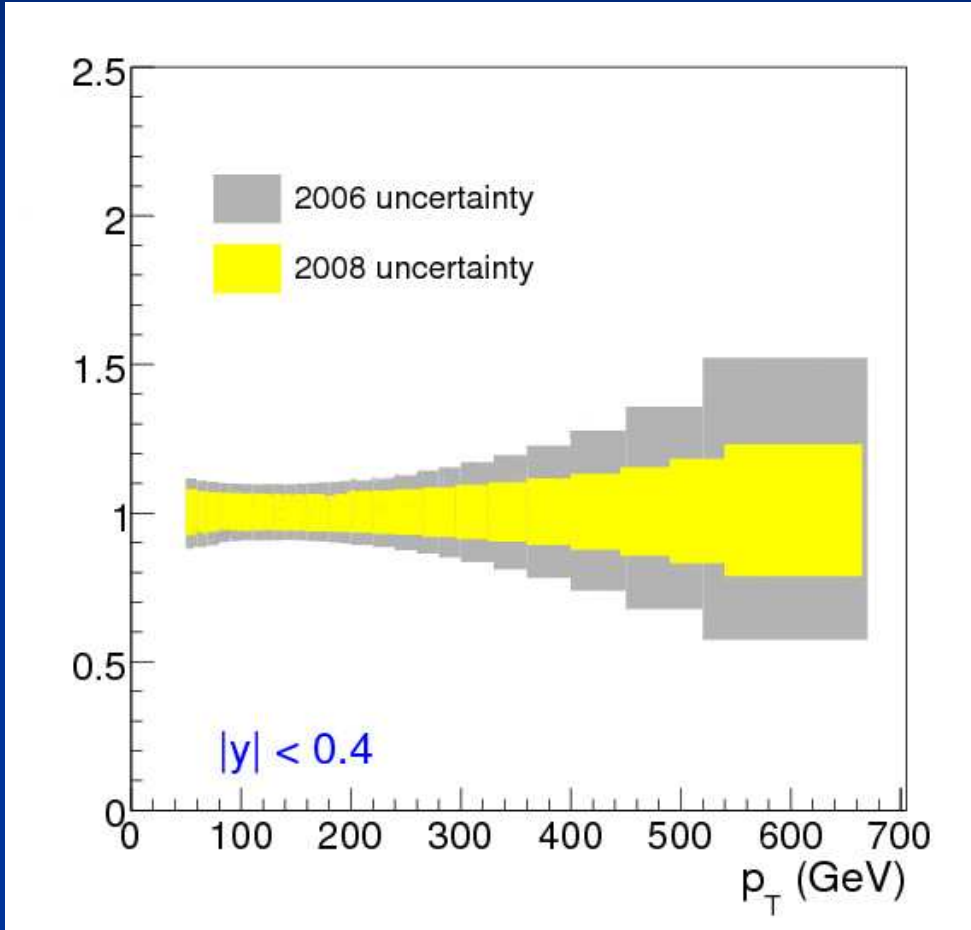
  $E_{ptcl} = (E_{cal} - \textit{Offset})/ R*S$

- *Offset* : Energy from noise + pile-up + multiple interactions
- Response (R): Conversion of calorimeter readout to energy
- Showering (S): Correction for in and out of cone showering



Jet Energy Scale

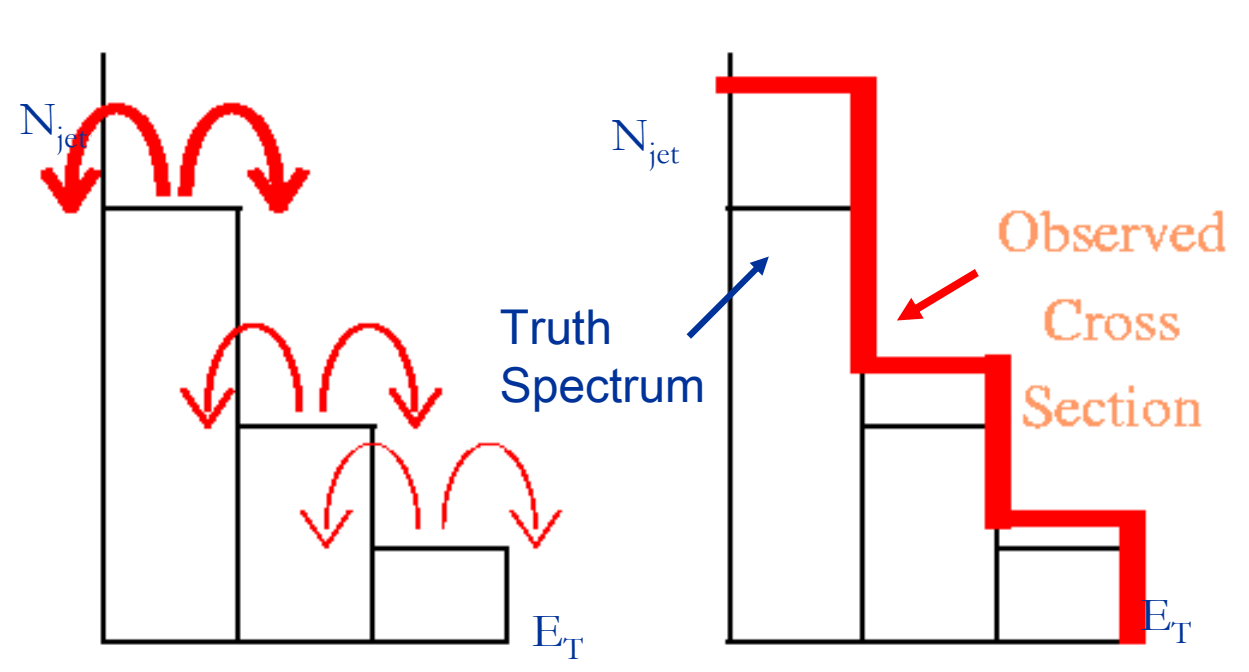
- JES improved by a factor of two at medium p_T compared to early Run II
  - Correction to include quark/gluon jet differences
- 7 years of dedicated work by many in collaboration to get the uncertainties this small



Unsmearing

This analysis uses a parameterized MC simulation to unsmear the steeply falling spectrum

Includes a correction for difference between true and reconstructed masses and then the MC is reweighted to Data



Unsmearing includes:

-p_T resolutions

-η/φ resolutions

-Misvertexing

-Jet ID efficiency

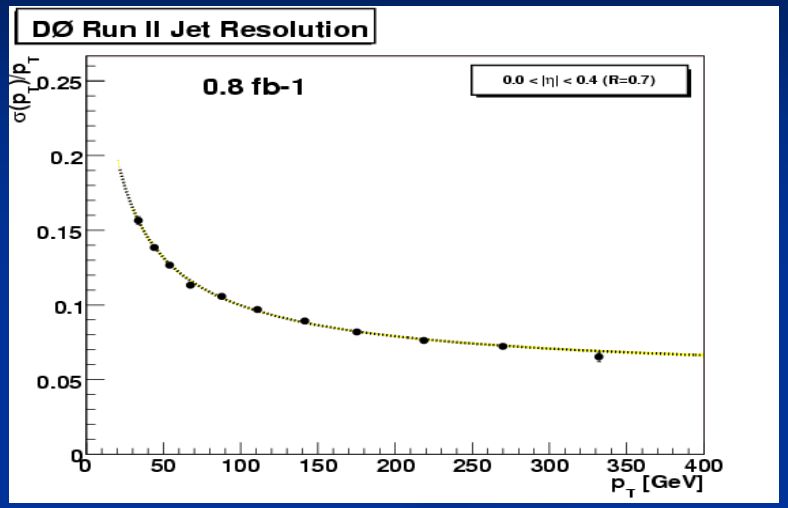
-Muon/neutrino energies

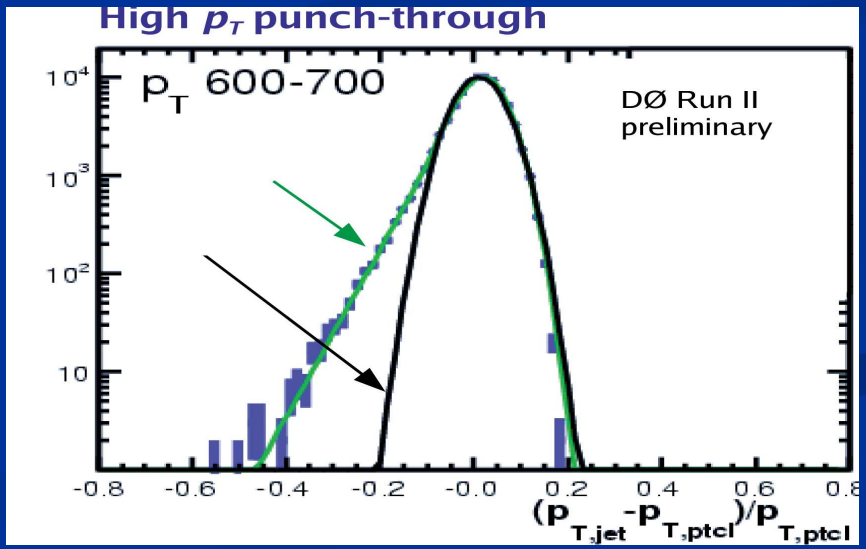
p_T Resolutions

- Measured directly from data
- Used dijet asymmetry variable with corrections from soft radiation (third jet below p_T threshold) and particle imbalance

$$A = \frac{| p_{T,1} - p_{T,2} |}{p_{T,1} + p_{T,2}}$$

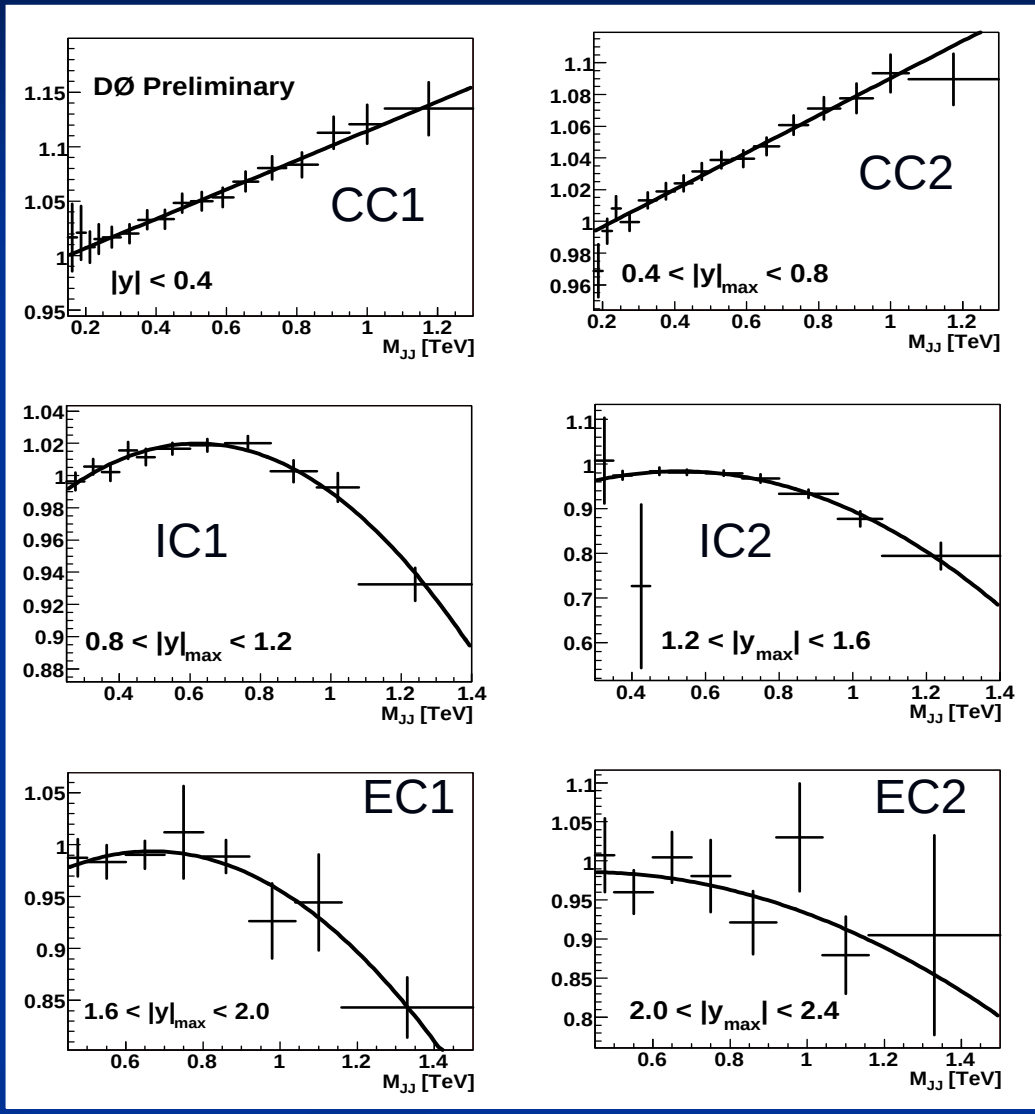
$$\frac{\sigma(p_T)}{p_T} = \sqrt{2}\,A$$



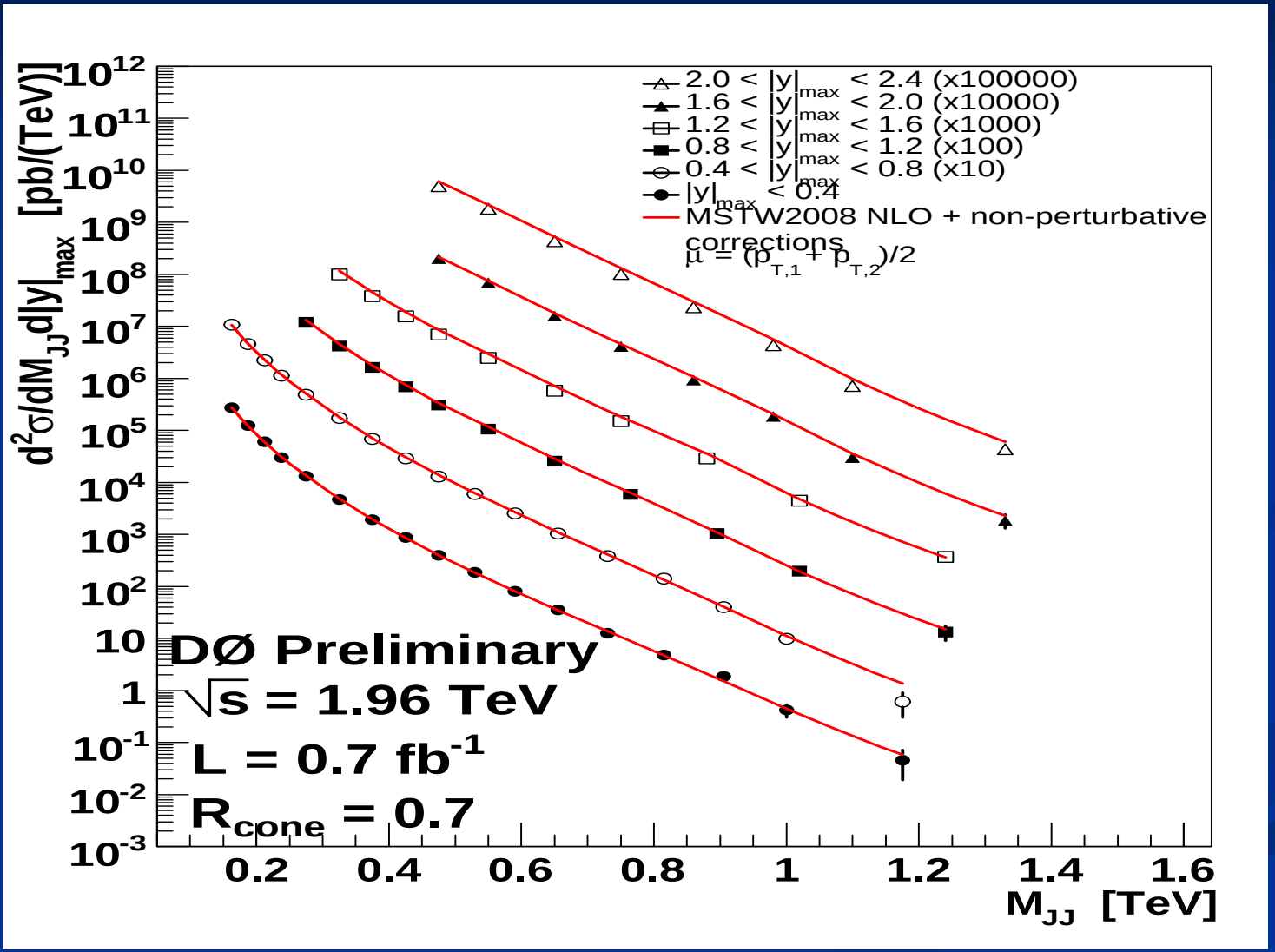


Total Unsmearing

- Total unsmearing factors in each region:
  - Central: 1-13%
  - ICR: 1-8%, 5-20%
  - EC: 1-15%
- Unsmearing is dominated by p_T resolutions

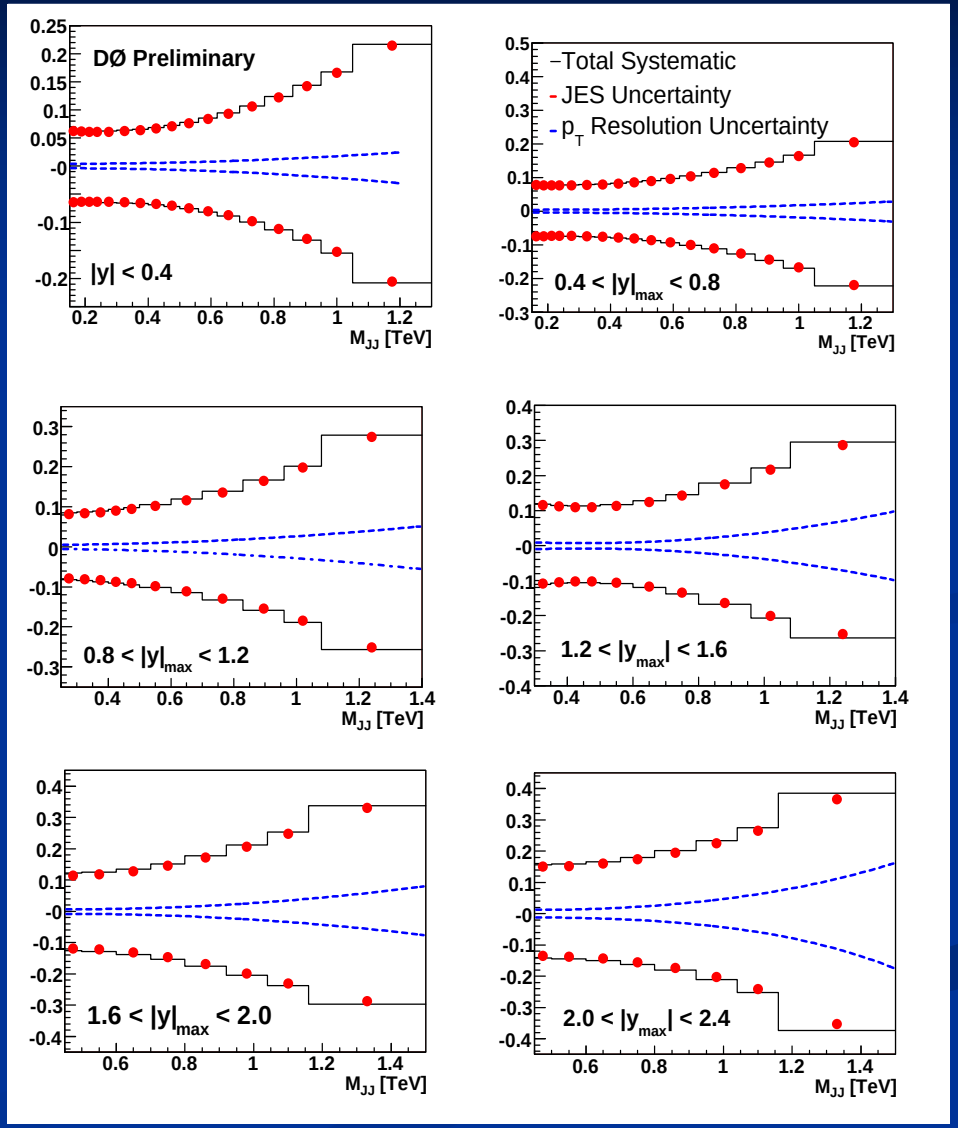


Results – Unsmeared Data

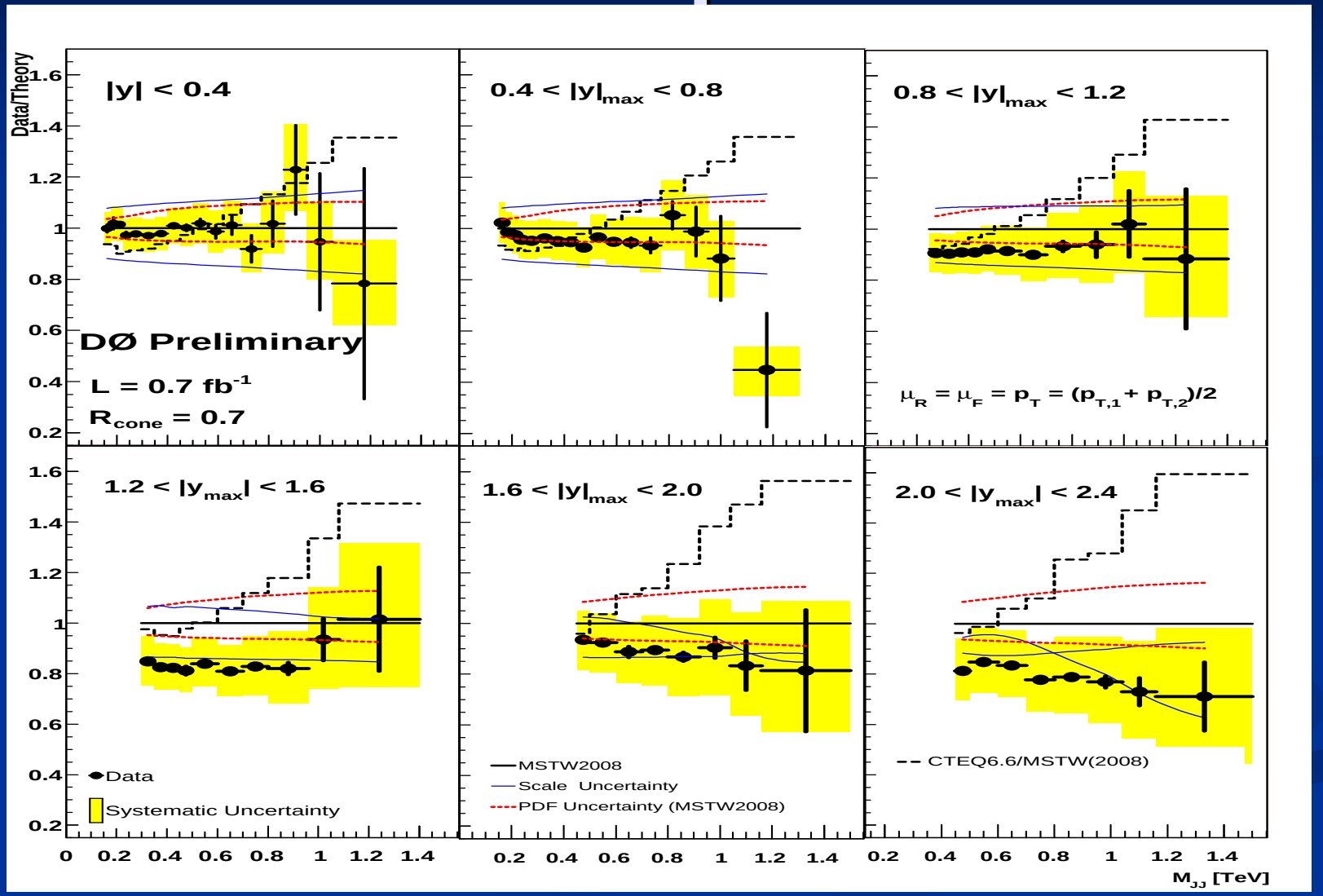


Systematic Uncertainties

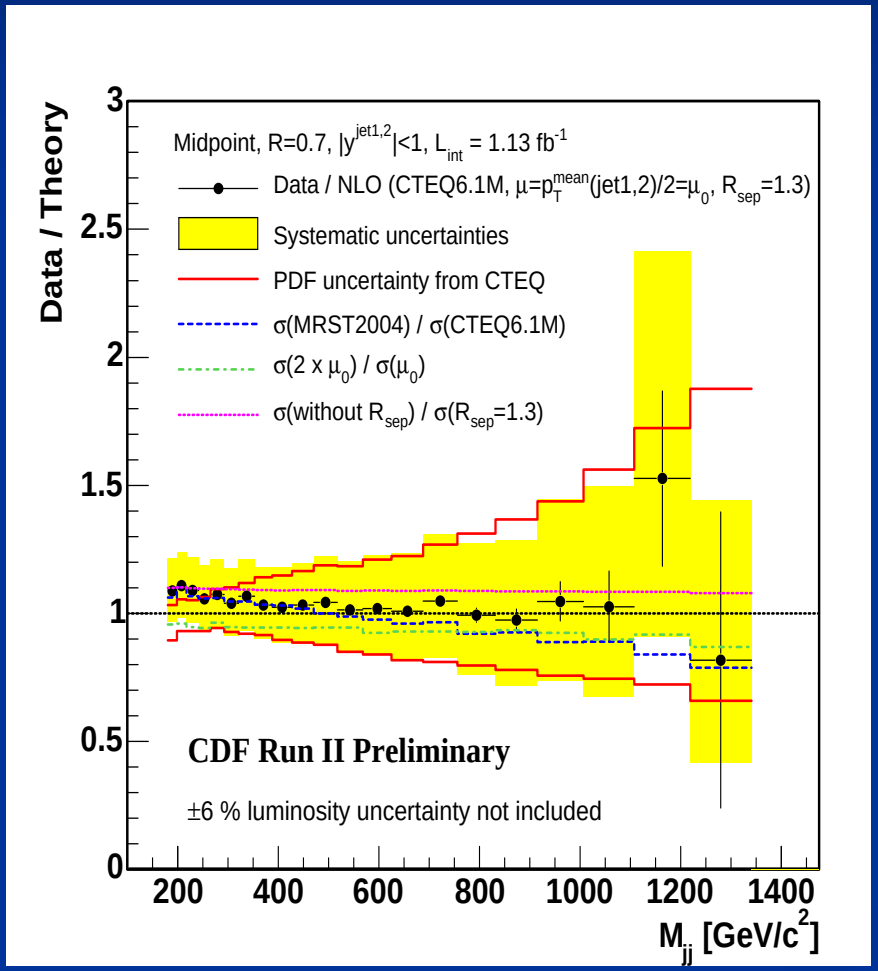
- Largest uncertainties from Jet Energy Scale and p_T resolutions
  - Calculated from various eigenvalues
- Other uncertainties are small (~2%)
  - Calculated by variations of 1 sigma
  - Uncertainties on all correction factors
  - Uncertainty associated with reweighting in the MC to determine the unfolding factor

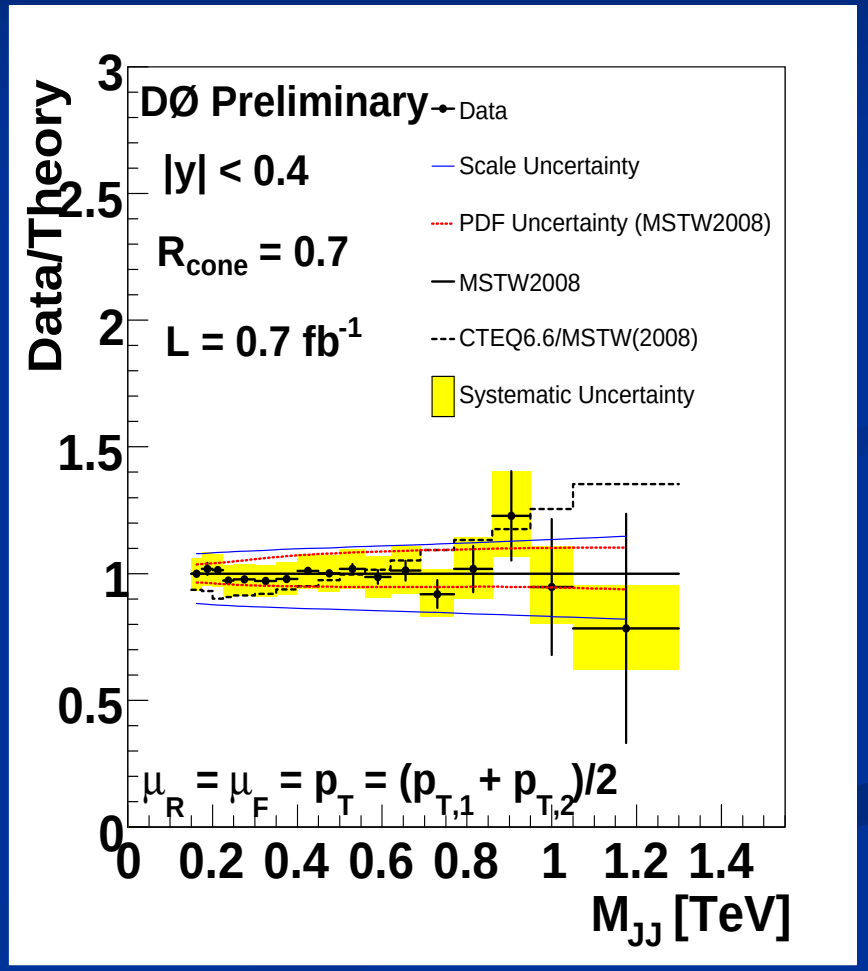


Data to Theory Comparisons



Comparison to other results



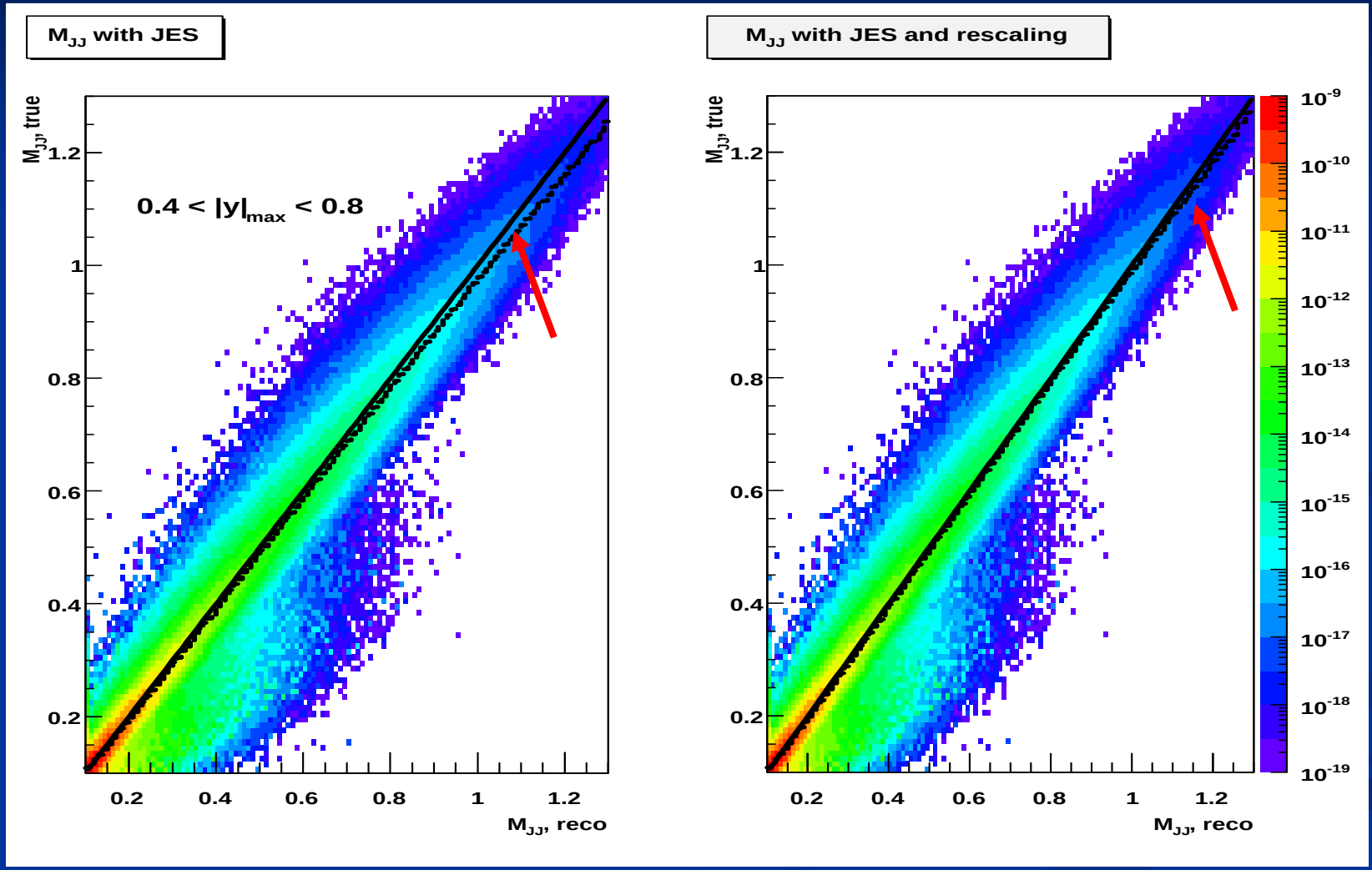


Conclusions

- We present a new measurement on differential dijet mass cross section
- 6 y_{max} regions, $|y|_{max} < 2.4$
  - Previous measurements out to $|y| < 1.1$
- Maximum dijet mass observed ~ 1.4 TeV
- Uncertainties are 50 – 70% of the previous measurement
- Good agreement is found between theory and data.
  - Data favors less gluon at high x
    - MSTW2008 over CTEQ6.6

Backups

Unsmearing- Mass correction



Mostly affects the high masses, but only by ~1.6%, improves statistical uncerts