Inclusive Three-jet Cross Section at DØ

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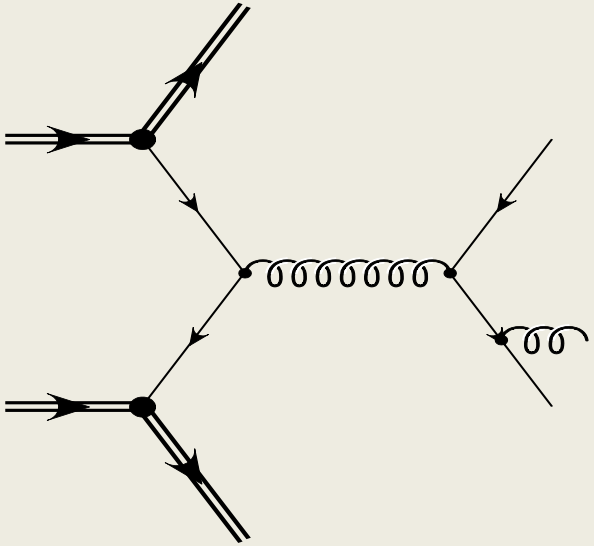
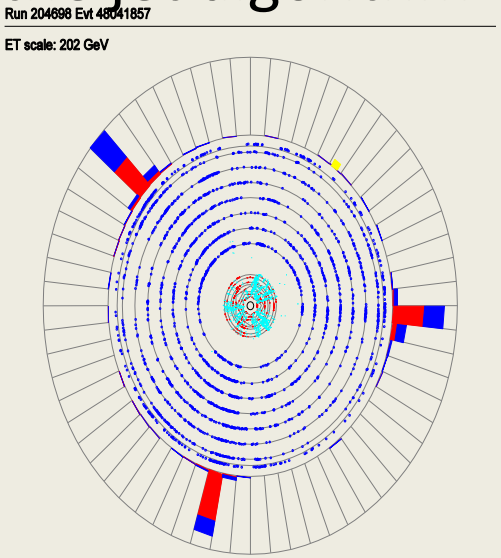
Three-jet motivation

- Three-jet production calculable at NLO (best available at the moment)
- Challenging numerically - cancellation of real and virtual divergences
- Question of IR and collinear stability of the jet algorithm





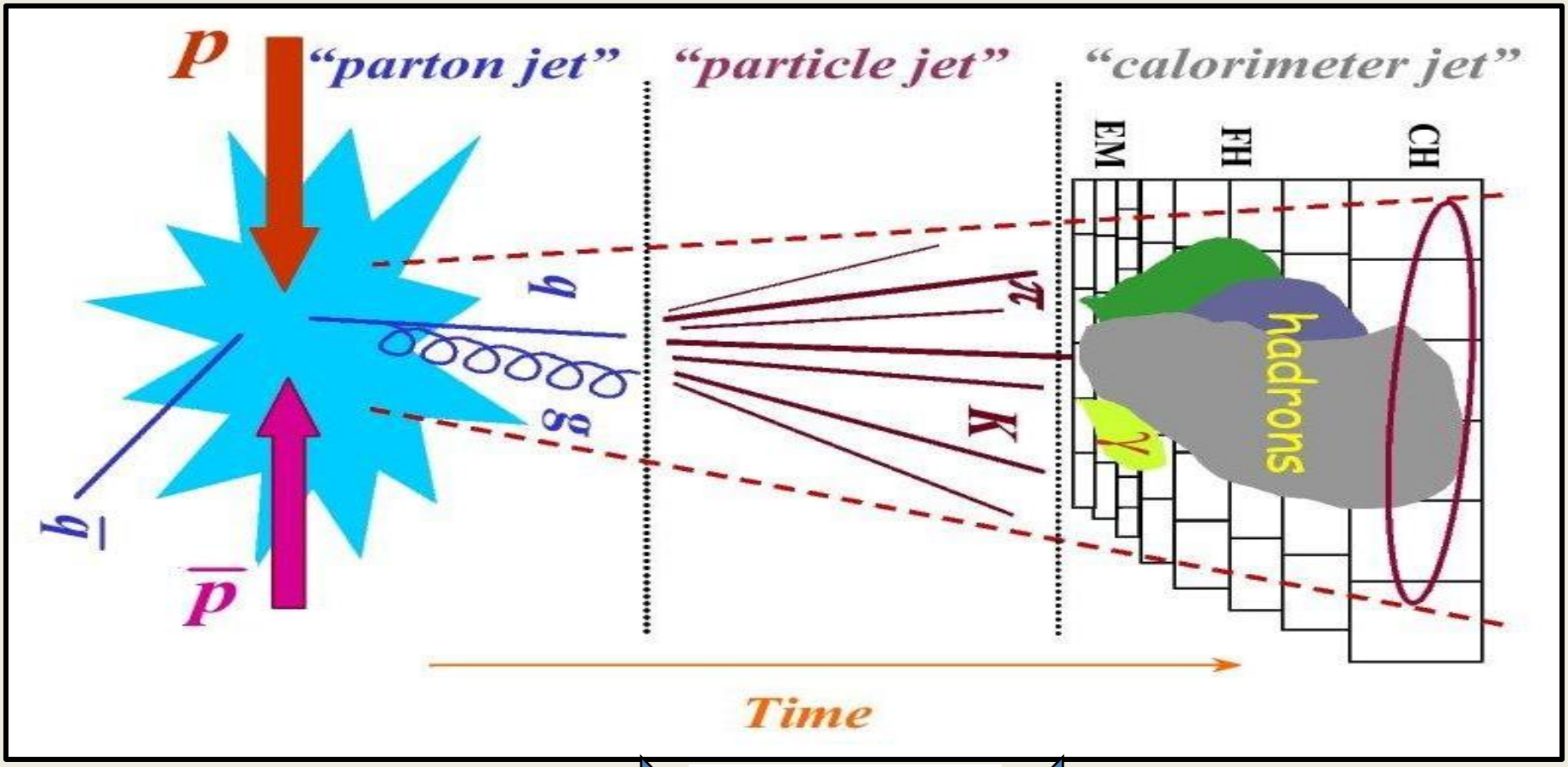
Three-jet cross section measurement

- Inclusive three-jet production in DØ 0.7 fb^{-1} data as a function of three-jet invariant mass (M_{3jet})
- $p_T^{leading\ jet}$>150 GeV, $p_T^{3rd\ jet}$>40 GeV
- 6 analysis bins for rapidity and $p_T^{3rd\ jet}$ dependence:

Rapidity dep. ($p_T^{3rd\ jet}$>40 GeV)	**CC** ($\|y_{1,2,3}\|$<0.8)	**IC** ($\|y_{1,2,3}\|$<1.6)	**EC** ($\|y_{1,2,3}\|$<2.4)
$p_T^{3rd\ jet}$ dep. ($\|y_{1,2,3}\|$<2.4)	**40** ($p_T^{3rd\ jet}$>40GeV)	**70** ($p_T^{3rd\ jet}$>70GeV)	**100** ($p_T^{3rd\ jet}$>100GeV)

- ΔR_{min}>1.4 (2*R_{cone}) to limit jet overlap (splitting/merging in the cone algorithm)

Analysis strategy



Computed in NLOJET++ → **COMPARE** ← What we measure

+ add hadronization and underlying event correction

Jet energy scale correction + unsmearing

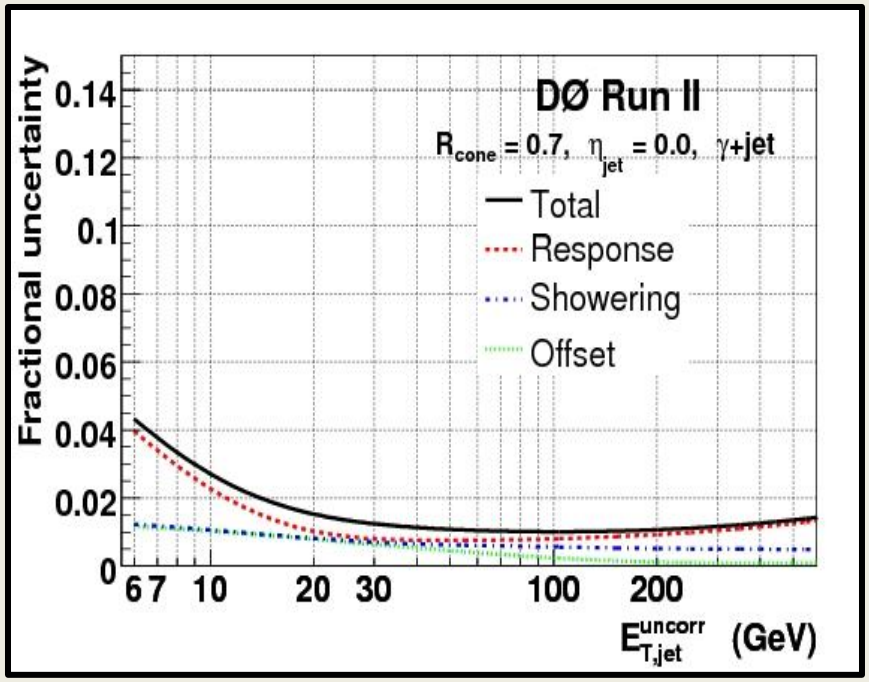
Jet energy scale calibration

- Jet energy scale correction applied to data first

$$E^{corr} = \frac{E^{orig} - O}{R * S}$$

- Offset contribution from noise and pile-up
- Response to jets in the calorimeter
- Showering correction outside the jet cone

Jet energy scale uncertainty for central jets:



Data unsmearing

- Jet simulation was created to derive the unsmearing coefficients
- Based on events generated with Sherpa
- The simulation uses resolutions and uncertainties measured in data
- Unsmearing coefficients are taken from the smeared/original distribution ratios

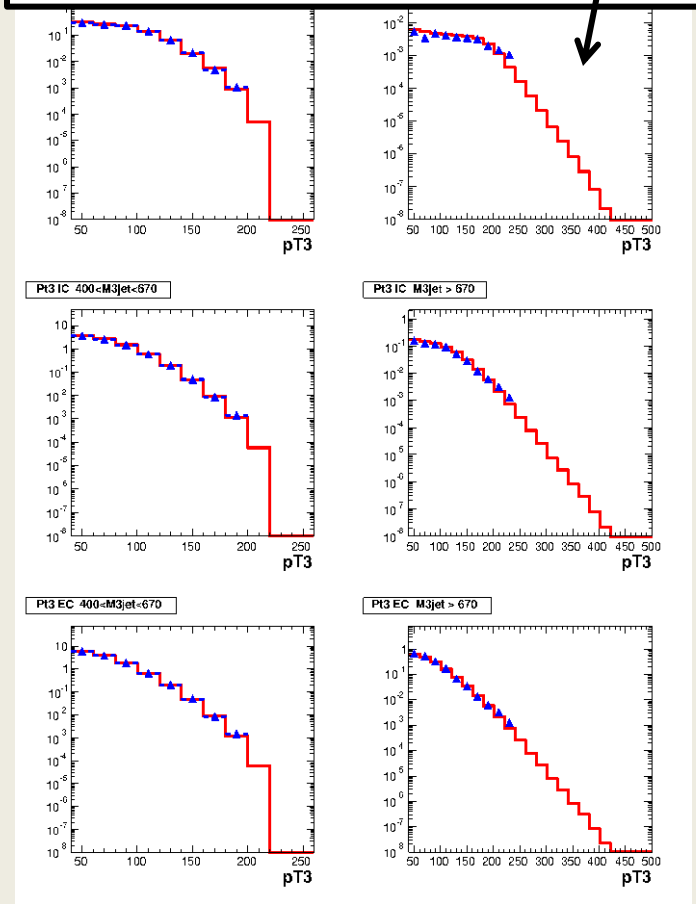
Jet simulation

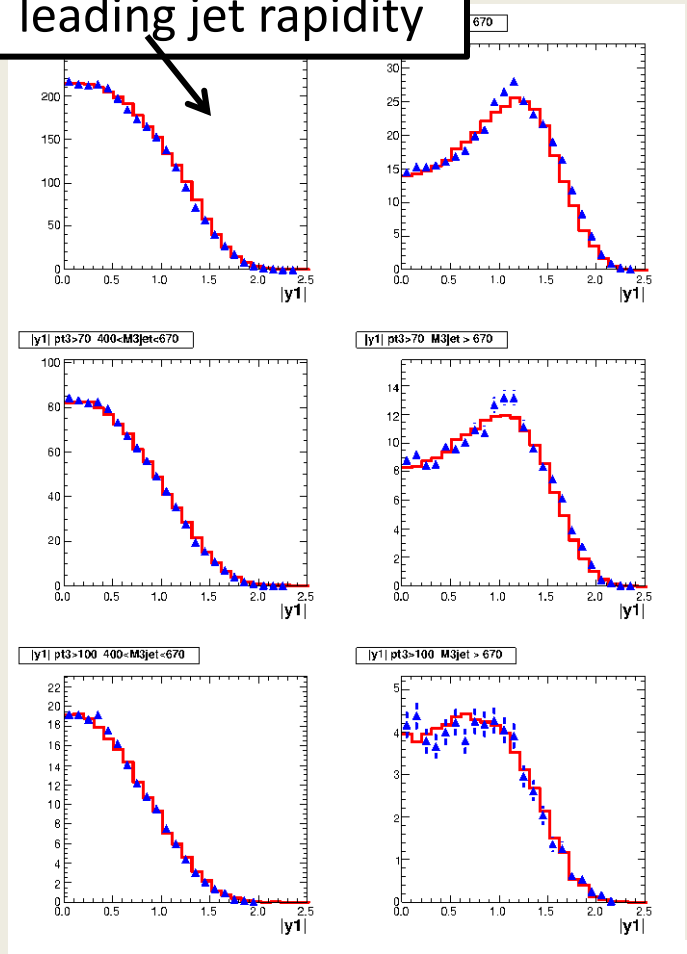
Comment: Better agreement with 2->N LO over 2->2 LO Monte Carlo generators

Huge set of control plots to prove that the simulation works:

3rd jet transverse momentum

leading jet rapidity



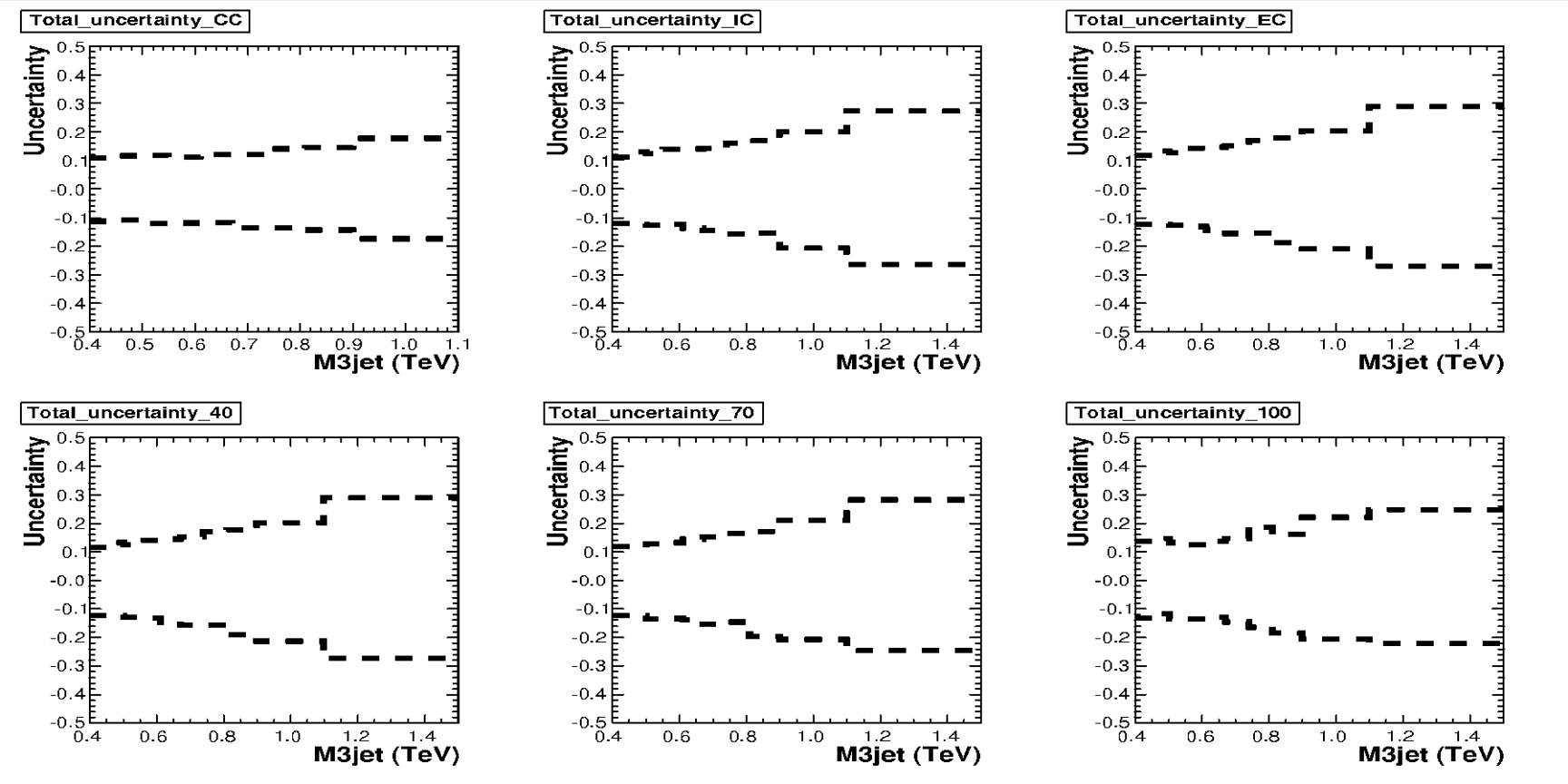


Low mass

High mass

Good agreement found after reweighting of Sherpa

Systematic uncertainty

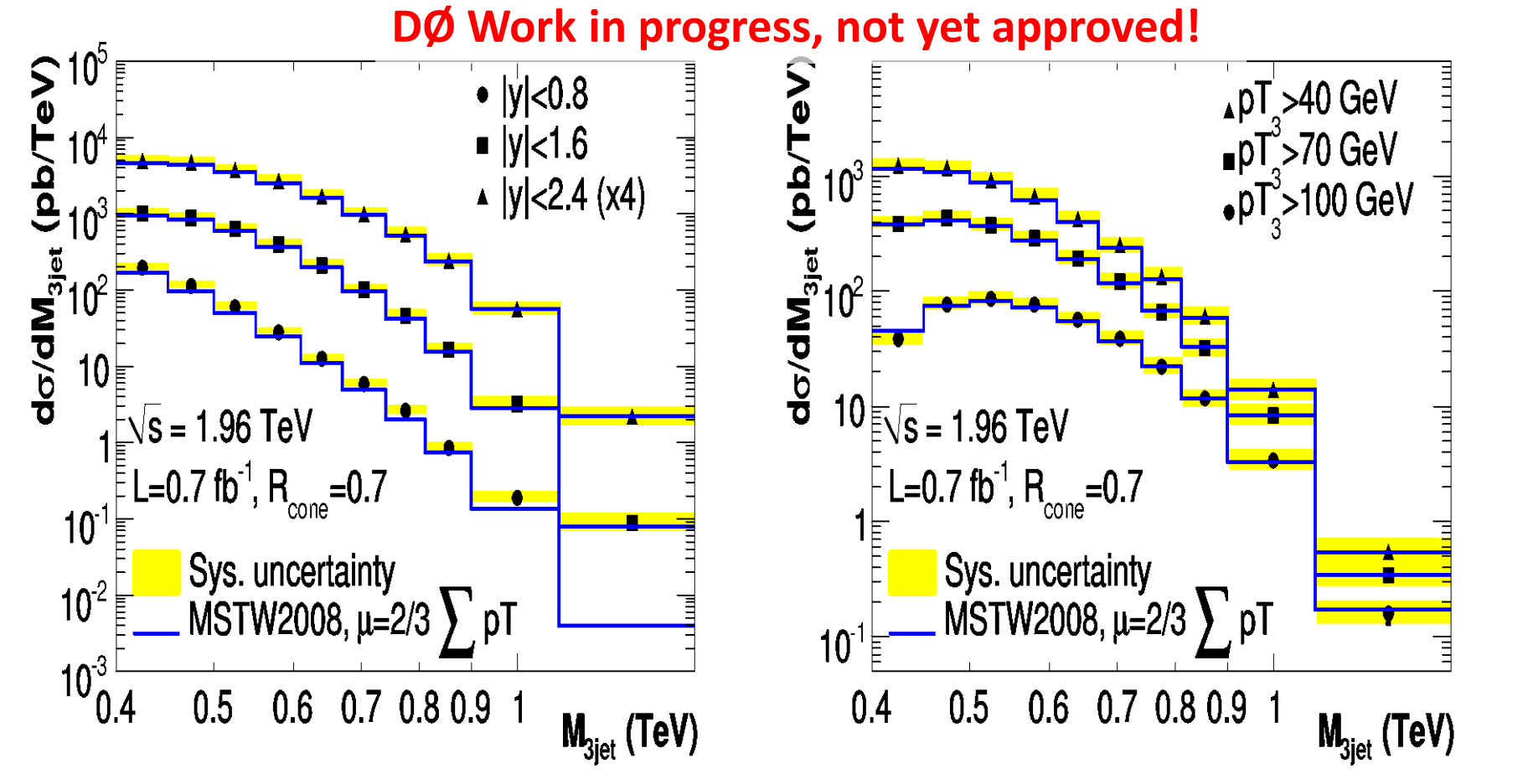


Total systematic uncertainty of the order of 20-30%, dominated by jet energy scale, then transverse momentum resolution and luminosity

NLOJET++ calculation

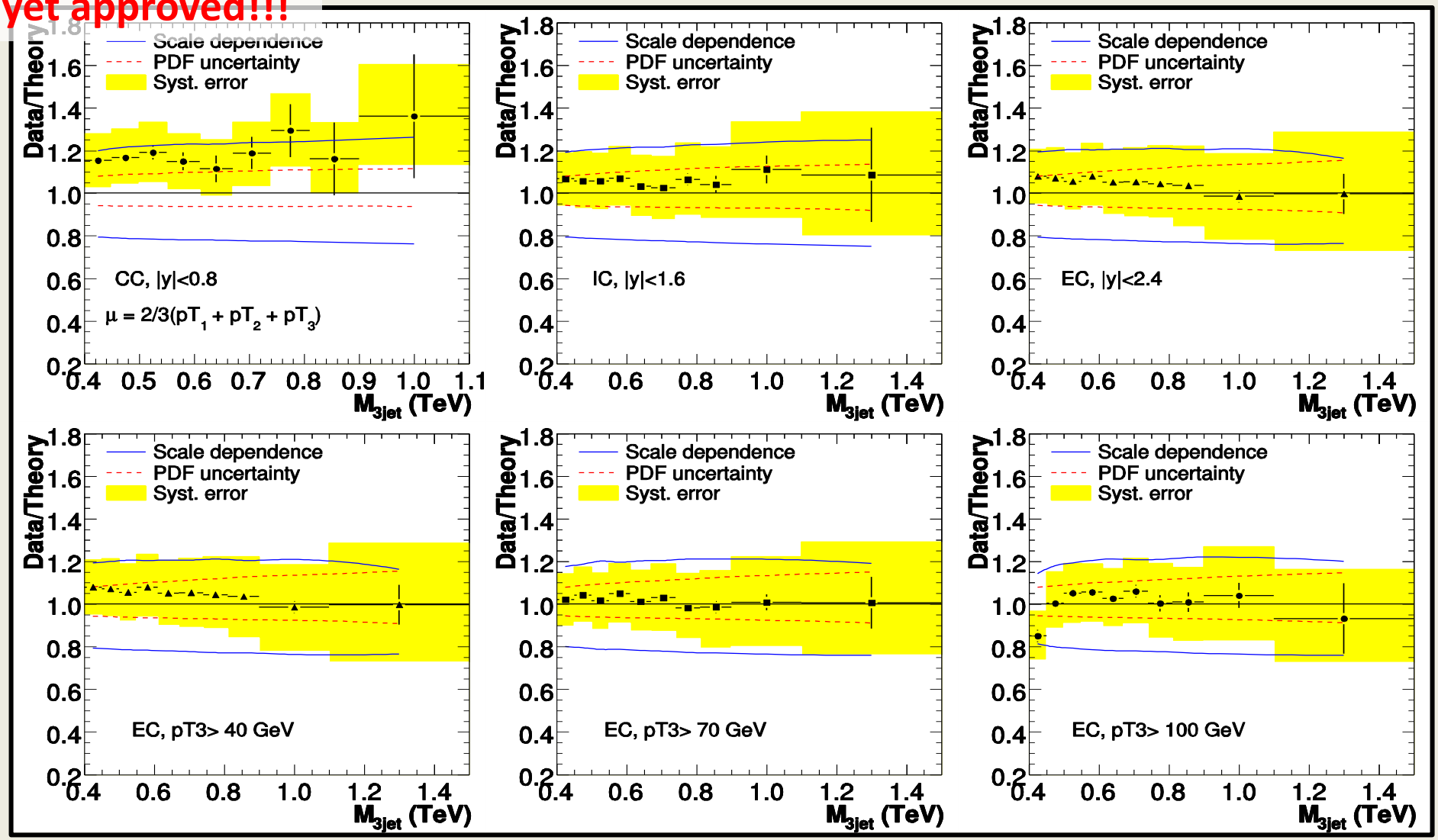
- NLOJET++ v4.1.2 for 3 jet production calculation at NLO order
- MSTW2008 NLO PDF set (already includes Tevatron RunII inclusive jet data -> best available constraint at high *x*)
- Choice of renormalization and factorization scales ($\mu = \mu_r = \mu_f = 2/3\Sigma p_T^{jet}$ with *0.5 and *2 variation for scale dependence)

Three-jet cross section vs rapidity and vs p_T^{min}



Work in progress, not yet approved!!!

Data and theory comparison



Summary and conclusions

- Good agreement is found using NLO QCD calculation for three-jet production in several bins of jet rapidities and tranverse momenta
- Results to be approved soon
- More three-jet variables can be studied in the future