Prospects on V+Jets @ 7TeV with the CMS Detector

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on behalf of the CMS collaboration

V+jets: Backgrounds for new physics and testing ground for QCD
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Outline

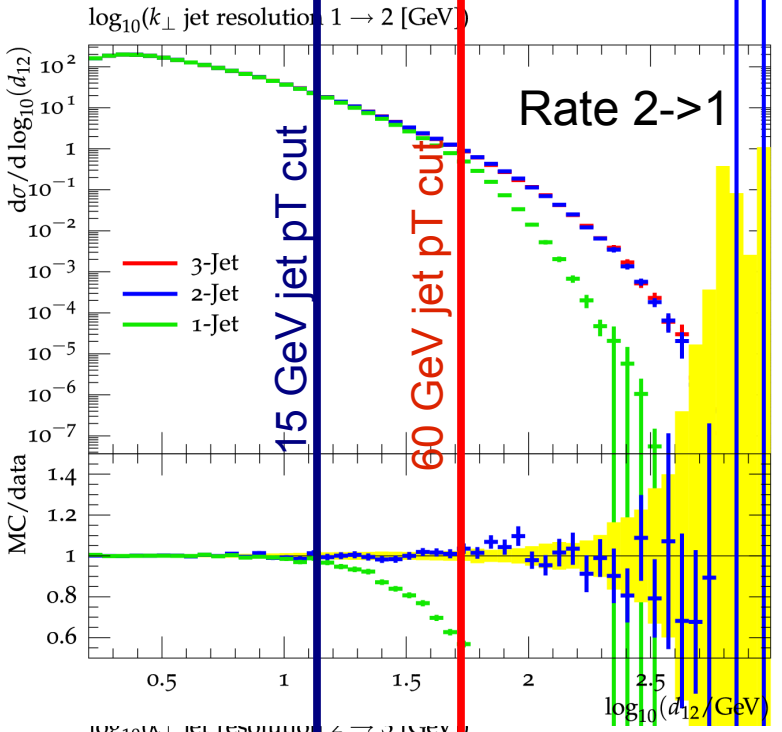
- Motivations for V+jets studies
- Observables
  - What are we starting with?
  - Precision studies
- MC generators for V+jets in CMS
  - What we use
  - What we would like
- What is the best way of presenting data
- Plans

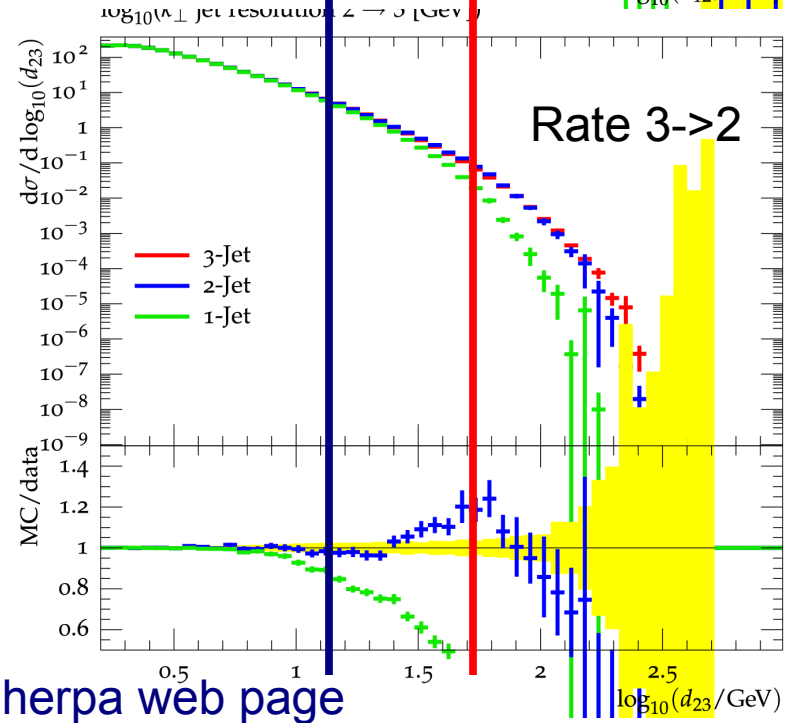
Motivations

- Important test of perturbative QCD
  - Compare rates to NLO predictions (MCFM, BlackHat, Rocket)
  - Compare shapes and relative rates to matrix element + parton shower calculations
- Final states with a vector boson plus jets are useful for searches, i.e.:
  - Normalization of SM backgrounds ($Z\to\nu\nu$, $W\to\tau\nu$)
  - Direct search of significant deviations in (W+n jets)/(Z+n jets) or [V+(n+1)jets]/[V+n jets]
- Important for detector commissioning
  - Jet energy scale calibration

What is a jet?

- Only infrared-collinear safe algorithms used in CMS
  - Anti-kt is our default
- Where to put the pt cut?
  - Low p_T cut makes the measurement sensitive to the Underlying event
  - High p_T cut is sensitive to higher order corrections
  - We are currently using two thresholds:
    - 15 GeV
    - 30 GeV



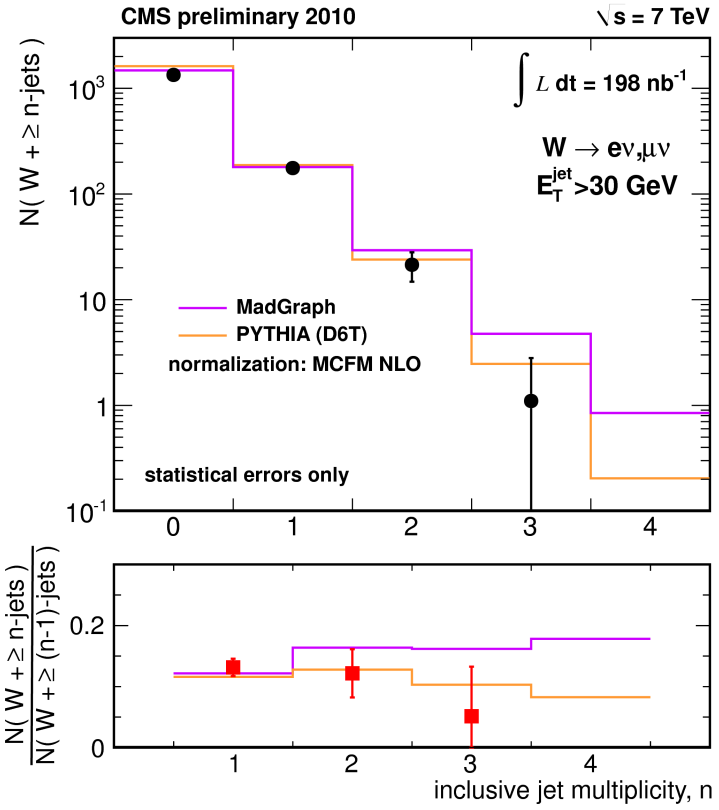


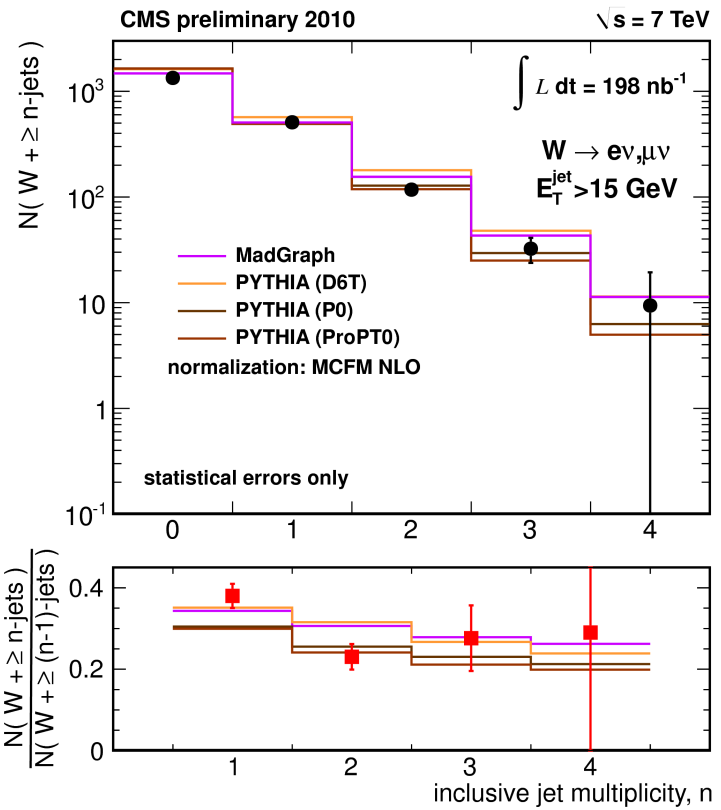
plots from Sherpa web page

Short term plan: Measuring Rates

Short term plan, O(50 pb^{-1}):

- Measure the rate of jet production in association with a weak boson
  - $(1/\sigma_0)\, d\sigma/dNj$, $\sigma[V+Nj]/\sigma[V+(N+1)j]$, $d\sigma/dNj$
  - Comparison of rates, $\sigma(W+Nj)/\sigma(Z+Nj)$

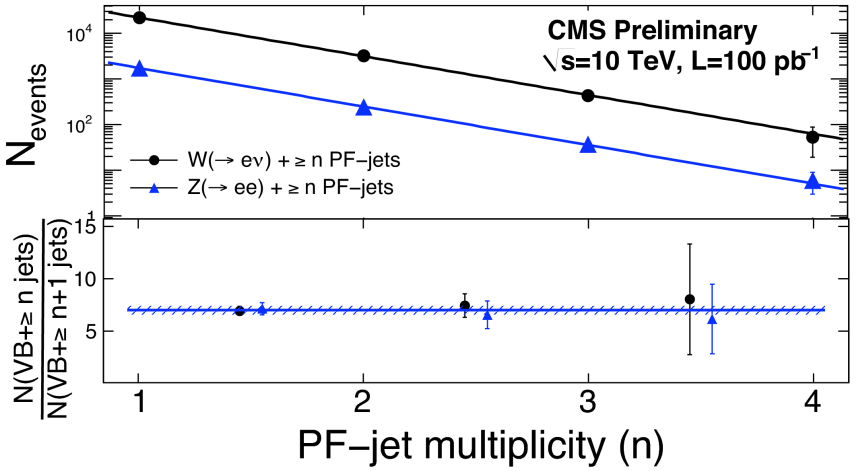


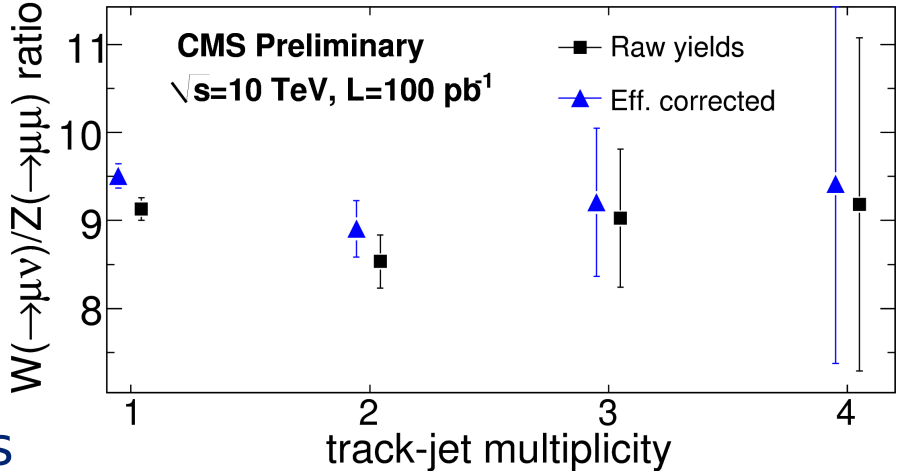


Program for measuring rates

MC study @ 10 TeV for O(100 pb^{-1})

- Start with ratios
  - Z/W + n jets absolute cross section suffers from experimental uncertainties (luminosity, jet energy scale, acceptance...)
  - Check Berends-Giele scaling
    - Many systematics cancel out
  - Measure the W/Z ratio and the double ratio
    - Keeping W and Z selections in sync allows almost complete cancellation of reconstruction efficiency
  - Unfold detector effects
- Deliver cross section measurements

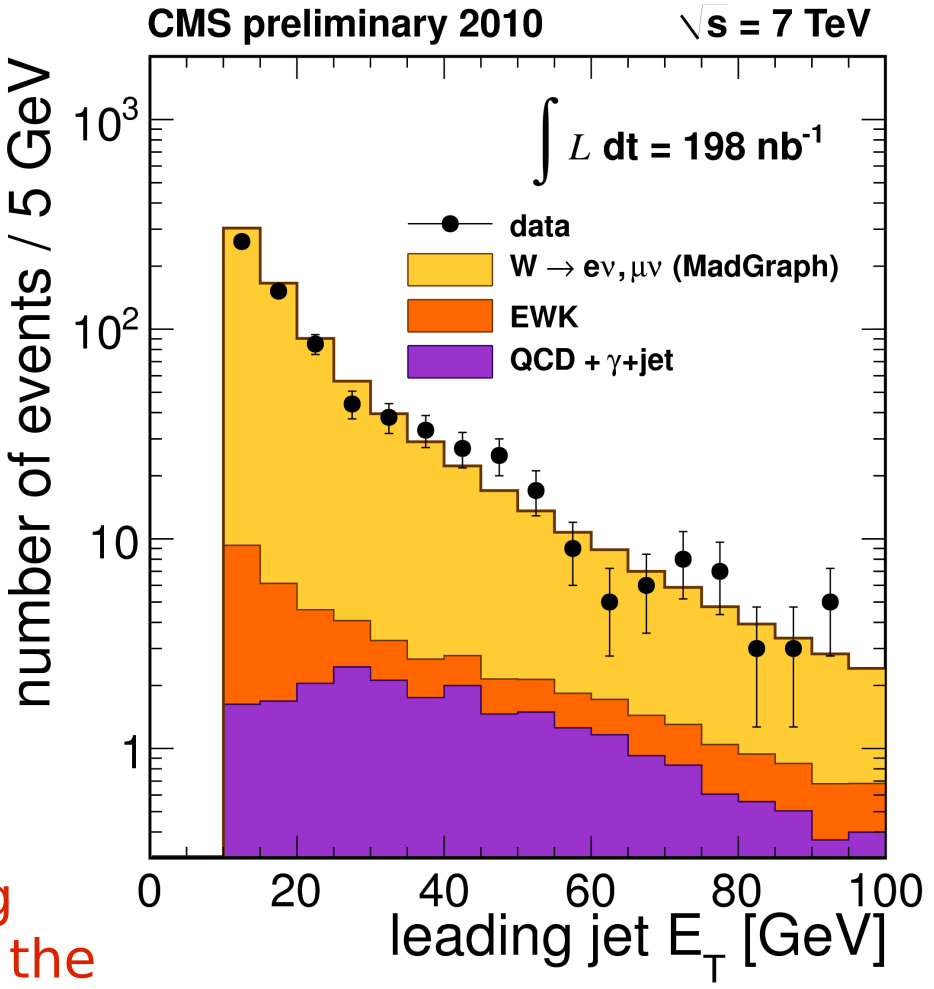




Precision studies: differential distributions

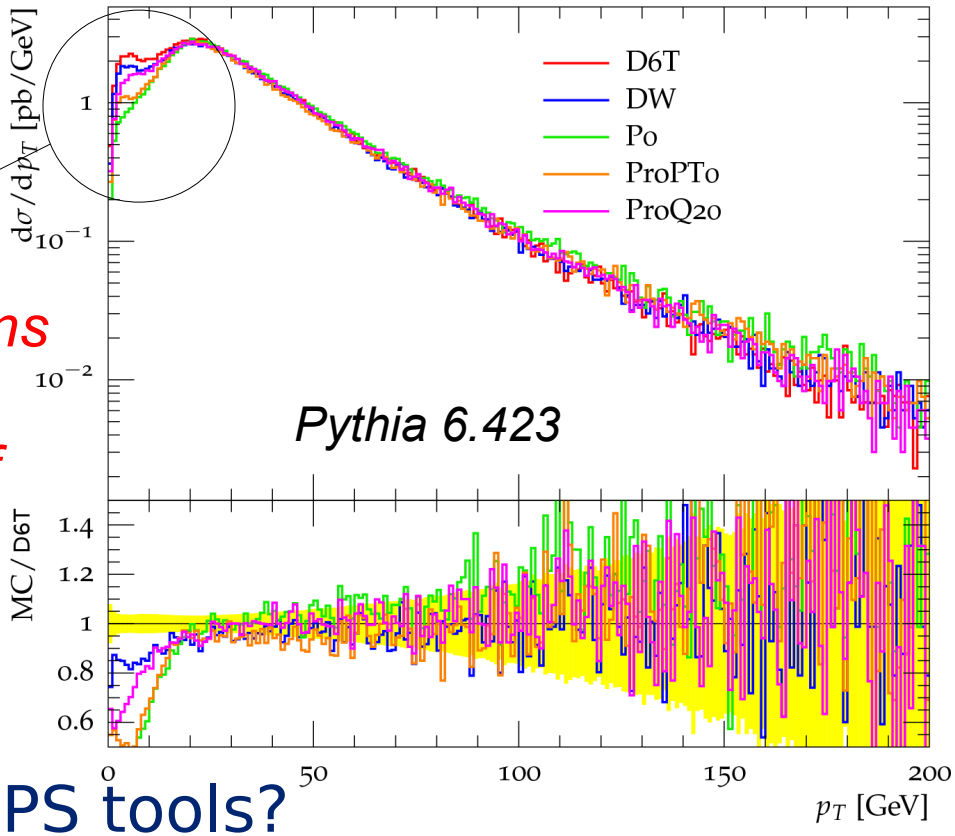
Longer term plan:

- Characterize V + jets in greater detail
  - $d\sigma/dE_T$ for each jet, $d\sigma/dR_{jj}$, $d\sigma/dM_{jj}$, $d\sigma/d\Delta y_{jj}$
- Events shapes
  - Differential jet rates
    - Very challenging
    - Usually, for jets:
      - Cluster uncorrected energy
      - Apply a global correction
    - For differential jet rates we need to enter the clustering step with objects that have the correct energy scale
    - → Particle Flow



Underlying event and V+jets

- We can use V+soft jets to study Underlying Event
  - E.g. using 15 GeV threshold, a not negligible fraction of jets come from UE
    - Z pT in events with at least 1 jet



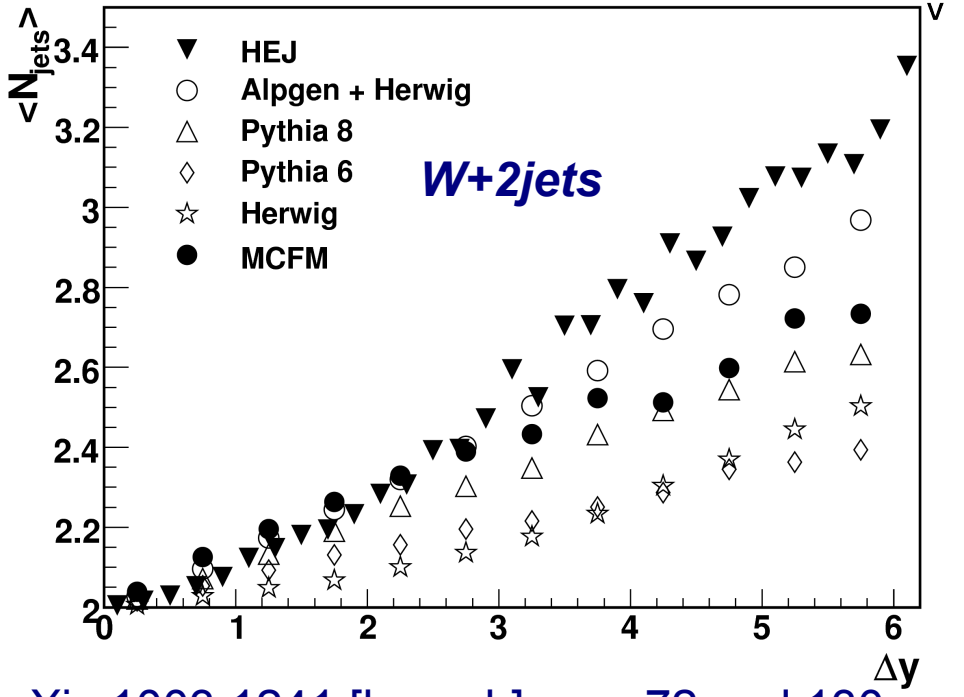
Missing shower from MPI partons in old model based tunes. The low momentum shoulder of this distribution could give us a handle to tune the UE

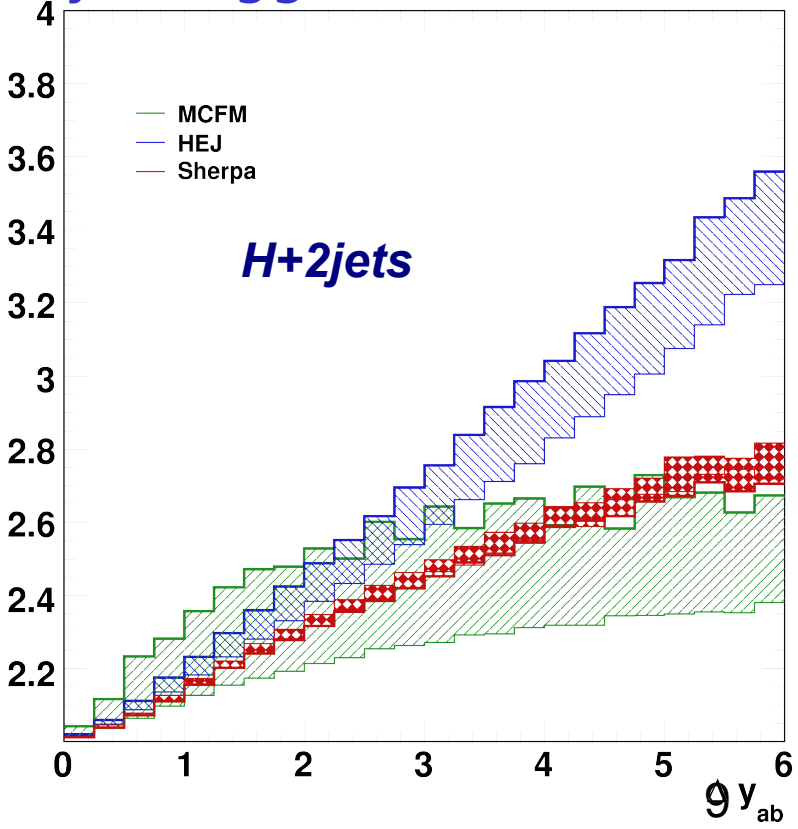
- Tuning status of ME+PS tools?

Rapidity gaps in V+jets

Rapidity gaps:

- Average number of jets VS rapidity gap between the forward and the backward jets
- Similar pattern in W+di-jets and in gluon fusion Higgs
- We can exploit W+di-jet to study the gg contamination to VBF





arXiv:1003.1241 [hep-ph], pag 72 and 130

Monte Carlos for V+jets

What are the desirable features?

- Describe multi jet topologies
  - ME + PS techniques
- Describe angular separation between jets and leptons
  - Our selections rely on isolation
- Refined treatment of QED fsr
  - FSR photons can fake jets
- Light and heavy flavor jets
  - We have both in the data
- It has to be tuned to data
  - Extremely important for a good understanding of isolation efficiencies

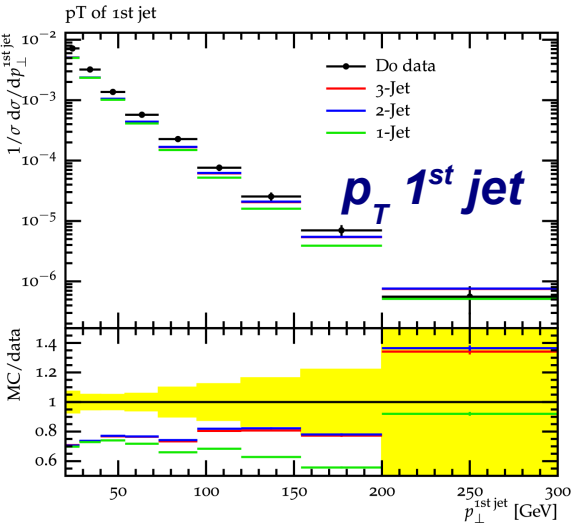
Parton level calculations

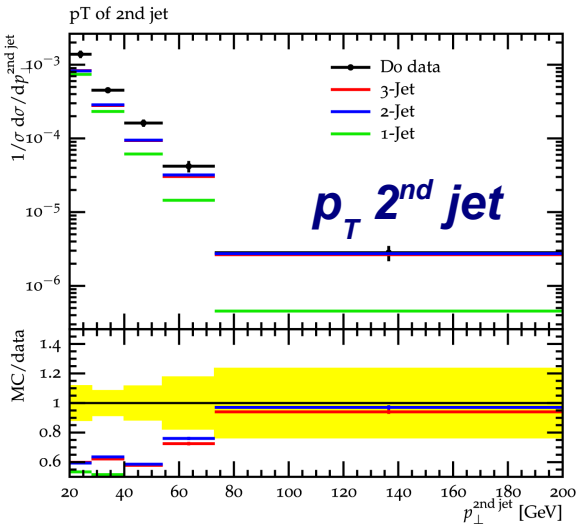
- FEWZ, DYNNLO, MCFM
  - To compute overall k-factors
- BlackHat and Rocket
  - We are in contact with the authors to get ntuples for W+1,2,3 jets at NLO 7TeV
  - samples produced with at least two scale choices
  - Parton level ntuples, so that we can re-cluster partons with different algorithms/cuts

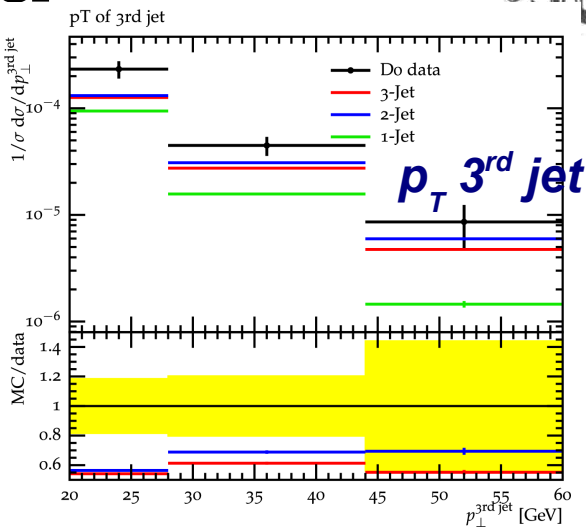
Comparing data and theory

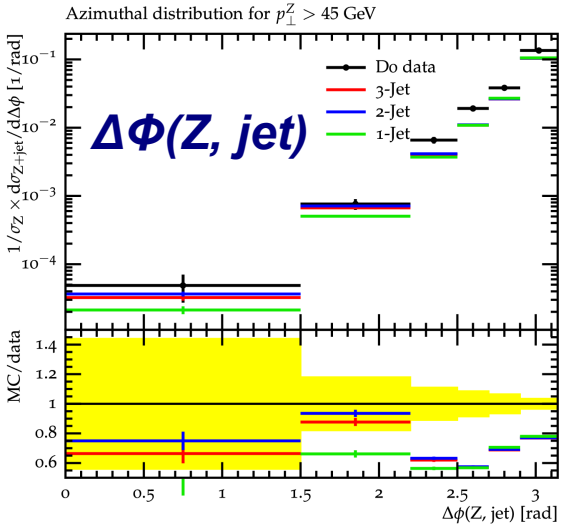
- How to present data to be most effectively comparable to theory predictions?
  - Unfold detector effects to particle level
    - Best solution to compare to MC particle level programs
  - Acceptance can be different as a function of the number of jets
    - Quote results both with and without acceptance corrections
  - How to compare with parton level calculations?
    - Unfold hadronization effects?
    - Apply corrections for the UE?

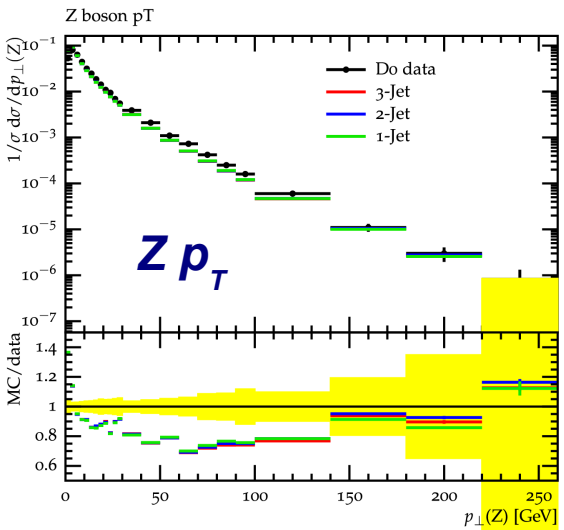
Comparisons to Tevatron data











- Need for a clear picture of how different generators compare to Tevatron
- Example: Comparison to Z + jets @D0 for Sherpa

plots from Sherpa web page

Conclusion

- Our plan for V+jets can be summarized as:
  - Short term: measure ratio of rates, rates
  - Longer term: measure differential distributions, event shapes
- We are using all the most popular particle level MC for our simulations
  - Status of tuning
  - Clear picture of how they compare to Tevatron
  - Need a good description of observables related to isolation and QED fsr
- We have a well established strategy for early analysis:
  - data driven techniques
  - unfolding of detector effects

Backup