Hadronization&UE Corrections from Pythia D6T and Herwig++ and Herwig/Jimmy

Physics at the Terascale
27.11.2008

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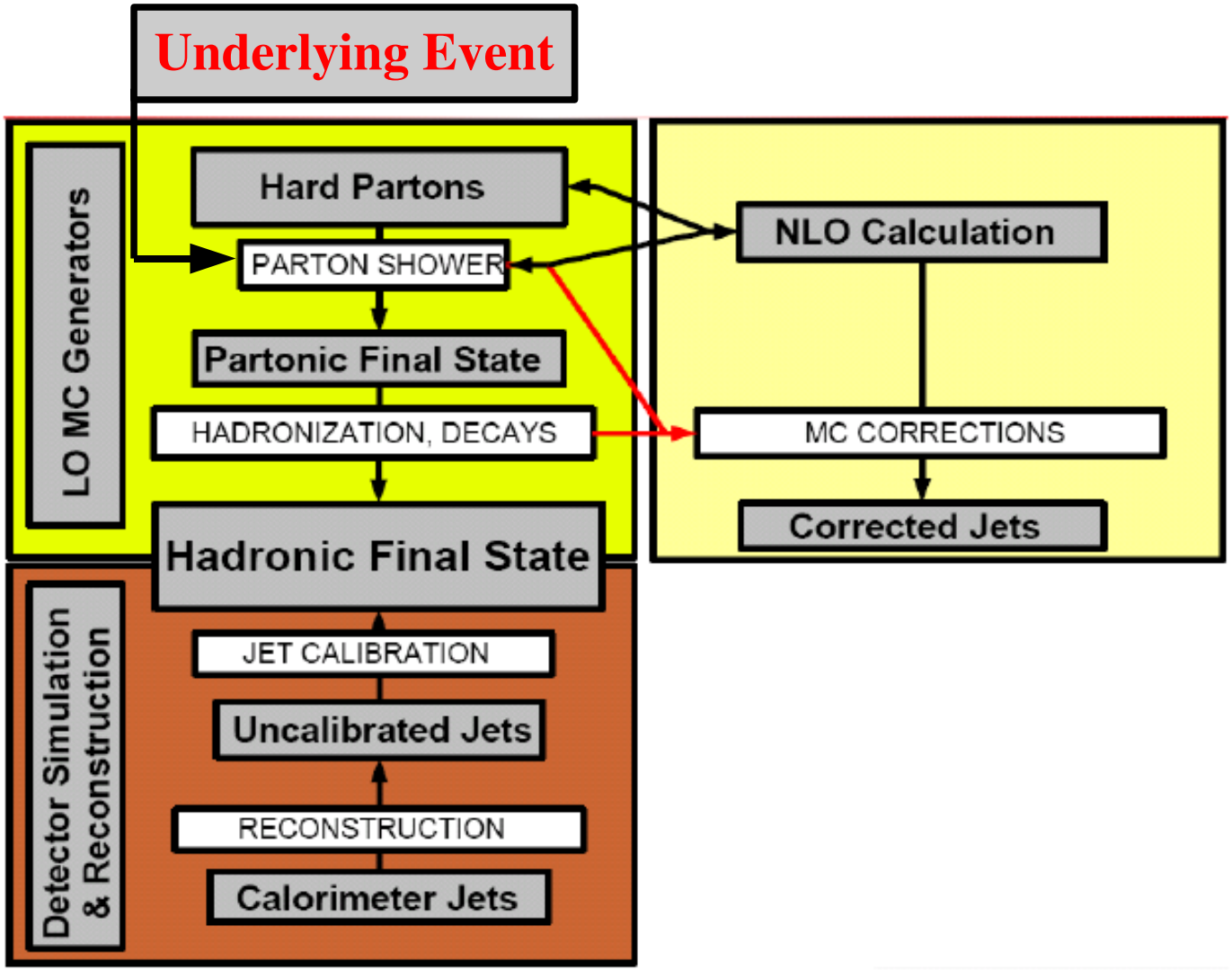
Outline

- Introduction
- Analysis Setup
- Comparison of Herwig++, Herwig&Jimmy and Pythia6
- Correction Factors for Underlying Event and Hadronisation

Introduction: Inclusive Jets

On the MC side:

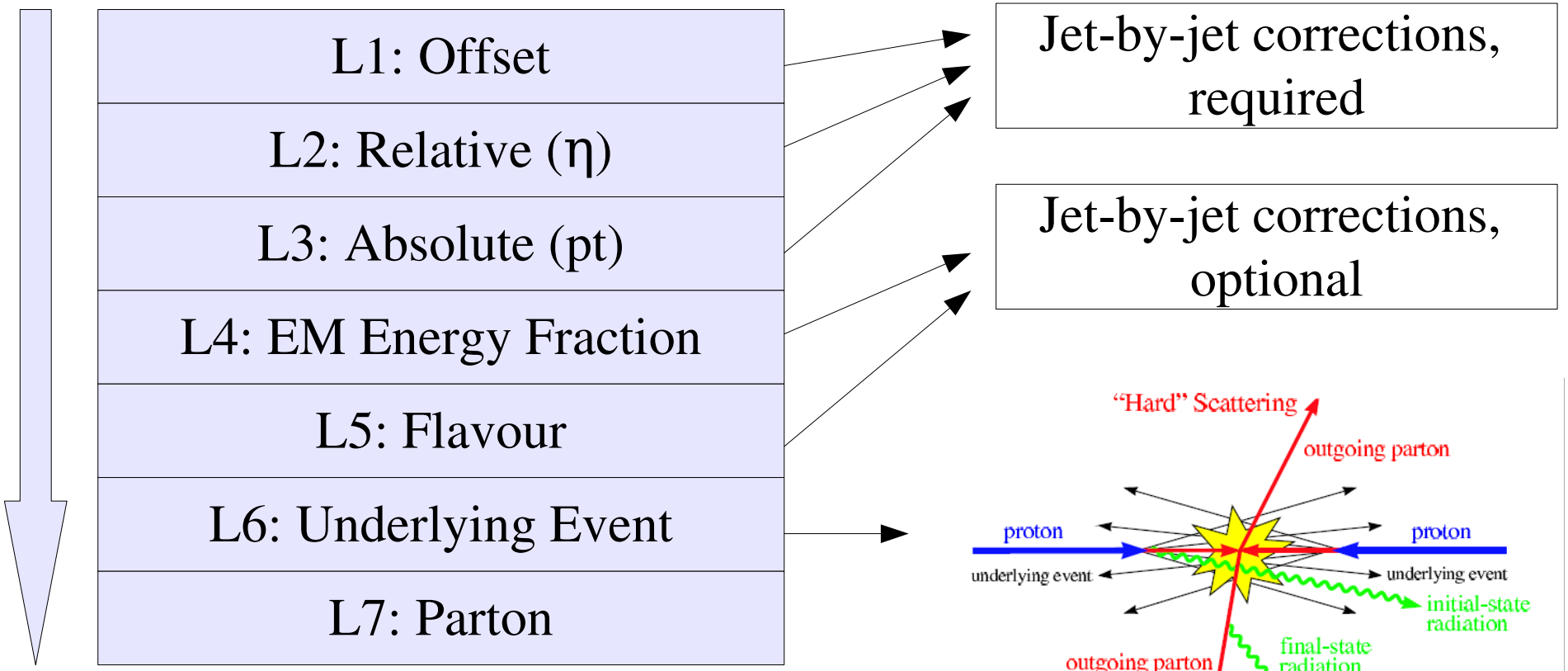
We want to use NLO calculations but need models for multi-parton interactions and hadronisation



Introduction: Jet Corrections

Jet Corrections:

- CMS uses a factorized approach for jet corrections



Introduction: Corrections

Idea:

- Take jet spectra from NLO calculation and apply correction factors for multi-parton interactions and hadronisation

But…

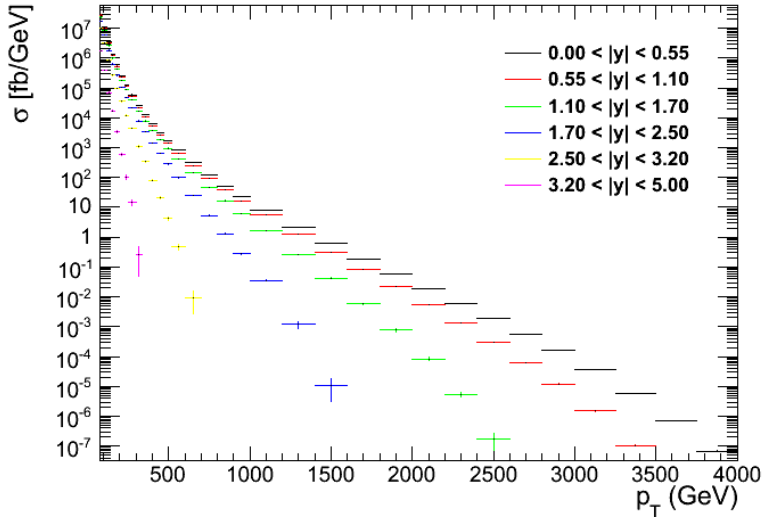
- Underlying event is used to tune MC generators to data
- UE is measured in transverse region
- Parton shower emulates higher-order effects, conflicts with NLO
- Different models for MPI and hadronisation are on the market
  - Which one to prefer?

Analysis Setup

- Herwig++ 2.2.1, Pythia 6.4 in CMSSW 2.1.4
- Herwig+Jimmy in CMSSW 2.1.9
- kt06 jets with pt > 50.0 GeV
- Comparison of hadronic final state with partonic final state without multiple parton interactions
- Binning in rapidity according to detector geometry:
  - 0.00 < |y| < 0.55 and 0.55 < |y| < 1.10 barrel region
  - 1.10 < |y| < 1.70 transition region
  - 1.70 < |y| < 2.50 endcap region
  - 2.50 < |y| < 3.20 transition region
  - 3.20 < |y| < 5.00 forward region

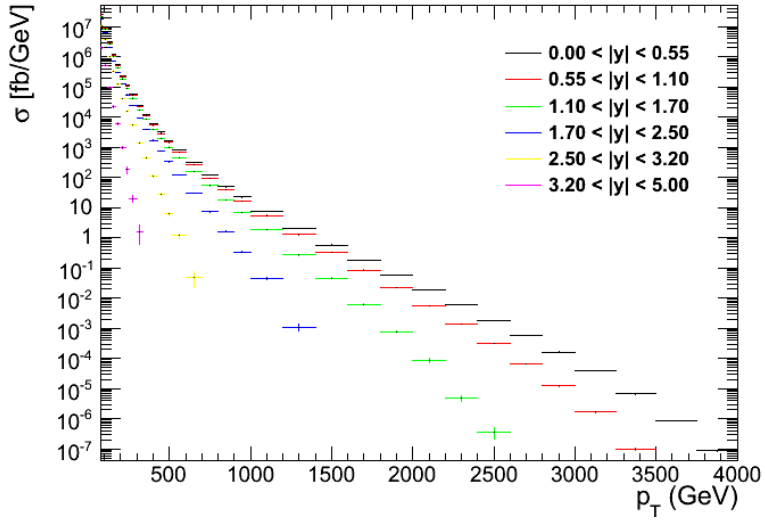
Herwig++, Herwig&Jimmy and Pythia6

Inclusive jet cross section from Pythia6

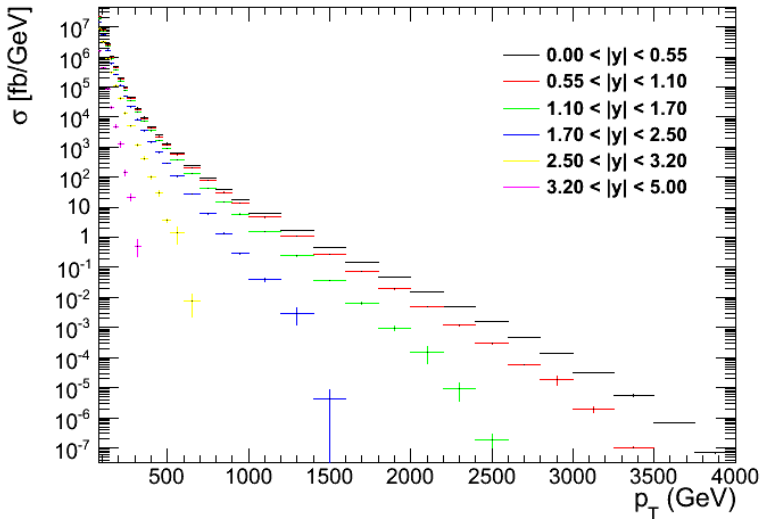


- Private production: 1.7M events in 17 pthat bins
- CTEQ6L PDF for Pythia and Herwig&Jimmy
- MRST2001 PDF for Herwig++

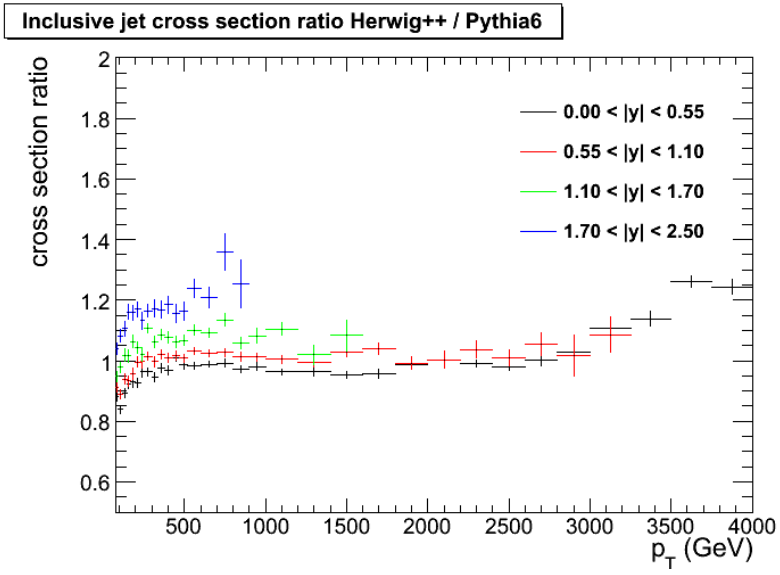
Inclusive jet cross section from Herwig++

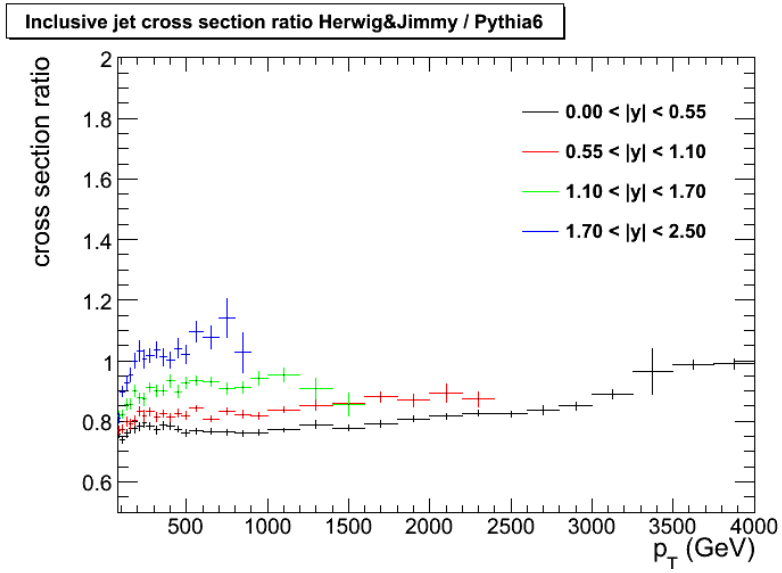


Inclusive jet cross section from Herwig&Jimmy



Herwig++, Herwig&Jimmy and Pythia6





- Herwig++ predicts more jets than Pythia, especially for high transverse momenta and outer rapidities
- Herwig&Jimmy agrees with Herwig++ in shape, yet has an offset of about -20%
- Differences due to PDFs?
- But: PDFs are important part of UE tunes

Herwig++, Herwig&Jimmy and Pythia6

- Herwig and Pythia6 use different hadronisation models:
  - Lund string model in Pythia
  - Cluster model in Herwig++ and Herwig&Jimmy
- And also different underlying event models:
  - Tune D6T for Pythia6
  - Herwig++ used with default settings
  - Herwig&Jimmy with Jimmy default settings
  - All three are tuned to Tevatron data

Herwig++, Herwig&Jimmy and Pythia6

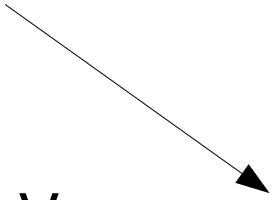
- Effects of UE and Hadronisation:
  - Additional pt in high pt jets
  - Additional jets above 50 GeV
- Example number of jets with pt > 50 GeV in events:
  - Pthat bin 80 GeV – 120 GeV:

  for Pythia 1.95 -> 2.05

  for Herwig++ 1.90 -> 2.05
  - Pthat bin 1000 GeV – 1400 GeV:

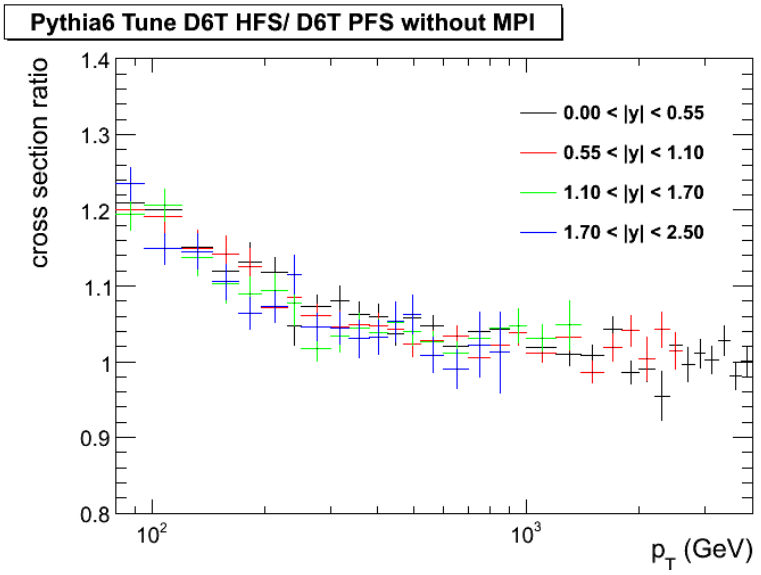
  for Pythia 3.05 -> 3.28

  for Herwig++ 3.16 -> 3.45

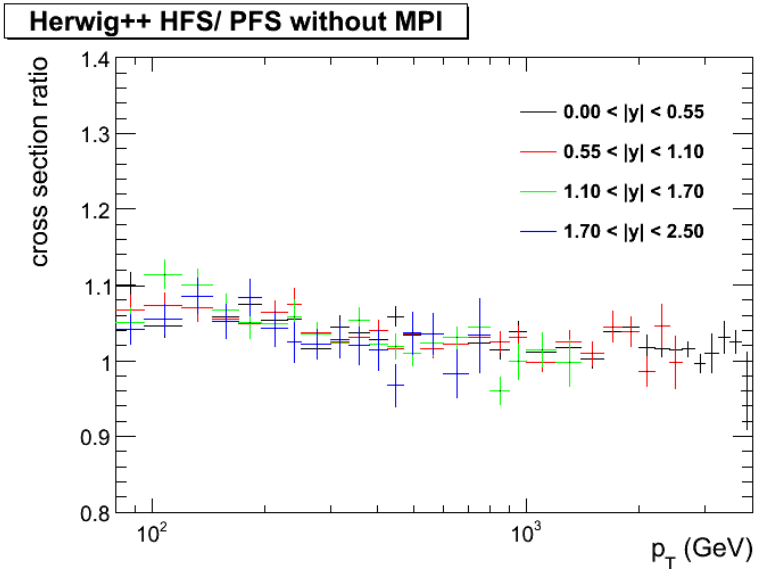


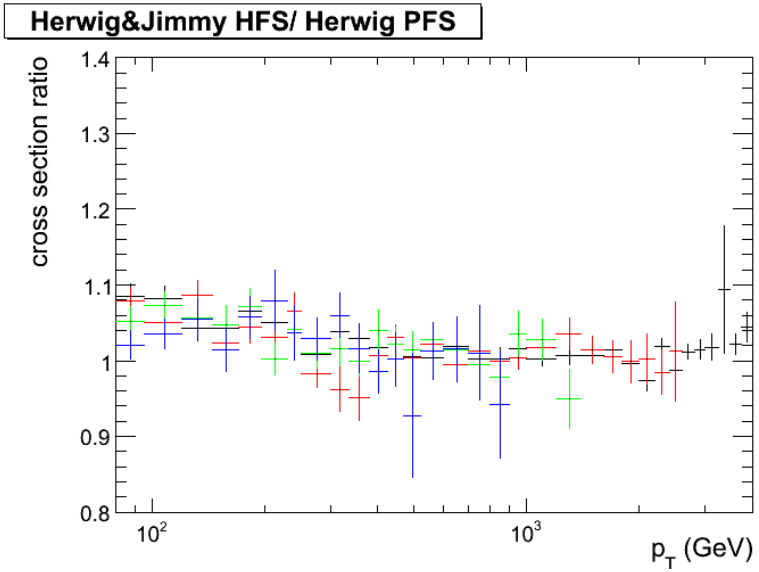
PFS,noMPI -> HFS

Corrections for UE and Hadronisation



- Corrections for hadronisation and multi-parton interactions
- Statistical uncertainty affected only by Monte-Carlo statistics





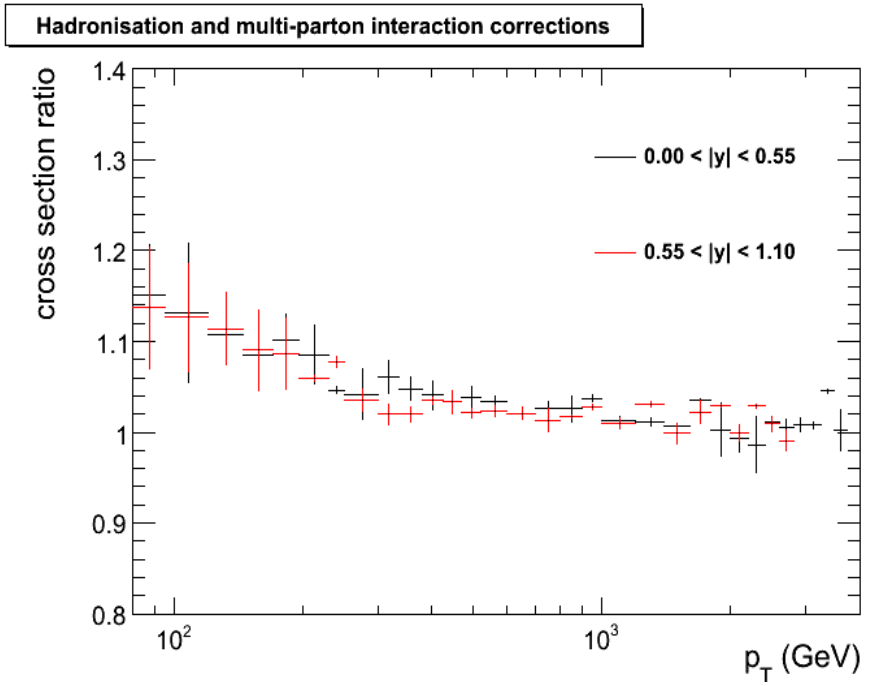
Corrections for UE and Hadronisation

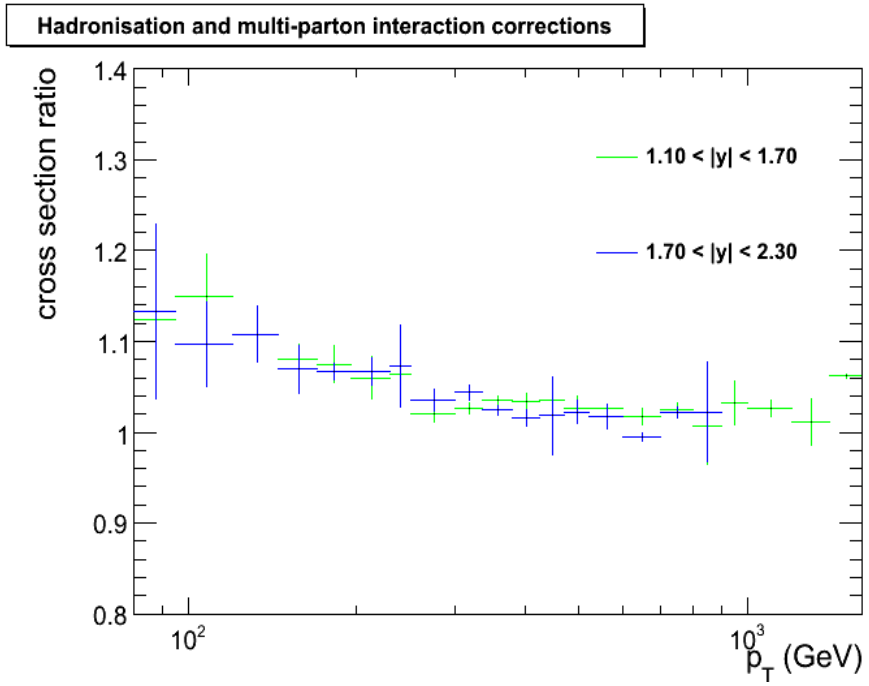
- Similar behaviour for Herwig++ and Herwig&Jimmy, corrections a littler larger for Pythia6
- No significant dependance on rapidity

How to put the two models together?

- First simple approach: Add weighted correction ratios
  - Average of Herwig&Jimmy and Herwig++ * 0.5
  - Pythia * 0.5
- Systematical error estimation:
  - Half the difference between Pythia and the average of Herwig&Jimmy and Herwig++

Corrections for UE and Hadronisation





- Systematic uncertainties are comparable to statistical uncertainties with the current number of events

Conclusion and Outlook

- Multiple parton interaction and hadronisation corrections for inclusive NLO jets are available from Herwig++, Herwig&Jimmy and Pythia6
- Comparison of generators and their models allows estimation of systematic uncertainties
- Statistical uncertainties can be reduced further with a bigger production (1M events per bin projected)