RATIO MEASUREMENT OF W/Z + JETS AT ATLAS

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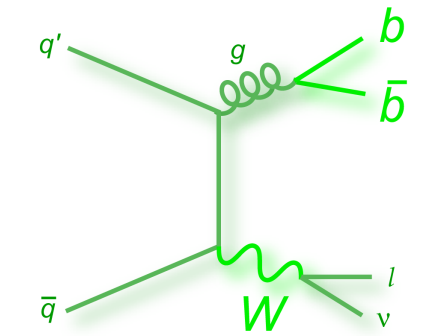
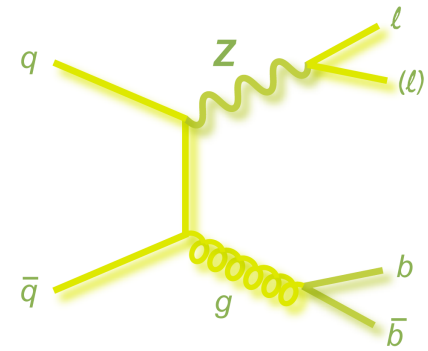
Motivation

- Vector boson (V) + jets measurements are in general an important background for new physics:
  - E.g. W+Jets events are a major background for physics processes with a final state including missing transverse energy (MET) and hadronic jets, such as single top measurements and SUSY searches.



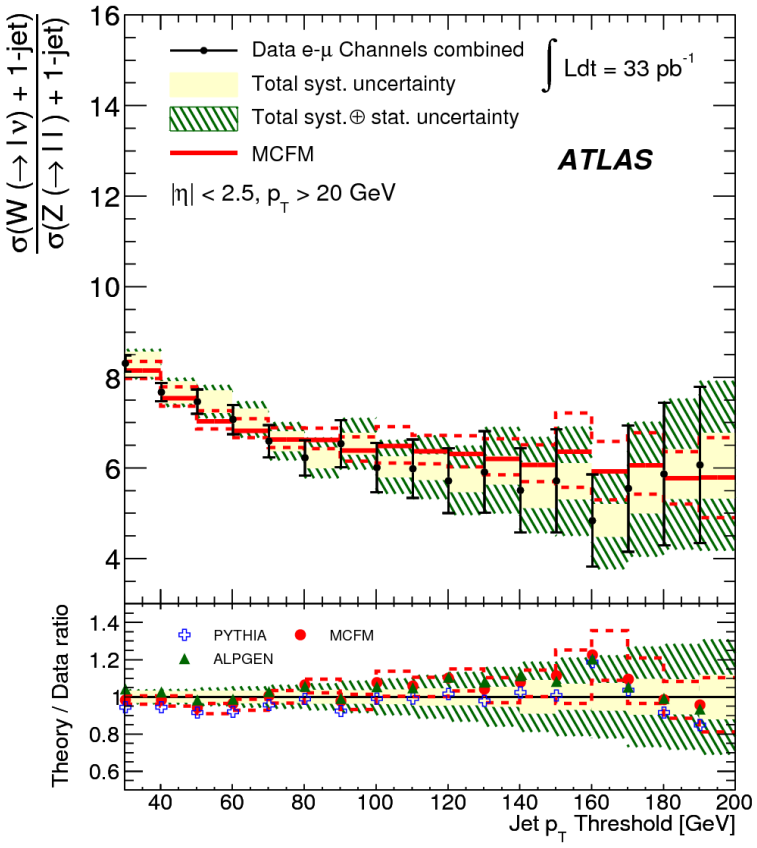
- The ratio measurement (W+Jets)/(Z+Jets) provides a high precision test of perturbative QCD since the ratio conserves information on the dynamics of V +Jets production whilst largely reducing the common systematic uncertainties associated with the measurement:
  - Experimental level: largely reduced jet energy scale and luminosity uncertainties.
  - Theoretical level: reduced dependence on PDFs.



Measurement

- Measurement performed for both the electron and muon channels and a combined cross-section.

- Previous measurement with 2010 data (Phys. Lett. B708 (2012), 221-240):
  - Measurement with exactly one associated jet.
  - Ratio presented as a function of jet P_T threshold.
  - Comparison with LO Monte Carlos (Pythia and Alpgen) and NLO calculations (MCFM) showed good agreement between data and predictions.

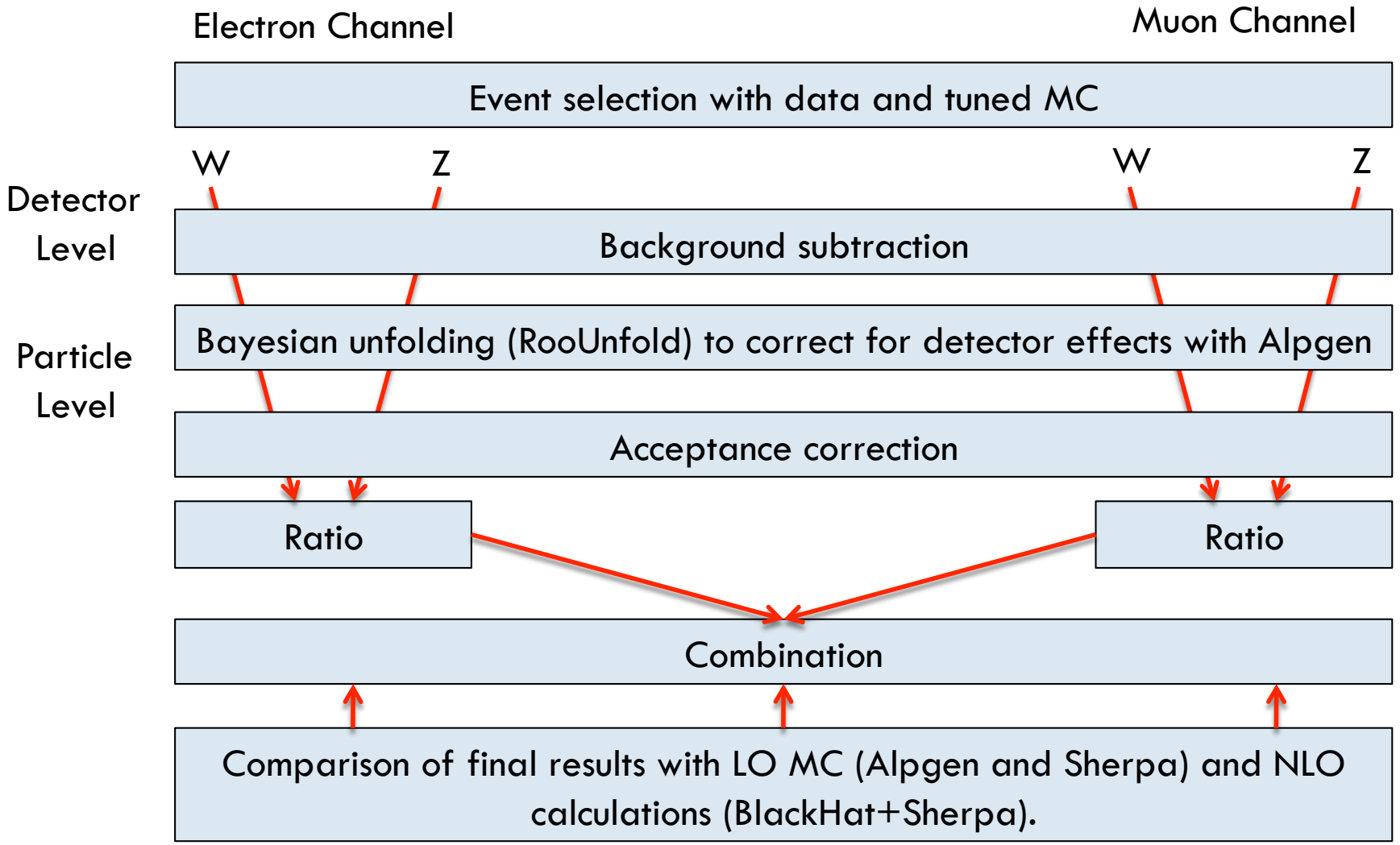


Measurement

- For the 2011 dataset we intend to perform comparisons with LO MCs (Alpgen and Sherpa) and with NLO calculations (BlackHat +Sherpa) and to extend the analysis scope to following distributions:
  - N_{jets}: Inclusive distribution and the ratio $N_{jet}/(N_{jet}-1)$
  - Jet properties: P_T and rapidity (y) of the 1st, 2nd, 3rd and 4th leading jets.
  - Dijet variables: M_{12}, ΔR_{12}, $\Delta \Phi_{12}$, Δy_{12}
  - P_T sums: H_T and S_T.

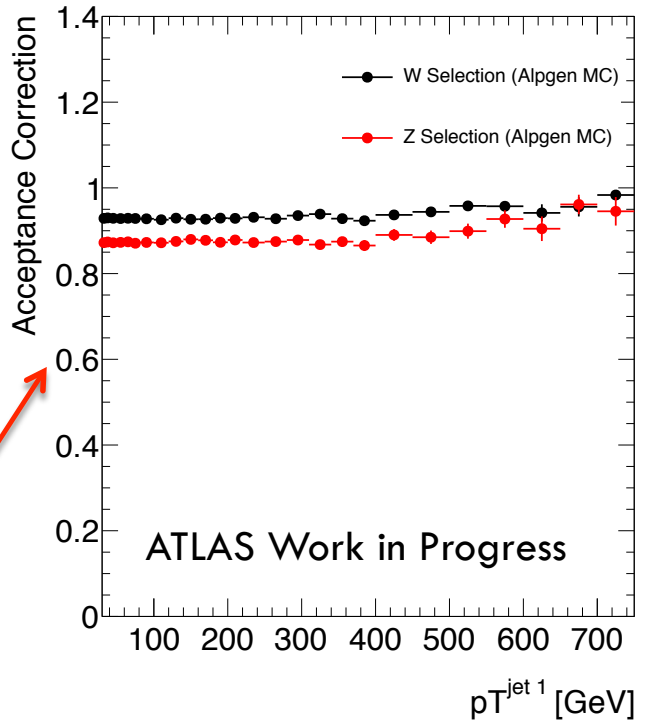
- Analysis group consists of members from QMUL, Oxford, UMass, Tufts, CERN, Santa Cruz, Michigan, Heidelberg, LBNL.

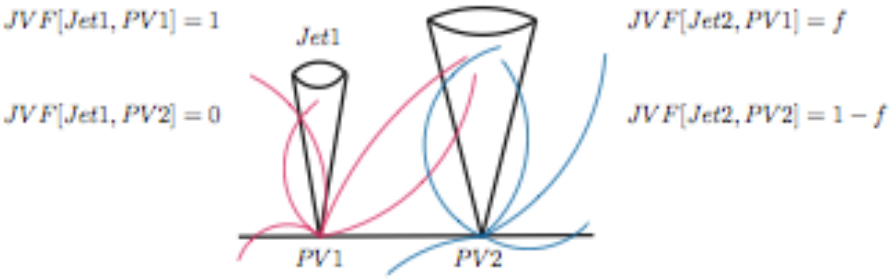
Analysis Strategy



Event Selection

- Boson Selection:
  - Z: $P_T(l)>20GeV$, $66 < M_{ll} < 116$ GeV
  - W: $P_T(l)>25GeV$, MET>25GeV, $M_T>40GeV$.
- Lepton η :
  - Electron channel: $|\eta|<2.47$ (excluding $1.37 < |\eta| < 1.52$).
  - Muon channel: $|\eta|<2.4$
  - Combination: Apply acceptance correction factors to correct to common phase space $|\eta|<2.5$.
    - Acceptance correction: #events passing fiducial phase space cut/#events passing common phase space cut.
    - Evaluated using Alpgen signal MC.
- Jet Selection:
  - $P_T>30GeV$, $|y|<4.4$, JVF>0.75
  - $\Delta R(l,jet)>0.5$





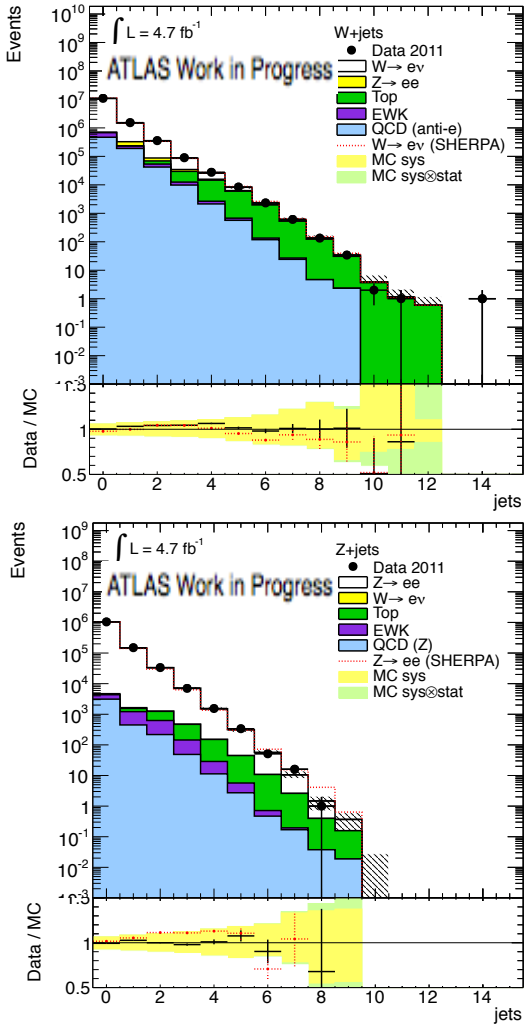
Detector Level Results

Data shows good agreement with current models up to N_{jet} >= 4.

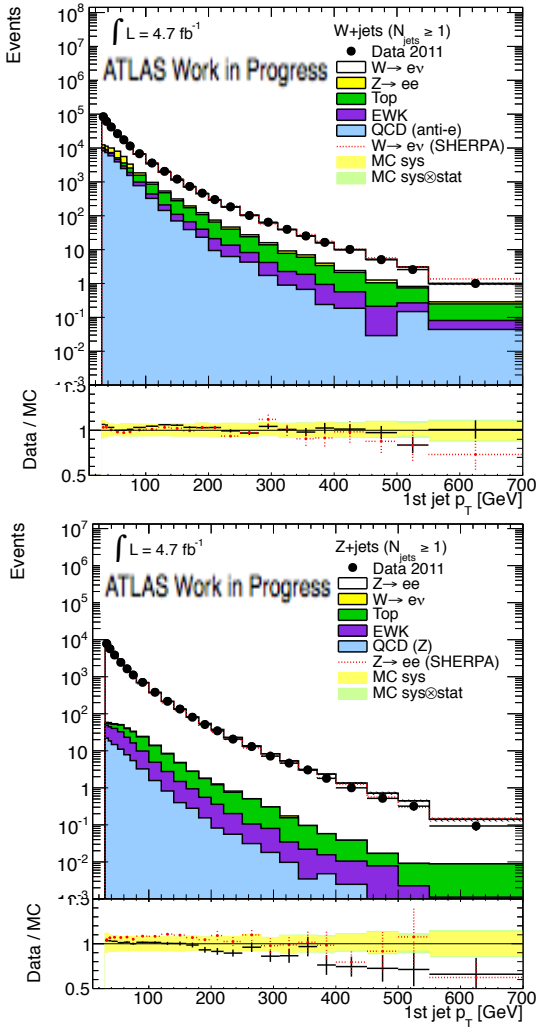
Here ttbar starts to dominate.

Data-driven estimation currently in process.

N_{jet}



Leading jet P_T

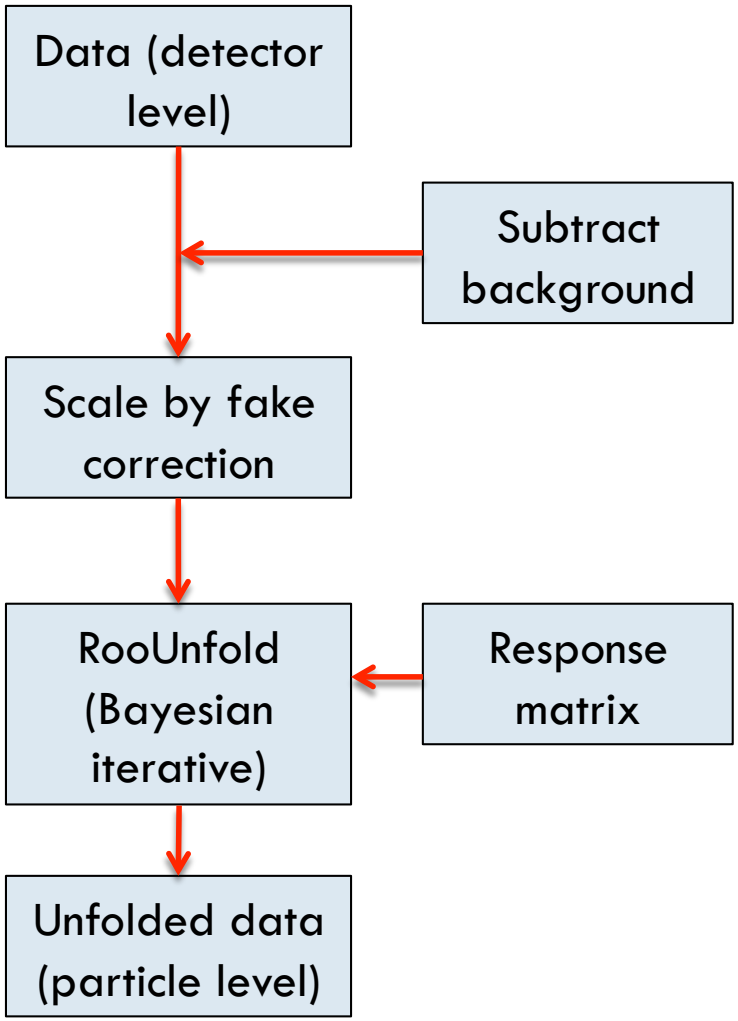


Measurement suffers at high P_T due to low statistics.

Plots on this slide courtesy of Craig Sawyer, University of Oxford.

Unfolding to Particle Level

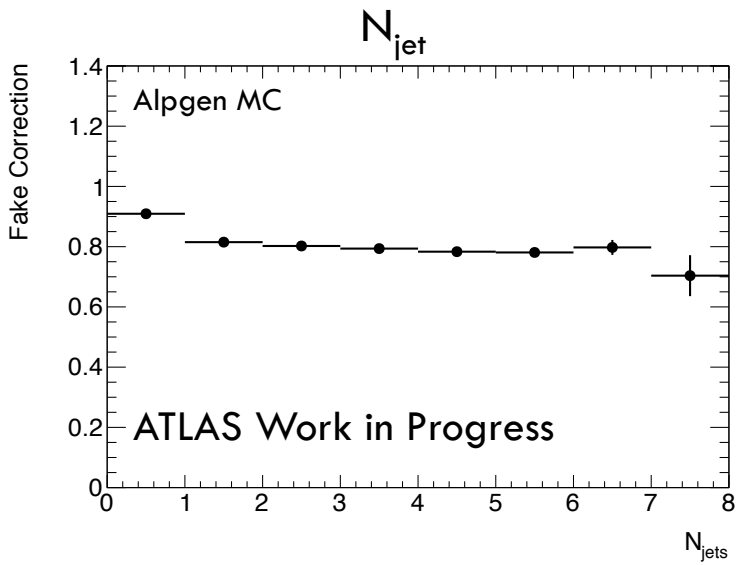
- Want to correct our data to account for detector level effects:
  - E.g. Trigger and reconstruction efficiencies and resolution.
- Bayesian iterative unfolding with RooUnfold.
  - Use Alpgen signal samples to build response matrices from events at reconstructed level and particle level.
- Apply external fake jet correction factors derived from Alpgen after background subtraction and before unfolding.
  - Accounts for reconstructed level events which are unmatched at particle level.
- Systematics associated with the unfolding procedure:
  - Model: Choice of signal MC used to unfold (e.g. Alpgen, Sherpa etc.)
  - Method: Bayesian vs. Bin-by-bin.
  - Statistical: Limits of MC sample size used to unfold.

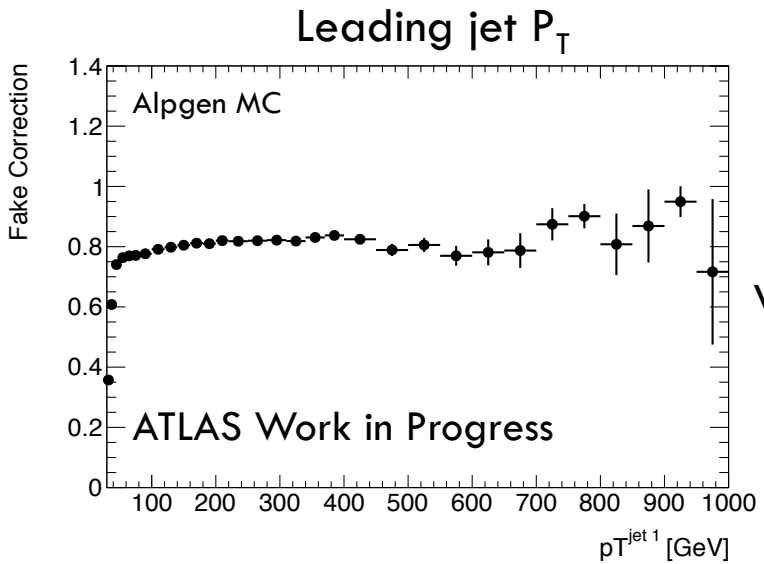


Fake Corrections

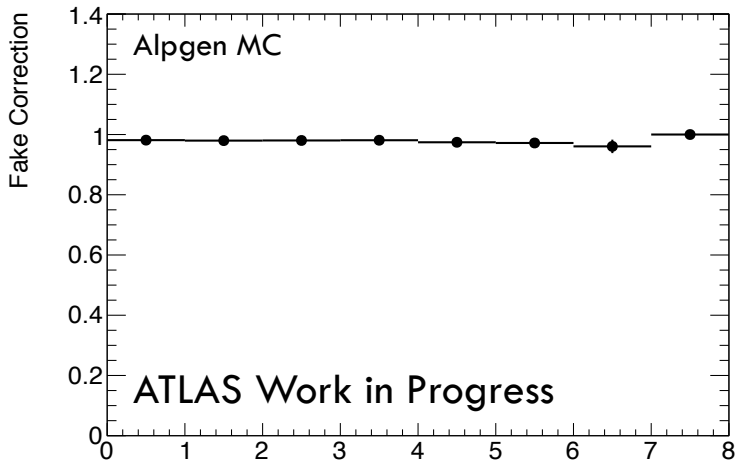
Fake correction:

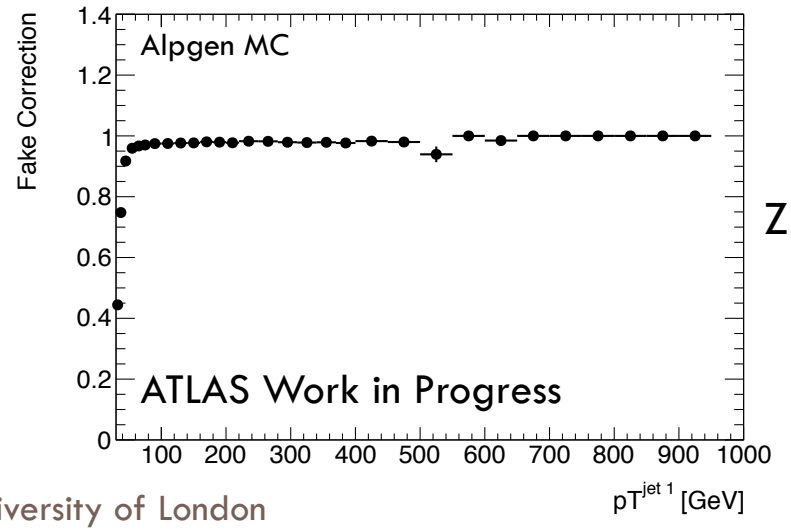
#events that pass both reco and particle level selections / #all reco events





W





Z

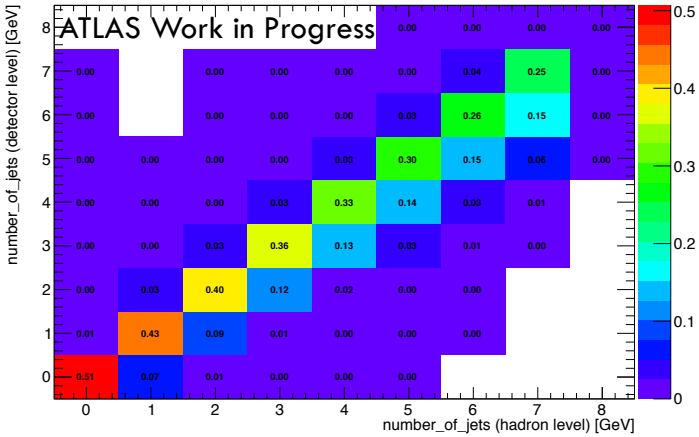
Response Matrices

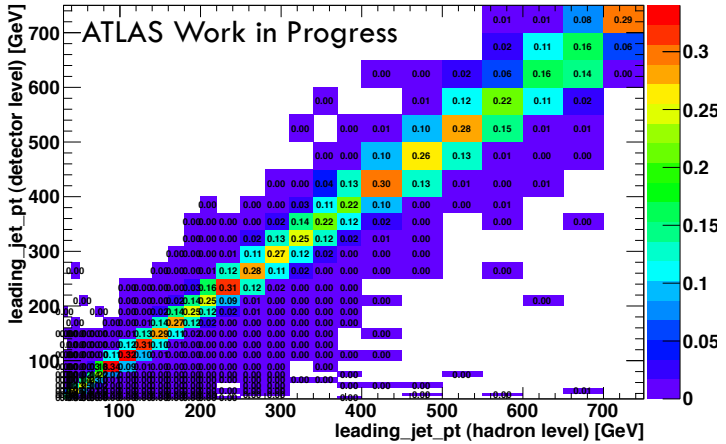
Built using Alpgen signal samples.

Here each bin is normalised to the particle level entries in each column.

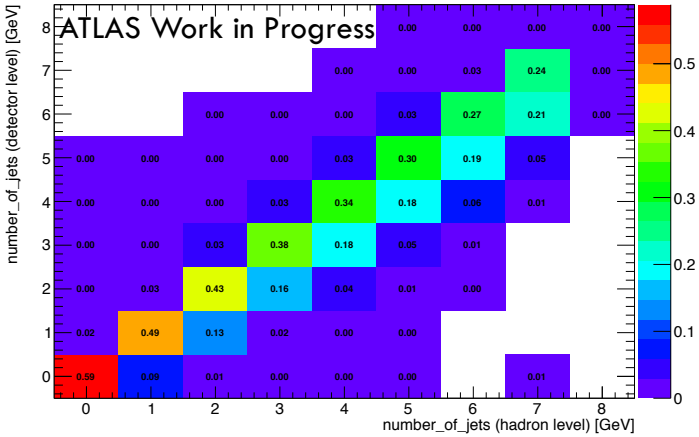
$$\frac{N_{ij}}{\sum_i N_{ij}}$$

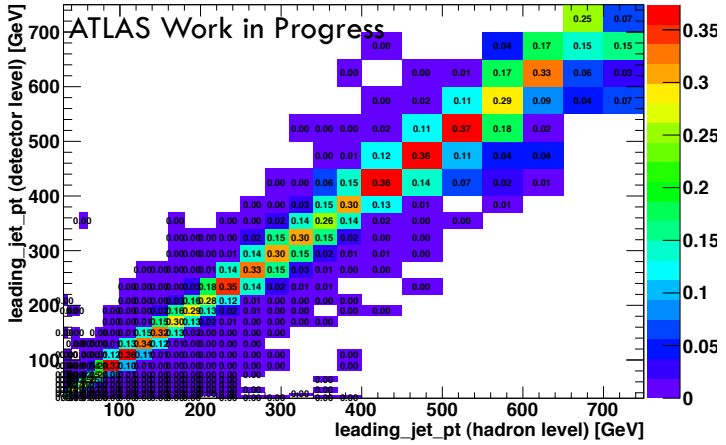
N_{jet} | Leading jet P_T





W



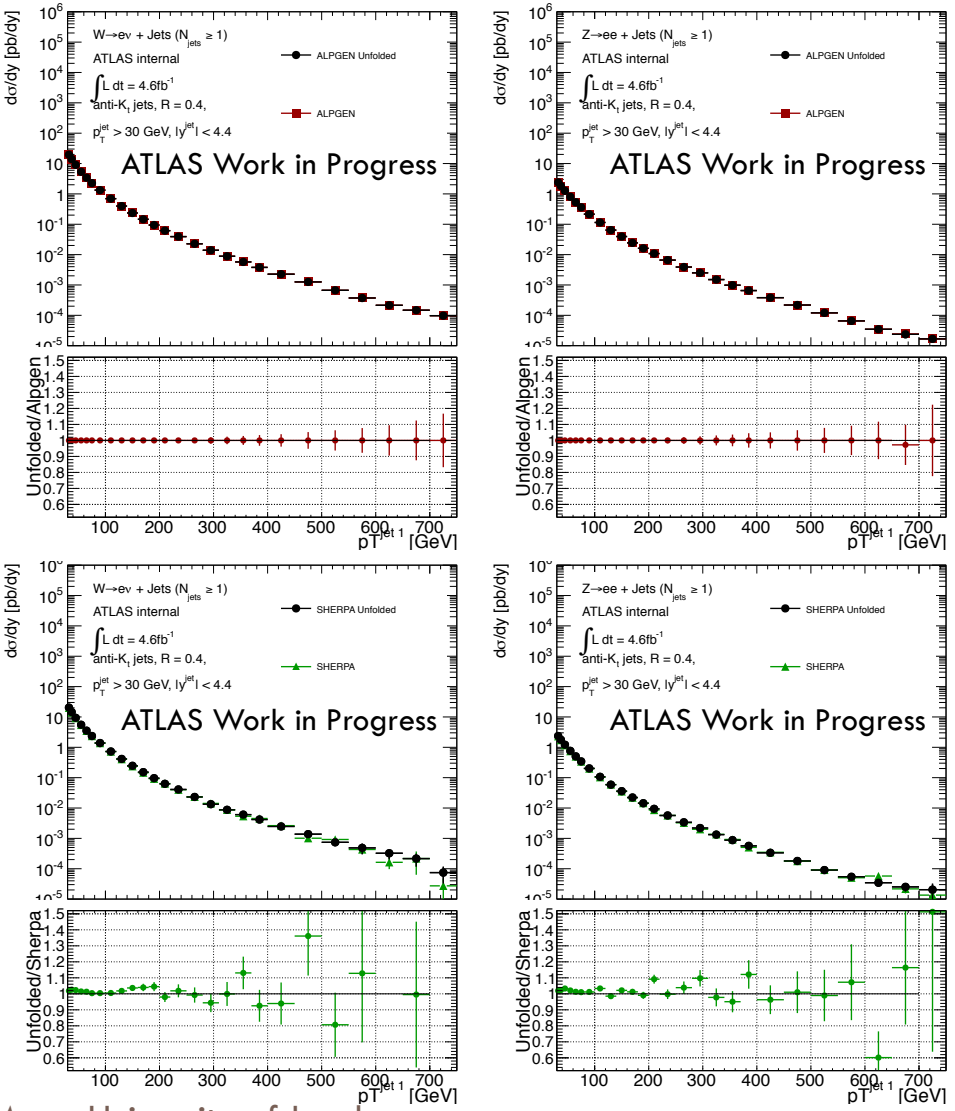


Z

Closure Tests

- Perform the unfolding procedure using Alpgen MC in place of data.
- Expect very good agreement.

- Unfold Sherpa signal MC using Alpgen.
- Good agreement in the low P_T region.
- Low statistics at high P_T, unfolded results agree with the prediction within our systematic errors.



Conclusions

- R_{jets} is a very high precision measurement which, with the high statistics of the 2011 ATLAS dataset, we can expand upon the 2010 analysis to include a large number of observables.

- Current state of the analysis:
  - Finalising unfolding procedure and associated systematics.
  - Studies ongoing to provide data-driven ttbar and QCD background estimations.
  - Aiming to publish as soon as possible.