Measurement of dijet production with a veto on additional central jet activity in pp collisions at $\sqrt{s}$ = 7 TeV using the ATLAS detector

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ABSTRACT: A measurement of jet activity in the rapidity interval bounded by a dijet system is performed using pp collisions at 7 TeV recorded by ATLAS detector in 2010. Events are vetoed if a jet with transverse momentum greater than 20 GeV is found between the boundary jet. The data are compared to NLO parton shower prediction from POWHEG, all order resummation prediction from HEJ and LO predictions from PYTHIA, HERWIG++ and ALPGEN event generators.

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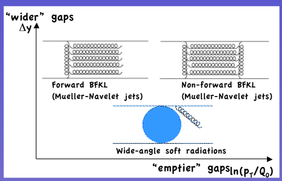
MOTIVATIONS:

Expect that fixed order calculations will do well when there is no hierarchy of scales.



All order resummation necessary when:

- *The boundary jet rapidity separation (Δy) is large*
- *The average transverse momentum of the boundary jets $\overline{p_T}$ is much larger than a jet veto scale Q_0*

This measurement probes the theory predictions and experimental techniques that are relevant for Higgs searches in the VBF channel.

CORRECTIONS FOR DETECTOR EFFECTS:

1.- Detector Unfolding: *quadrature sum of different effects*

- **Physics modelling**: evaluated by reweighting with arbitrary functions the following distributions in PYTHIA: Δy, boundary jets and third jet pT
- **Detector simulation/modeling**: evaluated by reweighting the (z) vertex position and varying the jet reconstruction efficiency and resolution
- **Statistical error** on PYTHIA distributions

2.- Jet Energy Scale: JES uncertainty determined per jet of a given pT and η from the JESProvider

- Examined effects of correlated and uncorrelated JES in different regions of the calorimeter. Largest effect comes from JES uncertainties that are correlated.

+ *Negligible sources:* effectiveness of one vertex requirement (stability with pile up), cosmic and beam related background, jet cleaning cut (loose versus medium), trigger strategy.

MONTE CARLO PREDICTIONS

Leading Order

- **PYTHIA 6** tune AMBT1 (used for unfolding), **HERWIG++** tune LHC-UE7-1, **ALPGEN**+HERWIG/JIMMY tune AUET1
- Comparison to ATLAS official samples has to be done in a limited phase space region (i.e. low Δy and/or small boundary jet average p_T) due to lack of MC statistics.

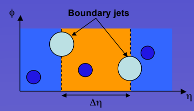
Next to Leading Order

- ***High Energy Jets*** (HEJ) is a BFKL-like approach to producing multi-leg final states. No soft parton shower / hadronisation (yet).
- ***POWHEG Box*** recently implemented NLO dijet production. POWHEG is interfaced to both PYTHIA and HERWIG to allow parton-shower, hadronisation and MPI.

MEASUREMENTS:

Event Selection:

- AntiK$_T$ jets R = 0.6, p_T > 20 GeV, |η| < 4.4
- Only one reconstructed vertex with 5 or more tracks
- Event required to pass appropriate jet trigger



Two definitions of **Boundary jets:**

A.- Two leading p_T jets in the event.

B.- Most forward and most backward jets in the event with p_T>20GeV.

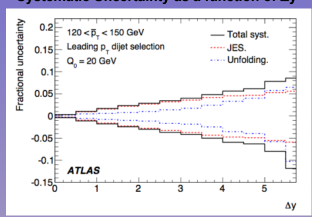
And 0 < Δy < 6, $\overline{p_T}$ > 50 GeV

Gap events: subset of events that do not contain an additional jet with p_T above the veto scale Q_0 = 20 GeV in the rapidity interval between the boundary jets.

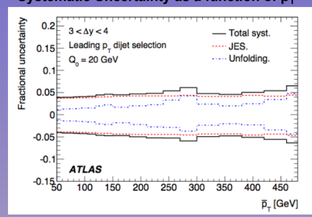
Main observables:

- The fraction of gap events to inclusive events → ***Gap Fraction***
- The ***Mean number of jets in the rapidity interval*** between the boundary jets (not shown here)

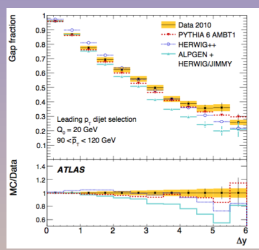
Systematic Uncertainty as a function of Δy

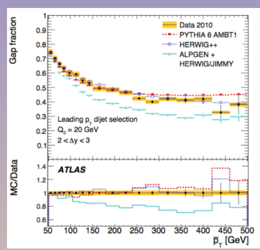


Systematic Uncertainty as a function of $\overline{p_T}$



COMPARISON of DATA to LO MONTE CARLO

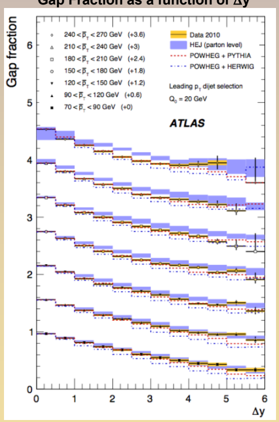




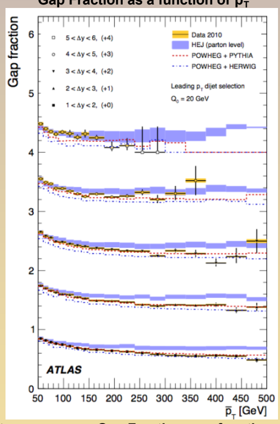
- See wide range of predictions between different MC's.
- Best descriptions provided by PYTHIA and HERWIG++

----FINAL RESULTS---

Gap Fraction as a function of Δy



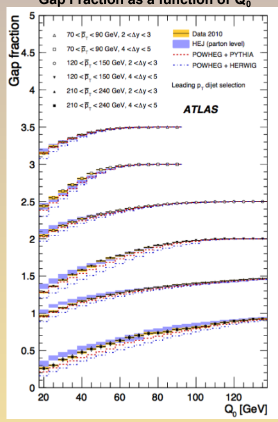
Gap Fraction as a function of $\overline{p_T}$



Leading-p_T jets selection

- In general POWHEG+PYTHIA provides the best description of the data.
- Both POWHEG predictions result in too low a gap fraction at large Δy → Fixed order plus parton shower approach does not contain higher QCD effect important as Δy increases.
- Parton-level HEJ prediction has too little a jet activity and too large a gap fraction at large $\overline{p_T}/Q_0$ → missing higher order QCD effects that become important as $\overline{p_T}/Q_0$ increases.
- HEJ describes Data well as a function of Δy.

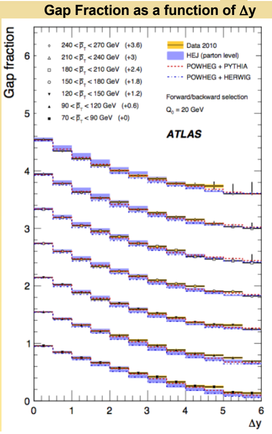
Gap Fraction as a function of Q_0



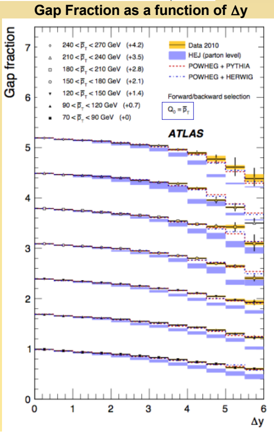
Leading-p_T jets selection

- Q_0 dependence of the cross section useful in studying the colour structure.
- HEJ description of the data improves as Q_0 approaches $\overline{p_T}$.

Gap Fraction as a function of Δy



Gap Fraction as a function of Δy



Forward/Backward jets selection

- p_T-imbalance between two jets typically much larger than in Leading-p_T jets selection.
- Data not well described by HEJ at low p_T resummation of soft emissions important in this configuration. POWHEG descriptions similar to HEJ.

In most of phase-space regions, the experimental uncertainty is smaller then theoretical ones, and smaller than the spread of LO Monte Carlo predictions.

Data can therefore be used to constrain the event generator modelling of QCD radiation between widely separated jets.