Forward and Diffractive Physics

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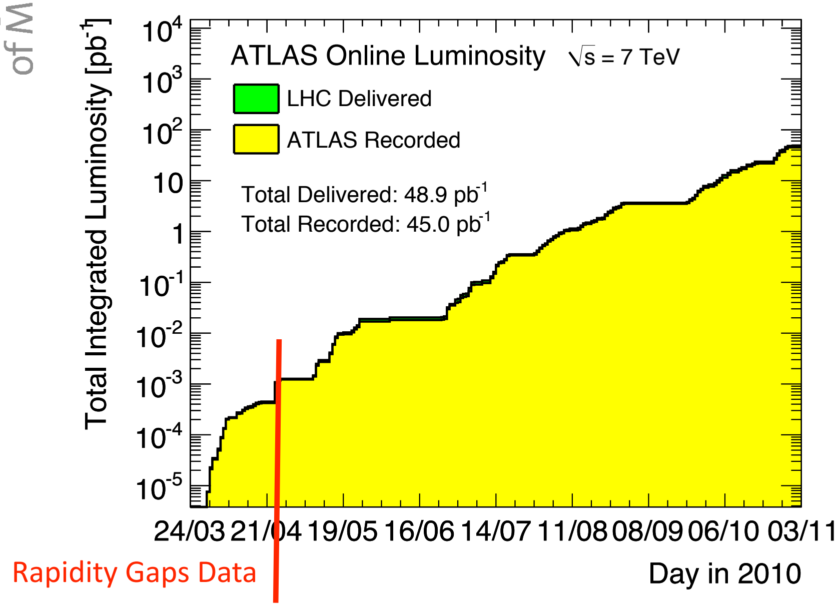
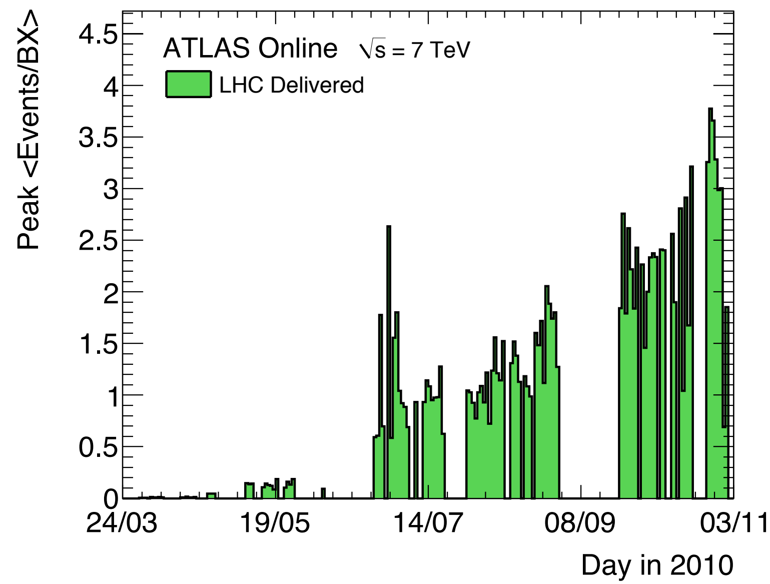
On behalf of the ATLAS Collaboration

Outline

- Overview of the LHC and ATLAS detector
- Measurement of the inelastic cross section as a function of the size of forward rapidity gaps
- Dijet Production with jet veto

The LHC





The inelastic cross section as a function of rapidity gap size result only uses a small proportion of the 2010 data because:

- Requires very low pile-up runs
- High rate (not statistics limited)

The dijet production with jet veto analysis uses all the 2010 data. 2011 data is not used as high levels of pile-up degrade the gap definition.

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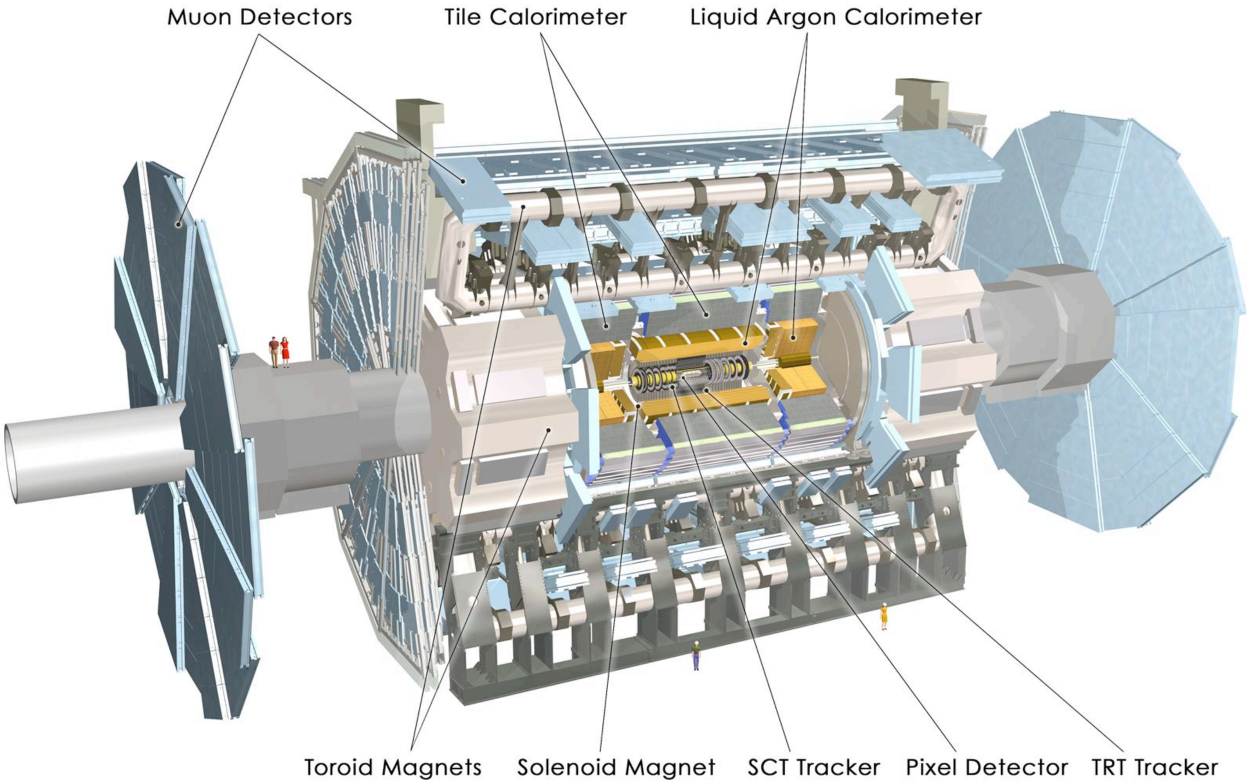
ATLAS Detector



Analyses presented today concerned with:

- Calorimeter: can measure energy deposits to $|\eta|<4.9$
- Inner detector tracking: can measure tracks out to $|\eta|<2.5$

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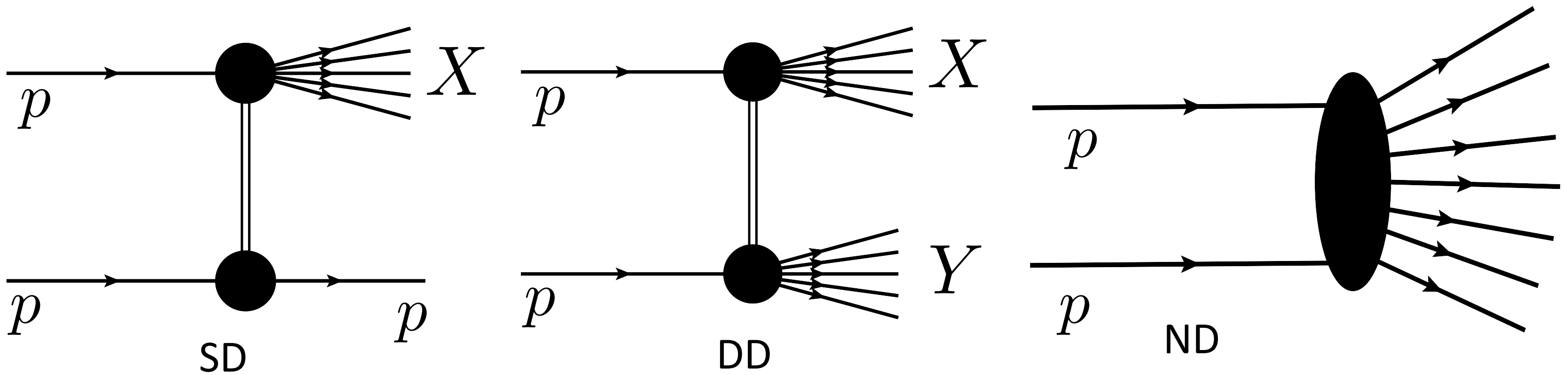
MEASUREMENT OF THE INELASTIC CROSS SECTION AS A FUNCTION OF THE SIZE OF FORWARD RAPIDITY GAPS

ATLAS-CONF-2011-059

Introduction

$$\sigma_{inelastic} = \sigma_{SD} + \sigma_{DD} + \sigma_{ND}$$

- $\sigma_{Inelastic}$ is composed of single diffractive dissociation (SD), double diffractive dissociation (DD) and non-diffractive (ND) components.
- Diffractive processes make up ~30% of $\sigma_{Inelastic}$, but have large theoretical uncertainties.



- ATLAS detectors have limited acceptance ($|\eta|<4.9$), meaning system X or Y sometimes not contained in the detector.

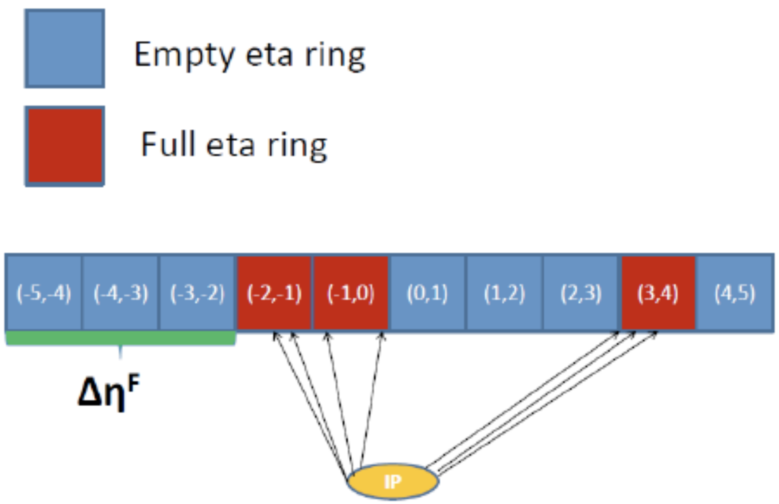
Gap Definition

Detector level rapidity gap definition

- Detector divided into rings of pseudo-rapidity (49 rings for $-4.9<\eta<4.9$)
- Ring has activity if there is either:
  - Track with $p_T>200$MeV and $|\eta|< 2.5$
  - Or calorimeter cell above noise threshold

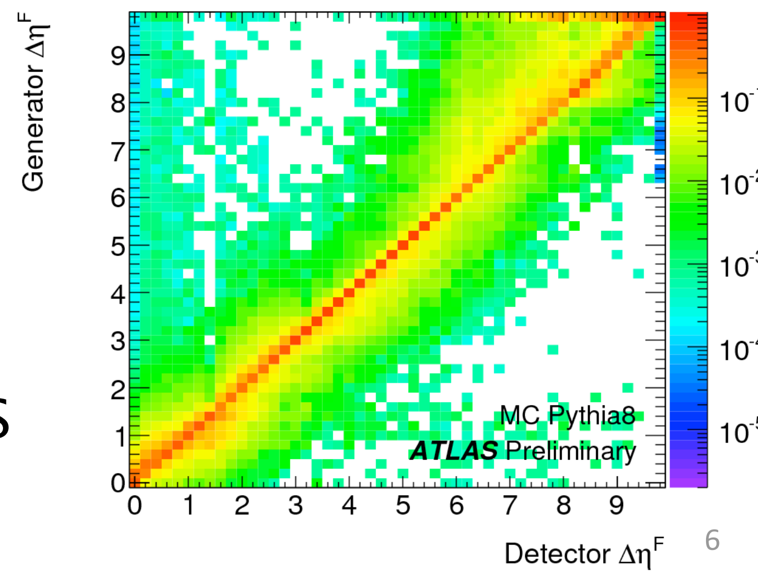
Particle level rapidity gap definition

- Divided into same pseudo-rapidity rings
- Ring has activity if:
  - stable particle with $p_T>200$MeV and $|\eta|< 4.9$

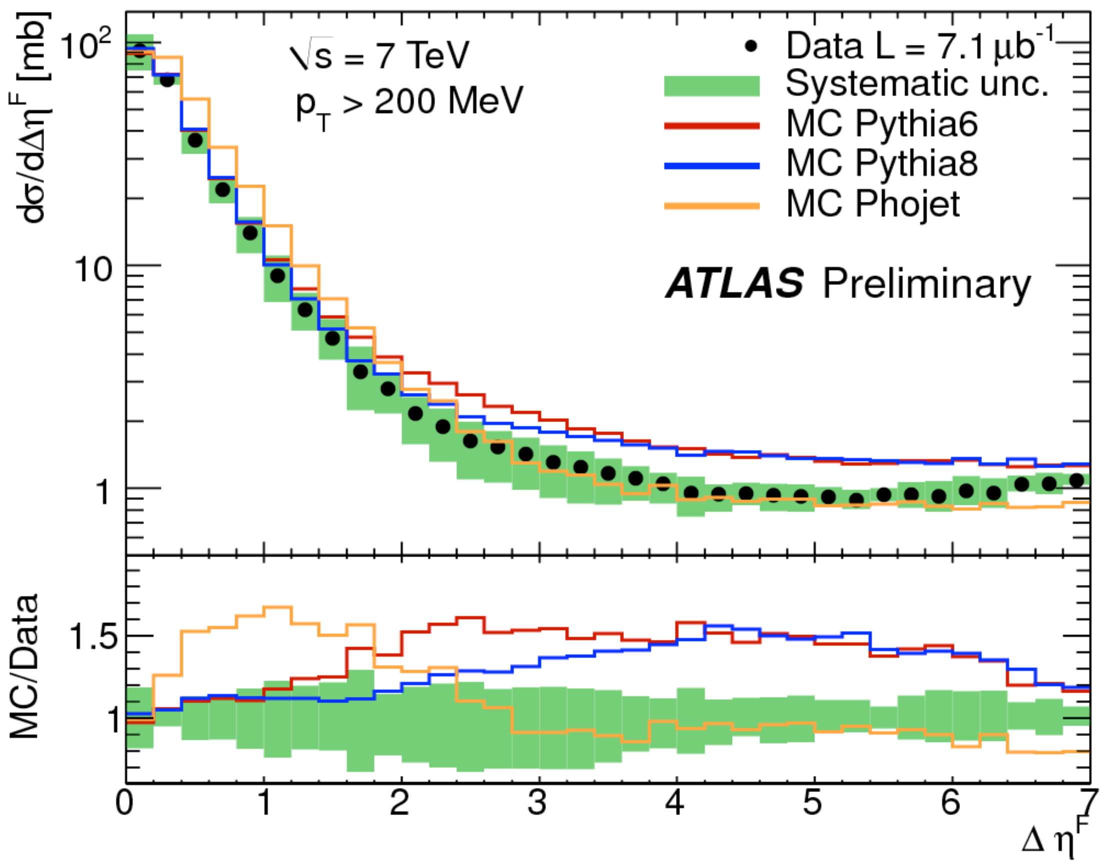


$\Delta\eta^F$ is defined by the largest consecutive collection of empty rings from edge of calorimeter.

All results are corrected to particle level and could be compared with non-ATLAS data/theoretical predictions



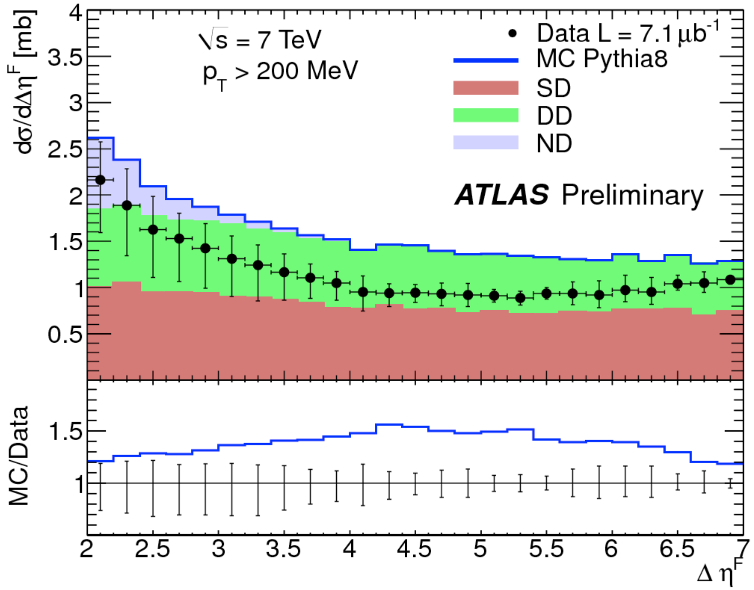
Results (i)

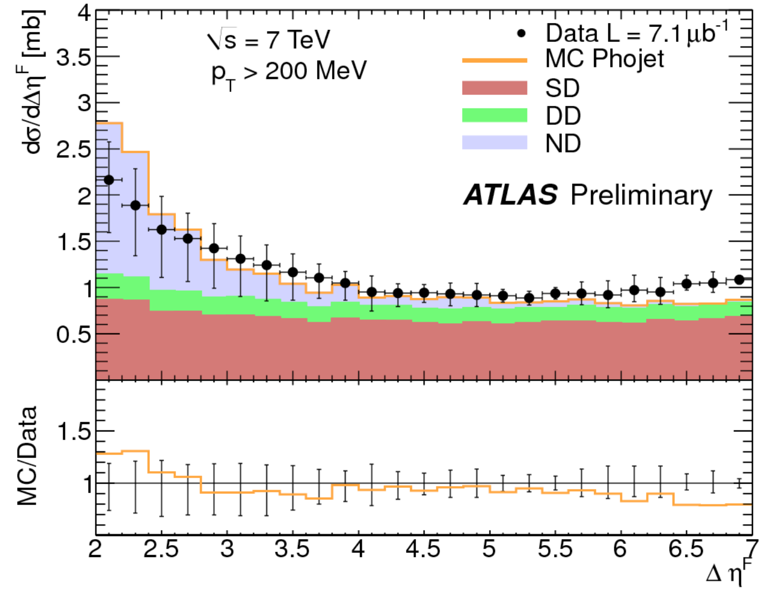


Neither MC matches the data perfectly

- Pythia agrees well for small $\Delta\eta^F$ but not for $\Delta\eta^F>3$
- Phojet agrees well for $\Delta\eta^F>3$ but not at small $\Delta\eta^F$

Results (ii)



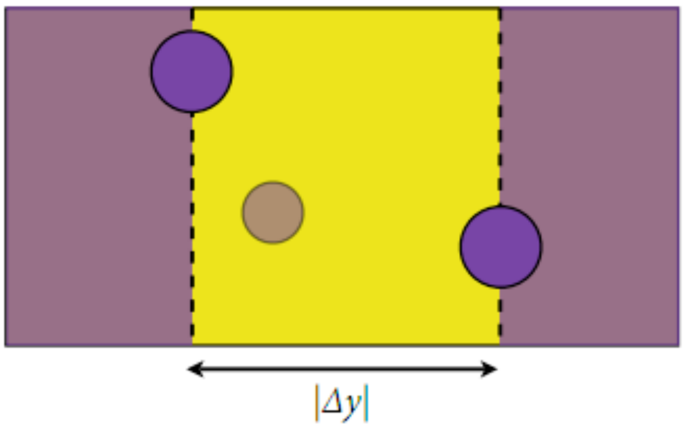


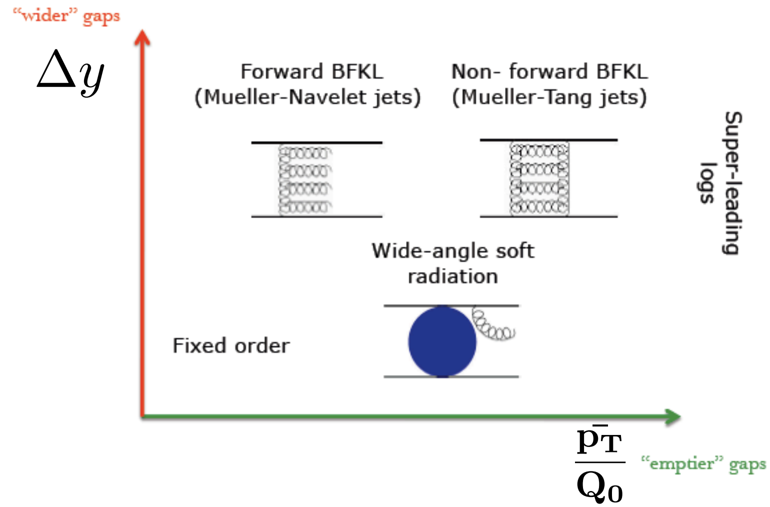
- For $\Delta\eta^F>3$ both MCs dominated by diffractive events
- Observe that $d\sigma/d\eta^F$ is about 1 mb after $\Delta\eta^F>3$
- Difference between MCs hints that Pythia8 is overestimating the DD contribution (both agree on the SD contribution).

DIJET PRODUCTION WITH JET VETO

arXiv:1107.1641v2, accepted by JHEP

Introduction





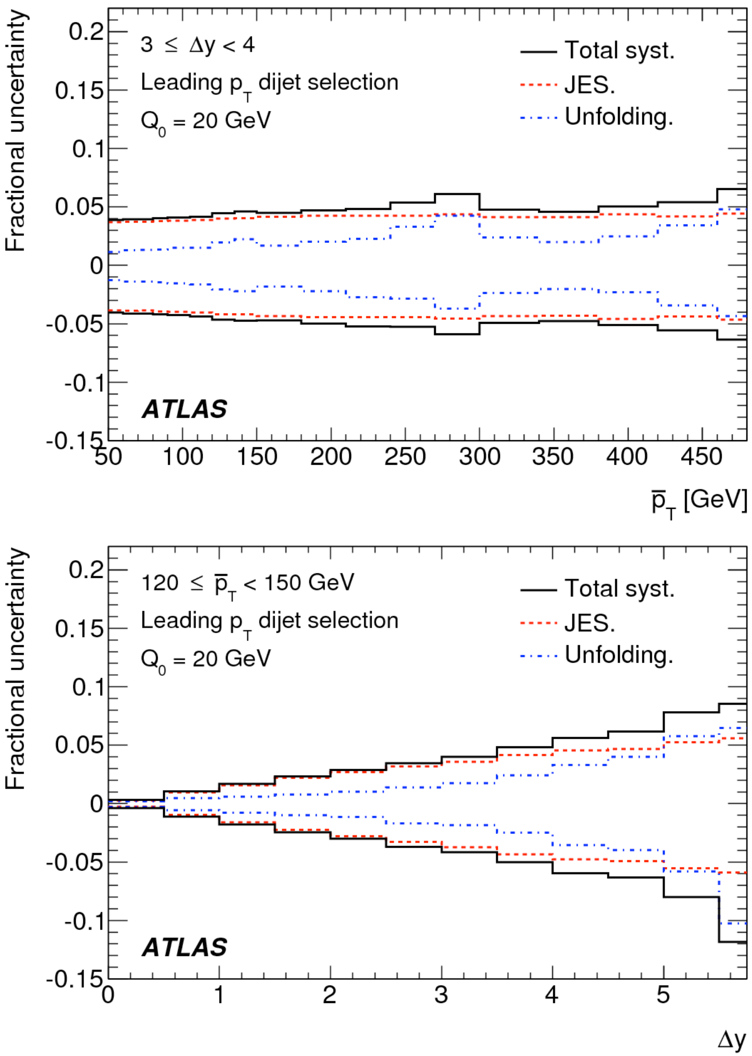
- Jets reconstructed using the anti-k_t algorithm with distance parameter R = 0.6. Jets considered if $|\eta|<4.4$ and $p_T>20$GeV
- The boundary dijets are defined as the 2 highest p_T jets in the event, and have a average p_T ($\bar{p_T}$) cut of 50 GeV
- Gap events have no 3[rd] jet with $p_T>Q_0$ lying in the rapidity interval. (Default value of Q_0=20GeV)
- $$GapFraction = \frac{N_{GapEvents}}{N_{InclusiveEvents}}$$
- All distributions are corrected to particle level

Theory Predictions

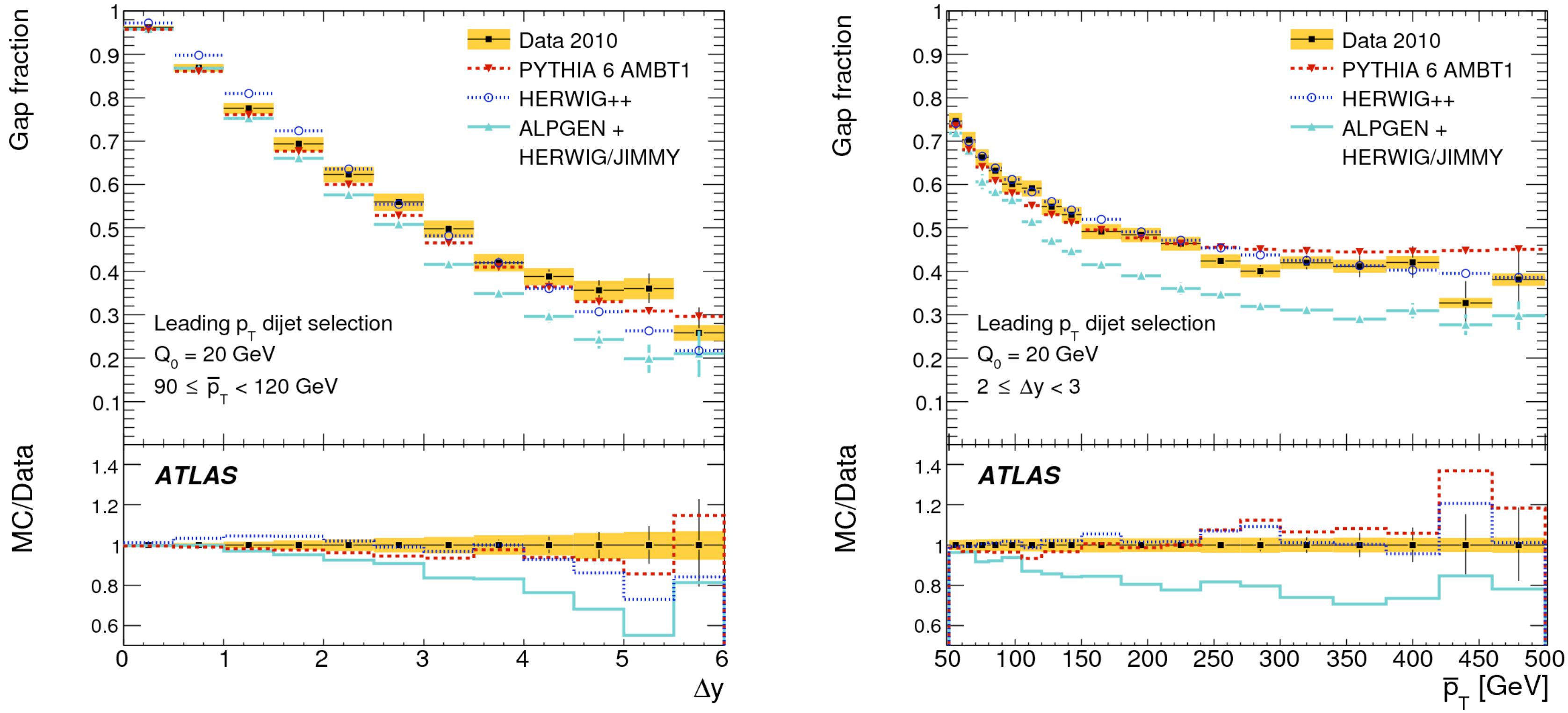
- We are probing extreme areas of phase space and at large values of p_T/Q_0 and Δy resummation to all orders of perturbation theory is necessary.
- Theoretical predictions were produced using:
  - POWHEG = NLO MC plus parton shower (through both PYTHIA and HERWIG)
  - HEJ = all order description of hard wide angle emissions
- Data is also compared to leading order MCs:
  - PYTHIA with AMBT1 tune
  - HERWIG++ with LHC-UE7-1 tune
  - ALPGEN with AUET1 tune (passed through HERWIG and JIMMY)

Uncertainties

- Main uncertainties in result come from unfolding and JES
- The overall uncertainty is weakly dependent on $\bar{p}_T$.
- Each uncertainty rises with Δy
  - Unfolding uncertainty rises due to lower statistics
  - JES uncertainty rises as the jets fall in different regions with different JES uncertainties

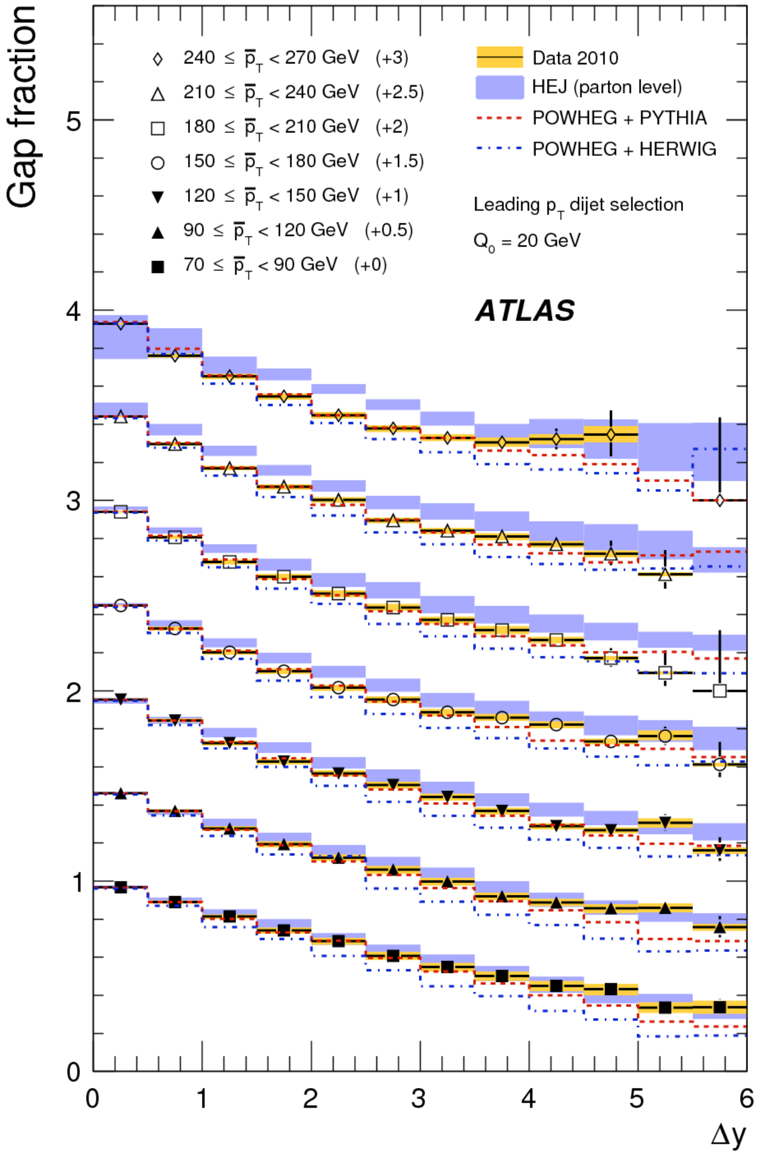


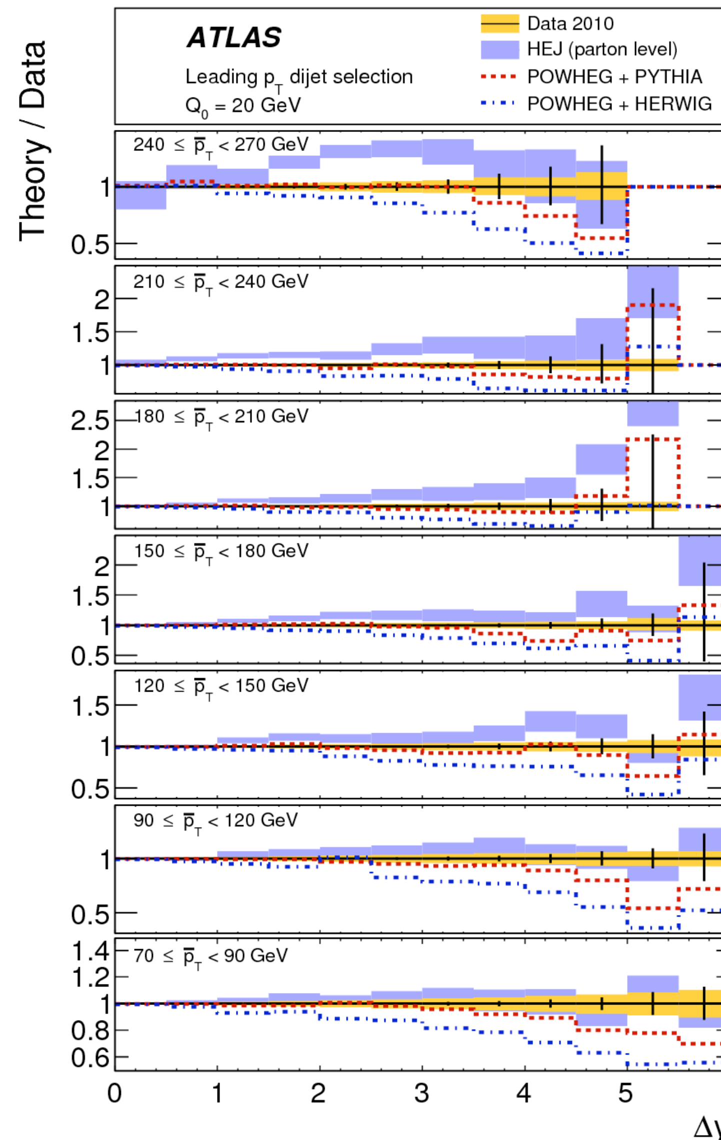
Leading order MC comparison



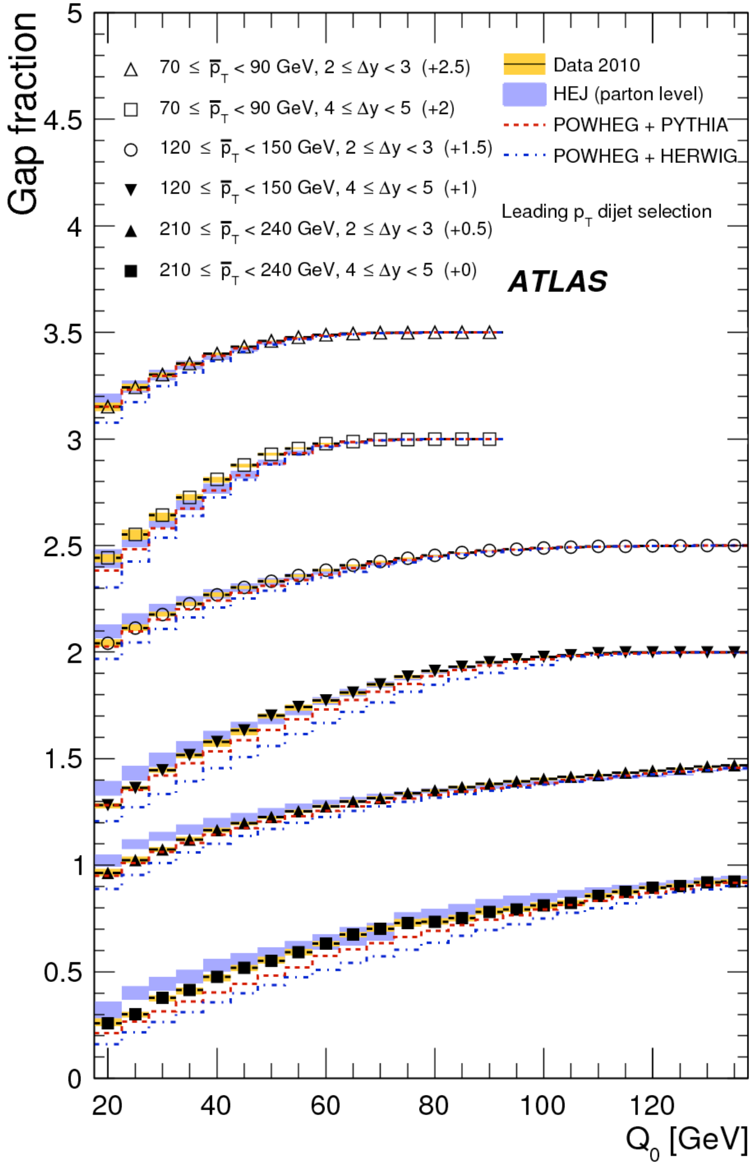
- Looking at the gap fraction as a function of Δy and $\bar{p_T}$
- Spread of LO MCs indicative of theory uncertainties
- Now will compare the data across lots of phase space to HEJ and POWHEG

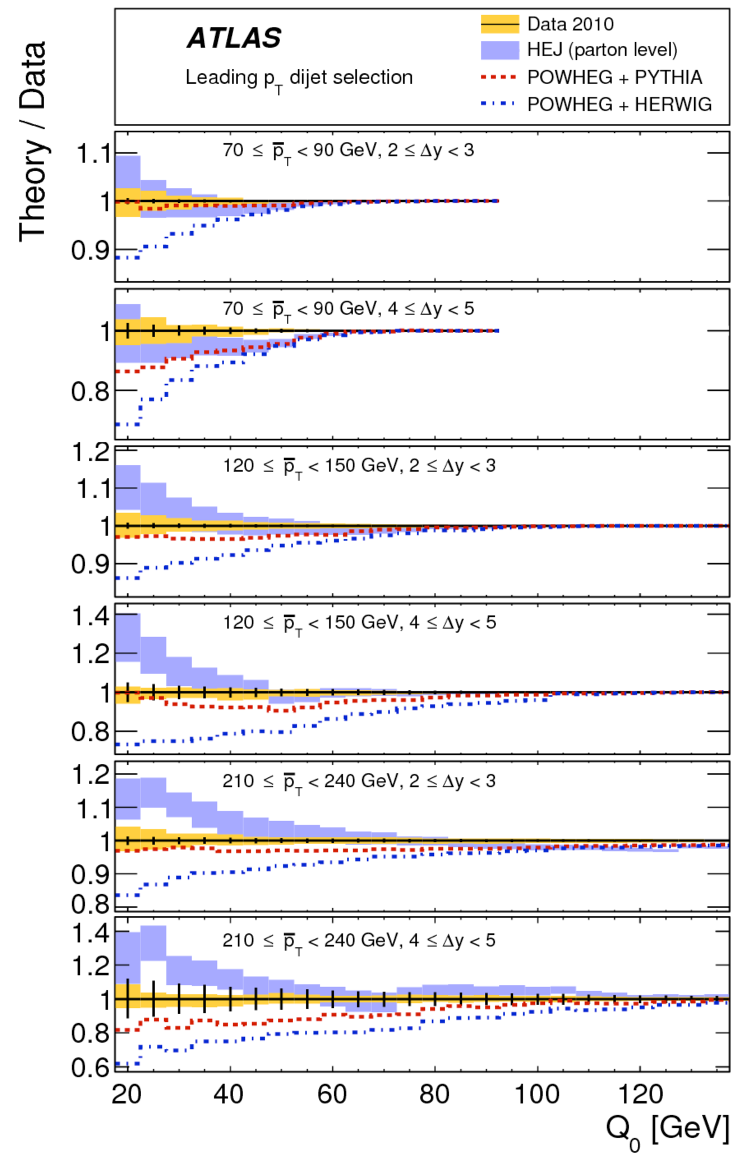
Gap fraction vs Δy





Gap fraction vs Q_0





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Summary

Dijet Production with a Jet Veto:

- The gap fraction, the fraction of dijets which have no additional jet above a $p_T > Q_0$ is measured.
- The gap fraction is shown as a function of Δy, Q_0 and $\bar{p_T}$
- None of the MCs considered show perfect agreement
  - POWHEG agrees well in the low Δy, but gives too low a gap fraction for large Δy
  - HEJ describes data vs Δy well for low $\bar{p_T}$, but gives too high a gap fraction at large $\bar{p_T}$

"The message is clear: the accuracy of the ATLAS data already demands better theoretical calculations", R Delgado et al, JHEP 1108 (2011) 157.

Forward Rapidity Gap analysis:

- The inelastic cross section as a function of the size of the forward rapidity gap is presented
- Neither MC got the distribution correct
  - Phojet gave a better description of the region $\Delta\eta^F > 3$.
  - Pythia's estimate of the double diffractive dissociation has a bigger contribution in the region $\Delta\eta^F > 3$.
- Observed that the $d\sigma/d\eta^F$ is about 1 mb after $\Delta\eta^F > 3$

Backup

Gap fraction vs $\bar{p}_T$