First jets and QCD results in ATLAS

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on behalf of the ATLAS collaboration

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Outline

Detector overview, data sample and event selection

Jet reconstruction performance

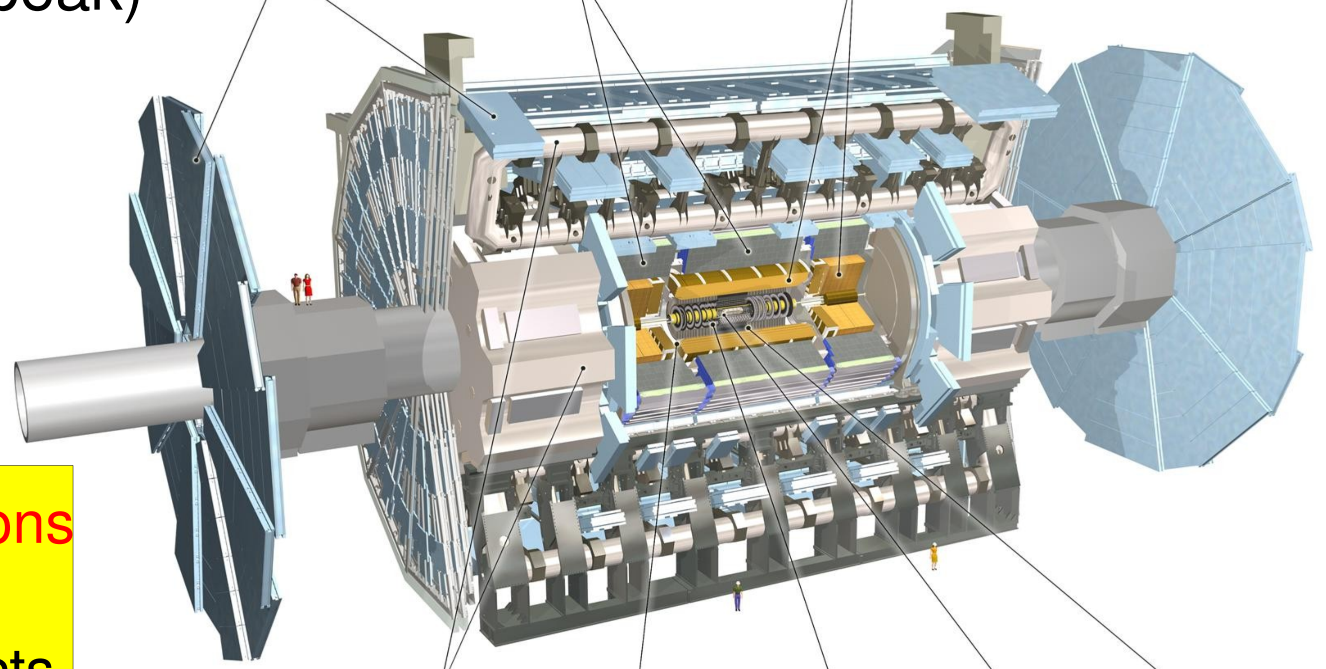
Inclusive jet and di-jet kinematic distributions

Conclusions

Detector overview
Data samples
Event selection

ATLAS Detector overview

Magnetic field: one solenoid surrounding the ID (2T), one toroid (muon spectrometer - 4T peak)



ID made up of three different detectors (Pixel, SCT, TRT):
High resolution tracking in $|\eta| < 2.5$

EM calorimeter - two sections covering up to $|\eta| \approx 3.2$.
High resolution on e/γ objects.

HAD calorimeter - 3 sections covering up to $|\eta| \approx 5$
Good containment, good resolution for jet measurement

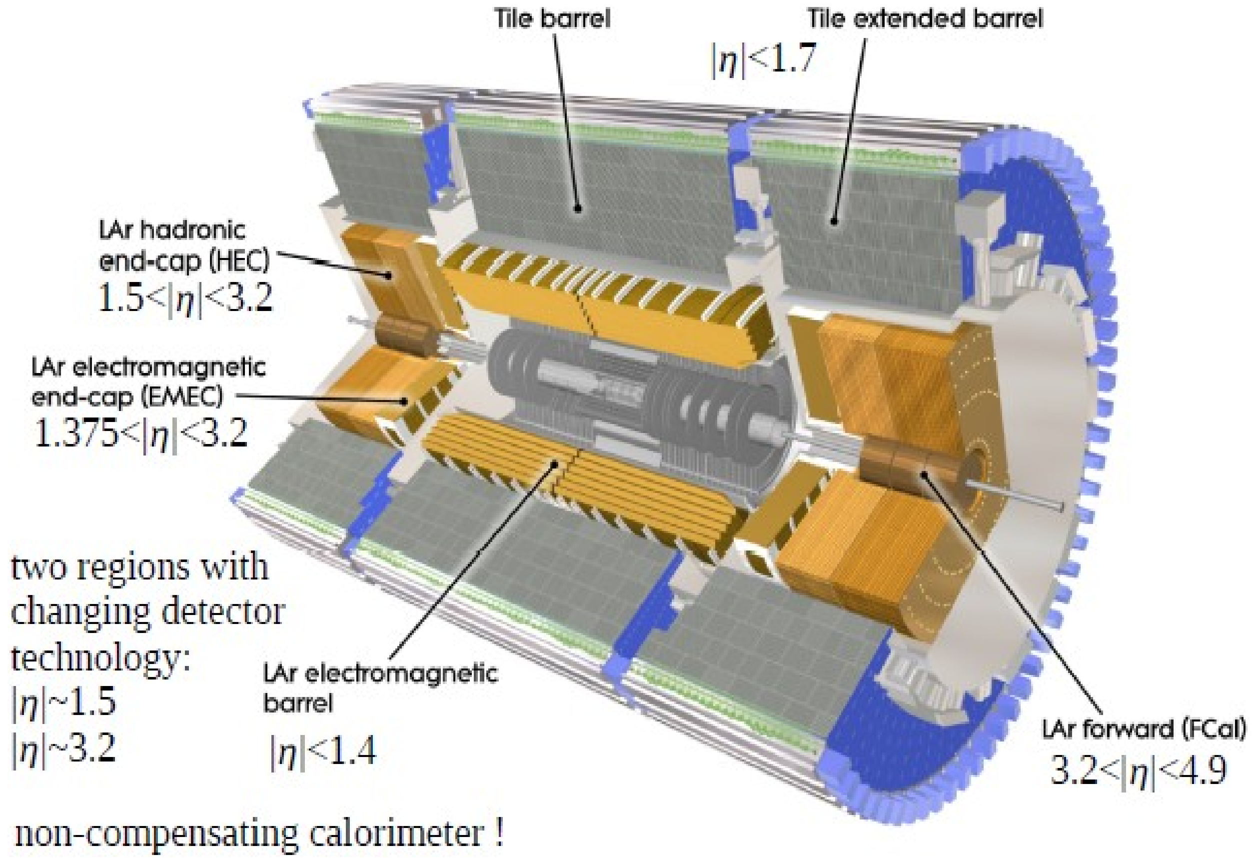
Muon system (4 different technologies) covering up to $|\eta| = 2.7$
High precision muon momentum measurement (also standalone)

ATLAS Calorimeter System

EM LAr: $|\eta| < 3$ - Pb/LAr calorimeter, high resolution for e/γ objects. e/h ~1.7

Central hadronic calorimeter (TileCal): $|\eta| < 1.7$: Fe(82%), scintillator (18%) - e/h = 1.36

End Cap Hadronic Calorimeter (HEC): $1.7 < |\eta| < 3.2$ - Cu/LAr



Forward calorimeter: $3 < |\eta| < 4.9$. First layer EM (Cu/LAr), the two remaining layers HAD.

Highly hermetical ($|\eta| < 5$), non compensating calorimeters.

Data Sample

Dataset recoded by ATLAS as of June 20th:

16 nb^{-1} at 7 TeV

In this talk:

For Jet Quality:

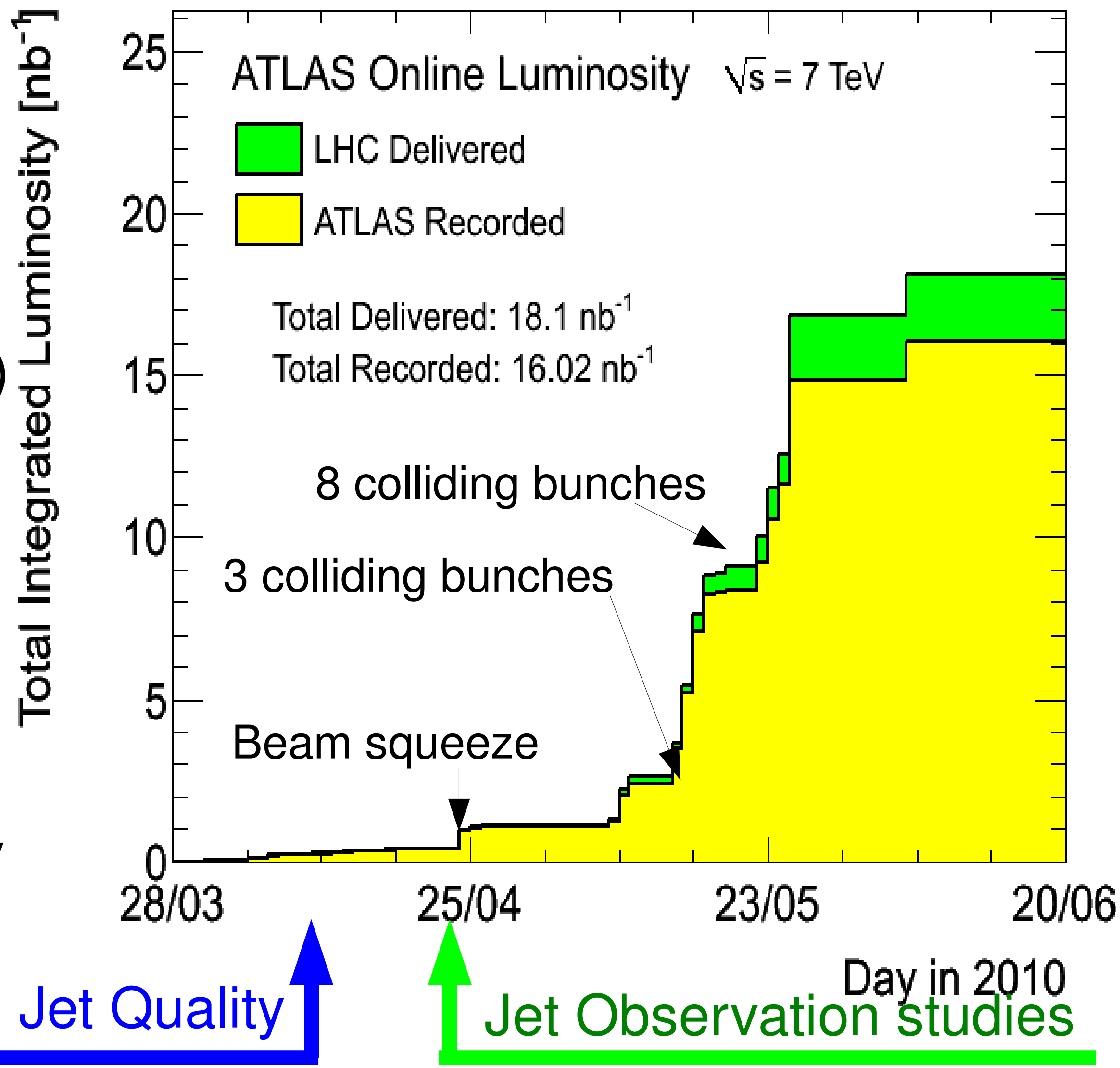
0.3 nb^{-1} (~1.4×10^{7} events)

Jet Observation studies:

1 nb^{-1}

For Jet Calibration and E/P studies:

3×10^{5} events at 900 GeV

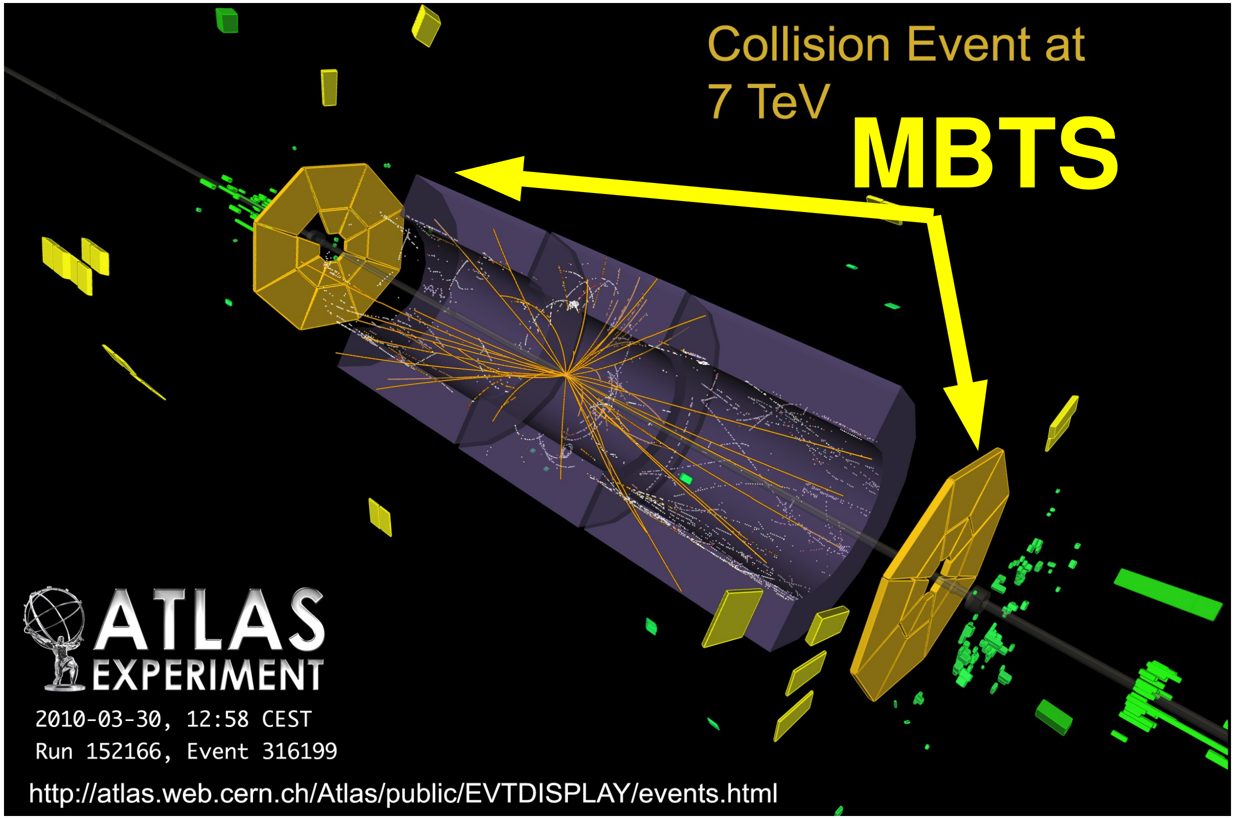


Trigger

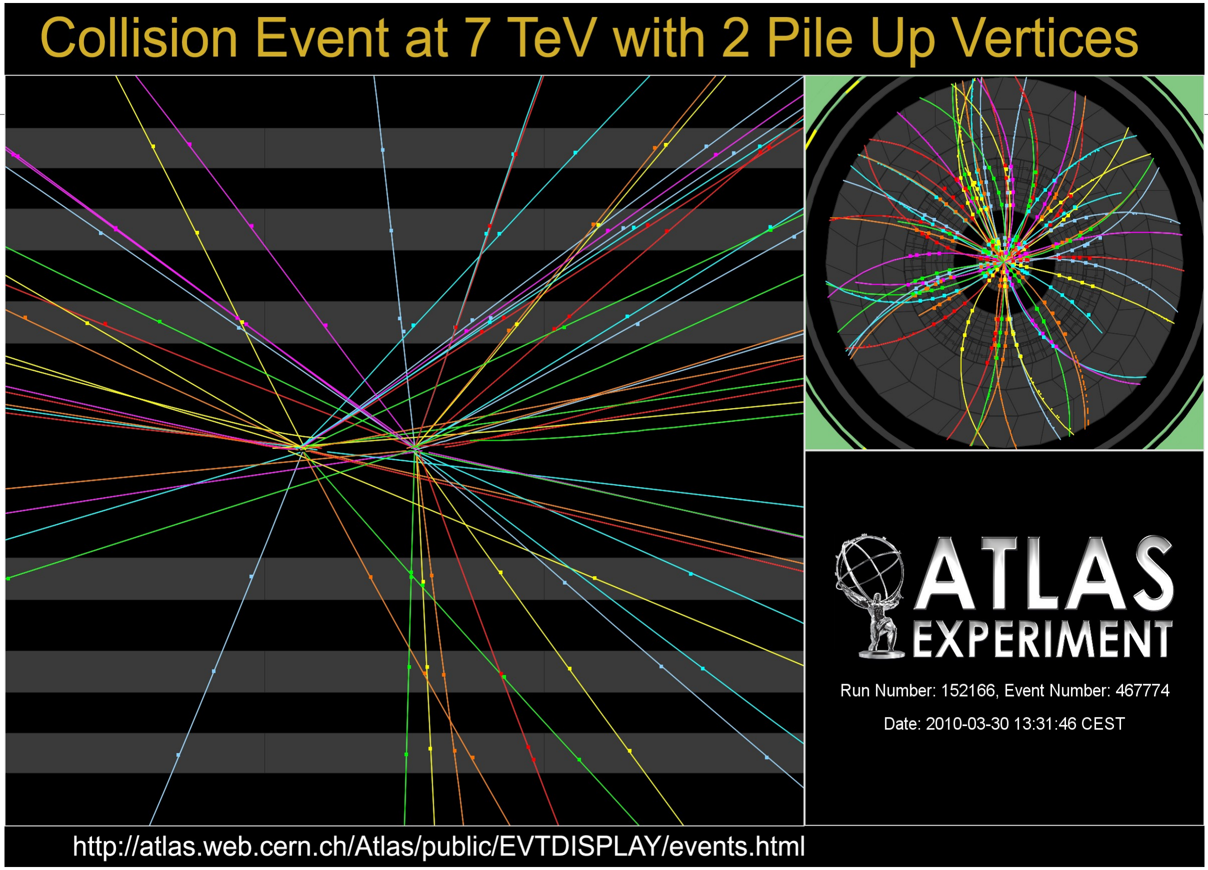
MBTS: Minimum Bias Trigger Scintillators

(scintillators that detect activity in the forward region of the detector)

- In coincidence of the beam pick-up signal
- Inclusive Trigger
- No significant bias introduced to the jet measurement



Event Selection



Data Quality (DQ) used to select the periods with the nominal performance of the detector

Primary vertex (PV) selection: PV from center of ATLAS detector

MBTS Trigger and timing requirements: depending on the detector and accelerator conditions of the different analyses presented here.

Effectively no bkg due to cosmic ray shower and beam related bkg left.

Negligible impact from pileup in data sample reported in these slides.

Jet reconstruction and performance

Inputs for the jet reconstruction

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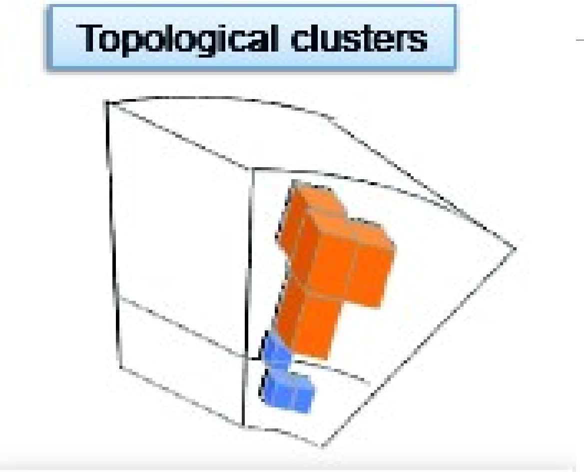
The calorimeter performance and the understanding of the inputs for the jet reconstruction have dominant effect on the physics potential

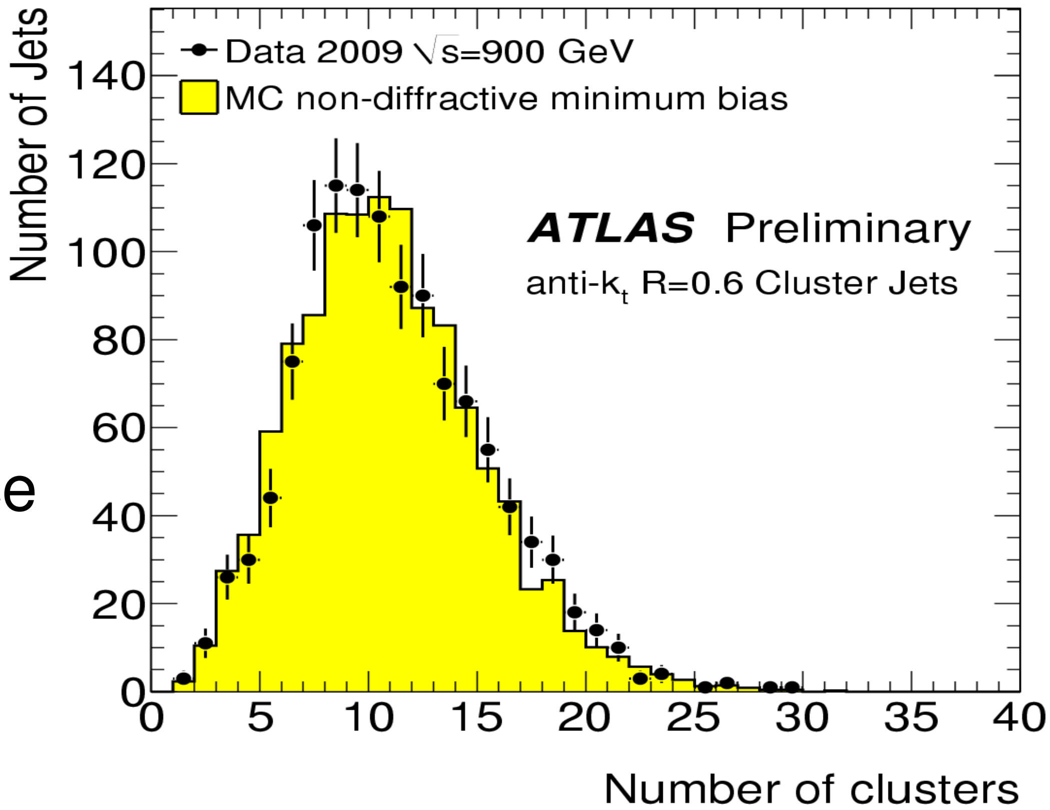


Several inputs studied in ATLAS. In this talk I will show the plots for the:

Topological clusters

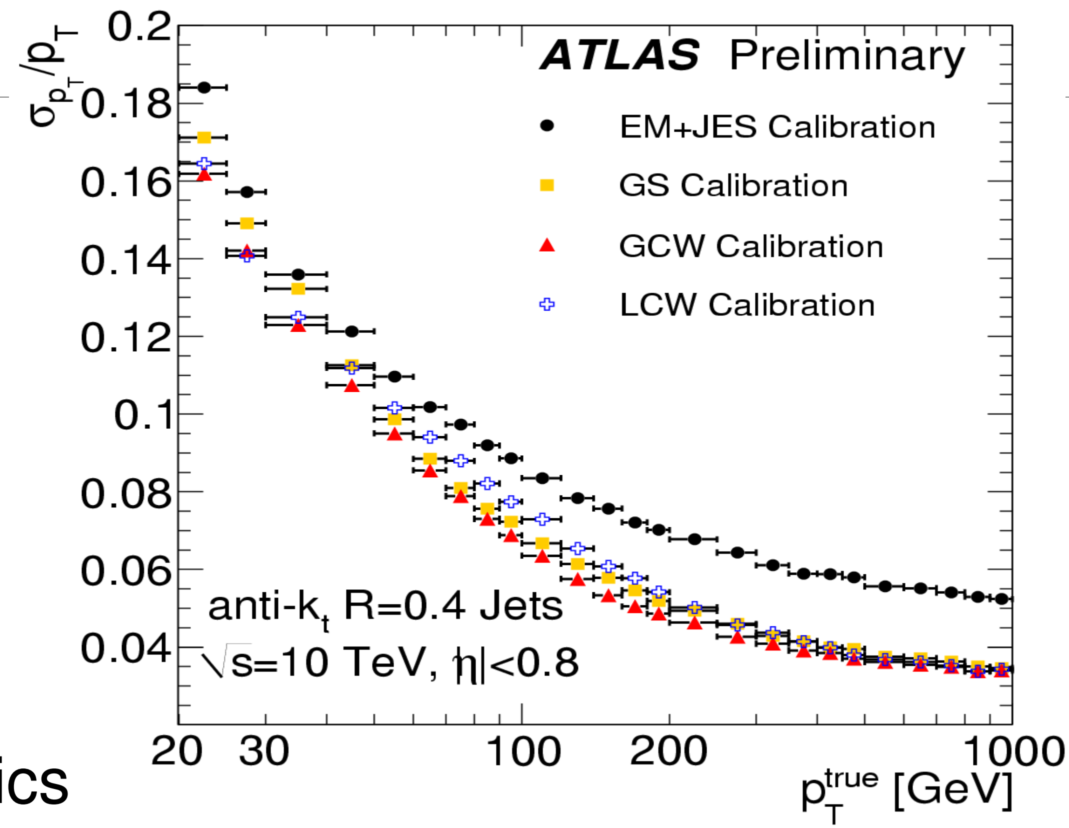
nearest neighbor energy significance

- evolution in all 3 dimensions
- excellent noise suppression



Calibration Schemes

Non-compensating calorimeters in ATLAS require software calibration of energy deposits of pions to equalize response to electrons and pions.



Calibration Schemes:

- Different level of complexity
- Different sensitivity to systematics

EM+JES	Simple p_T and η-dependent calibration
GS	Global sequential calibration using jet properties
GCW	Cell energy-density-based weighting
LCW	Cluster property-based weighting

Jet on electromagnetic scale (EM Scale) plus simple correction factor $f(p_T, \eta)$ for jet energy scale derived from the MC.

The results shown are done by using the EM+JES calibration.

Checks of the EM energy scale (E/P)

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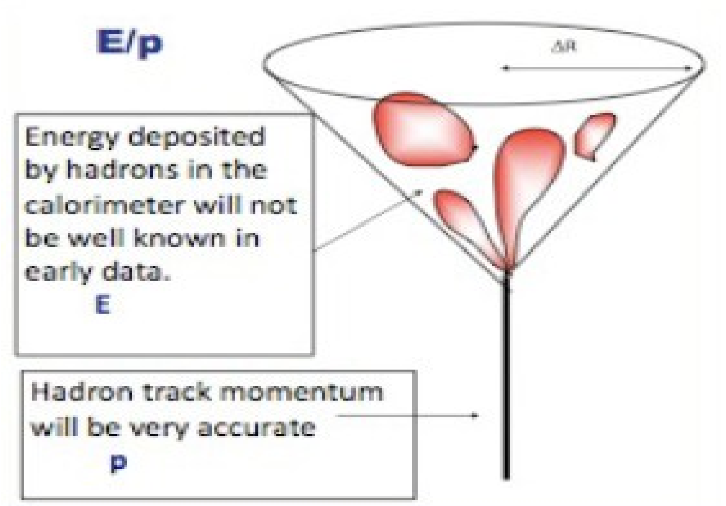
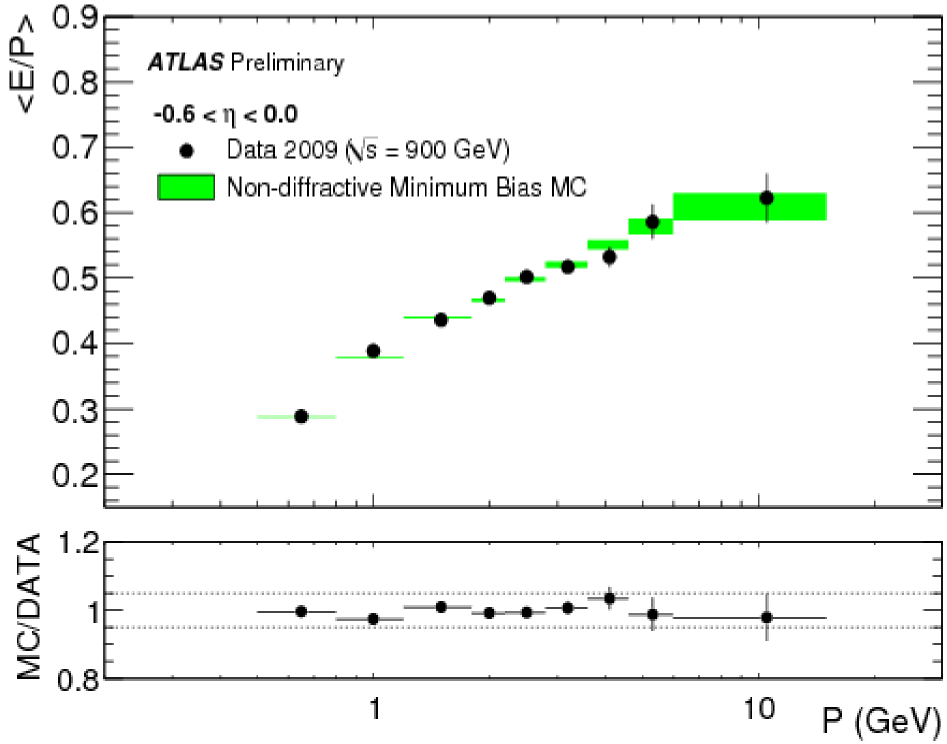
The basic idea:

- Select isolated tracks;
- Collect the energy in the calorimeter around the track;
- Compare to MC.



<E/P> measured in

- $|\eta| < 2.3$
- 500 MeV < p < 10 GeV



The calorimeter response to isolated hadrons shows agreement between Data and MC at the 5% level for most of the calorimeter.

Jet Reconstruction

Several jet algorithms are been studied and are used in the ATLAS jet reconstruction.

For this first period of data taking, the Anti-K_T (infrared safe) algorithm has been taken as the default jet algorithm.

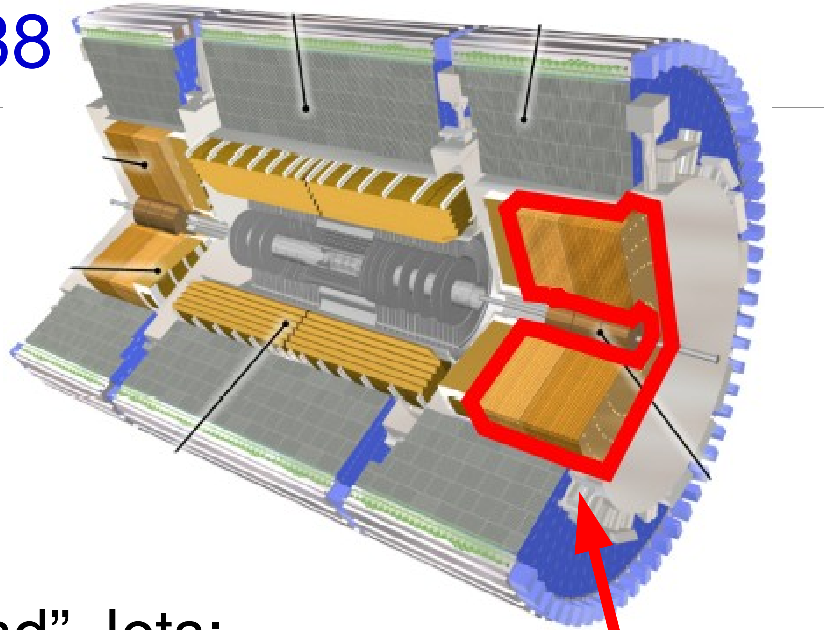
The Anti-K_T is a sequential recombination jet algorithms with p= -1, (Kt, p=1) which behaves like an idealised cone algorithm.

$$d_{ij} = \min(k_{ti}^{2p}, k_{tj}^{2p})\Delta R_{ij}^2 / R^2$$

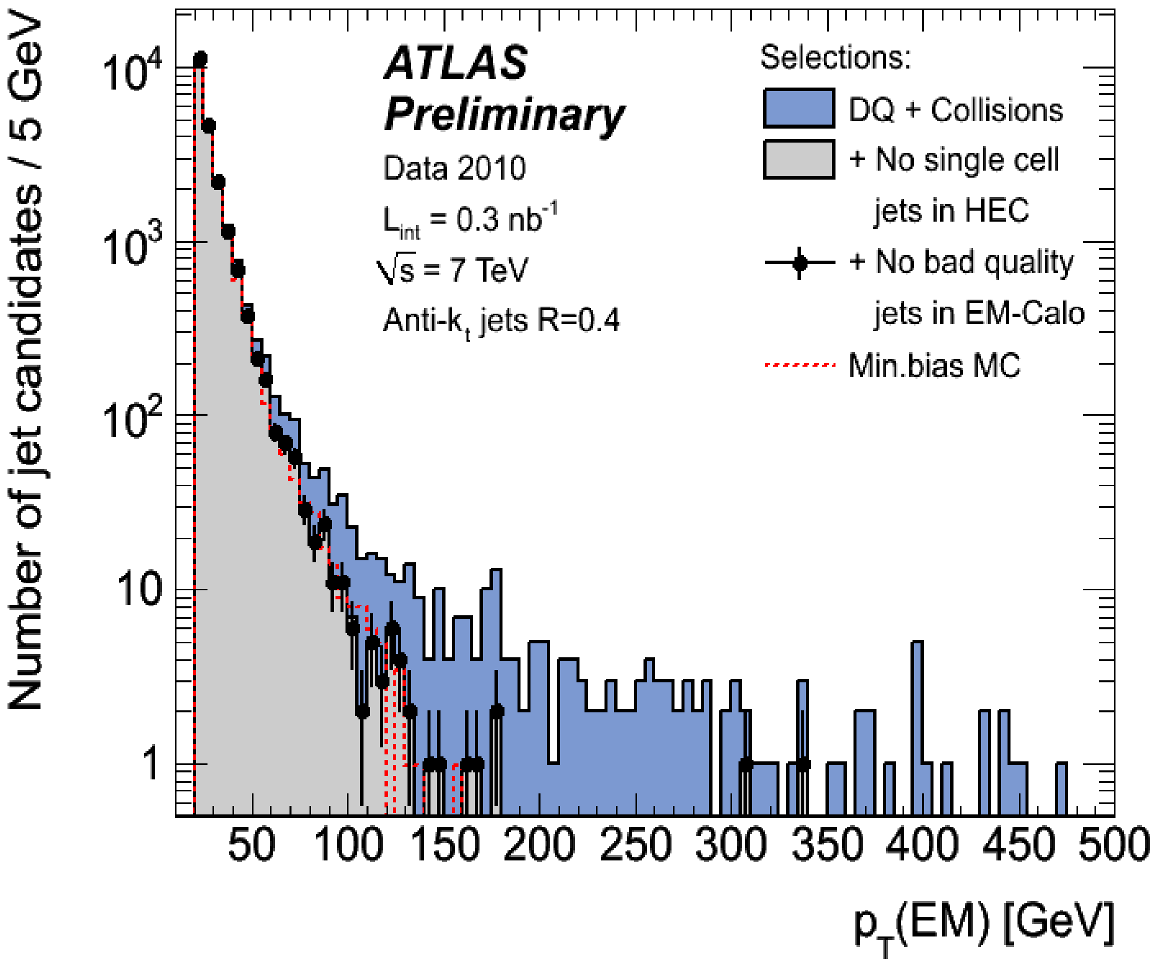
In these slides R=0.6,

but most of the studies done with both 0.6 and 0.4.

Jet Quality ATLAS-CONF-2010-038

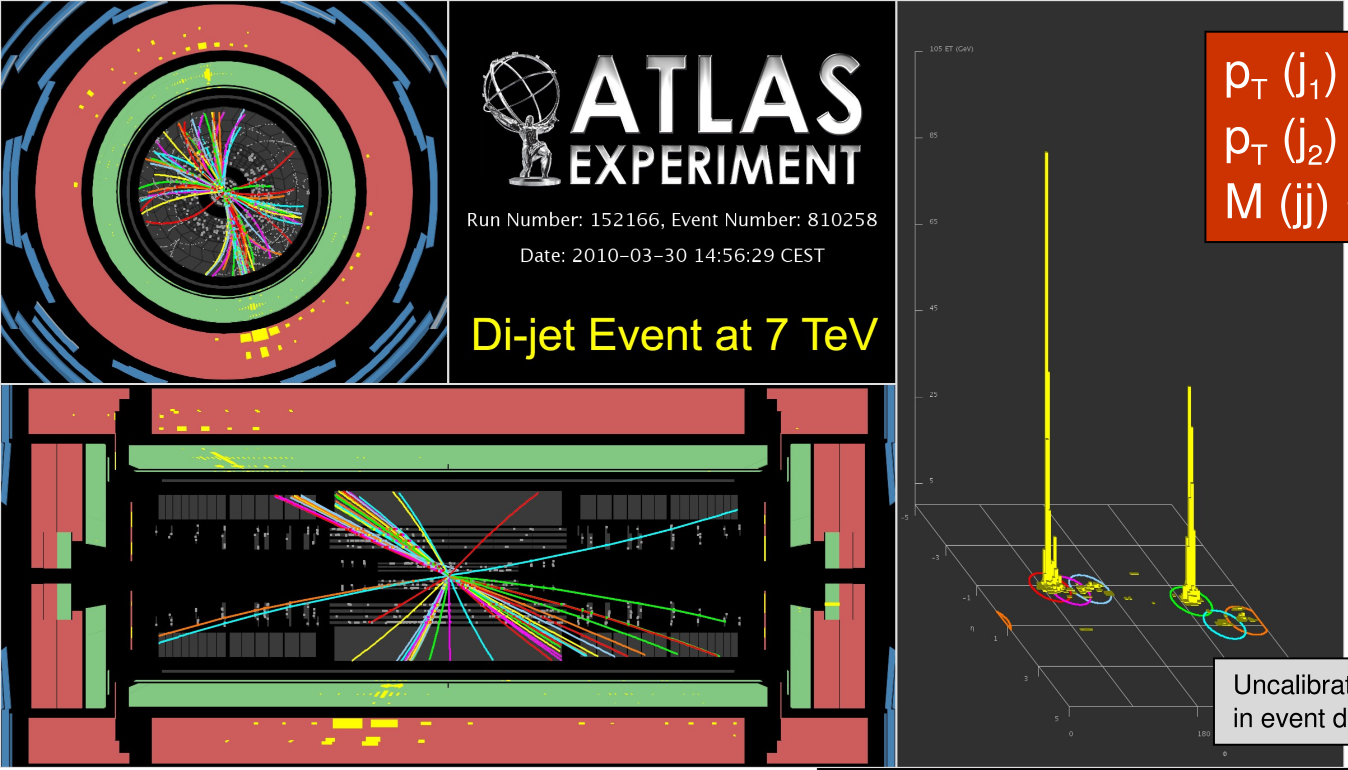


Events with at least one "bad" jet with p_T >10 GeV at EM scale anywhere in detector are removed



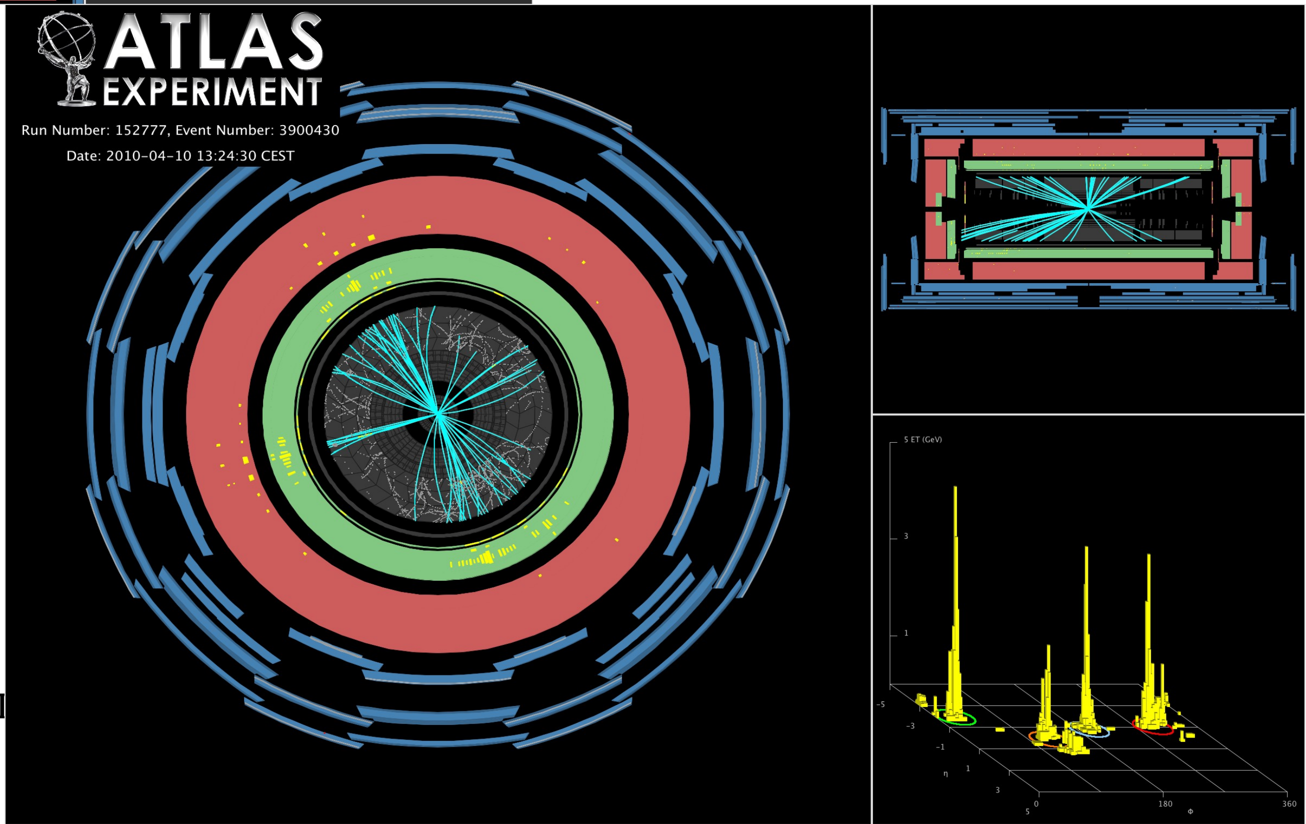
"Bad" Jets:

- Noisy cells in the hadronic endcap calorimeter (HEC)
- Coherent noise in the electromagnetic calorimeter
- Large out-of-time energy depositions, e.g. from cosmic ray showers



$p_T (j_1) \sim 455$ GeV
$p_T (j_2) \sim 390$ GeV
$M (jj) \sim 800$ GeV

Uncalibrated E
in event display



First jets and QCD results
in ATLAS

Inclusive jet and di-jet kinematic distributions

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Distribution shape comparison

All the kinematic distributions normalized to unity.

Comparisons at the hadronic scale only sensitive to shape differences.

Jet selection: $|\eta| < 2.8$ and $p_T > 30$ GeV

Data distributions compared to Monte Carlo at reconstruction level (not unfolded to particle level).

Theoretical model: Pythia dijet Monte Carlo
(LO matrix element + parton shower)

Only statistical uncertainties shown.

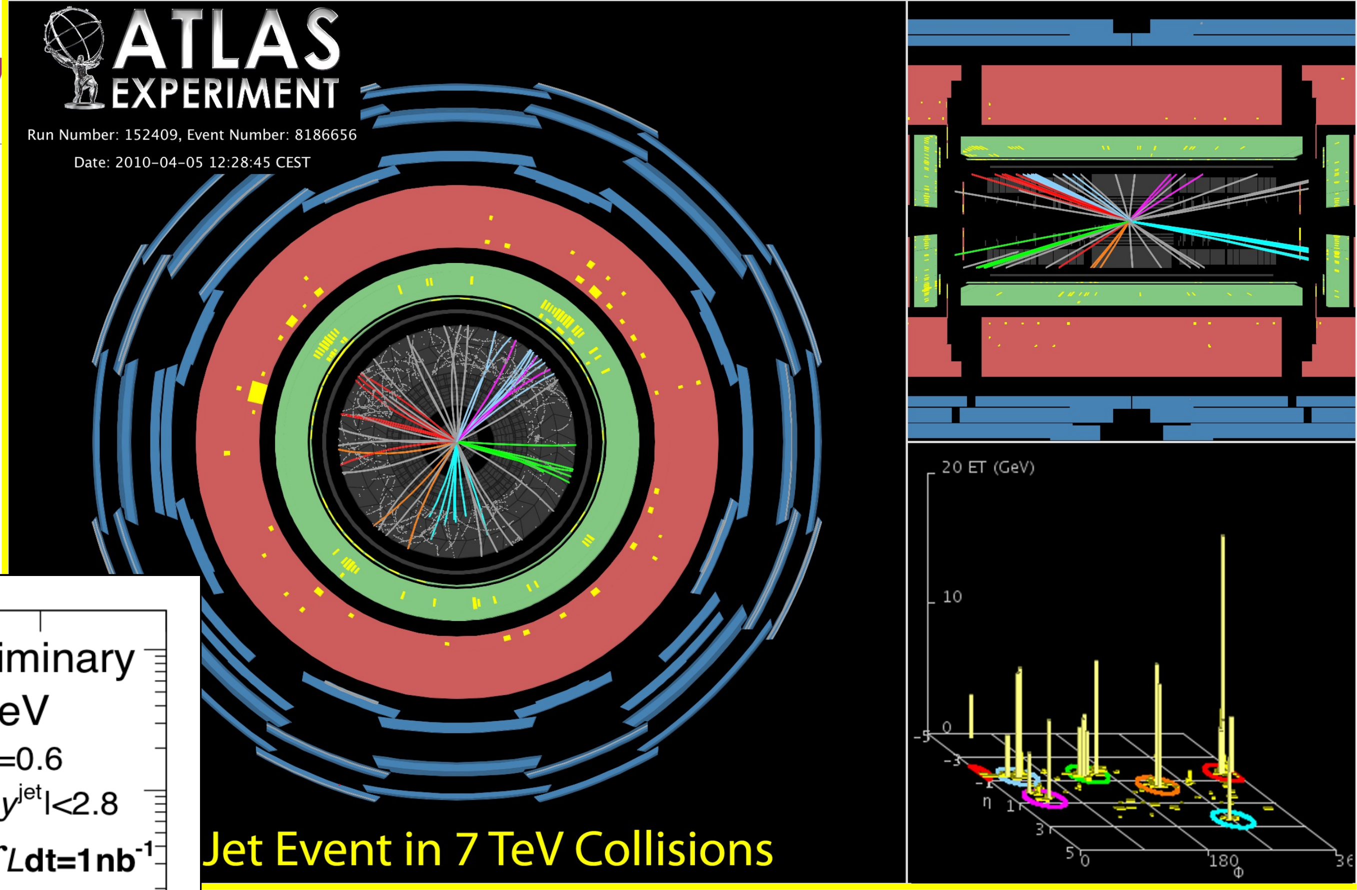
No attempt to show systematic uncertainties from jet energy scale or other sources.

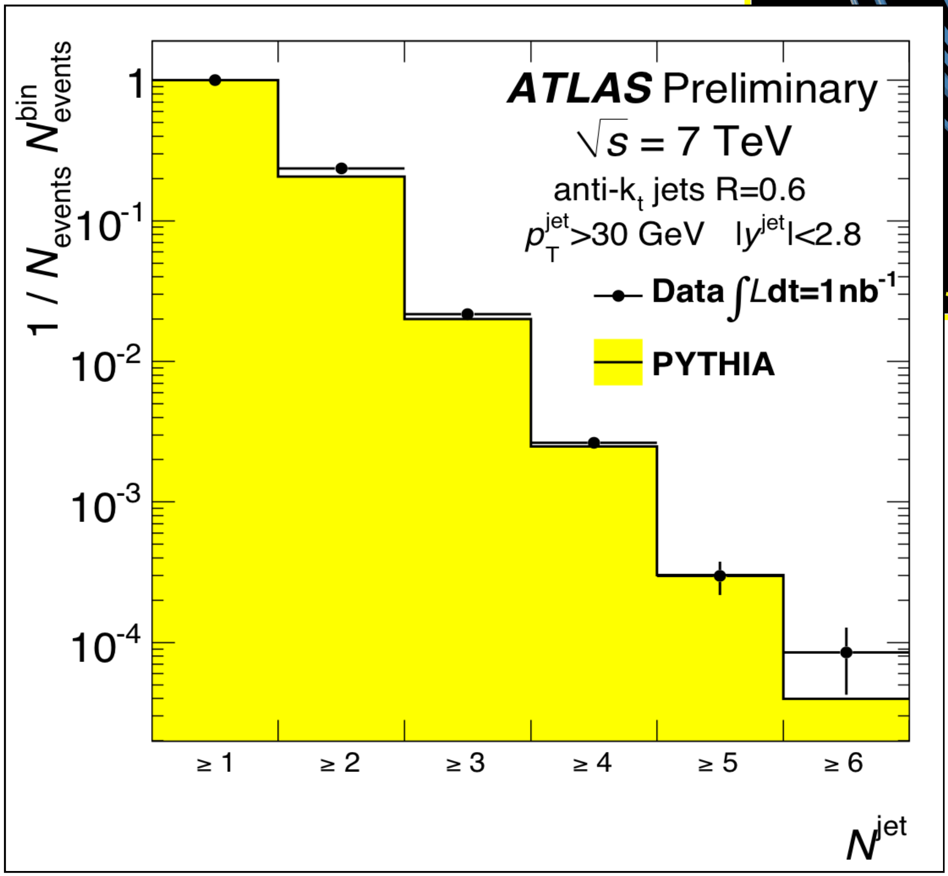
Jet cross-sections which contain all these effects will be reported later this summer.

Jets multiplicity

Integral distribution of number of jets

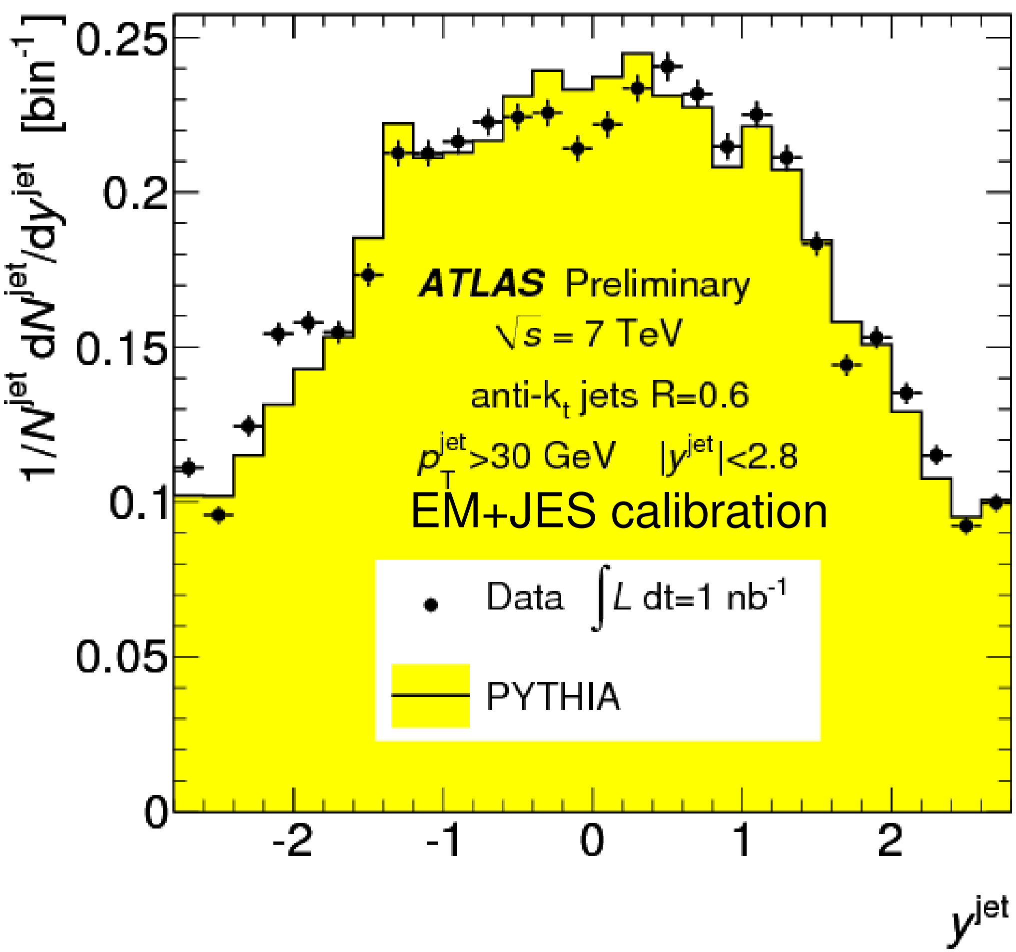
Up to 6 Jets in the data.

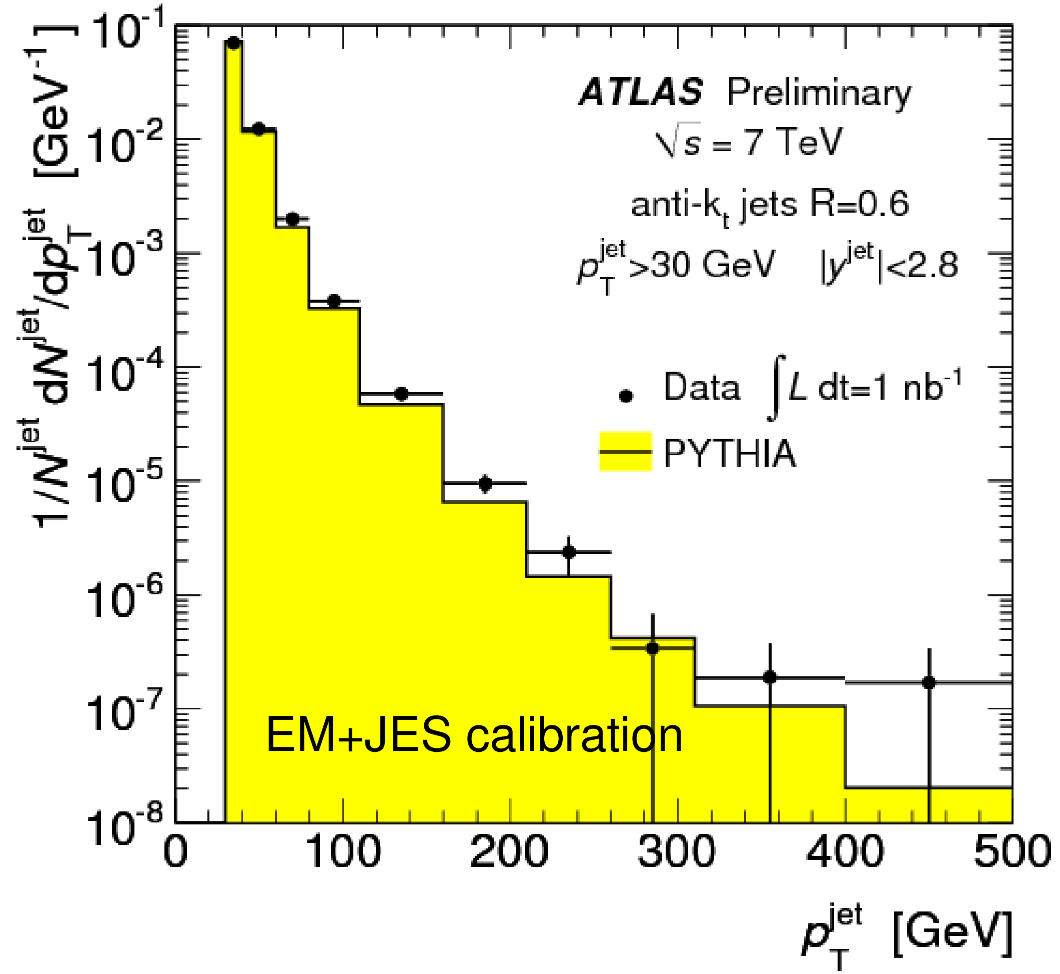




Good Agreement Data/MC, (LO parton shower)

Inclusive jet p_T and rapidity spectrum



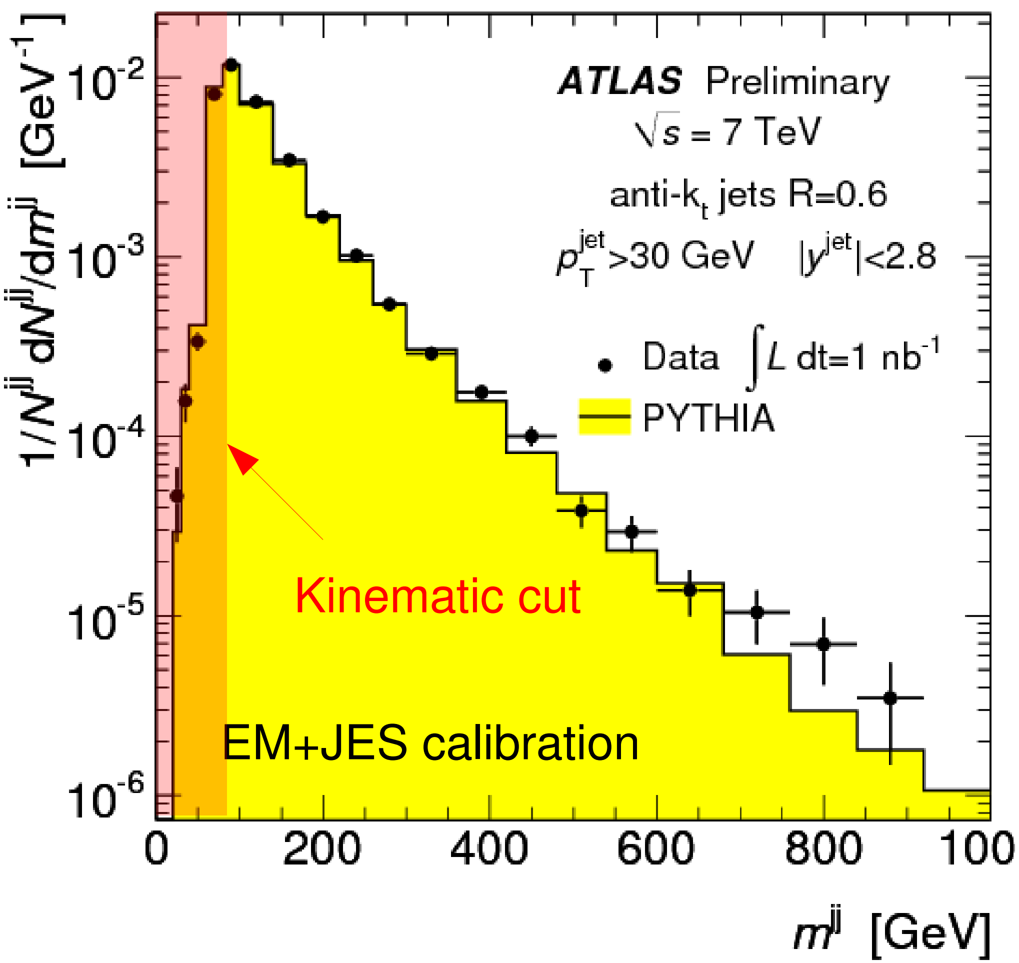


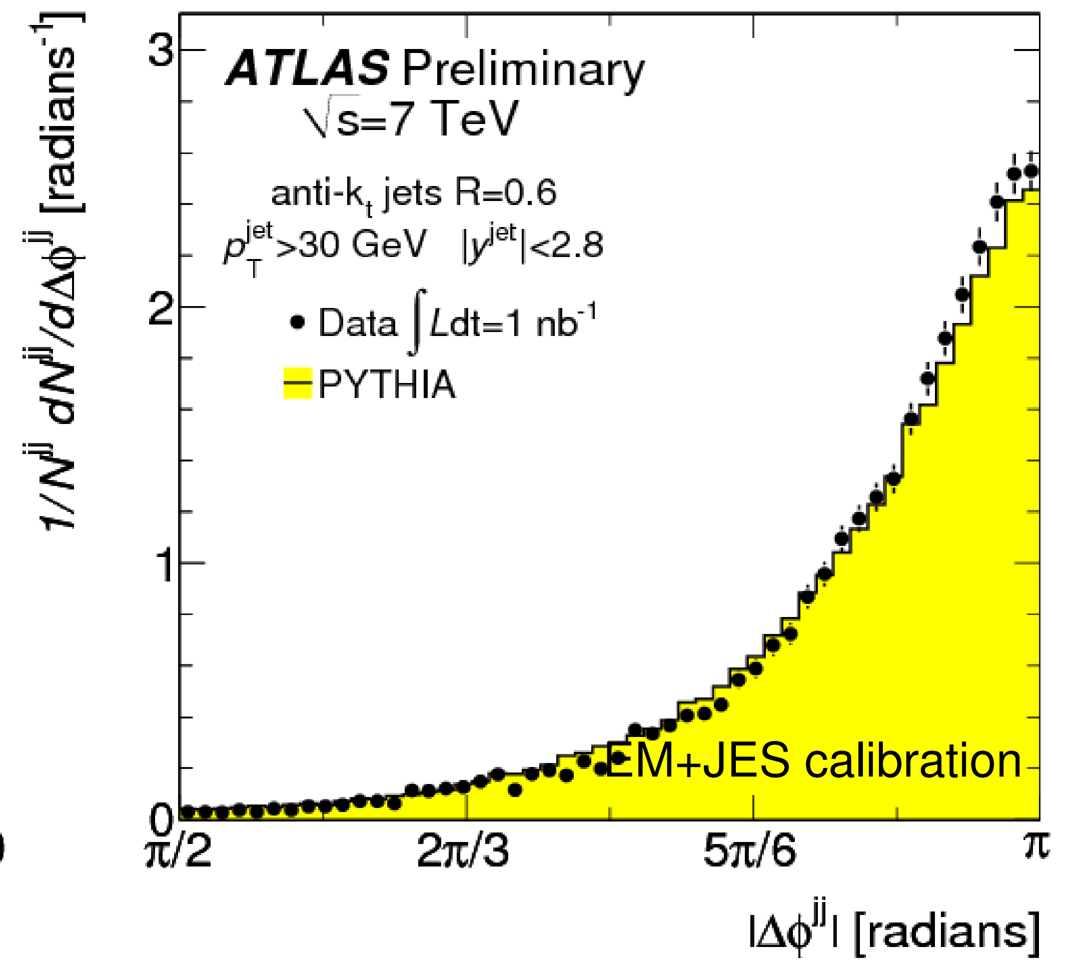
Monte Carlo follows the shape reasonably well.

Some small deviations near y=0 and y=-2.1 (under investigation)

Jet-jet mass and Δϕ distribution

Azimuthal separation Δφ indicates predominant back-to-back dijet final state.
Monte Carlo describes reasonably the shape of both distributions

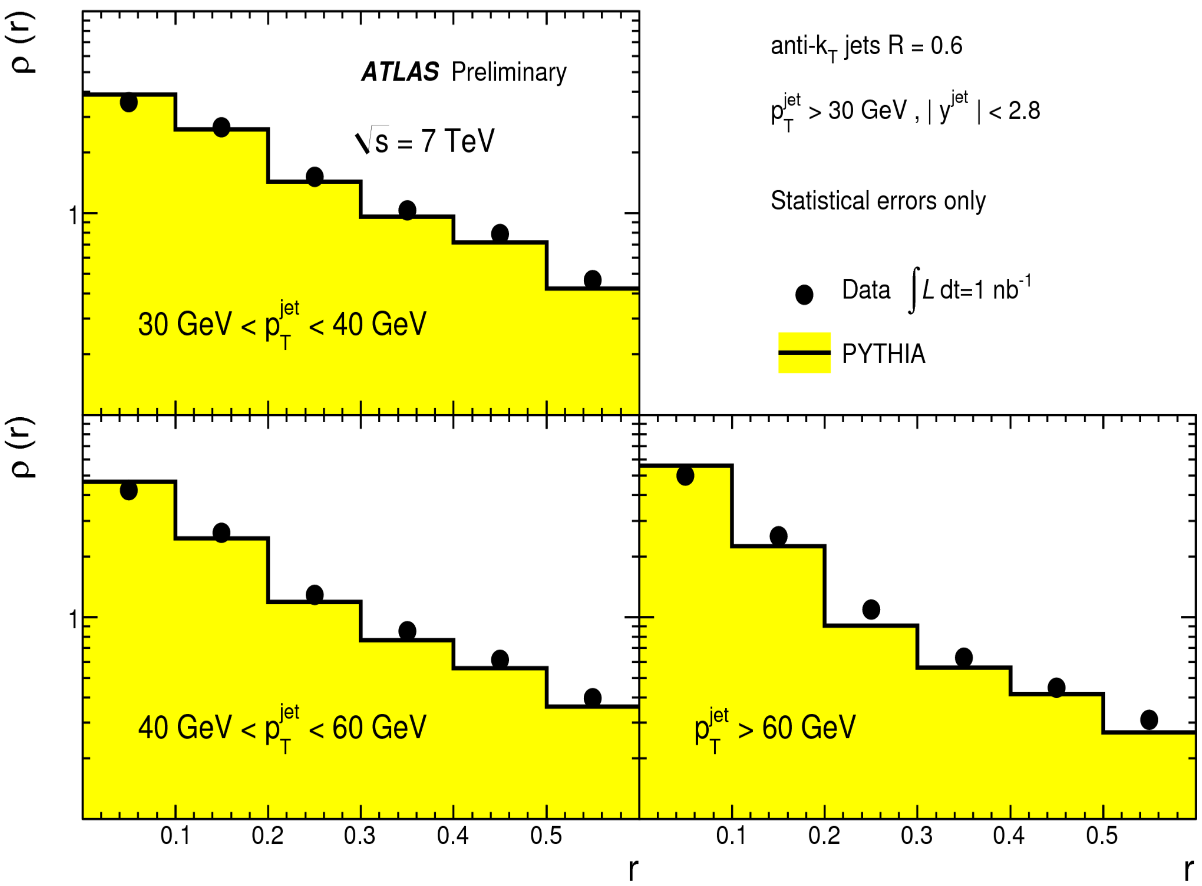


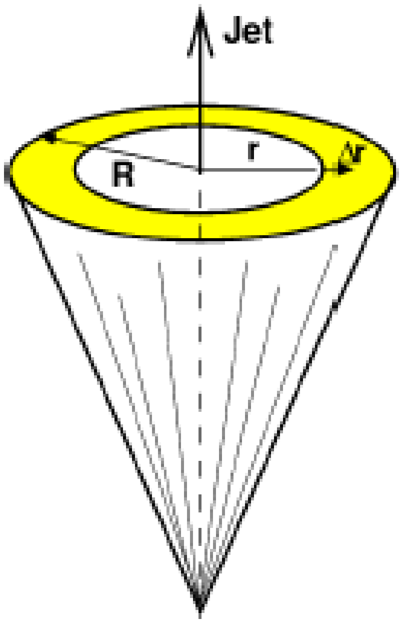


Jet shapes

Average fraction of jet transverse momentum within annulus of inner radius (r – Δr/2) and outer radius (r + Δr/2)

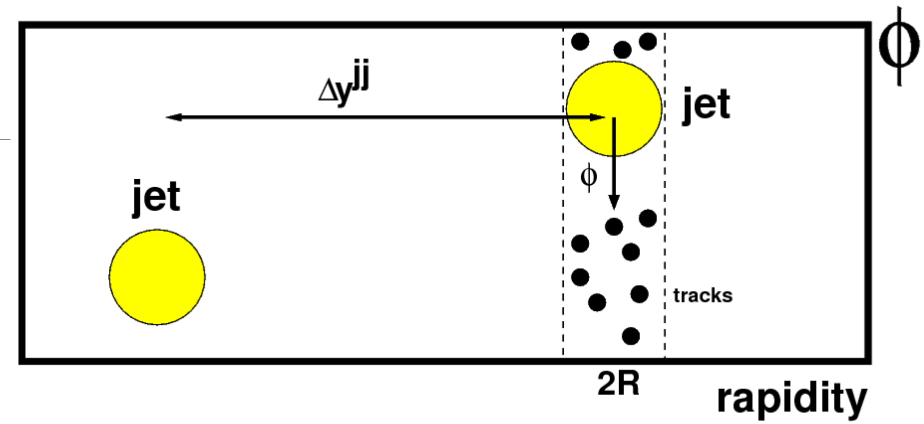
Information on the jet fragmentation process, the detector response to low energy particles, underlying event





Monte Carlo describes data reasonably well, producing slightly narrower jets than data.

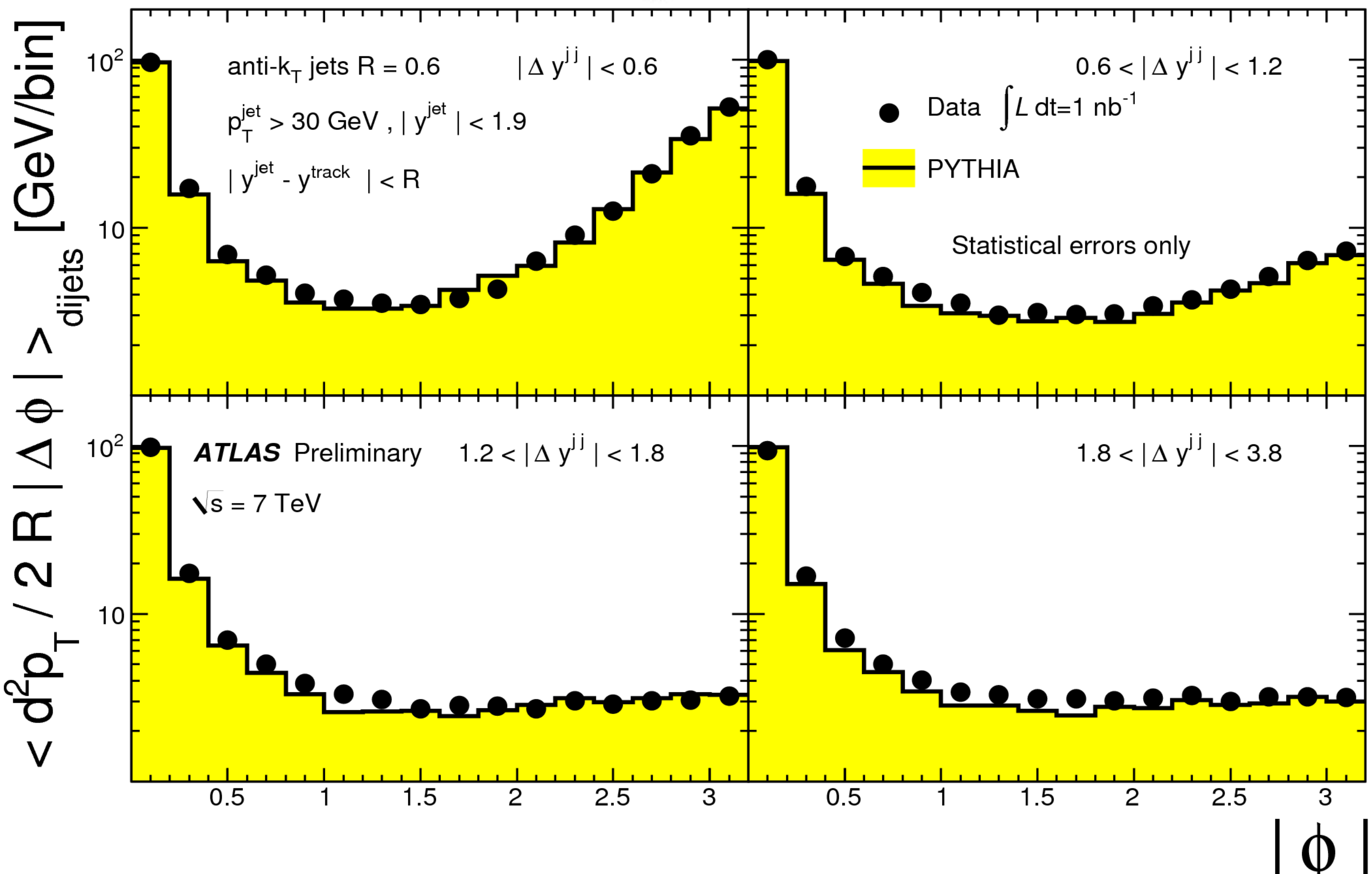
Charged Particle Flow



Avareage p_T density of tracks

as a function of $\Delta\varphi$ with respect to the leading jet.

$$< \frac{d^2 p_T}{|d\phi|dy} >_{jets} = \frac{1}{2R|\Delta\phi|}\frac{1}{N^{jet}}\sum_{jets} p_T(|\phi-\Delta\phi/2|,|\phi+\Delta\phi/2|), \text{with } 0 \le |\phi| \le \pi$$



Δy^{jj}=rapidity separation between the first two leading jets.

Track-based: confirm results from calorimeter-based jet shapes.

Information on jet structure and underlying event

Conclusions

The ATLAS detector has been operating and collecting data at high efficiency at both 900 GeV, 2.35 TeV and 7 TeV center-of-mass energy since November 2009.

Calorimeter performance and jet performance meet expectation and are well modeled by the Monte Carlo simulation.

In the data reported in this talk:

Jets with p_T up to 500 GeV and dijet invariant mass up to 900 GeV

Shapes of inclusive jet and dijet kinematic distributions are reasonably described by Pythia dijet Monte Carlo

Measurement of jet cross-sections will be reported later this summer using more integrated luminosity from the LHC