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

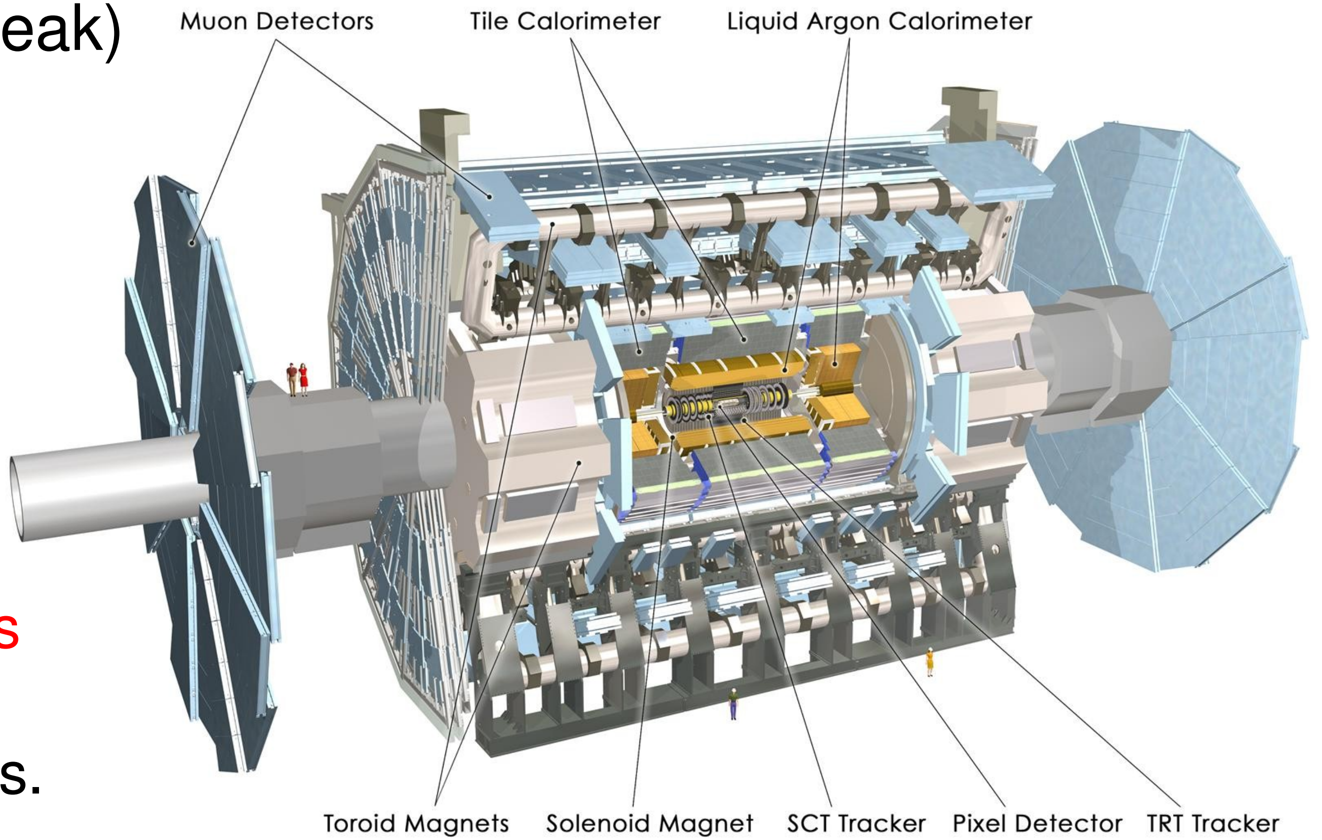
ATLAS Detector overview

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

From inside out:

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

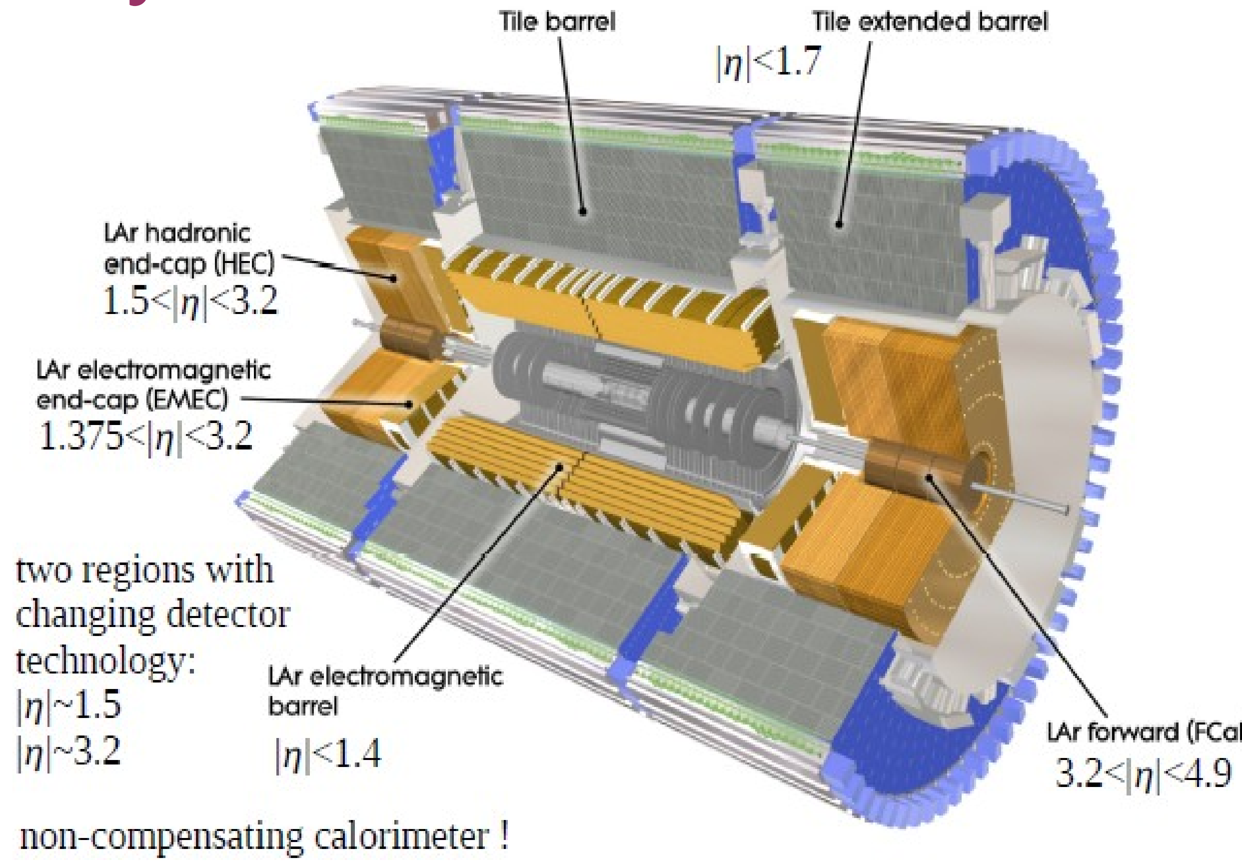
Muon system (4 different technologies) covering up to $|\eta|=2.7$
High precision muon momentum measurement (also standalone)

ATLAS Calorimeter System

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

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

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



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

Highly hermetical (|η| < 5), non compensating calorimeters.

Data sample

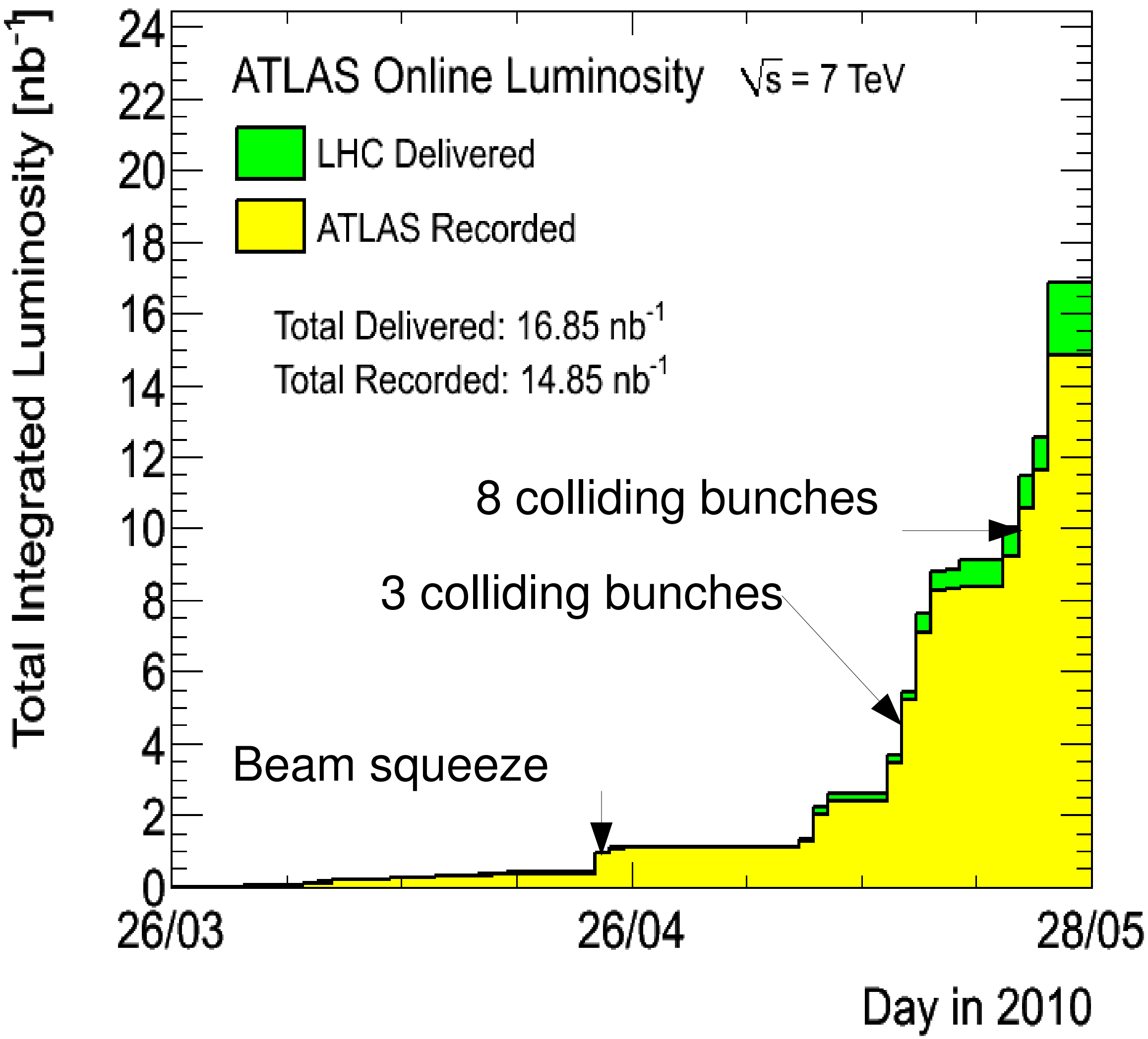
Dataset recoded by ATLAS as of May 31st:

15 nb^{-1} at 7 TeV

9×10^8 events

peak luminosity:

$2.1 \times 10^{29}\ cm^{-2}\ s^{-1}$



In this talk:

For Jet Quality:

0.3 nb^{-1} (~1.4×10^7 events)

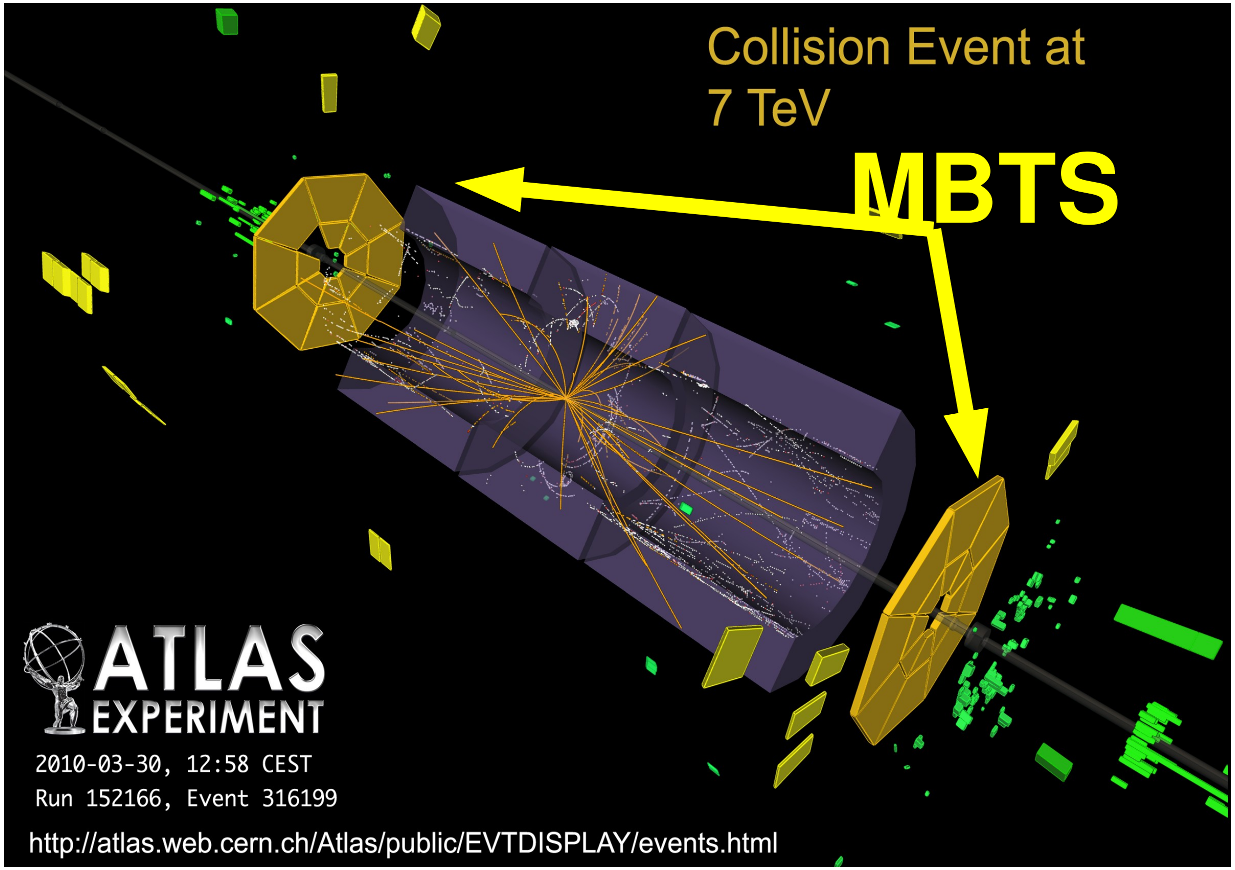
Jet Observation studies:

1 nb^{-1}

For Jet Calibration and E/P studies:

3×10^5 events at 900 GeV

Trigger

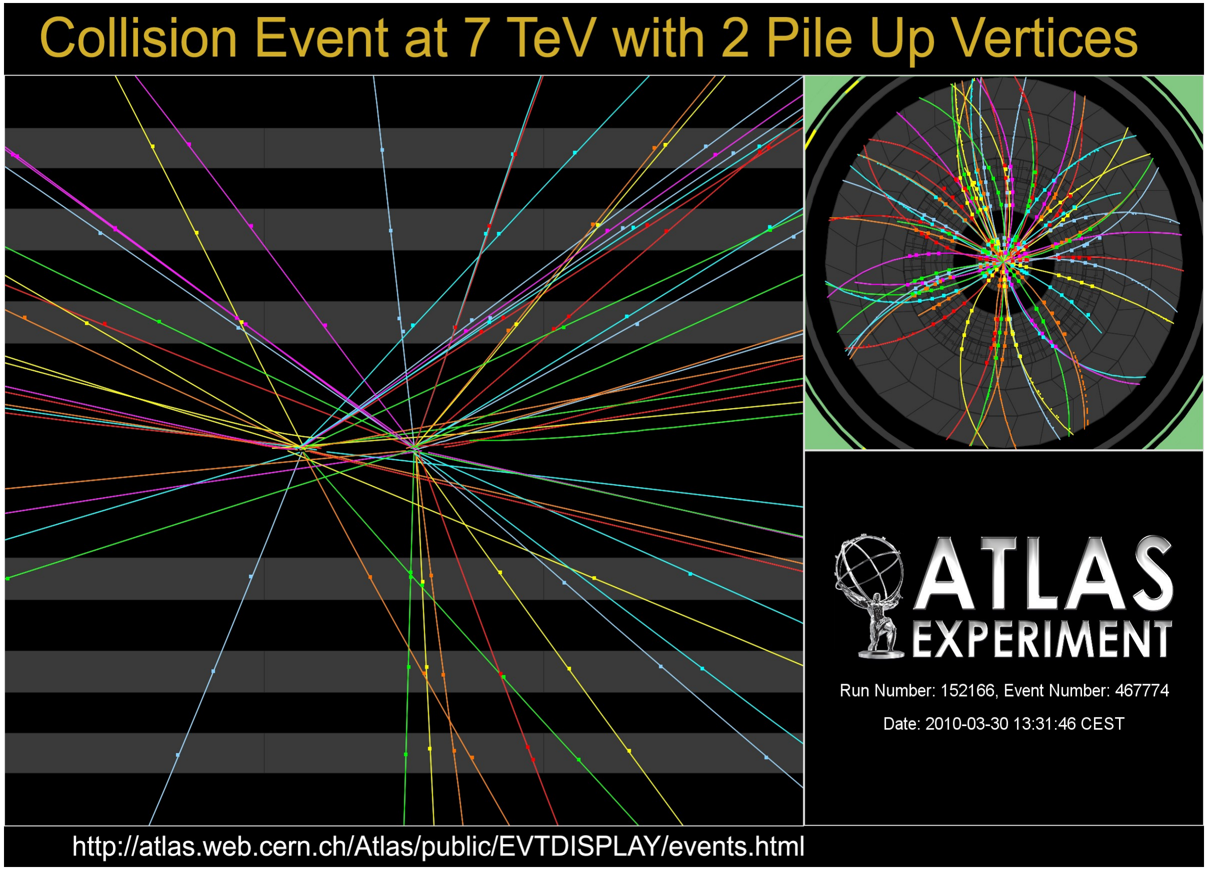


MBTS
(Minimum Bias
Trigger Scintillator)
Events are triggered by a coincidence of a beam pickup signal with a signal from the MBTS (scintillators implemented in ATLAS that detect activity in the forward region of the detector)

Inclusive Trigger

No significant bias introduced to the jet measurement

Event Selections



Stable beam flag
from accelerator

Detector fully operational
with nominal performance

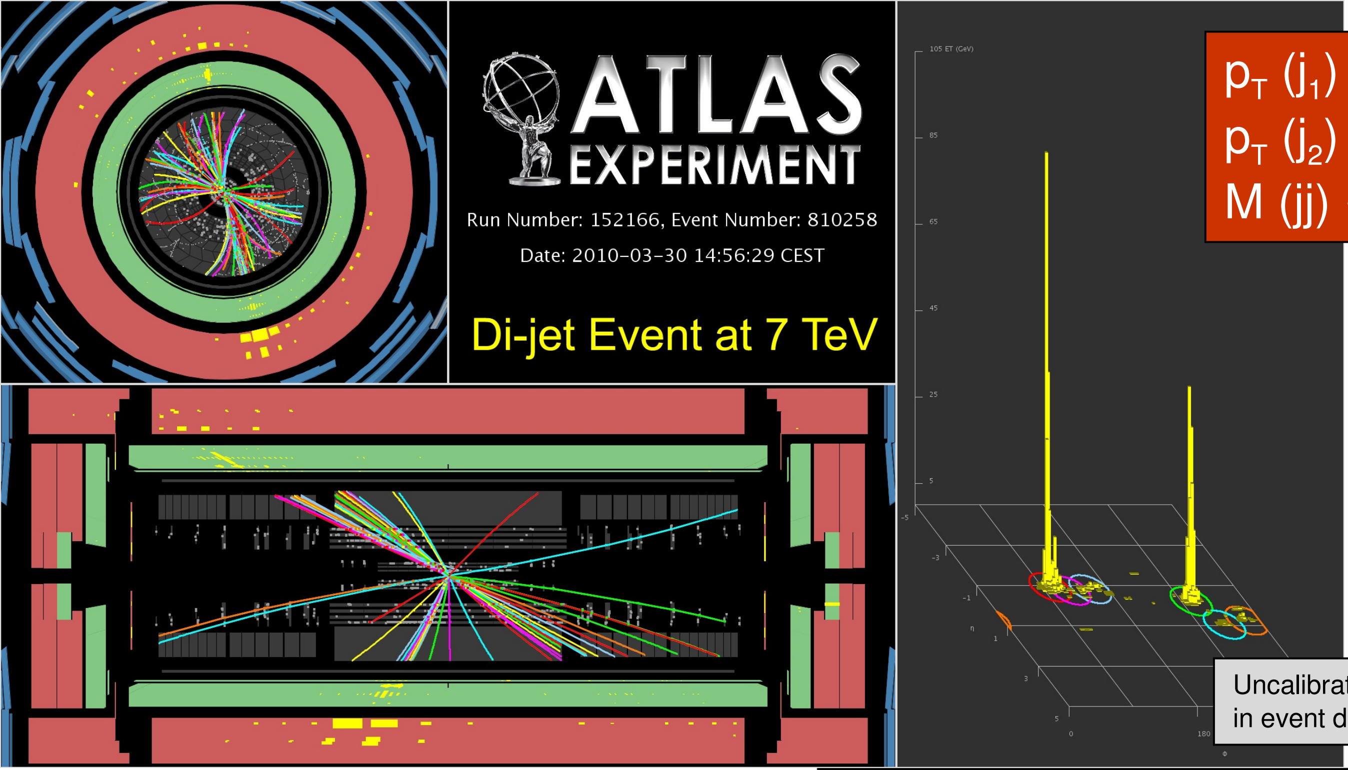
Primary vertex from center
of ATLAS detector

Event timing consistent with collisions

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

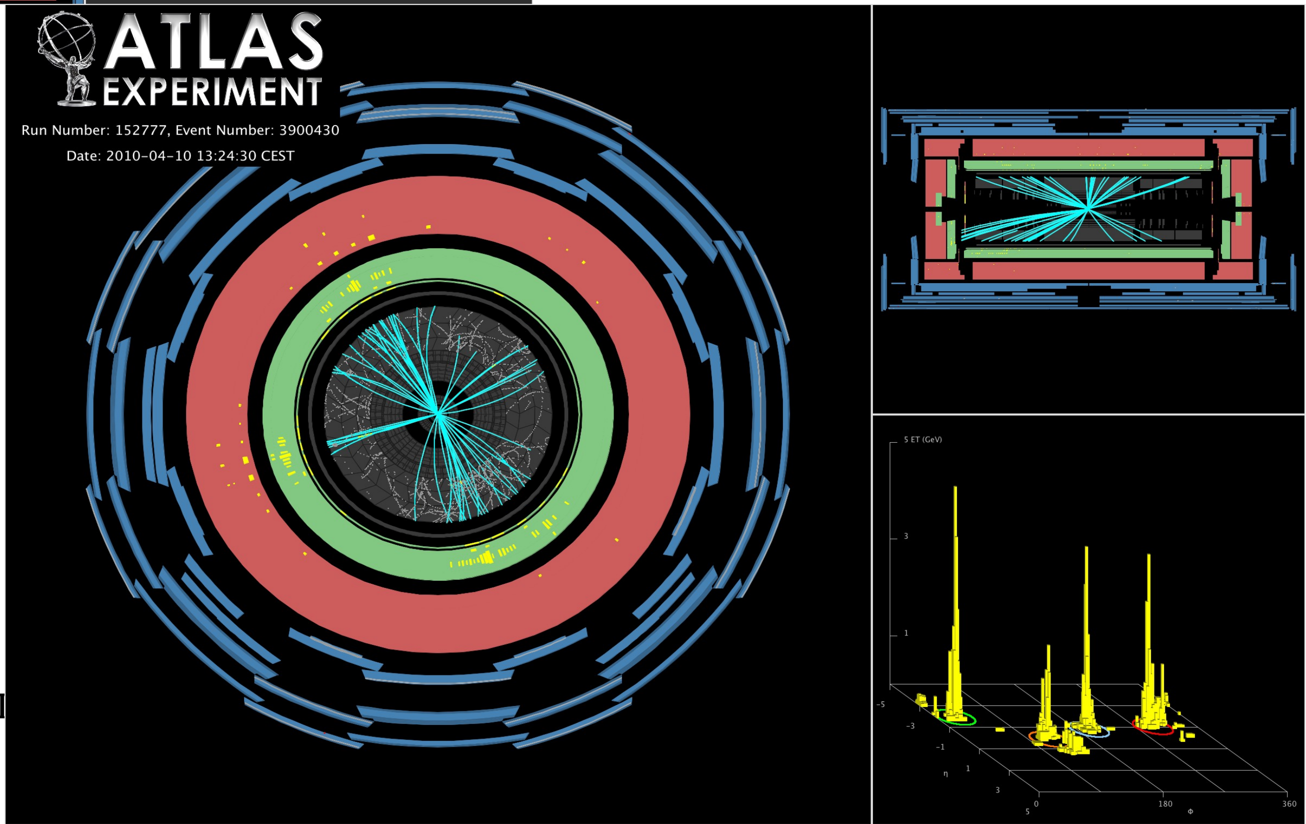
Negligible impact from pileup in data sample reported in these slides.

Jet reconstruction and performance



p_T (j_1) ~ 455 GeV
p_T (j_2) ~ 390 GeV
M (jj) ~ 800 GeV

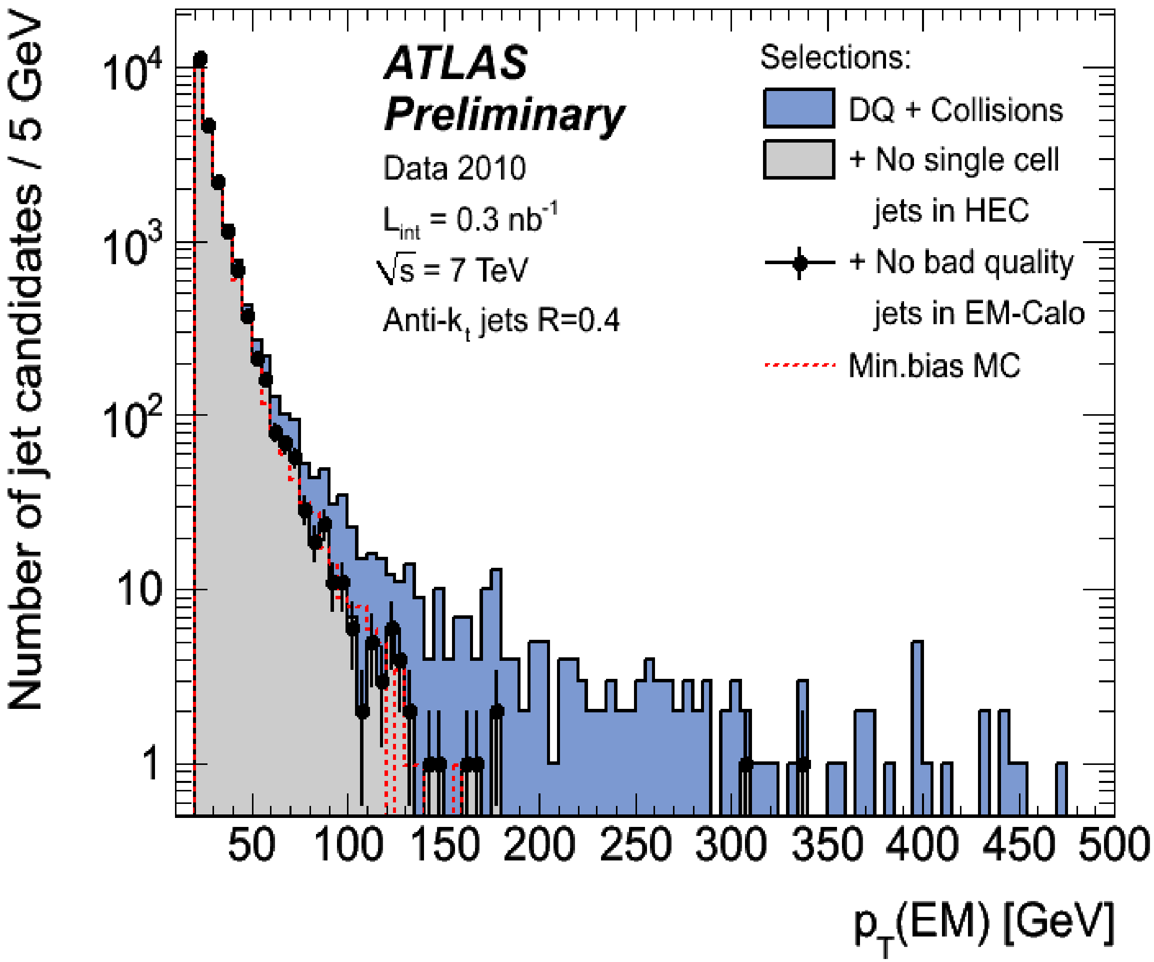
Uncalibrated E
in event display

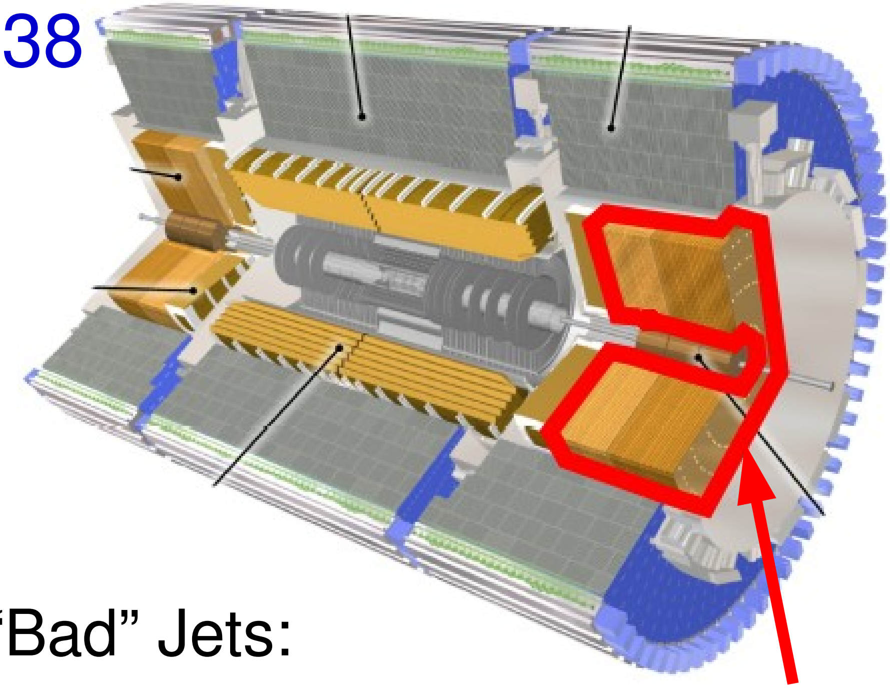


First jets and QCD results
in ATLAS

Jet Quality ATLAS-CONF-2010-038

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





"Bad" Jets:

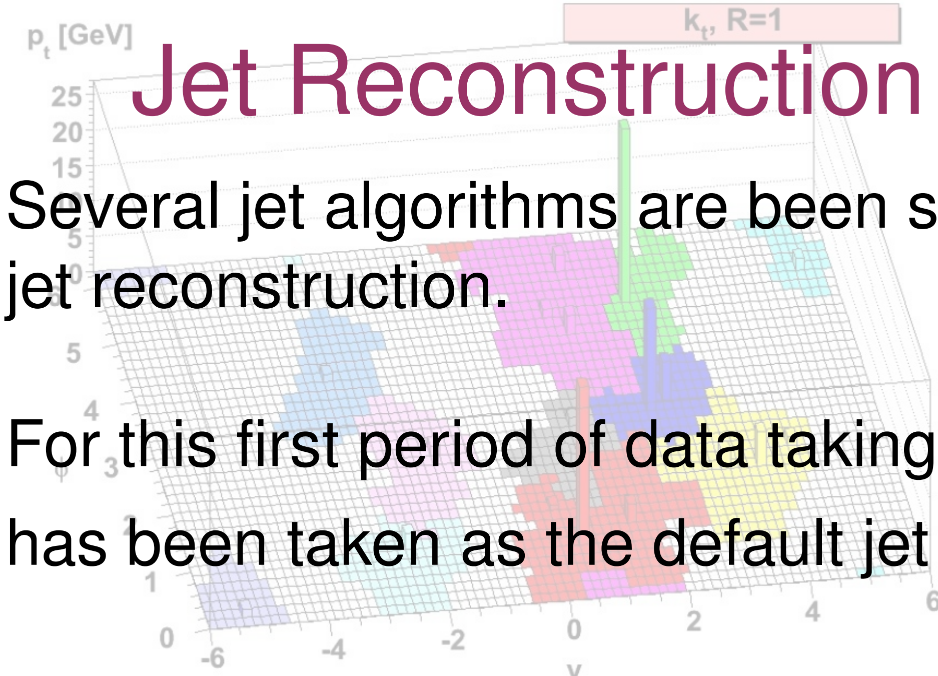
- Noisy cells in the hadronic endcap calorimeter (HEC)
- Coherent noise in the electromagnetic calorimeter
- Large out-of-time energy depositions, e.g. from cosmic ray muons

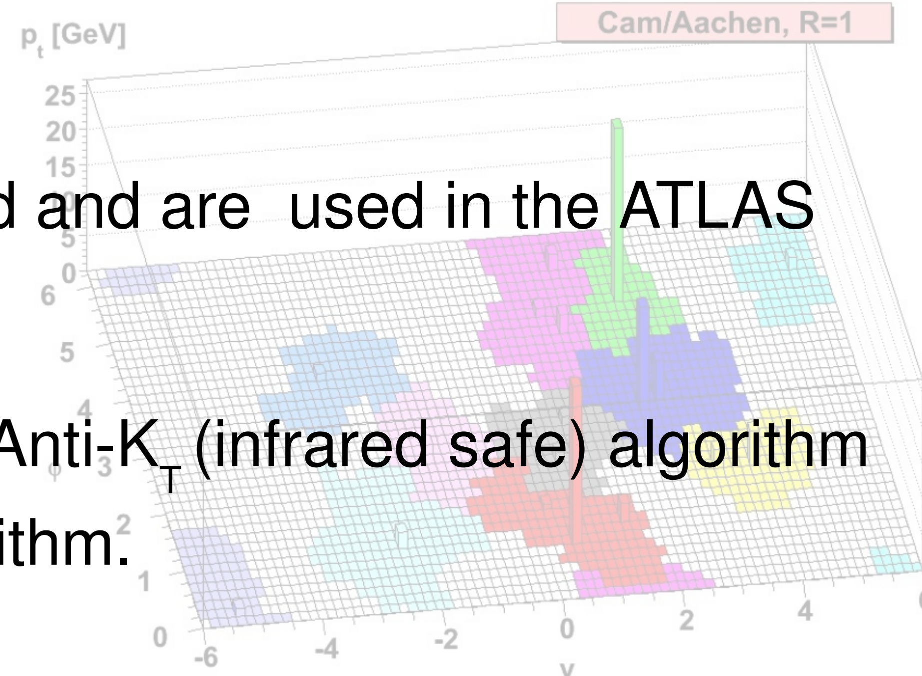
Jet Reconstruction

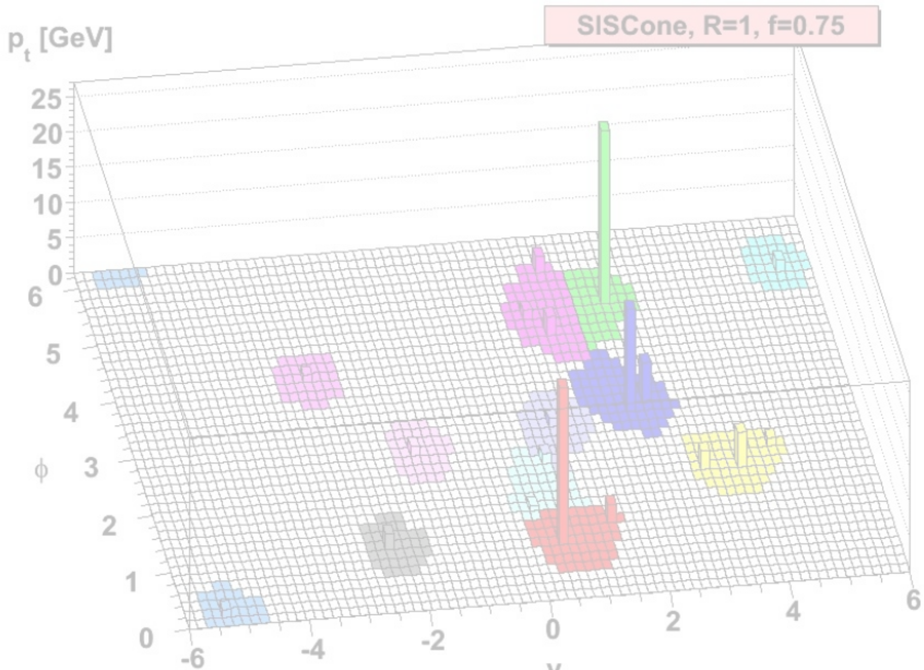
Several jet algorithms are been studied and are used in the ATLAS jet reconstruction.

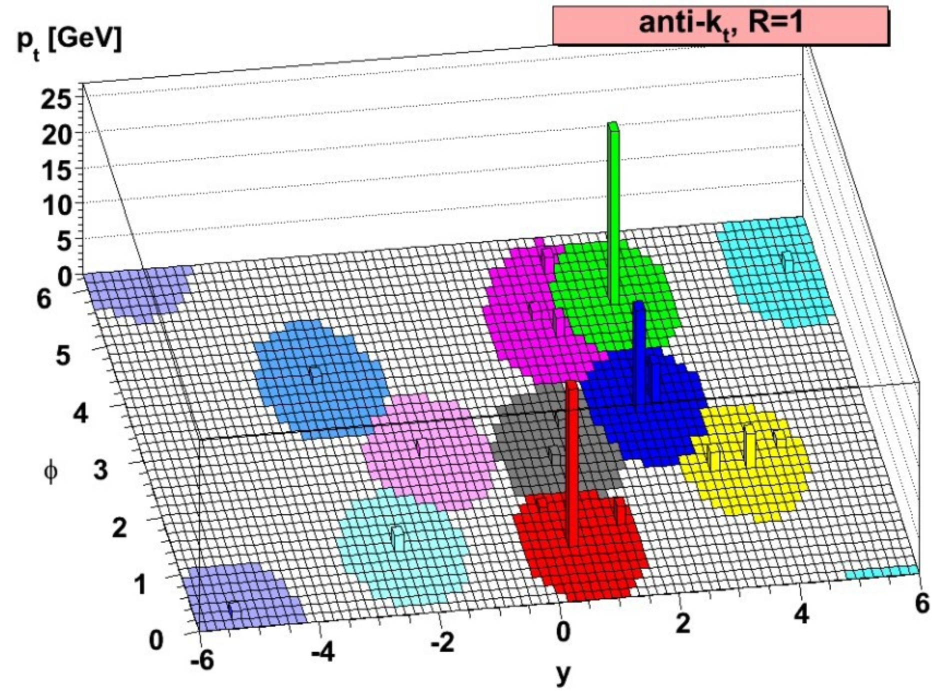
For this first period of data taking, the Anti-K_T (infrared safe) algorithm has been taken as the default jet algorithm.

In these slides D=0.6, but most of the studies done with both 0.6 and0.4



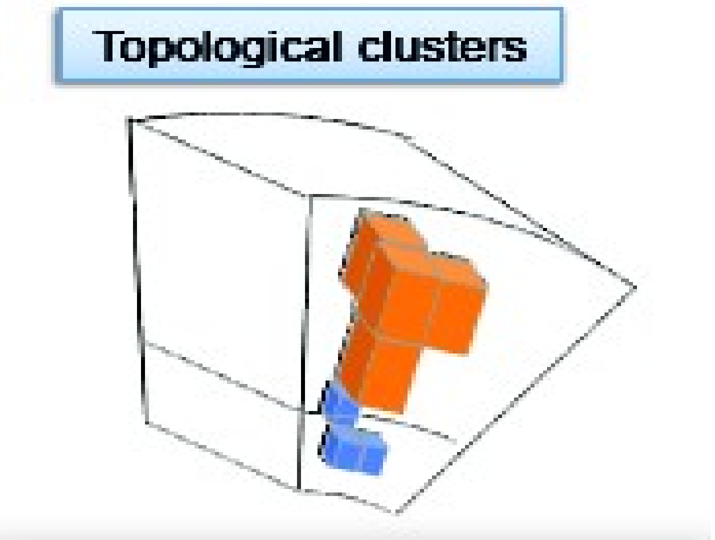






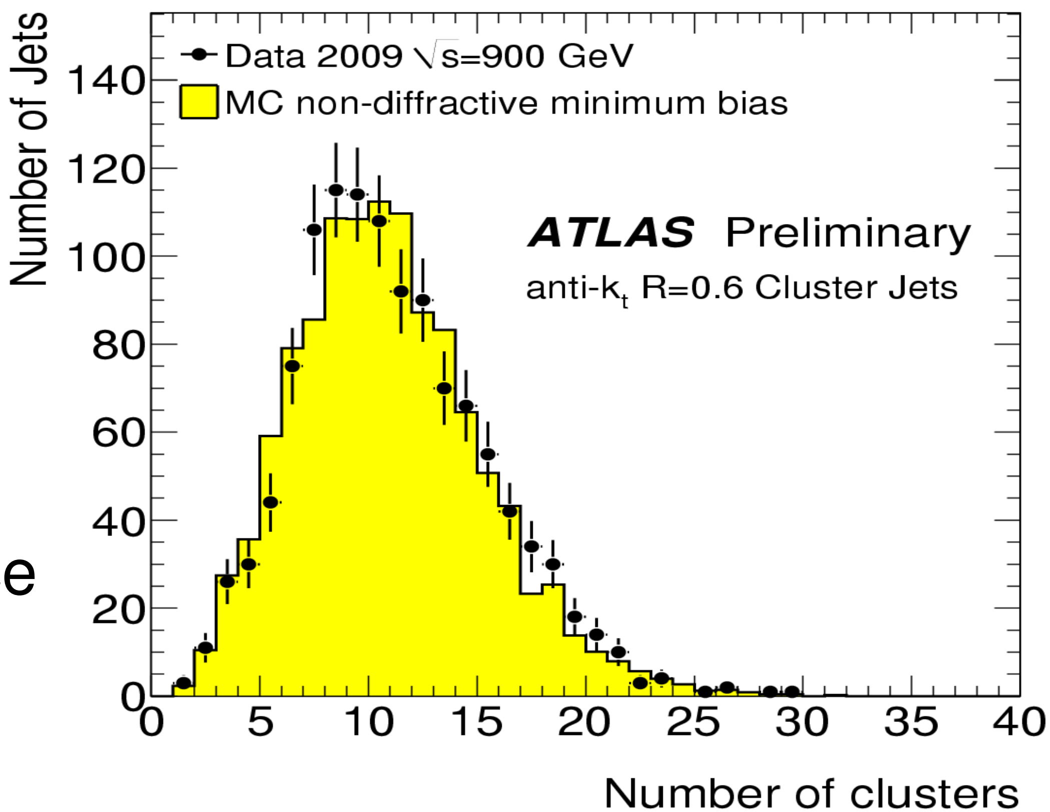
Inputs for the jet reconstruction

ATLAS-CONF-2010-016



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

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



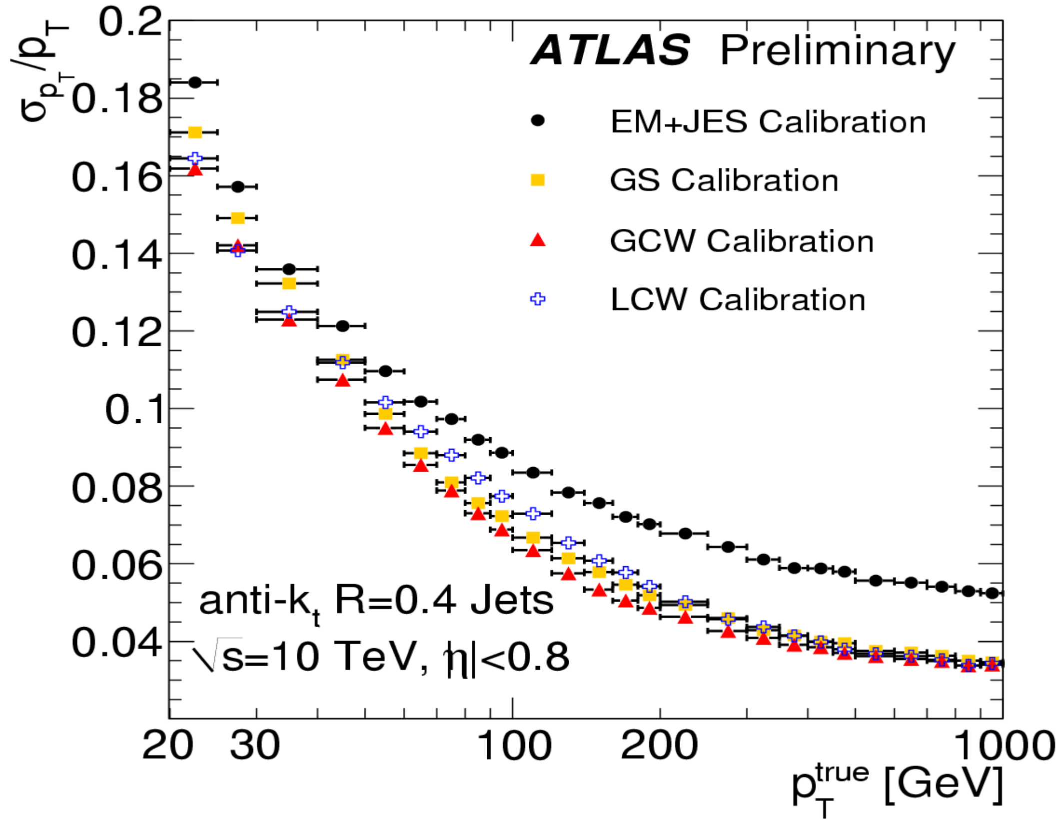
Topological clusters

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 with different level of complexity and different sensitivity to systematic effects

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

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

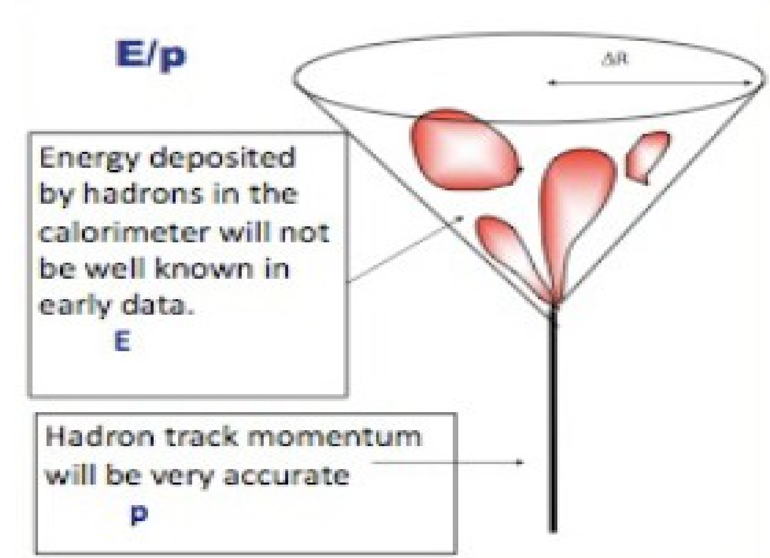
Jet on electromagnetic scale (EM Scale) plus simple correction factor $f(p_T, \eta)$ for jet energy scale derived from the MC.

Checks of the EM energy scale (E/P)

ATLAS-CONF-2010-017

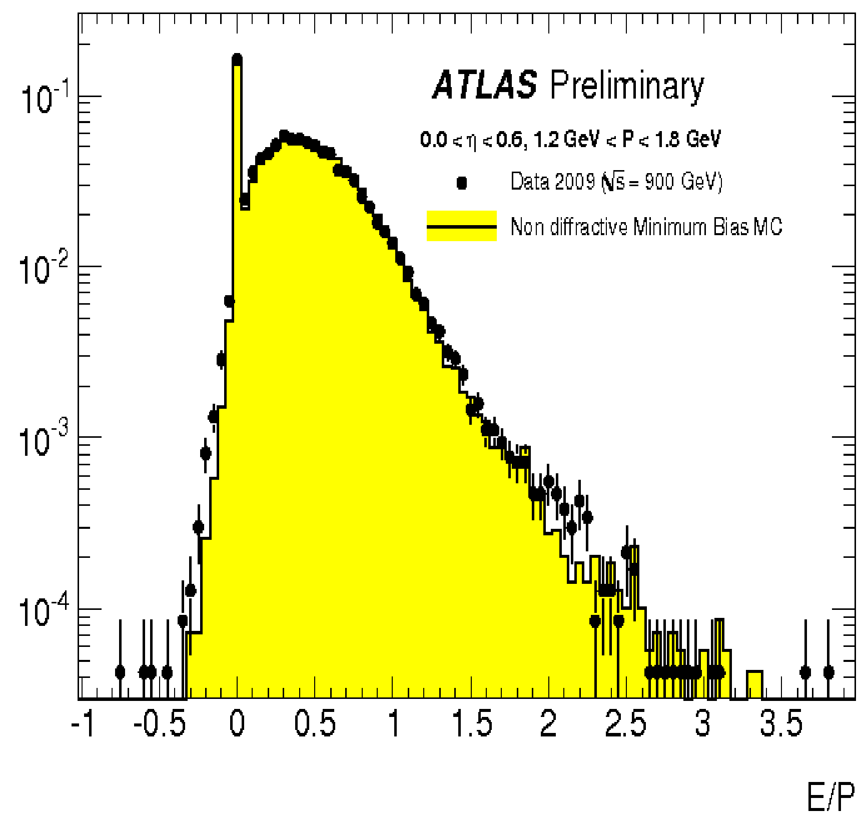
The basic idea:

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



A slight complication.
Showers from different particles can superimpose:

- Charged particle showers is strongly reduced by the isolation requirement
- Neutral particles cannot be reduced effectively. Their effect is estimated

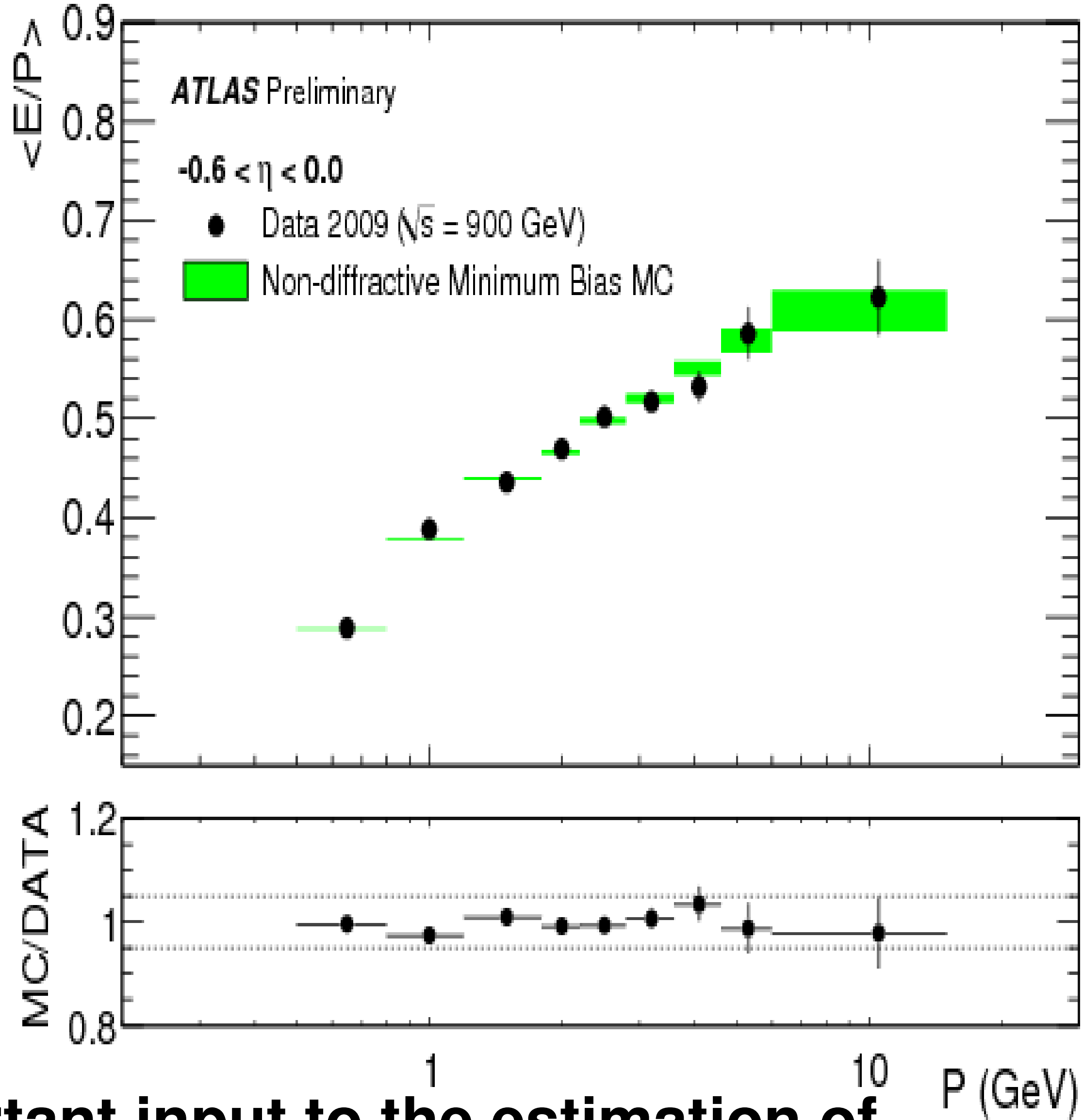


Results from the E/P

Comparing the mean values of the E/P distributions

<E/P> has been measured for
|η| < 2.3 and
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.



This measurement is an important input to the estimation of the jet calibration uncertainty which is the most relevant source of systematic errors in most of the QCD jet measurements.

Inclusive jet and di-jet kinematic distributions

ATLAS-CONF-2010-043

Distribution shape comparisons

All the kinematic distributions normalized to unity.
Comparisons 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.

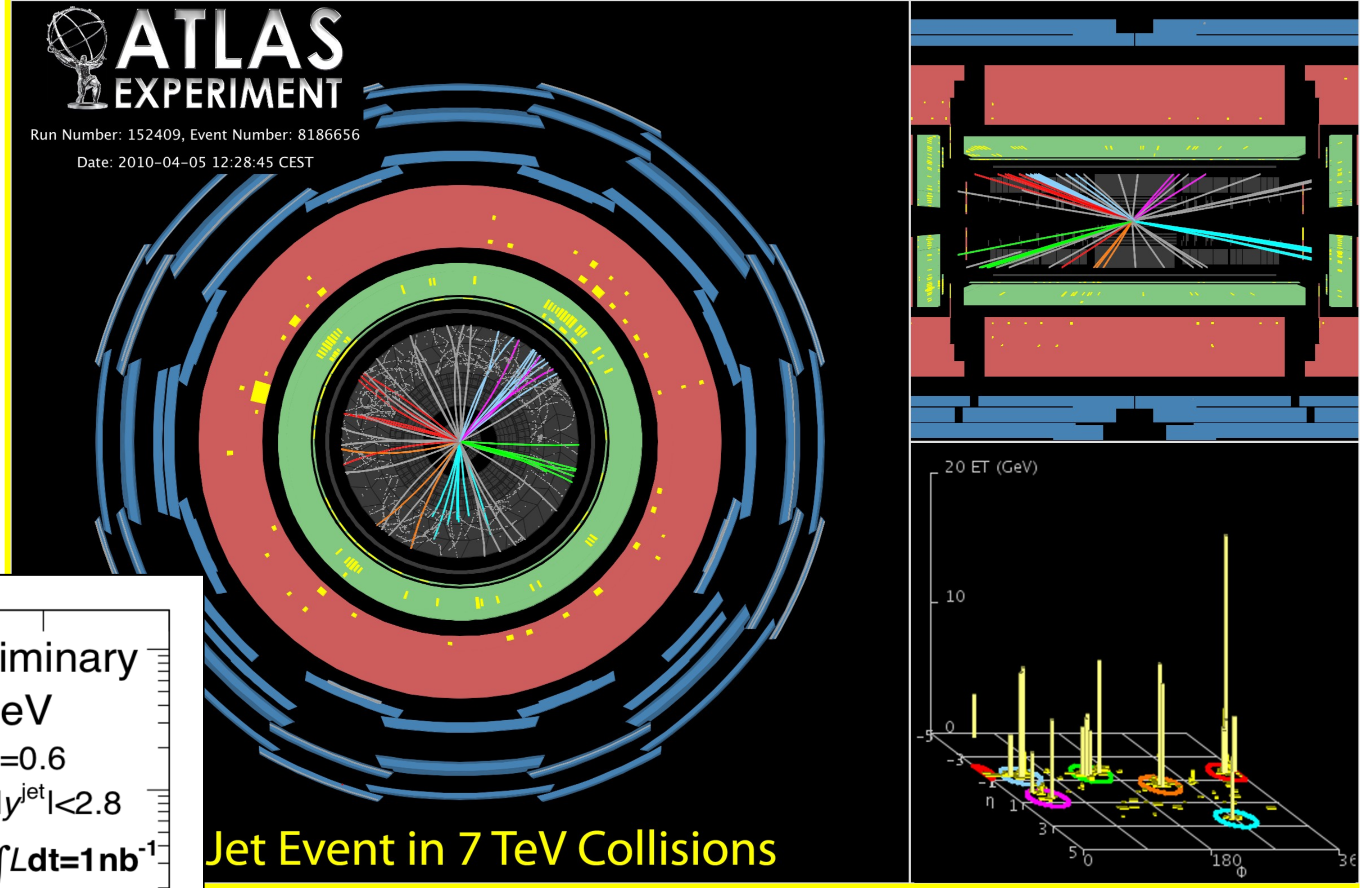
- No attempt to show systematic uncertainties from jet energy scale or other sources.

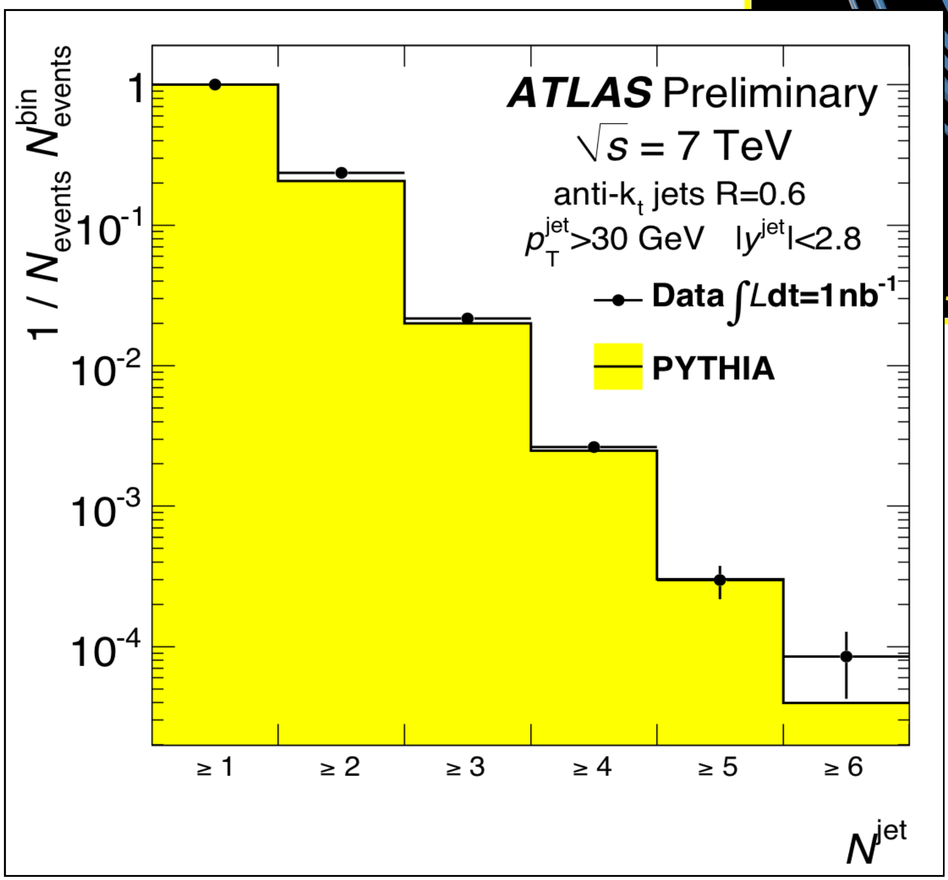
Jet cross-sections which contain all these effects will be reported later this summer.

Jets multiplicity

Integral distribution of number of jets

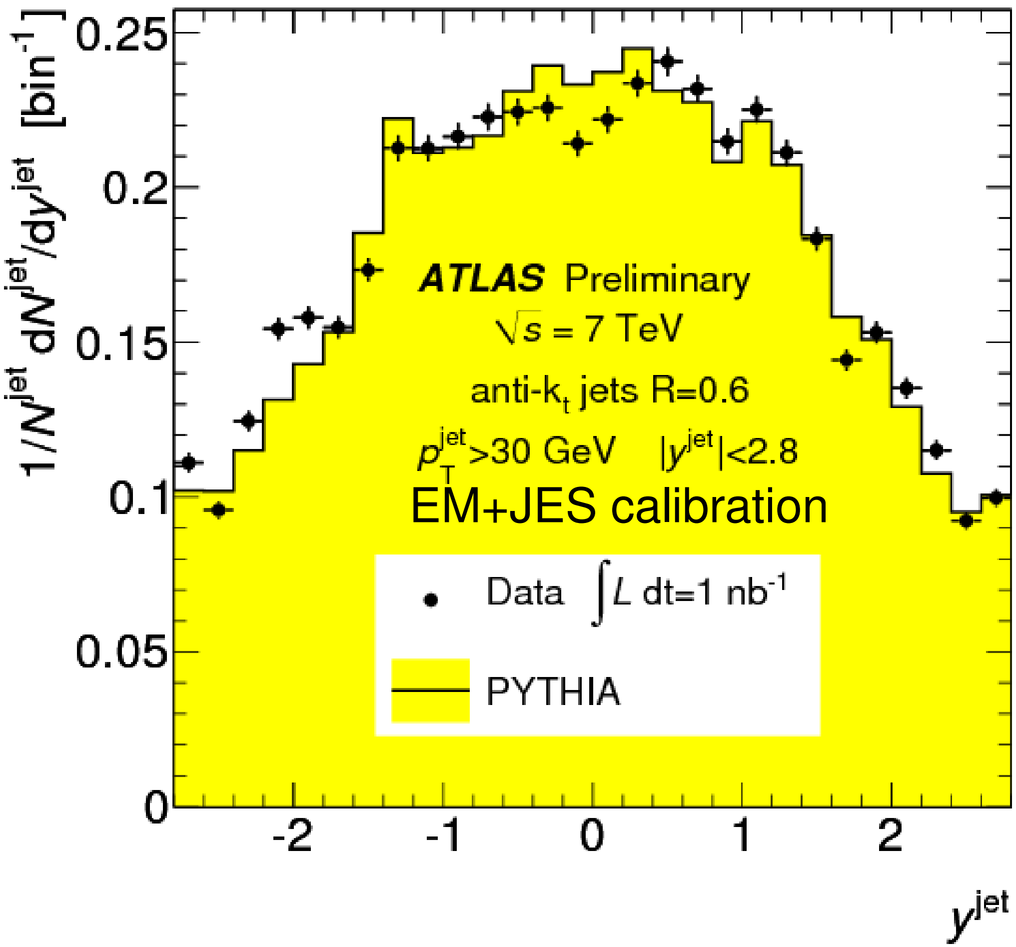
Up to 6 Jets in the data.

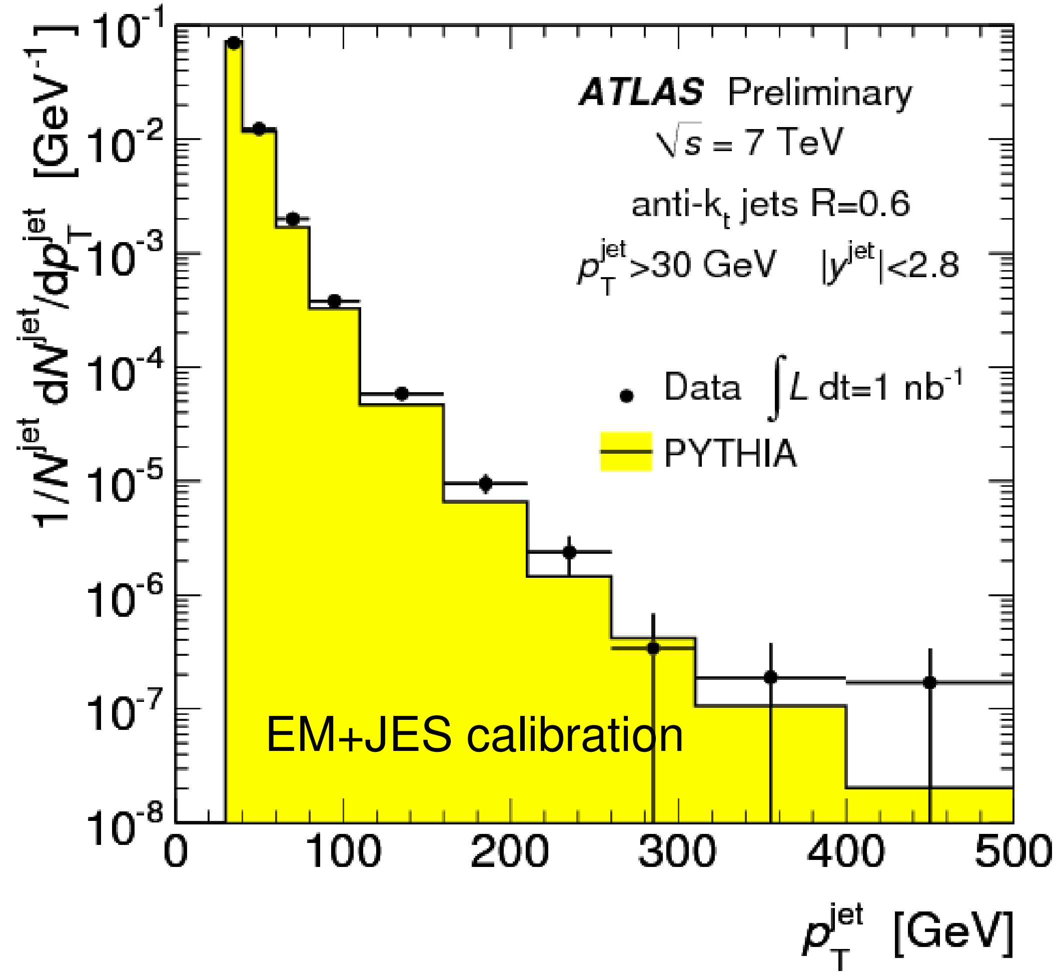




Good Agreement Data/MC, (LO parton shower)

Inclusive jet p_T and rapidity spectrum





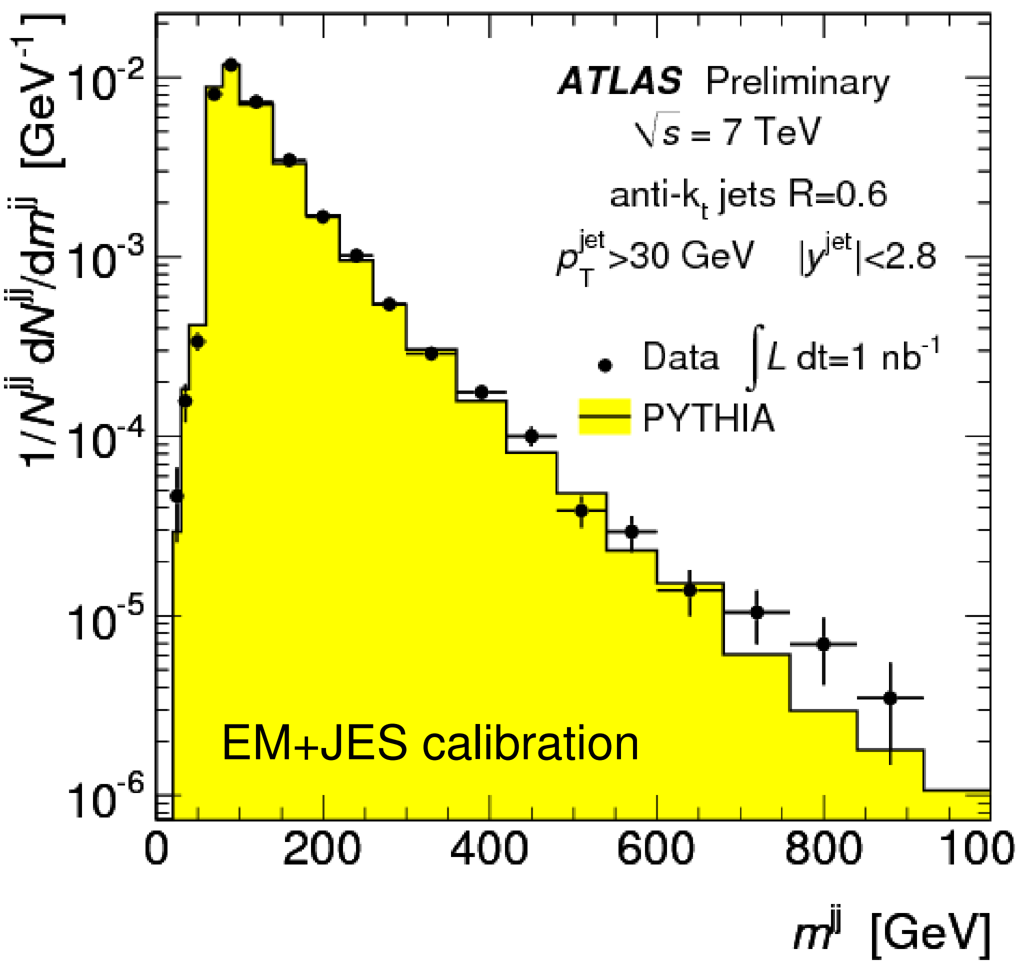
Monte Carlo follows the shape reasonably well.

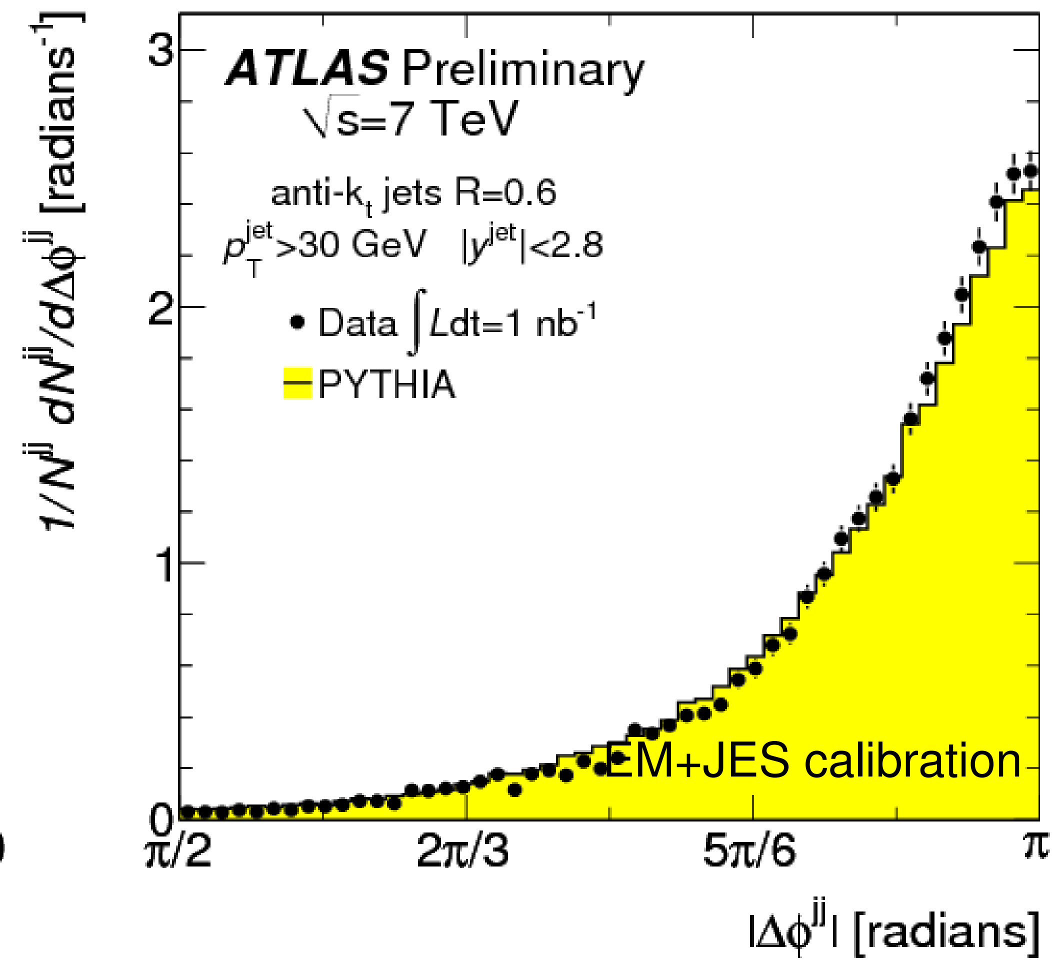
Some small deficiencies near y=0 and y=-2.1 (under investigation)

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

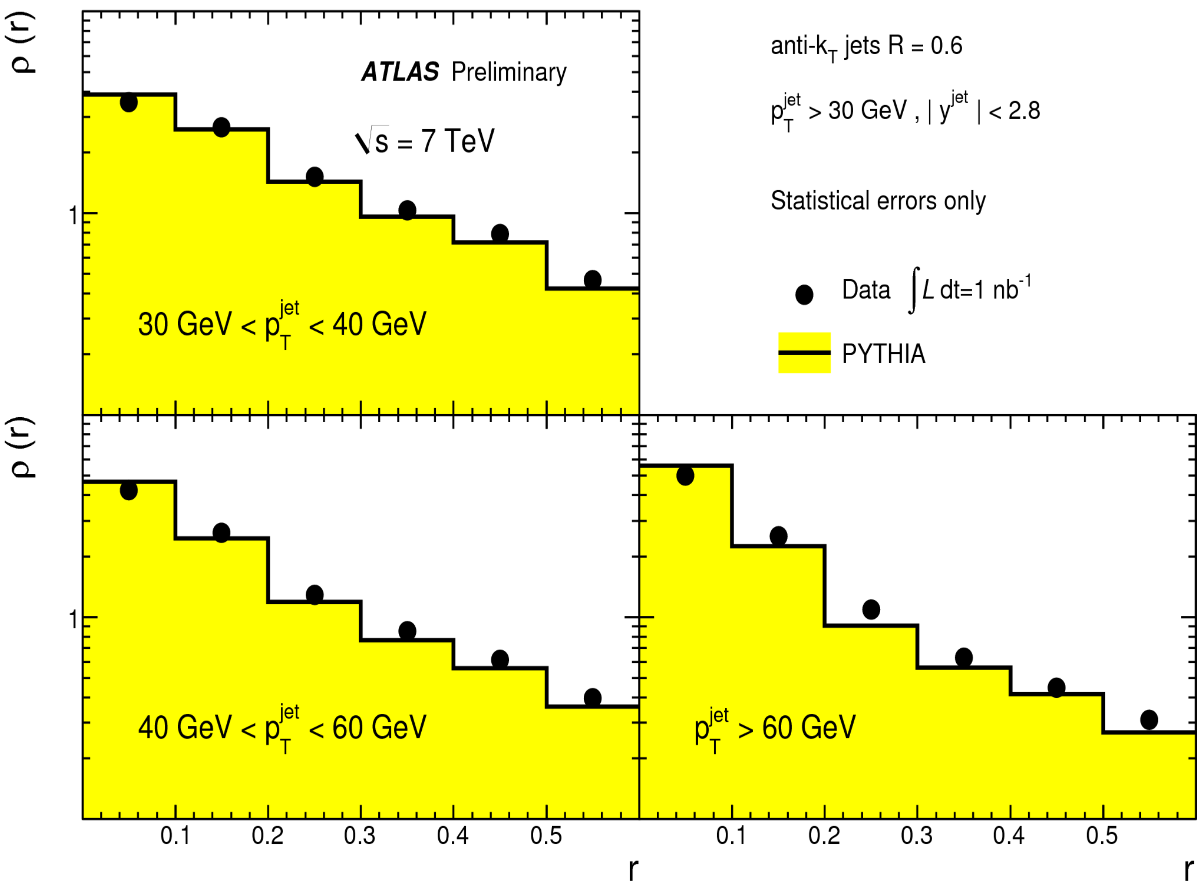


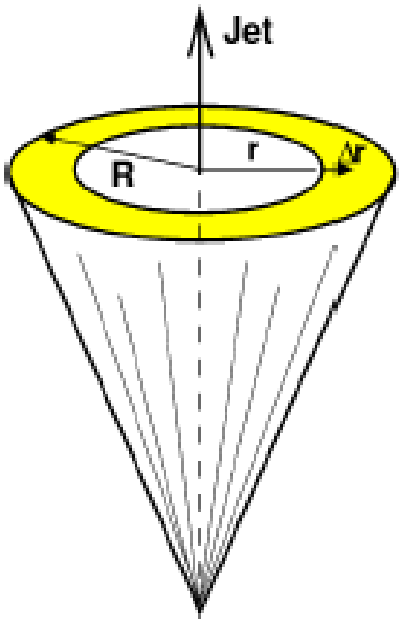


Jet shapes

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



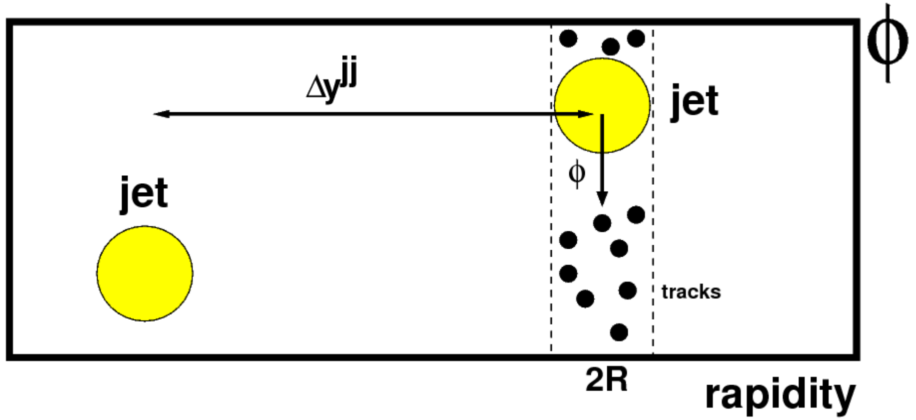


Monte Carlo describes data reasonably well, producing slightly narrower jets than data.

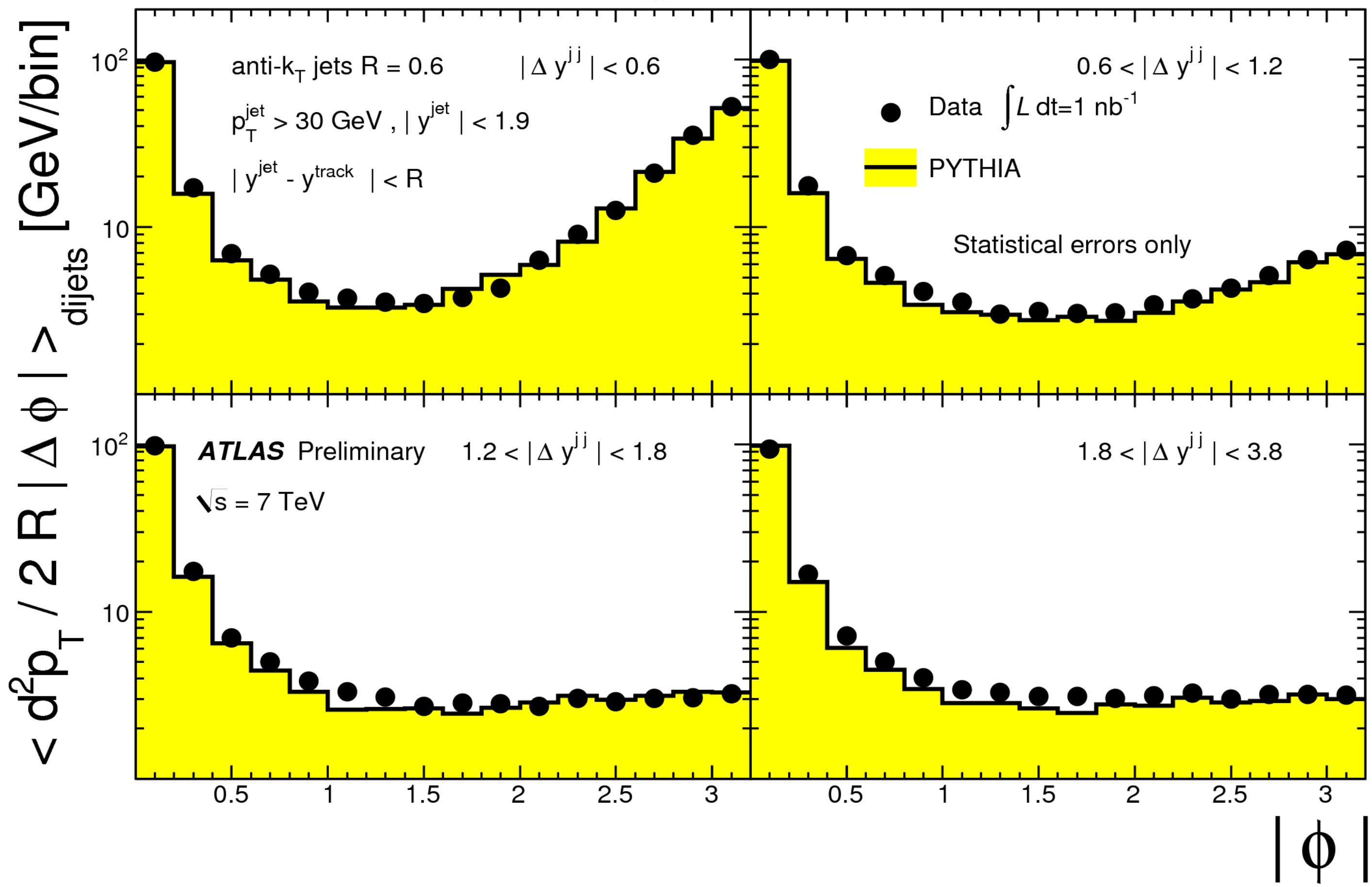
Charged Particle Flow

Avareage p_T density of tracks

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



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



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

Track-based method is useful to 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 and 7 TeV center-of-mass energy since November 2009.

Calorimeter performance and jet performance meets expectations and is well modeled by the Monte Carlo simulation.

Jets with p_T up to 500 GeV and dijet invariant mass up to 900 GeV have been observed.

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