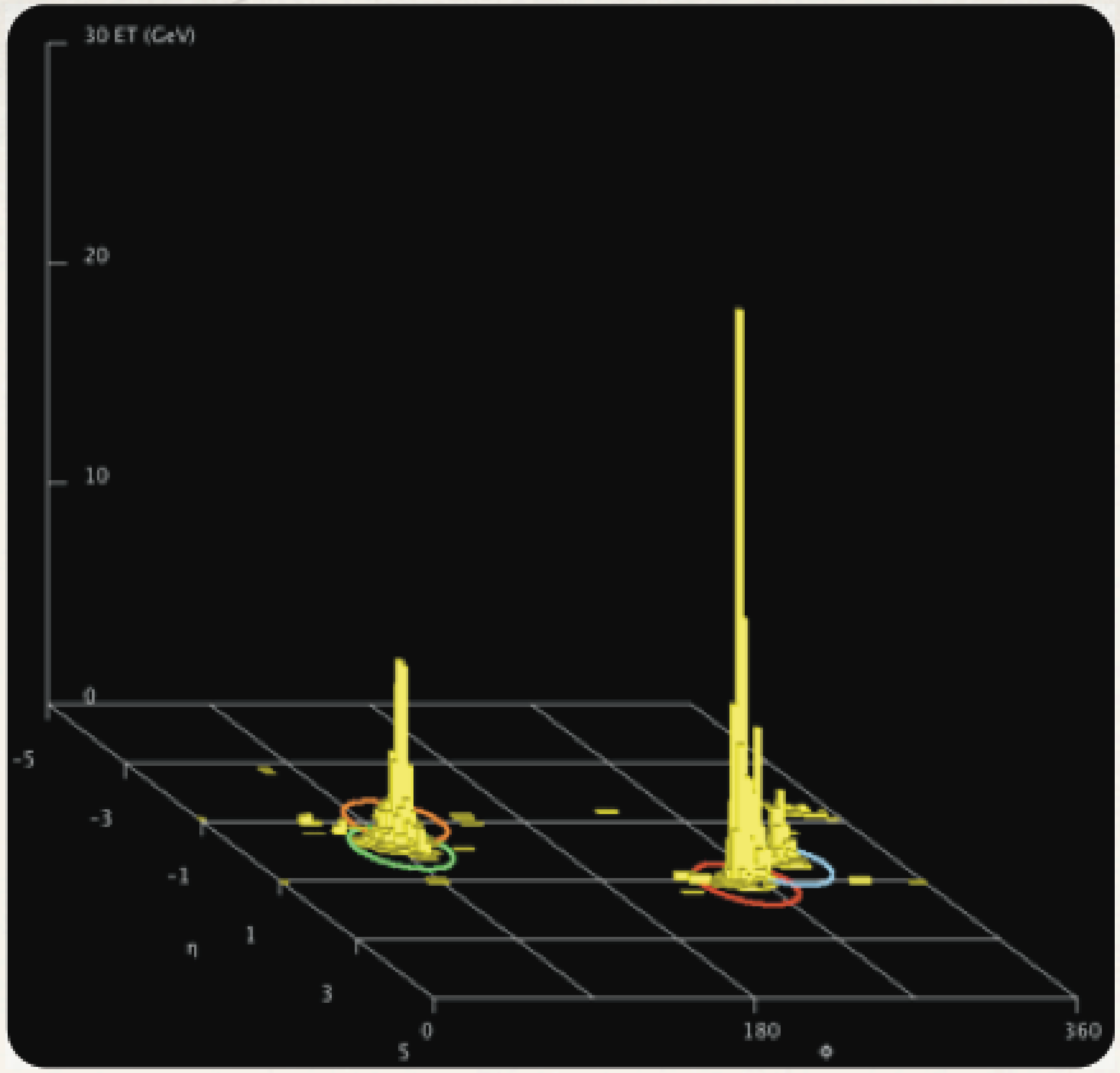


Observation of high-p_T jet production in p p at $\sqrt{s}$ = 7 TeV

Stephanie Majewski, Brookhaven National Laboratory,
on behalf of the ATLAS Collaboration

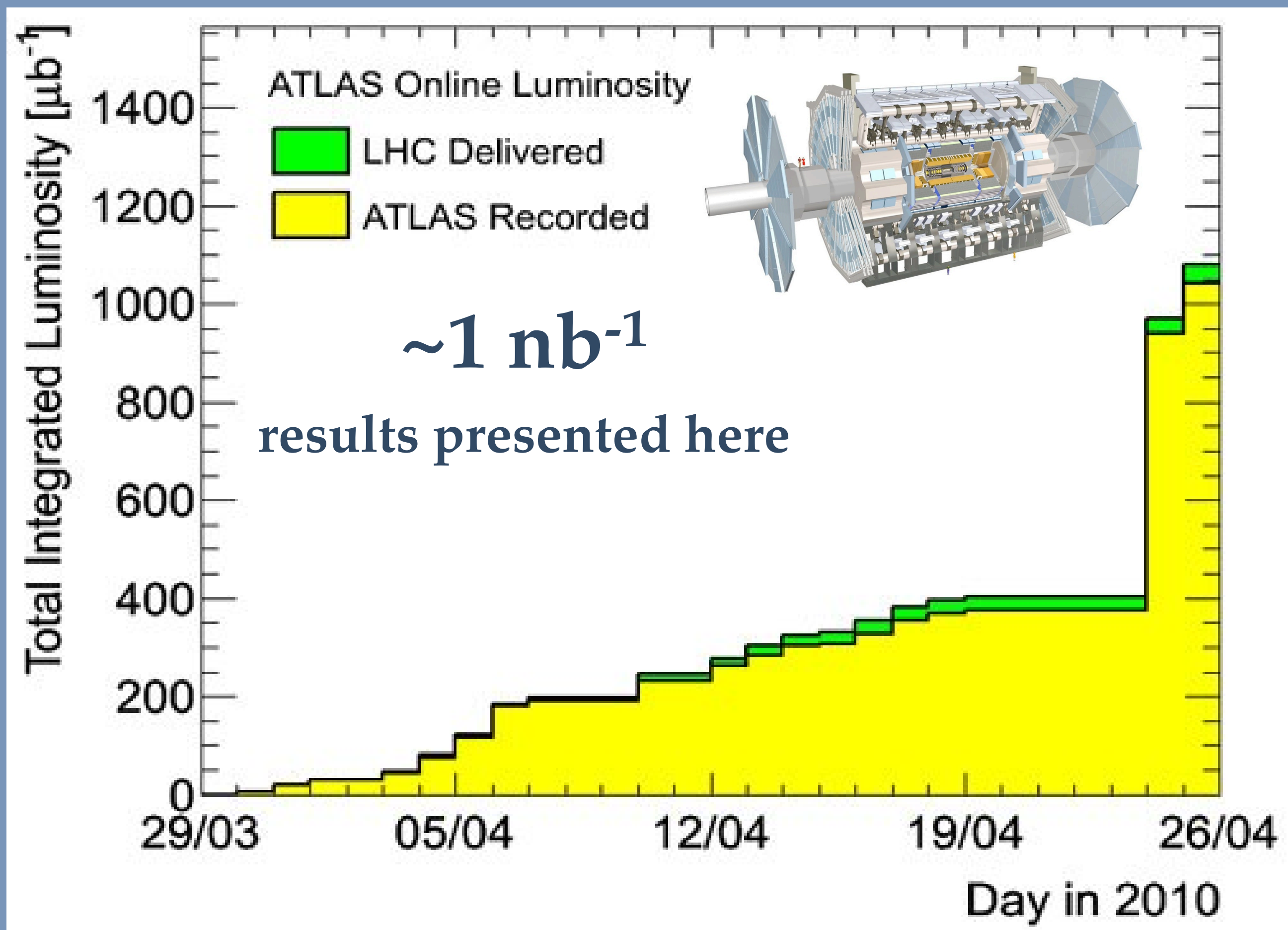
QCD@Work, June 20-23, 2010
Martina Franca, Italy

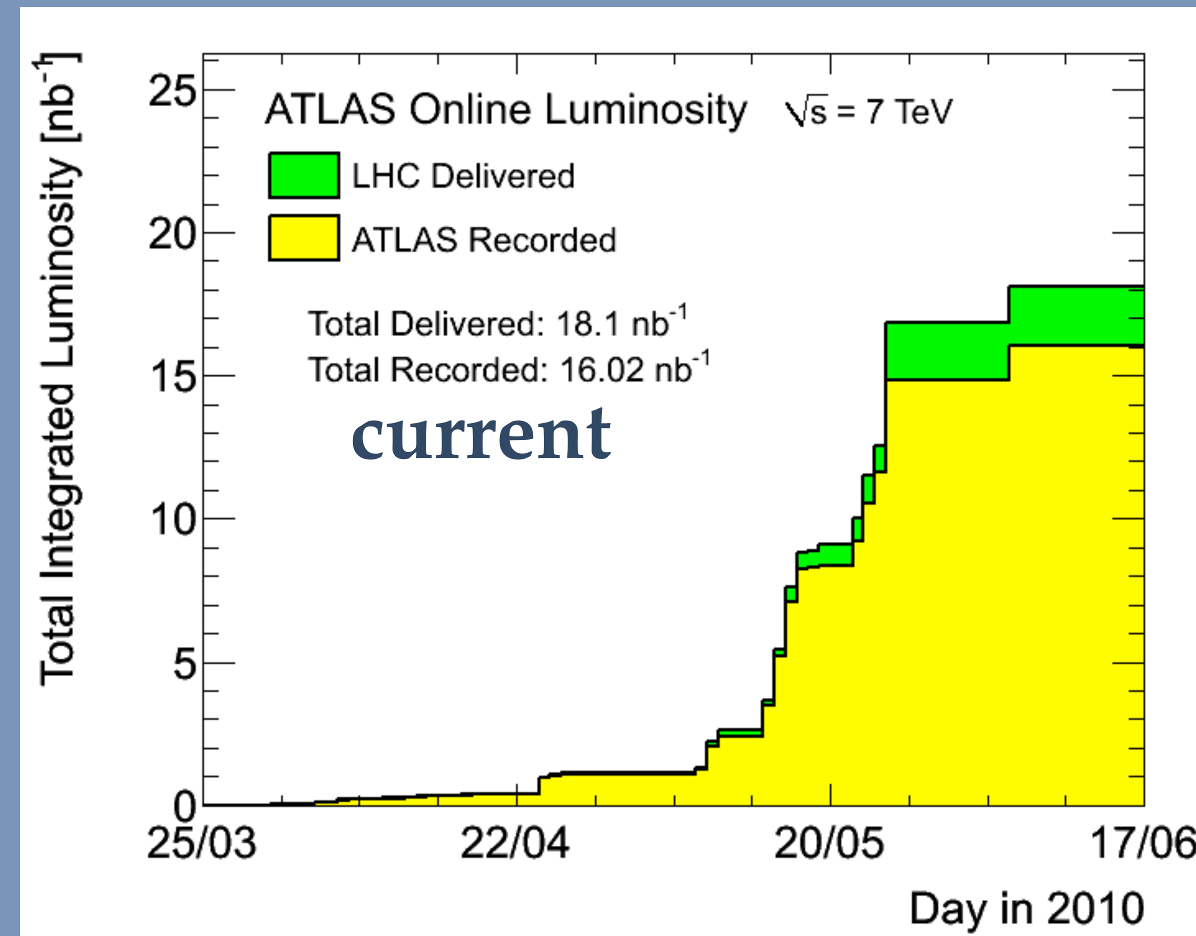
BROOKHAVEN
NATIONAL LABORATORY

Introduction

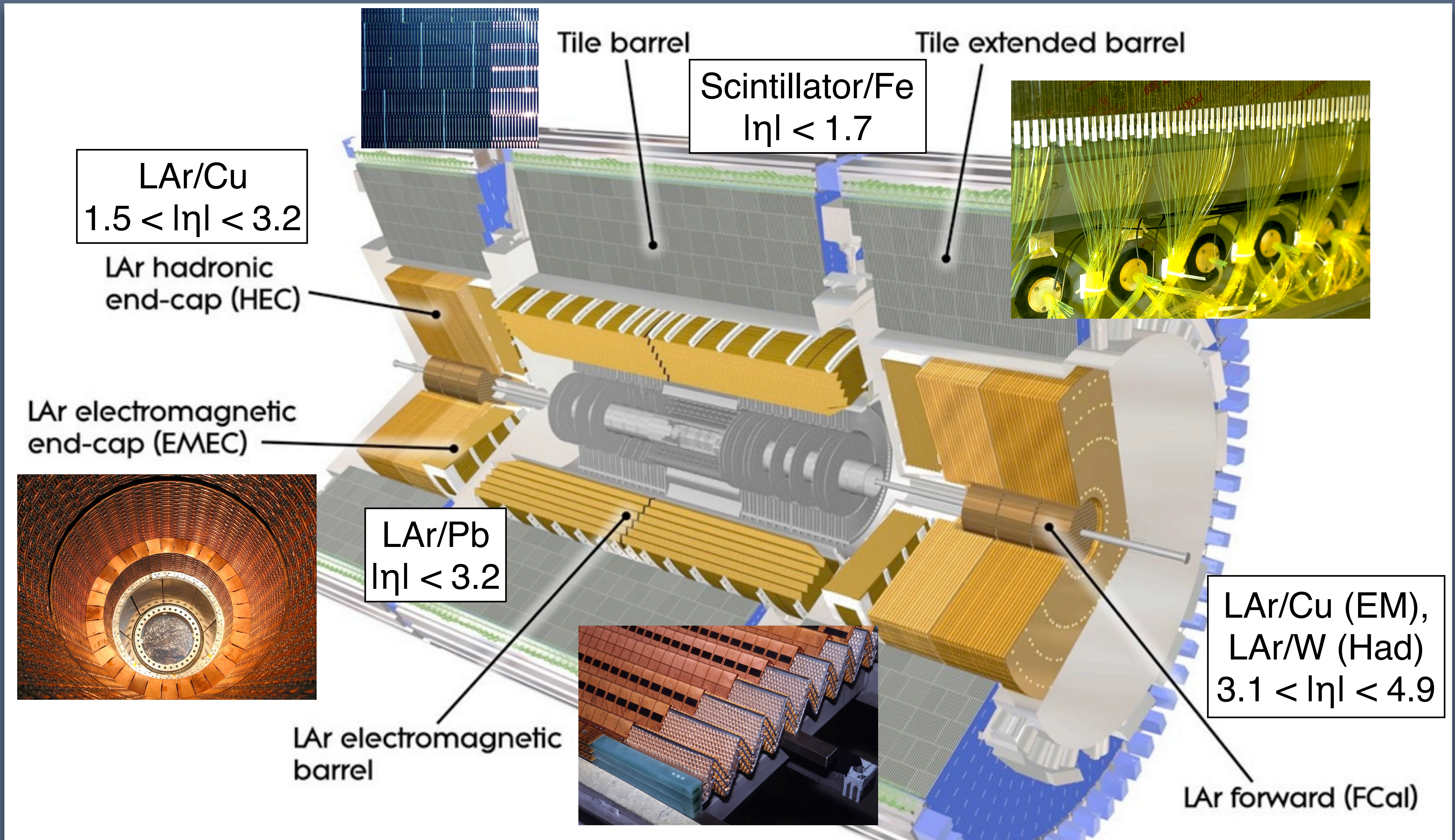
- **LHC and ATLAS performance**
- **Jet reconstruction and calibration**

LHC and ATLAS Performance



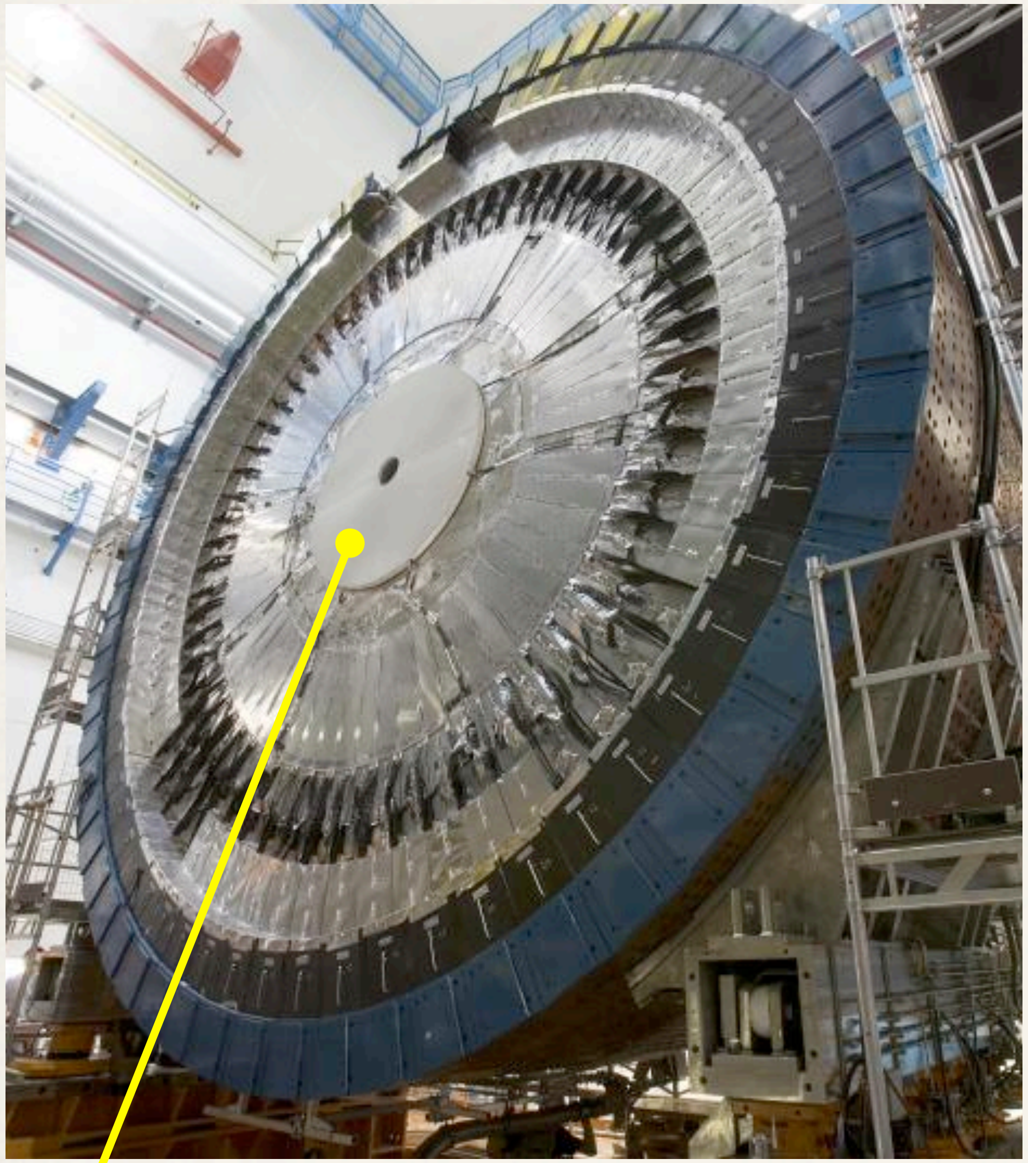


Subdetector	Number of Channels	Approximate Operational Fraction
LAr EM Calorimeter	170 k	98.5%
Tile calorimeter	9800	97.3%
Hadronic endcap LAr calorimeter	5600	99.9%
Forward LAr calorimeter	3500	100%



ATLAS Calorimeters

Trigger and Vertexing



Minimum Bias Trigger Scintillator (MBTS), $2.09 < |\eta| < 3.84$
(mounted on the LAr endcap cryostat)

ATLAS-CONF-2010-025

Trigger:

minimum bias inclusive trigger

require ≥ 1 scintillator hit on either side above threshold

collision event: $|t| < 7.5$ ns

Vertex Requirement:

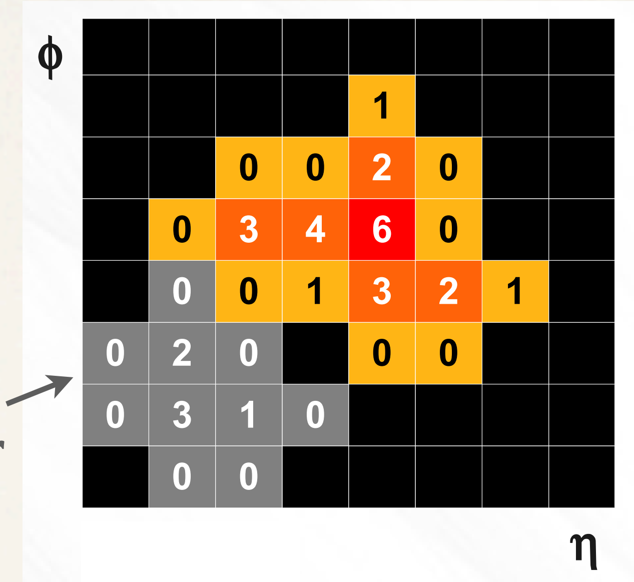
at least 1 vertex with $|z| < 10$ cm

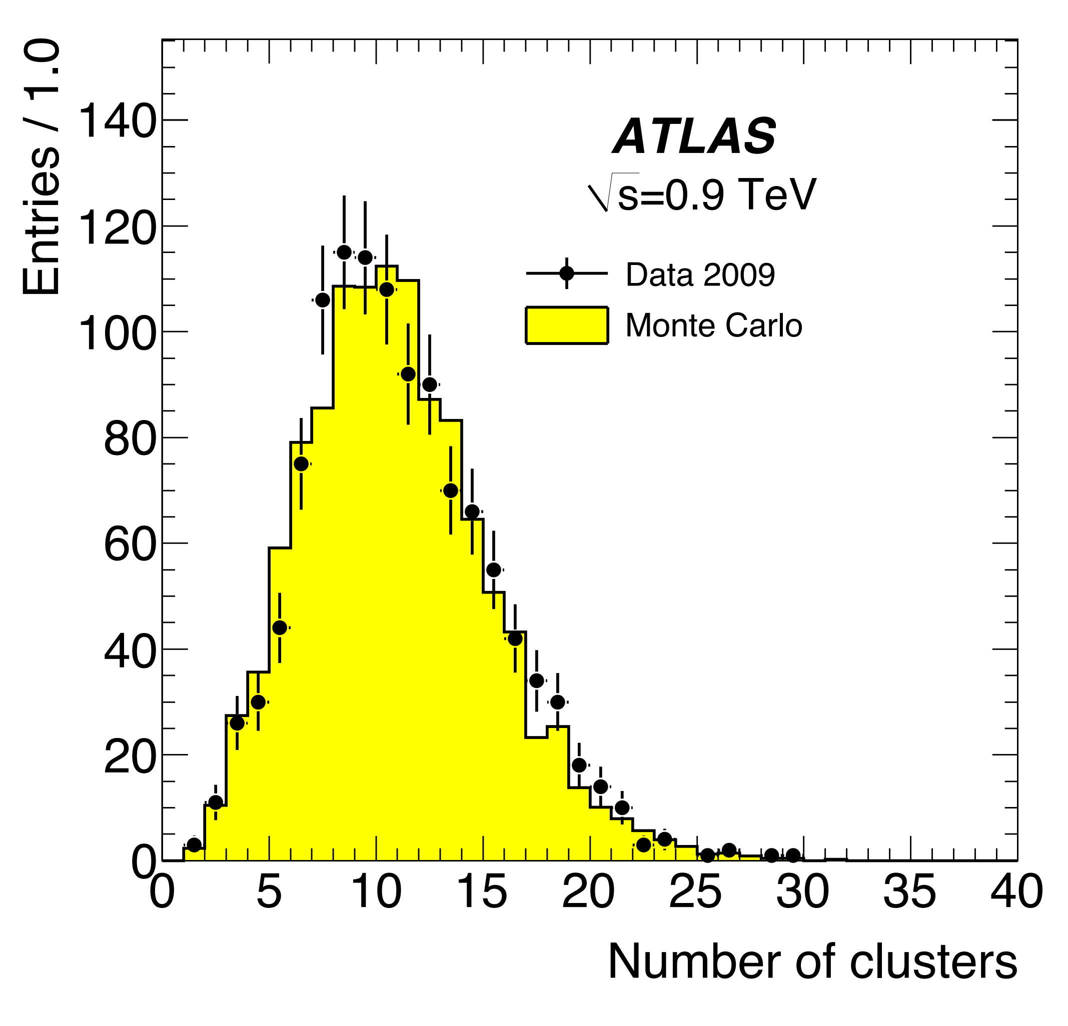
- suppresses beam-related bkg and cosmic rays

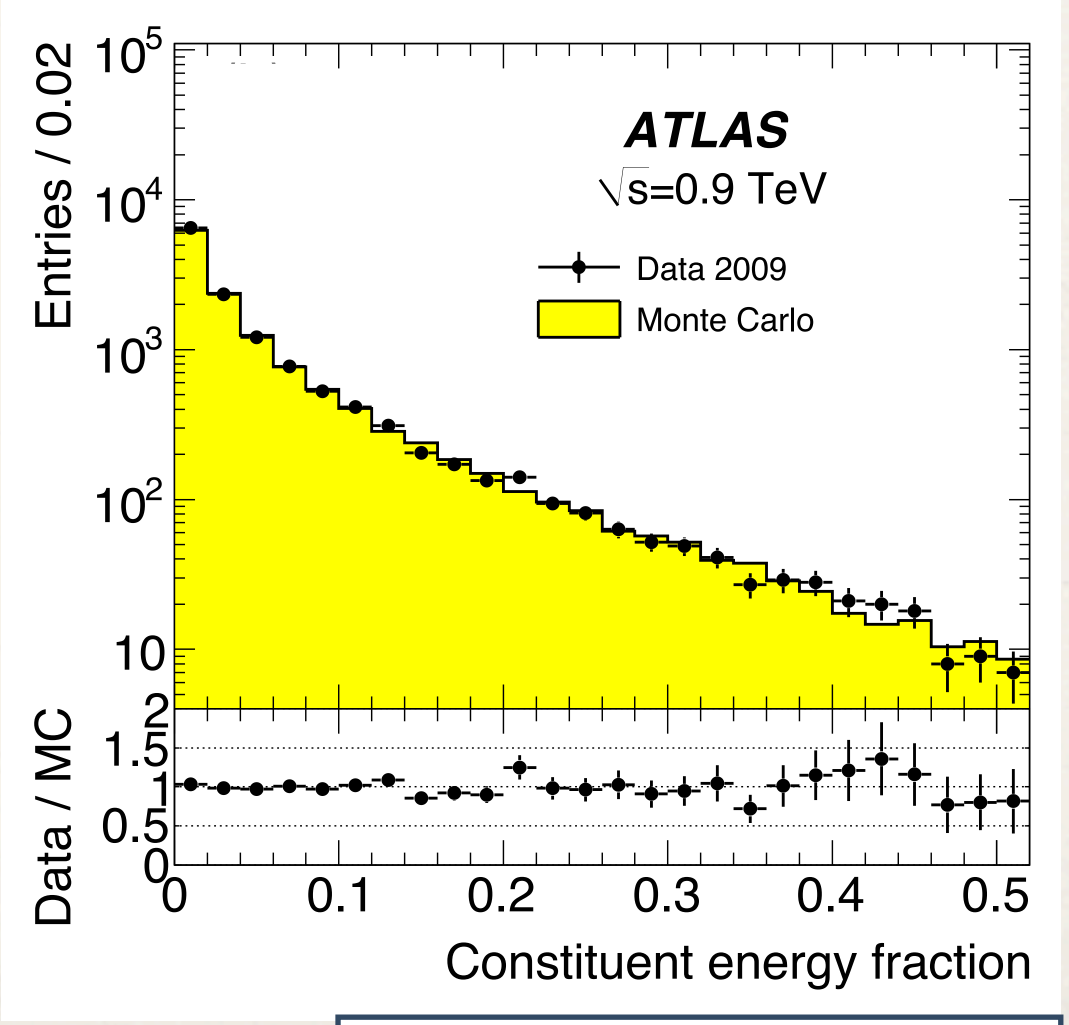
negligible impact from pileup ($< 0.2\%$)

Jet Reconstruction: Constituents

- **<u>Topological Clusters</u>**:
  - seeded from cells with $|E_{cell}| > 4\sigma$; “4-2-0 scheme” (σ = RMS of cell energy noise distribution)
  - evolution in 3 dimensions
  - excellent noise suppression



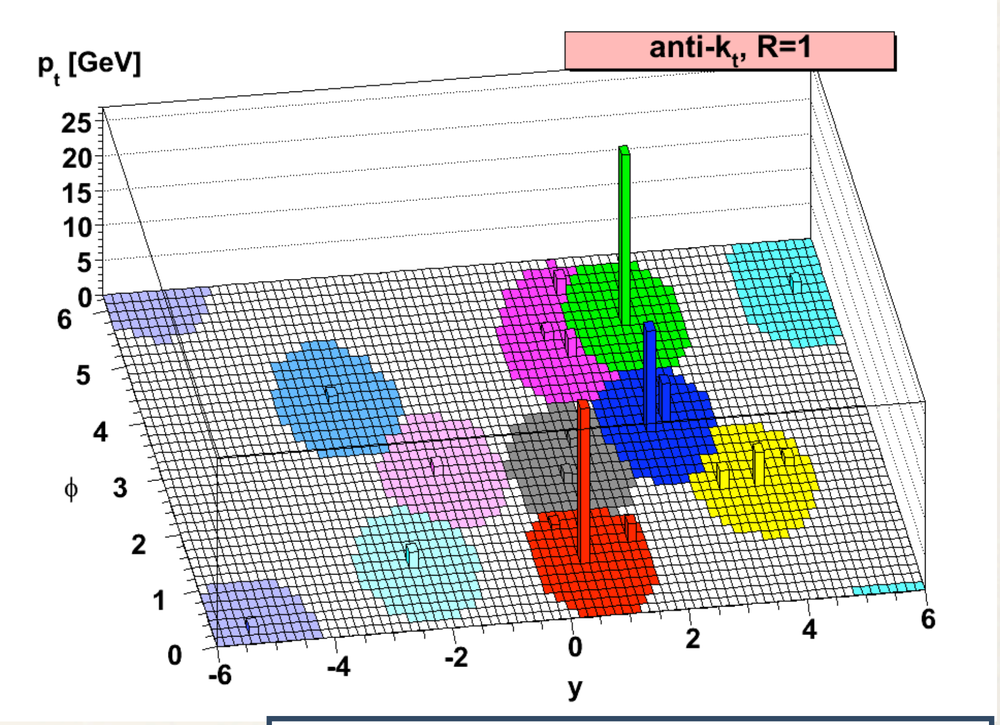




arXiv:1005.5254 [hep-ex]

Jet Reconstruction: Algorithm

- **anti-k$_T$ algorithm**:
  - sequential combination algorithm
  - iterative procedure to combine proto-jets
  - search for min(d_{ij},d_{ii}):
    - if d_{ij} is smaller, recombine (i,j)
    - if d_{ii} is smaller, jet *i* is final



arXiv:0802.1189 [hep-ex]

$$d_{ij} = \min\left(p_{T,i}^{-2}, p_{T,j}^{-2}\right) \frac{\Delta_{ij}^2}{R^2}$$

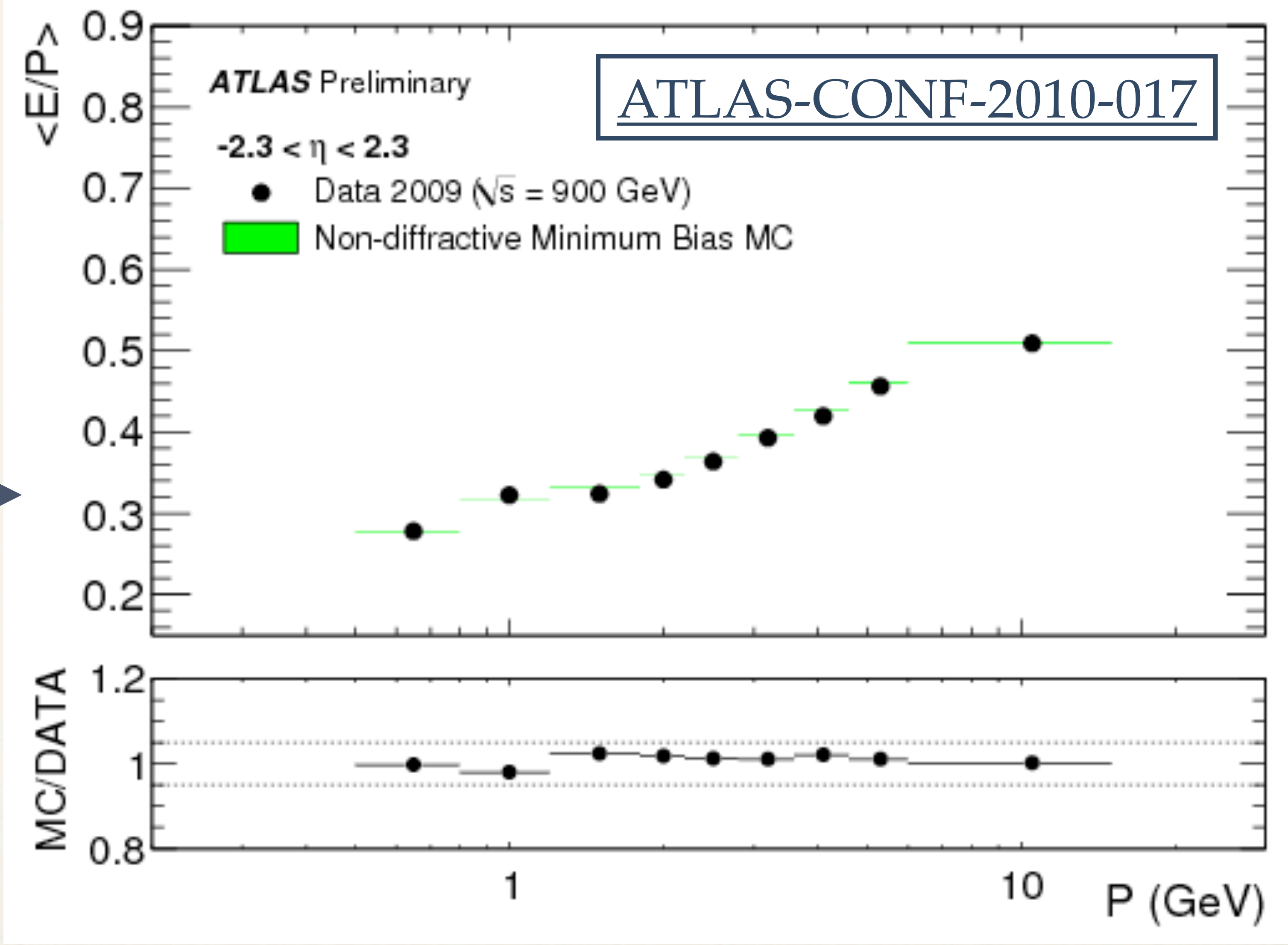
R = {0.4, 0.6} typically

$$\Delta_{ij}^2 = (y_i - y_j)^2 + (\phi_i - \phi_j)^2$$

  - theoretically clean (IR, collinear safe)
  - FastJet implementation

Jet Calibration

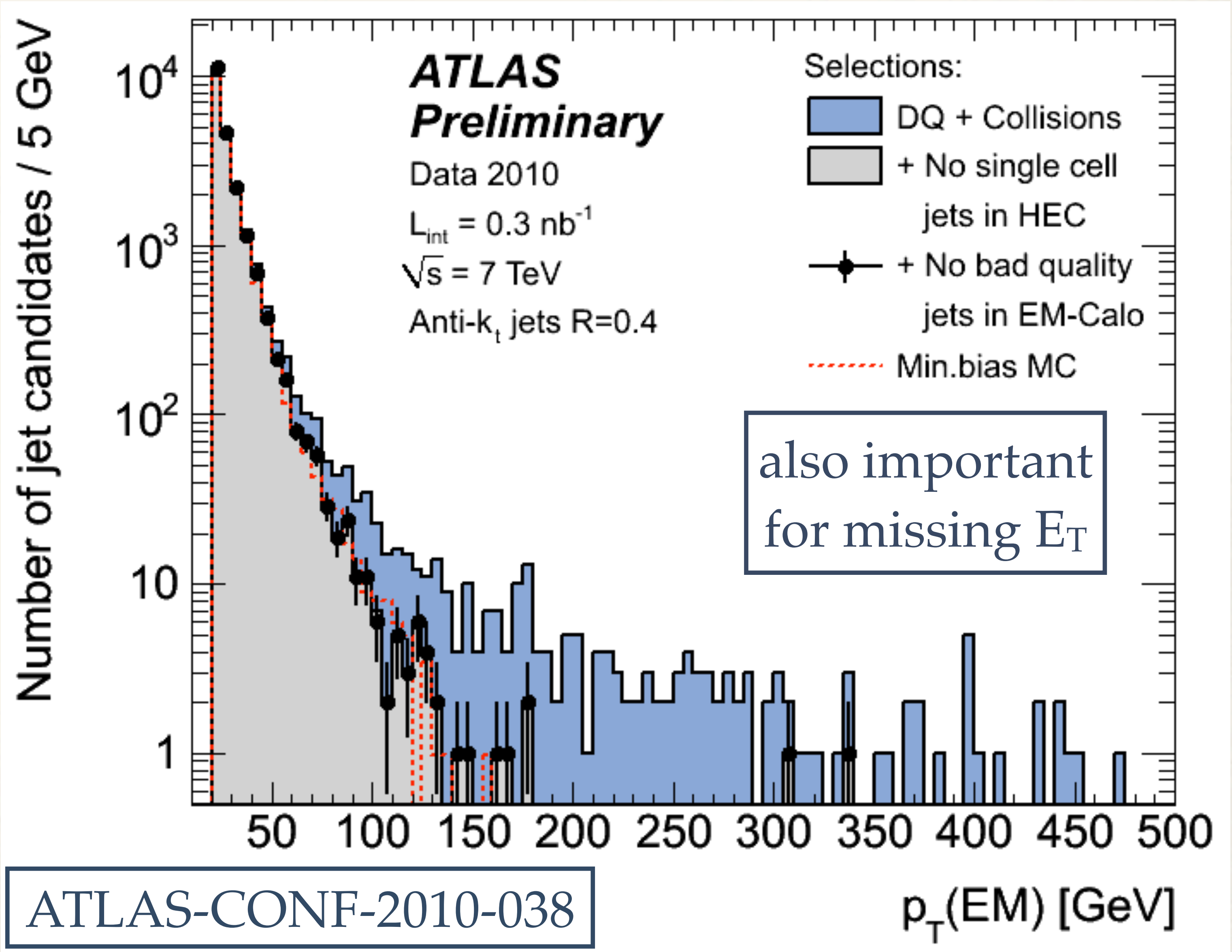
- Jet p_T corrected on average from EM scale to hadronic scale using a MC-based calibration (p_T, η)
- Preliminary studies show an absolute jet energy scale uncertainty of ± **7%**
  - calorimeter p_T response in different rapidity regions known to ± 5%
  - E/p from in situ isolated tracks matched to topological clusters
  - calorimeter measurements and test beam results establish absolute scale



Data Quality and Preselection

- **Run and Event Requirements**:
  - stable beam flag from the LHC
  - calorimeter fully operational with nominal performance
  - event timing consistent with collisions
- **Jet Veto**:
  - single noisy cells in the hadronic endcap region (largest effect)
  - jets from bad quality calorimeter pulses
  - out-of-time deposits

events with ≥ 1 "bad" jet, p_T > 10 GeV (EM scale) are removed



ATLAS-CONF-2010-038

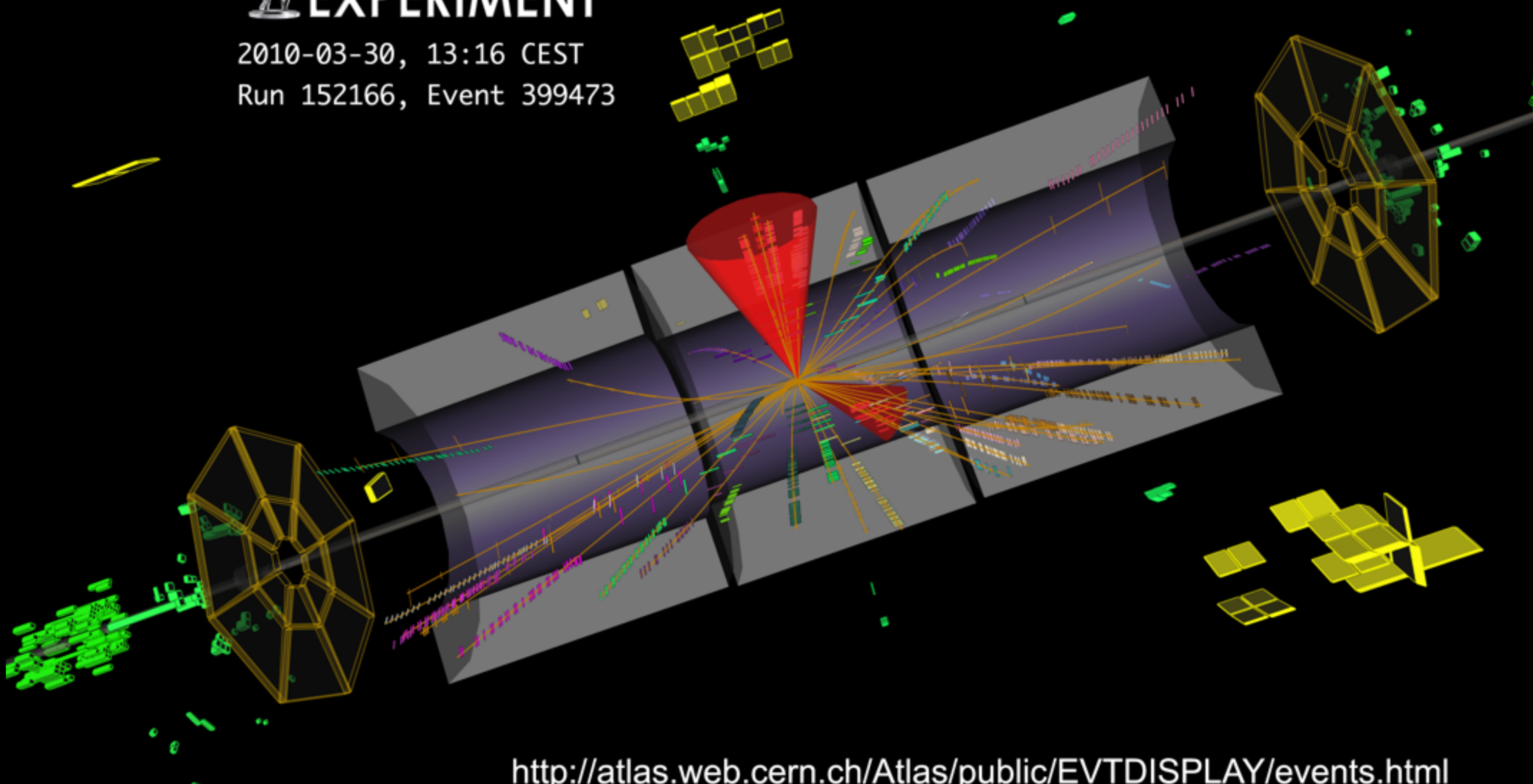
Event Displays

- **Jet events at $\sqrt{s} = 7$ TeV**

ATLAS EXPERIMENT

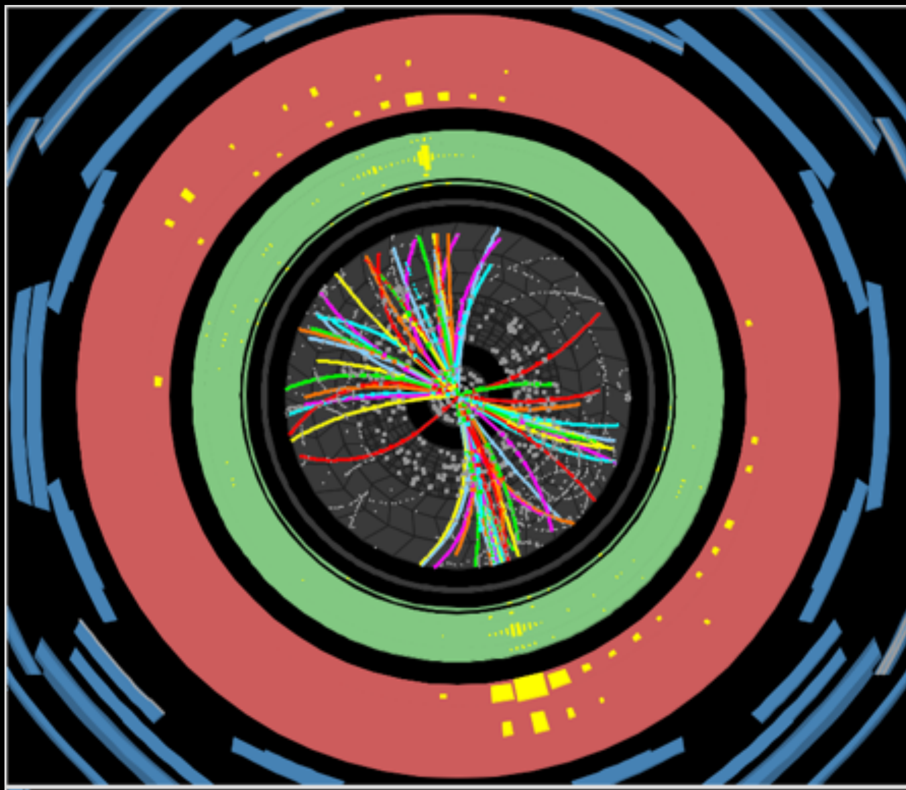
2-Jet Collision Event at 7 TeV

2010-03-30, 13:16 CEST
Run 152166, Event 399473



http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

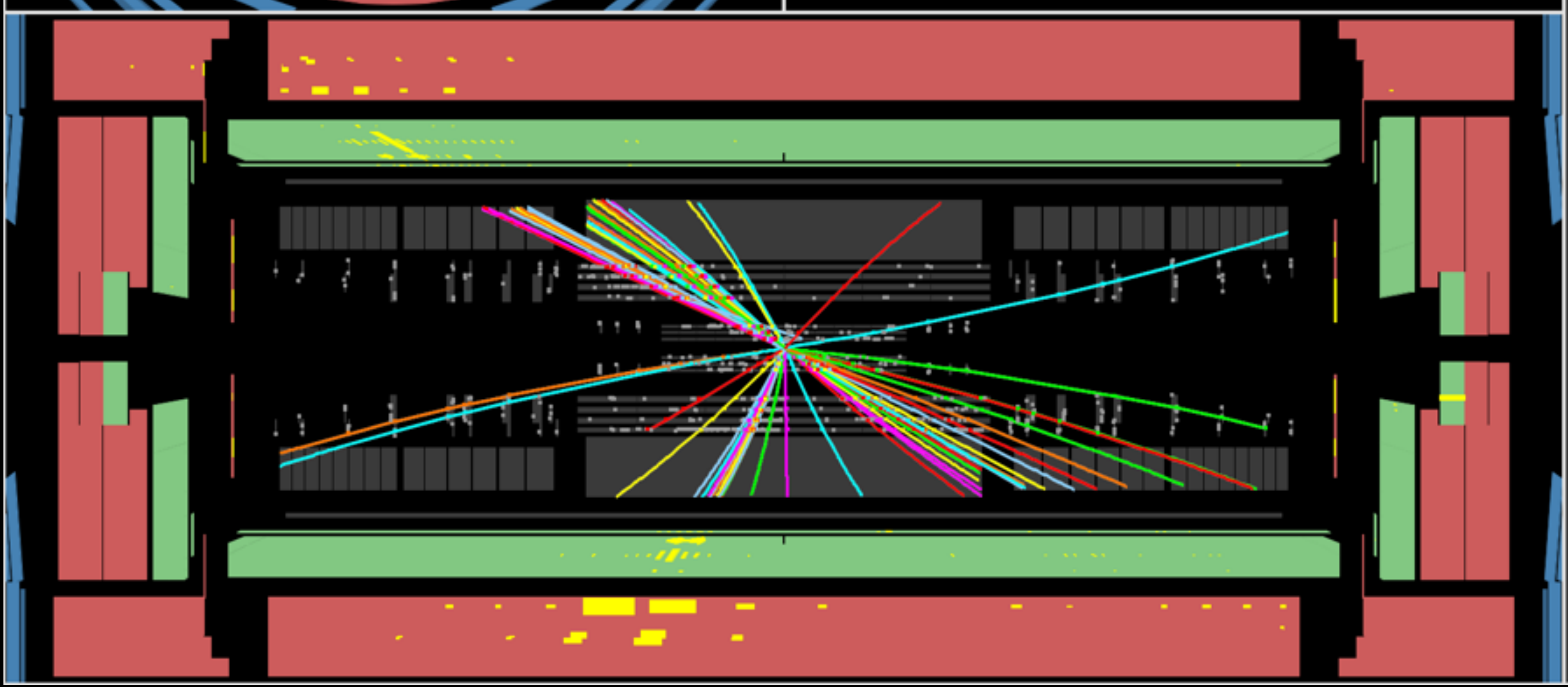
Highest p_T Dijet Event

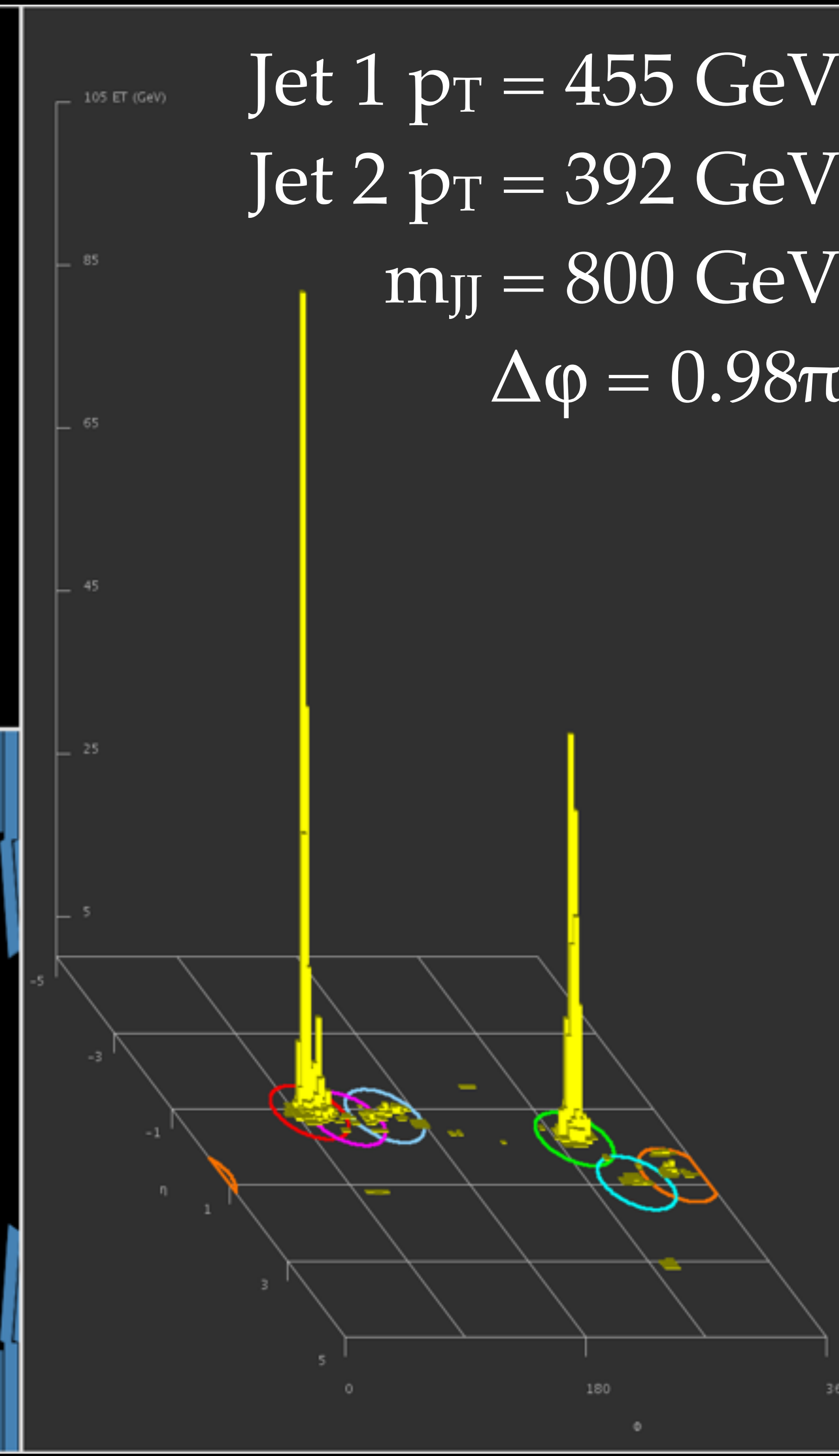


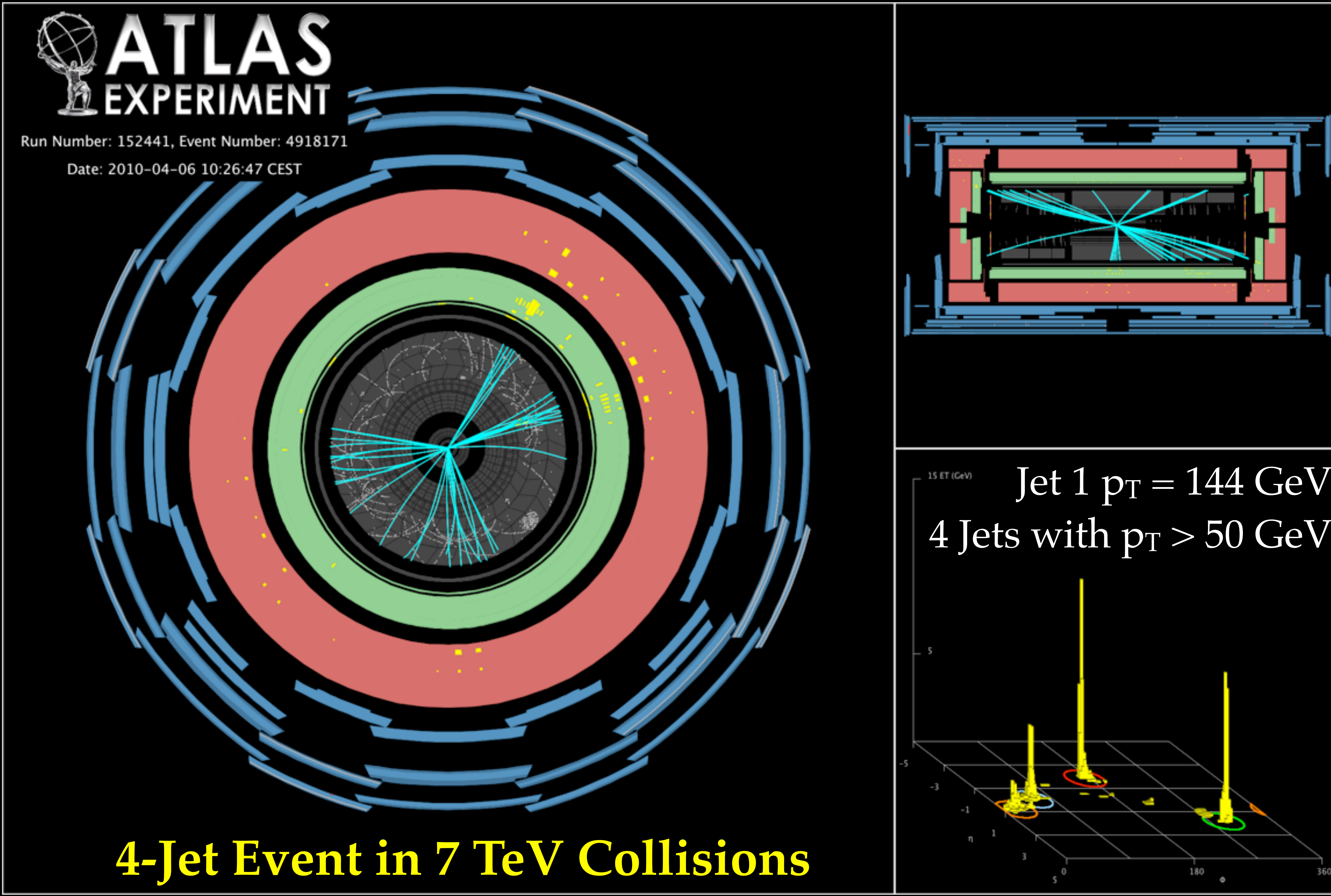
Run Number: 152166, Event Number: 810258

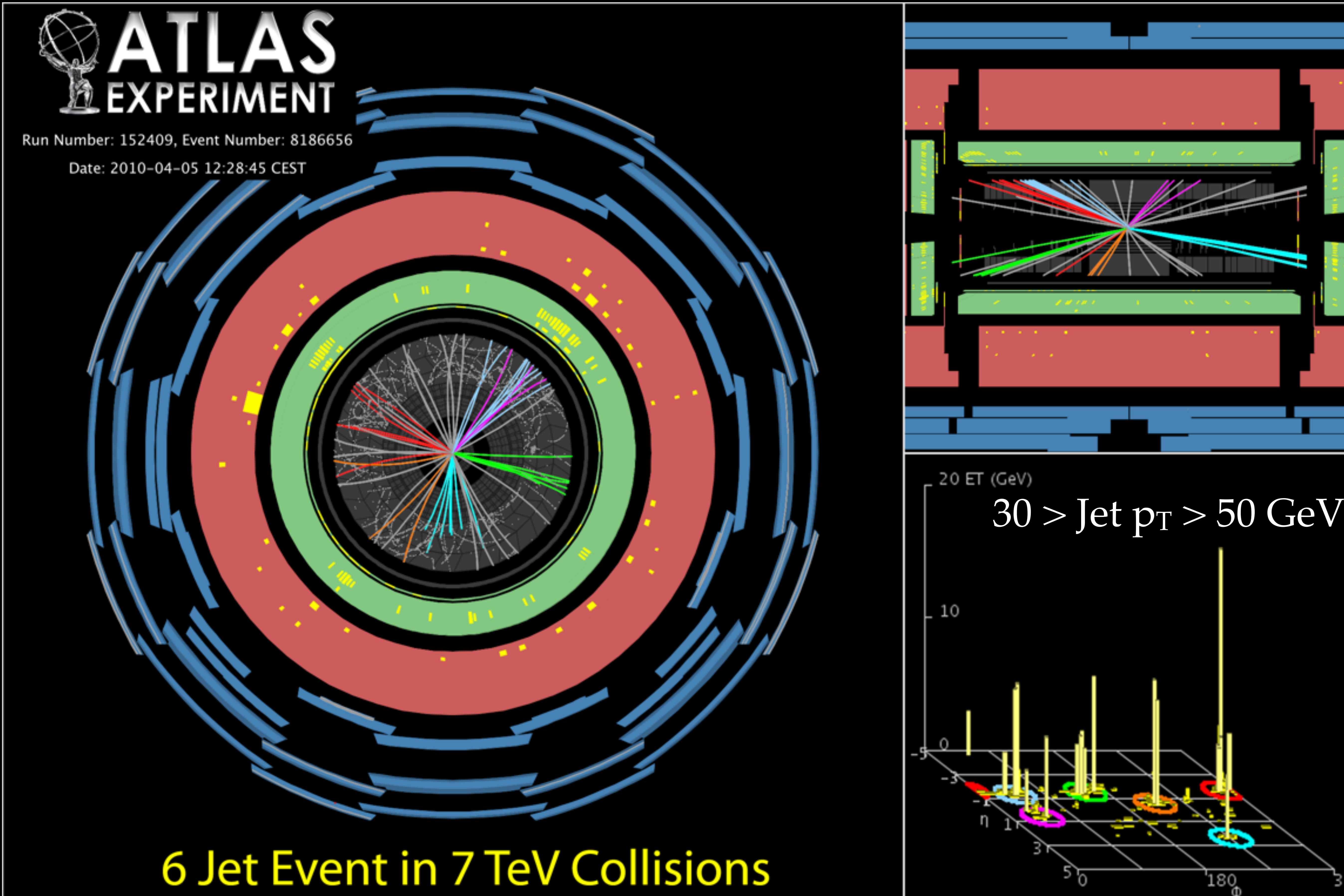
Date: 2010-03-30 14:56:29 CEST

Di-jet Event at 7 TeV






ATLAS EXPERIMENT
Run Number: 152441, Event Number: 4918171
Date: 2010-04-06 10:26:47 CEST
Jet 1 p_T = 144 GeV
4 Jets with p_T > 50 GeV
15 ET (GeV)
5
-5
-3
-1
1
3
5
η
0
180
360
φ
4-Jet Event in 7 TeV Collisions



6 Jet Event in 7 TeV Collisions

Results

- Inclusive jet production
- Dijet distributions
- Internal jet structure
- Charged particle flow

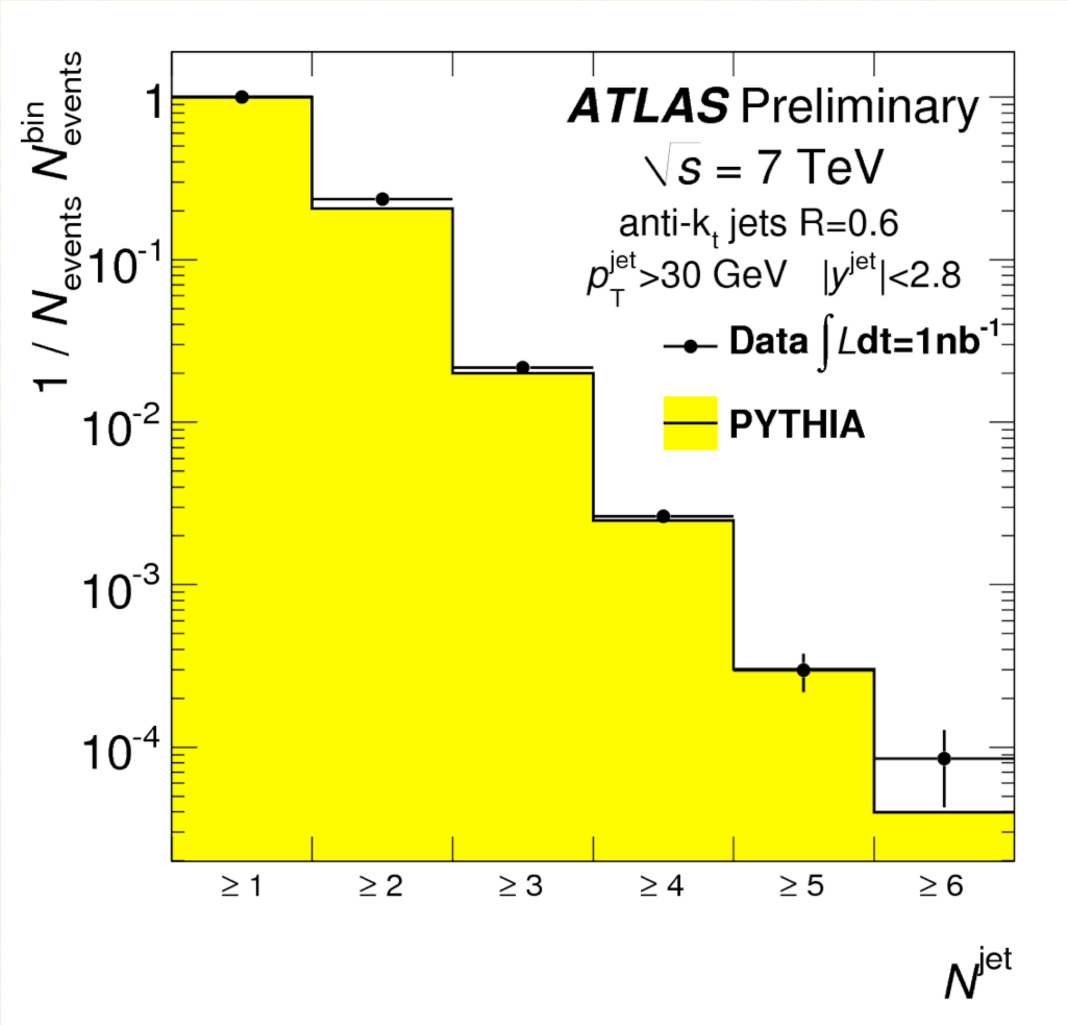
Comparison of Data with MC

$$p_T^{\mathrm{jet}} > 30\,\mathrm{GeV}\ \mathrm{and}\ \left|y^{\mathrm{jet}}\right| < 2.8$$

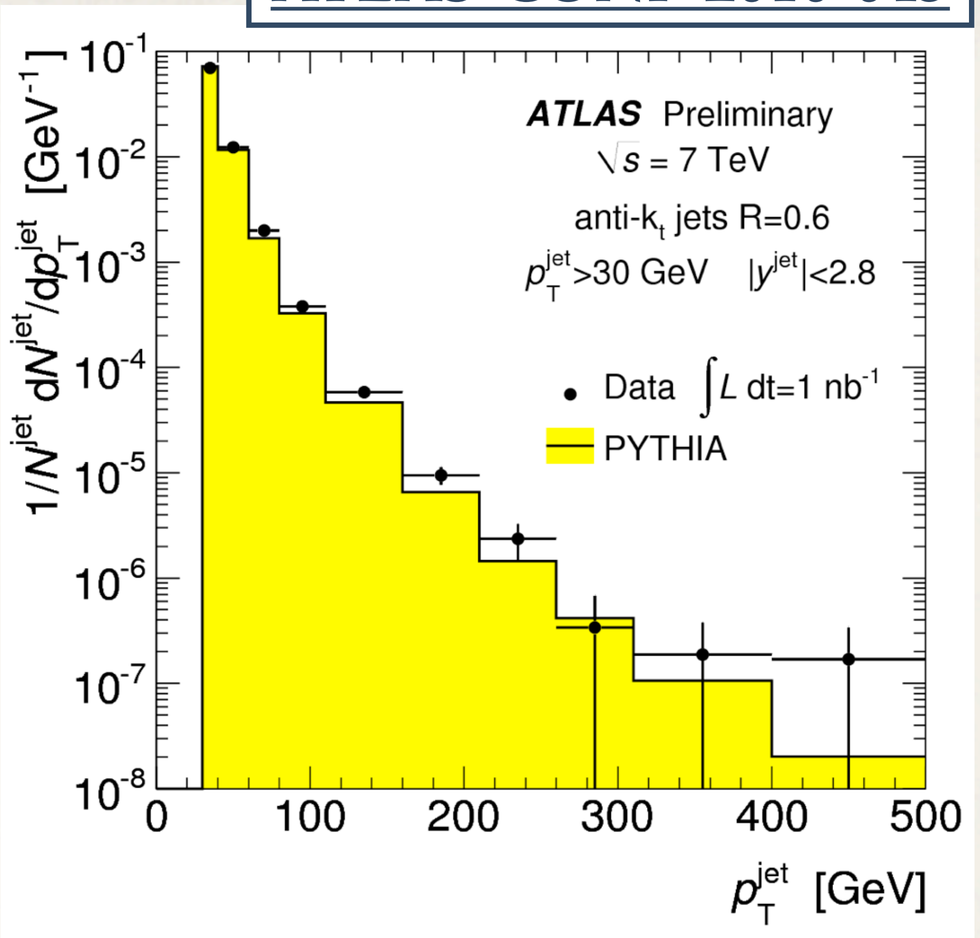
- Pythia dijet Monte Carlo sample (LO matrix element + parton shower),
  - ATLAS MC09 tune, MRST LO* PDFs, full GEANT4 simulation
- <u>All kinematic distributions normalized to unity</u>
  - comparisons are sensitive to shape differences
- Data/MC distributions compared at reconstruction level (not unfolded)
- **<u>Only statistical uncertainties</u>** are shown

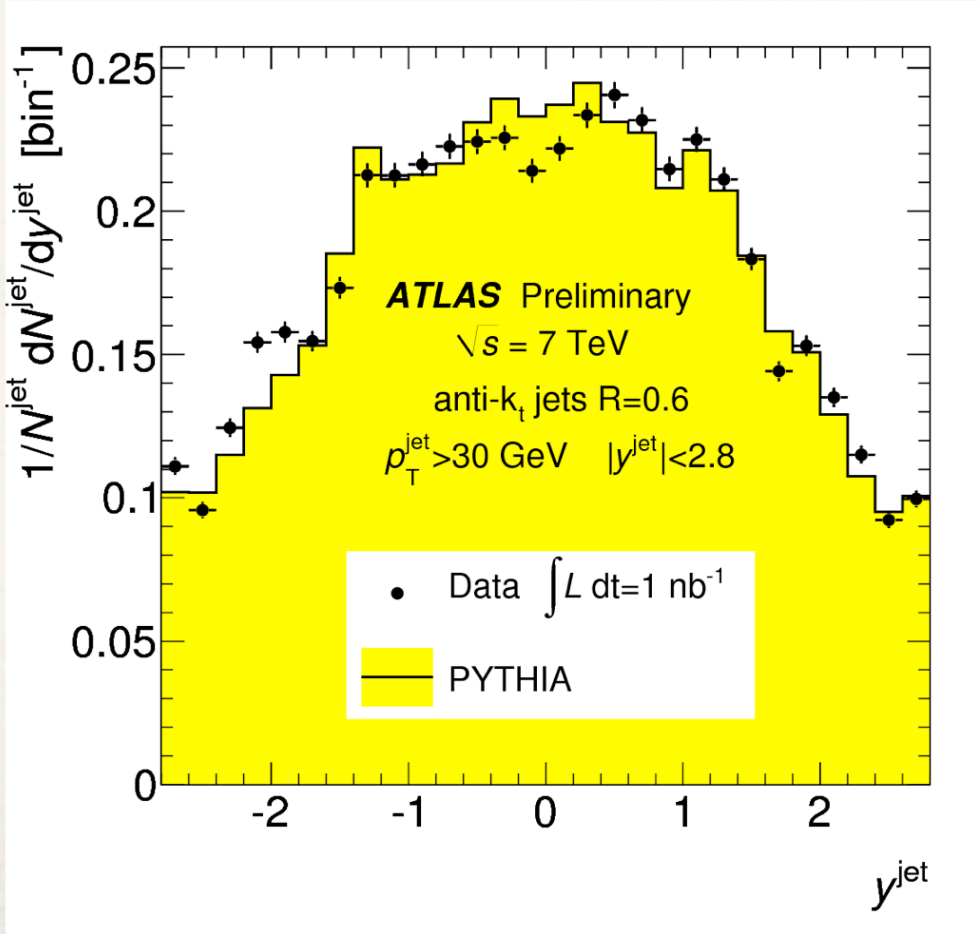
ATLAS-CONF-2010-043

Inclusive Jet Production



MC provides a reasonable description of the data

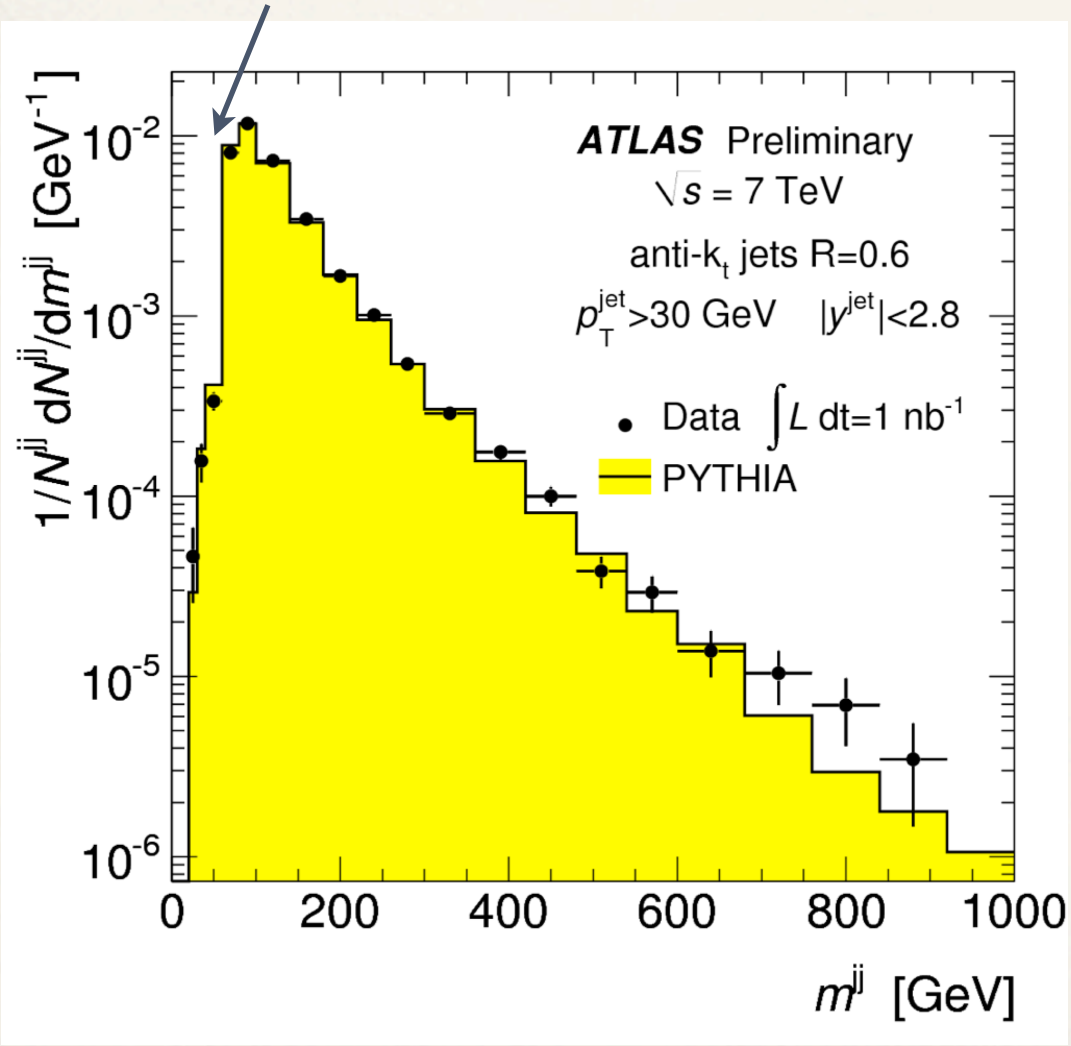




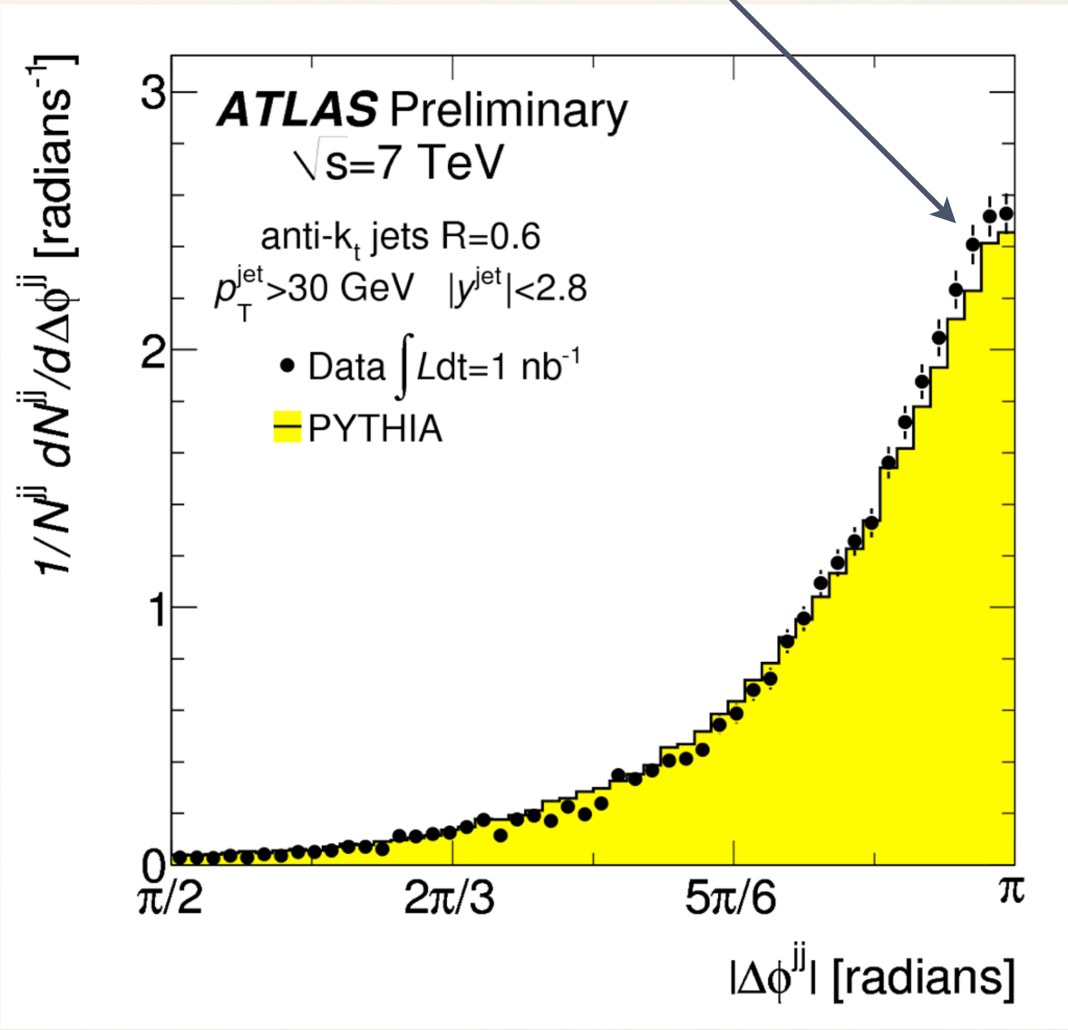
Dijet Mass and Δφ Distribution

- ~20% of the selected jet events are dijet events

limited phase space



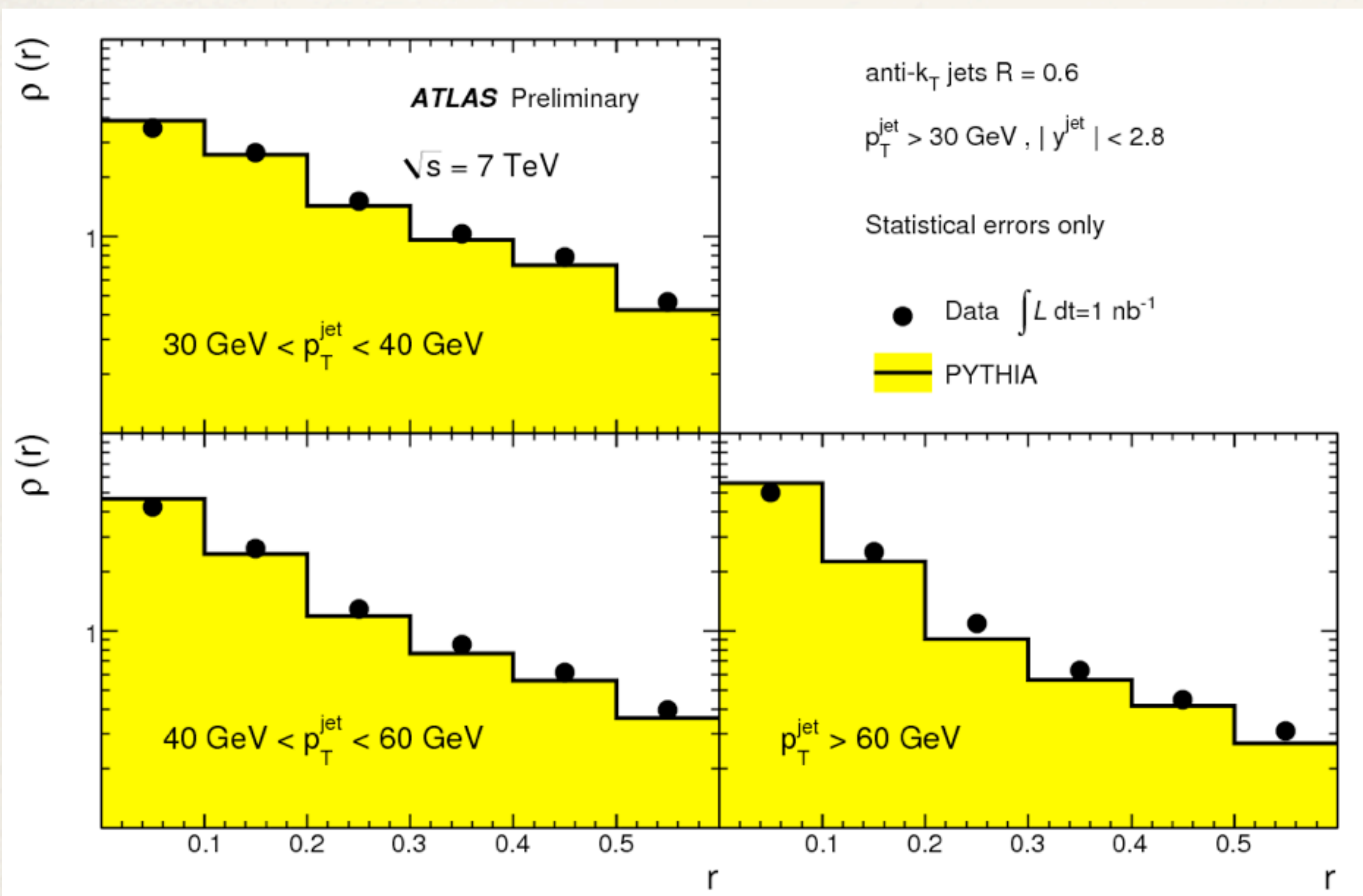
Δφ ~ π, back-to-back jets

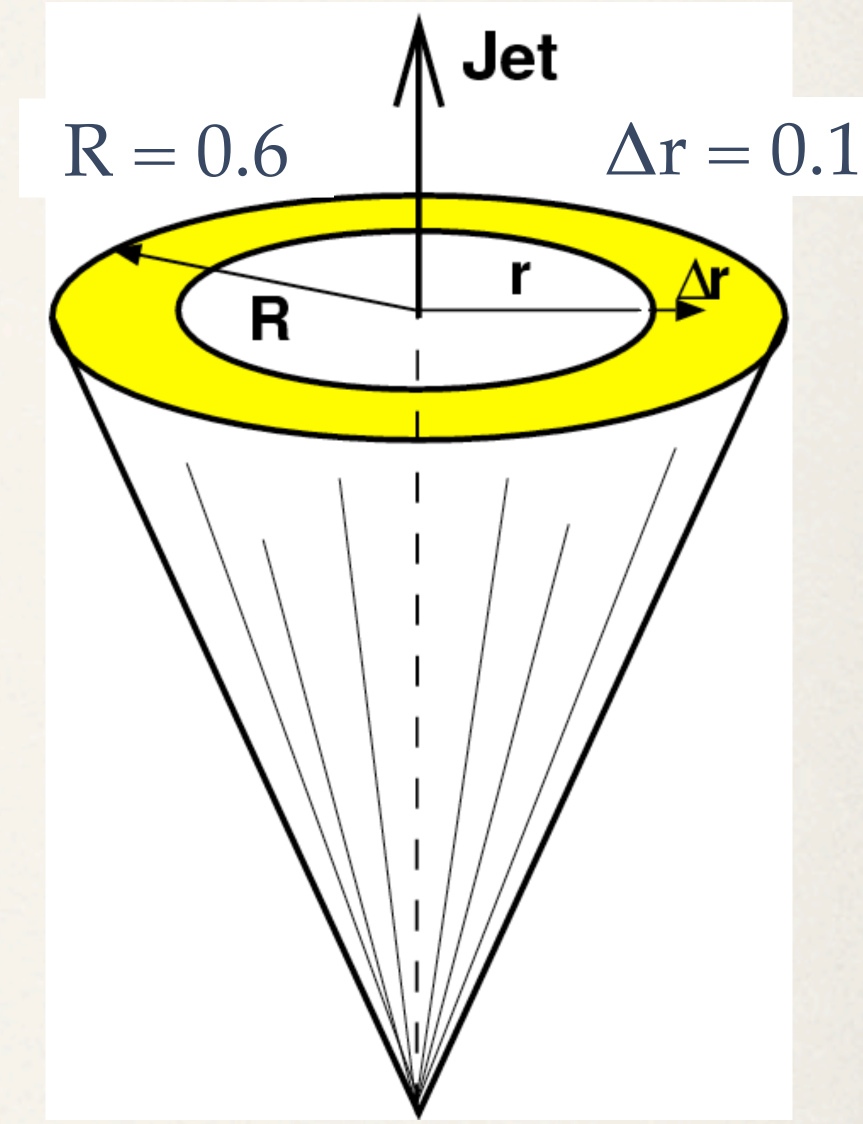


ATLAS-CONF-2010-043

Differential Jet Shape

- $\rho(r)$ is the average fraction of jet p_T within an annulus
  - $p_T = \Sigma$ topocluster $|\vec{p}_T|$ in that annulus
  - relatively insensitive to jet energy scale



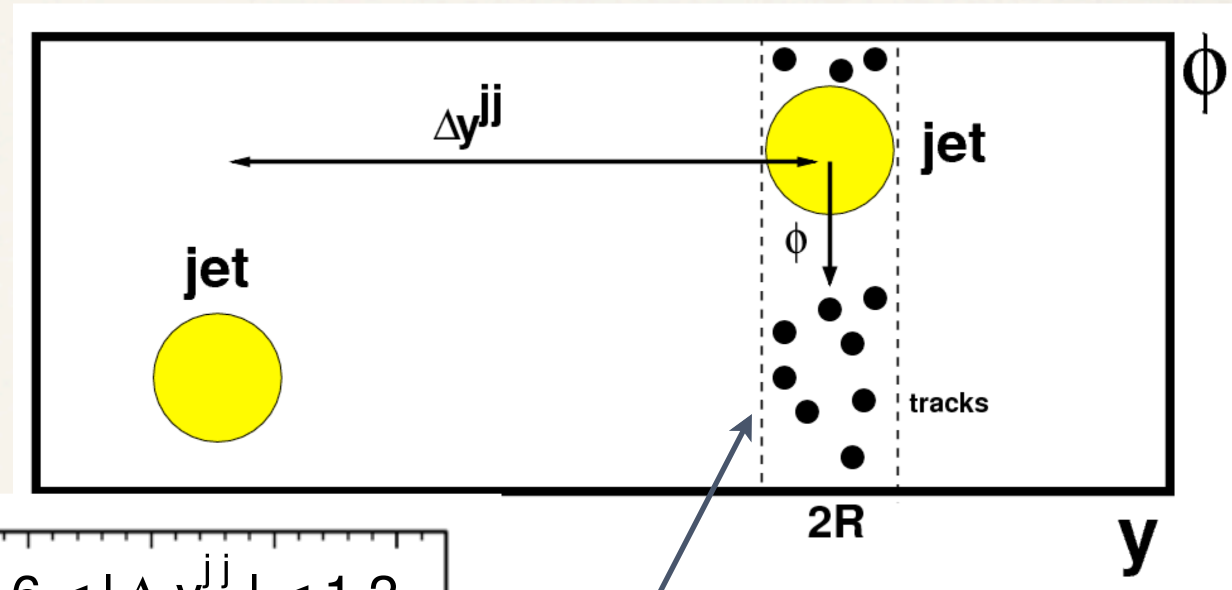


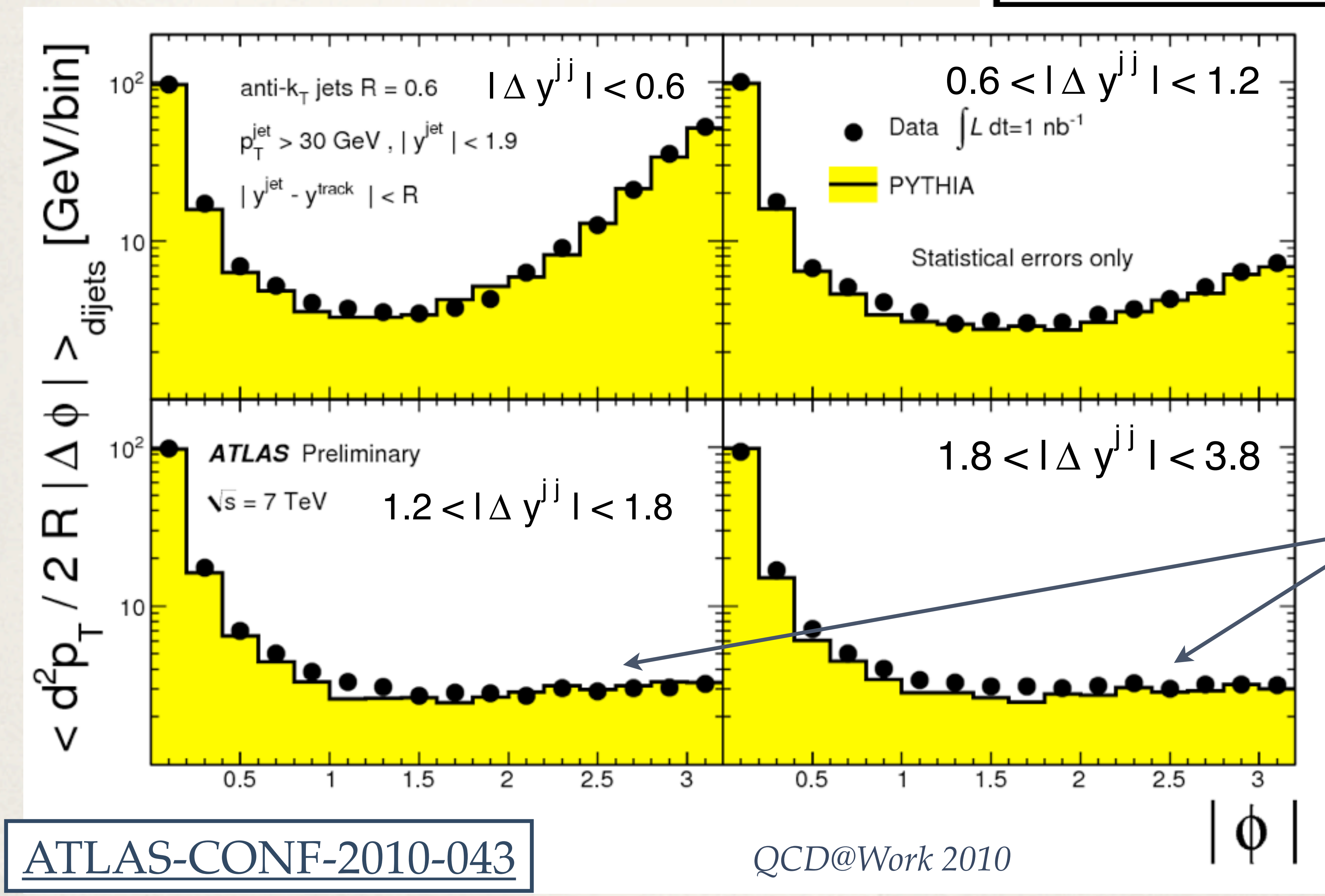
jets in the MC are slightly narrower than in data

ATLAS-CONF-2010-043

Charged Particle Flow

- independent information (from **tracks**) on the final state topology
- $|y^{jet}| < 1.9$, so tracks are within the inner detector acceptance ($|y| < 2.5$)





hadronic activity out of the jet cone

plateau of remaining hadronic activity

ATLAS-CONF-2010-043

Summary

- High-p_T jets have been observed in the ATLAS detector with the **first 1 nb^{-1}** of 7 TeV p p collisions from the LHC
  - p_T^{jet} up to ~500 GeV and m_{JJ} up to ~900 GeV
- Shapes of jet kinematic distributions reasonably described by the fully-simulated Pythia dijet MC sample
- Jet internal structure studied through differential jet shapes
- Charged particle flow confirms calorimeter-based results

- The LHC continues to deliver...

➡ Jet cross-section measurements will be reported later this summer