Measurement of Jet Cross Section and Fragmentation Using Tracks with the ATLAS Detector

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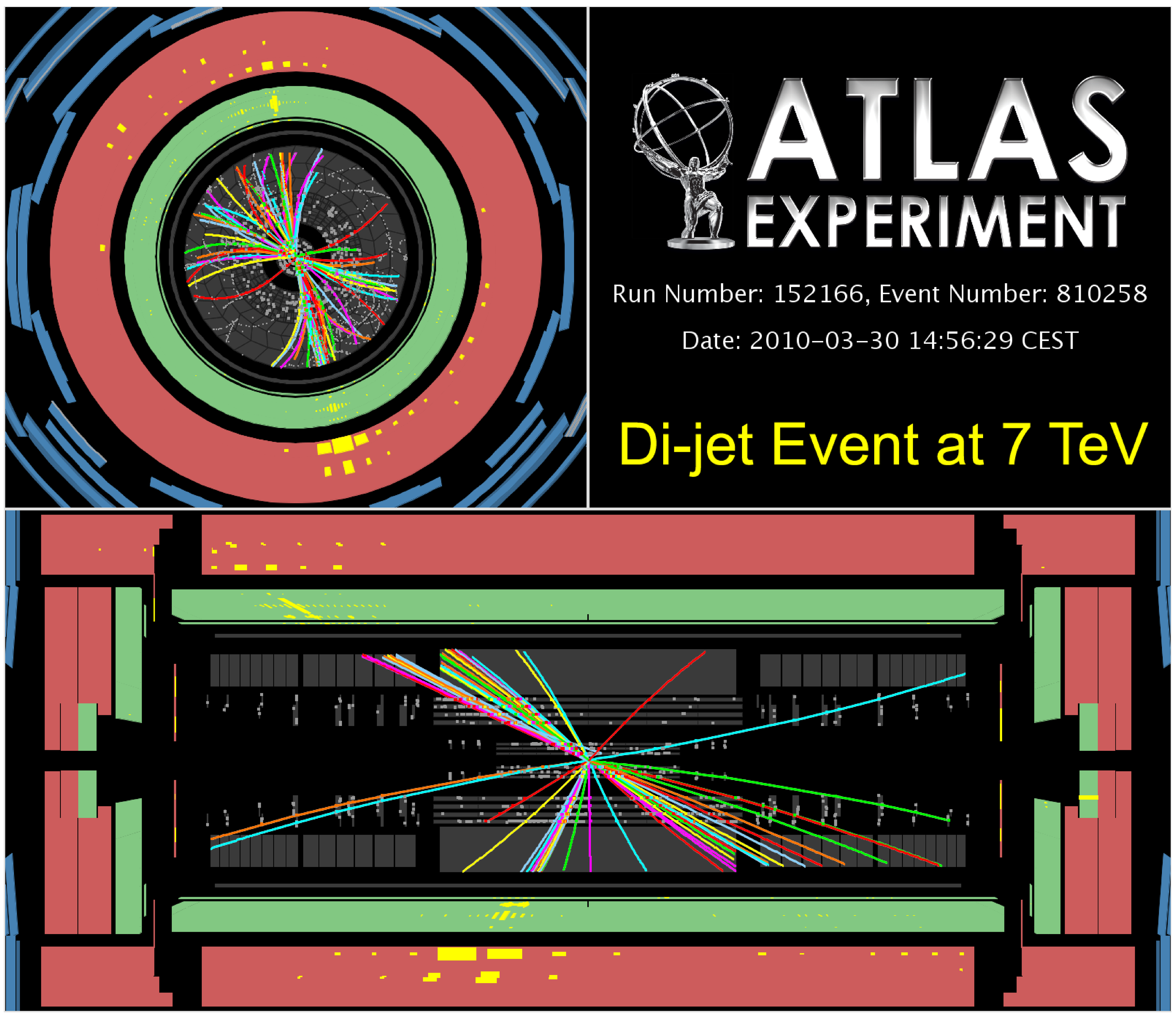
Jets are measured from tracks with $p_T > 500$ MeV reconstructed with the ATLAS Inner Detector in events with a primary vertex, using 370 μb^{-1} of data collected with the Minimum Bias Trigger Scintillators. Trigger and vertexing efficiencies are measured from data to be nearly 100% for events containing jets with $p_T > 4$ GeV and $|\eta| < 0.57$.

Charged Particle Jets

Corrections in this analysis are to the level of charged particle jets: apply anti-k_T algorithm [1] with parameter R = 0.4 and 0.6 to all charged primary particles with $p_T > 500$ MeV. Total jet momentum for differential cross-sections and fragmentation distributions thus includes charged particles only. No direct comparison to parton-level quantities or perturbative QCD is possible, but comparisons can be made to the phenomenological models implemented in Monte Carlo generators.

Why use tracks?

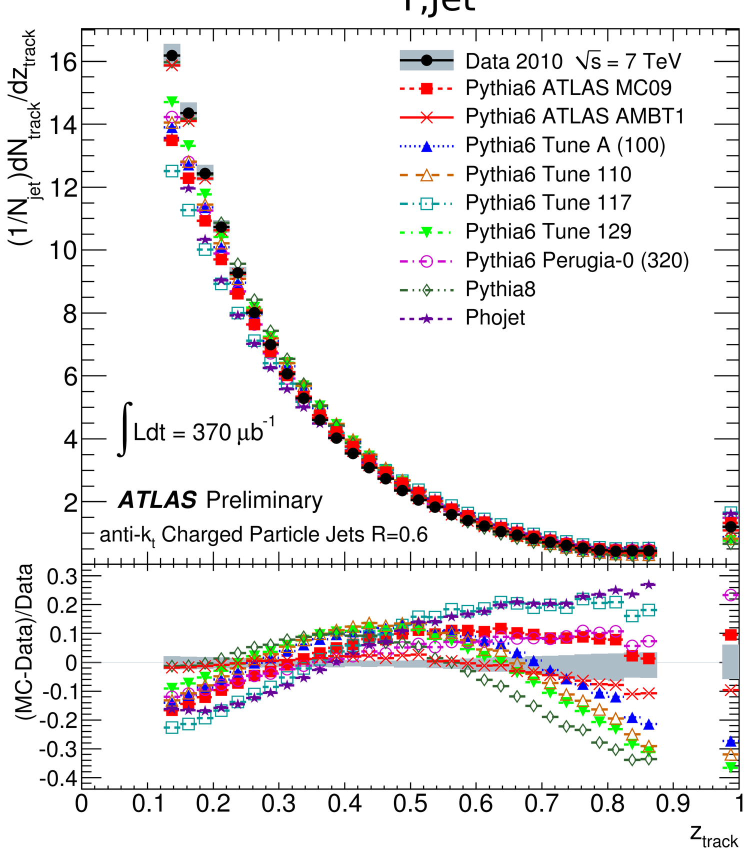
Measurement is independent of calorimeter: method is a complement to and cross-check of standard calorimeter-based measurements and has independent systematic uncertainties. Use of Inner Detector and minimum-bias trigger allows measurement down to very low jet momentum, so that the emergence of jets from minimum bias collisions can be studied.



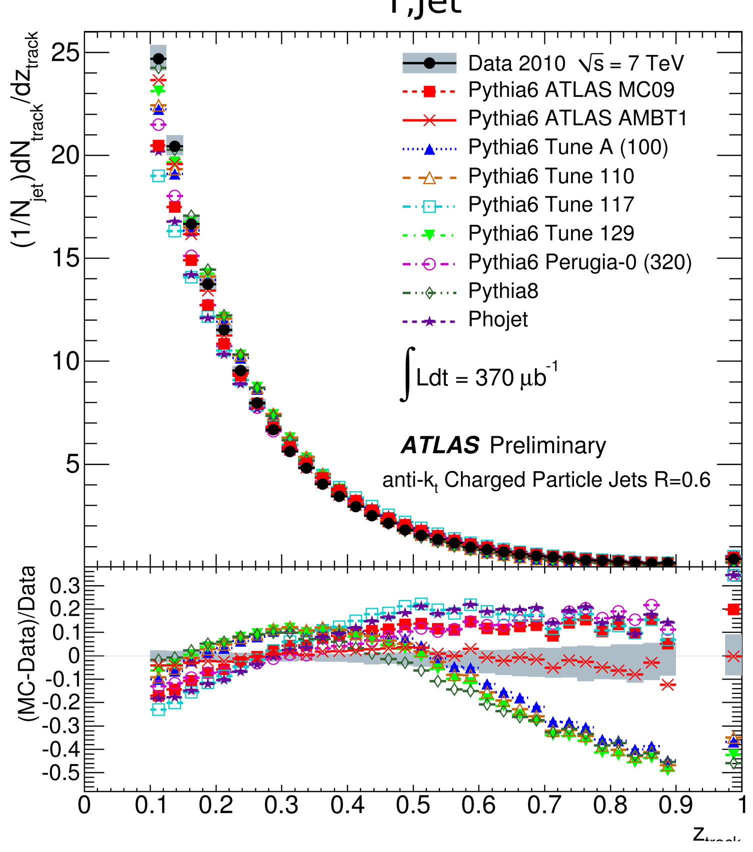
Fragmentation Distributions

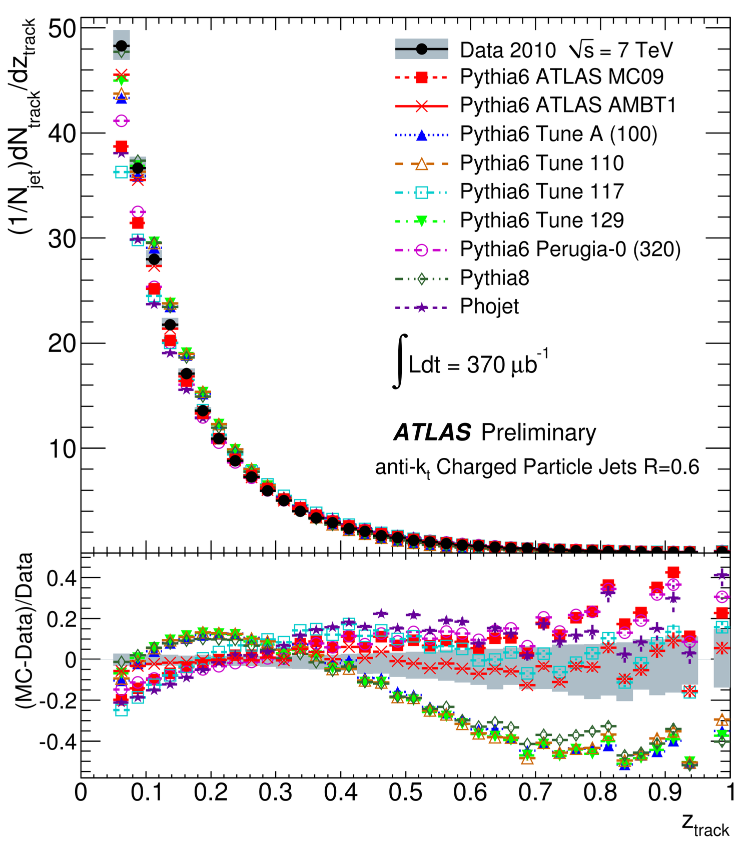
Distributions of z for particles in jets ($|\eta_{jet}| < 0.57$) are shown. For each particle in a jet, *z* is defined to be the component of the particle's momentum along the jet axis, divided by the jet momentum. Data are corrected to particle level using bin-by-bin correction factors derived from GEANT 4 simulation [2] of events generated in PYTHIA 6.421 [3] with the ATLAS MC09 tune [4]. The data are best described by the ATLAS AMBT1 tune [5], with agreement within error for jet $p_T > 10$ GeV.

$4\text{ GeV} < p_{T,Jet} < 6\text{ GeV}$

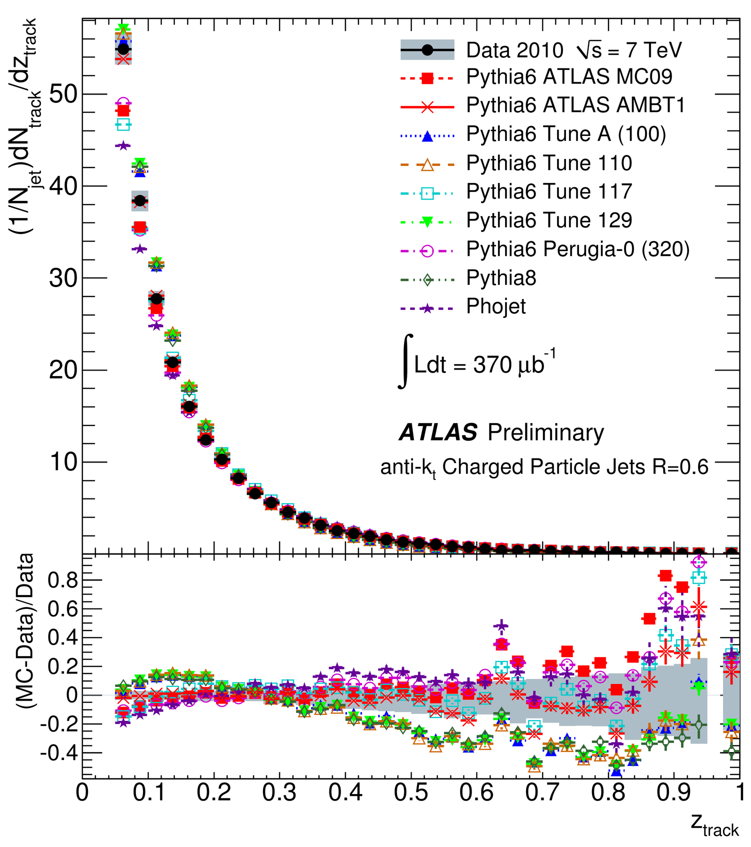


$6\text{ GeV} < p_{T,Jet} < 10\text{ GeV}$





$10\text{ GeV} < p_{T,Jet} < 15\text{ GeV}$



$15\text{ GeV} < p_{T,Jet} < 24\text{ GeV}$

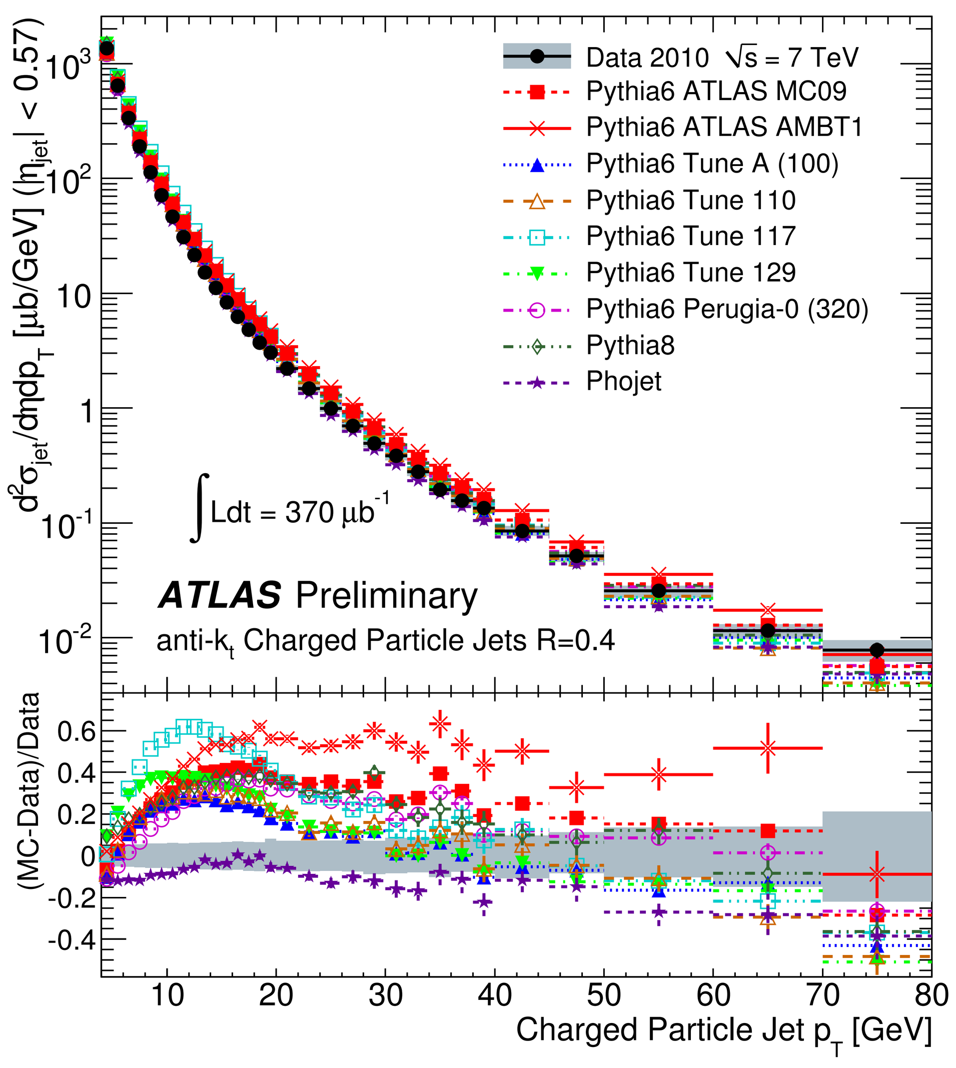
Cross Section vs. p_T

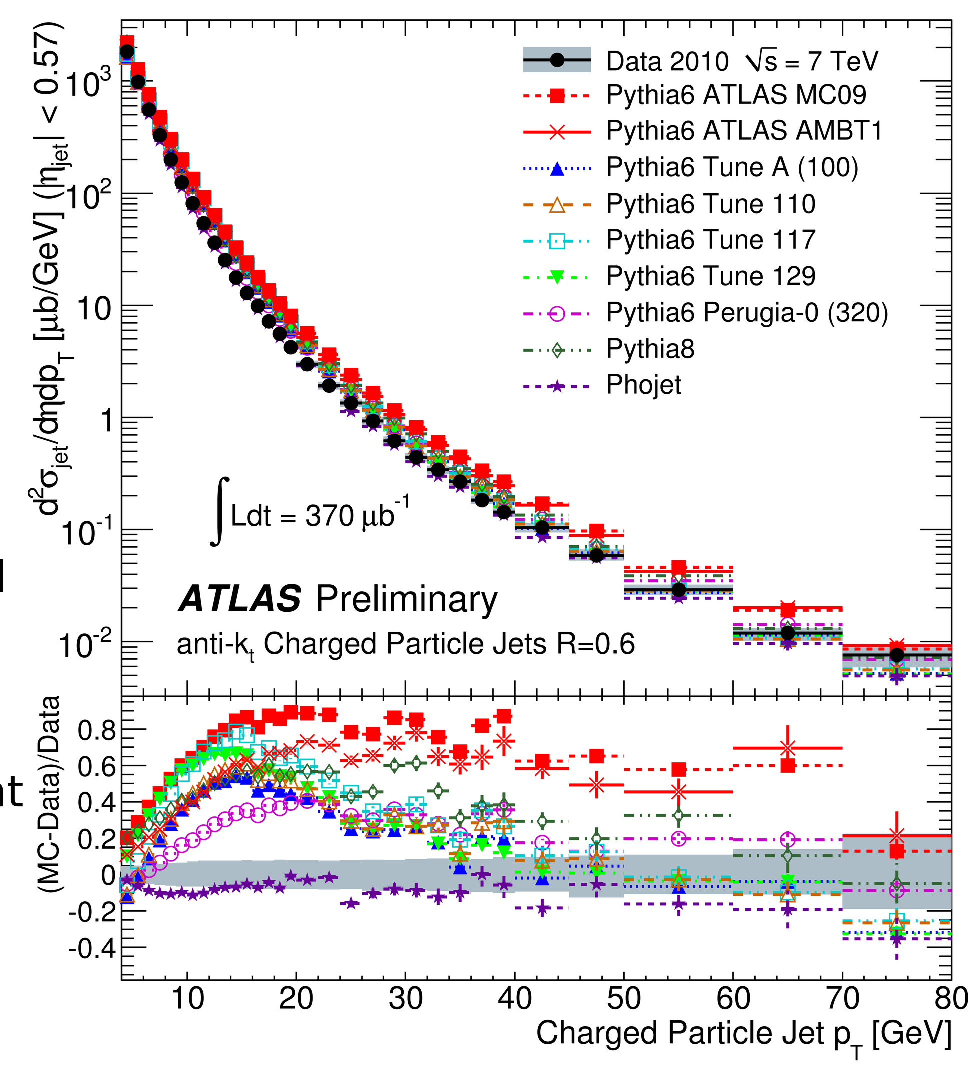
Differential cross sections for charged particle jets ($|\eta jet| < 0.57$) are shown at right for R = 0.4, 0.6.

Jets produced from reconstructed tracks are corrected to charged particle jets using the Bayesian Iterative Unfolding algorithm [6]. The unfolding procedure corrects for jet-finding efficiency, reconstructed track jets not matched to charged particle jets, and bin-to-bin migration of reconstructed jets due to tracking efficiency and resolution smearing. Detector response is determined from GEANT 4 simulation of events generated in PYTHIA with the ATLAS MC09 tune.

PHOJET [7] agrees best with the cross section data. The ATLAS MC09 and AMBT1 tunes disagree significantly with these data, although they describe single-particle data well.

Systematic uncertainties are summarized in the table below, with values for selected bins given for R = 0.6. The dominant systematic uncertainty in all bins but the highest is due to unknown track-finding efficiency; this is determined by varying the efficiency in toy Monte Carlo samples and computing the change in the final result. The fragmentation/underlying event uncertainty is similarly found by using a variety of tunes in toy MC. At high momentum, there is significant uncertainty associated with mismeasured high-p_T tracks and the cuts used to veto them. An 11% luminosity uncertainty is not included in the total error band in the figures.





Uncertainty	4 - 6 GeV	14 - 15 GeV	28 - 30 GeV	40 - 45 GeV	70 - 80 GeV
Tracking efficiency	+4% −4%	+7% −7%	+8% −7%	+8% −8%	+9% −8%
Fragmentation/ U.E.	+2% −1%	+0.4% −3%	+2% −0.0%	+2% −1%	+5% −11%
High p_T tracks	negligible	negligible	+0.1% −0.7%	+1% −4%	+6% −10%
Unmatched reconstructed jets	±1.0%				
Mismodelling in φ	±1.6%				
Luminosity	±11%				

References

[1] M. Cacciari, G. P. Salam, and G. Soyez, *The anti-kt jet clustering algorithm*, JHEP **04** (2008) 063.
[2] S. Agostinelli and others, *GEANT4: A simulation toolkit*, Nucl. Instrum. Meth **A506** (2003) 250.
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[4] A. Buckley, H. Hoeth, H. Lacker, H. Schulz, and J. E. von Seggern, Systematic event generator tuning for the LHC, Eur. Phys. J **C65** (2010) 331.
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