Jet Production Cross Section Measurement with ATLAS

on behalf of the ATLAS Collaboration

Sarah Baker
University College London

Inclusive and Dijet Cross Section

- Jet production is the dominant high p_T process at the LHC. The jet cross section measurement provides:
  - Precise measurements of the strong coupling constant.
  - Information on the structure of the proton and the strong interaction.
  - Base for search for physics beyond the Standard Model.

- ATLAS has published an initial measurement of the inclusive single-jet and dijet cross sections using 17 nb^{-1} of data.
  - Inclusive jet measurements are sensitive to the combination of the QCD matrix element and parton densities within the proton.
  - Dijet measurements were made in a region where sensitivity to the parton distributions functions is reduced, providing information on the structure of the QCD matrix element.

- Efforts are now focused on extending the measurement to the low transverse momentum and high rapidity regions, p_T > 20 GeV, $|y| < 4.4$ and high p_T via an increase of statistics.

Jet Selection and Uncertainties

- Jets are reconstructed at the electromagnetic (EM) scale, which is measured using test-beam measurements for electrons and muons in the calorimeters.
  - Jet clustering performed with the anti-kt algorithm.
  - Three dimensional topological clusters built from calorimeter cells.
  - The four-momentum of the uncalibrated EM-scale jet is defined as the sum of the four-momenta of its constituent calorimeter energy clusters.

- Events required to have 1 primary vertex, with 5 tracks within 10 cm of the beamspot to reduce non-collision backgrounds.

- Jet Energy Scale (JES) correction applied.
  - Calorimeter non-compensation (response to hadrons is lower than their response to electrons of the same energy),
  - Dead material effects.
  - Particles where the shower is not contained in the calorimeter.

Jet Selection and Uncertainties

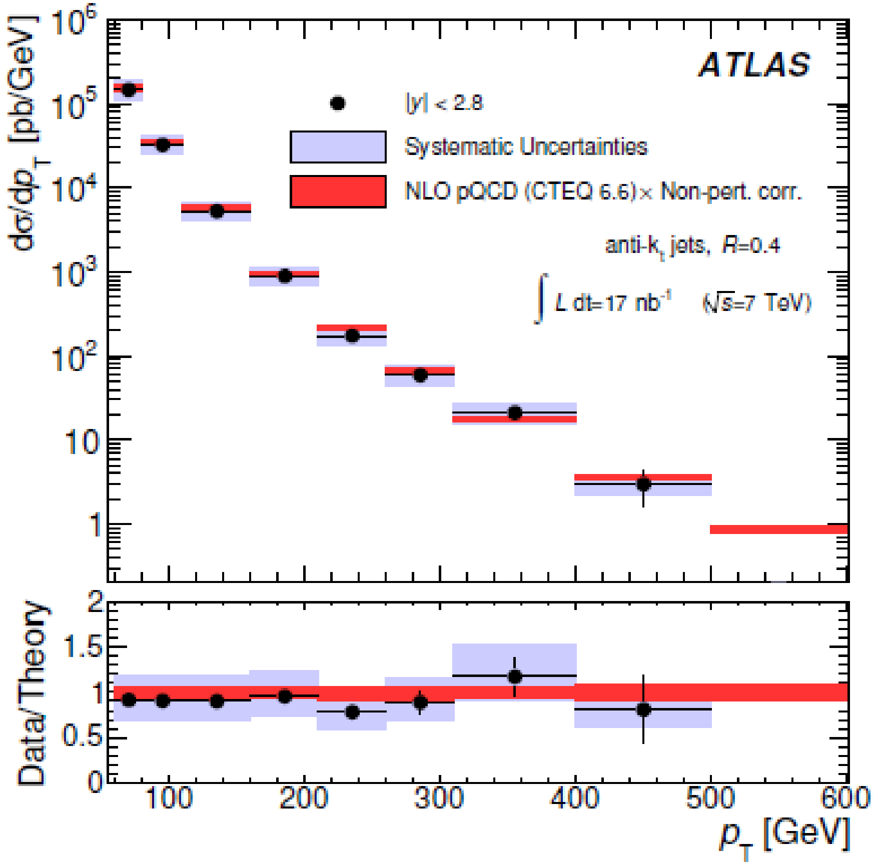
- Jet Energy Scale Uncertainty is dependent on:
  - Detector material and geometry.
  - Noise Thresholds.
  - Beamspot.
  - EM scale.
  - Closure test of the JES calibration.
  - JES uncertainty from dijet balance studies.

- Correction for trigger and detector efficiencies and resolutions (other JES) performed in a single step using a bin-by-bin unfolding from true (including muons and neutrinos) to reconstructed jets from Monte Carlo.
  - Uncertainties established by estimating from the spread of the correction for different generators, and by changing shape of the simulated distributions.

- The total systematic uncertainty 40% and is dominated by the jet energy response of the calorimeter.
  - 10% over the whole kinematic range.
  - 7% for central jets.

Inclusive Jet Cross Section

- Inclusive jet cross section was measured as as a function of jet transverse momentum p_T and rapidity y in the region $p_T > 60$ and $|y| < 2.8$.
  - Within the trigger high efficiency plateau region.
  - Jet energy scale is well understood in this region.
- Data compared with leading-logarithmic parton-shower Monte Carlo generators.
  - NLO pQCD calculations corrected for non-perturbative effects.
- Energy flow around the jets and jet shapes of the measured distributions well described by data. The differential cross sections described by theory within systematic uncertainties.

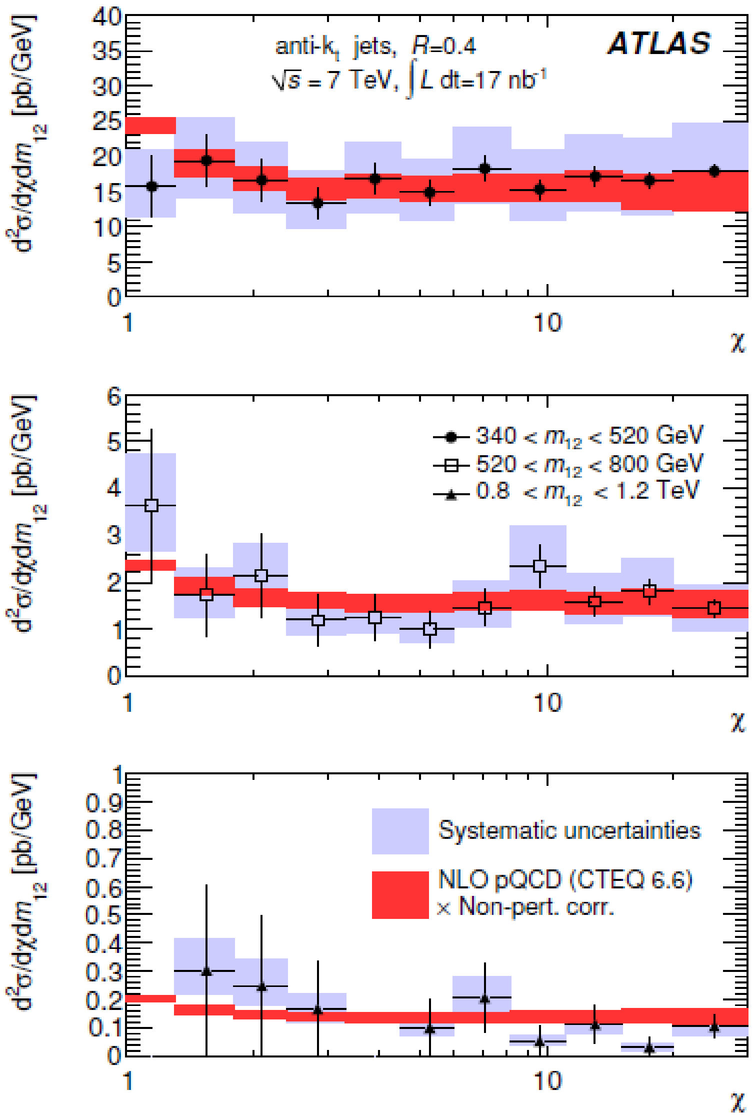


http://arxiv.org/abs/1009.5908

Dijet Cross Section

- Dijet cross section measured as a function of the dijet mass and the maximum rapidity of the two leading jets:
  - $|y|_{max} = \max(|y_1|, |y_2|)$.
  - $|y| < 2.8$ and leading jet $p_T > 60$ GeV and subleading jet $p_T > 30$ GeV to ensure jet reconstruction efficiency and purity > 99%.
  - $$\chi = \exp(|y_1 - y_2|) \approx \frac{1 + \cos\theta^*}{1 - \cos\theta^*}$$

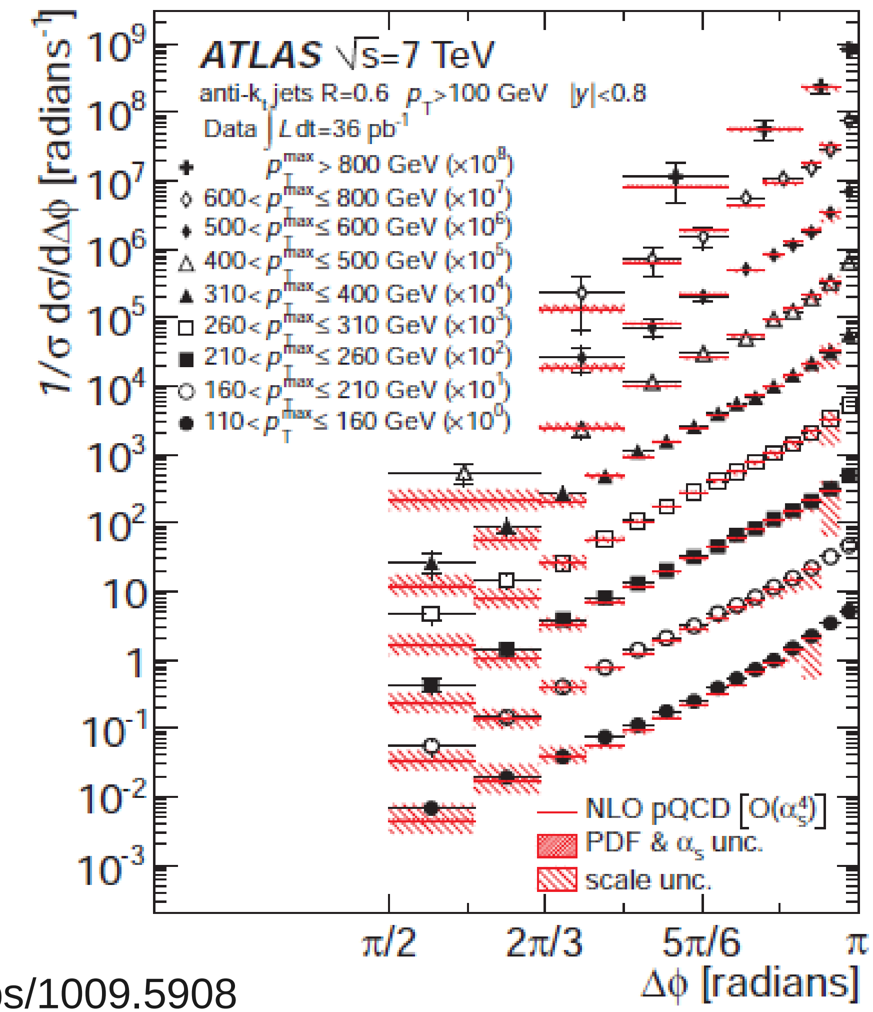
    θ is the polar scattering angle of outgoing jets in the dijet centre-of-mass frame.



- Data well described by theoretical predictions.

Dijet Azimuthal Decorrelations

- Decorrelation in the azimuthal angle between the two most energetic jets Δφ predicted by QCD.
  - Dependent on the number of partons produced.
- The normalized differential cross section (1/σ)(dσ/dΔφ) measured using the full 2010 data set. Integrated luminosity L dt = (36 ± 4) pb^{-1}. This is a factor of 2000 higher than the inclusive/dijet paper.
- Δφ ~ π suggest two high p_T jets. Δφ << π suggestive of several high p_T jets.
- Expectations from NLO pQCD [O(α4)] and Monte Carlo event generators successfully describe increasing slope of the Δφ distribution.



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Conclusions

- Over the past year great progress has been made towards understanding jet physics at the LHC. It is now established that theoretical predictions of QCD correspond with data within this energy regime.
- But, still much more to be done!
- Direct extension using all the 2010 dataset, extending the p_T range from 20 GeV to 1.5 TeV, and |y| to out to 4.4.
- Work continues into other areas of jet physics, including using the sub-structure of reconstructed jets as a means of identifying high p_T particle decays. This technique has multiple applications, including direct searches for the Higgs Boson.

Conclusions - a morale boost