High-p_T Jet Distributions and Properties of Inelastic pp Collisions at $\sqrt{s}$ = 7TeV -ATLAS –

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on behalf of the
ATLAS Collaboration

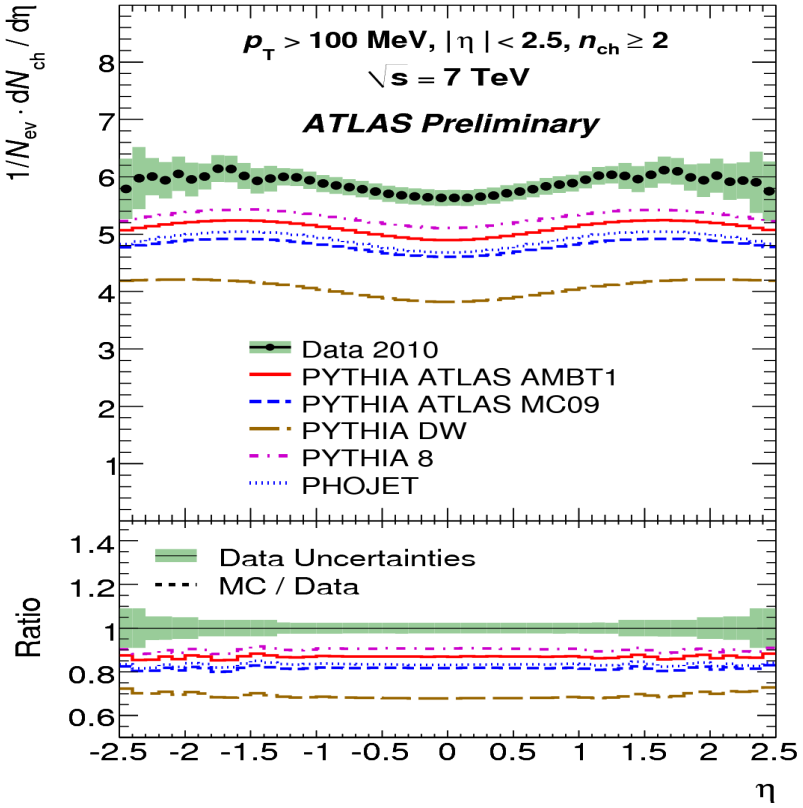
SUSY2010, 24th August 2010

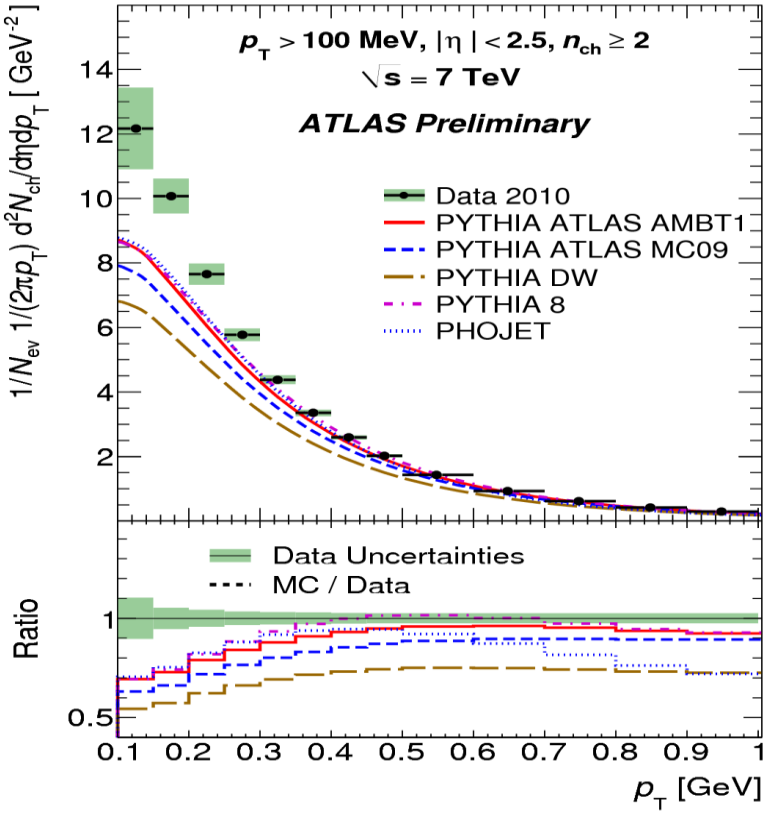
Overview

- Charged particle measurements
- Underlying event
- Jet properties
- Inclusive jet and dijet production cross-section
- Dijet searches – beyond the Standard Model (BSM)
- Summary

Only small subset of results shown – broad range available

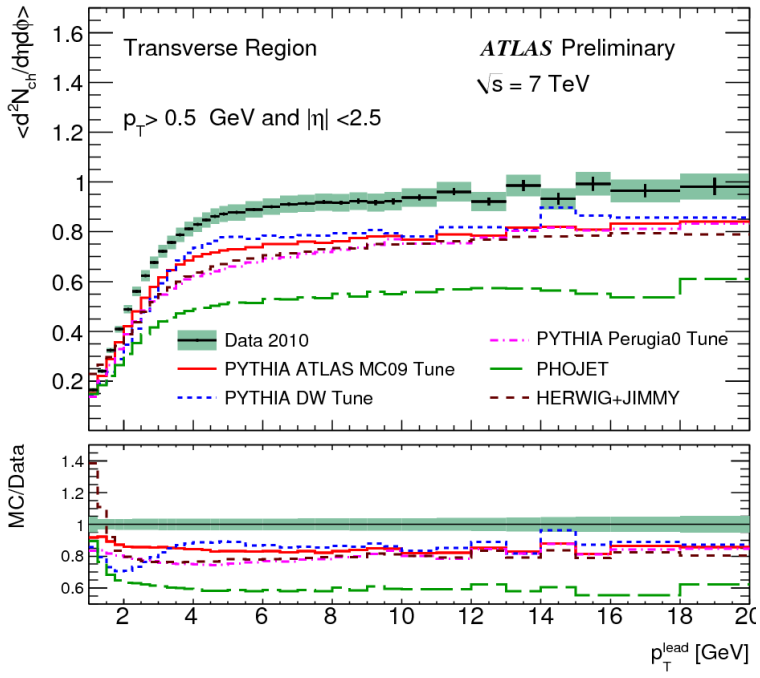
Charged particle measurements

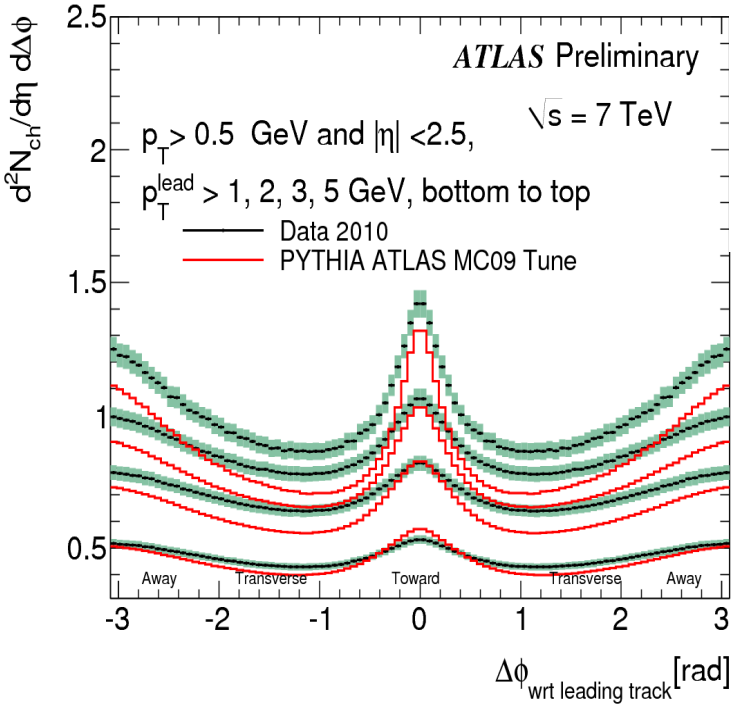


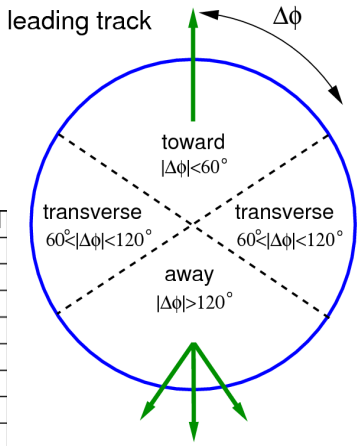


- Results available for 7 TeV (shown), 2.36 TeV and 900 GeV
- Charged particles down to 100 MeV measured by ATLAS
- Low shape dependency on models
- Normalization difference partly due to diffractive fraction
  - Potential for further tuning of models

Underlying event

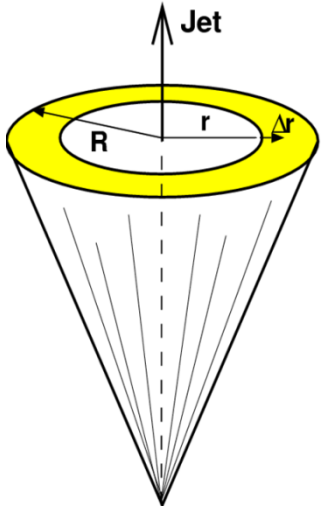


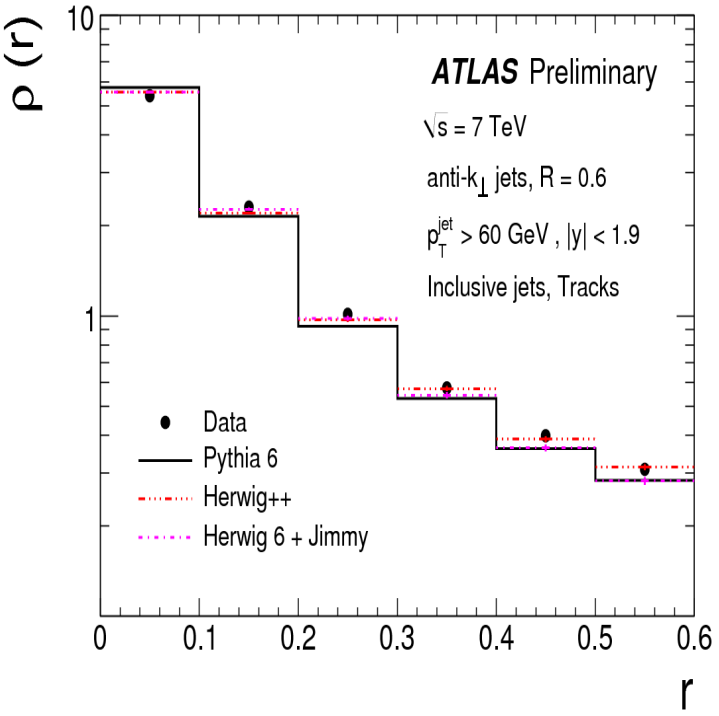


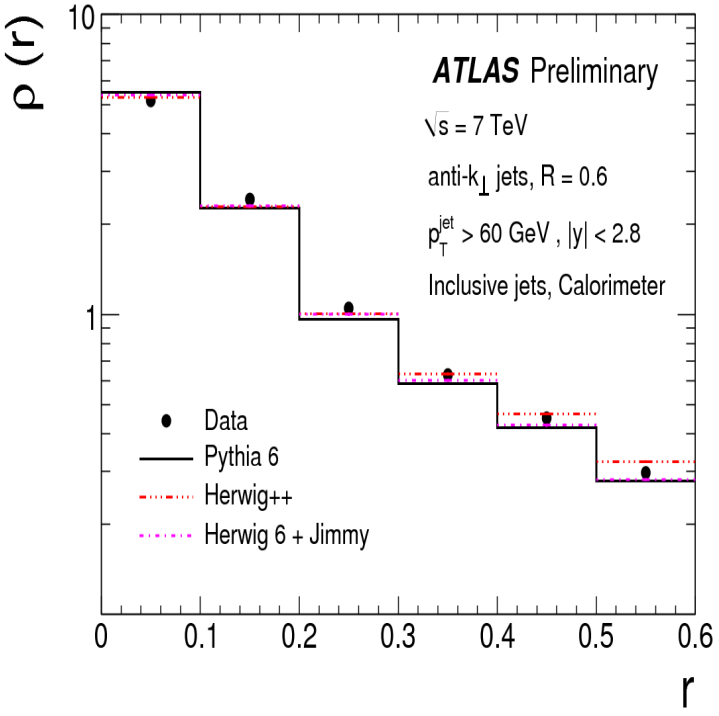


- Underlying event affects jets, E_T^{miss}, rapidity gaps, …
- Good description vital for hadron collider physics
  - Soft QCD – Phenomenological models
  - Requires tuning
- Tension between models tuned at Tevatron and LHC data

Internal Jet Structure



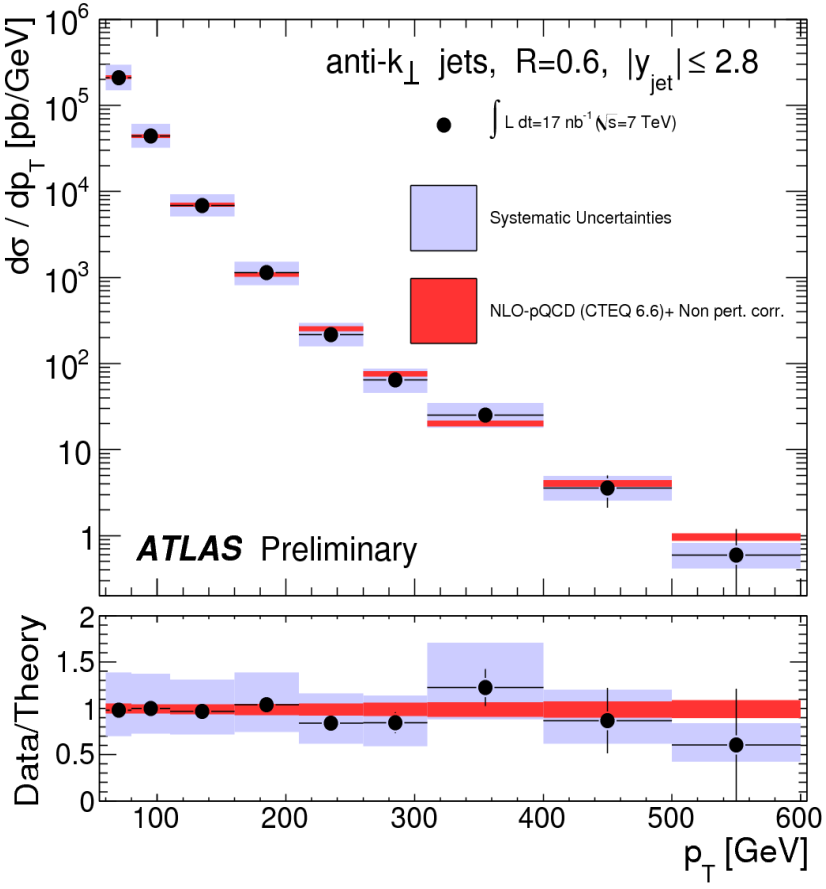




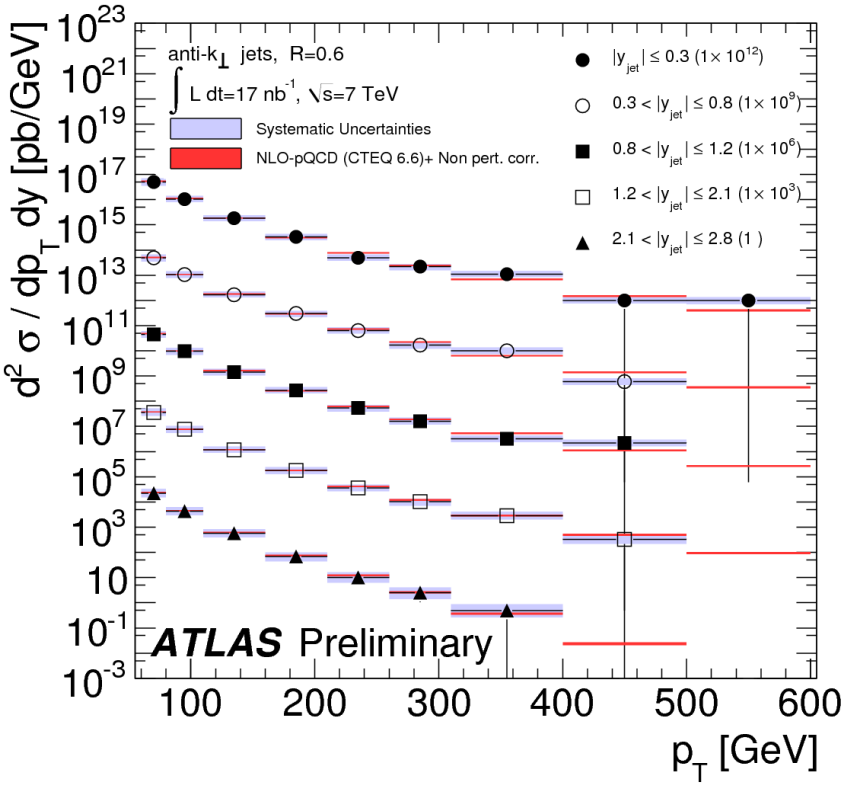
- Momentum/energy fraction of jets within a ring around the jet core
  - Comparison of Monte Carlo(MC) with detector simulation to data
  - Measured for both track and calorimeter jets
- Energy and momentum flow within jets reasonably well simulated

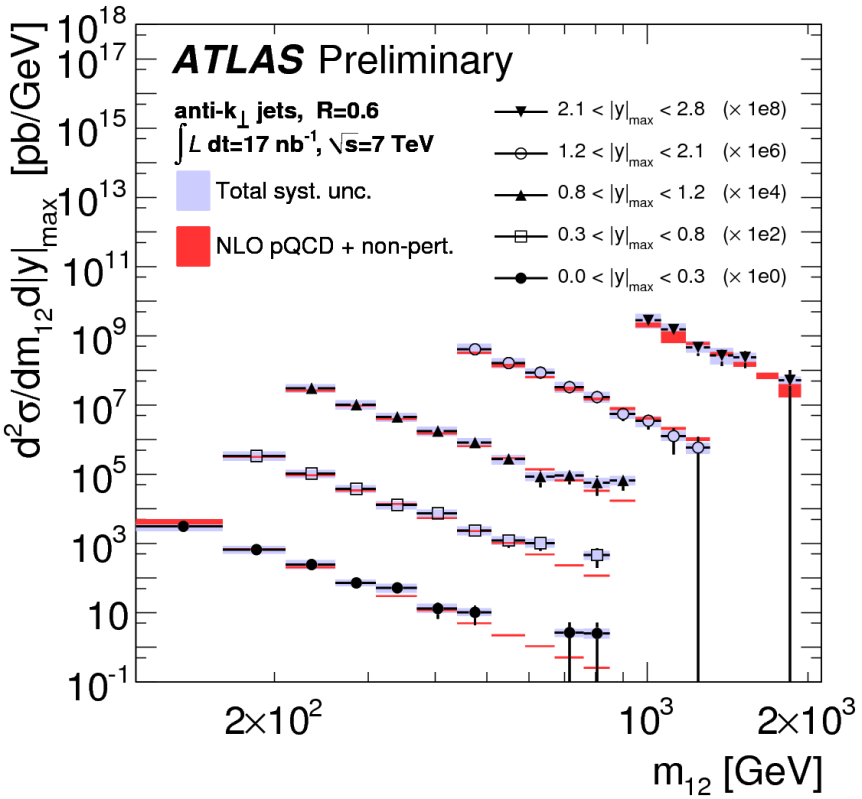
Inclusive jet production

- Jets reconstructed
  - from 3-d connected clusters of energy depositions optimized for noise suppression
  - AntiKt algorithm
    - size 0.6 (shown) and 0.4
- Uncertainty driven by Jet Energy Scale
  - MC simulation based correction
  - Uncertainty evaluated using MC variations and in-situ techniques
    - < 7% for p_T > 100 GeV
  - Excellent calorimeter understanding after first few months of data taking
- Data corrected to particle level



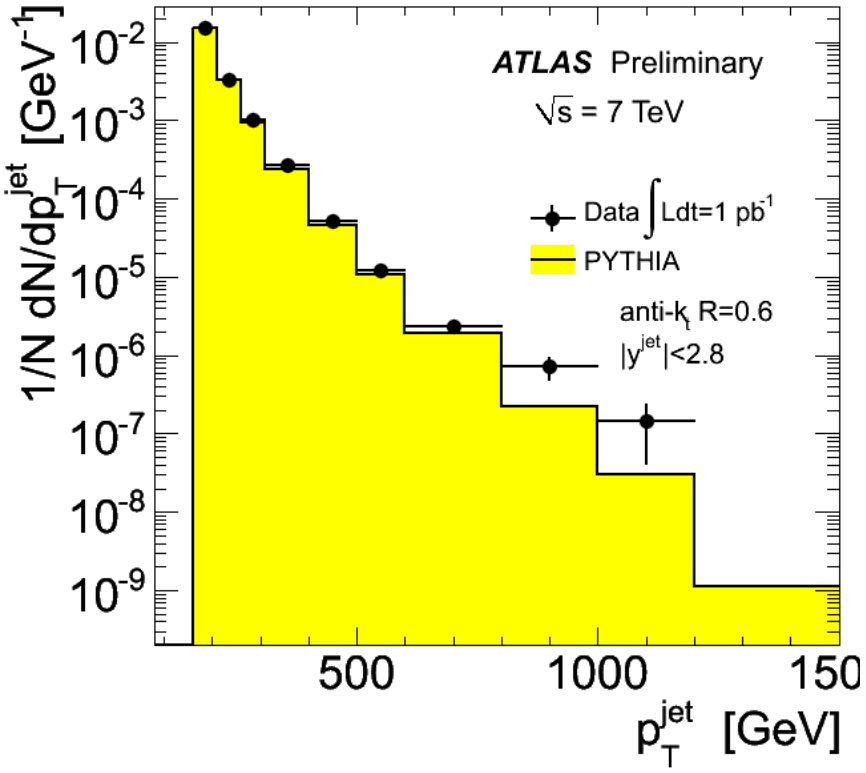
Inclusive jet and dijet production

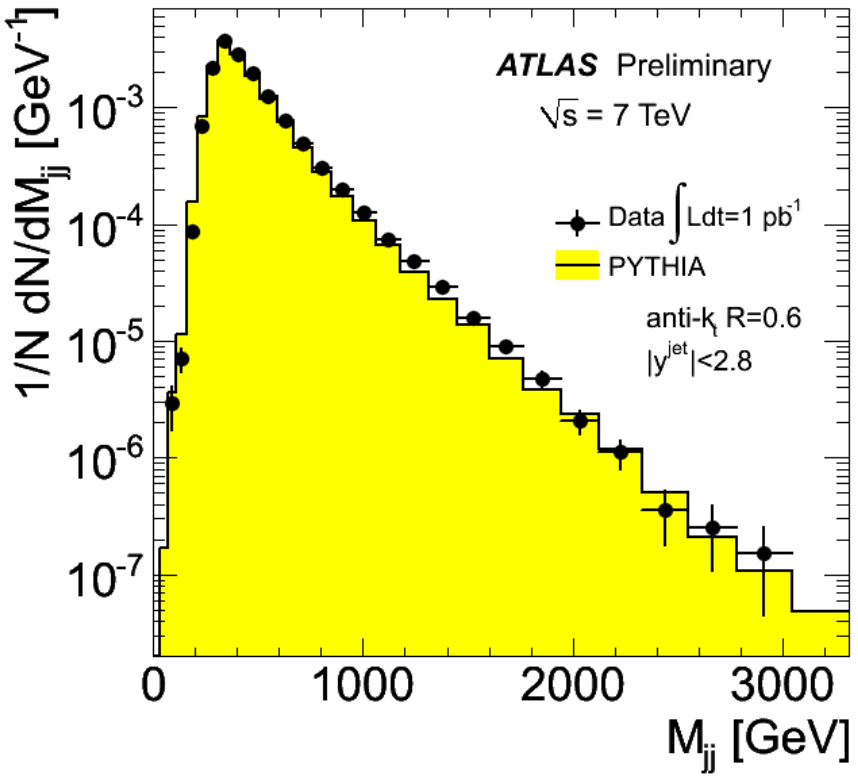




- Data and theory consistent in all rapidity regions
- Events with dijet masses above the Tevatron center-of-mass (cms) energy
- LHC already opened a window to short distance physics at the TeV Scale

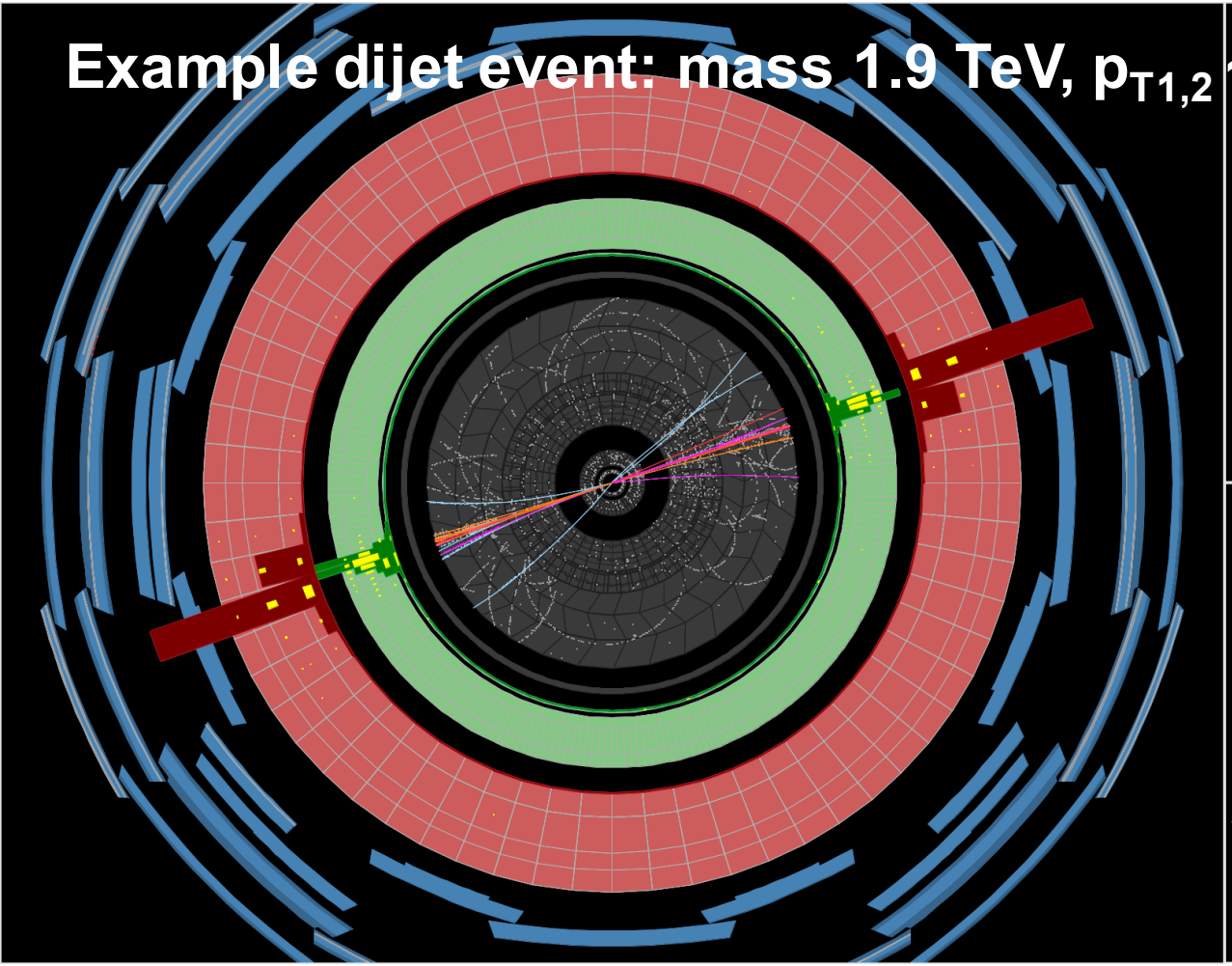
Inclusive jet and dijet production

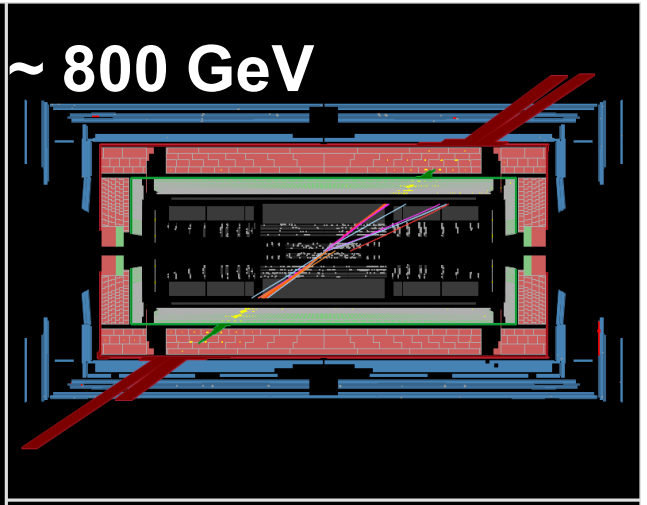


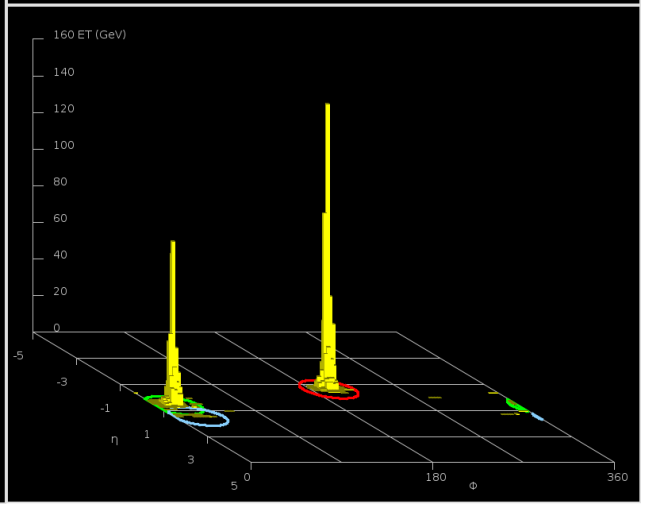


- **More than 1pb^{-1} of data taken**
- Preliminary data and MC comparisons at detector level
  - Statistical uncertainties only

Dijet Event Display

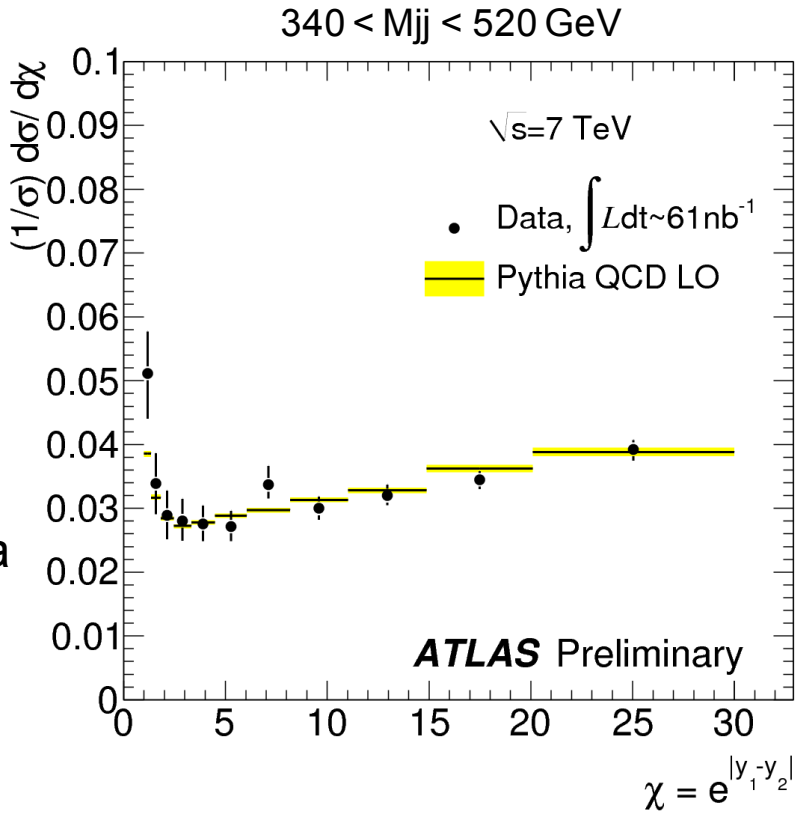






Dijet Angular Distributions – BSM

- Non-resonant production search at high M_{jj}
  - E.g. quark contact interactions with characteristic energy scale Λ
  - Quantify QCD scale probed
- Use of: $\chi = e^{|y1-y2|}$
  - boost invariant, relates to the cms scattering angle θ*
- MC and data comparison at detector level
  - Binned in M_{jj} and normalized to unit area
- Control region shown to the right
  - $340 < M_{jj} < 520$ GeV
  - Good agreement of data and QCD



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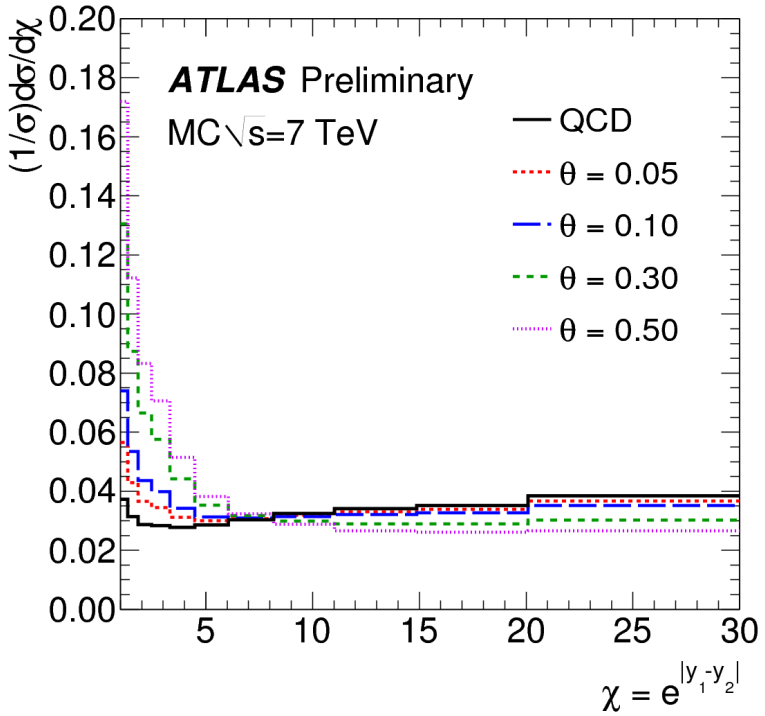
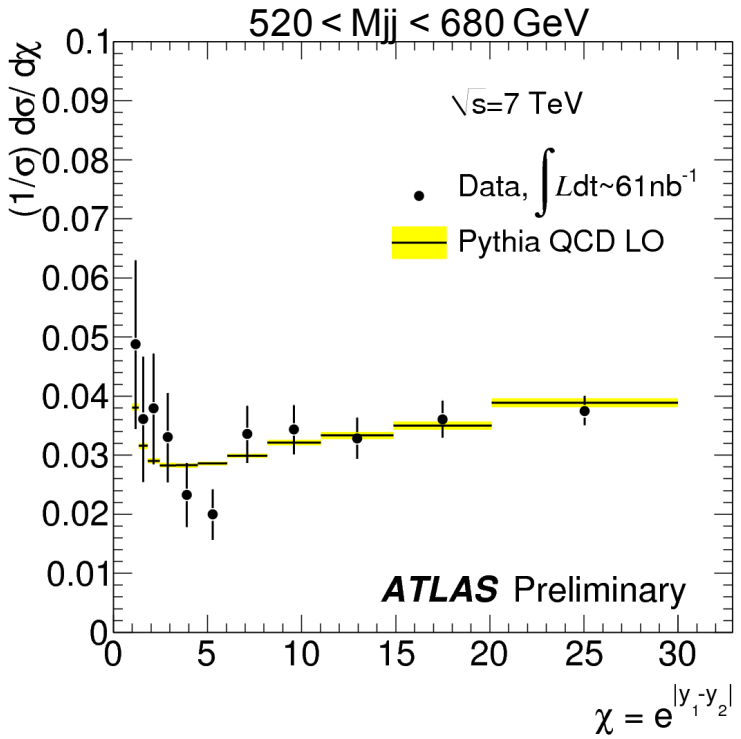




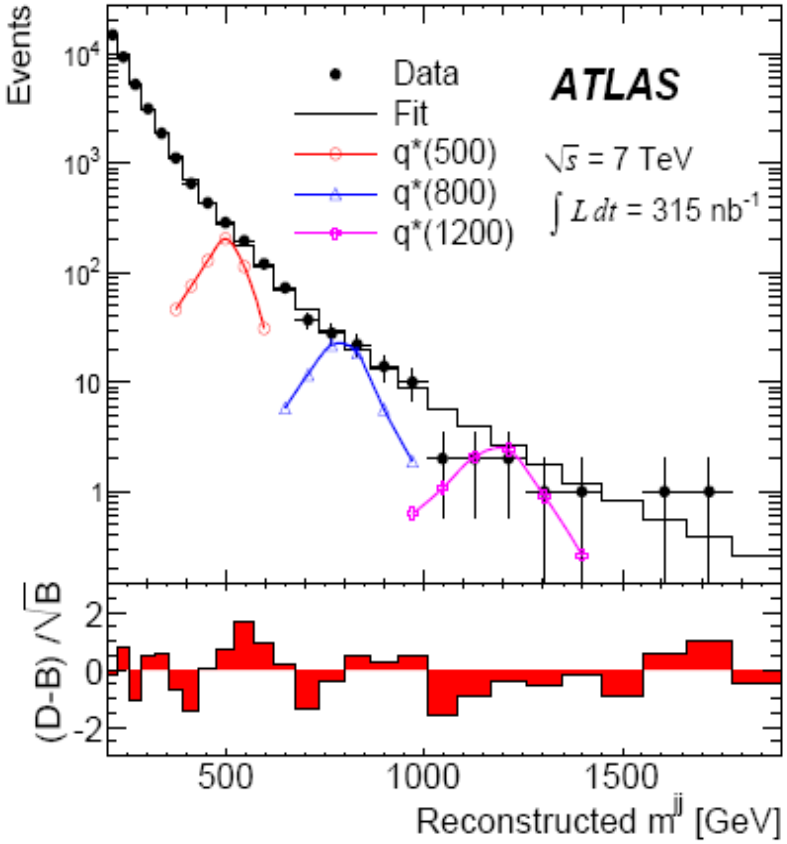
- **New physics:** excess of events **at low χ**
  - corresponding to high scattering angles in the cms system
- Bayesian analysis of high mass bin 520 < Mjj < 680 GeV
  - Benchmark limit on Λ of 875 GeV, distance scale 2.3 x 10^{-4} fm
  - Integrated luminosity 61nb^{-1}
  - >20 times the data recorded by ATLAS now – being analyzed

Resonance Search - BSM

- Is there a bump in Mjj?
- Potential signal enhanced by event selection on $|\eta_1-\eta_2| < 1.3$
- Background estimate by fitting uncorrected data with f(x)*

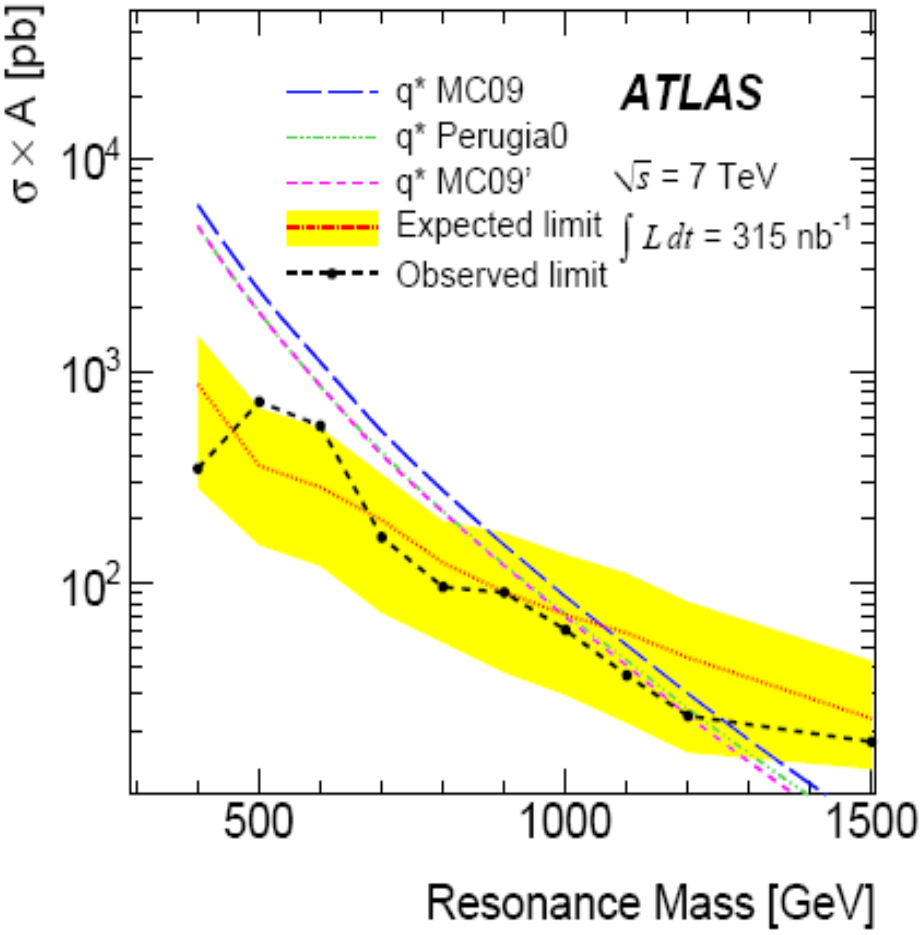
$$f(x) = p_0 \frac{(1-x)^{p_1}}{x^{p_2+p_3 \ln x}}, \quad x \equiv \frac{m^{jj}}{\sqrt{s}}.$$

  - Fits QCD predictions well
  - Fit uncertainty 3% to ~30% (low to high mass)
- No significant discrepancy seen
- Benchmark model of new physics: **Excited quarks at a mass m_{q^*}**



* CDF, Phys. Rev., D79, 346 112002 (2009)

Resonance Search - BSM



- Excluded at 95% CL with default ATLAS PDF:
  - **$400 < m_{q^*} < 1260$ GeV**
  - (CTEQ6L1
    $400 < m_{q^*} < 1230$ GeV)
- arXiv:1008.2461v1 [hep-ex]
  - **Submitted to PRL**
- Latest published limit:
  - $260 < m_{q^*} < 870$ GeV*
  - CDF, 1.13 fb^{-1}

* CDF, Phys. Rev. D79, 346 112002 (2009)

Summary

- Spectra of physics objects measured by ATLAS over 4 orders of magnitude in transverse momentum
  - from 100 MeV to more than 1 TeV
- Charged particle data has tension with MC predictions
  - Potential for tuning of soft QCD models
  - Essential for high precision predictions of hadron collider physics
- **Inclusive jet production cross-section consistent with NLO pQCD prediction over 6 orders of magnitude**
- Search for new physics in inclusive dijet angular and mass spectra
  - Excited quarks excluded up to a mass of 1.26 TeV at 95% CL
  - One of the first competitive limits from LHC
    - **First BSM ATLAS paper**
- **The LHC already explores uncharted territory**

Thanks for your attention!

Backup

CONF Note Repository

- Charged particle multiplicities
  - ATLAS-CONF-2010-046 – 900 GeV and 7 TeV
  - ATLAS-CONF-2010-047 – 2.36 TeV
- Underlying event
  - ATLAS-CONF-2010-029
- Hard QCD
  - ATLAS-CONF-2010-050 – Inclusive jet and dijet cross section
  - ATLAS-CONF-2010-049 – Track jet cross sections
  - ATLAS-CONF-2010-083 – Azimuthal Angular Distributions
  - ATLAS-CONF-2010-084 – Multijet production
  - ATLAS-CONF-2010-085 – Gaps in jet events
- Searches
  - ATLAS-CONF-2010-080 – Dijet mass
  - ATLAS-CONF-2010-074 – Dijet angular distributions