ATLAS status & physics overview

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ATLAS and ATLAS UK

First look with a new detector

First look in a new kinematic regime

QCD plus…


Argentina
Armenia
Australia
Austria
Azerbaijan
Belarus
Brazil
Canada
Chile
China
Colombia
Czech Republic
Denmark
France
Georgia
Germany
Greece
Israel
Italy
Japan
Morocco
Netherlands
Norway
Poland
Portugal
Romania
Russia
Serbia
Slovakia
Slovenia
South Africa
Spain
Sweden
Switzerland
Taiwan
Turkey
UK
USA
CERN
JINR
ATLAS
Collaboration
July 2010

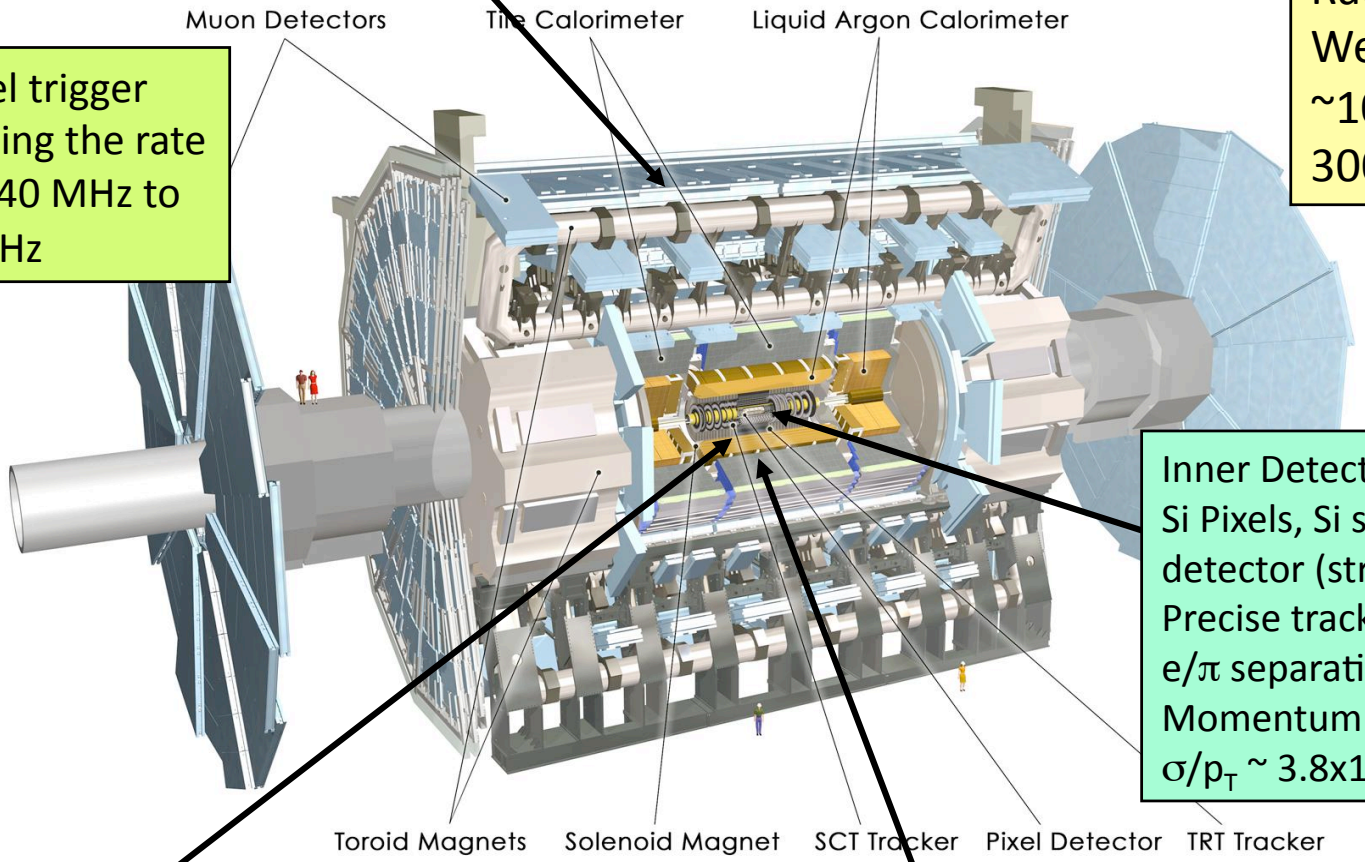
ATLAS UK

- ATLAS UK is around 330 people in 12 institutes:
  - Birmingham, Cambridge, Glasgow, Edinburgh, Lancaster, Liverpool, Manchester, Oxford, QMUL, RAL, RHUL, Sheffield, Sussex, UCL.
  - Includes about 50 PhD students.
- Major responsibilities in tracking, trigger, software & computing.
- Many leadership positions over the years (CB chair, project leaderships, coordination of physics groups…).
- Notable recent examples:
  - T. Wengler, run coordinator for first beam data.
  - D. Charlton, physics coordinator and now deputy spokesperson.
  - From 1 Oct, 5/16 physics coordinator positions held by ATLAS UK physicists

Muon Spectrometer ($|\eta|<2.7$) : air-core toroids with gas-based muon chambers
Muon trigger and measurement with momentum resolution < 10% up to E_μ ~ 1 TeV

Length : ~ 46 m
Radius : ~ 12 m
Weight : ~ 7000 tons
~10^8 electronic channels
3000 km of cables

3-level trigger reducing the rate from 40 MHz to ~200 Hz



Inner Detector ($|\eta|<2.5$, B=2T):
Si Pixels, Si strips, Transition Radiation detector (straws)
Precise tracking and vertexing,
e/π separation
Momentum resolution:
$\sigma/p_T \sim 3.8\times10^{-4}\ p_T\,(\mathrm{GeV}) \oplus 0.015$

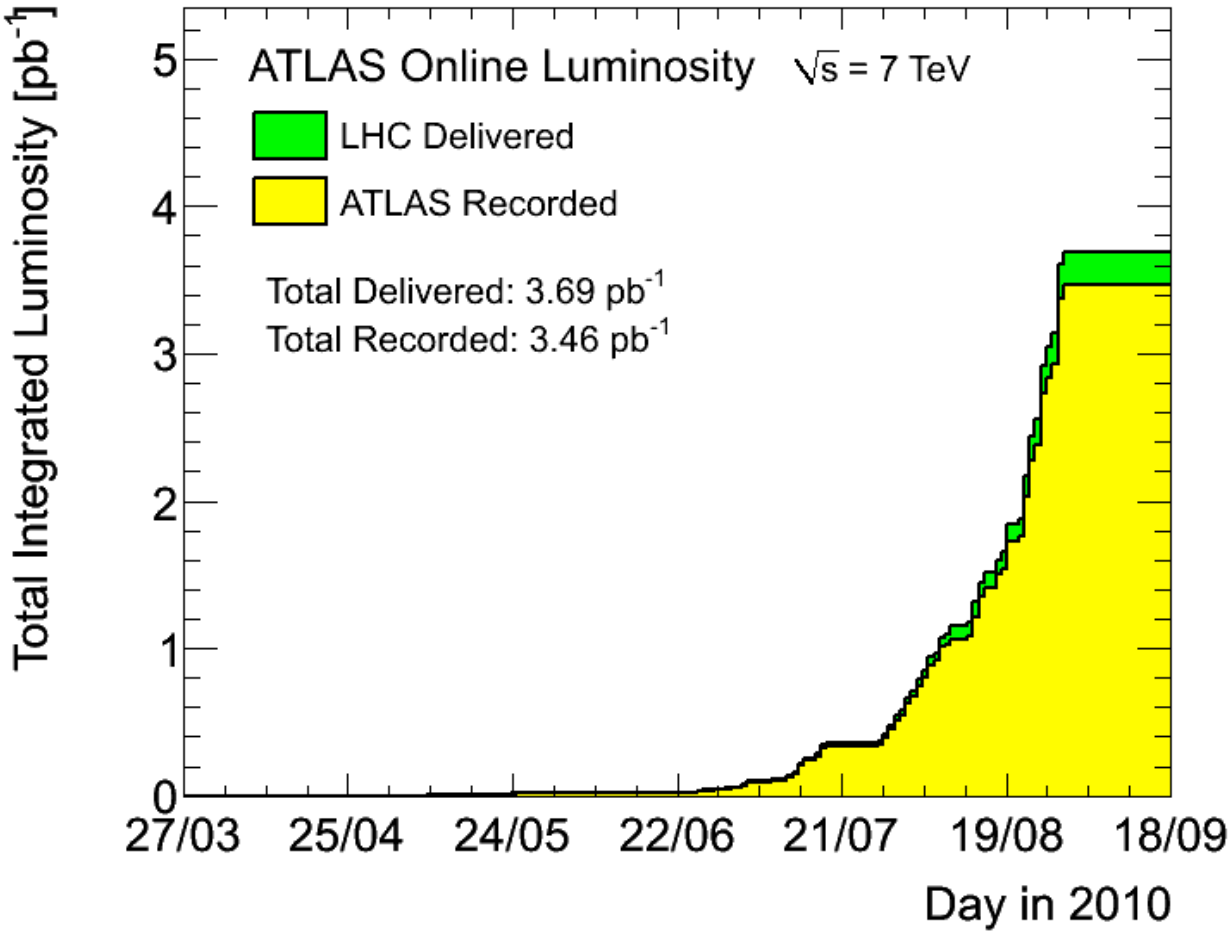
EM calorimeter: Pb-LAr Accordion
e/γ trigger, identification and measurement
E-resolution: $\sigma/E \sim 10\%/\sqrt{E}$

HAD calorimetry ($|\eta|<5$): segmentation, hermeticity
Fe/scintillator Tiles (central), Cu/W-LAr (fwd)
Trigger and measurement of jets and missing E_T
E-resolution: $\sigma/E \sim 50\%/\sqrt{E} \oplus 0.03$

ATLAS Operation

Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	97.3%
SCT Silicon Strips	6.3 M	99.2%
TRT Transition Radiation Tracker	350 k	97.1%
LAr EM Calorimeter	170 k	98.1%
Tile calorimeter	9800	96.9%
Hadronic endcap LAr calorimeter	5600	99.9%
Forward LAr calorimeter	3500	100%
LVL1 Calo trigger	7160	99.9%
LVL1 Muon RPC trigger	370 k	99.5%
LVL1 Muon TGC trigger	320 k	100%
MDT Muon Drift Tubes	350 k	99.7%
CSC Cathode Strip Chambers	31 k	98.5%
RPC Barrel Muon Chambers	370 k	97.0%
TGC Endcap Muon Chambers	320 k	98.6%

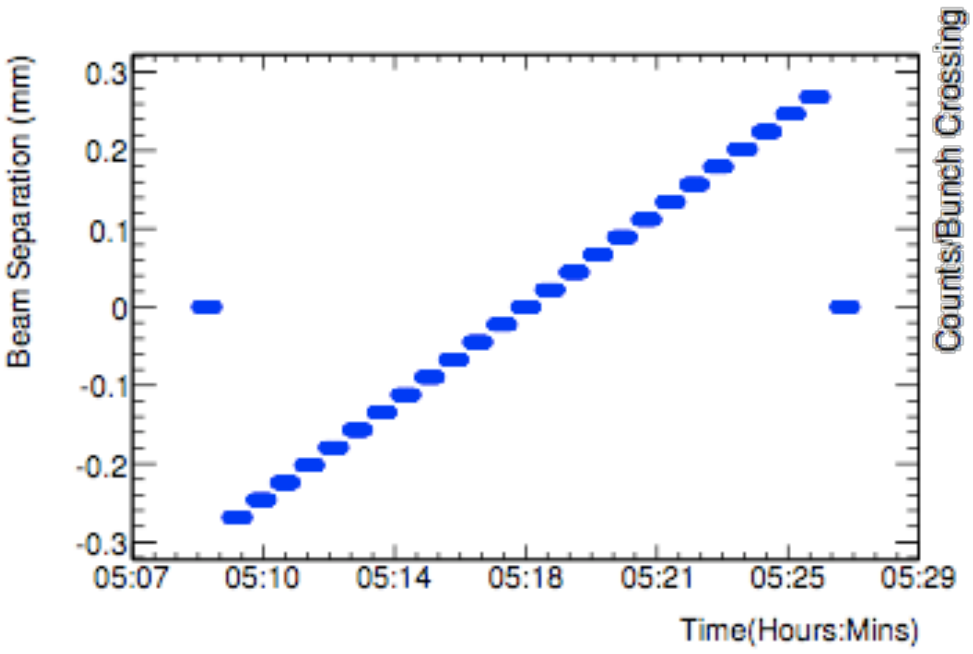
ATLAS Operation

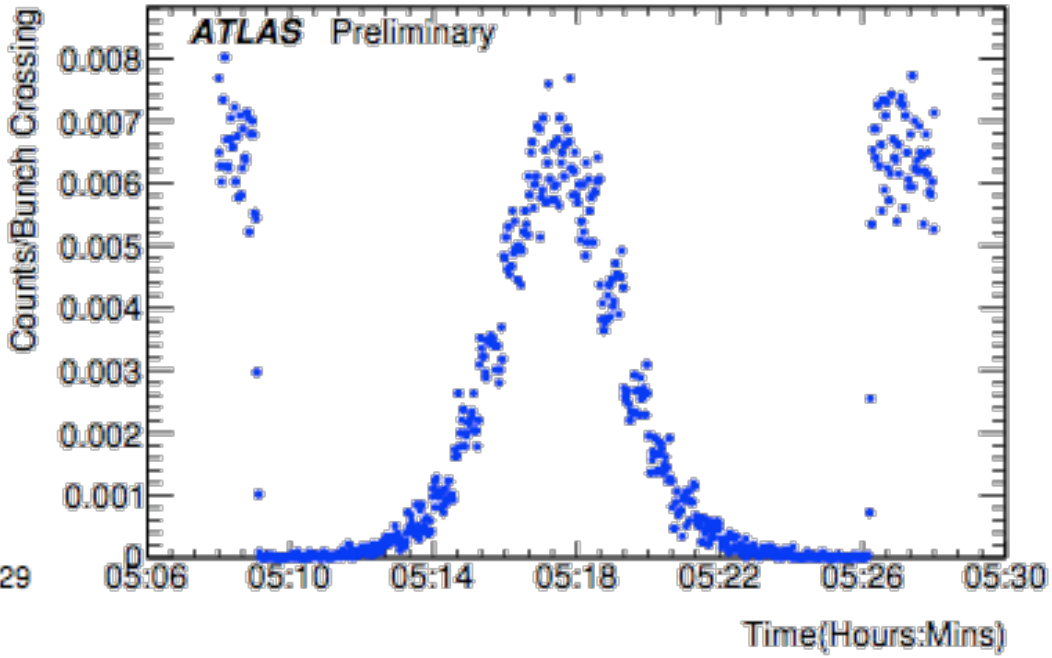


~95% data taking efficiency

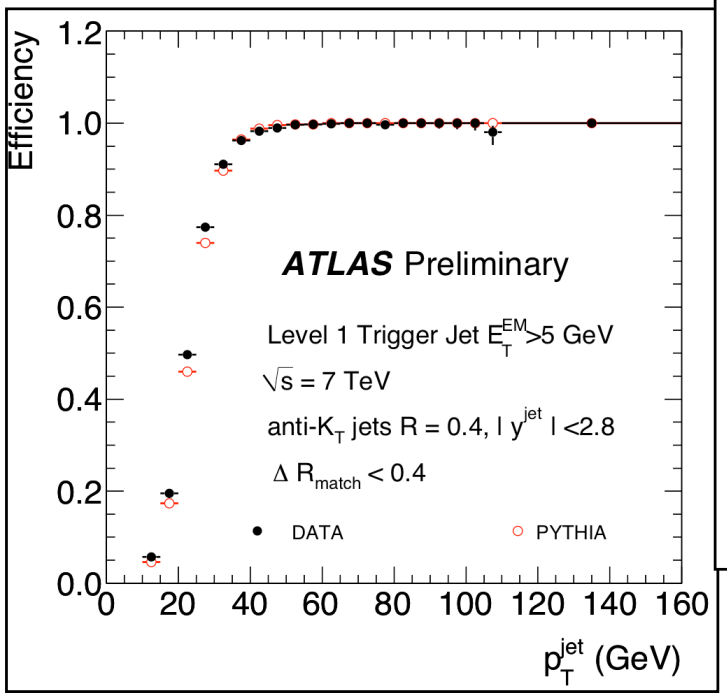
Luminosity

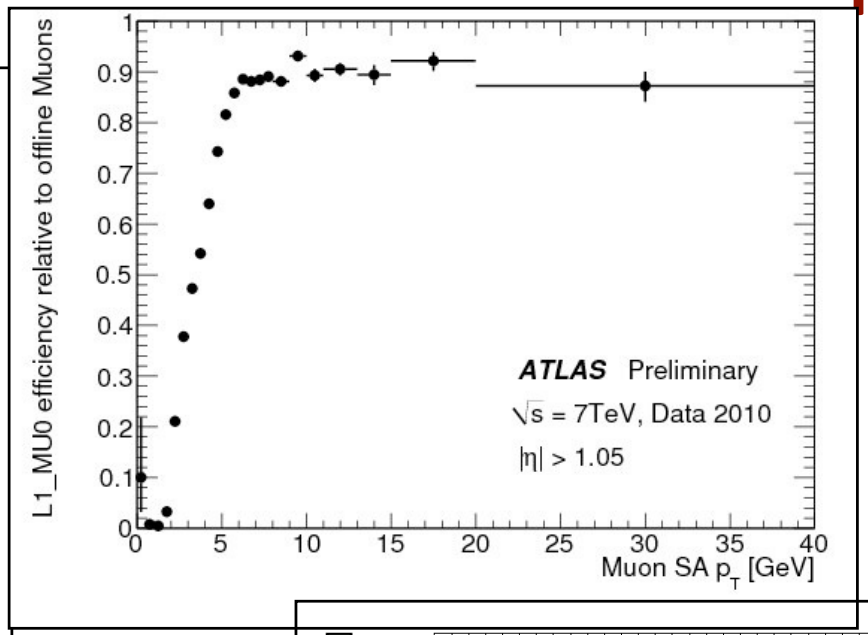
- Monitored by using rates in low-angle detectors & endcaps
- Absolute calibration from van der Meer scans
- Uncertainty ~11%
  - dominant error from knowledge of beam current

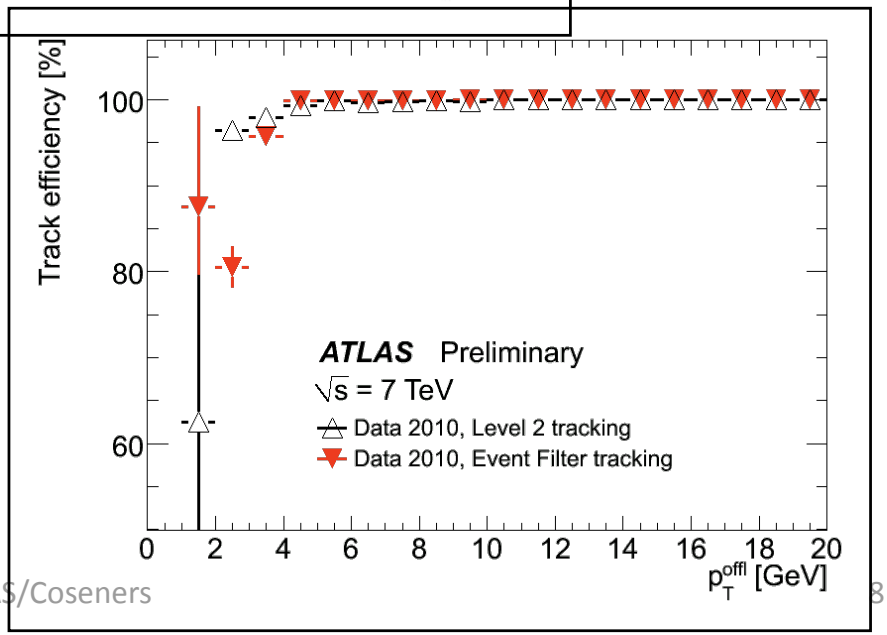




Trigger Performance Examples

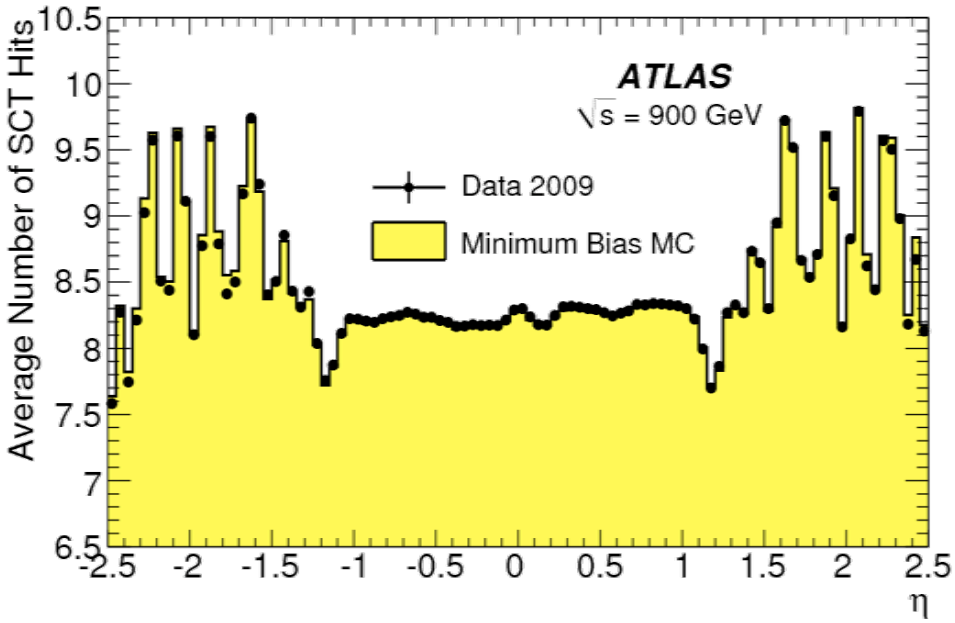




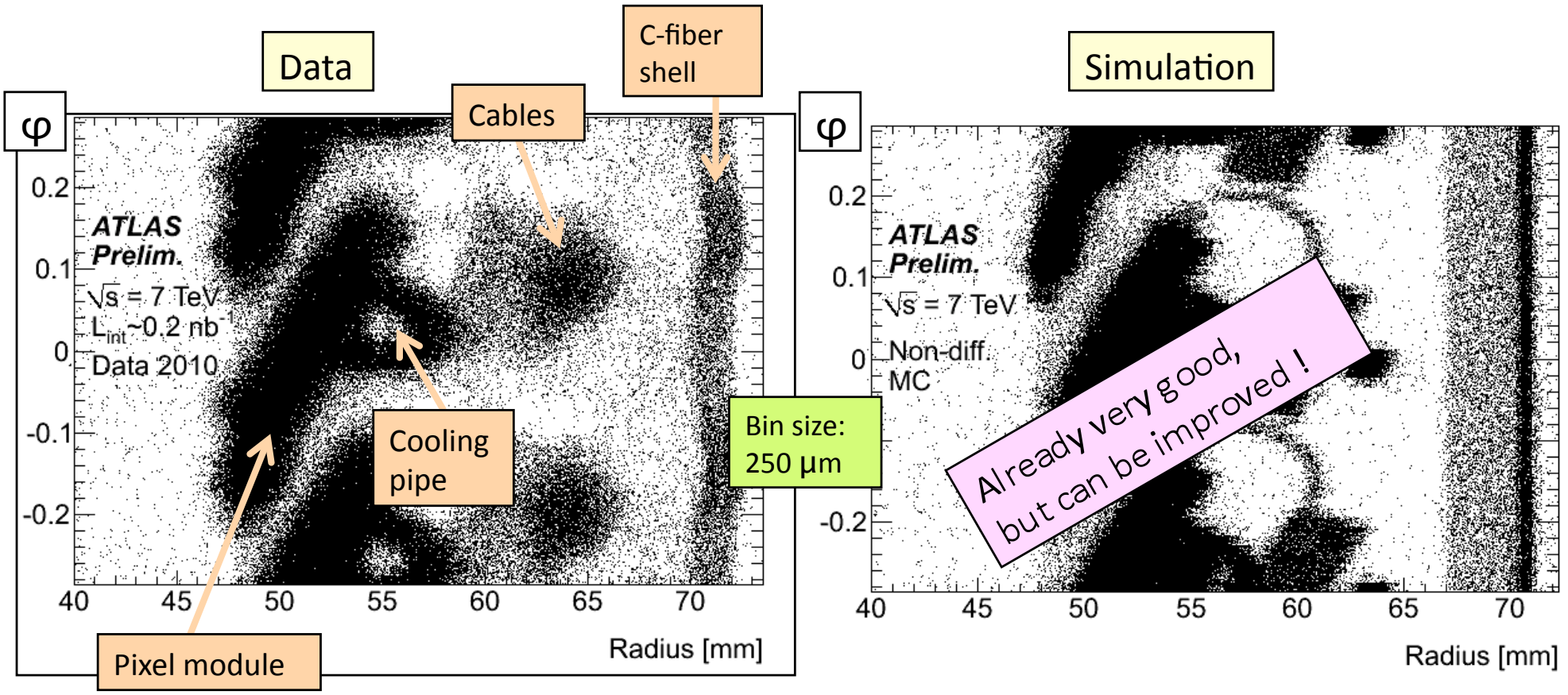


First collision results

- Particle multiplicities in 900 GeV collisions *Phys Lett B* 688, 1 (2010) pp.21-4
- Demonstrate excellent modeling of the detector (especially, in this case, SCT)



Reconstructed secondary vertices due to hadronic interactions in minimum-bias events in the first layer of the Pixel detector (from F.Gianotti's talk, ICHEP)



- Vertex mass veto applied against γ → ee, K_S^0 and Λ
- Vertex (R, Z) resolution ~ 250 μm (R <10 cm) to ~1 mm

First collision results

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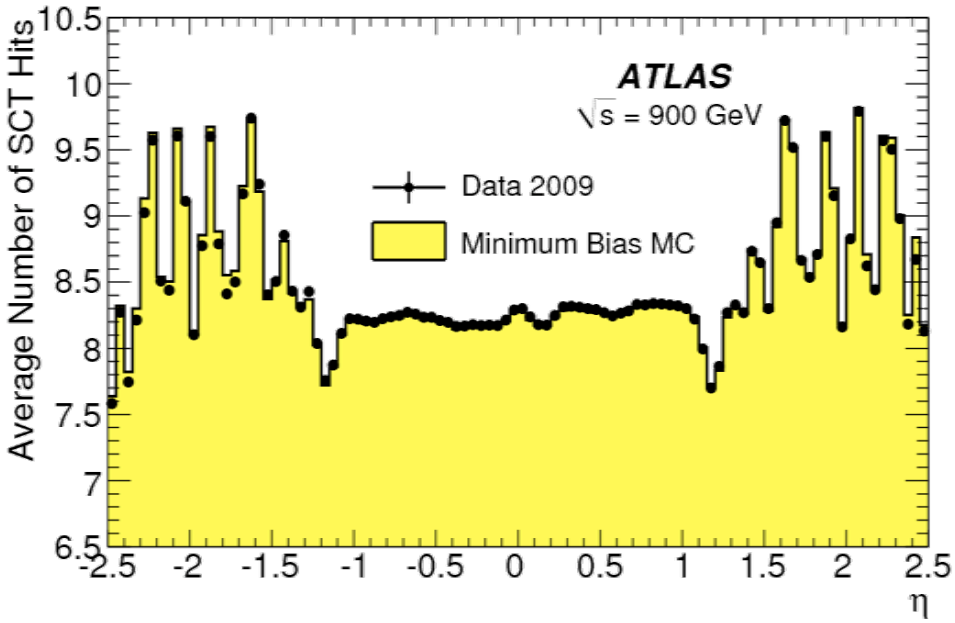
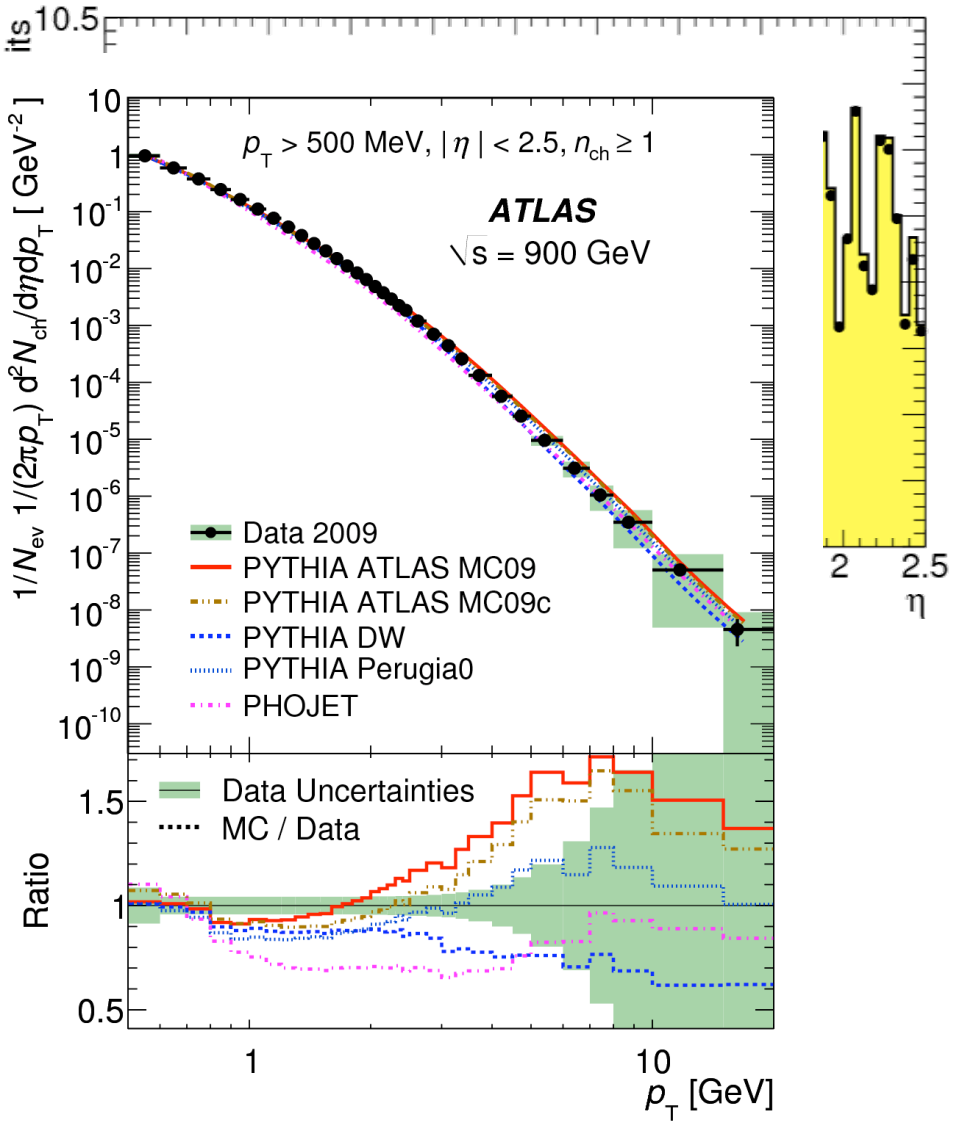
- Demonstrate excellent modeling of the detector (especially, in this case, SCT)

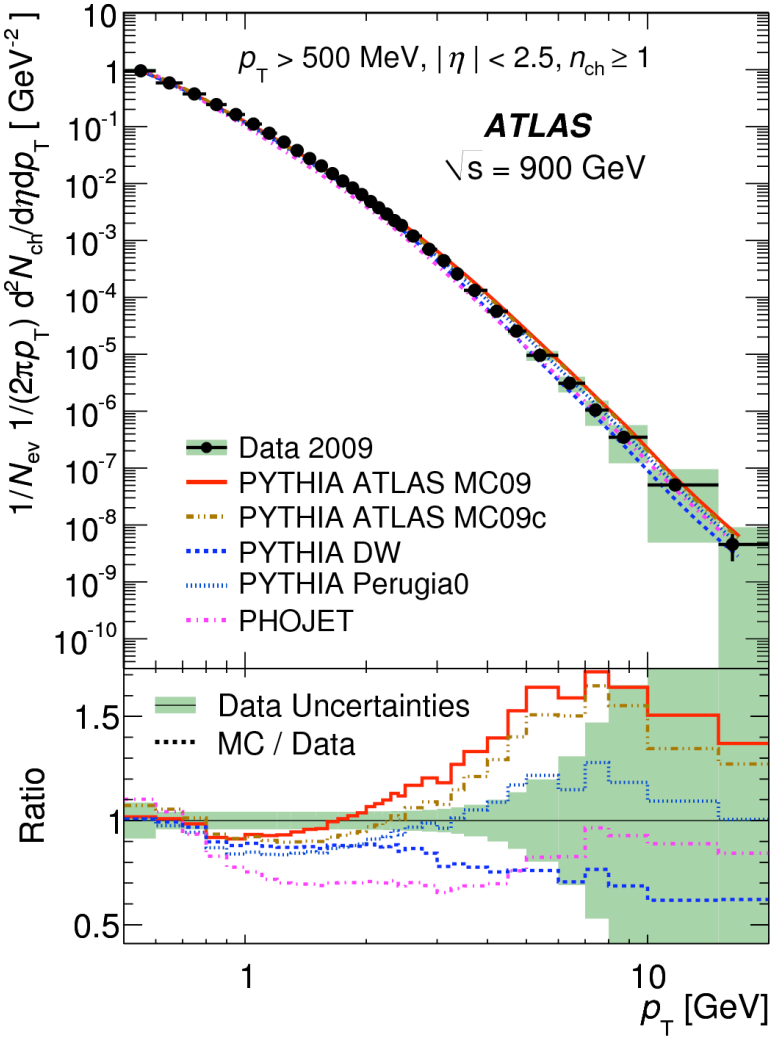


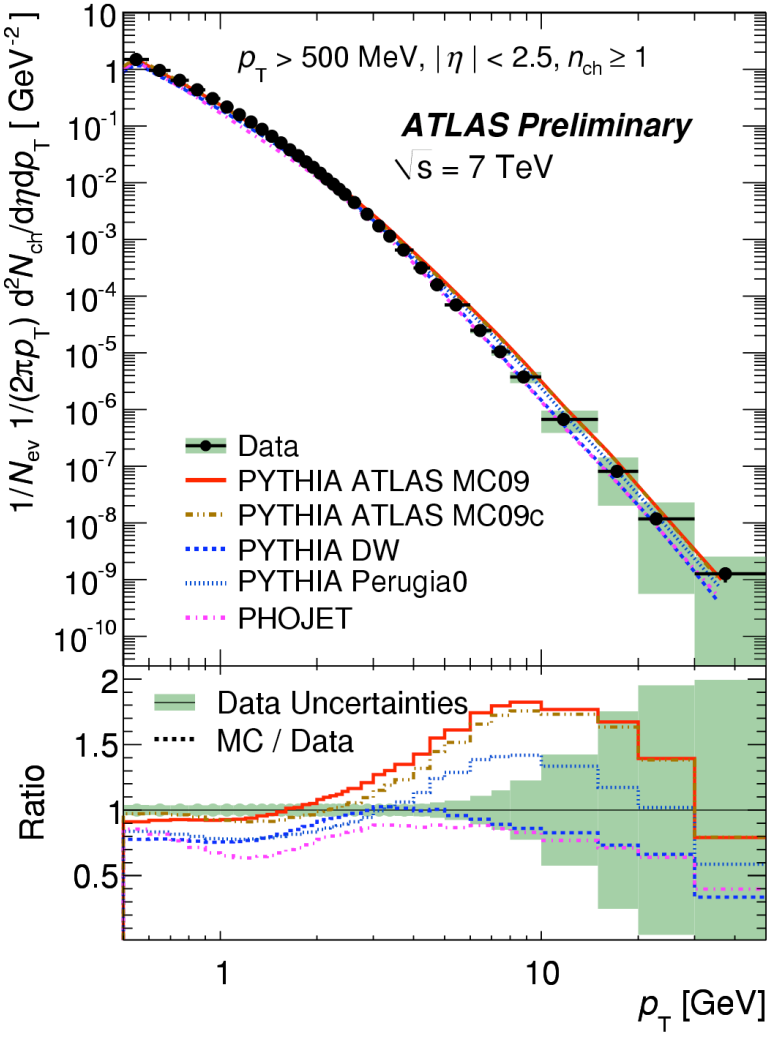
First collision results

- Particle multiplicities in 900 GeV collisions *Phys Lett B* 688, 1 (2010) pp.21-4
- Demonstrate excellent modeling of the detector
- and reasonable modeling of the soft QCD physics (of which more later from A Moraes)

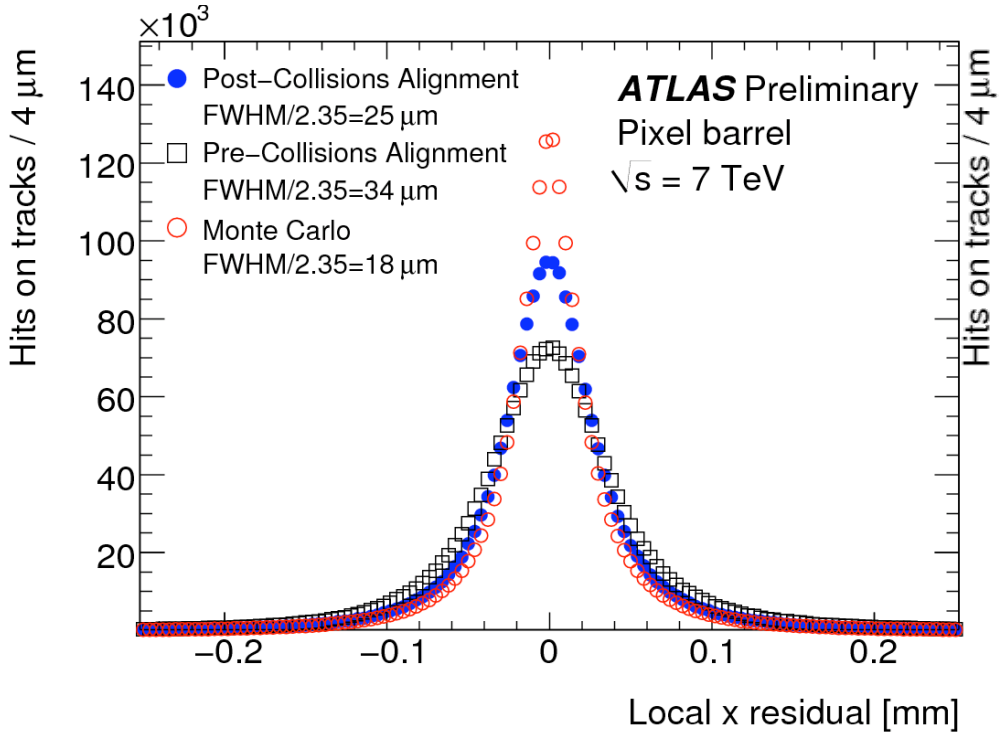


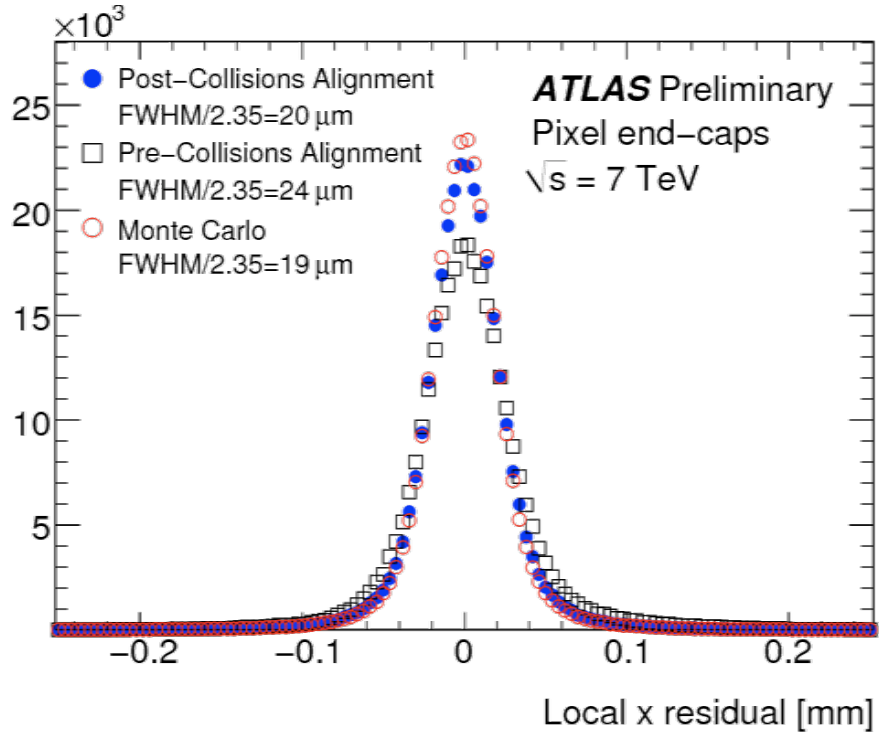
First 7 TeV Results



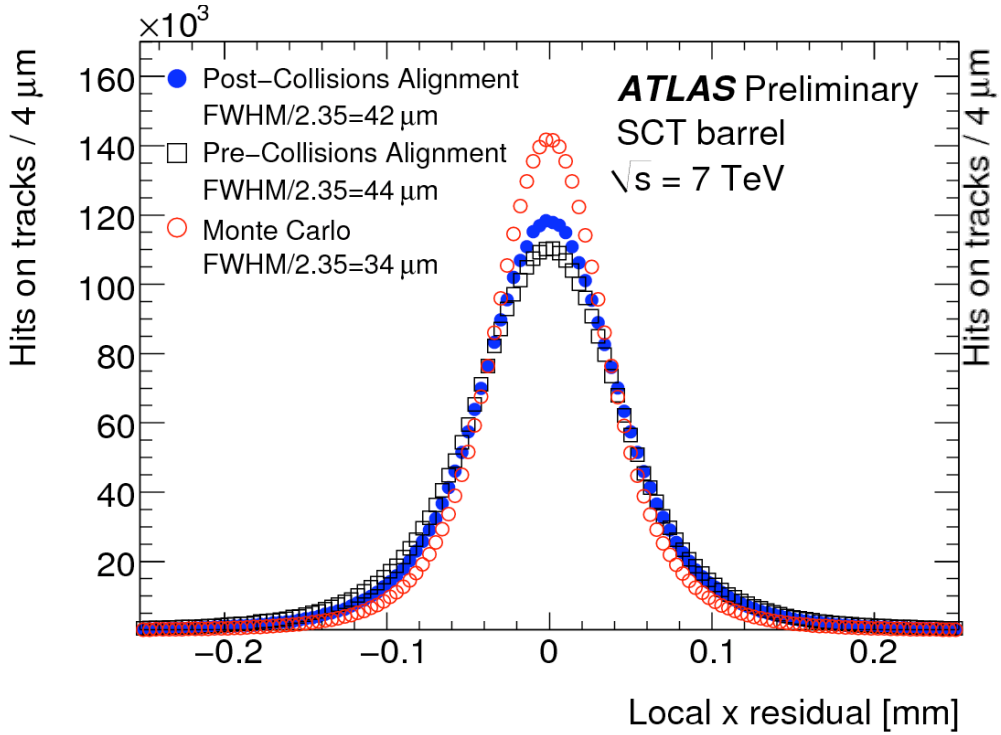


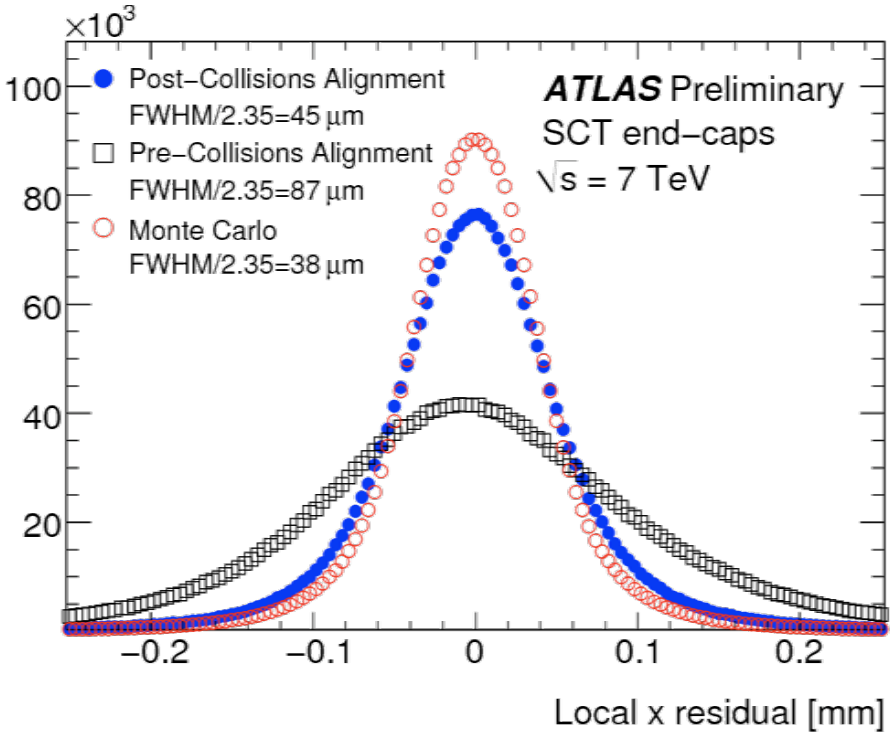
Tracker alignment (Pixel)



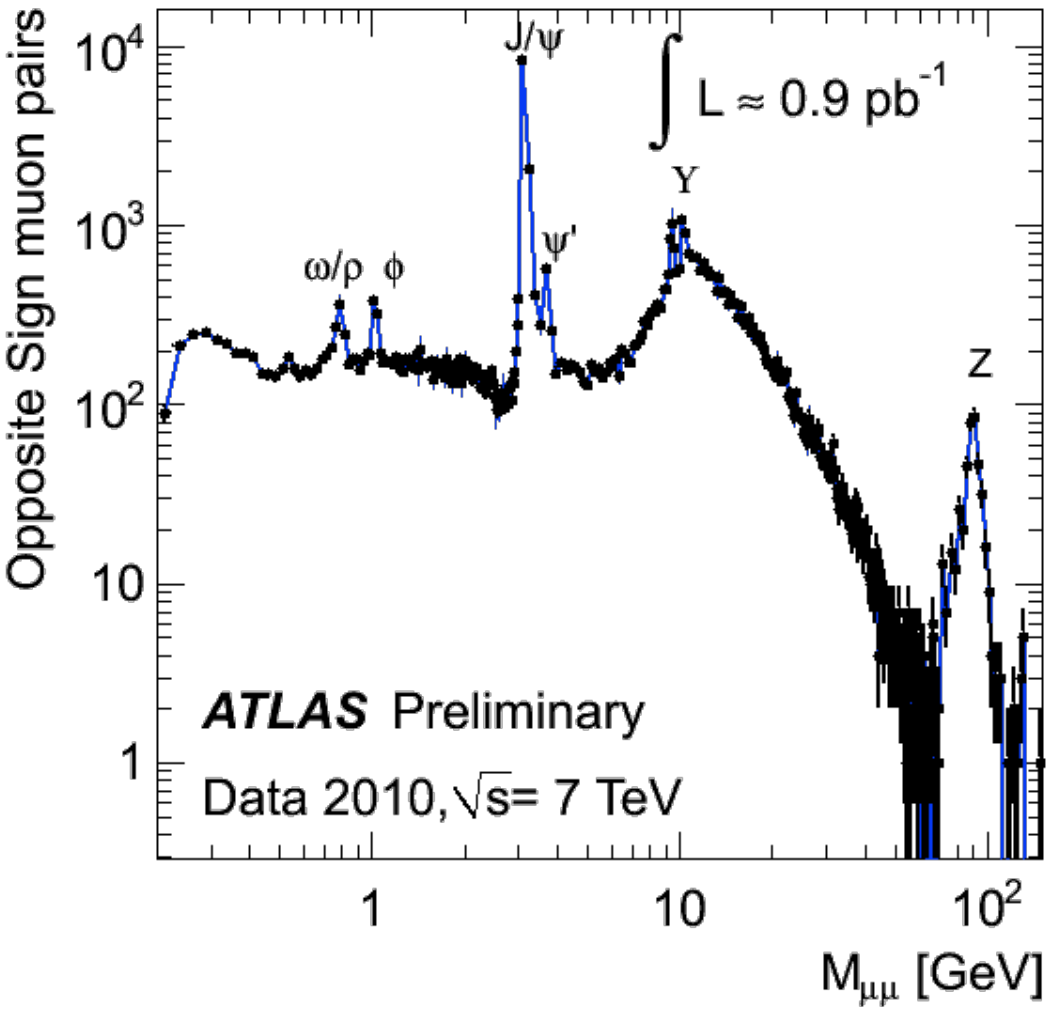


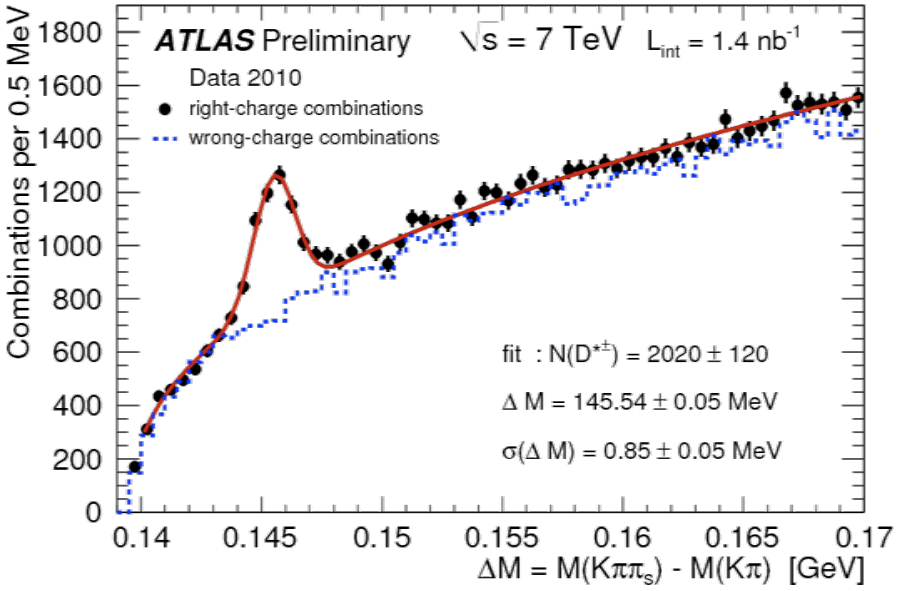
Tracker alignment (SCT)





Mass peaks everywhere…





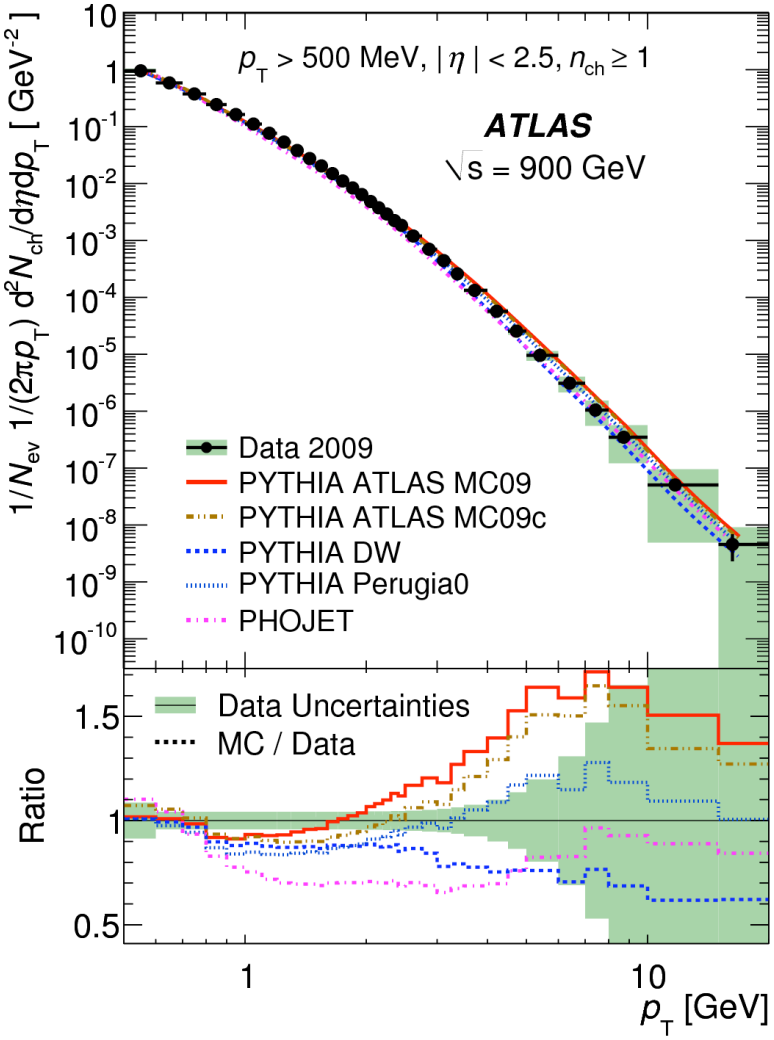
Understanding the environment

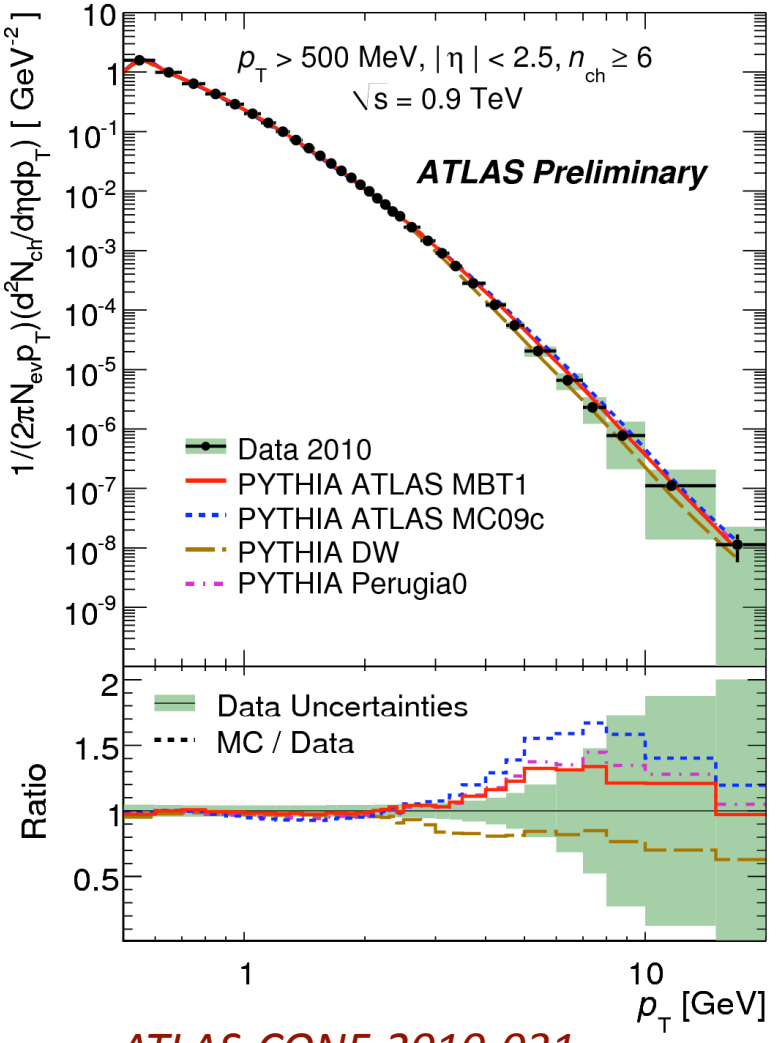
- First 'minimum bias' measurements in a well-defined, but limited, phase space
  - all events with > 0 stable charged particles with p_T > 500 MeV, $|\eta|<2.5$.
  - Extending this would be good (lower p_T)
- Sensitive to unknown diffractive component
  - Disrupts tuning, and less relevant for underlying event

Diffraction and the underlying event

- Diffraction contributes strongly to “minimum bias” (and so to pile up) but not much the “underlying event”
- Diffraction in pp is poorly understood even at lower energies.
  - However, lower multiplicity is a general property
- Measure “next-to-minimum” bias
  - Apply a higher multiplicity cut to reduce diffractive component
  - Tune to this (AMBT1)

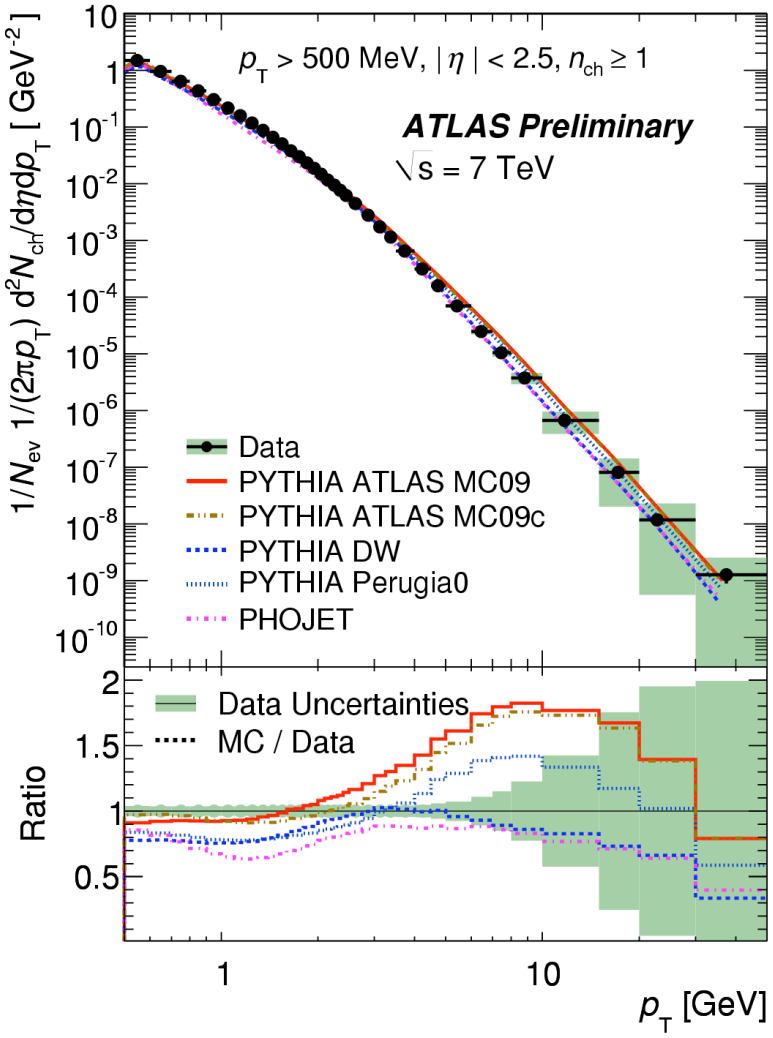
Diffraction and the underlying event

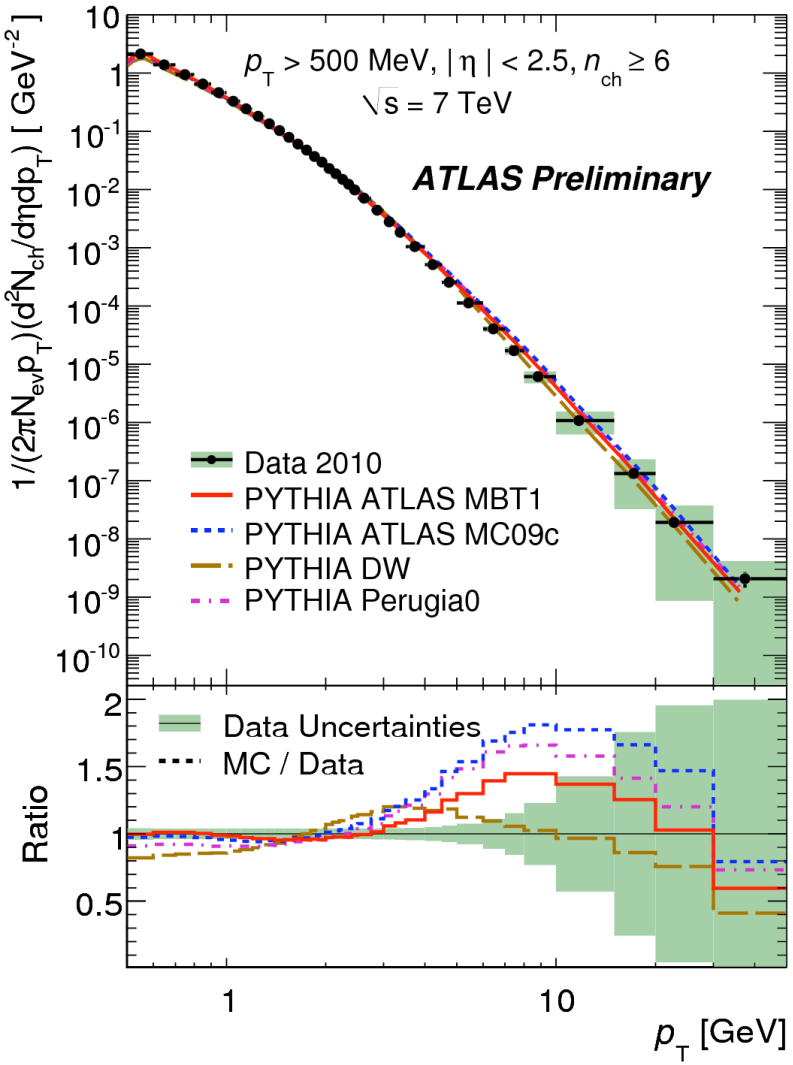




ATLAS-CONF-2010-031

Diffraction and the underlying event





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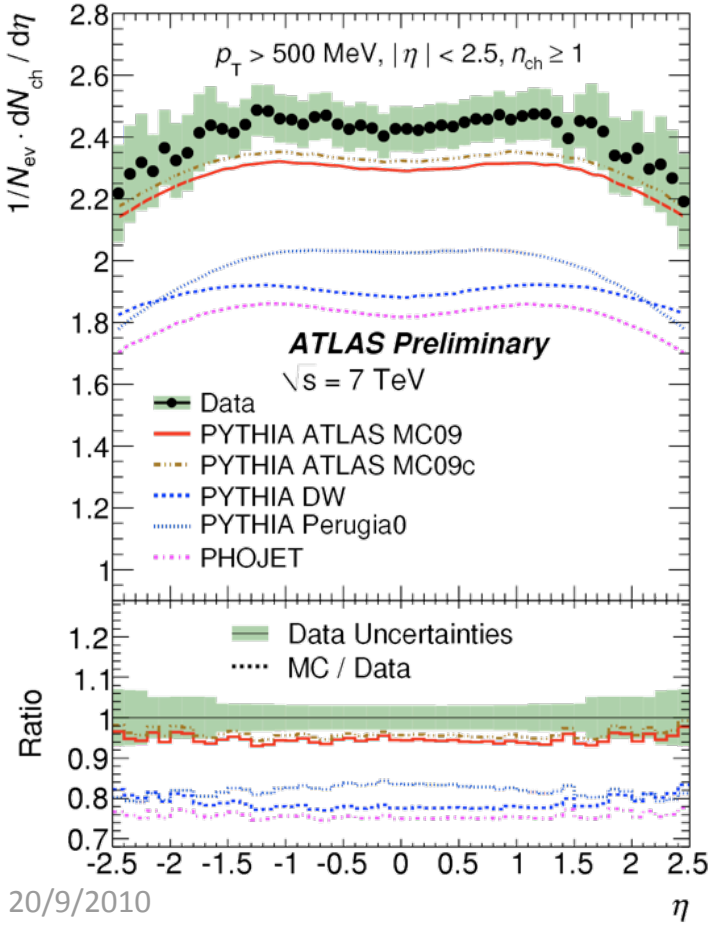
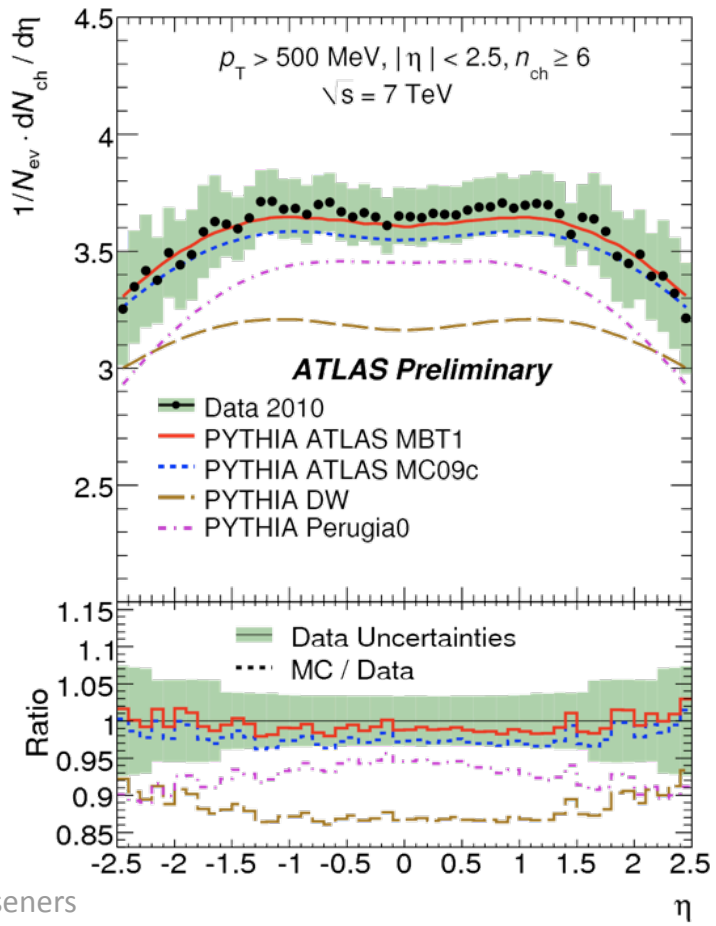
Diffraction and the underlying event

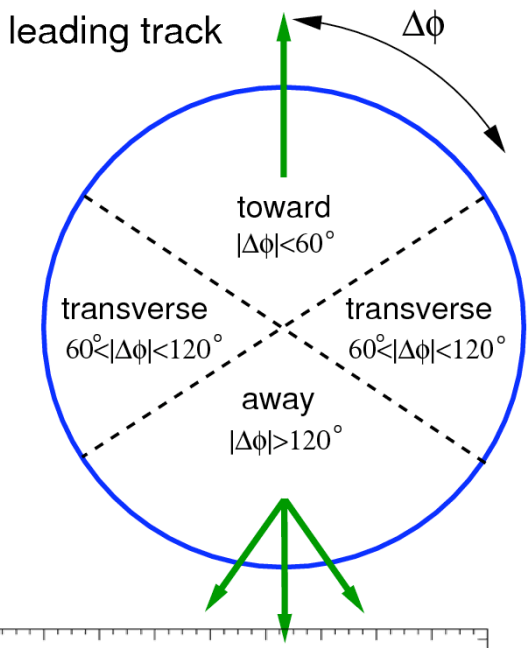
- Not only is the new tune an improvement, but the older tunes seem to do better at the "reduced diffractive" sample.

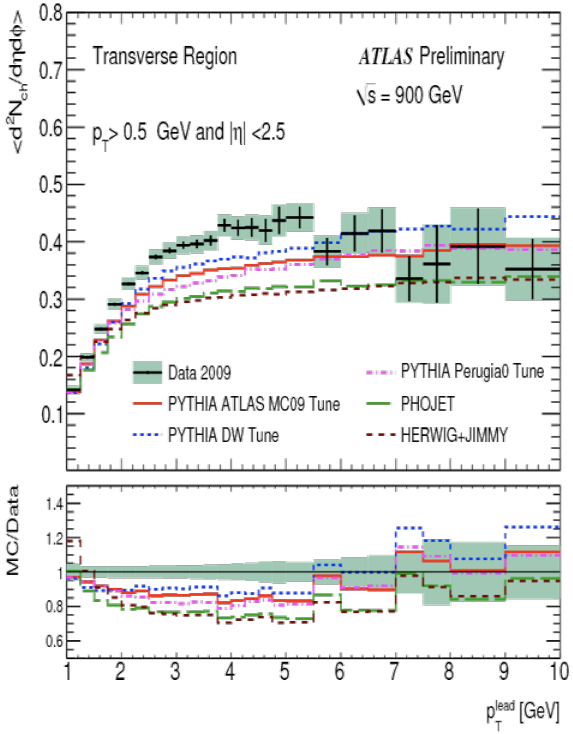


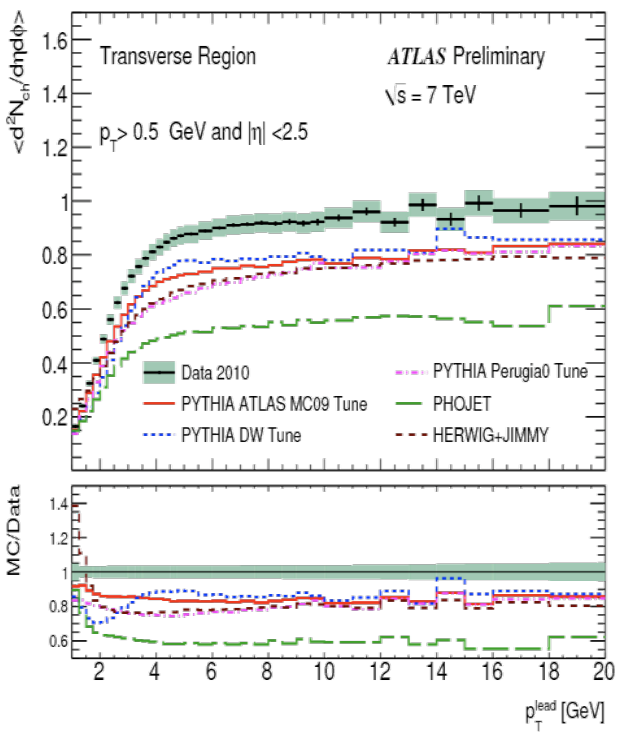


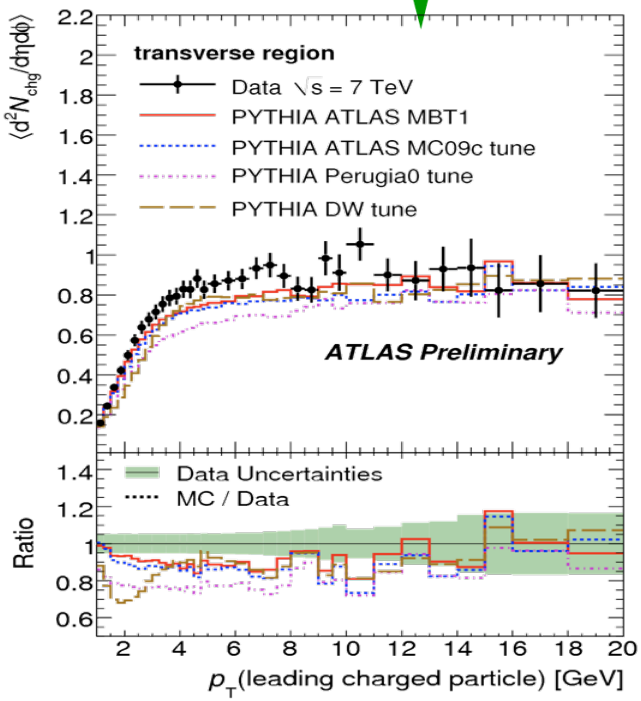
Underlying event

- Comparison to underlying event measurement *ATLAS-CONF-2010-081*

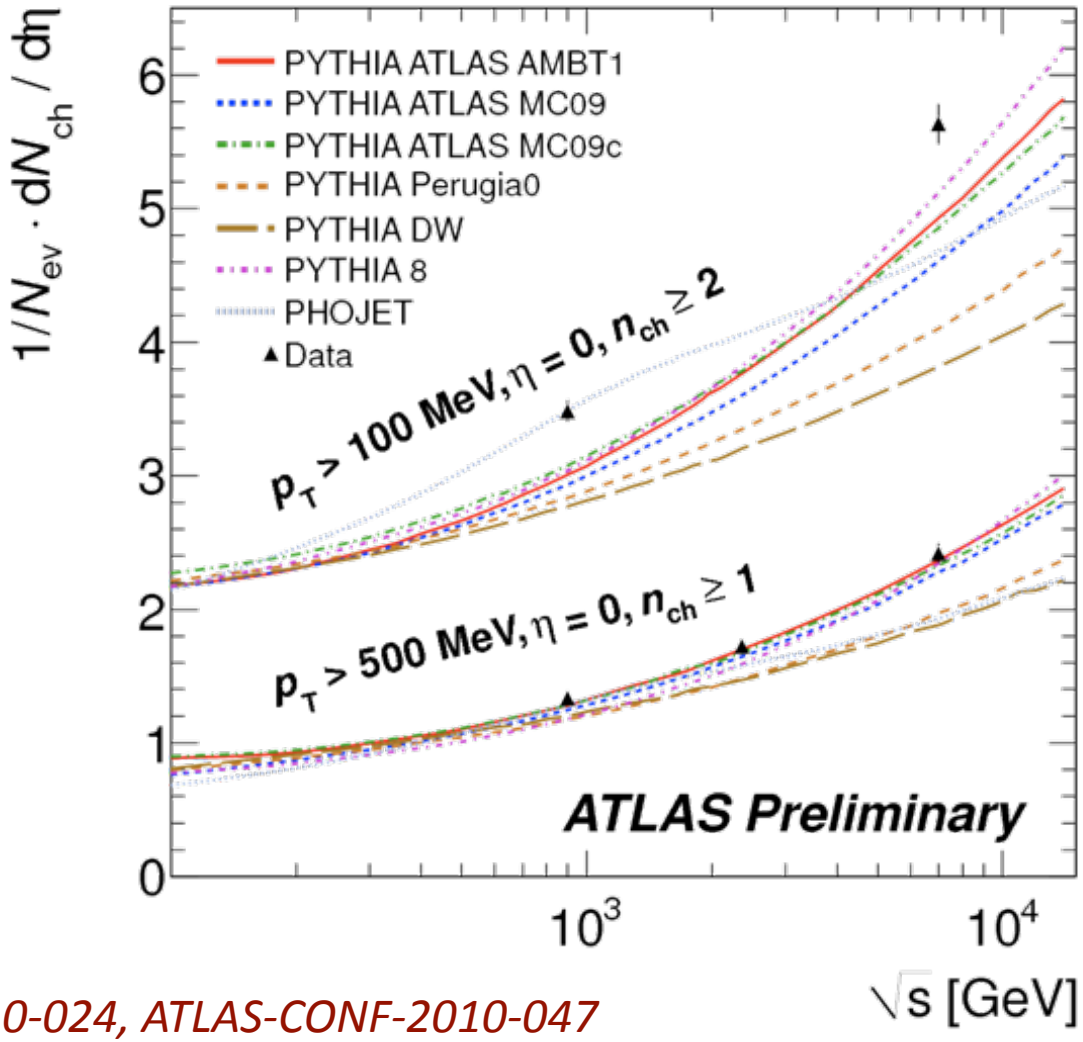








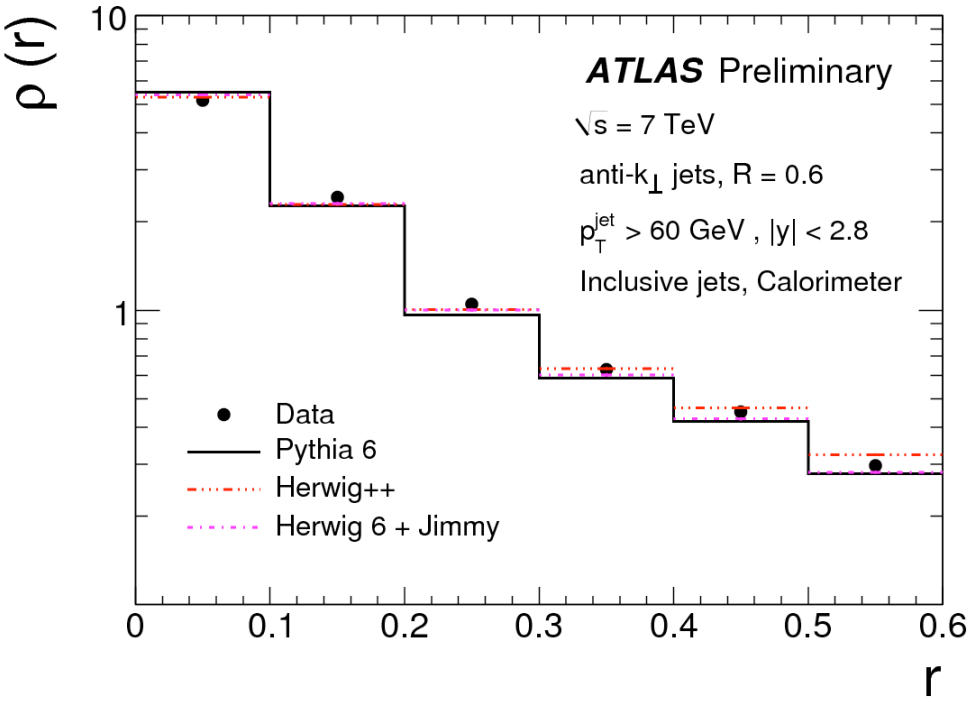
…and also 2.36 TeV

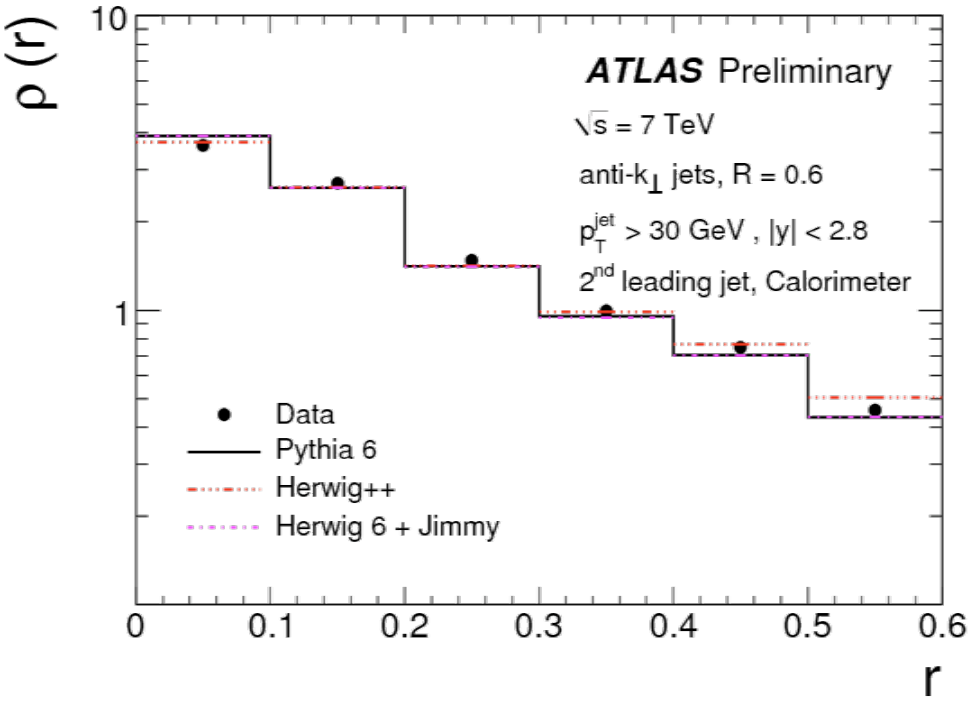


And extended to lower p_T

ATLAS-CONF-2010-024, ATLAS-CONF-2010-047

Hard QCD : Jet Shapes





ATLAS-CONF-2010-050

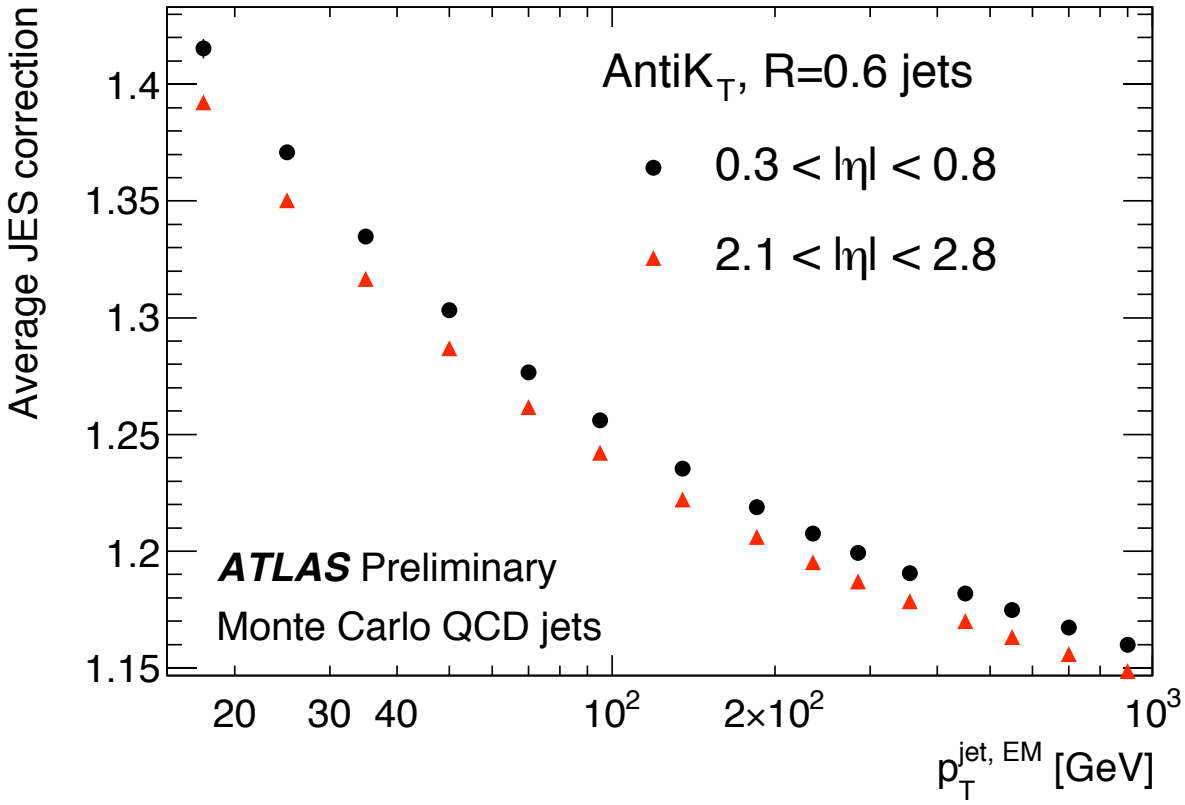
Jet Energy Scale

- Current strategy
  - Electromagnetic scale from test beam measurements (electrons & muons)
  - Correction for
    - Difference in hadronic/electromagnetic response
    - Losses in material in front of Calorimeter
    - Leakage from back of the calorimeter
    - Magnetic field
    - Cluster and jet algorithmic inefficiency

  are all dealt with by simulation

Jet Energy Scale

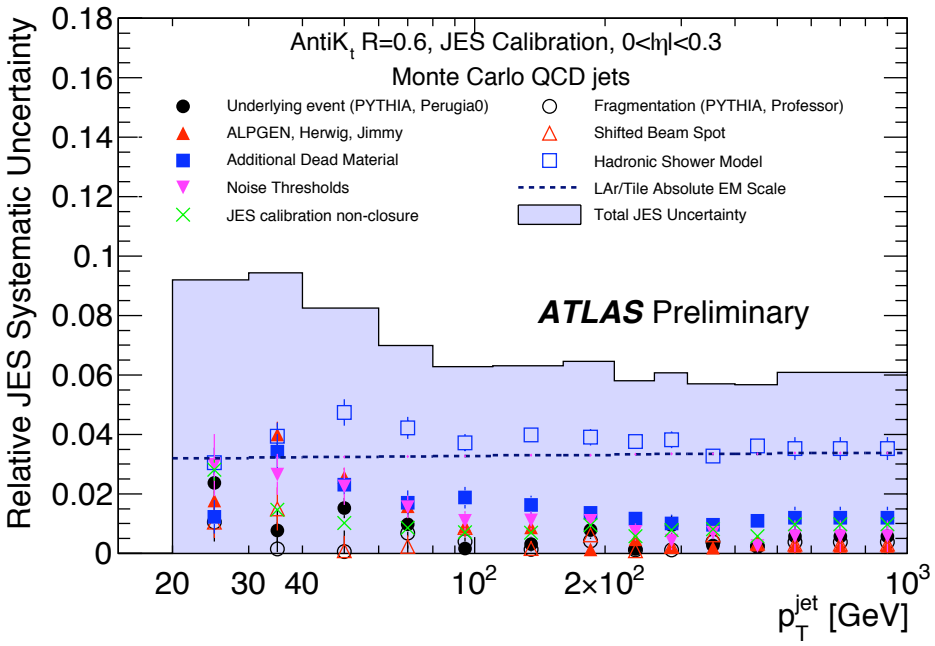
- Evaluate the transfer function
  - (true E)->(EM scale E)
- Invert it
- Refit in bins of EM-scale p_T
- Apply

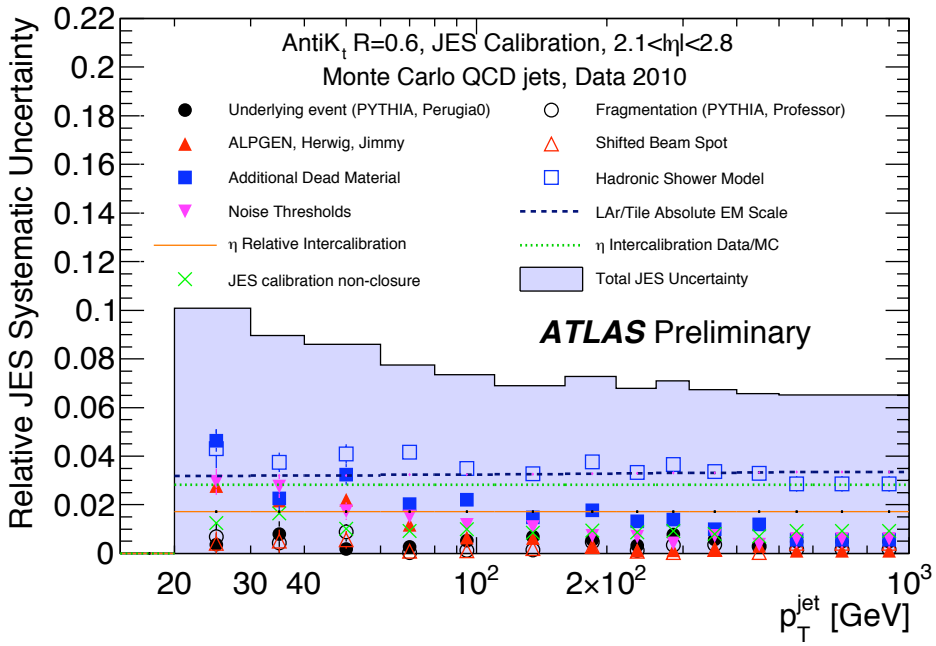


Jet Energy Scale Uncertainty

- Dominant systematic in ~all measurements involving jets or missing energy.
- Uncertainties from
  - Translating test beam EM scale to in situ (3-4%)
  - Material knowledge/simulation ~2%
  - Noise <3%
  - Beamspot position <1%
  - “closure test” <2%
  - Hadronic (GEANT) shower model ~4%
  - Hadronic (generator) show model <4%
  - Pile up: variable. (<1% for cross section mesurement)
  - Intercalibration in y (from in situ dijet balance) <3%
  - For dijet measurements, decorrelated error ~3%

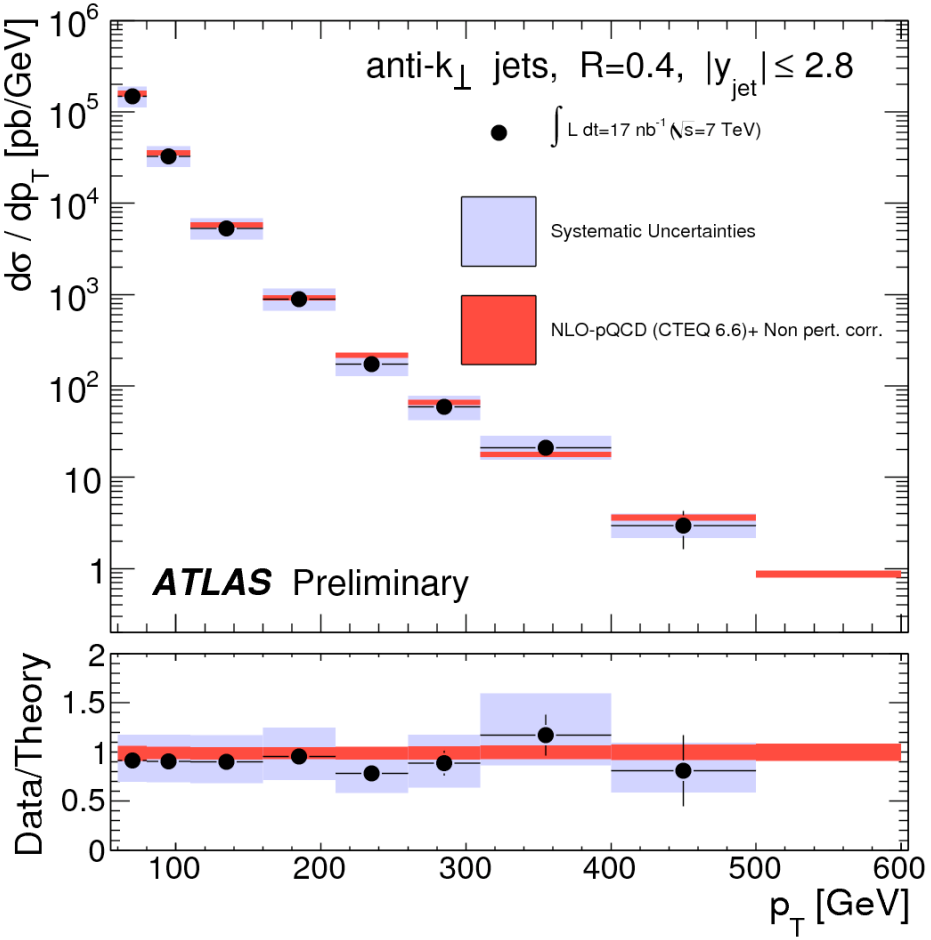
Jet Energy Scale Uncertainty

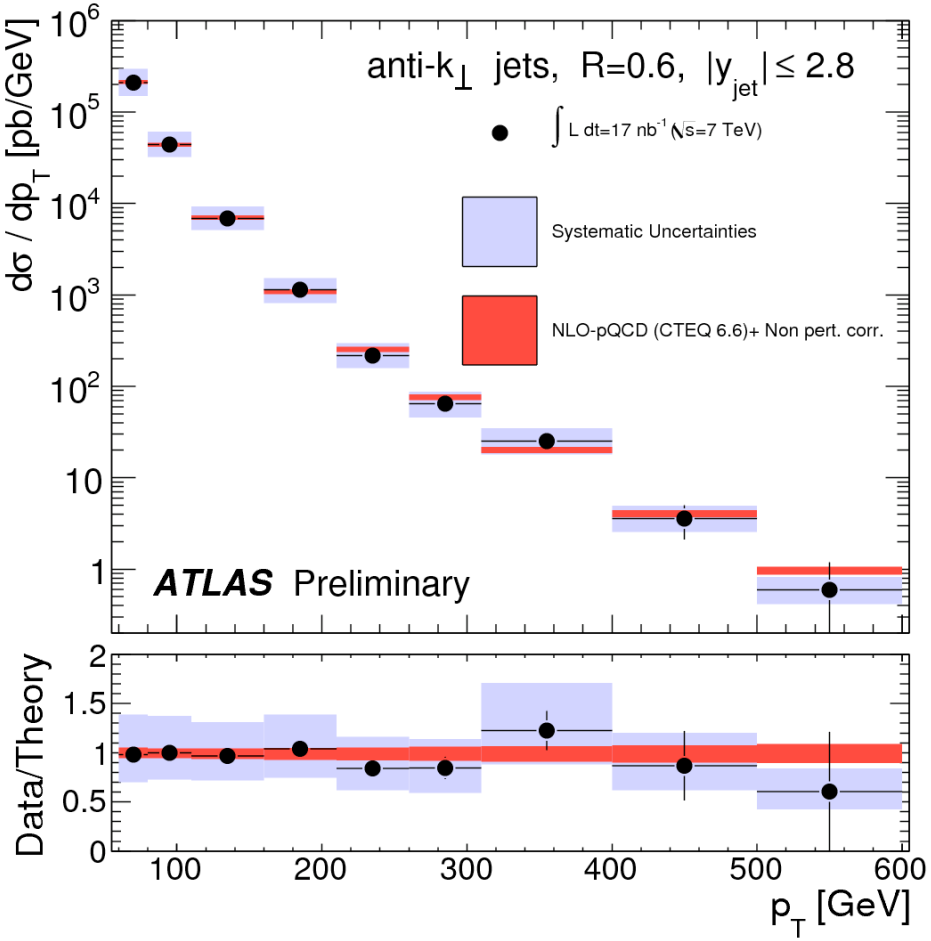




- < 9% everywhere. ~6% for high p_T
- ~40% error on jet cross section
- Checked with extensive single-particle studies in collision data and soon by photon-jet balance

Hard QCD : Jet Cross Sections





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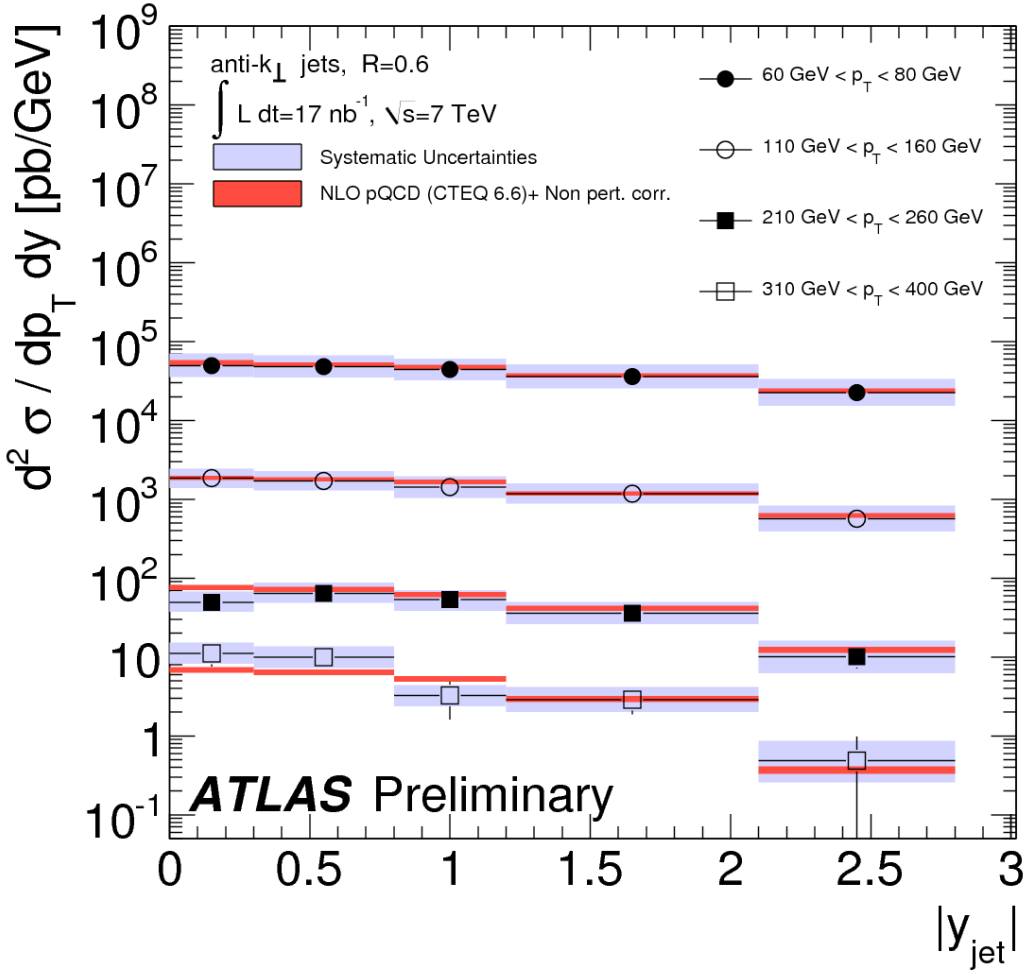
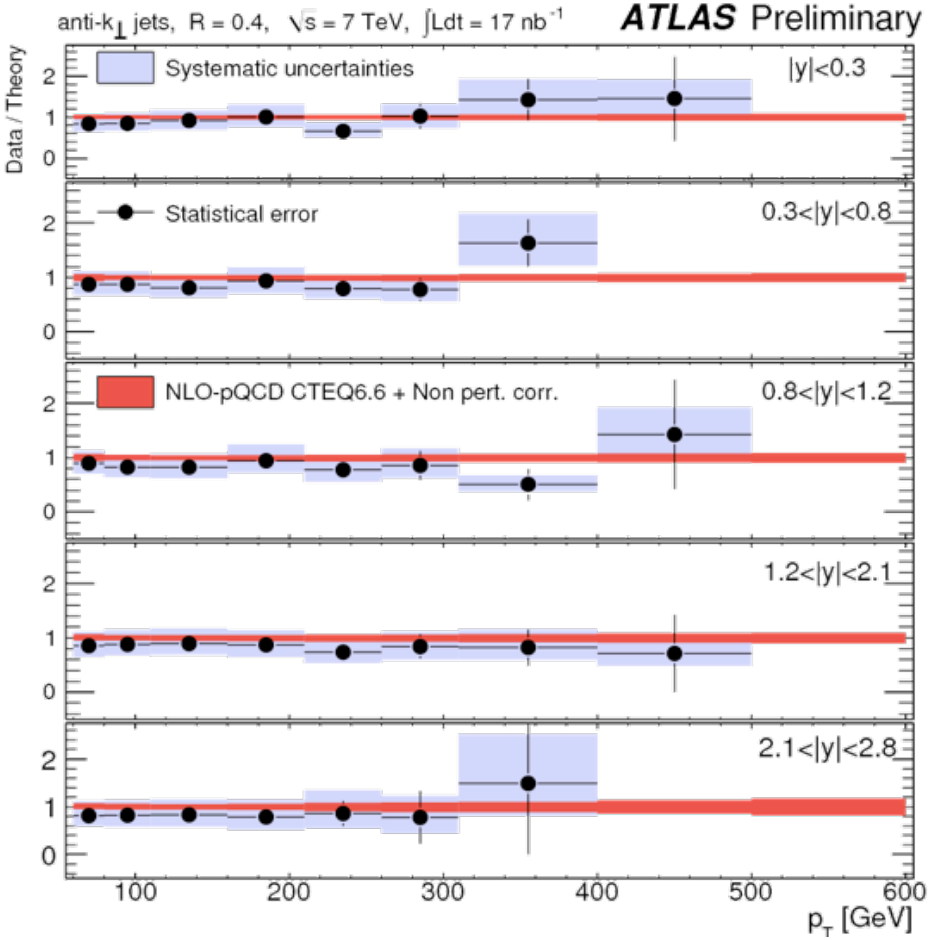
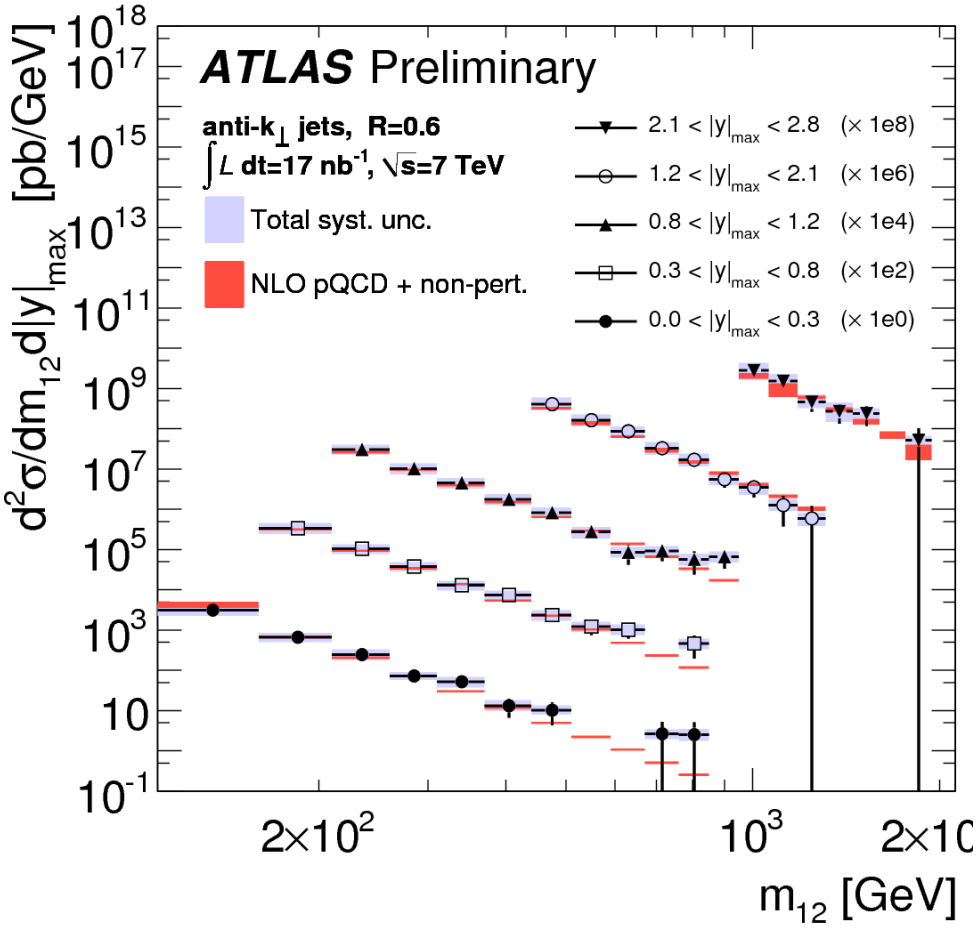
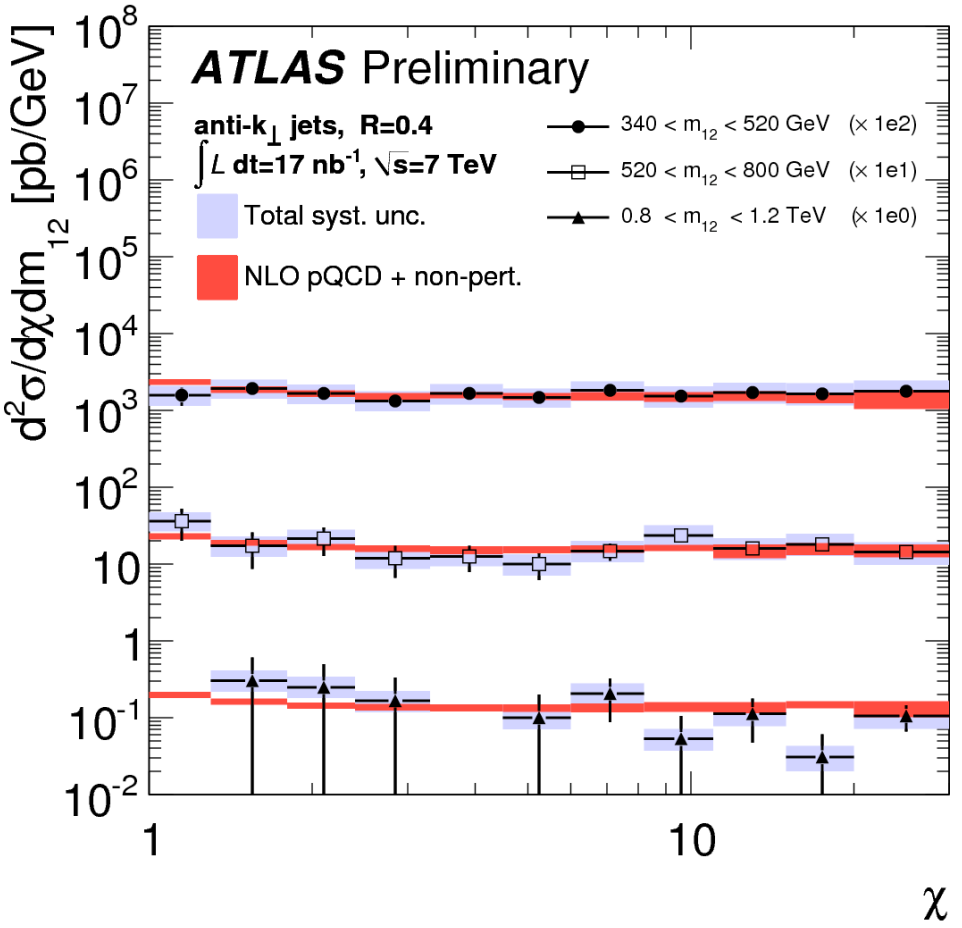
Inclusive Jet cross sections



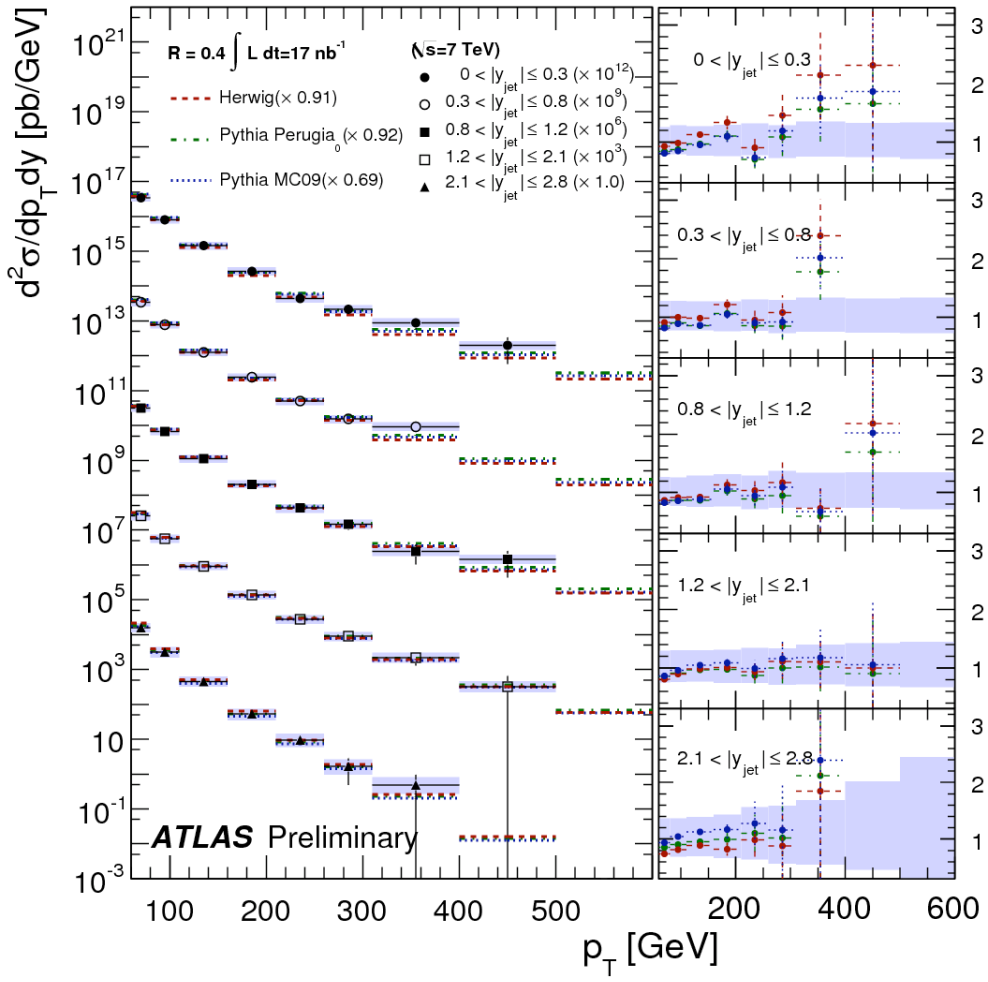


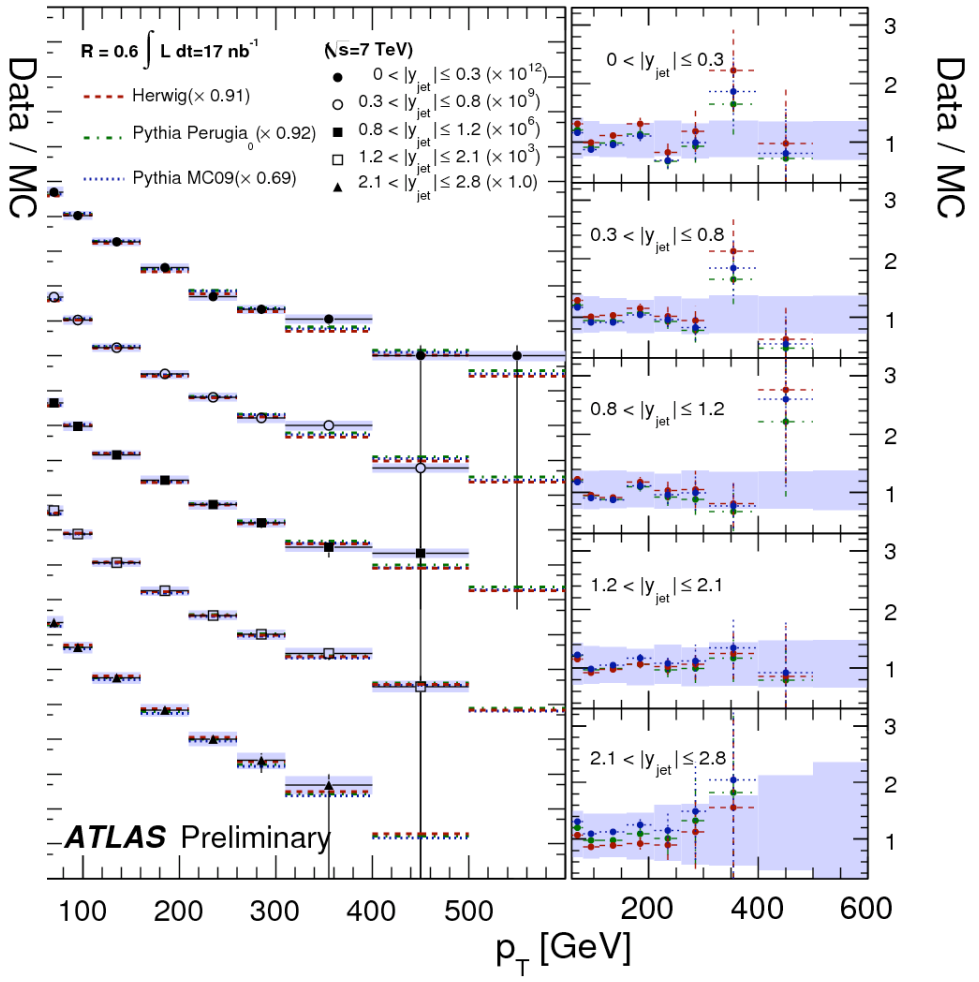
Dijet cross sections



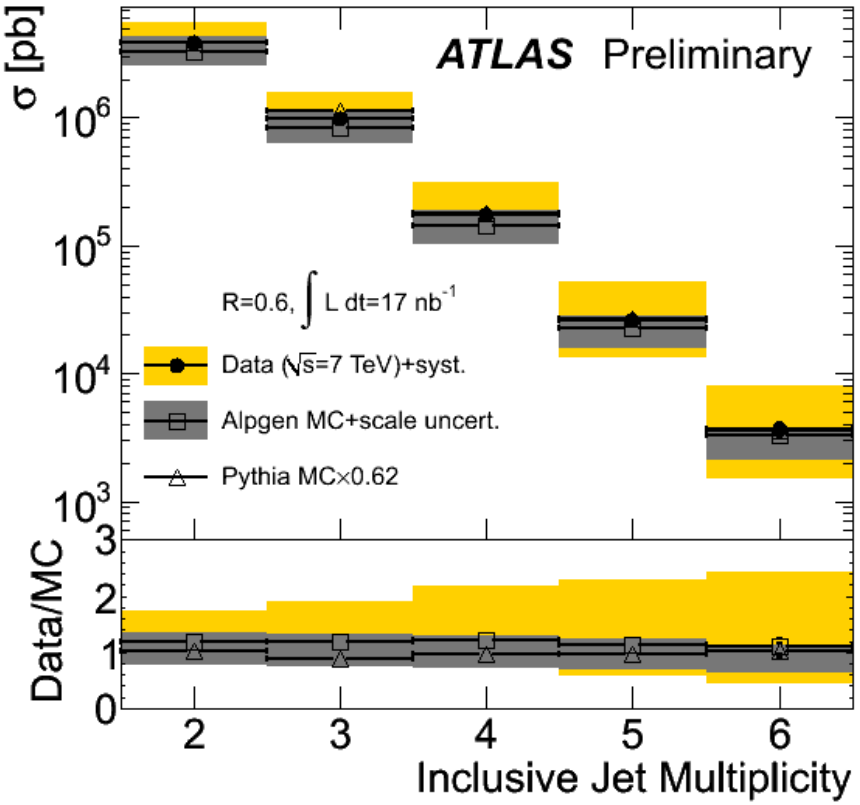


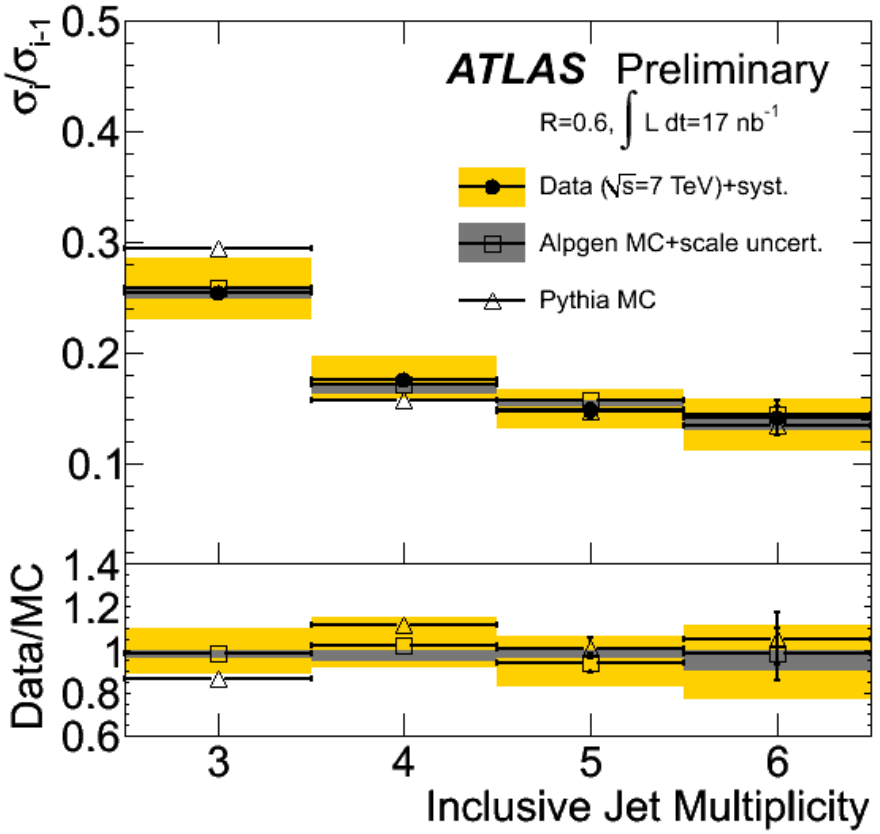
Jet cross sections vs MC





Multijets

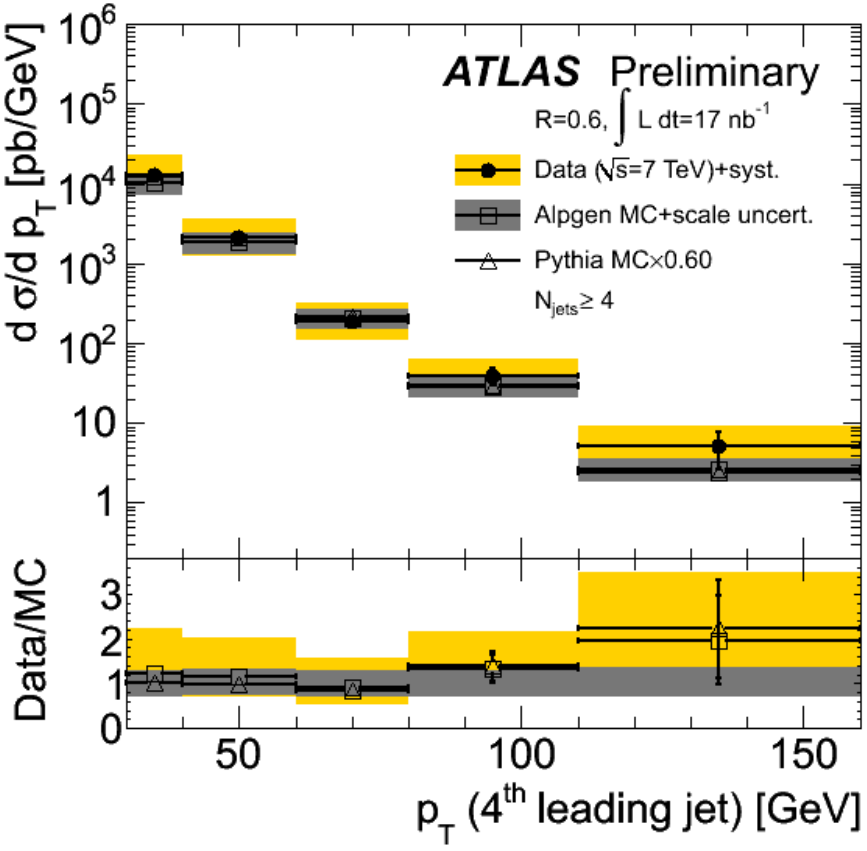


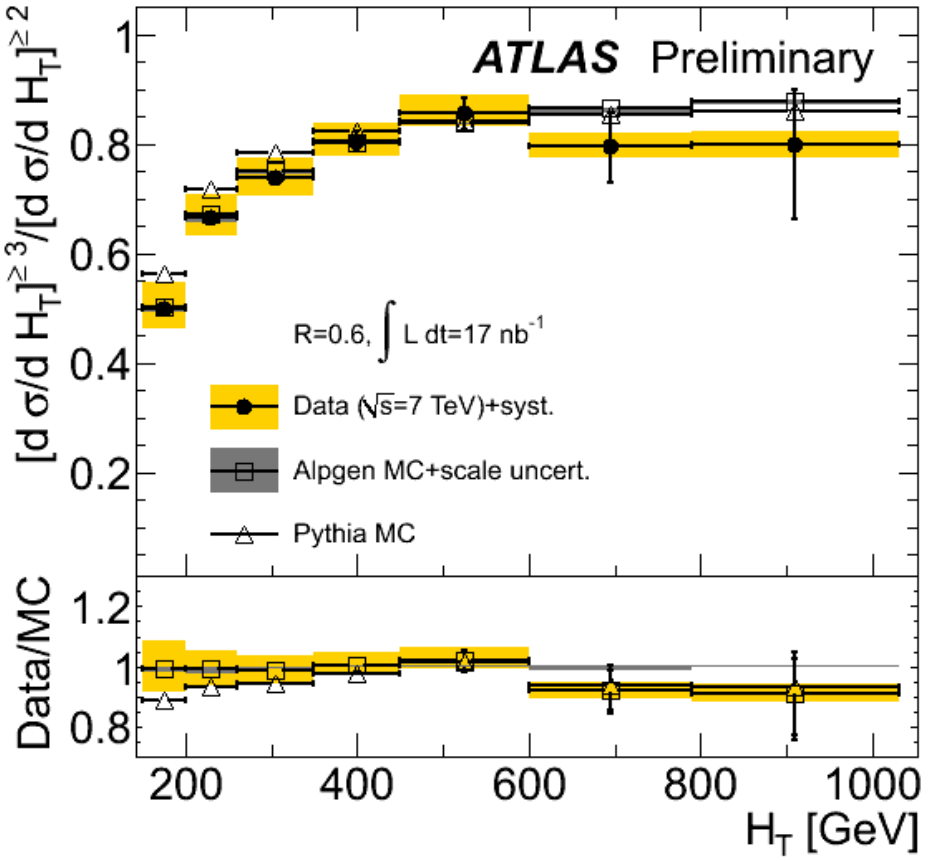


$p_T > 30$ GeV $|y| < 2.8$

ATLAS-CONF-2010-084

Multijets

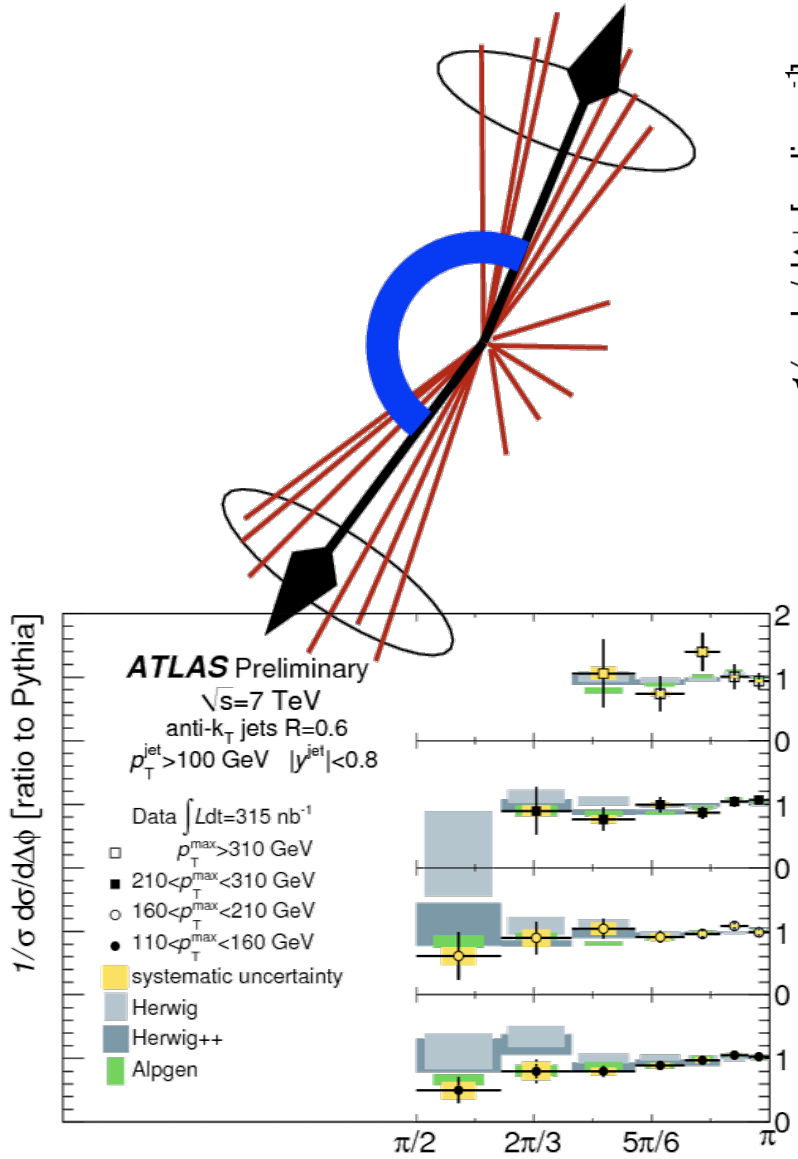


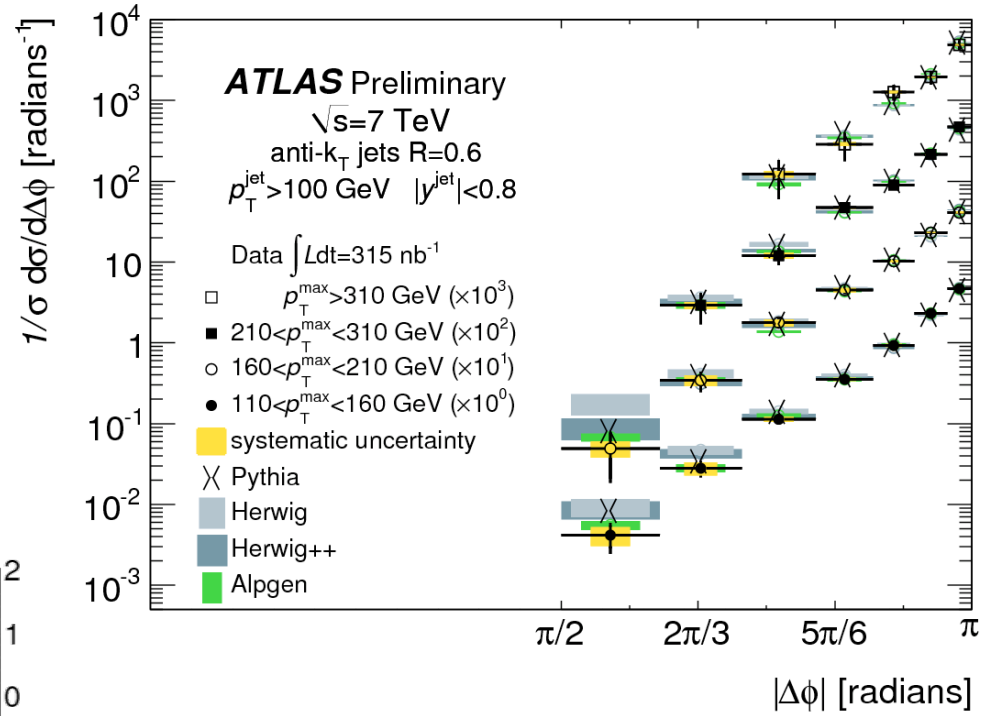


$p_T > 30$ GeV $|y| < 2.8$

ATLAS-CONF-2010-084

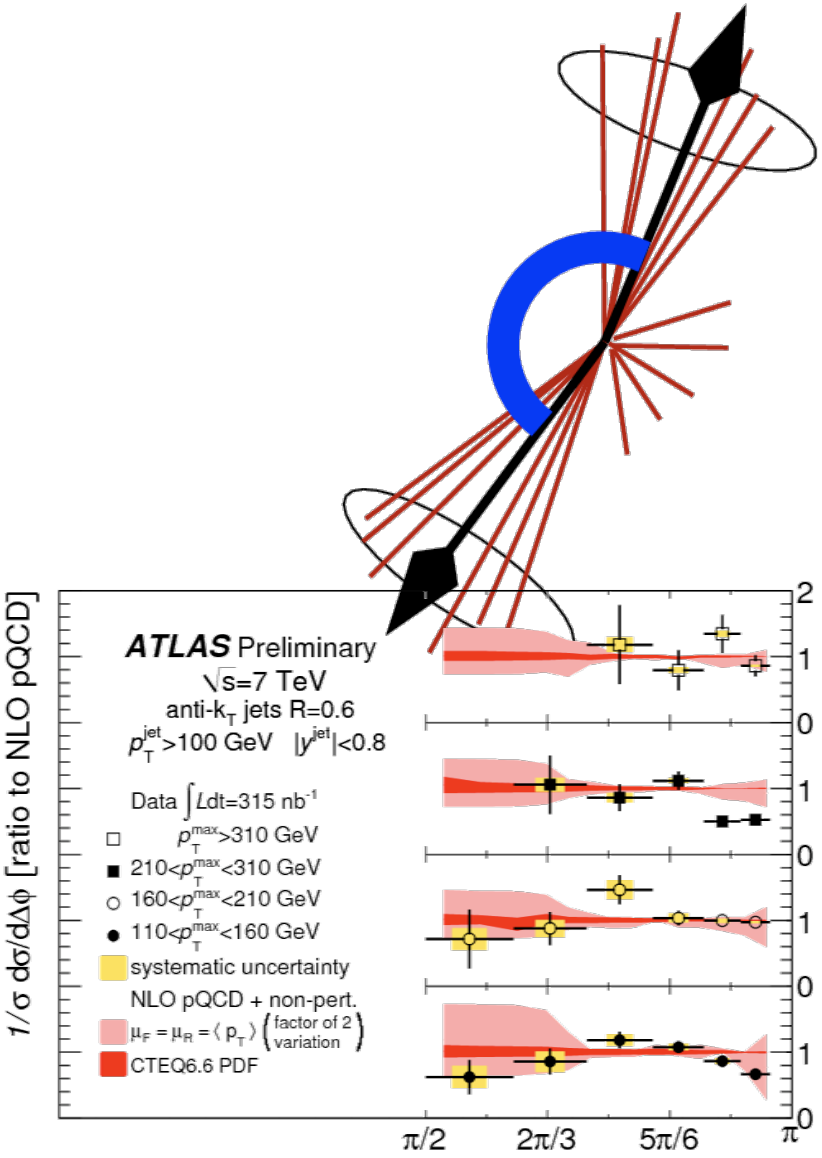
Azimuthal Jet Decorrelations

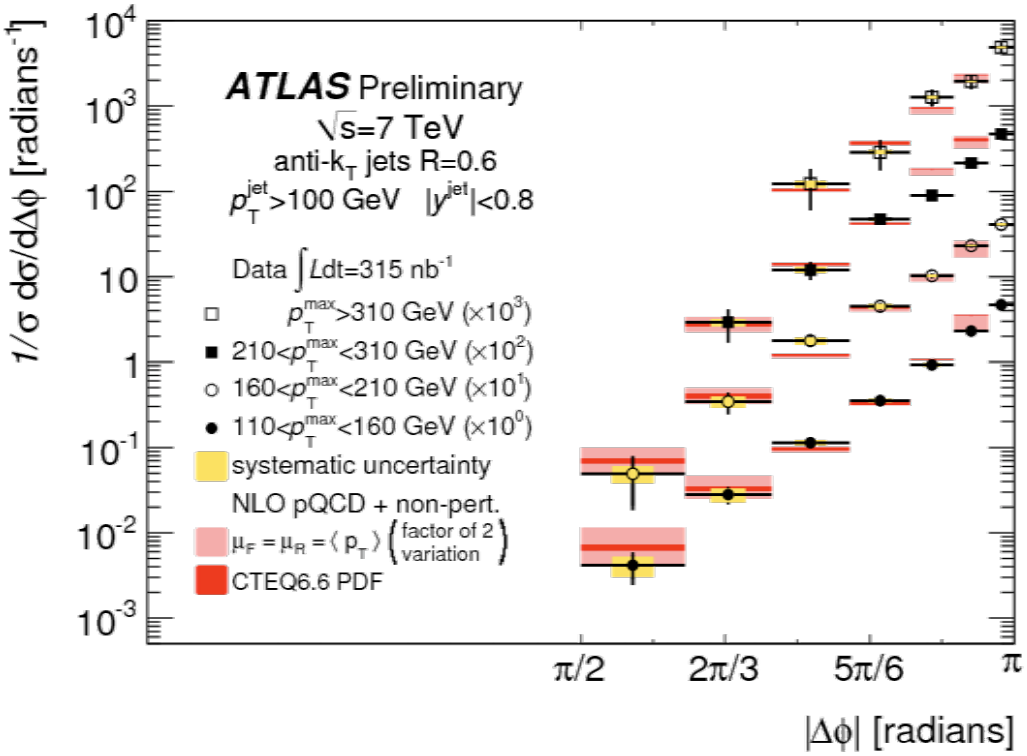




ATLAS-CONF-2010-084

Azimuthal Jet Decorrelations

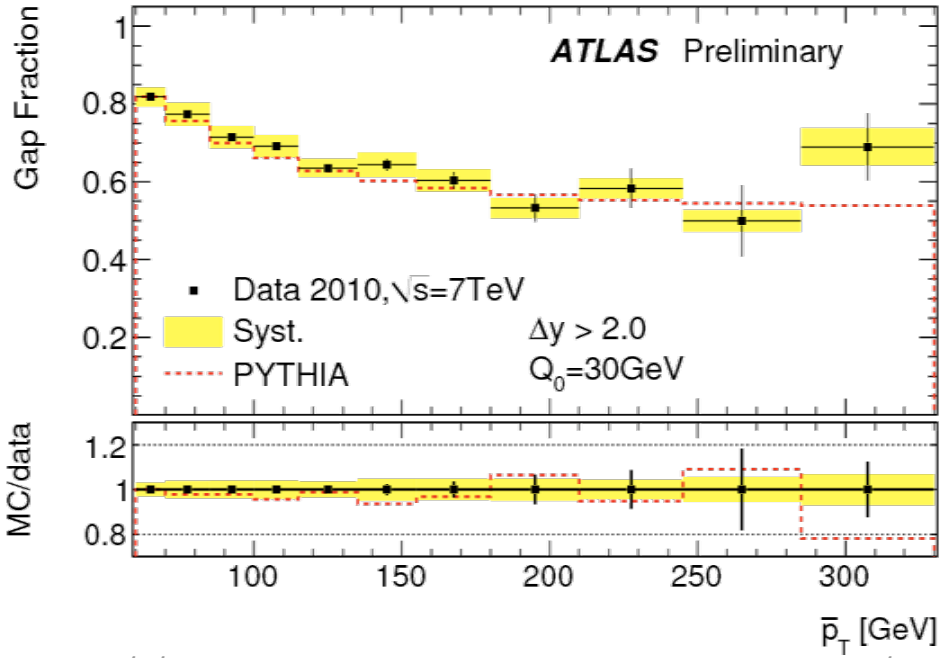


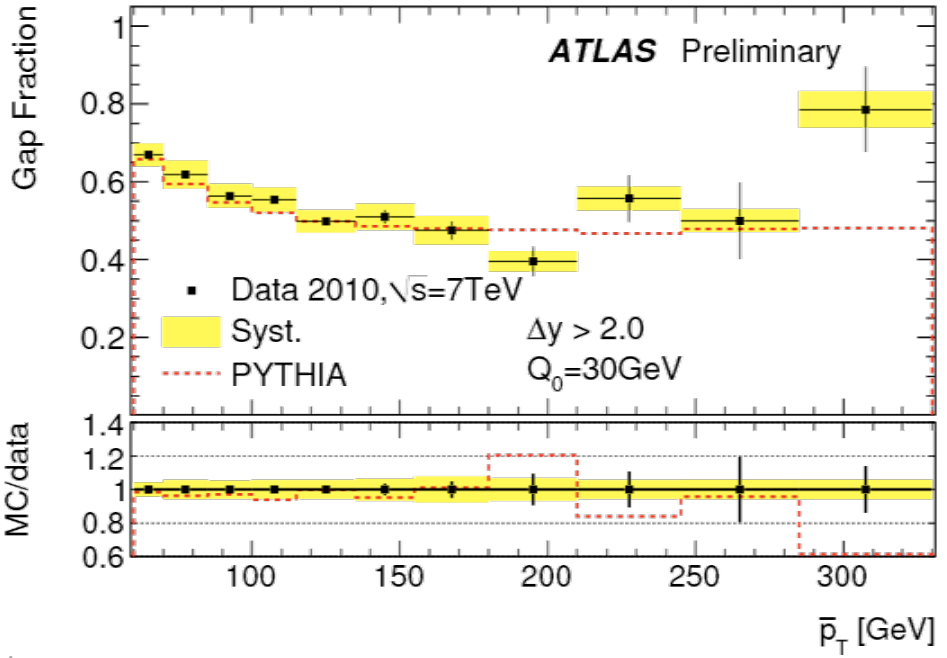


ATLAS-CONF-2010-084

Minijet Veto

- Select dijet events; jet p_T > 30 GeV, average jet pT > 60 GeV. Two selections:
  - A:boundary jets are the highest pT jets
  - B:boundary jets are the most forward/backward satisfying the above
- Veto on any extra jets between the boundary jets with p_T>30 GeV





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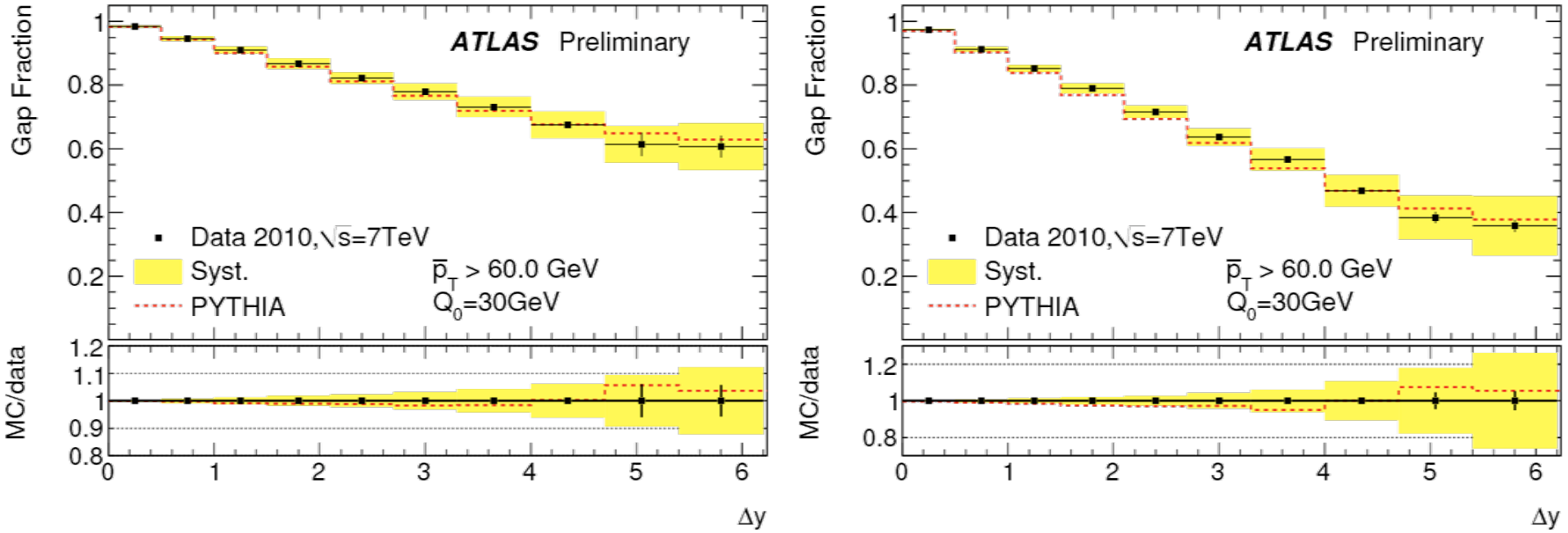
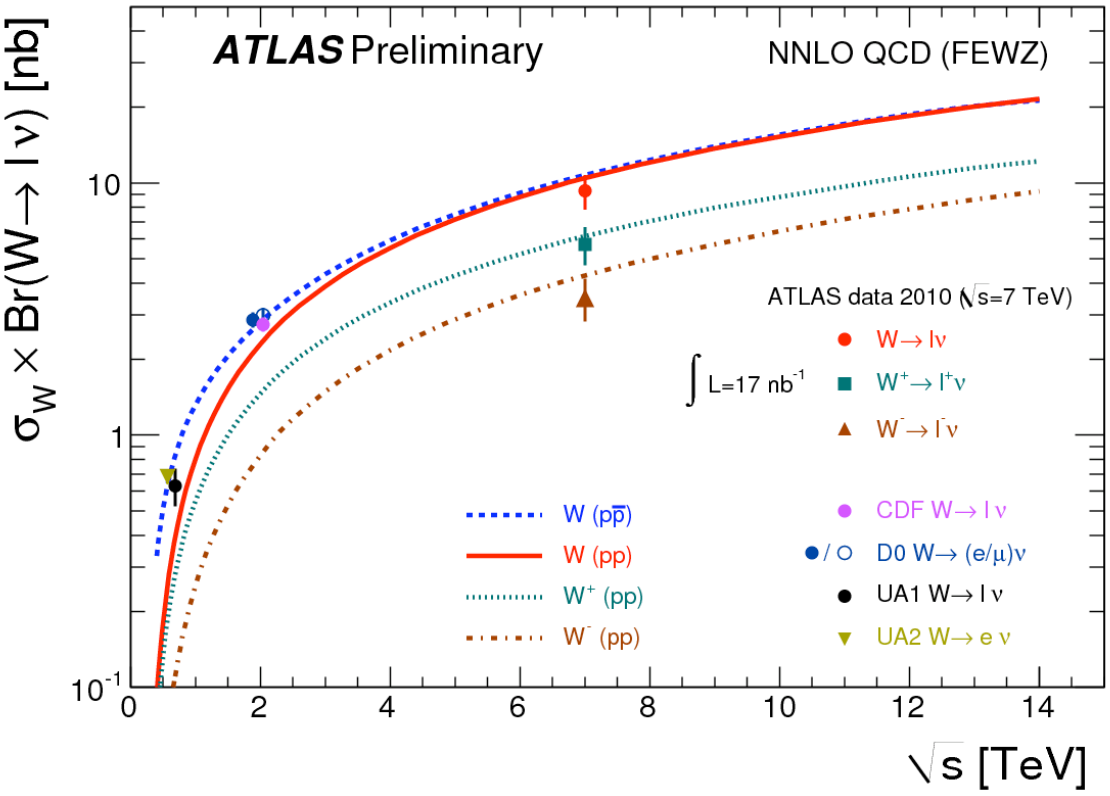
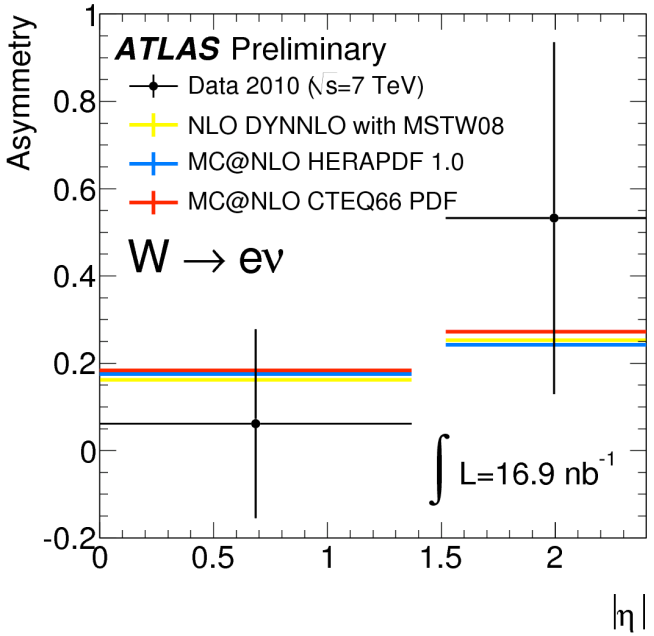


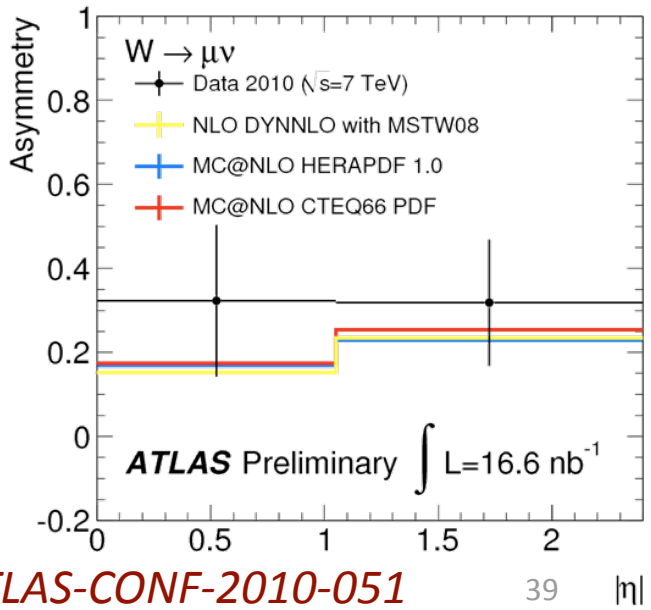
ATLAS-CONF-2010-085

QCD plus: Vector bosons

Cross sections and charged lepton asymmetry (W)



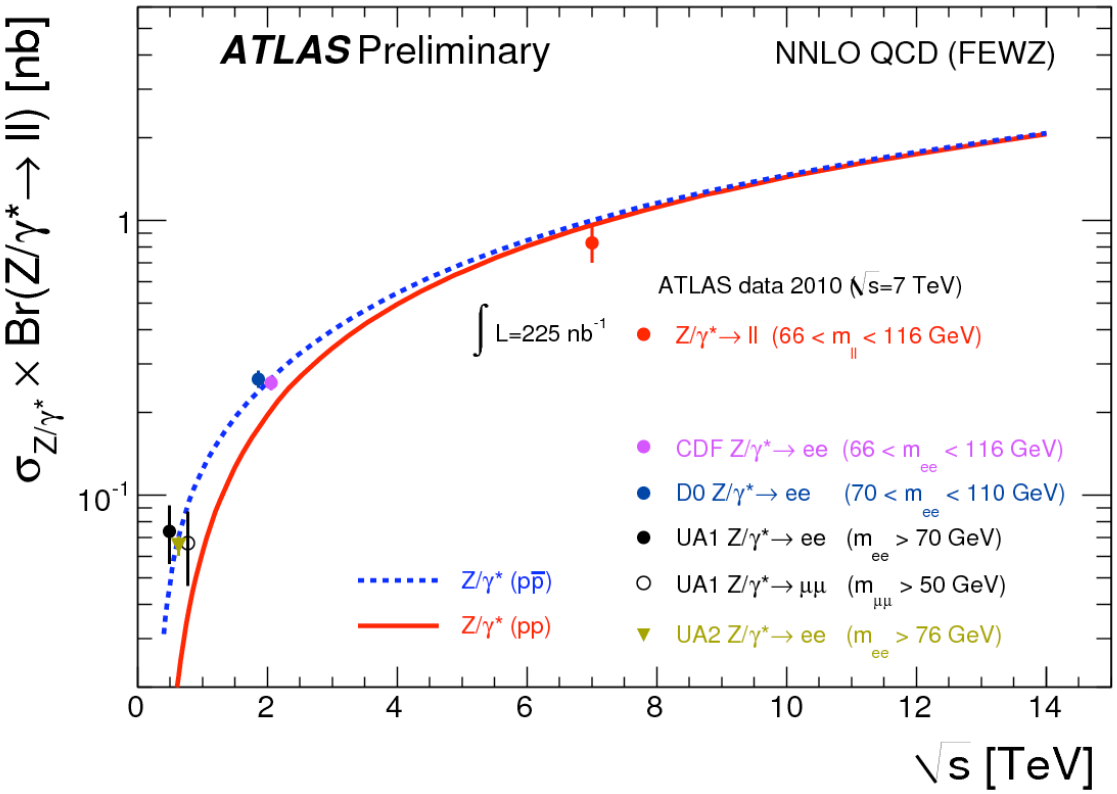


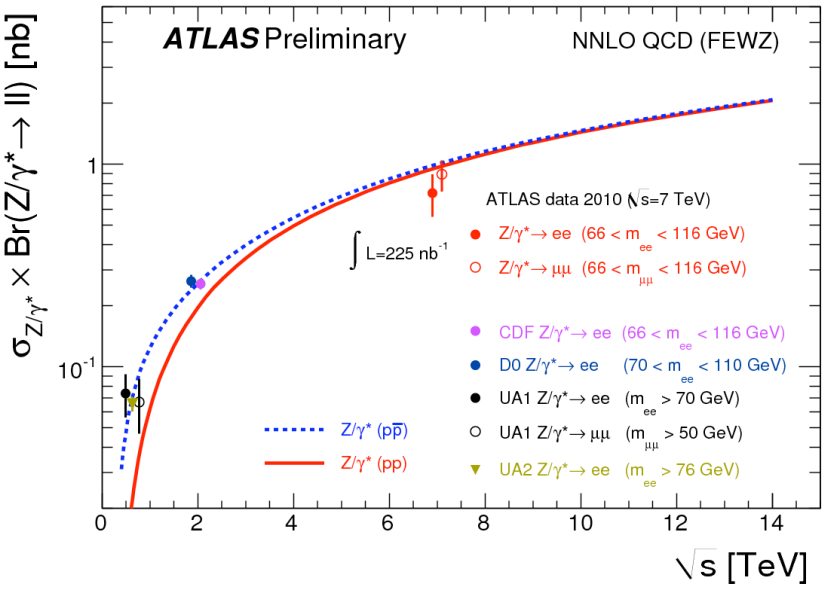


ATLAS-CONF-2010-051

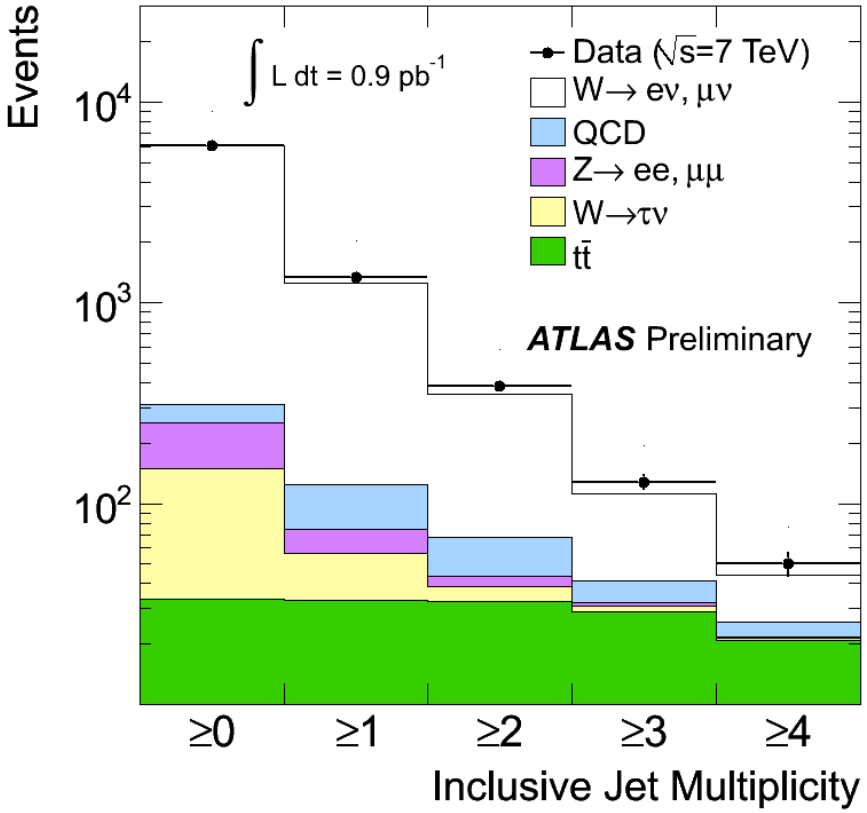
QCD plus: Vector bosons

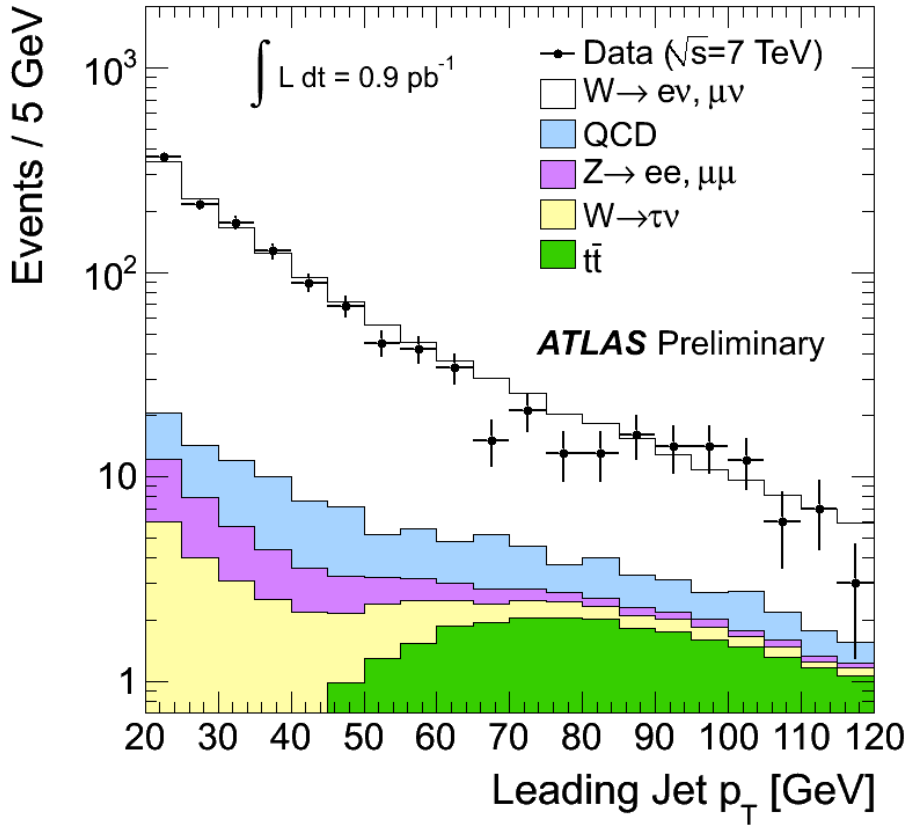
Cross sections (Z)



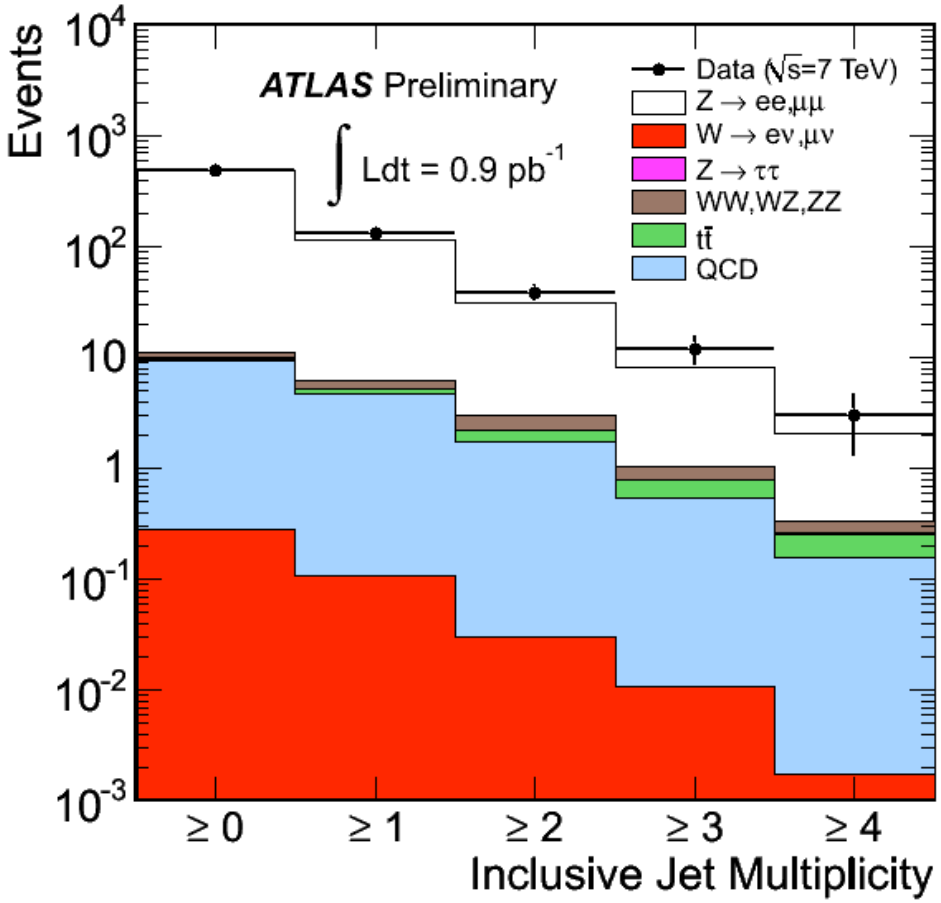


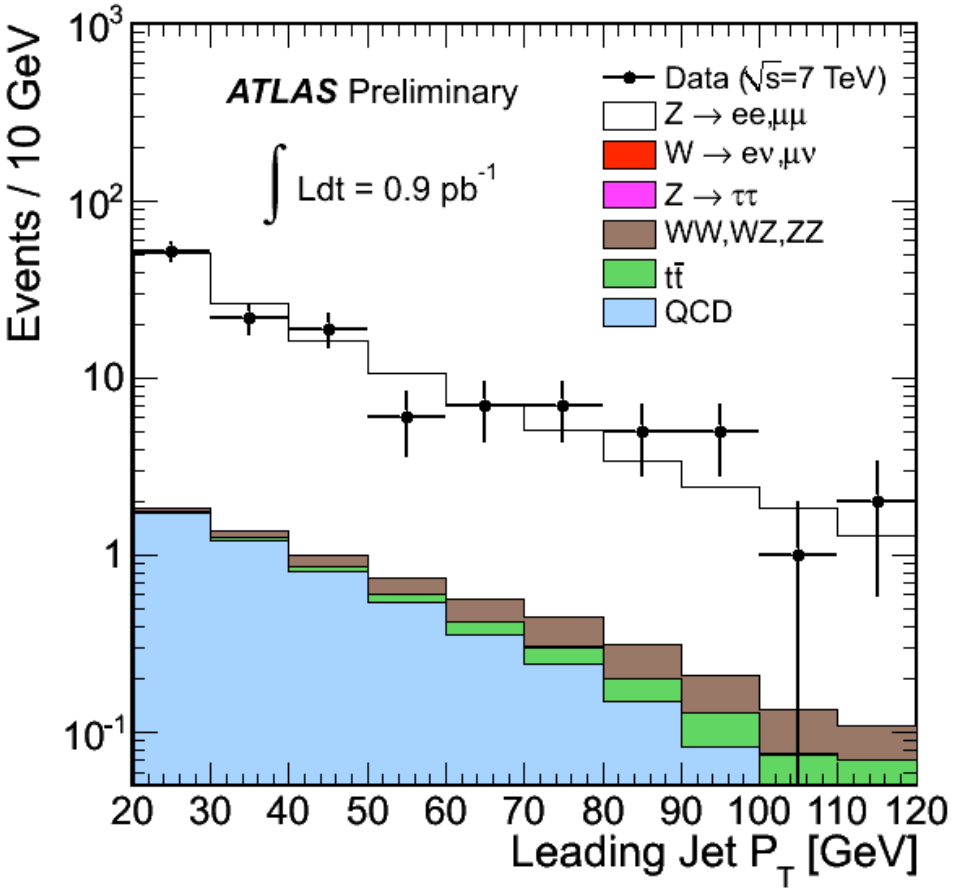
QCD plus: Vector bosons





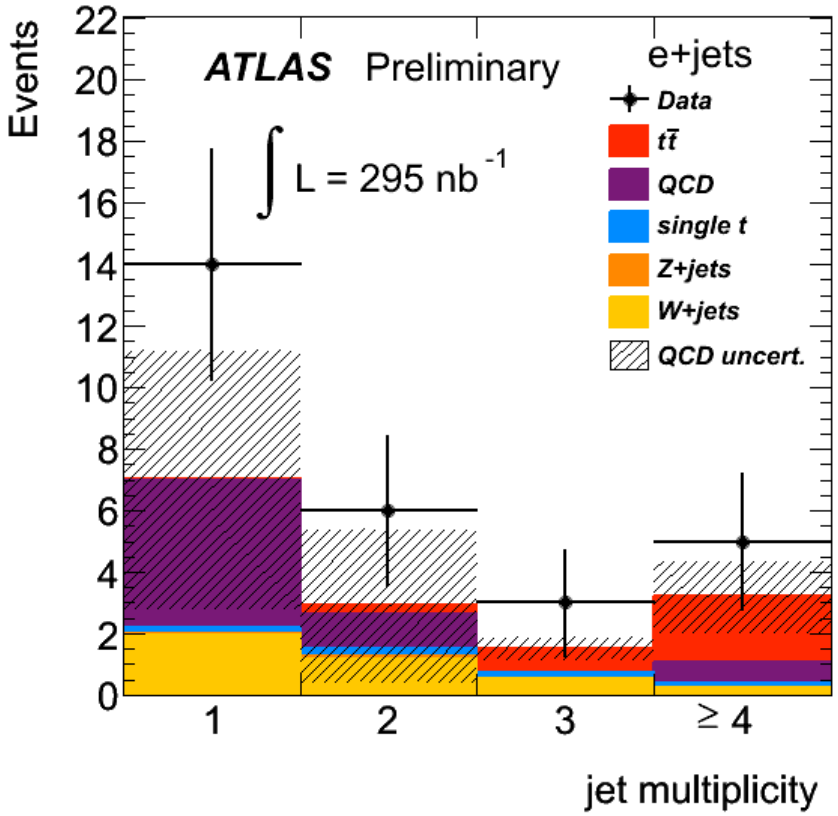
QCD plus: Vector bosons

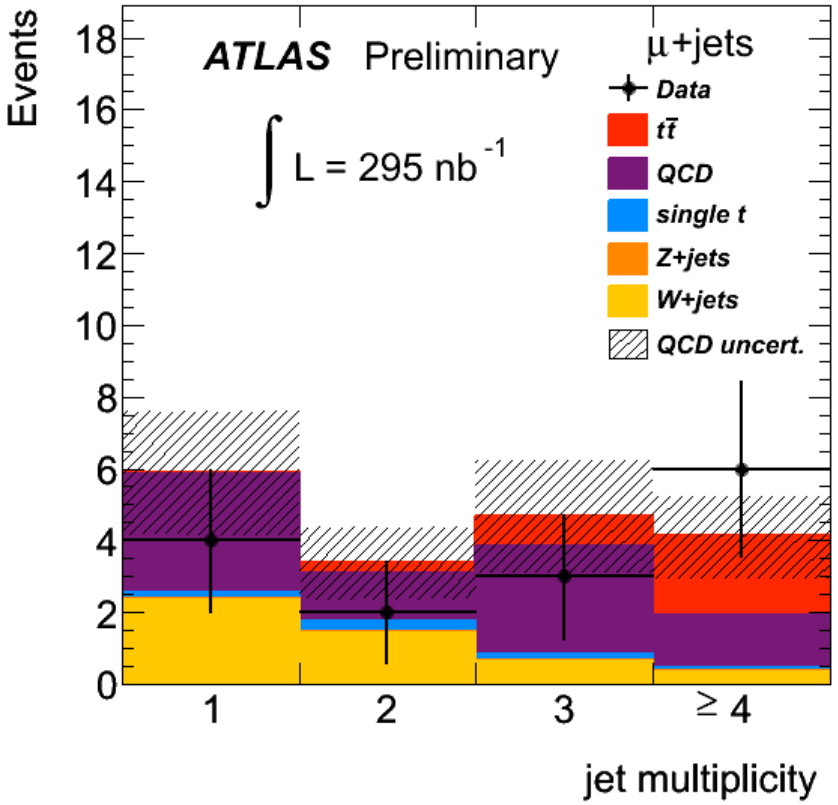




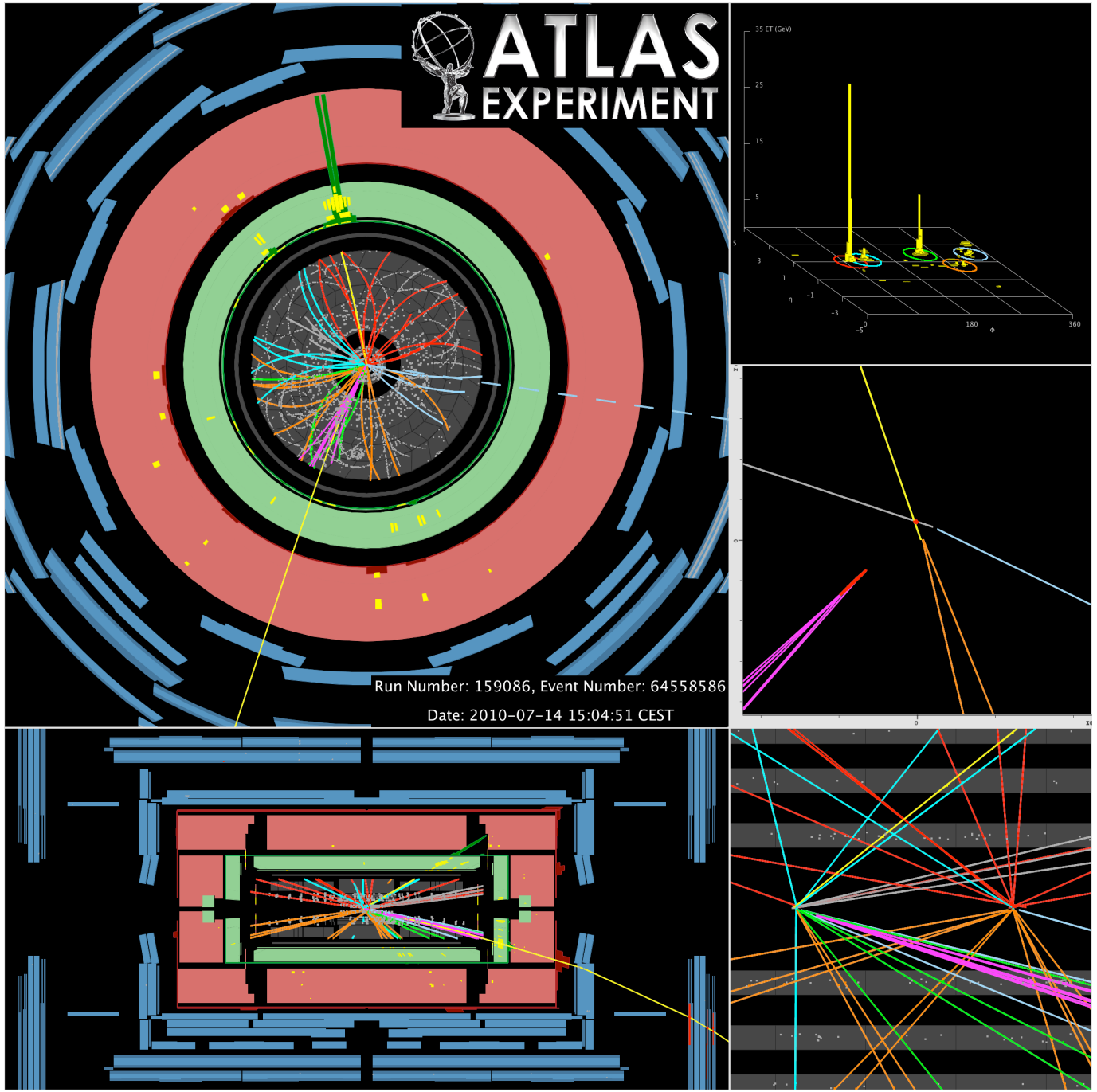
QCD plus: Top

- Jet $p_T > 20$ GeV (anti-k_t)
- At least one b-tagged jet



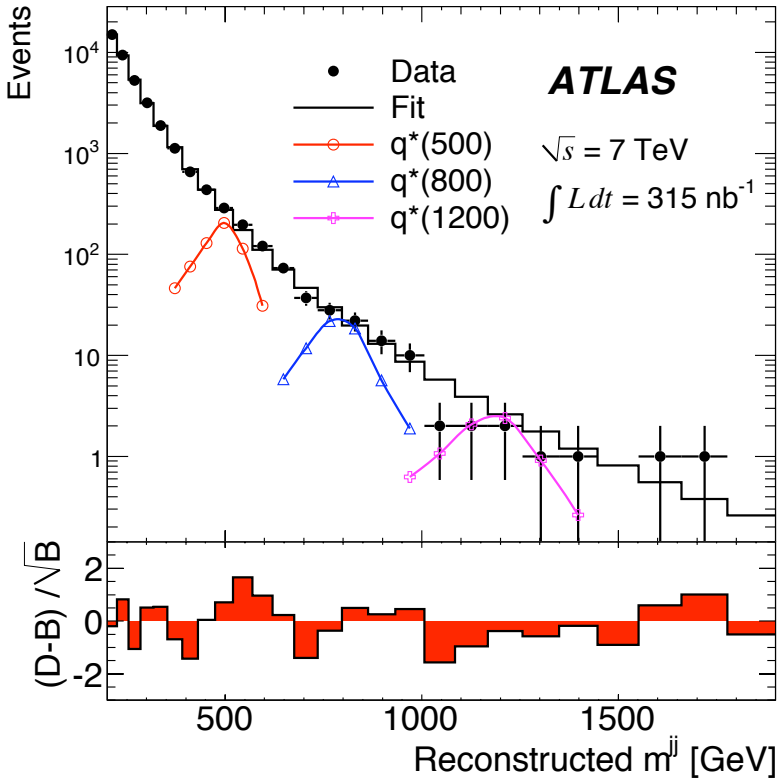


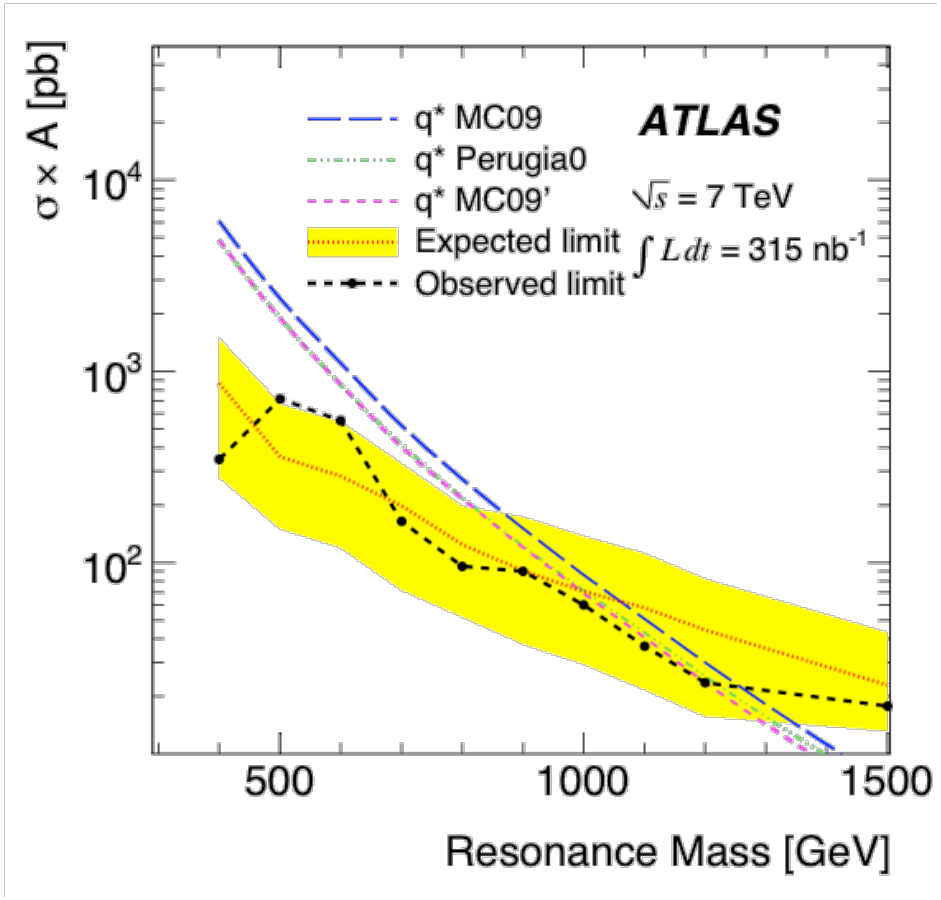
One of the top candidates



QCD plus: Searches

- Seach for resonances in dijet mass distribution.
  - q* mass limit ~ 1.26 TeV





arXiv:1008.2461 (accepted by PRL)

Searches

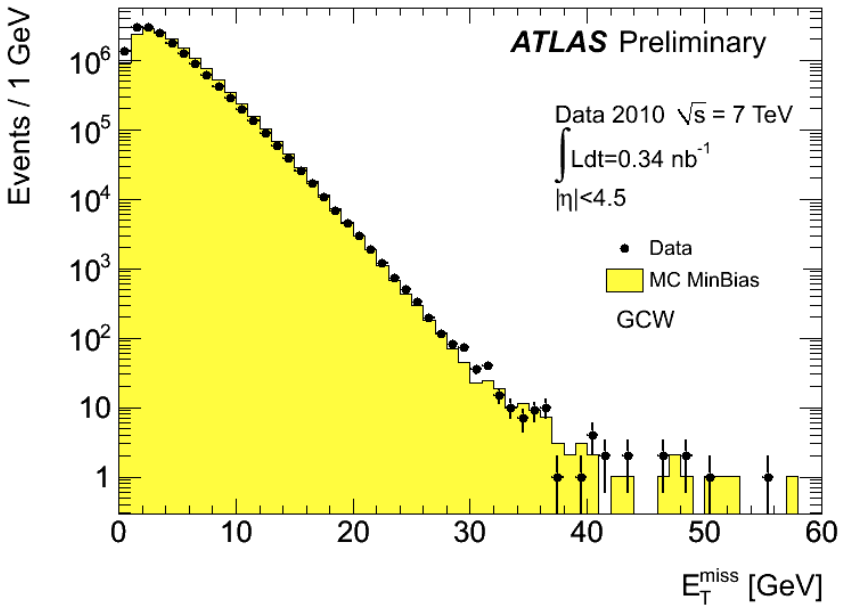
- Background determinations for SUSY (lepton, jets, missing E_T
- Jet angular distributions
- W', multilepton final states…
- Advancing into (or towards) new territory…

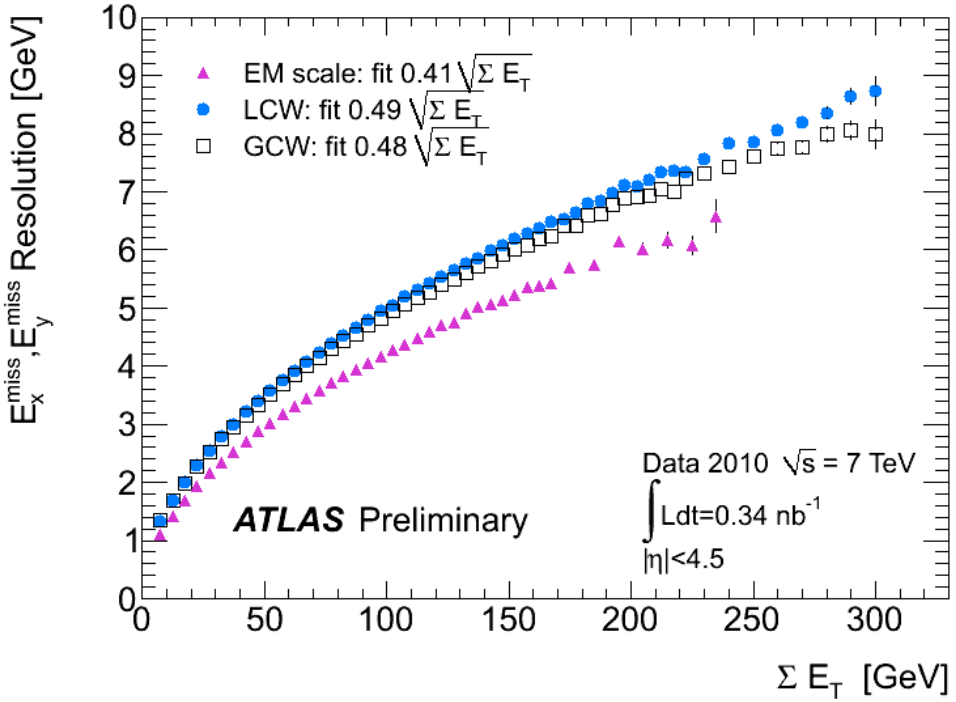
Summary

- Detector, trigger, software & computing performing well, and generally well understood (for this early stage)
  - Tracking detectors well aligned
- Detailed studies of the soft QCD environment, and MC tuning, well underway
- Jet energy scale determined to ~6-10%
  - 6% for high p_T central
- Luminosity uncertainty 11%
- Jet cross sections measured
  - agree with NLO QCD at the ~40% level.
- W & Z cross sections and asymmetries measured
- Studies of jet+W,Z well advanced, t+jets underway
- New physics searches exploiting the understanding of QCD and of the detectors already going beyond previous experiments

Extra info: E_T^{miss}

The E_T^{miss} distribution for minbias events, and the resolution
See ATLAS-CONF-2010-057



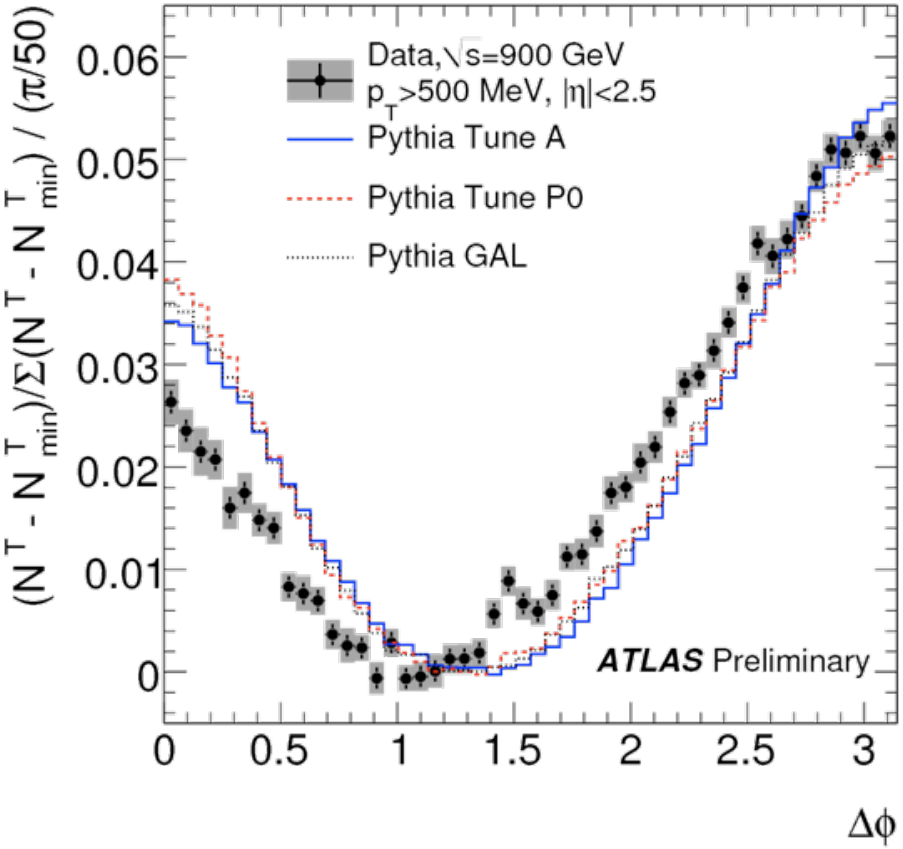


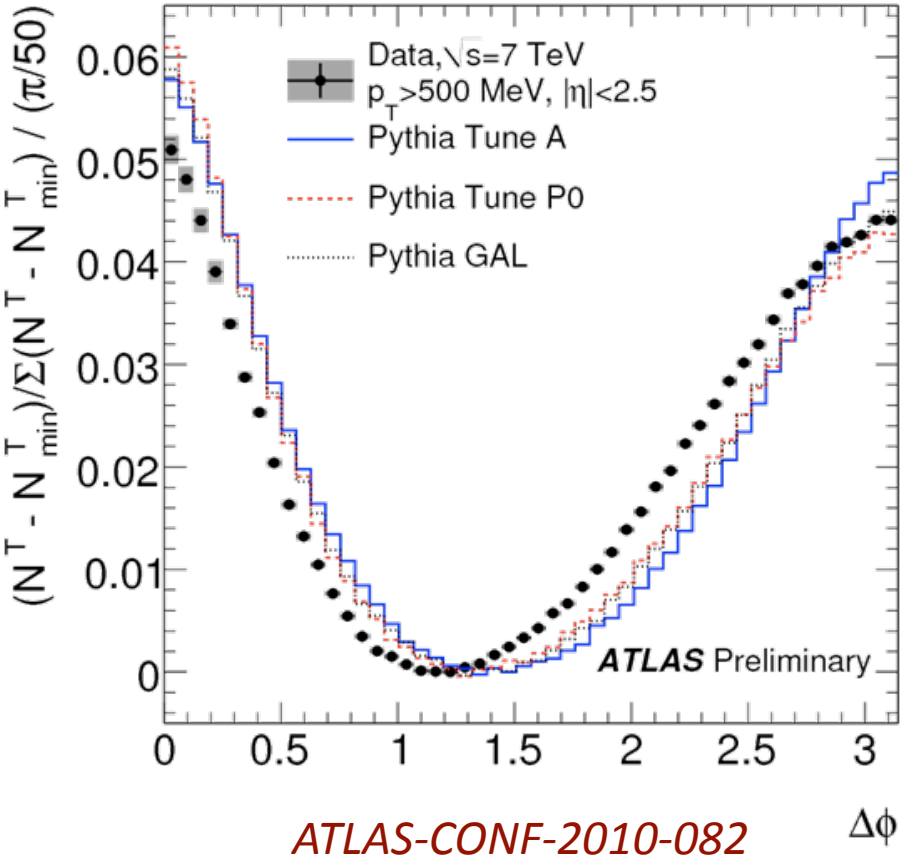
- See ATLAS-CONF-2010-086 for tau performance.. Status

END

Particle correlations

- Plot the ϕ distribution of all tracks relative to the highest p_T track.

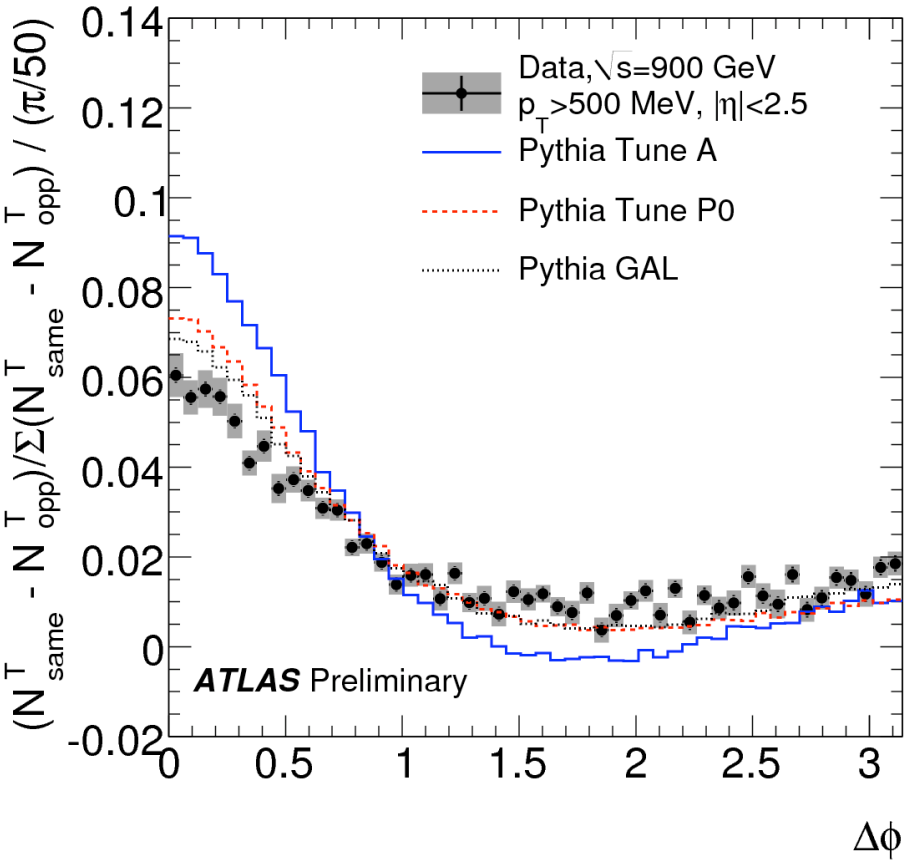


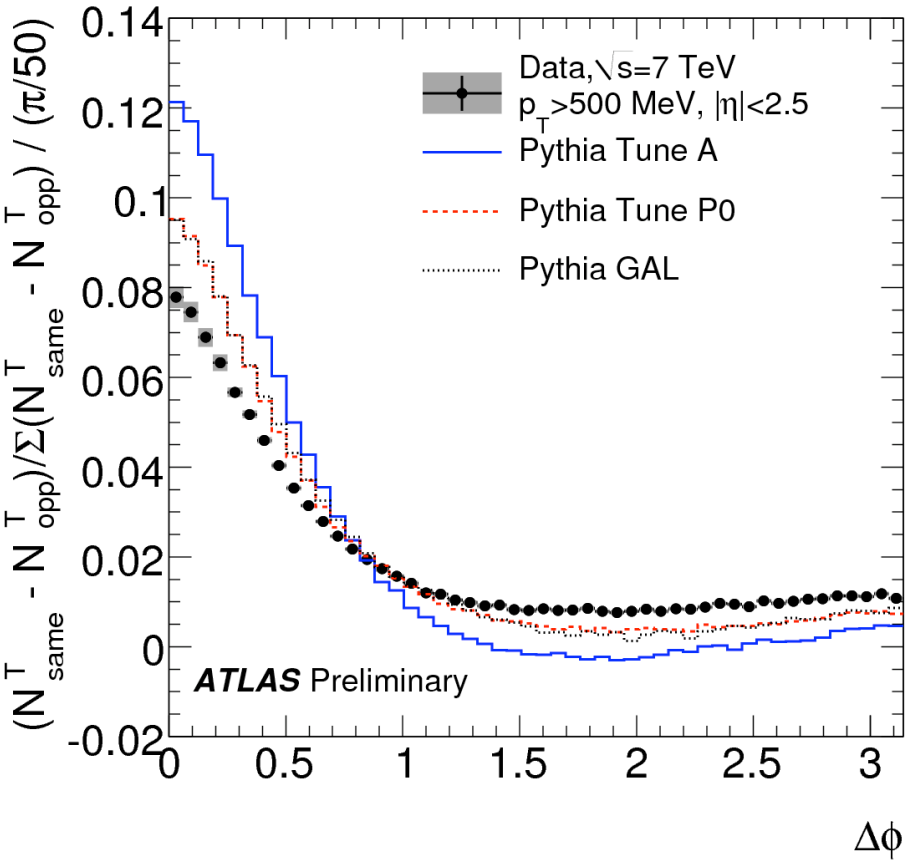


ATLAS-CONF-2010-082

Particle correlations

- Plot the ϕ distribution of tracks relative to the highest p_T track separately with same sign and opposite sign η, and substract.

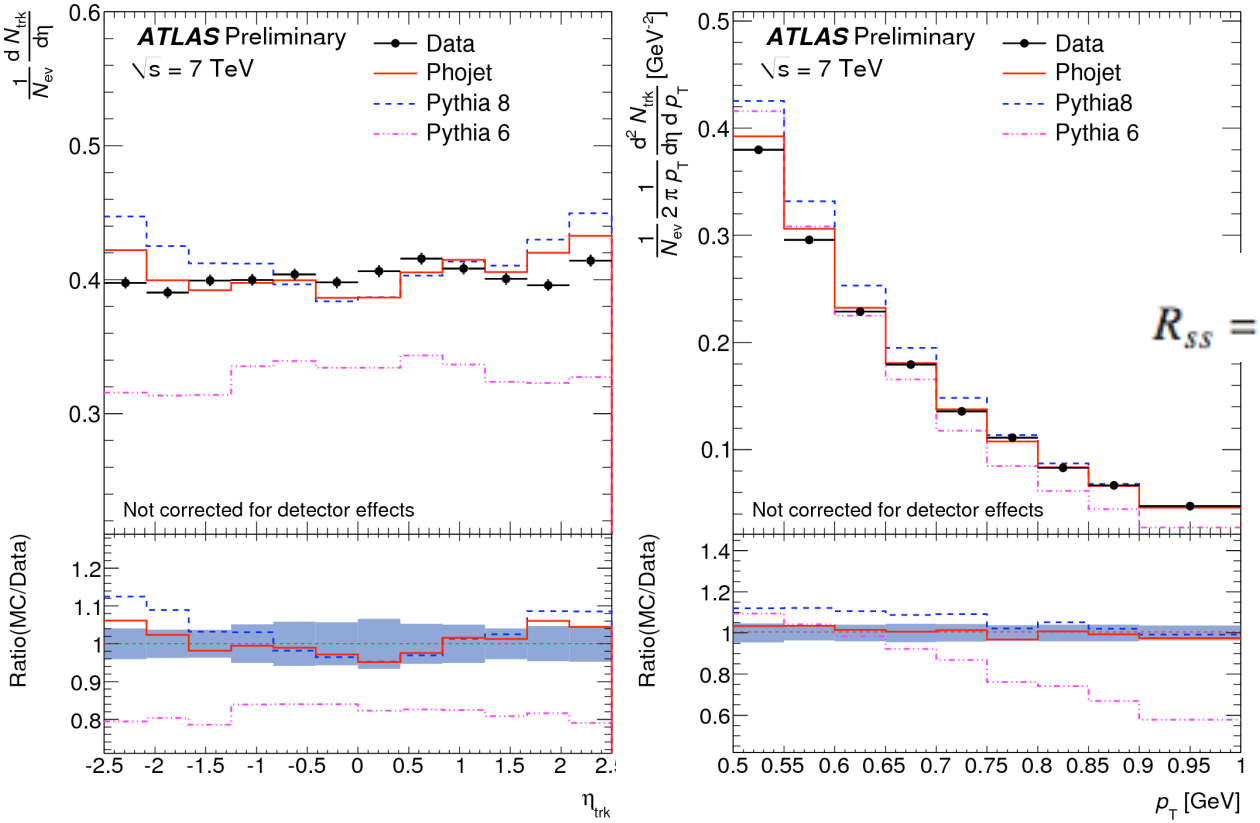




ATLAS-CONF-2010-082

Focus on diffraction

- Compare sample with exactly one side hit in the MBTS against those with any/both hit
  - Enhances single diffractive in the one-side sample



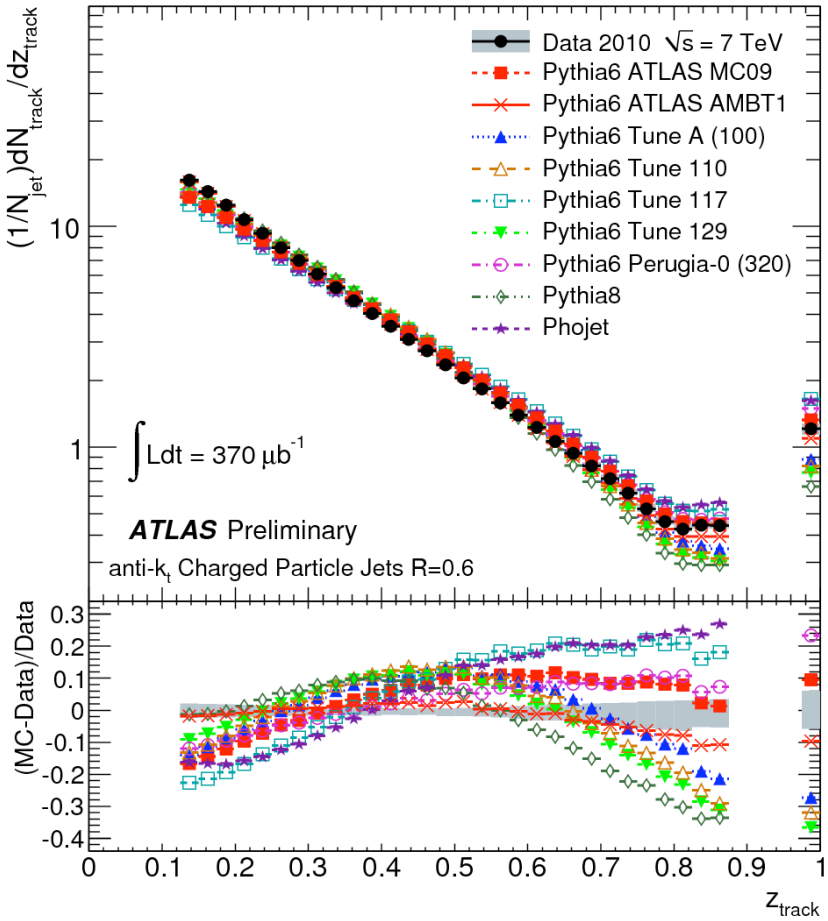
Proportional of single-sided events in data =

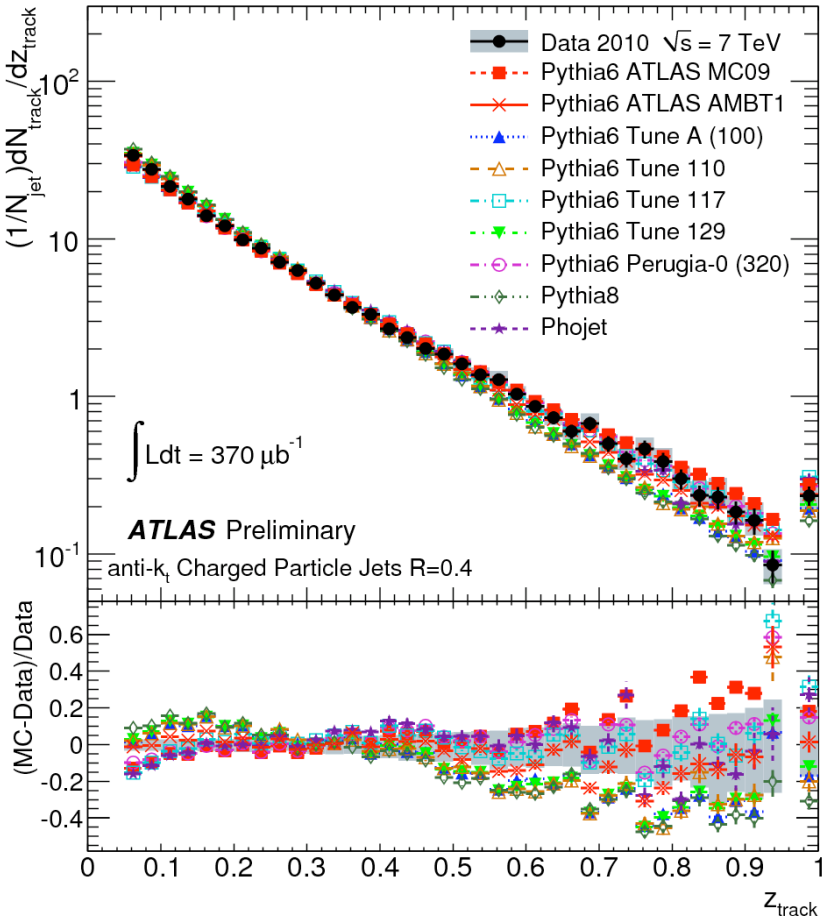
$$R_{ss} = [4.52 \pm 0.02(\text{stat.}) \pm 0.61(\text{syst.})]\,\%$$

Generator	R_{ss} (%)
Pythia6	4.01
Pythia8	5.11
Phojet	2.83

ATLAS-CONF-2010-048

Hard QCD : Jet Shapes





4 GeV < Track jet p_T < 6 GeV

15 GeV < Track jet p_T < 24 GeV

ATLAS-CONF-2010-049

Extend to lower p_T