ATLAS RESULTS

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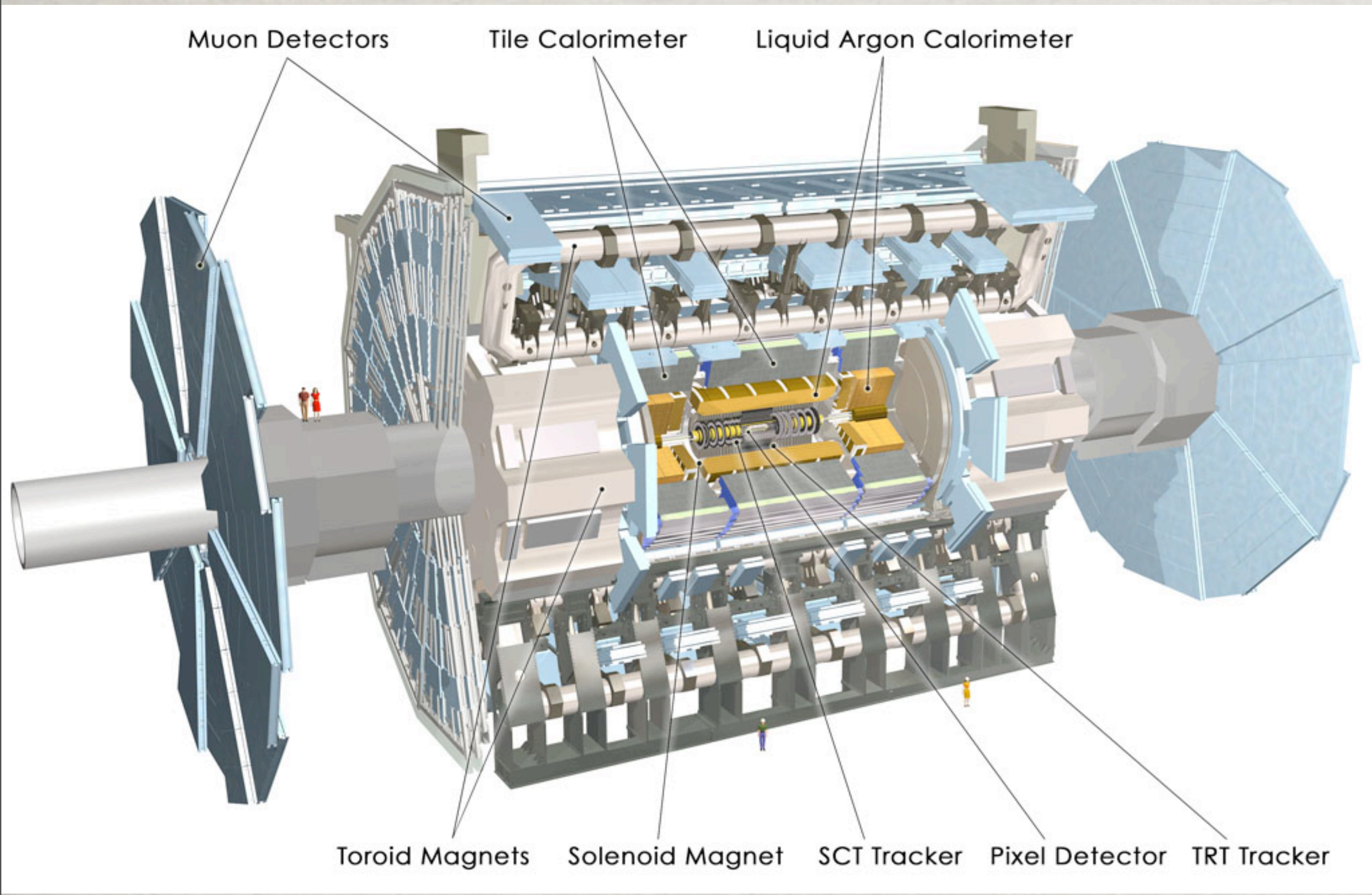
For the ATLAS
COLLABORATION

Outline

- ATLAS Detector and Status
- Luminosity and Data Collected
- Performance of the Detector
- Overview of Results

ATLAS



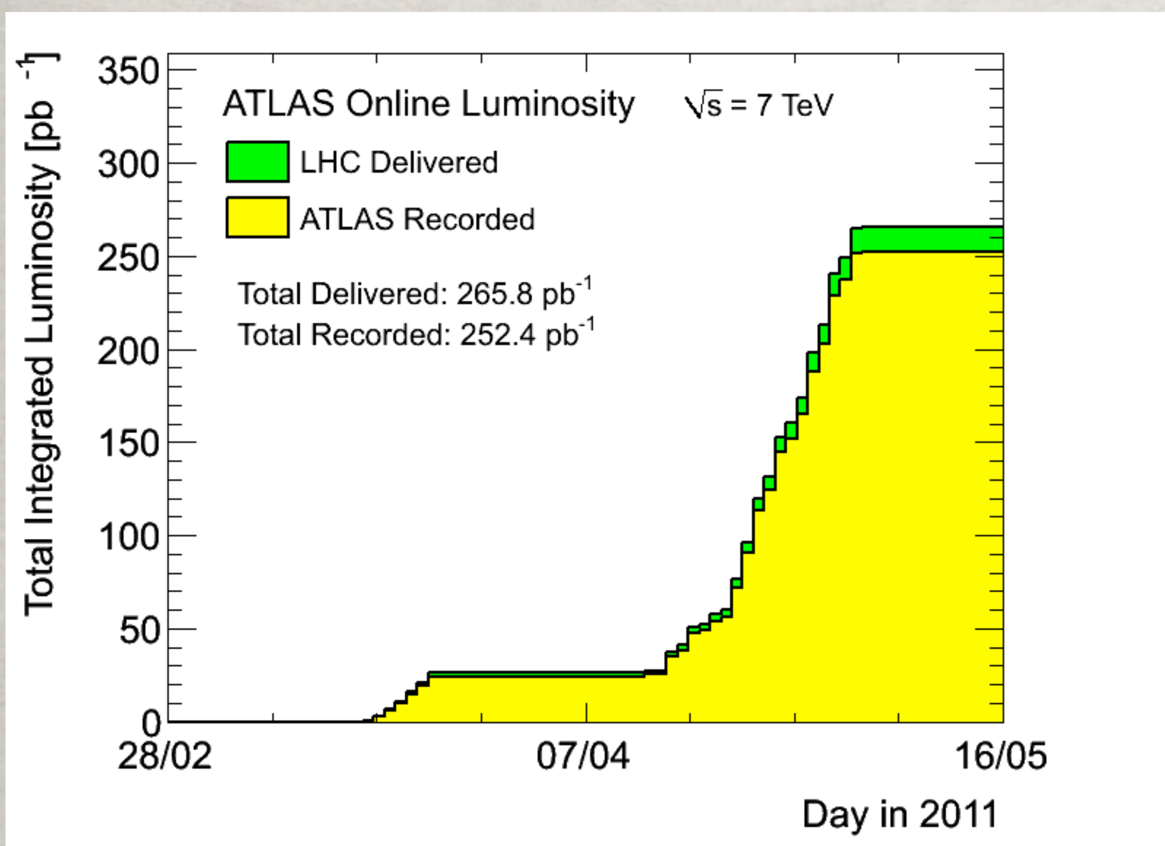
General Purpose
Collider Detector

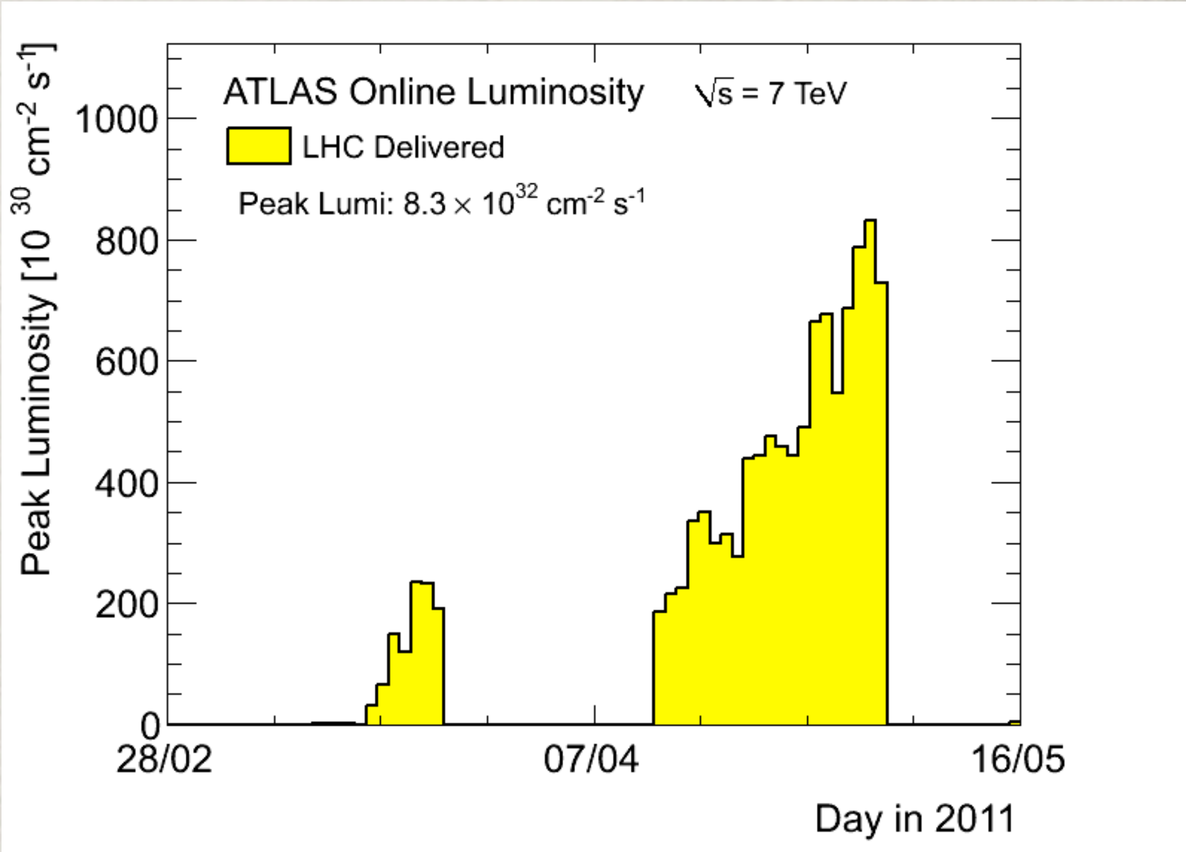
Broad Physics Program:
Heavy Ions, Electroweak,
QCD, Top, Higgs, exotics...

Magnets	2T solenoid 3 air-core toroids
Tracking	silicon + transition radiation tracker
EM Calorimetry	sampling LAr technology
Hadron Calorimetry	plastic scintillator (barrel) LAr technology (endcap)
Muon	independent system with trigger capabilities

Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	96.9%
SCT Silicon Strips	6.3 M	99.1%
TRT Transition Radiation Tracker	350 k	97.5%
LAr EM Calorimeter	170 k	99.5%
Tile calorimeter	9800	97.9%
Hadronic endcap LAr calorimeter	5600	99.6%
Forward LAr calorimeter	3500	99.8%
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	99.8%
CSC Cathode Strip Chambers	31 k	98.5%
RPC Barrel Muon Chambers	370 k	97.0%
TGC Endcap Muon Chambers	320 k	98.4%

Datasets

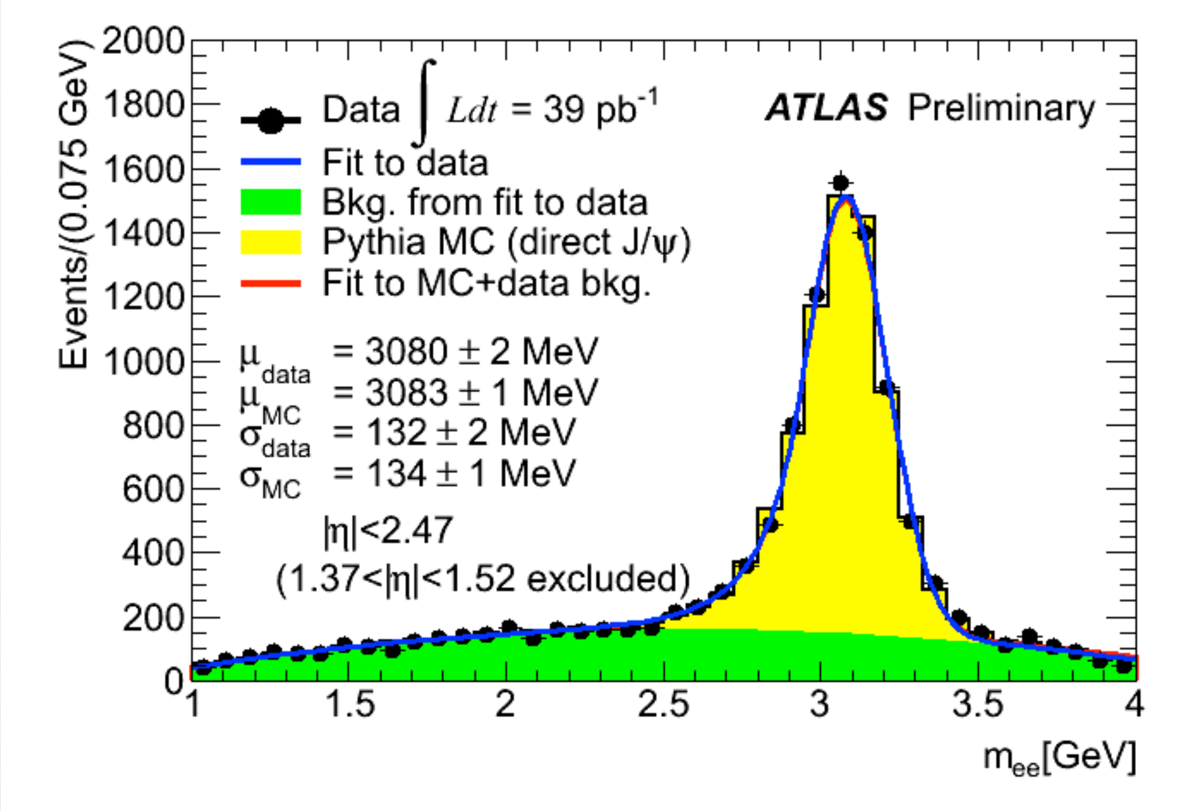


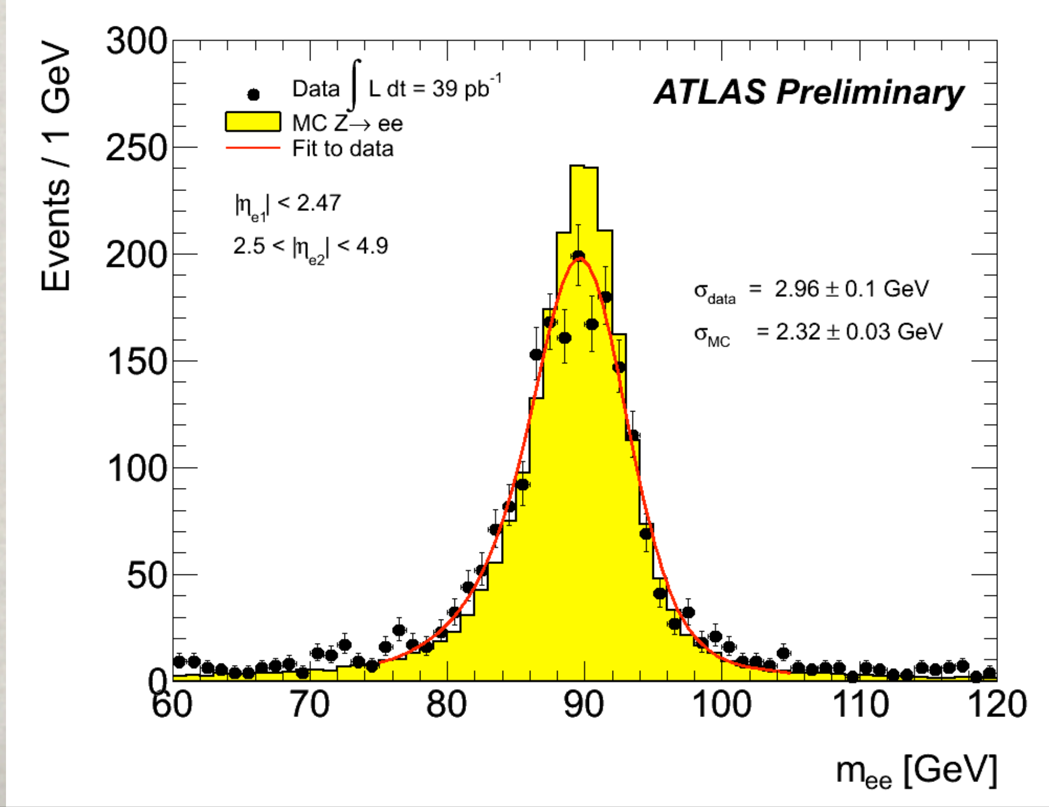


- Rapidly increasing dataset
- Expect ~ 1 fb^{-1} in 2011
- World record at hadron machine
- Expect ~ 5.0 x 10^{33} cm^{-2} s^{-1} in 2011

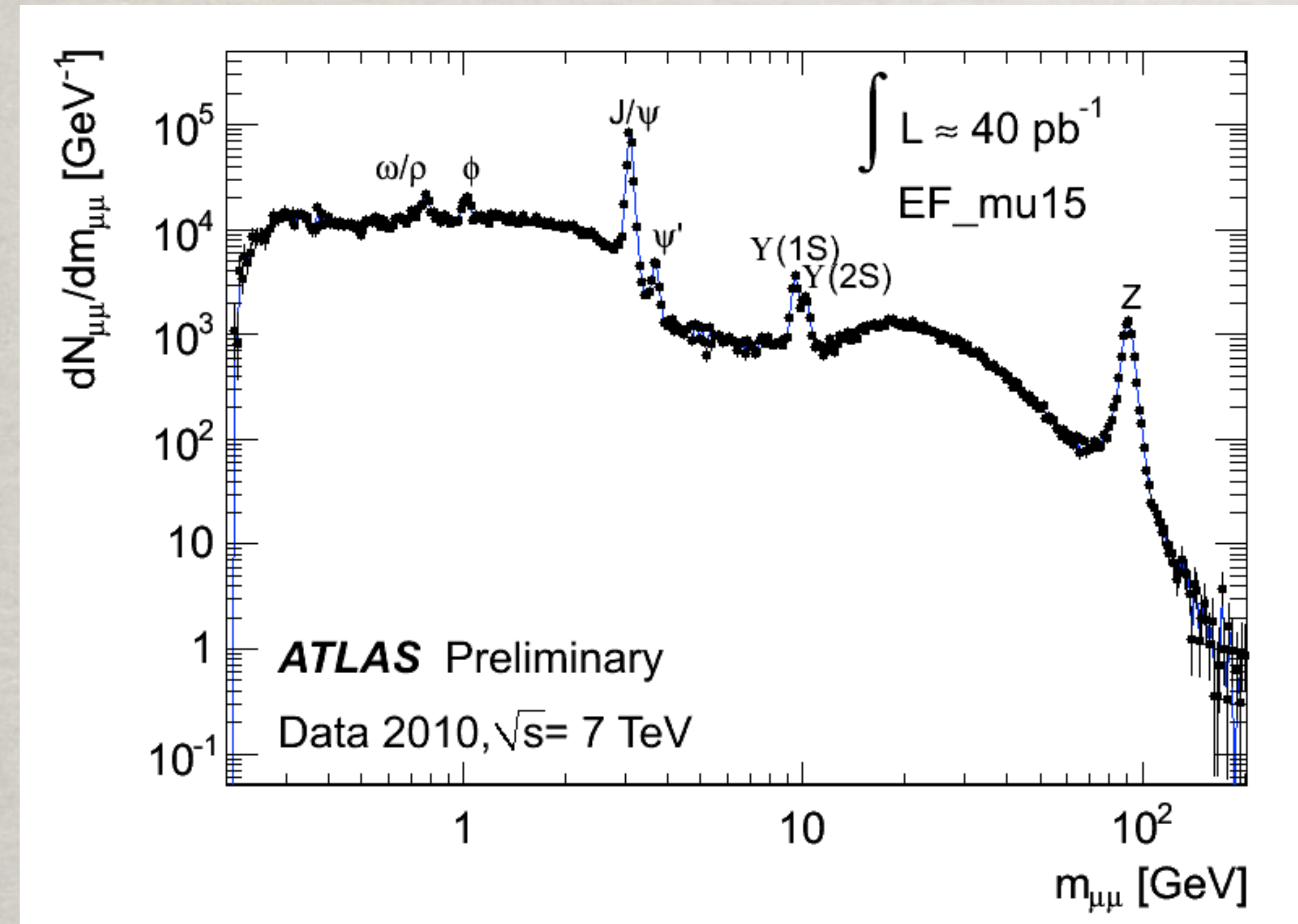
Performance: Electrons

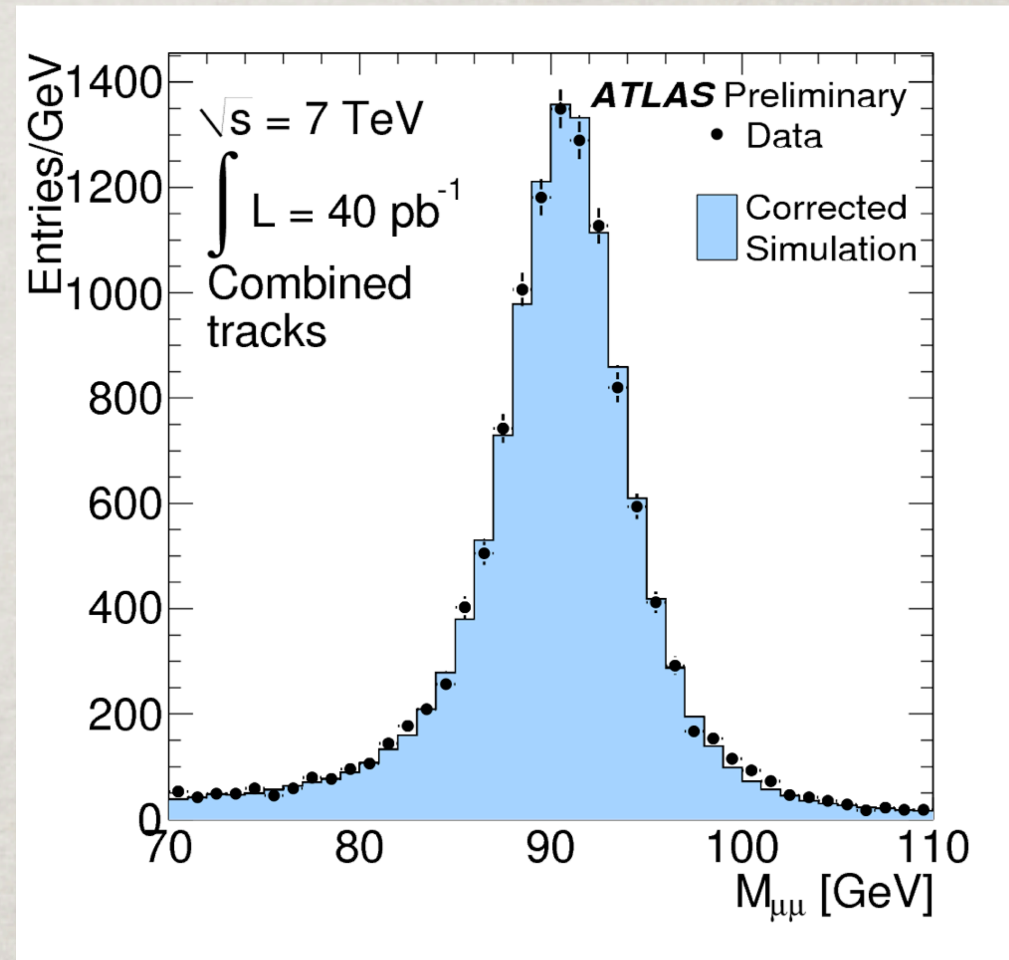
- Excellent performance over a wide range of momenta
- Data/MC comparison quite good slightly better resolution for high momentum electrons in simulation





Performance: Muons

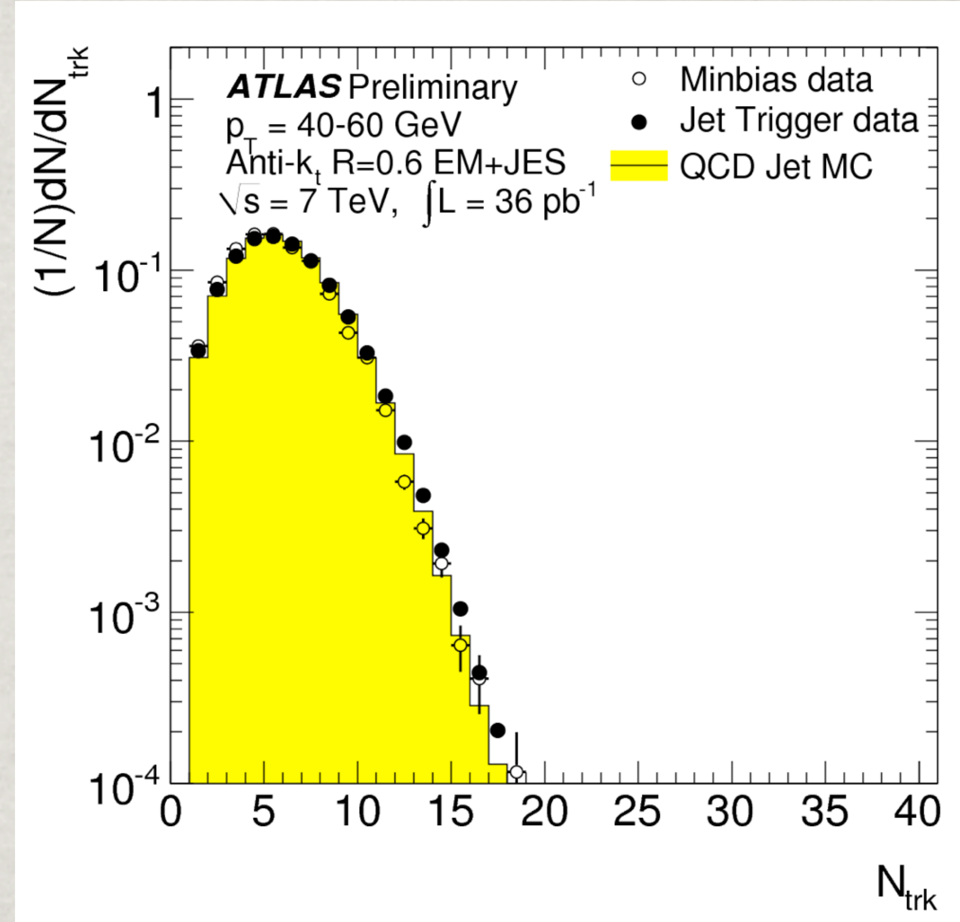


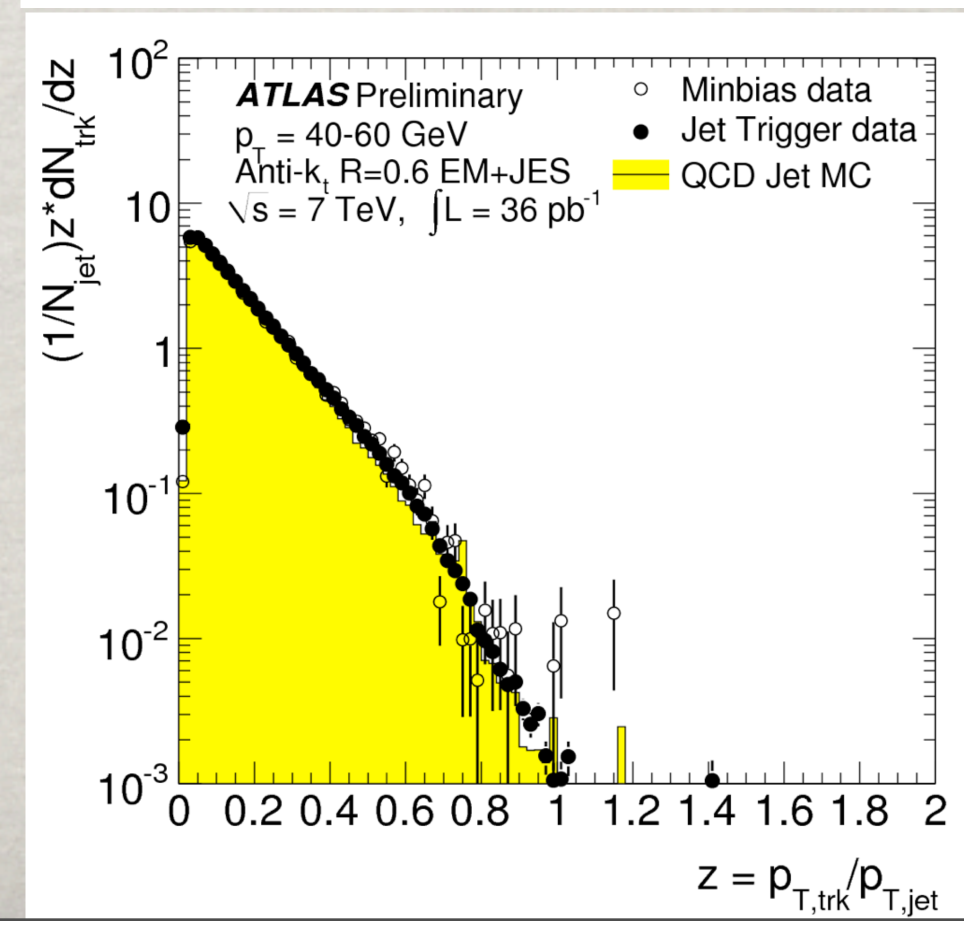


- Dimuon Resonances - Excellent Clean final state to calibrate the detector
- Good agreement with simulation

Performance: Jets

- Tracks used to validate jet energy measurements
- Relatively well known fraction of charged/neutral particles
- Tracker calibration independent of calorimeters



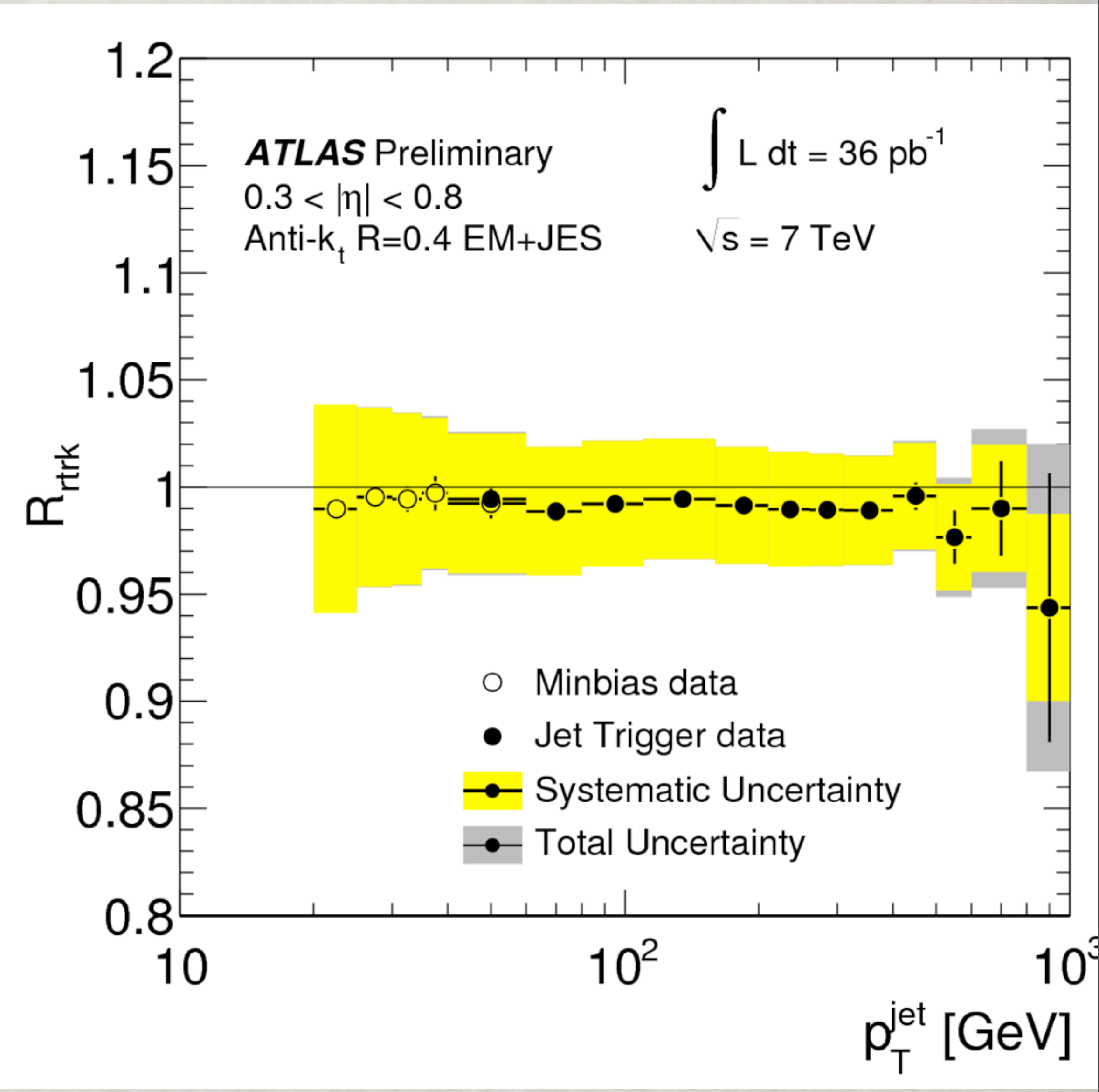


Track validation of jets

$$r_{trk} = \frac{|\Sigma \vec{p}_T^{\,track}|}{p_T^{jet}} \quad R_{r_{trk}} = \frac{< r_{trk}^{data} >}{< r_{trk}^{MC} >}$$

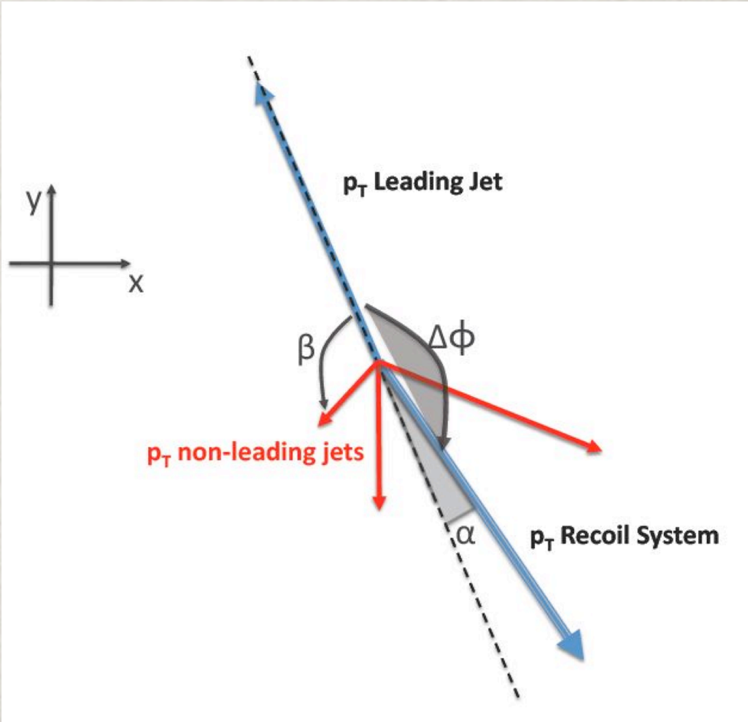
- Compare the sum of the charged tracks within a jet to the jet energy measurement

- Low momentum tracks fail reconstruction cuts but still deposit energy in calorimeter. Use double ratio.



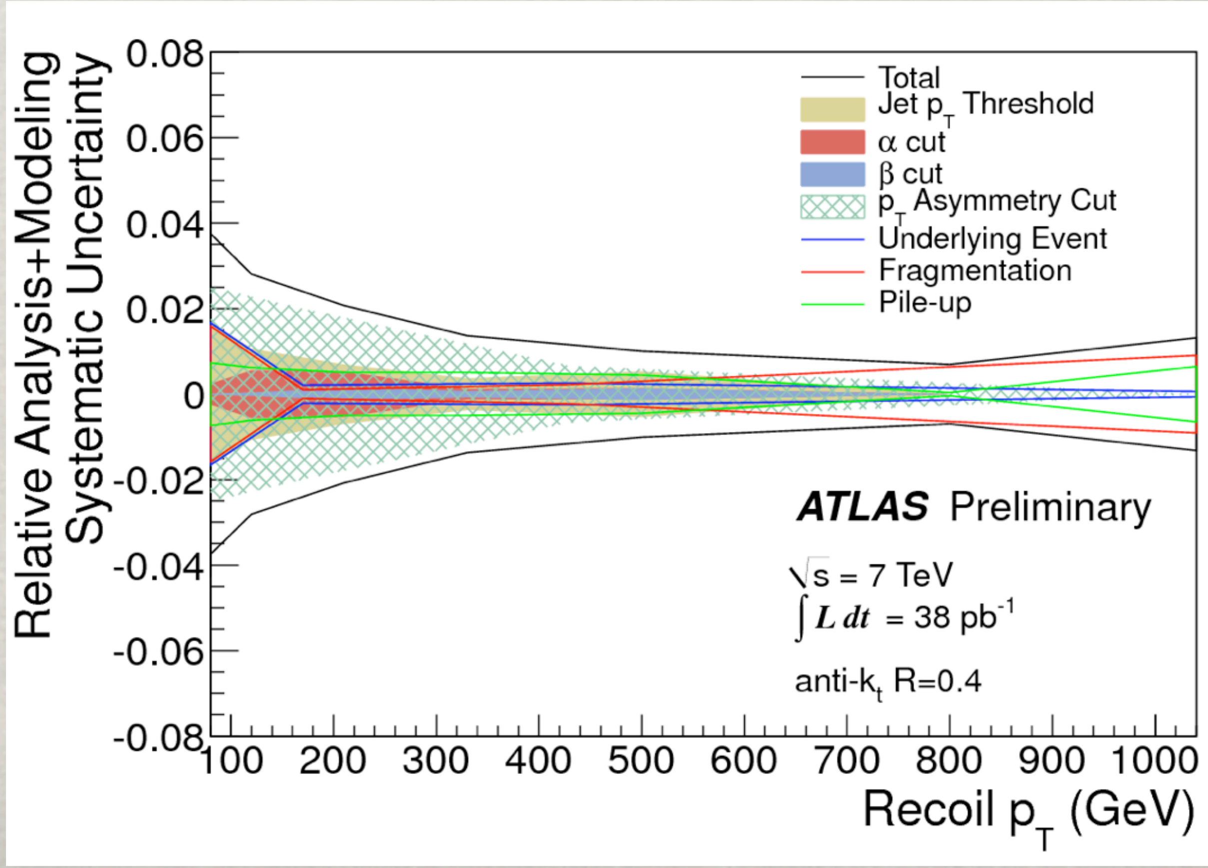
Performance: High Pt Jets

- Resolution and scale uncertainty generally improve at highest momentum



- Suffer statistical uncertainties at highest jet momentum

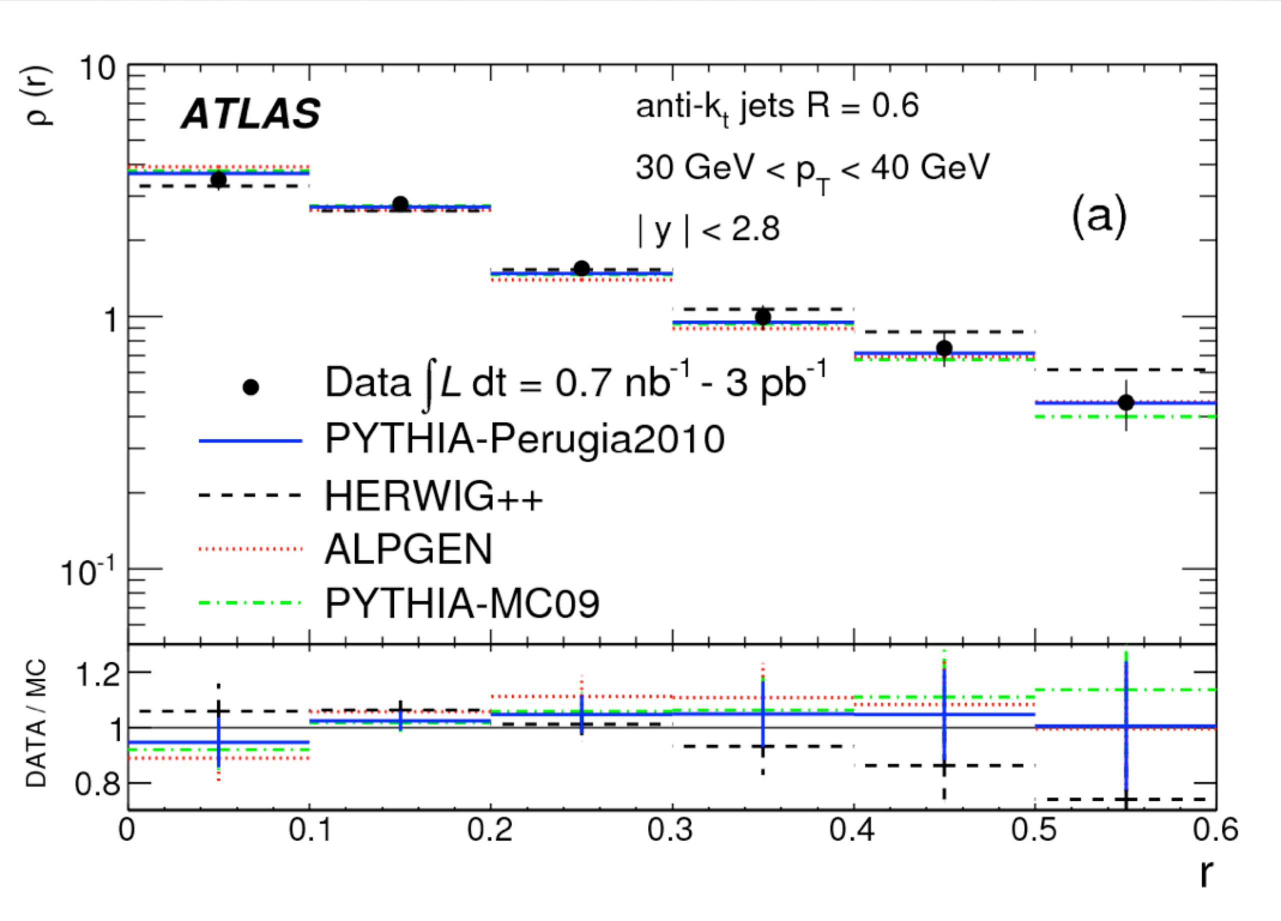
- Calibrate lower energy jets and then use events where several low energy jets balance high momentum jet

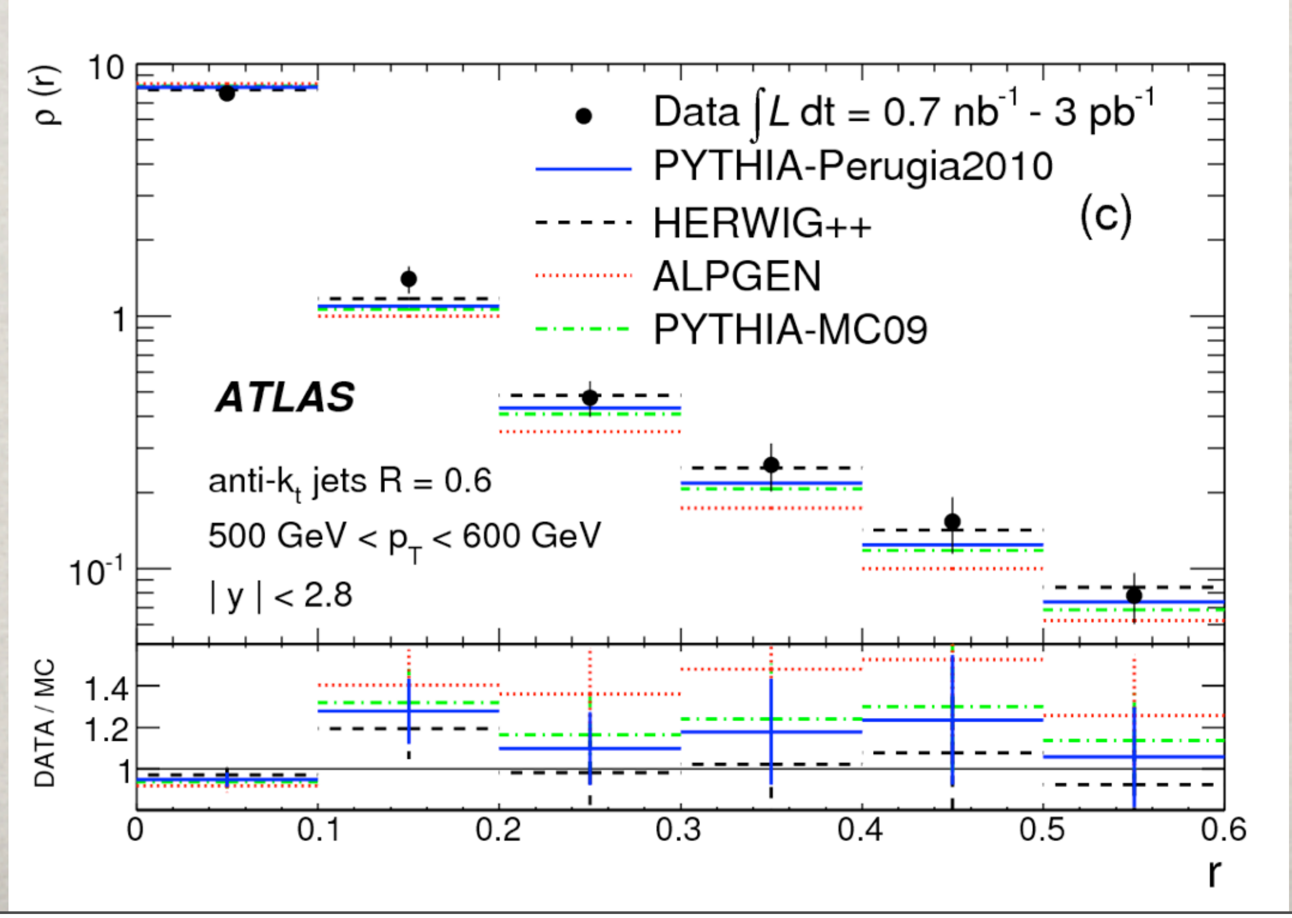


Jet Shapes

$$\rho(r) = \frac{p_T^r}{p_T^R}$$

- Momentum fraction of jet in annulus of radius r inside jet cone with radius R
- Shown here for different jet pt

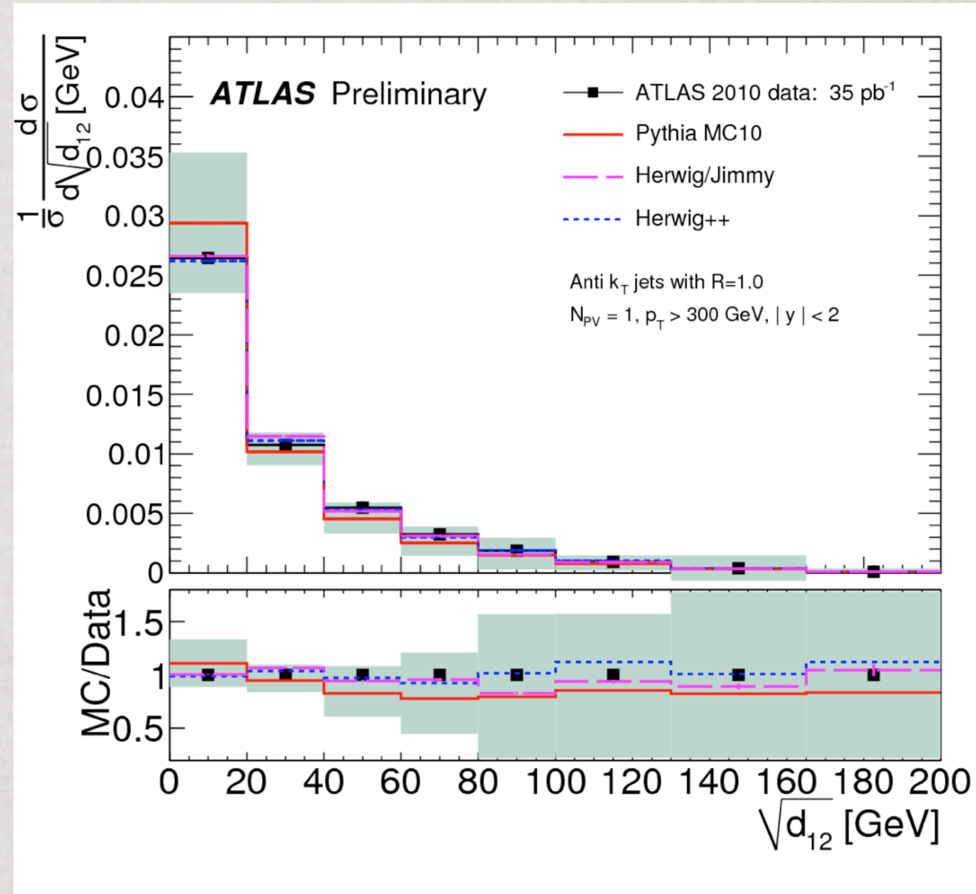




Jet Mass and Substructure

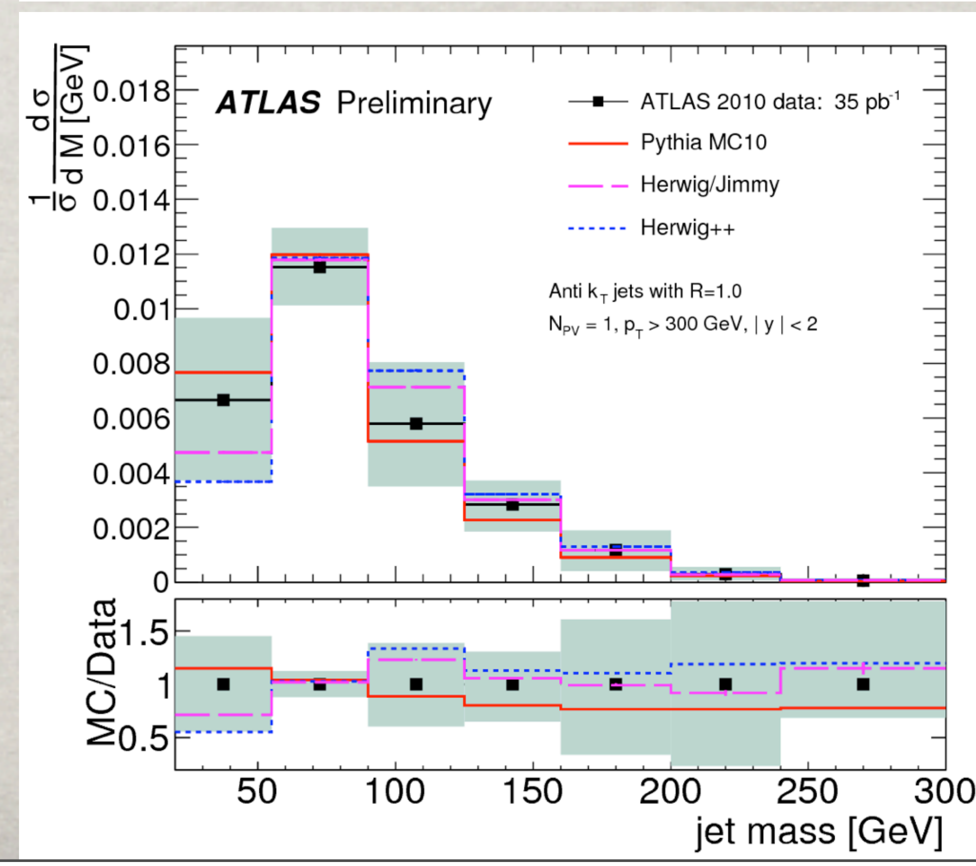
$\sqrt{d_{12}} = min(p_{Ta}, p_{Tb}) \times \delta R_{a,b}$

- Splitting scale variable of the two subjets (a,b) before the final clustering step

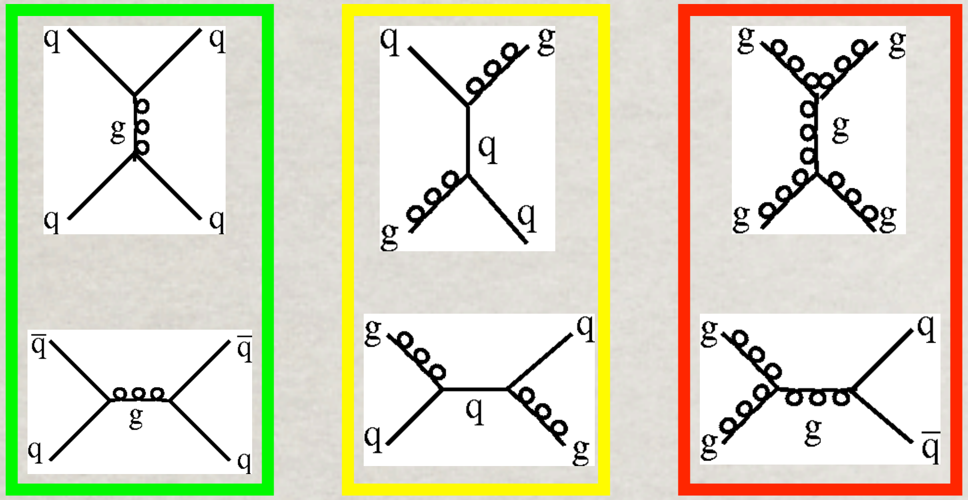


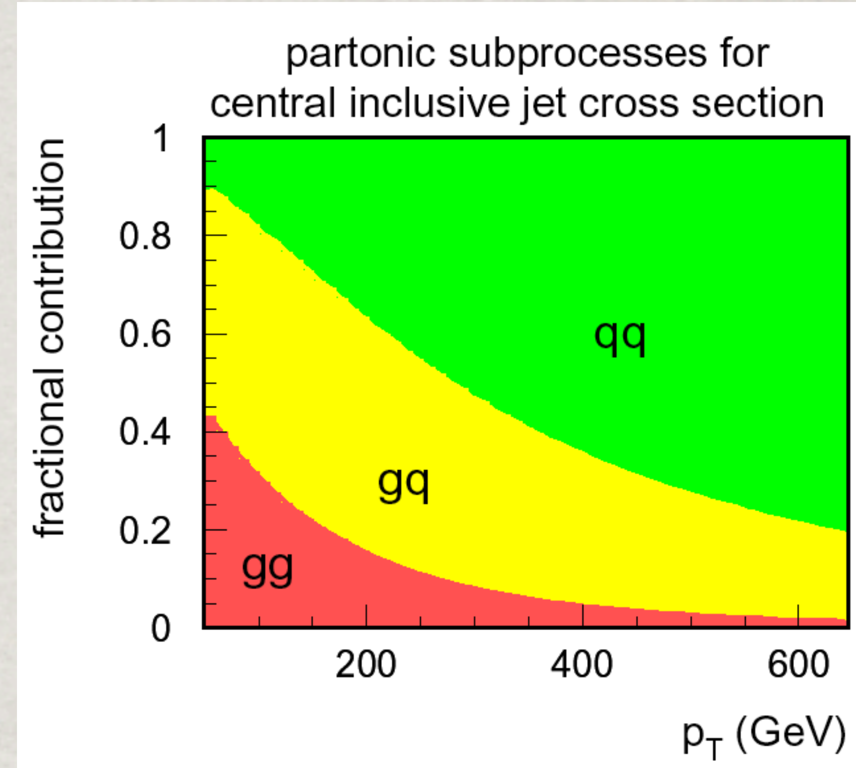
- Jet mass and splitting scale can be used to understand the structure of jets

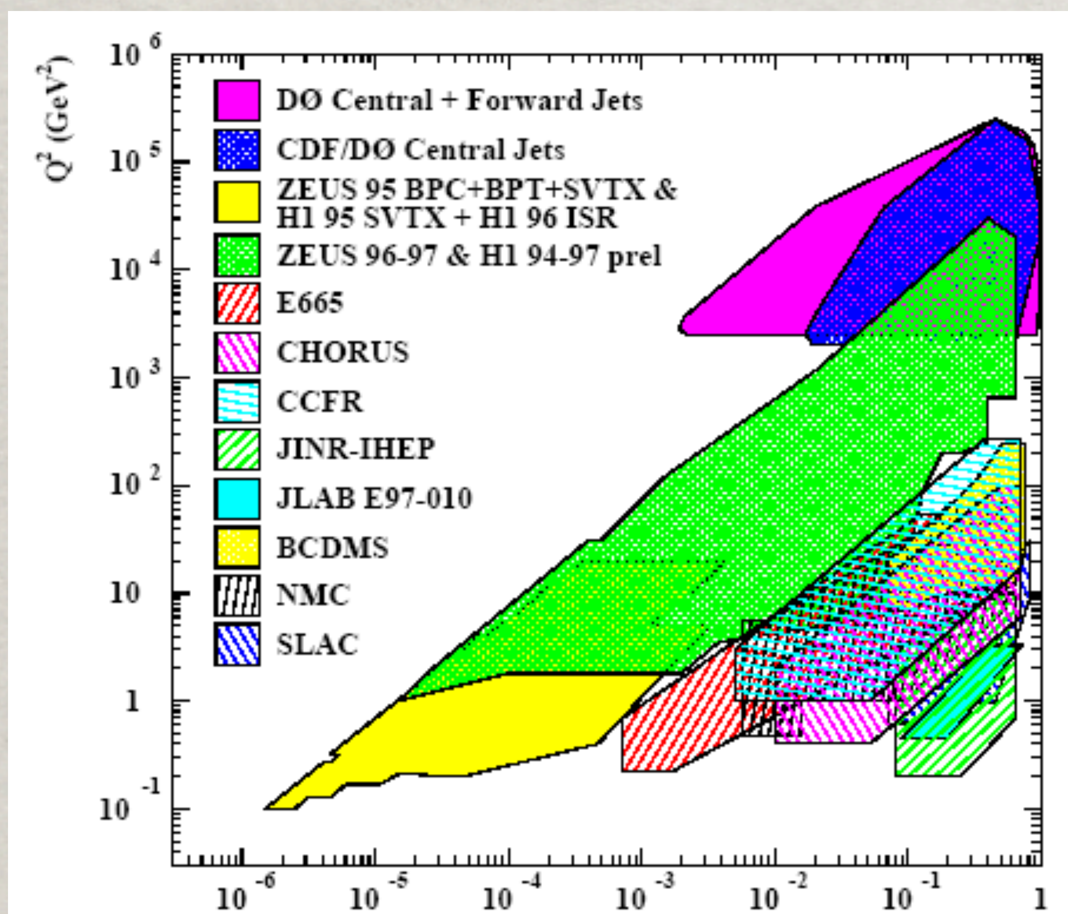
- Search for highly boosted objects->jets



Jet Cross-sections



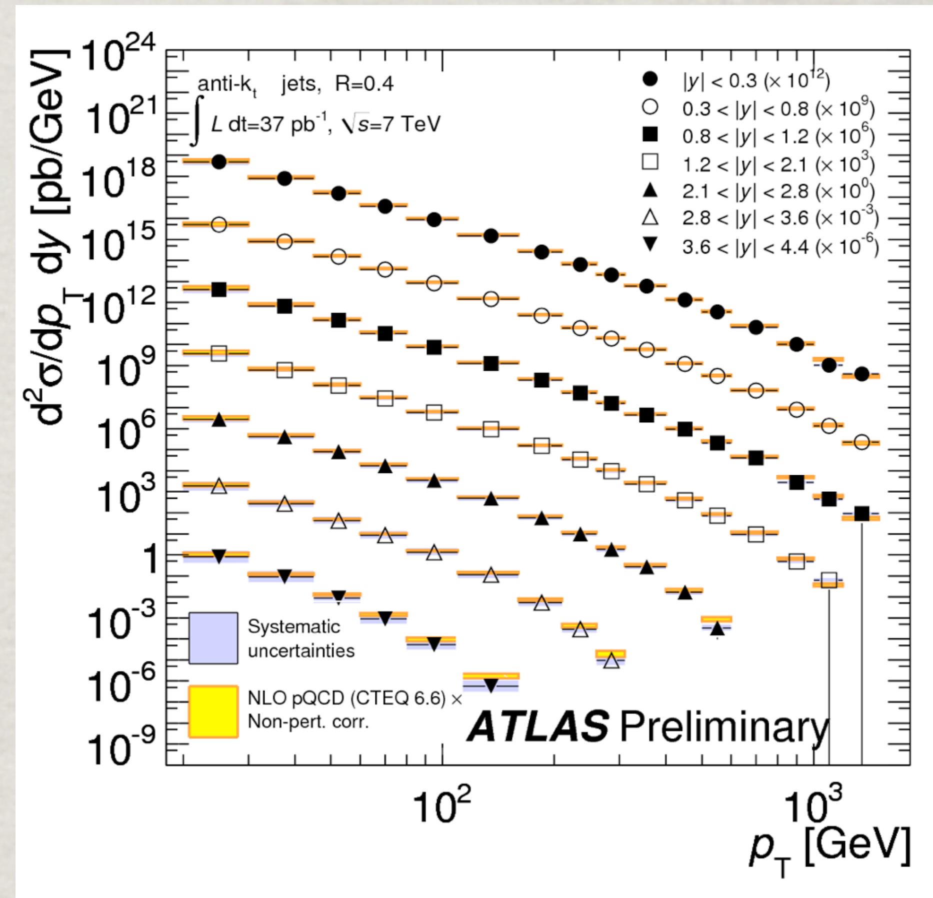


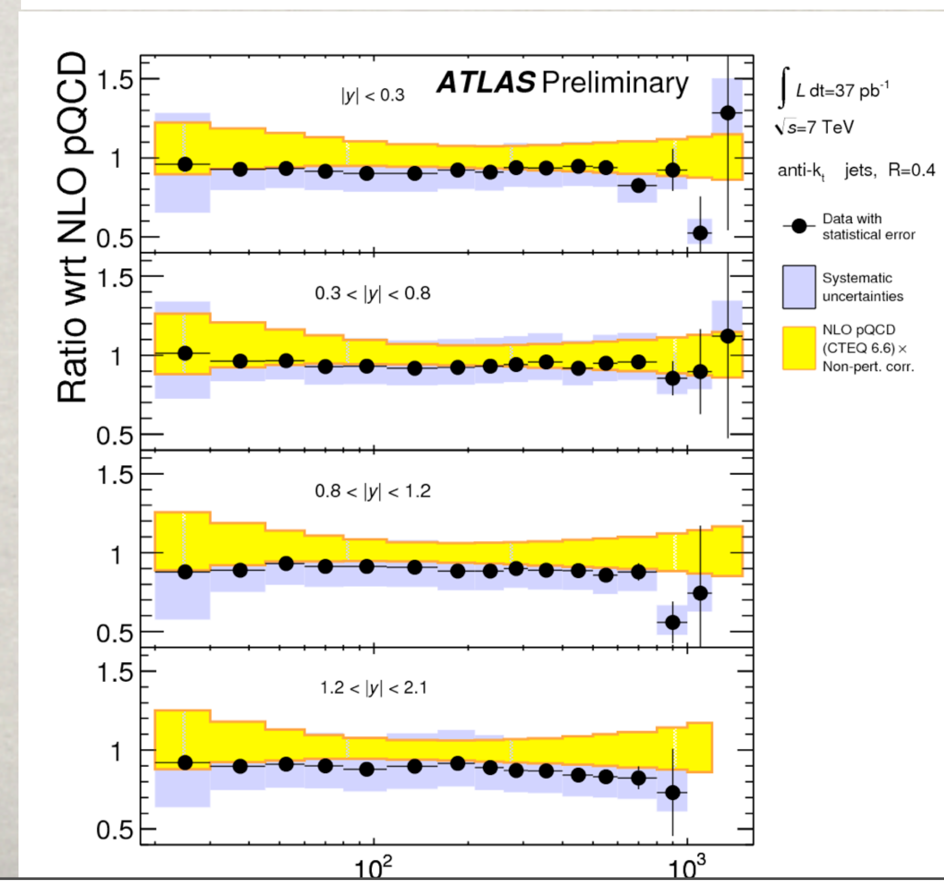


- Highest E_T probes shortest distances
  - Tevatron: $r_q<10^{-18}$ m
  - LHC: $r_q<10^{-19}$ m (?)
  - Could e.g. reveal substructure of quarks
- Tests perturbative QCD at highest energies

Jet cross-sections

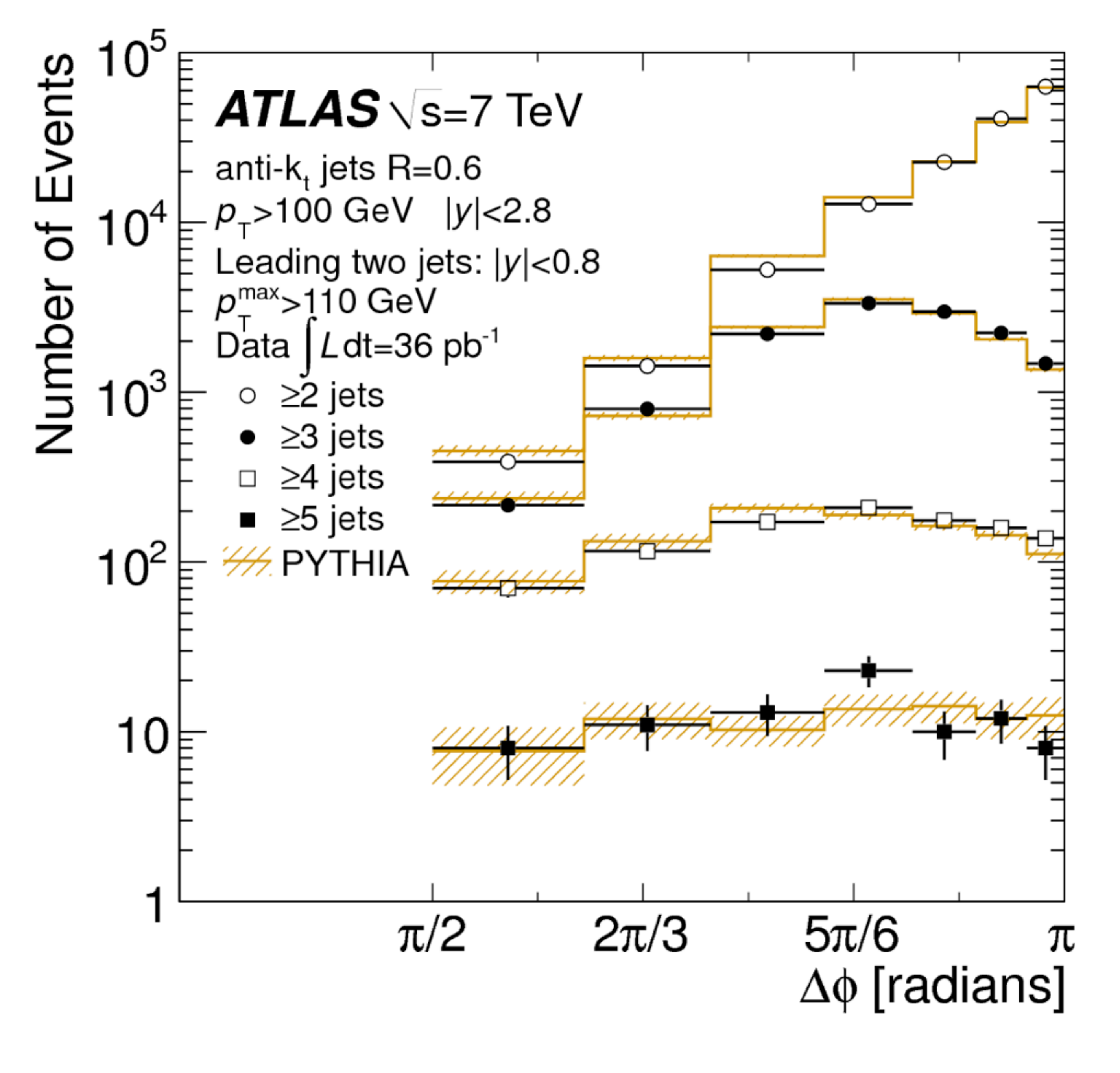
- Double differential cross section (pt,y)
- Differential cross section (pt)
- $1.4 \times 10^{-2} < x < 0.3$
- pQCD with NLOJET++ 4.1.2





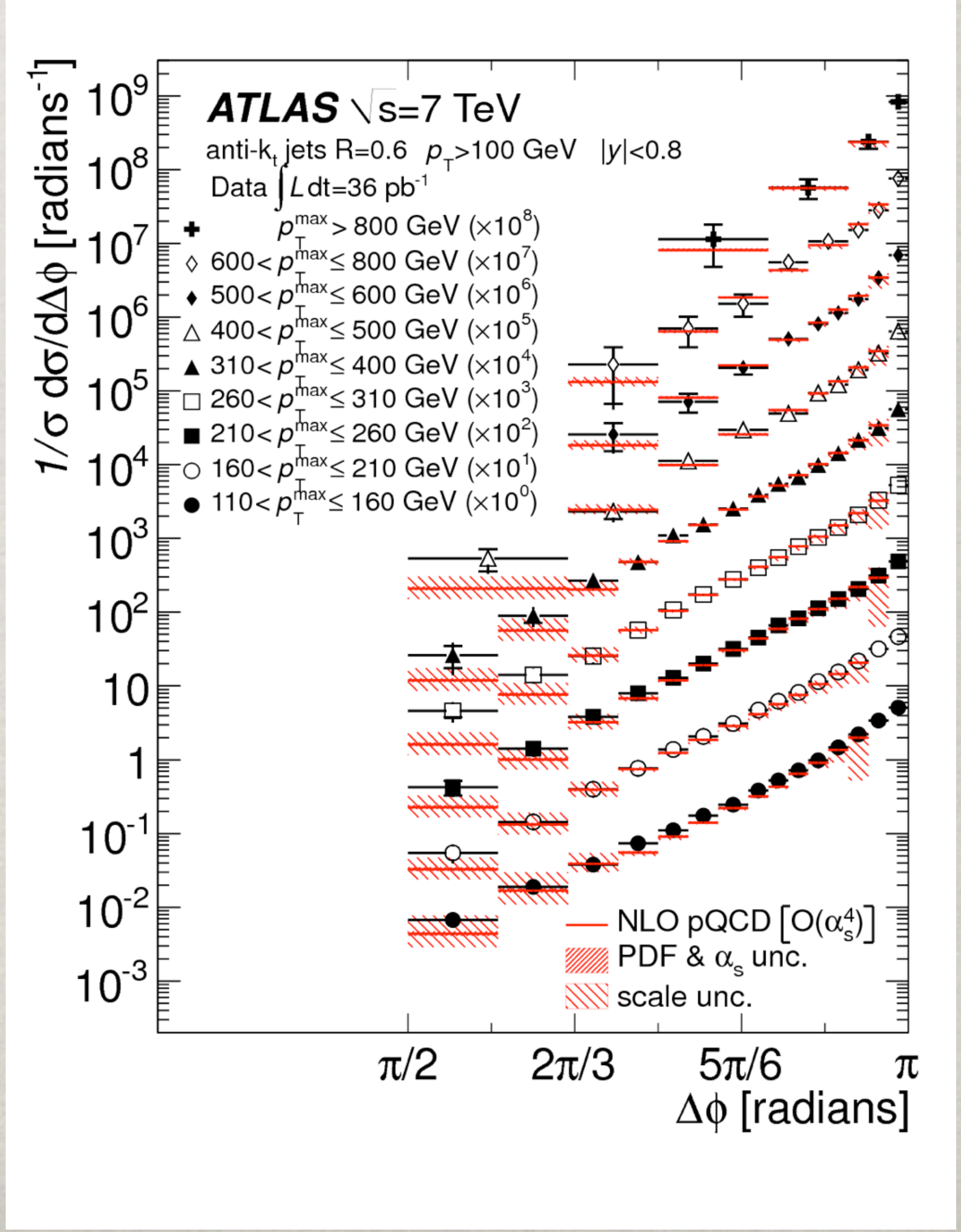
Azimuthal Decorrelations in jet events

- Dijets have Δϕ~π
- Presence of other partons causes Δϕ<<π
- pQCD has prediction for shape

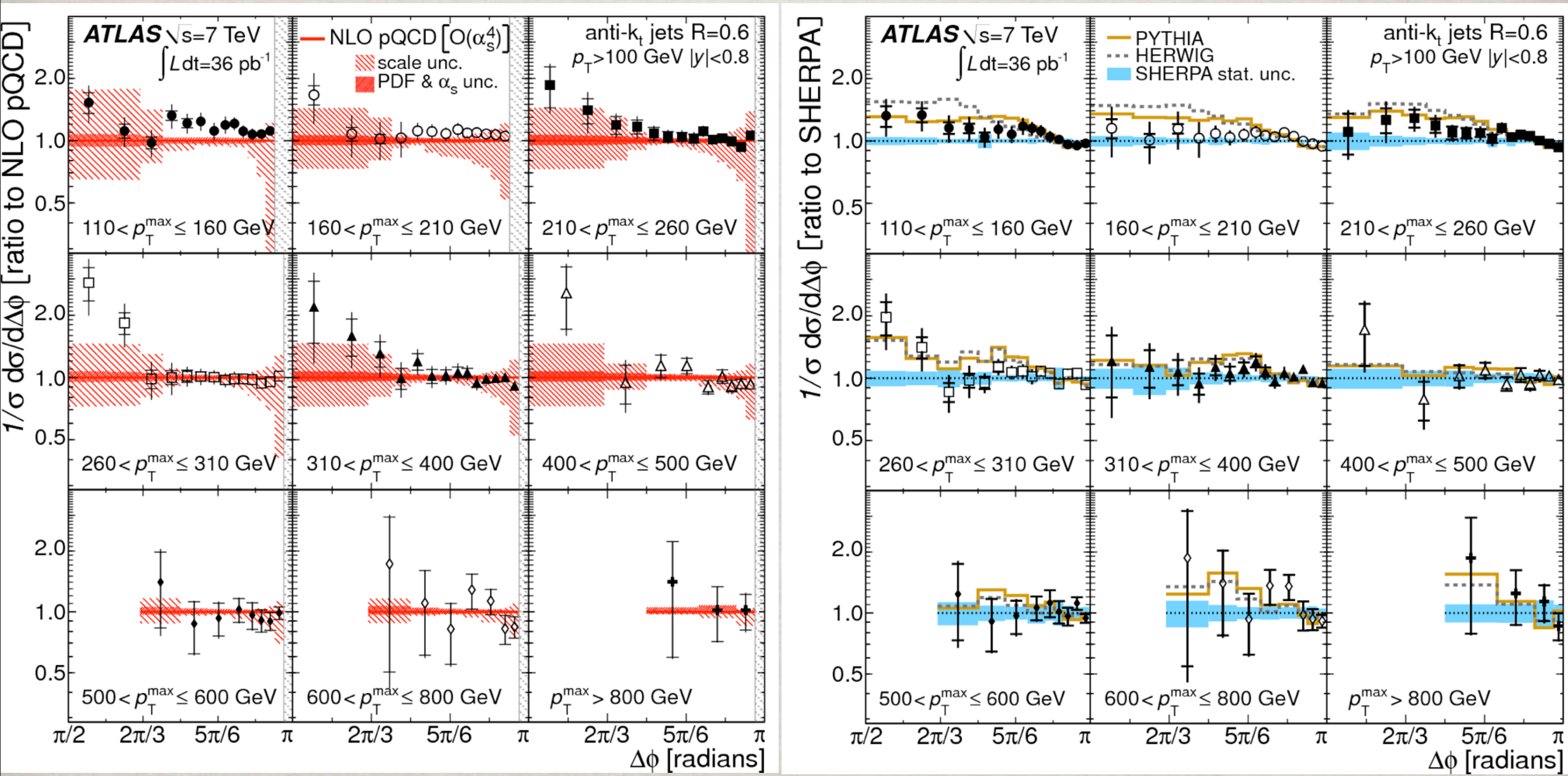


Azimuthal Decorrelations in jet events

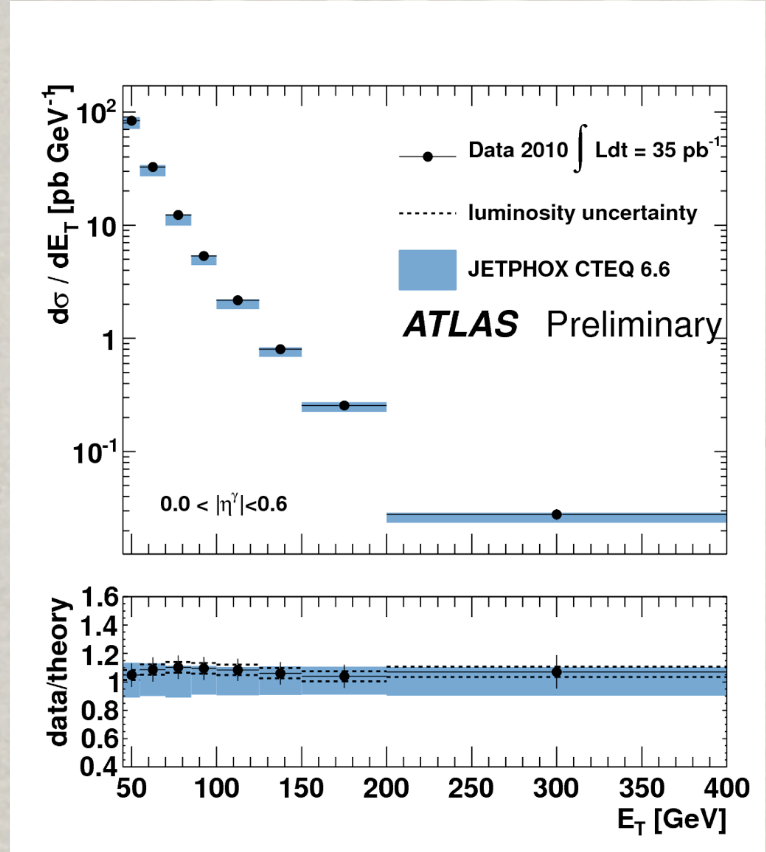
- Divided into 9 ranges of the leading jet P_T
- Normalized by total dijet cross section for each range
- $|\Delta y| < 0.8$ and $|y| < 2.8$ probes $0.02 \le x \le 0.14$

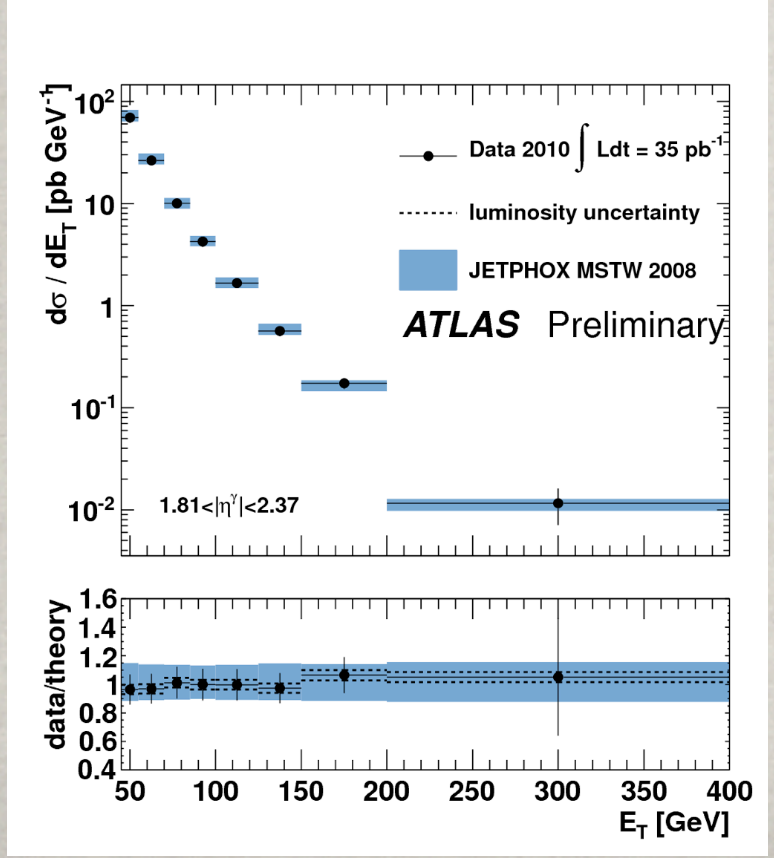


Azimuthal Decorrelations in jet events



Inclusive isolated photon cross-section





- Test pQCD with a colorless probe
- Important for wide variety of BSM searches
- Measured with $40 < p_T < 400$ (GeV) , split into several η ranges (shown here in most central and forward regions)

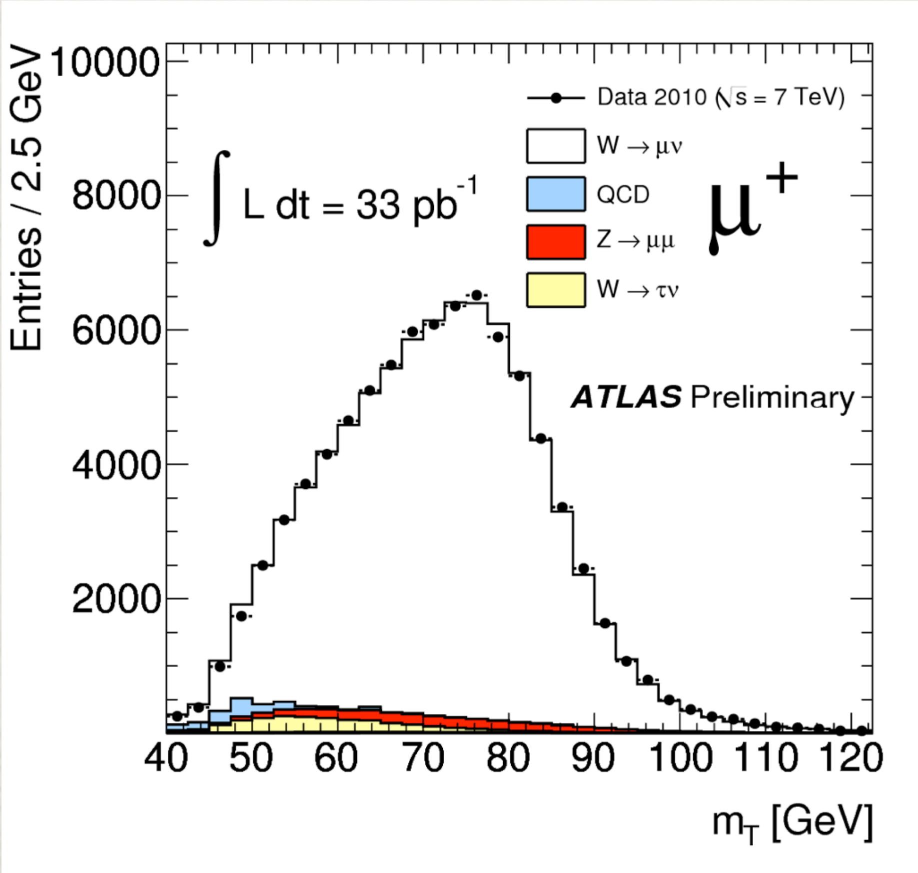
Electroweak W/Z

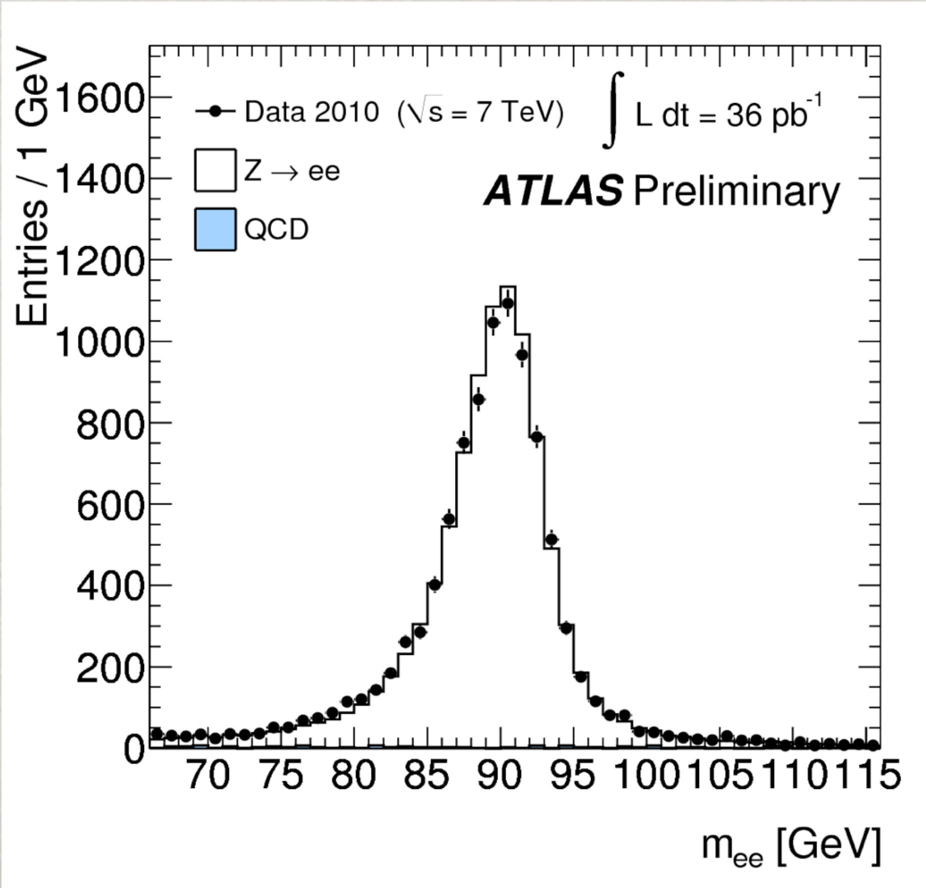
- Jacobian peak of W in transverse mass distribution

$$m_T = \sqrt{|p_T^l|^2 + |p_T^\nu|^2 - (\vec{p}_T^l + \vec{p}_T^\nu)^2}$$

  - High momentum lepton + MET

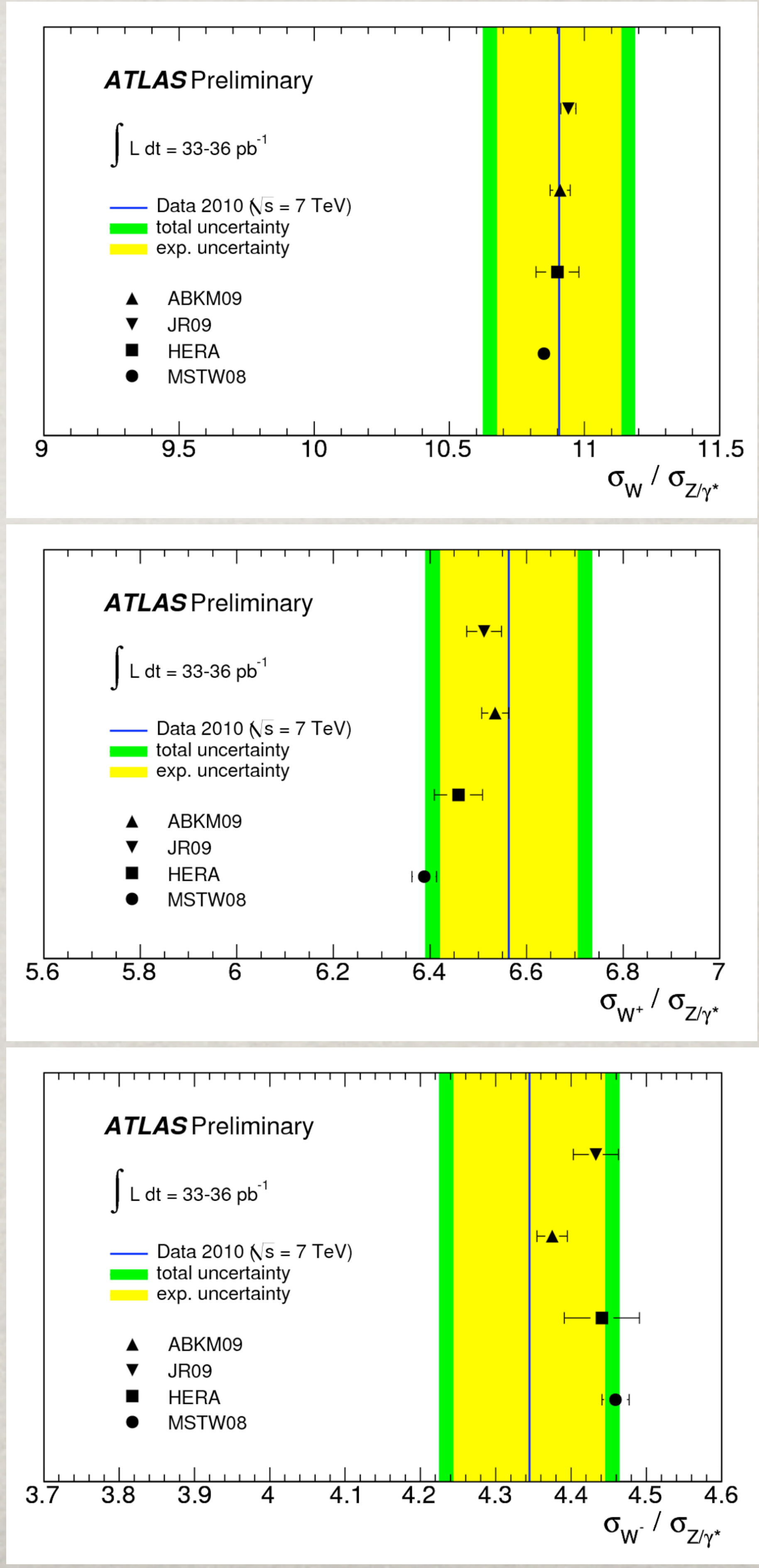
- Two high momentum leptons





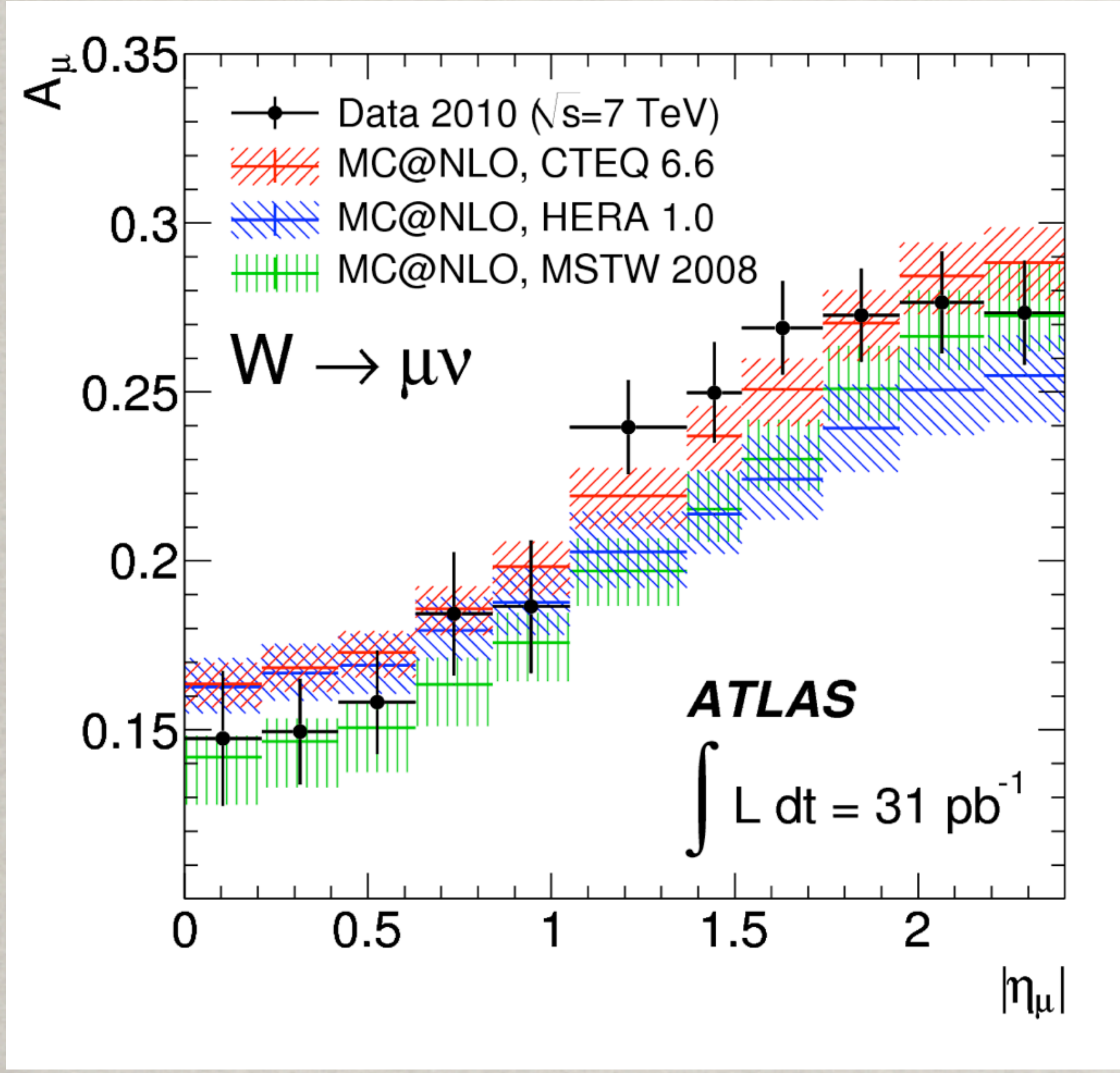
W/Z cross-sections

- Total cross-section x branching ratio measurement in electrons and muons
- Look at ratio to reduce systematics
- Good agreement with NNLO theory



W charge Asymmetry

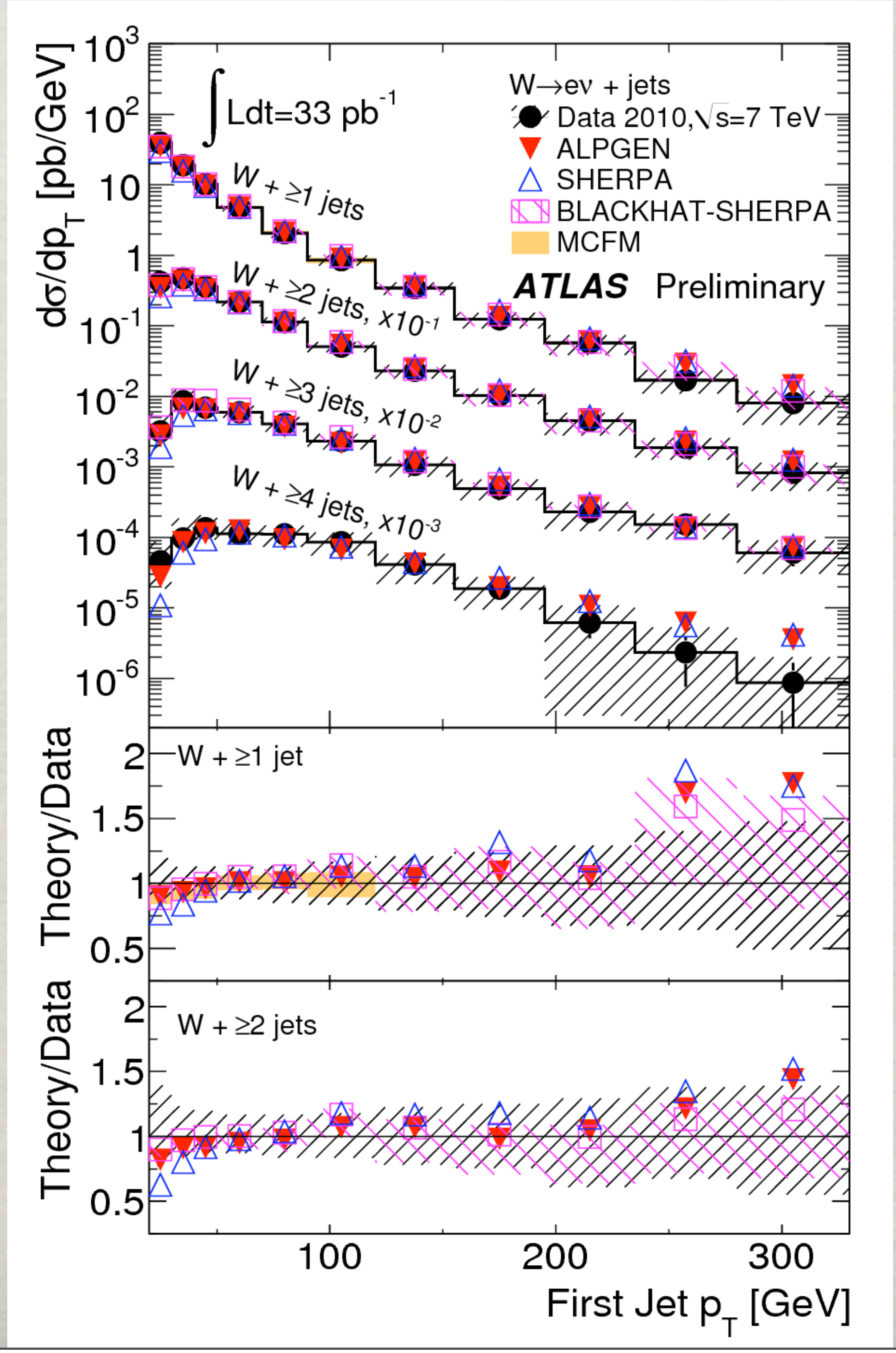
$$A_\mu = \frac{\frac{dW_{\mu+}}{d\eta_{mu}} - \frac{dW_{\mu-}}{d\eta_{mu}}}{\frac{dW_{\mu+}}{d\eta_{mu}} + \frac{dW_{\mu-}}{d\eta_{mu}}}$$



- pp (valence quarks, sea anti-quarks)
- W charge asymmetry sensitive to PDF
- Roughly in agreement with all sets - slight preference for CTEQ

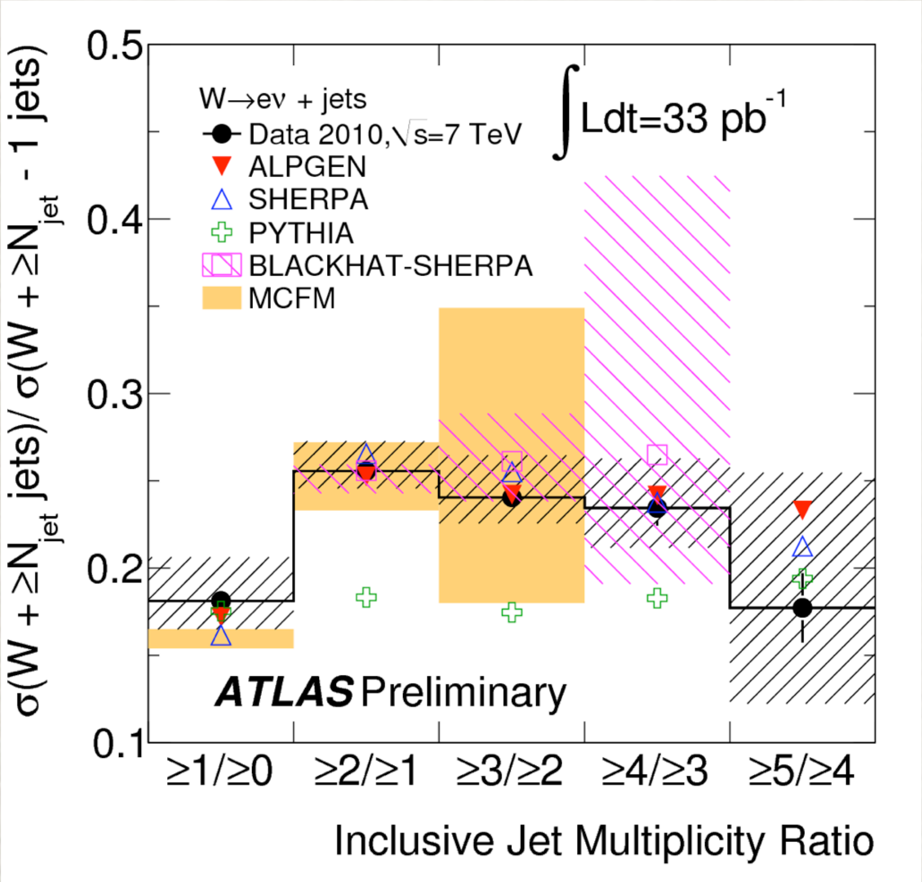
W+JETS

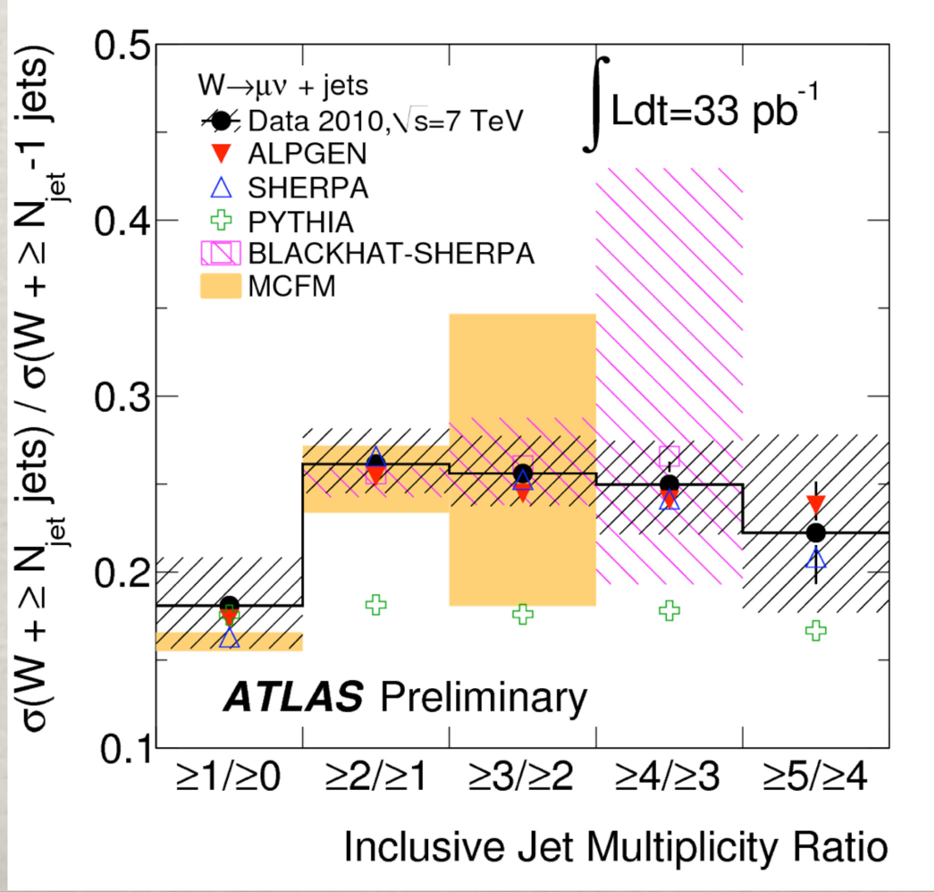
- Test of pQCD at NLO
- Test of showering model and Matrix Element + Parton Shower
- Important background to many exotics signatures
- also Z+jets not shown here



W+JET MULTIPLICITY

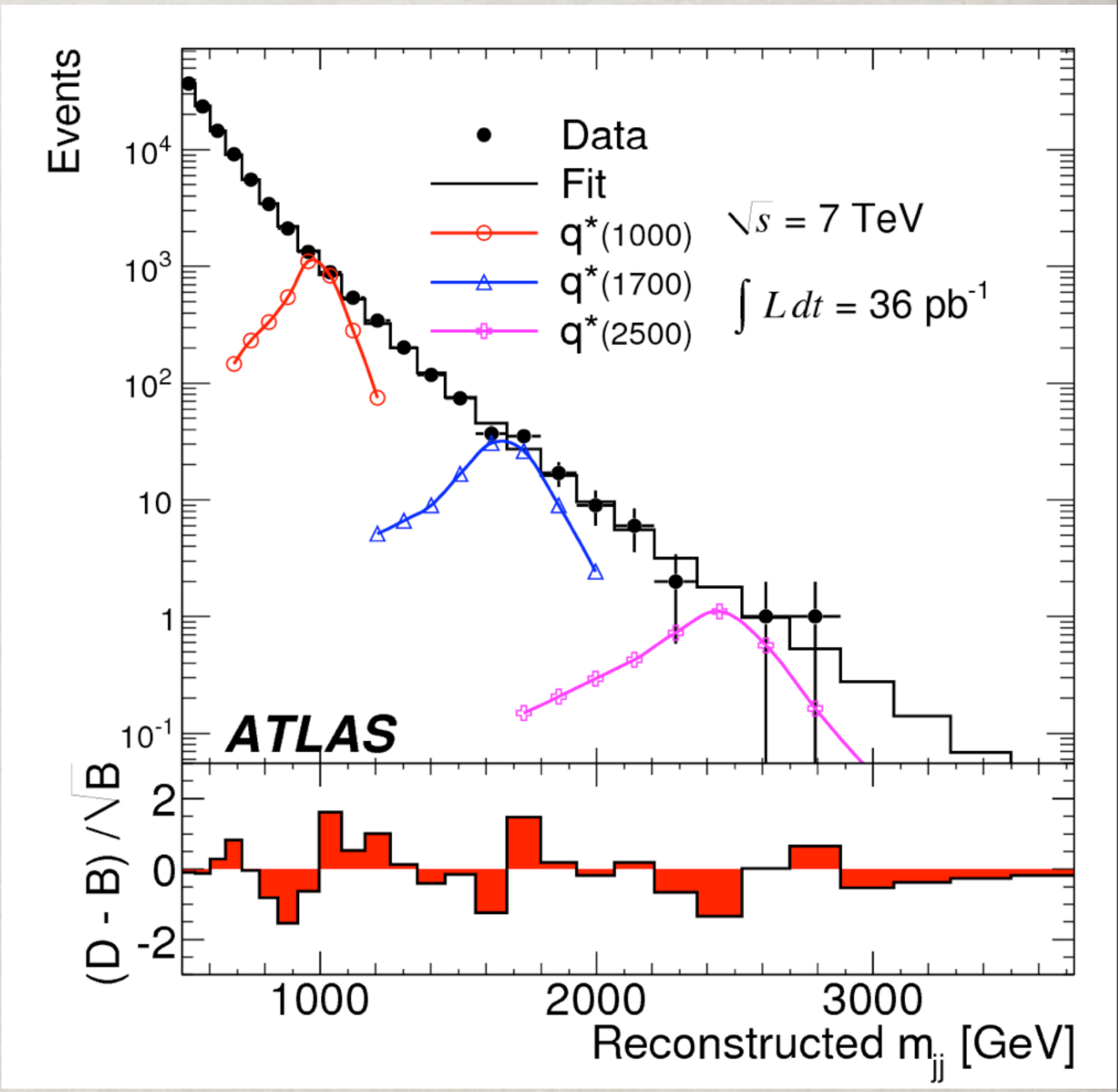
- Comparison of jet multiplicity ratio sensitive to modeling of ME+PS
- Pythia alone expected to have deviations at high jet multiplicity





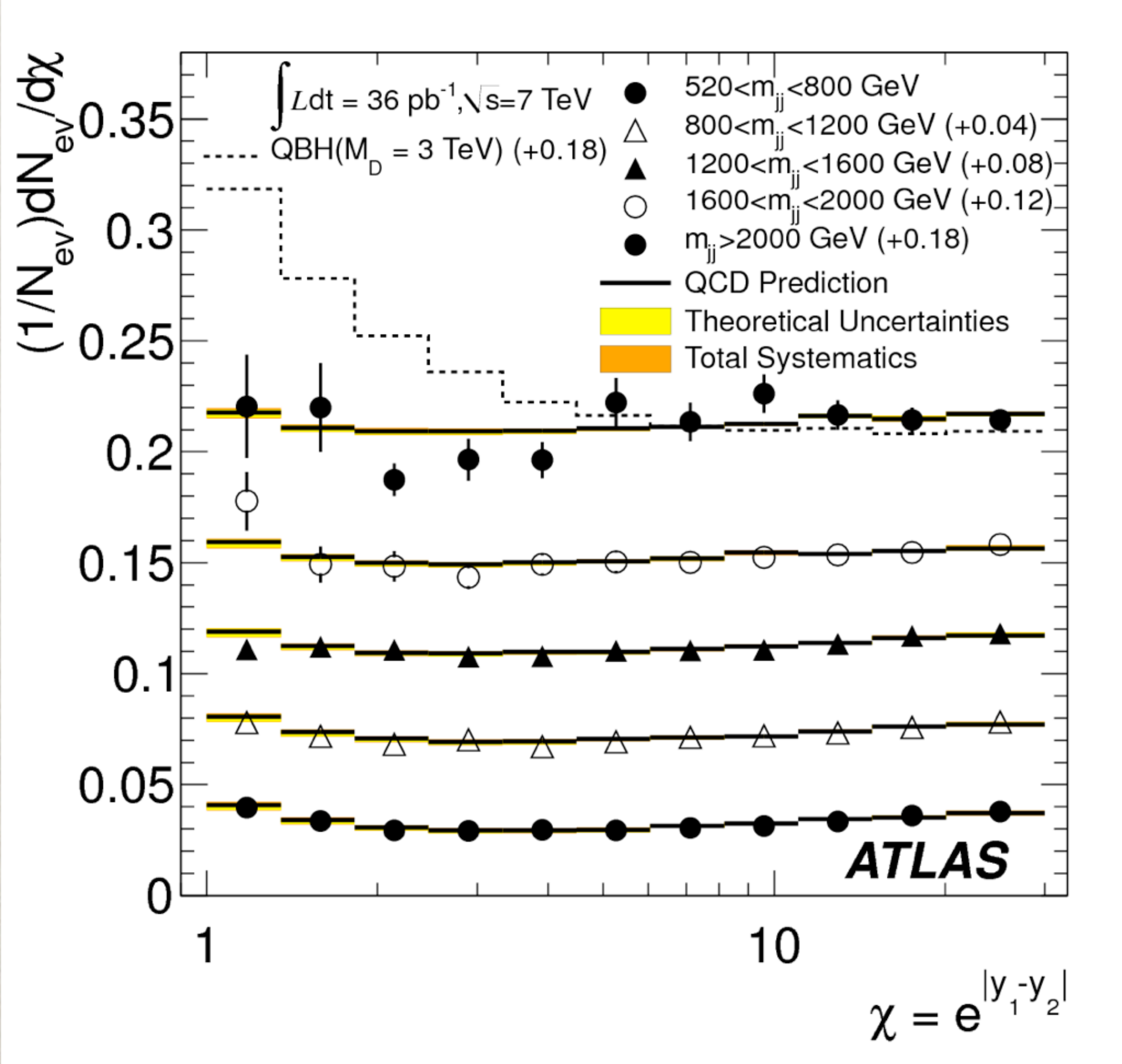
AT HIGHER X

- Fit dijet mass spectra over large range
- Look for evidence of deviation from prediction - resonant particle decay



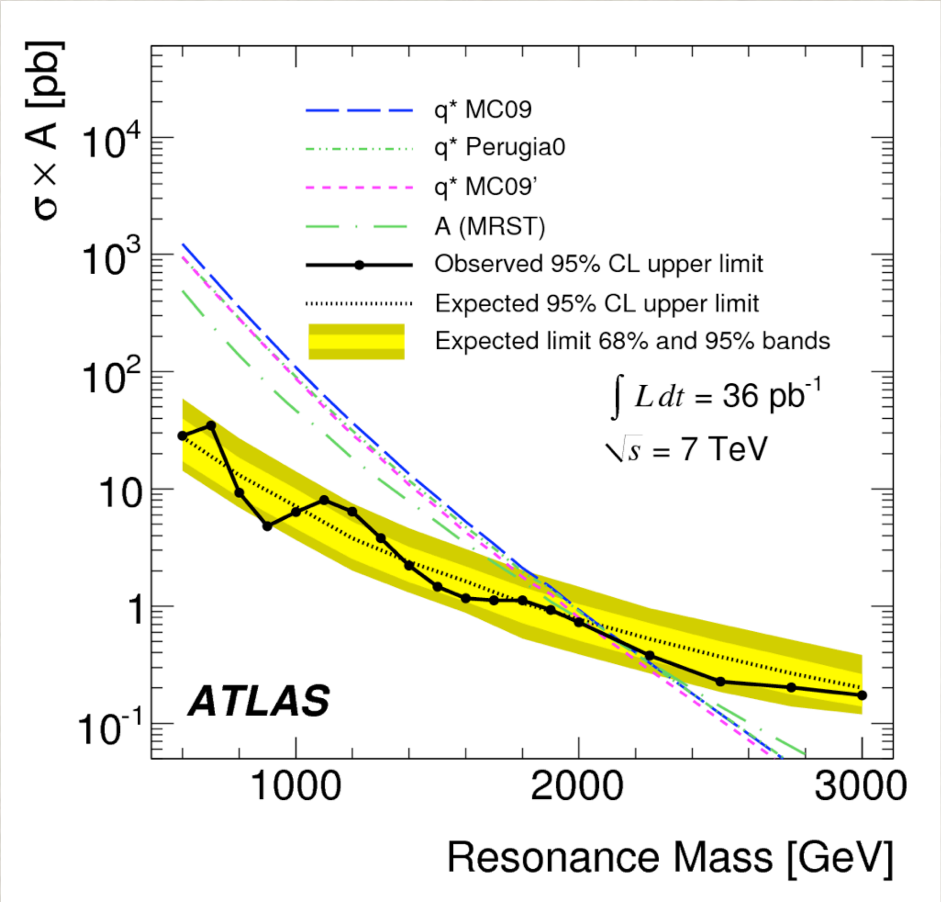
Angular analysis

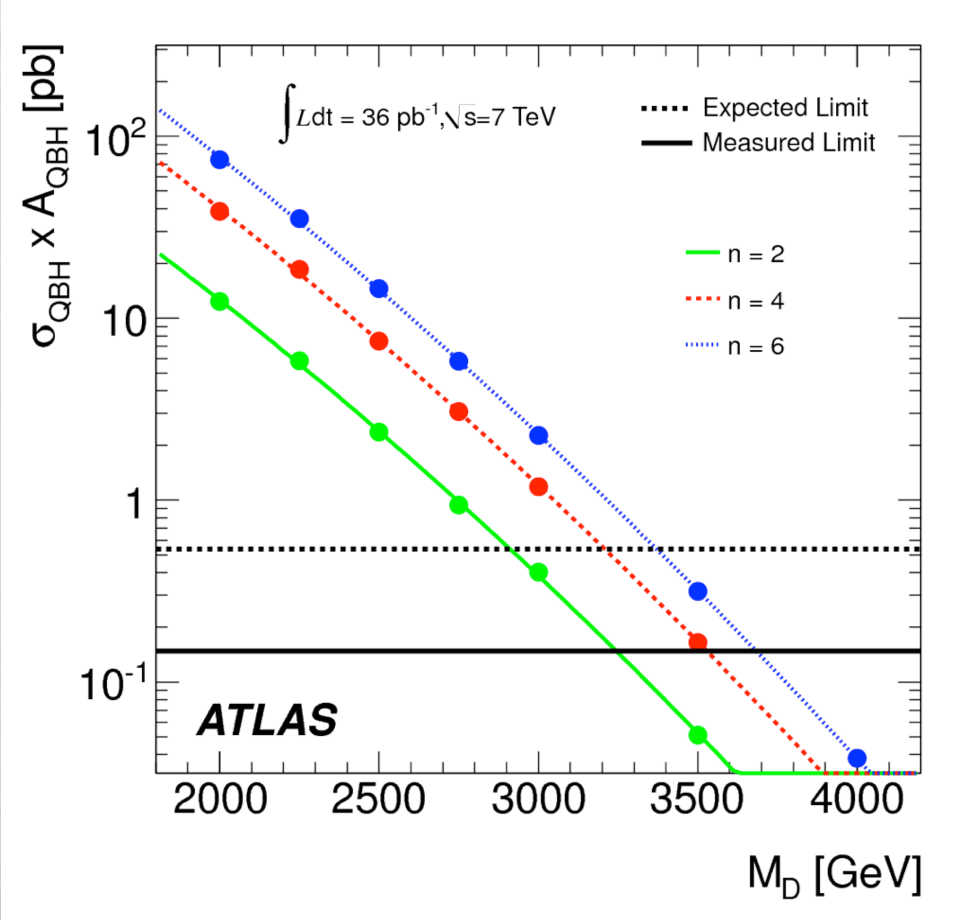
- Look for deviations from QCD prediction in rapidity distribution of jets
- More sensitive in some models
- Less sensitivity to largest systematic of jet energy scale



Limits

- No evidence of disagreement with QCD
- In fact, remarkable agreement over many decades





Summary

- LHC and ATLAS are a huge success!
- Many Many Measurements, Searches, on broad topics! Too many to cover here!
- Expect many more results in months and years to come