Inclusive and Dijet Cross-Section Measurements at CMS

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on behalf of the CMS Collaboration

EPS QCD Parallel Session

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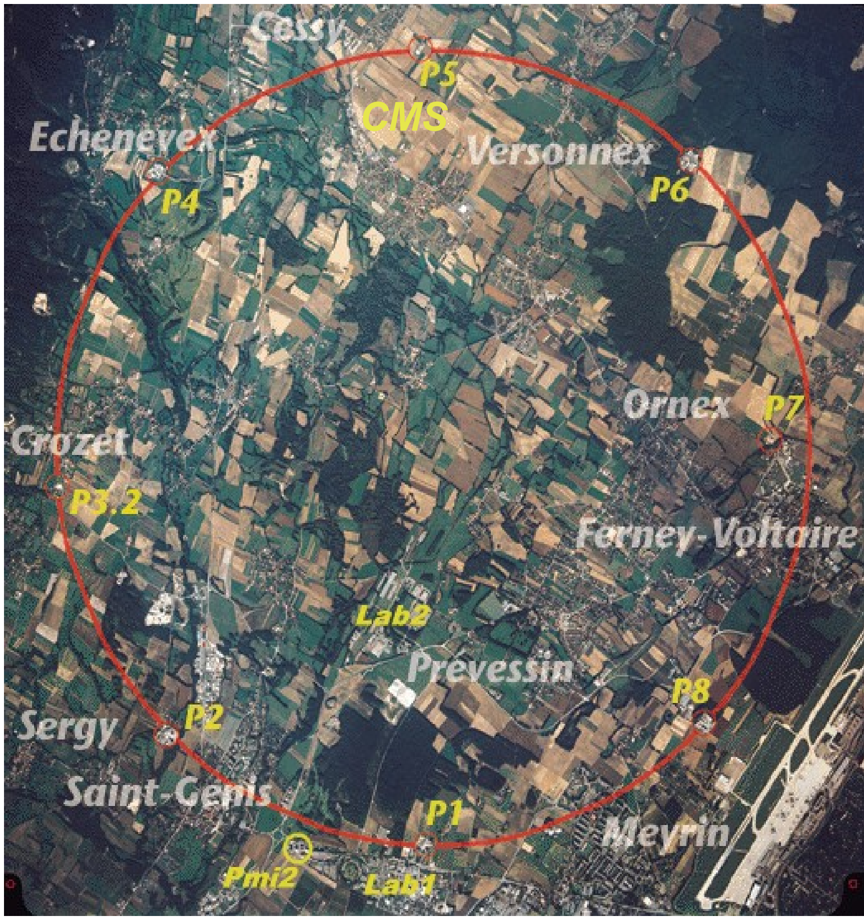
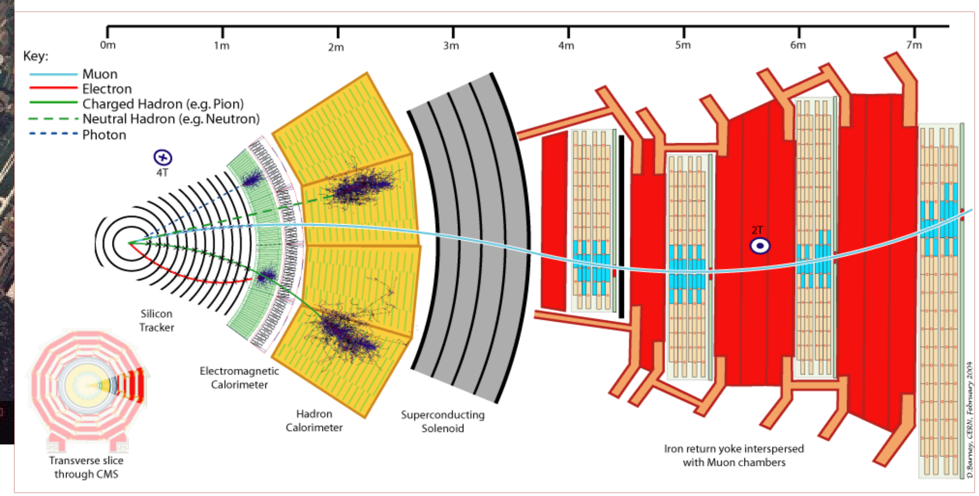
CMS cross section



CMS: One of 2 general-purpose experiments intended for data-taking on 7 TeV pp collisions at the LHC

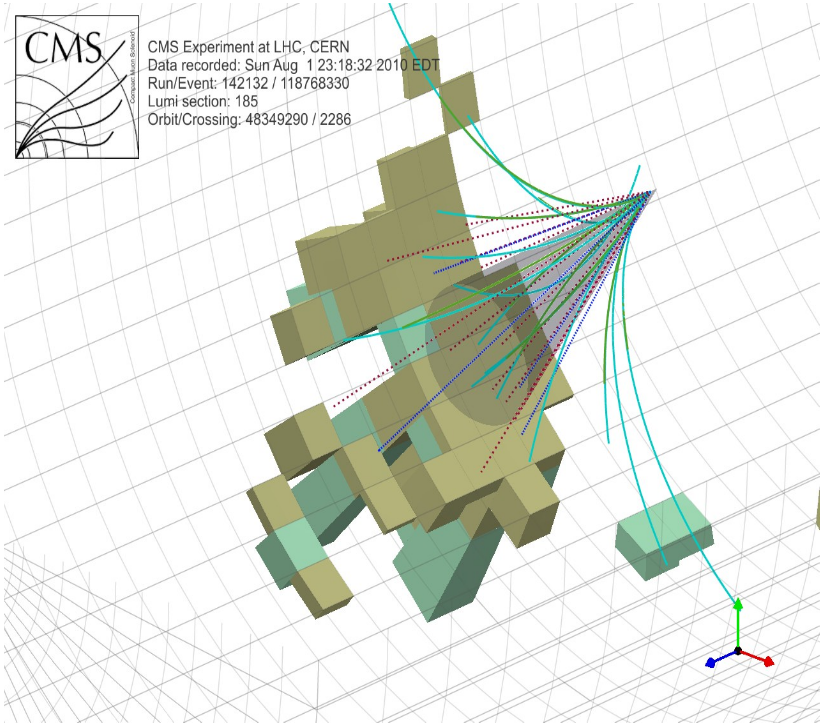
5 layers of subdetectors across more than 7 meters from the beam spot, of which we are most concerned with the silicon tracker and calorimeters.



Motivation

- Jets are seen in abundance at high energy colliders. As a result, QCD predictions are among the first that can be explored and validated at the new energy frontiers of the LHC
- Measurements such as the Inclusive Jet and Dijet Mass cross-section are important standard candles as well, for individual experiments
- Constrains theoretical predictions
- Validates generators used by nearly all analysis groups
- A wide variety of new physics shows up as a resonance "bump" or some other distortion

Jets at CMS



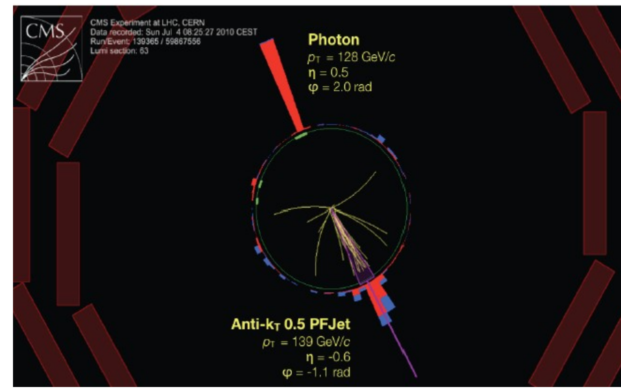
PF Jet (with calorimeter deposits) in CMS

- All algorithms in these measurements use anti-k_T clustering to produce jets
  - Seedless + Infra-red Safe
  - Default for most analyses requiring jets
- 3 reconstruction algorithms:
  - Calorimeter Jets
  - Jets + Tracks
  - Particle Flow (PF) Jets
- Particle Flow takes individual particle candidates and creates jets/MET
  - Best resolution and lowest Jet Energy Scale uncertainty (our highest experimental uncertainty)

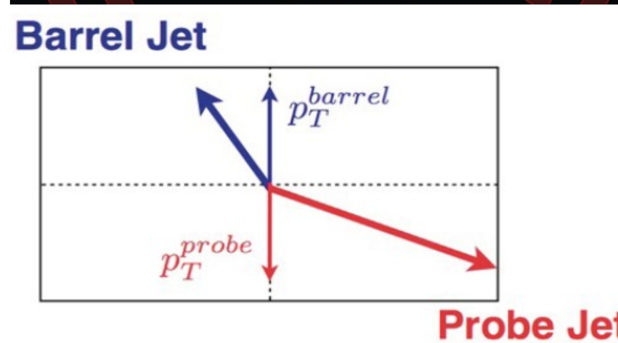
Jet Energy Scale

- Due to the sharply falling nature of both cross-sections in p_T/M_{jj}, the greatest contribution to the systematic uncertainty of both measurements is inaccuracy in the Jet Energy Scale.

Absolute p_T correction – The absolute scale for jets is determined by balancing photon + jet events. PF algorithm ensures that we measure the full recoil with minimal systematic error.

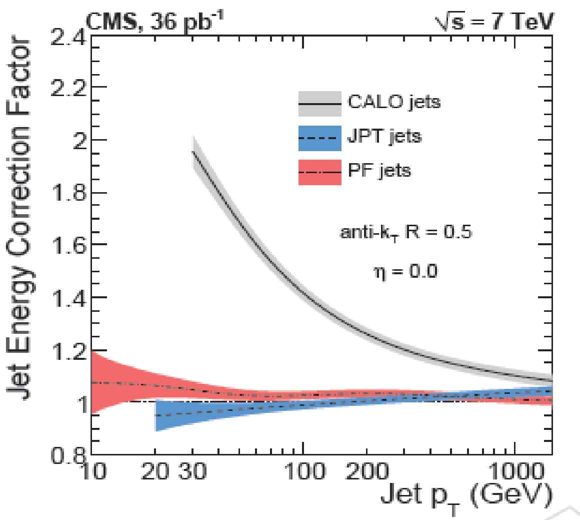


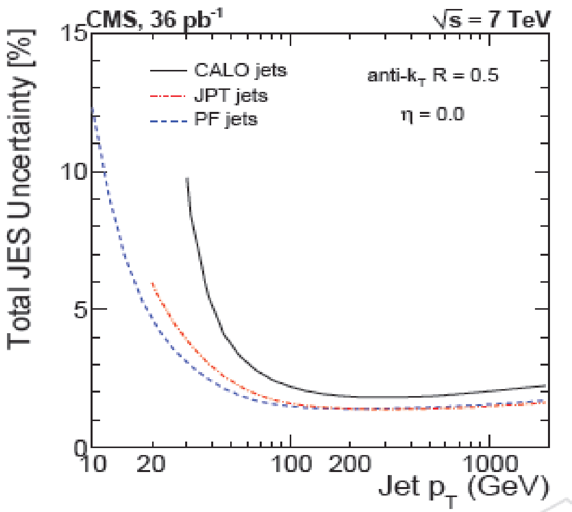
Relative p_T correction - Taking dijet events, balance the p_T of a jet in the barrel with that of a jet at arbitrary η. (Tag-and-probe)



The corrected jets are then compared to MC distributions and an additional residual correction is applied to achieve closure.

Jet Energy Corrections





Our corrective factors for the jet response for these measurements were derived on the full 36 pb^{-1} in 2010.

Again, due to the improved response for charged particles via tracking information, JPT and PF Jets require lesser corrections than CaloJets.

The end result is an overall JES uncertainty of 2-5% for the entirety of the phase space considered, allowing a precision measurement to be made

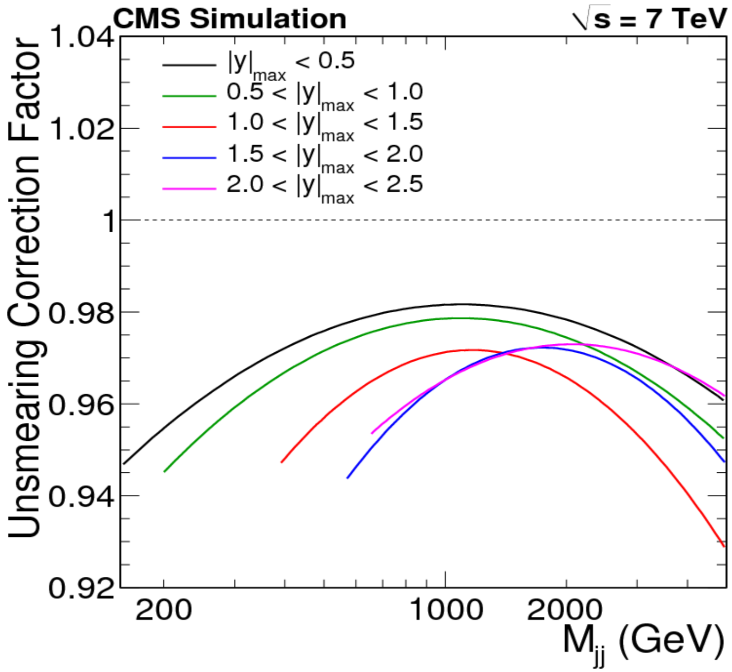
CMS approved result: JME-10-011

See talk: "Jet Energy Calibration and Transverse Momentum Resolution in CMS" (I. Iashvili)

Spectrum Construction

The events used in both measurements are selected using a series of triggers that fire on the uncorrected p_T of the leading jet. We then construct the spectra in p_T/M_{jj} (after corrections) in regions in which the individual triggers are 100% efficient.

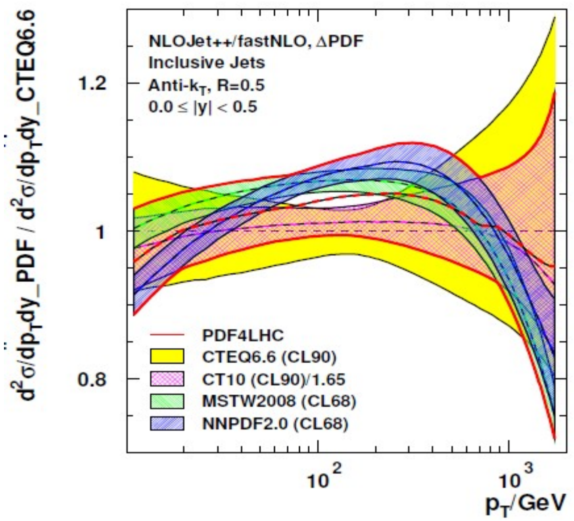
Trigger	Jet30	Jet50	Jet70	Jet100	Jet140
Eff. Lumi (pb^{-1})	0.32	3.2	8.6	19	36

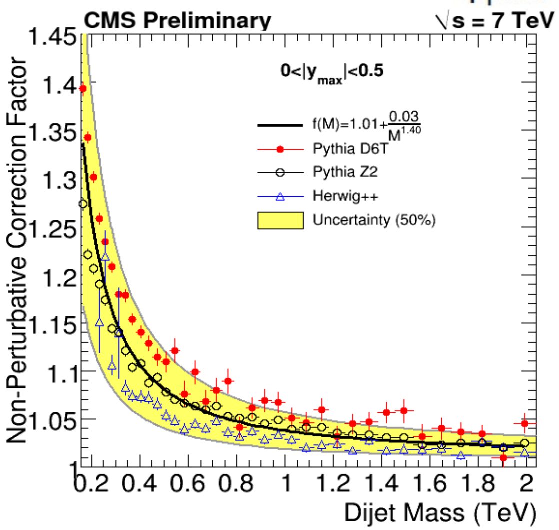


The comparison to theory is performed at particle level. We correct the detector level information back by applying the *ansatz* unfolding method.

The p_T/M_{jj} response is smeared by an estimation of the detector resolution and an "unsmearing" correction is derived bin-by-bin for both measurements.

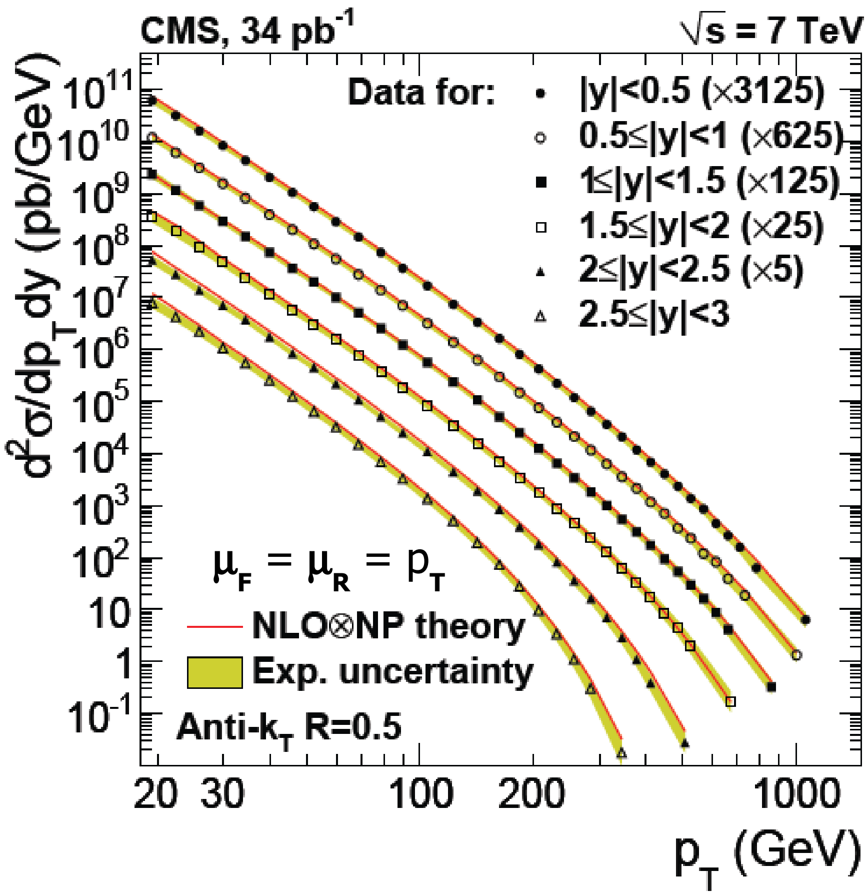
Comparison to Theory





- Variety of PDFs considered using the PDF4LHC method – prescription for general comparison of these measurements to theory
  - Prediction from each PDF is calculated with 1σ uncertainty
  - The center of the global area within these bands is the PDF4LHC prediction
- Generated using NLOJet++
- Non-perturbative corrections applied to bring parton-level calculations to particle-level
  - Corrections to NLO acquired by turning MPI and hadronization on/off in MC
  - Result averaged from Pythia6 and Herwig++

Inclusive Jet Cross-section

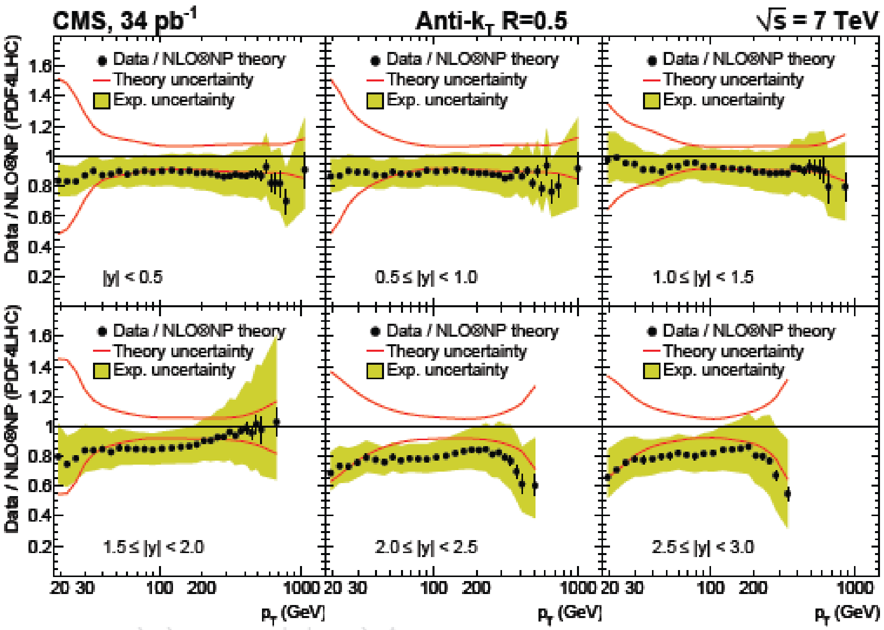


CMS public result: QCD-10-011
arXiv:1106.0208v1 [hep-ex]

$$\frac{d^2\sigma}{dp_T d|y|} = \frac{C_{\text{unsm}}}{\epsilon \cdot \mathcal{L}} \cdot \frac{N_{\text{jets}}}{\Delta p_T \Delta|y|}$$

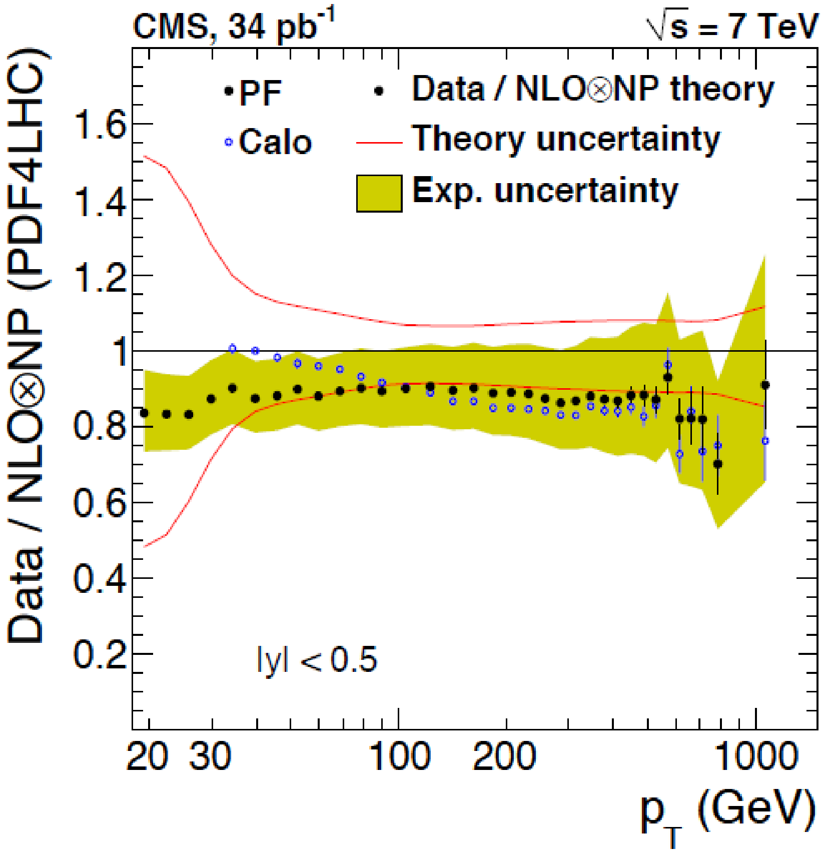
- The cross section measurement extends from 18 GeV to 1.1 TeV in jet p_T
- Good agreement with NLO theory predictions over 10 orders of magnitude in 6 rapidity bins

Inclusive Jets vs. NLO



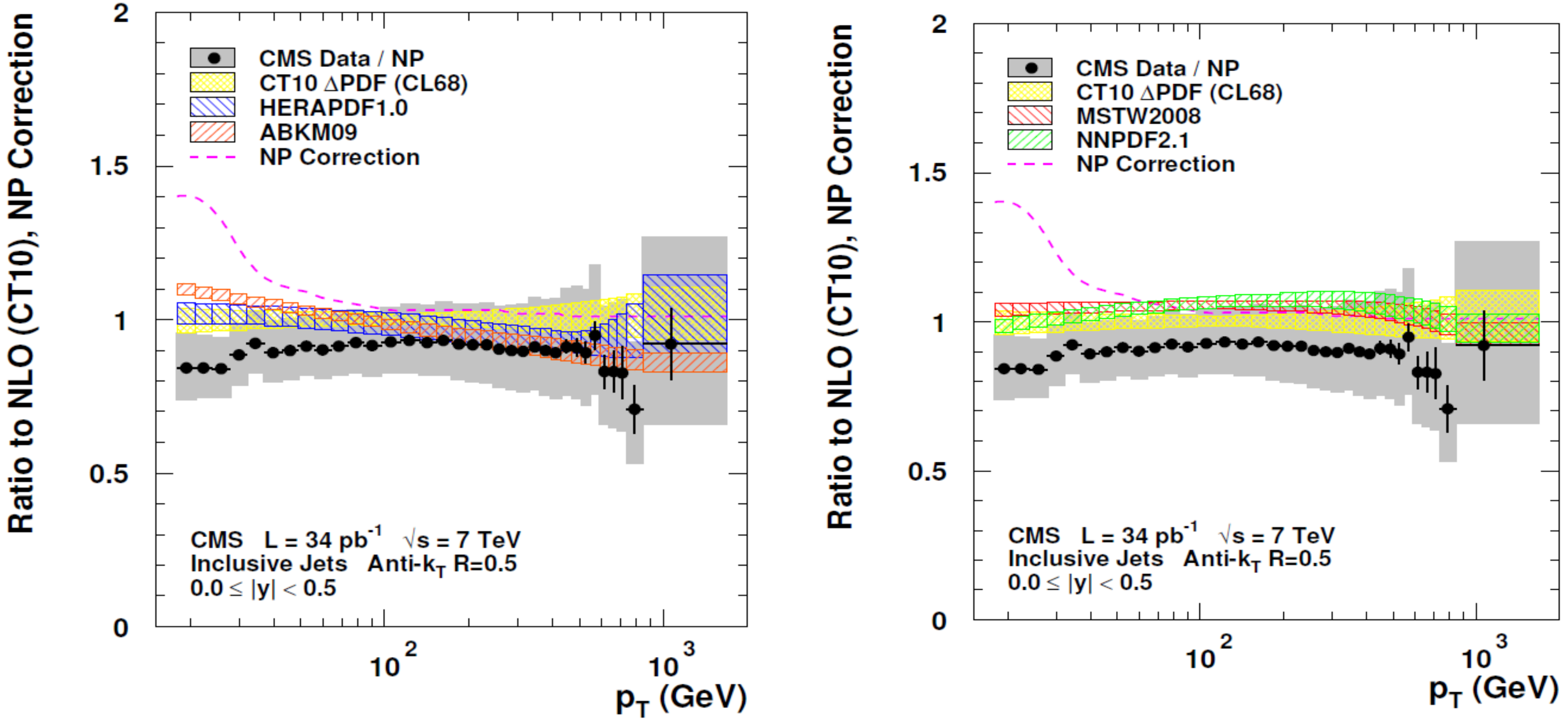
Theory uncertainty is dominated by NP corrections at low p_T and PDFs at high p_T

The direct ratio of the measurement to the theory prediction trends about 10% low, but still shows good agreement within uncertainty.



Additional cross-check with CaloJets shows consistency between algorithms

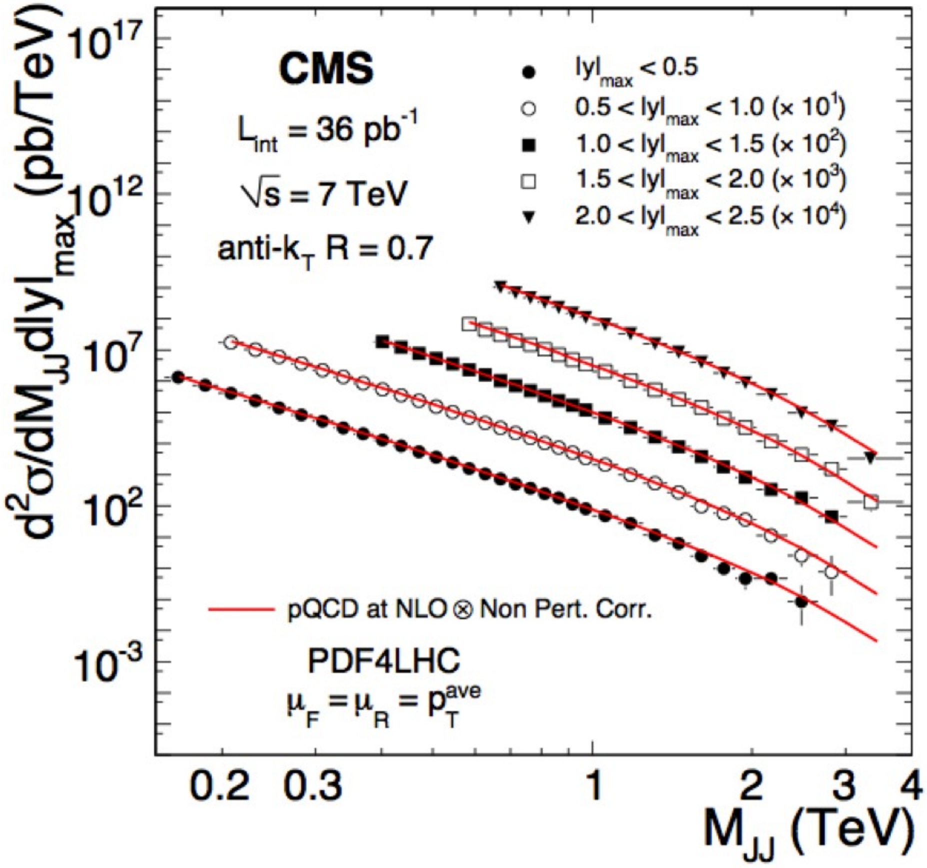
Additional PDFs



Additional comparisons have been performed against a variety of PDFs for consistency, using CT10 as a baseline. This is the next step in comparing the validity of various theoretical predictions.

The data remains consistent with respect to CT10 in the areas of interest for this measurement

Dijet mass differential cross-section



CMS public result: QCD-10-025
arxiv:1104.1693v1 [hep-ex]

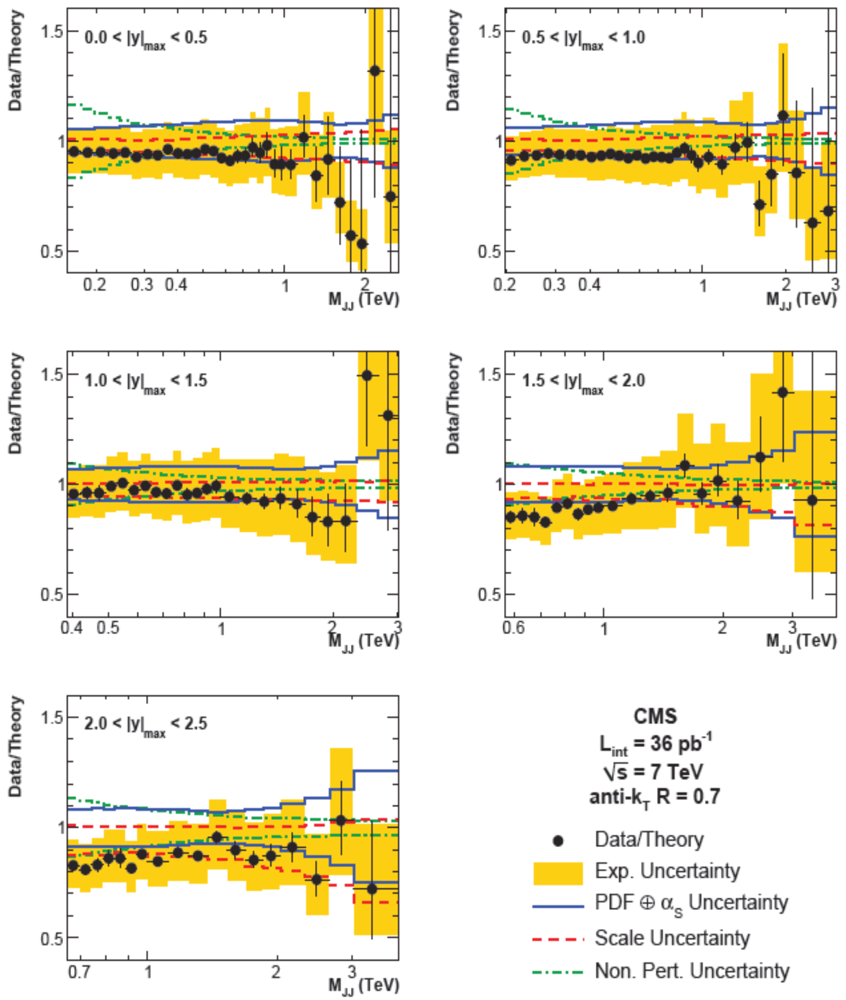
$$\frac{d^2\sigma}{dM_{JJ}d|y|_{max}} = \frac{C_{unsm}}{\epsilon \cdot \mathcal{L}} \cdot \frac{N_{ev}}{\Delta M_{JJ}\Delta|y|_{max}}$$

Dijet event selection requires:
$p_{T(jet1)}$ > 60 GeV, $p_{T(jet2)}$ > 30 GeV

Measurement uses larger cone size to remain consistent with previous dijet searches and reduce sensitivity to out-of-cone effects

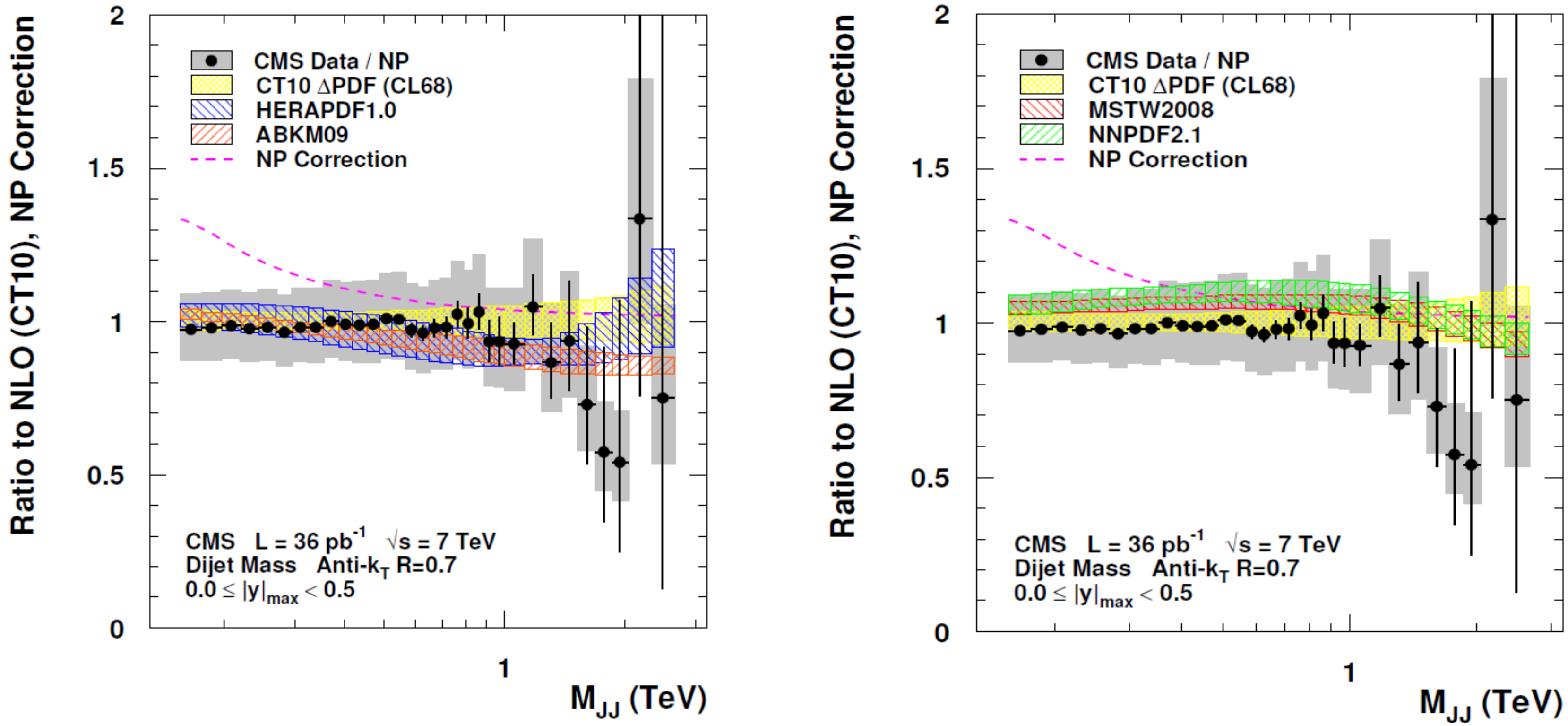
Final result: cross-section measurement with reach from 160 GeV to 3.5 TeV in M_{jj}

Dijet Mass Cross-section ratio



- Similar to the Inclusive Jet measurement, theory unceraínty is dominated by NP corrections at low mass and PDFs at high mass
- Measurement also trends low, but nonetheless shows good agreement with theory within uncertainties in all regions

Dijet Mass PDF comparisons



The same NLO comparisons to individual PDFs have been produced for the Dijet mass measurement. The spectra show agreement with most PDFs to a high degree.

Summary

- Dijet mass and Inclusive Jet cross-sections produced on the full 2010 dataset at CMS, and continue to be monitored as we cross 1 fb^{-1} in 2011
- Both results are, at this early stage, still in good agreement with NLO QCD predictions
  - Trending low, but still within uncertainties
- A wide variety of searches are primed to take advantage of these critical measurements as we continue taking data in 2011