Measurement of inclusive jet and dijet production in *pp* collisions at $\sqrt{s}$ = 7 TeV using the ATLAS detector

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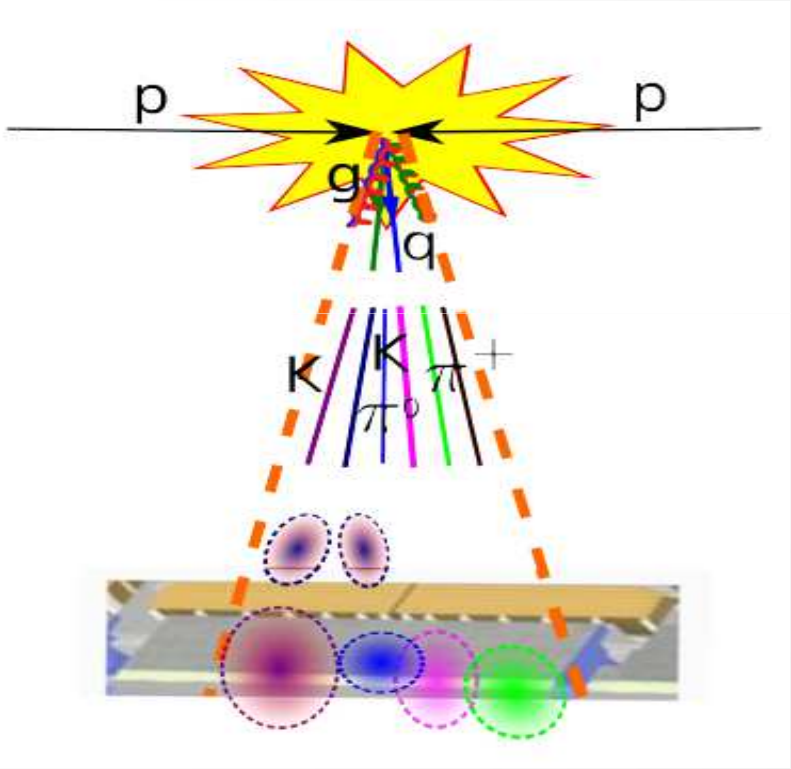
WHY TO STUDY JETS?

At LHC jet production is the dominant high p_T process.

Jet cross sections give us precise informations about the structure of the proton.

They are a powerful tool for understanding the strong interaction and searching for physics beyond Standard Model.



THE EXPERIMENT

2010 data sample

The goal of this experiment is the measurement of the inclusive jet and dijet ***cross sections***:

$$\text{Cross-section } \sigma = \frac{N_{\text{signal}} - N_{background}}{\epsilon \mathcal{L}}$$

INCLUSIVE JET: measurement of the cross sections of all the jets of the event.

DIJET: measurement of the cross section of only the two highest p_T jets.

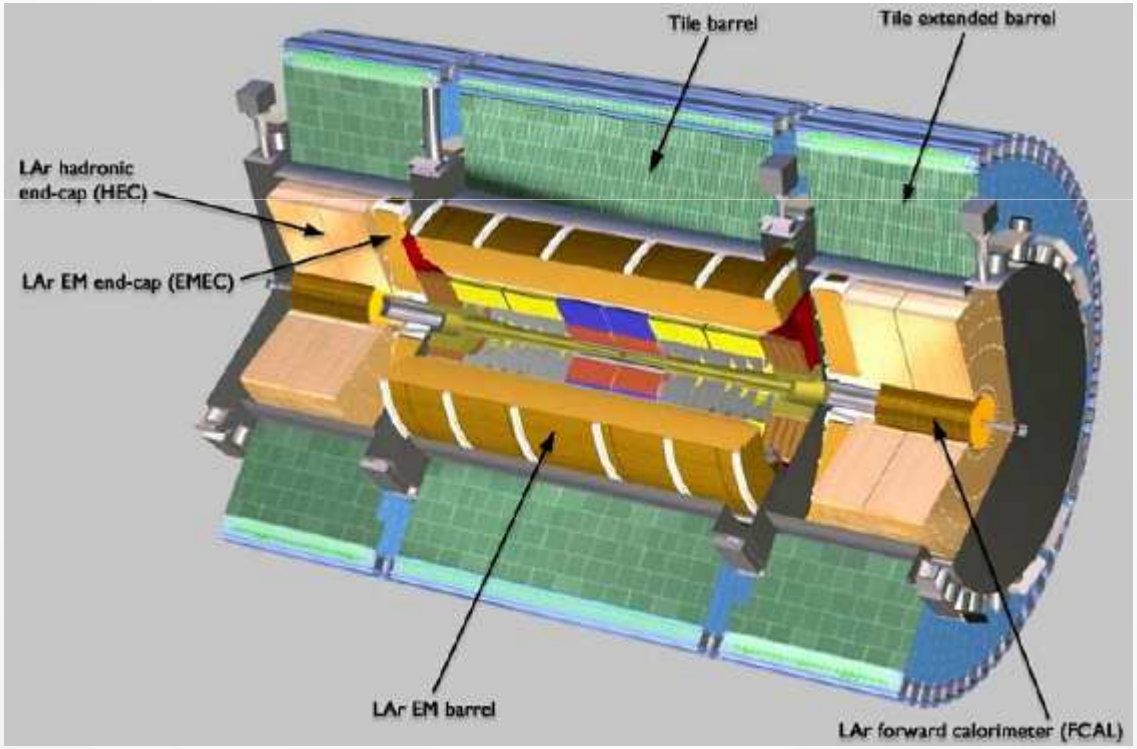
The ***luminosity*** is (37.3± 1.2) pb^{-1} (2000 times larger than that of the previous study): a new kinematic region is explored!

There are many theoretical predictions: next-to-leading order (NLO) QCD calculations corrected for non perturbative effects and NLO Monte Carlo predictions.

THE ATLAS CALORIMETER

-ECAL with LAr (endcap, barrel, forward)
-HCAL (barrel, extended barrel, endcap, Fcal)

The total calorimeter covers the region |η|<4.9.



TRIGGER

Three different triggers are used in this measurement:

1.MBTS (Minimum Bias Trigger Scintillators), in front of endcap cryostats, selects events with jets in the range $20<p_T<60$ GeV.

They are composed of three consecutive levels: L1, L2 and Event Filter (EF).

2.Central trigger
3.Forward trigger

The triggers act independently using several thresholds for the transverse energy of the jet $E_t \equiv E\sin\theta$.

For each L1 threshold there is a corresponding L2 threshold of about 15 GeV higher.

CROSS SECTION DEFINITION

Jets are reconstructed using *anti-k_T algorithm*, where clustering starts from the most energetic objects, with r=0.4 and r=0.6:

$$r = \sqrt{(\Delta y)^2 + (\Delta \phi)^2}$$

Inclusive jet double-differential cross sections are measured as a function of jet p_T in bins of y, in the region p_T>20GeV, |y|<4.4.

Dijet double-differential cross sections are measured as a function of invariant mass of the two leading jets:

$$m_{12} = \sqrt{(E_1 + E_2)^2 - (\vec{p}_1 + \vec{p}_2)^2}$$

Dijet cross sections are binned in the variable y* that is the rapidity in the two-parton centre of mass frame:

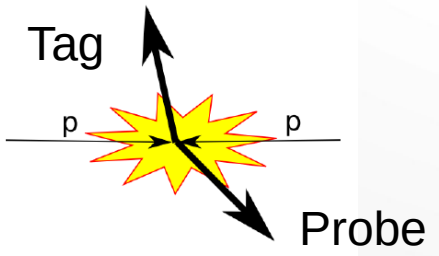
$$y^* = \frac{1}{2} \ln \left(\frac{1 + |\cos \theta^*|}{1 - |\cos \theta^*|} \right)$$

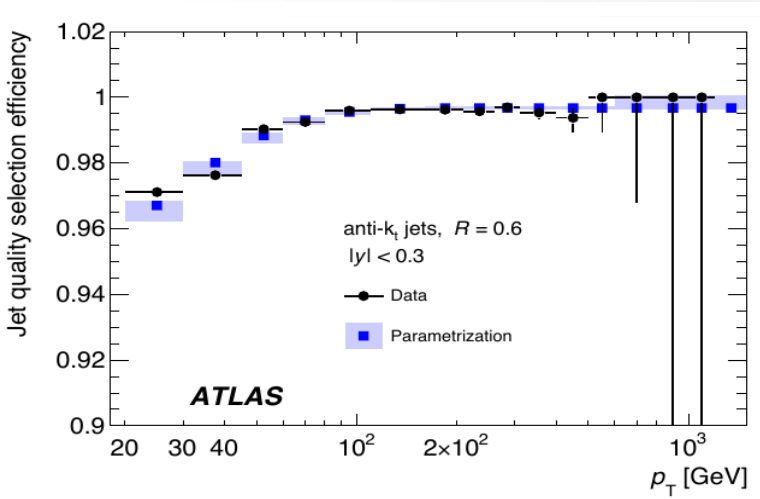
OFFLINE SELECTION

1. Event Selection → Avoid background, cosmic rays...
   - At least one primary vertex consistent with the beams.
   - At least five tracks associated with the vertex.

Efficiency over 99%

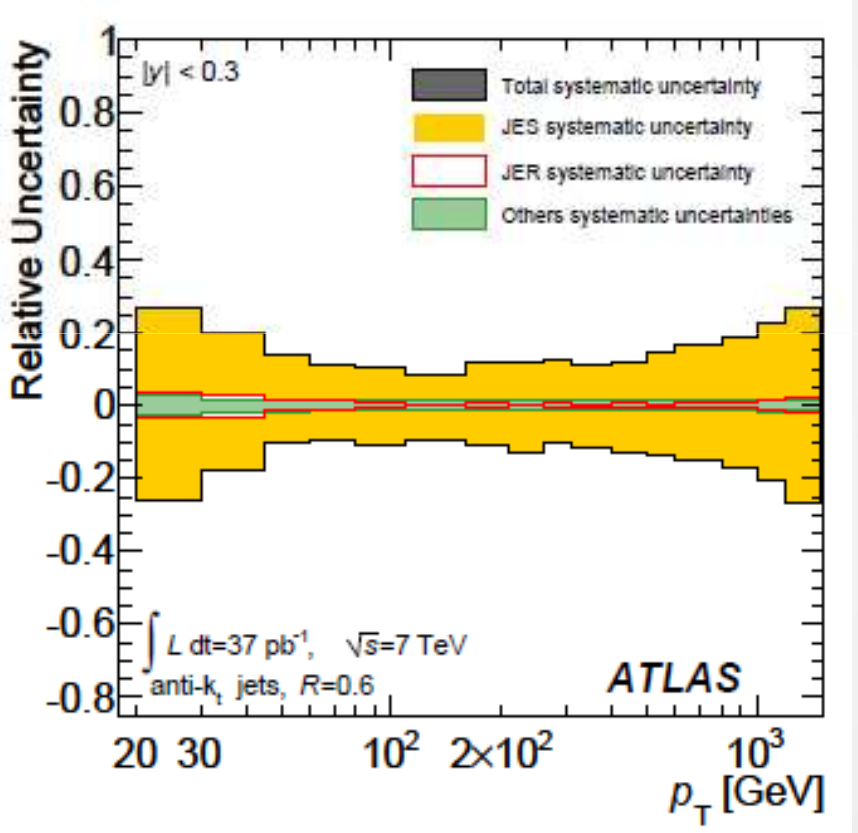
2. Jet Selection
   - Inclusive Jets: $p_T > 20$ GeV and |y| < 4.4.
   - Dijets: one with $p_T > 20$ GeV and the other one with $p_T > 30$ GeV .
   - ➔ Efficiency measured using a Tag & Probe method.
     - ✓ Greater than 99% for $p_T > 60$ GeV.





EXPERIMENTAL UNCERTAINTIES

- Non-collision background is taken to be negligible.
- The uncertainty from mis-modeling of the vertex position is taken to be negligible.
- Pile-up is negligible.
- The uncertainty on the luminosity is 3.4%.
- The biggest contribution to uncertainty comes from the Jet Energy Scale (JES).



COMPARING THEORY AND EXPERIMENT

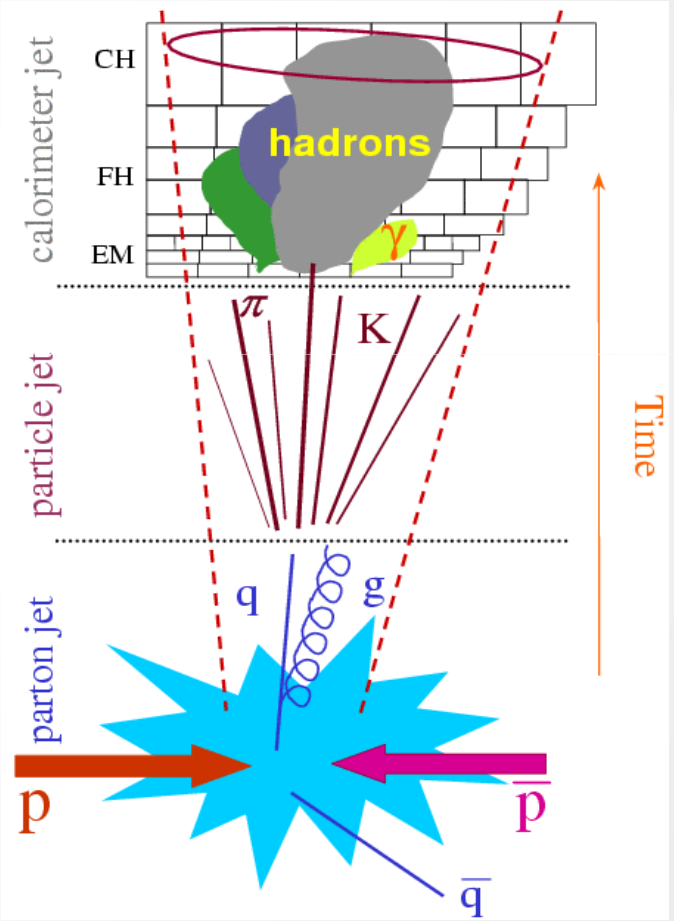
- Experiment: from energy depositions to particle jet.

  -Using a Montecarlo simulation a correction for the detector effects can be derived. This is done using an *unfolding* method.

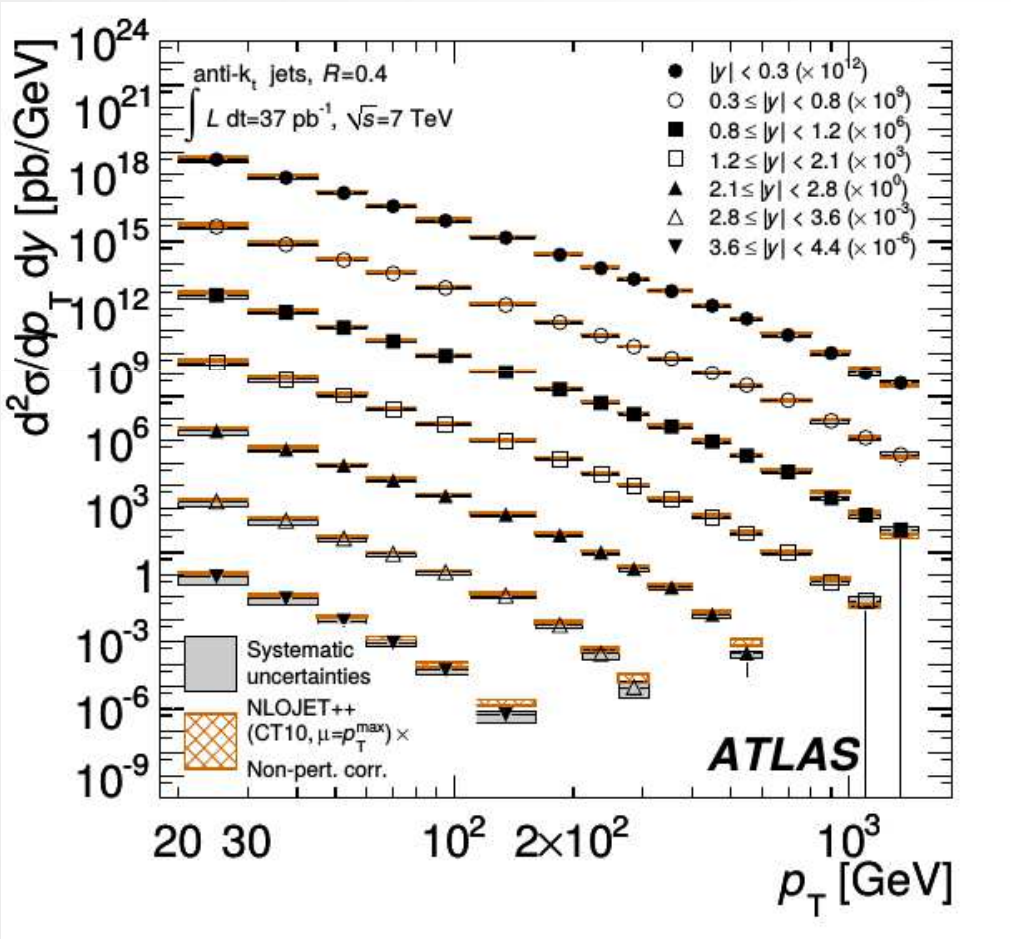
- Theory: from parton to particle jet.

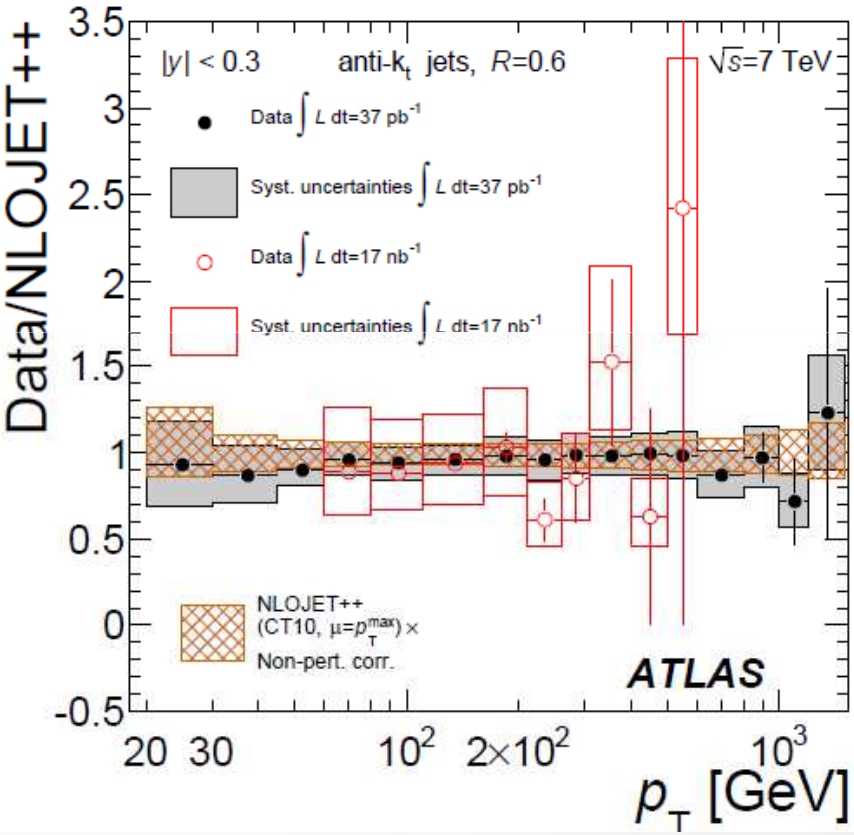
  -The hadronization can be switched on and off in the Montecarlo simulation. Comparing both samples the Non-Pertubative Corrections are derived.

➢The Montecarlo simulation was cross-checked comparing the shapes of the resulting jets.

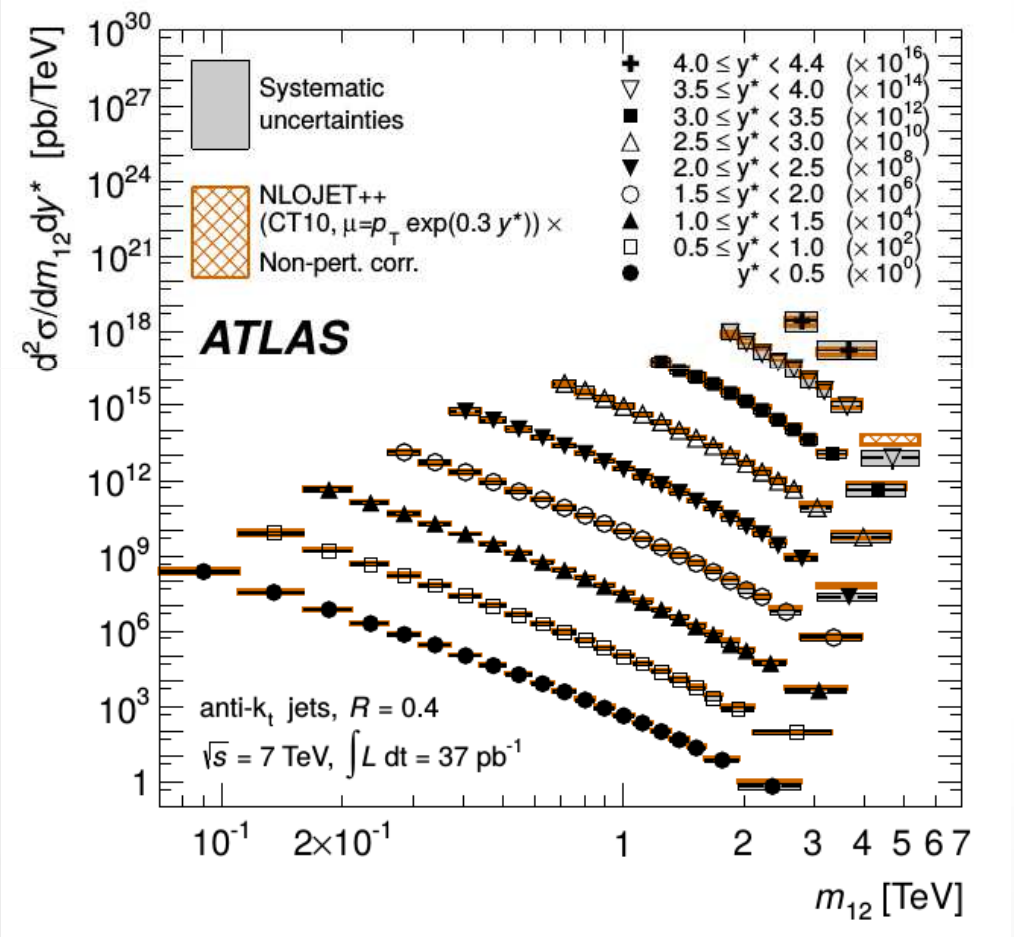


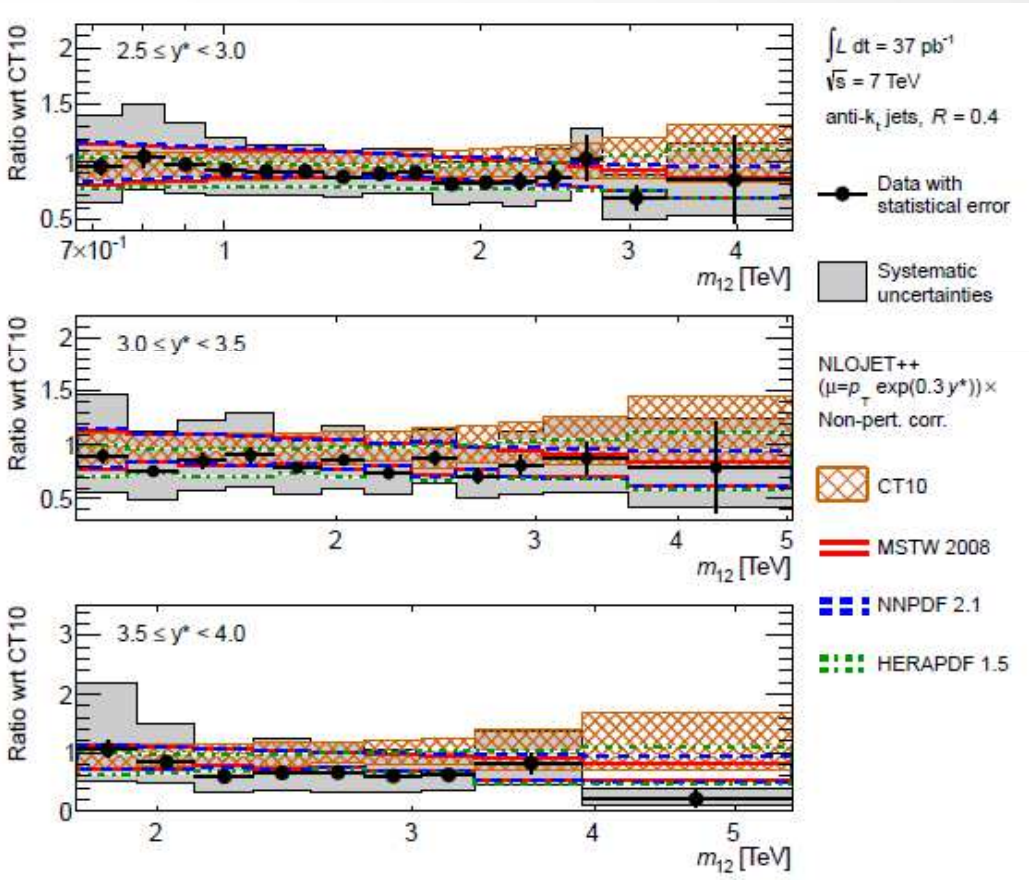
RESULTS: INCLUSIVE JET CROSS SECTIONS





RESULTS: DIJET CROSS SECTIONS





CONCLUSIONS

- Cross section measurements for inclusive jets and dijets reconstructed with two different clustering parameters have been presented and compared.
- The measurements have been corrected to particle level.
- These results probe NLO pQCD in a new kinematic regime.
- The cross sections are compared with NLO pQCD calculations. In spite of the good agreement, predicted cross sections tend to be larger at high energy.
- These measurements probe unexplored areas of parton distribution functions at large x and large momentum transfer.

✓ **These results constitute a comprehensive test of QCD across a large kinematic regime.**

THE END

Thanks for your attention!