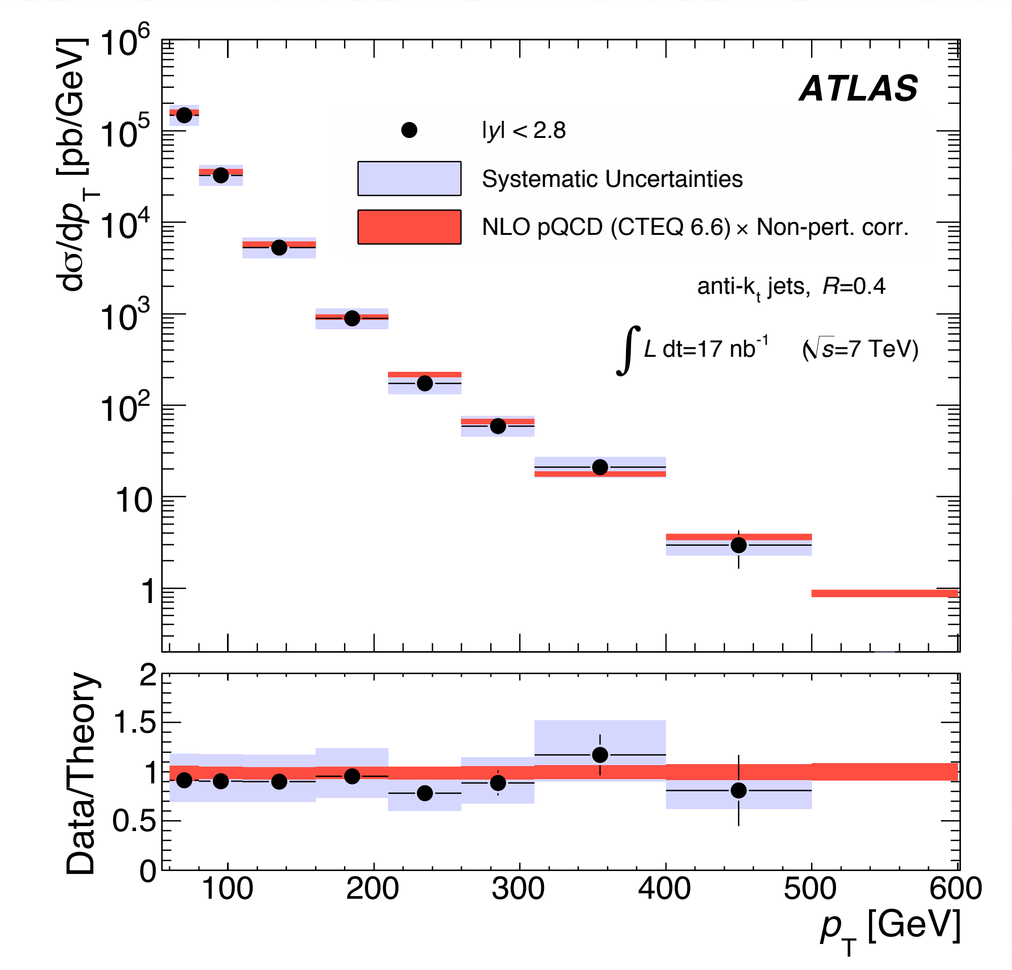
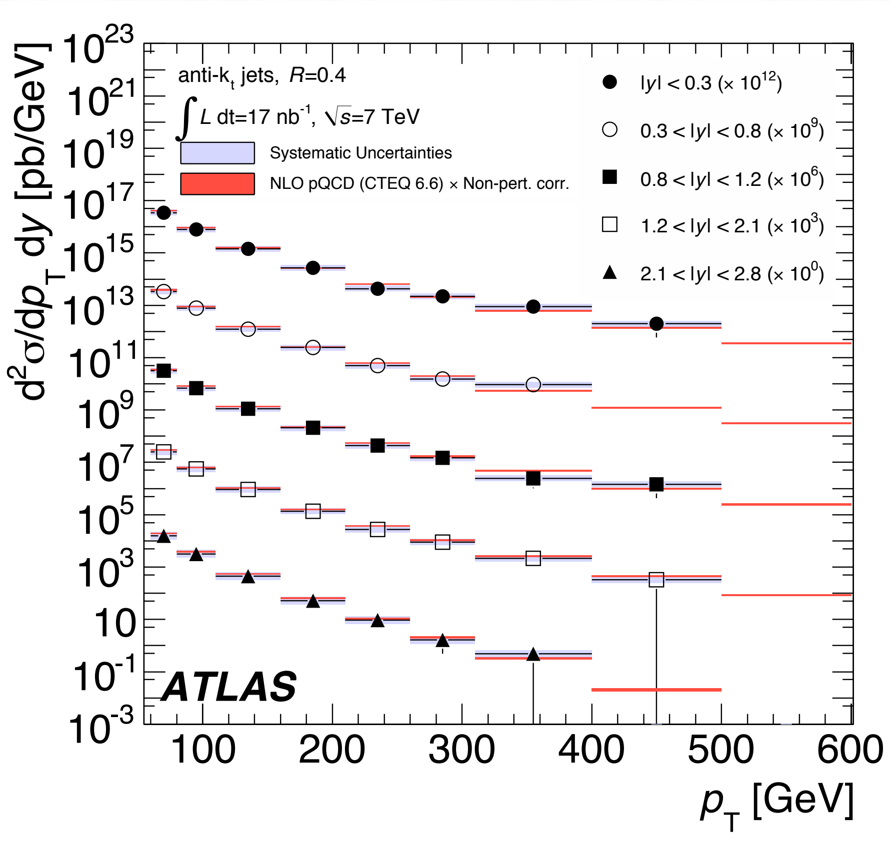
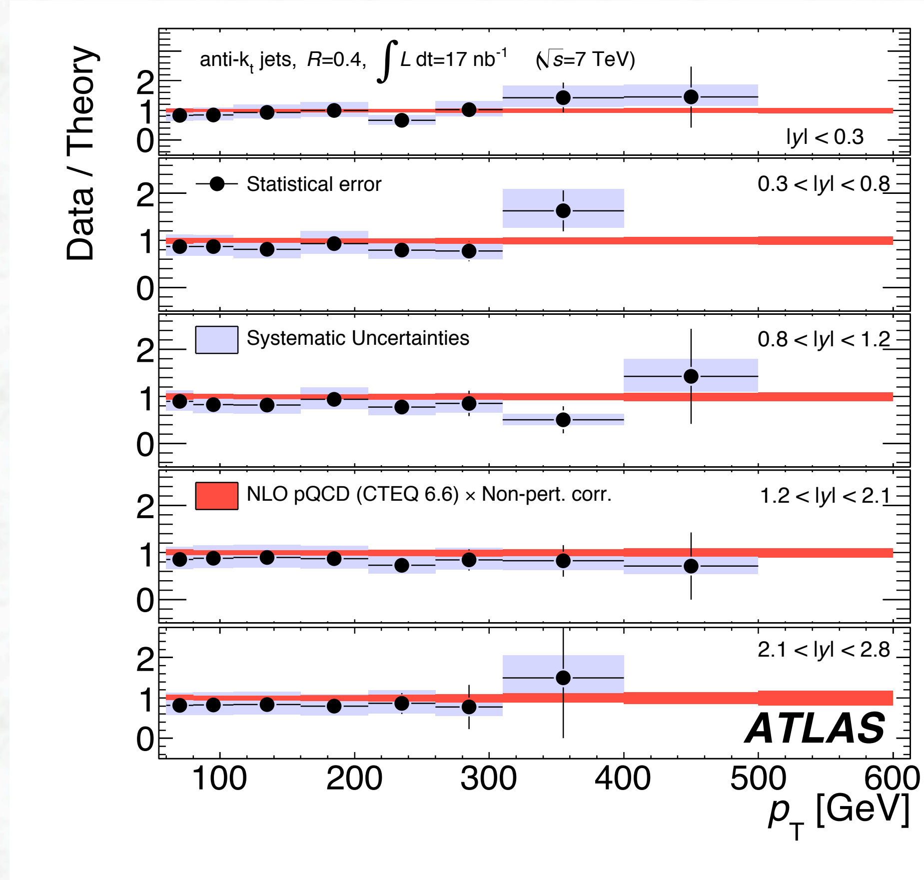
First measurements of jet p_T spectra:



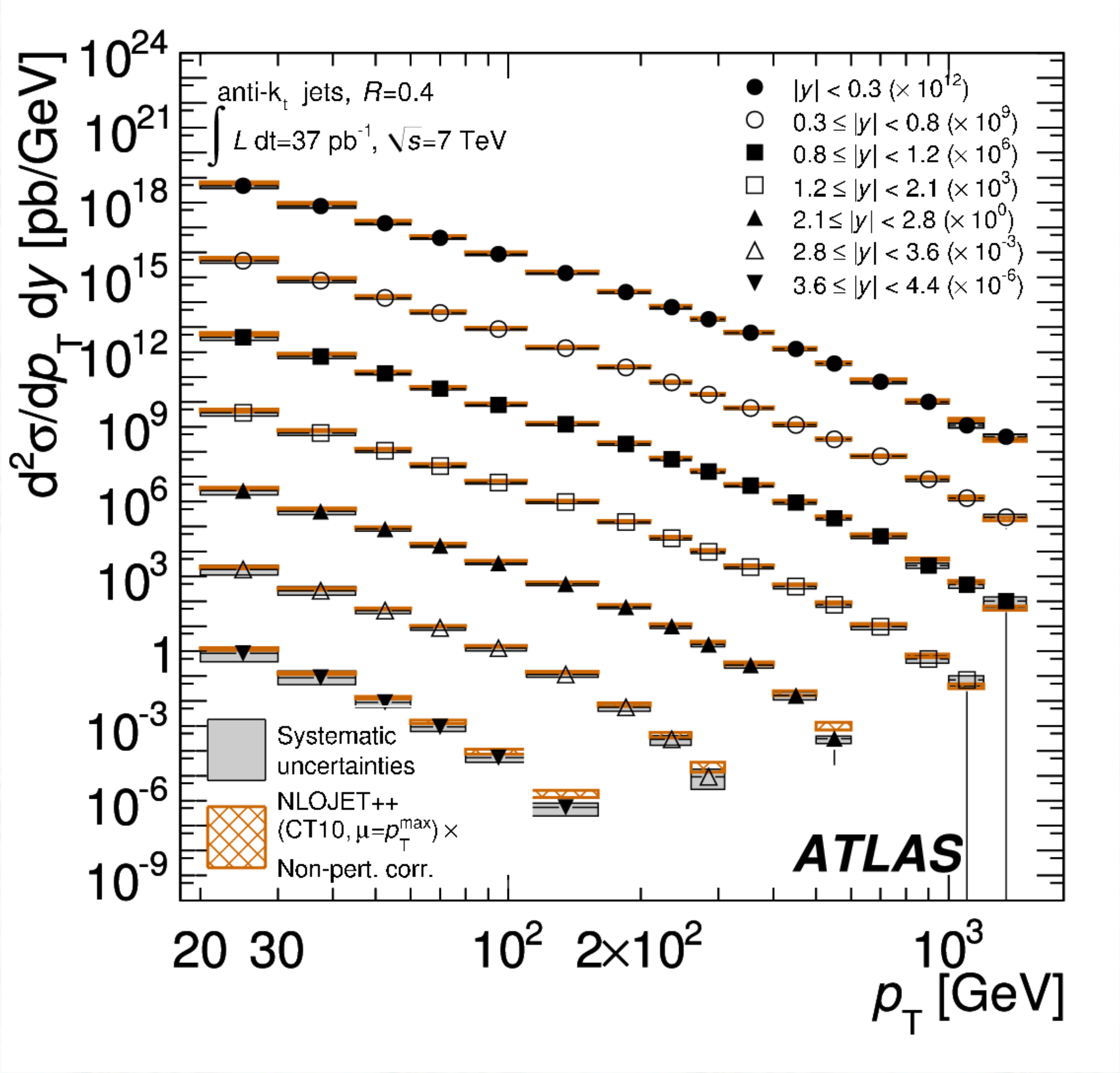
Inclusive jet differential cross section as a function of jet p_T integrated over the full region $|y| < 2.8$ for jets identified using the anti-kt algorithm with R = 0.4. The data are compared to NLO pQCD calculations to which soft QCD corrections have been applied. The error bars indicate the statistical uncertainty on the measurement, and the grey shaded bands indicate the quadratic sum of the systematic uncertainties, dominated by the jet energy scale uncertainty. There is an additional overall uncertainty of 11% due to the luminosity measurement that is not shown. The theory uncertainty shown in red is the quadratic sum of uncertainties from the choice of renormalisation and factorisation scales, parton distribution functions, $\alpha_s(m_Z)$, and the modelling of soft QCD effects.

Double differential cross sections:

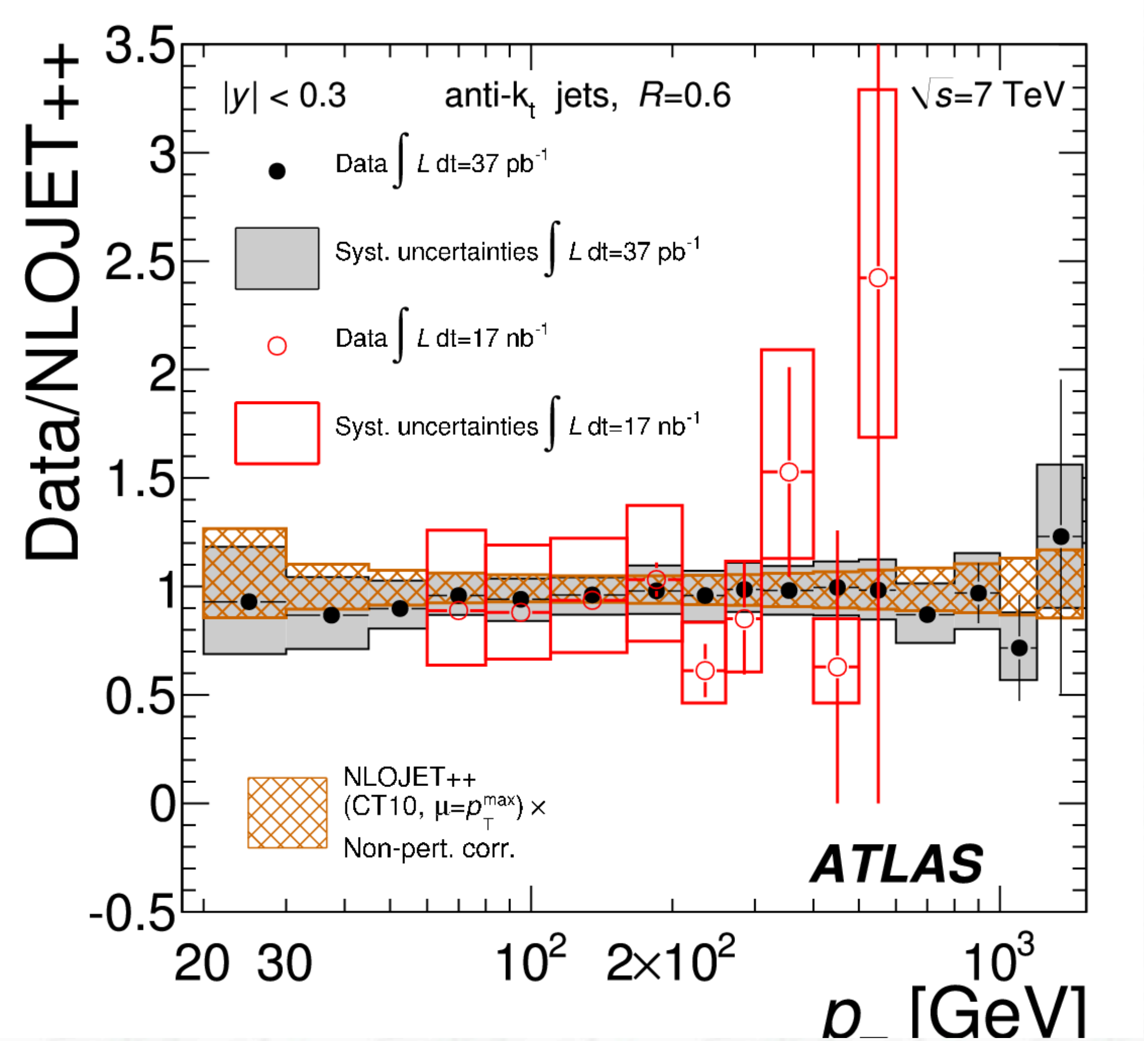




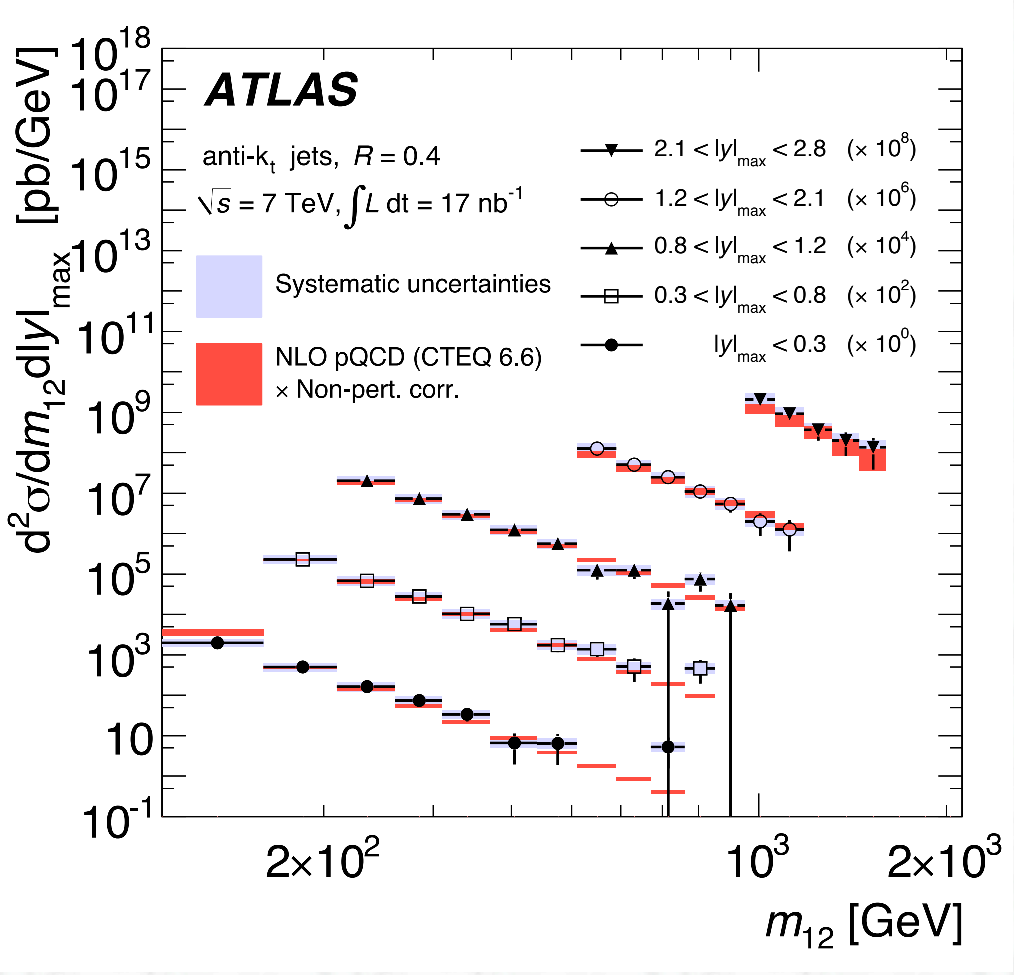
A more recent measurement



A comparison



Invariant di-jet mass spectra:

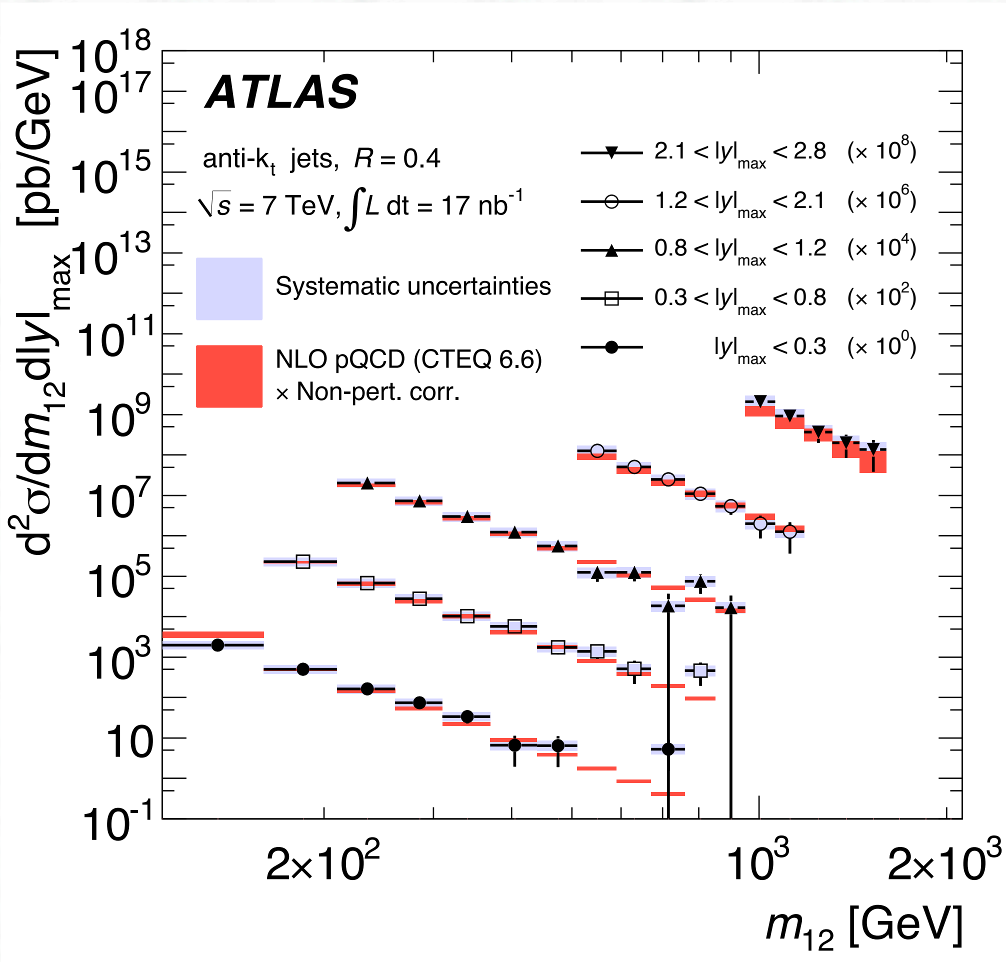


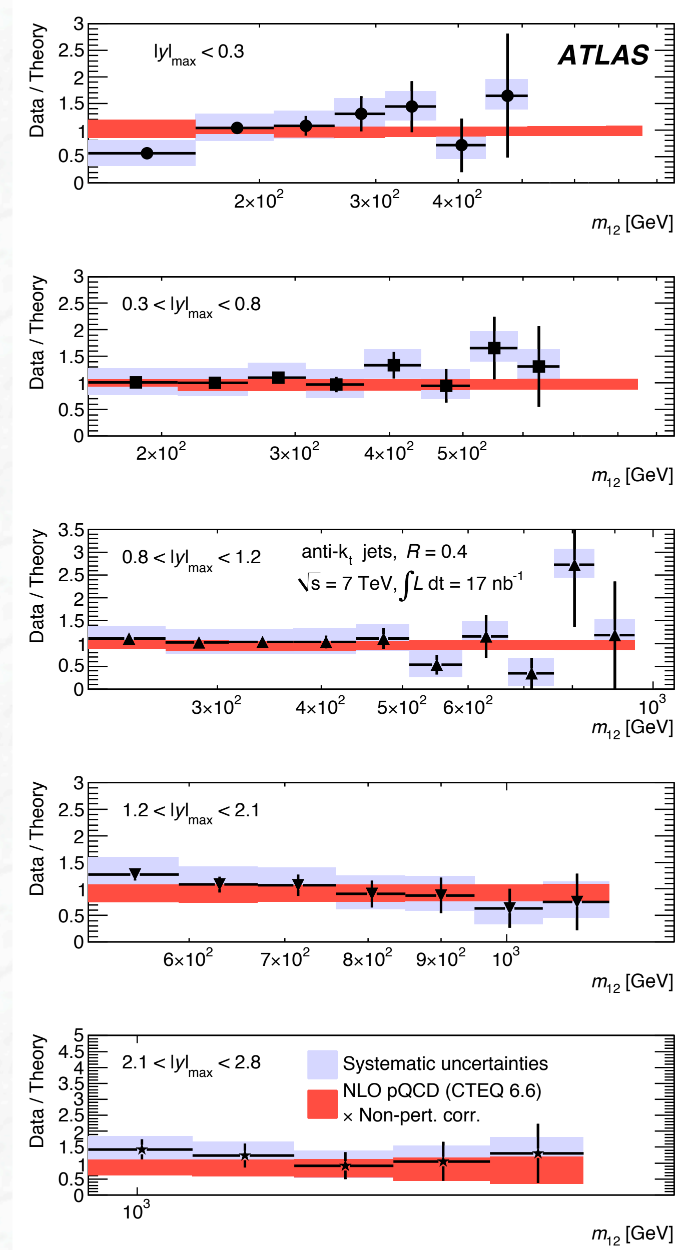
Dijet double-differential cross section as a function of dijet mass, binned in the maximum rapidity of the two leading jets, |y|_max. The results are shown for jets identified using the anti-kt algorithm with R = 0.4. The data are compared to NLO pQCD calculations to which soft QCD corrections have been applied. The uncertainties on the data and theory are shown as described above for the pT spectra.

Important for: - Test of QCD

- Search for new resonances decaying into two jets (see later)

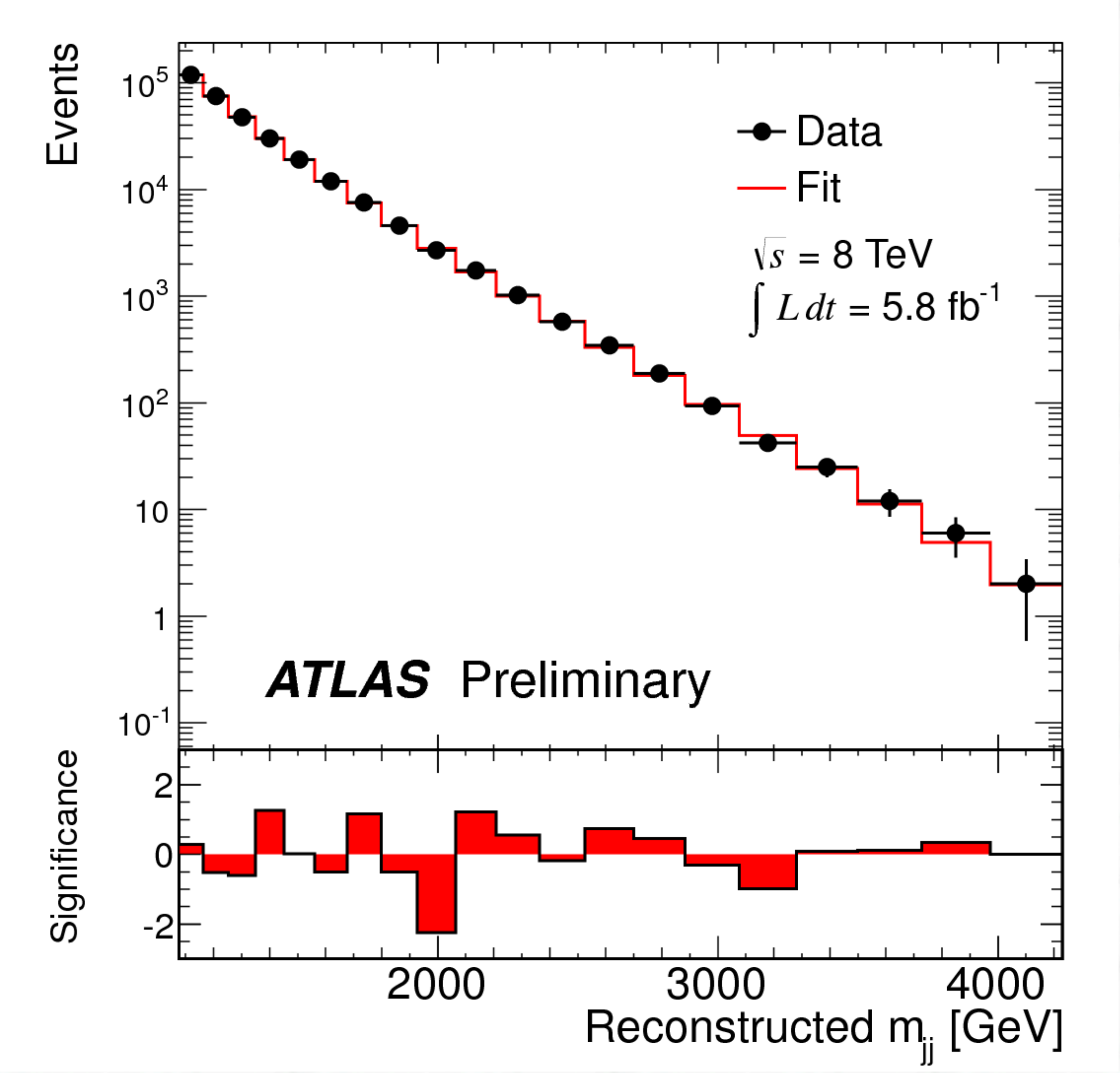
Invariant di-jet mass spectra, ratio data/theory:



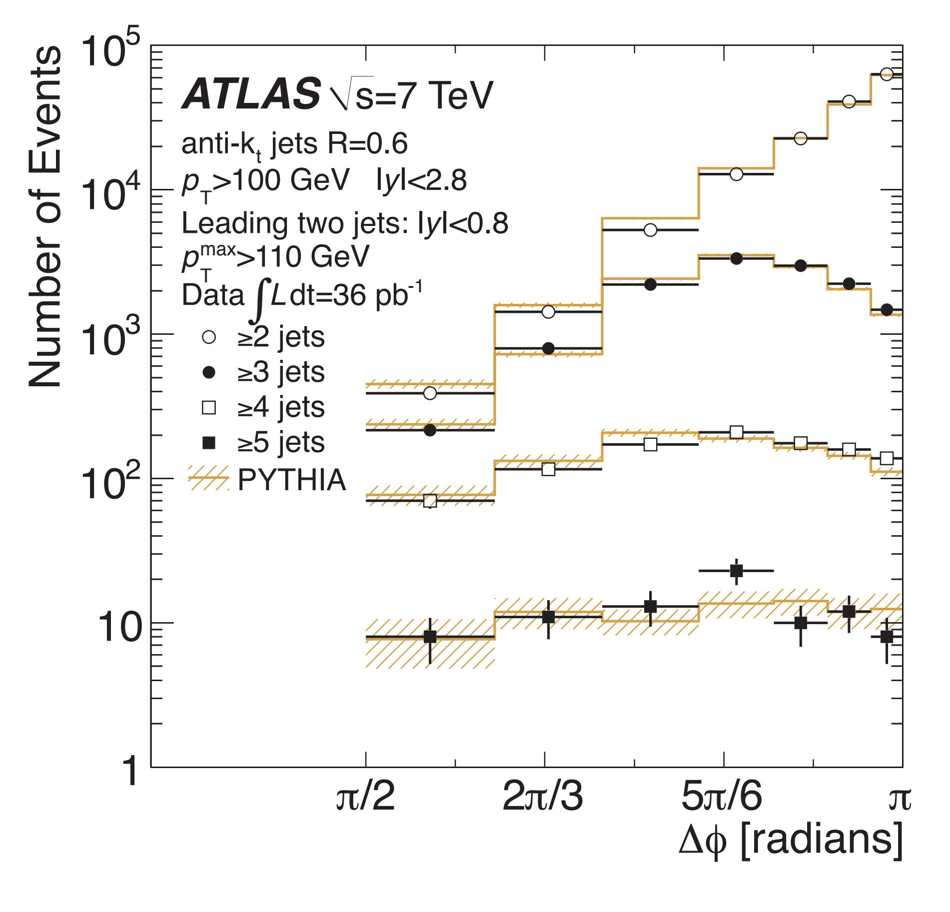


Important for:
- Test of QCD
- Search for new resonances decaying into two jets (see later)

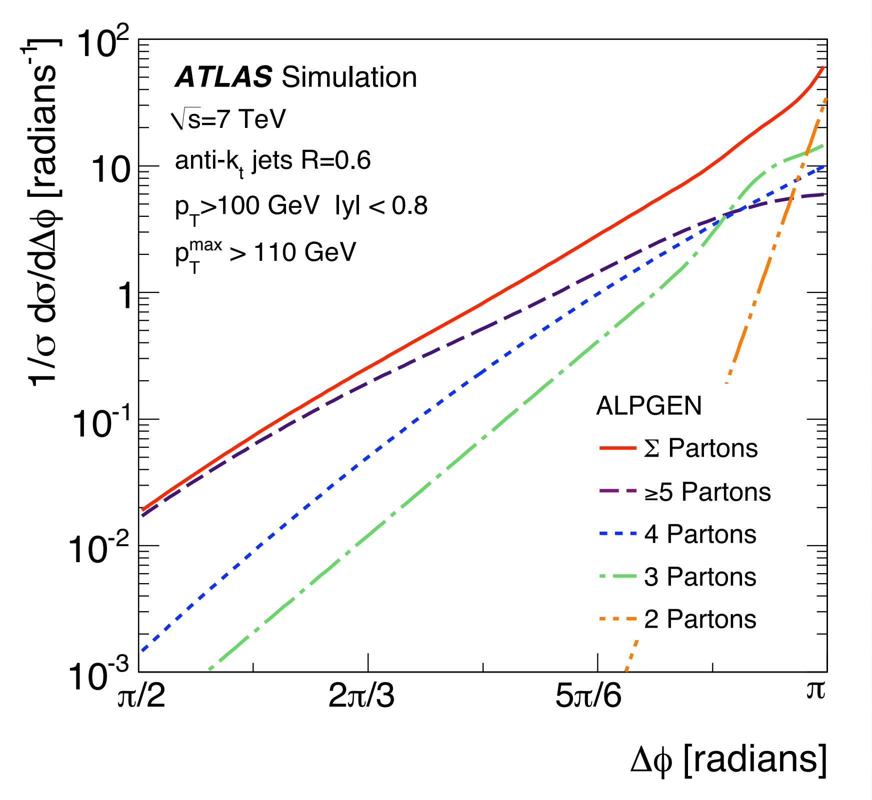
New resonances?



Angular correlations:

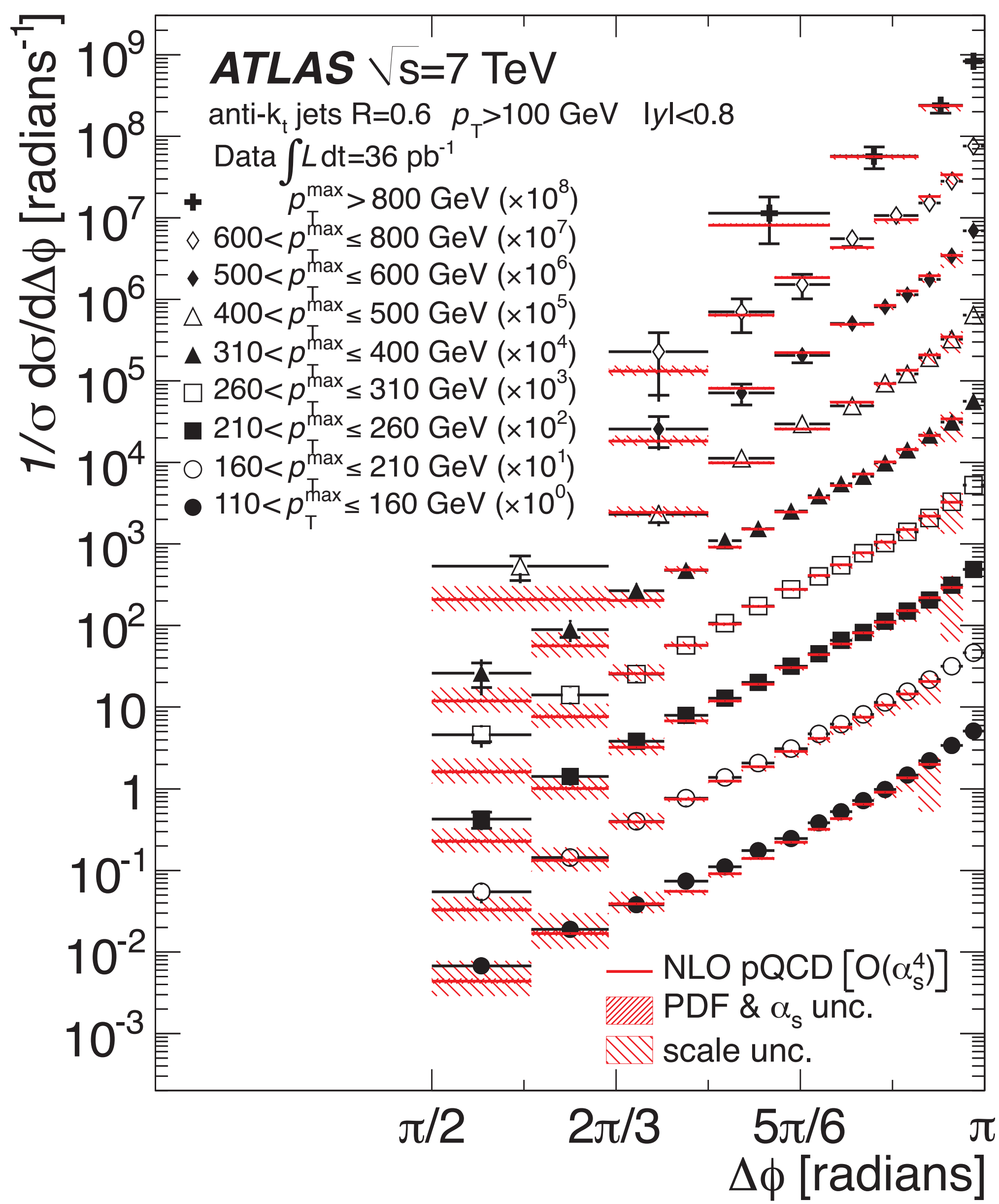


The delta phi distribution for >=2, >=3, >=4, and >=5 jets with pT > 100 GeV. Overlaid on the calibrated but otherwise uncorrected data (points) are results from PYTHIA processed through the detector simulation (lines). All uncertainties are statistical only.



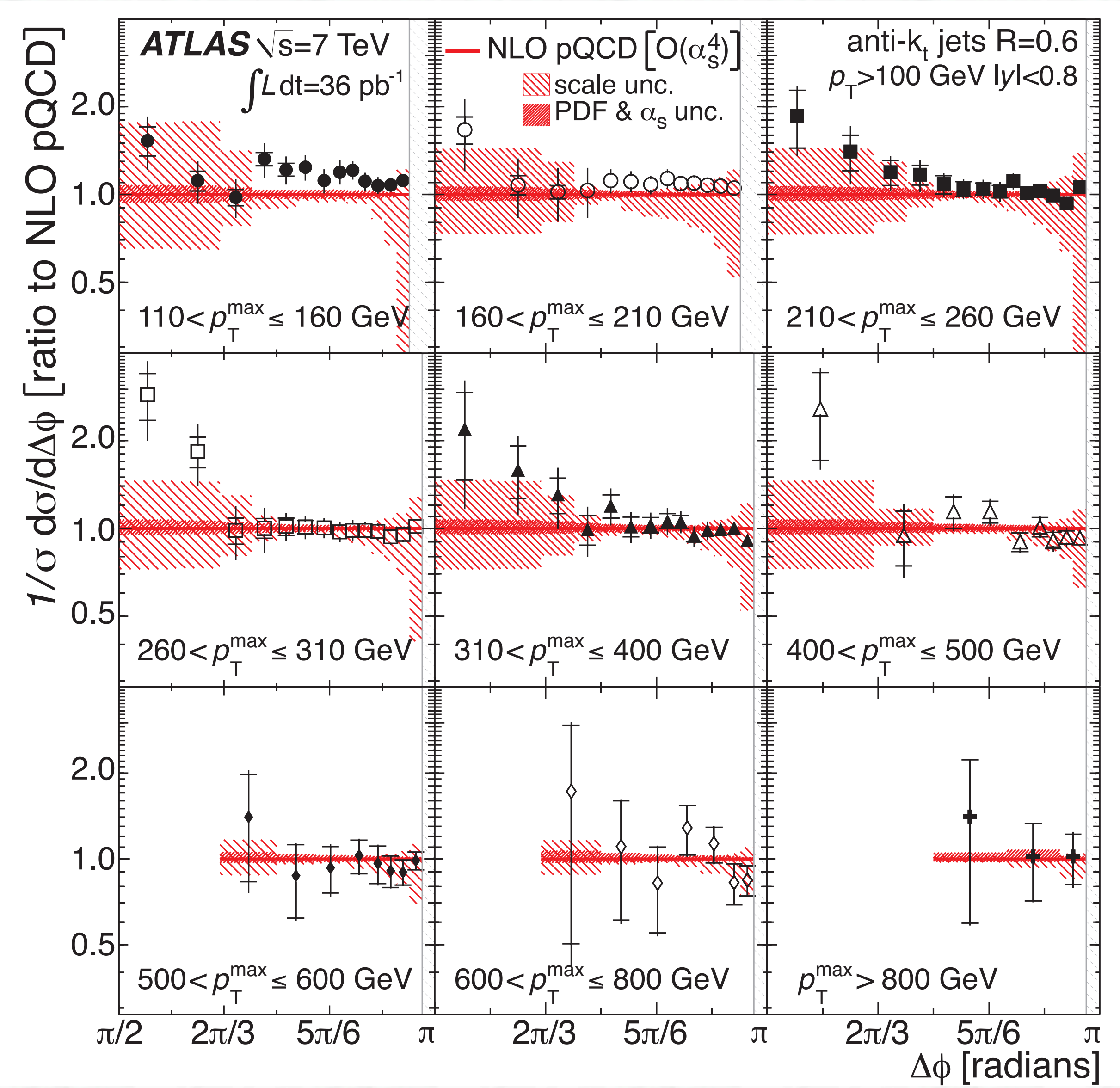
The delta phi distribution in an ALPGEN Monte Carlo sample at √s = 7 TeV. Individual contributions from 2 --> 2 (orange dot-dot-dashed line), 3 (green dot-dashed line), 4 (blue dotted line), and >=5 (purple dashed line) production are shown. The total contribution (indicated by "Sigma Partons") is represented by the solid red line. The minimum jet pT requirement is 100 GeV, and the leading jet pT must be > 110 GeV.

Angular correlations:



The differential cross section (1/sigma)(d sigma/ d delta phi) binned in nine pTmax regions. Overlaid on the data (points) are results from the NLO pQCD calculation. The error bars on the data points indicate the statistical (inner error bar) and systematic uncertainties added in quadrature in this and subsequent figures. The theory uncertainties are indicated by the hatched regions. Different bins in pTmax are scaled by multiplicative factors of ten for display purposes. The region near the divergence at delta phi --> pi is excluded from the calculation.

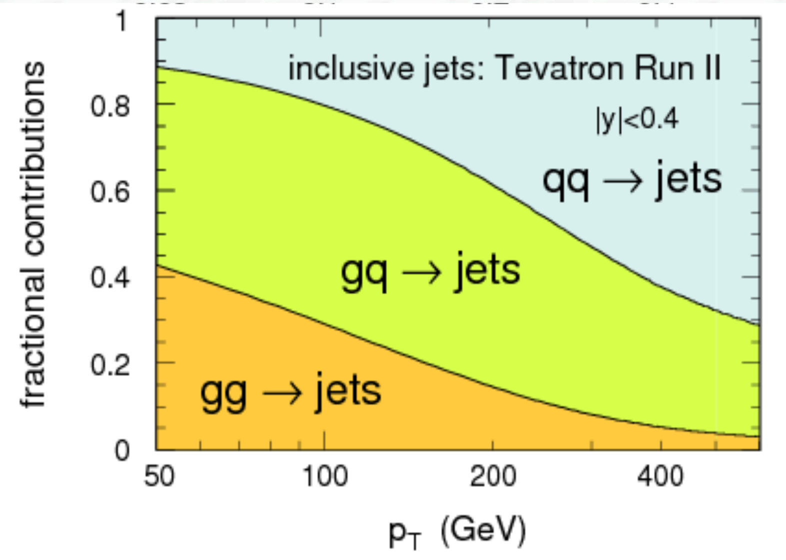
Ratio between data and NLO calculations:



Ratio of the differential cross section (1/sigma)(d sigma/d delta phi) measured in data with respect to expectations from NLO pQCD (points). The theory uncertainties are indicated by the hatched regions. The region near the divergence at delta phi --> pi is excluded from the comparison.

5.4 Impact on the parton density distributions

- As discussed before: there is a sizeable gluon contribution in the QCD jet cross sections

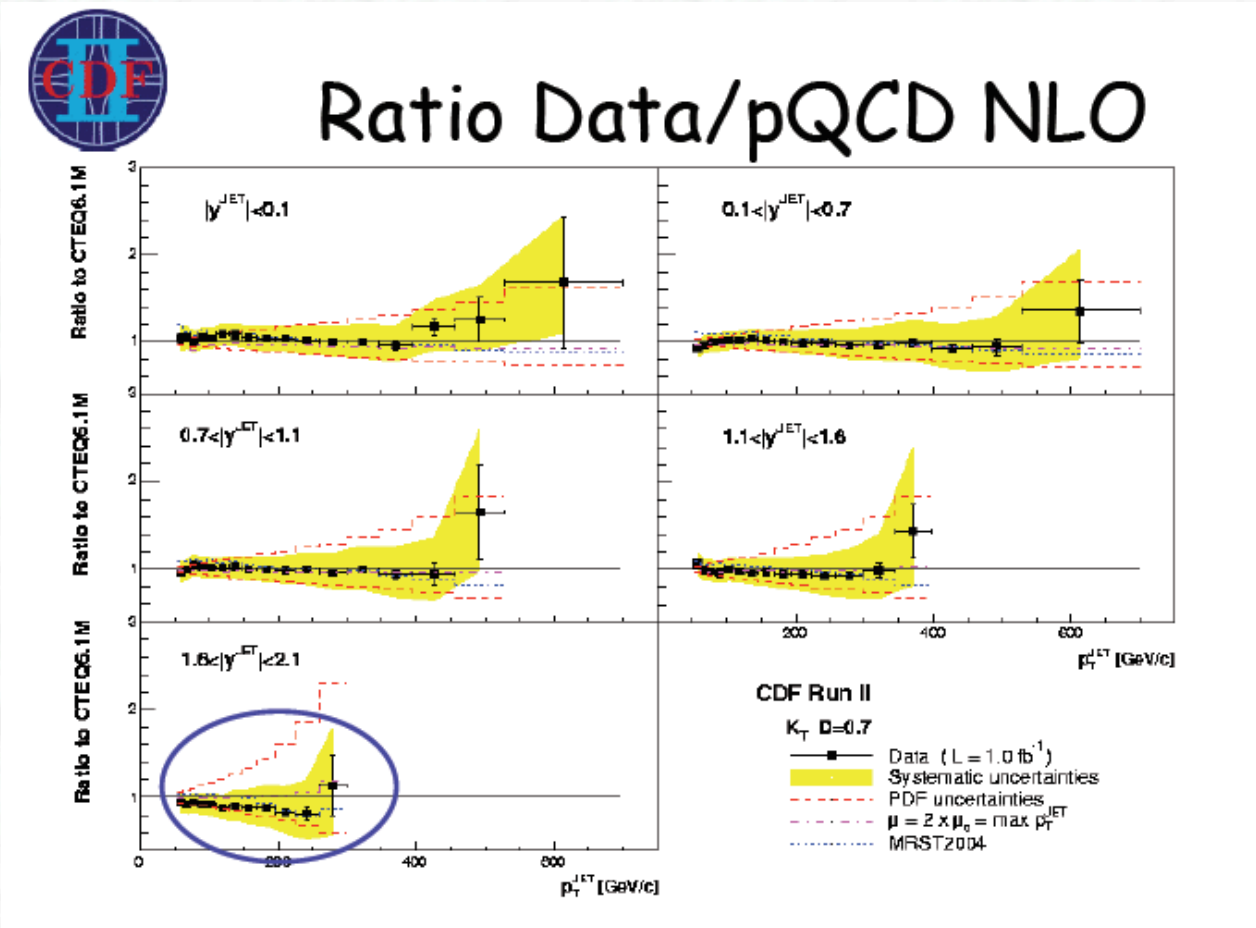


Tevatron,
ppbar, $\sqrt{s}$ = 1.96 TeV,
central region $|\eta| < 0.4$

- The gluon distribution, at particular at large x-values (high PT jets) is not well constrained from deep inelastic scattering or other experiments

  → large uncertainties (which are not easy to quantify)

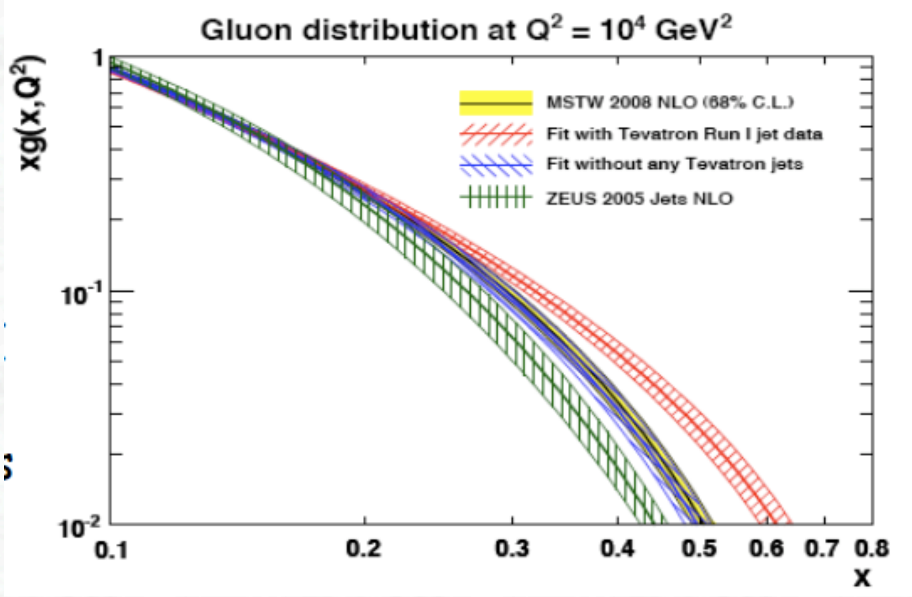
Tevatron data from 2008 (CDF experiment):

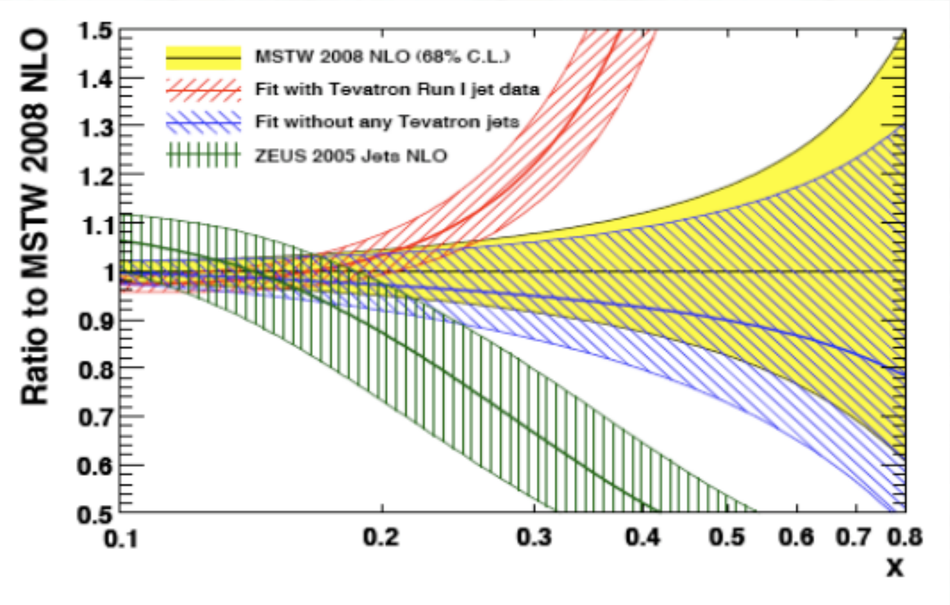


Since the experimental uncertainties are smaller than the pdf uncertainties, the latter can be reduced / pdfs can be more constrained

Tevatron jet data are included in recent pdf fits:

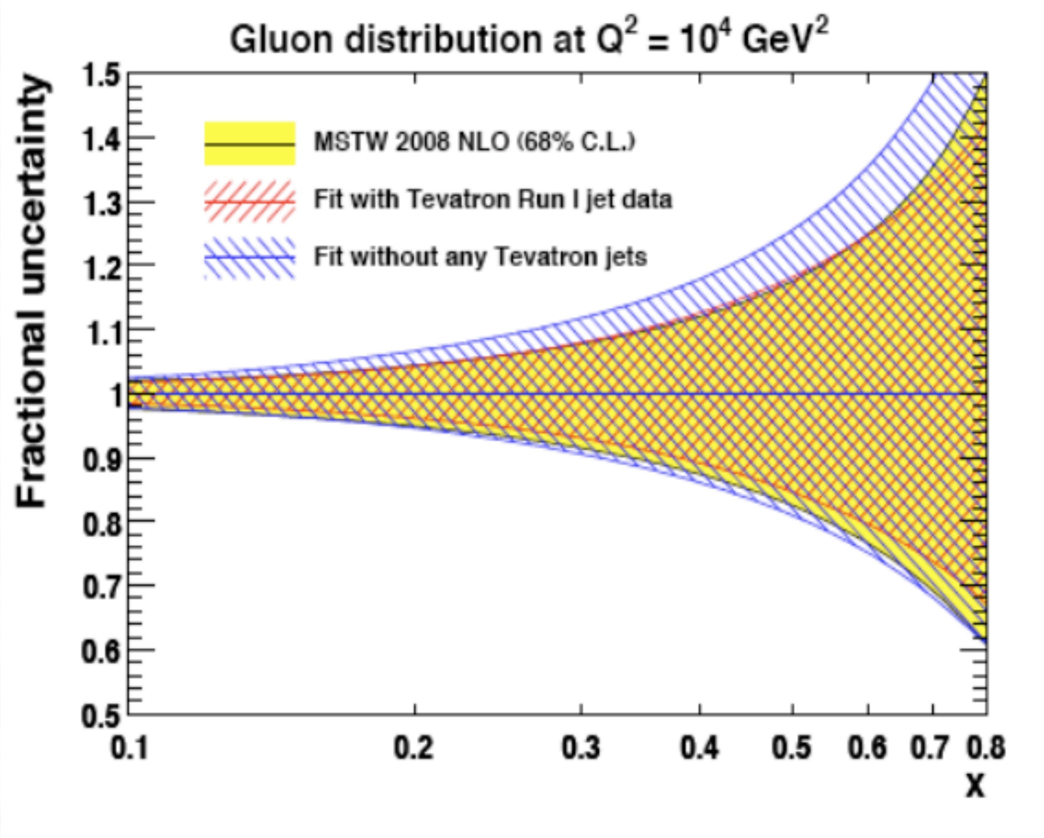
- For details, see MSTW analysis in Ref. hep-ph:0901.0002
- Data from CDF and D0 (Run-II, 2008) are included;
  Data favour a smaller gluon content at high x





Tevatron jet data are included in recent pdf fits:

- Reduced pdf uncertainty
  (already included and used in recent cross-section calculations at the Tevatron and at the LHC)



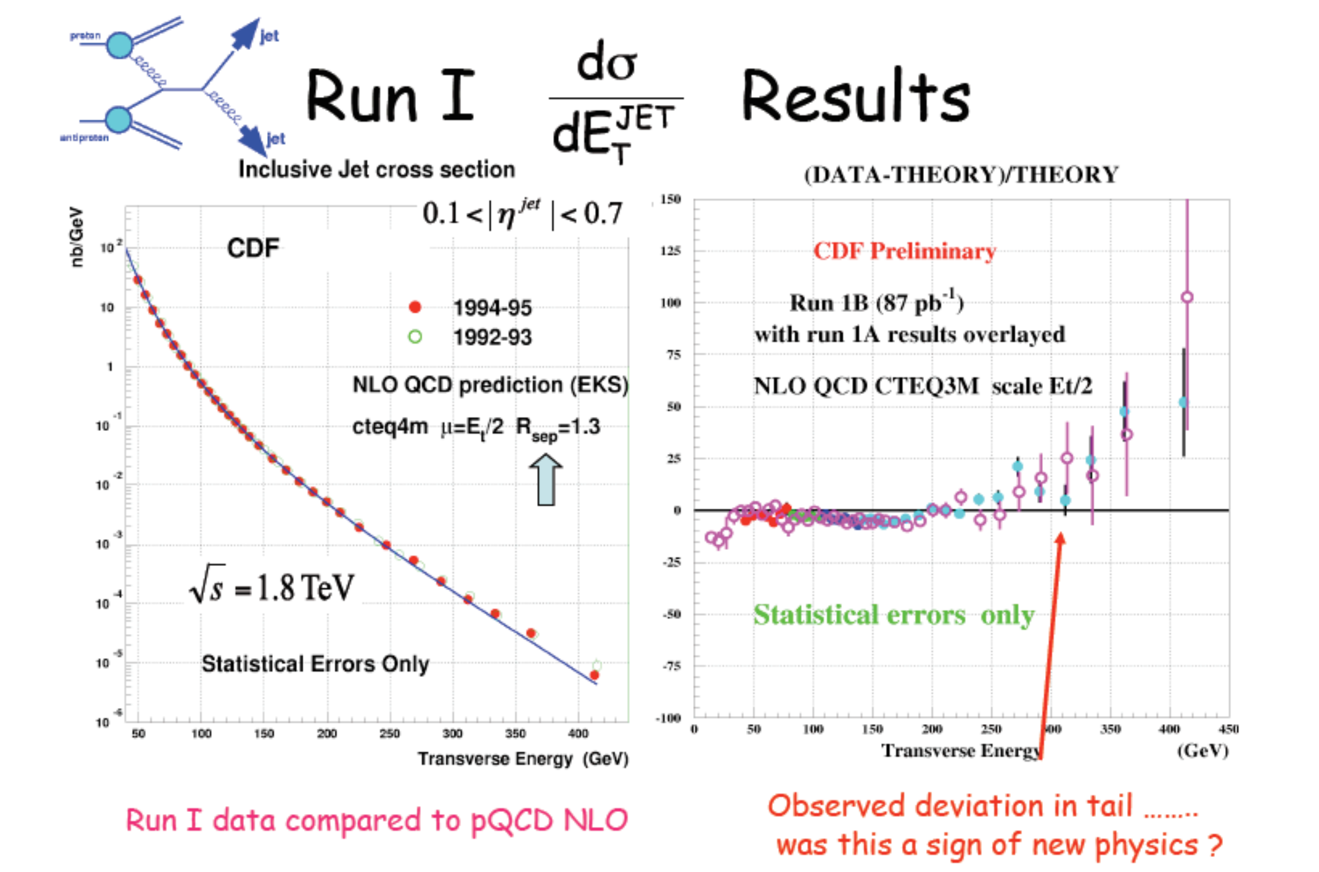
It is expected that LHC data will be added as well very soon → further constraints

Relevance for Searches for new physics:

- Several models for new physics, e.g. quark substructure, predict deviations from the QCD behaviour at large PT

  Effects from pdfs and "new physics" must be separated

- Famous "historical example": evidence for quark substructure in the CDF experiment in 1997



Some important comments:

- Disentangling the effects of pdfs and "new physics" is not easy

- All data entering the pdf fits must be described in the global fits by the pdf fitting groups…. it is important to have uncorrelated data sets (different physics processes, accelerators, as little common systematic uncertainties as possible)

- pdf uncertainties must be evaluated and and interpretation of new physics must take these uncertainties into account

Evaluation of pdf uncertainties:

(i) Uncertainties on the fitted parameters, within one parametrization (these uncertainties are provided by the pdf-fitting groups)

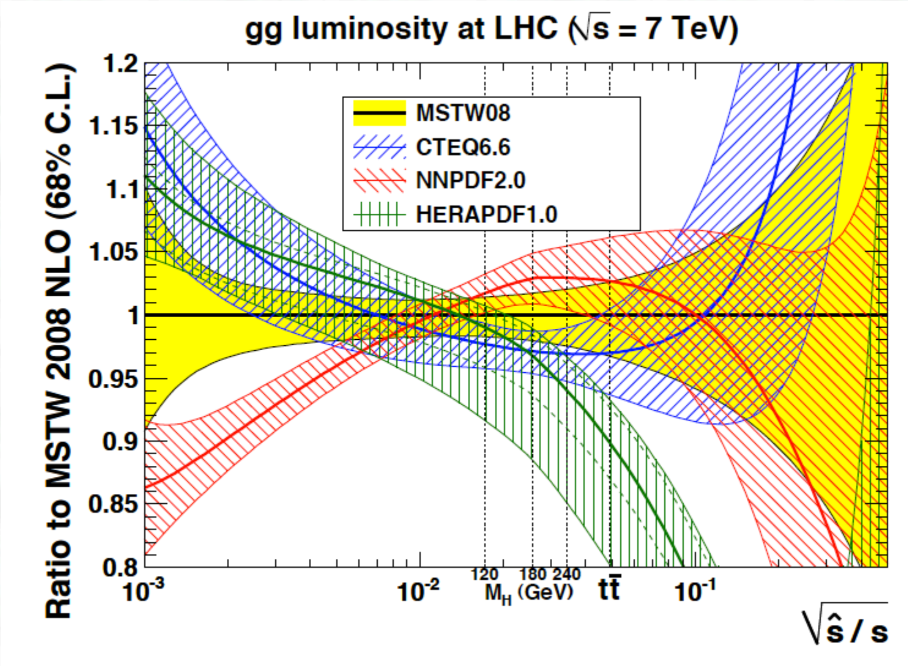
(ii) As an additional check → systematic uncertainties a comparison between different pdf fits (groups) must be performed

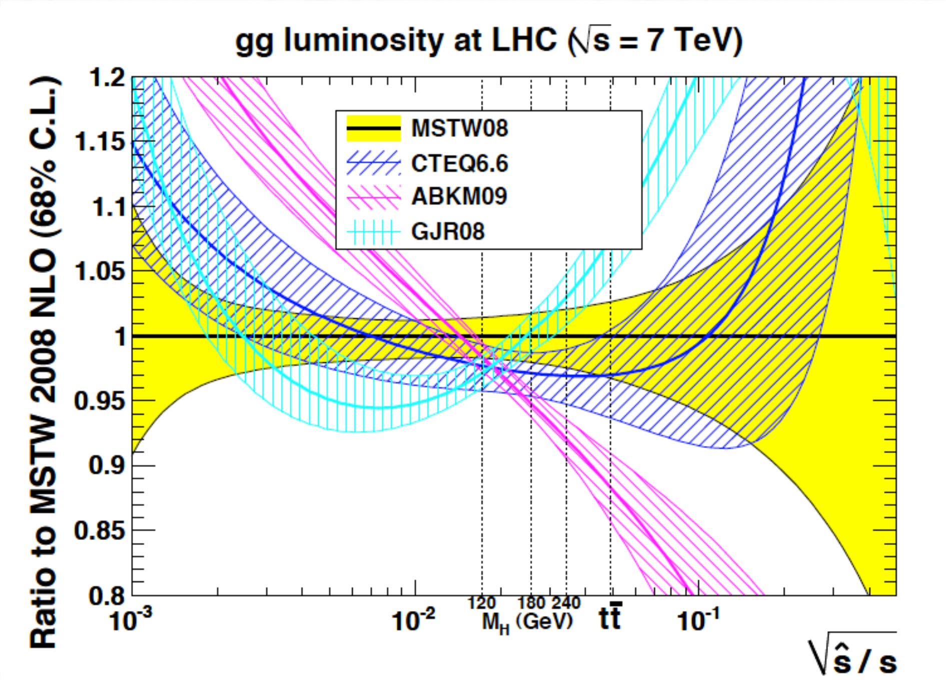
(iii) Uncertainties on the strong coupling constant α_s (enters via pdf evolution)

Error bands of individual parametrizations and consistency among them:

- MSTW (2008) is always used as a reference
- uncertainties depend on the x-values or the c.m.s energy of the parton-parton-system

gg luminosity at the LHC:

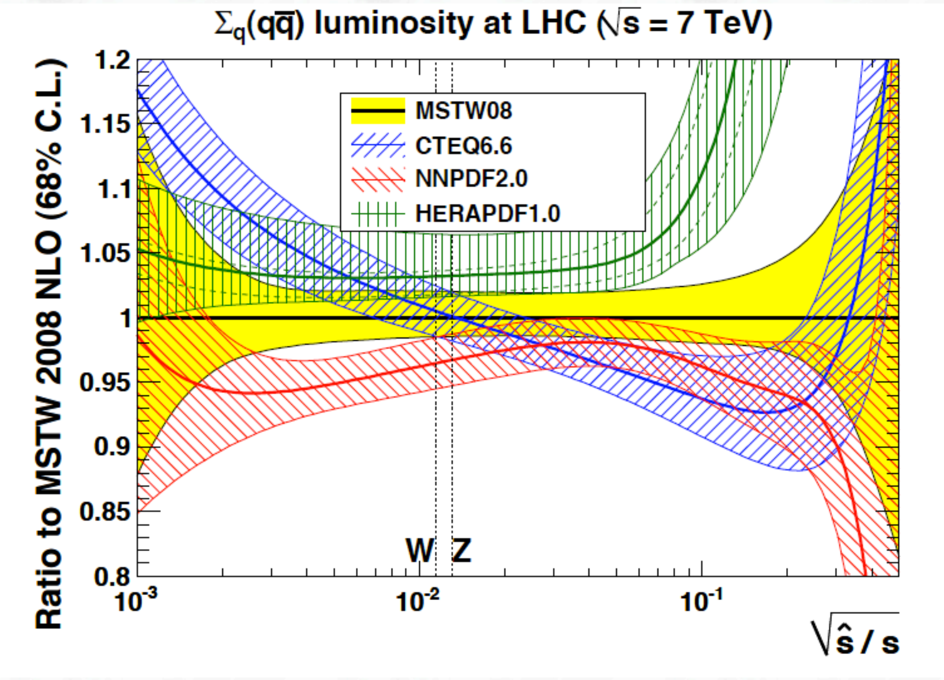


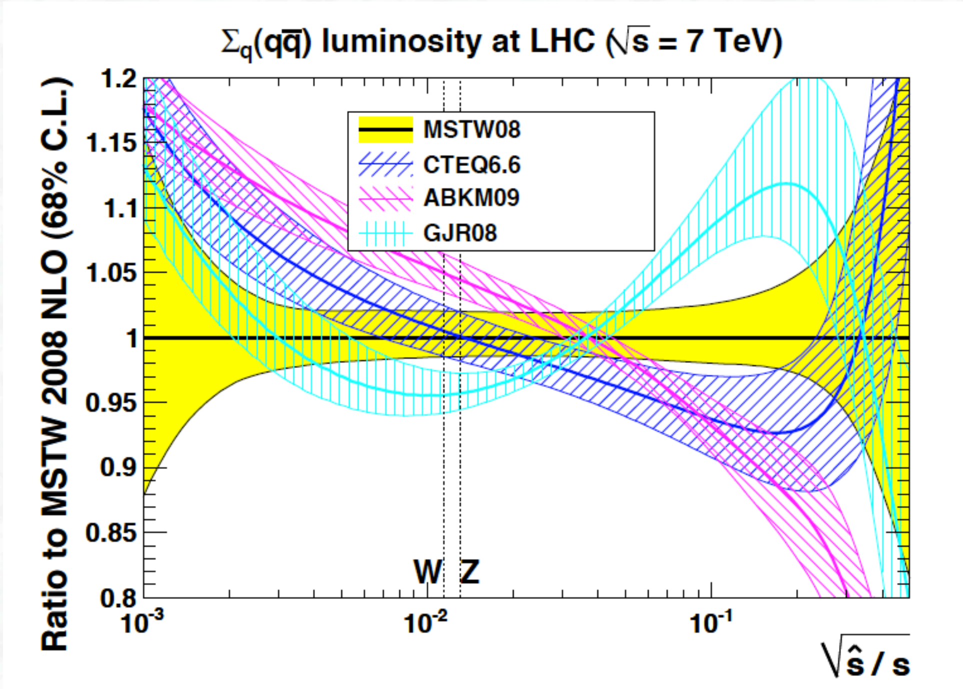


Error bands of individual parametrizations and consistency among them:

- MSTW (2008) is always used as a reference
- uncertainties depend on the x-values or the c.m.s energy of the parton-parton-system

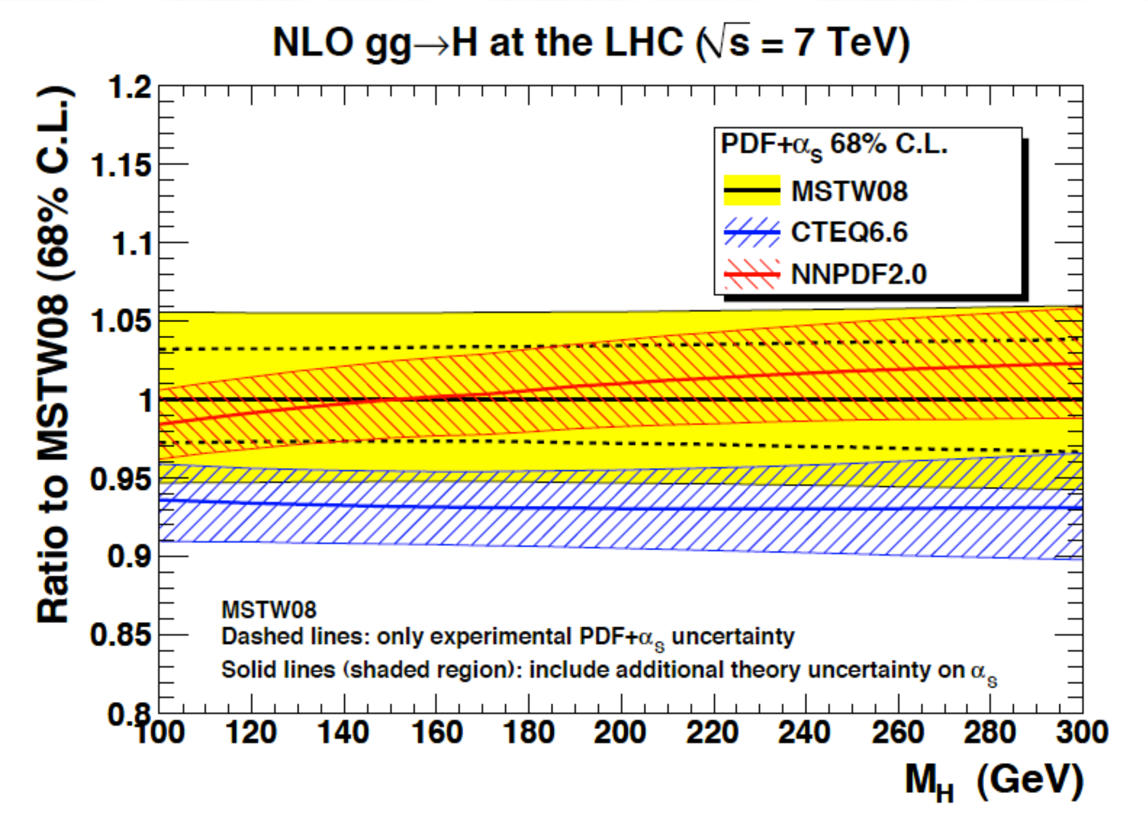
Σ qq luminosity at the LHC:

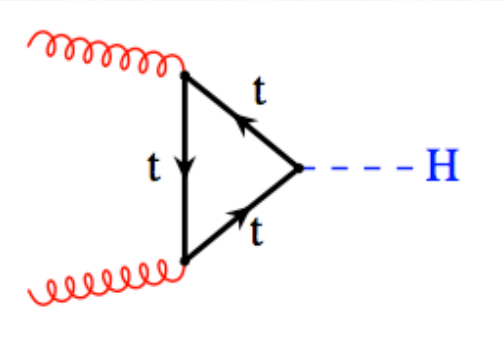




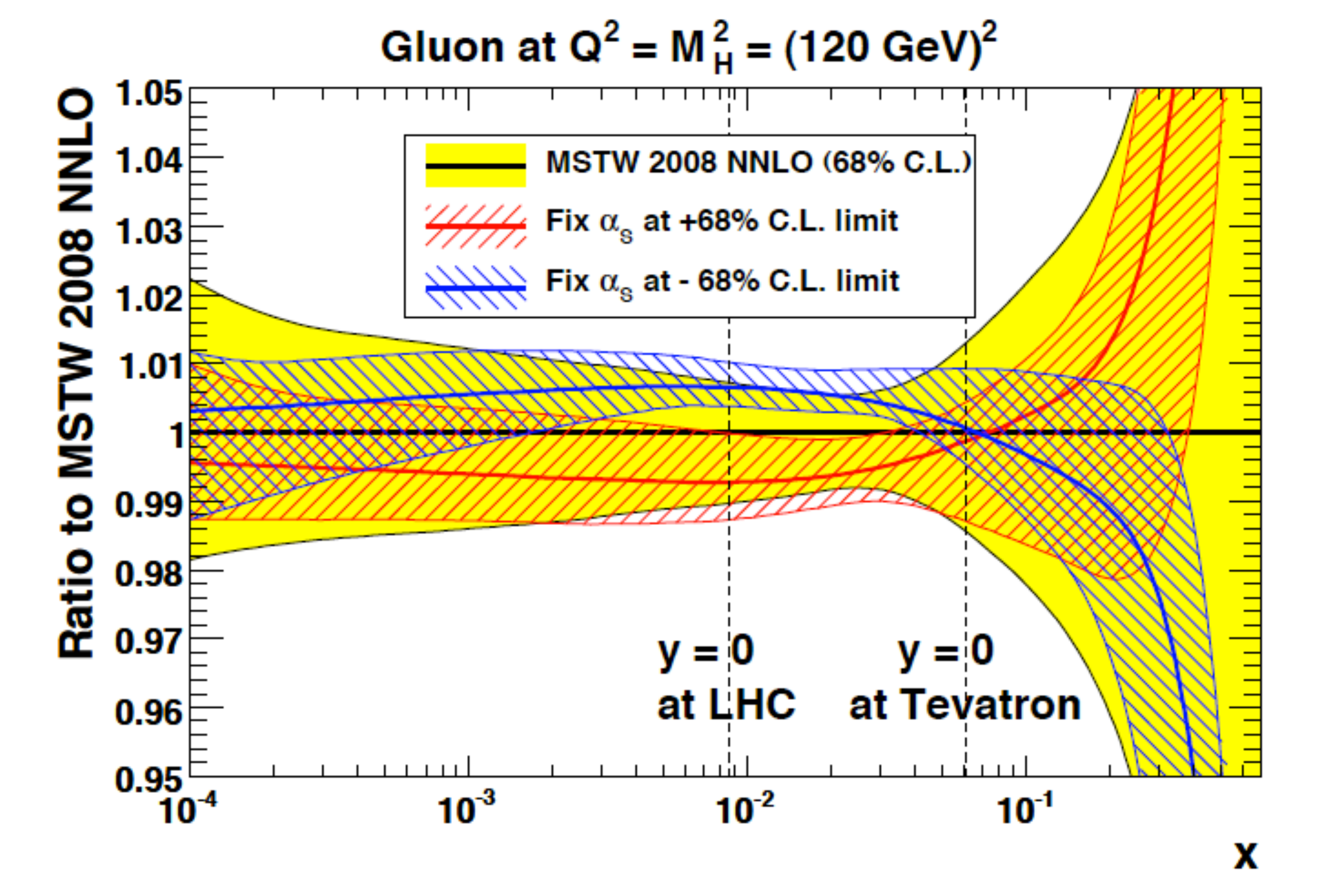
This has direct implications on the cross-section calculation at the LHC:

Example: Higgs production (via gluon fusion)

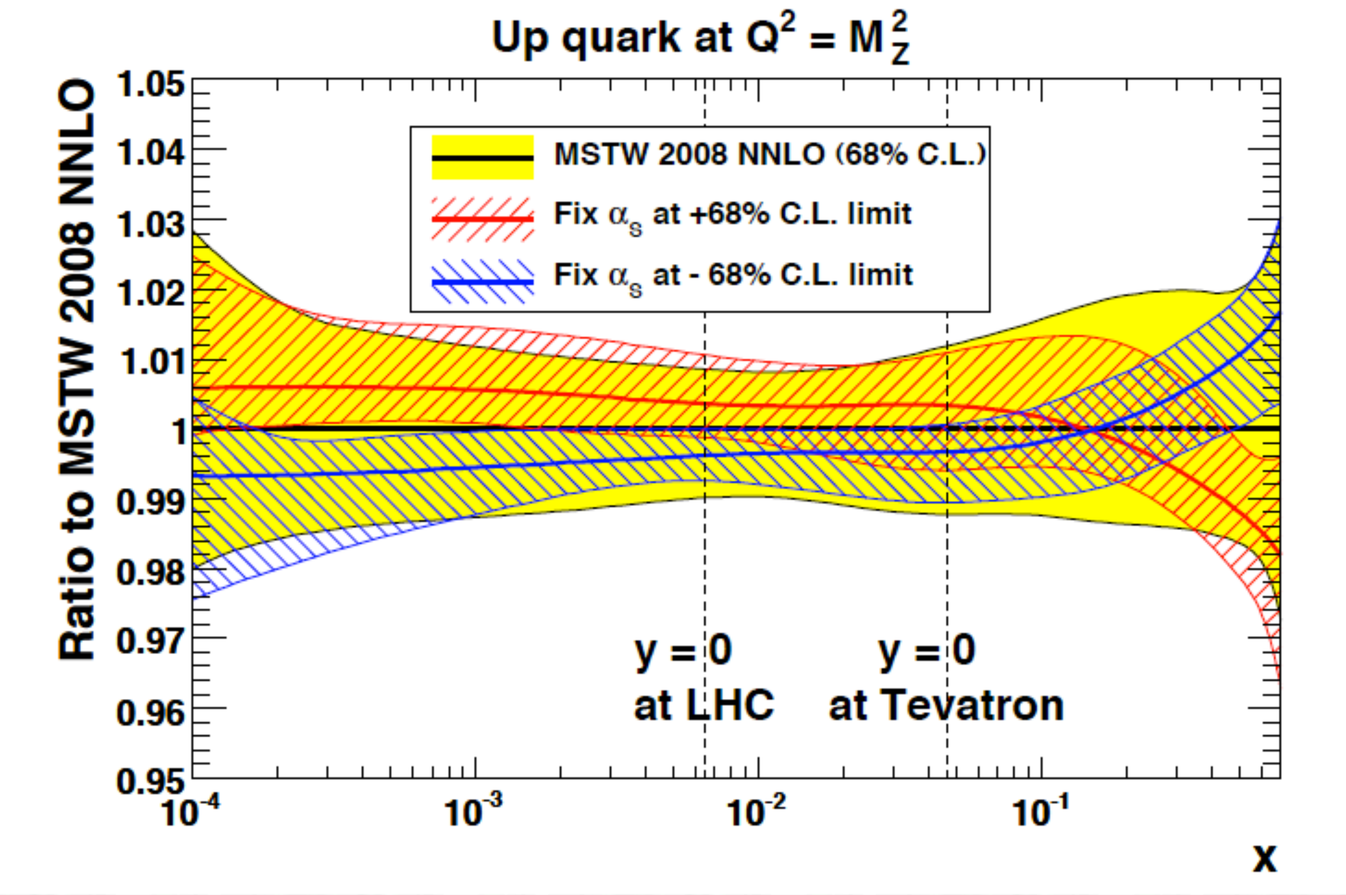




Correlation between pdfs and α_s (most affected is the gluon distribution):

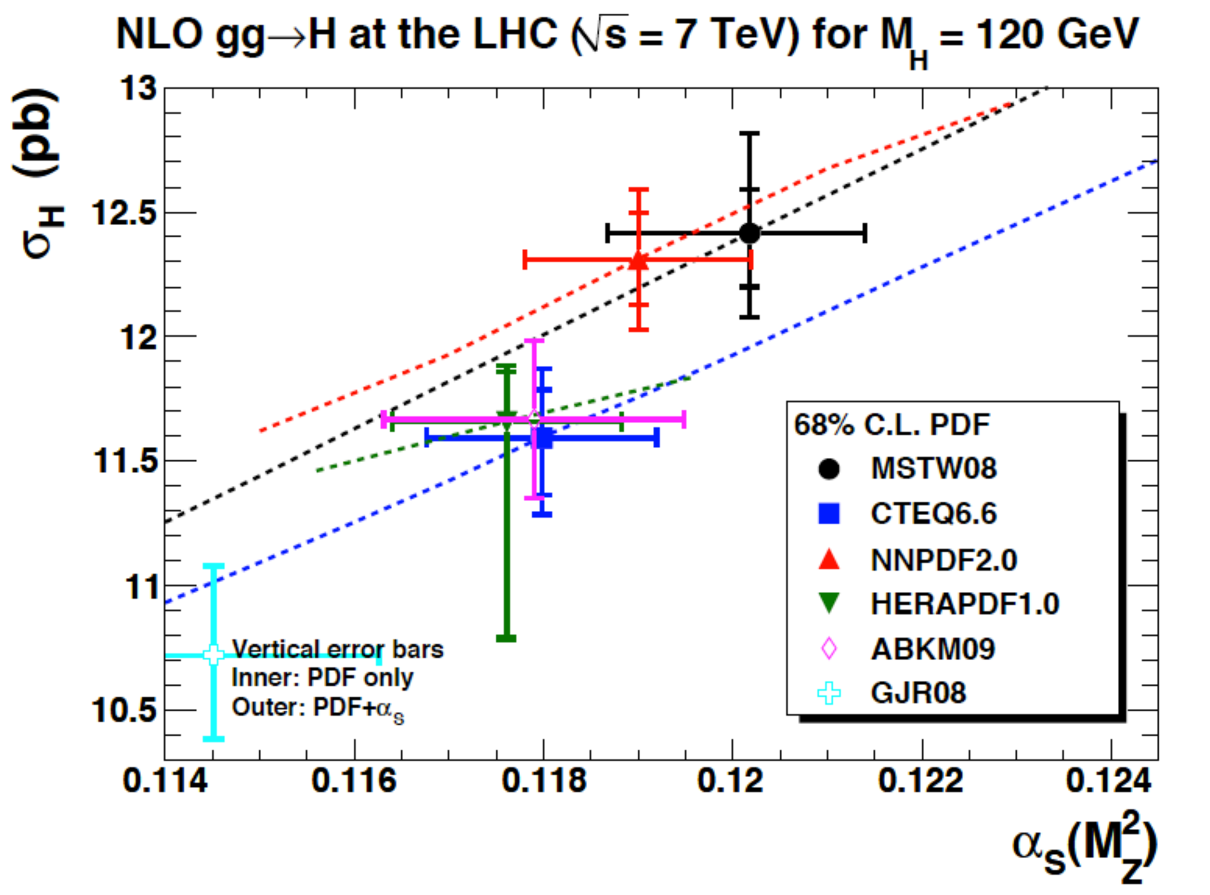


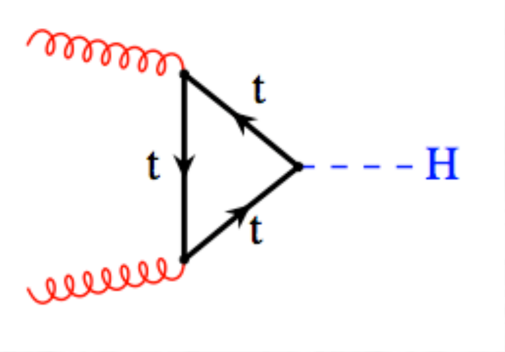
… less dramatic for quark distributions:



Implications on the cross-section calculation at the LHC:

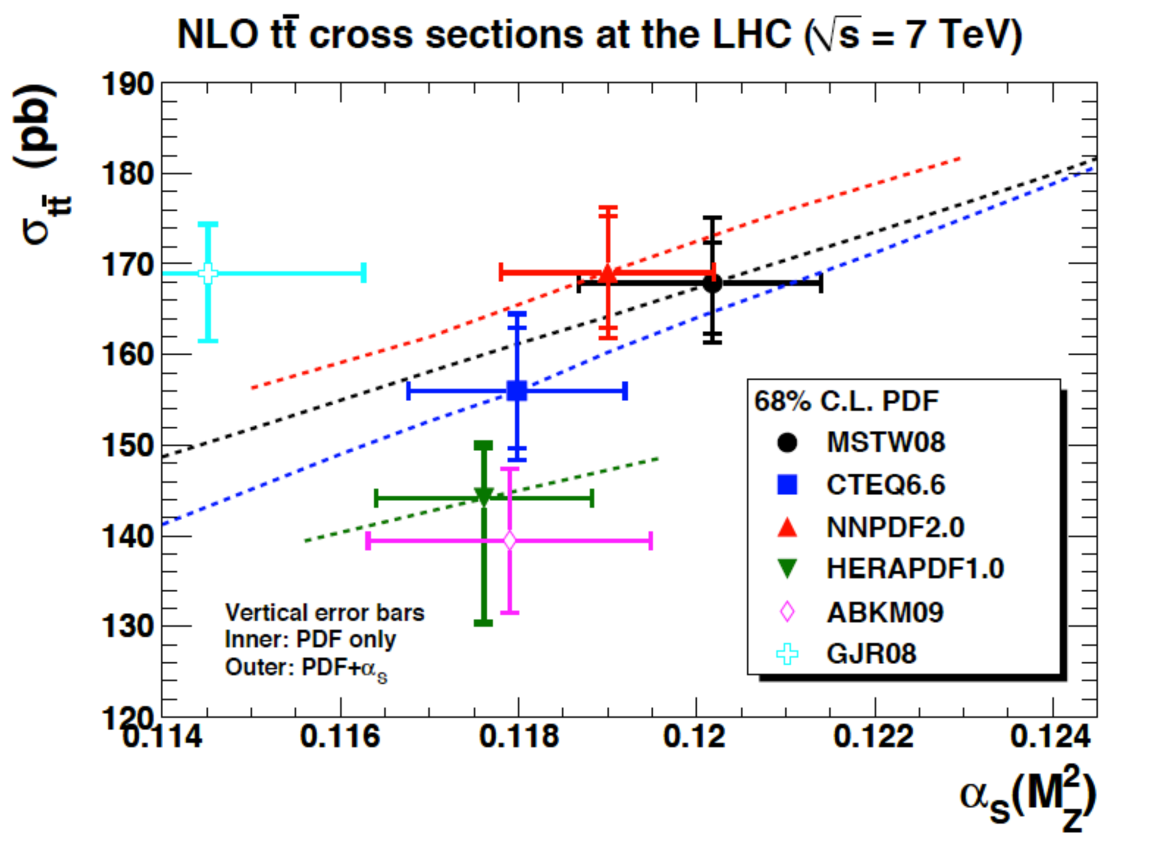
Example: Higgs production via gluon fusion, m_H = 120 GeV



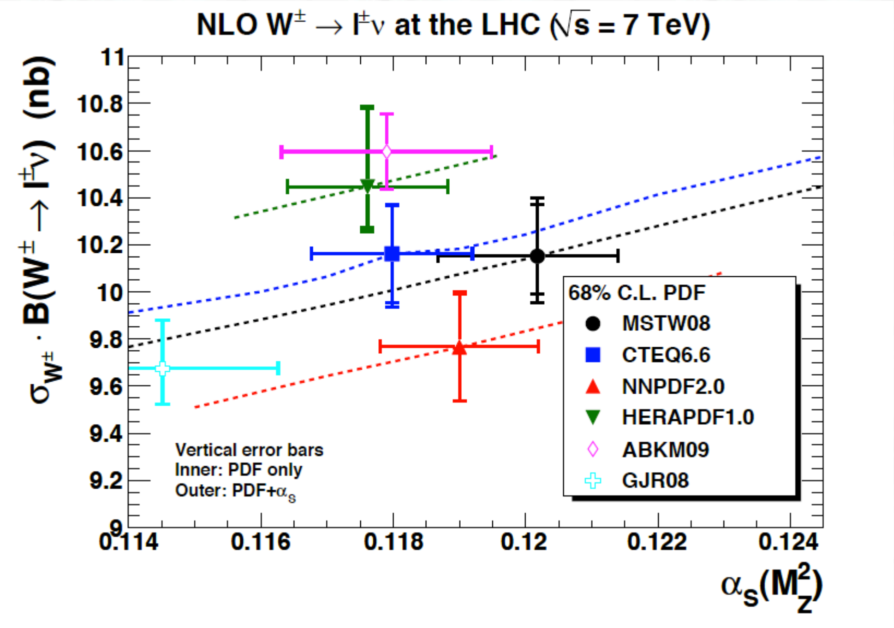


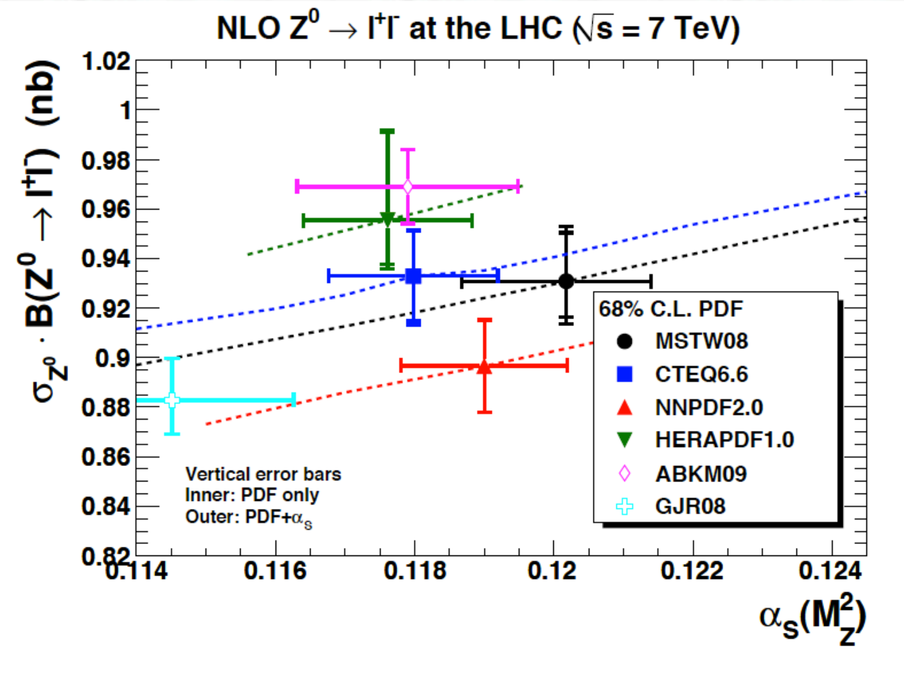
Implications on the cross-section calculation at the LHC:

Example: top pair production via gluon fusion



Example: Production of W and Z bosons at the LHC





All these processes will be measured in detail at the LHC (see next lectures), differential measurements will provide significant constraints on pdfs