Jet results from CMS

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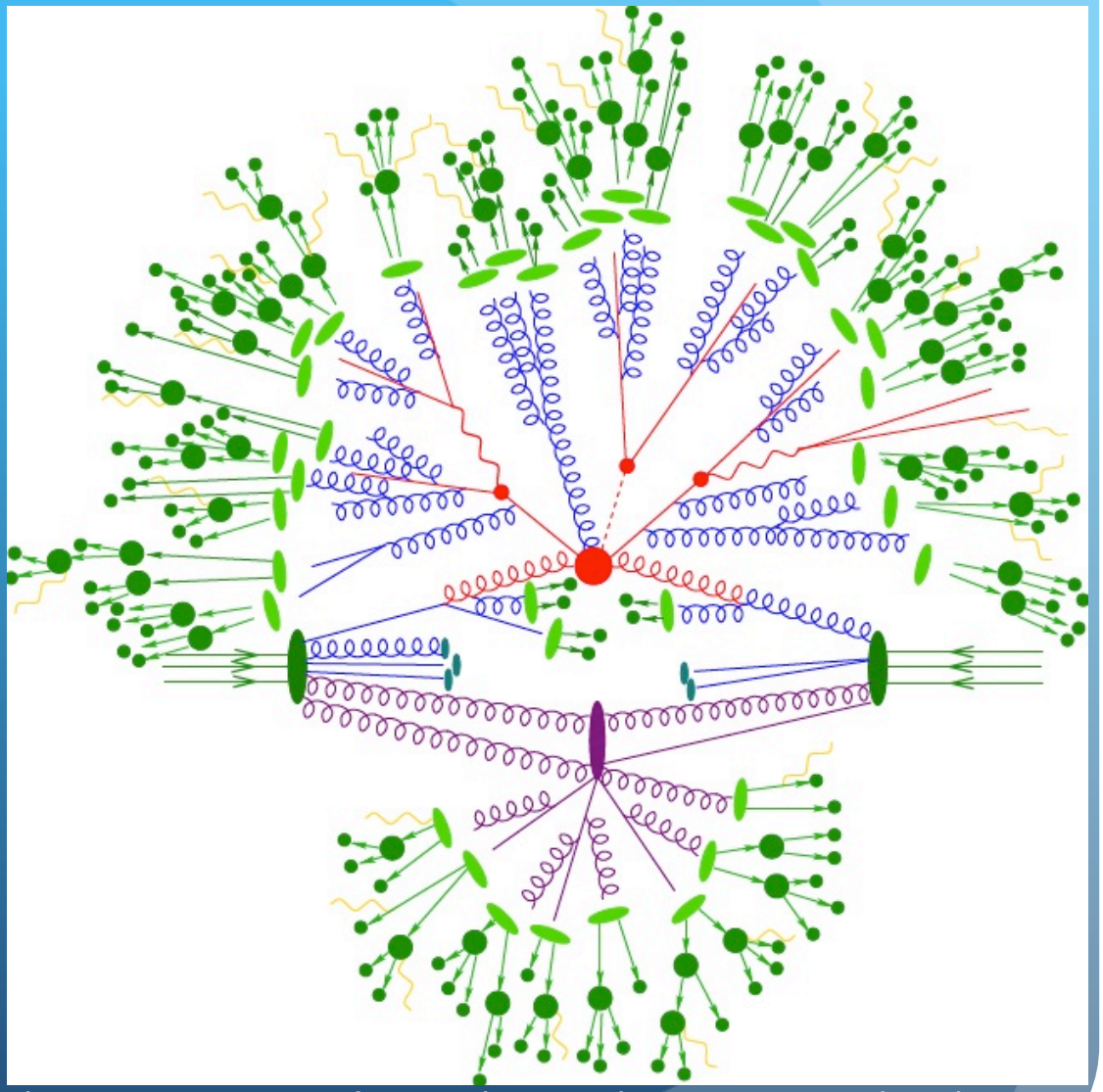
How do we test QCD with jets ?

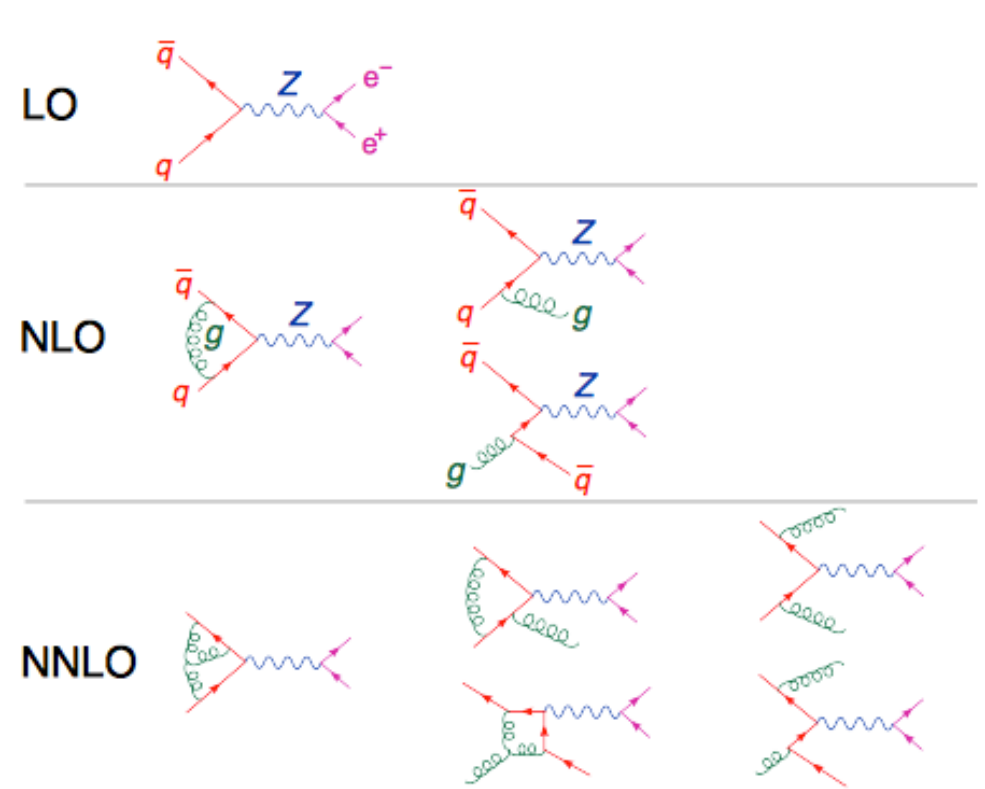
- Sherpa event
  - Matrix elements (hard)
  - Parton shower
  - Multiple interactions
  - Fragmentation/ hadronization
  - QED radiation



http://www.isgtw.org/feature/sherpa-and-open-science-grid-predicting-emergence-jets

Hard QCD at colliders

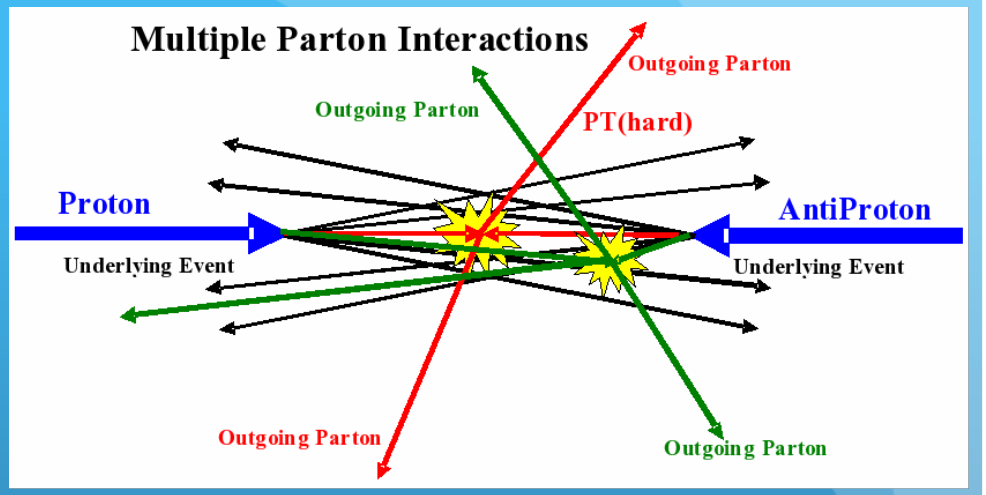
- pQCD predictions at fixed orders: LO, NLO, NNLO
- Soft- and collinear-approximations
- Mismatch between kinematics of virtual and real corrections: soft-gluon resummation
- Parton showers – PYTHIA or HERWIG
- Matching to fixed order



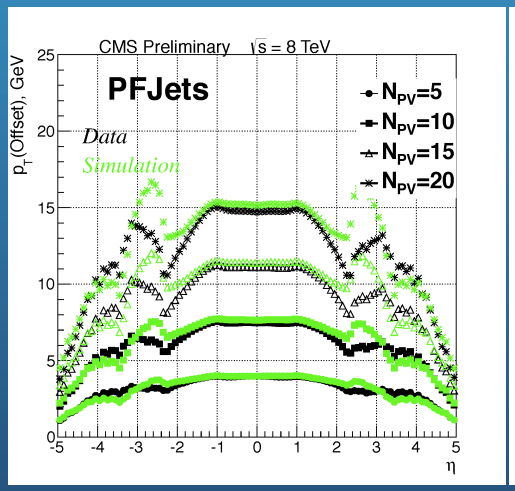
http://www.slac.stanford.edu/cgi-wrap/getdoc/slac-pub-13054.pdf

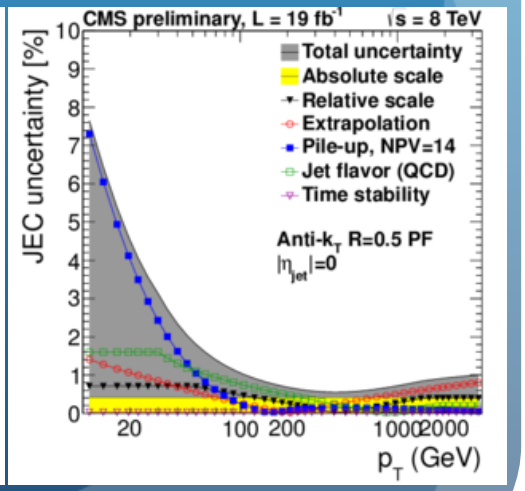
Jet production – LHC as a jet factory

- The most generic high-p_T objects
- Anti-kT algorithm – better treatment of underlying events
- Jet rates, normalized cross sections, correlations between jets and multidimentional differential cross sections



CMS-DPS2013/033



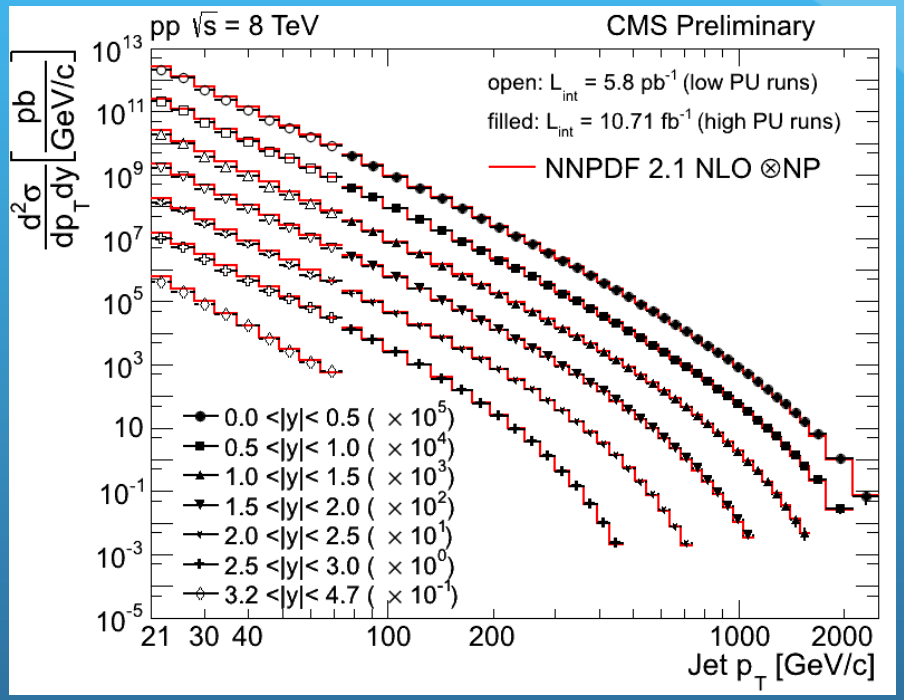


Inclusive jet results

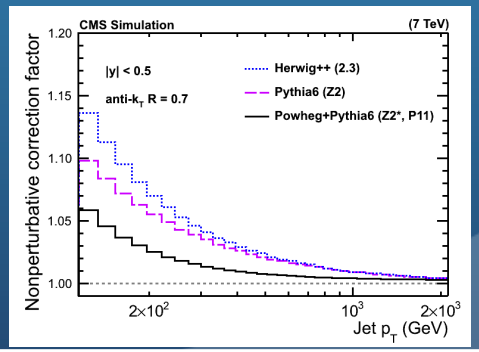
Double differential cross sections in p_T and y

$$\frac{d^2\sigma}{dp_T dy} = \frac{1}{\epsilon \cdot \mathcal{L}_{\text{eff}}} \frac{N_{\text{jets}}}{\Delta p_T (2 \cdot \Delta|y|)}$$

PAS-CMS-FSQ-12-031



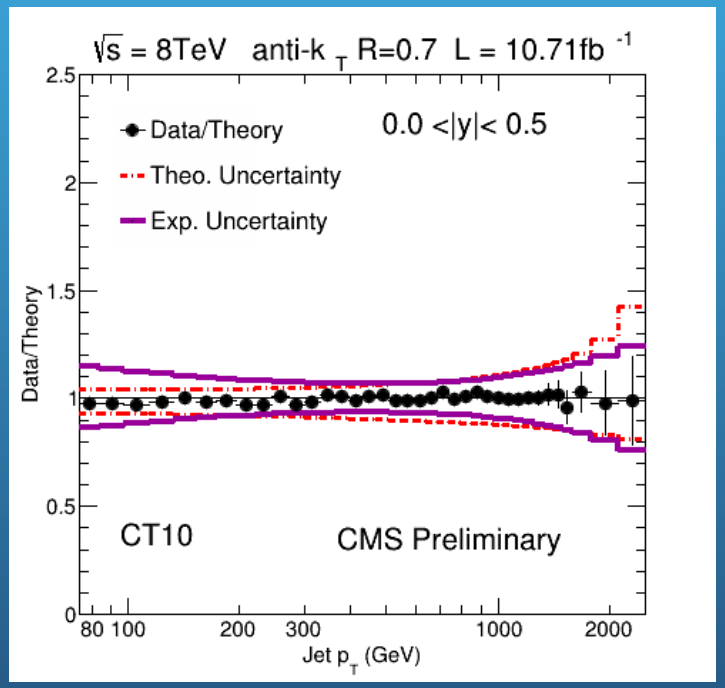
NLO x

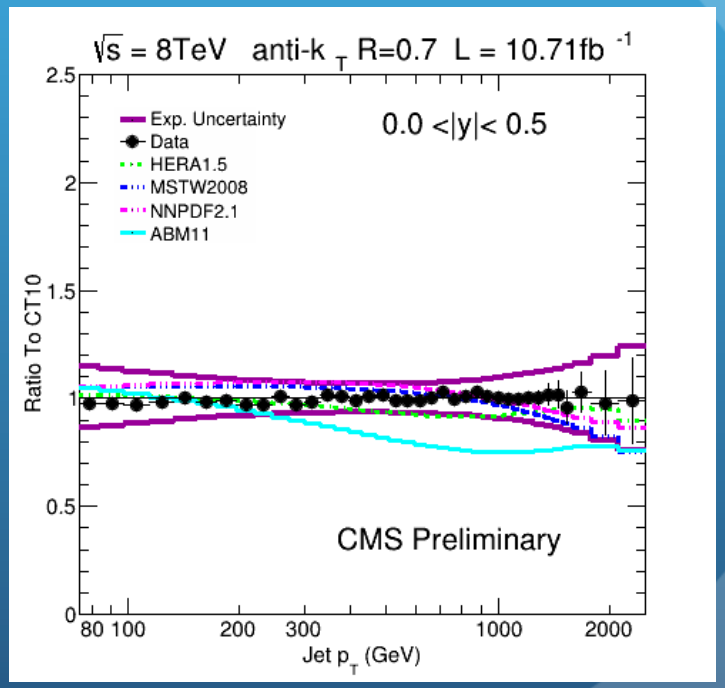


Inclusive jet results

Theoretical and experimental uncertainites

CMS-SMP-12-012

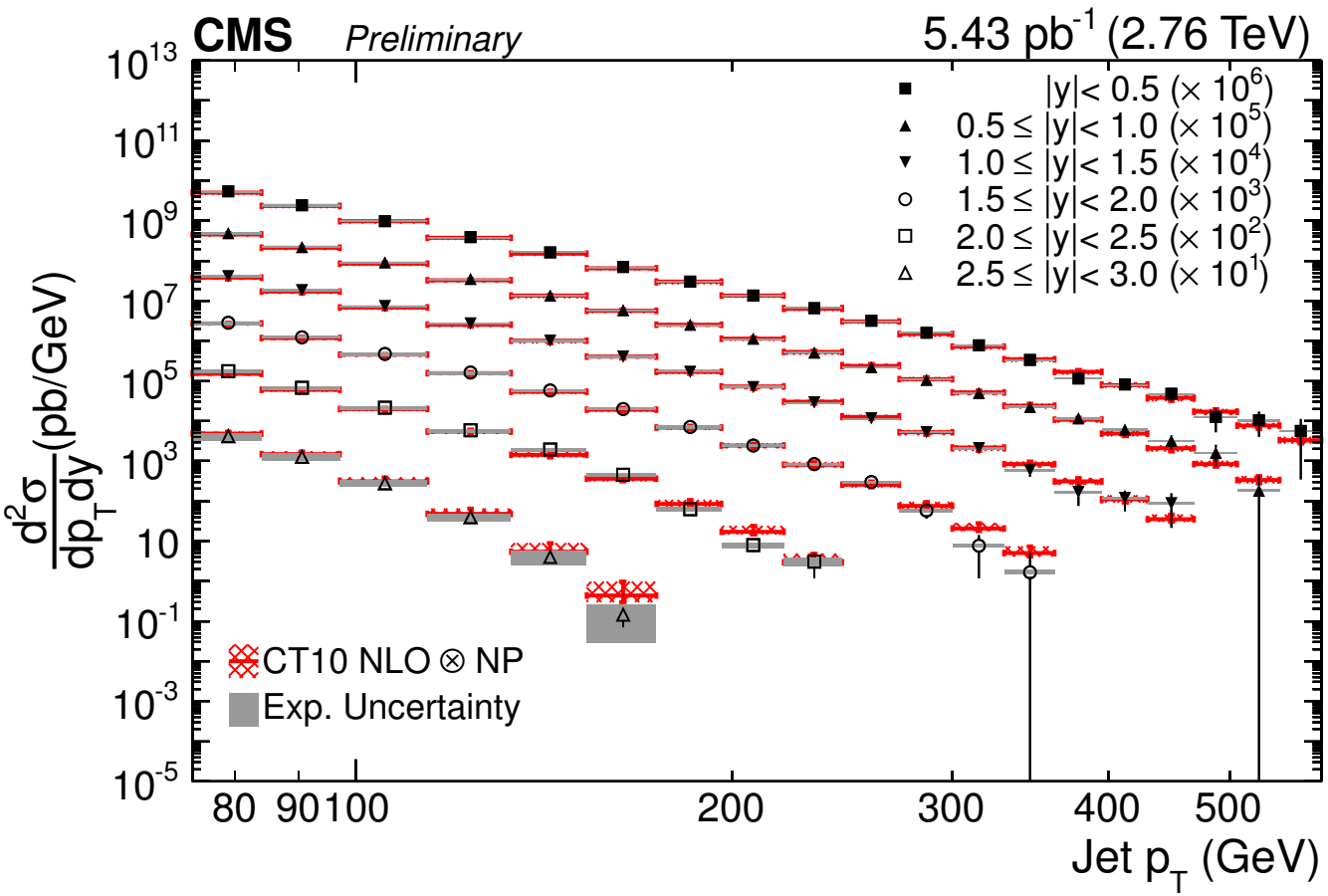




Sensitivity to PDFs

Inclusive jets at 2.76 TeV

CMS-SMP-14-017



Inclusive jets at 2.76 TeV

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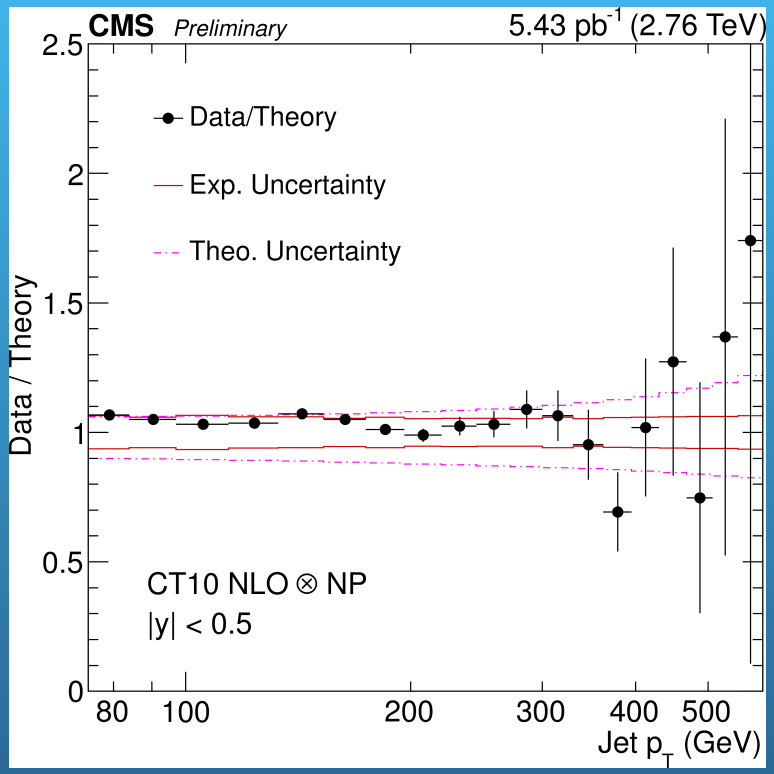
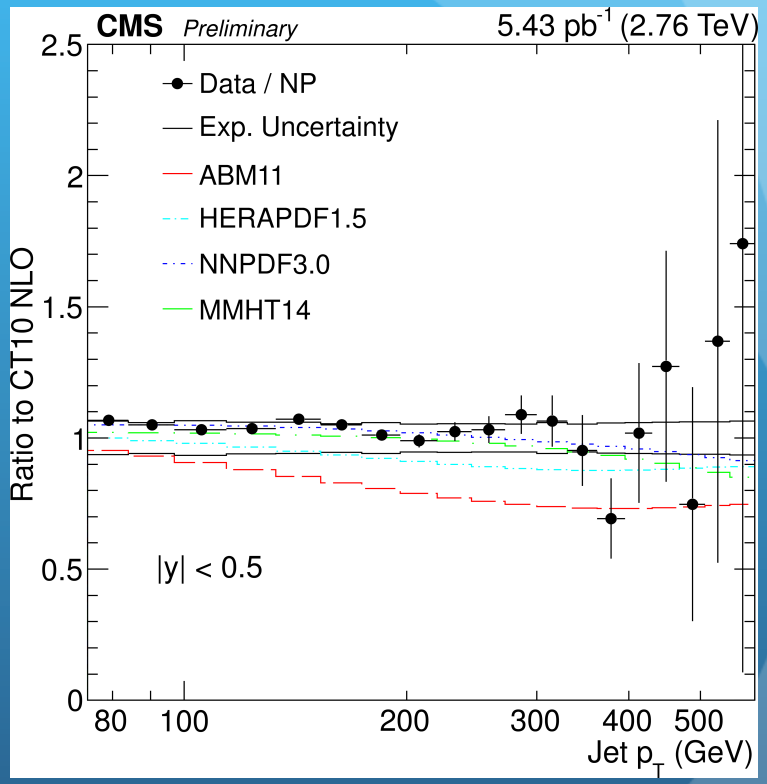
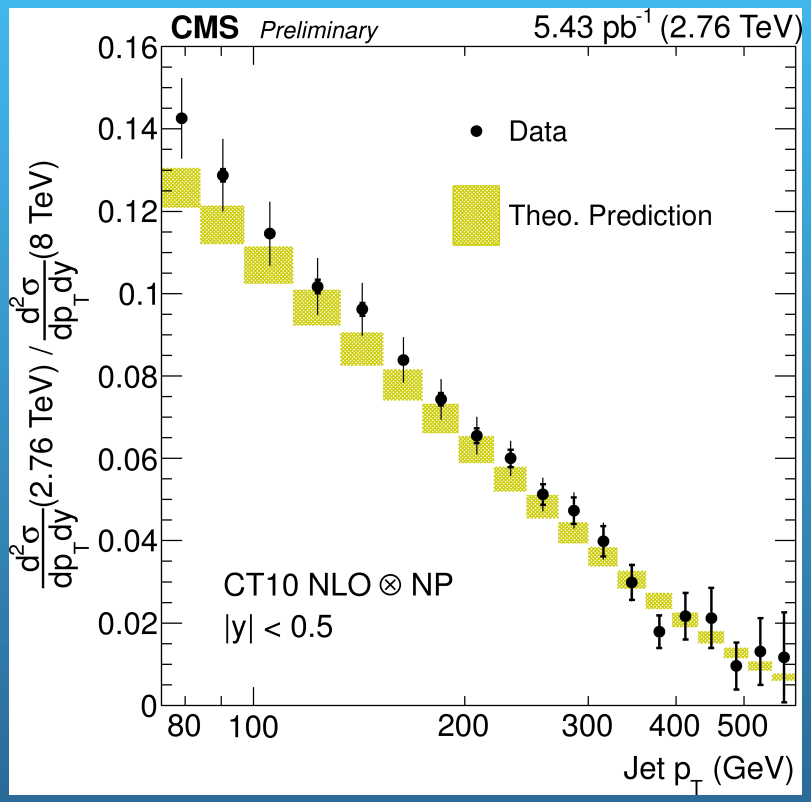


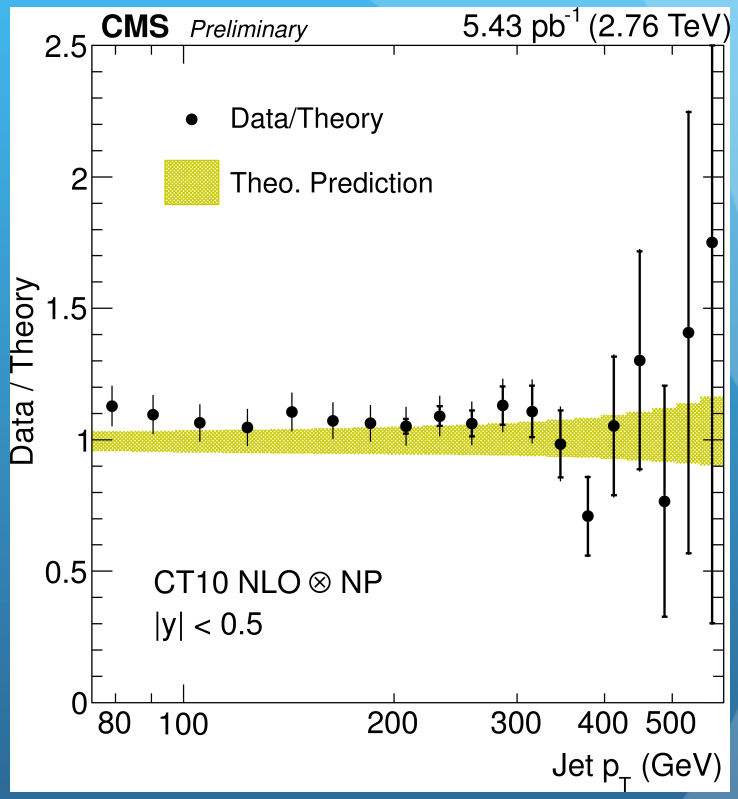


Theoretical predictions reproduce the data within uncertainties

Inclusive jets at 2.76 TeV

CMS-SMP-14-017



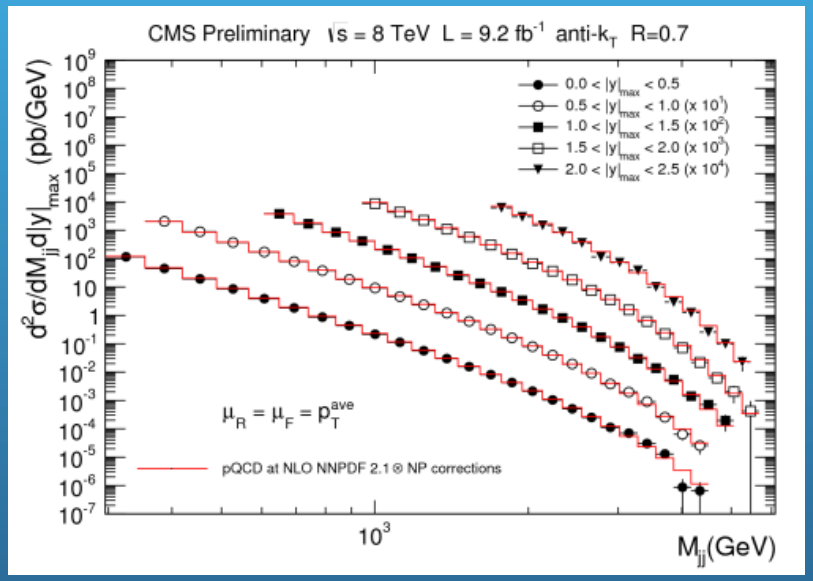


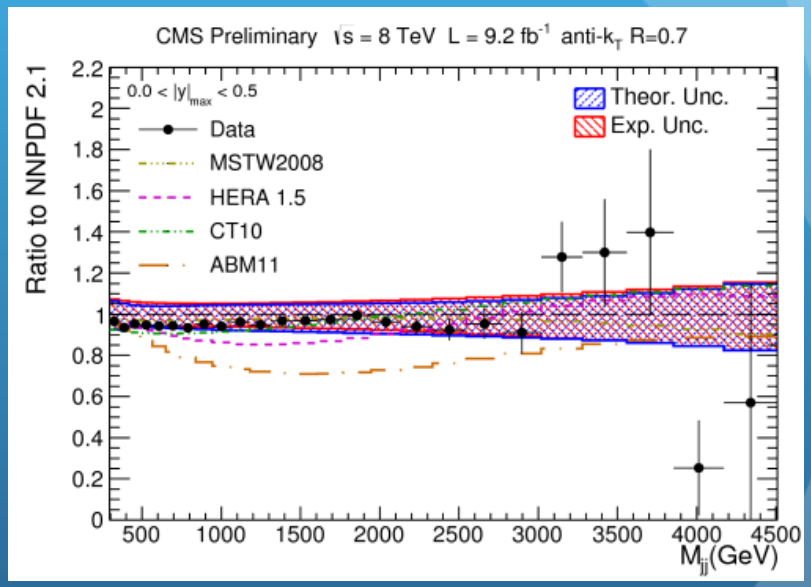
In the 2.76/8 TeV ratio some uncertainties cancel, low jet p_T data are slightly above

Dijet and trijet results

CMS-SMP-14-002

Dijet production cross section as function of dijet mass in bins of max absolute rapidity

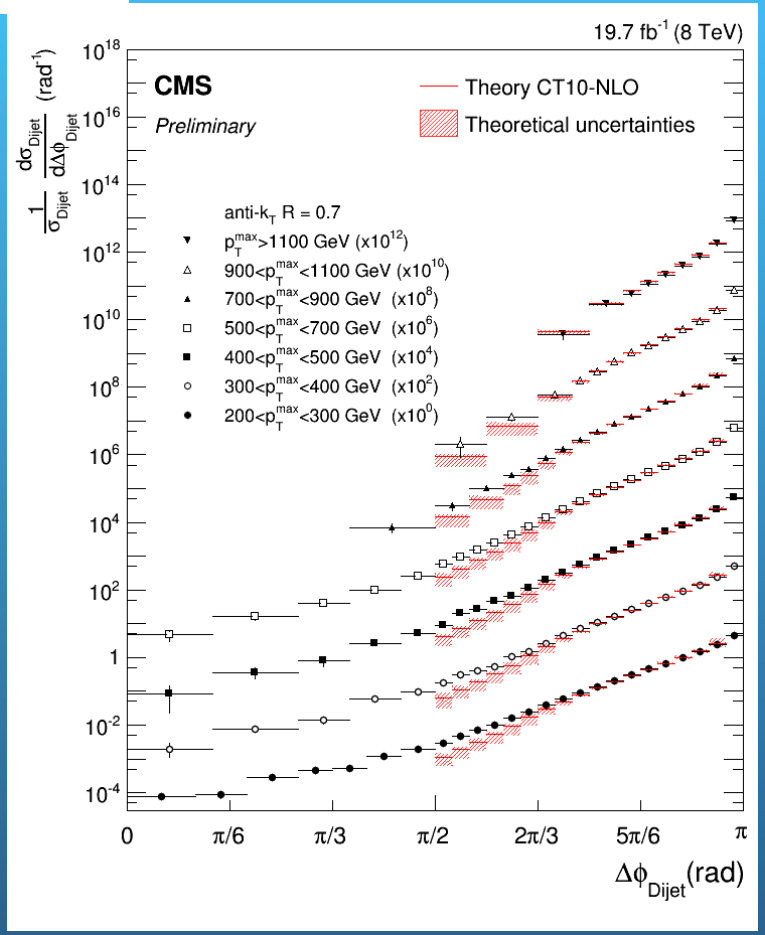


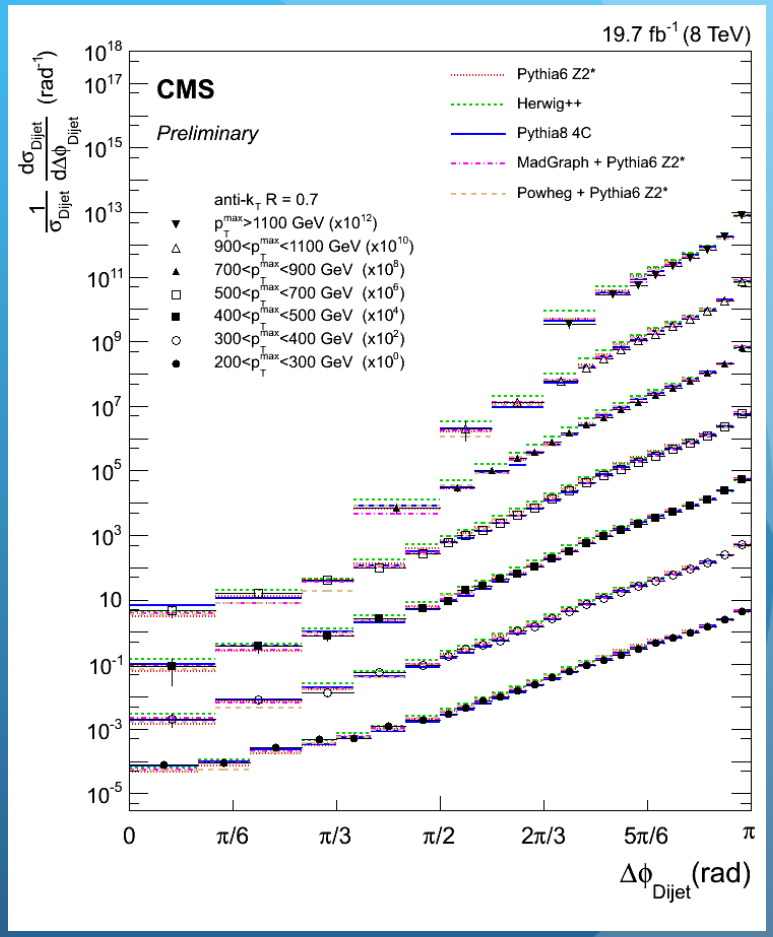


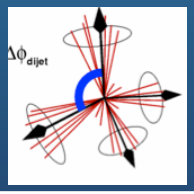
Mulitjets are extremely sensitive to NLO effects

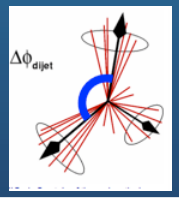
Dijet azimuthal correlations

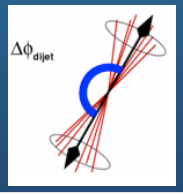
CMS-PAS-14-015









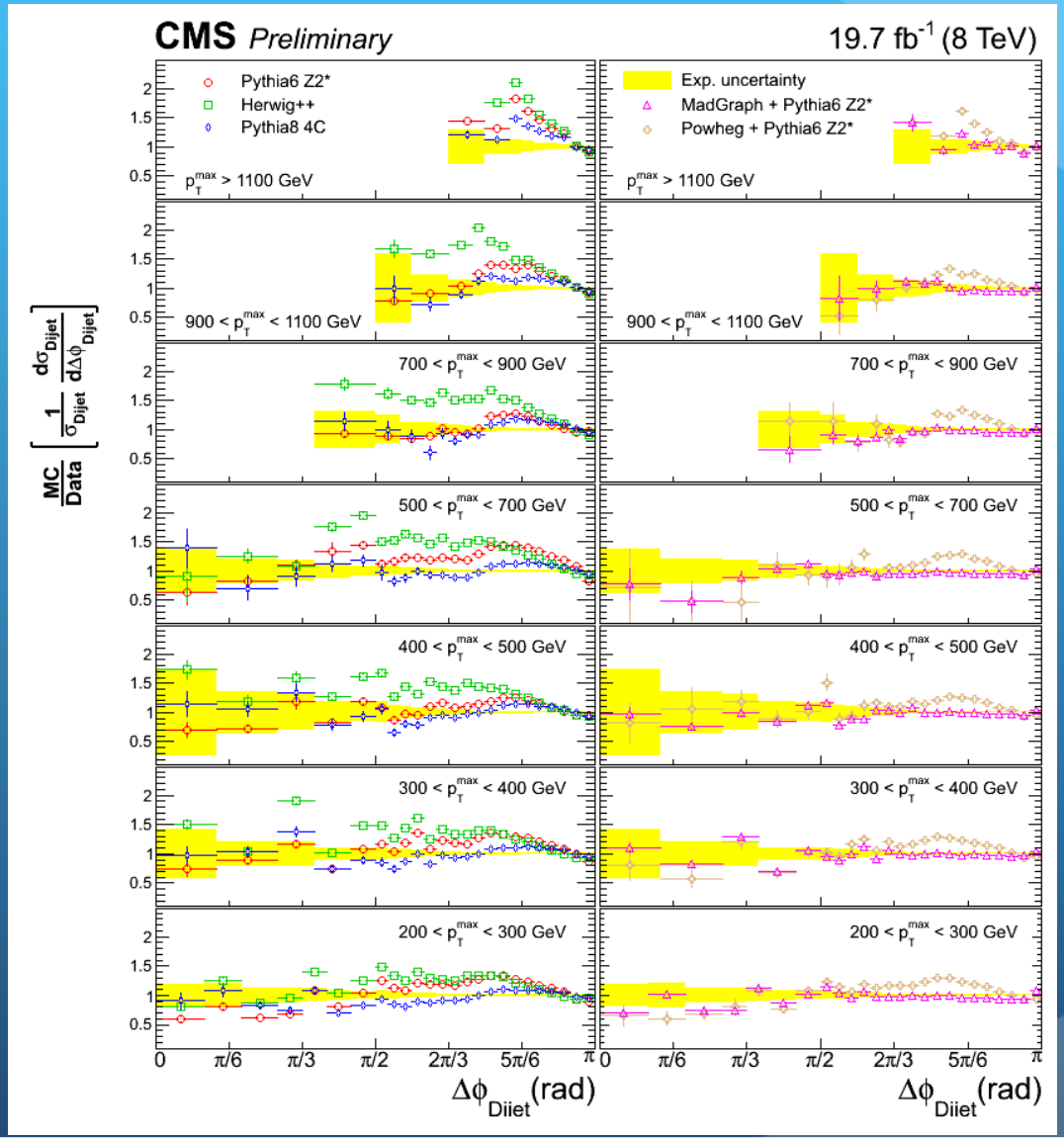


Sensitivity to ISR

Dijet azimuthal correlations

CMS-PAS-14-015

(LO+PS)/Data



(NLO+PS)/Data

α_S from inclusive jets

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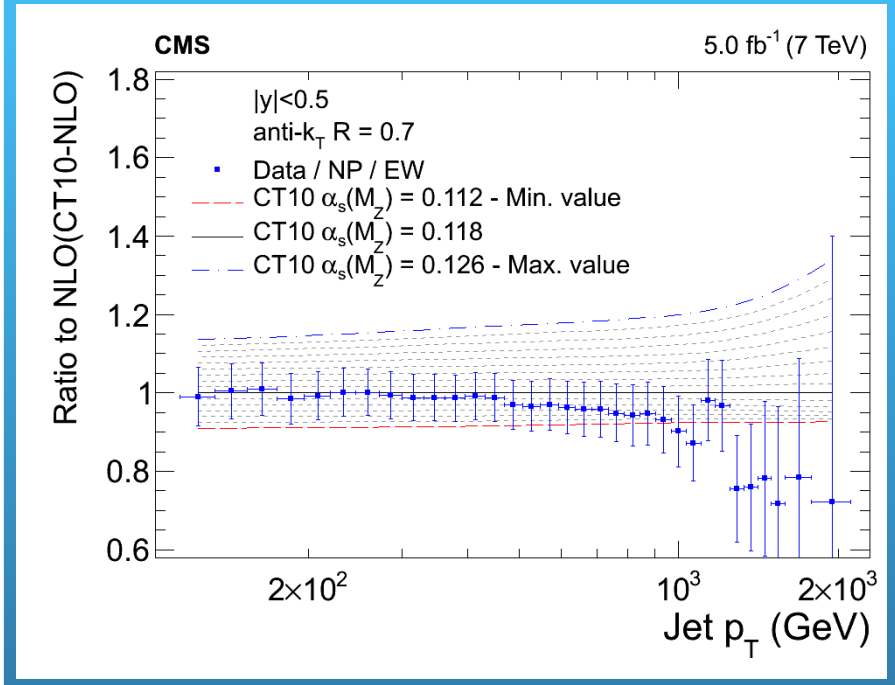
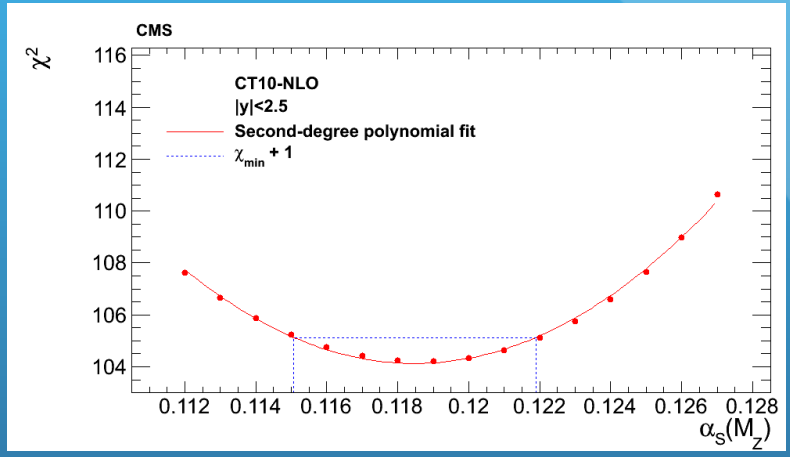


$$\chi^2 = \sum_{ij}^{N} (D_i - T_i)\, C_{ij}^{-1}\, (D_j - T_j)$$



$$C = \mathrm{cov}_{\mathrm{stat}} + \mathrm{cov}_{\mathrm{uncor}} + \left(\sum_{\mathrm{sources}} \mathrm{cov}_{\mathrm{JES}} \right) + \mathrm{cov}_{\mathrm{unfolding}} + \mathrm{cov}_{\mathrm{lumi}} + \mathrm{cov}_{\mathrm{PDF}}$$

$$\alpha_S(M_Z) = 0.1185 \pm 0.0019\,(\mathrm{exp}) \pm 0.0028\,(\mathrm{PDF}) \pm 0.0004\,(\mathrm{NP})^{+0.0053}_{-0.0024}\,(\mathrm{scale})$$

Inclusive 3-jet production

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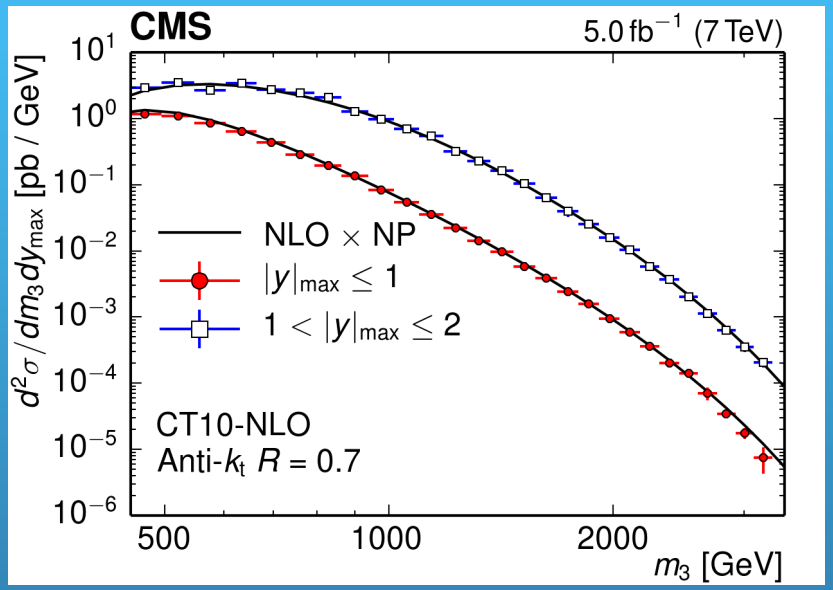
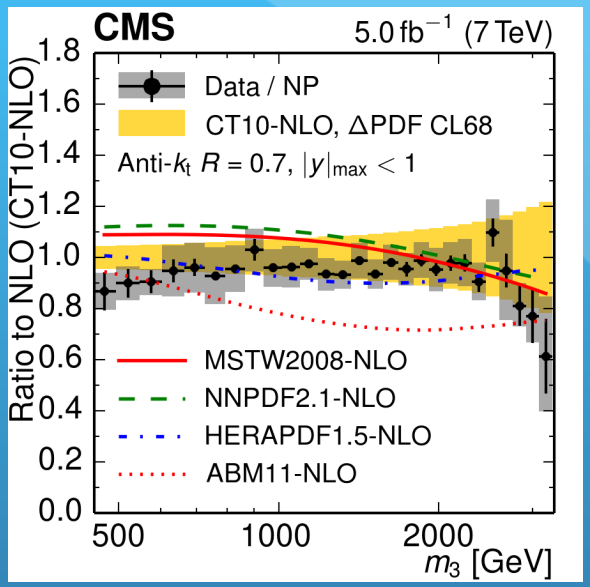
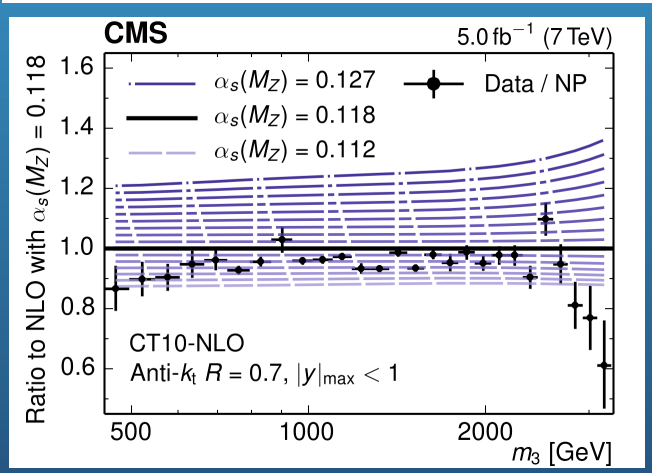




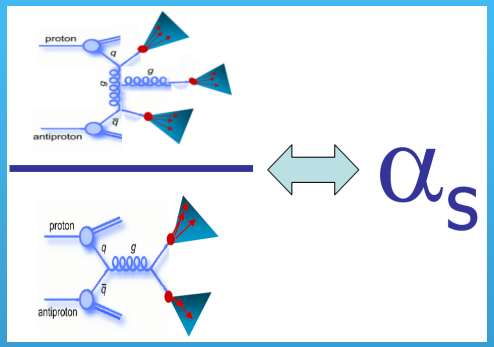


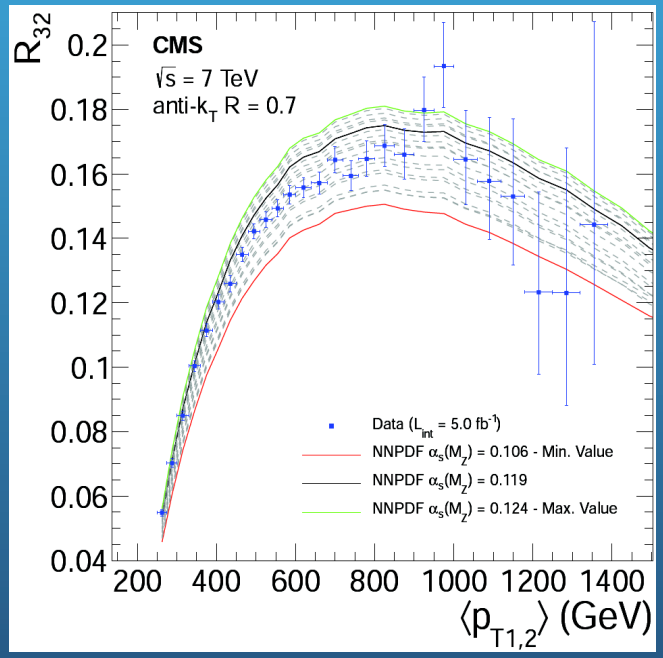
- Constraint on α_S and PDF
- Significant production rate

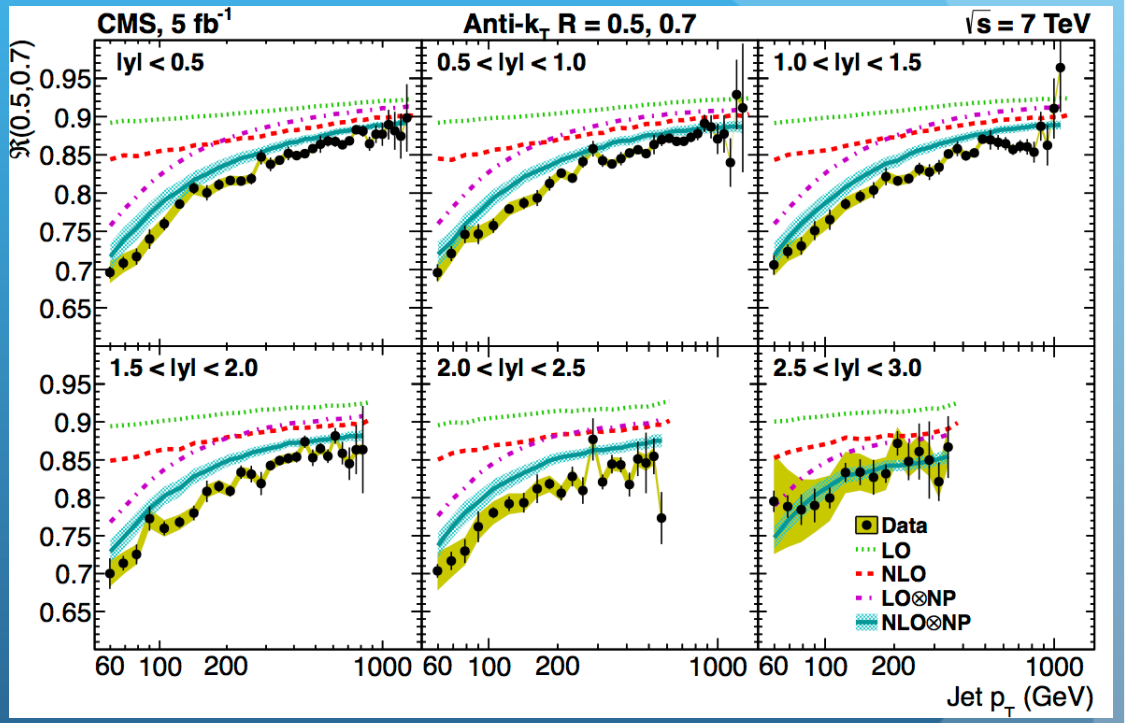
$$\alpha_S(M_Z) = 0.1171 \pm 0.0013\,(\text{exp}) \pm 0.0024\,(\text{PDF}) \pm 0.0008\,(\text{NP})\ ^{+0.0069}_{-0.0040}\,(\text{scale})$$

3-Jets/2-Jets Ratio

Eur.Phys.J. C73 (2013) 2604

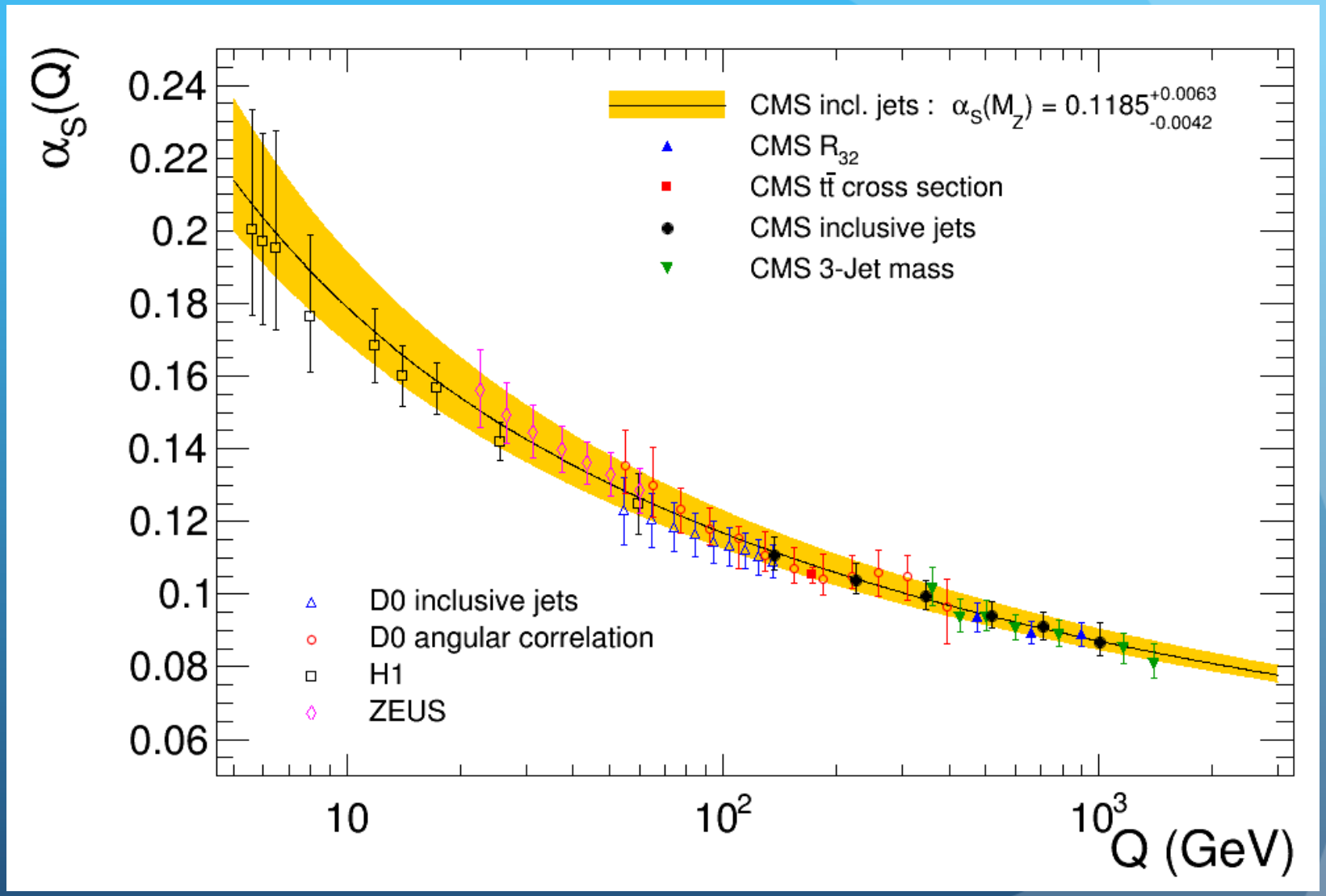




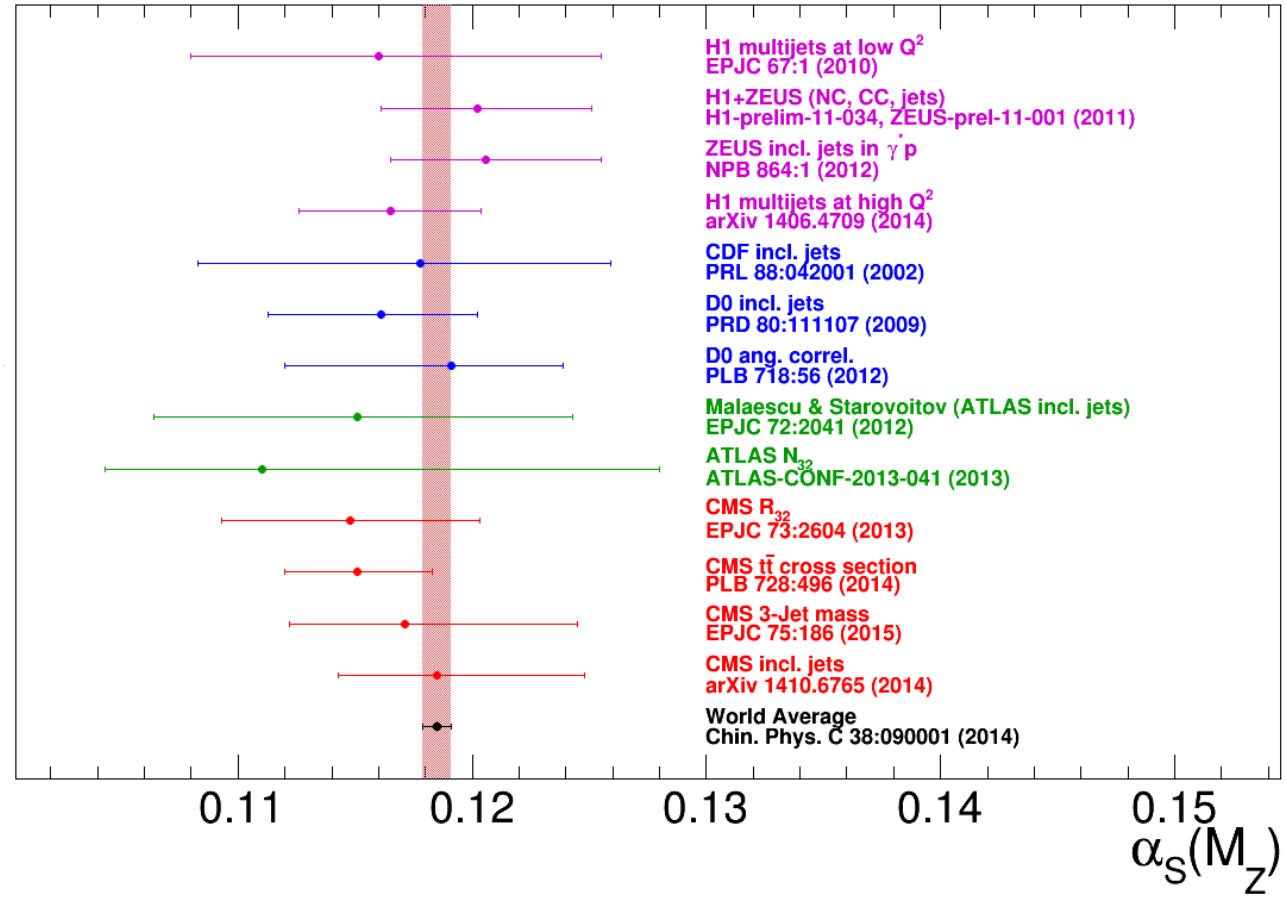


$$\alpha_S(M_Z) = 0.1148 \pm 0.0014\,(\text{exp.}) \pm 0.0018\,(\text{PDF}) \pm 0.0050\,(\text{theory})$$

Running α_s summary



α_s summary



Run I analyses are almost complete

Started to look at the first Run II data

Will keep you up-to-date

Backup

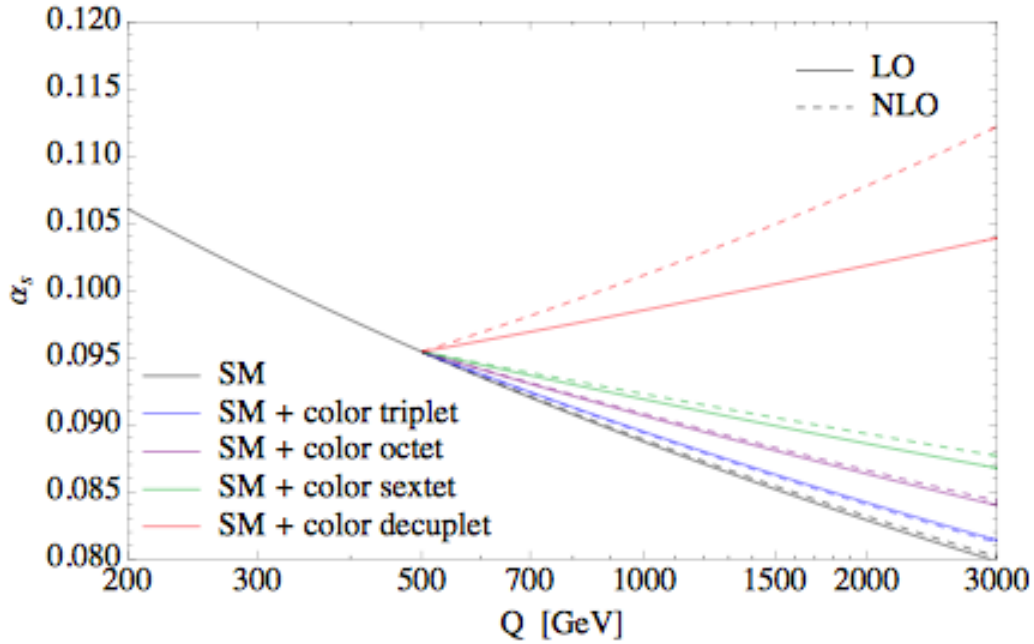


FIG. 4. Example of the change in α_s induced by a new fermion of mass 500 GeV in various representations of the color gauge group. The running of α_s is performed at NLO, showing for comparison the running at LO from the mass of the new fermion.