Update on the search for contact interactions using the inclusive jet p_T spectrum

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Goal: Look for deviations in the observed inclusive jet p_T at 8 TeV, in the phase space $(|y| < 0.5) \times (507 < p_T < 2500)\,\mathrm{GeV}$, from the predicted spectrum at next-to-leading order (NLO) and interpret any deviation in terms of NLO contact interaction (CI) models.

- QCD spectra computed using `fastNLO` (v2.1.0-1360 + `fnl3323y0.tab`)
- CI spectra computed using `CIJET` (v1.0, argXiv:1301.7263)

Today:

- Discuss the smearing of QCD and CI assuming 4% uncertainty in Jet Energy Scale (JES), and 10% uncertainty in Jet Energy Resolution (JER).

The deviation from QCD in the i^{th} p_T bin due to CI is calculated as follows:

$$\sigma_i^{CI} = \frac{1}{\Lambda^2}\left[B_i + B_i' \ln(\Lambda) - B_i' \ln(\mu_{0i})\right] + \frac{1}{\Lambda^4}\left[A_i + A_i' \ln(\Lambda) - A_i' \ln(\mu_{0i})\right]$$

- A,B coefficients come from CIJET by J. Gao.
- μ_{0i} is the central value of the i^{th} p_T bin.
- Λ is the energy scale of the CI interactions.

Review of PDF Uncertaintiy

- Following the procedure outlined here: `https://mstwpdf.hepforge.org/random/`
- The variance in an observable, F, is computed as follows:

$$\Delta F = \frac{1}{2}\sum_{k=1}^{n} \left| F(S_k^+) - F(S_k^-) \right| R_k$$

where R_k is a random number generated from a Gaussian distribution with a mean of 0 and σ of 1,

$S_k^{\pm}$ are the $\pm$ variations in the kth free parameter,

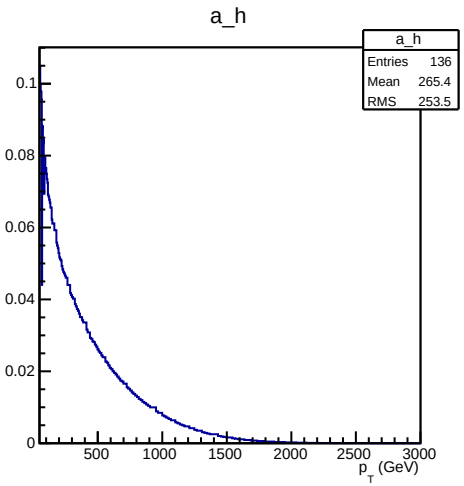
and n is the number of non-central members in the PDF set ($n = 26$ for CT10nlo, $n = 20$ for MSTW2008nlo68cl). The same set of n random numbers is used for all bins, all models.

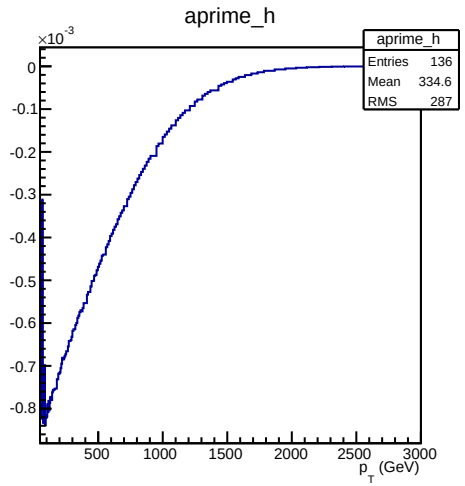
Smearing A,B coefficients with JES, and JER uncertainty

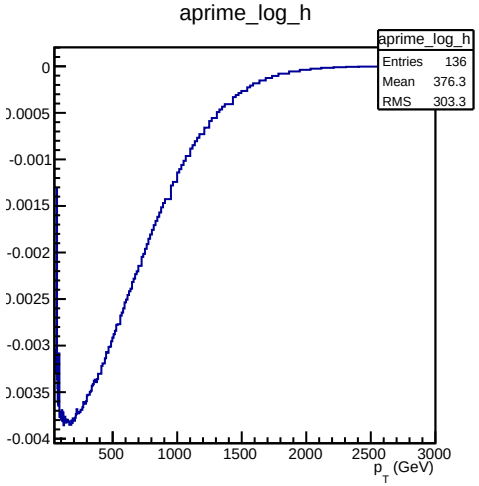
$$A_{\text{obs}} = \int_{p_T\,\text{bin}} \int_0^{\infty} R\left(p_T | xz, y\sigma_z(z)\right) \frac{dA(z)}{dz}\, dz\, dp_T$$

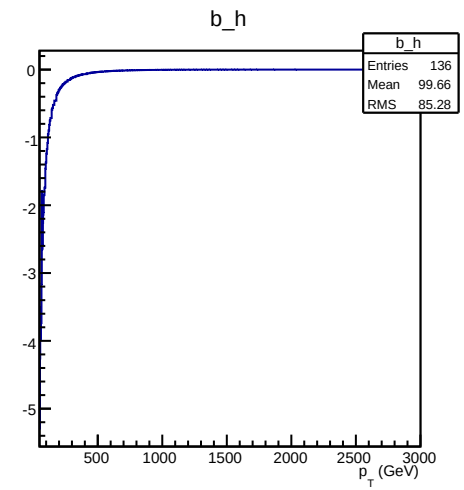
- z - integral over true p_T
- $R\left(p_T | xz, y\sigma_z\right) = \text{Gaussian}\left(p_T, xz, y\sigma_z(z)\right)$
- $\sigma_z(z) = \sqrt{\frac{N^2}{z^2} + \frac{S^2}{z} + C^2}$
- $N = 5.886,\ S = 1.136,\ C = 0.032$ (SMP-12-012)
- x represents the JES uncertainty. x is a random number taken from a Gaussian with mean of 1 and $\sigma = 0.04$
- y represents the JER uncertainty. y is a random number taken from a Gaussian with mean of 1 and $\sigma = 0.10$
- In practice we approximate the semi-infinite z integral by integrating from $p_T - 5\sigma_z(p_T)$ to $p_T + 5\sigma_z(p_T)$

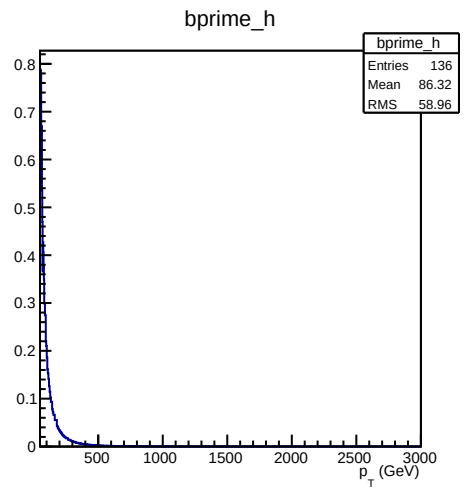
Central Coefficients (LL model)

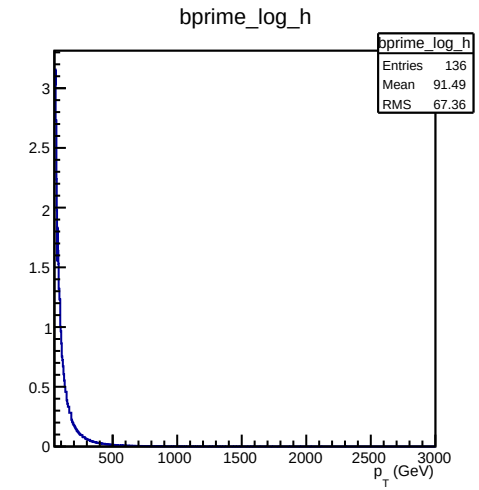


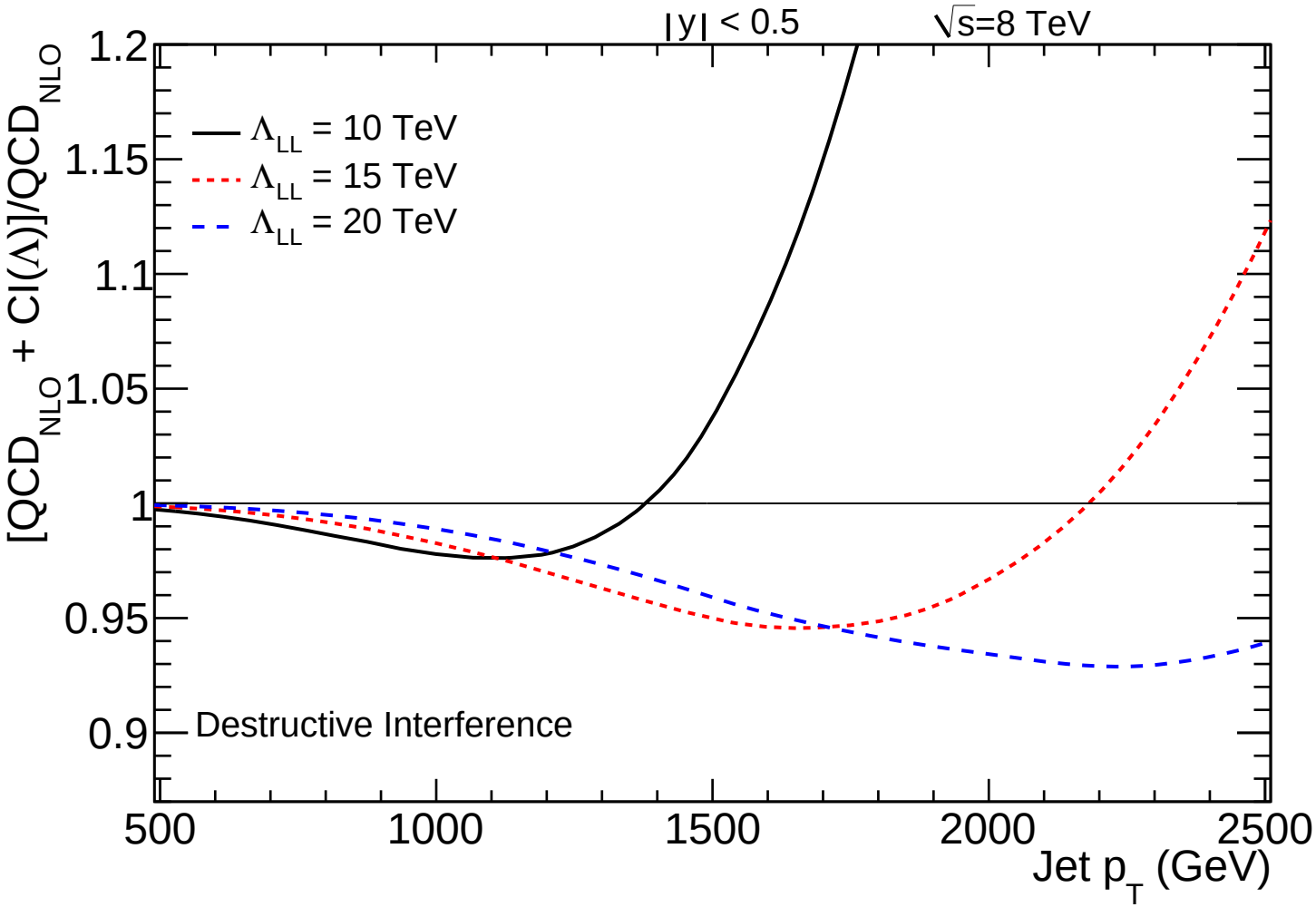




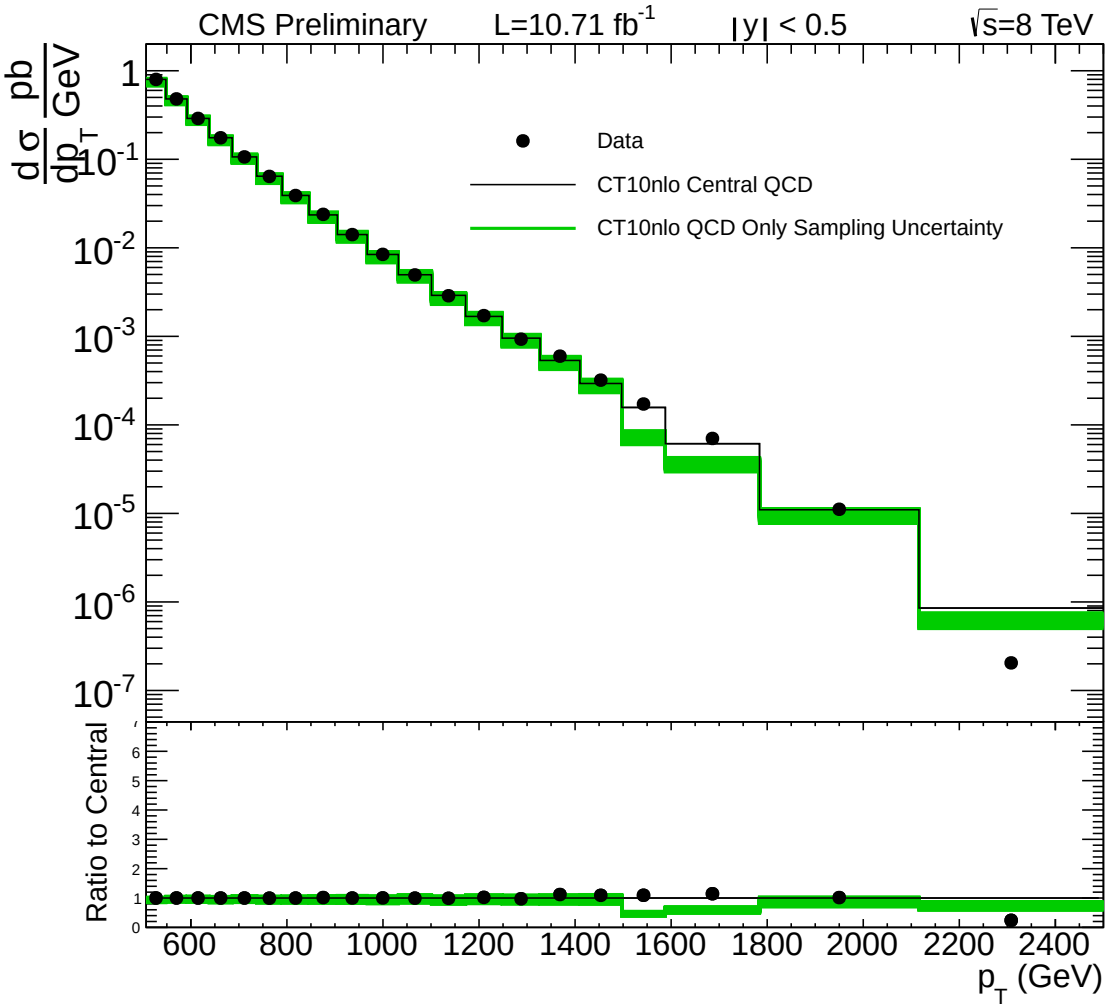




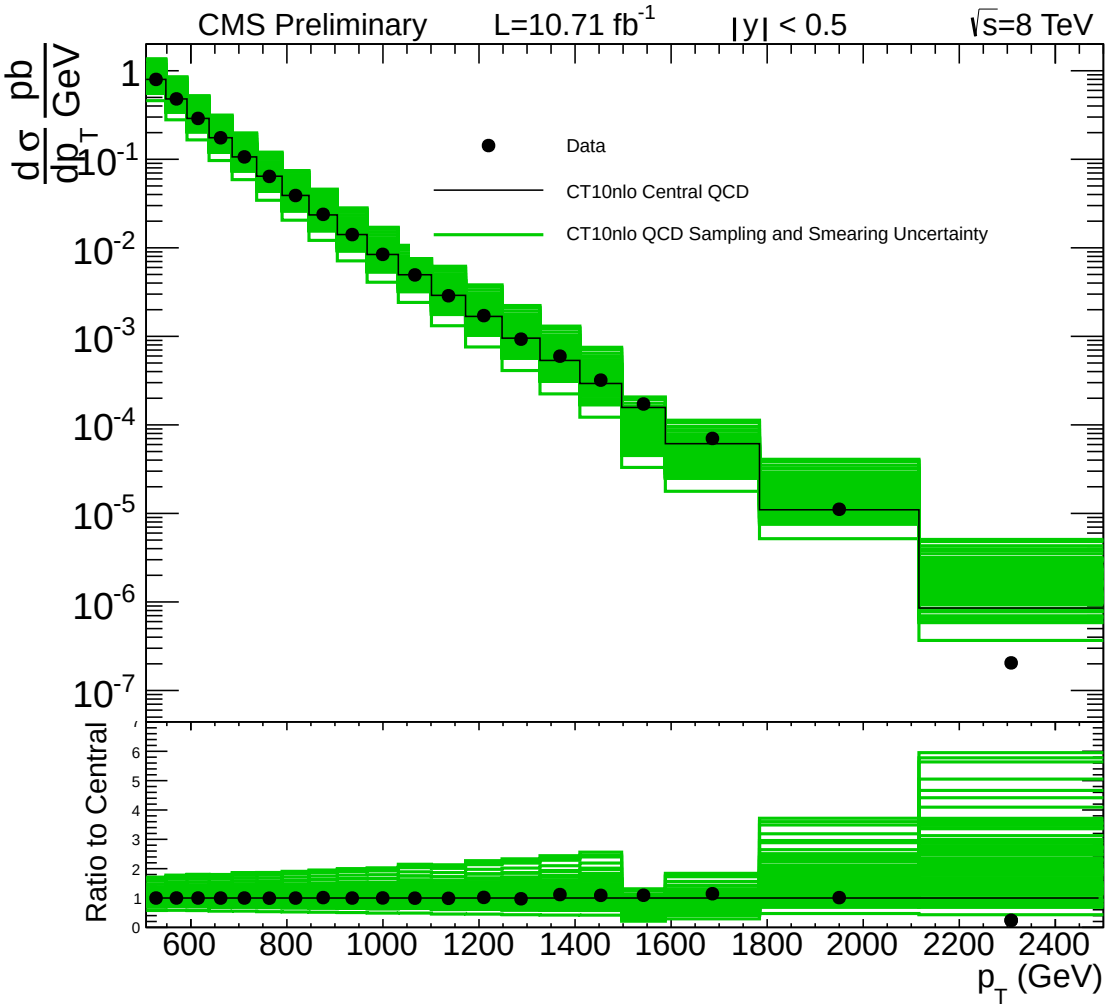



|y| < 0.5
√s=8 TeV
[QCD_NLO + CI(Λ)]/QCD_NLO
Λ_LL = 10 TeV
Λ_LL = 15 TeV
Λ_LL = 20 TeV
Destructive Interference
1.2
1.15
1.1
1.05
1
0.95
0.9
500
1000
1500
2000
2500
Jet p_T (GeV)

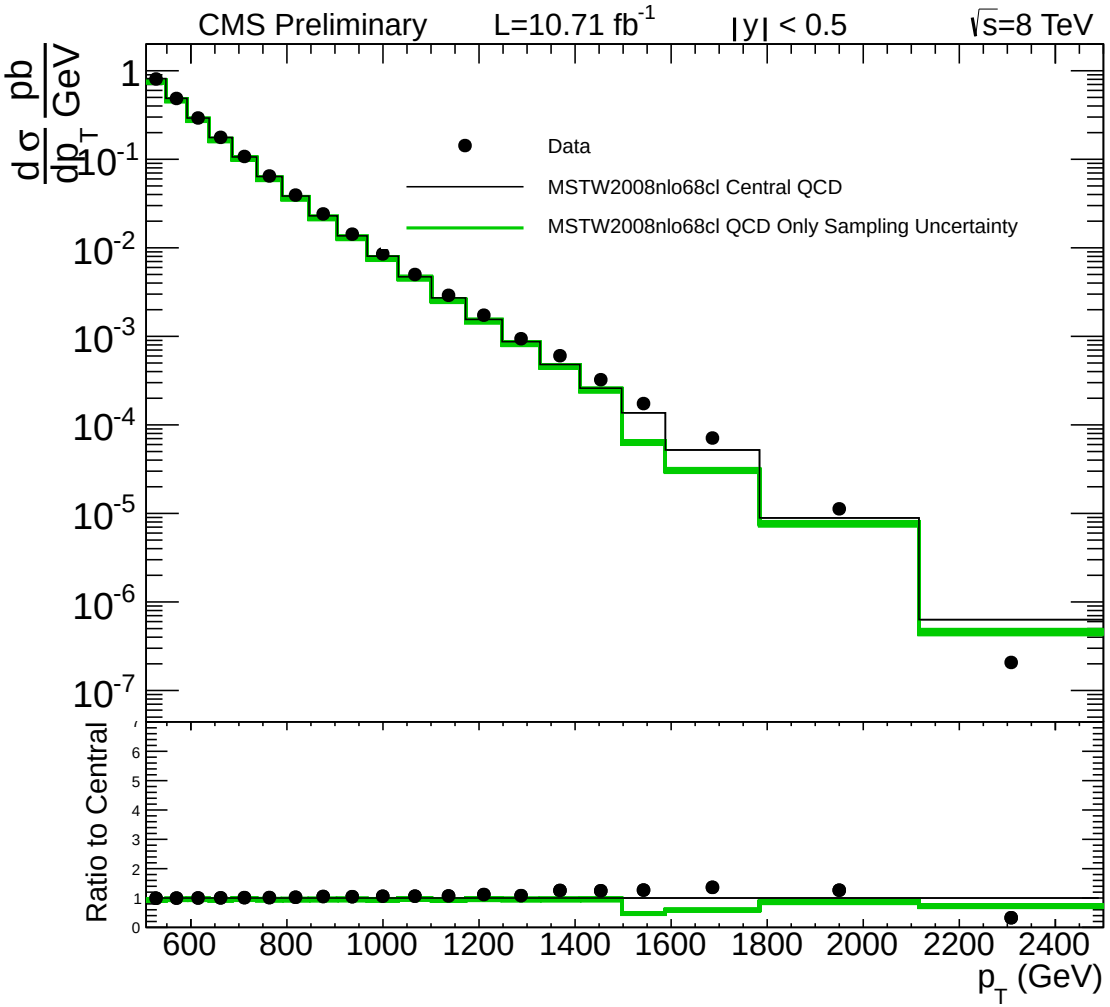
Only SamplingUncertainty



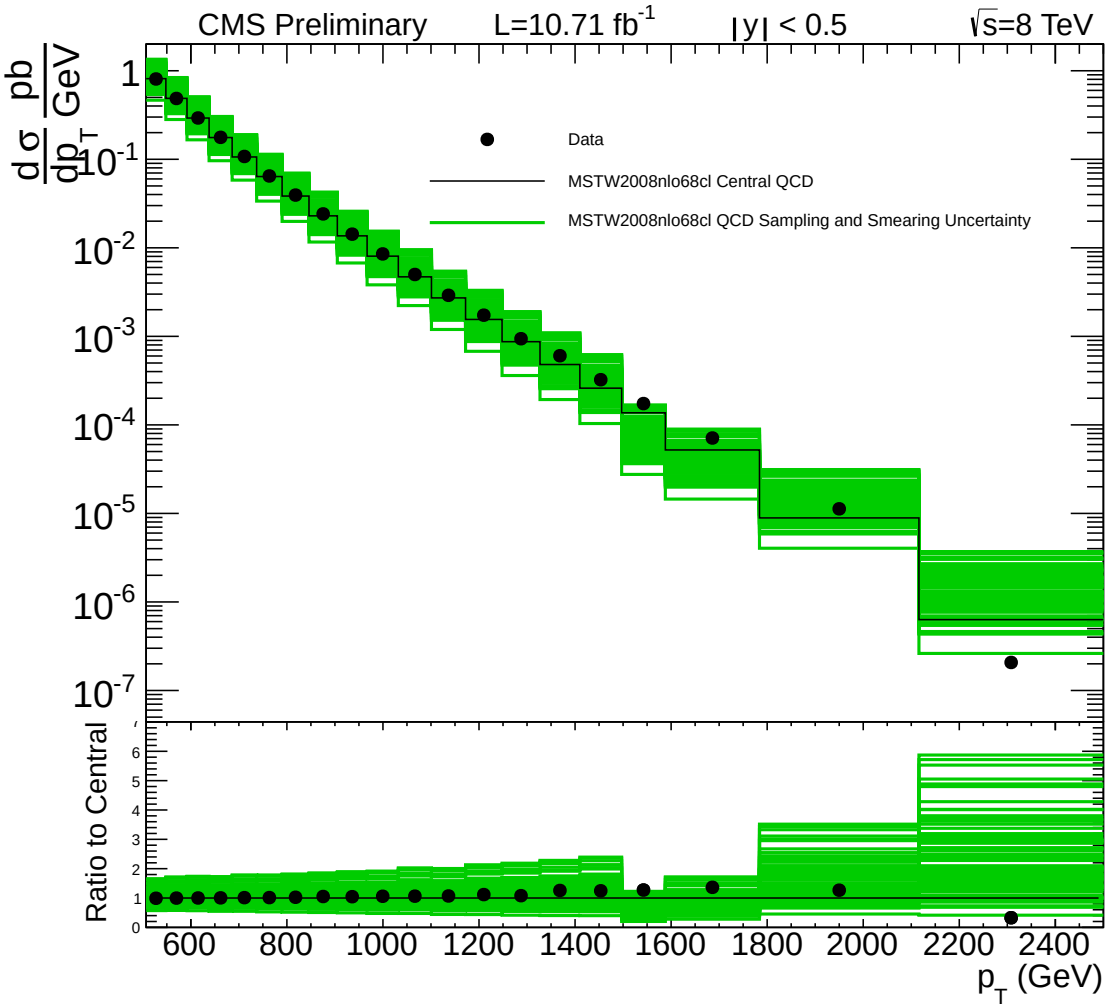
Jet Smearing and PDF Uncertainty



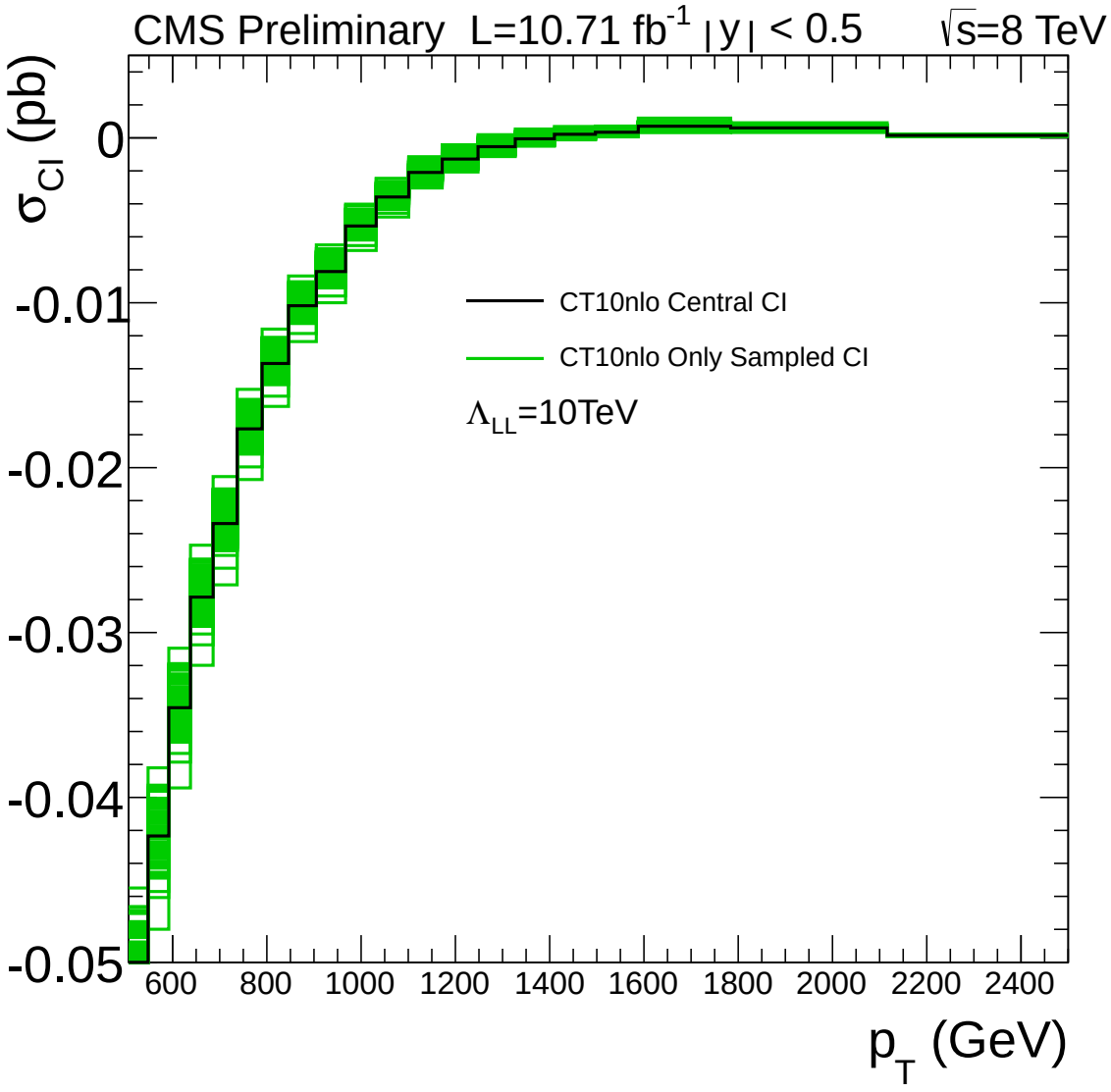
Only Sampling Uncertainty



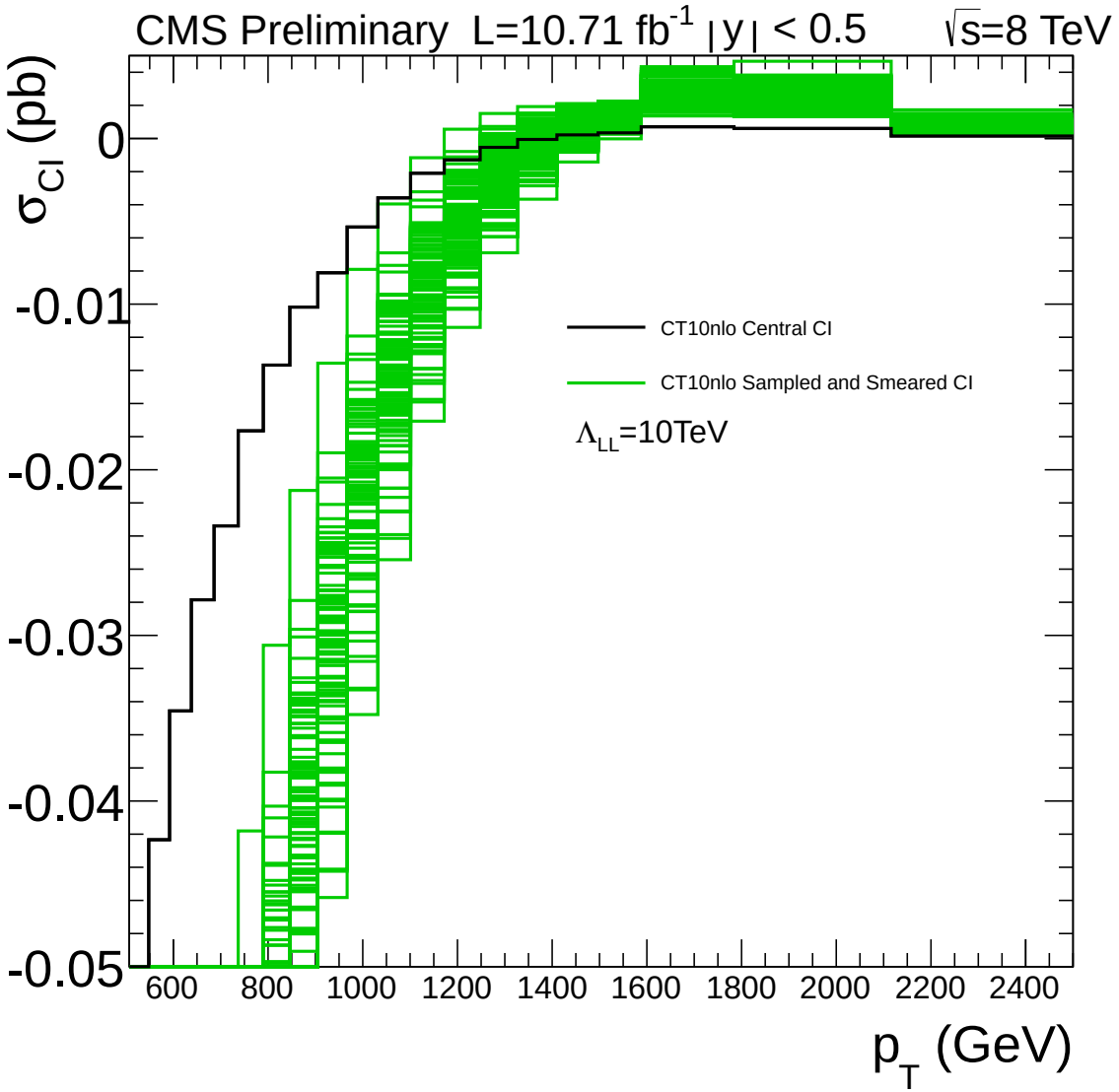
Jet Smearing and PDF Uncertainty



CI withPDF Uncertainty



CI with PDF and Smearing Uncertainty



To Do:

- Sort out CI smearing issues
- Include PDF+Smearing Uncertainties on signal
- Compute limits on Λ for each PDF and CI model
- Pool results from CT10nlo, MSTW2008nlo68cl, and NNPDF21_100 PDF sets
- Currently drafting an analysis note