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 deviations in terms of NLO contact interaction (CI) models.

- Spectra computed using the CT10, MSTW, NNPDF PDFs
- QCD spectra computed using `fastNLO` (v2.1.0-1360 + `fnl3323y0.tab`)
- CI spectra computed using `CIJET` (v1.0, argXiv:1301.7263)

Today: Discuss the inclusion of PDF uncertainties and the smearing of spectra assuming 4% uncertainty in the Jet Energy Scale (JES) and 10% uncertainty in Jet Energy Resolution (JER).

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

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

- 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 mass scale of the CI interactions.

The primed terms vanish at leading order.

Review of PDF Uncertainty

- We follow the procedure outlined here: `https://mstwpdf.hepforge.org/random/`
- The error 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 PDF parameter and n is the number of non-central members in the PDF set ($n = 26$ for CT10nlo, $n = 20$ for MSTW2008nlo68cl).

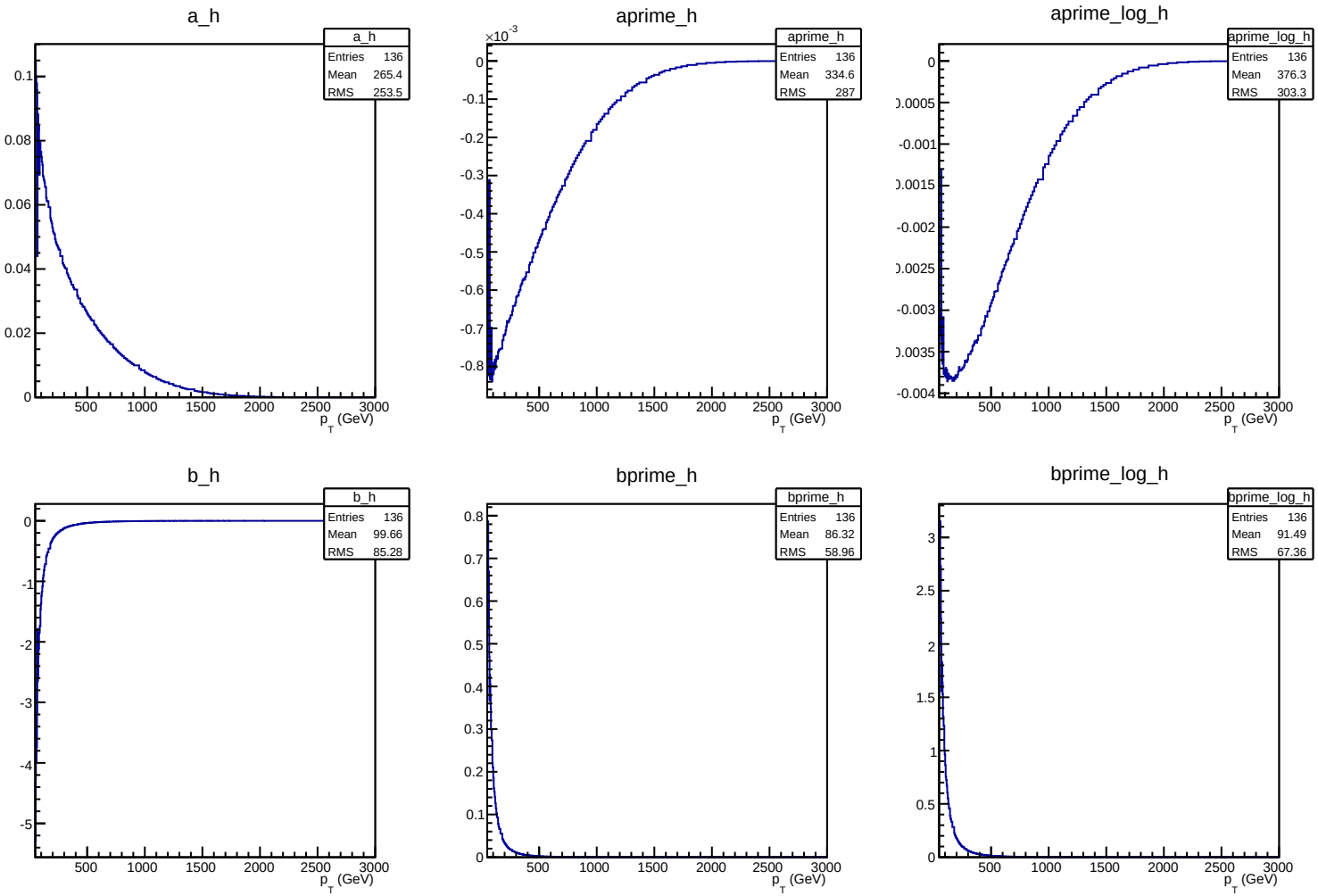
The same set of n random numbers is used for all bins, all models.

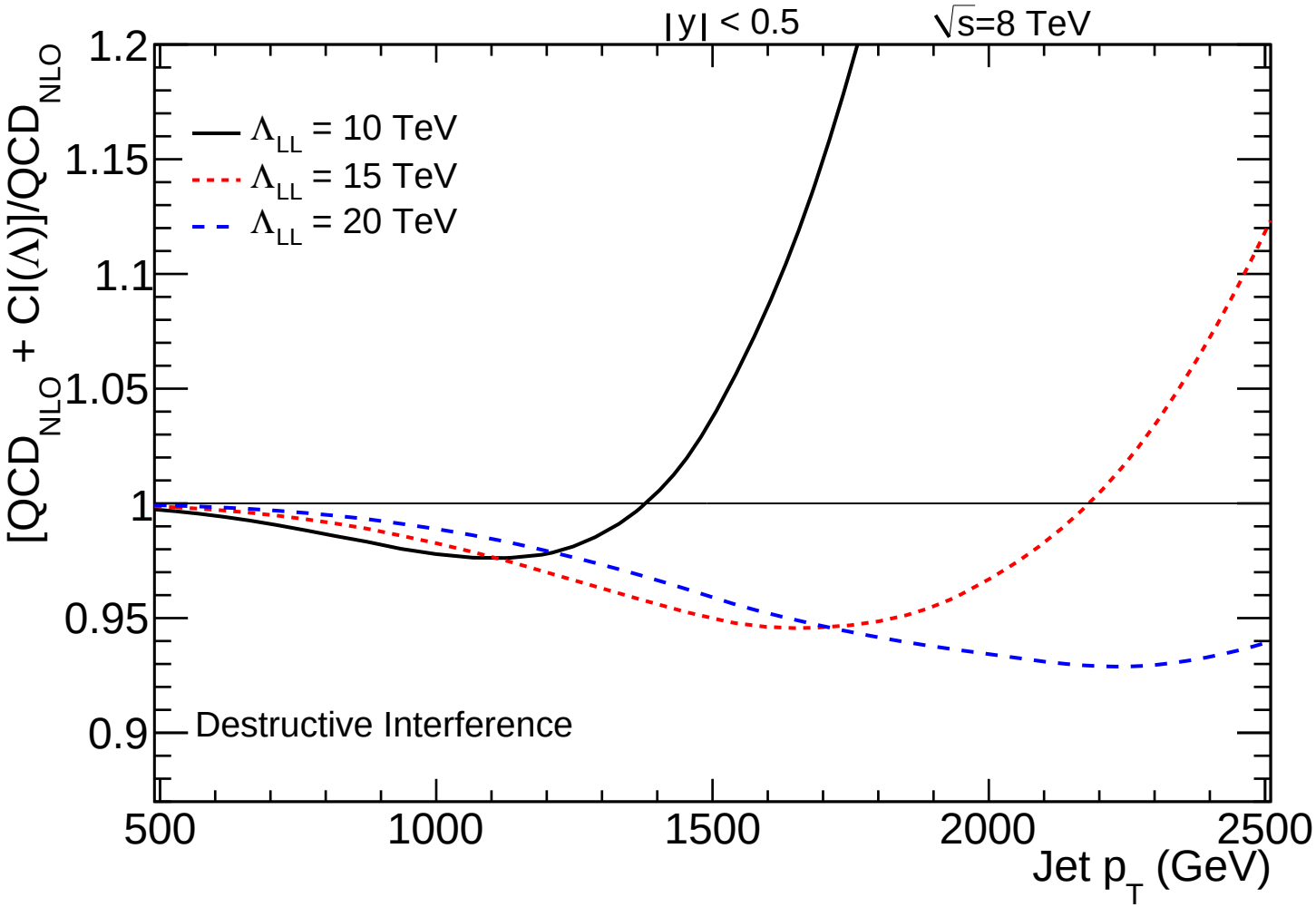
Smearing A, B coefficients with JES, and JER uncertainty

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

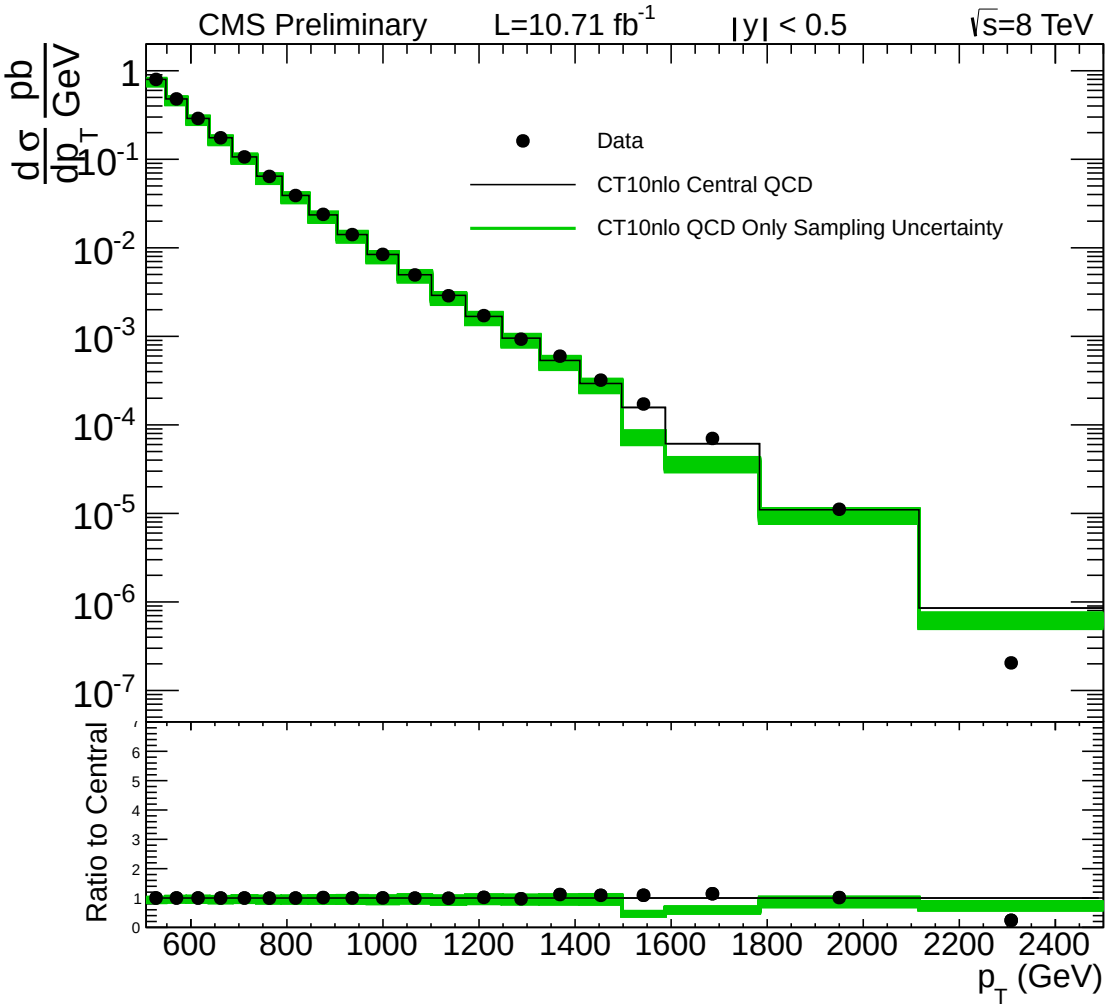
- z = true p_T
- $R\left(p_T | xz, y\sigma_z\right) = \text{Gaussian}\left(p_T, xz, y\sigma_z(z)\right)$
- $\sigma_z(z) = \sqrt{\frac{N^2}{z^2} + \frac{S^2}{z} + C^2}$
- $N = 5.886,\ S = 1.136,\ C = 0.032$ (SMP-12-012)
- x models the JES uncertainty, sampled from a Gaussian with mean of 1 and $\sigma = 0.04$
- y models the JER uncertainty, sampled 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)

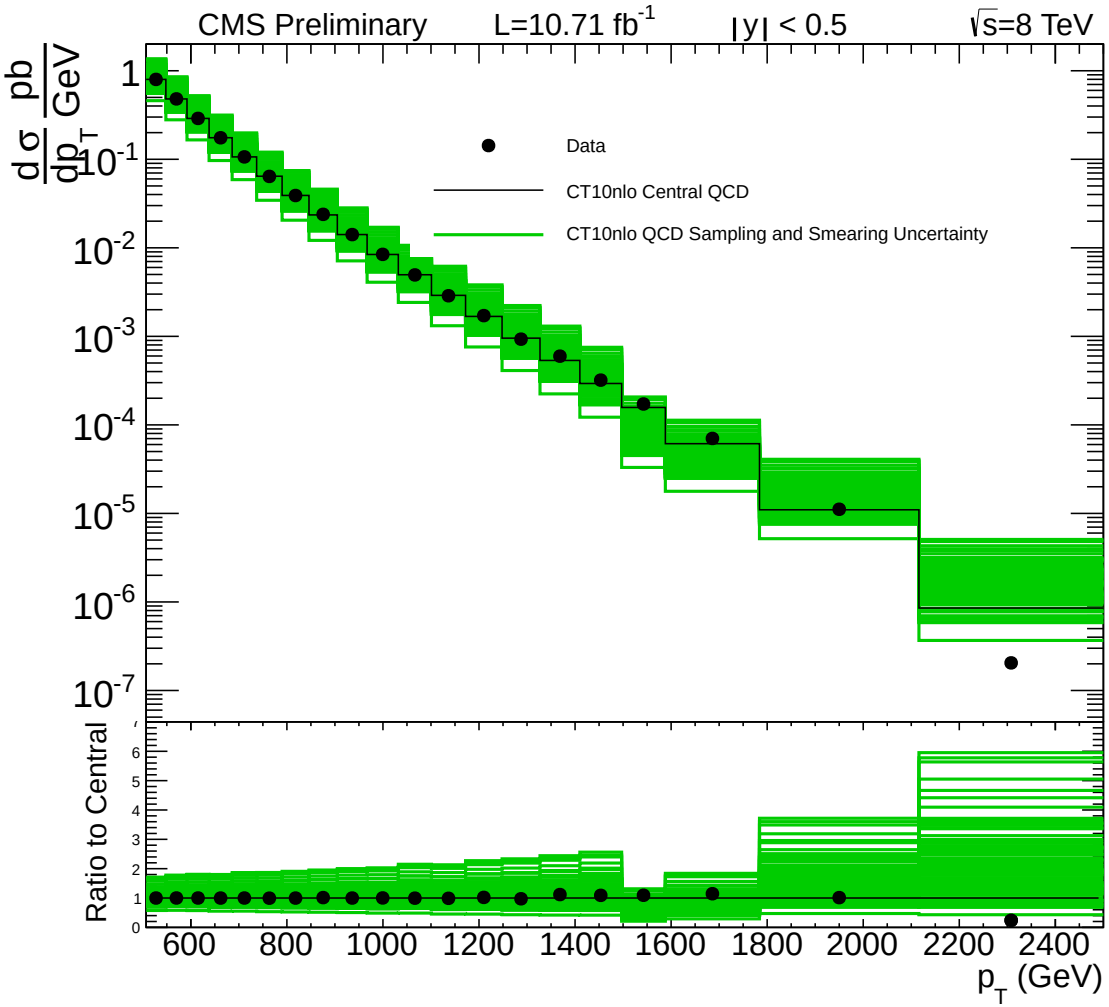



|y| < 0.5
√s=8 TeV
Λ_LL = 10 TeV
Λ_LL = 15 TeV
Λ_LL = 20 TeV
Destructive Interference
[QCD_NLO + CI(Λ)]/QCD_NLO
Jet p_T (GeV)
1.2
1.15
1.1
1.05
1
0.95
0.9
500
1000
1500
2000
2500

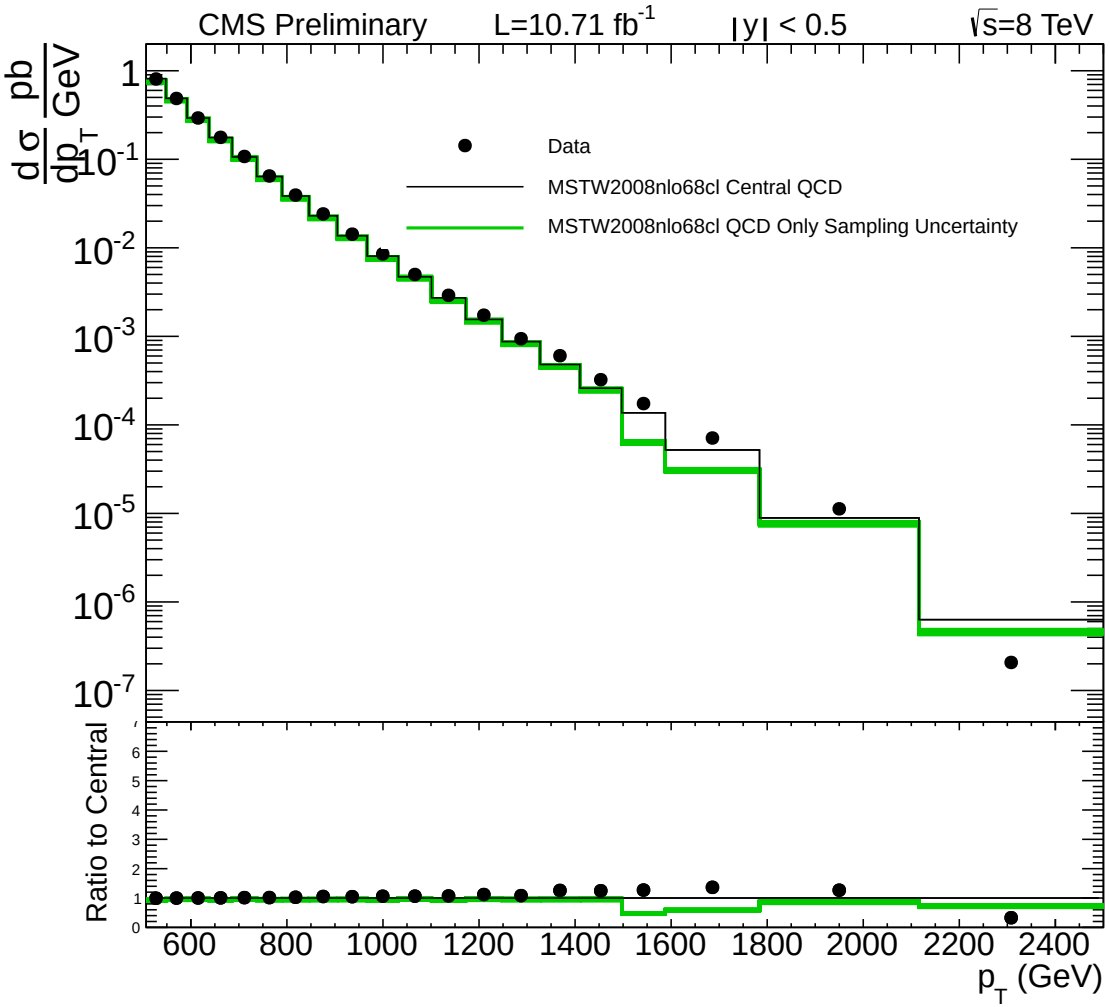
Only SamplingUncertainty



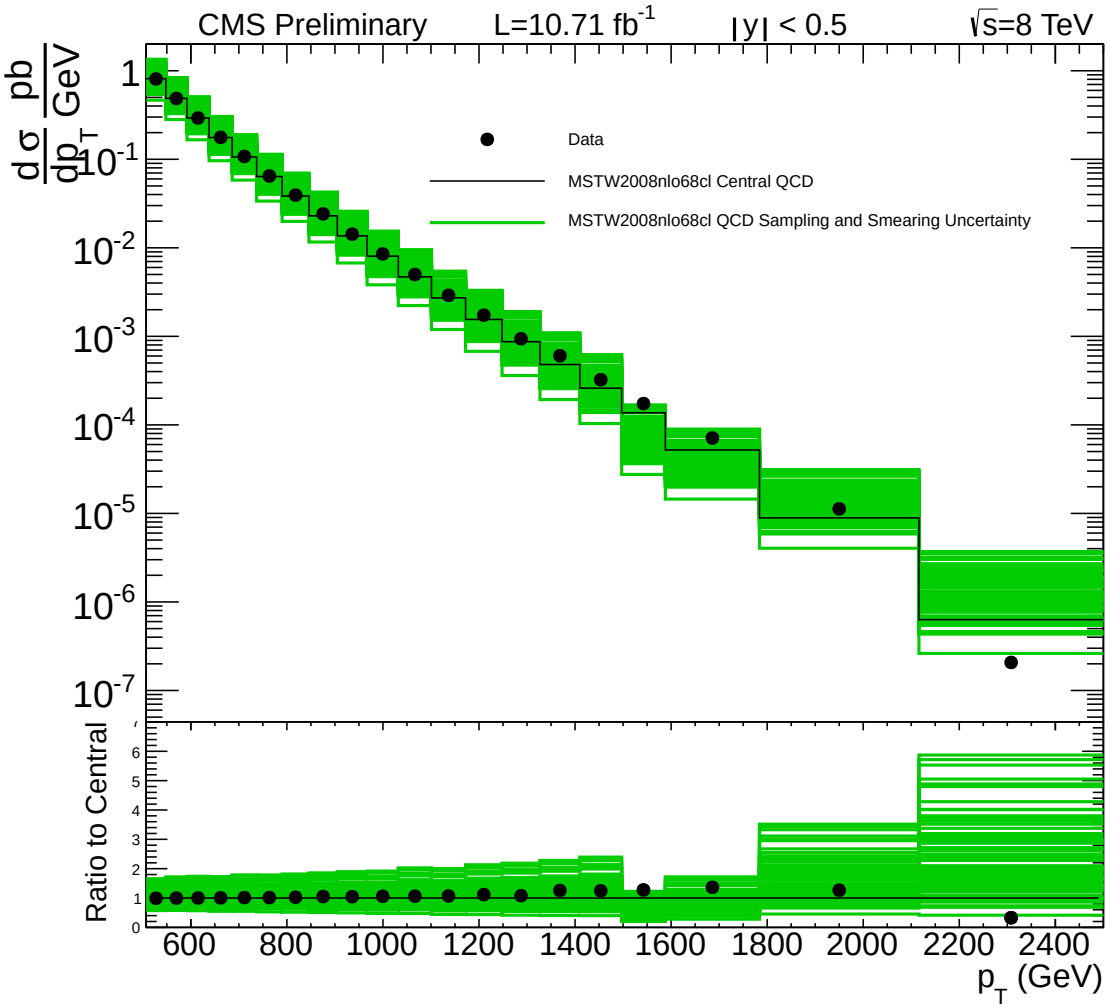
Jet Smearing and PDF Uncertainty



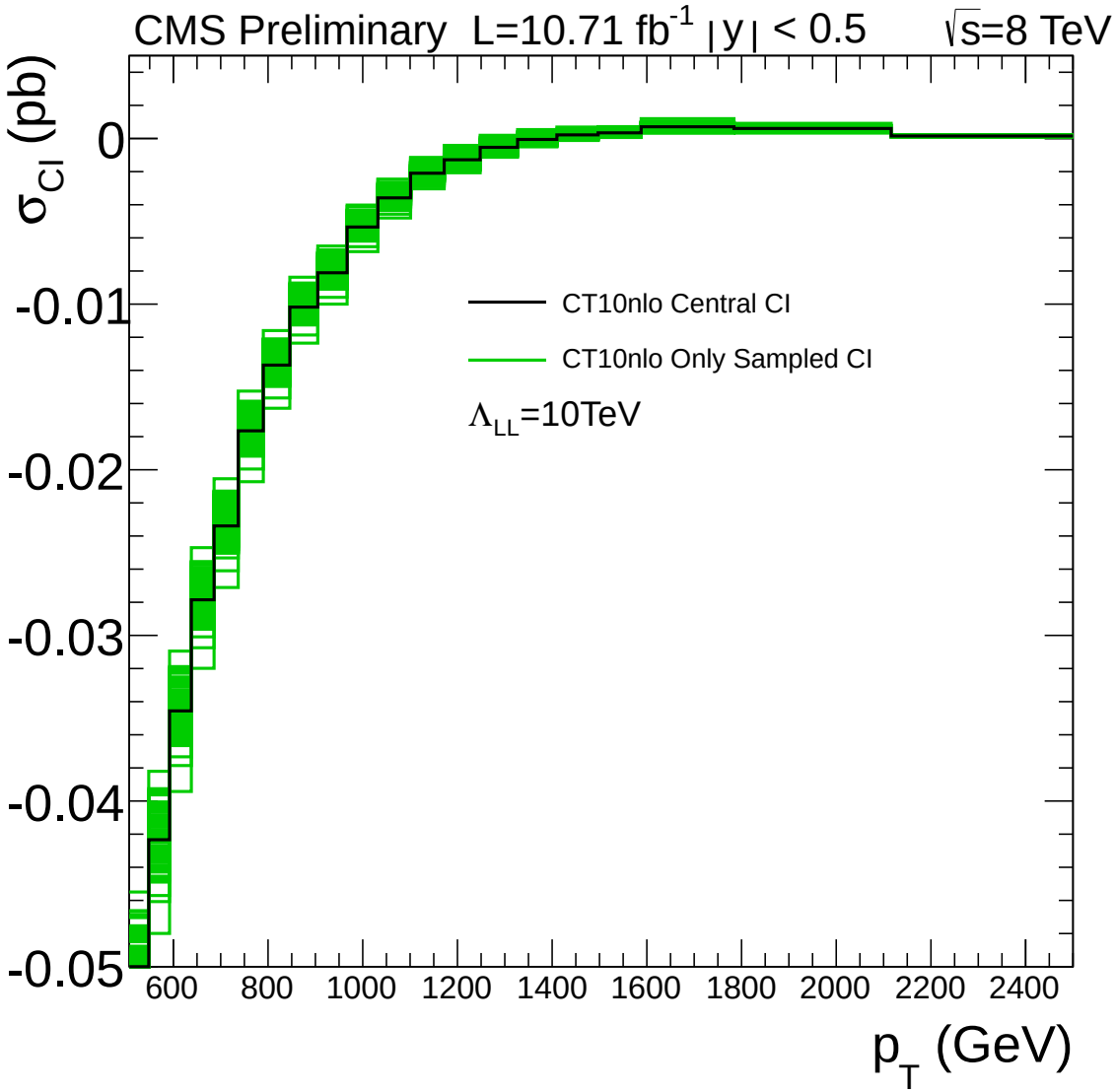
Only Sampling Uncertainty



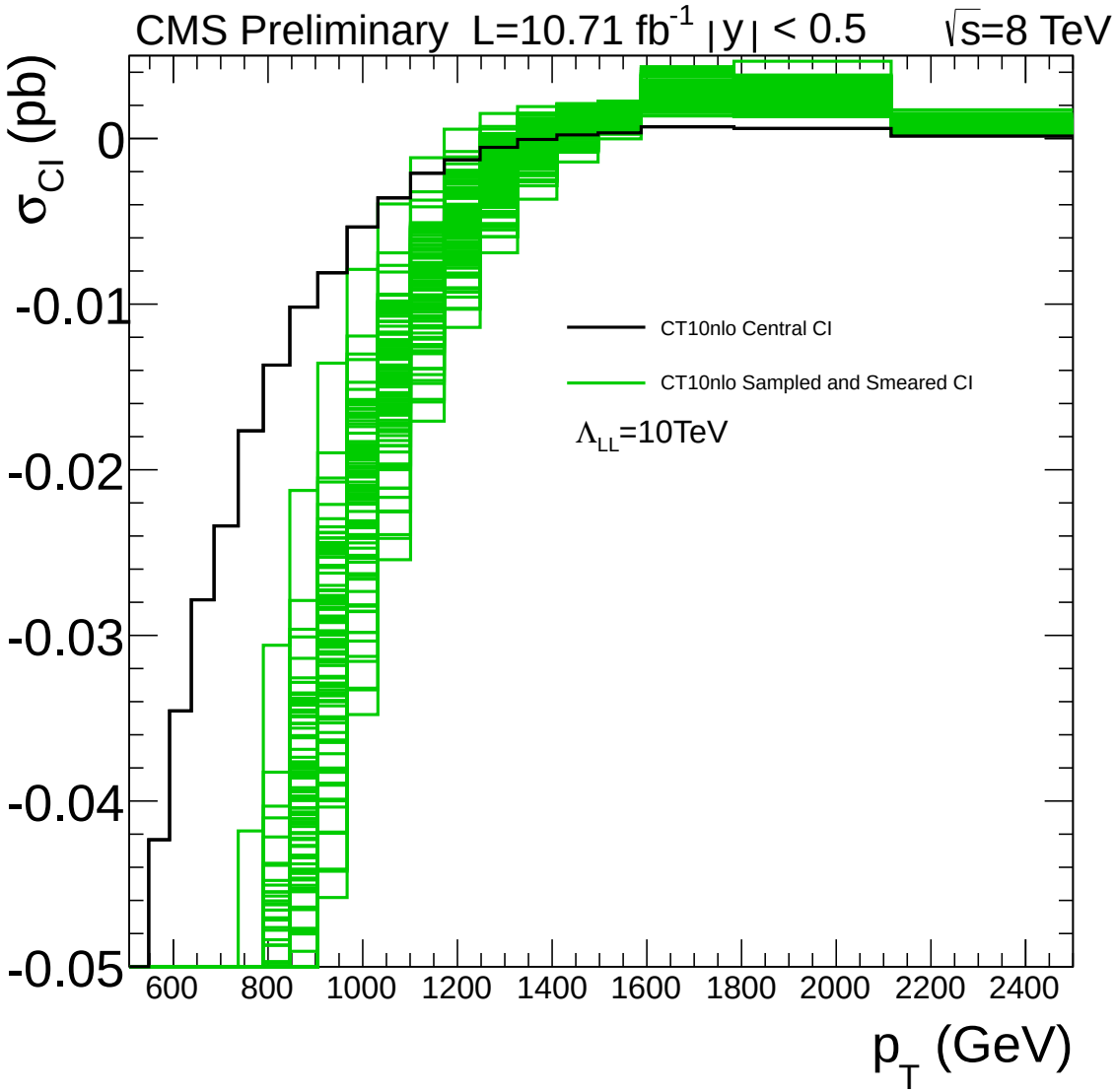
Jet Smearing and PDF Uncertainty



CI withPDF Uncertainty



CI with PDF and Smearing Uncertainty



To Do:

- Sort out CI smearing issues
- Include PDF+jet 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