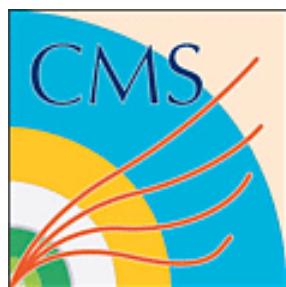


Measurement of Low p_T Jet Cross Section in proton-proton Collisions at $\sqrt{s} = 8 \text{ TeV}$

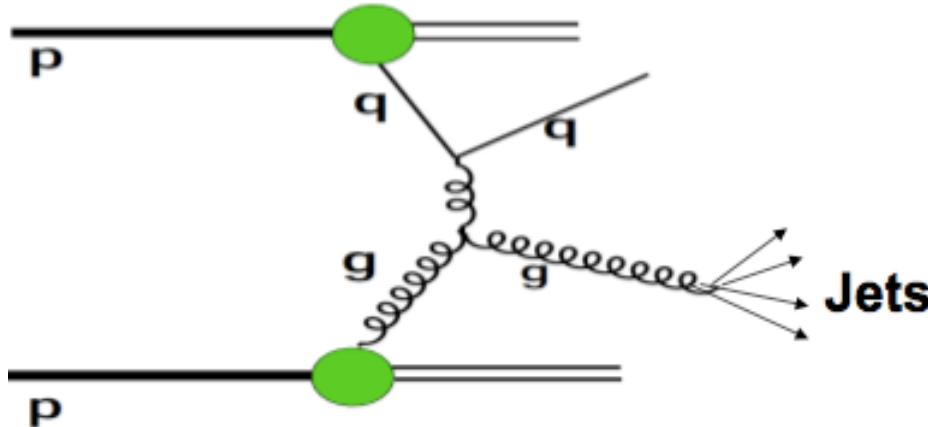


Ilknur Hos
(Cukurova University)
on behalf of
FSQ PAG



LHC Working Group on Forward Physics and Diffraction
26.08.2013

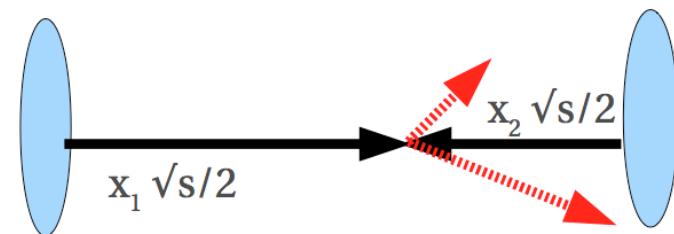
Motivation



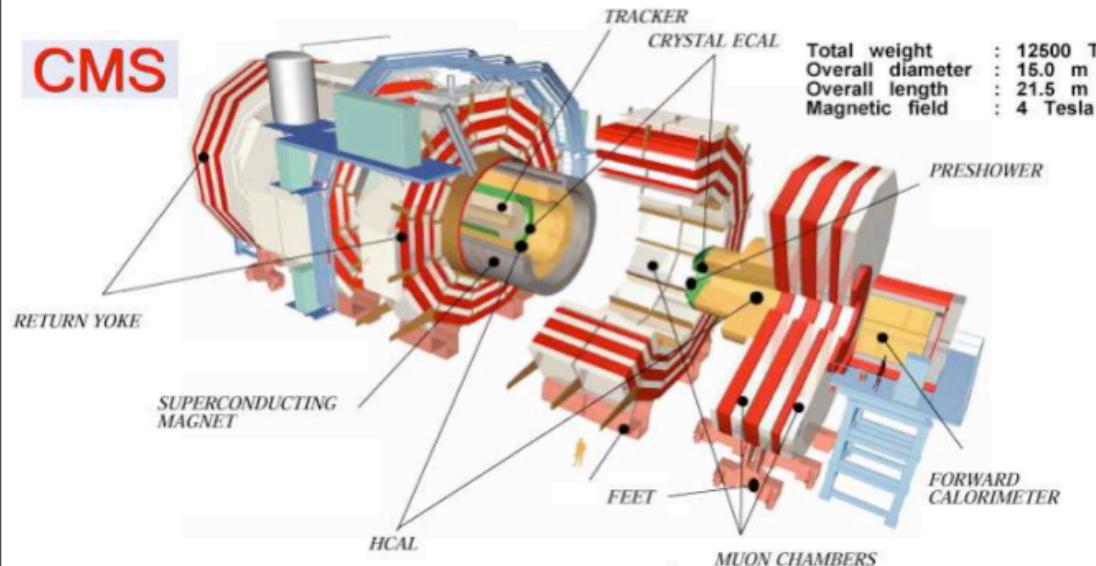
- Jets are used to constrain the parameters of **Parton Distribution Functions**.
- Jet measurements give a precise estimate of standard model background in new physics search.

- Forward jets allow to probe the **low- x** domain region sensitive to alternative parton dynamics and **non-linear QCD effects**.
- Better understanding of the parton density functions (**PDFs**).
- Sensitivity to parton radiation.

$$x_2^{\min} \approx \frac{p_T}{\sqrt{s}} \cdot e^{-y} = x_T \cdot e^{-y}$$



Inclusive Jets

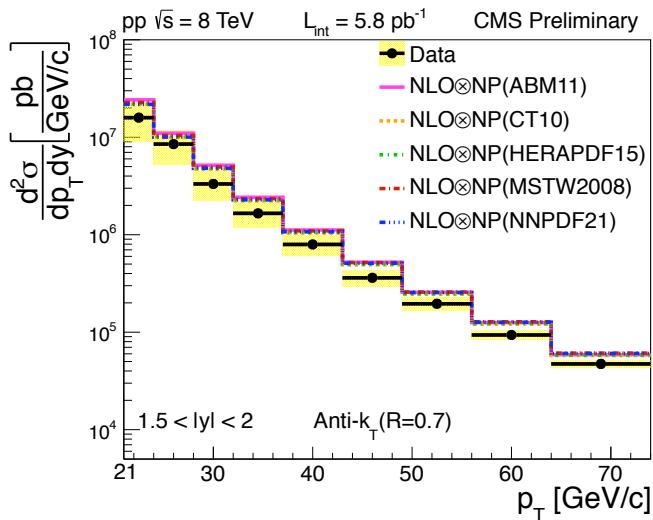
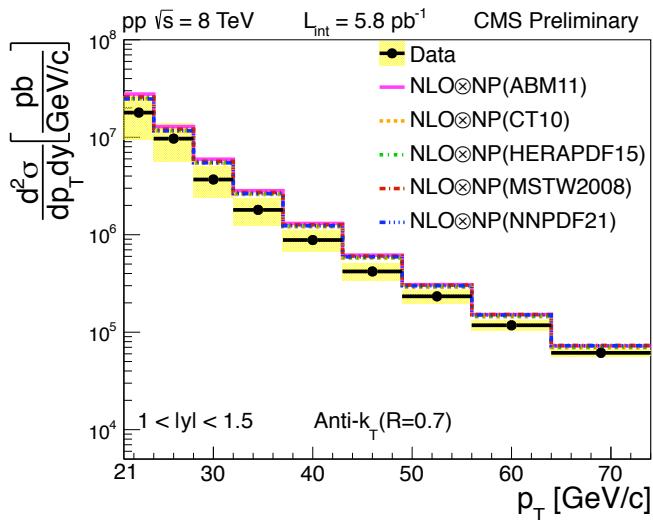
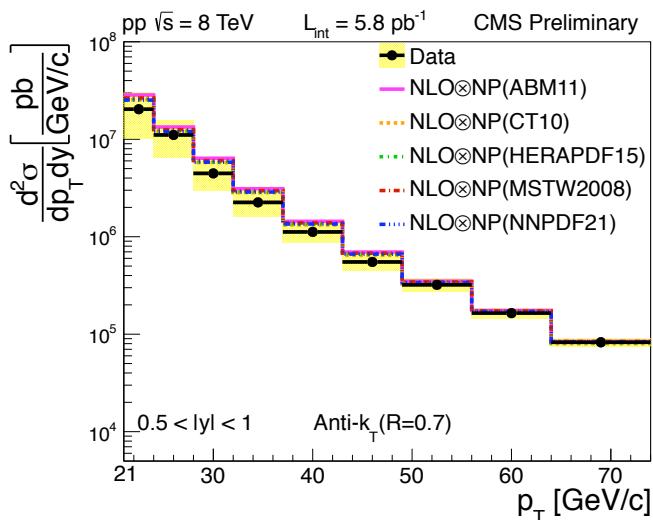
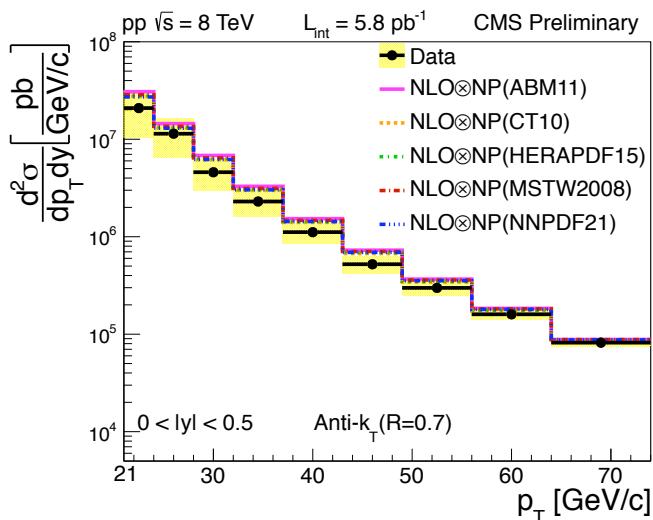


- 5.8 pb⁻¹ from 8 TeV 2012 (low pile-up)
- Anti-k_T ($R=0.7$) jet clustering algorithm
- ZeroBiasPixel trigger
- Jet identification criteria
- Good primary vertex

- L_{eff} is the effective integrated luminosity
- N is the number of jets
- Δp_{T} and Δy are the transverse momentum and rapidity bin sizes.

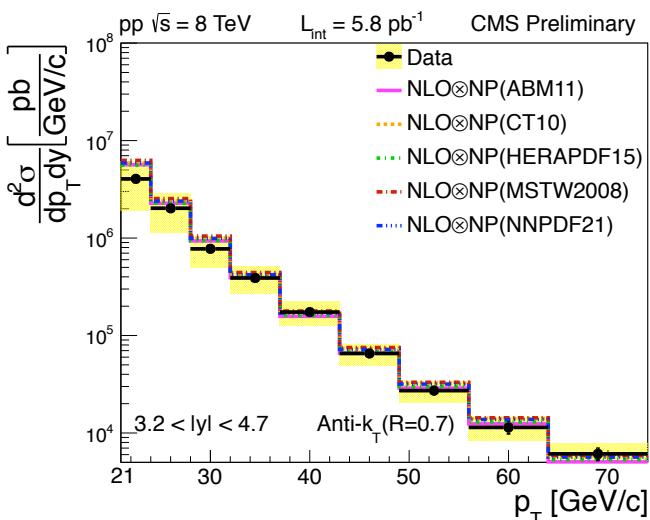
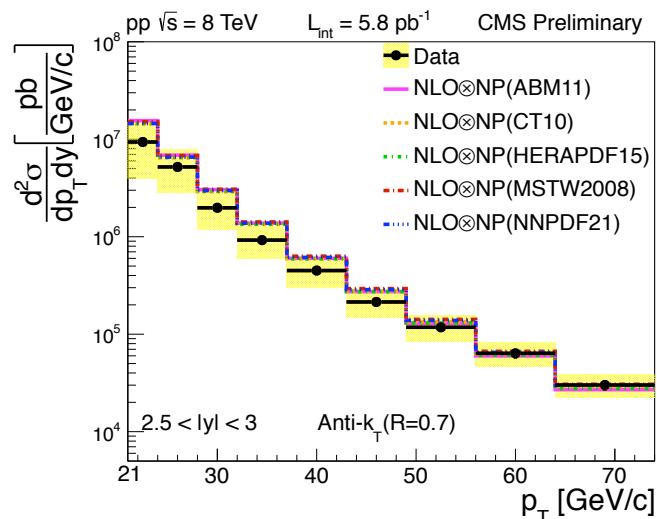
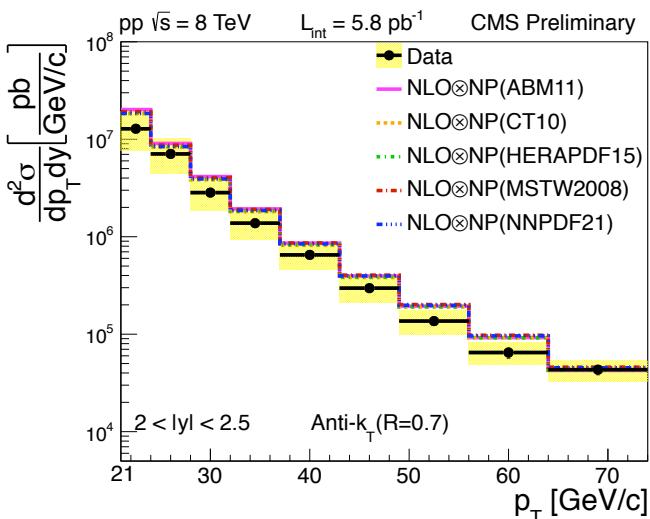
$$\frac{d^2\sigma}{dp_{\text{T}}dy} = \frac{1}{\mathcal{L}_{\text{eff}}} \cdot \frac{N}{\Delta p_{\text{T}} \cdot \Delta y}$$

Low p_T Jet Cross Section



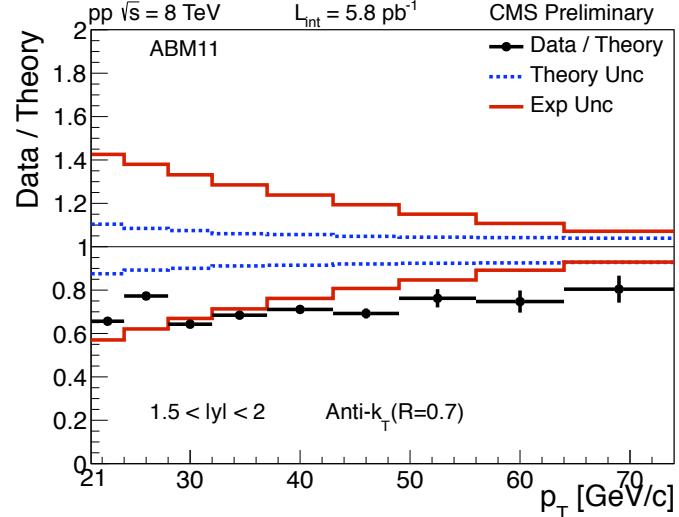
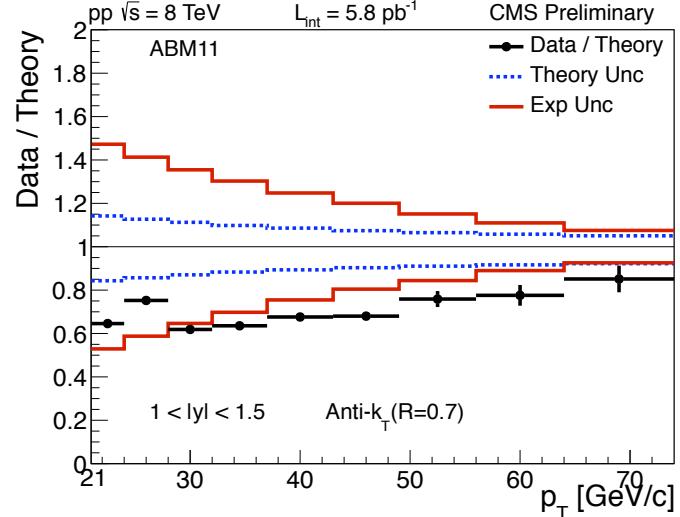
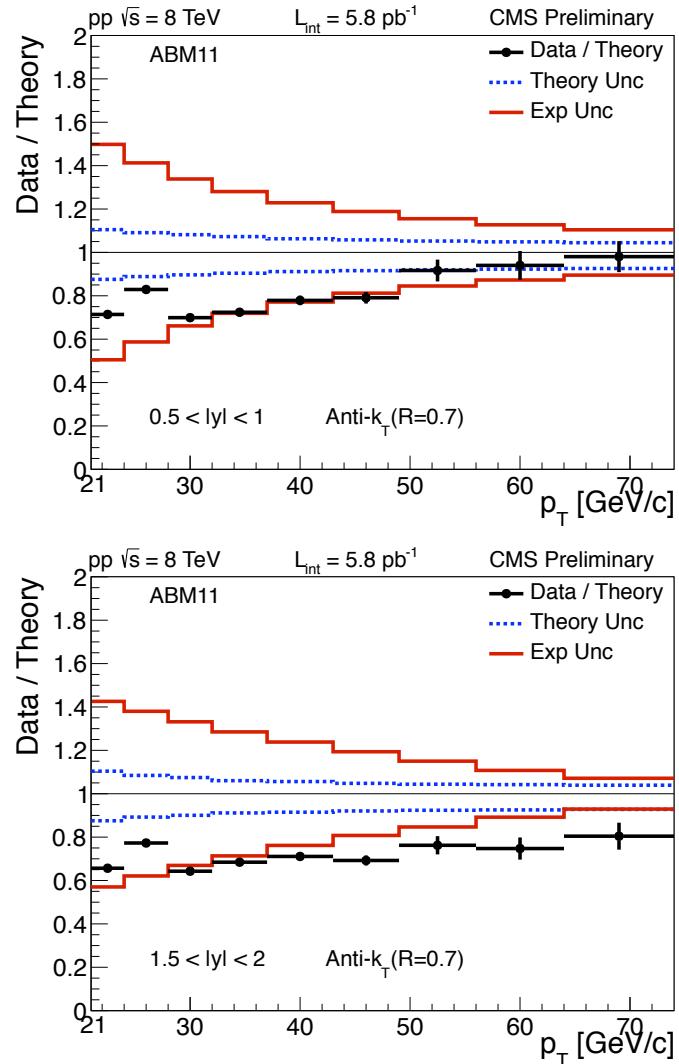
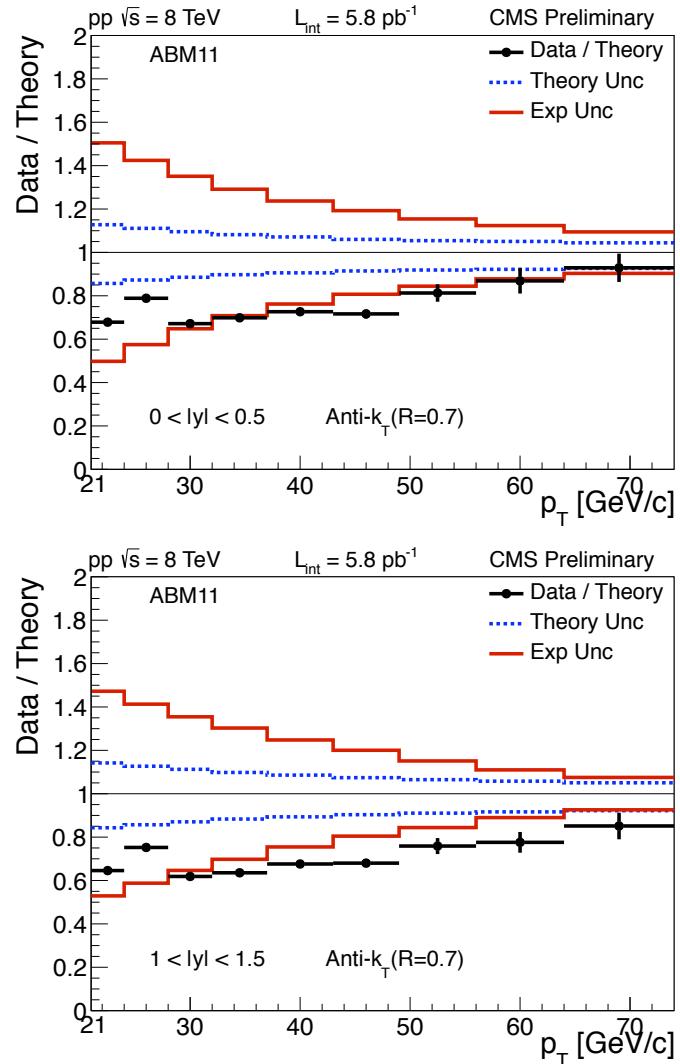
- Inclusive jet cross section measured at rapidities ($0 < |y| < 4.7$), **fully corrected and unfolded**, compared to various hadron-level theoretical predictions: NLO calculations for various PDFs (**ABM11, CT10, HERAPDF 1.5, MSTW2008 and NNPDF 2.1**)

Low p_T Jet Cross Section



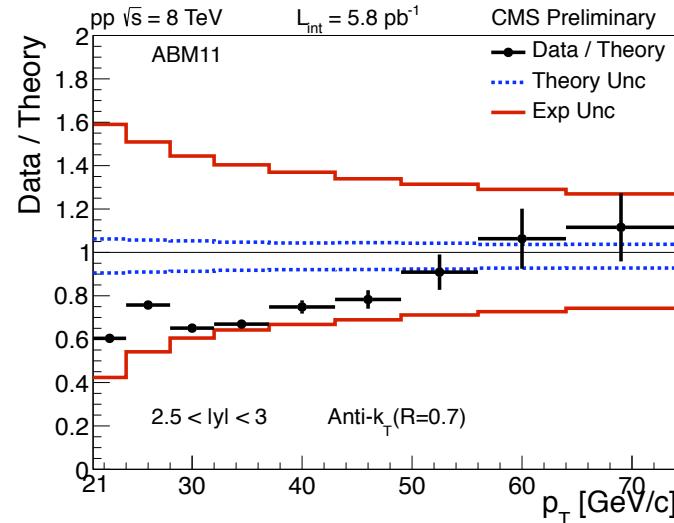
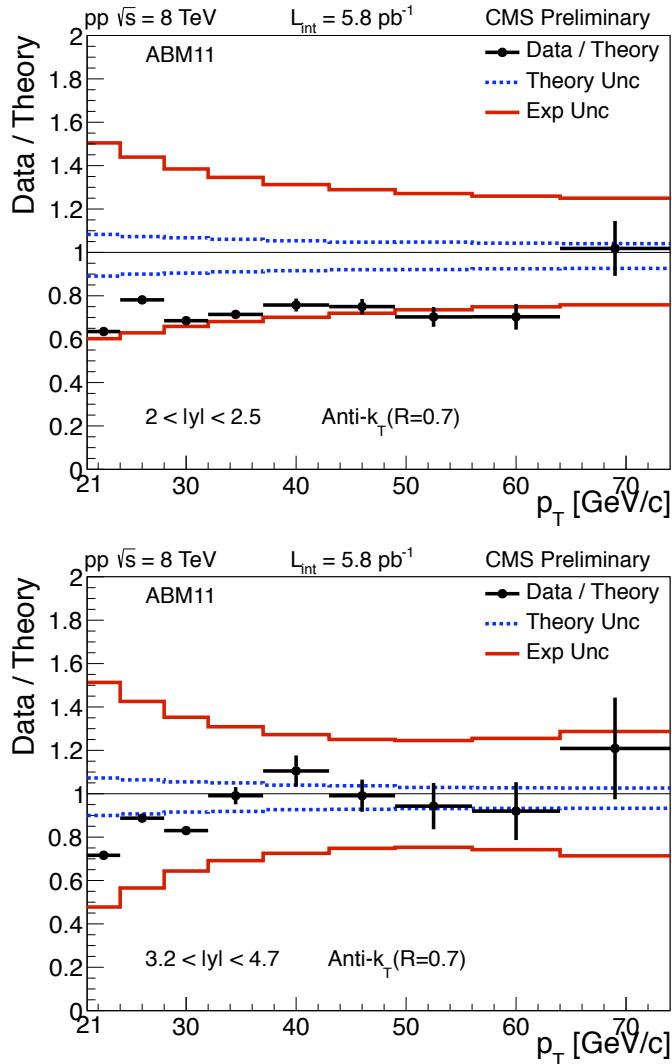
- The inclusive jet cross section corrected to hadron level as a function of p_T for different bins in rapidity y is shown.
- The cross section is steeply **falling** with **increasing p_T** .
- The slope of the p_T distribution becomes **steeper** with **increasing rapidity y** .

Data/Theory (ABM11) for different $|y|$



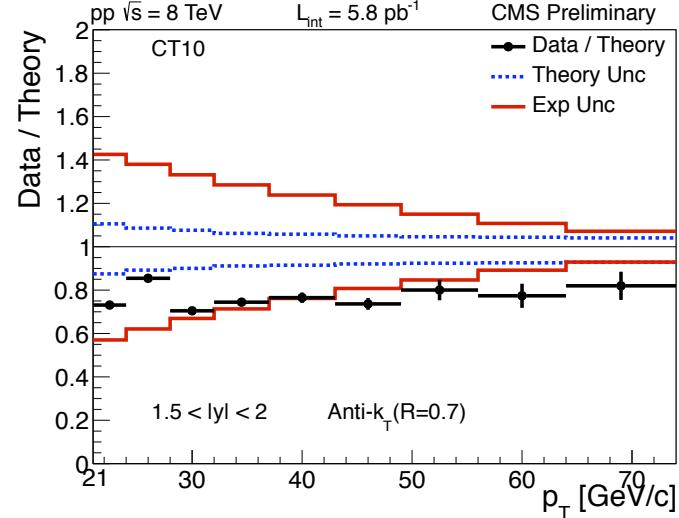
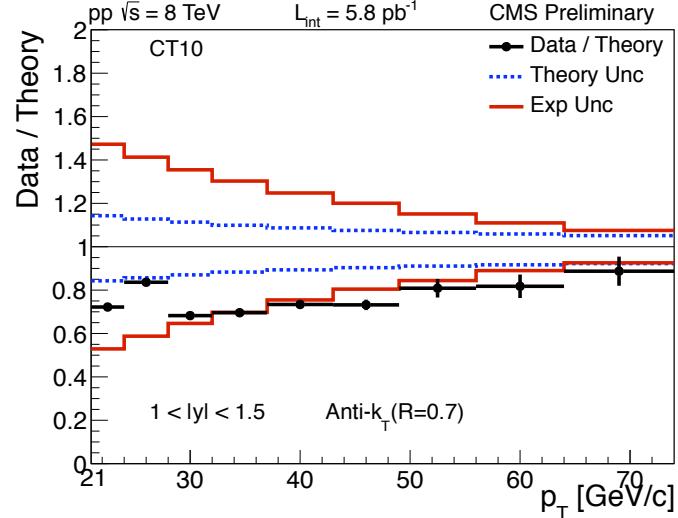
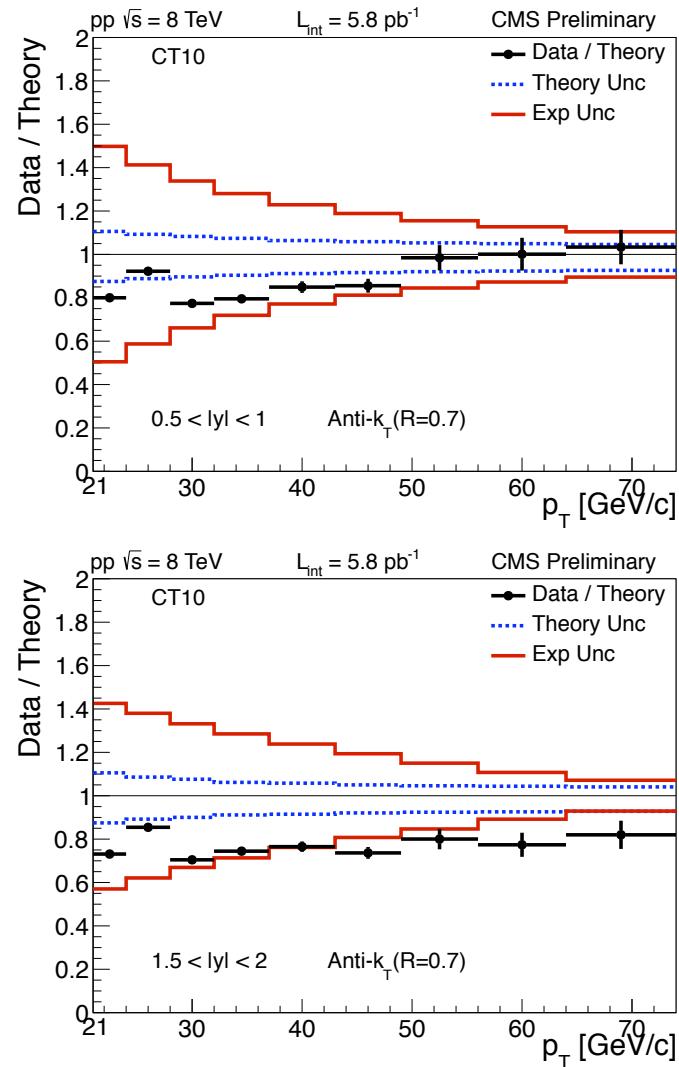
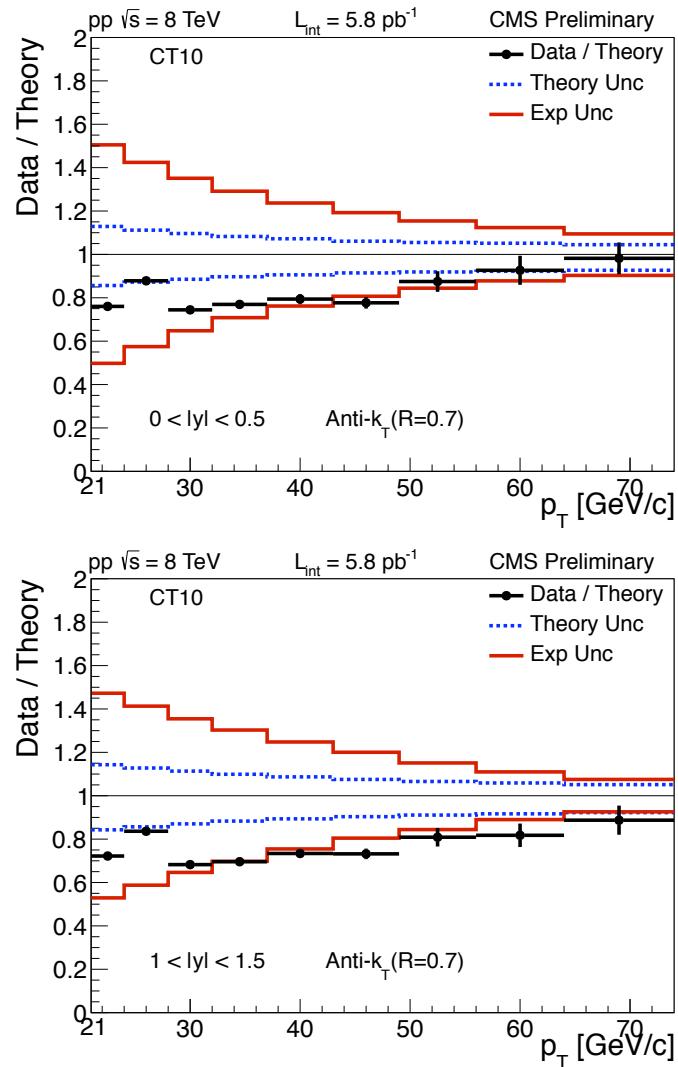
- Inclusive jet cross sections for data over the theoretical prediction of the ABM11 PDF set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Data/Theory (ABM11) for different $|y|$



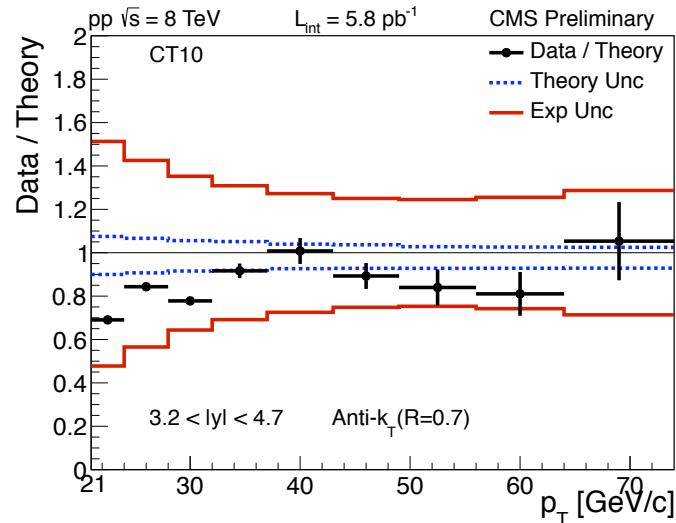
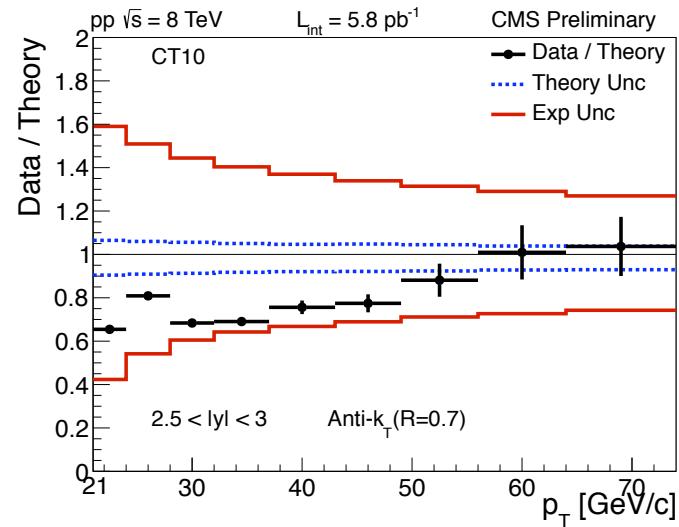
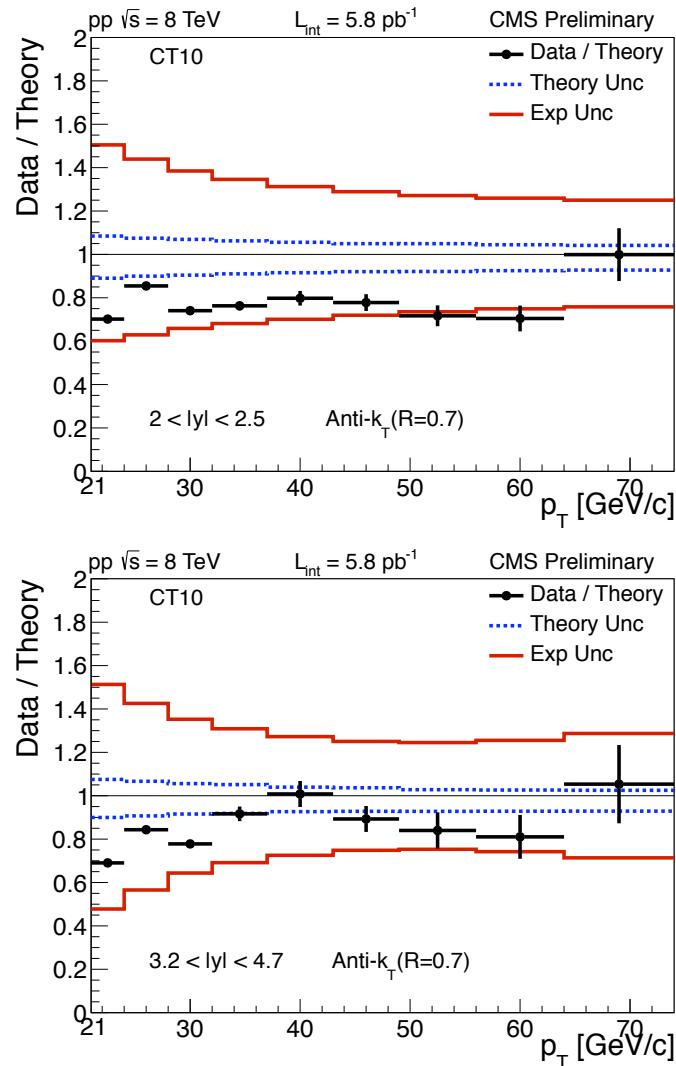
- The total experimental uncertainty band is dominated by the JES uncertainty(5-45%). Together with the uncertainty from JER(3-17%), unfolding(3-25%) and luminosity(4.4%), can reach 60% especially in the low p_T region.
- The total theoretical uncertainty, obtained by adding quadratically the uncertainties from NP and PS corrections and the scales can reach 14%.

Data/Theory (CT10) for different $|y|$



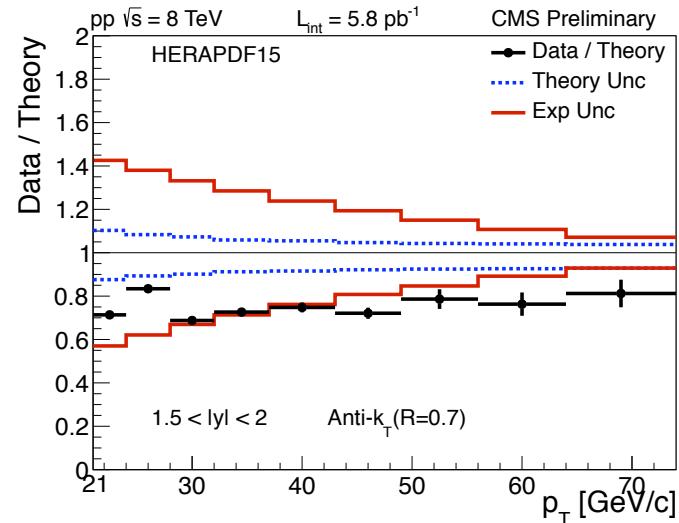
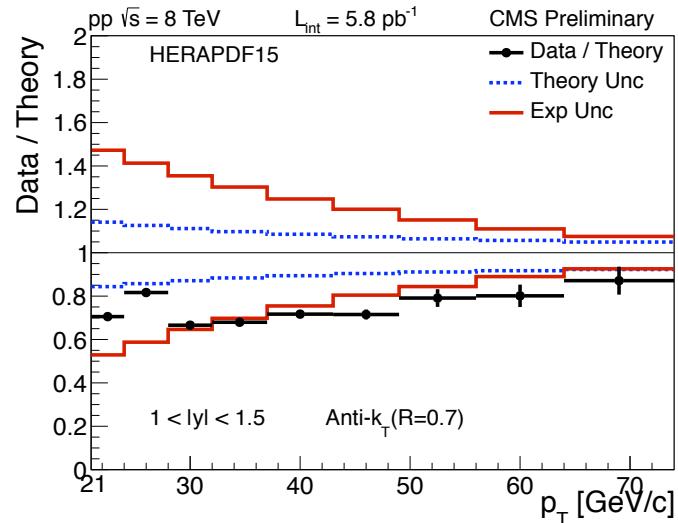
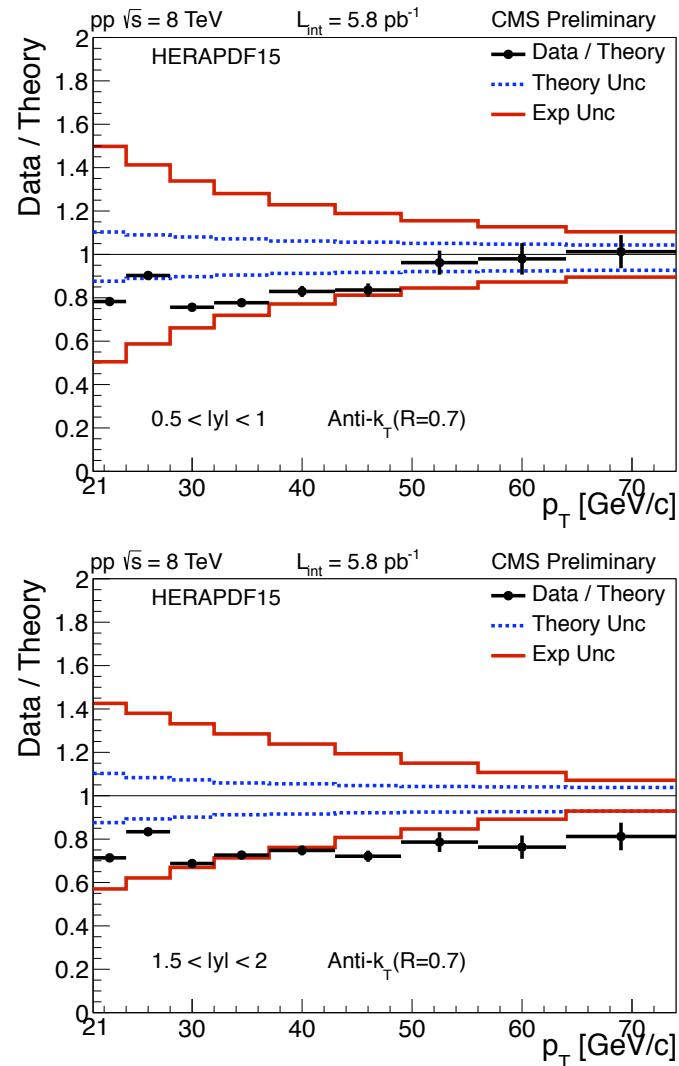
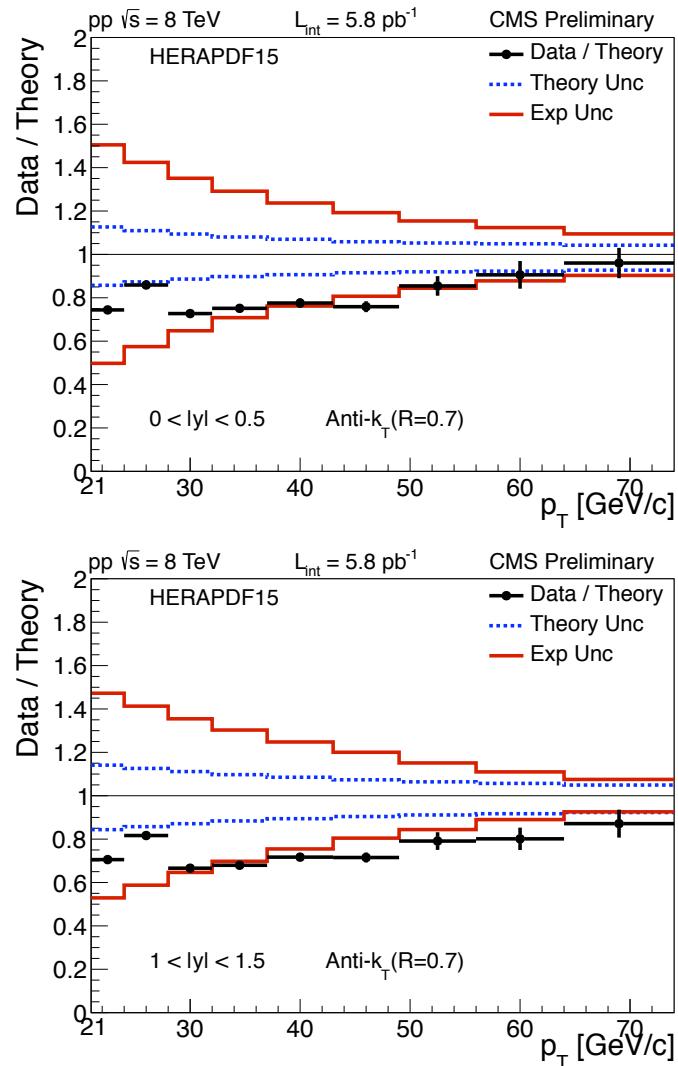
- Inclusive jet cross sections for data over the theoretical prediction of the **CT10 PDF** set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Data/Theory (CT10) for different $|y|$



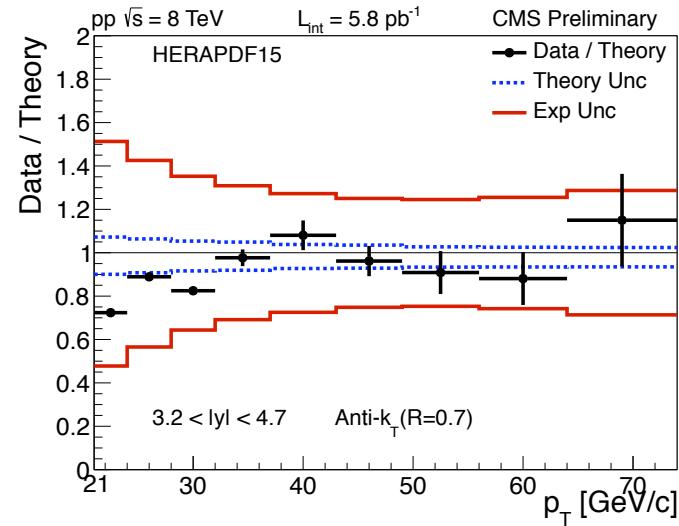
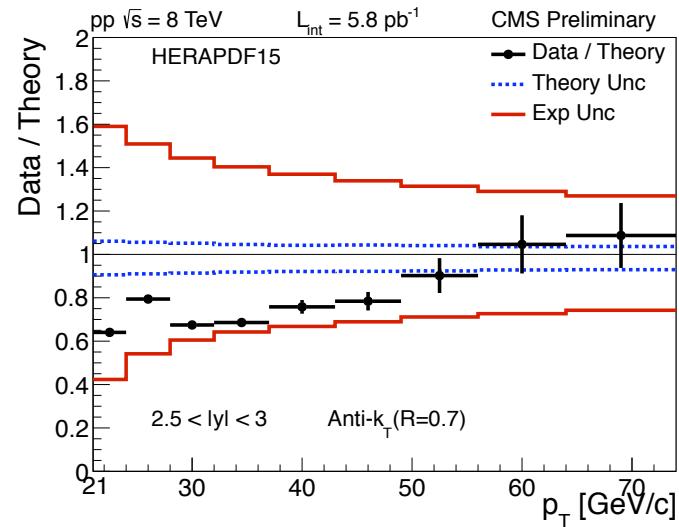
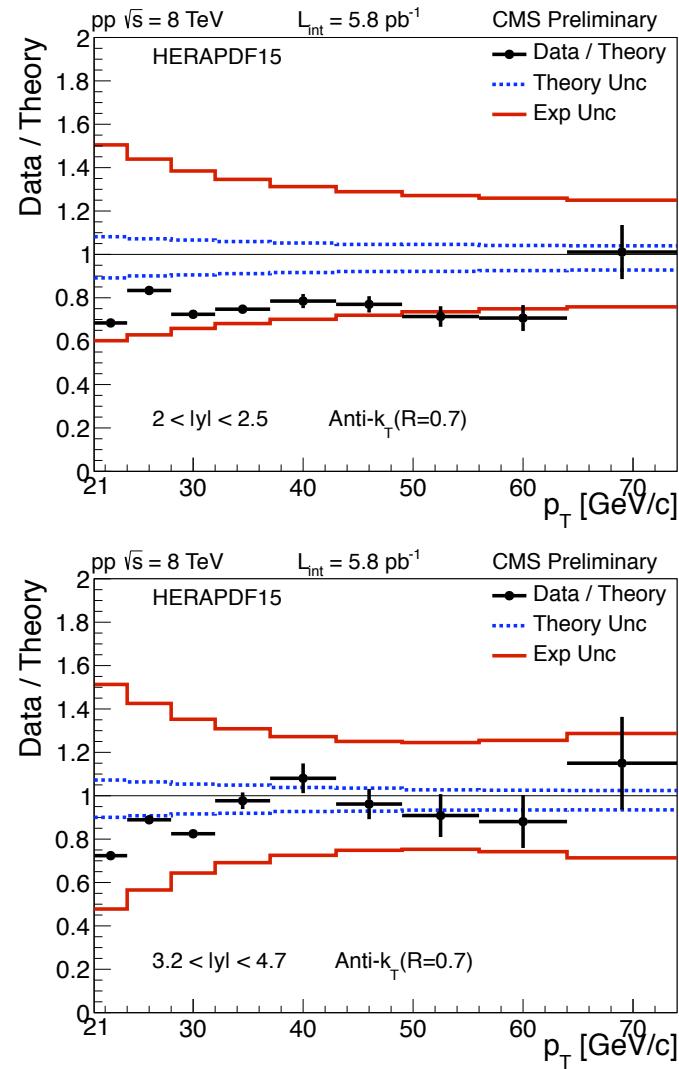
- Inclusive jet cross sections for data over the theoretical prediction of the CT10 PDF set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Data/Theory (HERAPDF 1.5) for different $|y|$



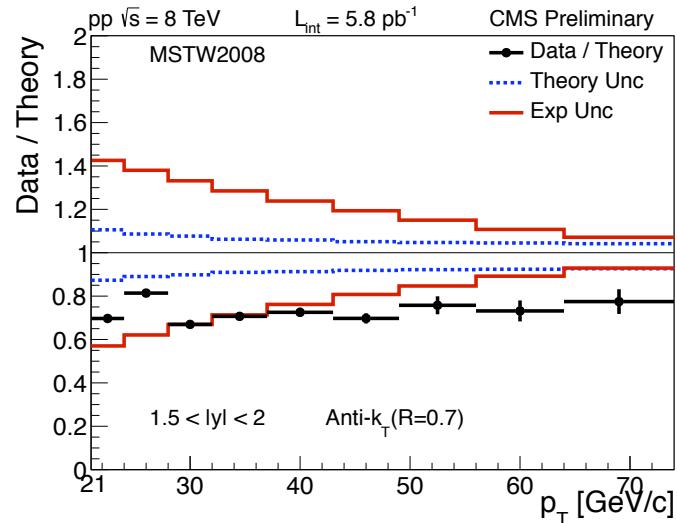
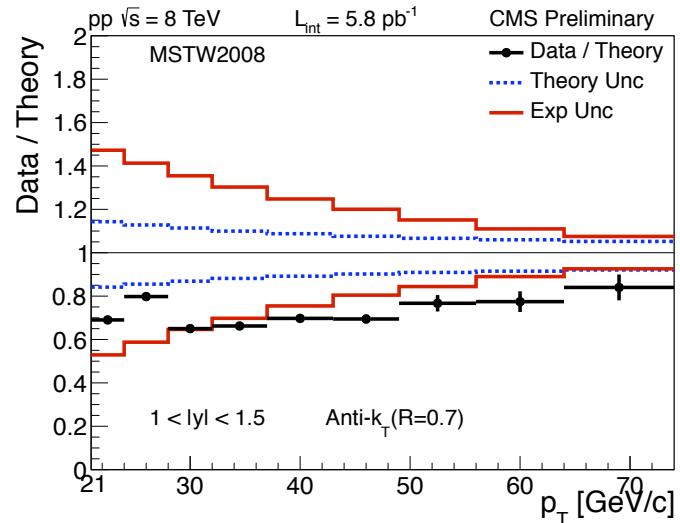
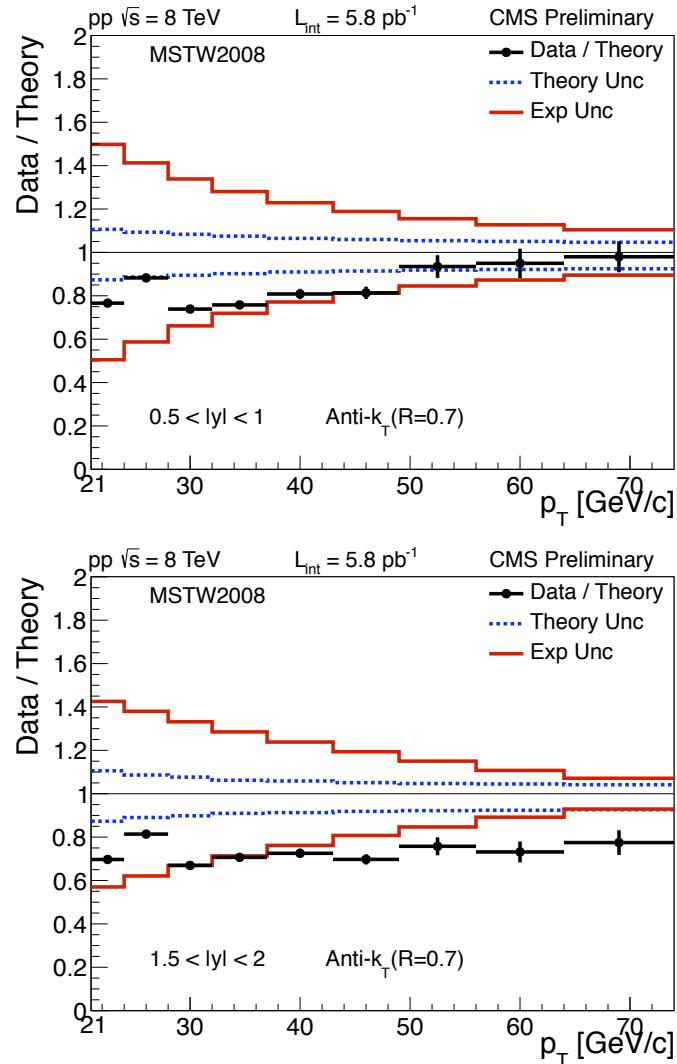
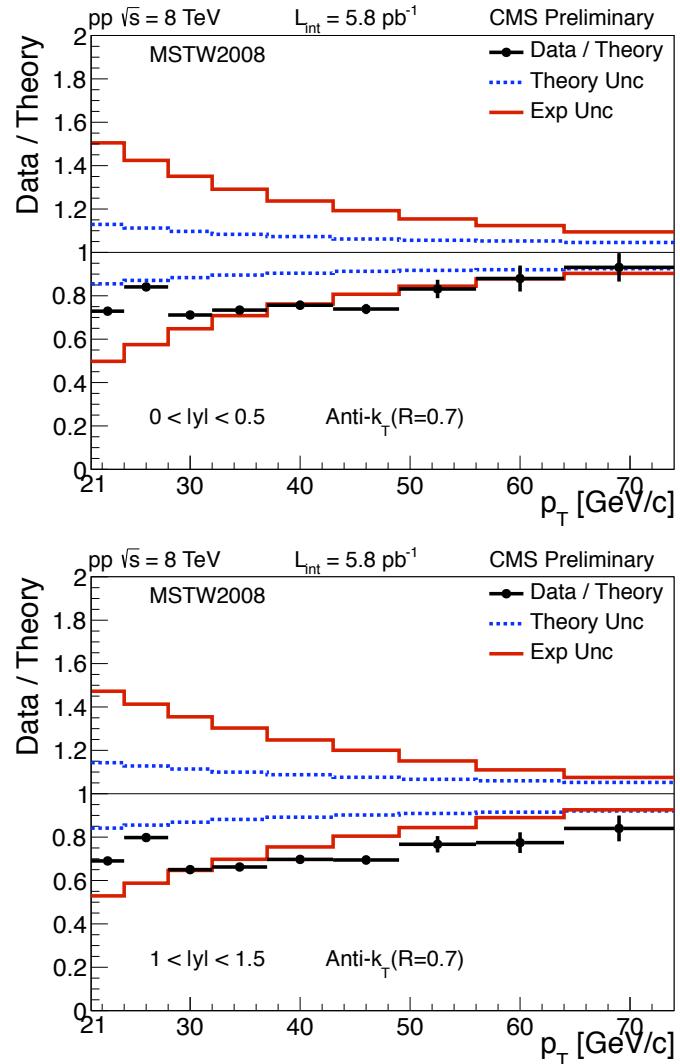
- Inclusive jet cross sections for data over the theoretical prediction of the HERAPDF 1.5 PDF set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Data/Theory (HERAPDF 1.5) for different $|y|$



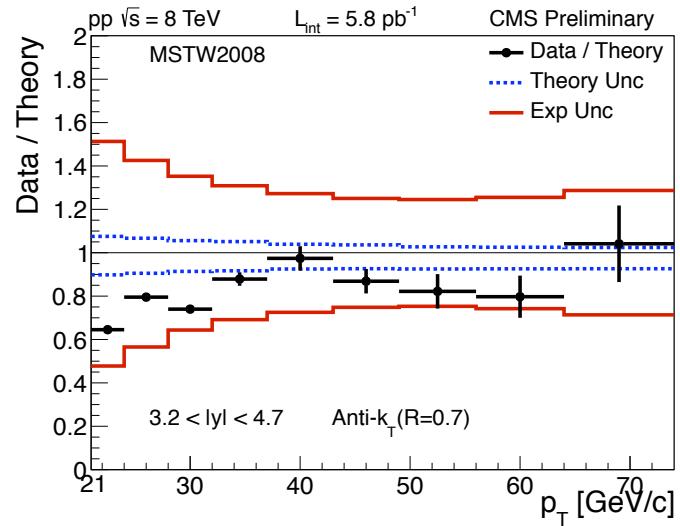
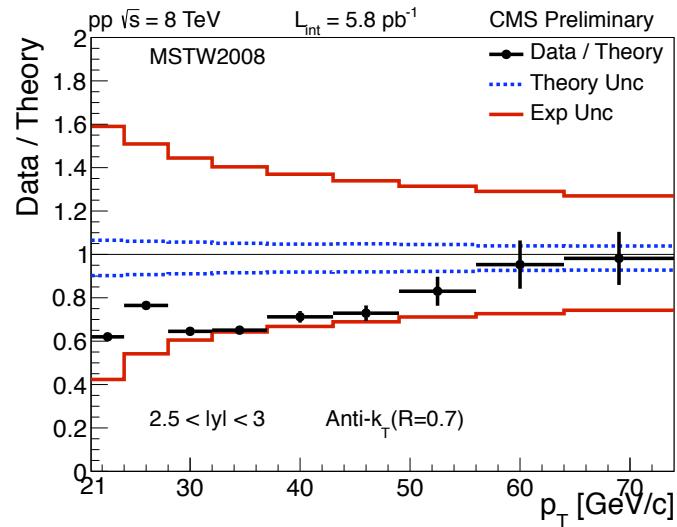
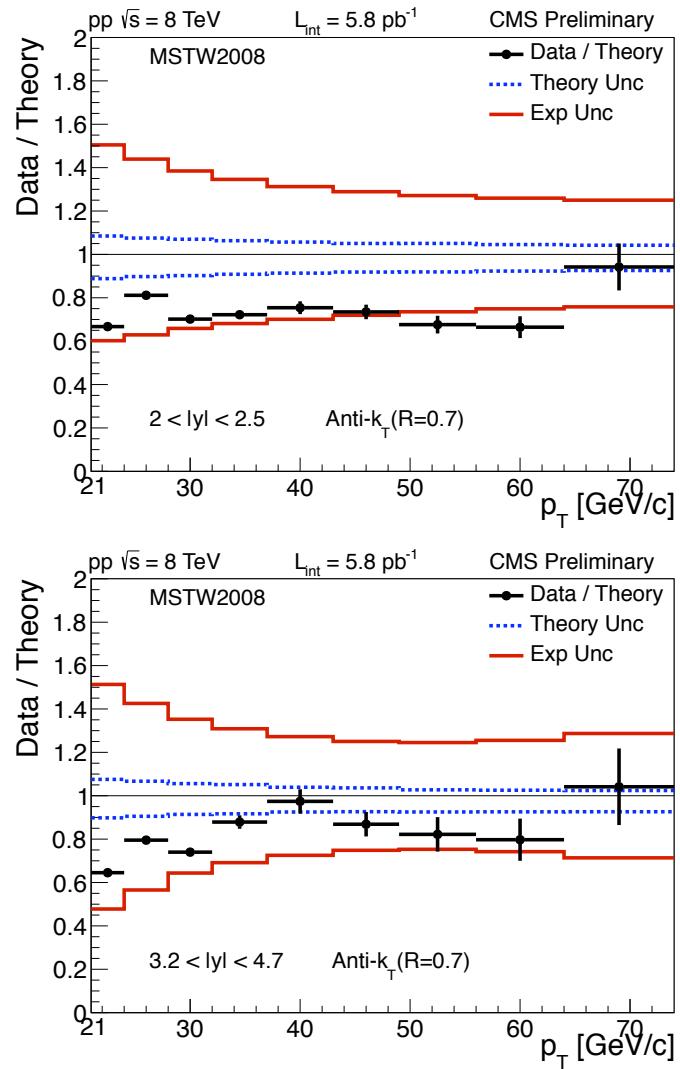
- Inclusive jet cross sections for data over the theoretical prediction of the HERAPDF 1.5 PDF set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Data/Theory (MSTW2008) for different $|y|$



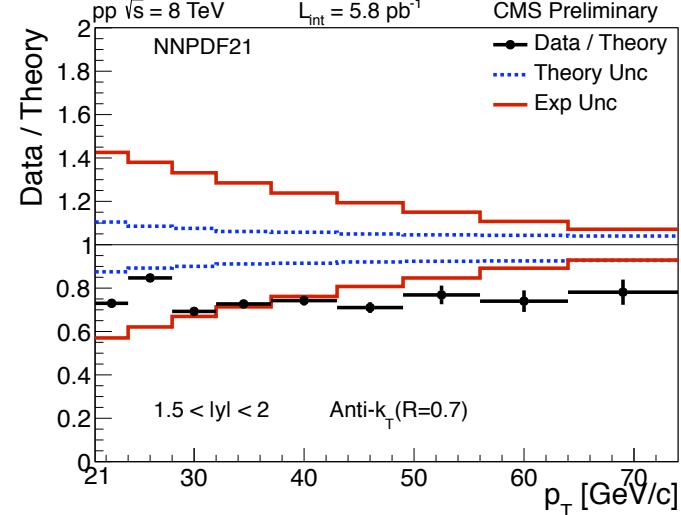
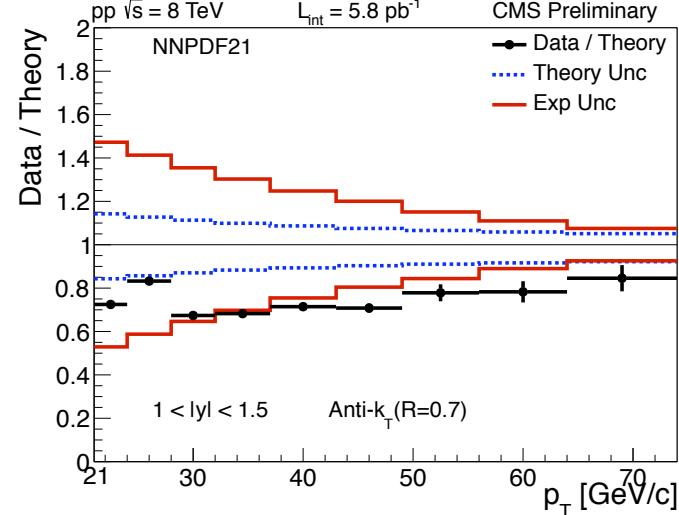
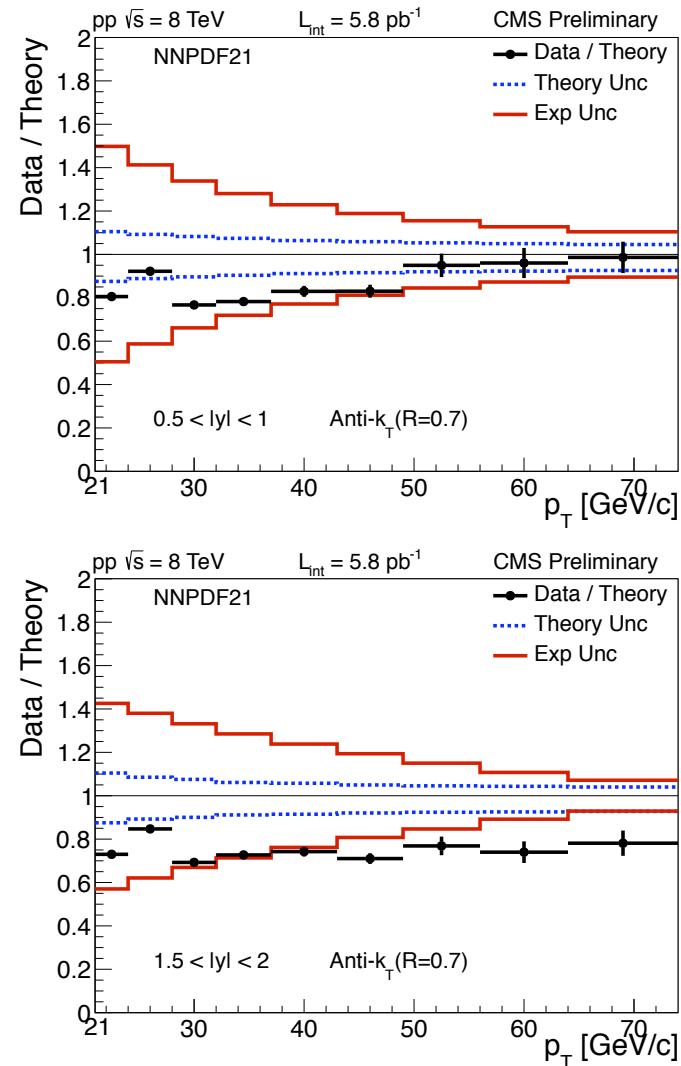
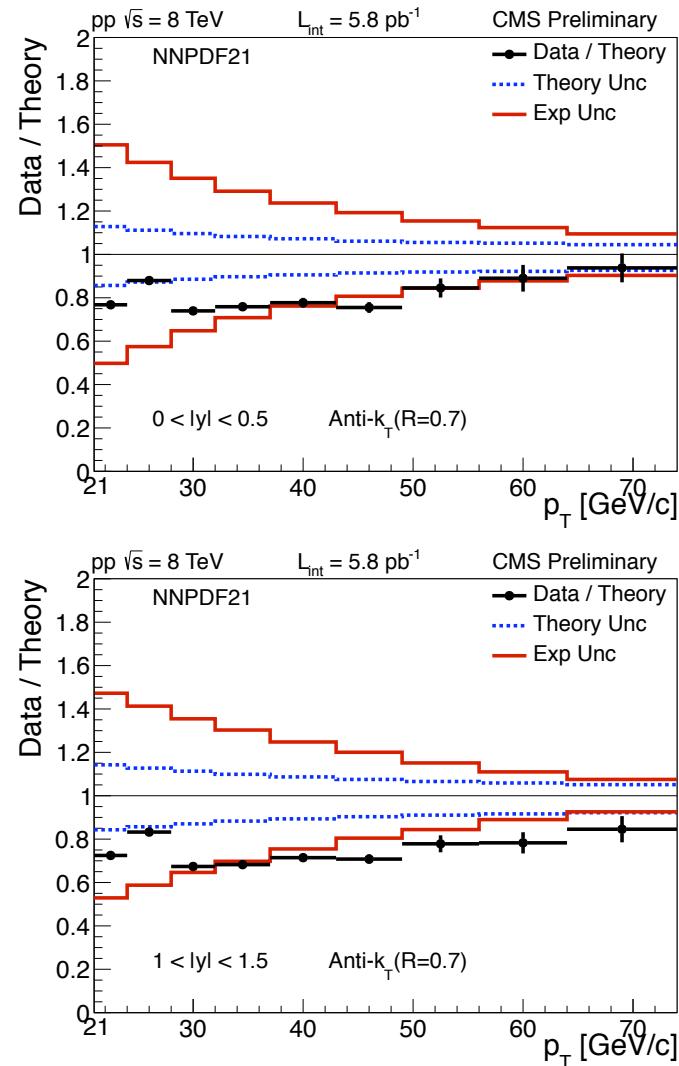
- Inclusive jet cross sections for data over the theoretical prediction of the **MSTW2008 PDF** set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Data/Theory (MSTW2008) for different $|y|$



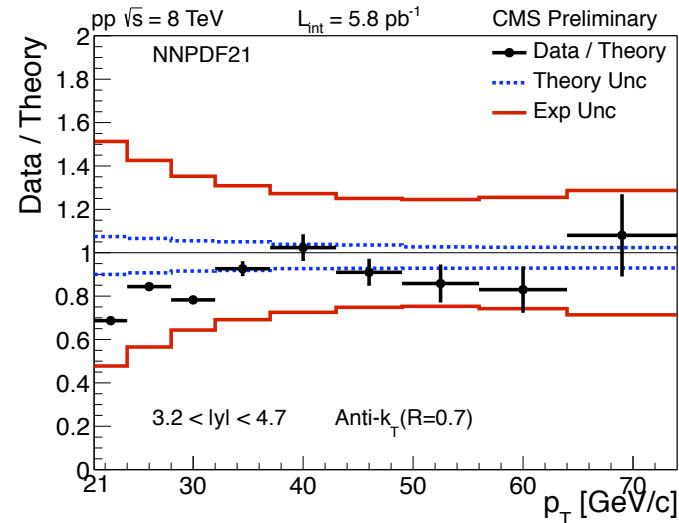
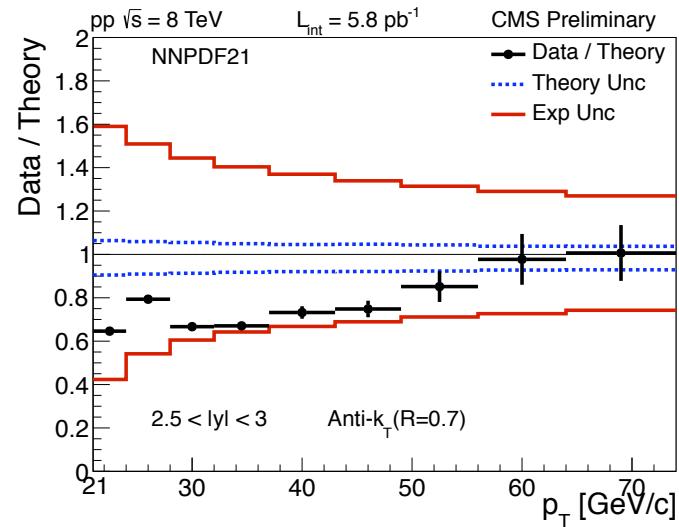
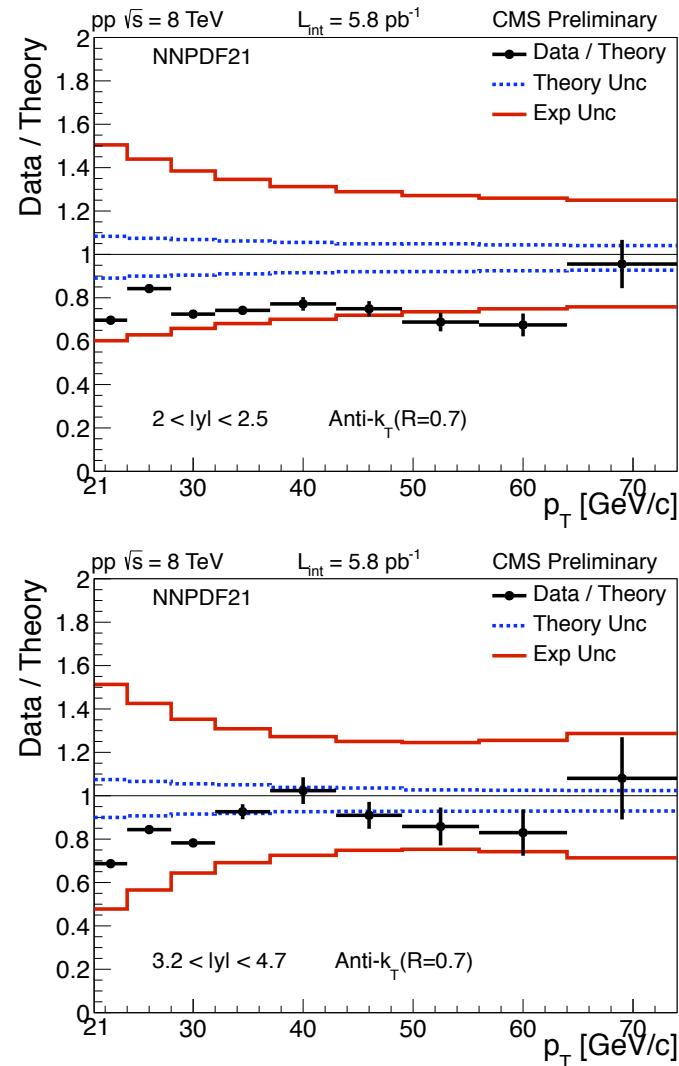
- Inclusive jet cross sections for data over the theoretical prediction of the **MSTW2008 PDF** set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Data/Theory (NNPDF 2.1) for different $|y|$



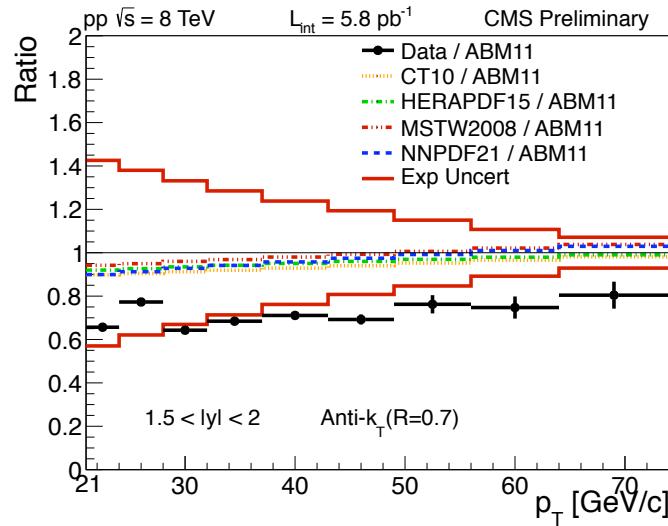
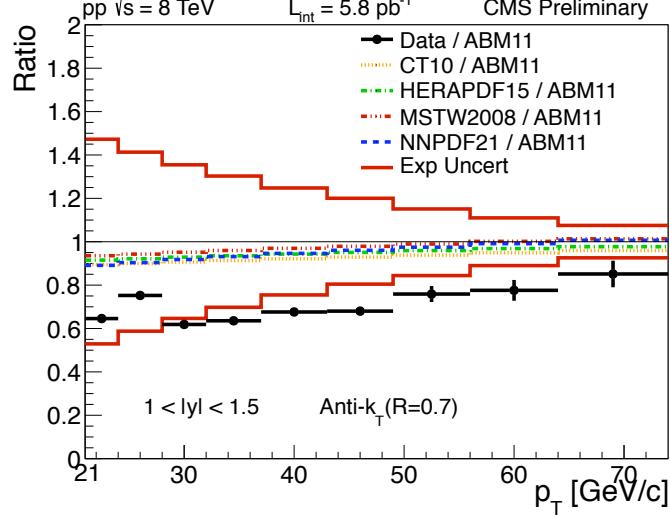
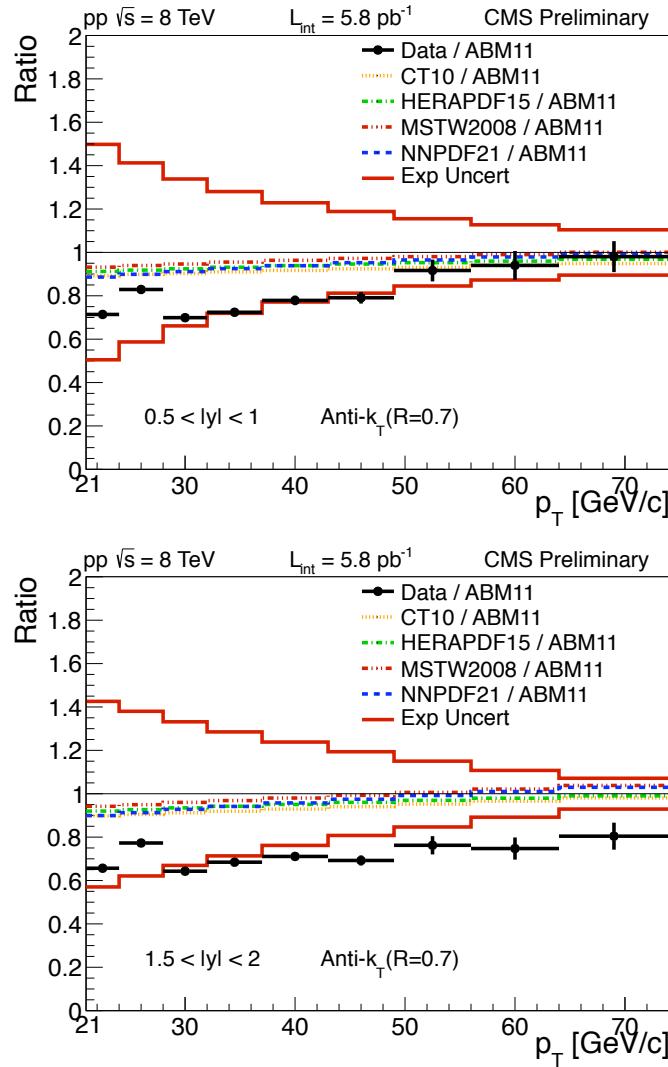
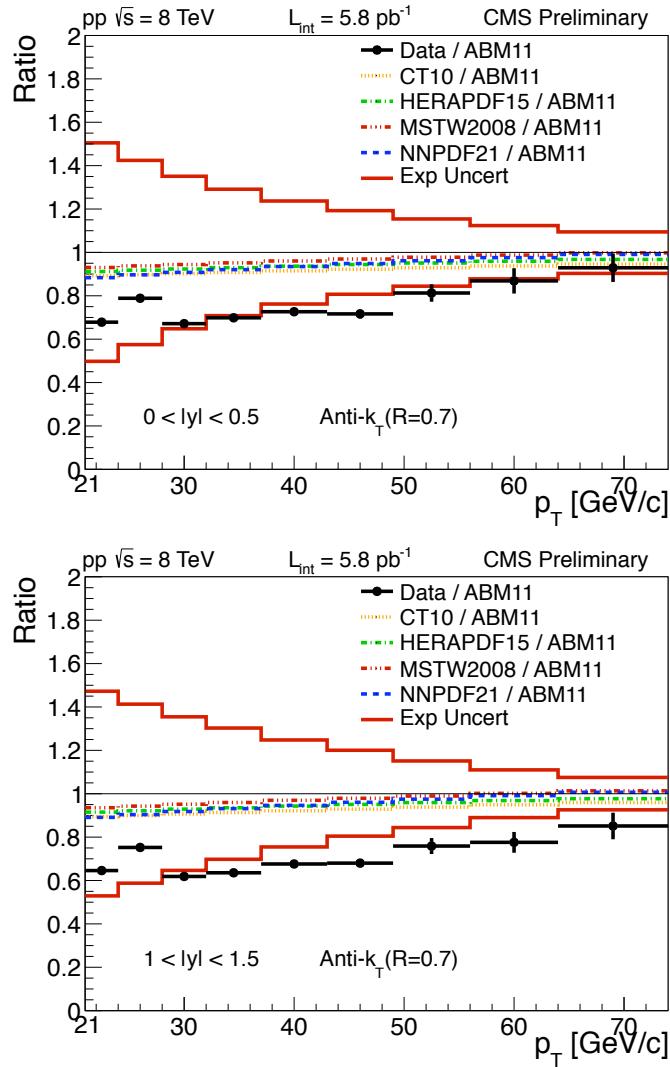
- Inclusive jet cross sections for data over the theoretical prediction of the **NNPDF 2.1 PDF** set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Data/Theory (NNPDF 2.1) for different $|y|$



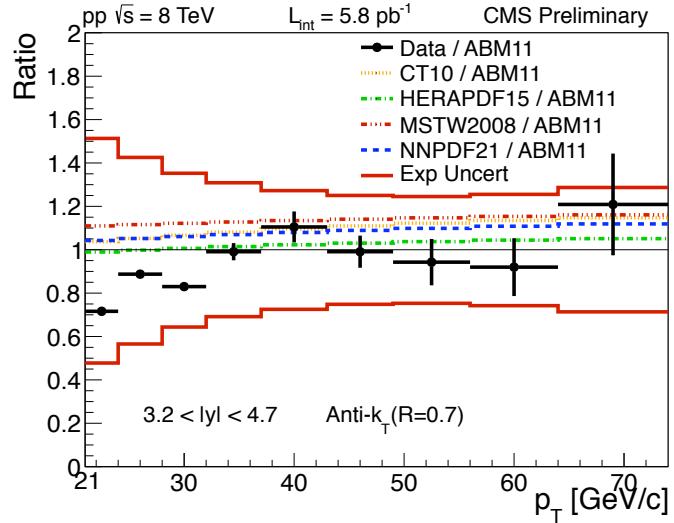
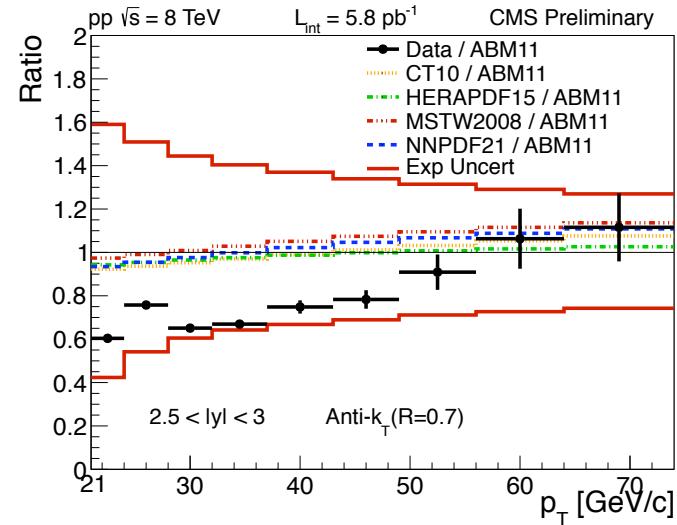
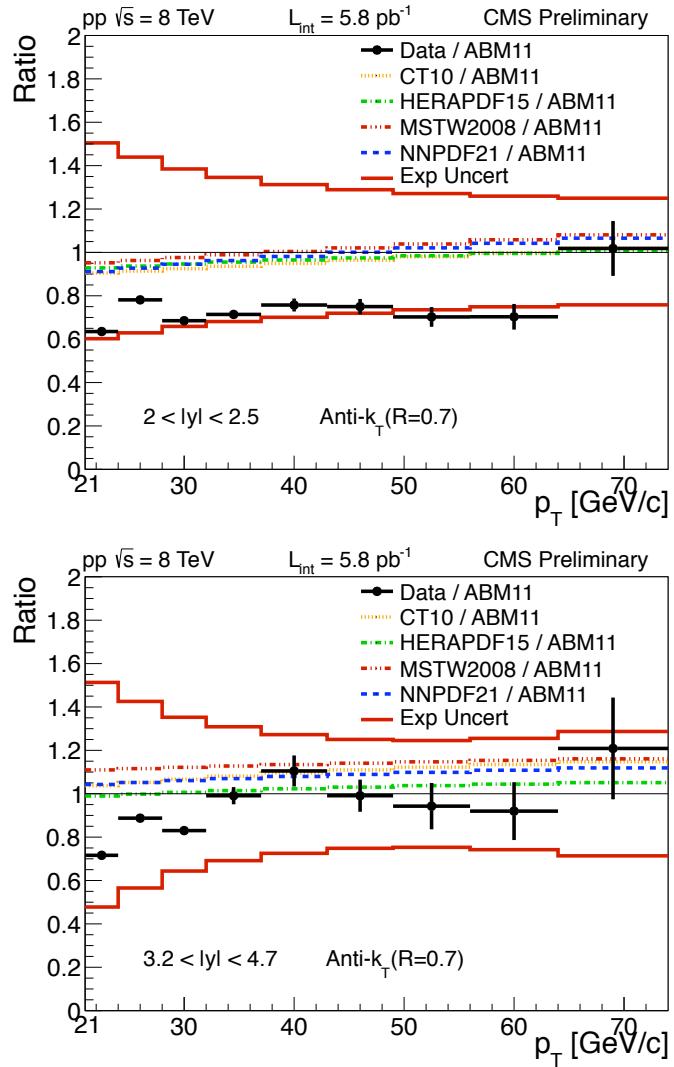
- Inclusive jet cross sections for data over the theoretical prediction of the **NNPDF 2.1 PDF** set for all $|y|$. The experimental and theoretical systematic uncertainties are represented by the continuous and dashed lines, respectively.

Ratio to ABM11



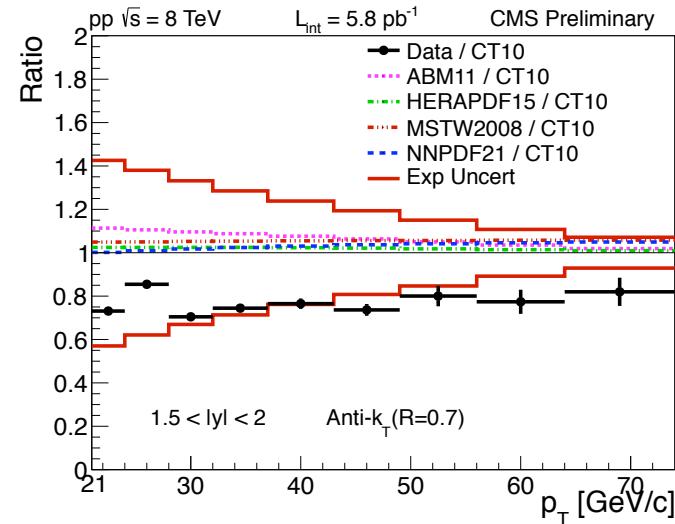
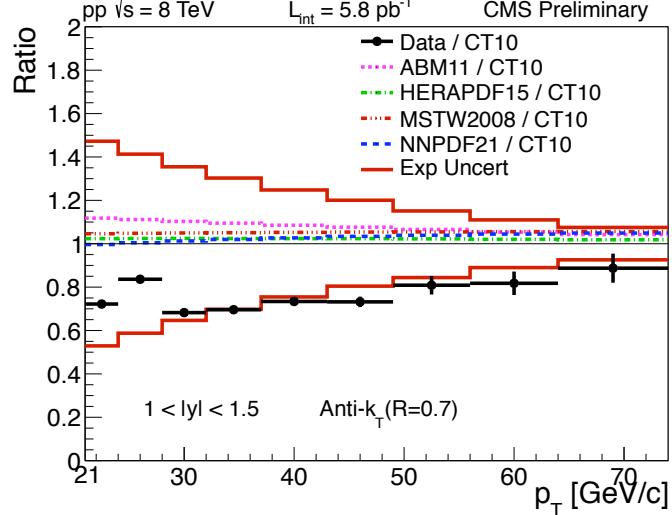
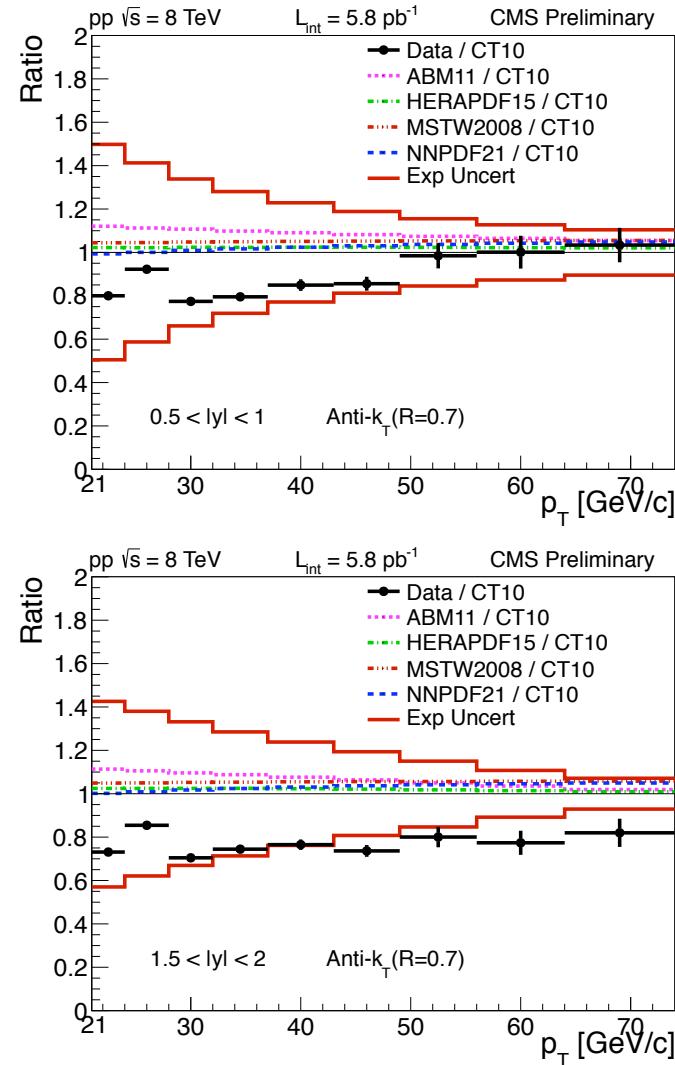
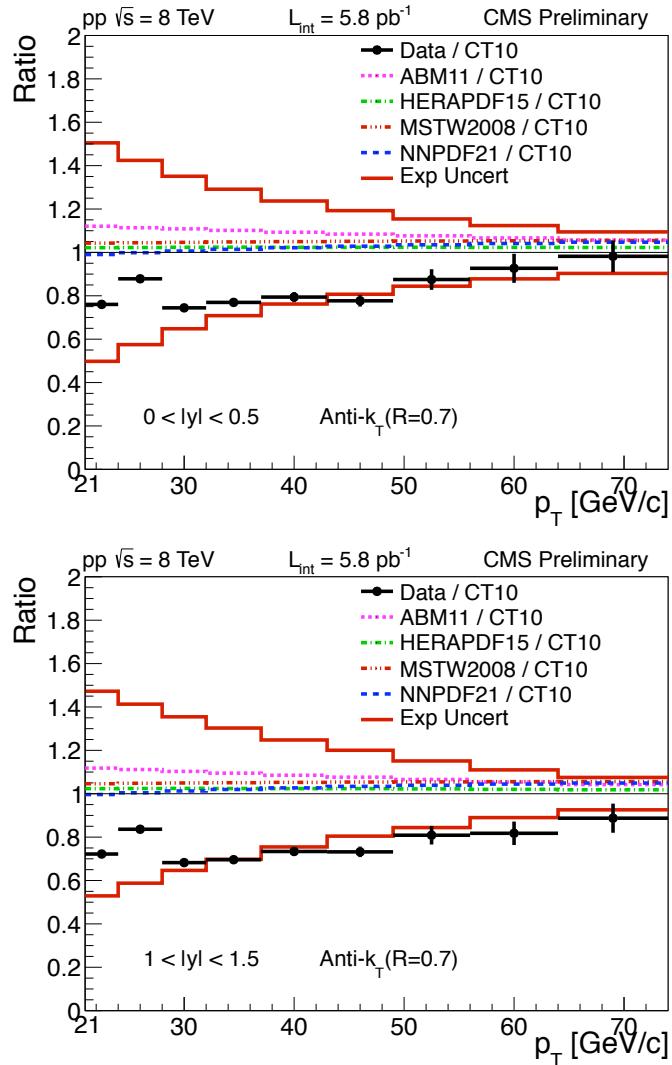
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **ABM11 PDF** set for all $|y|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **ABM11**.

Ratio to ABM11



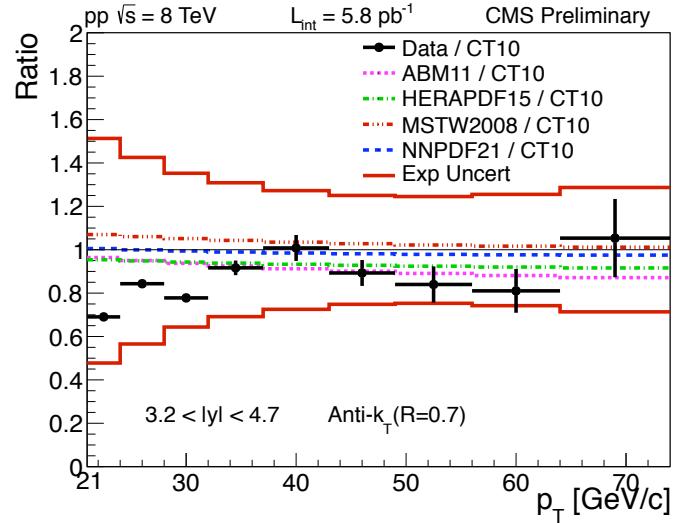
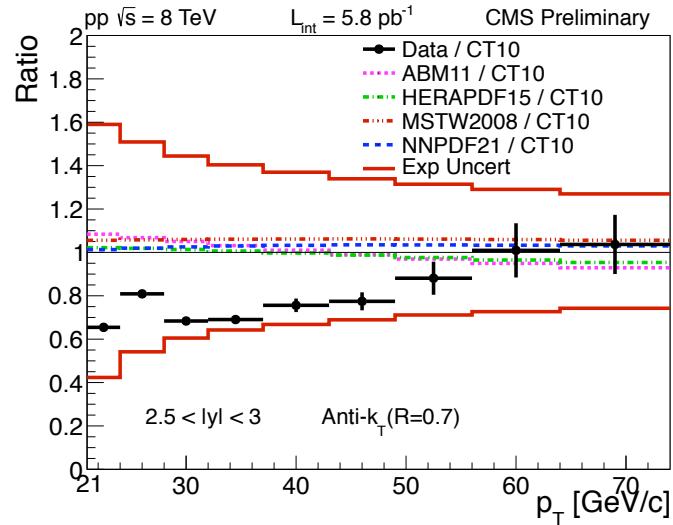
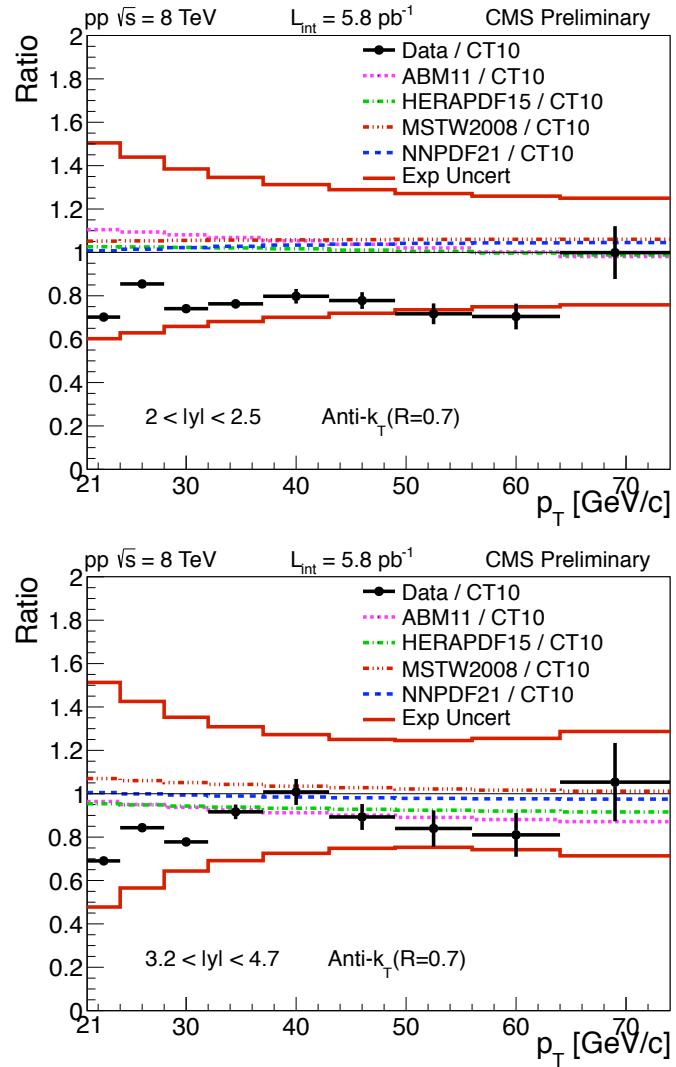
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **ABM11 PDF** set for all $|\gamma|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **ABM11**.

Ratio to CT10



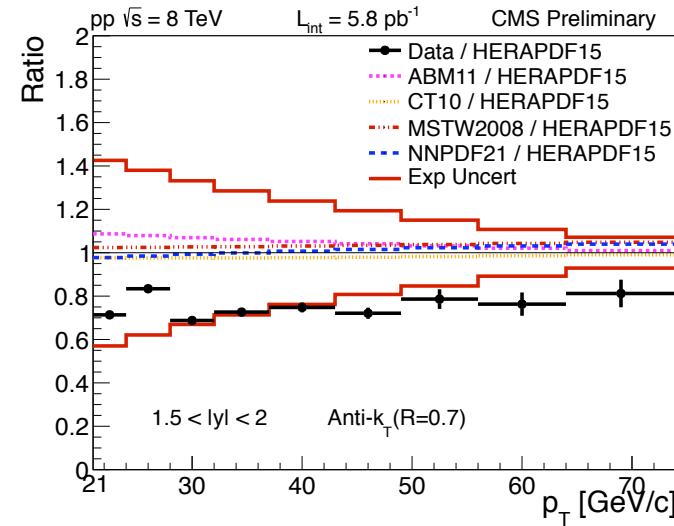
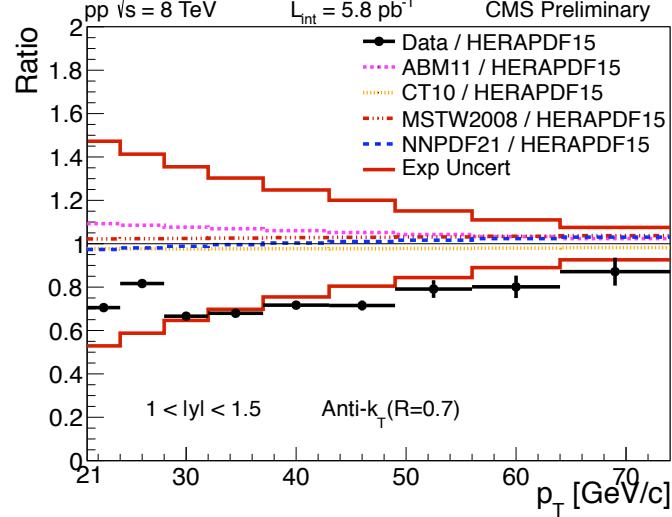
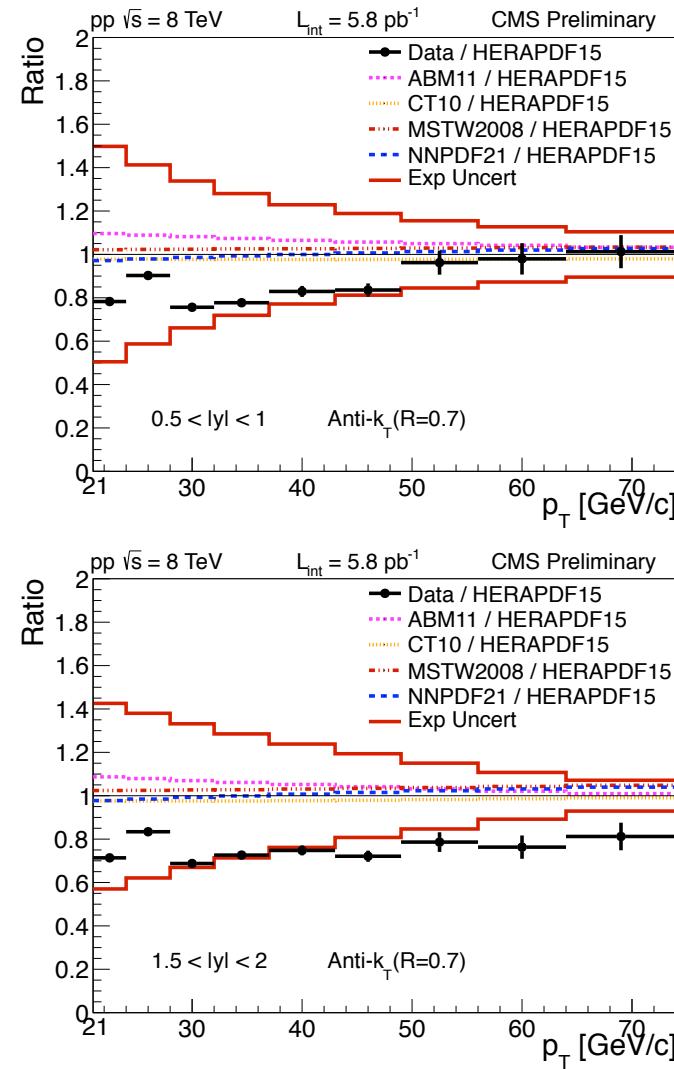
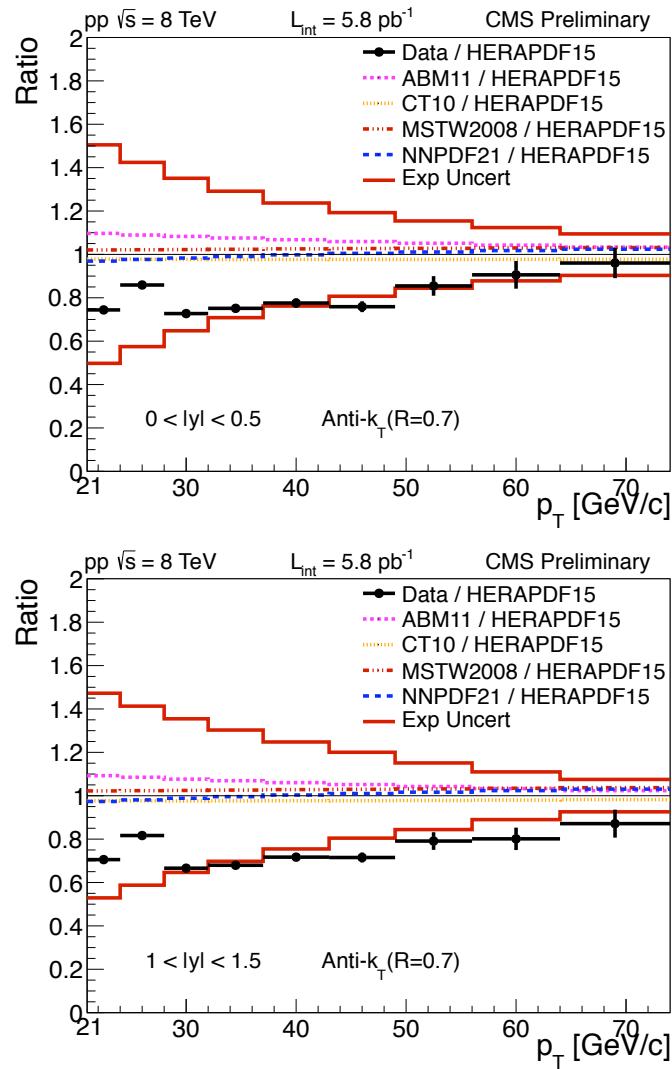
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **CT10 PDF** set for all $|y|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **CT10**.

Ratio to CT10



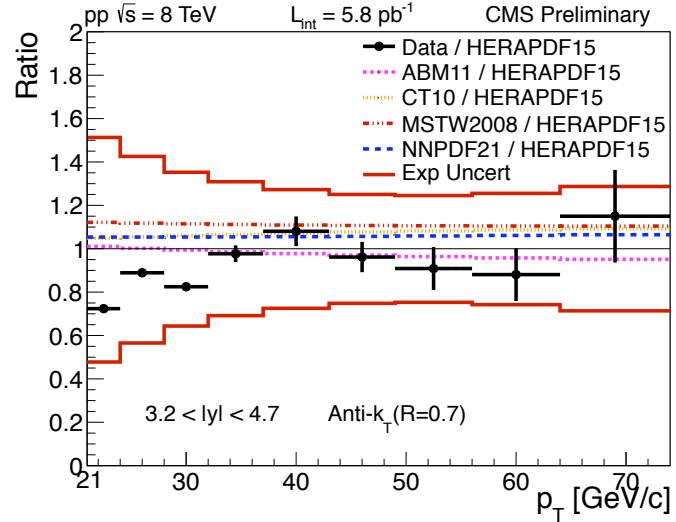
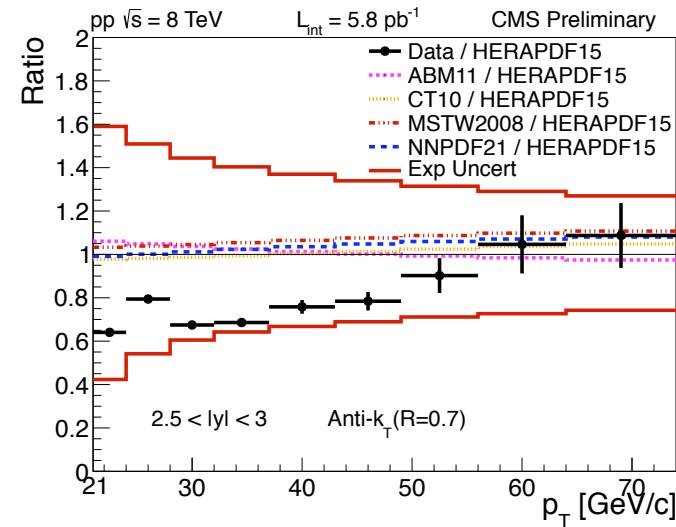
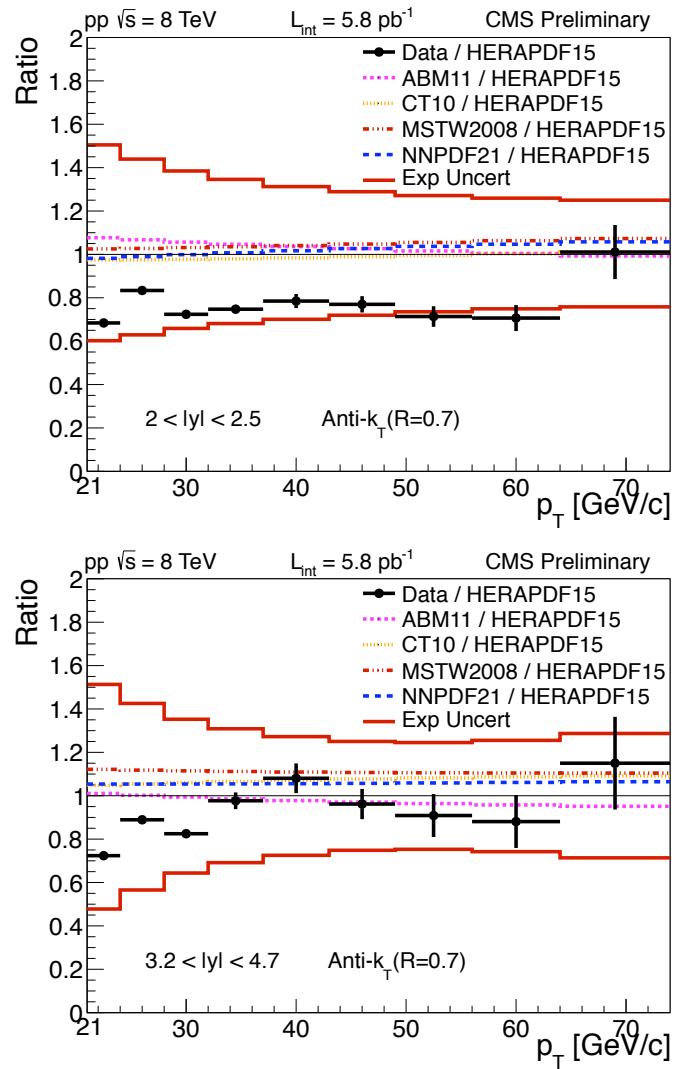
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **CT10 PDF** set for all $|\text{y}|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **CT10**.

Ratio to HERAPDF 1.5



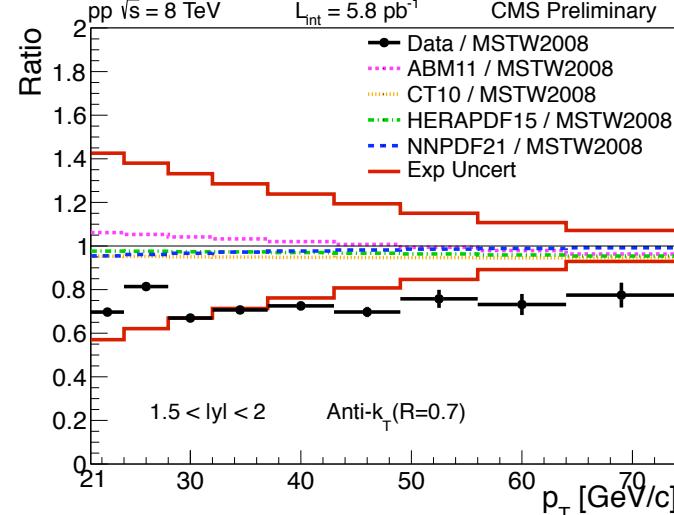
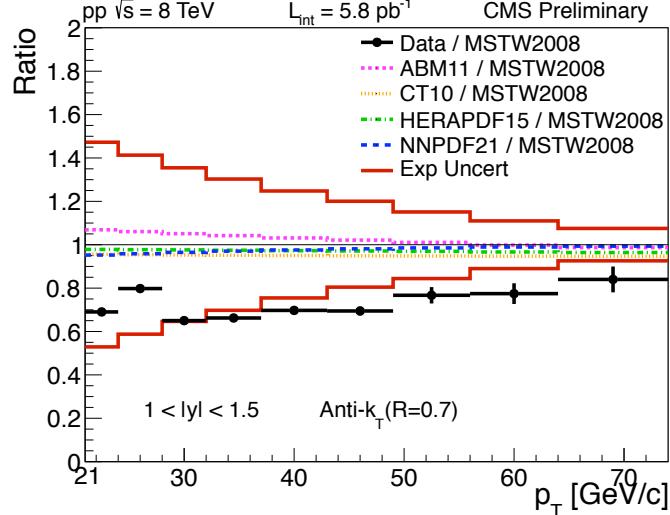
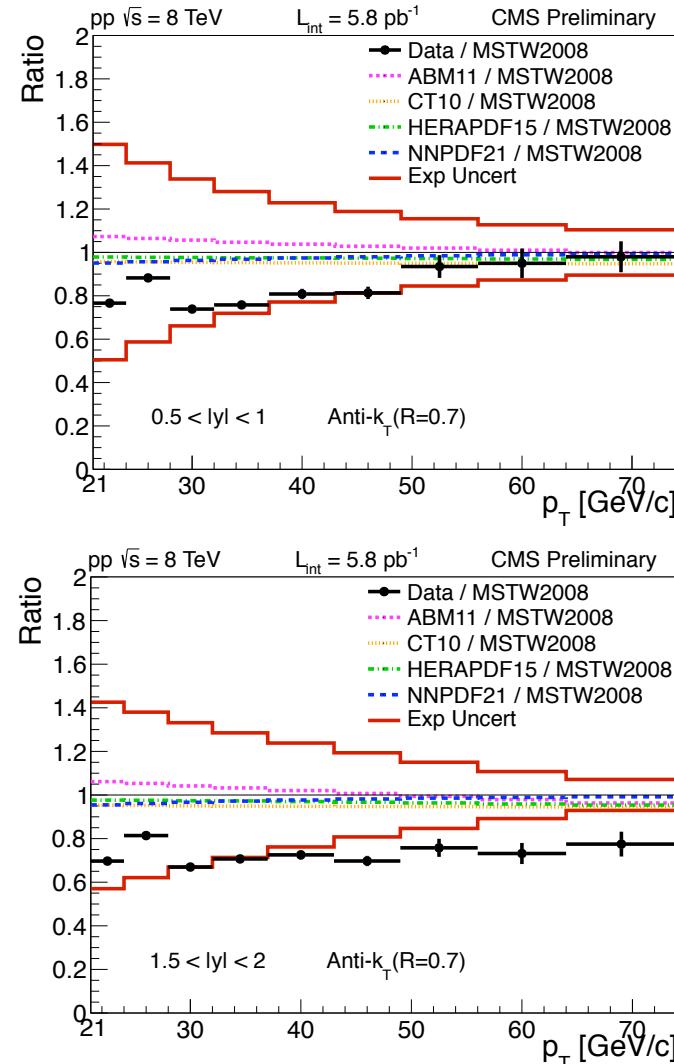
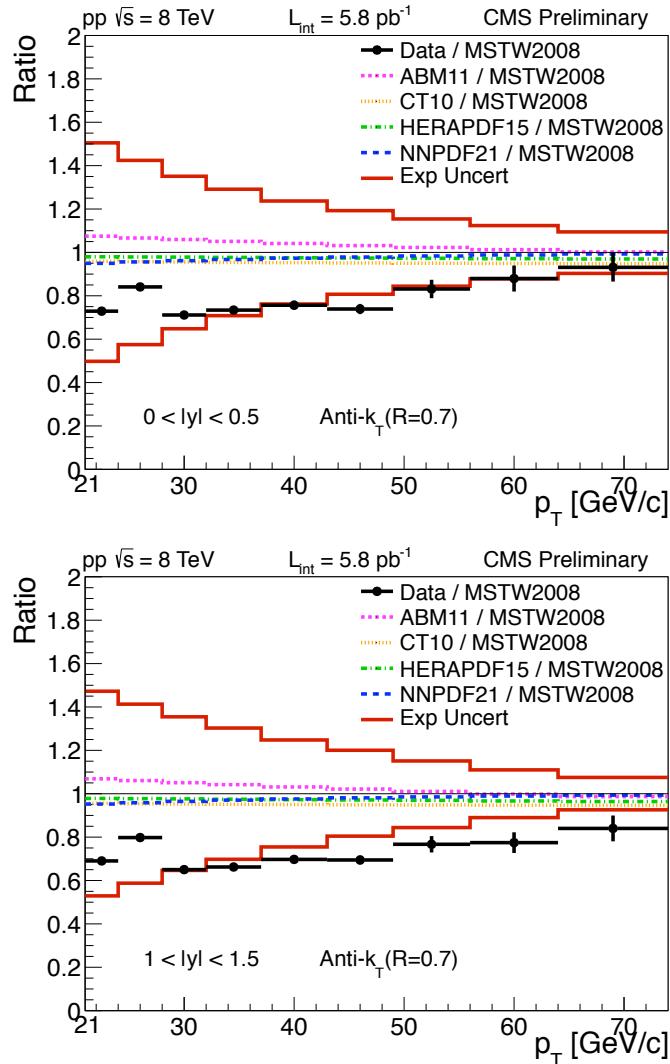
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **HERAPDF 1.5 PDF** set for all $|y|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **HERAPDF 1.5**.

Ratio to HERAPDF 1.5



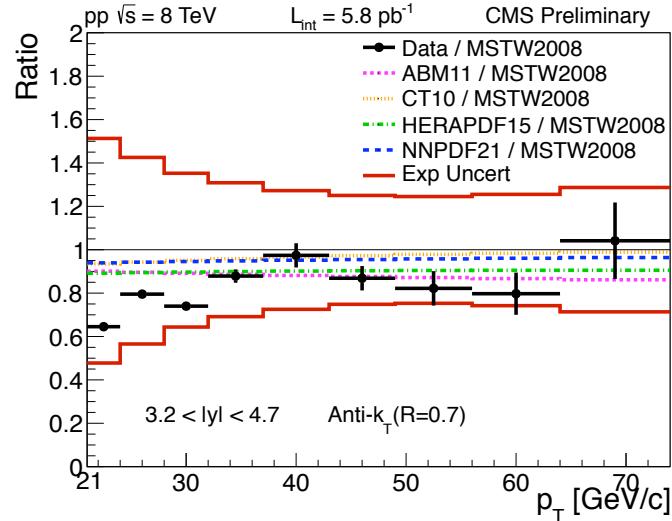
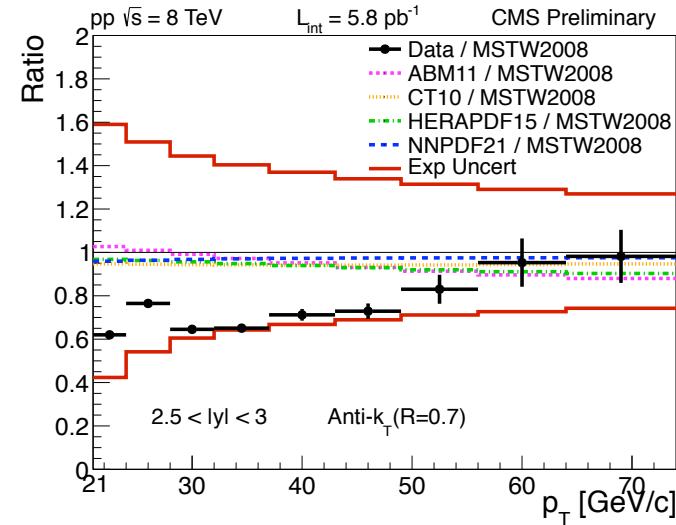
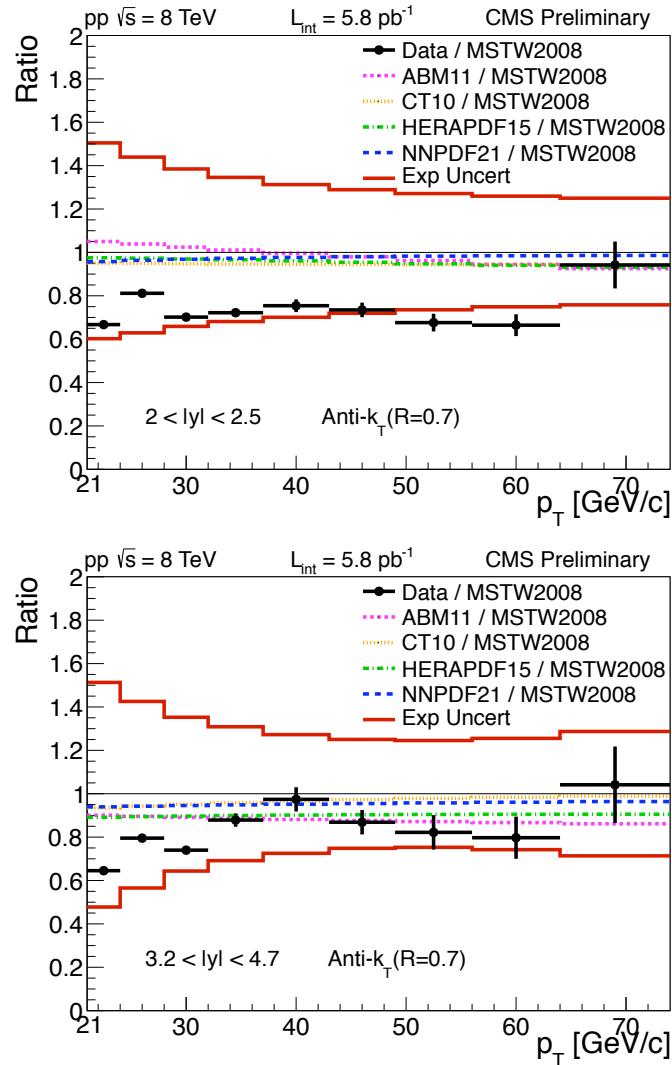
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **HERAPDF 1.5 PDF** set for all $|\text{y}|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **HERAPDF 1.5**.

Ratio to MSTW2008



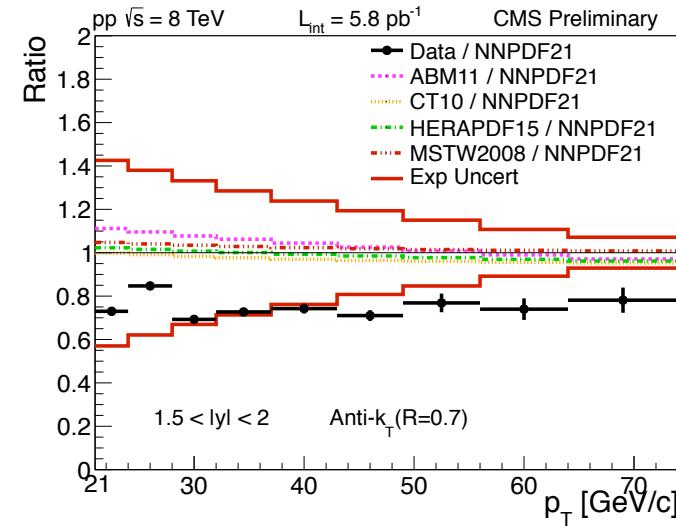
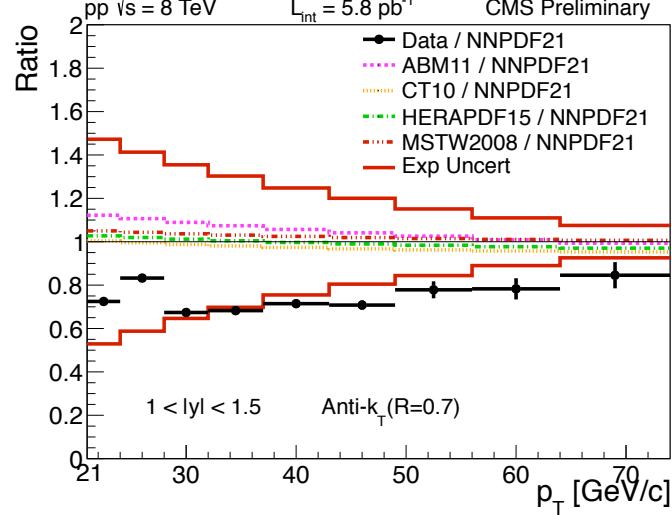
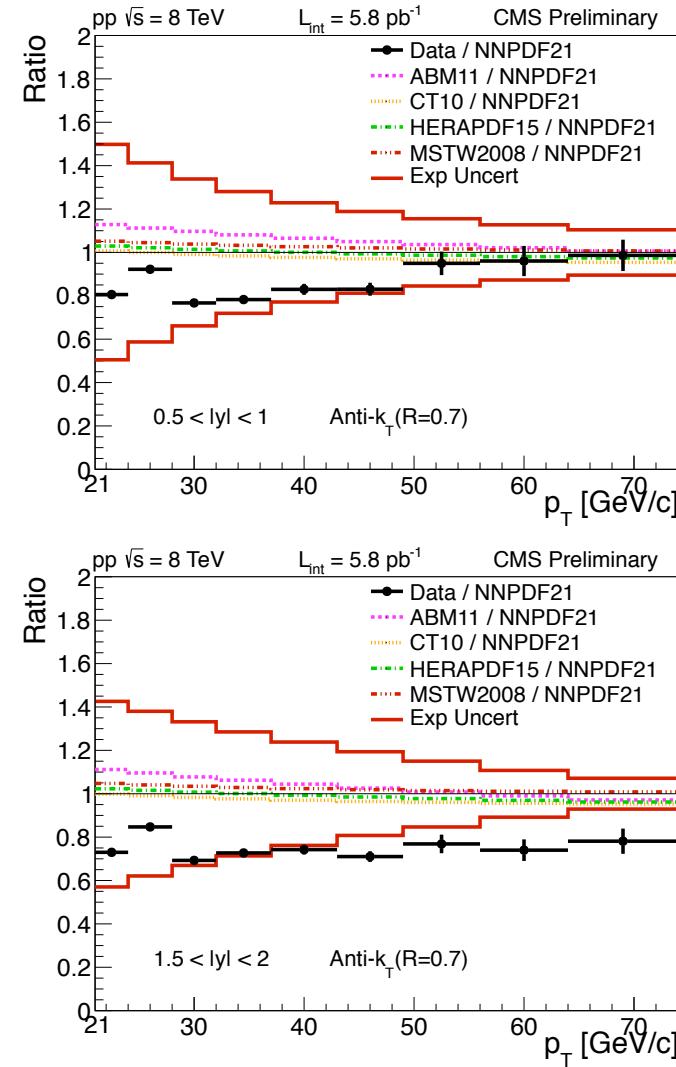
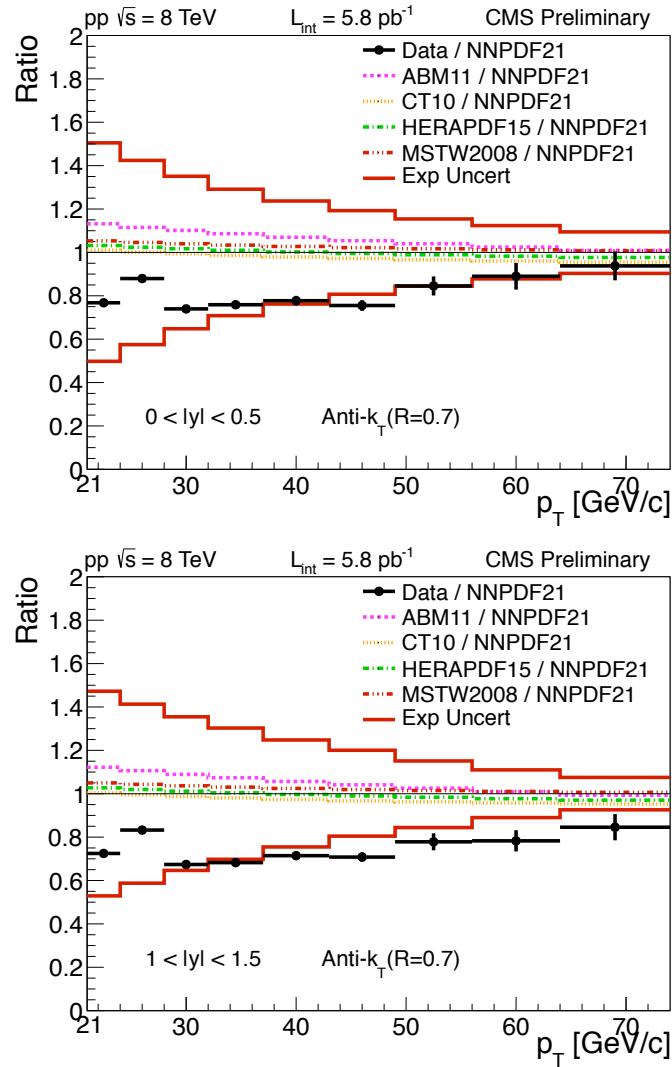
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **MSTW2008 PDF** set for all $|\text{y}|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **MSTW2008**.

Ratio to MSTW2008



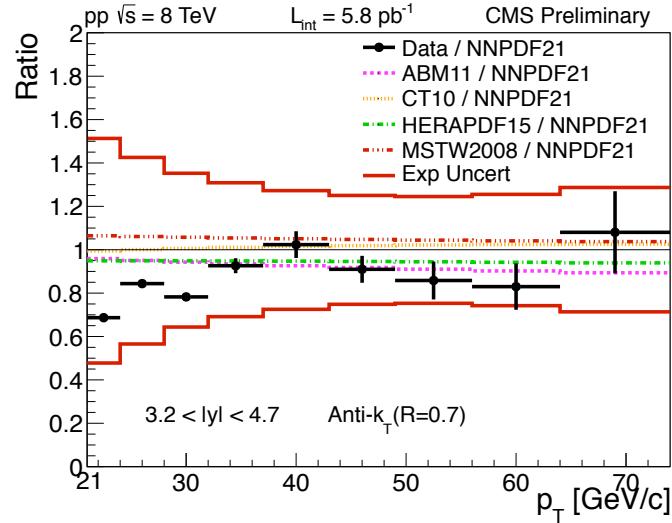
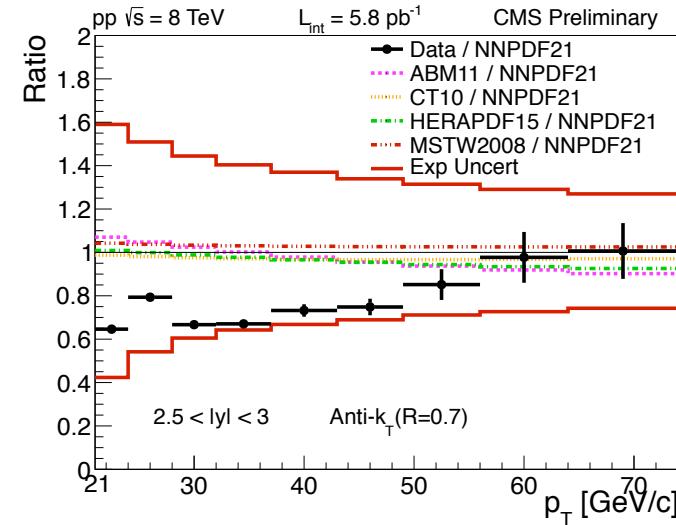
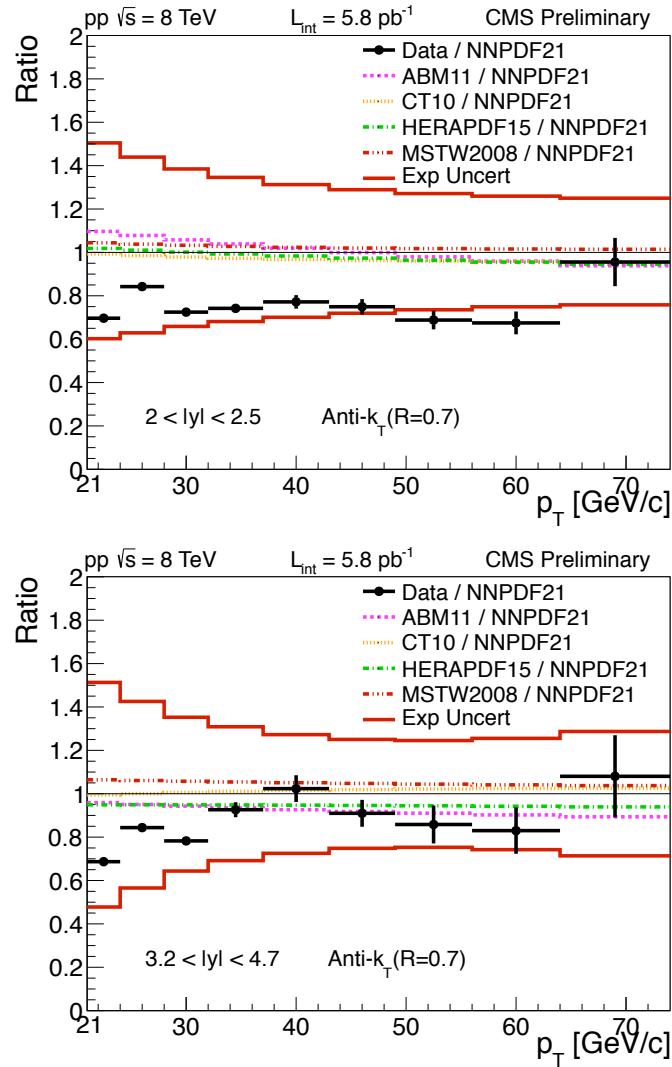
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **MSTW2008 PDF** set for all $|\text{y}|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **MSTW2008**.

Ratio to NNPDF 2.1



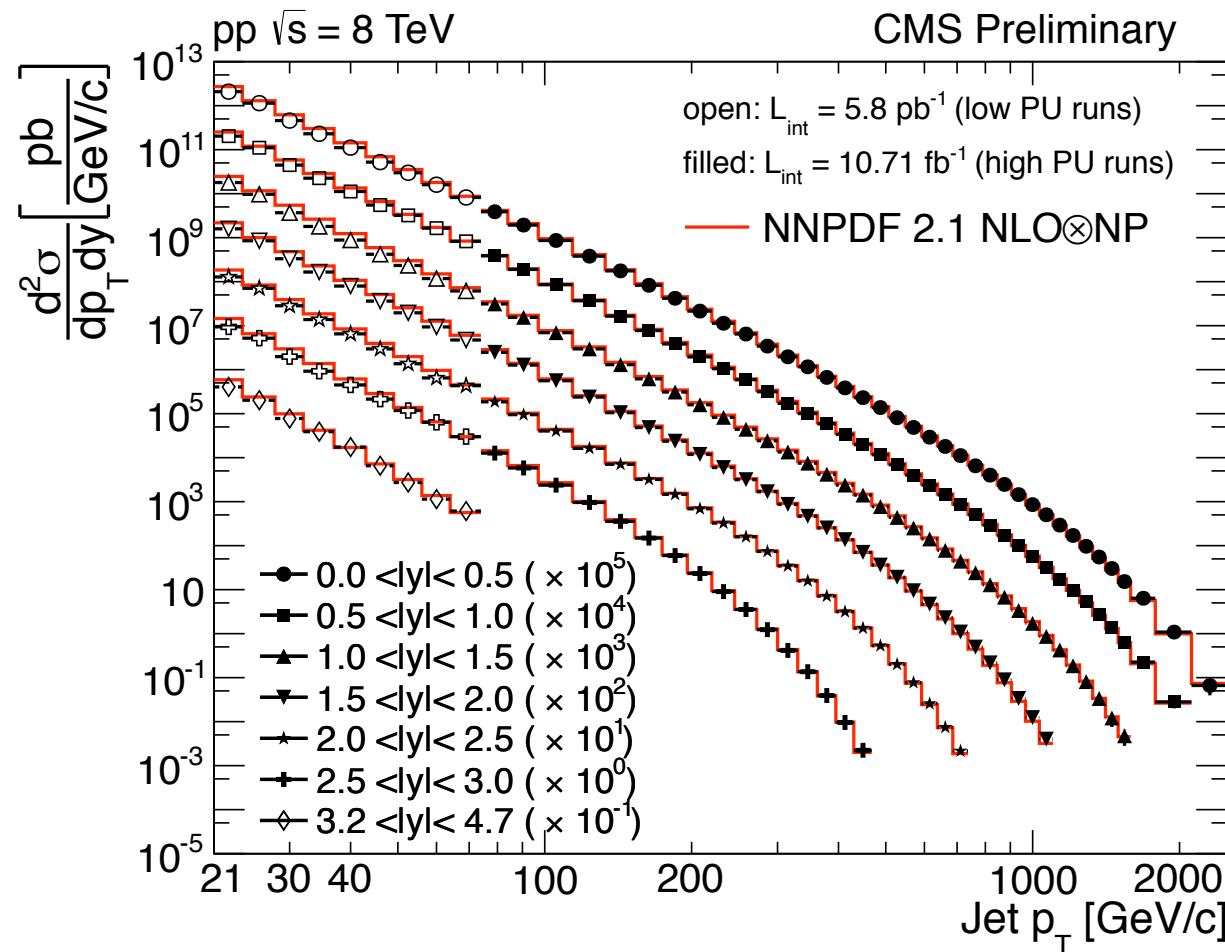
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **NNPDF 2.1 PDF** set for all $|y|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **NNPDF 2.1**.

Ratio to NNPDF 2.1



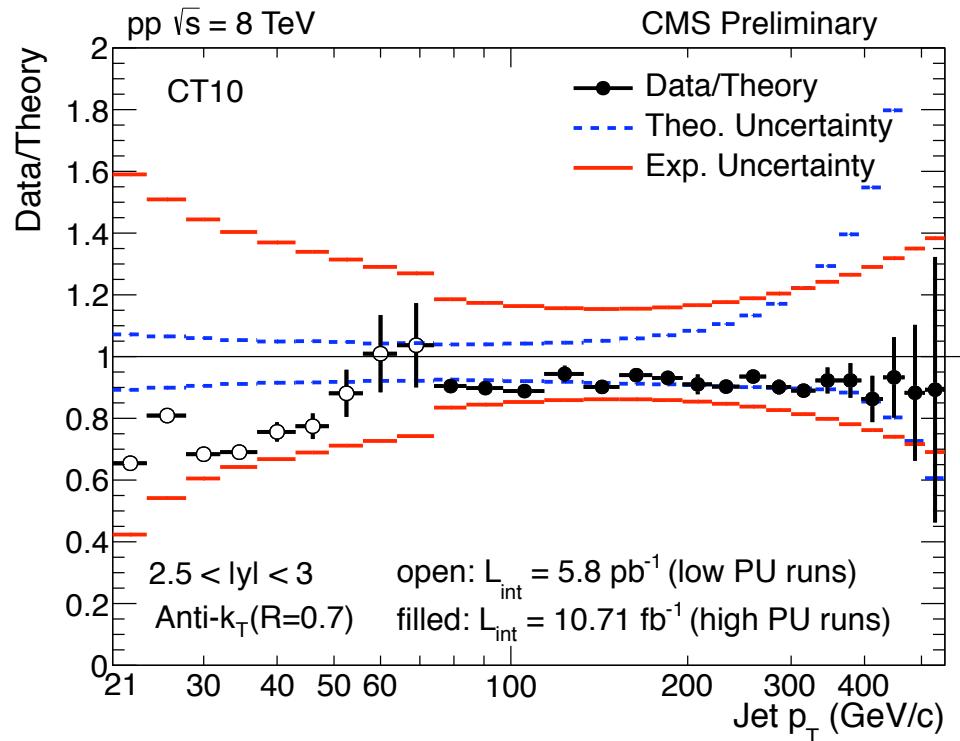
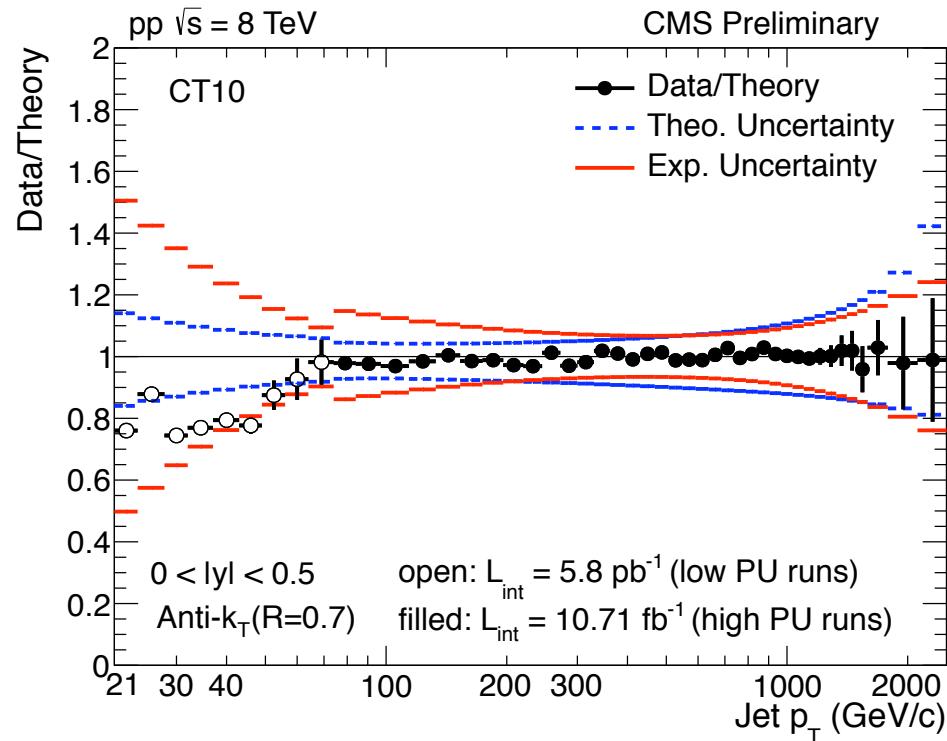
- Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the **NNPDF 2.1 PDF** set for all $|y|$ bins. The dashed lines show the ratio of the cross sections calculated with the other PDF sets to that calculated with **NNPDF 2.1**.

Combined Differential Inclusive Jet Cross Sections



- The combined differential inclusive jet cross sections in comparison to NLO predictions using the NNPDF2.1 PDF set times the NP correction factor.

Combined Ratio to CT10



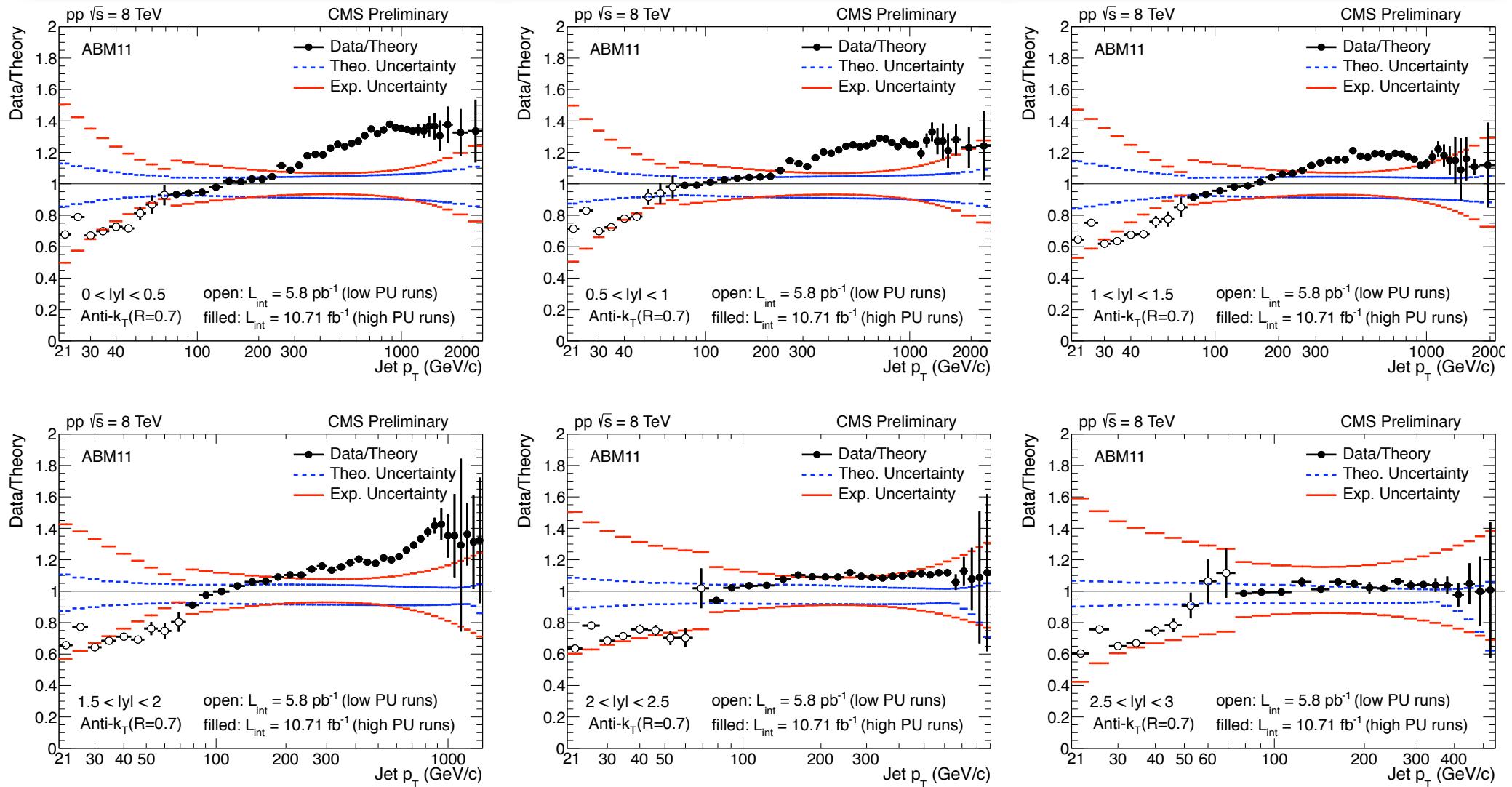
- The combined CMS jet spectra, measured at low and high transverse momenta, over the NLO predictions. In the transition between both measurements at $pT \sim 75$ GeV/c, the systematic uncertainties of the low-pT measurements are smaller than the high-pT ones because the former have been carried out with (much) smaller pileup conditions than the latter, except for the $2 < |y| < 3$ region where the endcap response to low-pT jets results in larger propagated systematics.

Conclusion

- The p_T -differential cross sections for the inclusive production of jets in the rapidity ranges $|y| < 4.7$ has been measured by the CMS detector using 5.8 pb^{-1} of low pile-up data collected in proton-proton collision at $\sqrt{s} = 8 \text{ TeV}$.
- Detailed studies of various experimental and theoretical uncertainties, and their relative comparison are carried out.
- The measured differential jet cross section is compared with the **NLO \otimes NP \otimes PS** theory predictions based on perturbative QCD predictions corresponding to five different PDF sets.
- Within the current experimental and theoretical uncertainties, perturbative QCD calculations are in agreement with the measured inclusive jet cross sections.

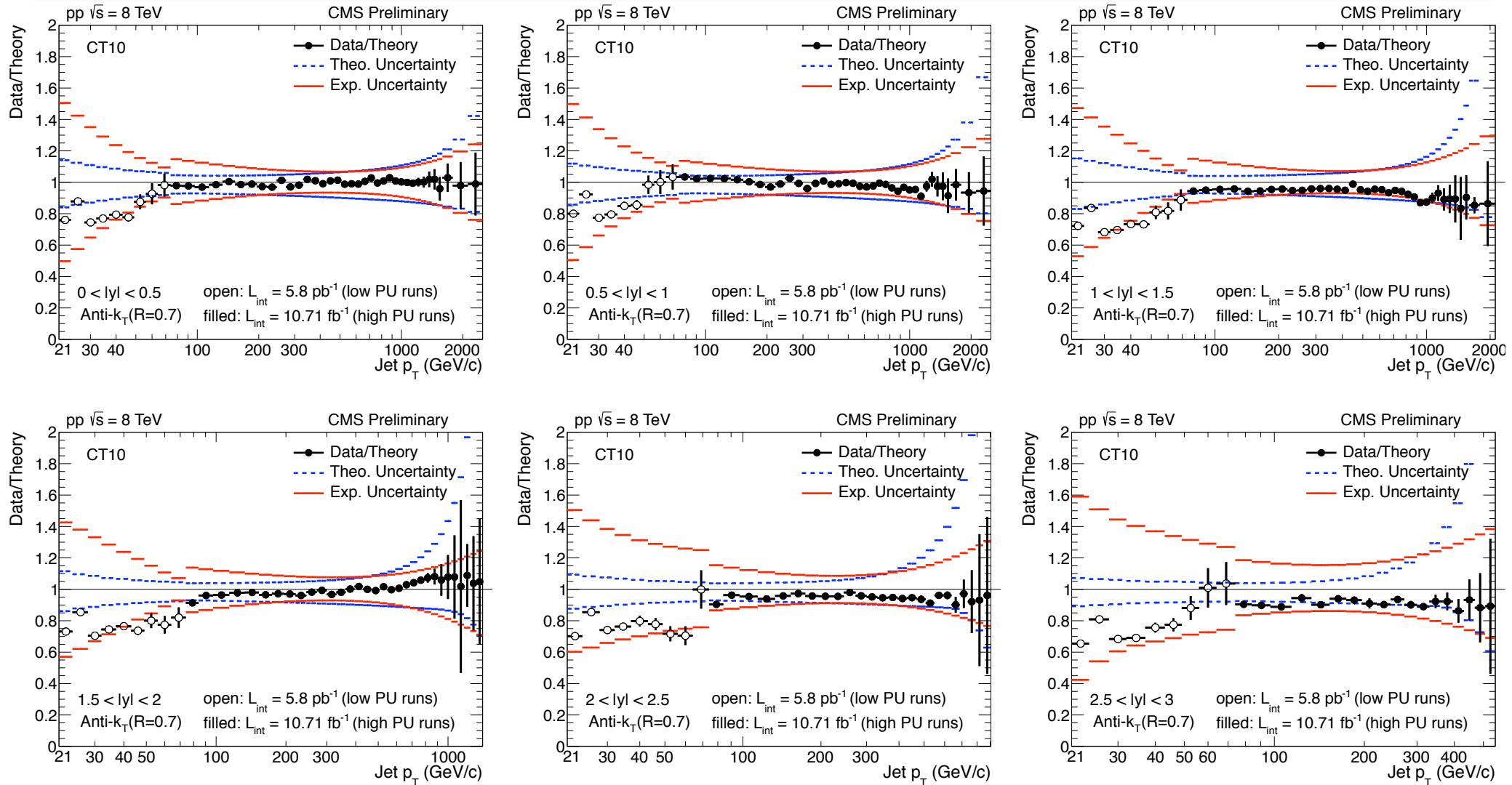
Backup

Combined Ratio to ABM11



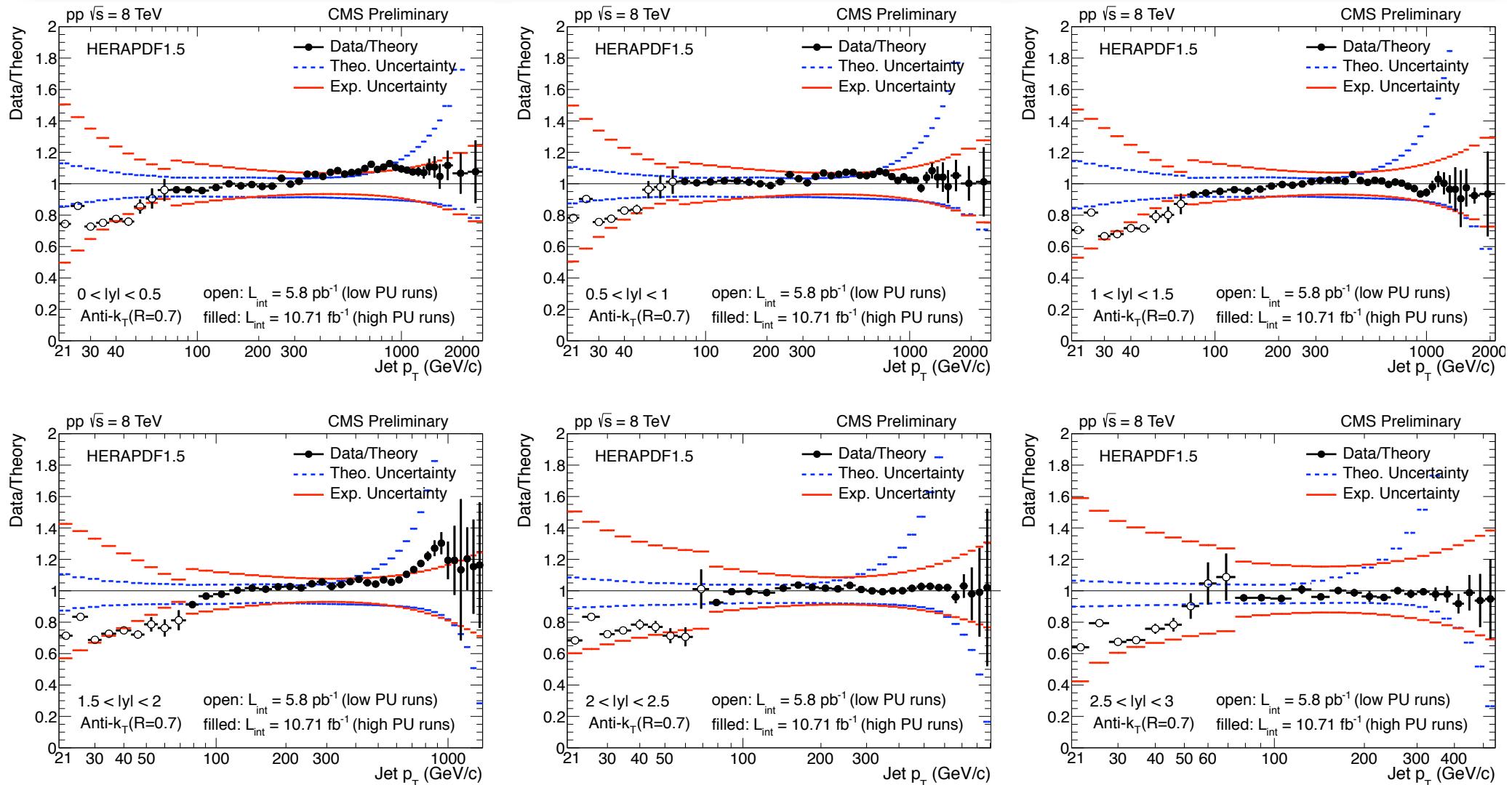
- The combined results both for low and high p_T jets. Ratio of data to the theoretical prediction of the ABM11 PDF set.

Combined Ratio to CT10



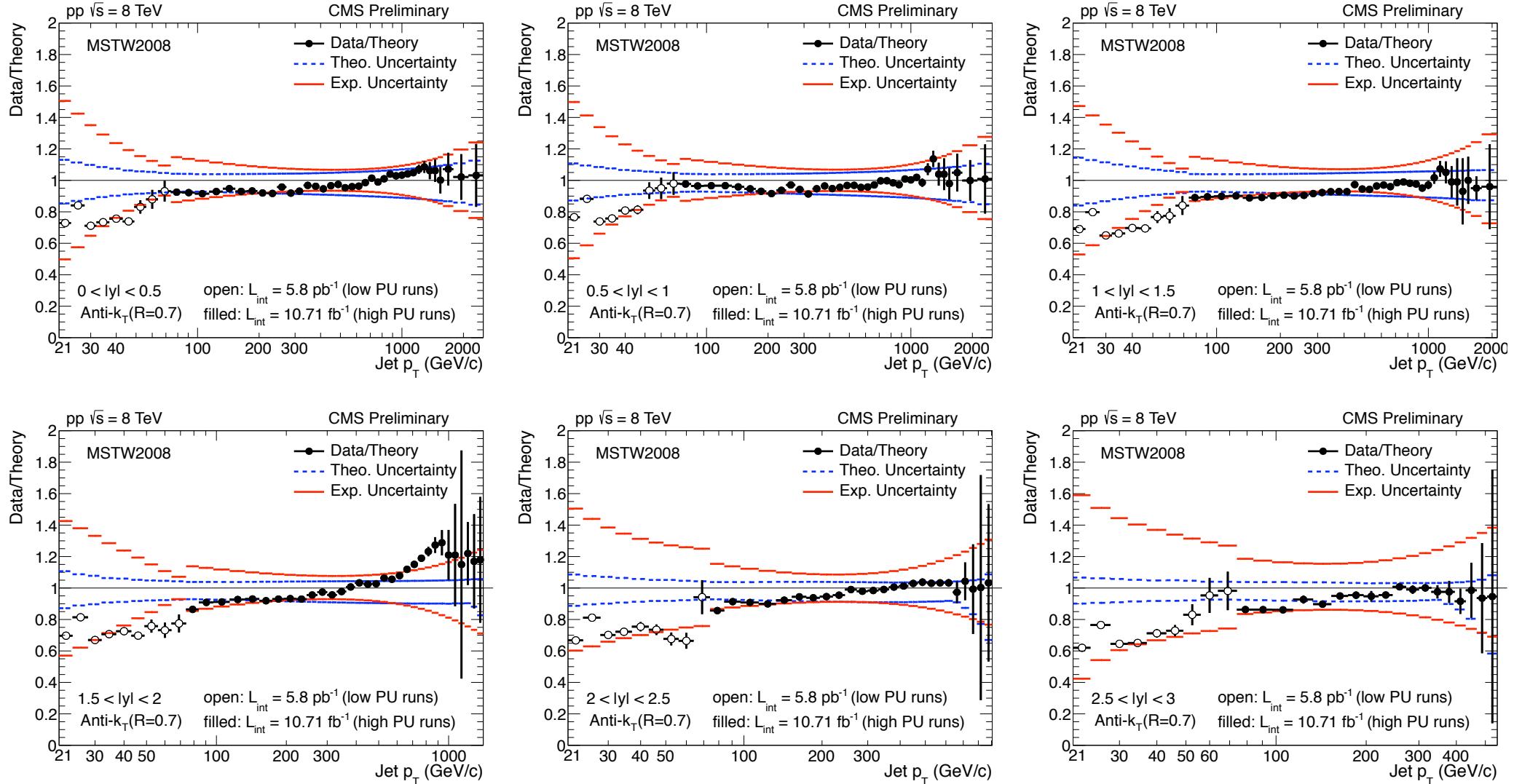
- The combined results both for low and high p_T jets. Ratio of data to the theoretical prediction of the CT10 PDF set.

Combined Ratio to HERAPDF 1.5



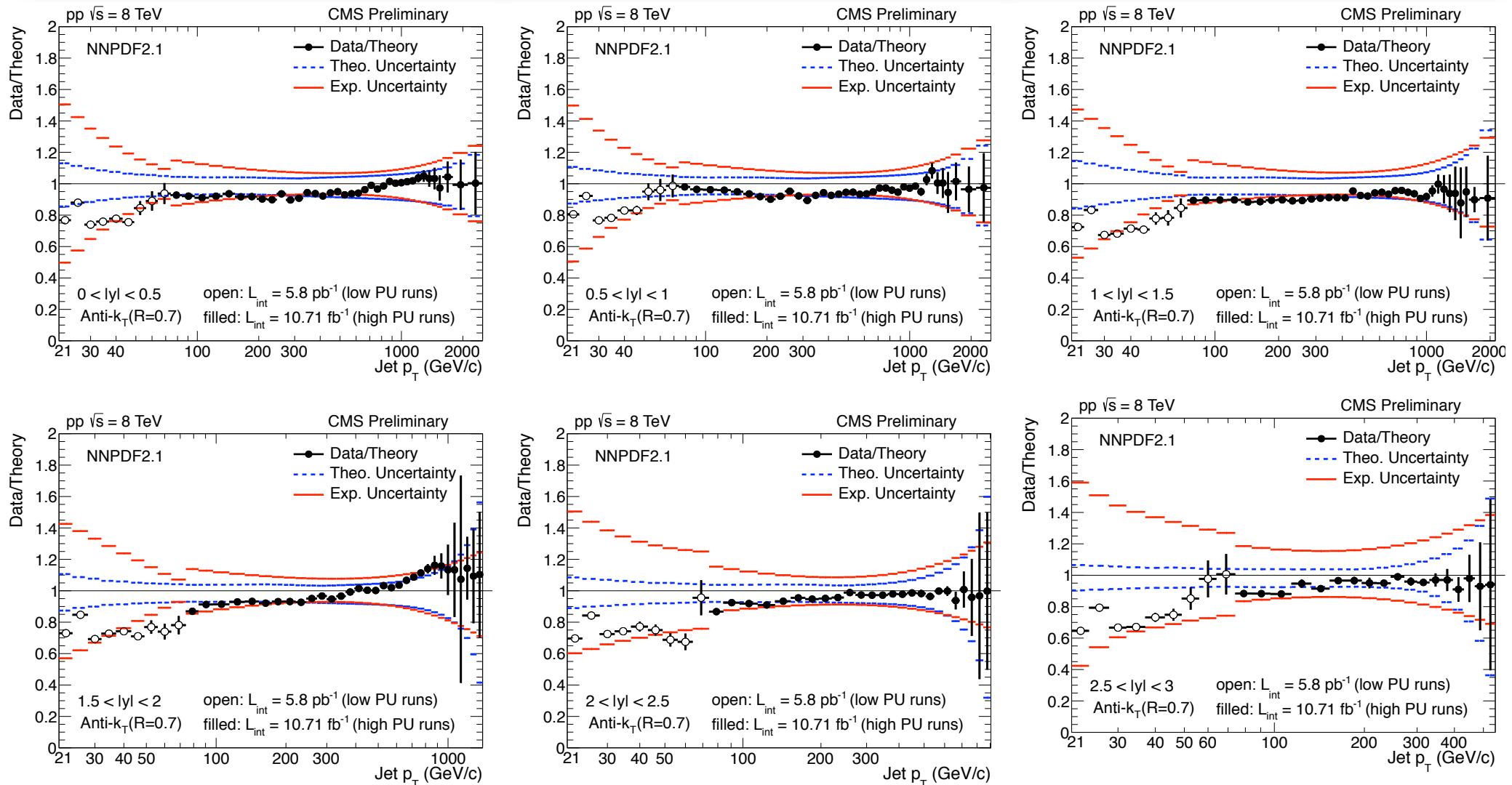
- The combined results both for low and high p_T jets. Ratio of data to the theoretical prediction of the HERAPDF 1.5 PDF set.

Combined Ratio to MSTW2008



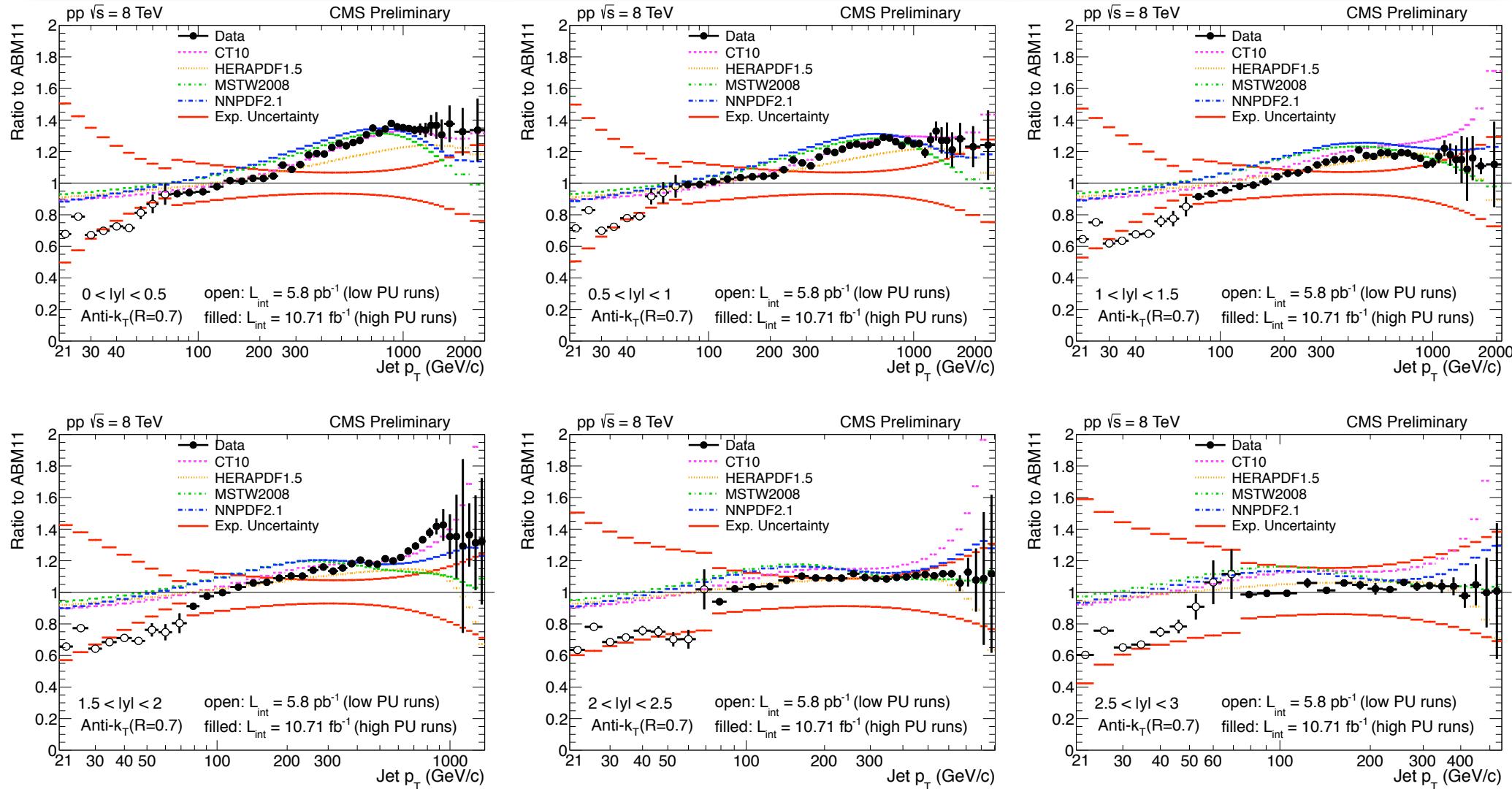
- The combined results both for low and high p_T jets. Ratio of data to the theoretical prediction of the **MSTW2008** PDF set.

Combined Ratio to NNPDF2.1



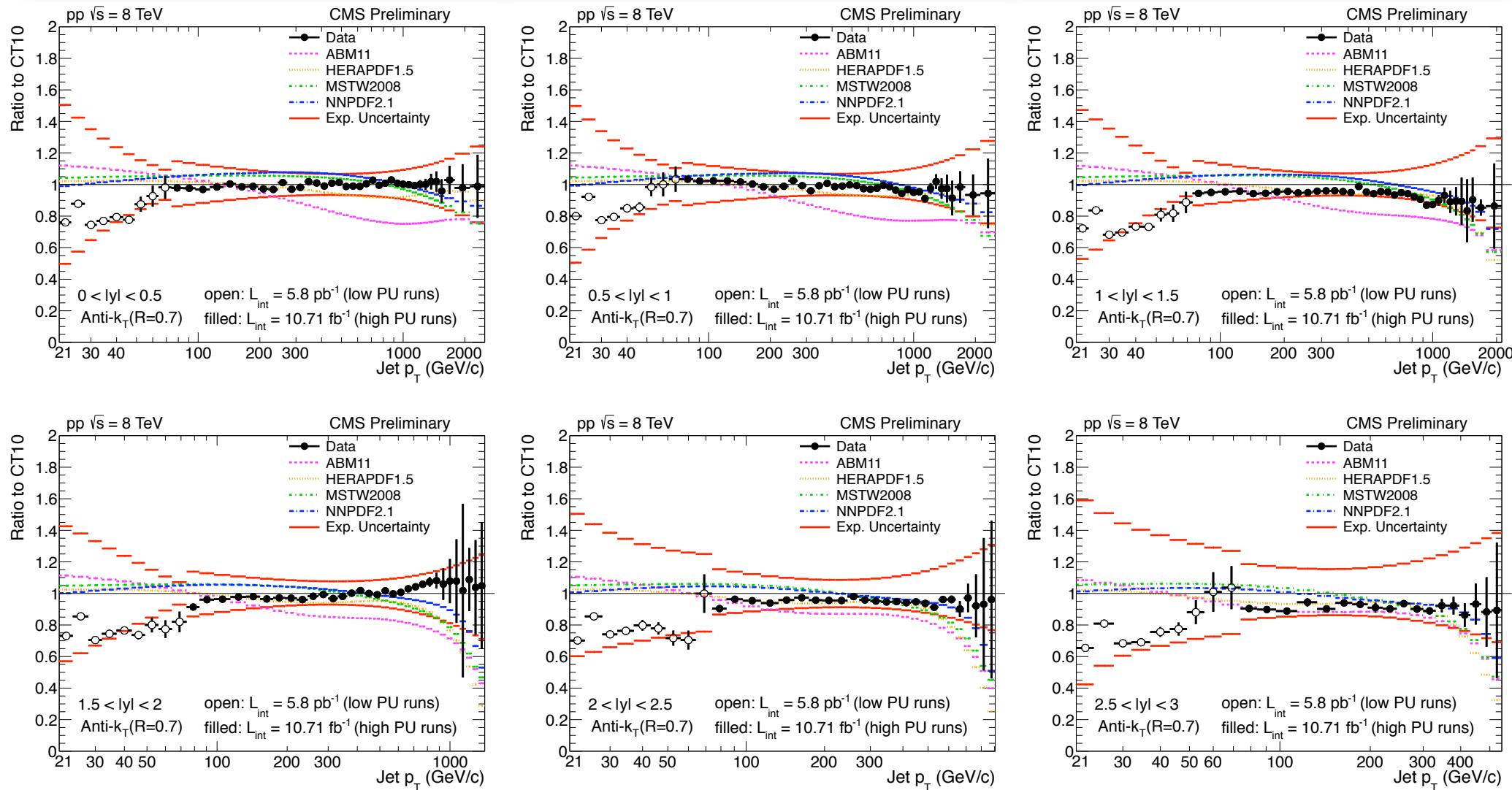
- The combined results both for low and high p_T jets. Ratio of data to the theoretical prediction of the NNPDF2.1 PDF set.

Combined Ratio of Incl. Jet x-sections to ABM11



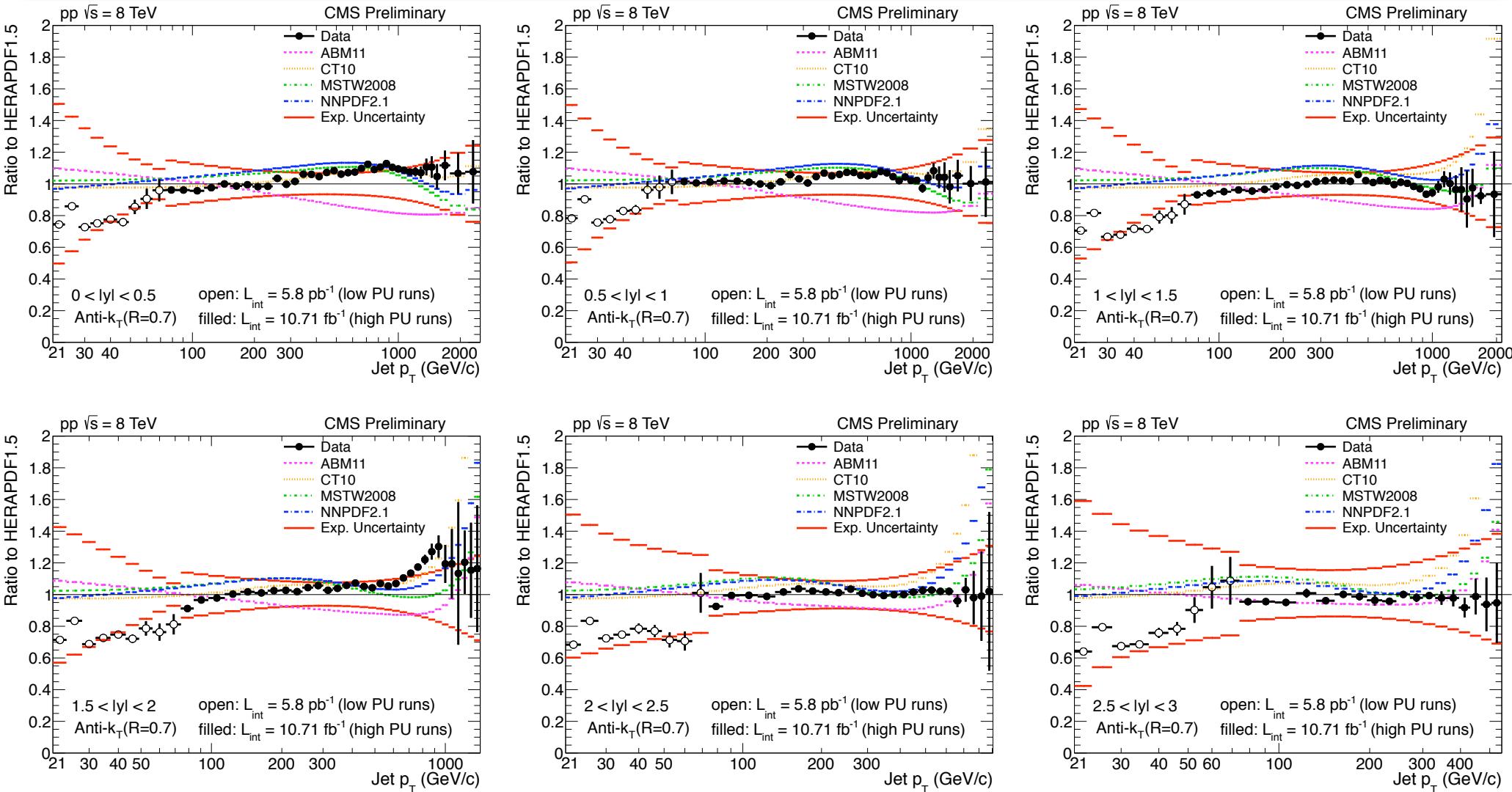
- The combined results both for low and high p_T jets. Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the ABM11 PDF set.

Combined Ratio of Incl. Jet x-sections to CT10



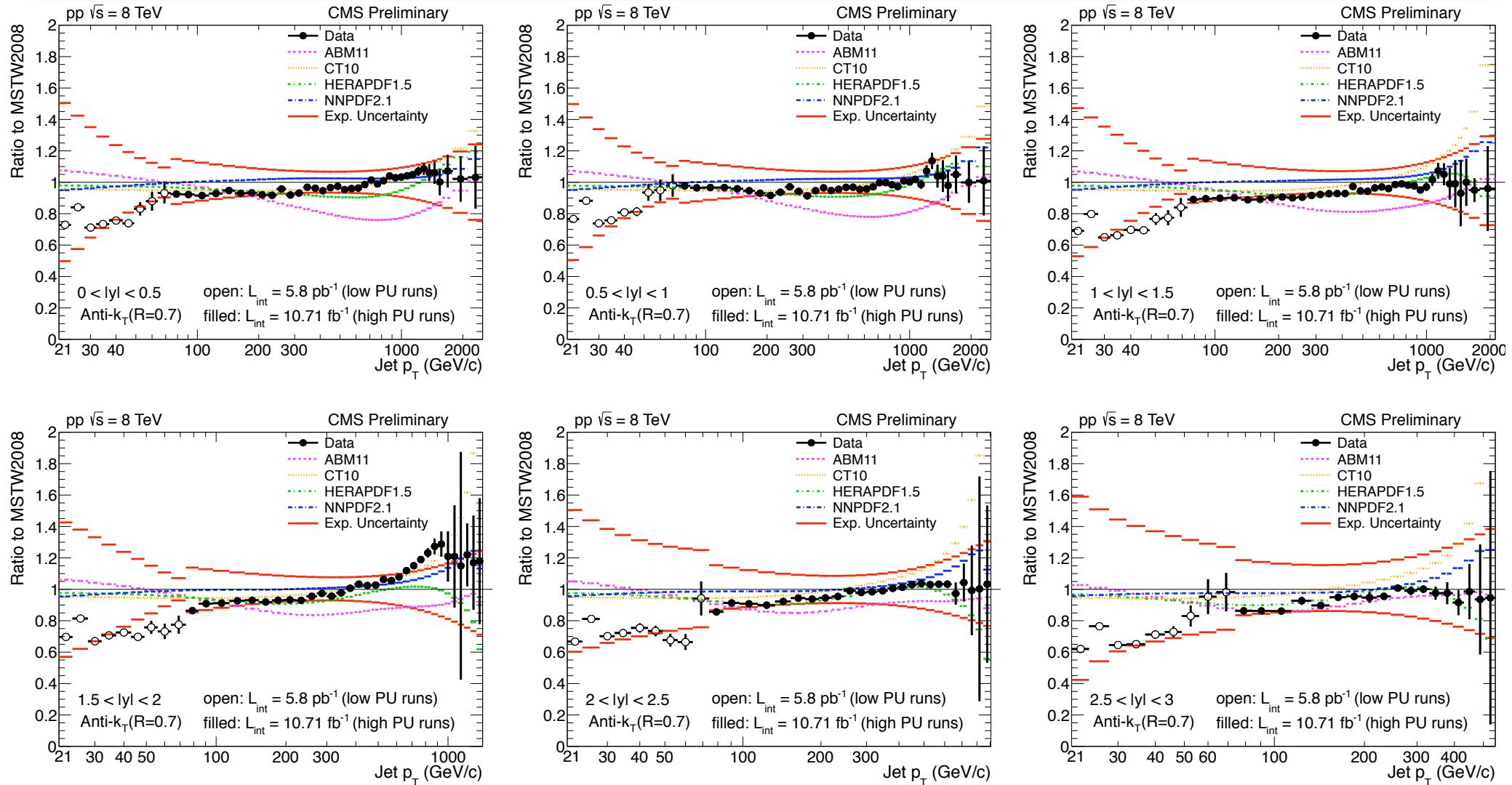
- The combined results both for low and high p_T jets. Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the CT10 PDF set.

Combined Ratio of Incl. Jet x-sections to HERAPDF



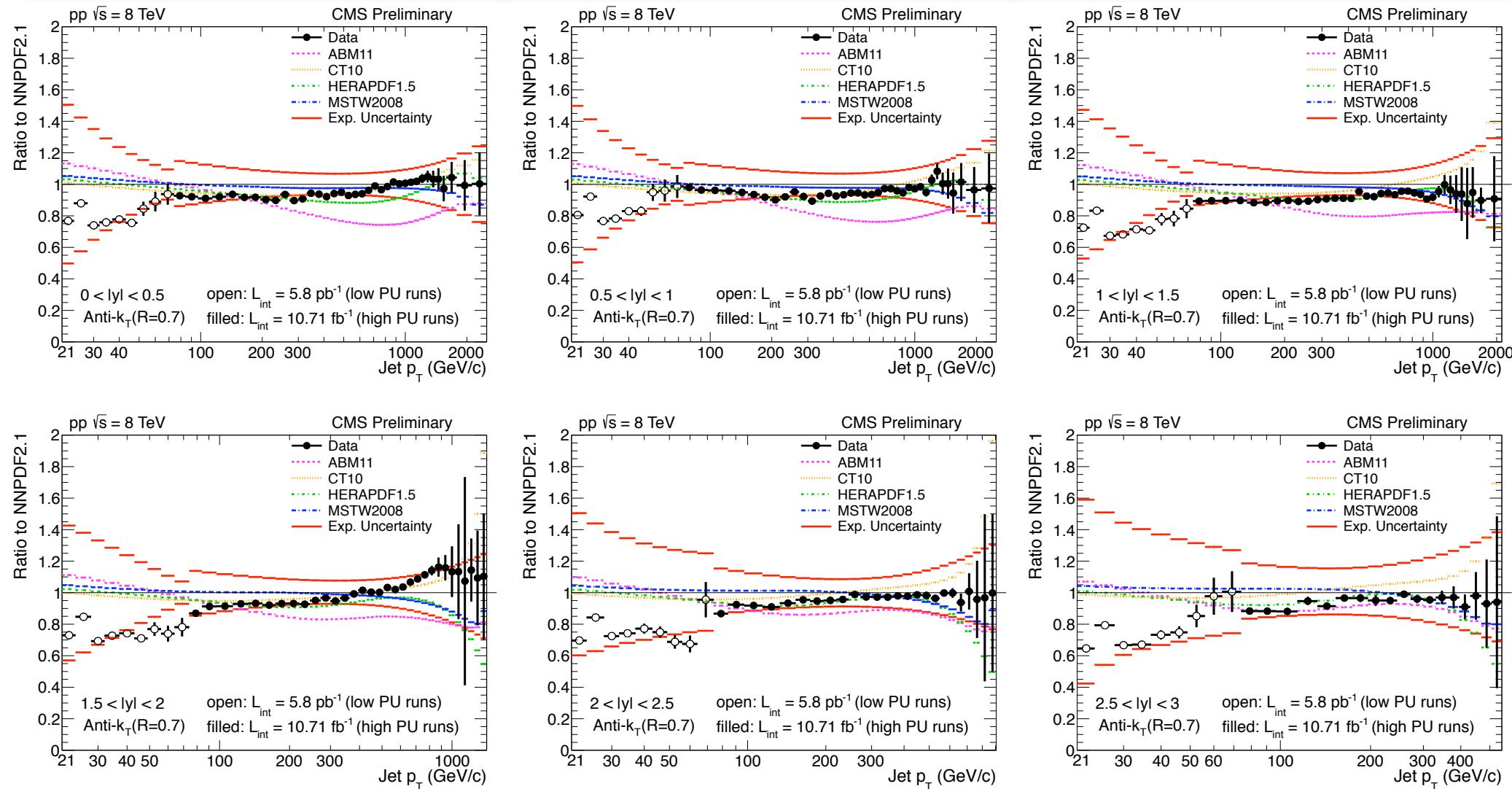
- The combined results both for low and high p_T jets. Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the HERAPDF PDF set.

Combined Ratio of Incl. Jet x-sections to MSTW2008



- The combined results both for low and high p_T jets. Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the MSTW2008 PDF set.

Combined Ratio of Incl. Jet x-sections to NNPDF2.1



- The combined results both for low and high p_T jets. Ratio of inclusive jet cross sections to the theoretical prediction using the central value of the NNPDF2.1 PDF set.