QCD with jets and photons at ATLAS and CMS

Zuzana Barnovska-Blenessy

on behalf of the ATLAS and CMS collaborations
Moriond 2017, QCD session

March 30, 2017

QCD is a well established theory

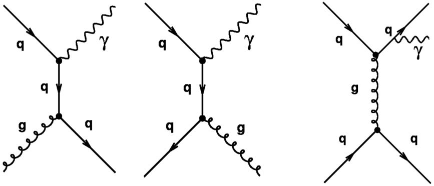
- but many regions of phase space are not well described by current theory predictions
- important also for new physics searches - need of proper background modelling
- placing constrains on PDFs $\rightarrow$ more precision for Higgs, top and other SM measurements
- running of α_S at new energies

ATLAS and CMS continue to provide new results

ATLAS	$\sqrt{s}$	
inclusive γ	13 TeV	arXiv:1701.06882, sub. to PLB
$\gamma + jets$	8 TeV	arXiv:1611.06586, NPB
inclusive $\gamma\gamma$	8 TeV	M. Saimpert, afternoon
inclusive jets	8 TeV	ATLAS-STDM-2015-01
inclusive jets	13 TeV	ATLAS-CONF-2016-092
k_T splitting	8 TeV	ATLAS-STDM-2015-14

CMS	$\sqrt{s}$	
inclusive jets	8 TeV	arXiv:1609.05331, JHEP accept.
inclusive jets	13 TeV	arXiv:1605.04436, EPJ C76
dijets	8 TeV	CMS-PAS-SMP-16-011
multijets	8 TeV	CMS-PAS-SMP-16-008

Inclusive isolated photon production at $\sqrt{s} = 13$ TeV in ATLAS



Inclusive photons with 3.2 fb^{-1} at $\sqrt{s} = 13$ TeV in ATLAS

- photons with $E_T^\gamma > 125$ GeV
- double differential in E_T^γ and four η bins
- data-driven jet background estimation-photon ID and isolation criteria
- compared to PYTHIA and SHERPA - good shape comparison
- compared to NLOpQCD JETPHOX (direct+fragmentation)
- three different PDFs used - up to 15% differences
- inclusive cross-section

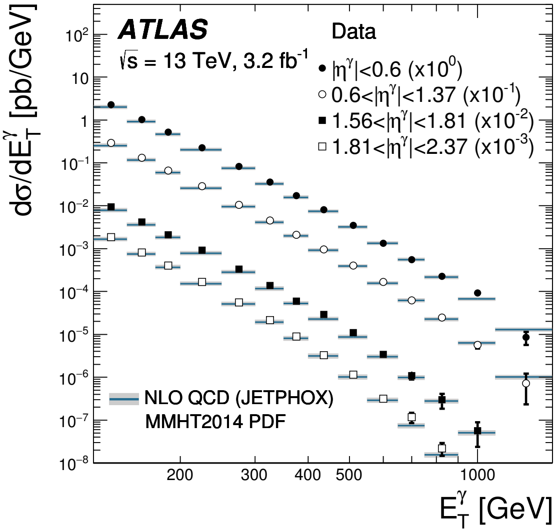
measured:

$$\sigma_{measured} = 399 \pm 13(\text{exp.}) \pm 8(\text{lumi}) \text{ pb}$$

predicted: $\sigma_{NLO} =$

$$352^{+36}_{-29}(\text{scale}) \pm 3(\text{PDF}) \pm 6(\alpha_s) \pm 4(NPC) \text{ pb}$$

arXiv:1701.06882, subm. to PLB



Inclusive photons with 3.2 fb^{-1} at $\sqrt{s} = 13$ TeV in ATLAS

- photons with $E_T^\gamma > 125$ GeV
- double differential in E_T^γ and four η bins
- data-driven jet background estimation-photon ID and isolation criteria
- compared to PYTHIA and SHERPA - good shape comparison
- compared to NLOpQCD JETPHOX (direct+fragmentation)
- three different PDFs used - up to 15% differences
- inclusive cross-section

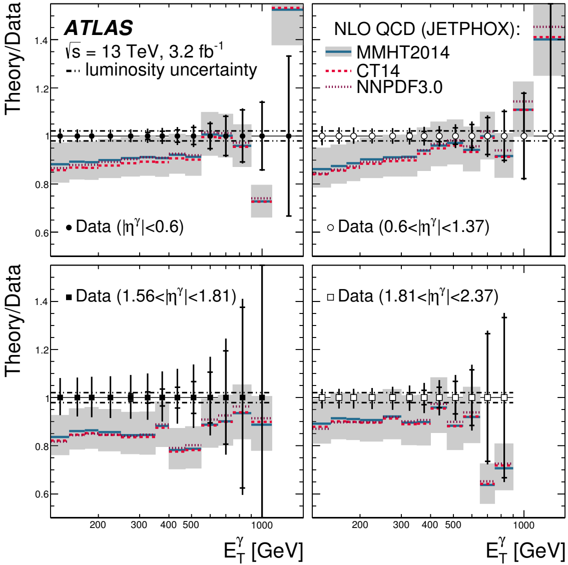
measured:

$$\sigma_{measured} = 399 \pm 13(\mathrm{exp.}) \pm 8(\mathrm{lumi})\ \mathrm{pb}$$

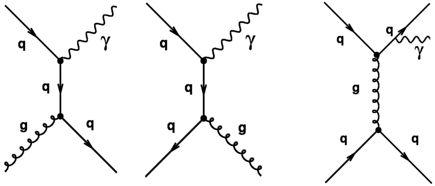
predicted: $\sigma_{NLO} =$

$$352^{+36}_{-29}(\mathrm{scale}) \pm 3(\mathrm{PDF}) \pm 6(\alpha_s) \pm 4(NPC)\ \mathrm{pb}$$

▸ arXiv:1701.06882, subm. to PLB



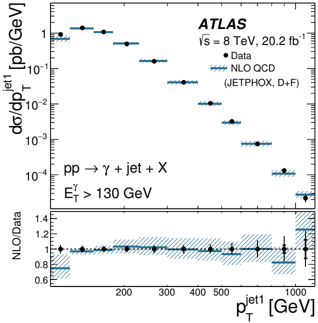
Isolated photon+jet production at $\sqrt{s} = 8$ TeV in ATLAS

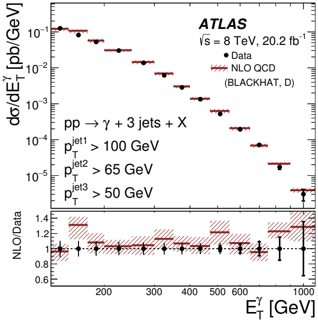


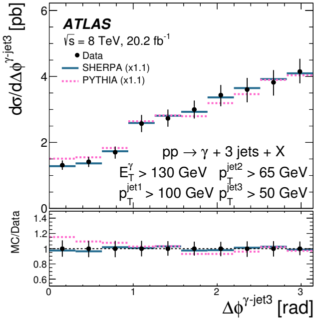
High-E_{T} isolated photon+jet production at $\sqrt{s} = 8$ TeV in ATLAS

Probing perturbative QCD - measurement of $\gamma +$ up to 3 jets

- isolated photons, $E_T^{\gamma} > 130$ GeV, high-p_{T} jets starting at $p_T^{jet} > 50$ GeV
- differential in E_{T}^{γ}, $p_{\mathrm{T}}^{\mathrm{j}}$, $m^{\gamma \mathrm{j}}$, $|\cos\theta^*|$, $\Delta\phi^{\gamma \mathrm{j}}$, $\Delta\phi^{\mathrm{jj}}$, production of jets around the photon
- photons up to $E_{\mathrm{T}}^{\gamma} = 1.1$ TeV, jets up to $p_{\mathrm{T}}^{j} = 1.2$ TeV
- JETPHOX - good shape and normalization description, SHERPA better than PYTHIA, BLACKHAT good for $E_{\mathrm{T}}^{\gamma} < 750$ GeV

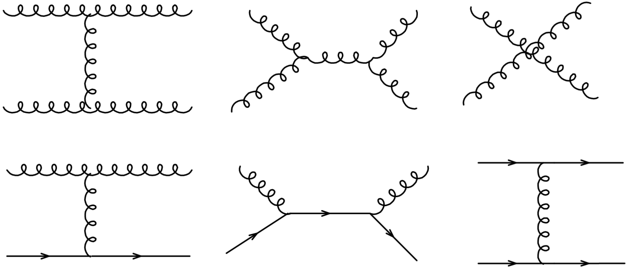






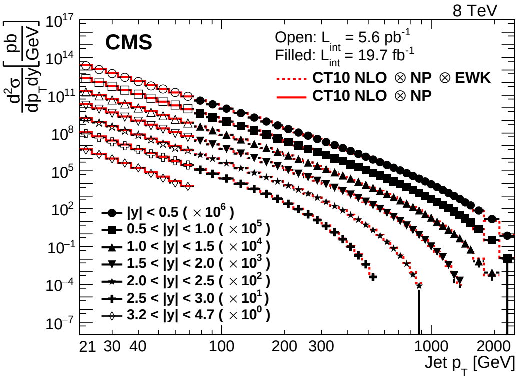
arXiv:1611.06586, NPB

Inclusive jet cross-sections at $\sqrt{s} = 8$ TeV



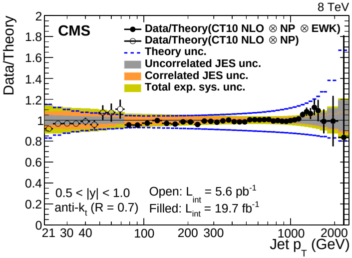
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS

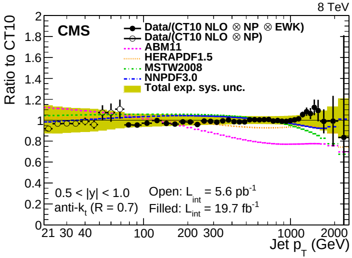
- 8 TeV dataset of 19.7 fb^{-1}
- inclusive anti-k_T jets with $R = 0.7$
- $p_\mathrm{T} > 74$ GeV up to 2.5 TeV in $|y| < 3.0$
- dedicated 5.6 fb^{-1} low-p_T range: 21 GeV $< p_\mathrm{T} <$ 74 GeV for $|y| < 4.7$
- comparisons to NLOJet++ with CT10 + corrections NPC, EW



- good description by most predictions
- except ABM11 in high-p_T range

‣ arXiv:1609.05331, accepted by JHEP





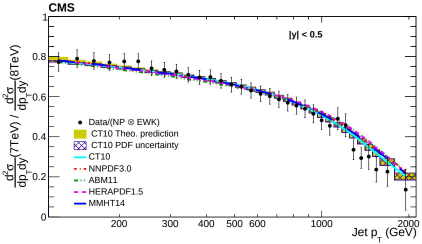
Ratios of 8 TeV results with 2.76 TeV and 7 TeV

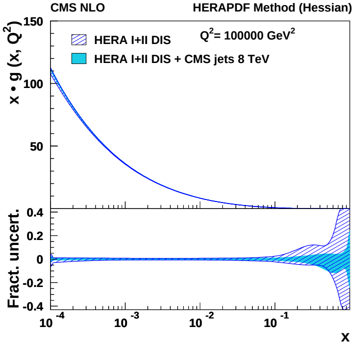
- cancellation of uncertainties and sensitivity to PDFs
- only the high-p_{T} dataset used, same cuts at all $\sqrt{s}$

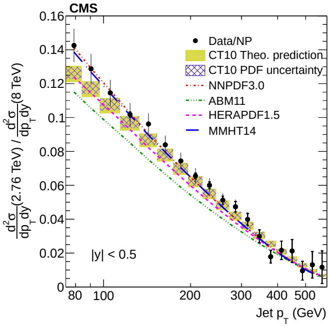
$\rightarrow \alpha_S$ extracted as

$\alpha_S(M_Z) = 0.1164^{+0.0060}_{-0.0043}(\mathrm{tot})$ (CT10 NLO PDF)

$\alpha_S(M_Z) = 0.1172^{+0.0083}_{-0.0075}(\mathrm{tot})$ (NNPDF3.0 NLO PDF)





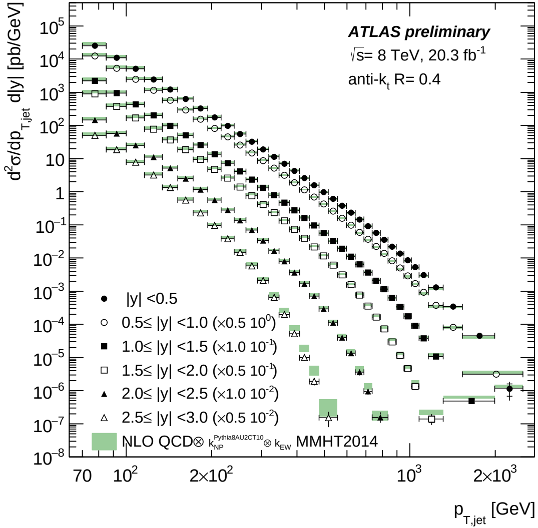


→ high x - gluon PDF improved, important for searches

arXiv:1609.05331, accepted by JHEP

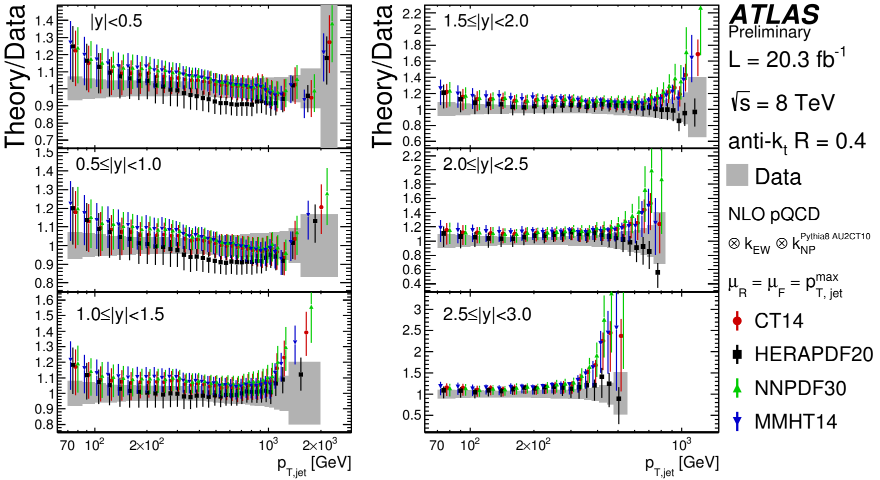
Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS *NEW*

- full 8 TeV dataset of 20.3 fb^{-1}
- double differential cross-section $\mathrm{d}^2\sigma/\mathrm{dp_T d}|y|$
- anti-k_T jets with $R = 0.4$ and $R = 0.6$
- 70 GeV $\leq p_T \leq$ 2.5 TeV
- $|y| < 3$ in six bins
- improved jet energy scale and resolution
- sensitivity to constrain PDFs
- compared to NLO QCD based on NLOJet++ with NPC and EW corrections



ATLAS SM public results

Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS *NEW*

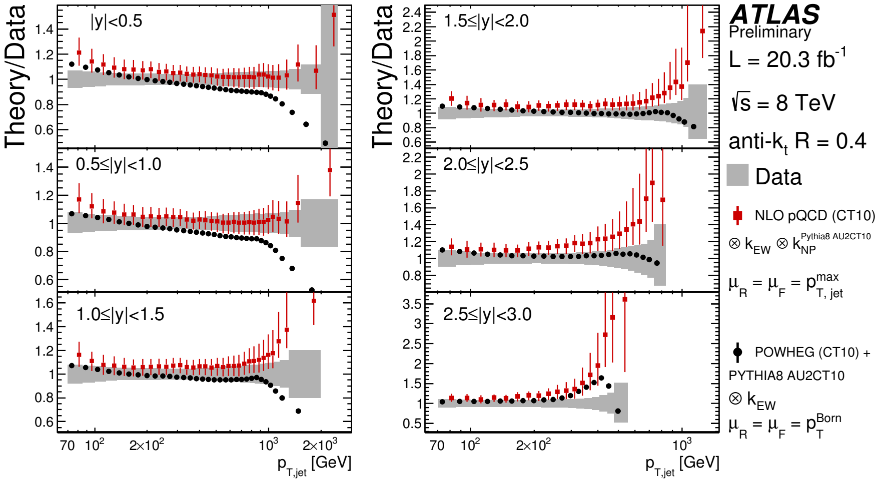


- qualitative comparison to NLO QCD including NPC, EW corrections
- CT14 PDF gives best qualitative agreement, HERAPDF2.0 worst over a wide p_T range
- but HERAPDF2.0 more consistent with data in high-p_T forward region

$\rightarrow$ sensitivity to constrain PDFs

▸ ATLAS SM public results

Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS *NEW*

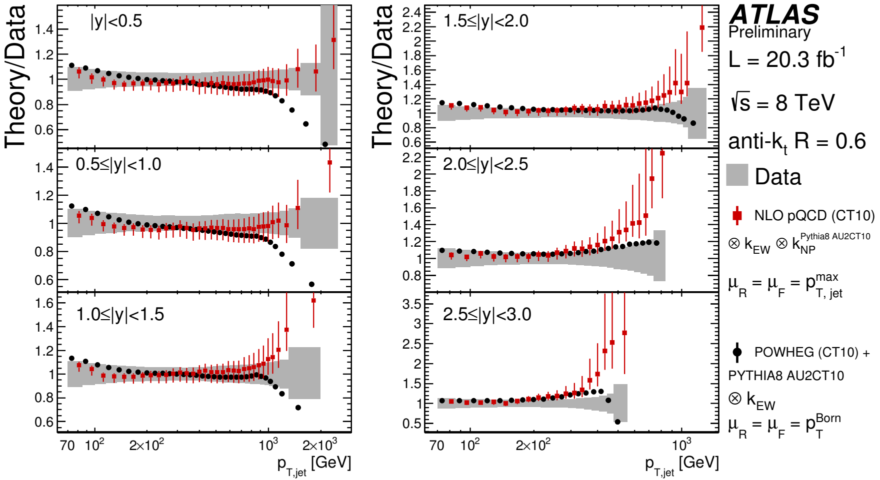


- qualitative comparison to PowHeg+Pythia8 and NLO QCD
- NLO QCD including parton shower and fragmentation
- ratio with PowHeg is less dependent on jet radius than NLO QCD (central low p_T up to 15% difference)

$\rightarrow$ sensitivity to constrain PDFs

ATLAS SM public results

Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS *NEW*



- qualitative comparison to PowHeg+Pythia8 and NLO QCD
- NLO QCD including parton shower and fragmentation
- ratio with PowHeg is less dependent on jet radius than NLO QCD (central low p_{T} up to 15% difference)

$\rightarrow$ sensitivity to constrain PDFs

▸ ATLAS SM public results

Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS ***NEW***

Also performed quantitative comparisons - coming out soon!

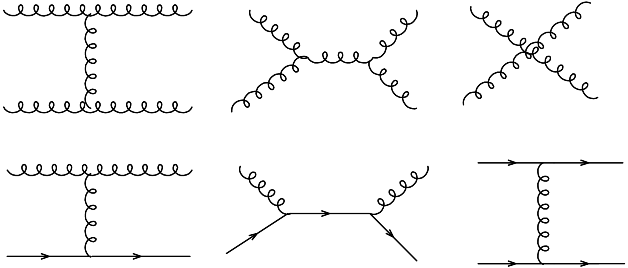
Goal is for the result to be used in PDF fit
$\rightarrow$ need to provide uncertainties and model of their correlations

- frequentist method, test statistic takes into account asymmetric uncertainties ▸ Ref.
- χ^2 and p-values for all PDFs, rapidity bins, jet p_{T} bins
- p-values for $R = 0.4$ all above 4%, lowest for $1.5 \leq |y| < 2$ and $2.5 \leq |y| < 3$, up to 92% for CT14
- p-values for $R = 0.6$ $|y| < 1$ reach below 1%, but $|y| > 1$ are all above 10%, up to 95%
- if all data points considered together (not split into rapidity regions) very low p-values $<< 10^{-3}$
- alternative correlation models considered to improve χ^2
- thorough investigation of decorrelation scenarios
- possibly due to phase space dependence of the size of uncertainties or duse to missing higher order corrections

Stay tuned for publication!

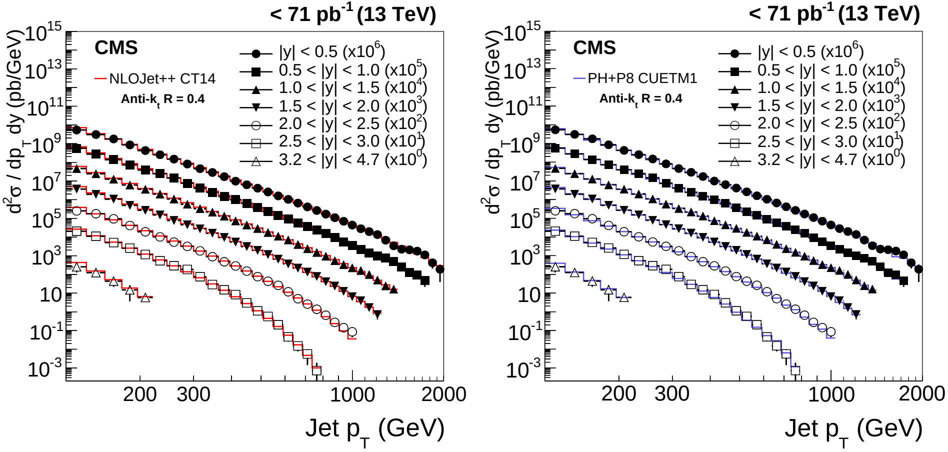
▸ ATLAS SM public results

Inclusive jet cross-sections at $\sqrt{s} = 13$ TeV



Inclusive jets with 71 pb^{-1} at $\sqrt{s} = 13$ TeV in CMS

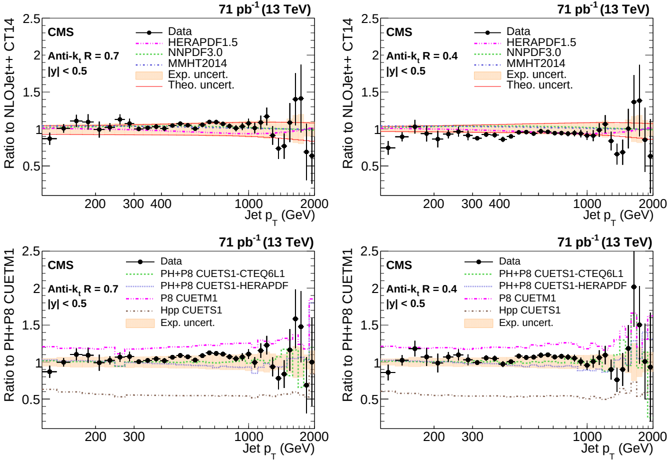
- double differential cross sections in p_T^{jet} and $|y|$
- inclusive high-pt anti-k_T jets in seven rapidity bins
- two R parameters: $R = 0.7$ and $R = 0.4$
- data consistent with predictions for a wide range of p_T: 114 GeV-2 TeV



arXiv:1605.04436, Eur.Phys.J C76 (2016)

Inclusive jets with 71 pb^{-1} at $\sqrt{s} = 13$ TeV in CMS

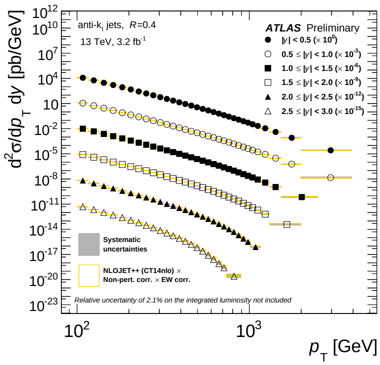
- NLOJet++ corr. for NP and EW effects → for $R = 0.4$ theory overestimates cross section by 5-10%, for $R = 0.7$ accurate description
- LO PYTHIA8 and HERWIG++ show differences in absolute cross section, NLO POWHEG+PYTHIA8 shows very good agreement for both $R = 0.4$ and $R = 0.7$

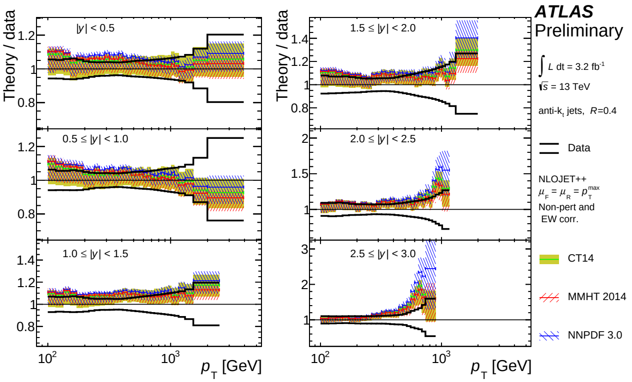


arXiv:1605.04436, Eur.Phys.J C76 (2016)

Inclusive jets with 3.2 fb^{-1} at $\sqrt{s} = 13$ TeV in ATLAS

- jets with $p_{\mathrm{T}}^{jet} > 100$ GeV and rapidity $|y| < 3$, anti-k_{T} jets $R = 0.4$
- compared to NLO pQCD NLOJet++ calculations with different PDFs, μ_R and μ_F scales
- overall good description, tend to overestimate at high p_{T} and y except for HERAPDF 2.0 and ABM12PDF
- ABM12 PDF for $|y| \leq 1$ underestimates data in medium to high-p_{T}

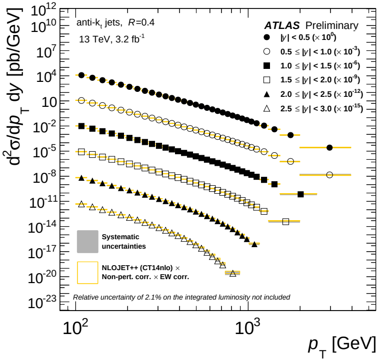


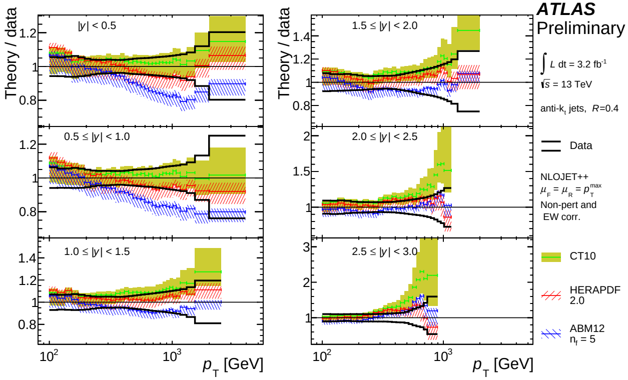


ATLAS-CONF-2016-092

Inclusive jets with 3.2 fb^{-1} at $\sqrt{s} = 13$ TeV in ATLAS

- jets with $p_{\mathrm{T}}^{jet} > 100$ GeV and rapidity $|y| < 3$, anti-k_{T} jets $R = 0.4$
- compared to NLO pQCD NLOJet++ calculations with different PDFs, μ_R and μ_F scales
- overall good description, tend to overestimate at high p_{T} and y except for HERAPDF 2.0 and ABM12PDF
- ABM12 PDF for $|y| \leq 1$ underestimates data in medium to high-p_{T}





ATLAS-CONF-2016-092

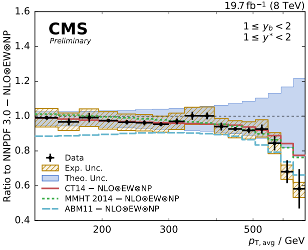
Dijet cross sections at $\sqrt{s} = 8$ TeV in CMS

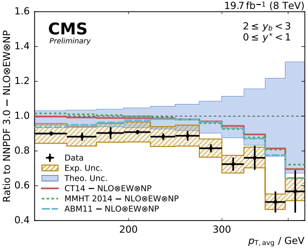
Dijets at $\sqrt{s} = 8$ TeV in CMS

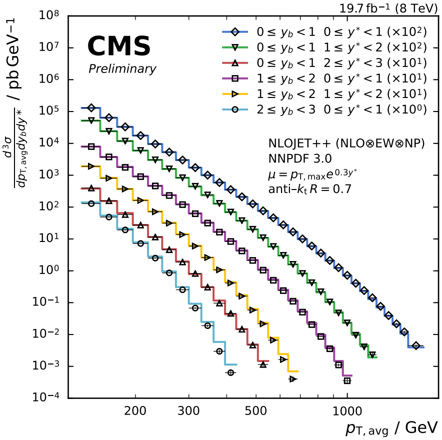
- high $p_T > 50$ GeV anti-k_T $R = 0.7$ jet selection
- differential in three observables:

$$p_{T,avg} = \frac{1}{2}(p_{T,1} + p_{T,2})$$
$$y^* = \frac{1}{2}|y_1 - y_2| \qquad y_b = \frac{1}{2}|y_1 + y_2|$$

- compared to NLOJet++ corrected for NP and EW effects
- discrepancies observed at high $p_{T,avg}$ - possible to constrain PDFs



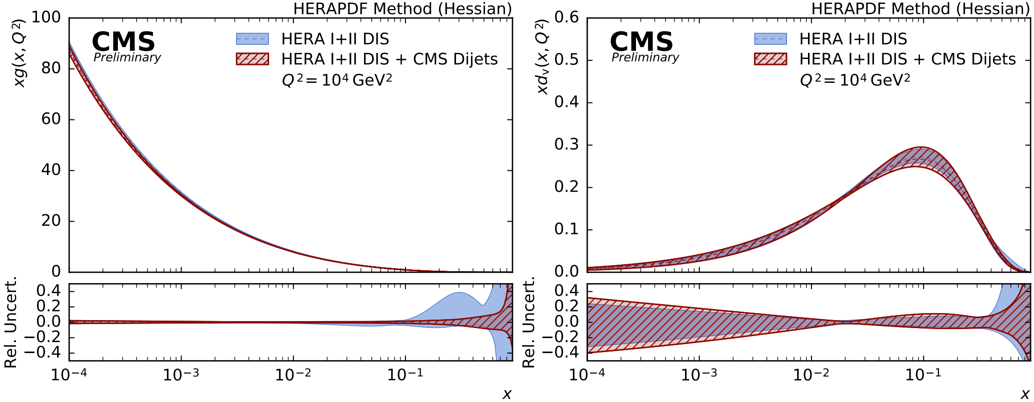




▸ CMS-PAS-SMP-16-011

Dijets at $\sqrt{s} = 8$ TeV in CMS

Providing effective constraints on PDFs for high x with HERA DIS results in XFITTER



$\rightarrow$ fitting the strong coupling constant

$$\alpha_S(M_Z) = 0.1199 \pm 0.0015(\text{exp}) \pm 0.0002(\text{mod})^{+0.0002}_{-0.0004}(\text{par})^{+0.0031}_{-0.0019}(\text{scale})$$

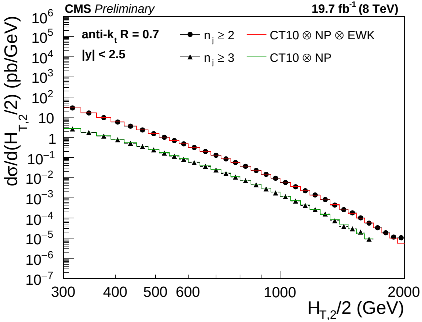
▸ CMS-PAS-SMP-16-011

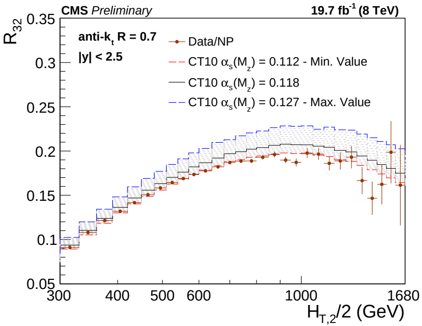
α_S with inclusive multijets at $\sqrt{s} = 8$ TeV in CMS

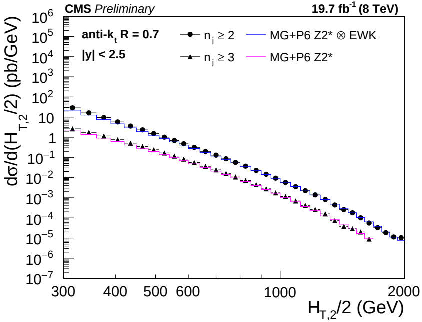
α_S with inclusive multijets at $\sqrt{s} = 8$ TeV in CMS ‣ CMS-PAS-SMP-16-008

Measuring differential multijet cross sections as a function of average p_T: $H_{T,2}/2 = \frac{1}{2}(p_{T,1} + p_{T,2})$

→ 8 TeV dataset of 19.7 fb^{-1}, anti-k$_T$ jets with $R = 0.7$
→ 2-jet and 3-jet event cross sections
→ jets up to 2 TeV and 1.68 TeV
→ R_{32}: 3-jet to 2-jet cross section ratio measured
→ sensitive to α_S
→ cancellation of uncertainties



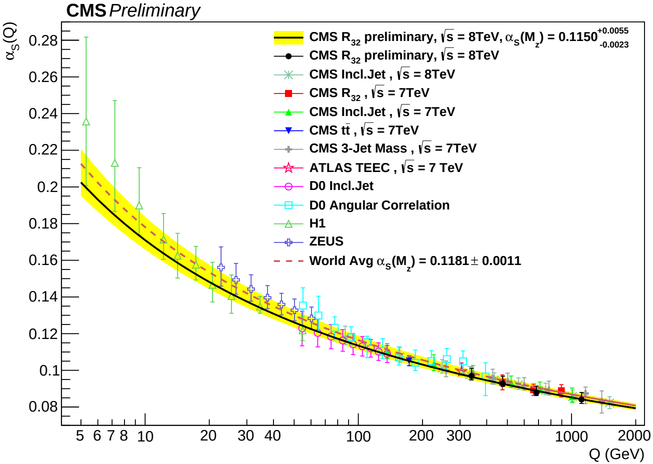




α_S with inclusive multijets at $\sqrt{s} = 8$ TeV in CMS

Extracting α_S, consistent with previous CMS measurements and world average

$$\alpha_S(M_Z) = 0.1150 \pm 0.0010(\text{exp}) \pm 0.0013(\text{PDF}) \pm 0.0015(\text{NP})^{+0.0050}_{-0.0000}(\text{scale})$$



CMS-PAS-SMP-16-008

$\mathrm{k_T}$ splitting scales in $Z \to \ell\ell$ events at $\sqrt{s} = 8$ TeV in ATLAS

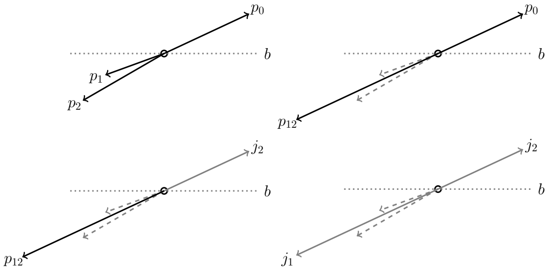
k_T splitting scales in $Z \to \ell\ell$ events at $\sqrt{s}$ =8 TeV in ATLAS

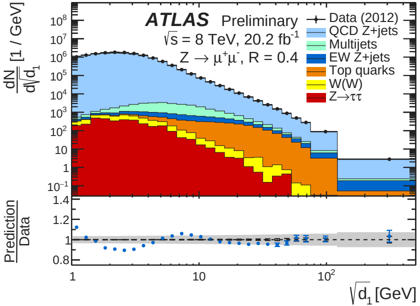
- full 8 TeV dataset of 20.2 fb^{-1}
- studying jets in $Z \to \ell\ell$ events ($\approx$ 99% pure)
- differential cross sections of k_T-splitting scales

$$d_{ij} = \min(p^2_{T,i}, p^2_{T,j}) \times \frac{\Delta R^2_{ij}}{R^2} \qquad d_{ib} = p^2_{T,i}$$

$$d_k = \min(d_{ij}, d_{ib})$$

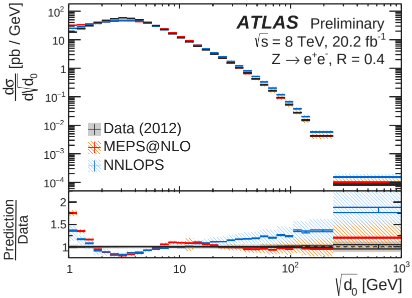
- $\sqrt{d_0}$ is leading jet p_T
- higher scales serve as QCD probe
- Z candidates: 71 GeV $< m_{\ell\ell} <$ 111 GeV
- $p_T^\ell > 25$ GeV, jets from charged particles with $p_T > 400$ MeV, $|\eta| < 2.5$, excluding Z
- data-driven multijet background, others from MC

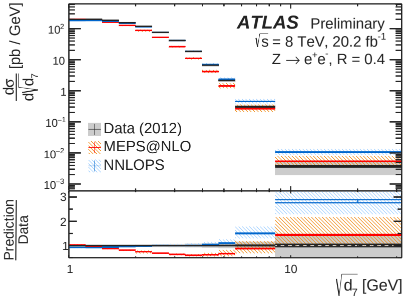


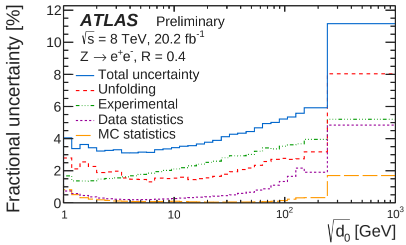


‣ ATLAS SM public results

k_T splitting scales in $Z \to \ell\ell$ events at $\sqrt{s}$ =8 TeV in ATLAS







- $\rightarrow$ unfolded distributions obtained from Bayesian unfolding
- $\rightarrow$ measured $d_0 - d_7$ for ee and $\mu\mu$ channels
- $\rightarrow$ separately for $R = 0.4$ and $R = 1.0$
- $\rightarrow$ also extrapolated to neutral tracks
- $\rightarrow$ altogether 8 sets of splitting scales distributions
- $\rightarrow$ compared to Z+ 0,1,2jets NLO+3,4jetsLOSherpa2.2 MEPS@NLO and Z+0jets@NNLO PowHeg NNLOPS

Providing means to constrain and potentially tune MC event generators

▸ ATLAS SM public results

Conclusions

Many interesting new results from both ATLAS and CMS

- both experiments exploring new regions of phase space
- measuring ratios at different energies or different phase spaces starting to be interesting due to canceling uncertainties
- reaching new levels of precision
- placing contraints on PDFs and measuring running α_S at new energies

More on diphotons at ATLAS from Matthias Saimpert this afternoon!

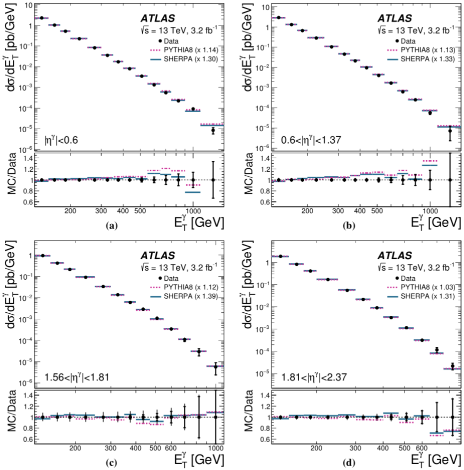
Click here for all: ATLAS SM public results and CMS SM public results

Stay tuned for more results to come soon!

BACKUP

Inclusive photons at $\sqrt{s}$ =13 TeV in ATLAS

- isolated high-pT photons
- fixed cone isolation: $E^{iso}_{\mathrm{T,cut}}(E_{\mathrm{T}})[\mathrm{GeV}] = 4.8 + 4.2.10^{-3}.E_{\mathrm{T}}[\mathrm{GeV}]$
- Frixione isolation for Sherpa MC
- 2DSB method for signal extraction
- unfolding with Pythia, Sherpa for systematics (had,PS model)
- uncertainties:
- Photon ID 1-6%
- Photon ES and ER: usually 2-5%
- definition of background CRs: anti-isolated and non-tight photons, $< 2\%$
- photon ID and isolation correlations in the background $< 2\%$
- PS and had. model $< 2\%$, isolation modelling $< 2\%$, signal modelling (brem) $< 1\%$
- pile-up $< 0.5\%$, trigger, luminosity 2.1%
- total: $< 5\%$ central, $8 - 19\%$ for peripheral
- stat dominant for $p_T^\gamma > 600$ GeV
- Theory unc: μ_R, μ_f scales, PDFs, α_S, NP effects, $10 - 15\%$ in total



Uncertainties [pb]					
γ ID	$(-5.2, +5.4)$	γ ES+ER	$(-7.9, +8.4)$	$E_{\mathrm{T}}^{\mathrm{iso}}$ Gap	± 0.3
$E_{\mathrm{T}}^{\mathrm{iso}}$ upp. lim.	$+0.6$	γ invert. var.	$(-4.1, +3.5)$	R^{bg}	$(-6.2, +6.1)$
Leak. Sherpa	± 4.1	Unf. Sherpa	± 2.9	$E_{\mathrm{T}}^{\mathrm{iso}}$ MC	-2.8
Hard and brem	$(-1.0, +1.9)$	Pile-up	$(-1.1, +1.3)$	MC stat.	± 0.4
Trigger	± 1.1	Data stat.	± 0.4	Luminosity	± 8.4

Photon+jets at $\sqrt{s} = 8$ TeV in ATLAS

	Sample					
	P1J	P1JM	P2J	P2JBP	P2JBJ	P3J
Common requirements	$E_T^\gamma > 130$ GeV and $\lvert\eta^\gamma\rvert < 2.37$, excluding $1.37 < \lvert\eta^\gamma\rvert < 1.56$; $\lvert y^{jet}\rvert < 4.4$ and $\Delta R^{\gamma-jet} > 1$					
p_T^{jet1} [GeV]	> 100	> 100	> 100	> 130	> 130	> 100
p_T^{jet2} [GeV]	–	–	> 65	> 50	> 50	> 65
p_T^{jet3} [GeV]	–	–	–	–	–	> 50
$\lvert\eta^\gamma + y^{jet1}\rvert$	–	< 2.37	–	–	–	–
$\lvert\cos\theta^*\rvert$	–	< 0.83	–	–	–	–
$m^{\gamma-jet1}$ [GeV]	–	> 467	–	–	–	–
$\Delta R^{\gamma-jet1}$	–	–	–	> 3	> 3	–
$\Delta R^{\gamma-jet2}$	–	–	–	$1 < \Delta R^{\gamma-jet2} < 1.5$	–	–
$\Delta R^{jet1-jet2}$	–	–	–	–	$1 < \Delta R^{jet1-jet2} < 1.5$	–
$\lvert\eta^{jet1}\rvert$	–	–	–	< 2.37	< 2.37	–
p_T^{jet2}, E_T^γ	–	–	–	$p_T^{jet2} < E_T^\gamma$	–	–
Number of Events	2 451 236	344 572	567 796	40 537	37 429	164 062
Normalisation factor SHERPA (PYTHIA)	1.0 (1.1)	1.0 (1.2)	1.1 (1.2)	1.0 (1.2)	1.0 (1.2)	1.1 (1.1)

Table 1: Characteristics of the six samples of γ + jet(s) events: kinematic requirements, number of selected events in data and normalisation factors applied to the MC predictions.

Source of uncertainty	Variable						
	Photon plus one-jet			Photon plus two-jet		Photon plus three-jet	
	E_T^γ	p_T^{jet1}	$\lvert\cos\theta^*\rvert$	p_T^{jet2}	$\Delta\phi$	p_T^{jet3}	$\Delta\phi$
Photon energy scale and resolution	(1–4)%	(0–3.5)%	(1–1.4)%	(0–2.5)%	(0–2.4)%	(0–1.9)%	(0–1.7)%
Jet energy scale	(0–1.7)%	(2.4–15)%	(1.8–2.3)%	(3.6–10)%	(1.8–9)%	(5.5–14)%	(4.5–11)%
Jet energy resolution	(0–0.3)%	(0.1–1.0)%	(0.1–0.4)%	(0.1–1.5)%	(0.2–2.0)%	(1.1–4.0)%	(0.1–2.5)%
Parton shower and hadronisation models	(0–0.8)%	(1.1–9)%	(0.6–1.3)%	(1–13)%	(0.8–4.6)%	(2.3–5.6)%	(2.1–7)%
Photon identification	(0–0.4)%	(0–0.4)%	(0–0.4)%	(0–0.4)%	(0–0.4)%	(0–0.4)%	(0–0.4)%
Background control regions	(0–1)%	(0–1.1)%	(0–0.6)%	(0–1.2)%	(0–0.5)%	(0–1.9)%	(0–1)%
Signal modelling	(0–0.1)%	(0–0.14)%	(0–0.4)%	(0–0.6)%	(0–0.7)%	(0–0.5)%	(0–1.2)%
Correlation in background	(0–0.8)%	(0–0.7)%	(0–0.9)%	(0–0.6)%	(0–0.6)%	(0–0.6)%	(0–0.5)%

Table 4: Overview of the relative systematic uncertainties in the cross sections.

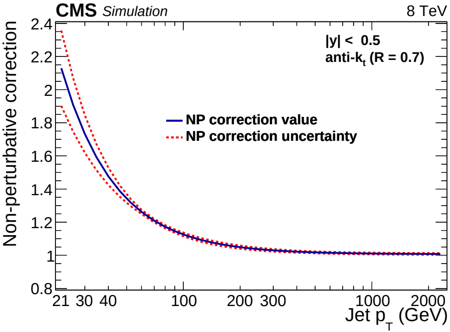
Photon+jets at $\sqrt{s} = 8$ TeV in ATLAS

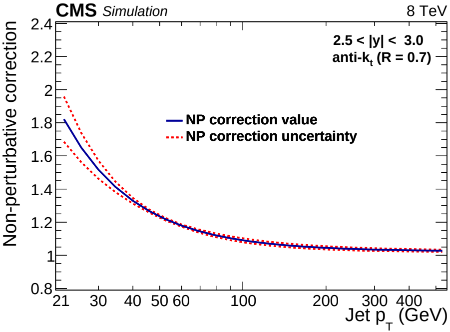
- high-ET photons $E_T^{\gamma} > 130$ GeV
- anti-kT jets with $R = 0.6$
- 2DSB method to subtract jet background
- Pythia used for unfolding, Sherpa for systematics
- cone isolation in Pythia, Frixione for Sherpa
- Pythia and Jetphox include fragmentation
- comparisons:
- 1jet: Jetphox, cone particle isolation 10 GeV
- 2jet, 3jet: BlackHat
- Pythia and Sherpa compared to all categories

Final state	Measured cross section [pb]	NLO QCD prediction JETPHOX/ BLACKHAT [pb]	PYTHIA prediction [pb]	SHERPA prediction [pb]
Photon plus one-jet	134 ± 4	128^{+11}_{-9} (J)	120	132
Photon plus two-jet	30.4 ± 1.8	$29.2^{+2.8}_{-2.7}$ (B)	26.4	27.4
Photon plus three-jet	8.7 ± 0.8	$9.5^{+0.9}_{-1.2}$ (B)	8.2	7.9

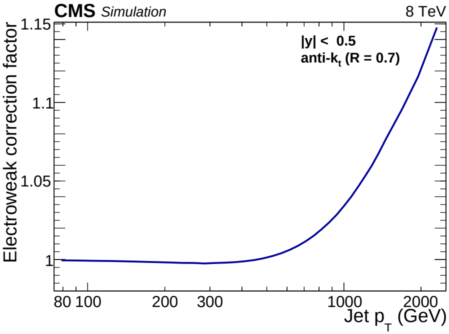
Table 5: Measured and predicted integrated cross sections.

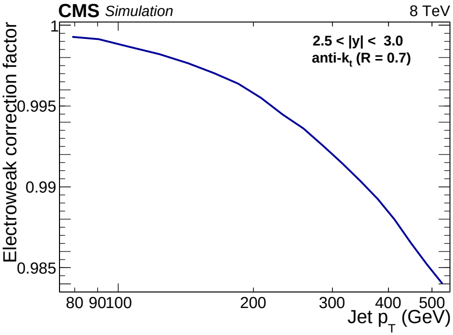
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



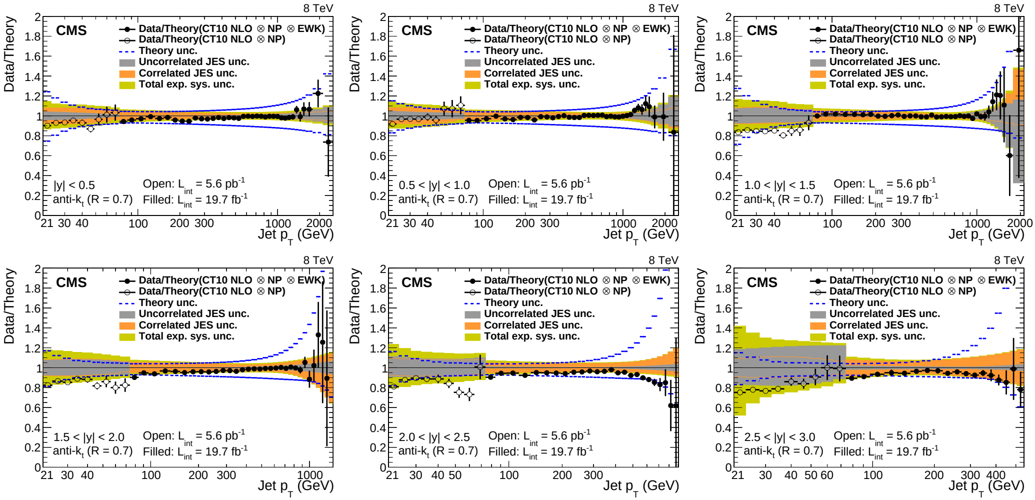


Inclusive jets at $\sqrt{s} = 8$ TeV in CMS

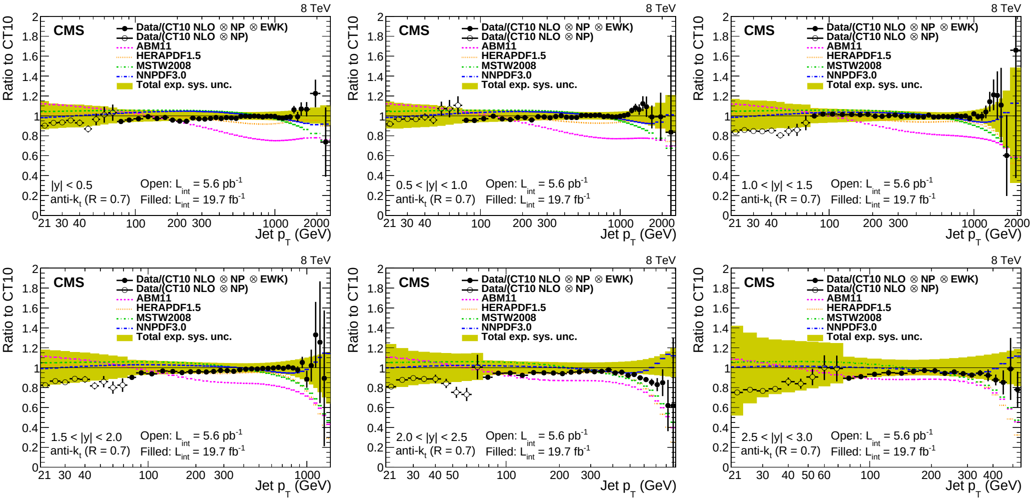




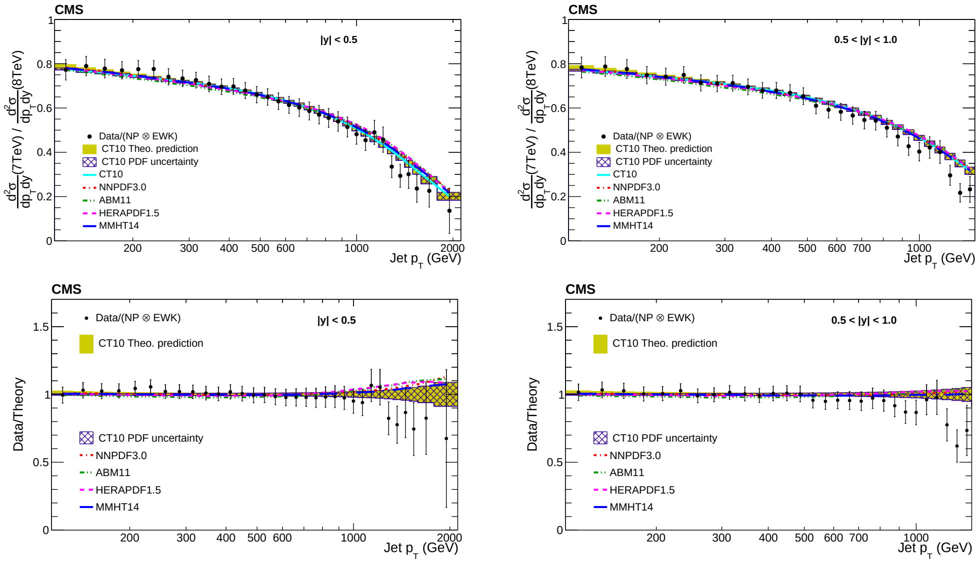
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



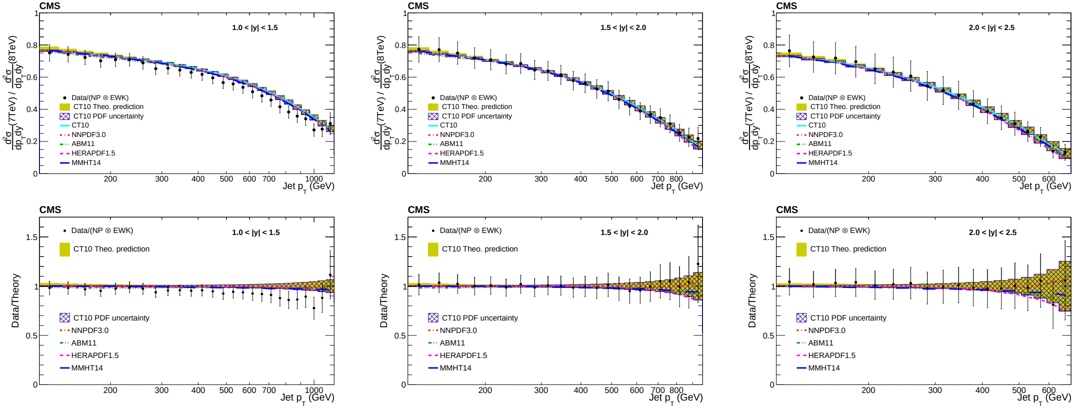
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



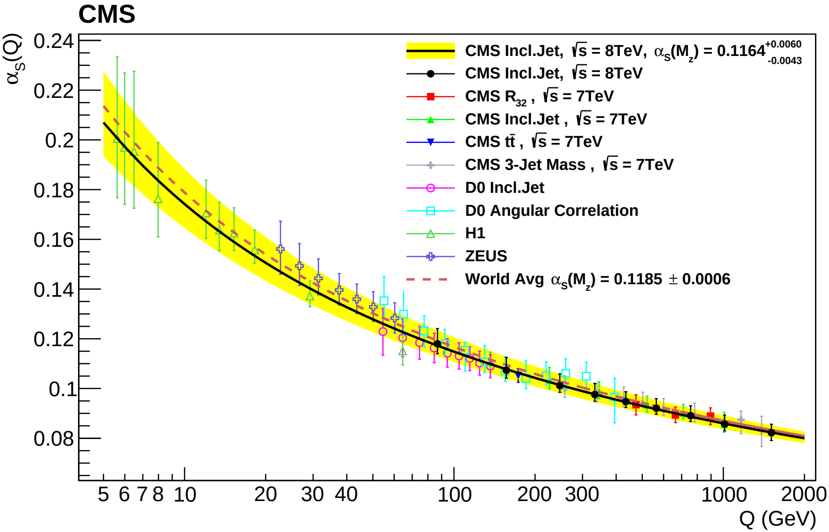
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



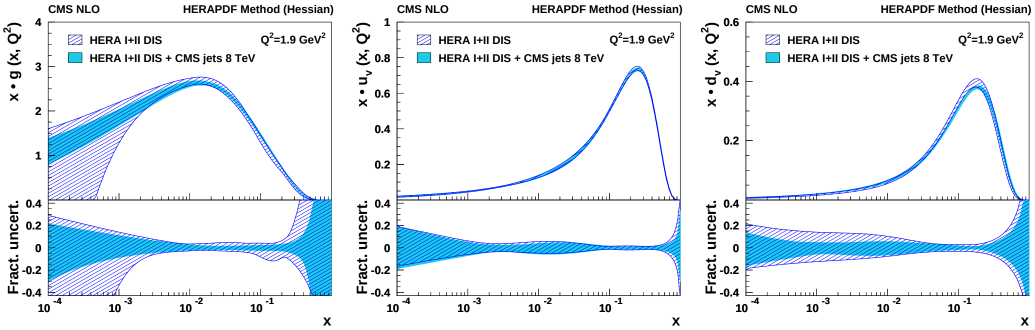
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



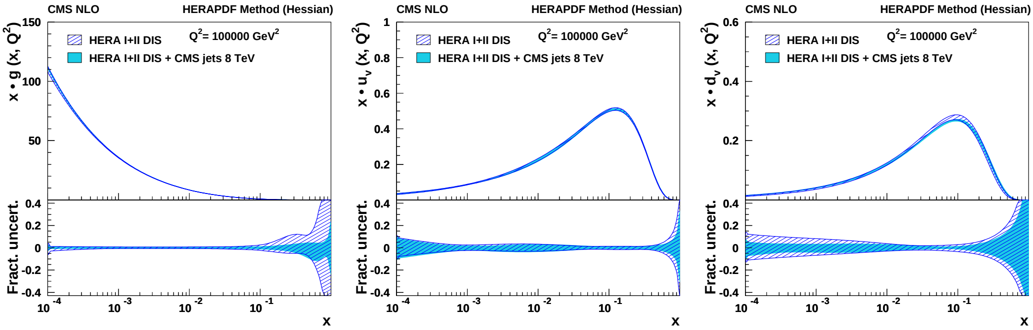
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



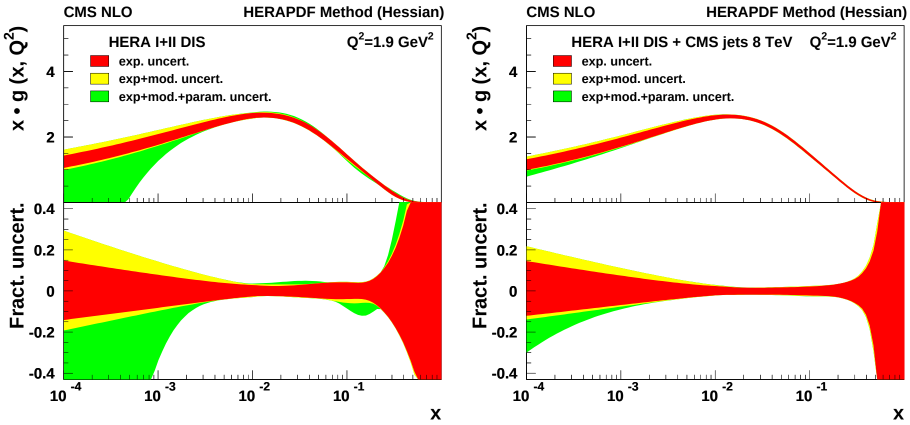
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



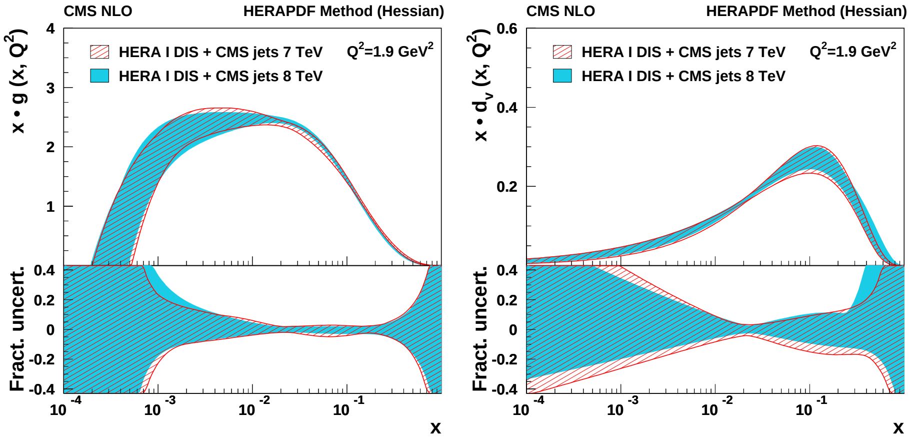
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



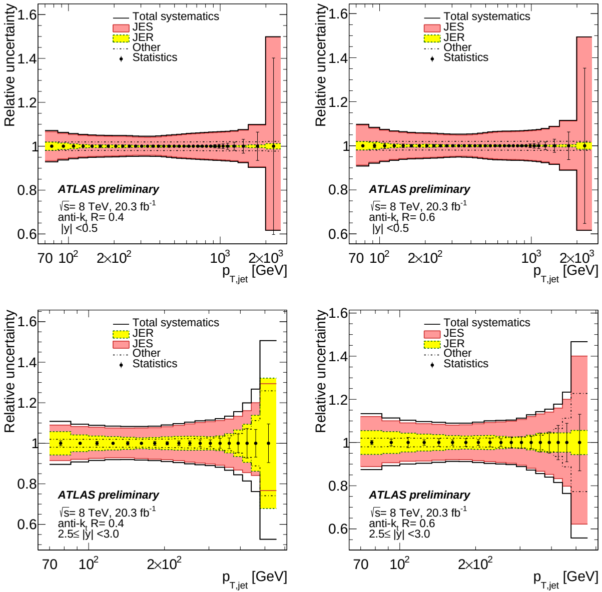
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



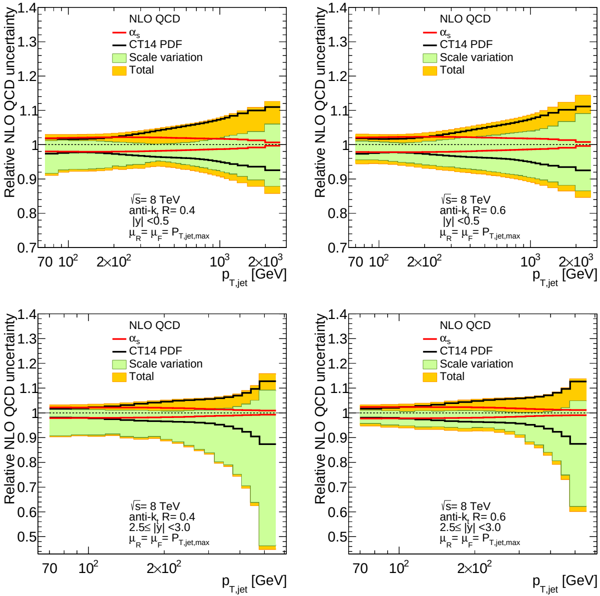
Inclusive jets at $\sqrt{s} = 8$ TeV in CMS



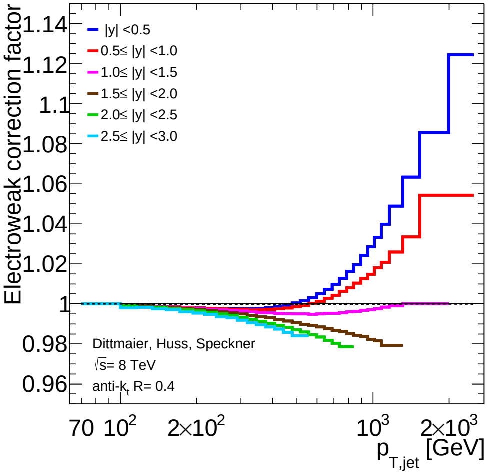
Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS (systematic uncertainties)

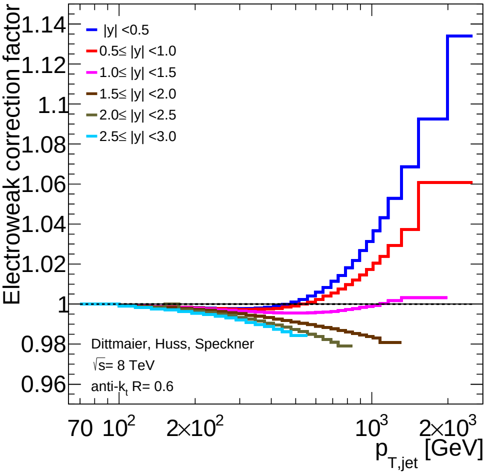


Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS (relative NLOQCD unc.)

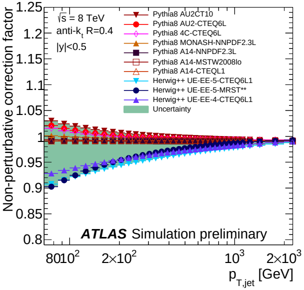


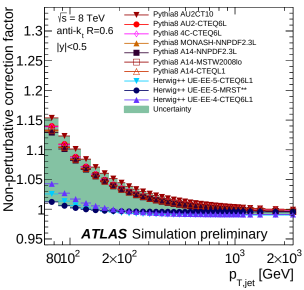
Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS (Electroweak corrections)

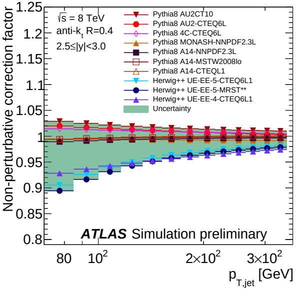


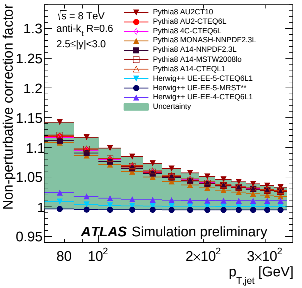


Inclusive jets at $\sqrt{s} = 8$ TeV in ATLAS (non-pert. corrections)

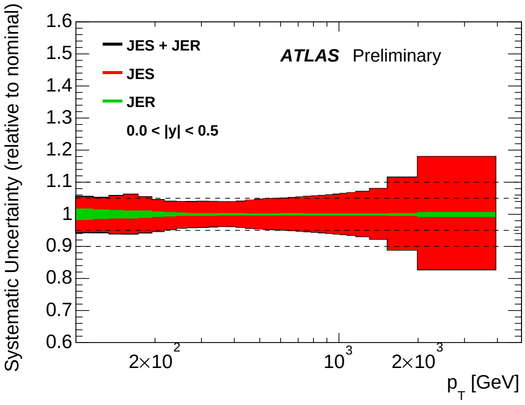


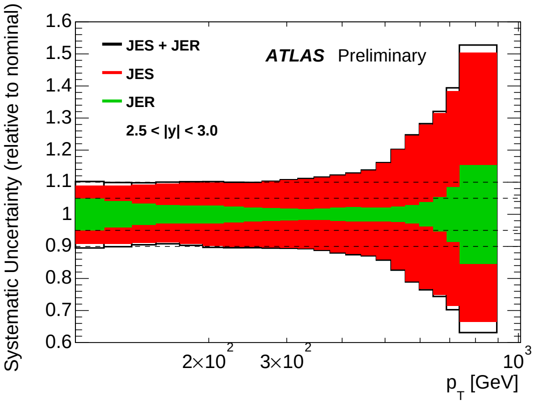




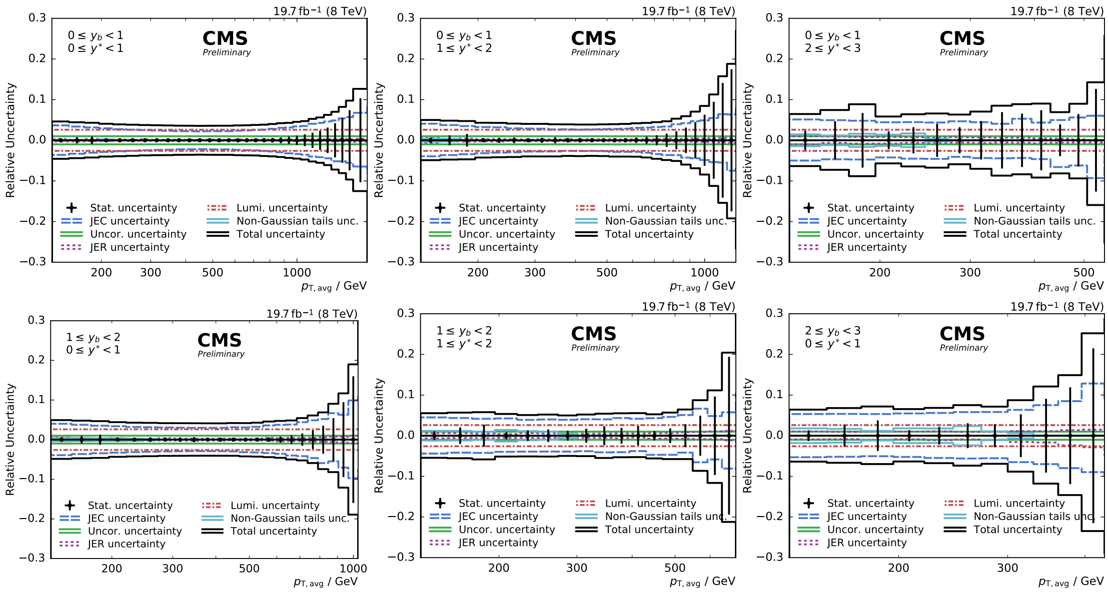


Jet systematics ATLAS 13 TeV

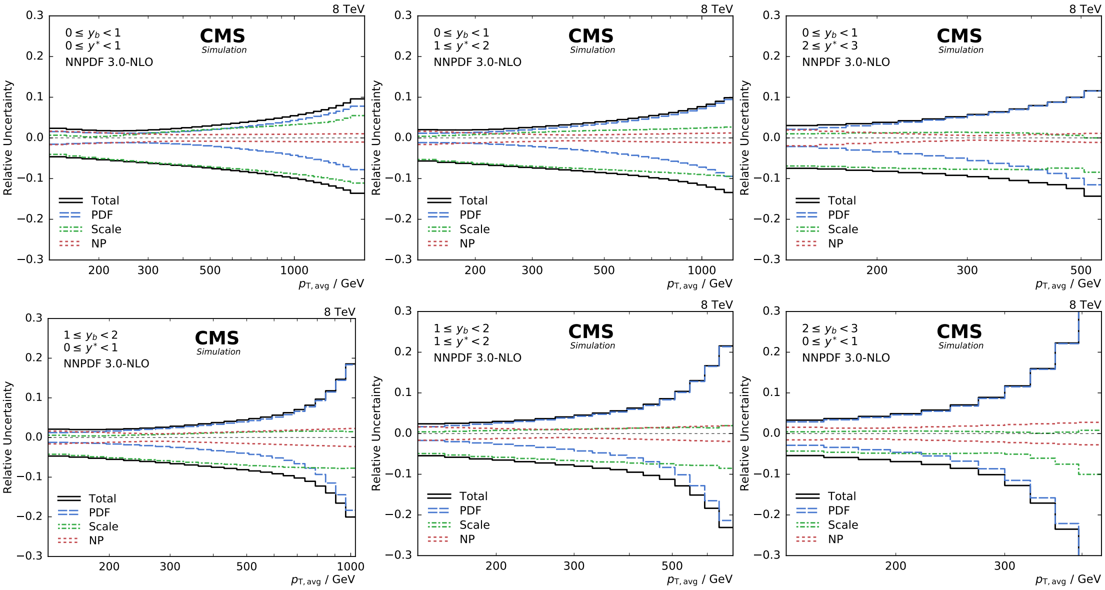




Dijets at $\sqrt{s} = 8$ TeV in CMS

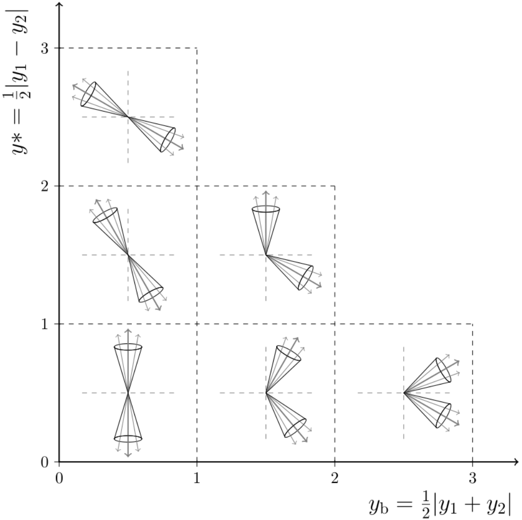


Dijets at $\sqrt{s} = 8$ TeV in CMS

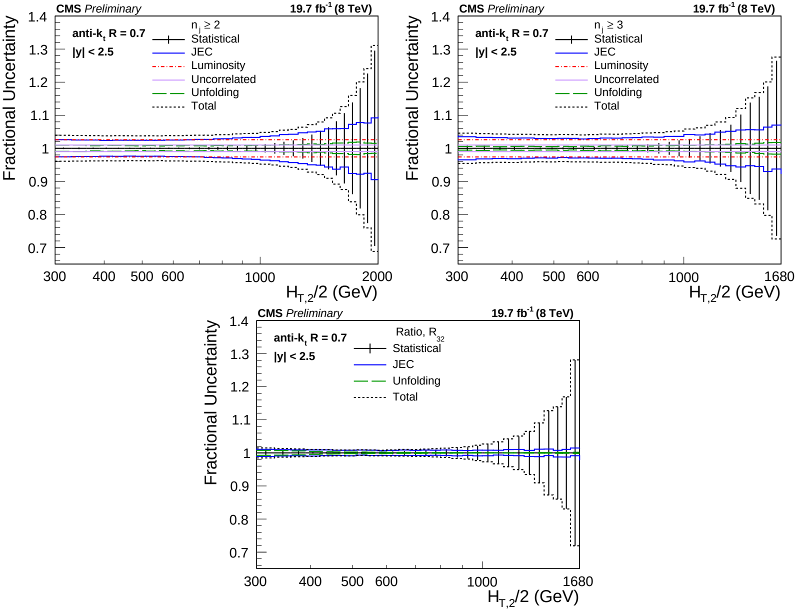


Dijets at $\sqrt{s} = 8$ TeV in CMS

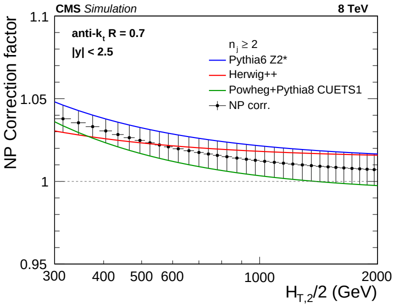
- dijet rapidity vs PDFs (LO)
  $x_{1,2} = \frac{p_T}{\sqrt{s}}(e^{\pm y_1} + e^{\pm y_2})$
- large y_b (boost) - momentum fractions are one large and one small value
- small y_b equal mom. fractions
- high dijet pT $\rightarrow$ probing x values beyond 0.1
- small y_b and large pT,avg mostly quark scattering
- large y_b > 80% of partonic subprocesses with at least one gluon

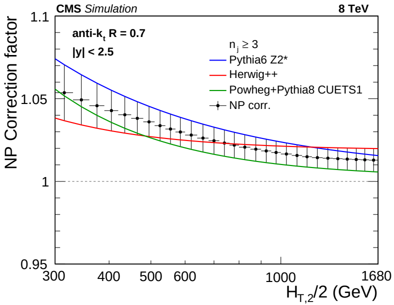


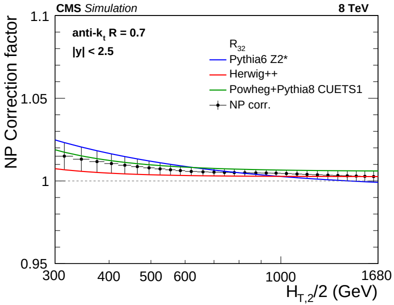
Inclusive multijets at $\sqrt{s} = 8$ TeV in CMS



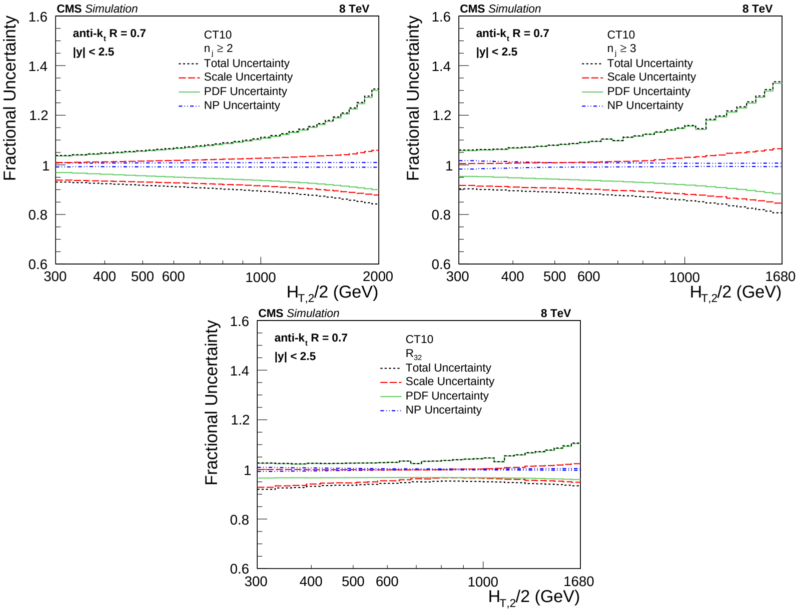
Inclusive multijets at $\sqrt{s} = 8$ TeV in CMS



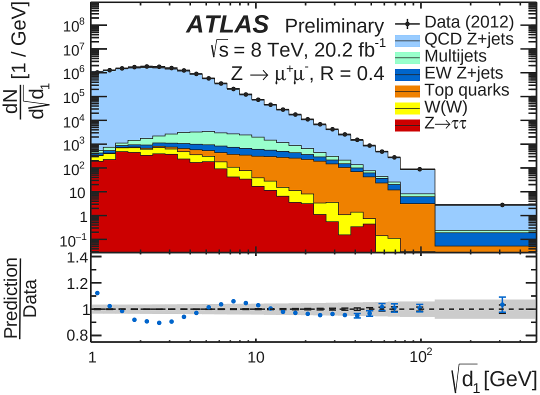


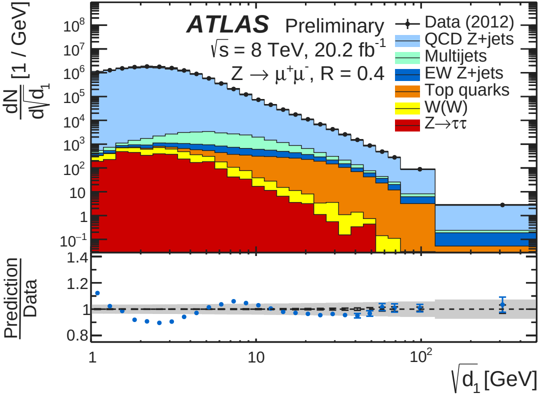


Inclusive multijets at $\sqrt{s} = 8$ TeV in CMS



kT splitting scales at $\sqrt{s} = 13$ TeV in ATLAS





kT splitting scales at $\sqrt{s} = 13$ TeV in ATLAS