Energy range for the RGE test and PDF sensitivity in α_s evaluations from jet cross section ratios at the LHC

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https://indico.cern.ch/event/555452/contributions/2495852/attachments/1436555/2222319/ScalesJetObservables_Malaescu.pdf

arXiv:2111.02319 T. Gehrmann and BM

alpha_S Workshop
03/02/2022

Content of the talk

→ Examples of $R_{3/2}$, $R_{\Delta\Phi}$, TEEC measurements

→ Scales for α_S evaluation & RGE test using jet cross-section ratio (and event-shape) observables

→ PDF sensitivity

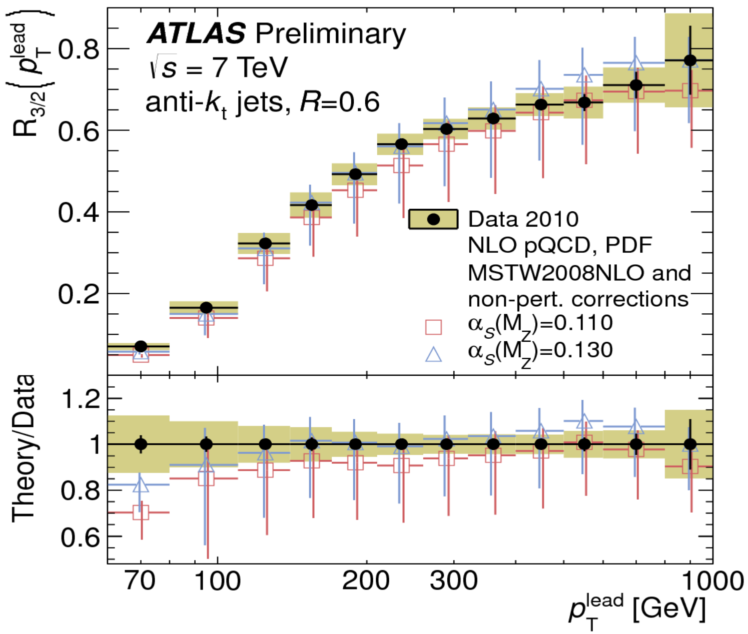
→ $p_T > 40$ GeV; $|y| < 2.8$; $p_T^{lead} > 60$ GeV (trigger ε & stability NLO pQCD)

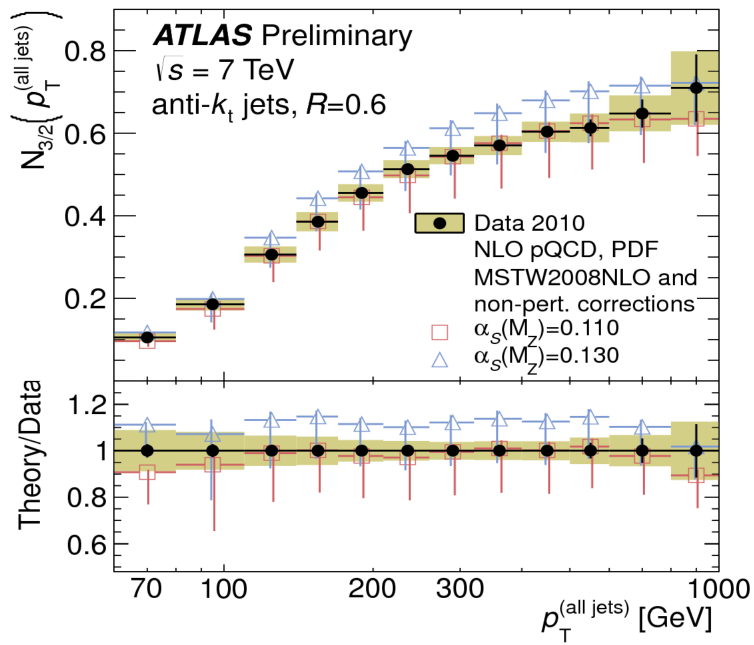
$$R_{3/2}(p_T^{lead}) = \frac{d\sigma_{N_{jet}\geq 3}/dp_T^{lead}}{d\sigma_{N_{jet}\geq 2}/dp_T^{lead}}$$

1 entry / event

$$N_{3/2}(p_T^{(all\,jets)}) = \frac{\sum_i^{N_{jet}} \left(d\sigma_{N_{jet}\geq 3}/dp_{T,i}\right)}{\sum_i^{N_{jet}} \left(d\sigma_{N_{jet}\geq 2}/dp_{T,i}\right)}$$

1 entry / jet





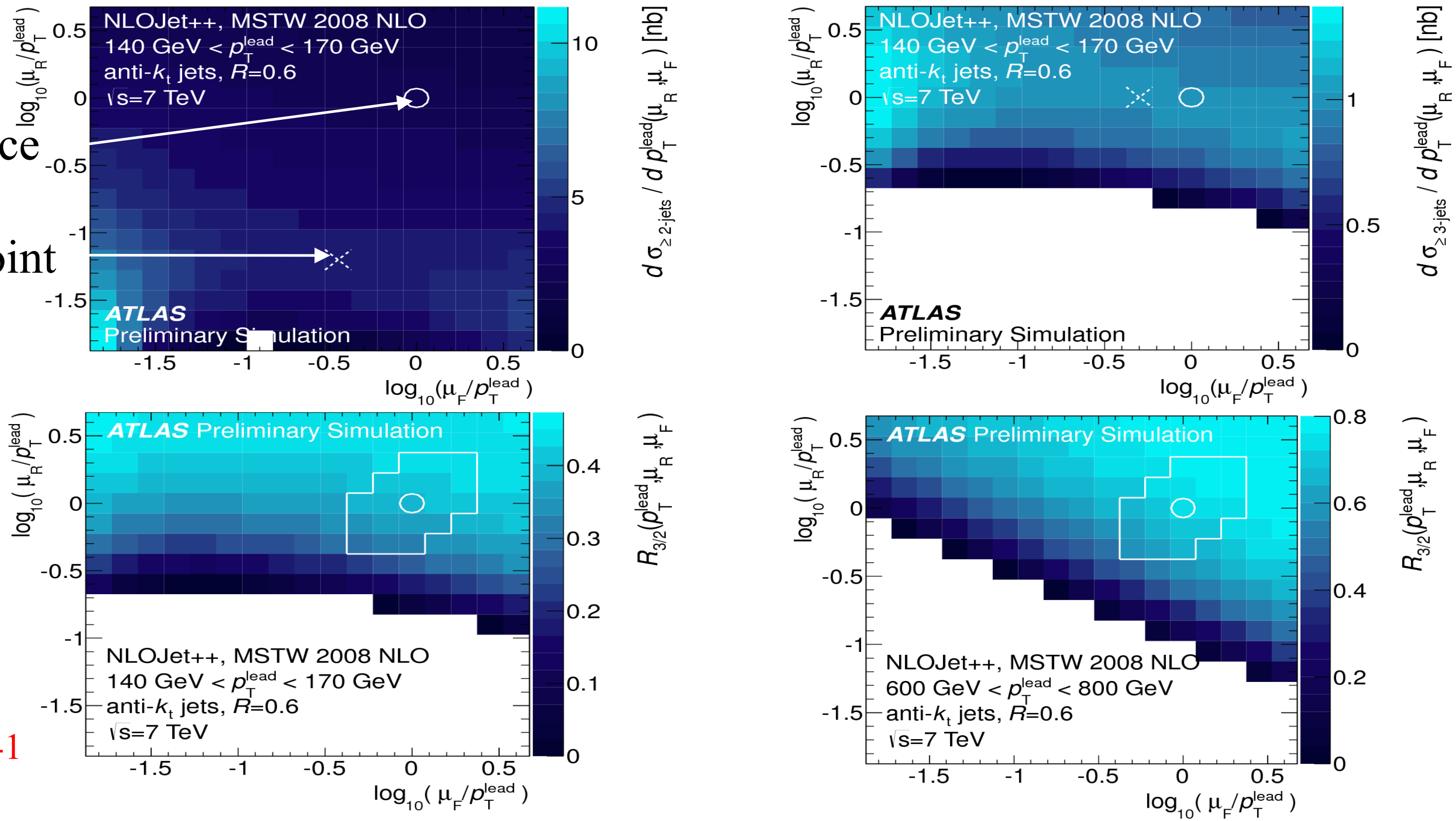
→ Unfolded Xsec ratios sensitive to α_S

ATLAS-CONF-2013-041

$R_{3/2}$ and $N_{3/2}$ – The scale sensitivity (1)

Nominal scale choice

Saddle point



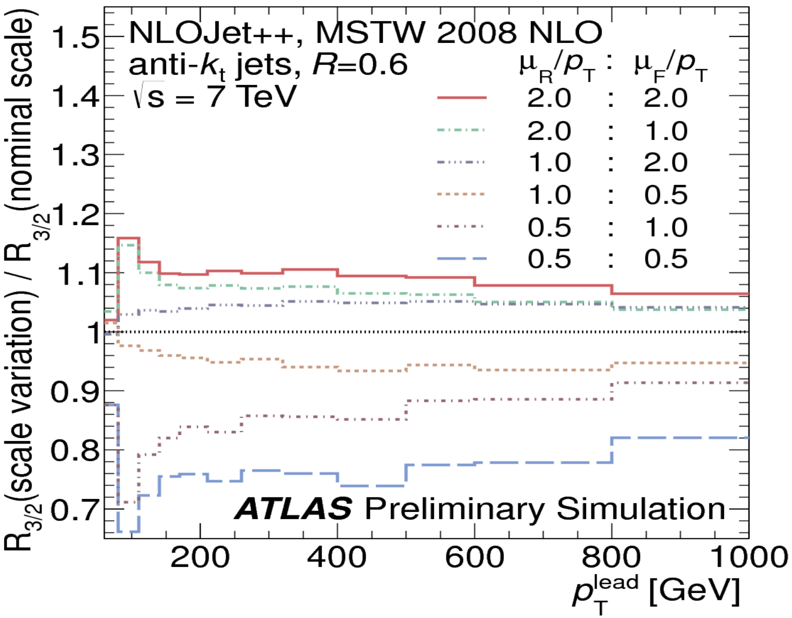
ATLAS-CONF-2013-041

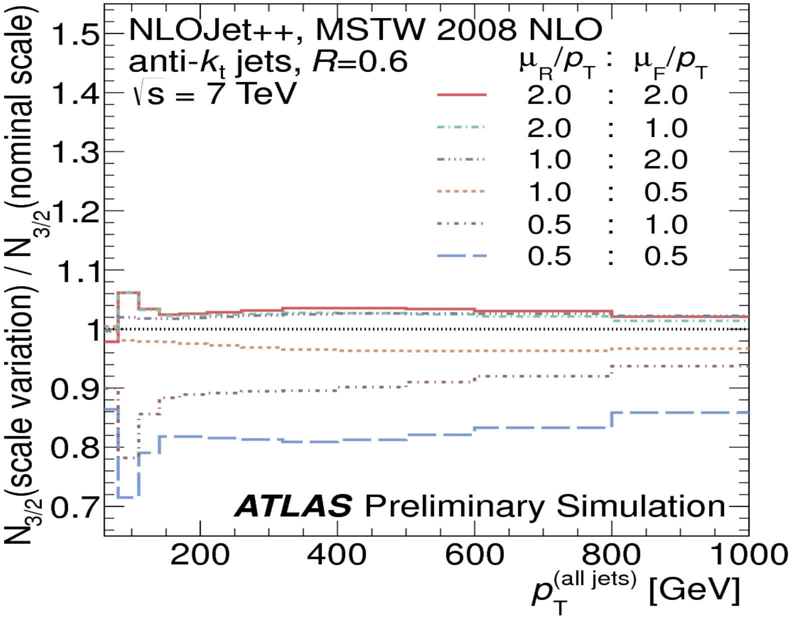
→ Performed detailed study of the scale dependence of NLO pQCD

→ Scale choice $\mu_R = \mu_F = p_T^{lead}$ ($p_T^{(all\ jets)}$) consistent for numerator and denominator of $R_{3/2}$ ($N_{3/2}$)

→ *Question of evaluation of scale (MHO) uncertainties for ratio observables relevant here*

$R_{3/2}$ and $N_{3/2}$ – The scale sensitivity (2)





ATLAS-CONF-2013-041

→ $N_{3/2}$ less sensitive to choice of scales & similar/better sensitivity to α_S:
Used to extract α_S, for $p_T^{(all\ jets)} > 210$ GeV

→ Predictions obtained with R=0.4 much more sensitive to scale choice: not used here

$N_{3/2}$ – the results for α_S

→ χ^2 fit in the range 210 GeV < $p_T^{(\text{all jets})}$ < 800 GeV used to extract α_S

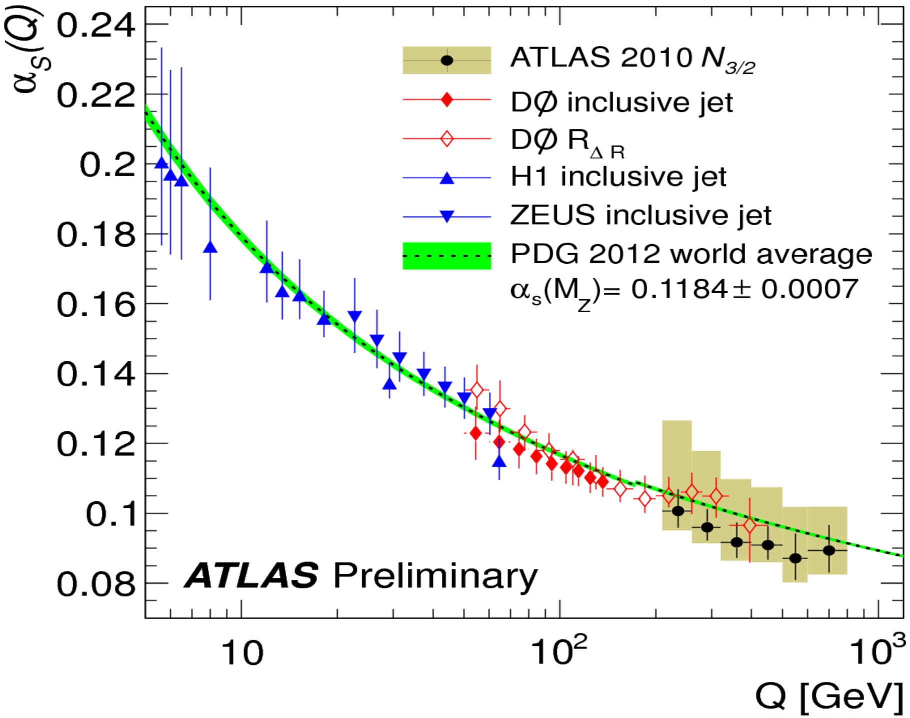
$\chi^2 \sim 7.1 / 5$ dof (test of RGE)

→ Takes into account experimental uncertainties and correlations

→ Theoretical uncertainties propagated through ± 1σ shifts

- *dominated by scale uncertainty*

PDF	$\alpha_s(M_Z)$
MSTW08	0.111 ± 0.006
CT10	0.109 ± 0.006
HERAPDF 1.5	0.114 ± 0.005
ABM11	0.116 ± 0.005
NNPDF 2.3	0.112 ± 0.005

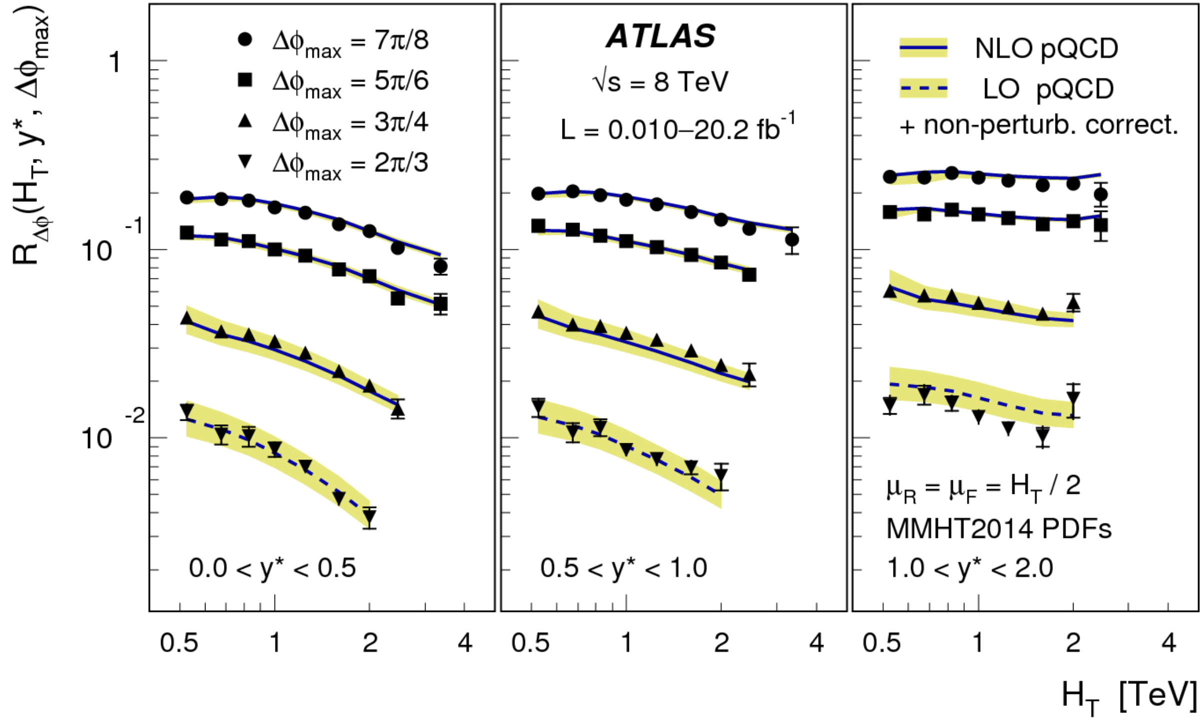


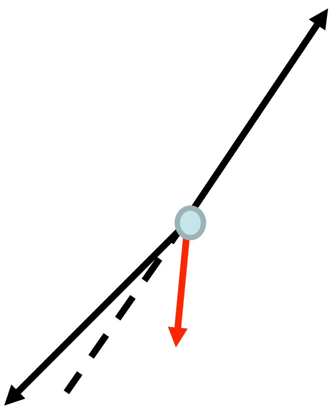
$$\alpha_s(M_Z) = 0.111 \pm 0.006(\text{exp.})\ ^{+0.016}_{-0.003}(\text{theory})$$

→ *PDF variations ~ Experimental uncertainty* arXiv:1805.04691

$$R_{\Delta\phi}(H_T, y^*, \Delta\phi_{max}) = \frac{\frac{d^2\sigma_{dijet}(\Delta\phi_{dijet}<\Delta\phi_{max})}{dH_T\,dy^*}}{\frac{d^2\sigma_{dijet}(\text{inclusive})}{dH_T\,dy^*}}$$

Variable	Value
$p_{T\min}$	100 GeV
y_{boost}^{max}	0.5
y^*_{max}	2.0
p_{T1}/H_T	$> 1/3$





→ $R_{\Delta\Phi}$ measured in H_T, y* and $\Delta\Phi_{max}$ bins

→ The observable is non-trivial (and hence sensitive to α_S) due to events that are not back-to-back dijets (i.e. with 3rd jet etc.)

$R_{\Delta\Phi}$

Q [GeV]	$\alpha_S(Q)$	Total uncert.	Stat.	Exp. correlated	Non-perturb. corrections	MMHT2014 uncertainty	PDF set	$\mu_{R,F}$ variation (*)
262.5	0.1029	$^{+6.0}_{-2.8}$	±1.6	$^{+1.6}_{-1.7}$	$^{+0.4}_{-0.4}$	$^{+0.4}_{-0.4}$	$^{+1.4}_{-0.9}$	$^{+5.3}_{-0.2}$
337.5	0.0970	$^{+8.0}_{-2.6}$	±1.8	$^{+1.5}_{-1.5}$	$^{+0.4}_{-0.4}$	$^{+0.3}_{-0.3}$	$^{+3.0}_{-0.5}$	$^{+7.0}_{-0.7}$
412.5	0.0936	$^{+4.0}_{-2.2}$	±0.9	$^{+1.3}_{-1.3}$	$^{+0.3}_{-0.3}$	$^{+0.3}_{-0.3}$	$^{+2.6}_{-1.4}$	$^{+2.5}_{-0.2}$
500.0	0.0901	$^{+3.7}_{-1.5}$	±0.6	$^{+1.2}_{-1.2}$	$^{+0.2}_{-0.2}$	$^{+0.3}_{-0.3}$	$^{+1.9}_{-0.3}$	$^{+2.9}_{-0.6}$
625.0	0.0890	$^{+3.9}_{-1.8}$	±0.5	$^{+1.1}_{-1.1}$	$^{+0.1}_{-0.1}$	$^{+0.3}_{-0.4}$	$^{+1.7}_{-0.3}$	$^{+3.3}_{-1.3}$
800.0	0.0850	$^{+5.9}_{-2.2}$	±0.6	$^{+1.0}_{-1.1}$	$^{+0.1}_{-0.1}$	$^{+0.4}_{-0.4}$	$^{+4.6}_{-0.2}$	$^{+3.5}_{-1.8}$
1000	0.0856	$^{+4.0}_{-2.7}$	±1.2	$^{+1.1}_{-1.1}$	$^{+0.1}_{-0.1}$	$^{+0.4}_{-0.4}$	$^{+1.4}_{-0.4}$	$^{+3.4}_{-2.0}$
1225	0.0790	$^{+4.6}_{-3.5}$	±2.5	$^{+1.2}_{-1.2}$	$^{+0.1}_{-0.1}$	$^{+0.5}_{-0.5}$	$^{+1.6}_{-0.4}$	$^{+3.2}_{-1.9}$
1675	0.0723	$^{+7.0}_{-8.6}$	±6.1	$^{+1.3}_{-1.2}$	$< \pm0.1$	$^{+0.5}_{-0.5}$	$^{+1.7}_{-5.1}$	$^{+2.8}_{-1.6}$

(*) All uncertainties have been multiplied by a factor of 10^3

arXiv:1805.04691

$\alpha_S(m_Z)$	Total uncert.	Statistical	Experimental correlated	Non-perturb. corrections	MMHT2014 uncertainty	PDF set	$\mu_{R,F}$ variation (*)
0.1127	$^{+6.3}_{-2.7}$	±0.5	$^{+1.8}_{-1.7}$	$^{+0.3}_{-0.1}$	$^{+0.6}_{-0.6}$	$^{+2.9}_{-0.0}$	$^{+5.2}_{-1.9}$

→ *Variation of PDF choice ~ Experimental uncertainty*

TEEC and ATEEC – Data / theory comparison @ 8 TeV

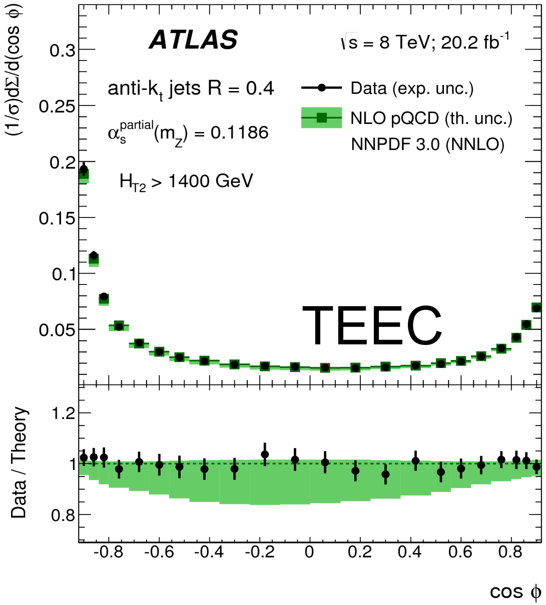
→ anti-k_t R=0.4; p_T > 100 GeV; |η| < 2.5; $N_{jets} \geq 2$; $p_{T1} + p_{T2}$ > 800 GeV

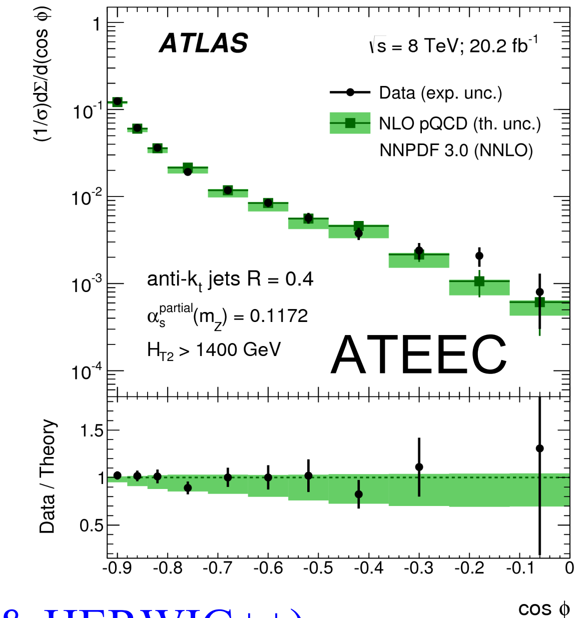
arXiv:1707.02562

$$\frac{1}{\sigma}\frac{d\Sigma}{d(\cos\phi)} = \frac{1}{\sigma}\sum_{ij}\int \frac{d\sigma}{dx_{Ti}dx_{Tj}d(\cos\phi)} x_{Ti}x_{Tj}dx_{Ti}dx_{Tj}$$

$$\frac{1}{\sigma}\frac{d\Sigma^{asym}}{d(\cos\phi)} \equiv \frac{1}{\sigma}\frac{d\Sigma}{d(\cos\phi)}\bigg|_{\phi} - \frac{1}{\sigma}\frac{d\Sigma}{d(\cos\phi)}\bigg|_{\pi-\phi}$$

→ Energy-weighted angular distributions: $w_{ij} = x_{Ti}x_{Tj} = \frac{E_{Ti}E_{Tj}}{(\sum_k E_{Tk})^2}$; in H_{T2} and cos Φ bins

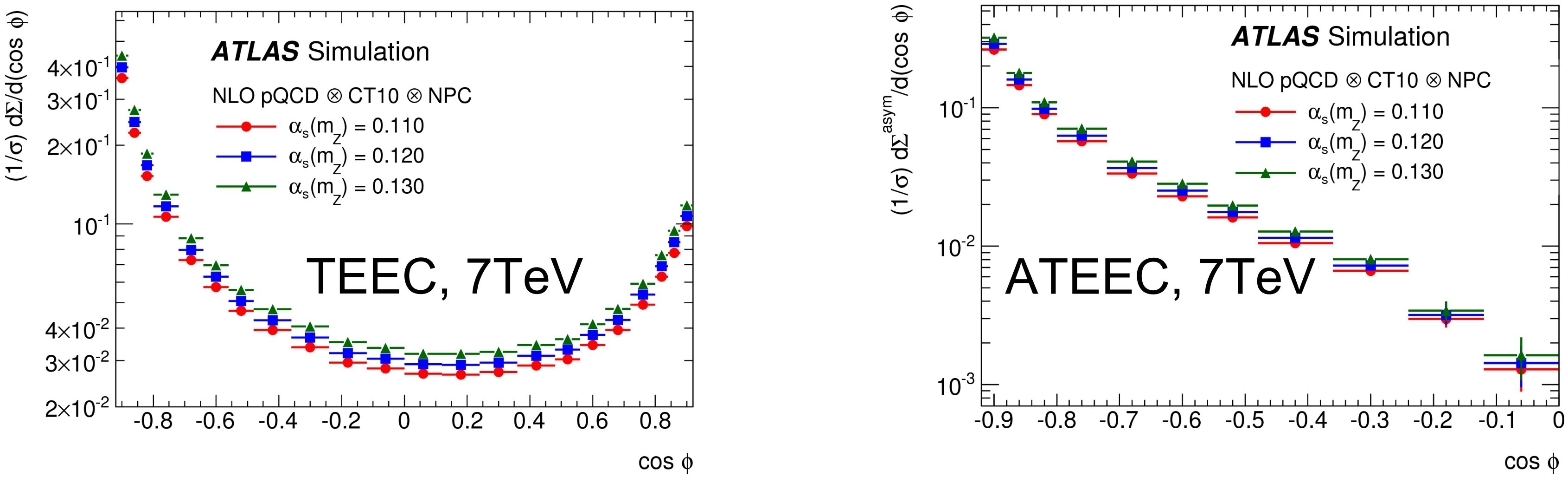




→ Theory prediction: NLOJet++ & NP corrections (PYTHIA8 & HERWIG++)

$$\frac{1}{\sigma}\frac{d\Sigma}{d\phi} = \frac{\sum_{a_i,b_i} f_{a_1/p}(x_1) f_{a_2/p}(x_2) \otimes \hat{\Sigma}^{a_1a_2\to b_1b_2b_3}}{\sum_{a_i,b_i} f_{a_1/p}(x_1) f_{a_2/p}(x_2) \otimes \hat{\sigma}^{a_1a_2\to b_1b_2}}$$

$$\mu_R = \frac{p_{T1}+p_{T2}}{2}; \quad \mu_F = \frac{p_{T1}+p_{T2}}{4}$$



$$\chi^2(\alpha_s, \vec{\lambda}) = \sum_i \frac{(x_i - F_i(\alpha_s, \vec{\lambda}))^2}{\Delta x_i^2 + \Delta \tau_i^2} + \sum_k \lambda_k^2, \qquad F_i(\alpha_s, \vec{\lambda}) = \psi_i(\alpha_s)\left(1 + \sum_k \lambda_k \sigma_k^{(i)}\right)$$

→ α_S evaluated through χ^2 fit taking into account experimental uncertainties and correlations: good fit quality – test RGE

→ Theory uncertainties (scales, PDFs, NP corrections) propagated through ± 1σ shifts

TEEC – α_S scale dependence / choice

$\langle Q \rangle$ (GeV)	TEEC $\alpha_s(Q^2)$ value (NNPDF 3.0)
412	0.0966 ± 0.0014 (exp.) $^{+0.0054}_{-0.0015}$ (scale) ± 0.0009 (PDF) ± 0.0001 (NP)
437	0.0964 ± 0.0012 (exp.) $^{+0.0048}_{-0.0011}$ (scale) ± 0.0009 (PDF) ± 0.0002 (NP)
472	0.0955 ± 0.0011 (exp.) $^{+0.0051}_{-0.0015}$ (scale) ± 0.0009 (PDF) ± 0.0001 (NP)
522	0.0936 ± 0.0011 (exp.) $^{+0.0043}_{-0.0010}$ (scale) ± 0.0010 (PDF) ± 0.0001 (NP)
604	0.0933 ± 0.0011 (exp.) $^{+0.0050}_{-0.0014}$ (scale) ± 0.0011 (PDF) ± 0.0003 (NP)
810	0.0907 ± 0.0013 (exp.) $^{+0.0049}_{-0.0020}$ (scale) ± 0.0011 (PDF) ± 0.0002 (NP)

$\langle p_{T3} \rangle$ (GeV)	$\alpha_s(\langle p_{T3} \rangle)$ value (TEEC, NNPDF 3.0)
169	0.1072 ± 0.0017 (exp.) $^{+0.0067}_{-0.0019}$ (scale) ± 0.0011 (PDF) ± 0.0001 (NP)
174	0.1074 ± 0.0014 (exp.) $^{+0.0060}_{-0.0014}$ (scale) ± 0.0012 (PDF) ± 0.0002 (NP)
179	0.1068 ± 0.0014 (exp.) $^{+0.0064}_{-0.0019}$ (scale) ± 0.0012 (PDF) ± 0.0001 (NP)
186	0.1052 ± 0.0014 (exp.) $^{+0.0054}_{-0.0013}$ (scale) ± 0.0013 (PDF) ± 0.0001 (NP)
197	0.1060 ± 0.0014 (exp.) $^{+0.0065}_{-0.0018}$ (scale) ± 0.0014 (PDF) ± 0.0004 (NP)
215	0.1052 ± 0.0018 (exp.) $^{+0.0066}_{-0.0027}$ (scale) ± 0.0015 (PDF) ± 0.0003 (NP)

→ *For observables like $R_{3/2}$, $N_{3/2}$, $R_{\Delta\Phi}$ and (A)TEEC, sensitivity to α_S originates from probability of emission of extra radiation (3^{rd} jet etc.)*

→ Effect acknowledged by evolving α_S to $\langle p_{T3} \rangle$ (significantly lower than $\langle H_{T2} \rangle$)

ATEEC – α_S scale dependence / choice

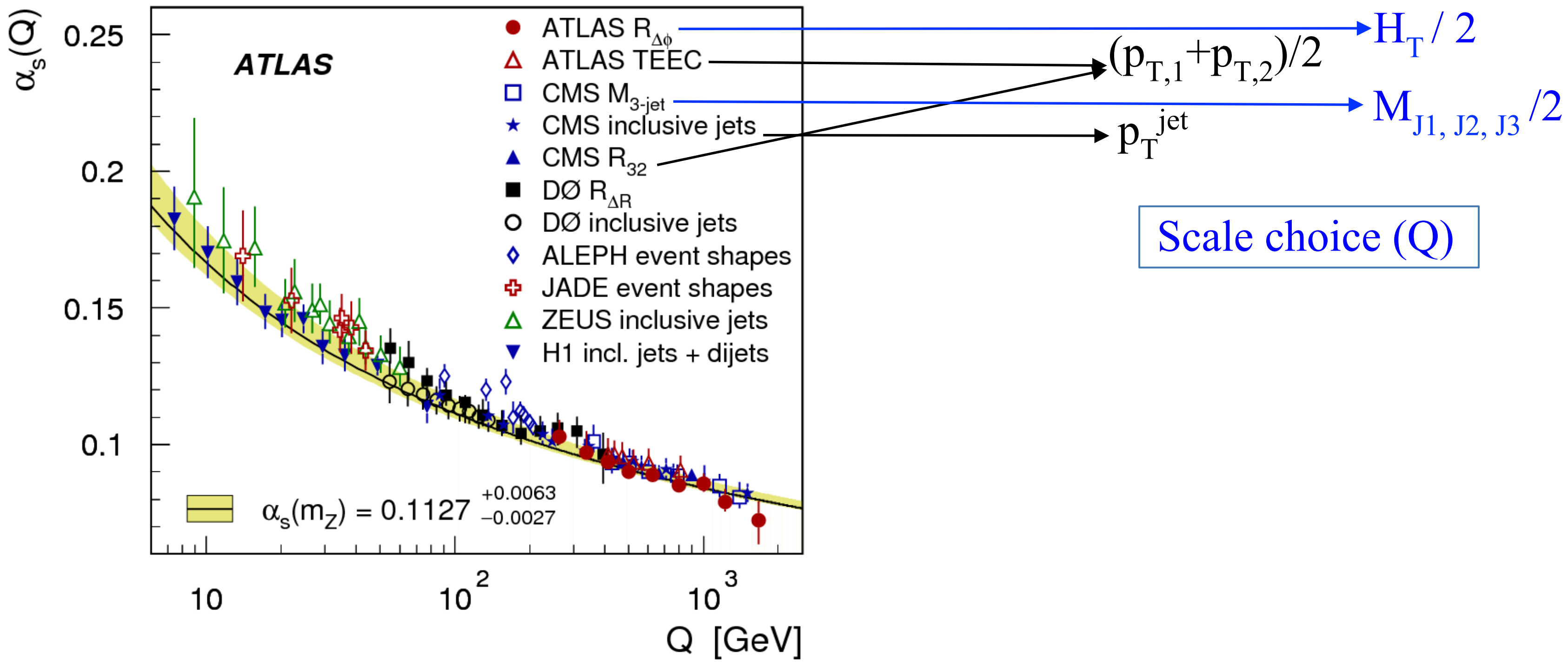
$\langle Q \rangle$ (GeV)	ATEEC $\alpha_s(Q^2)$ value (NNPDF 3.0)
412	0.0992 ± 0.0024 (exp.) $^{+0.0056}_{-0.0020}$ (scale) ± 0.0009 (PDF) ± 0.0002 (NP)
437	0.0986 ± 0.0017 (exp.) $^{+0.0041}_{-0.0009}$ (scale) ± 0.0010 (PDF) ± 0.0007 (NP)
472	0.0973 ± 0.0018 (exp.) $^{+0.0038}_{-0.0008}$ (scale) ± 0.0010 (PDF) ± 0.0001 (NP)
522	0.0957 ± 0.0016 (exp.) $^{+0.0034}_{-0.0006}$ (scale) ± 0.0011 (PDF) ± 0.0003 (NP)
604	0.0930 ± 0.0019 (exp.) $^{+0.0035}_{-0.0005}$ (scale) ± 0.0012 (PDF) ± 0.0003 (NP)
810	0.0899 ± 0.0021 (exp.) $^{+0.0031}_{-0.0005}$ (scale) ± 0.0013 (PDF) ± 0.0001 (NP)

$\langle p_{T3} \rangle$ (GeV)	$\alpha_s(\langle p_{T3} \rangle)$ value (ATEEC, NNPDF 3.0)
169	0.1104 ± 0.0030 (exp.) $^{+0.0070}_{-0.0025}$ (scale) ± 0.0011 (PDF) ± 0.0003 (NP)
174	0.1101 ± 0.0022 (exp.) $^{+0.0052}_{-0.0011}$ (scale) ± 0.0012 (PDF) ± 0.0008 (NP)
179	0.1090 ± 0.0023 (exp.) $^{+0.0049}_{-0.0011}$ (scale) ± 0.0013 (PDF) ± 0.0002 (NP)
186	0.1079 ± 0.0021 (exp.) $^{+0.0044}_{-0.0008}$ (scale) ± 0.0014 (PDF) ± 0.0003 (NP)
197	0.1056 ± 0.0025 (exp.) $^{+0.0046}_{-0.0006}$ (scale) ± 0.0016 (PDF) ± 0.0004 (NP)
215	0.1041 ± 0.0029 (exp.) $^{+0.0042}_{-0.0007}$ (scale) ± 0.0017 (PDF) ± 0.0001 (NP)

→ *For observables like $R_{3/2}$, $N_{3/2}$, $R_{\Delta\Phi}$ and (A)TEEC, sensitivity to α_S originates from probability of emission of extra radiation (3^{rd} jet etc.)*

→ Effect acknowledged by evolving α_S to $\langle p_{T3} \rangle$ (significantly lower than $\langle H_{T2} \rangle$)

Thoughts on RGE tests through jet measurements



→ *Can one really claim tests of RGE at scales from event-level observables ???*

e.g. $p_T^{\text{lead. jet}}(R_{3/2})$, $p_T^{\text{(all jets)}}(N_{3/2})$, $(p_{T,1}+p_{T,2})/2$, $H_T/2$, $M_{J1,J2,J3}/2$ (large even for low $p_{T,1\text{-}3}$)

→ *"Traditional criteria" of minimizing uncertainties/k-factors is not relevant here*

→ *Relevant scale for RGE test using $R_{3/2}$, $N_{3/2}$, $R_{\Delta\Phi}$ and (A)TEEC related to $p_{T,3}$ (low)*

Need consistency between scale for theory calculation and RGE test claim; MiNLO procedure may provide a way forward.

TEEC and ATEEC – α_s results @ 8 TeV

arXiv:1707.02562 - ATLAS

TEEC

PDF	$\alpha_s(m_Z)$ value	χ^2/N_{dof}
MMHT 2014	$0.1151 \pm 0.0008\ \text{(exp.)}\ ^{+0.0064}_{-0.0047}\ \text{(scale)} \pm 0.0012\ \text{(PDF)} \pm 0.0002\ \text{(NP)}$	173 / 131
CT14	$0.1165 \pm 0.0010\ \text{(exp.)}\ ^{+0.0067}_{-0.0061}\ \text{(scale)} \pm 0.0016\ \text{(PDF)} \pm 0.0003\ \text{(NP)}$	161 / 131
NNPDF 3.0	$0.1162 \pm 0.0011\ \text{(exp.)}\ ^{+0.0076}_{-0.0061}\ \text{(scale)} \pm 0.0018\ \text{(PDF)} \pm 0.0003\ \text{(NP)}$	174 / 131
HERAPDF 2.0	$0.1177 \pm 0.0008\ \text{(exp.)}\ ^{+0.0064}_{-0.0040}\ \text{(scale)} \pm 0.0005\ \text{(PDF)} \pm 0.0002\ \text{(NP)}\ ^{+0.0008}_{-0.0007}\ \text{(mod)}$	169 / 131

ATEEC

PDF	$\alpha_s(m_Z)$ value	χ^2/N_{dof}
MMHT 2014	$0.1185 \pm 0.0012\ \text{(exp.)}\ ^{+0.0047}_{-0.0010}\ \text{(scale)} \pm 0.0010\ \text{(PDF)} \pm 0.0004\ \text{(NP)}$	57.0 / 65
CT14	$0.1203 \pm 0.0013\ \text{(exp.)}\ ^{+0.0053}_{-0.0014}\ \text{(scale)} \pm 0.0015\ \text{(PDF)} \pm 0.0004\ \text{(NP)}$	55.4 / 65
NNPDF 3.0	$0.1196 \pm 0.0013\ \text{(exp.)}\ ^{+0.0061}_{-0.0013}\ \text{(scale)} \pm 0.0017\ \text{(PDF)} \pm 0.0004\ \text{(NP)}$	60.3 / 65
HERAPDF 2.0	$0.1206 \pm 0.0012\ \text{(exp.)}\ ^{+0.0050}_{-0.0014}\ \text{(scale)} \pm 0.0005\ \text{(PDF)} \pm 0.0002\ \text{(NP)} \pm 0.0007\ \text{(mod)}$	54.2 / 65

→ PDF variations similar to / larger than the most conservative PDF uncertainty (NNPDF replicas)

→ *Scale and PDF uncertainties > Experimental uncertainty*
(similar conclusions for (A)TEEC @ 7TeV – see backup)

Similar PDF sensitivity for α_s results @ CMS

→ R3/2 @ 7 TeV

arXiv:1304.7498

NNPDF 2.1: $\alpha_S(M_Z) = 0.1148 \pm 0.0014\,(\text{exp.}) \pm 0.0018\,(\text{PDF}) \pm 0.0050\,(\text{theory})$

MSTW2008: $\alpha_S(M_Z) = 0.1141 \pm 0.0022\,(\text{exp.})$

CT10: $\alpha_S(M_Z) = 0.1135 \pm 0.0019\,(\text{exp.})$

→ R3/2 @ 8 TeV

CMS-PAS-SMP-16-008

PDF set	2- & 3-jets			R_{32}		
	$\alpha_s(M_Z)$	$\pm\Delta\alpha_s(M_Z)^{(*)}$	χ^2/n_{dof}	$\alpha_s(M_Z)$	$\pm\Delta\alpha_s(M_Z)^{(*)}$	χ^2/n_{dof}
CT10	0.1170	0.0026	8.2/37	0.1141	0.0028	19./18
CT14	0.1161	0.0029	9.1/37	0.1139	0.0032	15./18
MSTW2008	0.1161	0.0021	11./37	0.1150	0.0023	21./18
MMHT2014	0.1168	0.0025	11./37	0.1142	0.0022	19./18
NNPDF2.3	0.1188	0.0019	15./37	0.1184	0.0021	12./18

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

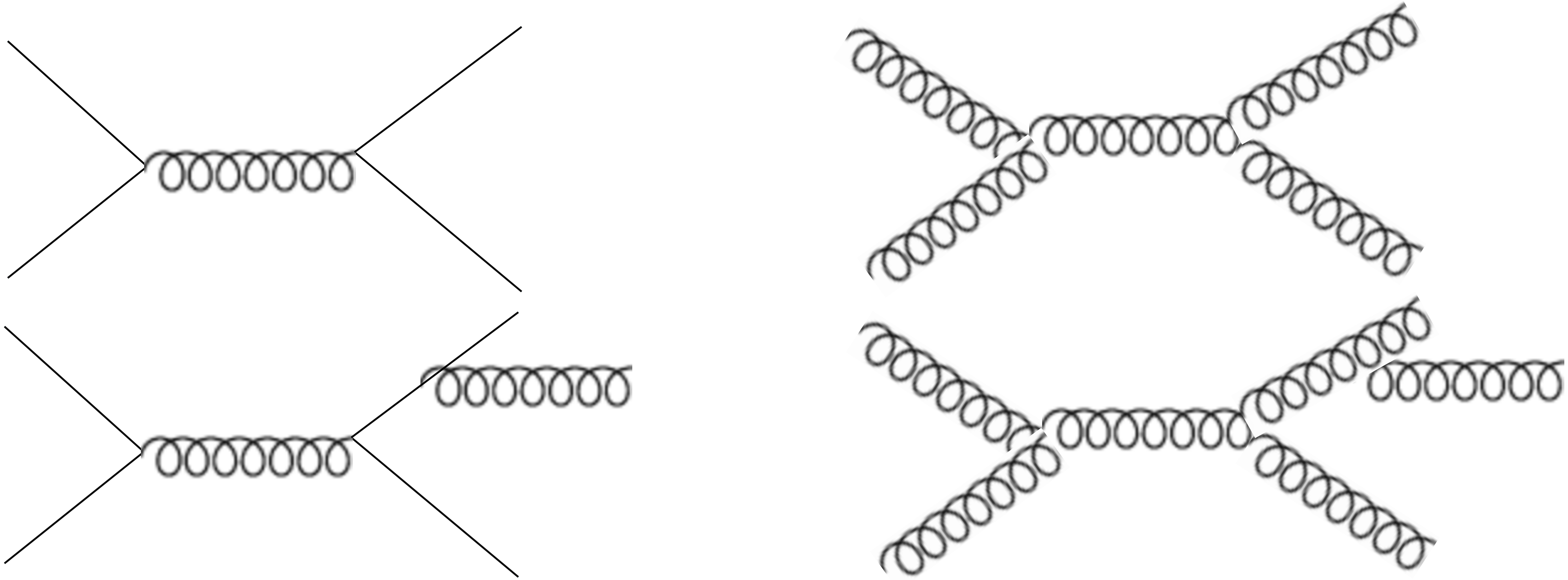
(*) Only total uncertainties without scale variations

→ 3-jet mass @ 7 TeV

arXiv:1412.1633

PDF set	χ^2/n_{dof}	$\alpha_S(M_Z)$	$\pm$(exp)	$\pm$(PDF)	$\pm$(NP)	$\pm$(scale)
CT10-NLO	47.2/45	0.1171	± 0.0013	± 0.0024	± 0.0008	$^{+0.0069}_{-0.0040}$
CT10-NNLO	48.5/45	0.1165	$^{+0.0011}_{-0.0010}$	$^{+0.0022}_{-0.0023}$	$^{+0.0006}_{-0.0008}$	$^{+0.0066}_{-0.0034}$
MSTW2008-NLO	52.8/45	0.1155	$^{+0.0014}_{-0.0013}$	$^{+0.0014}_{-0.0015}$	$^{+0.0008}_{-0.0009}$	$^{+0.0105}_{-0.0029}$
MSTW2008-NNLO	53.9/45	0.1183	$^{+0.0011}_{-0.0016}$	$^{+0.0012}_{-0.0023}$	$^{+0.0011}_{-0.0019}$	$^{+0.0052}_{-0.0050}$
HERAPDF1.5-NNLO	49.9/45	0.1143	± 0.0007	$^{+0.0020}_{-0.0035}$	$^{+0.0003}_{-0.0008}$	$^{+0.0035}_{-0.0027}$
NNPDF2.1-NNLO	51.1/45	0.1164	± 0.0010	$^{+0.0020}_{-0.0019}$	$^{+0.0010}_{-0.0009}$	$^{+0.0058}_{-0.0025}$

Thoughts on PDF sensitivity in α_s evaluations from jet Xsec ratios



→ *PDF uncertainties non-negligible* (typically between total experimental and NLO scale uncertainty) *for cross-section ratio measurements & (A)TEEC:*

- probability of extra radiation (which makes these observables non-trivial) sensitive to the type of partons in the initial state
- both α_s & PDF sensitivities of the observables are reduced when taking ratios and they are both relevant for the α_s evaluation

Backup

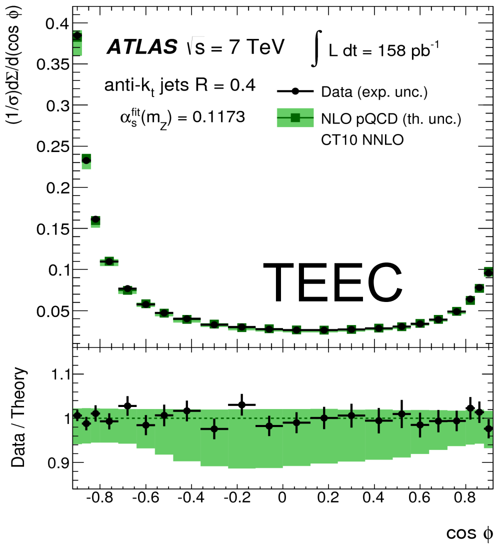
TEEC and ATEEC – Data / theory comparison @ 7 TeV

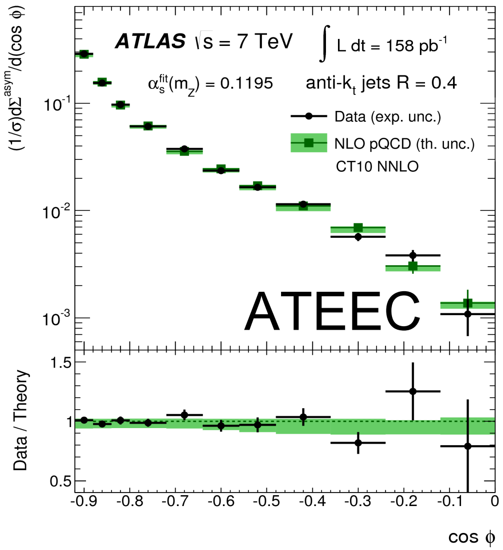
→ anti-k_t R=0.4; p_T > 50 GeV; $|\eta| < 2.5$; $N_{jets} \geq 2$; $p_{T1} + p_{T2}$> 500 GeV

$$\frac{1}{\sigma}\frac{d\Sigma}{d(\cos\phi)} = \frac{1}{\sigma}\sum_{ij}\int\frac{d\sigma}{dx_{Ti}dx_{Tj}d(\cos\phi)}x_{Ti}x_{Tj}dx_{Ti}dx_{Tj}$$

$$\frac{1}{\sigma}\frac{d\Sigma^{asym}}{d(\cos\phi)} \equiv \frac{1}{\sigma}\frac{d\Sigma}{d(\cos\phi)}\bigg|_{\phi} - \frac{1}{\sigma}\frac{d\Sigma}{d(\cos\phi)}\bigg|_{\pi-\phi}$$

→ Energy-weighted angular distributions: $w_{ij} = x_{Ti}x_{Tj} = \frac{E_{Ti}E_{Tj}}{(\sum_k E_{Tk})^2}$





→ Theory prediction: NLOJet++ & NP corrections (PYTHIA6 & HERWIG++)

$$\frac{1}{\sigma}\frac{d\Sigma}{d(\cos\phi)} = \frac{\Sigma_{a_i,b_i} f_{a_1}(x_1) f_{a_2}(x_2) \otimes \hat{\Sigma}^{a_1 a_2 \to b_1 b_2 b_3}}{\Sigma_{a_i,b_i} f_{a_1}(x_1) f_{a_2}(x_2) \otimes \hat{\sigma}^{a_1 a_2 \to b_1 b_2}};\quad \mu_R = \mu_F = \frac{p_{T1} + p_{T2}}{2};$$ (250-1300 GeV)

TEEC and ATEEC – α_s results @ 7 TeV

TEEC

PDF	$\alpha_s(m_Z)$ value	χ^2/N_{dof}
MSTW 2008	0.1175 ± 0.0010 (exp.) $^{+0.0059}_{-0.0010}$ (scale) ± 0.0006 (PDF) ± 0.0002 (NPC)	29.0 / 21
CT10	0.1173 ± 0.0010 (exp.) $^{+0.0063}_{-0.0020}$ (scale) ± 0.0017 (PDF) ± 0.0002 (NPC)	28.4 / 21
NNPDF 2.3	0.1183 ± 0.0010 (exp.) $^{+0.0059}_{-0.0013}$ (scale) ± 0.0009 (PDF) ± 0.0002 (NPC)	29.3 / 21
HERAPDF 1.5	0.1167 ± 0.0007 (exp.) $^{+0.0040}_{-0.0008}$ (scale) $^{+0.0007}_{-0.0024}$ (PDF) ± 0.0001 (NPC)	28.7 / 21

ATEEC

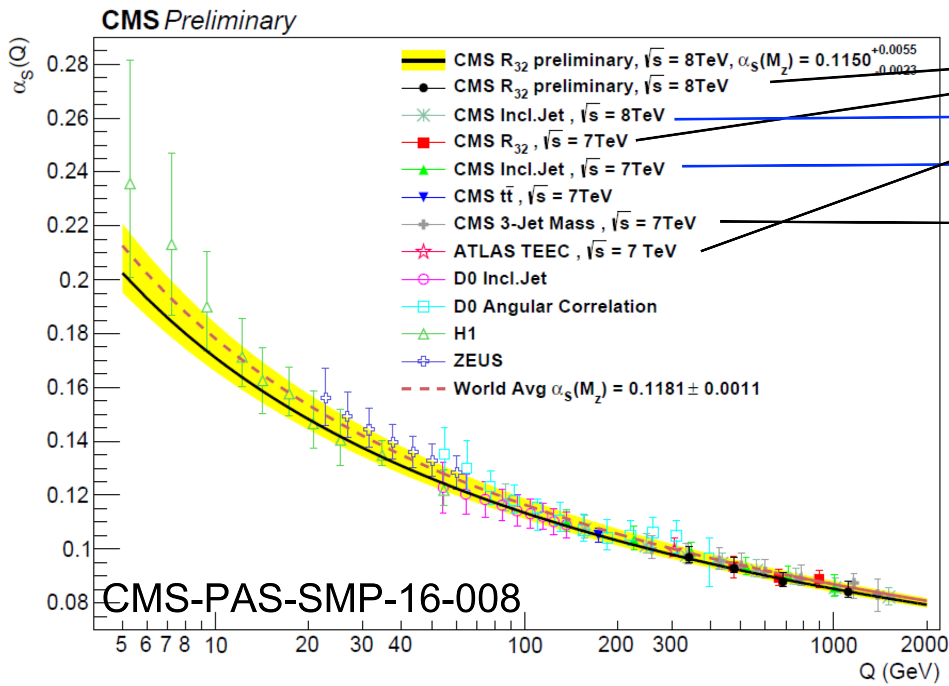
PDF	$\alpha_s(m_Z)$ value	χ^2/N_{dof}
MSTW 2008	0.1195 ± 0.0017 (exp.) $^{+0.0055}_{-0.0015}$ (scale) ± 0.0006 (PDF)	12.7 / 10
CT10	0.1195 ± 0.0018 (exp.) $^{+0.0060}_{-0.0015}$ (scale) ± 0.0016 (PDF)	12.6 / 10
NNPDF 2.3	0.1206 ± 0.0018 (exp.) $^{+0.0057}_{-0.0013}$ (scale) ± 0.0009 (PDF)	12.2 / 10
HERAPDF 1.5	0.1182 ± 0.0013 (exp.) $^{+0.0041}_{-0.0008}$ (scale) $^{+0.0007}_{-0.0025}$ (PDF)	12.1 / 10

→ Nominal result (TEEC; CT10) :

- good experimental precision
- PDF uncertainty (eigenvectors) covering PDF variations

→ *Scale and PDF uncertainties > Experimental uncertainty*

Thoughts on α_S results from jet measurements



$(p_{T,1}+p_{T,2})/2$

p_T^{jet}(not $p_T^{lead.\ Jet}$, as stated in paper)

p_T^{jet}

$M_{J1,\ J2,\ J3}/2$

Scale choice (Q)

→ *Can one really claim tests of RGE at scales from event-level observables ???*

e.g. $p_T^{lead.\ jet}(R_{3/2})$, $p_T^{(all\ jets)}(N_{3/2})$, $(p_{T,1}+p_{T,2})/2$, $H_T/2$, $M_{J1,J2,J3}/2$ (large even for low $p_{T,1-3}$)

→ *"Traditional criteria" of minimizing uncertainties/k-factors is not relevant here*

→ *Relevant scale for RGE test using $R_{3/2}$, $N_{3/2}$ and (A)TEEC related to $p_{T,3}$ (low)*

Need consistency between scale for theory calculation and RGE test claim