Determination of $\alpha_s(Q^2)$ from Transverse Energy-Energy Correlations in multijet events at $\sqrt{s} = 8$ TeV

Javier Llorente

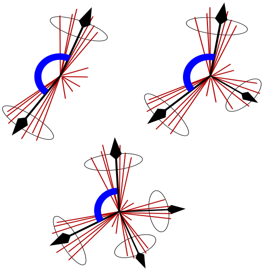
IHEP Beijing

PANIC 2017

Transverse energy-energy correlations

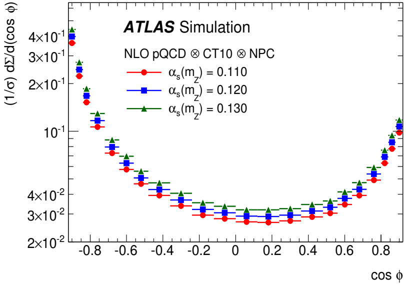
TEEC: The x_{T}-weighted distribution of differences in azimuth between jets i and j, with $x_{\mathrm{T}i} = \frac{E_{\mathrm{T}i}}{\sum_k E_{\mathrm{T}k}}$

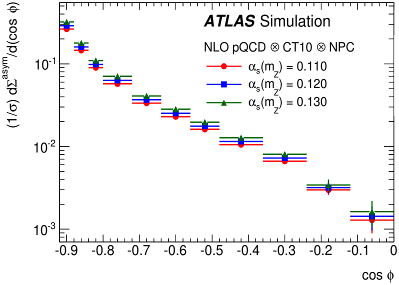
$$\frac{1}{\sigma}\frac{d\Sigma}{d(\cos\phi)} = \frac{1}{\sigma}\sum_{ij}\int \frac{d\sigma}{dx_{\mathrm{T}i}dx_{\mathrm{T}j}d(\cos\phi)} x_{\mathrm{T}i}x_{\mathrm{T}j}dx_{\mathrm{T}i}dx_{\mathrm{T}j}$$



And the azimuthal asymmetry ATEEC is defined as

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

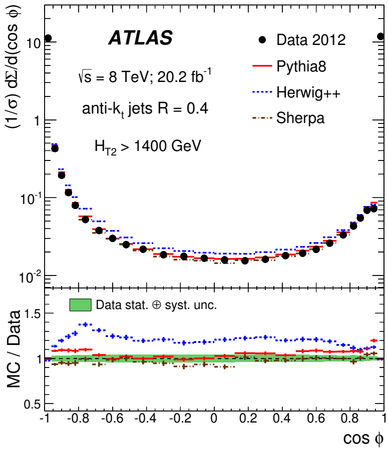


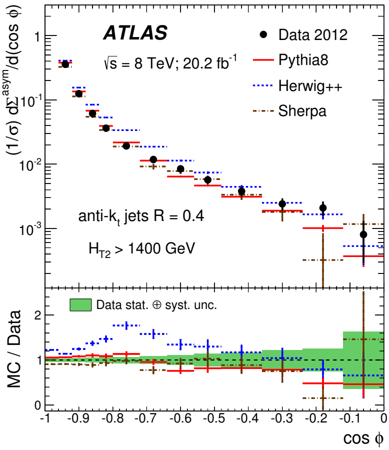


[A. Ali, F. Barreiro, J. Llorente, W. Wang. Phys. Rev. **D86**, 114017 (2012)]

Unfolded results: $H_{T2} > 1400$ GeV

The plots below show the unfolded TEEC and ATEEC functions along with MC expectations for $H_{T2} > 1400$ GeV.

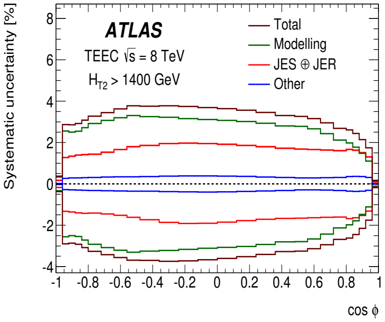


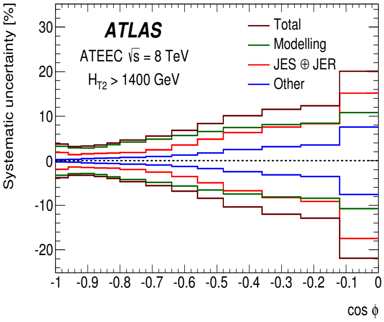


The error bars include both statistical and systematic uncertainties.

Total systematic uncertainty (TEEC)

The uncertainties discussed are added in quadratures to obtain the total systematic

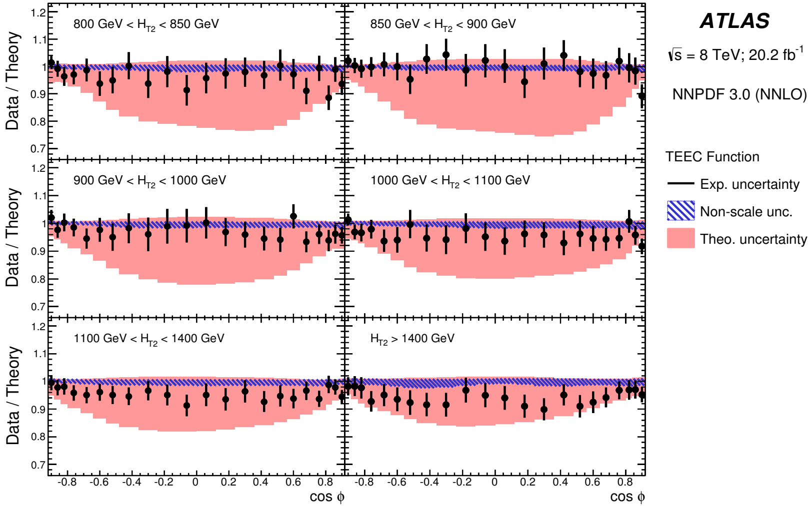




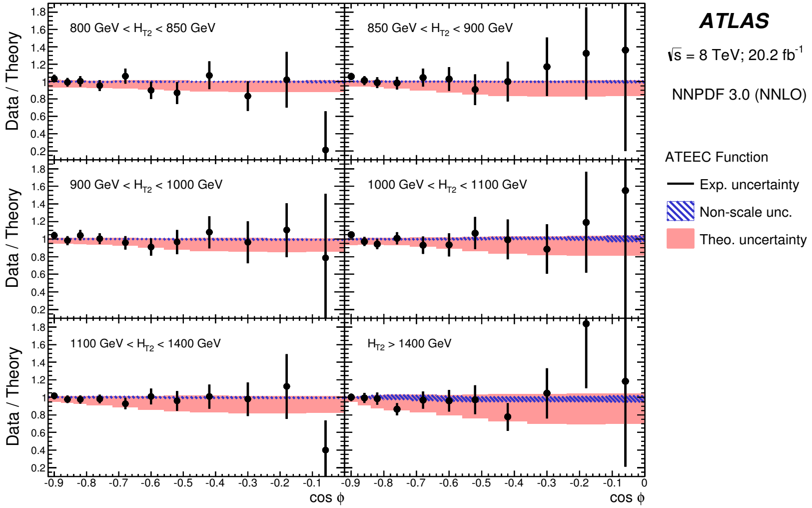
- Systematics due to jet energy measurements are highly suppressed
- Dominant source is from parton shower modelling.

Comparison with data (TEEC)

Ratios of the measured TEEC functions with the theoretical predictions obtained using NNPDF 3.0



Ratios of the measured ATEEC functions with the theoretical predictions obtained using NNPDF 3.0



Determination of $\alpha_s(m_Z)$: χ^2 definition

The determination of the strong coupling $\alpha_s(m_Z)$ relies on the minimization of a χ^2 function.

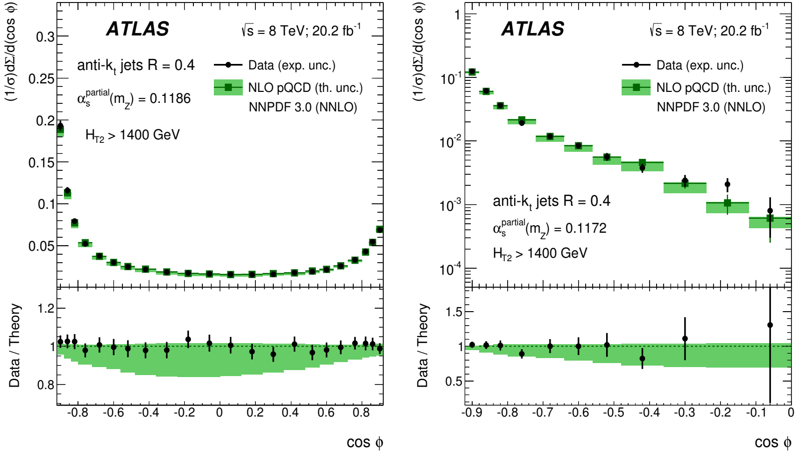
$$\chi^2(\alpha_s; \vec{\lambda}) = \sum_k \frac{(x_k - F_k(\alpha_s; \vec{\lambda}))^2}{\Delta x_k^2 + \Delta \tau_k^2} + \sum_i \lambda_i^2$$

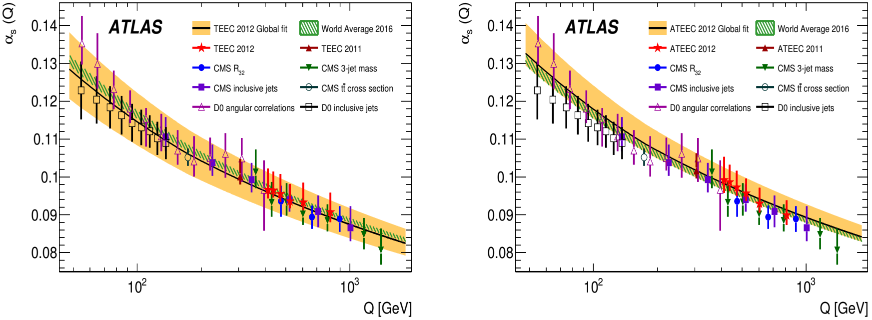
$$F_k(\alpha_s; \vec{\lambda}) = \phi_k(\alpha_s) \left(1 + \sum_i \lambda_i \sigma_{ik} \right)$$

- This method requires an analytical expression for the dependence of the observable on the parameter, given by $\phi_k(\alpha_s)$.
- The correlations between sources of systematic uncertainty are accounted for using the nuisance parameters $\{\lambda_i\}$.
- Statistical uncertainty on the theoretical predictions also taken into account in $\Delta\tau_k$.

Results of the partial fits

Data / Theory comparison for TEEC and ATEEC after the partial fits





PDF	$\alpha_s(m_Z)$ value (TEEC fit)	χ^2/N_{dof}
MMHT 2014	0.1151 ± 0.0008 (exp.) $^{+0.0064}_{-0.0047}$ (scale) ± 0.0012 (PDF) ± 0.0002 (NP)	172.8 / 131
CT14	0.1165 ± 0.0010 (exp.) $^{+0.0067}_{-0.0061}$ (scale) ± 0.0016 (PDF) ± 0.0003 (NP)	161.1 / 131
NNPDF 3.0	0.1162 ± 0.0008 (exp.) $^{+0.0076}_{-0.0061}$ (scale) ± 0.0018 (PDF) ± 0.0003 (NP)	173.5 / 131
HERAPDF 2.0	0.1177 ± 0.0008 (exp.) $^{+0.0064}_{-0.0040}$ (scale) ± 0.0009 (PDF) ± 0.0002 (NP)	169.2 / 131

PDF	$\alpha_s(m_Z)$ value (ATEEC fit)	χ^2/N_{dof}
MMHT 2014	0.1185 ± 0.0012 (exp.) $^{+0.0047}_{-0.0010}$ (scale) ± 0.0010 (PDF) ± 0.0004 (NP)	57.0 / 65
CT14	0.1203 ± 0.0013 (exp.) $^{+0.0053}_{-0.0014}$ (scale) ± 0.0015 (PDF) ± 0.0004 (NP)	55.4 / 65
NNPDF 3.0	0.1196 ± 0.0013 (exp.) $^{+0.0061}_{-0.0013}$ (scale) ± 0.0017 (PDF) ± 0.0004 (NP)	60.3 / 65
HERAPDF 2.0	0.1206 ± 0.0012 (exp.) $^{+0.0050}_{-0.0014}$ (scale) ± 0.0009 (PDF) ± 0.0002 (NP)	54.2 / 65

References

... Please read the papers!!

- 7 TeV result: PLB 750, 427 (2015)
- 8 TeV result: arXiv:1707.02562 [hep-ex]