Transverse energy-energy correlation and its asymmetry at the LHC

JAVIER LLORENTE (JAVIER.LLORENTE@UAM.ES)

UNIVERSIDAD AUTONOMA DE MADRID

OBSERVABLE DEFINITION

TEEC: The energy-energy weighted differential cross-section in the azimuthal angles between pairs of jets [1].

$$\frac{1}{\sigma}\frac{d\Sigma^{TEEC}}{d\phi} \equiv \frac{\int_{E_{\rm T}^{\rm min}}^{\sqrt{s}} d^2\Sigma/dE_{\rm T}d\phi dE_{\rm T}}{\int_{E_{\rm T}^{\rm min}}^{\sqrt{s}} d\Sigma/dE_{\rm T}dE_{\rm T}} = \frac{1}{N}\sum_{k=1}^{N}\frac{1}{\Delta\phi}\sum_{(i,j)}\frac{E_{{\rm T}i}^{(k)}E_{{\rm T}j}^{(k)}}{\left(E_{\rm T}^{(k)}\right)^2} \quad (1)$$

At NLO, one can express its perturbative expansion as the ratio of 3-jet to 2-jet cross sections

$$\frac{1}{\sigma}\frac{d\Sigma^{\rm TEEC}}{d\phi} = \frac{\sum_{(i,j)} f_i(x_1)f_j(x_2)\otimes\hat{\Sigma}^{ij\to klm}}{\sum_{(i,j)} f_i(x_1)f_j(x_2)\otimes\hat{\sigma}^{ij\to kl}} \sim \frac{\alpha_s(\mu)}{\pi}F(\phi)\left[1+\frac{\alpha_s(\mu)}{\pi}G(\phi)\right] \quad (2)$$

It is also useful to define the TEEC forward-backward asymmetry (ATEEC) as

$$\frac{1}{\sigma}\frac{d\Sigma^{\rm ATEEC}}{d\phi} = \frac{1}{\sigma}\frac{d\Sigma^{\rm TEEC}}{d\phi}\bigg|_{\pi-\phi} - \frac{1}{\sigma}\frac{d\Sigma^{\rm TEEC}}{d\phi}\bigg|_{\phi} \quad (3)$$

PROPERTIES

Both observables TEEC and ATEEC are studied using NLOJET++ [2] with the MSTW NNLO parton densities. They fulfill the following conditions:

- Large dependence on α_s.
- Moderate dependence on μ_R, μ_F.
- Small dependence on the PDF choice.
- Expected small sensitivity to experimental uncertainties (JES,JER) because of the energy-energy weighting.

These properties make them ideal for a determination of the strong coupling α_s in the ATLAS and CMS experiments.

KINEMATICAL CUTS

The event selection is done as follows:

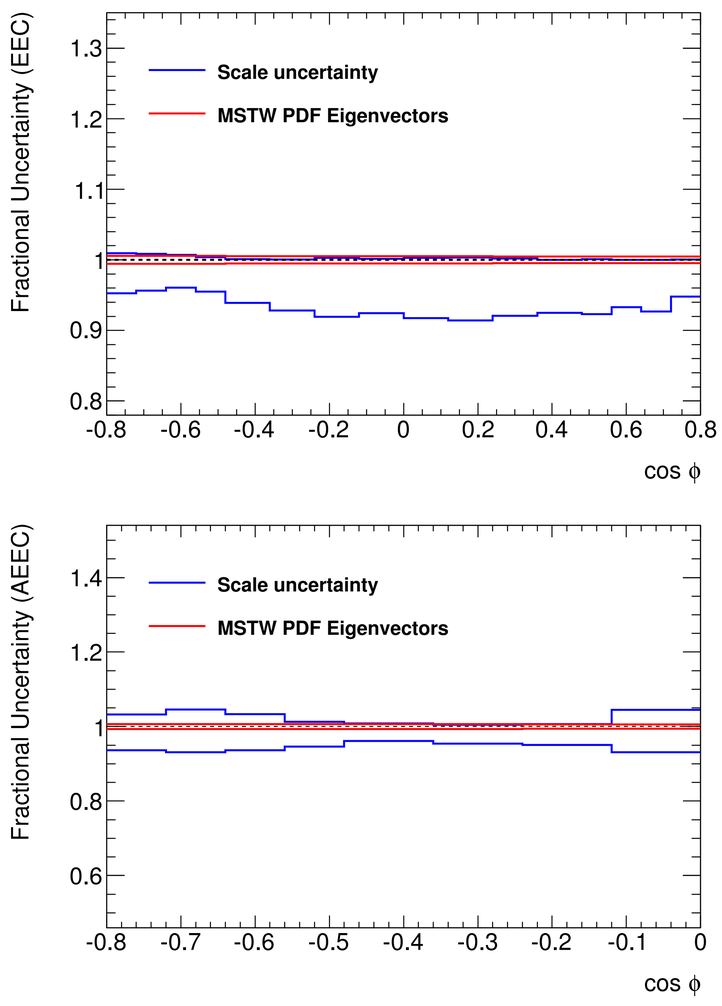
- Two jets with $p_{\rm T1}+p_{\rm T2} > 500$ GeV.
- Additional jets with $p_{\rm T} > p_{\rm T}^{\rm min}$.
- All jets should be within $|\eta| < 2.5$.

THEORY UNCERTAINTIES

The theoretical uncertainties come from two sources:

- Renormalization/Factorization scale.
- PDF eigenvector variations.

For $\sqrt{s} = 13$ TeV and $p_{\rm T}^{\rm min} = 50$ GeV:

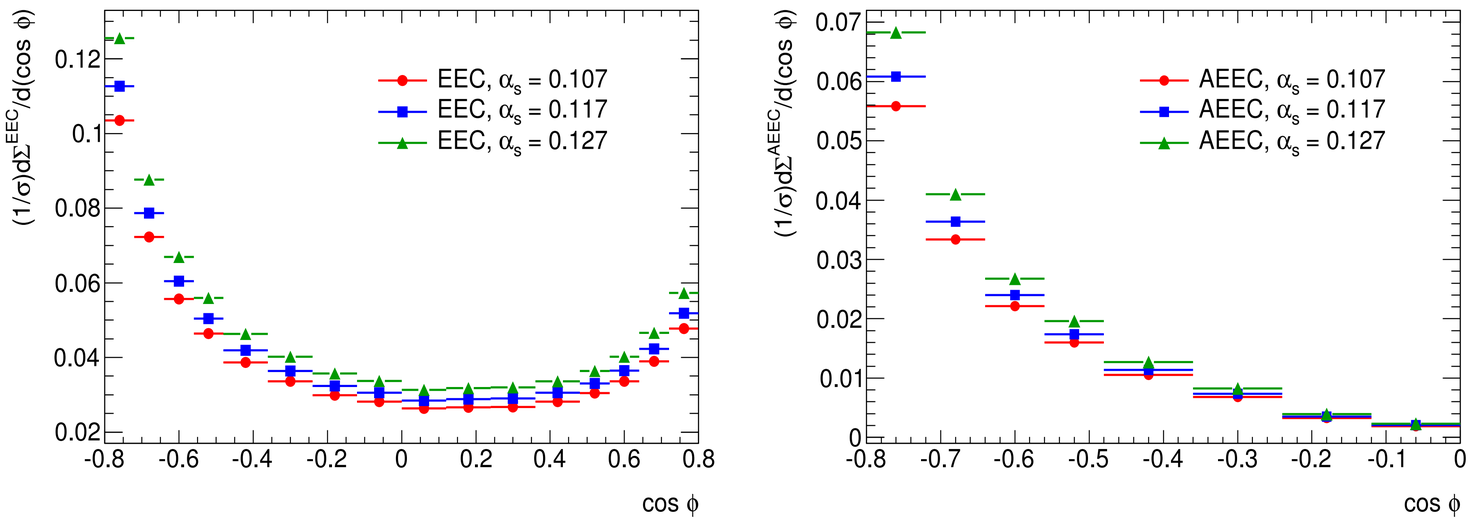


REFERENCES

- **[1]** A. Ali, F. Barreiro, J. Llorente and W. Wang, [Phys. Rev. D **86**, 114017 (2012)].
- **[2]** Z. Nagy, [Phys. Rev. Lett. **88**, 122003 (2002); Phys. Rev. D **68**, 094002 (2003)].

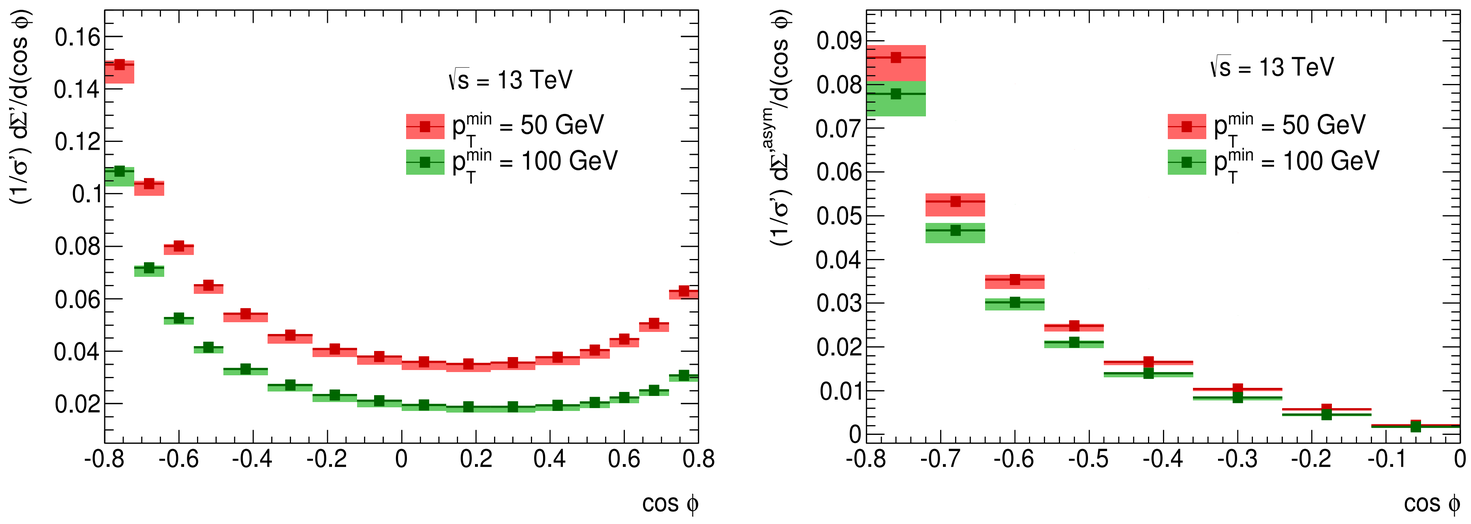
DEPENDENCE ON α_s

Both TEEC and ATEEC show a slightly parabolic (i.e. almost linear) dependence on $\alpha_s(m_Z)$



DEPENDENCE ON $p_{\rm T}^{\rm min}$

Both TEEC and ATEEC depend on $p_{\rm T}^{\rm min}$, as the amount of uncorrelated activity is larger for lower thresholds. The dependence of TEEC is larger than that of the ATEEC.



DEPENDENCE ON $\sqrt{s}$

Both TEEC and ATEEC depend on the CM energy as $f(\sqrt{s}) = P\log(\sqrt{s}) + Q$. Plots below show the theoretical uncertainties for the three nominal LHC energies for $p_{\rm T}^{\rm min} = 50$ GeV.