At the LHC collider, for the first time, t\bar{t}t\bar{t} processes can be measured with enough accuracy to be used in Monte Carlo (MC) tunes. Aim of this work is to study the sensitivity of these measurements to the initial- (ISR) and final-state radiation (FSR) parameters in the Pythia8 generator.

The resulting tunes can be compared to tunes performed on different processes, such as the Z boson transverse momentum and event shapes in Z boson hadronic decays at LEP, providing a stringent test of the parton shower model.

**Motivation and methodology**

The variation in the ISR and FSR parameters induces a change in the underlying event activity. Assuming universality between t\bar{t}t\bar{t} and in obtaining a value of $\alpha_{\text{ISR}}$ is expected to be a universal quantity.

The tunes are performed with the Professor program and with Rivet for the implementation of the measurements. For the first time in the context of MC tuning the correlations in the uncertainties among bins of the same observable and of different observables have been considered.

Three ATLAS measurements of t\bar{t}t\bar{t} production at 7 TeV are used:

- t\bar{t}t\bar{t} production with a veto on additional jet activity
- t\bar{t}+jets differential cross sections measurements
- measurements of jet shapes in t\bar{t}t\bar{t} events

**Initial-state radiation**

The ISR parameters are tuned to the t\bar{t}t\bar{t}+jets and the gap fraction as function of Q. While the fudge factor for the ISR damping $p_{\text{T}}$ is specific for the t\bar{t}t\bar{t} process, the value of $\alpha_{\text{ISR}}$ is expected to be a universal quantity.

The tuned parameters (with 4C as baseline) are found to be in agreement among the two different analyses and with the AZ tune to Z $p_{\text{T}}$ data.

**Final-state radiation**

The jet shapes in t\bar{t}t\bar{t} events are used to tune $\alpha_{\text{FSR}}$. The results show tension between the light- and b-jet shapes, the low value of $\alpha_{\text{FSR}}$ obtained for the b-jet shapes being incompatible with LEP data.

Removing the b-jet shapes from the tune and adding $p_{\text{T,low}}^{\text{FSR}}$ as additional parameter helps in obtaining a $\chi^2$/dof close to one and a value of $\alpha_{\text{FSR}}$ of 0.137, compatible with LEP.

The resulting high value of $p_{\text{T,low}}^{\text{FSR}}$ of about 1 GeV leaves however an undesirable gap in the scale of hadronization.

**Combined tune**

A combined tune of all four parameters is finally performed. The resulting values of the parameters are in agreement with the independent tunes. We show in this case how including correlations helps reducing the uncertainties in the parameters by up to 50%, and in obtaining a $\chi^2$/dof close to one.

The variation in the ISR and FSR parameters induces a change in the underlying event activity. Assuming universality between t\bar{t}t\bar{t} and Z boson production, the MPI cut-off has been retuned to Z events and a value of 2.12 GeV (2.28 in Monash) is obtained.

**Application to NLO+PS generators**

The ATTBAR tune has been finally applied to the Powheg and aMC@NLO generators and two additional parameters related to the scale of the process ($h_{\text{damp}}$ and frac\_low=frac\_upp=f) are tuned to data.