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Study of the underlying event and hadronization properties of b quarks in top-pair events

Abstract

Exploratory studies of the underlying event (UE) activity and of the fragmentation and hadronization of b quarks in final states containing a J/ are performed using tt candidate events. Proton-proton collision data acquired by the CMS experiment at a centre-of-mass energy of 8 TeV and corresponding to an integrated luminosity of 19.7 fb^{-1} are used. A good agreement is found using MADGRAPH plus the PYTHIA 6 Tune Z2* simulation. The effects predicted by alternative settings and generators for the characterization of the UE are also explored. These results are expected to contribute in the future to more precise measurements in the top quark sector in particular of the top quark mass by either constraining systematic uncertainties related to the modelling of the UE in tt events or by paving the way for alternative mass measurement methods.

Click on a plot/table to get the pdf version of it.

Additional Public Plots

Additional plots (regarding the reconstruction of charmed mesons in top pair events) are linked here.

Study of the Underlying Event

Event yields

Characterization of the UE properties in tt events

Event region profiles
Average p_T as function of the azimuthal angle with respect to the event-by-event axis (i.e. Δ) defined from the reconstructed tt direction using eμ events. The observed data is compared to the MADGRAPH plus the PYTHIA 6 tune Z2* prediction.
Inclusive distributions
Normalized distributions for the quantities used to characterize the UE event from the charged particle candidates selec (points) are compared to the MADGRAPH plus the PYTHIA 6 tune Z2* simulation (lines). The uncertainty bars and b
Profiled distributions
Profiled average of the distributions for the soft-charged activity in tt events as function of the reconstructed tt p_T. For MADGRAPH plus the PYTHIA 6 tune Z2* simulation (lines). The uncertainty bars and bands represent the statistical
Comparisons with alternative generator settings
After profiling the average of the distributions for the soft-charged activity in tt events as observed in data and expecte factors for alternative generator settings. The uncertainty bands represent the statistical uncertainty.
$Q=\mu_R=\mu_F$ scale choice
Perugia11 UE tune variations
Colour-reconnection effects (extra material, not in the PA
Data-to-simulation ratio for the average p_T of the charged particles.The bands represent the statistical uncertainty.

Modeling extra jet multiplicity in tt events

Extra jet multiplicity counted in the selected events. The simulated prediction is shown stacked for each sub-process and it is compared to the data represented as markers. The uncertainty bars represent the statistical uncertainty.

Average extra jet multiplicity counted in the selected events as function of the pseudo-rapidity interval spanned by the two b-jet candidates. The evolution of the average extra jet multiplicity is compared to the MADGRAPH plus the PYTHIA 6 tune Z2* prediction as well as for alternative generator settings. The uncertainty bars and bands represent the statistical uncertainty.

PYTHIA 6 configurations used

Available as: png pdf

Identification of b J/ + X μ⁺μ⁻ + X decays in tt events

Event yields
Dimuon invariant mass distributions
J/ kinematics
Kinematics of the reconstructed J/ in the dilepton (left) and l+jets (right) channels. In all distributions the total simulation-based prediction is shown stacked for each sub-process and it is compared to the data represented as markers. An alternative prediction based on a stand-alone PYTHIA 6 sample is shown superimposed as a dashed line.
J/ and nearest jet
Kinematics of the reconstructed J/ in the dilepton (left) and l+jets (right) channels. In all distributions the total simulation-based prediction is shown stacked for each sub-process and it is compared to the data represented as markers. An alternative prediction based on a stand-alone PYTHIA 6 sample is shown superimposed as a dashed line.
Event display (extra material, not in the PAS)
Display of the reconstructed tracks (green lines), calorimeter energy deposits (red for ECAL, blue for HCAL), jets (orange cones), muons (red lines) and missing transverse energy (red arrow) in one event selected in data. A pair of secondary muons with a mass close to the J/ is reconstructed within a jet and are identified as stemming from a secondary vertex. In the zoomed plot on the right the tracks belonging to the secondary vertex are drawn in black. Next to each object of interest a small caption reports the main kinematics characteristics.