

Studies of the $t\bar{t}$ Decay into the 6-Jets Final State at the LHC

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With an expected $t\bar{t}$ cross section of 833 pb at NLO at an integrated luminosity of 10 fb^{-1} , the Large Hadron Collider will be a top quark factory. Thus the analysis of top quark events and especially the hadronic top decay, as the most common top decay¹, will play a very important role at the LHC. It will also be possible to study the top quark production cross section, the top quark mass and its decay properties in great detail.

A Feynman diagram of the hadronic decay mode is shown in figure 1. In the final state one can observe six jets – originating from the hadronization of the two b-quarks and two pairs of $q\bar{q}$.

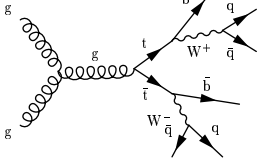


Fig. 1: Hadronic decay into 6-jets of a pair of top quarks.

But QCD background is substantial for this decay mode with a cross section orders of magnitude above the $t\bar{t}$ multijet cross section.

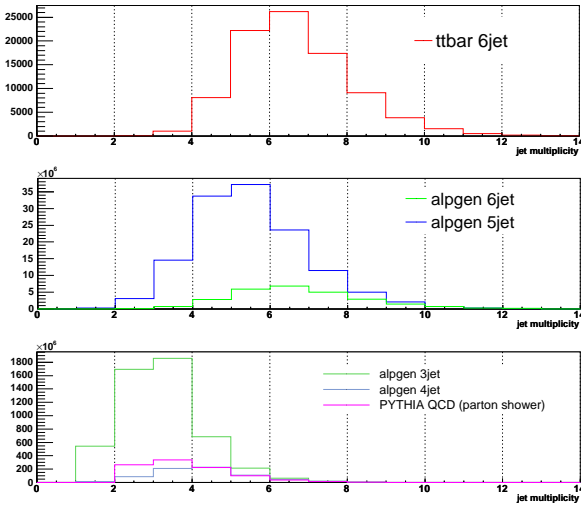


Fig. 2: Reconstructed jet multiplicity of $t\bar{t}$ 6-jets events and background events.

So far we have generated $t\bar{t}$ six-jets events with the leading-order (LO), i.e. proportional to α_s , generator PYTHIA, as well as QCD background events (\sim up to α_s^6) with 3-,4-,5- and 6-jets in final state with the generator ALPGEN.

In order to separate the background events from the $t\bar{t}$ 6-jets signal, appropriate selection cuts must be developed and applied.

Figure 2 shows the reconstructed multiplicity of jets in $t\bar{t}$ 6-jets and QCD background events, whereas the background

events have been scaled to the luminosity of the $t\bar{t}$ events². Obviously the background events with up to four jets in the final state can easily be separated from the $t\bar{t}$ signal by requiring five or more reconstructed jets in an event. Figure 3 left shows the total transverse momentum in $t\bar{t}$ and background events, in figure 3 right one can see the minimum p_T of a jet in these events.

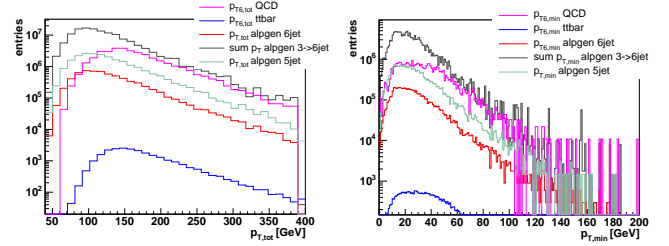


Fig. 3: Left: Total transverse momentum $p_{T,tot}$ in event Right: minimum transverse momentum of a jet $p_{T,min}$ in event.

Here cuts of $p_{T,tot} > 125\text{ GeV}$ as well as $10\text{ GeV} < p_{T,min} < 70\text{ GeV}$ can be required to reject as many background events as possible while most of the $t\bar{t}$ events are preserved. All selection cuts have been applied to yield the sphericity and the aplanarity of the generated events, figure 4. Thus we got rid of two magnitudes of the background events, while we have not lost many $t\bar{t}$ events. Still many background events are left and the event shapes – aplanarity and sphericity – of signal and background events differ marginally, although one would expect the $t\bar{t}$ events to be more spherical and aplanar than background events. So further selection cuts are studied to extract the $t\bar{t}$ 6-jets events.

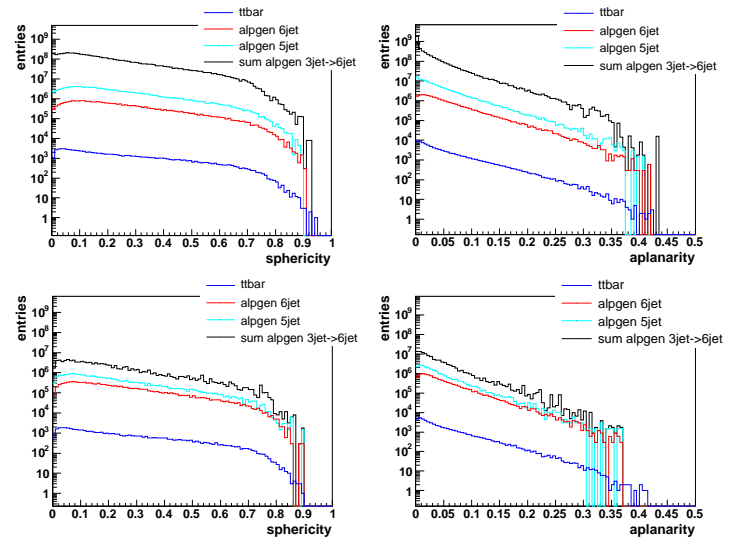


Fig. 4: Above: Sphericity and aplanarity of $t\bar{t}$ and background events without cuts. Below: Sphericity and aplanarity after applying the first selection cuts.

¹44% of all $t\bar{t}$ events decay hadronically.

²The magenta line represents a parton shower background sample from PYTHIA with up to four jets in LO.