Optimal jet clustering algorithms for the measurement of the top quark mass

J. D'Hondt and J. Heyninck

Vrije Universiteit Brussel,Pleinlaan 2, B-1050 Brussels, Belgium

Abstract

The top quark occupies not only a peculiar place within the Standard Model, but also in models beyond the Standard Model. The measurements of its properties will therefore reveal information about new physics in every possible discovery scenario. If no new phenomena are observed with the LHC experiment, the top sector will be the most sensitive domain to look for unexpected deviations from the Standard Model predictions.

To test the correctness of the predictions of the Standard Model it is crucial to obtain well estimated predictions, hence to obtain precise measurements of its free parameters. One of these parameters is the mass of the top quark, which is currently measured to be 174.3 ± 5.1 GeV/c^2 by the Tevatron Collaborations. The CMS experiment at the Large Hadron Collider aims to measure the top quark mass with a precision of about 1 GeV/c^2 by using the process $pp \to t\bar{t} \to bl\nu\bar{b}q\bar{q}'$.

A key issue to measure the kinematics of this multi-particle final state is to decide which particles originate from which primary partons. An optimal clustering algorithm should cluster the correct particles into jets aiming for the smallest residual polution of secundary particles which do not originate from the same primary parton. In practice one aims for an algorithm which results in the smallest bias on the reconstruced jet energy and momentum and the best resolution on these quantities. With Monte Carlo simulation of the physics process we studied these quantities for several well-known and some new jet clustering algorithms. A method was designed to identify the optimal algorithm.

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