VariableR Reclustering in Multiple Top Quark Events

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Internship (SULI) Program

This work was supported in part by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Science Undergraduate Laboratory Internship (SULI) program, under Contract No. DE-AC02-76SF00515.

Outline

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Abstract

VariableR jet reclustering is an innovative technique that allows for the reconstruction of boosted object over a wide range of kinematic regimes. Such capability enables the efficient identification of events with multiple boosted top quarks which is a typical signature for new physics processes such as the production of the supersymmetric partner of the gluon. In order to evaluate the performance of the algorithm, the VariableR reclustered jets are compared with fixed radius reclustered jets. The flexibility of the algorithm is tested by reconstructing both boosted top quarks and boosted W bosons. The VariableR reclustering method is found to be more efficient than the fixed radius algorithm at identifying top quarks and W bosons in events with four top quarks, therefore enhancing the sensitivity for gluino searches.

Introduction

- Looking at multiple top quark events in order to study new physics such as super symmetry
- In particular the top quarks decay into a W boson and bottom quark
- Gluinos can be very massive so their decay produces can be very energetic
- Key for signal discrimination is efficient reconstruction of top (or W) multiplicity.

LHC and ATLAS Detector

Overall view of the LHC experiments.

Jets

- What are jets?
  - Jets are a cone of hadrons which are produced by a quark or gluon hadronizing multiple times before it reaches the detector

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Jets leave energy deposits on the ATLAS calorimeters
They are reclustered with 0.4 radii in the $\eta - \varphi$ space

Boosted Objects

- When a top quark is highly boosted its decay products will be collimated
- The radius of the cone produced (jet) depends on the the P_T of the top quark ($R = 2M/P_T$)

Reclustering

Jet reclustering allows jets to be calibrated at a small radius r , and then used as inputs for reconstructing larger jets of radius R

VariableR vs Fixed

Fixed Reclustering: uses jets of $r = 0.4$ to reconstruct jets of $R = 1.0$

Variable Reclustering: uses a range from $R_{\min} = 0.4$ to $R_{\max} = 1.5$ to reconstruct jets

- VariableR Allows us to reconstruct jets of various kinematic regimes
- $R = 2M/PT$ define typical scale for the jets which is given by:
  - $\rho_T = 2 \cdot 173.5$ $\rho_W = 2 \cdot 80.4$

<http://arxiv.org/abs/0903.0392>

Variable

Low top p_T

Fixed

Fixed Reclus
jets of $R = 1$

Variable Rec

0.4 to reconstruct

from $R_{\min} = 0.4$ to

High top p_T

ct jets

reconstruct
regimes

1 scale for

$= 2 * 80.4$

2

Boosted Top Reconstruction

Mass distribution for highest P_T top quark candidate

Mass distribution for fourth highest P_T top quark candidate

Significance

Mass distribution for highest P_T top quark candidate

Mass distribution for fourth highest P_T top quark candidate

$$Significance = \frac{signal}{\sqrt{signal + background}}$$

The VariableR algorithm is more efficient at reconstructing multiple jets and so allows us to discriminate against low top quark candidate multiplicity

Boosted W Reconstruction

Mass distribution for highest P_T top quark candidate

VariableR can
reconstruct W bosons
in various regimes

Significance Comparison

Conclusions and Next Steps

- I learned about reconstructing boosted top quarks and W bosons in the hadronic final state
- Studied the application of a new algorithm (VariableR reclustering) for identification of new physic processes
- This technique will be implemented in the super-symmetry search for gluino mediated stop pair production

Acknowledgements

- Francesco Rubbo
- Ariel Schwartzman
- Ben Nachman
- Su Dong
- Fastjet.fr
- stackoverflow
- SULI, DOE, ATLAS and SLAC