Measurement of the Relative Fraction of $t\bar{t}$ Events produced via $q\bar{q}$ Annihilation Preliminary Study in the semi-leptonic Channel

B. Acharya, M. Cobal, P. Ferrari, K. Suruliz, Michele Pinamonti

INFN Gruppo Collegato di Udine & Nikhef - ATLAS

May 13, 2009

Introduction

From The Theoretical Point of View Effects in the Kinematical Distributions Measurement Method

Introduction

Last february:

Looking at lower CME $t\bar{t}$ with fast simulation (Pythia+PGS), we have seen some difference in kinematical distributions (centrality, sphericity, number of jets...) that were due to different relative contribution from $q\bar{q}$ and gg production channels

The Idea:

From the different shapes in some distributions is possible to separate the two contributions and to measure the relative number of $t\bar{t}$ events produced via $q\bar{q}$ annihilation

CDF already made it!

In 2007-2008 at the Tevatron, a similar measure has been done by CDF: in both semi-leptonic and di-leptonic channels, the relative ratio of $t\bar{t}$ events produced via gg fusion has been extracted from data, using low track multiplicities and spin correlation between top and antitop decay products (see http://www-cdf.fnal.gov/physics/new/top/public_tprop.html)

NLO Calculations for Different Production Channels Difference Between The Two Channels

NLO Calculations for Different Production Channels



NLO calculation by S. Frixione et al.				
(PDF: CTEQ6M, $m_t = 172.5 GeV/c^2$)				
	CME	gg	qq	
	14TeV	90%	10%	
	10TeV	87%	13%	

NLO Calculations for Different Production Channels Difference Between The Two Channels

Difference Between The Two Channels



Initial State Radiation

Gluons are more likely to radiate other (soft) gluons, than quarks $% \left(\frac{1}{2} \right) = \left(\frac{1}{2} \right) \left(\frac{1}{2} \right)$

 \rightarrow we expect to see a larger number of low p_T jets (or tracks) in gg than in $q\bar{q}$

PDFs

In *pp* collisions, *q* and \bar{q} have different PDFs \rightarrow the average boost of $t\bar{t}$ system may be differt in $q\bar{q}$ and *gg* produced events (this didn't happen at the Tevatron!)

Spin Correlation

gg produced events tend to produce $t\bar{t}$ with unlike spins, while $q\bar{q}$ produced events tend to produce $t\bar{t}$ with like spins But: at high energies (in the ultrarelatiovistic regime for tops) gg produced events loose their property and tend to produce $t\bar{t}$ with like spins...

Fast Monte Carlo Simulation Event Variables Distributions $t\bar{t}$ Delta Rapidity and Jet $\cos(\theta^*)$

Fast Monte Carlo Simulation

MC@NLO+PGS

- We were able to interface MC@NLO(+Herwig) with PGS, to better simulate semi-leptonic $t\bar{t}$ events (NLO corrections are very big!)
- We looked at the incoming partons type (in Herwig output) to discriminate between the production sub-processes (gg and $q\bar{q}$ channels) and build two different samples

Generated Samples

We generated 200k 10 TeV semi-leptonic (no τ s) $t\bar{t}$ events.

We applied the standard commissioning analysis "selection A" and look at the normalized kinematical distributions.

As background we generated W+jets samples with ALPgen-interfaced PGS

(using unweighted ALPgen events from the grid).

Note: background insn't there in the following plots.

Fast Monte Carlo Simulation Event Variables Distributions $t\bar{t}$ Delta Rapidity and Jet $\cos(\theta^*)$





Fast Monte Carlo Simulation Event Variables Distributions $t\bar{t}$ Delta Rapidity and Jet $\cos(\theta^*)$

$t\bar{t}$ Delta Rapidity and Jet $\cos(\theta^*)$



$t\bar{t}$ reconstruction:

hadronic and leptonic tops (as well as hadronic W) are reconstructed via kinematical fit, i.e. choosing the jet combination that minimize

$$\chi^2 = (m_{jj} - M_W)^2 + (m_{jjj} - M_t)^2 + (m_{\ell\nu j} - M_t)^2$$

The angle θ^* is evaluated in the event center of mass rest frame.

Likelhood Method with TMVA Measurement Strategy

Likelhood Method with TMVA

TMVA

TMVA (Toolkit for MultiVariate Analysis)

provides a ROOT-integrated machine learning environment for the processing and parallel evaluation of sophisticated multivariate classification techniques.

(https://twiki.cern.ch/twiki/bin/view/Main/TMVA)

We are interested to use it to build a Likelhood over our discriminant distributions (from MC) and apply it on data to extract a measured relative number of $t\bar{t}$ events coming from $q\bar{q}$ and gg.



Likelhood Method with TMVA Measurement Strategy

Measurement Strategy



Our Strategy:

- divide our samples in two: template (to extract classifier functions) and test (to simulate real data)
- our "signal" is $q\bar{q}$ produced $t\bar{t}$, and our two "backgrounds" are $gg \rightarrow t\bar{t}$ and W+jets
- try different TMVA functionalities and look for the most performant one
- evaluate systematics from MC (ISR/FSR, PDFs, distribution shapes...)

< 17 ▶

A B > A B >

Likelhood Method with TMVA Measurement Strategy

Backup:



10

Likelhood Method with TMVA Measurement Strategy

Backup:



.∋...>

< A