A Search for $t\bar{t}$ Resonances in the Dilepton Channel in 2.05 fb^{-1} of pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS experiment

M. Petteni On behalf of the ATLAS Collaboration
Simon Fraser University
Burnaby, BC, V5A 1S6, Canada

ATL-PHYS-PROC-2012-187
15 September 2012

1 Introduction

Many models of physics beyond the Standard Model (BSM) predict the existence of new resonances that decay predominantly into top quark pairs[1]. This note provides a description of the search [2] for a KK-gluon resonance in the Randall-Sundrum model[3], decaying to $t\bar{t}$ pairs in the dilepton channel by the ATLAS experiment [4][2] at the CERN Large Hadron Collider.

2 Event Selection

The data analyzed were collected between March and August 2011, corresponding to a total integrated luminosity of $\mathcal{L} = 2.05\ fb^{-1}$. The selection of $t\bar{t}$ events makes use of reconstructed electrons, muons, jets and $E_{\mathrm{T}}^{\mathrm{miss}}$, passing standard ATLAS event and object selection cuts as listed in [2]; $E_{\mathrm{T}}^{\mathrm{miss}}$ is the missing transverse momentum from the escaping neutrinos from the leptonic W boson decay. The final event selection is driven by the topology of the top decay. Events must have two or more jets and have exactly two oppositely charged leptons (electrons or muons) with a dilepton invariant mass greater than 10 GeV.

For the ee and $\mu\mu$ final states the signal region is defined by $E_T^{\mathrm{miss}} > 40$ GeV and $|m_Z - m_{\ell\ell}| > 10$ GeV, to reduce the large Z+jets background. For the $e-\mu$ channel the scalar sum of the transverse momenta of the selected leptons and jets is required to be greater than 130 GeV. A control region for the ee and $\mu\mu$ channels is defined by inverting the Z mass cut.

The main background to the KK-gluon signal production is the irreducible Standard Model $t\bar{t}$ production. Background sources also include: Z+jets, single top production, diboson production and "fake" i.e. QCD multijet and W+jets processes where one or two jets are misidentified as leptons. All background distributions are derived from Monte Carlo (MC) and normalised to the ATLAS luminosity, except for the fakes, which are obtained from data, and the the Z+jets background (for ee and $\mu\mu$ decays) which is normalised to data. The signal MC is generated using MadGraph interfaced to Pythia.

3 Analysis and Results

Due to the missing neutrinos in the event, we choose the effective mass, $H_{\mathrm{T}} + E_{\mathrm{T}}^{\mathrm{miss}}$, as the discriminating variable for this analysis; H_{T} is defined as the scalar sum of the transverse momenta of the two identified leptons and of the two leading jets in the event. For the statistical analysis we construct a binned likelihood function based on Poisson statistics for signal and background for each bin of the effective mass distribution. Sources of systematic uncertainty are included as nuisance parameters in the likelihood function.

The largest systematic variations on the background shape and yield prediction is from the jet energy scale (2.5%) and the choice of Parton Distribution Function (3.7%). For the signal the greatest is the modelling of the initial and final state radiation (5.1%) and the jet energy scale (3.0%). Both rate and shape dependences were computed. The largest rate only systemtatics are the luminosity (3.7%) and cross-section uncertainties for $t\bar{t}$, which were included as overall rate changes.

A p-value based on a likelihood ratio technique was found to be consistent with the SM only hypothesis. A lower limit at 95% C.L. on the mass of the KK-gluon in the Randall-Sundrum model was set at 1.08 TeV (1.07 TeV expected) with masses below 500 GeV not taken into consideration.

References

[1] K. Agashe et al., *CERN LHC Signals from Warped Extra Dimensions*, Phys.Rev. D **77**, 015003 (2008)

[2] ATLAS Collaboration, *A Search for $t\bar{t}$ Resonances with the ATLAS detector in 2.05 fb^{-1} of proton-proton collisions at $\sqrt{s}$ = 7 TeV*, Eur.Phys.J. **C72**, 2083 (2012)

[3] B. Lillie, L. Randall, L.-T. Wang, *The Bulk RS KK-gluon at the LHC*,JHEP **09**, 074 (2007)

[4] ATLAS Collaboration,*The ATLAS Experiment at the Large Hadron Collider*, JINST **3**, S08003 (2008)