PROCEEDINGS OF SCIENCE

$t\bar{t}$ resonance searches in the lepton plus jets topology using 200 pb^{-1} of pp collisions at $\sqrt{s}$ =7 TeV in ATLAS

Reina Camacho Toro[*†]
Laboratoire de Physique Corpusculaire (LPC) Clermont Ferrand, France.
E-mail: reina.coromoto.camacho.toro@cern.ch

The top quark is the heaviest elementary particle known. Some Beyond Standard Model theories predict the existence of new heavy particles decaying into top pairs. In the lepton plus jets topology the search of these resonances is done using the $t\bar{t}$ mass spectra, which is built by three or four jets, an electron or muon and a neutrino. The benchmark model used to quantify the experimental sensitivity to narrow resonances is a leptophobic Z' boson arising in models of strong electroweak symmetry breaking through top quark condensation [1]. The model used for wide resonances is a Kaluza-Klein gluon g_{KK}, which appears in Randall-Sundrum (RS) models with a warped extra dimension [2].

A search for $t\bar{t}$ resonances in the lepton (e/μ) plus jets topology has been performed using 200 pb^{-1} of pp collisions at $\sqrt{s}$ =7 TeV recorded by ATLAS in 2011. No evidence of a resonance was found. Limits were set on the production cross-section times branching ratio, using the $t\bar{t}$ mass spectra, for narrow and wide resonances. For a narrow leptophobic Z' in the TopColor model the observed 95% C.L. limits range from 38 pb to 3.2 pb for masses going from $m_{Z'}$ =500 GeV to $m_{Z'}$ =1300 GeV. While the wide Kaluza-Klein gluon in the RS models with mass below 650 GeV was excluded at 95% C.L.

The 2011 Europhysics Conference on High Energy Physics-HEP 2011,
July 21-27, 2011
Grenoble, Rhône-Alpes France

*Speaker.
†On behalf of the ATLAS collaboration

PoS(EPS-HEP2011)422

1. Event selection

After the event has been accepted by a single lepton trigger, it is required to have at least one offline-reconstructed primary vertex with at least five tracks, and it is discarded if any jet with p_T >20 GeV is identified as out-of-time activity or calorimeter noise. The event must contain exactly one isolated lepton (with p_T >25 GeV and $|\eta|$ <2.47 in the case of electrons and p_T >20 GeV and $|\eta|$ <2.5 for muons), and the lepton must match the triggered lepton. Events where an electron shares an inner detector track with a non-isolated muon are rejected. Finally the total event fraction of $t\bar{t}$ is enhanced by applying the following event cuts: first, in the electron channel, E_T^{miss} >35 GeV and M_T(lepton,E_T^{miss})>25 GeV, where E_T^{miss} is the missing transverse energy in the event and M_T(lepton,E_T^{miss}) is the lepton-E_T^{miss} transverse mass. While in the muon channel, E_T^{miss} >20 GeV and $E_T^{miss} + M_T$(lepton,E_T^{miss})>60 GeV is required. Finally, the event must contain at least four jets with p_T >25 GeV and $|\eta|$ <2.5, where at least one of the jets must be tagged as a *b-jet*. Jets are reconstructed using the anti-k_T algorithm (R =0.4) [3] and calibrated to the hadronic energy scale, using a correction factor obtained from simulation [4].

2. $t\bar{t}$ mass reconstruction

To reduce the non-gaussian tails in the $t\bar{t}$ mass resolution due to the use of a jet from initial- or final-state radiation in the place of one of the jets produced in the top quark decay, the *dRmin* algorithm [5] is used for the $t\bar{t}$ mass reconstruction. It consists in excluding a jet if its angular distance to the closest jet/lepton satisfies: $dRmin > 2.5 - 0.015 M_j$ (where M_j is the jet mass). The $t\bar{t}$ mass is reconstructed from the lepton, the neutrino and the leading four jets or three jets (if only three jets remain). Taking at least three jets allows one jet to be out of acceptance or merged with another jet(s) (which commonly happens for high mass $t\bar{t}$ resonances). The event E_T^{miss} correspond to the neutrino's transverse momentum p_T and the neutrino's longitudinal momentum (p_z) is determined by imposing the W-boson mass constraint.

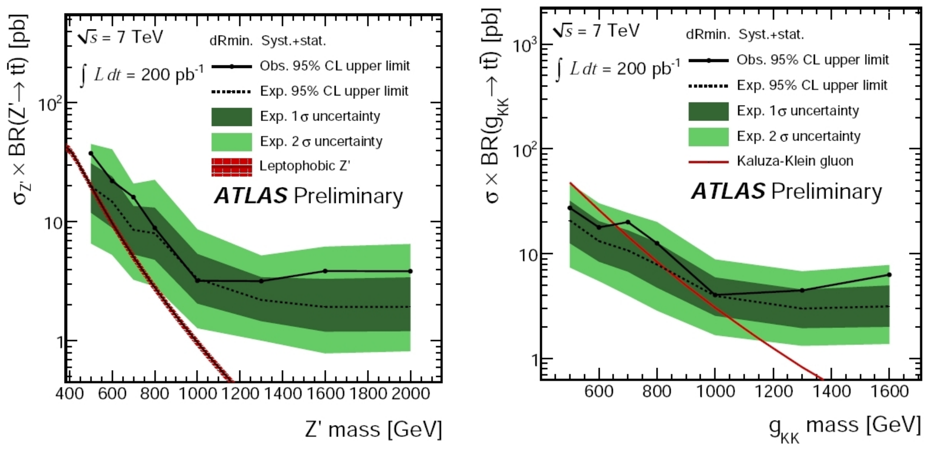
3. Backgrounds

The Standard Model $t\bar{t}$ in which at least one of the W bosons decays leptonically is simulated using MC@NLO generator interfaced to HERWIG. Electroweak single top quark is simulated using the same programs. W and Z plus jets samples are simulated with the ALPGEN generator. The W plus light flavor jets samples are normalized using data-driven coefficients. Diboson WW, ZZ and WZ samples are produced using HERWIG with Jimmy. QCD multijets events faking leptons are derived from data templates. The QCD normalization is done by fitting to the data the full E_T^{miss} distribution.

The agreement observed between data and background expectation after applying the event selection cuts is good. Good agreement is seen in the shapes of kinematic distributions as well.

4. Results

The null hypothesis was tested using the BumpHunter [6] and no excess was found. Then limits were set using a Bayesian approach [7] (taking into account all the normalization and shape systematic uncertainties) on the cross-section times branching ratio as a function of $m_{t\bar{t}}$. The observed (expected) limit for $\sigma \times BR(Z' \to t\bar{t})$ ranges between 38(20) pb at $m_{Z'}$ =500 GeV to 3.2(24) pb at $m_{Z'}$ =1300 GeV. No exclusion can be done for the Z' but the analysis is already able to probe the few picobarn range for masses close to 1 TeV. The observed (expected) limit for $\sigma \times BR(g_{KK} \to t\bar{t})$ ranges between 32(24) pb at $m_{g_{KK}}$ =500 GeV to 6.6(2.9) pb at $m_{g_{KK}}$ =1300 GeV, excluding g_{KK} resonances with mass below 650 GeV at 95% C.L. (see Figure 1)



(a) (b)

Figure 1: Expected (dashed line) and observed (black points) upper limits on $\sigma x BR(Z' \to t\bar{t})$ (a) and $\sigma x BR(g_{KK} \to t\bar{t})$. The dark and light green bands show the range in which the limit is expected to lie in 68% and 95% of experiments, respectively.

References

[1] C. T. Hill, *Topcolor assisted technicolor*, Phys. Lett. B345 (1995) 483-489, arXiv:hep-ph/9411426.

[2] B. Lillie, L. Randall, and L.-T. Wang, *The Bulk RS KK-gluon at the LHC*, JHEP 09 (2007) 074, arXiv:hep-ph/0701166.

[3] M. Cacciari, G. P. Salam, G. Soyez, *The anti$-k_T$ jet clustering algorithm*, JHEP 04 (2008) 063 [hep-ph/0802.1189]; Fastjet, http://fastjet.fr/

[4] The ATLAS Collaboration, *Jet energy scale and its systematic uncertainty in proton-proton collisions at $\sqrt{s}$ =7 TeV in ATLAS 2010 data*, ATLAS-CONF-2010-032.

[5] ATLAS Collaboration, *A Search for New High-Mass Phenomena Producing Top Quarks with the ATLAS Experiment*, ATLAS-CONF-2011-070.

[6] G. Choudalakis, *On hypothesis testing, trials factor, hypertests and the BumpHunter*, arXiv:1101.0390 [physics.data-an].

[7] D0 Collaboration, I. Bertram et al., *A Recipe for the construction of confidence limits*, FERMILAB-TM-2104, Fermilab, 2000.

[8] The ATLAS Collaboration. *A search for $t\bar{t}$ resonances in the lepton plus jets channel in 204 pb^{-1} of pp collisions at $\sqrt{s}$ =7 TeV*. ATL-CONF-2011-091.