



Search for new particles in events with one lepton and missing transverse momentum in pp collisions at $\sqrt{s} = 8$ TeV

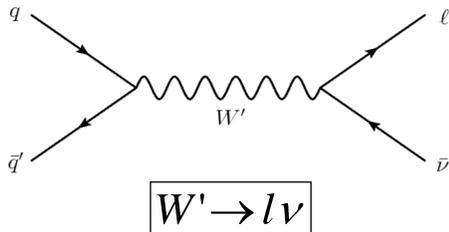


Nikolaos Tsirintanis, on behalf of the ATLAS collaboration

National and Kapodistrian University of Athens

Introduction

A search for new particles in events with one lepton (electron or muon) and missing transverse momentum using 20.3 fb⁻¹ of proton-proton collision data at $\sqrt{s} = 8$ TeV recorded by the ATLAS experiment [1].



Many models predict the existence of heavy gauge bosons. The first new physics scenario that is investigated is the Sequential Standard Model (SSM), the extended gauge model of ref. [2]. This model proposes the existence of additional heavy gauge bosons, of which the charged ones are commonly denoted as W' . The W' has the same couplings to fermions as the SM W boson and a width that increases linearly with the W' mass.

The second new physics scenario that is investigated originates from ref. [3] and proposes the existence of charged partners, denoted W^* , of the chiral boson excitations described in ref. [4]. The anomalous (magnetic moment-type) coupling of the W^* leads to kinematic distributions significantly different from those of the W' .

The analysis is also sensitive to dark matter pair production in association with a leptonically decaying W boson, see [8].

Search Strategy

Search for high mass states that decay into a lepton and E_T^{miss} . The observable is transverse mass:

$$m_T = \sqrt{2p_T^l E_T^{miss} (1 - \cos \phi_{l\nu})}$$

An event counting experiment is performed, and the probability of a significant excess above background expectations is investigated. If no excess is observed, set limit on the $\sigma \cdot B$.

To choose the optimal m_T threshold for a particular mass point in the W' search, the m_T threshold bins are scanned for the threshold that gives the smallest $\sigma \cdot B$ expected limit.

Mass [GeV]	$W' \rightarrow e\nu$ σB [pb]	$W^* \rightarrow e\nu$ σB [pb]	m_{Tmin} [GeV]	m_{Tmax} [GeV]
300	149.0		300	252
400	50.2	37.6	400	336
500	21.4	16.2	500	423
600	10.4	7.95	600	502
750	4.16	3.17	750	597
1000	1.16	0.882	1000	796
1250	0.389	0.294	1250	946
1500	0.146	0.108	1500	1191
1750	0.0581	0.0423	1750	1337
2000	0.0244	0.0171	2000	1589
2250	0.0108	0.00700	2250	1888
2500	0.00509	0.00290	2500	1888
2750	0.00258	0.00120	2750	1888
3000	0.00144	4.9×10^{-4}	3000	1888
3250	8.9×10^{-4}	2.0×10^{-4}	3250	1888
3500	5.9×10^{-4}	8.0×10^{-5}	3500	1888
3750	4.2×10^{-4}	3.2×10^{-5}	3750	1888
4000	3.1×10^{-4}	1.3×10^{-5}	4000	1888

Predicted values of the cross-section times branching fraction ($\sigma \cdot B$) for $W' \rightarrow l\nu$ and $W^* \rightarrow l\nu$.

The optimized m_{Tmin} thresholds for W' .

Background

- $W \rightarrow l\nu$ (Irreducible and the dominant one)
- $Z \rightarrow \ell\ell$ (One of the leptons is not reconstructed)
- $Diboson$ ($WW, WZ, ZZ, W\gamma$)
- Tbp quarks (Single top and $t\bar{t} \rightarrow \ell X$)
- Multijets - QCD** (Events with misidentified leptons and mismeasured jets - Data estimated)

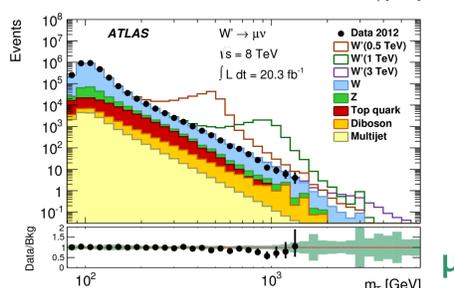
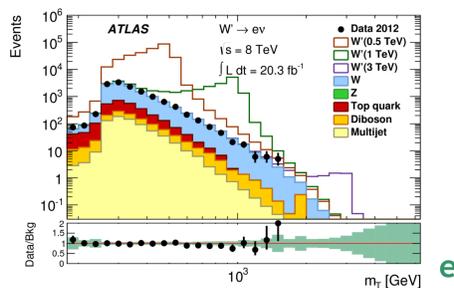
Process	σB [pb]
$W \rightarrow l\nu$	12190
$Z/\gamma^* \rightarrow \ell\ell$ ($m_{Z/\gamma^*} > 60$ GeV)	1120
$t\bar{t} \rightarrow \ell X$	137.3

Candidate selection

- Primary Vertex** – pp collision
 - at least 3 tracks, $|z| < 200$ mm
- Impact Parameter** – cosmic rejection
 - $|d_0^{PV}| < 0.2$ mm
 - $|z_0^{PV}| < 1$ mm
- Jet Cleaning** – avoid events with spurious E_T^{miss}
- $E_T^{miss} > 125$ GeV (e) or 45 GeV (μ)** – enhancement of associated neutrino production

- | Electron | Muon |
|---|---|
| ➤ Central electrons | ➤ Combined muons |
| ➤ $E_T > 125$ GeV | ➤ $p_T > 45$ GeV |
| ➤ $ \eta < 2.47$ | ➤ Combined = ID + MS tracks loosely matched |
| ➤ Medium electron identification | ➤ ID and MS hits |
| ➤ ID hits | ➤ Trigger matching |
| ➤ Trigger matching | ➤ Reconstructed muon with trigger track |
| ➤ Reconstructed electron with trigger track | ➤ Isolation |
| ➤ Isolation | ➤ QCD rejection |
| ➤ QCD rejection | ➤ ID-MS momentum |
| | ➤ Remove muons with mismeasured momentum |

Results



- ✓ Select a high- p_T lepton
- ✓ Require E_T^{miss} that balances the lepton p_T
- ✓ Search the m_T distributions for excesses

Source	ϵ_{sig}		N_{bkg}	
	$e\nu$	$\mu\nu$	$e\nu$	$\mu\nu$
$W' \rightarrow l\nu$				
Reconstruction and trigger efficiency	2.5%	4.1%	2.7%	4.1%
Lepton energy/momentum resolution	0.2%	1.4%	1.9%	1.8%
Lepton energy/momentum scale	1.2%	1.8%	3.5%	1.5%
E_T^{miss} scale and resolution	0.1%	0.1%	1.2%	0.5%
Beam energy	0.5%	0.5%	2.8%	2.1%
Multi-jet background	-	-	2.2%	3.4%
Monte Carlo statistics	0.9%	1.3%	8.5%	10%
Cross-section (shape/level)	2.9%	2.8%	18%	15%
Total	4.2%	5.6%	21%	27%
$W^* \rightarrow l\nu$				
Reconstruction and trigger efficiency	2.7%	4.1%	2.6%	4.0%
Lepton energy/momentum resolution	0.4%	0.9%	3.0%	1.7%
Lepton energy/momentum scale	2.4%	2.4%	3.1%	1.5%
E_T^{miss} scale and resolution	0.1%	0.4%	3.1%	0.6%
Beam energy	0.1%	0.1%	2.5%	1.9%
Multi-jet background	-	-	1.8%	2.6%
Monte Carlo statistics	1.2%	1.8%	6.7%	8.6%
Cross-section (shape/level)	0.2%	0.2%	17%	15%
Total	3.9%	5.1%	19%	25%

Relative uncertainties on the selection efficiency ϵ_{sig} and expected number of background events N_{bkg} for a W' and W^* with a mass of 2000 GeV.

References

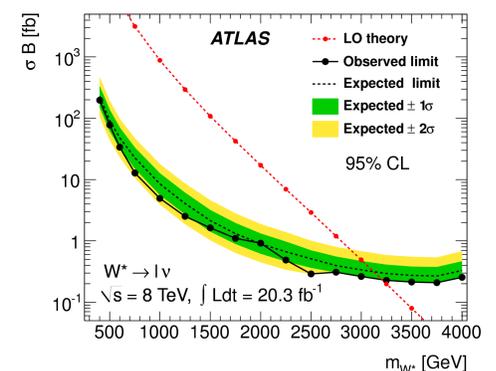
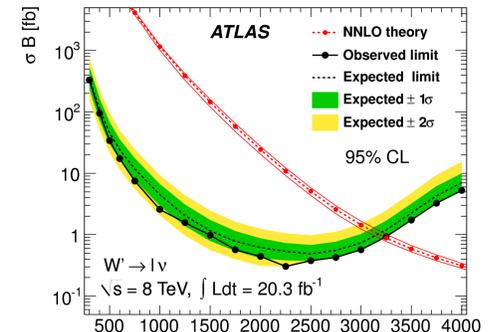
- [1] ATLAS Collaboration, JINST 3 (2008) S08003
- [2] G. Altarelli, B. Mele, and M. Ruiz-Altaba, Searching for new heavy vector bosons in pp colliders, Z. Phys. C 45(1989) 109.
- [3] M. Chizhov and G. Dvali, Origin and Phenomenology of Weak-Doublet Spin-1 Bosons, Phys Lett. B 703 (2011) 593–598
- [4] M. Chizhov, V. Bednyakov, and J. Budagov, Proposal for chiral bosons search at LHC via their unique new signature, Phys. Atom. Nucl. 71 (2008) 2096–2100
- [5] ATLAS Collaboration, Electron reconstruction and identification efficiency measurements with the ATLAS detector using the 2011 LHC proton-proton collision data [arXiv:1404.2240v3 [hep-ex]]
- [6] ATLAS Collaboration, Measurement of the muon reconstruction performance of the ATLAS detector using 2011 and 2012 LHC proton-proton collision data [Eur.Phys.J. C74 (2014) 3130]
- [7] ATLAS Collaboration, Reconstruction and Calibration of Missing Transverse Energy and Performance in Z and W events in ATLAS Proton-Proton Collisions at $\sqrt{s} = 7$ TeV [ATLAS-CONF-2012-101]
- [8] ATLAS Collaboration, Search for new particles in events with one lepton and missing transverse momentum in pp collisions at $\sqrt{s} = 8$ TeV with the ATLAS detector [arXiv:1407.7494v1 [hep-ex]]

Acknowledgments



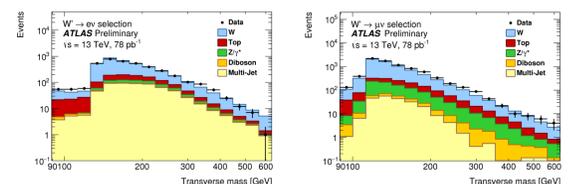
Conclusions - Limits

No significant excess beyond Standard Model expectations is observed. A W' with SSM couplings is excluded at the 95% confidence level for masses up to 3.24 TeV. Excited chiral bosons (W^*) with equivalent coupling strengths are excluded up to a mass of 3.21 TeV [8].

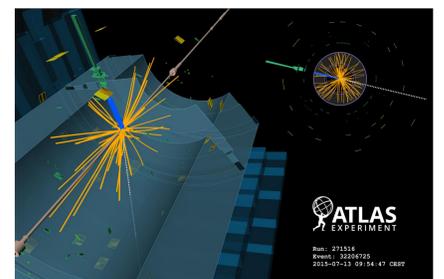


Decay	$m_{W'}$ [TeV]		m_{W^*} [TeV]	
	Exp.	Obs.	Exp.	Obs.
$e\nu$	3.13	3.13	3.08	3.08
$\mu\nu$	2.97	2.97	2.83	2.83
Both	3.17	3.24	3.12	3.21

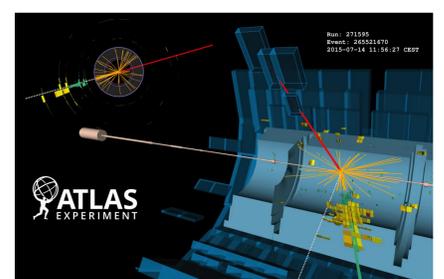
Initial $\sqrt{s} = 13$ TeV results for 78 pb⁻¹



m_T distributions after $W' \rightarrow e\nu$ (left) and $W' \rightarrow \mu\nu$ (right) event selection



One of the highest m_T events in the electron channel. The electron has a p_T of 525 GeV and $\eta=0.37$. The event has $E_T^{miss}=525$ GeV and $m_T=1050$ GeV.



One of the highest m_T events in the muon channel. The muon has a p_T of 902 GeV and $\eta=-0.78$. The event has $E_T^{miss}=259$ GeV and $m_T=966$ GeV