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Search for high-mass dielectron resonances at ATLAS

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We present a search for high-mass dielectron resonances produced by pp collisions at a center-of-mass energy of 7 TeV, using an integrated luminosity of $\sim$1 fb^{-1} recorded by the ATLAS detector in 2011. The reconstructed invariant mass spectrum is compared to Standard Model expectations. Possible signals include decays of heavy neutral spin-1 gauge bosons and the Randall-Sundrum graviton. In the absence of a signal we set exclusion limits for various models using a Bayesian approach.

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Using an integrated luminosity of $\sim$1 fb^{-1} recorded by the ATLAS detector [1] in 2011, we have searched for narrow high-mass resonances, produced in 7 TeV pp collisons, which decay into electron pairs [2]. Several extensions to the Standard Model (SM) suggest the existence of additional gauge bosons. Spin-1 resonances considered in this analysis are the Sequential SM Z'_{SSM} boson, which has the same couplings as the SM Z boson [3], as well as the Grand Unification Model Z'_{E_6} boson, which is a linear combination of two U(1) gauge groups [3, 4]. The Randall-Sundrum (RS) model predicts extra dimensions as a solution to the hierarchy problem. In this model, excited Kaluza-Klein modes of the graviton result in a spin-2 resonance [5].

We require each event to have at least one primary vertex with more than two tracks and to be selected by a single electron trigger with transverse energy $E_T > 20$ GeV. Both electrons in the event are required to pass the following cuts. The E_T of the electron must be larger than 25 GeV, the pseudo-rapidity $|\eta| < 2.47$ and it should not traverse problematic regions of the electro-magnetic calorimeter. In order to reject jets from QCD multijet production, cuts on the transverse shower shape and low leakage into the hadronic calorimeter are enforced and an isolation cut is applied to the calorimeter cluster of the leading electron. Candidates need to have good quality tracks which match the cluster. To reject conversions, we require a hit in the first layer of the Pixel detector. For a Z'_{SSM} boson with mass 1.5 TeV, the acceptance of the event selection is 67%.

The following background processes are estimated using simulated samples: Drell Yan, Dibosons, W+jets and Top pairs. Reverse identification is used to estimate the background due to QCD multijet production from data. We obtain the shapes by reversing cuts on the calorimeter shower widths, used in the electron identification. Since the data statistics is very poor for invariant masses above $\sim$400 GeV, extrapolation by fitting the dijet invariant mass spectrum with an empirical function is necessary. For the normalization we perform a 2-component template fit to the data using the previous empirical fit to set the shape of the dijet contribution, with the sum of the other backgrounds as the second component. The invariant mass is used as the discriminating variable.

All backgrounds are normalized to the data around the Z peak. Therefore mass-independent systematic uncertainties cancel out. Non-negligible mass-dependent uncertainties include Parton Distribution Function (PDF) and α_s variations, $\sim$10%. Next-to-leading order (NLO) and Next-to-next-to-leading order (NNLO) corrections are applied as mass dependent k-factors to Drell Yan (QCD and electroweak corrections) and the Z' boson signals (QCD corrections) with an uncertainty of $\sim$4% in both cases. In addition, the theoretical uncertainty on the Z boson cross-section is $\sim$5%.

The invariant mass distribution in data is compared to the expected background and signal templates (see Fig. 1, left). In order to search for a signal, we perform a scan in the ($\sigma(Z')$,m(Z')) plane and use the log-likelihood ratio of the signal+background hypothesis over the background-only hypothesis to rank the probabilities. For the largest deviation from the background-only hypothesis, a p-value of 54% is obtained, so no significant excess is found. Using a Bayesian approach we set upper limits on the Z' boson and RS graviton cross sections at the 95% confidence level (C.L.). We use a likelihood function which is a product of the Poisson probabilities over all mass bins with the systematic uncertainties as marginalized nuisance parameters and a uniform positive prior on σB.

The resulting limits on various Z' boson models and on RS gravitons are shown in Fig. 1, right and Table 1.

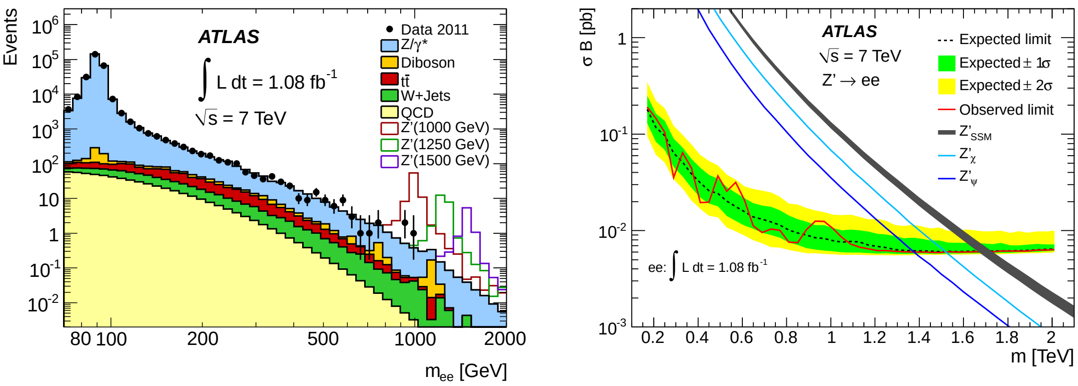

Figure 1: Left: Dielectron invariant mass distribution after final selection, compared to the stacked sum of all expected backgrounds, with three example Z'_{SSM} signals overlaid. The bin width is constant in log m_{ee}. Right: Expected and observed 95% C.L. upper limits on σB as a function of mass for several Z' models.

Table 1: Top: Observed (Expected) 95% C.L. lower limits in TeV on the masses of the Z'_{SSM} boson and the RS graviton with $k/\overline{M}_{Pl}$=0.1. Bottom: 95% C.L. lower limits obtained from muons and electrons on the masses of E_6-motivated Z' bosons and RS gravitons for various values of the coupling $k/\overline{M}_{Pl}$.

Model	ee	$\mu\mu$	ll
Z'_{SSM}	1.70 (1.70)	1.61 (1.61)	1.83 (1.83)
RS Graviton	1.51 (1.50)	1.45 (1.44)	1.63 (1.63)

	E_6 Z' Models						RS Graviton			
Model/Coupling	Z_ψ	Z_N	Z_η	Z_I	Z_S	Z_χ	0.01	0.03	0.05	0.1
Mass limit [TeV]	1.49	1.52	1.54	1.56	1.60	1.64	0.71	1.03	1.33	1.63

We have searched for narrow dielectron resonances in the invariant mass spectrum. The observed invariant mass spectrum is consistent with SM expectations, so we set 95% C.L. lower limits on the masses of the Sequential Standard Model Z'_{SSM} boson, E_6-motivated Z' bosons and RS gravitons, which significantly improve previous results by ATLAS [6], CMS [7] and the indirect constraints from LEP [8].

References

[1] ATLAS Collaboration, JINST 3, S08003 (2008).

[2] ATLAS Collaboration, hep-ex/1108.1582 (2011).

[3] P. Langacker, Rev. Mod. Phys. 81, 1199 (2009) [hep-ph/0801.1345].

[4] D. London and J. L. Rosner, Phys. Rev. D34, 1530 (1986).

[5] L. Randall and R. Sundrum, Phys. Rev. Lett. 83, 3370 (1999) [hep-ph/9905221].

[6] ATLAS Collaboration, Phys. Lett. B700, 163 (2011) [hep-ex/1103.6218].

[7] CMS Collaboration, JHEP 05, 093 (2011) [hep-ex/1103.0981].

[8] P. Langacker, hep-ph/0911.4294 (2009).