PROCEEDINGS OF SCIENCE

Search for di-lepton resonances and Wprimes with CMS

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The potential of the CMS experiment to discover neutral heavy resonances in the di-electron and di-muon channels as well as a heavy charged boson, W', has been studied considering an integrated luminosity of 100 pb^{-1}. This integrated luminosity was a realistic expectation of the size of an early LHC dataset circa summer 2008. Assuming Standard Model couplings, discovery of a di-lepton resonance was found to be possible up to a resonance mass of 1.5 TeV and up to approximately 1.2 TeV in the Z' ψ model. Massive spin-2 gravitons that arise in the RS model were found to be discoverable in the di-muon channel up to mases of 1.5 TeV assuming a coupling strength k/m_{Pl} = 0.1. The discovery of a heavy charged boson, decaying to an electron and anti-electron neutrino was found to be possible up to a mass of 2.2 TeV. In the absence of a signal, exclusion was found to be possible up to approximately 2.5 TeV.

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1. Introduction and Motivation

In addition to the well-known Standard Model (SM) bosons g, $W^{\pm}$, Z^0 and γ, many theoretical models predict further neutral heavy gauge bosons, Z' or charged heavy gauge bosons, W' [1]. Additionally, the extra-dimension model of Randall and Sundrum (RS) predicts massive spin-2 gravitons [2]. The sensitivity of the CMS experiment to such models has been studied.

Neutral resonances can decay to isolated lepton pairs with high E_T. This signature has been studied in the ee and $\mu\mu$ channels [3, 4]. The W' can decay to a lepton and an anti-lepton neutrino, leading to the signature of an isolated lepton with a large balancing missing E_T (MET). This signature has been studied in the $e\nu$ decay channel [5]. Full simulation of the detector response to simulated proton-proton collisions with a centre of mass energy of 14 TeV has been used with an integrated luminosity of 100 pb^{-1}. This was considered representative of an early LHC dataset.

2. Event Selection and Backgrounds

The single and di-electron selections require identified electrons to pass a standard set of quality and isolation requirements using both the calorimeter and the tracker [3, 5]. The di-muon selection requires two muons which are isolated in the tracker [4]. The W' event selection uses the ratio of the MET to electron E_T as well as the angle between the MET and the electron to further reduce backgrounds [5]. The trigger efficiency is expected to be more than 99 % with respect to the offline selection for signal di-electron events and more than 95 % for single electron events and is more than 97 % for the di-muon selection [3, 4, 5]. The expected di-electron and di-muon mass spectra of a hypothetical signal and expected backgrounds are shown in Figures 1 and 2. The dom-

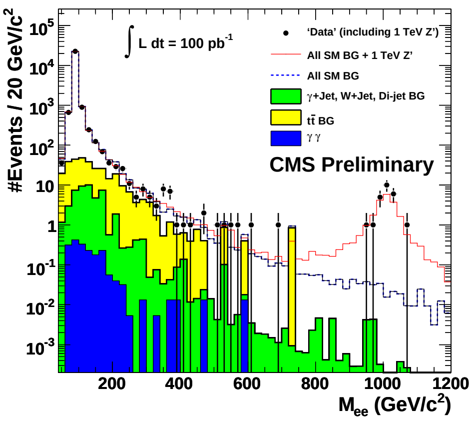

Figure 1: Expected di-electron mass spectrum for backgrounds and a hypothetical signal

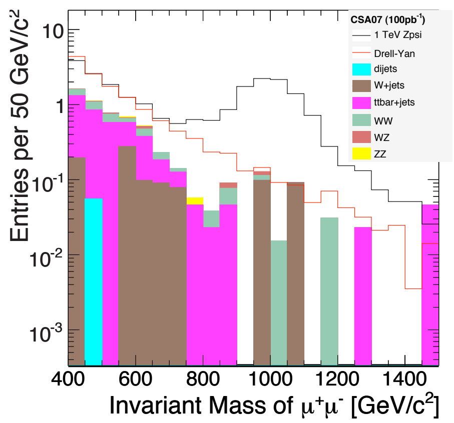

Figure 2: Expected di-muon mass spectrum for backgrounds and a hypothetical signal

inant irreducible background to di-lepton searches at high invariant mass is the Drell-Yan process. This may be determined by normalisation of the simulation to measurements at the Z^0 pole, or by independent measurement of the Drell-Yan cross section in an intermediate mass control region [3]. The largest irreducible background to W' searches is SM $W^{\pm}$ production. The estimation of this background from simulation with appropriate systematics has been studied [5]. The contribution from events containing hadronic jets which are mis-identified can be estimated using the fake rate method. Additionally techniques that exploit the expected charge blind nature of fakes and the selection of control regions through inverting event selection requirements have been studied. The $t\bar{t}$ background, expected to be considerable for all channels discussed, can be estimated by exploiting the $e\mu$ final state or by using b-tagging [3, 4, 5].

3. Results and Conclusion

Studies have predicted that neutral heavy gauge bosons, Z', with a mass between 1.2 TeV ($Z'\psi$) and 1.5 TeV (SM couplings) could be discoverable with the di-electon and di-muon channels with 100 pb^{-1} of integrated luminosity. RS gravitons could be discoverable in the di-muon channel for masses up to 1.5 TeV (k/M$_{Pl}$ = 0.1) [3, 4]. Heavy charged bosons with SM couplings, W', could be discoverable up to a mass of 2.2 TeV or excludable up to a mass of 2.5 TeV. These results are shown in Figures 3 and 4. It is concluded that new physics could be discovered in a small LHC dataset by exploiting distinctive leptonic final states.

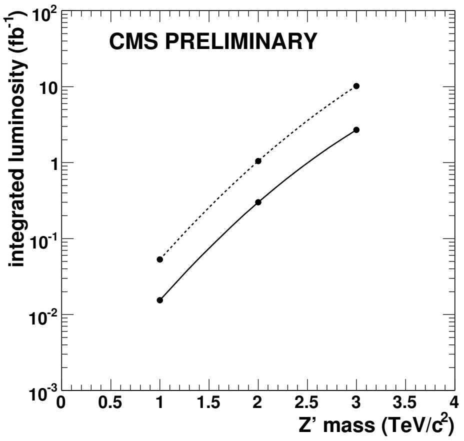

Figure 3: Discovery potential in the di-electron channel ($Z'\psi$ dashed, *SSM* solid)

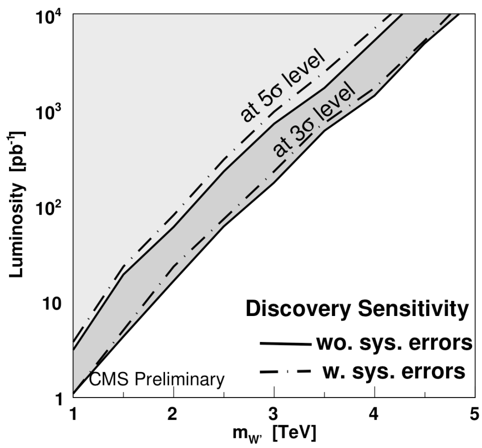

Figure 4: Discovery potential in the electron-MET channel (W' with SM couplings)

References

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