Dimuon Resonances

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I have been studying the potential of the CMS detector to discover new massive particles decaying to muon pairs since my Master thesis on searching for Randall-Sundrum gravitons in CMS in 2003. Since 2008 I am one of the contact persons for the High Mass Dimuon Resonance search in CMS. We have analyzed the full 2010 LHC dataset and found no evidence of a new resonance. I was one of the editors of the publication setting limits on masses of new vector bosons and RS gravitons, based on the analysis of dimuon and dielectron data, and the combination of the two channels [2]. The final limist are the most restrictive to date and, thanks to the LHC center-of-mass energy advantege, surpass results from Tevatron for particles above 1 TeV, despite having over 100 times less data. The final dimuon mass spectrum and the combined dimuon/dielectron exclusion plot are shown in Fig. 1.

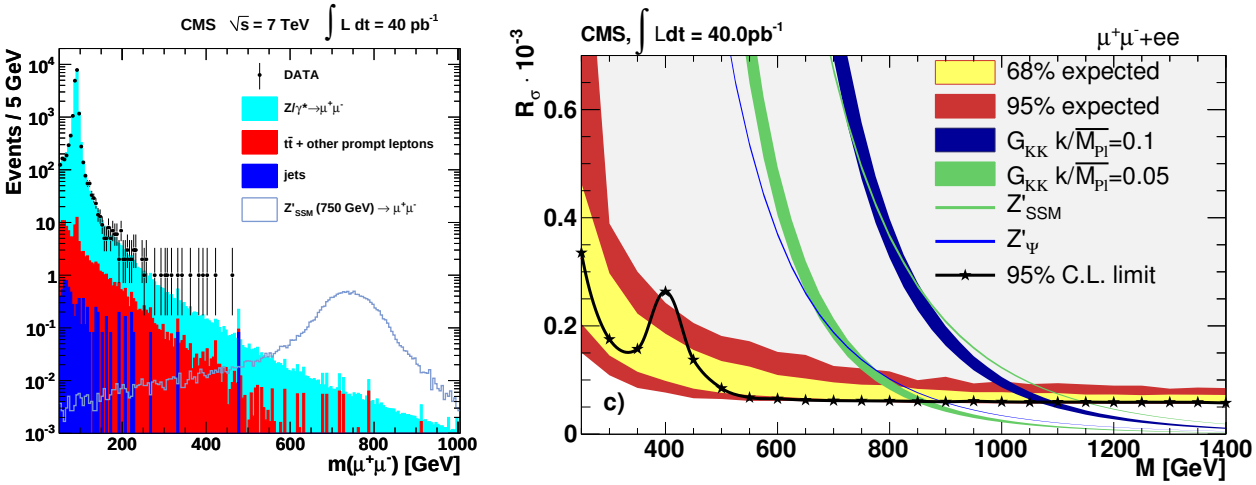

Figure 1: Left plot shows the invariant mass spectrum of dimuon events. The points with error bars represent the data, the filled histograms represent the expectations from Standard Model processes and the open histogram shows the signal expected for a Z'_{SSM} with a mass of 750 GeV. Right plot shows upper limits as a function of resonance mass M, on the cross section times branching fraction into lepton pairs for several types of new resonances. The predicted cross section ratios are shown as bands, with widths indicating the theoretical uncertainties.

My contribution, in addition to coordinating the group and writing the paper, include the design of the algorithm used for high energy muon momentum reconstruction. This algorithm is now part of standard reconstruction and is the one recommended for high-p_T muon studies. The development of this code was originally motivated by my involvement in high mass resonance searches. I have also studied cosmic-ray muon identification and designed a set of selection criteria for rejecting this background in the dimuon analysis. I have measured the performance of the rejection algorithm in a data-driven way and found the contamination from cosmic-ray muons in the signal-search sample with dimuon masses greater than 200 GeV to be smaller than 0.1 event. The importance of this background is illustrated in Fig. 2 showing a comparison between the dimuon spectrum with no selection apart from the quality cuts used in the analysis, and the same spectrum with the cosmic ray rejection cuts applied.

The plans for 2011 are to continue accumulating data in hope for a discovery and further refining and studying in data-driven ways the reconstruction. A big part of data-driven studies

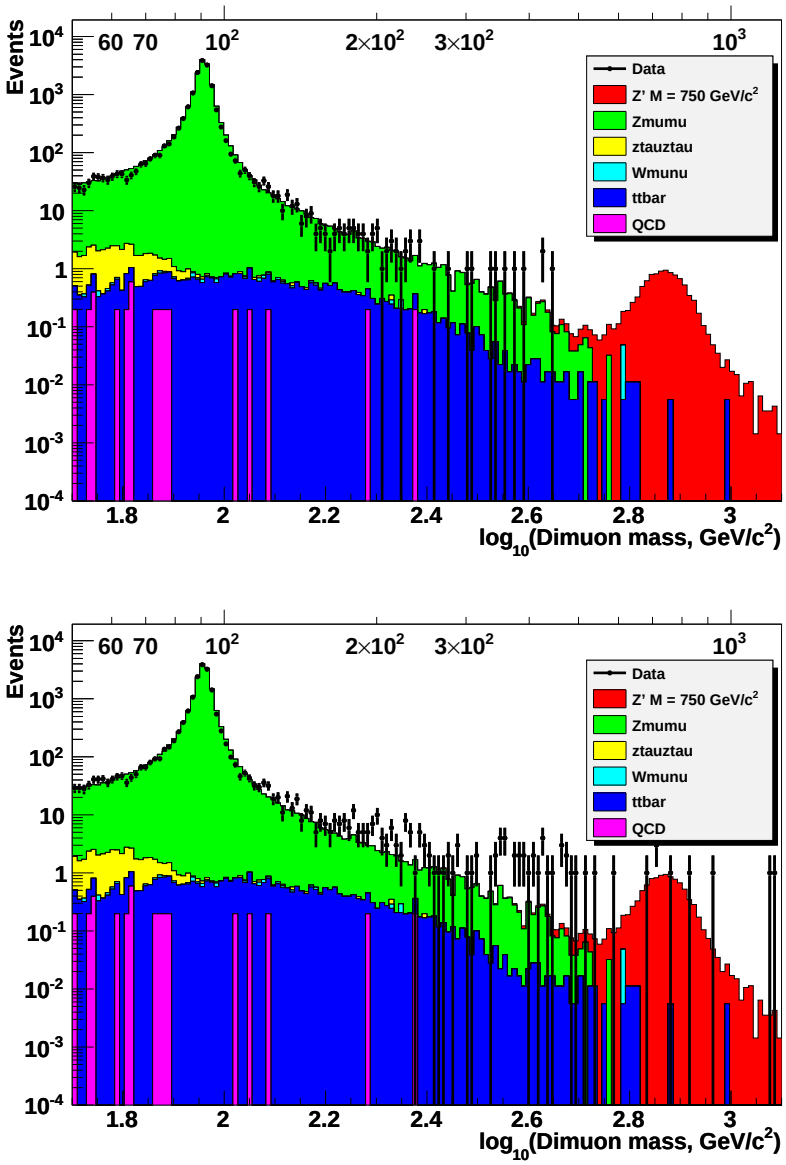

Figure 2: Dimuon invariant mass spectrum in log scale with all the analysis cuts applied (top) and with the 3D angle and impact parameter cuts and the primary vertex requirement removed in the data (bottom).

will be performed using cosmic-ray muons – I am working on these in both contexts: as a background that the analyses have to reject and as a source of energetic muons for detector performance studies.

References

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