The Search for tb Resonances with the CMS Experiment

David Sperka, Boston University
on behalf of the CMS Collaboration

Introduction

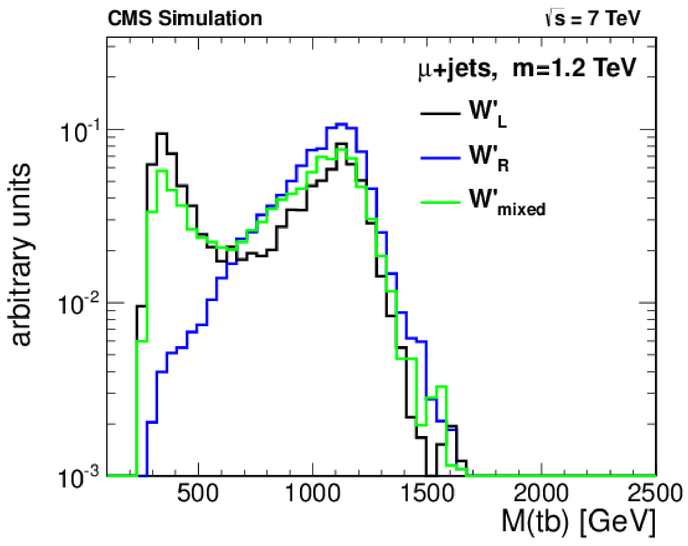
Many theories of physics beyond the Standard Model predict the existence of a new charged gauge boson [1-3], which is often referred to as a W'. A hypothetical heavy W' boson can decay in different ways, including a top and bottom quark pair. The CMS experiment at CERN has carried out a search for a W' boson in this channel using the 2011 [4] and 2012 [5] datasets. No significant excess over the Standard Model expectation is observed, and limits are set on the particle's mass, cross section, as well as its left- and right-handed coupling strengths.

Theory

The lowest order effective Lagrangian describing a W' boson's interaction with fermions can be written as [6]:

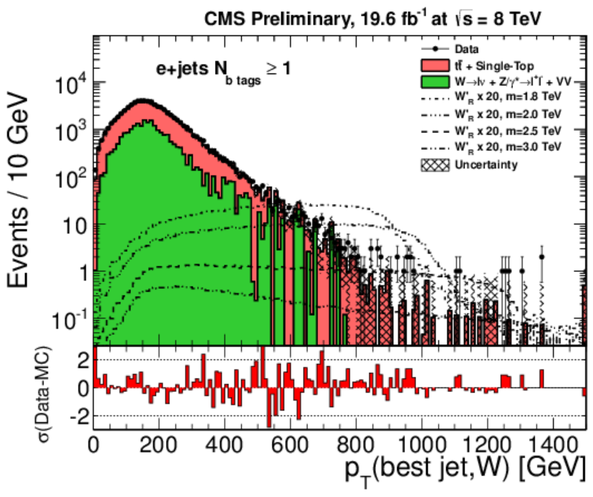
$$\mathcal{L} = \frac{V_{f_i f_j}}{2\sqrt{2}} g_w \bar{f}_i \gamma_\mu \left[a^R_{f_i f_j}(1+\gamma^5) + a^L_{f_i f_j}(1-\gamma^5) \right] W'^\mu f_j + \text{h.c.}$$

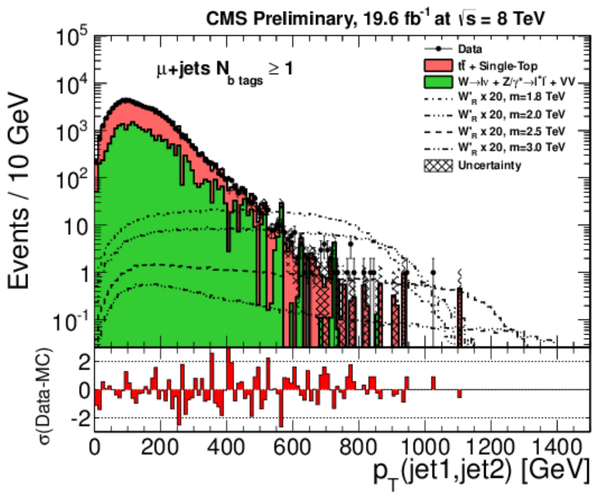
The W' may couple to right-handed fermions, left-handed fermions, or both. If the left-handed coupling is non-zero, there will be interference with the Standard Model s-channel single top production. The effect of the interference is significant, and is accounted for in the search.

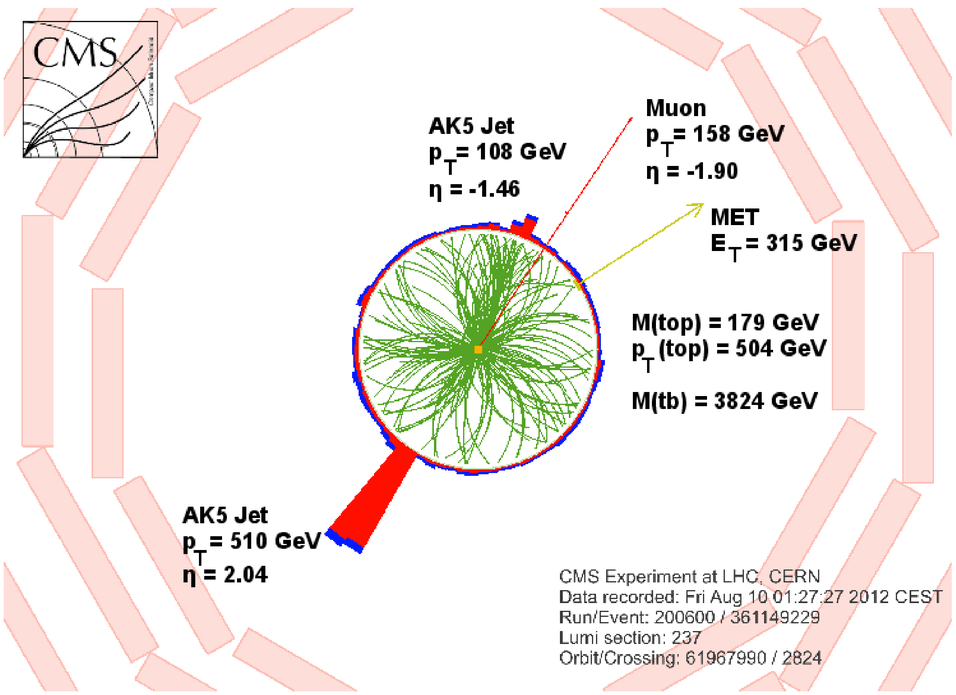


Event Selection

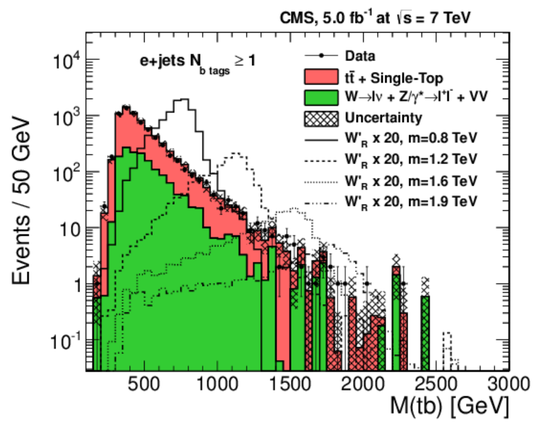
The search is performed by selecting events with an electron or muon, missing energy, and at least two jets, one of which is tagged as a b-jet. The main backgrounds are Standard Model W+jets and top pair production which are simulated using monte carlo generators. The simulation is validated in control regions in data. Additional kinematic cuts are applied to enhance the signal.

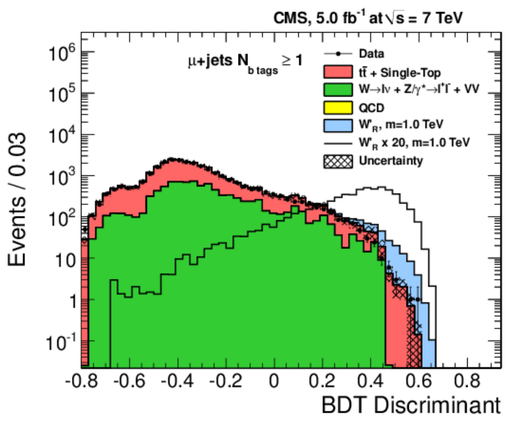




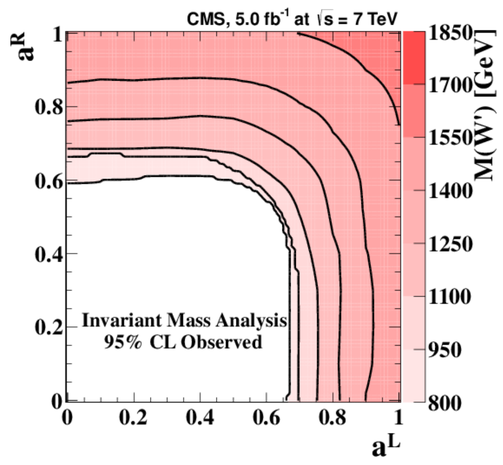


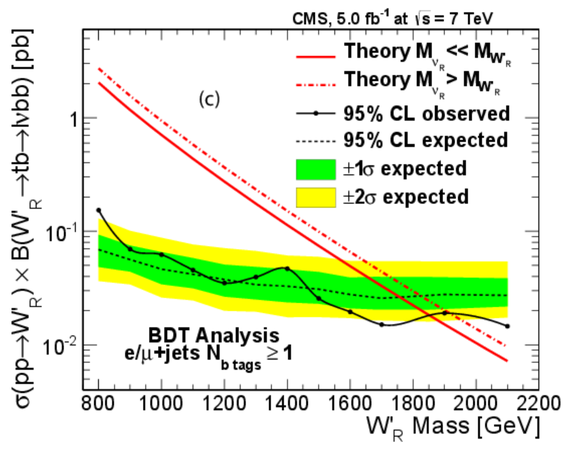
7 TeV Analysis



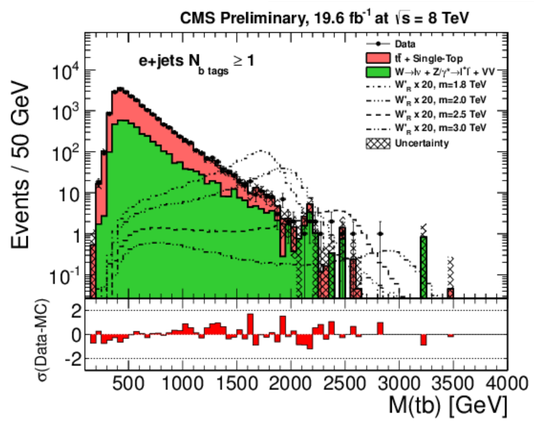


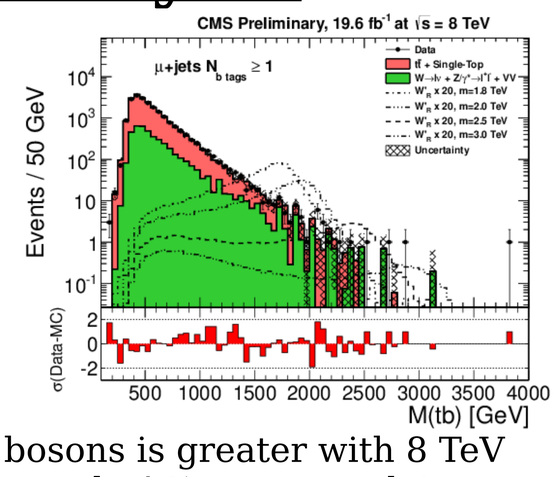
The 7 TeV CMS analysis used the reconstructed tb invariant mass distribution to set limits on the W' mass for arbitrary combinations of the left- and right-handed coupling strengths. A BDT analysis was used to enhance the sensitivity to a W' with purely right-handed couplings. No excess over the Standard Model prediction was observed and W' bosons with mass less than 1.85 TeV were excluded



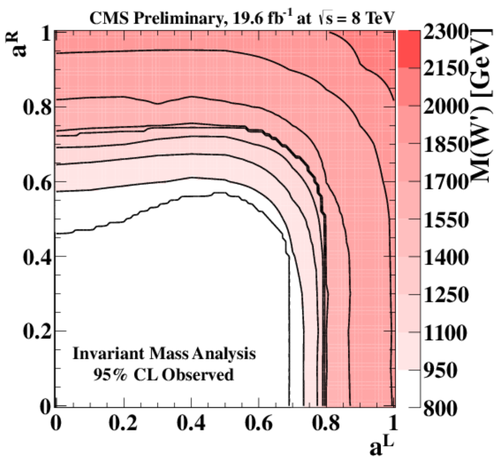


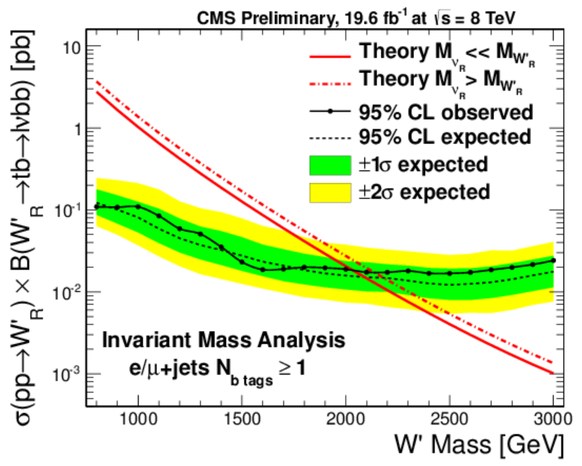
8 TeV Analysis





The sensitivity of CMS to W' bosons is greater with 8 TeV center of mass energy and nearly 4 times more data, especially for high masses. In the absence of signal, the tb invariant mass is used to place limits on the coupling strengths as well as the mass of W' boson with purely right handed couplings, resulting in a lower limit of 2.03 TeV





References

[1] M. Schmaltz, et al, Ann. Rev. Nucl. Part. Sci. 55 (2005) 229
[2] T. Appelquist et al, Phys. Rev. D 64 (2001) 035002
[3] H.C. Cheng et al, Phys. Rev. D64 (2001) 065007
[4]CMS Collaboration, Phys. Lett. B (2013) 718
[5] CMS Collaboration, CMS PAS B2G-12-010
[6] Z. Sullivan, Phys. Rev. D 66 (2002) 075011