Search for Heavy Resonances Decaying to Bosons at CMS

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Overview

Several BSM models predict the existence of new particles in the TeV scale. Searches for exotic particles decaying to pairs of W/Z bosons or pairs of qW/qZ have been performed analyzing semi-leptonic, fully-leptonic and fully-hadronic final states with data collected during 2012 by the CMS detector at the LHC based on 19.8 fb^{-1} of integrated luminosity at a center-of-mass energy of 8 TeV.

Signatures

Three general topologies have been considered:

- In the context of *bulk graviton* (G_{bulk}) model, we analyze the channels $G_{bulk} \to WW/ZZ \to \ell\ell q\bar{q}/\ell\nu q\bar{q}/q\bar{q}q\bar{q}$;
- *Randall-Sundrum* graviton (G_{RS}), excited quarks (q^*) and a heavy partner of the SM W boson (W') are studied with two jet final states through the channels $G_{\mathrm{RS}} \to WW/ZZ \to$ dijet, $q^* \to qW/qZ \to$ dijet and $W' \to WZ \to$ dijet;
- Sequential standard model and low-scale technicolor are tested with tri-lepton final states respectively from decays of W' and ρ_{TC} ($W'/\rho_{\mathrm{TC}} \to WZ \to \ell\nu\ell\ell$).

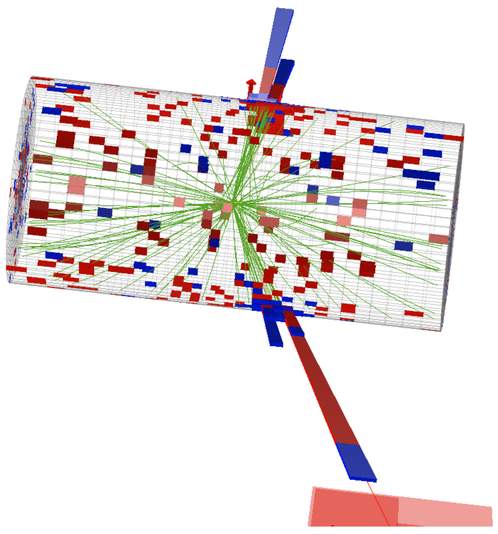
The two first scenarios have been studied based on a boosted regime, where final states are reconstructed as a merged object. Techniques of jet substructure are employed to improve the search sensitivity.

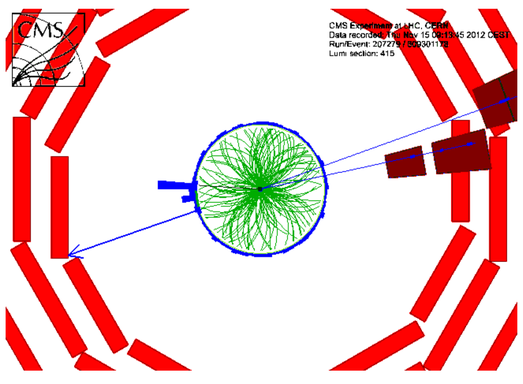
Event Selection

In the case of searching for *bulk graviton*:

- For $W \to \mu\nu(e\nu)$, we require $p_{\mathrm{T}} > 50(90)$ GeV, $|\eta| < 2.1(2.5)$ and $\not{E}_{\mathrm{T}} > 40(80)$ GeV.
- For $Z \to \ell^+\ell^-$ ($\ell \equiv \mu, e$), we require $70 < m_Z < 110$ GeV, $p_{\mathrm{T}}(\mu_1, \mu_2, e) > 40, 20, 40$ GeV and $|\eta(\mu, e)| < 2.4, 2.5$.
- For $W \to q\bar{q}$ ($Z \to q\bar{q}$), we require $65 < m_W < 105$ GeV ($70 < m_Z < 110$ GeV).

For the dijet final states, we require at least two jets of $p_{\mathrm{T}} > 30$ GeV, $|\eta| < 2.5$, $|\Delta\eta(jet_1, jet_2)| < 1.3$ and $70 < m_{W,Z} < 110$ GeV. Events are categorized as single (double) W/Z tagged for decays via qW/qZ ($WW/ZZ/WZ$), as well as of medium or high purity, depending on the discriminant power between subjets.





In searches with tri-lepton final states, $Z \to \ell^+\ell^-$ requires events with $71 < m_{\ell\ell} < 111$ GeV, $p_{\mathrm{T}}(\mu_1, \mu_2, e) > 25, 10, 35$ GeV and $|\eta(\mu, e)| < 2.4, 2.5$, while for $W \to \ell\nu$, remaining leptons are required to have $p_{\mathrm{T}}(\ell) > 20$ GeV and $\not{E}_{\mathrm{T}} > 30$ GeV.

Acknowledgements

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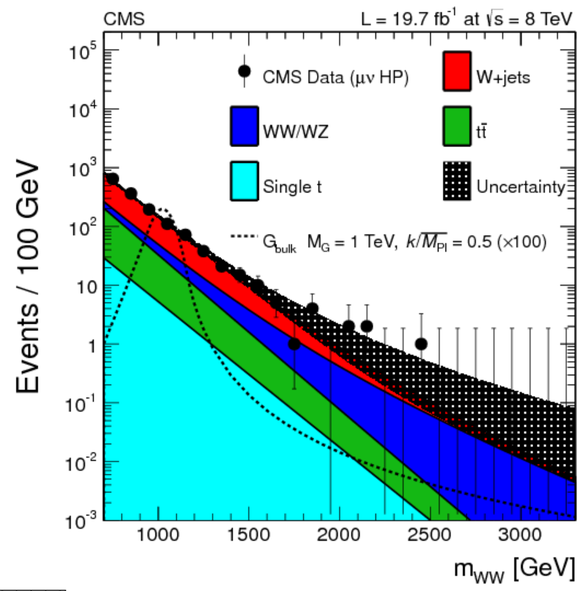
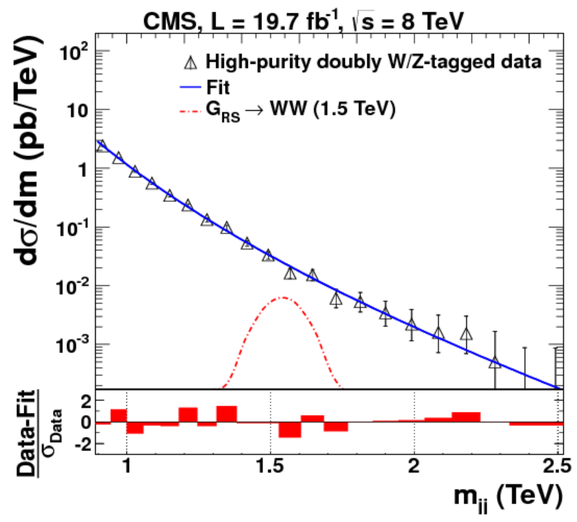
Background Modeling

Searching for G_{bulk}, SM V+jets ($V \equiv W, Z$) are dominant backgrounds. The shape of the m_{VV} distribution is estimated with a transfer function from sideband to signal regions in V+jets events, rescaling data events from the sideband region.

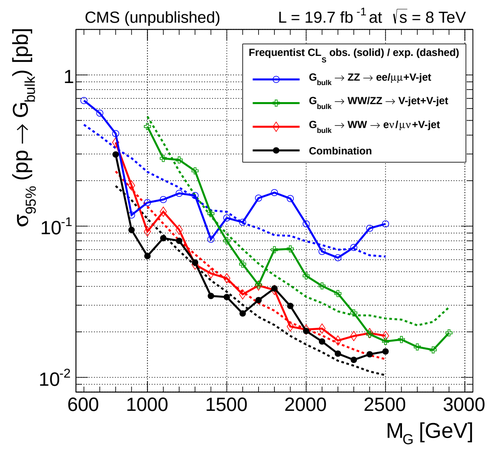


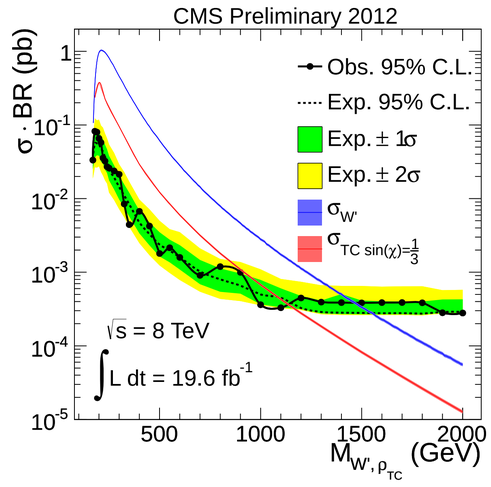


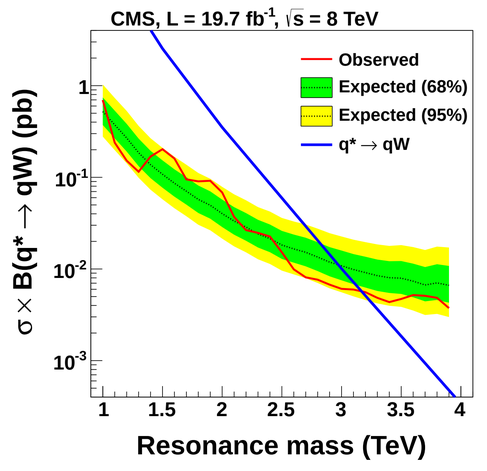
In the dijet topology, the background is modeled with parametrization of the QCD dijet mass spectrum $Fit(m_{jj}) = \frac{P_0(1-m_{jj}/\sqrt{s})^{P_1}}{(m_{jj}/\sqrt{s})^{P_2}}$, where P_0, P_1 and P_2 provide a description of normalization and shape.

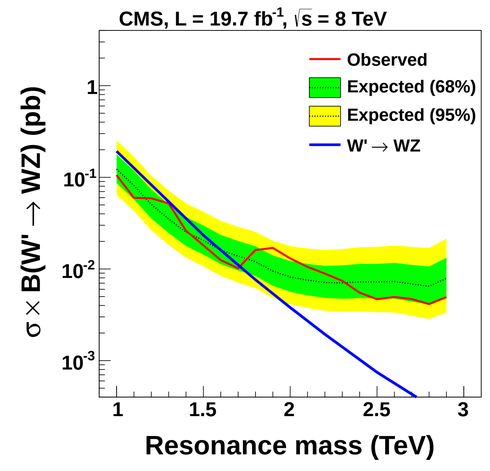
Results

Limits at 95% C.L. are set as a function of the mass.









References

[1] CMS Collaboration, "Search for massive resonances decaying into pairs of boosted bosons in semi-leptonic final states at $\sqrt{s}$ = 8 TeV", *Submitted to the Journal of High Energy Physics* **arXiv:1405.3447** (2014).

[2] CMS Collaboration, "Search for massive resonances in dijet systems containing jets tagged as W or Z boson decays in pp collisions at $\sqrt{s}$ = 8 TeV", *Submitted to the Journal of High Energy Physics* **arXiv:1405.1994** (2014).

[3] CMS Collaboration, "Search for a W' or ρ_{TC} decaying into WZ in pp collisions at $\sqrt{s}$ = 8 TeV", *CMS Physics Analysis Summary* **EXO-12-025** (2013).