SEARCH FOR HIGH-MASS RESONANCES DECAYING TO Z AND HIGGS BOSONS

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OVERVIEW

Several theories of physics beyond the standard model predict the existence of new TeV scale resonances that decay preferentially in dibosons. A search for resonances based on the reaction \( q\bar{q} \rightarrow Z' \rightarrow Z H \rightarrow q\bar{q} \tau^+\tau^- \) is presented, where both Z and Higgs (H) bosons have high-\( p_T \). Studies are based on proton-proton collisions at \( \sqrt{s} = 8 \) TeV with the CMS detector at LHC, analysing 19.7 fb\(^{-1}\) of integrated luminosity.

BOOSTED TOPOLOGY

The signal events are characterized by a Drell-Yan production of a narrow high-mass spin-1 resonance \( (M_{Z'} > \approx 0.8 \text{ TeV}) \), which decays in a Z and H bosons with transverse momentum \( (p_T) \) close to half of the resonance mass. This feature implies that the final products of the two quarks or the two \( \tau \) leptons, from the bosons decay, must be detected within a small angular interval:

\[
\Delta R_{\text{fit}} = \sqrt{\Delta R_{\text{fit}}^2 + (\Delta \phi_{\text{fit}})^2} \approx \frac{2 \times M^{Z/H}}{p_T^{Z/H}}.
\]

The boosted Z boson decaying in a pair of quarks is reconstructed using jet substructure techniques, which consider the 2-subjets-like configuration of the Z-jet and mitigate effects from pileup (PU) and underlying-event (UE). For the boosted H boson decaying into \( \tau \) leptons, the decay products of the two \( \tau \) leptons must be detected within a small angular interval. The constituents associated to one \( \tau \) are removed when identifying the other candidate of the pair.

(a) Boosted Z decaying into a pair of quarks.
(b) Boosted Higgs decaying into a pair of taus (visible components).

EVENT SELECTION

The selection is optimized comparing signal simulations with backgrounds from simulations and observed events. In addition, it is used a baseline selection dedicated to the Z-jet identification and hadronic trigger threshold.

The signal efficiency regarding this selection depends on the mass of the resonance and the channel. It is observed higher efficiencies in all-leptonic category \( (\tau_\ell \tau_\ell, \tau_\ell \nu_\tau, \nu_\tau \tau_\ell) \), between 20 - 60%. In semileptonic \( (\tau_\ell \nu_\tau, \nu_\tau \tau_\ell) \) and all-hadronic \( (\tau_\ell \tau_\ell) \) categories the efficiencies vary between 20 - 40%.

<table>
<thead>
<tr>
<th>Selection</th>
<th>( \tau_\ell \tau_\ell )</th>
<th>( \tau_\ell \nu_\tau )</th>
<th>( \nu_\tau \tau_\ell )</th>
<th>( \tau_\ell \tau_\ell )</th>
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<td>( E_{T,\text{miss}} )</td>
<td>&gt; 100 GeV</td>
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<td>&gt; 35 GeV</td>
<td>&gt; 50 GeV</td>
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<tr>
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<td>&gt; 50 GeV</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
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<td>&lt; 1.0</td>
<td>&lt; 1.0</td>
<td>&lt; 1.0</td>
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<tr>
<td>( m_{\text{eff}} )</td>
<td>-</td>
<td>105-180 GeV</td>
<td>-</td>
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REFERENCES