

Search for high-mass resonances in dilepton final states with associated b -jets at the ATLAS experiment

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A search for high-mass dilepton resonances produced in association with b -quarks is performed with the ATLAS detector using proton-proton collision data collected during Run 2 of the Large Hadron Collider (LHC) at a centre-of-mass energy of 13 TeV corresponding to an integrated luminosity of 140 fb^{-1} .

The Z' boson model, which is considered in this analysis, is a candidate explanation for potential anomalies in B hadron decays, and the Z' boson couples to b and s quarks in the production. An example Feynman diagram can be found in Figure 1. The presented search targets final states including two same-flavour leptons (electrons or muons) with either zero, one or at least two b -tagged jets.

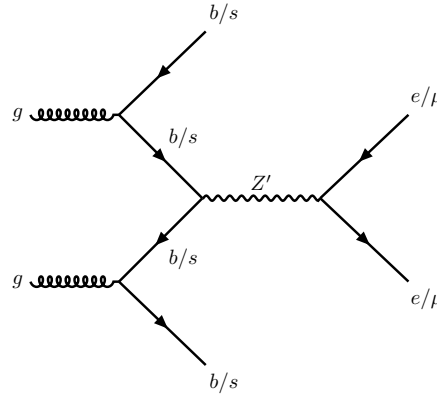


Abbildung 1: Example Feynman diagram showing the production and decay of the Z' boson.

The signal process and most background processes are estimated using Monte Carlo (MC) simulations. MC signal samples are available for Z' boson masses between 0.5 TeV and 4 TeV for resonances of narrow width ($\approx 2\%$) and of larger width ($\approx 8\%$). The width is controlled by the coupling parameter g between the Z' boson and the quarks and leptons. An additional background arises from events in which at least one of the two leptons is due to a misidentified jet that passes the lepton selection criteria. This background is estimated using a data-driven technique, the so-called Matrix Method.

Control regions for the dominant background processes are defined in order to verify the shape and normalisation of these processes. The normalisation is included as a free floating parameter in the final fit. Three signal regions are defined based on the number of b -jets in the final state: zero, one or at least two. Furthermore, the background

contributions can be reduced by applying additional selections. The missing transverse momentum significance, $\sigma(E_T^{\text{miss}})$, helps to distinguish between real missing transverse momentum, e.g. from neutrinos, and fake missing transverse momentum, e.g. stemming from detector resolution effects. Applying a selection criterion of $\sigma(E_T^{\text{miss}}) < 5$ reduces the background contribution. In signal regions with at least one b -jet, the background from $t\bar{t}$ events is further reduced by requiring $\min(m_{\ell b}) > 155 \text{ GeV}$, where $\min(m_{\ell b})$ is the minimum invariant mass of any lepton- b -jet pair in the event.

Finally, a statistical analysis is necessary to test the compatibility of the signal hypothesis with the observed data. Therefore, a profile likelihood fit is performed in the signal and control regions using the dilepton invariant mass spectrum as an observable. Limits on the Z' production cross-section are set as a function of the Z' boson mass.