

# Background determination of the control region of the $R \rightarrow SH \rightarrow 4\ell + E_T^{miss}$ signal at the ATLAS detector

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The 4-lepton final state is a clean and important signal that is being studied at the ATLAS detector. In this study, we focus on four leptons originated from the  $R \rightarrow SH \rightarrow 4\ell + E_T^{miss}$  signal.  $R$  is a scalar boson produced via gluon-gluon fusion and decays to two lighter scalar bosons,  $S$  and  $H$ . The  $S$  decays to a pair of Standard Model of particle physics neutrinos. And thereof considered here as missing transverse energy,  $E_T^{miss}$ . The 4-lepton final state comes from the  $H$  boson through the decay of the  $ZZ$  bosons. The signal region looks at four leptons invariant mass,  $m_{4\ell}$ , greater than 200 GeV. This study helps to understand the nature of the considered background for the  $4\ell + E_T^{miss}$  signal on a control region defined by  $m_{4\ell}(140-200)$  GeV. A comparison between the state-of-the-art Monte Carlo simulation for the background processes, and the data at an integrated luminosity of  $139 \text{ fb}^{-1}$  is provided.

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