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Reducing the Spurious Signal Systematic Uncertainty in Higgs to Diphoton Analyses in the ATLAS Experiment Using Gaussian Process Regression

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The Run II dataset of pp collisions at $\sqrt{s} = 13$ TeV taken with the ATLAS detector has resulted in multiple Higgs Boson analyses in the diphoton decay channel. These analyses measure the continuum diphoton background by fitting an analytic function to sideband regions in data. With this estimation comes a so-called "spurious signal"systematic uncertainty, meant to account for mismodeling of the true background shape under the Higgs signal by the analytic function. This systematic uncertainty is typically measured using a background-only Monte Carlo sample. Despite the production of huge numbers of Monte Carlo events, limited yields in particular phase spaces can lead to large statistical fluctuations in the background sample, which may be measured as spurious signal. In this case, the systematic uncertainty is greatly inflated, and it no longer reflects the shape discrepancy it is meant to describe. One possible approach to bettering the spurious signal calculation is to use Gaussian Process Regression to effectively smooth out statistical fluctuations in the background-only sample. Initial studies of this approach show promising improvements to the spurious signal calculation.

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