Abstract Submitted
for the APR21 Meeting of
The American Physical Society

Cuts Optimization and Machine Learning Models for Dark Photon Signal-Background Discrimination with the ATLAS Detector[1]

ELYSSA HOFGARD, LAUREN TOMPKINS, Stanford University, ATLAS COLLABORATION — Within Beyond the Standard Model (BSM) theories, interest has been growing in the proposed dark sector, containing particles that are not charged under Standard Model (SM) gauge groups. Dark photons may interact via the vector portal as a result of kinetic mixing, so the LHC could be a viable tool for dark photon production. We consider the ZH production mechanism to search for a newly-predicted decay of the Higgs boson into a photon (γ) and a massless dark photon (γ_D) with a target final state of $Z(\rightarrow \ell^+\ell^-)H(\rightarrow \gamma\gamma_D)$. We use Monte-Carlo simulation samples corresponding to the total integrated luminosity of pp collisions at $\sqrt{s} = 13$ TeV collected by the ATLAS detector in 2015-2018. First, we implement rectangular cut optimization to obtain a baseline signal region (SR) selection. Next, we explore the use of boosted decision trees (BDTs) and neural networks to train a classifier for signal-background discrimination. We find that BDTs using the Gradient Boosting algorithm yield the best performance with 93% accuracy and an area under the Receiver Operating Characteristic (ROC) curve (AUC) of 0.96. We finally present preliminary studies of using the BDT output scores for signal-background discrimination.

[1]This work was partially supported by an International Research Experience for Students (IRES) grant from the National Science Foundation and George Mason University.

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Date submitted: 07 Jan 2021 Electronic form version 1.4