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Probing the Supersymmetric Standard Model at the Large Hadron Collider through Vector Boson Fusion Processes and Machine Learning

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We present a phenomenology study probing the Supersymmetric Standard Model (SSM) at the Large Hadron Collider for a previously unexplored region of the parameter space.
In particular, we consider proton-proton collisions at $\sqrt{s} = 13$ and $\sqrt{s} = 14$ TeV and investigate the production of GeV-scale first and second-generation neutralinos $\widetilde{\chi}_1^0$ and $\widetilde{\chi}_2^0$, and first-generation charginos $\widetilde{\chi}_1^\pm$. This is done by employing a novel $pp \to$ ewkino ewkino jj vector boson fusion (VBF) topology. The analysis is performed using machine learning algorithms i.e. gradient boosting and deep learning methods, over traditional methods, to maximize the signal sensitivity with integrated luminosities of of 150, 300, and 3000 fb^{-1}. We expect that our methodology extends LHC constraints to the SSM with $\geq 5\sigma$ signal significance throughout this parameter space, traditionally considered difficult to probe due to SM backgrounds and small SSM cross sections.

Primary authors: GURROLA, Alfredo (Vanderbilt University); QURESHI, Umar Sohail (Vanderbilt University)

Presenter: QURESHI, Umar Sohail (Vanderbilt University)

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