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Test of CP-invariance of the Higgs boson in vector-boson fusion production in the H→γγ channel with the ATLAS detector

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The abundance of matter over antimatter in the Universe is one the confounding puzzles of modern physics. The Sakharov's conditions require C and CP violation as an essential ingredient to explain the cosmic baryon asymmetry. So far, the only source of CP-violation observed is through the complex phases of the quark mixing (CKM) matrix in the flavour-changing weak interactions. However, the magnitude is many orders below what is needed to account for the asymmetry. Although the Higgs boson interaction with other particles is determined to be CP-conserving (CP-even), there are extended Higgs sector models that allow admixtures between CP-even and additional CP-odd Higgs which could induce new sources of CP violation. Previous analyses have been utilising the angular and differential cross section distributions to look into the CP structure of the Higgs interactions however dedicated CP-odd observable would better enhance the sensitivity to probe for new physics.

This work presents the test for CP-invariance in the H⟶γγ channel via vector boson fusion using Run3 data of the ATLAS experiment at the Large Hadron Collider (LHC) in proton-proton collision at a center-of-mass energy of 13.6TeV. The analysis is designed to probe CP-violation in the HVV interaction vertex using an Optimal Observable (OO) approach. A multi-classifier is used to separate the contributions coming from the VBF signal and the main backgrounds from the gluon-gluon fusion Higgs production and the irreducible non-resonant diphoton production. The background template is constructed using a data-driven approach within a sideband control region. Maximum likelihood fits to the Wilson coefficient are performed to constrain CP-violating effects by shape-fit to the OO which are expected to be symmetric around zero in the SM.

Author: SOBERI, Firdaus (The University of Edinburgh (GB))

Co-authors: DUDA, Dominik (The University of Edinburgh (GB)); Dr CLARK, Philip (The University of Edinburgh)

Presenter: SOBERI, Firdaus (The University of Edinburgh (GB))

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