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Measurement of □ ⟶ □□* ⟶ 4l and H ⟶ μμ using the ATLAS detector at the LHC

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The Large Hadron Collider (LHC) is the most powerful particle accelerator ever built, designed to test the Standard Model and probe new frontiers in physics. One of its primary objectives was the discovery of the Higgs boson, whose detection confirmed the mechanism of electroweak symmetry breaking and explained the origin of mass for weak force mediators. The current focus of Higgs studies at the LHC is to study detailed properties of the Higgs boson, such as measuring kinematic distributions, its interaction strength (coupling) to other particles, and to establish evidence for its rare interactions.

This talk presents a recent measurement of Higgs boson properties that uses pp collision data at $\sqrt{s}$ = 13.6 TeV recorded during 2022-2023. The analysis focus on the so-called 'golden channel' where the Higgs boson decays into four leptons (□ ⟶ □□* ⟶ 4l, where l = e or μ), which has a small branching ratio but allows for precise measurements due to the ATLAS detector's excellent lepton momentum resolution and high identification efficiency. Modern machine learning techniques are used to enhance the precision of the measurements, which includes: production cross sections of the different Higgs production modes; Higgs coupling strengths to fermions and vector bosons; differential cross sections for multiple observables; and, constraints on the Higgs boson self-coupling and interpretations within an effective field theory framework.

A second focus of the talk is of the H ⟶ μμ decay, which has not yet been conclusively observed. A measurement of this very rare decay would establish the Higgs boson's interactions with second-generation fermions at the LHC. Despite being a relatively clean final state, it faces a significant irreducible background from Drell-Yan production and a small H ⟶ μμ branching fraction. An analysis based on data collected by ATLAS in 2015-2018 is presented, and ideas for improvements using novel techniques are discussed.

Keyword-1

Higgs boson

Keyword-2

Machine Learning

Keyword-3

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