T 20: Higgs 1 (boson final states)

Time: Monday 16:00–17:45 Location: Geb. 30.41: HS 2

T 20.1 Mon 16:00 Geb. 30.41: HS 2

Higgs Boson Production Cross-section Measurements at $\sqrt{s} = 13.6$ TeV in the $H \to ZZ^* \to 4l$ Channel With the ATLAS Detector — •Alice Reed, Sandra Kortner, and Oliver Kortner — Max Planck Institut für Physik, München

An important process for the measurement of Higgs boson properties is the Higgs boson decay into two Z bosons, which subsequently decay into a $\mu^+\mu^-$ or e^+e^- pair, $H \to ZZ^* \to 4l$. Due to its clear signature, this decay channel can be studied with the first Run 3 collision data collected with the ATLAS detector in 2022 and 2023, providing measurements at a new centre-of-mass energy of $\sqrt{s} = 13.6$ TeV.

To reduce the model dependence, the cross-section for this process is measured in a fiducial phase space which closely matches the detector-level kinematic selection and is corrected for detector effects. The inclusive fiducial cross-section measured using the 2022 ATLAS dataset, corresponding to 29.0 fb^{-1}, is in agreement with the corresponding Standard Model prediction. Expanding upon this measurement, differential fiducial cross-section measurements for observables sensitive to the Higgs boson production and decay can also be performed. Strategies for upcoming differential fiducial cross-section measurements with 56 fb^{-1} of data from the ATLAS detector in 2022 and 2023 will be presented.

T 20.2 Mon 16:15 Geb. 30.41: HS 2

Machine-learning-based optimisation of Higgs coupling measurements in the $H \to 4l$ decay channel with ATLAS Run 3 data — •Luca Spitzauer, Sandra Kortner, Alice Reed, and Hubert Kroha — Max-Planck-Institut für Physik

Cross-section measurements for different Higgs boson production and decay processes constitute a key area in the exploration of Higgs properties, with a high sensitivity to potential physics beyond the Standard Model. Due to its exceptionally clear signal, the decay of a Higgs boson into a ZZ^* pair with a subsequent decay of each Z boson into two leptons, $H \to ZZ^* \to 4l$, is one of the most important channels for the Higgs property measurements.

Optimized classification of events according to these 'production bins' is vital to improve the signal sensitivity and reduce sources of uncertainty. Previous round of STXS measurements in the $H \to 4l$ channel with the Run 2 ATLAS dataset employed a Neural Network classification approach. With the new Run 3 dataset at a centre-of-mass energy of 13.6 TeV, potential optimization of this classification is explored by means of additional machine-learning approaches with improved architectures.

T 20.3 Mon 16:30 Geb. 30.41: HS 2

Methodological developments for $H \to \gamma\gamma$ data analyses in Run-3 at the CMS experiment — Caio Daumann, Johannes Erdmann, Nitish Kumar, •Florian Mausolf, and Jan Lukas Späh — III. Physikalisches Institut A, RWTH Aachen University

In 2022, the Large Hadron Collider resumed operations, with a proton-proton beam at an unprecedented centre-of-mass energy of $\sqrt{s} = 13.6$ TeV. This marked the start of the Run-3 data taking period. Despite the Higgs boson's diphoton decay channel having a relatively low branching ratio of approximately 0.23 %, it offers wide opportunities for precision analyses. Due to a low background level combined with the excellent precision in the reconstruction of photons, this decay channel is already accessible with the data taken so far in Run-3.

This presentation focuses on methodological developments for the $H \to \gamma\gamma$ analyses in Run-3 at the CMS experiment. A new software framework based on the columar-analysis approach is introduced. The framework's application is demonstrated in the first Higgs boson cross-section measurement using the 2022 dataset taken with the CMS experiment. Furthermore, developments to enhance the sensitivity of this cross-section measurement are presented.

T 20.4 Mon 16:45 Geb. 30.41: HS 2

First measurement of $H \to \gamma\gamma$ fiducial cross sections with 13.6 TeV CMS data — Caio Daumann, Johannes Erdmann, Nitish Kumar, Florian Mausolf, and •Jan Lukas Späh — III. Physikalisches Institut A, RWTH Aachen University

The Higgs boson, which is of fundamental interest for the understanding of matter, has been studied in detail by the ATLAS and CMS collaborations since its discovery in 2012. Measurements of Higgs boson production cross sections are important to probe possible beyond the standard model effects in the scalar sector.

In this talk, the measurement of Higgs boson production cross sections in the diphoton decay channel at $\sqrt{s} = 13.6$ TeV based on a sample of proton-proton collision data collected in 2022 with the CMS experiment is presented. This analysis benefits from the clean topology of the diphoton decay channel. The cross sections are measured in a fiducial phase space at particle level, reducing extrapolation uncertainties and enhancing the model independence of the measurement. In this talk, special emphasis is placed on the statistical analysis, which includes the simulation-based signal modelling and the data-driven background modelling.

This analysis lays the foundation for further measurements of Higgs boson processes in the diphoton decay channel by the CMS collaboration in Run 3 of the LHC and beyond.

T 20.5 Mon 17:00 Geb. 30.41: HS 2

Measurement of gluon fusion and vector-boson fusion Higgs-boson production cross sections in $H \to WW^* \to l\nu l\nu$ decays at $\sqrt{s} = 13$ TeV with the ATLAS detector — •Ahmed Markhoos, Benedict Winter, Karsten Köneke, and Karl Jakobs — University of Freiburg, Freiburg, Germany

The Higgs-boson decay to two W bosons ($H \to WW^*$) has proven to be crucial for measuring the Higgs-boson couplings and testing the Standard Model, given that it is the decay mode with the second largest branching ratio. $H \to WW^* \to l\nu l\nu$ specifically provides a sizable signal and moderate background yields, allowing for accurate measurements of the total and differential cross-sections through gluon-gluon fusion (ggF), vector boson fusion (VBF) and Higgs Strahlung production modes. In this talk, an overview of the ongoing $H \to WW^* \to l\nu l\nu$ ggF and VBF Simplified Template Cross-Section (STXS) analysis is presented, based on the full Run 2 dataset. This analysis improves significantly upon the first full Run 2 analysis by extending the use of multivariate techniques and considering Higgs-boson decays to light leptons of the same flavor ($e\nu e\nu/\mu\nu\mu\nu$) in addition to different flavor decays ($e\nu\mu\nu$). This in return enables a more granular and precise STXS measurement with noticeably higher sensitivity.

T 20.6 Mon 17:15 Geb. 30.41: HS 2

Search for the Higgs plus charm quark production mode in the H→WW→e$\nu\mu\nu$ channel — •Ming-Yan Lee[1], Spandan Mondal[2], Alexander Schmidt[1], Andrey Pozdnyakov[1], Alena Dodonova[1], Uttiya Sarkar[1], and Valentyn Vaulin[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Germany — [2]Brown University, Providence, USA

The Higgs plus charm production mode is another topology to probe Higgs-charm Yukawa coupling complementary to H→cc channels. This topology provides the possibility to access the Higgs-charm coupling via cleaner final states. In this analysis, we aim to consider the Higgs decay into W boson to final states with additional charm-tagged jets. The upper limit to extract H-c coupling is determined using the data-taking period 2016 to 2018 of the CMS experiment at the LHC at $\sqrt{s}$=13 TeV.

T 20.7 Mon 17:30 Geb. 30.41: HS 2

Jet-Lepton Overlap Removal Optimization in context of the boosted $H \to WW \to l\nu qq$ measurement using Run 2 data in ATLAS — •Jan Philipp Jäkel, Chris Malena Delitzsch, and Carsten Daniel Burgard — Technische Universität Dortmund, Dortmund, Germany

The unprecedented center-of-mass energy of the Large Hadron Collider enables the production of Higgs bosons with a momentum much higher than their mass, resulting in a collimation of its decay products. In this presentation, the $H \to WW \to l\nu qq$ decay is explored due to its high branching ratio and the clean event signature. The hadronic decay of the W boson is reconstructed as one large-radius jet using particle flow-like objets as inputs, a combination of signals from the calorimeters and charged-particle tracks from the inner detector. In case of high collimation, the leptons from one of the W boson decays can overlap with the jet from the other W boson decay. In ATLAS, the reconstruction of leptons and jets is conducted independently from

another and therefore the deposited energy of a charged lepton in the electromagnetic or hadronic calorimeter can be also reconstructed as part of the jet leading to double counting of the lepton's energy in the event. The usage of particle flow-like objects for jet reconstruction enables the removal of the lepton's energy at the calorimeter cell level to avoid the double counting. Modifications to the currently used particle flow algorithm are explored to optimise the overlap removal between jets and leptons with focus on electrons. The studies use Monte Carlo simulated events of $\sqrt{s} = 13$ TeV proton-proton collisions.