T 2: Higgs Physics I (HH and trilinear coupling)

Time: Monday 16:45–18:45 Location: ZHG104

T 2.1 Mon 16:45 ZHG104

Status for Run3 in the $HH \longrightarrow b\bar{b}\tau^+\tau^-$ channel with the CMS Experiment — •Bogdan Wiederspan, Nathan Prouvost, Ana Andrade, Marcel Rieger, Philip Keicher, Anas Haddad, Tobias Kramer, and Peter Schleper — University Hamburg, Hamburg, Germany

Since its discovery at the Large Hadron Collider (LHC) in 2012, the Higgs boson advanced our understanding of the Standard Model. Despite significant progress, several of its fundamental properties and couplings remain elusive. Among these is the concrete form of the Higgs potential, which depends on the still-undiscovered trilinear self-coupling, often denoted in the kappa framework as κ_λ. The Di-Higgs production with subsequent decays into pairs of bottom quarks and tau leptons, holds particular interest to probe aforementioned coupling, due to its combination of a strong identifiable signature and substantially large statistics.

Given the challenges posed by the small predicted cross section of Di-Higgs processes and the large background contribution, machine learning proves to be an essential tool for enhancing the sensitivity of searches. This talk presents the current efforts of developing a stronger discriminator trained with partial Run3 data recorded with the CMS experiment, to classify events in the $HH \longrightarrow b\bar{b}\tau^+\tau^-$ channel and further increasing sensitivity.

T 2.2 Mon 17:00 ZHG104

Search for Di-Higgs Pair Production in the bbtautau decay channel using Run2+Run3 Data with the ATLAS Detector at the LHC. — •Bhupesh Dixit[1,2], Carl Gwilliam[3], Jordy Degens[4], and Katharina Behr[5] — [1]University of Liverpool, United Kingdom — [2]DESY, Hamburg — [3]University of Liverpool, United Kingdom — [4]University of Liverpool, United Kingdom — [5]DESY, Hamburg

Di-Higgs studies provide the possibility of probing the full shape of the Higgs potential via constraints on the Higgs trilinear coupling. Among all the di-Higgs decay channels, di-Higgs decays to two b-jets and two tau-leptons lies in the sweetspot for the study of di-Higgs owing to its relatively low background and significant branching ratio, making it the most sensitive channel among the ATLAS Run-2 searches for the study of Higgs self-coupling. Using Run2+Run3 data with improved analysis techniques a significant improvement is expected in the sensitivity to Higgs boson pair production. I will present an overview of the analysis strategy and current status with emphasis on the estimate of the important background from SM ttbar production.

T 2.3 Mon 17:15 ZHG104

Phase Space Optimization for the $b\bar{b}\tau^-\tau^+$ Di-Higgs Analysis using Machine Learning with the CMS Experiment — Ana Andrade, •Anas Haddad, Philip Keicher, Tobias Kramer, Nathan Prouvost, Marcel Rieger, Peter Schleper, and Bogdan Wiederspan — Institute for experimental physics, University of Hamburg, Hamburg, Germany

This year marks the twelfth anniversary of the Higgs boson discovery. Yet, many of its properties and couplings remain unexplored. Particularly interesting are the couplings producing a Di-Higgs system in the final state, which are modulated as κ_λ and κ_{2V} in the κ-framework and pose a significant challenge for analyses due to the extremely low cross-sections of their production processes.

Since an efficient usage of the available data is crucial in such analyses, the selection is an important part and decisive for all following analysis steps and resulting measurements. However, one is always confronted with the dilemma of having to trade off higher event statistics for large background contamination in the selected phase space, or vice versa.

This study aims to move away from a fully cut-based selection, usually based on a certain topology, towards a more data-driven approach. The latter utilizes a NN on top of a loose preselection with the goal of optimizing the event selection in the search for Di-Higgs production in the $b\bar{b}\tau^-\tau^+$ channel and enhancing the sensitivity of this analysis.

T 2.4 Mon 17:30 ZHG104

Neural-network-based di-tau mass reconstruction in Higgs boson pair production in the final state with two b quarks and two tau leptons — •Jonathan Pampel, Tatjana Lenz Lenz, and Jochen Dingfelder — Physikalisches Institut, Universität Bonn, Nussallee 12, 53115 Bonn

The Higgs boson self interaction could not yet be observed at the Large Hadron Collider due to the rarity of associated processes, such as Higgs boson pair production. Upper limits on the Higgs self-coupling strength have been set using ATLAS and CMS pp data from LHC Run 2. Run 3 data will improve the limits on the HH production cross section and on the Higgs self coupling.

Tau leptons provide a relatively distinct signature (triggering) during data taking and with a probability of about 6% for Higgs bosons to decay into tau pairs, this process is rather frequent. However, the most abundant decay mode for Higgs bosons is the decay into two b quarks. The HH->bb$\tau\tau$ decay mode benefits from both advantages.

One of the challenges of studying this decay mode is the reconstruction of the invariant mass of the di-tau system. This has long been done using a fitting tool – the missing mass calculator (MMC) – which performs well, but is computationally expensive and sometimes does not converge. To mitigate this issue, a neural network (NN) can be used since its evaluation is faster and there is no convergence issue.

This talk will present the training and the performance of the NN-based method for di-tau mass reconstruction, applied to ATLAS pp collision data from Runs 2 and 3.

T 2.5 Mon 17:45 ZHG104

Study of b+tau triggers in the $HH \to bb\tau\tau$ analysis with the ATLAS experiment — •Pim Bijl, Karl Jakobs, Benedict Winter, Christian Weiser, and Yingjie Wei — Insitute of Physics, Albert Ludwigs Universitaet, Freiburg, Germany

In order to search for di-Higgs production at the Large Hadron Collider (LHC) with the ATLAS experiment, a very efficient event selection is necessary. The first step in the event selection are triggers that decide what LHC collision events are kept for further analysis. This talk will present a study of newly introduced triggers that target the presence of a b-quark jet and a hadronically decaying tau lepton. These triggers are of great interest to the search for di-Higgs production, as they target the signature of the $HH \to bb\tau\tau$ decay channel. This decay channel has one of the largest branching ratios of di-Higgs decays and provides a clean decay signature. A comparison will be made to the efficiency of the triggers that are currently in use in the $HH \to bb\tau\tau$ search. Finally, the impact of the new triggers on the sensitivity to the production of di-Higgs in the $bb\tau\tau$ decay channel will be summarized.

T 2.6 Mon 18:00 ZHG104

Improving the sensitivity to the Higgs boson self-coupling in the $HH \to bb\tau\tau$ channel with the ATLAS experiment — •Katharina Häussler[1], Karl Jakobs[1], Karsten Köneke[2], Yingjie Wei[1], Christian Weiser[1], and Benedict Winter[1] — [1]University of Freiburg — [2]University of Göttingen

The Standard Model (SM) predicts final states with multiple Higgs bosons, involving processes with Higgs boson self-interactions, which have yet to be observed experimentally. Higgs boson pair production provides the most sensitive test of triple Higgs boson self-interactions and the $bb\tau\tau$ final state presents a good compromise between expected signal yield and background contamination, making it one of the three golden channels to explore this phenomenon.

This talk focuses on improvements that can be made in future analyses to increase the sensitivity to the Higgs boson self-coupling modifier κ_λ. Significant deviations from the SM prediction would provide a strong indication of physics beyond the Standard Model.

T 2.7 Mon 18:15 ZHG104

$\tau\tau$ background estimation with the τ-embedding method of CMS in Run3 — •Jannik Demand, Christian Winter, Artur Gottmann, Roger Wolf, and Günter Quast — ETP, Karlsruhe Institute of Technology, Karlsruhe, Germany

In $H \to \tau\tau$ analyses a major source of background are genuine tau leptons, mostly originating from $Z \to \tau\tau$ decays. The τ-embedding method is a method to estimate this background from data, by replacing muons in selected events in data with simulated τ-decays. This talk will explain the method and gives a report on its applicability on

Run3 data.

T 2.8 Mon 18:30 ZHG104

BSM X → YH searches in bb$\tau\tau$ final states with the CMS experiment — •Quanshan Li, Moritz Molch, Nikita Shadskiy, Roger Wolf, and Ulrich Husemann — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

BSM theory introduces additional Higgs bosons with different masses next to the Standard Model Higgs boson H. This talk presents a search for the decay of a heavy scalar boson X into two lighter scalar bosons Y and H with the data recorded during the LHC Run 2.

To distinguish the signal from backgrounds, a parametric neural network is used, enabling the training and evaluation of one single deep neural network for various X and Y mass hypotheses. Data-driven methods are utilized for background estimation. In addition, a comparison of the background prediction with data is shown in control regions.