T 89: Higgs Boson: Decay in Fermions 2

Time: Thursday 16:15–18:00 Location: T-H20

T 89.1 Thu 16:15 T-H20

Search for decays of boosted Higgs bosons to pairs of charm quarks with the CMS Experiment — •Andrzej Novak, Luca Mastrolorenzo, Xavier Coubez, Spadan Mondal, Andrey Pozdnyakov, and Andrzej Novak — Physics Institute III A, RWTH Aachen

The Higgs boson decay into charm quarks has the highest branching fraction of the yet unobserved decays. Moreover, it is predicted to be the strongest coupling to the second generation of fermions which as of now remains unconfirmed. This talk presents a search for the Higgs boson in the gluon fusion production mode with high Lorentz boosts, decaying to a pair of charm quarks. The analysis is modelled on a previous analysis of decays to pairs of bottom quarks and is enabled by recent developments in deep learning based tools for jet identification in such topologies. Probing this channel is not only important for completeness, but it could also be sensitive to potential beyond Standard Model corrections.

T 89.2 Thu 16:30 T-H20

Search for Higgs boson decay to a pair of charm quarks in a two-jets topology at CMS with full Run-2 data. — •Andrey Pozdnyakov[1], Bjorn Burkle[2], Xavier Coubez[1,2], Alena Dodonova[1], Luca Mastrolorenzo[1], Spandan Mondal[1], Andrzej Novak[1], and Alexander Schmidt[1] — [1]RWTH University, Germany — [2]Brown University, USA

Full Run-2 data of the CMS experiment has been analyzed in order to obtain the most sensitive result to date on the measurement of the Higgs boson coupling to charm quarks. The coupling of the Higgs boson to charm is probed in a direct search for the H → cc decay, when the Higgs boson is produced in association with a W or Z boson. The full analysis is carried out in two topologies : boosted, where the two jets from a Higgs boson candidate are merged into one large-cone jet, and resolved, where two small-radius jets are reconstructed. In this talk we present a detailed overview of the resolved part of the full analysis. Major developments are introduced compared to the previously published CMS result, based on a partial data set. Those include an improved jet flavor tagging for charm jets based on DNNs, a dedicated jet-energy regression, a "kinematic fit" that constrains momenta of the jets using leptons from an associated Z boson decay. All these improvements lead to a stringent constraint on $|\kappa_c|$, which pose a limit for BSM models with large κ_c variations.

T 89.3 Thu 16:45 T-H20

Deep Sets for the ttH(H->bb) cross section measurement — •José Manuel Clavijo Columbié and Judith Katzy — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

We present our analysis strategy for the measurement of the cross-section of the ttH(H->bb) process differential in Higgs pT. We use a newly developed Deep Set neural network to split the events into separate regions which are enriched in signal or any of the main background processes. This allows the signal measurement together with good control of the background normalization factors and their associated uncertainties. In addition, we split the signal-like events into different Higgs pT ranges for the differential cross-section measurement. We perform an Asimov fit which gives the expected uncertainties of the measurement, and a fit of the background regions to real collision data to measure our ability to control the background processes.

T 89.4 Thu 17:00 T-H20

Effective Field Theory interpretations in Higgs boson pair production studies and constraints on the Higgs boson self-coupling — •Christina Dimitriadi[1,2], Jochen Dingfelder[1], Arnaud Ferrari[2], Tatjana Lenz[1], and Serhat Ördek[2] — [1]Physikalisches Institut Universität Bonn, Germany — [2]Uppsala University, Sweden

After the discovery of the Higgs boson in 2012, an important test of electroweak symmetry breaking would be to establish evidence of the Higgs boson self-coupling (λ_{HHH}), which can be achieved through a measurement of Higgs boson pair production. In the Standard Model (SM), di-Higgs events are dominantly produced in gluon-gluon fusion processes, e.g. involving the Yukawa coupling to top quarks (top quark loops) or via the Higgs boson self-coupling. These two production mechanisms interfere destructively, which leads to a very small di-Higgs production cross-section. However, deviations in couplings of the Higgs boson from the SM expectation could lead to a significant enhancement of the di-Higgs production rate.

A re-interpretation of the search for non-resonant Higgs boson pair production in the $bb\tau\tau$ channel, which is one of the most sensitive for probing the Higgs self-coupling, is presented. A scan of the self-coupling modifier, $\kappa_\lambda = \lambda_{HHH}/\lambda^{SM}_{HHH}$, is performed and limits on κ_λ are set. Projected sensitivity results at the High-Luminosity LHC are also discussed. Finally, preliminary studies for Higgs Effective Field Theory interpretations of the existing analysis are shown.

T 89.5 Thu 17:15 T-H20

Search for Higgs Boson Pair Production in Multi-Lepton Final States with the ATLAS Detector — Volker Büscher, Antoine Laudrain, Christian Schmitt, •Niklas Schmitt, and Duc Bao Ta — Johannes Gutenberg-Universität, Mainz

After the discovery of the Higgs boson in 2012 at the LHC, many of its properties have already been determined precisely using data of an integrated luminosity of 139 fb^{-1}. However, one of the biggest challenges in this field remains the measurement of the coupling of the Higgs boson to itself. It allows for a deep insight into the real shape of the Higgs potential and hence has a big impact on the understanding of fundamental interactions not only at the electroweak scale. In order to constrain the trilinear self-coupling, the Di-Higgs production cross section is measured. While decay modes including b-quarks typically have larger branching fractions, leptonic final states are generally much cleaner and have less SM background. Accordingly, probing this channel as a complement to $b\bar{b}$ analyses will be very promising.

Because of the small branching ratio and the large number of different SM backgrounds, it is difficult to investigate every leptonic HH decay mode individually. For this reason, dedicated neural networks in the 2,3 and 4 lepton final states have been trained to distinguish all relevant signal processes against the sum of all backgrounds. This talk will introduce the analysis strategy and give an overview on the performance of the multi-lepton channel compared to other decay modes.

T 89.6 Thu 17:30 T-H20

Search for Higgs-boson pair production in the $bb\ell\ell$+$\mathbf{E_T^{miss}}$ final state with the ATLAS detector — •Benjamin Rottler, Benoit Roland, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The determination of the triple Higgs-boson self-coupling λ is one of the key goals of the physics program at current and future colliders. It will allow to reconstruct the Higgs potential. The self-coupling can be accessed via non-resonant Higgs-boson pair production, which can happen at the LHC via the destructively interfering top-loop and Higgs self-interaction diagrams.

The goal of this analysis is to measure the cross-section of the non-resonant Higgs-boson pair production σ_{HH} and the Higgs-boson self-coupling λ using the full Run-2 dataset collected by the ATLAS experiment, corresponding to an integrated luminosity of ∼139 fb^{-1} at $\sqrt{s} = 13$ TeV. This is done by considering the $bb\ell\ell + E_{\mathrm{T}}^{\mathrm{miss}}$ final state, which combines the high branching ratio of the $H \to bb$ decay and the good efficiency of lepton triggers. Our focus is on a combined search for the $HH \to bb(WW \to 2\ell 2\nu)$, $HH \to bb(\tau\tau \to 2\ell 4\nu)$ and $HH \to bb(ZZ \to 2\ell 2\nu/2\ell 2q)$ processes.

A multi-class deep neural network (NN) is used to separate signal and background processes on top of a loose preselection. The shape of the NN output distribution will be used in the statistical analysis. I will present the results of the σ_{HH} and λ measurements. I will also discuss the application of parametrized NNs (pNN) for the λ measurement, which allows to train a combined NN for multiple λ values.

T 89.7 Thu 17:45 T-H20

HH→bb$\tau\tau$ Run 3 Trigger Studies — •Andrés Melo, Jason Veatch, and Stan Lai — II. Physikalisches Institut, Georg-August-Universität Göttingen

The HH→bb$\tau\tau$ search is performed using data taken from the ATLAS experiment at the LHC, and allows us to probe the Higgs self-coupling (for non-resonant decays) and the existence of heavier particles from

which both Higgs would have been produced (for resonant decays). Since the Higgs boson is identified by its decay products, tau triggering is an important and crucial part of the search.

In order to ensure optimal trigger efficiency for this final state signature in Run-3, the efficiency at the high level trigger (HLT) with respect to the Level-1 trigger (L1) is studied. A characterization of various kinematic variables and quantities of the events that do not pass the HLT triggers is performed. This study allows for an improvement of the trigger efficiency, minimizing event loss.