T 30: Higgs decay in fermions II

Time: Tuesday 16:00–18:15 Location: Te

T 30.1 Tue 16:00 Te

Reconstruction of b- and c- jets at e^+e^- Higgs Factories with ParticleFlow detectors — •Yasser Radkhorrami[1,2] and Jenny List[1] — [1]DESY, Hamburg — [2]University of Hamburg, Hamburg

The Higgs boson decay modes to heavy b and c quarks are crucial for the Higgs physics studies. The presence of semileptonic decays in the jets originating from b and c quarks causes missing energy due to the undetectable neutrinos. A correction for the missing neutrino momenta can be derived from the decay kinematics up to a two-fold ambiguity. The correct solution can be identified by a kinematic fit, which exploits the well-known initial state at an e^-e^+ collider by adjusting the measured quantities within their uncertainties to fulfill the kinematic constraints. The ParticleFlow concept, based on the reconstruction of individual particles in a jet allows understanding the individual jet-level uncertainties at an unprecedented level. The modeling of the jet uncertainties and the resulting fit performance will be discussed for the example of the ILD detector. Applied to $H \to b\bar{b}/c\bar{c}$ events, the combination of the neutrino correction with the kinematic fit improves the Higgs mass reconstruction significantly, both in terms of resolution and peak position.

T 30.2 Tue 16:15 Te

Search for standard model Higgs boson decaying into a charm quark-antiquark pair with the CMS experiment — •Luca Mastrolorenzo, Alexander Schmidt, Andrey Pozdnyakov, Xavier Coubez, Andrzej Novak, Spandan Mondal, and Alena Dodonova — RWTH, Aachen, Germany

In this talk, the search for a standard model Higgs boson decaying into a charm quark-antiquark pair with the data collected by the CMS experiment during the 2016 data-taking period is presented. The search targets Higgs boson production in association with a vector boson (Z,W). To maximally enhance the analysis sensitivity and fully exploit the topology of the Higgs boson decay, two strategies are followed. In the first one, targeting lower vector boson transverse momentum, the Higgs boson candidate is reconstructed via two resolved jets arising from the two charm quarks from the Higgs boson decay. A second strategy identifies the case where the two charm quark jets from the Higgs boson decay merge to form a single jet, which generally only occurs when the vector boson has higher transverse momentum. One of the crucial aspects of the analysis is represented by the capability to correctly identify jets originating from charm quarks. To reach this goal, charm-taggers based on advanced machine learning algorithms have been deployed. The result achieved in this analysis represents the most stringent limit on the Higgs decay to charm quark-antiquark pair production cross-section to-date.

T 30.3 Tue 16:30 Te

Search for decays of boosted Higgs bosons to pairs of charm quarks with the CMS Experiment — •Andrzej Novak, Luca Mastrolorenzo, Xavier Coubez, Spadan Mondal, and Andrey Pozdnyakov — 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 modeled 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 30.4 Tue 16:45 Te

Full Run2 analysis of Higgs boson decay to b-quarks in CMS — •hessamoddin kaveh — DESY, Hamburg, Germany

After the discovery of the 125 GeV Higgs boson in July 2012, the data collected at the LHC in 2016 and 2017 facilitated the discovery of the Higgs boson also in its decays into b-quarks. By now, the focus has shifted to measuring this decay channel at further improved precision. A measurement of the properties of the Higgs boson produced in association with vector bosons and decaying into a pair of b-quarks (VH(bb)) is presented. The full data of pp collisions recorded by the CMS experiment during Run 2 is reported. The focus of the talk is on the mass cross-check analysis in comparison to the DNN-based approach, statistical and systematic power of the analysis, improving the analysis methods such as kinematical reconstruction and optimization.

T 30.5 Tue 17:00 Te

$H \to b\bar{b}$ Tagger Calibration in $Z \to b\bar{b}$+jet events — •Shubham Bansal, Jochen Dingfelder, and Tatjana Lenz — Physikalisches Institut, Universität Bonn

Within the ATLAS collaboration, the most recent algorithm to separate boosted $H \to b\bar{b}$ decays from dominant backgrounds like multijets and jets originating from hadronically decaying top-quarks, employs an algorithm based on a feed-forward neural network. In boosted $H \to b\bar{b}$ decays, the b-quark fragmentation products are reconstructed using a large-R ($R = 1.0$) jet containing variable-radius subjets. The neural network algorithm combines flavor discriminants from up to three subjets inside the large-R jet and discriminates boosted Higgs from the dominant backgrounds. Since these algorithms are optimized and evaluated in simulation only, they need to be calibrated in data in an environment with b-jets that are close to each other. This talk presents the developments of the $H \to b\bar{b}$ tagger calibration in $Z \to b\bar{b}$+jet events with the ATLAS experiment.

T 30.6 Tue 17:15 Te

Search for heavy neutral Higgs bosons decaying into a pair of b quarks — •Paul Asmuss — DESY Hamburg

With the discovery of the Higgs boson in 2012, a milestone in particle physics was reached. The precision measurements that followed indicate that the found particle agrees with the Standard Model predictions. Nevertheless, there is still room for theories beyond the Standard Model including an extended Higgs sector. Examples for such theories are Supersymmetry or general Two Higgs Doublet models. Not only feature these models additional Higgs bosons but they also allow for a significantly enhanced coupling of the Higgs boson to b quarks.This analysis targets heavy neutral Higgs bosons decaying into two b quarks and produced in association with one or two additional b quarks. The final state is thus fully hadronic. A mass range from 300 GeV to 1.6 TeV is investigated based on data collected in 2017 with the CMS detector at the LHC at a center-of-mass energy of 13 TeV. First results are shown.

T 30.7 Tue 17:30 Te

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 data can also be analyzed to probe resonant Higgs-boson pair production in a search for new heavy particles.

The goal of this analysis is to measure the cross-section of the non-resonant Higgs-boson pair production σ_{HH} using the full Run-2 dataset collected by the ATLAS experiment, corresponding to an integrated luminosity of $\sim$140 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 $H \to b\bar{b}$ 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 $HH \to bb(ZZ \to 2\ell 2\nu)$ processes.

A multi-class deep neural network (NN) is used to separate signal and background processes on top of a loose preselection. In this talk, I will focus on modern technologies used to optimize the NN architecture, like Bayesian hyperparameter optimization and input feature ranking algorithms, as well as on the statistical analysis which makes use of the shape of the NN output distribution to extract σ_{HH}.

T 30.8 Tue 17:45 Te

Search for pair production of Higgs bosons decaying to $b\bar{b}\tau^+\tau^-$ with the ATLAS detector — •Christopher Deutsch,

Jochen Dingfelder, and Tatjana Lenz — Physikalisches Institut, Bonn, Germany

The discovery of the Higgs boson and the measurement of its properties confirming the Standard Model (SM) is a major step towards the understanding of electroweak symmetry breaking. As a result, the potential of the Higgs field, and therefore the trilinear self-coupling of the Higgs boson, is precisely predicted in the SM. It can be probed by measuring the cross section of Higgs boson pair production, offering an additional test of the SM. In the SM such measurements are difficult due to the destructive interference of processes containing the self-coupling and processes with Yukawa couplings to top quarks, leading to a small production cross section at the Large Hadron Collider (LHC). An enhancement would indicate the presence of physics beyond the Standard Model (BSM), since heavy resonances decaying into pairs of Higgs bosons are predicted by several BSM models.

A search for non-resonant and resonant Higgs boson pair production in the $b\bar{b}\tau^+\tau^-$ channel is presented. This channel is one of the most sensitive for probing the Higgs self-coupling. The talk will focus on the subchannel with two hadronically decaying tau leptons. New developments towards the analysis of the $\sim 139\,\mathrm{fb}^{-1}$ dataset collected by the ATLAS experiment in Run 2 of the LHC are presented. These include improvements in object selection with new particle identification algorithms and using multivariate methods for signal selection.

T 30.9 Tue 18:00 Te

Search for ZZ/ZH events in the 4b final state — •Roman Küsters, Tatjana Lenz, and Jochen Dingfelder — Rheinische Friedrichs-Wilhelms-Universität Bonn

One of the primary physics goals at the LHC is to measure the Higgs self-coupling and to determine the shape of the Higgs potential. The Higgs self-coupling can be directly measured in the di-Higgs (HH) production channel. Thus a search for the HH production is one of the important goals at the LHC. The HH->4b decay mode has the highest branching ratio and is thus one of the main search channels. The current sensitivity to HH is about 6.9 times the Standard Model cross section. The idea is to use the ZZ and ZH channels with a higher production cross section to validate the HH analysis. This talk presents the search for ZZ and ZH production in the 4b final state at a center-of-mass energy of 13 TeV collected with the ATLAS detector in 2015-2018 and how it can be used to validate the HH->4b analysis.