T 54: Higgs Physics VI

Time: Wednesday 16:15–18:15 Location: KH 01.019

T 54.1 Wed 16:15 KH 01.019

Search for heavy neutral Higgs bosons A and H in the $t\bar{t}Z$ channel at CMS — •Yannick Fischer, Matteo Bonanomi, Lukas Ebeling, Johannes Haller, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

While the measurements of the Higgs boson at 125 GeV are so far consistent with the standard model (SM) prediction, the observed particle might well be part of an extended Higgs sector. Such an extended Higgs sector is predicted by many theories of physics beyond the SM. Two Higgs Doublet Models (2HDM) assume the existence of a second Higgs doublet, giving rise to a total of five physical Higgs bosons. This talk presents a search for a hypothetical heavy CP-odd Higgs boson A decaying into a hypothetical CP-even heavy Higgs boson H and a Z boson, with the H decaying into a top quark-antiquark pair. This channel has been dubbed the "smoking gun" channel for electroweak baryogenesis in 2HDMs. We will present the status of $A \to ZH$ with $H \to t\bar{t}$ searches at CMS at 13 and 13.6 TeV centre-of-mass energy, focusing on the fully-hadronic decay channel of the $t\bar{t}$ system. The results exclude masses of the A boson up to several TeV and constrain the 2HDM parameter space relevant for electroweak baryogenesis.

T 54.2 Wed 16:30 KH 01.019

Strong First-Order Phase Transitions and Exotic Phases in the CP-Conserving 2HDM — Lisa Biermann[1], •Christoph Borschensky[2], Rafael Boto[2], Margarete Mühlleitner[2], Rui Santos[3,4], and João Viana[3] — [1]PSI Center for Neutron and Muon Sciences, Villigen, Switzerland — [2]Karlsruher Institut für Technologie, Germany — [3]Centro de Física Teórica e Computacional, Faculdade de Ciências, Universidade de Lisboa, Portugal — [4]Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa, Portugal

Extended scalar sectors can significantly influence the cosmological evolution of the early universe. The additional scalar degrees of freedom allow for strong first-order phase transitions (SFOPT) into the electroweak-broken vacuum, which induce gravitational waves that, for sufficiently strong signals, might be detectable in the near future. Additionally, the universe might have undergone exotic intermediate phases such as charge-breaking or CP-violating phases via a multi-step phase transition.

In this talk, the parameter space of the CP-conserving 2-Higgs-Doublet Model is investigated with the recent version 3 of the public code BSMPT. Within this model, we study the viability of SFOPTs in light of the recent experimental data from Higgs measurements and exotic Higgs searches. We present points involving different one- and multi-step phase histories, and study their features such as the size of the trilinear Higgs couplings as well as the strength of their gravitational wave signals.

T 54.3 Wed 16:45 KH 01.019

Precision predictions of partial decay widths in the general Two-Higgs-Doublet Model — •Jose Angel Hernandez Cuevas, Heidi Rzehak, Martin Gabelmann, and Robin Feser — Albert-Ludwigs-Universität Freiburg, Physikalisches Institut, 79104 Freiburg, Germany

The Standard Model (SM) of particle physics has achieved remarkable success in describing a broad spectrum of experimentally observed phenomena in particle physics with high precision. However, there are still some phenomena that lie beyond its description, such as the existence of dark matter, the matter-antimatter asymmetry of the universe, and the origin of neutrino masses. Several extensions to the SM have been proposed to account for these phenomena. Among them, the general Two-Higgs-Doublet Model (THDM) provides a framework with a rich phenomenology. It comprises the symmetry-constrained THDM scenarios as special limits, and enables the study of new sources of CP violation, Higgs-mediated flavor violation, generalized Yukawa structures, and the impact of complex parameters in both the potential and the Yukawa sector. In this talk, I will present next-to-leading-order (NLO) predictions of partial decay widths of the Higgs boson within the general THDM. I will focus on Higgs-boson decays into fermions and on exploring renormalization conditions, including on-shell and $\overline{\text{MS}}$ renormalization conditions, together with different tadpole treatments, in order to establish criteria that can point to a good choice of renormalization schemes for some extensions of the SM.

T 54.4 Wed 17:00 KH 01.019

tbH$^+$ Analysis with Multileptons Using Run-2 ATLAS Data — •Azad Afandizada and André Sopczak — CTU in Prague

The latest results with Run-2 ATLAS data are presented for the search tbH$^+$ in the multilepton channel. The charged Higgs boson decay into WH is studied.

T 54.5 Wed 17:15 KH 01.019

Search for a charged Higgs ($H^\pm$) boson in $Wh(h \to bb)$ boosted channel using multivariate methods in ATLAS — •Satyajit Chakraborty and Tatjana Lenz — Physikalisches Institut, Universität Bonn, Germany

To address the shortcomings of the Standard Model, many models describing physics beyond the Standard Model (BSM) have been proposed. One such extension is the Two-Higgs-Doublet Model (2HDM), which predicts the existence of five Higgs Bosons: three neutral and two charged Higgs($H^\pm$).

This talk presents the search for a charged Higgs boson produced in association with a top quark and a bottom quark. The decay channel studied is $H^\pm \to W^\pm h$, where h is the Standard Model Higgs boson (125 GeV) and $h \to b\bar{b}$, while the $W^\pm$ boson decays either hadronically ($W^\pm \to qq'$) or leptonically ($W^\pm \to \ell\nu$). The analysis is performed in the high-p_T (Boosted) region using the full ATLAS Run-2 dataset. In this work, $H^\pm$ masses ranging from 1.2 TeV to 3 TeV have been studied. Multivariate methods based on a Deep neural network (DNN) architecture have been used to separate signal from background following the strategy used in the previous analysis. The use of a mass parameterized neural network (PNN) has also been investigated. The resulting limits on the charged Higgs boson production cross-section times branching ratio are compared between the two approaches to assess their relative performances.

T 54.6 Wed 17:30 KH 01.019

Jet Matching Performance with SPANet and GN3 in the Search for Charged Higgs Bosons Decaying to a cs Final State with the ATLAS Experiment — •Johannes Klas, Tatjana Lenz, and Jochen Dingfelder — Universität Bonn

The discovery of the Higgs boson solved the mystery of particle masses. Although the Standard Model requires the existence of only one Higgs boson, an extension of the Higgs sector with at least four Higgs bosons is possible and required by many theories beyond the Standard Model, e.g. SUSY. This leads to the existence of a pair of charged Higgs bosons with the same mass and opposite electric charges. The main production mechanism is $pp \to Wb\bar{b}H^\pm$ and the $H^\pm \to cs$ decay is one of the favoured decay modes. Below the top quark mass this is realized via $pp \to t\bar{t} \to Wb\bar{b}H^\pm$. The search targets leptonic decays of the W, resulting in a final state with at least four expected jets and one lepton. Matching these jets to the appropriate particles is a difficult task. New developments like SPANet offer improved performance in jet matching and signal/background separation. The possibility of further improvements using the GN3 flavour tagger, which is currently in development, is being investigated. This is especially relevant when considering improvements in the correct matching of the s-jet and the rejection of gluon-initiated jets.

T 54.7 Wed 17:45 KH 01.019

Search for resonances decaying to Higgs boson pairs at $\sqrt{s} = 13.6$ TeV with the CMS experiment — •Haoyu Wang[1,2], Suman Chatterjee[1], Elisabetta Gallo[1,2], Rainer Mankel[1], and Roberval Walsh[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607, Hamburg, Germany — [2]University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

The Higgs boson, since its discovery, has been a powerful probe of physics beyond the standard model of particle physics. The CMS experiment at the Large Hadron Collider is analysing the data from the ongoing proton-proton collisions at $\sqrt{s} = 13.6$ TeV, which provides an unprecedented opportunity to search for the production of Higgs boson pairs through the decays of heavy resonances. The analysis to be presented here targets such new physics signatures in the final state with four bottom quarks. Cutting-edge machine-learning techniques are employed for the reconstruction of Higgs boson pairs and the estimation of standard model background. We present the expected sensitivity

for a large range of resonance masses, using data corresponding to an integrated luminosity of 170 fb^{-1}.

T 54.8 Wed 18:00 KH 01.019

The CMS Run2 resonant HH → bb$\tau\tau$ analysis — •Tobias Kramer, Marcel Rieger, Peter Schleper, Ana Andrade, Nathan Prouvost, and Bogdan Wiederspan — Hamburg University, Hamburg, Germany

This contribution presents an analysis in the search for the decays of heavy spin 0/2 resonances to a pair of Higgs bosons in the bb$\tau\tau$ final state. A wide mass range of the hypothetical resonance from 250 GeV up to 3 TeV is covered. The analysed data correspond to 138 fb^{-1} recorded by the CMS experiment at the LHC from 2016 to 2018. The talk highlights key aspects, such as the momentum regression of the neutrinos from the tau decays and the neural network for signal-background classification, and will present the results of the analysis.