T 48: BSM Higgs 2 (extended Higgs sectors)

Time: Tuesday 16:00–17:45 Location: Geb. 30.41: HS 3

T 48.1 Tue 16:00 Geb. 30.41: HS 3

Revisiting the Yukawa Type I for N2HDM and 2HDMS with a 95 GeV Higgs boson including the recent ATLAS results — •Dominik Heintz[1], Sven Heinemeyer[3], Gudrid Moortgat-Pick[1,2], and Cheng Li[4] — [1]II. Institut für Theoretische Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]DESY, Notkestraße 85, 22607 Hamburg, Germany — [3]Instituto de Física Teórica UAM-CSIC, Cantoblanco, 28049, Madrid, Spain — [4]School of Science, Sun Yat-Sen University, Gongchang Road 66, 518107 Shenzhen, China

The **2HDM** (Two-Higgs-Doublet Model) can be extended by a real singlet, **N2HDM**, or a complex singlet, **2HDMS**. Both models are promising candidates to describe the excess at $\sim 95\,\text{GeV}$ observed both at **CMS** and at **ATLAS** in the $\gamma\gamma$ channel with $\sim 2.9\sigma$ and $\sim 1.7\sigma$, respectively, as well as in the $b\bar{b}$ decay channel at **LEP** with $\sim 2.3\sigma$. The lightest Higgs boson in the models, h_1 was interpreted as a new particle at $\sim 95\,\text{GeV}$. Studies so far focused on the Yukawa types II and IV. However, the signal strength in the $\gamma\gamma$ channel went down substantially over the last year. This allows a greater freedom for $\frac{c_{h_1 bb}}{c_{h_1 tt}}$, the ratio of the coupling modifiers of the light Higgs to bottom and top quarks, respectively. This motivates the phenomenological study of the **2HDMS** and **N2HDM** in the Yukawa type I. The study includes current theoretical and experimental constraints using **HiggsTools** (**HiggsBounds** and **HiggsSignals**) and incorporates the most recent signal rates from **ATLAS**.

T 48.2 Tue 16:15 Geb. 30.41: HS 3

Search for X → YH **production in** bb$\tau\tau$ **final states at the CMS experiment** — •Moritz Molch, Ulrich Husemann, Ralf Schmieder, Nikita Shadskiy, Michael Wassmer, and Roger Wolf — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Extensions of the Standard Model (SM), like the Next-to-Minimal Supersymmetric Standard Model (NMSSM) introduces additional Higgs bosons with different masses next to the already known SM Higgs boson H. This talk presents a search for the resonant decay of a heavier scalar particle X into a lighter resonance Y and H at the CMS experiment. The analysis considers final states, in which either the Y or the H decays into a pair of bottom quarks, and the other one into a pair of τ leptons.

The analysis presented in this talk uses data recored with the CMS detector in proton-proton collisions during the LHC Run 2. In addition, topologies, in which the four final state particles are well separated from each other, boosted topologies of the bottom quark pair and the τ lepton pair are considered to improve the sensitivity of the analysis, especially in the high mass regions of X. For signal extraction, a parametric deep neural network is used, which enables the treatment of all signal hypotheses with a single neural network at once.

T 48.3 Tue 16:30 Geb. 30.41: HS 3

Non-prompt lepton background estimate in the split-boosted 1-lepton $X \to SH \to b\bar{b}WW$ **analysis at ATLAS** — •Lena Schulz, Stan Lai, and Kira Abeling — II. Physikalisches Institut, Georg-August-Universität Göttingen

The known incompleteness of the Standard Model gives rise to many theories of physics beyond the Standard Model. Many of those theories predict the existence of additional particles, motivating the search for new signatures.
This talk will focus on the resonant production of a Higgs boson in conjunction with an additional scalar particle S in the $X \to HS \to b\bar{b}WW$ decay channel with one lepton in the final state. Depending on the masses of the resonance X and the particle S, multiple possible topologies arise for this decay channel. The split-boosted topology, which will be the focus of this talk, is characterized by a sufficiently large separation between the two W bosons, allowing for the resolution of the final-state lepton from the jet of the hadronically decaying W boson, whilst the hadronic decay products of the Higgs boson and the W boson are too collimated to be resolved.
In the one lepton final state, non-prompt leptons contribute to the background of the decay channel. A data driven approach is presented to model this non-prompt lepton background.

T 48.4 Tue 16:45 Geb. 30.41: HS 3

Search for a BSM resonance decaying into two SM Higgs bosons in the bbWW final state with the CMS detector. — Matteo Bonanomi, Mathis Frahm, Johannes Haller, •Viacheslav Kosterin, Lara Markus, Janek Moels, Alexander Paasch, and Matthias Schroeder — Institut für Experimentalphysik, Universität Hamburg

The study of the pair production of Standard Model (SM) Higgs bosons (HH) allows a direct determination of the trilinear Higgs coupling and enhances our understanding of the Higgs potential. In addition, theories beyond the SM predict the existence of heavy particles that manifest as a resonance in the decay of two SM Higgs bosons.

In this talk we present the search for such heavy particles in final states containing two b quarks and two W bosons, where one of the W bosons decays into a pair of light jets and the other decays into a charged lepton and a neutrino.

We present the analysis strategy and the first results obtained using multiclass classifiers based on deep neural networks to address the main challenge of the analysis, that is the small fraction of signal events compared to the large amount of background.

We present expected results based on the data recorded at the CMS experiment during Run 2 and the preparation of the corresponding Run 3 analysis.

T 48.5 Tue 17:00 Geb. 30.41: HS 3

Interference Effects in Di-Higgs-Production in the singlet extension of the Standard Model — •Finn Feuerstake[1], Elina Fuchs[1,2], and Tania Robens[3] — [1]Leibniz Universität Hannover — [2]Physikalisch-Technische Bundesanstalt Braunschweig — [3]Institut Ruder Bošković Bijenička Zagreb

Real singlet models are simple extensions of the SM as these models add a new Higgs-like scalar that transforms as a singlet under the SM gauge group. For the case of an additional particle that is heavier than twice the SM-Higgs this scalar, labelled S, could play a role in resonant-enhanced $pp \to hh$ production. We here simulate samples for such scenarios for the inclusive process, the scenario where $pp \to S \to hh$ only, as well as production without the intermediate resonance. By comparing distributions of these three processes in different observables, such as the invariant mass or the final state transverse momenta, taking the finite width of the heavy scalar into account, we discuss the importance of interference effects for di-Higgs production.

T 48.6 Tue 17:15 Geb. 30.41: HS 3

Resonant di-Higgs production in the RxSM considering one-loop corrections for the triple Higgs couplings: Pure resonant vs. full cross sections — •Alain Verduras Schaeidt — DESY

Within the RxSM (the SM extended by a real singlet) we focus on a parameter region giving rise to a Strong First Order Electroweak Phase Transition (SFOEWPT). For the (HL-)LHC we compute the total di-Higgs production cross section and the differential cross section with respect to the di-Higgs invariant mass in the parameter region of interest. We include for the first time the one-loop corrections to the trilinear Higgs couplings using the public tool anyH3. It is shown that only taking into account the purely resonant diagram in di-Higgs production, gg -> H -> hh, as often done in experimental analyses, is not sufficient to obtain reliable results for the resonant di-Higgs production.

T 48.7 Tue 17:30 Geb. 30.41: HS 3

Effective Field Theories for Heavy Higgs Bosons in Standard Model Extensions — Stefan Dittmaier, •Sebastian Schuhmacher, and Maximilian Stahlhofen — Albert-Ludwigs-Universität Freiburg, Physikalisches Institut, Hermann-Herder-Straße 3, D-79104 Freiburg, Germany

We consider the extension of the Standard Model by a heavy, real Higgs singlet. In order to obtain a phenomenologically interesting low-energy effective theory, we define a specific decoupling limit. We integrate out the heavy degrees of freedom at the one-loop level directly in the path integral via functional methods, employing the background field method as well as the method of regions. Working in the mass-eigenfield basis we take mixing between the Higgs fields into account. Also the renormalization of the full UV model is performed. We generate the effective Lagrangian up to mass dimension six and discuss the possibility of matching it onto SMEFT/HEFT.