T 59: Extended Higgs models II

Time: Wednesday 16:00–18:15 Location: Ti

T 59.1 Wed 16:00 Ti

Search for additional Higgs bosons in $H \to h_S(bb)h(\tau\tau)$ decays in the context of the NMSSM with CMS Run-2 data — •Felix Heyen, Ralf Schmieder, Janek Bechtel, Tim Voigtländer, Günter Quast, Roger Wolf, Sebastian Brommer, and Maximilian Burkhart — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

In the next-to-minimal supersymmetric extension of the Standard Model (NMSSM), modifications to the SM Higgs sector lead to a total of seven Higgs bosons. The decay of a heavy scalar Higgs boson (H) into a light scalar (h_S) and an SM-like Higgs boson (h) is a very promising signature to search for this extension, which has not been addressed by experiments so far. This talk discusses the physics motivation of the NMSSM and introduces the search for such a decay in the $h \to \tau\tau$ and $h_S(bb)$ partonic final state.

T 59.2 Wed 16:15 Ti

Event selection optimization in the $X \to SH \to b\bar{b}WW$ analysis with $\sqrt{s} = 13$ TeV ATLAS data — •Naman Kumar Bhalla, Kira Abeling, Jason Veatch, and Stan Lai — II. Physikaliches Institut, Georg-August-Universität Göttingen

Pair production of the Higgs boson, H, offers a direct measurement of the Higgs potential and is hence a crucial probe for the nature of the Standard Model. Additionally, many Beyond Standard Model scenarios predict heavy resonances, X, with a possible decay to a pair of Higgs bosons. Furthermore, theories such as the "Two Real Scalar Singlet" extension of the Standard model, predict a possible decay of X into another scalar, S, along with a Higgs Boson. The Higgs boson can further decay into a pair of b-quarks while S, with sufficient mass, can decay into a pair of on-shell W bosons. Here, the case where one W boson decays hadronically and the other W boson decays leptonically is considered.

Depending on the relation between the masses of the two additional scalars, m_X and m_S, the kinematic properties of the final state products may differ significantly from $X \to HH \to b\bar{b}WW^*$ decays. Hence, the methods used for event selection such as the classification of the jets observed from the hadronic decay of the W boson and those from the decay of the Higgs boson to a pair of b-quarks are investigated and re-optimized for the $X \to SH$ topology. This talk presents studies performed to optimize such event selection techniques.

T 59.3 Wed 16:30 Ti

Search for $H \to h_S(bb)h(\tau\tau)$ decays with CMS Run-2 data, using NN multi-classification — •Ralf Schmieder, Felix Heyen, Tim Voigtländer, Günter Quast, Roger Wolf, Janek Bechtel, Sebastian Brommer, and Maximilian Burkhart — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

The decay $H \to h_S(bb)h(\tau\tau)$ of a heavy scalar Higgs boson (H) into a light scalar (h_S) and an SM-like Higgs boson (h) is one of the most promising search channels for an next-to-minimal supersymmetric (NMSSM) extension of the SM. This talk summarizes the technical details of the analysis to search for such a decay in the $h \to \tau\tau$ and $h_S(bb)$ partonic final state, using a multiclass neural network categorization. The main challenge arises from training the neural network to a variety of different decay signatures given by the two unconstrained mass parameters of the model.

T 59.4 Wed 16:45 Ti

Constraints on Higgs $\mathcal{CP}$-properties in the Higgs Characterization model from HiggsSignals — •Marco Menen, Tobias Klingl, Tim Stefaniak, Henning Bahl, Philip Bechtle, and Klaus Desch — Rheinische Friedrich-Wilhelms-Universität Bonn

Following the discovery of a Standard Model (SM) like Higgs boson in 2012, many of it's properties are by now determined with high precision from measurements by the ATLAS and CMS experiments. This includes that it is not a pure $\mathcal{CP}$-odd state. However, a possible $\mathcal{CP}$-mixing of the Higgs Boson or a complex $\mathcal{CP}$-structure of it's couplings to individual particles are still allowed.

Many theories of physics beyond the SM (BSM) allow or motivate the introduction of CP violation in the Higgs sector. This can be described within concrete models, such as Supersymmetry or the 2-Higgs-Doublet model, or in different frameworks of effective models. In this talk, the Higgs Characterization (HC) model is presented. It introduces either a global mixing angle α between the two $\mathcal{CP}$ states and/or individual $\mathcal{CP}$-even and $\mathcal{CP}$-odd couplings of the Higgs Boson to SM particles, partly due to BSM higher-dimensional operators.

The programs HiggsBounds and HiggsSignals are used to calculate couplings, rates and limits on additional states, and compare them to available data from the 7, 8 and 13 TeV runs of the LHC at CERN via a statistical χ^2 test. To find constraints on the new parameters of the HC model, a Markov Chain Monte Carlo approach is used and its performance is evaluated against other techniques. The fit results for different realizations of the HC model are presented.

T 59.5 Wed 17:00 Ti

Combined measurements of Effective Field Theories with the ATLAS Experiment — •Carsten Burgard — DESY, Hamburg

The LHC experiments have so far not been able to present discoveries of new physics beyond the Standard Model (SM), be it in the form of Supersymmetry, additional Higgs bosons or other new exotic particles. At present, deeper investigations of the collected data in the form of precision measurements of the most elusive parts of the SM are one of the most promising paths to success in discovering physics beyond the SM. Many analyses in the Higgs sector are progressing from discovery to precision measurement as the dataset grows. Additional statistical precision beyond that can be gained by combining data from different individual analyses, usually focused on specific decay modes. For the measurement of Higgs boson production sections and decay ratios such combinations are well-established, both within ATLAS and across experiments, but a more exciting prospect is the ability to directly measure Wilson coefficients of Effective Field theories from LHC data. A combined simultaneous fit of Wilson coefficients to a subset of ATLAS Higgs data has recently been published. Such a combination could conceivably incorporate not only Higgs boson data, but also measurements of other SM particles and even other experiments. Novel techniques for these types of measurements need to be developed, such as the use of principal component analyses to identify sensitive directions within an EFT model of the measured data, or the combination of unfolded differential fiducial measurements with results using the simplified template cross section method.

T 59.6 Wed 17:15 Ti

A 96 GeV Higgs Boson in the 2HDMS — •Cheng Li[1,2], Steven Paasch[1,2], Gudrid Moortgat-Pick[1,2], and Sven Heinemeyer[3,4,5] — [1]DESY, Notkestrasse 85, 22607 Hamburg, Germany — [2]II. Institut für Theoretische Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Instituto de Física Teórica (UAM/CSIC), Universidad Autónoma de Madrid, Cantoblanco, 28049, Madrid, Spain — [4]Campus of International Excellence UAM+CSIC, Cantoblanco, 28049, Madrid, Spain — [5]Instituto de Física de Cantabria (CSIC-UC), 39005, Santander, Spain

CMS reported a $\sim 3\sigma$ excess at ~ 96 GeV in the $pp \to H \to \gamma\gamma$ channel. In the same mass range a $\sim 2\sigma$ excess in the $e^+e^- \to ZH, H \to b\bar{b}$ channel has been reported at LEP as well. We interpret the experimental excesses as the lightest Higgs boson in the Two-Higgs-Doublet Model with a complex singlet (2HDMS) with type II Yukawa structure. We demonstrate the the model can fit both excess simultaneously, while being in agreement with all other existing theoretical and experimental constraints. In this talk, we will present the scan of parameter space of 2HDMS and discuss the "best fit" points from the scan. Furthermore, we will also study the experimental uncertainties of specific Higgs couplings that can be obtained at the future International Linear Collider (ILC) with 250 GeV center-of-mass energy.

T 59.7 Wed 17:30 Ti

Influence of Higgs potential parameters on Dark Matter observables in a Two Higgs Doublet Model with a complex singlet — Juhi Dutta, Gudrid Moortgat-Pick, and •Merle Schreiber — II. Institute for Theoretical Physics, University Hamburg, Hamburg, Germany

Since the Standard Model of particle physics (SM) cannot explain the Dark Matter (DM) observed in the Universe, it is interesting to look at extensions of the SM, which include a DM candidate. An interesting new physics candidate is the Two Higgs Doublet Model (THDM) with

an additional complex singlet, which provides a DM candidate that has a mass and interacts weakly with the Higgs doublets.

In this talk I will explore how the Higgs potential parameters of a THDM with a complex singlet influence DM observables, specifically the DM relic density and the cross section of direct detection processes. This is in order to understand how to find a parameter configuration that matches the experimental observations available and then make predictions on how to potentially observe this model in experiments and distinguish it form other extensions of the SM.

T 59.8 Wed 17:45 Ti

Search for charged Higgs bosons in $H^+ \to Wh \to qqbb$ decay channel — •Shubham Bansal, Jochen Dingfelder, and Tatjana Lenz — Physikalisches Institut, Universität Bonn

The observation of a heavy charged scalar particle (H^+) would clearly indicate physics beyond the Standard Model. Charged Higgs bosons are predicted by several non-minimal Higgs scenarios, one of which is the two-Higgs-Doublet Model (2HDM). The H^+ production mechanism and decay modes at the tree level depend on its mass (m_{H^+}) and two parameters namely, α, the mixing angle between the neutral CP-even Higgs bosons, and tanβ, the ratio of the vacuum expectation values of the two Higgs doublets.

For $m_{H^+} > m_t + m_b$, the leading production mode of H^+ at the LHC is the associated production with a top and a bottom quark via $gg \to tbH^+$, and in the alignment limit for 2HDM when cos (β-α) ≈ 0, the dominant decay mode is $H^+ \to tb$. Nevertheless, it is possible to attain sizable branching ratios for $H^+ \to Wh$ in the 2HDM scenarios where the 125 GeV Higgs is the heaviest CP-even scalar, and in a few other scenarios such as the N2HDM and the Georgi-Machacek (GM) model. This talk focuses on the first studies of the $H^+ \to Wh \to qqbb$ decay channel in ATLAS Run-2 data.

T 59.9 Wed 18:00 Ti

Search for a low mass charged Higgs decaying to cs — •Christian Nass, Tatjana Lenz, and Jochen Dingfelder — Physikalisches Institut, Universität Bonn, Deutschland

In the Standard Model (SM) electroweak symmetry breaking (EWSB) is introduced by a single complex scalar field. The consequence is the prediction of a scalar, neutrally charged particle, the Higgs Boson, which was discovered in 2012 at the LHC. The simplest extension of the SM is to introduce EWSB through two complex scalar fields. This theory is called two Higgs doublet model (2HDM) and is very prominent because it offers opportunity to include additional CP-violation in the SM, which is needed for explaining baryogenesis. It features 3 neutral and 2 charged Bosons. Observation of such a charged scalar would be a striking signal for physics beyond the SM.

In the low mass region, i.e. $m_H^{\pm} < m_t$, the dominant production mode is by a $t\bar{t}$ pair with one t-quark decaying to $H^{\pm}b$. It is advised by several theory papers to search for $H^p m \to cs$ decays in the low mass region. Compared to previous analyses the sensitivity is expected to be higher, because statistics is higher, b-tagging and other techniques improved, and the introduction of new tools, i.e. c-tagging or multivariate analysis techniques. This search in Run-2 ATLAS data at 13 TeV will be presented.