T 78: Higgs: Extended models

Time: Thursday 16:30–18:45 Location: H-HS XVI

T 78.1 Thu 16:30 H-HS XVI

Messung der HZZ-Tensor-Kopplung in $pp \to H \to ZZ^* \to 4\ell$ - Zerfällen mit dem ATLAS-Detektor — •Verena Walbrecht, Sandra Kortner, Oliver Kortner und Hubert Kroha — Max-Planck-Institut für Physik, München

Ein wichtiger Zerfallsprozess für die Messung der Eigenschaften des Higgs-Bosons ist der Zerfall in zwei Z-Bosonen, die jeweils in ein e^+e^-- oder $\mu^+\mu^-$-Paar zerfallen, $pp \to H \to ZZ^* \to 4\ell$.
Im Standardmodell wird das Higgs-Boson als Spin-0-Teilchen mit positiver CP-Quantenzahl vorhergesagt. Diese Hypothese wird auch von den Run-1-Daten des LHC bevorzugt. Dabei sind kleine Beimischungen anomaler, möglicherweise auch CP-verletzender Kopplungen mit geänderter Tensorstruktur nicht ausgeschlossen.
Solche Abweichungen vom Standardmodell können unter anderem im Rahmen effektiver Feldtheorien (EFT) beschrieben werden, in denen die Standardmodell-Lagrangedichte durch weitere Operatoren höherer Dimensionen erweitert wird.
In diesem Vortrag werden die Messungen der Produktions- und Zerfallseigenschaften des Higgs-Bosons im Kanal $pp \to H \to ZZ^* \to 4\ell$ vorgestellt und im Rahmen einer effektiven Feldtheorie interpretiert, um die EFT-Parameterwerte einzuschränken. Die Messungen basieren auf dem vollen Run-2-Datensatz des ATLAS-Detektors.

T 78.2 Thu 16:45 H-HS XVI

Analysis of heavy Higgs boson decays into lighter Higgs bosons in the bb+$\tau\tau$ final state — •Janek Bechtel, Günter Quast, and Roger Wolf — Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany

In the Next-to-Minimal-Supersymmetric-Standard-Model (NMSSM), an additional complex Higgs singlet leads to modifications in the Higgs sector resulting in seven Higgs bosons, of which three are scalar, two are pseudoscalar and two are charged. One scalar Higgs boson can be identified with the observed Higgs boson at 125 GeV. The lightest additional boson (h') can be lighter or heavier than 125 GeV, and its coupling to quarks and leptons can be suppressed, such that the dominant production of h' is via the decay of a heavy Higgs boson into the 125 GeV Higgs boson plus this additional boson h'. A promising decay channel to find these states is the decay of one boson into b quarks, and of the other into tau leptons. In the talk, the signal simulation towards this measurement and an analysis strategy in this final state using data collected by the CMS experiment are presented.

T 78.3 Thu 17:00 H-HS XVI

New Analysis Techniques for the search for BSM H $\to \tau\tau$ with the full Run-2 dataset — •Lino Gerlach and Stan Lai for the ATLAS-Collaboration — Georg-August-Universität Göttingen

In 2012, a scalar boson was found at CERN that is consistent with the properties of the Higgs boson predicted by the Standard Model of particle physics. Some theories, in particular supersymmetric models, also predict the existence of additional heavier neutral Higgs bosons. The decays of these heavy Higgs bosons to a pair of τ leptons can be siginificant because of the relatively large mass of the τ lepton and additional effects of two-Higgs-doublet models that can enhance the coupling to down-type fermions.

While efforts are ongoing to quickly publish results of a search with the full Run-2 dataset, detailed investigations on the analysis methods and techniques are being carried out to ensure maximal sensitivity in a legacy result with 139 fb^{-1}.

This talk places special emphasis on these investigations. They include a new method of estimating the background of QCD jets faking hadronic tau decays, a machine learning based approach to identify possible signal signatures, and a Z' scenario signal interpretation.

T 78.4 Thu 17:15 H-HS XVI

Search for additional Higgs bosons decaying to a pair of W bosons in the semi-leptonic final state with the CMS detector using full Run 2 data — Mate Farkas, Olena Hlushchenko, Wolfgang Lohmann, Dennis Roy, Hale Sert, •Sebastian Siebert, Achim Stahl, Lucas Wiens, and Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University, Germany

During Run 2 of the LHC an integrated luminosity of 137 fb^{-1} at $\sqrt{s} = 13$ TeV was recorded by the CMS detector. Apart from measuring properties of known particles more precisely, it is also expected that new particles might be discovered with such a large dataset. Additional heavy Higgs bosons are suggested by many theories beyond the standard model. The high mass $H \to WW$ analysis studies gluon-gluon fusion and vector-boson fusion as Higgs production mechanisms. The analysis aims to find Higgs-like resonances in the mass region from 115 $\mathrm{GeV/c^2}$ to 5000 $\mathrm{GeV/c^2}$ or set exclusion limits in the context of MSSM and also two-Higgs-doublet scenarios. This talk presents the status and future plans in the semi-leptonic channel.

T 78.5 Thu 17:30 H-HS XVI

Lepton selection in the boosted $HH \to b\bar{b}WW^*$ analysis with $\sqrt{s} = 13$ TeV ATLAS data — •Kira Abeling, Stan Lai, and Jason Veatch — Georg-August-Universität Göttingen

Higgs boson pair production is an important probe for the nature of the Standard Model as it provides a direct measurement of the Higgs potential. Furthermore, many theories predict heavy resonances, X, that can decay into two Higgs bosons which then decay further, in this case, to a b-quark pair and a W boson pair.

Depending on the mass of X, the Higgs bosons are boosted, which results in overlapping decay products that are difficult to resolve. These effects can be counteracted by using larger jet sizes to collect all Higgs decay products in a single object.

In the case that one of the W bosons decays leptonically while the other decays hadronically, it is expected that the lepton will be inside or very close to the jet. To fully exploit this unique topology, the leptonic and hadronic components need to be disentangled. This talk presents studies performed to define an optimal lepton selection in the context of the boosted $X \to HH \to b\bar{b}WW^*$ analysis.

T 78.6 Thu 17:45 H-HS XVI

Search for charged Higgs bosons of a Type I 2HDM in the final state with one lepton and multiple jets — •David Brunner, Isabell Melzer-Pellmann, and Dirk Krücker — Deutsches Elektronen-Synchrotron (DESY)

The search for the direct production of non Standard Model (SM) elementary particles is one of the portals to explain new physics using high energy collider experiments like the Large Hadron Collider (LHC).

This search focuses on a Type I 2-Higgs Doublet Model (2HDM). The heavier neutral CP-even Higgs boson (H) is defined as the SM Higgs boson. In this configuration the decay of the charged Higgs boson ($\mathrm{H}^\pm$) to the lighter CP-even Higgs boson (h) and a $\mathrm{W}^\pm$ boson is enhanced, while the h decays predominantly into b quarks and τ leptons. The production mode of the charged Higgs boson in association with one h is studied, where both h bosons each decay into two b quarks and the $\mathrm{W}^\pm$ decays leptonically.

Two types of machine learning algorithms are used in the analysis. First, a mass-parameterized boosted decision tree (BDT) is trained to optimize the signal significance for each mass point of interest. Second, a deep neural network (DNN) is trained on the substructure of highly boosted jets originating from h bosons and top quarks to differentiate between signal and background jets.

The search will be based on proton-proton collision data recorded by the CMS experiment at the LHC in 2016-18 with a center of mass energy of $\sqrt{s} = 13$ TeV. The results are given as expected limit on the cross section times branching ratio of the $\mathrm{H}^\pm$ decay.

T 78.7 Thu 18:00 H-HS XVI

Search for additional Higgs bosons decaying into W^+W^- in the di-leptonic final state with CMS using full Run 2 data — Mate Farkas, Olena Hlushchenko, Wolfgang Lohmann, •Dennis Roy, Hale Sert, Sebastian Siebert, Achim Stahl, Lucas Wiens, and Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University, Germany

After the successful second data-taking period of the LHC, analyses using the full Run 2 data are being performed. With an integrated luminosity of 137 fb^{-1} recorded by CMS, the search for additional Higgs bosons, such as those expected from the minimal supersymmetric standard model (MSSM), is extended to higher masses.
The high mass $H \to WW$ analysis aims to search for resonances at higher masses. Their origin might be a heavier Higgs boson. In case

no signal is found, new limits on 2HDM and MSSM scenarios are set. The status of this analysis in the di-leptonic final state is presented in this talk.

T 78.8 Thu 18:15 H-HS XVI

Studies of an Extended Higgs Sectors — •Judith Höfer, Claudia Seitz, Rickard Strom, Priscilla Pani, and Beate Heinemann — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The Higgs particle is a vital part of the current Standard Model (SM) of particle physics. Since its discovery, the measurements of its properties have confirmed the SM predictions. However, astrophysical observations hint towards the existence of physics Beyond the Standard Model (BSM) to explain, for example, phenomena like dark matter and baryon asymmetry. An extended Higgs sector is a prominent candidate to provide a connection between this BSM physics and the SM. Since the current measurements of the Higgs boson are limited in precision, they still provide sizeable space for such an extension of the Higgs sector. Here, an extension of the SM Higgs doublet by two additional scalar particles is considered. Depending on the mass of these new particles, processes where the 125 GeV SM Higgs decays into two new scalar particles can occur. In addition, asymmetric decays and successive cascade decays of the new Higgs particles are considered and their novel collider signatures are explored in the context of the ATLAS experiment at the Large Hadron Collider, CERN.

T 78.9 Thu 18:30 H-HS XVI

Suche nach unsichtbaren Zerfällen des Higgs-Bosons in Ereignissen mit einem hadronisch zerfallenden Vektorboson mit dem ATLAS-Detektor — •Johannes Balz, Volker Büscher, Andreas Reiss und Duc Bao Ta — Institut für Physik, Johannes Gutenberg-Universität Mainz

Eines der gegenwärtig größten Ziele für das ATLAS Experiment ist neben der präzisen Vermessung des Standardmodells (SM) die Suche nach Physik jenseits des SM (BSM).

In diesem Vortrag geht es um die Suche nach unsichtbaren Zerfällen des Higgs-Bosons, die nur mit Modellen jenseits des Standardmodells beschrieben werden können. Beim untersuchten Kanal wird das Higgs-Boson über Assoziierte-Produktion erzeugt, wobei das beteiligte Vektorboson hadronisch zerfällt. Daher werden Ereignisse mit hohem fehlendem Transversalimpuls und einem großflächigen Jet selektiert, der als W/Z-Jet klassifiziert ist. Die Quark- und Gluonanteile dieses Jets unterscheidet sich zwischen Signal- und Hauptuntergrundereignissen, wodurch eine Untergrundunterdrückung mithilfe von Quark-Gluon-Tagging möglich ist.

Im Vortrag wird der aktuelle Stand der Analyse bei einer Schwerpunktsenergie von $\sqrt{s}$=13 TeV vorgestellt.