T 53: Suche nach Neuen Teilchen III

Zeit: Mittwoch 16:00–18:30 Raum: H07

T 53.1 Mi 16:00 H07

Search for Excited Leptons in the 2-Lepton + 2-Jet Final State with CMS — •Jonas Roemer, Thomas Hebbeker, and Kerstin Hoepfner — III. Physikalisches Institut A, RWTH Aachen University

This talk presents a new search for excited leptons using data collected by the CMS detector. The theory is based on compositeness models and allows the production of excited leptons via contact interactions in conjunction with a Standard Model lepton. It would provide an explanation for the observed hierarchy of three generations of fermions. This search features a new decay mode of the excited leptons into one lepton and two jets via a contact interaction.

We present limits based on the full 2016 and 2017 proton-proton dataset corresponding to a luminosity of 77.4 fb^{-1} at a center of mass energy of $\sqrt{s} = 13$ TeV.

T 53.2 Mi 16:15 H07

Search for heavy Vh resonances with the ATLAS detector in the final state with boosted $h \to b\bar{b}$ decays — •Andreas Hönle, Dominik Duda, Sandra Kortner, Hubert Kroha, and Stefan Maschek — Max-Planck-Institut für Physik, München, Deutschland

Many extensions of the Standard Model (SM) predict the existence of heavy resonances that decay into boson pairs. A process with promising search prospects is the decay of a heavy particle into a SM vector boson V ($\equiv W, Z$) and the SM Higgs boson h with a subsequent leptonic V decay and a Higgs boson decay into a pair of b quarks.

The final Run 2 ATLAS dataset of approximately 140 fb^{-1}, recorded at $\sqrt{s} = 13$ TeV, allows for probing regions of the process' phase space that were not accessible before. Consequently, new analysis strategies are being implemented, aiming to maximise the sensitivity in those regions.

This talk presents the strategy to search for Vh resonances in the semileptonic decay channel based on the Run 2 ATLAS dataset. It will highlight differences to the previously published search which was based on a subset of the Run 2 data recorded in 2015 and 2016.

T 53.3 Mi 16:30 H07

Search for new Physics in Boosted $hh \to bb\tau\tau$ Decays — •David Kirchmeier, Fabian Petsch, Arno Straessner, and Wolfgang Mader — IKTP, TU Dresden, Germany

The resonant and non-resonant production of two Higgs bosons play an important role in the investigation of the Higgs self-coupling and in searches for physics beyond the Standard Model. Due to the relatively high Higgs mass and its narrow width, decays into two Higgs bosons are ideal e.g. in searches for heavy Higgs bosons or heavy Kaluza-Klein gravitons. Furthermore the $hh \to bb\tau\tau$ decay channel is promising as the Higgs decay into a pair of b quarks has the highest branching ratio, while the decay into $\tau\tau$ final states has still a moderately high branching ratio and allows good separation against QCD background.

In particular the regime of very high mass resonances above 1 TeV is experimentally challenging. The high boost of the two b quarks and the two τ leptons lead to signatures with close-by pairs of b jets and τ decays in the ATLAS detector and requires dedicated experimental techniques to tag those topologies. This talk presents how the search for new physics in the $bb\tau\tau$ final state can be extended to the regime of high mass resonances above 1 TeV. For that purpose the latest developments in the identification of highly boosted τ pairs in the fully hadronic decay channel are presented. It will be shown how these new techniques apply to the $bb\tau\tau$ final state and how the main background coming from multi-jet events can be estimated. The reconstruction and identification of boosted τ pairs is furthermore verified in boosted Z boson decays.

T 53.4 Mi 16:45 H07

Identifizierung geboosteter $H \to b\bar{b}$ - Zerfälle mit dem ATLAS-Detektor — •Stefan Maschek, Dominik Duda, Andreas Hönle, Sandra Kortner und Hubert Kroha — Max-Planck-Institut für Physik, München

Das Heavy Vector Triplet (HVT)-Modell fasst mehrere Erweiterungen des Standardmodells zusammen und sagt neue, schwere Vektorbosonen Z' und W' voraus, die für geeignete Modelparameter in das Higgs-Boson und ein Z- oder W-Boson zerfallen. Beim Zerfall eines neuen HVT-Teilchens, das viel schwerer als das Higgs-Boson ist, erhält das Higgs-Boson einen hohen Transversalimpuls. Im dominantem Higgs-Zerfallskanal in zwei b-Quarks führt dies zu kollimierten b-Quarkjets. Um eine solche geboostete Topologie identifizieren zu können, werden Jets mit einem großen Radiusparameter rekonstruiert, welche die Zerfallsprodukte beider b-Hadronen umfassen. In diesem Vortrag werden die jüngsten Entwicklungen bei der Identifizierung geboosteter H→bb-Zerfälle und deren Anwendung bei der Suche nach den oben genannten Resonanzen vorgestellt. Die H→bb-Jets müssen effizient vom Untergrund getrennt werden. Hierfür werden die Standardalgorithmen zur b-Jetidentifizierung in ATLAS verwendet, ergänzt durch Anforderungen an die Jetsubstruktur, charakterisiert durch die Jetmasse und die Anzahl der Jetkonstituenten. Diese etablierte Methode wird neuen Algorythmen gegenüber gestellt, welche multivariate Verfahren oder Reclustering verwenden.

T 53.5 Mi 17:00 H07

Search for a light CP-odd Higgs boson decaying into a pair of taus — •Paul Moder, Arno Straessner, and Wolfgang Mader — IKTP, Dresden, Germany

Even though the predictions of the SM have often agreed with experimental observations to an incredible degree, there are still some phenomena it can not explain, for example the anomalous magnetic moment of the muon, which shows significant deviations in the experiment. This deviation could be explained in the context of a 2 Higgs Doublet Model(2HDM), which predicts a second Higgs doublet with one CP-odd Higgs boson. Interesting parameters of the model are the mass of the CP-odd Higgs boson and the couplings to charged leptons and up type quarks.

In this talk, a search for a light CP-odd Higgs boson is presented through a cut based analysis. In the analysis the Higgs boson is produced via gluon fusion and then decays into a pair of two tau leptons, where both tau leptons decay leptonically, one into an electron, one into a muon. The analysed mass range of the CP-odd Higgs boson lies between 60 GeV and 90 GeV, which is a favored part of the parameter space to explain the deviation between SM prediction and experimental results of the magnetic moment of the muon. This potential new search is discussed based on Monte Carlo simulations, assuming 36.1 fb^{-1} of data collected by the ATLAS experiment at 13 TeV. The sensitivity of the analysis is then presented in terms of discovery significance and expected exclusion limits for the coupling to up type quarks in this scenario.

T 53.6 Mi 17:15 H07

Reconstruction techniques for displaced particle decays in the CMS calorimeter — Gregor Kasieczka and •Zhiyuan He — Institut für Experimentalphysik, Universität Hamburg, Deutschland

We present how deep neural networks (DNN) can be exploited to improve searches for beyond Standard Model (SM) physics, peformed with the CMS detector. One of the SM issues, the hierarchy problem, can be addressed by introducing a so-called "dark sector", that interacts with SM particles via the Higgs boson. The Higgs boson is expected to decay into a pair of new scalar long lived particles (LLPs), that in turn decay predominantly into SM b quark pairs, expected to be "displaced" with regards to the interaction point. If the new scalar particles have decay lengths of approximately the radius of the CMS calorimeter radius, high-level jet variables, as well as low-level quantities calculated from jet components, can be used to discriminate the b-jet decay products of the LLPs from SM b-jets. These attributes, extracted from Monte Carlo simulations of the new exotic process and of SM processes, are used to train a DNN algorithm. We focus on optimizing the search strategy for masses of the LLP ranging from 15 to 60 GeV, and decay lengths from 100 mm up to several meters.

T 53.7 Mi 17:30 H07

Search for long-lived particle decays in the CMS tracking system — Lisa Benato, Melanie Eich, Zhiyuan He, Gregor Kasieczka, and •Karla Pena — Institut für Experimentalphysik, Universität Hamburg

Twin Higgs models propose the existence of a dark sector, neutral under all SM gauge groups. Interaction between the dark sector and the SM is mediated solely by the Higgs boson, which mixes with its dark

partner. As a consequence of this, the Higgs boson is predicted to decay to non-SM particles. Scenarios are considered where the Higgs boson decays into a pair of dark long-lived particles (LLPs), each of which travels a macroscopic distance before decaying back to a pair of SM particles—predominantly b quarks.

Decays occurring within the CMS tracking system result on displaced-vertex signatures, which can be observed with almost no SM background. However, as conventional track reconstruction and vertex finding algorithms are optimized for prompt decays, these signatures are very challenging to find and advanced tracking reconstruction techniques are required. A benchmark analysis is performed, where information from reconstructed tracks is used to tag jets whose origin is significantly displaced with respect to the primary vertex.

The status of a search for LLPs decaying in the CMS tracker is presented, using data collected by the CMS detector in 2016 pp collisions at $\sqrt{s} = 13$ GeV.

T 53.8 Mi 17:45 H07

Search for Highly Ionizing Particles with the Pixel Detector in the Belle II Experiment — Soeren Lange, Klemens Lautenbach, Leonard Koch, Dennis Getzkow, Simon Reiter, and •Katharina Dort — Justus Liebig University Giessen, Giessen, Germany

The Belle II experiment, located at the SuperKEKB collider at the high-energy research facility KEK in Tsukuba, Japan, started operation in 2018. Compared to the predecessor experiment Belle, Belle II plans to increase the peak luminosity by a factor of 40, by employing nano-beam technology in the interaction region.

In particular the new, innermost sub-detector of Belle II - the Pixel Vertex Detector (PXD) - is in close proximity to the interaction point. This allows for the detection of particles, which do not leave a signal in the outer sub-detectors. Among these, Highly Ionizing Particles (HIPs) possess a characteristically severe energy loss limiting their penetration depth into the detector.

Magnetic monopoles, stable tetraquarks and anti-deuterons as possible HIPs are considered. Without a signal in the outer sub-detectors, no trigger is issued resulting in a loss of information about them. In this talk the possibility of identifying HIPs solely with information provided by the PXD is presented, by using neural network algorithms operating in a multi-dimensional parameter space of e.g. PXD cluster data. Most notably, the application of unsupervised learning in the form of Self-Organizing Maps (SOM) is presented.

T 53.9 Mi 18:00 H07

Search for long-lived particles decaying in the CMS calorimeters — •Lisa Benato, Melanie Eich, Zhiyuan He, Gregor Kasieczka, and Karla Peña — Institut für Experimentalphysik, Universität Hamburg

A search for long lived exotic particles, performed with 2016 data collected by the CMS detector, is presented. Many models of new physics aim at solving the hierarchy problem of the Standard Model by extending the SM gauge group to a dark QCD sector, that interacts with SM particles via the Higgs boson. The Higgs boson is predicted to decay with sizeable branching fraction into a pair of dark mesons, that are long lived (with decay lengths from ˜50 cm up to ˜10 meters), and that each sequentially decay into pairs of b-quarks. Given the lifetimes considered, b-quarks are expected to shower mainly in the CMS calorimeters, producing only few hits in the tracker: as a consequence, they are reconstructed as displaced or trackless jets, with peculiar features in terms of their compositions when compared to the overwhelming multi-jet background. The SM predictions are calculated using control regions in data. Results are presented as function of the mass and lifetime of the exotic particles.

T 53.10 Mi 18:15 H07

Searches for long-lived particles produced in Higgs decays with b-quark like signature — •Melanie Eich, Lisa Benato, Zhiyuan He, Gregor Kasieczka, and Karla Pena — Institut für Experimentalphysik, Universität Hamburg

Beyond Standard Model (BSM) theories including electrically neutral, long-lived particles (LLP) can solve the hierarchy problem. In these theories, a mirror version of all or some SM gauge group exists alongside additional fermions. The particles of SM and mirror group are connected via a discrete symmetry. In our analysis the Higgs boson is seen as a mediator between the two groups, because it mixes with its mirror partner. It is expected that the Higgs boson decays into a pair of long- lived scalars $\pi\nu$.

In this analysis each $\pi\nu$ is expected to decay into two b-quarks, while the lifetime of the $\pi\nu$ is in the order of a few millimeters. Such a lifetime result in a displaced vertex (DV), mimicking a b-quark like signature. The search for such $\pi\nu$ requires new analysis techniques to distinguish between decay products coming from DV and background events. In this talk an overview of the reconstruction techniques and the current analysis status is presented, using data recorded with the CMS detector in 2016.