T 2: Search for new particles 1 (LHC)

Time: Monday 16:00–18:00 Location: Geb. 20.30: 1.067

T 2.1 Mon 16:00 Geb. 20.30: 1.067

Exploring new physics at LHC with Model Unspecific Search in CMS — Thomas Hebbeker, Yannik Kaiser, Lucas Karwatzki, •Chinmay Seth, and Felipe Torres Da Silva De Araujo — RWTH Aachen University

The Standard Model of Particle Physics, while highly successful, has limitations and fails to provide a comprehensive description of fundamental particles. Beyond Standard Model theories explore alternative explanations for these shortcomings.

The Large Hadron Collider provides access to unprecedented energy for proton-proton collision experiments, generating data to explore theories beyond the Standard Model. Model Unspecific Search in CMS (MUSiC) is one such effort where a model-independent approach is used to look for regions of possible discrepancies between observations from the CMS detector and a statistical model based on a theoretical understanding of the standard model.

MUSiC classifies events into 'event classes' based on the multiplicity of specific physics objects. Kinematic distributions for these classes are generated using three key event variables. The algorithm calculates a p-value, considering systematic and statistical effects, and identifies regions in distributions that deviate from the statistical model. Applying further statistical corrections yields a final value, highlighting the most deviating event classes. If the corrected p-value surpasses a set threshold, it signifies a potential window to new physics in that corresponding region. We discuss the concept of MUSiC, its scope, and challenges in this talk.

T 2.2 Mon 16:15 Geb. 20.30: 1.067

A new global approach to the Model Unspecific Search in CMS — Thomas Hebbeker, Yannik Kaiser, •Lucas Karwatzki, Arnd Meyer, Chinmay Seth, and Felipe Torres da Silva de Araujo — III. Physikalisches Institut A, RWTH Aachen University.

Model independent searches are an essential alternative to more specific searches, as new physics may manifest itself in ways that have not been predicted yet. The "Model Unspecific Search in CMS" (MUSiC) is a general approach to the search for new physics. Here, CMS data and Monte-Carlo simulations of the Standard Model are first systematically categorised into classes and then the deviations are quantified. MUSiC is based on a hybrid Bayesian-frequentist approach in which an algorithm finds the region of interest (ROI) where the deviation is evaluated by a given statistical test, taking into account the Look Elsewhere Effect.

Here we present a study on a global search algorithm, based on the Jensen-Shannon-Distance as a complementary MUSiC statistical test. This approach has the advantage of a reduced calculation time and because of the global nature, no ROI scan is performed. The method reduces the complexity of the algorithm in the number of histogram bins from $\mathcal{O}(n^2)$ to $\mathcal{O}(n)$.

We discuss initial results based on Monte-Carlo simulations of the Standard Model as well as possible new physics signals, while using MUSiC as a benchmark.

T 2.3 Mon 16:30 Geb. 20.30: 1.067

Searching for new physics in dijets using anomaly detection — •Manuel Sommerhalder, Tobias Quadfasel, Louis Moureaux, and Gregor Kasieczka — Institut für Experimentalphysik, Universität Hamburg

Despite compelling experimental and theoretical motivation as well as extensive new physics searches at the Large Hadron Collider, there have been no discoveries of physics beyond the standard model (BSM) to date. A potential reason for this might be that the common search strategy relies on selecting BSM signal candidate events based on specific signal and background models. Such a dedicated search cannot be performed for every possible BSM theory and phase space region. And even if this was computationally feasible, it would still lack sensitivity to unthought-of models. Thus, model-independent anomaly detection methods are an important addition to the existing search paradigm. These algorithms aim to select signal candidates in a data-driven manner based on anomalous phase space signatures.

One such anomaly detection method is CATHODE. It detects resonant signal peaks by combining neural density estimation in a sideband region with a weakly supervised classification task of distinguishing real data from an in-situ simulation of the background. We present the first application of CATHODE in a search for BSM physics in the CMS experiment targeting a dijet final state.

T 2.4 Mon 16:45 Geb. 20.30: 1.067

Searching for dijet resonances with the ATLAS trigger — •Falk Bartels — Kirchhoff-Institut für Physik, Heidelberg

The search for sub-TeV dijet resonances at the LHC is statistically limited due to the reduced readout rate of lower p_{T} jet triggers. The ATLAS trigger-level analysis covers this part of the spectrum by recording a strongly reduced set of event-level information processed by the High Level Trigger for all events passing the seeding Level-1 trigger. This allows for lowering the minimal detectable dijet resonance mass from above 1 TeV to around 400 GeV.

With more than 1 billion events in the recorded dijet mass spectrum, an exceptional statistical precision can be achieved. This level of precision is required for all steps of the analysis to achieve a high sensitivity for Physics beyond the Standard Model. The analysis is presented with special emphasis on the custom trigger-level jet calibration and the newly implemented fitting strategy to estimate the QCD background.

T 2.5 Mon 17:00 Geb. 20.30: 1.067

Search for top-antitop quark resonances in the lepton+jets final state with the CMS detector — Johannes Haller[1], Roman Kogler[2], •Johanna Matthiesen[1], and Daniel Savoiu[2] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]Desy, Hamburg

A search for new physics effects in the top-antitop quark mass spectrum in data of the CMS experiment is presented. Heavy resonances decaying into a top-antitop quark pair and then decaying into a lepton and jets are considered. As a preparation for the analysis of the Run 3 data, an existing analysis is reproduced, using a new columnar-based analysis framework `columnflow`. As a proof of principle and base for the upcoming Run 3 analysis, corrections, event selection, reconstruction of the mass of the top-antitop quark pair, a machine learning-based approach for process classification, and a statistical inference model are implemented and improved. Furthermore, expected limits are derived.

T 2.6 Mon 17:15 Geb. 20.30: 1.067

Search for new phenomena with top-quark pairs using 140 fb^{-1} of data at $\sqrt{s}$ = 13 TeV with the ATLAS detector — •Simran Gurdasani, Daniele Zanzi, and Christian Weiser — Albert-Ludwigs-Universitaet Freiburg, Germany

This presentation will highlight the latest search for Beyond Standard Model (BSM) phenomena within the $t\bar{t}$+E_T^{miss} 1-lepton (1L) final state within the ATLAS experiment. Utilizing proton-proton collision data from LHC Run-2 at $\sqrt{s}$ = 13TeV with 140 fb^{-1} of data, Dark Matter (DM) production via scalar/pseudo-scalar mediators and SUSY stop pair production are explored. The improved approach is heavily inspired by Machine Learning techniques using Neural Nets (NN) to first reconstruct hadronically decaying top quarks and then discern signal events from background. Across various kinematic spaces, signal presence is inferred by template fitting the NN output distributions. Furthermore, the improved 1L results are combined with previously published 0L and 2L results for the $t\bar{t}$+E_T^{miss} final state yielding the best limits on stop pair production and DM production via scalar/pseudo-scalar mediators for the ATLAS Run-2 dataset. Additionally, a first time ever interpretation is performed in the context of a search for effective vector contact interactions between top quarks and all three generations of left-handed neutrinos ($tt\nu\nu$).

T 2.7 Mon 17:30 Geb. 20.30: 1.067

Search for excited leptons in the contact interaction and Z decay channels with CMS — •Fabian Nowotny, Kerstin Hoepfner, and Thomas Hebbeker — III. Physikalisches Institut A, RWTH Aachen University

The Standard Model of particle physics does not provide a comprehensive explanation for the observed hierarchy of three generations

of fermions, for both leptons and quarks. A possible explanation is delivered by models postulating that quarks and leptons themselves are composite objects. Their constituents are bound by an asymptotically free gauge interaction below a characteristic scale Λ. Such models of compositeness predict the existence of excited lepton ($l^\star$) and excited quark ($q^\star$) states at the characteristic scale Λ of the new binding interaction. The theory allows the production of excited leptons via contact interactions in conjunction with a Standard Model lepton. Subsequently the excited leptons can decay into several final states.

This talk focuses on the contact interaction and Z-boson decay channels, both resulting in $l^\star \to lq\bar{q}$ transitions where l represents e and μ. Preliminary results are presented on the Run 2 proton-proton dataset of CMS corresponding to a luminosity of 137.6 fb^{-1} at a center of mass energy of $\sqrt{s} = 13$ TeV.

T 2.8 Mon 17:45 Geb. 20.30: 1.067

Search for high-mass resonances in dilepton final states with associated b-jets at the ATLAS experiment — Frank Ellinghaus and •Anna Vorländer — Bergische Universität Wuppertal

A search for the Z' boson in high-mass dilepton (ee,$\mu\mu$) final states with associated b-jets is presented. The considered Z' model is a candidate explanation for potential anomalies in B hadron decays and couples to b and s quarks in the production. The search is carried out using the dataset collected by the ATLAS detector in Run-2 of the LHC corresponding to an integrated luminosity of $140\,\text{fb}^{-1}$. Control, signal and validation regions are defined, and these regions are fitted in a profile-likelihood fit. Expected exclusion limits on the Z' mass are obtained based on the results of the fit.