T 64: Search for New Particles 5

Time: Wednesday 16:15–18:30 Location: T-H23

T 64.1 Wed 16:15 T-H23

Model Unspecific Search in CMS (MUSiC) — •Lorenzo Vigilante[1], Arnd Meyer[1], Thomas Hebbeker[1], and Saranya Samik Ghosh[2] — [1]III. Physikalisches Institut A, RWTH Aachen, 52074 Aachen, Germany — [2]CERN, Experimental Physics Department, Geneva, Switzerland

The Model Unspecific Search in CMS (MUSiC) is a search for new physics beyond the standard model (BSM). The analysis looks for significant deviations from the standard model (SM) expectation in LHC data. The method of the analysis is to compare kinematic distributions of the data with the SM expectation in hundreds of different final states, using an automated procedure. This strategy allows MUSiC to search for new phenomena in final states that are not all covered by dedicated analyses in CMS. In this talk the general method and its implementation will be discussed and results of the MUSiC analysis using 35.9 $\text{fb}^{-1}$of data collected by the CMS experiment during proton-proton collisions at a center of mass energy of 13 TeV will be presented. The current status of the analysis and a possible new search method, based on machine learning technique, will be described.

T 64.2 Wed 16:30 T-H23

Search for high mass lepton flavour violating processes with CMS — •Sebastian Wiedenbeck, Thomas Hebbeker, Arnd Meyer, and Swagata Mukherjee — III. Physikalisches Institut A, RWTH Aachen University

Lepton flavour is a conserved quantity in the standard model of particle physics, but it does not follow from an underlying symmetry. Neutrino oscillations imply that lepton flavour is not conserved in the neutral sector. Lepton flavour violating processes are common in several models of physics beyond the standard model (e.g. supersymmetry with R-parity violation, black hole production, and leptoquarks). Some models predict objects at the TeV mass scale that can decay into two standard model leptons of different flavours: electron + muon, muon + tau, or electron + tau. The challenges in a search for such phenomena are to achieve a high mass resolution, good rejection of standard model backgrounds, and efficient lepton identification at the same time. The status of the analysis is presented, based on the latest CMS data taken in Run 2.

T 64.3 Wed 16:45 T-H23

Search for new physics in the τ+MET final state with CMS — •Christoph Schuler, Kerstin Hoepfner, Thomas Hebbeker, and Swagata Mukherjee — III. Physikalisches Institut A, RWTH Aachen University

A search for new physics in the τ+missing transverse momentum (MET) channel is presented based on proton-proton collisions measured with the CMS detector at the LHC, using the full Run-2 CMS data set recorded at a center of mass energy of 13 TeV. The analysis strategy is discussed and the results are interpreted in the context of various models predicting enhancements to the Standard Model in the high mass region.

T 64.4 Wed 17:00 T-H23

Interpreting the ATLAS missing-energy-plus-jets measurement for New Physics — •Martin Habedank and Priscilla Pani — Deutsches Elektronen-Synchrotron (DESY)

The large dataset of $139\,\text{fb}^{-1}$ of proton–proton collisions at $13\,\text{TeV}$ recorded with the ATLAS detector allows for a precise measurement of events with large missing transverse momentum and at least one jet. In the Standard Model, this final state can mostly be attributed to Z bosons being produced in association with jets, with subsequent decay of the Z boson into neutrinos. By correcting for detector effects, the measurement can thus make an important contribution to our Standard Model understanding and modelling.

However, various questions that cannot be answered within the framework of the Standard Model give rise to models predicting New Physics. Many of those – in particular when incorporating a Dark Matter candidate – also give rise to events with missing transverse momentum and one or more jets, rendering the mentioned measurement a powerful handle in constraining these models.

This talk gives insight into the approach taken by the mentioned measurement and progress on interpreting it with regard to New Physics models.

T 64.5 Wed 17:15 T-H23

Identification of highly boosted $\mathbf{Z\rightarrow e^+e^-}$ decays with the ATLAS detector — Dominik Duda, •Florian Kiwit, Sandra Kortner, and Hubert Kroha — Max-Planck-Institut für Physik

The identification of W, Z and Higgs bosons with large transverse momenta is crucial in many searches for new heavy resonances. Thus far, the development of algorithms for the tagging of boosted bosons focuses on the reconstruction and identification of hadronic boson decays, while no dedicated algorithm to identify boosted $Z\rightarrow e^+e^-$ decays exists. The performance of the standard electron reconstruction and identification algorithms degrades with decreasing angular separation between the e^+e^- pairs and will eventually vanish once the angular separation between the e^+e^- pairs is too small to construct individual clusters in the calorimeter. To improve the reconstruction and identification of such highly boosted $Z\rightarrow e^+e^-$ decays, a dedicated algorithm for $Z\rightarrow e^+e^-$ tagging is being developed using a deep neural network. This talk presents first results of this development.

T 64.6 Wed 17:30 T-H23

Search for charged Higgs bosons in $H^+\rightarrow Wh\rightarrow l\nu bb$ decays with the ATLAS detector — Dominik Duda, •Simon Grewe, Sandra Kortner, and Hubert Kroha — Max-Planck-Institut für Physik, München

Various theories predicting an extended Higgs sector predict also the existence of at least one set of charged Higgs bosons. The main production mode of these new particles depends on their mass. For charged Higgs boson masses larger than the sum of the top and the bottom quark mass, the dominant production mode is expected to be in association with a top quark and a bottom quark (tbH^+).

In the alignment limit of the two-Higgs-Doublet Model (2HDM), heavy charged Higgs bosons with $\text{m}(\text{H}^+)>\text{m}(\text{t})+\text{m}(\text{b})$ decay almost exclusively via $H^+\rightarrow tb$. However, in other models such as the Next-to-two-Higgs-Doublet Model (N2HDM), the three-Higgs-Doublet model (3HDM) or in Higgs triplet models (e.g. Georgi-Machacek model), significant branching ratios for $H^+\rightarrow W^+h$ are possible. The latter decay mode has so far been covered neither by ATLAS nor CMS.

We present first studies on the search for $H^+\rightarrow W^+h\rightarrow \ell\nu bb$ decays in final states with the resolved topology containing five or more jets, one charged lepton and missing transverse momentum. A multiclass classifier is used to separate the semileptonic $H^+\rightarrow l\nu bb$ and fully hadronic $H^+\rightarrow qqbb$ decay modes from the dominant background processes. The reconstruction of the charged Higgs boson decay is performed using boosted decision trees (BDTs).

T 64.7 Wed 17:45 T-H23

Status of the FASER Experiment — •Markus Prim and Florian Bernlochner — Rheinische Friedrich-Wilhelms-Universität Bonn

FASER, or the Forward Search Experiment, is a new experiment at CERN designed to complement the LHC's ongoing physics programme, extending its discovery potential to light and weakly-interacting particles that may be produced copiously at the LHC in the far-forward region. New particles targeted by FASER, such as long-lived dark photons or dark scalars, are characterised by a signature with two oppositely-charged tracks or two photons in the multi-TeV range that emanate from a common vertex inside the detector. The experiment is composed of a silicon-strip tracking-based spectrometer using three dipole magnets with a 20-cm aperture, supplemented by four scintillator stations and an electromagnetic calorimeter to allow for energy measurements. The full detector was successfully installed in March 2021 in an LHC side-tunnel 480 meters downstream from the interaction point in the ATLAS detector. FASER is planned to be operational for the upcoming LHC Run 3. We will discuss the physics reach of FASER, present the current status of the experiment and results from the ongoing in situ commissioning.

T 64.8 Wed 18:00 T-H23

Results from First Simulation Studies for a Dark Photon Search Experiment at the ELSA Electron Accelerator — Philip Bechtle, Klaus Desch, Oliver Freyermuth, Matthias

Hamer, •Jan-Eric Heinrichs, and Martin Schürmann — Rheinische Friedrich-Wilhelms-Universität Bonn

The true nature of Dark Matter (DM) has long been of interest for scientists worldwide. Previous searches have so far been unsuccessful in finding proposed DM particles. A promising and not well explored parameter space of light DM particles up to 1 GeV remains to be subjected to intense experimental testing. Mainly two approaches are investigated by the community, namely beam dump and fixed targets experiments.

This talk highlights the future prospects of a fixed target experiment aimed at finding evidence for a dark sector, which couples to the standard model through a dark photon. The underlying theory and the resulting experimental challenges and strategy will be explained. The possibility of building a corresponding experiment at the ELSA electron accelerator in Bonn is highlighted. This talk covers first steps towards a Geant 4 simulation. Special emphasis will be put on some first simulation results concerning the layout and technology for an electromagnetic calorimeter based on requirements on radiation hardness and response times.

T 64.9 Wed 18:15 T-H23

Neutrino and Muon induced background studies - SHiP experiment — •Anupama Reghunath, Heiko Lacker, Andrew Conaboy, and Jakob Schmidt for the SBT-Collaboration — Institut für Physik, Humboldt-Universität zu Berlin, Berlin, Germany

The Search for Hidden Particles (SHIP) experiment is proposed to be constructed at a dedicated beam-dump facility at the CERN Super Proton Synchrotron (SPS) aiming to search for new feebly interacting particles generated in the decay of heavy flavour hadrons or through interactions of photons inside the beam-dump target. During a period of five years, SHIP aims to collect data from $2 \cdot 10^{20}$ 400 GeV/c protons on target. The experimental design is optimised to maximise the production of charm and beauty mesons with zero background events to have the best sensitivity to hidden-sector particles. Simulation studies with emphasis on the neutrino and muon induced background arising from inelastic interactions and its rejection using kinematical and topological requirements as well as information dedicated veto detectors, such as the Surround Background Tagger, will be discussed.