T 13: Higgs Physics II

Time: Monday 16:15–18:15 Location: KH 02.013

T 13.1 Mon 16:15 KH 02.013

Search for light pseudoscalar Higgs boson decays in the flavour-asymmetric $\mu^+\mu^-$ $c\bar{c}$ final state with the CMS detector — Kai Fabian Adamowicz, Danyer Perez Adan, Lutz Feld, Philipp Nattland, and •Keitlin Sejdarasi — 1. Physikalisches Institut B, RWTH Aachen

A search for exotic decays of the Standard Model (SM) Higgs boson into pairs of light pseudoscalar Higgs bosons a decaying in the flavour-asymmetric final state $a \to \mu^+\mu^-$ and $a \to c\bar{c}$ is presented. This channel exploits both the clean experimental signature provided by the excellent detector resolution for muons and the large branching fraction of the pseudoscalar decay into charm quarks, as predicted by the two-Higgs-doublet model extended by a singlet (2HDM+S). Pseudoscalar masses in the range 4-11 GeV are probed, corresponding to a kinematic regime where they exhibit a significant Lorentz boost. The resulting, highly collimated decay products lead to a distinctive topology: the dimuon invariant mass is used as the primary discriminating observable to extract any potential signal, while in the hadronic channel, the decay to charm quarks can be reconstructed using existing charm-jet identification techniques. In this talk, results obtained using the newly acquired Run 3 CMS data from 2024, at a center-of-mass energy of 13.6 TeV, are presented, aiming at improving the sensitivity through increased statistics. In addition, the performance and suitability of newly developed charm jet identification algorithms for Run 3 are investigated in the context of this search.

T 13.2 Mon 16:30 KH 02.013

Search for light pseudoscalar bosons from Higgs boson decays in the four-kaon final state with the CMS detector — Nils Faltermann[1], Jonas Flossmann[1], •Johannes Hornung[1], Benedikt Maier[2], and Markus Klute[1] — [1]Karlsruher Institut für Technologie, Karlsruhe, Germany — [2]Imperial College, London, United Kingdom

Since the discovery of the Higgs boson, extensive measurements of its properties have set upper limits on the branching ratio of its yet undetected decay modes. The branching ratio encompasses immediate decays into SM particles that are not detectable, as well as decays into BSM particles. This talk focuses on a search for Higgs boson decays into pairs of hypothetical pseudoscalar bosons a. These bosons can either be identified as pseudoscalar Axion-Like Particles (ALPs) or, more specifically, as additional Higgs Bosons, as suggested for example by the NMSSM. Specifically, the search strategy, focussing on the background estimation, and expected limits of an analysis targeting prompt decays H -> aa -> KKKK using data collected by the CMS detector during Run 2 of the LHC will be discussed.

T 13.3 Mon 16:45 KH 02.013

Searches for rare Higgs boson decays to light hadronic resonances with CMS data — Konstantinos Nikolopoulos, •Mahtab Jalal Vandi, and Robert James Ward — University of Hamburg, Hamburg, Germany

The current experimental constraints still allow for light, weakly coupled states in the *Higgs* sector. This motivates searches for rare *Higgs* boson decays such as $H \to Za$, where a is a hadronically decaying resonance with a mass between 0.5 and 3.5 GeV. While this mass range has been explored in previous searches, it remains experimentally challenging, and further investigation can benefit from improved experimental techniques. Studies on the development of such techniques and on the estimation of the expected sensitivity will be presented.

T 13.4 Mon 17:00 KH 02.013

Interference effects of Beyond Standard Model Higgs to ditau production on Z pole — •Frank Nowak, Luka Vomberg, Philip Bechtle, Christian Grefe, and Klaus Desch — Universität Bonn

The Higgs sector is still one of the most interesting areas of the Standard Model (SM), even more than 13 years after the discovery of the Higgs boson. There is a wide variety of motivation for expanded Higgs sectors in beyond-the-SM theories (BSM), both from theoretical considerations and from experimental hints. A particularly attractive addition would involve an additional light Higgs-boson below the mass of the SM-like Higgs boson at 125 GeV. It would be even more theoretically attractive to consider CP even H, CP odd A and mixed CP states ϕ for this particle.

For this study the search for these BSM Higgs bosons in the decay of $H/A \to \tau\tau$ covers the particularly challenging mass range around the Z peak. In this case, interference of the BSM Higgs boson production with Z boson production cannot be excluded for some contributions to the production. The possible interference effects of new particles are explored in truth level Monte Carlo samples in the $pp \to \tau\tau + X$ channel. A special emphasis of this study is the influence of the CP-state of the new bosons on the interference between the BSM Higgs and Z.

T 13.5 Mon 17:15 KH 02.013

The Importance of Being Kite — •Karim Elyaouti[1], Rafael Boto[1], Duarte Fontes[1], Maria Gonçalves[1], Milada Margarete Mühlleitner[1], Jorge C. Romão[3], Rui Santos[2], and João P. Silva[3] — [1]Karlsruher Institut für Technologie — [2]Universidade de Lisboa, Campo Grande — [3]Departamento de Física and CFTP, Instituto Superior Técnico, Universidade de Lisboa

The Complex Two-Higgs-Doublet Model (C2HDM) features an explicitly CP-violating scalar sector, making the electron electric dipole moment (eEDM) one of the most stringent probes of the model. The current limit of 4.1×10^{-30} e.cm already places strong constraints on CP-violating Higgs interactions, and future sensitivities are expected to improve by several orders of magnitude. This talk presents an updated analysis of the C2HDM parameter space under all current theoretical and experimental constraints. The calculation of the eEDM includes the contribution from the charm quark, which can be relevant in certain regions of the parameter space. Machine-learning techniques are employed to explore parameter regions that are difficult to access with traditional search strategies.

T 13.6 Mon 17:30 KH 02.013

The cS2HDM as a unified framework for dark matter and electroweak baryogenesis — Thomas Biekötter[1], •Pedro Gabriel[2,3], Milada Margarete Mühlleitner[2], and Rui Santos[3,4] — [1]Instituto de Física Teórica UAM/CSIC, Madrid, Spain — [2]Institute for Theoretical Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany — [3]Centro de Física Teórica e Computacional, Faculdade de Ciências da Universidade de Lisboa, Lisboa, Portugal — [4]ISEL - Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa, Lisboa, Portugal

The discovery of the Higgs boson at the LHC confirms the Standard Model's (SM) mechanism for electroweak symmetry breaking, yet the SM fails to address key cosmological phenomena such as dark matter (DM) and the matter-antimatter asymmetry. Higgs-portal models with extended scalar sectors offer promising frameworks to bridge this gap. Among them, models incorporating a complex singlet scalar field can host pseudo-Nambu-Goldstone (pNG) DM, naturally suppressing direct-detection signals and making them ideal candidates for collider-based DM searches. However, minimal pNG DM models lack ingredients for electroweak baryogenesis. To overcome this, we look at the CP-violating singlet-extended two Higgs doublet model (cS2HDM) which contains both a pNG DM candidate and several sources of CP-violation and could serve as a benchmark for upcoming LHC searches

T 13.7 Mon 17:45 KH 02.013

Machine learning in the 2HDM2S model for dark matter — •Rafael Boto[1], Tiago Rebelo[2], Jorge Romão[2], and João Silva[2] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology, 76128 Karlsruhe, Germany — [2]CFTP, Instituto Superior Técnico, Universidade de Lisboa, Av Rovisco Pais, 1, P-1049-001 Lisboa, Portugal

In this work, we build a two real scalar singlet extension of the two Higgs doublet model to answer the dark matter problem. We study the vacuum structure, the bounded from below conditions, the restrictions from the oblique parameters S,T and U, as well as the unitarity constraints. We submit the model to collider and Dark Matter experimental constraints and explore its allowed parameter space. We compare randomly populated simulations, simulations starting near the alignment limit, and a Machine Learning based exploration to find viable solutions.

T 13.8 Mon 18:00 KH 02.013

Dark Matter Aspects of the Composite Higgs Models — •Yu Chen — Universität Würzburg

The nature of Dark Matter (DM) and the origin of small neutrino masses remain open questions in particle physics, motivating extensions of the Standard Model. In this talk, I explore Composite Higgs (CH) models that can simultaneously address both issues. As a concrete example, I will present a CH model based on the coset SU(6)/Sp(6), which naturally provides potential DM candidates as a composite pseudo-Nambu Goldstone boson. I will discuss the phenomenological implications, focusing on explaining the DM relic density within this framework.