T 28: Search for new particles 3 (ALPS)

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

T 28.1 Tue 16:00 Geb. 20.30: 1.067

Search for long-lived axion-like particles in top production — Juliette Alimena[1], Freya Blekman[1,2], Jeremi Niedziela[1], •Lovisa Rygaard[1,2], Susanne Westhoff[3,5,6], Ruth Schäfer[3], and Sebastian Burgisser[3,4] — [1]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [2]Universität Hamburg, Hamburg, Germany — [3]Heidelberg University, Heidelberg, Germany — [4]Uppsala University, Uppsala, Sweden — [5]Radboud University, Nijmegen, The Netherlands — [6]Nikhef, Amsterdam, The Netherlands

We investigate the discovery potential for long-lived axion-like particles produced in association with a top quark-antiquark pair at the (High-Luminosity) LHC. Compared to inclusive searches for a displaced vertex, top quark associated signals offer new trigger options and an extra handle to suppress background. The search strategy includes axion-like particle decays to a displaced di-muon vertex which further contributes to the suppression of prompt background. For axion-like particles with masses above the di-muon threshold, we find that the (High-Luminosity) LHC can probe effective top-quark couplings as small as $|c_{tt}|/f_a = 0.03(0.002)$ TeV and proper decay lengths as long as 20 (300) m, assuming a cross section of 1 fb, with data corresponding to an integrated luminosity of 150 fb^{-1} (3 ab^{-1}). Our predictions suggest that searches for top quark associated displaced di-muons will explore new terrain in the current sensitivity gap between searches for prompt di-muons and missing energy.

In this talk I will present the results of our phenomenology study, and the first results of the CMS analysis searching for this same signature.

T 28.2 Tue 16:15 Geb. 20.30: 1.067

Search for top quark decays to long-lived axion-like particles with ATLAS — •Frederic Fischer, Alexander Basan, Lucia Masetti, Jessica Höfner, Eftychia Tzovara, and Doğa Elitez — Universität Mainz

The Standard Model (SM), although confirmed with great precision experimentally, is still insufficient to answer many fundamental questions. Hence, axion-like particles (ALPs) appear in many beyond Standard Model (BSM) theories trying to address these questions.

One way to approach ALPs is to parameterise ALP couplings to Standard Model particles like top quarks. ALPs appear in flavour-changing exotic top decays where the top quark decays into an ALP and an up- or charm-quark. Within this decay mode, parts of the allowed parameter space suggests ALPs to have lifetimes long enough to travel macroscopic distances before decaying. This search is dedicated to top-antitop events with one SM semi-leptonically decaying top quark and one exotically decaying top quark.

In this topology the focus is on ALPs decaying in the hadronic calorimeter at ATLAS with a centre-of-mass energy of 13 TeV. They are assumed to be electrically neutral and thus leave no signal in the ATLAS tracking system. Moreover, the ratio of energy deposits in the electromagnetic calorimeter and hadronic calorimeter are used to suppress SM backgrounds.

This talk presents the search for long-lived ALPs from exotic top decays at ATLAS.

T 28.3 Tue 16:30 Geb. 20.30: 1.067

Search for ALPs in $e^+e^- \to \gamma a, a \to \gamma\gamma$ at Belle II — •Alexander Heidelbach, Giacomo De Pietro, Torben Ferber, and Pablo Goldenzweig — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Axion-Like Particles (ALPs), predicted by theoretical extensions of the Standard Model, represent potential Dark Matter mediators. The Belle II collaboration is conducting a search for the $e^+e^- \to \gamma a$ channel, with subsequent ALP decay into a photon pair. This study utilizes the Belle II detectors precision, high luminosity, and unique understanding of the initial state to explore a diverse range of ALP masses and couplings in this fully neutral three-photon final state. Compared to the predecessor analysis based on the 2018 dataset, this analysis uses around 1000 times larger dataset, an improved understanding of the photon reconstruction resolution, and an MVA-based candidate selection. This talk will discuss the current state of the new analysis

T 28.4 Tue 16:45 Geb. 20.30: 1.067

ALPS II Overview and Data Taking — •Henry Frädrich for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron (DESY)

The Any Light Particle Search II (ALPS II) is an ongoing 'light-shining-through-a-wall' experiment located at DESY in Hamburg. ALPS II will look for axions and axion like particles, which are hypothetical particles outside the standard model, motivated by exciting hints. The existence of axions would solve the strong CP-problem and could also be an explanation for multiple cosmic phenomena including dark matter, TeV transparency as well as the excess cooling of horizontal branch stars. The ALPS II experiment uses the axion's property of coupling to photons in the presence of magnetic fields, to measure light that has undergone axion-photon conversion and subsequent photon-axion conversion. On the experimental site we use the magnetic fields of 24 superconducting HERA magnets and two state of the art optical cavities with a length of 122 m each, to probe the axion parameter space in new regions. The experiment has been running since May 2023 with multiple successful science runs. In this talk I will give a general overview of the ALPS II experiment and discuss recently acquired data from the first science campaign.

T 28.5 Tue 17:00 Geb. 20.30: 1.067

Precision Optics and Control for the ALPS II Experiment — •Daniel Brotherton for the ALPS-Collaboration — University of Florida

The Any Light Particle Search II (ALPS II) is an experiment at DESY which searches for axions via a "light-shining-through-a-wall" scheme. Namely, light is directed through a region of magnetic field where it has a probability of conversion into axions. A barrier beyond this region impedes the light, but axions converted from the light may traverse the barrier and reconvert back into light in a second magnetic field region. The experiment employs 120-meter long high-finesse optical cavities to improve the final photon-axion-photon coupling sensitivity. Currently a "regeneration cavity" (RC) amplifies the reconverted light's amplitude by a demonstrated factor > 7000. A future "production cavity" (PC) will aim to store 150 kW of power to increase the flux of generated axions. This requires a control scheme to maintain the resonance of laser light within the cavities while also mitigating stray light from entering the RC. This talk will discuss the precision optics techniques utilized in ALPS II, including optical offset phase-locking and heterodyne interferometric sensing of ultra-low power fields. Some initial results of the optics performance from ALPS II's current data-taking campaign will also be discussed. Work at Florida is supported by the NSF PHY-2309918.

T 28.6 Tue 17:15 Geb. 20.30: 1.067

Axion-Like-Particle (ALP) search using ATLAS central and ATLAS Forward Proton (AFP) detectors — •Ondrej Matousek and Andre Sopczak — Czech Technical University in Prague

The latest results of the ALP search with the AFP detector are presented.

T 28.7 Tue 17:30 Geb. 20.30: 1.067

Searching for axion like particles in the H->Za->llyy decay with ATLAS — •Georgios Lamprinoudis — Johannes Gutenberg Universitat Mainz

Axion-like particles (ALPs) are motivated by numerous theoretical models, including the two-Higgs-doublet model (2HDM). ALPs can couple to the Higgs and Z bosons via a 5-dim effective coupling and may decay to photons. Depending on the axion – photon coupling ALPs can have a significant life-time which may lead to displaced decay vertices. While previous analyses assumed a negligible axion lifetime, a finite lifetime with displaced vertex signatures is studied in the present analysis of the h->Za->2l2y channel. The analysis covers a mass range of the axions from 1 GeV to 33 GeV. In the case that no signal is observed, the analysis will establish upper limits on the axion-Higgs-Z coupling.

T 28.8 Tue 17:45 Geb. 20.30: 1.067

Multivariate photon classification for an axion-like particle (ALP) search in Higgs boson decays at the ATLAS experiment — •Peter Krämer, Kristof Schmieden, Matthias Schott,

and Olivera Vujinović — Johannes Gutenberg Universität Mainz

Some puzzling questions in particle physics, such as the strong CP problem or the discrepancy of the muon magnetic moment could be solved by introducing light scalar or pseudo-scalar axion-like particles (ALPs). Theoretical models allow a wide range of ALP-masses and couplings to SM particles such as photons and the Higgs boson. Therefore, parts of the ALP parameter space could be investigated with collider experiments like the ATLAS experiment at the LHC.

For low mass ALPs, the decay photons can appear strongly collimated. These collimated photon pairs are reconstructed as a single photon. In this talk it will be discussed how multivariate classification techniques can be applied on detector level information to identify these collimated photons.