T 86: Search for New Particles IV

Time: Thursday 16:00–18:00 Location: Tk

T 86.1 Thu 16:00 Tk

Limit setting in the current search for displaced heavy neutral leptons with the ATLAS detector using the full integrated LHC Run 2 luminosity — •Christian Appelt and Heiko Lacker — Humboldt University, Berlin, Germany

The existence of right-handed neutrinos with Majorana masses below the electroweak energy scale can address ongoing problems of neutrino masses, matter-antimatter asymmetry of the universe, and dark matter. In this talk, we present limit-setting methods, as applied in the current search for heavy neutral leptons using the full LHC Run 2 luminosity of 139 / fb. The heavy neutral leptons are produced in leptonic decays of on-shell W bosons formed in 13 TeV pp collisions at the LHC. We focus on unique displaced signatures captured by the ATLAS detector, characterized by a prompt lepton originating from the W boson decay and a secondary vertex displaced in the radial direction by 4-300 mm from the beamline. The expected limit results are given as exclusion contours in the heavy neutral lepton coupling strength versus mass plane.

T 86.2 Thu 16:15 Tk

Search for long-lived particle decays in the CMS tracker — Lisa Benato, Melanie Eich, Gregor Kasieczka, •Karla Peña, and Jörg Schindler — Institut für Experimentalphysik, Universität Hamburg

Higgs-portal models propose the existence of a dark sector, neutral under all Standard Model (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 also in the dark sector. 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 background from the SM. However, as conventional tracking and vertex finding algorithms are optimized for prompt decays, these signatures are challenging to find and advanced reconstruction techniques are required. Studies of machine-learning methods for displaced-vertex reconstruction will be discussed and compared to a benchmark analysis, where information from displaced tracks is used to tag jets resulting from LLP decays. The status of a search for LLPs is presented, using data collected by the CMS detector in *pp* collisions at $\sqrt{s} = 13$ GeV.

T 86.3 Thu 16:30 Tk

Search for displaced decays of massive particles in multijet events with the ATLAS detector — •Emily Thompson — DESY, Hamburg, Germany

The existence of long-lived particles (LLPs) is a common feature in many theories beyond the Standard Model. For example, models with small couplings (i.e. R-parity-violating supersymmetry) and models allowing for decays via highly virtual intermediate states (i.e. Split supersymmetry) predict the presence of LLPs. With lifetimes ranging from picoseconds to nanoseconds, massive LLPs could decay to several electrically charged particles in the inner tracking volume of the ATLAS detector, allowing for the reconstruction of a displaced secondary vertex

In this talk, an inclusive search for new long-lived massive particles leaving a displaced vertex signature in the ATLAS inner detector in multijet events with 139 fb^{-1} of data collected at $\sqrt{s} = 13$ TeV is presented. As there are no Standard Model particles which give rise to high-mass displaced vertices, the backgrounds stem from various instrumental and algorithmic effects. A data-driven technique to estimate the dominant source of background is presented.

T 86.4 Thu 16:45 Tk

Search for pair-produced leptoquarks decaying into quarks of the third and leptons of the first or second generation with the ATLAS experiment at $\sqrt{s} = 13\,\mathrm{TeV}$ — •Volker Austrup and Frank Ellinghaus — Bergische Universität Wuppertal

Motivated by similarities between the quark and lepton sectors in the Standard Model, leptoquarks (LQs) are hypothetical bosons that are assumed to couple to quarks and leptons at the same time. First proposed in the 1980s, the initial model includes couplings only within one generation. However, hints at flavor anomalies recently observed by various experiments such as LHCb, BaBar, and Belle have sparked interest in extended models with LQs coupling to quarks and leptons of different generations.

In this talk, a search for up- ($q = 2/3\,\mathrm{e}$) and down-type ($q = -1/3\,\mathrm{e}$) LQs decaying into quarks of the third and leptons of the first or second generation is presented. The focus of this analysis is on final states with exactly one lepton and large amounts of missing transverse energy. Neural networks (NNs) are applied to ensure good separation between signal and background processes over a wide range of the parameter space. The NN output is subsequently used as the discriminating variable in a profile-likelihood fit in control and signal regions. Expected lower limits on the signal mass are obtained from the fit results as a function of the LQ branching ratio into charged and uncharged leptons. The analysis shown is based on *pp*-collision data at a centre-of-mass energy of $\sqrt{s} = 13\,\mathrm{TeV}$ measured by the ATLAS experiment at the LHC between 2015 and 2018.

T 86.5 Thu 17:00 Tk

Leptoquark production in a single τ, charm/bottom and met final state at the ATLAS detector — •Patrick Bauer, Philip Bechtle, and Klaus Desch — Physikalisches Institut Bonn

At B-factories, anomalies were observed in decays of the B-hadrons into $\mathrm{D}^{(*)}$ and $\mathrm{K}^{(*)}$, which are consistent with the hypothesis of contributions from Leptoquarks in the high GeV to low TeV range.

Therefore, the direct search for leptoquarks (LQ) got once again in focus at high energy collider experiments. So far most searches aimed at the pair-production via strong interaction, as it is enables a almost model independent approach and is for LQ-masses below 1 TeV expected to be dominating.

However for LQ masses well above 1 TeV the single production mode becomes more relevant. The analysis presented this talk, offers the most direct approach for a search of LQ signature related to the $\mathrm{B} \to \mathrm{D}^{(*)}\tau\nu$ anomaly, as it incorporates essentially the same couplings. Furthermore the process to be investigated could be mediated by a U_1-vector LQ, which is presently widely discussed among theorists, as preferred solution to B-anomalies.It could explain the two observed anomalies within one model. The talk will motivate the analysis and present the ongoing search for vector LQ in single and pair production in final states with one τ, bottom or charm jet and large met.

T 86.6 Thu 17:15 Tk

Vector-Leptoquark Interpretation of the Search for Top Squarks with Decays via Tau Sleptons — •Kyeong Ro Lee and Alexander Mann — Ludwig-Maximilians-Universität, Munich, Germany

Leptoquarks are bosons predicted by various extensions of the Standard Model. Carrying non-zero baryon and lepton numbers, they can decay into a quark-lepton pair and can explain similarities between the lepton and the quark sector of the Standard Model, as well as hints of lepton-flavor universality violation observed in physics of B mesons. Supersymmetry (SUSY) is a framework of theories extending the Standard Model by introducing an additional symmetry between bosons and fermions. If leptoquarks coupling to third-generation fermions (i.e. top and bottom quarks, tau leptons and neutrinos) exist, pair production of such leptoquarks at the LHC would show similar final states as pair-produced top squarks (the SUSY partner of the top quark). More specifically, pair-produced leptoquarks decaying into bottom-tau or top-neutrino pairs will leave similar signatures as pair-produced top squarks decaying via tau sleptons (the SUSY partner of the tau lepton). Thus the search for this SUSY model can be reinterpreted as a search for leptoquarks. In addition to the existing interpretation for scalar (spin-0) leptoquarks, we here look at vector (spin-1) leptoquarks using data taken by the ATLAS detector.

T 86.7 Thu 17:30 Tk

Sensitivity of the SHiP experiment to dark photons decaying to a pair of charged particles — •Atakan Tuğberk Akmete — Johannes Gutenberg-Universität, Mainz, Germany

SHiP is a planned fixed-target experiment that aims to search directly or indirectly for electrically neutral, feebly interacting, hidden particles with masses below $\mathcal{O}(10)$ GeV. It plans to collect 2×10^{20} protons on target with a 400 GeV SPS proton beam in 5 years of running. The hidden particles should have renormalizable interactions with SM fields through small dimensionless coupling operators, so-called portals. According to their spin, each portal refers to a different mediator. One of the most critical portals is the vector portal since all three fundamental forces interact through vector bosons. The kinetic mixing model of the vector portal has a mediator that mixes with the $U(1)$ photon by a coupling ε. This mediator is known as dark photon and has a mass of m_{γ^D}. It is the lightest particle of the hidden sector; therefore, it could decay into fermion pairs. In this talk, recent research on the SHiP experiment's sensitivity to dark photons decaying to a pair of charged particles is presented. Our exclusion contours claim a unique sensitivity for m_{γ^D} ranging between 0.7 and 3 GeV, and ε^2 ranging between 10^{-11} and 10^{-17}.

T 86.8 Thu 17:45 Tk

Results of the Muon Flux and Spectrum Measurement for the SHiP Experiment — •Stefan Bieschke, Caren Hagner, and Daniel Bick — Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

The SHiP experiment is a proposed beam dump experiment dedicated for the Search for Hidden Particles. Utilizing the 400 GeV proton beam of CERN's SPS at a high intensity, it can explore physics beyond the standard model at the intensity frontier. A large number of protons on target, however, is accompanied by a huge amount of muons emerging from the target which would enter the detector's acceptance and render the observation of hidden particle decays impossible. A magnetic shield is foreseen to deflect the muons away from the detector, which is optimized using a particle simulation. Due to the complex interactions in a dense proton beam dump, an experimental verification of the simulation was considered necessary. In 2018, a replica of the proton target was used in the SPS beam to verify the simulated flux and spectrum. The experimental setup and the results of the data analysis will be presented.