

## T 52: Search for new particles 4 (leptoquarks, LHC)

Time: Wednesday 16:00–18:00

Location: Geb. 20.30: 1.067

T 52.1 Wed 16:00 Geb. 20.30: 1.067

**Leptoquark production in a single  $\tau$  charm/bottom and  $E_T^{\text{miss}}$  final state at the ATLAS detector** — ●PATRICK BAUER, PHILIP BECHTLE, and KLAUS DESCH — Physikalisches Institut Bonn

The searches for leptoquarks (LQ), as predicted in some Grand-Unified-Theories, have been explored by collider experiments for quite a some time.

Recent results from CMS, showing a 3.4 sigma excess, consistent with contributions from non-resonant LQ processes, renewed the focus on this topic once again. Furthermore some anomalies, observed in decays of the B-hadrons into  $D^{(*)}$  and charged Leptons, still persist and could also be explained by LQ processes. These observations once more emphasize the importance of exploitation of all possible LQ production modes. For for LQ masses well above 1 TeV the single- and non-resonant production modes can become a key ingredient for ongoing and future searches. With the single production into final states with  $\tau$  lepton(s), bottom or charm jet with large missing transverse momentum, one can directly probe the couplings expected to be involved in the  $B \rightarrow D^{(*)}\tau\nu$  anomaly. For the inclusion of a non-resonant processes it is crucial to study the interference behaviour of LQ signal with the SM.

This talk will provide an overview over the ongoing search for singly produced LQ in the  $\tau$  and charm quark with high  $E_T^{\text{miss}}$  in the final state. Furthermore ATLAS results for LQ single production in b  $\tau\tau$  final state will be shown.

T 52.2 Wed 16:15 Geb. 20.30: 1.067

**Search for resonant leptoquark production with the ATLAS experiment** — ●CHRISTOPHER MAXIMILIAN ENGEL, ADRIAN ALVAREZ FERNANDEZ, and STEFAN TAPPROGGE — Institute for Physics, Johannes Gutenberg University, Mainz, Germany

A leptoquark is a hypothetical particle that couples to both leptons and quarks and carries both lepton and quark quantum numbers. Leptoquarks are predicted by many extensions of the Standard Model, including Grand Unified Theories, and might explain the similarities between the lepton and the quark generations. One way of searching for such a particle would be to look for the production of a single leptoquark in proton-proton collisions caused by the interaction of a lepton and a quark coming from the inner structure of protons.

This talk focuses on this resonant production of a single leptoquark decaying into a lepton and a quark, which results in a lepton+jet signal in the detector. This resonant structure in the invariant mass distribution of the lepton and jet system could be identified on top of a smoothly falling background. One of the main goals of this contribution is the optimization of the selection criteria to achieve maximum signal sensitivity. The current state of the studies and future goals will be presented.

T 52.3 Wed 16:30 Geb. 20.30: 1.067

**Search for Leptoquarks in the multilepton channel with ATLAS Run-2 data** — ●JANICK BÖHM and ANDRE SOPCZAK — Czech Technical University in Prague

The latest results in the search for leptoquarks in the multilepton channel are presented using ATLAS Run-2 data.

T 52.4 Wed 16:45 Geb. 20.30: 1.067

**The LHC as Lepton-Proton Collider: Search for Resonant Production of Leptoquarks** — ●DANIEL BUCHIN, MICHAEL HOLZBOCK, SANDRA KORTNER, and HUBERT KROHA — Max-Planck-Institut für Physik

Searches for leptoquarks constitute an essential part of the physics programme at the ATLAS detector. These hypothetical particles couple to a lepton and a quark and are predicted by many extensions of the Standard Model such as Grand Unified Theories. The existing leptoquark searches at the LHC currently only consider production modes via quark and/or gluon interactions. The small but non-zero lepton content of the proton, however, allows also to study the significantly less explored resonant leptoquark production.

This production mode gives rise to lepton-plus-jet signatures. Thus, leptoquarks would emerge as distinctive peaks over the smoothly falling Standard Model background in the invariant mass spectrum of the lepton-plus-jet system. The talk will give an overview of the

analysis strategy and discuss sensitivity estimates to previously unexplored leptoquark masses using this process.

T 52.5 Wed 17:00 Geb. 20.30: 1.067

**Search for heavy right-handed Majorana neutrinos in  $t\bar{t}$  decays** — ●TONGBIN ZHAO<sup>1,2</sup>, DIPTAPARNA BISWAS<sup>1</sup>, BEATRICE CERVATO<sup>1</sup>, MARKUS CRISTINZIANI<sup>1</sup>, CARMEN DIEZ PARDOS<sup>1</sup>, IVOR FLECK<sup>1</sup>, ARPAN GHOSAL<sup>1</sup>, GABRIEL GOMES<sup>1</sup>, JAN JOACHIM HAHN<sup>1</sup>, VADIM KOSTYUKHIN<sup>1</sup>, NILS KRENGEL<sup>1</sup>, BUDDHADEB MONDAL<sup>1</sup>, KATHARINA VOSS<sup>1</sup>, WOLFGANG WALKOWIAK<sup>1</sup>, and ADAM WARNERBRING<sup>1</sup> — <sup>1</sup>Experimentelle Teilchenphysik, Center for Particle Physics Siegen, Universität Siegen — <sup>2</sup>Shandong University, China

A search for heavy right-handed Majorana neutrinos is performed with the Run-2 dataset recorded from 2015 to 2018 with the ATLAS detector at the CERN Large Hadron Collider and is based on  $\sqrt{s} = 13\text{TeV}$  proton-proton collision data with an integrated luminosity of  $140.1\text{fb}^{-1}$ . The targeted process is  $t\bar{t}$ : one of the top quarks decays into a pair of same-sign same-flavour leptons (electrons or muons), a  $b$ -quark and two light quarks, while the other decays into a  $b$ -quark and two light quarks. The final states feature same-sign dilepton signatures. This analysis is the first search for heavy neutrinos with  $t\bar{t}$  events at the mass range of 15 – 75GeV.

The multivariate analysis is performed to set the signal region to improve the significance. Besides, several control regions are defined to estimate the main backgrounds from the  $t\bar{t}$  + X samples. After performing the statistical analysis with profile likelihood fit, we could set the best limits on the mixing parameter of  $ee/\mu\mu$  channel at the mass region of 15 – 75GeV.

T 52.6 Wed 17:15 Geb. 20.30: 1.067

**Search for new physics in the final state with a lepton and  $\vec{p}_T^{\text{miss}}$**  — ●VALENTINA SARKISOVI, KERSTIN HOEPFNER, and THOMAS HEBBEKER — RWTH Aachen University, Aachen, Germany

Various Beyond the Standard Model (BSM) theories anticipate the existence of new particles that could decay into final states characterized by the presence of a charged lepton and missing transverse momentum ( $\vec{p}_T^{\text{miss}}$ ) as their most distinctive experimental signature. The CMS detector at the CERN LHC is used to hunt for novel physics in the high mass region of final states containing a lepton (electron, muon, tau) and  $\vec{p}_T^{\text{miss}}$ . Achievement of a high mass resolution, rejection of the standard model backgrounds, and efficient identification and reconstruction of TeV leptons are crucial in a search for such phenomena. One of the main challenges of this search is represented by the high rate of QCD multi-jet background produced in the LHC proton-proton collisions, leading to the possible misidentification of a jet as a lepton. Data driven methods as well as advanced machine learning technologies are used to model the QCD contamination and to properly identify leptons. The latest CMS data, recorded in 2022 and 2023 at unprecedented center-of-mass energy of 13.6 TeV, have been analysed. The key concepts of the analysis techniques employed in the search for new physics in the final state with a lepton and  $\vec{p}_T^{\text{miss}}$  are addressed.

T 52.7 Wed 17:30 Geb. 20.30: 1.067

**Sensitivity to lepton-flavour-violating decays of  $Z$  and  $Z'$  bosons using data-driven background estimation with the ATLAS Experiment** — ●NAMAN KUMAR BHALLA, VALERIE LANG, and MARKUS SCHUMACHER — Albert-Ludwigs-Universität Freiburg

One of the primary goals of the Large Hadron Collider (LHC) program is to look for processes beyond the Standard Model (SM) of particle physics. One such process is lepton flavour violation (LFV), which has already been observed in neutrino oscillations, but never in processes involving charged leptons. A search for LFV decays of  $Z$  and  $Z'$  bosons with  $Z^{(\prime)} \rightarrow e\tau\mu$  and  $Z^{(\prime)} \rightarrow \mu\tau e$  final states is motivated by various beyond-SM theories. These searches can be performed using a data-driven background estimation, which takes advantage of the idempotency of SM backgrounds under the exchange of an electron and a muon. This symmetry is broken only by the difference in branching ratios between LFV decays with  $e\tau$  and  $\mu\tau$  final states.

This talk discusses the achievable sensitivities for the search of LFV decays of  $Z$  and  $Z'$  bosons using the full Run-2 data set collected by the ATLAS detector in  $pp$  collisions at  $\sqrt{s} = 13\text{TeV}$ , corresponding to an integrated luminosity of  $140\text{fb}^{-1}$ . The neural network used to

classify the LFV signal against other background processes along with the statistical model used for the analysis are presented.

T 52.8 Wed 17:45 Geb. 20.30: 1.067

**Search for new physics in the top, charm and missing transverse energy final state with the ATLAS detector —**  
•MARAWAN BARAKAT — DESY

A search for new Beyond the Standard Model(BSM) particles in final states with a top quark, charm quark and missing transverse momen-

tum is performed, using a dataset collected with the ATLAS detector during LHC Run 2, corresponding to an integrated luminosity of 139 fb<sup>-1</sup> at a centre-of-mass energy 13 TeV. The search is motivated by BSM theoretical models featuring a non-minimal flavor violation in the 2nd and 3rd generation quark sector, giving rise to final states where BSM particles can decay almost equally to a top quark or a charm quark in association with invisible particles. Good agreement is generally found between data and SM background, with slight deviations of at most 2 sigmas. Exclusion limits are presented for different BSM signal scenarios.