T 73: Flavour physics 3

Time: Wednesday 16:00–18:00 Location: Geb. 30.41: HS 4

T 73.1 Wed 16:00 Geb. 30.41: HS 4

Testing Lepton Flavour Universality with $B_s^0 \to \phi\ell^+\ell^-$ decays using LHCb data — •Sebastian Schmitt[1], Christoph Langenbruch[2], Stefan Schael[1], and Eluned Smith[3] — [1]RWTH Aachen — [2]Universität Heidelberg — [3]Massachusetts Institute of Technology

In the Standard Model of Particle Physics (SM), $b \to s\ell^+\ell^-$ transitions are forbidden at tree-level and may only occur at the loop-level. The branching fractions of these so-called flavour changing neutral currents can thus be significantly affected by New Physics (NP) beyond the SM. While in the SM, the coupling of the electro-weak gauge-bosons is lepton flavour universal, this universality can be broken in NP scenarios. Thus, ratios of branching fractions of semileptonic rare decays with muons and electrons in the final state constitute clean SM tests.

The LHCb detector is located at the LHC at CERN and is optimised to study rare b-hadron decays. For this purpose, LHCb features high trigger efficiencies, excellent track reconstruction, and particle identification.

This talk gives an overview of the current status of the measurement of $R_\phi = \mathcal{B}(B_s^0 \to \phi\mu^+\mu^-)/\mathcal{B}(B_s^0 \to \phi e^+e^-)$, which benefits from the experimentally clean $B_s^0 \to \phi\ell^+\ell^-$ environment. The analysis uses the full Run 1 and Run 2 dataset collected by LHCb which corresponds to $9\,\mathrm{fb}^{-1}$ of integrated luminosity.

T 73.2 Wed 16:15 Geb. 30.41: HS 4

Search for $B^+ \to K^{*+}\nu\bar{\nu}$ using Lorentz Equivariant Neural Networks at the Belle II Experiment — •Caspar Schmitt, Nikolai Hartmann, Sviatoslav Bilokin, and Thomas Kuhr — Ludwig-Maximilians-Universität München

Searches for rare B meson decays allow precision standard model tests owing to particularly precise theory predictions. At the Belle II experiment, B meson pairs are produced exclusively at a known center of mass energy. This allows searches for decays with invisible final state particles, by fully reconstructing one B meson and thereby kinematically constraining the other.

Current precision of searches for $B \to K^{*+}\nu\bar{\nu}$ is statistically limited, therefore, reconstruction efficiency and background suppression are key figures. In a novel method, the accompanying B meson decay is inclusively reconstructed and neural networks are used to suppress background contaminations. We demonstrate the feasibility of Lorentz-equivariant graph neural nets in inclusive reconstruction, which respect the physical symmetries of the input features and improve the experimental upper limit on the branching fraction.

T 73.3 Wed 16:30 Geb. 30.41: HS 4

A model-independent likelihood method and its application to the Belle II $B^+ \to K^+\nu\bar{\nu}$ analysis — •Lorenz Gärtner[1], Thomas Kuhr[1], Slavomira Stefkova[2], Danny van Dyk[4], Méril Reboud[5], Lukas Heinrich[3], Nikolai Hartmann[1], and Malin Horstmann[3] — [1]LMU, Munich, DE — [2]KIT, Karlsruhe, DE — [3]TU, Munich, DE — [4]IPPP, Durham, UK — [5]Siegen University, Siegen, DE

$B^+ \to K^+\nu\bar{\nu}$ decays offer a window into physics beyond Standard Model. The Belle II collaboration found the first evidence for this decay. In order to search for this decay, assumptions on its kinematic distribution were made. Consequently, the results feature a model dependency arising from both Standard Model assumptions and from the description of the pertinent hadronic matrix element, making reinterpretation complicated without reanalysing the underlying data.

We develop a novel reweighting method in order to perform reinterpretations and combinations of particle physics results. The generality of this method allows for statistical inference in the space of theoretical parameters, assuming different kinematic distributions, according to any beyond Standard model prediction.

We implement our method as an extension to the `pyhf` software for statistical inference and interface it with the `EOS` software for flavor physics phenomenology.

Furthermore, we present an easily publishable format of the resulting likelihood function and argue why publishing such likelihoods is crucial for a full exploitation of experimental results.

T 73.4 Wed 16:45 Geb. 30.41: HS 4

Testing of lepton universality with $\Lambda_b^0 \to pK^-\ell^+\ell^-$ decays at LHCb — Johannes Albrecht[1], Vitalii Lisovskyi[2], and •Jannis Speer[1] — [1]TU Dortmund University, Dortmund, Germany — [2]EPFL, Lausanne, Switzerland

Rare decays involving $b \to s\ell^+\ell^-$ transitions offer a wide variety of probes for the Standard Model. This includes null tests of fundamental properties of the Standard Model, such as lepton flavour universality (LFU), which states that the couplings of the gauge boson to the three lepton generations are identical.

The LHCb experiment has performed several measurements of LFU in rare b-meson decays, most recently the ratio of branching fractions of the electron and muon mode in the decay channels $B^+ \to K^+\ell^+\ell^-$ and $B^0 \to K^{*0}\ell^+\ell^-$. However, LFU can also be tested in rare b-baryon decays, which are subject to partly orthogonal experimental and theoretical uncertainties. The first measurement of the ratio of branching fractions of the decays $\Lambda_b^0 \to pK^-e^+e^-$ and $\Lambda_b^0 \to pK^-\mu^+\mu^-$, R_{pK}^{-1}, was performed by the LHCb Collaboration using proton-proton collision data corresponding to an integrated luminosity of $4.7\,\mathrm{fb}^{-1}$. The ratio was measured to be $R_{pK}^{-1} = 1.17^{+0.18}_{-0.16} \pm 0.07$ in the dilepton mass-squared range $0.1 < q^2 < 6.0\,\mathrm{GeV}^2/\mathrm{c}^4$ and the pK mass range $m(pK) < 2600\,\mathrm{MeV}/\mathrm{c}^2$. The updated measurement of R_{pK}^{-1} seeks to reduce the uncertainties by analysing the full $9\,\mathrm{fb}^{-1}$ dataset of LHCb experiment and implementing new selection techniques.

This contribution presents the current status of the ongoing analysis.

T 73.5 Wed 17:00 Geb. 30.41: HS 4

Inclusive analysis of untagged $B \to X\ell^+\ell^-$ decays at Belle II — •Arul Prakash Sivagurunathan, Sviatoslav Bilokin, and Thomas Kuhr — Ludwig-Maximilians-Universität München

In recent years various deviations from the standard model expectation were observed in $b \to s\ell^+\ell^-$ measurements, dominated by exclusive studies. The combined deviations, while being large, are still not above the 5σ discovery threshold, partially owing to theoretical uncertainties. Precision measurements of inclusive $B \to X\ell^+\ell^-$ decays can provide invaluable complementary information to scrutinize anomalies observed in their exclusive decay counterparts. However, limited tagging efficiency, small Standard Model signal and very high background rate make these measurements extremely challenging, with no results being published so far.

In our work, we will evaluate the chances of a 5σ result with data from the Belle and Belle II experiments. We will apply machine learning algorithms to tackle background rejection. We will finally compute the lepton flavour universality ratio $R(X) = \mathcal{B}(B \to X\mu^+\mu^-)/\mathcal{B}(B \to Xe^+e^-)$ which will be key to constrain potential New Physics contributions.

T 73.6 Wed 17:15 Geb. 30.41: HS 4

Measurement of D^+ and D_s^+ production asymmetries on pp collisions at the LHCb experiment with data from Run 3 — •Paula Herrero Gascon — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany

The production asymmetry of charm hadrons and anti-hadrons in pp collisions at the LHC is an important input to many CP violation measurements in the charm system. Thus their measurement is one of the first analyses carried out with the upgraded LHCb experiment. In this talk, we focus on the production asymmetries, A_P, of the $D_{(s)}^+$ mesons exploiting their decay to $\phi\pi^+$. The raw asymmetries must be corrected for the different detection efficiencies of π^+ and π^-. These are determined in a data-driven approach via a tag-and-probe method applied in the abundant decay $K_S^0 \to \pi^+\pi^-$. These results represent the first measurement of D^+ and D_s^+ production asymmetries at a center-of-mass energy of 13.6 TeV.

T 73.7 Wed 17:30 Geb. 30.41: HS 4

Early measurement of charm meson production asymmetries at LHCb in Run 3 — •Luca Balzani[1], Laurent Dufour[2], Paula Herrero Gascon[3], Serena Maccolini[1], Dominik Stefan Mitzel[1], Sascha Stahl[2], Giulia Tuci[3], and Francesco Zenesini[4] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneva, Switzerland — [3]Heidelberg University, Heidelberg, Germany — [4]University of Bologna, Bologna, Italy

Ahead of Run 3 of the LHC, the LHCb detector was profoundly up-

graded to leverage the programmed increase in luminosity. Studying the features of the upgraded detector is of paramount importance in order to reliably perform measurements.

Production asymmetries, of charm mesons in particular, are observables which depend on the colliding system characteristics but shall not be influenced by experimental effects, having these latter contributions under control is essential to perform a consistent measurement. This makes production asymmetries ideal candidates to investigate the characteristics of the new LHCb detector. Being this measurements one of the firsts done with the new data, it will also provide useful insights for their validation. Precise measurements of production asymmetries also allow for a better understanding of QCD models used in Monte Carlo generators, especially in the high-rapidity region. Finally, this analysis will lead to the first measurement of neutral charm meson production asymmetry for proton-proton collisions at the LHC energies. This contribution will discuss the general strategy and the techniques used for the extraction procedure.

T 73.8 Wed 17:45 Geb. 30.41: HS 4

Measurements of prompt-charm-production-cross-sections in pp collisions at LHCb for Run 3 — Rowina Caspary, Giulia Frau, Paul André Günther, Stephanie Hansmann-Menzemer, and •Maurice Pierre Morgenthaler — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany

The LHCb experiment at CERN plays a leading role in the study of bottom and charm quark physics. The experiment was heavily upgraded for Run 3, necessitating studies to validate its performance. In this talk, we will present one of the initial Run 3 analysis which delivers interesting first physics results and provide a detailed understanding of the upgraded experiment simultaneously. The data used to measure the prompt-charm-production-cross-sections is taken in pp-collisions in 2023 at a center-of-mass energy of 13.6 TeV corresponding to an integrated luminosity of 47 pb^{-1}. Using bins of charm-hadron transverse-momentum and rapidity, the cross-sections of D^0, D^+, D_s^+ and D^{*+} mesons are measured.