T 7: Flavour physics V

Time: Monday 16:00–18:30 Location: Tg

T 7.1 Mon 16:00 Tg

Hadronically tagged $B \to D^{(*)}\ell\nu_\ell$ with Belle II — Florian Bernlochner[1], Racha Cheaib[2], Jochen Dingfelder[1], •Michael Eliachevitch[1], Max Graf[1], Markus Prim[1], William Sutcliffe[1], and Hannah M. Wakeling[3] for the Belle II-Collaboration — [1]Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn — [2]Deutsches Elektronen–Synchrotron, 22607 Hamburg, Germany — [3]McGill University, Montréal, Québec, H3A 2T8, Canada

The analysis of semileptonic B meson decays is one of the main pillars of the physics program of the Belle II experiment, since their theoretical cleanliness enables precise theoretical predictions which can be compared with measurements for tests of the Standard Model of particle physics. This talk presents early results and analysis plans for the $B \to D^{(*)}\ell\nu_\ell$ decay with ℓ denoting the light leptons e and μ. The other B meson originating from the $\Upsilon(4S)$ is fully reconstructed in hadronic decay modes via the *Full Event Interpretation* tagging algorithm, providing the full four-momentum of the signal B meson. Due to its high branching fraction and ease of reconstruction, this decay allows for early measurements on available Belle II data. A good understanding of this channel on observed data and discrepancies to simulated data is essential in the context of future measurements of the lepton flavour universality probing $R\left(D^{(*)}\right)$ observable, which measures the ratio of semitauonic $B \to D^{(*)}\tau\nu_\tau$ decays to the $B \to D^{(*)}\ell\nu_\ell$ channel as a normalization. Furthermore, it is of interest due to its sensitivity to the magnitude of the V_{cb} CKM matrix element.

T 7.2 Mon 16:15 Tg

Study on semileptonic $\mathrm{B} \to \mathrm{D}^{**}\ell\nu$ decays for a $\mathcal{R}(\mathrm{D}^{(*)})$ measurement at Belle — •Patrick Ecker[1], Felix Metzner[1], Florian Bernlochner[2], and Pablo Goldenzweig[1] — [1]Karlsruher Institut für Technologie — [2]Universität Bonn

Measuring the semileptonic ratio $\mathcal{R}(\mathrm{D}^{(*)})$ shows an over 3σ tension to the prediction of the standard model. This tension is still one of the most interesting open questions in flavor physics, which makes a more precise measurement of the ratio desirable. Nevertheless, the precision of the measurement is mainly limited by the insufficient knowledge about the $\mathrm{B} \to \mathrm{D}^{**}\ell\nu$ background decays.
This study uses the $711\mathrm{fb}^{-1}$ dataset provided by Belle to analyse the form factor modeling of these modes, as well as giving ratios of the branching fractions of the D^{**} decays to the $\mathrm{B} \to \mathrm{D}^{(*)}\ell\nu$ decays used in the $\mathcal{R}(\mathrm{D}^{(*)})$ analysis.

T 7.3 Mon 16:30 Tg

$R(D^{**})$ at Belle II with leptonic τ decays — Ariane Frey, •Noreen Rauls, and Benjamin Schwenker — II. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Deutschland

Semileptonic B meson decays to τ leptons are used to probe the standard model. This can be investigated in the rate of the semitauonic decay $B \to D^{**}\tau\nu$, which can be enhanced, for instance, by the presence of an additional charged Higgs boson.
$R(D^{**})$ is defined as the ratio of the branching ratio $B \to D^{**}\tau\nu$ by the averaged branching ratio of both light leptons $B \to D^{**}\ell\nu$ and is hence sensitive to new physics that couples differently to light and heavy leptons.
At the Belle II experiment, B mesons are always produced in pairs at the $\Upsilon(4S)$ resonance. One B meson is reconstructed using the B decay modes stated above. Here, the τ lepton is reconstructed in the leptonic mode. For the reconstruction of the other B meson the Full Event Interpretation (FEI) is chosen. The FEI algorithm reconstructs the other B meson using multivariate classifiers in various different hadronic decay modes.
This talk will present first studies on the reconstruction of the B meson decays used to extract $R(D^{**})$ conducted on Belle II Monte Carlo samples as well as an outlook on future plans.

T 7.4 Mon 16:45 Tg

Probing the $R(D^{(*)})$ discrepancy with the $B \to X\tau\nu$ channel at Belle II — Florian Bernlochner, Jochen Dingfelder, •Henrik Junkerkalefeld, and Peter Lewis for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

In the absence of direct evidence for new physical phenomena at the TeV scale, several measurements in the flavor sector are spotlighted that might be in tension with theoretical predictions. Of these flavor anomalies, excesses in the $R(D)$ and $R(D^*)$ ratios measured by multiple experiments have caused particularly large interest in recent years.

The new Belle II experiment in Japan enables a complementary test of these measurements. Due to the controlled production of $B\bar{B}$ pairs, the inclusive measurement of $B \to X\tau\nu$ becomes possible. Its measurement should contribute important information to the $R(D^{(*)})$ problem. Additionally, this channel should help constrain the currently unmeasured contribution of $B \to D^{**}\tau\nu$ decays.

In this talk, the general analysis strategy of the $B \to X\tau\nu$ branching fraction measurement is presented and first attempts to separate the signal from background are outlined.

T 7.5 Mon 17:00 Tg

Search for the decay $B_s^0 \to D^{*+}D^{*-}$ with the LHCb experiment — Sophie Hollit, Philipp Ibis, •Jan Langer, and Antje Mödden — Experimentelle Physik 5, TU Dortmund

At the LHCb experiment precise measurements are performed to search for physics beyond the Standard Model. For this it is important to observe new decays and measure their branching ratio. Besides the primary aim of observing the decay $B_s^0 \to D^{*+}D^{*-}$, this analysis also aims to measure the branching ratio relative to the decay $B^0 \to D^{*+}D^{*-}$. By measuring the relative branching ratio, dominant systematic uncertainties can be cancelled.

In this talk, the current status of the analysis is presented, in which the full data set of the LHCb experiment is used corresponding to an integrated luminosity of $9\,\mathrm{fb}^{-1}$.

T 7.6 Mon 17:15 Tg

Fully Inclusive Analysis of Untagged $B \to X_s\ell^+\ell^-$ Decays at Belle II — Thomas Kuhr, Sviatoslav Bilokin, and •Michail Moussine — Ludwig-Maximilians-Universität München

Semileptonic B meson decays to $X_s\ell^+\ell^-$, where X_s stands for a set of final state particles with non-vanishing total strangeness, are very rare because they are forbidden at tree level in the standard model (SM). They can occur through loop diagrams, where particles beyond the SM could contribute. Measurements of branching fractions or kinematic distributions are therefore sensitive to new physics.

The Belle II experiment at the SuperKEKB accelerator is well suited to study inclusive decays because of the clean environment with known initial conditions. However, a full reconstruction of the second B meson in $\Upsilon(4S) \to B\bar{B}$ events suffers from a low reconstruction efficiency. Feasibility studies of an untagged analysis, including optimizations of selection criteria, will be presented.

T 7.7 Mon 17:30 Tg

Testing Lepton Flavour Universality with $B_s \to \phi\ell^+\ell^-$ decays using LHCb data — Christoph Langenbruch, Stefan Schael, •Sebastian Schmitt, and Eluned Smith — I. Phys. Inst. B RWTH Aachen

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 (FCNCs) 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 (LFU), this universality can be broken in NP scenarios. The ratios R_H, defined as the ratios of the branching fractions $\mathcal{B}\left(B \to H\mu^+\mu^-\right)$ and $\mathcal{B}\left(B \to He^+e^-\right)$, constitute precise tests of the SM. Recent measurements of R_K and $R_{K^{*0}}$ show tensions with the SM of 2.1 to 2.5 standard deviations (σ), complementary R_H measurements are therefore of great interest.

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

This talk summarises the status of the measurement R_ϕ, which benefits from the experimentally clean $B_s \to \phi\ell^+\ell^-$ decay. The analysis is using the full Run 1 and Run 2 dataset collected by LHCb that

corresponds to $9\,\text{fb}^{-1}$ of integrated luminosity.

T 7.8 Mon 17:45 Tg

Branching fraction measurement of $B_s^0 \to \phi\mu^+\mu^-$ and search for $B_s^0 \to f_2'(1525)\mu^+\mu^-$ using LHCb data — •Sophie Kretzschmar, Christoph Langenbruch, and Eluned Smith — I. Physikalisches Institut B, RWTH, Aachen

The LHCb detector at CERN is an experiment optimised to study decays of b-quarks, which are produced copiously in the proton-proton collisions at the Large Hadron Collider (LHC). Flavour-changing neutral-current decays proceeding via $b \to s\ell\ell$ transitions are of particular interest since they occur only via higher order loop corrections in the Standard Model (SM), and thus can be significantly affected by new heavy particles beyond the SM.

One example of such a rare decay is $B_s^0 \to \phi\mu^+\mu^-$, which has been previously analysed by the LHCb collaboration using data taken in 2011 and 2012. The $B_s^0 \to \phi\mu^+\mu^-$ branching fraction was measured to be more than $3\,\sigma$ below the SM expectation. Now, an updated measurement is performed including the data taken by the LHCb experiment during 2015-2018, which will provide more insight on the nature of this discrepancy with the SM.

This talk presents the status of the updated measurement of the $B_s^0 \to \phi\mu^+\mu^-$ branching fraction using the full LHCb data sample. In addition, a search for the decay $B_s^0 \to f_2'(1525)\mu^+\mu^-$ will be presented.

T 7.9 Mon 18:00 Tg

Analysis of $B^0_{s,d} \to \mu^+\mu^-$ decays with the full LHCb dataset — Johannes Albrecht, •Maik Becker, and Titus Mombächer — Experimentelle Physik 5, TU Dortmund

The first observation of the decay $B_s^0 \to \mu^+\mu^-$ with a single experiment was reported by the LHCb collaboration in 2017 with a significance of 7.8σ using data corresponding to 4.4 fb^{-1} of integrated luminosity. The measurement demonstrated the excellent sensitivity of the LHCb experiment in this channel, but no deviations from the Standard Model predictions were found, introducing strong constraints to New Physics models. Since the uncertainty on the result is driven by statistical limitations, an analysis with a larger dataset and improved methods is performed, which may also allow for the first observation of the decay $B_d^0 \to \mu^+\mu^-$.

In this talk the ongoing measurement of $B^0_{s,d} \to \mu^+\mu^-$ with the full LHCb dataset corresponding to $9\ \text{fb}^{-1}$ will be presented.

T 7.10 Mon 18:15 Tg

Non-local matrix elements in $B_{(s)} \to \{K^{(*)}, \phi\}\ell^+\ell^-$ — •Nico Gubernari[1], Danny van Dyk[2], and Javier Virto[3] — [1]Universitaet Siegen, Walter-Flex-Strasse 3, 57068 Siegen — [2]Technische Universitaet Muenchen, James-Franck-Strasse 1, 85758 Garching — [3]Universitat de Barcelona, Marti Franques 1, E08028 Barcelona, Catalunya

We revisit the theoretical predictions and the parametrization of non-local matrix elements in rare $\bar{B}_{(s)} \to \{\bar{K}^{(*)}, \phi\}\ell^+\ell^-$ and $\bar{B}_{(s)} \to \{\bar{K}^*, \phi\}\gamma$ decays. We improve upon the current state of these matrix elements in two ways. First, we recalculate the hadronic matrix elements needed at subleading power in the light-cone OPE using B-meson light-cone sum rules. Our analytical results supersede those in the literature. We discuss the origin of our improvements and provide numerical results for the processes under consideration. Second, we derive the first dispersive bound on the non-local matrix elements. It provides a parametric handle on the truncation error in extrapolations of the matrix elements to large timelike momentum transfer using the z expansion. We illustrate the power of the dispersive bound at the hand of a simple phenomenological application. As a side result of our work, we also provide numerical results for the $B_s \to \phi$ form factors from B-meson light-cone sum rules.