

## T 84: Flavour Physics

Time: Thursday 16:15–18:30

Location: T-H15

T 84.1 Thu 16:15 T-H15

**Tagged analysis of  $B \rightarrow X_u \ell \nu$  at Belle** — ●ARMINDOKHT AFSHARIPOUR, FLORIAN BERNLOCHNER, JOCHEN DINGFELDER, SVENJA GRANDERATH, PETER LEWIS, and RIEKA RITTSTEIGER — Physikalisches Institut, Universität Bonn

We present a study of the exclusive charmless semileptonic decays,  $B \rightarrow X_u \ell \nu$ , where  $X_u = \pi^0, \eta, \eta'$  and  $\ell$  is an electron or a muon, with the Belle experiment at the SuperKEKB collider in Japan. In the Belle experiment, electrons and positrons are collided at the center-of-mass energy equal to the mass of the  $\Upsilon(4S)$  resonance, which decays to pairs of  $B$  mesons. One of the two  $B$  mesons can be fully reconstructed in a hadronic decay mode (hadronic B tagging) using the Full Event Interpretation algorithm. The signal  $B$  meson is then reconstructed from the remaining particles (hadrons and leptons) formed from the unassigned tracks and neutral clusters in the event. In this talk, the general analysis strategy and status of the  $B \rightarrow X_u \ell \nu$  analysis using hadronic B-tagging in Belle is presented.

T 84.2 Thu 16:30 T-H15

**Untagged Analysis of  $B \rightarrow \pi \ell \bar{\nu}_\ell$  and extraction of  $|V_{ub}|$  at Belle II** — FLORIAN BERNLOCHNER, JOCHEN DINGFELDER, ●SVENJA GRANDERATH, and PETER LEWIS for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

One of the puzzles of current research in flavor physics is the persisting discrepancy between the results of exclusive and inclusive measurements of the CKM matrix element  $|V_{ub}|$ . The charmless semileptonic decay  $B \rightarrow \pi \ell \bar{\nu}_\ell$  is one of the most accessible and powerful channels for determining  $|V_{ub}|$  in exclusive modes. Using data from the Belle II experiment, a new precision measurement of  $|V_{ub}|$  can be performed. In preparation for this, an untagged measurement method for extracting  $B \rightarrow \pi \ell \bar{\nu}_\ell$  events is developed using Belle II data. An untagged measurement allows for sufficiently large samples of this rare decay already with the current Belle II dataset. In order to increase the signal purity, boosted decision trees are employed to suppress continuum and  $B\bar{B}$  backgrounds. This talk will discuss the current status of the analysis and  $|V_{ub}|$  extraction.

T 84.3 Thu 16:45 T-H15

**Exclusive  $B \rightarrow X_u \ell \nu_\ell$  Decays with Hadronic Tagging in Belle II Data** — ●MORITZ BAUER, PABLO GOLDENZWEIG, and TORBEN FERBER for the Belle II-Collaboration — KIT, Karlsruhe, Germany

There has been a longstanding  $3\sigma$  tension between inclusive and exclusive measurements of the magnitude of the CKM matrix element  $|V_{ub}|$ . Semileptonic decays involving  $b \rightarrow u$  transitions present a unique opportunity to measure  $|V_{ub}|$  with the current Belle II dataset due to their comparatively high branching fraction.

We present analyses of the semileptonic processes  $B \rightarrow \pi \ell \nu_\ell$  and  $B \rightarrow \rho \ell \nu_\ell$  in Belle II data as steps towards the extraction of this matrix element from exclusive decays. These analyses are conducted with hadronic tagging, utilizing a new tagging algorithm, the Full Event Interpretation.

T 84.4 Thu 17:00 T-H15

**Tagged analysis of  $B \rightarrow \rho^0 \ell \nu$ ,  $B \rightarrow \rho^+ \ell \nu$  and  $B \rightarrow \omega \ell \nu$**  — ARMINDOKHT AFSHARIPOUR, FLORIAN BERNLOCHNER, JOCHEN DINGFELDER, SVENJA GRANDERATH, PETER LEWIS, and ●RIEKA RITTSTEIGER for the Belle-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

We present a study of the charmless semileptonic decays  $B \rightarrow \rho^0 \ell \nu$ ,  $B \rightarrow \rho^+ \ell \nu$  and  $B \rightarrow \omega \ell \nu$ , where  $\ell$  is an electron or a muon, with the Belle experiment at KEK in Tsukuba, Japan. Belle took data from 1999 until 2010 at a center-of-mass energy corresponding to the mass of the  $\Upsilon(4S)$ , which predominantly decays into a pair of  $B$  mesons. The Full Event Interpretation is used to fully reconstruct one  $B$  meson in a hadronic decay mode. The signal  $B$  meson is reconstructed from a lepton and the respective hadron ( $\rho, \omega$ ) using the remaining tracks and neutral clusters in the event. The precise knowledge of the tag-side B decay leads to a good signal-to-background ratio but also a very small efficiency.

In this talk the analysis strategy and status of the  $B \rightarrow \rho^0 \ell \nu$ ,

$B \rightarrow \rho^+ \ell \nu$  and  $B \rightarrow \omega \ell \nu$  analysis using hadronic B-tagging at Belle are presented.

T 84.5 Thu 17:15 T-H15

**Measurement of the photon energy spectrum in the fully-inclusive hadronic-tagged  $B \rightarrow X_s \gamma$  decays at the Belle II experiment** — ●HENRIKAS SVIDRAS — DESY, Hamburg

Belle II is an experiment at the next-generation  $B$  factory SuperKEKB located at KEK in Tsukuba, Japan. It aims to probe heavy flavour physics at a higher precision than its predecessors, namely BaBar and Belle. The goal is to collect  $50 \text{ ab}^{-1}$  of data during its run: more than 50 times that of Belle. One of the particularly promising decay channels to study is the inclusive radiative  $B \rightarrow X_s \gamma$  decay, where  $X_s$  denotes any possible decay products containing an  $s$  quark and  $\gamma$  is a high-energetic photon. This decay can provide constraints for beyond-SM theories, for example by measuring  $CP$  asymmetries, and be used to extract important parameters such as the  $b$  quark mass. The analysis presented in this talk focuses on the hadronic-tagged fully-inclusive approach, where one of the daughter  $B$  mesons of the  $\Upsilon(4S) \rightarrow B\bar{B}$  decays into hadrons. The extraction of the photon energy spectrum of the  $B \rightarrow X_s \gamma$  is one of the goals of the analysis. The talk presents the analysis setup and main challenges of this measurement at Belle II.

T 84.6 Thu 17:30 T-H15

**Measurement of the  $q^2$  moments in semi-leptonic B meson decays at Belle II** — ●MAXIMILIAN WELSCH, FLORIAN BERNLOCHNER, and JOCHEN DINGFELDER — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

The determination of inclusive  $|V_{cb}|$  from  $b \rightarrow c \ell \nu$  decays relies on the Heavy Quark Expansion (HQE) involving coefficients and associated non-perturbative matrix elements, which can be expressed in terms of a number of expansion parameters. The moments of the kinematic distribution of the decay can be computed in a similar manner and are dependent on the same HQE parameters. Consequently, measurements of such moments can be used to better constrain the expansion parameters and, thereby, more precisely determine  $|V_{cb}|$ . In this talk, we present the first measurement of the  $q^2$  moments of  $B \rightarrow X_c \ell \nu$  decays with  $62.8 \text{ fb}^{-1}$  of Belle II data. The  $q^2$  moments of the  $b \rightarrow c \ell \nu$  transition are particularly powerful for constraining the HQE expansion as they can be expressed in terms of a reduced set of non-perturbative parameters due to reparametrization invariance. In addition, we present an preliminary determination of  $|V_{cb}|$ .

T 84.7 Thu 17:45 T-H15

**Untagged  $\bar{B}^0 \rightarrow D^{*+} \ell^- \bar{\nu}_\ell$  studies with Belle II** — FLORIAN BERNLOCHNER<sup>1</sup>, LU CAO<sup>1,2</sup>, JOCHEN DINGFELDER<sup>1</sup>, and ●CHAOYI LYU<sup>1</sup> — <sup>1</sup>Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn — <sup>2</sup>Deutsches Elektronen-Synchrotron DESY

The precise determination of the CKM matrix element  $|V_{cb}|$  and semileptonic form factors in  $B$  meson decays are important for carrying out precision tests of the flavour sector of the Standard Model and to search for new physics. The decay of  $\bar{B}^0 \rightarrow D^{*+} \ell^- \bar{\nu}_\ell$  is particularly well suited to determine  $|V_{cb}|$  due to its large branching fraction, small backgrounds and the availability of lattice data to describe the form factors. In this talk, we will present the current status of establishing an untagged measurement of the  $\bar{B}^0 \rightarrow D^{*+} \ell^- \bar{\nu}_\ell$  branching fraction and form factors using early Belle II data.

T 84.8 Thu 18:00 T-H15

**Measuring kinematic distributions of  $B \rightarrow D^* \ell \nu_\ell$  with hadronic tagging at Belle II** — FLORIAN BERNLOCHNER, JOCHEN DINGFELDER, ●MICHAEL ELIACHEVITCH, MICHAEL HEDGES, PETER LEWIS, MARKUS PRIM, and WILLIAM SUTCLIFFE — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

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 (SM).

This talk presents early results and analysis plans for the  $B \rightarrow D^* \ell \nu_\ell$  decay with  $\ell$  denoting the light leptons  $e$  and  $\mu$ . Its high branching fraction and ease of reconstruction allow to use available Belle II data

for differential measurements of the shapes describing the decay kinematics. These are sensitive to the  $|V_{cb}|$  CKM matrix-element and to the form-factors describing the interactions of the hadronic current. Based on these shapes we can further measure angular observables such as the forward-backward asymmetry  $A_{FB}$  to probe the SM. In the presented analysis 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 the resulting high purity and good resolution this serves as an important cross-check of similar measurements using an inclusive tagging approach.

T 84.9 Thu 18:15 T-H15

**Studies of  $B \rightarrow D^{**}\ell\nu$  at Belle II** — ARIANE FREY, •NOREEN RAULS, and BENJAMIN SCHWENKER — II. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Deutschland

The semileptonic decay  $B \rightarrow D^{**}\ell\nu$  is one of the main background

modes for the determination of the ratio  $R(D^{(*)})$ , which is used to probe the Standard Model. One of the aims of this analysis is to understand the decay  $B \rightarrow D^{**}\ell\nu$  as background contribution to the  $R(D^{(*)})$  measurement. For the reconstruction of the daughters of the  $D^{**}$  various different hadronic  $D$  and  $D^*$  modes are used. The  $B$  meson is reconstructed using these  $D^{**}$  decay modes as well as light and charged leptons.

$B$  mesons are always produced in pairs on the  $\Upsilon(4S)$  resonance at the Belle II experiment in Japan. One of these  $B$  mesons is reconstructed using the decay mode stated above. The other  $B$  meson uses the hadronic Full Event Interpretation (FEI) for its reconstruction. The FEI is an algorithm, which is based on the hierarchical reconstruction of final-state, intermediate particles and  $B$  mesons using multivariate classifiers.

This talk will give a first insight on the reconstruction of the  $B$  meson in these channels using Belle II Monte Carlo samples. Furthermore, a brief outlook will be shown.