2025 Helmholtz – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

World first inclusive measurement of V_{us} using τ decays

DESY Division & Group:

FH-Belle

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Description of the project (max. 1 page)**:**

We propose the first inclusive measurement of the CKM element V_{us} using τ decays at Belle II.

In the standard model of particle physics, the CKM matrix is a unitary matrix that describes the mixing between quarks of different flavours. Some experimental measurements are however in tension with the unitarity condition. This is the case, in particular, of measurements of V_{ud} related to the rate of neutron beta decays and V_{us} related to the rate of of τ decays to strange hadrons. Establishing that the CKM matrix is non unitary would have profound implications on our understanding of the universe: this could indicate the existence of additional flavours of quarks, and of new fundamental forces [1].
We propose to perform the first ever inclusive determination of V_{us} using the rate of τ decays to a strange quark. This will be done by measuring the decay rates of $\tau^+ \to K^+ X \nu$ and $\tau^+ \to K^0 \pi^+ Y \nu$, where X and Y stand for a hadronic system of total strangeness zero. Although measurements of V_{us} have been performed using exclusive τ decays such as $\tau^+ \to K^+ \nu$, this inclusive measurement will be the first of its kind, having the potential to confirm or rule out the long-standing unitarity anomaly.
The measurement will use the Belle II data accumulated between 2019 and today, which constitutes the world's largest sample of τ decays. The DESY Belle II group is uniquely placed to perform this analysis, building upon an established expertise in precision measurements using τ decays and in precise CKM metrology using inclusive decays: the DESY Belle II group recently published the most precise measurement of the τ mass [2] and the world's first inclusive and exclusive determination of V_{ub} [3]. The postdoctoral researcher working on this project will benefit from the support of the DESY Belle II group and his work will in addition be supported by a DESY PhD student.

[1] JHEP12(2020)166
[2] PRD108(2023)032006
[3] PRL131(2023)211801

Description of existing or sought Chinese collaboration partner institute (max. half page)**:**

Required qualification of the postdoc:

- PhD in experimental high energy physics
- Experience with data analysis
- Additional skills with programming languages: Python, C++
- Language requirement: English