



## 2025 Helmholtz – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

### PART A

**Title of the project:**

Precision measurements in  $\tau$  physics

**DESY Division & Group:**

FH-Belle

**Project leader/supervisor:**

Armine Rostomyan

**Web-address:**

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

### Scientific Motivation

Precision measurements in  $\tau$  physics play a crucial role in testing the standard model (SM) and probing potential signs of new physics. One key aspect is **lepton flavor universality (LFU)**, a fundamental property of the SM stating that the electroweak gauge bosons couple identically to all three generations of leptons. However, many SM extensions predict the existence of new particles that interact differently with each lepton flavour, making LFU violation a compelling avenue for new physics searches.

Experimental tests of LFU have been conducted in various processes, including pion and kaon decays, B-meson decays, W boson decays, as well as  $\tau$  decays. Despite extensive studies, no significant deviation from SM predictions has been observed, reinforcing the need for even more precise measurements.

### DESY Group and $\tau$ Physics

The Belle II collaboration, **with a leading contribution from the DESY group**, has recently achieved two major milestones in  $\tau$  physics:

- The world's most precise measurement of the  **$\tau$  mass** [1].



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- The most precise test of **e-μ universality** to date by measuring **the ratio of branching fractions of  $\tau$  decays to a muon and an electron** [2].

Building on this expertise, the DESY group aims to improve the precision of **the  $\tau$  mass and absolute branching fractions**,  $\tau \rightarrow \mu \nu \bar{\nu}$  and  $\tau \rightarrow e \nu \bar{\nu}$ , further refining our understanding in  $\tau$  physics. These studies will also improve the precision of **the coupling constants ratio  $g_\tau/g_e$**  - key parameters in probing LFU and potential new physics effects.

### Research Plan

At DESY, two students will work on the two projects updating the measurement of the  $\tau$  mass and performing the measurement of absolute leptonic branching fractions of  $\tau$  lepton. We propose that the postdoctoral researcher joining our team will contribute to the analysis, supervise the students and drive the publication effort. By joining this effort, the postdoc will play a key role in advancing the  $\tau$  physics research, contributing to one of the most sensitive tests of the SM.

[1] Belle II Collaboration, Phys. Rev. D 108, (2023) 032006

[2] Belle II Collaboration, JHEP 08 (2024) 205

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

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### Required qualification of the postdoc:

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<Sample text below>

- PhD in High Energy Physics
- Experience with data analysis
- Additional skills in programming languages: Python, C++
- Language requirement: English