

# Work package 1 summary

“Search for New Physics Signals at Belle II”

# WP1 tasks

**Task 1.1:** Detector performances assessment. Determine and optimize detector resolutions and efficiencies using real data, in order to provide precise inputs to physics analyses. Each sub-detector has to be studied both by itself and in combination with the others, thus requiring the collaboration of all sub-detector experts from different groups.

**Task 1.2:** Study of CP violation and search for new phenomena in rare decays. Physics analyses to test CKM matrix unitarity (measurement of  $|V_{cb}|$  and  $|V_{ub}|$  using leptonic and semileptonic decays; measurement of the angles of the CKM unitarity triangle, in particular the gamma angle), studies of rare B decays ( $B \rightarrow X_s \gamma$ ; charmless hadronic B decays) and of rare charm decays are developed in this task.

**Task 1.3:** Lepton flavour and lepton universality violations. Hints for lepton flavour non-universality are currently seen in the  $B \rightarrow D^* \tau \nu$  and  $B \rightarrow X_s l+l-$  channels by the BaBar, Belle and LHCb experiments. These anomalies can be interpreted within various new physics models but require final experimental confirmation, for which Belle II measurements are essential. Lepton flavour violation is best tested in tau decays, where many channels can also be studied. Missing energy due to neutrinos requires in turn full event reconstruction to reject backgrounds.

**Task 1.4:** Dark sector and exotics. Production of the so called “dark photon” and of other Z-like or Higgs-like particles will be searched for. Limits on exotic processes including axions and WIMPS can also be improved. All such events require hermeticity and excellent control of machine and accidental backgrounds.

**Task 1.5:** Quarkonium Spectroscopy. This task aims at performing quarkonium spectroscopy in B decays, ISR and two-photon processes.

# WP1 partners

Partner number and short name <sup>10</sup>
1 - INFN
2 - DESY
3 - OEAW
4 - JSI
5 - CNRS
9 - UKP
10 - IFJ PAN
12 - TAU
13 - METU
18 - KEK

# WP1 milestones

May 2023

Done

Milestone number <sup>18</sup>	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Report on detector performances	1 - INFN	24	Belle II internal reports on detector performances
MS2	Conference presentation on CPV	3 - OEAW	24	Presentation to international conference of the preliminary Belle II results on CPV
MS3	Conference presentation on LFV and LFUV	2 - DESY	24	Presentation to international conference of the preliminary Belle II results on Lepton Flavour Violation and Lepton Flavour Universality Violation
MS4	Conference presentation on dark sector	3 - OEAW	24	Presentation to international conference of the preliminary Belle II results on dark sector searches
MS5	conference presentation on spectroscopy	4 - JSI	24	Presentation to international conference of the preliminary Belle II results on quarkonium spectroscopy

# WP1 deliverables

May 2025

Deliverable Number <sup>14</sup>	Deliverable Title	Lead beneficiary	Type <sup>15</sup>	Dissemination level <sup>16</sup>	Due Date (in months) <sup>17</sup>
D1.1	Publication on detector Performance	1 - INFN	Report	Public	48
D1.2	Publication on CPV	3 - OEAW	Report	Public	48
D1.3	Publication on LFV and LFUV	2 - DESY	Report	Public	48
D1.4	Publication on dark sector	3 - OEAW	Report	Public	48
D1.5	Publication on Spectroscopy	4 - JSI	Report	Public	48

D1.1 : Publication on detector Performance [48]

Journal(s) publication(s) on detector performances and calibration

D1.2 : Publication on CPV [48]

Paper on CP violation analysis with Belle II detector

D1.3 : Publication on LFV and LFUV [48]

First publication on searches for Lepton Flavour Violation and Lepton Flavour Universality Violation

D1.4 : Publication on dark sector [48]

First publication on searches for dark sector processes

D1.5 : Publication on Spectroscopy [48]

First publication on quarkonium spectroscopy

# WP1 secondment status (as of May 3, 2024)

## Including planned (future) secondments

Institution	WP1 done (months)	WP1 available	WP1 % done
INFN	52.6	56.0	94.0%
DESY	63.3	70.0	90.4%
OEAW-HEPHY	22.5	22.0	102.4%
JSI	10.8	15.0	71.8%
LAL-CNRS	18.3	26.0	70.4%
UKP	1.8	9.0	20.4%
IFJ-PAN	6.0	11.0	54.8%
TAU	2.2	6.0	36.1%
METU	0.0	6.0	0.0%
<b>Total</b>	<b>177.5</b>	<b>221.0</b>	<b>80.3%</b>

43.5 PMs still to be done  
by May 2025

This table assumes that all secondments declared are recognised by REA  
(the sum of split secondments must exceed 1 PMs to be recognised (paid) by REA)

# Scientific output of WP1 (highlights)

- “Search for lepton flavour violating  $B \rightarrow K\tau\ell$  decays at Belle and Belle II”  
Junaid Ur Rehman (IFJ PAN)
- “Measurement of  $B \rightarrow D\ell\nu$  at Belle II and determination of  $|V_{cb}|$ ”  
Philipp Horak (OEAW)