B-factory Programme Advisory Committee
Short report of
the Focused Review Meeting

30 June and 1 July 2025, Remote meeting

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Short Summary

A focused review meeting of the B-Factory Programme Advisory Committee (BPAC) was held remotely on 30 June and 1 July 2025. Presentations were delivered by members of the KEK accelerator groups and the Belle II collaboration on the status of the accelerator complex and the Belle II detector. They are currently in preparation for the upcoming data-taking period in autumn. Progress on the upgrade plan was also discussed. The committee is impressed by the work being carried out and acknowledges with appreciation the high quality of the presentations.

In this short report, the committee provides feedback on the two specific issues raised by the management of the Institute of Particle and Nuclear Studies. A more detailed report will be issued in a separate document currently under preparation.

Assess the progress of the preparation for the coming 7-month long operation and identify areas for further focus.

The upcoming run, starting in autumn 2025, marks a critical phase for the KEK B-Factory programme. For SuperKEKB, it is essential to clearly demonstrate the potential to reach peak luminosities well above 10^{35} $\mathrm{cm}^{-2}\mathrm{s}^{-1}$. This will require further increases in beam currents and reductions in beam spot sizes at the interaction point, along with improved efficiency and stability for the beam injection. These enhancements must be implemented while maintaining safe machine background levels for the detector components.

The committee finds that the progress made and the planned work for the SuperKEKB rings and injection chain are adequate to meet these challenges. Once the rate of Sudden Beam Loss (SBL) events is significantly reduced, through the cleaning of the beam pipes from Vacseal contamination, systematic machine studies can be carried out to better understand the accelerator's behaviour under various parameter settings. While the proposed hardware changes in the injection chain may not address all existing issues, they are expected to bring notable improvements to operational performance. The committee also appreciates the continued efforts to reduce machine background and to protect the Belle II detector from uncontrolled beam losses, especially through fast beam abort systems. The strong collaborative framework between the accelerator teams and the Belle II collaboration should be maintained during the current shutdown and throughout the upcoming run period. The ongoing simulation effort to reproduce observed beam backgrounds also remains a critical activity.

On the detector side, the ongoing hardware activities are addressing issues identified during the previous run. Upon completion of these efforts, the committee believes that the Belle II detector will be ready for the upcoming seven-month run. In addition, the improvements presented in the data acquisition system, trigger, and data processing will enable Belle II to collect data more efficiently and support prompt physics analysis. Given the large number of concurrent activities, the committee advises the Belle II management to carefully monitor the allocation of resources, particularly with regard to qualified personnel. The operation of CDC at high beam currents remains a major concern for the coming run and warrants close attention.

The current plan for the coming run prioritises achieving an integrated luminosity of at least 425 fb^{-1}. To this end, two possible scenarios have been presented:

A Baseline plan targeting a peak luminosity of 10^{35} $\text{cm}^{-2}\text{s}^{-1}$ with an accelerator efficiency exceeding 67%.

B Alternative plan, targeting a peak luminosity of 6×10^{34} $\text{cm}^{-2}\text{s}^{-1}$ with an accelerator efficiency exceeding 85%.

In both cases, 80% of beam time is allocated for physics data taking. The committee recognises the importance of the integrated luminosity goal set by the Belle II collaboration to deliver significant physics results surpassing those of Belle and BaBar, particularly in core B physics measurements. However, achieving or approaching a peak luminosity of 10^{35} $\text{cm}^{-2}\text{s}^{-1}$ is an essential step for the final goal of the project. The committee therefore urges the accelerator and Belle II teams to engage in further discussions to refine the run plan and develop a shared strategy that accounts for the two objectives: peak and integrated luminosities. In this context, a stepwise approach, with agreed-upon intermediate targets for peak and integrated luminosities, could be a practical solution. Above all, all stakeholders must remain flexible and responsive to evolving operational conditions.

The upgrade options need to converge in one year to determine a baseline for the upgrade and to summarise it in TDR in 2027. Review the

studies planned for the year and the steps toward TDR 2027, and advise on those plans.

Flavour physics remains one of the least understood areas of the Standard Model. In recent discussions at the Open Symposium for the update of the European Strategy for Particle Physics, flavour physics was identified as a key subject in evaluating the next flagship project at CERN. In this context, a credible demonstration that SuperKEKB can collect 50 ab^{-1} of data by early 2043 would be highly impactful. Furthermore, SuperKEKB's performance will serve as a benchmark for evaluating the feasibility of future high-luminosity circular colliders. Achieving the peak luminosity target of 6×10^{35} $cm^{-2}s^{-1}$ would be a major milestone for the global particle physics community.

The committee is pleased to see steady progress in defining the LS2 upgrade plan. Establishing a baseline scenario for the new final focusing magnet (QCS), including agreement on its dimensions, is an important step. Concentrating upgrade efforts on the vertex and tracking detectors, while assessing the continued viability of other subsystems for post-LS2 operation, is a sensible approach.

That said, the proposed timeline, i.e. completion of a detector Technical Design Report (TDR) by autumn 2027, construction starting in 2029, and installation beginning in 2032, is highly ambitious. While some benchmark studies have begun, a substantial amount of work remains to reach the level of detail required for a full TDR. A dedicated and sufficiently staffed team will be essential to this process. The committee also notes that a comprehensive and convincing overall project management plan was not presented and encourages the preparation of such a plan as a matter of urgency.

The committee also emphasises the need for synchronisation between the detector and accelerator upgrade planning. The mechanical design of the vertex and tracking detectors depends critically on the confirmed position and design of the QCS and other constraints from the machine around the interaction point. A joint accelerator?detector upgrade plan, including a resource loaded schedule is essential for informed evaluation and planning. Establishing an upgrade project office should be considered.

Finally, achieving the peak luminosity goal will require a comprehensive performance review of the entire accelerator complex, including the injector system. Necessary upgrades should be identified and planned accordingly.

The committee wishes to express its appreciation for the continued dedication of the KEK accelerator groups and Belle II collaboration, and looks forward to hearing the progress during the next meeting.