

B-factory Programme Advisory Committee

Short Report for Annual Review Meeting

5-7 February 2024, Tsukuba, Japan

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& Remote participation

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25 February 2024

Short Summary

The annual review meeting of the B-factory Programme Advisory Committee (BPAC) took place at KEK from 5th to 7th of February, where the committee heard presentations from the accelerator and Belle II groups on the status and upgrade plan. This short report gives the committee's feedback for the six questions asked by the management of the Institute of Particle and Nuclear Studies. A detailed report on the findings of the committee will be found in a separate document.

1. **Reviewing the overall project, is there anything on which the collaboration should focus more to strengthen the project?**

The committee finds that the overall project, with the accelerator complex and experiment, is well focused on obtaining large statistics of high quality data, processing them rapidly and exploiting them for physics analyses.

2. **Are the objectives of SuperKEKB and Belle II upgrades well defined and achievable?**

The accelerator group and Belle II collaboration have been developing plans for upgrading the accelerator complex and Belle II detector components during the next long shutdown, LS2, with the aim to reach a peak luminosity of $6 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$

and to collect 50 ab^{-1} of data by around 2035. The Conceptual Design Report (CDR) for the LS2 upgrade plans, presented during this meeting, described various ideas for how to increase the machine luminosities, enhance the detector performance and the tolerance against beam backgrounds and radiation damage. Some of them are well advanced, in particular the new vertex detector system (VTX), which is envisioned to replace the current vertex detector, for which *the committee recommends that the group should advance towards the engineering level of studies, including the aspects of system integration and operation.*

Some of the other subsystems appear to be still at the exploration stage and further technical studies are required. Although those items are marked as “long term”, this prevents drawing a coherent picture of the upgrade plan. The machine group presented an upgrade path with a new set of final focusing magnets. Since they have just started machine operations after the Long Shutdown 1 with a lot of changes and improvements having been made, they need first to understand the behaviour of the machine in order to identify the remaining causes of luminosity limitation and to provide a definite scheme for the upgrade.

While the CDR provides an excellent initial framework to continue the development of the plans for the upgrade, the BPAC is not yet in a position to judge the validity of the plan described in the CDR. While *the committee recommends further R&D work to continue, it also thinks that a new document providing a coherent and integrated description of the accelerator and detector upgrade plan with a quantitative demonstration of expected physics performance should be submitted for making a decision on the project.* Such a document should also demonstrate the tolerance against background rates at the peak luminosity of $6 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$ and integrated radiation damage up to 50 ab^{-1} .

As for the idea to collect data with a longitudinally polarised electron beam, the proposed test of production of polarised e^- in the injector and measuring the polarisation decay time in the SuperKEKB ring will provide essential information for making further decisions. However, *it should be noted that the highest priority of the coming period must be to achieve stable machine operation with a luminosity above $10^{35} \text{ cm}^{-2}\text{s}^{-1}$ for data taking.*

3. Can the updated scheme of the data and run dependent MC production accommodate the current and coming high luminosity data?

The committee supports the new format for the data recording being adequate for the forthcoming high luminosity run. Production of run-dependent simulation data will be crucial for controlling systematics in the analysis. Presented progress for the planning of large production of data is satisfactory. The committee took note of the increased effort in event generators and *encourages the software group towards further collaboration with existing activities elsewhere. Fast calibration by the subdetector groups remains critical for smooth data processing.*

4. Have all the concerns about the detector operation been addressed?

The committee was pleased by the progress being made in the detector hardware,

online and detector control, on and offline monitoring framework, software and computing for the start of Run 2 data taking.

5. Are physics analysis plans for the winter conferences and also toward summer convincing? Are we missing any physics opportunities?

The BPAC considers the analysis activities presented for the winter conferences and beyond very adequate and convincing. Published results demonstrate that the Belle II collaboration has been exploiting well the advantage of being able to reconstruct final states with neutral particles including neutrinos. Merging of the Belle and Belle II analyses has also been successful. The committee is looking forward to hear the progress in the analysis of dark sector and tau physics, as well as other analyses relevant to the understanding of the muon $g - 2$ anomaly. With Run 2, the Belle II experiment should be able to start collecting data with statistics competitive with those of the BaBar and Belle experiments, and *the analysis effort on the core B physics should be prepared.*

6. Is the computing resource estimate adequate?

The committee took note of the presented computing resource accounting for 2023 and estimates for 2025 to 2028. A dedicated discussion and recommendation will be given by the expert group consisting of G. Carlino, W. Hulsbergen, P. McBride and P. Mato, and chaired by the BPAC chair, after receiving the written accounting report and request.