

B-factory Programme Advisory Committee

Short Report for Annual Review Meeting

19-21 February 2023

A. Andreazza* (Milano), P. Collins* (CERN), G. Corti (CERN),
M. Demarteau (ORNL), R. Forty (CERN), B. Gavela (Madrid),
S. Gori (UCSC), W. Hulsbergen*& (NIKHEF), M. Ishino& (Tokyo),
V. Luth (SLAC), P. McBride*& (FNAL) P. Mato*& (CERN),
F. Meijers* (CERN), N. Neufeld& (CERN), B. Ratcliff* (SLAC),
A. Petrov* (Univ. South Carolina), M. Sullivan (SLAC),
H. Tajima& (Nagoya), M. Titov* (Saclay)
and chaired by T. Nakada (EPFL)

& Remote participation

* Expert member.

27 March 2023

Short Summary

The annual review for the Japanese Fiscal Year (JFY) 2022 by the B-factory Programme Advisory Committee took place from the 19th to the 21st of February 2023 at KEK. This report gives brief responses to the questions presented by the director of the Institute of Particle and Nuclear Studies, including some additional remarks. It was refreshing to have a face-to-face discussion after three years of remote meetings due to the COVID restrictions.

-General: Since this was an annual review of the overall project, reviewers were asked to give general advice to further promote the Belle and Belle II projects. Especially, the plan to join the analysis efforts of the two collaborations is to be evaluated.

It is impressive to note that the Belle collaboration continues to publish papers in high-quality peer-reviewed journals after they completed data taking in 2010. Although the statistics of the Belle II data are still about half of the sample collected by Belle, the Belle II analyses start to produce results competitive with those of Belle, benefiting from the superior detector. It was shown that analysis strategies developed for Belle II data could be applied to the Belle data to improve the results. Furthermore, Belle data have been ported to a format that could be analysed by the Belle II analysis software.

Therefore, the committee strongly urges the Belle and Belle II collaborations to merge the two efforts by unifying the analysis plan and development, as well as the review process. There are several possibilities to implement this goal, and it should be left to the scientists to work out a solution. Since the two collaborations are largely overlapping, the committee is confident that a solution acceptable to both parties will be found very soon.

-Progress of LS1 works and Plan: Review the progress of the work to be completed in LS1 on the various detector systems: PXD2, TOP PMT, KLM RPC, CDC, and the online/offline monitoring and control. Point out if there are other possible improvements to be made on this occasion.

-Plan to resume machine operation after LS1: Is the run plan for JFY2023 appropriate to ensure improvements of the machine and detector while securing reasonable operation time?

The two halves of the PXD2 have now been assembled and should be transported to KEK at the earliest possible time. TOP PMTs from one slot have been removed, and laboratory tests confirmed the suspected degradation of the quantum efficiency. A firm plan for the PMT replacement has been accepted. The action being taken now on the KLM-RPC monitoring should avoid irregularities in the detector performance passing unnoticed. Any attempt to recover the chamber performance by changing the gas mixture should only be tried after thorough laboratory tests with spare chambers. The long-term instability of the CDC operation remains a concern since the cause of the gain drift has not been understood. Careful monitoring of the gas properties, water and oxygen content, and the laboratory irradiation test should be reinforced. The systematic consolidation of the HV control and monitoring of multiple subsystems is highly appreciated, and the committee recommends that this effort be extended to other detector control and monitoring processes, including the interlocks and alarm systems.

It was reported that the MEXT budget plan for KEK would allow three months of machine operation during JFY2023. If LS1 can be completed by the end of the calendar year 2023, this will give a sizeable block of running time before the 2024 summer shut-down. This should allow time for commissioning the machine and detector and collecting data for the summer conferences, judging from the luminosity projection. The Belle II LS1 schedule, which is basically driven by PXD2, is currently not quite compatible with this goal. Thus the Belle II collaboration is strongly encouraged to examine options that could allow the machine operation to start at the beginning of 2024 by carefully assessing the risks. For example, the extraction of the VXD could begin already after the initial mechanical and electrical integrity assessments of the PXD2 while further tests of PXD2 would proceed in parallel. The PXD2 group should be prepared for some repairs, including the replacement of ladders if necessary at KEK, and spare ladders should be ready.

-Analysis: Are the planned analyses for the winter conferences ready? Is there anything to be streamlined to improve the output?

The presented analysis plan is good and advancing well. As already pointed out, com-

bined analysis of Belle and Belle II data will enhance the precision of the results and should be pursued. In order to obtain new world-leading results, further strengthening and broadening of the analysis efforts for the dark sector physics is encouraged.

-Computing [to remind] the adequacy of the resource estimate is to be reported by April/May.

A preliminary estimate of the computing resource requirement was shown at this meeting. A dedicated discussion and recommendation will be given once the final document, prepared by the expert group consisting of G. Carlino, W. Hulsbergen, P. McBride and P. Mato, and chaired by the BPAC chair, becomes available.

In addition to these responses, there are some comments on the LS2 upgrades. It is understood that some upgrade of SuperKEKB will be required during LS2 to achieve the Belle II goal, i.e. collecting 50 ab^{-1} of data, within a reasonable timescale. This, in turn, calls for upgrades of the detector to fully exploit the upgraded machine capability. The committee was presented with the current ideas for upgrades of various detector systems. Their scope will be strongly influenced by the way the machine upgrade will be implemented, in particular the design of the intersection region. Since the machine group is still developing ideas for the full scope of the upgrade, it is premature to start the actual detailed design of the detector components. The committee recommends the group to remain open for exploring further promising technologies. This would allow the Belle II collaboration to proceed rapidly in defining the scope and definite design of an optimal detector once the extent of the machine upgrade has been fixed.

The committee fully appreciates the effort by the KEK management and the positive response by MEXT to secure funding for adequate running time for the Belle II experiment. However, uncertainty in future data taking due to the increase in electricity cost remains a serious concern.