

B-factory Programme Advisory Committee
Short report for
focused review meeting

27–28 October 2019 at KEK

A. Andreazza* (Milano), D. Cassel (Cornell), P. Collins^{&*} (CERN),
G. Corti (CERN), S. Gori (UCSC), W. Hulsbergen* (NIKHEF),
M. Ishino (Tokyo), Z. Ligeti (LBL), F. Meijers* (CERN),
N. Neufeld[&] (CERN), B. Ratcliff* (SLAC),
M. Sullivan (SLAC), H. Tajima (Nagoya), M. Titov* (Saclay)
and chaired by T. Nakada (EPFL)

* Expert members, & Remotely participated in part

19 November 2019

The SuperKEKB machine and Belle II detector are now entering the second phase of commissioning, where the machine should achieve luminosities well above those provided by the KEKB machine with a background condition that allows the Belle II detector to perform safe data taking. Similarly, the Belle II experiment should become capable of fully exploiting the delivered luminosities for physics analysis.

The SuperKEKB machine team has shown that the machine could be operated with a luminosity well above $10^{33} \text{ cm}^{-2}\text{s}^{-1}$ and a background condition acceptable for the Belle II to operate. The background level became too high when the machine operated above $\sim 10^{34} \text{ cm}^{-2}\text{s}^{-1}$. In the meeting, it was reported that the newly installed collimators reduced the background as expected, which shows that the simulation is providing improved understanding of the machine behaviour, and the simulation effort should continue. A very small beam spot size at the interaction point, which is one of the key ingredients to achieve luminosities well above those of the KEKB with acceptable background levels, has not been fully demonstrated yet. The proposed working plan to understand the machine properties with $\beta^* = 2 \text{ mm}$ first, then to proceed reducing it to 1 mm and below is very appropriate. For optimising the amount of useful data for physics before the summer shutdown in 2020, giving a priority for the machine work during this year is sensible and strongly supported. The current effort on understanding the background sources and devising mitigation plans is essential in order to progress toward the design luminosity. The committee congratulates the successful collaboration

between the SuperKEKB machine operation team and the Belle II background study group and encourages their collaboration to continue and be strengthened.

It was reported that there were many repairs and improvements in the machine during the summer shutdown. The committee is pleased to hear that now a fast beam abort signal can be generated by the power supply of the superconducting final focusing quadrupole magnets (QCS). This clearly improves the protection of the Belle II vertex detector system. Introduction of further protection systems such as a very fast beam abort system is recommended. The committee is pleased to learn that the power supply of the Pixel Detector (PXD) is being modified to allow fast ramping down for protection from beam background.

The goal of the Belle II collaboration to collect 200 fb^{-1} of data by the time of the summer conferences in 2020 appears to be extremely ambitious. However, the committee fully encourages the collaboration to make every effort for this goal, since this would allow the collaboration to start providing physics results comparable to the Belle experiment in the core physics programme.

The overall performance of the Belle II detector is good. Although the second layer of the PXD is not fully equipped, there should be no real degradation in physics performance with the currently expected background level. However, the PXD readout in a gated mode has not been fully demonstrated and remains a concern. Construction of new PXD ladders, needed for the new PXD with two full layers, is progressing well with a plan to complete the production by the summer 2020, if the current high yield is maintained. Assembly of the new PXD integrated with the rest of the vertex detector will require expertise and skill. The collaboration should ensure that the necessary personnel will be retained for the work as well as those needed for the operation and maintenance of the system. The dark current issue of the Central Drift Chamber (CDC) is under control for the moment, after various interventions. Test chamber studies for understanding the long term behaviour of the CDC should continue. In parallel with the careful monitoring of the CDC and the test chamber, the Belle II management should work out a plan for a possible major repair. It could even become necessary to construct a new CDC. An algorithm to filter the cross-talk signals based on the TDC information has been validated in software. This must be implemented as firmware in the ASIC of the CDC frontend card for the Level-1 trigger to work efficiently at high luminosities. Acquisition of radiation hard photon detectors (MCP-PMT) for the barrel particle identification system (TOP), to replace those which are not expected to last long due to the beam background radiation, is in progress. Ensuring the radiation hardness of the delivered devices is essential. The K_L -Muon detector (KLM) has made good progress by merging the barrel and endcap groups together. However, further effort is needed for long term stable operation of the device and fully exploiting its performance. The committee recommends the KLM group producing a work plan for this.

The currently functioning trigger system is sufficient for the experiment for the moment. However, several subsystem trigger components are missing. The committee would like to see a clear plan for the completion of the full trigger system. The trigger performance should be monitored in real time to detect quickly any problem with the detector or machine background that may arise.

In the Belle II operational system, the committee is pleased to see many routine actions have been automatised in data taking and processing. Further effort should be invested to make those automatised procedure more complete and reliable, which is essential for sustaining a long period of data taking. Both online and offline computing as well as the control system of the experiment are working well. Dedicated human resources given to the online and offline teams using the maintenance and operation fund of the collaboration are showing a positive impact. The committee encourages continuing this practice to ensure smooth running of the experiment. For the offline computing resources, the committee encourages the collaboration to utilise resources in small computing centres more effectively by finding suitable roles appropriate for their capabilities. The committee would also like to congratulate the collaboration for making a decision on the choice of technology for the new readout card, which will replace the current COPPER board.

Finally, the committee appreciates the effort to explore physics results with the early Belle II data and encourages the collaboration continuing to do so. It is also important to plan for a transition from the Belle analysis work. The committee is looking forward to seeing progress in all aspects of the experiment during the next annual review meeting in February 2020.