

B-factory Programme Advisory Committee
Short Summary for the 14th Focused Meeting
Review on Findings in Phase 2 and Preparation for Phase 3
21–22 October 2018 at KEK

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The Belle Programme Advisory Panel held its focused review meeting on the 21st and 22nd of October 2018. The committee listened to presentations on the status of the experiment and machine by the Belle II collaboration and the SuperKEKB machine team, respectively, who have been busy with the preparation for the Phase 3 Run.

The committee congratulates the SuperKEKB team for achieving a peak luminosity as high as $\sim 5 \times 10^{33} \text{cm}^{-2} \text{s}^{-1}$ during the Phase 2 Run. Machine parameter studies showed that a target luminosity of $10^{34} \text{cm}^{-2} \text{s}^{-1}$ could have been achieved if the beam currents were increased, which will be possible for the Phase 3 Run already before the summer shut down in 2019, with some hardware being installed during the shutdown. While a path to increase the luminosity is defined, the cause of the unexpectedly high machine background observed by the BEAST detector at the interaction region during the Phase 2 Run has not yet been understood, introducing uncertainties about how the machine will continue to improve performance while keeping the background levels at tolerable levels for the experiment. With the Vertex Detector (VXD) installed, the background remediation and measurement must now be fully integrated into Belle II activities. Commissioning work for the machine and the Belle II detector must be done in close contact. The operation plan of the machine should be discussed together with the detector group so that the best condition for physics can be achieved efficiently. With increasing beam currents, utmost care must be taken for protecting the machine and detector from beam related accidents. The person who leads the Belle II commissioning should also be entrusted to coordinate with the machine group and follow closely the background studies.

In order to ensure high integrated luminosity, the machine must run with continuous injection and the Belle II detector must be ready to cope with this.

The BPAC is very pleased to hear that the Phase 3 VXD has been assembled and is being commissioned with cosmic rays and is ready for the installation. Although only one layer of pixel detectors is fully placed, rather than two as designed, the committee believes that it will be sufficient for the early stage of the Phase 3 Run, since the machine will not reach the design luminosity yet, and it will play a vital role in the physics analysis. The committee notes that the gating mode of the pixel readout operation is a critical component for the continuous injection and still has to be shown to work reliably. Since the VXD cooling is a specialised system, all the spare parts must be made available at KEK so that repairs can be made swiftly if required.

The BPAC is very impressed by the Belle II analysis work with the Phase 2 data showing fully reconstructed B mesons. However, the committee also notices that there are several issues to be sorted out for the Phase 3 Run to achieve the planned physics programme.

In order to understand the noise and cross talk observed in the Central Drift Chamber (CDC), the frontend electronics must be checked systematically. For keeping the CDC dark current under control, the chamber must be kept at high voltage with continuous gas flow and the current monitored. The gas system should be prepared so that H₂O or alcohol could be added later if the dark current persists. Chemical analysis of the exhaust gas would also be necessary in such a case.

The end-cap particle identification system (ARICH) was not fully operational during the Phase 2 Run. During the shutdown, the ARICH had to be removed from the Belle II structure in order to install a cooling system for the frontend electronics and will be put back after the installation. This is an unforeseen major operation. The ARICH group needs to make a careful commissioning plan of the detector after the reinstallation. The barrel particle identification system (TOP) is generally in a good shape, but still requires effort by the engineers for debugging frontend electronics, in particular the FPGA firmware.

While the status of the Electromagnetic Calorimeter is satisfactory, the situation with the K-Long Muon (KLM) system, in particular for the barrel, is rather worrisome. For the barrel part, much effort is still ahead of the group in order to make the detector ready for physics data taking. The Belle II management should monitor progress carefully to ensure that enough resources are provided for timely completion of their work. Engineering effort for the readout electronics is also needed for the endcap KLM. Unifying the operation effort of the endcap and barrel KLM should be considered.

Data Acquisition (DAQ), Slow Control and Trigger are the areas where central teams need to work closely with the detector teams and must often support the detector groups. Lack of experts has been a long standing problem for the central teams. The committee is pleased to observe that some progress has been made to mitigate this problem for the central DAQ team. The effort should continue to increase the number of experts needed for Phase 3. This problem remains for Slow Control. Although some people became available for the operation of the system, the number of experts, who are still needed to make the system viable for physics data taking, is extremely limited. Recruiting young

people and training them for the coming period is a good idea. The human resource situation for Trigger is critical. Effort is needed for not only implementing hardware functionality but also monitoring carefully the performance, where physics groups can contribute. Stronger cooperation among the three central teams would also be very helpful and a Belle II collaboration wide effort should be made to bring in more human resources.

The committee does not find major problems with the progress in software and computing and expects them to be ready for Phase 3.

The committee recommends the collaboration to take a holistic view of the next six months identifying key vulnerabilities and areas of concern for the experiment. This should help in developing an overarching plan to ensure adequate resources for critical tasks and the proper organisational structure with well-defined responsibilities and authorities to be in place well before data taking starts. The BPAC is looking forward to see the progress during the next BPAC meeting in February 2019, just before the start of Phase 3.