

Short Summary
B-Factory Programme Advisory Committee
Focused Review of the Vertex Detector System
24 – 25 October 2015 at KEK and 26 October 2015 at IPMU

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Short Summary of the Focused Review Meeting

A focused review meeting by the Belle Programme Advisory Committee (BPAC) for the Belle II vertex detector system (VXD) was held on the 24th and 25th of October at KEK and on the 26th at IPMU. The VXD consists of a two layer pixel detector system (PXD) immediately outside the beam pipe at the interaction point and a four layer silicon micro-strip detector system (SVD). At KEK, general VXD issues and particular items for the PXD were discussed. In addition, a visit to the VXD and SVD assembly areas and to the machine interaction point took place. Discussion on the 26th at IPMU was focused on the SVD issues, and the committee members also visited the clean room for SVD ladder production at IPMU. This is a short summary reporting only the most essential conclusions of the review and a comprehensive detailed report will follow separately. The BPAC was very impressed by the overall achievements, not only in the detector construction, but also in the area of data acquisition, detector control and software.

VXD

The revised project schedule shows that the assembly of the VXD system will be completed just in time for installation before the start of physics run without any contingency. A detailed integration procedure for the PXD and SVD is still to be developed. The committee recommends the Belle II management to carefully monitor the progress of the VXD construction and to direct effort towards generating contingencies wherever possible.

The work on the thermal mockup shows good progress. However this must be continued with further studies with both simulation and mockup measurements. The implications of the changes in the ASIC power consumption must be understood and the design of the cooling system must take into account all operational scenarios, ensuring that the system is protected against thermal shocks and that operation remains above the dew point for any of the structures.

In the current plan, detector halves for the PXD and SVD will be separately assembled, and then mounted together on the beam pipe. Although the procedure presented appears to be feasible, the committee feels that not enough attention is paid to protect the beryllium section of the beam pipe from possible mechanical stresses or some objects accidentally falling during the assembly operation. A detailed step by step assembly procedure is urgently needed in order to avoid last minute modifications of the support mechanics.

For protecting the beryllium part of the beam pipe, bellows connecting both sides of the VXD beam pipe to the beam pipes of the final focus Super Conducting Quadrupole magnets (QCSs) are crucial. Their design and fabrication should proceed as soon as possible so that enough time will be left for the safety verification.

A serious concern for the Remote Vacuum Coupling device (RVC), that the connection mechanism between the QCS and the VXD vacuum pipes might get stuck, is largely mitigated by the introduction of the Emergency Decoupling Insertion (EDI). However, the device must be thoroughly tested in all possible conditions.

The committee learned that the machine group has recently discovered a small QCS design problem during the production of the first QCS. Design changes which should also speed up the production are being discussed for the second QCS. Such changes may modify the mechanical strength of the QCS. Furthermore, the machine background may also be affected due to the changes in the cryostat design. Although it is not within its competence, the BPAC thinks that advices from external experts would be useful and that Belle II should be consulted in the decision process.

Safety is a paramount issue. The Belle II interlock and safety system should prevent all accidents which endanger human life, environment, infrastructure and the detector itself. The committee heard good progress made by the VXD group on their interlock system. The BPAC thinks that the Belle II collaboration should soon establish a global guideline for the interlock and safety system of the whole experiment to ensure that all subsystems follow the same safety standard for safe operation.

Many items in the VXD project are relevant for both PXD and SVD and must be treated globally. Successful installation and operation of the VXD system requires good coordination between the two systems. In order to ensure that those aspects will be properly addressed, the committee suggests the Belle II management to strengthen the overall coordination role of the VXD project.

PXD

The committee applauds the successful production of the first functioning pixel sensor ladder with electronics by the PXD group. This is a substantial step for the success of the project. On the other hand, the committee noted with concern that two of the three necessary ASICs did not perform as expected and revised designs have been submitted for production. Even if the corrected version of ASICs perform as expected, the new PXD production schedule looks very tight with little contingency for the planned date of the VXD installation. The PXD group should be prepared well in advance so that ASIC chip functionalities can be immediately verified upon delivery.

Only conceptual ideas have been developed for the PXD assembly. It should be noted that the PXD is the closest detector to the beryllium beam pipe section, which is a part of the mechanical structure of the VXD. The PXD assembly procedure must be rapidly developed with great care together with all necessary tools and infrastructure so that it can be practiced well. The idea to assemble and test the PXD system at MPI, where

necessary expertise and resources are readily available, is well motivated and supported. However, the BPAC stresses that when the completed PXD is shipped to KEK, all the tools and infrastructure for the assembly must also be transported to KEK. It is essential that the PXD can be disassembled and reassembled at KEK for rapid intervention during initial VXD assembly or after data taking commences, if necessary.

SVD

The committee notes with great pleasure the progress made by the SVD group in improving its organisation, particularly the introduction of: a project leader who oversees the overall status of the project; a quality control and assurance group who ensures the production of high quality ladders with a uniform specification among all the production sites; and a common data base where all SVD production information is stored.

Development of the detector mechanics and assembly procedure together with necessary tools is advancing well. Some of the procedures have already been rehearsed. Tight communication with the PXD group is important in this area, which could be helped by introducing an overall VXD coordination level, which has been mentioned before.

Critically low availability of human resources at the IPMU production site is a concern. Since this site is responsible for producing the ladders for the outermost layer, which are the largest in both size and number, the problem must be solved with the highest priority.

BEAST Phase-2 Detector

During the second machine commissioning phase, the outer part of the Belle II detector and the QCSs will be in place, without the VXD. This is an essential period to understand the sources of machine background and to tune the machine parameters for the later physics run with the VXD. In place of the VXD, the BEAST Phase-2 detector will be installed in order to perform measurements needed for the Phase-2 commissioning. Detector components currently considered for the BEAST Phase-2 detector were presented during the review meeting. However, it appears that not all of those detectors are well motivated for the goals of the Phase-2. The BPAC recommends that the Belle II collaboration, in collaboration with the machine group, should establish a list of required measurements first, then work out which detector components are needed for those measurements.

Miscellaneous Observation

The BPAC committee noticed lack of engineering and infrastructure support by the host laboratory. Supports for the construction of subsystems are largely provided by the laboratories and institutes who are responsible for those components. However, for large structures and those items closely related to the accelerator components and safety issues, major support from the host laboratory is required. The work in the experimental area is also where support from the host laboratory is needed, primarily for safety. Some basic software and hardware computing needs, including database and communication infrastructure, require additional support. This support will benefit other experiments at KEK, as well as Belle II.