Report from the PHENIX Review of the Silicon Vertex Barrel (VTX)
October 1, 2008

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Charge to the Review Committee:

The PHENIX Silicon Vertex Barrel (VTX) project was reviewed in June 2008 by a BNL-charged committee that assessed the project's overall technical progress. The review identified a number of issues with the VTX project that PHENIX and BNL agreed to closely monitor and resolve as quickly as possible. The issues were:

- Material budget of the VTX and simulations of its impact on the PHENIX physics program
- Performance of the Read Out Card-3 (ROC-3) + Stripixel sensor, especially its noise performance.
- Manufacturability and assembly of the ROC
- Need for a back-up sensor option if the baseline Stripixel sensor is shown to be unable to meet performance specifications

The charge to the review committee is to assess the progress of the VTX project on all of these aforementioned issues. As part of the assessment, we would like a recommendation on whether there remains a need to continue working on the back-up sensor option. After the conclusion of the review we request that the committee provide a brief written report to PHENIX Management.

The review committee's evaluation of the PHENIX VTX project is a very valuable contribution to both PHENIX and BNL's effort to manage the project to a successful conclusion. Thank you for your willingness to participate in this process.

Review Report:

Both PHENIX Management and the Review Committee would like to thank the VTX group for the comprehensive set of presentations given at the recent PHENIX review. The presentations as a whole clearly described the status of the project with respect to the four topics contained in the review charge and provided the committee with the information needed to assess the project's current situation.

The VTX group is to be commended for the tremendous progress they have made since the June review**.**

Material Budget and Simulations:

The VTX group has performed detailed and more realistic simulations since the June 2008 review and has worked on the material budget. The J/psi reconstruction performance was used as a benchmark for the effect of the VTX materials on general reconstruction performance. Specifically the VTX group presented results on the width and efficiency of the J/Psi as well as a study of the DCA for tracks off the primary vertex. The impact of material on the width of the J/Psi is small and despite a bug that worsened the DCA simulation result, this result was also reasonable. The latter bug has already been fixed and will only make an already acceptable DCA result better. The studies suggest that the amount of material in the current VTX design is acceptable and fits the PHENIX detector performance goals.

However, parts of the simulations had programming bugs, or were simply incomplete. There is a concern that there is insufficient simulation effort in the VTX group. In the November 2007 DOE review of the FVTX project, the DOE review committee requested a tremendous amount of additional simulation work; a similar request was also a part of the Review report from the June 2008 DOE review of the VTX.

Recommendation:
The VTX group should consider finding additional people to work on simulations and increase overall simulations effort.

Performance of the ROC3+Stripixel Sensor:

The VTX group has achieved dramatic performance improvements in recent months. The ROC-3 tests have demonstrated a 10X signal to noise ratio in lab and a Fermi Lab test beam. On-the-fly pedestal adjustments in the FEM will be used to overcome past issues with the pedestal distributions that were not uniform and/or wandered. A lot of progress has been made.

The SV4 chip has 8 bits ADC range, i.e. 256 ADC bins. The data presented is about 70 counts on the pedestal. The Fermi data shows that the MIPS signal occupied the remaining ADC range. The offset and gain of the SVX4 could be adjusted. One needs to explore the phase space of these adjustable ranges to understand the optimum operating conditions.

There are remaining issues with the ROC3-stripixel performance that require continued attention. The signal-to-noise performance of 10 for the ROC3+stripixel sensor is nice, but tests were done in relatively quiet conditions and need to be carried out in a more complex electrical environment. Perhaps the chain test scheduled for Q1CY09 will be able to address this concern. In addition, the stripixel ROC is now on the critical path and has used up its share of budget contingency while there remain some outstanding technical issues to resolve. It seems likely that some schedule slippage will occur if additional engineering steps are needed (beyond those currently anticipated).

Overall, the ROC-3 performance is suitable for PHENIX.

Recommendation:
None

Manufacturability of the ROC:

Machine-based manufacture of the ROC in PHENIX is highly desired, particularly since early troubles in the ROC designs can be partly attributed to imperfections in by-hand assembly techniques. Although these hand assembly techniques have improved to an acceptable level, machine assembly is the goal. The machine manufacturability of the ROC has been explored and improved in every phase of the ROC design. Much progress has been made in the design of a manufacturable ROC.

There are still a number of outstanding issues for the ROC. Substantial modifications need to be made to go from the ROC3 design to the preproduction ROC. The yield of the ROC is not clear. Cost/schedule/repair issues need to be addressed prior to ROC production. Large-scale changes (such as movement of components among layers), may require an extra prototyping cycle.

The RCC board has been layed-out. The status of the readout bus was not presented. To have a successful chain test, all these boards have to work correctly with matched physical and electrical interfaces. The schedule presented only has one design/prototype cycle before the chain test.

The stripixel detector occupancy for Au-Au central interaction is around 4.5% for the first layer and 2.5% for the second layer. The proposed zero suppression method requires sending un-zero suppressed events through the DAQ system. If this is not planned carefully, it could impact the overall PHENIX data-taking rate and data size. The VTX group should work closely with the PHENIX DAQ group to optimize the VTX zero-suppression scheme and minimize any impact the VTX might have on PHENIX DAQ performance.

Recommendation:
The project file needs to reflect cost and schedule issues associated with an extra preproduction ROC prototype round. The impact of an additional prototype round on the project should be analyzed by the VTX group.

Need for Continued Effort of the Conventional Strip Sensor Option:

The conventional strip option was born in a time of crisis (back in June 2008) when it was unclear if the problems surrounding the readout of the strip-pixel sensors could be resolved; at the time, switching to conventional strips seemed relatively straightforward. In the meantime a lot of progress has been made to resolve the problems with reading out the strip-pixel sensors, and the true cost (in time and dollars) of switching to

conventional strips has been evaluated. It is clear that if the VTX project switched to conventional strips then all of the VTX project contingency will be spent on this item alone, and the completion of the project could be significantly delayed. In this regard it is very fortunate that so much progress has been made on the strip-pixel sensor readout. The VTX group should focus all its efforts on resolving the remaining strip-pixel readout issues, as such a resolution seems to be in reach.

Recommendation:

Based upon both the progress in the stripixel system and the more realistic cost and schedule estimates of the backup option, the committee finds that further work on the backup option is neither necessary nor justified. The conventional strip sensor option should not be pursued at this time.