Plan for PHENIX FVTX Disk and Cage Assembly

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Scope: The scope of the FVTX assembly task, in broad terms, is to receive the assembled sensor wedges from the wedge assembly factory at Nevis, as well as the final (tested) ROC's, and produce the four FVTX half-cages. The locations of the sensors inside the cages must be known for event reconstruction purposes; this means careful metrology and surveying must be done in the process of assembly. The assembled half-cages will be tested using a DAQ system incorporating the new ROC and FEM modules being designed for the FVTX. Coordination of the installation of the FVTX in the PHENIX IR also falls into this task; however, the main focus of this document is on the assembly and testing of the FVTX half-cages.

Important Dates (from MS Project file):

Assembly jigs manufactured by 6/17/09
Support structures manufactured by 7/29/09

Testing of wedge assemblies 7/15/09 -- 2/9/10

Q/A of Production ROC's 4/9/09 – 6/15/09

Nominal start date for assembly is 7/29/09
(as support structures and first completed wedges become available)

Cages completed and surveyed by 8/17/10

Support Structures and Assembly Jigs:

Here, "support structures" refers to the mechanics that will hold the wedges and ROC's together in a unit half-cage (WBS 1.6.2-1.6.4); "assembly jigs" refers to a set of temporary supports used in the process of assembly (WBS 1.6.5). Many parallel design issues for the wedges, support structures, and assembly jigs must be finalized in the near term, since the manufacture of these items occurs basically simultaneously. We have a baseline design that addresses these issues, and we will continue to optimize the design; the deadline for finalizing these design issues is 1/16/08. Here are some open issues:

(a) Where to place alignment marks on the half-disks and half-cages for survey in the IR?

(b) What is the appropriate tolerance for the alignment holes that locate the wedges on a half-disk? Our proposed tolerance is 10 microns.

(c) How should the ROC's be built and installed so as to be compatible with the VTX installation?

In order to make sure that mechanical problems will not occur at later stages, "dummy wedges" will be manufactured to make possible a mock assembly of half-disks and half-cages. These dummies can be made from metal plate or G-10. The final ROC's will already be available at this time and can be used in the mock assembly too.

Assembly Lab at BNL:

The lab space for the final assembly will be ready by 7/29/09 so that the support structures and assembly jigs can have a place to be delivered and additional QA checking can be done on them. The first wedge assemblies should also be available at this time, so that some preliminary assembling can be done very early on.

Some equipment and requirements for this lab:

(a) This lab should be "clean" at the level of having a sticky-pad on the floor at the entrance, and there will be specific handling requirements for the completed wedges. We have determined that we do not need HEPA filters or other special air-handling measures.

(b) A "dry box" will be used for the storage of the wedges before assembly.

(c) Basic electronic testing equipment; oscilloscope, multi-meters, appropriate connectors and test leads, etc. to be determined. We are seeking institutional contributions to provide this kind of generic equipment.

(d) Benches and chairs to allow about 4 people to work comfortably at one time.

(e) Metrology equipment for locating the wedges with respect to survey targets on the half-disks; Robert Pak has indicated that BNL should have the appropriate equipment onsite.

(f) A "mini-DAQ" system for testing the assembled half-disks and half-cages.

(g) A cooling system will be needed to operate the detector system for long periods. We plan to use the old PHENIX MVD cooling system, or a stand-alone cooling system in the Chemistry Department, for such tests.

The location of this lab space at BNL is being determined with the help of Robert Pak.

A "mini-DAQ" System:

We will have a DAQ system available to test the assembled FVTX half-cages in the assembly lab. This system will use the new ROC and FEM electronics being built for the FVTX. LANL will support the setup and operation of the mini-DAQ, and other groups involved in the assembly will learn how to use it.

Proposed Assembly Process:

(a) Finished wedges will arrive from Nevis. Some re-testing of the wedges should be done after arrival at BNL to make sure they have not been damaged in this short trip.

(b) When sufficient wedges of a given type exist, then a half-disk can be assembled. Any mechanical problems can be addressed at this time; this is a critical issue to look at in the first wedges to be delivered, but presumably the "dummy wedges" mock assembly test will have found these problems out already.

(c) Electronic testing of the assembled half-disk is appropriate at this point; the final ROC's will be available and are an integral part of a half-disk. The precise test protocol remains to be determined; that protocol will be determined by our experiences

with testing the wedges at Nevis, and from testing experience with the ROC's. If all systems are go, then the next steps can take place.

(d) The final metrology of the wedges on a half-disk will take place after it is determined that there is no need to remove and replace any of the wedges. Some general ideas about metrology and alignment are described in the next section.

(e) As half-disks become available, one can look to the assembly of a half-cage. This is another area where mechanical problems may arise; the mock assembly using "dummy wedges" should have already found out any problems of this type.

(f) A survey crew will be brought in to survey the half-disks in the half-cages --- see next section.

(g) Completed half-cages will be subjected to additional testing with the "mini-DAQ" and then stored until transportation to PHENIX.

Alignment, metrology and survey:

Based on the experience at RIKEN with the VTX sensors, we know that sensors can be placed on a wedge with an internal precision on the order of a micron or better. Based on our requirements for track reconstruction, we are requiring that the sensors be placed and surveyed into a detector plane to an accuracy of 10 microns in x and y. This suggests the following assembly and survey plan:

(1) Identify some "golden points" on each wedge. We can place cross hairs at the top and bottom of the sensor, or use distinguishing features of the sensors themselves.

(2) Using a telescope table, find these golden points on each wedge and reference them to survey marks on each half-disk. One possibility is to have a precision hole on the outside radius of the three support tabs that accepts an alignment flag with a crosshair on it. All wedges are referenced to these 3 flags. The flags would extend through the support cage and would serve as reference points for the location of the disks within the cage. The flags are removable.

(3) Survey the half-disks into the half-cages in the assembly lab.

(4) Survey the half-cages into the IR during the final installation there.

Manpower for Assembly: The critical time period for the assembly is from 7/29/09 through 8/17/10, just a little more than one year. During this time the critical pieces of hardware (the finished wedges and the disk and cage parts) will become available and can be assembled, tested, and surveyed. Here is a summary of known workforce commitments.

NMSU: Vipuli Dharmawardane (new NMSU postdoc) will be in residence at BNL during this time and will take the lead in getting the assembly tasks done. There will also be at least one NMSU grad student (to be named) in residence at BNL to work on this project. Three NMSU Faculty (Kyle, Papavasiliou, Pate) will make trips to BNL during this period to assist in the assembly.

Columbia: Dave Winter estimates they can contribute 1 faculty FTE, 1-2 scientific staff, 2-3 students, 1 postdoc, and perhaps 1 technician.

UNM: A post-doc will be made available.

LANL: A post-doc will be made available, with the assistance of other LANL staff traveling to BNL during the period of assembly.

BNL: Robert Pak and Angelika Drees have offered their help in the assembly process.

It is important to note that some personnel, especially people from NMSU and Columbia, will spend time on both wedge assembly and the final detector assembly, and that these two assembly processes overlap somewhat in time.

Manpower for Movement and Installation into the PHENIX IR: This activity will be planned in close cooperation with BNL/PHENIX scientists and technicians. The PHENIX technical crew has a tremendous amount of experience installing equipment in the PHENIX IR, and we depend on them to perform the large-scale movement and installation. The survey and alignment of the FVTX also falls into this activity. The vast majority of the collaboration scientists mentioned above in "Manpower for Assembly" will follow the detector to the IR and be responsible for the other detailed work (hooking up cables, testing detector and DAQ functions, commissioning, etc.).

LANL, NMSU, and UNM worked very closely together on the construction, installation, survey, commissioning and operation of the north and south muon tracker arms a few years ago, in close collaboration with BNL and the rest of PHENIX, and we are already drawing on those experiences as we plan this new project.