**SV Report for WBS 2.0 1008 I&F Upgrade Project**

April 2021

Cumulative BCWS $20,778,364

Cumulative BCWP $18,085,332

Cumulative ACWP $17,233,288

SV = -$2,693,031

CV = +$852,044

SPI = 0.8704

CPI = 1.0494

The following report discusses the major sources of schedule variance, including all items comprising 1% of the total schedule variance, plus a few select other items, and discusses the impact as well as the corrective actions taken. The analysis is done at level 3 of the Work Breakdown Structure.

**WBS 2.2.3 Magnet Cryogenics (SV = -$364,728)**

Description – The LHe cryogenics system has the 1008B cryobox delivery delayed and the design for the for 1008IR cryobox behind schedule, SV = -$211,304. Rigging in of the 1008B box could also not be done, SV = -$11,700.

The supervision of the LHe cryogenics contract is being claimed more slowly than planned due to necessary delays in the LHe fabrication at the vendor due to COVID-19 absences, resulting in SV = -$25,994.
The fabrication of the LN2 delivery system is also slightly delayed at the vendor due to delays in placing the contract and some delay in the vendor’s being able to staff the task early on, resulting in SV = -$1,112. This SV is small this month but upcoming contract milestones merit attention.

Rigging and installation of LN2 piping supports was delayed, SV = -$10,637.

The design and subsequent fabrication and parts procurement of the warm gas piping and vapor-cooled-lead returns was delayed due to the need to focus engineering attention on the outside vendor contracts for the He and LN2 cryogenic items, resulting in SV = -$108,955, which is an improvement over prior months’ status.

Procurement of cryogenics instrumentation is not complete, resulting in SV = -$30,310.

Installation of cryogenic racks and instruments and preparation of the control firmware is ahead of schedule, resulting in SV = $35,284.

Impact – None as yet. The projected delivery dates for the cryogenic items from external vendors are still ahead of when the items can be installed at the earliest. The warm gas piping is being done ahead of need-by date to take advantage of and adjust to the timing of technical stops in the RHIC running schedule. The controls work benefits from the general upgrade of the RHIC cryogenic controls but must make similar instrument choices and procurements, most but not all of which have been made. In contrast the cryogenics installation and controls has been able to work somewhat ahead of planned schedule.

Corrective – The vendor orders for LHe and LN2 cryogenics systems continue to demonstrate steady progress. The 1008B cryobox for the LHe system was delivered in early May. The warm piping design advanced in April due to staff availability, as could some of the work done in preparation for LN2 piping installation. Cryogenic controls procurement continued and stays ahead of need-by date.

**WBS 2.2.4 Magnet Power Supply and Quench Detector (SV = -$178,381)**

Description – The installation of trays and power cabling between the power supply in Building 1008B and the magnet location in 1008 IR has started but cannot yet be completed due to the ongoing RHIC run, resulting in SV = -$145,725.
Testing of the existing quench detector for the superconducting magnet has started but is not complete, resulting in SV = -$31,920.

Impact – None as yet. The magnet power cables will be installed after the current RHIC run is complete. The quench detector is also needed by early CY2022 when the magnet is connected to the power supply. The quench detector exists and has been operated recently with the magnet and will be tested as part of preparing the magnet. Positive float remains.

Corrective – The power cable will be installed when access to 1008 IR is again possible. The quench detector work is ongoing.

**WBS 2.2.5 Magnet Field Measurement (SV = -$68,132)**
Description – The calculations for the magnet field map are done but the preparations for the mapping effort are still in progress, including placing a contract with CERN to borrow their large magnet mapping apparatus. This causes a SV of -$68,132.

Impact – None as yet. However, the contract with CERN does need to be placed in order to be able to deploy it by summer 2022.

Corrective – The electronics boards and probes are in development and will be tried out by late CY2021, well ahead of the need. The contract discussion with CERN have started but need attention in order to progress, as we have determined that an actual subcontract with CERN will be needed and this takes time to implement.

**WBS 2.3.1 Carriage Cradle (SV = -$232,871)**

Description – The seismic restraints have not started production, resulting in SV = -$231,309.

The final modifications to the existing steel tracks in the IR are only 95% complete, SV = -$1,563.

Impact – None

Corrective – The seismic restraint engineering and design work was stopped at about 95% complete to move engineering and design staff to more pressing tasks. These restraints are needed only after sPHENIX roll-in to the Interaction Region in April 2022. Their design is closely modelled upon the existing ones for STAR. It is anticipated the seismic restraints will be reviewed for procurement by mid-summer 2021.
The modifications to the existing steel tracks in the IR will be completed as soon as the RHIC Run 21 ends, in mid-summer 2021. The preparatory shop work for this task is complete.

**WBS 2.3.2 Inner Detector Rings and Interfaces (SV = -$781,518)**

Description – The design work for the various support structures for inner detectors which are supported from the InnerHCal is not complete, resulting in SV = -$43,575. The associated procurement package preparation and reviews are not complete, resulting in SV = -$159,080. The procurements of the various items themselves is not complete, resulting in SV = -$516,505, of which the Large Support Rings are the largest item, SV = -$330,795. The acceptance testing is thus also not complete, resulting in SV = -$55,888.

Impact – None, except for the Large Support Rings, which are now ten days from being on the critical path.

Corrective – The Large Support Rings are ordered and in fabrication, with a scheduled delivery date from the vendor in late August 2021. Design work on the magnet supports and IHCal support tabs is complete. The designs were reviewed in March, procurement packages were prepared, and solicitations made to potential vendors. The EMCal supports are complete. Work on the TPC, INTT, MVTX, MBD, and beampipe supports is continuing, with coordination with the external collaborators who are leading the design of the INTT and MVTX.

**WBS 2.3.5 Bridges and Platforms (SV = -$33,279)**

Description – The bridges and platforms that attach to the carriage cradle and support the racks and cryogenics interfaces are not complete, resulting in SV = -$33,279.

Impact – None.

Corrective – Designs, reviews and procurement packages were completed in March. The procurement solicitation has been issued and vendor responses received. The fabrication is expected to be complete 2-3 months before the bridges and platforms are needed for installation.

**WBS 2.4.1 Detector Infrastructure Upgrades (SV = -$215,394)**

Description – The power distribution design is not quite complete but a bit ahead of schedule at present, resulting in SV = $12,927.
The cable routing plan is complete for the calorimeters but is still addressing routing for the TPC and silicon detectors, resulting in SV = -$7,313.

The rack protection system prototyping is not quite finished, resulting in SV = -$17,047.

The routing for the main gas and cooling lines both on the detector and in the IR is just started, resulting in SV = -$200,561.

Rack support services work is behind schedule, SV = -$22,504.
The rack room modification plans are somewhat ahead of schedule, resulting in SV = $21,811

Impact – None for all but the gas and cooling routing, which is nearing the critical path for the I&F upgrade.

Corrective – The power distribution design has progressed to where orders are being prepared for all parts needed, as is the case for the rack protection systems. The cable routing is progressing but needs further input concerning the TPC support system, which is being designed and analyzed to understand its deflection under load. The gas and cooling system work has had to wait until detector-specific items for the calorimeters and TPC were settled. Those for the calorimeters are now in full production and well over half of those for the TPC are now specified, so that this overall routing work can now proceed over the Spring.

**WBS 2.4.2 Facility Infrastructure Upgrades (SV = -$349,794)**

Description – The beampipe work is not complete, resulting in SV = -$5,889.

The HVAC system upgrade has had requirements determined but is still in design, resulting in SV = -$57,876.
The cooling water upgrade is ahead of schedule, resulting in SV = $36,603.

The safety system design needs to be converted to use the new logic and reporting infrastructure, thus is still being assessed for requirements, resulting in SV = -$79,654.

The Assembly Hall modifications have not started, resulting in SV = -$60,082.

The Track reinforcement work is not complete, resulting in SV = -$182,895.

Impact – None yet, except for the Track reinforcement work. All items are being upgraded well ahead of their needed installation. The exception to this is the Track reinforcement upgrade, which is being done in two stages, one for the Assembly Hall and the other for the Interaction Region. The Assembly Hall tracks reinforcement in complete, thus Carriage/Cradle assembly can start in summer 2021. The Interaction Region tracks must be upgraded before sPHENIX can be rolled into the Interaction Region in Spring 2022.

Corrective – The beampipe is in progress. A sample of it with the non-evaporable getter (NEG) coating which must be removed and replaced has been prepared. The method for NEG coating removal was tested and will have to be revised to be less aggressive, i.e. remove less material. The HVAC system has a designer now assigned to complete design matters, review the design, and prepare procurement packages. The cooling water work will continue ahead of schedule. The safety systems are being reviewed with CAD to determine requirements in particular for control room notifications. The contract for the Track reinforcement has been placed and the contractor has begun work, with the Assembly Hall work now complete and a deadline for completing the Interaction Region work of November 3. The deadline for the IR track work is compatible with the RHIC Run 22 plans.

**WBS 2.5 Installation (SV = -$472,659)**

Description – There are several items related to installation preparations which cause the SV.

The carriage assembly preparation is not complete, SV = -$127,688.

The SC Magnet fixtures are not complete, SV = -$21,620.

The IHCal assembly fixture is still in design and not yet fabricated, SV = -$129,004.

The EMCal fixtures are ahead of schedule, SV = $18,580.

The TPC fixtures are not built awaiting a redesign of the support structure, SV = -$60,713.
The INTT fixtures are not finished, SV = -$61,343.
The MVTX fixtures are not finished, SV = -$58,967.

The MBD fixtures are not finished, SV = -$31,905.

Impact – None except for the IHCal assembly fixture, which is within 2 weeks of the critical path and needs to be reviewed before manufacture can commence.

Corrective – The carriage is being held at the vendor who is also manufacturing the motion system and has done an assembly test, which was successful. The carriage will be delivered to BNL in May. The SC magnet main fixtures are ready, but some small alignment fixtures are being made in the shop to aid in survey and positioning. The IHCal assembly fixture design was reviewed in mid-April and is now being detailed to be readied for procurement and manufacture. The EMCal fixture is underway and should continue to meet schedule. The fixture for the TPC had to be put on hold pending a redesign of the support to address concerns about flexing of the TPC. A new concept for the TPC support and fixture has been put forth and is being analyzed to determine its deflection under load. The fixtures for the INTT and MVTX are being designed by the relevant external collaborators. The MBD fixture will be addressed once more pressing designs are complete, as it is needed last.