sPHENIX Project Status Report – September 2020

HOST LABORATORY: BROOKHAVEN NATIONAL LAB

FEDERAL PROGRAM MANAGER: ELIZABETH BARTOSZ

BHSO POINT OF CONTACT: ROBERT CARADONNA

CONTRACTOR PROJECT DIRECTOR: EDWARD O'BRIEN

1. **SCORECARD AS OF September 30, 2020**

Current PD:	**2/3**	Date of Current CD/PD approval		September 2019	
Next PD:	**4**	Forecast approval:	**1QFY23**	Baseline:	**1QFY23**
% Complete:	**58.3%**	Planned:		**60.2%**	
ETC:	**$10.4M**	TPC or Cost Range:		**$27.0M**	
Contingency:	**46.2%** on ETC	Float to PD-4 in months:		**11.5**	
Cumulative CPI:	**1.00**	Cumulative SPI:		**0.97**	

2. **NEAR TERM MILESTONES**

The sPHENIX Project team will continue the monthly EVMS process, Change Control, and updating of the ETC. We will continue to place orders for detector components approved at PD-3. We are implementing a plan to mitigate COVID-19 related delays including allowing certain collaborating universities that host sPHENIX fabrication and testing activities to hire additional technicians to replace a shortfall in student labor. Contract amendments are being put in the place to allow additional hires. We will continue to hire replacement personnel for our recently retired staff members.

R&D for most subsystems components is nearing completion and most of the recent project activities are associated with production of final detector components.

The TPC field cage will be assembled in the coming few months. TPC Fee preproduction boards will arrive at BNL and testing will begin. Testing of TPC DAM (FELIX) preproduction electronics will continue. Testing of production SAMPA v5 chips will continue at Lund.

The production of all the remaining EMCal blocks for Sectors 1-12 should be completed and the blocks delivered to BNL by the beginning of November. Production of blocks for Sectors 13-64 will then begin at UIUC and fiber filling for Sectors 13-64 will continue. UIUC will also ship the first set of 24 high rapidity blocks to BNL, and if they pass inspection, they will be installed in one of the first 12 sectors. Work will continue on EMCal module production and sector assembly at BNL. Additional light guide deliveries will resume at BNL. Completed sectors will be tested with the LEDs and test pulses but additional testing will be slow until we have additional labor.

Contracts will be in place to procure the iHCAL mechanical sectors in the next 4-6 weeks. After the ISU contract is in place and RFQ will be released and a vendor selected. Over the next six months work on the outer HCAL will center on production sector assemblies in the HCAL factory at BNL. The high-strength endplates, pucks, and pins are expected before December 2020. The vendor is on track to deliver as scheduled.

Calorimeter electronics work over the next three months will be focused on the continued testing of preproduction sectors and procurement of production electronics. Tasks include the start of fabrication of cable assemblies for the remaining 26 HCal sectors, placing of orders for other calorimeter external cables, testing of EMCal SiPM boards, HCal preamps and HCal LED Driver boards, system chain test of the calorimeter digitizer system, and placing orders for the LV systems. The contract for the EMCal preamps for the production sectors will be placed next month. The contract for the full production digitizer system will be awarded in October.

DAQ/Trigger work on the Global Level-1 Trigger system and the Timing system is continuing. As soon as hardware is available, we will augment the calorimeter-type DAQ readout slice with another, FELIX card-based one for the development of the whole variety of readout hardware.

The MBD will prepare for the Final Design Review and Production Readiness Review of the MBD Discriminator/Shaper (D/S) boards. Additional tests will be performed including the read-out of multiple D/S boards and checking the performance in a multi-board system. This requires firmware changes so it will likely be done I the next 4-8 weeks. The MBD L2 Manager continues to meet weekly with grad students from Howard and Florida A&M Univ to train them on the MBD testing and operations.

3. **STATUS HIGHLIGHTS**

Production components for the sPHENIX detector continue to arrive. The early completion date remains unchanged in September that indicates that the schedule has stabilized after 2.5 months of delay in the schedule over the summer due to COVID. sPHENIX met all of its PEMP-related milestones for FY20 on or ahead of schedule. The sPHENIX PEMP notables for 2021 have been defined.

The EVMS processing is complete for September. The schedule contingency remains unchanged at 11.5 months and cost performance remained excellent with over 46% contingency remaining on a project that is now 58.3% complete. Cobra and P6 monthly reports have been uploaded to IPD. There were no PCRs for September. A replacement for DAQ/Trigger software engineer was hired.

TPC GEM factories all have initial GEMs in hand and have begun framing. Results from these framed GEMs will be validated well in time for production that begins following the first major GEM shipment scheduled for November. All striped circuit cards are applied to the inner field cage. Newly written software was used to take microscope pictures at ~1400 independent locations verifying the “as built” alignment is significantly better than required. All SAMPA chips are delivered to Lund Univ, and QA inspection is ongoing. The first FEE card was populated at BNL instrumentation for testing and validation. Orders are under way for the gas, cooling, and laser system components.

EMCal block production at UIUC continued at a good pace. Eight complete sectors worth of blocks were shipped from UIUC to BNL and work is continued on producing more complete sets of blocks for Sectors 9-12 throughout October. Fiber filling for Sectors 13-64 also continued and ~ 54% of these fiber assemblies have now been completed. The batch of W powder from the last delivery to UIUC was found to have a very high tap density. It was reprocessed by the tungsten powder vendor, Starck, and returned to UIUC. The reprocessed powder was found to have a tap density that is consistent with all the other batches (~ 10.5 g/cm^3) and sample blocks made with this powder potted well and turned out fine. Further studies will be done but it seems that the reprocessed powder is now useable along with the rest of the powder.
Work on module production and sector assembly also continued at BNL. BNL has received enough blocks for 8 complete sectors. All of the modules for Sector 6 are complete and BNL is currently in the process of installing the light guides and SiPM daughter cards on the blocks for Sector 7. We currently have enough light guides for Sectors 7, 8 and 9. The light guide vendor (NN, Inc.) has overcome a perceived QA problem, which turned out to be a non-issue, and have now resumed production of more light guides. BNL expects that the delivery of the light guides will soon be back on track in October and allow us to maintain our production schedule.

Work is underway to put the contract between BNL and Iowa State University (ISU) in place for the iHCAL mechanical parts. ISU and Rutgers will place the orders for the iHCAL sector parts and manage their production. The end ring supports will be procured through BNL. GSU has tested >95% of the total number of scintillating tiles required for the outer HCAL, with only 1.3% failing performance testing. A last shipment of the remaining ~350 tiles is expected by the end of November. Shipments of tested tiles have been sent to BNL on a weekly basis; 93% of the tiles required for the oHCAL have been shipped to BNL. Factory operations at BNL are continuing with technician labor and collaborator support from the NY metropolitan area. The first five pre-production sectors have been fully assembled, tested and moved to storage. Nine production sectors have been moved into the assembly area for tile and electronics and cabling installation. At the present time the limiting factor in sector assembly is the availability of signal cables and tested preamps, however cables assembled by technicians at BNL NSLS-II are expected in the next few weeks, and preamp testing has made recent breakthroughs in the operation of the test stand. The L3 manager for sector assembly is soliciting additional collaboration labor for the end of 2020 and early 2021 to keep sector assembly on schedule.

Testing of the EMCal SiPM daughter boards continues with a failure rate of less them 1%. The Lehigh group completed testing and pre-assembly of the Preproduction EMCal preamps, with a yield of >98%. The production the HCal and EMCal Interface boards for the production sectors is in progress. The projected delivery dates are mid-October for the HCal Interface boards and mid-December for the EMCal Interface boards. HCal LED drive boards were delivered from the assembly house mid-October. The order for the LV bulk supplies was submitted to PPM the first week of September. A number of the cables are being done in-house, taking advantage of the expertise of technicians assigned to NSLS-II, with the balance being sent out to a local vendor. Assembly of the XMIT boards for 7-Crate production has started. A partial delivery was received in late September with the balance of the boards to be delivered in mid-October. The Digitizer boards for the 7-Crate production have gone through their initial

power up tests with 100% yield. The Colorado group has agreed to take on the responsibility for the full performance testing of the boards, and fabrication and installation of front panels

After the DAQ "Procurement Readiness Review" was passed, purchase orders 20 PCs were placed, in addition to a "first article" file server that we call a "buffer box". The role of the latter is the interim storage of data at the experimental site to level the variable data rates, and a steady stream of data can be sent to the computing center for storage. After the arrival of more hardware from our collaborators from Nevis Laboratories, it was possible to set up a small data acquisition system that is a full "slice" of a calorimeter-type readout chain that is used for testing and development of the DAQ components. In this way it is possible not to disturb the other DAQ system in the Physics Department High-Bay, which is in use to test and characterize newly assembled EMCal sectors. Before setting up the full slice of the calorimeter chain, we had to coordinate the development and often production-level tests, which often delayed the development efforts. The development of the Local-Level-1 (LL1) board has progressed, and fully assembled boards have been received. Drawings and designs for the new power distribution system are under development to provide the required power in a managed way (UPS and normal power).

Testing of the 2nd prototype of the MBD electronics has progressed well. The new time-calibration system using the controlled test pulse delays allow us to get timing calibration data over ~30 ns in 160 ps steps, giving us decent calibration data on non-linearity's in the system. We are now demonstrating sub-30 ps resolution capabilities, which will easily beat the 120 ps timing requirement in the trigger.

WBS 1.1 Project Management (L2 Manager: Irina Sourikova)

Current Status:

- SPI is 0.97, CPI is 1.00.

Highlights:

- No PCRs in September.
- EVMS processing complete; schedule contingency remained unchanged and cost performance remained excellent.
- Risk Register updated based on recent progress, risk contingency reduced.
- Cobra and P6 monthly reports uploaded to IPD.
- August variance reports approved.
- A replacement for DAQ/Trigger software engineer was hired.

Plans for the next 2-3 month:

- Finalize a plan to mitigate COVID-19 related delays.
- Continue monthly EVMS process and Change Control.
- Place production orders and monitor procurements.

Issues:

- No issues.

WBS 1.2 Time Projection Chamber (L2 Manager: Tom Hemmick, SBU)

Current Status:

GEM factories all have initial GEMs in hand and have begun framing. Results from these framed GEMs will be validated well in time for production that begins following the first major GEM shipment scheduled for November.

All striped circuit cards are applied to the inner field cage. Newly written software was used to take microscope pictures at ~1400 independent locations verifying the "as built" alignment is significantly better than required.

Now that all SAMPA chips are now fully delivered QA inspection at Lund is just ongoing. The first FEE card was populated at BNL instrumentation for testing and validation.

Orders are under way for the gas, cooling, and laser systems. The philosophy follows an "order at least one of every part" for all systems so that prototyping is available before full orders are placed.

Plans for the next 2-3 Months

The field cage will be assembled in the coming few months. Production-level GEMs are anticipated to arrive starting in November.

Issues:

None

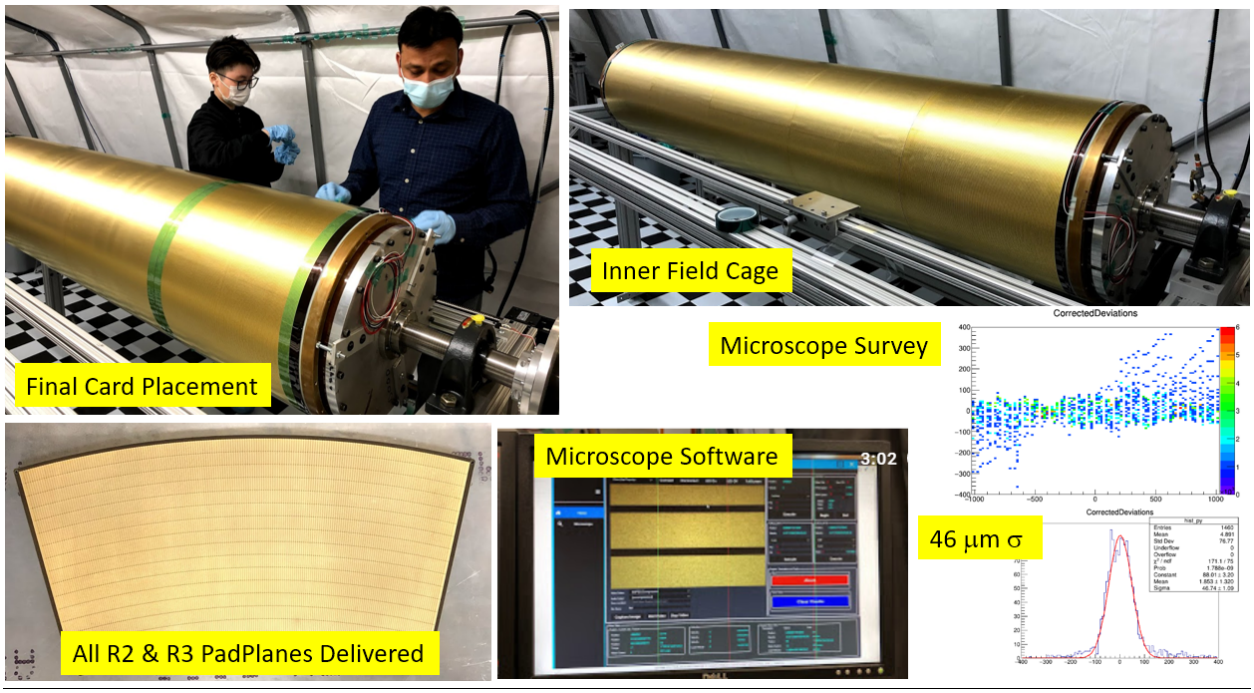


Figure 1. Clockwise from upper left: Final card placement on Inner Field Cage. Completed Inner Field Cage at SBU. Microscope survey results of Inner Field Cage alignment. Computer output of Inner Field Cage survey. Sample of R2/R3 Pad Plane delivered at SBU.

WBS 1.3 Electromagnetic Calorimeter (L2 Manager: Craig Woody, BNL)

Current Status:

Block production at UIUC continued. Progress on producing blocks for Sectors 1-12 through the end of September is shown in Figure 2. Eight complete sectors worth of blocks have now been shipped to BNL and work is continuing on producing more complete sets of blocks for Sectors 9-12. The negative bars to the left indicate blocks that failed at various stages of production as well as the monitoring blocks that are used as references for each block type. Current production losses are at a rate of ~ 11%, which represents an improvement from ~ 14% compared with last month. Fiber filling for Sectors 13-64 also continued and ~ 54% of these fiber assemblies have now been completed.

Figure 3 shows the rate of block production for Sectors 1-12 (light green) and Sectors 13-64 (dark green), which has just started. The number of failed blocks for Sectors 1-12 is indicated in brown. Over the past several weeks, the average rate has been ~ 48 blocks per week, but it has also reached the full-scale production rate of 60 blocks per week during week 36. This is very encouraging for being able to reach this number by the time full-scale production begins for Sectors 13-64.

The batch of W powder from the last delivery that was found to have a very high tap density was reprocessed by Starck and returned to UIUC. The reprocessed powder was found to have a tap density that is consistent with all the other batches (~ 10.5 g/cm^3) and sample blocks made with this powder

potted well and turned out fine. Further studies will be done but it seems that the reprocessed powder is now useable along with the rest of the powder.

The first set of 24 high rapidity blocks from Fudan were received and tested at UIUC. All of them passed all of our standard QA procedures but three had some minor physical damage to their corners, which appears to have occurred during shipping. We've discussed this problem with Fudan and they are now taking steps to protect future shipments of blocks from this happening again. These 24 blocks will now be sent to BNL where they will also be inspected, and if they again look acceptable, we plan to install them in one of the remaining preproduction sectors. Fudan also has ~ 30 more blocks that are ready for machining, and when they are ready, they plan to ship those blocks directly to BNL. More students have also been employed for fiber filling which is proceeding well.

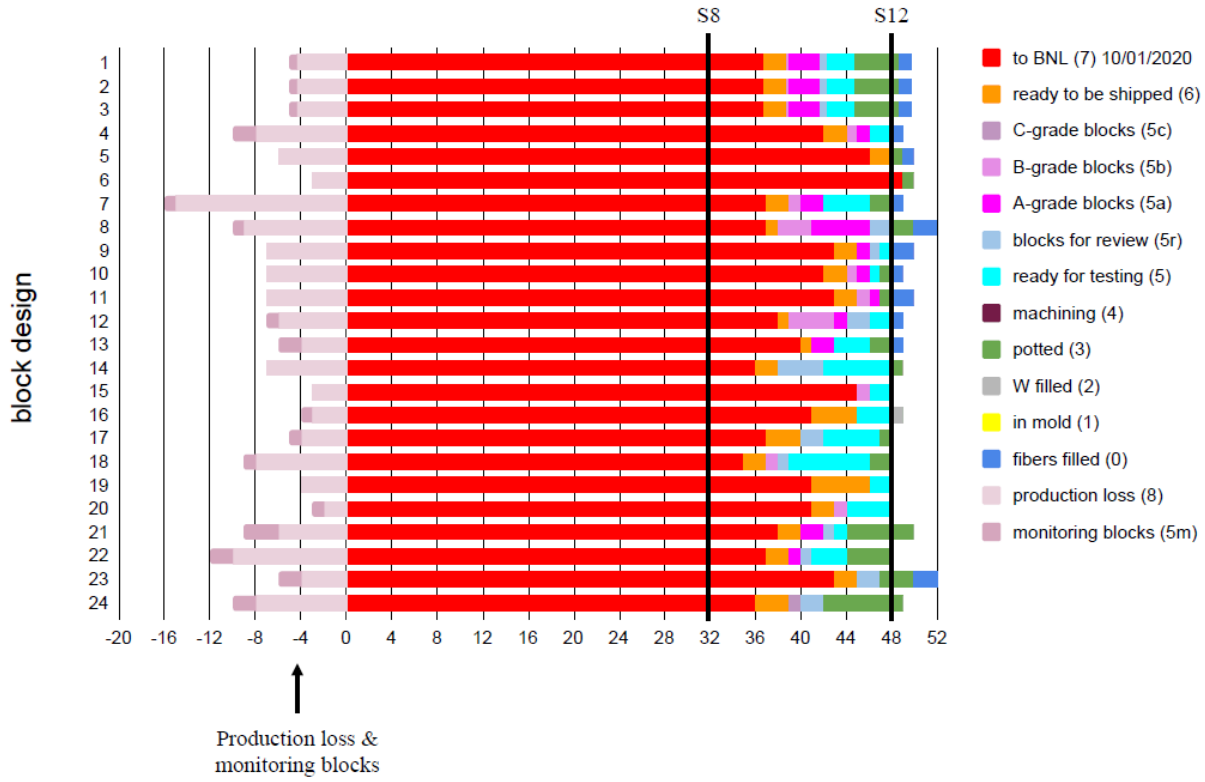


Figure 2. Progress on block production at UIUC as of the end of September. Eight complete sectors worth of blocks for Sectors 1-12 have been delivered to BNL along with additional blocks of various block types.

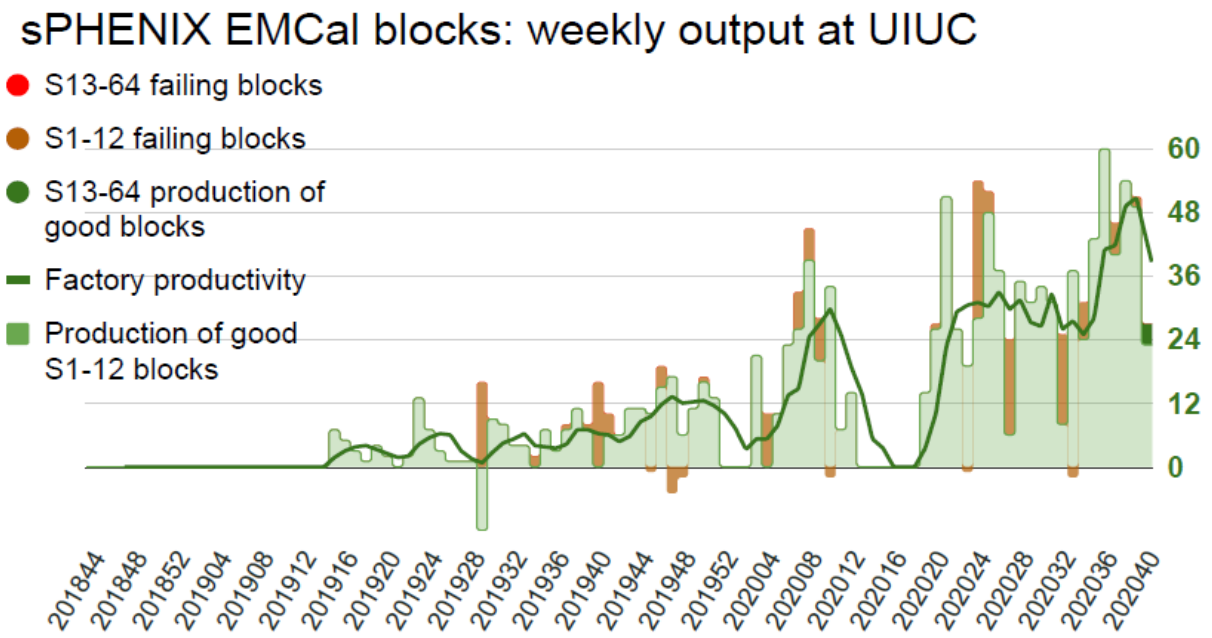


Figure 3. Rate of block production for Sectors 1-12 (light green) and Sectors 13-64 (dark green). The number of failed blocks for Sectors 1-12 is indicated in brown.

Work on module production and sector assembly also continued at BNL. Figure 4 shows the status of module production as of Sept 18. We have now received enough blocks for 8 complete sectors and more of various block types for additional sectors. All of the modules for Sector 6 are complete and we are currently in the process of installing the light guides and SiPM daughter cards on the blocks for Sector 7. We currently have enough light guides for Sectors 7,8 and 9 and we believe the vendor (NN, Inc.) has overcome its problem with what they thought was a QA issue (but which turned out to be not as bad as they thought) and have now resumed production of more light guides. We are therefore expecting that the delivery of the light guides will soon be back on track and allow us to maintain our production schedule.

Figure 5 shows the status of sector assembly as of Sept 18. Five sectors have now been assembled and tested and 100% of the LEDs and test pulses were shown to be working. However, we also plan to do additional testing with these as well as future sectors in order to complete their QA procedures. More cooling loops are being made at Stony Brook for Sectors 1-12 and more mechanical parts have been arriving for Sectors 13-64.

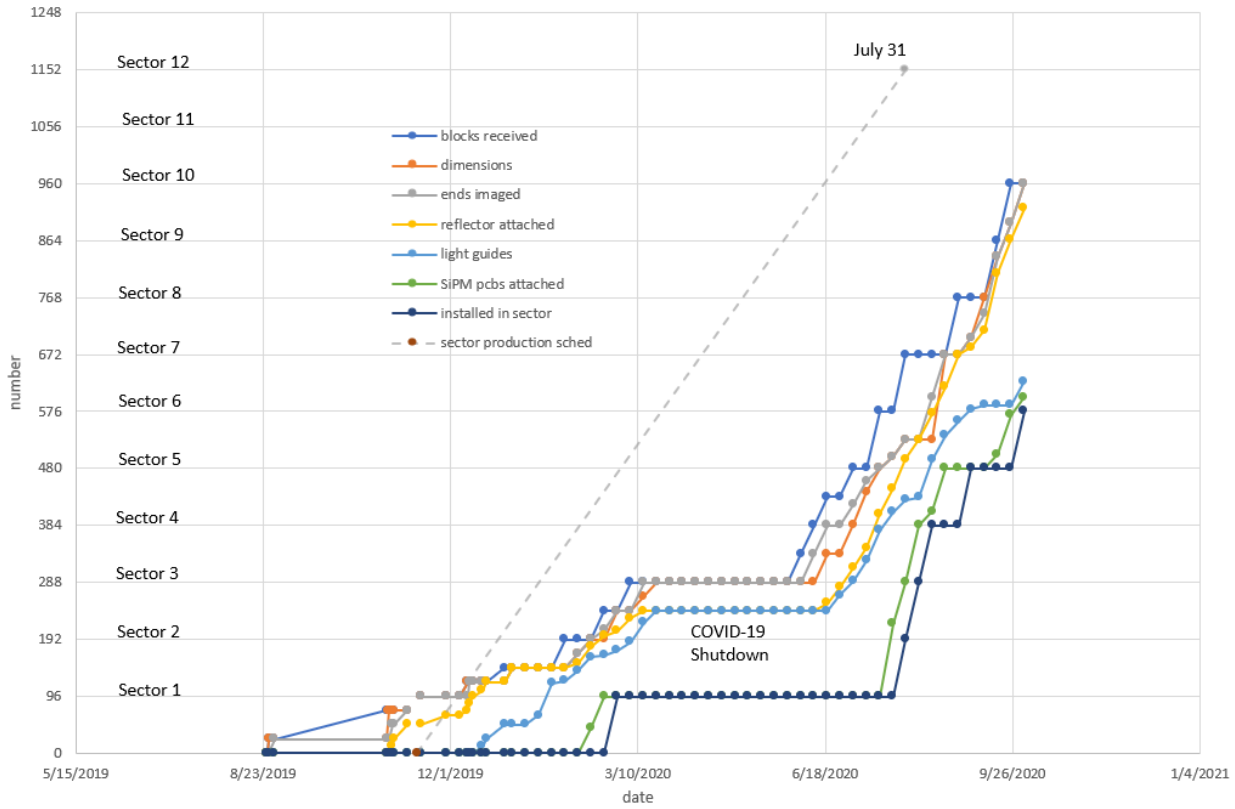


Figure 4. Progress on module production at BNL as of September 18.

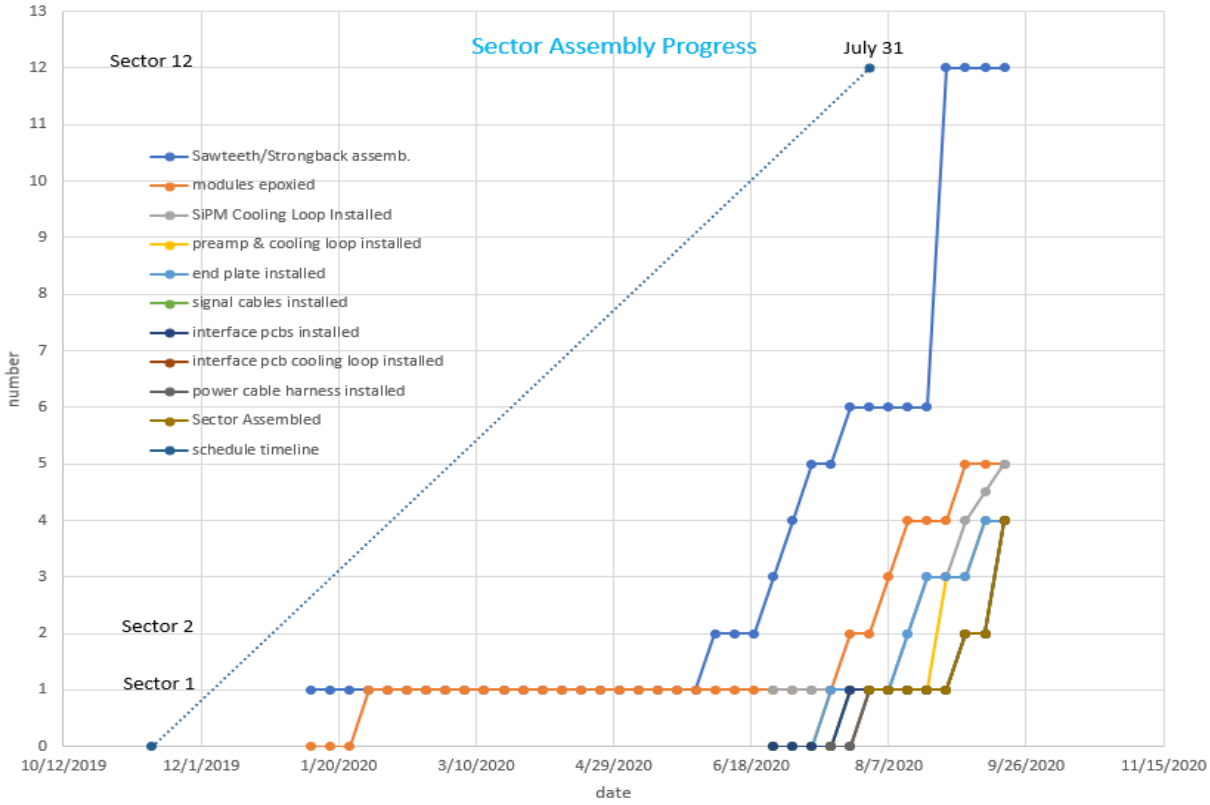


Figure 5. Progress on sector assembly at BNL as of September 18.

Work For the Next 2-3 Months:

The production of all the remaining blocks for Sectors 1-12 should be completed and the blocks delivered to BNL by the middle to end of October. Production of blocks for Sectors 13-64 will then begin at UIUC and fiber filling for Sectors 13-64 will continue. UIUC will also ship the first set of 24 high rapidity blocks to BNL, and if they pass inspection, they will be installed in one of the first 12 sectors. Additional blocks from Fudan will be sent directly to BNL.

Work will continue on module production and sector assembly at BNL. We will continue receiving more blocks from UIUC and Fudan, inspecting them and entering them into our data base, and installing reflectors, light guides and SiPM daughter cards onto the modules for Sectors 7, 8 and 9. We hope that additional light guide deliveries will resume soon and that we will have enough light guides to continue making modules for Sectors 9-12. We expect to glue the modules into Sector 6 in early October and begin further assembly of that sector. Completed sectors will be tested with the LEDs and test pulses but additional testing must wait until we have additional technicians. We do not currently have enough technicians to carry out more than one or two of these operations at any given time, which will slow down the production by preventing a fully parallel assembly line. The rate of testing of additional sectors will slow until additional student, postdoc or scientist help is identified.

Issues:

Our biggest concern is insufficient labor to carry out all of the tasks and various operations that are required to make modules, and assemble and test sectors in a fully parallel effort. Our RLS calls for 4 FTEs working full time on production and assembly, but through September we had at most 3 FTEs working on these tasks, along with the help of some of senior techs (who have many other duties). One tech working in the factory will be need for CAD shutdown work starting in October. In addition, vacation time of other techs will reduce available factory labor further. However, we have approval to hire two additional entry-level techs that would be assigned full time to production and assembly. As of the end of September, we have not heard when the additional techs will be available to start work (Editors note: the interview process for the hiring of additional techs is advanced as of Oct 26 and we expect to have two additional techs available to the EMCal factory by early November). Additional sector testing is also awaiting the availability of additional manpower in the form of collaborator graduate students, postdocs or scientists.

WBS 1.4 Hadronic Calorimeter (L2 Manager: John Lajoie, Iowa State University)

WBS 1.4.1 Inner Hadronic Calorimeter

Current Status:

The iHCAL design has been updated to include a cooling tube with "fingers" for individual preamps and a radiator assembly in the electronics bays. This will remove the heat generated by the iHCAL and prevent excessive temperature next to the solenoid cryostat.

Work is underway to place the contract between BNL and Iowa State University (ISU) for the iHCAL mechanical parts. ISU and Rutgers will place the orders for the iHCAL sector parts and manage their production. The end ring supports will be procured through BNL.

Work for the Next 2-3 Months:

Contracts should be in place to procure the iHCAL sectors in the next 4-6 weeks. After the ISU contract is in place and RFQ will be released and a vendor selected.

Issues:

The COVID-19 pandemic can potentially have a negative schedule impact on the inner HCAL assembly schedule due to the availability of student labor. More will be known when we have a sector production schedule from the manufacturer.

WBS 1.4.2/3/4 Outer Hadronic Calorimeter

Current Status:

GSU has tested >95% of the total number of scintillating tiles required for the outer HCAL, with only 1.3% failing performance testing. A last shipment of the remaining ~350 tiles is expected by the end of November. Shipments of tested tiles have been sent to BNL on a weekly basis; 93% of the tiles required for the oHCAL have been shipped to BNL.

Factory operations at BNL are continuing with technician labor and collaborator support from the NY metropolitan area. The first five pre-production sectors have been fully assembled, tested and moved to storage. One pre-production module remains to be completed. Nine production sectors have been moved into the assembly area for tile and electronics and cabling installation. At the present time the limiting factor in sector assembly is the availability of signal cables and tested preamps. Cables from the technicians at NSLS-II are expected in the next few weeks, and preamp testing has made recent breakthroughs in the operation of the test stand. The L3 manager for sector assembly (Stefan Bathe) is soliciting additional collaboration labor for the end of 2020 and early 2021 to keep sector assembly on schedule.

The high-strength endplates, pucks, and pins are expected before December, 2020. The vendor is on track to deliver as scheduled.

Work for the Next 2-3 Months:

Over the next six months work on the outer HCAL will center on production sector assemblies in the HCAL factory will continue.

Issues:

We continue to be optimistic that we will be able to supplement oHCAL factory labor with graduate students and postdocs from beyond the NY state area in late fall 2020 or early 2021.

Figure 6: The 912 factory oHCAL storage area showing the first five fully completed pre-production sectors.

WBS 1.5 Calorimeter Electronics (L2 Manager: Eric Mannel, BNL)

Current Status:

Testing of the EMCal SiPM daughter boards continues with a failure rate of less them 1%. The Lehigh group completed testing and pre-assembly of the Preproduction EMCal preamps, with a yield of >98%. The production the HCal and EMCal Interface boards for the production sectors is in progress, with projected delivery dates of mid-October for the HCal Interface boards and mid-December for the EMCal Interface boards. HCal LED drive boards were delivered from the assembly house mid-October. Installation of the light cans and testing of the boards has started and will continue through November. The contract for the EMCal preamps for the production sectors is currently being worked on by PPM. Bids for the boards have been received and are less than the initial estimate. The order will be placed in October. The order for the LV bulk supplies was submitted to PPM the first week of September. A number of the cables are being done in-house, taking advantage of the expertise of technicians assigned to NSLS-II, with the balance being sent out to a local vendor

Assembly of the XMIT boards for 7-Crate production has started. A partial delivery was received in late September with the balance of the boards to be delivered in mid-October. The Digitizer boards for the 7-Crate production have gone through their initial power up tests with 100% yield. The Colorado group has agreed to take on the responsibility for the full performance testing of the boards, and fabrication and installation of front panels. The contract for the full production of the digitizer system is being prepared and will be awarded in October.

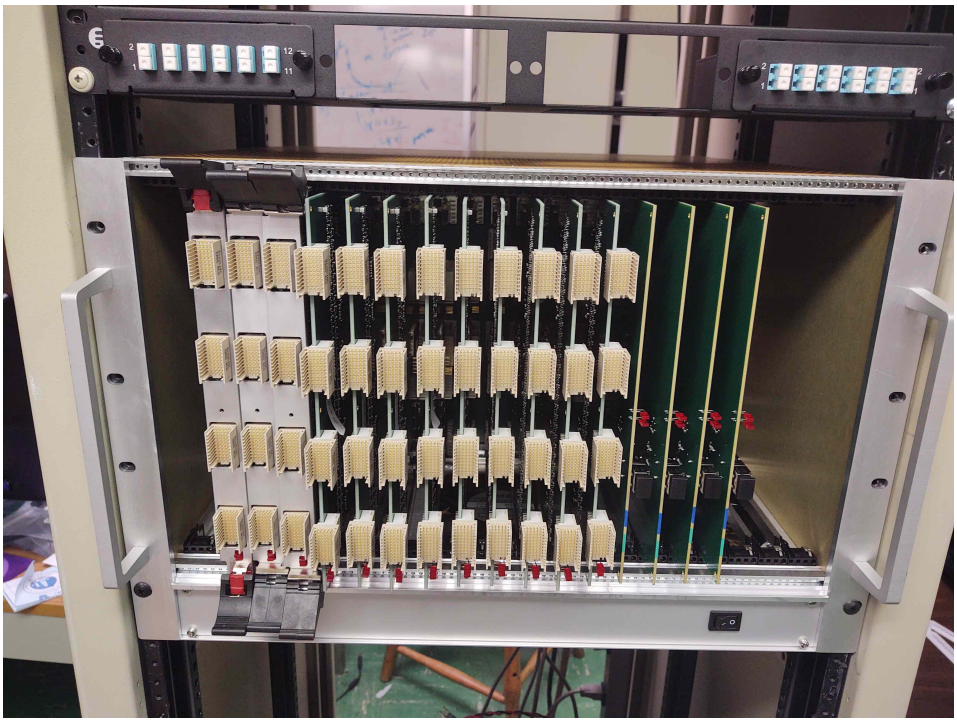


Figure **7**: First Preproduction crate with Preproduction Digitizer and XMIT boards. The boards are waiting for installation of front panels and performance testing.

Work for the next 2-3 months:

Work over the next 3 months will be focused on the continued testing of preproduction sectors and procurement of production electronics. This work includes:

1. Start assembly of cable assemblies for the remaining 26 HCal modules
2. Test EMCal SiPM boards, HCal Preamps, and HCal LED Driver board.
3. Start testing of EMCal Sector 2 and HCal Module 2-6.
4. System chain test of the Digitizer ½-Crate system at BNL
5. Work with the Integration and Installation group to finalize cable lengths and rack design
6. Place orders for external cables.
7. Production of low voltage systems.

Issues:

- COVID-19 travel and work restrictions will impact the short-term schedule for testing of delivered electronics.

WBS 1.6 DAQ/Trigger (L2 Manager: Martin Purschke, BNL)

Current Status:

After the DAQ "Procurement Readiness Review" was passed, purchase orders 20 PCs were placed, in addition to a "first article" file server that we call "buffer box". The role of he latter is the interim storage of data at the experimental site to level the variable data rates, and a steady stream of data can be sent to the computing center for storage.

The network setup in the experimental building has been re-made from scratch, with all legacy names and IP addresses removed for a clean and organized start. At the same time, we have reserved enough address space for the needs of the on-carriage devices in the interaction region, such as crate controllers, bias control, and high voltage controls.

After the arrival of more hardware from our collaborators from Nevis Laboratories, it was possible to set up a small data acquisition system that is a full "slice" of a calorimeter-type readout chain that is used for testing and development of the DAQ components. In this way it is possible not to disturb the other DAQ system in the Physics Department High-Bay, which is in use to test and characterize newly assembled sectors of the EMCal. Before we had to coordinate the development and often production-level tests, which often delayed the development efforts. We have resurrected an older small prototype of the electromagnetic calorimeter to test the readout with realistic calorimeter signals; the old prototype is simply used as a source of such signals with either LEDs or cosmics.

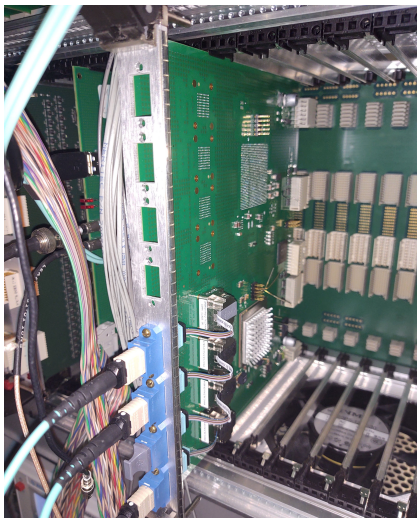


Figure 8: A picture of a half-assembled Local-level-1 (LL1) board. Initially, only one half of the board was assembled in order not to waste an expensive FPGA in case the first-article PCB had problems.

The development of the Local-level-1 (LL1) board has progressed, and fully assembled boards have been received. Tests are meanwhile progressing with the earlier half-assembled board shown in Fig.8. The board has two identical halves, and initially only one half was assembled in order not to waste an expensive FPGA in case the first-article PCB had problems (which was not the case).

Work to clear out the old PHENIX racks in the experimental building 1008 is ongoing. Drawings and designs for the new power distribution system are under development to provide the required power in a managed way (UPS and normal power).

Work for the next 2-3 months:

We will continue the work in 1008 on the new setup. Work on the Global Level-1 Trigger system and the Timing system is continuing . As soon as hardware is available, we will augment the calorimeter-type DAQ readout slice with another, FELIX card-based one for the development of the whole variety of readout hardware.

Issues :

None

WBS 1.7 Minimum Bias Trigger Detector (L2 Manager: Mickey Chiu, BNL)

Current Status:

Testing of the 2nd prototype of the MBD electronics has been going well. The new timing-calibration system using the controlled test pulse delays allow us to get timing calibration data over ~30 ns in 160 ps steps, giving us decent calibration data on non-linearities in the system. We are now demonstrating sub-30 ps resolution capabilities, which will easily beat the 120 ps timing requirement in the trigger. We found one relatively minor issue, which is a baseline shift with rate. Since we digitize the full waveform every event, we can digitally subtract the baseline event by event, largely removing this effect. However, at around 100 kHz, there is a 0.3% systematic decrease in the amplitude of pulses. This should be correctable from the data, but we are exploring ways to tune the electronics and/or software extraction algorithms to remove this effect.

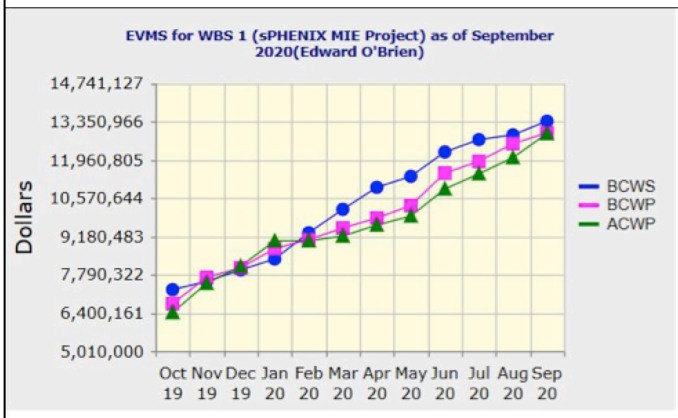
Work for Next 2-3 Months:

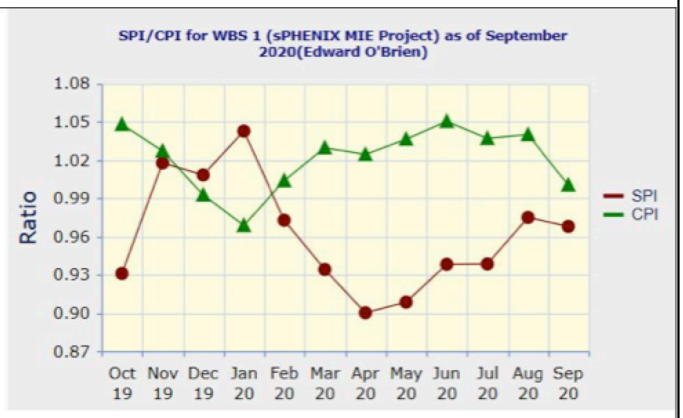
We have a few more tests to do, such as reading out multiple boards and checking the performance across more than one board. This requires firmware changes so it will likely be done around the end of October. After that last set of tests, we will start planning for the final Production Readiness Review. A BNL scientist continues to meet weekly with grad students from Howard and Florida A&M Univ to train them on the MBD and the skill set required for testing and eventually for operating it.

Issues:

None.

SPI and CPI Trends





BAC: $22,198,743 **EAC:** $23,303,428 **VAC:** ($1,104,685)

Cumulative SPI	Cumulative CPI
0.97	1.00

Cumulative BCWS (Scheduled)	$13,357,837
Cumulative BCWP (Performed)	$12,931,617
Cumulative ACWP (Actual)	$12,909,861

DOE SPI or CPI Value Thresholds
- 0.90 to 1.15
- 0.85 to 0.89 or 1.16 to 1.25
- <0.85 or >1.25

September 2020 Cost Performance Report

8. PERFORMANCE DATA

CA (3)	CUMULATIVE TO DATE					AT COMPLETION				
	BUDGETED COST		ACTUAL	VARIANCE		BUDGETED	ESTIMATED	VARIANCE		
ITEM	WORK SCHEDULED	WORK PERFORMED	COST WORK PERFORMED	SCHEDULE	COST					
(1)	(7)	(8)	(9)	(10)	(11)	(14)	(15)	(16)	SPI	CPI
1.01A Project Management	1,762,844	1,762,844	1,609,770	0	153,073	1,951,679	1,798,605	153,073	1.00	1.10
1.02A TPC	2,410,939	1,990,460	1,800,052	-420,479	190,408	4,180,135	4,000,063	180,072	0.83	1.11
1.03A EMCal	3,965,068	3,764,346	4,205,679	-200,722	-441,333	5,255,094	6,003,975	-748,881	0.95	0.90
1.04A HCal	2,486,538	2,390,182	2,477,307	-96,356	-87,125	4,033,110	4,126,410	-93,301	0.96	0.96
1.05A Calorimeter Electronics	2,391,286	2,601,810	2,476,341	210,523	125,469	5,363,466	6,039,995	-676,528	1.09	1.05
1.06A DAQ & Trigger	242,014	322,827	261,786	80,813	61,041	1,245,090	1,184,433	60,658	1.33	1.23
1.07A MinBias Trigger Detector	99,148	99,148	78,926	0	20,221	170,170	149,948	20,221	1.00	1.26
b. COST OF MONEY	0	0	0	0	0	0	0	0		
c. GENERAL AND ADMINISTRATIV	0	0	0	0	0	0	0	0		
d. UNDISTRIBUTED BUDGET						0	0	0		
e. SUBTOTAL	13,357,837	12,931,617	12,909,861	-426,220	21,755	22,198,743	23,303,428	-1,104,685	0.97	1.00
f. Contingency						4,801,257				
g. TOTAL	13,357,837	12,931,617	12,909,861	-426,220	21,755	27,000,000				
9. RECONCILIATION TO CONTRACT BUDGET BASELINE										
a. VARIANCE ADJUSTMENT				0	0					
b. TOTAL CONTRACT VARIANCE				-426,220	21,755	0	0	0		

CLASSIFICATION (When Filled In)

$10,393,567	ETC
$9,267,127	BCWR
46.19%	% Contingency on ETC
51.81%	% Contingency on Remaining Work
60.17%	% Planned
58.25%	% Complete
58.16%	% Spent

DOE SPI or CPI Value Thresholds
- 0.90 to 1.15
- 0.85 to 0.89 or 1.16 to 1.25
- <0.85 or >1.2

*Highlights in table above takes variance $ into consideration, not just Indices

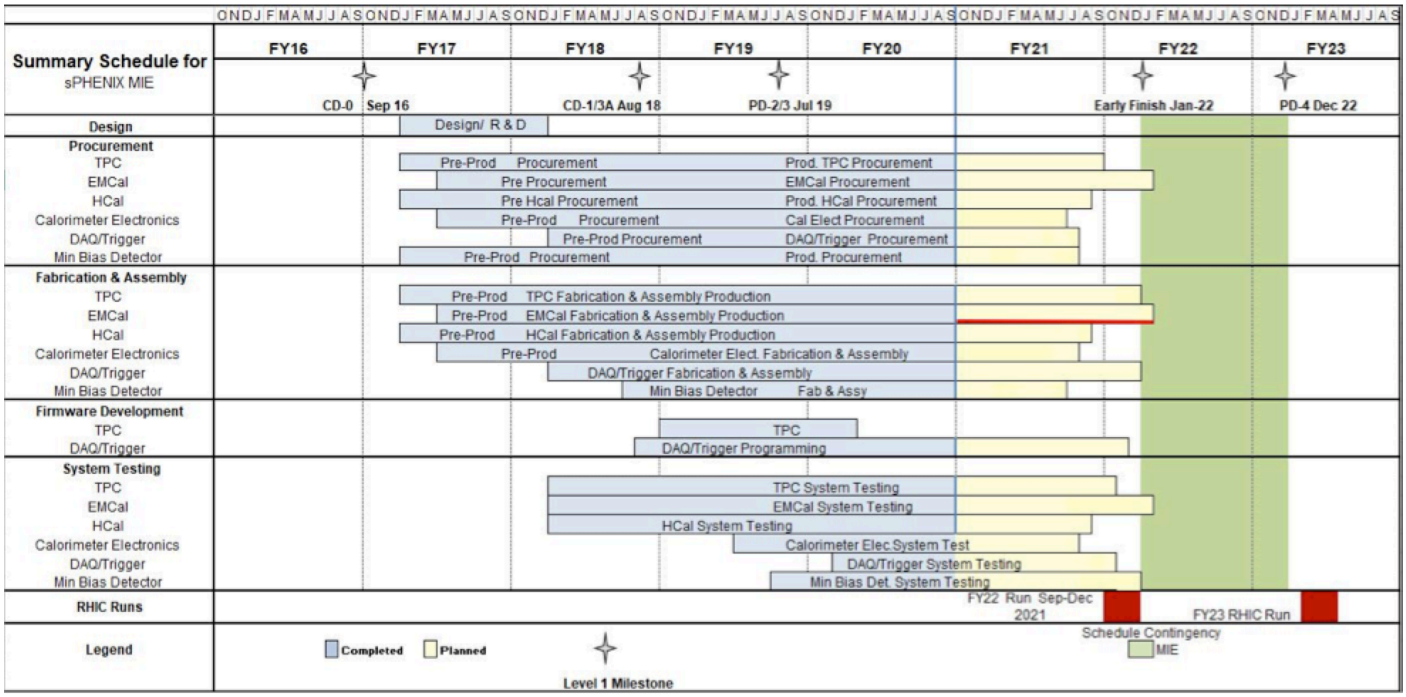
L1 & L2 Milestones

#	WBS	Milestone Name	Target Milestone Date	Forecast	Actual Finish	Variance (in work days)
1	01.01.01	Approve Project Baseline and Construction PD2/3	30-Sep-19	20-Sep-19 A	20-Sep-19	6
2	01.02.02.02	Production Readiness Review - TPC Module Factories	31-Dec-19	17-Dec-19 A	17-Dec-19	8
3	01.03.02.03.02	EMCal Preproduction Sector 0 Assembled	31-Dec-19	25-Nov-19 A	25-Nov-19	23
4	01.02.06.02	Production Readiness Review - TPC DAM	28-Feb-20	04-Feb-20 A	4-Feb-20	16
5	01.05.02.03	HCal Preproduction FEE Complete	30-Apr-20	22-Jan-20 A	22-Jan-20	70
6	01.05.02.01	EMCal Electronics Preproduction Complete	29-May-20	28-May-20 A	28-May-20	0
7	01.03.01.03.01	EMCal W Powder Acquisition Complete	30-Jun-20	15-Jun-20 A	15-Jun-20	11
8	01.03.02.03.03	EMCal Production Readiness Review Blocks/Modules/Sectors Complete	31-Jul-20	30-Jul-20 A	30-Jul-20	1
9	01.02.05.03	SAMPA ASIC Performance Accepted	30-Sep-20	29-May-20 A	29-May-20	86
10	01.05.01	EMCal/HCal SiPM Sensor Procurement Complete	30-Oct-20	28-Feb-20 A	28-Feb-20	171
11	01.05.02.04	HCal SiPM Boards Assembly Complete	30-Nov-20	22-Sep-20 A	22-Sep-20	45
12	01.02.06.03	TPC DAM Felix 2.0 Production Complete	29-Jan-21	13-Aug-21		-138
13	01.06.02.03	Trigger LL1 Preproduction complete	26-Feb-21	16-Mar-21		-13
14	01.05.02.02	EMCal SiPM Boards Production Complete	31-Mar-21	6-Jan-21		57
15	01.04.04.02	First Outer HCAL Sector and Splice Plates Ready to Install	30-Apr-21	14-Dec-20		94
16	01.04.01	Inner HCAL Support Structure Ready for Installation	30-Apr-21	30-Jun-21		-43
17	01.02.01.06	GEM Production Complete	31-May-21	15-Mar-21		54
18	01.03.01.03.01	EMCal Scintillating Fiber Acquisition Complete	31-May-21	3-Mar-21		62
19	01.06.01.03	DAQ Production: DAQ Ready for Operation	31-May-21	16-Nov-21		-117
20	01.05.02.04	HCal Electronics Complete: Production	30-Jun-21	8-Feb-21		99
21	01.02.05.04	TPC FEE Production Complete	30-Jul-21	6-Aug-21		-6
22	01.05.03.02	Calorimeter Electronics Complete	30-Jul-21	15-Jun-21		31
23	01.05.02.02	EMCal Electronics Complete	30-Jul-21	15-Jun-21		31
24	1.07	MinBias Detector Ready to Install	30-Sep-21	17-Dec-21		-53
25	01.06.03.03	GL1 Ready to Operate	30-Sep-21	3-Jan-22		-62
26	01.01.01	Early Project Completion	29-Oct-21	7-Jan-22		-45
27	01.02.01.08	TPC Ready to Install (Assembly Complete)	29-Oct-21	19-Nov-21		-15
28	01.02.06.03	TPC DAM Production Complete	29-Oct-21	27-Dec-21		-38
29	01.03.02.03.03	EMCal Ready to Install	29-Oct-21	6-Jan-22		-45
30	01.04.04.02	Last Outer HCAL Sector Ready to Install	29-Oct-21	28-Jul-21		64
31	01.06.02.04	LL1 Trigger Production Complete	29-Oct-21	5-Oct-21		16
32	01.06.02.04	LL1 Ready to Operate	29-Oct-21	5-Oct-21		16
33	01.01.01	Approve Project Closeout PD-4	30-Dec-22	29-Dec-22*		0

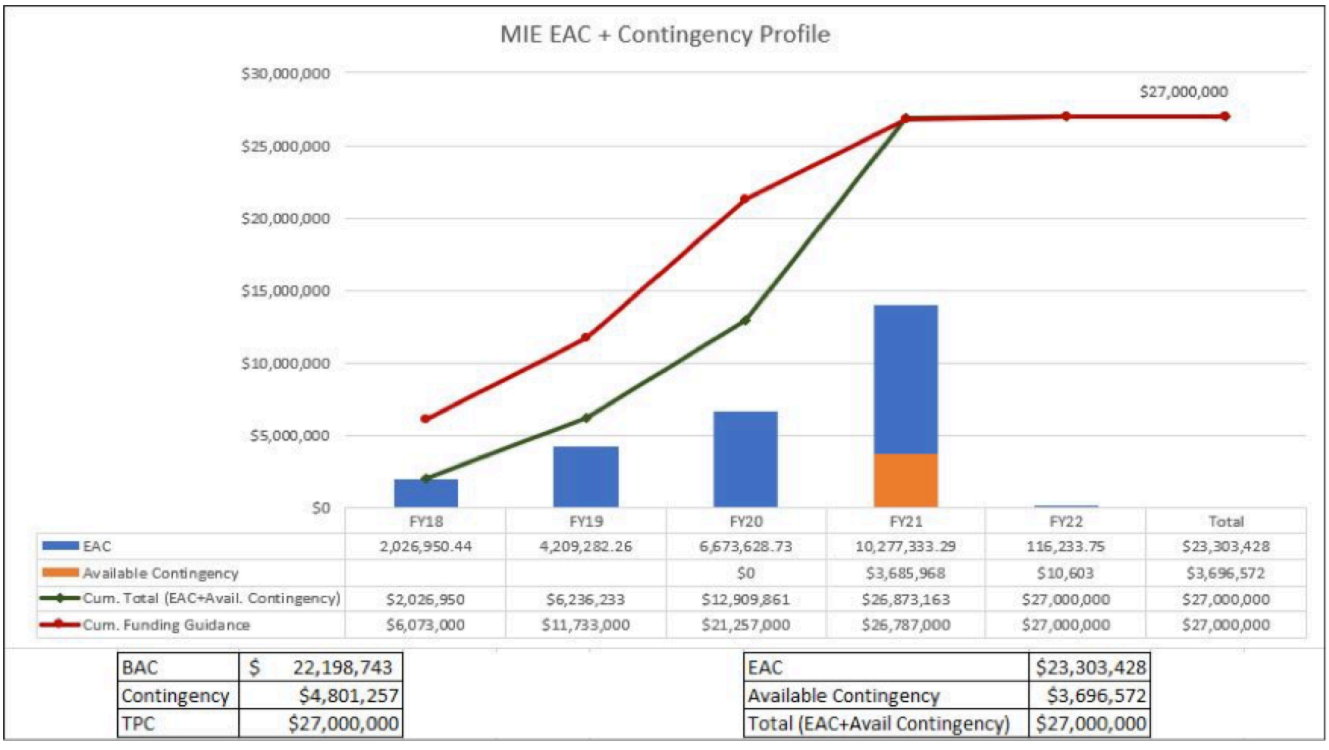
sPHENIX Budget Profile:

Funding Profile At Year k$								
	Prior Yrs	FY17	FY18	FY19	FY20	FY21	FY22	Total
R&D		1,513	4,260	350				**6,123**
CDR		100	200					**300**
PED								
Pre-ops								
OPC (R&D+CDR)		**1,613**	**4,460**	**350**				**6,423**
TEC				**5,310**	**9,524**	**5,530**	**213**	**20,577**
Total Project Cost		**1,613**	**4,460**	**5,660**	**9,524**	**5,530**	**213**	**27,000**

Summary Schedule with critical path



Estimate at Completion Profile



	FY18	FY19	FY20	FY21	FY22	Total
EAC	2,026,950.44	4,209,282.26	6,673,628.73	10,277,333.29	116,233.75	$23,303,428
Available Contingency			$0	$3,685,968	$10,603	$3,696,572
Cum. Total (EAC+Avail. Contingency)	$2,026,950	$6,236,233	$12,909,861	$26,873,163	$27,000,000	$27,000,000
Cum. Funding Guidance	$6,073,000	$11,733,000	$21,257,000	$26,787,000	$27,000,000	$27,000,000

BAC	$ 22,198,743
Contingency	$4,801,257
TPC	$27,000,000

EAC	$23,303,428
Available Contingency	$3,696,572
Total (EAC+Avail Contingency)	$27,000,000

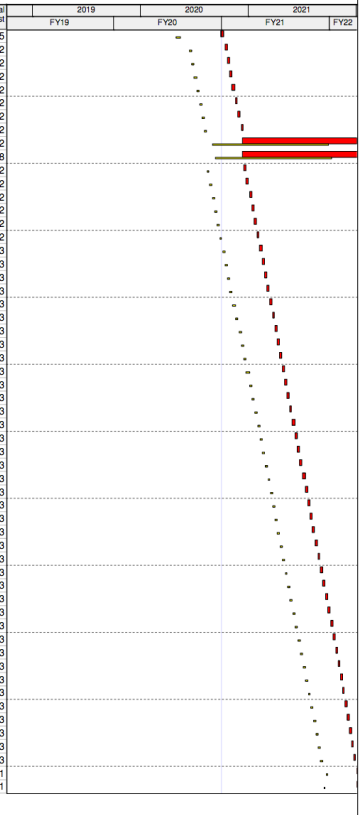
Baseline/Contingency Log

Baseline/Contingency Log - sPHENIX MIE Project							
Date	**PCR ID**	**PCR Title**	**WBS affected**	**sPHENIX MIE Baseline Cost**	**PCR Change**	**Contingency**	**Total Project Cost**
9/20/2019	Approved MIE	Setting up Baseline	all	$22,169,490		$4,830,510	$27,000,000
9/24/2019	007A	Hcal Scin Tiles placed Contract delivery schedule	1.04 HCal	$22,132,844	($36,646)	$4,867,156	$27,000,000
1/31/2020	008A	OHCal Sci.Tiles delivery schedule update	1.04 HCal	$22,132,943	$100	$4,867,056	$27,000,000
2/27/2020	009A	Extending the lead time for IHCal Support Rings	1.04 HCal	$22,132,943	$0	$4,867,056	$27,000,000
3/31/2020	011A	Added management labor for EMCal block production. EMCal Powder and TPC Sampa Cost and Delivery Schedule update	1.02 TPC and 1.03 EMCal	$22,193,813	$60,870	$4,806,187	$27,000,000
4/28/2020	013A	EMCal Block assembly contract details schedule update	1.03 EMCal	$22,195,549	$ 1,736	$4,804,451	$27,000,000
5/27/2020	014A	EMCal Light guides delivery schedule; EMCal SiPM daughterboards for Sectors 13-64 contract schedule	1.03 EMCal and 1.05 Cal E	$22,176,963	$ (18,586)	$4,823,037	$27,000,000
6/19/2020	015A	COVID-19 Schedule Adjustment	all	$22,198,743	$ 21,780.00	$4,801,257	$27,000,000

Critical Path

POM02 sPHENIX WBS 1.x, 2.x September 2020 — IPD - MIE Critical

Activity ID	Activity Name	At Completion Duration	Total Float	Start	Finish	BL Project Start	BL Project Finish	Variance - BL Project Finish Date	Budgeted Labor Units	Budgeted Nonlabor Units	Budgeted Total Cost	BL Project Total Cost
S167000	Fabricate EMCAL Prepro blocks sector 12	10	0	28-Sep-20 A	09-Oct-20	01-May-20	14-May-20	-103	168	0	9,623	9,425
S173000	Fabricate final blocks sector 13	6	0	13-Oct-20	20-Oct-20	15-Jun-20	22-Jun-20	-83	135	0	5,163	5,012
S173100	Fabricate final blocks sector 14	6	0	21-Oct-20	28-Oct-20	23-Jun-20	30-Jun-20	-83	135	0	5,163	5,012
S173200	Fabricate final blocks sector 15	6	0	29-Oct-20	05-Nov-20	01-Jul-20	09-Jul-20	-83	135	0	5,163	5,012
S173300	Fabricate final blocks sector 16	6	0	06-Nov-20	16-Nov-20	10-Jul-20	17-Jul-20	-83	135	0	5,163	5,012
S173400	Fabricate final blocks sector 17	6	0	17-Nov-20	24-Nov-20	20-Jul-20	27-Jul-20	-83	135	0	5,163	5,012
S173500	Fabricate final blocks sector 18	6	0	25-Nov-20	04-Dec-20	28-Jul-20	04-Aug-20	-83	135	0	5,163	5,012
S173600	Fabricate final blocks sector 19	6	0	07-Dec-20	14-Dec-20	05-Aug-20	12-Aug-20	-83	135	0	5,163	5,012
S187700	Install light guides on final blocks M&S	266	0	10-Dec-20	04-Jan-22	02-Sep-20	30-Sep-21	-62	0	1650	1,924	1,912
S188100	Install SiPMs daughterboards on final blocks M&S	266	0	11-Dec-20	05-Jan-22	11-Sep-20	08-Oct-21	-57	0	300	350	348
S173700	Fabricate final blocks sector 20	6	0	15-Dec-20	22-Dec-20	13-Aug-20	20-Aug-20	-83	135	0	5,163	5,012
S173800	Fabricate final blocks sector 21	6	0	23-Dec-20	31-Dec-20	21-Aug-20	28-Aug-20	-83	135	0	5,163	5,012
S173900	Fabricate final blocks sector 22	6	0	04-Jan-21	11-Jan-21	31-Aug-20	08-Sep-20	-83	135	0	5,163	5,012
S174000	Fabricate final blocks sector 23	6	0	12-Jan-21	20-Jan-21	09-Sep-20	16-Sep-20	-83	135	0	5,163	5,012
S174100	Fabricate final blocks sector 24	6	0	21-Jan-21	28-Jan-21	17-Sep-20	24-Sep-20	-83	135	0	5,163	5,012
S174200	Fabricate final blocks sector 25	6	0	29-Jan-21	05-Feb-21	25-Sep-20	02-Oct-20	-83	135	0	5,163	5,062
S174300	Fabricate final blocks sector 26	6	0	08-Feb-21	16-Feb-21	05-Oct-20	13-Oct-20	-83	135	0	5,163	5,163
S174400	Fabricate final blocks sector 27	6	0	17-Feb-21	24-Feb-21	14-Oct-20	21-Oct-20	-83	135	0	5,163	5,163
S174500	Fabricate final blocks sector 28	6	0	25-Feb-21	04-Mar-21	22-Oct-20	29-Oct-20	-83	135	0	5,163	5,163
S174600	Fabricate final blocks sector 29	6	0	05-Mar-21	12-Mar-21	30-Oct-20	06-Nov-20	-83	135	0	5,163	5,163
S174700	Fabricate final blocks sector 30	6	0	15-Mar-21	22-Mar-21	09-Nov-20	17-Nov-20	-83	135	0	5,163	5,163
S174800	Fabricate final blocks sector 31	6	0	23-Mar-21	30-Mar-21	18-Nov-20	25-Nov-20	-83	135	0	5,163	5,163
S174900	Fabricate final blocks sector 32	6	0	31-Mar-21	07-Apr-21	30-Nov-20	07-Dec-20	-83	135	0	5,163	5,163
S175000	Fabricate final blocks sector 33	6	0	08-Apr-21	15-Apr-21	08-Dec-20	15-Dec-20	-83	135	0	5,163	5,163
S175100	Fabricate final blocks sector 34	6	0	16-Apr-21	23-Apr-21	16-Dec-20	23-Dec-20	-83	135	0	5,163	5,163
S175200	Fabricate final blocks sector 35	6	0	26-Apr-21	03-May-21	24-Dec-20	04-Jan-21	-83	135	0	5,163	5,163
S175300	Fabricate final blocks sector 36	6	0	04-May-21	11-May-21	05-Jan-21	12-Jan-21	-83	135	0	5,163	5,163
S175400	Fabricate final blocks sector 37	6	0	12-May-21	19-May-21	13-Jan-21	21-Jan-21	-83	135	0	5,163	5,163
S175500	Fabricate final blocks sector 38	6	0	20-May-21	27-May-21	22-Jan-21	29-Jan-21	-83	135	0	5,163	5,163
S175600	Fabricate final blocks sector 39	6	0	28-May-21	07-Jun-21	01-Feb-21	08-Feb-21	-83	135	0	5,163	5,163
S175700	Fabricate final blocks sector 40	6	0	08-Jun-21	15-Jun-21	09-Feb-21	17-Feb-21	-83	135	0	5,163	5,163
S175800	Fabricate final blocks sector 41	6	0	16-Jun-21	23-Jun-21	18-Feb-21	25-Feb-21	-83	135	0	5,163	5,163
S175900	Fabricate final blocks sector 42	6	0	24-Jun-21	01-Jul-21	26-Feb-21	05-Mar-21	-83	135	0	5,163	5,163
S176000	Fabricate final blocks sector 43	6	0	02-Jul-21	12-Jul-21	08-Mar-21	15-Mar-21	-83	135	0	5,163	5,163
S176100	Fabricate final blocks sector 44	6	0	13-Jul-21	20-Jul-21	16-Mar-21	23-Mar-21	-83	135	0	5,163	5,163
S176200	Fabricate final blocks sector 45	6	0	21-Jul-21	28-Jul-21	24-Mar-21	31-Mar-21	-83	135	0	5,163	5,163
S176300	Fabricate final blocks sector 46	6	0	29-Jul-21	05-Aug-21	01-Apr-21	08-Apr-21	-83	135	0	5,163	5,163
S176400	Fabricate final blocks sector 47	6	0	06-Aug-21	13-Aug-21	09-Apr-21	16-Apr-21	-83	135	0	5,163	5,163
S176500	Fabricate final blocks sector 48	6	0	16-Aug-21	23-Aug-21	19-Apr-21	26-Apr-21	-83	135	0	5,163	5,163
S176600	Fabricate final blocks sector 49	6	0	24-Aug-21	31-Aug-21	27-Apr-21	04-May-21	-83	135	0	5,163	5,163
S176700	Fabricate final blocks sector 50	6	0	01-Sep-21	09-Sep-21	05-May-21	12-May-21	-83	135	0	5,163	5,163
S176800	Fabricate final blocks sector 51	6	0	10-Sep-21	17-Sep-21	13-May-21	20-May-21	-83	135	0	5,163	5,163
S176900	Fabricate final blocks sector 52	6	0	20-Sep-21	27-Sep-21	21-May-21	28-May-21	-83	135	0	5,163	5,163
S177000	Fabricate final blocks sector 53	6	0	28-Sep-21	05-Oct-21	01-Jun-21	08-Jun-21	-83	135	0	5,240	5,163
S177100	Fabricate final blocks sector 54	6	0	06-Oct-21	14-Oct-21	09-Jun-21	16-Jun-21	-83	135	0	5,318	5,163
S177200	Fabricate final blocks sector 55	6	0	15-Oct-21	22-Oct-21	17-Jun-21	24-Jun-21	-83	135	0	5,318	5,163
S177300	Fabricate final blocks sector 56	5	0	25-Oct-21	29-Oct-21	25-Jun-21	02-Jul-21	-82	135	0	5,318	5,163
S177400	Fabricate final blocks sector 57	5	0	01-Nov-21	05-Nov-21	06-Jul-21	13-Jul-21	-81	135	0	5,318	5,163
S177500	Fabricate final blocks sector 58	5	0	08-Nov-21	15-Nov-21	14-Jul-21	21-Jul-21	-80	135	0	5,318	5,163
S177600	Fabricate final blocks sector 59	5	0	16-Nov-21	22-Nov-21	22-Jul-21	29-Jul-21	-79	135	0	5,318	5,163
S177700	Fabricate final blocks sector 60	5	0	23-Nov-21	01-Dec-21	30-Jul-21	06-Aug-21	-78	135	0	5,318	5,163
S177800	Fabricate final blocks sector 61	5	0	02-Dec-21	08-Dec-21	09-Aug-21	16-Aug-21	-77	135	0	5,318	5,163
S177900	Fabricate final blocks sector 62	5	0	09-Dec-21	15-Dec-21	17-Aug-21	24-Aug-21	-76	135	0	5,318	5,163
S178000	Fabricate final blocks sector 63	5	0	16-Dec-21	22-Dec-21	25-Aug-21	01-Sep-21	-75	135	0	5,318	5,163
S178100	Fabricate final blocks sector 64	5	0	23-Dec-21	30-Dec-21	02-Sep-21	10-Sep-21	-74	135	0	5,318	5,163
S178900	Pack and ship final blocks for sectors 57-64 to BNL - Purchased Servic	1	0	03-Jan-22	03-Jan-22	21-Sep-21	27-Sep-21	-64	41	0	2,638	2,561
S176010	Pack and ship final blocks for sectors 57-64 to BNL - M&S	1	0	03-Jan-22	03-Jan-22	13-Sep-21	17-Sep-21	-70	0	6480	7,672	7,521



Filtered by: TASK filters: Critical, Fund Source = A-MIE, No OBLG, WBS 1.X but not 1.1.

Page 1 of 1

Variance Analysis

WBS 1.02A **Reporting Period:** 9/1/2020 - 9/30/2020

TPC (Thomas Hemmick [H5685])

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV %	SPI	CPI
Current:	40,480	68,890	63,875	28,410	70%	5,015	7%	1.70	1.08
Cumulative:	2,410,939	1,990,460	1,800,052	-420,479	-17%	190,408	10%	0.83	1.11
	BAC								
At Complete:	4,180,135								

Threshold(s) Exceeded: Cumulative Schedule

Explanation of Variance/Description of Problem:
WBS 1.2.2-4.3 – TPC GEM Modules R1, R2, R3 – Procure TPC Module Parts – The Pad Planes had to be re-bid to a new vendor, causing delay. The R3 & R2 boards are delivered, while R1 is in production. This leads to a -$105K of SV. WBS 1.2.7 TPC Support System - Laser – new conceptual design for laser optics reviewed only in August. Final laser test in magnetic field (Argonne) postponed due to COVID. This leads to -$252K of SV. WBS 1.2.7 TPC Support System – Gas System – Gas system was approved only in an August review. This leads to -$67k of SV. WBS 1.2.7 TPC Support System – Cooling System – Bench test required for validation delayed due to COVID. This leads to -$50k of SV.

Impact:
WBS 1.2.2-4.3 – TPC GEM Modules R1,R2,R3 – Procure TPC Module Parts – impact none. Pad plane has 93 days float. WBS 1.2.7 TPC Support System - Laser impact none. Optics has 190 days float. WBS 1.2.7 TPC Support System – Gas System – Impact none. The system has 82 days float; impact none. WBS 1.2.7 TPC Support System – Cooling System – Impact none. The system has 46 days float; impact none.

Corrective Action:
WBS 1.2.2-4.3 – TPC GEM Modules R1,R2,R3 – Procure TPC Module Parts – New Pad Planes in hand for R3 and R2. R1 design in engineering review. WBS 1.2.7 TPC Support System - Laser – Design concept finalized and reviewed. Parts orders are presently initiated. WBS 1.2.7 TPC Support System – Gas System – First parts now on order. WBS 1.2.7 TPC Support System – Cooling System – Tests successful after partial lab opening. Orders initiated.

Prepared By:	**Date:**	**Approved By:**	**Date:**
Thomas Hemmick [H5685]	10/27/2020	Edward O'Brien [18368]	10/27/2020