sPHENIX Project Status Report – August 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 August 31, 2020**

Current PD:	**2/3**	Date of Current CD/PD approval		September 2019	
Next PD:	**4**	Forecast approval:	**1QFY23**	Baseline:	**1QFY23**
% Complete:	**56.5%**	Planned:		**57.9%**	
ETC:	**$11.0M**	TPC or Cost Range:		**$27.0M**	
Contingency:	**43.6%** on ETC	Float to PD-4 in months:		**11.5**	
Cumulative CPI:	**1.04**	Cumulative SPI:		**0.98**	

2. **NEAR TERM MILESTONES**

The sPHENIX Project team will continue the monthly EVMS process, Change Control, and the monthly updating of the ETC. We will continue to place orders for parts 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. Production-level GEMs are anticipated to arrive at SBU from various university facilities starting in November. Tests of the production SAMPA v5 chips will continue at Lund. Preproduction TPC FEE boards will start to arrive at BNL. Test of the preproduction TPC DAM boards will be completed. Orders for the production TPC Fee and TPC DAM boards will be placed.

Progress on block production for EMCal Sectors 1-12 and fiber filling for Sectors 13-64 will continue at UIUC. We expect all of the Sector 1-12 blocks to be completed and delivered to BNL by mid October. Production of blocks for Sectors 13-64 will then begin. BNL will continue on module production and sector assembly at BNL. We will complete the first 12 preproduction sectors by the end of the year.

Over the next six months work on the outer HCAL will center on production sector assembly in the HCAL factory. The current working plan is to complete the first five sectors, which will then be moved to storage and five new sectors moved into the factory for assembly. Tile testing will continue at GSU at GSU, with the last shipment of OHCAL tiles expected at BNL in November. Documentation required for the procurement process for the sectors and end ring is being prepared, and contracts should be in place to procure the IHCAL sectors in the next month or so.

Work on the calorimeter electronics over the next 3 months will be focused on the continued testing of preproduction sectors and procurement of production electronics. Work will include placing orders for remaining EMCal production electronics, start the assembly of cables for the remaining 26 HCal modules, testing the remaining EMCal SiPM boards, testing of the preproduction Calorimeter digitizer modules, and work with the Integration and Installation group to finalize cable lengths and rack design

The DAQ/Trigger group will continue the work in 1008 to set up DAQ components in the rack room. Work on the Global Level-1 Trigger system and the Timing system will continue. The MBD group will take more test data and evaluate the performance of the new prototype Discriminator/Shaper boards. From these tests, we plan to have the MBD D/S board production readiness review in December.

3. **STATUS HIGHLIGHTS**

Production components for the sPHENIX detector continue to arrive. The early completion date remains unchanged in August after having slipped two and one half months over the previous three months due to the COVID pandemic. The sPHENIX SPI improved to 0.98 in August. sPHENIX met all of its PEMP-related milestones for FY20 on or ahead of schedule. The Project Management team continues to work to address the recommendations from the sPHENIX Annual Review held in July. There were no technical recommendations from the review.

EVMS processing is complete for August. The schedule contingency remains unchanged at 11.5 months and cost performance remained excellent with over 43% contingency remaining on a project that is now 56.5% complete. Cobra and P6 monthly reports have been uploaded to IPD. The August Variance report is approved. There were no PCRs for August.

All SAMPA v5 chips for the TPC electronics were packaged and delivered to Lund University for tasting. TPC R2 pad plane first articles were delivered to SBU and passed inspection. As a result the R2 production contract was released for full production. The R3 pad planes delivery was completed and the boards are under inspection. First article GEMs of all sizes arrived from CERN and passed inspection. These GEMs were then delivered to the university factories. The go-ahead for full GEM foil production was submitted to CERN.

The order for the preproduction TPC FEE cards has been placed. The TPC DAM (FELIX) cards were ordered in sufficient supply to reduce risk to the project. The August reviews for TPC cooling, gas, and laser systems were held and the reports show no surprises. All recommendations matched the plans that we already had in place for all these systems.

EMCal block production at UIUC continued. The rate of block production has essentially reached the production goal of 60 blocks per week and the rate for fiber filling has exceeded the production goal of 31 fiber sets per week. Approximately 75% of the blocks needed for Sectors 1-12 have been produced (which constitutes approximately 18% of the total needed for the entire calorimeter) and 66% have been shipped to BNL. By the end of August there were enough blocks delivered to BNL to build six complete sectors along with additional blocks for two more sectors. All the modules for Sectors 1-5 have been completed at BNL and work is continuing on preparing modules for Sectors 6 and 7. Four sectors have been completed and a fifth sector is ready to have its modules installed. BNL is planning to add technicians to the EMCal sector factory.

Preliminary quotes have been received for the IHCAL sectors and end rings, and 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 rings will be procured through BNL. OHCal Tile testing has continued. GSU has tested 5215 (of 6360 total tiles received, or 82%), with only 61 tiles (1.1%) failing performance testing. If there are no additional delays, GSU will complete the tile testing by the end of November. One OHCal sector is complete at BNL and undergoing cosmic ray tests. Cabling of a second sector is complete, with a third almost complete. An additional seven sectors have been fully loaded with scintillating tiles and are in various stages of being cabled.

Testing of the EMCal SiPM daughter boards continues with boards for another 5 EMCal sectors were tested. Of the 900 boards tested to date, less then 1% of the boards have failed. Board testing will continue through September. The Lehigh group continues preamp testing and pre-assembly for installation into the EMCal sectors with another 150 board assemblies delivered to BNL in August. The first article XMIT board for the 7-Crate production was received at Nevis and successfully tested and passed all QA requirements. All of the 7-Crate ADC boards (84 boards) have been received and work is in progress for testing. The Columbia engineering team continues to work on FPGA code. Work with the sPHENIX Integration and Installation team continues to finalize the cable routing for the EMCal and HCal.

A DAQ “Procurement Readiness Review” was held. The review result was positive with no recommendations and only a few actionable comments. The DAQ/Trigger group ordered 20 PCs of the “Event Builder and Data Compressor” (EBDC) variety in two racks with 10 machines each. The other large DAQ purchase is for a “first article” large file server, of which will need 6 to 8 in 2023. This server will provide about 1200 TB usable disk space, and high throughput. With this server, the two racks of machines, and a high-end network switch that has already been purchased, the DAQ/Trigger group will be able to set up a system that represents about 1/3 of the eventual sPHENIX DAQ, and develop and fine-tune the operations, and test the performance limits. It will also allow us to perform a mock data challenge next year once the network link to the computing center has been re-established.

Nevis received the MBD prototype disc/shaper boards in late August. Nevis scientists worked on reviving the D/S board test stand and sent some preliminary test data to BNL for further analysis.

WBS 1.1 Project Management (L2 Manager: Irina Sourikova)

Current Status:

- SPI improved to 0.98 from 0.94 in August, CPI is above 1.

Highlights:

- DAQ Computing Final Design and Production Readiness Reviews complete.
- TPC Gas and Cooling Preliminary Design Review complete.
- TPC Laser Calibration System Preliminary Design Review complete.
- No PCRs in August.
- EVMS processing complete; schedule contingency remained unchanged and cost performance remained excellent.
- Cobra and P6 monthly reports uploaded to IPD.
- August variance reports approved.

Plans for the next 2-3 month:

- Develop a plan to mitigate COVID-19 related delays.
- Continue monthly EVMS process and Change Control.
- Place TEC orders and monitor procurements.
- Hire replacements for retired personnel.

Issues:

- Worldwide COVID-19 pandemic continued to delay MIE schedule though the DP-4 date is still on track.

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

Current Status:

R2 pad plane first articles were delivered and passed inspection. This contract has been released for full production. R3 pad planes delivery was completed and the boards are under inspection.

First article GEMs of all sizes arrived and passed inspection. These GEMs were delivered to the factories. The go-ahead for full production was submitted.

The 3/5 of the inner field cage striped cathodes were applied and surveyed. Variations from ideal positions are +/- 0.002" significantly better than specifications.

All SAMPA chips are now packaged and fully delivered. QA inspection at Lund is just beginning. The order for the first 35 articles of FEE cards has been placed. The second bidding process for the full FEE card production is under way

The August reviews for cooling, gas, and laser systems were held and the reports show no surprises. All recommendations matched the plans that we already had in place for all these systems.

The DAM cards were ordered in sufficient supply to reduce risk to the project.

Work Anticipated 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:

The second bidding process on the FEE cards must be watched closely so that it does not result in another failed bid. The de-coupling of the 35 board preproduction order and the full production order from this bid is expected to bring back an additional vendor to bid on the process.

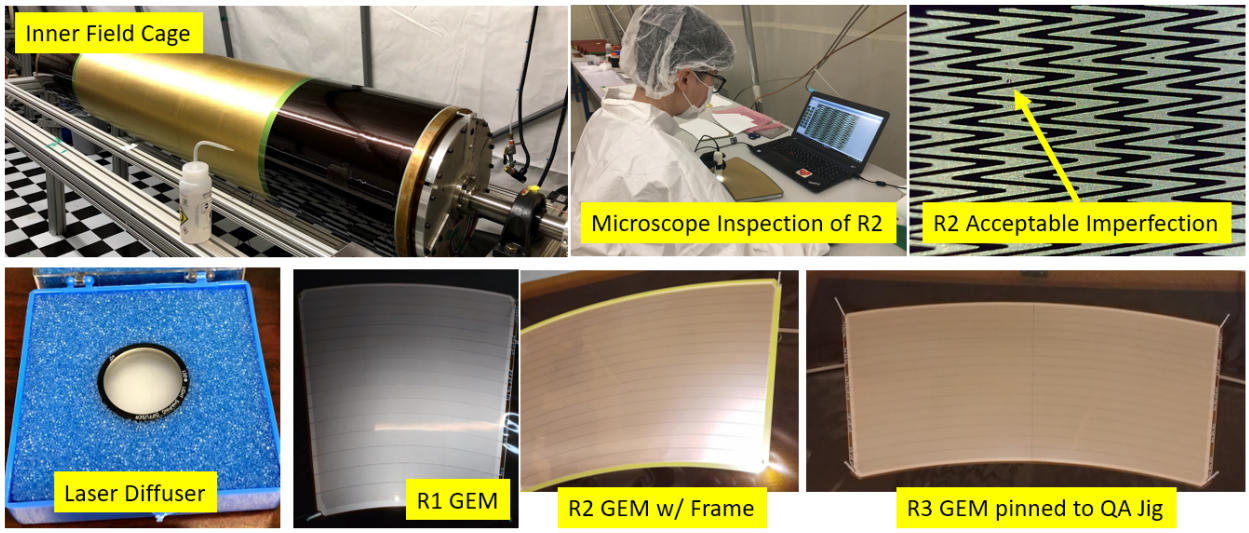


Figure 1. Clockwise from upper left: Inner field cage. Inspection of R2 pad layer. Close up of R2 layer. R3 GEM module. R2 GEM module. R1 GEM module. Laser diffuser.

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 third week of August is shown in Figure 2. Approximately 75% of the blocks needed for Sectors 1-12 have been produced (which constitutes approximately 18% of the total needed for the entire calorimeter) and 66% have been shipped to BNL. By the end of August there were enough blocks delivered to BNL to build six complete sectors along with additional blocks for two more sectors (shown in red in the figure).

Fiber filling also continued. The focus has been on filling more fiber sets to replace some of the failed blocks for Sectors 1-12. This will allow completing all the block types needed to produce entire sectors. The overall failure rate for blocks produced so far for Sectors 1-12 has been ~ 14%, but this has improved significantly for blocks currently being produced as various problems from the early stages of production have been resolved.

Figure 3 shows the rates for block production and fiber filling. The rate of block production has essentially reached the production goal of 60 blocks per week and the rate for fiber filling has exceeded the production goal of 31 fiber sets per week.

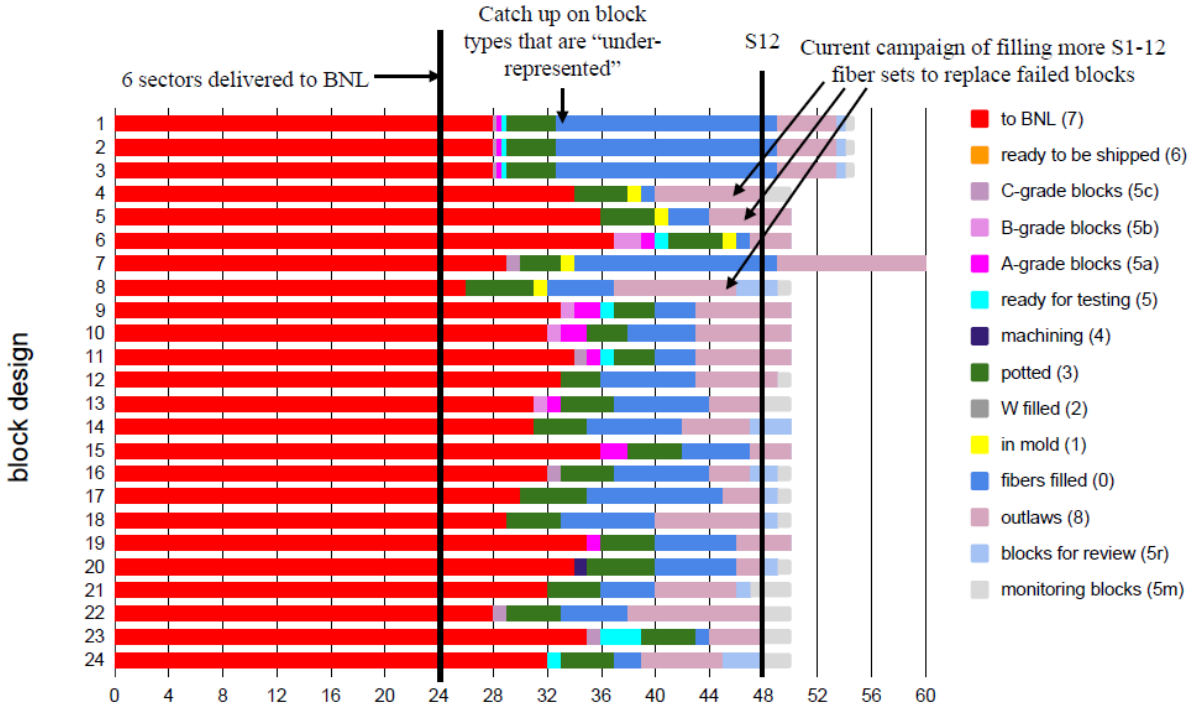


Figure 2. Progress on block production at UIUC as of August 21st. Six complete sectors worth of blocks for Sectors 1-12 have been delivered to BNL plus additional blocks for two more sectors.

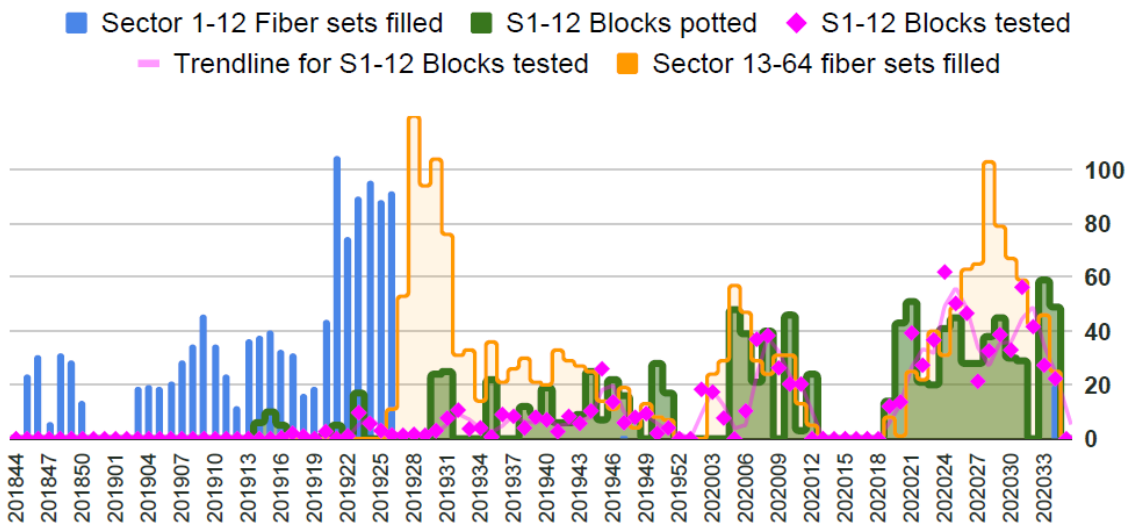


Figure 3. Production rate for various stages of block production for Sectors 1-12 and fiber filling for Sectors 13-64. The production goal for blocks is 60 blocks per week and for fiber filling is 31 fiber sets per week.

Work on module production and sector assembly also continued at BNL. All the modules for Sectors 1-5 have been completed and work is continuing on preparing modules for Sectors 6 and 7. We are currently limited in producing more modules due to a lack of light guides which was caused by the manufacturer (NN, Inc) pausing their production while they investigated a problem they were having with their QA. They began observing small inclusions and/or bits of dark material in the extruded parts and were concerned that these would not be acceptable to us. However, after inspecting a number of these parts and having several conversations with the company, we determined that most of the parts were in fact acceptable and that the overall rejection rate was < 10%. They have now resumed production and we expect to start receiving parts again within the next few weeks.

Figure 4 shows the progress on module production at BNL. Four sectors have been completed and a fifth sector is ready to have its modules installed. Figure 5 shows the progress on sector assembly at BNL. Sector 1 has now been completed and is currently undergoing preliminary testing. Work is continuing on Sector 2 to install the preamps, cables and cooling loops. Once Sector 2 is completed we will be able to confirm that all the electronics, cables and cooling system components fit into both a north and south sector, which will allow us to proceed with the assembly of all the remaining sectors.

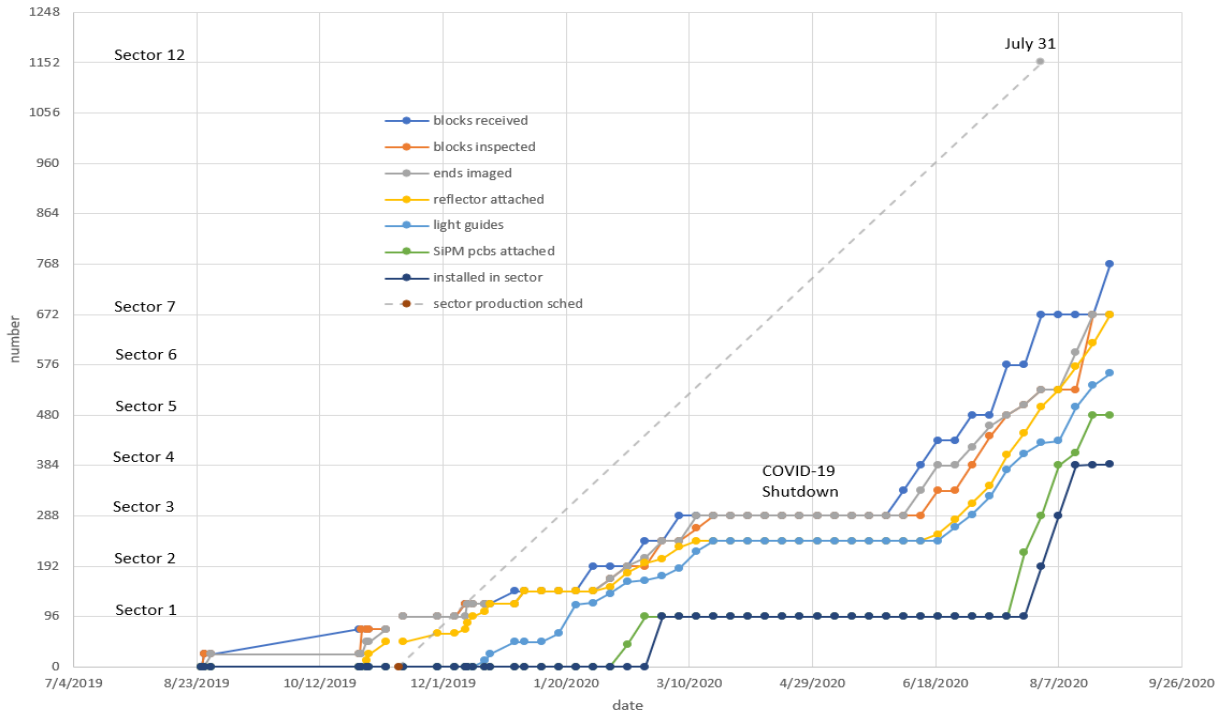


Figure 4. Progress on module production at BNL.

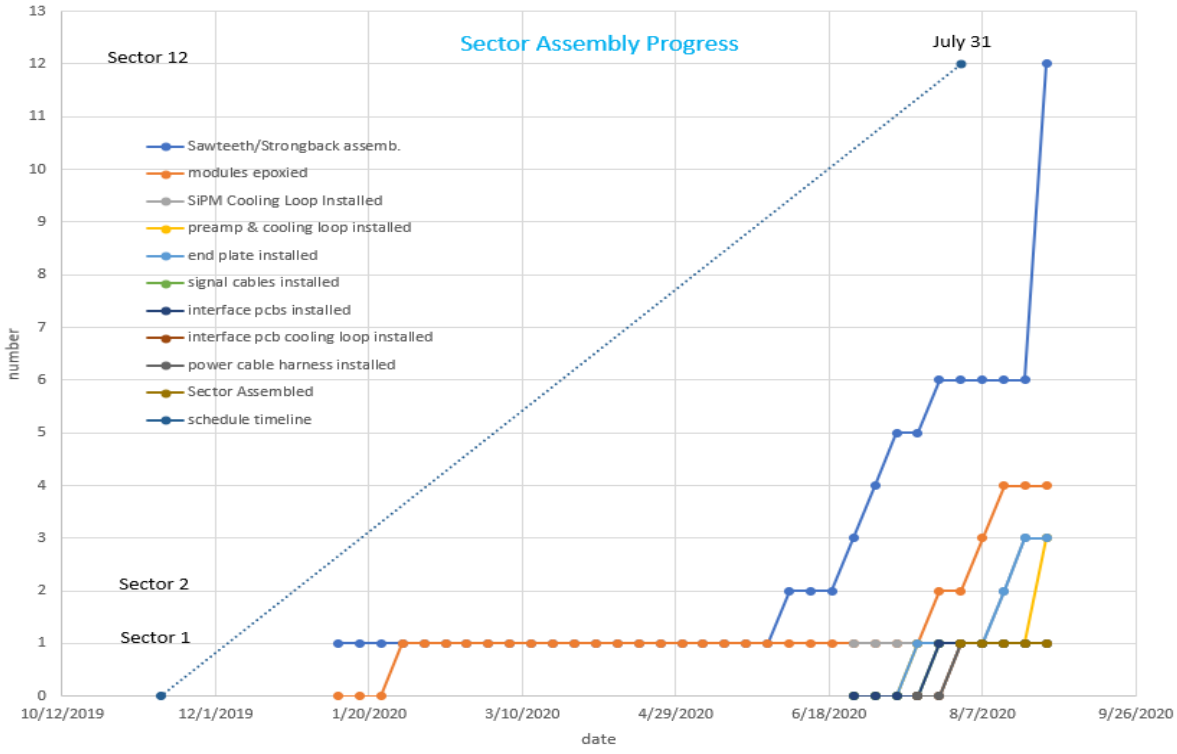


Figure 5. Progress on sector assembly at BNL.

Progress on the production of the high rapidity blocks for Sectors 13-64 also continued at Fudan. They have now produced 24 blocks that are ready to ship to UIUC where they will be tested and compared with our standard blocks. Figure 6 shows the latest set of 24 blocks that will be sent to UIUC.

Figure 6. Latest set of 24 high rapidity blocks produced at Fudan.

Work For the Next 2-3 Months:

Progress on block production for Sectors 1-12 and fiber filling for Sectors 13-64 will continue at UIUC. We expect all of the Sector 1-12 blocks to be completed and delivered to BNL by mid October. Production of blocks for Sectors 13-64 will then begin. Fudan will ship the first set of 24 high rapidity blocks to UIUC where they will be tested and compared with our standard blocks. If they pass all of our QA procedures, they will then be sent to BNL where they will be installed in one of the first 12 sectors.

BNL will continue on module production and sector assembly at BNL. However, we will not be able to keep up with the rate of block delivery from UIUC until the number of technicians is

increased in the EMCal factory at BNL. We expect to be able to complete several more sectors over the next month or so, and, if we can increase the number of technicians as planned, we will complete the first 12 preproduction sectors by the end of the year.

Issues:

We are limited in our module production and sector assembly rate at BNL by the amount of technical manpower. We have approximately 3.5 FTEs techs for up to 7 tasks that could in be performed simultaneously though each task is not a full time job. However, 1.5 of these FTE are senior techs that are needed for specialized tasks, such as investigating and fixing problems in the completed sectors when they undergo testing and helping to maintain operations in the two factories. This results not only in slowing down all of these activities but also in the loss of efficiency in the use of these experienced senior technicians. We feel that we need at least 4 full time FTEs dedicated strictly to production and assembly leaving the 1.5 senior techs available for testing, diagnostics, and repair of the completed sectors and maintaining factory operations. Two additional technicians would be the minimum required to get the EMCAL project back on schedule. We have started the process to hire them. An additional 1-2 techs may be required to meet our final production schedule and we will evaluate that as we increase the sector production rate. Scientists are carrying out all of the Sector testing. Neither postdocs nor graduate students have been identified to carry out this work.

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

WBS 1.4.1 Inner Hadronic Calorimeter

Current Status:

Thermal testing of the IHCAL prototype is underway. Preliminary quotes have been received for the IHCAL sectors and end rings, and 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 rings will be procured through BNL.

Work for the Next 2-3 Months:

IHCAL thermal testing will be completed. Documentation required for the procurement process for the sectors and end ring will be prepared, and contracts should be in place to procure the IHCAL sectors in the next month or so.

Issues:

The COVID-19 pandemic will have a negative schedule impact on the inner HCAL assembly schedule. 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:

Tile testing has been continuing and has been achieving the goal of shipping two pallets of tested tiles to BNL each week. GSU has tested 5215 (of 6360 total tiles received, or 82%), with only 61 tiles (1.1%) failing performance testing. Ideally, if there are no additional delays, GSU should complete testing by the end of November. Shipments of tested tiles have been sent to BNL on a weekly basis. Testing was slowed briefly due to a SiPM holder in the tile tester, but the tester has been repaired and tests with reference tiles show consist performance after the repairs.

Factory operations at BNL are continuing with technician labor and collaborator support from the NY state area. The first pre-production sector has been fully assembled and we are finalizing the cosmic ray test procedures. This has identified a cable polarity issue and questions about channel-mapping to the new digitizers that that has been addressed, and additional signal cables are being produced. Cabling of a second sector is complete, with a third almost complete, and the remaining sectors have been fully loaded with scintillating tiles and are in various stages of being cabled. Technician labor is being used to sort incoming tiles, attach SiPMs, load tiles into production sectors, and cable pre-production sectors and install electronics while collaboration labor is being used to install tiles in the sectors.

The three-sector test stand and remaining shipment of OHCAL sectors skins and electronics boxes have arrived at BNL and passed inspection. The high-strength endplates, pucks, and pins are expected before November 2020. A completed first-article inspection report has been received by BNL for the machined endplate; all machining is within specifications and we will receive complete reports on the remaining endplates. A problem with cracking in high-stress locations was identified with 26 (of 70) of the splice plates after heat treatment of the material. Astro recommended scrapping the current run (at their expense) and adding additional steps to mitigate the stress concentrations. This requires ordering additional heat-treated material, which will incur about a month delay in receiving the splice plates. This will have no effect on the overall OHCAL assembly schedule.

Work for the Next 2-3 Months:

Over the next six months work on the outer HCAL will center on production sector assembly in the HCAL factory. The current working plan is to complete the first five sectors, which will then be moved to storage and five new sectors moved into the factory for assembly. Tile testing will continue at GSU at GSU, with the last shipment of oHCAL tiles expected at BNL in November.

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.

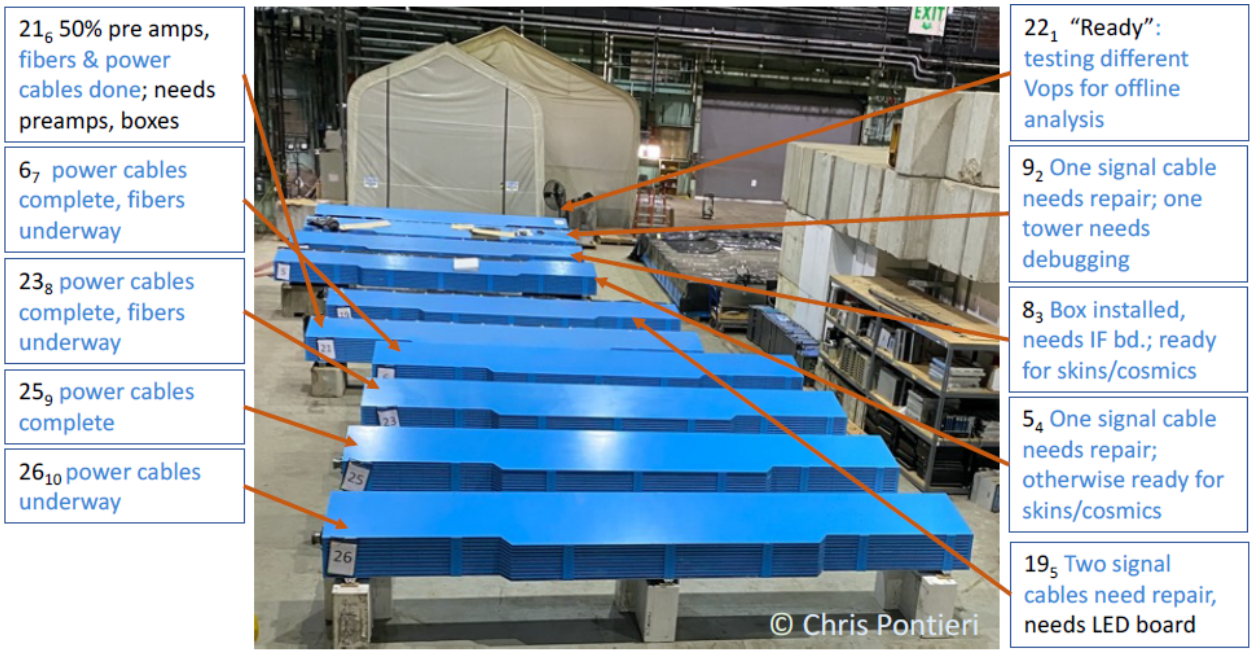


Figure 7: The 912 factory floor showing the current status of the ten OHCAL sectors (six pre-production and four production) currently undergoing assembly. All ten sectors have tiles installed, one sector is under test and a second sector is ready for testing.

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

Current Status:

Testing of the EMCal SiPM daughter boards continues with boards for another 5 EMCal sectors were tested and broken out. Of the 900 boards less then 1% of the boards have failed. Board testing will continue through September. The Lehigh group continues preamp testing and pre-assembly for installation into the EMCal sectors with another 150 board assemblies delivered to BNL in August. Design work continues on the digitizer and control racks for the EMCal. Orders for the EMCal and HCal interface boards, and HCal LED drive boards have been received by the vendors. Long lead times on a few of the components have delayed delivery until October but will not impact assembly schedules. The requisition for the EMCal preamps for the production sectors was submitted to PPM. The order for the LV bulk was prepared, with a submission to PPM expected in early September. Testing of the first LV distribution modules was successfully completed and orders for the fully production order are being prepared. The design files for all the interior cables required for the HCal have been released. 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

The first article XMIT board for the 7-Crate production was received at Nevis and successfully tested and passed all QA requirements. The vendor was given permission to start the assembly of the balance of the XMIT boards that will be completed in 6-8 weeks. All of the 7-Crate ADC boards have been received and work is in progress for testing. The Columbia engineering team continues to work on FPGA code.

Work with the sPHENIX Integration and Installation team continues to finalize the cable routing for the EMCal and HCal. This will allow cable lengths to be determined which are needed for ordering the signal and power cables. The 18-meter signal cable was tested by the Nevis group and the results are being evaluated. Initial results show some degradation of the signal, but the performance still meets the requirements for the EMCal and HCal. Additional studies are being scheduled to further understand the impact of the increased cable length.

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. Place orders for remaining EMCal production electronics
2. Start assembly of cable assemblies for the remaining 26 HCal modules
3. Test EMCal SiPM boards
4. Start testing EMCal Sector 2 and HCal Module 2-6.
5. System chain test of the Digitizer ½-Crate system at BNL
6. Work with the Integration and Installation group to finalize cable lengths and rack design

Issues:

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

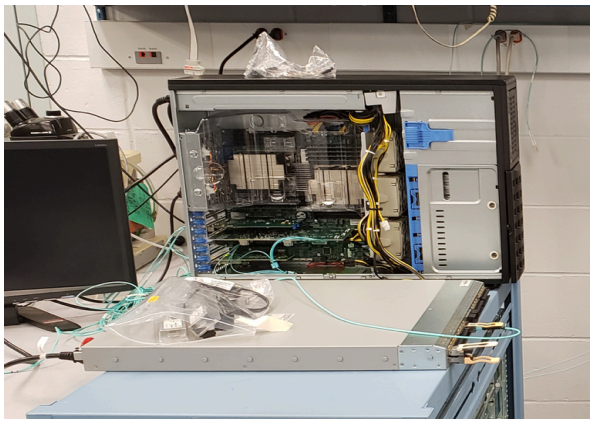
WBS 1.6 DAQ/Trigger (L2 Manager: Martin Purschke, BNL)

Current Status:

As the cautious re-opening of Brookhaven National Laboratory continues, we have some access to our hardware now, and continue to make progress.

We held the DAQ "Procurement Readiness Review", which we passed without recommendations and only a few actionable comments. After the review, and after taking the comments into account, the next purchase orders were placed and are now being processed.

We are purchasing 20 PCs of the "Event Builder and Data Compressor" (EBDC) variety in two racks with 10 machines each. Those machines can either hold one or more FELIX cards and read out the detectors in the tracking systems (TPC, INTT, or MVTX), or can be equipped with a "jSEB2" cards and read out any of the calorimeters or the Minimum-Bias Detector. By using the same PC platform for both we will economize on spares and reduce system management efforts. Eventually we will need 60 such PCs, and 6 racks. The two racks in this initial purchase will give us experience with the layout, power and network distribution, and thermal management, and will show us if any modifications are needed for the other 4 racks.



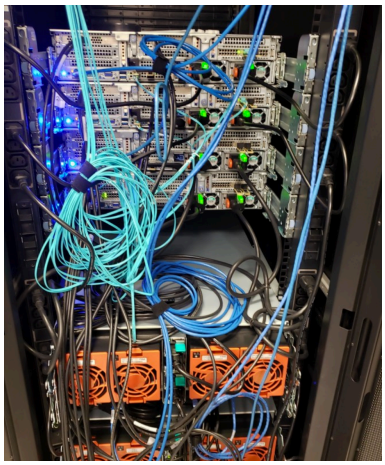


Figure 8: Left: A PC identical to the 20 in the recent purchase order. On top of the blue rack is the high-end network switch that will carry the sPHENIX data flow. Right: A rack with file servers like the one we are purchasing (picture taken in the RHIC/ATLAS Computing Facility).

The other large purchase is for a "first article" large file server, of which will need 6 to 8 in 2023. This server will provide about 1200 TB usable disk space, and high throughput. With this server, the two racks of machines, and a high-end network switch that has already been purchased, we will be able to set up a system that represents about 1/3 of the eventual sPHENIX DAQ, and develop and fine-tune the operations, and test the performance limits. It will also allow us to perform a mock data challenge next year once the network link to the computing center has been re-established.

Work to clear out the old PHENIX racks in the experimental building 1008 are ongoing. We have replaced the network infrastructure, and are in the process to remove old racks to make room for the new ones. We are assessing the power distribution to provide the required power in a managed way (UPS and normal power). Once this is done, we will start to move various test setups to building 1008.

Work for the next 2-3 months :

We will continue the work in 1008 for the new setup. Work on the Global Level-1 Trigger system and the Timing system is continuing.

Issues:

None

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

Current Status:

Nevis received the prototype disc/shaper boards back in late August. Nevis scientists worked on reviving the test stand and sent some preliminary test data to BNL for analysis. More tests are planned for September, and based on the current preliminary tests, it looks promising that we can finish the testing by end of September or October. BNL scientists 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.

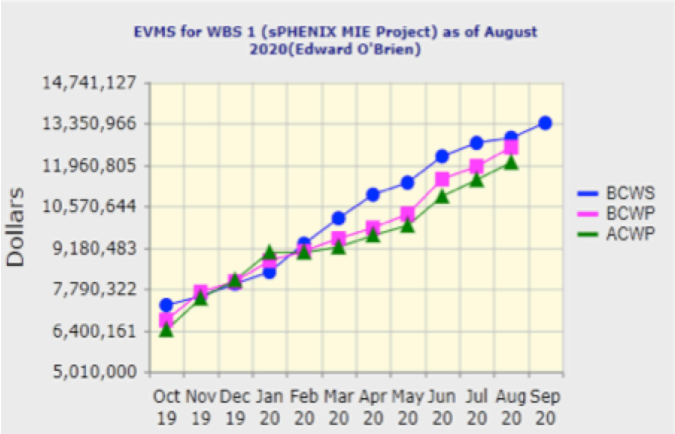
Work for Next 2-3 Months

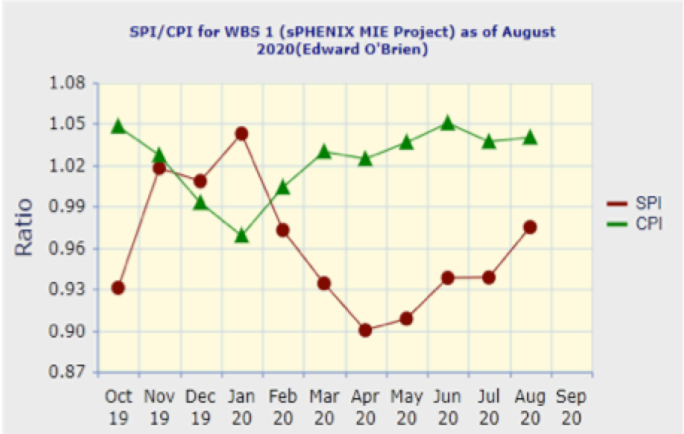
We will take more test data and evaluate the performance of the new D/S prototype boards. From these tests, we hope that sometime in December we can have the production readiness review for the final MBD D/S production boards.

Issues

None.

Performance Indices and Earned Value Data





BAC: $22,198,743 EAC: $23,043,414 VAC: ($844,670)

Cumulative SPI	Cumulative CPI
0.98	1.04

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

Cumulative BCWS (Scheduled)	$12,860,835
Cumulative BCWP (Performed)	$12,543,729
Cumulative ACWP (Actual)	$12,032,662

August 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				SPI	CPI
(1)	(7)	(8)	(9)	(10)	(11)	(14)	(15)	(16)		
1.01A Project Management	1,740,007	1,740,007	1,590,872	0	149,135	1,951,679	1,802,544	149,135	1.00	1.09
1.02A TPC	2,370,459	1,921,570	1,736,177	-448,889	185,393	4,180,135	3,999,704	180,430	0.81	1.11
1.03A EMCal	3,829,025	3,660,949	3,826,272	-168,076	-165,324	5,255,094	5,727,692	-472,598	0.96	0.96
1.04A HCal	2,248,795	2,382,007	2,093,381	133,213	288,626	4,033,110	3,985,511	47,598	1.06	1.14
1.05A Calorimeter Electronics	2,331,388	2,417,222	2,397,687	85,834	19,535	5,363,466	6,146,021	-782,554	1.04	1.01
1.06A DAQ & Trigger	242,014	322,827	309,969	80,813	12,859	1,245,090	1,232,615	12,475	1.33	1.04
1.07A MinBias Trigger Detector	99,148	99,148	78,304	0	20,844	170,170	149,326	20,844	1.00	1.27
b. COST OF MONEY	0	0	0	0	0	0	0	0		
c. GENERAL AND ADMINISTRATIVE	0	0	0	0	0	0	0	0		
d. UNDISTRIBUTED BUDGET						0	0	0		
e. SUBTOTAL	12,860,835	12,543,729	12,032,662	-317,106	511,067	22,198,743	23,043,414	-844,670	0.98	1.04
f. Contingency						4,801,257				
g. TOTAL	12,860,835	12,543,729	12,032,662	-317,106	511,067	27,000,000				

$11,010,751	ETC
$9,655,014	BCWR
49.73%	% Contingency on Remaining Work
43.61%	% Contingency on ETC
57.93%	% Planned
56.51%	% Complete
54.20%	% 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 >1.25

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

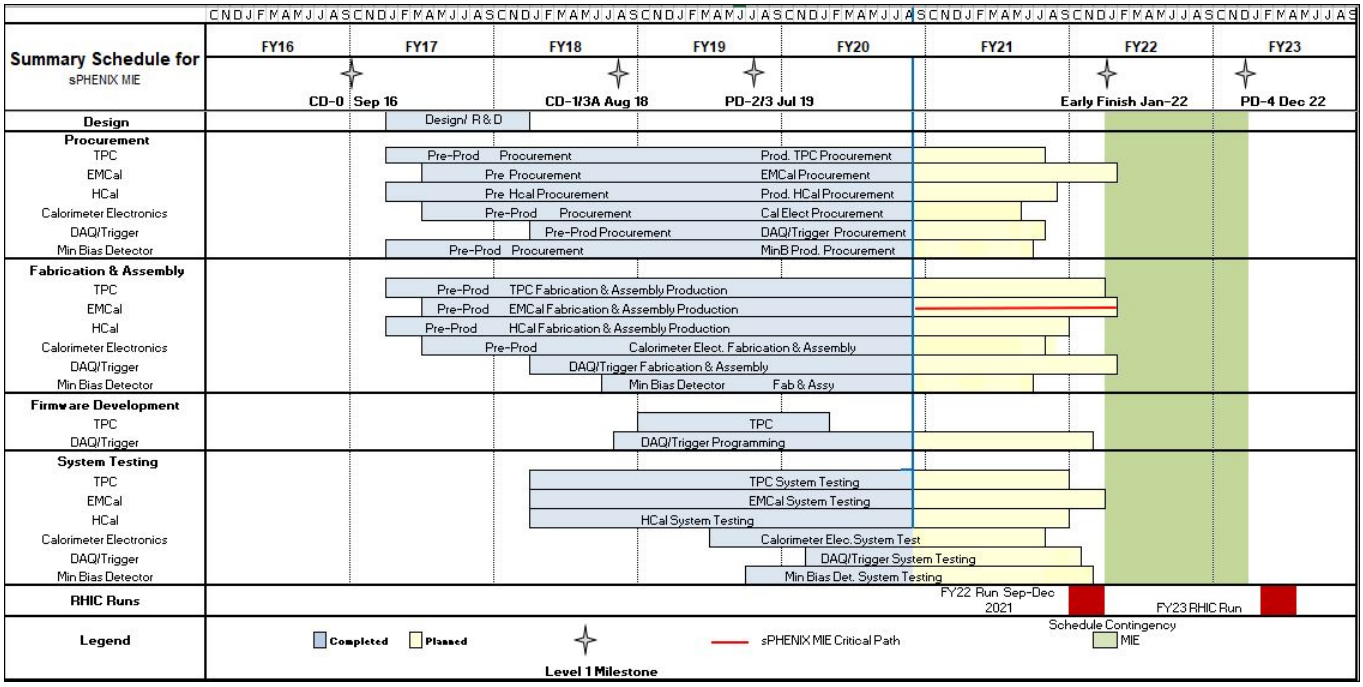
L1 & L2 Milestones

#	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	15-Jan-21		-33
12	01.02.06.03	TPC DAM Felix 2.0 Production Complete	29-Jan-21	30-Jul-21		-128
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	4-Dec-20		78
15	01.04.04.02	First Outer HCAL Sector and Splice Plates Ready to Install	30-Apr-21	16-Nov-20		112
16	01.04.01	Inner HCAL Support Structure Ready for Installation	30-Apr-21	1-Jun-21		-22
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	15-Oct-21		-96
20	01.05.02.04	HCal Electronics Complete: Production	30-Jun-21	5-Aug-21		-26
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	5-Aug-21		-5
23	01.05.02.02	EMCal Electronics Complete	30-Jul-21	14-May-21		52
24	1.07	MinBias Detector Ready to Install	30-Sep-21	16-Nov-21		-32
25	01.06.03.03	GL1 Ready to Operate	30-Sep-21	29-Oct-21		-21
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	10-Dec-21		-28
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	10-Sep-21		33
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

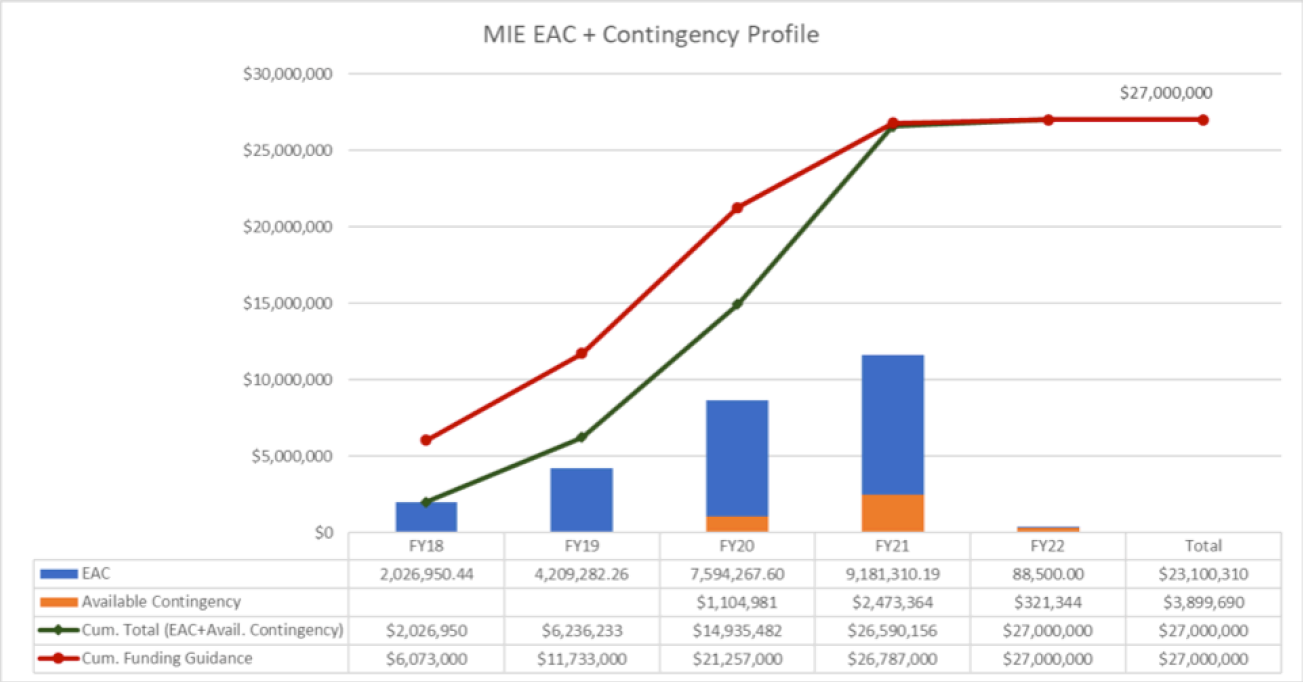
sPHENIX Budget Profile:

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	7,594,267.60	9,181,310.19	88,500.00	$23,100,310
Available Contingency			$1,104,981	$2,473,364	$321,344	$3,899,690
Cum. Total (EAC+Avail. Contingency)	$2,026,950	$6,236,233	$14,935,482	$26,590,156	$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	$23,100,310
Available Contingency	$3,899,690
Total (EAC+Avail Contingency)	$27,000,000

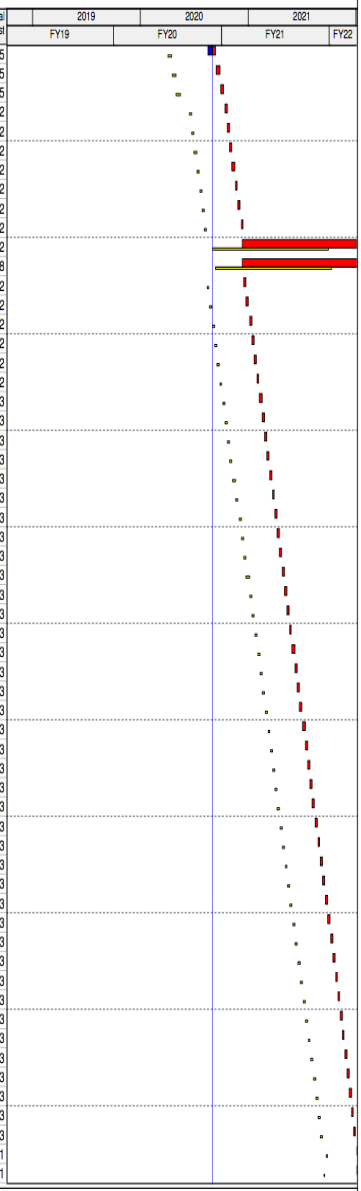
Baseline/Contingency Log

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 August 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
S166800	Fabricate EMCAL Prepro blocks sector 10	19	0	17-Aug-20 A	11-Sep-20	03-Apr-20	16-Apr-20	-103	168	0	9,425	9,425
S166900	Fabricate EMCAL Prepro blocks sector 11	10	0	14-Sep-20	25-Sep-20	17-Apr-20	30-Apr-20	-103	168	0	9,425	9,425
S167000	Fabricate EMCAL Prepro blocks sector 12	10	0	28-Sep-20	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

Fiscal Year: 2020 **Month:** August **Approver:** Edward O'Brien [18368]

WBS 1.02A
TPC

Reporting Period: August 2020

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV in %	SPI	CPI
Current:	59,447	7,737	9,786	-51,710	-87%	-2,049	-26%	0.13	0.79
Cumulative:	2,370,459	1,921,570	1,736,177	-448,889	-19%	185,393	10%	0.81	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 first set, R3, is delivered, while R2 and R1 are in production. This leads to a -$105K of SV. The GEM foil work at CERN is slightly ahead of schedule due to early placement of that contract, resulting in +$26K of SV. WBS 1.2.7 TPC Support System - Laser – new conceptual cost-saving design for laser optics agreed upon only in May. The implications of this had to be propagated through the balance of the laser system design. This leads to -$252K of SV. WBS 1.2.7 TPC Support System – Gas System – An evaluation to ascertain which existing parts from the PHENIX HBD gas system could be reused vs replaced/upgraded has delayed purchase of identical parts until the inventory is complete. This leads to -$55k 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 90 days float. WBS 1.2.7 TPC Support System - Laser impact none. Completion and test of the laser system has 120 days float. WBS 1.2.7 TPC Support System – Gas System – Impact none. The system has 103 days float. WBS 1.2.7 TPC Support System – Cooling System – Impact none. The system has 65 days float.

Corrective Action:
WBS 1.2.2-4.3 – TPC GEM Modules R1, R2, R3 – Procure TPC Module Parts – New Pad Planes - R3 complete, R2 first articles in hand, R1 designs submitted for quote. WBS 1.2.7 TPC Support System - Laser – Design concept finalized, design review finished, prototype under construction. WBS 1.2.7 TPC Support System – Gas System – First parts now on order, design review finished, prototype under construction. WBS 1.2.7 TPC Support System – Cooling System – Tests demonstrate adequate cooling power; design review finished, prototype under construction.

Prepared:	**Prepared By:**	**Approved:**	**Approved By:**
9/21/2020	Irina Sourikova [22419]	9/21/2020	Edward O'Brien [18368]

WBS 1.04A
HCal

Reporting Period: August 2020

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV in %	SPI	CPI
Current:	1,838	361,315	237,414	359,477	19,559%	123,901	34%	196.59	1.52
Cumulative:	2,248,795	2,382,007	2,093,381	133,213	6%	288,626	12%	1.06	1.14
	BAC								
At Complete:	4,033,110								

Threshold(s) Exceeded: Cumulative Cost

Explanation of Variance/Description of Problem:
WBS 1.4.2 – OHCal Sector Mechanics – the splice plates are behind schedule, with negative SV =-$303K. WBS 1.4.2 OHCal Scintillating Tiles – production batches 9, 10 and 11 were delivered early, with positive SV = $355K. WBS 1.4.3 OHCal Sector Assembly – the assembly equipment for production sectors was delivered early for a positive SV = $87K.

Impact:
WBS 1.4.2 OHCal Sector Mechanics – impact none, the splice plates are needed in June 2021 and thus have 120 days float. WBS 1.4.3 OHCal Scintillating Tiles – impact none. WBS 1.4.4 OHCal Sector Assembly – impact none.

Corrective Action:
WBS 1.4.2 OHCal Sector Mechanics – the splice plates are under fabrication at a vendor, with delivery expected in November 2020, some 80 working days before they are needed. WBS 1.4.3 OHCal Scintillating Tiles – none. The schedule will catch up with the progress by November 2020. WBS 1.4.4 OHCal Sector Assembly – none. The schedule will catch up with the progress by November 2020.

Prepared:	**Prepared By:**	**Approved:**	**Approved By:**
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