sPHENIX Project Status Report – July 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 JULY 31, 2020**

<table>
<tr><td>Current PD:</td><td>2/3</td><td colspan="2">Date of Current CD/PD approval</td><td colspan="2">September 2019</td></tr>
<tr><td>Next PD:</td><td>4</td><td>Forecast approval:</td><td>1QFY23</td><td>Baseline:</td><td>1QFY23</td></tr>
<tr><td>% Complete:</td><td>53.6%</td><td colspan="2">Planned:</td><td colspan="2">57.2%</td></tr>
<tr><td>ETC:</td><td>$11.7M</td><td colspan="2">TPC or Cost Range:</td><td colspan="2">$27.0M</td></tr>
<tr><td>Contingency:</td><td>41.2% on ETC</td><td colspan="2">Float to PD-4 in months:</td><td colspan="2">11.5</td></tr>
<tr><td>Cumulative CPI:</td><td>1.04</td><td colspan="2">Cumulative SPI:</td><td colspan="2">0.94</td></tr>
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2. **NEAR TERM MILESTONES**

In the near term the sPHENIX Project team will continue the monthly EVMS process, Change Control, and the monthly updating of the ETC. We 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.

Reviews of the TPC gas system, TPC Laser System, and TPC carriage-level cooling system will be performed. Construction of TPC production components will continue including the production and testing of SAMPA v5 chips, TPC Fee and DAM boards, GEM foils, GEM modules and the TPC HV enclosure.

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 early fall. Production of blocks for Sectors 13-64 will then begin. Progress on sector assembly and testing will continue at BNL. BNL Management has indicated that Phase 2 for reopening at BNL may continue until the end of CY2020. This will limit the available manpower that can be devoted to module production and sector assembly at any given time. However, we have arranged the module receiving, module production, sector assembly and sector testing areas to allow up to seven different teams to work on these tasks at the same time while still respecting social distancing requirements. We are looking at ways to increase the number of people available to work in the EMCal factory on both assembly and testing.

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 ten sectors in the next couple of months. Once five sectors are complete and tested they 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 (final 6%) of OHCAL tiles expected at BNL in November. Inner HCal Sector and End Rings structural components will have their drawings finalized, procurement documentation will be prepared and contracts will be in place to procure the IHCAL sectors within the next few months.

Work on the Calorimeter Electronics over the next three months will be focused on the continued testing of preproduction sectors and procurement of production electronics. This work includes placing orders for the remaining EMCal electronics, starting cable assemblies for the remaining 26 HCal modules, continued testing of the EMCal SiPM daughter cards, begin the testing of EMCal Sector 1 and HCal Sector 2, continued system chain test of the calorimeter digitizer ½ crate system and collaboration with the sPHENIX infrastructure and installation group to finalize cable lengths and the rack designs.

We will hold the Procurement Readiness Review for various DAQ/Trigger components and equipment. We will continue the work in 1008 for the new setup.

The MBD group expects the fully assembled Discriminator/Shaper board in August for testing. The FPGA coding for the disc/shaper board is written, so it just needs to be tested live on the board.

3. **STATUS HIGHLIGHTS**

Our annual review of the sPHENIX project was held July 28-29. The review was fully remote. The outcome was very positive. There were no technical action items. Of the four recommendations, three related to evaluating cost, schedule and risk due to the pandemic and the four recommended generating a scope opportunity plan if the project continues to perform well on cost. The EVMS process is ongoing as the MIE continues to show good cost performance. The July SPI shows impact of COVID-19 related delays across al MIE elements. EVMS processing for July is complete. The schedule contingency decreased by two weeks from 12 months to 11.5 months while the cost performance remained excellent. Cobra and P6 monthly reports have been uploaded to IPD. June variance reports have been approved. Estimate Uncertainty and Risks were updated and the bottom-up contingency estimate was revised.

The EMCal, HCal and TPC GEM factories are all fabricating production blocks, sectors and modules. Production electronics orders have been placed and in certain cases, like the EMCal SiPM daughter cards, are starting to arrive from the vendors. BNL has reopened, albeit with a lower density work force, as have all sPHENIX universities that are fabricating parts for the experiment.

The GEM foil order is placed with CERN and at the time of this writing first articles of each size GEM foil are expected at SBU. The FEE procurement reached a snag for which only one company placed a bid and the process needs to be restarted. The new approach will be to order the assembly of preproduction boards and after testing order the assembly of the final boards. Bench tests of TPC FEE cooling have been performed and very closely match the calculations demonstrating the efficacy of the design. Production SAMPA chips (final round) were sent for packaging.

UIUC continues to make progress on EMCal block production. By the end July, eight complete sectors worth of blocks for preproduction Sectors 1-12 were complete and six sectors worth had been delivered to BNL. The problem with some blocks having dark fibers around the edges has now been eliminated by cooling the blocks before their final machining and the use of a special tool to remove the excess tabs from the screens. In addition, the overall quality of the blocks has been steadily improving in terms of their density, dimensional tolerances and light transmission. All of the remaining tungsten powder for Sectors 13-64 was delivered to UIUC in early June. By the end of July, all the modules were glued into Sector 2 and the modules for Sector 3 were test fit onto their saw tooth supports. The blocks for Sector 4 were being worked on to turn them into modules. The SiPM daughter boards are now available at a sufficient rate to enable production to continue. We are carefully watching the light guide delivery from the vendor who is behind schedule.

ISU is preparing to place the orders for the iHCAL mechanicals and manage their production once the drawing package is complete. Shipment #6 of outer HCAL tiles from Uniplast was received at Georgia State University. Approximately 94% of the production tiles have been delivered from the vendor. Tile testing continues at GSU. GSU has tested 72% of the production tiles with only 54 tiles (1.27%) failing performance testing. Ideally, if there are no additional delays, GSU should complete testing by the end of November.

The first OHCal sector has been fully assembled and we are finalizing the cosmic ray test procedures. Cabling of a second sector is complete, with a third almost complete, and sectors 4-6 have been fully loaded with scintillating tiles. Work has also started on installing tiles in sectors 7-10. With BNL permission, visiting students and scientists from local universities (Baruch, Rutgers, Lehigh) are participating in assembly and testing of the OHCal sectors at BNL.

Testing of the 3420 EMCal SiPM daughter boards started in early July and boards for 4 EMCal sectors were tested and broken out. Of the 450 boards tested only three boards failed and the failure modes are understood. The Lehigh group continues preamp testing and pre-assembly for installation into the EMCal sectors with another 100 board-assemblies delivered to BNL on the first of August. The PCB order for the XMIT boards for the 7-Crate production was received at Nevis and the assembly order was placed. Nevis received 84 digitizer boards for the 7-Crate production with final delivery in August. The Columbia engineering team continues to work on FPGA code. All the boards were successfully powered and the FPGAs programmed. Fully functionality testing of the digitizers will start in August.

We have equipped 3 computers with the proposed sPHENIX network interfaces, and carried-out network and other performance tests with the PCs and also with the switch. The performance is just as advertised, 24.6Gbit/s out of possible 25Gbit/s. This will allow us to set up a slice of the full eventual DAQ system in Building 1008 and perform measurements and also find the best “tune” of the system. The preparations for the DAQ “Procurement Readiness Review” are under way, where those measurements will be a part of the review charge. We have demonstrated that our 2 principal custom readout cards, the “jseb2” and the “FELIX” cards work properly in the new AMD-based system.

The assembly kit for the v2 of the MBD disc/shaper board prototype was sent out, with the new calibration circuit, and we expect to get the board back in August. We plan to be able to get started with the testing in August. Graduate students from Howard and Florida A&M Univ will take part in the electronics testing.

WBS 1.1 Project Management (L2 Manager: Irina Sourikova)

Current Status:

- Annual Director’s Review was a big success.
- July SPI shows COVID-19 related delays, CPI is above 1.

Highlights:

- Annual Director’s Review went very well, no technical recommendations to implement.
- TPC Transport Cart Final Design Review complete.
- EMCal Block/Module/Sector Production Readiness Review complete.
- No PCRs in July.
- EVMS processing complete; schedule contingency decreased slightly (10 days) while cost performance remained excellent.
- Cobra and P6 monthly reports uploaded to IPD.
- June variance reports approved.

Plans for the next 2-3 month:

- Continue to implement 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:

All frames are delivered to the factories and passed QA inspection. R2 pad plane contract was awarded and is under production. The GEM foil order is placed and at the time of this writing first articles of each size GEM are expected at SBU.

The review of the DC power plan was held successfully. Orders for LV power supplies are common across systems in sPHENIX and are handled at BNL.

The FEE procurement reached a snag for which only one company placed a bid and the process needs to be restarted. To avoid significant schedule impact, we are separating the orders for populating the first 35 cards (in hand) from the order for the full system. This detaches the dependency of the need for cards for module testing from the full production of cards. We also resolved in advance of the final order the decision on protection resistor (same as ALICE) to relieve the pressure of this final design choice.

Bench tests of TPC FEE cooling have been performed and match very closely the calculations demonstrating the efficacy of the design. The August reviews for cooling, gas, and laser systems were scheduled and committees were formed.

Production SAMPA chips (final round) were sent for packaging. A design choice was made for testing. The test apparatus at LUND is a little noisy for the 80 nsec shaping option. Therefore, we have chosen a strategy whereby the 160 nsec shaper is tested for noise performance and the 80 nsec stage is tested as working. This is approved by all cognizant TPC FEE experts as well as experienced ALICE experts.

The TPC received no recommendations at the annual review.

Work Anticipated for the Next 2-3 Months:

Reviews of the TPC gas system, TPC Laser System, and TPC carriage-level cooling system will be performed.

Issues:

SBU labs and BNL labs are just initiating a staged re-entry of personnel. The level of work approved will become a driving factor in determining the overall impact of the COVID pandemic. SBU plans include availability of undergraduate personnel and we anticipate hiring technician help (as described in the TPC risk registry) to mitigate the impact.

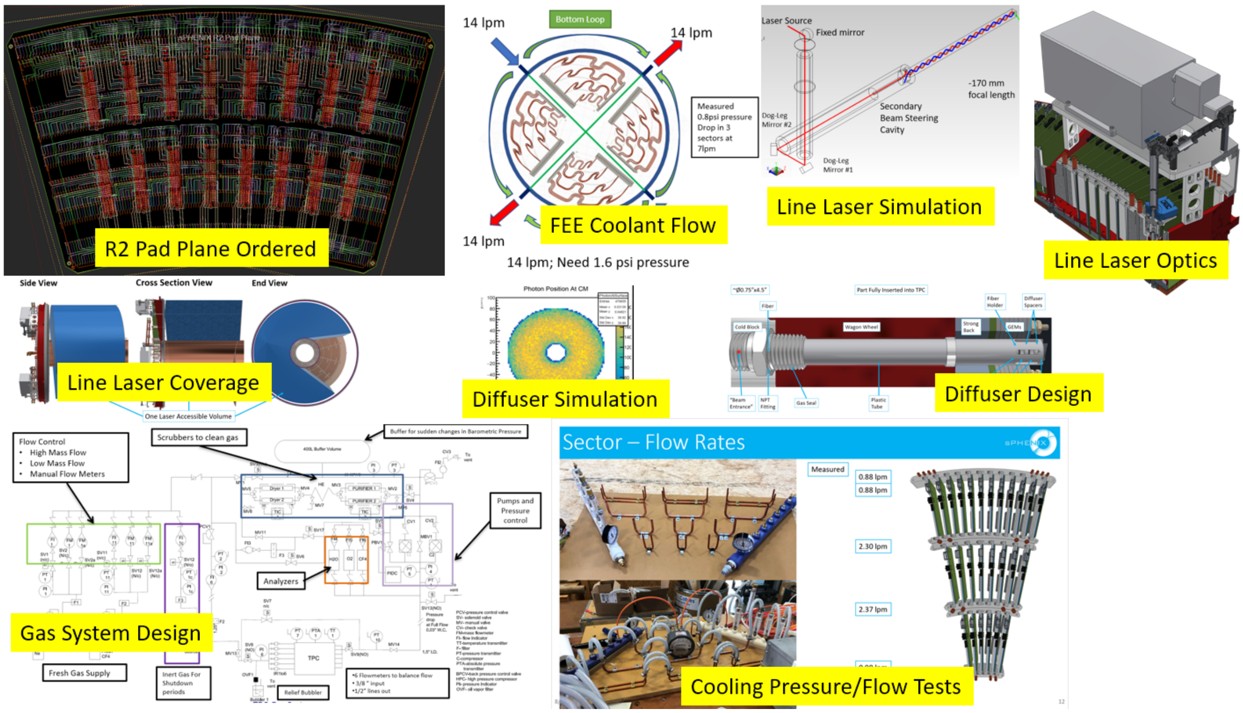


Figure 1. Clockwise from upper left: Layout of R2 pad plane. Schematic of TPC FEE coolant flow system. Line laser schematic and 3D model. Laser diffuser design and simulation. Sector coolant flow tests. Gas system schematic. Line Laser coverage.

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

Current Status:

UIUC continues to make progress on block production. Figure 2 shows the status as of July 24th. By the end July, eight complete sectors worth of blocks for preproduction Sectors 1-12 were complete and six sectors worth had been delivered to BNL. The problem with some blocks having dark fibers around the edges has now been eliminated by cooling the blocks before their final machining and the use of a special tool to remove the excess tabs from the screens. In addition, the overall quality of the blocks has been steadily improving in terms of their density, dimensional tolerances and light transmission.

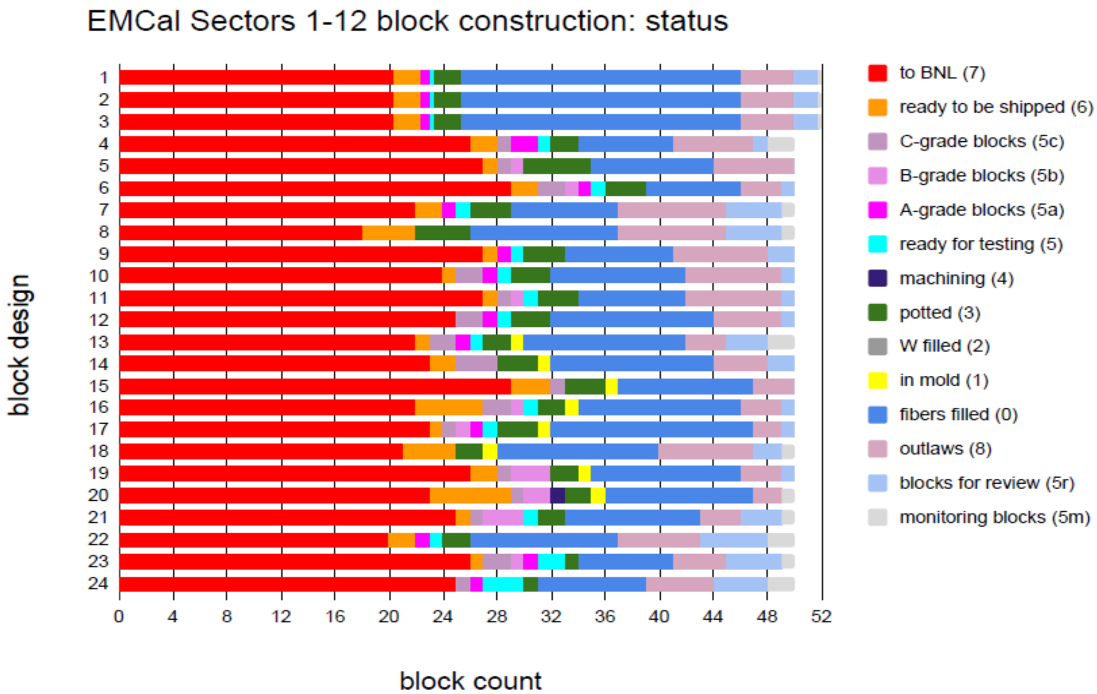


Figure 2. Progress on block production at UIUC as of July 24th. Six complete sectors worth of blocks for Sectors 1-12 were delivered to BNL by the end of July.

All of the remaining tungsten powder for Sectors 13-64 was delivered to UIUC in early June. However, one batch of the powder showed a significantly higher tap density than our normal powder (~ 11.5 g/cm^3 vs. 10.6 g/cm^3) which caused some problems that prevented the epoxy from flowing freely during the fabrication of the blocks. This was due to a larger number of very small particles in the powder. After a number of attempts to change the production procedure to use this powder that did not succeed, we contacted the vendor (Starck) who agreed to allow us to return the batch of high density powder, and they will sieve out the smaller particles and return the batch to us with the same properties as our normal powder.

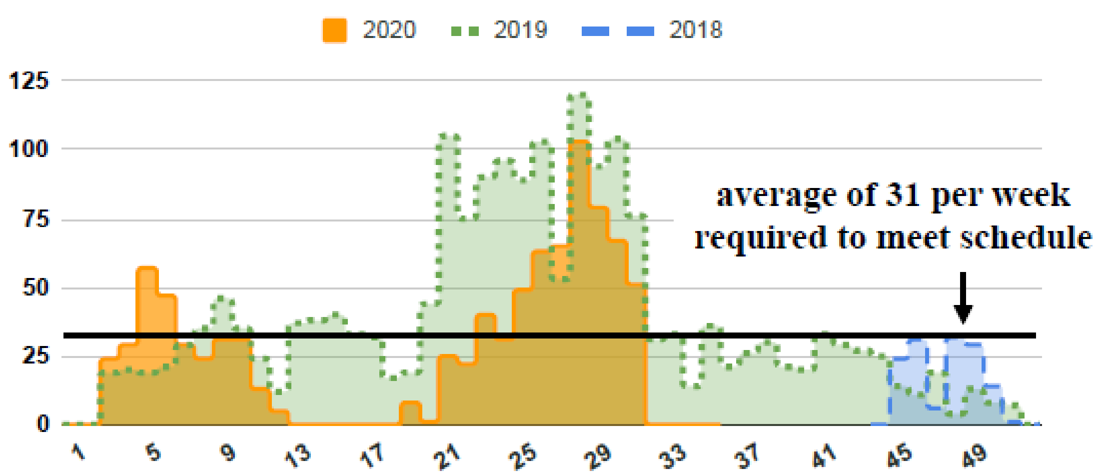


Figure 3. Progress on fiber filling at UIUC. The orange histogram shows the number of fiber sets filled per week in 2020 which exceeds the required rate of 31 sets per week to meet our production schedule.

Fiber filling for Sectors 13-64 also continued and approximately 40% of the needed fiber assemblies have been completed. Figure 3 shows the progress over the past 3 years. The average rate for fiber filling now comfortably exceeds the required level of 31 fiber assemblies per week that is needed to meet our production schedule.

Work on module production and sector assembly also continued at BNL, although with limited access to the factories and with reduced manpower. BNL entered Phase 2 of reopening in early July that allowed more people on site and for some of our technicians to return to work. A new lab was set up to receive the blocks where they are inspected and the information about them entered into a database. Figure 4 shows the new lab with a recent shipment of 48 blocks from UIUC.

Figure 4. New lab at BNL for receiving block shipments from UIUC along with a recent shipment of 48 blocks.

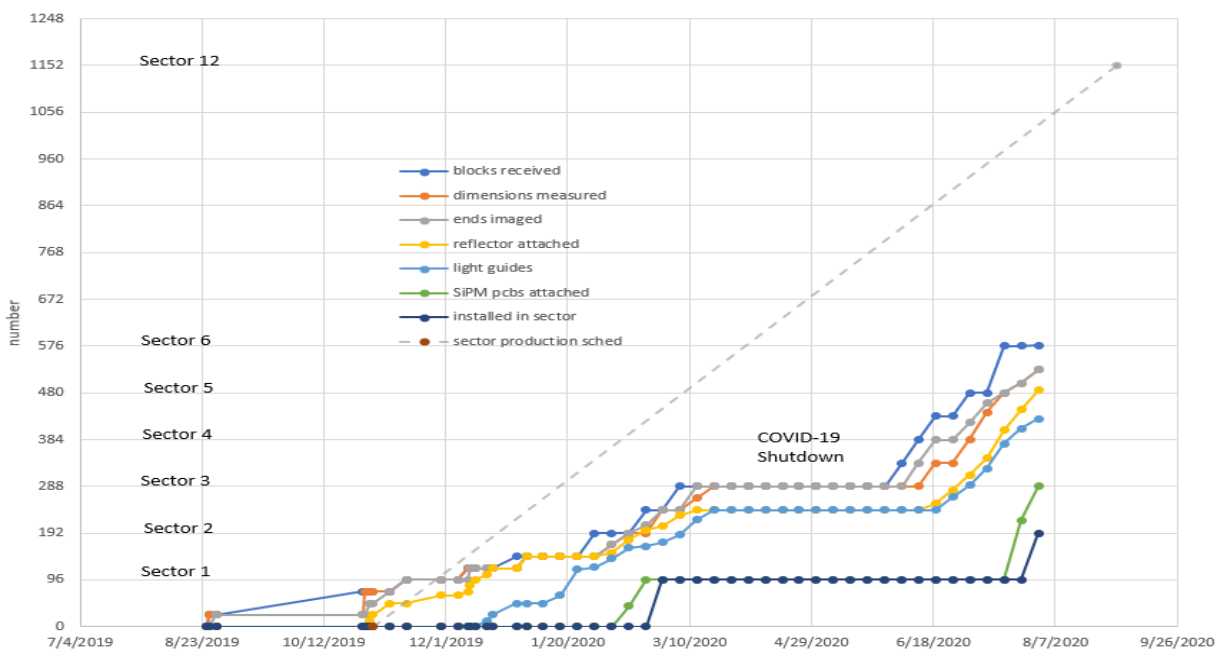


Figure 5. Progress on module production and sector assembly at BNL.

Module production and sector assembly at BNL continued in July although with limited manpower. Figure 5 shows the progress made at the various stages. Assembly of Sector 1 was completed and is now undergoing testing. By the end of the month, all the modules were glued into Sector 2 and the modules for Sector 3 were test fit onto their sawtooth supports. The blocks for Sector 4 were being worked on to turn them into modules. The SiPM daughter boards are now available at a sufficient rate to enable production to continue, but we only have enough light guides to equip the modules for Sector 4. There was a problem with the light guides that are being produced by the vendor (NN, Inc) where the number of small inclusions and defects began to increase during production. They paused production in order to investigate this problem and are still working on it. However, based on a number of samples they have sent us, the number of inclusions and defects is still very small in most samples and we believe they would be acceptable. We plan to have a series of discussions with them in the coming weeks to decide what is acceptable in order for them to resume production.

Progress on the production of the high rapidity blocks for Sectors 13-64 also continued at Fudan. Approximately 1300 kg of powder and 225 km of fiber has been delivered. A total of 58 blocks have been produced and 27 were sent to a separate company for machining. Two sample blocks were sent to UIUC where they were inspected and tested and were determined to be of the same quality as the UIUC production blocks. They are now waiting for more screens to arrive from UIUC in order to continue making more blocks of all the required types for the high rapidity sectors.

We had the sPHENIX Annual Review on July 28th-29th and a Production Readiness Review (PRR) for the EMCAL blocks, modules and sectors on July 31st. This included a final design review for all of the components as well as for the overall mechanical design and installation plan for installing the sectors into the sPHENIX detector in the IR. This was one of the milestones of the project and was completed on time. There were no recommendations from the Annual Review for the EMCAL. The PRR went very well and we are awaiting the final report.

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 early fall. Production of blocks for Sectors 13-64 will then begin.

BNL Management has indicated that Phase 2 for reopening at BNL may continue until the end of CY2020. This will limit the available manpower that can be devoted to module production and sector assembly at any given time. However, we have arranged the module receiving, module production, sector assembly and sector testing areas to allow up to seven different teams to work on these tasks at the same time while still respecting social distancing requirements.

At the present time, EMCAL module production and sector assembly are both several months behind schedule. If labor were available, we could work on several tasks simultaneously and try and make up some of the loss in schedule. However, we presently have 3 techs available for all of these tasks at any given time. We are currently staffing-limited. We are trying to keep both module production and sector assembly moving forward and not loose additional schedule. Additional personnel working in the factories would help us keep to our schedule.

Production of the first sector's worth of high rapidity blocks will continue at Fudan. The goal will be to complete the 24 blocks by the end of August and ship them to UIUC where they will be tested and compared with the UIUC production blocks. If they are deemed satisfactory, they will then be sent to BNL where they will be installed in one of the preproduction sectors.

Issues:

The number of available technicians limits our module production and sector assembly rate at BNL. We have 3 techs for up to 7 tasks that could in principle be performed in parallel. We are also looking for help from our institutional collaborators for testing completed sectors. Help in both of these areas will help us maintain schedule. The EMCAL is on the critical path for completing sPHENIX. Additional technical labor and student help for testing will reduce the risk of not being able to meet our delivery schedule for the installation of the final sectors into sPHENIX in late 2021.

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 will place the orders for the iHCAL mechanicals and manage their production.

Work for the Next 2-3 Months:

iHCAL thermal testing should be completed in the next month. 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 several months.

Issues:

The current mitigation efforts for COVID-19 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:

Shipment #6 (of a total of 6) of outer HCAL tiles from Uniplast was received at Georgia State University on August 14th. A final remaining shipment is still expected, consisting of approximately 400 tiles (6% of the total), some of which will be replacements for tiles that did not pass quality testing at GSU.

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 4220 (of 5854 total tiles), with only 54 tiles (1.27%) failing performance testing. Ideally, if there are no additional delays, GSU should complete testing by the end of November.

Factory operations at BNL are resuming with technician labor and some 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. Sector testing has identified a cable polarity issue that is currently being addressed. Cabling of a second sector is complete, with a third almost complete, and the remaining sectors have been fully loaded with scintillating tiles. Work has also started on installing tiles in the first four production sectors. 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, splice plates, pucks and pins are expected before November 2020. The manufacturer (Astro machine works) has completed certification testing on the HT strength material and demonstrated it meets the yield strength specification of 150ksi. Inspection reports have been received by BNL for the first two machined endplates; all machining is within specifications.

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:

The plan for OHCAL sector assembly relied on undergraduate and graduate labor from collaborating institutions. Collaborating institutions had made commitments for sufficient labor for summer 2020, but with the ongoing COVID-19 this plan will not be fully realized in the summer of 2020. We are planning work in the summer that will make use of technician labor, but this will have schedule impacts based on availability. We are optimistic that we will be able to supplement OHCAL factory labor with graduate students and postdocs from beyond the NY metropolitan area in the fall of 2020.

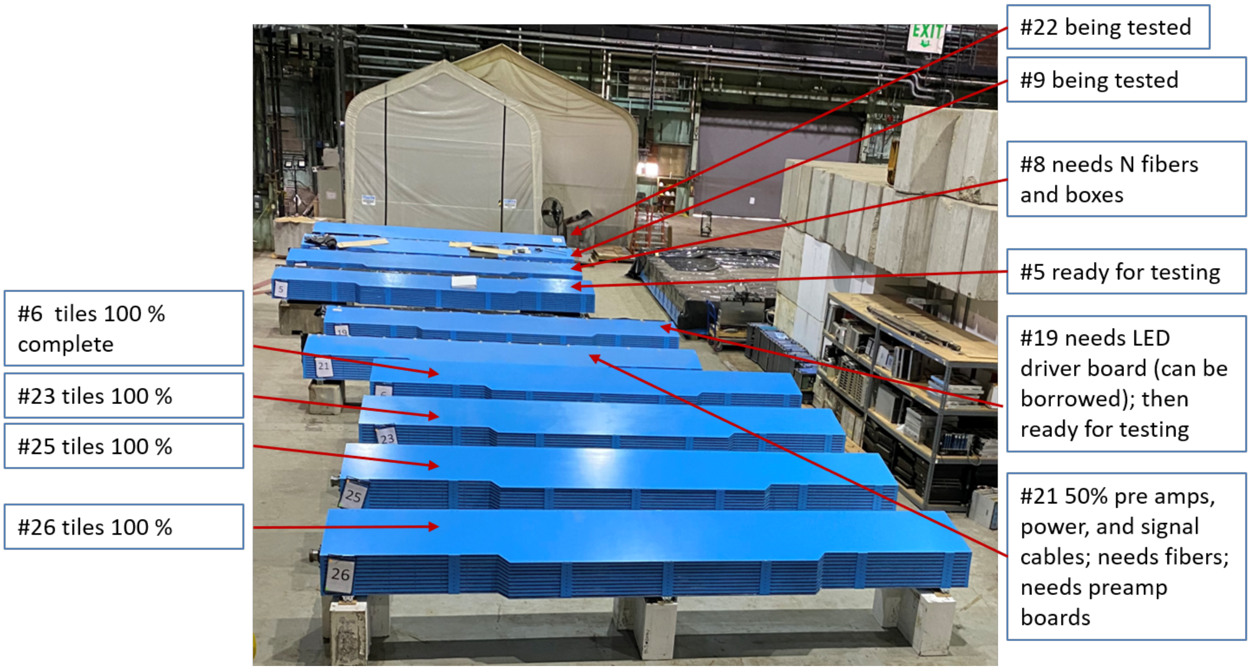


Figure 6: The 912 factory floor showing the status of the ten OHCAL sectors (six pre-production and four production) currently undergoing assembly. All ten sectors have tiles installed, one sector is under test.

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

Current Status:

Testing of the 3420 EMCal SiPM daughter boards started in early July and boards for 4 EMCal sectors were tested and broken out. Of the 450 boards tested only three boards failed and the failure modes are understood:

1) component failure due to thermal stress of the reflow process (2)

2) damage done during the breakout process.

Board testing will continue through September (see figure 7). The Lehigh group continues preamp testing and pre-assembly for installation into the EMCal sectors with another 100 board-assemblies delivered to BNL the first of August. The prototype Test Pulse Driver board was assembled, and testing started at the end of July. Preliminary test results show that the board is fully functional. Design work continues on the digitizer and control racks for the EMCal. Orders for the EMCal and HCal interface boards have been received by the vendors, with deliveries scheduled for August.

The PCB order for the XMIT boards for the 7-Crate production was received at Nevis and the assembly order was placed. Nevis received 84 digitizer boards for the 7-Crate production with final delivery in August. The Columbia engineering team continues to work on FPGA code. All the boards were successfully powered and the FPGAs programmed. Fully functionality testing will start in August.

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. A sample 18 m signal cable was received from Meritec for evaluation by the Nevis group. This represents an 80% increase in the length of the cable from what was originally estimated during the initial design stages and is 10% longer the maximum length that is required for sPHENIX. The increased length results from a better understanding of the cable routing for the sPHENIX detector. Discussions with 3-M for the signal cables are also on going.

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 1 and HCal Module 2.
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.

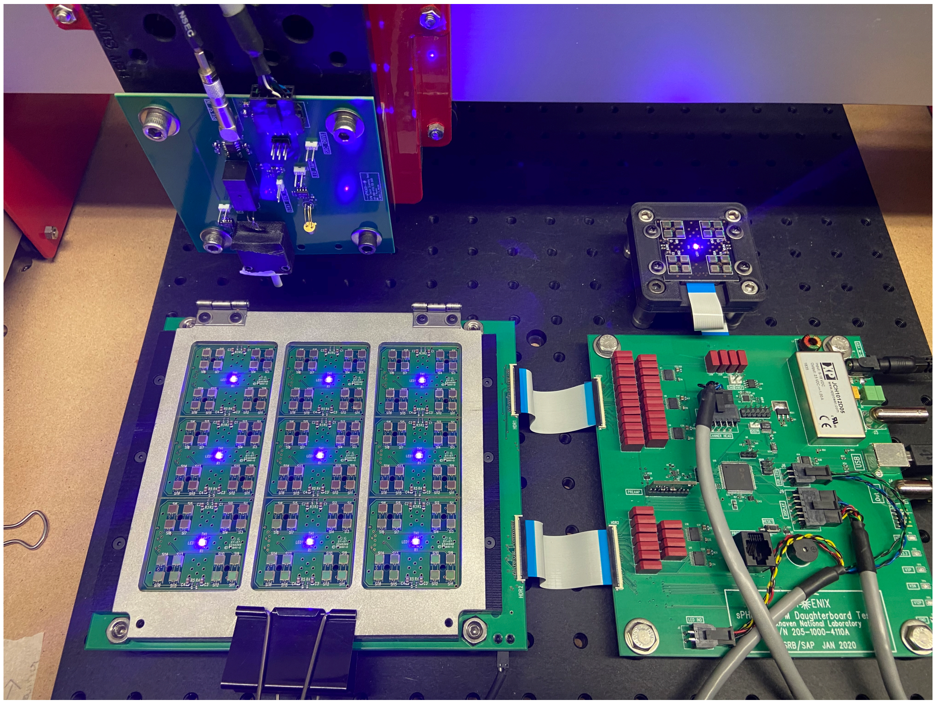


Figure 7: EMCal SiPM Board tester with a full panel of boards. The tester allows for fast verification that all aspects of the SiPM boards function. In this picture, the LEDs are light up to provide a visual confirmation that they are functional.

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

Current Status:

As the cautious re-opening of Brookhaven National Laboratory continues, we had intermittent access to our hardware, and have been able to make progress.

We have received further deliveries that had been stalled during the min-safe condition, in particular the new network switch (figure 8). We have equipped 3 machines with the network interfaces, and carried-out network and other performance tests with the PCs and also with the switch (see figure 10). The performance is just as advertised, 24.6Gbit/s out of possible 25Gbit/s. This will allow us to set up a slice of the full eventual DAQ system in Building 1008 and perform measurements and also find the best "tune" of the system.

Figure 8: The high-end network switch that will enable the data flow in the experiment.

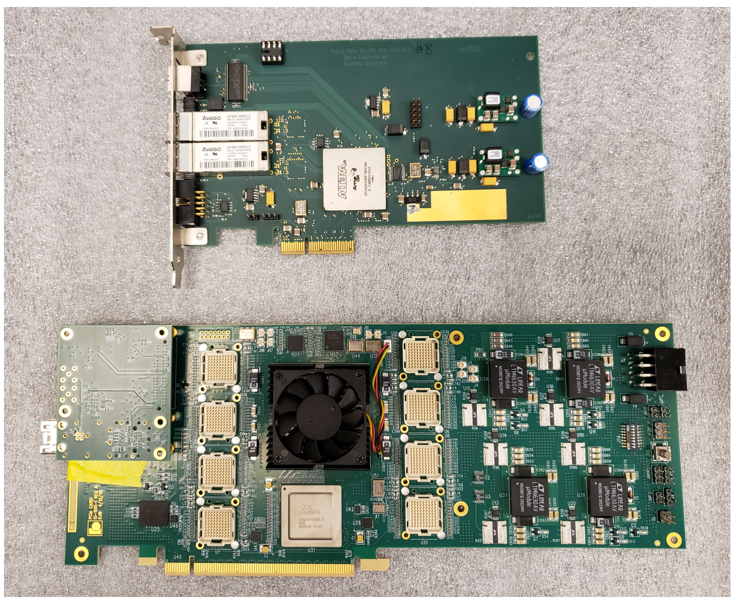


Figure 9: A picture of the jSEB2 card (top), and the FELIX card (bottom).

The preparations for the DAQ “Procurement Readiness Review” are under way, where those measurements will be a part of the review charge. We have also demonstrated that our 2 principal custom readout cards, the “jseb2” and the “FELIX” cards, pictured in Figures 8 and 9, work properly in the new AMD-based system. We want to switch to the AMD system because of its better performance, and needed to show that the cards function properly in that system.

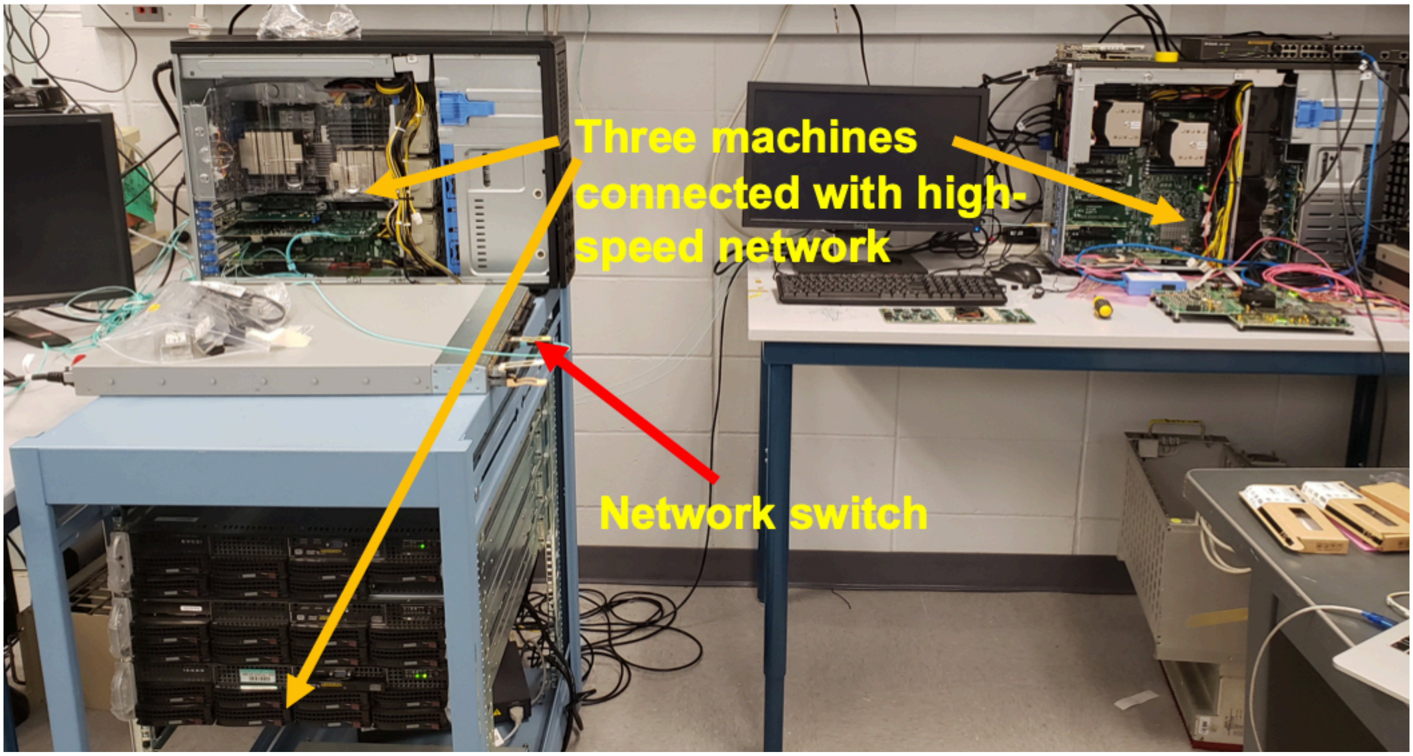


Figure 10: The small high-speed network setup used for throughout tests. The 3 machines are connected with a high-speed (25GBit/s) network interfaces

Work to clear out the old PHENIX racks in the experimental building 1008 is 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 hold the Procurement Readiness Review. We will continue the work in 1008 for the new setup.

Issues:

None

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

Current Status:

The assembly kit for v2 of the disc/shaper board prototype was sent out, with the new calibration circuit, and we expect to get the board back in August. Currently the situation with COVID is stable, so we hope to be able to get started with the testing in August. I am meeting weekly with grad students from Howard and Florida A&M Univ, and they are slowly getting up to speed on the MBD and the skill set required for testing it.

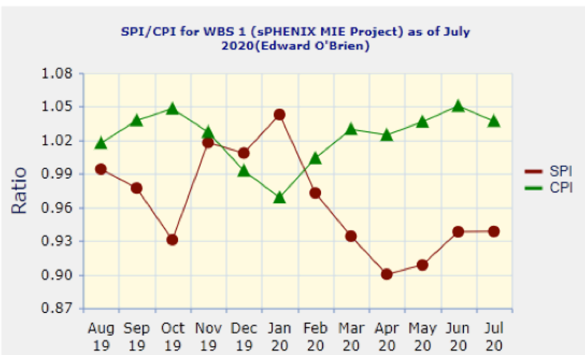
Work for Next 2-3 Months:

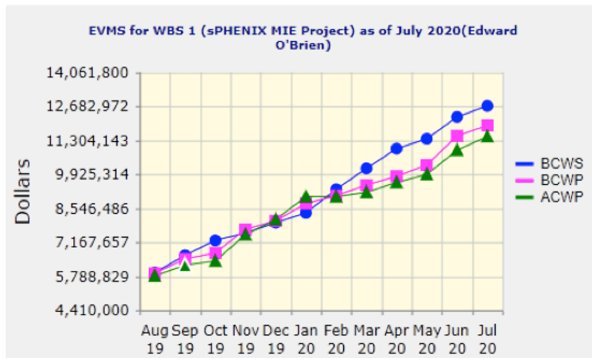
We expect the fully assembled v2 disc/shaper board in August for testing. The FPGA coding for the disc/shaper board is written, so it just needs to be tested live on the board.

Issues:

None

Performance Indices and Earned Value Data





BAC: $22,198,743 EAC: $23,100,310 VAC: ($901,567)

Cumulative SPI	Cumulative CPI
0.94	1.04

Cumulative BCWS (Scheduled)	$12,688,746
Cumulative BCWP (Performed)	$11,898,007
Cumulative ACWP (Actual)	$11,447,803

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

July 2020 Cost Performance Report

8. PERFORMANCE DATA											
CA (3)	CUMULATIVE TO DATE					AT COMPLETION					
	BUDGETED COST		ACTUAL	VARIANCE		BUDGETED	ESTIMATED	VARIANCE			
ITEM (1)	WORK SCHEDULED (7)	WORK PERFORMED (8)	COST WORK PERFORMED (9)	SCHEDULE (10)	COST (11)	(14)	(15)	(16)		SPI	CPI
1.01A Project Management	1,717,170	1,717,170	1,564,402	0	152,767	1,951,679	1,798,911	152,767		1.00	1.10
1.02A TPC	2,311,012	1,913,833	1,726,391	-397,179	187,442	4,180,135	3,996,235	183,900		0.83	1.11
1.03A EMCal	3,750,911	3,572,721	3,692,149	-178,190	-119,428	5,255,094	5,681,205	-426,112		0.95	0.97
1.04A HCal	2,246,957	2,020,693	1,855,968	-226,264	164,725	4,033,110	4,109,425	-76,316		0.90	1.09
1.05A Calorimeter Electronics	2,321,535	2,251,616	2,224,786	-69,919	26,830	5,363,466	6,136,758	-773,292		0.97	1.01
1.06A DAQ & Trigger	242,014	322,827	305,804	80,813	17,024	1,245,090	1,228,450	16,640		1.33	1.06
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	12,688,746	11,898,007	11,447,803	-790,738	450,204	22,198,743	23,100,310	-901,567		0.94	1.04
f. Contingency						4,801,257					
g. TOTAL	12,688,746	11,898,007	11,447,803	-790,738	450,204	27,000,000					

$11,652,508	ETC
$10,300,736	BCWR
46.61%	% Contingency on Remaining Work
41.20%	% Contingency on ETC
57.16%	% Planned
53.60%	% Complete
51.57%	% 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

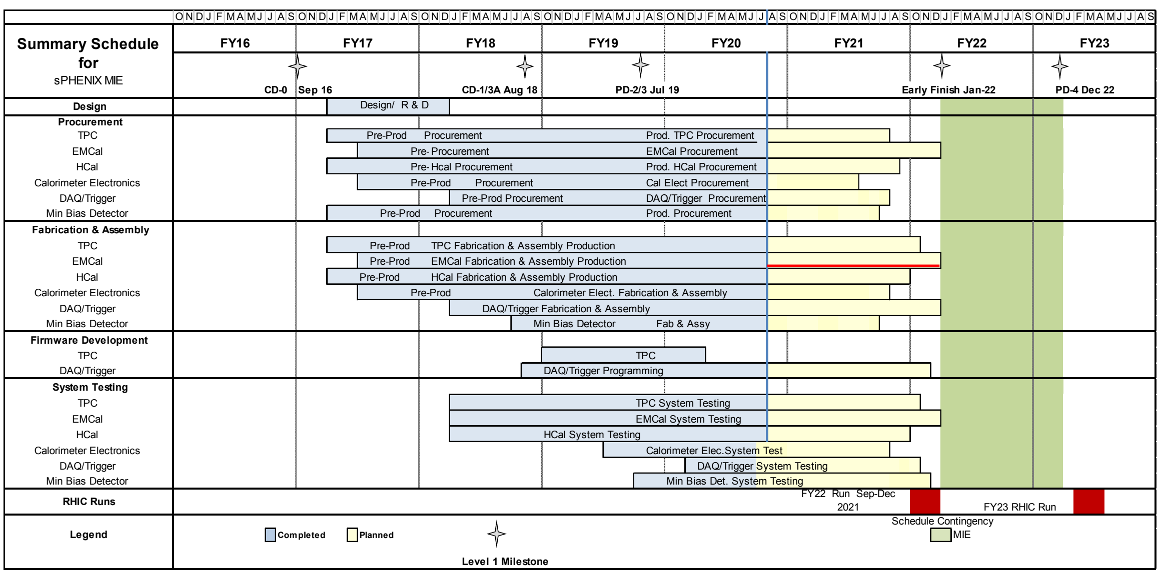
L1 & L2 Milestones

#	WBS	Milestone Name	Target Milestone Date	Forecast	Actual Finish	Variance (in work days)
1	1.01.01	Approve Project Baseline and Construction PD2/3	30-Sep-19	20-Sep-19 A	20-Sep-19	6
2	1.02.02.02	Production Readiness Review - TPC Module Factories	31-Dec-19	17-Dec-19 A	17-Dec-19	8
3	1.03.02.03.02	EMCal Preproduction Sector 0 Assembled	31-Dec-19	25-Nov-19 A	25-Nov-19	23
4	1.02.06.02	Production Readiness Review - TPC DAM	28-Feb-20	04-Feb-20 A	4-Feb-20	16
5	1.05.02.03	HCal Preproduction FEE Complete	30-Apr-20	22-Jan-20 A	22-Jan-20	70
6	1.05.02.01	EMCal Electronics Preproduction Complete	29-May-20	28-May-20 A	28-May-20	0
7	1.03.01.03.01	EMCal W Powder Acquisition Complete	30-Jun-20	15-Jun-20 A	15-Jun-20	11
8	1.03.02.03.03	EMCal Production Readiness Review Blocks/Modules/Sectors Complete	31-Jul-20	30-Jul-20 A	30-Jul-20	1
9	1.02.05.03	SAMPA ASIC Performance Accepted	30-Sep-20	29-May-20 A	29-May-20	86
10	1.05.01	EMCal/HCal SiPM Sensor Procurement Complete	30-Oct-20	28-Feb-20 A	28-Feb-20	171
11	1.05.02.04	HCal SiPM Boards Assembly Complete	30-Nov-20	15-Jan-21		-33
12	1.02.06.03	TPC DAM Felix 2.0 Production Complete	29-Jan-21	11-Jun-21		-94
13	1.06.02.03	Trigger LL1 Preproduction complete	26-Feb-21	16-Mar-21		-13
14	1.05.02.02	EMCal SiPM Boards Production Complete	31-Mar-21	2-Nov-20		99
15	1.04.04.02	First Outer HCAL Sector and Splice Plates Ready to Install	30-Apr-21	16-Nov-20		112
16	1.04.01	Inner HCAL Support Structure Ready for Installation	30-Apr-21	3-May-21		-2
17	1.02.01.06	GEM Production Complete	31-May-21	15-Mar-21		54
18	1.03.01.03.01	EMCal Scintillating Fiber Acquisition Complete	31-May-21	4-Mar-21		61
19	1.06.01.03	DAQ Production: DAQ Ready for Operation	31-May-21	15-Dec-21		-136
20	1.05.02.04	HCal Electronics Complete: Production	30-Jun-21	5-Aug-21		-26
21	1.02.05.04	TPC FEE Production Complete	30-Jul-21	15-Jul-21		10
22	1.05.03.02	Calorimeter Electronics Complete	30-Jul-21	5-Aug-21		-5
23	1.05.02.02	EMCal Electronics Complete	30-Jul-21	15-Apr-21		73
24	1.07	MinBias Detector Ready to Install	30-Sep-21	16-Nov-21		-32
25	1.06.03.03	GL1 Ready to Operate	30-Sep-21	13-Oct-21		-9
26	1.01.01	Early Project Completion	29-Oct-21	7-Jan-22		-45
27	1.02.01.08	TPC Ready to Install (Assembly Complete)	29-Oct-21	27-Oct-21		1
28	1.02.06.03	TPC DAM Production Complete	29-Oct-21	20-Oct-21		6
29	1.03.02.03.03	EMCal Ready to Install	29-Oct-21	6-Jan-22		-45
30	1.04.04.02	Last Outer HCAL Sector Ready to Install	29-Oct-21	17-Sep-21		28
31	1.06.02.04	LL1 Trigger Production Complete	29-Oct-21	5-Oct-21		16
32	1.06.02.04	LL1 Ready to Operate	29-Oct-21	5-Oct-21		16
33	1.01.01	Approve Project Closeout PD-4	30-Dec-22	29-Dec-22*		0

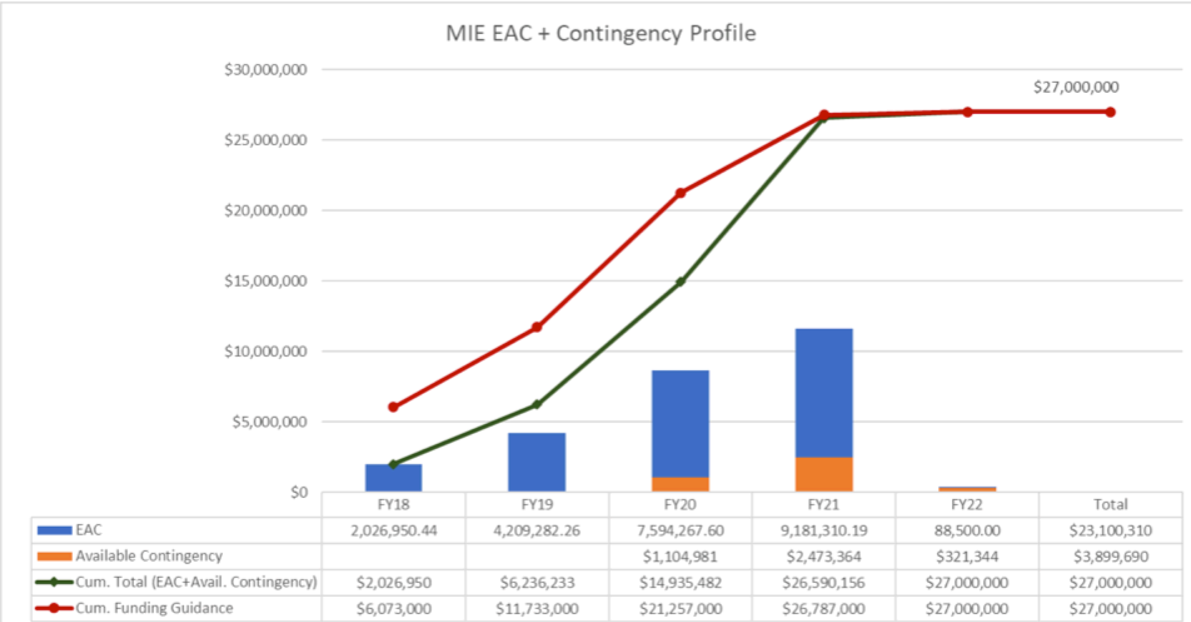
sPHENIX Budget Profile:

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



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

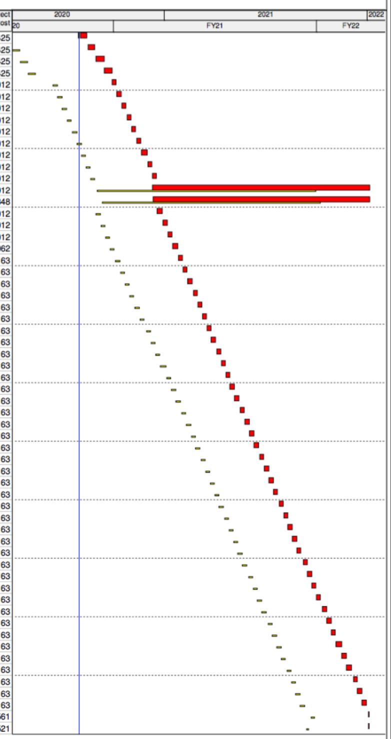
Date	PCR ID	PCR Title	WBS affected	sPHENIX MIE Baseline Cost	PCR Change	Contingency	Total Project Cost
9/20/2019	Approved MIE	Setting up Baseline	all	$22,169,490		$4,830,510	$27,000,000
9/24/2019	007A	Hcal Scin Tiles placed Contract delivery schedule	1.04 HCal	$22,132,844	($36,646)	$4,867,156	$27,000,000
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 July 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
S166700	Fabricate EMCAL Prepro blocks sector 9	12	0	30-Jul-20 A	14-Aug-20	20-Mar-20	02-Apr-20	-94	168	0	$9,425	$9,425
S166800	Fabricate EMCAL Prepro blocks sector 10	10	0	17-Aug-20	28-Aug-20	03-Apr-20	16-Apr-20	-94	168	0	$9,425	$9,425
S166900	Fabricate EMCAL Prepro blocks sector 11	10	0	31-Aug-20	14-Sep-20	17-Apr-20	30-Apr-20	-94	168	0	$9,425	$9,425
S167000	Fabricate EMCAL Prepro blocks sector 12	10	0	15-Sep-20	28-Sep-20	01-May-20	14-May-20	-94	168	0	$9,425	$9,425
S173000	Fabricate final blocks sector 13	6	0	29-Sep-20	06-Oct-20	15-Jun-20	22-Jun-20	-74	135	0	$5,113	$5,012
S173100	Fabricate final blocks sector 14	6	0	07-Oct-20	15-Oct-20	23-Jun-20	30-Jun-20	-74	135	0	$5,163	$5,012
S173200	Fabricate final blocks sector 15	6	0	16-Oct-20	23-Oct-20	01-Jul-20	09-Jul-20	-74	135	0	$5,163	$5,012
S173300	Fabricate final blocks sector 16	6	0	26-Oct-20	02-Nov-20	10-Jul-20	17-Jul-20	-74	135	0	$5,163	$5,012
S173400	Fabricate final blocks sector 17	6	0	03-Nov-20	10-Nov-20	20-Jul-20	27-Jul-20	-74	135	0	$5,163	$5,012
S173500	Fabricate final blocks sector 18	6	0	12-Nov-20	19-Nov-20	28-Jul-20	04-Aug-20	-74	135	0	$5,163	$5,012
S173600	Fabricate final blocks sector 19	6	0	20-Nov-20	01-Dec-20	05-Aug-20	12-Aug-20	-74	135	0	$5,163	$5,012
S173700	Fabricate final blocks sector 20	6	0	02-Dec-20	09-Dec-20	13-Aug-20	20-Aug-20	-74	135	0	$5,163	$5,012
S173800	Fabricate final blocks sector 21	6	0	10-Dec-20	17-Dec-20	21-Aug-20	28-Aug-20	-74	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
S173900	Fabricate final blocks sector 22	6	0	18-Dec-20	28-Dec-20	31-Aug-20	08-Sep-20	-74	135	0	$5,163	$5,012
S174000	Fabricate final blocks sector 23	6	0	29-Dec-20	06-Jan-21	09-Sep-20	16-Sep-20	-74	135	0	$5,163	$5,012
S174100	Fabricate final blocks sector 24	6	0	07-Jan-21	14-Jan-21	17-Sep-20	24-Sep-20	-74	135	0	$5,163	$5,012
S174200	Fabricate final blocks sector 25	6	0	15-Jan-21	25-Jan-21	25-Sep-20	02-Oct-20	-74	135	0	$5,163	$5,062
S174300	Fabricate final blocks sector 26	6	0	26-Jan-21	02-Feb-21	05-Oct-20	13-Oct-20	-74	135	0	$5,163	$5,163
S174400	Fabricate final blocks sector 27	6	0	03-Feb-21	10-Feb-21	14-Oct-20	21-Oct-20	-74	135	0	$5,163	$5,163
S174500	Fabricate final blocks sector 28	6	0	11-Feb-21	19-Feb-21	22-Oct-20	29-Oct-20	-74	135	0	$5,163	$5,163
S174600	Fabricate final blocks sector 29	6	0	22-Feb-21	01-Mar-21	30-Oct-20	06-Nov-20	-74	135	0	$5,163	$5,163
S174700	Fabricate final blocks sector 30	6	0	02-Mar-21	09-Mar-21	09-Nov-20	17-Nov-20	-74	135	0	$5,163	$5,163
S174800	Fabricate final blocks sector 31	6	0	10-Mar-21	17-Mar-21	18-Nov-20	25-Nov-20	-74	135	0	$5,163	$5,163
S174900	Fabricate final blocks sector 32	6	0	18-Mar-21	25-Mar-21	30-Nov-20	07-Dec-20	-74	135	0	$5,163	$5,163
S175000	Fabricate final blocks sector 33	6	0	26-Mar-21	02-Apr-21	08-Dec-20	15-Dec-20	-74	135	0	$5,163	$5,163
S175100	Fabricate final blocks sector 34	6	0	05-Apr-21	12-Apr-21	16-Dec-20	23-Dec-20	-74	135	0	$5,163	$5,163
S175200	Fabricate final blocks sector 35	6	0	13-Apr-21	20-Apr-21	24-Dec-20	04-Jan-21	-74	135	0	$5,163	$5,163
S175300	Fabricate final blocks sector 36	6	0	21-Apr-21	28-Apr-21	05-Jan-21	12-Jan-21	-74	135	0	$5,163	$5,163
S175400	Fabricate final blocks sector 37	6	0	29-Apr-21	06-May-21	13-Jan-21	21-Jan-21	-74	135	0	$5,163	$5,163
S175500	Fabricate final blocks sector 38	6	0	07-May-21	14-May-21	22-Jan-21	29-Jan-21	-74	135	0	$5,163	$5,163
S175600	Fabricate final blocks sector 39	6	0	17-May-21	24-May-21	01-Feb-21	08-Feb-21	-74	135	0	$5,163	$5,163
S175700	Fabricate final blocks sector 40	6	0	25-May-21	02-Jun-21	09-Feb-21	17-Feb-21	-74	135	0	$5,163	$5,163
S175800	Fabricate final blocks sector 41	6	0	03-Jun-21	10-Jun-21	18-Feb-21	25-Feb-21	-74	135	0	$5,163	$5,163
S175900	Fabricate final blocks sector 42	6	0	11-Jun-21	18-Jun-21	26-Feb-21	05-Mar-21	-74	135	0	$5,163	$5,163
S176000	Fabricate final blocks sector 43	6	0	21-Jun-21	28-Jun-21	08-Mar-21	15-Mar-21	-74	135	0	$5,163	$5,163
S176100	Fabricate final blocks sector 44	6	0	29-Jun-21	07-Jul-21	16-Mar-21	23-Mar-21	-74	135	0	$5,163	$5,163
S176200	Fabricate final blocks sector 45	6	0	08-Jul-21	15-Jul-21	24-Mar-21	31-Mar-21	-74	135	0	$5,163	$5,163
S176300	Fabricate final blocks sector 46	6	0	16-Jul-21	23-Jul-21	01-Apr-21	08-Apr-21	-74	135	0	$5,163	$5,163
S176400	Fabricate final blocks sector 47	6	0	26-Jul-21	02-Aug-21	09-Apr-21	16-Apr-21	-74	135	0	$5,163	$5,163
S176500	Fabricate final blocks sector 48	6	0	03-Aug-21	10-Aug-21	19-Apr-21	26-Apr-21	-74	135	0	$5,163	$5,163
S176600	Fabricate final blocks sector 49	6	0	11-Aug-21	18-Aug-21	27-Apr-21	04-May-21	-74	135	0	$5,163	$5,163
S176700	Fabricate final blocks sector 50	6	0	19-Aug-21	26-Aug-21	05-May-21	12-May-21	-74	135	0	$5,163	$5,163
S176800	Fabricate final blocks sector 51	6	0	27-Aug-21	03-Sep-21	13-May-21	20-May-21	-74	135	0	$5,163	$5,163
S176900	Fabricate final blocks sector 52	6	0	07-Sep-21	14-Sep-21	21-May-21	28-May-21	-74	135	0	$5,163	$5,163
S177000	Fabricate final blocks sector 53	6	0	15-Sep-21	22-Sep-21	01-Jun-21	08-Jun-21	-74	135	0	$5,163	$5,163
S177100	Fabricate final blocks sector 54	6	0	23-Sep-21	30-Sep-21	09-Jun-21	16-Jun-21	-74	135	0	$5,163	$5,163
S177200	Fabricate final blocks sector 55	6	0	01-Oct-21	08-Oct-21	17-Jun-21	24-Jun-21	-74	135	0	$5,318	$5,163
S177300	Fabricate final blocks sector 56	6	0	12-Oct-21	19-Oct-21	25-Jun-21	02-Jul-21	-74	135	0	$5,318	$5,163
S177400	Fabricate final blocks sector 57	6	0	20-Oct-21	27-Oct-21	06-Jul-21	13-Jul-21	-74	135	0	$5,318	$5,163
S177500	Fabricate final blocks sector 58	6	0	28-Oct-21	04-Nov-21	14-Jul-21	21-Jul-21	-74	135	0	$5,318	$5,163
S177600	Fabricate final blocks sector 59	6	0	05-Nov-21	15-Nov-21	22-Jul-21	29-Jul-21	-74	135	0	$5,318	$5,163
S177700	Fabricate final blocks sector 60	6	0	16-Nov-21	23-Nov-21	30-Jul-21	06-Aug-21	-74	135	0	$5,318	$5,163
S177800	Fabricate final blocks sector 61	6	0	24-Nov-21	03-Dec-21	09-Aug-21	16-Aug-21	-74	135	0	$5,318	$5,163
S177900	Fabricate final blocks sector 62	6	0	06-Dec-21	13-Dec-21	17-Aug-21	24-Aug-21	-74	135	0	$5,318	$5,163
S178000	Fabricate final blocks sector 63	6	0	14-Dec-21	21-Dec-21	25-Aug-21	01-Sep-21	-74	135	0	$5,318	$5,163
S178100	Fabricate final blocks sector 64	6	0	22-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 Serv	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
TPC

Reporting Period: July 2020

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV in %	SPI	CPI
Current:	70,945	216,680	52,664	145,735	205%	164,016	76%	3.05	4.11
Cumulative:	2,311,012	1,913,833	1,726,391	-397,179	-17%	187,442	10%	0.83	1.11
	BAC								
At Complete:	4,180,135								

Threshold(s) Exceeded: Cumulative Schedule

Explanation of Variance/Description of Problem:

Impact:

Corrective Action:

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

WBS 1.04A
HCal

Reporting Period: July 2020

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV in %	SPI	CPI
Current:	254,507	92,325	207,364	-162,182	-64%	-115,039	-125%	0.36	0.45
Cumulative:	2,246,957	2,020,693	1,855,968	-226,264	-10%	164,725	8%	0.90	1.09
	BAC								
At Complete:	4,033,110								

Threshold(s) Exceeded: Cumulative Schedule

Explanation of Variance/Description of Problem:
The schedule variance for the current period is driven by "S208308 Procure Outer HCAL Scintillating Tiles (Prod) - Delivery Acceptance 7&8". This is the last large batch of tiles to be delivered from Uniplast. It arrived at GSU on 8/14 (consisting of 1081 tiles and the remaining injection molded parts)

Impact:
No impact anticipated. Tile testing remains on schedule and there are sufficient tiles at BNL of all types for sector assembly.

Corrective Action:
No corrective action required.

Prepared:	**Prepared By:**	**Approved:**	**Approved By:**
8/20/2020	John Lajoie [L5823]	8/24/2020	Edward O'Brien [18368]