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

Current PD:	**2/3**	Date of Current CD/PD approval		September 2019	
Next PD:	**4**	Forecast approval:	**1QFY23**	Baseline:	**1QFY23**
% Complete:	**60.25%**	Planned:		**70.7%**	
ETC:	**$9.85M**	TPC or Cost Range:		**$27.0M**	
Contingency:	**25.1%** on ETC	Float to PD-4 in months:		**11.0**	
Cumulative CPI:	**1.02**	Cumulative SPI:		**0.85**	

2. **NEAR TERM MILESTONES**

The sPHENIX Project team will continue the monthly EVMS process, Change Control, and updating of the ETC. We will continue to place orders for detector components approved at PD-3. We are continuing to implement a plan to mitigate COVID-19 related delays and have hired additional technical and engineering labor at both BNL and universities to maintain the project schedule. We plan to implement a PCR in the near future to add tech labor to the Time Projection Chamber and change the schedule contingency to match current progress in P6

The schedule contingency was reduced by 10 days in December primarily due to effects from increasing COVID cases in the US. Eleven months of schedule contingency to the PD-4 date remains. A drop in the SPI for December was also driven by COVID delays, especially from manufacturers providing production parts to sPHENIX. We expect the SPI to slowly improve over the next few months as the parts arrive from the manufacturers. The project cost performance remains excellent.

The TPC will begin the fab of its central membrane with aluminum stripes being evaporated onto the central membrane petals. The TPC field cage pieces will begin assembly into the final full unit. First production TPC FEE boards will be ordered pending a successful preproduction round from the board assembly house.

Production of blocks for EMCal Sectors 13-64 will continue at UIUC. Work will continue on EMCal module production and sector assembly at BNL. We expect that additional deliveries of light guides to BNL will continue for the next few months. Additional technical labor for the EMCal sector factory has been hired by BNL and will begin working on module and sector fabrication.

ISU has a Request for Quotation (RFQ) for the IHCal frame. Bids are expected in January followed by vendor selection and contract award. The delivery schedule from the vendor will be integrated into the IHCAL assembly and sPHENIX assembly plan. Over the next several months work on the outer HCAL will center on production of fully instrumented sectors as work in the BNL HCAL factory continues. OHCal sector fabrication will continue to

proceed at a pace consistent with the P6 schedule. We expect the parts that enable the mechanical assembly of the OHCal sectors into the detector barrel will arrive at BNL in February. The parts have been delayed by COVID issues at the vendor. The OHCal parts include the joining plates, pins and pucks.

Calorimeter electronics work over the next 3 months will be focused on the fabrication of cable assemblies for the remaining OHCal modules, testing of EMCal SiPM boards and HCal preamps, assembly of a Calorimeter digitizer rack with a fully instrumented crate of electronics, production of LVPS systems, and ordering external signal and LV cables for the EMCal and HCal.

The DAQ/Trigger group will work on the further implementation of the sPHENIX run control software. The development of the Local-Level 1 board and firmware will continue.

The Min Bias Detector (MBD) group will hold the MBD Discriminator/Shaper (D/S) board Production Readiness Review in February. BNL scientists will continue to train grad students from Howard Univ and Florida A&M Univ on testing and operation of the MBD.

3. **STATUS HIGHLIGHTS**

Production components for the sPHENIX detector continue to arrive. Most of the recent project activities are associated with production of final detector components. Remaining R&D is limited to electronics and calibration components for the detector, and will be completed in the near future.

The early completion date was reduced by 10 days in December primarily due to impacts from the spike of COVID cases in the US. Eleven months of schedule contingency to the PD-4 date remains. The project cost performance remained excellent. We retired risks in the Risk Registry for the HCal and EMCal. Subsequently there was an increase in availability in the amount of contingency funds not tied to risks. EVMS processing was completed for December. Cobra and P6 monthly reports uploaded to IPD. The variance reports were approved. The remaining LLP item approved at CD-3A, the scintillating fiber for the EMCal, continues to arrive on schedule. A PCR was approved in December to add technical labor to EMCal and HCal to remedy COVID delays. The project is 60.25% compete in December with a 25.1% contingency on the ETC.

Each TPC GEM factory has framed their first GEMs and requested the start of full production. GEMs from every factory passed second inspection at WSU. The first major shipment of GEM foils arrived at SBU from CERN on time and was distributed to all GEM module factories. Full GEM foil production is now under way. The TPC R1 pad plane design is completed and bids are received. FEE cards FPGA programming continues at BNL. A preliminary design review for TPC installation was held. The first prototype line laser for the TPC has arrived and is under preparation for tests at full magnetic field strength at the BNL magnet division.

Block production at UIUC for Sectors 1-12 has been completed and production continued for Sectors 13-64. As of the third week in December a total of 487 blocks (6.8 sectors) have been produced and 5.2 sectors have been shipped to BNL. In addition, 62% of the fiber assemblies for Sectors 13-64 have been filled. Work on module production and sector assembly continued at BNL. All of the modules for Sectors 1-9 have been completed and work is continuing on the modules for Sectors 10 and 11.

The contract between BNL and Iowa State University (ISU) for the IHCAL sectors has been completed. ISU has released an RFQ that will remain active until Jan. 29, 2021, after which a vendor will be selected. ISU and Rutgers will place the orders for the IHCal sector parts and manage their production. The end ring supports have

contracted with a vendor for production. GSU has completed testing of the scintillating tiles required for the outer HCAL, with only 1.4% failing performance testing. All OHCAL tiles have been shipped to BNL. OHCal Factory operations at BNL are continuing with technician labor and collaborator support from the NY state area. The first six pre-production sectors have been fully assembled and tested, along with five production sectors, and all eleven have been tested and moved to storage. Five additional production sectors are in various stages of electronics installation and testing. Delivery of the high-strength endplates, splice plates, pucks, and pins required for the assembly of the OHCal sectors into the central barrel has been delayed to the end of February, 2021. The vendor has indicated a lack of labor due to COVID-19 has slowed the production schedule.

Testing of the EMCal SiPM daughter boards continues with a failure rate of less them 1%. Testing of HCal preamps continues with the assistance of Lehigh University and Iowa State University. The testing of the HCal Interface Boards and LED Driver Boards has been completed. The assembly of interior cables for the EMCal and HCal continues. For the EMCal, all power and communications cables have been assembled and the vendor continues to deliver the signal cables on a regular basis. Work continues on finalizing the rack designs and generating the line drawings required to assemble the EMCal and HCal power, slow control and digitizer racks. The bias crates for the EMCal and HCal systems have been delivered and are available for installation. Work at Nevis continues to refine the FPGA firmware and prepare the documentation needed to start ordering the parts for the full production of the digitizer system. The University of Colorado group has completed the assembly of the digitizer test stand and is working on finalizing the software required for detailed testing of the digitizer boards.

The setup of the previously procured Data Acquisition PCs and the Buffer Box, one of 6 total, has been completed and performance tests have been completed. For the Global Level-1 (GL1) and Timing System, the design of an add-on board has been completed, and was sent out for fabrication. Tests of the DAQ/Trigger system are underway to prove the absolute alignment of the data passing through the Calorimeter portion of the DAQ. Tests of the Run Control part of the DAQ were also performed in December.

Columbia University Nevis Labs personnel took data reading out up to 3 Min Bias Detector D/S Boards, and 2 ADC boards. The test results looked good, resulting in timing resolutions of 30-40 ps, which exceeds the performance metric by over a factor of two. We are preparing for a MBD D/S board procurement readiness review to happen in early February.

WBS 1.1 Project Management (L2 Manager: Irina Sourikova)

Current Status:

- SPI is 0.85, CPI is 1.02

Highlights:

- PCR to add technical labor to EMCal and HCal to remedy COVID delays.
- TPC cooling FDR/PRR review complete.
- Retired risks in HCal and EMCal; risk contingency increased.

- EVMS processing complete. Schedule contingency reduced by 10 days, cost performance remained excellent. Eleven months of schedule contingency to PD-4 date remains.
- Cobra and P6 monthly reports uploaded to IPD.
- Variance reports approved.

Plans for the next 2-3 month:

- Continue monthly EVMS process and Change Control.
- Implement a PCR to add tech labor to TPC and change Schedule Contingency to match current progress in P6.
- Implement corrective actions to improve schedule performance.

Issues:

- COVID impact on schedule due to US spike in November and December has had impact on delivery schedules from vendors.

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

Current Status:

Each factory has framed their first GEMs and requested start of full production. GEMs from every factory passed a second inspection at WSU. The first major shipment of GEM foils arrived on time and was distributed to all factories. Full GEM foil production is now under way. All factories are entering progress and evaluation data (leakage currents vs. time) into the database for all framed GEMs.

The evaporator at SBU has evaporated test samples to characterize rate of deposition of Al and Cr in preparation for the central membrane petals.

The R1 pad plane design is completed and bids are received.

The FPGA programming for the TPC Fee cards is continuing. No errors in the cards have been identified.

Orders are under way for the gas, cooling, and laser systems for all components that do not require a review. Design reviews for the full design of the TPC gas, cooling and laser system were held. A preliminary design review for TPC installation was also held.

The first prototype line laser arrived and is under preparation for tests at full magnetic field strength at the BNL magnet division. If successful, the NRE development phase is ended and procurements can begin.

Work Anticipated 2-3 Months:

The Al stripes will be evaporated onto the central membrane petals. The field cage pieces will begin assembly into the final full unit. First production TPC Fee boards will be ordered pending a successful preproduction round from the board assembly house.

Issues:

The plans for the JACK card have been expended to include backdoor scrubbing of the FEE FPGA during normal operation. While leading to a more robust operation, this change would also require additional expense. A cost/benefit analysis is under way (first meeting in December, continuing meetings in January) to finalize the best strategy. Options include replacing the JACK card with Felix cards.

The central tube for the TPC assembly cart was to have been completed in December 2020 in the BNL shops, but the BNL central shops decided to send this out for commercial manufacture. This resulted in additional costs to keep our schedule.

COVID: The initial GEM production at CERN was delayed due to the closing of their shop resulting with a delay that has reduced our float to 90 days on GEMs. Thermal tests were held late due to prior unavailability of BNL personnel and a backlog of other projects upon their return to the lab. Population and testing of the FEE card was delayed in exactly the same way. None of these have yet put the TPC on or near the critical path.

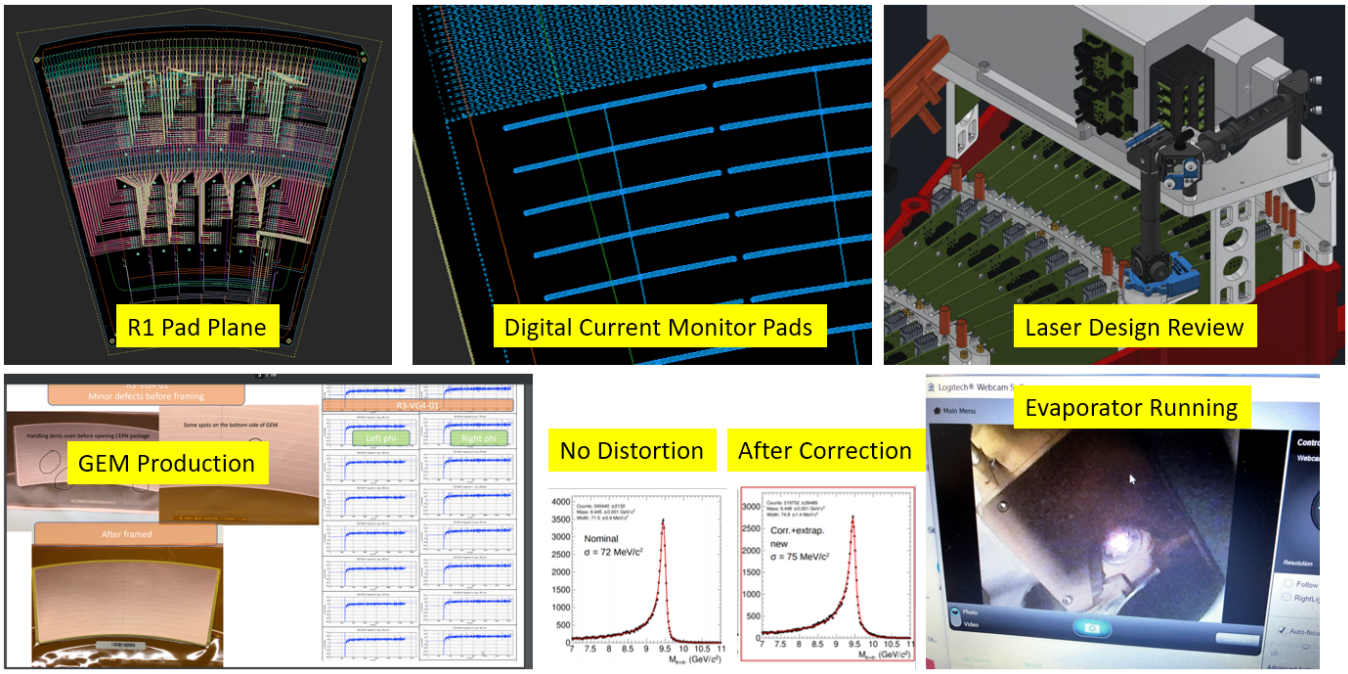


Figure 1: Clockwise from upper left: Layout of the R1 pad planes. Layout of the central membrane focusing on the digital current monitor pads. 3-D model of the TPC laser calibration system mounted on the TPC endcap. Evaporator at SBU to be used to place aluminum stripes on the TPC central membrane. Simulated TPC response without space charge distortion, and with inclusion of both space charge distortion and distortion correction. QA testing of GEM modules after framing at university labs.

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

Current Status:

Block production at UIUC for Sectors 1-12 has been completed and production continued for Sectors 13-64. Figure 2 shows the status for the Sector 13-64 blocks as of December 18th. A total of 487 blocks (6.8 sectors) have been produced and 5.2 sectors have been shipped to BNL. The rejection rate for the 487 blocks was 2.4 % (12 blocks). In addition, 62% of the fiber assemblies for Sectors 13-64 have been filled.

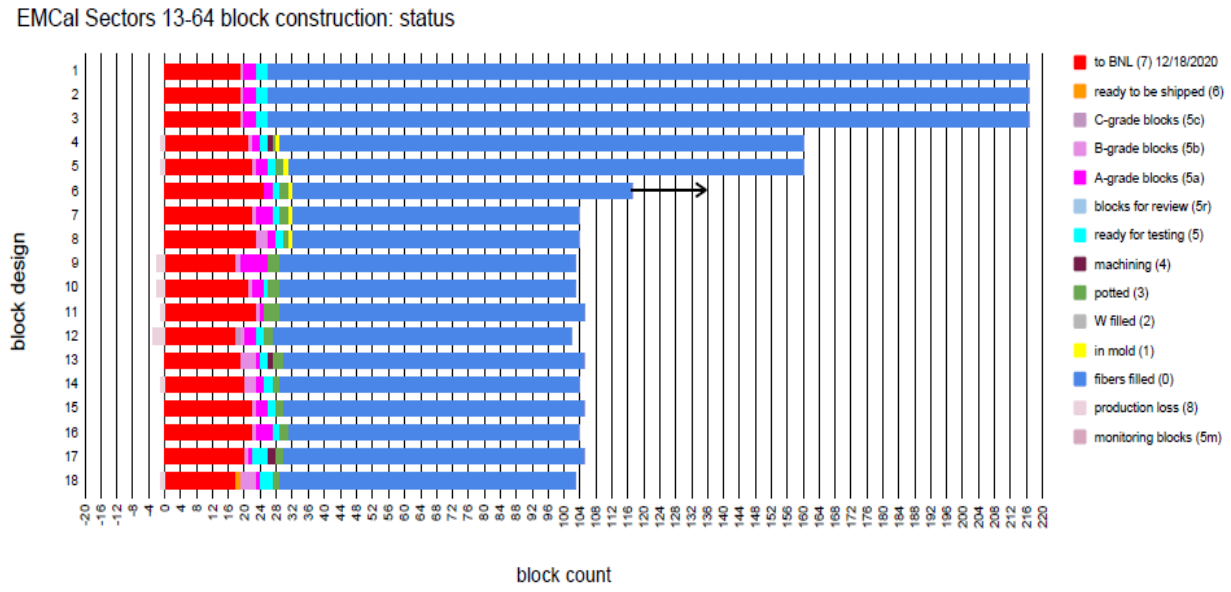


Figure 2: Progress on block production for Sectors 13-64 at UIUC as of December 18th.

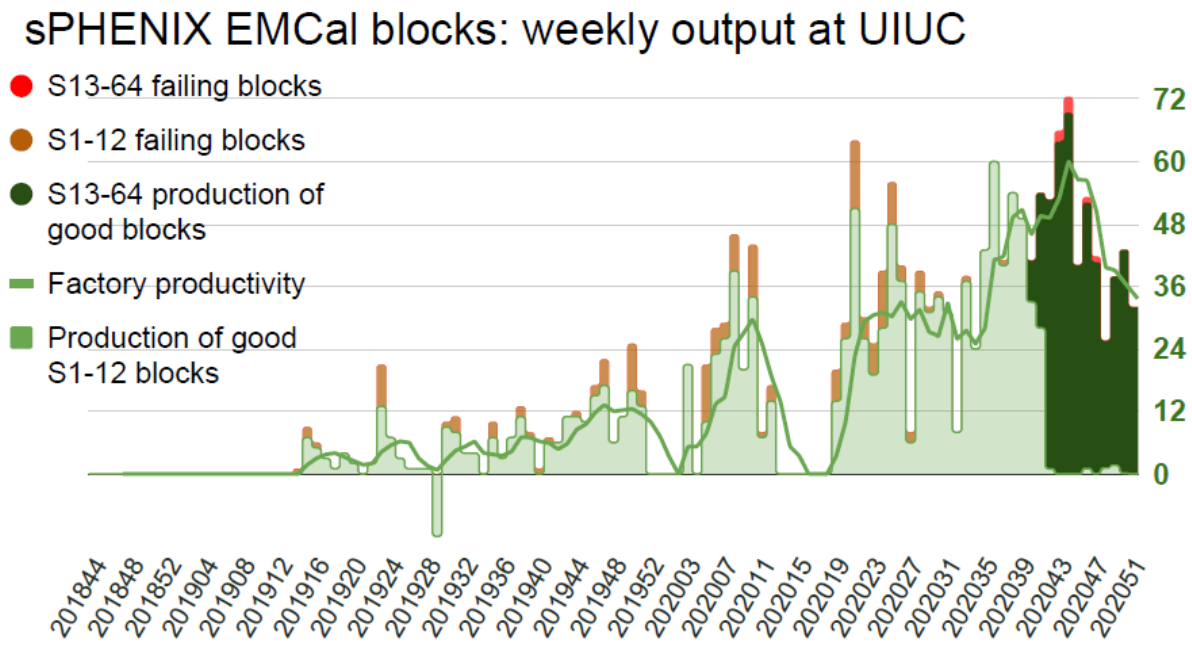
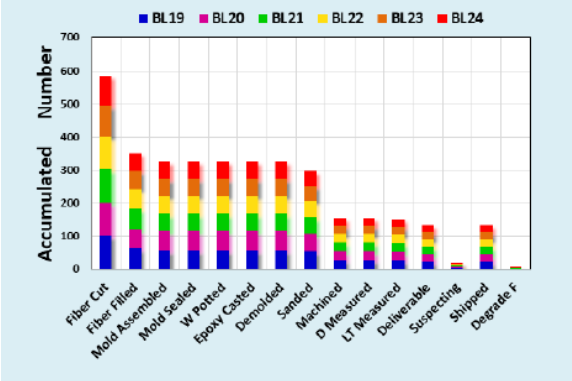


Figure 3: Weekly rate of block production at UIUC (moving average over 4 weeks).

Figure 3 shows the weekly rate of block production at UIUC. The rate of blocks produced exceeded the target production rate of 60 blocks per week in late October but dropped off somewhat in November, partially due to the Thanksgiving holiday, then picked up for several weeks but began slowing down again due to a shortage of personnel during winter break.



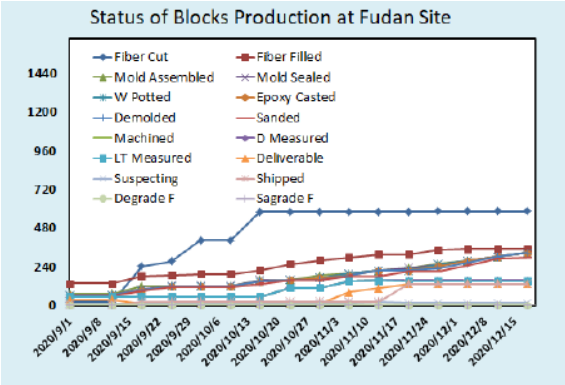


Figure 4: Block production at Fudan. Left shows the total number of blocks at various stages of production. Right shows production and shipment per week.

Block production also continued at Fudan. Figure 4 shows the status of various stages of block production and shipment as of December 18th. It is expected that another 119 blocks will arrive back at Fudan from the company that is doing the machining on the blocks by Dec 25th. These blocks will then be checked and prepared for shipment to BNL in early January.

Work on module production and sector assembly continued at BNL. Figure 5 shows the status of the various stages of module production as of Dec 18th. All of the modules for Sectors 1-9 have been completed and work is continuing on the modules for Sectors 10 and 11. More light guides arrived from the manufacturer and we now have enough on hand to complete Sector 12 and most of Sector 13.

Figure 6 shows the status of sector assembly. Nine sectors have been completed and work is proceeding on Sector 10. We expect that Sector 10 and possibly Sector 11 will have their blocks glued in by the end of the year. Sectors 1-8 have passed their initial postproduction testing and are awaiting further burn-in testing. The sector test area was reorganized for greater throughput and burn-in capacity. The electronics rack for the burn-in station was installed and will be operational shortly.

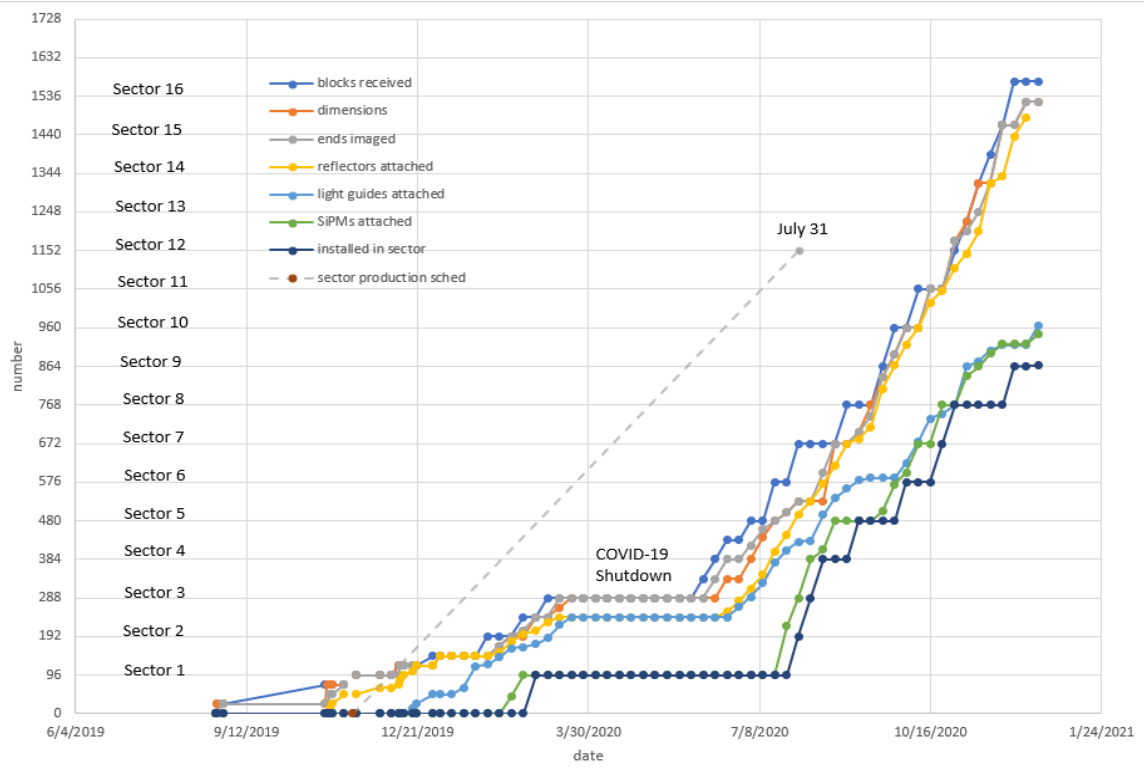


Figure 5: Status of module production at BNL as of Dec 18th.

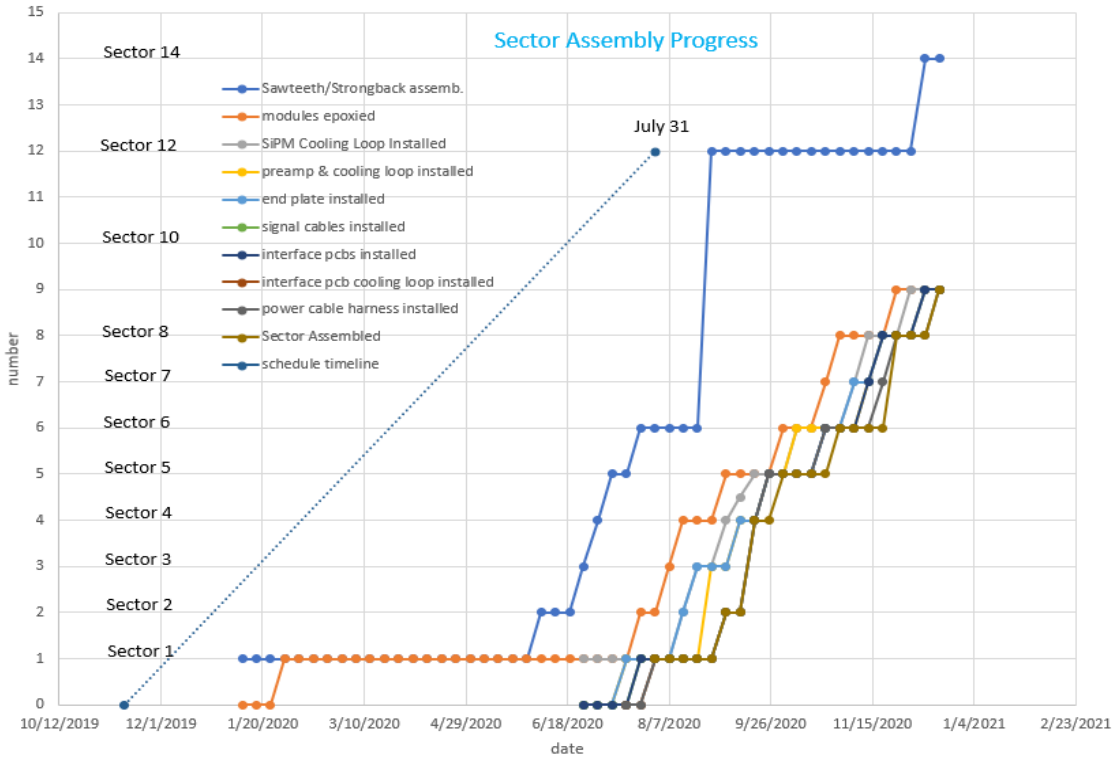


Figure 6: Status of sector assembly at BNL as of Dec 18th.

Work For the Next 2-3 Months:

Production of blocks for Sectors 13-64 will continue at UIUC. There will be an expected slowdown during the Christmas and New Year holidays but should pick up again after the New Year assuming no further COVID delays and that sufficient manpower (particularly student labor) is available.

Production of the high rapidity blocks for Sectors 13-64 will also continue at Fudan. A second shipment of ~ 100 blocks is expected to be sent to BNL in early January.

Work will also continues on module production and sector assembly at BNL. There is now a steady stream of parts arriving, including light guides, cooling loops and sawteeth, which should allow module production and sector assembly to proceed on schedule. However, in December the rate of both module production and sector assembly was limited due to availability of technical labor.

Issues:

Two new techs were hired by BNL to work in the last week of December and are getting trained. We expect that they will be of great help starting in January 2021. Furthermore we have two additional techs that are on loan to us from the Collider Accelerator Department that will also be of great help as we move forward.

Though we have one graduate student working with us on sector testing, we still lack sufficient manpower to begin to organize all of the data from sector testing into a useful form that can be used to turn on the entire EM calorimeter, make it operational and calibrate it after it is installed approximately one year from now. The work should be the responsibility of a dedicated postdoc.

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

WBS 1.4.1 Inner Hadronic Calorimeter

Current Status:

The contract between BNL and Iowa State University (ISU) for the iHCAL sectors has been completed. ISU has released an RFQ that will remain active until Jan. 29, 2021, after which a vendor will be selected. ISU and Rutgers will place the orders for the IHCAL sector parts and manage their production. The end ring supports have contracted between BNL and Strecks.

A combined engineering review for the installation of the iHCAL/EMCal/TPC was held Dec. 22, 2020.

Work for the Next 2-3 Months:

After the ISU RFQ is complete a vendor will be selected. The delivery schedule from the vendor will be integrated into the IHCAL assembly and sPHENIX assembly plan.

Issues:

The COVID-19 pandemic can potentially have a negative schedule impact on the inner HCAL assembly schedule due to the availability of student labor in summer 2021. More will be known when we have a sector production schedule from the manufacturer.

WBS 1.4.2/3/4 Outer Hadronic Calorimeter

Current Status:

GSU has completed testing of the scintillating tiles required for the outer HCAL, with only 1.4% failing performance testing. All oHCAL tiles have been shipped to BNL.

Factory operations at BNL are continuing with technician labor and collaborator support from the NY state area. The first six pre-production sectors have been fully assembled and tested, along with five production sectors, and all eleven have been tested and moved to storage (see Figure 6). Five new production sectors have been moved into the assembly area for tile and electronics and cabling installation. Five additional production sectors are in various stages of electronics installation and testing. At the present time the limiting factor in sector assembly continues to be the availability of signal and thermistor cables. Cables from the technicians at NSLS-II have not yet ramped up to two sector's worth per week and cable assembly is being supplemented with additional sPHENIX technician labor. Collaboration labor resources from Baruch, Lehigh, Rutgers, Colorado, and Iowa State are working regularly in the oHCAL factory.

Delivery of the high-strength endplates, splice plates, pucks, and pins has been delayed to the end of February, 2021. The vendor has indicated a lack of labor due to COVID-19 has slowed the production schedule. A partial shipment consistent of the high-strength endplates and a subset of the splice plates, pucks and pins is expected in early February, 2021, with the remainder expected by the end of the month.

Work for the Next 2-3 Months:

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

Issues:

We continue to be optimistic that we will be able to supplement OHCAL factory labor with graduate students and postdocs from beyond the NY state area in early 2021. BNL Management is supporting us in our effort to get sPHENIX visitors approved to come on BNL site.

Figure 7: sPHENIX-BNL technicians along with BNL riggers, move completed OHCAL sectors into storage.

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

Current Status:

Testing of the EMCal SiPM daughter boards continues with a failure rate of less them 1%. Testing of HCal preamps continues with the assistance of Lehigh University and Iowa State University. The testing of the HCal Interface Boards and LED Driver Boards has been completed and boards for the OHCal have been delivered to the HCal group for installation. The Assembly of interior cables for the EMCal and HCal continues. For the EMCal all power and communications have been assembled and vendor continues to provide the signal cables on a regular basis. All interior power and communication have been received and interior signal cables for 12 of the 32 HCal modules have been delivered. Work continues on finalizing the rack designs and generating the line drawings required to assemble the EMCal and HCal power, slow control and digitizer racks. A preliminary PPR for the exterior signal cables for the EMCal and HCal was performed in December and the final review scheduled for January of 2021. The bias crates for the EMCal and HCal systems have been delivered and are available for installation. The power modules are scheduled for delivery in February of 2021 has been confirmed with the vendor.

The Nevis group completed the initial power up testing of the boards for the first 7 crates of the digitizer system, with all boards passing. Work at Nevis continues to refine the FPGA firmware and prepare the documentation needed to start ordering the parts for the full production of the digitizer system. The University of Colorado group has completed the assembly of the digitizer test stand and is working on finalizing the software required for detailed testing of the digitizer boards.

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:

- Continue assembly of cable assemblies for the 20 remaining uncabled HCal modules
- Testing of EMCal SiPM boards and HCal Preamps.
- Build the first Digitizer rack with a full crate operational.
- Work with the Integration and Installation group to finalize cable lengths and rack design
- Place orders for external cables.
- Production of low voltage systems.

Issues:

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

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

Current Status:

The setup of the previously procured data acquisition PCs and the Buffer Box (shown in Fig.8), one of 6 total, has been completed and more performance tests have been done.

Figure 8: A picture of the disk enclosure with 102 14TB disks during setup.

In a largely realistic test of the future production setup, 15 individual instances of readout processes were started and controlled on 15 of the PCs, all sending their data to the buffer box. This exercises the data transfer, as well as the configuration and control of those instances, commonly referred to as “Run Control”. We found that we can log data at a rate of 25GBit/s over an extended period of time (multiple hours), and could also start and stop, and re-configure the readout. About 150,000 start and stop operations were executed without any failure.

Another welcome finding was that starting and ending data taking runs took well below a second. Often, large data acquisition systems take a long time, sometimes minutes, for this, mostly due to the underlying data protocol that then needs to communicate with a large number of components. This validates our choice of the RPC (Remote Procedure Call) mechanism that was adopted as the main control interface mechanism.

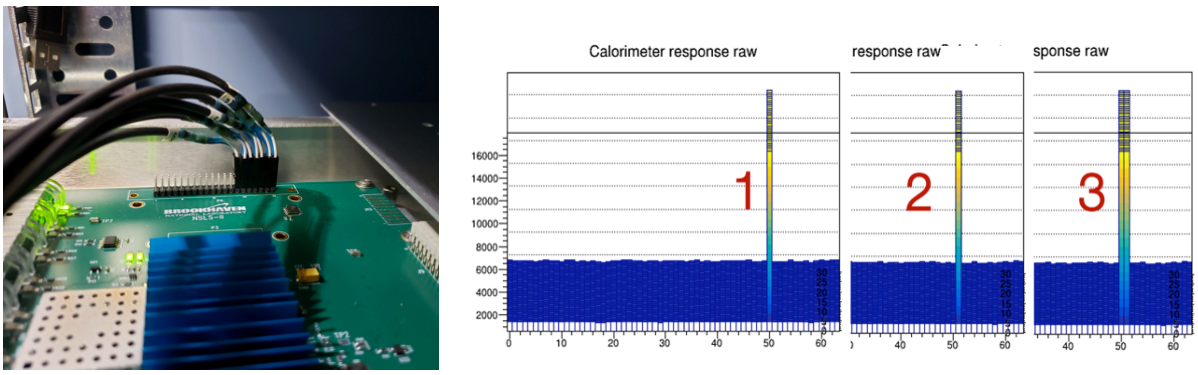


Figure 9: “imprinting” the event number of calorimeter data

As we are moving towards reading out multiple systems at the same time, an important milestone is demonstrating that the different systems actually read out the same event. The detector-specific Granule Timing Modules (GTMs) communicate 40 bits of the 64-bit beam clock counter to the front-ends. This ever-increasing count of the RHIC beam crossings serves as a unique identifier for a given collision, and most front-ends embed a certain number of those bits (like all 40 in the TPC FELIX card, and again 20 in the TPC front-end cards) into the data stream. This makes it easy to verify the proper absolute alignment of the data for those systems. The notable exceptions are the legacy front-ends for the various calorimeters and the Minimum-Bias detector that do not have the ability to embed a copy of that information into the data stream. They rather count the beam crossings individually on their own. This allows us to show that the data are aligned internally, among the various calorimeter channels, but does not allow us to verify the absolute alignment with the Global Level-1 trigger. To overcome this shortcoming, we re-programmed the GL1 so it puts out 8 bits of either the event number or the beam clock counter on a debug header on the board (Fig. 9 left). These 8 signals are then connected to spare channels of the digitizer board, so that the system digitizes that bit pattern. The right part of Figure 9 shows the digitizer channels in question when we put out the binary representation of the numbers 1, 2 and 3. In this way we can verify the absolute alignment of the data also for the calorimeter system.

For the GL1 and Timing System, the design of an add-on board has been completed, and was sent out for fabrication. The layout of the board is shown in Figure 10.

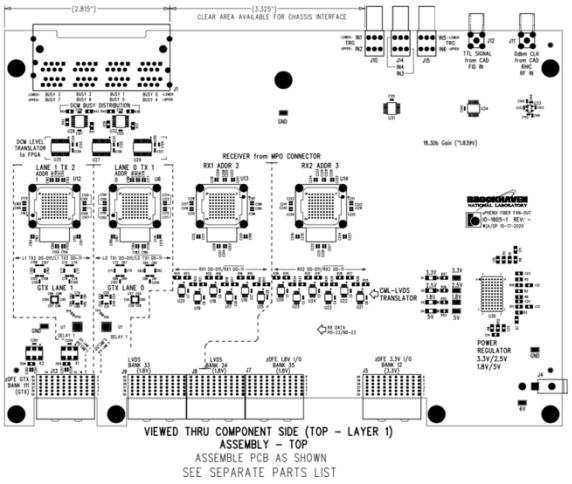


Figure 10: The layout of the GL1/GTM add-on board. The board has been sent out for fabrication.

Once completed, and after we gain experience with it, the development will shift to a second version with additional features that will then be the unit in use in the actual experiment.

Work for the next 2-3 months:

We will work on the further implementation of our run control software. The development of the Local-Level 1 board and firmware will continue.

Issues:

None

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

Current Status:

Columbia University Nevis Labs personnel took data reading out up to 3 D/S Boards, and 2 ADC boards. This is all that is possible with the prototype electronics, but is enough to test different loads on the backplane, and jitter across multiple ADC and D/S boards. The results look good with this more stringent test, resulting in timing resolutions of 30-40 ps. We are preparing for a procurement readiness review to happen in late January or early February. Studies of the MBD in the sPHENIX simulation are on-going, as part of the sPHENIX mock data challenge. These studies will be used to fine-tune the MBD location, the preamp and shaper gain, as well as to determine the effect of pile-up from high rate collisions.

Work for Next 2-3 Months:

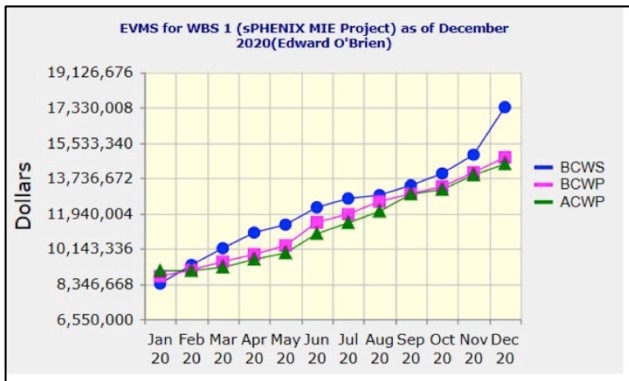
We are preparing for the production readiness review, and following that to prepare the procurement and production-testing plan. The BNL L2 Manager for the MBD continues to meet weekly with grad students from Howard and Florida A&M Univ to train them on the MBD and the skill set required for testing and eventually for

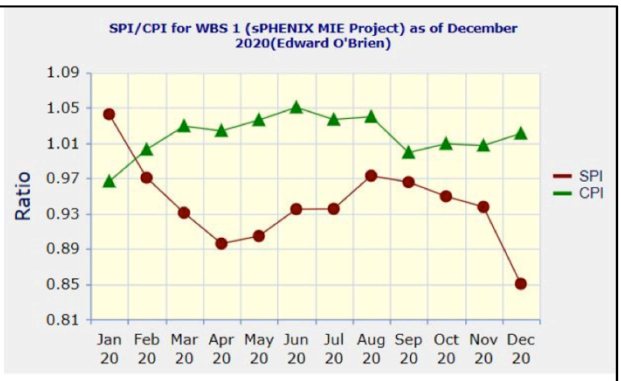
operating the MBD. The current plan is for them to come to BNL in the summer 2021 and test the production electronics.

Issues

None.

SPI and CPI Trends





BAC: $24,531,363 **EAC:** $24,286,242 **VAC:** $245,121

Cumulative SPI	Cumulative CPI
0.85	1.02

Cumulative BCWS (Scheduled)	$17,338,141
Cumulative BCWP (Performed)	$14,779,328
Cumulative ACWP (Actual)	$14,439,729

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

December 2020 Cost Performance Report

CA (3)	CUMULATIVE TO DATE					AT COMPLETION				
	BUDGETED COST		ACTUAL	VARIANCE		BUDGETED	ESTIMATED	VARIANCE		
ITEM	WORK SCHEDULED	WORK PERFORMED	COST WORK PERFORMED	SCHEDULE	COST					
(1)	(7)	(8)	(9)	(10)	(11)	(14)	(15)	(16)	SPI	CPI
1.01A Project Management	1,806,314	1,806,314	1,661,868	0	144,447	1,951,679	1,807,232	144,447	1.00	1.09
1.02A TPC	3,091,106	2,541,329	2,228,659	-549,777	312,669	4,702,483	4,416,883	285,600	0.82	1.14
1.03A EMCal	4,527,964	4,284,680	4,511,534	-243,284	-226,854	5,950,740	6,234,694	-283,953	0.95	0.95
1.04A HCal	2,813,551	2,523,485	2,566,018	-290,066	-42,533	4,220,580	4,269,179	-48,599	0.90	0.98
1.05A Calorimeter Electronics	4,581,874	2,998,594	2,820,351	-1,583,280	178,243	6,290,621	6,113,522	177,099	0.65	1.06
1.06A DAQ & Trigger	418,184	525,778	572,372	107,594	-46,594	1,245,090	1,294,784	-49,694	1.26	0.92
1.07A MinBias Trigger Detector	99,148	99,148	78,926	0	20,221	170,170	149,948	20,221	1.00	1.26
b. COST OF MONEY	0	0	0	0	0	0	0	0		
c. GENERAL AND ADMINISTRATIV	0	0	0	0	0	0	0	0		
d. UNDISTRIBUTED BUDGET						0	0	0		
e. SUBTOTAL	17,338,141	14,779,328	14,439,729	-2,558,813	339,599	24,531,363	24,286,242	245,121	0.85	1.02
f. Contingency						2,468,637				
g. TOTAL	17,338,141	14,779,328	14,439,729	-2,558,813	339,599	27,000,000				
9. RECONCILIATION TO CONTR	CT BUDGET BASELINE									
a. VARIANCE ADJUSTMENT				0	0					
b. TOTAL CONTRACT VARIANCE				-2,558,813	339,599	0	0	0		

CLASSIFICATION (When Filled In)

$9,846,513	ETC
$9,752,035	BCWR
25.07%	% Contingency on ETC
25.31%	% Contingency on Remaining Work
70.68%	% Planned
60.25%	% Complete
58.86%	% 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

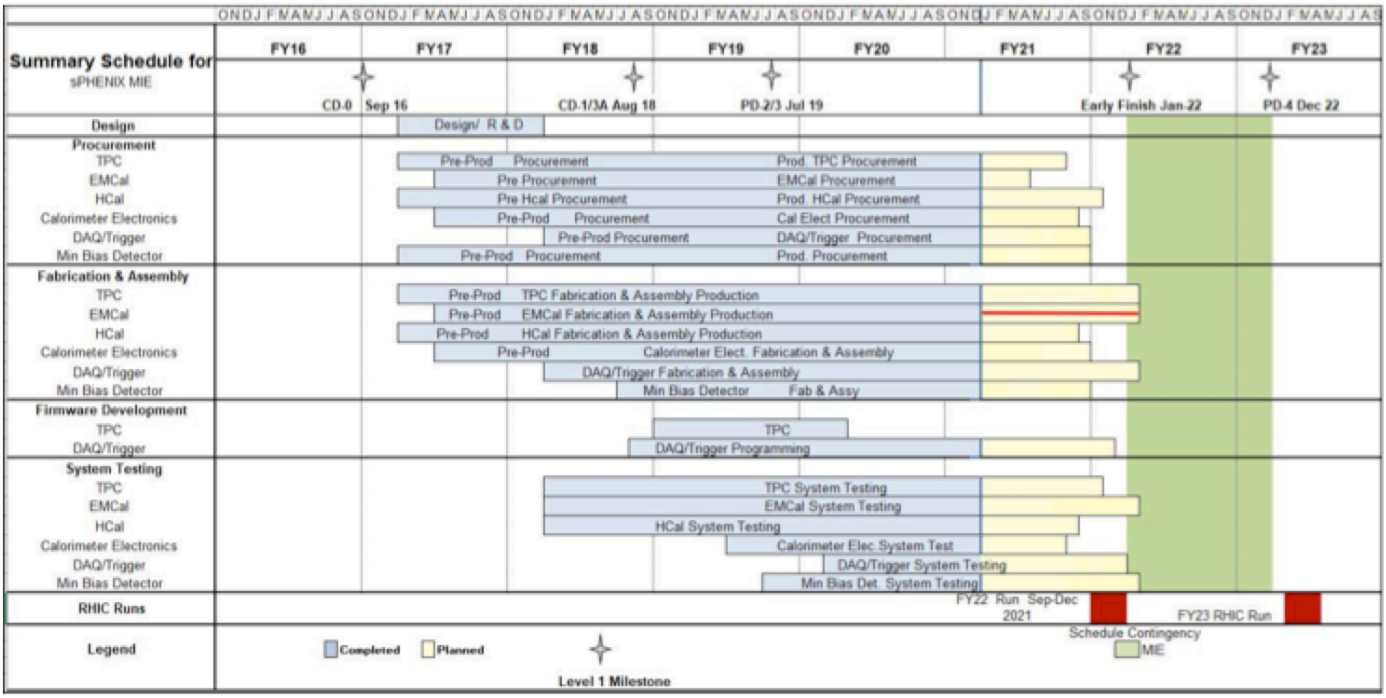
L1 & L2 Milestones

#	WBS	Milestone Name	Target Milestone Date	Forecast	Actual Finish	Variance (in work days)
1	01.01.2001	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	01.05.2001	EMCal/HCal SiPM Sensor Procurement Complete	30-Oct-20	28-Feb-20 A	28-Feb-20	171
11	01.05.02.04	HCal SiPM Boards Assembly Complete	30-Nov-20	22-Sep-20 A	22-Sep-20	45
12	01.06.02.03	Trigger LL1 Preproduction complete	26-Feb-21	2-Jun-21		-68
13	01.05.02.02	EMCal SiPM Boards Production Complete	31-Mar-21	5-Apr-21		-4
14	01.04.04.02	First Outer HCAL Sector and Splice Plates Ready to Install	30-Apr-21	25-Jan-21		67
15	01.04.2001	Inner HCAL Support Structure Ready for Installation	30-Apr-21	11-May-21		-8
16	01.02.01.06	GEM Production Complete	31-May-21	15-Mar-21		54
17	01.03.01.03.01	EMCal Scintillating Fiber Acquisition Complete	31-May-21	31-Mar-21		42
18	01.02.06.03	TPC DAM Felix 2.0 Production Complete	28-Jun-21	20-Sep-21		-59
19	01.05.02.04	HCal Electronics Complete: Production	30-Jun-21	8-Feb-21		99
20	01.02.05.04	TPC FEE Production Complete	16-Aug-21	24-Sep-21		-29
21	01.05.02.02	EMCal Electronics Complete	16-Aug-21	2-Sep-21		-14
22	01.05.03.02	Calorimeter Electronics Complete	20-Sep-21	2-Sep-21		10
23	1.07	MinBias Detector Ready to Install	30-Sep-21	5-Jan-22		-64
24	01.06.03.03	GL1 Ready to Operate	30-Sep-21	6-Jan-22		-65
25	01.01.2001	Early Project Completion	29-Oct-21	27-Jan-22		-58
26	01.02.01.08	TPC Ready to Install (Assembly Complete)	29-Oct-21	24-Jan-22		-56
27	01.02.06.03	TPC DAM Production Complete	29-Oct-21	3-Dec-21		-23
28	01.04.04.02	Last Outer HCAL Sector Ready to Install	29-Oct-21	31-Aug-21		40
29	01.06.01.03	DAQ Production: DAQ Ready for Operation	29-Oct-21	14-Dec-21		-30
30	01.06.02.04	LL1 Trigger Production Complete	29-Oct-21	28-Dec-21		-39
31	01.06.02.04	LL1 Ready to Operate	29-Oct-21	28-Dec-21		-39
32	01.03.02.03.03	EMCal Ready to Install	29-Nov-21	26-Jan-22		-40
33	01.01.2001	Approve Project Closeout PD-4	30-Dec-22	29-Dec-22*		0

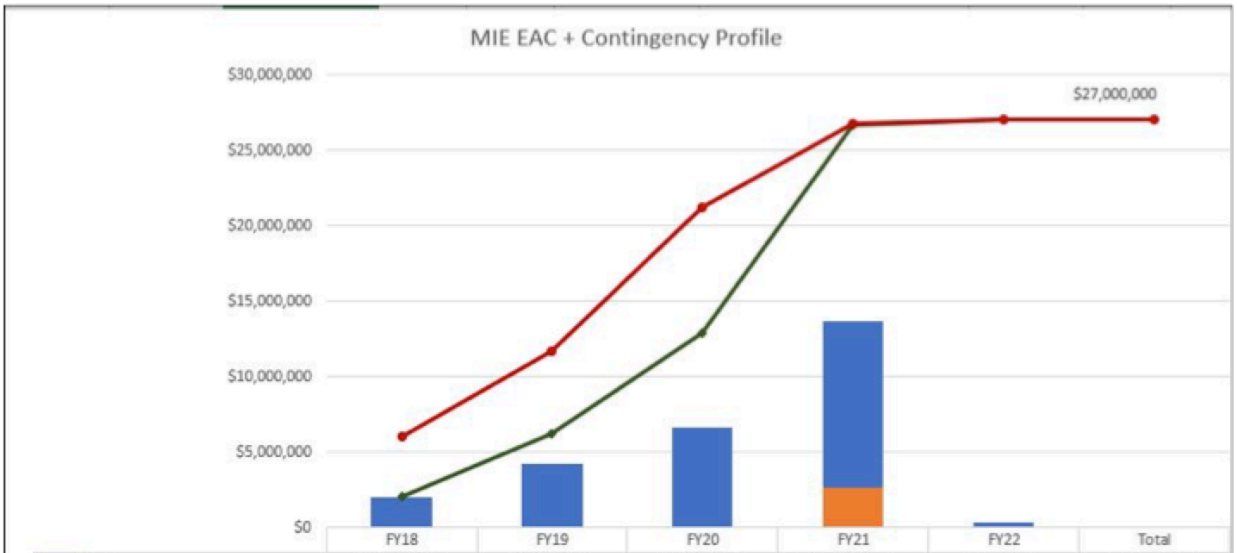
sPHENIX Budget Profile:

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

Summary Schedule with critical path



Estimate at Completion Profile



	FY18	FY19	FY20	FY21	FY22	Total
EAC	2,026,950.44	4,209,282.26	6,673,628.73	11,080,685.19	295,695.47	$24,286,242
Available Contingency			$0	$2,634,609	$79,149	$2,713,758
Cum. Total (EAC+Avail. Contingency)	$2,026,950	$6,236,233	$12,909,861	$26,625,156	$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	$ 24,531,362
Contingency	$2,468,638
TPC	$27,000,000

EAC	$24,286,242
Available Contingency	$2,713,758
Total (EAC+Avail Contingency)	$27,000,000

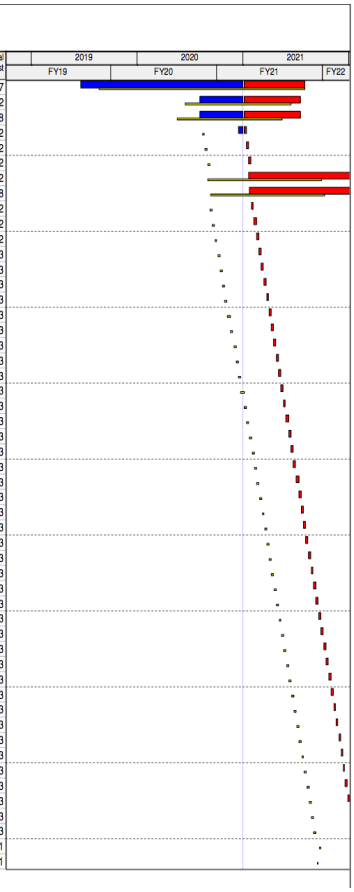
Baseline/Contingency Log

Date	sPHENIX Baseline TPC	PCR Change	Contingency	PCR ID	WBS affected	PCR Title
20.09.2019	$ 22,169,490		$ 4,830,510			Setting up Baseline
24.09.2019	$ 22,132,844	$ (36,646)	$ 4,867,156	007A	1.4 HCal	Hcal Scin Tiles placed contract delivery schedule
31.01.2020	$ 22,132,943	$ 100	$ 4,867,056	008A	1.4 HCal	Extended the lead time for IHCal Support Rings
31.03.2020	$ 22,193,813	$ 60,870	$ 4,806,186	011A	1.2 TPC, 1.3 EMCal	Added management labor for EMCal block production. EMCal Powder and TPC SAMPA cost and delivery schedule update
28.04.2020	$ 22,195,549	$ 1,736	$ 4,804,451	013A	1.3 EMCal	EMCal Block assembly contract details schedule update
31.05.2020	$ 22,176,963	$ (18,586)	$ 4,823,037	014A	1.3 EMCal, 1.5 CalEI	EMCal Light guides delivery schedule; EMCal SiPM daughterboards for Sectors 13-64 contract schedule
19.06.2020	$ 22,198,743	$ 21,780	$ 4,801,257	015A	ALL	COVID-19 Schedule Adjustment
30.10.2020	$ 24,309,836	$ 2,111,093	$ 2,690,164	017A	1.2; 1.3; 1.4; 1.5	Risk Reduction and Realization
31.12.2020	$ 24,531,362	$ 221,527	$ 2,468,637	019A	1.3; 1.4	Additional tech labor for EMCal and HCal

Critical Path

POM02 sPHENIX WBS 1.x, 2.x December 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
S172800	Prepare fiber assemblies for final blocks	529	0	21-Jun-19 A	02-Aug-21	21-Aug-19	02-Aug-21	0	9360	0	163,757	163,757
S171800	Procure EMCAL Epoxy for Final Blocks - Delivery Acceptance	240	0	03-Aug-20 A	19-Jul-21	15-Jun-20	14-Jun-21	-24	0	90653	104,858	104,592
S172500	Order parts and fabricate molds for EMCal Sectors 13-64 Blocks - Deliv	240	0	03-Aug-20 A	19-Jul-21	18-May-20	17-May-21	-43	0	26230	30,340	30,218
S173700	Fabricate final blocks sector 20	16	0	17-Dec-20 A	11-Jan-21	13-Aug-20	20-Aug-20	-95	135	0	5,163	5,012
S173800	Fabricate final blocks sector 21	6	0	12-Jan-21	20-Jan-21	21-Aug-20	28-Aug-20	-95	135	0	5,163	5,012
S173900	Fabricate final blocks sector 22	6	0	21-Jan-21	28-Jan-21	31-Aug-20	08-Sep-20	-95	135	0	5,163	5,012
S187700	Install light guides on final blocks M&S	250	0	21-Jan-21	20-Jan-22	02-Sep-20	30-Sep-21	-73	0	1650	1,926	1,912
S188100	Install SiPMs daughterboards on final blocks M&S	250	0	22-Jan-21	21-Jan-22	11-Sep-20	08-Oct-21	-68	0	300	350	348
S174000	Fabricate final blocks sector 23	6	0	29-Jan-21	05-Feb-21	09-Sep-20	16-Sep-20	-95	135	0	5,163	5,012
S174100	Fabricate final blocks sector 24	6	0	08-Feb-21	16-Feb-21	17-Sep-20	24-Sep-20	-95	135	0	5,163	5,012
S174200	Fabricate final blocks sector 25	6	0	17-Feb-21	24-Feb-21	25-Sep-20	02-Oct-20	-95	135	0	5,163	5,062
S174300	Fabricate final blocks sector 26	6	0	25-Feb-21	04-Mar-21	05-Oct-20	13-Oct-20	-95	135	0	5,163	5,163
S174400	Fabricate final blocks sector 27	6	0	05-Mar-21	12-Mar-21	14-Oct-20	21-Oct-20	-95	135	0	5,163	5,163
S174500	Fabricate final blocks sector 28	6	0	15-Mar-21	22-Mar-21	22-Oct-20	29-Oct-20	-95	135	0	5,163	5,163
S174600	Fabricate final blocks sector 29	6	0	23-Mar-21	30-Mar-21	30-Oct-20	06-Nov-20	-95	135	0	5,163	5,163
S174700	Fabricate final blocks sector 30	6	0	31-Mar-21	07-Apr-21	09-Nov-20	17-Nov-20	-95	135	0	5,163	5,163
S174800	Fabricate final blocks sector 31	6	0	08-Apr-21	15-Apr-21	18-Nov-20	25-Nov-20	-95	135	0	5,163	5,163
S174900	Fabricate final blocks sector 32	6	0	16-Apr-21	23-Apr-21	30-Nov-20	07-Dec-20	-95	135	0	5,163	5,163
S175000	Fabricate final blocks sector 33	6	0	26-Apr-21	03-May-21	08-Dec-20	15-Dec-20	-95	135	0	5,163	5,163
S175100	Fabricate final blocks sector 34	6	0	04-May-21	11-May-21	16-Dec-20	23-Dec-20	-95	135	0	5,163	5,163
S175200	Fabricate final blocks sector 35	6	0	12-May-21	19-May-21	24-Dec-20	04-Jan-21	-95	135	0	5,163	5,163
S175300	Fabricate final blocks sector 36	6	0	20-May-21	27-May-21	05-Jan-21	12-Jan-21	-95	135	0	5,163	5,163
S175400	Fabricate final blocks sector 37	6	0	28-May-21	07-Jun-21	13-Jan-21	21-Jan-21	-95	135	0	5,163	5,163
S175500	Fabricate final blocks sector 38	6	0	08-Jun-21	15-Jun-21	22-Jan-21	29-Jan-21	-95	135	0	5,163	5,163
S175600	Fabricate final blocks sector 39	6	0	16-Jun-21	23-Jun-21	01-Feb-21	08-Feb-21	-95	135	0	5,163	5,163
S175700	Fabricate final blocks sector 40	6	0	24-Jun-21	01-Jul-21	09-Feb-21	17-Feb-21	-95	135	0	5,163	5,163
S175800	Fabricate final blocks sector 41	6	0	02-Jul-21	12-Jul-21	18-Feb-21	25-Feb-21	-95	135	0	5,163	5,163
S175900	Fabricate final blocks sector 42	6	0	13-Jul-21	20-Jul-21	26-Feb-21	05-Mar-21	-95	135	0	5,163	5,163
S176000	Fabricate final blocks sector 43	6	0	21-Jul-21	28-Jul-21	08-Mar-21	15-Mar-21	-95	135	0	5,163	5,163
S176100	Fabricate final blocks sector 44	6	0	29-Jul-21	05-Aug-21	16-Mar-21	23-Mar-21	-95	135	0	5,163	5,163
S176200	Fabricate final blocks sector 45	6	0	06-Aug-21	13-Aug-21	24-Mar-21	31-Mar-21	-95	135	0	5,163	5,163
S176300	Fabricate final blocks sector 46	6	0	16-Aug-21	23-Aug-21	01-Apr-21	08-Apr-21	-95	135	0	5,163	5,163
S176400	Fabricate final blocks sector 47	6	0	24-Aug-21	31-Aug-21	09-Apr-21	16-Apr-21	-95	135	0	5,163	5,163
S176500	Fabricate final blocks sector 48	6	0	01-Sep-21	09-Sep-21	19-Apr-21	26-Apr-21	-95	135	0	5,163	5,163
S176600	Fabricate final blocks sector 49	6	0	10-Sep-21	17-Sep-21	27-Apr-21	04-May-21	-95	135	0	5,163	5,163
S176700	Fabricate final blocks sector 50	6	0	20-Sep-21	27-Sep-21	05-May-21	12-May-21	-95	135	0	5,163	5,163
S176800	Fabricate final blocks sector 51	6	0	28-Sep-21	05-Oct-21	13-May-21	20-May-21	-95	135	0	5,240	5,163
S176900	Fabricate final blocks sector 52	6	0	06-Oct-21	14-Oct-21	21-May-21	28-May-21	-95	135	0	5,318	5,163
S177000	Fabricate final blocks sector 53	6	0	15-Oct-21	22-Oct-21	01-Jun-21	08-Jun-21	-95	135	0	5,318	5,163
S177100	Fabricate final blocks sector 54	6	0	25-Oct-21	01-Nov-21	09-Jun-21	16-Jun-21	-95	135	0	5,318	5,163
S177200	Fabricate final blocks sector 55	6	0	02-Nov-21	09-Nov-21	17-Jun-21	24-Jun-21	-95	135	0	5,318	5,163
S177300	Fabricate final blocks sector 56	5	0	10-Nov-21	17-Nov-21	25-Jun-21	02-Jul-21	-94	135	0	5,318	5,163
S177400	Fabricate final blocks sector 57	5	0	18-Nov-21	24-Nov-21	06-Jul-21	13-Jul-21	-93	135	0	5,318	5,163
S177500	Fabricate final blocks sector 58	5	0	29-Nov-21	03-Dec-21	14-Jul-21	21-Jul-21	-92	135	0	5,318	5,163
S177600	Fabricate final blocks sector 59	5	0	06-Dec-21	10-Dec-21	22-Jul-21	29-Jul-21	-91	135	0	5,318	5,163
S177700	Fabricate final blocks sector 60	5	0	13-Dec-21	17-Dec-21	30-Jul-21	06-Aug-21	-90	135	0	5,318	5,163
S177800	Fabricate final blocks sector 61	5	0	20-Dec-21	27-Dec-21	09-Aug-21	16-Aug-21	-89	135	0	5,318	5,163
S177900	Fabricate final blocks sector 62	5	0	28-Dec-21	04-Jan-22	17-Aug-21	24-Aug-21	-88	135	0	5,318	5,163
S178000	Fabricate final blocks sector 63	5	0	05-Jan-22	11-Jan-22	25-Aug-21	01-Sep-21	-87	135	0	5,318	5,163
S178100	Fabricate final blocks sector 64	5	0	12-Jan-22	19-Jan-22	02-Sep-21	10-Sep-21	-86	135	0	5,318	5,163
S178900	Pack and ship final blocks for sectors 57-64 to BNL - Purchased Servic	1	0	20-Jan-22	20-Jan-22	21-Sep-21	27-Sep-21	-76	41	0	2,638	2,561
S176010	Pack and ship final blocks for sectors 57-64 to BNL - M&S	1	0	20-Jan-22	20-Jan-22	13-Sep-21	17-Sep-21	-82	0	6480	7,672	7,521



Variance Analysis

WBS 1.02A
TPC (Thomas Hemmick [H5685])

Reporting Period: 12/1/2020 - 12/31/2020

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV %	SPI	CPI
Current:	444,221	183,301	92,761	-260,920	-59%	90,540	49%	0.41	1.98
Cumulative:	3,091,106	2,541,329	2,228,659	-549,777	-18%	312,669	12%	0.82	1.14
	BAC								
At Complete:	4,702,483								

Threshold(s) Exceeded: Cumulative Schedule, Cumulative Cost

Explanation of Variance/Description of Problem:
WBS 1.2.1.6 – GEM acquisition – The GEM start of production was delayed by CERN COVID shutdown leading to a -$74k SV. WBS 1.2.2.3 – TPC GEM Modules R1, R2, R3 – Procure TPC Module Parts – The R1 Pad Planes had to be changed to avoid amplifier saturation in the inner 10 cm. The R2 & R3 pad planes are fully delivered. This leads to a -$50K of SV. Accordingly, the R1 Module construction and testing had to be delayed, adding another -$59k of SV. WBS 1.2.5.4 – TPC FEE production. The FEE cooling system is late, leading to -$69k SV. The FEE parts are being acquired early, yielding positive +$212k SV. The Low Voltage power supplies are not delivered, causing -$220k SV. WBS 1.2.6.3 TPC DAM production. Parts have arrived early leading to +$106k SV. WBS 1.2.7.1 TPC Support System - Laser – manufacturer delays experienced in the first magnetic-field-tolerant laser for sPHENIX leads to -$260K of SV. WBS 1.2.7.2 TPC Support System – Gas System – Gas system components order delayed with -$61k of SV. WBS 1.2.7.3 TPC Support System – Cooling System – Bench test required for validation delayed due to COVID. This leads to -$76k of SV.

Impact:
WBS 1.2.1.6 – GEM acquisition – impact none. GEMs have 65 days float. WBS 1.2.2.3 – TPC GEM Modules R1, R2, R3 – Procure TPC Module Parts – impact none. Pad plane has 23 days float. WBS 1.2.5.4 – FEE Components Acquisition. Impact none, 10 days of float. WBS 1.2.6.3 TPC DAM production – None WBS 1.2.7.1 TPC Support System - Laser impact none. Optics has 200 days float, diffuse laser has 60 days float. WBS 1.2.7 TPC Support System – Gas System – Impact none. The system has 43 days float; impact none. WBS 1.2.7 TPC Support System – Cooling System – Impact none but now concerning for completion of connection plumbing. The system has 2 days float.

Corrective Action:
WBS 1.2.1.6 – GEM acquisition – none. CERN has produced and shipped 20% of the GEM foils with two more deliveries scheduled for February. This is adequate to keep the module production lines running. We continue weekly dialog with CERN. WBS 1.2.2-4.3 – TPC GEM Modules R1, R2, R3 – R1 design and layout are completed. Production order for the R1 pad-planes is being sent to same vendor which produced the R2 and R3 pad planes. WBS 1.2.5.4 – FEE Components Acquisition – Improve testing plan for increased parallelization to recoup time after first article deliveries. First 30 boards are delivered. If these pass QA tests, then one vendor is qualified for the production order of 700 boards. All parts other than chip-on-reel type small capacitors and resistors, which are to be supplied by the board assembler, are now received. Cooling system parts are being ordered from a vendor after a successful test of the cooling performance of the prototype. Low voltage power supplies are included in the larger order in WBS 1.5.2; for this larger order the crates have been delivered and the power units are awaiting parts deliveries at the manufacturer. WBS 1.2.6.3 – TPC DAM production – parts are delivered. Board and assembly order is being prepared. WBS 1.2.7.1 TPC Support System - Laser – First article laser is delivered and will have safety review by BNL in January. Magnetic field testing will follow the next week. WBS 1.2.7 TPC Support System – Gas System – procurements are started, with about one-third of the items delivered. WBS 1.2.7 TPC Support System – Cooling System – Design review held, decision taken to proceed with first article procurement and test. Parts orders proceeding. The deadline for the chiller units' delivery will have to be tracked once it is established.

Prepared By:	**Date:**	**Approved By:**	**Date:**
Irina Sourikova [22419]	1/26/2021	Edward O'Brien [18368]	1/26/2021

WBS 1.04A **Reporting Period:** December 2020

HCal

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV in %	SPI	CPI
Current:	541	10,217	76,273	9,676	1,789%	-66,056	-647%	18.89	0.13
Cumulative:	2,813,551	2,523,485	2,566,018	-290,066	-10%	-42,533	-2%	0.90	0.98
	BAC								
At Complete:	4,220,580								

Threshold(s) Exceeded: Cumulative Schedule

Explanation of Variance/Description of Problem:
WBS 1.4.2 – OHCal Sector Mechanics (S205100) – the splice plates delivery from the manufacturer is behind schedule, with negative SV =-$303K. This dominates the HCAL schedule variance. Communication with the vendor indicates the delay is due to equipment failures and employees out for COVID infections or quarantine.

Impact:
WBS 1.4.2 OHCal Sector Mechanics (S205100) – impact none, the splice plates are needed in June 2021 and thus have 120 days float.

Corrective Action:
WBS 1.4.2 OHCal Sector Mechanics (S205100) – the splice plates are under fabrication at a vendor. The vendor has updated the delivery schedule to the end of February. This is still well in advance of when they are required for outer HCAL assembly and no corrective action is required. The vendor has promised a partial shipment the first week of February, 2021, with the remainder to follow by the end of the month.

Prepared:	**Prepared By:**	**Approved:**	**Approved By:**
1/18/2021	John Lajoie [L5823]	1/20/2021	Edward O'Brien [18368]

WBS 1.05A **Reporting Period:** December 2020

Calorimeter Electronics

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV in %	SPI	CPI
Current:	1,502,538	336,664	117,511	-1,165,874	-78%	219,153	65%	0.22	2.86
Cumulative:	4,581,874	2,998,594	2,820,351	-1,583,280	-35%	178,243	6%	0.65	1.06
	BAC								
At Complete:	6,290,621								

Threshold(s) Exceeded: Cumulative Schedule

Explanation of Variance/Description of Problem:
WBS 1.5.2 Calorimeter Electronics – EMCal low voltage system has not been delivered due to long lead-time on parts. This leads to -$46K of SV. WBS 1.5.2 Calorimeter Electronics – EMCal bias power system has not been delivered due to long lead-time on parts. This leads to -$37K of SV. WBS 1.5.2 Calorimeter Electronics – EMCal SiPM board order has not been completed. This leads to -$24K of SV. WBS 1.5.2 Calorimeter Electronics - EMCal SiPM board testing has not been started. This leads to -$1K of SV. WBS 1.5.2 Calorimeter Electronics – EMCal Preamps have not been delivered. This leads to -$549K of SV. WBS 1.5.2 Calorimeter Electronics – EMCal Preamps have not been tested. This leads to $1K of SV. WBS 1.5.2 Calorimeter Electronics – EMCal Interface boards have been tested ahead of schedule. This leads to +$4K of SV. WBS 1.5.2 Calorimeter Electronics – Calorimeter Controller boards were purchased in advance and tested in advance schedule. This leans to +$92K of SV. WBS 1.5.2 Calorimeter Electronics – Calorimeter Controller boards were tested ahead of schedule. This leads to +2K of SV. WBS 1.5.2 Calorimeter Electronics – EMCal interior signal, and power cables order has not been fully delivered by vendors. This leads to -$187K of SV. WBS 1.5.2 Calorimeter Electronics – Calorimeter test pulse boards have not been ordered. This leads to -$8K of SV. WBS 1.5.2 Calorimeter Electronics – EMCal exterior signal cables have not been ordered. This leads to -$101K of SV. WBS 1.5.2 Calorimeter Electronics – EMCal controller crates have not been ordered. This leads to -$5K of SV WBS 1.5.2 Calorimeter Electronics – HCal SiPM daughter boards were assembled with the preproduction order ahead of schedule. This leads to +$111K of SV. WBS 1.5.2 Calorimeter Electronics - HCal interior power and signal cables were purchased ahead of schedule. This leads to +$94K of SV. WBS 1.5.2 Calorimeter Electronics – HCal external power and signal cables, low voltage system and bias systems have not been delivered. This leads to -$101K of SV.

Impact:
WBS 1.5.2 Calorimeter Electronics – EMCal low voltage system- None. The power supplies have been ordered with a delivery date of April 2021. The low voltage crates have already been received and can be used to start rack assembly. WBS

1.5.2 Calorimeter Electronics – EMCal bias power system- None. The bias system has been ordered and the crates delivered. The bias modules are scheduled for a Feb 2021 delivery time. WBS 1.5.2 Calorimeter Electronics – EMCal SiPM boards- None. The order for the second half of the boards was placed in December, with an estimated completion date of February 2021. There are sufficient daughter boards to maintain sector assembly. WBS 1.5.2 Calorimeter Electronics – EMCal SiPM board testing- None. Testing procedures are in place to test boards before they are required for installation. WBS 1.5.2 Calorimeter Electronics – EMCal Preamps- Moderate. Parts for the board assembly are delayed. Unavailability of preamps will impact EMCal Sector assembly schedule. WBS 1.5.2 Calorimeter Electronics – EMCal Preamp Testing- None. Testing procedures are in place and testing will begin as soon as parts are received. WBS 1.5.2 Calorimeter Electronics – EMCal Interface board testing- None. Testing is complete. WBS 1.5.2 Calorimeter Electronics – EMCal controller boards- None. This task is complete ahead of schedule. WBS 1.5.2 Calorimeter Electronics – EMCal controller board testing- None. This task is complete ahead of schedule. WBS 1.5.2 Calorimeter Electronics – EMCal interior signal, and power cables- None. All power cables have been delivered and partial deliveries of signal cables have been received to allow assembly of EMCal sectors to continue on schedule. WBS 1.5.2 Calorimeter Electronics – Calorimeter test pulse boards- None. There are sufficient boards to perform initial EMCal and HCal testing. WBS 1.5.2 Calorimeter Electronics – EMCal exterior signal cables- None. A Procurement Readiness Review is schedule for mid-January and procurement documentation is being prepared. WBS 1.5.2 Calorimeter Electronics – EMCal Controller Crates- None. The sufficient crates needed to perform initial sector testing of the EMCal and HCal WBS 1.5.2 Calorimeter Electronics – HCal SiPM daughter boards- None. This task is complete ahead of schedule. WBS 1.5.2 Calorimeter Electronics – HCal interior power and signal cables, low voltage system- None. The cables have been delivered and are available for installation. The low voltage and bias systems are ordered with an early 2021 delivery date. Rack assembly can start before the scheduled arrival.

Corrective Action:
WBS 1.5.2 Calorimeter Electronics – EMCal low voltage system: The order has been placed and the vendor has a strong track record of delivering on time. Will continue to follow up with vendor on delivery schedule to monitor any changes in schedule. WBS 1.5.2 Calorimeter Electronics – EMCal bias power system: The order has been placed and the vendor has a strong track record of delivering on time. Will continue to follow up with vendor on delivery schedule to monitor any changes in schedule. WBS 1.5.2 Calorimeter Electronics – EMCal SiPM boards: The order has been placed with a fully delivery the end of February. Vendor delivered the first half of the number of boards required ahead of schedule. Sufficient boards have been received to maintain EMCal Sector assembly. WBS 1.5.2 Calorimeter Electronics – EMCal SiPM board testing: Procedures are in place and students trained to carry out the testing when the boards arrive. WBS 1.5.2 Calorimeter Electronics – EMCal Preamps: The vendor will receive sufficient parts to assembly preamps for 3 more EMCal sectors. Will work with vendor to monitor production schedule. WBS 1.5.2 Calorimeter Electronics – EMCal Preamp testing: Procedures are in place and students trained to carry out the testing when the boards arrive. WBS 1.5.2 Calorimeter Electronics –EMCal Interface board testing: All boards have been tested WBS 1.5.2 Calorimeter Electronics – EMCal controller boards: This task is complete ahead of schedule. WBS 1.5.2 Calorimeter Electronics – EMCal controller board testing: This task is complete ahead of schedule. WBS 1.5.2 Calorimeter Electronics – EMCal interior signal, and power cables: All interior power cables have been delivered. Signal cables are being delivered on a regular schedule by the vendor with fully delivery scheduled in February. Sufficient cables have been delivered to meet the EMCal Sector assembly schedule. WBS 1.5.2 Calorimeter Electronics – Calorimeter test pulse boards: These boards will be ordered in early 2021 and are not needed until the digitizer racks are assembled. WBS 1.5.2 Calorimeter Electronics – EMCal exterior signal cables- A Procurement readiness review is schedule for January and procurement documents are being prepared. WBS 1.5.2 Calorimeter Electronics – EMCal Crates for controllers: These crates are stock items and will be ordered in early 2021 with delivery scheduled before rack assembly starts in mid-2021. WBS 1.5.2 Calorimeter Electronics – HCal SiPM daughter boards: This task is complete ahead of schedule. WBS 1.5.2 Calorimeter Electronics – HCal interior power and signal cables, low voltage system: The power cables and signal cables have been delivered and are available for installation into HCal sectors. The low voltage and bias systems are ordered with an early 2021 delivery date. The crates for them have been received allowing for assembly of the HCal power racks.

Prepared:	**Prepared By:**	**Approved:**	**Approved By:**
1/24/2021	Irina Sourikova [22419]	1/25/2021	Edward O'Brien [18368]

WBS 1.06A
DAQ & Trigger

Reporting Period: December 2020

	BCWS	**BCWP**	**ACWP**	**SV in $**	**SV in %**	**CV in $**	**CV in %**	**SPI**	**CPI**
Current:	176,170	0	7,862	-176,170	-100%	-7,862	0%	0.00	0.00
Cumulative:	418,184	525,778	572,372	107,594	26%	-46,594	-9%	1.26	0.92

	BAC
At Complete:	1,245,090

Threshold(s) Exceeded: Cumulative Schedule

Explanation of Variance/Description of Problem:
WBS 01.06.01.03 1) "Procurement of SEBs and ATPs" - the procurement happened ahead of schedule. 2) "JSEB Slow control

Computers" - we may have found an easier way to accomplish the slow controls, and decided to delay the procurement until we perform tests to see if this is a viable solution. 3) As with 1), we procured 1 of 6 "Buffer Boxes" ahead of schedule to get a head-start with setup and experience in tuning, resulting in a SV and CV of $41,513. 4) We also procured the main network switch ahead of schedule. 5) That switch, originally budgeted for $99,994, was procured for about half the price for the same or better performance.

Impact:
None. The procurements of SEBs and ATPS, the "first article" buffer box, and the network switch allows us to partially mitigate the impact of COVID-19 restrictions by performing tasks that can be done safely now, such as the hardware setup. The configuration and testing can largely be done remotely. The deferral of the slow controls computers procurement might lead to an easier way to accomplish this, but also frees up time to perform the tasks that can more easily be done during the COVID-19 restrictions. The overall CV of -$46,594 are true cost savings for the same or better performance.

Corrective Action:
None

Prepared:	**Prepared By:**	**Approved:**	**Approved By:**
1/24/2021	Martin Purschke [21498]	1/25/2021	Edward O'Brien [18368]