

sPHENIX Annual MIE Review

Project Management and Status

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BNL

sPHENIX MIE Project Scope



Charge Question 1

- Scope is unchanged since PD-2/3 (Sept 2019)
- Three large detectors, with their support services (LV, HV, gas)
 - Time Projection Chamber (**TPC**) to track charged particles
 - ElectroMagnetic Calorimeter (**EMCal**) to measure energies and positions of gamma-rays and electrons/positrons
 - Hadronic Calorimeter (**HCal**) to measure energies and positions of charged pions/kaons/neutrons/protons
- Minimum Bias Detector (**MBD**, existing) to tag RHIC collisions of interest
- Front-End Electronics (**FEE**) to process & digitize analog signals from all detectors
- Data-Acquisition (**DAQ**) to collect & buffer this digital information
- **Triggering** system to select events of interest
- **Timing** system to synchronize all the above

sPHENIX Project Management



Charge Question 3

- sPHENIX Project Management at BNL, staffed by BNL
 - Includes Project Director, Project Manager, Project Scientist, Project Engineer, ES&H rep, QA rep, Chief Mechanical Engineer, Project Controls Manager and staff, Integration
 - Significant experience – core of scientific and engineering group that built PHENIX and operated it for 16 years; project controls group experienced on several other completed DOE-413-type projects
- L2 Managers/CAMs: 2 University-based, 5 BNL staff
- L3 Managers: 12 University-based, 8 BNL Staff

- Time Projection Chamber
 - Engineering, Design – **BNL, Stony Brook**
 - Facilities and Clean Rooms – **Stony Brook, Wayne State U, Vanderbilt U, Weizmann Institute, Temple U**
 - Electronics – **U Sao Paulo, Lund U, BNL**
 - Assembly & Testing – **Stony Brook, Wayne State U, Vanderbilt U, Weizmann Institute, Temple U, U Sao Paulo, Lund U, BNL**
- Electromagnetic Calorimeter
 - Engineering, Design – **BNL, U Illinois UC**
 - Facilities and High-Bay areas – **BNL (510), U Illinois UC**
 - Electronics – **BNL, Lehigh U, Iowa State U**
 - Assembly & Testing – **U Illinois UC, Ohio U, U Colorado, BNL**

sPHENIX Resources (2)



Charge Question 2

- Hadronic Calorimeter (complete except for one ongoing vendor item)
 - Engineering, Design – **BNL, Iowa State U**
 - Facilities and High-Bay areas – **BNL (912), Georgia State U, Iowa State U**
 - Electronics – **BNL, Iowa State U**
 - Assembly & Testing – **Iowa State U, Georgia State U, Baruch C, Ohio U, Rutgers U, Lehigh U**
- Calorimeter Electronics
 - Engineering, Design – **BNL, Columbia U/Nevis Lab**
 - Facilities – **BNL, Columbia U/Nevis Lab, commercial vendors**
 - Testing and Firmware – **BNL, Lehigh U, U Michigan, Augustana U, Debrecen U, Columbia U/Nevis Lab, U Colorado**

sPHENIX Resources (3)



Charge Question 2

- Data Acquisition, Triggering, Timing
 - Engineering, Design – **BNL, Columbia U/Nevis Lab**
 - Facilities – **BNL, Columbia U/Nevis Lab, commercial vendors**
 - Testing and Firmware – **BNL, Columbia U/Nevis Lab, U Colorado**
 - Computer networks and storage at **BNL/RACF**
- MBD
 - Engineering, Design – **Columbia U/Nevis Lab**
 - Facilities – **BNL, Columbia U/Nevis Lab, commercial vendors**
 - Testing and Firmware – **Columbia U/Nevis Lab, Lehigh U, Florida A&M, Howard U**
- Everything
 - sPHENIX to be housed in the **1008 PHENIX complex** – Assembly Hall w/40-ton crane, Gas Pad and Mixing House, Counting House with existing networking, racks, electronics crates, DAQ equipment, Interaction Region w/10-ton crane, links to RHIC cryogenics

Review List – PDR, FDR, PRR



Charge Questions 1, 3

MIE Upcoming Major Reviews		P6 Activity Numbers			Dates			
WBS	Area	Prelim DR	Final DR	PRR	Prelim DR	Final DR	PRR	
1.2.1	TPC Field Cage	109200	112300	112600	May-19	Jul-21	Mar-21	Dates are Month/Year
1.2.2	TPC Module	114600	116801	119100	Mar-18	Dec-19	May-20	
1.2.2, 1.2.3, 1.2.4	TPC Module Factories			123800			Dec-19	Color Key
1.2.1	TPC Final Assembly		121601	121601		Jul-21	Jul-21	
1.2.5	TPC FEE	135301	137700	137700	Sep-18	Jun-21	Jun-21	Held
1.2.5	SAMPA v5 Full Chip	137801	138901	140800	Jul-18	Aug-19	May-20	To be Held in next 3 months
1.2.6	TPC DAM	143900	146201	146500	Dec-17	Jan-20	Feb-20	
1.2.7	TPC Laser		148701	148900		Aug-20	Jun-21	
1.2.7	TPC Gas System		151201	151400		Aug-20	Jun-21	
1.2.7	TPC Cooling System		154101	154300		Aug-20	Oct-20	
1.3.1	EMCal Blocks	158201	160900	172900	May-18	Aug-18	Aug-20	
1.3.2.1	EMCal Modules for Sectors 1-12	182201	183801	183801	Dec-17	Aug-19	Aug-19	
1.3.2.1	EMCal Modules for Sectors 13-64			186400			Jul-20	
1.3.2.2	EMCal Sectors 1-12	190000	192100	192100	Jul-18	Aug-19	Aug-19	
1.3.2.2	EMCal Sectors 13-63			194600			Jul-20	
1.4.1	IHCal Support Structure	197801	197900	197900	Aug-18	Mar-20	Mar-20	
1.4.1	IHCal Support Rings	198401	198500	198500	Dec-19	May-20	May-20	
1.4.2	OHCal Splice Plates	203901	204401	204450	Jul-18	Aug-19	Feb-20	
1.4.2	OHCal Lifting Fixture	205201	205300	205300	Jul-19	Oct-19	Oct-19	
1.4.4	OHCal Sector Assembly 1-6	200801	201201	203050	Sep-17	Dec-17	Nov-19	
1.4.4	OHCal Sector Assembly 7-32			209701			Aug-20	
1.5.2.1	EMCal FEE sectors 1-12	216601	217800	221200	Apr-18	Jul-18	Sep-19	
1.5.2.2	EMCal FEE sectors 13-64			226901			Jul-20	
1.5.2.3	HCal FEE Sectors 1-6	234401	235800	235800	May-18	Oct-18	Oct-18	
1.5.2.4	HCal FEE Sectors 7-32			238200			Feb-20	
1.5.3.1	Calorimeter Digitizer 7-crate	246701	249400	249400	May-18	Aug-19	Aug-19	
1.5.3.2	Calorimeter Digitizer Final order			251500			Dec-20	
1.6.1	DAQ		254000	255100		Aug-18	Aug-20	
1.6.2	Local Level-1	262801	263800	264200	Feb-21	Jul-21	Sep-21	
1.6.3	Global Level-1	265501	266701	266702	Apr-18	Jul-21	Jul-21	
1.6.4	Timing System	268301	269501	269502	May-18	Jul-21	Jul-21	
1.7	MBD (Discriminator/Shaper board)	271901	272701	272701	Dec-17	Feb-21	Feb-21	
1.3.1	EMCAL - Tungsten Powder (LLP)			160900			Aug-18	
1.3.1	EMCal - Scintillating Fibers (LLP)			161800			Apr-18	
1.4.3	OHCal - Scintillating Tiles (LLP)			206400, 206800, 207200			Mar-17 to May-17	
1.5.1	EMCal, OHCal - Silicon Photomultipliers (LLP)		211601	212201		Feb-17	Dec-17	

- All detector construction proceeds through a series of prototypes
- Major effort to identify and remove risks and validate design
- This effort included
 - In-beam tests of TPC and all types of calorimeters
 - Coupling of TPC/EMCal/HCal with their Front-End Electronics and Digitizers
 - Prototyping and testing of the one custom Application Specific Integrated Circuit (ASIC) for the Time Projection Chamber (the SAMPA v5 ASIC)
 - Coupling of FEE and Digitizers to elements of the DAQ system
 - Incorporating Timing and Global Level-1 Trigger prototypes into DAQ operation
- There is one prototype remaining under test – for Local Level 1 Trigger
- John Haggerty's talk will cover prototyping and testing as part of fabrication results

Production Status

- TPC
 - End-cap wheels complete; Field cage in final assembly steps
 - GEM module frames, strongbacks & padplanes complete
 - SAMPA v5 built, tested & delivered; FEE assembly contract awarded
 - GEM foil all produced, GEM foil framing at 85%, modules started
- EMCal
 - Screens, W powder & scintillating fibers complete
 - All other parts in hand or being produced well in advance of need
 - 42+ (of 64) sectors' worth of blocks complete
 - Illinois has added techs for powder-fill, epoxy-molding & machining steps
 - BNL has set up production area, assembled 28+ sectors

Production Status (cont.)

- HCal
 - **All 32 OuterHCal sectors fully assembled at BNL; over half have finished pre-installation operational testing**
 - **Eight of the 32 InnerHCal mechanical structures arrived; balance by November**
- Calorimeter Electronics
 - **All FEE boards are fabricated; all power supplies in hand**
 - **Internal cables are in hand; external cables are ordered or in Procurement**
 - **Digitizer production underway at Columbia U/Nevis Lab**
- DAQ
 - **All computer orders placed, most received for Day-1 operation**
 - **Final production of Triggers and Timing is underway**
- MBD – **proceeded to full FEE production; detector is ready**

Long Lead Procurements Status



Charge Question 3

- Four Long Lead Procurements approved at CD-1/3A
- Silicon Photomultipliers for EMCal & OHCAL - **COMPLETE**
- Tungsten Powder for EMCal - **COMPLETE**
- Scintillating Fibers for EMCal - **COMPLETE**
- Scintillating Tiles for OHCAL - **COMPLETE**

COVID-19 Impact (Charge Element 6)



Charge Question 6

- All labs working on sPHENIX were closed for six weeks up to several months, starting March 2020. Immediate impact on schedule
- All Labs are now re-opened; some cases of lowered staffing
- COVID-19 peak at end of CY2020 delayed many vendor orders; clear drop in SPI, recovering even now; electronics affected the most (automobile industry).
- Some specific impacts:
 - **EMCal, OHCAL, TPC construction suspended**
 - **CalFEE, DAQ testing suspended**
 - **Commercial vendors by and large continued in mid-2020 – CalFEE benefited**
- Executed sPHENIX Change Request to obtain added personnel to recover schedule
- Overall schedule slip delays early finish by >3 months, out of baseline 14 months

EMCaI COVID-19 Impact – Blocks (U Illinois)



Charge Question 6

- Returned first part of May 2020, restarted all aspects of production, ramped back up to desired production rates, ensuring quality of blocks still good. UIUC Lab has stayed open since
- Schedule impact (C. Riedl) is that end date moves from mid-Sept 2021 to end-CY2021
- Three major task areas, all fully funded based on labor-to-complete (i.e. not by standing-army-size) – U Illinois has brought on more staff using funds-in-hand to improve schedule
 - **Fiber-filling into brass screens – (undergraduate) students, <one hour/block, ~400 blocks (out of 5000) to go, >30 students in the labor-pool; Has kept well ahead of need-by date**
 - **Cleaning molds, loading W powder into mold with fibers - done by dedicated junior techs**
 - **Loading epoxy, vacuum impregnation, mold removal, machining – junior techs and machinist supervised by senior tech**
- To Help Recovery From COVID-19
 - **Added funds for U. Illinois to allow hiring more junior techs, machinist**
 - **Add to the storage space, freezer space, consumable tools (diamond bits)**

EMCal COVID-19 Impact – Sectors (BNL) SPHENIX

Charge Question 6

- Lost 3 months. BNL is back at work; separated the various work areas
- Working on ~sector 30 (of 64). Completion now projects to early Feb 2022
- All mechanical parts are either in hand or in last stages of production; Electronics in hand.
- Four major task areas - first 3 staffed by BNL techs, last done by scientist/engineer
 - **Receive, inspect, adding reflectors and light guides to all blocks (1 tech/block, but multiple techs possible)**
 - **Glue blocks to strongbacks (minimum 2 people)**
 - **Add electronics, cabling, cooling loops; multiple workstations**
 - **Test for operation, then with cosmic rays**
- To Hold Remaining Schedule:
 - **Maintain 6 techs for the first three tasks; multiple sectors are in-process at once**
 - **Visitor (e.g. grad student) support for testing step**

EMCal COVID-19 Impact – Overall

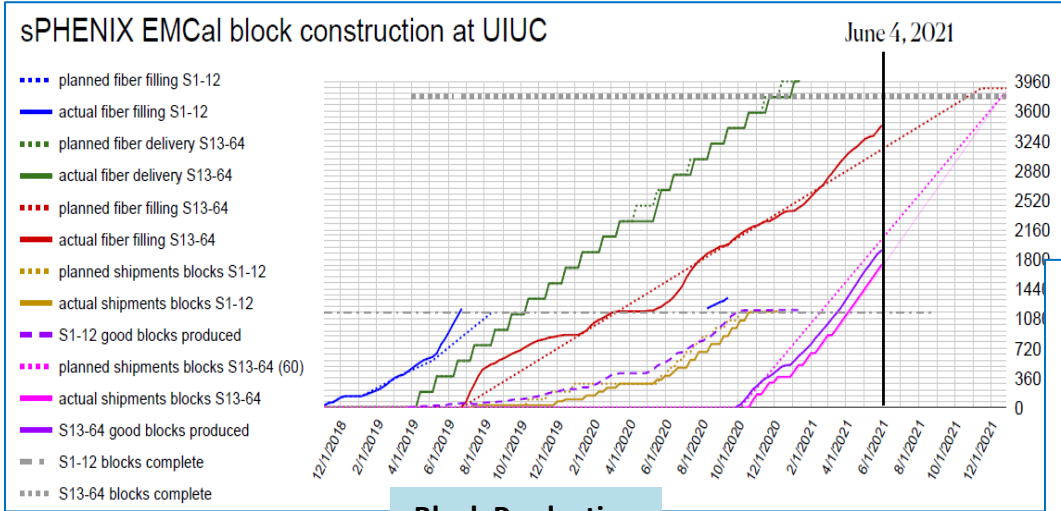


- Rate of progress would allow completion by early February 2022, if personnel levels are maintained
- Any further delay of progress results in day-for-day delay of Early Completion
- Additions of personnel to sector construction would add to the present schedule margin
- Cost impact of \$816K for personnel and M&S
 - \$534K on blocks, \$282K on sectors
 - **Change Request executed in Fall 2020**

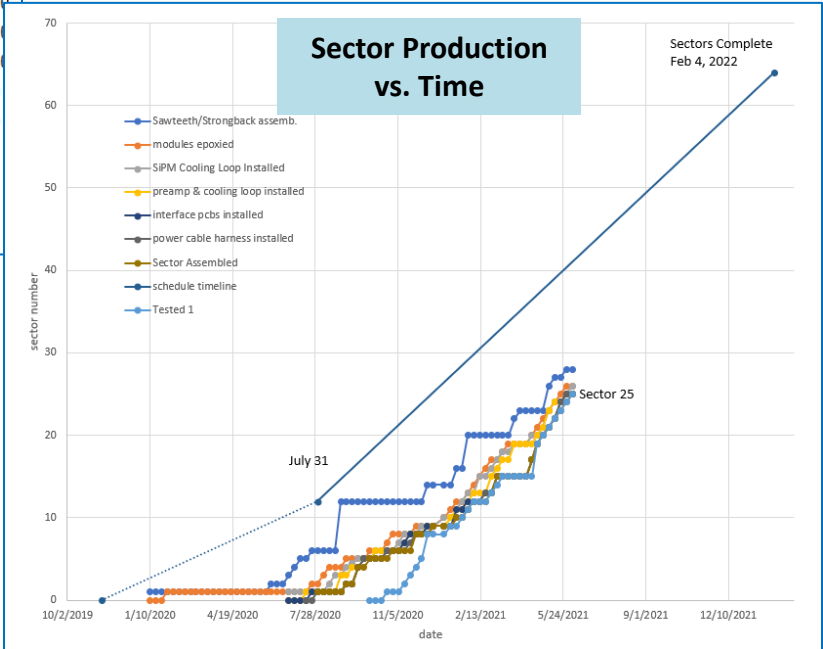
sPHENIX Critical Path – EMCal (1)



Charge Questions 1,2



Block Production vs. Time



sPHENIX Critical Path – EMCal (2)



Charge Questions 1,2

POM02 sPHENIX WBS 1.x, 2.x May 2021

IPD - MIE Critical

Activity ID	Activity Name	At Completion	Total Float	Start	Finish	Variance - BL Project Finish	Budgeted Labor Units	Budgeted Nonlabor Units	Budgeted Total Cost	2021				2022		2023	
										FY21	FY22	FY23	FY24				
S195400	Procure EMCAL Mechanical Parts for Final Sectors - Delivery Acceptanc	187	0	14-Sep-20	14-Jun-21	-108	0	251357	291,746								
S187500	Receive, unpack, log & inspect of final blocks	295	0	23-Nov-20	31-Jan-22	-82	1384	0	179,882								
S187800	Install reflectors on final blocks Labor	295	0	23-Nov-20	31-Jan-22	-78	1384	0	179,723								
S187900	Install reflectors on final blocks M&S	295	0	23-Nov-20	31-Jan-22	-78	0	0	0								
S196200	Build mechanical enclosures for final sectors	107	0	12-Jan-21	14-Jun-21	-108	720	0	84,633								
S196300	Build mechanical fixtures for final sectors	107	0	12-Jan-21	14-Jun-21	-129	720	0	84,633								
S196400	Build cooling system for final sectors	107	0	12-Jan-21	14-Jun-21	-84	180	0	27,303								
S196100	Procure EMCAL Cooling System for Final Sectors - Delivery Acceptanc	103	0	18-Jan-21	14-Jun-21	-84	0	70893	82,284								
S187800	Install lightguides on final blocks Labor	257	0	21-Jan-21	31-Jan-22	-80	1384	0	180,018								
S187700	Install lightguides on final blocks M&S	257	0	21-Jan-21	31-Jan-22	-80	0	1650	1,926								
S188000	Install SiPMs daughterboards on final blocks Labor	259	0	22-Jan-21	03-Feb-22	-77	1384	0	180,039								
S188200	Glue final blocks together into modules	259	0	22-Jan-21	03-Feb-22	-75	1384	0	180,039								
S188100	Install SiPMs daughterboards on final blocks M&S	259	0	22-Jan-21	03-Feb-22	-77	0	300	350								
S196500	Install modules in final sectors	257	0	26-Jan-21	03-Feb-22	-75	1845	0	234,726								
S196700	Install readout electronics on final sectors	240	0	22-Feb-21	04-Feb-22	-74	1845	0	235,148								
S196800	Install cables & cooling system on final sectors	240	0	22-Feb-21	04-Feb-22	-72	3573	0	500,103								
S196900	Test final sectors with LEDs & cosmic rays	239	0	23-Feb-21	04-Feb-22	-70	5532	0	125,893								
S229400	Test EMCAL Preamp Boards: Production Sectors 13-84	76	0	26-Feb-21	14-Jun-21	-46	384	0	6,313								
S197000	Repair or rework any sectors as required	224	0	16-Mar-21	04-Feb-22	-69	3921	0	252,651								
S229405	Test EMCAL Preamp Boards: Production Sectors 13-84 - Contributed Lab	55	0	29-Mar-21	14-Jun-21	-46	249	0	31,221								
S196900	EMCAL Modules Complete	0	0		03-Feb-22	-75	0	0	0								
S197300	EMCAL Ready to Install	0	0		04-Feb-22	-16	0	0	0								
S197100	EMCAL Sectors Complete	0	0		04-Feb-22	-69	0	0	0								
S101022	Early Project Completion	0	0		07-Feb-22	-7	0	0	0								
S101030	WBS 1X Schedule Contingency	225	0	07-Feb-22	29-Dec-22	0	0	0	0								
S101040	Approve Project Closeout PD-4	0	0		29-Dec-22*	0	0	0	0								

EMCal Sector
Production
Fabrication/
Assembly/Testing

- ◆ EMCAL Modules Complete
 - ◆ EMCAL Ready to Install
 - ◆ EMCAL Sectors Complete
 - ◆ Early Project Completion
- ◆ Approve Project Closeout PD-4

Schedule
Contingency



- Digitizer parts and Local-Level-1 Trigger parts are in competition with the international market
 - **Experience in mid-CY2020 was acceptable**
 - **Experience since the late CY2020 COVID-19 peak has been much more problematic**
 - **At least 6, likely 9-12 months delay in obtaining parts for digitizers**
 - **No particular delays in obtaining or assembling boards in the USA**
 - **Digitizer fabrication**
 - **Projected as of May to late November 2021 completion, now expect January 2022**
 - **1 month float then remaining to Early Completion**
 - **4 months float then remaining to installation**

Review Charge Element #1

- “Project scope: Is the project executing its technical baseline in a manner to deliver the science? Is the fabrication progress appropriate for this stage of the project? Are all interfaces properly understood?
- Prototypes built meet specifications - Testing remains on LocalLevel-1 Trigger
- Production underway
 - Revised ASIC for TPC (the SAMPAs v5 chip) meets specs, has been produced, tested & delivered
 - OuterHCal production is complete
 - TPC and EMCal are building production series – factory rates known, exercising QA procedures
 - Calorimeter Electronics boards and internal cables complete; external cables on order
 - Digitizer units in production
 - DAQ & Trigger procuring all production units; most computers in hand
 - Min Bias Detector placing contract for production FEE; detector is in hand
 - Interface Control Documents signed, released, under configuration control
- Detector/FEE/DAQ/Timing exercised together for TPC, EMCal, HCal, MBD
- Schedule performance to date preserves >10 months schedule contingency

Review Charge Element #3

- “Management: Is the project being properly managed at this stage? Are the risks properly identified and managed and are appropriate mitigation strategies in place? Are the procurements being properly managed?”
- We have the resources needed to manage the Project
 - Management team is staffed and experienced on projects of similar scale
 - L2/CAM and L3 managers all at work
 - Personnel to staff production efforts on-board
 - Laboratory, factory, high bay space identified and engaged
 - Management protocols (design reviews, ICDs, ES&H/QA reviews, procurement readiness reviews, QA plans, MoA, etc.) in place and being used
 - Risk Registry developed/populated/updated in continuing regular consultation with L2, L3 and engineering staff
 - Long Lead Procurements finished as planned
 - Procurement proceeding steadily; weekly meeting with Procurement. EVMS in use to track
 - Production of all subsystems is underway
 - Costed and committed at 90%

- Vendors – Schedule, possibly Cost
 - 4 >\$100K procurements remain (or, 11 >\$25K procurements remain)
 - Long Lead Procurements
 - EMCal & OHCAL SiPMs - COMPLETE
 - EMCal W powder - COMPLETE
 - OHCAL Scintillating tiles - COMPLETE
 - EMCal Scintillating Fiber - COMPLETE
 - Testing detectors requires electronics deliveries – we have all the needed test setups built and in use
 - GEM foils from CERN for the TPC all in-hand and 85% framed
 - SAMPA v5 chips for TPC all manufactured and tested for use
 - Digitizers and Local Level-1 Trigger electronics parts – competing in the International market for electronics parts, has delayed digitizer completion by >6 months
- Materials – Cost
 - Digitizers, Local-Level-1 Trigger – International market for electronics parts - so far have been able to obtain all parts at planned cost – HOWEVER - “past performance is no guarantee of future results”

Issues and Concerns (cont)



- Schedule
 - Monitor task durations going forward
 - TPC Field cage full-scale tests in near future
 - Parts flows stable and staying ahead of need-by dates

 - Labor needs for EMCal Sectors series production
 - Have added techs at BNL
 - Workflow separated into isolated workstations (COVID-19 protocols)
 - Maintaining the technician workforce is key to meeting schedule
 - Adding further techs would increase the schedule contingency

- Overall schedule contingency reduced from 14 to >10 months due to COVID-19

- We have the team, plans and procedures in place to build sPHENIX
- We have a RLS that still lays out a feasible schedule to do this
- We have the tools and methods in place to manage the Project
- Long Lead procurements are complete
- We have steady progress on all production lines
- We have reached 75% “costed” and 90% “costed plus committed”
- We have reached the last few of FDRs, PRRs

Project is projecting to complete on time and is managing COVID-19 impact

Back Up

OuterHCal and EMCal Installation



Charge Question 5

	Fabrication Complete	Installation Date	Delta (wk)
OHCAL Sector 1 & Splice Plates	Week 8, 2021	Week 25, 2021	17
OHCAL Sector 13	Week 5, 2021	Week 36, 2021	31
SC Magnet Coil	2018 (testing at BNL)	Week 39, 2021	>100
OHCAL Sector 14	Week 5, 2021	Week 43, 2021	38
OHCAL Sector 32	Week 17, 2021	Week 48, 2021	31
EMCAL Sector 1	Week 14, 2020	Week 1, 2022	91
EMCAL Sector 32	Week 26, 2021	Week 5, 2022	31
EMCAL Sector 59	Week 52, 2021	Week 10, 2022	10
EMCAL Sector 64	Week 5, 2022	Week 11, 2022	6

TPC and Electronics Installation



Charge Question 5

	Fabrication Complete	Installation Date	Delta (wk)
TPC	Week 4, 2022	Week 28, 2022	24
OHCAL Cabling	Week 3, 2022	Week 5, 2022	2
EMCAL Cabling	Week 3, 2022	Week 5, 2022	2
Digitizers	Week 4, 2022	Week 17, 2022	13
Trigger & Timing Systems	Week 4, 2022	Week 17, 2022	13
Beampipe	Week 8, 2022	Week 32, 2022	24

TPC, EMCAL and OHCAL on-detector electronics are installed as part of detector fabrication
Digitizer, Trigger and Timing installed after roll-in during April 2022
EMCAL & HCal cabling starts only after Upper Platform in place and essential cryogenics work is underway

OHCaI COVID-19 Impact – Sectors in 912



Charge Question 6

- Lost >3 months. All Labs re-opened late Spring 2020
- Summer 2020 plan had been to install electronics and cabling, light-tight, and test remaining 5 sectors of the 6 prototype sectors using 'army' of students. This had to shift to Fall 2020/Winter 2020-21 to mesh with BNL COVID-19 re-opening protocols
- Students and their professors are mostly contributed labor
- Scintillating tile production resumed at UNIPLAST after 3-month delay; first post-COVID shipment has June 2020; Last UNIPLAST shipment November 2020
- Students at Georgia State resumed scintillating tile testing; completed December 2020
- Work on all 32 sectors of OHCaI was completed in March 2021

TPC COVID-19 Impact – GEM Foils (CERN)



Charge Question 6

- Lost >3 months due to CERN closure. All labs re-opened June 2020
- Time quoted by CERN after they re-opened was 48 weeks to fabricate GEM foils for sPHENIX.
- P6 schedule had allocated 30 weeks based on 2018 discussions with CERN and assumptions about CERN tech availability. CERN noted the new delay was due to personnel availability
- Agreed with CERN to add one tech – this allowed us to ‘prime the pump’ at the GEM framing facilities – Wayne State, Vanderbilt, Weizmann, Temple
- Overall schedule was delayed 2 months relative to baseline
- GEM Foil production and shipping to Stony Brook completed in April 2021

Calorimeter FEE COVID-19 Impact



Charge Question 6

- This group managed to proceed with all their production orders and reviews for calorimeter electronics, with good cooperation from Procurement and from assembly houses. **Bravo!**
- Testing was a key to proceeding. Some was done at BNL by sPHENIX 'first-arrivals'. Some being continued at Lehigh U. This effort now off critical path. **Bravo!**
- BNL has placed the contract with Nevis for the production order of digitizers. Parts availability and lead-time has emerged as a significant issue. Production digitizers are not likely to be complete before end of CY2021.

DAQ COVID-19 Impact – System Test



Charge Question 6

- Lost >3 months; all sites now open
- Interrupted ongoing tests of GL1 and Timing systems under expected operating conditions; these are since completed
- LL1 trigger board testing interrupted at Nevis and since completed; LL1 initial board shipped to U. Colorado for main testing
- Interrupted full-speed tests of first buffer box; these are since completed and production purchases made
- sPHENIX scientific and professional staff perform this work, together with staff from Instrumentation/NSLS-II for the GL1/Timing systems
- DAQ has had adequate schedule float to absorb the interruptions to date but now needs to complete remaining hardware fabrication

Remaining MIE Procurements >\$25K



Charge Question 3

Major MIE Procurements >\$25K still to be Placed - July 5 2021				
Subsystem	Item	\$K	Notes	Subsystem total
TPC	FELIX Optical fibers & connectors	81	Requisition being written	356
TPC	FEE Transceivers	75	Requisition being written	
TPC	Diffuse Lasers	200	Requisition being written	
EMCal	(none)	0		0
HCal	(none)	0		0
Cal FEE	EMCal & Hcal external cables	1100	At BNL Procurement	1100
DAQ	DCM-2 boards	105	SOW being written; produces more of an existing design	417
DAQ	Crates	64	SOW being written; produces more of an existing design	
DAQ	Preproduction LL1	60	At BNL Procurement	
DAQ	Production LL1	118	At BNL Procurement	
DAQ	GL1	28	In-house fabrication at BNL	
DAQ	Timing	42	In-house fabrication at BNL	
MBD	Shaper/discriminator boards	46	At BNL Procurement	46
	TOTAL	1919		

- All construction, be it detector, electronics, DAQ, trigger, timing or support services, must undergo a series of reviews
 - **Design: conceptual (CDR), preliminary (PDR), final (FDR)**
 - **Performance evaluation after prototyping steps (1 or more)**
 - **Final Design Requirements and Specifications Review (FDR&SR) (c.f. May 2019)**
 - **Procurement/Production Readiness Review (PRR)**
 - **ES&H and QA check**


- Conduct of Reviews
 - **Addressed in sPHENIX Procedure sP-SE.QAM.006**
 - **Further information in Backup slides**

sPHENIX Guidelines for Conduct of Design Reviews

Charge Question 3

- sPHENIX Procedure No. sP-SE.QAM.006

sP-SE.QAM.006 rev. A



sPHENIX Guidelines for the Conduct of Design Reviews

sPHENIX Procedure No. sP-SE.QAM.006

Revision: A **Date:** 8/24/2018

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2.2 Preliminary Design Review (PDR)

A PDR is a subsystem level review held when the subsystem design concept has coalesced to the extent that the subsystem is ready to proceed towards the final production design and layouts of all subsystem assemblies, subassemblies and components are available, analyses of the subsystem performance, structural integrity, integration with other subsystems, and safe assembly, handling and operation can be defended. Interface Control Documents (“ICD’s”) should be completed and under configuration control. The panel of reviewers will be mostly internal to sPHENIX but should include key independent experts as determined by sPHENIX project management. Elements presented at the review are well understood and ready to be detailed as represented by layouts, 3D models, schematics, tooling, fixtures, assembly procedures and support systems. Safety issues shall be addressed and mitigation plans to manage these issues shall be presented. Cost and schedule should be within budget, but these are generally not presented at the PDR.

2.4 Final Design Review (FDR)

An FDR is a subsystem level review held when the subsystem design is fully understood to the extent that the subsystem design documentation package is ready to be “frozen” for final production. (“frozen” implies that no documentation changes may take place without detailed justification and explicit approval from sPHENIX Project Management and, as required, through the sPHENIX change control process (see sPHENIX Configuration Management Procedure, document # sP-SE.QAM.003.)

.Design of all subsystem assemblies, subassemblies and components are presented, analyses of the subsystem performance, structural integrity, integration with other subsystems, and safe assembly, handling and operation are to be defended. The panel of reviewers will be internal sPHENIX experts augmented with key independent experts invited by sPHENIX project management. Elements presented at the review are generally final completed documents and analyses but may include some near completed components that are well understood and ready to be detailed. Presentations will also address system and personnel safety, tooling, fixtures, assembly procedures, support systems internal and external integration with layouts, 3D models, schematics, etc. Cost and schedule should be demonstrably within budget, but these are not a primary focus of the FDR.

2.5 Production Readiness Review (PRR)

A PRR is a pre-procurement review of a major components, assembly, fixtures, tool, equipment or service(s) in support of an sPHENIX project subsystem, held to assure that all documentation required for the procurement is complete, accurate and comprehensive, fully describes the item(s) to be procured/fabricated with all tolerances, capabilities, processes and deliverables appropriately specified. Elements presented at the review are generally final and complete. Presentations will also address item design by reference to related design reviews and action items from design reviews satisfied prior to the PRR. PRR reviewers will generally include appropriate internal sPHENIX staff, sPHENIX QA representative, sPHENIX Safety Officer and in some cases, BNL procurement specialist(s).

PRR's in general, also include reviews of sPHENIX production facilities and procedures prior to initiating fabrication, assembly and or installation work at BNL and/or sPHENIX collaborators facilities. The review panel for these PRR's will be assembled by the safety organization for the specific facility (e.g. Physics Department safety group, CAD Experimental Safety Review Committee [ESRC], collaborating institutions safety review organization).

Expectations for FDR and PRR (partial list)



Charge Question 3

- Final Design review looks at results from initial prototypes; FEA and drawings for mechanical parts can be frozen; circuit schematics, data-flow diagrams, and Bills of Material for electronic items; data rates and volumes and networking topologies for DAQ/Trigger/Timing
 - **Drawings to be final, possible exception for well-understood items needing some detailing**
 - **Interface Control Document should be drafted and reviewed**
- Procurement/Production Readiness review looks at final drawings that can be sent to vendors for fabrication, final parts selections including suitability and availability, factory and/or vendor plans, qualified vendor list if applicable, specifications (e.g. tolerances, weld requirements, electronics board finishes)
 - **Full compliance with specifications by the prototype should be demonstrated - e.g. mechanical items match dimensions and materials, electronics items meet noise, speed and power specifications**
 - **“Manufacturability” should be demonstrated**

RLS Activity Lines



- WBS is enumerated (usually at Level 4) as a set of specific Activities:
 - **Resources (labor and/or materials) assigned**
 - **Duration assigned**
 - **Predecessor and successor links made**
 - **Tags attached for e.g. milestone status, funding source, and other fields.**
- Estimating and scheduling works from these Activities
- The Activity numbering is typically “S” followed by a 6-digit sequential number
 - **Each Activity has entries identifying its WBS, manager, estimator, and other identifying markers**

RLS Schedule Construction

- A Resource Loaded Schedule has been developed for sPHENIX
- All tasks have resources, durations & links determined
- MIE Level 2 WBS are largely self-contained and consist of a prototype, preproduction prototype and fabrication sequence. Key predecessor links are to funding authorizations. These WBS typically end on a completion milestone and a link out to Installation (WBS 2.05)
- OHCaI (WBS 1.04) necessarily has a dependency on delivery schedule for the Barrel Flux Return Steel (WBS 2.03.03)

Sample Basis of Estimate

- Sample of Labor estimate sheet for WBS 1.02.01.05 TPC v2 Modules

Labor						
WBS	Activity	Description	Justification	Category	Hours	TOTAL
1.02.01.05.02	117800	Assemble TPC v2 Module Grid	Similar to PHENIX HBD.	TECH	80	80
1.02.01.05.03	118800	Assemble TPC v2a Module Prototype	Similar to PHENIX HBD.	TECH	40	80
				STUD	40	
1.02.01.05.02	117200	Design TPC v2 Module Frames	Copied from v1 field cage design.	PROF	8	24
				TECH	8	
				SCI	8	
1.02.01.05.02	117500	Design TPC v2 Module Grid	Copied from v1 field cage design.	PROF	8	24
				TECH	8	
				SCI	8	
1.02.01.05.02	116900	Design TPC v2 Module Strongback	Copied from v1 field cage design.	PROF	80	240
				STUD	80	
				SCI	80	
1.02.01.05.03	118200	Design TPC v2a Module GEMs	Copied from v1 field cage design.	PROF	40	360
				SCI	160	
				STUD	160	
1.02.01.05.03	117900	Design TPC v2a Module Padplane	Similar to EIC R&D from eRD6	PROF	80	320
				STUD	160	
				SCI	80	
1.02.01.05.03	118600	Frame TPC v2a Module GEMs	Similar to PHENIX HBD.	TECH	40	40
1.02.01.05.02	117300	Procure TPC v2 Module Frames	Vendor purchase	TECH	24	24
1.02.01.05.02	117600	Procure TPC v2 Module Grid Parts	Vendor purchase	TECH	24	24
1.02.01.05.02	117000	Procure TPC v2 Module Strongback	SBU shop	TECH	16	16
1.02.01.05.03	118300	Procure TPC v2a Module GEMs	Similar to EIC R&D from eRD6	TECH	32	32
1.02.01.05.03	118000	Procure TPC v2a Module Padplane	Similar to EIC R&D from eRD7	TECH	16	16
1.02.01.05.03	118700	Test TPC v2a Module Framed GEMs	Similar to PHENIX HBD.	TECH	40	80
				STUD	40	
1.02.01.05.03	118500	Test TPC v2a Module GEMs	Similar to PHENIX HBD.	TECH	40	80
				STUD	40	
1.02.01.05.03	118900	Test TPC v2a Module Prototype	Similar to PHENIX HBD.	TECH	160	320
				STUD	160	
		Grand Total			1760	1760