sPHENIX Director's Review

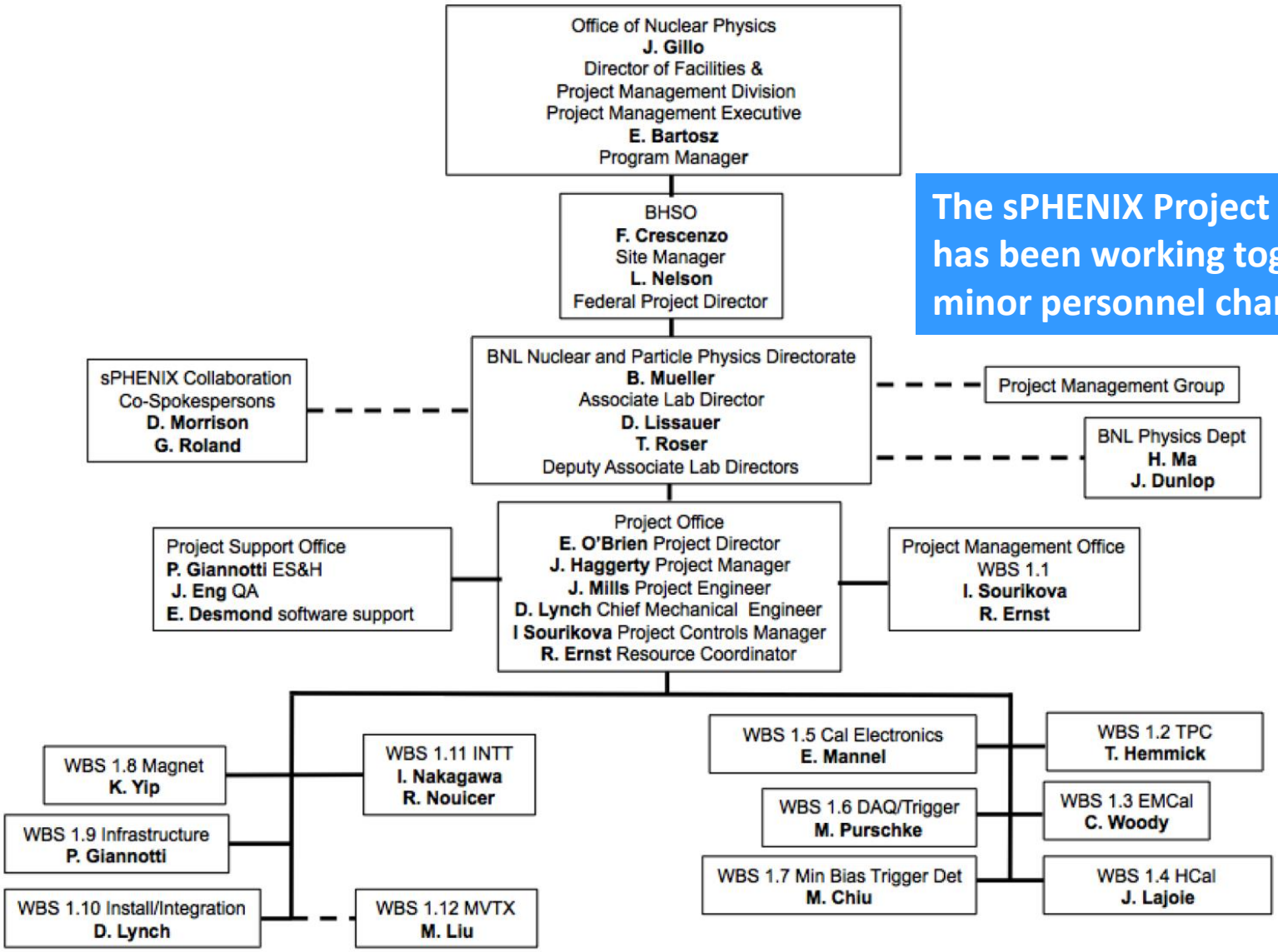
Project Organization and the Preliminary Project Execution Plan

Edward O'Brien

August 2-4, 2017

BNL

sPHENIX Project Organization



The sPHENIX Project Organization has been working together with minor personnel changes for 3 years

Project Team Brief Bios

Edward O'Brien
Project Director

Senior Scientist, Assistant Department Chair, Physics Department, BNL

Relevant Experience
Three years as sPHENIX Project Director. Thirteen years as PHENIX Operations Director during which time I coordinated the addition of $25M in upgrade detectors to PHENIX and managed a staff of 25-30 FTEs. Four years as project manager of the $10M PHENIX Central Tracking system. Eight years as head of the PHENIX Central Tracking group and Project Manager of the $4M Time Expansion Chamber. Designed and built major components of the E814/E877 Tracking System, a BNL AGS fixed-target HI experiment.

John Haggerty
Project Manager

Senior Scientist, Physics Department, BNL

Relevant Experience
BNL AGS/E-787 1986-1996, DAQ and 500 MHz waveform digitizers; PHENIX Deputy Project Manager, 1997-2001; PHENIX Data Acquisition Coordinator, 2001-2007; PHENIX Deputy Operations Director, 2008-2016; PHENIX Run Coordinator 2009-2010; sPHENIX management 2012-present. Design, construction, implementation, and software support for PHENIX timing system, slow controls of front end electronics, high speed PCI interface to DAQ.

James Mills, P.E.
Project Engineer

Senior Project Engineer, Collider-Accelerator Department, BNL

Relevant Experience
Over 37 years of Engineering and Project Management experience at Brookhaven National Laboratory. 8 years as Manager of the

Modernization Project Office Engineering and Design Group (2006-2014) with overall responsibility for the successful completion of a portfolio of projects in excess of $15 million annually; 6 years as Project Engineer for conventional construction in support of facility operations at Brookhaven (2000-2006); managing projects up to $6 million in total scope. 4 years of experience as Head of the Facility and Experimental Support Group, RHIC Project (1996-2000). Responsible for approximately $13 million dollars of conventional construction in support of experiments at RHIC. 6 years as Project Engineer for the STAR Magnet (1990-1996), providing engineering analysis and design of the 0.5 tesla solenoidal magnet. 10 years as Project Engineer, experimental support for High Energy Physics experiments at Brookhaven National Laboratory's Alternating Gradient Synchrotron (1980-1990).

Don Lynch, P.E.
Chief Mechanical Engineer
Mechanical Engineer, Physics Department, BNL

Relevant Experience
Five years as sPHENIX Chief Engineer. Thirteen years as PHENIX Chief Engineer (12 data taking runs, 9 new detector subsystem projects, numerous overhaul/upgrades of existing subsystems, numerous facility and infrastructure projects). Thirteen years as Senior Project Engineer at BNL/NSLS (numerous accelerator and beamline projects, 15 years non-BNL aerospace, thermal and mechanical engineering projects.

Project Team Brief Bios

Irina Sourikova
Project Controls

Advanced Applications Engineer, Project Management Professional, Physics Department, BNL

Relevant Experience
Sixteen years as PHENIX software Engineer, database developer and database administrator. Designed, implemented and supported PHENIX calibrations and collaboration databases providing legacy data migration, data archival and replication. Two years as sPHENIX Project Controls. Certified Project Management Professional.

Robert Ernst
Resource Coordinator

Nuclear and Particle Physics Directorate Chief Operations Officer (DCOO) for Physics, Instrumentation and Magnet Division, BNL

Relevant Experience
Thirty-five years of administrative and budget management experience working at two national laboratories and private industry; including providing project control and procurement oversight for the construction phase of the PHENIX experiment at RHIC.

Paul Giannotti
ES&H Coordinator

Electrical Engineer, Physics Department, BNL

Relevant Experience
Designer of PHENIX Control Room indication and alarm system, emergency shutdown safety system, and electrical power distribution. Operations and ES&H support for all PHENIX runs 2000-2016.

Thomas Hemmick
TPC Level 2 Manager

Distinguished Teaching Professor, Stony Brook University

Relevant experience (1988-present)
Heavy Ion Experiments: BNL AGS/E-814, BNL AGS/E-877, PHENIX. Detector Systems: E814 drift/pad chambers(construction), E877 MWPC chambers (design/construction/management), PHENIX RICH (design/construction/management), PHENIX drift chambers (design/construction/management), PHENIX hadron blind detector(design/construction/management), PHENIX MPC-EX(construction). R&D: CsI-GEM HBD, CsI-GEM RICH, W-Si preshower, large area GEM chambers, TPC-Cherenkov hybrid, TPC Ion Back Flow.

Project Team Brief Bios

Craig Woody
EMCAL Level 2 Manager

Senior Scientist, Physics Department, BNL

CERN ISR R807, BNL AGS E787, E814, E877 and E855 (Spokesperson), PHENIX. More than 40 years of detector experience. Built and operated uranium scintillator electromagnetic sampling calorimeters at CERN. Played a major role in the design and construction of the PHENIX Pb-scintillator shashlik EMCAL and Hadron Blind Detector. Extensive R&D on scintillating crystals (APS Fellow). Developed medical instrumentation for PET and PET/MRI imaging. Carrying out R&D with GEMs for tracking applications at EIC, including TPCs. Co-Group Leader of the PHENIX Group from 2001-2009, Deputy Group Leader 2016-present. Past President of the IEEE Nuclear and Plasma Sciences Society and IEEE Fellow.

John Lajoie
HCAL Level 2 Manager

Professor of Physics, Iowa State University

Relevant Experience
BNL AGS/E864 1992-1998; PHENIX Level-1 Trigger Detector Council Member 1996-2015; PHENIX Run Coordinator 2004-2005; Elected to PHENIX Executive Council 2007-2013; PHENIX Deputy Spokesperson 2013-2015; PHENIX MPC-EX Project Spokesperson 2012-present; sPHENIX management 2014 - present.

Eric Mannel
Calorimeter Electronics Level 2 Manager

Electrical Engineer, Physics Department, BNL

Relevant Experience
Columbia University, HiRes Fly's Eye Experiment 1991-2005: research scientist responsible for overseeing the production, testing and operations of the HiRes-II FADC based DAQ and daily calibrations of the HiRes-II detector; PHENIX VTX/FVTX 2005-2011: electronics engineer responsible for overseeing the VTX and FVTX electronics design construction and for overseeing VTX and FVTX annual maintenance and operations.

Brookhaven National Laboratory, PHENIX VTX/FVTX 2011-2016: electrical engineer responsible for overseeing VTX and FVTX annual maintenance and operations; spokesperson for the sPHENIX calorimeter beam test at Fermilab Test Beam Facility 2014-2018. sPHENIX management 2015-present.

Martin Purschke
DAQ/Trigger Level 2 Manager

Senior Scientist, Physics Department, BNL

Relevant Experience
PHENIX DAQ group, 1997-2016; PHENIX DAQ coordinator, 2007-2016. Designed and maintained the PHENIX online computing infrastructure, networks, control systems, data transfers, compression algorithms, storage systems, procured PHENIX computing and network hardware.

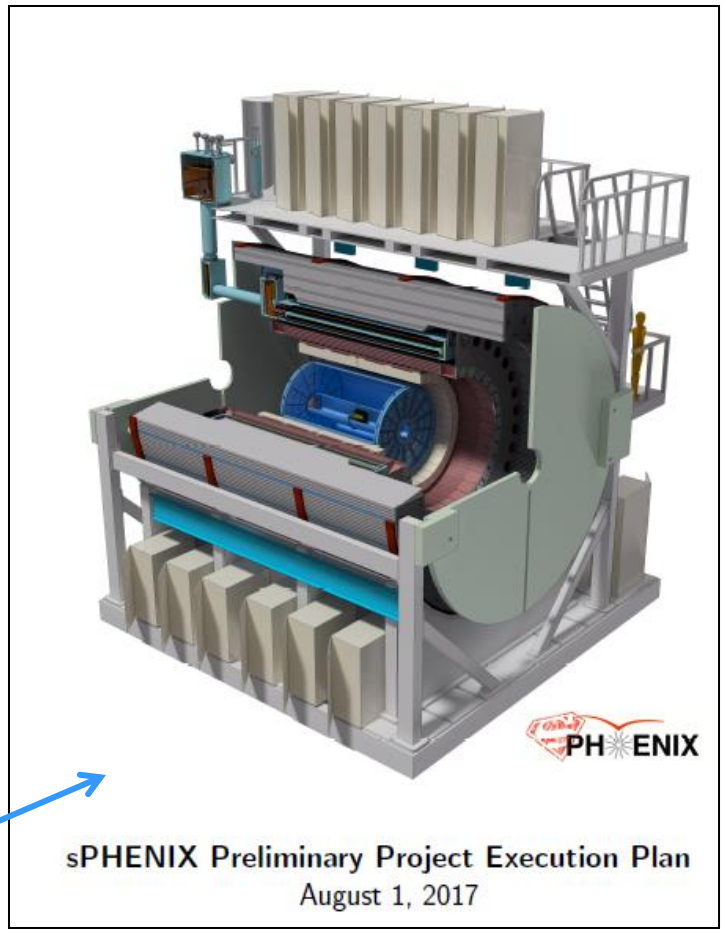
Mickey Chiu
Minimum Bias Detector Level 2 Manager

Staff Scientist, Physics Department, BNL

Relevant Experience
PHENIX, 1998-2016: As grad student was responsible for installation, commissioning, and support for the BBC/TOF/ZDC/NTCp electronics, ZDC detector, and DCM/DAQ, including both hardware and software aspects of 6 above subsystems. As post-doc and staff scientist, was PI and Detector Council Member for the MPC PbWO4 forward calorimeter Project, and awarded PECASE in 2007 for this work. Served as PHENIX Director of Operations for final 3 years of PHENIX running. Currently member of sPHENIX and NEXO Collaborations, and PI of 10 ps TOF Project for the EIC Generic Detector R&D Program.

CD-1 Documents Available to the Committee

1. **Project Team Organization**
2. **WBS (WBS Dictionary)**
3. **Basis of Estimate documents**
4. **Contingency Risk/Analysis**
5. **Project Schedule**
6. **Critical Milestones**
7. **Proposed Funding Profile**
8. **Proposed Labor Profile**
9. **Preliminary Hazard Analysis Report**
10. **NEPA form**
11. **Integrated Safety Management Plan**
12. **Conceptual Design/Conceptual Design Report-**
13. **Acquisition Strategy**
14. **Preliminary Project Execution Plan**
15. **Preliminary Risk Assessment and Risk Registry**
16. **Security Vulnerability Assessments (Equipment protection & cyber security)**
17. **Alternate Analysis**



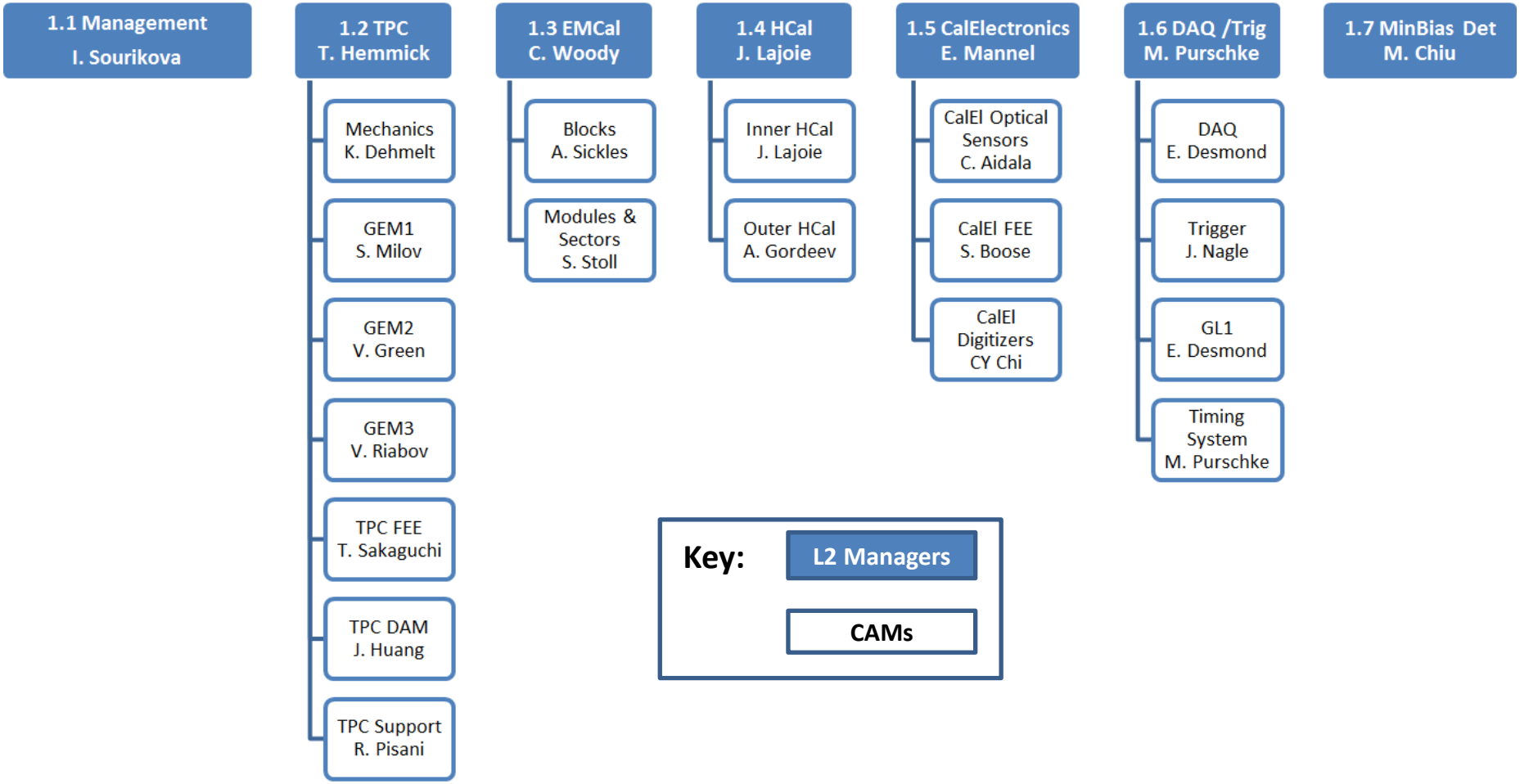
Content of the Preliminary PEP

1. Project Background and Mission Need
2. Preliminary Project baseline
3. Life Cycle Costs
4. Acquisition Approach
5. Tailoring Strategy
6. Baseline Change Control
7. Management Organization and Structure
8. Project Management Oversight
9. Environmental, Safety, Security, Health and Quality
10. Transition to Operations
11. Project Close Out
12. Integrated Project Team Charter

sPHENIX MIE Scope

- A Time Projection Chamber (TPC), Electromagnetic Calorimeter (EMCal), Hadronic Calorimeter (HCal), all covering 2π in azimuth and a fiducial pseudo-rapidity coverage of $-1 \leq \eta \leq 1$.
- Readout electronics to fully instrument the TPC, EMCal and HCal.
- A Data Acquisition system with the capability to readout the TPC, EMCal and HCal with an event rate and data logging rate commensurate with the sPHENIX physics goals.
- A DAQ/Trigger system that can provide minimum bias and energy cluster triggers at a rate necessary to carry out the sPHENIX physics program in AA, pA and pp at RHIC.
- A Minimum Bias Trigger Detector
- Project Management to carry the Project Scope through to a successful completion.

L2 and CAM Structure of MIE



Proposed Key Performance Parameters

Installation is NOT part of the MIE and not a deliverable. Beam collisions are not needed to satisfy the KPP's.
Preliminary KPP's listed in the PPEP. They are under Discussion with DOE-ONP

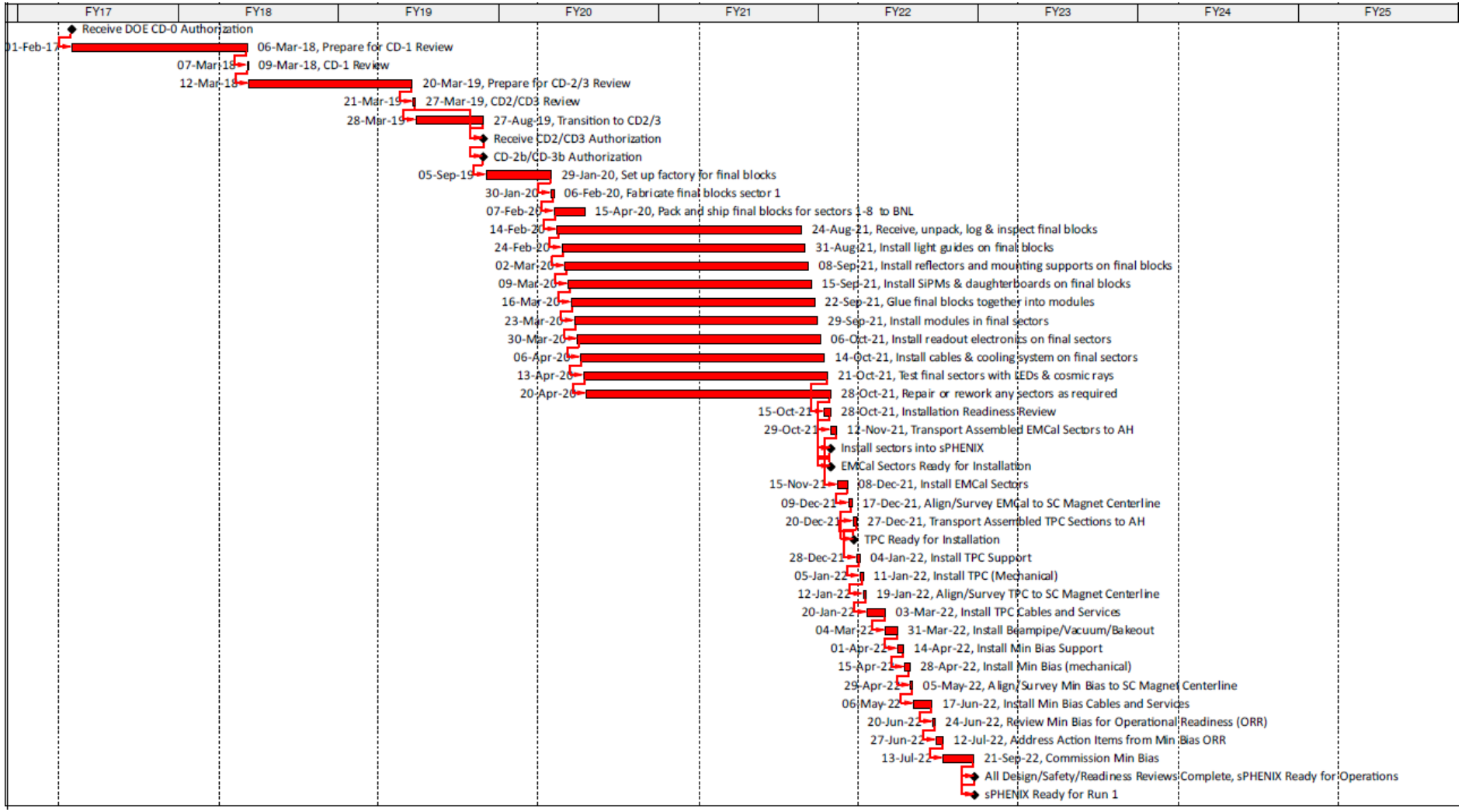
System	Demonstration or Measurement	Preliminary KPP's
Time Projection Chamber	Preinstall Bench Test	$\geq$ 90% live chns based on laser, pulser, cosmics
Time Projection Chamber	Preinstall Bench Test	Ion Back Flow $\leq$ 2% per QuadGEM Module
Time Projection Chamber	Preinstall Test w/ cosmics	$\geq$ 90% single hit efficiency / mip track
Time Projection Chbr FEE	Preinstall Bench Test	Cross talk $\leq$ 2% ea chn
EM Calorimeter	Preinstall Bench Test	$\geq$ 90% live channels based on LED, cosmics
Hadronic Calorimeter	Preinstall Bench Test	$\geq$ 90% live chns based on LED, cosmics
EM Calorimeter	Preinstall Bench Test	Ea sector with an absolute energy pre-calibration to a precision of $\leq$ 35% RMS
Hadronic Calorimeter	Preinstall Bench Test	Ea sector with an absolute energy pre-calibration to a precision of $\leq$ 20% RMS
Min Bias Trigger Detector	Preinstall Bench Test	$\geq$ 90% live channels based on laser. 120 ps/ch timing resolution w/ Bench Test
DAQ/Trigger	Event rate	10 kHz with random pulser
DAQ/Trigger	Data Logging rate	10 GBit/s with pulser

Major Project Milestones for L2 Subsystems

WBS	Project Milestone of LEVEL-2 subsystems	Scheduled Dates
1.2.1	TPC available for installation	11/2020
1.2.2	Quad GEM Module Readiness review	6/2019
1.2.2/3/4	Quad GEM Module Production complete	6/2020
1.2.5	TPC FEE Production Readiness review	5/2019
1.2.5	TPC FEE Production complete	7/2020
1.2.6	TPC DAM Production Readiness review	6/2019
1.2.6	TPC DAM Production complete	9/2020
1.3.2	Block Production Readiness review	1/2020
1.3.3	Module and Sector Production Readiness review	8/2019
1.3.4	EMCal sectors complete, available for installation	11/2021
1.4.2	Procurement of IHCal mechanical structure complete	4/2021
1.4.2	Procurement of IHCal scintillating tiles complete	10/2020
1.4.2	Last sector IHCal available for installation	6/2021
1.4.3	Procurement of OHCal scintillating tiles complete	3/2020
1.4.3	First sector OHCal available for installation	9/2020
1.4.3	Last sector OHCal available for installation	4/2021
1.5.1	Optical Sensor Procurement Complete	9/2020
1.5.2	EMCal Fee Production Complete	2/2021
1.5.2	HCal Fee Production Complete	10/2020
1.5.3	Calorimeter Digitizer Production start	8/2019
1.5.3	Calorimeter Digitizer Production Complete	10/2020
1.6	DAQ Ready for Operation	10/2021
1.7.3	Receive Digitizers for Min Bias Det	4/2020
1.7.4	Min Bias Det available for installation	12/2020

sPHENIX Critical Path Calculated in P6

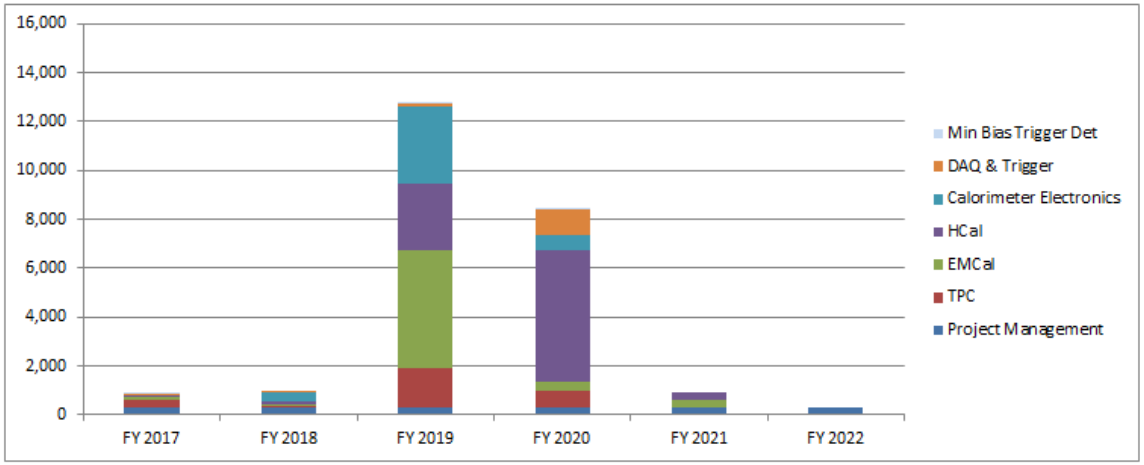
sPHENIX MS-Project and P6 give the same critical path



sPHENIX Project Scoped to fit within the CD-0 Cost Range

Baseline Scenario

AY k$'s - with Extraordinary Construction Overhead Application



Baseline Scenario

AY k$'s - with Extraordinary Construction Overhead Application

WBS	SYSTEM	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total
1.1	Project Management	280	320	320	320	305	305	**1,850**
1.2	TPC	323	31	1,575	675	0		**2,604**
1.3	EMCal	161	96	4815	337	323		**5,732**
1.4	HCal	15	129	2,752	5,427	313		**8,636**
1.5	Calorimeter Electronics	52	351	3,160	598	0		**4,161**
1.6	DAQ & Trigger	19	32	114	1,035	0		**1,200**
1.7	Min Bias Trigger Det	63	0	19	54	0		**136**
	Baseline Total	913	959	12,755	8,446	941	305	**24,319**
	MIE Contingency	274	288	3,827	2,534	282	92	7,296
	MIE Total	1187	1247	16582	10980	1223	397	**31615**

WBS	SYSTEM	Baseline	Contingency	Total
1.1	Project Management	1,850	555	2,405
1.2	TPC	2,604	781	3,385
1.3	EMCal	5,732	1720	7,451
1.4	HCal	8,636	2591	11,227
1.5	Calorimeter Electronics	4,161	1248	5,409
1.6	DAQ & Trigger	1,200	360	1,560
1.7	Min Bias Trigger Det	136	41	177
	MIE Totals	24,319	7296	31,615

The budget shown has deferred the Inner HCal and only built 85% of the EMCal eta coverage

Risk Registry

sPHENIX Risk Registry									
Owner	WBS	Risk Name	Risk trigger (if)	Consequences (then)	Timeframe	Probability	Impact	Rank	Mitigation Plan
E.O'Brien	1.1 Management	Departure of Key Personnel	Someone critical to the Project informs of his intention to leave sPHENIX	Schedule delay occurs	all	10%	Schedule: 3 months	Low	Closely work with sPHENIX collaboration to identify a potential replacement.
E.O'Brien	1.1 Management	Safety Incident	Safety Incident resulting in injury	Schedule delay occurs	all	5%	Schedule: 1 month	Low	Carefully plan all work in accordance with BNL SBMS. Include safety reviews and safety review recommendations implementation in sPHENIX resource loaded schedule.
E.O'Brien	1.1 Management	Funding profile stretches	Funds not available on time	Cost increases because procurements need to be broken down into smaller units, or existing quotes expire, or new contracts need to be negotiated.	production	30%	Schedule: 12-24 months Cost: $500K	High	Work closely with the funding agency so any funding profile changes can be evaluated as early as possible and sPHENIX Project schedule optimally adjusted to match the new funding profile.
E.O'Brien	1.1 Management	Infrastructure support delayed	Infrastructure milestone is delayed	Project activities dependent on infrastructure milestone are delayed	all	5%	Schedule: 2 months	Low	Develop a detailed resource loaded schedule with key milestones for infrastructure support and closely monitor this schedule for risk triggers.
T. Hemmick	1.3 TPC	Procure v1a GEMs	Delivery date on v1-shapes GEMs leaves less than one month before magnet test.	The test will require that we use existing GEMs which will be 10x10cm^2. This will require a special module to adapt the smaller square GEMs to the standard opening.	R&D Phase	20%	Cost $10k for square-GEM adapter parts	Low	In case the proper GEMs for the v1a prototype are not in hand, an adapter plate will be required to fit an existing GEM-stack to allow the magnet test to proceed.
T. Hemmick	1.3 TPC	Performance failure of v2 prototype	The v2 prototype fails in any performance criterion that requires more than trivial re-design.	If the v2 prototype fails, then there will need to be a v3 prototype added to the cycle.	R&D phase	5%	Schedule: 3 months of float lost. Cost:$15k (only gain structure at risk...new GEMs)	Moderate	We will add a design cycle of a smaller device than the full sized field cage if the v1 prototype fails. We will proceed on v2 only after success of the small version.
T. Hemmick	1.3 TPC	Failure or delay of CERN production	Factories wait upon GEM foil delivery and suffer schedule shifts.	The factory production of modules is critical path and will directly affect schedule.	production	10%	Schedule: 3-5 months	Moderate	We will monitor carefully the success of CERN foil production and will hire a technician who will exclusively work on producing GEM foils for our project. If delays still occur, we will seek a second vendor.
T. Hemmick	1.3 TPC	SAMPA Chip Failure	SAMPA chips fail to match performance specifications.	Affects delivery of the TPC since FEE must be applied before delivery.	production	2%	Schedule: Unknown since mediation requires action from ALICE.	Moderate	ALICE and STAR shall be forced to mitigate the situation and if not, alternatives such as the ePIC TRO and DREAM chips must be considered.
S. Stoll	1.3 EmCal	Loss of W powder supplier	Failure of the primary supplier of W powder (Tungsten Heavy Powder) to sign a contract and deliver the powder for the final block production at an affordable price.	Would need to obtain a quote and sign a contract with a different supplier for the powder. This will cause a delay in the schedule and possibly an increase in cost. In addition, powder from a different vendor could lead to poorer detector performance.	production	Low 20%	High. Cost: price increase + $500k. Schedule: 9 mo to rebid/negotiate contract/ place order.	Moderate	Find another source of W powder which can meet our specs. Some have already been investigated. Attempt to identify primary source of raw powder in China and identify new distributor. Accept degraded detector performance if new powder does not meeet specs.
S. Stoll	1.3 EmCal	Loss of SciFi supplier	Failure of fiber vendor to sign a contract or deliver fiber on time.	Would cause a delay in the schedule and result in higher cost for the fiber	production	Moderate 30%	Moderate Cost: $1.4M higher cost for alternate supplier	Moderate	Two suppliers have been identified. We believe both can meet our specs, but one is roughly 2X high cost. If the lower priced supplier cannot deliver then we must use contingency to purchase from the other supplier.
S. Stoll	1.3 EmCal	Loss of primary production site for blocks (University of Illinois Urbana Champaign)	UIUC decides to not fabricate the absorber blocks	Would cause a delay in schedule and a significant increase in labor resources required to build the blocks at BNL.	production	Low 10%	High Cost: Slight cost increase to relocate factory to BNL Schedule: Significant. At least 12 mo. Delay to set up new factory and begin production	High	Blocks would have to be built at BNL. However, we would also loose scientific oversight provided by UIUC, student labor, free use of facilities, space, etc.
S. Stoll	1.3 EmCal	Cannot find a cost effective solution for making light guides	R&D studies and beam tests do not lead to improvements in the light collection uniformity from the modules	Will require position dependent correction for obtaining the desired energy resolution from the detector	R&D phase	High 75%	Low - Scope: Poorer detector energy resolution	Moderate	We will have optical quality injection molded light guides produced with what we believe will be the optimal shape given the space constraints of the detector. The resulting energy resolution will be measured in a beam test.
J. Lajoie	1.4 HCal	Loss of scintillating tile provider (Uniplast)	Uniplast is unable to engage in or complete the production contract	Schedule delay in the procurement of the scintillating tiles, along with correspond delays in inner and outer HCAL assembly.	production	10%	Schedule: 6-9 months	Moderate	Explore alternate scintillator vendors (FNAL, Elgin).
J. Lajoie	1.4 HCal	Unable to produce Inner HCAL in $3310 in a cost effective manner	Evaluation of Inner HCAL prototype yields higher than anticipated production costs	Schedule delay in finalizing the design of the inner HCAL; re-engineering required.	production	25%	Schedule: 6 months	Moderate	Investigate value-engineering designs and alternate materials (brass); will require re-engineering.
J. Lajoie	1.4 HCal	Unable to identify suitable site(s) for Inner HCAL assembly (joint, and electronics)	No participating University site can identify the space resources for assembly.	Schedule delay to set up assembly site at BNL	production	5%	Schedule 3 months	Low	Investigate possibility of assembly (scintillator and electronics) at BNL.
E. Mannel	1.5 Cal Electronics	Delay in SIPM Delivery	SIPM order not placed on schedule or vendor unable to meet production schedule	Delay in assembly of HCal and EmCal SIPM daughter boards. Potential delay in HCal and EMCal module assembly	Procurement	Moderate: 50%	Low: Schedule delay 3-3 months	Low	Closely monitor the procurement stage.
E. Mannel	1.5 Cal Electronics	Delay in testing of SIPMs	SIPM Delivery not placed on schedule or vendor unable to meet production schedule	Delay in assembly of HCal and EMCal SIPM daughter boards. Potential delay in HCal and EMCal module assembly	Production	Moderate: 50%	Low: Schedule delay 3-3 months	Low	Increase number of testing stations. Identify additional collaborators who can contribute to the testing program. Streamline testing program.
E. Mannel	1.5 Cal Electronics	Delay in Assembly of HCal Daughter boards, Preamps, Interface boards, LED Drivers	Procurement of components, issuing of orders.	Potential delay in HCal module assembly and testing	Production	Moderate: 25%	Low: Schedule delay 3-3 months	Low	Staged partial deliveries of boards. Use multiple assembly houses
E. Mannel	1.5 Cal Electronics	Delay in assembly of EMCal Daughter boards, Preamps or Interface boards	Procurement of components, issuing of orders.	Potential delay in EMCal module assembly and testing	Production	Moderate: 25%	Low: Schedule delay 3-3 months	Low	Staged partial deliveries of boards. Use multiple assembly houses
M. Purschke	1.6 DAQ/Trigger	DAQ Prototype	Tests with the various prototype stages reveal problems	DAQ prototype throughput and performance is below specifications	All	Moderate: 25%	Cost, Increase number of boards/PCs	Low	Acquire more expensive PCs / re-design parts of the architecture
M. Purschke	1.6 DAQ/Trigger	Network switch	One of the currently identified vendors go out of business	Network switch more expensive than projected	Production	Low 30%	Cost due to lack of alternatives, Schedule (1Month)	Low	alternate vendors, different brands / getting acquainted with potentially new software interface
M. Purschke	1.6 DAQ/Trigger	Global Lvl1	Loss of engineering expertise due to employees leaving	adaptation of PHENIX GL1 runs into obstacles	Production	Low 30%	Schedule (2 months)	Low	select different card, identify a different engineer
M. Purschke	1.6 DAQ/Trigger	Timing System	Insufficient number of now-obsolete parts	Conversion/adaptation from GLINK problematic, or envisioned replacement board cannot be used	All	Low 10%	Schedule 3 months	Low	select different card, re-engineer fiber interface
M. Purschke	1.6 DAQ/Trigger	Local LVL1	Simulations reveal the failure of an envisiond algorithm	Performance of LLVL1 algorithms inadequate. Trigger latency too high.	Production	Moderate 30%	Schedule 3 months	Moderate	Prioritize Physics goals, procure more hardware
M. Purschke	1.6 DAQ/Trigger	Storage	The TPC or other subsystem cannot meet the envisioned data reduction specifications	Data volume, especially from the TPC, too high	Production	Moderate 30%	cost ($100K)	Moderate	Invest in more local storage, change compression algorithms
M. Chiu	1.7 MinBias	Magnetic field capability of BBC PMTs	Testing shows PMT gain drops below spec for B-field at preferred MBD location.	Must move MBD further away in z, losing some MB efficiency	All	3%	Moderate: Cost: $0, Schedule: 0-6 months	Low	Testing mesh dynode PMTs to remove uncertainty in B-field performance. Worst case, move BBC to z=±300 cm
K. Yip	1.8 SuperConducting Magnet	Magnet does not work; cannot achieve specified field	Failure of magnet to reach field. Possible causes, internal electrical failure, vacuum leak failure, cryo system failure, Power supply failure	Detector System can't resolve data without adequate magnetic field. Rework of magnet to correct deficiency is necessary	All	Low 10%	High: Cost ~$100-500K schedule 6-12 mos	Moderate	Full field test at bldg 912 prior to transport to bldg 1008 to prove out magnet performance, cryo, power supply and quench detection systems. Electrical check (warm) at 1008 to check for faults induced in shipping. Final full field/mapping test in 1008 lab.
P. Giannotti	1.9 Infrastructure	Engineering Resources not available	Engineering not available for timely design efforts	Cascading delays to production, assembly and installation	Design	Moderate: 30%	Moderate: Cost: $0, Schedule: 0-6 months	Moderate	Schedule relies on significant engineering resources not yet fully committed. Get early commitments from contributing groups for timely participation
P. Giannotti	1.9 Infrastructure	Cradle Fabrication delayed	Fabrication delayed	Cradle not available on time to commence assembly and installation	Installation	low: 10%	Moderate: Cost: $0, Schedule: 0-6 months	Low	Reliable experienced fabricator(s), adequate schedule contingency
D. Lynch	1.10 Integration and Installation	Subsystem not ready for installation	Subsystem not delivered in time for scheduled installation	Delays in construction/installation of sPHENIX	Installation	Moderate: 30%	Moderate: Cost: $0, Schedule: 0-6 months	Moderate	Build in adequate schedule contingency
D. Lynch	1.10 Integration and Installation	Labor not available for installation	Labor not available for timely installation	Delays in construction/installation of sPHENIX	Installation	low: 10%	Moderate: Cost: 0-$30K, Schedule: 0-6 months	Low	Secure more labor support/ temporary hires
D. Lynch	1.10 Integration and Installation	Pole Tips delayed	Fabrication delayed	Pole tips not available when scheduled for installation delays move to IR for following installation.	Installation	low: 10%	Moderate: Cost: $0, Schedule: 0-6 months	Low	Reliable experienced fabricator(s), adequate schedule contingency (pole tips installation near end of installation schedule)

Risk Matrix

Uniformly Applied Graded Approach to Risk Across All Subsystems

Table 3: Impact Assessment Matrix for Project-Level Global Risks

Impact Risk Area	Low	Moderate	High
Cost:	≤ $250K	≤$500K	>$500K
Schedule:	Delays Level 2 milestone or Project critical path by ≤3 month	Delays Level 2 milestone or Project critical path by ≤6 months	Delays Level 2 milestone or Project critical path by >6 months
Scope/Technical:	Negligible, if any, degradation.	Significant technical/scope degradation.	Baseline scope or performance requirements will not be achieved.

Table 6: Risk Classification Matrix

	Impact		
Probability	**Low**	**Moderate**	**High**
High (probability > 75%)	Moderate	High	High
Moderate (25% < probability < 75%)	Low	Moderate	High
Low (probability < 25%)	Low	Low	Moderate

Tailoring Strategy

Critical Decisions	Scheduled Dates
CD-0	September 2016
CD-1/CD-3a Authorization	December 2018
CD-2/CD-3b Authorization	September 2019
CD-4 Approve Project Completion	January 2024

All CD dates are subject to DOE approval

Procure of those long-lead "items" through authorization from the PME in advance of CD-2 would be carried out via a tailoring strategy (Letter of Authorization) , or early CD-3a
Justification:

1. Reduce overall project risk
2. Materials will be needed regardless of . . .
3. Contract option already in placed to be executed with excellent price
4. Reduce project schedule
5. Reduce overall cost to project (estimated to be . . .)

SiPMs for EMCal and HCal	**$1.0M**
Outer HCal Steel	**$5.3M**
Scintillating Tiles for HCal	**$1.8M**
Scintillating Fibers for EMCal (1/2 order)	**$0.7M**

Each items has a long production time, long queue time or both. All are for detectors on or near the critical path.

Baseline Change Control - Authorizations

	Deputy Director for SC or Delegate Change Control L0	**Project Manager Executive** Change Control L1	**Federal Project Director** Change Control L2	**sPHENIX Project Director** Change Control L3
Scope	Any changes in scope and/or performance that affects the ability to satisfy the mission need or is not in conformance with the current approved and budget narratives	Any changes that negatively impact achieving the KPP's as defined in the PEP. Major changes in technology/approach to L2 components listed in Table 2. Any major addition to scope described in PEP Scope Baseline section.	Changes in scope affecting the technical performance WBS L3 components that do not affect the KPP's or major changes in the technology or approach to Level 3 WBS components	Changes to technical scope below the FPD threshold
Cost	Any increase in the TPC, TEC or OPC of the Project as stated in the PEP Table 2	Cumulative allocation of $2M of contingency Any change to TEC or OPC	Any cumulative change of $\geq$ $1M in a WBS Level 2 cost shown in Table 2 or allocation of $\geq$ $1M cumulative in contingency**	Any use of Management Reserve* Change in cost below the FPD threshold
Schedule	Any delay in CD-4 project completion date as stated in Table 3.	Any delay to a milestone as shown in Table 3 (with the exception of CD-4). Delay > six mo to a Level 2 schedule milestone shown in Table 4.	Three month delay to a Level 2 schedule milestone shown in Table 4.	Any delay below the FPD threshold in a Level 2 threshold milestone as shown in Table 4 that does not affect a Level 2 Control Milestone date
Funding	Any changes to the funding profile as shown in Fig 1 that negatively affects the performance baseline			

Project Roles and Responsibilities Defined in the PPEP

- Project Management Executive – Dr. Jehanne Gillo
- Federal Program Manager – Dr. Elizabeth Bartosz
- Federal Project Director – Mr. Lloyd Nelson
- BNL Associate Lab Director – Dr. Berndt Mueller
- sPHENIX Project Director – Dr. Edward O'Brien
- sPHENIX Project Manager – Dr. John Haggerty
- Project Engineer – Mr. James Mills
- Chief Mechanical Engineer – Mr. Donald Lynch
- Project Controls Manager – Ms. Irina Sourikova
- Resource Coordinator – Mr. Robert Ernst
- Level-2 Managers
- Control Account Managers

sPHENIX Project Director Roles and Responsibilities

7.5 sPHENIX Project Director

Edward O'Brien, Brookhaven National Laboratory. The sPHENIX Project Director (PD) leads the sPHENIX Project Management team. He is appointed-by and reports directly-to the BNL ALD for Nuclear and Particle Physics, and to the FPD and FPM through the ALD's office. The PD's responsibilities include:

- The successful execution of sPHENIX project scope.
- Collaboration with the Project Manager, Project Engineer and Chief Mechanical Engineer, to assemble the staff and resources necessary to complete the sPHENIX project.
- Collaboration with the Project Manager, Project Engineer and Chief Mechanical Engineer, in setting the technical direction of the sPHENIX project.
- The completion of Project deliverables as defined in the Project Execution Document.
- Ensures that the project deliverables meet sPHENIX functional requirements.
- Allocation of Management Reserve and contingency funds according to the procedure defined in the Baseline Change Controls Procedure.
- Approval of major subcontracts.
- Implementation of a performance measurement system.
- Assurance that work is performed in compliance with the BNL Environmental, Safety and Health requirements.
- Delegation of all responsibilities to the sPHENIX Management team including Level-2 (L2)-Managers and Control Account Managers (CAMs) as appropriate for the successful completion of the sPHENIX MIE Project.

sPHENIX Project Manager Roles and Responsibilities

7.6 sPHENIX Project Manager

John Haggerty, Brookhaven National Laboratory. The sPHENIX Project Manager (PM) is appointed by and works directly for the sPHENIX Project Director.

- Under the direction of and by delegation from the Project Director, the Project Manager executes project scope and supplies the deliverables of the WBS items covered by the MIE scope (WBS 1.2-1.7) with the exception of WBS 1.1 Project Management. The L2 deliverables to be supplied on-time and on-budget include a Time Projection Chamber, EM Calorimeter, Hadronic Calorimeter, Calorimeter Electronics, DAQ/Trigger and Minimum Bias Detector.
- Collaborates with the Project Director to assemble the staff and resources necessary to complete the sPHENIX project.
- Collaborates with the Project Director in setting the technical direction of the sPHENIX project.
- Communicates the functional requirements to the Level2 managers and the Control Account Managers.

sPHENIX Project Engineer Roles and Responsibilities

7.7 Project Engineer

James Mills, Brookhaven National Laboratory The sPHENIX Project Engineer is appointed by and works directly for the sPHENIX Project Director.

- Supervises the Project Controls Office and the Project Support Office.
- Collaborates with the Project Director to assemble the staff and resources necessary to complete the sPHENIX project.
- Collaborates with the Project Director in setting the technical direction of the sPHENIX project.
- Is responsible for the Scheduling and Management of Design, Safety and Readiness reviews together with the assistance of the PD, PM, Chief Mechanical Engineer and the ES&H Coordinator.
- Under direction of and delegation from the Project Director executes project scope and supplies the deliverables covered by WBS 1.8-1.10. The L2 deliverables to be supplied on time and on budget are the scope defined for the SC-magnet, sPHENIX Infrastructure, sPHENIX Integration & Installation.
- Under the direction of and by delegation from the Project Director, the Project Engineer executes project scope and supplies the engineering deliverables associated with the MIE and any other sPHENIX parallel effort so designated by the Project Director.
- Communicates the functional requirements of the BNL-provided Infrastructure and Facility upgrade support activities to the appropriate L2 Manager and Control Account managers.

sPHENIX Chief Mechanical Engineer Roles and Responsibilities

7.8 Chief Mechanical Engineer

Don Lynch, Brookhaven National Laboratory The sPHENIX Chief Mechanical Engineer is appointed by and works directly for the sPHENIX Project Director.

- Under the direction of and by delegation from the Project Director, the Chief Mechanical Engineer oversees the mechanical engineering content of all tasks within the MIE project scope WBS 1.2-1.7.
- Serves as the Level 2 Manager for Integration & Installation, WBS 1.10.
- Collaborates with the Project Director to assemble the staff and resources necessary to complete the sPHENIX project.
- Collaborates with the Project Director in setting the technical direction of the sPHENIX project.
- Communicates all the mechanical engineering requirements to the L2 managers and the Control Account managers.
- Assists the Project Engineer in the scheduling, planning and oversight of Design, Safety and Readiness reviews.

Integrated Project Team

The IPT mission is to provide strategic planning, coordination, and communication for the sPHENIX Project to ensure the project's objectives are achieved on schedule, within budget, and consistent with quality, environmental, safety, and health standards. The IPT insures that project management is carried out with integrity and in compliance with applicable laws. The team generally meets monthly or bi-monthly, depending on project activities, supplemented with specific issue-resolution meetings. It is the responsibility of the FPD to ensure the necessary skills are always represented to meet project needs.

The IPT is composed of the FPD (chair), the FPM, sPHENIX Project Director, sPHENIX Project Manager, sPHENIX Project Engineer, the Project Controls Manager and the Resource Coordinator.

Responsibilities include:

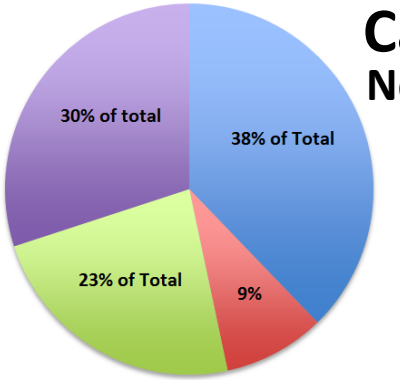
- Development of the Acquisition Strategy and Acquisition Plan
- Identify and define Project interfaces
- Assist in the writing of ESSH, QA and Risk documents
- Perform periodic internal project reviews
- Participate in reviews, audits and appraisals including Operational Readiness reviews and Readiness assessments
- Review Project documents and deliverables
- Support the Baseline Change Request Process

Summary

- A Project Organization for sPHENIX exists. All the positions are filled by people with many years of Project and Technical experience.
- The sPHENIX Project team has been working together for ~ 3 years with basically the same group of people.
- A first release of the Preliminary Project Execution Plan is available for the committee to review.
- The PPEP has gone through one round of revisions based on comments from members of BHSO, especially the FPD.

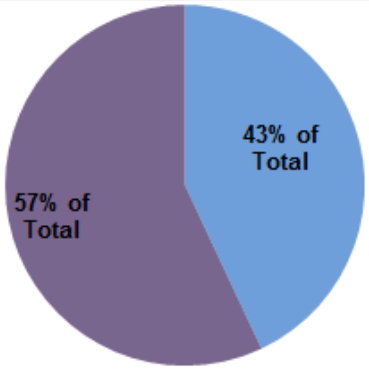
Back Up

Basis of Estimate



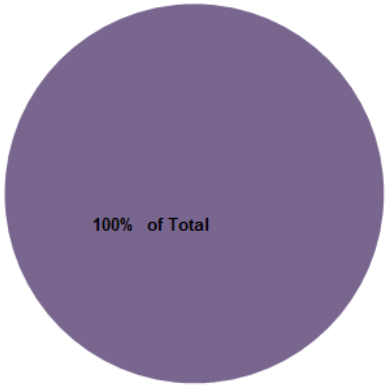
Calorimeter Electronics
Net contingency 30%

- Engineering estimate - 40%
- Engineering estimate - 30%
- Engineering estimate - 25%
- Quotes - 20%



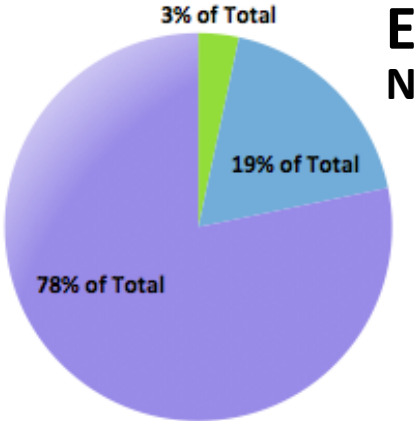
- Engineering estimate 40%
- Quotes 20%

HCal
Net Contingency 29%



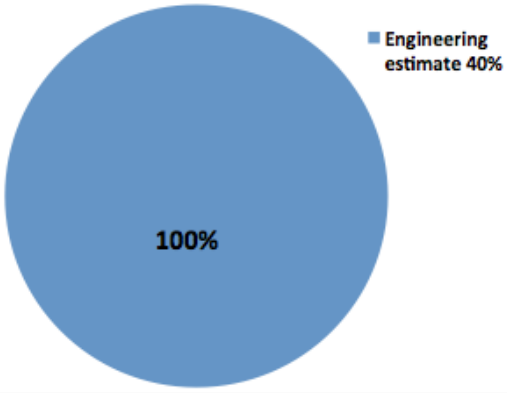
- Quotes - 20%

DAQ/Trigger
Net contingency 20%



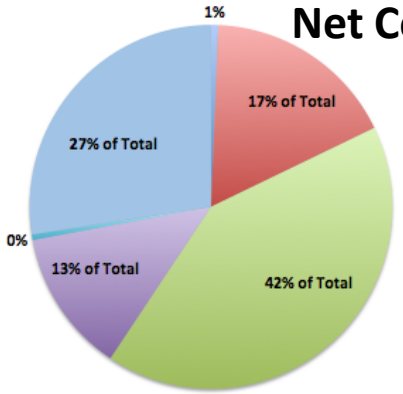
EMCal
Net Contingency 25%

- catalog/web quote 23%
- engineering estim. 32%
- quote 23%



- Engineering estimate 40%

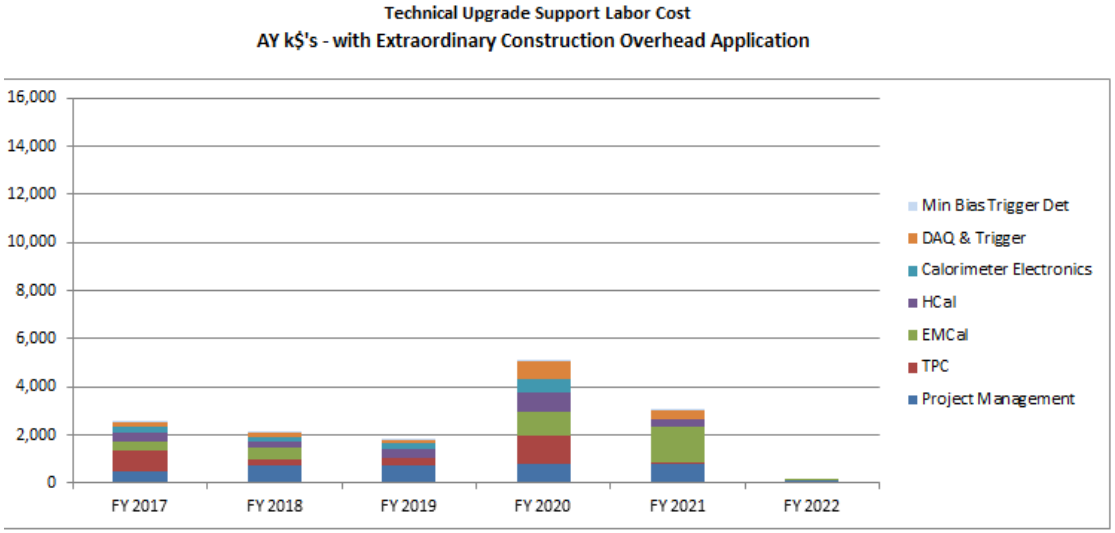
MBD
Net Contingency 40%



- Pending Delivery
- Quote 15%
- Quote 20%
- Older quote 25%
- Engineering Estimate 25%
- Engineering Estimate 40%

TPC
Net Contingency 25%

sPHENIX Upgrade Support Labor



Baseline Scenario

AY k$'s - with Extraordinary Construction Overhead Application

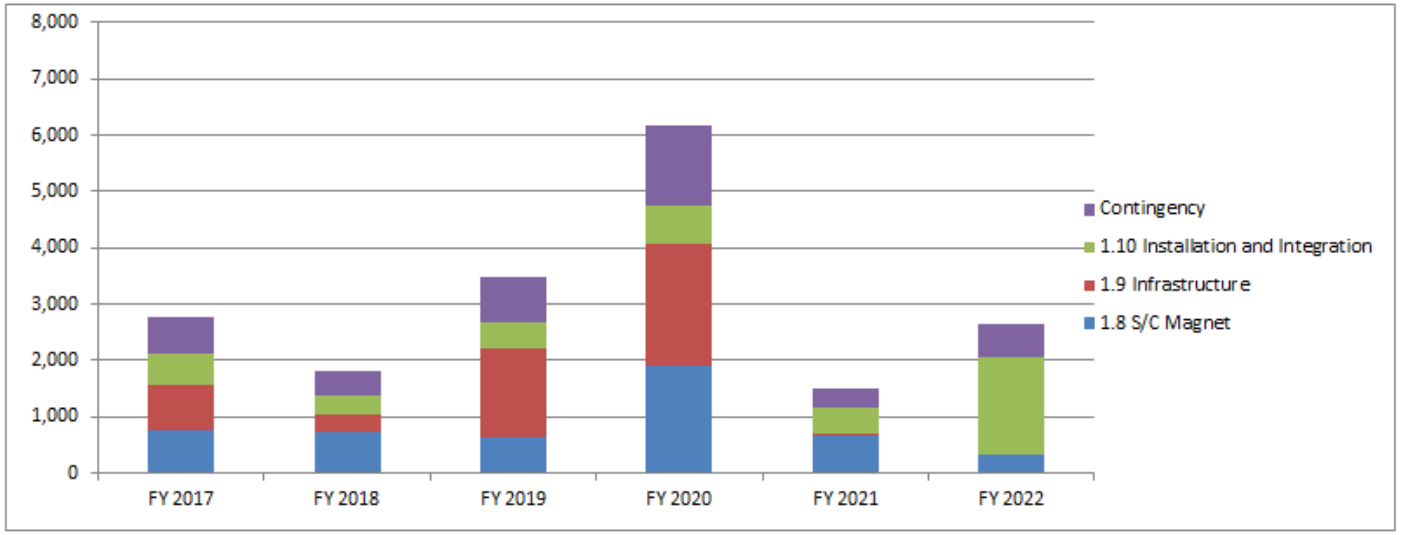
WBS	SYSTEM	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total
1.1	**Project Management**	481	716	761	802	820	139	3,719
1.2	**TPC**	894	252	287	1,162	29		2,624
1.3	**EMCal**	375	505	7	985	1489	46	3,407
1.4	**HCal**	367	259	392	813	316		2,147
1.5	**Calorimeter Electronics**	235	152	217	576	32		1,212
1.6	**DAQ & Trigger**	170	231	123	704	351		1,579
1.7	**Min Bias Trigger Det**	58	25	3	38	5		129
	Baseline Total	2,580	2,140	1,790	5,080	3,042	185	14,817
	MIE Contingency	774	642	537	1,524	913	56	4,445
	MIE Total	3354	2782	2327	6604	3955	241	19262

WBS	SYSTEM	Baseline	Contingency	Total
1.1	**Project Management**	3,719	1116	4,835
1.2	**TPC**	2,624	787	3,411
1.3	**EMCal**	3,407	1022	4,429
1.4	**HCal**	2,147	644	2,791
1.5	**Calorimeter Electronics**	1,212	364	1,576
1.6	**DAQ & Trigger**	1,579	474	2,053
1.7	**Min Bias Trigger Det**	129	39	168
	MIE Totals	14,817	4445	19,262

30% Labor contingency included
In budget

Infrastructure and Facility Upgrade

Baseline Scenario - Facility Upgrades (Labor and Non-labor)
AY k$'s - with Extraordinary Construction Overhead Application



Baseline Scenario
AY k$'s - with Extraordinary Construction Overhead Application

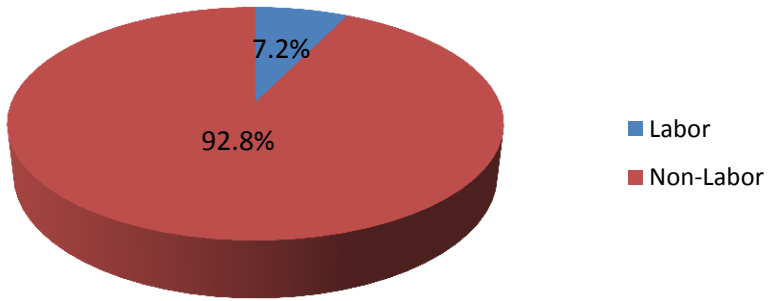
WBS	SYSTEM	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total
1.8	**S/C Magnet**	771	727	623	1,890	660	340	5,011
1.9	**Infrastructure**	781	301	1,586	2,178	50	0	4,896
1.10	**Installation and Integration**	572	360	468	685	451	1704	4,240
	Baseline Total	2,124	1,388	2,677	4,753	1,161	2,044	14,147
	Contingency	637	416	803	1,426	348	613	4,244
	MIE Total	2761	1804	3480	6179	1509	2657	18391

WBS	SYSTEM	Baseline	Contingency	Total
1.8	**Magnet**	5,011	1503	6,514
1.9	**Infrastructure**	4,896	1469	6,365
1.10	**Installation and Integration**	4,240	1272	5,512
	Facility Upgrade Totals	14,147	4244	18,391

Funding Split M&S and Labor

Capital Project Scope

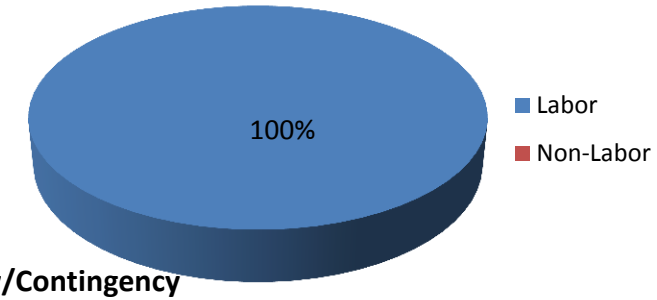
sPHENIX - Major Item of Equipment (MIE)



38.6 AY M$ w/Contingency
32 AY M$ w/ Contingency after descope

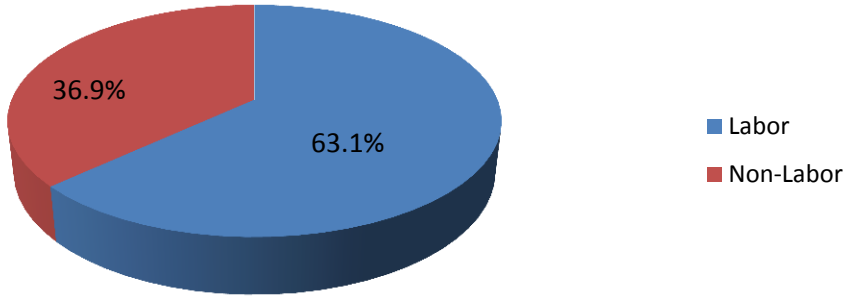
RHIC Operations Scope

Upgrade Support



19.2 AY M$ w/Contingency

Infrastructure & Facility Upgrade



18.3 AY M$ w/Contingency

sPHENIX Extraordinary Project Rates

sPHENIX Upgrade and Support Projects
Composite Rates - Assumes Cost Accounts are under "DB" - NPP Directorate

Row Labels	Category	Description	EPR Rate TMC FY 17 - FY18	EPR Rate VAB FY 19 - on
Low value material	300	PO Purchases	0.28	0.12
Travel	280	Foreign Travel	0.28	0.33
Capital Equipment	425	HI Value - Laboratory	0.11	0.12
High Value > 25k	216	R&D Sub-Contract	0.17	0.12
	190	Contract Labor	0.19	0.23
Salary	50	Labor	0.22	0.25

EPR - Extraordinary Project Rate
TMC- Total Modified Cost
VAB – Value Added Base

Major sPHENIX Procurements in FY19-FY21

Item	Aspects of Contract
OHCal steel **$5.3M**	Competitive bid
EMCal W-powder **$2.2M**	Sole source vendor?
EMCal scint fibers **2X$0.7M**	Only 2 known vendors
Cal digitizing elec. **$1.9M**	Contract w/ Columbia Univ
Cal Front end elec **$0.4M**	BNL order, 1st article + balance
HCal scint tiles **$1.8M**	Russian vendor, would like sole source
TPC Fee board **$0.7M**	BNL order, 1st article + balance
TPC DAM board **$0.3M**	BNL order, 1st article + balance
SiPMs **$1.0M**	Japanese vendor. Catalog purchase
EMCal blocks **$0.8M**	Contract with Univ of Illinois
IHCal assembly **2X$150k**	Contract with Iowa St + Wayne St
IHCal stainless steel **$1.5M**	Competitive bid
Magnet cryo system **$1.1M**	Vendor RFP
Detector Carriage **$0.9M**	Competitive bid

Total ~ $20M