sPHENIX Director's Review
Project Overview

Edward O'Brien

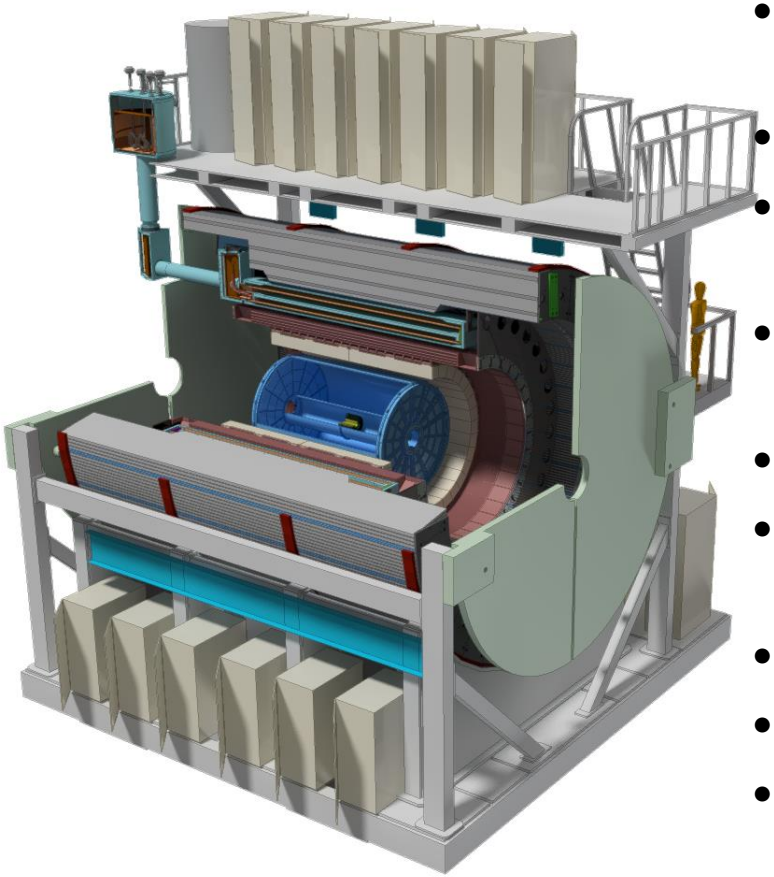
August 2-4, 2017

BNL

What is sPHENIX ?

- **sPHENIX is a major upgrade to the PHENIX detector. It is a large-acceptance, high-rate detector for Heavy Ion physics that repurposes >$20M in existing PHENIX equipment, infrastructure and support facilities**
- **The detector is optimized to measure jet and heavy quark physics by incorporating a Tracker, full EM and Hadronic calorimeter coverage at $|\eta| < 1.1$, and a 1.5 T solenoidal magnetic field.**
- **It will utilize much of the infrastructure already existing in the PHENIX detector complex and the BaBar SC-magnet. The Min Bias Trigger Detector is the reused PHENIX Beam Beam Counter with upgraded electronics.**
- **A bottom-up resource-loaded project plan has sPHENIX assembled, commissioned and ready to take data in January 2023 based on the DOE-ONP guidance for the Critical Decision from earlier this year.**

sPHENIX Conceptual Design



- Uniform fiducial acceptance $-1<\eta<1$ and $0<\phi<2\pi$
- Superconducting solenoid enabling high resolution tracking
- Hadronic calorimeter doubling as flux return
- Compact electromagnetic calorimeter to allowing fine segmentation at a small radius
- Solid state photodetectors that work in a magnetic field, have low cost, do not require high voltage
- Common readout electronics in the calorimeters
- High rate 15 kHz in AA allows for large unbiased MB data sample
- Utilization of existing PHENIX exp Infrastructure
- Compact TPC 250 mm hit res & continuous readout
- 4 Intermediate silicon strip tracking layers (Japanese funds)

Not part of this review →

- 3 layer – 2π MAPS-based vertex det (DOE-Upgrade)

Most Detector components are at an advanced state of R&D

The Three Parts of sPHENIX

MIE Cost range is $29-35M	**DOE funded & Managed**
Upgrade Support is ~$20M	**BNL Funded & Managed**
Infrastructure/Facility Upgrade ~$20M	**BNL Funded & Managed**

A. **sPHENIX MIE Upgrade covering the detector (Project Management, TPC, EMCal, HCal, Calorimeter Electronics, DAQ/Trigger, Min Bias Detector). Dominated by M&S costs. The MIE carries labor for Project Management and ~$1M in paid University labor for building things.**

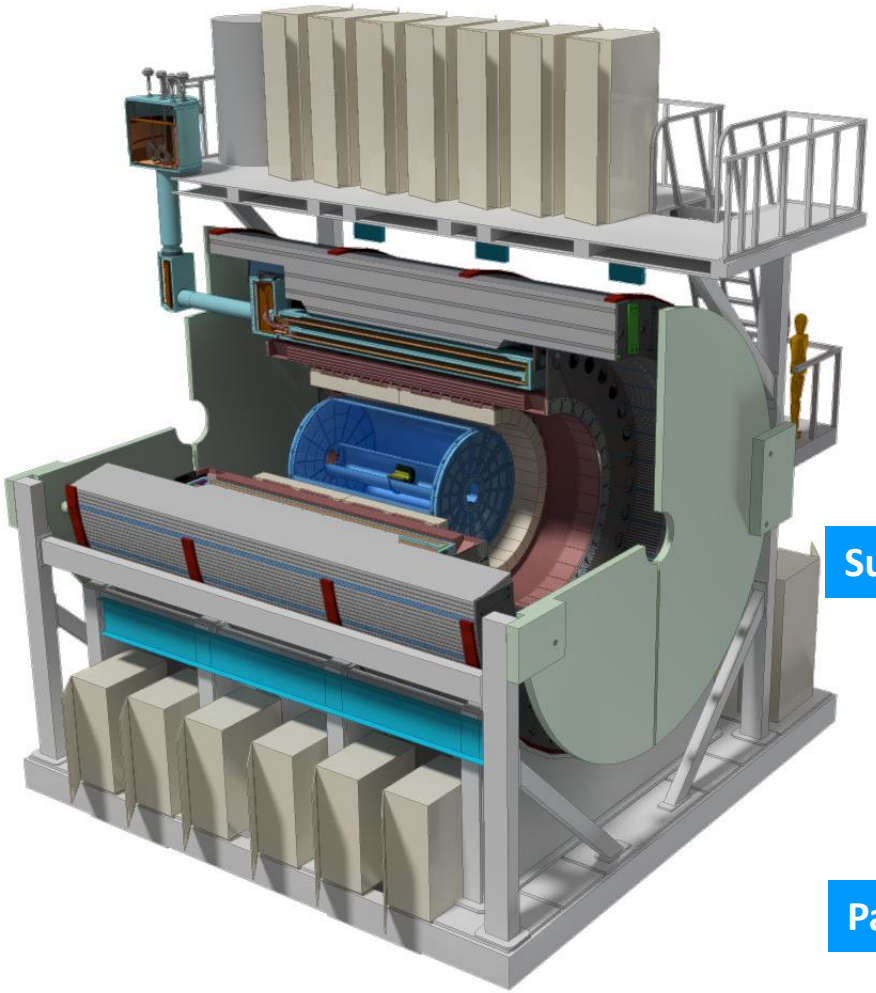
B. **Upgrade Support is 100% BNL labor that supports the sPHENIX MIE upgrade. Primarily the Phys Dept PHENIX/sPHENIX technical support group augmented by CAD, Magnet Div and Instrumentation Div.**

C. **Infrastructure and Facility Upgrade of the 1008 complex . Combination of M&S and Labor. Purpose is the upgrade of 1008 to modern standards. Enables cryo operations in 1008 and provides a facility optimized for the operation of a modern detector.**

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.

WBS of sPHENIX MIE & Support Effort



MIE

WBS	sPHENIX MIE Project Elements
1.1	Project Management
1.2	Time Projection Chamber
1.3	Electromagnetic Calorimeter
1.4	Hadron Calorimeter
1.5	Calorimeter Electronics
1.6	DAQ-Trigger
1.7	Minimum Bias Trigger Detector

Support Activities managed by the sPHENIX Project team

WBS	Infrastructure & Facility Upgrade
1.8	SC-Magnet
1.9	Infrastructure
1.10	Installation-Integration

Parallel Activities funded from other sources

WBS	Parallel Activities
1.11	Intermediate Silicon Strip Tracker
1.12	Monolithic Active Pixel Sensors

sPHENIX Schedule

CD-0 Mission Need Approved	Sep 2016
BNL Director's pre CD-1 Review	Sep 2017
OPA-CD-1/CD-3a Review	Spring 2018
CD-1/CD-3a authorization (?)	Dec 2018
Fabrication (orders) of long lead time components begins	Dec 2018
All Preproduction R&D and Design complete	Spring 2019
OPA- CD-2/CD-3b review	Spring 2019
CD-2/CD-3b authorization (?)	Aug 2019
All fabrication (orders) begin	Aug 2019
sPHENIX installation begins in 1008 Facility	Apr 2021
MIE deliverables complete	Dec 2021
sPHENIX Installed, cabled, ready to commission	Jul 2022
Commissioning complete	Sep 2022
First RHIC beam for sPHENIX	Jan 2023
CD-4 Approval	Jan 2024

The MIE has 25 months of float between completion of deliverables and CD-4

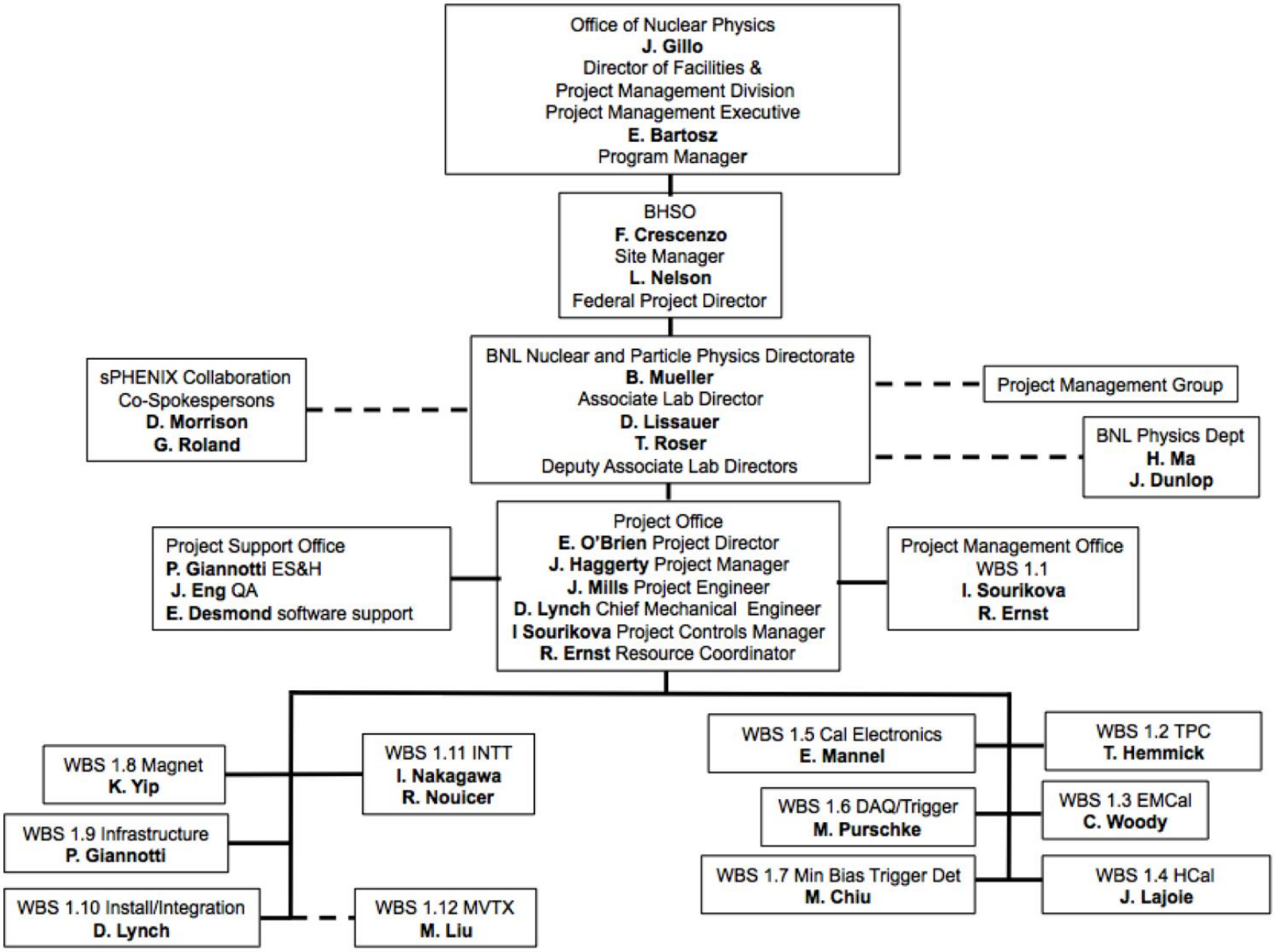
The Resource-loaded Schedule contains 6 months of float to Jan 2023 first beam @ RHIC

CD-1 Documents Available to the Committee

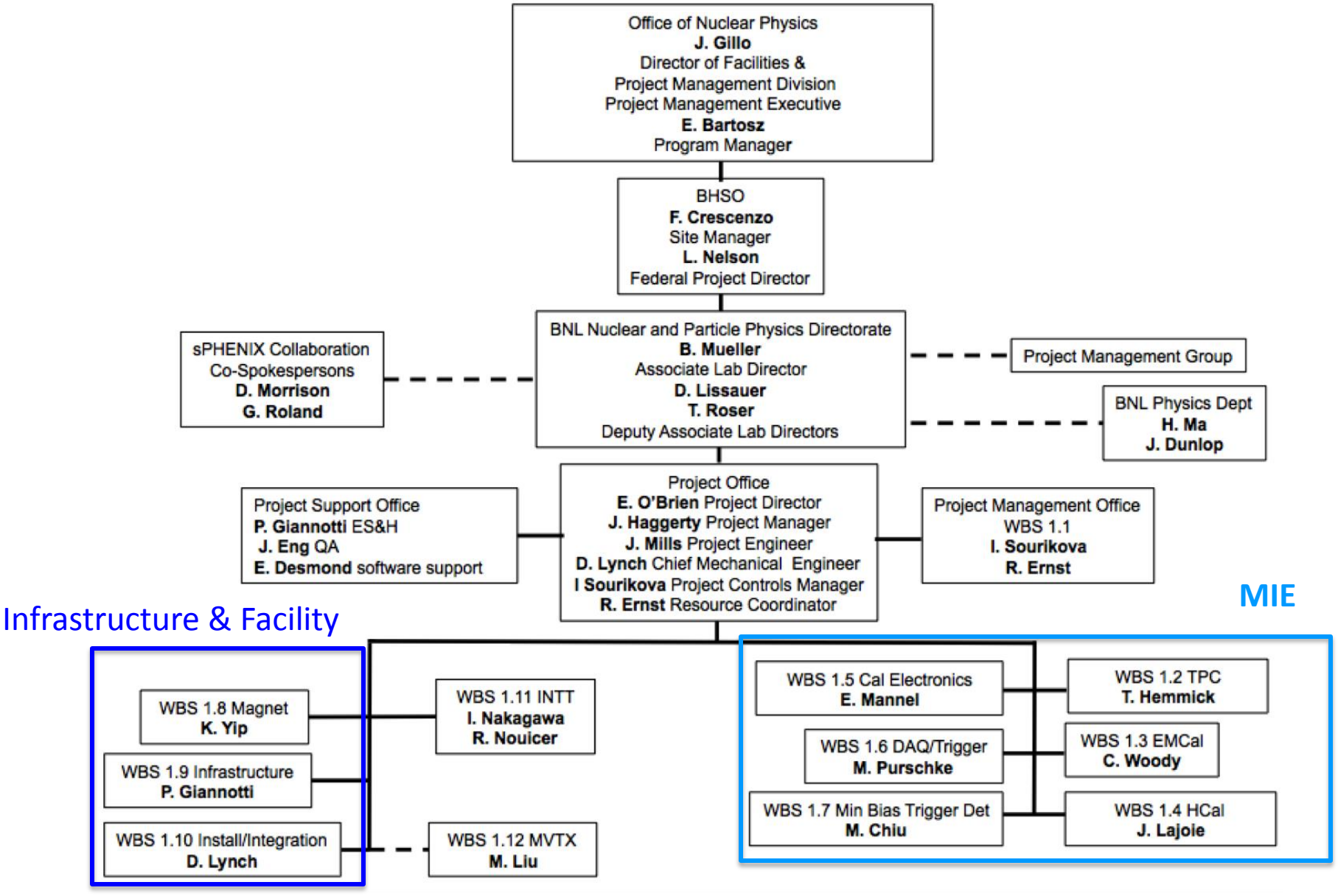
1. **Project Team Organization**
2. **WBS (WBS Dictionary)**
3. **Basis of Estimate documents**
4. **Contingency Risk/Analysis**
5. **Project Schedule**
6. **Critical Milestones**
7. **Proposed Funding Profile**
8. **Proposed Labor Profile**
9. **Preliminary Hazard Analysis Report**
10. **NEPA form**
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**

Project Organization

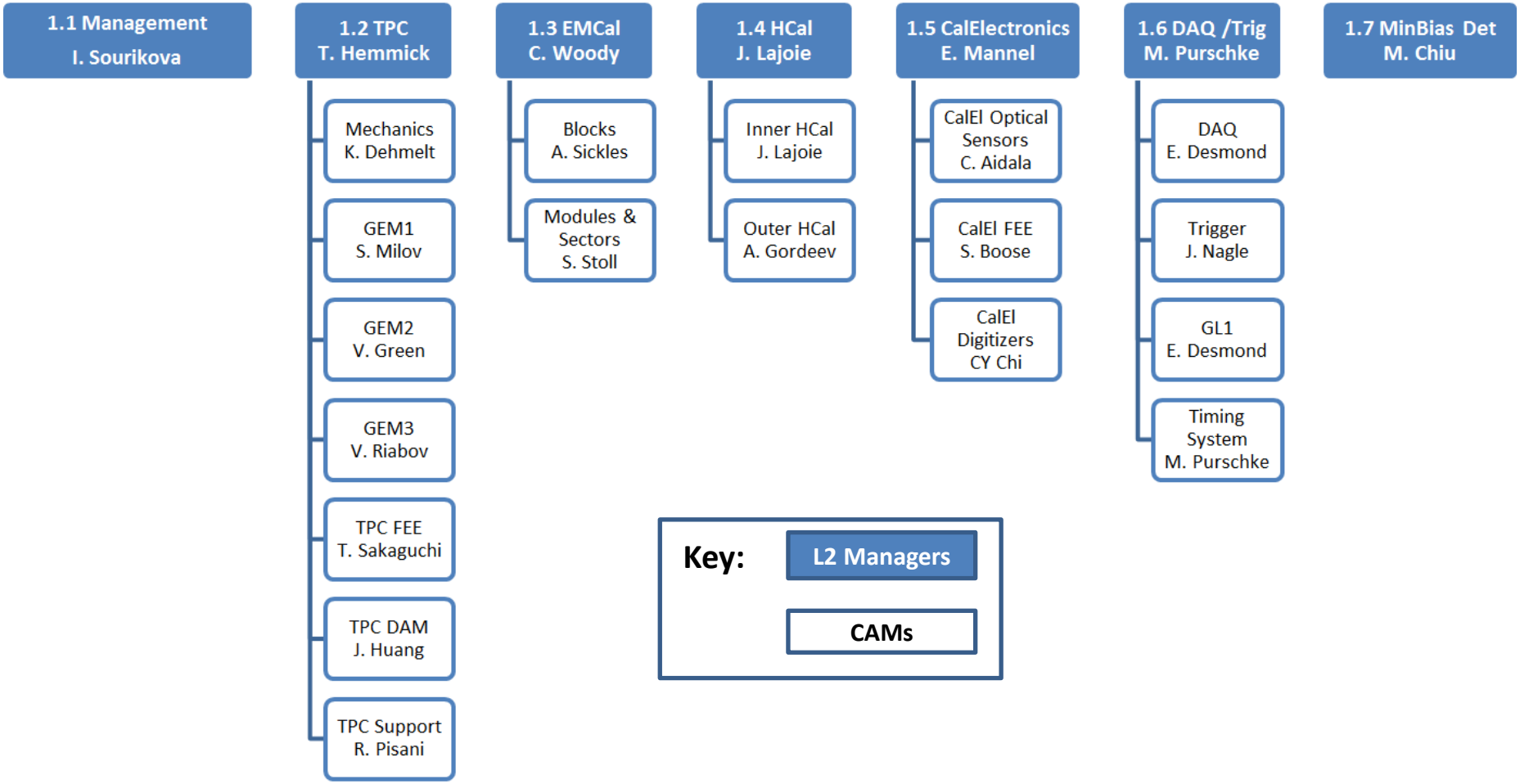
https://docdb.sphenix.bnl.gov/0001/000104/001/sPHENIX-Bios.docx.pdf



Project Organization



L2 and CAM Structure of MIE



L2 Managers & Control Account Managers

L2 Managers:

1.1 Project Management	**Irina Sourikova(BNL-Project Controls)**
1.2 TPC	**Tom Hemmick (SBU)**
1.3 EMCal	**Craig Woody (BNL)**
1.4 HCal	**John Lajoie (ISU)**
1.5 Calorimeter Electronics	**Eric Mannel (BNL)**
1.6 DAQ/Trigger	**Martin Purschke (BNL)**
1.7 Min Bias Trigger Detector	**Mickey Chiu (BNL)**

Control Account Managers

Project Managmt	Irina Sourikova (BNL)
TPC Detector	Klaus Dehmelt (SBU)
GEM r1	Sasha Milov (WIS)
GEM r2	Vicki Greene (Vandblt)
GEM r3	Victor Riabov (PNPI)
TPC FEE	Takao Sakaguchi (BNL)
TPC DAM	Jin Huang (BNL)
EMC Blocks	Anne Sickles (UIUC)
EMC Module/Sector	Sean Stoll (BNL)

Inner HCal	John Lajoie (ISU)
Outer HCal	Anatoli Gordeev (BNL)
CalE SiPMs	Christine Aidala (UM)
CalE Preamps	Steve Boose (BNL)
CalE Digitizer	CY Chi (Columbia)
DAQ	Ed Desmond (BNL)
Trigger	J. Nagle(UColorado)
Timing Sys	TBD (If necessary)
MB Trig Det	Mickey Chiu (BNL)

Resource-Loaded Schedule Status

We are finishing a bottom-up revision to the Resource-loaded schedule

- **6 month effort of ~40 - 50 people.**
- **1800+ activities over 11 WBS L2 categories. All in MS-Project**
- **The MIE Activities were integrated with the Magnet, Infrastructure, Installation/integration.**
- **Merged the INTT with the rest of the project files**
- **Consultant migrating the files to P6 in process. No review yet by L2's or CAMs. Ready for primetime early Sept**

RLS and BOE Procedure:

- **BOE of Cost and Duration based on Vendor bids or quotes, catalog prices, engineering estimates or previous experience**
- **L2s/CAMs Bottom-up contingency based on uncertainty(risk) table**
- **Use BNL Labor bands, BNL Extraordinary OH rates, university rates where applicable.**
- **Non-BNL labor availability estimates came from collaborating institutions**
- **No RFP's on MIE. 1 RFP in SC-Magnet (cryo bypass)**
- **The CERN GEM order involves only vendor that doesn't take payment in $.**
  - **No significant foreign exchange issues.**
- **Labor resources not available from BNL Phys Dept will come from CAD, Mag Div, Instrumentation Div, or collaborating Institutions**

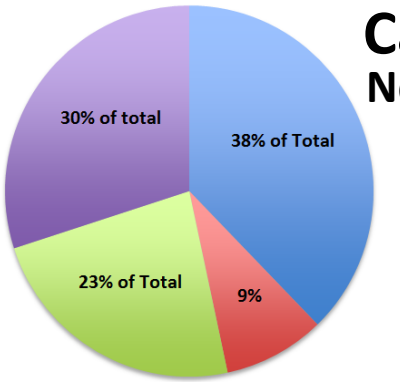
sPHENIX BOE Contingency Guidelines

Materials Bottom-Up Contingency
Uniformly Graded Approach to Risk Across All Subsystems

There is a similar table for Labor contingency estimates

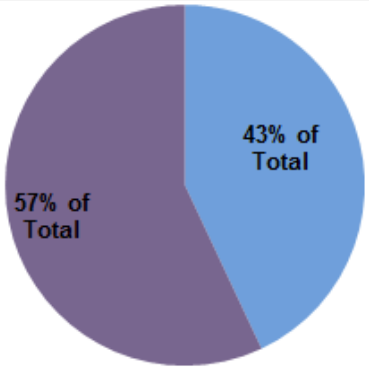
Code	Type of Estimate	Contingency %	Description
M1	Existing Purchase order	0%	Items have been completed or obligated. (Note: Contact Change Orders are considered a Risk and should not be included)
M2	Procurement for LOE/Oversight work	0%-20%	M&S items such as travel, software purchases and upgrades, computers, etc. estimated to support LOE efforts and other work activities.
M3	Advanced	10%-25%	Items for which there is a catalog price or recent vendor quote based on a completed or nearly completed design or an existing design with little or no modifications and for which the costs are documented.
M4	Preliminary	25%-40%	Items that can be readily estimated from a reasonably detailed but not completed design; items adapted from existing designs but with moderate modifications, which have documented costs from past projects. A recent vendor survey (e.g., budgetary quote, vendor RFI response) based on a preliminary design belongs here.
M5	Conceptual	40%-60%	Items with a documented conceptual level of design; items adapted from existing designs but with extensive modifications, which have documented costs from past projects.
M6	Pre-conceptual - Common work	60%-80%	Items that do not have a documented conceptual design, but do have documented costs from past projects. Use of this estimate type indicates little confidence in the estimate. Its use should be minimized when completing the final estimate.
M7	Pre-conceptual - Uncommon work	80%-100%	Items that do not have a documented conceptual design, and have no documented costs from past projects. Its use should be minimized when completing the final estimate.
M8	Beyond state of the art	> 100%	Items that do not have a documented conceptual design, and have no documented costs from past projects. Technical requirements are beyond the state of the art.

Basis of Estimate



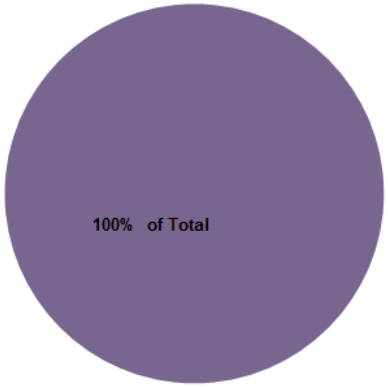
Calorimeter Electronics
Net contingency 30%

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



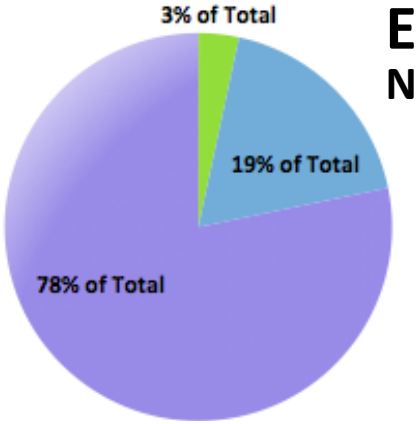
- Engineering estimate 40%
- Quotes 20%

HCal
Net Contingency 29%



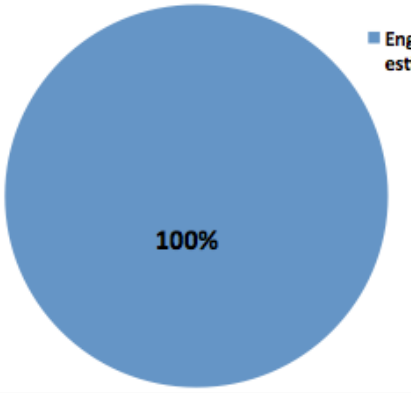
- Quotes - 20%

DAQ/Trigger
Net contingency 20%



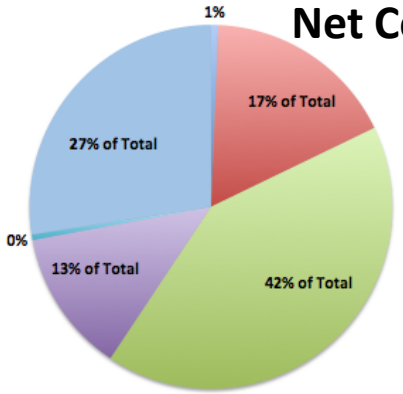
EMCal
Net Contingency 25%

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



- Engineering estimate 40%

MBD
Net Contingency 40%

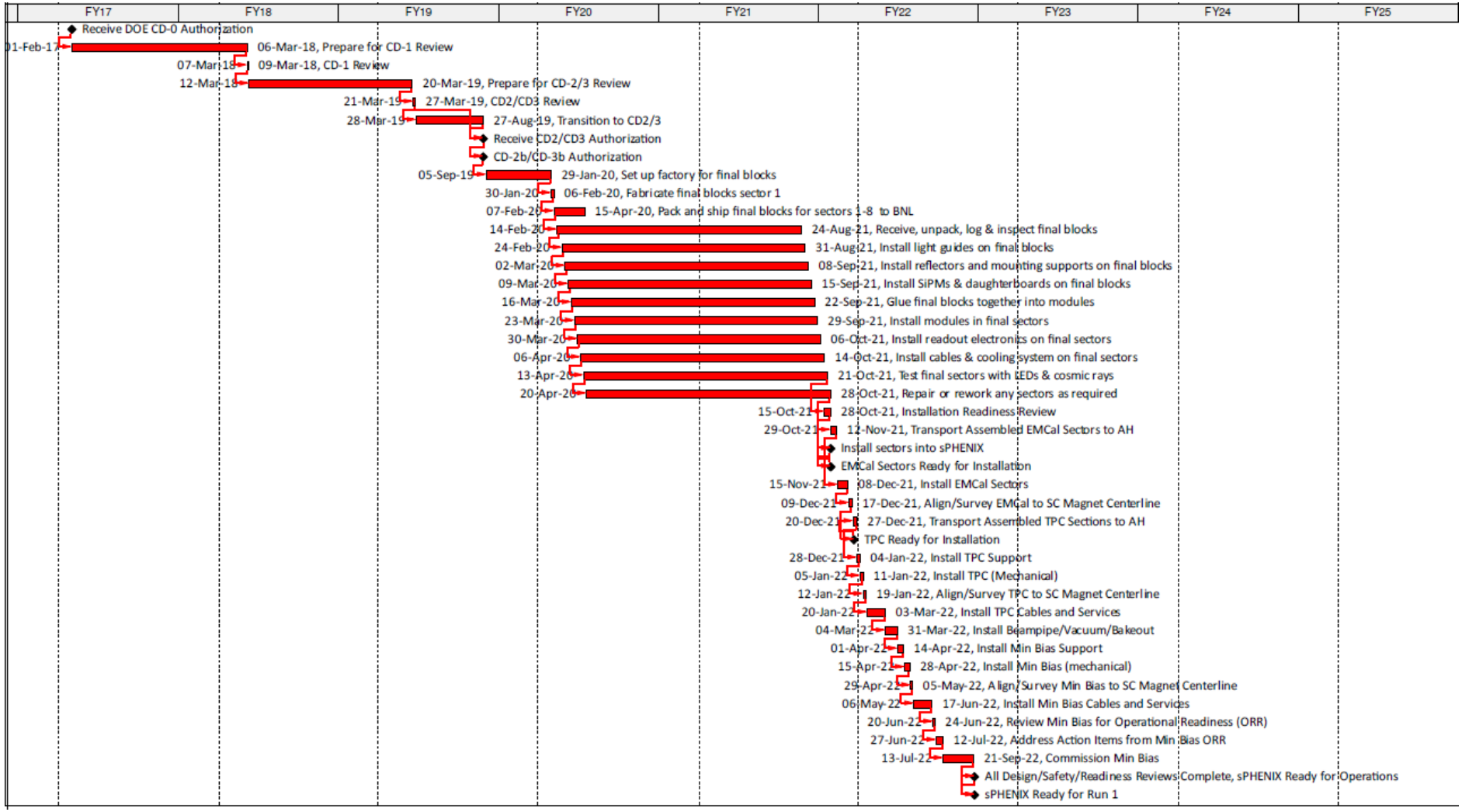


- Pending Delivery
- Quote 15%
- Quote 20%
- Older quote 25%
- Engineering Estimate 25%
- Engineering Estimate 40%

TPC
Net Contingency 25%

sPHENIX Critical Path Calculated in P6

sPHENIX MS-Project and P6 give the same critical path



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

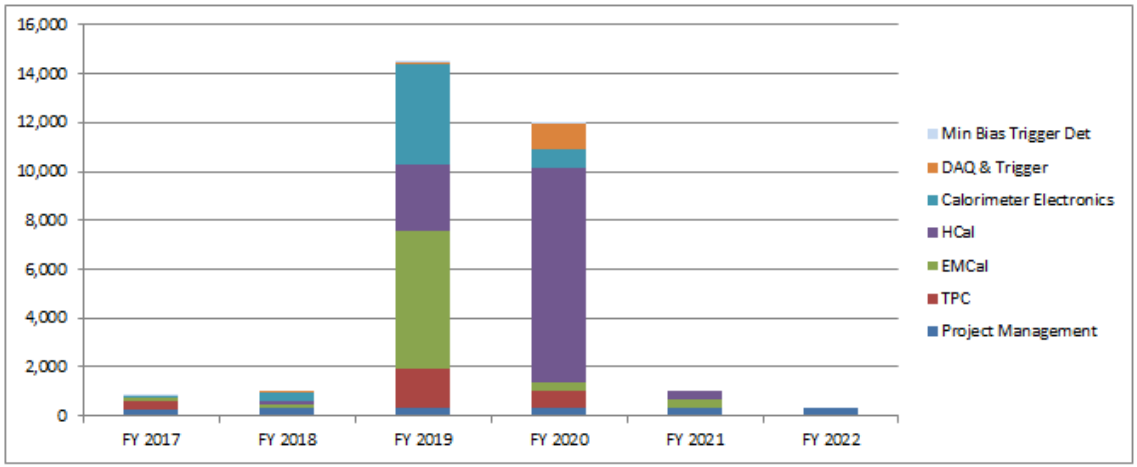
The MIE Part of sPHENIX

CD-0 Cost range is $29-35M **DOE Funded & Managed**

- The full MIE scope exceeds the cost range by ~3.5 M AY$ (contingency included)
- All documents including the RLS, BOEs, labor profiles etc. assume the full scope
- We have two de-scope scenarios that fall within the budget range but the detailed science impact has yet to be evaluated by the collaboration.
- The intention is to build the full scope by reducing costs through scrubbing and value engineering, while also pursuing additional funds from International and other sources. Barring that we would implement a de-scope scenarios
- The sPHENIX Project, collaboration and BNL will devise a plan to fit within CD-0 cost range well in advance of the OPA review.

sPHENIX Cost Estimate – Full Scope

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



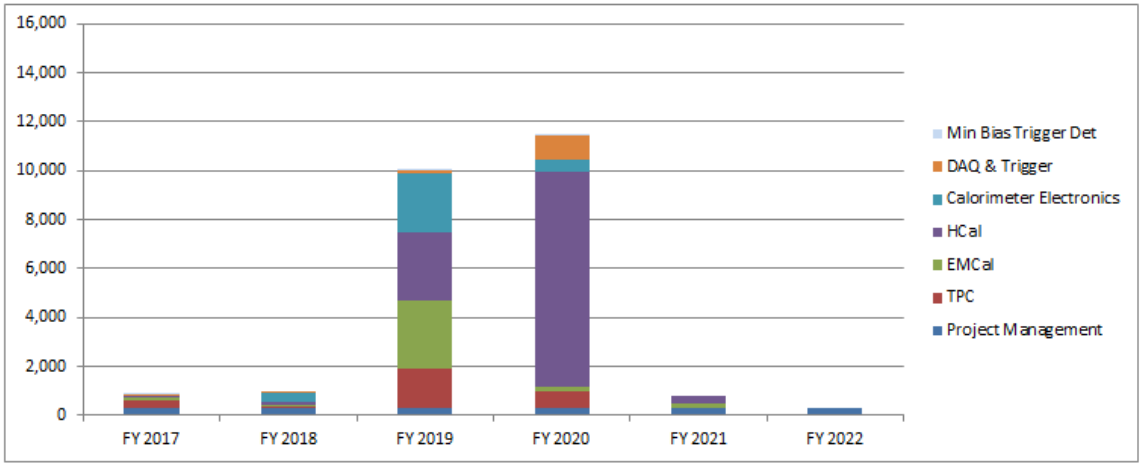
Baseline Scenario
AY k$'s - with Extraordinary Construction Overhead Application

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	5665	396	380		6,698
1.4	**HCal**	15	129	2,752	8,777	313		11,986
1.5	**Calorimeter Electronics**	52	351	4,051	767	0		5,221
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	14,496	12,024	998	305	29,695
	MIE Contingency	274	288	4,349	3,607	299	92	8,909
	MIE Total	1187	1247	18845	15631	1297	397	38604

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**	6,698	2009	8,707
1.4	**HCal**	11,986	3596	15,582
1.5	**Calorimeter Electronics**	5,221	1566	6,787
1.6	**DAQ & Trigger**	1,200	360	1,560
1.7	**Min Bias Trigger Det**	136	41	177
	MIE Totals	29,695	8909	38,604

sPHENIX Descope Scenario -1, 50% EMCal

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



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

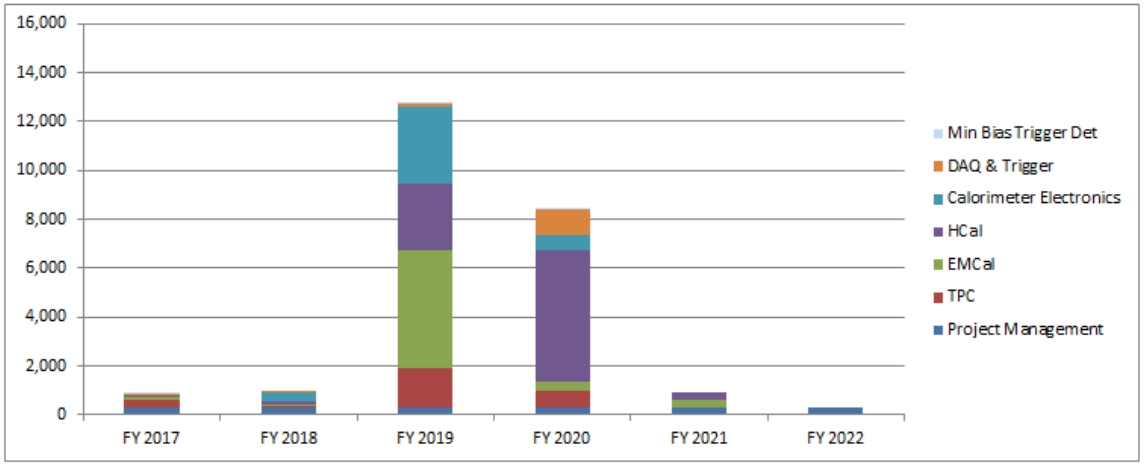
WBS	SYSTEM	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total
1.1	**Project Management**	280	320	320	320	305	305	1,850
1.2	**TPC**	323	31	1,575	675	0		2,604
1.3	**EMCal**	161	96	2832.5	198	190		3,478
1.4	**HCal**	15	129	2,752	8,777	313		11,986
1.5	**Calorimeter Electronics**	52	351	2,431	460	0		3,294
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	10,043	11,519	808	305	24,547
	MIE Contingency	274	288	3,013	3,456	242	92	7,364
	MIE Total	1187	1247	13056	14975	1050	397	31911

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**	3,478	1043	4,521
1.4	**HCal**	11,986	3596	15,582
1.5	**Calorimeter Electronics**	3,294	988	4,282
1.6	**DAQ & Trigger**	1,200	360	1,560
1.7	**Min Bias Trigger Det**	136	41	177
	MIE Totals	24,547	7364	31,911

sPHENIX Descope Scenario -2, No IHCal, 85% EMCal

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

Impacts of the De-scope Scenarios

- Building ½ the EMCal will reduce our acceptance for Upsilons by almost a factor of four. In addition we lose γ+jet statistics, direct γ statistics and our ability to look at jets over a full range of R values due the restrictions on the acceptance. The other physics capabilities of the detector are preserved.

- Building No IHCal will reduce our e/h separation due to leakage out the back of the EMCal which in turn creates a bigger combinatorics background for the upsilon through hadron misidentification as an electron.

- The collaboration has agreed to study the physics impact of these issues in detail and recommend a de-scope option. In the mean time institutions involved with the EMCal (UIUC+UM) and IHCal (ISU&WSU) are investigating the possibility of an NSF MRI proposal or proposals to fund components of these subsystems. Initial talks with Garcia-Solis and Opper of NSF were promising but incipient.

- International funding is being pursued with IHEP-Protvino as a possible contributor to the IHCal. Other endeavors such as Saclay contributing to the TPC would free up funds that could be directed to restore parts of our de-scoped subsystems. Recent discussions with new potential Chinese collaborators for work on the EMCal also show the promise of resulting in an in-kind contribution to sPHENIX.

Long Lead-Time Items for Letter or Authorization or CD-3a

Two options for Long Lead procurements: Letter of Authorization from the Project Management Executive (J. Gillo), or CD-3a authorization.

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.

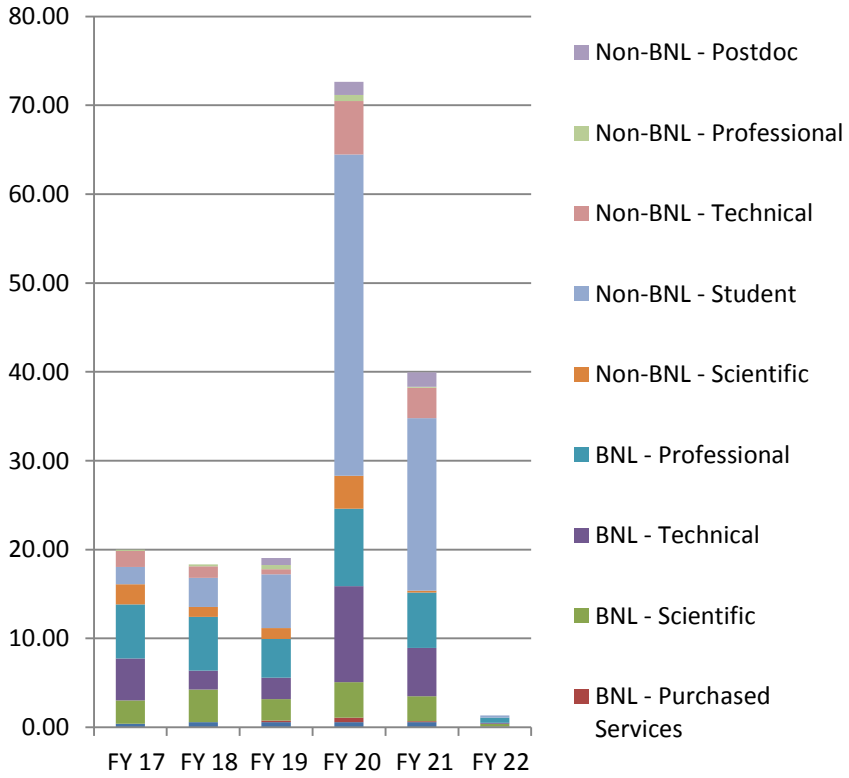
Procure of those long-lead "items" through authorization from the PME in advance of CD-2 would be carried out via a tailoring strategy (Letter of Authorization)

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 . . .)

Labor Supporting for sPHENIX MIE

WBS 1.1 through 1.7



No FTE contingency shown in plots or spreadsheet

FTE Profile

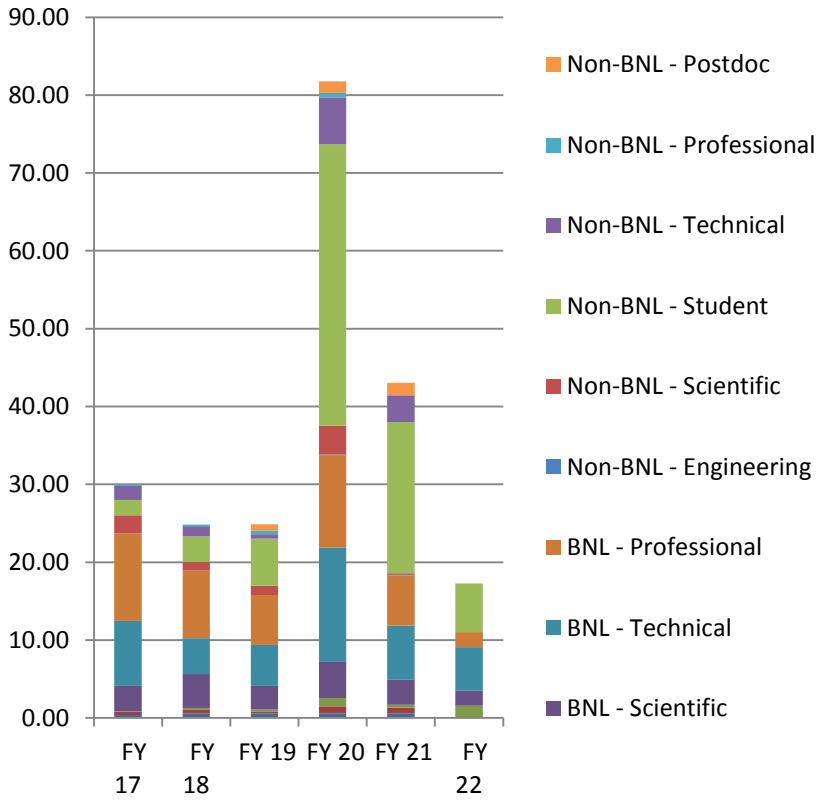
WBS Level	Group	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22
BNL	Purchased Services	0.00	0.00	0.18	0.48	0.12	0.00
	Scientific	2.65	3.65	2.40	4.02	2.79	0.32
	Technical	4.70	2.15	2.40	10.79	5.47	0.11
	Professional	6.10	6.03	4.38	8.73	6.23	0.55
	Administrative	0.40	0.59	0.59	0.59	0.57	0.09
BNL Sum		**13.84**	**12.41**	**9.96**	**24.61**	**15.18**	**1.08**
Non-BNL	Scientific	2.24	1.12	1.21	3.68	0.20	0.00
	Student	1.96	3.29	6.05	36.16	19.43	0.27
	Technical	1.80	1.28	0.56	6.01	3.42	0.00
	Professional	0.15	0.23	0.46	0.71	0.10	0.00
	Postdoc	0.00	0.00	0.82	1.46	1.61	0.00
Non-BNL Sum		**6.15**	**5.93**	**9.10**	**48.01**	**24.75**	**0.27**
Grand Total		**20.00**	**18.34**	**19.06**	**72.63**	**39.94**	**1.34**

- The student contribution is commensurate with past student contributions from the same institutions on similar detector projects
- We will secure the non-BNL labor contributions with Memoranda of Agreement between Institutions.

Labor Supporting MIE+Infra/Facility Upgrade +INTT

WBS 1.1 – 1.11

FTE Profile by Category



FTE Profile by Fiscal Year

WBS Level	Group	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22
BNL	Purchased Services	0.05	0.22	0.26	1.04	0.37	1.47
	Scientific	3.29	4.39	3.03	4.64	3.21	1.94
	Technical	8.35	4.59	5.28	14.71	6.93	5.58
	Professional	11.64	9.12	6.62	12.75	7.20	1.94
	Administrative	0.40	0.59	0.59	0.59	0.57	0.09
BNL Sum		**23.73**	**18.90**	**15.78**	**33.73**	**18.29**	**11.02**
Non-BNL	Scientific	2.31	1.13	1.21	3.68	0.20	0.00
	Student	1.96	3.29	6.05	36.16	19.43	6.27
	Technical	1.80	1.28	0.56	6.01	3.42	0.00
	Professional	0.15	0.23	0.46	0.71	0.10	0.00
	Postdoc	0.00	0.00	0.82	1.46	1.61	0.00
Non-BNL Sum		**6.23**	**5.94**	**9.10**	**48.01**	**24.75**	**6.27**
Grand Total		**29.95**	**24.84**	**24.88**	**81.75**	**43.04**	**17.29**

No FTE contingency shown in plots or spreadsheet

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

Oversight and Project Meetings

Oversight

- Biweekly sPHENIX meeting with DOE BHSO
- Monthly sPHENIX meeting with DOE-ONP
- Monthly PHENIX R&R(decommissioning) meeting with DOE-ONP
- Biweekly meeting with BNL ALD's Project Management Group
- 8 internal BNL reviews of the subsystems
- 2 BNL Director's reviews with external committees.

Project Meetings

- Weekly Management meeting
- Weekly simulations meeting
- Biweekly meetings for each MIE subsystems
- Biweekly meetings for SC-magnet
- Biweekly sPHENIX engineering meeting
- Biweekly Tracking meeting
- Biweekly L2 Managers meeting

In addition there is a biweekly General Meeting for the whole collaboration at which the Project reports and a biannual Collaboration meeting.

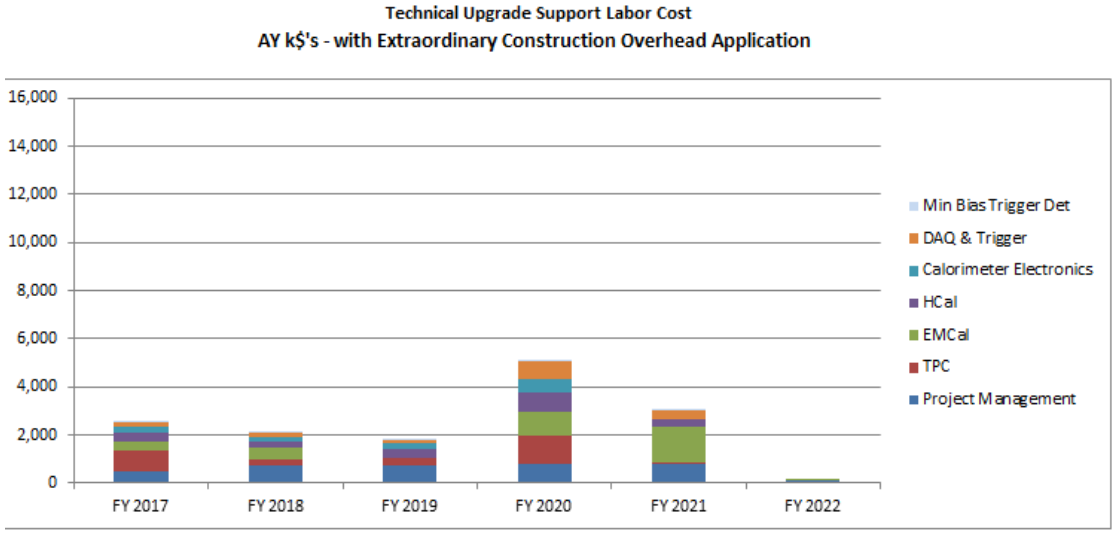
We've held 900 sPHENIX meetings over the last 3 years. It is a very active collaboration.

Summary

- sPHENIX is a major upgrade to the PHENIX experiment that will utilize >$20M in existing equipment. The sPHENIX scientific collaboration is a new organization that was formed 1.5 years ago.
- The sPHENIX Project team is established and has been working together for 3 years.
  - **The Project Organization including L2's and CAMs is established.**
- We have releases or advanced draft of the documents required for CD-1 including a CDR(300 pages, 200 figures) and a preliminary PEP.
  - **They are available on the review web site.**
- There is a newly revised Resource-loaded schedule with a bottom-up cost and contingency estimate.
  - **We are migrating the RLS schedule in MS-Project to P6. The L2 Managers and CAMs have yet to review the new P6 implementation.**
  - **Bottom-up cost estimate exceeds BNL guidance. We've established two "straw man" technical de-scope scenarios that fit within budget guidance. We are working with the collaboration and BNL to assess the physics impact of those scenarios.**
- Project schedule exists that has the MIE Project complete by Dec 2021. The fully installed and commissioned detector in ready for RHIC collisions Jan 2023 with 8 months float.
  - **The FY18 President's Budget required DOE to delay sPHENIX 1 year**
  - **The Project team will pursue an aggressive R&D and conceptual design effort during the next 12-15 months prior to the CD-1 start.**

Back Up

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

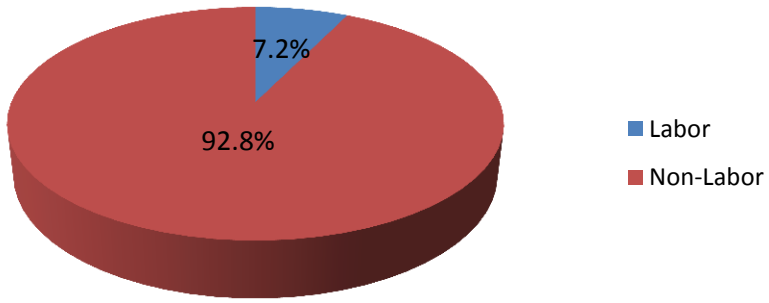
WBS	SYSTEM	Baseline	Contingency	Total
1.1	**Project Management**	3,719	1116	4,835
1.2	**TPC**	2,624	787	3,411
1.3	**EMCal**	3,407	1022	4,429
1.4	**HCal**	2,147	644	2,791
1.5	**Calorimeter Electronics**	1,212	364	1,576
1.6	**DAQ & Trigger**	1,579	474	2,053
1.7	**Min Bias Trigger Det**	129	39	168
	MIE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

30% Labor contingency included
In budget

Funding Split M&S and Labor

Capital Project Scope

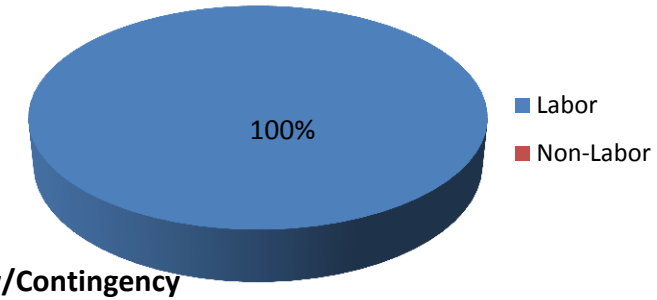
sPHENIX - Major Item of Equipment (MIE)



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

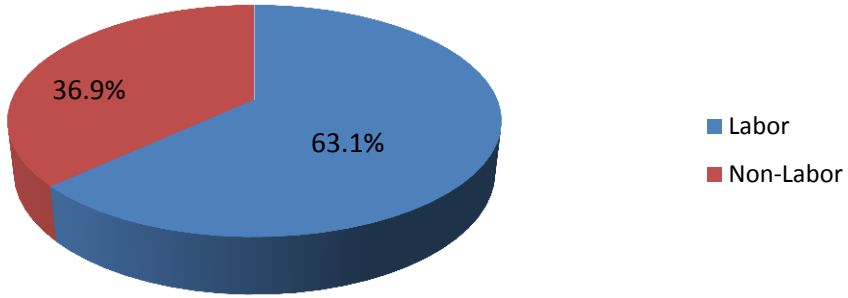
RHIC Operations Scope

Upgrade Support



19.2 AY M$ w/Contingency

Infrastructure & Facility Upgrade



18.3 AY M$ w/Contingency

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

sPHENIX BOE Contingency Guidelines

Labor Bottom-Up Contingency - Uniformly Graded Approach to Risk Across All Subsystems

	Type of Estimate	Contingency %	Description
L1	Actual	0%	Actual costs incurred on activities completed to date.
L2	Level of Effort Tasks	0%-20%	Support type activities that must be done to support other work activities or the entire project effort, where estimated effort is based on the duration of the activities it is supporting.
L3	Advanced	10%-25%	Based on experience with documented identical or nearly identical work. Development of activities, resource requirements, and schedule constraints are highly mature. Technical requirements are very straightforward to achieve.
L4	Preliminary	25%-40%	Based on direct experience with similar work. Development of activities, resource requirements, and schedule constraints are defined as preliminary (beyond conceptual) design level. Technical requirements are achievable and with some precedent.
L5	Conceptual	40%-60%	Based on expert judgment using some experience as a reference. Development of activities, resource requirements, and schedule constraints are defined at a conceptual level. Technical requirements are moderately challenging.
L6	Pre-conceptual	60%-80%	Based on expert judgment without similar experience. Development of activities, resource requirements, and schedule constraints are defined at a pre-conceptual level. Technical requirements are moderately challenging.
L7	Rough Estimate	80%-100%	Based on expert judgment without similar experience. Development of activities, resource requirements, and schedule constraints is largely incomplete. Technical requirements are challenging.
L8	Beyond state of the art	> 100%	No experience available for reference. Activities, resource requirements, and schedule constraints are completely undeveloped. Technical requirements are beyond state of the art.

Technical Status

1.2 TPC: Mechanical design is advanced. In 1st round of prototyping but we're building on ALICE, STAR and EIC R&D work. Full scale prototype with limited readout, ready fall 2017.

Two electronics boards needed FEE and DAM. Both based on existing boards.

1st prototype FEE produced & being tested in BNL Instrumentation. Similar to both ALICE & STAR boards.

DAM will be ATLAS FELIX board w/ new firmware. Testing in BNL Instrumentation has started with FELIX 1.5

1.3 EMCal: 2nd round of prototyping complete. Test beam analysis ongoing but initial results show that we are going to meet performance spec. Needs 1 more round of small prototype plus preproduction.

1.4 HCal: Advanced. 2ND round of prototyping complete. Meets performance specs. Detector design complete. Full size mech prototype for IHCal exists. Full size prototype for OHCal complete at vendor in 2 weeks. Working on installation plans.

1.5 Calorimeter Electronics: Advanced. Hamamatsu SiPM chosen. Preamp design done except for optimization of form factor(board size and shape). Digitizer board done. Working on back plane and crate controller. Nine months from ready to start production.

1.6 DAQ/Trigger: Costed upgrade commercial equipment for existing DAQ. Trigger simulations to identify rejection requirements.

1.7 Min Bias Detector: Reuse of existing PHENIX Detector.

1.8 Magnet: Exists. Former BaBar magnet passed cold low-field test. Full-field test Sept 2017. Conceptual design exists for cryo, PS, controls.

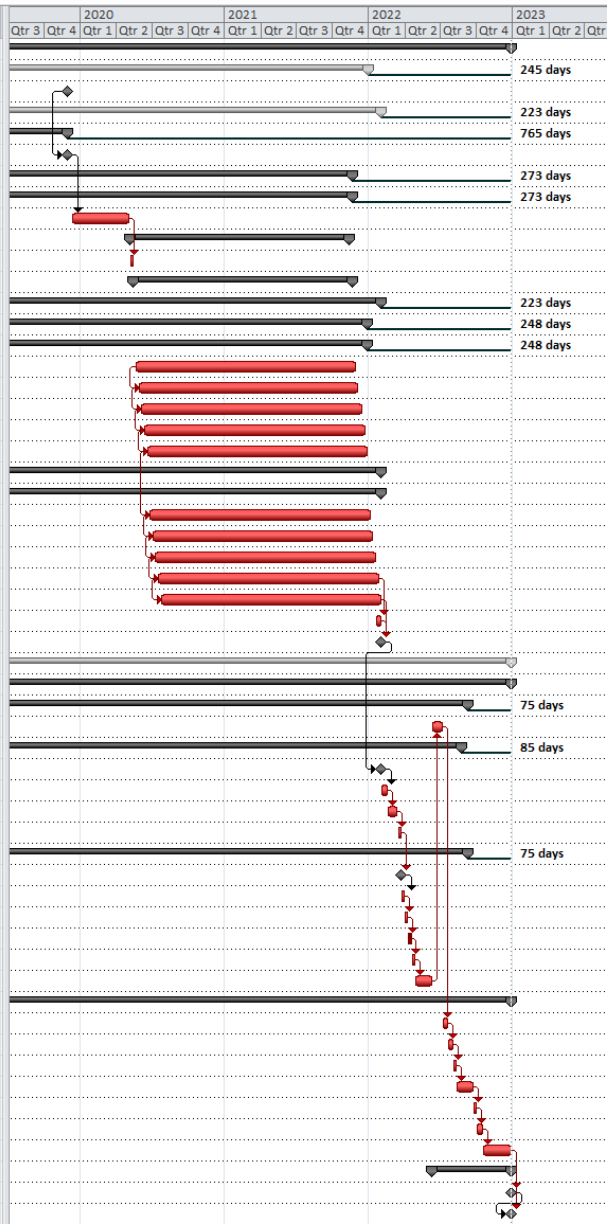
1.9 Infrastructure: Early planning stages.

1.10 Integration & Installation: Conceptual design exists for outer detector. Engineering work started for for inner detectors: TPC, INTT, MVTX, Min Bias Det.

1.11 Intermediate Tracker: First round of prototyping with Si strip ladder produced and being tested at BNL.

sPHENIX Critical Path EMCal through Installation

WBS	Name	Duration	Start	Finish
1	**sPHENIX_Project**	**1409 days**	**2/1/17**	**9/26/22**
1.1	**sPHENIX_Project_Management**	**1164 days**	**2/1/17**	**9/30/21**
1.1.8	Receive CD2/CD3 Authorization	0 days	8/30/19	8/30/19
1.3	**sPHENIX_EMCal**	**1186 days**	**2/1/17**	**11/1/21**
1.3.1	**EMCAL Management**	**644 days**	**2/1/17**	**8/30/19**
1.3.1.5	CD-2b/CD-3b Authorization	0 days	8/30/19	8/30/19
1.3.2	**EMCAL Block Production**	**1095 days**	**3/31/17**	**8/20/21**
1.3.2.3	**EMCAL Final Block Production**	**1056 days**	**5/25/17**	**8/20/21**
1.3.2.3.10	Set up factory for final blocks	98 days	9/9/19	1/31/20
1.3.2.3.13	**Fabricate final blocks**	**384 days**	**2/3/20**	**8/13/21**
1.3.2.3.13.1	Fabricate final blocks sector 1	6 days	2/3/20	2/10/20
1.3.2.3.14	**Pack and ship final blocks to BNL**	**383 days**	**2/11/20**	**8/20/21**
1.3.3	**EMCAL Module Production and Sector Assembly**	**1167 days**	**3/1/17**	**11/1/21**
1.3.3.2	**EMCAL Module Production**	**1142 days**	**3/1/17**	**9/27/21**
1.3.3.2.3	**EMCAL Final Module Production**	**831 days**	**5/29/18**	**9/27/21**
1.3.3.2.3.6	Receive, unpack, log & inspect final blocks	384 days	2/18/20	8/27/21
1.3.3.2.3.7	Install light guides on final blocks	384 days	2/25/20	9/3/21
1.3.3.2.3.8	Install reflectors and mounting supports on final blocks	384 days	3/3/20	9/13/21
1.3.3.2.3.9	Install SiPMs & daughterboards on final blocks	384 days	3/10/20	9/20/21
1.3.3.2.3.10	Glue final blocks together into modules	384 days	3/17/20	9/27/21
1.3.3.3	**EMCAL Sector Assembly**	**1144 days**	**4/3/17**	**11/1/21**
1.3.3.3.3	**EMCAL Final Sector Assembly**	**1144 days**	**4/3/17**	**11/1/21**
1.3.3.3.3.11	Install modules in final sectors	384 days	3/24/20	10/4/21
1.3.3.3.3.12	Install readout electronics on final sectors	384 days	3/31/20	10/11/21
1.3.3.3.3.13	Install cables & cooling system on final sectors	384 days	4/7/20	10/18/21
1.3.3.3.3.14	Test final sectors with LEDs & cosmic rays	384 days	4/14/20	10/25/21
1.3.3.3.3.15	Repair or rework any sectors as required	384 days	4/21/20	11/1/21
1.3.3.3.3.16	Installation Readiness Review	10 days	10/19/21	11/1/21
1.3.4	Install sectors into sPHENIX	0 days	11/1/21	11/1/21
1.10	**sPHENIX_Integration_and_Installation**	**1409 days**	**2/1/17**	**9/26/22**
1.10.2	**Integration Management and Technical Coordination, Installation Tooling and Fixt**	**1409 days**	**2/1/17**	**9/26/22**
1.10.2.2	**Infrastructure Installation**	**1124 days**	**12/4/17**	**6/8/22**
1.10.2.2.3	Install Beampipe/Vacuum/Bakeout	20 days	3/9/22	4/5/22
1.10.2.7	**EMCal Installation**	**1324 days**	**2/1/17**	**5/24/22**
1.10.2.7.7	EMCal Sectors Ready for Installation	0 days	11/1/21	11/1/21
1.10.2.7.8	Transport Assembled EMCal Sectors to AH	10 days	11/2/21	11/16/21
1.10.2.7.9	Install EMCal Sectors	16 days	11/17/21	12/10/21
1.10.2.7.10	Align/Survey EMCal to SC Magnet Centerline	7 days	12/13/21	12/21/21
1.10.2.8	**TPC Installation**	**1334 days**	**2/1/17**	**6/8/22**
1.10.2.8.7	TPC Ready for Installation	0 days	12/21/21	12/21/21
1.10.2.8.8	Transport Assembled TPC Sections to AH	5 days	12/22/21	12/30/21
1.10.2.8.9	Install TPC Support	5 days	12/31/21	1/7/22
1.10.2.8.10	Install TPC (Mechanical)	5 days	1/10/22	1/14/22
1.10.2.8.11	Align/Survey TPC to SC Magnet Centerline	5 days	1/18/22	1/24/22
1.10.2.8.12	Install TPC Cables and Services	30 days	1/25/22	3/8/22
1.10.2.11	**Min Bias Installation**	**1409 days**	**2/1/17**	**9/26/22**
1.10.2.11.9	Install Min Bias Support	10 days	4/6/22	4/19/22
1.10.2.11.10	Install Min Bias (mechanical)	10 days	4/20/22	5/3/22
1.10.2.11.11	Align/Survey Min Bias to SC Magnet Centerline	5 days	5/4/22	5/10/22
1.10.2.11.12	Install Min Bias Cables and Services	30 days	5/11/22	6/22/22
1.10.2.11.13	Review Min Bias for Operational Readiness (ORR)	5 days	6/23/22	6/29/22
1.10.2.11.14	Address Action Items from Min Bias ORR	10 days	6/30/22	7/15/22
1.10.2.11.15	Commission Min Bias	50 days	7/18/22	9/26/22
1.10.2.12	**sPHENIX Full Detector Installation**	**140 days**	**3/9/22**	**9/26/22**
1.10.2.12.9	All Design/Safety/Readiness Reviews Complete, sPHENIX Ready for Operatic	0 days	9/26/22	9/26/22
1.10.9	sPHENIX Ready for Run 1	0 days	9/26/22	9/26/22



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