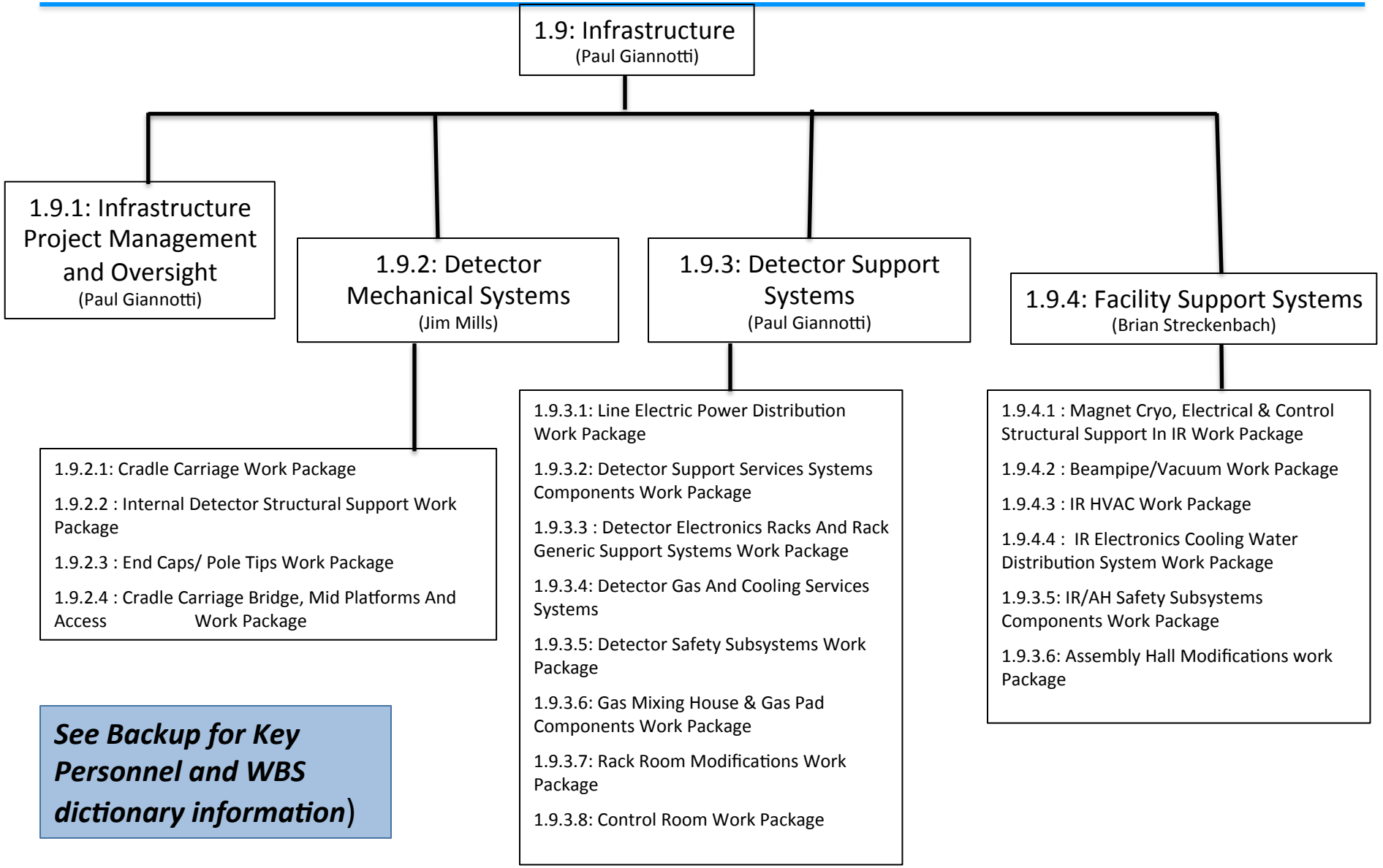
sPHENIX Director's Review Infrastructure

Level II Manager: Paul Giannotti

August 2-4, 2017

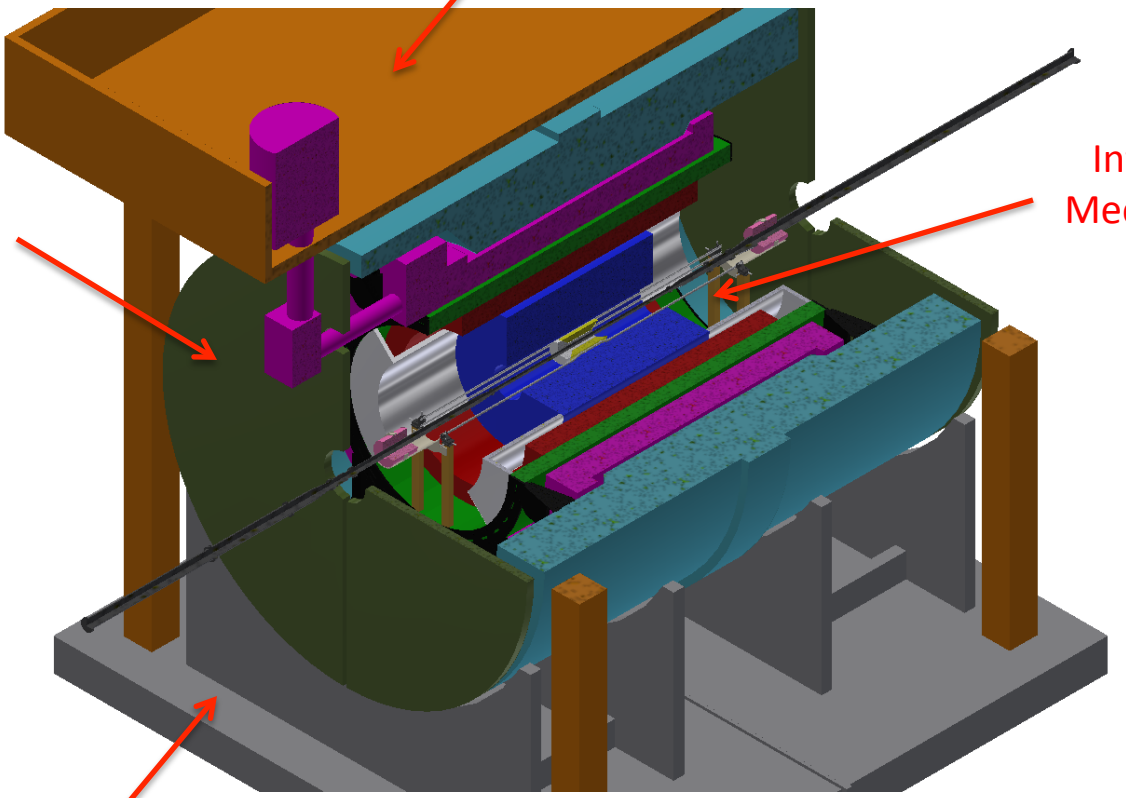
BNL



See Backup for Key Personnel and WBS dictionary information)

System Scope for: 1.9.2 Detector Mechanical Systems (Jim Mills)

Bridge and Mid Platforms
1.9.2.4



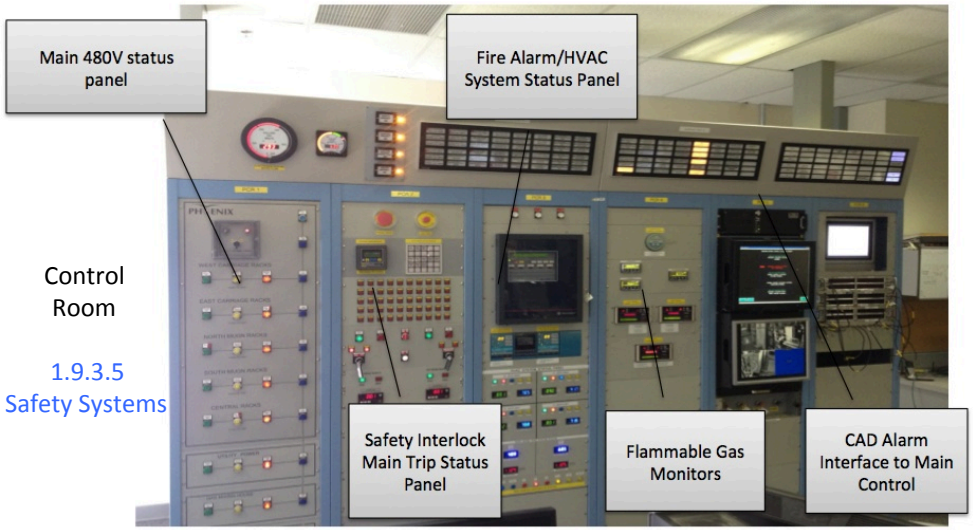
End Caps/Pole Tips
1.9.2.3

Internal Detector Mechanical Supports
1.9.2.2

Cradle Carriage
1.9.2.1

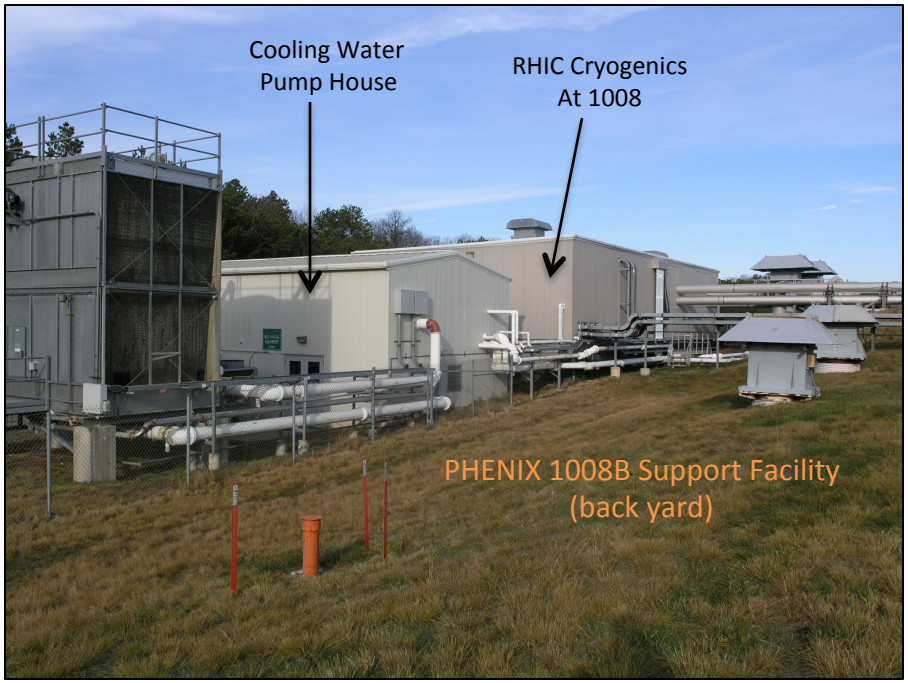
Note: Assembly and Installation of these Infrastructure items is not in the scope of this WBS effort but rather in the scope of WBS 1.10 (Installation and Integration)

System Description for: 1.9.3 Detector Support Systems 1.9.4 Facility Support Systems



Control Room

1.9.3.5 Safety Systems



1.9.3 (P. Giannotti)

1.9.3.1 Electric Power
1.9.3.2 Support Services (cable trays etc.)
1.9.3.3 Electronics Racks
1.9.3.4 Detector Gas & Cooling
1.9.3.5 Safety Systems
1.9.3.6 Gas Mixing House & Gas Storage Pad
1.9.3.7 Rack Room Modifications
1.9.3.8 Control Room computers/furniture

1.9.4 (B. Streckenbach)

1.9.4.1 Magnet Cryo & Structural Supports
1.9.4.2 Beampipe/Vacuum
1.9.4.3 IR HVAC
1.9.3.4 IR Electronics Cooling Water
1.9.4.5 IR/AH Safety Systems
1.9.4.6 Assembly Hall Modifications

See Backup for Details on these work packages)

Note: Assembly and Installation of these Infrastructure items is not in the scope of this WBS effort but rather in the scope of WBS 1.10 (Installation and Integration)

Design Drivers

Infrastructure Design Drivers:

All work packages
- Safety
- Subsystem design requirements
- Cost
- Maintainability, Reliability, Accessibility
- Future upgrades/expansion

WBS 1.9.2 (Cradle, etc)
- SC Magnet (Dimensions, chimney extension)
- Outer HCal (Dimensions, weight)
- Existing shield wall opening
- Existing rail system

WBS 1.9.3 (Detector support systems)
- Available infrastructure (repurposed from PHENIX)
- Minimize footprints in detector active areas
- Maintainability

WBS 1.9.4 (Facility support systems)
- Maximize repurposing from PHENIX
- Minimize impact on detectors

Schedule Drivers/Cost Drivers

Schedule Drivers

- Design of Detector Support Cradle, Base, and Bridge
- Fabrication time and availability for installation of Detector Cradle and Base (First article for detector construction)
- Cryo. Piping Supports and Building Modifications (elevated work)
- Modify existing AC Power Distribution System
- Modify existing Safety Interlock System
- Modify existing IR HVAC units (controls only)

Cost Drivers

- Cradle carriage
- Labor
- Repurposed Infrastructure Modifications
- (Cryo is part of Magnet subsytem) (1.8)

BoE

Cost summaries from BoE's 1.9.2, 1.9.3 and 1.9.4

1.9.2.1	Cradle Carriage Work Package	$888,358.00
1.9.2.2	Internal Detector Structural Support Work Package	$273,890.00
1.9.2.3	End Caps/ Pole Tips Work Package	$250,200.00
1.9.2.4	Cradle Carriage Bridge, Mid Platforms and Access Work Package	$77,200.00
	Total Procurements Cost [2017 dollars, no overhead or contingency added] for the WBS #1.9.2: Detector Mechanical Systems Control Account	$1,489,648.00

WBS #	Work Package Description	Material Cost for this Work Package
1.9.4.1	Magnet Cryo, Electrical & Control Structural Support in IR	$50,000.00
1.9.4.2	Beampipe/Vacuum Work Package	$50,000.00
1.9.4.3	IR HVAC Work Package	$35,000.00
1.9.4.4	IR Electronics Cooling Water	$65,000.00
1.9.4.5	Components Work Package	$32,000.00
1.9.4.6	Assembly Hall Modifications	$10,000.00
	Total Unburdened Material Cost for CA # 1.9.4 =	**$242,000.00**

WBS #	Work Package Description	Material Cost for this Work Package
1.9.3.1	Line Electric Power Distribution Work Package	$50,000.00
1.9.3.2	Detector Support Services Systems Components Work Package	$32,000.00
1.9.3.3	Detector Electronics Racks and Rack generic support systems	$32,000.00
1.9.3.4	Detector Gas and Cooling Services Systems	$107,000.00
1.9.3.5	Detector Safety Subsystems Work Package	$12,000.00
1.9.3.6	Gas Mixing House & Gas Pad Components Work Package	$10,000.00
1.9.3.7	Rack Room Modifications Work Package	$20,000.00
1.9.3.8	Control Room Work Package	$50,000.00
	Total Unburdened Material Cost for CA # 1.9.3 =	**$313,000.00**

Note: Cost savings due to use of existing facility & repurposed equipment = $millions

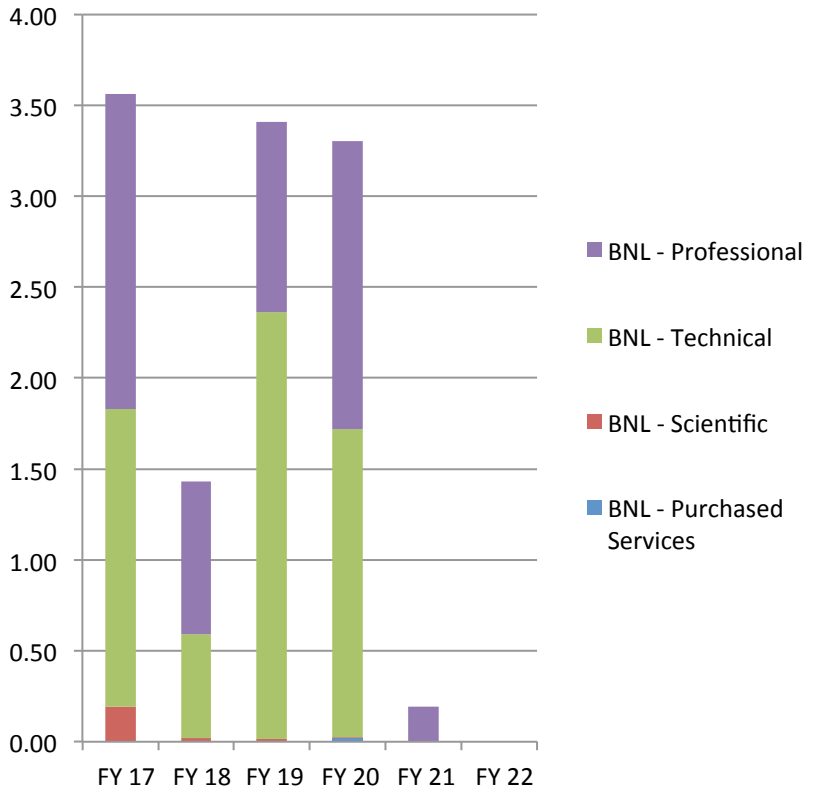
Resource Summary for Integration Documentation, Technical Coordination, Installation, Tooling, Fixtures and Subsystem Installation in FTE's by Resource Category

Administrators	Scientists	Engineers	Designers	Technicians	Trades	Students
0.0	0.2	5.1	3.3	3.0	0.0	0. 0

*BoE's for Infrastructure packages can be found in **here***

Infrastructure Staffing

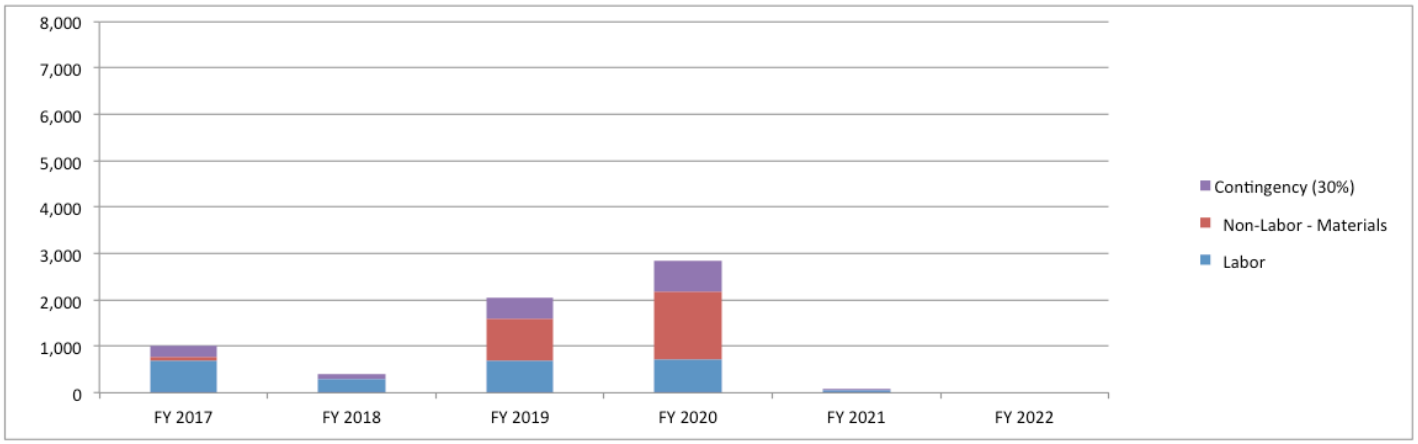
FTE Profile by Category



FTE Profile by Fiscal Year

WBS Level	Org Sort	Group	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22
1.9	**BNL**	Purchased Services	0.00	0.00	0.00	0.02	0.00	0.00
		Scientific	0.19	0.02	0.02	0.00	0.00	0.00
		Technical	1.64	0.57	2.34	1.70	0.00	0.00
		Professional	1.73	0.84	1.05	1.58	0.19	0.00
	BNL Sum		**3.56**	**1.43**	**3.41**	**3.30**	**0.19**	**0.00**
Grand Total			**3.56**	**1.43**	**3.41**	**3.30**	**0.19**	**0.00**

Cost Profile: Infrastructure



Baseline Scenario

AY k$'s - with Extraordinary Construction Overhead Application

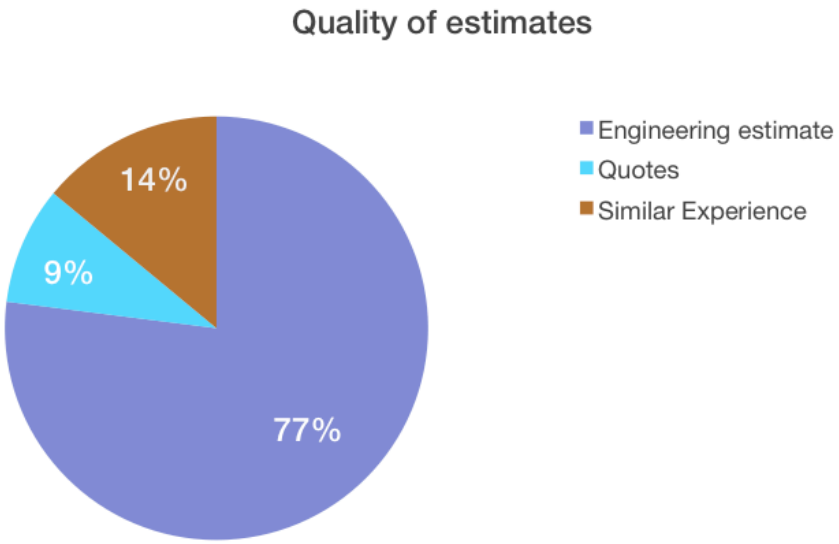
Resource	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total
Labor	692	301	701	733	50	0	2,477
Non-Labor - Materials	90	0	884	1,445	0	0	2,419
Baseline Total	782	301	1,585	2,178	50	0	4,896
Contingency (30%)	235	90	476	653	15	0	1,469
MIE Total	1017	391	2061	2831	65	0	6365

Resource	Baseline	Contingency	Total
Labor	2,477	743	3,220
Non- Labor	2,419	726	3,145
1.9 Infrastructure	4,896	1469	6,365

Basis of Estimate: Contingency

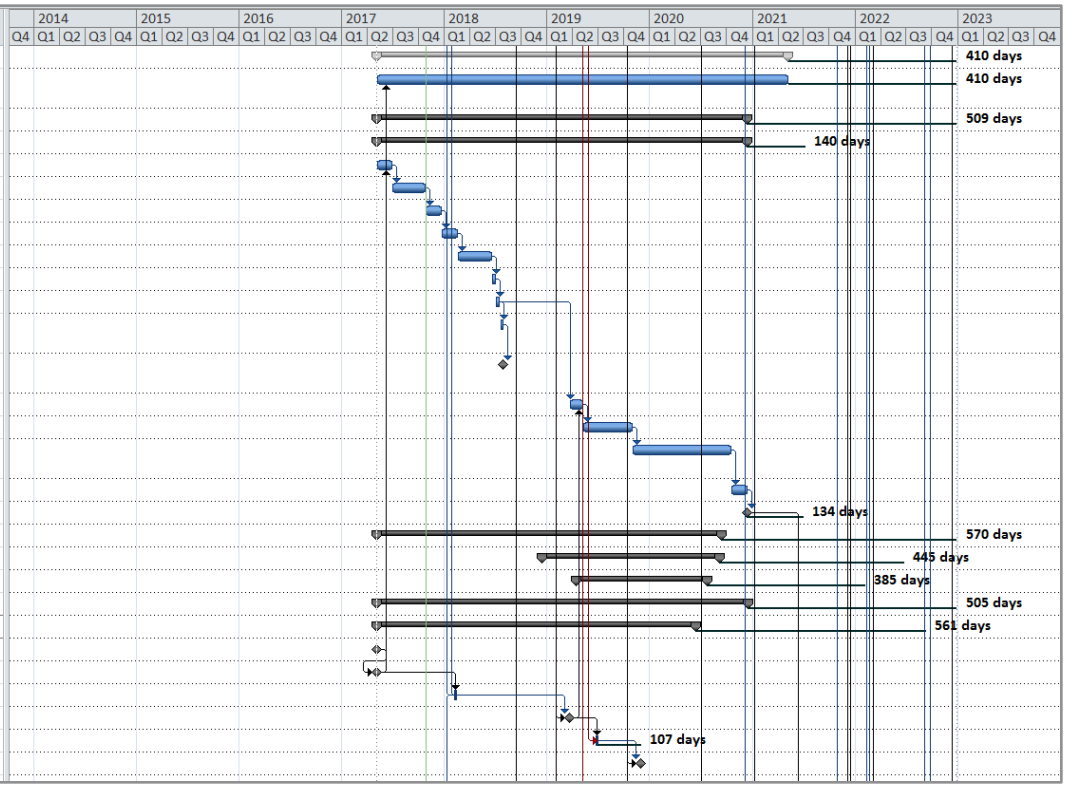
Infrastructure

SUBSYSTEM	PERCENT OF ESTIMATES	CONTINGENCY
Engineering estimate	77	0.40
Quotes	9	0.25
Similar Experience	14	0.25
Average contingency		0.37



Schedule

WBS	Name	Duration
1.9	**sPHENIX_Infrastructure**	**1000 days**
1.9.1	Project Management and Oversight of Infrastructure Requirements for sPHENIX	1000 days
1.9.2	**Detector Mechanical and Support System**	**901 days**
1.9.2.1	**Cradle Carriage**	**901 days**
1.9.2.1.1	Create Cradle Carriage Overall Layout	40 days
1.9.2.1.2	Perform Cradle Carriage Analyses & Design	80 days
1.9.2.1.3	Create Cradle Carriage Envelope Drawing	40 days
1.9.2.1.4	Create Cradle Carriage Assembly Drawing	40 days
1.9.2.1.5	Create Cradle Carriage Detail Drawings	80 days
1.9.2.1.6	Review Cradle Carriage Safety	10 days
1.9.2.1.7	Review Cradle Carriage Design	10 days
1.9.2.1.8	Address Action Items from Cradle Carriage Design & Safety Reviews	10 days
1.9.2.1.9	Design/Safety Reviews Complete, Cradle Carriage Released for Production	0 days
1.9.2.1.10	Prepare Cradle Carriage Procurement Package(s)	30 days
1.9.2.1.11	Evaluate & ProcessCradle Carriage Bid	120 days
1.9.2.1.12	Procure & Deliver Cradle Carriage (leadtime and fabrication included)	240 days
1.9.2.1.13	Perform Cradle Carriage Components Acceptance	40 days
1.9.2.1.14	Cradle Carriage Components Ready for Installation	0 days
1.9.2.2	**Internal Detector Structural Support**	**840 days**
1.9.2.3	**End Caps/ Pole Tips**	**430 days**
1.9.2.4	**CC Bridge, Mid Platforms and Access**	**320 days**
1.9.3	**Detector Support Systems**	**905 days**
1.9.4	**Facility Support Systems**	**775 days**
1.9.5	Start of Project	0 days
1.9.6	CD0 Approved	0 days
1.9.7	CD1/CD3a Review	3 days
1.9.8	CD1/CD3a Approved	0 days
1.9.9	CD2/CD3b Review	5 days
1.9.10	CD2/CD3b Approved	0 days



Infrastructure Schedule: Cradle Carriage details, support systems rolled up

*Full details of the Infrastructure schedule can be found in **here***

sPHENIX Infrastructure Status & Highlights

- Removal & Repurposing effort is clearing IR equipment making water piping and cable trays available for rework.

- Repurposed equipment being cataloged and stored for future use (electronics racks, heat exchangers etc.

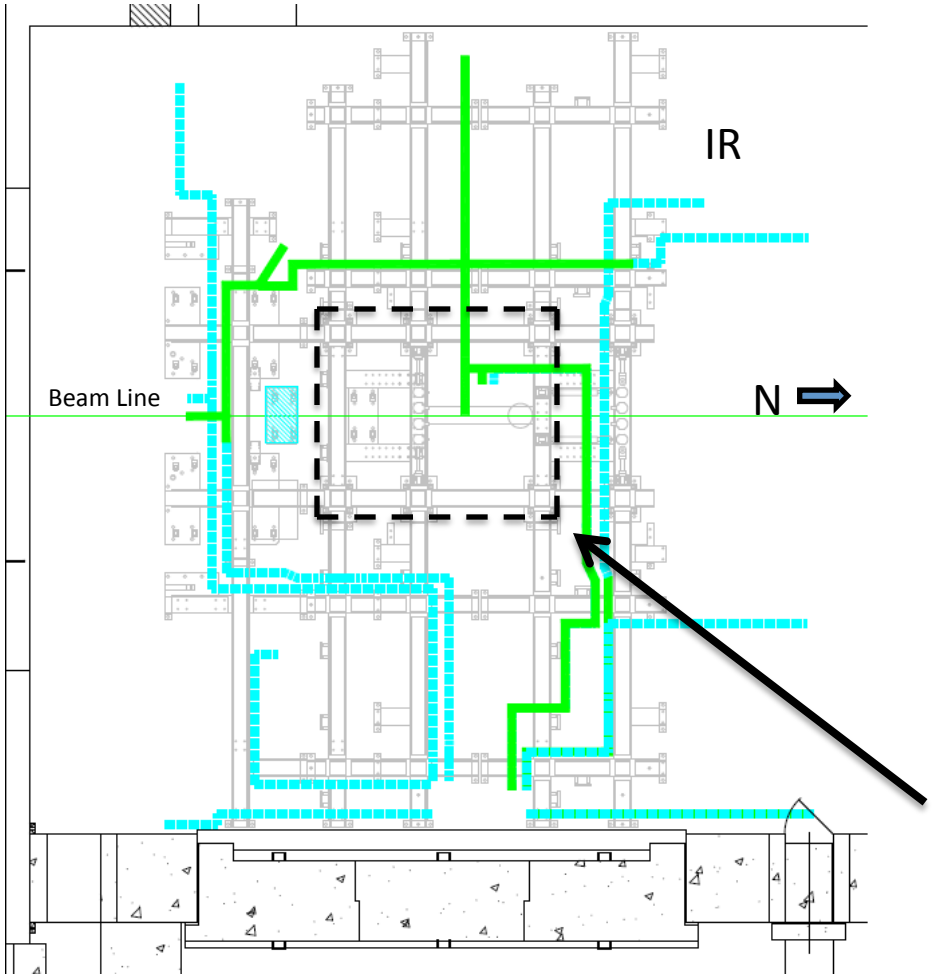
- Cradle Carriage design has started.

- Acquiring quotes for limited amount of new electric power distribution, cooling water and safety system components (modification to existing systems only).

- Design effort Cooling water, magnet cryogenics & cooling water piping has started.

Backup

IR Power and signal trays

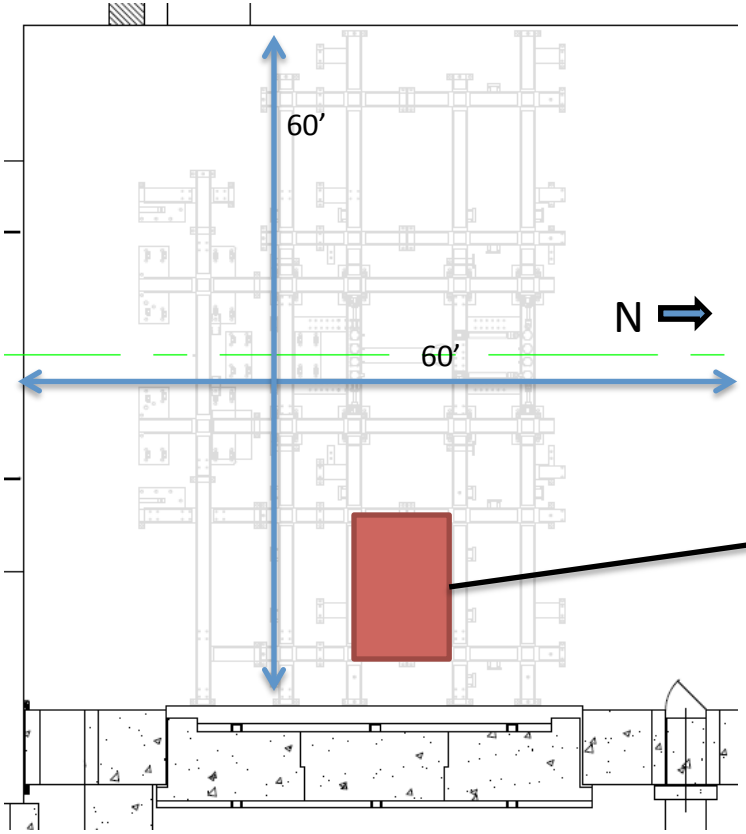


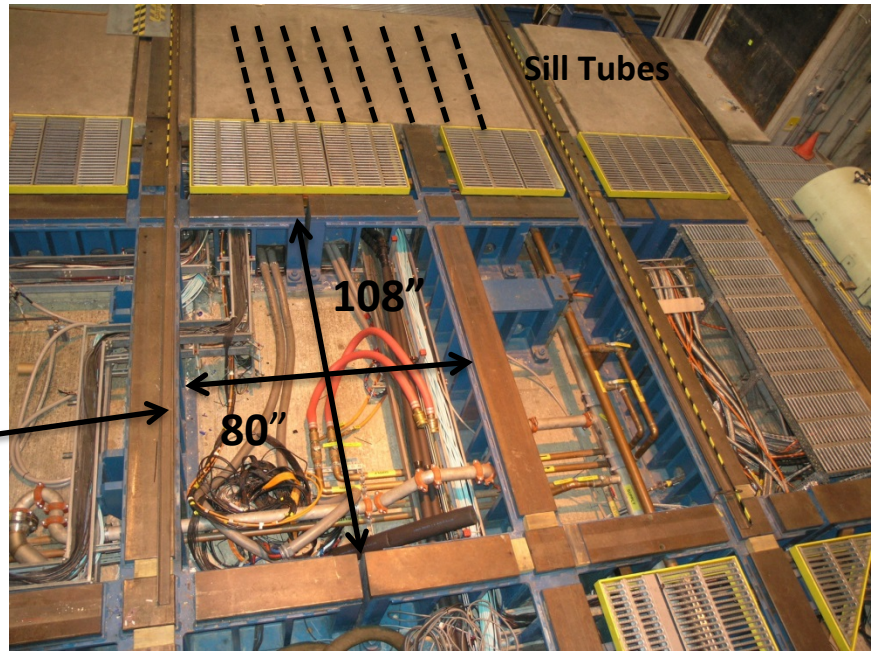
- Existing configuration uses heavy duty 6” wide steel galvanized tray.
- Blue and Green show upper and lower tiers.
- Upper tier is signal, lower tier is power.

Approximate sPHENIX footprint (Cradle Carriage)

Assembly Hall

Typical track services detail



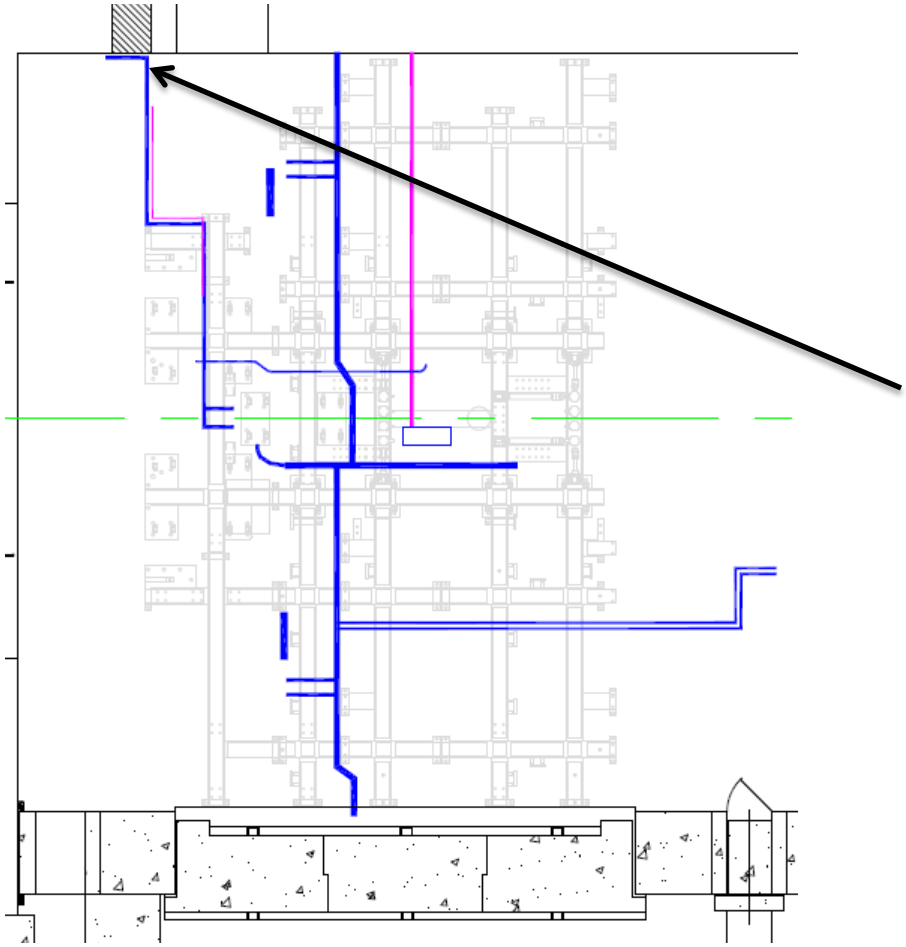


Current routing of IR services

Through Sill Only (other services run via backyard and North & South Tunnels)

- 30 total 4” diameter PVC pipes (Sill Tubes)
- 377 sq. inches of available space

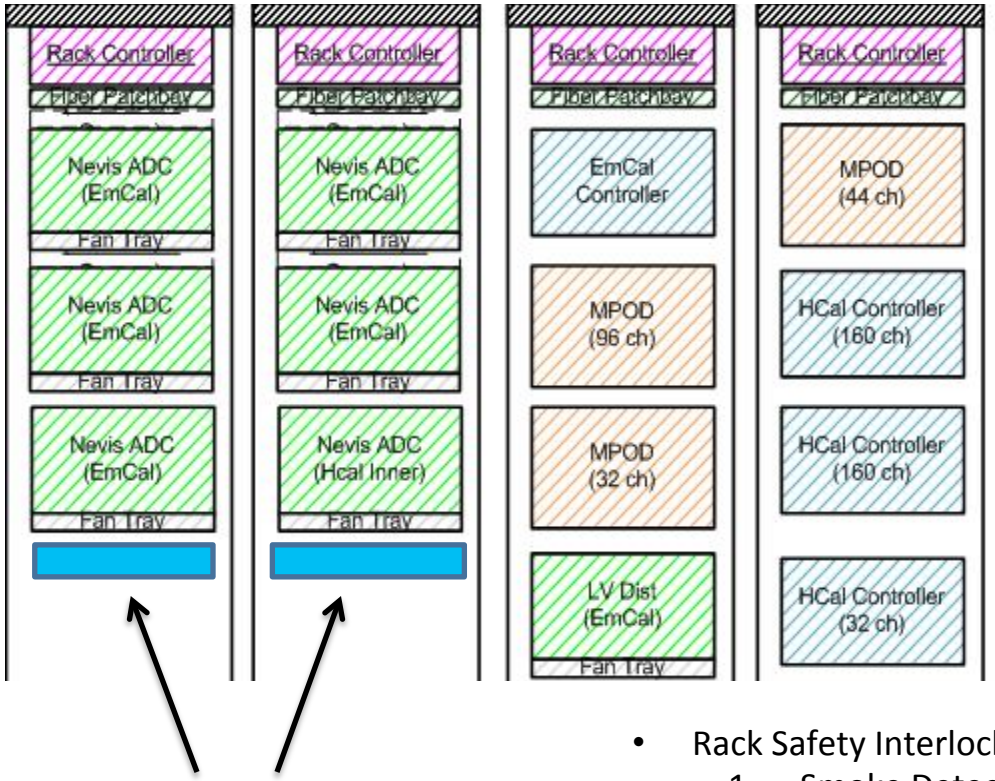
cooling water piping



Fed from Building 1008B (backyard)

- Electronics Cooling Water Piping remains
- Magnet Cooling Water Piping to be removed
- Cryogenic piping for magnet

Racks, rack generic requirements



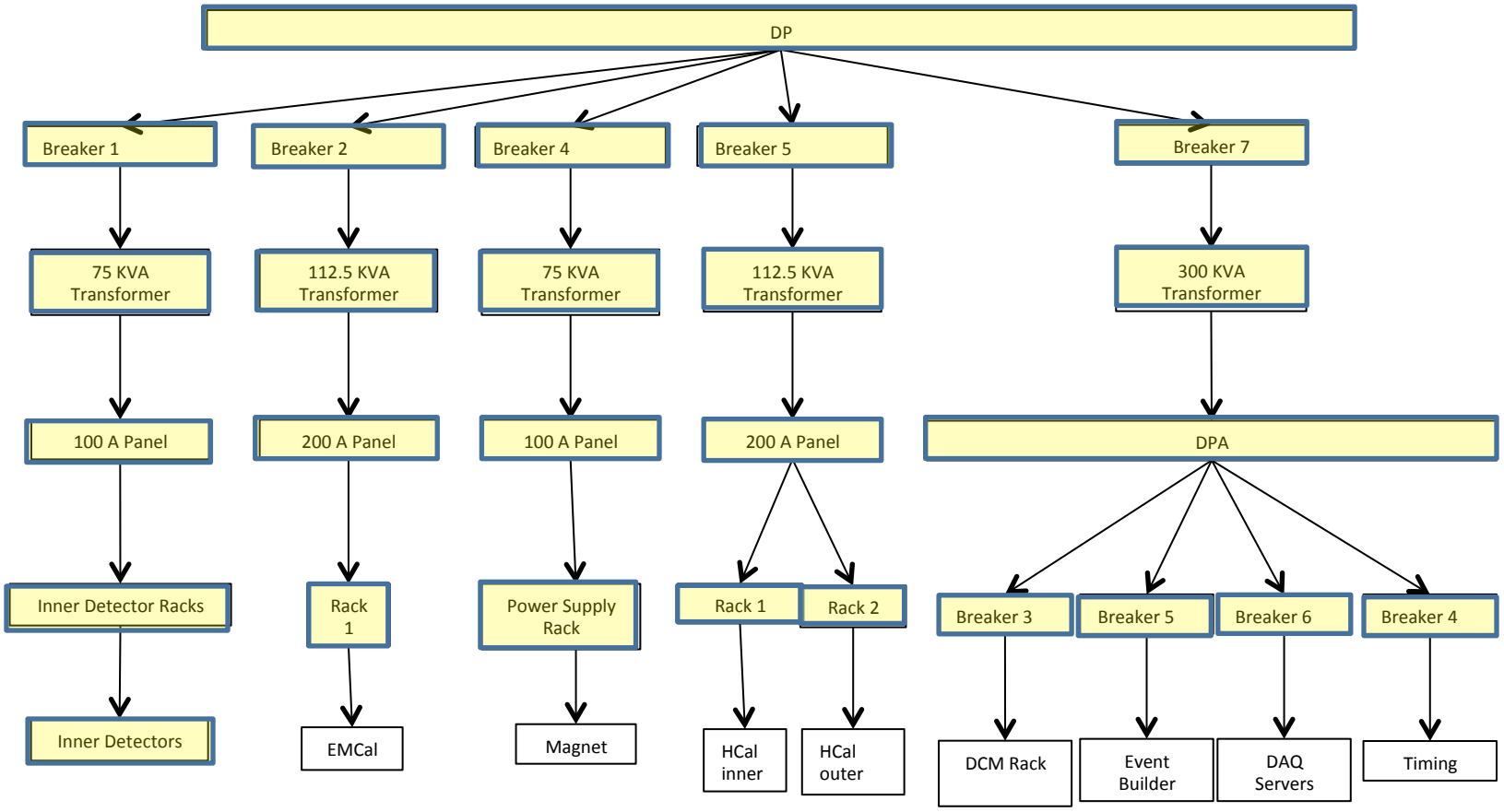
Water Cooled Heat Exchangers

- Power Requirements
  1. One 30A 208V AC Feeder Breaker

- Rack Safety Interlocks
  1. Smoke Detection
  2. Over Temp. Detection
  3. Water Leak Detection

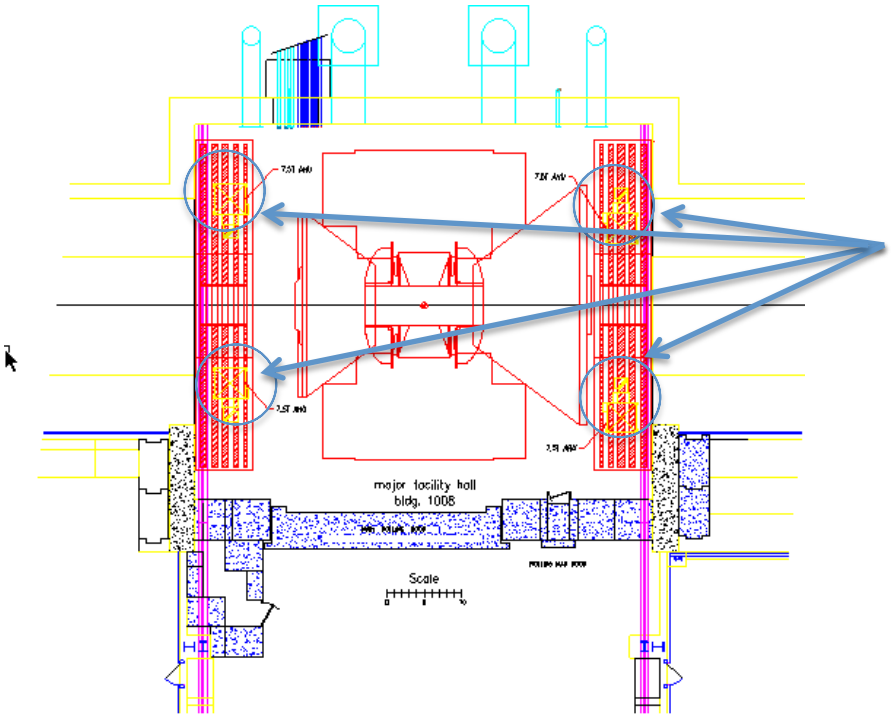
AC Line Electric Power Distribution

AC line electrical power distribution utilizes existing power distribution
Magnet power effort is being handled by super conducting magnet group



IR HVAC

- Plan to use existing existing 4 HVAC units infrastructure
- We have done well with a periodic maintenance schedule, which has increased the systems overall reliability
- 4 condensers located outdoors on IR roof

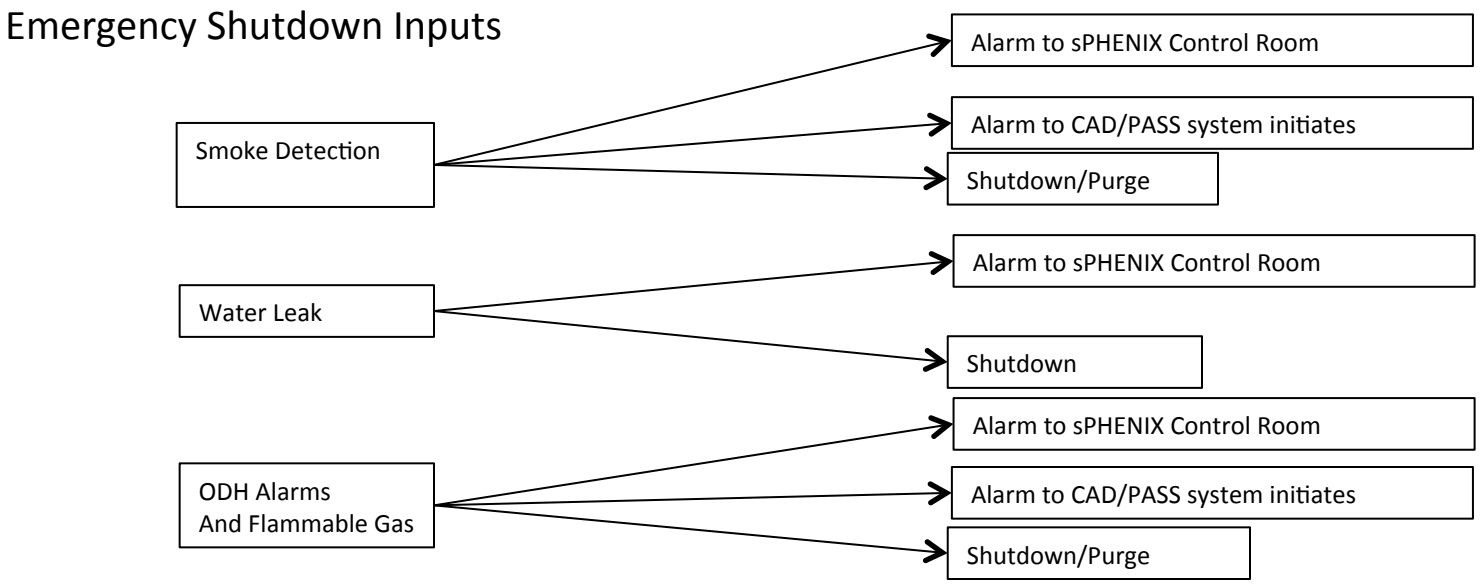


4 air handlers in IR
on top of MuID Steel

Safety System Sample Logic

Existing Infrastructure Changes

- Trip Logic to Remain Relay Based
- PHENIX Control Room upgrade for ODH sensors and monitoring
- CAD PASS system upgrade due to use of He in IR



Installation L2/CAM/Key Personnel

Key Personnel:

Paul *Giannotti* *Principal Engineer and 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.

Rob Pisani, Sr. Scientific Associate for sPHENIX
Relevant Experience
25 years particle detector support experience. SSC EmCal Prototype R&D(1993 Built/test), R&D PHENIX Rich Prototype, PHENIX HBD prototype, Phenix TEC detector, PHENIX Gas System Coordinator (multiple systems), PHENIX VTX/FVTX Cooling System, Deputy Manager of PHENIX Removal & Repurposing.

Steve Boose, *Electronics Engineer for sPHENIX*
Relevant Experience
25 years. Software / hardware design at BNL in support of the NASA SeaWiFS, DOE Ocean Margins Program and the PHENIX experiment at RHIC. 4 years Software / hardware design and technical support for the scientific laser industry. 10 years Electronics troubleshooting and repair in high vacuum, information systems and audio.

Rich Ruggiero, *Sr. Design Engineer for sPHENIX*
Relevant Experience
2012 - Present as sPHENIX Sr. Design Engineer. Responsible for all sPHENIX integration coordination and conceptual design. 1997-Present PHENIX Design Engineer responsible for all integration and cable routing, survey/installation, work access and detector upgrades. 1986 – 1997 BNL Designer for D0 Central Calorimeter, D0 EMCal and Coarse Hadronic sectors, Oasis proposal (predecessor to PHENIX), and various NSLS, AGS and ATLAS design projects.

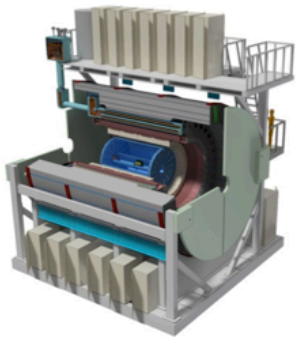
Brian Streckenbach, CAD liaison Engineer to sPHENIX

James Mills, P.E., *Project Engineer for sPHENIX*, 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 (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).

Installation Interfaces

Interface Control documents(ICD's) define and quantify the interfaces between any 2 subsystems. Interfaces include mechanical, electrical, optical, cooling, gas media, etc. For the Installation and Integration effort there are 9 such documents currently conceived. For purposes of the installation efforts, these generally refer to interfaces between the subsystems components and the tooling, fixtures, procedures and equipment required to accomplish the installation and alignment of these components..

1.1 Project Management	1.2 TPC	1.3 EMCal	1.4 HCal	1.5 Calorimeter Electronics	1.6 DAQ/ Trigger	1.7 Min Bias	1.8 SC Magnet	1.9 Infrastructure	1.10 Integration & Installation	1.11 INTT	1.12 MVTX	
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.1 Project Management
	N/A	N/A	N/A	N/A	sP.SE-ICD-004	N/A	N/A	sP.SE-ICD-[illegible]	sP.SE-ICD-016	N/A	N/A	1.2 TPC
		N/A	sP.SE-ICD-001	sP.SE-ICD-002	sP.SE-ICD-005	N/A	N/A	sP.SE-ICD-[illegible]	sP.SE-ICD-017	N/A	N/A	1.3 EMCal
			N/A	sP.SE-ICD-003	sP.SE-ICD-006	N/A	N/A	sP.SE-ICD-[illegible]	sP.SE-ICD-018	N/A	N/A	1.4 HCal
				N/A	sP.SE-ICD-007	N/A	N/A	sP.SE-ICD-[illegible]	sP.SE-ICD-019	N/A	N/A	1.5 Calorimeter Electronics
					N/A	sP.SE-ICD-008	N/A	sP.SE-ICD-[illegible]	sP.SE-ICD-020	SE-ICD-024	sP.SE-ICD-027	1.6 DAQ/ Trigger
						N/A	N/A	sP.SE-ICD-[illegible]	sP.SE-ICD-021	N/A	N/A	1.7 Min Bias
							N/A	sP.SE-ICD-[illegible]	sP.SE-ICD-022	N/A	N/A	1.8 SC Magnet
								N/A	[illegible]	[illegible]	[illegible]	1.9 [illegible]astructure
									N/A	SE-ICD-026	sP.SE-ICD-029	1.10 [illegible]egration & [illegible]tallation
										N/A	sP.SE-ICD-030	1.11 INTT
											N/A	1.12 MVTX



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

WBS	Infrastructure & Facility Upgrade
1.9	SC-Magnet
1.11	Installation-Integration

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

The mechanical mounting, electrical, optical, cooling and gas connections that are made between adjacent detector subsystems and between detector subsystems and infrastructure/ structural support components are defined in the ICD's that are shared by each pairing of those subsystems.

WBS Dictionary

WBS Dictionary entries for the 4 control accounts that comprise the Infrastructure Subsystem

Technical Scope:

WBS 1.9.1 is the Control Account for Project Management costs associated with Infrastructure Management.

Work Statement:

This Control Account encompasses the efforts of the Infrastructure level 2 manager to manage this subsystem in accordance with the BNL and DOE requirements, including collecting and analyzing management performance data for this subsystem, reporting the data as appropriate and generally assuring that this subsystem meets cost and schedule estimates, and if the subsystem management performance strays from the baseline, implementing appropriate actions to restore performance to the baseline."

Technical Scope:

WBS 1.9.2 is the Control Account for all scientific, engineering and technical staff efforts to plan and supervise all aspects of the design, fabrication and assembly of the sPHENIX infrastructure components associated with sPHENIX facility Cradle Carriage and structural support:

1. Cradle Carriage
2. Internal detector structural supports. (includes the structural support mounting and positional alignment features for the Inner HCal/EMCal, superconducting solenoid, TPC, INTT, MVTX and Min Bias detector subsystems)
3. Flux return end caps/pole tips and related mounting components
4. Upper (bridge), intermediate and lower carriage work platforms and access (stairs) on the cradle carriage

Work Statement:

The assembly of the cradle carriage and actual installation of these components and equipment will take place at the sPHENIX experiment complex at building 1008 (in the asembly hall) and is covered in the sPHENIX 1.10.2 control account. There are 4 work packages included in this control account where the actual work is defined for these items. Each work package has its own separate Basis of Estimate (BoE) document elsewhere in this workbook. These documents can be accessed from the Navigation page in this workbook. (see link below).

*WBS dictionary entries for installation work packages can be found in **here***

WBS Dictionary

WBS Dictionary entries for the 4 control accounts that comprise the Infrastructure Subsystem

Technical Scope:

WBS 1.9.3 is the Control Account for all scientific, engineering and technical staff efforts to plan and supervise all aspects of the design, fabrication and assembly of the sPHENIX infrastructure components associated with sPHENIX facility support systems, safety systems and non-IR infrastructure including the following work packages:

1. Line Electric Power Distribution
2. Detector Support Services Systems Components
3. Detector Electronics Racks and Rack generic support systems
4. Detector Gas and Cooling Services Systems
5. Detector Safety Subsystems
6. Gas Mixing House & Gas Pad Components
7. Rack Room Modifications
8. Control Room and Offices Modifications

Work Statement:

The actual installation of these components and equipment will take place at the sPHENIX experiment complex at building 1008 and is covered in the sPHENIX 1.10.2 control account. There are 8 work packages included in this control account. Each work package has its own separate Basis of Estimate (BoE) document elsewhere in this workbook. These documents can be accessed from the Navigation page in this workbook. (see link below).

*WBS dictionary entries for installation work packages can be found in **here***

WBS Dictionary

WBS Dictionary entries for the 4 control accounts that comprise the Infrastructure Subsystem

Technical Scope:

WBS 1.9.4 is the Control Account for all scientific, engineering and technical staff efforts to plan and supervise all aspects of the design, fabrication and assembly of the sPHENIX infrastructure components associated with sPHENIX facility support systems, safety systems and non-IR infrastructure including the following work packages:

1. Magnet Cryo, Electrical & Control Structural Support in IR
2. Beampipe/Vacuum
3. IR HVAC
4. IR Electronics Cooling Water Distribution System
5. IR/AH Safety Subsystems Components
6. Assembly Hall Modifications

Work Statement:

The actual installation of these components and equipment will take place at the sPHENIX experiment complex at building 1008 and is covered in the sPHENIX 1.10.2 control account. There are 6 work packages included in this control account. Each work package has its own separate Basis of Estimate (BoE) document elsewhere in this workbook. These documents can be accessed from the Navigation page in this workbook. (see link below). "

*WBS dictionary entries for installation work packages can be found in **here***

Technical Scope:

WBS 1.9.4 is the Control Account for all scientific, engineering and technical staff efforts to plan and supervise all aspects of the design, fabrication and assembly of the sPHENIX infrastructure components associated with sPHENIX facility support systems, safety systems and non-IR infrastructure including the following work packages:

1. Magnet Cryo, Electrical & Control Structural Support in IR
2. Beampipe/Vacuum
3. IR HVAC
4. IR Electronics Cooling Water Distribution System
5. IR/AH Safety Subsystems Components
6. Assembly Hall Modifications

Work Statement:

The actual installation of these components and equipment will take place at the sPHENIX experiment complex at building 1008 and is covered in the sPHENIX 1.10.2 control account. There are 6 work packages included in this control account. Each work package has its own separate Basis of Estimate (BoE) document elsewhere in this workbook. These documents can be accessed from the Navigation page in this workbook. (see link below). "