Director’s Cost, Schedule and Status Review of the sPHENIX Infrastructure and Facility Upgrade Project Management and Progress

Glenn R. Young
October 16-17, 2019

BNL
sPHENIX I&F Project Scope

• Superconducting Magnet and support systems
  – associated cryogenics (LHe, LN₂, warm piping), links to RHIC cryogen lines
  – power supply and quench detection system
  – controls
• Cradle/Carriage to support all parts of the experiment
  – Internal detector supports, upgrades to rail system (twice mass of old PHENIX)
  – Platforms, bridge, access items, stairs, motion control, seismic restraints
• Magnet steel: Barrel Yoke (doubles as Outer HCal absorber) and Pole Tips
• Infrastructure improvements to Building 1008 complex
• Installation of all items
• Testing in-situ of all items
2.01 I&F Management
I. Sourikova

2.02 SC-Magnet
K. Yip

2.02.01 Reviews & Tests
K. Yip

2.02.02 Transport & Assembly
M. Anerella

2.02.03 Cryogenics
R. Than

2.02.04 PS, Controls, Quench Protection
C. Shultheiss

2.02.05 Magnet Mapping
J. Haggerty

2.03 Carriage & Structural Components
C. Pontieri

2.03.01 Carriage/Cradle
J. Mills

2.03.02 Inner Rings
C. Pontieri

2.03.03 Magnet Barrel Steel
C. Pontieri

2.03.04 End Caps/Pole tips
J. Mills

2.03.05 Bridge, Platforms & Access
J. Mills

2.04 Infrastructure
R. Pisani

2.04.01 Detector Support Services
J. Vasquez

2.04.02 Facility Support Services
B. Streckenbach

2.05 Installation Integration
R. Feder

All Control Account Managers are at L2
sPHENIX Project Management

- sPHENIX Project Management at BNL, staffed by BNL
  - Includes Project Director, Project Manager, Project Scientist, Project Engineer, Resource Coordinator, ES&H rep, QA rep, Chief Mechanical Engineer, Project Controls Manager and staff, Integration
  - Significant experience – core of scientific and engineering group that built PHENIX and operated it for 16 years; project controls group experienced on several other completed DOE-413-type projects

- L2 Managers/CAMs, L3 Managers: BNL staff
sPHENIX Project Organization

- BNL Staff direct, engineer, design, and perform the Infrastructure and Facilities work
  - Superconducting Magnet and all support systems
  - Cradle/Carriage, Inner Detector Supports, Platforms
  - Magnet Steel: yoke and pole tips
  - Infrastructure upgrades
    - Detector - High/DC Low Voltage, AC Power, Cabling/Fiber Optics, Racks, Gas & Cooling Systems
    - Facility - Supports for Electrical & Cryogenic Services, HVAC, IR Cooling Water Supply, Safety Systems, Track Modifications
  - Installation
    - University and all Lab groups all participate in the in-situ testing step

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sPHENIX Labor Resources

• Engineering and Design Staff from
  – Physics
  – Collider-Accelerator
  – Instrumentation
  – Superconducting Magnet

• Installation phase is led by BNL staff (Physics, Collider-Accelerator)

• Cabling and later in-situ testing work depends upon outside contributions
  – University staff
  – Staff from other Laboratories: RIKEN/LANL/LBNL/MIT-LNS/Columbia-Nevis
sPHENIX MOAs

- The sPHENIX Project plans for effort by personnel from the Physics Department, the Collider-Accelerator Department, the Superconducting Magnet Division, and the Instrumentation Division at BNL
- Memoranda of Agreement between sPHENIX and these organizations address the activities and personnel involved, and the amounts and duration of the planned effort
- All five are complete:
  - Physics
  - C-AD for Magnet and Carriage/Cradle
  - Instrumentation for TPC and DAQ including installation
  - SMD for Engineering/FEA
  - C-AD for Infrastructure improvements
sPHENIX Internal Reviews

• All construction must undergo a series of reviews
  – Design: conceptual, intermediate, final as needed
  – Performance evaluation after prototyping steps (1 or more)
  – Procurement (or production) readiness
  – ESHQ check

• A series of reviews of the conceptual designs has been held
  – Reports on the Indico sites of the various reviews
  – These outputs informed construction of the Resource Loaded Schedule, in particular prototyping and testing that should be done prior to proceeding with Production effort
sPHENIX Prototyping

• This is a key component of the effort to identify and remove risks associated with building a new detector as a series of subsystems and getting the various subsystems all to assemble into a coherent whole
  – Barrel steel yoke (OHCal sectors) included a first article and revision cycle
  – Barrel steel yoke has carried out a series of test assembly cycles
  – SC Magnet was assembled and tested in Bldg 912
  – Detector subsystems are all tested with their infrastructure elements (LV, HV, cooling water, gas) and the DAQ, to insure everything will function as a unit, prior to Installation
sPHENIX Large Procurements

- Infrastructure/Facilities has three major >$1M procurements
  - Barrel Steel (2.3.3) – placed ($5.6M) – last sector delivery was in August 2019
  - Cradle/Carriage (2.3.1) – PRR planned for November 2019
  - Helium Interface for cryogenics (2.2.3) – vendor chosen, final procurement steps underway prior to placing contract

- Eight other procurements over $100K
  - Pole tips (2.3.4) - $617K
  - Bridge/Platforms (2.3.5) - $320K
  - Large Support Rings (2.3.2) - $300K
  - LN2 transfer system (2.2.3) - $220K
  - Cryogenics controls (2.2.3) - $160K (collection of items)
  - Track strengthening (2.4.2) - $140K
  - Seismic Restraints (2.3.1) - $126K
  - Gas & Cooling Services (2.4.1) - $107K
A Resource Loaded Schedule has been developed for sPHENIX. There is one P6 file for both MIE (WBS 1.x) and Installation and Facilities (WBS 2.x).

- All tasks have resources, durations & links determined
- The RLS for MIE subsystems (WBS 1.x) end on completion milestones and links out to Installation (WBS 2.05), an integral part of the overall P6 file

- SC Magnet (WBS 2.02), Cradle/Carriage and Steel fabrications(WBS 2.03), and Infrastructure (WBS 2.04) have major design/engineering/review stages followed by Procurement Readiness Review and lengthy procurement strings
- Similarly, have included ~40 reviews under Magnet (WBS 2.2) and Carriage & Structural Components (WBS 2.3) for various large procurements/productions

- Included reviews of each of the 14 Infrastructure upgrade topics (WBS 2.4)
- Included review for each of the 10 subsystem installations, plus a following subsystem-specific ORR, plus general ORR for the full sPHENIX
WBS Schedule Construction

• Critical path for (2.x) is Carriage/Cradle (WBS 2.3.1) and its installation (WBS 2.5.3)
  – This is central to installation sequence
  – Carriage/Cradle must be placed first on the track system in Bldg. 1008 AH
  – OHCal installation follows, including SC magnet installation, with platforms afterwards
  – Cryogenics installation in 1008 IR can then proceed, with detector subsystem installation up thru EMCal, followed by pole-tips installation
  – Roll-in to 1008 IR after the above and conclusion of RHIC FY22 Run

• All detectors (WBS 1.x) have hand-offs to Installation (WBS 2.05)
### Critical Path (2.x) – Cradle & Installation

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<thead>
<tr>
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<th>CRD/CP</th>
<th>SBT</th>
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<td>13 Sep</td>
<td>Sep 25</td>
<td>1999</td>
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</table>

- **Cradle/Carriage Assembly**
- **Cradle/Carriage Production**
- **Cradle/Carriage Engineering/Design/Proc.Prep**
- **OHCal – 1**
- **SC Magnet Install**
- **OHCal – 2**
- **Platforms**

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Critical Path(2.x) – Cradle & Installation

IHCal and EMCal also install now

Platforms (cont.)

Magnet Infrastructure

Magnet Commissioning

Director's Cost, Schedule and Status Review

TPC Install

INTT/MVTX Install

MBD Install

Full sPHENIX ORR

Schedule Contingency

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Schedule Contingency

Director's Cost, Schedule and Status Review

TPC Install
Critical Path (2.x) – Cradle & Installation

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Director's Cost, Schedule and Status Review

- Magnet Infrastructure
- Magnet Commissioning
- TPC Install
- Beampipe Install
- INTT/MVTX Install
- MBD Install
- Float for Roll-In to IR

Platforms (cont.)

- RHIC Run FY21 ends Dec 31, 2021
- Want to Start Magnet Coolodown by early May 2022
- Allow One Month to Remove Shield Wall, Roll In to IR, and Connect to RHIC Cryogenics

- IHCal and EMCal also install now

- RHIC Run FY22 ends Dec 31, 2021
- Want to Start Magnet Coolodown by early May 2022
- Allow One Month to Remove Shield Wall, Roll In to IR, and Connect to RHIC Cryogenics
# Milestone Table

<table>
<thead>
<tr>
<th>WBS</th>
<th>Milestone Description</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>2.03.02</td>
<td>Magnet Supports Released for Production</td>
<td>20-Mar</td>
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<tr>
<td>2.03.03</td>
<td>Completion of Outer ICal Sector Mechanical Structure Procurement</td>
<td>20-Apr</td>
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<tr>
<td>2.03.04.01</td>
<td>Completed - (Controls Hardware) Power distribution drawings</td>
<td>20-Jul</td>
</tr>
<tr>
<td>2.04.02.01</td>
<td>Magnet cryo, electrical &amp; control structural support components Ready for Installation</td>
<td>20-Jul</td>
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<tr>
<td>2.03.01</td>
<td>Completed - Steel Track Modifications</td>
<td>20-Sep</td>
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<tr>
<td>2.03.02</td>
<td>ICal Structural Support Components Ready for Installation</td>
<td>20-Dec</td>
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<tr>
<td>2.05.04</td>
<td>Outer ICal Sectors Ready for Installation</td>
<td>21-Apr</td>
</tr>
<tr>
<td>2.03.01</td>
<td>Carriage Cradle - Components Ready for Installation</td>
<td>21-Apr</td>
</tr>
<tr>
<td>2.02.03.02.04.02</td>
<td>Completed - Procure LN2 supply transfer line system - Delivery Acceptance</td>
<td>21-Jul</td>
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<tr>
<td>2.03.05</td>
<td>CC Bridge, Mid Platforms &amp; Access - Ready for Installation</td>
<td>21-Oct</td>
</tr>
<tr>
<td>2.04.01.03</td>
<td>Electronics Racks &amp; Rack generic support systems components Ready for Installation</td>
<td>21-Nov</td>
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<tr>
<td>2.04.02.06</td>
<td>Assembly Hall Components Ready for Installation</td>
<td>21-Nov</td>
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<tr>
<td>2.05.05</td>
<td>Completed - Install SC Magnet on Cradle</td>
<td>21-Nov</td>
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<tr>
<td>2.04.01.05</td>
<td>Detector Safety Subsystems Components Ready for Installation</td>
<td>21-Dec</td>
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<tr>
<td>2.02.02</td>
<td>Completed - Magnet and Solenoid Valvebox - Reinstall</td>
<td>22-Jan</td>
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<tr>
<td>2.05.04</td>
<td>Completed - Install Remainder of Outer ICal Sectors</td>
<td>22-Jan</td>
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<tr>
<td>2.05.03</td>
<td>Completed - Install platforms &amp; access</td>
<td>22-Feb</td>
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<tr>
<td>2.05.07</td>
<td>Completed - Install EMCal Sectors</td>
<td>22-Mar</td>
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<tr>
<td>2.02.03.01.06</td>
<td>RHIC Helium Interface - Installation complete</td>
<td>22-May</td>
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<tr>
<td>2.02.03.04.03</td>
<td>(Cryo Controls Hardware) Hardware Installed</td>
<td>22-May</td>
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<tr>
<td>2.05.03</td>
<td>Completed - Install Pole Tips</td>
<td>22-May</td>
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<tr>
<td>2.02.01.02</td>
<td>Magnet is operational</td>
<td>22-Jul</td>
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<tr>
<td>2.02.05.03</td>
<td>Completed - Magnet Field Measurements: Map Magnetic Field of SC Magnet</td>
<td>22-Aug</td>
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<tr>
<td>2.05.08</td>
<td>Completed - Install TPC</td>
<td>22-Sep</td>
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<td>2.05.11</td>
<td>Completed - Install Min Bias</td>
<td>22-Oct</td>
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<tr>
<td>2.05.10</td>
<td>Completed - Install MVTX</td>
<td>22-Nov</td>
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<tr>
<td>2.05.12</td>
<td>sPHENIX Ready for Operations</td>
<td>22-Nov</td>
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</table>
sPHENIX QA Plans

• All construction must create and submit a QA plan
• sPHENIX has created a master QA plan
  – C. Gortakowski’s talk

• Subsystems submit a Subsystem-Specific QA Plan
  – That for Barrel Steel (WBS 2.3.3) was carried out as part of that contract
  – Upcoming for cryogenics procurement (WBS 2.2.3)
  – Upcoming for carriage/cradle (WBS 2.3.1), detector supports (WBS 2.3.2), poletips (WBS 2.3.4), platforms (WBS 2.3.5) and related procurements
  – Lifting fixtures, included as part of Installation (WBS 2.5)
# Sample Basis of Estimate

- Sample of Labor estimate sheet for WBS 2.03.01 Carriage/Cradle

<table>
<thead>
<tr>
<th>TASK/ACTIVITY</th>
<th>Task/Activity Description</th>
<th>Engineer hrs</th>
<th>CAD Engineer PROF5 AD</th>
<th>CAD Engineer PROF4 AD</th>
<th>Mag. Div. Engineer PROF4 AM</th>
<th>SPHENIX Engineer Mechanical PROF4 PD M</th>
<th>SPHENIX Engineer Electrical PROF4 PD E</th>
<th>Designer hrs</th>
<th>Designer/ Drafter hrs</th>
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<th>Technician hrs</th>
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<tbody>
<tr>
<td>Carriage Cradle - Perform Analyses, Design &amp; System Integration (Final)</td>
<td>Technical Scope: All tasks related to the design of the sPHENIX cradle carriage layout. Work Statement: gather all relevant information and analysis requirements, calculate performance, create layout drawing.</td>
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<td>Carriage Cradle - Create Assembly &amp; Detail Drawings</td>
<td>Technical Scope: All tasks related creating carriage assembly and detail drawings. Work Statement: Under engineering guidance create a package of drawings to fully define the carriage cradle.</td>
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<td>Carriage Cradle - Final Review (Design &amp; Safety)</td>
<td>Technical Scope: All tasks related to the design and safety review of the carriage cradle. Work Statement: Review all aspects of the proposed design for the carriage cradle.</td>
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<td>Carriage Cradle - Address Action Items from Design &amp; Safety Reviews</td>
<td>Technical Scope: All tasks related to addressing issues raised during the design and safety review. Work Statement: Revisit design calculations, revise designs and drawings as necessary to satisfy issues raised during design and safety review.</td>
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<td>Carriage Cradle - Prepare Procurement Package(s)</td>
<td>Technical Scope: All tasks related to the preparation of procurement documents for the cradle carriage. Work Statement: Create statement of work, design specifications and RFQ drawing package to support procurement effort.</td>
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# WBS Dictionary (Sample Entry)

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<th>WBS L2</th>
<th>WBS L3</th>
<th>WBS L4</th>
<th>WBS Name</th>
<th>Dictionary Definition</th>
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<td>2.03</td>
<td></td>
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<td>CARRIAGE AND STRUCTURAL COMPONENTS</td>
<td>WBS 2.03 Includes The Design, Fabrication And Assembly Of The sPHENIX Carriage and Detector Support Systems, As Well As The Barrel Steel That Forms The SC Magnet Return Yoke, Organized As Follows: WBS 2.03.01. Cradle Carriage WBS 2.03.02. 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 (MBD) Subsystems WBS 2.03.03. Flux Return Barrel Steel WBS 2.03.04. End Caps/Pole Tips Steel WBS 2.03.05 Upper (Bridge), Intermediate And Lower Carriage Work Platforms And Access (Stairs)</td>
</tr>
<tr>
<td>2.03</td>
<td>2.03.01</td>
<td></td>
<td>Cradle Carriage</td>
<td>Technical Scope: This Work Package Includes All Scientific, Engineering And Technical Staff Efforts To Analyze The Requirements For An Integrated Support (&quot;Cradle Carriage&quot;) System, Which Will Support All Of The sPHENIX Experimental Detector Subsystems And The Effort Required To Fully Design The System. The Analyses Required To Determine The Components And Equipment Needed, The Design, Procurement And Acceptance Of Such Equipment The Work Includes The Cradle Carriage Itself, The Drive and Alignment System, Any Needed Seismic Restraints, And Any Needed Track Modifications. Reviews Of These Analyses Are Also In The Scope Of This Work Package. Work Statement: This Work Package Includes The Following Tasks: 1. Evaluate The Requirements For The Structural Integrity, Accuracy, Stability And Repeatability For The Carriage With Respect To The Direct Support Of The Outer HCAL And The Indirect Support Of The Other Detector And Support Subsystems. 2. Prepare Appropriate Drawings And Related Documentation 3. Review The Design; Make Appropriate Modifications Per Review Recommendations 4. Procure Equipment Needed To Implement This Design. 5. Prepare The Equipment For Delivery To Building 1008, The sPHENIX Complex, Ready To Be Installed.</td>
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<tr>
<td>2.03</td>
<td>2.03.02</td>
<td></td>
<td>Inner Detector Rings and Interface to Mechanical Structural Supports</td>
<td>Technical Scope: This Work Package Includes All Scientific, Engineering And Technical Staff Efforts To Analyze The Requirements For An Integrated Support System Which Will Support All Of The sPHENIX Experimental Detector Subsystems Not Directly Supported By The Cradle Carriage And The Effort Required To Fully Design The System. The Analyses Required To Determine The Components And Equipment Needed, The Design, Procurement And Acceptance Of Such Equipment And Reviews Of These Analyses Are Also In The Scope Of This Work Package. Work Statement: This Work Package Includes The Following Tasks: 1. Evaluate The Requirements For The Structural Integrity, Accuracy, Stability And Repeatability For The Carriage With Respect To The Support Of The sPHENIX Superconducting Solenoid Magnet, And Inner Detector Subsystems (Inner HCAL, E.MCAL, TPC, INTT, MVTX And Min Bias (MBD)) And Inner Detector Subsystem Utilities Support. 2. Prepare Appropriate Drawings And Related Documentation 3. Review The Design; Make Appropriate Modifications Per Review Recommendations 4. Procure Equipment Needed To Implement This Design. This includes OHCal Large Support Rings, beampipe supports, and internal supports for SC Magnet coil, HCAL, E.MCAL (as needed), TPC, INTT, MVTX and MBD. 5. Prepare The Equipment For Delivery To Building 1008, The sPHENIX Complex, Ready To Be Installed.</td>
</tr>
</tbody>
</table>
sPHENIX Risk Registry

• Risk Registry is developed and populated in continuing consultation with L2, L3 and engineering staff.
  – Risk evaluation includes consideration of dollar cost risk and schedule risk
  – Probability assigned after discussion among PM, L2 and L3 managers

• Project plans to update and review Elements on regular basis
  – Monthly review is foreseen, coupled with monthly status, cost and schedule reporting
## Risk Registry for 2.x

### Risk Identification

<table>
<thead>
<tr>
<th>Risk ID Number</th>
<th>RLS activity or next WBS</th>
<th>Owner</th>
<th>Risk Title</th>
<th>IF/THEN</th>
<th>Likelihood of Impact (%)</th>
<th>Schedule Impact</th>
<th>Technic al Impact</th>
<th>Cost Impact Eliminat (€K)</th>
<th>Probability of Occurrence</th>
<th>Probablity Score (1-4)</th>
<th>Cost Score (1-4)</th>
<th>Schedule Score (1-4)</th>
<th>Overall Impact Score</th>
<th>EMV KS</th>
<th>Overall Impact Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Departure of Key Personnel</td>
<td>R. Feder</td>
<td>Negligible</td>
<td>Failure of a major piece of equipment</td>
<td>If someone critical to the Project informs of his intention to leave SPhENIX, then a replacement needs to be found.</td>
<td>10%</td>
<td>Moderate</td>
<td>75</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>3.33</td>
<td>High</td>
<td>Add work to SPhENIX collaboration and BNL.</td>
</tr>
<tr>
<td>2</td>
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<td>Roberto Than</td>
<td>Low</td>
<td>Vendor Delay in fabrication (Cryogenic)</td>
<td>If a delay in SPhENIX support platform construction occurs, then the installation of cryogenic components on platform can't start</td>
<td>5%</td>
<td>Low</td>
<td>65</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2.67</td>
<td>Moderate</td>
<td>Carefully plan all work in accordance with BNL, SIAM.</td>
</tr>
<tr>
<td>4</td>
<td>Delays in SPhENIX support platform construction</td>
<td>Roberto Than</td>
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<td>Delays in SPhENIX support platform construction</td>
<td>Roberto Than</td>
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<td>Magnet temperature sensors fail to read</td>
<td>If a delay in SPhENIX support platform construction occurs, then the installation of cryogenic components on platform can't start</td>
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<td>Delays in SPhENIX support platform construction</td>
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### Risk Handling Plan (Mitigations)

- **Risk ID Number**: RLS activity or next WBS
- **Owner**: Name of the owner
- **Risk Title**: Description of the risk
- **IF/THEN**: Condition and consequence of the risk
- **Likelihood of Impact (%)**: Probability of occurrence
- **Schedule Impact**: Likelihood of impact on schedule
- **Technical Impact**: Likelihood of impact on technical performance
- **Cost Impact Elimination (€K)**: Cost impact if not mitigated
- **Probability of Occurrence**: Likelihood of occurrence
- **Probability Score (1-4)**: Likelihood of occurrence
- **Cost Score (1-4)**: Likelihood of cost impact
- **Schedule Score (1-4)**: Likelihood of schedule impact
- **Overall Impact Score**: Combined impact score
- **EMV KS**: Expected monetary value of the key strategy
- **Overall Impact Score**: Combined impact score

### Risk Handling Method

- **Mitigate**: Mitigate the risk by implementing controls or strategies to reduce the likelihood or impact of the risk.
- **Transfer**: Transfer the risk to another party through insurance, contracts, or other arrangements.
- **Accept**: Accept the risk if the potential benefits outweigh the costs.
- **Avoid**: Avoid the risk by eliminating or removing the source of the risk.

### Risk Reviews

- **October 16-17, 2019**: Director's Cost, Schedule and Status Review
Recommendation Tracking System (RTS)

• Formal Recommendation Tracking System set up
  – Spreadsheet in DocDB
  – Manager assigned to each Recommendation,
  – Status, Response plus any attachment, Date of Update
  – Tracking all Recommendations using this RTS

• Most recent major Infrastructure & Facilities review
  – Director’s Review April 9-11, 2019
  – Eleven recommendations, all Closed
  – See following slides for specifics
1. **Infrastructure and Facility Upgrade Project** – Add resources in areas currently at the conceptual design level to increase the design maturity and further develop implementation plans. There are a number of areas that are not PD-3 ready and need to prepare for successful Production Readiness Reviews after the MIE PD-3 approval.
   - Added engineering and design resources
   - Helium Interface had FDR, LESHCl review, PRR – contract in award
   - Carriage/Cradle had FDR, PRR is next month, preparing procurement drawings and package
   - Track Upgrades, Pole Tips, Bridge/Platforms are all advancing
   - Established MOA with CAD for Infrastructure and Installation – resource needs identified and being met
   - Brought various Detector Support Structures to engineering and design stage, continuing to FDR and PRR

2. **Add a risk for magnet not meeting operating current performance. This needs to be included in the risk register (complete 6 months after the MIE PD-2/3 review)**
   - Added to Risk Registry. Present approach is replacement with low probability

3. **Acquire additional mechanical engineering resources for structural component design (complete 6 months after the MIE PD-2/3 review)**
   - Have added several designers to group via loans and other arrangements – all at work
4. Hire an engineer to support the Infrastructure and facility support designs for the project (complete 6 months after the MIE PD-2/3 review).
   • Engineer has been hired and started work

5. Finalize the MOU between sPHENIX and C-AD for Infrastructure Support (complete 2 months after the MIE PD-2/3 review).
   • Signed in early October

6. Define RHIC run on the high-level schedule document (complete 6 months after the MIE PD-2/3 review).
   • Added RHIC runs for FY21 and FY22; see annotated Critical Path slide

7. Amend the sPHENIX P6 Cost and Schedule to reflect the impact of RHIC operations on sPHENIX activities. (complete 6 months after the MIE PD-2/3 review)
   • RHIC Runs FY20, FY21, FY22 are added to P6 Schedule
   • Schedule impacts have been examined – presently no conflicts
   • Will add Shield Wall removal and re-installation to P6 after this Review concludes
8. Review designer labor resources estimates and increase levels to support design efforts (complete 6 months after the MIE PD-2/3 review)
   • Made several increases in P6, notably in WBS 2.4 and 2.5; these are reflected in the MOA with C-AD
   • Also reviewed Carriage/Cradle and Support (WBS 2.3) and added hours to P6 and designers to the design room

9. Clearly state the proposed increase in temperature in some Interface or design document, so the magnet operating temperature is captured (complete 6 months after the MIE PD-2/3 review).
   • The increase is from 4.5K to 4.65K, and still leaves a margin of over 2.6K relative to the current-sharing Temperature for the operating point of 2.3T maximum field and 4600 A for this superconductor
   • The TDR has been updated, and a technical note has been written and reviewed by Magnet and Cryogenics

10. Modify P6 and the Risk Register to reflect that CERN is going to do the Magnet Mapping (complete 6 months after the MIE PD-2/3 review).
    • P6 modified; cost impact captured in Estimate Uncertainty; schedule impact negligible

11. Review the cost of operating the solenoid during field mapping. Inform Lab Management on the cost impact (complete 6 months after the MIE PD-2/3 review).
    • C-AD has discussed possible schedule times to carry out magnet cooldown, operations and mapping, and have also quoted us a weekly cost for operating the cryogenics plant; this cost has been communicated to ALD and senior Lab management
Issues and Concerns

• Vendors – Impacts to Schedule, or Cost and Schedule if replace vendor
  – Helium Interface is in award – delivery schedule impacts whether we can install e.g. piping on west wall of 1008 IR during CY2021 RHIC shutdown
  – Carriage/Cradle and other large steel items require bid cycles
  – We built significant float into P6 schedule to accommodate infrastructure work, magnet ancillary systems (PSU, QD, controls), and preparation of most of the detector support infrastructure

• Placing Major Contracts - Schedule
  – Overall installation critical path requires the two largest remaining items – Cradle/Carriage and Helium Interface
  – Helium interface is ahead of schedule
  – Carriage/Cradle is expected to remain on Critical Path until installed in 1008 AH
Summary

• We have the team, plans and procedures in place to build sPHENIX
• We have a RLS that lays out a feasible schedule to do this
• We have a plan that respects the proposed Cost Range
• We have the tools and methods in place to manage this process
• We are proceeding with the major procurements that define the critical path for Installation and Facilities
• The I&F Project is ready to set the Cost and Schedule baseline
Back Up
WBS Activity Lines

• WBS is enumerated (usually at Level 4) as a set of specific Activities:
  – Resources (labor and/or materials) assigned
  – Duration assigned
  – Predecessor and successor links made
  – Tags attached for e.g. milestone status, funding source, and other fields.

• Estimating and scheduling works from these Activities

• The Activity numbering is typically “S” followed by a 6-digit sequential number
  – Each Activity has entries identifying its WBS, manager, estimator, and other identifying markers