sPHENIX Transition to Operations Plan

December 9, 2022

Overview

sPHENIX is a major upgrade to the PHENIX detector, providing state of the art capability for the measurement of observables involving jets, photons and heavy flavor in hadronic collisions at RHIC.

The sPHENIX MIE deliverables include all scope delineated in the PMP and WBS dictionary, including all deliverable-listed items and tasks mentioned in the WBS with performance satisfying the Threshold KPPs. The management and organization of operations including installation and commissioning is outside the scope of the sPHENIX MIE project, and is summarized in this document, developed in support of the Project Closeout Review. The Transition to Operations plan includes a schedule for accomplishing the UPPs and will be tracked to completion.

The deliverables of the sPHENIX Upgrade of the PHENIX experiment include:

- A Time Projection Chamber (TPC), Electromagnetic Calorimeter (EMCal), and a Hadronic Calorimeter (HCal) each covering 2π in azimuth. The TPC and HCal have pseudorapidity coverage of $-1.1 \leq \eta \leq 1.1$. The EMCal has pseudorapidity coverage of $-0.85 \leq \eta \leq 0.85$.
- A Minimum Bias Trigger Detector (MBD).
- Readout electronics to fully instrument the TPC, EMCal, HCal and MBD.
- A Data Acquisition (DAQ) system with the capability to readout the TPC, EMCal, HCal and MBD 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 AuAu, pAu and pp collisions at RHIC.

The sPHENIX upgrade is supported by mechanical and electrical infrastructure that enables the detector subsystems to operate to the expected performance specifications, a superconducting solenoid magnet that produces a 1.4 T axial field in the inner detector region of sPHENIX, creating an environment for precision tracking and momentum reconstruction, safety and equipment protection systems that allow sPHENIX to operate safely for both personnel and equipment, and online and offline software systems that monitor system performance, data integrity and data quality. The amount of effort required to produce useful data for research using the sPHENIX upgrade in the FY2023 RHIC run will be similar to that required in final year of sPHENIX assembly and commissioning.

Scope of work

Below is a list of the major M&O tasks to be performed for sPHENIX operations.

- Coordinate the maintenance and operation of the sPHENIX TPC, EMCal HCal, MBD, DAQ/Trigger, SC-Magnet and ancillary systems during FY2023 and all future RHIC runs and maintenance periods.
- Investigate, diagnose, and fix the numerous system integration issues expected to arise during the commissioning and operation of an electronics system of this complexity

- Maintain the TPC, EMCal, HCal and MBD hardware systems.
- Maintain all subsystem readout read-out electronics.
- Maintain the Data Acquisition System and Trigger
- Maintain subsystem slow controls.
- Maintain the LV and HV supplies.
- Maintain the cooling, gas and calibration system.
- Maintain the databases that contain the locations and test history of the detector subsystem components including calibration information.
- Monitor the stability of the noise-levels and gain-values over time.
- Maintain the online QA diagnostic plots.
- Ensure that the system is well documented for shift operation and that the shift crews are well trained to operate the system safely and efficiently.
- Develop and maintain support algorithms for offline analysis software, simulation software and data production for sPHENIX.

We expect sPHENIX M&O resource requirements to plateau in 2023 and remain at that steady state for the out years of sPHENIX operations.

The sPHENIX M&O organization includes: sPHENIX Director of Operations, Deputy Director of Operations, Chief Mechanical Engineer, Chief Electronics Engineer, Head Safety Engineer, and subsystem managers for the: Time Projection Chamber, EM Calorimeter, Hadron Calorimeter, Calorimeter Electronics, Min Bias Detector, DAQ/Trigger, Online Software, Offline Software, and SC-Magnet Ancillary Systems. An organizational structure has been established and key roles filled as shown in the following diagram. The structure may be augmented as seems appropriate.

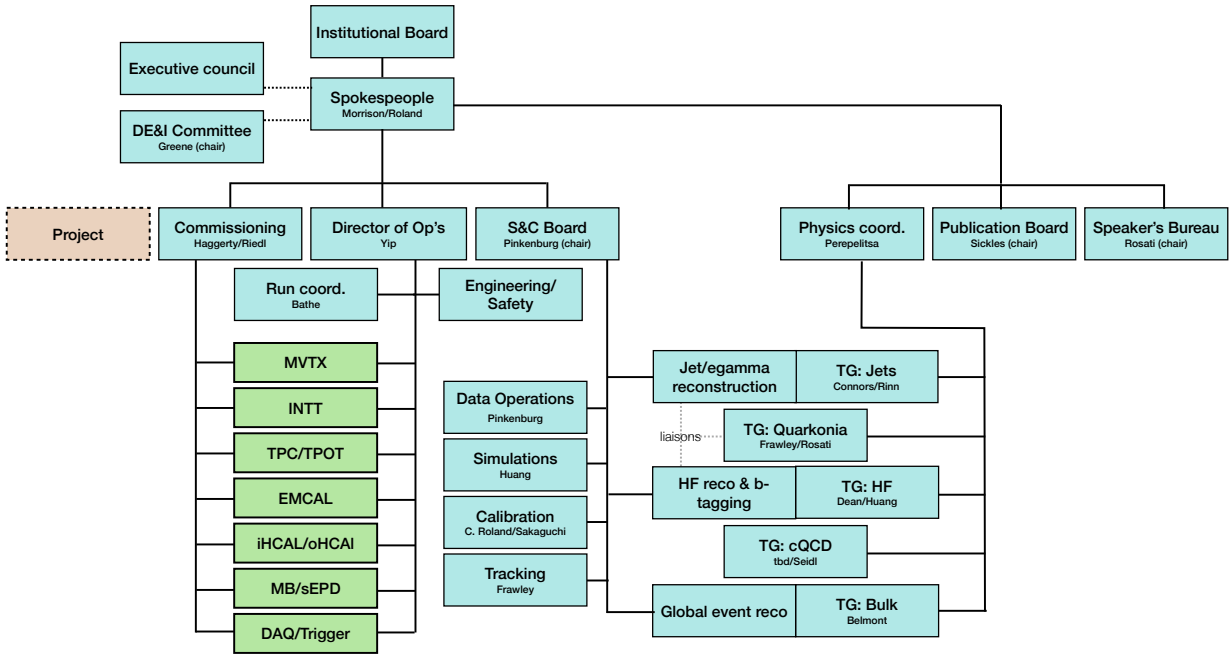

Figure 1: sPHENIX run organization and its relation to the larger sPHENIX collaboration organization.

Schedule for meeting UPPs

The sPHENIX MIE project addresses a set of KPPs that enable sPHENIX to fulfill its science mission. At the same time, the KPPs do not reflect the ultimate performance of the detector. Those performance metrics are embodied in a set of UPPs which are met through extended operating experience, refined calibrations (both alignment and detector response), a sufficient quantity of acquired data and generated simulated data, and analysis to realize the full performance and scientific potential of the experiment. The following table lists the UPPs for the sPHENIX MIE, shows how they will be verified, what prerequisites have to be met, and a schedule for meeting that UPP.

Performance Goal	Verification	Prerequisites	Date
Data taking rate of 15 kHZ for AuAu	Direct observation	-	2025
Y(1s) mass resolution ≤ 125 MeV/c2 in central AuAu	Direct observation	Alignment, TPC/EMCal calibrations	2027
$\sigma/\mu \leq 150\%/\sqrt{p_{Tjet}}$ in central AuAu for R=0.2 jets	Extracted using AuAu, pp data and simulations, following LHC examples	Alignment, EMCal and HCal calibration	2027
Tracking efficiency ≥ 90% in central AuAu	Extracted using AuAu, pp data and simulations, following LHC examples	Alignment, TPC calibration	2027
Momentum resolution $\lesssim$ 10% for pT = 40 GeV	Extracted using AuAu, pp data and simulations, following LHC examples	Alignment, TPC calibration	2027
Single photon resolution ≤ 8% for p_T = 15 GeV in central AuAu	Extracted using AuAu, pp data and simulations, following LHC examples	EMCal calibration	2027

The start of sPHENIX Transition to Operations began at the start of FY23. The transition will be complete after sPHENIX has been commissioned using RHIC collisions and is ready to begin taking RHIC collision data for physics analysis.

Operations and Maintenance Training

As part of the transition to operations, the project will provide staff that have the requisite skills and knowledge to support the start-up, commissioning and maintain operating systems to assure they meet the performance and reliability goals. The plan for achieving this relies on proper execution of the testing, installation, and commissioning activities. Any facility or system specific training required will be included as a requirement in the training database for specific operation staff. Training is also provided

for emergency response staff (fire rescue, police) to assure familiarity with systems and access requirements.

ES&H and QA Documentation

ES&H safety and quality documentation for commissioning and start-up will be developed as part of the sPHENIX System Testing and Commissioning phase of the sPHENIX Infrastructure and Facility Upgrade project prior to Operations.

Project transfer to Operations

The Project team will conduct a Project completion Review to meet the Laboratory requirements for Operations. The Review at completion of the performance tests will be documented in a Project Completion Report and will serve as the basis for PD-4. For Project completion, the sPHENIX Project will have completed all systems defined to Level 2 of the WBS Dictionary and have conducted inspections to demonstrate systems meet sPHENIX threshold KPPs at completion. Approval of PD-4 complete the production phase of the project. Lessons learned and best practices will be documented during the transition to operations period.