

**Memorandum of Agreement between the
sPHENIX Project and the Collider-Accelerator Department Covering
C-AD Responsibilities for Activities Supporting the sPHENIX MIE, the PHENIX R&R
and the B1008 Complex Infrastructure and Facility Upgrade**

A. Purpose

The purpose of this Memorandum of Agreement (MoA) is to establish general principles of agreement, and to serve as a basis for developing detailed Memoranda of Understanding (MoU's) between the sPHENIX Project (sPHENIX) and the BNL Collider-Accelerator Department (C-AD) for the tasks and support assigned to C-AD for the sPHENIX project and related activities.

This MoA describes the personnel support and summary tasks being requested from C-AD for the following three major sPHENIX activities:

1. Work supporting the sPHENIX Major Item of Equipment (MIE)
2. The Removal and Repurposing of the PHENIX Detector.
3. Work supporting the Infrastructure and Facility upgrade to the B1008 complex needed for sPHENIX installation and operations.

This MoA also describes:

- Procedures for modification to this document including amendments and termination.
- Procedures for developing detailed MoU's that will specifically define the responsibilities, scope, requirements, and funding profiles, as appropriate, for the MoU's between sPHENIX and C-AD.

B. Responsibilities

The sPHENIX Management Team has identified major activities and summary tasks where support is needed from C-AD. The sPHENIX activities proposed for C-AD consists of direct support to sPHENIX, which is under the direction of the sPHENIX project management, and tasks, mainly in the Infrastructure and Facility upgrade, where C-AD is taking the lead and has the responsibility to deliver the scope on the required schedule. The major activities will be organized into summary task packages and covered by individual MoUs between sPHENIX and C-AD. The MoU's will define scope, schedule, and funding profile for each of these summary task packages. Profiles for funding, obligation and expenditures will be developed for each summary task package MoU.

The leaders of the summary task packages can also function in L2 or L3 roles of the sPHENIX project and therefore provide a liaison function between sPHENIX and the C-AD responsibilities. However, their management responsibilities within sPHENIX should be kept at a minimum.

All activities by C-AD staff will be performed under the supervision of C-AD Group Leaders and Management. C-AD staff (engineers, a liaison Physicist and the C-AD Cryogenic System Group Leader) have been working on the preliminary design for sPHENIX and have helped to develop cost estimates and schedules. As part of the MoU approval process the task lists, the associated design, system interfaces, the cost estimates, and the schedules will be reviewed by C-AD and sPHENIX management and staff. This will help assure that there is adequate understanding of the project needs, resource availability, and adequate cost and contingency for the tasks.

Funding for all C-AD labor, material, and supply costs for the activities listed in this MoA will be provided from the following sources as appropriate:

- sPHENIX MIE (M&S) and Upgrade Support (Labor) accounts (for item 1 above)
- The PHENIX R&R account (for M&S associated with item 2 above)
- The 1008 Infrastructure and Facility Upgrade sPHENIX accounts (mainly M&S for item 3 above)
- 50% of the C-AD allocation for RHIC Experimental Operations funds received under the B&R code KB-02-02-01-2 (mainly labor for item 3 above, space charge for sPHENIX use of Building 1008 and 912, and customary operational support specified in section E. of this document)

If BNL is unable to meet the funding profile or if obligations or expenditures exceed the funding profile during the execution of the summary task packages then work on these MoU's shall cease until funding is restored or alternative sources are identified and authorized. The sPHENIX Project Director will authorize any draw on M&S contingency or change to project scope as defined in the MoU's. Any additional draw on RHIC accelerator operations labor resources for the execution of the summary task packages will need to be approved by the signatories of this agreement.

C. Dedicated Level of Effort Support for sPHENIX MIE

The sPHENIX Management Team has requested the assignment of C-AD staff members who will be dedicated to sPHENIX for Level of Effort activities for a significant fraction of their time. They will work under a specific Memoranda of Understanding (MoU) between C-AD and the sPHENIX project that will include a yearly and quarterly estimate of man-hour support needed.

- Provide Project Engineer for participation in the sPHENIX Management team (J. Mills).
- Provide mechanical engineer for contribution to the mechanical design and ANSYS analysis of the sPHENIX Time Projection Chamber (S. Bellavia)

The sPHENIX Management Team and C-AD recognizes that additional support from C-AD staff may be needed in the future. An example would be to provide technicians to support the sPHENIX EMCal and HCal factories at BNL if they fall behind schedule. This level of effort

cannot be defined at this time so the availability for technical support will have to be determined at the time of the request and a specific MoU developed to support these types of requests.

The draft MoU for “Provide Project Engineer for participation in the sPHENIX Management team (J. Mills)” is provided in Appendix A.

D. Summary Tasks

A list of summary tasks has been developed for the other two major activities:

- The Removal and Repurposing (R&R) of the PHENIX Detector
- Work supporting the Infrastructure and Facility upgrade to the B1008 complex

The R&R will be organized into one summary task package MoU. The Infrastructure and Facility Upgrade will be organized into five summary task package MoU’s.

The MoU for each summary task package will contain the following:

1. The sPHENIX Project WBS Section #'s and WBS dictionary descriptions with additional narrative description including major interface efforts.
2. Project milestones, major interface points with other experimental components and installations, and critical path concerns will be identified.
3. A summation of the overall funding needs (from item 2 above) by year.
4. Major procurements costs and totals for minor procurement costs by fiscal year.
5. A list of the C-AD staffing by skill needed to complete by fiscal year.
6. Estimated contingency.

Approval of the MoU’s:

- C-AD: the cognizant C-AD Engineer or Group Leader assigned to each summary task, their line supervisor, affected C-AD division heads, and the C-AD Chairperson.
- sPHENIX: the sPHENIX cognizant WBS Manager(s), the sPHENIX Project Manager and sPHENIX Project Director

C-AD and sPHENIX shall keep each other informed on the status of the work and changes to the plans. This will be done through regular meetings and the distribution of routine project plan, cost, and schedule status reports. Additionally, the C-AD resources needed for the sPHENIX project will be included in the C-AD Staffing Plan. Quarterly baseline reports will also be distributed, and alerts will be sent out by the Project Team when project metrics, for instance earned value calculations, show significant cost or schedule variations. The draft MOU for cryogenic systems support is attached in Appendix B and will serve as a model for other summary tasks.

The Removal and Repurposing of the PHENIX Detector (R&R)

C-AD personnel have engineering responsibility and are providing technical and craft (rigging) personnel to complete PHENIX R&R tasks. They will perform the tasks listed below on the schedule described in the PHENIX R&R MoU.

- Produce Muon Magnet North (MMN) rigging plan
- Produce procurement documentation for MMN rigging disassembly
- Procurement and equipment rental for MMN disassembly
- Remove MMN and associated components

Work supporting the Infrastructure and Facility upgrade to the B1008 complex

The following is a list of summary tasks packages in which C-AD will have the lead responsibility.

a. Superconducting Solenoid Magnet management and technical oversight

- Complete magnet testing in building B912.
- Store magnet in B912 in a safe preservation state until the base assembly in B1008 is ready
- Preparation for shipping: remove steel assembly, disconnect magnet power, instrumentation, and cryogenic system in preparation for shipping.
- Transport of the Magnet from B912 to B1008.
- Installation of the Magnet into the sPHENIX detector base assembly in B1008, including technician and survey support for the attachment and alignment of the coil to the steel flux return base assembly.
- Coordination and interface with power supply and cryogenics group for initial powered commissioning of the solenoid magnet. Preparation and installation of any strain gauge, position, or any other similar instrumentation for commissioning.
- Complete experimental area safety reviews and rigging, transport, and installation plans and safety reviews.
- Prepare and present at design reviews, system interface reviews, and production readiness reviews. Provide and update cost and schedule information to the project control team
- Interface with the magnet measurement group for magnetic field measurement/mapping. The magnetic field measurement/mapping itself is the subject of a separate MoU between sPHENIX and SMD.

b. Superconducting Solenoid Magnet Power Supply Systems

- All of the items below start with the design, procurement, fabrication, and installation of the Magnet PS systems and subsystems into the B1008 complex using equipment prepared and commissioned during the B912 super conducting magnet test with upgrades and new equipment needed for operations and implementing any lessons learned from commissioning.
- Testing and commissioning the magnet power supply.
- Testing and commissioning of the magnet quench protection system including the quench energy dump resistor.
- Identify power supply support services including building space layout for the power supply systems, cooling water, air cooling, AC power, and PS to magnet DC cable tray,

high current cable and connections and controls cable tray. Interface with C-AD ES&F division to identify needs so they can provide the supporting equipment.

- Power supply control system hardware, cabling, communications, and programming for operating the complete system from the SPHENIX control room. This includes lead flow and system protection interfaces with the cryogenic system and experimental systems.
- Complete necessary experimental area safety reviews and electrical equipment safety inspections.
- Prepare and present at design reviews, system interface reviews, and production readiness reviews. Provide and update cost and schedule information to the project control team.

c. Superconducting Solenoid Magnet Cryogenic Supply Systems

- All of the items below are for the design, procurement, fabrication, and installation of the cryogenic systems into the B1008 complex using equipment prepared and commissioned during the B912 super conducting test with additional equipment and upgrades needed for operations and implementing any lessons learned from testing.
- LHe and GHe extraction system from the 1008B blue valve box with a new SPHENIX valve box and LHe storage dewar/phase separator for cold Helium supply to IR 08:00.
- Helium piping: cold Helium supply, cold helium return, and warm helium return lines between 1008B and magnet.
- Helium piping interface with the superconducting magnet in IR 08:00 including providing current lead flow and lead flow control and quench reaction/high pressure vent system to prevent Helium loss; piping and mounting on the IR area wall, on the SPHENIX platform, and the removable connections between them; phase separation and valve box equipment on the SPHENIX platform.
- 100K maintenance system using LN2 dewar, LN2 to GHe heat exchanger, warm He piping to 10:00 IR to utilize 10:00 IR warm compressor.
- Cryogenic control system hardware, cabling, communications, and programming for operating the complete system from the 1005S cryogenic control room. This is for multiple modes to cooldown the magnet, maintain it at temperature for operations, respond and recover from a quench, store the magnet at 100K during shutdown, and warm it to ambient temperature. This includes system protection interfaces with the RHIC cryogenic system and magnet power supply systems, particularly the quench protection system.
- Interface with C-AD ES&F division to identify requirements for infrastructure needed for cryogenic equipment including power, water cooling, space, pipe supports, cable tray, etc.
- Complete necessary experimental area safety reviews and laboratory Cryogenic and Pressure System safety reviews and walkthroughs and inspections.
- Prepare and present at design reviews, system interface reviews, and production readiness reviews. Provide and update cost and schedule information to the project control team.

d. sPHENIX Detector and Magnet Support Carriage System

- All of the items below start with the design, procurement, fabrication, assembly, and installation of the sPHENIX Detector and Magnet Support Carriage systems into the B1008 complex.
- The carriage frame base assembly that supports the weight of SPHENIX experiment detectors, the superconducting solenoid magnet systems, the magnet/HCal steel, the magnet end plates, and detector electronic racks and their associated support systems. The frame base assembly includes a roller translation system and its interface with the existing PHENIX track system.
- Design interface with the sPHENIX group responsible for the detector electronic racks on the base and their associated support systems, space requirements for rack access, cable trays, power, and cooling systems that must be mounted on the base frame assembly. The rack system design, procurement, and installation is not the responsibility of this MOA task.
- The cradle assembly for supporting the weight of sPHENIX experiment detectors and the superconducting solenoid magnet systems through the magnet HCal steel/detector sectors.
- Design interface of the cradle assembly with the full HCal magnet steel cylindrical assembly and the magnet steel end plates. The full HCal magnet steel assembly and the superconducting magnet coil assembly mounting points are the responsibility of the sPHENIX engineering group.
- The top equipment platform for detector electronics racks, cryogenic equipment, the magnet valve box and cable terminations and leads into the magnets.
- Design interface with magnet power supply group, detector electronic racks and their associated support systems, and the cryogenics groups and space requirements for rack access, cryogenics access, magnet lead access, cable trays, power, and cooling systems that must be mounted on the top platform. The rack system design, procurement, and installation are not the responsibility of this MOA.
- Safe personnel access stairs and secondary egress, if required, to the top equipment platform.
- Interface with C-AD ES&F division to identify requirements for carriage systems assembly, installation, translation into the experimental area, and survey alignment. Survey alignment includes individual experimental detector alignment, magnet coil and HCal magnet steel alignment.
- Complete necessary experimental area safety reviews, elevated equipment platform reviews, and rigging, transport, and installation plans and safety reviews.
- Prepare and present at design reviews, system interface reviews, and production readiness reviews. Provide and update cost and schedule information to the project control team.

e. C-AD Facilities and Experimental Support for sPHENIX

- Provide technical support for the assembly and installation of the sPHENIX base assembly, cradles, magnet, HCal steel, platforms, access ladders and stairs, racks, and detectors.
- Provide survey services for the installation and alignment of sPHENIX detector, magnet and support components in B1008.
- Evaluate and interface with multiple groups on water cooling and chiller needs; evaluate existing systems; design, procure, assemble, and install cooling water systems. Update and relocate water mat and water system loss monitoring and alarms.
- Evaluate and interface with sPHENIX project for updates and modifications needed for the beam line vacuum pipes; evaluate existing beam tubes (including Be beam tube), mounting points, and pumping locations; design, procure, assemble, and install updates needed.
- Evaluate and interface with multiple groups on HVAC needs; evaluate existing systems; design, procure, assemble, and install HVAC systems.
- Evaluate and interface with multiple groups on AC line power needs; evaluate existing systems; design, procure, assemble, and install HVAC systems.
- Evaluate and interface with multiple groups on cable tray and conduit needs and additional lighting; evaluate existing systems; design, procure, assemble, and install cable tray, conduit, and lighting.
- Evaluate and interface with cryogenic group on cryogenic piping supports anchoring needs; evaluate existing systems; design, procure, assemble, and install additional piping supports.
- Evaluate and interface with Radiation Safety Committee and C-AD Access Controls Group for updates to shielding and tunnel access gates, ODH detector and alarm location, ODH ventilation; evaluate existing systems; design, procure, assemble, and install updated systems.
- Evaluate and interface with fire safety group for updates to heat and smoke detectors and detector locations, fire sprinkling systems, etc.; evaluate existing systems; design, procure, assemble, and install updated systems.
- Evaluate and interface with C-AD Communications and Electronic Support Group for updates to needed for the cryogenics, power supply, water group communications with the B1008 complex; design, procure, assemble, and install updated systems.
- Evaluate and interface with F&O to perform existing condition evaluations of provided building services and utilities; formulate and execute with F&O plans for improvements via various funding sources (i.e. CURL program, etc.).
- Evaluate and interface with F&O representatives/SMEs to ensure that new facility installation complies with all relevant Building Code and Electrical Code provisions.
- Evaluate and interface with sPHENIX project for updates to B1008 gas pad, gas mixing hut, and experimental gas piping to the 0800 IR; evaluate alarms and fire safety needs; design, procure, assemble, and install updated systems.
- Evaluate and interface with Experimental Safety Review Committee; evaluate need, design, procure, assemble and install Safety Interlock Systems.

- Complete necessary experimental area safety reviews, interface and support elevated equipment platform reviews, and rigging, transport, and installation plans and safety reviews.
- Prepare and present at design reviews, system interface reviews, and production readiness reviews. Provide and update cost and schedule information to the project control team.

E. Customary Operational Support

It is expected that C-AD will cover the space charge for space used by sPHENIX in the B1008 complex and assigned space in B912 for R&D, construction, testing, and commissioning of detector systems and support components. The B1008 complex will need regular maintenance during the construction of the sPHENIX project. Maintenance and repair of building infrastructure such as VAC, HVAC and other environmental control, chilled-water, lighting, crane maintenance, fire protection, etc. will be supported from 50% of the C-AD allocation for RHIC Experimental Operations funds received under the B&R code KB-02-02-01-2. Project funds will not be used for the normal maintenance and repair activities. The customary operational support costs will be projected and compared with the projected experimental operations funds to assure that the funding is adequate.

F. General Provisions

This MoA will become effective upon the date of signatures of all the parties. This MoA is executed as of the date of the last signature.

Modifications to this MoA

Modifications within the scope of this MoA will be made by mutual consent of the parties and by issuance of a written modification, signed and dated by all parties, prior to any changes being performed. It is the responsibility of the signing parties to communicate any modifications to the appropriate managers overseeing the work to be performed.

Amendments to this MoA

Amendments to the MoA Summary Task list will be made at the time of a major revision to the sPHENIX Resource-Loaded Schedule. All amendments will be agreed to by mutual consent with written modifications issued, signed and dated by all parties. It is the responsibility of the signing parties to communicate any amendments to the appropriate managers overseeing the work to be performed. These amendments must also be incorporated in and agreed to in the affected summary task MoU's.

Termination of this MoA

The sPHENIX Project or C-AD may, in writing, terminate this MoA in whole, or in part, at any time prior to the expiration date. Termination shall become effective 30 days after notification of intent to terminate.

Signatures:

sPHENIX Project Director: Edus OB date: 5/4/18

C-AD Chair: han lee date: 5/2/18

ALD for NPP: Prude Smith date: 5/7/2018

