

**Memorandum of Understanding between the
sPHENIX Project and the Collider-Accelerator Department (C-AD)
for Providing Support for the Installation of the
Superconducting Coil Assembly for the Solenoid Magnet**

A. Purpose

This Memorandum of Understanding (MoU) documents and establishes support and services the BNL Collider-Accelerator Department (C-AD) will provide to the sPHENIX Project for the managing the superconducting coil and cryostat assembly (coil assembly, hereafter) for the sPHENIX solenoid magnet system. This MoU describes procedures for modification to this document including amendments due to scope change, interface issues, and cost variances.

This MoU defines the coil assembly management scope, basic requirements, summary tasks and responsibilities, schedule, and major milestones. It also includes the estimated funding profile needed for CAD & BNL personnel and for equipment procurements to complete the project on schedule as presently defined. The management of the coil assembly system is part of the sPHENIX project WBS. The WBS description details are in Addendum A.

B. Responsibilities

The sPHENIX Management Team has identified major activities and summary tasks where support is needed from C-AD. For managing the coil assembly, C-AD is taking the lead and has the responsibility to deliver the scope on the required schedule outlined in Addendum B. All activities for this MoU will be performed by C-AD staff under the supervision of C-AD Group Leaders and Management.

In preparing this MoU, the task list, the WBS descriptions, the associated preliminary design, system interfaces, the cost estimates, and the schedules have been reviewed by C-AD and sPHENIX management and staff. Major interfaces have been identified along with support needed from other C-AD groups to support the CAD cryogenics group. The labor estimates and material costs have been updated and include the support labor and materials needed from multiple C-AD groups (Addendum C).

C-AD and sPHENIX will use regular meetings and the distribution of routine project plan, cost, and schedule status reports to maintain communication on progress and monitor cost. Additionally, the C-AD resources needed for the sPHENIX project will be included in the C-AD Staffing Plan. Quarterly baseline reports will be distributed and alerts will be sent out by the sPHENIX Project Team when project metrics show significant cost or schedule variations. Every effort will be made not to disrupt on going work; however, if the level of funding is not available on schedule or if obligations or expenditures exceed the funding profile, then work on this MoU shall cease until funding is restored or alternative sources are identified and authorized. The sPHENIX Project Director will authorize any draw on contingency or change to project scope as defined in the MoU.

C. sPHENIX Superconducting Solenoid Coil Installation Management Description

The coil assembly has been successfully cooled to operating temperature and tested to operating current in building 912. Minor instrumentation issues with voltage taps, strain gages, and temperature sensors internal to the cryostat were identified during the testing. As part of this MoU, these issues will be further investigated and repairs will be done if the problems are in the smaller cryostat chambers external to the main solenoid cryostat. If the problems are internal to the main cryostat, they will not be repaired and work-arounds for that instrumentation will be developed.

The management of the coil assembly will entail doing maintenance and repairs as noted above, preparing the cryostat for the move, moving the assembly, installing and aligning the coil on the cradle/platform, and removing/recycling the material and equipment used for the coil assembly testing and transport and not used for the final installation. After the repair and prior to the move, the coil assembly will be stored in a safe state in building 912.

Summary Task List:

- Disconnect solenoid power, instrumentation, and cryogenic system instrumentation and piping.
- Investigate and repair instrumentation issues found during the operating current test. This is a Magnet Division responsibility to open the cryostat chambers and inspect the wires. This is a C-AD responsibility to provide support for access to the boxes and electrical engineering review of the inspection and repair from the power supply and cryogenic groups. Inspection and repairs to be completed in FY2019 while the coil assembly is still in 912:
 1. Check the voltage taps and strain gauge boards at the “dog house” location closest to the solenoid cryostat and between the “2nd” dog house and the cable termination valve box.
 2. Check the temperature sensors wiring in the dog houses for the sensors that were not working.
- After repairs, store solenoid cryostat in B912 in a safe preservation state on transport cradle until the base assembly in B1008 is ready.
- Preparation for storage: support Magnet Division during the removal of the valve box/cable termination cryostat.
- Preparation for storage: seal cryostat insulating vacuum volume and backfill with dry N2 gas.
- Remove and recycle steel yoke assembly, scaffolding and stairways, AC power, cables, cable tray, cryogenic piping, etc. Clear 912 test areas.
- Preparation for shipping: design and install cribbing for transport trailer (remove and recycle cribbing after the move).
- Transport of the solenoid cryostat from B912 to B1008 and installation of the solenoid cryostat onto the sPHENIX detector base assembly in B1008 directly from the trailer.
- Installation and alignment support including survey support for the attachment and alignment of the solenoid cryostat to the steel flux return (HCal steel) base assembly.
- After installation, support the magnet division for the re-installation of the valve box/cable termination cryostat and removal of shipping support fixtures.
- 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.

Magnetic measurement of the solenoid magnet assembly is not included in this MoU now because the requirements, interfaces, scheduling, and need has not been defined. This MoU will be updated or a new MoU prepared when magnetic measurement is defined and scheduled.

D. Project Schedule and Milestones

Addendum B has a single page schedule for the major steps for the coil assembly preparation and installation.

E. Major System Interfaces

The following major interfaces for the solenoid assembly installation management have been identified so far:

1. Interface with the CAD Power Supply Group, Cryogenics Group, and Magnet Division for inspection and repair of the solenoid wiring internal to the cryostat.
2. Interface with the CAD Power Supply Group, Cryogenics Group, and Magnet Division for the removal of equipment used for the solenoid high current test.
3. Interface with the Magnet Division for the removal and installation of the valve box/cable termination cryostat before and after shipping. (Magnet Division has indicated shipping fixtures for the two "dog house" cryostats are not needed).
4. Interface with the sPHENIX HCal & CAD cradle/platform engineering teams for the installation of the solenoid assembly onto the lower HCal assembly. The design, fabrication, and installation of the magnet mounting points on the HCal steel is the responsibility of the sPHENIX HCal engineering team.
5. Interface with sPHENIX project team on schedule for installation on the bottom half of the HCal assembly in the 1008 assembly area.
6. Interface with the CAD cryogenics group and CAD vacuum group for re-establishing insulating vacuum in the cryostat and leak checking after the termination valve box and been re-installed.

Support from the CAD ESF group and other CAD groups for the supporting activities above has been included in the labor and material estimates in this MoU.

E. Funding Needs Profile

Addendum C contains the outline of the labor hours and material procurements estimates needed to support this MoU by year without BSA burden or contingency. Both labor and material should assume 30% contingency for missing details in the estimate at this point of the design development. Interface and support for the project management system is assumed to be supported by the project management account. Changes in scope will be covered by modifications and amendments in accordance with Section F herein.

F. General Provisions, Modifications, and Amendments

This MoU will become effective upon the date of signatures of all the parties.

Modifications to the scope of this MoU will be made by mutual consent of the sPHENIX Project and CAD by issuance of a written modification, signed, and dated by all parties. This must be done prior to any modifications being performed. It is the responsibility of the sPHENIX Project and

CAD to communicate any modifications to the appropriate managers overseeing the work to be performed.

Amendments will be made when there is a major revision to the sPHENIX Resource-Loaded Schedule or at minimum once per year. 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.

The sPHENIX Project or C-AD may, in writing, terminate this MoU in whole, or in part, at any time by mutual agreement prior to the expiration date.

Approvals:

K. Yip (sPHENIX Magnet L2 Manager)

C. Folz (CAD F & E Support Group Leader)

W. Christie (CAD Division Head)

T. Roser (CAD Chairperson)

J. Mills (sPHENIX Project Engineer)

G. Young (sPHENIX Project Manager)

E. O'Brien (sPHENIX Project Director)

Addendum A – WBS Dictionary Coil Assembly Installation Management

L2	L3	L4	WBS Name	Dictionary Definition
2.08	.01		Superconducting Coil Assembly for the sPHENIX Solenoid Magnet Management and Technical Oversight.	Preparation, transport, and installation of the Superconducting Magnet Coil Assembly into the sPHENIX detector assembly.
2.08	.01	.01	Laboratory Safety Committee Review.	Specify and coordinate the completion of the safety reviews needed before the sPHENIX superconducting solenoid can be installed and commissioned in RHIC IR0800. a) The C-AD Experimental Safety Committee Review will be prepared and presented under this MoU. This includes follow-up on committee findings and walk through inspections prior to commissioning. b) The BNL Pressure and Cryogenic System Safety review will be prepared and presented under the cryogenic system MoU with support and oversight covered in this MoU. c) Electrical safety inspections and any reviews will be carried out as part of the Power Supply and Quench detector system MoU. d) Rigging and transport safety review for moving and installing the coil assembly will be carried out as part of the is MoU.
2.08	.01	.02	Magnet Systems Commissioning Planning	Planning of the solenoid assembly, power supply, cryogenic system individual system commissioning efforts and coordinating combined first system operation.
2.08	.02		Solenoid Assembly Preparation, Transport, and Installation.	Solenoid assembly moved from test area in 912 and installed and aligned to the HCal (magnet) steel, connected to the valve box and valve box extension, and ready to be connected to cryogenic service lines, instrumentation, and power supply cables.
2.08	.02	.01	Solenoid Assembly Inspection and Instrumentation Testing Prior to Shipping.	Inspect and repair solenoid wiring internal to the cryostat extensions (dog houses 1&2 and valve box). Prepare, seal, and backfill with gN2 insulating and helium volumes for long term storage.
2.08	.02	.02	Preparation of the Coil Assembly for shipping: component removal and shipping fixture installation.	Preparation and removal of the solenoid assembly valve box, valve box extension vacuum jacketed pipe, and the solenoid cryostat (install of shipping fixtures inside the cryostat to support the coil) for shipment from building 912 to the 1008 assembly area. After the HCal magnet steel and the carriage top platform is installed and the coil assembly surveyed: reassembly of the valve box and valve box extension VJP to the solenoid assembly and removal of the coil shipping fixtures. Store shipping fixtures.
2.08	.02	.03	Coil Assembly Transport and	Most of this work will be done by the Magnet Division under a separate MoU for their labor and materials. This MoU will cover planning management and coordination. Other shipping preparations: trailer cribbing design and installation, lifting preparations, and safety

L2	L3	L4	WBS Name	Dictionary Definition
			Installation.	<p>planning, review, and approval.</p> <p>Disconnect and remove any remaining cables and equipment. Lift solenoid assembly from test area, transport assembly from 912 to 1008 assembly hall, and install onto the carriage assembly.</p> <p>Survey coil assembly onto the carriage assembly. Re-survey coil assembly to HCal Steel after all HCal steel has been installed over the coil assembly.</p> <p>Remove, store, or recycle remaining equipment from 912 test areas; return area to "green field condition. Remove and recycle all transport components.</p>

Addendum B – Schedule

Task	Duration
Cost & Schedule MoU w/CAD	6/2018 – 9/2018
Cost & Schedule MoU w/AM	6/2018 – 9/2018
Solenoid cryostat repair planning meetings and approval	7/2018 – 12/2018
Solenoid shipping fixture analysis, design, and approval (AM)	3/2018 – 3/2019
Solenoid shipping fixture fabrication (AM)	3/2019 – 7/2019
Solenoid valve box/cable termination cryostat removal (AM)	1/2019 – 3/2019
Solenoid cryostat doghouse(s) wiring inspection and repair (AM & CAD)	4/2019 – 8/2019
912 Test area clean-up phase I: disconnect and remove solenoid power cables, instrumentation cables, vacuum pumps, and cryogenic system instrumentation and piping. Remove and store magnet steel, scaffolding and stairways, and any remaining racks, power/water/air for cryostat, etc.	1/2019 – 12/2019
Solenoid shipping fixture installation (AM).	8/2019 – 10/2019
Solenoid cryostat storage on shipping cradle.	9/2019 – 5/2021
Solenoid transport cribbing design, planning.	1/2021 – 4/2021
Solenoid transport 912 to 1008IR, install and survey on the carriage assembly.	5/2021 – 7/2021
912 Test area clean-up complete store shipping cradle	7/2021 – 9/2021
Re-install valve box/cable termination cryostat and re-establish insulating vacuum.	10/2021 – 2/2022

Addendum C – Labor (Hours) and Material (FY18 \$\$) Cost Estimate

	LABOR (Hours)	FY18	FY19	FY20	FY21	FY22	Totals
SCI3	ESF Scientist						0
Prof4	AD Engineer EE		120				120
Prof4	ESF Engineer ME		104	40	80	48	272
TECH3	ESF MT		336		24	8	368
TECH3	ESF ET						0
TECH3	ESF Survey					40	40
CRAFT3	F&O		16				16
CRAFT3	Rigging		668		96	32	796
CRAFT3	Carpenter		36		32	8	76
CRAFT3	Electrician		16				16
	Totals		1296	40	232	136	1704
	Materials (\$)	FY18	FY19	FY20	FY21	FY22	
Purchases	(no overhead) <\$25K				\$1,000		\$1000
Purchases	(no overhead) >\$25K						\$0