Electron-Ion Collider, Brookhaven National Laboratory			
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Interface Control Document: Solenoid Magnet to Detector System Interface Control Document			**Revision:** 00

Electron-Ion Collider, Requirements, Specifications, and Interfaces

Solenoid Magnet (6.10.07) to Detector System (6.10) Interface Control Document

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REVISION HISTORY

Revision #	Effective Date	Additional Reviewers	Summary of Change
00	6/12/2025		Initial release.

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LIST OF ACRONYMS

B0	B0 is the name of the forward magnet just past the Hadron Endcap
CDR	Conceptual Design Report
COTS	Commercial Off the Shelf
DAQ	Data Acquisition
DET	EIC Detector
DIRC	Detection of Internally Reflected Cherenkov Light
dRICH	Dual radiator ring imaging Cherenkov
DVCS	Deeply Virtual Compton Scattering
EIC	Electron-Ion Collider
EMCAL	Electro-magnetic Calorimeter
ESR	Electron Storage Ring
FCC	Federal Communications Commission
FDR	Final Design Review
GEM	Gas Electron Multiplier
HCAL	Hadronic Calorimeter
HSR	Hadron Storage Ring
HVAC	Heating/Ventilation/Air Conditioning
IP	Interaction Point
IR	Interaction Region
MPGD	Micro Pattern Gaseous Detectors
NAS	National Academy of Sciences
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
PID	Particle Identification
PRR	Production Readiness Review
PWO	PbWO4
RCS	Rapid Cycling Synchrotron
TBD	To Be Determined
UL	Underwriter Laboratories
WBS	Work Break Down Structure

Solenoid Magnet (6.10.07) to Detector System (6.10) Interface Control Document

1. PURPOSE AND SCOPE

This document records the agreed upon interfaces between the detector solenoid magnet and other sub-systems within the larger detector system. These interfaces are based on the system requirements that are necessary to integrate these sub-systems as part of the Electron Ion Collider Project.

2. INTRODUCTION

These interfaces describe the relationships between the detector solenoid magnet and the other detector sub-systems to include the Hall infrastructure. The Detector/Hall Infrastructure will provide space, mechanical supports, Liquid Helium, electrical power, cooling and low-conductivity water to support the operation of the Detector systems as described below. The solenoid magnet will need space for the magnet, power supply, cooling water and data acquisition racks. The space should also be provided to support all the leads and data cables. All the data cables will move with the magnet. Low conductivity water (LCW) is required to cool the water-cooled leads and power supply. The electrical power is required to energize the magnet and power up all the instrumentations, the instrumentation racks will move with the magnet and will need uninterrupted power. The solenoid magnet is cooled by liquid Helium, liquid Helium will be supply to the magnet by the infrastructure.

2.1 Detector Solenoid Magnet

The central detector solenoid is a superconducting magnet, with a central field of 2 Tesla at full current. The magnet will be cooled using liquid Helium. The magnet will be powered using a superconducting magnet power supply, which is cooled using low conductivity water. Likewise, the copper leads coming from the magnet power supply to the top of the magnet chimney will require LCW for cooling. The magnet will be instrumented with temperature sensors, hall sensors and voltage taps. All instrumentation racks will be positioned close to the magnet on a platform. The data acquisition racks will need clean power from a UPS backed power source. These racks will be mounted on the detector carriage and will move as part of the central detector assembly, whenever the magnet is relocated between the assembly hall and the experimental hall.

The overall weight of the magnet is approximately 30 metric tons. This weight does not include the weight of the power supply, dump resistor, water-cooled leads, instrumentation cables, instrumentation racks, or any supporting sub-systems that are mounted in the bore of the magnet. The flux return steel is also not included in this weight estimate. While in operation, the magnet will have stray fields in the extended region. To ensure personnel safety, a 5 Gauss line, 50 Gauss line and 500 Gauss line will be identified and marked accordingly.

The space for this magnet is limited by the detectors, sub-systems, and supporting infrastructure that is installed around it.

2.2 Detector Systems

The detector infrastructure provides all the necessary utilities and support for the magnet's installation, commissioning, testing and operation. The interfaces between the detector systems and the solenoid magnet also identify physical interferences/limitations between the magnet and the surrounding sub-detectors. The detector infrastructure sub-system will be responsible for finding a suitable place for the magnet power supply, dump resistor, data acquisition racks, supports for water cooled leads and support for instrumentation cable.

2.3 Overview of Interface Relationships

The following are the detector systems and sub-systems that have interfaces connected to the solenoid magnet.

- **Detector System (6.10):** These are interfaces that represent general constraints that exist between the magnet and all (or multiple) sub-systems within the overall detector.
- **Detector Infrastructure (6.10.10):** These connections provide physical support and stabilization for the magnet, as well as resources such as cooling water, cryogenics, power and communications.
- **Hadronic Calorimetry (6.10.06):** The solenoid magnet fits inside of the barrel hadron calorimeter and its size is constrained by the diameter of the barrel HCal.
- **Particle ID Detectors (6.10.04):** The size and position of the solenoid magnet is limited in the backward direction by the Dual RICH detector and the cabling plenum.
- **Electromagnetic Calorimetry (6.10.05):** The barrel electromagnetic calorimeter fits within the barrel of the solenoid. The interior radius of the solenoid and the exterior radius of the EMCal must be coordinated to ensure a proper fit.
- **Computing (6.10.09):** The solenoid magnet will require signal, data and control cabling and communications infrastructure to connect it to electronic services.

2.4 Safety and Environmental Considerations

The detector solenoid has very high stored energy (of the order of 45 MJ), in the event of a quench this energy needs to be dissipated in a safe manner. There will be limitations on things that can be brought within 500G line while the magnet is in operation.

The magnet without the flux return steel weighs approximately 30 metric tons, during installation and relocation, the floor loading capacity at each location should be confirmed before staging, storing or moving the magnet.

The operating current for the magnet is approximately 4000 Amps, and electrical safety should be addressed. The magnet is a large vacuum vessel and pressure vessel safety codes will be applied to the vacuum vessel design.

The 5G line should be clearly marked, identified and restricted while the magnet is in operation. Anyone with any metallic implant should not be allowed within this region during magnet operation.

2.5 Design Considerations

The magnet power supply will be located approximately 300 feet away from the magnet, and the instrumentation racks will be on the north platform. This is shown in figure 1. Figure 2 shows the circuit diagram for connecting the magnet to the power supply.

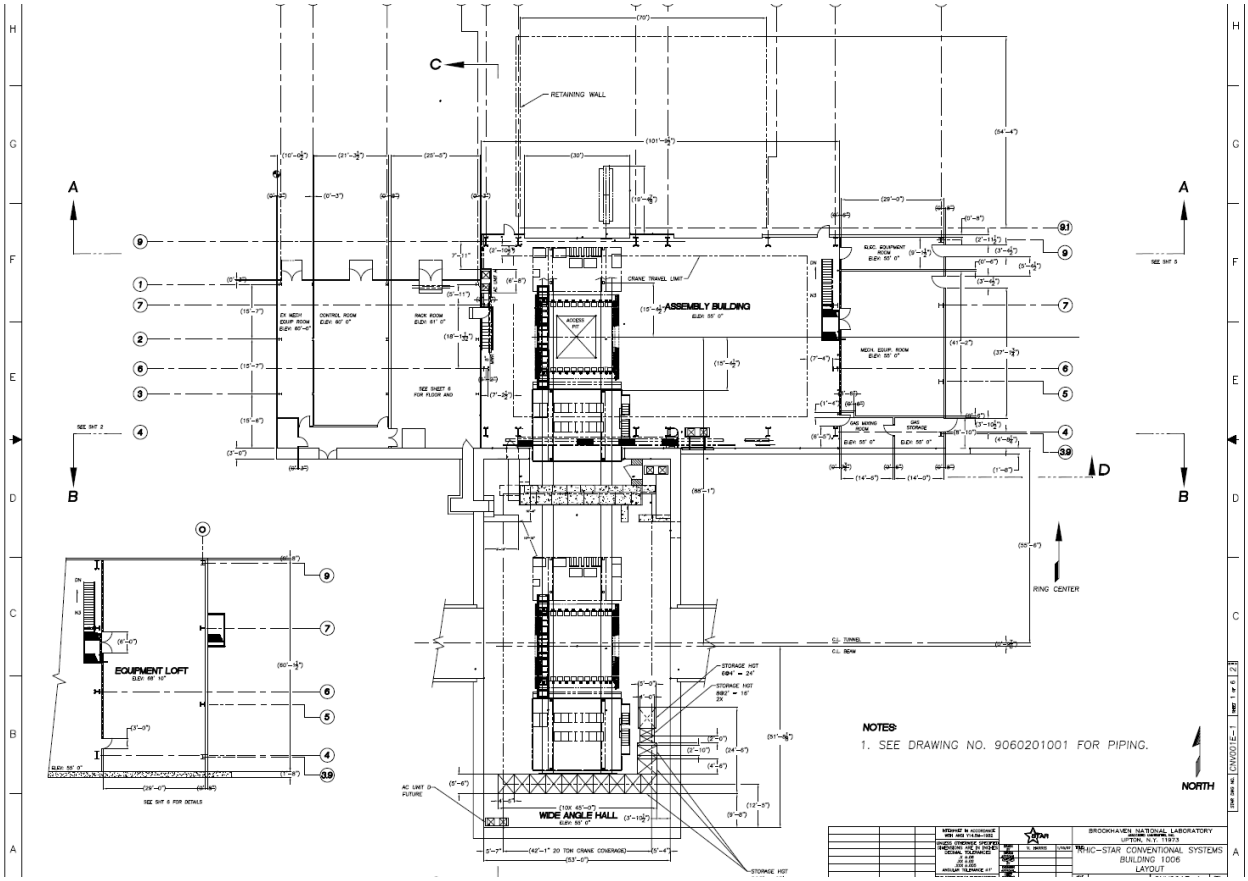

Fig.1: The Hall Layout

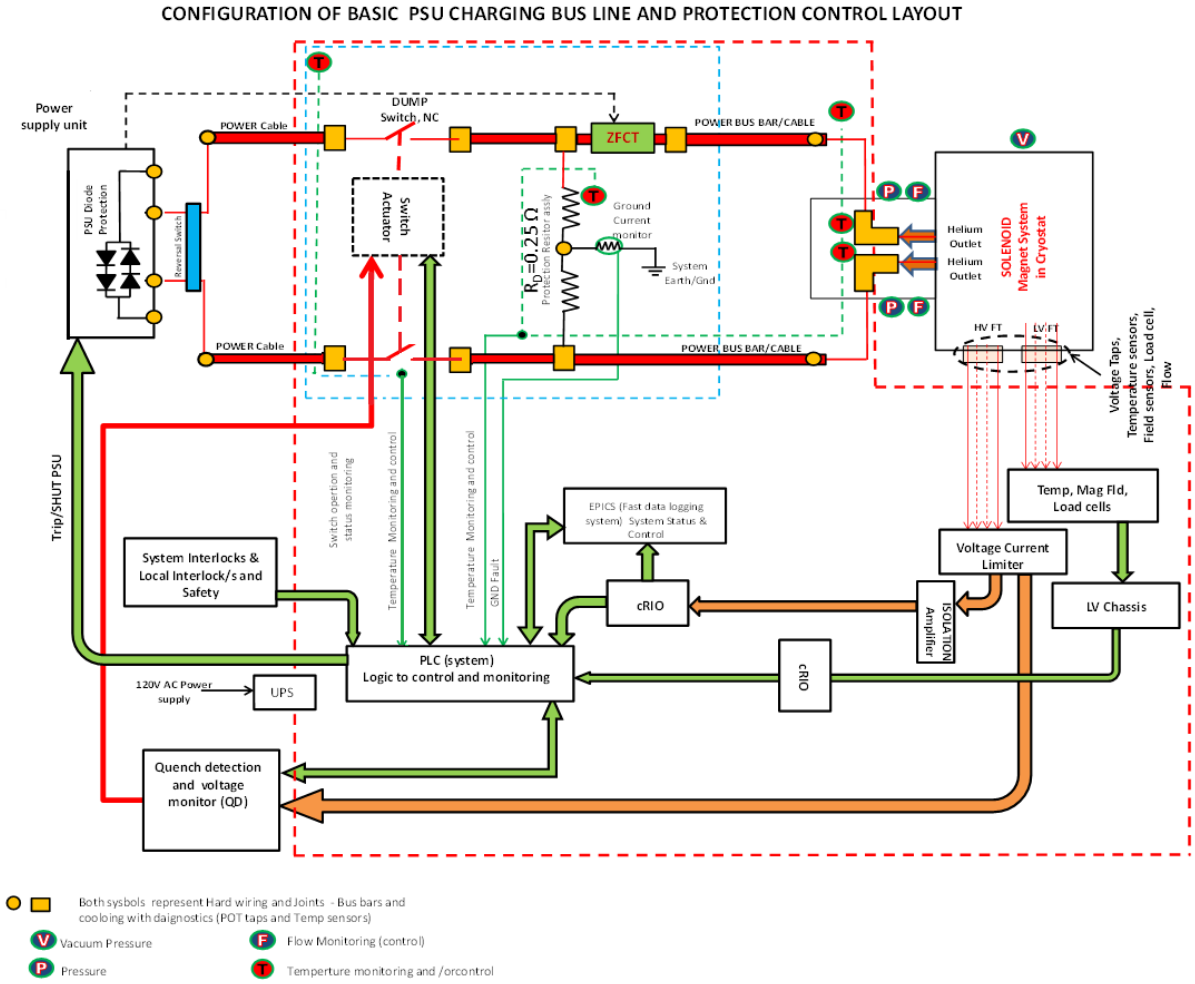

Fig. 2: Circuit Diagram

2.6 Organization

The interfaces in this document are grouped by sub-system as identified in the sub-system identifier. All interfaces between the solenoid magnet and a related sub-system will be included in a single section. Entries within that section will be sorted by the interface identifier or WBS number, as appropriate.

3. INTERFACE SUMMARY

This tables in this section provide a list of all interfaces that are defined within this document. The interfaces are grouped by sub-system/WBS. Each table has the following fields:

- Section: the section number in this document where the interface is addressed.
- WBS (1): the WBS number within the ICD reference system, unless the reference system is the owner.
- WBS (2): the WBS number for the connected system.
- ID: the interface identifier as defined in the Interface Requirement Document (IRD).
- Name: the name of the interface as defined in the IRD.

- Description: the description of the interface as defined in the IRD.
- Owner: identifies the WBS number of the entity that is responsible for ensuring the interface is provided and that it meets validation/verification requirements.

Table 1. Solenoid Magnet to Detector System

Section	WBS1	WBS2	ID	Name	Description	Owner
4		6.10			Detector System	
4.1	6.10.07	6.10	I-DET-INF-INT.001	Magnetic Material	No detectors or components constructed with magnetic material may be added to the detector without prior consultation with the magnet group.	6.10.10.04
4.2	6.10.07	6.10	I-DET-INF-INT.002	Magnetic Field Requirement	All subordinate detectors are dependent on the continuous operation of the solenoid and on the delivery of a consistent, stable magnetic field.	6.10.10.04

Table 2. Solenoid Magnet to Data Acquisition and Computing Systems

Section	WBS1	WBS2	ID	Name	Description	Owner
5		6.10.09			Data Acquisition and Computing Systems	
5.1	6.10.07	6.10.09	I-DET-COMP-ONLINE.040	Controls and Instrumentation	Control cabling for the magnet instrumentation will be run from the solenoid to the instrumentation rack on the carriage.	6.10.09.02
5.2	6.10.07	6.10.09	I-DET-COMP-ONLINE.041	Monitoring Data	Live monitoring data from the solenoid's operation must be recorded and maintained for diagnostic purposes.	6.10.09.02
5.3	6.10.07	6.10.09	I-DET-COMP-ONLINE.042	Slow Controls	A network connection will be provided from the DAQ system to the solenoid cryogenic's slow controls interface.	6.10.09.02
5.4	6.10.07	6.10.09	I-DET-COMP-ONLINE.043	Slow Controls	A network connection will be provided from the DAQ system to the solenoid's slow controls interface.	6.10.09.02
5.5	6.10.07	6.10.09	I-DET-COMP-ONLINE.044	Slow Controls	A network connection will be provided from the DAQ system to the slow controls interface of the solenoid's power supply.	6.10.09.02

Table 3. Solenoid Magnet to Electromagnetic Calorimetry Systems

Section	WBS1	WBS2	ID	Name	Description	Owner
6		6.10.05			Electromagnetic Calorimetry Systems	
6.1	6.10.07	6.10.05	I-DET-INF-INT.012	Space Constraint	The exterior radius of the barrel ECAL (and its support system) is limited by the interior bore of the solenoid magnet.	6.10.10.04

Section	WBS1	WBS2	ID	Name	Description	Owner
					Modifications to either must be coordinated.	

Table 4. Solenoid Magnet to Electronic Systems

Section	WBS1	WBS2	ID	Name	Description	Owner
7		6.10.08			Electronic Systems	
7.1	6.10.07	6.10.08	I-DET-ELEC.037	Bias Voltage	Bias voltage DC power will be provided from the electronics racks to support the magnet cryogenic systems.	6.10.08
7.2	6.10.07	6.10.08	I-DET-ELEC.038	High Voltage	High voltage DC power will be provided from the electronics racks to support the magnet instrumentation and control systems.	6.10.08
7.3	6.10.07	6.10.08	I-DET-ELEC.039	Low Voltage	Lower voltage DC power will be provided from the electronics racks to support the magnet cryogenic systems.	6.10.08
7.4	6.10.07	6.10.08	I-DET-ELEC.040	Bias Voltage	Bias voltage DC power will be provided from the electronics racks to support the magnet instrumentation and control systems.	6.10.08
7.5	6.10.07	6.10.08	I-DET-ELEC.041	High Voltage	High voltage DC power will be provided from the electronics racks to support the magnet power supply.	6.10.08
7.6	6.10.07	6.10.08	I-DET-ELEC.042	Low Voltage	Low voltage DC power will be provided from the electronics racks to support the magnet instrumentation and control systems.	6.10.08
7.7	6.10.07	6.10.08	I-DET-ELEC.043	Bias Voltage	Bias voltage DC power will be provided from the electronics racks to support the magnet power supply.	6.10.08
7.8	6.10.07	6.10.08	I-DET-ELEC.044	High Voltage	High voltage DC power will be provided from the electronics racks to support electronics in the detector.	6.10.08
7.9	6.10.07	6.10.08	I-DET-ELEC.045	Low Voltage	Low voltage DC power will be provided from the electronics racks to support the magnet power supply.	6.10.08

Table 5. Solenoid Magnet to Hadronic Calorimetry Systems

Section	WBS1	WBS2	ID	Name	Description	Owner
8		6.10.08			Hadronic Calorimetry Systems	
8.1	6.10.07	6.10.08	I-DET-INF-INT.031	External Space Constraint	The exterior radius of the solenoid magnet is limited by the interior bore of	6.10.10.04

Section	WBS1	WBS2	ID	Name	Description	Owner
					the barrel HCAL and necessary support structures. Modifications to either must be coordinated.	
8.2	6.10.07	6.10.08	I-DET-INF-INT.035	Space Constraint	The maximum backward location for the solenoid magnet is limited by the backward HCAL and the adjacent cabling pathway that provides services to the interior detectors. Modifications to either must be coordinated.	6.10.10.04

Table 6. Solenoid Magnet to Detector Infrastructure

Section	WBS1	WBS2	ID	Name	Description	Owner
9		6.10.10			Detector Infrastructure	
9.1	6.10.07	6.10.10	I-DET-INF-BAR.015	External Support Structure	Total weight of the solenoid and all embedded components must be supported.	6.10.10.01
9.2	6.10.07	6.10.10	I-DET-INF-BAR.017	DIRC Readout Supports	The DIRC prism box containing the photosensor readouts, will be supported by an external structure supporting the ECAL within the solenoid magnet.	6.10.10.01
9.3	6.10.07	6.10.10	I-DET-INF-INT.001	Magnetic Material	No detectors or components constructed with magnetic material may be added to the detector without prior consultation with the magnet group.	6.10.10.04
9.4	6.10.07	6.10.10	I-DET-INF-INT.002	Magnetic Field Requirement	All subordinate detectors are dependent on the continuous operation of the solenoid and on the delivery of a consistent, stable magnetic field.	6.10.10.04
9.5	6.10.07	6.10.10	I-DET-INF-INT.012	Space Constraint	The exterior radius of the barrel ECAL (and its support system) is limited by the interior bore of the solenoid magnet. Modifications to either must be coordinated.	6.10.10.04
9.6	6.10.07	6.10.10	I-DET-INF-INT.031	External Space Constraint	The exterior radius of the solenoid magnet is limited by the interior bore of the barrel HCAL and necessary support structures. Modifications to either must be coordinated.	6.10.10.04
9.7	6.10.07	6.10.10	I-DET-INF-INT.035	Space Constraint	The maximum backward location for the solenoid magnet is limited by the backward HCAL and the adjacent cabling pathway that provides services to the interior detectors. Modifications to either must be coordinated.	6.10.10.04

Section	WBS1	WBS2	ID	Name	Description	Owner
9.8	6.10.07	6.10.10	I-DET-INF-INT.042	Magnet Cooling	The solenoid will require a continuous flow of cryogens to maintain temperature in both the experimental hall and the maintenance area. Interface includes cryogenic source and warm return.	6.10.10.04
9.9	6.10.07	6.10.10	I-DET-INF-INT.079	Power Supply Cooling	The power supply, located in an adjacent electrical room, will need to be cooled with low conductivity water.	6.10.10.04
9.10	6.10.07	6.10.10	I-DET-INF-INT.080	Magnet Cooling	The solenoid will require a continuous flow of cryogens to maintain temperature in both the experimental hall and the maintenance area. Interface includes cryogenic source and warm return.	6.10.10.04
9.11	6.10.07	6.10.10	I-DET-INF-INT.081	Electrical Power	Solenoid will be provided power via the power supply located in an adjacent room.	6.10.10.04
9.12	6.10.07	6.10.10	I-DET-INF-INT.082	Instrumentation Backup Power	The instrumentation rack for the solenoid will require backup/UPS power adequate to safely shutdown the system in the event of a power failure.	6.10.10.04
9.13	6.10.07	6.10.10	I-DET-INF-INT.084	Fringe Field	A boundary must be established to identify the extent of the magnet's stray field during operations.	6.10.10.04
9.14	6.10.07	6.10.10	I-DET-INF-INT.085	Ice Management	An ice management system will be required to melt accumulated ice on the chimney. (Water should evaporate and will not require drainage)	6.10.10.04
9.15	6.10.07	6.10.10	I-DET-INF-INT.086	Cryogenic Connection Point	The cryogenic connection must be as close as possible to the source.	6.10.10.04
9.16	6.10.07	6.10.10	I-DET-INF-INT.087	LCW Connection	The LCW water cooled leads must be fully supported along their path between the electrical room and the magnet.	6.10.10.04
9.17	6.10.07	6.10.10	I-DET-INF-INT.101	Space Constraint	The maximum forward location for the solenoid is limited by the position of the Dual RICH detector and the cabling plenum (gap) between them. Modifications to either must be coordinated.	6.10.10.04
9.18	6.10.07	6.10.10	I-DET-INF-INT.118	LN2 Flow (Hall)	A supply and return of liquid nitrogen must be provided to the experimental hall for cooling the solenoid magnet during operation.	6.10.10.04
9.19	6.10.07	6.10.10	I-DET-INF-INT.119	LHE Flow (Hall)	A supply and return of liquid helium must be provided to the experimental hall for	6.10.10.04

Section	WBS1	WBS2	ID	Name	Description	Owner
					cooling the solenoid magnet during operation.	
9.20	6.10.07	6.10.10	I-DET-INF-INT.120	LN2 Flow (Assembly Area)	A supply and return of liquid nitrogen must be provided to the assembly hall for cooling the solenoid magnet during maintenance.	6.10.10.04
9.21	6.10.07	6.10.10	I-DET-INF-INT.121	LHE Flow (Assembly Area)	A supply and return of liquid helium must be provided to the assembly hall for cooling the solenoid magnet during maintenance.	6.10.10.04

Table 7. Solenoid Magnet to Particle Identification Systems

Section	WBS1	WBS2	ID	Name	Description	Owner
10		6.10.04			Particle Identification Systems	
10.1	6.10.07	6.10.04	I-DET-INF-BAR.017	DIRC Readout Supports	The DIRC prism box containing the photosensor readouts, will be supported by an external structure supporting the ECAL within the solenoid magnet.	6.10.10.01
10.2	6.10.07	6.10.04	I-DET-INF-INT.101	Space Constraint	The maximum forward location for the solenoid is limited by the position of the Dual RICH detector and the cabling plenum (gap) between them. Modifications to either must be coordinated.	6.10.10.04

4. SOLENOID MAGNET (DET-MAG) TO DETECTOR SYSTEM (DET)

4.1 I-DET-INF-INT.001 Magnetic Material

- System 1: Detector System (6.1)
- System 2: Solenoid Magnet (6.10.07)
- Type: ENV
- Description: No detectors or components constructed with magnetic material may be added to the detector without prior consultation with the magnet group.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The magnet is sensitive to the magnetic material in and around the magnet, any additional magnetic material can affect the forces in the magnet. The tie-rods used in the magnet are designed to take certain load, any additional load may lead the tie rods failure.
- Requirements: P-DET-MAG.13, P-DET-MAG.14
- References:

4.2 I-DET-INF-INT.002 Magnetic Field Requirement

- System 1: Detector System (6.1)
- System 2: Solenoid Magnet (6.10.07)
- Type: PARAM
- Description: All subordinate detectors are dependent on the continuous operation of the solenoid and on the delivery of a consistent, stable magnetic field.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: P-DET-MAG.13
- References:

5. SOLENOID MAGNET (DET-MAG) TO DATA ACQUISITION AND COMPUTING SYSTEMS (DET-COMP)

5.1 I-DET-COMP-ONLINE.040 Controls and Instrumentation

- System 1: Online DAQ and Computing Systems (6.10.09.02)
- System 2: Solenoid Magnet (6.10.07)
- Type: CONTROL
- Description: Control cabling for the magnet instrumentation will be run from the solenoid to the instrumentation rack on the carriage.
- Provider: Online DAQ and Computing Systems (6.10.09.02)
- Details: *See details in the Data Acquisition and Computing Systems Interface Control Document.*
- Requirements: F-DET-COMP.6
- References:

5.2 I-DET-COMP-ONLINE.041 Monitoring Data

- System 1: Online DAQ and Computing Systems (6.10.09.02)
- System 2: Solenoid Magnet (6.10.07)
- Type: DATA
- Description: Live monitoring data from the solenoid's operation must be recorded and maintained for diagnostic purposes.
- Provider: Online DAQ and Computing Systems (6.10.09.02)
- Details: The magnet is equipped with various sensors. All these sensors are monitoring various signals when magnet is in operation. This data should be recorded and maintained for diagnostic purpose.
- Requirements: F-DET-COMP.6
- References:

5.3 I-DET-COMP-ONLINE.042 Slow Controls

- System 1: Online DAQ and Computing Systems (6.10.09.02)
- System 2: Magnet Cryogenics (6.10.07.01)
- Type: CONTROL
- Description: A network connection will be provided from the DAQ system to the solenoid

cryogenic's slow controls interface.

- Provider: Online DAQ and Computing Systems (6.10.09.02)
- Details: A network connection is required to monitor and record the data from the cryogenic controls.
- Requirements: F-DET-COMP-SC.1
- References:

5.4 I-DET-COMP-ONLINE.043 Slow Controls

- System 1: Online DAQ and Computing Systems (6.10.09.02)
- System 2: Magnet Instrumentation and Control (6.10.07.02)
- Type: CONTROL
- Description: A network connection will be provided from the DAQ system to the solenoid's slow controls interface.
- Provider: Online DAQ and Computing Systems (6.10.09.02)
- Details: A network connection is required to monitor and record the data from the solenoid control.
- Requirements: F-DET-COMP.6
- References:

5.5 I-DET-COMP-ONLINE.044 Slow Controls

- System 1: Online DAQ and Computing Systems (6.10.09.02)
- System 2: Magnet Power Supply (6.10.07.03)
- Type: CONTROL
- Description: A network connection will be provided from the DAQ system to the slow controls interface of the solenoid's power supply.
- Provider: Online DAQ and Computing Systems (6.10.09.02)
- Details: A network connection is required to monitor and record the data from the power supply control.
- Requirements: F-DET-COMP.6
- References:

6. SOLENOID MAGNET (DET-MAG) TO ELECTROMAGNETIC CALORIMETRY SYSTEMS (DET-ECAL)

6.1 I-DET-INF-INT.012 Space Constraint

- System 1: Barrel EMCal Systems (6.10.05)
- System 2: Solenoid Magnet (6.10.07)
- Type: SPACE
- Description: The exterior radius of the barrel ECAL (and its support system) is limited by the interior bore of the solenoid magnet. Modifications to either must be coordinated.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The EM calorimeter sits inside the magnet bore; all the dimensions are given in the detector layout.
- Requirements: P-DET-ECAL.1, P-DET-MAG.1

- References:

7. SOLENOID MAGNET (DET-MAG) TO ELECTRONIC SYSTEMS (DET-ELEC)

7.1 I-DET-ELEC.037 — Bias Voltage

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Cryogenics (6.10.07.01)
- Type: ELEC
- Description: Bias voltage DC power will be provided from the electronics racks to support the magnet cryogenic systems.
- Provider: Electronic Systems (6.10.08)
- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

7.2 I-DET-ELEC.038 — High Voltage

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Cryogenics (6.10.07.01)
- Type: ELEC
- Description: High voltage DC power will be provided from the electronics racks to support the magnet instrumentation and control systems.
- Provider: Electronic Systems (6.10.08)
- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

7.3 I-DET-ELEC.039 — Low Voltage

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Cryogenics (6.10.07.01)
- Type: ELEC
- Description: Lower voltage DC power will be provided from the electronics racks to support the magnet cryogenic systems.
- Provider: Electronic Systems (6.10.08)
- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

7.4 I-DET-ELEC.040 — Bias Voltage

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Instrumentation and Control (6.10.07.02)
- Type: ELEC
- Description: Bias voltage DC power will be provided from the electronics racks to support the magnet instrumentation and control systems.
- Provider: Electronic Systems (6.10.08)

- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

7.5 I-DET-ELEC.041 **High Voltage**

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Instrumentation and Control (6.10.07.02)
- Type: ELEC
- Description: High voltage DC power will be provided from the electronics racks to support the magnet power supply.
- Provider: Electronic Systems (6.10.08)
- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

7.6 I-DET-ELEC.042 **Low Voltage**

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Instrumentation and Control (6.10.07.02)
- Type: ELEC
- Description: Low voltage DC power will be provided from the electronics racks to support the magnet instrumentation and control systems.
- Provider: Electronic Systems (6.10.08)
- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

7.7 I-DET-ELEC.043 **Bias Voltage**

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Power Supply (6.10.07.03)
- Type: ELEC
- Description: Bias voltage DC power will be provided from the electronics racks to support the magnet power supply.
- Provider: Electronic Systems (6.10.08)
- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

7.8 I-DET-ELEC.044 **High Voltage**

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Power Supply (6.10.07.03)
- Type: ELEC
- Description: High voltage DC power will be provided from the electronics racks to support electronics in the detector.
- Provider: Electronic Systems (6.10.08)

- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

7.9 I-DET-ELEC.045 **Low Voltage**

- System 1: Electronic Systems (6.10.08)
- System 2: Magnet Power Supply (6.10.07.03)
- Type: ELEC
- Description: Low voltage DC power will be provided from the electronics racks to support the magnet power supply.
- Provider: Electronic Systems (6.10.08)
- Details: *See details in the Electronic Systems Interface Control Document.*
- Requirements: P-DET-MAG.6
- References:

8. SOLENOID MAGNET (DET-MAG) TO HADRONIC CALORIMETRY SYSTEMS (DET-HCAL)

8.1 I-DET-INF-INT.031 **External Space Constraint**

- System 1: Barrel HCal Systems (6.10.08)
- System 2: Solenoid Magnet (6.10.07)
- Type: SPACE
- Description: The exterior radius of the solenoid magnet is limited by the interior bore of the barrel HCAL and necessary support structures. Modifications to either must be coordinated.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The solenoid sits inside the barrel hadron calorimeter, the clearance between the two are well defined and recorded in the technical note.
- Requirements: P-DET-HCAL.1, P-DET-MAG.1
- References:

8.2 I-DET-INF-INT.035 **Space Constraint**

- System 1: Backward HCal Systems (6.10.08)
- System 2: Solenoid Magnet (6.10.07)
- Type: SPACE
- Description: The maximum backward location for the solenoid magnet is limited by the backward HCAL and the adjacent cabling pathway that provides services to the interior detectors. Modifications to either must be coordinated.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The distance between the solenoid and Lepton end cap is well defined and recorded in a technical note.
- Requirements: P-DET-HCAL.1, P-DET-MAG.1
- References:

9. SOLENOID MAGNET (DET-MAG) TO DETECTOR INFRASTRUCTURE (DET-INF)

9.1 I-DET-INF-BAR.015 External Support Structure

- System 1: Barrel Detector Structures (6.10.10.01)
- System 2: Solenoid Magnet (6.10.07)
- Type: STRUCT
- Description: Total weight of the solenoid and all embedded components must be supported.
- Provider: Barrel Detector Structures (6.10.10.01)
- Details: A support structure must be provided that adequately supports the solenoid magnet and all of the components that are supported within its bore. This structure must hold all supported components stably and in the correct position. The structure must carry the weight to the floor and distribute it in a manner that does not exceed the floor loading capacity.
- Requirements: P-DET-MAG.2
- References:

9.2 I-DET-INF-BAR.017 DIRC Readout Supports

- System 1: Solenoid Magnet (6.10.07)
- System 2: Barrel DIRC Particle ID Systems (6.10.04)
- Type: STRUCT
- Description: The DIRC prism box containing the photosensor readouts, will be supported by an external structure supporting the ECAL within the solenoid magnet.
- Provider: Barrel Detector Structures (6.10.10.01)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: P-DET-MAG.1, P-DET-MAG.2, P-DET-PID.4
- References:

9.3 I-DET-INF-INT.001 Magnetic Material

- System 1: Detector System (6.1)
- System 2: Solenoid Magnet (6.10.07)
- Type: ENV
- Description: No detectors or components constructed with magnetic material may be added to the detector without prior consultation with the magnet group.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: P-DET-MAG.13, P-DET-MAG.14
- References:

9.4 I-DET-INF-INT.002 Magnetic Field Requirement

- System 1: Detector System (6.1)
- System 2: Solenoid Magnet (6.10.07)
- Type: PARAM
- Description: All subordinate detectors are dependent on the continuous operation of the solenoid and on the delivery of a consistent, stable magnetic field.

- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The magnet should be able to operate to the full field continuously.
- Requirements: P-DET-MAG.13
- References:

9.5 I-DET-INF-INT.012 Space Constraint

- System 1: Barrel EMCal Systems (6.10.05)
- System 2: Solenoid Magnet (6.10.07)
- Type: SPACE
- Description: The exterior radius of the barrel ECAL (and its support system) is limited by the interior bore of the solenoid magnet. Modifications to either must be coordinated.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The EM calorimeter sits inside the magnet bore; all the dimensions are given in the detector layout.
- Requirements: P-DET-ECAL.1, P-DET-MAG.1
- References:

9.6 I-DET-INF-INT.031 External Space Constraint

- System 1: Barrel HCal Systems (6.10.08)
- System 2: Solenoid Magnet (6.10.07)
- Type: SPACE
- Description: The exterior radius of the solenoid magnet is limited by the interior bore of the barrel HCAL and necessary support structures. Modifications to either must be coordinated.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: P-DET-HCAL.1, P-DET-MAG.1
- References:

9.7 I-DET-INF-INT.035 Space Constraint

- System 1: Backward HCal Systems (6.10.08)
- System 2: Solenoid Magnet (6.10.07)
- Type: SPACE
- Description: The maximum backward location for the solenoid magnet is limited by the backward HCAL and the adjacent cabling pathway that provides services to the interior detectors. Modifications to either must be coordinated.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: P-DET-HCAL.1, P-DET-MAG.1
- References:

9.8 I-DET-INF-INT.042 Magnet Cooling

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: CRYO

- Description: The solenoid will require a continuous flow of cryogens to maintain temperature in both the experimental hall and the maintenance area. Interface includes cryogenic source and warm return.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: P-DET-MAG.4
- References:

9.9 I-DET-INF-INT.079 Power Supply Cooling

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: COOL
- Description: The power supply, located in an adjacent electrical room, will need to be cooled with low conductivity water.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The power supply will need low conductivity water to cool the internal circuitry, the inlet temperature, outlet temperature, and the water pressure is governed by the power supply requirement.
- Requirements: P-DET-MAG.3
- References:

9.10 I-DET-INF-INT.080 Magnet Cooling

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: CRYO
- Description: The solenoid will require a continuous flow of cryogens to maintain temperature in both the experimental hall and the maintenance area. Interface includes cryogenic source and warm return.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The solenoid is a superconducting magnet and therefore needs to be cooled by liquid Helium, the magnet system has a phase separator where liquid helium will be stored and magnet will be indirectly cooled using the thermosiphon method.
- Requirements: P-DET-MAG.4
- References:

9.11 I-DET-INF-INT.081 Electrical Power

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: ELEC
- Description: Solenoid will be provided power via the power supply located in an adjacent room.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The power supply will be located in the electrical room which is about 300 ft away from the magnet. The power supply will be connected to the magnet with water-cooled leads. The powers supply is 5000 A, 20 V, the experimental hall should be able to provide the

required power for the supply.

- Requirements: P-DET-MAG.6
- References:

9.12 I-DET-INF-INT.082 Instrumentation Backup Power

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: ELEC
- Description: The instrumentation rack for the solenoid will require backup/UPS power adequate to safely shutdown the system in the event of a power failure.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The instrumentation racks are powered up for about an hour after a sudden power failure or while moving the magnet from the experimental hall to the assembly hall.
- Requirements: P-DET-MAG.6
- References:

9.13 I-DET-INF-INT.084 Fringe Field

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: ENV
- Description: A boundary must be established to identify the extent of the magnet's stray field during operations.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The magnet stray field extends beyond the physical size of the magnet and it is important to identify these boundaries for safety reasons.
- Requirements: P-DET-MAG.14
- References:

9.14 I-DET-INF-INT.085 Ice Management

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: ENV
- Description: An ice management system will be required to melt accumulated ice on the chimney. (Water should evaporate and will not require drainage)
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: P-DET-MAG.5
- References:

9.15 I-DET-INF-INT.086 Cryogenic Connection Point

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: SPACE
- Description: The cryogenic connection must be as close as possible to the source.

- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The magnet will be moved between experimental hall and assembly hall, magnet needs to remain cold during this move and also when magnet is in the assembly hall during long shut down periods.
- Requirements: P-DET-MAG.4
- References:

9.16 I-DET-INF-INT.087 LCW Connection

- System 1: Detector Infrastructure and Utilities Integration (6.10.10.04)
- System 2: Solenoid Magnet (6.10.07)
- Type: SPACE
- Description: The LCW water cooled leads must be fully supported along their path between the electrical room and the magnet.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: A support structure in the form of cable tray or similar should be used between electrical room and the magnet.
- Requirements: P-DET-MAG.2
- References:

9.17 I-DET-INF-INT.101 Space Constraint

- System 1: Solenoid Magnet (6.10.07)
- System 2: Forward RICH Detector Systems (6.10.04)
- Type: SPACE
- Description: The maximum forward location for the solenoid is limited by the position of the Dual RICH detector and the cabling plenum (gap) between them. Modifications to either must be coordinated.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The distance between the solenoid and dRICH is well defined and recorded in a technical note.
- Requirements: P-DET-MAG.1, P-DET-PID.5
- References:

9.18 I-DET-INF-INT.118 LN2 Flow (Hall)

- System 1: Solenoid Magnet (6.10.07)
- System 2: To Be Determined (TBD)
- Type: CRYO
- Description: A supply and return of liquid nitrogen must be provided to the experimental hall for cooling the solenoid magnet during operation.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: F-DET-INF-CRYO.1
- References:

9.19 I-DET-INF-INT.119 LHE Flow (Hall)

- System 1: Solenoid Magnet (6.10.07)
- System 2: To Be Determined (TBD)
- Type: CRYO
- Description: A supply and return of liquid helium must be provided to the experimental hall for cooling the solenoid magnet during operation.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: F-DET-INF-CRYO.1
- References:

9.20 I-DET-INF-INT.120 LN2 Flow (Assembly Area)

- System 1: Solenoid Magnet (6.10.07)
- System 2: To Be Determined (TBD)
- Type: CRYO
- Description: A supply and return of liquid nitrogen must be provided to the assembly hall for cooling the solenoid magnet during maintenance.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: F-DET-INF-CRYO.1
- References:

9.21 I-DET-INF-INT.121 LHE Flow (Assembly Area)

- System 1: Solenoid Magnet (6.10.07)
- System 2: To Be Determined (TBD)
- Type: CRYO
- Description: A supply and return of liquid helium must be provided to the assembly hall for cooling the solenoid magnet during maintenance.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: *See details in the Detector Infrastructure Interface Control Document.*
- Requirements: F-DET-INF-CRYO.1
- References:

10. SOLENOID MAGNET (DET-MAG) TO PARTICLE IDENTIFICATION SYSTEMS (DET-PID)

10.1 I-DET-INF-BAR.017 DIRC Readout Supports

- System 1: Solenoid Magnet (6.10.07)
- System 2: Barrel DIRC Particle ID Systems (6.10.04)
- Type: STRUCT
- Description: The DIRC prism box containing the photosensor readouts, will be supported by an external structure supporting the ECAL within the solenoid magnet.
- Provider: Barrel Detector Structures (6.10.10.01)
- Details: *See details in the Detector Infrastructure Interface Control Document.*

- Requirements: P-DET-MAG.1, P-DET-MAG.2, P-DET-PID.4
- References:

10.2 I-DET-INF-INT.101 **Space Constraint**

- System 1: Solenoid Magnet (6.10.07)
- System 2: Forward RICH Detector Systems (6.10.04)
- Type: SPACE
- Description: The maximum forward location for the solenoid is limited by the position of the Dual RICH detector and the cabling plenum (gap) between them. Modifications to either must be coordinated.
- Provider: Detector Infrastructure and Utilities Integration (6.10.10.04)
- Details: The distance between the solenoid and dRICH is well defined and recorded in a technical note.
- Requirements: P-DET-MAG.1, P-DET-PID.5
- References:

11. REFERENCES

1. doi:10.17226/25171., National Academies of Sciences, Engineering, and Medicine, "An Assessment of U.S.-Based Electron-Ion Collider Science", The National Academies Press, Washington, DC, 2018.
2. EIC-ORG-PLN-010, Electron-Ion Collider L1 Requirements (Global Requirements Document)
3. BNL-221006-2021-FORE, EIC Conceptual Design Report
4. arXiv:2103.05419, Science Requirements and Detector Concepts for the Electron-Ion Collider: EIC Yellow Report
5. EIC-SEG-PLN-016, Requirements Management Plan
6. EIC-SEG-PLN-022, Systems Engineering Management Plan
7. EIC-SEG-PLN-020, EIC Interface Management Plan