Electron-Ion Collider, Requirements, Specifications, and Interfaces

General, Functional, and Performance Requirements for the EIC Detector Systems

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REVISION HISTORY

Revision #	Effective Date	Additional Reviewers	Summary of Change
00	10/24/2022	E. Akers, K. Wilson, T. Satogata, T. Michalski, C. Cullen, J. Rochford, K. Baggett	Initial release
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LIST OF ACRONYMS

AC-LGAD	AC-Coupled Low-Gas Avalanche Detector
ATLAS	Automatically Tuned Linear Algebra Software
CDR	Conceptional Design Report
COTS	Commercial Off the Shelf
DAQ	Data Acquisition
DET	EIC Detector
DIRC	Detection of Internally Reflected Cherenkov Light
DVCS	Deeply Virtual Compton Scattering
EEI	Electrical Equipment Inspection
EIC	Electron-Ion Collider
EMI	Electromagnetic Interference
ESR	Electron Storage Ring
FCC	Federal Communications Commission
FEB	Front End Board
FELIX	Front-End Link Exchange
FEP	Front-End Processor
GEM	Gas Electron Multiplier
HSR	Hadron Storage Ring
HV	High Voltage
HVAC	Heating/Ventilation/Air Conditioning
IP	Interaction Point
IR	Interaction Region
LED	Light Emitting Device
LV	Low Voltage
MAPS	Monolithic Active Pixel Sensor
ML	Machine Learning
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
OS	Operating System
PCB	Printed Circuit Boards
PID	Particle Identification
PWO	$PbWO4$
RCS	Rapid Cycling Synchrotron
RFI	Radio Frequency Interference
RICH	Ring-Imaging Cherenkov Detector

RPOT	Roman Pots
STAR	Solenoidal Tracker at RHIC
UL	Underwriter Laboratories
VAC	Volts A/C
VME	Versa Module Europa
WAH	Wide Access Hall
WBS	Work Break Down Structure

General, Functional, and Performance Requirements for the EIC Detector Systems

1. PURPOSE AND SCOPE

This document presents the general, functional, and performance requirements for the EIC Detector Systems. This document is a requirement of the Systems Engineering and Requirements Management Plans [6][5].

The requirements for any system in the EIC flow down from the system's top-level general requirements to the functional requirements, and finally to the performance requirements. These requirements are defined as such,

- General requirements identify the fundamental capabilities that the system must have in order to accomplish its purpose,
- Functional requirements identify the functions that the system must perform in order to satisfy its general requirements, and
- Performance requirements quantitatively describe how well the functions must be performed in order for the system to be successful in its operating environment.

Interfaces are also part of the requirements management process and are collected and maintained in accordance with the Interface Management Plan [7]. The Interface Management Plan specifies the need for Interface Requirement Documents, which are companions to the general/functional/performance requirements documents. Taken together, they provide a complete foundation for designing detector systems that can successfully integrate and operate within the larger EIC environment.

2. DETECTOR SYSTEMS SUMMARY

The physics program of an EIC imposes several challenges on the design of a general-purpose detector, and more globally the extended interaction region, as it spans center-of-mass energies from 29 GeV to 141 GeV, different combinations of both beam energy and particle species, and several distinct physics processes. The various physics processes encompass inclusive measurements e + p/A → e'+X; semi-inclusive processes e + p/A → e'+h+X, which require detection of at least one hadron in coincidence with the scattered lepton; and exclusive processes e + p/A → e'+N'A'+ γ/h, which require the detection of all particles in the reaction with high precision. The EIC CDR [3] and the Yellow Report [4] discuss in detail how the requirements on the accelerator, the interaction region and the experimental equipment flow down from the EIC science.

The EIC general-purpose detector, ePIC, must be capable to cover the physics program detailed in the NAS review [1] at the full center-of-mass energy range and luminosity ($10^{33\text{-}34}$ $cm^{-2}s^{-1}$). The central detector consists of a solenoidal magnet, the central detector with 6 subsystems and a lepton and hadron endcap with each 6 subsystems. Further data-acquisition and trigger, infrastructure, and integration as well as online software efforts are included in the scope. The EIC experimental equipment does not stop at the central detector. To realize the full science program, the design of the IR and the integration of the far backward and forward detectors along the outgoing lepton and hadron beam are equally critical. There are further implications to both the detector and the integration of the detector and interaction region to accommodate the large range of ion species required for the EIC science program, and the various electron and proton/ion beam polarizations. Figure 1 illustrates the EIC accelerator complex, at the time this document was signed the decision was just taken to remove the RCS from the tunnel and build a green-field solution, this is not yet reflected in the figure. Figure 2 shows the EIC general-purpose detector and how it is embedded together with its ancillary detectors into the EIC interaction region at IR6.

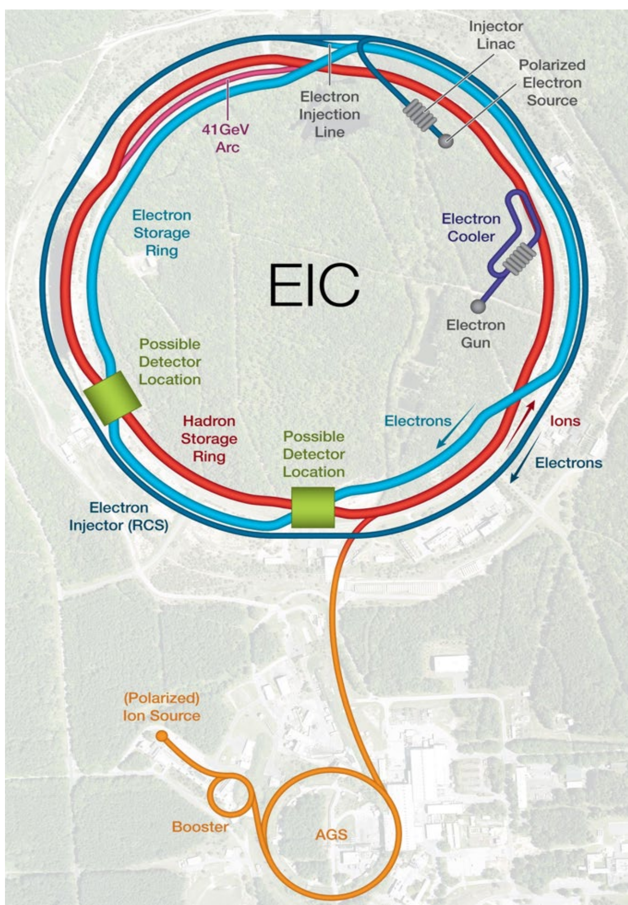

Figure 1: The EIC accelerator complex, the EIC detector is located at the IR6 interaction region

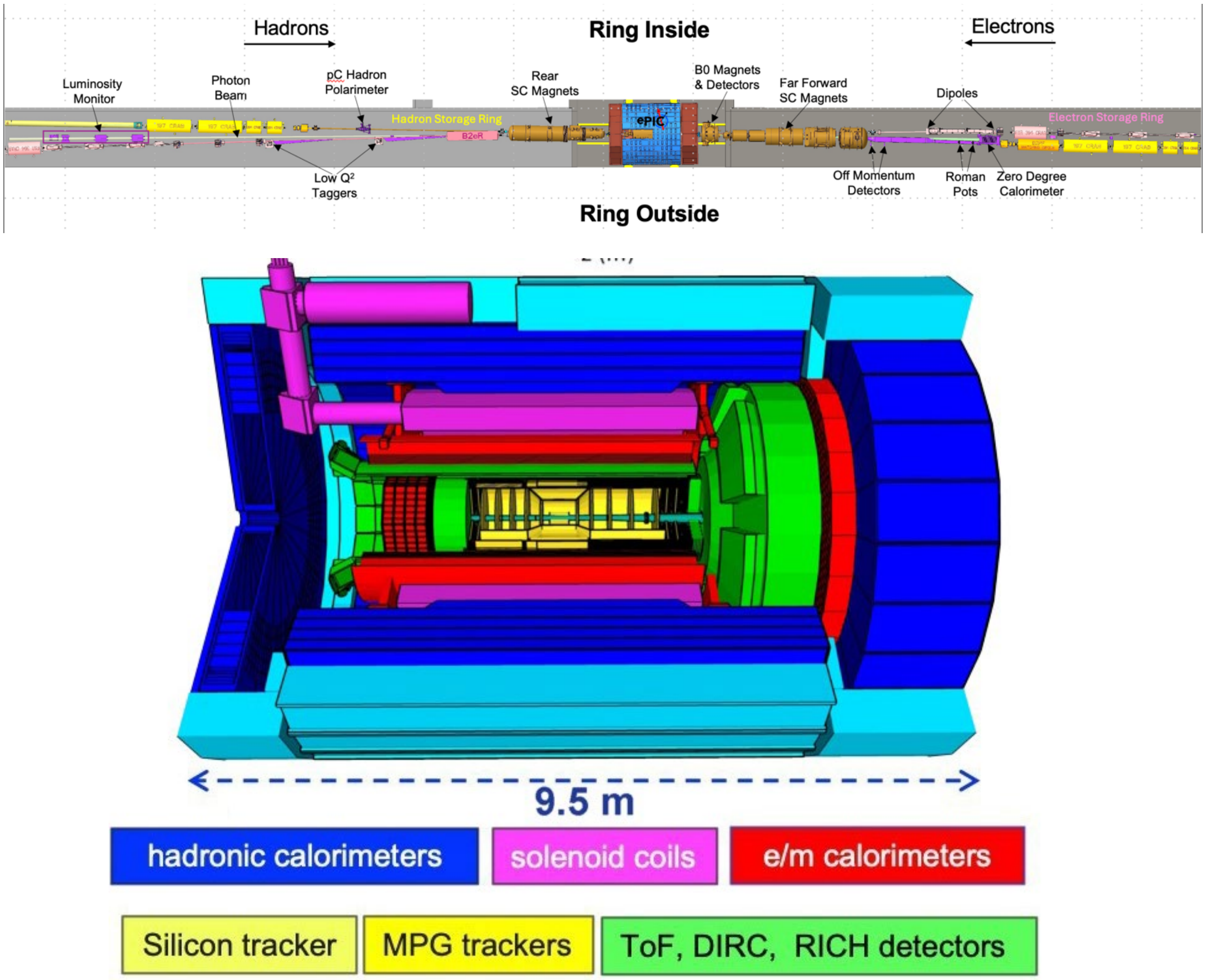

Figure 2: The top shows, how the EIC general-purpose detector, ePIC, is embedded together with its ancillary detectors into the EIC interaction region at IR6. Note that the forward direction is the on the incoming lepton beam side and the backward direction is on the incoming hadron beam side in this figure. The bottom shows the ePIC detector indicating in the different colors the different subsystem detector categories.

3. DETECTOR SUB-SYSTEMS

The detector system consists of ten sub-systems that are aggregated into a single, fully integrated detector package that will operate within the interaction region. Each of these sub-systems has a complete set of requirement and interface documents that describe its functions, performance requirements and interconnectivity both within the detector system and to the larger environment. The following sub-systems are included in the detector.

3.1. Tracking Systems

The compact tracker consists of a MAPS silicon barrel vertex detector augmented by MAPS tracking layers and by a set of forward/backward disks, and several GEM stations, all placed into solenoid with a 1.7 T solenoidal field, with an inner diameter of 2.84 m. To have good, charged particle-identification (PID) at central rapidities, a DIRC is complemented with AC-LGAD layers for tracking and Time-of-Flight. The vertex detector covering the central rapidity range (-1 to 1) has multiple layers of high-resolution MAPS sensors with a 20 µm pixel size and an effective thickness of only 0.3% radiation length per layer. Such a setup enables a momentum resolution better than 3% for scattered electrons and secondary charged hadrons for momenta up to a few tenths of GeV/c in the pseudo-rapidity range –4 to 4. For a compact forward tracker design, it is critical to maintain high spatial resolution.

3.2. Particle Identification Systems

The PID detector systems cover the three main regions of the central detector. These are the magnet bore region and the two regions in the direction of the incoming (backward) and outgoing (forward) hadron beam. The central region is assumed to harbor a high performance DIRC (hpDIRC) detector based on detector components from the BaBar DIRC, in particular the quartz bars. It is optimized by a focusing system to provide proton-kaon separation up to 6GeV/c. The forward region will be equipped with a dual RICH (dRICH) detector optimized for a wide range in particle momenta using Aerogel and gas as the two radiator materials. On the backward side, in the direction of the outgoing electron beam, a modular RICH (mRICH) detector will provide hadron identification at moderate momenta. Alternatively, the mRICH detector could be replaced by a proximity focusing Aerogel RICH. It is expected that these detectors will be constructed by the EIC user community.

3.3. Electromagnetic Calorimetry Systems

A general-purpose EIC detector is supposed to have a 4π hermetic coverage in tracking, PID and calorimetry. For the electromagnetic (e/m) calorimetry there are several technology options available, for both the high-resolution homogeneous and the medium-resolution sampling solutions. The choice will depend on the actual requirements for a given part of the acceptance, driven by the physics requirements and simulations. The e/m calorimetry subsystem can be split into three distinct parts, the electron-going endcap, barrel, and hadron-going endcap. The majority of the e/m calorimeter options were developed within the generic EIC detector R&D program. For the most backward pseudo-rapidities in the electron endcap the highest resolution is required as provided by $PbWO_4$ crystals. The high-energy resolution $PbWO_4$ crystals is a well-established technology, where EIC can rely on the experience of CERN/CMS, GSI/PANDA and also the Jefferson Lab experiments. In the less-backward pseudo-rapidity region extending to the more central barrel region, around pseudo-rapidity of zero, medium- to high-resolution is required. Starting around pseudo-rapidity near zero, in the positive and forward pseudo-rapidity (hadron endcap) region medium resolution will be required leading to a sampling calorimeter solution. In the barrel region, a hybrid sampling calorimeter of sufficient resolution based on scintillating fibers embedded in lead coupled with imaging calorimetry based on sensors may provide an alternate solution that is complementary to SciGlass. In the forward hadron endcap region, a lead-scintillator shaslik calorimeter is envisioned or alternately a sampling calorimeter based on scintillating fibers with a tungsten powder epoxy mix. It is anticipated that the electron endcap and barrel e/m calorimeters will be an integral part of the central detector, while the hadron endcap e/m calorimeter will be co-located on the hadron-endcap hadronic calorimeter carriage.

3.4. Hadronic Calorimetry Systems

Several physics studies indicate that an EIC detector will require a continuous hadronic calorimetry (HCal) coverage in the polar angular range from approximately 2 to 178 degrees, in order to meet the scientific goals. The HCal subsystem will be naturally split into the barrel part and the two endcaps. As mentioned already, the barrel part is reused from the already existing sPHENIX detector. The endcaps need to be designed and manufactured from scratch, in a close connection to the e/m calorimetry subsystem. The latter typically provides the very first interaction length of the active tower matrix, and in case of the h-going endcap will be assembled on the same heavy duty roller platform. It is currently envisioned that each of the HCal tower matrices in the endcaps will be built utilizing a technology based forming towers from an alternating steel scintillator structure. The photo-sensors will be embedded into the scintillators. The lepton endcap hadron calorimeter will mainly function as a tail-catcher and to identify neutral hadrons.

3.5. Solenoid Magnet

This section includes all labor and materials to design, procure, fabricate, cold test, magnetic measurements, surveys, installation & commissioning, and system test & integration of the solenoid magnet system (magnet system includes coils, support structure, cryostat, control & instrumentation for magnet, quench protection, magnet power supply, current leads, trim coil power supply, cryogenic flex-line, and associated connectors). This will also include all the vendor visits for various sub-systems.

3.6. Electronics Systems

This section covers the effort for the front-end electronics integrated on the different sub-detectors. One estimates ~700k channels for a reference EIC detector. Costs cover the final design and construction of all the electronics from the detectors to the input of the DAQ system and include the fabrication and procurement of ASICs; printed circuit boards (PCB) such as FEB and FEP cards; high voltage (HV), low voltage (LV), bias power supply systems; cabling and optical fibers.

3.7. Data Acquisition and Computing Systems

This section covers the effort for the data-acquisition (DAQ) and computing needed to collect all the data from the front-end electronics. The current plan for the DAQ is to not have any trigger, but to collect all the data from the different sub-detectors and only suppress detector pedestals and noise. This type of DAQ is commonly referred to as a streaming DAQ. The cost was estimated based on the FELIX cards developed for ATLAS. In addition, the servers, network switches and network fibers needed to fully collect the data are costed as well. Currently the need of ~88 Felix cards and ~44 servers are assumed to collect the data from the ~700k channels.

3.8. Detector Infrastructure

This section covers the entire effort needed to design and built the support structures for the EIC detector and includes the support to complete the installation scope prior to commissioning.

3.9. IR Integration and Ancillary Detectors

The EIC physics program requires several detectors along the outgoing lepton and hadron beam line. These include the low-Q^2 tagger along the outgoing electron beam. Along the hadron outgoing beam, these include the Zero-degree calorimeter, for neutron and photon detection and the silicon detectors for charged particles scatters at < 20 mrad: B0-tracker inside the BO magnet, off-momentum detectors after the B1-dipole magnet and the Roman Pots integrated into the beam pipe vacuum system between B1 and B2.

3.10. Polarimetry and Luminosity Systems

All design and construction activities needed to integrate the Luminosity Monitor into the IR as well as the construction activities for hadron and electron beam polarimetry in the hadron SR and the lepton RCS and ESR.

4. GENERAL REQUIREMENTS

General requirements identify the fundamental capabilities that the system must have in order to accomplish its purpose.

4.1. Detector Systems

Requirement ID	*Description*
G-DET.1	The EIC detector system shall be capable to detect all reaction products, related to the scattered electron, the scattered parton, and the remnant proton/ion, such that the impact of incomplete kinematic coverage on the respective science is minimized.
G-DET.2	The interaction region and detector system shall allow electron-ion collisions over the full energy range ($\sqrt{s}$ = 29 GeV to 141 GeV), polarized beams, and a

Requirement ID	*Description*
	range of ion beams ($\sqrt{s}$ = 29 GeV to 89 GeV), and allow measurements of luminosity and polarizations. The hadron polarimeters can be located at a different ring location.
G-DET.3	The EIC shall be upgradable with a second interaction region and detector system.
G-DET.4	The detector shall be installed in one of two available interaction points for the EIC, currently selected as IP-6.
G-DET.5	The central detector shall consist of a barrel augmented by a forward endcap and a backward endcap region forming the central detector to cover the rapidity range h between -4 and 4 for the measurements of electrons, photons, hadrons and jets.
G-DET.6	The central detector shall be augmented with detectors in the far backward region to measure scattered electrons at small scattering angles.
G-DET.7	The central detector shall be augmented with detectors in the far forward region to measure proton and ion remnants at small scattering angles.
G-DET.8	The polarimetry and luminosity detectors shall measure the electron and proton beam polarization and monitor the instantaneous collision luminosities.
G-DET.9	The detector and its sub-systems will be functionally integrated with one another, with the interaction region components, and with the facility infrastructure.
G-DET.10	The detector systems must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.

4.2. Tracking Systems

Requirement ID	*Description*
G-DET-TRAK.1	The tracking systems shall provide coordinate measurements of charged particles traversing a magnetic field, and provide a sufficient lever arm to provide measurements of the momenta and angles of the particles.
G-DET-TRAK.2	Tracking functionality shall cover the backward, the barrel and the forward region.
G-DET-TRAK.3	The tracking system shall provide a measurement of the vertex coordinates in the barrel region.
G-DET-TRAK.4	The tracking system will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-TRAK.5	The tracking system must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.

4.3. Particle Identification Systems

Requirement ID	*Description*
G-DET-PID.1	The PID detector systems shall provide a means to separately identify pions, kaons and protons following the electron-ion collision.
G-DET-PID.2	The particle identification systems shall consist of backward, barrel, and forward sub-systems.
G-DET-PID.3	The PID detector system will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-PID.4	The PID detector system must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.
G-DET-PID-BAR-DIRC.1	The barrel PID detector is responsible for high momenta particle identification.
G-DET-PID-BAR-TOF.1	The barrel PID detector is responsible for low momenta particle identification.
G-DET-PID-FWD-RICH.1	The forward PID detector is responsible for high momenta particle identification.
G-DET-PID-FWD-TOF.1	The forward PID detector is responsible for low momenta particle identification.
G-DET-PID-BCK-RICH.1	The PID detector in the backward region is responsible for particle identification of charged hadrons.

4.4. Electromagnetic Calorimetry Systems

Requirement ID	*Description*
G-DET-ECAL.1	EMCal shall provide measurements of photons, including ones from pi0, eta and other decays; and shall play a key role to identify scattered and decay electrons and measure their kinematic parameters
G-DET-ECAL.2	EMCal subsystem(s) shall cover the backward, the barrel and the forward region.
G-DET-ECAL.3	The EMCAL subsystems will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-ECAL.4	The EMCAL subsystems must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.

Requirement ID	***Description***
G-DET-ECAL-BAR.1	Barrel EMCal shall identify scattered electrons and measure their energy, in high Q^2 events; it also serves to identify decay electrons, e.g. from vector or heavy flavor meson decays, and to measure DVCS photons and decay photons
G-DET-ECAL-BAR.2	EMCal shall provide a charged tracking point behind the DIRC to help charged hadron PID
G-DET-ECAL-BAR.3	EMCal shall assist with muon identification.
G-DET-ECAL-BCK.1	Backward EMCal shall identify scattered electrons and measure their energy, in low and medium Q^2 events; it also serves to identify decay electrons, e.g. from vector or heavy flavor meson decays, and measure DVCS photons and decay photons
G-DET-ECAL-FWD.1	Forward EMCal shall identify decay electrons, e.g. from vector or heavy flavor meson decays, and to measure DVCS photons and decay photons, e.g. from pi0 decays

4.5. Hadronic Calorimetry Systems

Requirement ID	***Description***
G-DET-HCAL.1	Hadronic calorimeter (HCal) subsystem must provide hadron energy measurement, in particular for the jet neutral component identification (neutrons and K-long's), as well as to serve as a tail catcher for the e/m calorimeters
G-DET-HCAL.2	Functionality shall cover the barrel and the forward region, and should cover the backward region.
G-DET-HCAL.3	The Hadronic Calorimetry subsystem will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-HCAL.4	The Hadronic Calorimetry subsystem must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.
G-DET-HCAL-BAR.1	Barrel HCal shall provide adequate functionality for hadronic jet neutral component reconstruction at central rapidities
G-DET-HCAL-BCK.1	Backward HCal shall provide functionality of a tail catcher for the high-resolution e/m calorimeter in electron identification, as well as for jet kinematics measurement at small Bjorken x
G-DET-HCAL-FWD.1	Forward HCal shall play a crucial role in jet energy and kinematics reconstruction in the hadron endcap, complementing tracking and e/m calorimetry in the particle flow algorithms, and be consistent with the ePIC detector solenoid design

4.6. Solenoid Magnet

Requirement ID	***Description***
G-DET-MAG.1	The EIC detector magnet shall provide a central field, a sufficiently large room temperature bore, and a magnet length consistent with the detector need to fulfill EIC science requirements
G-DET-MAG.2	The EIC detector magnet will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-MAG.3	The EIC detector magnet must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.

4.7. Electronics Systems

Requirement ID	***Description***
G-DET-ELEC.1	The EIC detector readout electronics shall provide the means to acquire, process and deliver detector signals to the DAQ system. Streaming readout shall be the default or nominal operation mode; to facilitate calibration and testing or debugging, a triggered operation mode shall be implemented at every level.
G-DET-ELEC.2	All components and equipment will comply with standards established by the EIC project.
G-DET-ELEC.3	The EIC detector readout electronics will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-ELEC.4	The EIC detector readout electronics must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.

4.8. Data Acquisition and Computing Systems

Requirement ID	***Description***
G-DET-COMP.1	The DAQ subsystem shall consist of all resources necessary to communicate with all DET subsystems in order to configure, control and monitor these systems as well as read, process and store data they generate.
G-DET-COMP.2	The DAQ subsystem shall consist of COTS hardware where possible, and custom electronics as needed.

Requirement ID	*Description*
G-DET-COMP.3	The DAQ subsystem shall use COTS and Open-Source software where possible, and collaboration developed software, firmware libraries and applications as needed.
G-DET-COMP.4	The DAQ subsystem shall distribute all experimental data generated to an external data center for supplemental and optional data processing and archival storage.
G-DET-COMP.5	The DAQ subsystem will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-COMP.6	The DAQ subsystem must fit within the available space in the experimental hall, assembly hall, and control rooms, and be consistent with the available infrastructure and resources.
G-DET-COMP-SC.1	The DET that will require a slow control system that provides system interlocks, interfaces, monitoring, and control.

4.9. Detector Infrastructure

Requirement ID	*Description*
G-DET-INF.1	There will be distinct infrastructure requirements for the assembly hall, the collider hall, and the interaction region.
G-DET-INF.2	All components, equipment and assemblies will comply with standards established by the EIC project.
G-DET-INF.3	Infrastructure systems for the assembly hall shall include all power, water, environmental cooling, cryogenics, gas handling, clean compressed air delivery, space, fire protection, Helium Leak Detection, ODH Detection and any other Personnel Safety Systems, material handling and support systems required to assemble and maintain the central detector systems.
G-DET-INF.4	Infrastructure systems for the collider hall shall include all power, water, environmental cooling, cryogenics, gas handling, clean compressed air delivery, space, fire protection, Helium Leak Detection, ODH Detection and any other Personnel Safety Systems, Cryo Protection, material handling and support systems required to operate the entire detector systems.
G-DET-INF.5	Infrastructure systems for the interaction region shall include all power, water, environmental cooling, cryogenics, gas handling, space, material handling and support systems required to assemble, operate and maintain the far forward and far backward detector systems.
G-DET-INF.6	Infrastructure systems shall provide adequate space, environmental cooling, and distribution for DAQ and local computing.

Requirement ID	***Description***
G-DET-INF.7	Space and facilities for the experimental control room and operations shall be preserved.
G-DET-INF.8	Where feasible, existing infrastructure systems will be reused.
G-DET-INF.9	The infrastructure systems will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-INF.10	The infrastructure systems must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.

4.10. IR Integration & Ancillary Detectors

Requirement ID	***Description***
G-DET-ANC.1	The EIC ancillary detectors should provide a measurement of particle scattering at small angles.
G-DET-ANC.2	The forward ancillary detectors shall provide a means to measure forward going charged particles (including those close to the beam core), forward going neutral particles, and to tag charged and neutral particles following decay.
G-DET-ANC.3	The backward ancillary detectors shall provide a means to measure scattered electrons.
G-DET-ANC.4	The EIC ancillary detectors will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-ANC.5	The EIC ancillary detectors must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.
G-DET-ANC-LOWQ2.1	The Low-Q^2 detectors will measure the momentum of scattered electrons with Q^2 below 0.1 GeV^2 in the far-backward region.
G-DET-ANC-B0.1	The B0 system will provide measurements of charged particles in the forward directions.
G-DET-ANC-B0.2	The B0-system will tag protons at higher angles (especially important for lower beam energies).
G-DET-ANC-B0.3	The B0 system will provide measurements of forward photons and pi0.
G-DET-ANC-OFFMO.1	The Off-Momentum detectors should provide measurements of charged particles with different magnetic rigidity
G-DET-ANC-ROMAN.1	The Roman-Pots should provide measurements of charged particles close to the beam core.

Requirement ID	*Description*
G-DET-ANC-ZDC.1	The zero-degree Calorimeter should provide measurements of neutral particles (neutrons and photons).
G-DET-ANC-LUMI.1	The luminosity system utilizes the bremsstrahlung process to provide measurements of the absolute luminosity to a precision of $\delta L/L <= 1\%$ and relative luminosity at 10^-4.

4.11. Polarimetry and Luminosity Systems

Requirement ID	*Description*
G-DET-POL.1	The polarimeters at EIC shall measure the spin polarizations of the colliding beams.
G-DET-POL.2	The polarization lifetime must be measured for each fill of beams or bunches.
G-DET-POL.3	The polarization must be measured for each bunch of the beams.
G-DET-POL.4	The polarimeters will be functionally integrated with the other detectors, with the interaction region components, and with the facility infrastructure.
G-DET-POL.5	The polarimeters must fit within the available space in the experimental hall, and be consistent with the available infrastructure and resources.
G-DET-POL-EPOL.1	The EIC electron polarimeter system shall provide a measurement of the absolute beam polarization in the ESR and RCS. The ESR Compton must measure the polarization bunch-by-bunch and be sensitive to the beam transverse polarization profile.
G-DET-POL-EPOL-ESR.1	The ESR Compton shall measure the electron polarization in the electron storage ring.
G-DET-POL-EPOL-RCS.1	The RCS Compton shall measure the electron polarization either in, or just after the Rapid Cycling Synchrotron.
G-DET-POL-HPOL.1	The EIC hadron polarimeter system must provide a measurement of the absolute beam polarization in the HSR, the polarization lifetime and the transverse bunch polarization profile.
G-DET-POL-HPOL-HJET.1	The HJET polarimeter shall measure the absolute beam polarization for light hadron beams.
G-DET-POL-HPOL-PC.1	The pC polarimeter shall measure the relative polarization loss at flattop energy during a store and the transverse polarization profile of the hadron bunches.
G-DET-POL-HPOL-PC.2	The pC polarimeter near the experimental IR shall measure the orientation of the polarization vector (local polarimetry).

5. FUNCTIONAL REQUIREMENTS

Functional requirements identify the functions that the system must perform in order to satisfy its general requirements.

5.1. Detector Systems

Requirement ID	***Description***
F-DET.1	The EIC detector shall be capable to operate over the full range of Center-Of-Mass energy ($\sqrt{s}$ = 29 GeV to 141 GeV), at full luminosity, and for all ion species.
F-DET.2	The EIC central detector shall cleanly identify the electron-quark and electron-gluon scattering process to high efficiency by a combination of tracking, particle identification detectors and calorimeters.
F-DET.3	The EIC central solenoid magnet shall provide the means to momentum-analyze the charged particles associated with the hadrons produced in electron-quark / electron-gluon scattering process.
F-DET.4	The EIC central detector system shall allow for particle identification of pions, kaons and protons over a wide range of momentum in the barrel, forward endcap and backward endcap regions.
F-DET.5	The EIC central detector shall allow for heavy flavor and other long-living particle measurements through a vertex resolution.
F-DET.6	The EIC central detector shall allow for separation of single-photons from neutral-pion decay into two photons over a wide region in momentum.
F-DET.7	The EIC far-backward detector shall complement the central detector in the low- Q^2 electron scattering region below 1 GeV^2.
F-DET.8	The forward hadron detection shall provide sufficient energy resolution to identify the electron-scattering kinematics for those DIS cases where it must be determined from remnant hadron detection.
F-DET.9	The hadron acceptance shall be sufficient to identify spectators and proton/ion remnants for electron scattering processes with far-forward particles.
F-DET.10	The EIC far-forward detector shall measure proton/ion remnants with momenta up to less than 1% different from the proton/ion beam momentum.
F-DET.11	The detector and its sub-systems will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET.12	The detector and its sub-systems will require adequate infrastructure capabilities (i.e. crane capacity, floor loading, physical space, etc.) to effectively support operations and maintenance.

Requirement ID	***Description***
F-DET.13	The configuration of the sub-systems within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET.14	The sub-systems and their support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET.15	A structural support infrastructure must be provided that supports the weight of the detectors and peripheral equipment, and safely distributes that load to the ground.

5.2. Tracking Systems

Requirement ID	***Description***
F-DET-TRAK.1	The tracking system must provide a low detection threshold for pions and kaons.
F-DET-TRAK.2	The tracking system must provide high hermicity in exclusive and diffractive channels.
F-DET-TRAK.3	The tracking system must provide good impact parameter resolution for heavy flavor measurements.
F-DET-TRAK.4	The tracking system will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-TRAK.5	The configuration of the tracking system within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-TRAK.6	The tracking system and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-TRAK.7	A structural support infrastructure must be provided that supports the weight of the tracking system and peripheral equipment, and safely distributes that load to the ground.

5.3. Particle Identification Systems

Requirement ID	***Description***
F-DET-PID.1	The PID detector system will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-PID.2	The configuration of the PID detector system within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-PID.3	The PID detector system and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-PID.4	A structural support infrastructure must be provided that supports the weight of the PID detector system and peripheral equipment, and safely distributes that load to the ground.
F-DET-PID-BAR-DIRC.1	The PID detector in the barrel region shall differentiate between pions, kaons and protons.
F-DET-PID-BAR-TOF.1	The time-of-flight system will provide separation of pions from kaons to match the high-performance DIRC detector in particle momentum range.
F-DET-PID-FWD-RICH.1	The PID detector in the forward region shall differentiate between pions, kaons and protons.
F-DET-PID-FWD-TOF.1	The forward time-of-flight system will provide separation of pions from kaons to match the forward RICH detector in particle momentum range.
F-DET-PID-BCK-RICH.1	The PID detector in the backward region shall differentiate between pions, kaons and protons.

5.4. Electromagnetic Calorimetry Systems

Requirement ID	***Description***
F-DET-ECAL.1	Design must minimize the loss of functionality in transition between barrel and endcap regions.
F-DET-ECAL.2	Must operate at full luminosity and expected background conditions (rad. dose, neutron flux).
F-DET-ECAL.3	Must provide adequate energy and position resolution for photon and electron measurements, and eID through E/p cut.
F-DET-ECAL.4	Shall provide discrimination between single photon and merged photon from pi0 decay.
F-DET-ECAL.5	Shall provide photon measurements down to 100 MeV.

Requirement ID	***Description***
F-DET-ECAL.6	Must provide timing sufficient to discriminate between different bunch crossings.
F-DET-ECAL.7	Material in front of EMCals will be minimized to the level not jeopardizing EMCal performance.
F-DET-ECAL.8	The EMCAL subsystems will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-ECAL.9	The configuration of the EMCAL subsystems within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-ECAL.10	The EMCAL subsystems and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-ECAL.11	A structural support infrastructure must be provided that supports the weight of the EMCAL subsystems and peripheral equipment, and safely distributes that load to the ground.
F-DET-ECAL-BAR.1	Shall provide electron ID up to 50 GeV and down to 1 GeV and below.
F-DET-ECAL-BAR.2	Shall provide photon measurements up to 10 GeV.
F-DET-ECAL-BAR.3	Must provide discrimination between single photon and merged photon from pi0 decay up to 10 GeV.
F-DET-ECAL-BAR.4	The first imaging layer shall provide a charged tracking point behind the DIRC to help charged hadron PID
F-DET-ECAL-BAR.5	Four imaging planes shall be produced for a baseline, with mechanical design being capable to accommodate six imaging planes.
F-DET-ECAL-BCK.1	Shall provide high precision measurements for electrons up to 18 GeV and pseudo rapidity down to -3.5.
F-DET-ECAL-BCK.2	Shall provide measurements of scattered electrons for the events down to Q^2=1 GeV^2 (=> acceptance requirements).
F-DET-ECAL-BCK.3	Must provide strong eID capabilities down to 1 GeV/c.
F-DET-ECAL-BCK.4	Shall provide photon measurements up to 18 GeV.
F-DET-ECAL-BCK.5	Must provide discrimination between single photon and merged photon from pi0 decay up to 18 GeV.
F-DET-ECAL-BCK.7	A cooling system shall be provided for the lead-tungstate based detector.
F-DET-ECAL-FWD.1	Shall provide electron and photon measurements up to 50 GeV.

Requirement ID	*Description*
F-DET-ECAL-FWD.2	Must provide discrimination between single photon and merged photon from pi0 decay up to 50 GeV.
F-DET-ECAL-FWD.3	Along with forward HCal, shall provide high precision jet measurements.

5.5. Hadronic Calorimetry Systems

Requirement ID	*Description*
F-DET-HCAL.1	Must operate reliably at a full projected EIC luminosity.
F-DET-HCAL.2	Must provide a reasonable energy measurement for charged hadrons.
F-DET-HCAL.3	Must provide means for neutral hadron identification and energy measurement.
F-DET-HCAL.4	The Hadronic Calorimetry subsystem will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-HCAL.5	The configuration of the Hadronic Calorimetry subsystem within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-HCAL.6	The Hadronic Calorimetry subsystem and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-HCAL.7	A structural support infrastructure must be provided that supports the weight of the Hadronic Calorimetry subsystem and peripheral equipment, and safely distributes that load to the ground.
F-DET-HCAL-BAR.1	Shall be optimized to provide hadron energy measurements at relatively small jet energies (up to few dozens of GeV).
F-DET-HCAL-BCK.1	Shall accommodate the possibility of hadron energy measurements in the range up to few dozens of GeV and pseudorapidity down to -3.5.
F-DET-HCAL-BCK.2	Shall accommodate the ability to complement e/m calorimeter by tail catching capability for electron ID purposes, especially below 3-4 GeV/c.
F-DET-HCAL-FWD.1	Must provide hadron energy measurements up to the highest hadron energies in a 250(p) x 18(e) GeV beam configuration and pseudorapidity up to 3.5, with energy resolution defined by the community Yellow Report and subsequent ePIC simulation studies
F-DET-HCAL-FWD.2	The design must be coupled well with a compensated forward e/m calorimeter for high precision jet energy measurements.
F-DET-HCAL-FWD.3	The calorimeter structure must serve as part of the solenoid flux return

5.6. Solenoid Magnet

Requirement ID	*Description*
F-DET-MAG.1	The EIC detector magnet shall fulfill the field specification (as specified in the magnetic field specification document), the main area for field specifications are (i) flat field area, (ii) RICH detector area, and (iii) stray field at IR magnets.
F-DET-MAG.2	The EIC detector magnet will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-MAG.3	The configuration of the EIC detector magnet within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-MAG.4	The EIC detector magnet and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-MAG.5	A structural support infrastructure must be provided that supports the weight of the EIC detector magnet and peripheral equipment, and safely distributes that load to the ground.
F-DET-MAG-I&C.1	The magnet control and instrumentation shall be able to read all the temperature and stress sensor in the magnet.
F-DET-MAG-CCR.1	The magnet shall require a cryo-can and cryogenic line that will deliver Liquid Helium to the solenoid.
F-DET-MAG-PSU.1	Magnet power shall be able to supply required current to the magnet to produce a 1.7 T central field, with a stretch goal of 2 T.

5.7. Electronics Systems

Requirement ID	*Description*
F-DET-ELEC.1	The EIC detector readout electronics will provide signal conditioning to detector signals by the shaping constants, amplification, digitization and signal drive via discrete components and Application Specific Integrated Circuits (ASIC).
F-DET-ELEC.2	The EIC detector readout electronics will process detector signals on the Front End Board (FEB). The FEB is typically characterized by the use of ASICs and customized for each type of sub-detector. Data transport off the FEB is made via copper links to the RDOs (Readout Boards) or DAQ system.
F-DET-ELEC.3	The EIC detector readout electronics will process, collect and aggregate data within the Readout Board (RDO). The RDO is typically characterized by the use of FPGAs. Data transport off the RDO is made via optical fibers to the

Requirement ID	***Description***
	DAQ, which may consist of FELIX-type cards, network servers or network switches.
F-DET-ELEC.4	The FEB and RDO boards will be remotely configured for proper operation of their programmable logic device, such as FPGAs. Processor boards or single board computers used with critical detector systems may require remote booting of OS.
F-DET-ELEC.5	All components, whether procured or manufactured, will, at a minimum, meet the standards specified by the EIC project AND meet the additional standards and specifications identified in these requirements.
F-DET-ELEC.6	Where not governed by specific standards, components will be implemented, installed, and utilized in a manner that is consistent with industry best practices.
F-DET-ELEC.7	The EIC detector readout electronics will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-ELEC.8	The configuration of the EIC detector readout electronics within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-ELEC.9	The EIC detector readout electronics and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-ELEC.10	A structural support infrastructure must be provided that supports the weight of the EIC detector readout electronics and peripheral equipment, and safely distributes that load to the ground.

5.8. Data Acquisition and Computing Systems

Requirement ID	***Description***
F-DET-COMP.1	DAQ related resources shall require physical space in the experimental hall (e.g. electronics racks). In the experimental hall multiple designated locations must be available to provide necessary proximity to all instrumented DET systems.
F-DET-COMP.2	DAQ related resources shall require physical space within the "counting house". A single separated closed space for computing resources (DAQ Room) shall be required in addition to a User occupied operations space (Control room).
F-DET-COMP.3	The DAQ subsystem shall be designed to operate continuously, independent of the state of the other detector subsystems.

Requirement ID	*Description*
F-DET-COMP.4	Temperature and humidity levels in all spaces where DAQ hardware exists must be maintained within specifications defined by the manufacturer or by custom electronics operational requirements.
F-DET-COMP.5	DAQ Room computing shall have an alternate power source available that is battery or generator backed-up for a subset of core resources in case of power outages.
F-DET-COMP.6	The DAQ system will provide resources for communication with DET subsystems via fiber links between the experimental hall and the DAQ room.
F-DET-COMP.7	The Data Acquisition system will support triggerless (streaming) readout of all DET subsystems as part of normal operation. Asynchronous (triggered) readout from front-end systems will also be supported as an option.
F-DET-COMP.8	The DAQ system will support independent and simultaneous operation (configuration, control and readout) from multiple DET sub-systems.
F-DET-COMP.9	All DAQ system communication with DET subsystems will be supported through proprietary fiber-based links. This includes distribution of a system-wide common clock that can be used to synchronize all DET subsystems. This also includes configuration and monitoring of all DET subsystem front end electronics.
F-DET-COMP.10	There will be sufficient online processing and networking resources to manage the full DET subsystem output for purposes of zero suppression, primary noise and background filtering as well as event identification for purposes of filtering non-physics related signals.
F-DET-COMP.11	Global Timing Unit (GTU) will provide common timing information to all DET sub systems.
F-DET-COMP.12	The DAQ subsystem will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-COMP.13	The configuration of the DAQ subsystem within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-COMP.14	The DAQ subsystem and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-COMP.15	A structural support infrastructure must be provided that supports the weight of the DAQ subsystem and peripheral equipment, and safely distributes that load to the ground.
F-DET-COMP-SC.1	General network infrastructure for support of Slow Controls management, configuration and operation will be provided for all DET subsystems as well as

Requirement ID	***Description***
	all the general ancillary network capable equipment in the counting house and experimental hall.
F-DET-COMP-SC.2	Shared hardware and software computing components will be available for Slow Controls configuration, operation, monitoring and management.
F-DET-COMP-SC.3	Slow Controls will monitor and modify operational parameters of DET subsystems.
F-DET-COMP-SC.4	Slow Controls will manage an alarm chain and its responses.
F-DET-COMP-SC.5	Slow Controls will provide electromechanical interlocks for the DET subsystems.
F-DET-COMP-SC.6	Slow controls will provide user interfaces for the adjustment of operational parameters for DET subsystems.
F-DET-COMP-SC.7	Slow controls will provide Experimental Physics and Industrial Controls System (EPICS) interface that will run on DAQ provided systems.
F-DET-COMP-SC.8	Slow controls will provide collections of operational parameters that DET subsystems will be able to use as restore points.

5.9. Detector Infrastructure

Requirement ID	***Description***
F-DET-INF.1	All components, whether procured or manufactured, will, at a minimum, meet the standards specified by the EIC project AND meet the additional standards and specifications identified in these requirements.
F-DET-INF.2	Where not governed by specific standards, components will be implemented, installed, and utilized in a manner that is consistent with industry best practices.
F-DET-INF.3	The infrastructure systems will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-INF.4	The configuration of the infrastructure systems within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-INF.5	The infrastructure systems and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.

Requirement ID	***Description***
F-DET-INF.6	A structural support infrastructure must be provided that supports the weight of the infrastructure systems and peripheral equipment, and safely distributes that load to the ground.
F-DET-INF.7	Predefined detector envelopes shall not be infringed upon.
F-DET-INF-CRYO.1	A cryogenic transfer system shall be provided within the collider hall to allow cryogenic distribution for the experimental solenoid.
F-DET-INF-MECH.1	Floors in the assembly and collider hall must be adequate to support the static and moving load of the experimental detector systems. Load limits need to be determined and verified.
F-DET-INF-MECH.2	The existing rail system used to move the detector from the assembly hall to the collider hall should be preserved.
F-DET-INF-MECH.3	Cradles, carriages, platforms and other support systems from the STAR experiment shall be preserved for reuse.
F-DET-INF-MECH.4	The existing crane systems in the assembly hall and collider hall shall be preserved.
F-DET-INF-ELEC.1	All detectors require isolated power and grounding from facilities power systems. This will be accomplished from existing and newly installed Delta/Wye transformers with a single point star grounding (AKA clean or magnet ground) scheme at the WAH.
F-DET-INF-COOL.1	The WAH requires cooling capacity adequate for the heat generated by the detector, detector sub systems, detector support electronics and facility systems in the WAH. Comment: New air handlers and cooling systems needed
F-DET-INF-GAS.1	Gas based detectors will require the appropriate gas mixing and handling systems.

5.10. IR Integration & Ancillary Detectors

Requirement ID	***Description***
F-DET-ANC.1	The Low Q^2 detectors shall provide a means to measure scattered electrons at small angles in the backward direction.
F-DET-ANC.2	The B0 system shall provide a means to measure charged particles in the forward direction and to tag neutral particles in the forward direction.
F-DET-ANC.3	The off-momentum detectors shall provide a means to measure charged particles (e.g. primarily protons and/or other decay particles), where these particles have a different magnetic rigidity than the beam being used.
F-DET-ANC.4	The roman pot detectors shall provide a means to measure charged particles close to the beam core.

Requirement ID	***Description***
F-DET-ANC.5	The zero-degree calorimeter shall provide a means to measure neutral particles at small angles.
F-DET-ANC.6	The EIC ancillary detectors will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-ANC.7	The configuration of the EIC ancillary detectors within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-ANC.8	The EIC ancillary detectors and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-ANC.9	A structural support infrastructure must be provided that supports the weight of the EIC ancillary detectors and peripheral equipment, and safely distributes that load to the ground.
F-DET-ANC-LOWQ2.1	The acceptance for the low-Q^2 tagger should complement the central detector to reach the coverage close to the limits given by the divergence of the beam and beamline magnets.
F-DET-ANC-LOWQ2.2	To measure the energy of the scattered electrons the Low-Q^2 tagger will include a calorimeter.
F-DET-ANC-LOWQ2.3	To measure the momentum of the scattered electron the Low-Q^2 tagger will include a tracker.
F-DET-ANC-LOWQ2.4	Low-Q^2 tagger will be positioned next to the outgoing electron beampipe, between the B2eR dipole and Q3eR quadrupole.
F-DET-ANC-LOWQ2.5	LowQ2 system must operate at a full projected EIC luminosity
F-DET-ANC-LOWQ2.6	LowQ2 system must be resistant to extreme background conditions (synchrotron radiation, bremsstrahlung events and slow neutrons in particular) at the levels specified by the simulation studies
F-DET-ANC-B0.1	Silicon detector with sufficient timing and spatial resolution will provide tracking measurements of the charged particles in the hadron-outgoing direction.
F-DET-ANC-B0.2	B0-system shall provide theta coverage in the range $5.5 < \theta < 20.0$ mrad ($4.6 < \eta < 5.9$) with respect to the hadron beam line.
F-DET-ANC-B0.3	B0-system must fit and be integrated into the warm area of the B0-dipole. The B0-systems shall require appropriate power and cabling to support operation of the detector elements. Should have survey marks to determine their physical location
F-DET-ANC-B0.4	B0-system shall measure photons down to 100 MeV.

Requirement ID	***Description***
F-DET-ANC-B0.5	B0-system must operate at a full projected EIC luminosity and must be resistant to extreme background conditions, high neutron flux in particular, at the levels specified by the simulation studies
F-DET-ANC-OFFMO.1	OFF-Momentum detectors will be placed as close as possible to the beam pipe (outside or inside of the vacuum) (to be verified).
F-DET-ANC-OFFMO.2	Silicon detector with sufficient timing and spatial resolution will provide tracking measurements of the charged particles in the hadron-outgoing direction.
F-DET-ANC-OFFMO.3	Must be resistant to extreme background conditions, high neutron flux in particular, at the levels specified by the simulation studies.
F-DET-ANC-ROMAN.1	The Roman-Pots will provide coverage in the range $0.0^* < \theta < 5.0$ mrad ($\eta > 6$) (*depends on beam optics, ca 10 sigma)
F-DET-ANC-ROMAN.2	RPOT will be integrated into the accelerator vacuum system.
F-DET-ANC-ROMAN.3	RPOT will provide good t-measurements of far-forward charged particles.
F-DET-ANC-ROMAN.4	Must be resistant to extreme background conditions, high neutron flux in particular, at the levels specified by the simulation studies.
F-DET-ANC-ZDC.1	ZDC will provide theta coverage in the range $0 < \theta < 4.5$ mrad.
F-DET-ANC-ZDC.2	ZDC will provide good PT (or t) -measurements of far-forward neutral particles (photons and neutrons)
F-DET-ANC-ZDC.3	ZDC will provide good identification and energy measurements of far-forward neutral particles (photons and neutrons)
F-DET-ANC-ZDC.4	Must be resistant to extreme background conditions, high neutron flux in particular, at the levels specified by the simulation studies.
F-DET-ANC-ZDC.5	The ZDC EMCAL calorimeter hall provide photon measurements down to 100 MeV.
F-DET-ANC-ZDC.6	Must be compact enough to fit in the limited space allocated in the accelerator tunnel
F-DET-ANC-ZDC.6	ZDC should provide a VETO for the charged particles
F-DET-ANC-LUMI.1	The luminosity detectors shall be composed of a Pair Spectrometer (PS) with 2 stations (above and below zero-degree line) with tracking layers in front, and a direct photon CAL along the zero-degree line.
F-DET-ANC-LUMI.2	The PS must measure the energy and position of e+e- pairs from bremsstrahlung conversions. The direct photon CAL must measure the energy of the large bremsstrahlung flux while mitigating the high rates of background synchrotron radiation.

Requirement ID	***Description***
F-DET-ANC-LUMI.3	Must be resistant to extreme background conditions, magnetic interference and radiation.

5.11. Polarimetry and Luminosity Systems

Requirement ID	***Description***
F-DET-POL.1	The polarimeters must measure the beam polarizations at all flattop energies.
F-DET-POL.2	The beam polarimetry shall happen concurrent to the physics measurement and be non-invasive.
F-DET-POL.3	The polarimeters will require adequate infrastructure resources (i.e. power, cooling, cryogens, etc.) to ensure it can function reliably during continuous operations.
F-DET-POL.4	The configuration of the polarimeters within the detector will be coordinated to ensure efficient operation and to minimize adverse interactions between sub-systems.
F-DET-POL.5	The polarimeters and its support systems must fit in the available space AND provide adequate plenums and pathways for the delivery of services, resources and communications, and for the removal of heat and waste during operations.
F-DET-POL.6	A structural support infrastructure must be provided that supports the weight of the polarimeters and peripheral equipment, and safely distributes that load to the ground.
F-DET-POL-EPOL.1	Laser shall provide a "photon target" for Compton reaction.
F-DET-POL-EPOL.2	An optical system will be used to determine laser polarization at interaction point.
F-DET-POL-EPOL.3	Windows are required to allow laser to enter and exit beamline vacuum.
F-DET-POL-EPOL-ESR.1	A strip detector will be used to detect scattered electrons from (at least) asymmetry zero crossing to kinematic endpoint.
F-DET-POL-EPOL-ESR.2	A Roman pot will be required to protect electron detector from beam Wakefield.
F-DET-POL-EPOL-ESR.3	The strip detector shall be used to detect back-scattered photons with sufficient resolution measure the spatial asymmetry.
F-DET-POL-EPOL-ESR.4	A calorimeter will be used to measure backscattered photon energy.
F-DET-POL-EPOL-ESR.5	The photon detector system will be at least 20 to 25 meters from the Compton IP (to be verified).
F-DET-POL-EPOL-ESR.6	The electron polarization measurement shall be completed in a context appropriate time frame.

Requirement ID	***Description***
F-DET-POL-EPOL-RCS.1	The photon detector will measure the spatial asymmetry of backscattered photons in multi-photon (integrating) mode.
F-DET-POL-EPOL-RCS.2	The photon detector system will be at least 20 to 25 meters from the Compton IP (to be verified).
F-DET-POL-HPOL.1	Silicon detectors shall measure elastic recoil particles from the polarimeter target.
F-DET-POL-HPOL.2	The Si detector energy response shall be calibrated with two alpha sources (Am & Gd).
F-DET-POL-HPOL.3	Particle identification shall be based on time-of-flight and energy measurements of hits in the Si strips.
F-DET-POL-HPOL.4	A second layer of Si shall be used to reject background from punch-through particles.
F-DET-POL-HPOL-HJET.1	The HJET polarimeter shall measure the polarization throughout a whole hadron store (about 8 hours).
F-DET-POL-HPOL-HJET.2	Silicon detectors must be located to the left and right of the beam direction (in the accelerator plane).
F-DET-POL-HPOL-HJET.3	The atomic target shall be polarized through a set of hyperfine transitions and the target polarization shall be monitored in a Breit-Rabi unit.
F-DET-POL-HPOL-HJET.4	The unpolarized molecular fraction of the target shall be continuously monitored with a beam gas analyzer.
F-DET-POL-HPOL-HJET.5	A zero-degree Calorimeter shall be located downstream of the HJET (separated by a 10-12 Tm dipole magnet).
F-DET-POL-HPOL-PC.1	Six silicon detectors must be located to the left and right of the beam and under 45 degrees with respect to the accelerator plane.
F-DET-POL-HPOL-PC.2	The pC polarimeters shall be equipped with ultra-thin fiber targets which scan the beam profile horizontally and vertically.
F-DET-POL-HPOL-PC.3	The pC polarimeter target stations shall carry enough fiber targets to last throughout a year of EIC operations.
F-DET-POL-HPOL-PC.4	The bias current of the detectors shall be constantly monitored.

6. PERFORMANCE REQUIREMENTS

Performance requirements quantitatively describe how well the functions must be performed in order for the system to be successful in its operating environment.

6.1. Detector Systems

Requirement ID	*Description*
P-DET.1	The EIC central detector shall require a region free of interaction region magnets and other large collider equipment of at least 4.5 m in the backward and 5m in the forward direction around the interaction point.
P-DET.2	The EIC central solenoid magnet combined with tracking detectors shall be capable of providing momentum resolution to a level of spT/pT (%) = 0.05pT + 0.5 in the barrel region and to 0.1pT + 1 in the forward and backward region.
P-DET.3	The electromagnetic calorimeter in the central detector shall be capable of providing a resolution of s(E)/E ~ 10%/sqrt(E) + (1-3) % in the barrel and forward region and s(E)/E ~ 2%/sqrt(E) + (1-3) % in the backward region.
P-DET.4	The impact parameter resolution for heavy flavor measurements enabled by the vertex tracker shall be capable of providing a vertex resolution sxy of level 10/pT x 5 mm.
P-DET.5	The hadronic calorimeter in the central detector shall be capable of providing a resolution of s(E)/E ~ 50%/sqrt(E) + 10% in the forward region.
P-DET.6	The angular acceptance of the far-forward detection shall be capable of providing up to 20 mrad for charged particles and 4.5 mrad for neutrons.
P-DET.7	The acceptance of the far-backward electron detection shall be able to reach 0.0001 GeV < Q^2 < 0.1 GeV^2.
P-DET.8	The EIC central detector shall allow for separation of single-photons from neutral-pion decay into two photons, for momenta up to 10 GeV and to a level of TBD.
P-DET.9	The EIC central detector shall allow an electron-hadron separation with efficiency > 90% and a purity > 80%.
P-DET.10	The EIC central detector system shall have the resolution of 3s separation for particle identification of pions, kaons and protons with momenta up to 10 GeV/c in the barrel region, up to 50 GeV/c in the forward endcap region, and up to 7 GeV/c in the backward endcap region.
P-DET.11	A gap of at least 10 cm must be provided between the interior face of the Hadron endcap and the adjacent face of the central detector.
P-DET.12	A gap of at least 10 cm must be provided between the interior face of the Lepton endcap and the adjacent face of the central detector.

6.2. Tracking Systems

Requirement ID	*Description*
P-DET-TRAK.1	The tracking system must provide a minimum pT of 100 MeV π, 130 MeV K.

Requirement ID	***Description***
P-DET-TRAK.2	The tracking system shall provide cooling (air/liquid) for silicon sensors.
P-DET-TRAK.3	The tracking system shall provide power supplies for bias and low voltages.
P-DET-TRAK.4	The tracking system shall provide a gas mixing system for gaseous detectors.
P-DET-TRAK.5	The tracking system will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-TRAK.6	The tracking system will require electrical power to support the operation of the detector sub-components and electronics.
P-DET-TRAK.7	The tracking system will require communications infrastructure to support data collection, monitoring and control.
P-DET-TRAK.8	The tracking system will require a structural support system to carry the cumulative weight of the detectors and peripheral services, and to distribute that load to other supporting infrastructure or to the floor.
P-DET-TRAK.9	The tracking system must fit within the constraints of the surrounding detector sub-systems and have adequate space for the delivery of services and the removal of waste.
P-DET-TRAK-BAR.1	The barrel tracking system shall provide a momentum resolution < 5%.
P-DET-TRAK-BAR.2	The barrel tracking system shall provide a low material budget: < 5% X0.
P-DET-TRAK-BAR.3	The barrel tracking system shall provide a momentum resolution of $\sigma p/p \sim 0.05\% \times p + 0.5\%$ in the rapidity region between -1 to 1.
P-DET-TRAK-BAR.4	The barrel tracking system shall provide a spatial resolution of $\sigma xy \sim 20/pT \oplus 5$ μm in the rapidity region between -1 to 1.
P-DET-TRAK-BCK.1	The backward tracking system shall provide coverage in rapidity region between -3.5 to -1.0.
P-DET-TRAK-BCK.2	The backward tracking system shall provide a momentum resolution of $\sigma p/p \sim 0.05\% \times p + 1.0\%$ in the rapidity region between -2.5 to -1.0.
P-DET-TRAK-BCK.3	The backward tracking system shall provide a momentum resolution of $\sigma p/p \sim 0.10\% \times p + 2.0\%$ in the rapidity region between -3.5 to -2.5.
P-DET-TRAK-BCK.4	The backward tracking system shall provide a spatial resolution of $\sigma xy \sim 30/pT \oplus 20$ μm in the rapidity region between -2.5 to -1.0.
P-DET-TRAK-BCK.5	The backward tracking system shall provide a spatial resolution of $\sigma xy \sim 30/pT \oplus 40$ μm in the rapidity region between -3.5 to -2.5.
P-DET-TRAK-FWD.1	The forward tracking system shall provide coverage in rapidity region between -1.0 to 3.5.
P-DET-TRAK-FWD.2	The forward tracking system shall provide a momentum resolution of $\sigma p/p \sim 0.05\% \times p + 1.0\%$ in the rapidity region between 1.0 to 2.5.

Requirement ID	***Description***
P-DET-TRAK-FWD.3	The forward tracking system shall provide a momentum resolution of $\sigma p/p \sim 0.10\% \times p + 2.0\%$ in the rapidity region between 2.5 to 3.5.
P-DET-TRAK-FWD.4	The forward tracking system shall provide a spatial resolution of $\sigma xy \sim 30/pT \oplus 20$ μm in the rapidity region between 1.0 to 2.5.
P-DET-TRAK-FWD.5	The forward tracking system shall provide a spatial resolution of $\sigma xy \sim 30/pT \oplus 40$ μm in the rapidity region between 2.5 to 3.5.

6.3. Particle Identification Systems

Requirement ID	***Description***
P-DET-PID.1	The PID detectors will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-PID.2	The PID detectors will require electrical power to support the operation of the detector sub-components and electronics.
P-DET-PID.3	The PID detectors will require communications infrastructure to support data collection, monitoring and control.
P-DET-PID.4	The PID detectors will require a structural support system to carry the cumulative weight of the detectors and peripheral services, and to distribute that load to other supporting infrastructure or to the floor.
P-DET-PID.5	The PID detectors and support system must fit within the constraints of the surrounding detector sub-systems and have adequate space for the delivery of services and the removal of waste.
P-DET-PID-BAR-DIRC.1	The PID Detector in the barrel region will require appropriate support structure to hold the detector in place as well as all sub-detector systems that reside within its bore.
P-DET-PID-BAR-DIRC.2	The PID Detector in the barrel region will require appropriate support DC voltage and power for operating detector sensors and associated electronics. HV up to 2000V negative is for 5x72 channels and LV for 4x72 channels.
P-DET-PID-BAR-DIRC.3	The PID Detector in the barrel region will require cooling and removal of heat generated by detector electronics and digitizers.
P-DET-PID-BAR-DIRC.4	The PID Detector in the barrel region will require detector signal transmission electronics and lines defined by the DAQ system.
P-DET-PID-BAR-DIRC.5	The PID Detector in the barrel region will require survey marks or hooks for survey tools to determine its physical location in the barrel as a whole and its sub-components.
P-DET-PID-BAR-DIRC.6	The PID detector requires a 0.5mrad tracking resolution as input to reach its peak performance.

Requirement ID	*Description*
P-DET-PID-BAR-DIRC.7	The DIRC system will provide 3 sigma pi/K separation above 1 GeV/c.
P-DET-PID-BAR-TOF.1	Will require DC voltage supply of approximately 11V. There will be 2 lines for each of the 144 connections.
P-DET-PID-BAR-TOF.2	Will require sensor voltage supply of approximately 200V. There will be 2 lines for each of the 144 connections.
P-DET-PID-BAR-TOF.3	Will require DAQ fiber optics. Two lines for each of the 144 connections.
P-DET-PID-BAR-TOF.4	Will require cooling to remove 4kW of heat
P-DET-PID-BAR-TOF.5	TOF will weigh approximately 70 KG, and will require structural support to maintain its position and stability.
P-DET-PID-BAR-TOF.6	The time-of-flight system will provide 3 sigma pi/K separation from 0.2 up to 1.2 GeV/c.
P-DET-PID-FWD-RICH.1	The PID Detector in the forward region will require appropriate support structure to hold the detector in place.
P-DET-PID-FWD-RICH.2	The PID Detector in the forward region will require appropriate support DC voltage and power for operating detector sensors and associated electronics. The expected LV are 70V/1mA 312 channels, 4V/5A 312 channels, 3V/5A 312 channels 4V/2A 312 channels.
P-DET-PID-FWD-RICH.3	The PID Detector in the forward region will require cooling and removal of heat generated by detector electronics and digitizers. Expect coolant at "room" temperature to remove 2.75kW heat for each of the 6 sectors.
P-DET-PID-FWD-RICH.4	The PID Detector in the forward region will require detector signal transmission electronics and lines defined by the DAQ system.
P-DET-PID-FWD-RICH.5	The PID Detector in the forward region will require survey marks or hooks for survey tools to determine its physical location in the barrel as a whole and its sub-components.
P-DET-PID-FWD-RICH.6	The RICH detector will require a continuous recirculating flow of radiator gas. This will require a gas recovery system operating at high pressure outside the detector on the platform. (Design authority required)
P-DET-PID-FWD-RICH.7	The RICH detector will require a continuous flow of dry nitrogen to protect the aerogel radiator.
P-DET-PID-FWD-RICH.8	The RICH detector will require subzero cooling for its photo-sensors at -30deg C. Cooling lines with insulation required.
P-DET-PID-FWD-RICH.9	Input from tracking with an angular resolution of about 0.X mrad is required to reach full performance of the dRICH.
P-DET-PID-FWD-RICH.10	The dRICH system will provide 3 sigma pi/K separation between 3 and 50 GeV/c.

Requirement ID	*Description*
P-DET-PID-FWD-TOF.1	The PID Detector in the forward region will require appropriate support structure to hold the detector in place.
P-DET-PID-FWD-TOF.2	Will require DC voltage supply of approximately 11V. There will be 2 lines for each of the 212 connections.
P-DET-PID-FWD-TOF.3	Will require sensor voltage supply of approximately 200V. There will be 2 lines for each of the 212 connections.
P-DET-PID-FWD-TOF.4	Will require DAQ fiber optics. Two lines for each of the 212 connections.
P-DET-PID-FWD-TOF.5	Will require cooling to remove 13kW of heat
P-DET-PID-FWD-TOF.6	The time-of-flight system will provide 3 sigma pi/K separation from 0.2 up to 2.3 GeV/c.
P-DET-PID-BCK-RICH.1	The PID Detector in the backward region will require appropriate support structure to hold the detector in place.
P-DET-PID-BCK-RICH.2	The PID Detector in the backward region will require appropriate support DC voltage and power for operating detector sensors and associated electronics. HV up to 2000V negative for 68x5 channels and LV for 68x4 channels.
P-DET-PID-BCK-RICH.3	The PID Detector in the backward region will require cooling and removal of heat generated by detector electronics and digitizers.
P-DET-PID-BCK-RICH.4	The PID Detector in the backward region will require detector signal transmission electronics and lines defined by the DAQ system.
P-DET-PID-BCK-RICH.5	The PID Detector in the backward region will require survey marks or hooks for survey tools to determine its physical location in the barrel as a whole and its sub-components.
P-DET-PID-BCK-RICH.6	The PID detector in the backward region will require a continuous flow of dry nitrogen to protect the aerogel radiator.
P-DET-PID-BCK-RICH.7	The particle identification system will provide 3 sigma pi/K separation from 1 up to 7 GeV/c.

6.4. Electromagnetic Calorimetry Systems

Requirement ID	*Description*
P-DET-ECAL.1	The EMCal detectors and support system must fit within the constraints of the surrounding detector sub-systems and have adequate space for the delivery of services and the removal of waste.
P-DET-ECAL.2	The EMCal systems will require a structural support system to carry the cumulative weight of the detectors and peripheral services, and to distribute that load to other supporting infrastructure or to the floor, and will require survey marks to determine their physical location.

Requirement ID	***Description***
P-DET-ECAL.3	The EMCal systems will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-ECAL.4	The EMCal systems will require electrical power to support the operation of the detector sub-components and electronics.
P-DET-ECAL.5	The EMCal systems will require communications infrastructure to support data collection, monitoring and control.
P-DET-ECAL.6	Photosensors and readout electronics must tolerate the magnetic field in the subsystem location.
P-DET-ECAL.7	The noise level per channel shall be low enough to provide photon measurements down to the minimal photon energy.
P-DET-ECAL.8	The monitoring system shall contain: Light system (LED or laser), test pulse (for electronics), dark current (for SiPM).
P-DET-ECAL-BAR.1	Energy resolution shall be s(E)/E < 10%/sqrt(E) + (2-3) %.
P-DET-ECAL-BAR.2	System shall provide high power for e/pi separation down to 1 GeV/c.
P-DET-ECAL-BAR.3	System shall be capable of distinguishing two showers with opening angle down to 30 mrad.
P-DET-ECAL-BAR.4	The first imaging layer shall provide a charged tracking point with space resolution of <150um.
P-DET-ECAL-BAR.5	Shall have sufficient dynamic range to detect MIP signals in all layers.
P-DET-ECAL-BCK.1	System shall cover pseudo rapidity down to -3.5.
P-DET-ECAL-BCK.2	Energy resolution shall be s(E)/E ~ (2-3) %/sqrt(E) + (1-2) %
P-DET-ECAL-BCK.3	System shall have high power for e/pi separation down to 1 GeV/c.
P-DET-ECAL-BCK.4	System shall have high granularity and be capable of distinguishing two showers with opening angle down to 0.015 (=>tower size).
P-DET-ECAL-BCK.6	System shall have low material budget on the way from the vertex: <5%X0 in the 1st half a way, or <10%X0 on the second half a way, or <30%X0 just in front of EMCal (within 10cm).
P-DET-ECAL-BCK.7	A cooling system shall be provided.
P-DET-ECAL-FWD.1	System shall have energy resolution s(E)/E < (10-12) %/sqrt(E) + (2-3) %.
P-DET-ECAL-FWD.2	System shall have sufficient granularity to be capable of distinguishing two showers with opening angle down to 0.005 (=>tower size).

6.5. Hadronic Calorimetry Systems

Requirement ID	***Description***
P-DET-HCAL.1	Must be compact enough to fit in the limited space allocated for the EIC detector, but at the same time provide a hermetic coverage and have sufficient depth in order to efficiently contain the hadronic showers.
P-DET-HCAL.2	The HCal systems will require a structural support system to carry the cumulative weight of the detectors and peripheral services, and to distribute that load to other supporting infrastructure or to the floor, and will require survey marks to determine their physical location.
P-DET-HCAL.3	The HCal systems will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-HCAL.4	The HCal systems will require electrical power to support the operation of the detector sub-components and electronics.
P-DET-HCAL.5	The HCal systems will require communications infrastructure to support data collection, monitoring and control.
P-DET-HCAL.6	Must be resilient against harsh background conditions, high neutron flux in the IR area in particular, at the levels specified by the simulation studies.
P-DET-HCAL.7	HCal layout shall minimize the gaps in coverage between barrel and endcaps.
P-DET-HCAL.8	Shall provide practical detection threshold ~500 MeV as defined in the EIC Yellow Report.
P-DET-HCAL-BAR.1	Should have a moderate energy resolution s(E)/E ~ 100%/sqrt(E) + 10% constant term.
P-DET-HCAL-BAR.2	Must have sufficient granularity in azimuthal and polar angle to resolve neutral clusters.
P-DET-HCAL-BAR.3	Shall have sufficient radial depth to contain medium energy hadronic showers past 2-3 interaction length material of the e/m calorimeter and the solenoid.
P-DET-HCAL-BCK.1	Must provide capability to cover pseudo rapidity range down to at least -3.5.
P-DET-HCAL-BCK.2	Shall provide capability to have energy resolution s(E)/E ~ 100%/sqrt(E) + a 10% constant term.
P-DET-HCAL-BCK.3	Should be built of non-magnetic materials
P-DET-HCAL-BCK.4	Must provide space to have tower depth of 3-4 interaction lengths (together with the e/m PWO crystal calorimeter) in order to suppress longitudinal leakage for relatively small hadron energies in the e-endcap.
P-DET-HCAL-BCK.5	Shall not interfere with the detector solenoid magnetic field
P-DET-HCAL-FWD.1	Must cover pseudo rapidity range up to at least 3.5.
P-DET-HCAL-FWD.2	Shall have energy resolution s(E)/E ~ 50%/sqrt(E) + a 10 % constant term.

Requirement ID	***Description***
P-DET-HCAL-FWD.3	Granularity (transverse tower size) should be adequate to resolve deposits from different charged and neutral hadrons taking into account the local abundance, resulting in transverse tower sizes of at least ~5x5 cm^2 for \eta < 2.5 and 3x3 cm^2 for 2.5 < \eta < 4
P-DET-HCAL-FWD.4	Must have tower depth of 6-7 interaction lengths (together with the e/m section) in order to avoid longitudinal leakage for highest energy hadrons at the EIC.
P-DET-HCAL-FWD.5	Granularity (longitudinal tower size) should be adequate to allow for association of showers starting at different depth to the corresponding charged and neutral hadrons. At least 5 longitudinal segments should be read out to determine the shower maximum reliably. For higher rapidity the segmentation should be increased due to the higher particle density
P-DET-HCAL-FWD.6	Calorimeter absorber blocks in the volume allocated for the flux return must be partly built out of a magnetic steel with the permeability defined by the solenoid designers

6.6. Solenoid Magnet

Requirement ID	***Description***
P-DET-MAG.1	The detector solenoid and supporting infrastructure must fit within the constraints of the surrounding detector sub-systems and have adequate space for the delivery of services and the removal of waste.
P-DET-MAG.2	The detector solenoid systems will require a structural support system to carry the cumulative weight of the detectors and peripheral services, and to distribute that load to other supporting infrastructure or to the floor.
P-DET-MAG.3	The detector solenoid systems will require conventional cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-MAG.4	The detector solenoid will require cryogenic cooling infrastructure that is sufficient to maintain the solenoid cryostat temperature within an acceptable range.
P-DET-MAG.5	The detector solenoid will require an ice management system.
P-DET-MAG.6	The detector solenoid systems will require electrical power to support the operation of the magnet and its peripheral sub-systems.
P-DET-MAG.7	The detector solenoid systems will require communications infrastructure to support data collection, monitoring and control.
P-DET-MAG.8	The EIC detector magnet must be consistent with the cryogenic capability of the supply.

Requirement ID	***Description***
P-DET-MAG.9	The EIC detector magnet shall be able to operate at 4.5K (liquid Helium).
P-DET-MAG.10	The detector solenoid shall be able to operate at a lower field (0.5 T), without sacrificing the field quality.
P-DET-MAG.11	The detector solenoid shall be aligned along the electron axis.
P-DET-MAG.12	The magnet shall provide a minimum 2.84 meter bore diameter to support insertion of the detector elements.
P-DET-MAG.13	The detector solenoid must produce a consistent, stable magnetic field that is sufficient to satisfy the requirements of all subordinate detectors.
P-DET-MAG.14	The detector solenoid's magnetic field extends beyond its physical boundaries, and must be accounted for and managed.
P-DET-MAG.15	The flux return shall reduce the magnetic field to no more than 10 Gauss at the location of the most nearby active beam transport elements (IR magnets).
P-DET-MAG-I&C.1	The magnet I&C should be able diagnose a quench and initiate the energy dumping procedure.
P-DET-MAG-I&C.2	The magnet I&C should be able to provide all the interlocks required for the magnet safe operation.
P-DET-MAG-CCR.1	The cryo-can should be able to hold the required volume of Liquid Helium and shall be protected for pressure overages.
P-DET-MAG-CCR.2	The cryo lines should be long enough to reach the magnet from the relevant cryo-connection in either the Wide-Angle Hall or when rolled out to the Assembly Hall.
P-DET-MAG-CCR.3	The cryo-flex line should have sufficiently low losses, so that the input temperature to the magnet can be maintained.
P-DET-MAG-PSU.1	Magnet power supply shall be able to dump the magnet stored energy in a dump resistor.

6.7. Electronics Systems

Requirement ID	***Description***
P-DET-ELEC.1	The electronics systems, their support systems, enclosures, and distribution systems must fit within the space constraints of their areas of installation, and leave adequate space for the delivery of other services and the removal of waste.
P-DET-ELEC.2	The electronics systems will require a structural support system to deliver cabling and services throughout the experimental hall and control room.

Requirement ID	*Description*
P-DET-ELEC.3	The electronics systems will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-ELEC.4	The electronics systems will require a source of electrical power that will energize local devices and be distributed to other detectors and systems.
P-DET-ELEC.5	The electronics systems will require communications infrastructure that will be used to support data collection, monitoring and control.
P-DET-ELEC.6	The electronics systems must be shielded against the effects of electromagnetic interference, radiation, and other external influences that may impact their performance.
P-DET-ELEC.7	In the current conceptual design, two ASICs shall be used for the readout of MPGD and photonic sensors. These will be 64-channel, 1 W nominal power consumption. MPGDs: amplification (1 to 10), shaping (40 to 250 ns), digitization (12-bit precision), better than 20 ns timing resolution. Photonic sensors: amplification (2 to 30 mV/fC), shaping (1 to 40 ns), digitization (10 to 14-bit precision), timing resolution (100 ps to <1 ns).
P-DET-ELEC.8	FEB shall include ASICs, support components and interfaces, where applicable. FEBs may implement data reduction techniques, such as zero suppression, to reduce data volume.
P-DET-ELEC.9	RDO shall include FPGAs and interface via optical fibers to the DAQ. Data aggregation (10:1), reduction techniques and processing via ML/AI algorithms shall reduce data volume by a factor of 10 or more during normal operation.
P-DET-ELEC.10	Electronics and electronic components shall meet commercial operating environment specifications; critical systems shall consider conformance to industrial specifications, and use industrial/automotive grade components when available and economically feasible.
P-DET-ELEC.11	The detector ground (i.e., Clean Ground) shall be segregated from other equipment grounding. The grounding around the solenoid and the south platform from the detector ground reference, which shall be isolated from other systems and structures and connected to the experimental area ground via six (6) low impedance, insulated 4/0 wires. Other equipment, such as the solenoid power supplies and control systems, shall connect to the experimental area grounding connection separately from the clean ground. All connections shall be affected via low impedance insulated wires (e.g., 4/0). These wires shall have differently colored insulation for easy identification of segregated grounds.
P-DET-ELEC.12	Power supplies (HV, LV, Bias) shall be of the floating type and referenced to the detector clean ground.
P-DET-ELEC.13	Cabling shall be rated to National Electrical Code (NEC) 2020, NFPA 70, UL CL2 or better. Cable jackets shall be marked to UL standards by the

Requirement ID	***Description***
	manufacturer. Cables rated with the X suffix (Dwellings) (e.g., CL2X, CMX) are not permitted.
P-DET-ELEC.14	Cable routing shall conform to NECA/NEMA 105/2007 for open cable tray systems.
P-DET-ELEC.15	All electrical equipment in the experimental area shall conform to EMI/RFI standards FCC Class B, CISPR11/EN 55011 Class B, CISPR22/EN 55022 Class B, EN 61000-6-3 or equivalent. Exceptions shall be evaluated via EMI/RFI measurement surveys.
P-DET-ELEC.16	Cabinet racks (19-inch type), open or closed frame types (e.g., Hammond C4F247736), shall be COTS and equipped with horizontal and vertical cable managers. These shall accommodate a minimum of three equipment crates or chassis.
P-DET-ELEC.17	Equipment crates or chassis for HV, LV and Bias supplies and for data acquisition shall be rated for a maximum of 2.5 kW each and powered from 120 VAC or 208 VAC 3-phase, preferably.
P-DET-ELEC.18	Any equipment that is powered by a plug and cord shall be either listed by a Nationally Recognized Testing Lab (NRTL) such as UL or have been approved by the Laboratory EEI (Electrical Equipment Inspection) program.
P-DET-ELEC.19	Cables shall have sufficient excess length (slack or service loop) to allow connection without strain. Cables outside of the enclosure shall be dressed in a way that allows removal of any module without obstruction, those inside the enclosure shall have sufficient slack to allow visual inspection, connection, and disconnection with all other modules installed.
P-DET-ELEC.20	Electrical components shall be derated to 80%, if the manufacturer has not already done so, and if such derating is economically feasible.
P-DET-ELEC.21	Enclosures and removable modules should use captive hardware when possible.

6.8. Data Acquisition and Computing Systems

Requirement ID	***Description***
P-DET-COMP.1	The DAQ systems, their support systems, enclosures, and distribution systems must fit within the space constraints of their areas of installation, and leave adequate space for the delivery of other services and the removal of waste.
P-DET-COMP.2	The DAQ systems will require consoles, cabinets, and structural support systems to hold equipment and deliver cabling and services throughout the experimental hall, control room, and to locations in the interaction region.

Requirement ID	*Description*
P-DET-COMP.3	The DAQ systems will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-COMP.4	The DAQ systems will require electrical power to support the operation of the detector sub-components and electronics.
P-DET-COMP.5	All DAQ powered services in the experimental hall and counting house must have access to either 120V AC or 208V AC three phase power.
P-DET-COMP.6	All DAQ services in the experimental hall must have access to a "clean" ground to maintain good signal quality.
P-DET-COMP.7	All DAQ services in the experimental hall must be adequately shielded from prompt radiation from the beam crossing region of the EIC detector to minimize electronics failures.
P-DET-COMP.8	User management of required cabling shall be facilitated via a combination of cable trays and/or conduit or rigging between the DAQ room patch panels and the experimental hall areas where DAQ and general network fibers are required.
P-DET-COMP.9	DAQ Room resources shall sit on a raised floor to allow for forced air, power and signal cabling to be routed to all racks.
P-DET-COMP.10	DAQ Room computing shall require electrical power via raised floor distribution sufficient to support XX kW total power usage levels.
P-DET-COMP.11	DAQ Room computing shall require HVAC cooling via raised floor distribution sufficient to support a XX kW power outlay at temperatures at or below 76 degrees Fahrenheit.
P-DET-COMP.12	Fiber connected to patch panels from the DAQ Room to the external Data Center shall at a minimum be implemented with enough single mode fiber capable of supporting experimental data bandwidths with redundant 100Gb and 400Gb bidirectional network links.
P-DET-COMP.13	Fiber connected to patch panels from the Rack Room to Experimental Hall Patch panel shall be implemented with enough single and/or multi-mode fiber capable of supporting both commercial and proprietary bidirectional serial links for all detector system requirements. Minimum aggregate bandwidth capabilities shall not be less than 10Tb/s.
P-DET-COMP.14	Online data processing capabilities within the experimental hall and counting house shall be sufficient to support event identification, background & noise suppression and data quality monitoring necessary to be able to keep up with front-end data rates and temporarily store filtered data - ready for further offline processing.
P-DET-COMP.15	Online data storage capabilities within the counting house COMP resources shall be fast enough to keep up with processed data rates and large enough to hold all acquired data locally for up to 72 hours.

Requirement ID	***Description***
P-DET-COMP.16	Network infrastructure for online computing will provide at least 100Gb non-blocking ethernet links between compute nodes.
P-DET-COMP.17	Individual fiber interfaces with all DET subsystems will support at least a 10Gb serial link to DAQ online processing.
P-DET-COMP.18	The GTU will deliver a stable high-resolution clock at the level of 100ps jitter to DET subsystems, with an option to deliver up to a 5ps jitter clock to DET subsystems requiring very high-resolution timing measurements.
P-DET-COMP.19	The DAQ system will require interfaces to the accelerator which provide timing and data exchange, and allow the accelerator to read the state and condition of detector systems.
P-DET-COMP.20	The DAQ system will transfer collected data from the local systems to an offline storage facility.
P-DET-COMP-SC.1	The general network infrastructure within the counting house and experimental hall will support at a minimum 1 and 10 Gb ethernet links.
P-DET-COMP-SC.2	Enough computing hardware will be made available for all DET subsystems to run a minimum of 20 input/output controllers (IOCs) to encapsulate subsystem performance.
P-DET-COMP-SC.3	All temperatures recorded by Slow Controls shall be measured with a minimum precision of 0.1°C.
P-DET-COMP-SC.4	All voltages recorded by Slow Controls shall be measured with a minimum precision of 10mV.
P-DET-COMP-SC.5	All currents recorded by Slow Controls shall be measured with a minimum precision of 1mA.
P-DET-COMP-SC.6	The flow of all fluids recorded by Slow Controls shall be measured with a minimum precision of 1 lpm.
P-DET-COMP-SC.7	All pressures recorded by Slow Controls shall be measured with a minimum precision of 1 mbar.
P-DET-COMP-SC.8	The concentration of gases in mixtures shall be recorded by Slow Controls with a minimum precision of 1%.
P-DET-COMP-SC.9	Slow Controls shall generate alarms with at least three levels of priority: high, low, and diagnostic.
P-DET-COMP-SC.10	The alarm chain will maintain standard operation in the event of a network and/or power outage.
P-DET-COMP-SC.11	All interlocks will be reported in the alarm chain with a priority level of low or high.
P-DET-COMP-SC.12	Interlock controllers and remote IO will maintain standard operation in the event of a network and/or power outage.

Requirement ID	*Description*
P-DET-COMP-SC.13	Interlocks will be meet a minimum performance level (PL) appropriate for the system to be interlocked.

6.9. Detector Infrastructure

Requirement ID	*Description*
P-DET-INF-STD-SAF.1	Safety factors will be calculated based off yield strength.
P-DET-INF-STD-SAF.2	Parts with a safety factor of 3 or greater will be generally accepted and will not require further review.
P-DET-INF-STD-SAF.3	Parts with a safety factor of 1.5 to 3 are required to be internally reviewed to determine if it's acceptable.
P-DET-INF-STD-SAF.4	Parts with a safety factor of 1.5 or less will be considered unacceptable.
P-DET-INF-STD-SAF.5	Bolts with a safety factor of 2 or greater will be generally accepted and will not require further review.
P-DET-INF-STD-SAF.6	Bolts with a safety factor of 1 to 2 are required to be internally reviewed to determine if it's acceptable.
P-DET-INF-STD-SAF.7	Bolts with a safety factor of 1 or less will be considered unacceptable.
P-DET-INF-STD-SAF.8	Engineering judgment will be used for identifying and disregarding any singularities which may go below these minimums.
P-DET-INF-STD-PIPECLR.1	Inner Detectors will have a minimum clearance to the beampipe of 5mm all around.
P-DET-INF-STD-PIPECLR.2	For Inner Detectors that will be installed over flanges then the minimum clearance will be 5mm to the flange all around.
P-DET-INF-STD-PIPECLR.3	All other central detectors will have a minimum clearance to the beampipe of 10mm all around.
P-DET-INF-STD-PIPECLR.4	For all other central detectors that will be installed over flanges then the minimum clearance will be 10mm to the flange all around.
P-DET-INF-STD-PIPECLR.5	Endcaps will have a minimum clearance to the beampipe of 30mm all around.
P-DET-INF-STD-MECHCLR.1	Carbon Fiber Tube adjustments in the beampipe shall have an angular tolerance of ±1 mrad.
P-DET-INF-STD-MECHCLR.2	Carbon Fiber Tube adjustments in the Barrel EMCal will be within ±5m.
P-DET-INF-STD-MECHCLR.3	Carbon Fiber Tube adjustments in the STAR Cradle will be within ±~1/8" (4mm).
P-DET-INF-STD-MECHCLR.4	The Carbon Fiber Tube shall be able to be located within 12 mm.
P-DET-INF-STD-MECHCLR.5	The Barrel EMCal shall be able to be located within 5 mm.

Requirement ID	***Description***
P-DET-INF-STD-MECHCLR.6	The STAR Cradle shall be able to be located within 4 mm.
P-DET-INF-STD-RCS.1	Endcaps shall have cutouts to accommodate spaces needed for the RCS beampipe. The minimum clearance shall be 30mm
P-DET-INF-STD-RCS.2	The RCS beampipe shall be supported by either the South Platform or the Central Barrel.
P-DET-INF-STD-RCS.3	If extra steel is needed for the fringe field, then support for it shall also be provided by either the South Platform or Central Barrel.
P-DET-INF-STD-WEIGHT.1	The weight limit of 1200 metric tons of the floor shall not be exceeded.
P-DET-INF-STD-WEIGHT.2	The combined weight of the Central Barrel shall not exceed 1200 metric tons.
P-DET-INF-STD-WEIGHT.3	The combined weight of both halves of the Hadron endcap shall not exceed 450 metric tons.
P-DET-INF-STD-WEIGHT.4	The combined weight of both halves of the Hadron endcap shall not exceed 275 metric tons.
P-DET-INF-STD-ALIGN.1	The main barrel and both endcaps shall be rotated 8mrad counterclockwise about the Y axis (looking top down).
P-DET-INF-STD-ALIGN.2	The tolerance for this measurement shall be ± 1mrad.
P-DET-INF-STD-SVCGAP.1	Area needed around pfRICH: 2000 cm2 + 10% = 2200 cm2
P-DET-INF-STD-SVCGAP.2	Area needed around EEEMcal: 2150cm2 + 10% = 2365 cm2
P-DET-INF-STD-SVCGAP.3	Area needed between CF tube and dRICH: 4350 cm2 + 10% = 4785 cm2
P-DET-INF-STD-SVCGAP.4	Area needed between dRICH boxes: 4800 cm2 + 10% = 5280 cm2
P-DET-INF-STD-SVCGAP.5	Area needed between dRICH and HCAL: 5650 cm2 + 10% = 6215 cm2
P-DET-INF-CRYO.1	The cryogenic transfer system must be installed in the available space and have no interferences with new and existing infrastructure.
P-DET-INF-CRYO.2	The cryogenic transfer system will have a support structure and connectors that allow the central detector to be relocated between the experimental hall and the assembly area without disconnection.
P-DET-INF-CRYO.3	The cryogenic system shall provide a flow rate of XX g/s to the experimental solenoid.
P-DET-INF-MECH.1	The floor, rails and cradle shall be capable of supporting a static or moving load of 1200 tons (central detector).
P-DET-INF-MECH.2	A rail system for the Hadron end cap calorimeters shall be installed that is sufficient to carry 600ton and maintain a free center gap of 10 centimeters.
P-DET-INF-MECH.3	A rail system for the Lepton end cap calorimeters shall be installed that is sufficient to carry 400ton and maintain a free center gap of 10 centimeters.

Requirement ID	*Description*
P-DET-INF-ELEC.1	60 Amp 4 wire power (120/ 208V AC) shall be fed to each 19-inch equipment rack from a circuit breaker on the detector platform.
P-DET-INF-ELEC.2	Cabinets are bonded/ grounded to the appropriate clean ground.
P-DET-INF-COOL.1	The temperature in the WAH should be maintained between 20°C to 25°C
P-DET-INF-COOL.2	Relative Humidity under 50% to prevent condensation.
P-DET-INF-COOL.3	Where fan/ blower cooling is inadequate, water-cooled heat exchangers are required to maintain the ambient environment of enclosed electronic assemblies and equipment to a temperature of under 40°C.
P-DET-INF-GAS.1	Gas based detectors shall be provided with the appropriate gas handling systems.

6.10. IR Integration & Ancillary Detectors

Requirement ID	*Description*
P-DET-ANC.1	The ancillary detectors and support system must fit within the constraints of the surrounding systems and have adequate space for the delivery of services and the removal of waste.
P-DET-ANC.2	The ancillary systems will require a structural support system to carry the cumulative weight of the detectors and peripheral services, and to distribute that load to other supporting infrastructure or to the floor, and will require survey marks to determine their physical location.
P-DET-ANC.3	The ancillary systems will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-ANC.4	The ancillary systems will require electrical power to support the operation of the detector sub-components and electronics.
P-DET-ANC.5	The ancillary systems will require communications infrastructure to support data collection, monitoring and control.
P-DET-ANC-LOWQ2.1	Low-Q2 will have one or more tagger stations to cover the maximum momentum acceptance
P-DET-ANC-LOWQ2.2	Each Low-Q2 station will have up to 4 silicon tracking layers
P-DET-ANC-LOWQ2.3	The Low-Q2 tracking system shall have a spatial resolution providing a momentum resolution < 5%.
P-DET-ANC-LOWQ2.4	Low- Q^2 trackers shall provide timing resolution sufficient to resolve 10ns beam buckets
P-DET-ANC-LOWQ2.5	Low-Q^2 trackers will have Q^2 acceptance between 0 and 0.1 GeV^2

Requirement ID	***Description***
P-DET-ANC-LOWQ2.6	Low- Q^2 tagger will be able to measure the momentum of more than 10 electrons per bunch crossing.
P-DET-ANC-LOWQ2.7	The Low-Q^2 system shall provide cooling (air/liquid) for silicon sensors.
P-DET-ANC-LOWQ2.8	The Low-Q^2 system shall provide power supplies for bias and low voltages.
P-DET-ANC-LOWQ2.9	The position of the Low-Q^2 tracker should be removable and adjustable to accommodate different running conditions.
P-DET-ANC-LOWQ2.10	Low- Q^2 calorimeter will have granularity (cell size) XX (to be determined)
P-DET-ANC-LOWQ2.11	Low-Q2 calorimeter energy resolution for electrons shall be s(E)/E < 10%/sqrt(E) + 3%.
P-DET-ANC-LOWQ2.12	Low- Q^2 tagger 1 calorimeter will have dimensions XX in X and XX in Y (to be determined)
P-DET-ANC-LOWQ2.13	Low- Q^2 tagger 2 calorimeter will have dimensions XX in X and XX in Y (to be determined)
P-DET-ANC-LOWQ2.14	The Low-Q2 detectors must handle a data rate and operate reliably at a full projected EIC luminosity.
P-DET-ANC-LOWQ2.15	The Low-Q2 detector must be protected from magnetic interference.
P-DET-ANC-LOWQ2.16	The performance of the Low-Q2 detector will be dependent on the characteristics of the electron beam pipe exit window.
P-DET-ANC-B0.1	B0 tracker shall have a pixel granularity < XX (to be determined)
P-DET-ANC-B0.2	B0 tracker shall have a timing resolution < XX (to be determined)
P-DET-ANC-B0.3	B0- tracker shall have at least 4 layers
P-DET-ANC-B0.4	The barrel tracking system shall provide a low material budget: < 5% X0.
P-DET-ANC-B0.5	B0 tracker dimensions shall be 24 [cm] in X and 30 [cm] in Y
P-DET-ANC-B0.6	B0 tracker shall provide momentum resolution < 6%.
P-DET-ANC-B0.7	B0 calorimeter dimensions shall be 24 [cm] in X and 30 [cm] in Y
P-DET-ANC-B0.8	B0 calorimeter thickness shall be 7 [cm] 6.4(X/X0)
P-DET-ANC-B0.9	B0 calorimeter shall provide high granularity which is capable of distinguishing two showers (calorimeter transverse cell size shall be 2 [cm] in X and 2 [cm] in Y)
P-DET-ANC-B0.10	Energy resolution for photons shall be s(E)/E < 8%/sqrt(E) + (2) %.
P-DET-ANC-B0.11	Detectors and readout electronics must tolerate the magnetic field in the subsystem location.
P-DET-ANC-B0.12	Must handle a data rate and operate reliably at a full projected EIC luminosity.

Requirement ID	***Description***
P-DET-ANC-OFFMO.1	OFFM tracker shall have granularity of 500um (pixels) with charge-sharing to achieve spatial resolution < 20um per hit.
P-DET-ANC-OFFMO.2	OFFM will have 2 layers per station
P-DET-ANC-OFFMO.3	OFFM will have 2 stations, separated by 2m
P-DET-ANC-OFFMO.4	OFFM system dimensions will be 10[cm] in X and 20 [cm] in Y (to be determined)
P-DET-ANC-OFFMO.5	OFFM tracker will have timing resolution X<35ps
P-DET-ANC-OFFMO.6	The OFFM tracking system shall provide a low material budget: < 5% X0.
P-DET-ANC-OFFMO.7	OFFM tracker shall provide momentum resolution <5% and pT resolution of 5% for pT > 500 MeV/c.
P-DET-ANC-OFFMO.8	The OMDs need cooling of ~60 Watts per active layer,
P-DET-ANC-OFFMO.9	The OMDs will generate RF radiation and must provide shielding to protect adjacent systems that are sensitive to this.
P-DET-ANC-ROMAN.1	RPOT tracker will have granularity of 500um (pixels) with charge-sharing to achieve spatial resolution < 20um per hit.
P-DET-ANC-ROMAN.2	RPOT will have 2 layers per each station
P-DET-ANC-ROMAN.3	RPOT will have 2 stations, separated by 2m
P-DET-ANC-ROMAN.4	RPOT system dimensions will have 26 [cm] in X and 13 [cm] in Y (to be determined)
P-DET-ANC-ROMAN.5	RPOT tracker will have timing resolution < 35 ps
P-DET-ANC-ROMAN.6	The RPOT tracking system shall provide a low material budget: < 5% X0.
P-DET-ANC-ROMAN.7	RPOT tracker shall provide momentum resolution < 5% and pT resolution of 5% for pT > 500 MeV/c.
P-DET-ANC-ROMAN.8	The RPOTs need cooling of ~100 Watts per active layer,
P-DET-ANC-ROMAN.9	The RPOTs will generate RF radiation and must provide shielding to protect adjacent systems that are sensitive to this.
P-DET-ANC-ROMAN.10	The proximity of the Roman Pots to the accelerator beam will impact beam characteristics.
P-DET-ANC-ZDC.1	The ZDC will have at least two sections: electromagnetic (EMCAL) and hadronic pars (HCAL)
P-DET-ANC-ZDC.2	ZDC system will have dimensions 60 [cm] in X and 60 [cm] in Y and <200 [cm] in Z (to be determined)
P-DET-ANC-ZDC.3	Energy resolution for photons shall be s(E)/E < 10%/sqrt(E) + (1-3) %.
P-DET-ANC-ZDC.4	Energy resolution for neutrons shall be s(E)/E < 50%/sqrt(E) + 5%.

Requirement ID	*Description*
P-DET-ANC-ZDC.5	Must handle a data rate and operate reliably at a full projected EIC luminosity.
P-DET-ANC-ZDC.6	ZDC shall have granularity: 1. EMCAL crystal 2cmx2cm towers 2. EMCAL imaging calorimeter 3mmx3mm 3. HCAL 10cmx10cm towers (to be determined)
P-DET-ANC-ZDC.7	The ZDC system shall provide cooling (air/liquid) for silicon sensors.
P-DET-ANC-ZDC.8	The ZDC system shall provide power supplies for bias, HV and low voltages.
P-DET-ANC-LUMI.1	The PS CAL energy resolution for electrons shall be s(E)/E < 15%/sqrt(E).
P-DET-ANC-LUMI.2	The PS CALs, direct CAL, and trackers shall all provide timing resolution sufficient to resolve 10ns beam buckets
P-DET-ANC-LUMI.3	The PS CAL dimensions shall be 18 [cm] in X, 18 [cm] in Y, and 18 [cm] in Z
P-DET-ANC-LUMI.4	The PS CAL readout granularity shall be 3 [mm] in X, 3 [mm] in Y, and 3 [mm] in Z
P-DET-ANC-LUMI.5	The PS tracker dimensions shall cover the transverse face of the calorimeter with no acceptance gaps.
P-DET-ANC-LUMI.6	The direct photon CAL energy resolution for electrons shall be s(E)/E < 15%/sqrt(E).
P-DET-ANC-LUMI.7	The direct photon CAL dimensions is expected to be similar to the PS CAL
P-DET-ANC-LUMI.8	The direct photon CAL readout granularity is expected to be more coarse-grained than the PS CAL
P-DET-ANC-LUMI.9	Some components of the luminosity detector and its electronics must be protected from magnetic interference and radiation.
P-DET-ANC-LUMI.10	The two luminosity detector dipoles must be connected by a beamline that is under vacuum.

6.11. Polarimetry and Luminosity Systems

Requirement ID	*Description*
P-DET-POL.1	The polarimeters, their control rooms and support system must fit within the constraints of the surrounding systems, be properly located relative to other systems, and have adequate space for the delivery of services and the removal of waste.
P-DET-POL.2	The polarimeters will require a structural support system to carry the cumulative weight of the detectors and peripheral services, and to distribute that load to other supporting infrastructure or to the floor, and will require survey marks to determine their physical location.

Requirement ID	***Description***
P-DET-POL.3	The polarimeters and their control rooms will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.
P-DET-POL.4	The polarimeters and their control rooms will require electrical power to support the operation of the detector sub-components and electronics.
P-DET-POL.5	The polarimeters and their control rooms will require communications infrastructure to support data collection, monitoring and control.
P-DET-POL.6	The laser labs, control rooms and access paths must be shielded to allow personnel access during beam/laser operations.
P-DET-POL.7	The laser labs, control rooms, and equipment must have interlocks where required for personnel safety.
P-DET-POL.8	The beam polarizations shall be measured to within 1% or less (relative).
P-DET-POL.9	The polarimeters must be able to determine the polarization vector.
P-DET-POL-EPOL.1	The laser average power shall be 5-10 W, with a wavelength = 532 nm.
P-DET-POL-EPOL.2	The laser beam M2 will be approximately 1 (diffraction limited).
P-DET-POL-EPOL-ESR.1	The systematic and statistical uncertainty will be 1% or better.
P-DET-POL-EPOL-ESR.2	The measurement time shall be less than the bunch lifetime in the ring (~2 minutes).
P-DET-POL-EPOL-ESR.4	The laser repetition rate shall match the beam frequency (25-100 MHz) and will have the capability of achieving a ~75 kHz pulse rate.
P-DET-POL-EPOL-ESR.6	The time response of all detectors (electron and photon) will be sufficient to resolve beam bunch (<10 ns).
P-DET-POL-EPOL-ESR.7	The electron detector shall cover at least 6 cm (horizontal) (to be verified).
P-DET-POL-EPOL-ESR.8	The electron strip detector pitch shall be 400 um or smaller (to be verified).
P-DET-POL-EPOL-ESR.9	The photon calorimeter and strip detector will cover at least 4 x 4 cm^2 (to be verified).
P-DET-POL-EPOL-ESR.10	The photon detector strip detector pitch shall be ~100 um (to be verified).
P-DET-POL-EPOL-RCS.1	The systematic and statistical uncertainty will be better than 5% (to be verified).
P-DET-POL-EPOL-RCS.2	The measurement time will be less than 10-20 minutes.
P-DET-POL-EPOL-RCS.4	The laser repetition rate shall be 2-100, Hz, with a 3-10 ns pulse-width.
P-DET-POL-EPOL-RCS.6	The photon detector segmentation will be XX (to be determined).
P-DET-POL-HPOL.1	Each detector shall consist of 12 vertical Si strips (1.375 mm pitch).
P-DET-POL-HPOL.2	The energy resolution shall be 25 keV or better.

Requirement ID	*Description*
P-DET-POL-HPOL.3	The time resolution of the waveform digitizers shall be 0.5 ns or better.
P-DET-POL-HPOL-HJET.1	The relative uncertainty of the beam polarization measurement must be 1% or less.
P-DET-POL-HPOL-PC.1	The pC devices shall measure the relative beam polarization within 30 seconds with an uncertainty of 2% or less.
P-DET-POL-HPOL-PC.2	The target fibers shall be thin enough to provide a measurement of the transverse polarization profile of the beam bunches.
P-DET-POL-HPOL-PC.3	The pC polarimeter shall be able to measure the bunch-by-bunch polarization for each hadron beam fill.
P-DET-POL-HPOL-PC.4	Vacuum separation will be required to access and replacement targets during maintenance.

7. 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 Plan*
7. EIC-SEG-PLN-020, *EIC Interface Management Plan*