EIC Tracking and Particle Identification Requirements

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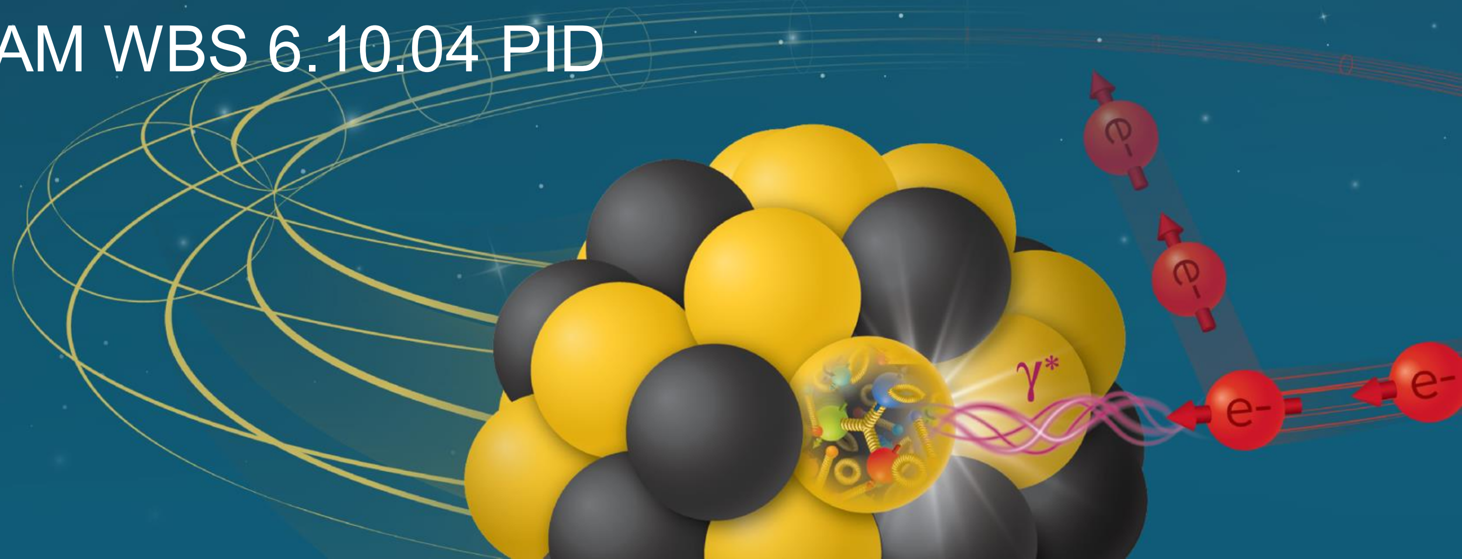
Electron-Ion Collider



Outline

- Overview of Subsystem Requirements.
- Tracking detectors in ePIC
- Requirements for Tracking Detectors
- Overview of Interfaces
- Interfaces for Tracking Detectors
- Particle Identification Detectors in ePIC
- Requirements for Particle Identification Detectors
- Interfaces for Particle Identification Detectors
- Conclusion

Subsystem Requirement Overview

Requirement flow

General Requirement → Functional Requirement → Performance Requirement

Identifies fundamental capabilities that the system must have in order to accomplish its purpose

e.g. Need to identify low momentum particles to satisfy Physics requirement of EIC

Identifies the functions that the system must perform in order to satisfy it's general requirements

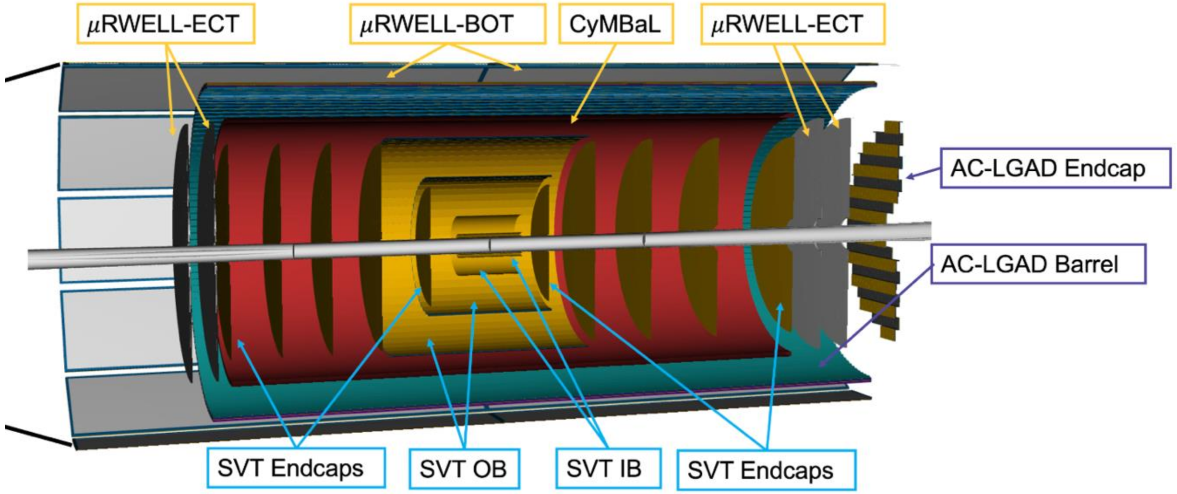
*e.g. To identify low momentum particles there has to be x*sigma separation*

Describes quantitatively how well the functions must perform in order for the system to be successful in it's operating environment.

e.g. ToF sensors need to have xxx ps timing resolution

(All info is online at https://eic.jlab.org/Detector)

ePIC Tracking subsystems



- Two different technologies for charged particle tracking
  - Silicon
  - Gaseous

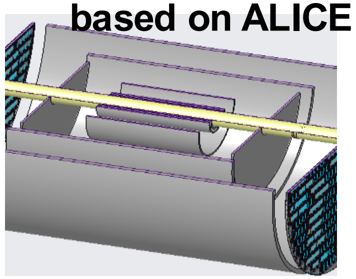
- Silicon based trackers
  - SVT (Silicon Vertex Tracker) Endcaps
  - SVT (Silicon Vertex Tracker) OB
  - SVT (Silicon Vertex Tracker) IB
  - AC-LGAD Barrel & Endcap

- Gas based trackers
  - CyMBaL (Cylindrical MicroMegas Barrel Layer)
  - μRWELL-BOT (μRWELL Barrel Outer Tracker)
  - μRWELL-ECT (μRWELL End Cap Tracker)

ePIC Tracking subsystems

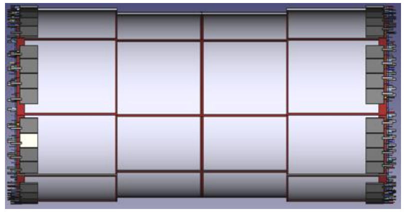
BARREL TRACKERS

Silicon vertex tracker based on ALICE ITS3



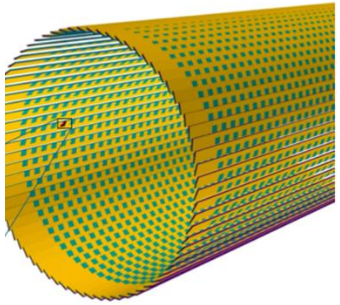
- Displaced vertex reconstruction
- Momentum resolution of $0.05\%p_T \oplus 0.5\%$ and spatial resolution $20\mu m/p_T \oplus 5\mu m$

CyMBaL based on μMegas technology



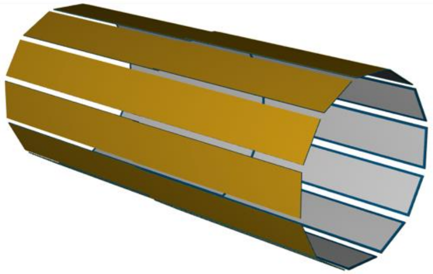
- Provide redundancy and pattern recognition for tracking

Barrel AC-LGAD



- Provide additional space point with spatial resolution of ~ 30 μm

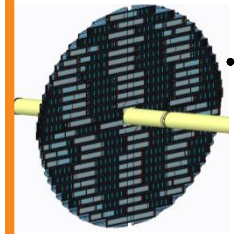
μRWELL-BOT based on μRWELL technology



- Placed close to hpDIRC to improve angular and space point resolution to aid in PID.
- Provide redundancy and pattern recognition for tracking

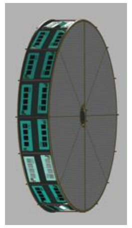
Backward (e^- end cap) trackers

MAPS disks



- Momentum resolution of $(0.1)\%p_T \oplus 1.0\ (2.0)\%$ and spatial resolution $30\mu m/p_T \oplus (20\text{-}40)\ \mu m$

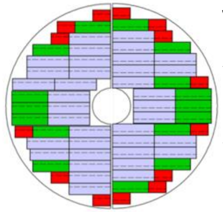
μRWELL disks



- Provide redundancy and pattern recognition for tracking.
- Aid in background rejection

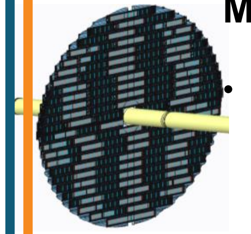
Forward (hadron end cap) trackers

AC-LGAD disk



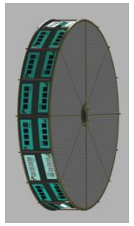
With 30 um spatial resolution aid in providing additional space point

MAPS disks



- Momentum resolution of $(0.1)\%p_T \oplus 1.0\ (2.0)\%$ and spatial resolution $30\mu m/p_T \oplus (20\text{-}40)\ \mu m$

μRWELL disks



- Provide redundancy and pattern recognition for tracking.
- Aid in background rejection

** More details in the upcoming presentations*

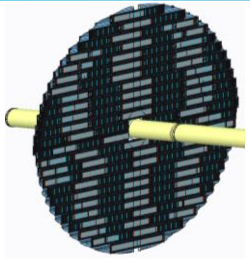
Subsystem Requirements (Tracking detectors)

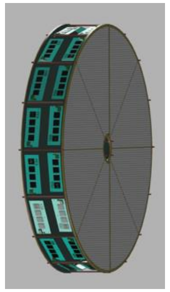
GENERAL REQUIREMENTS	
Name	Description
Tracking Systems	
G-DET-TRAK.1	The tracking systems shall provid coordinate measurements of charged particles traversing a magnetic field, and provide a sufficient lever arm to provide measurements of the momenta and angles of the particles.
G-DET-TRAK.2	Tracking 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 withi the available space in the experimental hall, and be consistent with the available infrastructure and resources.

FUNCTIONAL REQUIREMENTS		
Name	Description	Parent
Tracking Systems		
F-DET-TRAK.1	The tracking system must provide a low detection threshold for pions and kaons.	G-DET.1 G-DET-TRAK.1
F-DET-TRAK.2	The tracking system must provide high hermicity in exclusive and diffractive channels.	G-DET.1 G-DET-TRAK.2
F-DET-TRAK.3	The tracking system must provide good impact parameter resolution for heavy flavor measurements.	G-DET-TRAK.3
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.	G-DET-TRAK.4
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.	G-DET-TRAK.4 G-DET-TRAK.5
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.	G-DET-TRAK.4 G-DET-TRAK.5
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.	G-DET-TRAK.4 G-DET-TRAK.5

PERFORMANCE REQUIREMENTS		
Name	Description	Parent
Tracking Systems		
P-DET-TRAK.1	The tracking system must provide a minimum pT of 100 MeV π, 130 MeV K.	F-DET-TRAK.1
P-DET-TRAK.2	The tracking system shall provide cooling (air/liquid) for silicon sensors.	F-DET-TRAK.4 F-DET-TRAK.6
P-DET-TRAK.3	The tracking system shall provide power supplies for bias and low voltages.	F-DET-TRAK.4 F-DET-TRAK.6
P-DET-TRAK.4	The tracking system shall provide a gas mixing system for gaseous detectors.	F-DET-TRAK.4 F-DET-TRAK.6
P-DET-TRAK.5	The tracking system will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.	F-DET-TRAK.4 F-DET-TRAK.6
P-DET-TRAK.6	The tracking system will require electrical power to support the operation of the detector sub-components and electronics.	F-DET-TRAK.4 F-DET-TRAK.6
P-DET-TRAK.7	The tracking system will require communications infrastructure to support data collection, monitoring and control.	F-DET-TRAK.4 F-DET-TRAK.6
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.	F-DET-TRAK.7
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	F-DET-TRAK.5 F-DET-TRAK.6

Backward Tracking System Requirement



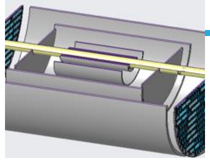
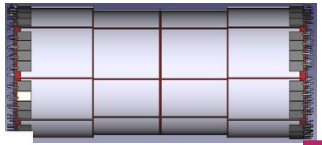
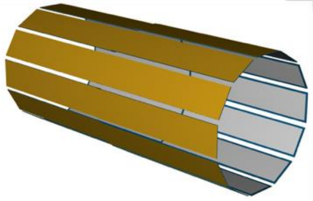


Tracking Systems		
F-DET-TRAK-1	The tracking system must provide a low detection threshold for pions and kaons.	G-DET.1 G-DET-TRAK-1

Tracking Systems	
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.

Backward Tracking Systems		
P-DET-TRAK-BCK.1	The backward tracking system shall provide coverage in rapidity region between -3.5 to -1.0.	F-DET-TRAK.2
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.	F-DET-TRAK.2
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.	F-DET-TRAK.2
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.	F-DET-TRAK.2
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.	F-DET-TRAK.2

Barrel Tracking System Requirement

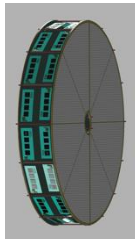




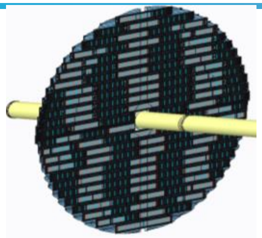
Tracking Systems	
G-DET-TRAK-1	The tracking systems shall provide coordinate measurements of charged particles traversing a magnetic field, and provide a sufficient lever arm to provide measurements of the momenta and angles of the particles.

Tracking Systems		
F-DET-TRAK-1	The tracking system must provide a low detection threshold for pions and kaons.	G-DET.1 G-DET-TRAK-1
F-DET-TRAK.2	The tracking system must provide high hermicity in exclusive and diffractive channels.	G-DET.1 G-DET-TRAK.2
F-DET-TRAK.3	The tracking system must provide good impact parameter resolution for heavy flavor measurements.	G-DET-TRAK.3

Barrel Tracking Systems		
P-DET-TRAK-BAR.1	The barrel tracking system shall provide a momentum resolution < 5%.	F-DET-TRAK.2
P-DET-TRAK-BAR.2	The barrel tracking system shall provide a low material budget: < 5% X0.	F-DET-TRAK.1
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.	F-DET-TRAK.2
P-DET-TRAK-BAR.4	The barrel tracking system shall provide a spatial resolution of $\sigma xy \sim 20/pT \oplus 5\ \mu m$ in the rapidity region between -1 to 1.	F-DET-TRAK.3

Forward Tracking System Requirement





Tracking Systems	
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.

Tracking Systems		
F-DET-TRAK-1	The tracking system must provide a low detection threshold for pions and kaons.	G-DET.1 G-DET-TRAK-1
F-DET-TRAK.2	The tracking system must provide high hermicity in exclusive and diffractive channels.	G-DET.1 G-DET-TRAK.2
F-DET-TRAK.3	The tracking system must provide good impact parameter resolution for heavy flavor measurements.	G-DET-TRAK.3

Forward Tracking Systems		
P-DET-TRAK-FWD.1	The forward tracking system shall provide coverage in rapidity region between -1.0 to 3.5.	F-DET-TRAK.2
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.	F-DET-TRAK.2
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.	F-DET-TRAK.2
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.	F-DET-TRAK.2
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.	F-DET-TRAK.2

Detector Systems Interface General Idea

- Defined relationship between two or more distinct entities to satisfy a dependency or requirement .

- Identifying interfaces : Interrogate set of parameters
  1. Requirements
  2. Known interfaces
  3. Related systems

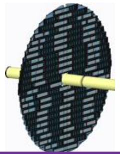
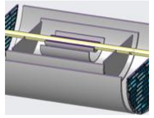
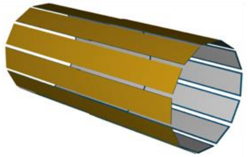
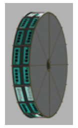
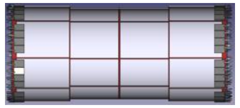
- Examples of questions for interrogating requirements :

STRUCTURAL	Direct	Does the entity provide support or stability to another component?	*Used to identify any intermediate structural supports, interfaces that provide stability (balance or dampen vibrations), or any internal/externally supported load that transfers weight to the system.*
		Is the entity supported or stabilized by another component?	*This interface defines how the weight of this system (and supported systems) is transferred, and mechanisms that provide stability.*
	Indirect	Is the weight of the item constrained by an external factor?	*This indirect interface describes limitations that are driven by material handling capabilities, crane capacity, floor strength, etc.*

ELECTRICAL	Direct	Does the entity receive electrical power from another component or system?	*This interface identifies the physical connections that conduct power between entities, the types of connectors used, the amount of power that is provided, and the characteristics of the power being delivered.*
		Does the entity provide electrical power to another component or system?	*In addition to the physical connections, amount of power and power characteristics, this interface also identifies power transformations that may produce waste heat.*

- Other examples of interrogations can be based on data, cryogenics, controls, gas/fluid flows etc.

Tracking subsystem Interfaces

Detectors – DAQ/Computing interface (Data interrogation)

Interface ID	From	To	Description
I-DET-COMP-ONLINE.081	DET-TRAK	DET-COMP	Cables required to transfer data from the detector to the online data acquisition system.
I-DET-COMP-ONLINE.082	DET-TRAK	DET-COMP	A fiber connection will be provided from the DAQ system to the barrel tracking system's readout board to perform configuration, control, and data acquisition.
I-DET-COMP-ONLINE.083	DET-TRAK	DET-COMP	A network connection will be provided from the DAQ system to the barrel tracking system's slow controls interface.
I-DET-COMP-ONLINE.084	DET-TRAK	DET-COMP	A fiber connection will be provided from the DAQ system to the barrel tracking system's readout board for timing synchronization.

Detectors- Electronics interface (Electrical interrogation)

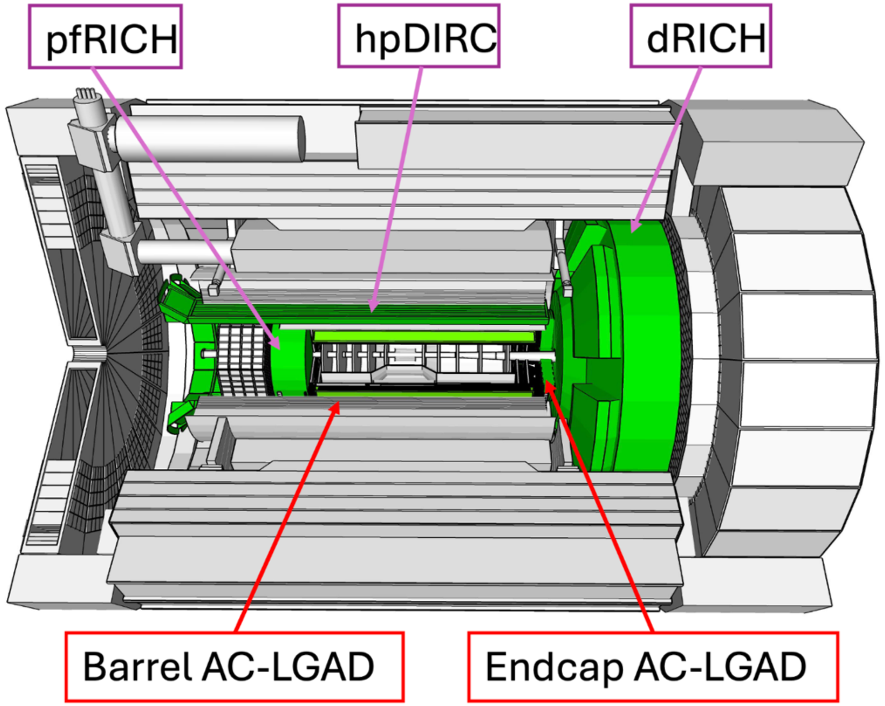
I-DET-ELEC.069	DET-TRAK	DET-ELEC	Bias voltage DC power will be provided from the electronic racks to support electronics in the silicon photomultipliers.
I-DET-ELEC.070	DET-TRAK	DET-ELEC	High voltage DC power will be provided from the electronics racks to support silicon sensors and gas detectors
I-DET-ELEC.071	DET-TRAK	DET-ELEC	Low voltage DC power will be provided from the electronic racks to support electronics in the detector.

Interface between tracking and PID detectors also exist
https://eic.jlab.org/Interfaces/InterfaceMatrix.html

Detectors – Infrastructure interface (Structural interrogation)

I-DET-INF-BAR.016	DET-TRAK	DET-INF	A single structural support system will support the silicon detectors and the micro-pattern gaseous detectors within the DIRC detector.
I-DET-INF-BAR.021	DET-TRAK	DET-INF	The DIRC support system will provide support for the silicon trackers in the detector barrel.
I-DET-INF-BAR.022	DET-TRAK	DET-INF	The weight of the barrel tracking systems will be transferred to the DIRC support system.
I-DET-INF-FWD.012	DET-TRAK	DET-INF	The maximum forward location for the tracking system is limited by the position of the AC LGAD Time of Flight Detector. Modifications to either must be coordinated.
I-DET-INF-FWD.013	DET-TRAK	DET-INF	The interior radius of the tracking detectors is governed by the size of the beamline.
I-DET-INF-INT.098	DET-TRAK	DET-INF	Air, liquid or other cooling technology will be required for the tracking detectors.
I-DET-INF-INT.099	DET-TRAK	DET-INF	Gas will need to be provided to the trackers for detector operation.
I-DET-INF-INT.100	DET-TRAK	DET-INF	A single structural support system will support the silicon detectors and the micro-pattern gaseous detectors within the DIRC detector.
I-DET-INF-INT.105	DET-TRAK	DET-INF	Conduits must be provided within the DIRC support system that are adequate to deliver services (power, signal, cooling) to the barrel tracking detectors.
I-DET-INF-INT.106	DET-TRAK	DET-INF	The exterior radius of the silicon trackers is limited by the interior bore of the DIRC support system. Modifications to either must be coordinated.
I-DET-INF-INT.107	DET-TRAK	DET-INF	The maximum forward location for the DIRC is limited by the position of the silicon trackers.
I-DET-INF-INT.110	DET-TRAK	DET-INF	The maximum size of the silicon trackers is limited by the interior radius of the barrel Time of Flight detector. Modifications to either must be coordinated.
I-DET-INF-INT.111	DET-TRAK	DET-INF	The maximum backward location for the tracking system is limited by the position of the pfRICH/mRICH. Modifications to either must be coordinated.

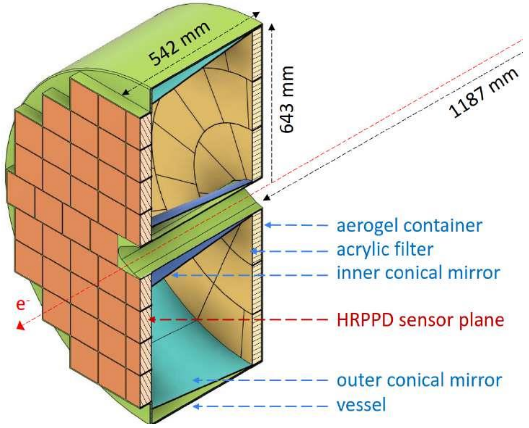
ePIC PID subsystem



- Two different techniques for particle identification
  - Cherenkov imaging
  - Time of Flight
- Cherenkov imaging detectors in ePIC
  - Proximity Focussing RICH (pfRICH)
  - High Performance DIRC (hpDIRC)
  - Dual-radiator RICH (dRICH)
- Time of Flight detectors in ePIC
  - Barrel AC-LGAD Time of Flight
  - Endcap AC-LGAD Time of Flight

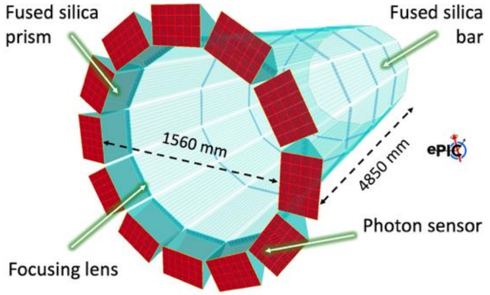
ePIC PID subsystem

Backward RICH (pfRICH)



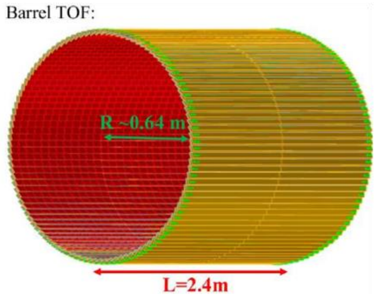
- $\pi/K/p$ of 3σ separation up to 7 GeV/c
- Utilizes long proximity gap (~30 cm) with 1.04 refractive index aerogel
- High-Rate Picosecond Photon Detectors (HRPPD) as photosensor with single photon timing resolution of ~30-40 ps

Barrel DIRC (hpDIRC)



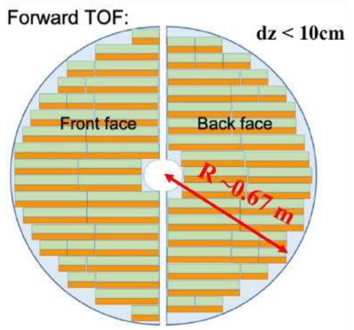
- $\pi/K/p$ of 3σ separation up to 6 GeV/c
- Quartz bars as radiators
- Saphire lens as focusing optics
- Compact Solid fused silica prism as expansion volume
- MCP-PMT as photosensors.

Barrel TOF



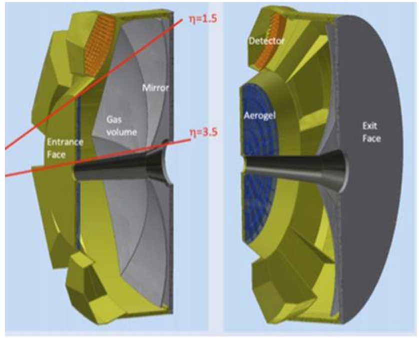
- π/K of 3σ separation between 0.2-1.2 GeV/c
- AC-LGAD strip sensors with timing resolution of ~ 35 ps.

Forward TOF



- π/K of 3σ separation between 0.2 to 2.3 GeV
- AC-LGAD pixel sensors with timing resolution of ~ 20 ps

Forward RICH



- π/K of 3σ separation between 3 and 50 GeV/c.
- Aerogel (n = 1.026) and C_2F_6 gas as two different radiators.
- Focusing mirror
- SiPM as Photosensors

** More details in the upcoming presentations*

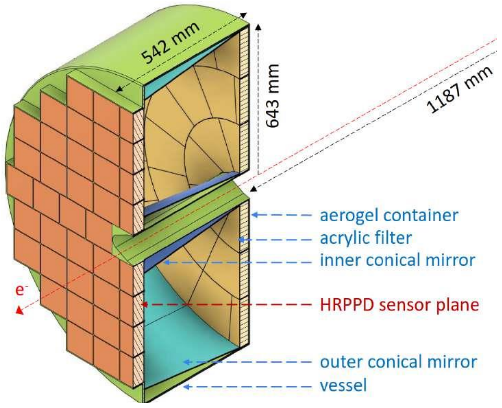
Subsystem Requirements (PID detectors)

GENERAL REQUIREMENTS	
Name	Description
Particle Identification Systems	
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.

FUNCTIONAL REQUIREMENTS		
Name	Description	Parent
Particle Identification Systems		
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.	G-DET-PID.3
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.	G-DET-PID.3 G-DET-PID.4
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.	G-DET-PID.3 G-DET-PID.4
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.	G-DET-PID.3 G-DET-PID.4

PERFORMANCE REQUIREMENTS		
Name	Description	Parent
Particle Identification Systems		
P-DET-PID.1	The PID detectors will require cooling infrastructure that is sufficient to ensure the operating temperature remains within an acceptable range.	F-DET-PID.1 F-DET-PID.3
P-DET-PID.2	The PID detectors will require electrical power to support the operation of the detector sub-components and electronics.	F-DET-PID.1 F-DET-PID.3
P-DET-PID.3	The PID detectors will require communications infrastructure to support data collection, monitoring and control.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.4
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.	F-DET-PID.3 F-DET-PID.4

Backward RICH (pfRICH) Requirements

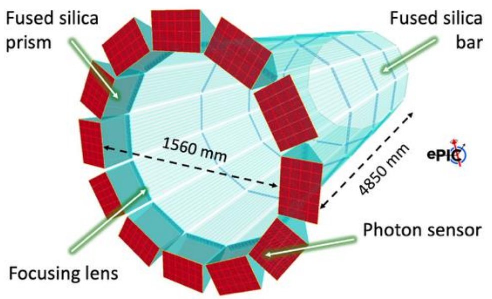


Backward PID Systems	
Backward RICH Detectors	
G-DET-PID-BCK-RICH.1	The PID detector in the backward region is responsible for particle identification of charged hadrons.

Backward PID Systems		
Backward RICH Detectors		
F-DET-PID-BCK-RICH.1	The PID detector in the backward region shall differentiate between pions, kaons and protons.	G-DET-PID-BCK-RICH.1

Backward PID Systems		
Backward RICH Detectors		
P-DET-PID-BCK-RICH.1	The PID Detector in the backward region will require appropriate support structure to hold the detector in place.	F-DET-PID-BCK-RICH.1
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.	F-DET-PID-BCK-RICH.1
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.	F-DET-PID-BCK-RICH.1
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.	F-DET-PID-BCK-RICH.1
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.	F-DET-PID-BCK-RICH.1
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.	F-DET-PID.1 F-DET-PID.3
P-DET-PID-BCK-RICH.7	The particle identification system will provide 3 sigma pi/K separation from 1 up to 7 GeV/c.	F-DET-PID-BCK-RICH.1

Barrel DIRC (hpDIRC) Requirements

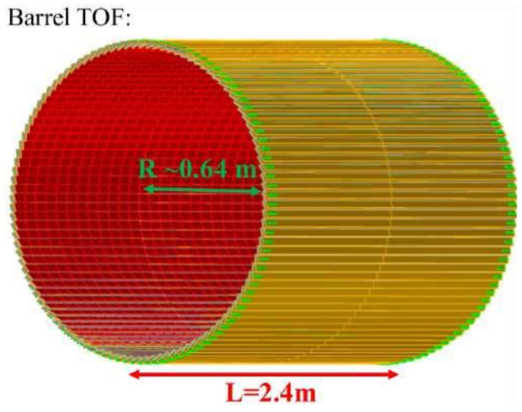


Barrel PID Systems	
Barrel DIRC Systems	
G-DET-PID-BAR-DIRC.1	The barrel PID detector is responsible for high momenta particle identification.

Barrel PID Detectors		
Barrel DIRC Detectors		
F-DET-PID-BAR-DIRC.1	The PID detector in the barrel region shall differentiate between pions, kaons and protons.	G-DET-PID-BAR-DIRC.1

Barrel PID Detectors		
Barrel DIRC Detectors		
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.	F-DET-PID.4
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.3
P-DET-PID-BAR-DIRC.6	The PID detector requires a 0.5mrad tracking resolution as input to reach its peak performance.	F-DET-PID.3
P-DET-PID-BAR-DIRC.7	The DIRC system will provide 3 sigma pi/K separation above 1 GeV/c.	F-DET-PID-BAR-DIRC.1

Barrel Time of Flight Requirements

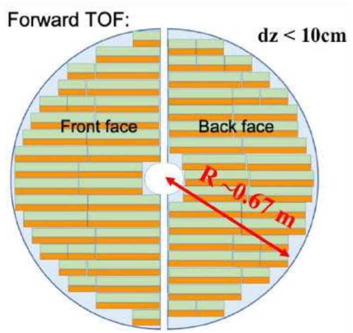


Barrel time-of-flight Systems	
G-DET-PID-BAR-TOF.1	The barrel PID detector is responsible for low momenta particle identification.

Barrel time-of-flight Systems		
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.	G-DET-PID-BAR-TOF.1

Barrel time-of-flight Systems		
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
P-DET-PID-BAR-TOF.3	Will require DAQ fiber optics. Two lines for each of the 144 connections.	F-DET-PID.1 F-DET-PID.3
P-DET-PID-BAR-TOF.4	Will require cooling to remove 4kW of heat	F-DET-PID.1 F-DET-PID.3
P-DET-PID-BAR-TOF.5	TOF will weigh approximately 70 KG, and will require structural support to maintain its position and stability.	F-DET-PID.4
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.	F-DET-PID-BAR-TOF.1

Forward Time of Flight Requirements

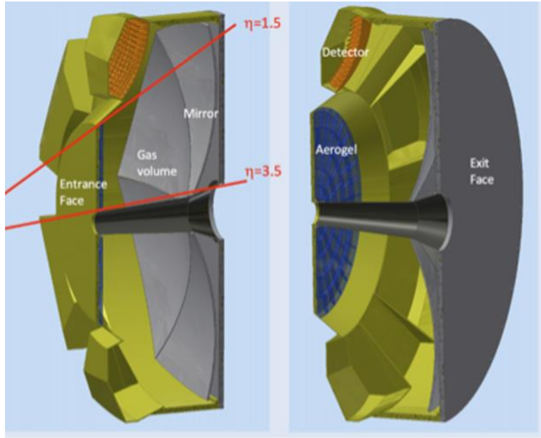


Forward TOF Detectors	
G-DET-PID-FWD-TOF.1	The forward PID detector is responsible for low momenta particle identification.

Forward TOF Detectors		
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.	G-DET-PID-FWD-TOF.1

Forward TOF Detectors		
P-DET-PID-FWD-TOF.1	The PID Detector in the forward region will require appropriate support structure to hold the detector in place.	F-DET-PID.4
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
P-DET-PID-FWD-TOF.4	Will require DAQ fiber optics. Two lines for each of the 212 connections.	F-DET-PID.1 F-DET-PID.3
P-DET-PID-FWD-TOF.5	Will require cooling to remove 13kW of heat	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID-FWD-TOF.1

Forward RICH (dRICH)



Forward PID Systems		
Forward RICH Detectors		
G-DET-PID-FWD-RICH.1	The forward PID detector is responsible for high momenta particle identification.	

Forward PID Systems		
Forward RICH Detectors		
F-DET-PID-FWD-RICH.1	The PID detector in the forward region shall differentiate between pions, kaons and protons.	G-DET-PID-FWD-RICH.1

Forward PID Systems		
Forward RICH Detectors		
P-DET-PID-FWD-RICH.1	The PID Detector in the forward region will require appropriate support structure to hold the detector in place.	F-DET-PID.4
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
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)	F-DET-PID.1 F-DET-PID.3
P-DET-PID-FWD-RICH.7	The RICH detector will require a continuous flow of dry nitrogen to protect the aerogel radiator.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
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.	F-DET-PID.1 F-DET-PID.3
P-DET-PID-FWD-RICH.10	The dRICH system will provide 3 sigma pi/K separation between 3 and 50 GeV/c.	F-DET-PID-FWD-RICH.1

PID subsystem Interfaces

PID subsystem – DAQ/Computation interface

Interface ID	From	To	Description
I-DET-INF-INT.003	DET-PID	DET	The DIRC structure will provide integrated pathways for cabling and services to be delivered from the interior detectors (pf RICH/mRICH and silicon trackers) to the exterior infrastructure.
I-DET-COMP-ONLINE.045	DET-PID	DET-COMP	A fiber connection will be provided from the DAQ system to the barrel PID detector's readout board to perform configuration, control, and data acquisition.
I-DET-COMP-ONLINE.046	DET-PID	DET-COMP	A network connection will be provided from the DAQ system to the barrel PID detector's slow controls interface.
I-DET-COMP-ONLINE.047	DET-PID	DET-COMP	A fiber connection will be provided from the DAQ system to the barrel PID detector's readout board for timing synchronization.
I-DET-COMP-ONLINE.048	DET-PID	DET-COMP	Signal cables will run from the DIRC electronics to the DAQ system.
I-DET-COMP-ONLINE.049	DET-PID	DET-COMP	Signal cables from environmental sensors will run from the DIRC electronics to the DAQ system to provide detector shutdown/protection system.
I-DET-COMP-ONLINE.050	DET-PID	DET-COMP	Signal cables will run from the DIRC electronics to the DAQ system.
I-DET-COMP-ONLINE.051	DET-PID	DET-COMP	Signal cables from environmental sensors will run from the DIRC electronics to the DAQ system to provide detector shutdown/protection system.
I-DET-COMP-ONLINE.052	DET-PID	DET-COMP	Signal cables will run from the pfRICH/mRICH electronics to the DAQ system.
I-DET-COMP-ONLINE.053	DET-PID	DET-COMP	Signal cables from environmental sensors will run from the pfRICH/mRICH electronics to the DAQ system to provide a detector shutdown/protection system.
I-DET-COMP-ONLINE.054	DET-PID	DET-COMP	Signal cables will run from the dRICH electronics to the DAQ system.
I-DET-COMP-ONLINE.055	DET-PID	DET-COMP	Signal cables from environmental sensors will run from the cold photosensors to the DAQ system to provide a detector shutdown/protection system.

PID subsystem – Electronics interface

Interface ID	From	To	Description
			provides services to the interior detectors. Modifications to either must be coordinated.
I-DET-ELEC.046	DET-PID	DET-ELEC	Bias voltage DC power will be provided from the electronics racks to support electronics the silicon photomultipliers.
I-DET-ELEC.047	DET-PID	DET-ELEC	High voltage DC power will be provided from the electronics racks to support silicon sensors and gas detectors.
I-DET-ELEC.048	DET-PID	DET-ELEC	Low voltage DC power will be provided from the electronics racks to support electronics in the detector.
I-DET-ELEC.049	DET-PID	DET-ELEC	High voltage power will be delivered from the power supplies on the carriage to the photosensors in the DIRC.
I-DET-ELEC.050	DET-PID	DET-ELEC	Low voltage power will be delivered from the power supplies on the carriage to the DIRC electronics.
I-DET-ELEC.051	DET-PID	DET-ELEC	High voltage power will be delivered from the power supplies on the carriage to the photosensors in the DIRC.
I-DET-ELEC.052	DET-PID	DET-ELEC	Low voltage power will be delivered from the power supplies on the carriage to the DIRC electronics.
I-DET-ELEC.053	DET-PID	DET-ELEC	High voltage power will be delivered from the power supplies on the carriage to the photosensors in the pfRICH/mRICH.
I-DET-ELEC.054	DET-PID	DET-ELEC	Low voltage power will be delivered from the power supplies on the carriage to the pfRICH/mRICH electronics.
I-DET-ELEC.055	DET-PID	DET-ELEC	Bias voltage DC power will be delivered from the power supplies on the carriage to the photosensors.
I-DET-ELEC.056	DET-PID	DET-ELEC	Low voltage power will be delivered from the power supplies on the carriage to the dRICH electronics.

PID subsystem Interfaces (subsys – subsys)

PID subsystem – Calorimeter interface

I-DET-INF-BAR.012	DET-PID	DET-HCAL	The Dual RICH will be supported by a structural system within the barrel hadron calorimeter.
I-DET-INF-INT.032	DET-PID	DET-HCAL	The size of the dRICH is limited by the interior bore of the barrel HCAL, and must provide adequate space for cables and services to itself and the interior detectors. Modifications to either must be coordinated.
I-DET-INF-INT.036	DET-PID	DET-HCAL	The maximum backward location for the DIRC is limited by the backward HCAL and the adjacent cabling pathway that provides services to the interior detectors. Modifications to either must be coordinated.
I-DET-INF-BAR.003	DET-PID	DET-ECAL	The DIRC bar boxes will be supported by a frame inside the barrel Electromagnetic Calorimeter, that allows the boxes to be extracted using a system of rollers.
I-DET-INF-BAR.005	DET-PID	DET-ECAL	The weight of the backward ECAL will be transferred to the DIRC detector support and must be accommodated by all subsequent support systems.
I-DET-INF-BAR.006	DET-PID	DET-ECAL	The DIRC support system will provide support for the backward electromagnetic calorimeter.
I-DET-INF-INT.013	DET-PID	DET-ECAL	The backward position and shape of the barrel EMCAL is limited by the size and shape of the DIRC readout supports. Changes to the size or position of either must be coordinated with the other.
I-DET-INF-INT.014	DET-PID	DET-ECAL	The maximum size of the DIRC is limited to the interior bore of the barrel ECAL (and its support structures). Modifications to either must be coordinated.
I-DET-INF-INT.015	DET-PID	DET-ECAL	The forward position and shape of the barrel ECAL is limited by the backward face of the Dual RICH detector and the adjacent cabling pathway that provides services to the interior detectors. Modifications to either must be coordinated.
I-DET-INF-INT.017	DET-PID	DET-ECAL	The maximum backward location for the DIRC is limited by the position of the backward electromagnetic calorimeter. Modifications to either must be coordinated.

PID subsystem – Tracking subsystem

Interface ID	From	To	Description
I-DET-INF-BAR.021	DET-PID	DET-TRAK	The DIRC support system will provide support for the silicon trackers in the detector barrel.
I-DET-INF-BAR.022	DET-PID	DET-TRAK	The weight of the barrel tracking systems will be transferred to the DIRC support system.
I-DET-INF-FWD.012	DET-PID	DET-TRAK	The maximum forward location for the tracking system is limited by the position of the AC LGAD Time of Flight Detector. Modifications to either must be coordinated.
I-DET-INF-INT.105	DET-PID	DET-TRAK	Conduits must be provided within the DIRC support system that are adequate to deliver services (power, signal, cooling) to the barrel tracking detectors.
I-DET-INF-INT.106	DET-PID	DET-TRAK	The exterior radius of the silicon trackers is limited by the interior bore of the DIRC support system. Modifications to either must be coordinated.
I-DET-INF-INT.107	DET-PID	DET-TRAK	The maximum forward location for the DIRC is limited by the position of the silicon trackers.

- Not complete list of interfaces shown on slides.
- Interfaces between PID subsystem , magnet, detector infrastructure also exist
- More details can be found in https://eic.jlab.org/Interfaces/InterfaceMatrix.html

Summary

- Requirements for both tracking and PID subsystem are well defined

(all are accessible online at https://eic.jlab.org/Detector)

- Final version of General, Functional & Performance Requirements for EIC Detector Systems document has been approved.

(*ref: https://indico.bnl.gov/event/28081/attachments/62045/106458/General_Functional_Performance.Requirements.pdf*)

- Interfaces are well defined.

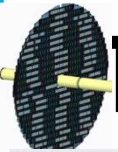
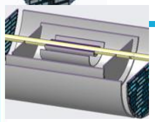
(*ref: https://eic.jlab.org/Documents/DET/Interfaces/DET-Interfaces-20241212.pdf*)

- Interface controls are being worked on. Some Interface Control Documents exist (CD-3A scope).

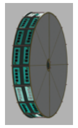
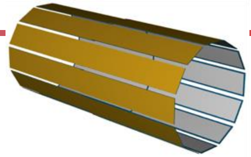
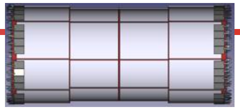
(the process to automatically generate templates from interfaces is ready)

QUESTIONS

Backup

Tracking subsystem upcoming presentations

Ongoing Engineering Design activities

- SVT Endcaps :
  - Ongoing effort in finalizing design and layout along with development of test article.
- SVT IB :
  - Completion of preliminary design and ongoing effort to finalize assembly procedure along with building test articles.
- SVT OB :
  - Prototyping of curved surface is ongoing
- Gas based trackers
  - All gaseous trackers are in the process of assembling first test article.

More details on future tasks on Si-trackers and MPGD trackers later today

PID subsystem upcoming presentations

pfRICH Engineering Design activities

- First article pfRICH vessel outer shell production
- Fine tuning of the aerogel refractive index and bulk uniformity measurement procedure
- HRPPD performance confirmation in the ~1.7 T magnetic field
- Engineering aspects of cooling, light monitoring, HV and LV.

More details on future tasks by Brian Page for pfRICH.

TOF Engineering Design activities

- Characterization of both strip and pixel sensors with encouraging results
- Testing of first ever large AC-LGAD (3.2 X 4 cm)
- Production status of full size pixel sensors by HPK

More details in talk by Simone Mazza & Mathieu Benoit *for ToF.*

hpDIRC future activities

- Disassembly of bar boxes
- QA of disassembled bars
- Validity of photosensors (MCP-PMTs and HRPPD)

More details on future activities by Greg Kalicy on hpDIRC.

dRICH Engineering Design activities

- Real scale 1-sector prototype validation
- ALCOR readout with RDO validation.
- Ongoing optimization of Optics parameters.
- Composite material usage to minimize material budget

More details about future activities by Marco Contalbrigo on dRICH.