

CENTRAL DETECTOR SUB-SYSTEMS FOR INTERACTION POINT 6

THREE TESLA REFERENCE DETECTOR

OVERVIEW AND ASSUMPTIONS

Overview

In order to simplify the development and adaptation of central detector models for the Electron Ion Collider project, a collection of drop-in dynamic components has been developed. These components, which are based on Trimble Sketchup, are dramatically simplified representations of the engineering models and have user configurable settings that allow their dimensions, position and other parameters to be easily altered. For several of the expected configurations, an initial model has been created that contains all of the components in their default configuration. This document provides a list of the components in the 3-Tesla model for Interaction Point 6, along with all of their initial parameters. Using this document, in conjunction with the [Detector Menagerie](#) of dynamic components, any user should be able to reconstruct this model and then make alterations to suit their preferred configurations.

A separate document will be available that provides a description of each of the components, their configuration options and how they can be best used. As these dynamic components continue to be developed, automatic volume calculations and other features will be added to assist in using them for weight and material calculations.

Keep in mind that these objects are for conceptual design only. While they are very effective for facilitating the exchange of ideas, they do not constitute an engineering design.

Assumptions

The following are design assumptions related to the 3 tesla magnet in IP-6. These assumptions governed the construction of the initial model and the component parameters that are included in this document.

- Because of interference with the RCS beamline, the maximum outer radius of the detector cannot exceed 3.2 meters.
- The maximum length of the detector cannot exceed 9.5 meters (4.5 meters in the lepton direction, and 5 meters in the hadron direction.)
- The crossing angle at IP-6 is fixed at 25 mrad, with 8 mrad in the electron beam and 17 mrad in the hadron beam.
- The axis of the solenoid must be aligned with the electron beam, thus the central detector is rotated by 8 mrad.
- As much as possible will be reused from the IP-6 infrastructure; i.e. rail systems, cradle, platform components, etc.
- To be able to reuse the STAR cradle, we extended the barrel HCAL length by 60 cm on the backward (lepton direction) side.
- The hadron calorimeter endcap on the lepton side will remain in the collider hall during maintenance.
- The hadron calorimeter endcap and the electromagnetic calorimeter on the hadron side will remain in the hall during maintenance.
- The cryo-can will be in a fixed position in the collider hall and will be connected to the solenoid cryostat using a flexible cryo-line.

- Based on preliminary engineering designs by Roland Wimmer, we assume that the support structure for the barrel EMCal will be 7.62 cm thick and will be installed between the solenoid cryostat and the barrel EMCal.
- Based on another adaptation of Wimmer's engineering design, we assume a universal support structure for the DIRC that will be 16 cm thick. This may be more substantial than needed in some configurations, but will allow the DIRC support to be used to also support other heavier components within the barrel.

3
TESLA

IP-6 FIXED CARRIAGE

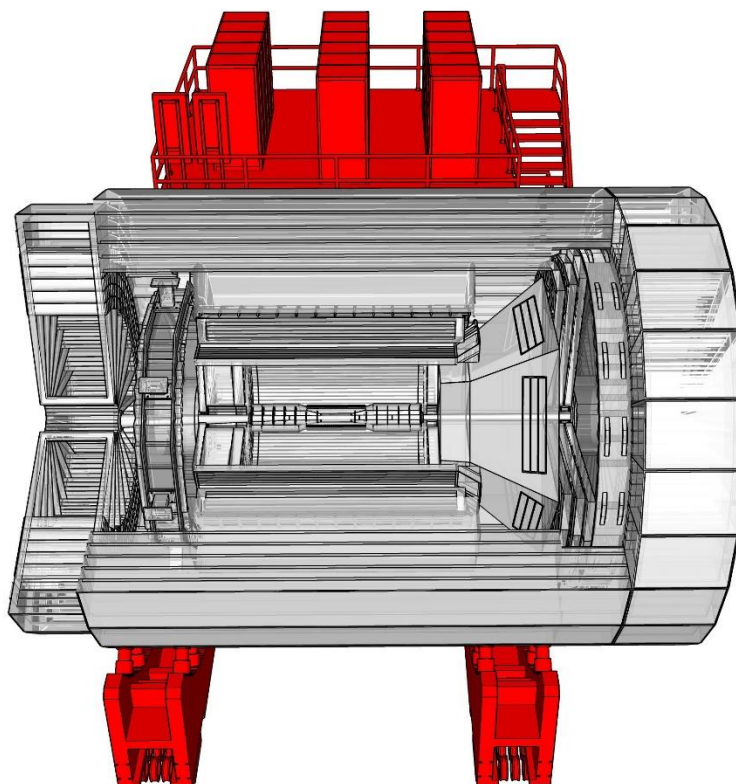


Figure 1: IP-6 Fixed Carriage

Dimensions/Location

N/A

Weight Estimates

Element	Basis	Weight
Carriage (5.92 m ³ Steel)	7850 kg/m ³	46,452 kg
STAR Cradles (6.88 m ³ Steel)	7850 kg/m ³	54,046 kg
Danfysik Power Supplies	2 @ 850kg	1,700 kg
Computing Racks	39 @ 227kg	8,845 kg
Transformers	4 @ 231kg	925 kg
Total:		111,968 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3

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BARREL HADRON CALORIMETER

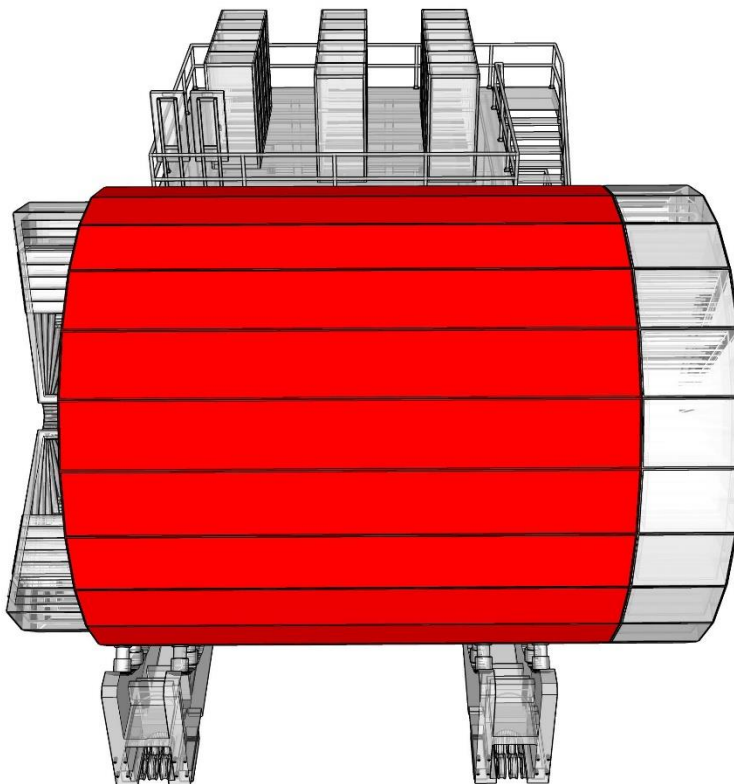


Figure 2: Barrel Hadron Calorimeter

Dimensions/Location

Overall Length	690 cm
Lepton Direction Section Length	610 cm
Hadron Direction Section Length	80 cm
Lepton Direction Bore	220 cm
Hadron Direction Bore	250 cm
Radius	320 cm
Offset	30 cm in Hadron Direction
Total Volume	113.51 m ³

Weight Estimates

Element	Basis	Weight
89.7 m ³ of Iron	7,847 kg/m ³	703,676 kg
23.8 m ³ of Plastic	970 kg/m ³	23,122 kg
Cabling		
	Total:	726,798 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

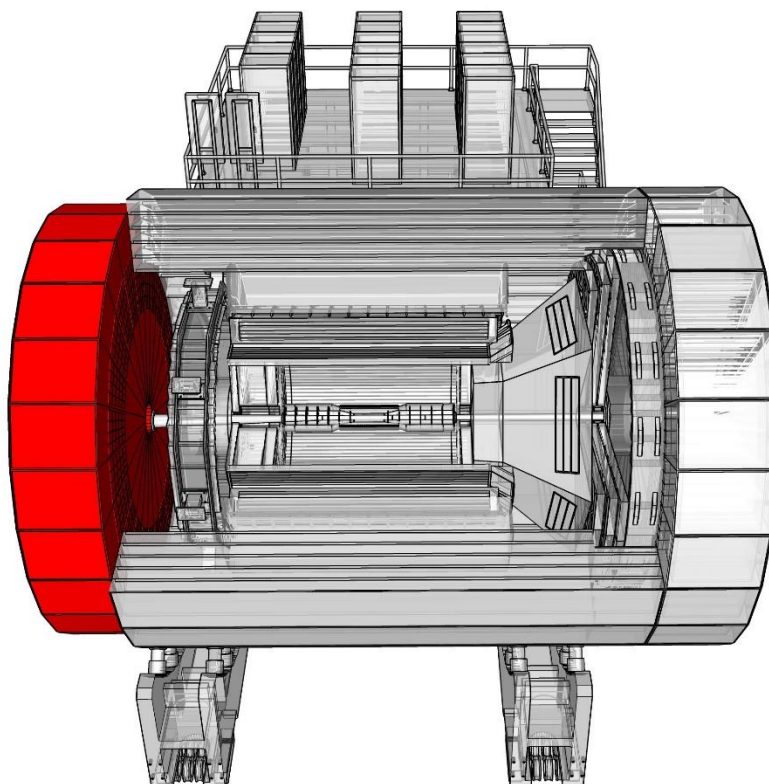
LEPTON DIRECTION HADRON CALORIMETER ENDCAP


Figure 3: Lepton Direction Endcap

Dimensions/Location

<i>Overall Length</i>	105 cm
<i>Bore</i>	22 cm
<i>Radius</i>	300 cm
<i>Offset</i>	315 cm in Lepton Direction
<i>Total Volume</i>	29.53 m ³

Weight Estimates

<i>Element</i>	<i>Basis</i>	<i>Weight</i>
23.3 m ³ of Iron	7,847 kg/m ³	183,050 kg
6.2 m ³ of Plastic	970 kg/m ³	6,015 kg
Cabling		
	Total:	189,065 kg

Power Requirements

<i>Component</i>	<i>Source/Voltage</i>	<i>Amps</i>
Data Not collected		

Heat Dissipation

<i>Removal Mechanism/Medium</i>	<i>BTUs</i>
Data Not collected	

Communications/Signal

<i>Element</i>	<i>Cables/Connections</i>
Data Not Collected	

3

TESLA

HADRON DIRECTION HADRON CALORIMETER ENDCAP

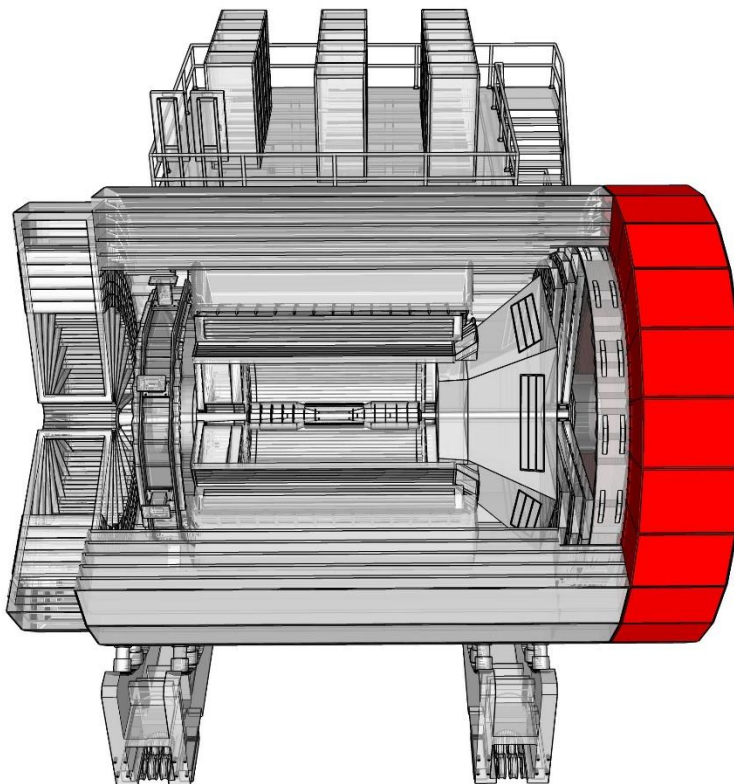


Figure 4: Hadron Direction Endcap

Dimensions/Location

Overall Length	120 cm
Bore	30 cm
Radius	320 cm
Offset	375 cm in Hadron Direction
Total Volume	38.26 m ³

Weight Estimates

Element	Basis	Weight
30.2 m ³ of Iron	7,847 kg/m ³	237,207 kg
8. m ³ of Plastic	970 kg/m ³	7,794 kg
Cabling		
Total:		245,002 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3
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SOLENOID CRYOSTAT

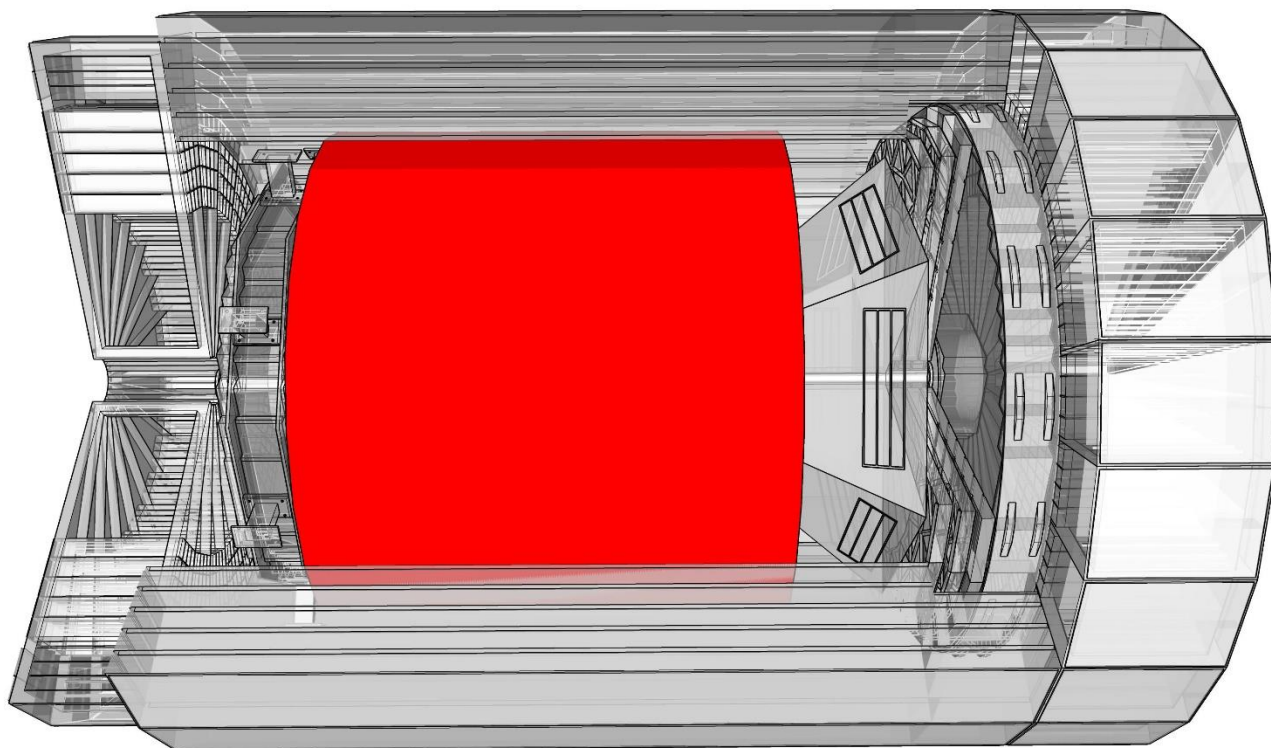


Figure 5: Solenoid Cryostat

Dimensions/Location

Overall Length	384 cm
Bore	160 cm
Radius	220 cm
Offset	1 cm in Hadron Direction
Total Volume	27.51 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (CLEO II)	3,412 kg/m ³	93,846 kg
Cabling		
Total:		93,846 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3
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BARREL SUPPORT

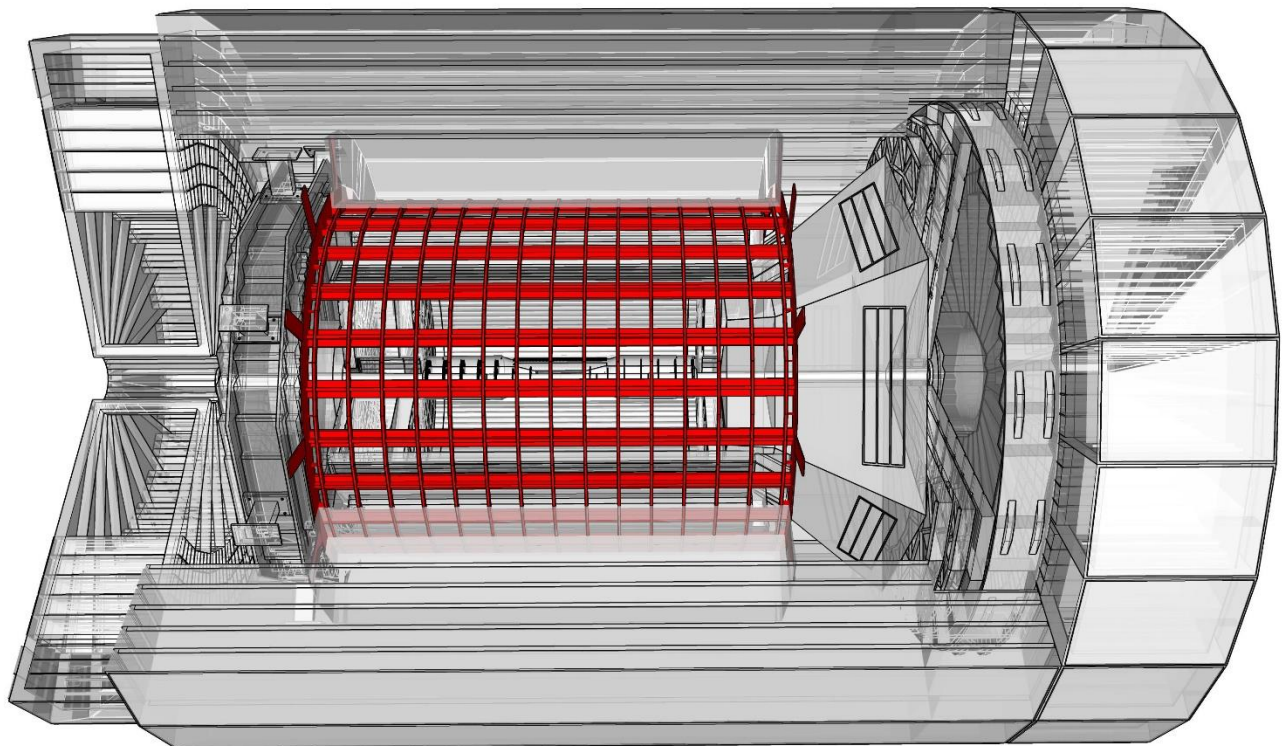


Figure 6: Barrel Support

Dimensions/Location

Structure Length	384 cm
Radius	160 cm
Support Radius	220 cm
Offset	1 cm in Hadron Direction

Weight Estimates

Element	Basis	Weight
Data Not Collected		
Total:		lbs
		tons

3

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BARREL ELECTROMAGNETIC CALORIMETER

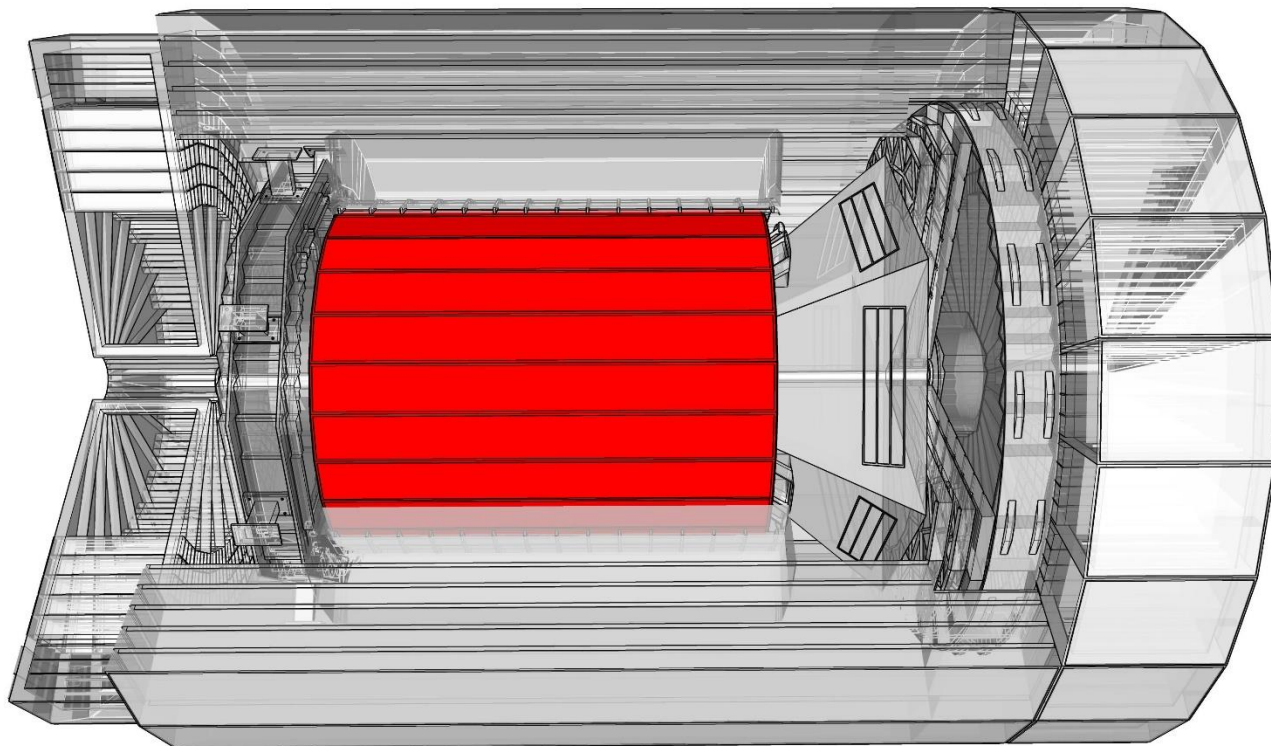


Figure 7: Barrel Electromagnetic Calorimeter

Dimensions/Location

Overall Length		370 cm
Bore		115 cm
Radius		152 cm
Offset	5 cm in Lepton Direction	
Total Volume		11.48 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (CMS)	3,508 kg/m ³	40,284 kg
Cabling		
Total:		40,284 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3

TESLA

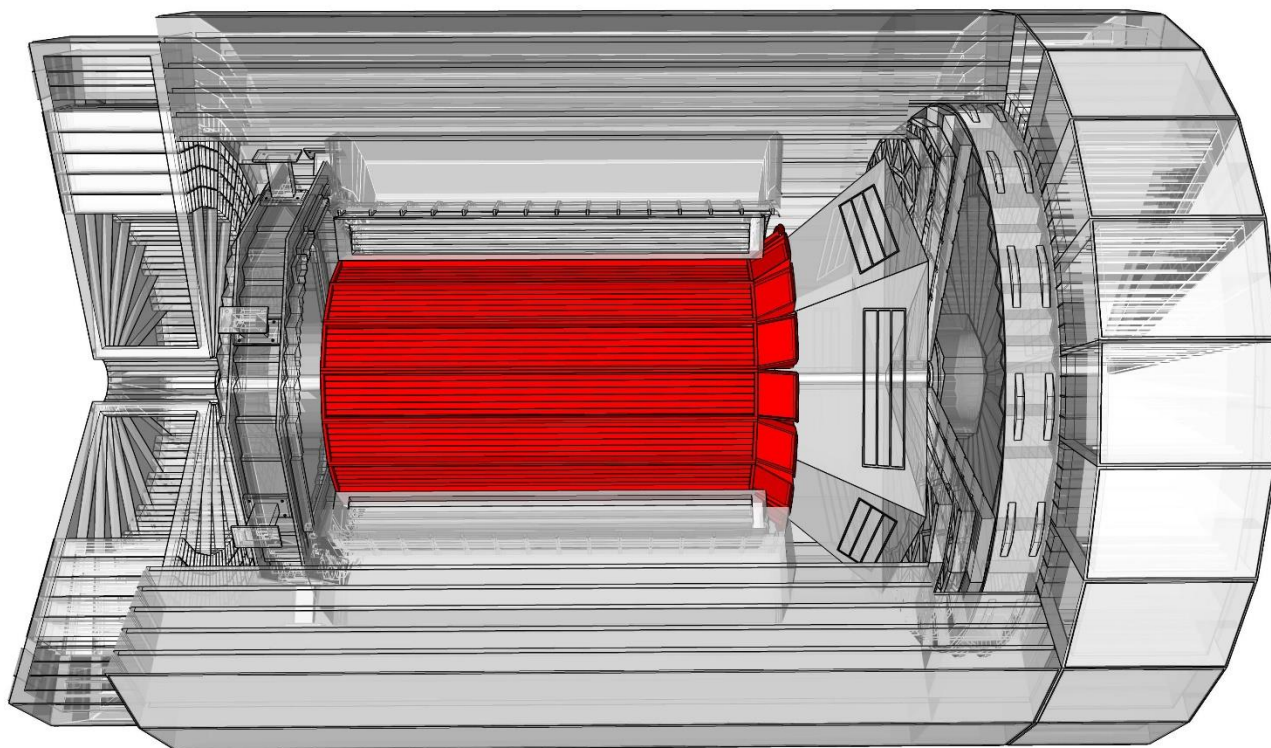
DIRC (DETECTION OF INTERNALLY REFLECTED CHERENKOV LIGHT) DETECTOR

Figure 8: DIRC Detector

Dimensions/Location

<i>DIRC Bar Length</i>		360 cm
<i>DIRC Segment Count</i>		17
<i>Bore</i>		N/A
<i>Radius</i>		112 cm
<i>Offset</i>	169 cm in Hadron Direction	
<i>Total Volume</i>		1.10 m ³

Weight Estimates

<i>Element</i>	<i>Basis</i>	<i>Weight</i>
0.22 m ³ of Steel	7,850 kg/m ³	1,690 kg
0.89 m ³ of Quartz	2,320 kg/m ³	2,058 kg
Cabling		
	Total:	3,747 kg

Power Requirements

<i>Component</i>	<i>Source/Voltage</i>	<i>Amps</i>
Data Not collected		

Heat Dissipation

<i>Removal Mechanism/Medium</i>	<i>BTUs</i>
Data Not collected	

Communications/Signal

<i>Element</i>	<i>Cables/Connections</i>
Data Not Collected	

3 TESLA

LEPTON DIRECTION ELECTROMAGNETIC CALORIMETER

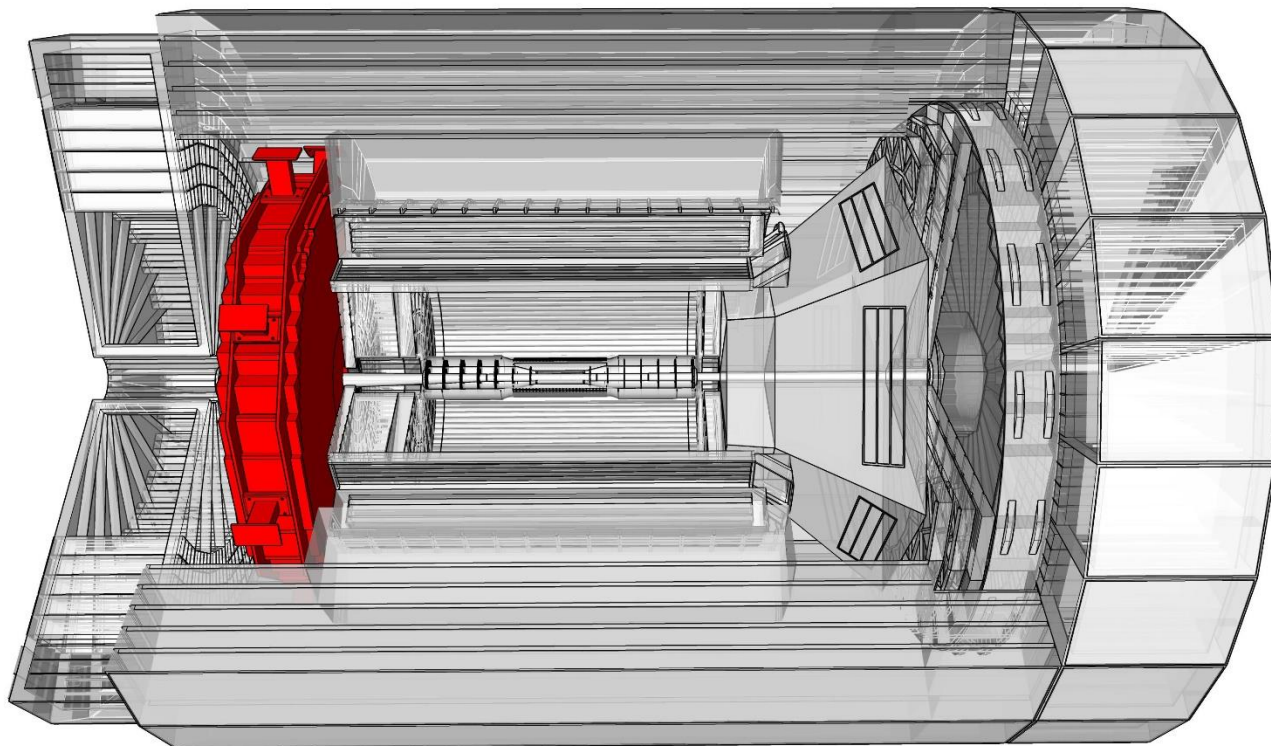


Figure 9: Lepton Direction Electromagnetic Calorimeter

Dimensions/Location

Overall Length	60 cm
Bore	15 cm
Radius	160 cm
Support Radius	220 cm
Offset	195 cm in Lepton Direction
Total Volume	5.14 m ³

Weight Estimates

Element	Basis	Weight
4.8 m ³ of Lead Glass	6,220 kg/m ³	29,738 kg
0.4 m ³ of Steel	7,850 kg/m ³	2,856 kg
Cabling		
	Total:	32,595 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3 TESLA

LEPTON DIRECTION TIME OF FLIGHT DETECTOR

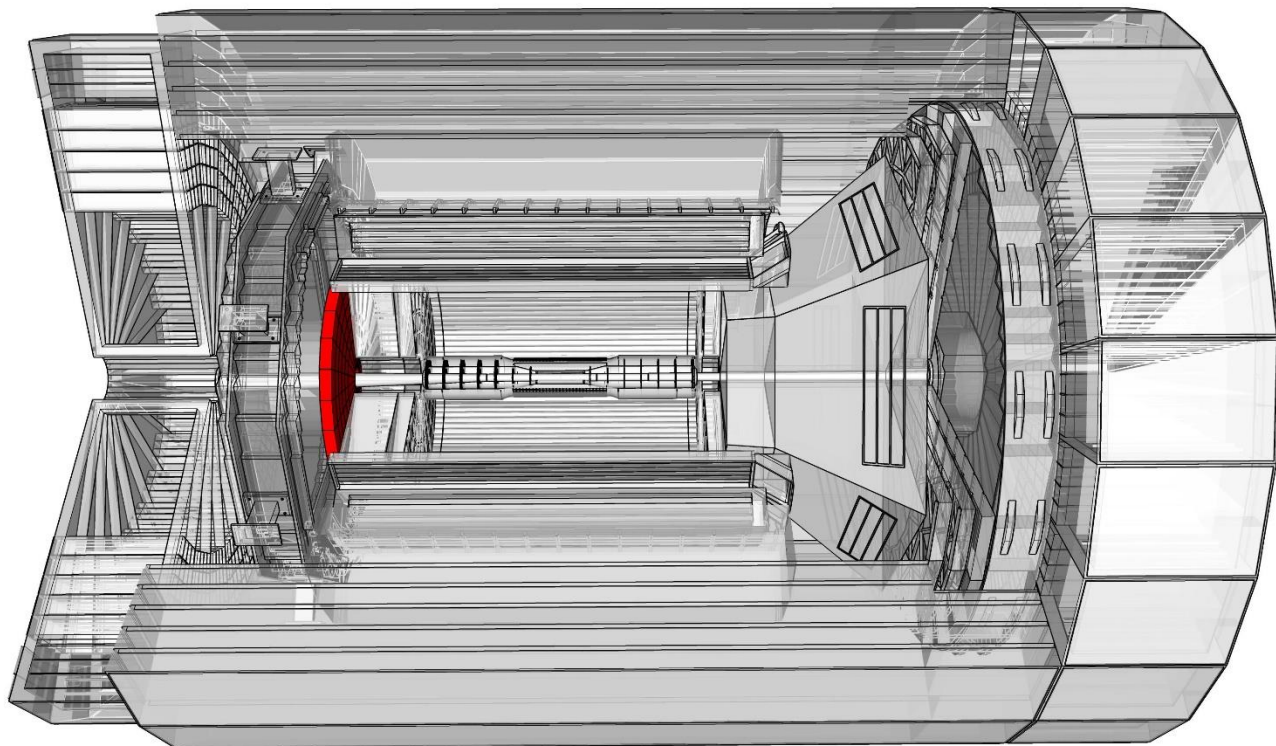


Figure 10: Lepton Direction Time of Flight Detector

Dimensions/Location

Overall Length		10 cm
Bore		10 cm
Radius		100 cm
Offset	185 cm in Lepton Direction	
Total Volume		0.31 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (PANDA)	605 kg/m ³	188 kg
Cabling		
	Total:	188 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3 TESLA

CHERENKOV COUNTER

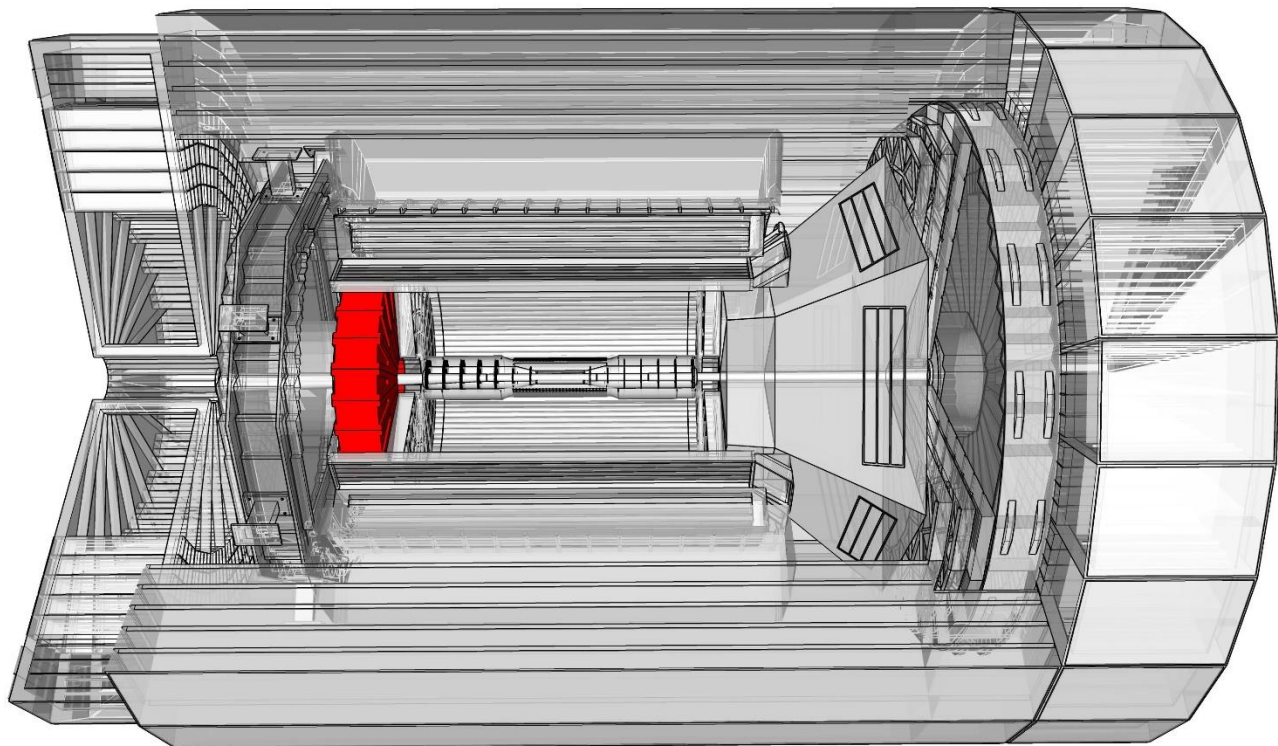


Figure 11: Cherenkov Counter

Dimensions/Location

Overall Length	40 cm
Bore	20 cm
Radius	100 cm
Offset	145 cm in Lepton Direction
Total Volume	1.21 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (CLAS LTCC)	186 kg/m ³	224 kg
Cabling		
Total:		224 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3 TESLA

LEPTON DIRECTION MICRO-PATTERN GAS DETECTOR

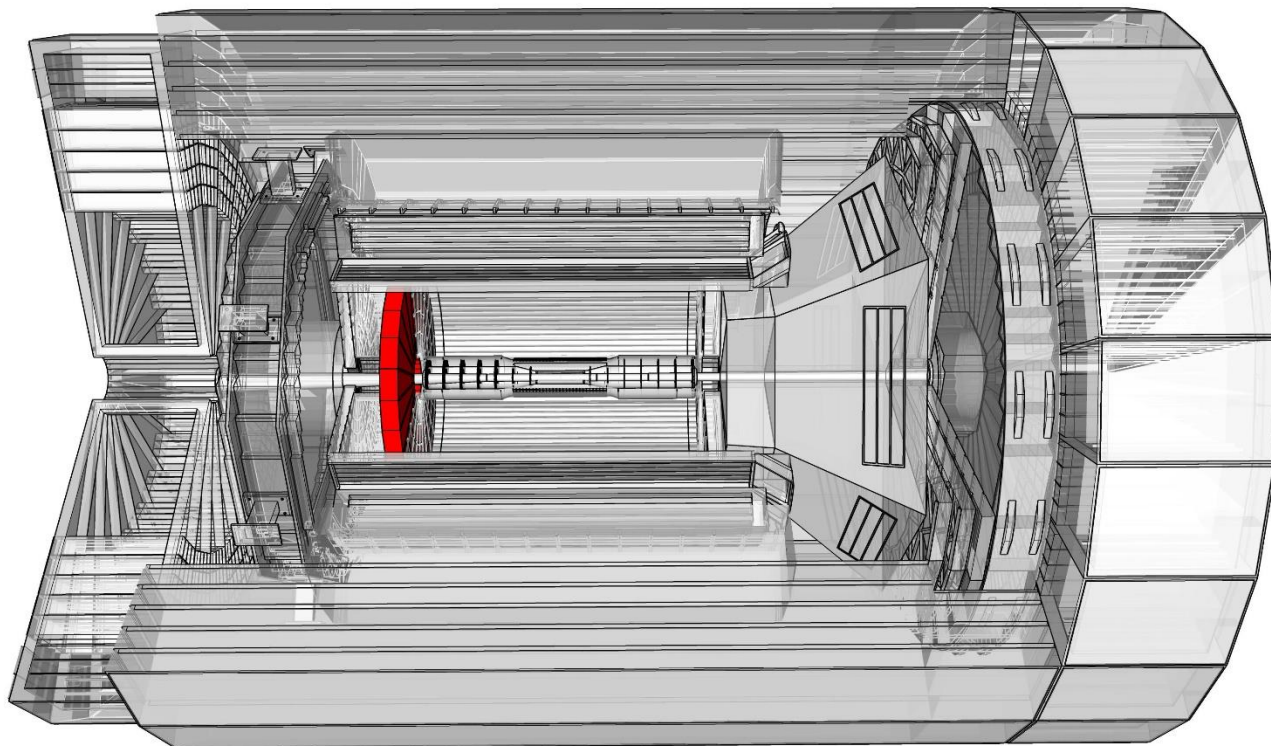


Figure 12: Lepton Direction Micro-Pattern Gas Detector

Dimensions/Location

Overall Length		15 cm
Bore		20 cm
Radius		100 cm
Offset	130 cm in Lepton Direction	
Total Volume		0.45 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (SBS GEM)	200 kg/m ³	91 kg
Cabling		
	Total:	91 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3 TESLA

OUTER TRACKING

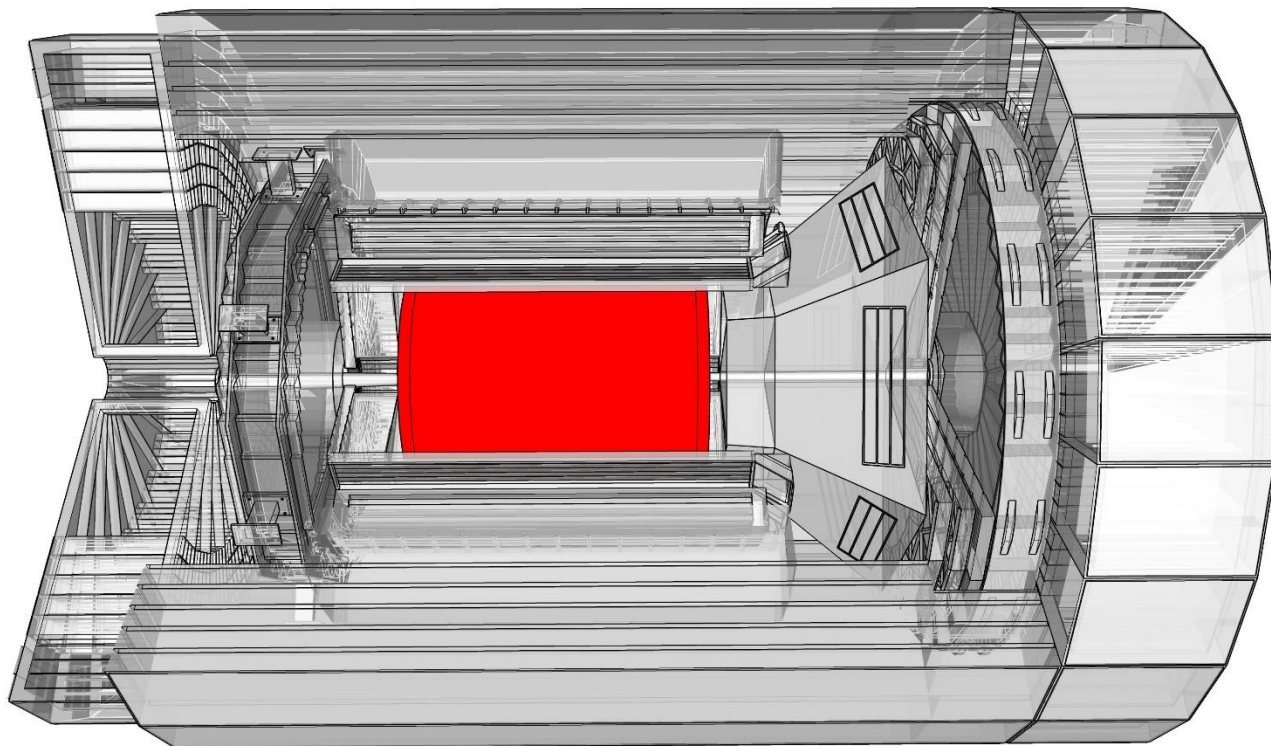


Figure 13: Outer Tracking

Dimensions/Location

<i>Overall Length</i>	260 cm
<i>Bore</i>	20 cm
<i>Radius</i>	100 cm
<i>Offset</i>	0 cm
<i>Total Volume</i>	7.84 m ³

Weight Estimates

<i>Element</i>	<i>Basis</i>	<i>Weight</i>
Volume Coeff (sPHENIX TPC)	99 kg/m ³	777 kg
Cabling		
Total:		777 kg

Power Requirements

<i>Component</i>	<i>Source/Voltage</i>	<i>Amps</i>
Data Not collected		

Heat Dissipation

<i>Removal Mechanism/Medium</i>	<i>BTUs</i>
Data Not collected	

Communications/Signal

<i>Element</i>	<i>Cables/Connections</i>
Data Not Collected	

3 TESLA

HADRON DIRECTION MICRO-PATTERN GAS DETECTOR

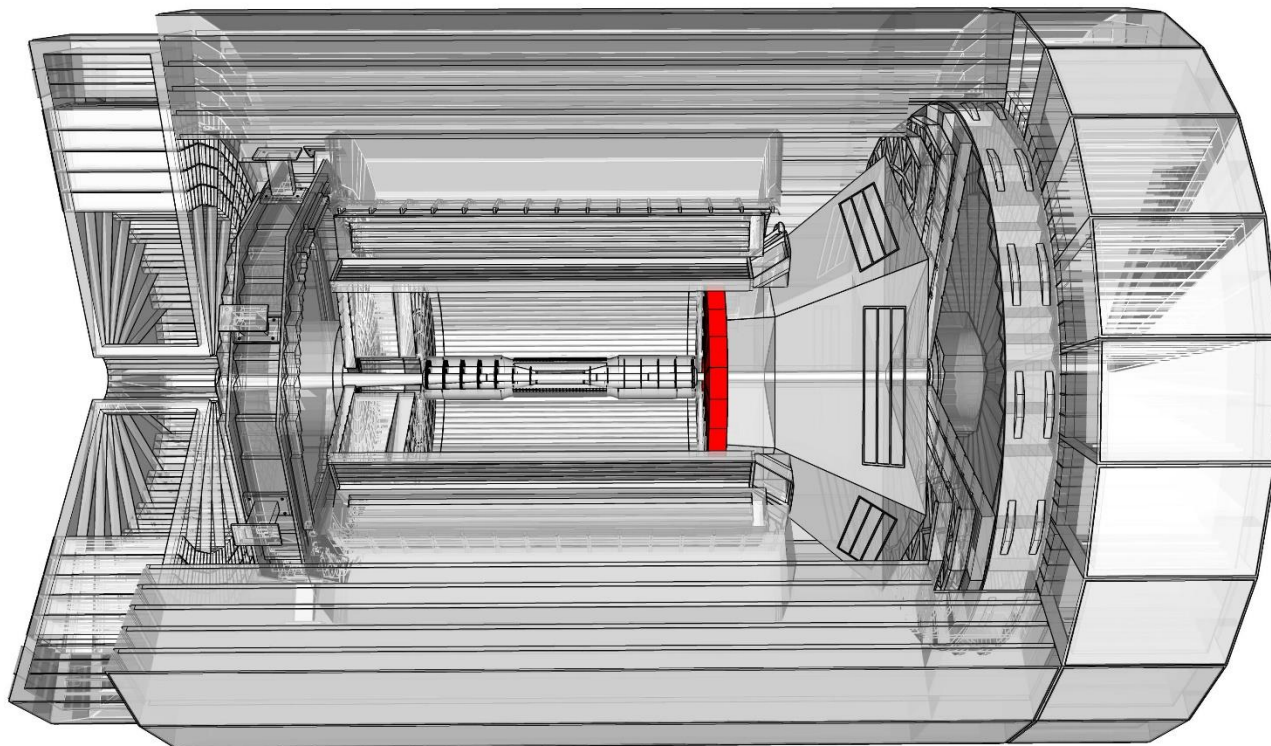


Figure 14: Hadron Direction Micro-Pattern Gas Detector

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	100 cm
Offset	130 cm in Hadron Direction
Total Volume	0.45 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (SBS GEM)	200 kg/m ³	91 kg
Cabling		
Total:		91 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3

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RICH (RING IMAGING CHERENKOV) DETECTOR

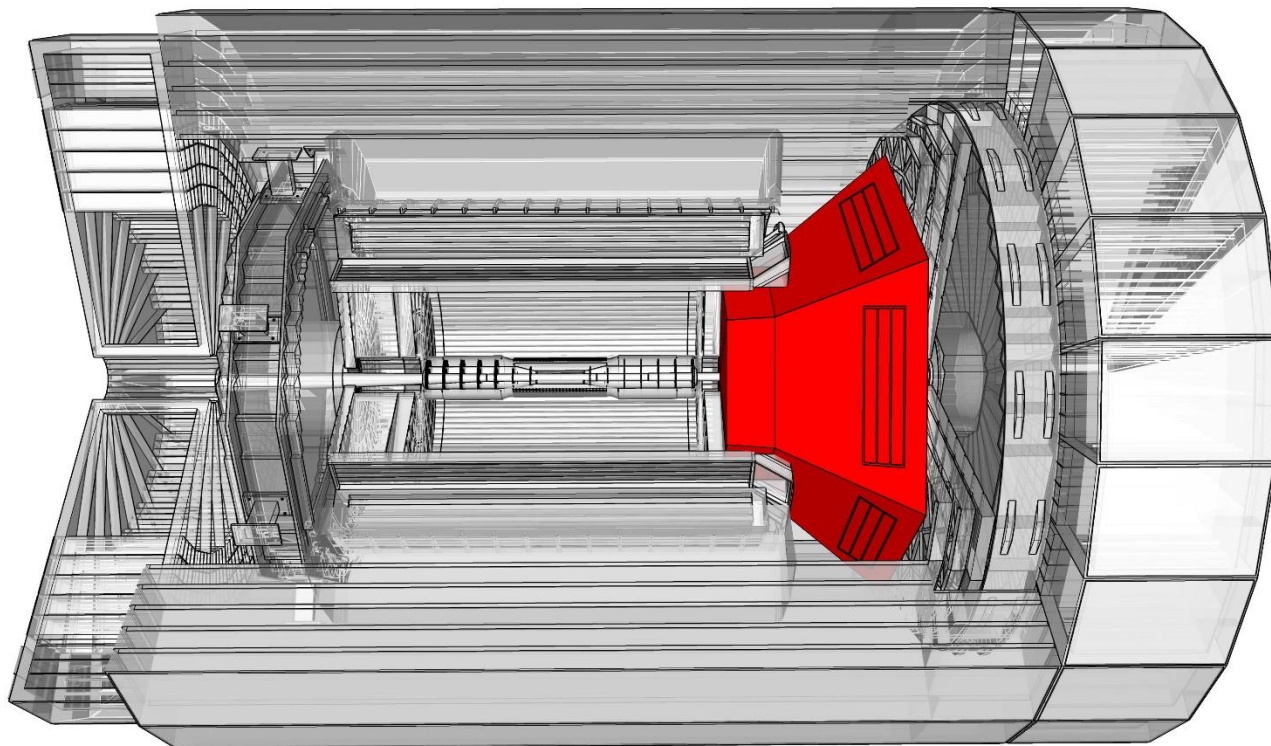


Figure 15: RICH Detector

Dimensions/Location

Overall Length		150 cm
Aerogel Length		40 cm
Aerogel Radius		105 cm
Detector Length		110 cm
Bore		10 cm
E1 (Far) Radius		200 cm
E2 (Near) Radius		110 cm
Offset	295 cm in Hadron Direction	
Segment Count		6
Total Volume		9.99 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (CLAS LTCC)	185.81 kg/m ³	1,856 kg
Cabling		
	Total:	1,856 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

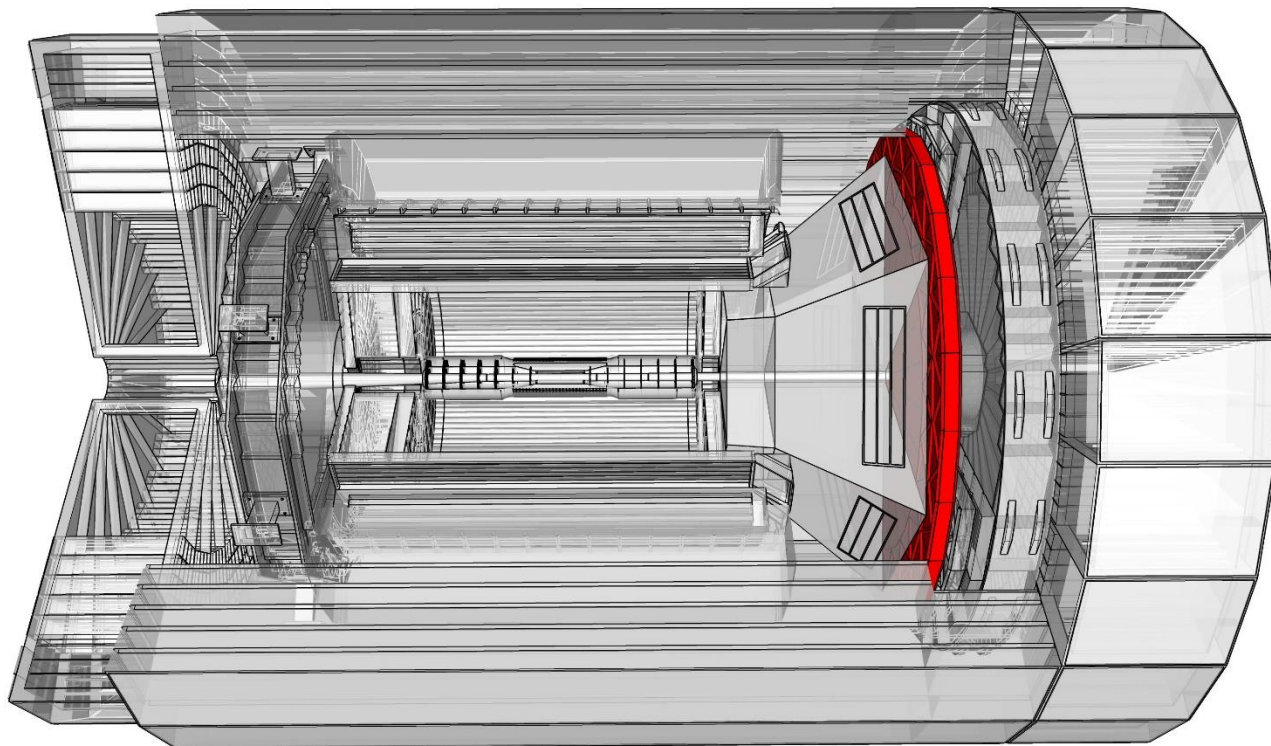
HADRON DIRECTION TRANSITION RADIATION DETECTOR 2


Figure 16: Hadron Direction Transition Radiation Detector 2

Dimensions/Location

<i>Overall Length</i>		15 cm
<i>Bore</i>		20 cm
<i>Radius</i>		220 cm
<i>Offset</i>	295 cm in Hadron Direction	
<i>Total Volume</i>		2.26 m ³

Weight Estimates

<i>Element</i>	<i>Basis</i>	<i>Weight</i>
Volume Coeff (SBS GEM)	239 kg/m ³	540 kg
Cabling		
	Total:	540 kg

Power Requirements

<i>Component</i>	<i>Source/Voltage</i>	<i>Amps</i>
Data Not collected		

Heat Dissipation

<i>Removal Mechanism/Medium</i>	<i>BTUs</i>
Data Not collected	

Communications/Signal

<i>Element</i>	<i>Cables/Connections</i>
Data Not Collected	

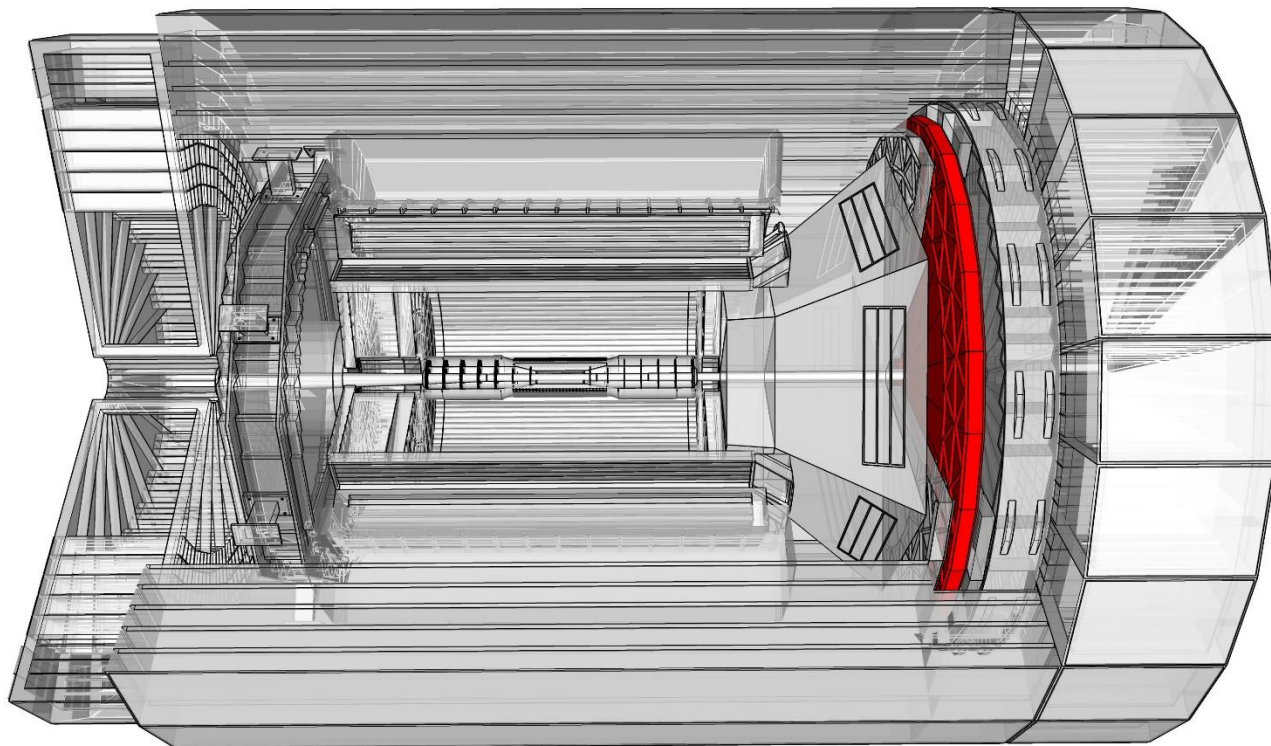
HADRON DIRECTION TRANSITION RADIATION DETECTOR 1


Figure 17: Hadron Direction Transition Radiation Detector 1

Dimensions/Location

<i>Overall Length</i>		15 cm
<i>Bore</i>		20 cm
<i>Radius</i>		230 cm
<i>Offset</i>	310 cm in Hadron Direction	
<i>Total Volume</i>		2.47 m ³

Weight Estimates

<i>Element</i>	<i>Basis</i>	<i>Weight</i>
Volume Coeff (SBS GEM)	239 kg/m ³	590 kg
Cabling		
	Total:	590 kg

Power Requirements

<i>Component</i>	<i>Source/Voltage</i>	<i>Amps</i>
Data Not collected		

Heat Dissipation

<i>Removal Mechanism/Medium</i>	<i>BTUs</i>
Data Not collected	

Communications/Signal

<i>Element</i>	<i>Cables/Connections</i>
Data Not Collected	

3 TESLA

HADRON DIRECTION TIME OF FLIGHT DETECTOR

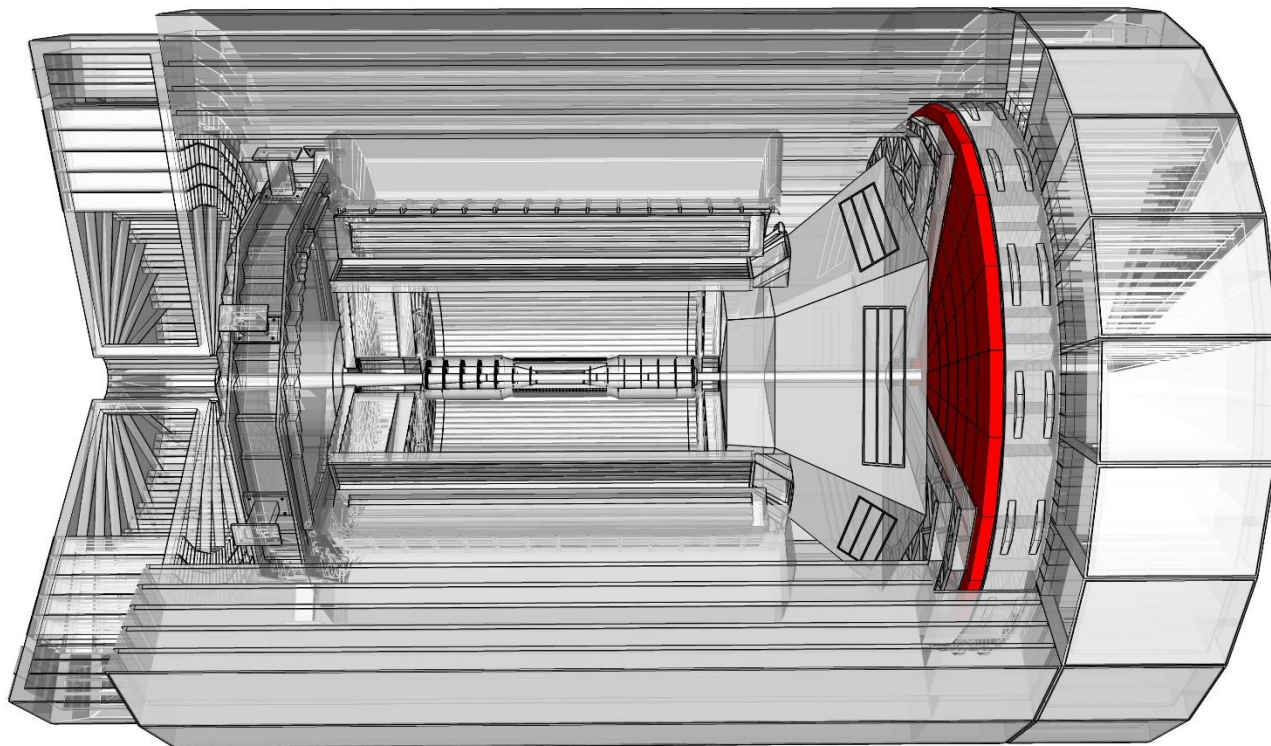


Figure 18: Hadron Direction Time of Flight Detector

Dimensions/Location

Overall Length		10 cm
Bore		20 cm
Radius		240 cm
Offset	325 cm in Hadron Direction	
Total Volume		1.80 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (PANDA)	605 kg/m ³	1,088 kg
Cabling		
	Total:	1,088 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3

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HADRON DIRECTION ELECTROMAGNETIC CALORIMETER

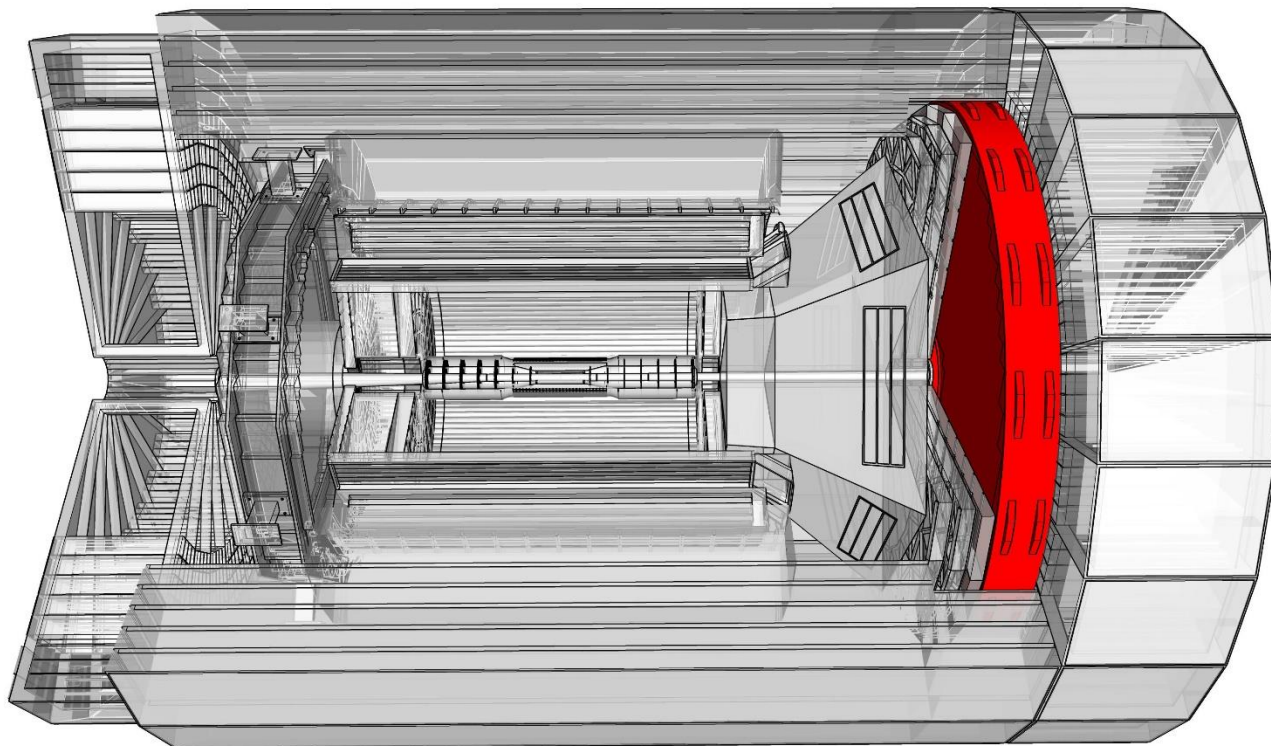


Figure 19: Hadron Direction Electromagnetic Calorimeter

Dimensions/Location

<i>Overall Length</i>		40 cm
<i>Bore</i>		30 cm
<i>Radius</i>		250 cm
<i>Offset</i>	335 cm in Hadron Direction	
<i>Total Volume</i>		7.74 m ³

Weight Estimates

<i>Element</i>	<i>Basis</i>	<i>Weight</i>
7.58 m ³ of Lead Glass	6,220 kg/m ³	47,161 kg
0.16 m ³ of Steel	7,850 kg/m ³	1,246 kg
Cabling		
	Total:	48,407 kg

Power Requirements

<i>Component</i>	<i>Source/Voltage</i>	<i>Amps</i>
Data Not collected		

Heat Dissipation

<i>Removal Mechanism/Medium</i>	<i>BTUs</i>
Data Not collected	

Communications/Signal

<i>Element</i>	<i>Cables/Connections</i>
Data Not Collected	

3 TESLA

SILICON VERTEX DETECTOR

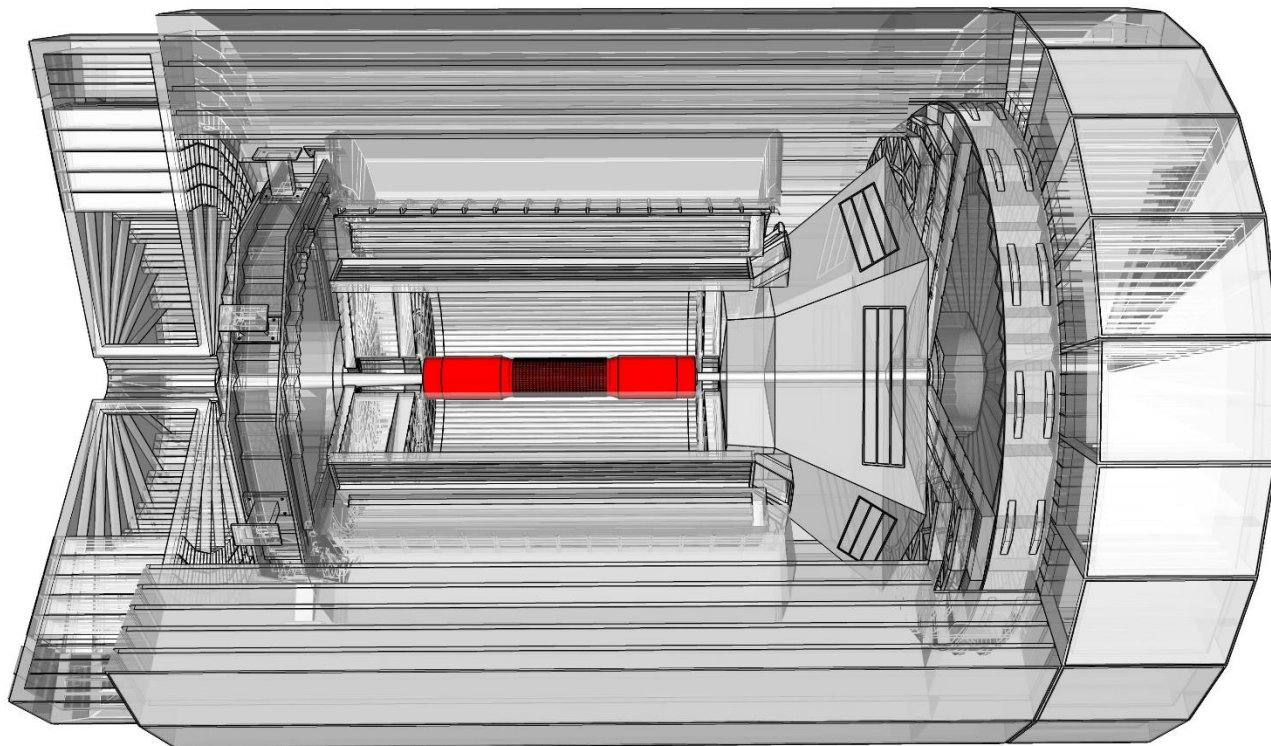


Figure 20: Silicon Vertex Detector

Dimensions/Location

Overall Length	244 cm
Bore	0 cm
Radius	19.8 cm
Offset	0 cm
Total Volume	0.30 m ³

Weight Estimates

Element	Basis	Weight
0.009 m ³ of Aluminum	2,710 kg/m ³	24 kg
0.009 m ³ of Silicon	2,330 kg/m ³	21 kg
Cabling		
Total:		45 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3
TESLA

VACUUM CHAMBER

That vacuum chamber shown here is specific to IP-6. An alternate design will be provided for IP-5.

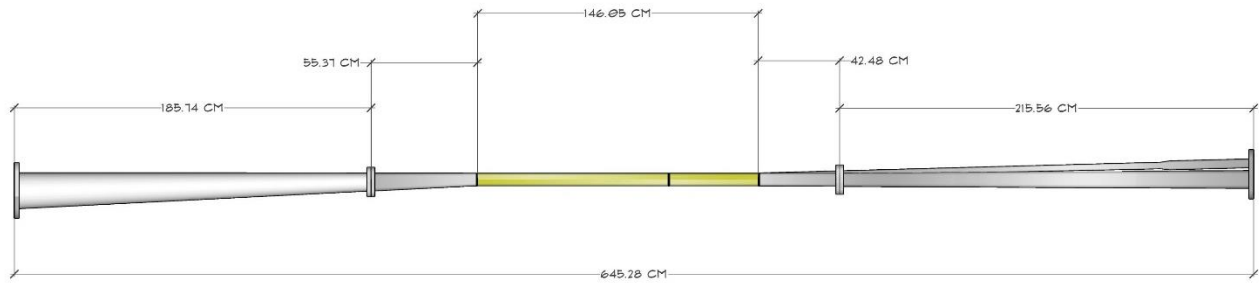


Figure 21: Vacuum Chamber (Top View)

Dimensions/Location

Overall Length	645.28 cm
Beryllium Length	146.05 cm
Interior Section Length	243.90 cm
Lepton Section Length	185.74 cm
Hadron Section Length	215.56 cm

Weight Estimates

Element	Basis	Weight
Data Not Collected		
Total:		lbs
		tons

Power Requirements

Component	Source/Voltage	Amps
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3
TESLA

ALTERNATE DIRC: BARREL SUPPORT

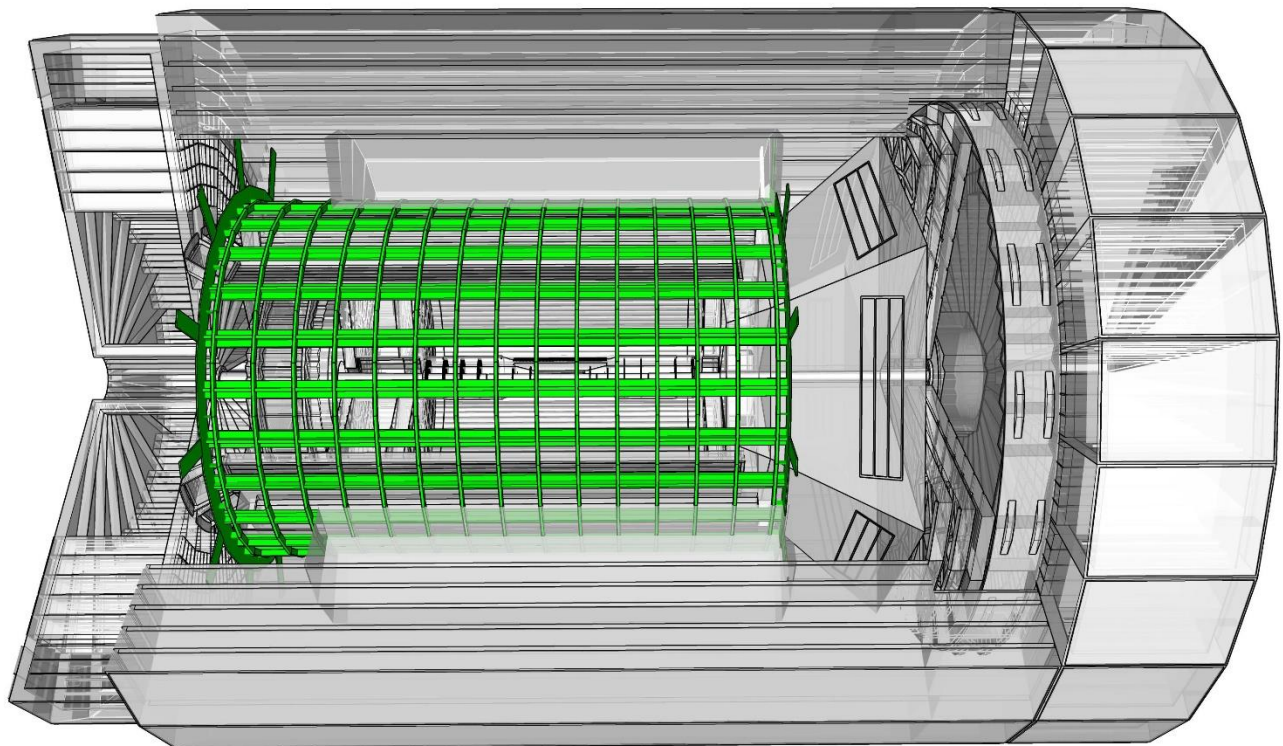


Figure 22: Barrel Support

Dimensions/Location

Structure Length	460 cm
Radius	160 cm
Support Radius	220 cm
Offset	42 cm in Lepton Direction

Weight Estimates

Element	Basis	Weight
Data Not Collected		
Total:		lbs
		tons

3 TESLA

ALTERNATE DIRC: BARREL ELECTROMAGNETIC CALORIMETER

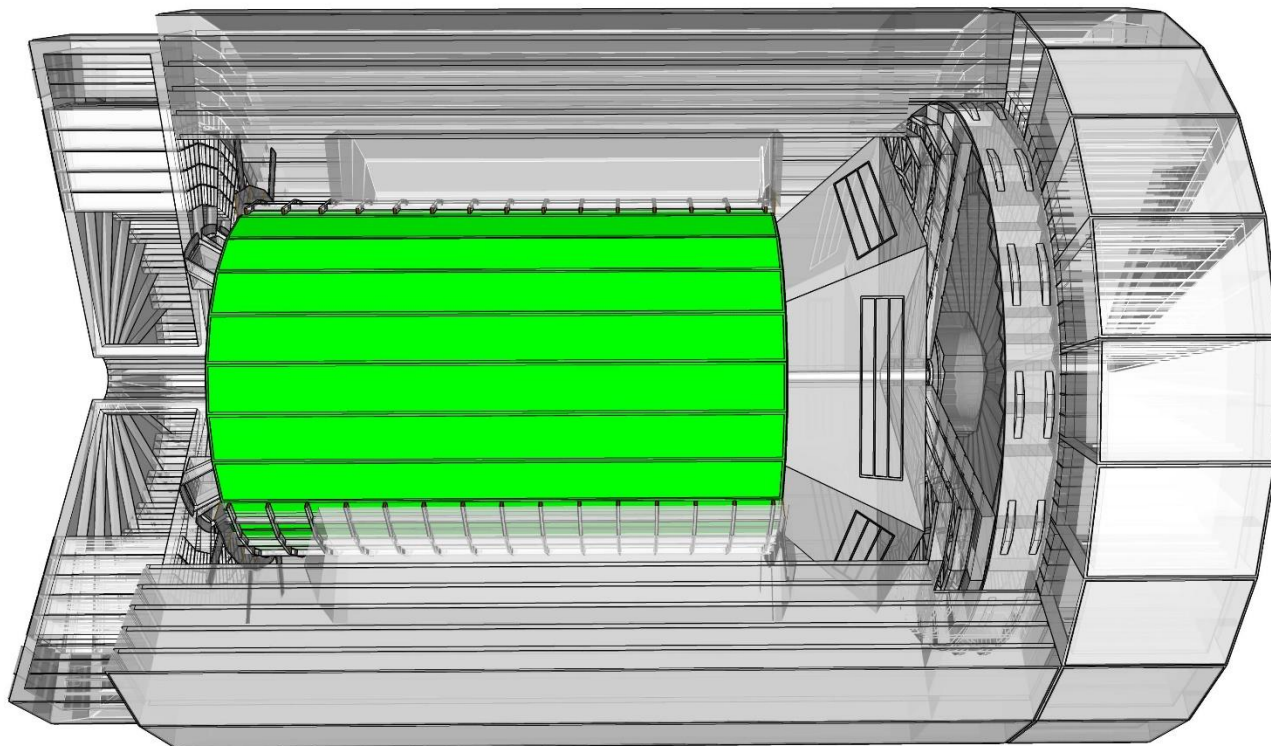


Figure 23: Barrel Electromagnetic Calorimeter

Dimensions/Location

Overall Length		460 cm
Bore		115 cm
Radius		152 cm
Offset	42 cm in Lepton Direction	
Total Volume		14.28 m ³

Weight Estimates

Element	Basis	Weight
Volume Coeff (CMS)	3,508 kg/m ³	50,082 kg
Cabling		
Total:		50,082 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not Collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3
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ALTERNATE DIRC: DIRC DETECTOR

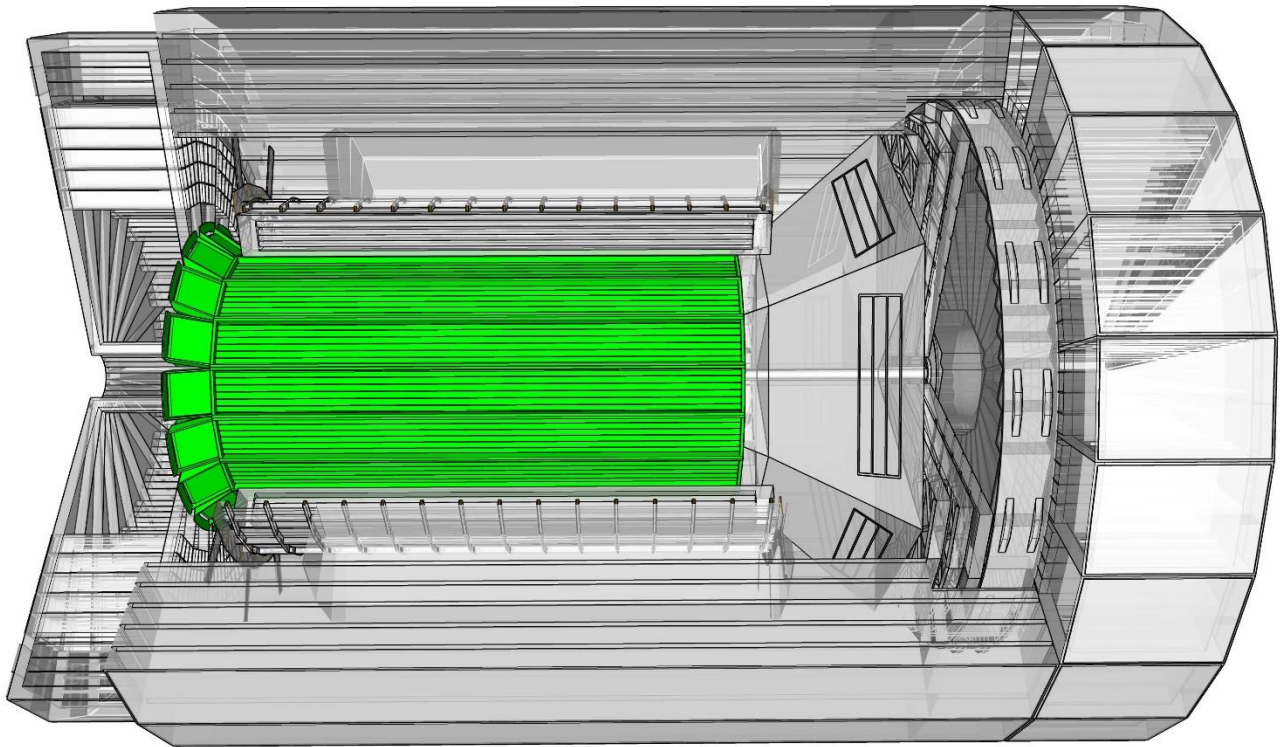


Figure 24: DIRC Detector

Dimensions/Location

<i>DIRC Bar Length</i>	440 cm
<i>DIRC Segment Count</i>	17
<i>Bore</i>	N/A
<i>Radius</i>	112 cm
<i>Offset</i>	280 cm in Lepton Direction
<i>Total Volume</i>	1.27 m ³

Weight Estimates

<i>Element</i>	<i>Basis</i>	<i>Weight</i>
0.25 m ³ of Steel	7,850 kg/m ³	1,973 kg
1.02 m ³ of Quartz	2,320 kg/m ³	2,368 kg
Cabling		
	Total:	4,341 kg

Power Requirements

<i>Component</i>	<i>Source/Voltage</i>	<i>Amps</i>
Data Not Collected		

Heat Dissipation

<i>Removal Mechanism/Medium</i>	<i>BTUs</i>
Data Not Collected	

Communications/Signal

<i>Element</i>	<i>Cables/Connections</i>
Data Not Collected	

3 TESLA

ALTERNATE DIRC: LEPTON DIRECTION ELECTROMAGNETIC CALORIMETER

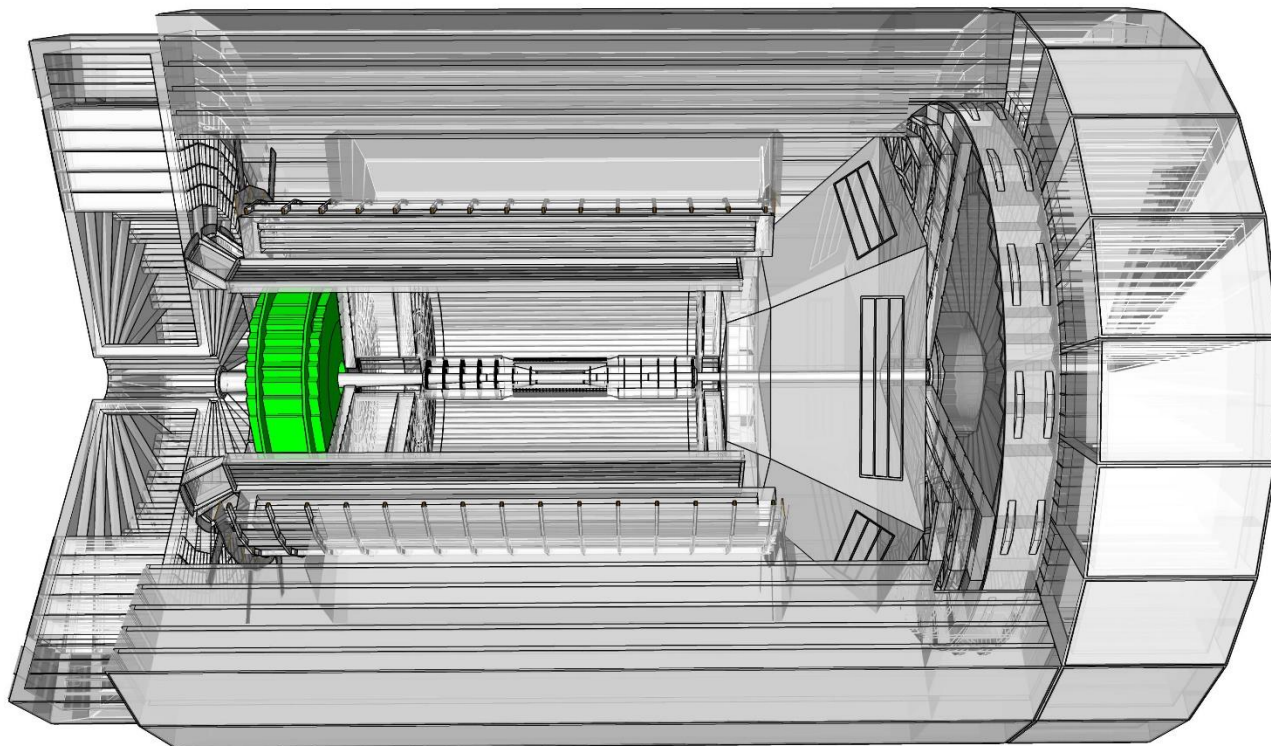


Figure 25: Lepton Direction Electromagnetic Calorimeter

Dimensions/Location

Overall Length		60 cm
Bore		16 cm
Radius		82 cm
Support Sides		17
Support Radius		100 cm
Offset	199 cm in Lepton Direction	
Total Volume		1.27 m ³

Weight Estimates

Element	Basis	Weight
1.2 m ³ of Lead Glass	6,220 kg/m ³	7,596 kg
0.1 m ³ of Steel	7,850 kg/m ³	410 kg
Cabling		
	Total:	8,006 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not Collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	

3
TESLA

ALTERNATE DIRC: RICH (RING IMAGING CHERENKOV) DETECTOR

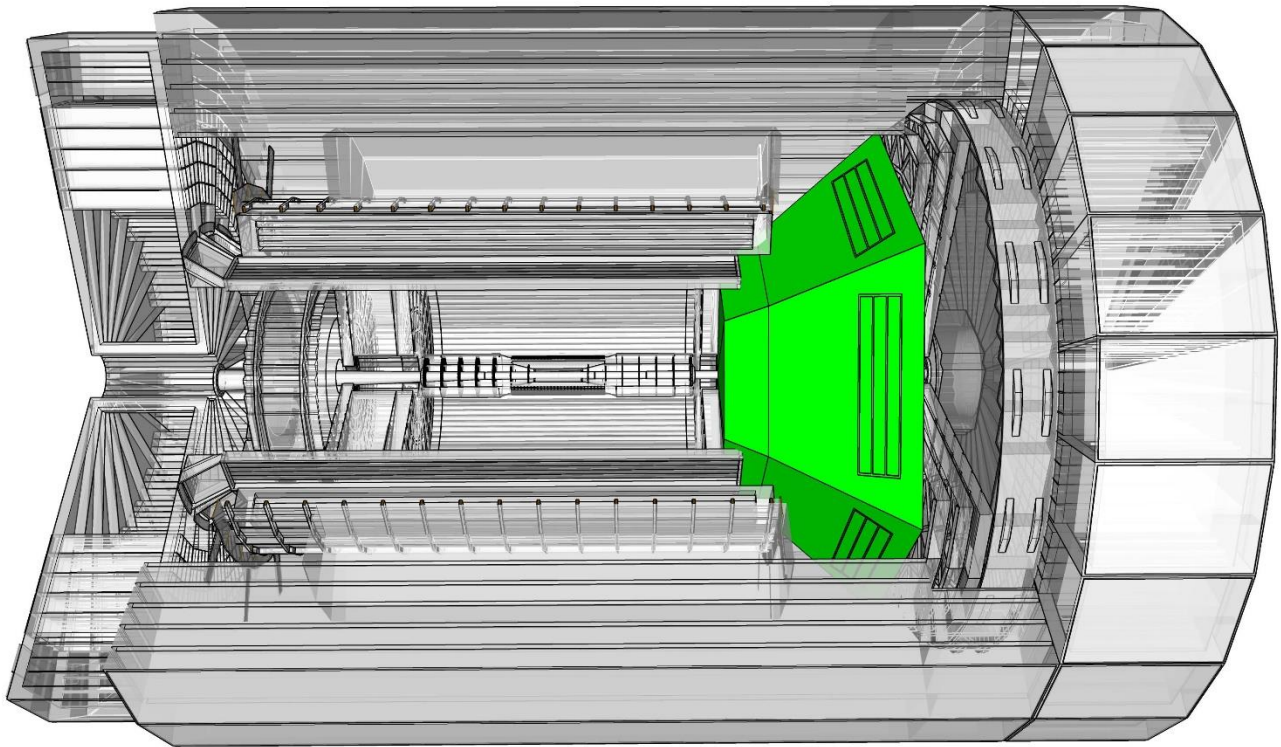


Figure 26: RICH Detector

Dimensions/Location

Overall Length	145 cm	
Aerogel Length	35 cm	
Aerogel Radius	100 cm	
Detector Length	110 cm	
Bore	10 cm	
HD Radius	220 cm	
LD Radius	125 cm	
Offset	290 cm in Hadron Direction	
Segment Count	6	
Total Volume	11.94 m ³	

Weight Estimates

Element	Basis	Weight
Volume Coeff (CLAS LTCC)	185.81 kg/m ³	2,219 kg
Cabling		
	Total:	2,219 kg

Power Requirements

Component	Source/Voltage	Amps
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	BTUs
Data Not Collected	

Communications/Signal

Element	Cables/Connections
Data Not Collected	