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 mrads, with 8 mrads in the electron beam and 17 mrads in the hadron beam.
- The axis of the solenoid must be aligned with the electron beam, thus the central detector is rotated by 8 mrads.
- 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

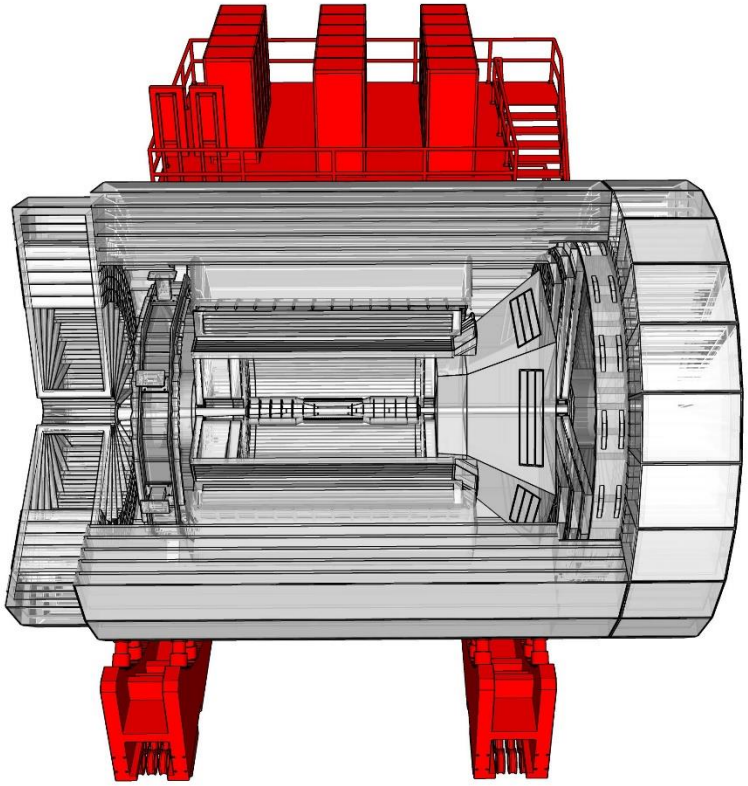

Figure 1: IP-6 Fixed Carriage

Dimensions/Location

N/A

Weight Estimates

Element	*Basis*	*Weight*
Carriage (5.92 m³ Steel)	7850 kg/m³	46,452 kg
STAR Cradles (6.88 m³ Steel)	7850 kg/m³	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 TESLA

BARREL HADRON CALORIMETER

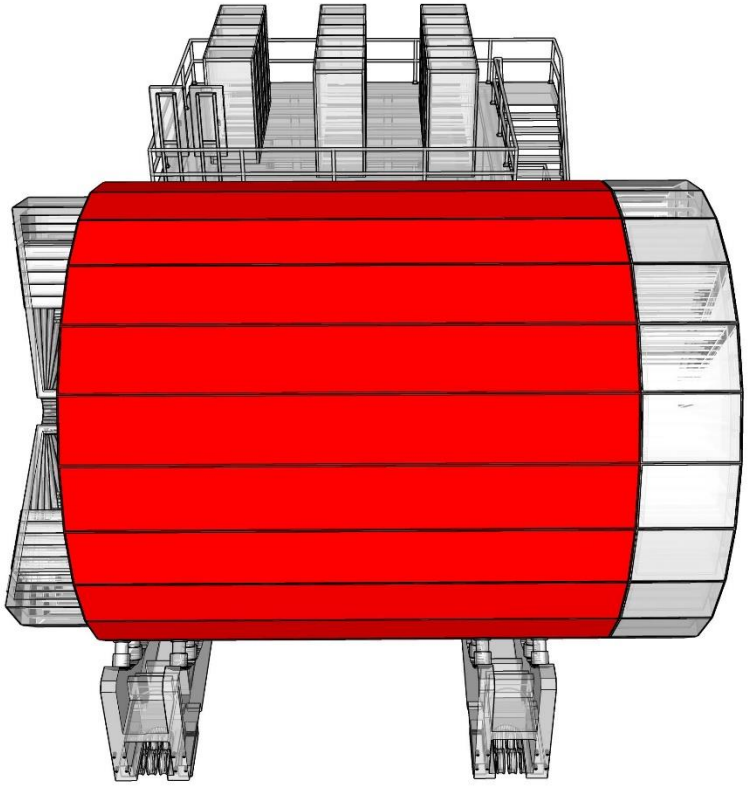

Figure 2: Barrel Hadron Calorimeter

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	

3 TESLA

LEPTON DIRECTION HADRON CALORIMETER ENDCAP

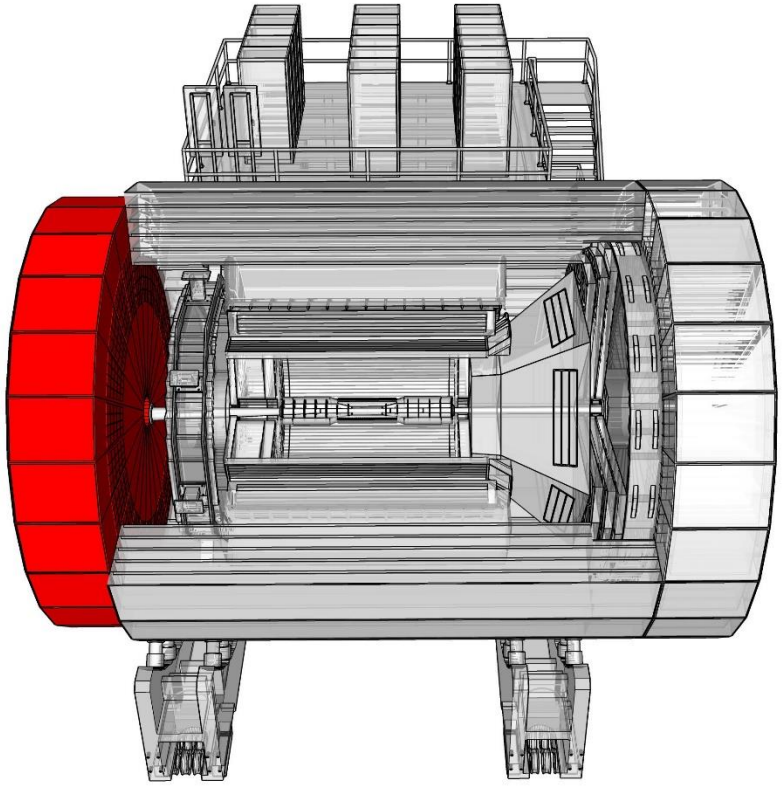

Figure 3: Lepton Direction Endcap

Dimensions/Location

Overall Length	105 cm
Bore	22 cm
Radius	300 cm
Offset	315 cm in Lepton Direction
Total Volume	29.53 m^3

Weight Estimates

Element	*Basis*	*Weight*
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

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

HADRON DIRECTION HADRON CALORIMETER ENDCAP

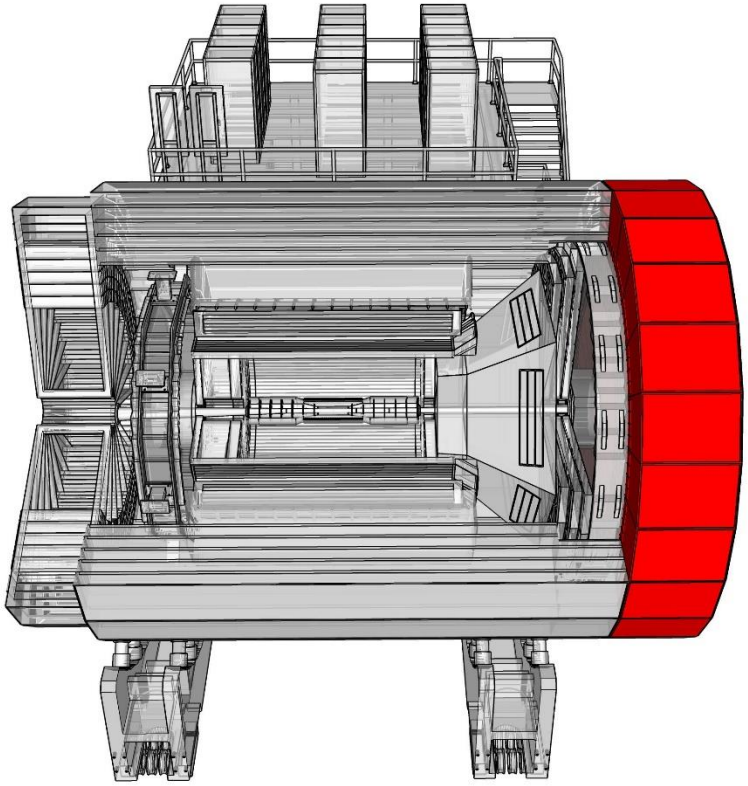

Figure 4: Hadron Direction Endcap

Dimensions/Location

Overall Length	120 cm
Bore	30 cm
Radius	320 cm
Offset	375 cm in Hadron Direction
Total Volume	38.26 m³

Weight Estimates

Element	*Basis*	*Weight*
30.2 m³ of Iron	7,847 kg/m³	237,207 kg
8. m³ of Plastic	970 kg/m³	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 TESLA SOLENOID CRYOSTAT

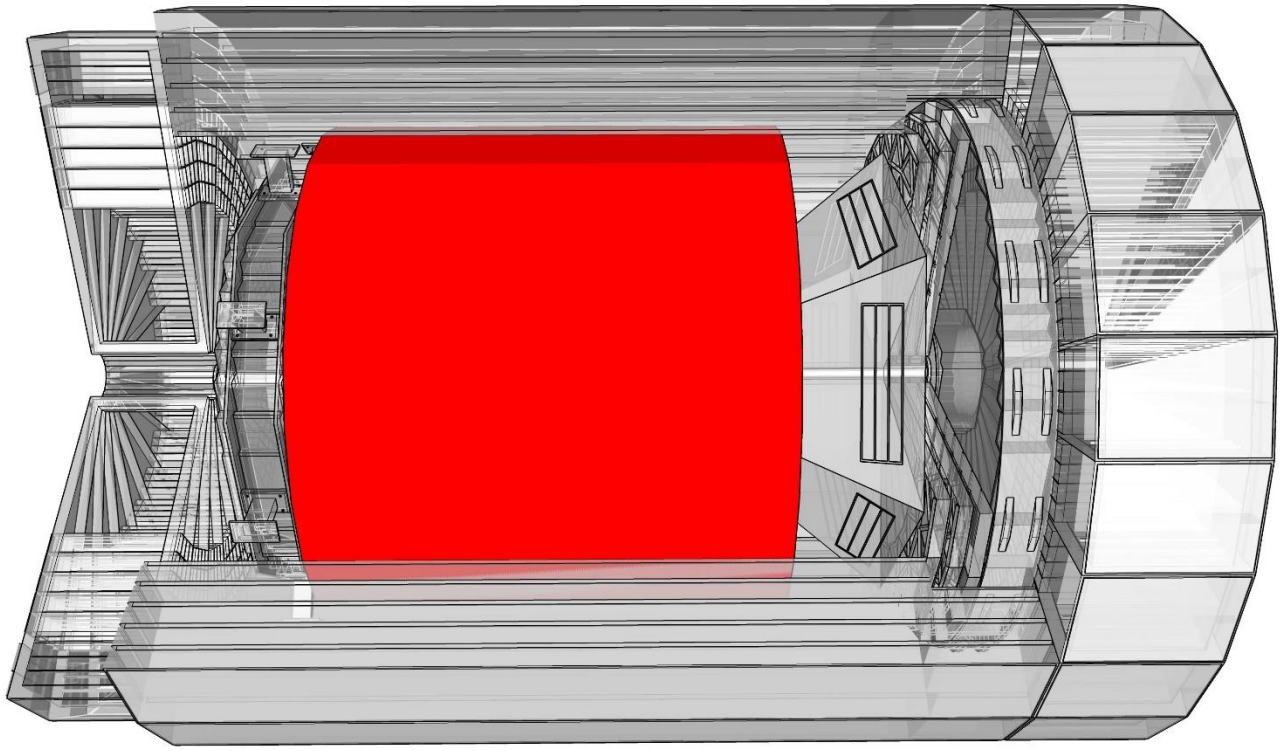

Figure 5: Solenoid Cryostat

Dimensions/Location

Overall Length	384 cm
Bore	160 cm
Radius	220 cm
Offset	1 cm in Hadron Direction
Total Volume	27.51 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLEO II)	3,412 kg/m³	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 TESLA

BARREL SUPPORT

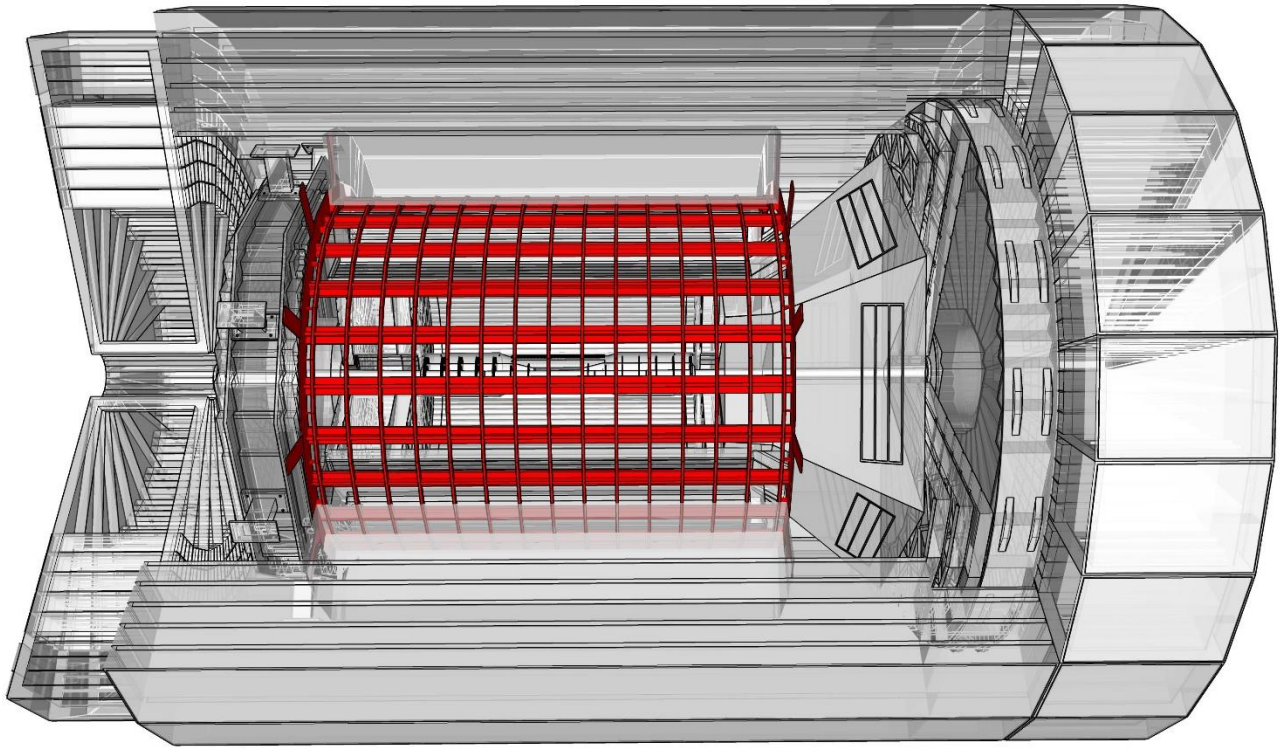

Figure 6: Barrel Support

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 TESLA

BARREL ELECTROMAGNETIC CALORIMETER

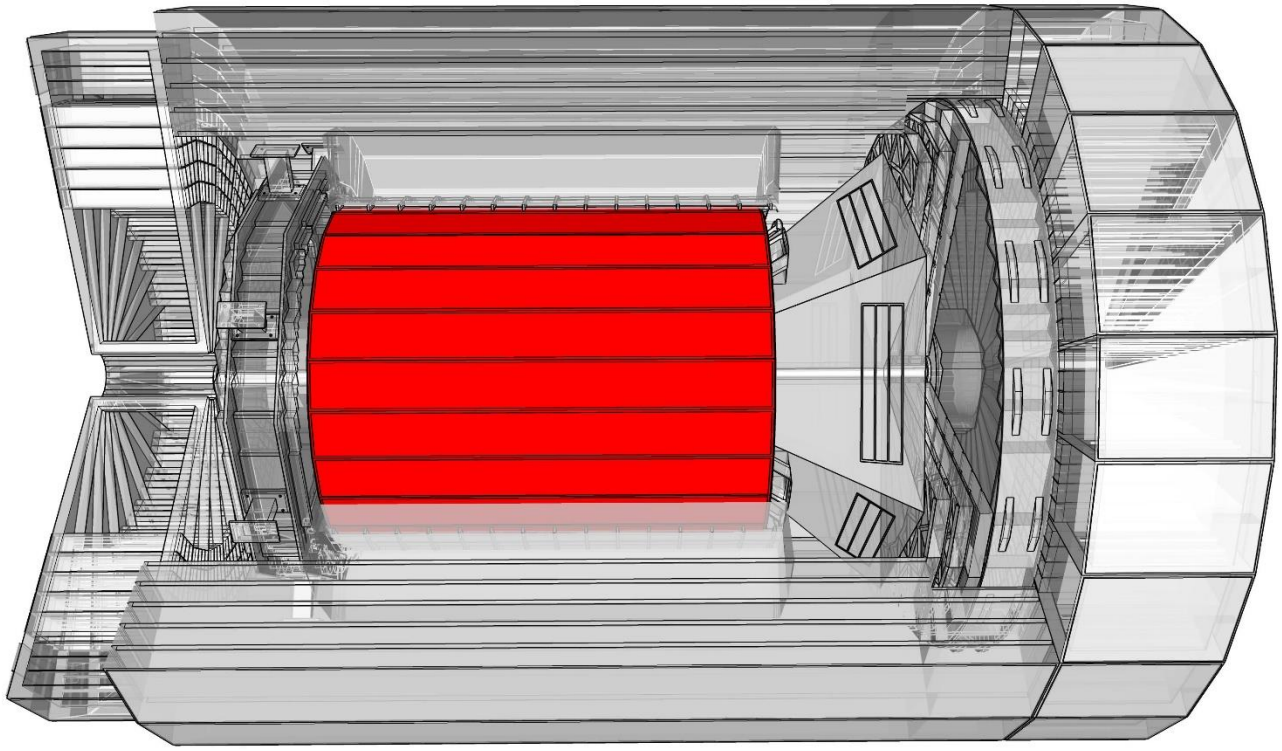

Figure 7: Barrel Electromagnetic Calorimeter

Dimensions/Location

Overall Length	370 cm
Bore	115 cm
Radius	152 cm
Offset	5 cm in Lepton Direction
Total Volume	11.48 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CMS)	3,508 kg/m³	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

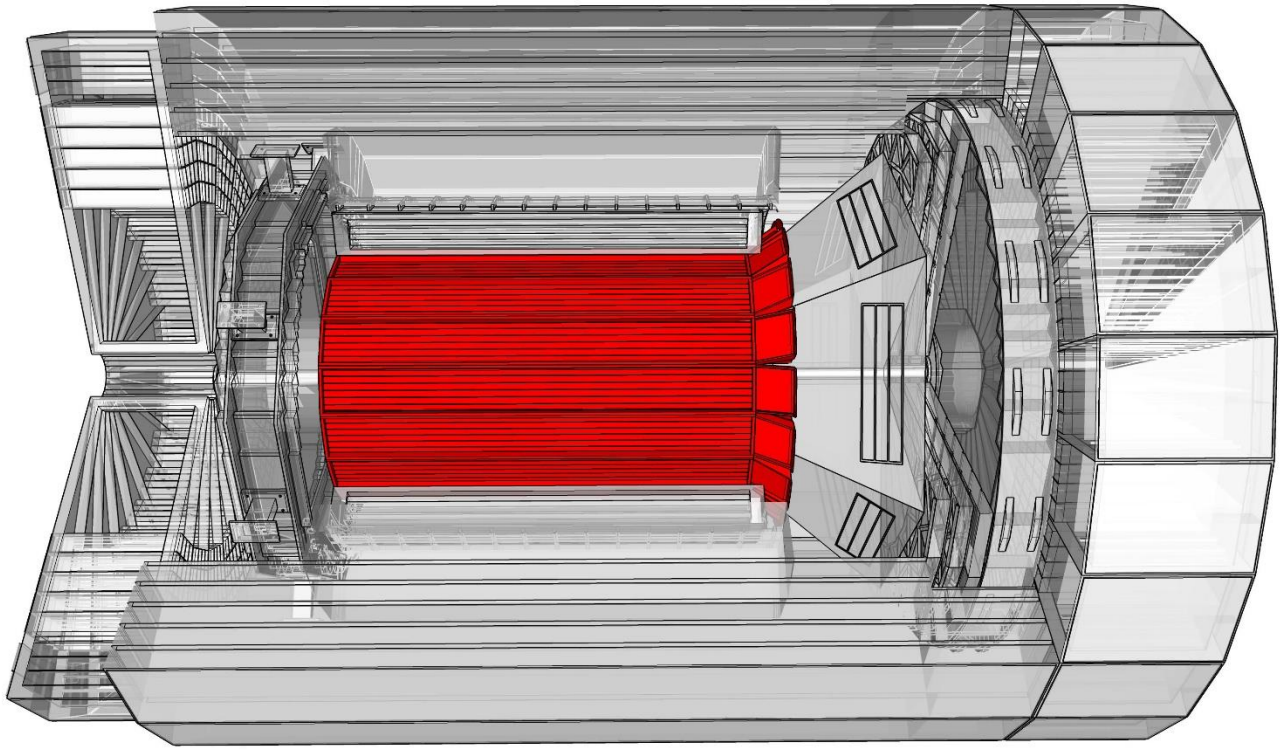

Figure 8: DIRC Detector

Dimensions/Location

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

Weight Estimates

Element	*Basis*	*Weight*
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

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 ELECTROMAGNETIC CALORIMETER

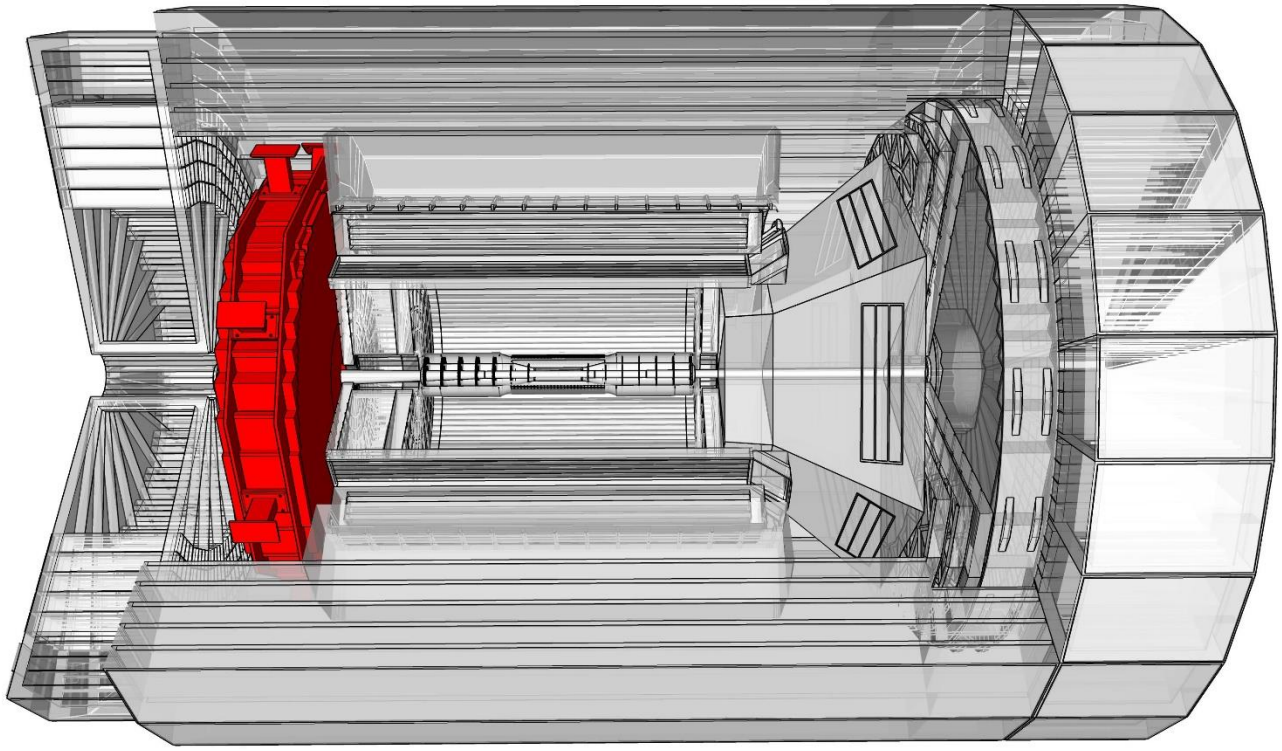

Figure 9: Lepton Direction Electromagnetic Calorimeter

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

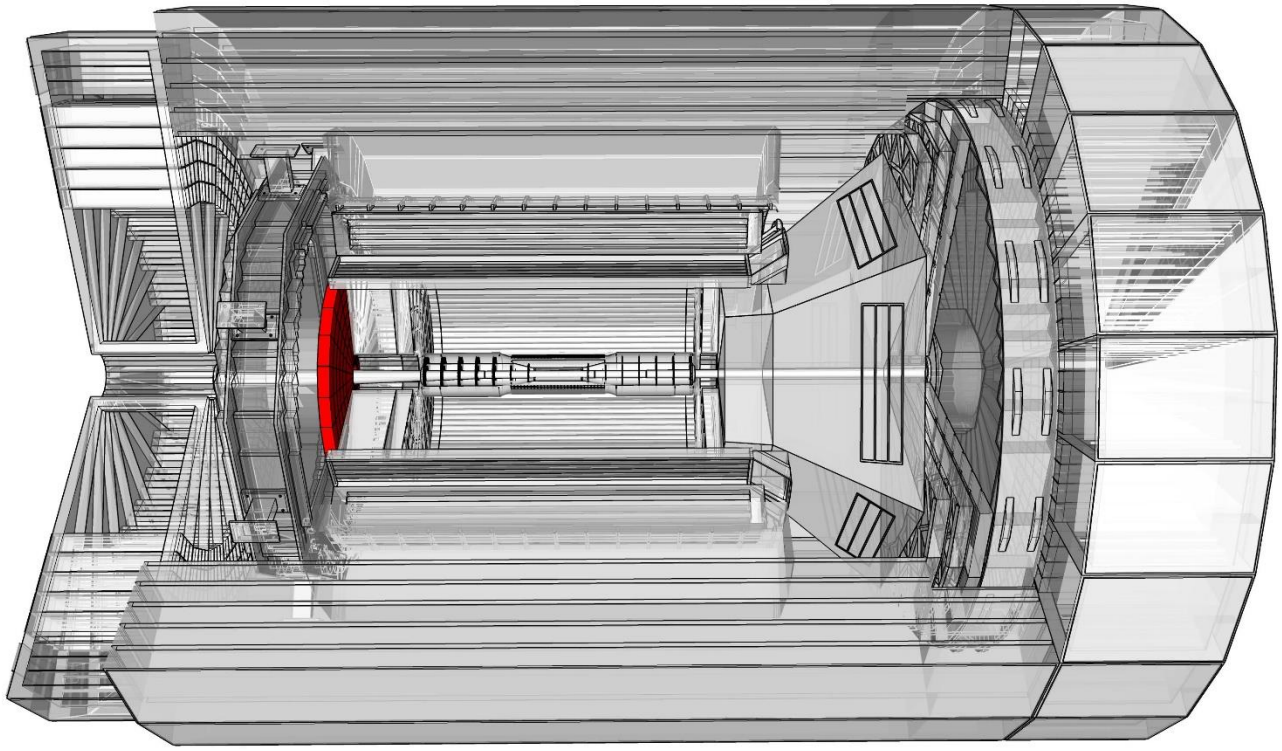

Figure 10: Lepton Direction Time of Flight Detector

Dimensions/Location

Overall Length	10 cm
Bore	10 cm
Radius	100 cm
Offset	185 cm in Lepton Direction
Total Volume	0.31 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (PANDA)	605 kg/m³	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

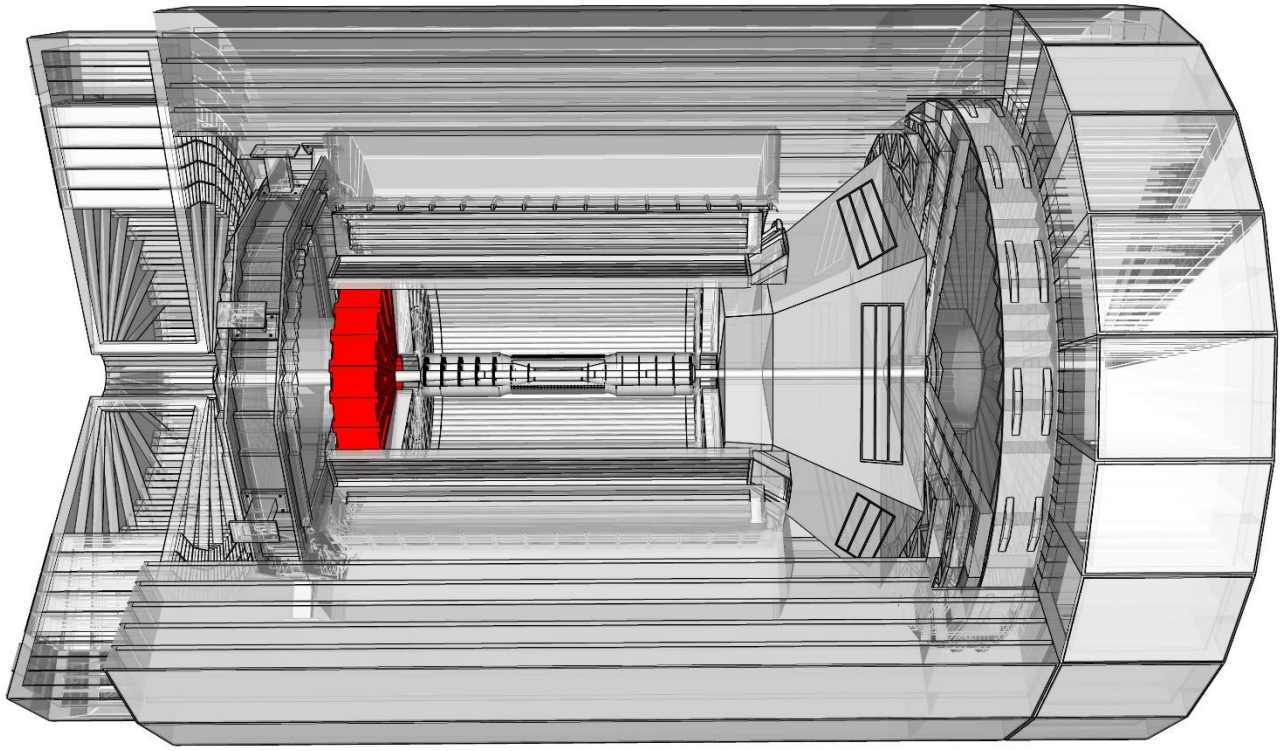

Figure 11: Cherenkov Counter

Dimensions/Location

Overall Length	40 cm
Bore	20 cm
Radius	100 cm
Offset	145 cm in Lepton Direction
Total Volume	1.21 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLAS LTCC)	186 kg/m³	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

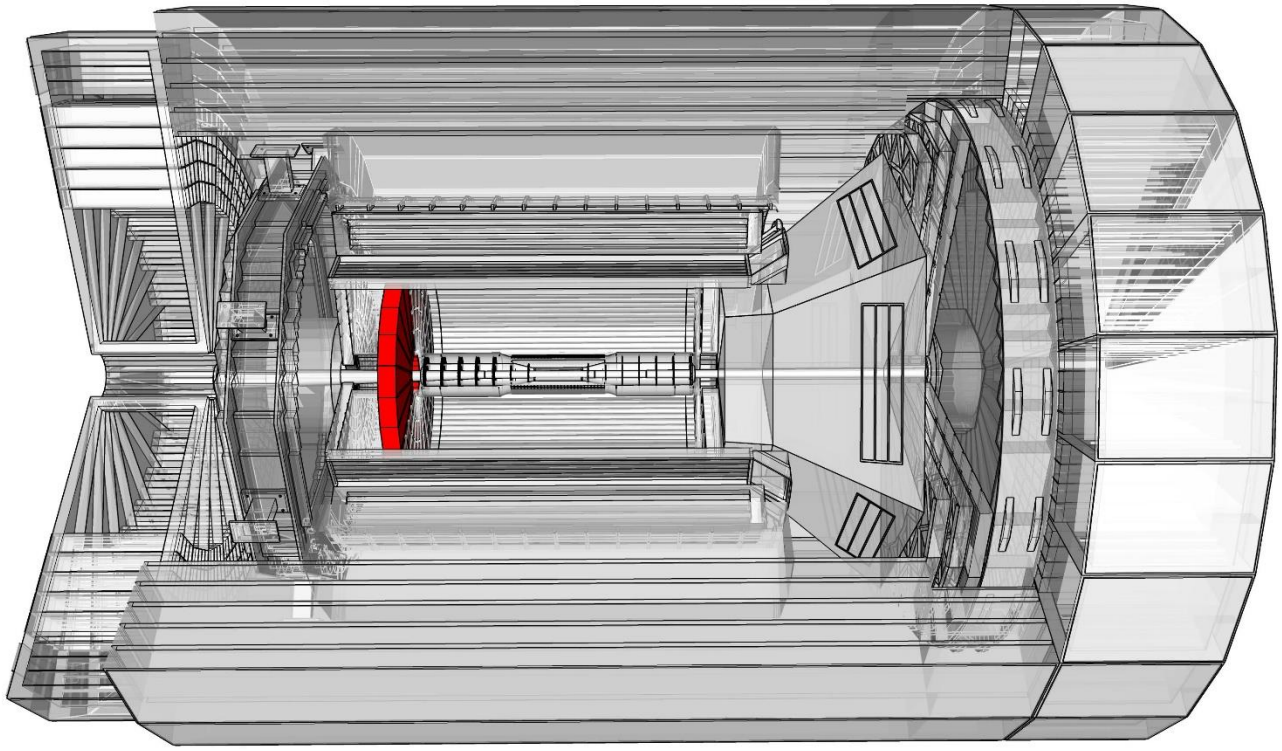

Figure 12: Lepton Direction Micro-Pattern Gas Detector

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	100 cm
Offset	130 cm in Lepton Direction
Total Volume	0.45 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	200 kg/m³	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

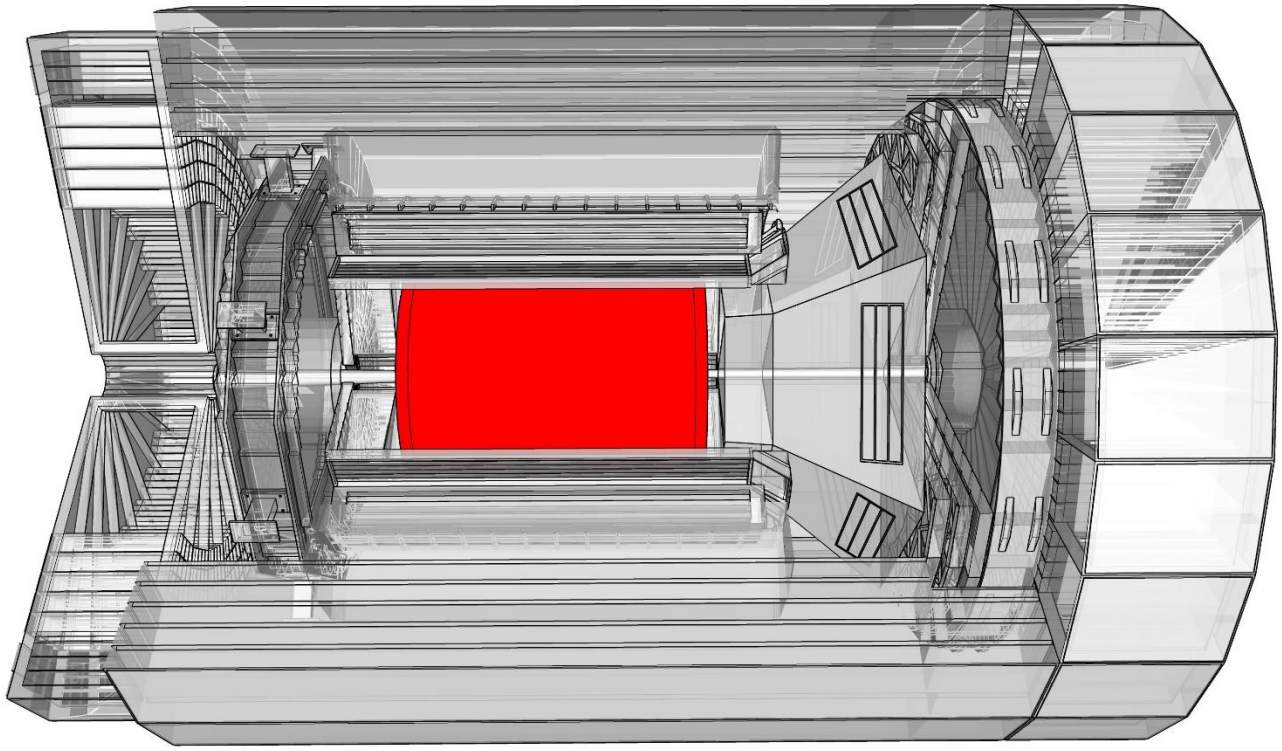

Figure 13: Outer Tracking

Dimensions/Location

Overall Length	260 cm
Bore	20 cm
Radius	100 cm
Offset	0 cm
Total Volume	7.84 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (sPHENIX TPC)	99 kg/m³	777 kg
Cabling		
	Total:	777 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

HADRON DIRECTION MICRO-PATTERN GAS DETECTOR

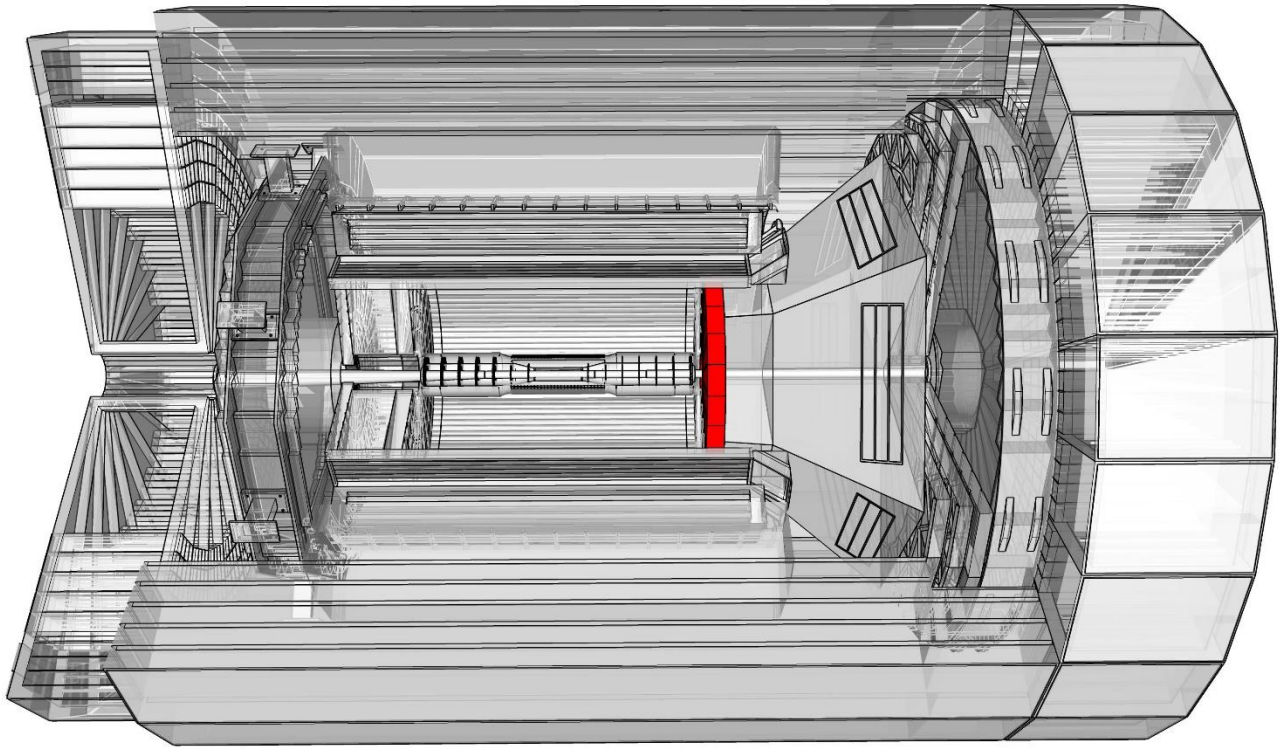

Figure 14: Hadron Direction Micro-Pattern Gas Detector

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	100 cm
Offset	130 cm in Hadron Direction
Total Volume	0.45 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	200 kg/m³	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

RICH (RING IMAGING CHERENKOV) DETECTOR

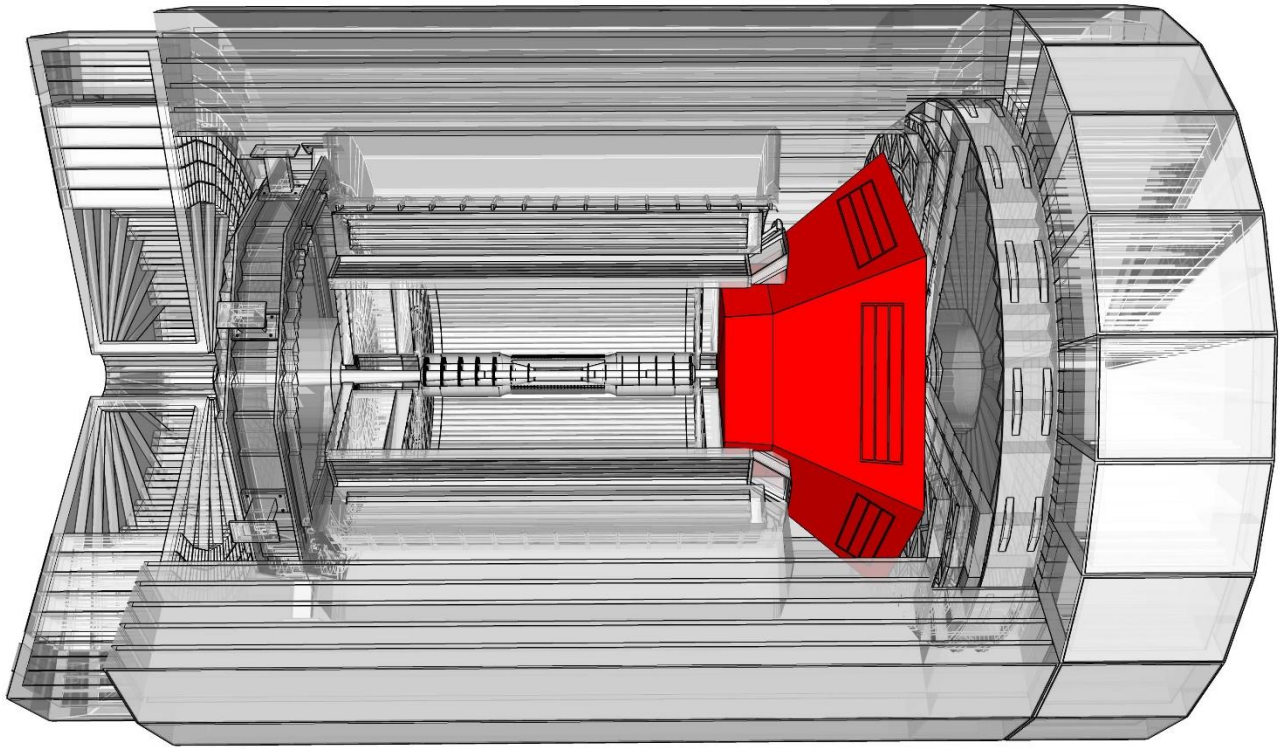

Figure 15: RICH Detector

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	

3 TESLA

HADRON DIRECTION TRANSITION RADIATION DETECTOR 2

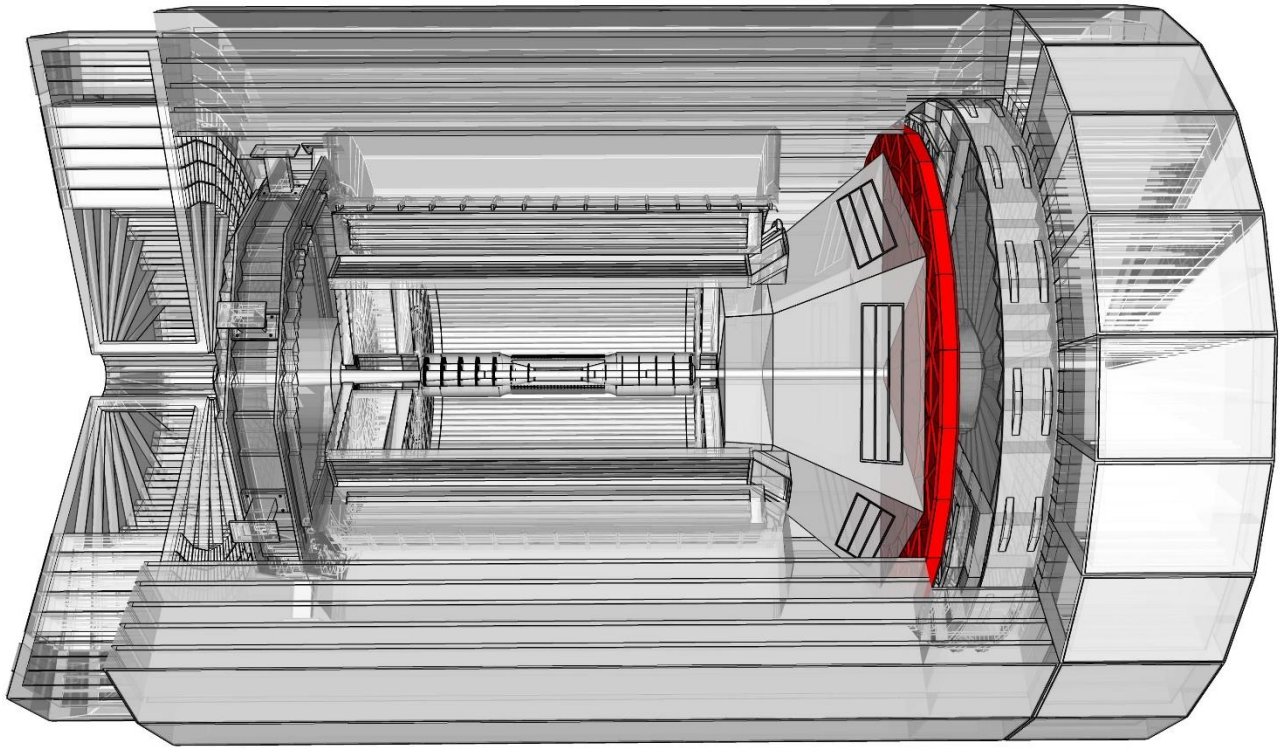

Figure 16: Hadron Direction Transition Radiation Detector 2

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	220 cm
Offset	295 cm in Hadron Direction
Total Volume	2.26 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	239 kg/m³	540 kg
Cabling		
	Total:	540 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

HADRON DIRECTION TRANSITION RADIATION DETECTOR 1

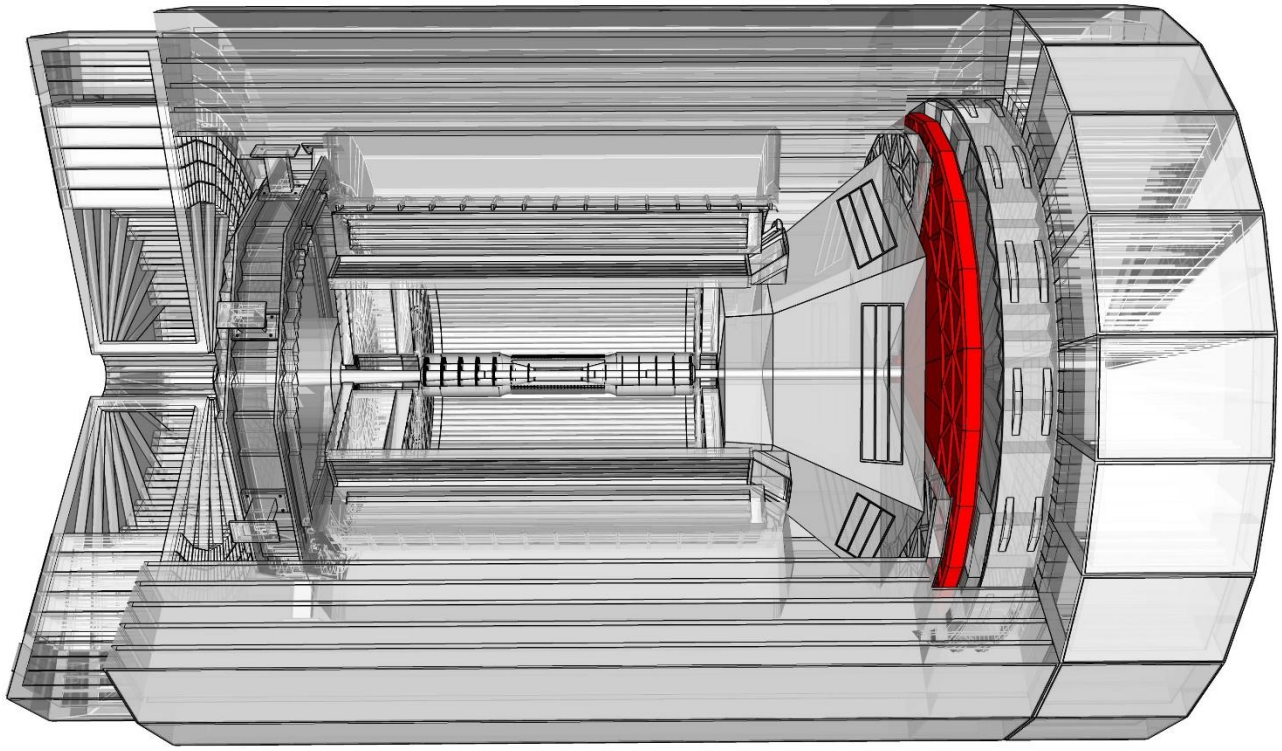

Figure 17: Hadron Direction Transition Radiation Detector 1

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	230 cm
Offset	310 cm in Hadron Direction
Total Volume	2.47 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	239 kg/m³	590 kg
Cabling		
	Total:	590 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

HADRON DIRECTION TIME OF FLIGHT DETECTOR

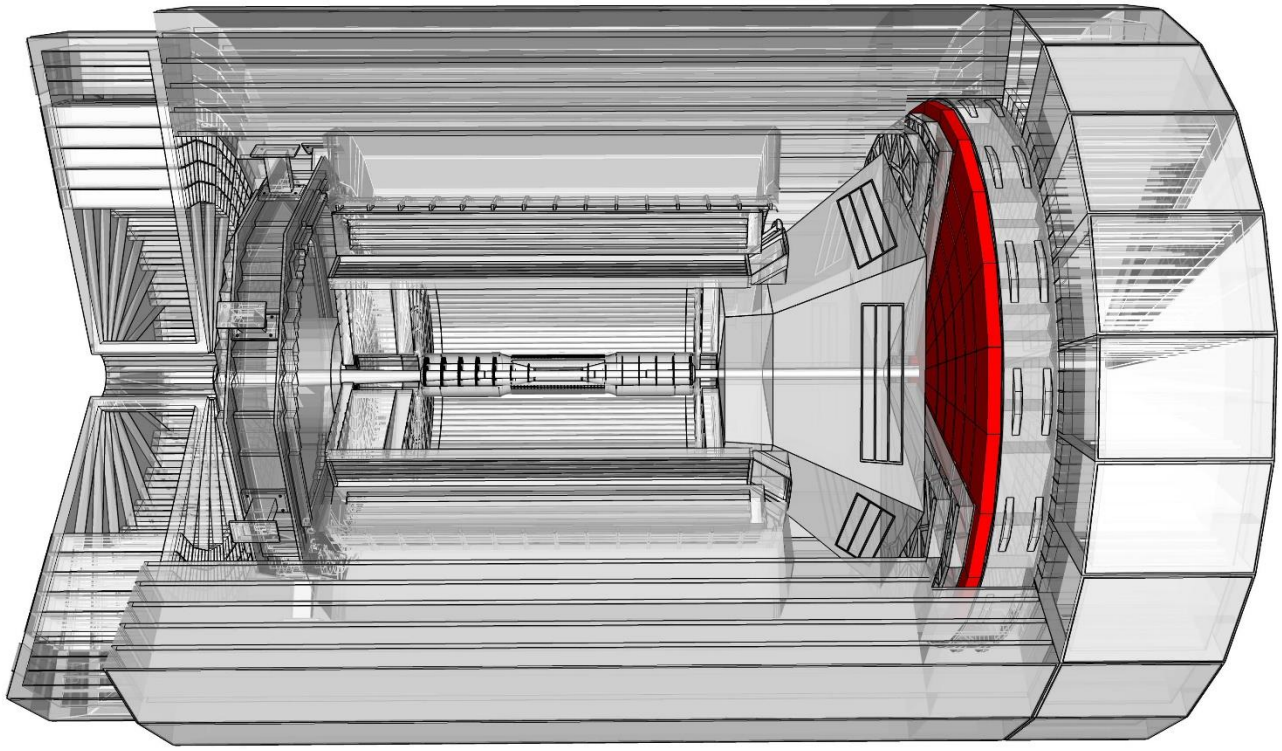

Figure 18: Hadron Direction Time of Flight Detector

Dimensions/Location

Overall Length	10 cm
Bore	20 cm
Radius	240 cm
Offset	325 cm in Hadron Direction
Total Volume	1.80 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (PANDA)	605 kg/m³	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 TESLA

HADRON DIRECTION ELECTROMAGNETIC CALORIMETER

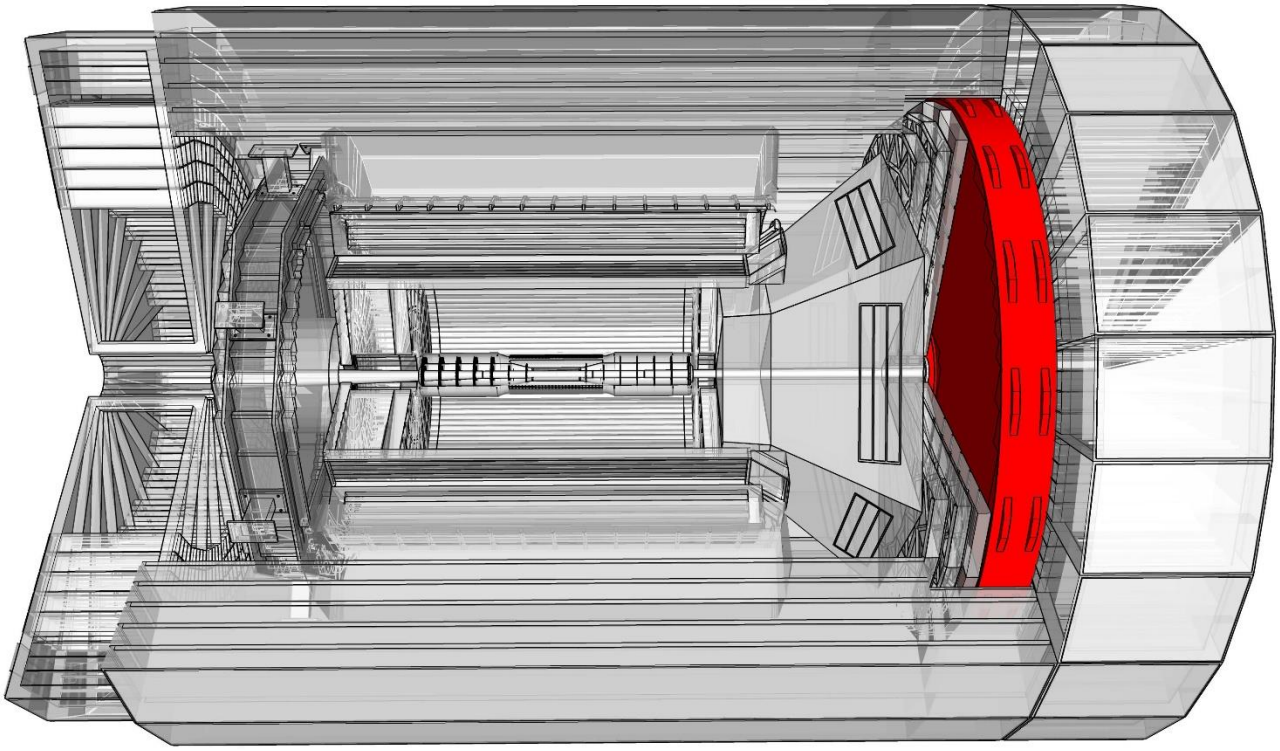

Figure 19: Hadron Direction Electromagnetic Calorimeter

Dimensions/Location

Overall Length	40 cm
Bore	30 cm
Radius	250 cm
Offset	335 cm in Hadron Direction
Total Volume	7.74 m³

Weight Estimates

Element	*Basis*	*Weight*
7.58 m³ of Lead Glass	6,220 kg/m³	47,161 kg
0.16 m³ of Steel	7,850 kg/m³	1,246 kg
Cabling		
	Total:	48,407 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 SILICON VERTEX DETECTOR

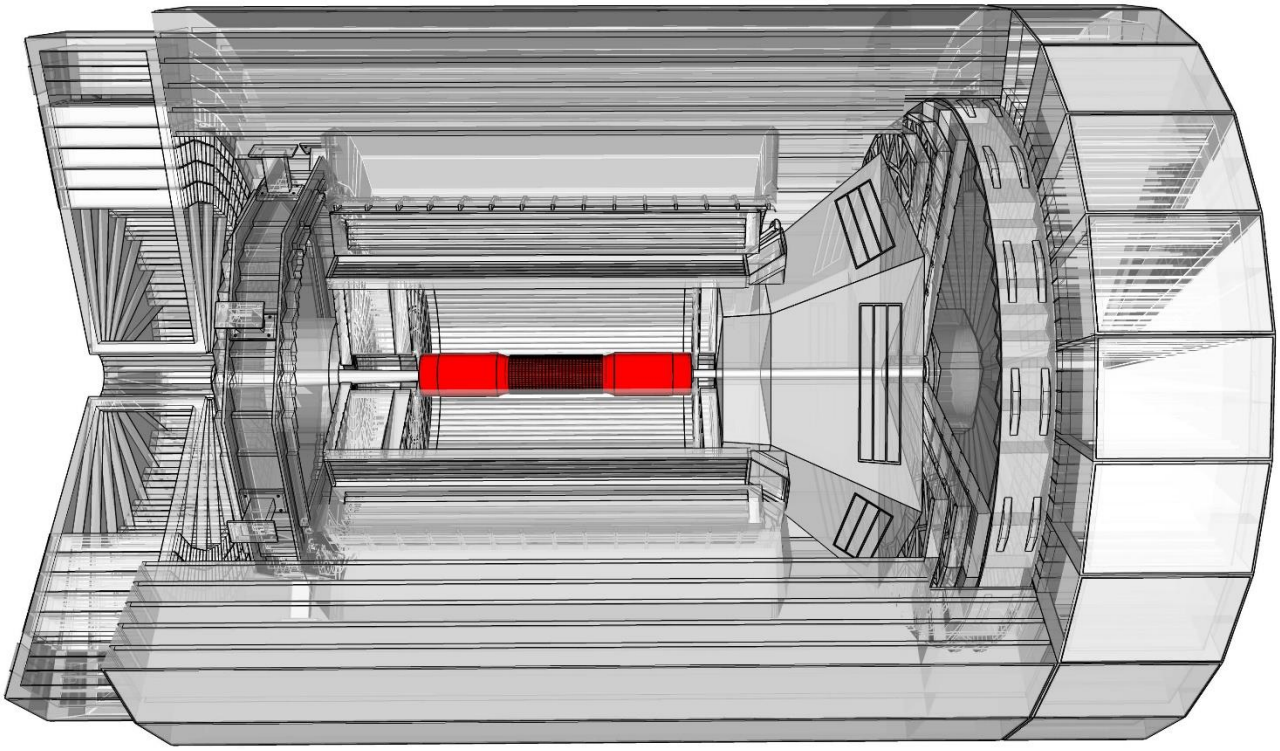

Figure 20: Silicon Vertex Detector

Dimensions/Location

Overall Length	244 cm
Bore	0 cm
Radius	19.8 cm
Offset	0 cm
Total Volume	0.30 m³

Weight Estimates

Element	*Basis*	*Weight*
0.009 m³ of Aluminum	2,710 kg/m³	24 kg
0.009 m³ of Silicon	2,330 kg/m³	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.

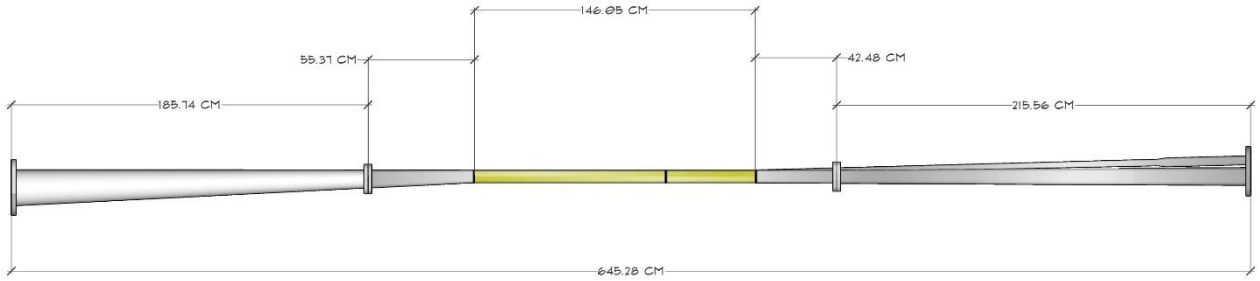

Figure 21: Vacuum Chamber (Top View)

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	