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.

- 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

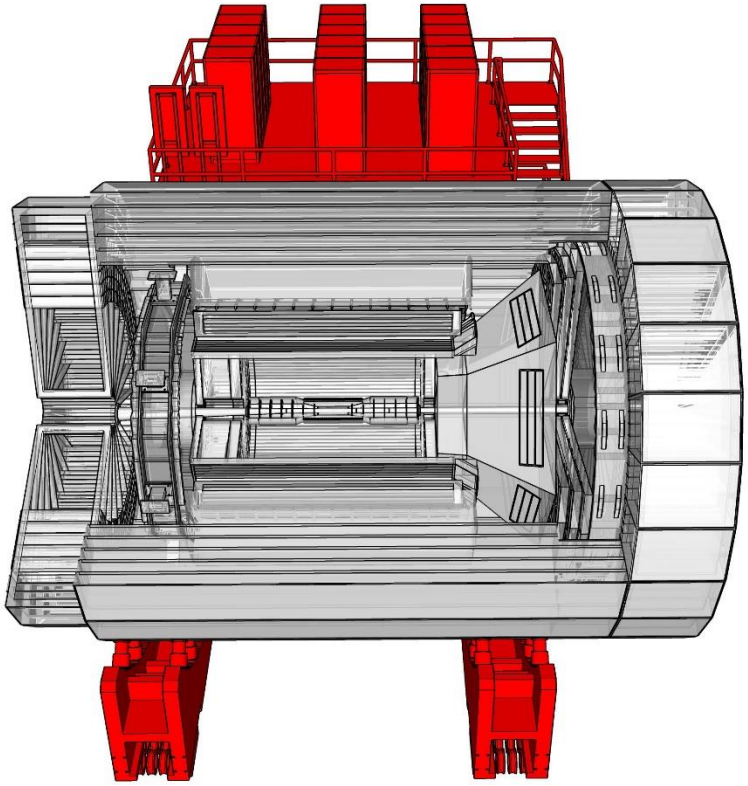

Figure 1: IP-6 Fixed Carriage

Dimensions/Location

N/A

Weight Estimates

Element	*Basis*	*Weight*
209 ft³ of Steel	489 lb/ft³	102,201 lbs
Danfysyk Power Supplies	2 @ 1,874 lbs	3,748 lbs
Computing Racks	39 @ 500 lbs	19,500 lbs
Transformers	4 @ 510 lbs	2,040 lbs
Star Cradle (243 ft³)	489 lb/ft³	118,891 lbs
	Total:	246,380 lbs
		123.19 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

BARREL HADRON CALORIMETER

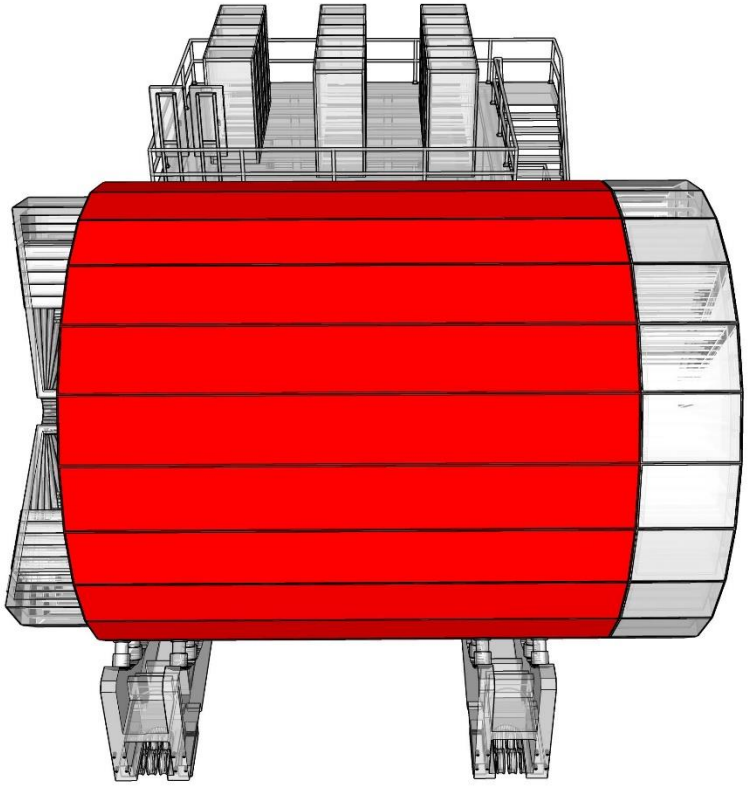

Figure 2: Barrel Hadron Calorimeter

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 (4,009 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
3,167 ft^3 of Iron	491 lb/ft^3	1,554,913 lbs
842 ft^3 of Plastic	59.90 lb/ft^3	50,425 lbs
Cabling		
	Total:	1,605,337 lbs
		802.67 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

LEPTON DIRECTION HADRON CALORIMETER ENDCAP

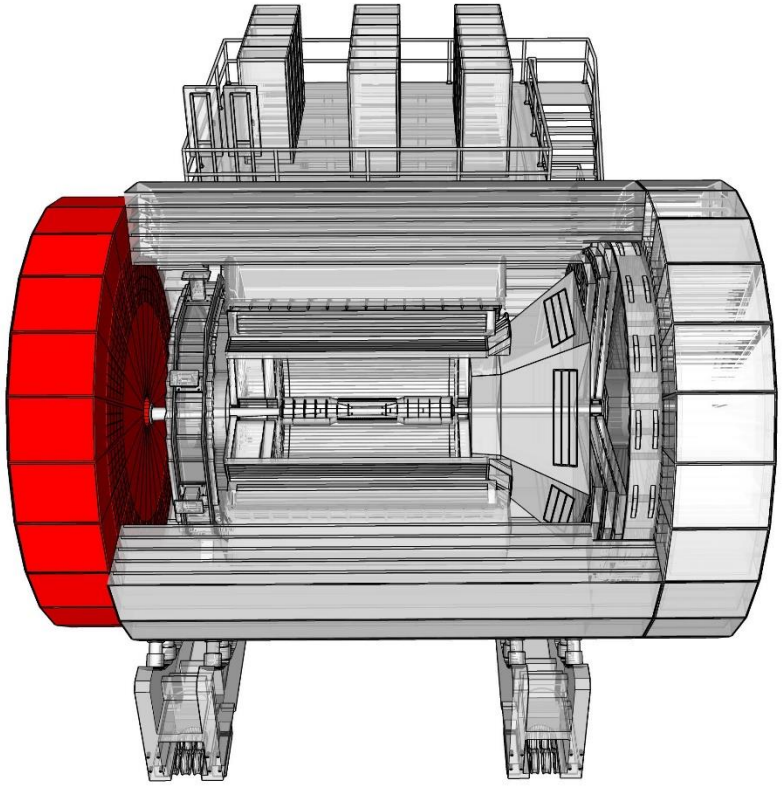

Figure 3: Lepton Direction Endcap

Dimensions/Location

Overall Length	105 cm
Bore	22 cm
Radius	300 cm
Offset	315 cm in Lepton Direction
Total Volume	29.53 m^3 (1,043 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
824 ft^3 of Iron	491 lb/ft^3	404,486 lbs
219 ft^3 of Iron	59.90 lb/ft^3	13,117 lbs
Cabling		
	Total:	417,604 lbs
		208.80 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

HADRON DIRECTION HADRON CALORIMETER ENDCAP

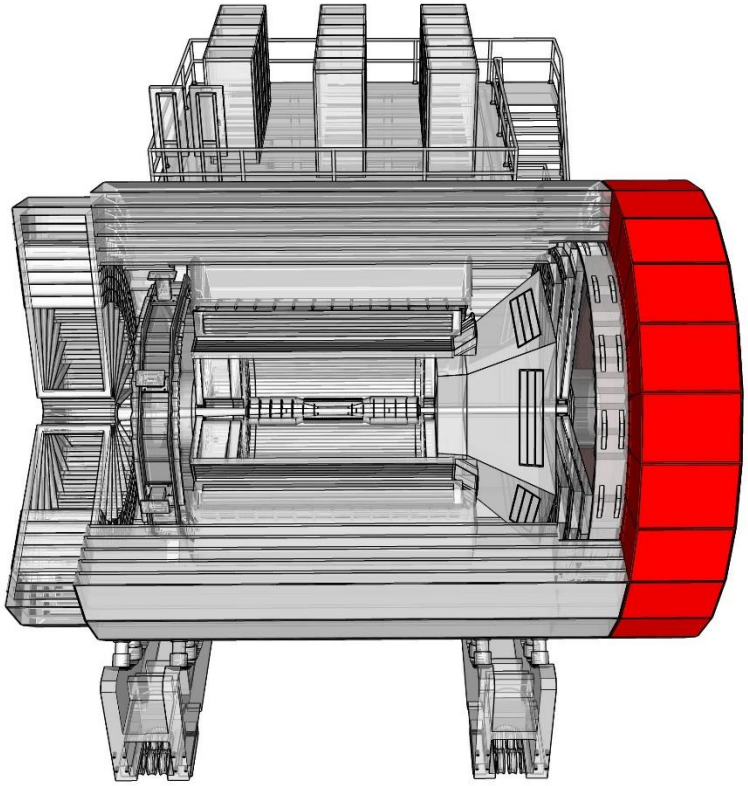

Figure 4: Hadron Direction Endcap

Dimensions/Location

Overall Length	120 cm
Bore	30 cm
Radius	320 cm
Offset	375 cm in Hadron Direction
Total Volume	38.26 m^3 (1,351 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
1,068 ft^3 of Iron	491 lb/ft^3	524,157 lbs
284 ft^3 of Iron	59.90 lb/ft^3	16,998 lbs
Cabling		
	Total:	541,155 lbs
		270.58 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 SOLENOID CRYOSTAT

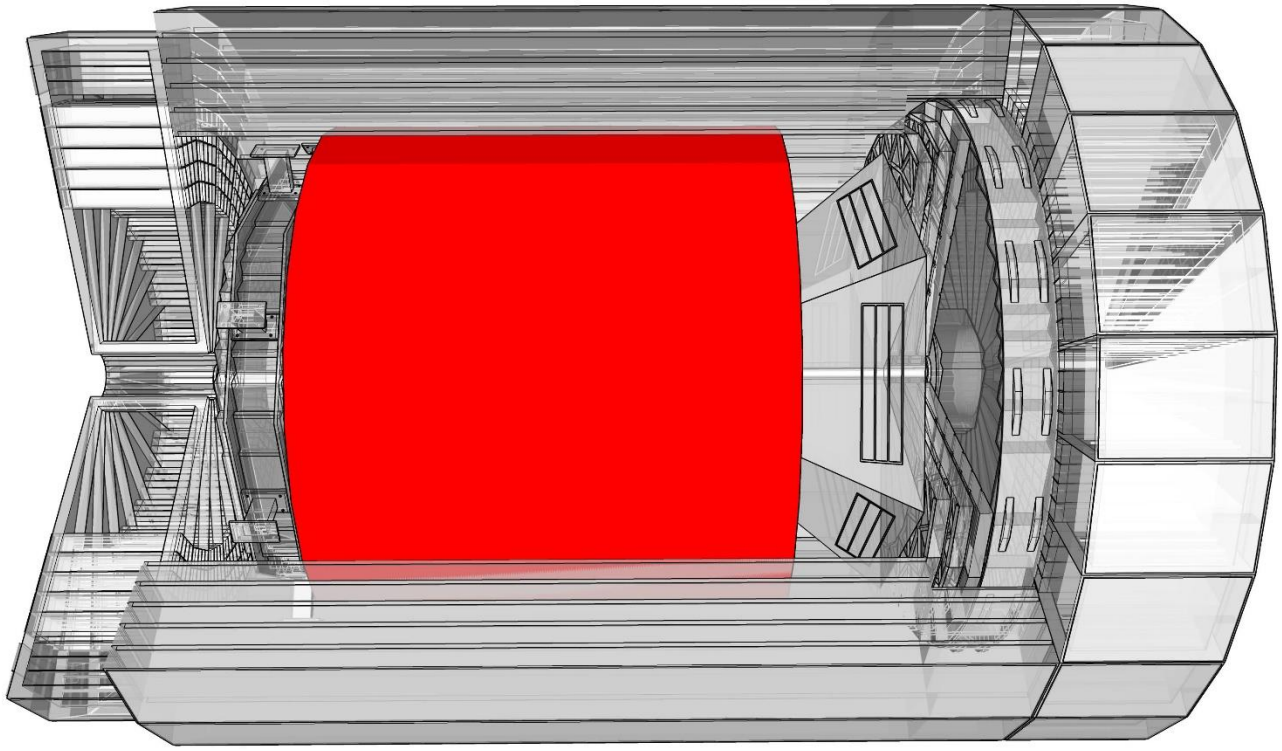

Figure 5: Solenoid Cryostat

Dimensions/Location

Overall Length	384 cm
Bore	160 cm
Radius	220 cm
Offset	1 cm in Hadron Direction
Total Volume	27.51 m^3 (971 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLEO II)	213 lb/ft^3	206,896 lbs
Cabling		
	Total:	206,896 lbs
		103.45 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

BARREL ELECTROMAGNETIC CALORIMETER

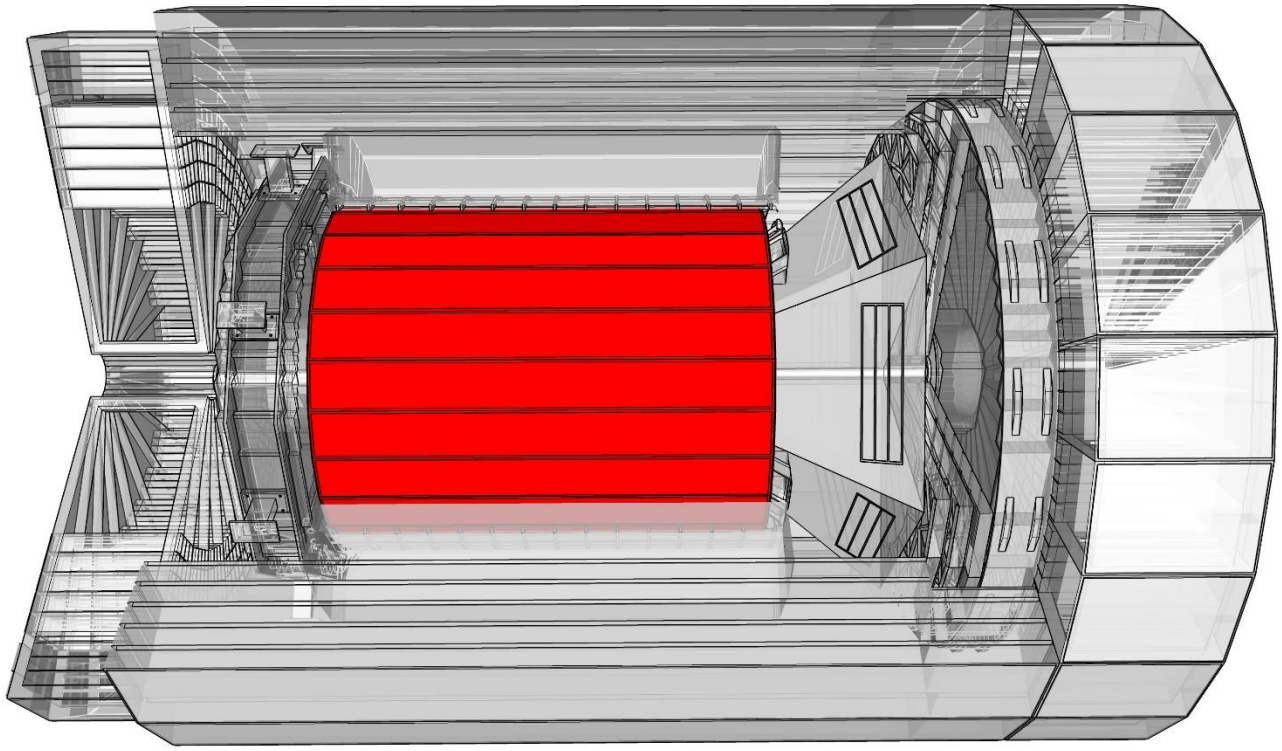

Figure 6: Barrel Electromagnetic Calorimeter

Dimensions/Location

Overall Length	370 cm
Bore	115 cm
Radius	152 cm
Offset	5 cm in Lepton Direction
Total Volume	11.48 m^3 (406 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CERN CMS)	219 lb/ft^3	88,810 lbs
Cabling		
	Total:	88,810 lbs
		44.41 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 DIRC (DETECTION OF INTERNALLY REFLECTED CHERENKOV LIGHT) DETECTOR

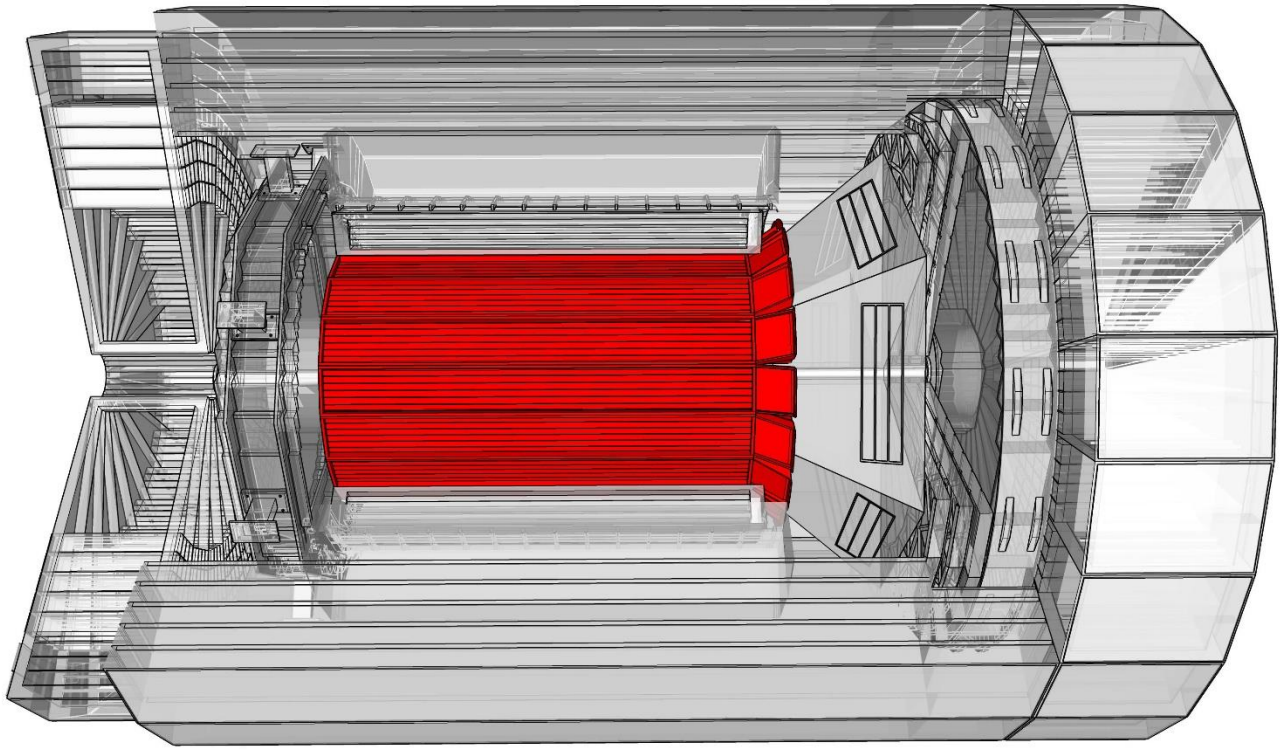

Figure 7: DIRC Detector

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	0.60 m^3 (21.25 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
7.60 ft^3 of Carbon Fiber	141 lb/ft^3	1,072 lbs
31.32 ft^3 of Quartz	97 lb/ft^3	3,038 lbs
Cabling		
	Total:	4,110 lbs
		2.05 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

LEPTON DIRECTION ELECTROMAGNETIC CALORIMETER

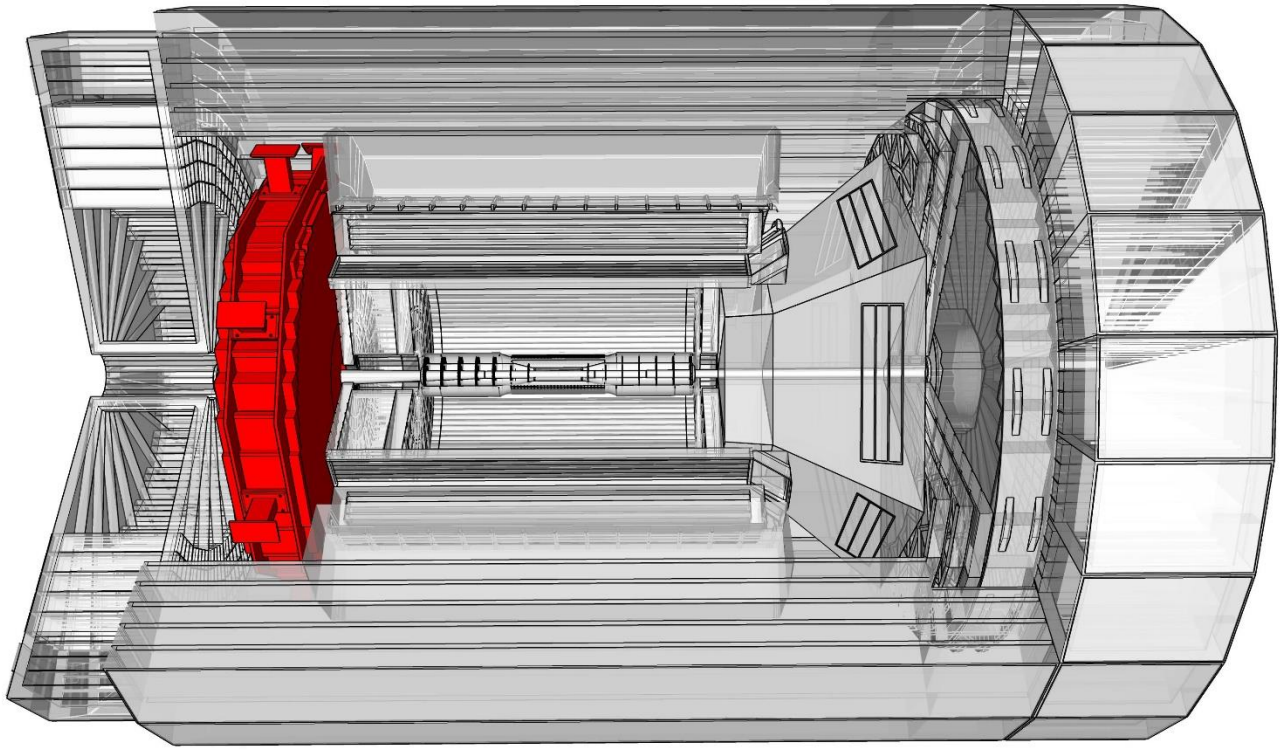

Figure 8: Lepton Direction Electromagnetic Calorimeter

Dimensions/Location

Overall Length	60 cm
Bore	30 cm
Detector Radius	160 cm
Support Radius	220 cm
Offset	195 cm in Lepton Direction
Total Volume	4.66 m^3 (164 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
3.29 ft^3 of Steel Frame	490 lb/ft^3	1,611 lbs
14.80 ft^3 of Carbon Fiber	141 lb/ft^3	2,086 lbs
146.33 ft^3 of Lead Glass	388 lb/ft^3	56,777 lbs
Cabling		
	Total:	60,475 lbs
		30.24 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

LEPTON DIRECTION TIME OF FLIGHT DETECTOR

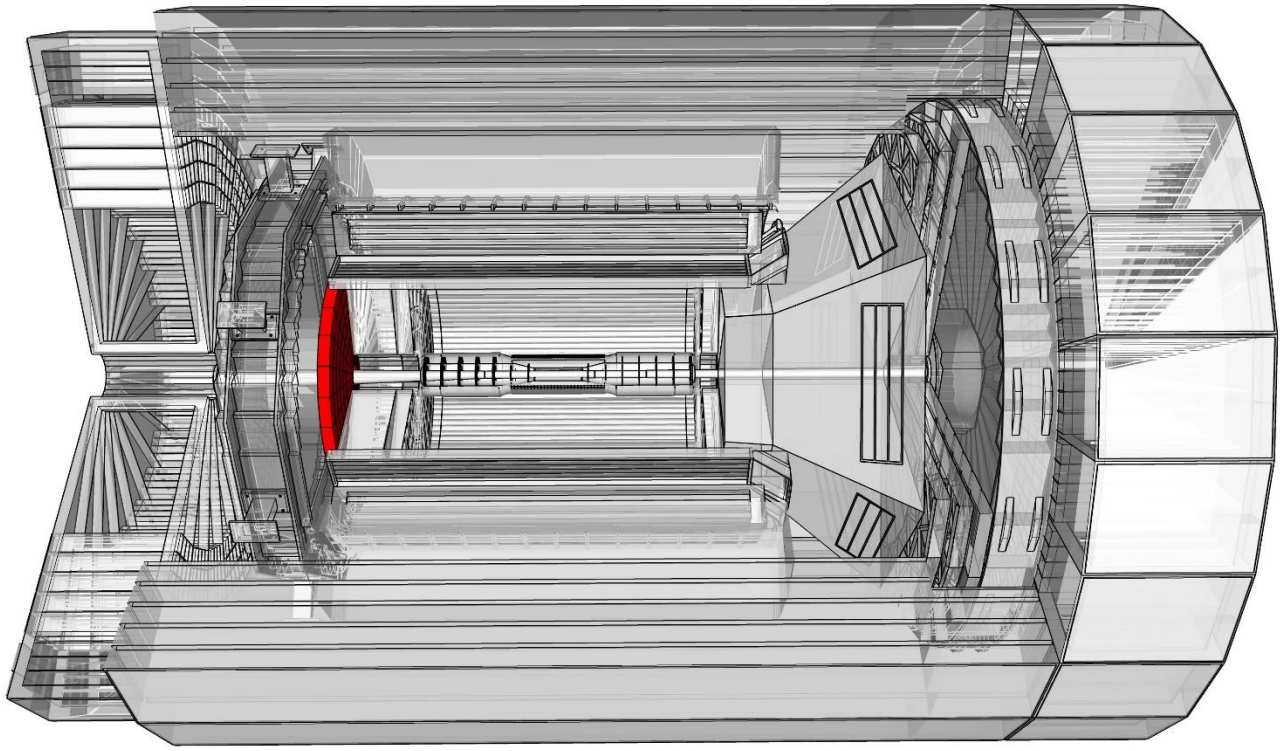

Figure 9: Lepton Direction Time of Flight Detector

Dimensions/Location

Overall Length	10 cm
Bore	10 cm
Radius	100 cm
Offset	185 cm in Lepton Direction
Total Volume	0.31 m^3 (10.98 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (PANDA)	37.80 lb/ft^3	415 lbs
Cabling		
	Total:	415 lbs
		0.21 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

CHERENKOV COUNTER

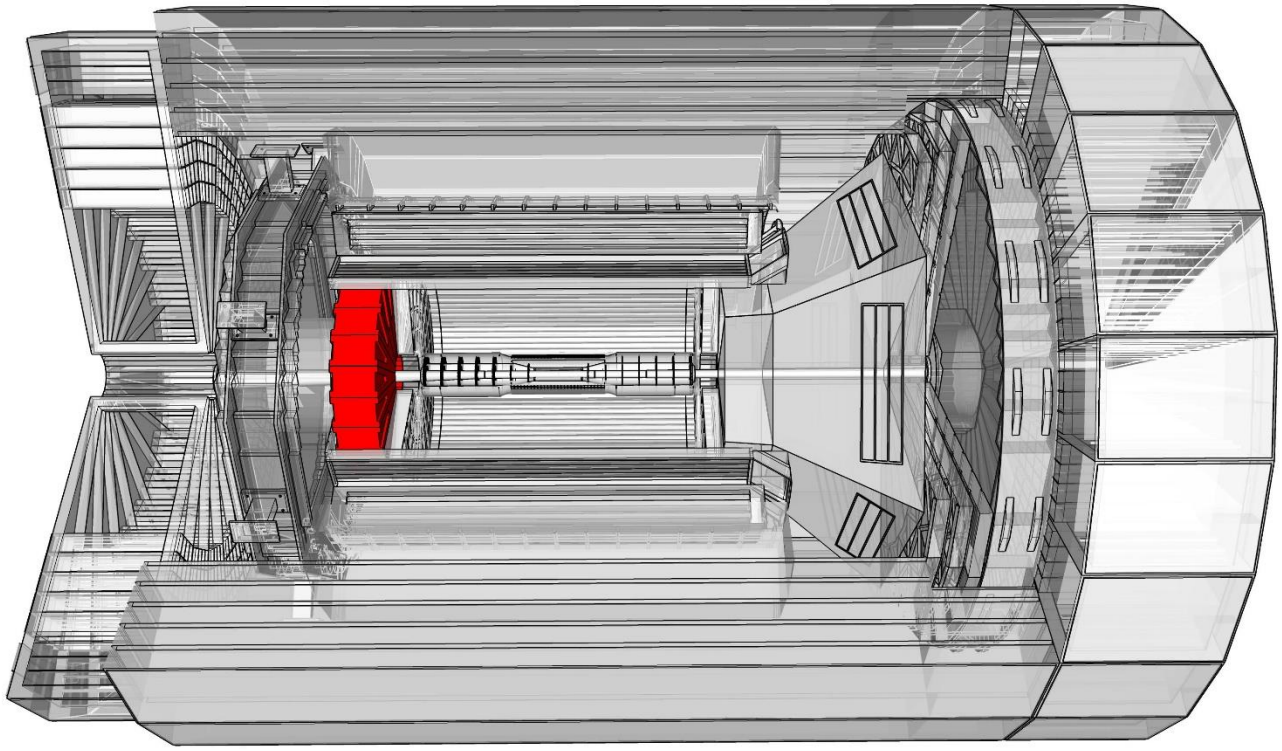

Figure 10: Cherenkov Counter

Dimensions/Location

Overall Length	40 cm
Bore	20 cm
Radius	100 cm
Offset	145 cm in Lepton Direction
Total Volume	1.21 m^3 (42.60 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLAS12 LTCC)	11.60 lb/ft^3	494 lbs
Cabling		
	Total:	494 lbs
		0.25 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

LEPTON DIRECTION MICRO-PATTERN GAS DETECTOR

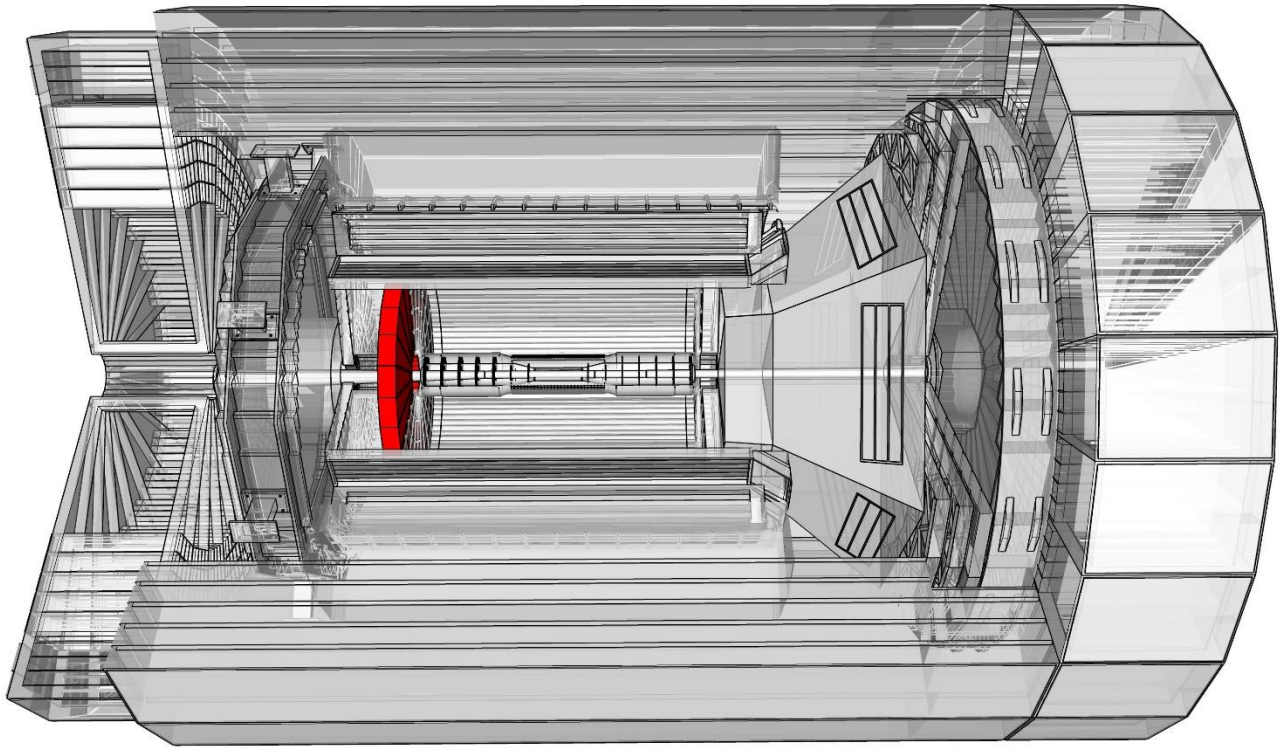

Figure 11: Lepton Direction Micro-Pattern Gas Detector

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	100 cm
Offset	130 cm in Lepton Direction
Total Volume	0.45 m^3 (15.98 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (sPHENIX)	12.50 lb/ft^3	200 lbs
Cabling		
	Total:	200 lbs
		0.10 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

TIME PROJECTION CHAMBER

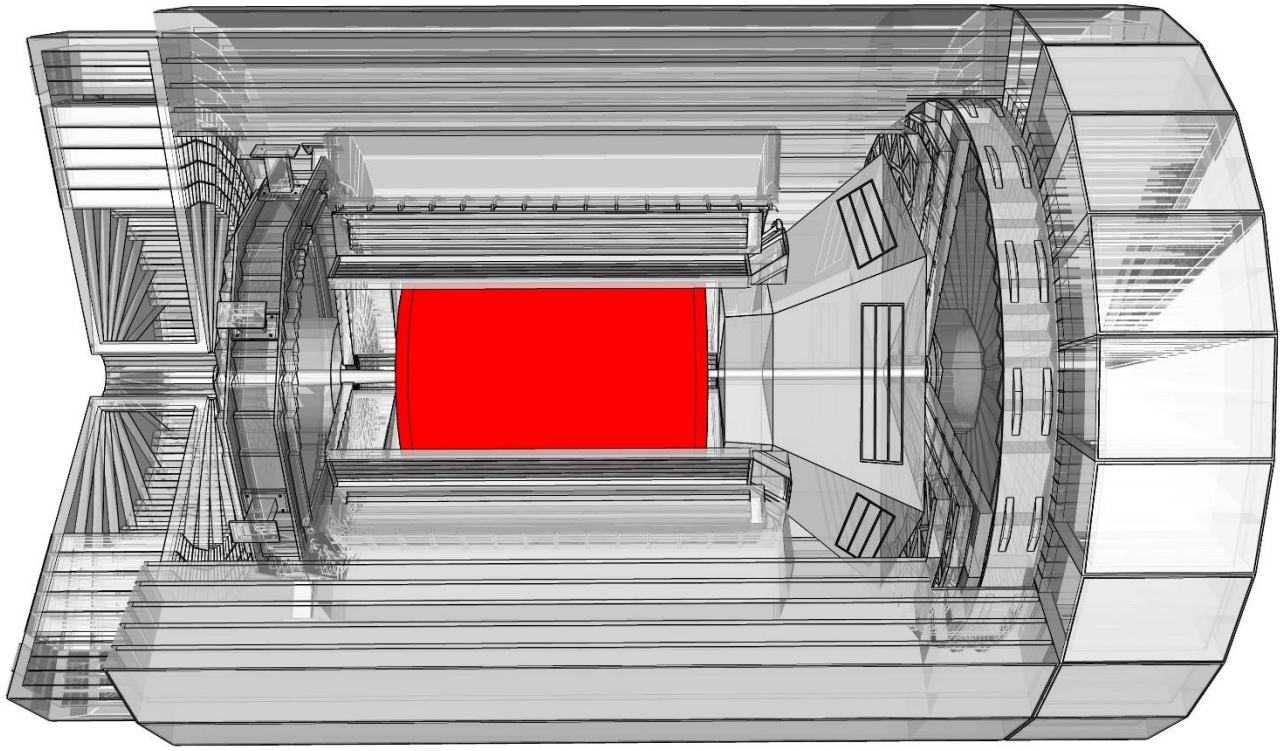

Figure 12: Time Projection Chamber

Dimensions/Location

Overall Length	260 cm
Bore	20 cm
Radius	100 cm
Offset	0 cm
Total Volume	7.84 m³ (276.92 ft³)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (PANDA)	6.19 lb/ft³	1,714 lbs
Cabling		
	Total:	1,714 lbs
		0.86 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

HADRON DIRECTION MICRO-PATTERN GAS DETECTOR

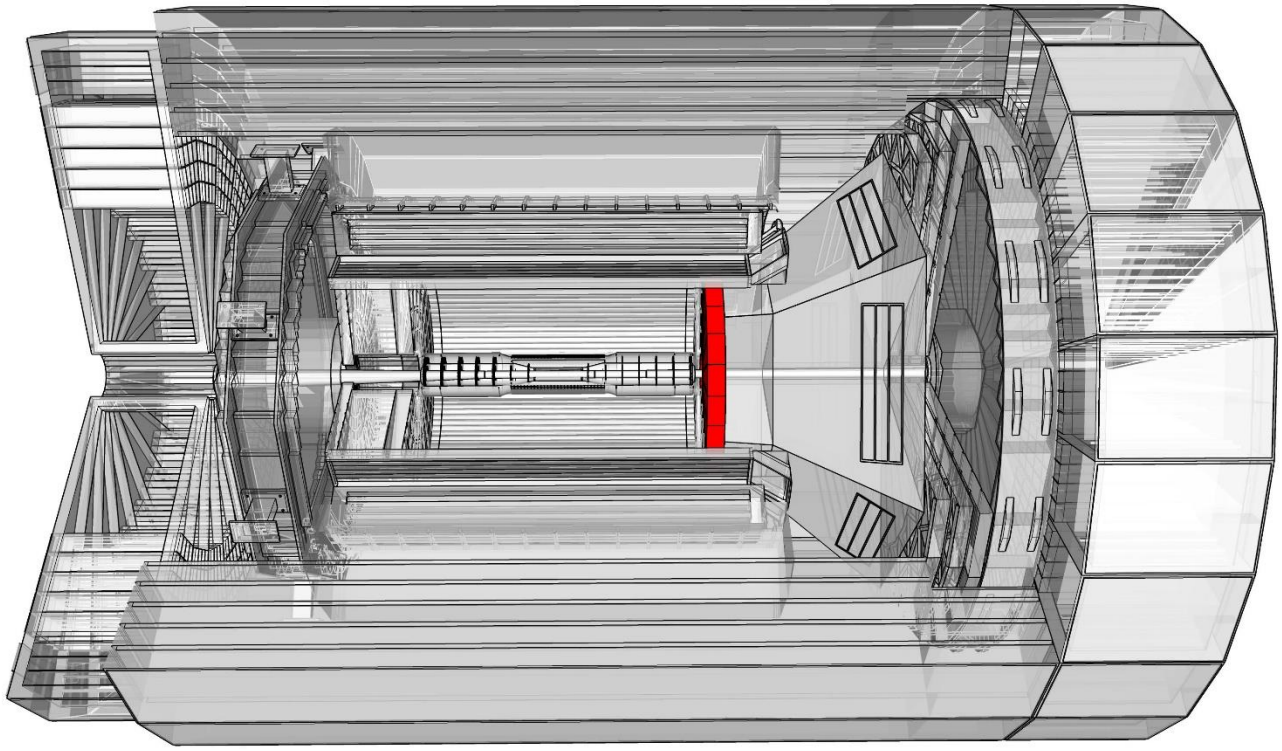

Figure 13: Hadron Direction Micro-Pattern Gas Detector

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	100 cm
Offset	137 cm in Hadron Direction
Total Volume	0.45 m^3 (15.98 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	12.50 lb/ft^3	200 lbs
Cabling		
	Total:	200 lbs
		0.10 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 RICH (RING IMAGING CHERENKOV) DETECTOR

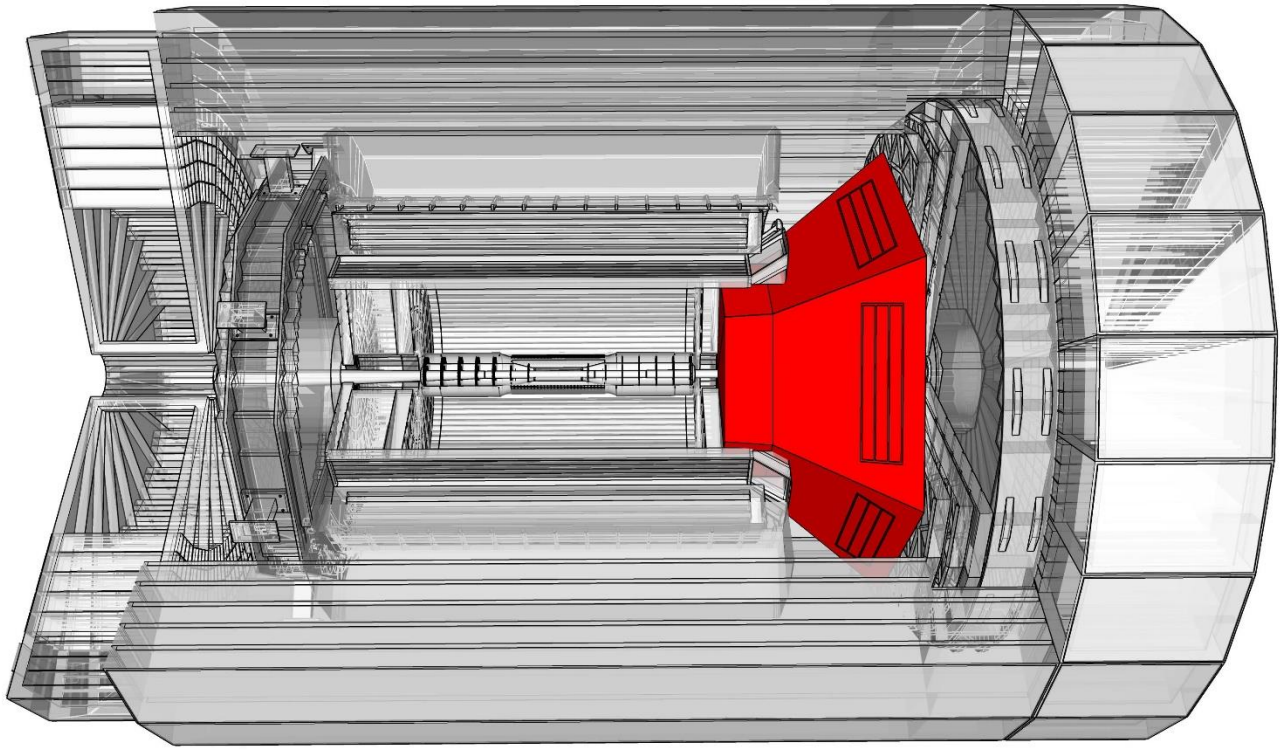

Figure 14: RICH Detector

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	260 cm in Hadron Direction
Segment Count	8
Total Volume	8.88 m^3 (313.59 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLAS LTCC)	11.60 lb/ft^3	3,638 lbs
Cabling		
	Total:	3,638 lbs
		1.82 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

HADRON DIRECTION TRANSITION RADIATION DETECTOR 2

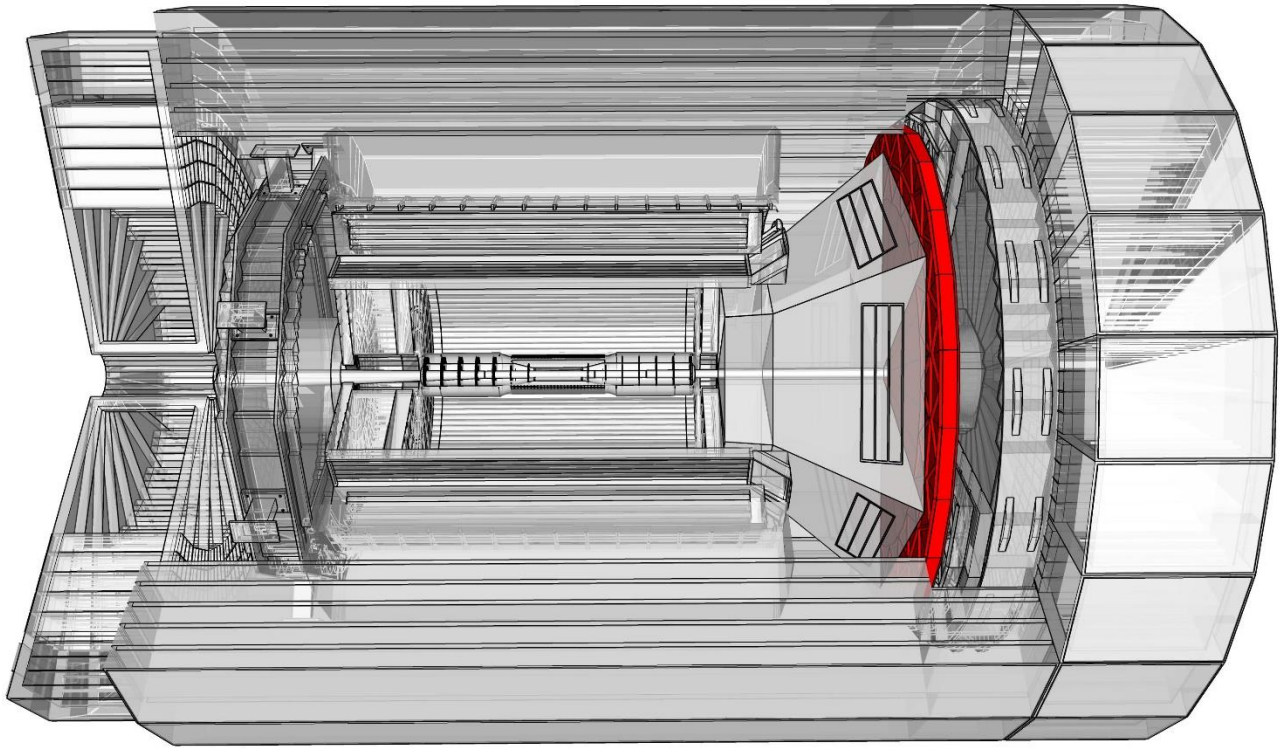

Figure 15: Hadron Direction Transition Radiation Detector 2

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	220 cm
Offset	295 cm in Hadron Direction
Total Volume	2.26 m³ (79.88 ft³)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	14.90 lb/ft³	1,190 lbs
Cabling		
	Total:	1,190 lbs
		0.60 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

HADRON DIRECTION TRANSITION RADIATION DETECTOR 1

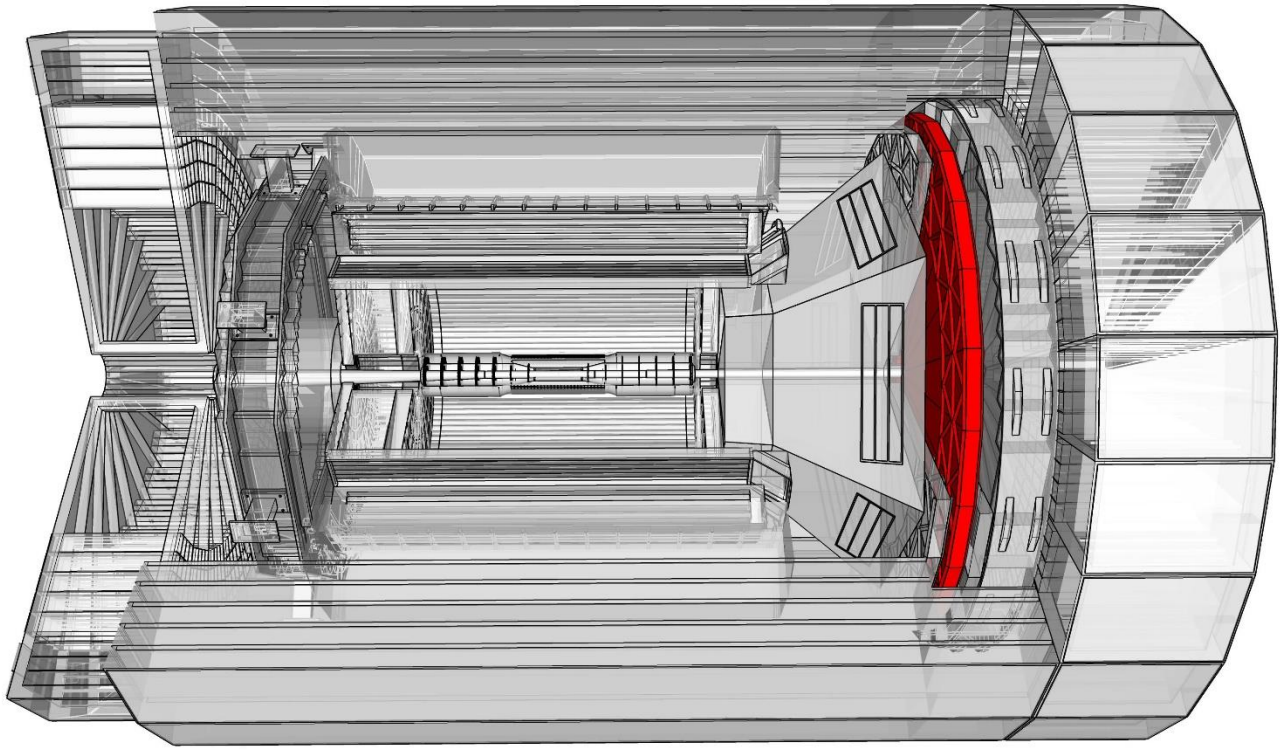

Figure 16: Hadron Direction Transition Radiation Detector 1

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	230 cm
Offset	310 cm in Hadron Direction
Total Volume	2.47 m^3 (87.37 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	14.90 lb/ft^3	1,302 lbs
Cabling		
	Total:	1,302 lbs
		0.65 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

HADRON DIRECTION TIME OF FLIGHT DETECTOR

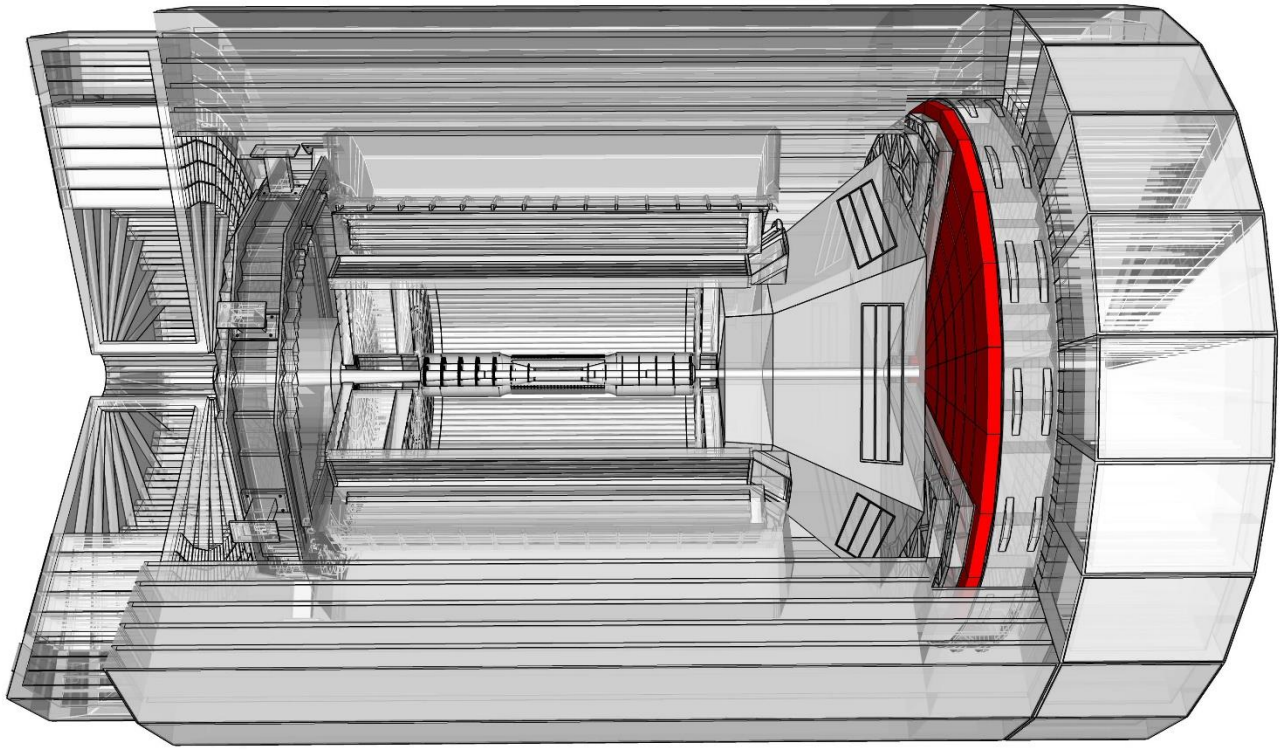

Figure 17: Hadron Direction Time of Flight Detector

Dimensions/Location

Overall Length	10 cm
Bore	20 cm
Radius	240 cm
Offset	325 cm in Hadron Direction
Total Volume	1.80 m^3 (63.46 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (PANDA)	37.80 lb/ft^3	2,399 lbs
Cabling		
	Total:	2,399 lbs
		1.20 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

HADRON DIRECTION ELECTROMAGNETIC CALORIMETER

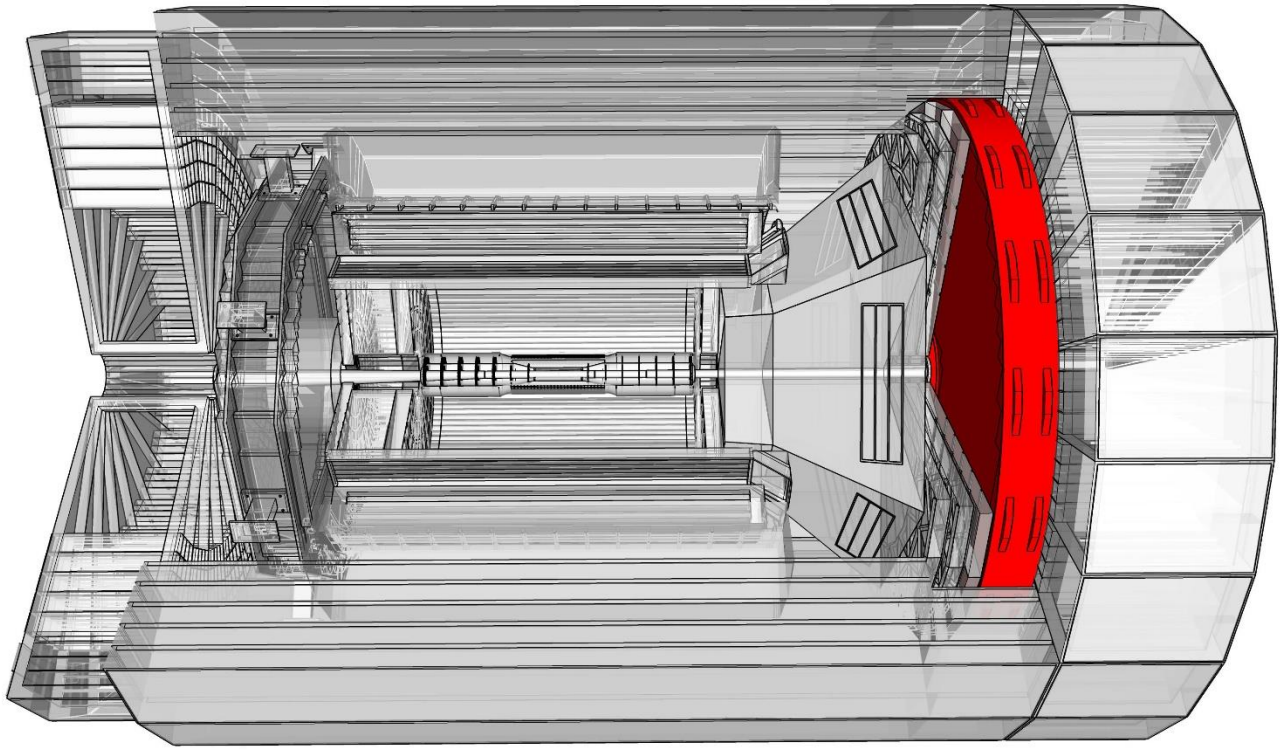

Figure 18: Hadron Direction Electromagnetic Calorimeter

Dimensions/Location

Overall Length	40 cm
Bore	30 cm
Radius	250 cm
Offset	335 cm to Hadron Direction
Total Volume	7.74 m^3 (273 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
5.47 ft^3 of Steel Frame	490 lb/ft^3	2,679 lbs
24.60 ft^3 of Carbon Fiber	141 lb/ft^3	3,469 lbs
243.30 ft^3 of Lead Glass	388 lb/ft^3	94,399 lbs
Cabling		
	Total:	100,547 lbs
		50.27 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 SILICON VERTEX DETECTOR

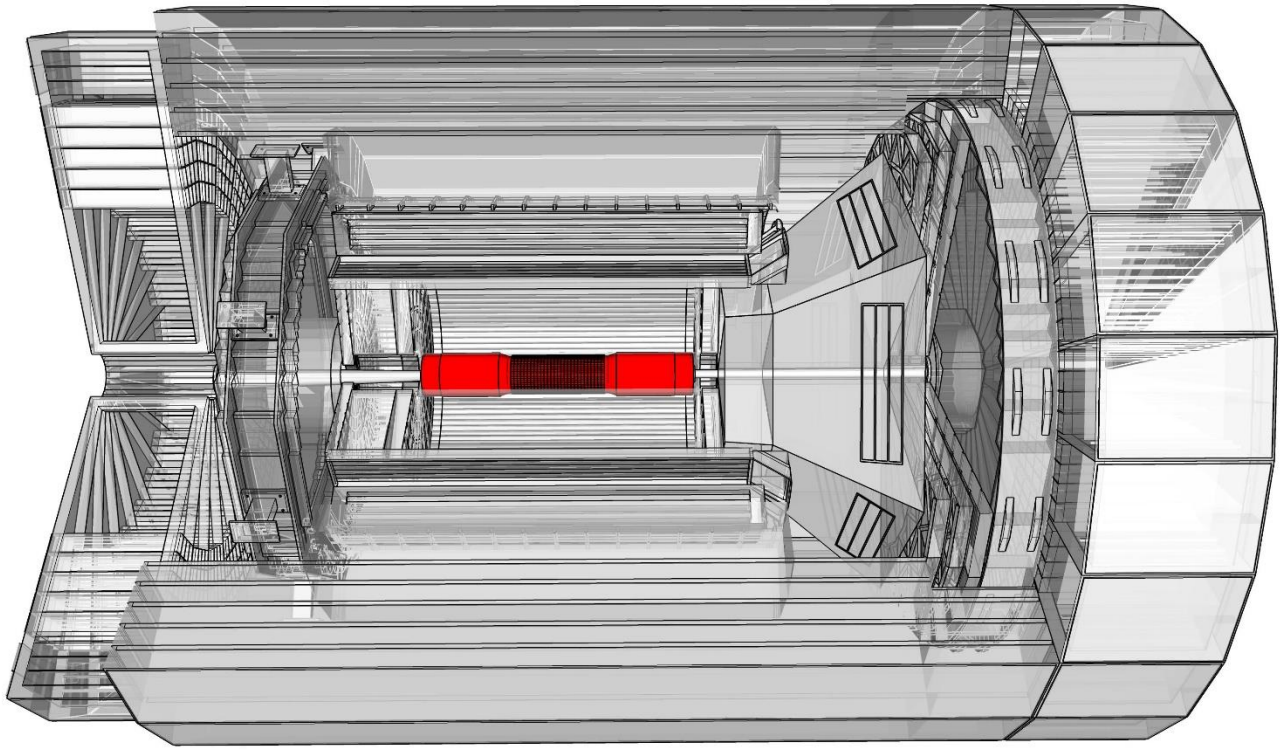

Figure 19: Silicon Vertex Detector

Dimensions/Location

Overall Length	244 cm
Bore	N/A
Radius	19.80 cm
Offset	0 cm
Total Volume	0.30 m^3 (11 ft^3)

Weight Estimates

Element	*Basis*	*Weight*
0.32 ft^3 of Aluminum	169 lb/ft^3	53.81 lbs
0.32 ft^3 of Silicon	145.00 lb/ft^3	46.17 lbs
Cabling		
	Total:	99.97 lbs
		0.05 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 VACUUM CHAMBER

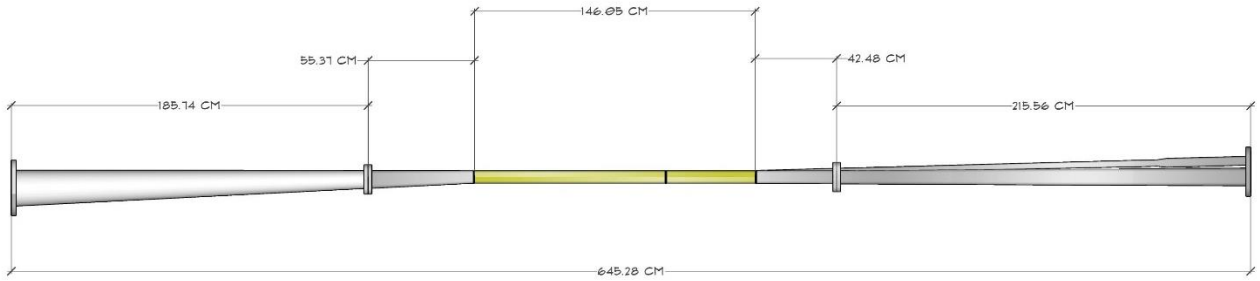

Figure 20: Vacuum Chamber (Top View)

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	