

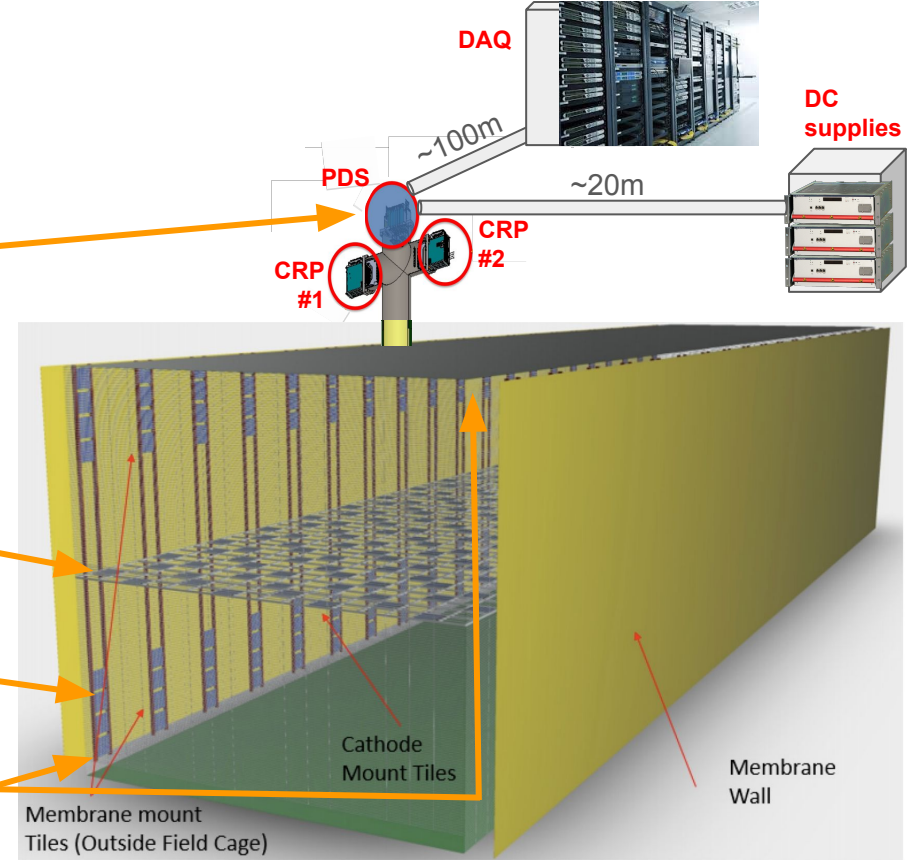
FD2 PDS

Component Quantity/Cost Breakdown

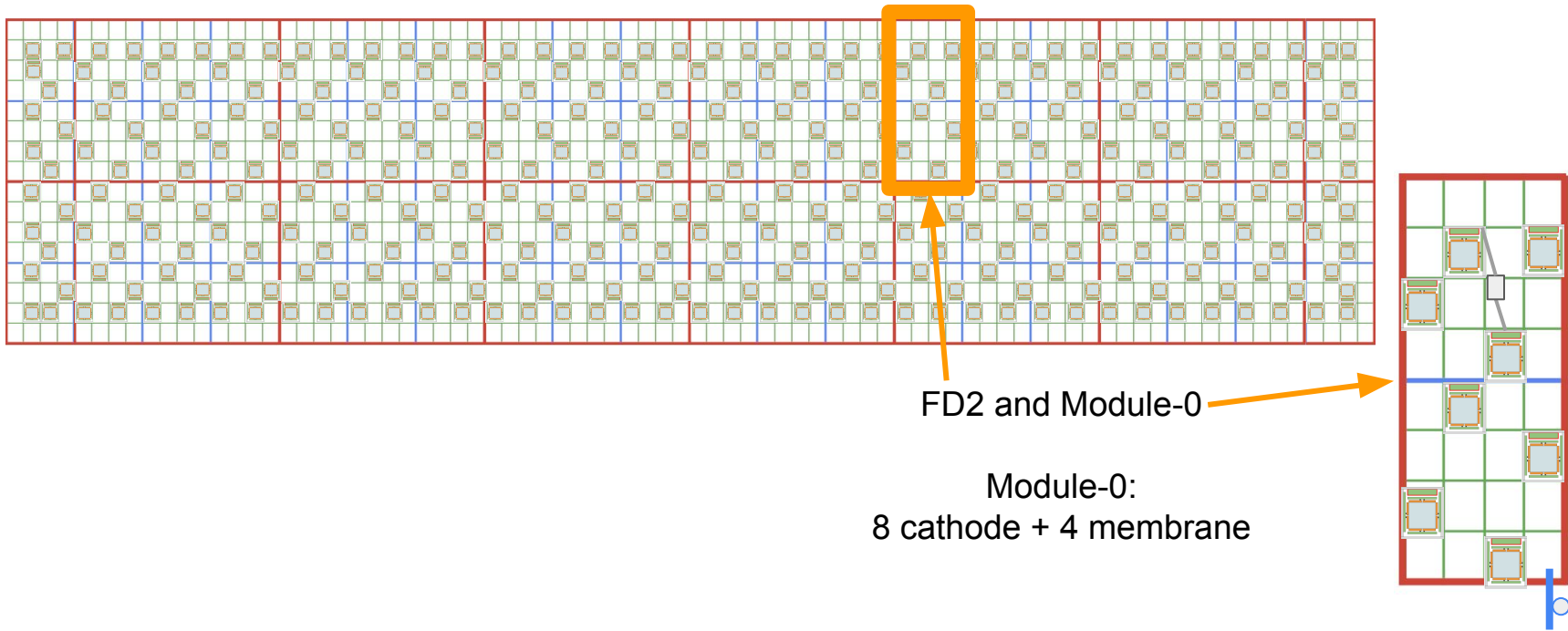
17 June 2022
DUNE FD2 PDS Preliminary Design Review
Ryan Rivera

FD2 PDS Scope

- Warm electronics
 - 1280 digitizer channels (640 opto-electrical)
 - Cathode fiber power supplies
 - DC copper power supplies
 - Response & Monitoring source modules
- 320 Cathode modules
 - Each module has 8 fibers:
 - 2 signal-over-fiber channels out
 - 6 power, calibration, control, redundancy
- 320 Membrane modules
 - Each module has 6 conductors:
 - 2 differential signal pairs out w/Bias
 - 1 low voltage and return pair
- Response & Stability Monitoring light diffusers
 - O160 LED flasher fibers + diffusers
- 40 Penetrations
 - Each services 8 cathode modules + 8 membrane modules



Baseline Cathode PDS Topology



2022 and Beyond

Parasitic ARIADNE run run complete!

Cold Box A PDS install is 18 April 2022

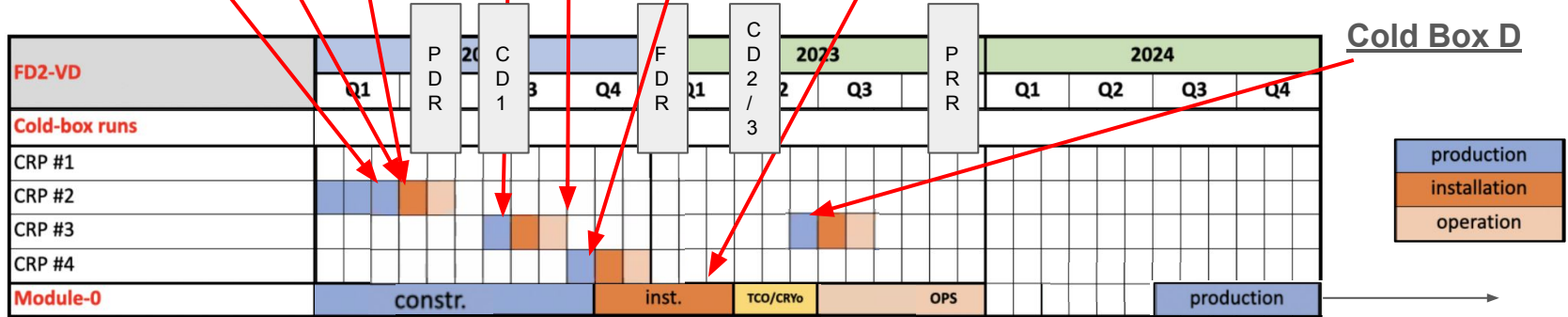
Preliminary Design Review (PDR) is 1st week of May 2022

Cold Box B PDS install is July 2022

Cold Box C PDS install is October 2022

Cold Box B+
(No CRP)

FD2 PDS Module-0 install thru March 2023



Far Site Construction

- Mid-2024 launch production.
 - +320 modules (double-sided) in US and +320 modules (single-sided) in EU
 - +9% spares
- Mid-2026 Warm Electronics installation starts
- Early-2027
 - Cathode module cavern assembly starts
 - Feedthroughs, fibers, cables installed
 - Membrane module installation into Cryostat starts
- End-of-2027 commissioning complete.

Scope Split with EU/Brazil

<u>Core M&S/Labor Line Item</u>	<u>Cathode</u>	<u>Membrane</u>
Production SiPMs w/9% spare	EU/Brazil	EU/Brazil
Production Dichroic Filters w/9% spare	EU/Brazil	EU/Brazil
Production WLS plates w/9% spare	EU/Brazil	EU/Brazil
Production Warm Electronics w/9% spare	EU/Brazil	EU/Brazil
Production Support Structure Mechanics	US	EU/Brazil
Production Monitoring System w/9% spare	US	EU/Brazil
Production xARAPUCA mechanics w/9% spare	US	US
Production Cold Electronics w/9% spare	US	US
Production Power-over-Fiber w/9% spare	US	-
Production fibers/cables/flanges w/9% spare	US	EU/Brazil
module-0 SiPMs w/20% spare	EU/Brazil	EU/Brazil
module-0 Dichroic Filters w/20% spare	EU/Brazil	EU/Brazil
module-0 WLS w/20% spare	EU/Brazil	EU/Brazil
module-0 Warm Electronics w/20% spare	EU/Brazil	EU/Brazil
module-0 Monitoring System w/20% spare	US	EU/Brazil
module-0 xARAPUCA mechanics w/20% spare	US	US
module-0 Cold Electronics w/20% spare	US	US
module-0 Power-over-Fiber w/20% spare	US	-
module-0 fibers/cables/flanges w/20% spare	US	US

EU/Brazil Scope

EU/Brazil Core M&S Line Item	USD
All Production SiPMs w/9% spare	\$ 1,562,624
All Production Dichroic Filters w/9% spare	\$ 1,009,567
All Production WLS plates w/9% spare	\$ 279,040
All Production Warm Electronics w/9% spare	\$ 470,880
Membrane Production fibers/cables/flanges	\$ 175,000
Membrane Support Structure Mechanics	\$ 30,000
Membrane Production Calibration System w/9% spare	\$ 231,080
All module-0 SiPMs w/20% spare	\$ 129,024
All module-0 Dichroic Filters w/20% spare	\$ 83,359
All module-0 WLS w/20% spare	\$ 23,040
All module-0 Warm Electronics	\$ 60,000
Membrane module-0 Calibration System	\$ 30,000
EU/Brazil Core Total USD:	\$ 4,083,613
USD to EURO conversion	0.85
EU/Brazil Core Total Euro:	€ 3,471,071

DOE Scope

US Core M&S Line Item	USD
All Production xARAPUCA mechanics w/9% spare	\$ 1,078,720
All Production Cold Electronics w/9% spare	\$ 837,120
All Production Power-over-Fiber w/9% spare	\$ 1,183,304
Cathode Production fibers/cables/flanges	\$ 180,000
Cathode Support Structure Mechanics	\$ 30,000
Cathode Production Calibration System w/9% spare	\$ 231,080
All module-0 xARAPUCA mechanics w/20% spare	\$ 48,845
All module-0 Cold Electronics w/20% spare	\$ 115,200
All module-0 Power-over-Fiber w/20% spare	\$ 116,544
All module-0 fibers/cables/flanges	\$ 16,641
Cathode module-0 Calibration System	\$ 50,000
US Core Total USD:	\$ 3,887,453
USD to EURO conversion	0.85
US Core Total Euro:	€ 3,304,335

EU/Brazil Quantity/Cost Breakdown

EU/Brazil Core M&S Line Item	USD	Price ea.	Quantity (Cathode)	Cost (Cathode)	Quantity (Membrane)	Cost (Membrane)	Total Cost (Cathode + Membrane)	Delta (I - C)
All Production SiPMs w/9% spare	\$1,562,624	\$ 14	55,808	\$ 781,312	55,808	\$ 781,312	\$ 1,562,624	\$ -
All Production Dichroic Filters w/9% spare	\$1,009,567	\$ 27	25,114	\$ 673,044	12,557	\$ 336,522	\$ 1,009,567	\$ (0)
All Production WLS plates w/9% spare	\$279,040	\$ 400	349	\$ 139,520	349	\$ 139,520	\$ 279,040	\$ -
All Production Warm Electronics w/9% spare	\$470,880	\$ 338	698	\$ 235,789	698	\$ 235,789	\$ 471,578	\$ 698
Membrane Production fibers/cables/flanges (row 9-14)	\$175,000		-	\$ -		\$ -	\$ 202,740	\$ (2,260)
Membrane Production fibers			-	\$ -	-	\$ -	\$ -	
Membrane Production cables		\$ 150	-	\$ -	349	\$ 52,320	\$ 52,320	
Membrane Production cable support		\$ 700		\$ -	44	\$ 30,520	\$ 30,520	
Membrane Production feedthroughs		\$ 200		\$ -	87	\$ 17,440	\$ 17,440	
Membrane Production flanges		\$ 350	-	\$ -	44	\$ 15,260	\$ 15,260	
Membrane Support Structure Mechanics	\$30,000	\$ 2,000	-	\$ -	44	\$ 87,200	\$ 87,200	
Membrane Production Calibration System w/9% spare	\$231,080	\$ 331	-	\$ -	698	\$ 230,906	\$ 230,906	\$ (174)
All module-0 SiPMs w/20% spare	\$129,024	\$ 21	3,072	\$ 64,512	3,072	\$ 64,512	\$ 129,024	\$ -
All module-0 Dichroic Filters w/20% spare	\$83,359	\$ 40	1,382	\$ 55,572	691	\$ 27,786	\$ 83,359	\$ (0)
All module-0 WLS w/20% spare	\$23,040	\$ 600	19	\$ 11,520	19	\$ 11,520	\$ 23,040	\$ -
All module-0 Warm Electronics	\$60,000	\$ 676	38	\$ 25,958	38	\$ 25,958	\$ 51,917	\$ (8,083)
Membrane module-0 Calibration System	\$30,000	\$ 662		\$ -	38	\$ 25,421	\$ 25,421	\$ (4,579)
EU/Brazil Core Total USD:	\$4,083,613						\$ 4,069,214	\$ (14,400)
USD to EURO conversion	0.85							
EU/Brazil Core Total Euro:	\$3,471,071							

DOE-US Quantity/Cost Breakdown

US Core M&S Line Item	USD	Price ea.	Quantity (Cathode)	Cost (Cathode)	Quantity (Membrane)	Cost (Membrane)	Total Cost (Cathode + Membrane)	Delta (I - C)
All Production xARAPUCA mechanics w/9% spare	\$1,078,720	see links	Cathode Detector'IA1	\$ 706,104	Membrane Detector'IA1	\$ 638,204	\$ 1,344,308	\$ 265,588
All Production Cold Electronics w/9% spare	\$837,120	see links	Cathode Tile CE'IA1	\$ 686,684	Membrane Tile CE'IA1	\$ 276,991	\$ 963,675	\$ 126,555
All Production Power-over-Fiber w/9% spare	\$1,183,304	see links	Cathode Power Supplies'IA1	\$ 1,085,007		\$ -	\$ 1,085,007	\$ (98,297)
Cathode Production fibers/cables/flanges (row 9-14)	\$180,000	combined with Cathode Power Supplies tab and Cathode Cold-Electronics tab					\$ -	\$ (180,000)
Cathode Production fibers						\$ -		
Cathode Production cables						\$ -		
Cathode Production cable support						\$ -		
Cathode Production feedthroughs						\$ -		
Cathode Production flanges						\$ -		
Cathode Support Structure Mechanics	\$30,000	combined in xARAPUCA mechanics (cathode mount is the support structure)					\$ -	\$ (30,000)
Cathode Production Calibration System w/9% spare	\$231,080	see links	Cathode Non-tile CE'IA1	\$ 282,236		\$ -	\$ 282,236	\$ 51,156
All module-0 xARAPUCA mechanics w/20% spare	\$48,845	50% price premium and 20% spare		\$ 58,302		\$ 52,696	\$ 110,998	\$ 62,153
All module-0 Cold Electronics w/20% spare	\$115,200	50% price premium and 20% spare		\$ 56,699		\$ 22,871	\$ 79,569	\$ (35,631)
All module-0 Power-over-Fiber w/20% spare	\$116,544	50% price premium and 20% spare		\$ 89,588		\$ -	\$ 89,588	\$ (26,956)
All module-0 fibers/cables/flanges	\$16,641	combined with Cathode Power Supplies tab and Cathode Cold-Electronics tab					\$ -	\$ (16,641)
Cathode module-0 Calibration System	\$50,000	combined with Cathode Power Supplies tab and Cathode Cold-Electronics tab					\$ -	\$ (50,000)
US Core Total USD:	\$3,887,453						\$ 3,955,381	\$ 67,928
USD to EURO conversion	0.85							
US Core Total Euro:	\$3,304,335							

DOE Detector Breakdown

Line Item	Price ea.	Quantity per XA	Cost
SiPM mount board	\$56.30	8	\$450.40
Filter Plate Frame	\$324.07	2	\$648.14
Frame Side Component set	\$243.90	1	\$243.90
SiPM Spring Loading Components (Set, molded)	\$25.00	1	\$25.00
Response & Monitoring Custom Mount Components	\$150.00	1	\$150.00
Misc. Components	\$200.00	1	\$200.00
Cathode Module Mounting Hardware	\$100.00	1	\$100.00
Miscellaneous Electronic Components	\$200.00	1	\$200.00
		XA Total =	\$2,017.44
		# of XA =	350
		Cathode DOE Detector Total =	\$706,104.00
Line Item	Price ea.	Quantity per XA	Cost
SiPM mount board	\$56.30	8	\$450.40
Module Frame Plate Set (single-sided)	\$454.14	1	\$454.14
Frame Side Component set	\$243.90	1	\$243.90
SiPM Spring Loading Components (Set, molded)	\$25.00	1	\$25.00
Response & Monitoring Custom Mount Components	\$150.00	1	\$150.00
Misc. Components	\$200.00	1	\$200.00
CPA Module Mounting Hardware	\$100.00	1	\$100.00
Miscellaneous Electronic Components	\$200.00	1	\$200.00
		XA Total =	\$1,823.44
		# of XA =	350
		Membrane DOE Detector Total =	\$638,204.00

DOE Cold Electronics Breakdown

Line Item	Price ea.	System Quantity	Cost
Optical Transmitter	\$89	700	\$62,300
SoF (signal) Fibers	\$199	700	\$138,957
Extra fibers for redundancy	\$199	1050	\$208,436
Motherboard PCB Fabrication	\$5	350	\$1,750
Motherboard PCB Assembly	\$18	350	\$6,300
Motherboard PCB Parts	\$38	350	\$13,381
Mechanical Parts, Miscellaneous	\$300	350	\$105,000
Shielding Enclosure	\$55	350	\$19,250
Cold Electronics Twisted-pair Cables	\$150	440	\$66,000
Miscellaneous electronics parts	\$100	350	\$35,000
Teflon tie wraps external to cathode	\$2.80	6540	\$18,312
Teflon tie wraps internal to cathode	\$0.69	17440	\$11,999
		Cathode CE Total =	\$686,684
Line Item	Price ea.	System Quantity	Cost
Motherboard PCB Fabrication	\$5	350	\$1,750
Motherboard PCB Assembly	\$18	350	\$6,300
Motherboard PCB Parts	\$38	350	\$13,381
Mechanical Parts, Miscellaneous	\$300	350	\$105,000
Shielding Enclosure	\$55	350	\$19,250
Cold Electronics Twisted-pair Cables	\$150	440	\$66,000
Miscellaneous electronics parts	\$100	350	\$35,000
Teflon tie wraps external to cathode	\$2.80	6540	\$18,312
Teflon tie wraps internal to cathode	\$0.69	17440	\$11,999
		Membrane CE Total =	\$276,991

DOE Power Supplies Breakdown

Line Item	Price ea.	System Quantity	Cost
PoF Transmitter Housing Units	\$300.00	123	\$36,900
Bias PoF Transmitter	570	350	\$199,500
LV PoF Transmitter	325	265	\$86,125
Bias PoF Fibers	198.51	440	\$87,344
LV PoF Fibers	198.51	265	\$52,605
Fiber bundling & spooling	\$17.50	0	\$0
Feedthroughs	\$173.00	51	\$8,823
Flanges	\$328.45	44	\$14,452
Conduit	\$3,168.00	44	\$139,392
Bias PoF Receiver	650	440	\$286,000
LV PoF Receiver	555	265	\$147,075
LV PoF Receiver Housing Unit	36	88	\$3,168
Bias Twisted-pair Cables	\$32.81	350	\$11,484
Teflon tie wraps external to cathode	\$2.80	2620	\$7,336
Teflon tie wraps internal to cathode	\$0.69	6980	\$4,802
		Power Supply Total =	\$1,085,006

DOE Calibration System Breakdown

Line Item	Price ea.	System Quantity	Cost
Calibration Unit	\$ 299	640	\$191,467
Calibration Misc	\$ 7	640	\$4,609
Feedthrough	\$ 718	120	\$86,160
		Response & Monitoring Total =	\$282,236