Photon Detector Calibration/Monitoring System Update

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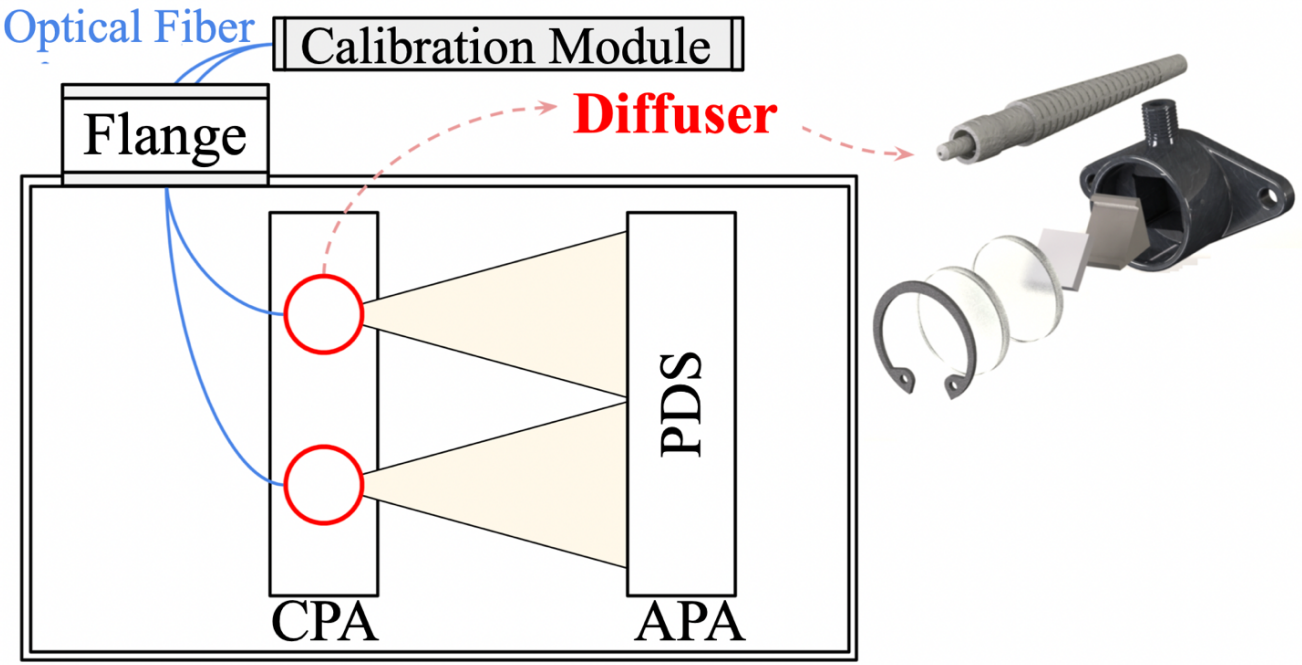
Ian Helgeson, Diana Leon, Jairo Rodriguez, Cooper Vermeulen.

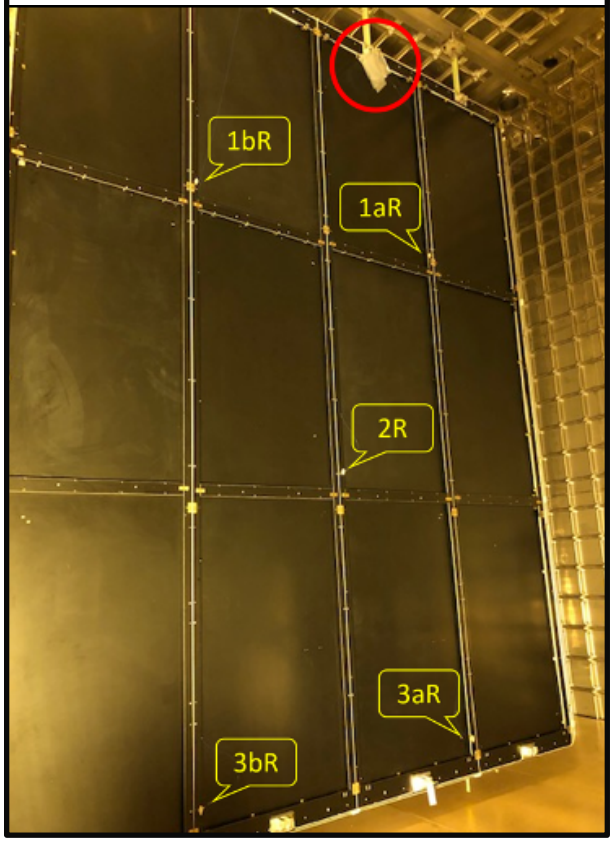
Schematic of the UV light calibration/monitoring system



PDS Calibration/Monitoring System

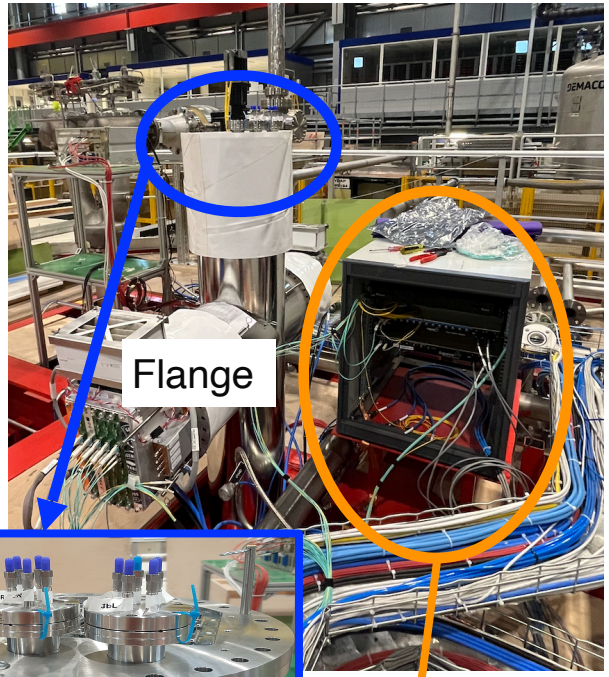
What was installed in ProtoDUNE-HD-II (Module-0 for DUNE): pictures with the description added to FD-HD1 TDR update.

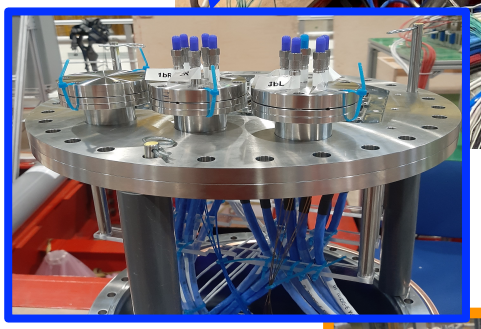
Beam right side installation (image courtesy of Steve Magill)



Optical Fibers

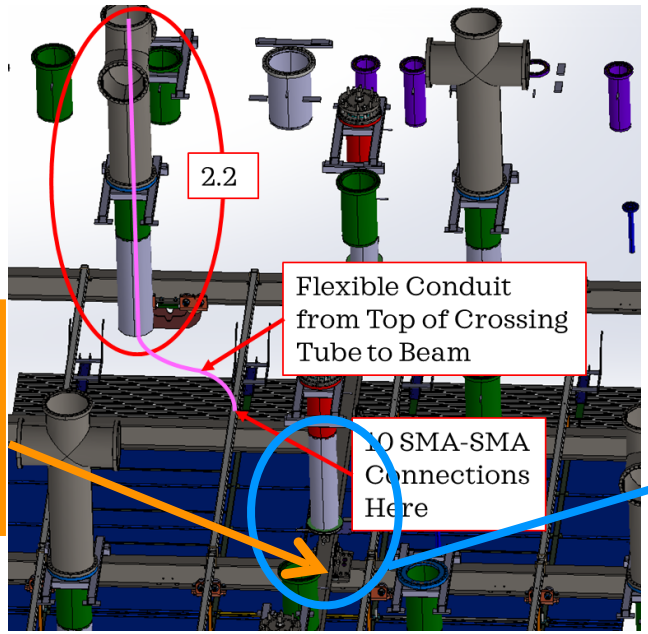
3D PEEK printed diffusers



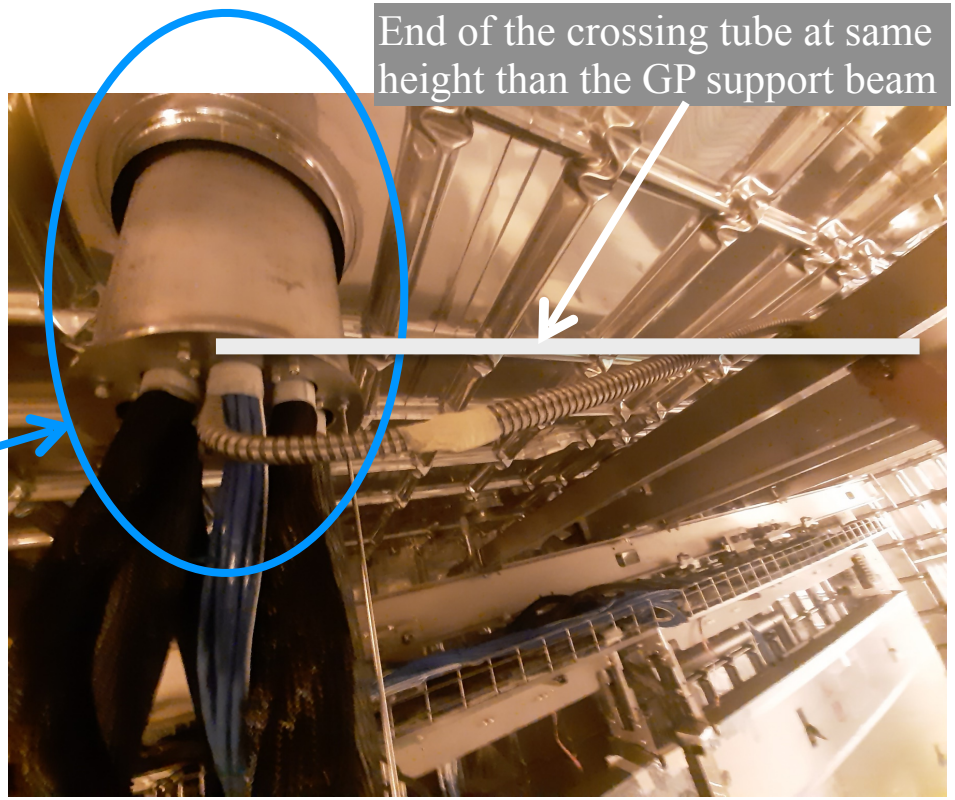


PDS Calibration/Monitoring System

The proposed routing for Groups B and C was modified during the installation respect with the proposed plan based in 3D model. Crossing tube in 3D model was shorter than the one onsite.



Expected gap between end of crossing tube and GP support beam.



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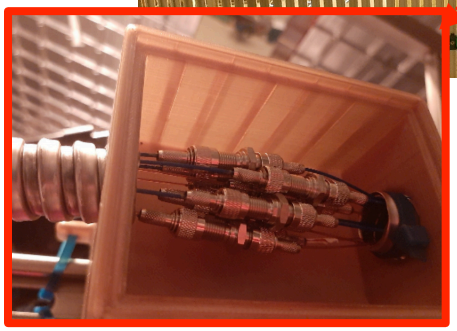
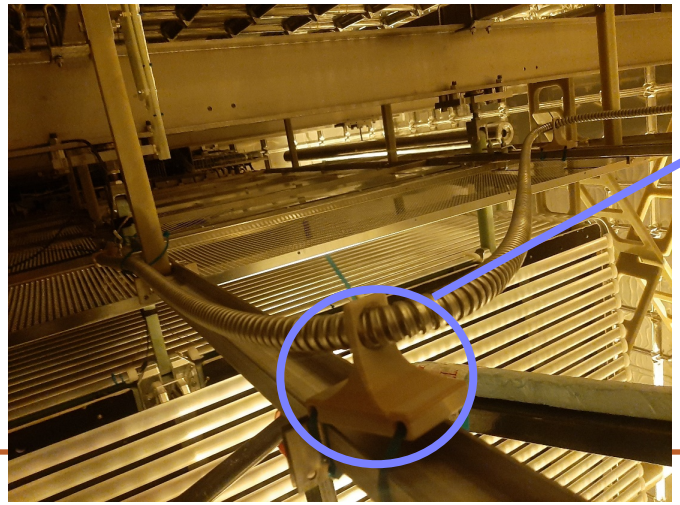
The routing during the installation was done using the GP frame and one Unistrut as shown the pictures below.





Sloping stands

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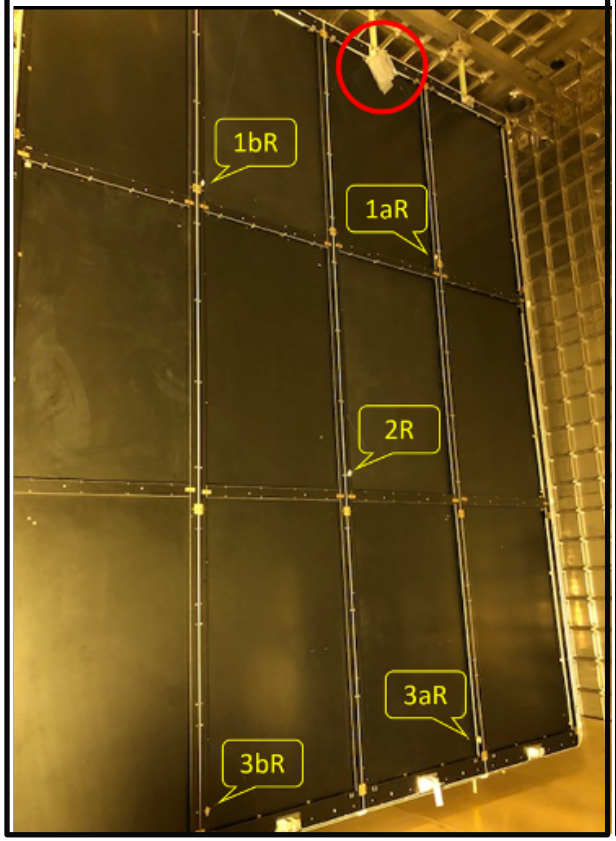
Diffuser 1aL was replaced with the most recent design using single ear diffuser

Beam right side installation



Single ear diffuser installation (side view)

Single ear diffuser installation (front view)

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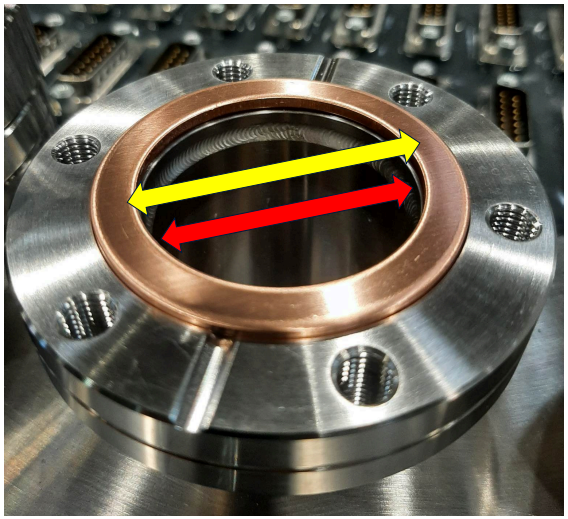
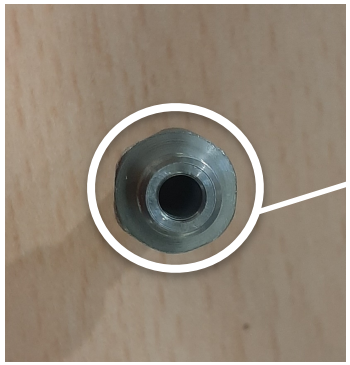
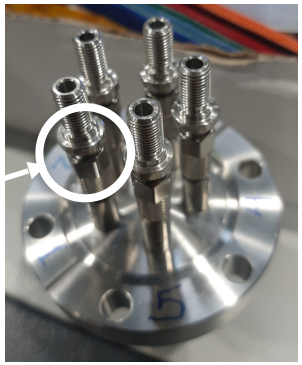
When the fibers were connected to the optical feedthrough, the circular pattern of 5 SMA connectors could not fit through it, the reason is because of a difference between the diameter copper gasket part and the inner of the flange below the welding line shown in the picture. The solution was filed down the corners of the hexagonal nuts of the SMA connectors to fit it.

Copper gasket diameter

Inner diameter of feedthrough below welding line







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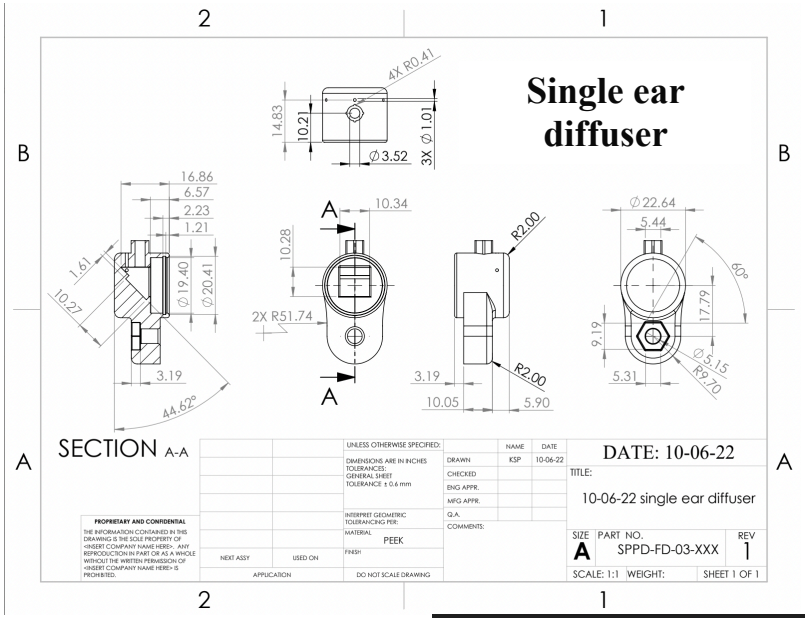
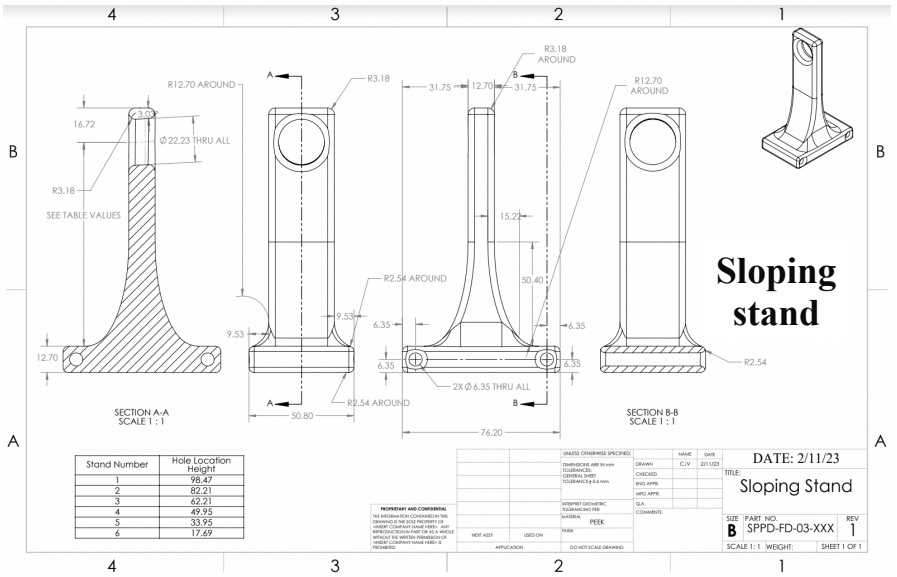
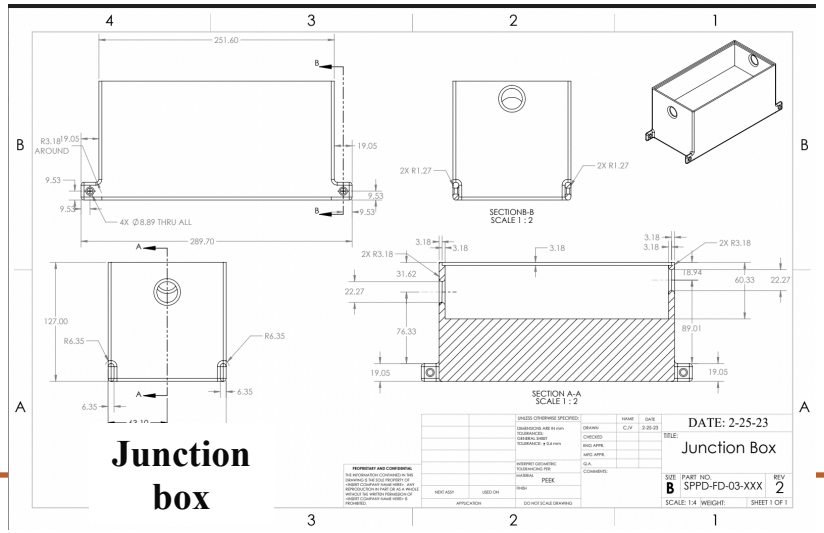
- Multiple drawings of the designs for the different components used in the installation have been produced. i.e sloping stands, junction box, final design single ear diffuser.

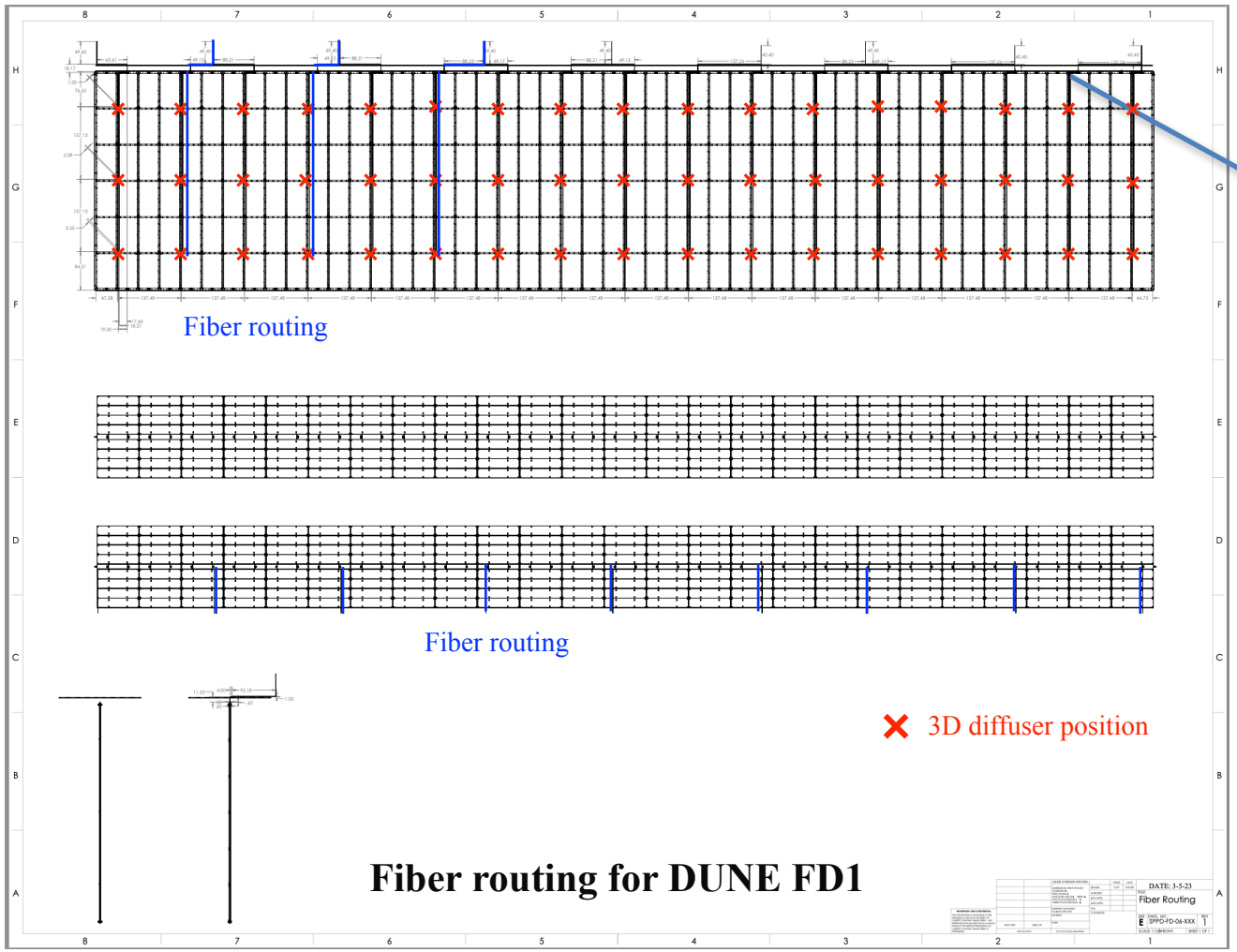


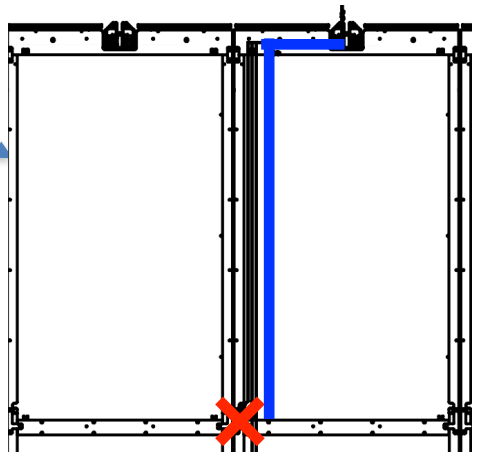


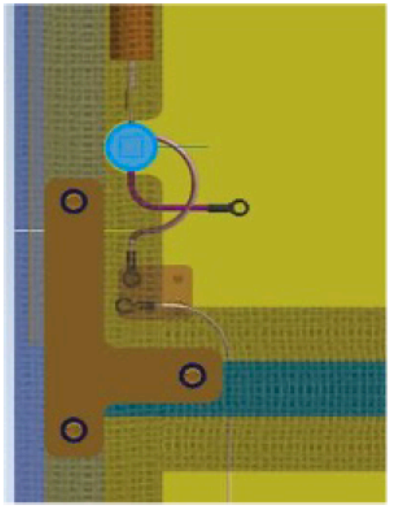


PDS Calibration/Monitoring System

- Optical fiber routing in DUNE FD1 detector model is underway.
  - Apply all lessons learned during installation in ProtoDUNE HD







PDS Calibration/Monitoring System

- Document with lessons learned during the optical fiber installation is being prepared.

Light Calibration System Installation: Lessons Learned from ProtoDUNE II

Through the process of installing the light calibration system in the second ProtoDUNE module, there were several areas in which improvements could be made for the future installation in DUNE.

3. The label tags on the ends of the fibers (shown in Figure 3) made it difficult for the fibers to be inserted into the conduit. This can easily be mitigated by using smaller tags. It is recommended to not include tags on Groups B and C, as each fiber's tag will need to be changed if one fiber is broken. The fibers could instead be identified by checking the diffuser that lights up during a light test on each fiber.

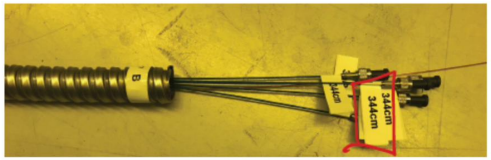


Figure 3: Fiber Identification Tags

4. When the Group C conduit and fibers are being pulled up into the crossing tube, simple coverings should be added to the exposed fibers to protect them and hold them in place within the larger-diameter conduit. The coverings must also be easily removed after the conduits have been pulled up. Bubble wrap was used for this purpose in ProtoDUNE II, as shown in Figures 4 and 5. It should be noted that the conduits' lengths should be cut so that the ends of the Group C fibers are as close to the end of the larger-diameter conduit as possible, as

The length from the top connection point to the top of the crossing tube is 30-40 cm (shown in Figure 20).

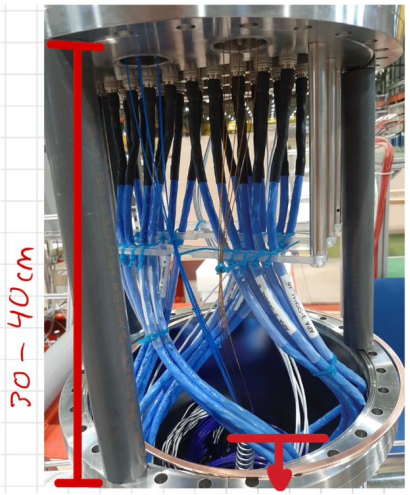


Figure 20: Distance from Top Connection Point to Top of Crossing Tube

14. At the top feedthrough, the inside diameter where the copper gasket lies, was larger than the welded portion below it, as shown in Figure 21.

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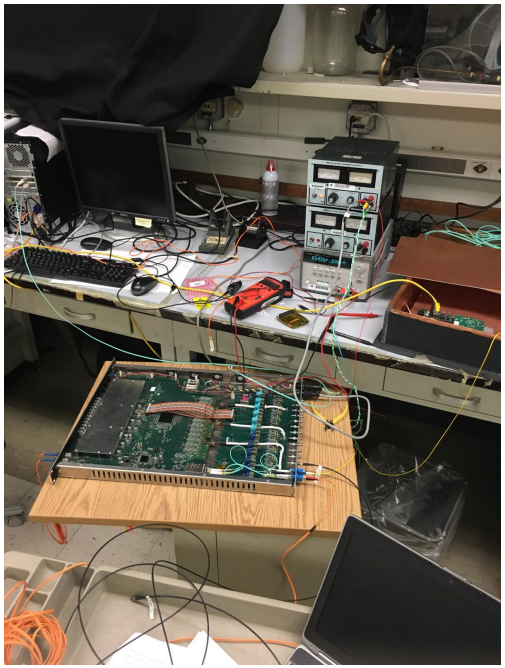
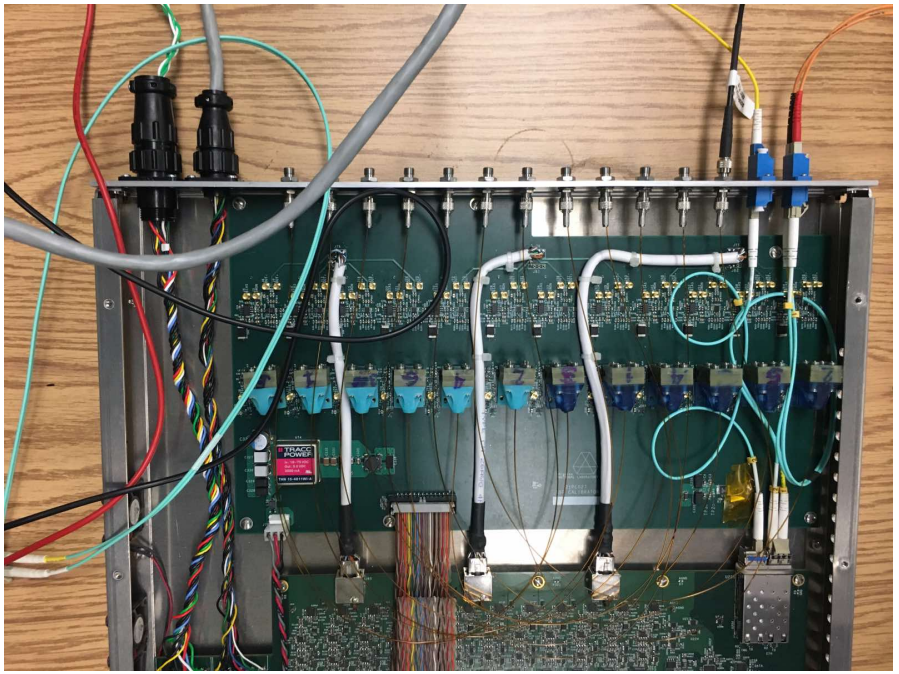
- Building the second of DUNE Module-0 grade calibration modules
  - finally have all the supplies and components
  - exercise a full-scale QA/QC and integration tests
  - new timing/DAQ system integration (significant changes in DUNE timing/DAQ to be incorporated with ProtoDUNE-HD-II)
  - update of our test stand





PDS Calibration/Monitoring System

- Final design review for the DUNE FD1 Photon detection System: March 2023
  - documentation under preparation: cost estimate quotes, system schematics, QA/QC, test results, cable information.
- Incorporated FD1-HD TDR design/test-results updates

Argonne NATIONAL LABORATORY

Calibration Electronic Module Light Source QA/QC Checks

Argonne National Laboratory

Z. Djurcic, A. Rafique, M. Oberling, T. Hyden, P. De Lurgio

January 23, 2023

Version 1.00

Argonne NATIONAL LABORATORY

ProtoDUNE Calibration Module

Pulser Configuration and Testing Guide

Argonne National Laboratory

M. Oberling, Z. Djurcic, A. Rafique, P. De Lurgio

January 23, 2023

PURCHASE COST FOR CALIBRATION MODULE AND OPTICAL FEEDTHROUGH

Optical Feedthroughs:

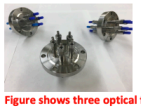


Figure shows three optical feedthrough units, each unit with five optical channels

Note: Single feedthrough comprises five optical channels. We assume that three feedthroughs will be used per PDS flange, and that three feedthroughs will provide 12 optical penetrations. For 204 channels we would need 17 x (3 feedthrough units) i.e. the total 51 optical feed through units.

Recent quote (10/14/22) for 50-60 optical feedthrough units: the single feedthrough unit is $625.50

Your Reference:	Quotation Date:	Expiration:	Salesperson:
RFQ 14 OCT 2022	10/14/2022	11/14/2022	Craig Vogeley

Description	Quantity	Unit Price	Taxes	Amount
[2580004] VFT,2.75CF, 5 x FDP600um fiber,SMA-905,Cryo adhesive,Torr-Seal ** Price is valid for 50-60 pieces	60.0000 Unit(s)	625.50	Exempted Tax (Sale)	$ 37530.00
			Subtotal	$ 37530.00
			Taxes on $ 37530.00	$0.00
			Total	$ 37530.00

For small quantities the cost is higher. Example quote for three feedthrough units (July 2022); the single feedthrough unit is $934.72

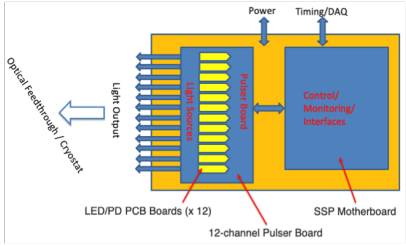
Your Reference:	Quotation Date:	Salesperson:
RFQ 11 JUL 2022	07/11/2022	Craig Vogeley

Qty Pre Board	# of Units + spares	Total	Digi-Key Part Number	Cost		
24	24	576	490-16413-6-ND	$33.47		
48	24	1152	490-GRM21BZ71E106KE15LDKR-ND	$136.32		
2	24	48	399-C1206C475M5RACAUTODKR-ND	$31.53		
46	24	1104	445-181404-6-ND	$177.60		
2	24	48	399-14193-6-ND	$13.62		
12	24	288	445-6926-6-ND	$24.57		
120	24	2880	399-14105-6-ND	$140.80		
36	24	864	399-14758-6-ND	$47.61		
12	24	288	399-13389-6-ND	$62.21		
12	24	288	399-C0603C479C1GAC7867DKR-ND	$53.94		
12	24	288	445-15523-6-ND	$32.55		
1	24	24	399-16806-6-ND	$53.78	$808.00	Other Caps
12	22	264	399-16636-6-ND	$811.25		
1	24	24	493-13787-6-ND	$76.29		
2	24	48	399-10461-6-ND	$306.66		
4	24	96	399-14801-6-ND	$599.70		
3	24	72	399-13128-6-ND	$330.45	$2,124.35	High Value Caps
	22	264	7-pin Header	$117.62		
1	24	24	59190-ND	$28.42	$146.04	Connector Costs
60	21	1260	WM9481-ND	$1,882.18	$1,882.18	MCX Test Point costs
36	24	864	490-BLM18SP015Z1DDKR-ND	$106.84		
2	24	48	490-11055-6-ND	$18.67		
1	22	22	732-3939-6-ND	$104.70		
1	22	22	732-7442724711DKR-ND	$75.40	$305.61	Inductor costs
11	24	288	RTF015N03TLDKR-ND	$132.08		
2	24	48	RMCF0805JT09R0DKR-ND	$7.61		
1	24	24	2019-RK73H1JTTD6343FDKR-ND	$7.60		
1	24	24	2019-RK73H1JTTD6193FDKR-ND	$7.60		
1	24	24	2019-RK73H1JTTD4533FDKR-ND	$7.60		
121	24	2904	RR08P100KDDKR-ND	$60.29		
1	24	24	RR08P499DDKR-ND	$10.02		
12	24	288	RR08P4.99KDDKR-ND	$20.91		
36	24	864	RR08P10.0KDDKR-ND	$48.73		
24	24	576	RR08Q49.9DDKR-ND	$34.82		
24	24	576	RMCF0603ZT0R00DKR-ND	$8.89		
36	24	864	RR08P200DDKR-ND	$48.73		
12	24	288	RCWE..33CDKR-ND	$87.63		
12	24	288	RR08P100DDKR-ND	$20.91	$371.34	Resistor Costs
1	24	24	505-1730866FF8P8F-ND	$203.47		
12	22	264	296-40443-6-ND	$412.77		
12	22	264	505-A0813BARMZ-ND	$2,307.28		
12	22	264	ADG719BRTZ-REEL7DKR-ND	$535.06		
12	22	264	AP2138N-3.3TRG1DIODKR-ND	$67.32		
12	22	264	296-38705-6-ND	$310.91		
1	22	22	THN 2O-4811WI	$1,039.08	$4,997.97	IC Costs
12 Channel Board BOM Cost for build Qty 20:				$10,635.49		

Qty Pre Board	# of Units + spares	Total	Digi-Key Part Number	Cost	
	1 reel	250	270nm LED: 1214-XBT-3535-UV-A130-CD270-I	$3,765.59	
12	22	264	367nm: 2112-CUN6GF1ADKR-ND	$1,452.11	
12	24	288	Photo Diode:	$593.08	
12	22	264	7 pin header	$235.95	
				270nm	367nm

Calibration Module PCB Schematics

Board schematics: control/interface board ("SSP Motherboard", pulser board ("12-channel Pulser Board"), light sources PCB boards ("LED/PD PCB Boards").



SSP Calibration LED boards. HEP part number: 22pc009
Schematic PDF
Gerber Zip (Fabrication files)
Gerber PDF

12 channel Calibration HEP part number: 21pc027
Schematic PDF
Gerber Zip (Fabrication files)
Gerber PDF

SSP Mainboard HEP part number: 17pc001b
Schematic PDF
Gerber Zip (Fabrication files)
Gerber PDF

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PDS Calibration/Monitoring System

- New figures added to FD1-HD TDR design/test-results updates

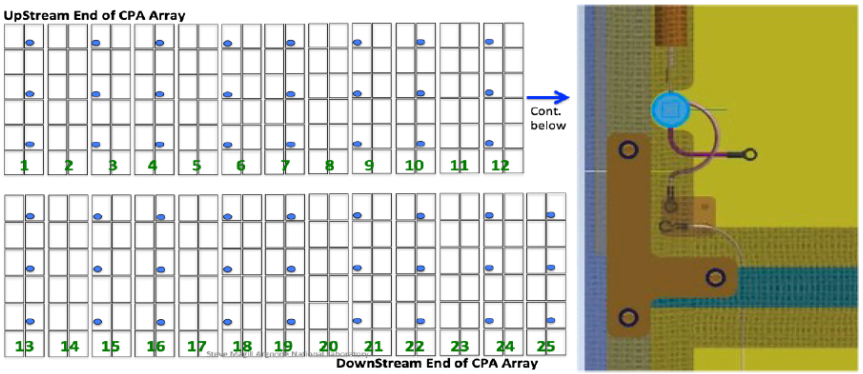
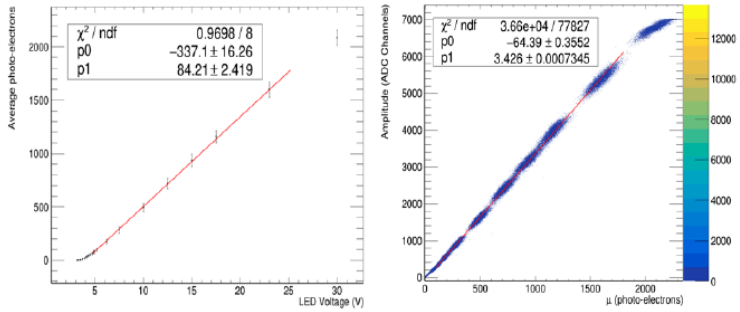


Figure 1.15: Schematic of a complete SP cathode plane (60 m × 12 m) showing the locations of the calibration and monitoring system diffusers (left). Each diffuser illuminates a region of about 4 m × 4 m on APAs 3.6 m away. The diffuser locations will be in the CPA FSS notches (right).

Figure 1.27: The photographs show the hardware components of the FD1-HD Module 0 calibration and monitoring system.



Courtesy: Sabrina Sacerdoti

Figure 1.26: A single channel calibration module pulser has been verified in CERN cold box operation. The left figure shows an average number of photoelectrons observed by an X-ARAPUCA module in the cold box as a function of a bias applied to UV-LED (275 nm). The right figure shows how the calibration pulser was used to study X-ARAPUCA response as a function of collected photoelectrons.

Next Steps

- Optical fibers installation was completed up to the cold side of the PDS flange.
  - Optical fibers from the warm side of the PDS flange to the UV LCS module are ready to be installed when necessary
- Calibration and Monitoring plan PDS operation in ProtoDUNE HD will include the following:
  - Collect data runs with two type of fibers (Polymide, Tefzel) and with two type of LEDs (270nm, 365 nm)
  - Take data runs with multiple diffusers and with individual (a single) diffuser to verify the calibration light coverage
  - Analyze data to calibrated PDS gain and monitor stability. -Use results to inform DUNE FD systems.