

# ProtoDUNE-VD

## Light Response Monitoring

ProtoDUNE-VD PDS meeting

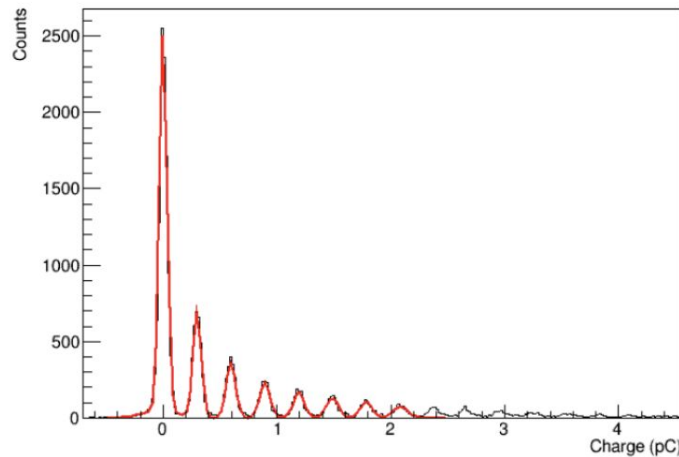
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Enrique Calvo, Clara Cuesta, Ignacio López, Antonio Verdugo

October 7<sup>th</sup>, 2022

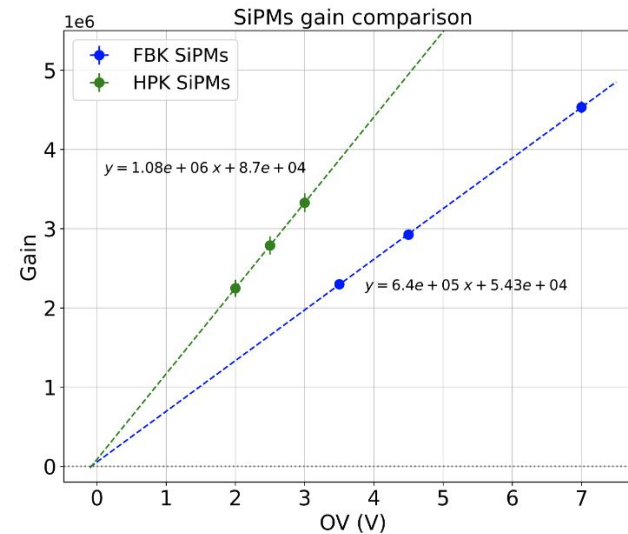
# ProtoDUNE-VD LRM

Light Response Monitoring (a.k.a. light calibration system or light monitoring system)

- **Goal:** calibrate the X-ARAPUCA response by determining the SiPM gain during the operation of the detector. It is important to guarantee an equalized response and to measure the light collected in PE units. An accurate measurement of the collected light is essential for calorimetry and to estimate the detection efficiency of the PDS.



*SPE Charge spectrum with gaussian fit of a SiPM*



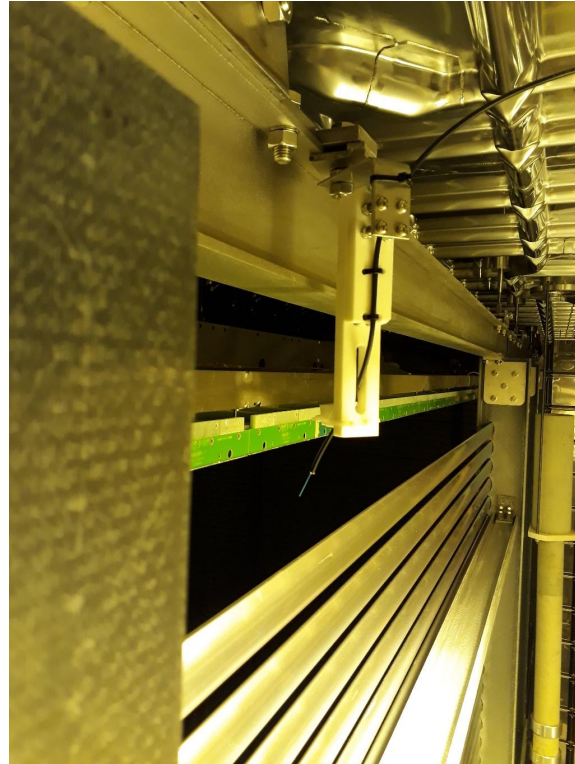
*Gain vs OV for two SiPMs with a linear fit*

- Based on **previous work** of ProtoDUNE-SP/HD and the ProtoDUNE-DP successful experience and reusing some material installed at NP02 ([JINST 14\(2019\)T04001](#), [EPJC 82\(2022\)618](#)).
- Redundancy to ensure the photon detector calibration and allow to select the best suitable fibers for the FD2-VD.

# Design Readiness

## Top (ANL, SDSMT)

- 2 Bare fibers pointing towards the cathode X-ARAPUCAs.
- 1 fiber with a diffuser pointing towards the cathode X-ARAPUCAs, redundant, to test the diffuser
- 2 fibers pointing downwards to calibrate the membrane X-ARAPUCAs

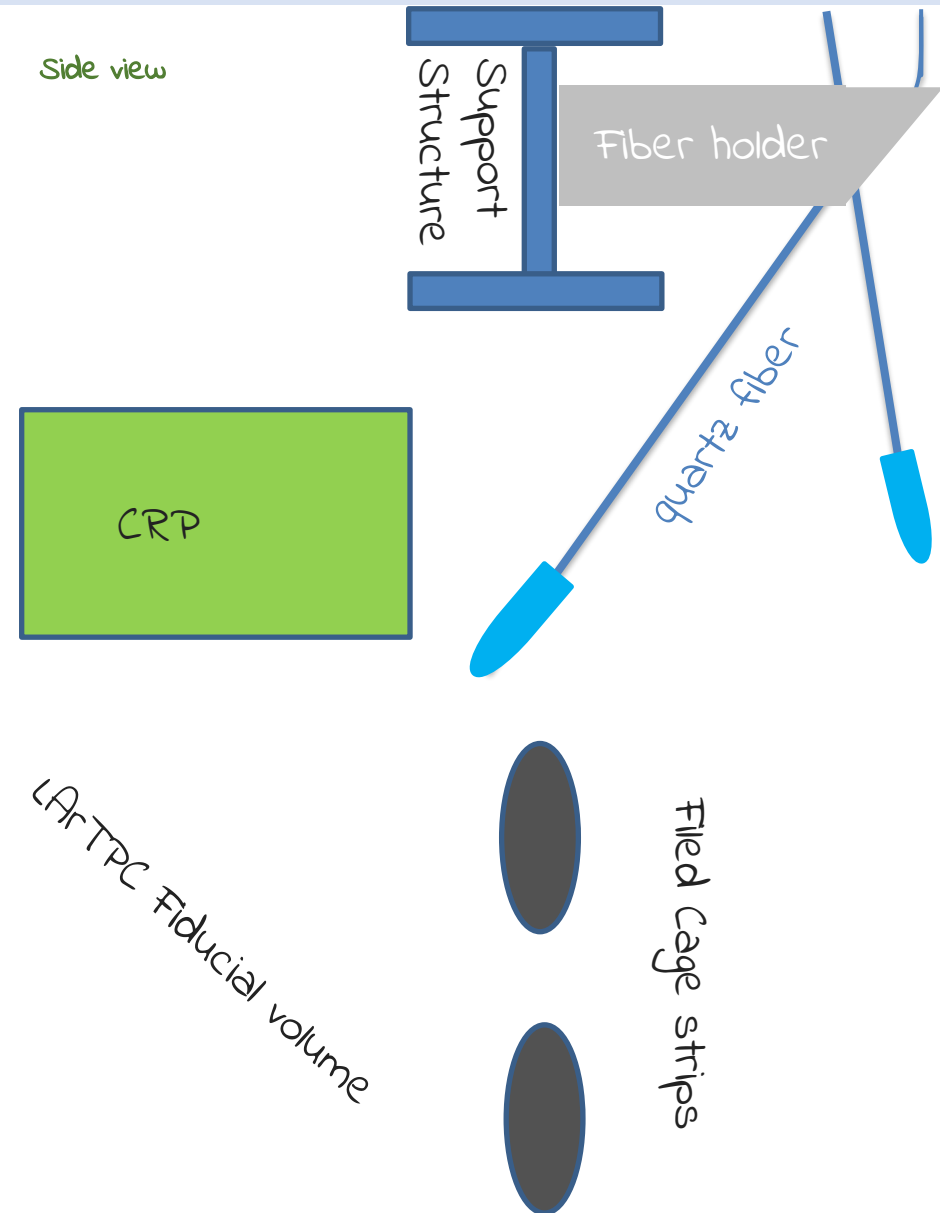


Fiber installed at ProtoDUNE-DP

top view



Side view

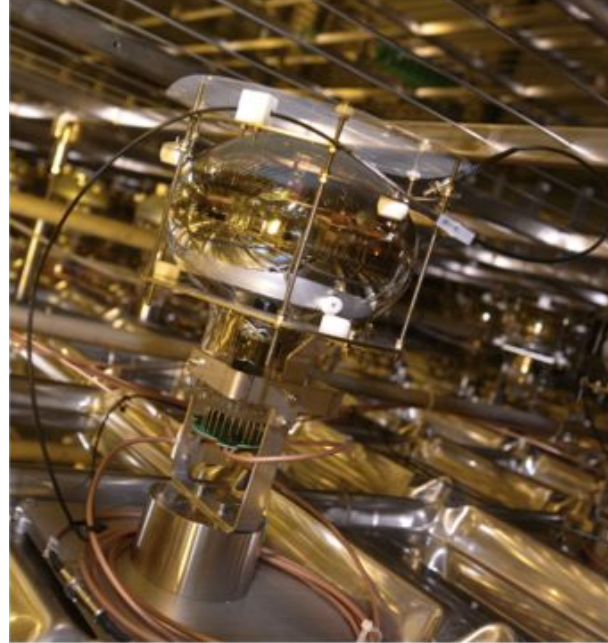


Cryostat wall with PDs below

# Design Readiness

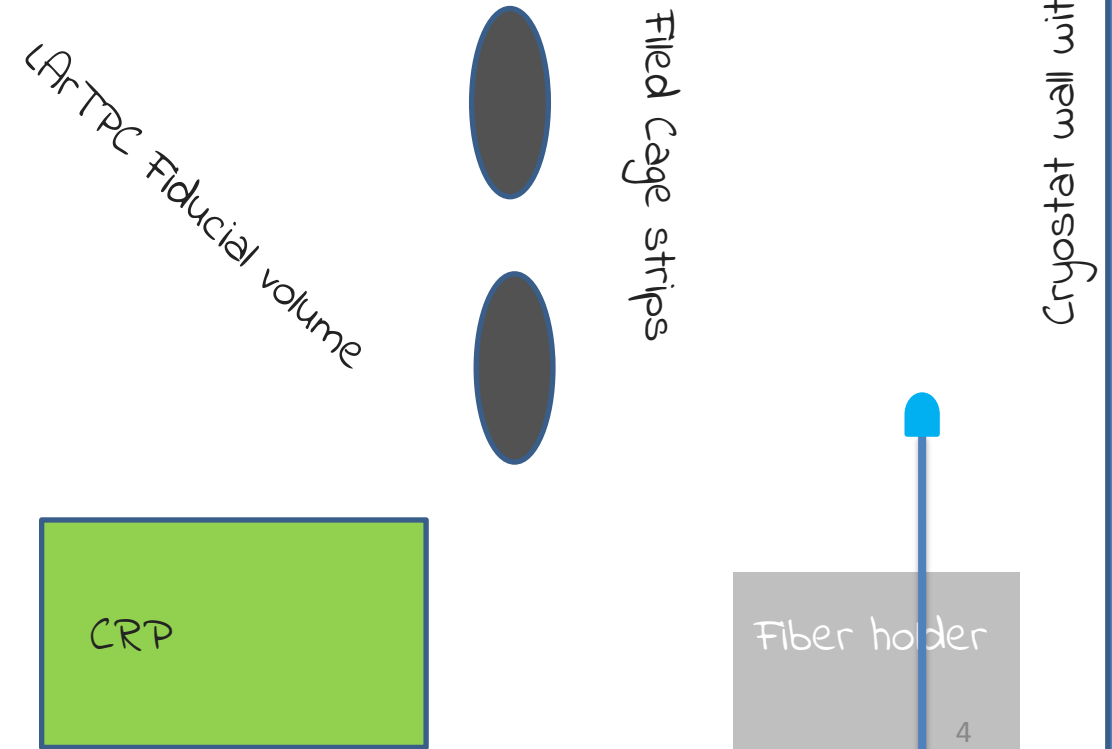
## Bottom (CIEMAT)

- 2 fibers placed at the floor pointing upwards to calibrate the membrane X-ARAPUCAs.  
22.5 m fibers from ProtoDUNE-DP
- 4 sets of fiber+bundle & 2 top fibers to calibrate 24 PMTs, same as ProtoDUNE-DP

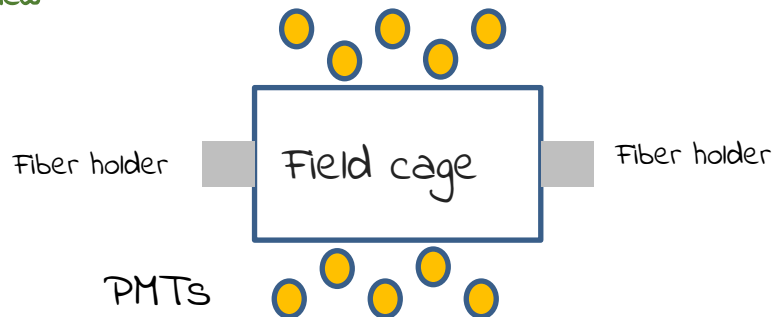


Fiber installed at ProtoDUNE-DP

Side view

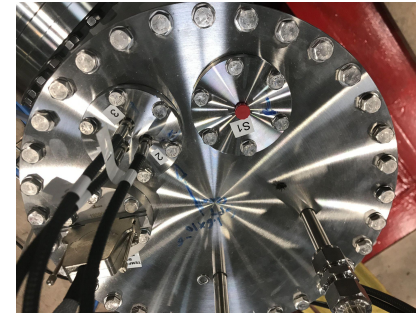


top view

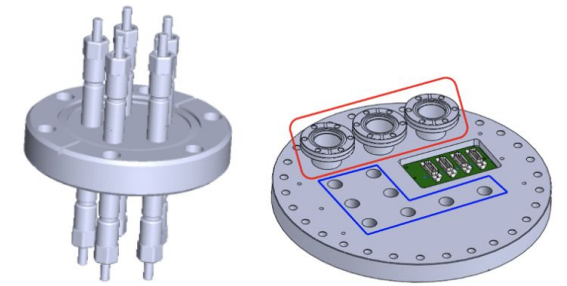


# Purchasing of components and fabrication

- Top fibers (ANL, SDSMT):
  - 2 Bare fibers pointing towards the cathode X-ARAPUCAs.
  - 1 fiber with a diffuser pointing towards the cathode X-ARAPUCAs, redundant, to test the diffuser.
  - 2 fibers pointing downwards to calibrate the membrane X-ARAPUCAs.
  - Fiber holders: to be designed and 3D printed.
  - In process of production of four feedthroughs (SMA).
- Bottom fibers (CIEMAT):
  - 2 fibers placed at the floor pointing upwards to calibrate the membrane X-ARAPUCAs.  
[Thorlabs FT800UMT](#), 22.5-m length, 800- $\mu\text{m}$  diameter, [Available at CERN](#).
  - 4 sets of fiber+bundle & 2 top fibers to calibrate 24 PMTs.  
[Thorlabs FT800UMT](#) and [FT200UMT](#). [Available at CERN](#).
  - Fiber holders: similar to PMT support
  - Flange feedthroughs: from ProtoDUNE-DP, [available at CERN](#):
    - 2x flanges with 3 SMA feedthroughs.
    - 2x flanges with 1 SMA feedthrough.



*ProtoDUNE-DP  
flange feedthroughs*



*ProtoDUNE-VD Optical flange  
and feedthrough*



*ProtoDUNE-VD  
feedthroughs in  
preparation*

# Schedule

		October				November					December				January				February			
		1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4
Top fibers	Fibers and diffusers fabrication	█	█	█	█	█	█	█	█	█	contingency											
	Optical feedthrough fabrication and testing	█	█	█	█	█	█	█	█	█	contingency											
	Design of fiber holders	█	█	cont																		
	Fabrication of fiber holders			█	█	cont																
	Fibers and diffusers shipment to CERN										█	█	cont									
	Optical feedthrough shipment to CERN								cont		█	cont										
	Fiber holders shipment to CERN					█	cont															
Bottom fibers	Dismantling ProtoDUNE-DP LRM			█																		
	Fabrication of fiber holders					█	█	█	█	█	contingency											
	Shipment to CERN																		█	cont		
Integration	Top fibers installation																█	█	█	contingency		
	Bottom fibers installation																		█	█	contingency	