DUNE PHOTON DETECTOR CALIBRATION SYSTEM

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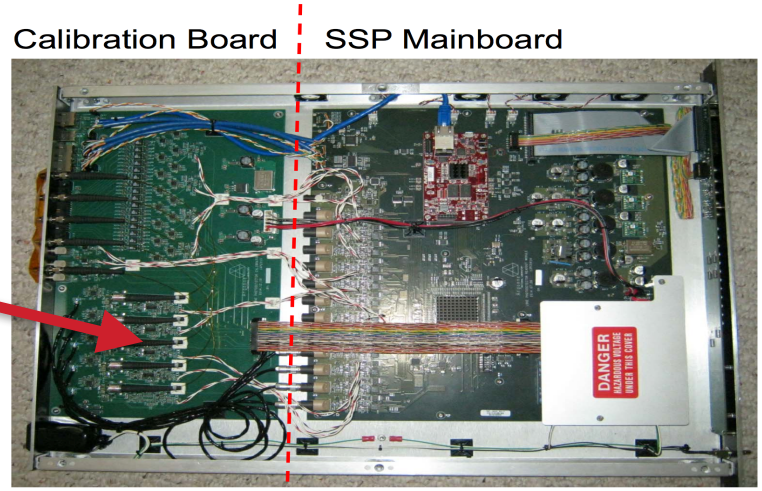
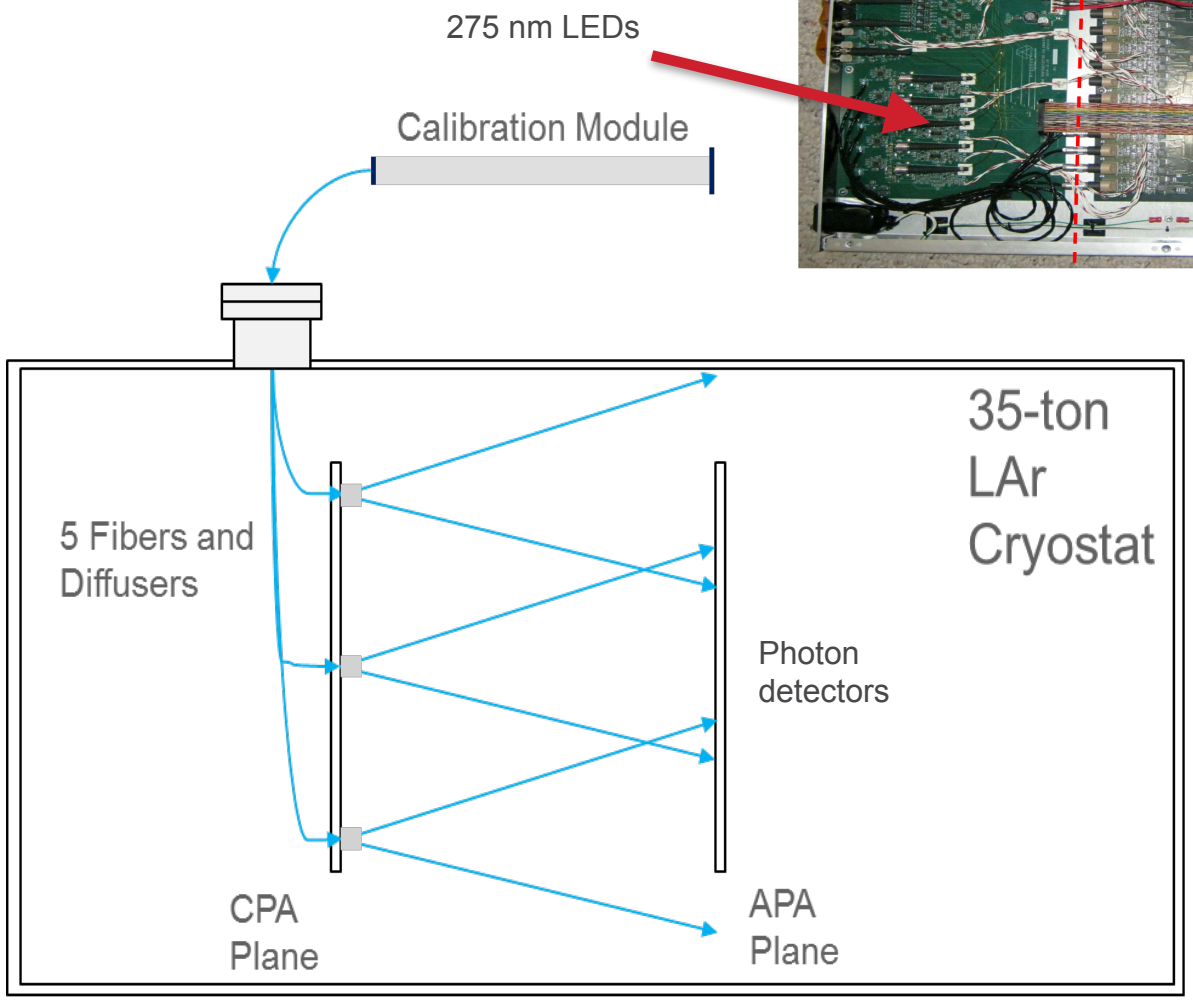
Objectives

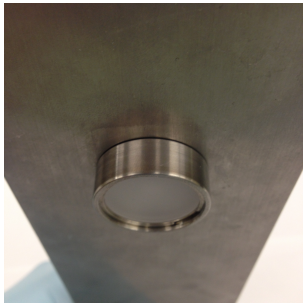
- Verify the photon detector gain and timing resolution
- Monitor stability and response as a function of time
- The UV calibration system would also be crucial during the commissioning of the detector system—before the detector is filled with LAr –- to test the photon detectors.
- In DUNE 35t performance of various photon detectors was compared
- A quick reliable test of PDS specially after some change made. Don't have to wait for cosmic muon coverage of whole detector

Design, layout and components



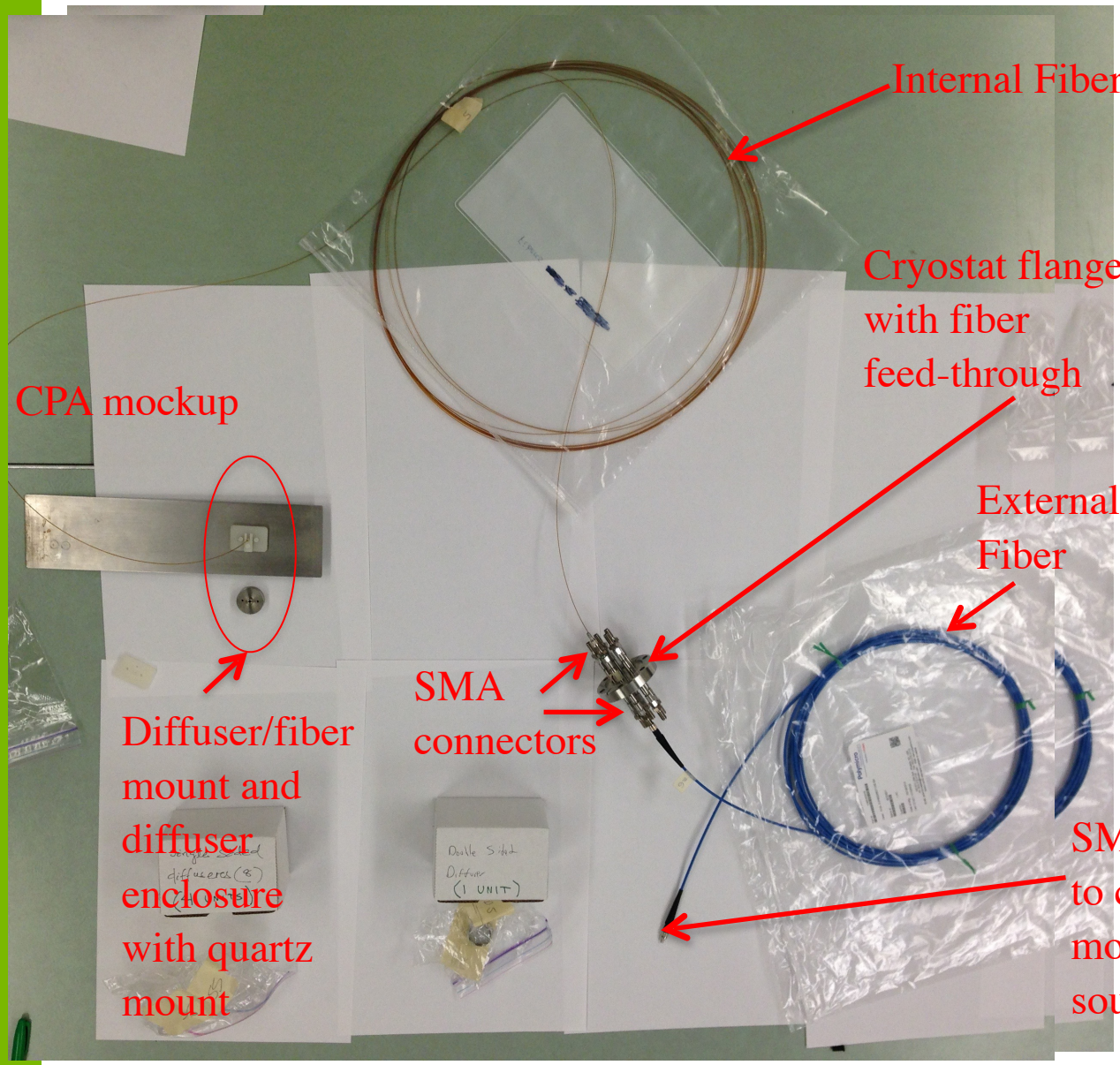


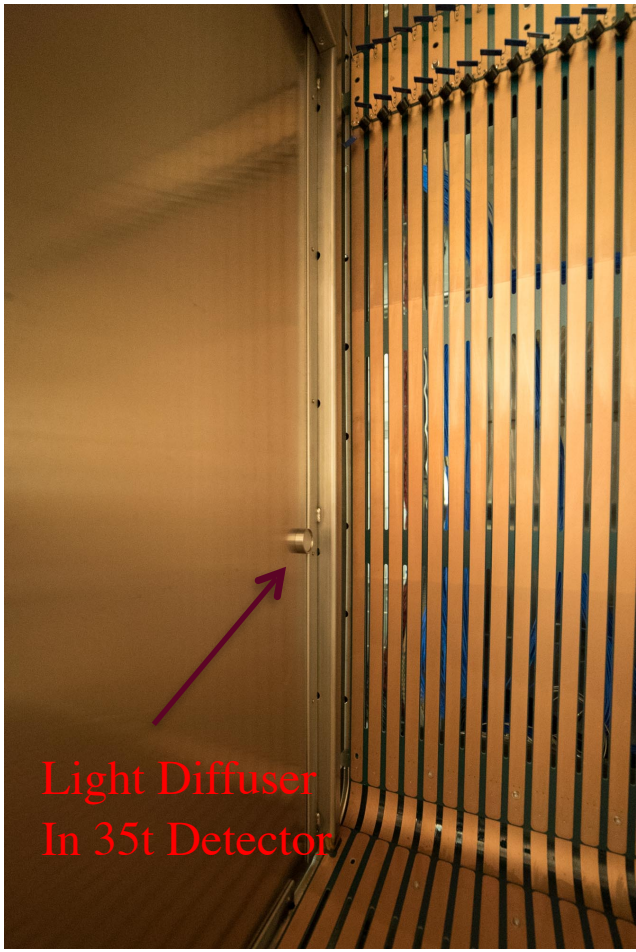
Diffusers



Design, layout and components

- Components installed with 35t DUNE prototype

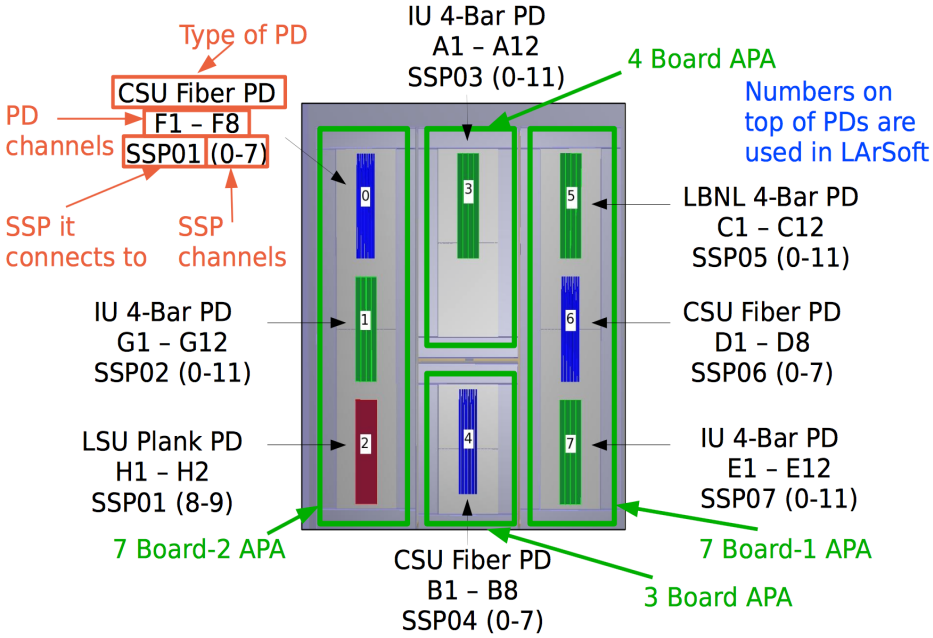




Photon detector calibration system in DUNE 35t

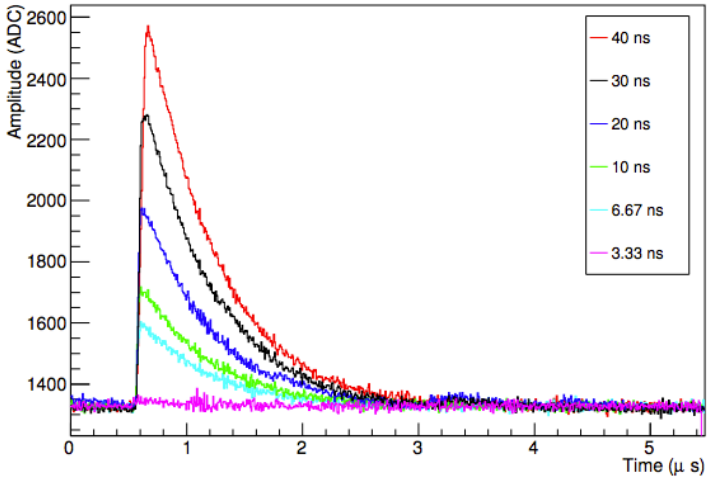
- Collected calibration data demonstrated functionality of the calibration system and examined the functionality of the photon-detector channels
  - -observe normal channels (i.e. standard response)
  - -discover noise channels
  - -discover malfunctioning PD channels

- Example of PD Calibration Runs
  - -pulse width = 50, 10, 3.33 ns
  - -pulse amplitude 30 V
  - -pulse frequency 143 Hz

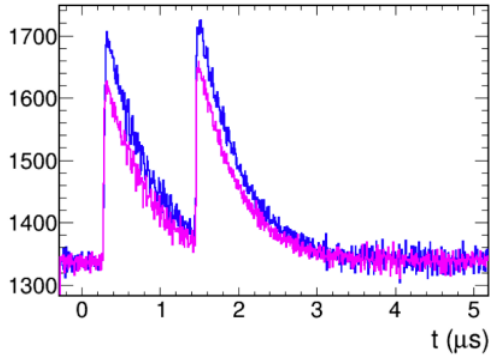


Performance in DUNE 35t

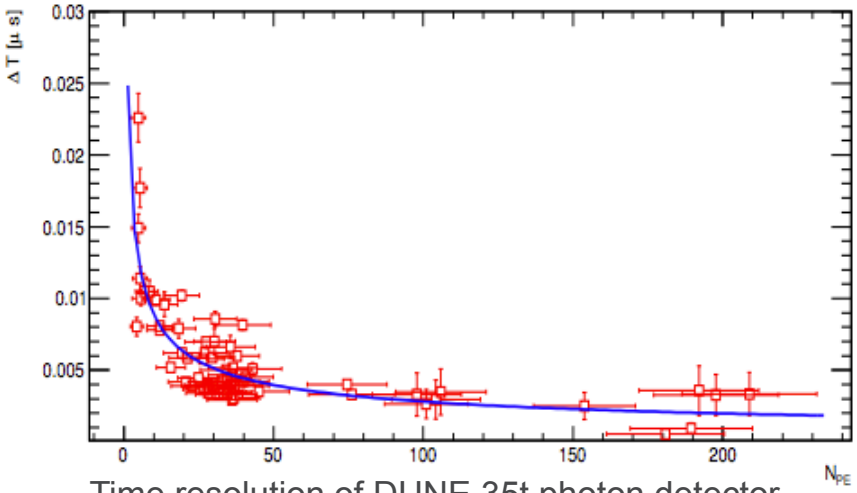
- Special calibration runs
- Calibration module able to vary pulse width and pulse amplitude
- Double pulse modes to quantify timing resolution



Response of a single photon detector to varying pulse width run of the calibration run



A double pulse pairs from calibration module



Time resolution of DUNE 35t photon detector system as a function of light intensity

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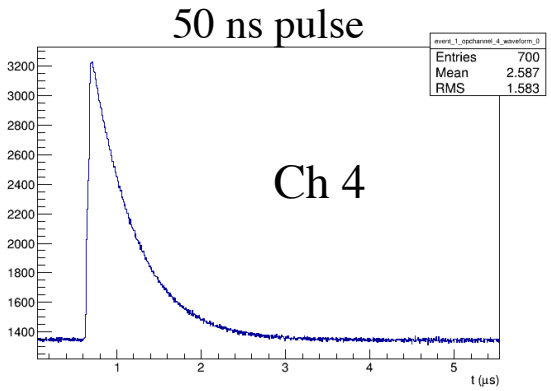
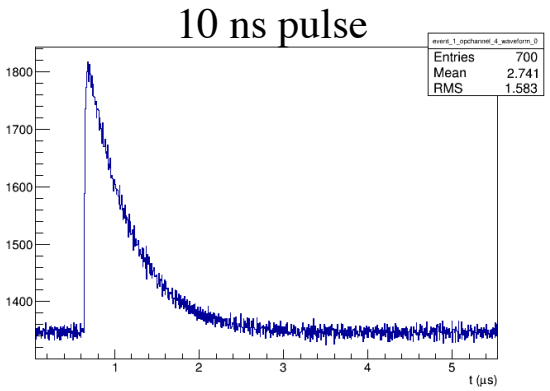
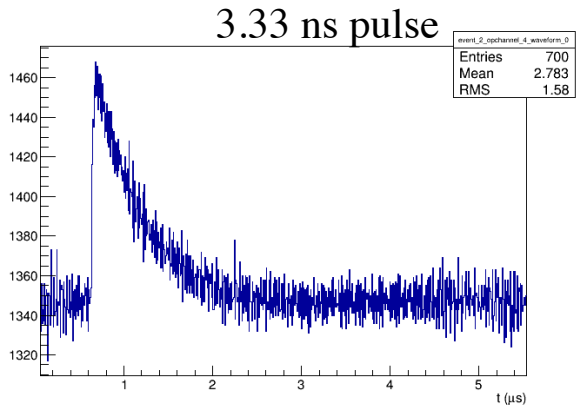
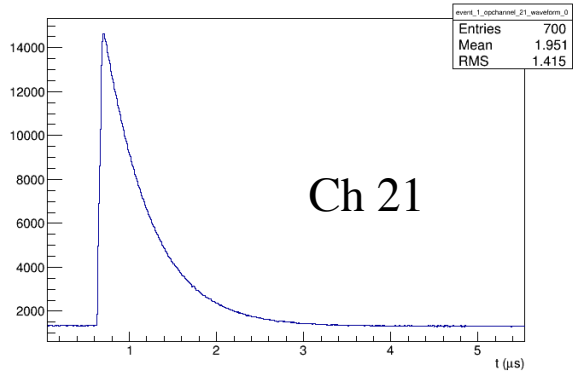
Performance in DUNE 35t

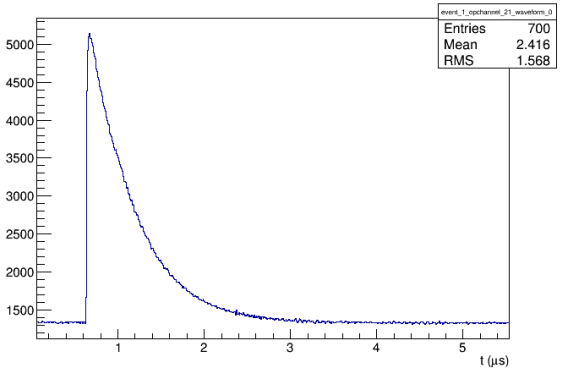
- Standard Response

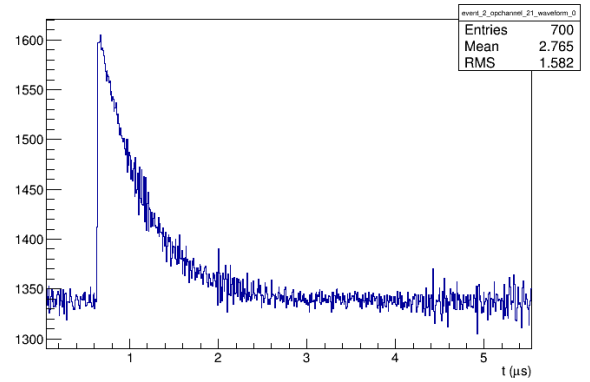


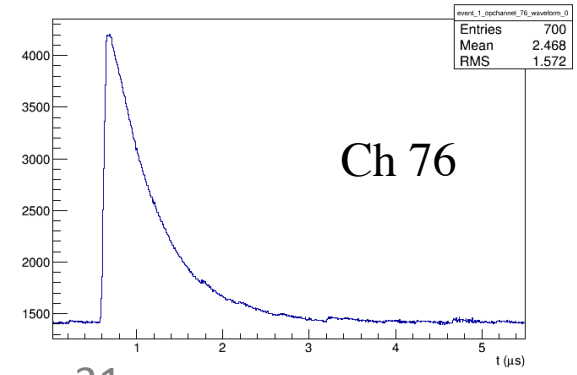


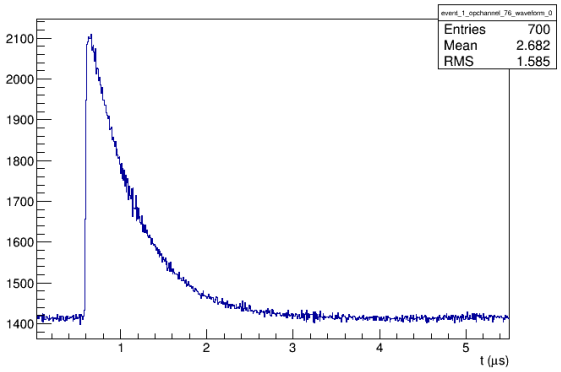


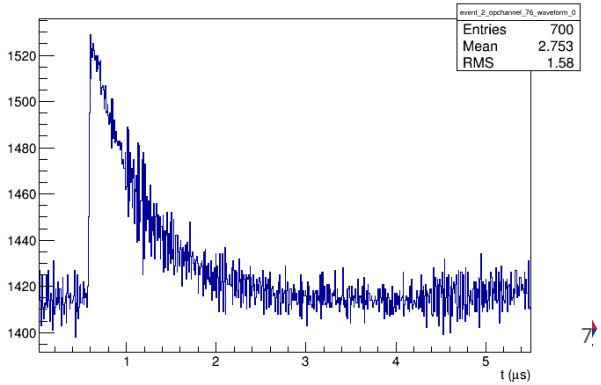






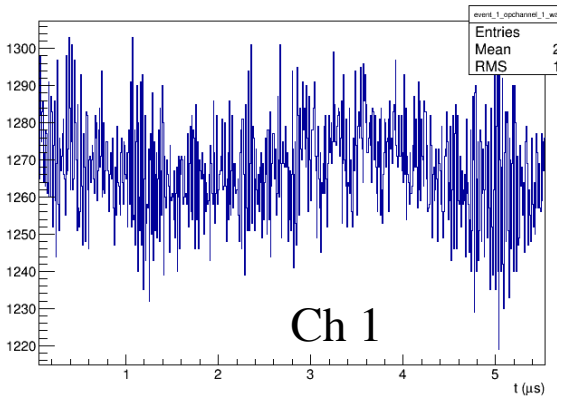


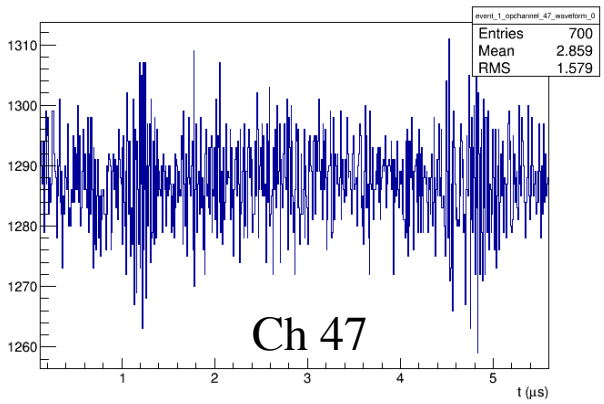


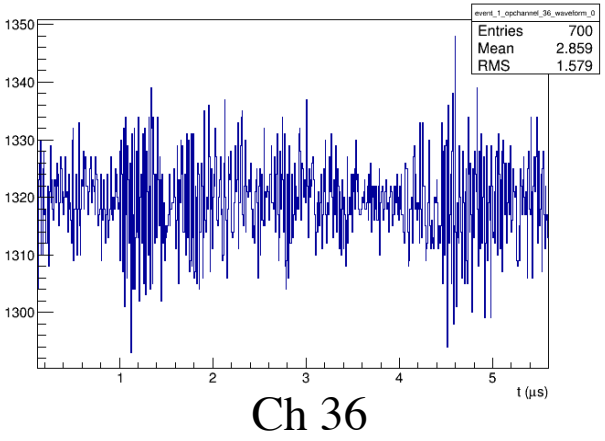


Performance in DUNE 35t

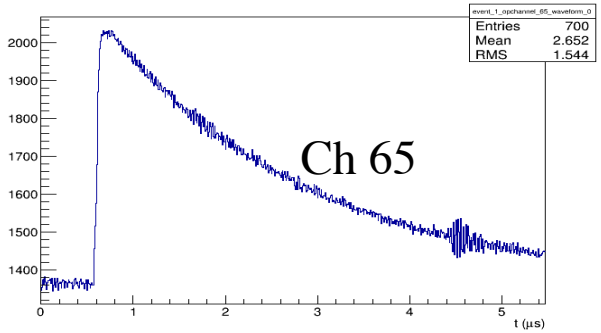
- Malfunctioning Channels

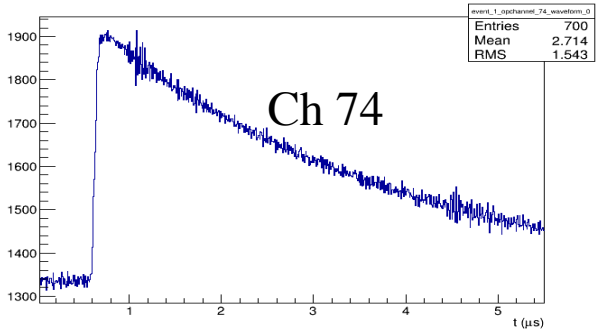






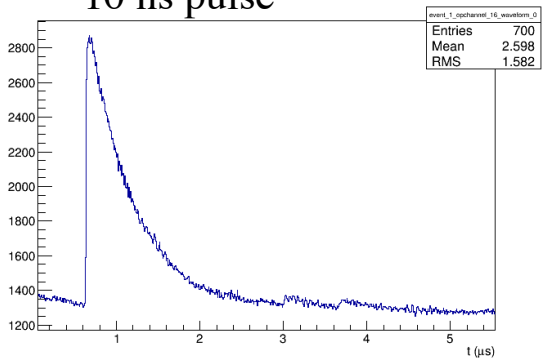
- "Slow" PD Channels



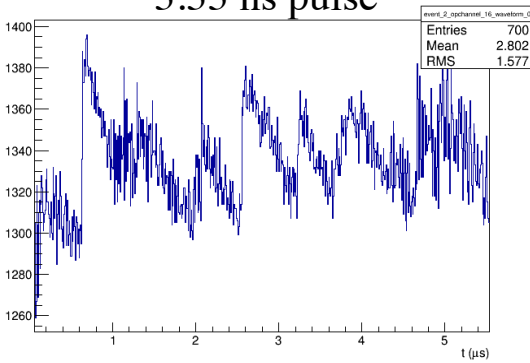


- Channels with p.e.-like noise

10 ns pulse

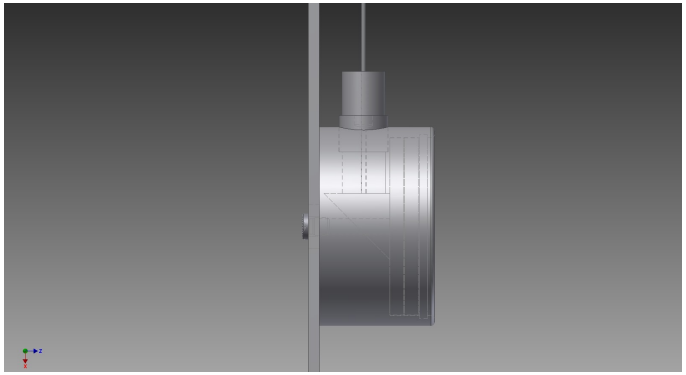


3.33 ns pulse

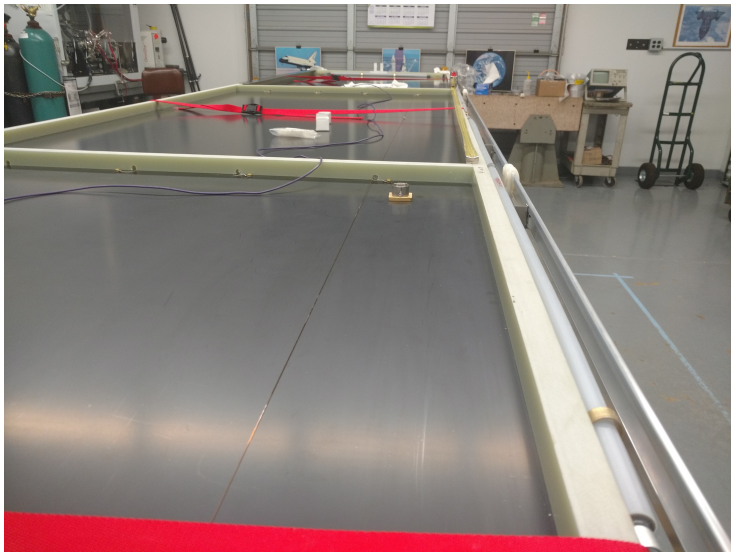


PDS Calibration in ProtoDUNE

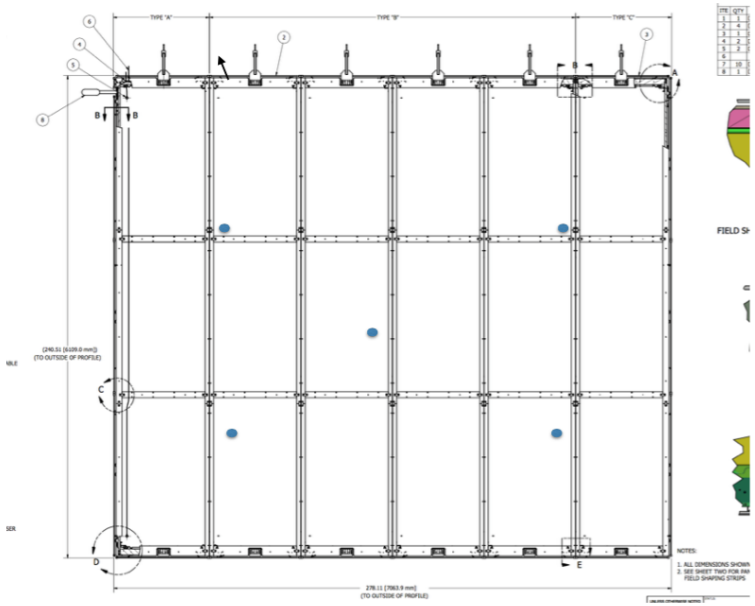
New design: fiber from top to a UV mirror

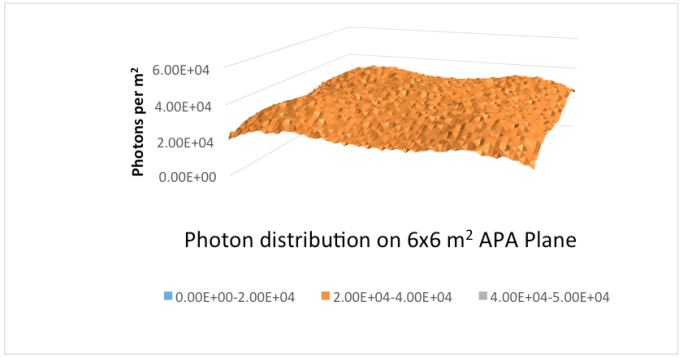


Diffusers on CPA assembled ar Argonne



Position of diffusers on the CPA panels

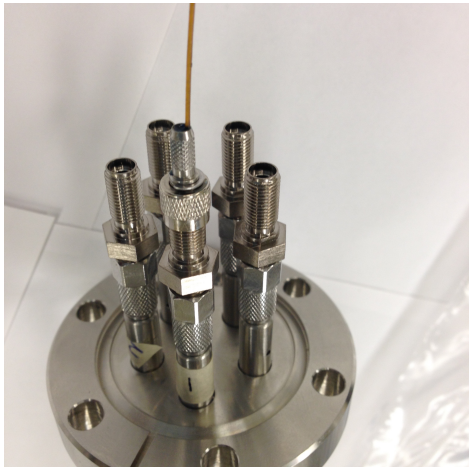




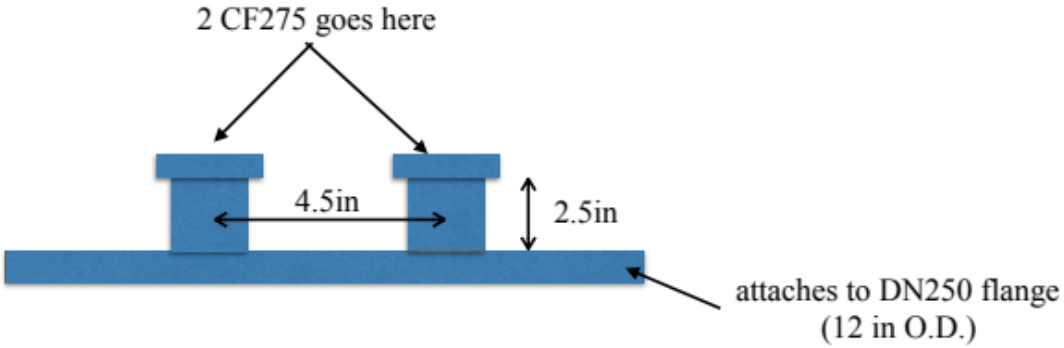
Diffuser location based on simulation studies

Feedthrough for ProtoDUNE

- For ProtoDUNE we will have a dedicated custom FT 12’ DF Flange with 2 CF275



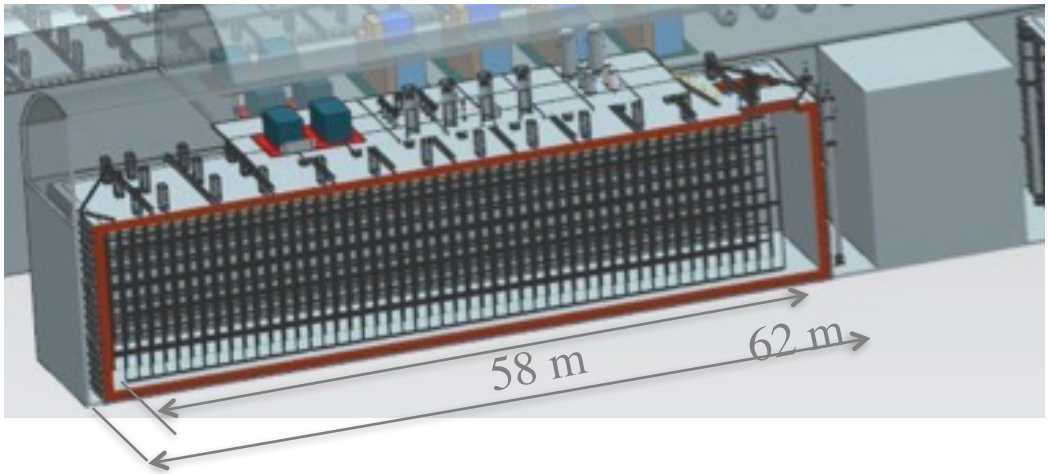
CF 275 with fiber feedthroughs

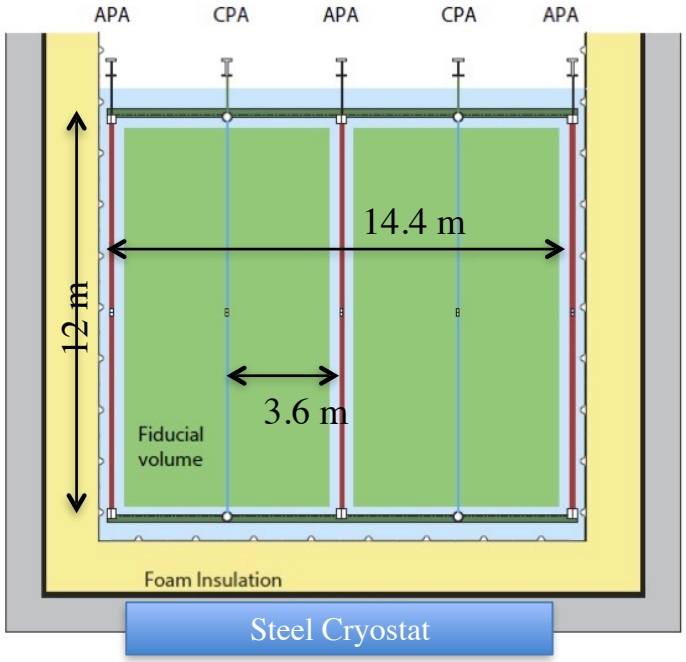


- Used existing design of flange (CF275) from DUNE35t

DUNE photon calibration system

We plan to use ProtoDUNE to optimize the requirement for DUNE PDS calibration system



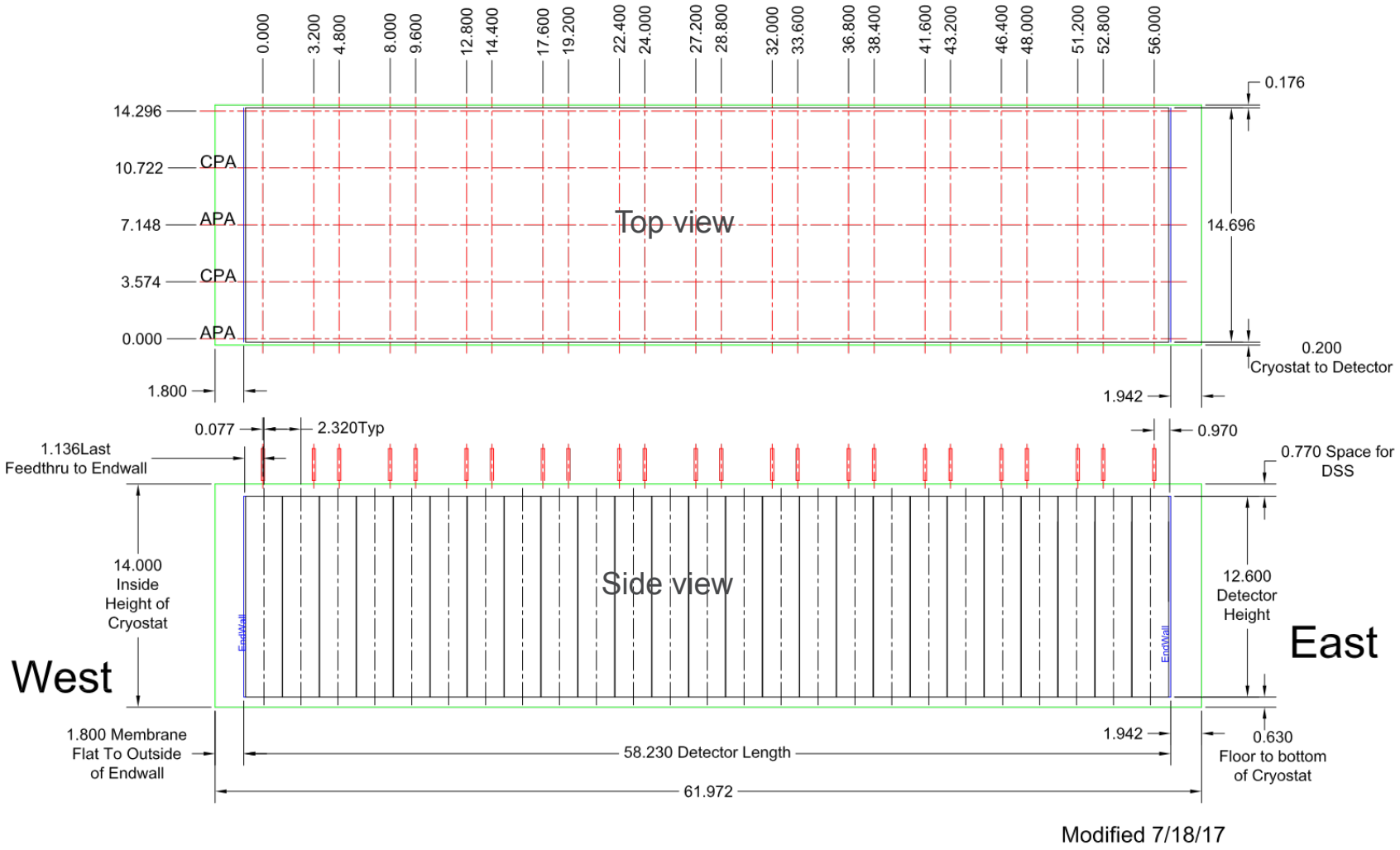


- 3 Anode Plane Assemblies wide (3.6 m drift length)
- CPAs are internal
- 58 m long x 12 m high

- Diffusers on both sides of one CPA
- Only one side for other CPA?

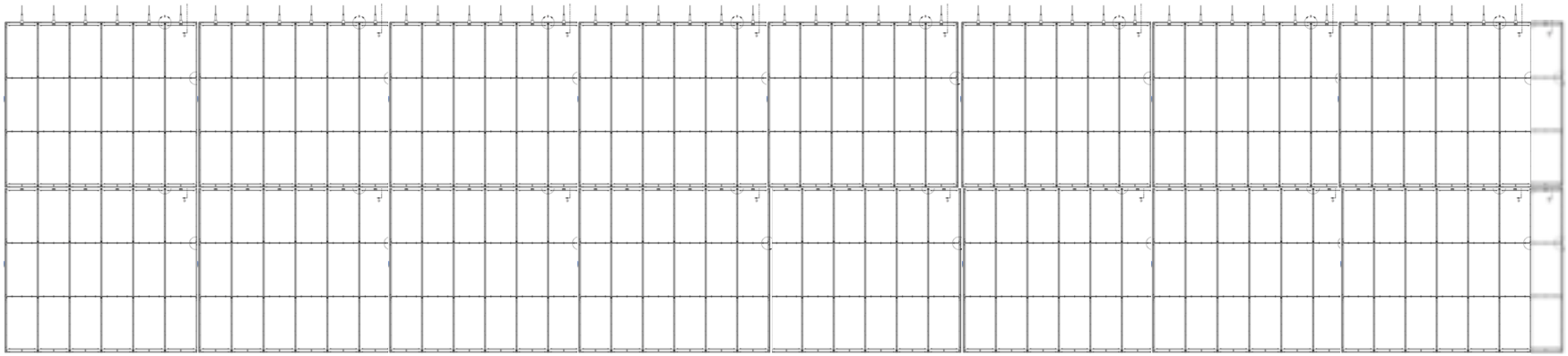
DUNE photon calibration system

Use Detector Support Structure (DSS) drawings to orient ourselves (From Vic Guarino)



DUNE photon calibration system

Side view one DUNE CPA Panel

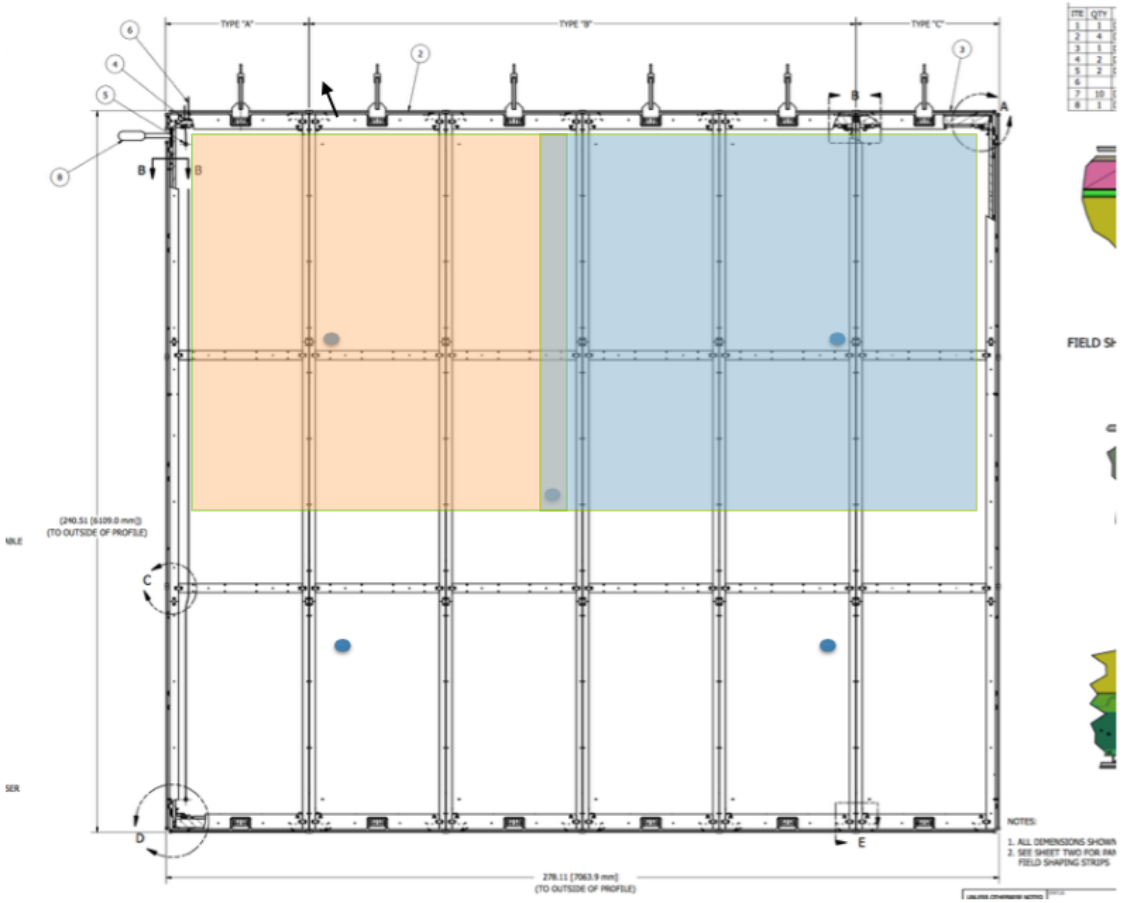


DUNE photon calibration system

We plan to use ProtoDUNE to optimize the requirement for DUNE PDS calibration system

Will we be able to cover 4x4 m with a single diffuser with overlap (see next slides)

Position of diffusers on the CPA panels



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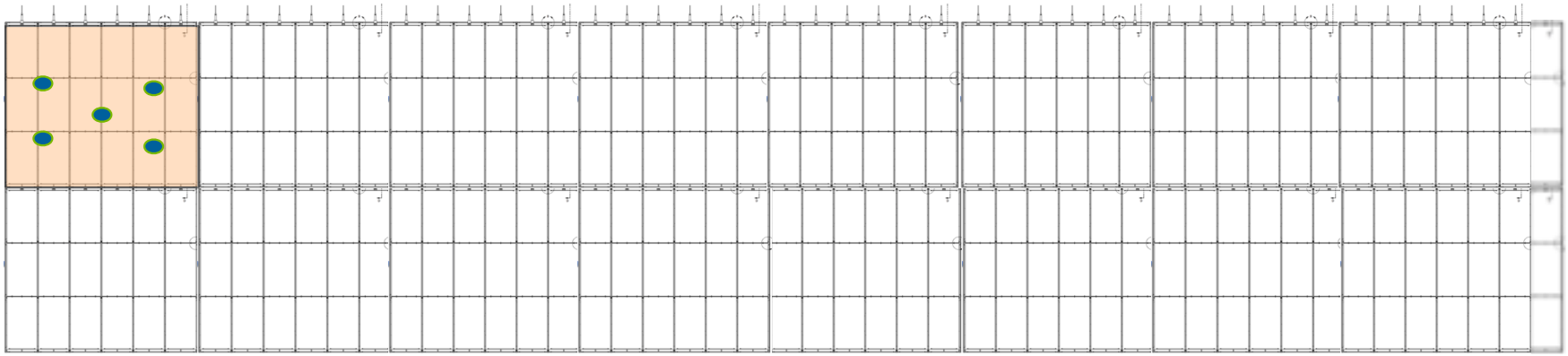
DUNE photon calibration system

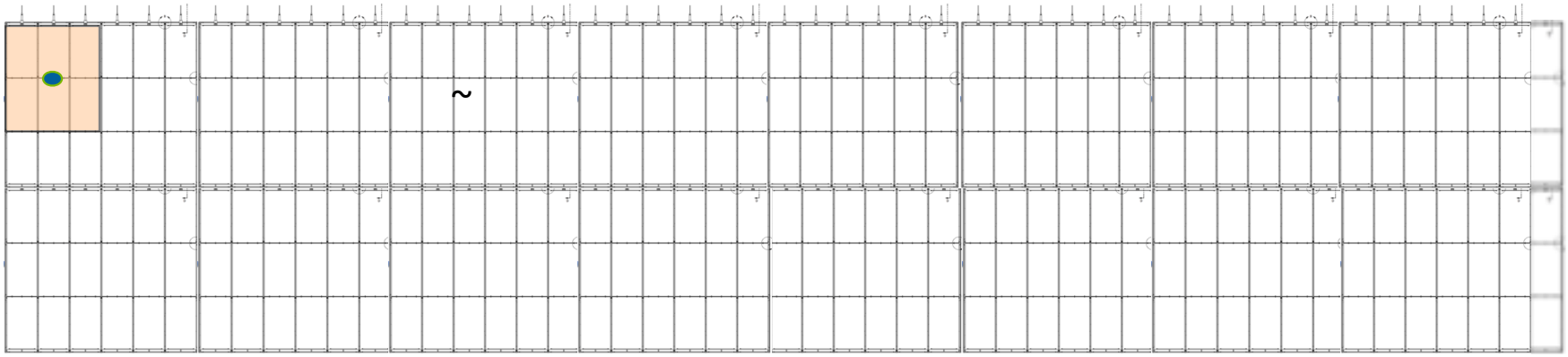
Side view one DUNE CPA Panel

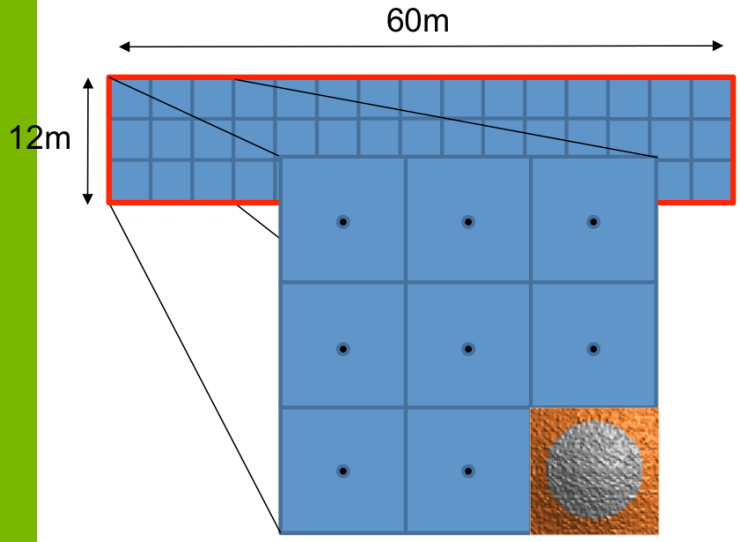
ProtoDUNE SP with
approx location of diffusers
in it



DUNE photon calibration system

One potential approach: CPA diffuser to cover 4x4 m area



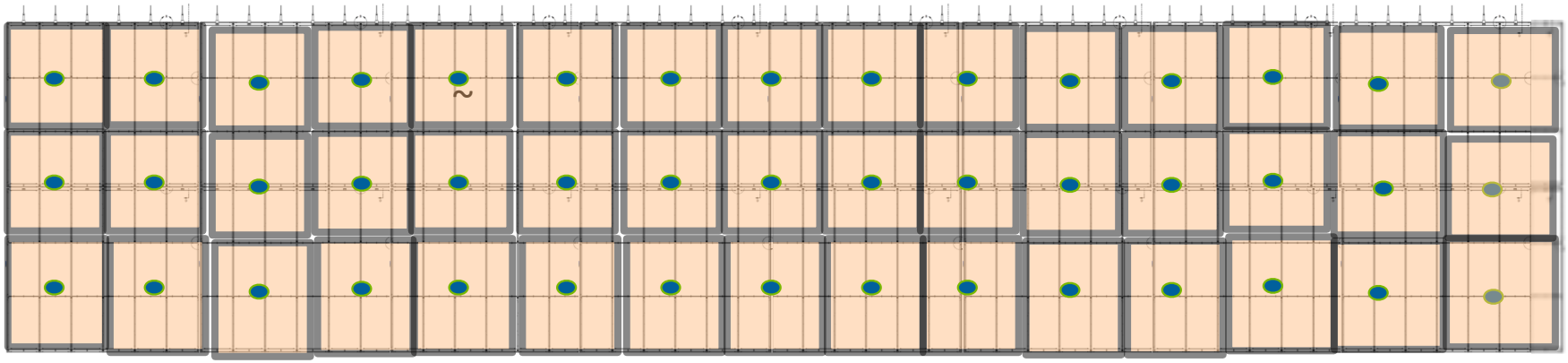


- Simulation shows it will cover 4x4 m on APA
- We would need overlap of photons from adjacent diffusers for cross calibration
- This configuration offers that opportunity

DUNE photon calibration system

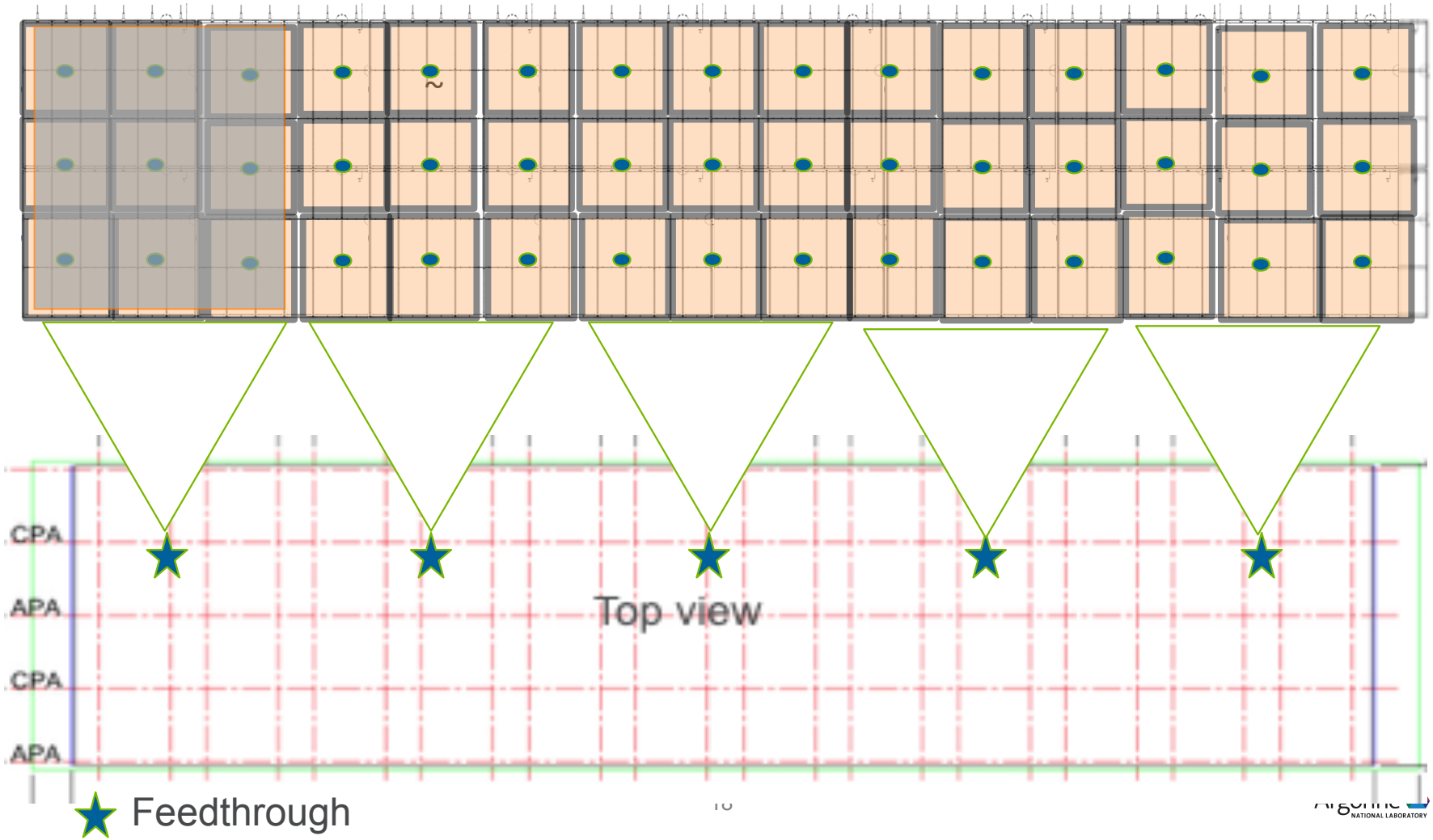
One potential approach: CPA diffuser to cover 4x4 m area

45 fibers per CPA side



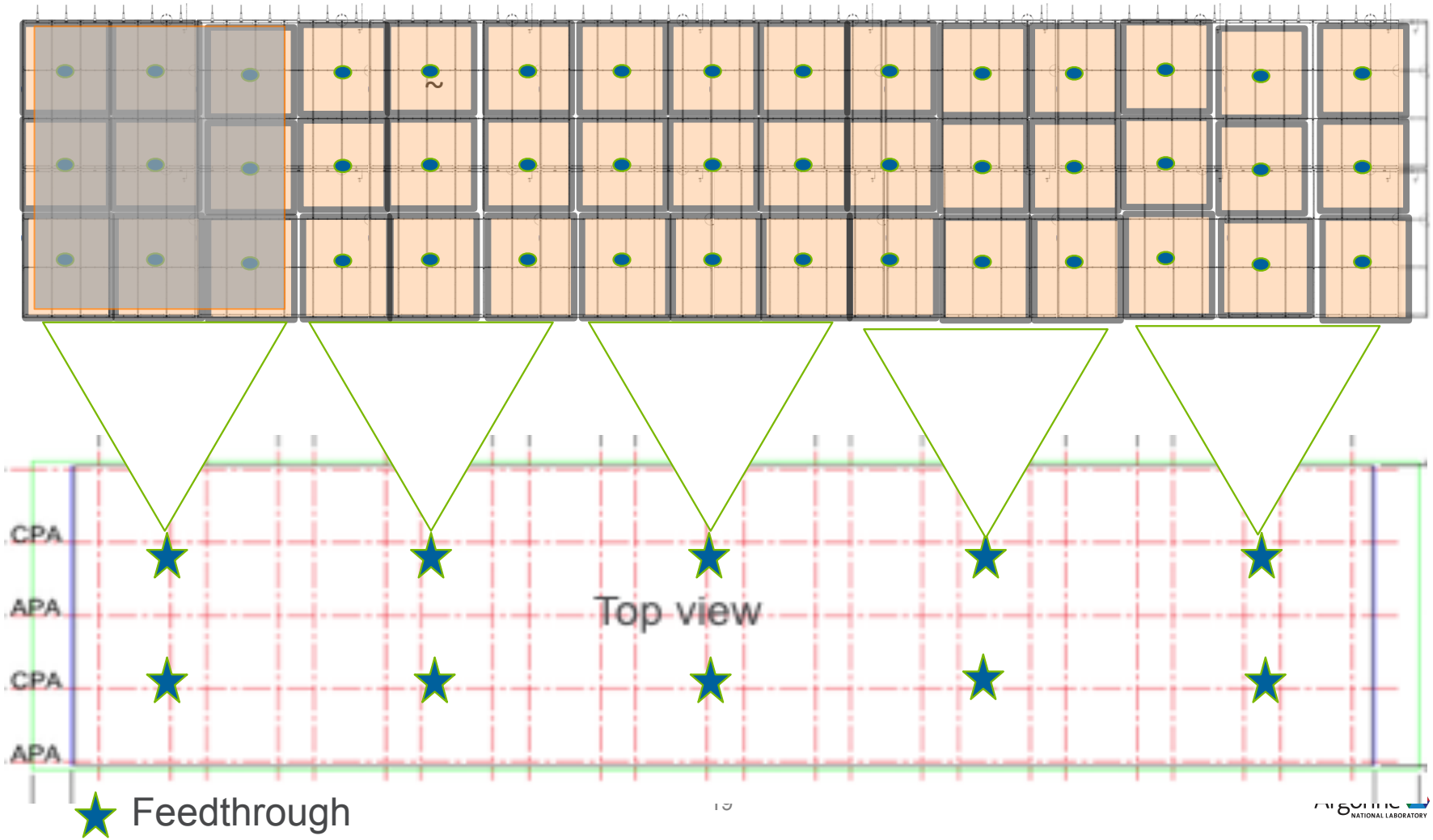
DUNE photon calibration system

- 45 fibers per CPA side
- 18 penetrations on each of 5 feedthrough on one CPA



DUNE photon calibration system

- 18 penetrations on each of 5 feedthrough on one CPA
- 9 penetrations each on 5 of second CPA.



Summary

- The photon detector calibration system has been tested in DUNE 35t, will be operated in ProtoDUNE where further optimization for implementation in DUNE is possible.

- In this talk we present one possible configuration with feedthrough locations for DUNE.