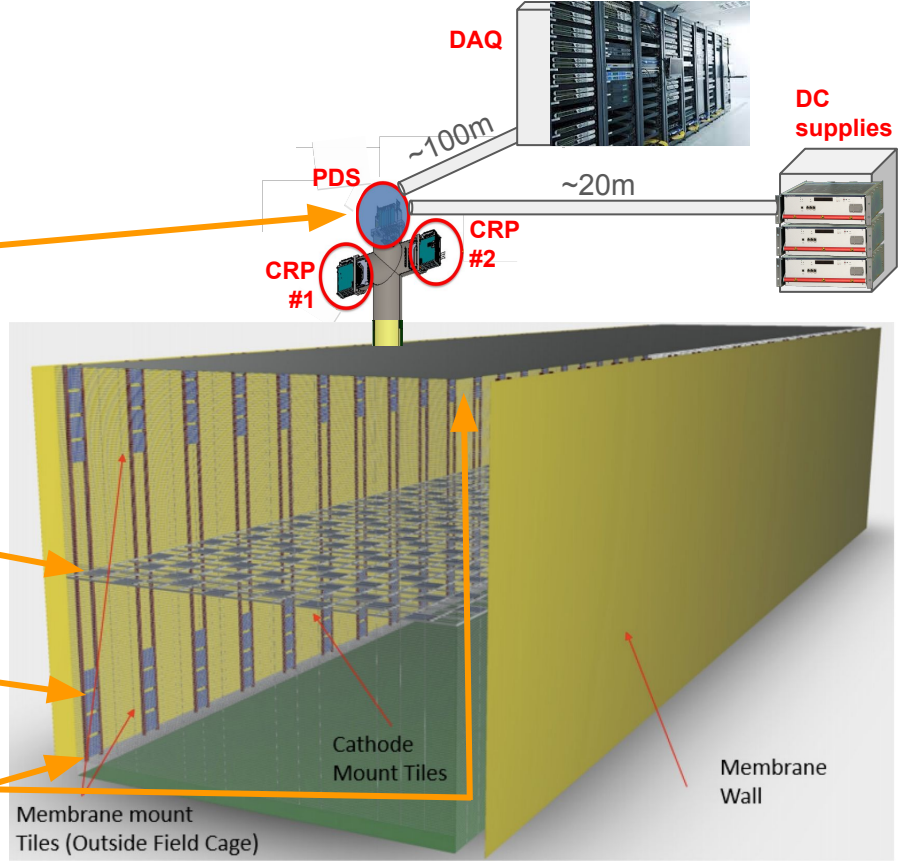
FD2 PDS
Module-0 Installation Plan

24 August 2022

Ryan Rivera -- DUNE FD2 PDS Level 2 Manager

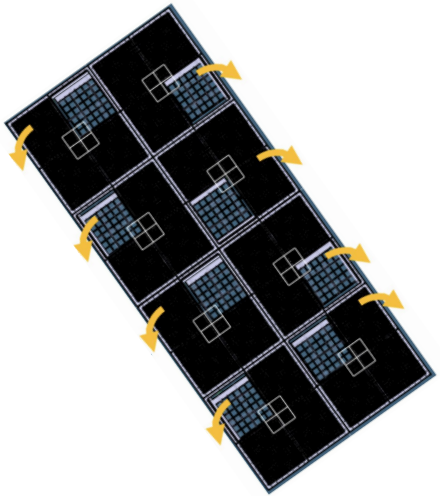
Far-site FD2 PDS Topology

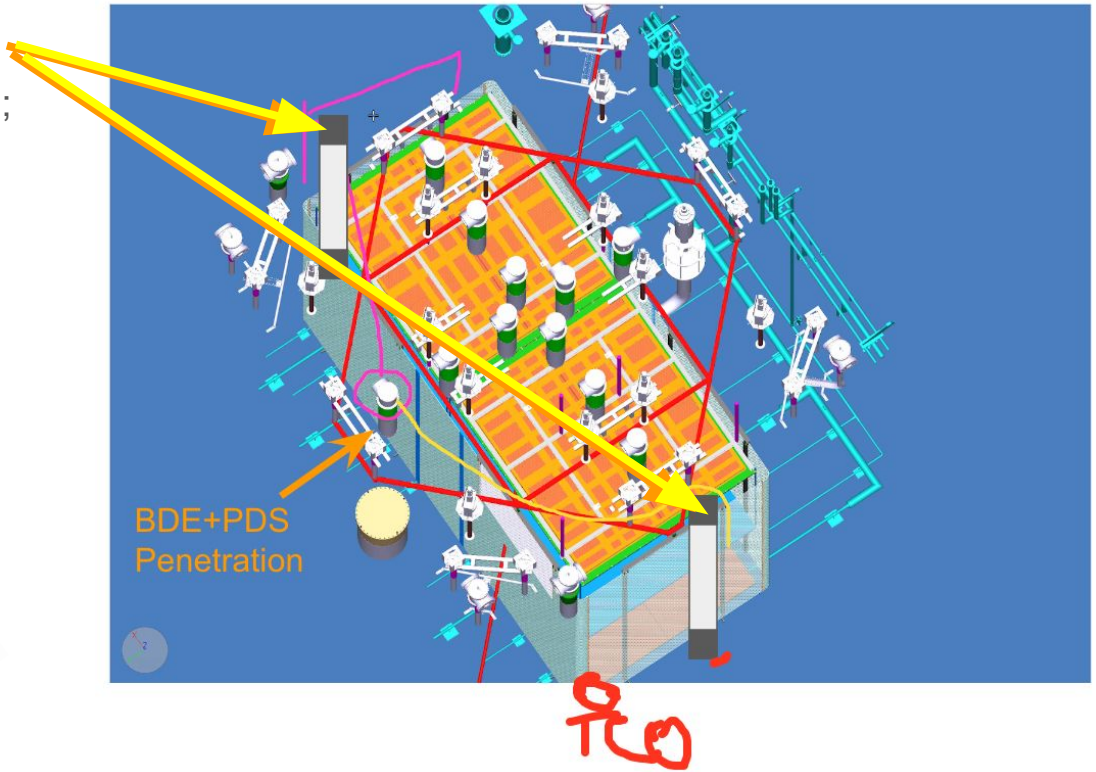
- Warm electronics
  - 1280 digitizer channels (640 opto-electrical)
  - Cathode fiber power supplies
  - DC copper power supplies
  - Calibration source modules
- 320 Cathode modules
  - Each module has 8 fibers:
    - 2 signal-over-fiber channels out
    - 6 power, calibration, control, redundancy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



ProtoDUNE2-VD FD2 PDS Topology

- 2 Membrane XA columns
  - 8 XA; 4 XA on each column; 2 XA at top and 2 XA at bottom.
- 8 Cathode XA





FD2 PDS Module-0 Installation Steps (start 1st of December)

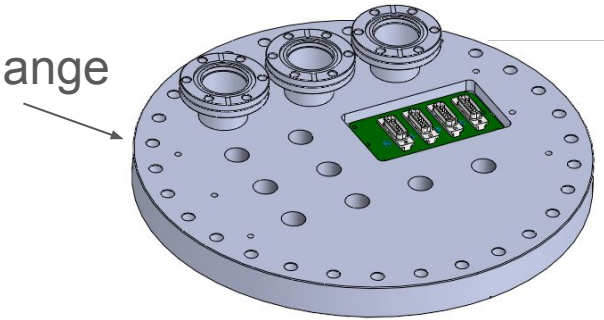
1. Initial Warm electronics
2. Flange, feedthroughs, cables, fibers (prior to detector installation)
3. Far-side Membrane X-ARAPUCA column
4. Response & Monitoring System fibers/diffusers
5. Cathode X-ARAPUCA into cathode modules
6. Splice cathode fibers **AND** pull fibers up
7. TCO-side Membrane X-ARAPUCA column
8. Optimized Warm electronics

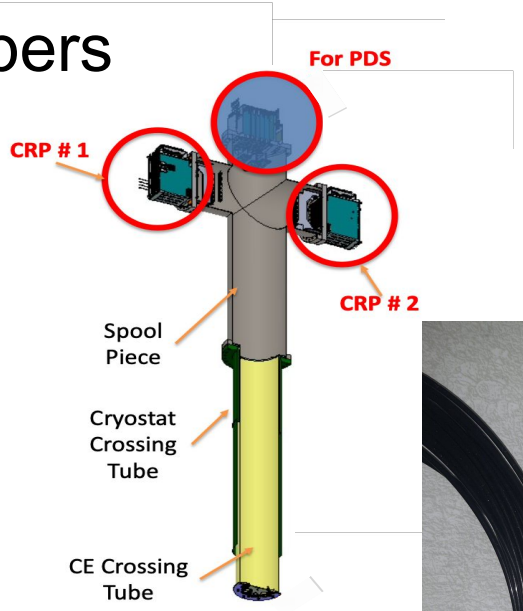
1. Initial Warm Electronics at module-0

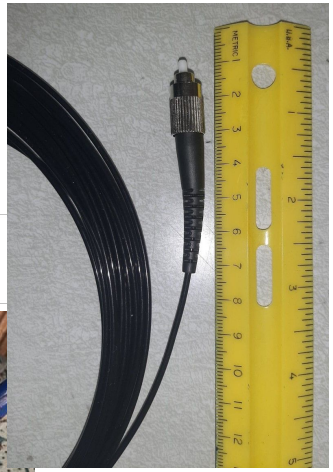
- Initial warm electronics installation is to support warm verification testing of X-ARAPUCA and Response & Monitoring installation
- Simple PoF transmitter units
- Simple digitizers/oscilloscope
- Poor DAQ integration
- Space:
  - We need 1 full-height (36U) rack near penetration

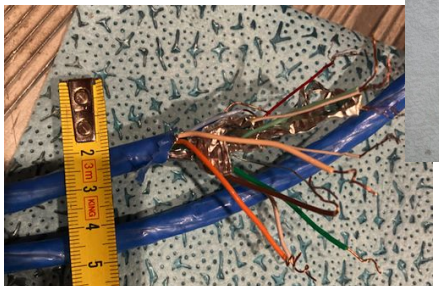
2. Flange, feedthroughs, cables, fibers

- Copper cables, ½ cathode fibers, and Response & Monitoring fibers can be dressed to cryostat (cable tray solution unknown, potentially use field-cage support structure)
- Declare other ½ cathode fiber space with septum
- Secure primary flange



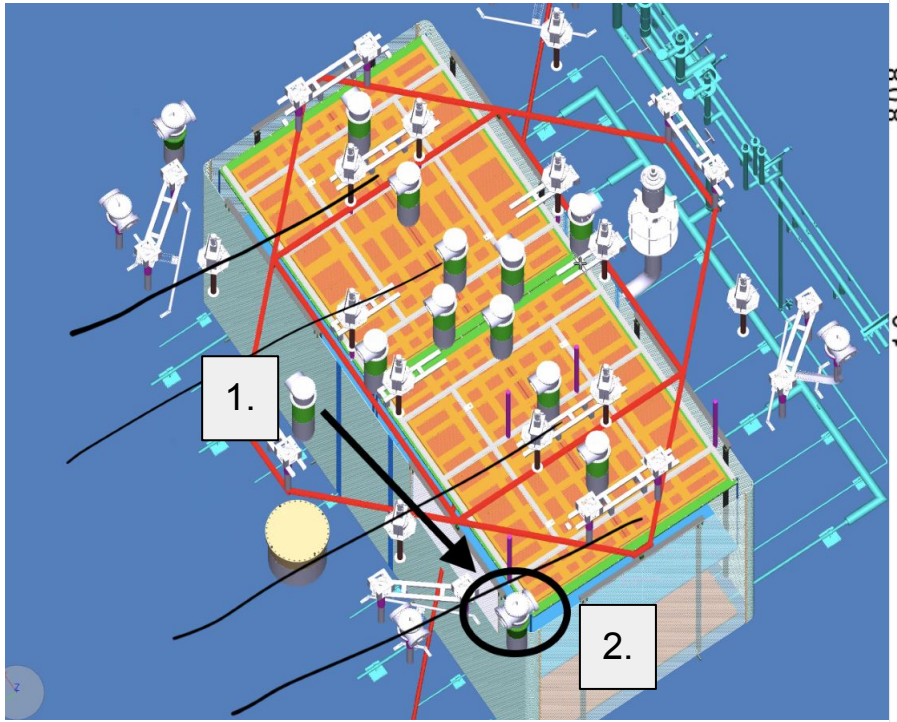


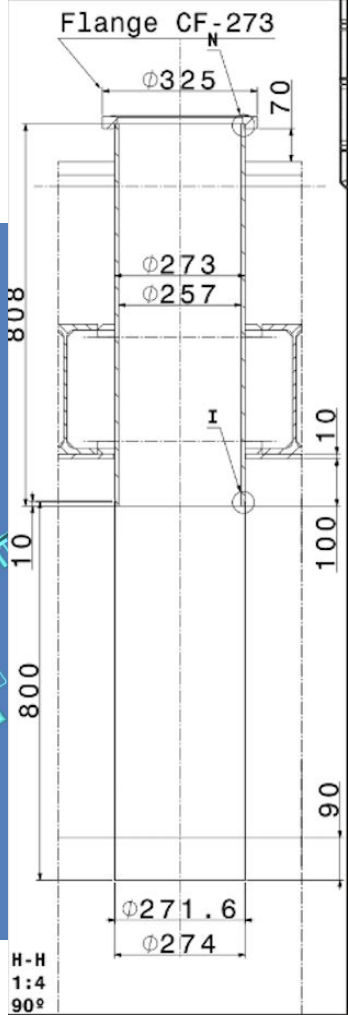




Which penetration?

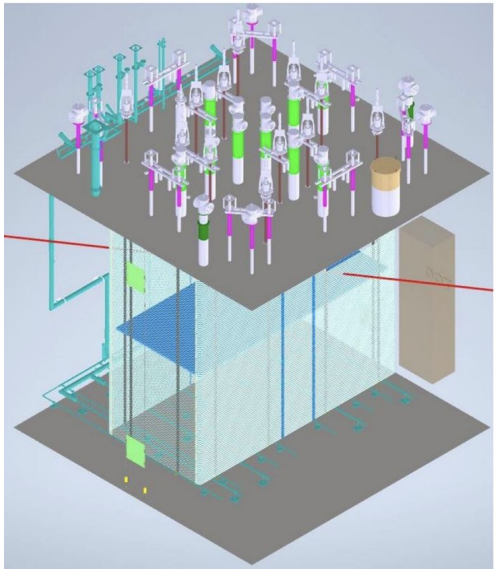
1. Initial BDE-PDS penetration
2. More similar to FD2 cable route (especially for BDE and TCO-membrane XA)?

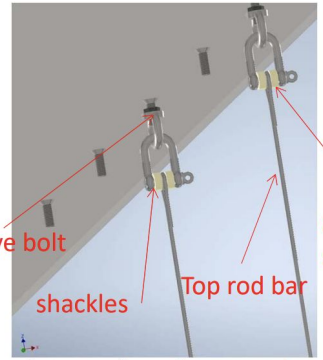




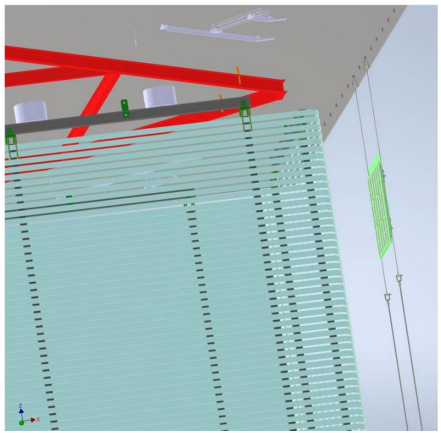
3. Far-side Membrane X-ARAPUCA column

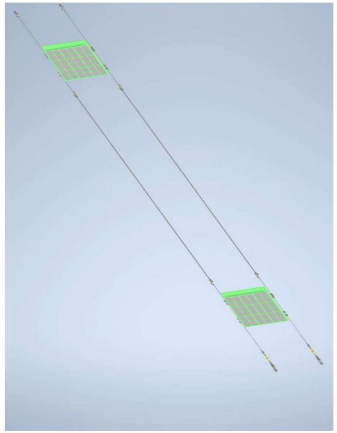
- Minimum column has 2 XA
- Ideally 4 XA in column from Spare or Cold Box prototypes (2 XA at top and 2 XA at bottom to represent FD2 one-cable-per-2XA topology)

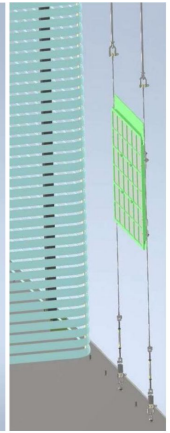




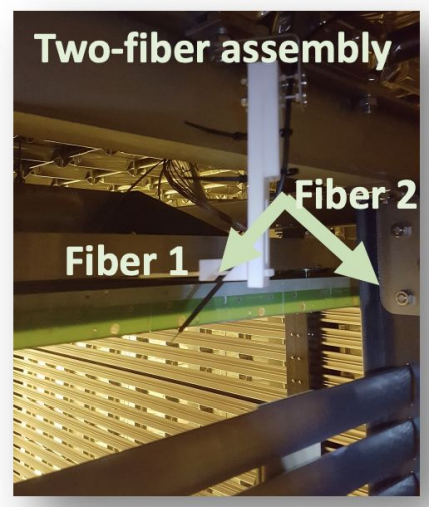
The tools to perform it are ready and tested. Several prototypes has beem produced.





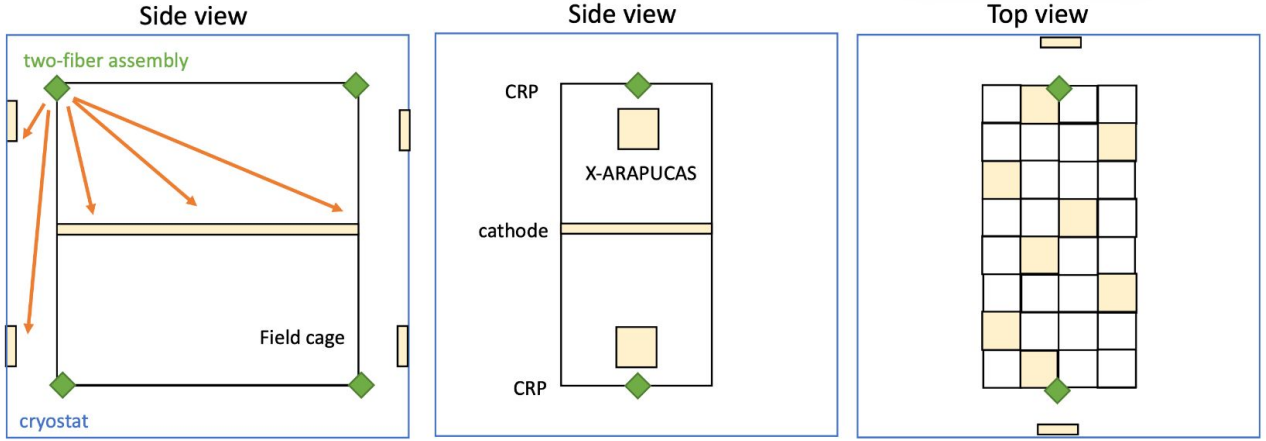


4. Response & Monitoring System fibers/diffusers



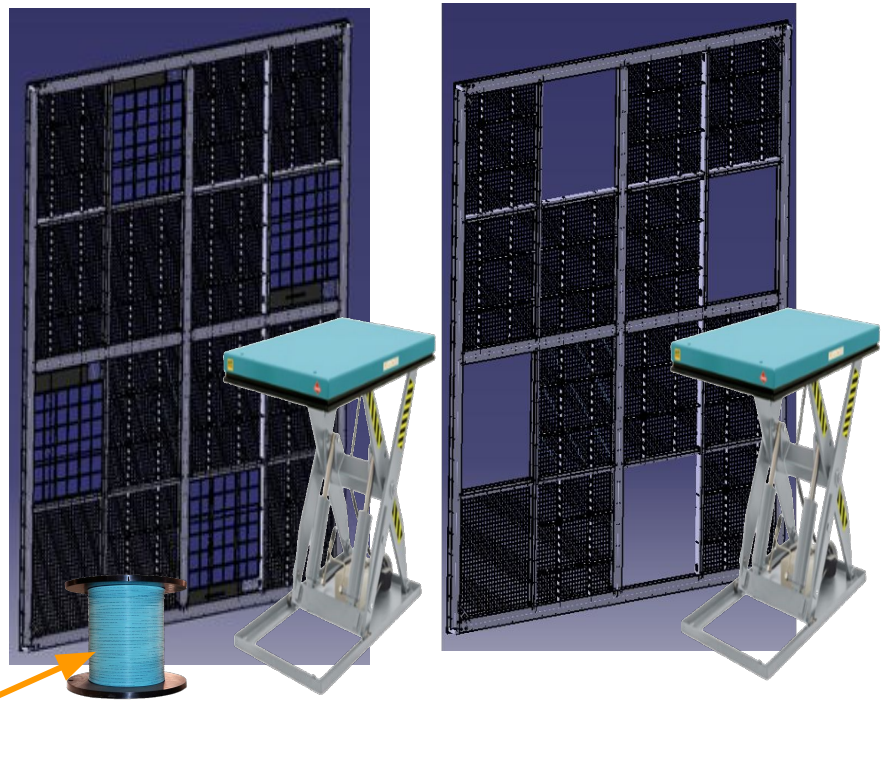
- 3 feedthroughs allow for 15 fibers; 3 flavors of fibers. Fibers mount to CRP superstructure.
- Goal is to compare approaches and characterize.

It's a redundant system, only 4 fibers should illuminate the whole system probing the extrapolation to DUNE FD2-VD.



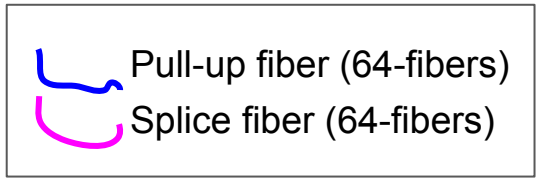
5. Cathode X-ARAPUCA into cathode modules

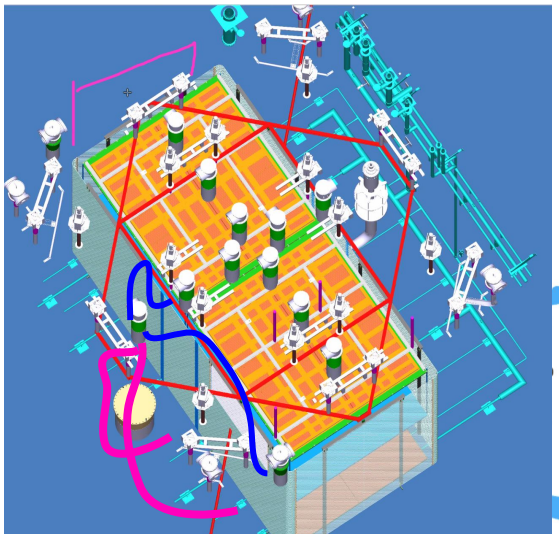
- Assemble modules into cathode wall in staging area
  - 8 XA into two cathode modules (4 each)
- 32 x 20m fibers will be hanging off cathode module
- Warm class-4 laser test in staging area!

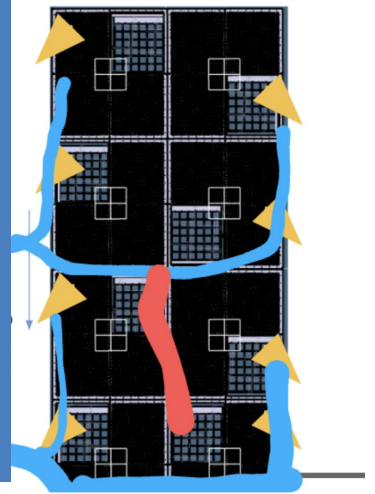


6. Splice cathode fibers AND pull fibers up

- Install double fiber plant to experience splice **AND** pull
- Splice spare fibers first
- If confident
  - Splice primary fibers
  - Pull-up cut off fiber ends for experience
- If not confident
  - Do not splice primary fibers
  - Pull-up primary fiber ends
- Final warm class-4 laser test in cryostat after fiber installation complete!







7. TCO-side Membrane X-ARAPUCA column

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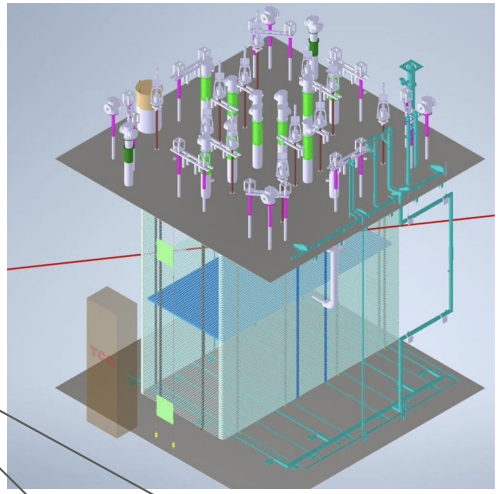

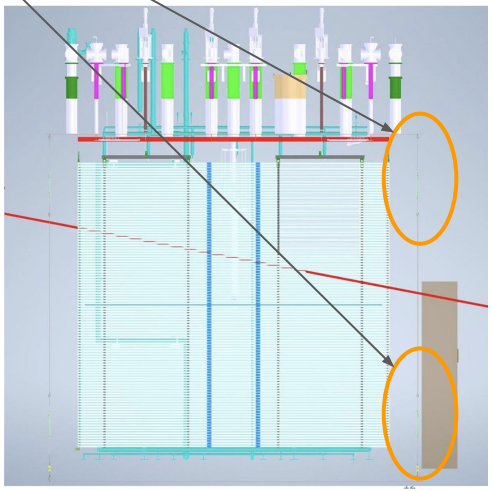

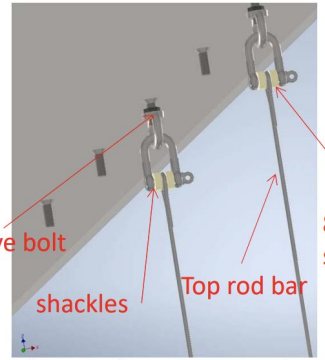

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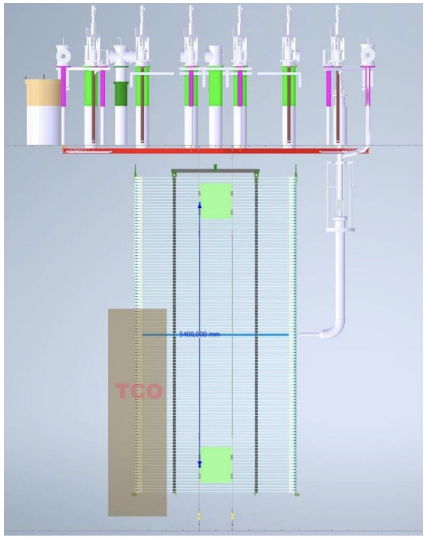
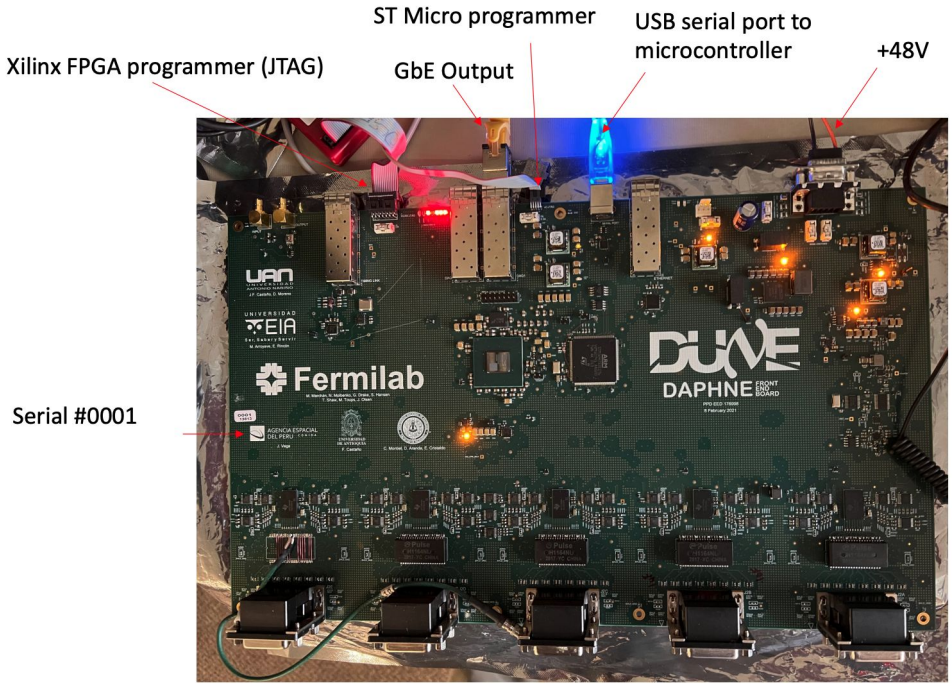
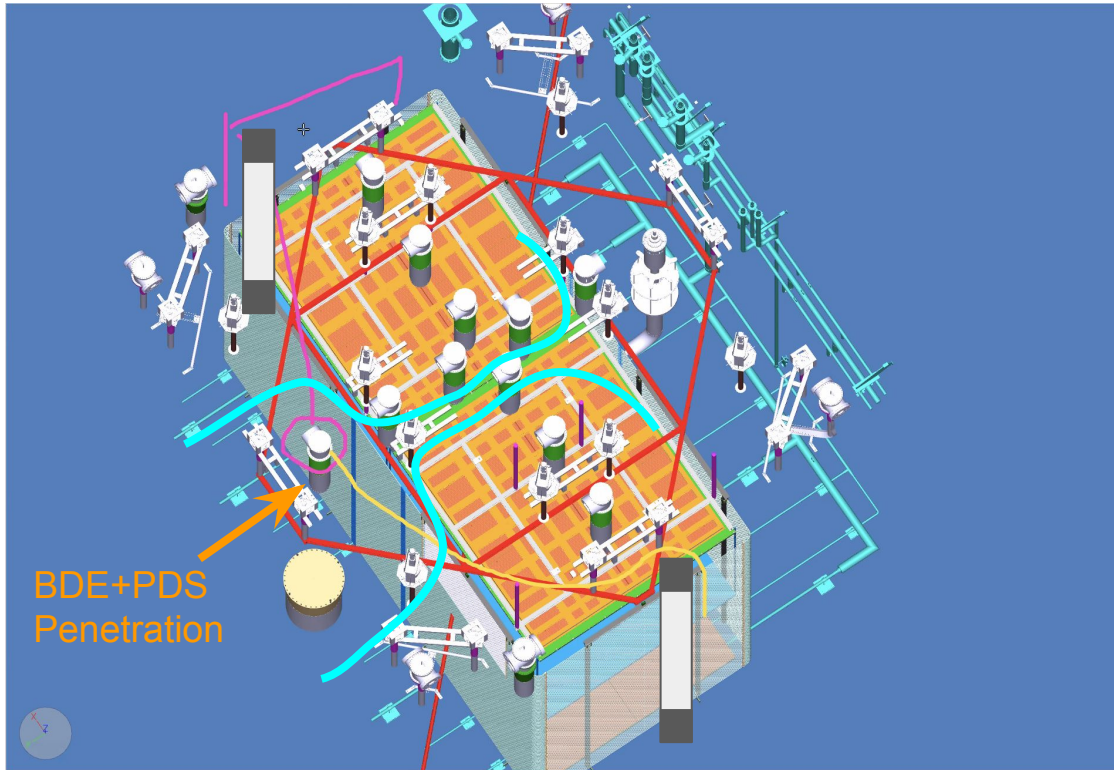


8. Optimized Warm Electronics at module-0

- Optimized warm electronics installation allows for full DAQ integration
- Advanced PoF transmitter units
- DAPHNE digitizer



Module-0 FD2 PDS Installation Overview

- **Cable trays** installed **November** 2022
- 4 **Membrane-mount XA** installed **December** 2022
  - One column on short-wall is being pushed from a mechanical perspective
    - This could have a significant interference with the instrumentation cabling or CALCI.
  - PD consortium would like to plan for two columns, one on each short-wall
- 8 **Cathode-mount XA** installed **January** 2023
- **Response & Monitoring** installed **December** 2022 and **January** 2023
  - Attached to top CRP
  - Direct to XA
- 4 **Membrane-mount XA** installed **February** 2023
  - The 2nd column on TCO side