

# DUNE FD2-VD & ProtoDUNE-VD: *Membrane PD Modules.* *Ciemat proposal update*

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on behalf of the Ciemat Neutrino group.

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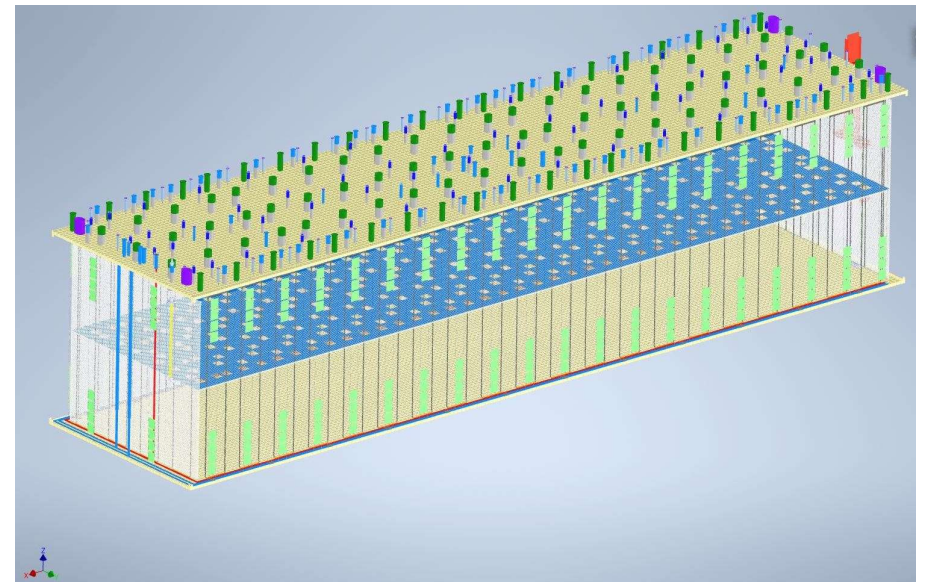
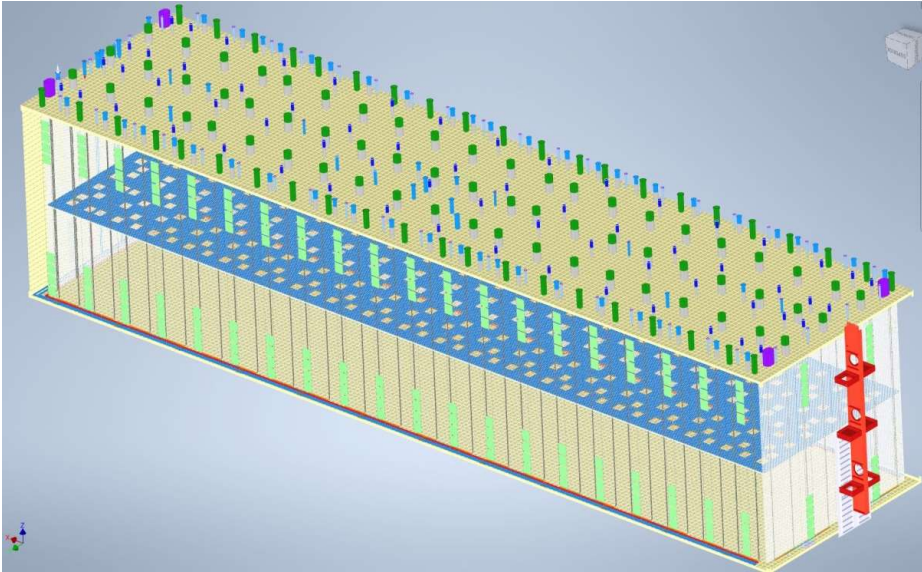
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# 1.- DUNE-FD2-VD: *Photon Detector Modules*

## A option:

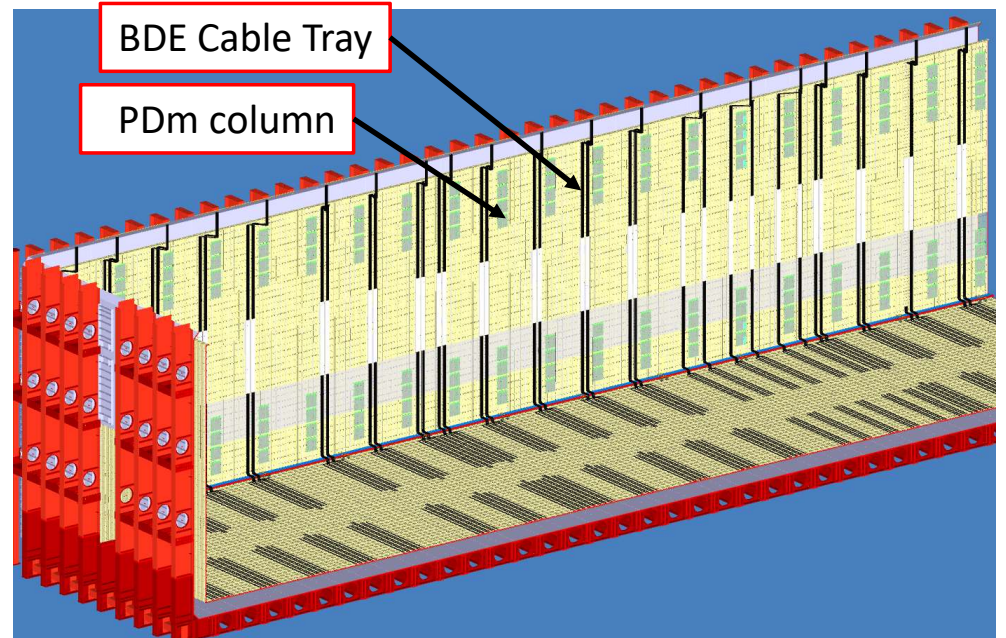
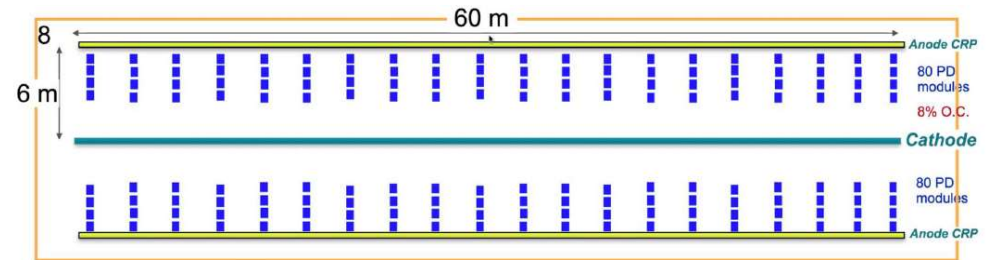
20 column of 8 PD modules by long walls + 2 columns of 8 PD modules by short walls:  
**352 PD** modules on the vertical membranes.



From Nicholas Joniak/James Stewart

## Design Requirements

- The wall photon detector (PD) system consists of 320 (*A option*) single-sided modules mounted on the membrane walls behind the field cages.
- The modules will need to be placed evenly across the cryostat long walls to maximize light detection.
  - Membrane walls and roof feedthroughs to be shared with Bottom Drift Electronics (BDE) cable trays.
  - The modules will need to be placed close to the anode planes where the field cage has approximately 70% transparency.

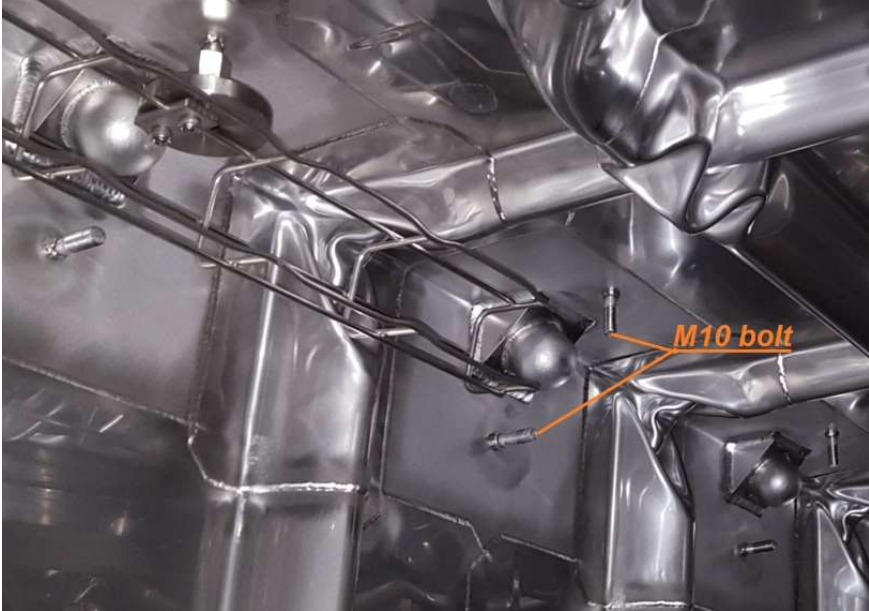
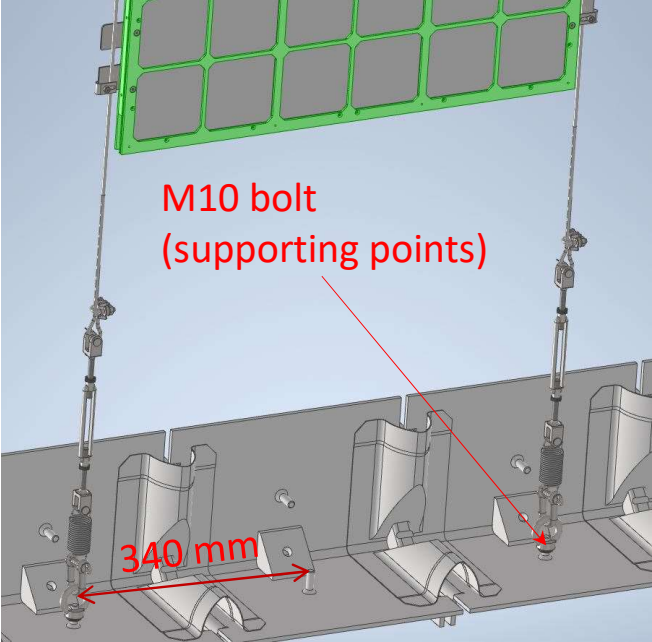


Fixation system of the PD modules on the membrane:

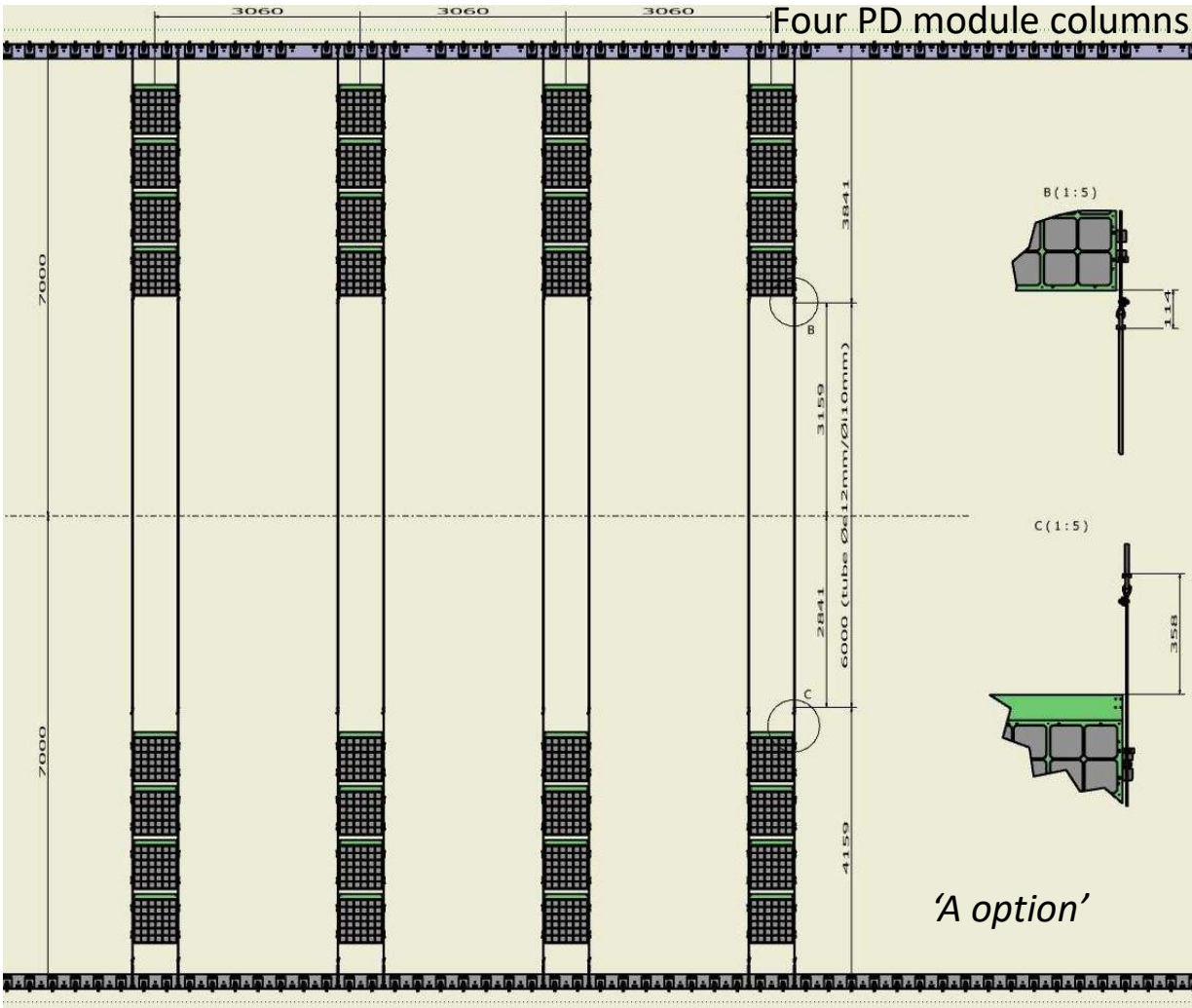
Modular system fixed on the top and bottom of the cryostat, on the *M10 bolt of the corners*.

Main parameters considered:

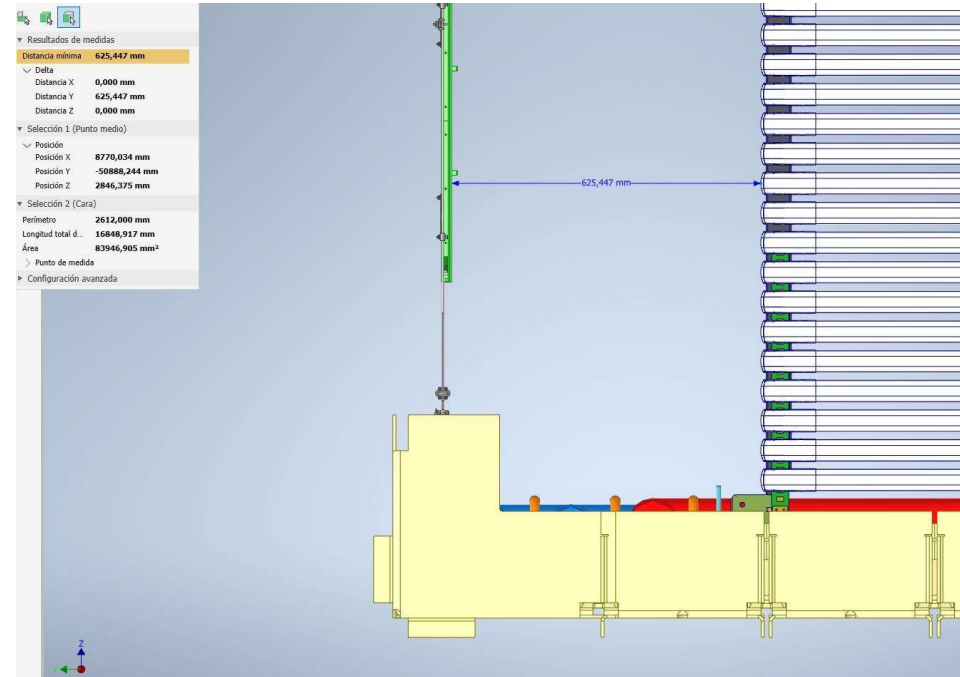
- Standard and Ciemat custom made pieces and rod bars/tubes are Stainless steel (AISI 304 or AISI 304L or AISI 316 ) and G10-FR4. All materials are cryogenic/vacuum compatible.
- Install two vertical suspension lines: two rod bars of 5 mm diameter (to support each PD module column) & 12/10 mm diam. tube on the central region (To avoid induce a big field gradient in the region close the cathode).
- Minimum step between bolts is 340 mm
- Pre-tensioned suspension lines (15-20 kg)
- PD modules can be installed at the desired positions along the rod bars, placing *Wire Rope Grip*.
- Both top and bottom corners are free.
- Estimated weight of the each PD module column (8 PDm), electronics, cables, its fixation elements, and rod bars/tube lines: ~110 kg.



## Long walls

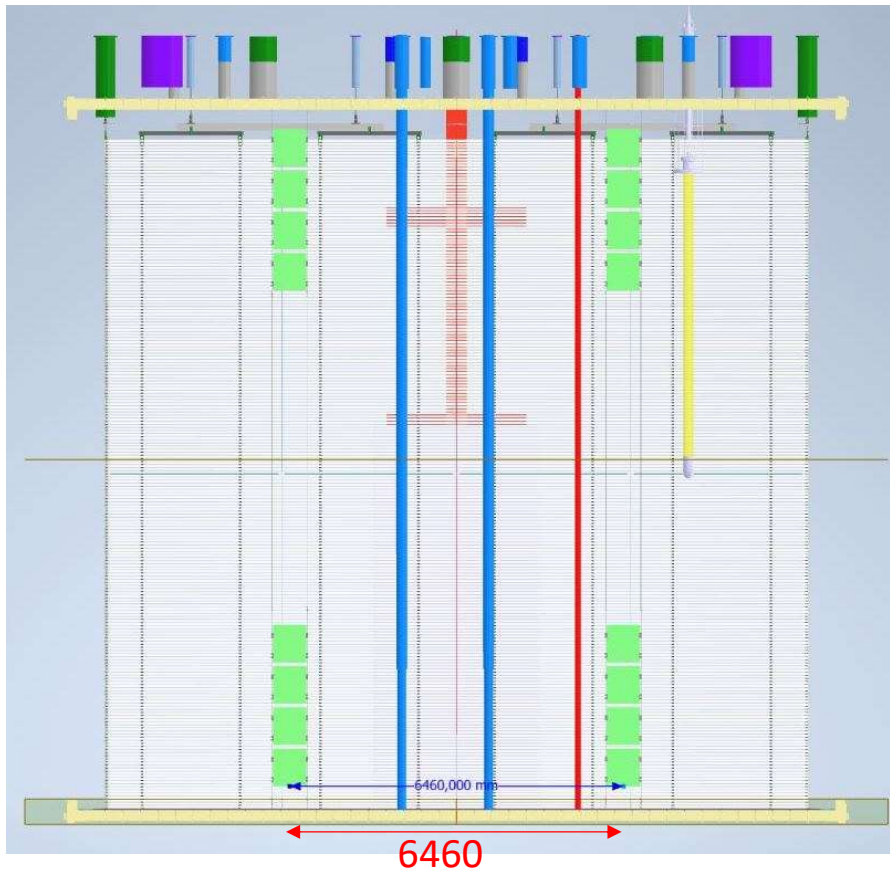


Distance between PDm to FC: ~625 mm

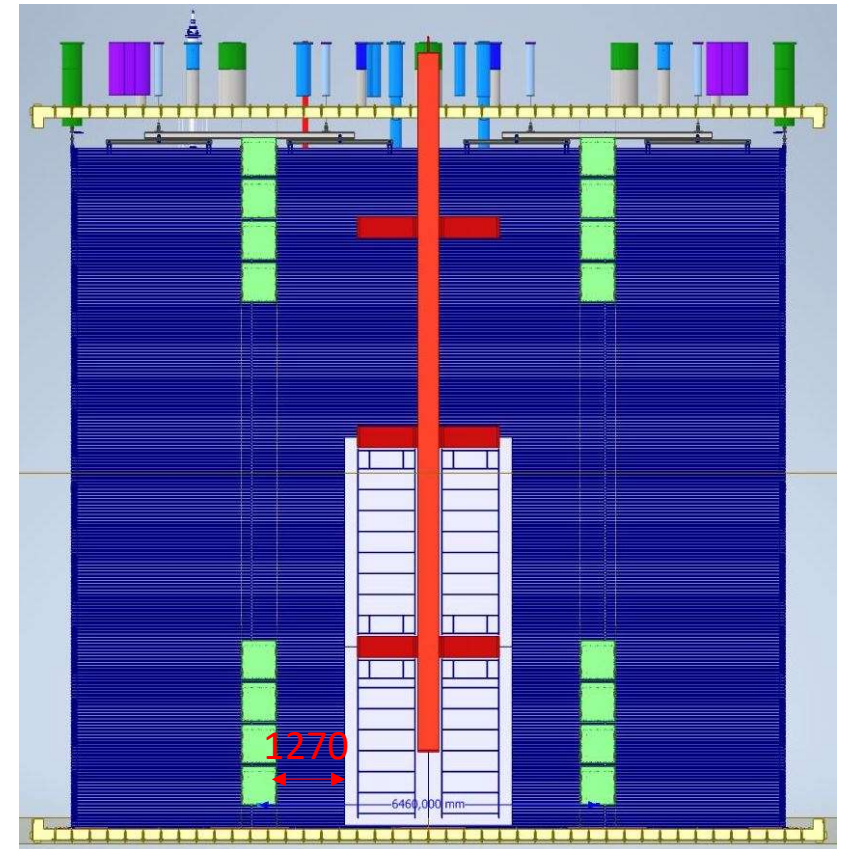


## Short walls

Under study other Distance between columns of PDM:  $\sim 4.42$  m, the tolerance between PDM to TCO will be about 380 mm only instead of 1270 mm



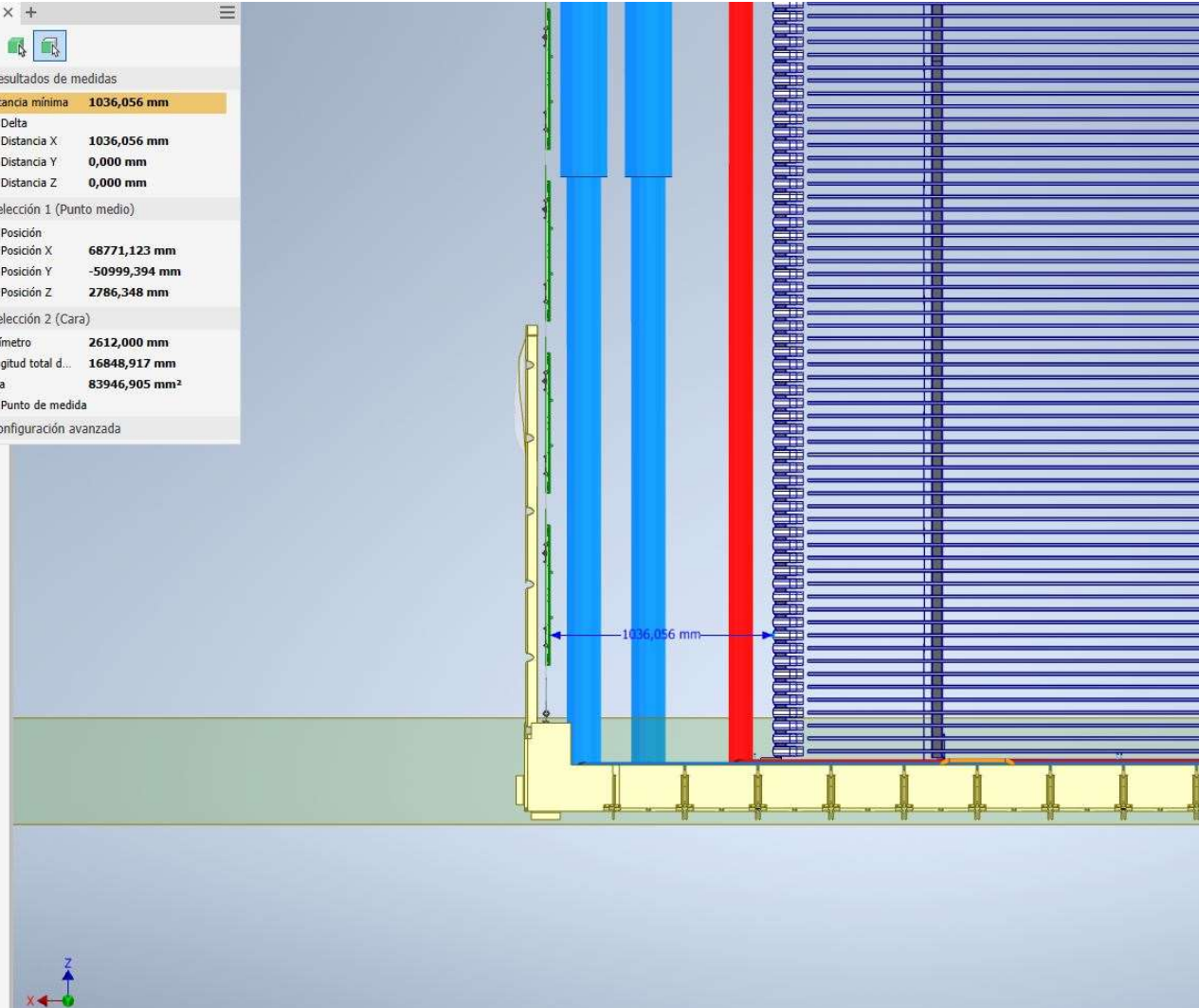
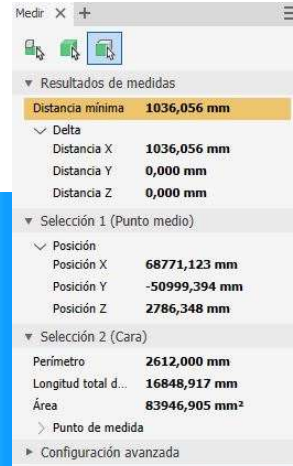
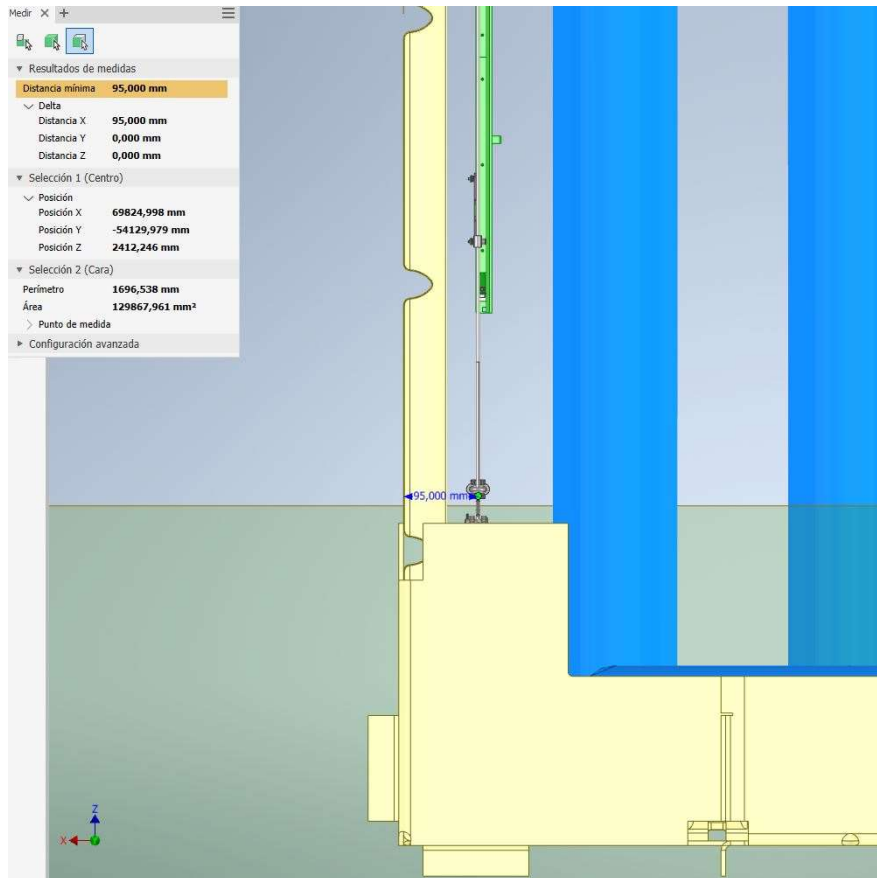
**East side**



**West side**

## Short walls

Distance between PDM to FC: ~1036 mm





# 1.2- Cables routing

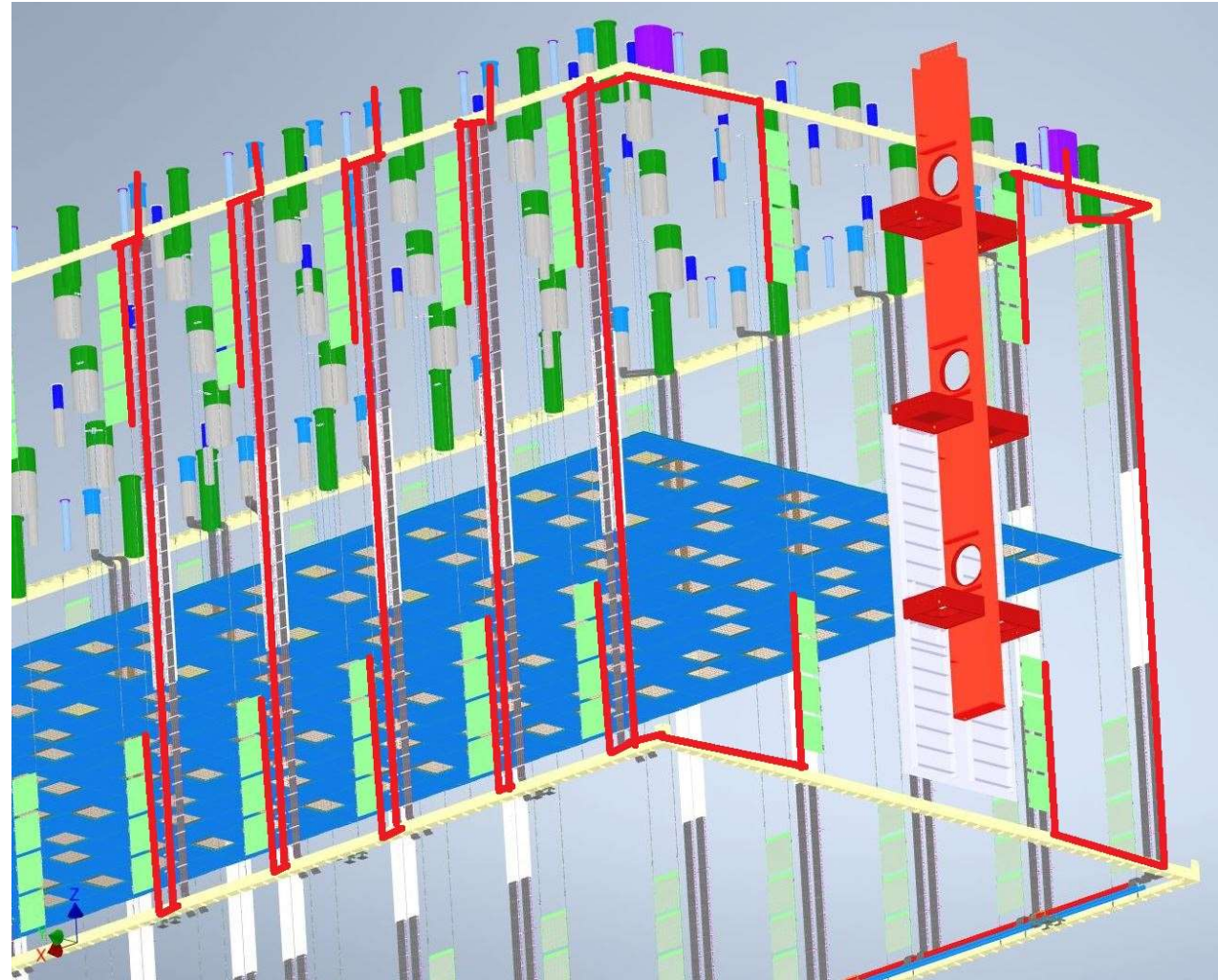
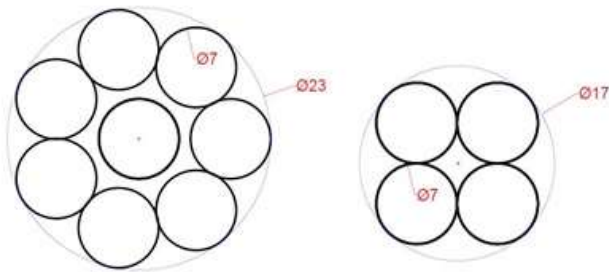
Signal cables of the top PD module: routed along the Stainless steel rod bar lines toward the top side of the membrane toward the top BDE cables tray.

Bottom PD modules cables: routed along the rod bar toward the bottom side of the membrane and then exit on the BDE cables tray.

Installation sequence of the cables to be defined depending on the location of the cables excess, using cables ties to fix them to the rod bars or cables trays.

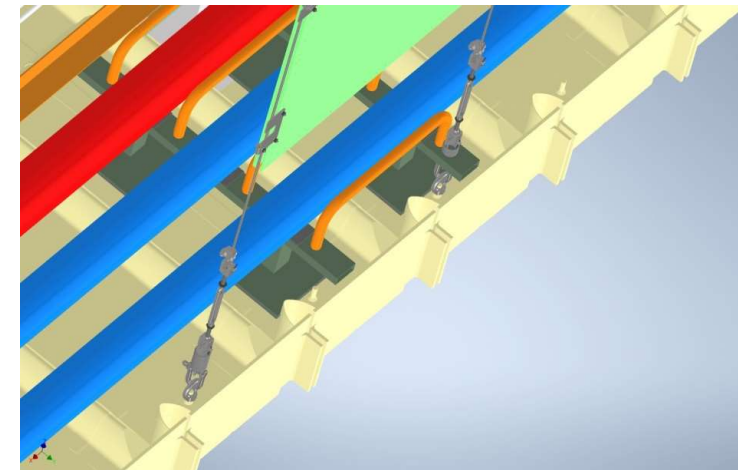
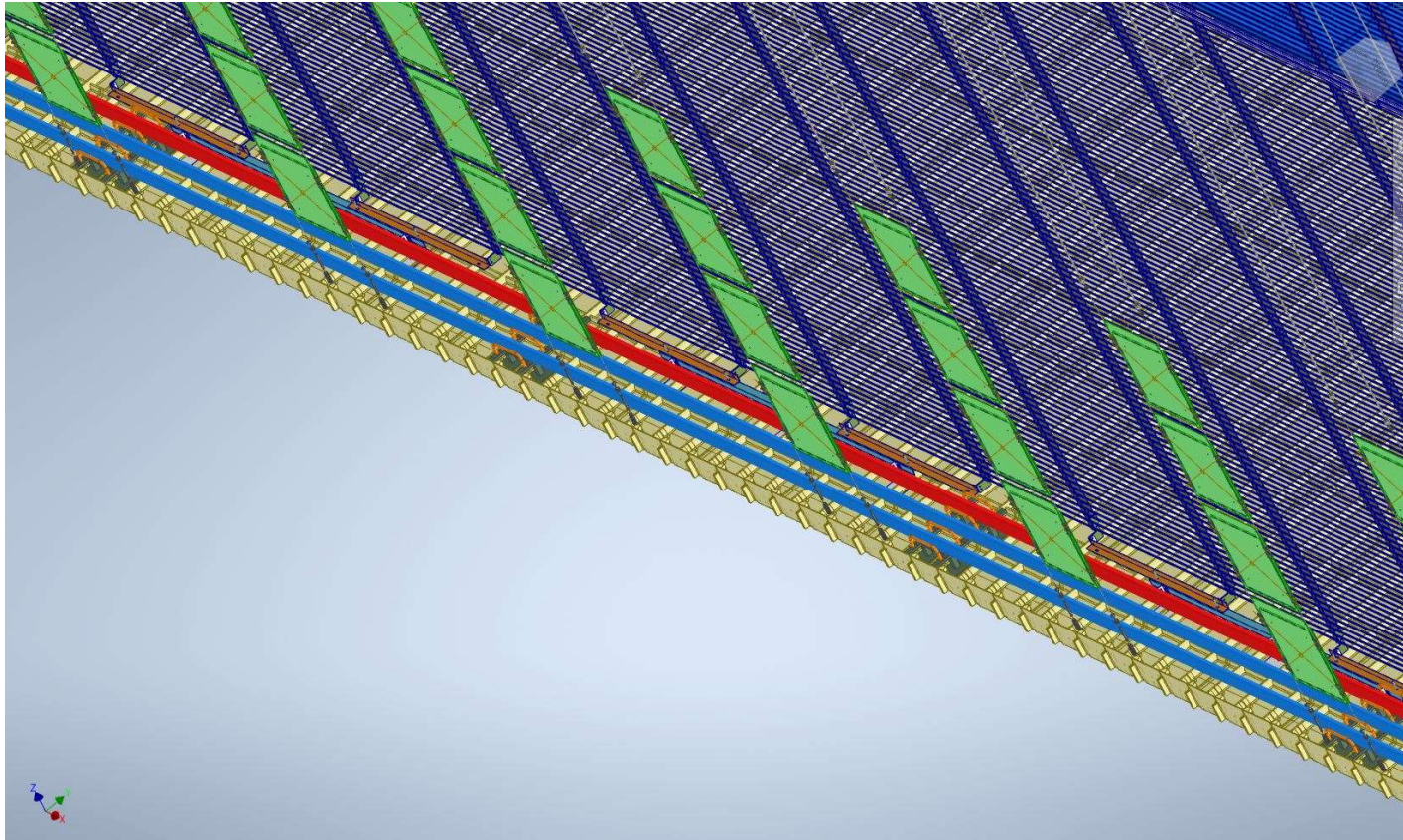
Cable bundles:

1 bundle of 8 cables (if two cables/PDm) or 1 bundle of 4 cables each (if one cables/PDm) :



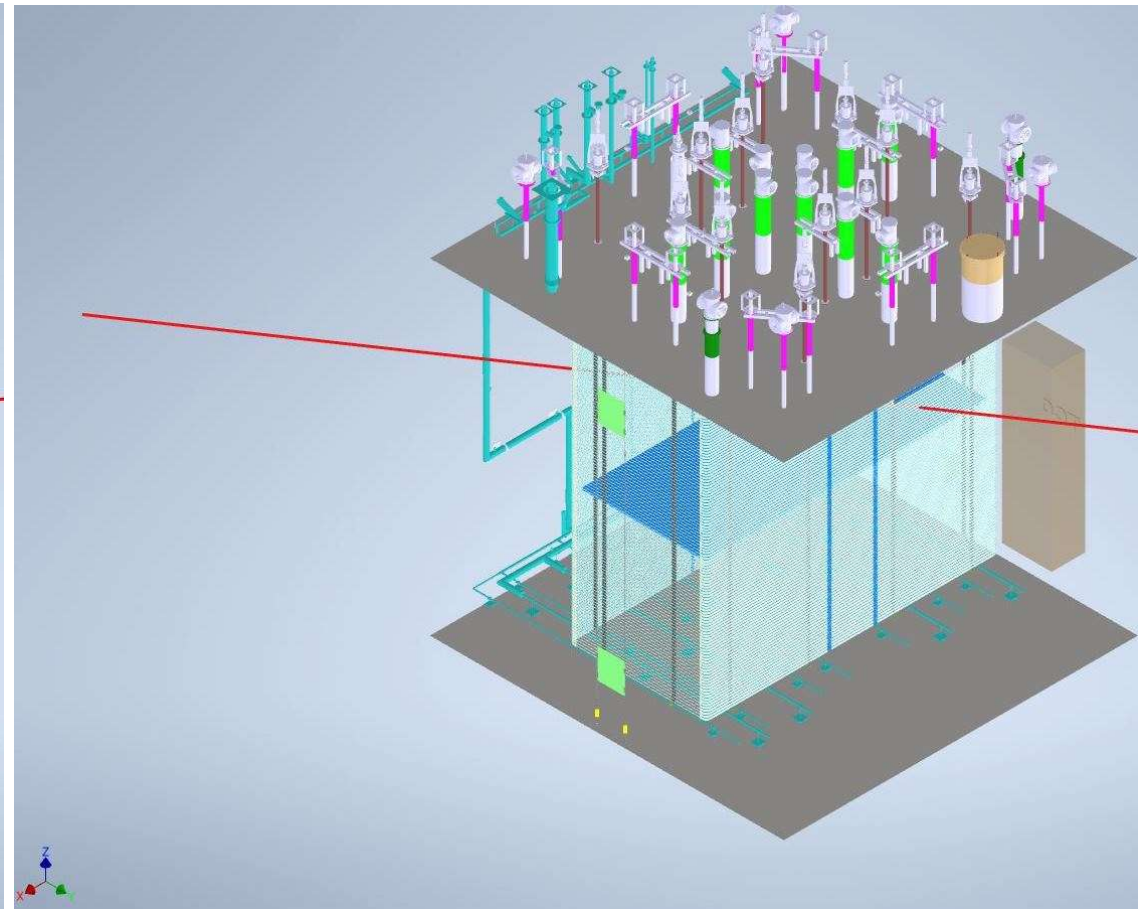
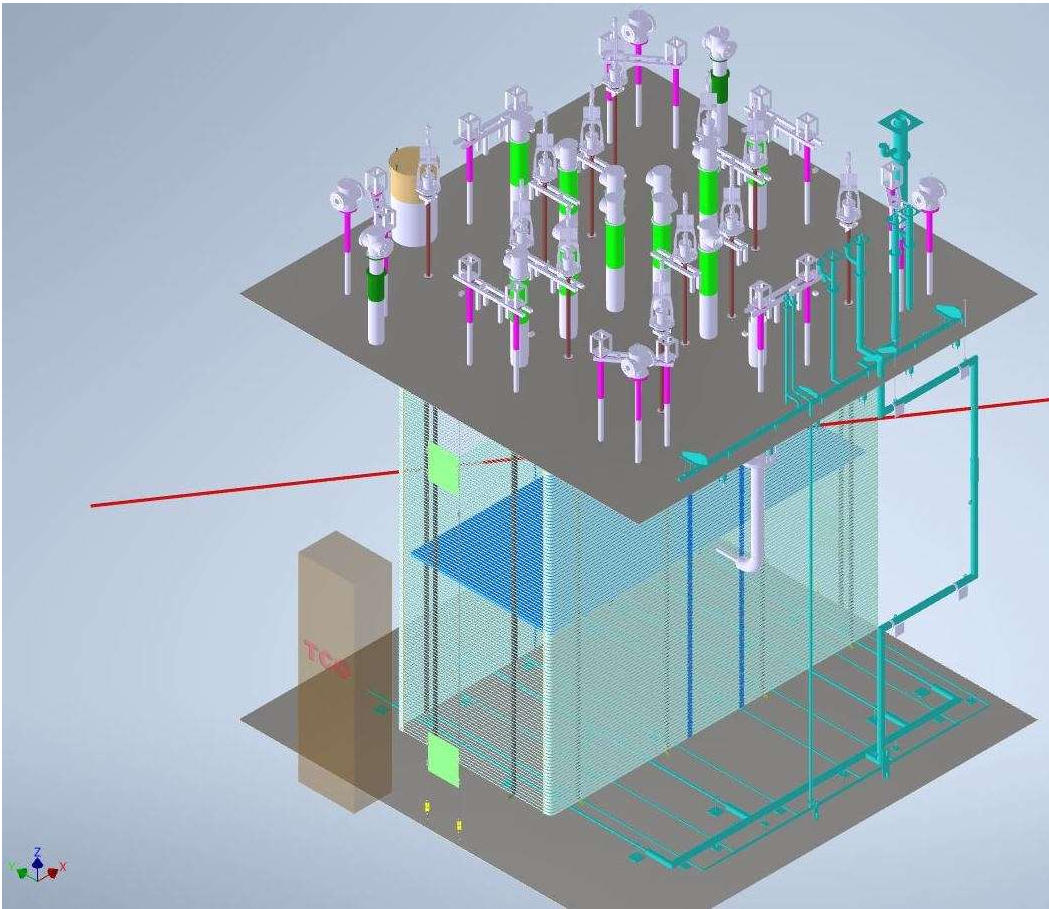
# 1.2- Interferences

On the long walls 4 columns of 8 PD modules, by wall, interfere with the floor cryo tubes support element slightly. Could be moved along X one-two membrane step?



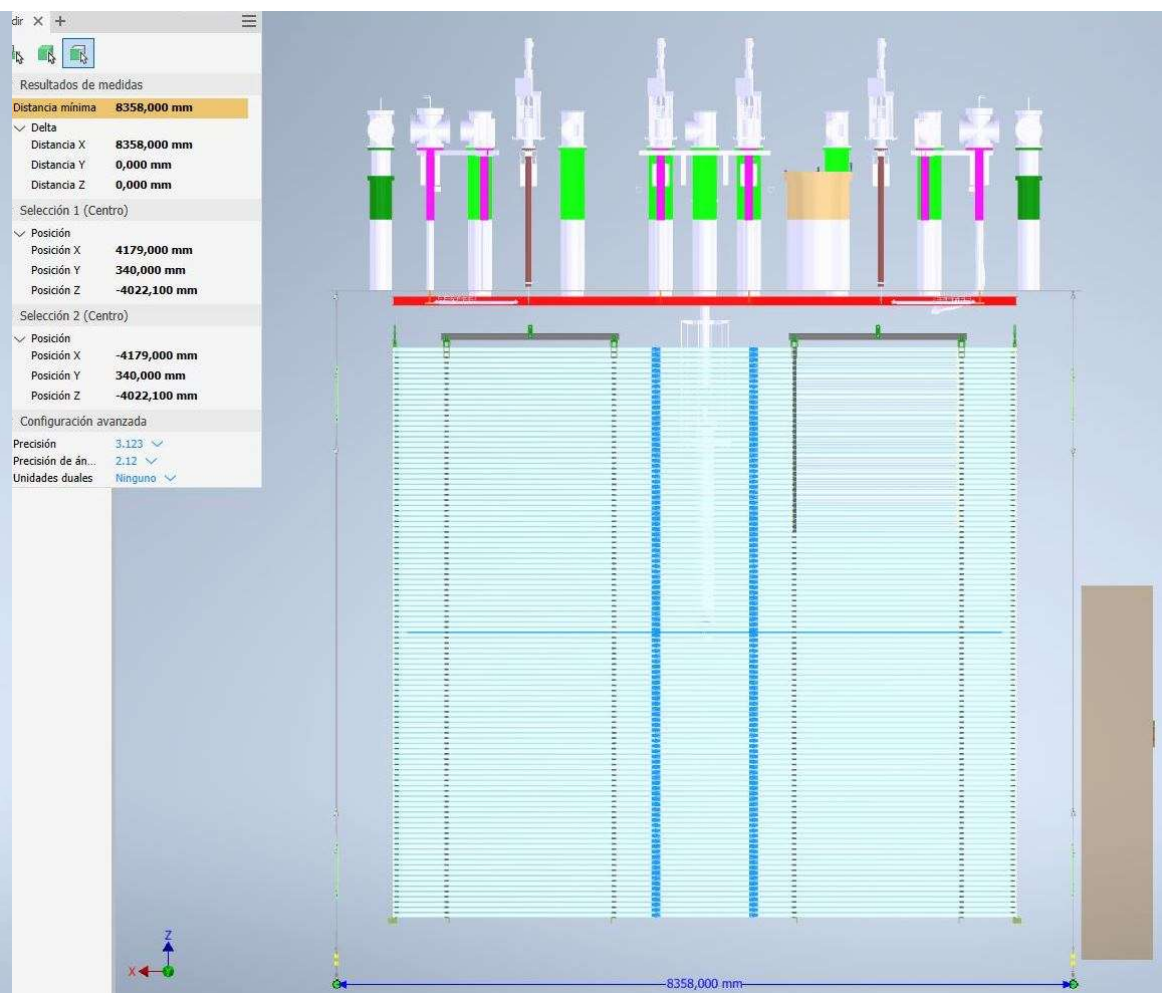
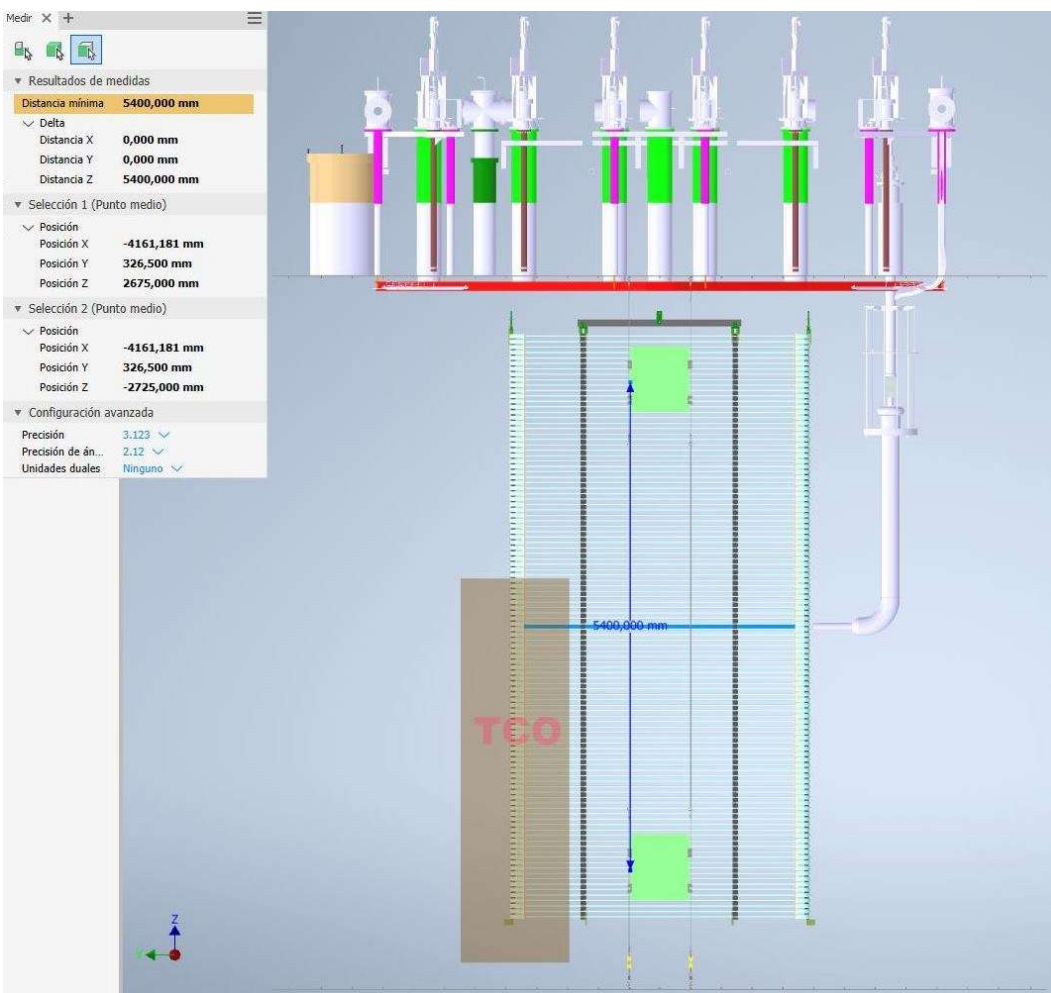
## 2.- ProtoDUNE-VD: *Photon Detector Modules*

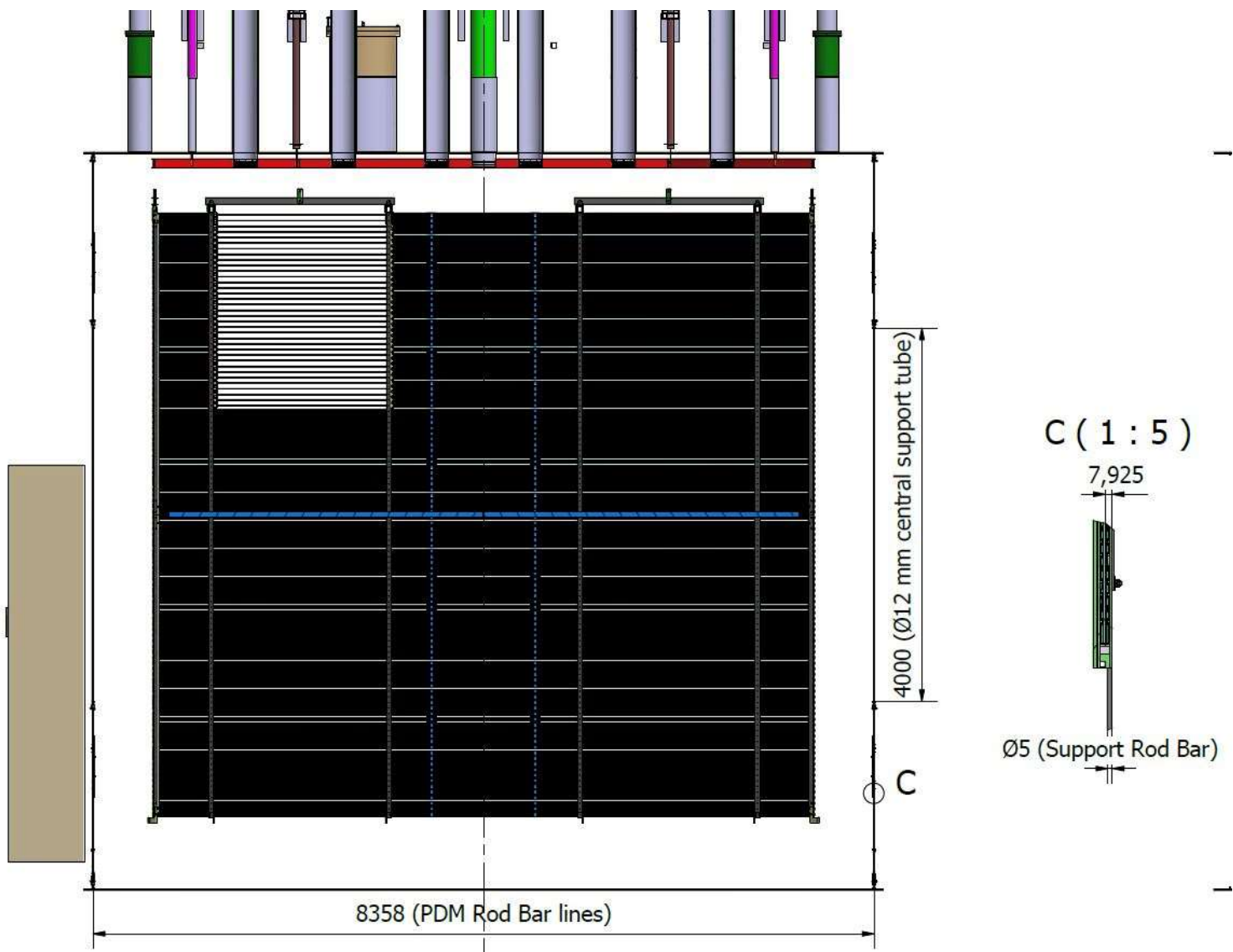
1 column of 2 PD modules by short FC side:  
4 PD modules on the vertical membranes (or 8 PDm).



Distance between PDm: 5700 mm, vertically

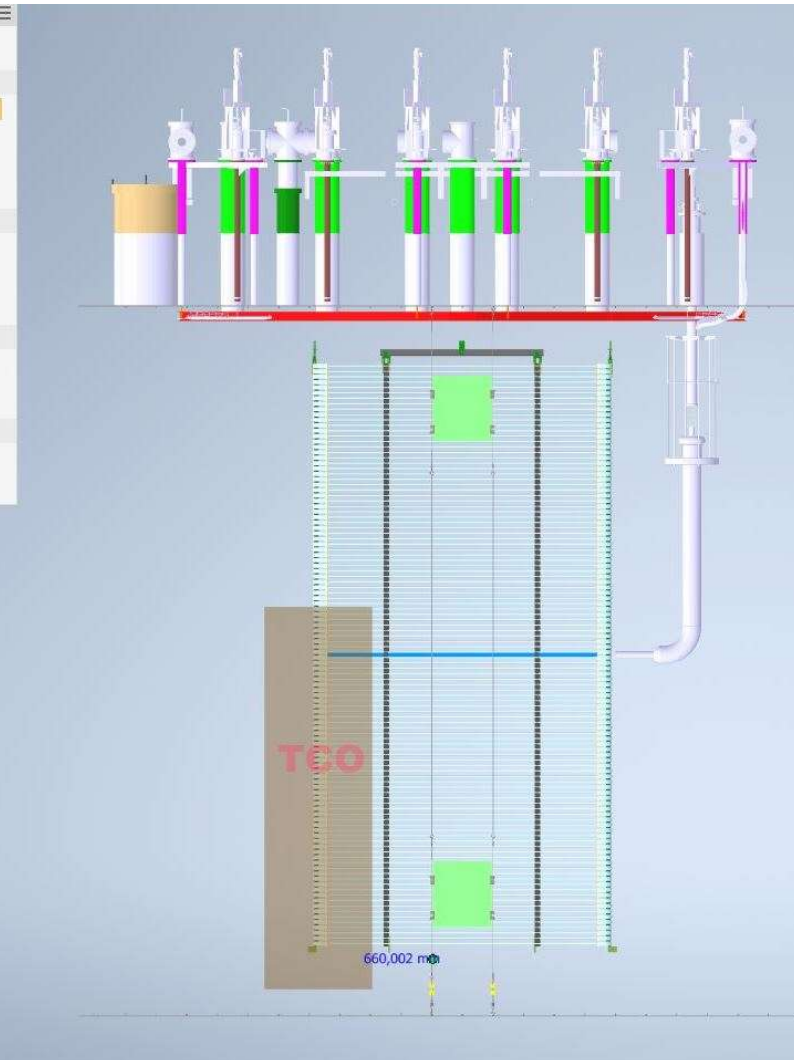
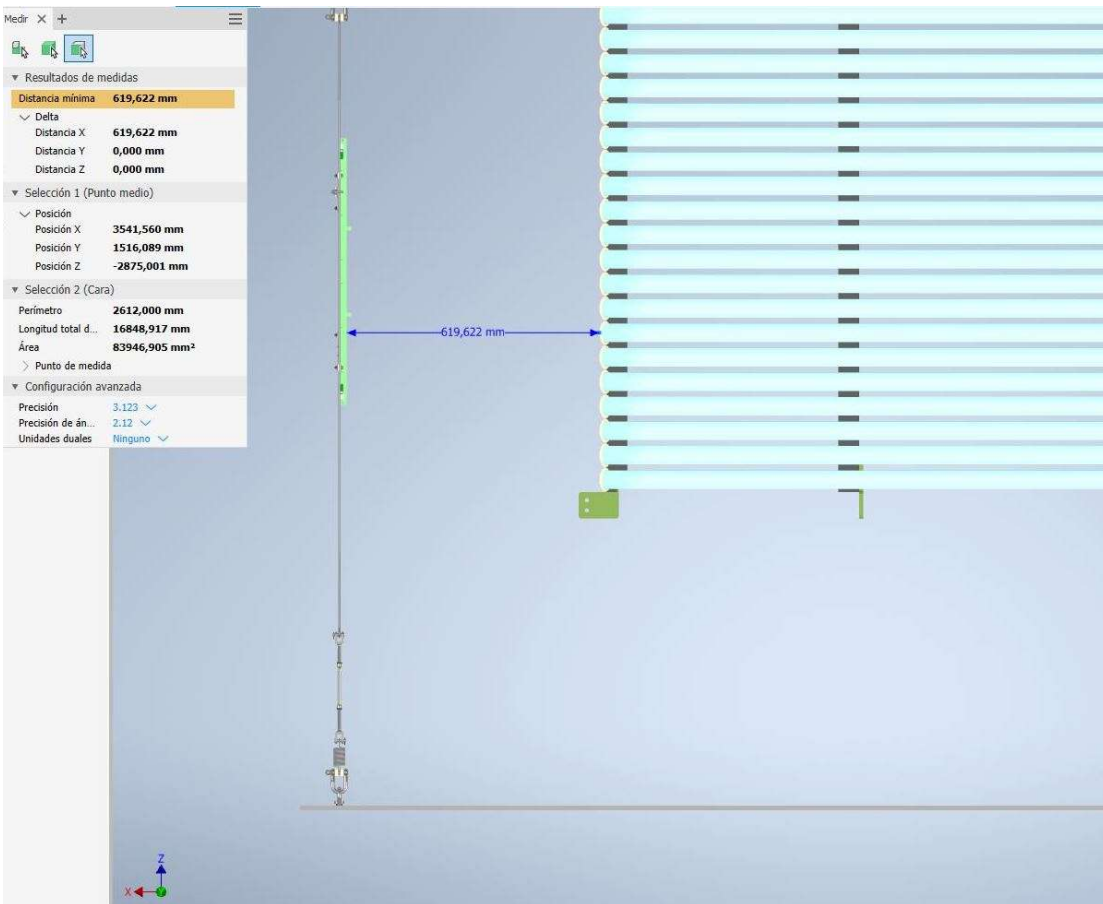
Distance between PDm suspension lines : 8358mm

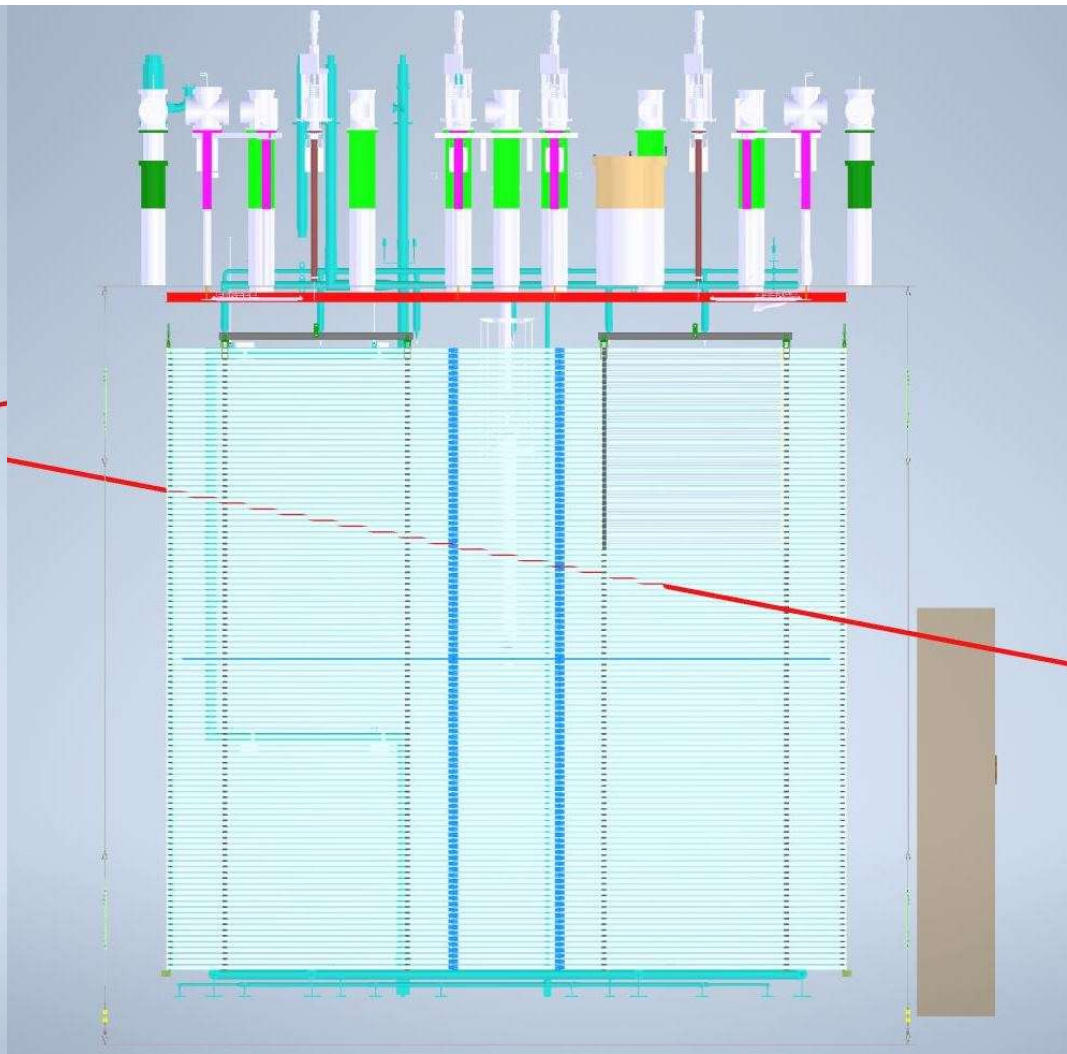
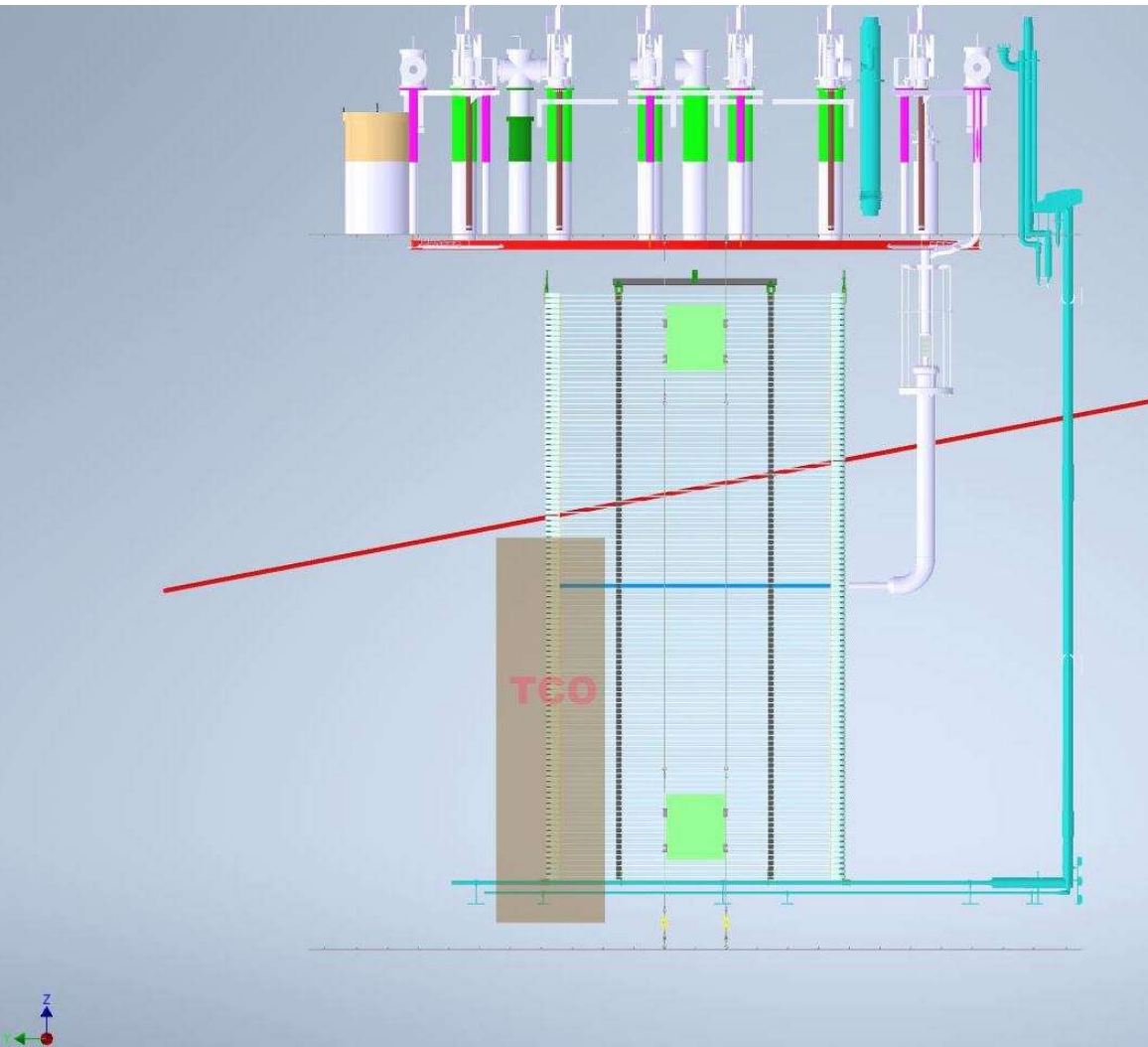




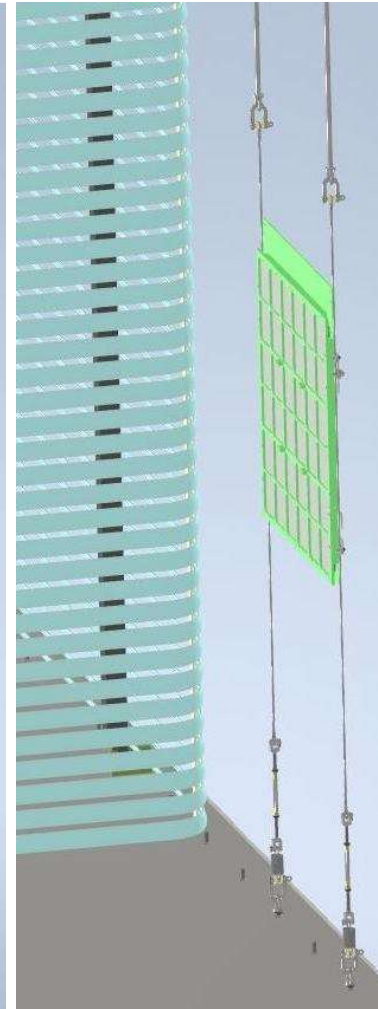
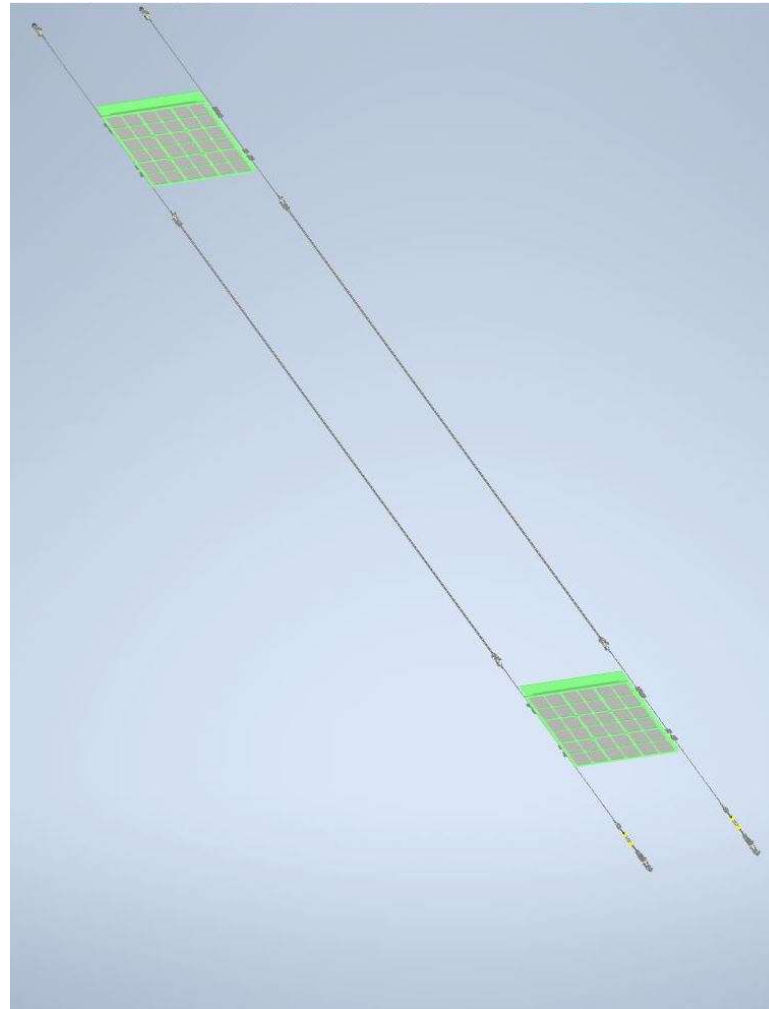
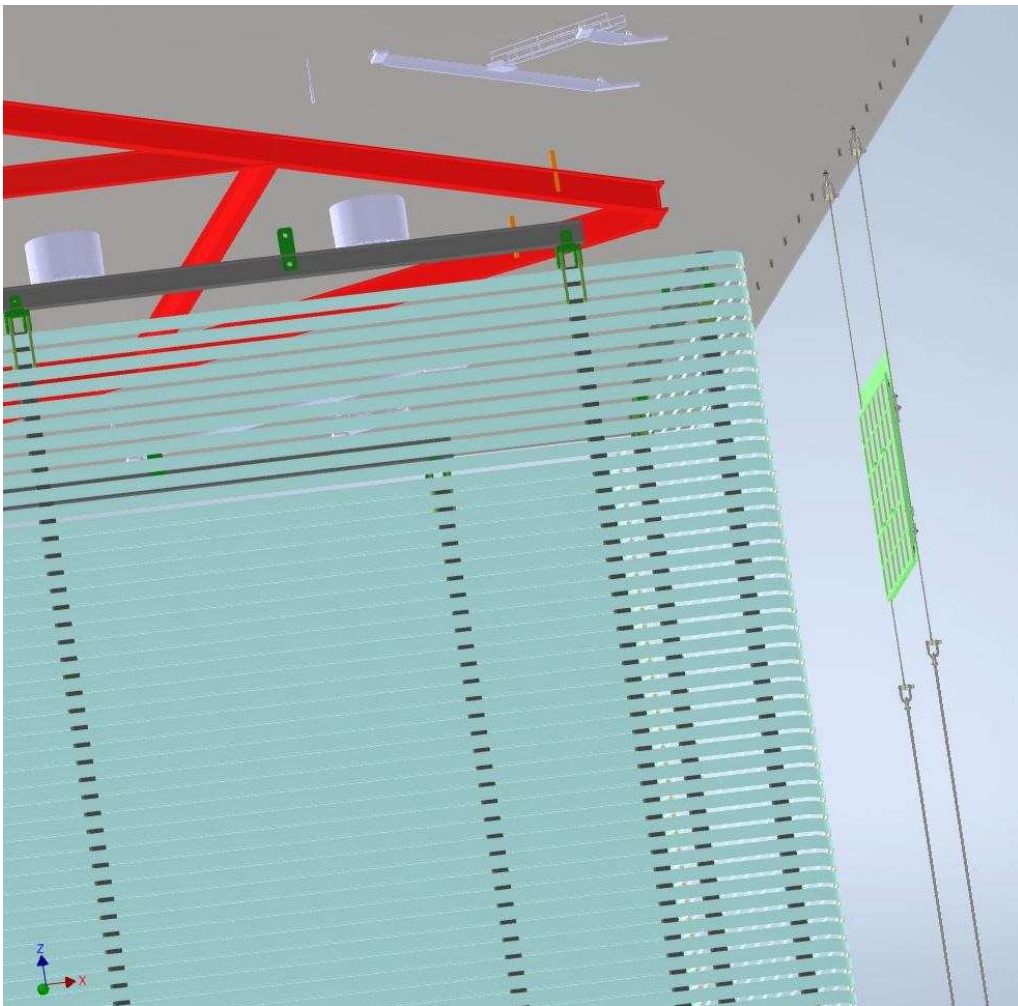
Distance between PDM to FC: ~620 mm

Distance between PDM to TCO: ~660 mm





## 2.1- ProtoDUNE Suspension Lines



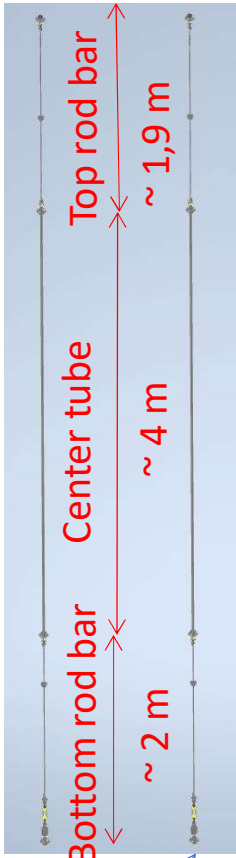
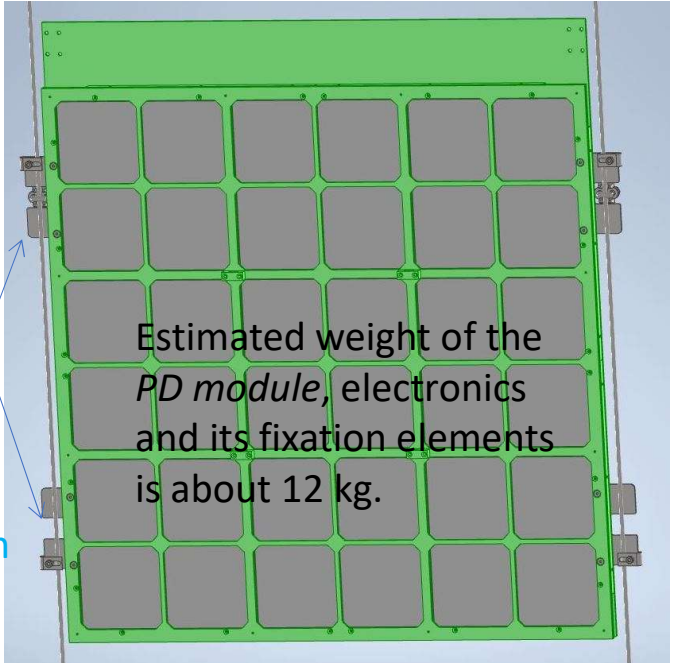
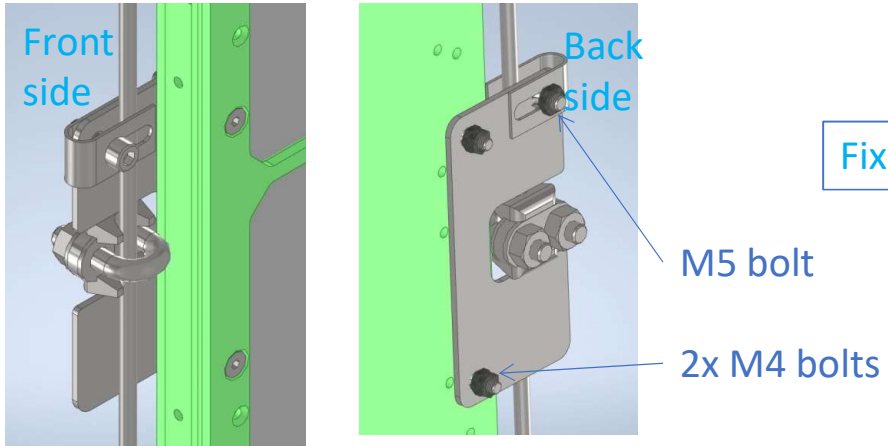
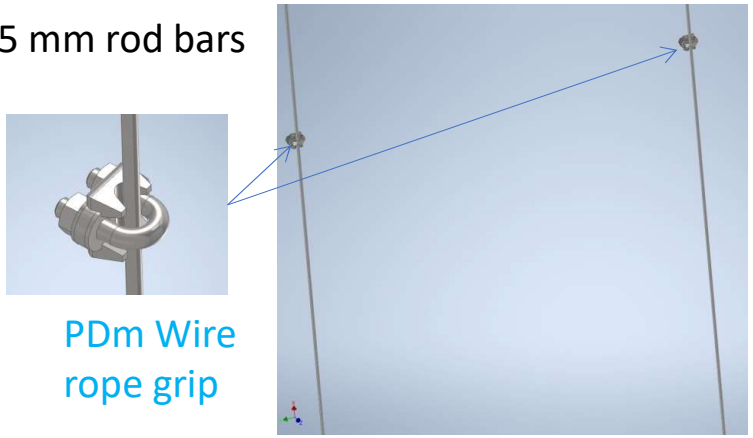


2.1.1.- Suspension lines description:

Each *PD module column* has two suspension lines compose of two 5 mm rod bars (top & bottom) & 12/10 mm diam. tube in the center

Each *PD module* is supported on both lines by two 'Wire Rope Grip' pre-positioned along the 5 mm rod bars, on the top side of each PD module.

Each *PD module* has four 'fixation points'.  
 The two top fixation points will be inserted on the two 'Wire Rope Grip' pre-positioned along the rod bars.  
 The fixation points are fixed to the PD module by two M4 bolt.

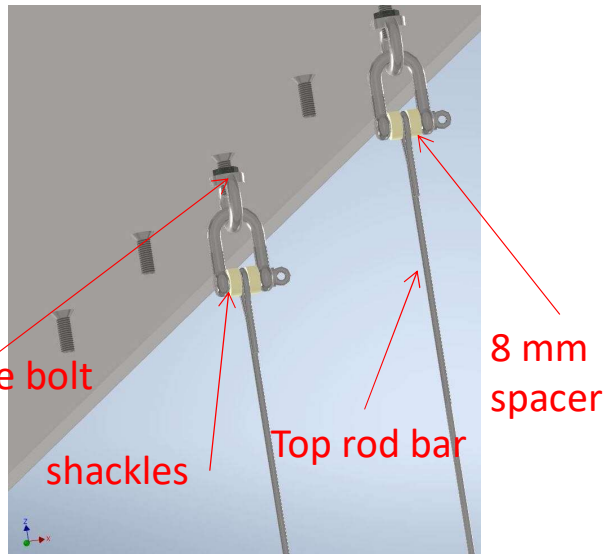


Suspension lines

2.1.2.- PD modules fixation along the suspension lines. Top Rod bar description:

Suspension lines are supported at top and bottom on the wall: The top rod bar end has an *eye bolt* to be fixed in the M10 bolt and then fix the top rod bar by the *shackles*. They can be previously pre-assembled on the ground or at home, like a chain.

The bars will have the *'wire rope grip'* pre-positioned at home.



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

Spot welds at the end of the rod bars replacing the wire rope grips.



Top end



PDM 'wire rope grip'

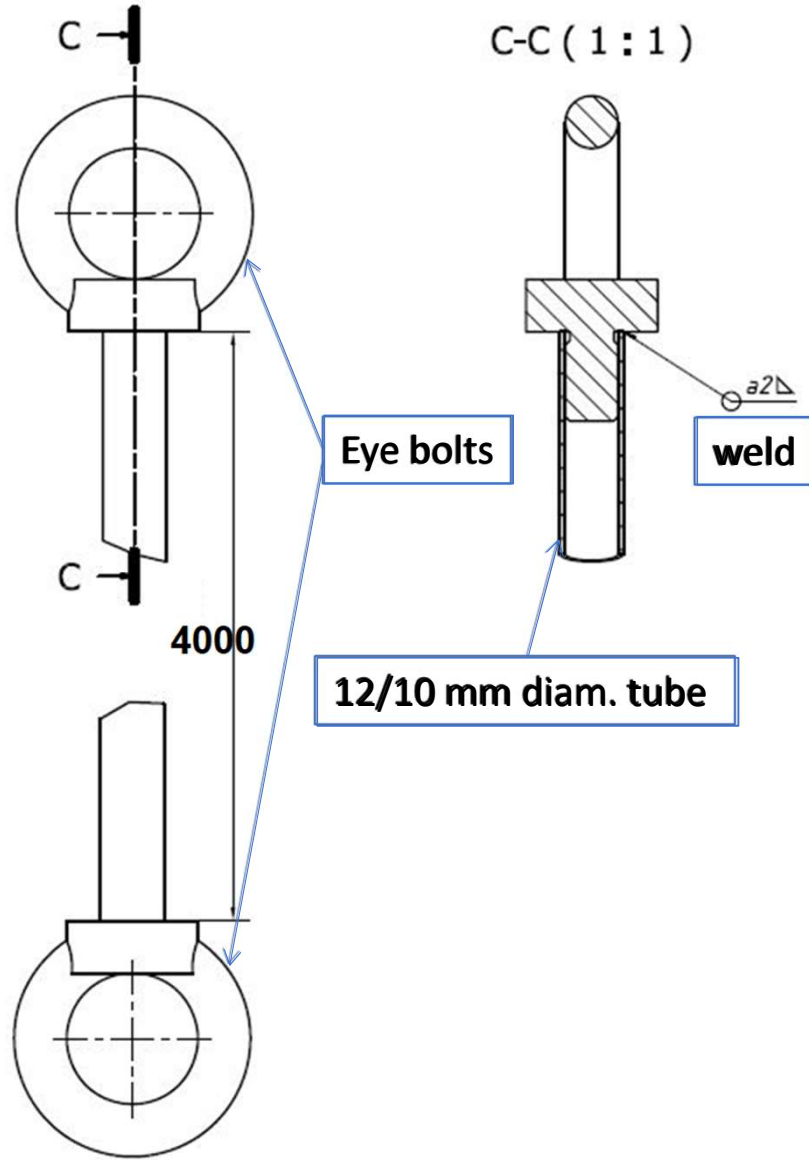
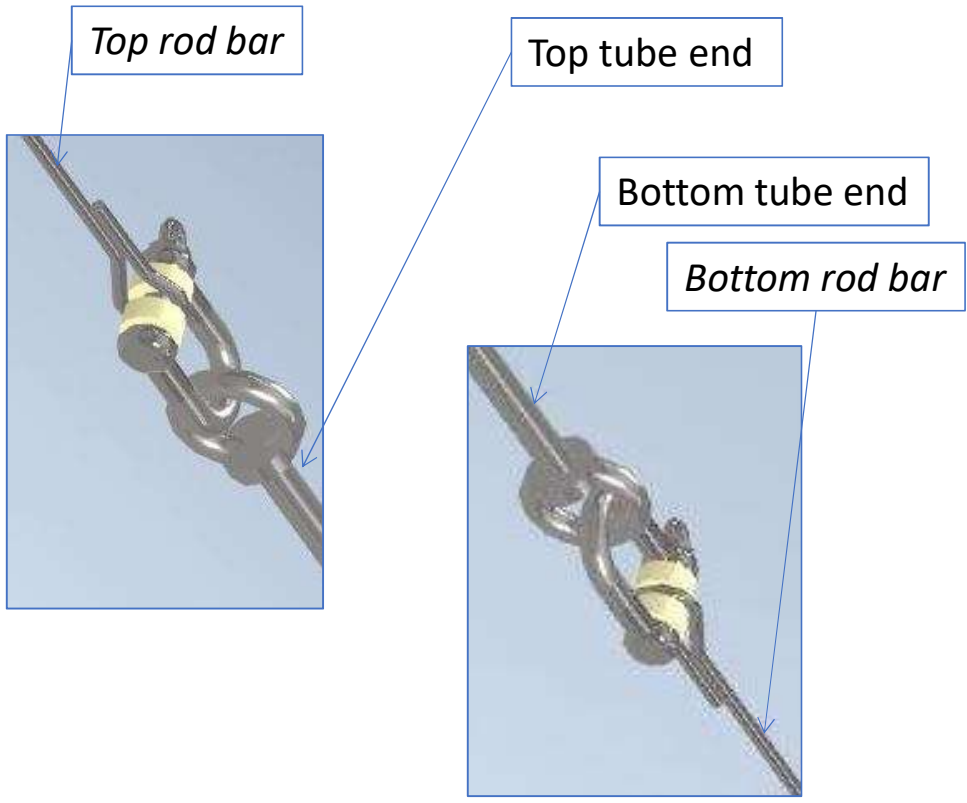
bottom end



2.1.3- PD modules fixation along the suspension lines. Central tube description:

Following the recommendation from the HV team: In the central region close to the cathode we should use at least 10 mm diameter tube, to avoid induce a big field gradient.

The end eye bolt of tubes will be welded. Prototypes are ready.

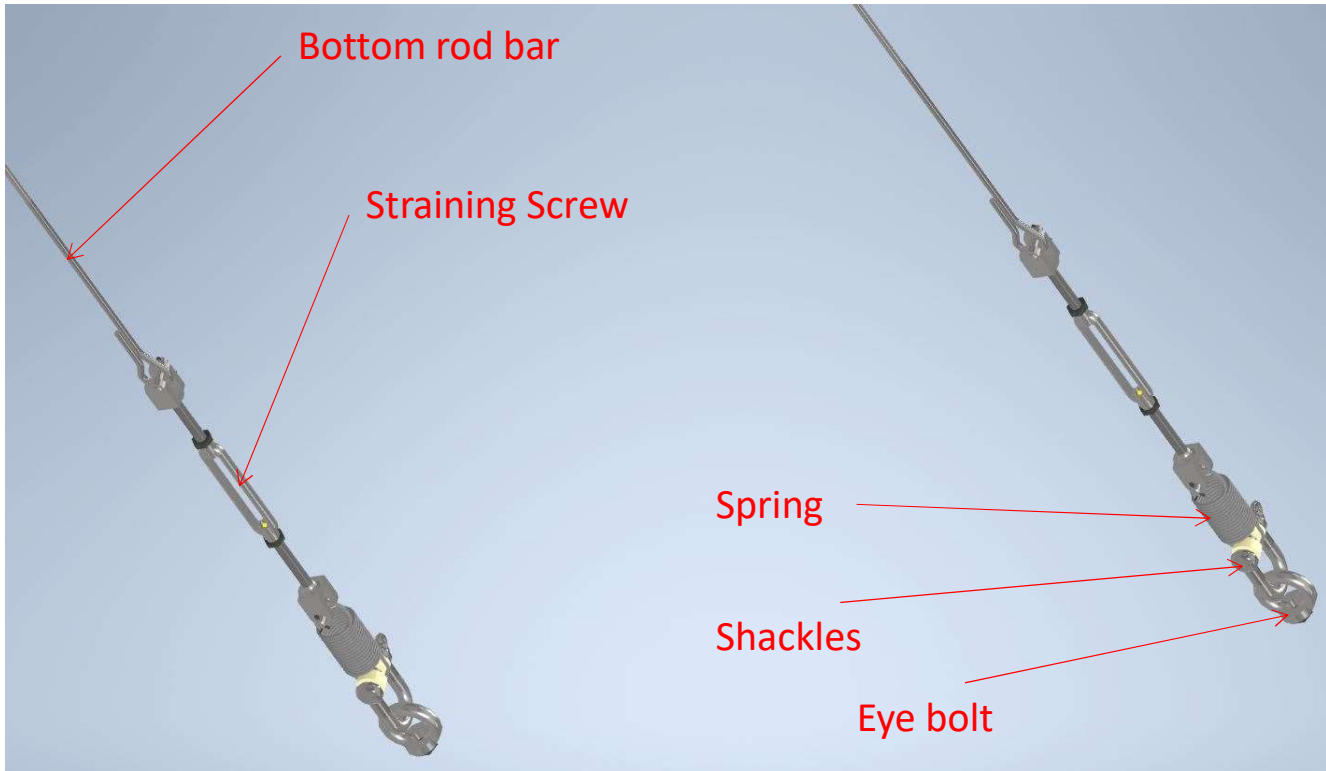


2.1.4- PD modules fixation along the suspension lines. Bottom Rod bar description:

Bottom rod bars of the support lines: The bottom rod bar end has an *eye bolt* to be fixed in the M10 bolt and then fix the bottom rod bar by the *shackles*.

The Straining Screw, Jaw to Jaw (adjustment range 75 mm) needs to be installed to compensate the differences between nominal and real dimension of the suspension lines.

The spring is needed to absorb the overload produced by thermal expansion and to Pre-tension suspension lines (15-20 kg).



All material sent will be cleaned and double-bagged (Filled with nitrogen atmosphere, if necessary), to dispose of the outer bag before entering the clean area of the detector, avoiding contamination inside.

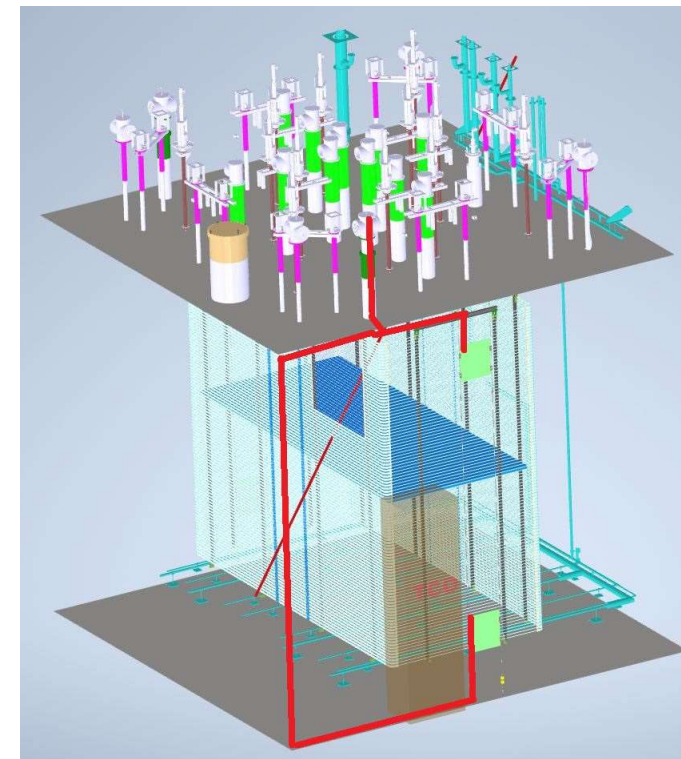
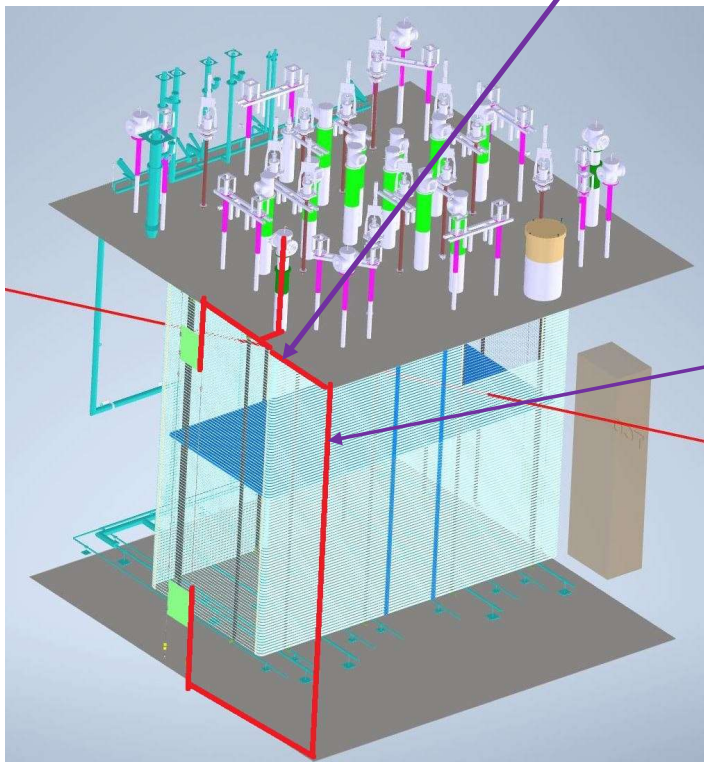
## 2.2- Cables routing

Signal cables of the top PD module: routed along the Stainless steel rod bar lines toward the top side of the membrane toward the cables tray feedthrough.

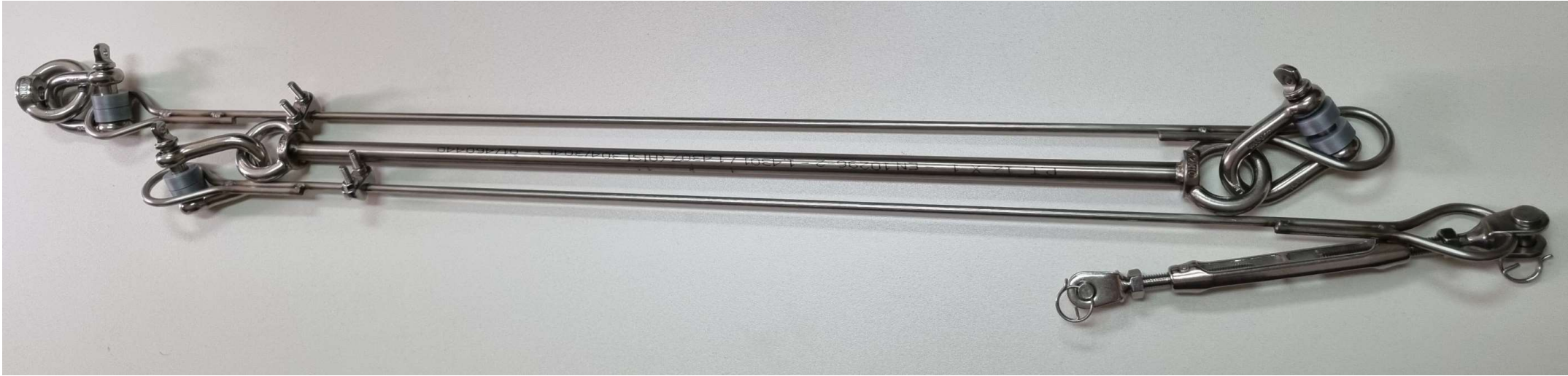


Bottom PD modules cables: routed along the rod bar toward the bottom side of the membrane and then exit on the toward the cables tray until the cables tray feedthrough.

Installation sequence of the cables to be defined depending on the location of the cables excess, using cables ties to fix them to the rod bars or cables trays.



### 3.- Suspension Line Prototype



The rod bar line has 2 rod bars and one tube that can be previously pre-assembled on the ground or at home, like a chain.





We have the tools for this issue ready:  
-Rod bars and central tube could be produced for the ProtoDUNE-VD in a couple of days.  
-And for the DUNE-FD2-VD in 3-4 week.

#### 4.- To be finalized & questions.

- Fix the membrane PD modules position (PDS sim./reco. Group input and I&I team).
  - 3D integration of the signal cables up to the feedthroughs.
  - Complete the installation plan in coordination with the I & I (Installation and Integration team).
  - Quality Control and Quality Assurance.
- 
- Possible field shielding on the PDm: In this case, will be sent with this protection element included?
  - How many cables have each PDm and what kind of cable?
  - Will all PDm cables have the same length?
  - ProtoDUNE-VD: Will be used the same cables tray feedthrough than for PMTs?
  - ProtoDUNE-VD: will be used some PMTs?
  - ProtoDUNE-VD: When should these elements be at CERN?



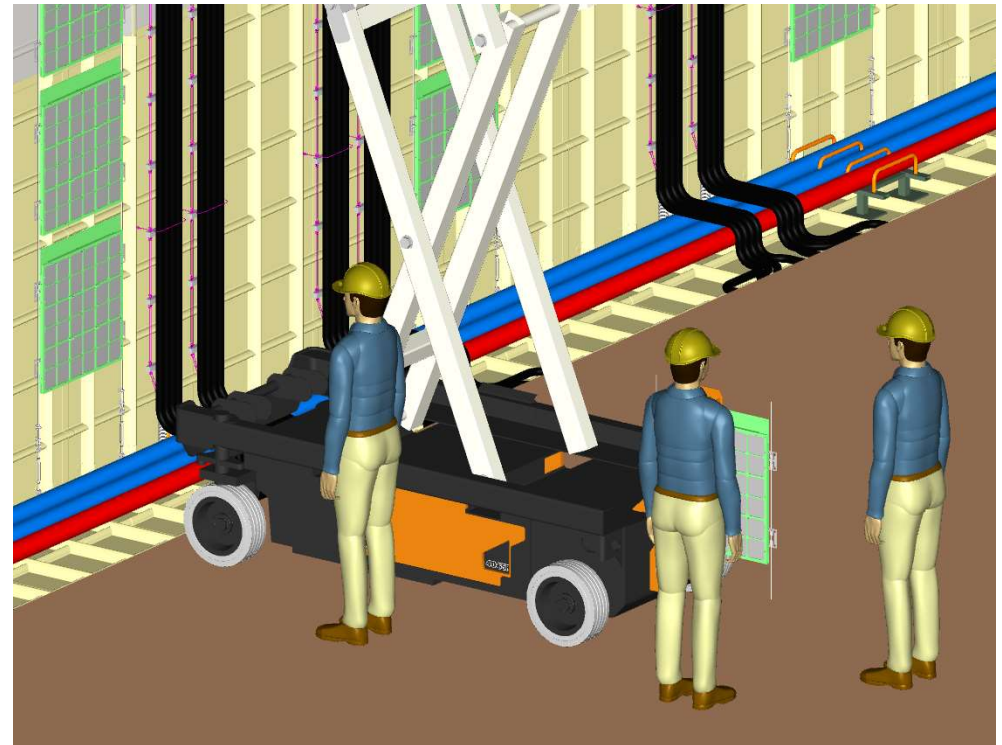
Spares

## 5.- Installation coordination:

From Nicholas Joniak/James Stewart

### Installation Coordination

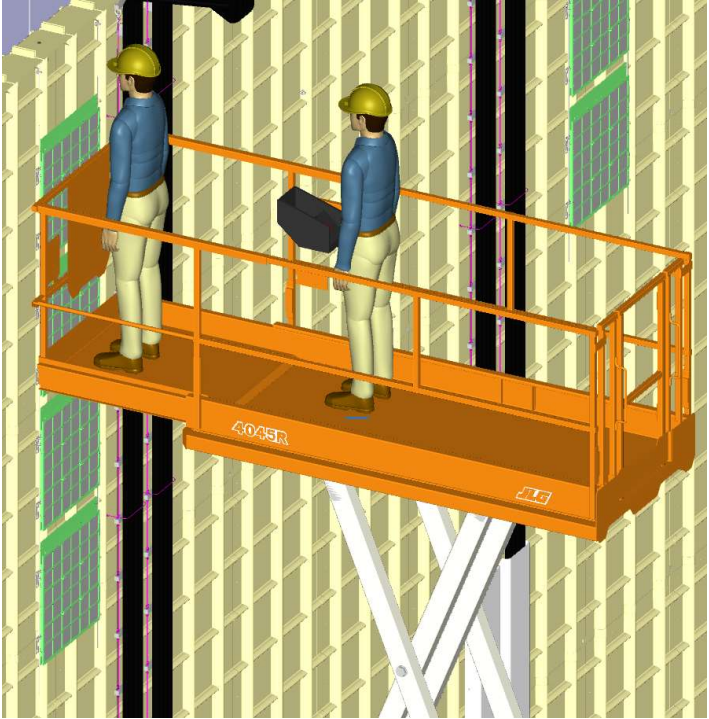
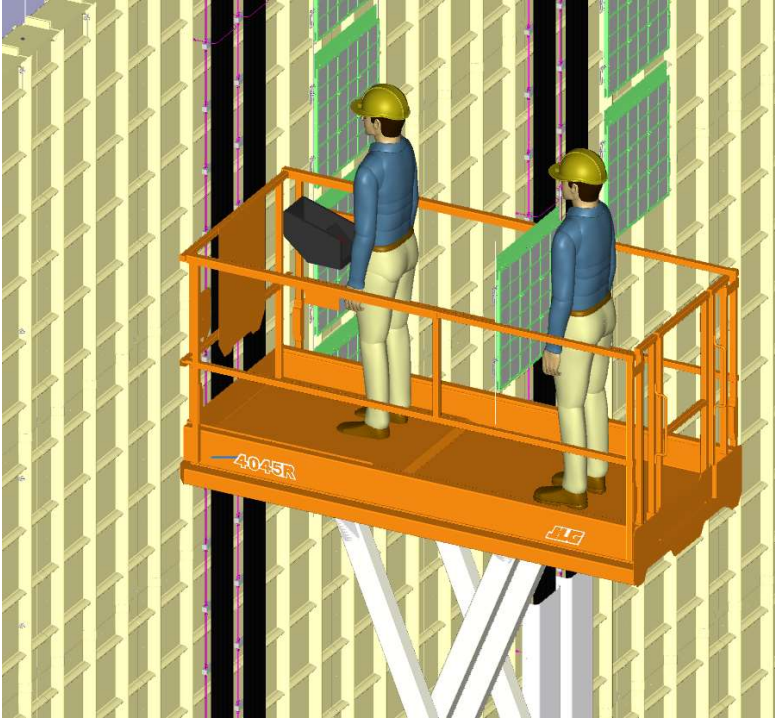
- A scissor lift will be used to bring the installers to the correct installation elevation.
- The lift will need to be placed perpendicular to the membrane wall and almost flush to the edge of the false floor.
- After the installation of the suspension system, the individual PD modules will be loaded in the lift and installed at the correct elevation.
- It is estimated that there will be one PD installer and two I&I (Installation and Integration team) technicians at the base of the scissor lift to load material and assist with coordinating installation.



5.- Installation coordination:

From Nicholas Joniak/James Stewart

# Installation Coordination (Cont.)



One PD installer and one I&I lift driver will be in the scissor lift basket for installation of the wall modules.

While there is approximately a 0.9m gap between the end of the false floor and the cryostat threaded rod attachment point, the scissor lift can extend this distance to allow for installer access.

5.- Installation coordination:

From Nicholas Joniak/James Stewart

# Interfaces (Cont.)

