GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
cfp CIEMAT física de partículas

Membrane PD Modules:

Ciemat proposal

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on behalf of the Ciemat Neutrino group.

2022 June 13

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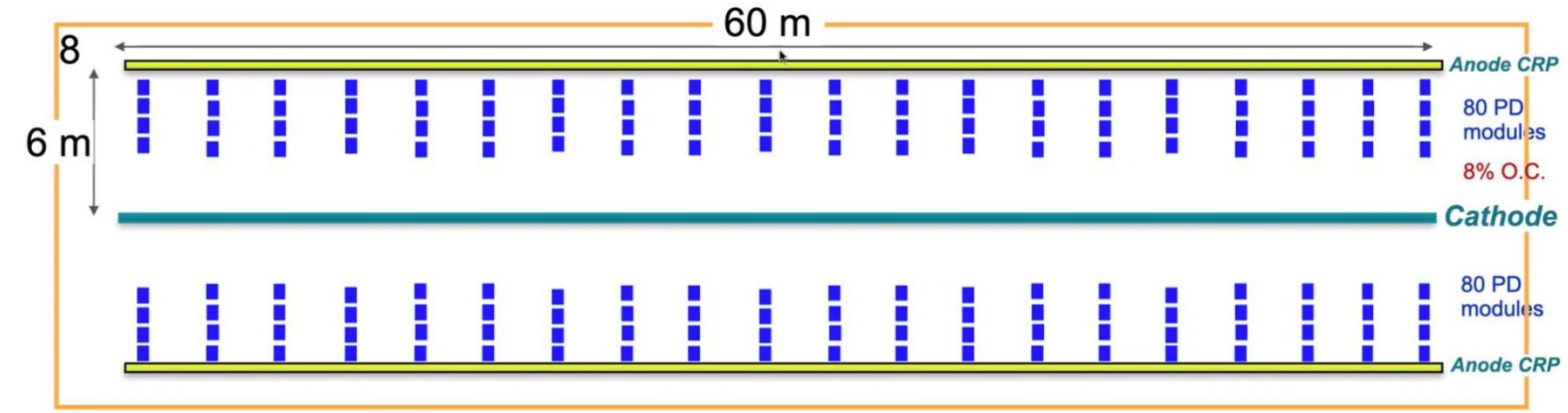
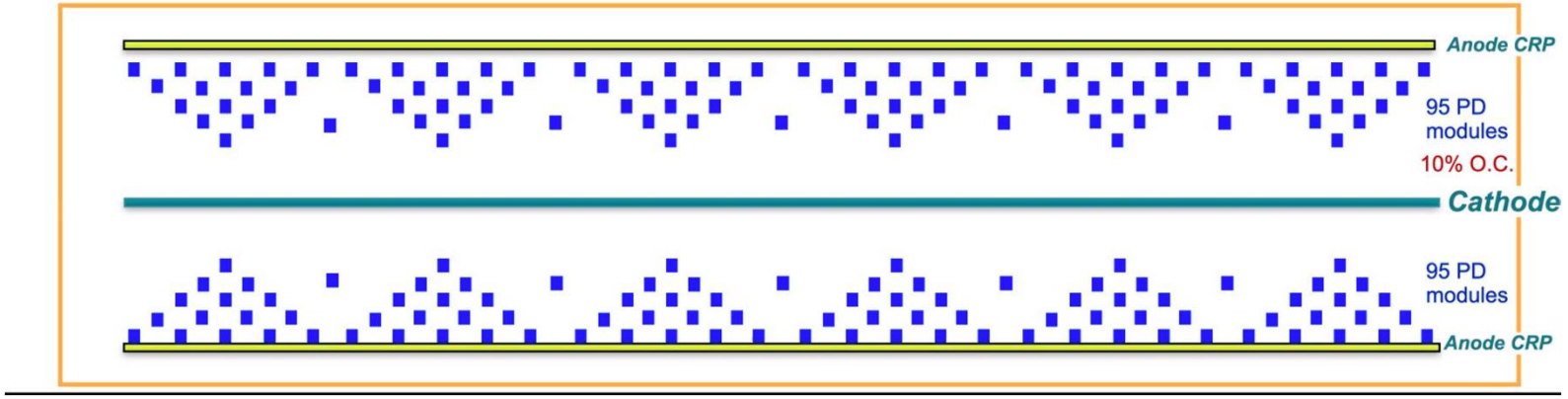
1.- Possible configuration of the PD modules on the membrane:

Final configuration of the PD modules on the membrane is still being studied by the PDS sim./reco. group, in order to maximize the light yield and uniformity of the response within the volume. But the most likely options are:

A *option*:
20 column of 8 PD modules by side:
320 PD modules on the membranes.

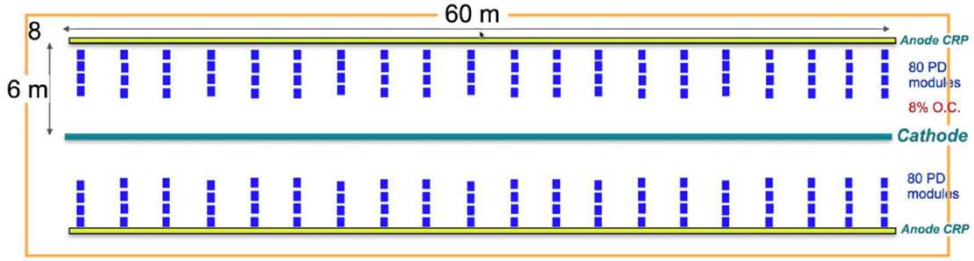


B *option*:
59 column of (2, 4 or 6) PD modules by side:
380 PD modules on the membranes.

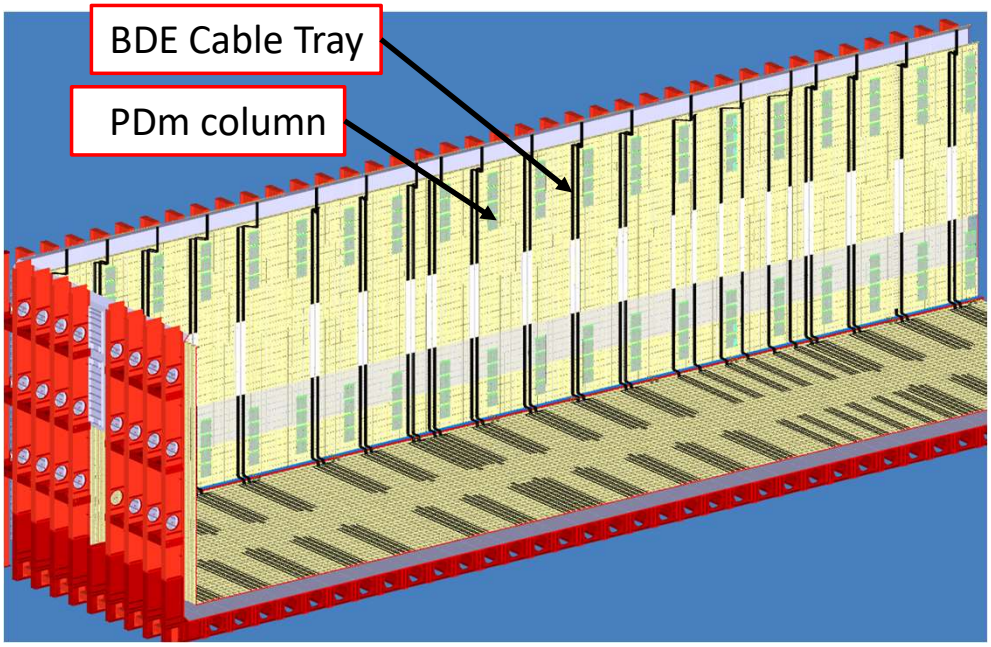


From Nicholas Joniak/James Stewart

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.



2.- <u>Fixation system of the PD modules on the membrane</u>:

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 are Stainless steel (AISI 304 or AISI 304L or AISI 316) and G10-FR4 (all material are cryogenic compatible).

-Install two vertical rod bar stainless steel lines system of 5 mm diameter to support each PD module column.

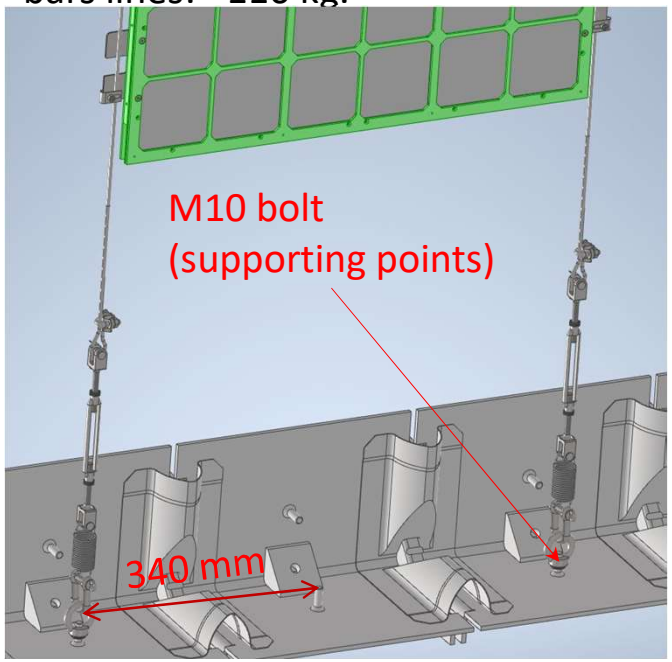
-Minimum step between bolt are 340 mm (Option showed: columns separated 680 mm, 3060 mm)

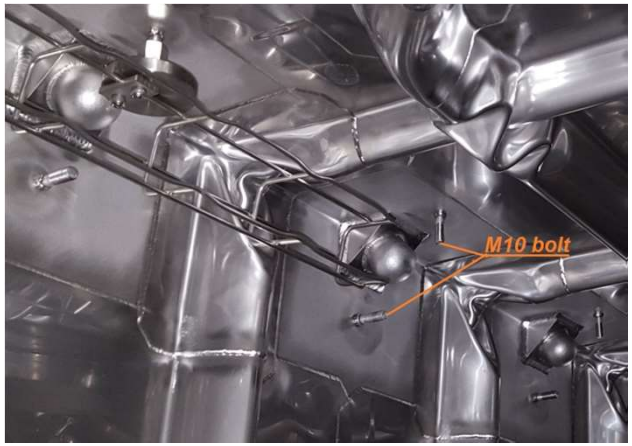
-Pre-tensioned bar lines (15-20 kg)

-PD modules can be installed at the desired positions along the rod bar lines, placing *Wire Rope Grip*.

-Both top and bottom corners are free.

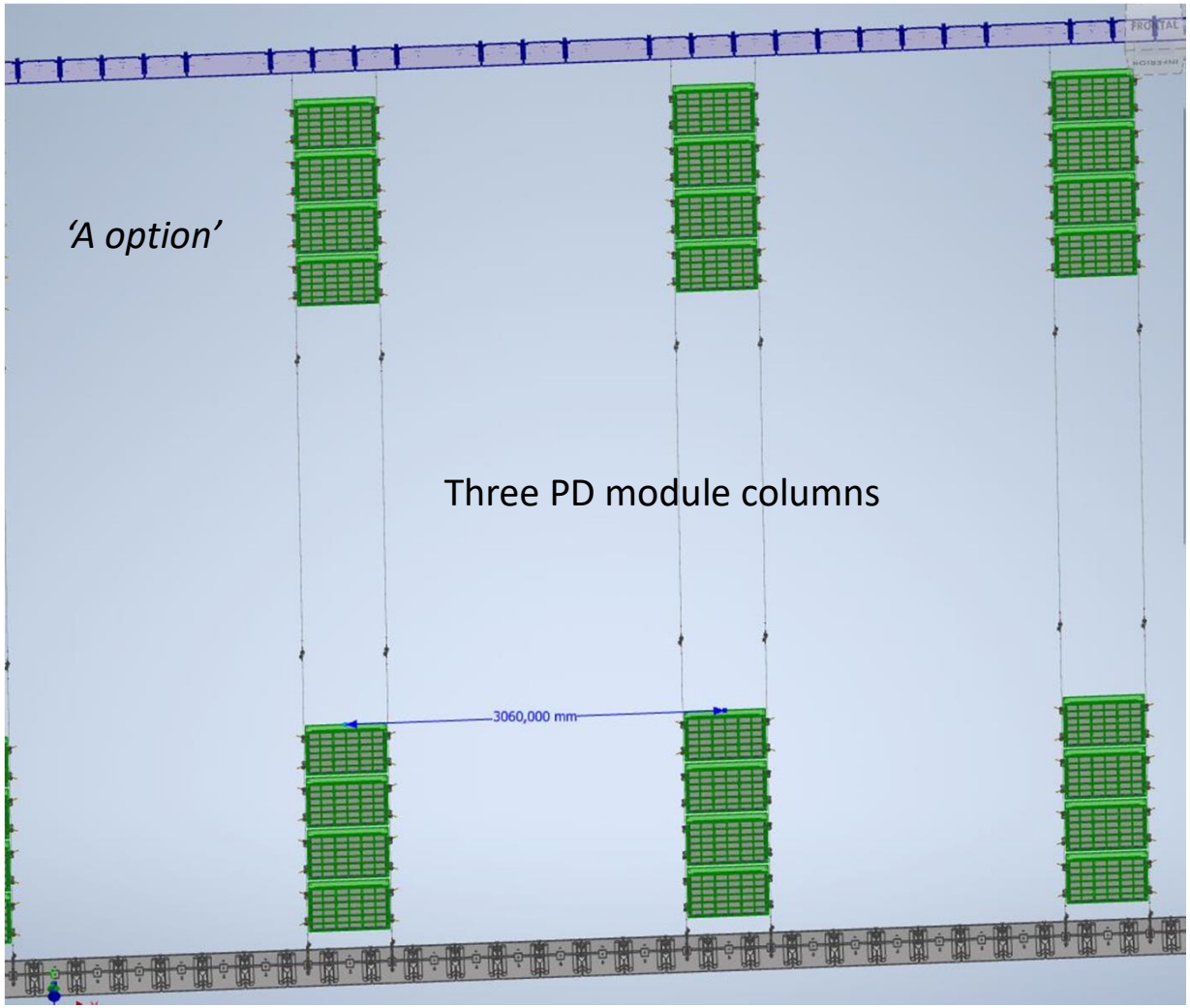
-Estimated weight of the each PD module column (8 PDm), electronics, cables, its fixation elements, and rod bars lines: ~110 kg.

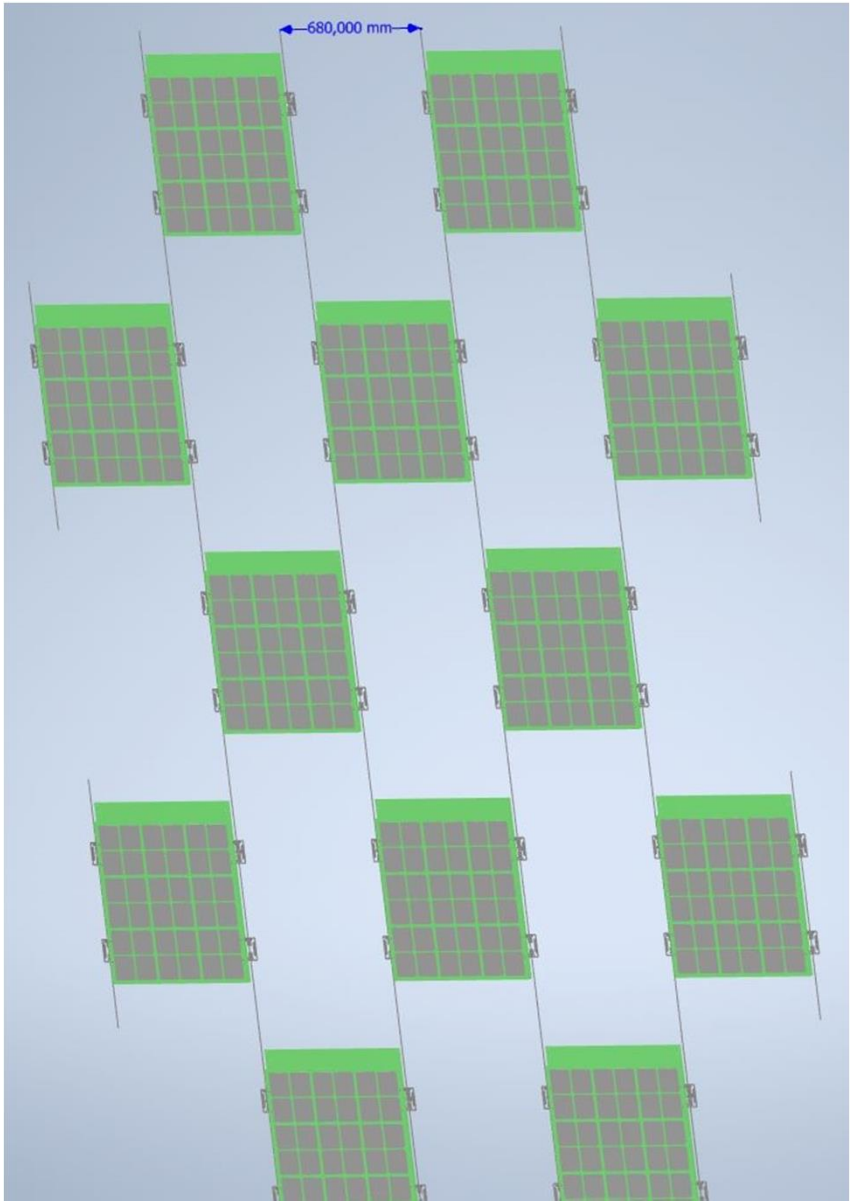




2.1.- <u>PD modules fixation along the rod bar lines.</u> Rod bar lines description:

Minimum possible distance between lines: 680 mm



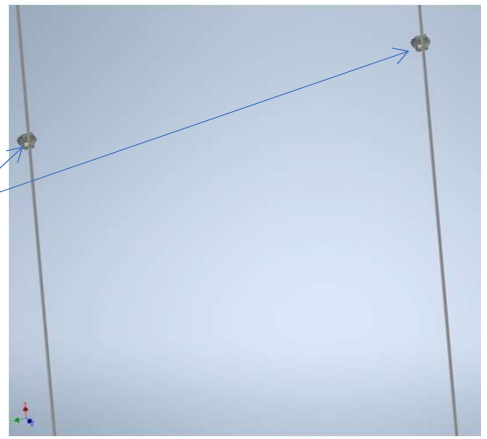


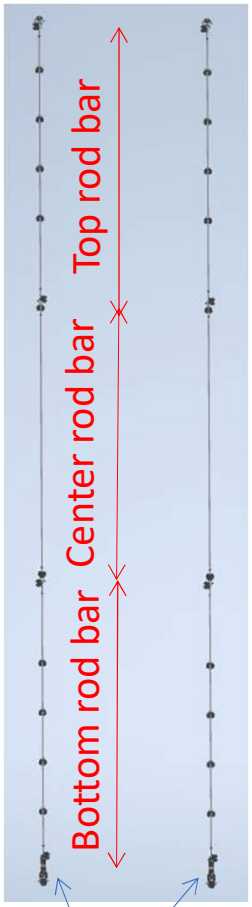
2.1.- PD modules fixation along the rod bars. Rod bar lines description:

Each *PD module column* has two 5 mm rod bar support lines composed by 3 rod bars (top, bottom and center) produced at Ciemat:
-'*A option*' shown:

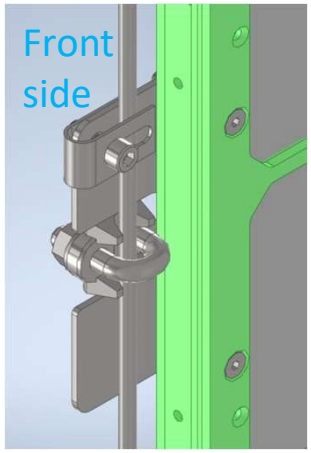
Each *PD module* is supported on both lines by two '*Wire Rope Grip*' pre-positioned along the 5 mm rod bars, on the top side of each PD module.

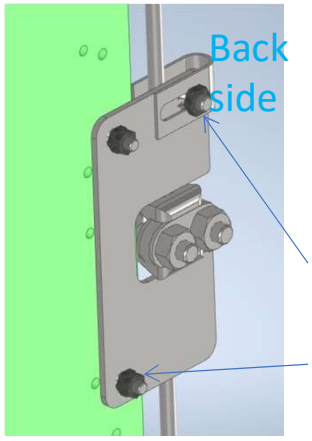
PDm Wire rope grip

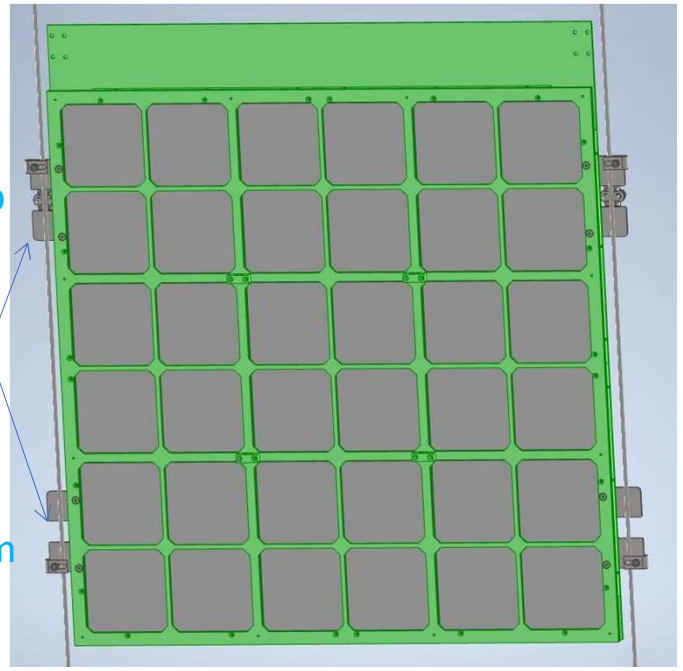




Each *PD module* has four '*fixation points*', produced at Ciemat:
The two top fixation points will be inserted on the two '*Wire Rope Grip*' pre-positioned along the rod bars.
The fixation points are fixed to the PD module by two M4 bolt.



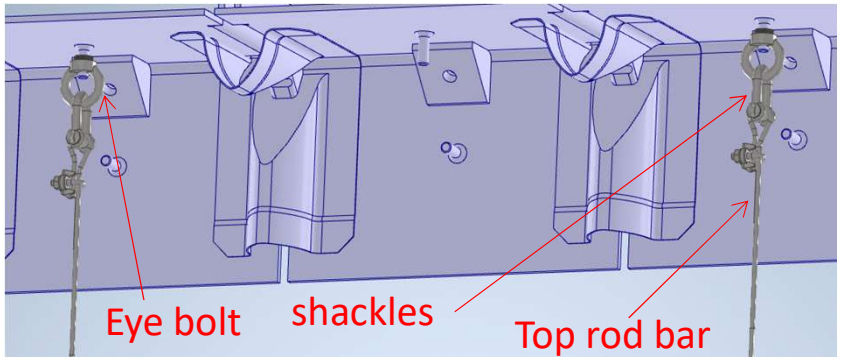


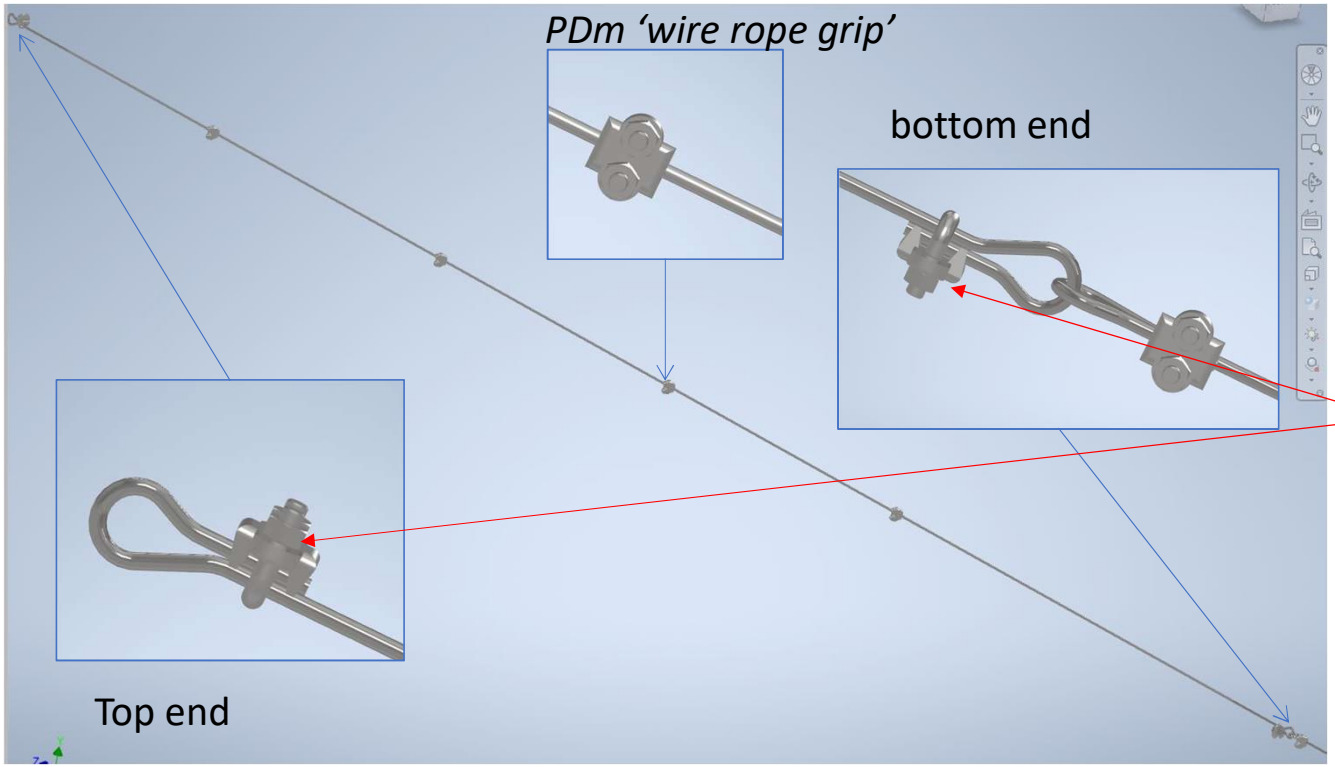


Support rod bar lines

2.1.- <u>PD modules fixation along the rod bar lines</u>. Rod bar lines description:

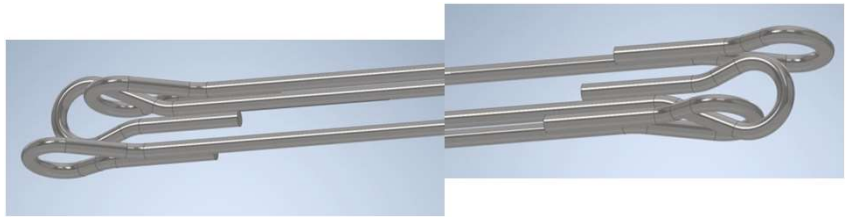
Rod bar support lines are supported at top and bottom on the wall: The top rod bar end has an *eye bolt* to be fixed in the M10 bolt and then fix the top rod bar by the *shackles*. The rod bar line has 3 rod bars (can be previously pre-assembled on the ground or at Ciemat, like a chain).
The bars will have the '*wire rope grip*' pre-positioned at home.





The modification of the 5 mm rod bars ends will be produced at Ciemat. The tools to perform it are under development. Several prototypes will be produced in the coming weeks.

´the '*Wire Rope Grip*' at the ends could be replaced by spot welds. That will be defined during the prototypes test.



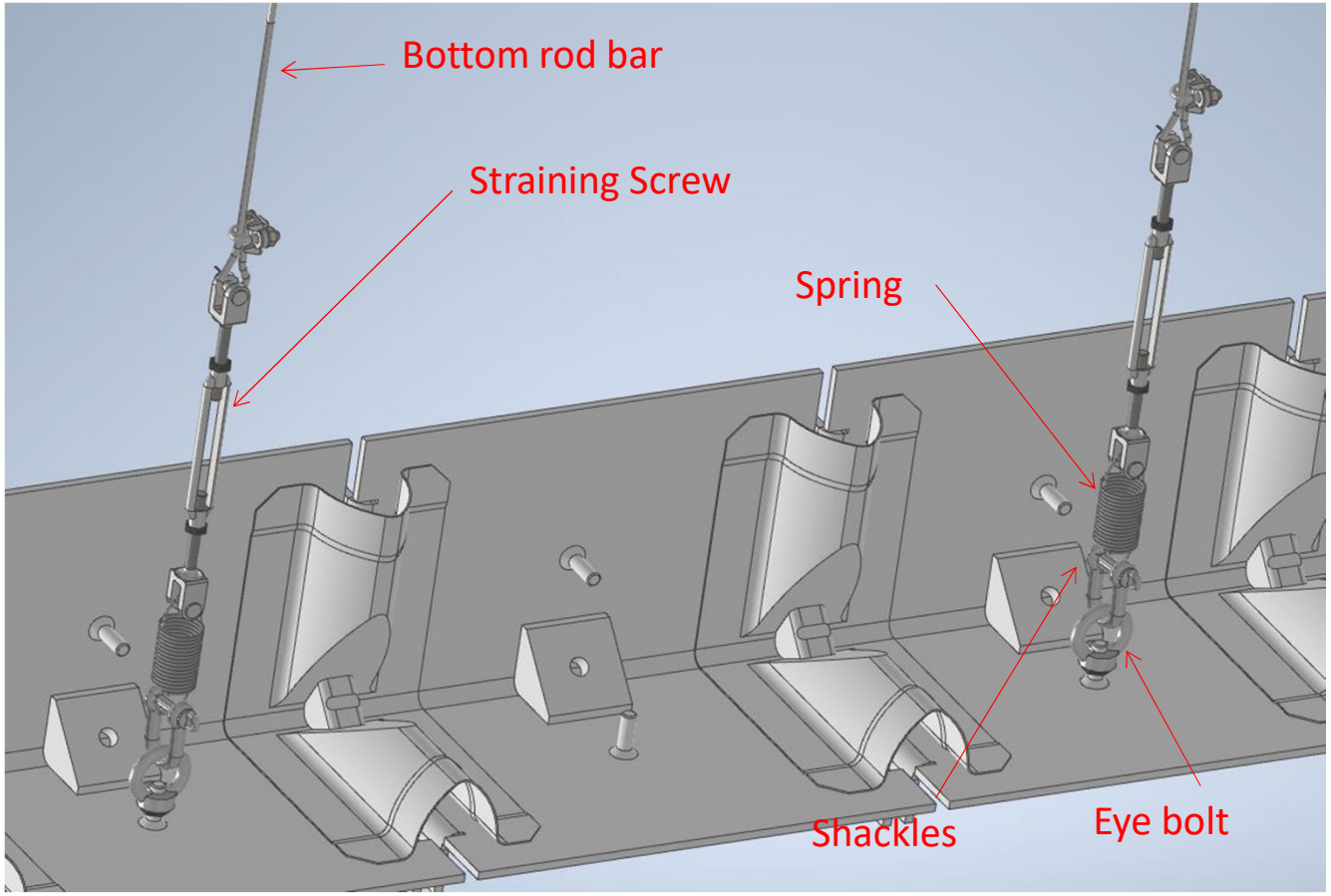
Bar can be sent from Ciemat (Spain), Pre-assembled.

2.1.- <u>PD modules fixation along the rod bar lines</u>. Rod bar lines 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 rod bar lines.

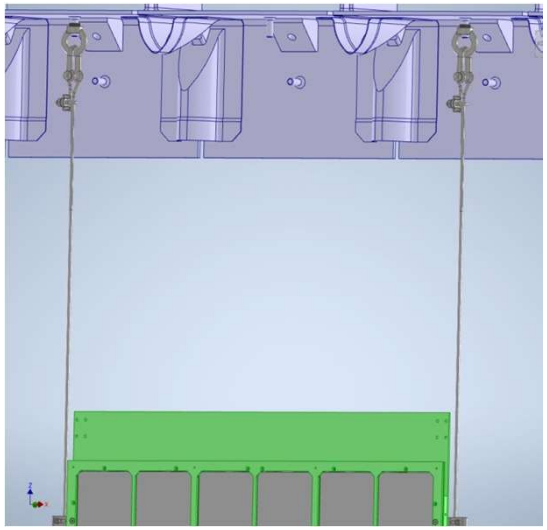
The spring is needed to absorb the overload produced by thermal expansion and to Pre-tension the rod lines (15-20 kg).

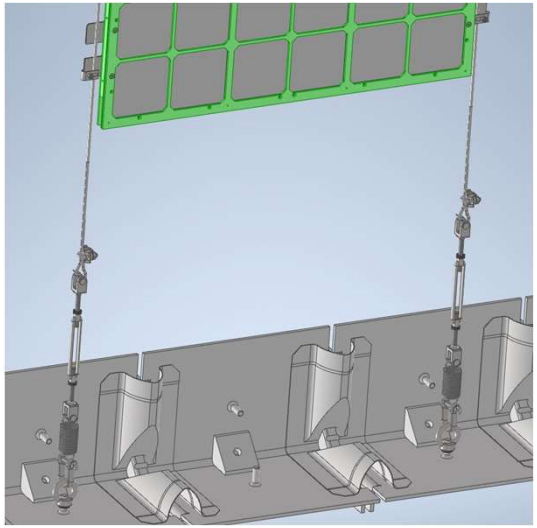


All material sent from Ciemat will be cleaned and double-bagged (Filled with nitrogen atmosphere, if necessary), to dispose of the outer bag before entering the clean area of the detector, avoiding contamination inside.

2.1.- PD modules fixation along the rod bar lines : *Rod bar lines description*.

Rod bar lines fixed directly to the M10 bolt of the top and bottom corner of the membrane.
Standard AISI 302 spring.





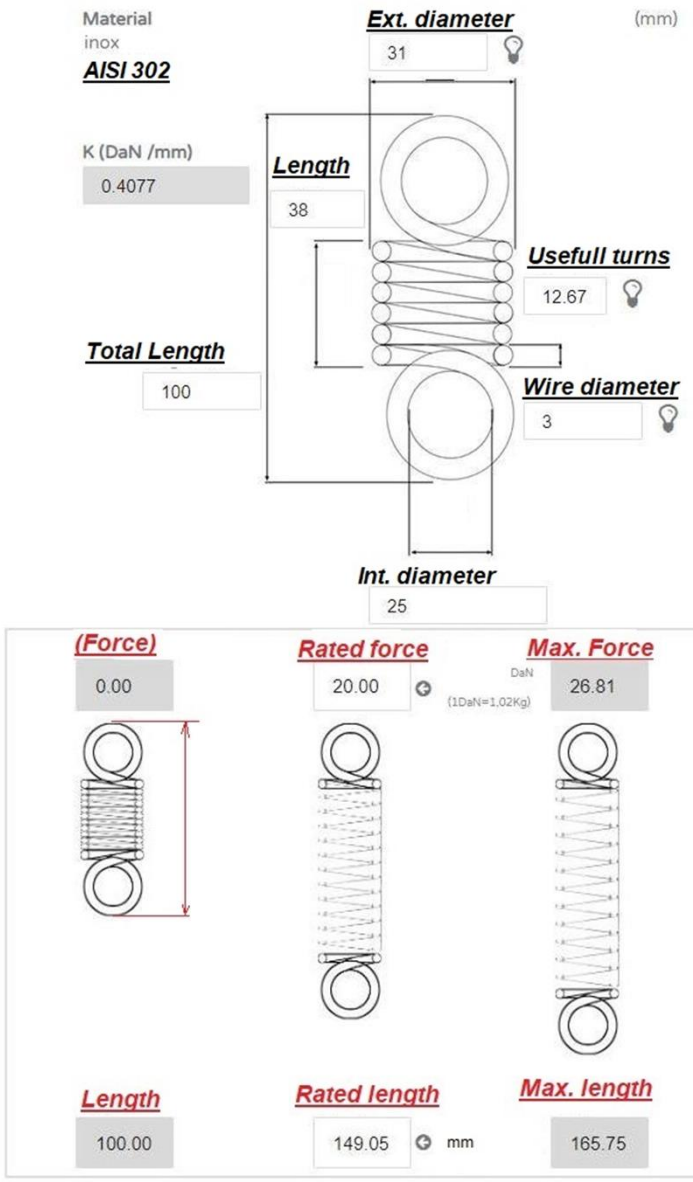
Theoretically: maximum deformation induced on the membrane by the thermal expansion at cryogenic temperature between top and bottom side of the membrane (14 m and *dt* 200 K) is about 46 mm.

But, the cool down will be performed slowly, cooling at the same time the membrane and fixation system of the PD modules, minimizing the deformation gradient (maybe only a few millimeters).

Straining Screw, Jaw to Jaw (adjustment range 75 mm)

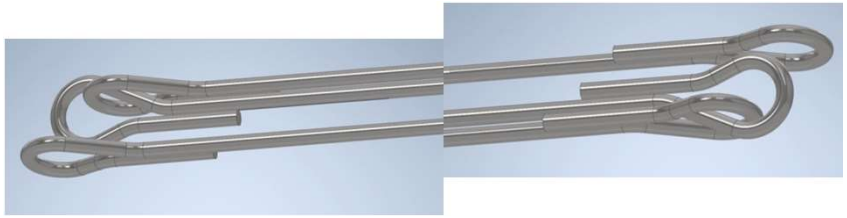
Pre-tensioned rod bar lines (15-20 kg)

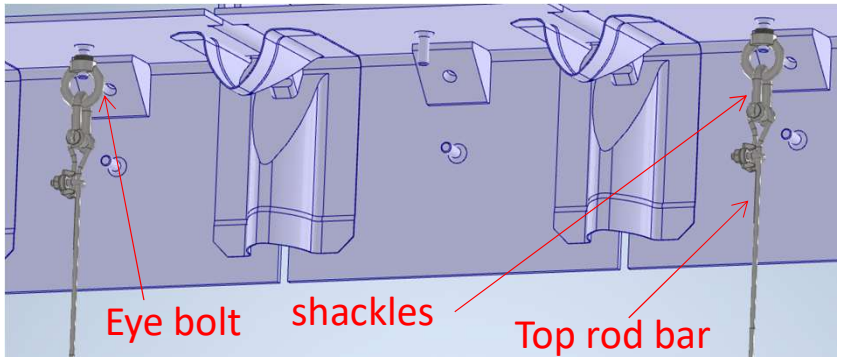
Spring to absorber the overload due to the thermal expansion, avoiding induce big forces on the M10 bolt.



2.2.- <u>The installation sequence</u> :

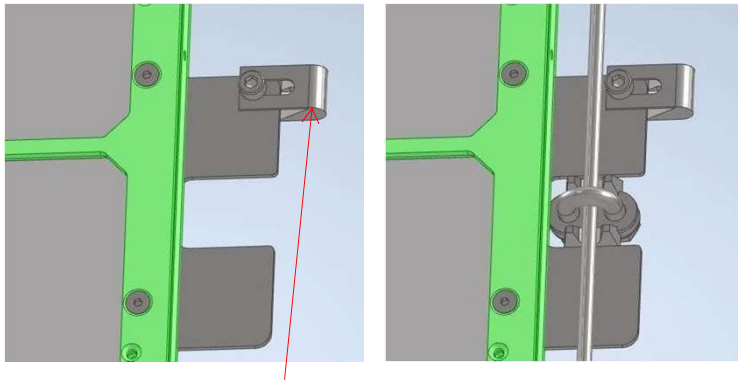
Step 1: Install the rod bar support lines from top to bottom on the wall: Screwing the *eye bolt* in the M10 bolt support point first and then fix the top rod bar by the *shackles*. Next expand the 3 rod bar to the bottom.



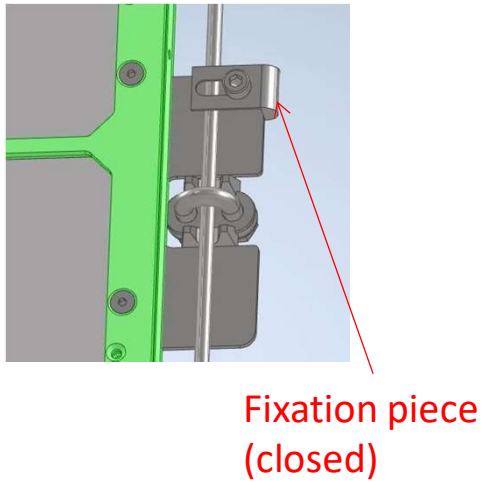


Step 2: Fix the bottom rod bars of the support lines. Screwing the eye bolt in the bottom M10 bolt support point first and then fix the bottom rod bar by the shackles. Adjust the Straining Screw to expand the spring (approx. 133 mm) to the nominal Pre-tension of the rod lines (approx. 15 kg).

Step 3: Insert the PD module in the two '*Wire Rope Grip*' pre-positioned along the column bar lines, at the top side of the PDm.

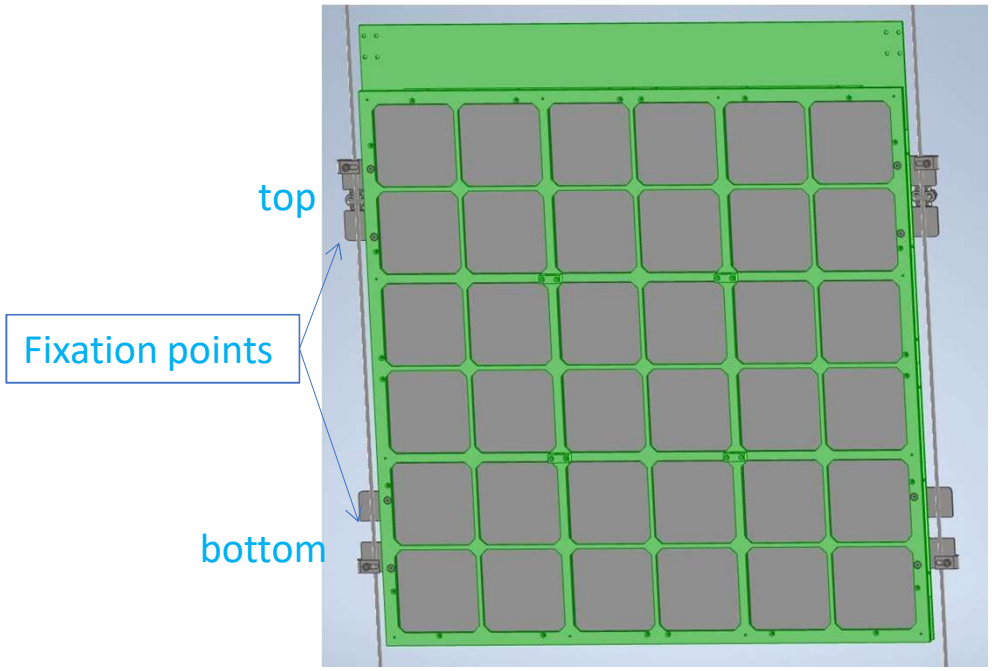


Step 4: Attach the two top fixation points of the PD module by M5 bolts, closing the fixation piece.



2.2.- The installation sequence :

Step 5: And then, fix the two bottom fixation points of the PD module by M5 bolts.



Estimated weight of the *PD module*, electronics and its fixation elements is about 12 kg.

		A *option* PD modules by membrane)	**B *option*** PD modules by membrane)
Rod bars version	Weight of the bar lines+ standars elements	264	778
	Weight of the PD modules fixation elements	57	67
	Weight of the PDm	3776	4484
	Total (kg)	**4096**	**5329**

Cables weight is not included

2.3.- Installation coordination:

From Nicholas Joniak/James Stewart

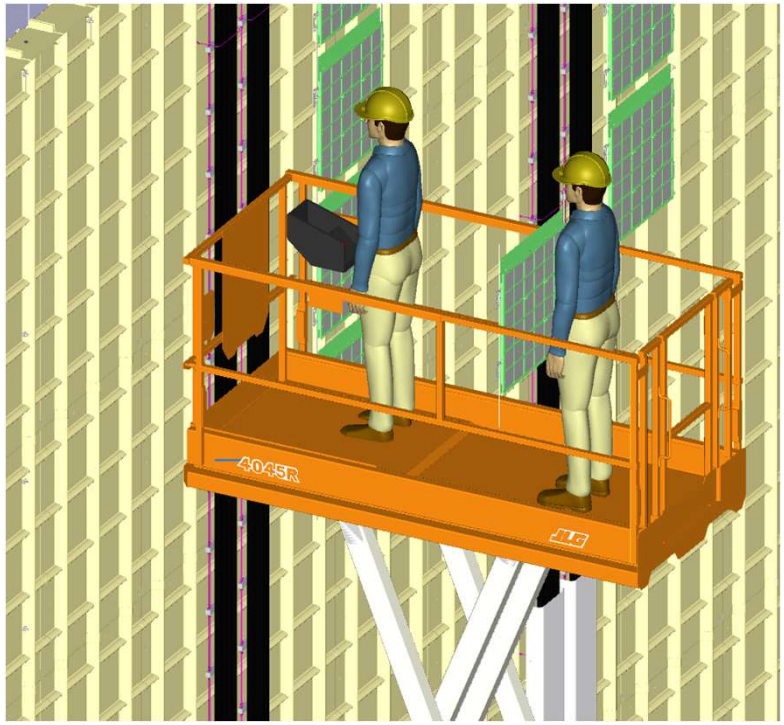
Installation Coordination

- 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 Coordination team) technicians at the base of the scissor lift to load material and assist with coordinating installation.

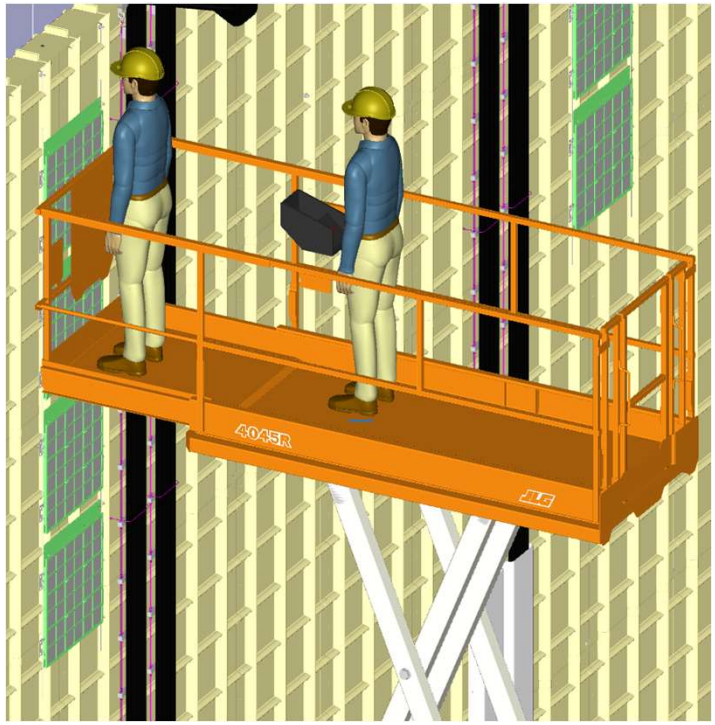
2.3.- Installation coordination:

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.

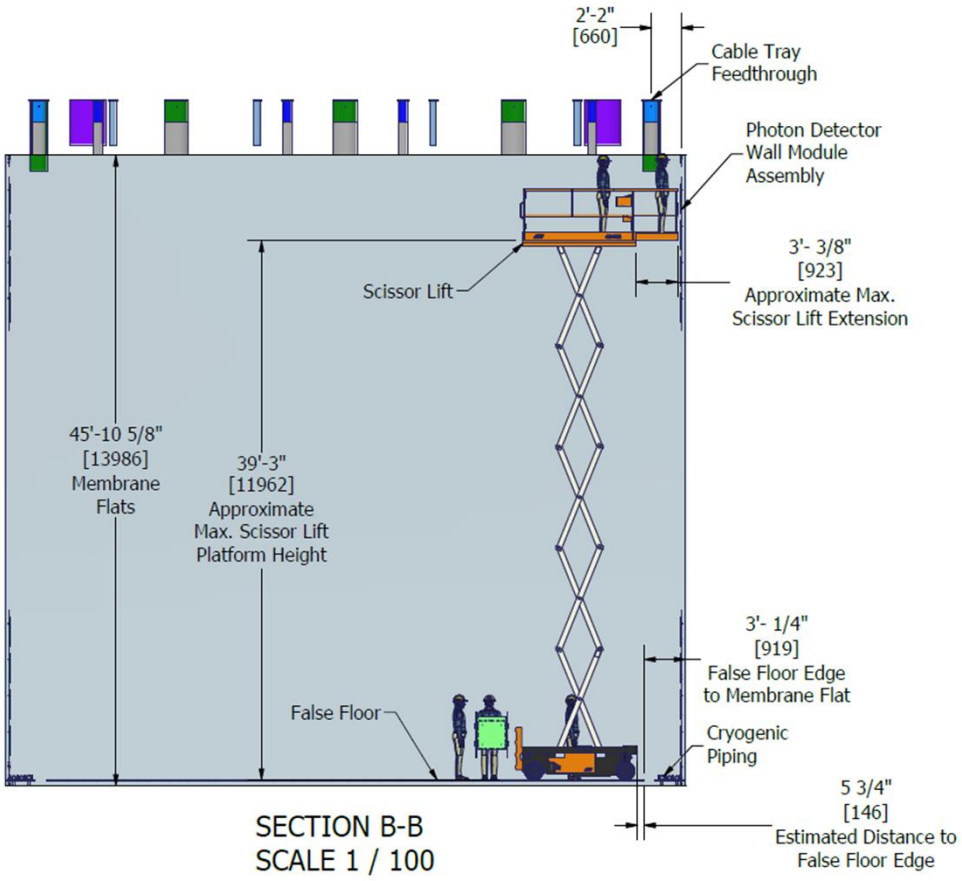


While there is approximately a 0.9m gap between the end of the false floor and the cryostat threaded rod attachment point, the scissor lift can extend this distance to allow for installer access.

2.3.- Installation coordination:

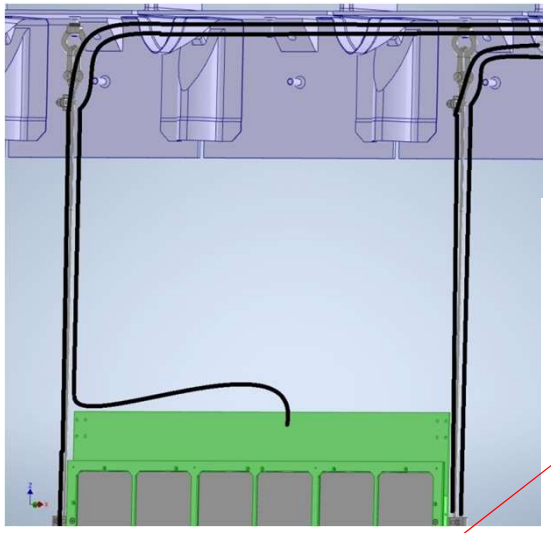
From Nicholas Joniak/James Stewart

Interfaces (Cont.)

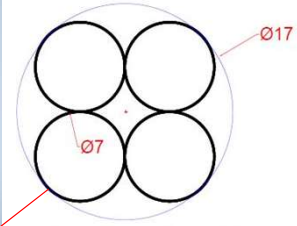


2.4.- Routing of the cables.

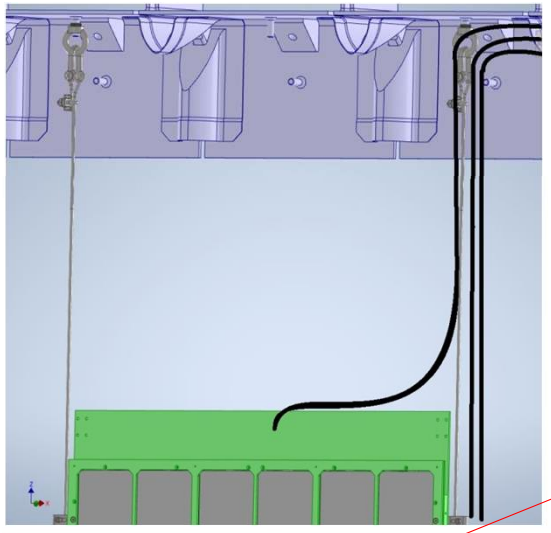
Signal cables of the PD module: routed along the Stainless steel rod bar lines toward the top side of the membrane. Installation sequence of the cables from bottom to top (to be defined depending on the location of the cables excess) using cables ties to fix them to the rod bars. Cable bundles can be arranged in two option: 1 bundle of 8 cables or 2 bundles of 4 cables each:



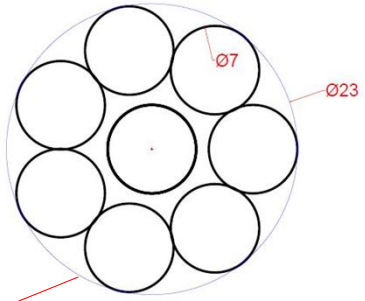
3,5 kg/bundle to the top of the membrane.



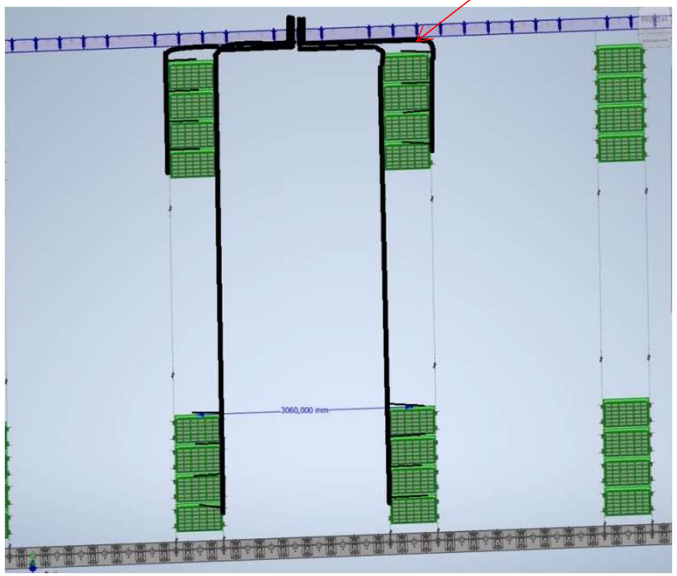
Two cable bundles by PD module column

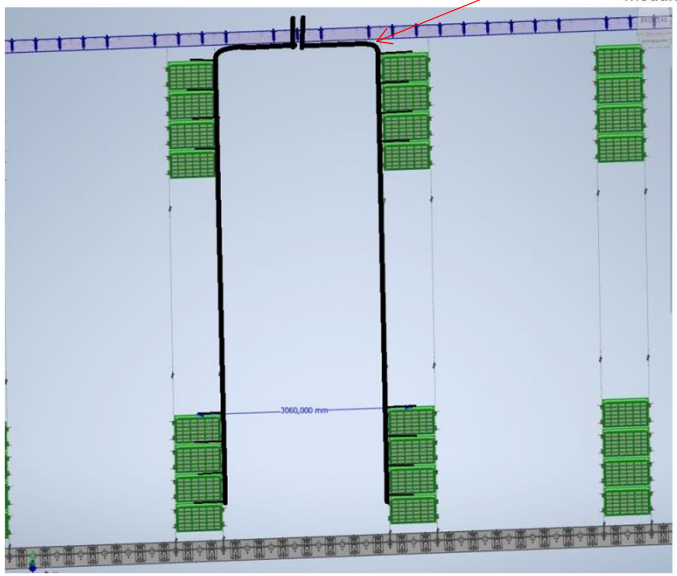


7 kg/bundle to the top of the membrane.



One cable bundle by PD module column



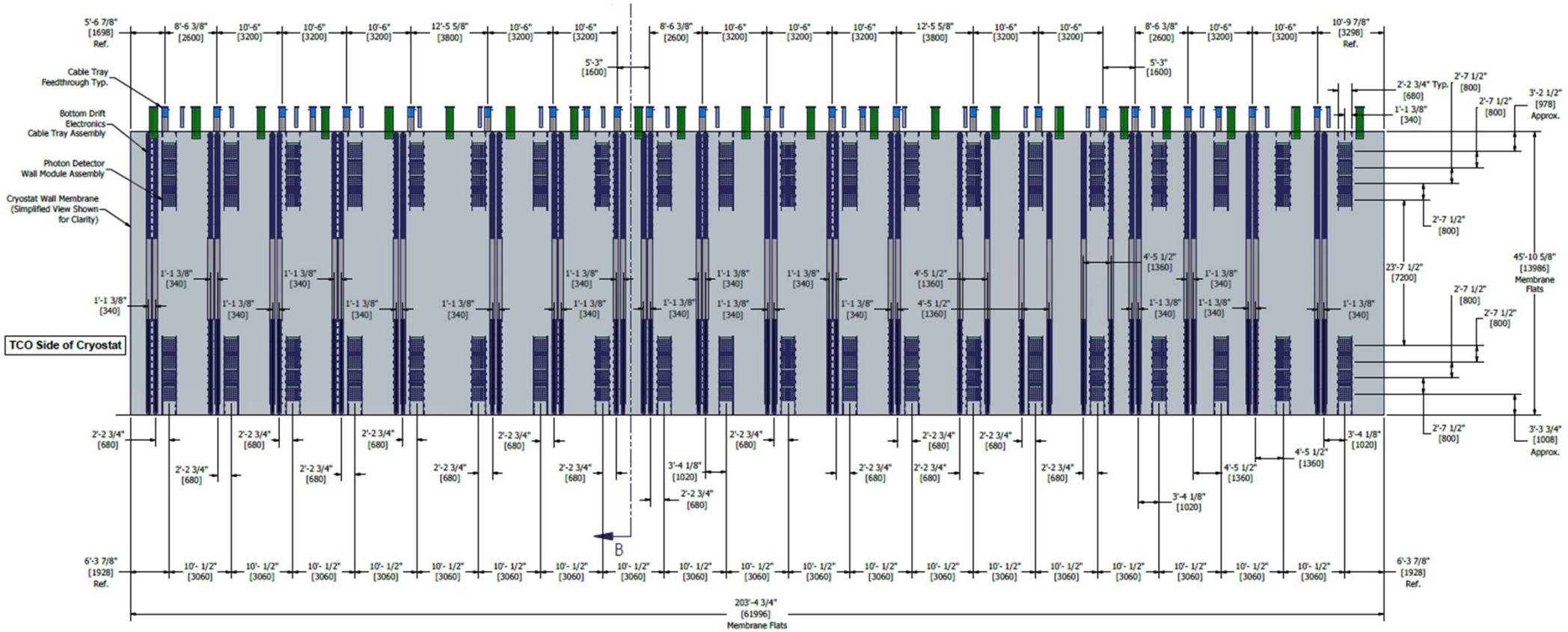


Signal cables of approx. 7 mm diameter. Total weight on detector wall: 280 kg

2.5.-Interfaces between systems.

Interfaces

The interfaces between the wall PD modules and BDE cable trays are understood.
Interfaces with the membrane and PD modules is defined.



From Nicholas Joniak/James Stewart

3.- Budget of the different configurations.

Only quantified the material and 'Ciemat' production cost of the system elements, not installation manpower included.

		A *option* Regular distribution of 20 columns (160 PD modules by membrane)	**B *option*** Non-regular distribution of 59 columns (190 PD modules by membrane)
Rod bar version	Budget of the bar lines+ standars elements	22246	65625
	Budget of the PD modules fixation elements	14128	16776
	Total (€)	**36373**	**82401**

4.- To be finalized.

-Fix the membrane PD modules position (PDS sim./reco. Group input).
-3D integration of the signal cables up to the feedthroughs.
-Complete the installation plan in coordination with the I & I (Installation and Coordination team).
-Quality Control and Quality Assurance.