IFIC group meeting
11/12/2017

Many things, but mainly T-gradient

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Installation

- Installed November 20-25:

https://indico.cern.ch/event/685099/contributions/2809199/attachments/1568292/2472826/20171130_ww-protoDUNE_CryoInst.pdf

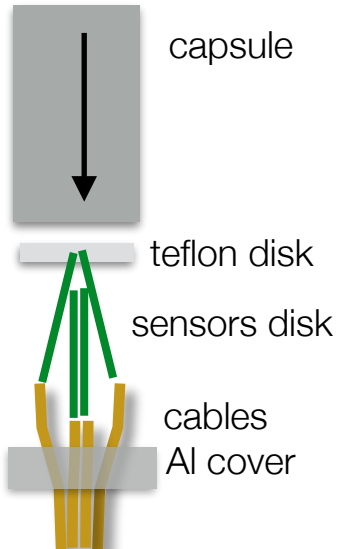
  - Floor cable/sensors (12 standard sensors)
  - Pipes cables (for 12 precision sensors)
    - High precision 20 Ω resistor installed on December 4th
  - four SUBD-25 connectors for all above
  - Ground planes cables (for precision sensors). For 1/3 of ground planes installed

Muchas gracias a los servicios de mecánica y de electrónica por su implicación !!!!!

Calibration procedure I

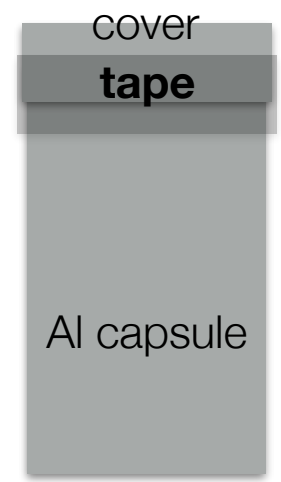
1. Put 4 sensors as close as possible
2. Fix them with tape (be careful with connectors to avoid breaking them)

4. Introduce the disk and the sensors into the aluminum capsule



3. Introduce the edge into the teflon disk slot

5. Put tape surrounding the aluminum cover but keep the slot open

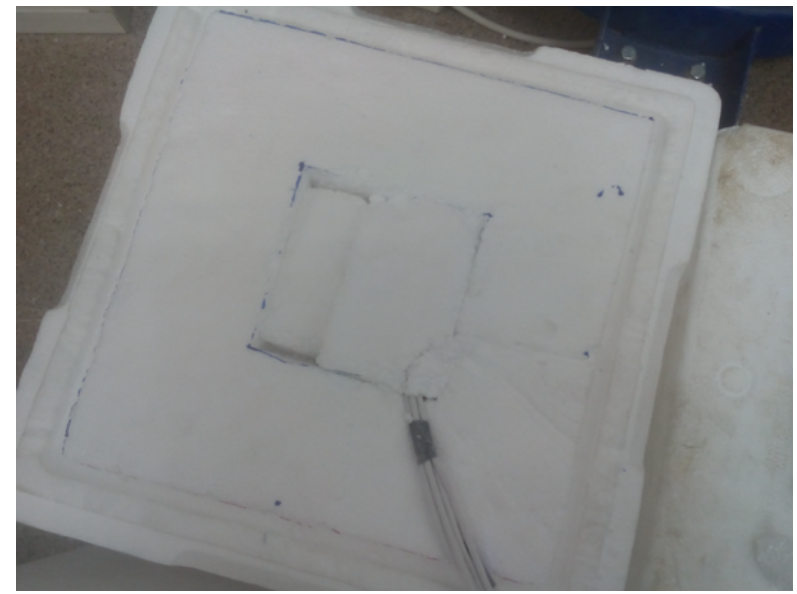


Calibration procedure II

6. Start a new measurement with positive polarity (all switches down). The name of the file should be: DDMMYY_repro_#1_#2_#3_#4_N_pre, where #1,#2,#3 and #4 are the serial numbers of sensors at channels 1, 2, 3 and 4 respectively. N is the index of the file for those sensors

7. Put capsule into LN2, but don't fully submerge it to avoid LN2 going in through the slot in the cover. Be careful with boil-off since LN2 could enter into the capsule. The idea is to cool-down the capsule but with a slow cool-down of the sensors (they should be in air). Put the polystyrene cover and the weight above it

8.When sensors are at 81-83 K open the box put more LN2 until the capsule is fully covered and full of LN2. Then put a small polystyrene cover as in the i mage and then the big cover with the weight on top of it

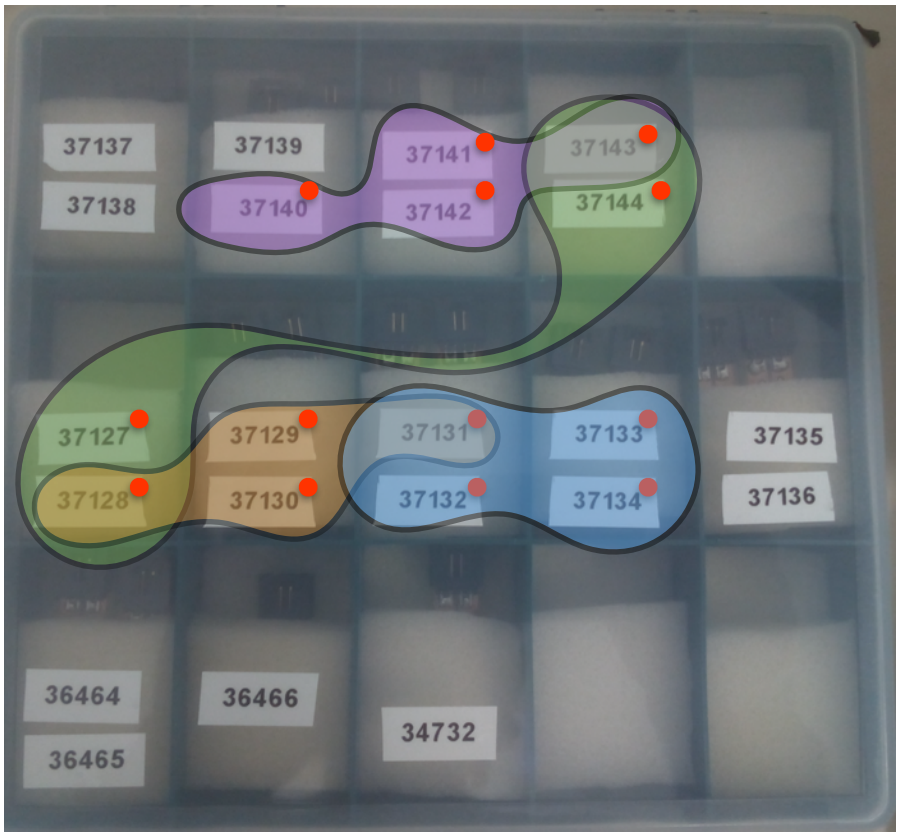


Some considerations

- All sensors have a limit, even when avoiding strong thermal shocks.
  - We have observed small changes in the offsets after many baths
  - We don't want many baths per sensor (5 to start with)
- The system is currently very stable and all offsets do not seem to vary more than 2-3 mK. To achieve this is very important:
  - Avoid electromagnetic noise. Careful connections and current source inside faraday cage
  - Fully cover capsule with LN2
  - Close as hermetic as possible the polystyrene box. Heat flow into the LN2 should be as small as possible to minimise convection.
  - Wait until all sensors indicate a very stable temperature. Variation of less 1 mk per minute in all sensors.
- Treat very carefully all sensors: don't hit them, avoid vibrations and any shocks.

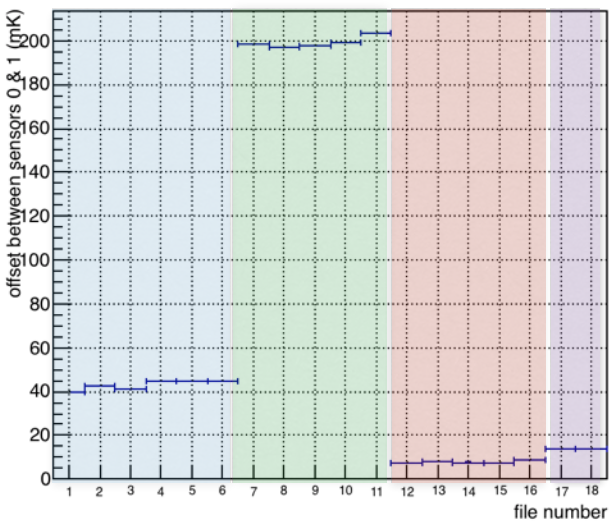
Calibration status

- The ones marked have been calibrated
- For each set of sensors we take 5 measurements, 2 one day and another 3 the next day

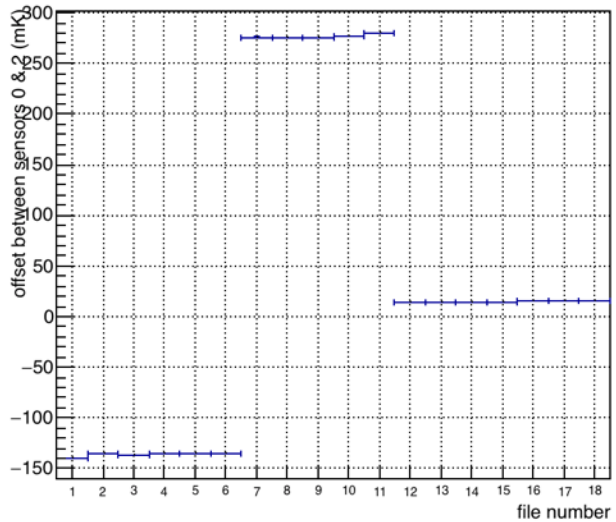


- After five measurements we change all sensors except the one at channel 4, which is moved to channel 1 and kept as reference for the next set
- Then we take three measurements one day with those four sensors, another two measurement the next day, with the same sensors, and then change sensors again.

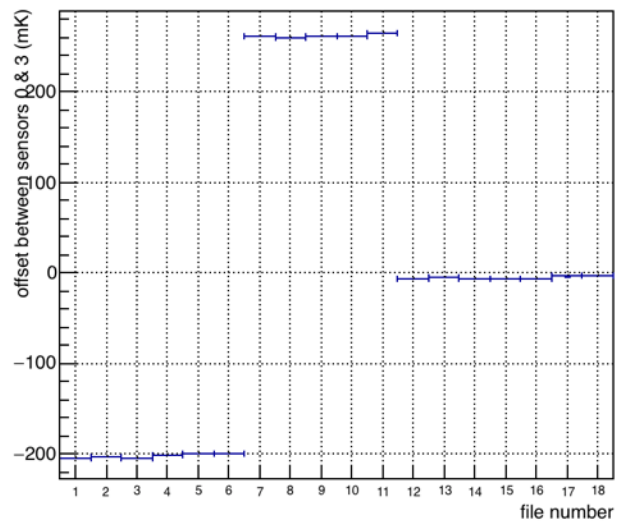
offset_1



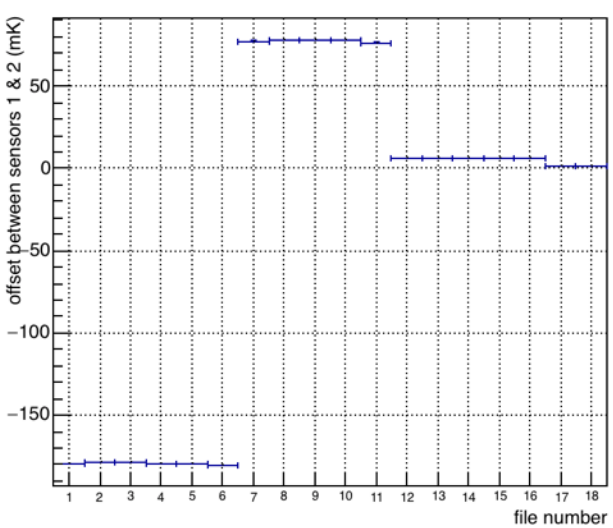
offset_2



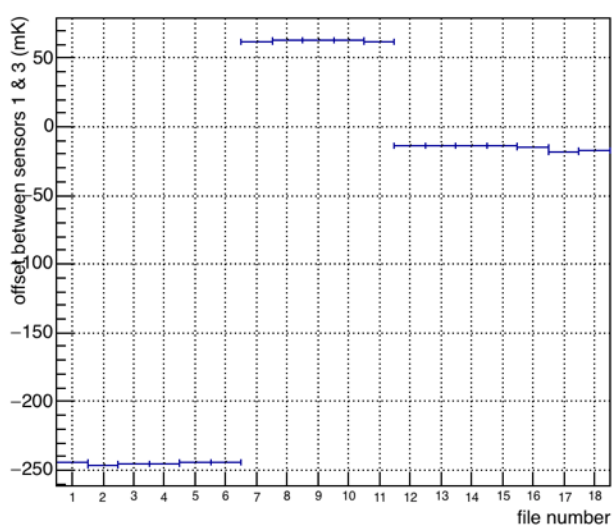
offset_3



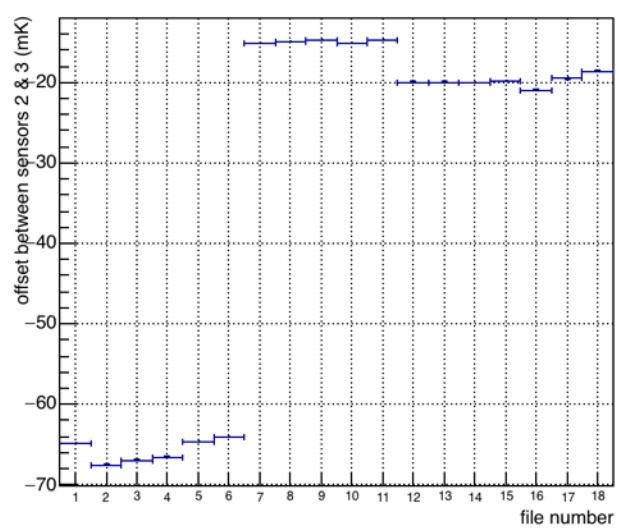
offset_4



offset_5



offset_6



Next Steps

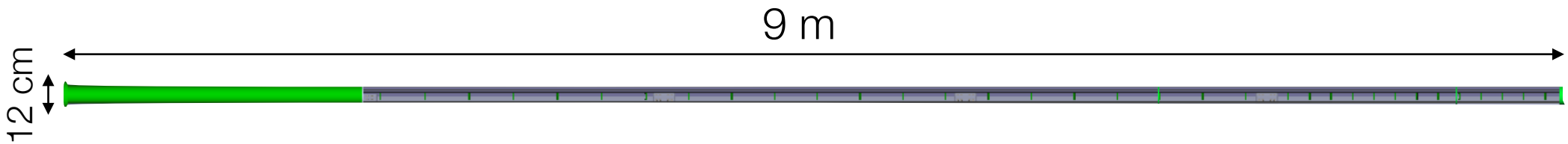
- Pipe and ground plane sensors must be installed in February

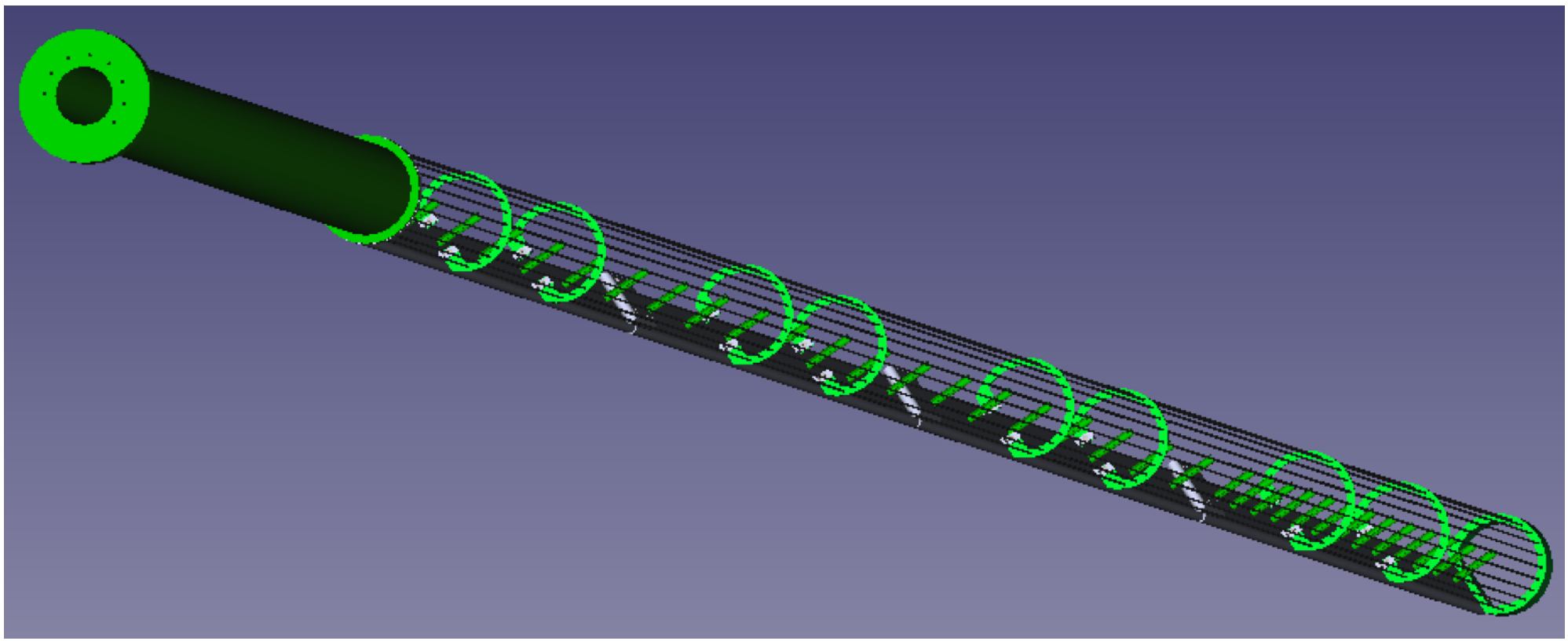
- Schedule
  - **December**: The new readout system with multiplexing card will arrive this week
  - **January-March**: Sensors will be calibrated first at IFIC with LN2
  - **April, may:** Sensors sent to CERN and calibrated with final readout and LAr

T-gradient

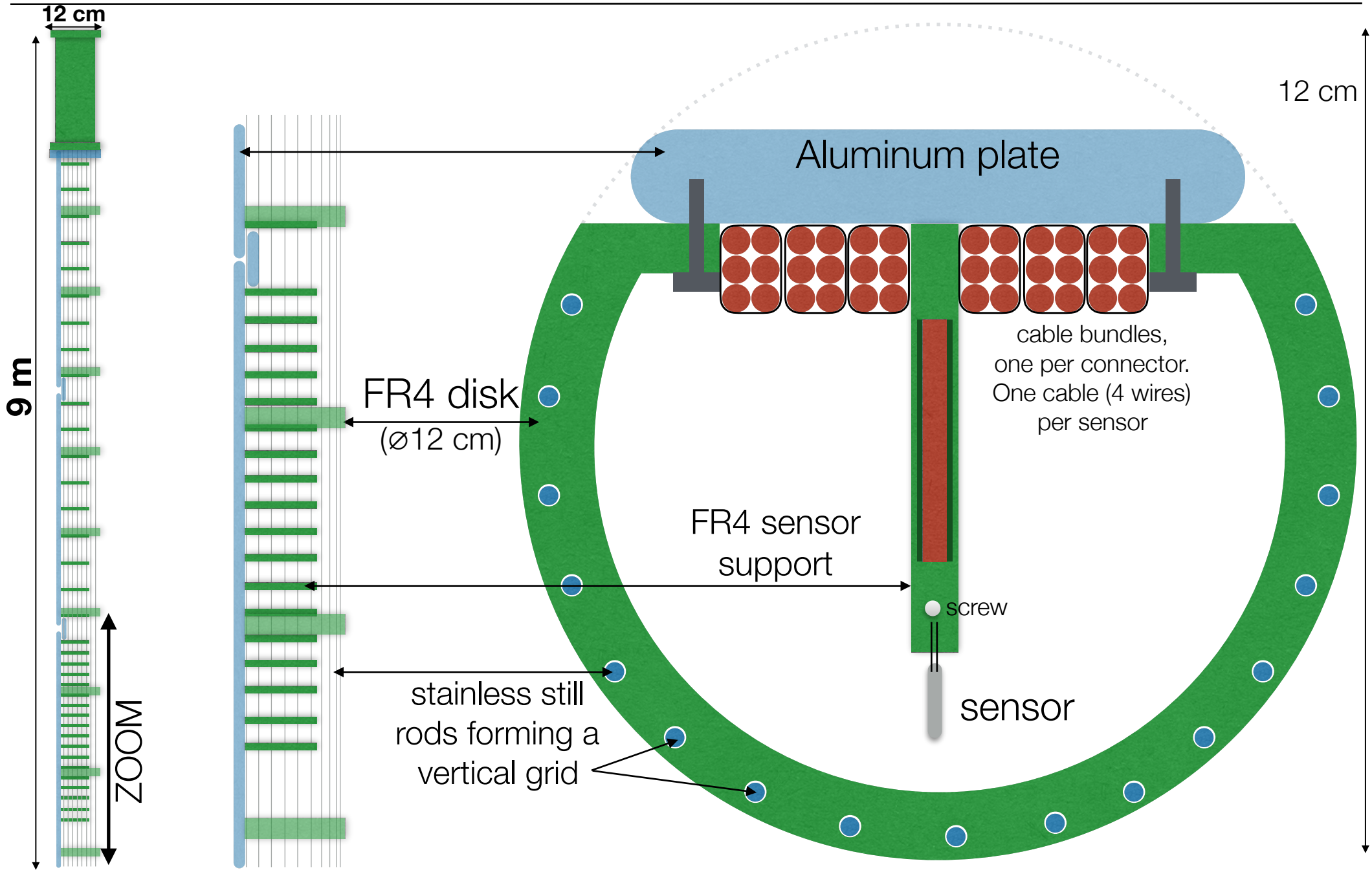
April 3D model

- 9 meters long and 12 cm diameter cylinder hanging from port 14.4 (14 cm diameter)



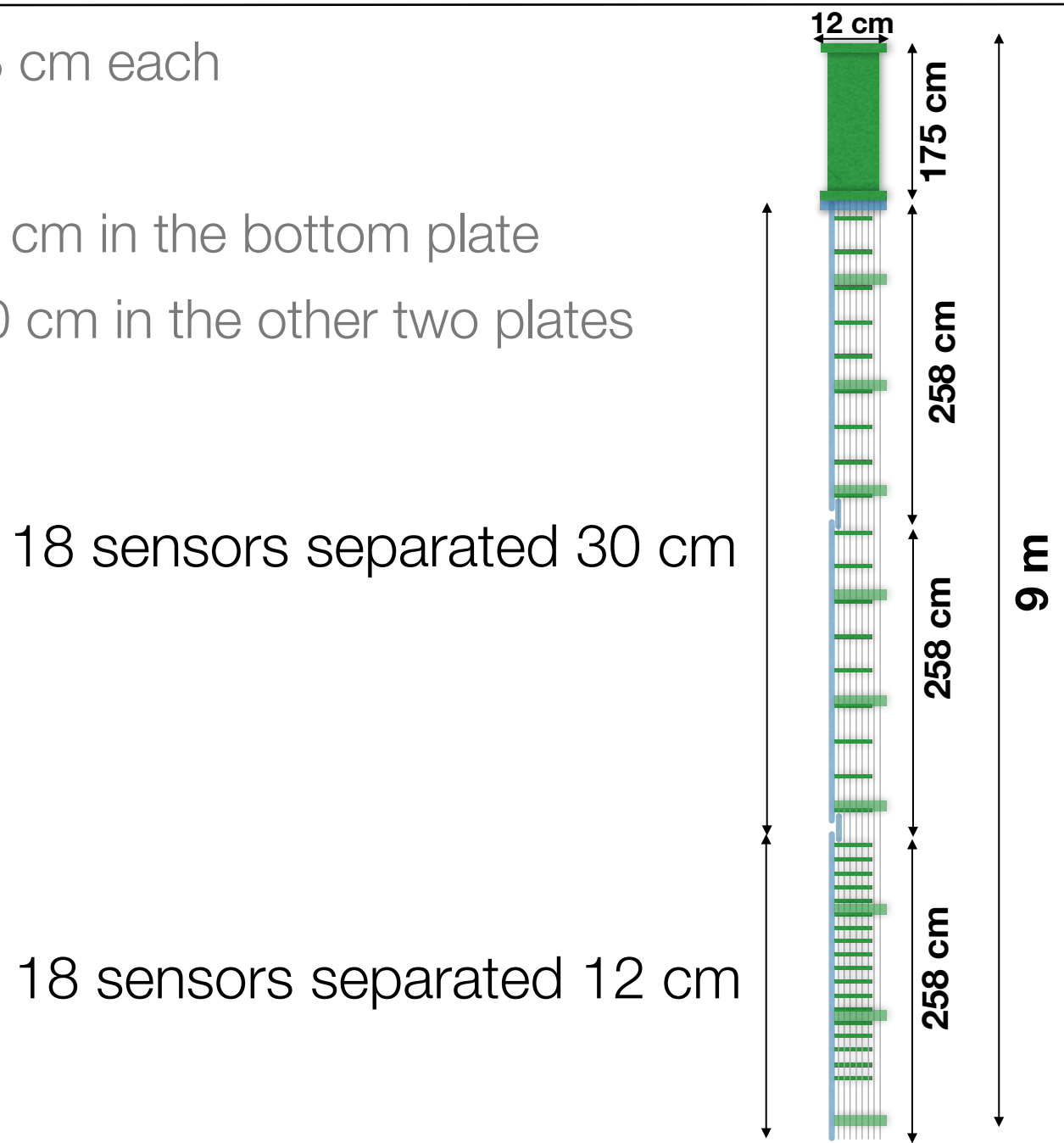


April conceptual design



April configuration

- 3 aluminum plates of 258 cm each
- 3 FR4 disks per plate
- 18 sensors separated 12 cm in the bottom plate
- 18 sensors, separated 30 cm in the other two plates

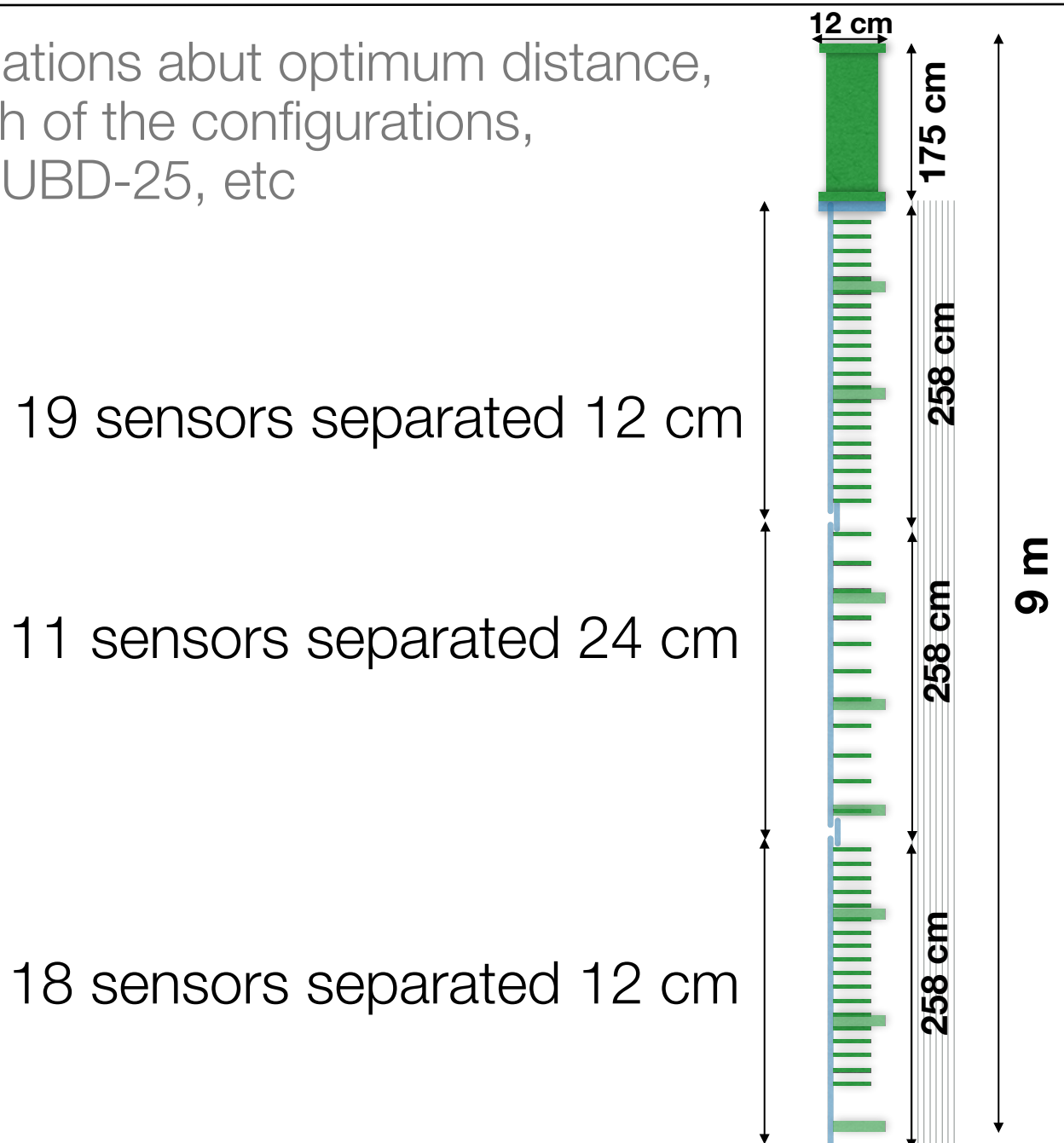


News

- Will use 48 sensors instead of 36. As suggested by the review committee The lack of in situ calibration can be somehow compensated by the usage of more sensors

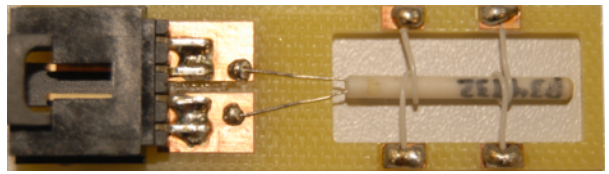
New configuration

- Need to do precise calculations abut optimum distance, number of sensors in each of the configurations, considering grouping in SUBD-25, etc

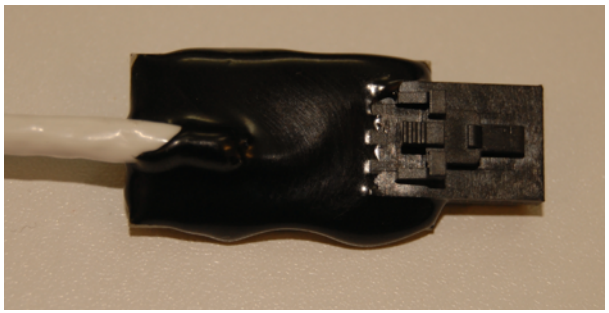


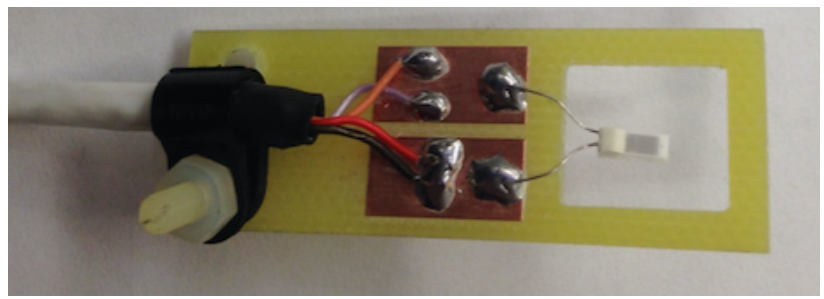
Lessons learned I

- Sensor support
  - The current support works very well
  - The IDC-4 connector with retain system gave no problems so far



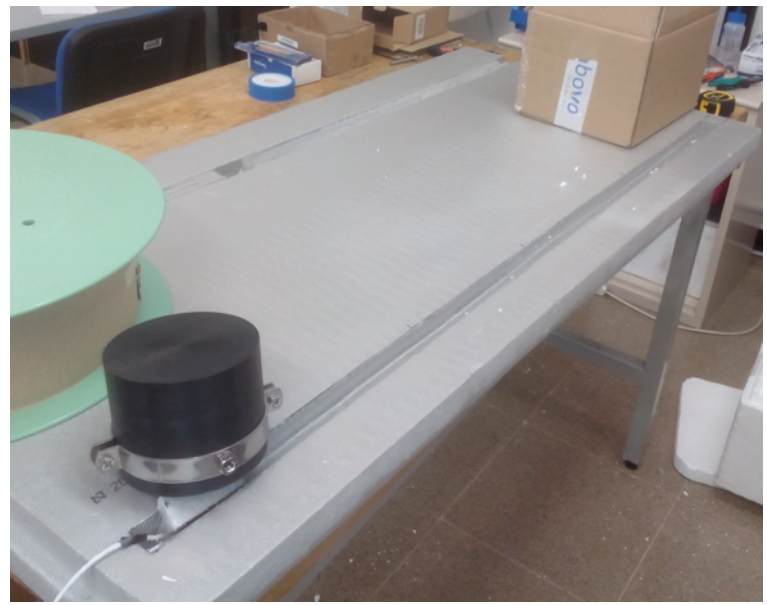
- Cable retain system:
  - Epoxied: used for pipe sensors
  - Cable tie: used for floor sensors. It seems to work well.





Lessons learned II

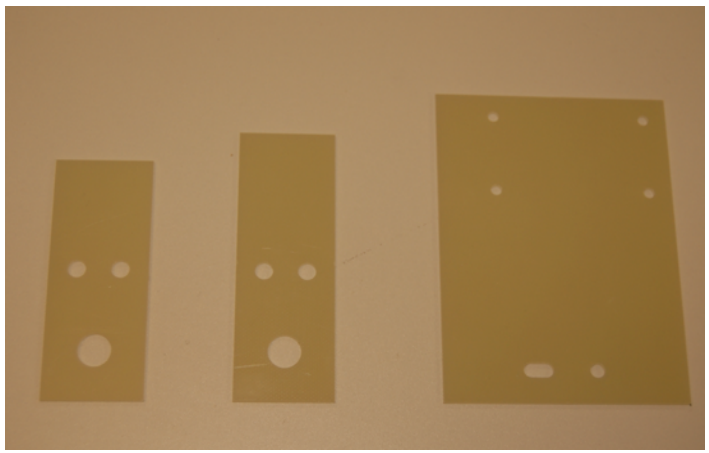
- Cable shrinkage
  - While for teflon-only we expect 2% shrinkage, the actual cable only shrinks 0.5 %. Need to do more measurements to confirm that

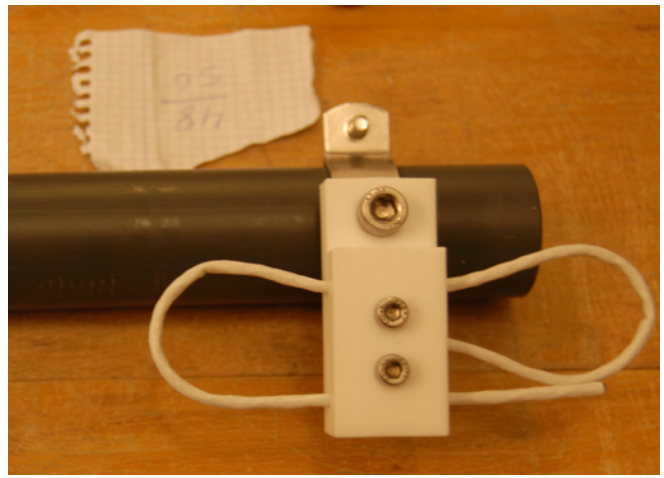


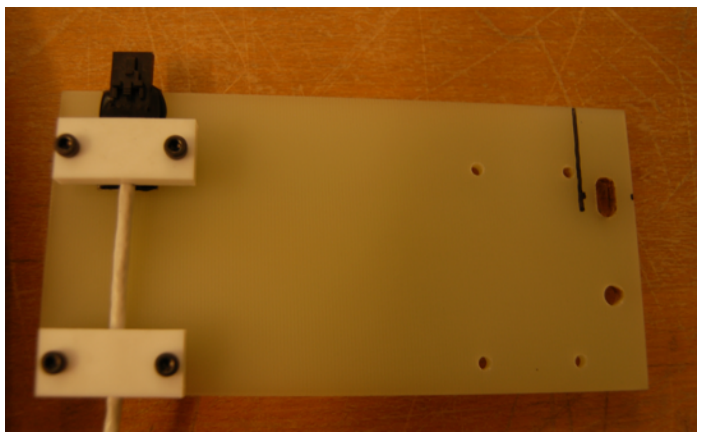
- If this is finally the case, aluminum will have a very similar contraction so a minimal tolerance would be sufficient.

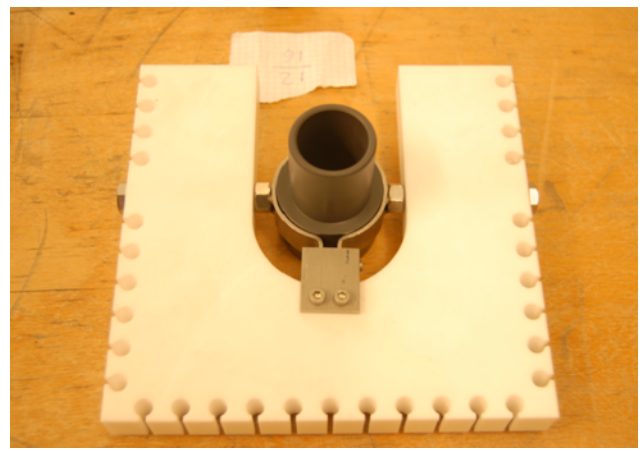
Lesson learned III

- thin FR4 plates (< 2 mm) can be easily machined at IFIC and are quite versatile for support structures (sensor, cable, grid, etc)
- teflon pieces can be machined at IFIC. They are useful to join other pieces and to attach cables



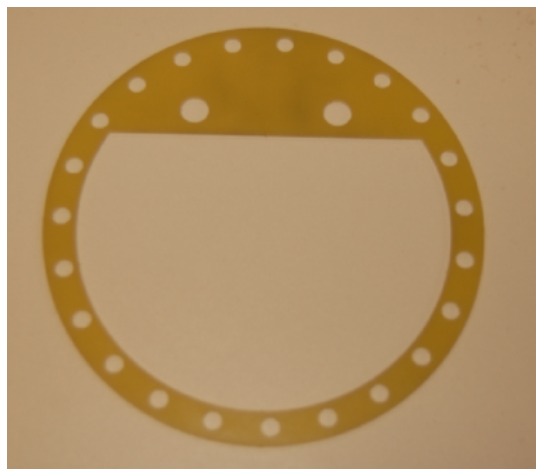


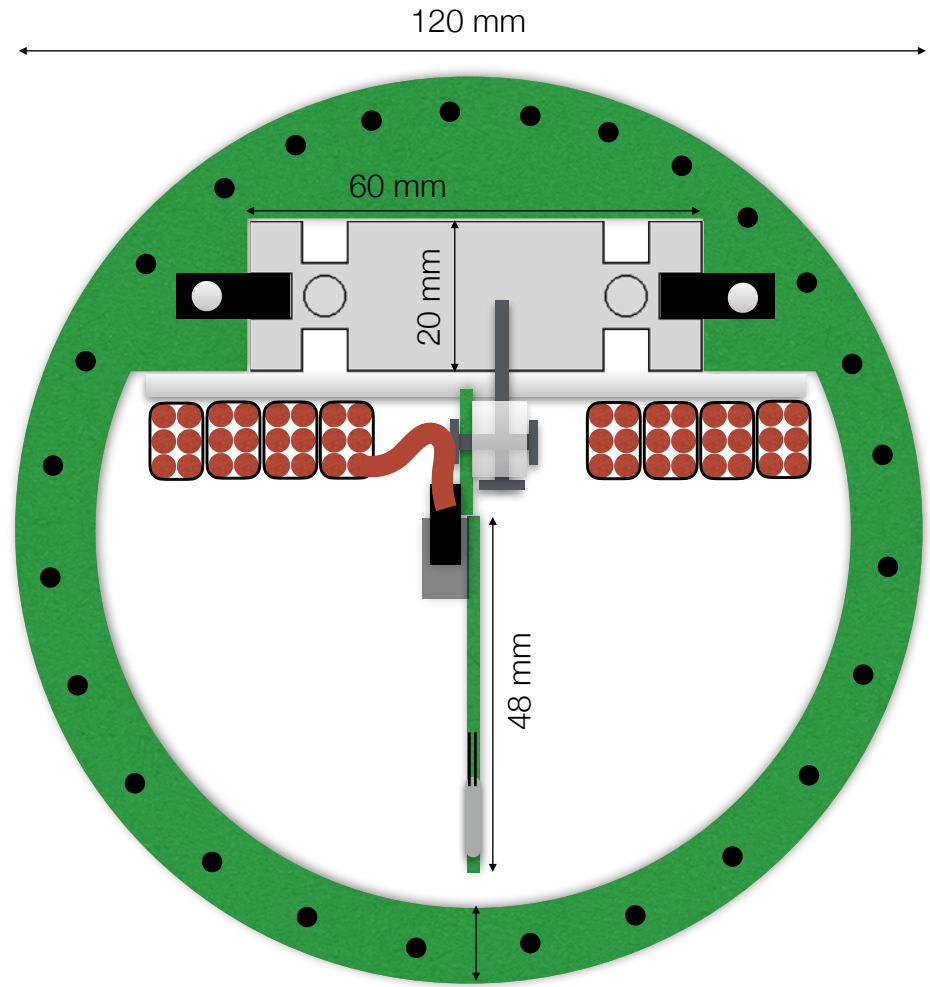




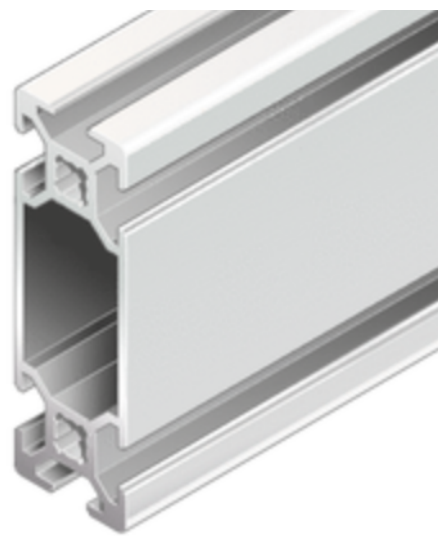
New conceptual design

Prototype FR4 disk with holes as support for SS rods forming the faraday cage

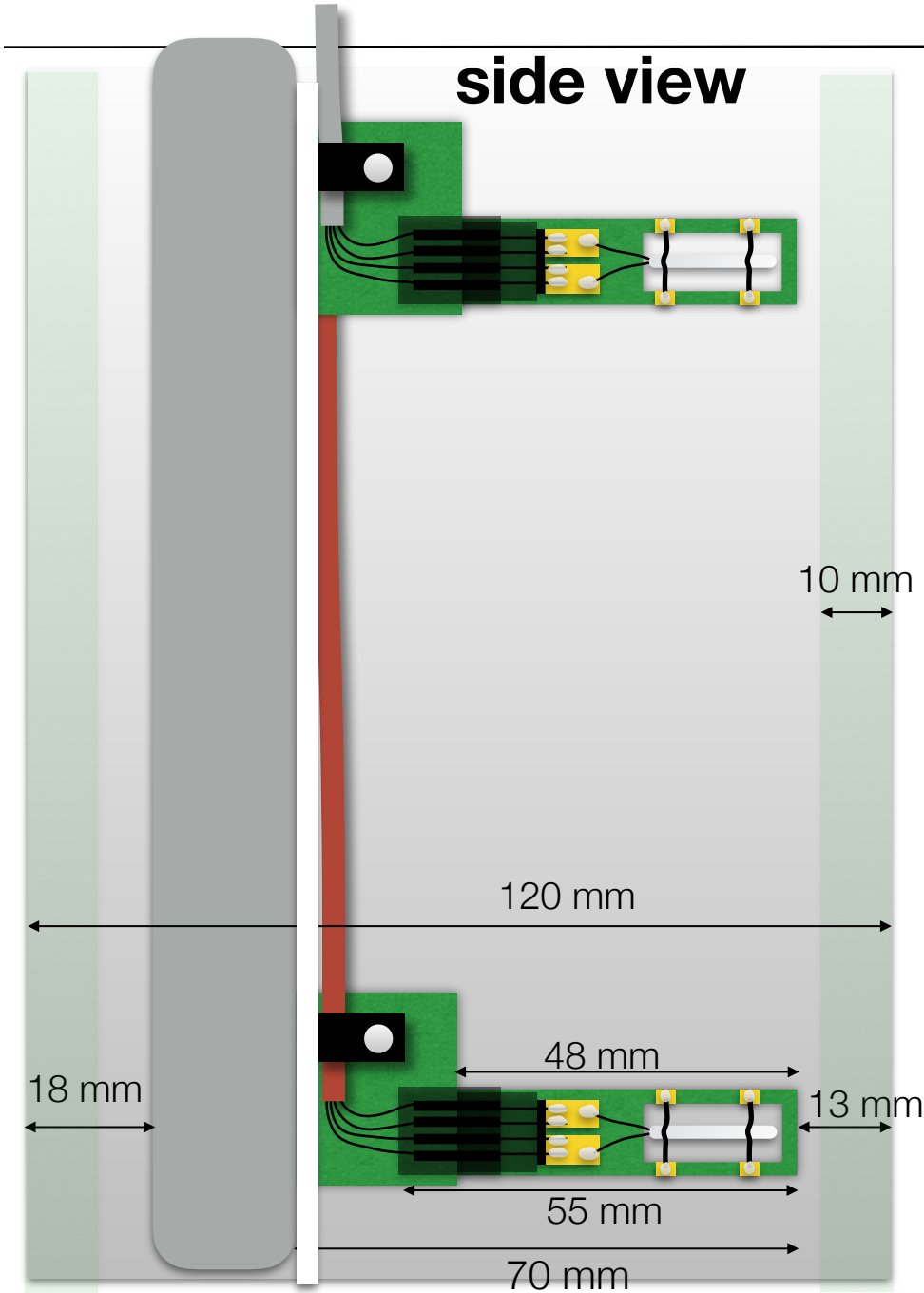


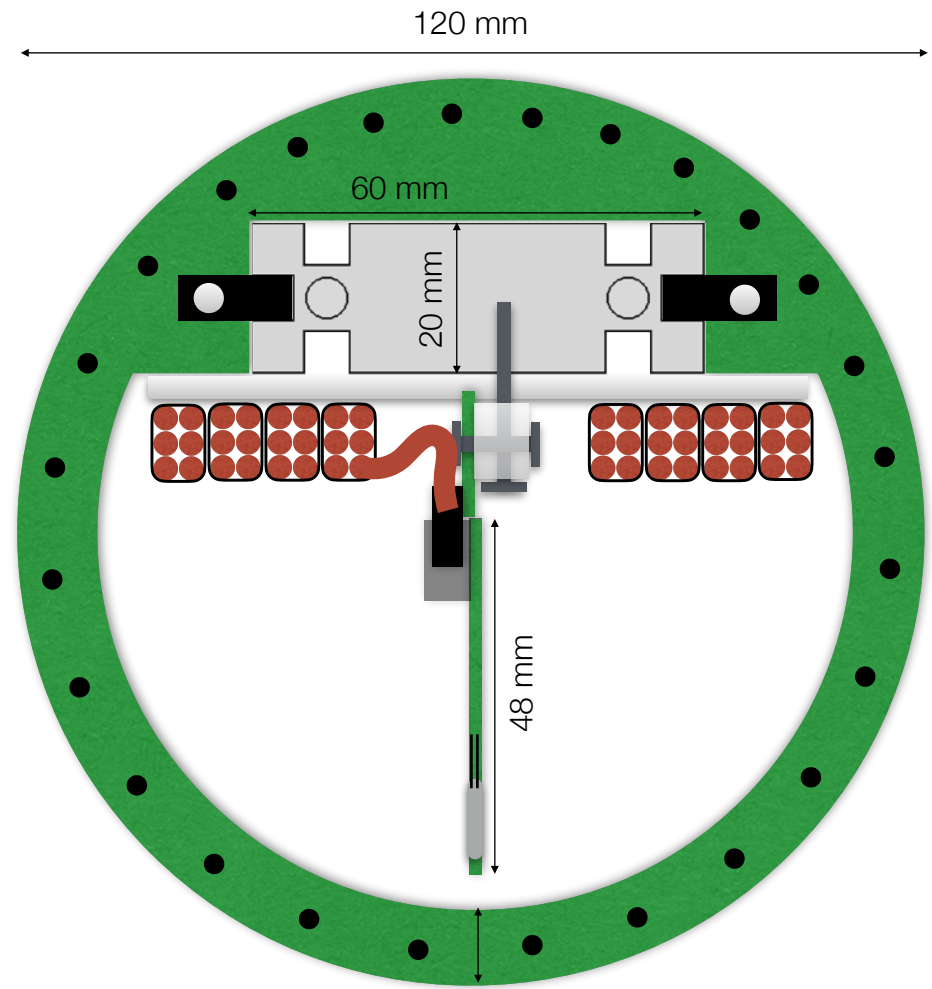


this is an option for the mechanical structure



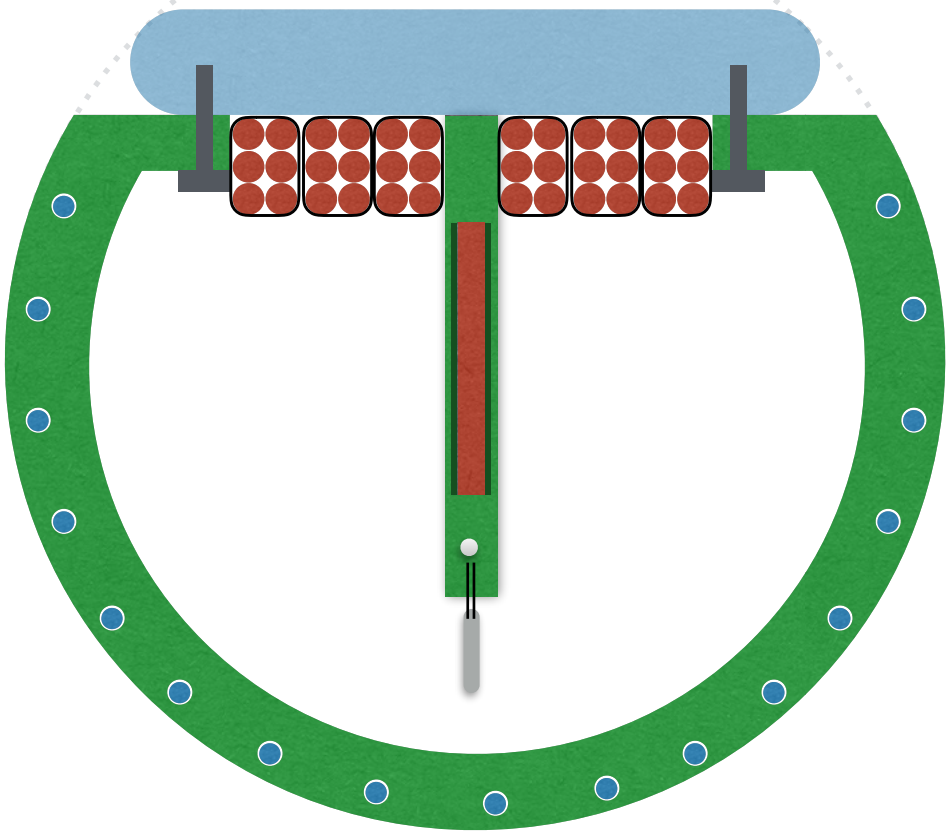
New conceptual design



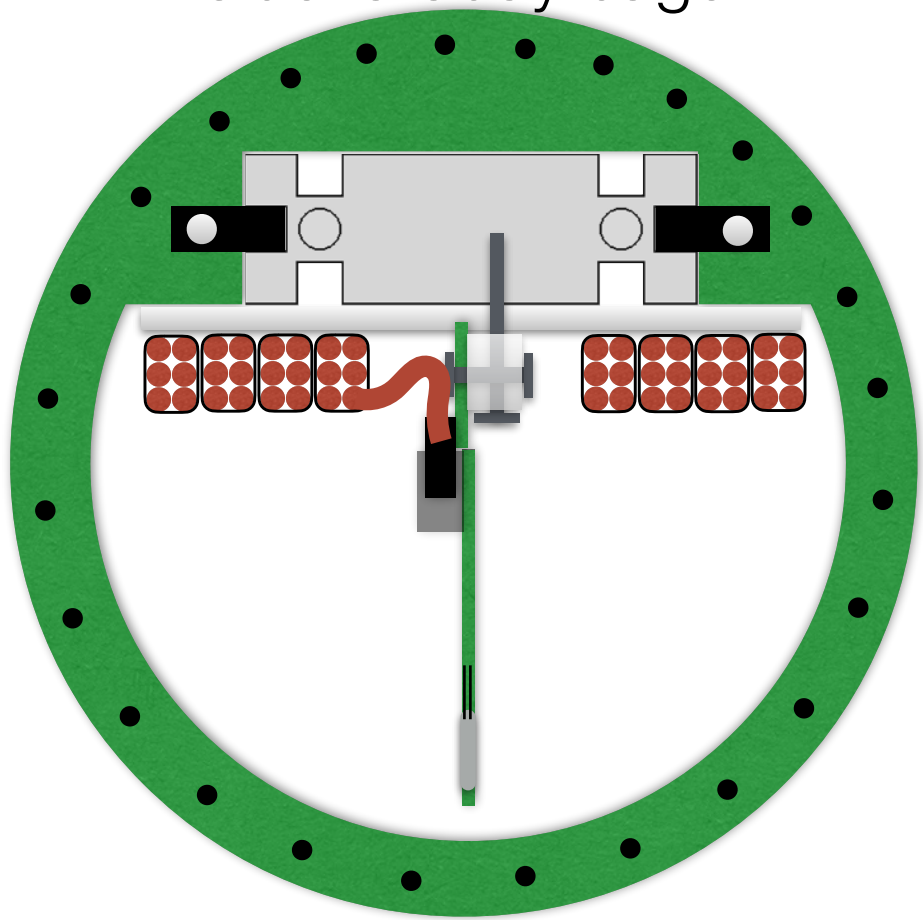


Faraday cage

mechanical structure
part of faraday cage

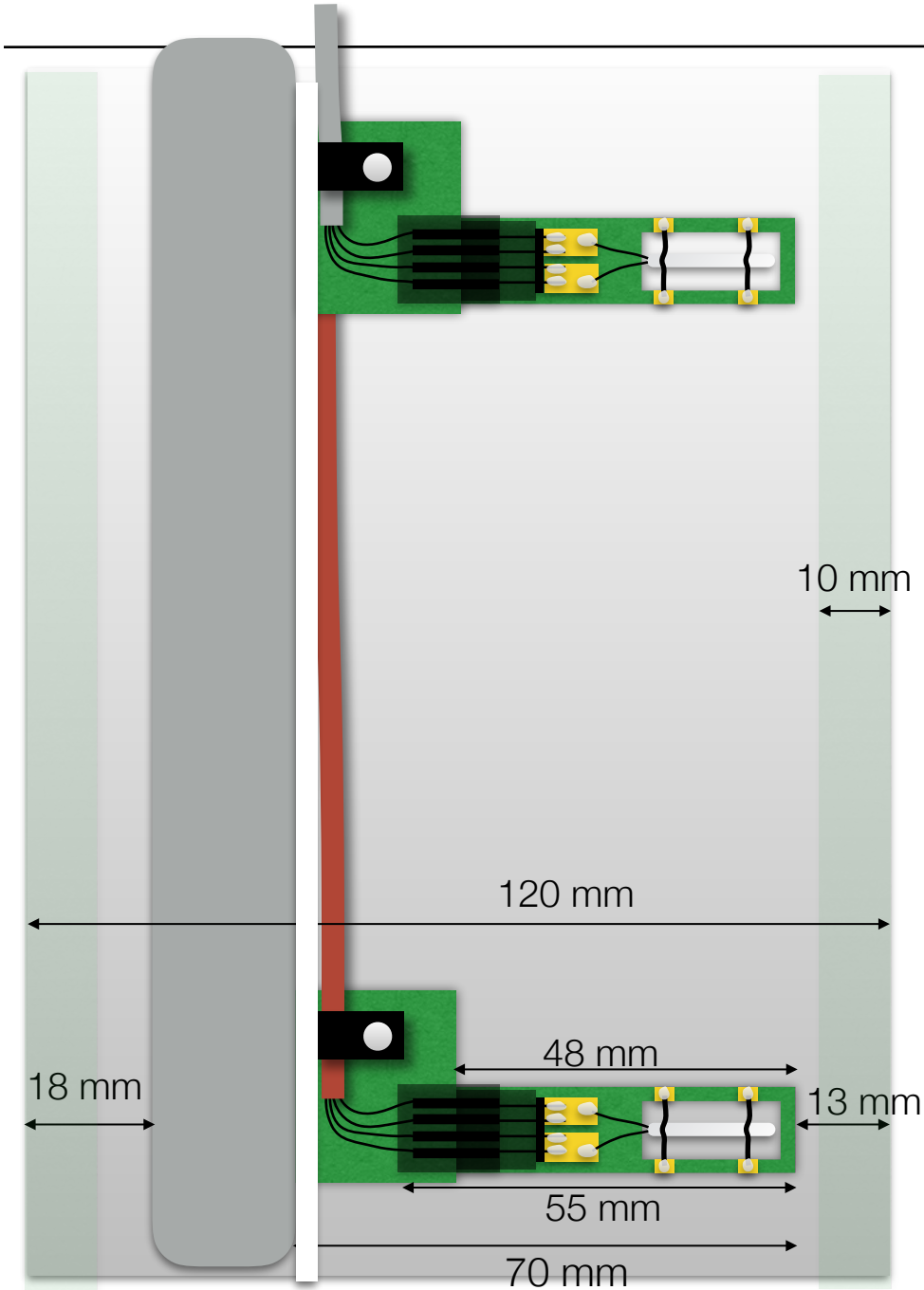


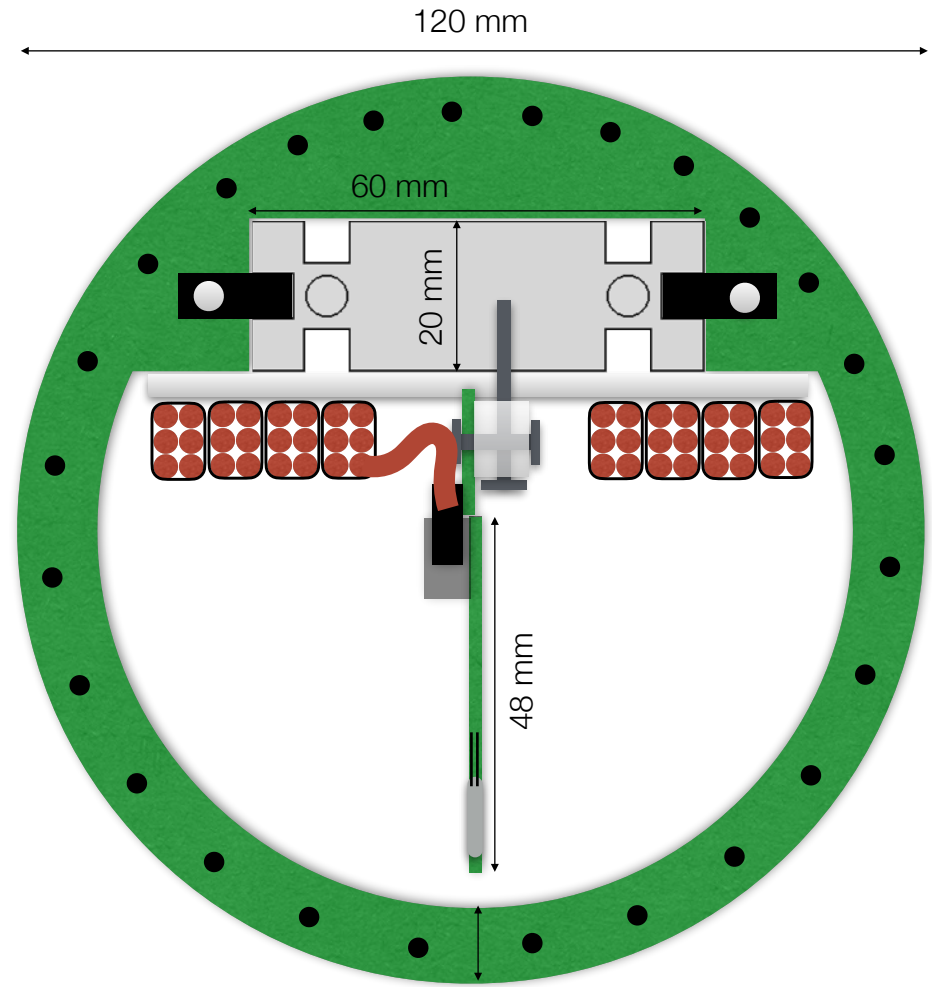
mechanical structure
inside faraday cage



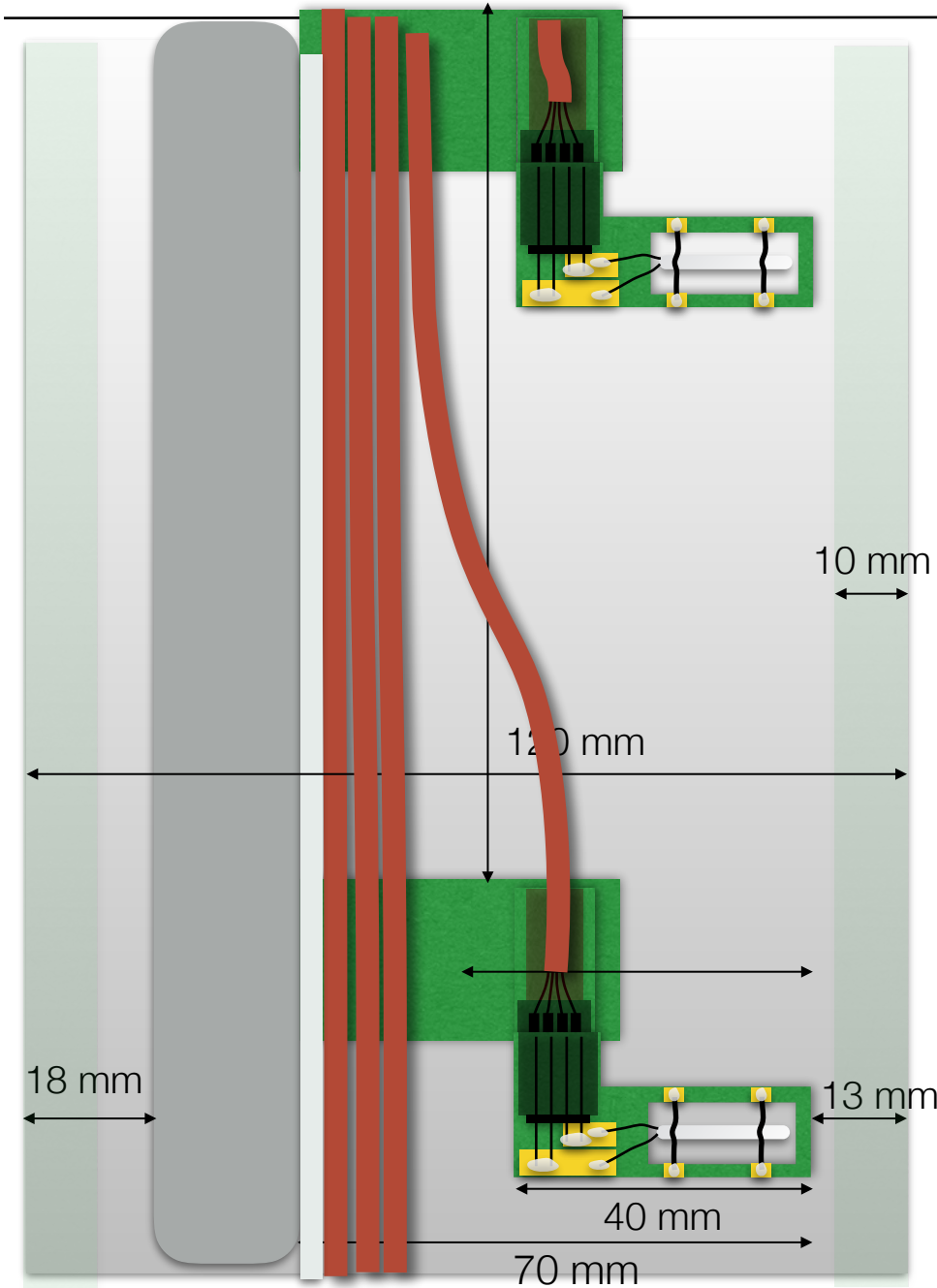
Notice that density of SS rods could be larger at the top

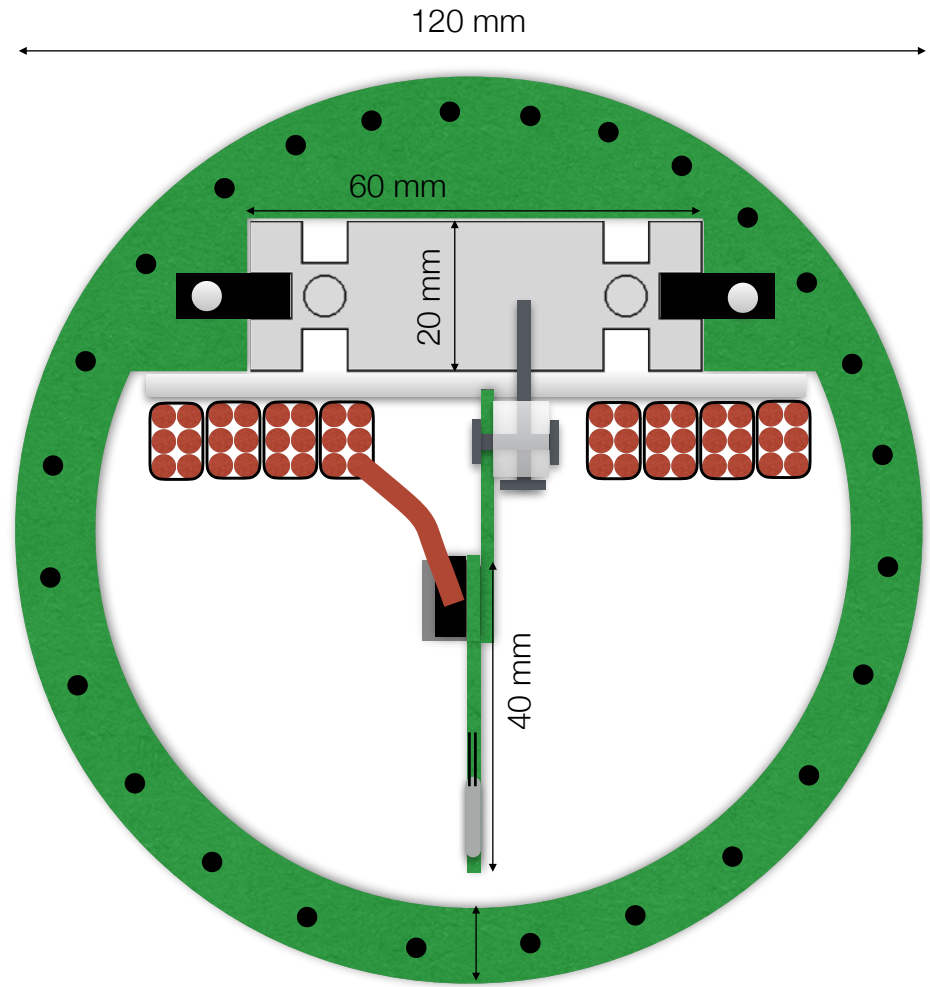
New conceptual design





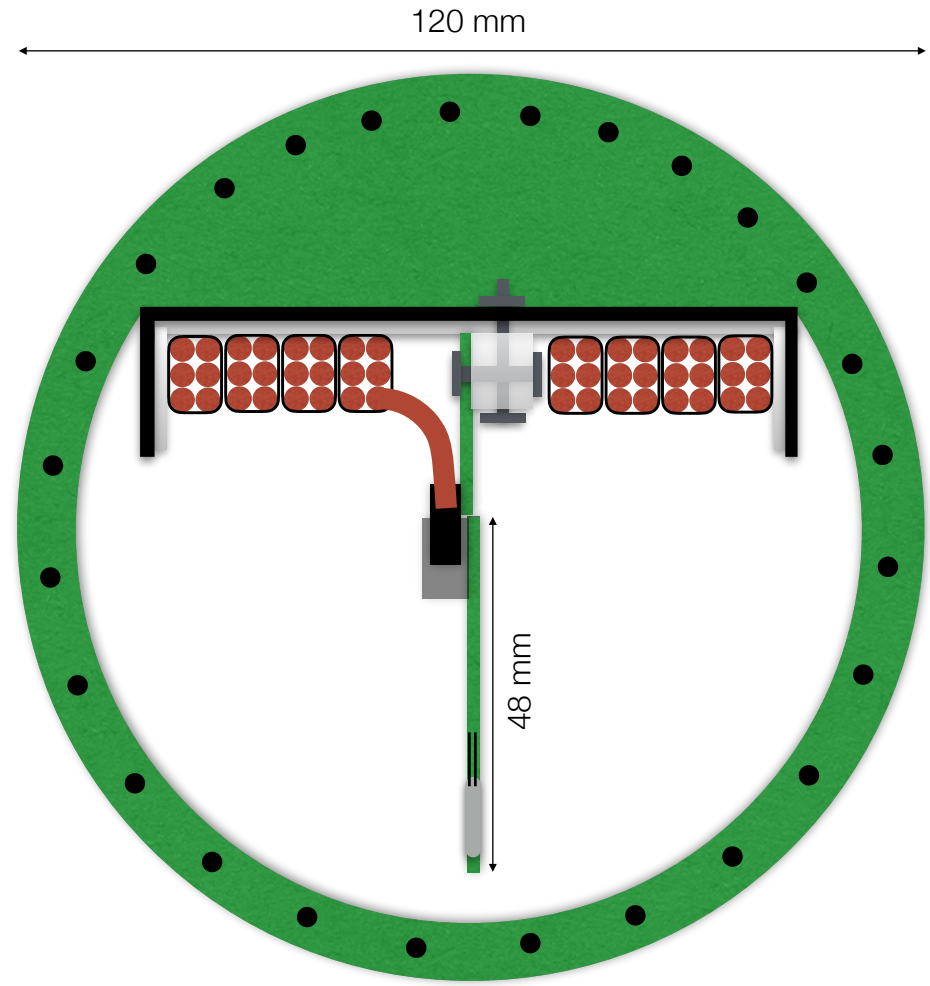
With vertical connection



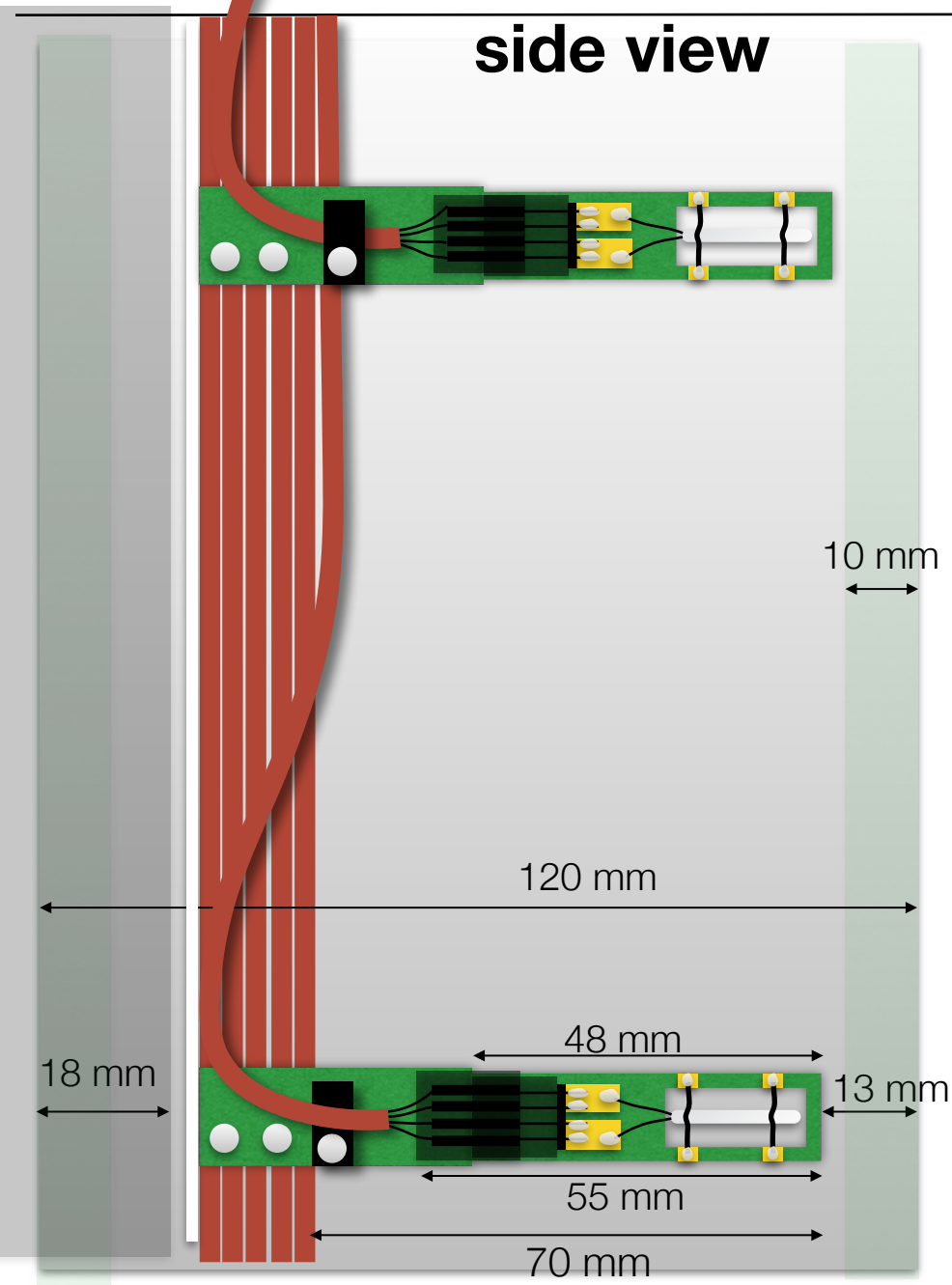


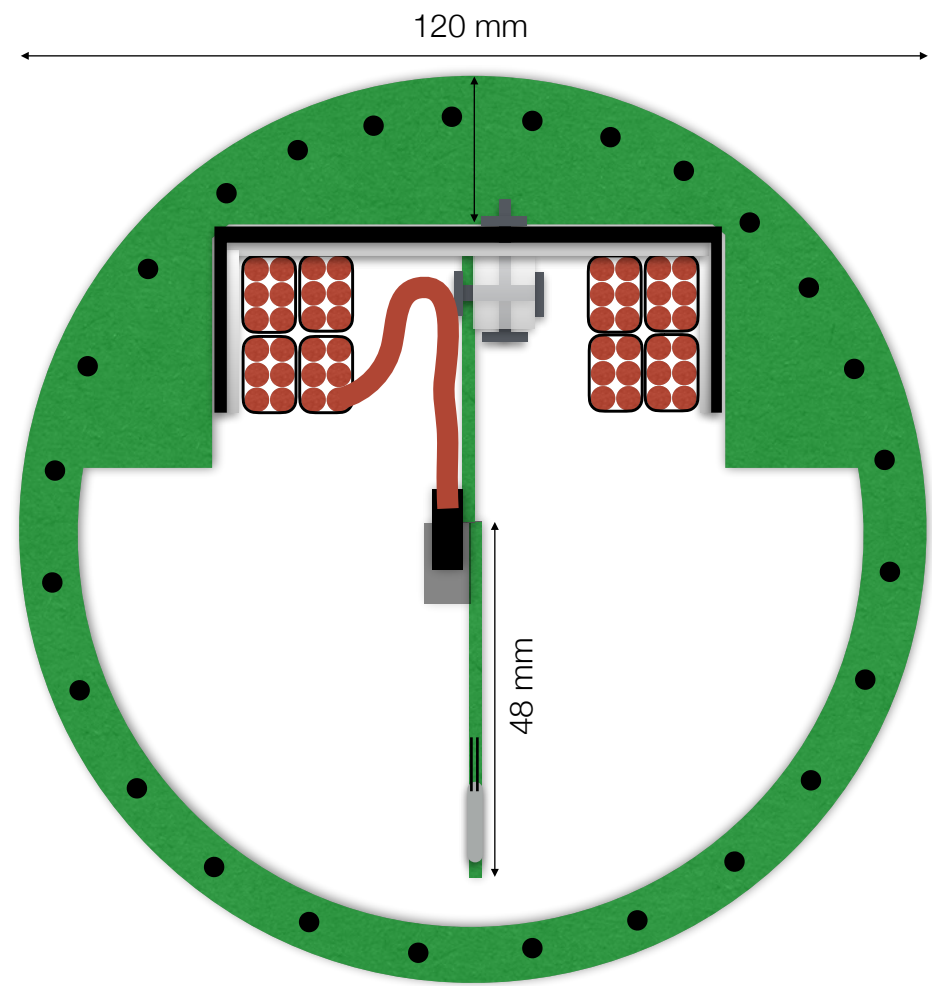
alternative: U-profile

- Covered internally with teflon (~1.5 mm)
- This has some advantages
  - There is less aluminum and is farther from the sensor, so less thermal bias
  - Cables are also farther from the sensor
  - There will be space to put the connector horizontally
- Questions:
  - Is the structure rigid enough ?

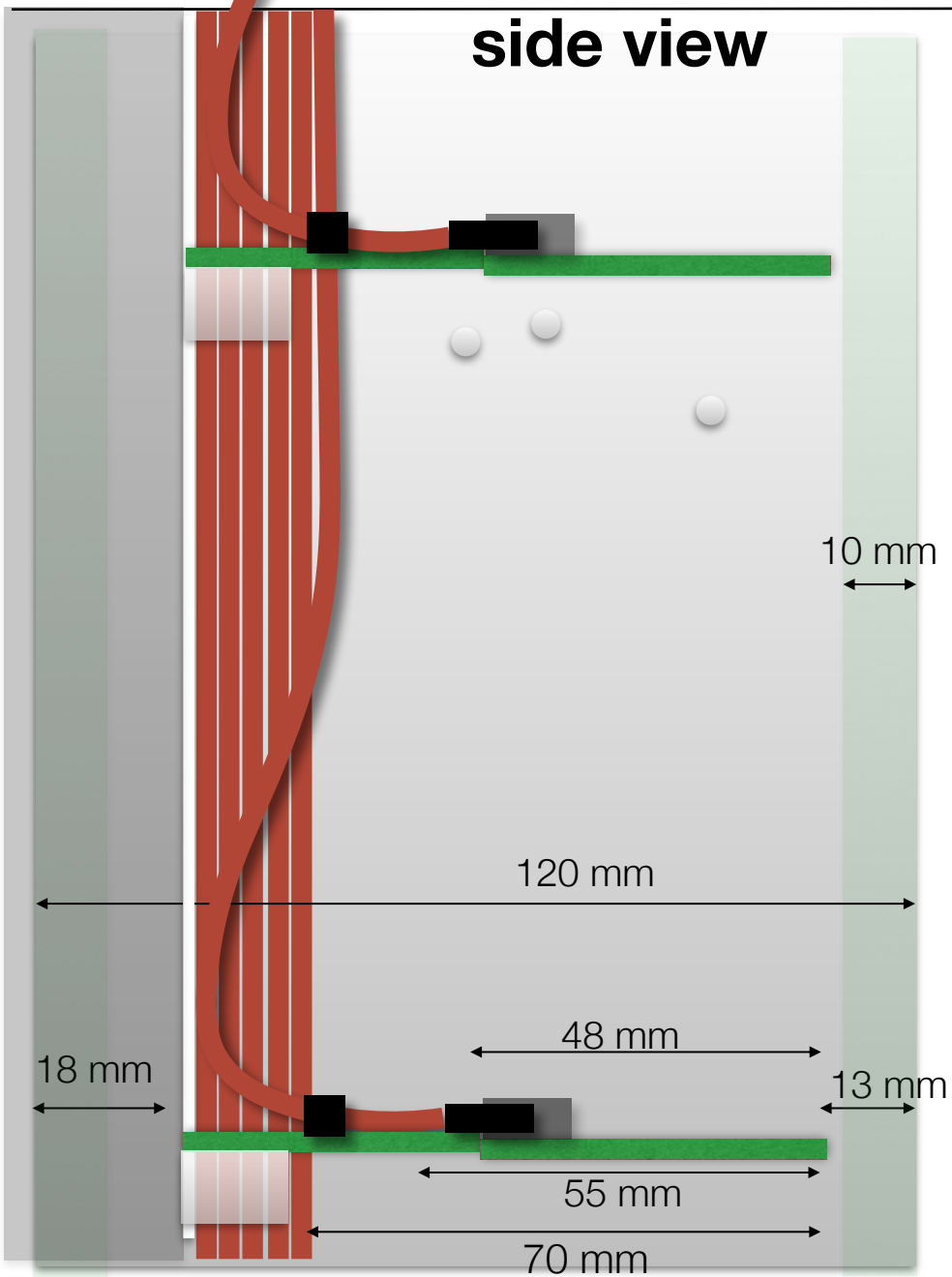


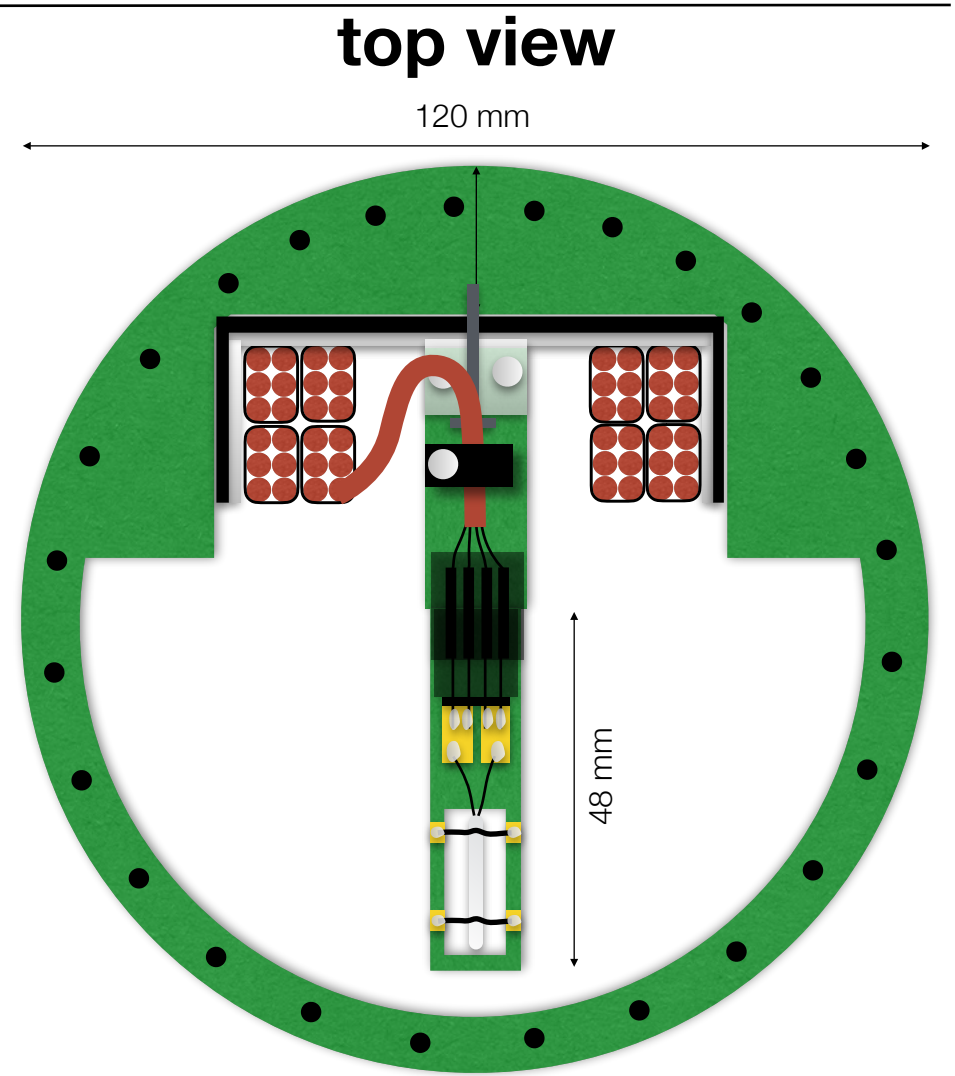
New conceptual design



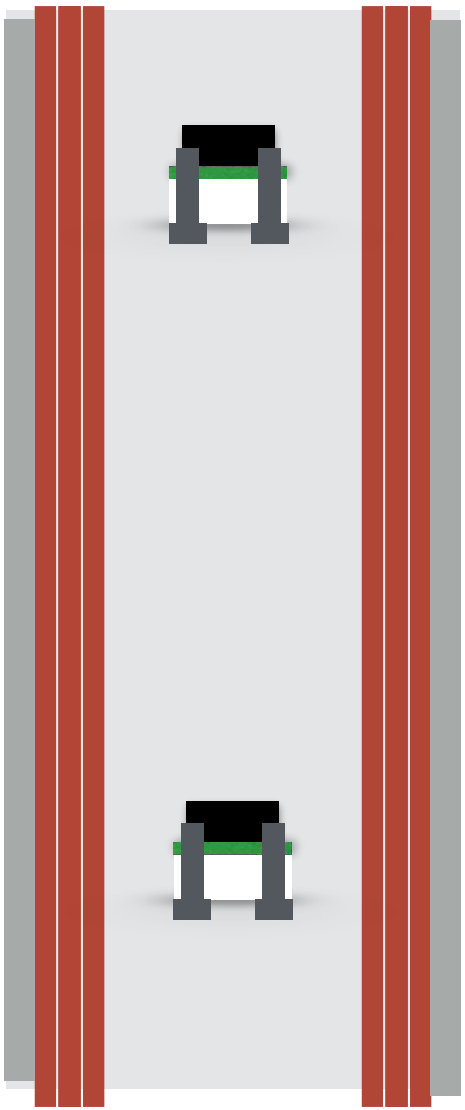


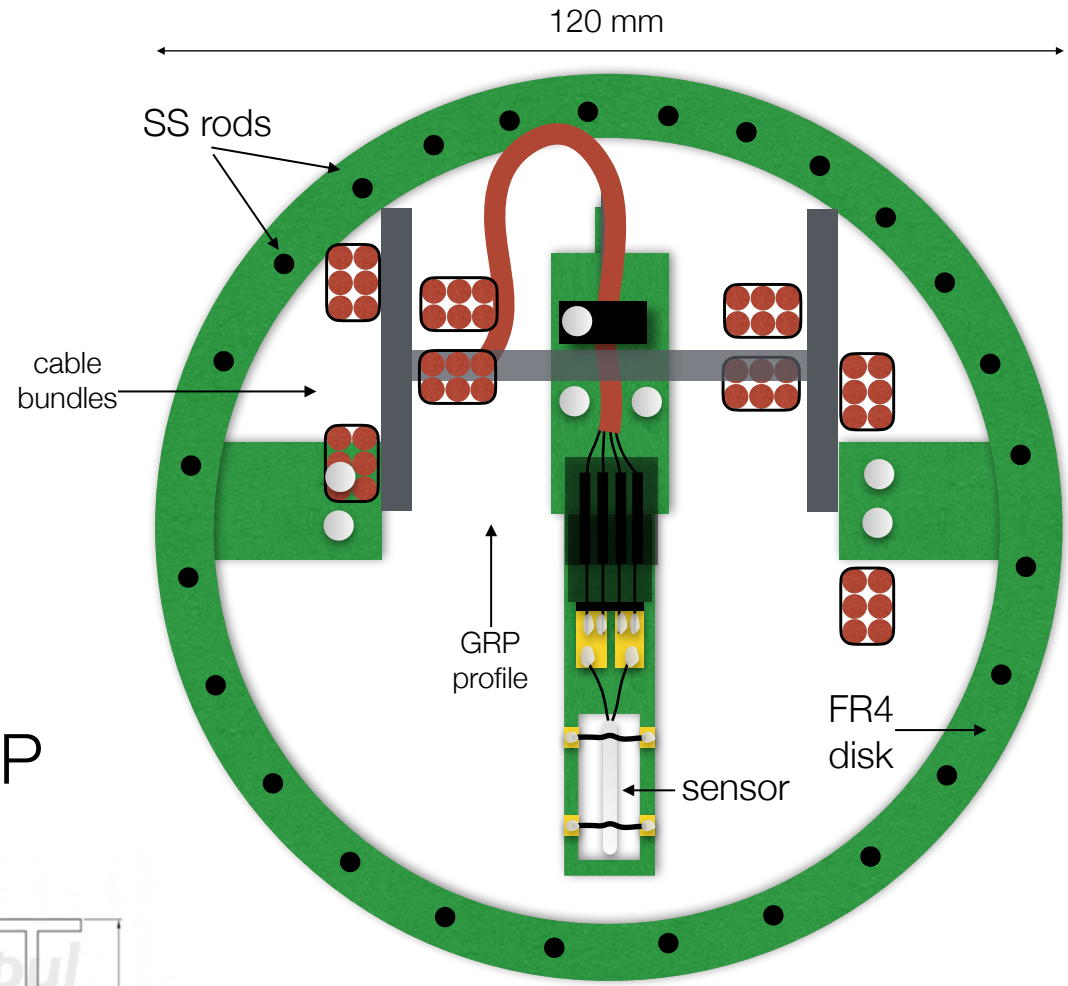
New conceptual design



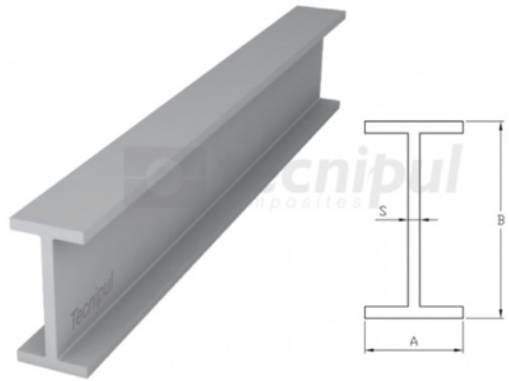


alternative: H-profile



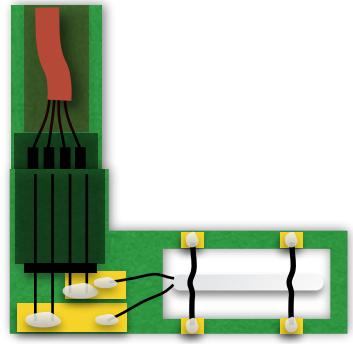


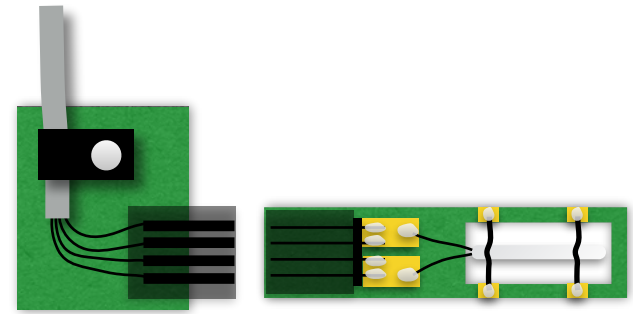
Tecnipul: GRP



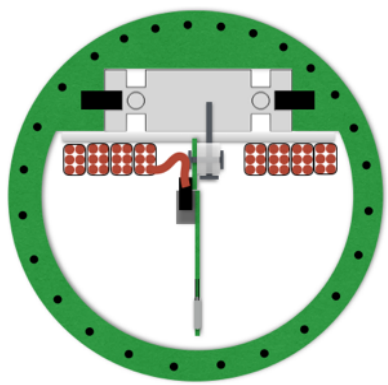
Key items I

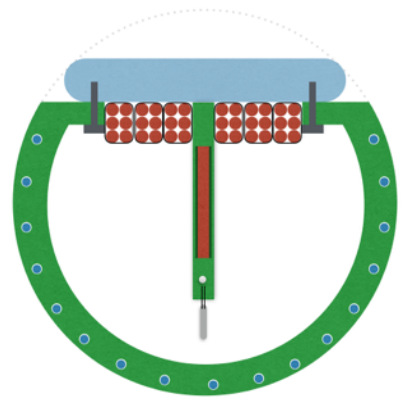
- Freeze the sensor and cable supports ASAP





- Decide strategy for support structure:
  - SS vs Aluminum vs **GRP/FR4**
  - Solid vs **hollow profile**
  - U vs **H** vs rectangular profile
  - **Inside faraday cage** or part of Faraday cage



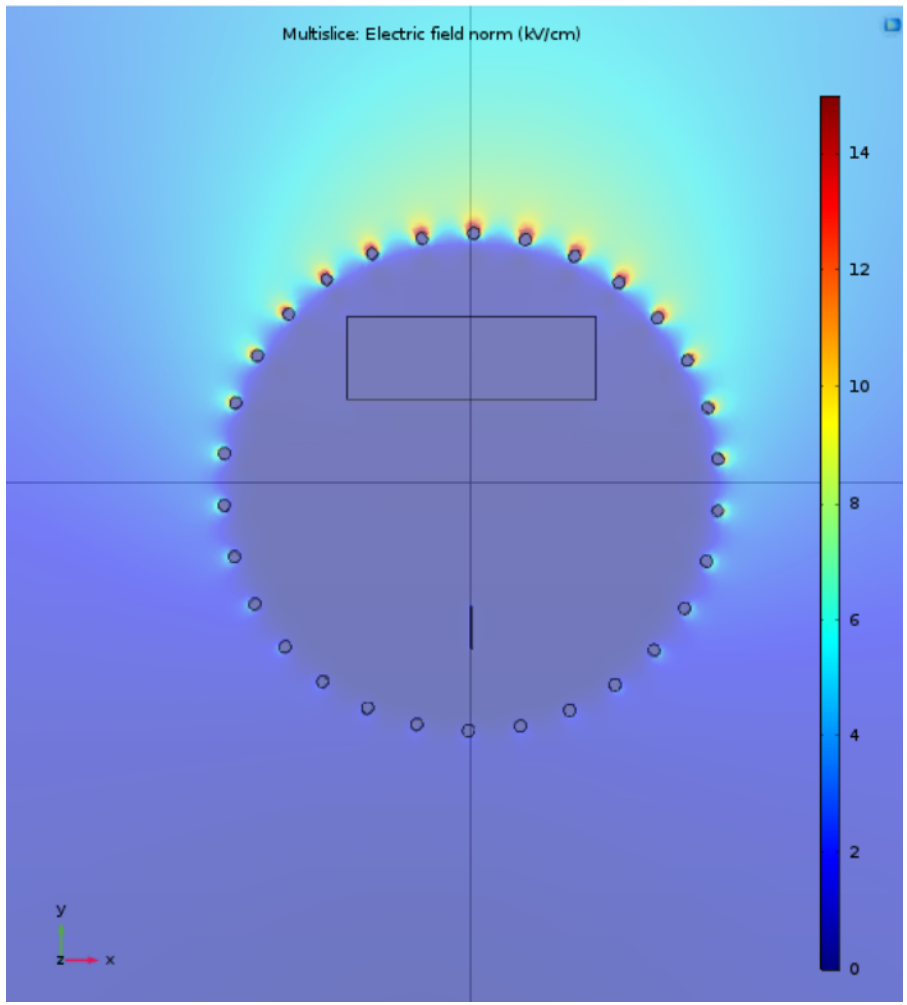


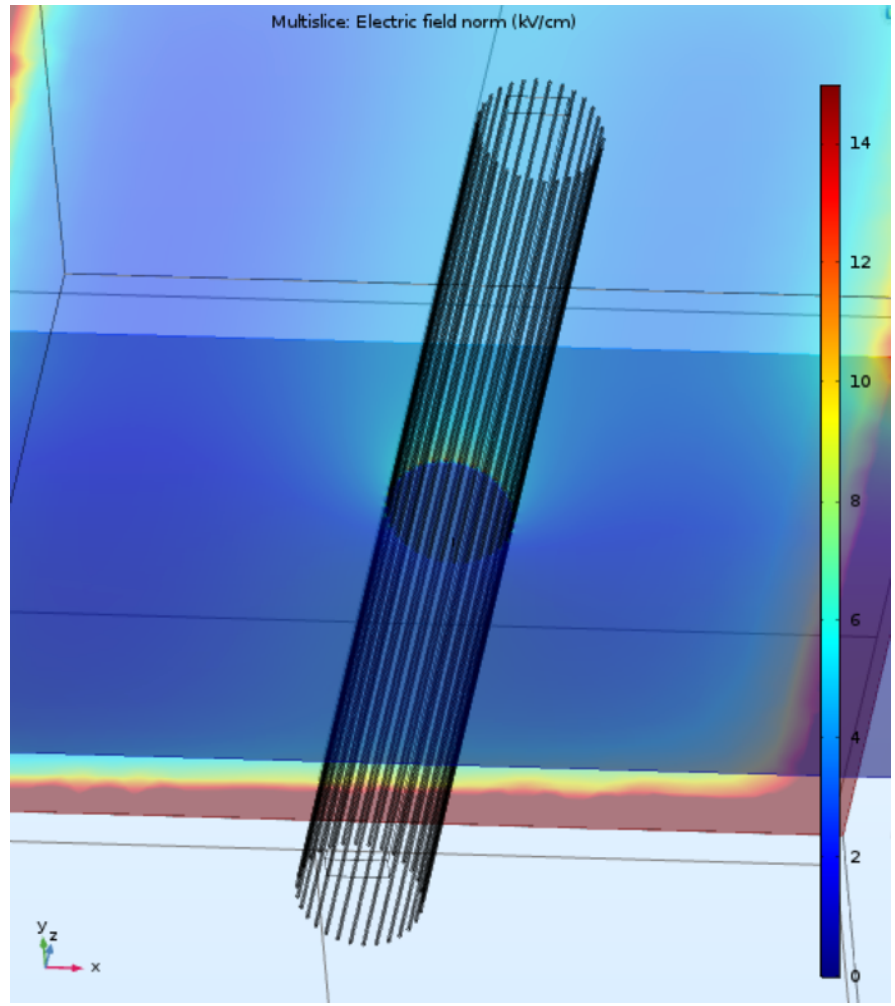
Key items II

- System to attach cables to support structure
  - Which tolerance (if any) should be considered to account for cable shrinkage ?
  - How many anchorage points
- Perform 3D electrostatic simulations

3D electrostatic simulation

- Have just started, but progressing fast. New master student Miguel Garcia will take care of that





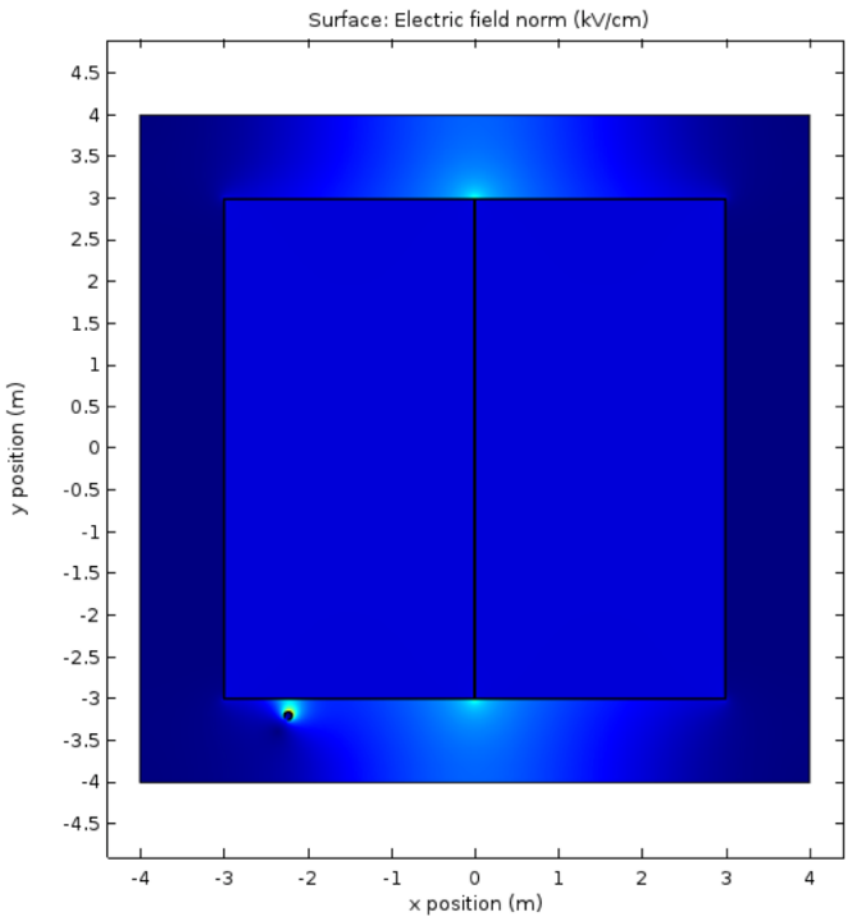
Schedule

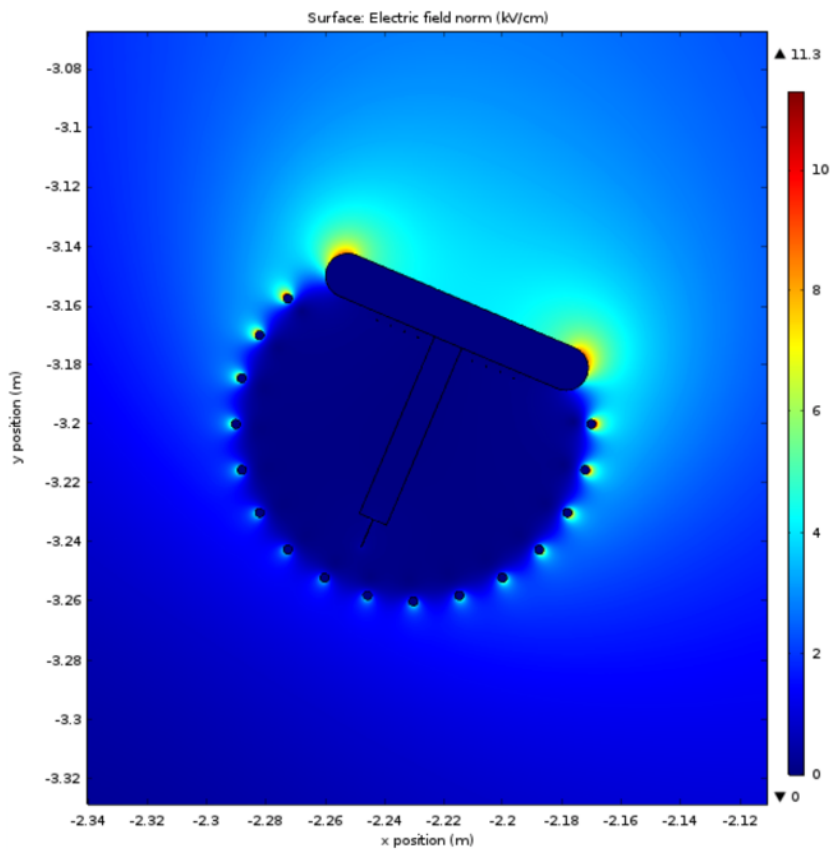
- **December**: Converge on conceptual design
- **January**: Technical design
- **January/February**: Prototype for most of the pieces
- **February/March**: Fabricate all pieces
- **March**: Mounting tests at IFIC
- **April**: Send to CERN, and mount it there
- **May:** installation

backup

Electrostatics simulations

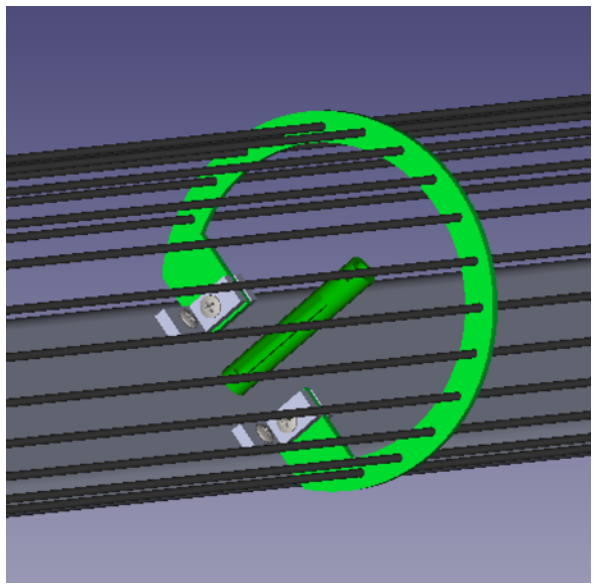
- Use Comsol v5.2a
- Several configurations tested. Maximum field for this one is 11.3 kV/cm
- Still some room for improvement

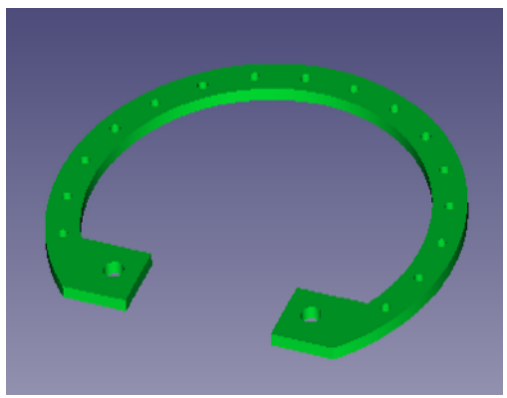


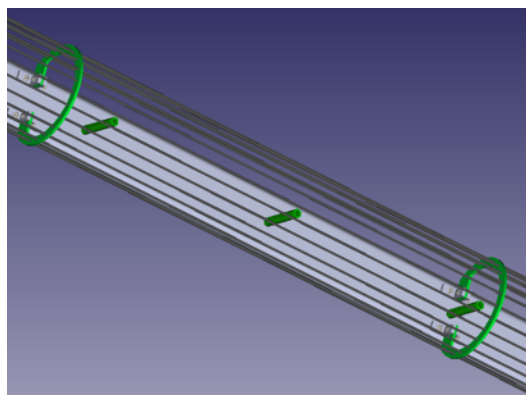


Shielding grid

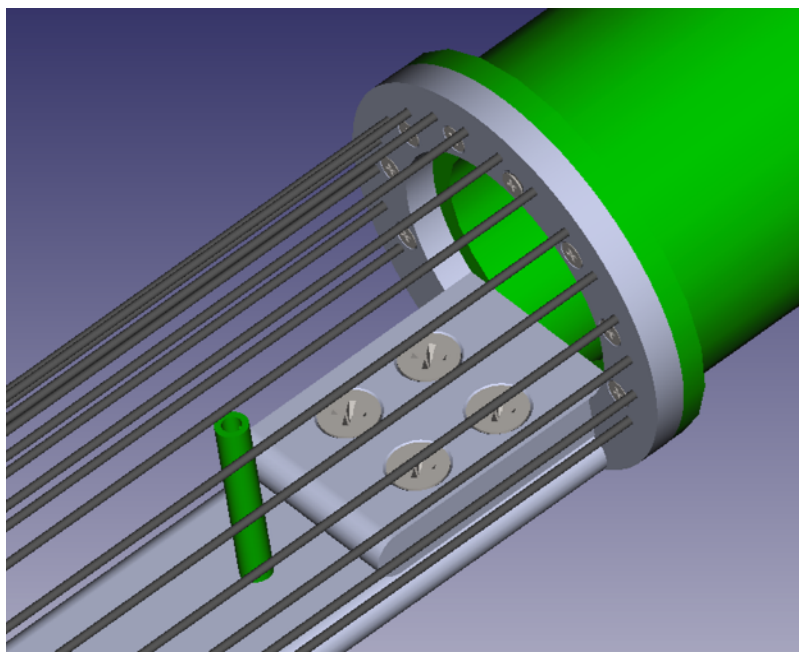
- FR4 disks keep the 3 mm diameter stainless still rods vertical and at a fix distance





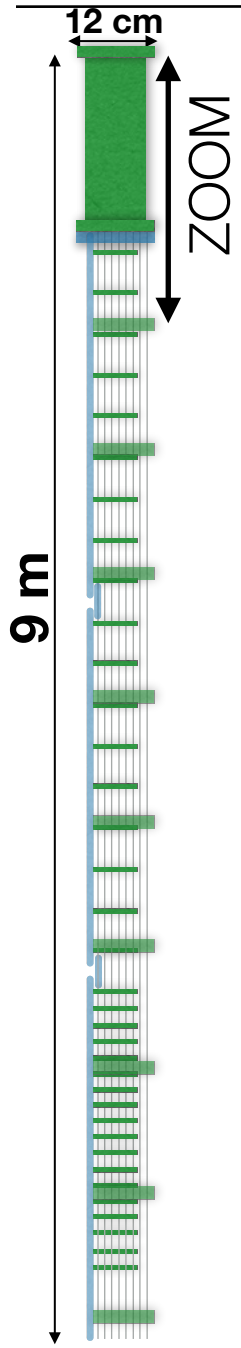


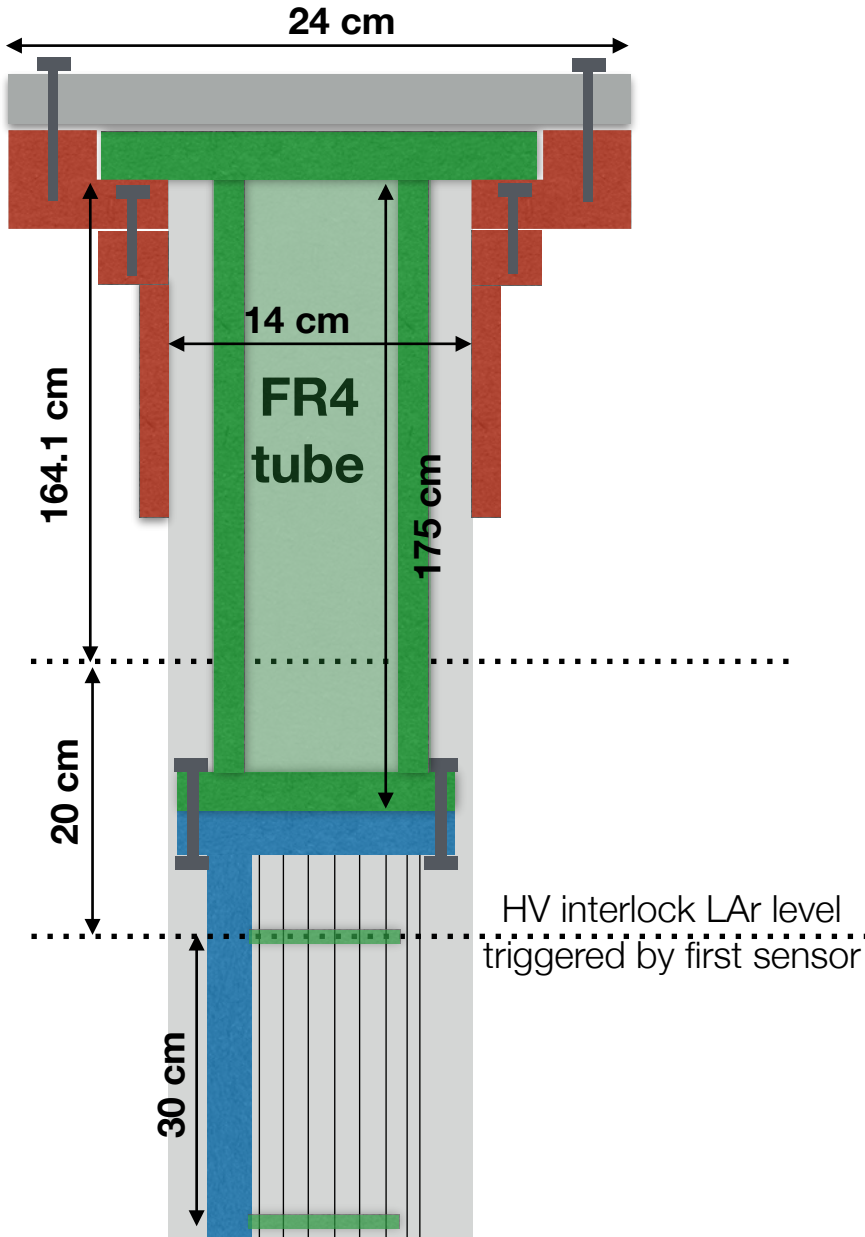
- Stainless still rods are screwed onto the aluminum disk, which is screwed to the FR4 tube and the aluminum plate

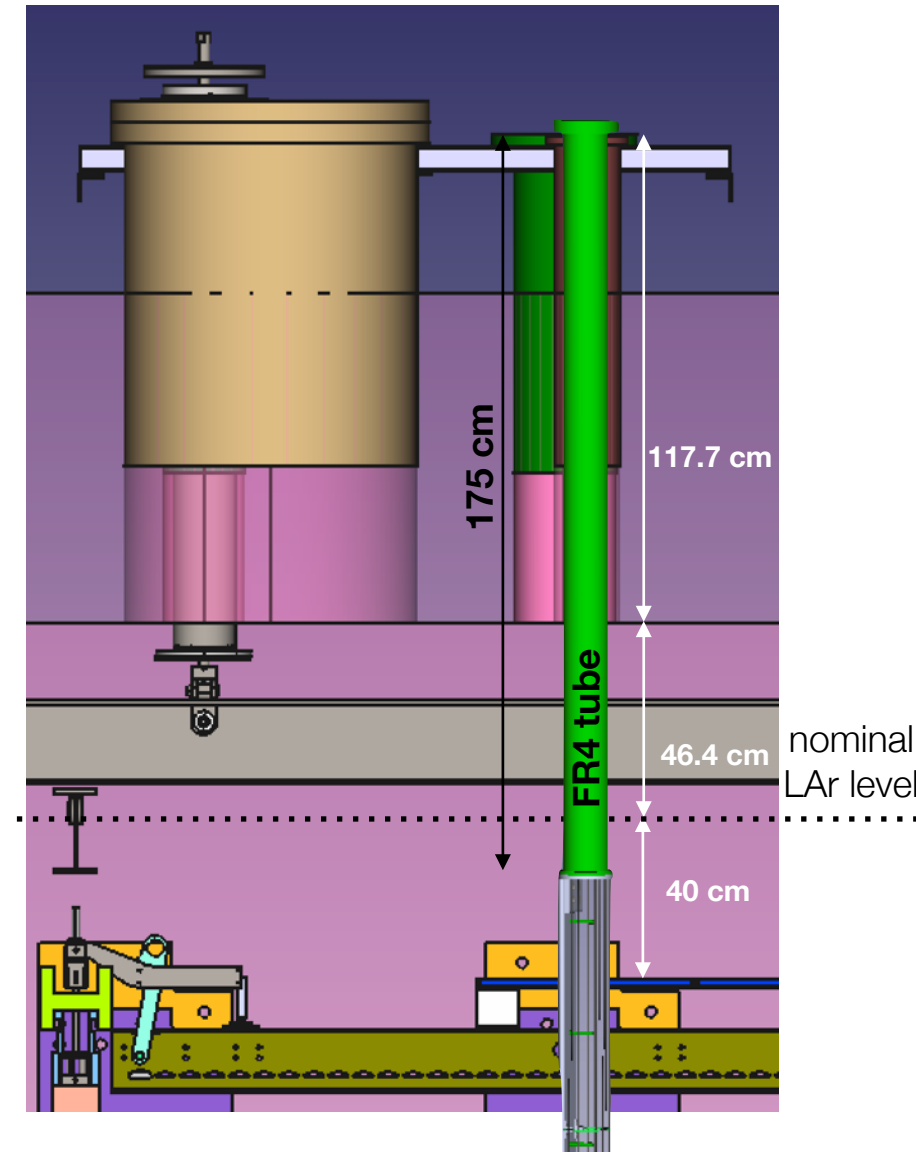


Top section

- A FR4 tube with only cables inside, to insulate aluminum structure from flange

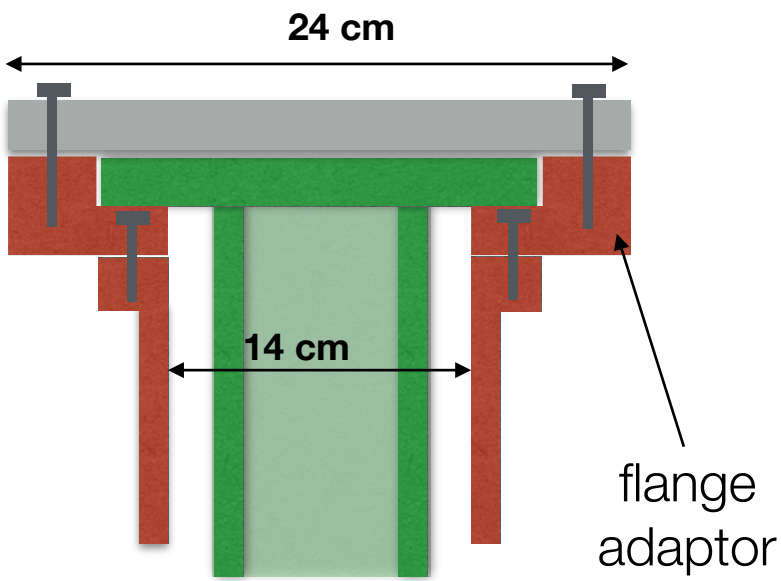




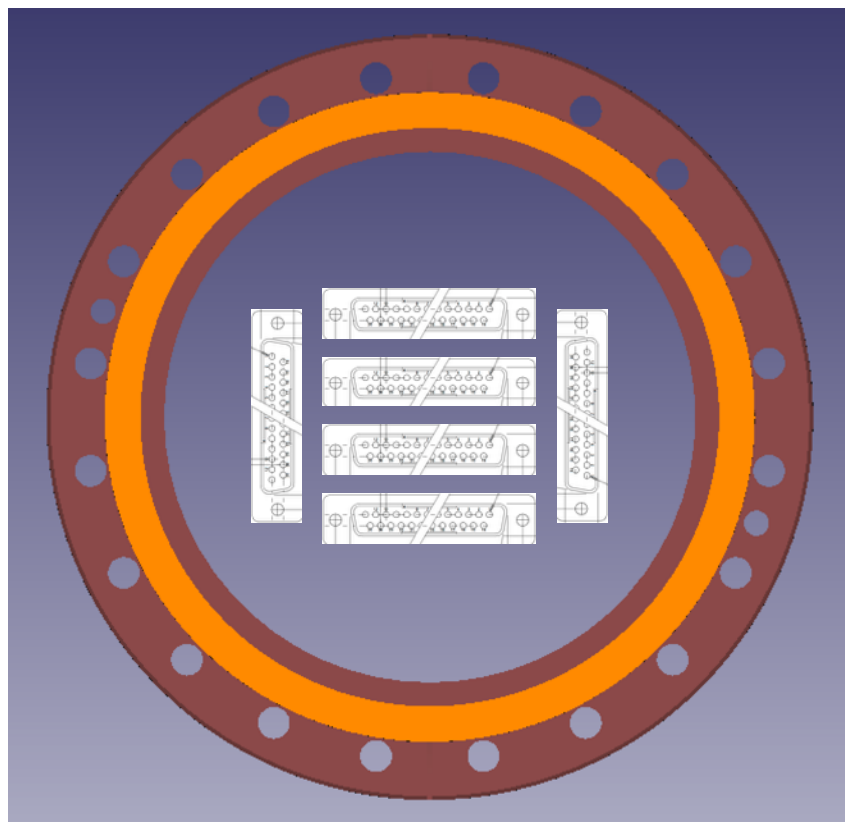


Flange area

- The FR4 tube rests on top of the chimney (use a flange adaptor) in this way the T-gradient monitor and the flange are independent
  - We could for example open the flange to check the connections



6 SUB-D 25 pin
36 sensors
144 wires



Getting the required precision

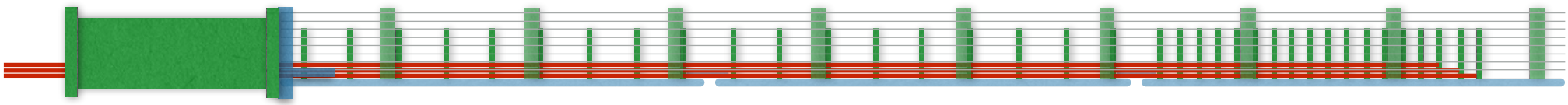
- How can we make sure we get the required precision ?
  - Make sure **mechanical design** do not bias the measurements
  - Use high quality **sensors** (Lakeshore PT102)
  - Use low noise **cables** and **4-wires readout**
  - Use high quality **readout system**: very precise current source and very precise voltage meter
  - Cross **calibrate** all sensors in the temperature range of interest: find curve of voltage versus temperature for each sensor
  - Investigate the effect of **connectors** and cables and find alternative solutions when needed
  - Perform all kind of **reproducibility tests**

Calibration strategy & schedule

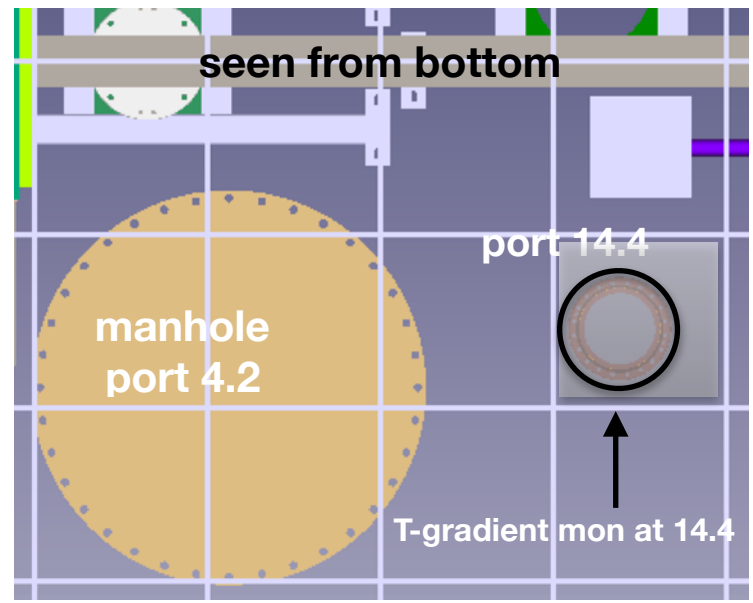
- Calibrate all sensors inside the dewar
  - Perform reproducibility tests with different kind of connections, including different soldering, different cables, etc
- Solder sensors to their final cables (up to 9 meters long) and calibrate them again, to test the effect of the cable (all cable submerged in LAr)
  - Perform reproducibility tests, comparing with the previous calibration, connecting and disconnecting, etc
- If possible bring the calibration system to CERN and do a definitive calibration with the final readout system mounted on the rack
- **Schedule**:
  - We will get the readout system from CERN EP-DT today
  - We already have four sensors (one of them calibrated). Order the rest ASAP
  - We will build a small support for the sensors next week
  - We can start playing with the system next week

Installation procedure

- The system will be mounted in horizontal position outside the cryostat



- Then it will be put in vertical position and introduced in the cryostat through port 14.4
- An operator inside the cryostat will put the bottom cup in place and make sure the system enters into the cup
- In principle the whole process should not interfere with any other action
- Working out the details with experts

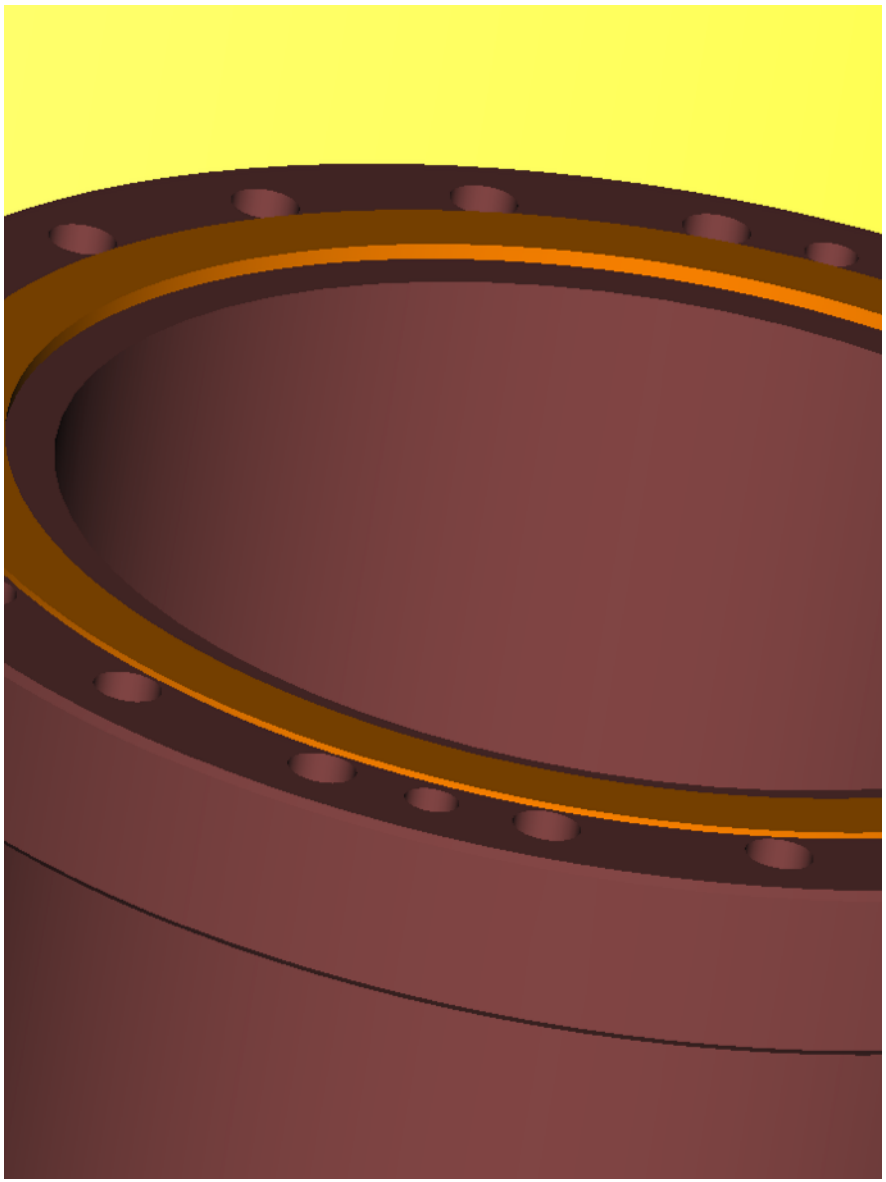


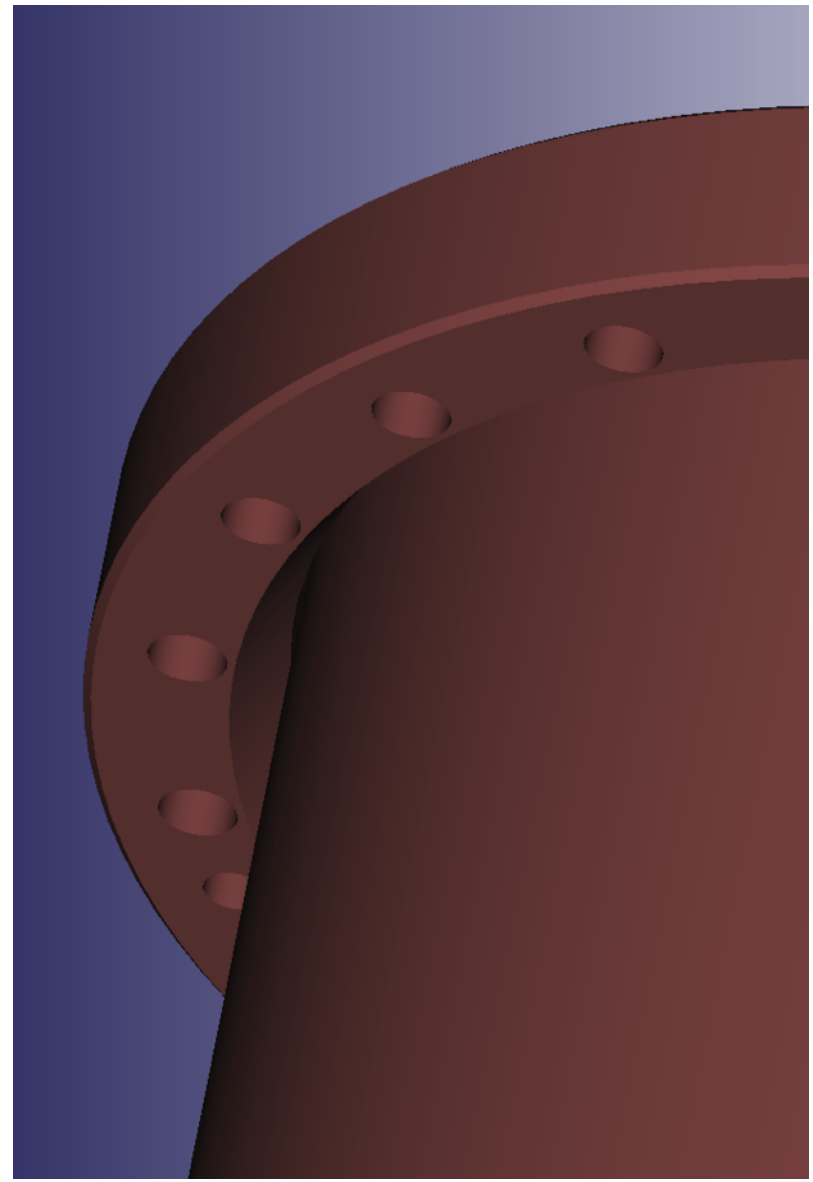
Schedule

- Schedule is quite relaxed
- No critical aspects have been identified

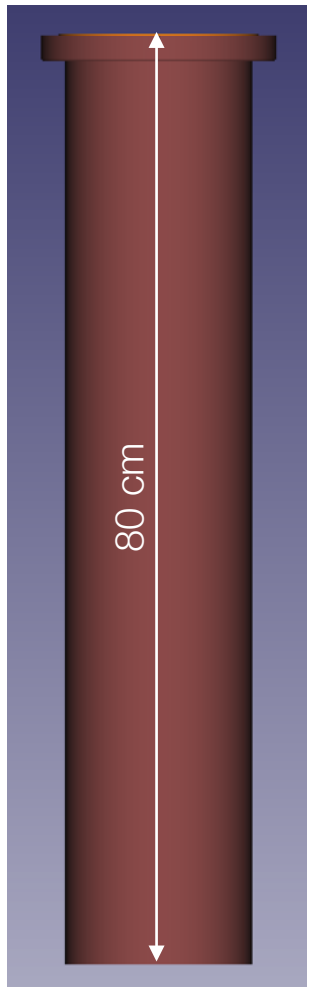
	2017									2018				
	Apr	May	Jun	Jul	Aug	Set	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Conceptual design	x													
Engineering design	x	x												
Prototiping			x	x	x									
Design calibration system	x													
calibration comissioning		x												
Sensor calibration			calibrate “other” sensors			x	x	x						
Fabricate mechanical structure						x	x	x	x					
cable preparation and sensor-cable calibration									x					
sensor-cable assembly into mechanical structure										x				
tests in Valencia										x	x			
test at CERN												x	x	
installation														x

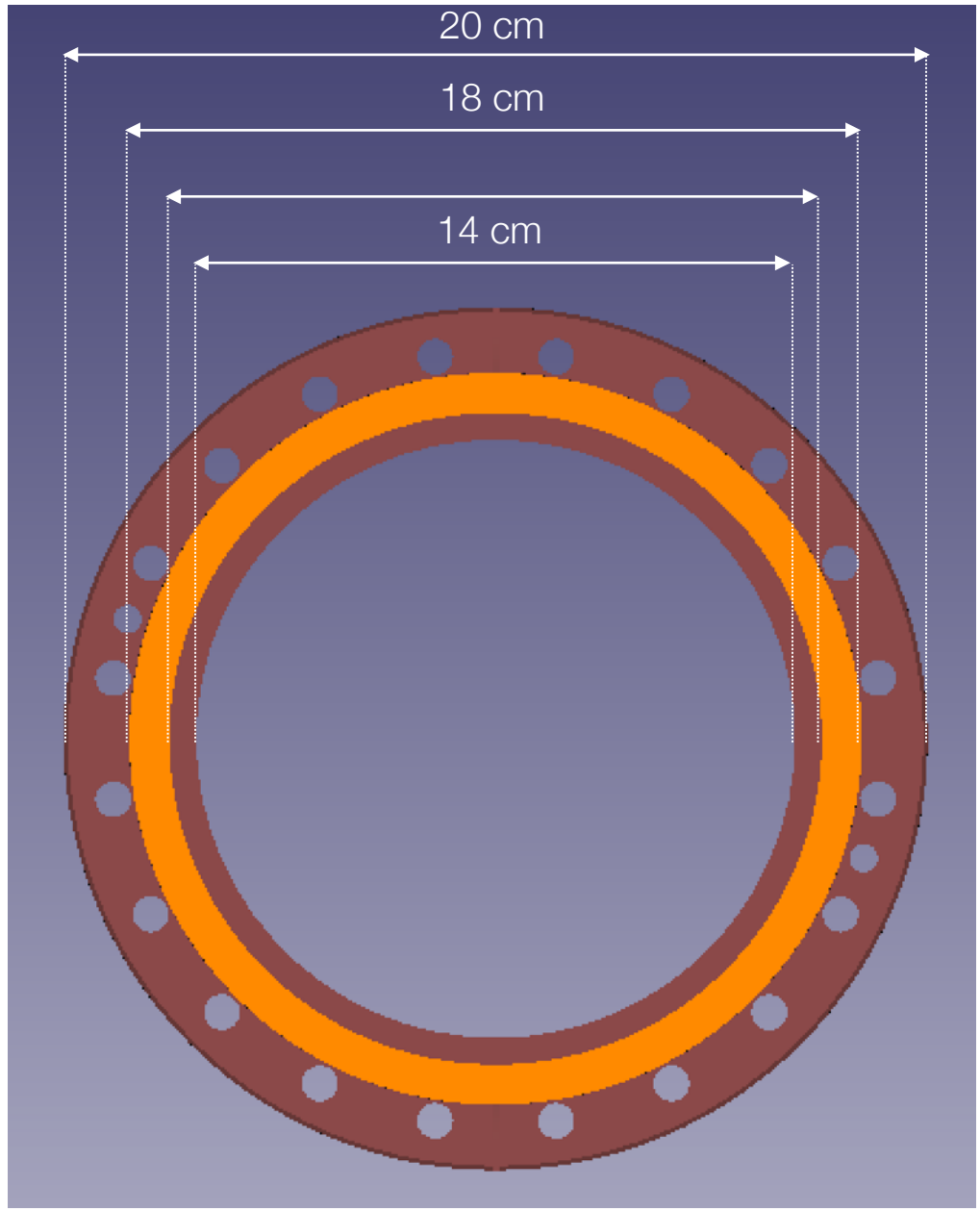
backup





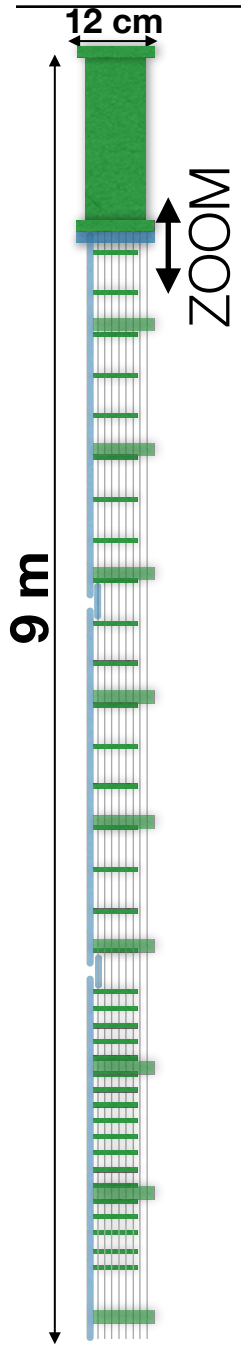

2 cm

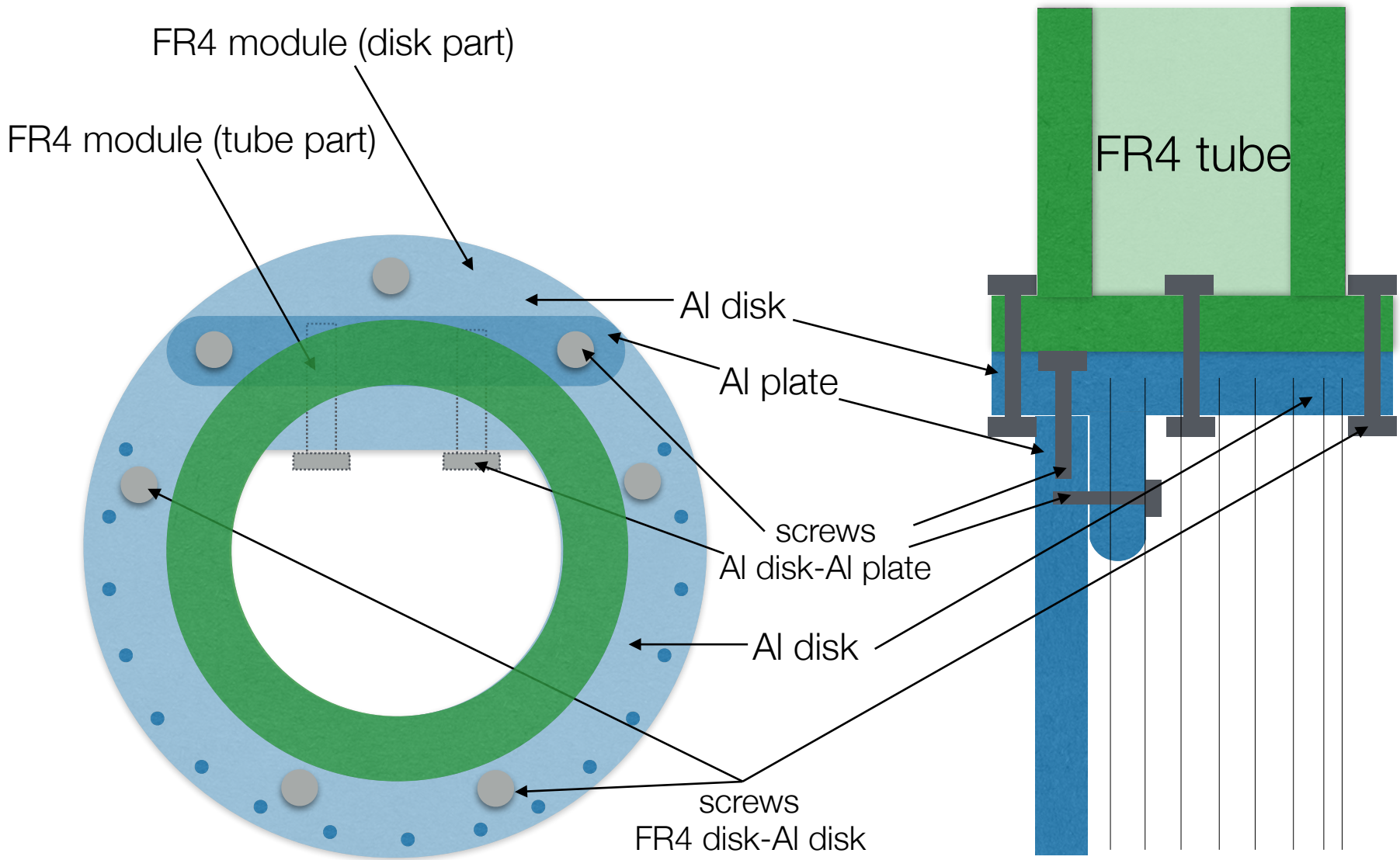

80 cm


20 cm
18 cm
14 cm

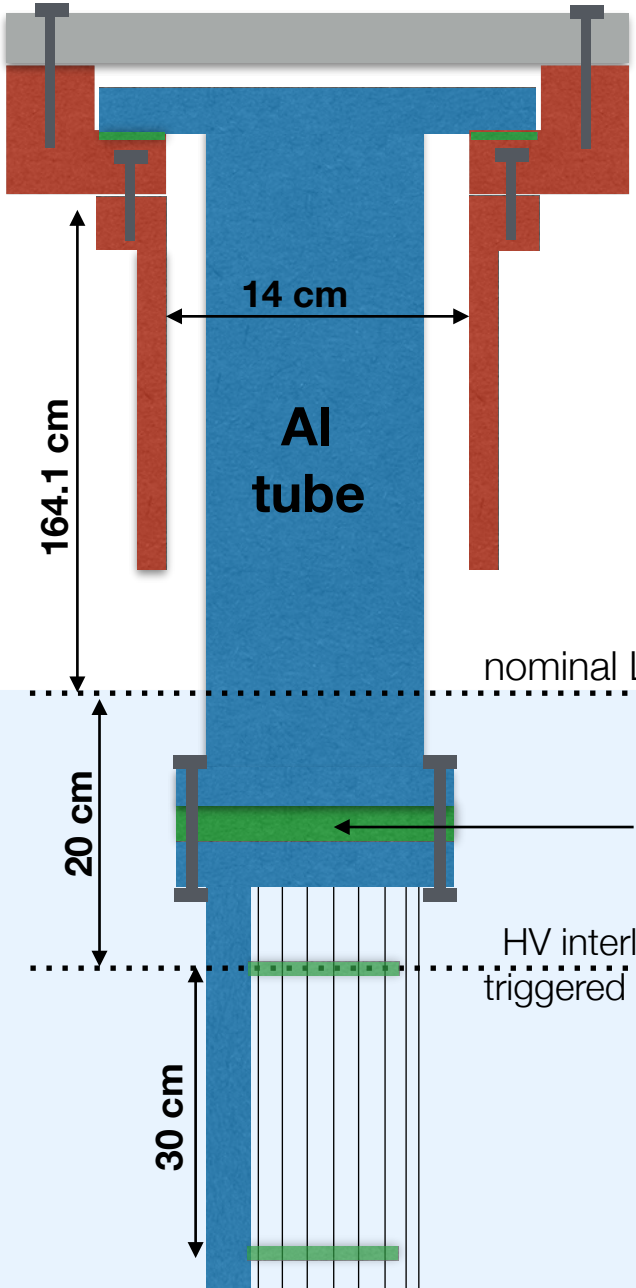
FR4-Aluminum interface

- Stainless still rods are screwed (?) onto the aluminum disk, which is screwed to the FR4 tube and the aluminum plate

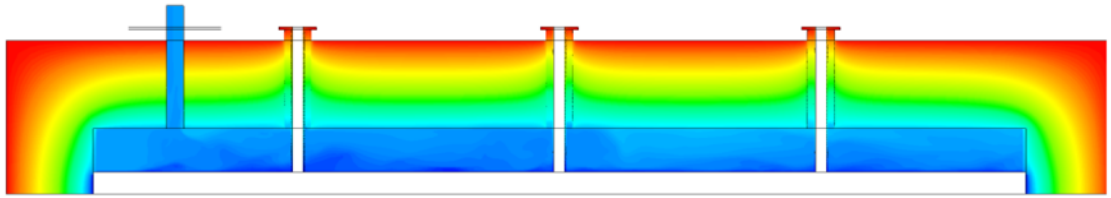


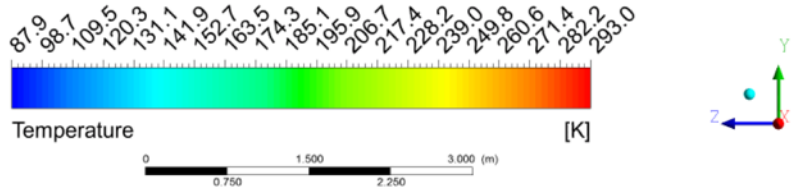


Question ?



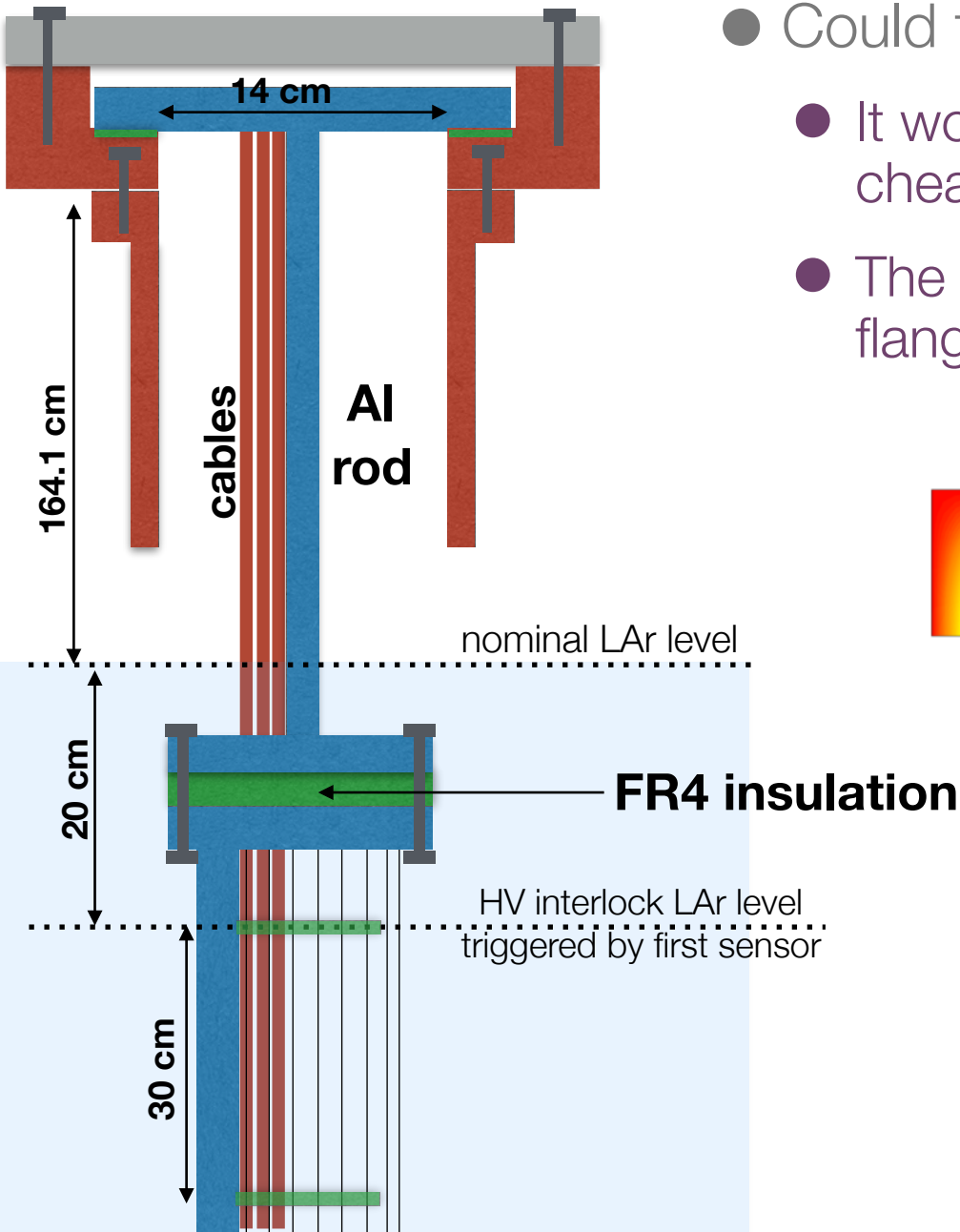
- Could the top tube be made of aluminum ?
  - It would be much easier to machine and cheaper
  - The issue could be the heat flux from the flange (at room temperature) to the LAr



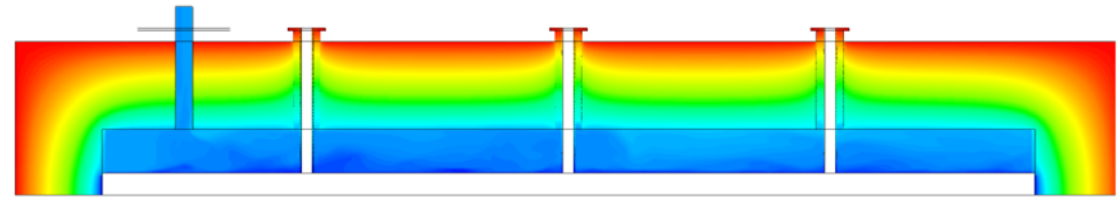


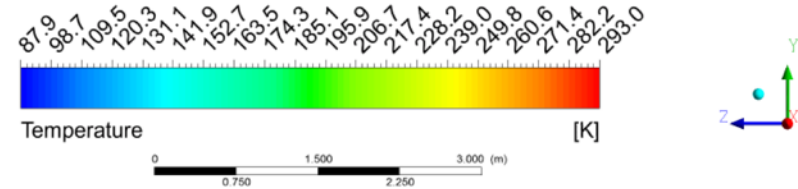
waiting for answer

Question ?

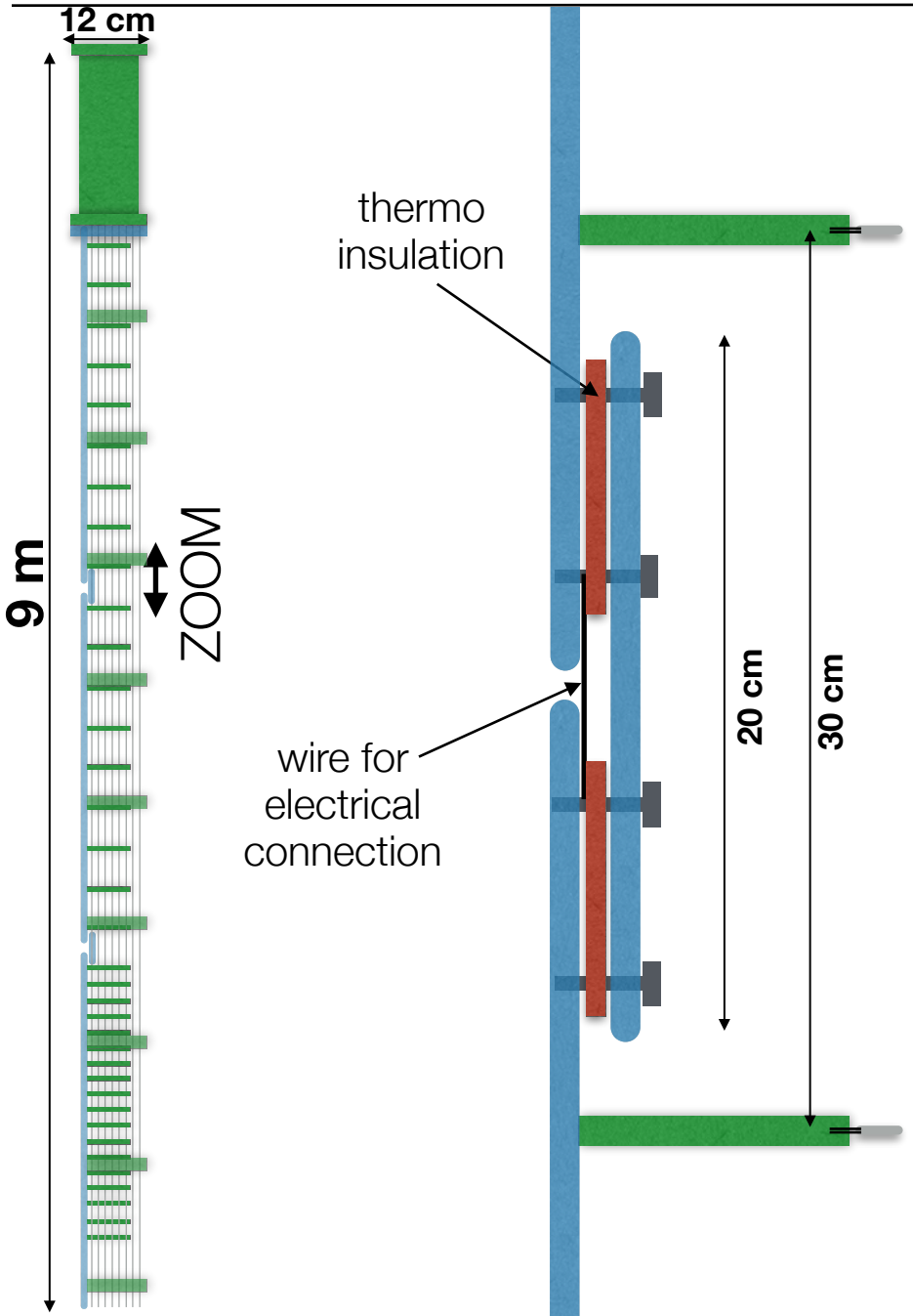


- Could the top tube be made of aluminum ?
  - It would be much easier to machine and cheaper
  - The issue could be the heat flux from the flange (at room temperature) to the LAr

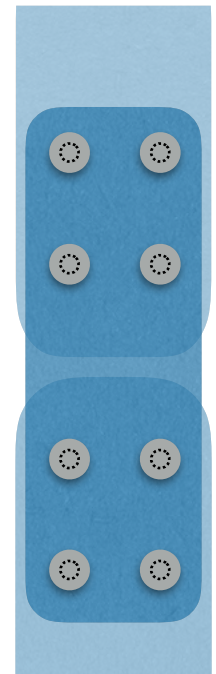




Connection between sections



- We probably need **insulation** between plates to avoid thermal coupling, or a FR4 connection instead of aluminum
- If **two screws** are used vertically in each side we have to be **careful with shrinking**
- An **electrical connection** to guaranty all plates are at **ground**
- We need a proper design with rigidity studies



front view