LBNO-DEMO: Latest news

April 2014 TDR for LBNO-DEMO:

Detailed TDR submitted to CERN. ~120 authors 22 institutes

>150 page document describing in detail every technical aspects and physics goals of the 300 ton LBNO-Demo.

Positively received by CERN:

*The SPSC **received with interest** the technical proposal describing in detail the CERN WA105 R&D programme (SPSC-TDR-004-2014). The Committee **supports** the technical goals of the Double Phase Liquid Argon (DLAr)-TPC programme and considers it as the WA105 priority for the forthcoming years.*

June 2014 CERN council decision:

CERN has committed **55 MCHF in the next 5 years to the "CERN neutrino platform"** which is foreseen to host the LBNO-DEMO demonstrator (June 2014 CERN Council decision) and other activities. Extension of the North Area starts next year.

Detector assembly: clean room

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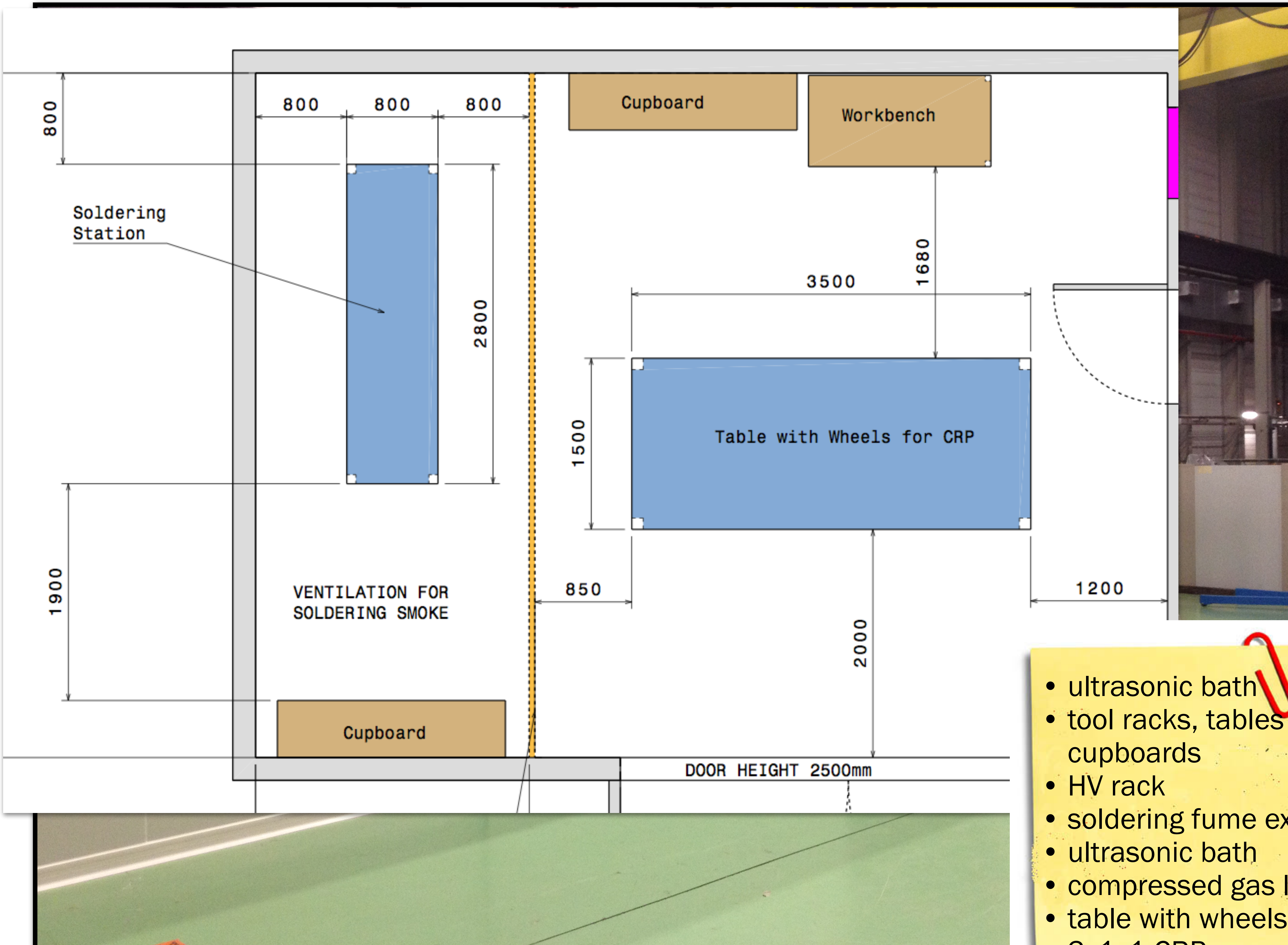


- ultrasonic bath
- tool racks, tables and cupboards
- HV rack
- soldering fume extractor
- ultrasonic bath
- compressed gas line
- table with wheels for the 3x1x1 CRP

One year timescale the 3x1x1 m³

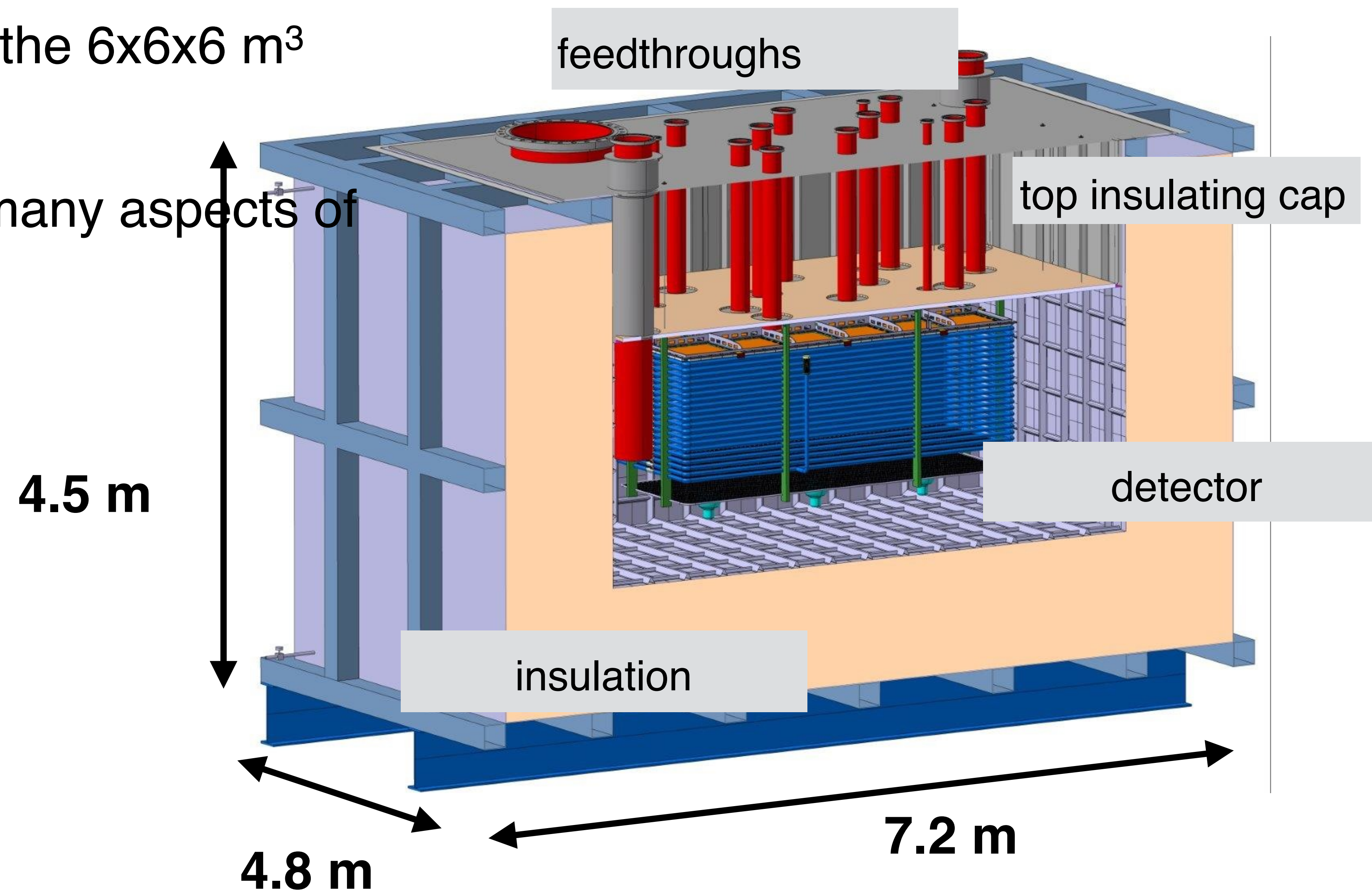
A lot of R&D has been invested in optimising the charge readout.
We have shown that we can get uniform and stable gain on detectors at the liter scale.

Now is the time to move to the relevant LBNO-scale detectors!

Important step in parallel to the 300 ton LBNO-DEMO

3x1x1 m³ (5 ton) Double phase LAr TPC

- ✓ Same detector concept as the 6x6x6 m³ prototype
- ✓ Will allow to test/optimise many aspects of the 300 ton LBNO-DEMO
  - Tank installation
  - cryogenic operation
  - insulation
  - charge readout



Timescale 2014-2015
cost o(1 M€)

In the coming year the 3x1x1 m³

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We have shown that we can get uniform and stable gain on detectors at the liter scale.

Now is the time to move to the relevant LBNO-scale detectors!

Important st

e LAr TPC

✓Same de
prototype

✓Will allov
the 300 t

- Tank i
- cryoge
- insulat
- charge

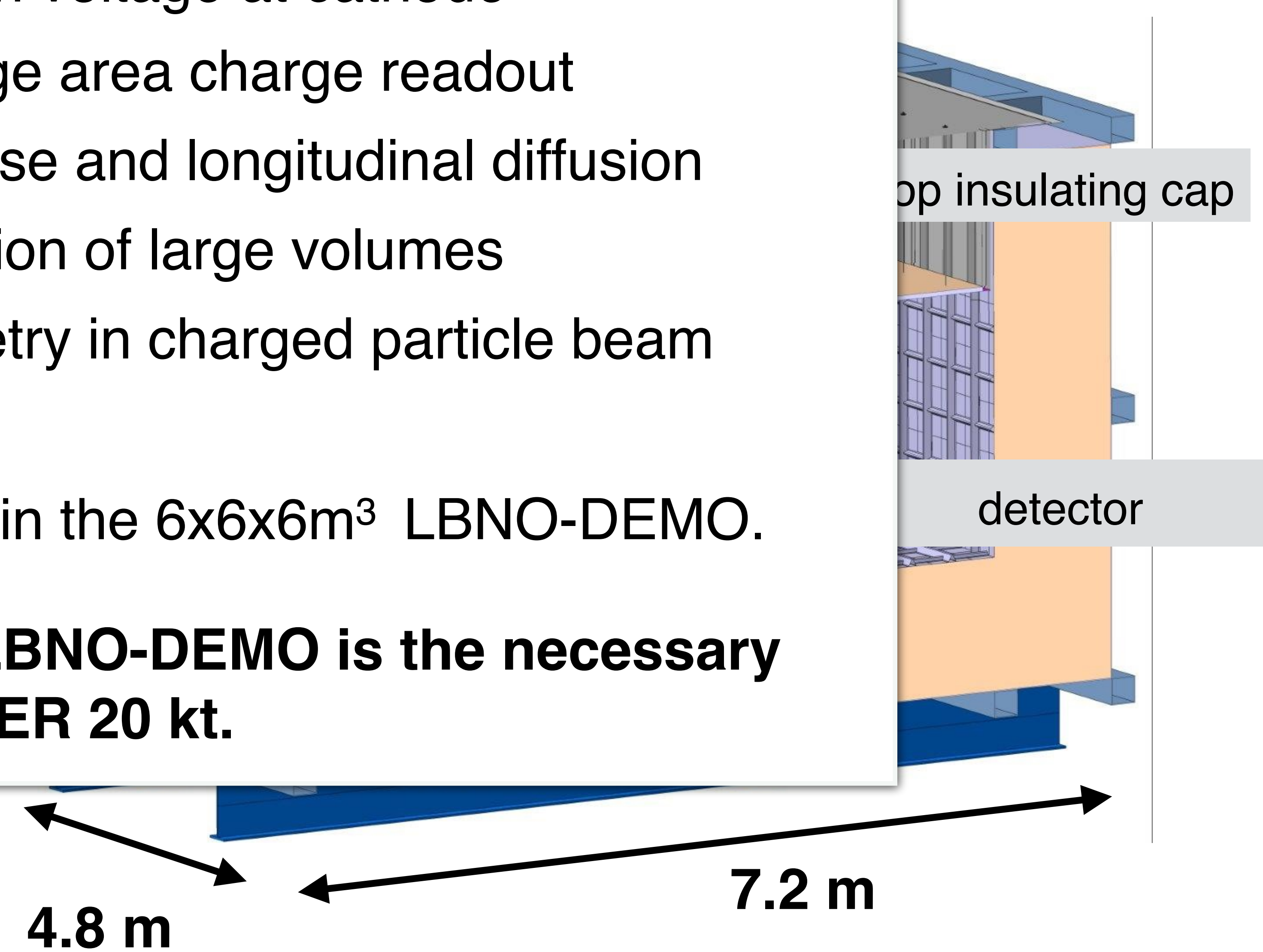
Timescale
cost o(1 M€)

However here we do not test

- long drift
- very high voltage at cathode
- very large area charge readout
- transverse and longitudinal diffusion
- purification of large volumes
- calorimetry in charged particle beam
- …

All this will be addressed in the 6x6x6m³ LBNO-DEMO.

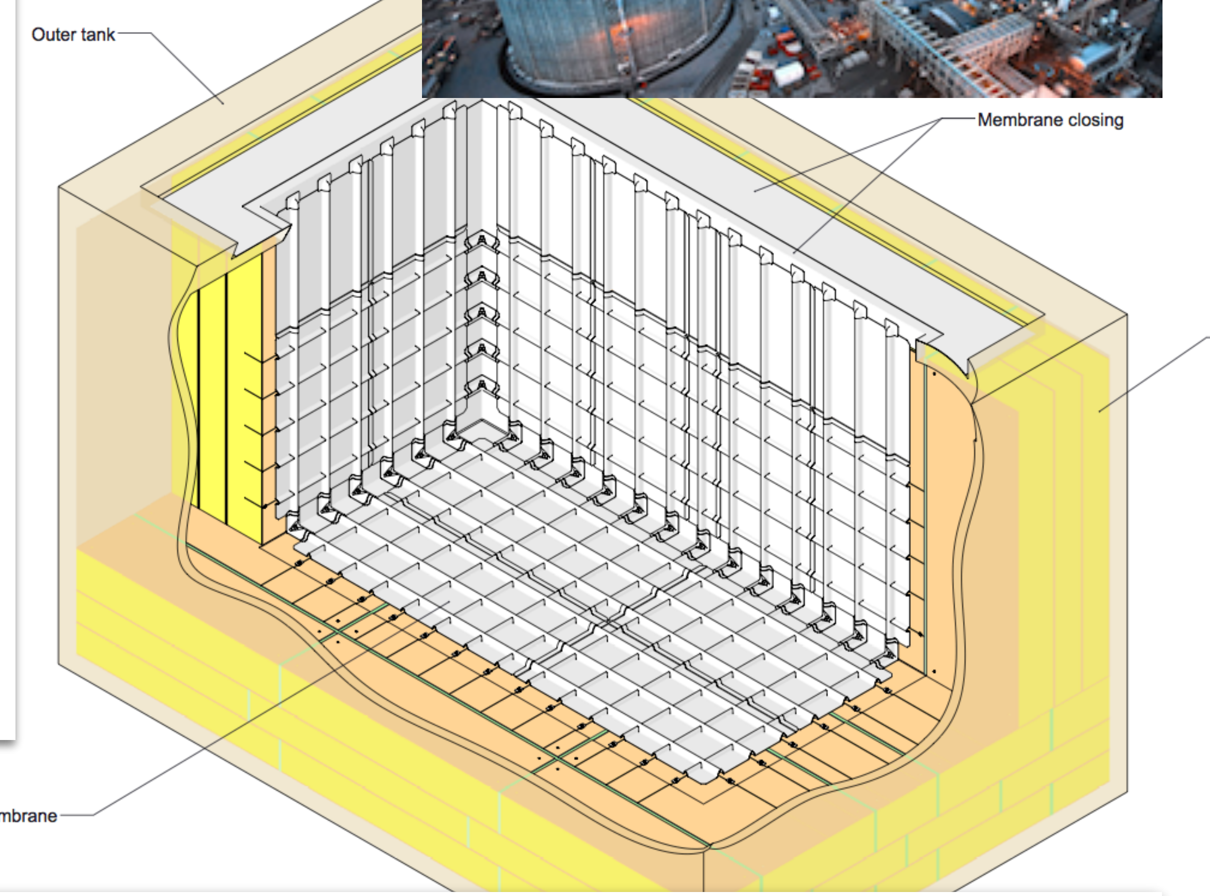
The completion of the LBNO-DEMO is the necessary final step before GLACIER 20 kt.



Installation sequence

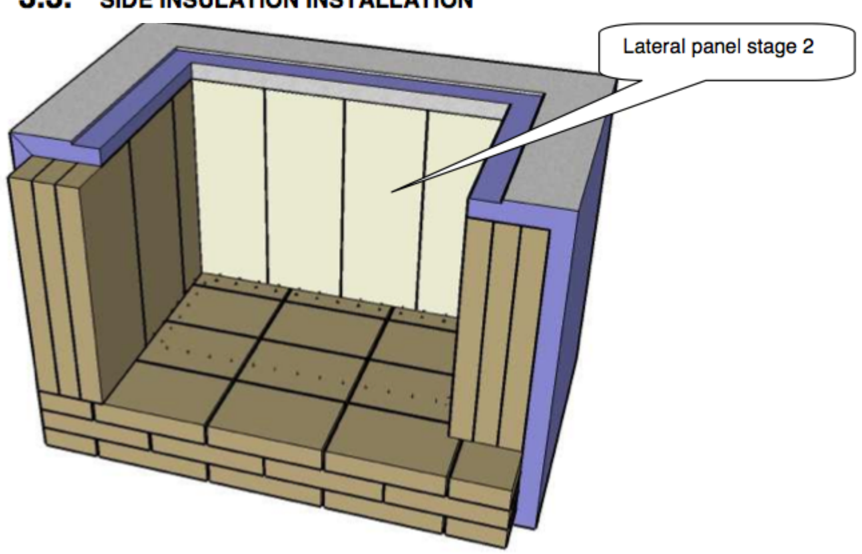
Schedule

- ✓ Detailed drawings, mechanical and thermal calculation, July 2014
- ✓ Final bill of material to be delivered to CERN, September 2014
- ✓ Assembly procedure at CERN, September 2014
- ✓ Material delivery schedule, September 2014
- ✓ Welding procedure qualification, October 2014
- ✓ Start assembly at CERN, December 2014
- ✓ **Cryostat delivery to CERN for operation March 2015,** this includes all qualification tests.



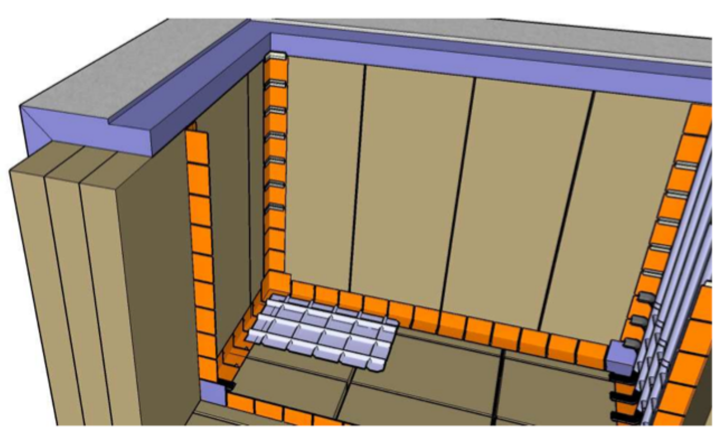
installation sequence (some steps)

3.3. SIDE INSULATION INSTALLATION



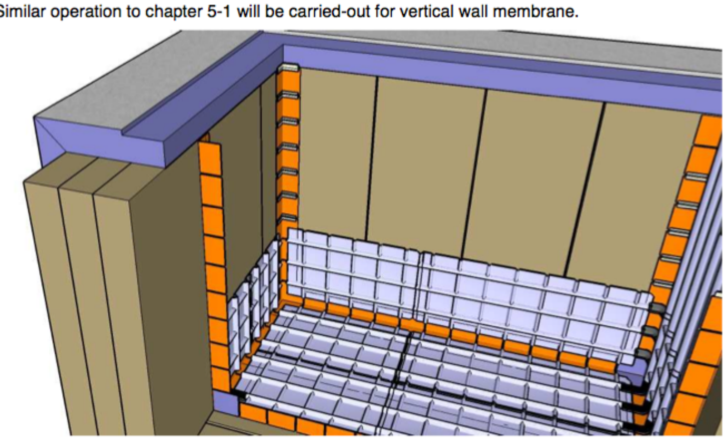
5.1. BOTTOM MEMBRANE INSTALLATION

Membrane on bottom is installed on bottom and tight welded together.

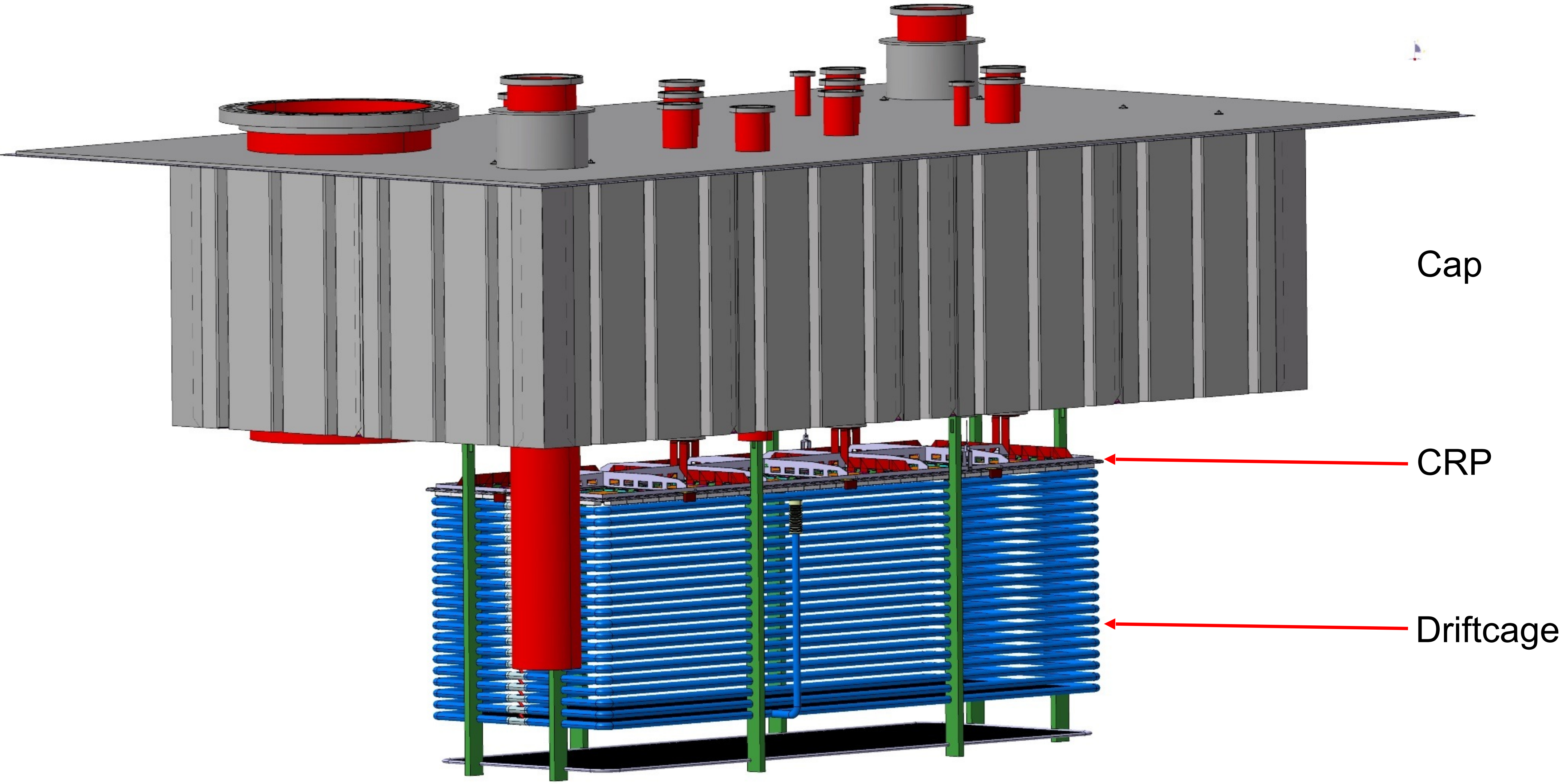


5.2. SIDE MEMBRANE INSTALLATION

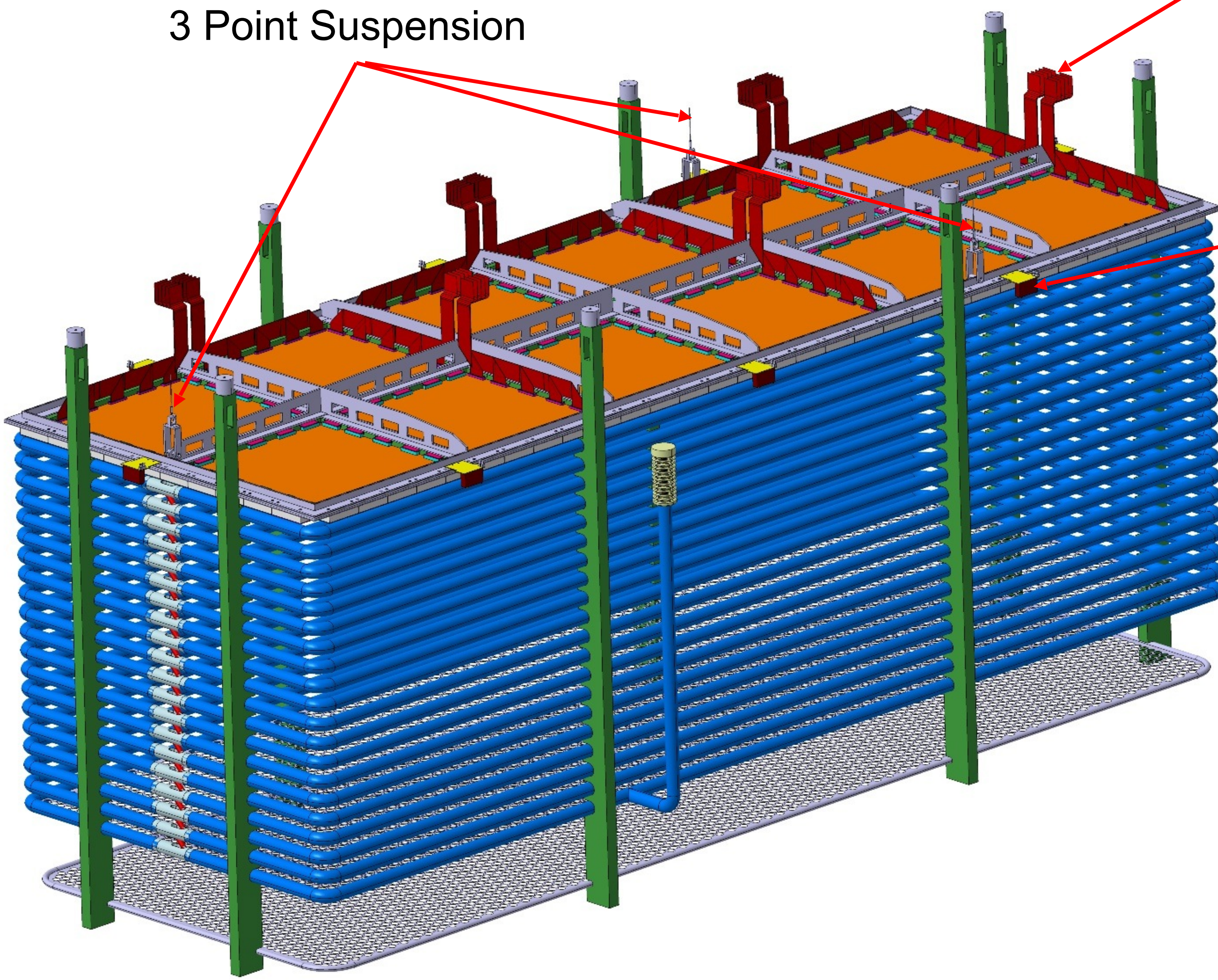
Similar operation to chapter 5-1 will be carried-out for vertical wall membrane.



Design Overview

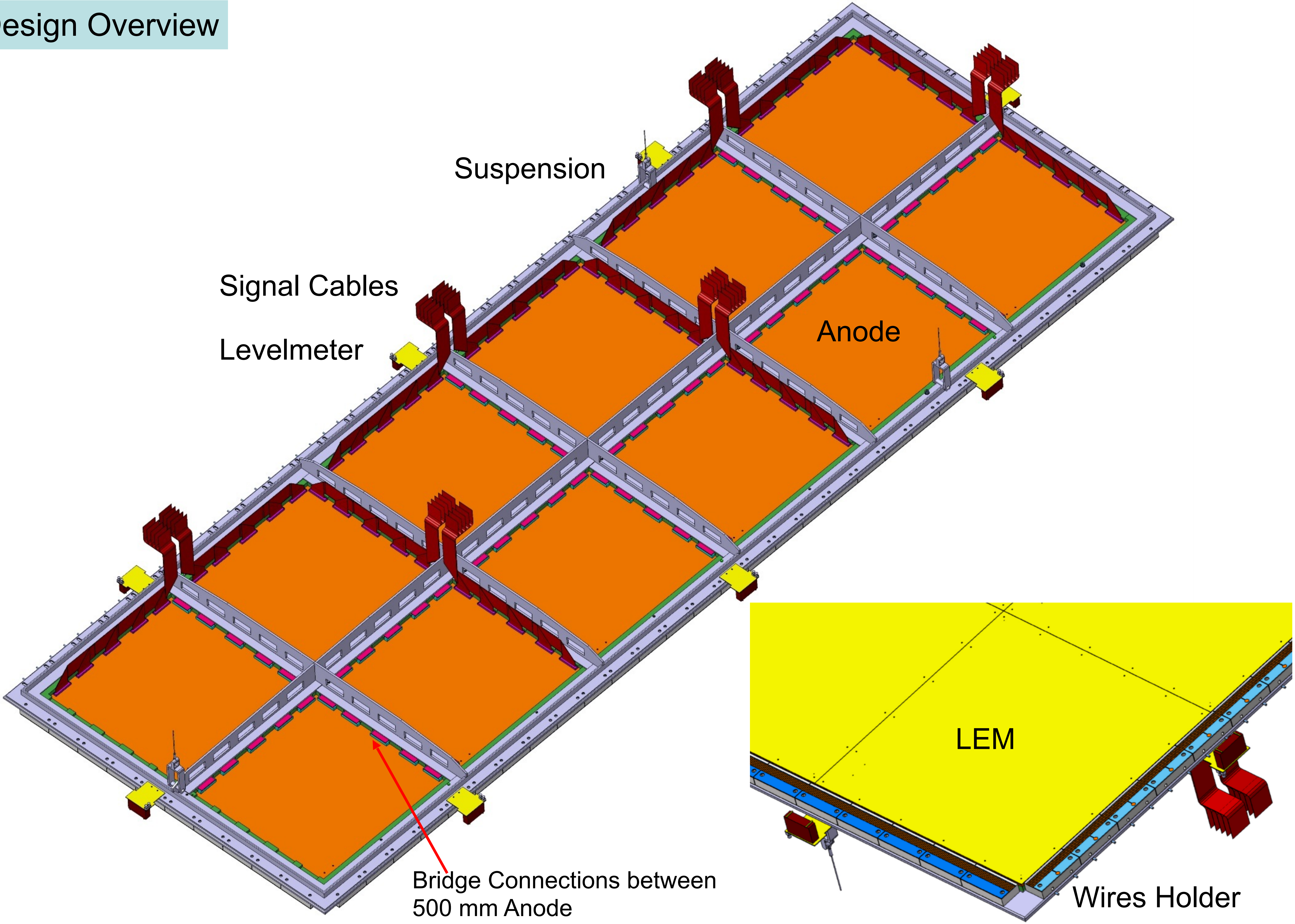


Design Overview

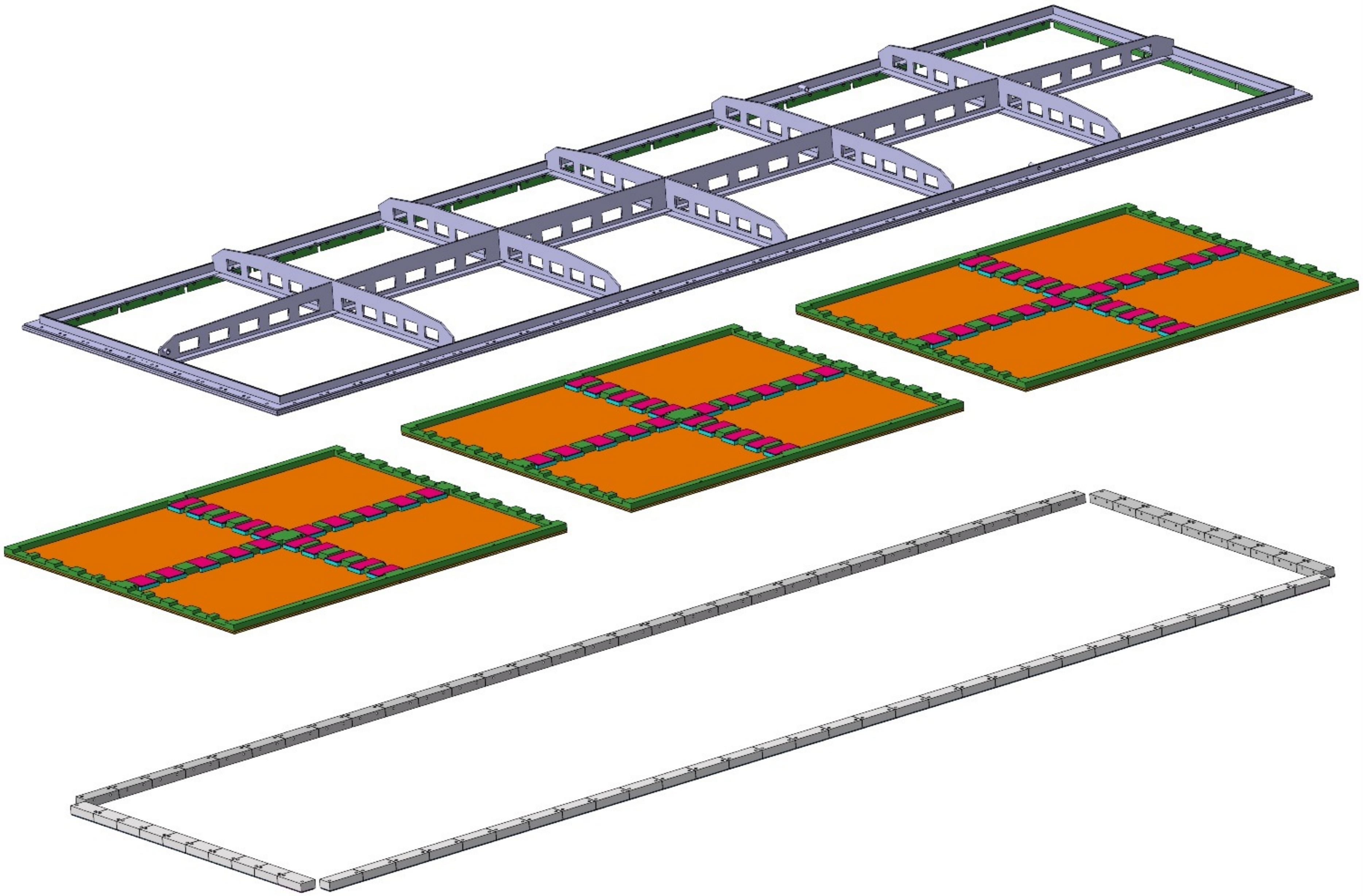


Comment: Field Cage is indipendetly fixed to the Top Cap (Fixed Position)

Design Overview



Design Overview



Stainless Steel
Support Structure
~60 Kg

3 CRP modules 1x1
-G10 Structure
-Anode (3.2mm)
-LEM (1 mm)

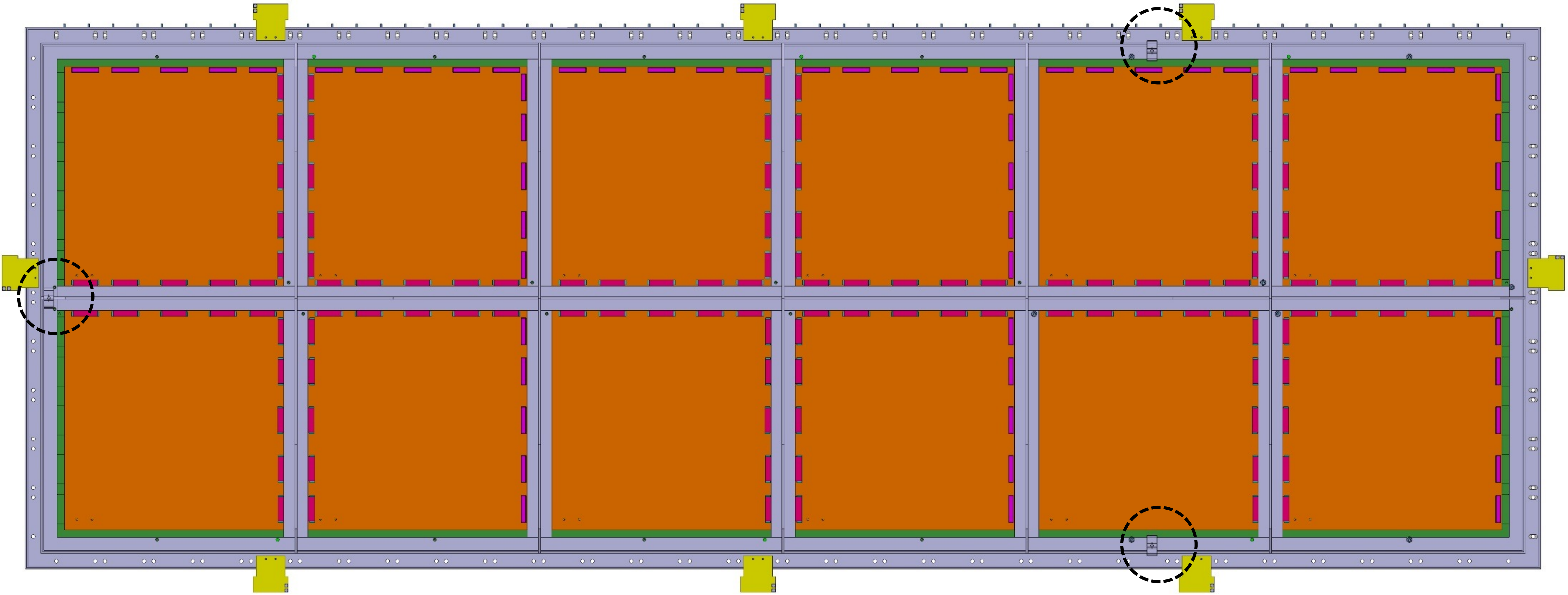
3x ~12.5 = ~37.5 Kg

Wires Holder
~14 Kg

Total Weight: ~111.5 Kg
➔ ~37 Kg/m^2

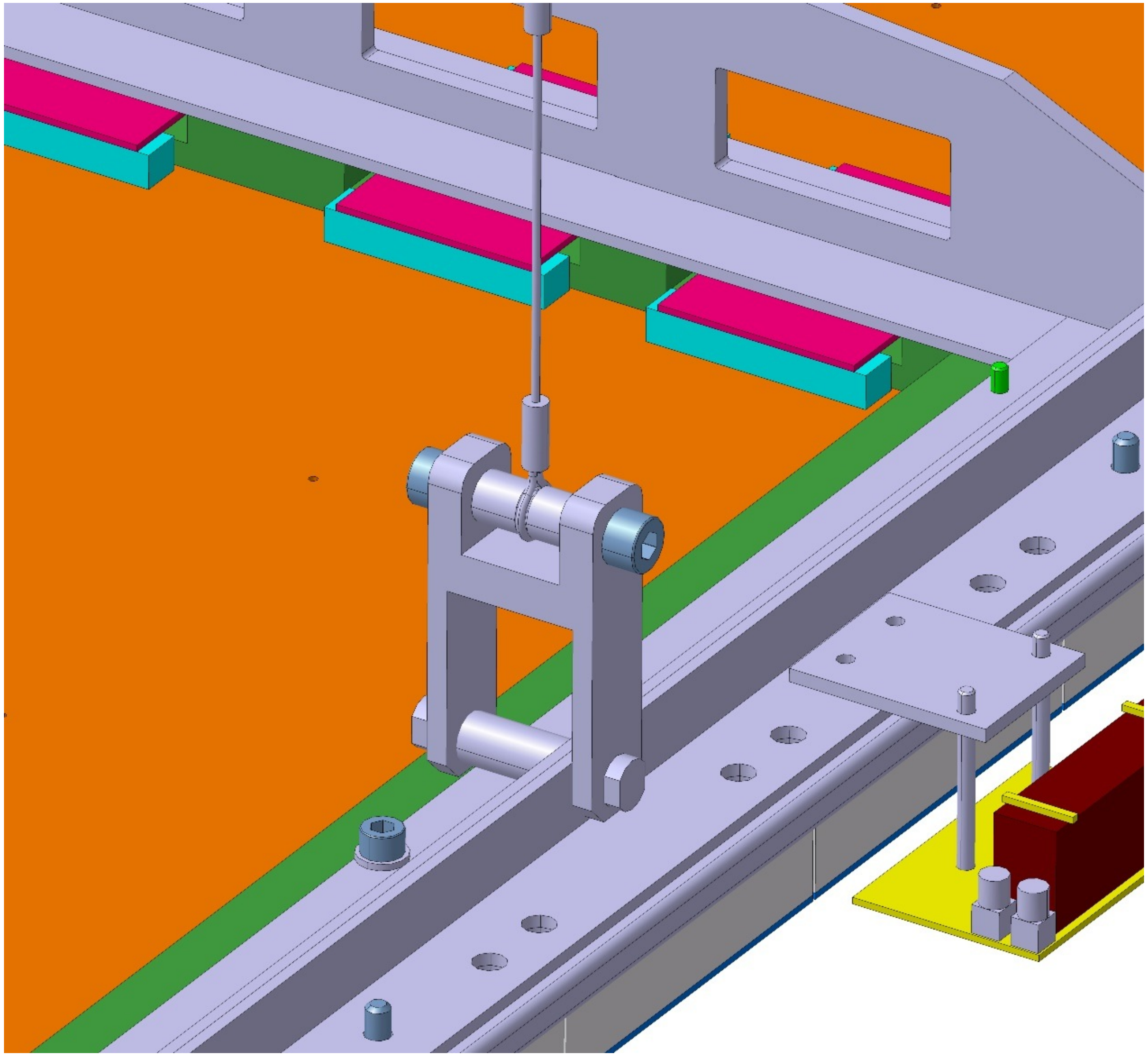
Hanging System

- Connection points for the suspension are 7 mm of axis respect to the chimneys
  ➔ maintain the CRP centered
- Field Cage give the possibility to have centering guides for the CRP



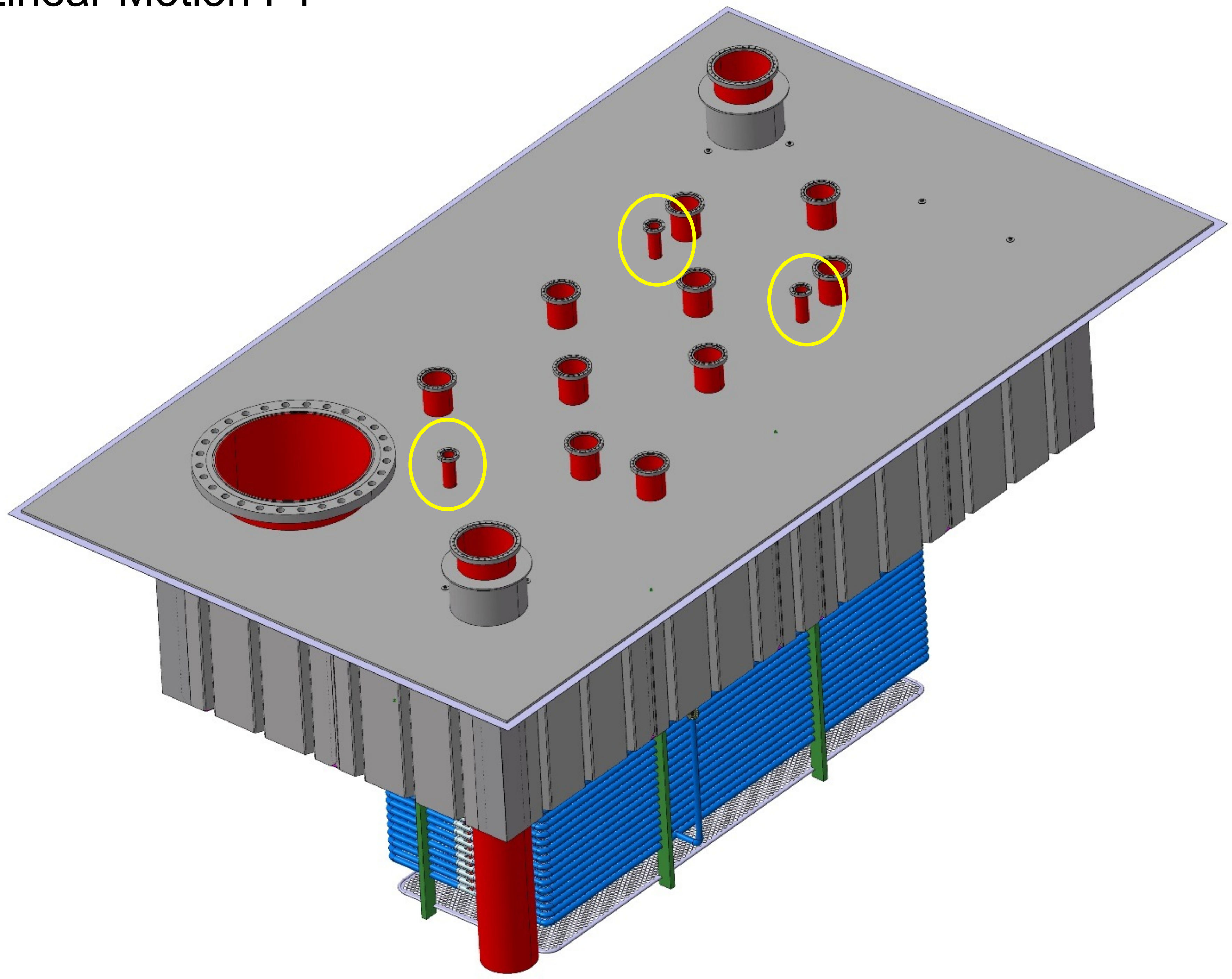
Hanging system

- Hanging Connection at the CRP



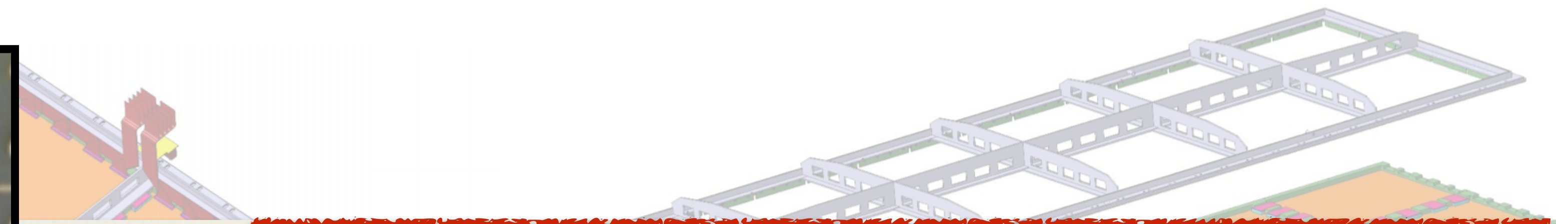
Hanging system

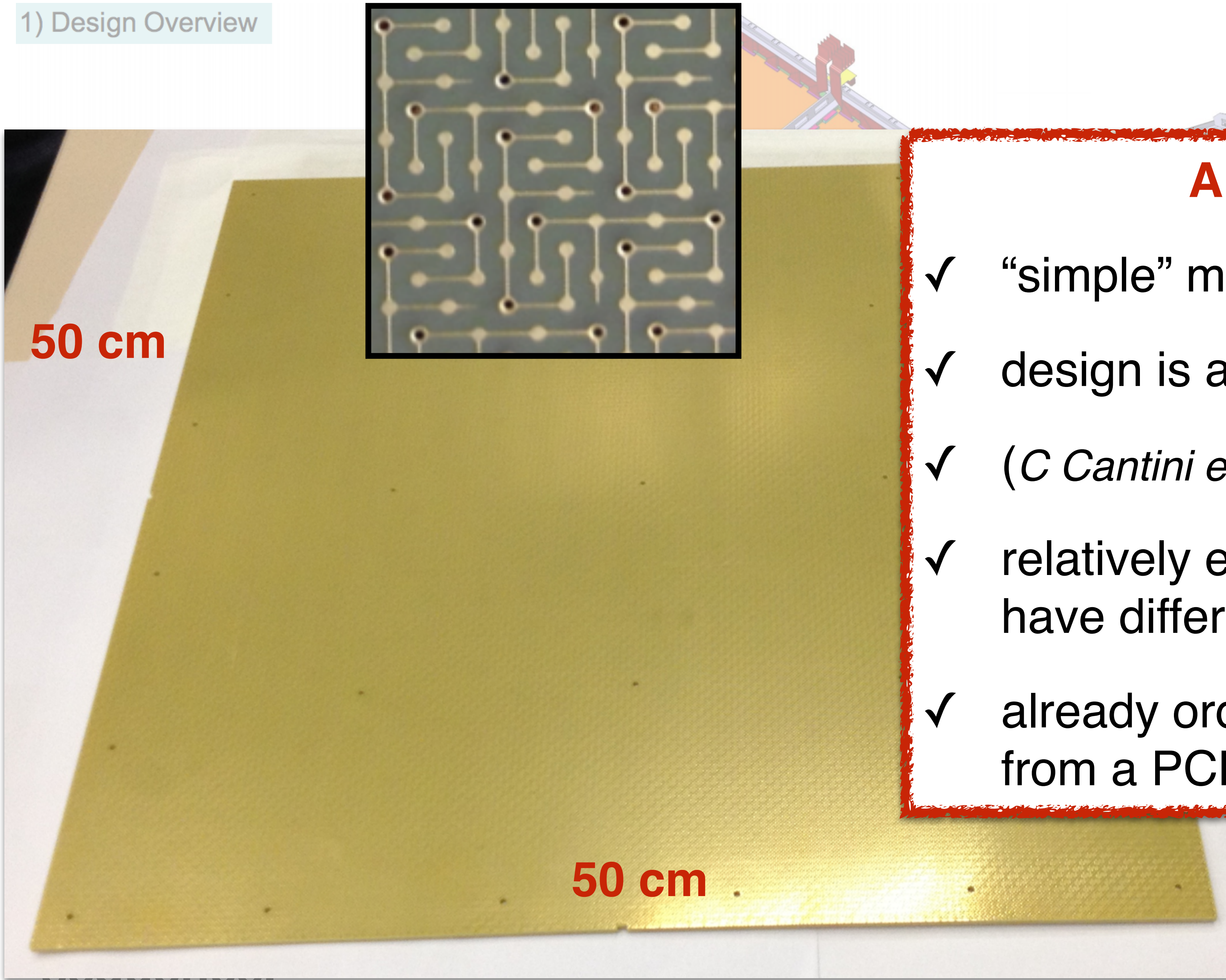
- 3 Hanging Feedthrough
- CF63 Connection FT
- Idea is to use MDC Linear Motion FT



The detector: Charge Readout Plane

1) Design Overview





Anode

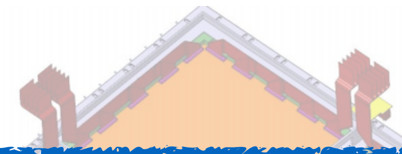
- ✓ "simple" multilayer PCB.
- ✓ design is a result of ~1 year R&D.
- ✓ (*C Cantini et al 2014 JINST 9 P03017)*
- ✓ relatively easy and fast to produce have difference suppliers/options.
- ✓ already ordered 4 50x50 cm^2 pieces from a PCB company (multi-CB).

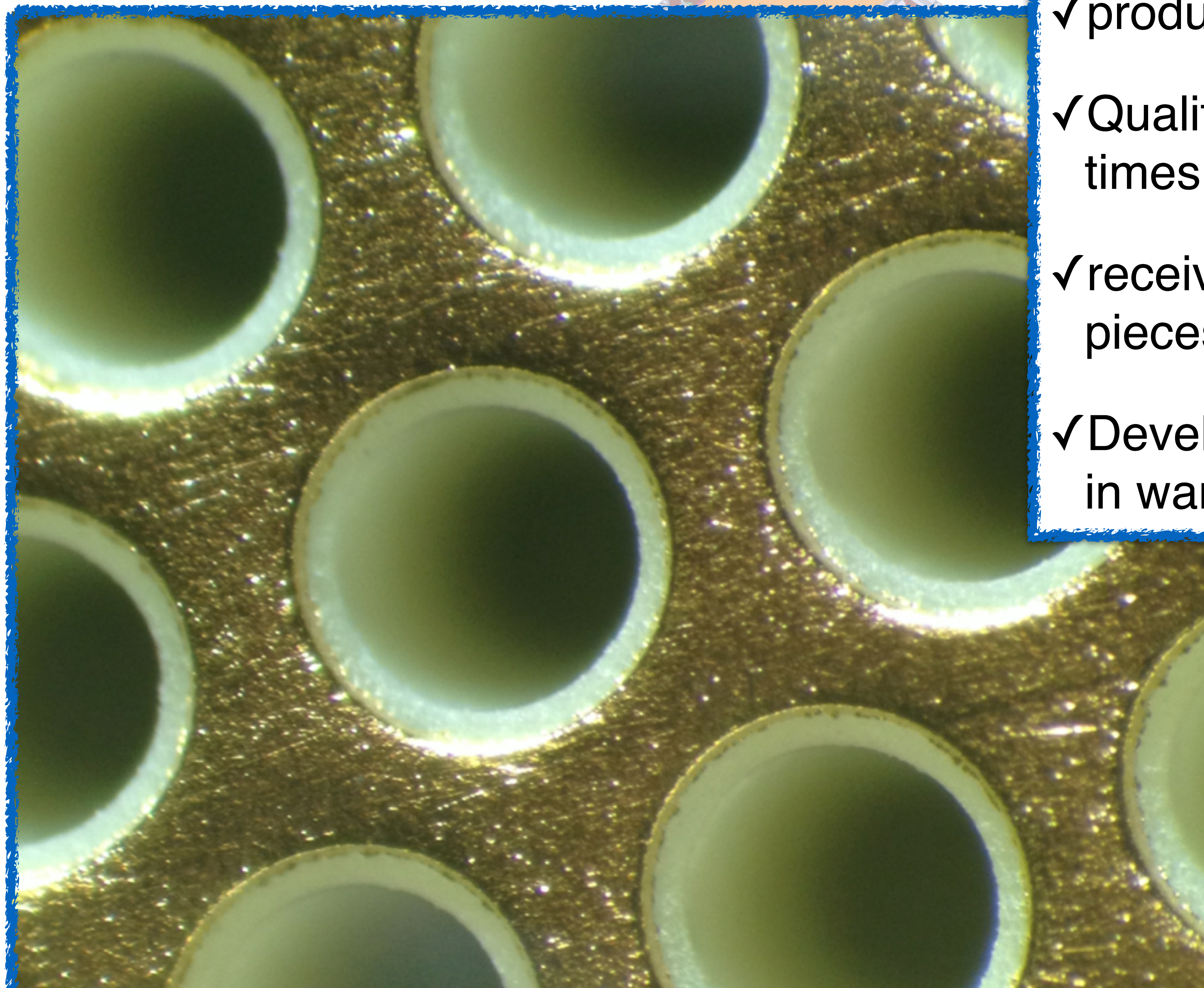
defined installation sequence.

✓In the process of getting quotes and ordering material from various companies.

The detector: Charge Readout Plane

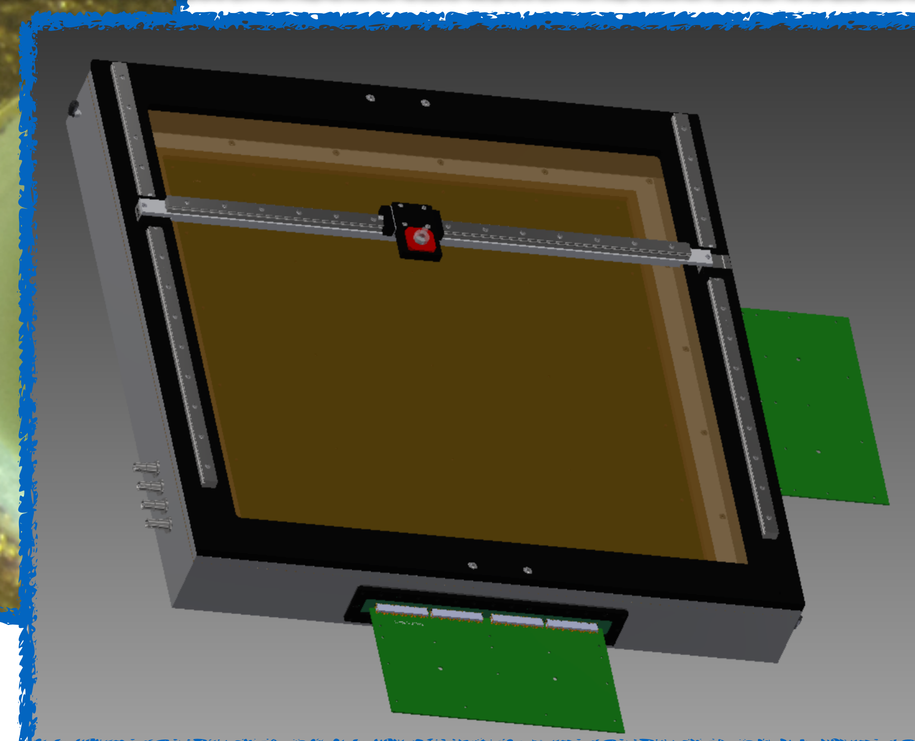
1) Design Overview





LEM

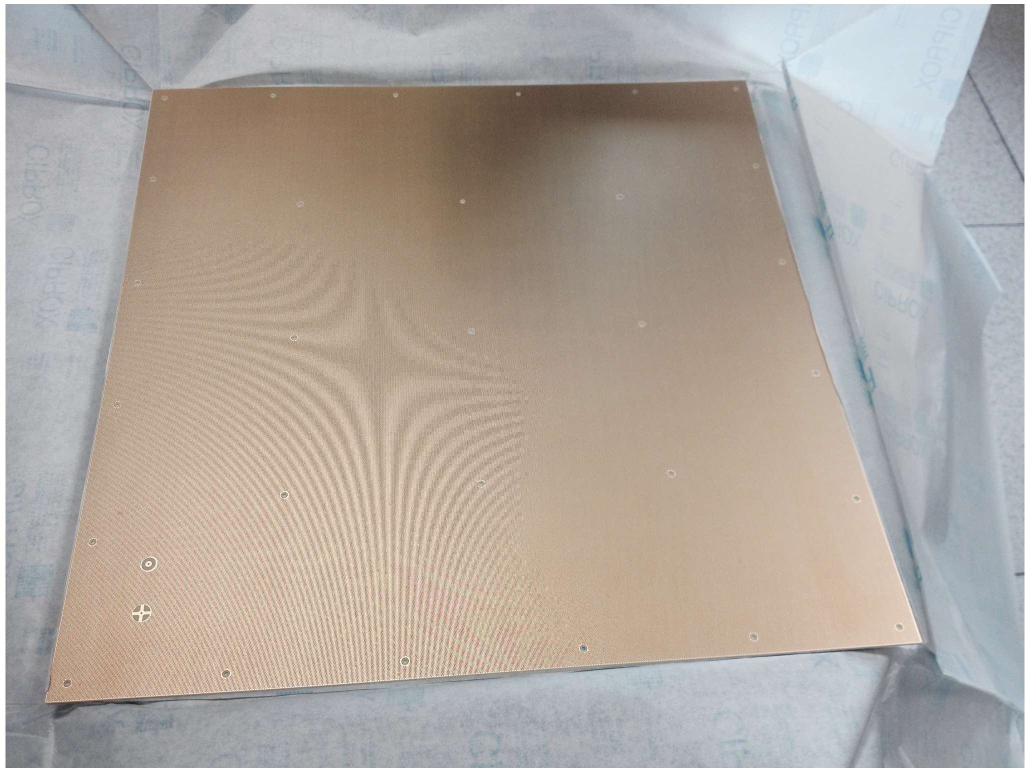
- ✓produced by ELTOS (Italy)
- ✓Quality has been tested numerous times on 10x10 cm^2 samples.
- ✓received first batch of 4 50x50 cm^2 pieces.
- ✓Developing a chamber for serial testing in warm Argon gas. (Saclay)

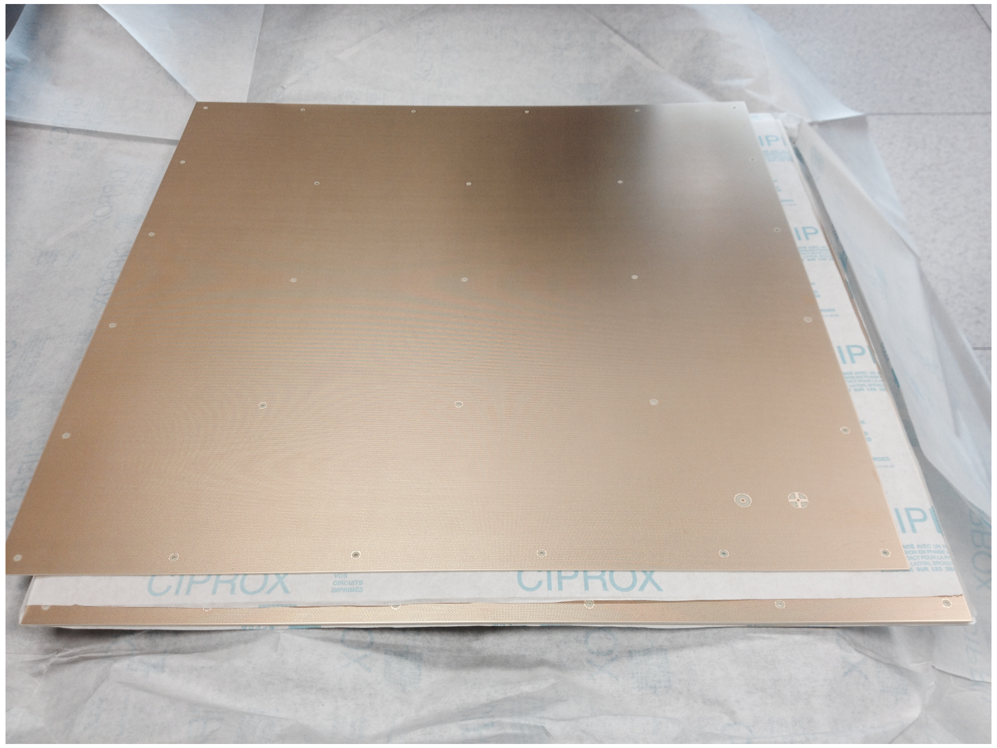


companies.

LEMs

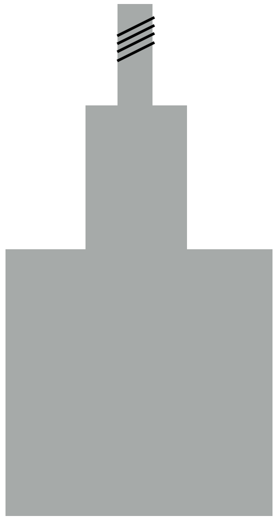
Receive first batch of 4 LEMs from ELTOS yesterday





Need to do a HV test in air.

machine pillars to hold
the LEM for the test
(ETH workshop)



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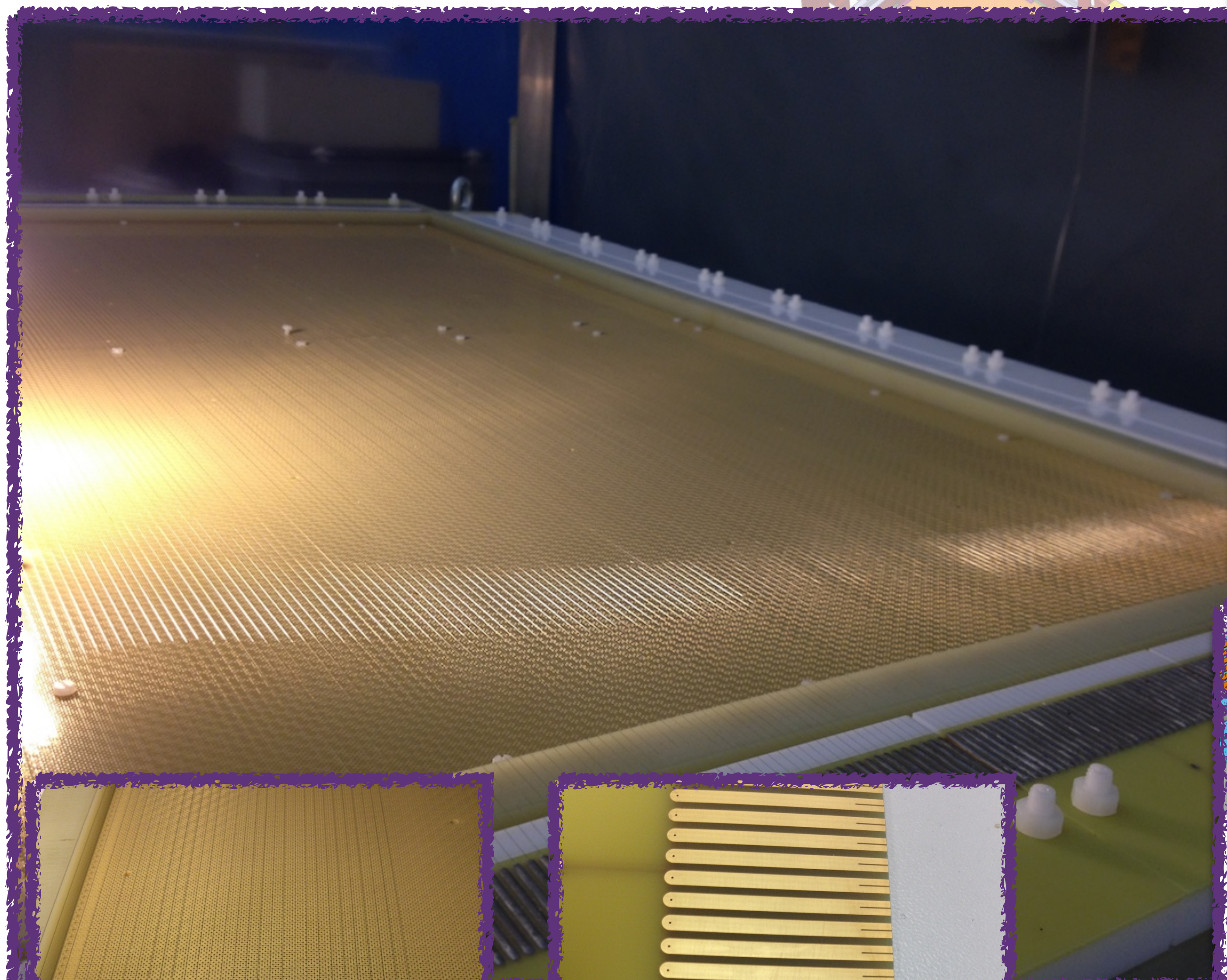
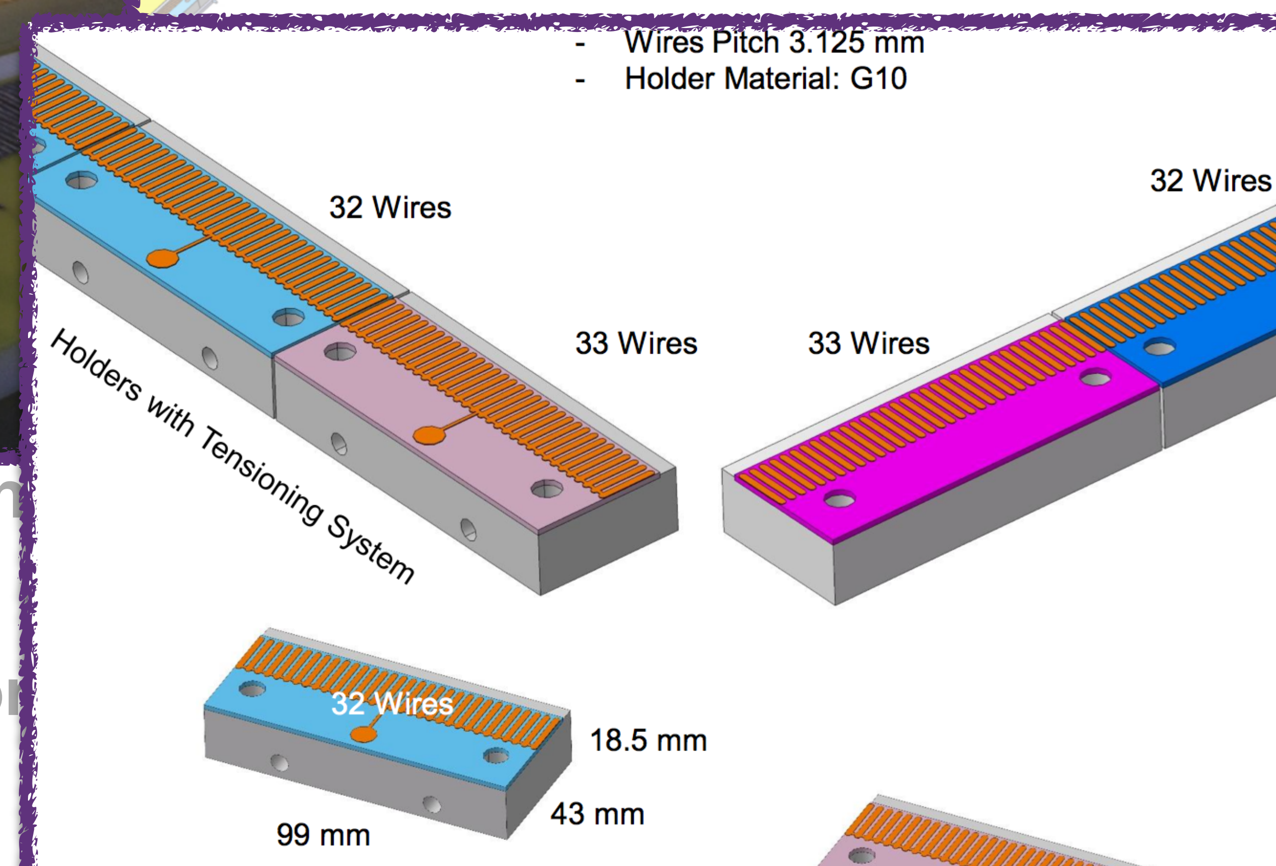
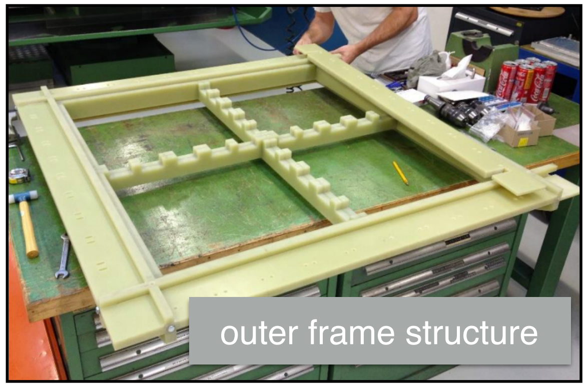


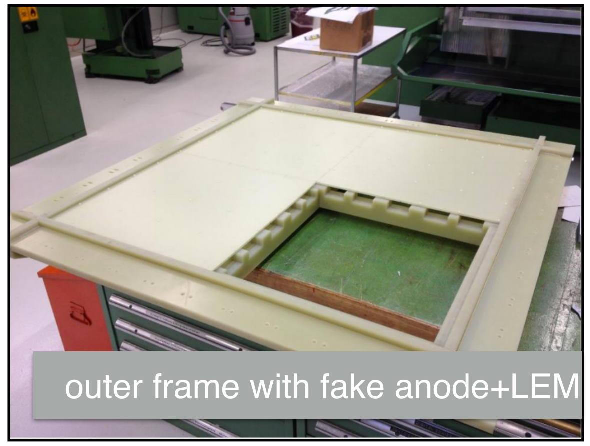
Extraction grid

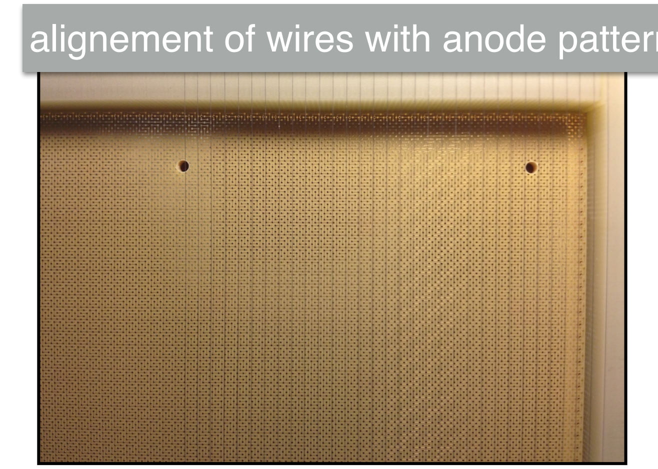
- ✓ 100 micron stainless wire with 3 mm pitch in x and y directions
- ✓ effect on gain uniformity tested in LAr on 10x10 cm² readout
- ✓ design has been extensively tested on a 1 m² prototype

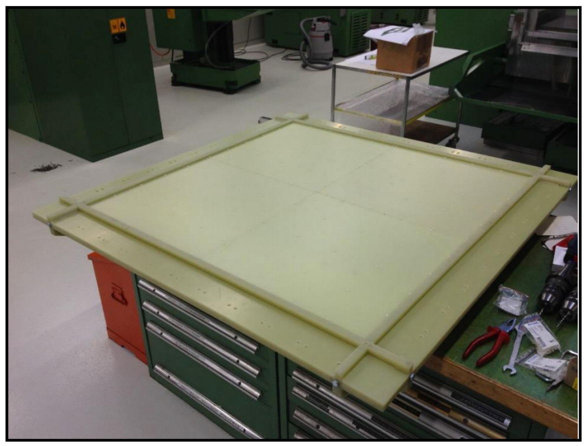


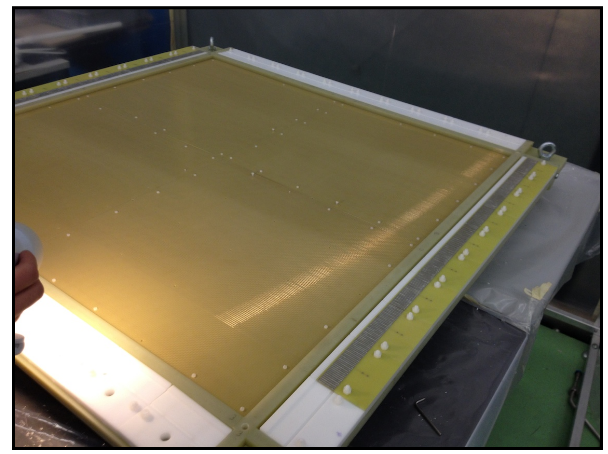
1 m² mockup of the whole charge readout

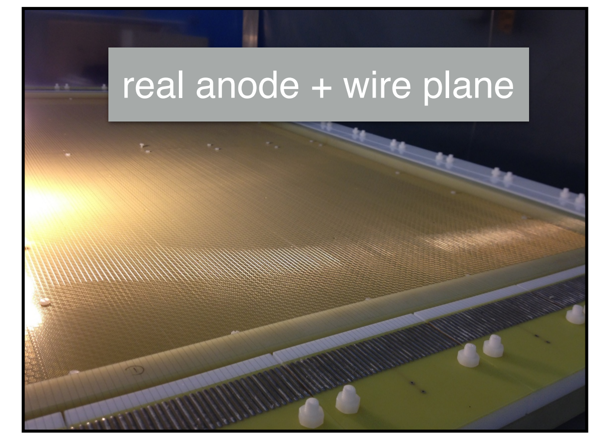


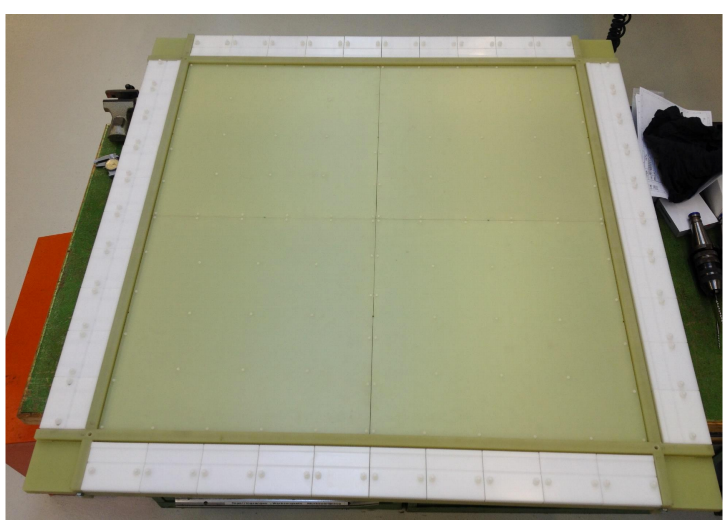


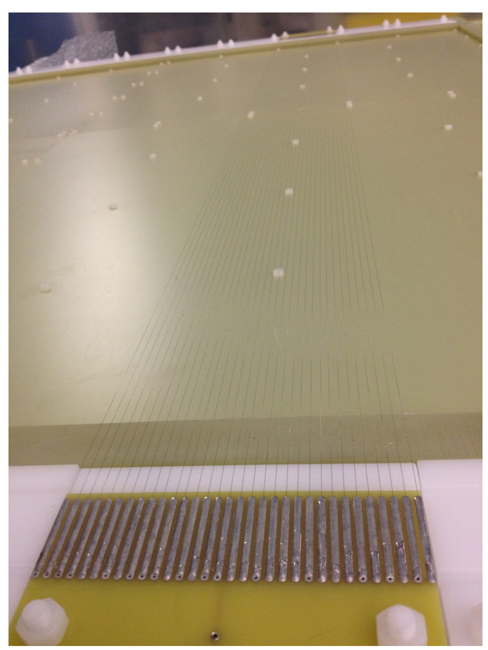




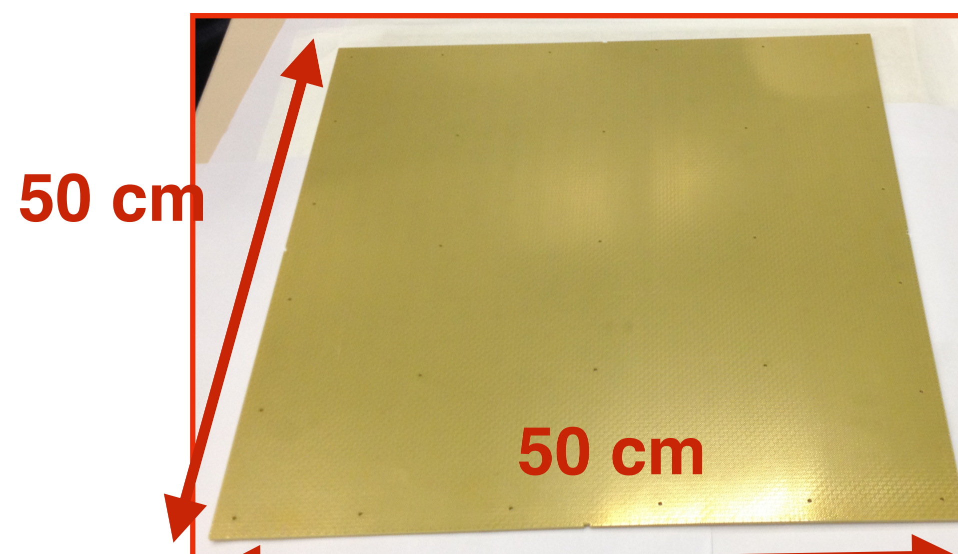








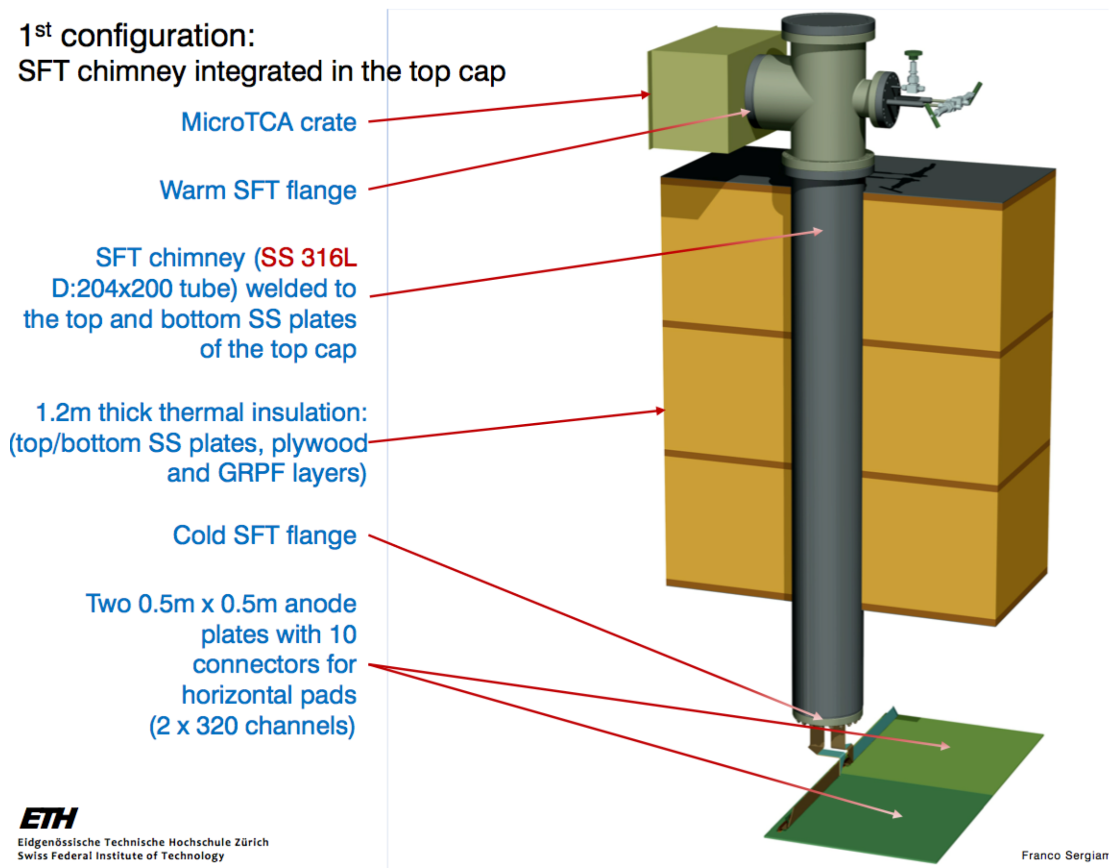
Charge readout plane divided in anode /LEM modules of 50 cm².



- 1280 wires in total (640 in *x* and 640 in *y*)
- precisely soldered on a PCB wire holder with a pitch of 3 mm.
- Each PCB wire holder hosts 32 wires and are tensioned individually

Design of signal feedthrough chimney

WA105

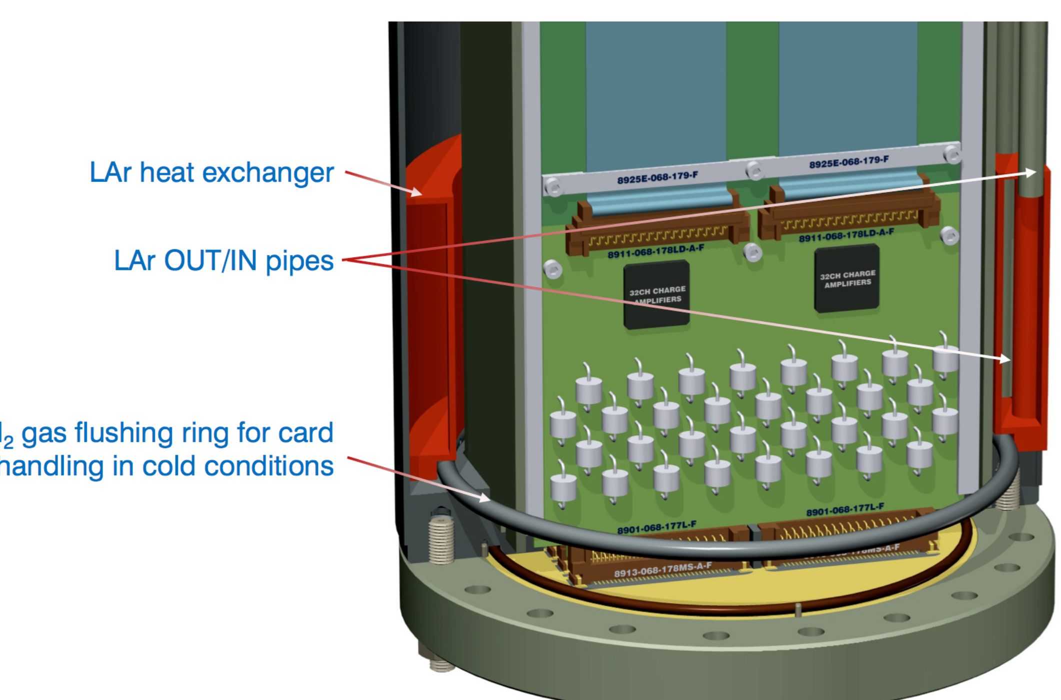


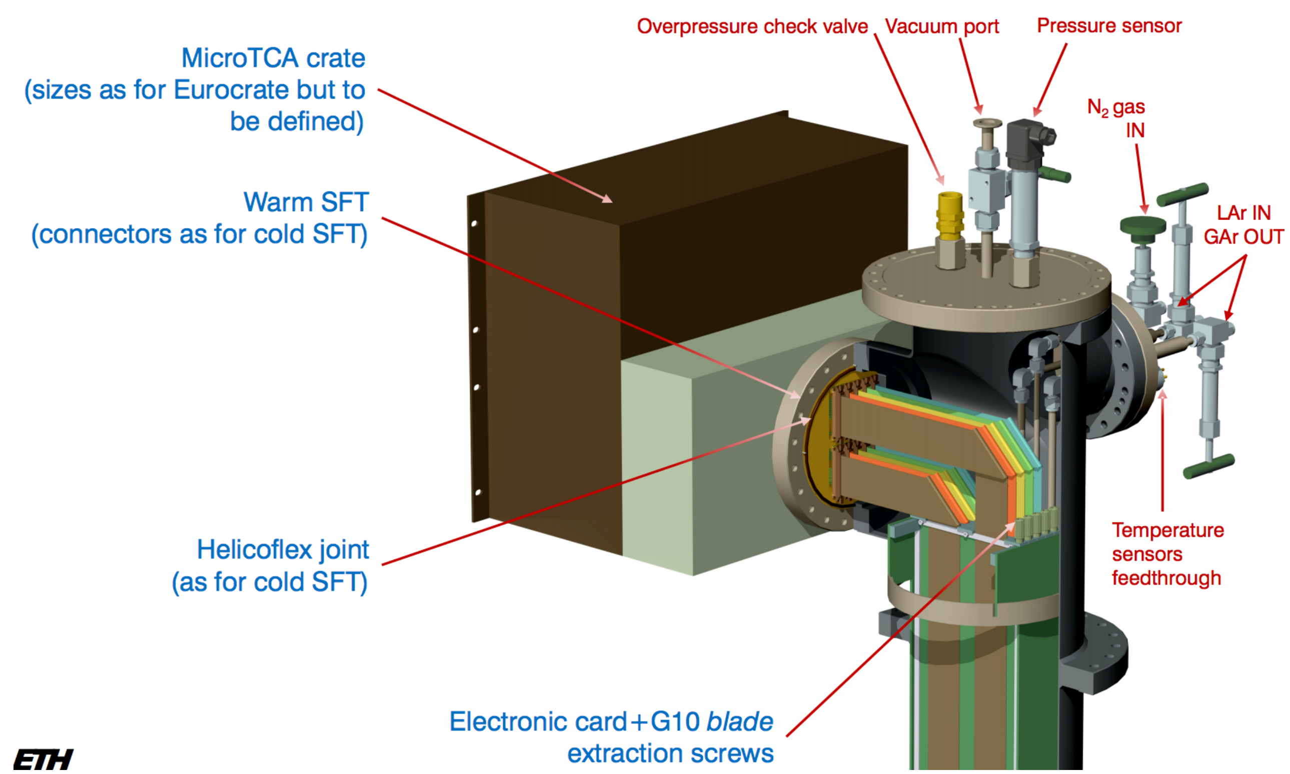
Chimney for the signal readout:

✓FE electronics in cold to reduce noise (cable length between anode an FE ~50 cm).

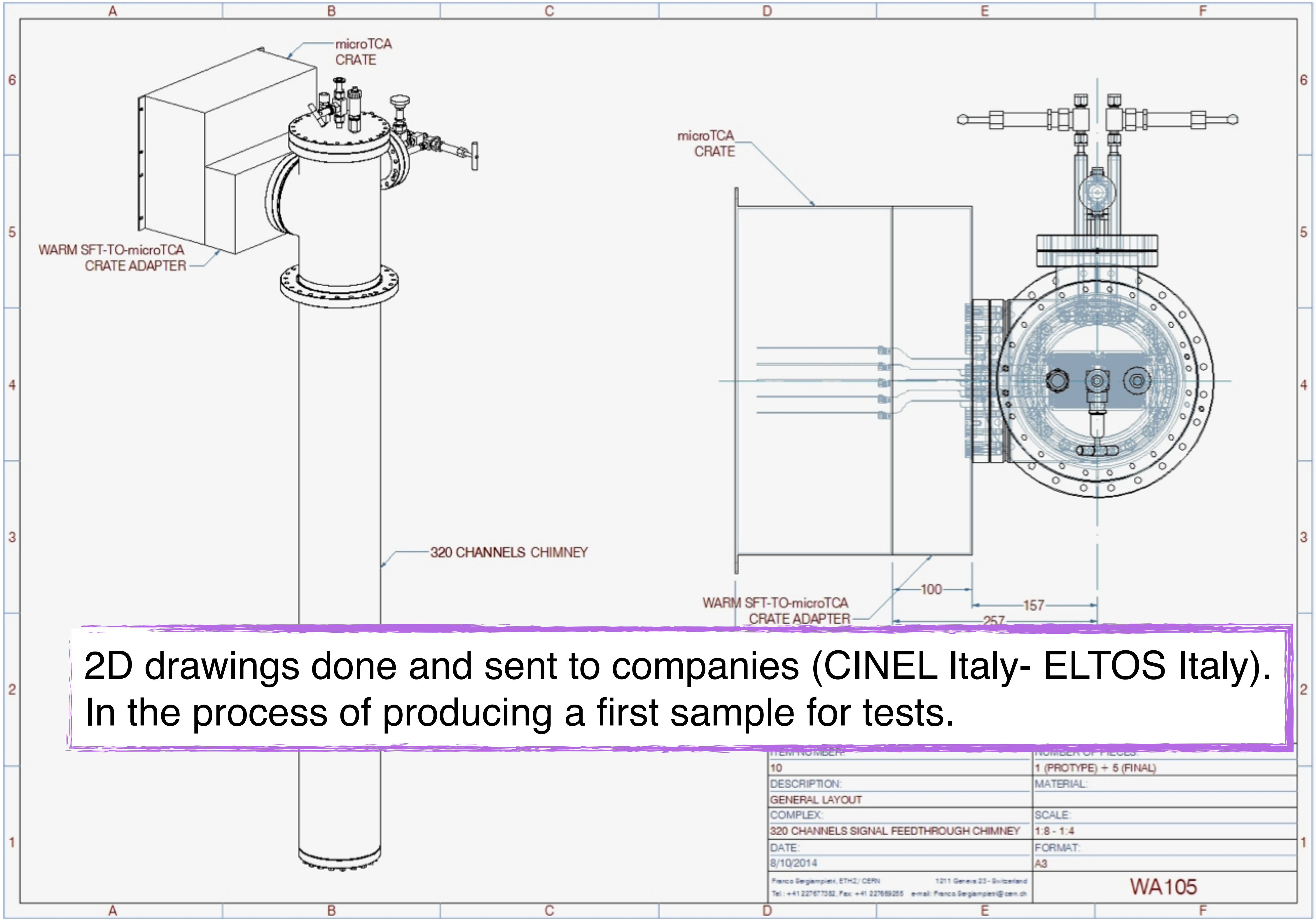
✓FE electronics are accessible (i.e can be changed w/o opening the whole detector and spoiling the purity).

✓requires carefully designed feedthroughs



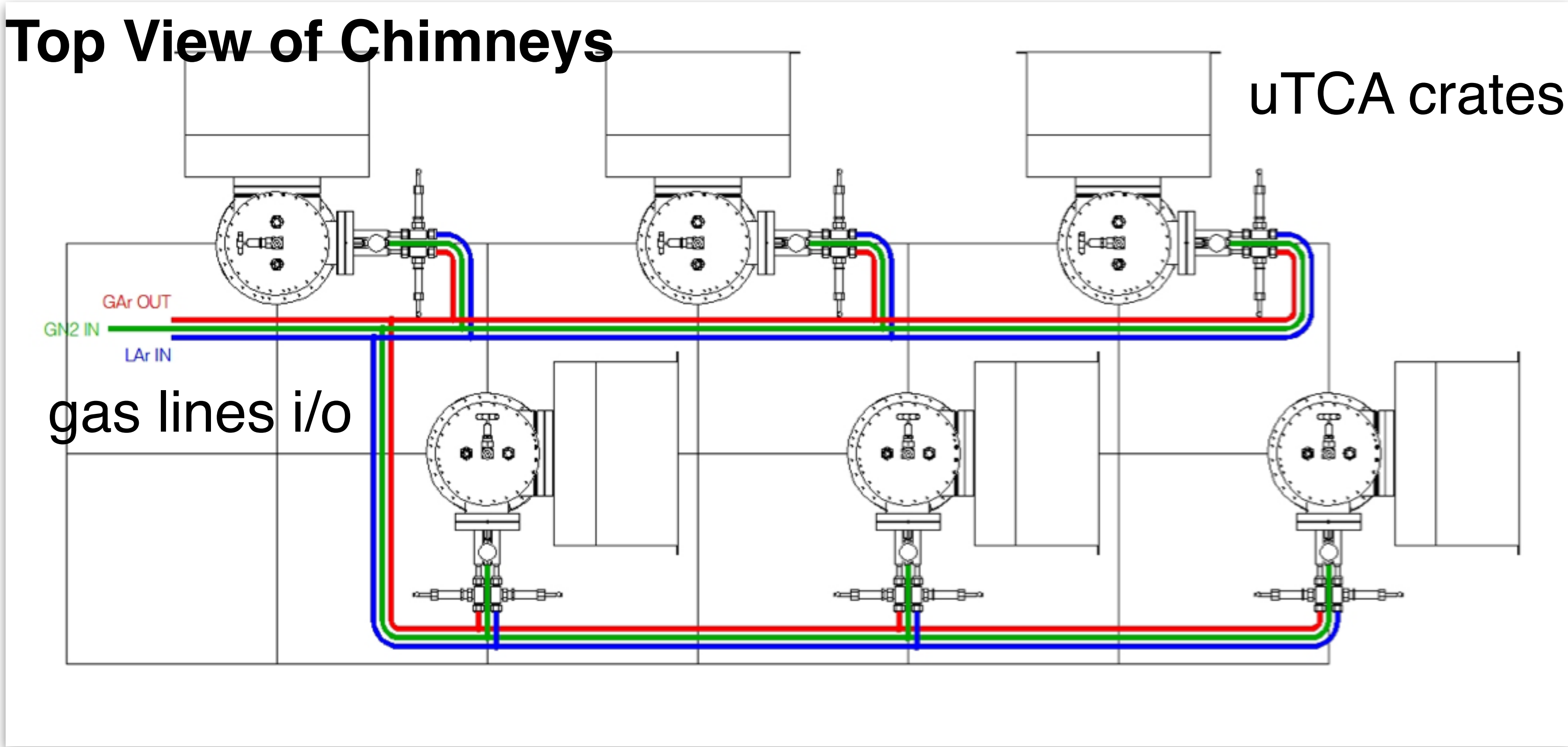


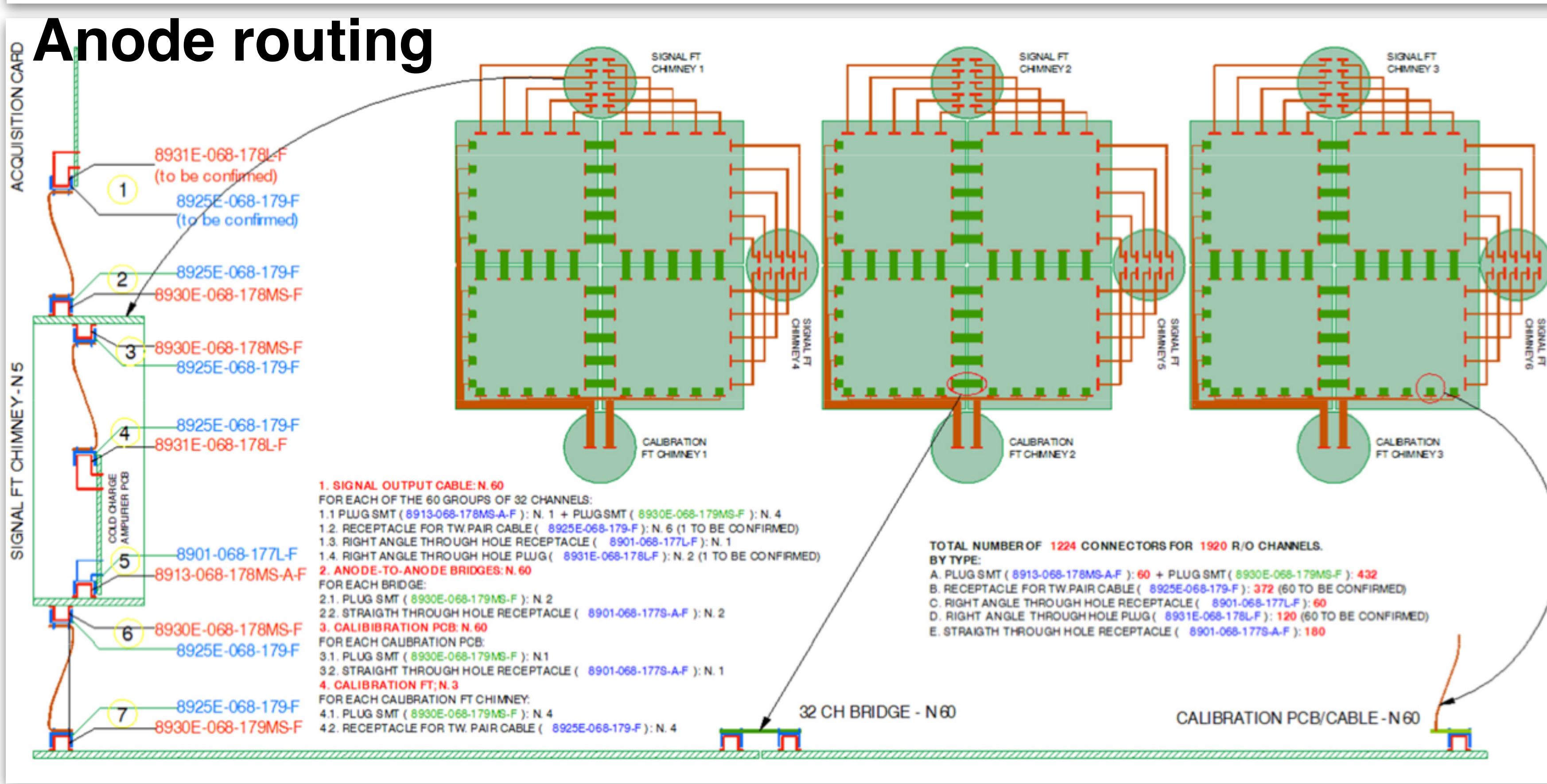
Design of signal feedthrough chimney



2D drawings done and sent to companies (CINEL Italy- ELTOS Italy).
In the process of producing a first sample for tests.

Design of signal feedthrough chimney





extra slides

Summary

✳WA105 has a well defined R&D roadmap to test the LBNO far detector at the relevant scale of 300 tons. Physics goal are compelling: it is the first time we will have fully contained showers in a test beam. Vital feedback on the LBNO far detector capabilities.

✳The construction of $1x1x3m^3$ is an important step and will give vital feedback for the construction $6x6x6m^3$ prototype.

✳The Charge Readout plane is the result of **Significant R&D efforts** made on the LEM grid and anode design. We now have a final design of the CRP ready to be constructed.

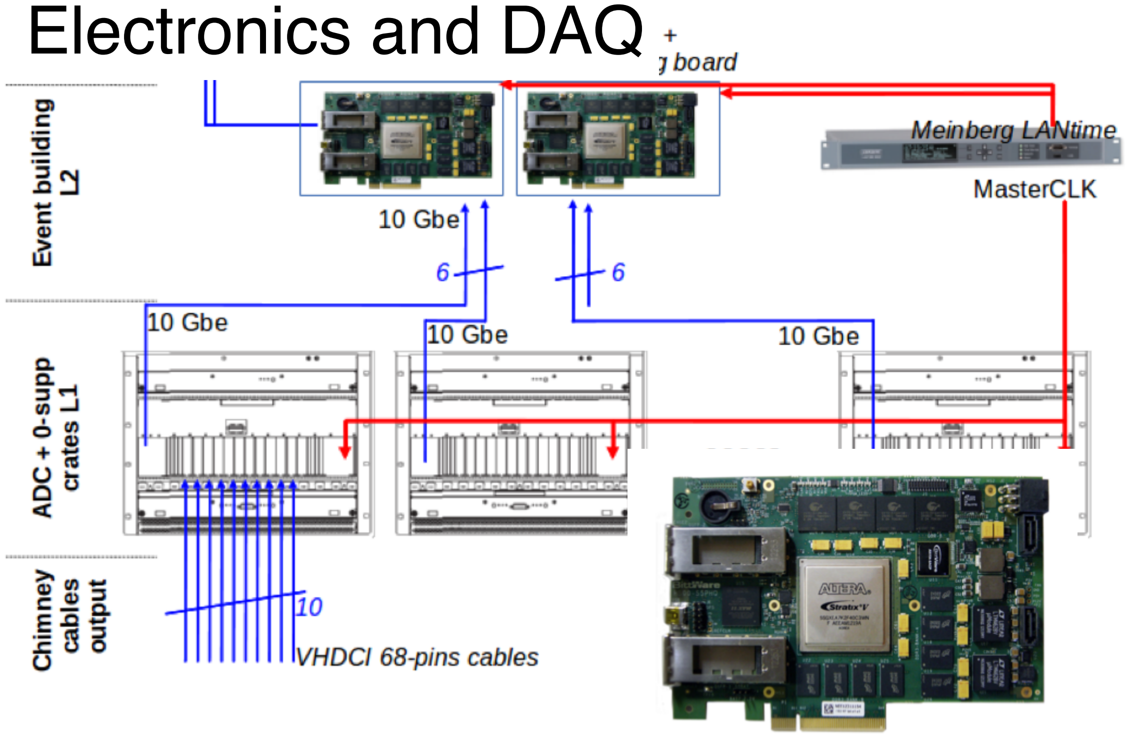
✳We have a well defined plan to build the 3x1x1 over the time scale of one year.

✳This includes validating the design on small scale mockups (CRP, Chimney) and dedicated QA tests of the material.

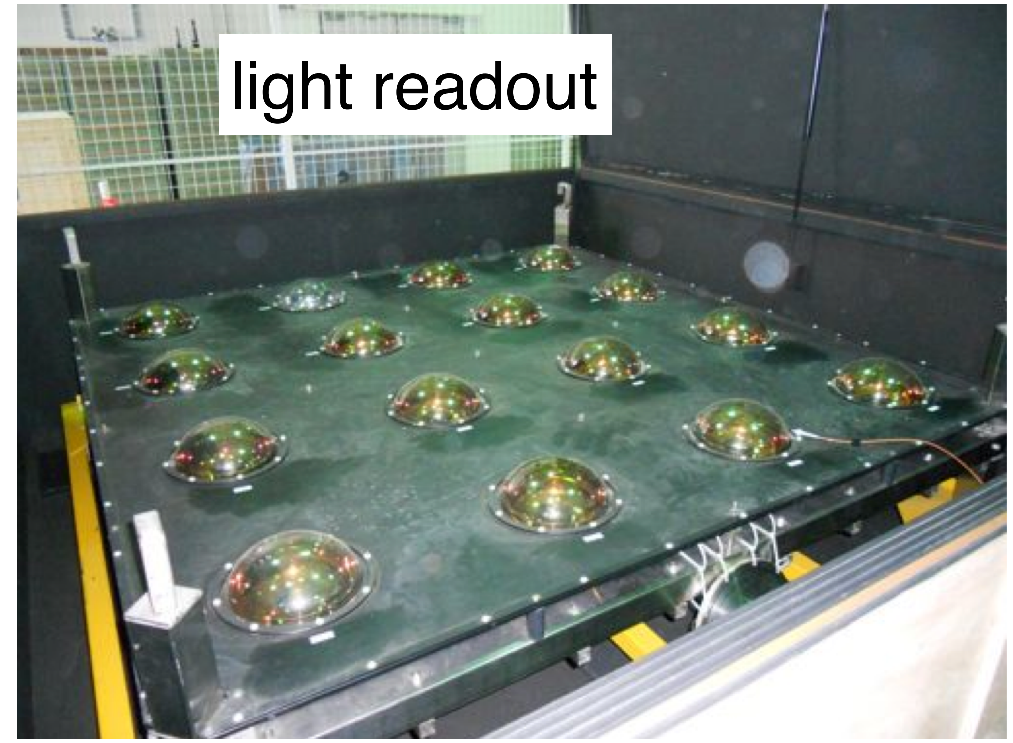
✳**A lot of work has already been done. And a lot of work is ahead!**

LBNO-DEMO: design work in progress

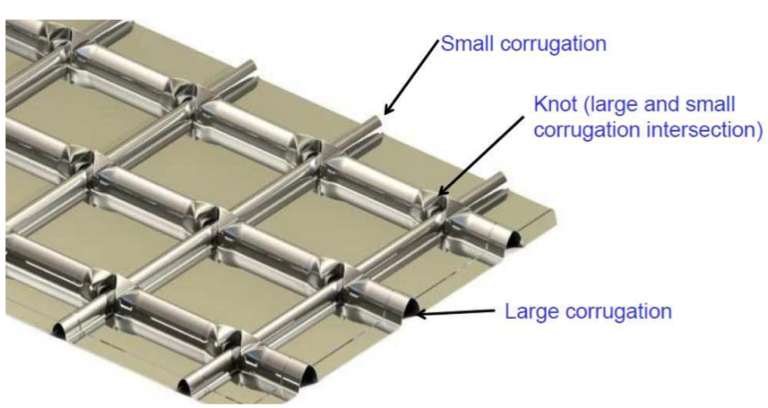
Electronics and DAQ



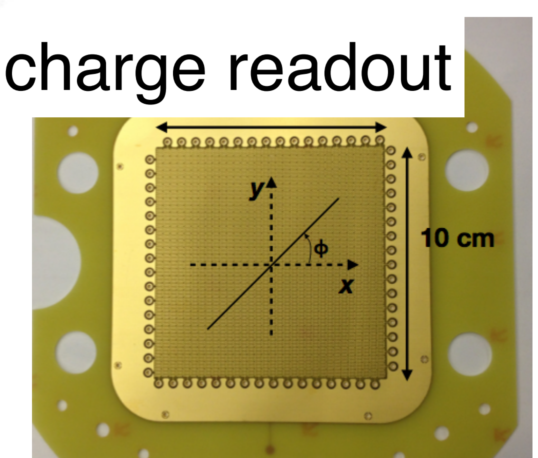
light readout



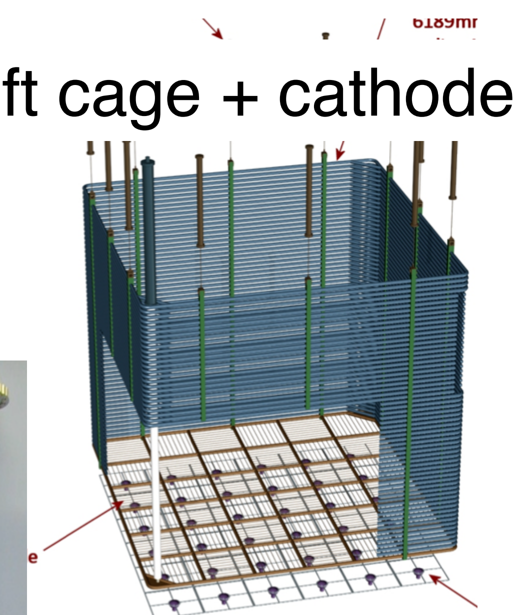
membrane tank



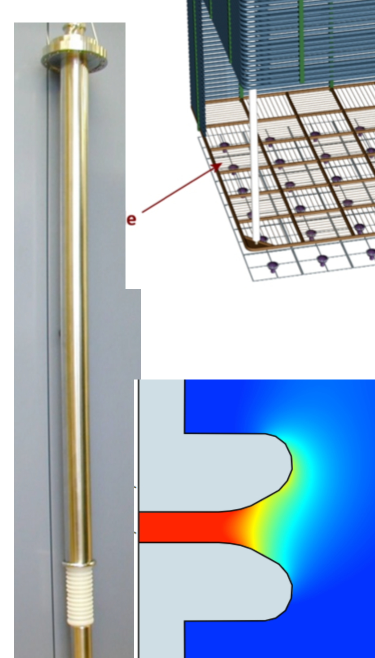
charge readout



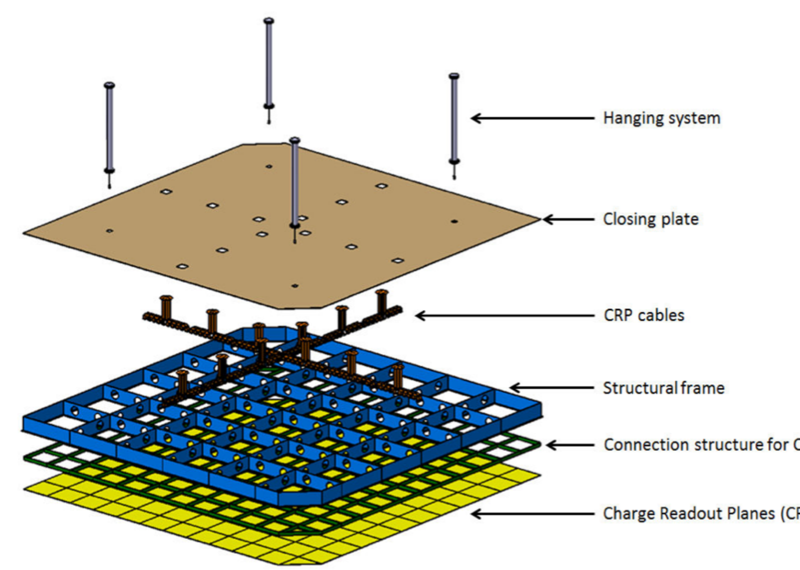
drift cage + cathode



HV

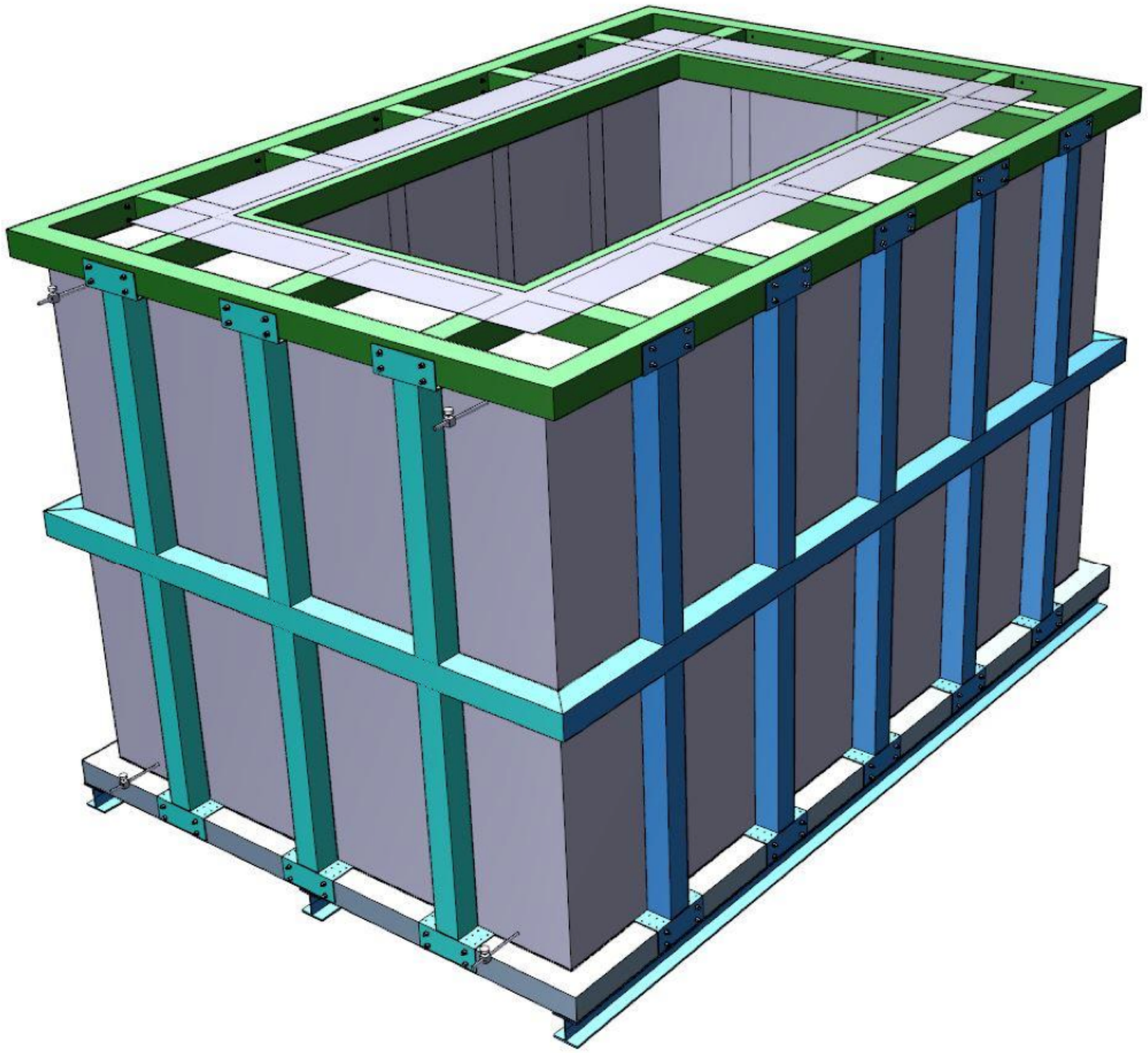


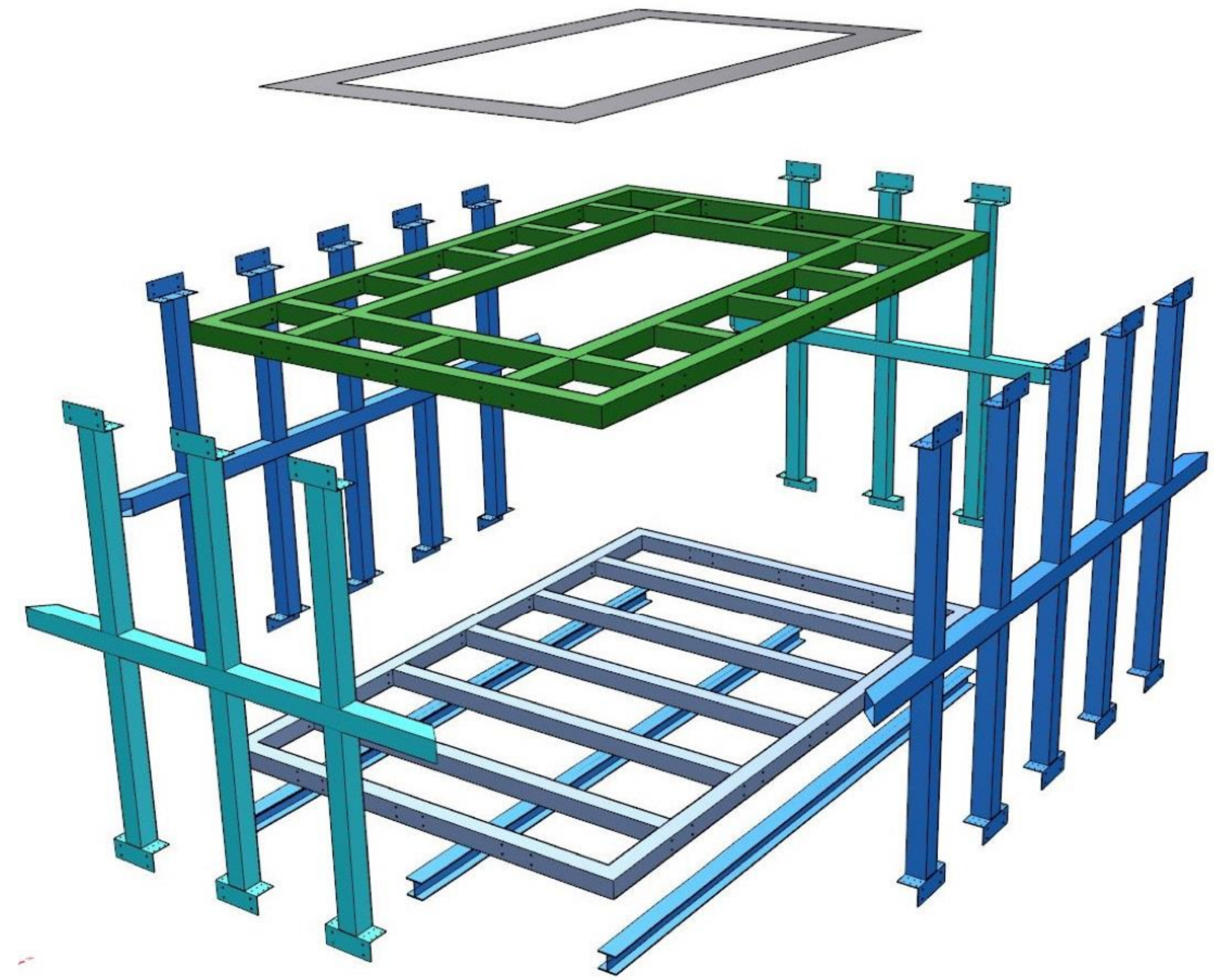
anode deck suspension



LAr process

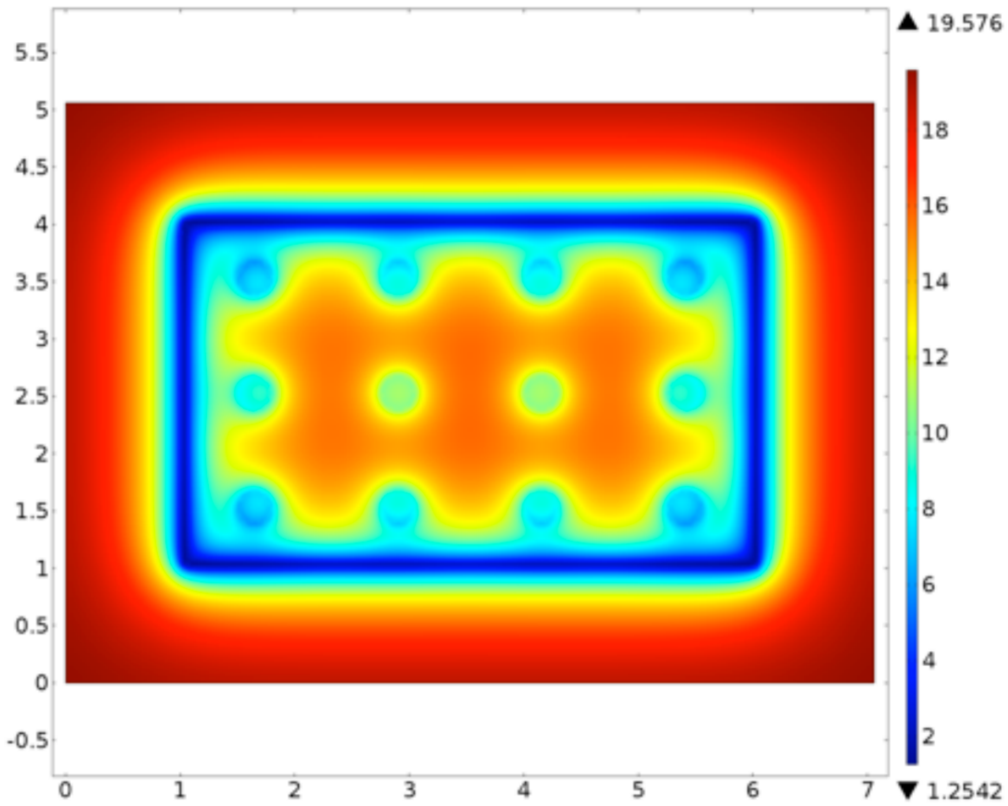
Tank outer structure

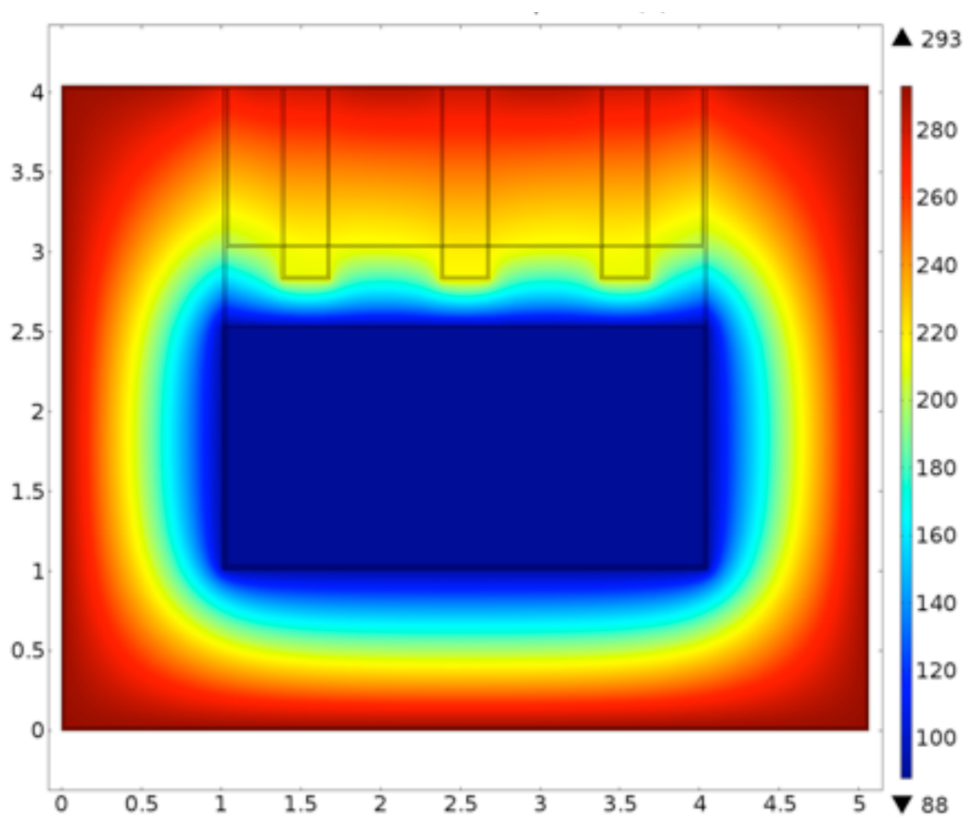




- **Outer tank structure being designed by ETHZ**
- **assembled on site with the help of CERN technicians**

Cryogenic installation

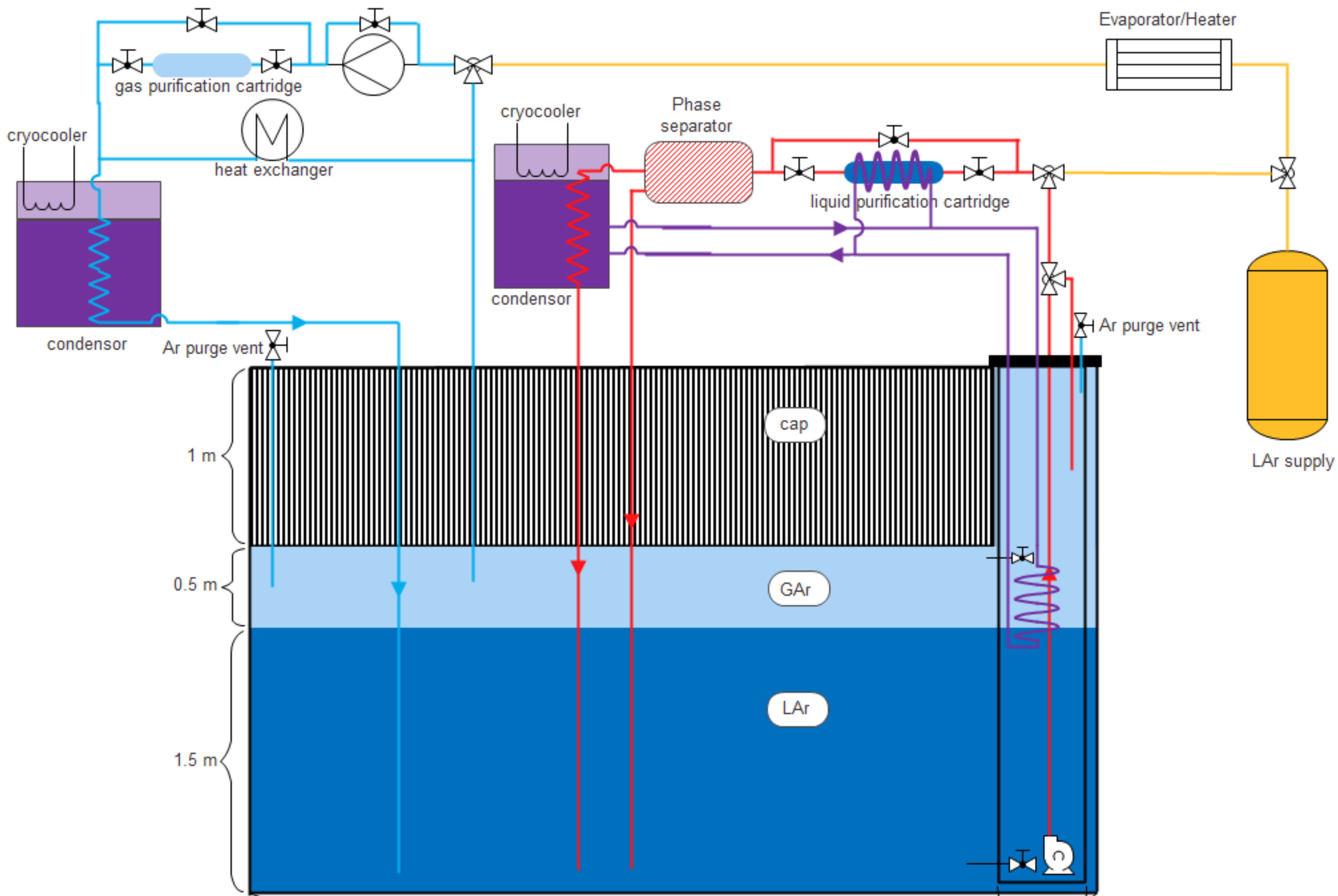




General parameters	
Membrane dimension	3x4.8x2.4 m3
Membrane total volume	35 m3
LAr level	1.5m from bottom
LAr volume dimension	1.5x4.8x2.4 m3
LAr volume	17 m3
GAr volume dimention	0.5x4.8x2.4 m3
GAr volume	5.76 m3
Insulation density	70 kg/m3 (PU Aged HFC245)
Insulation thickness	1 m
Vacuum	No vacuum
Design pressure	Max 1050 mbar/ Min 950 mbar
Design/Operation temperature	77 / 87 K
Total internal area	52.2 m2
Total heat input (membrane+ chimneys + top cap)	**~700 W**

Cryogenic installation

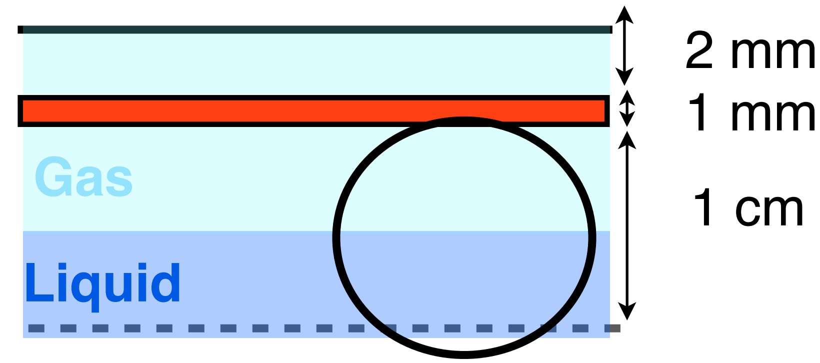
WA105

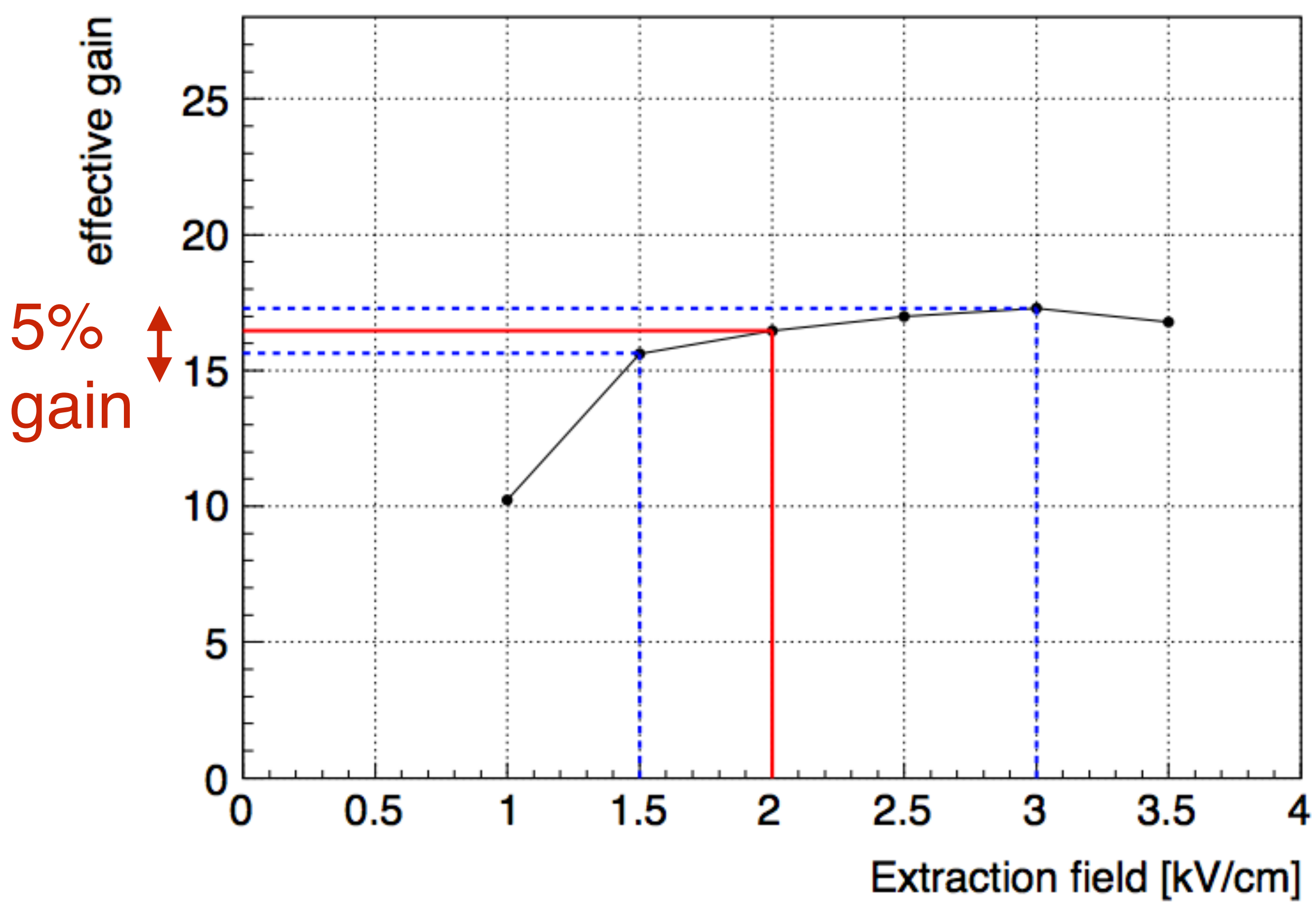


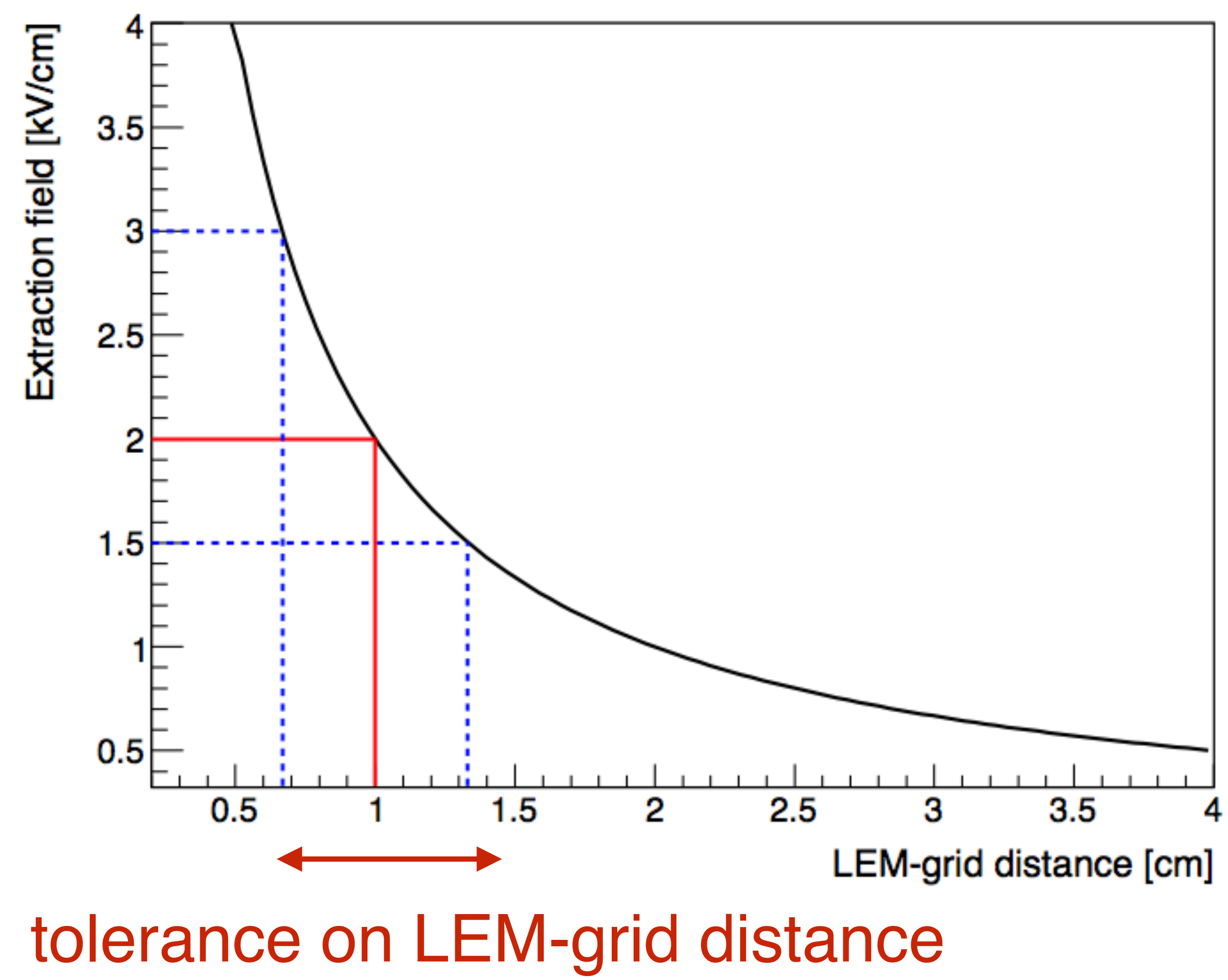
Meeting on 24-25 September with Fermilab + CERN cryogenic engineers

tolerance on the inter-stage distance

- to have the best PID performance in the TPC we want to keep gain uniform within ±5%.
- We translate on this on tolerances on the inter-stage distances between each stage of the CRP.
- example for LEM-Grid distance:

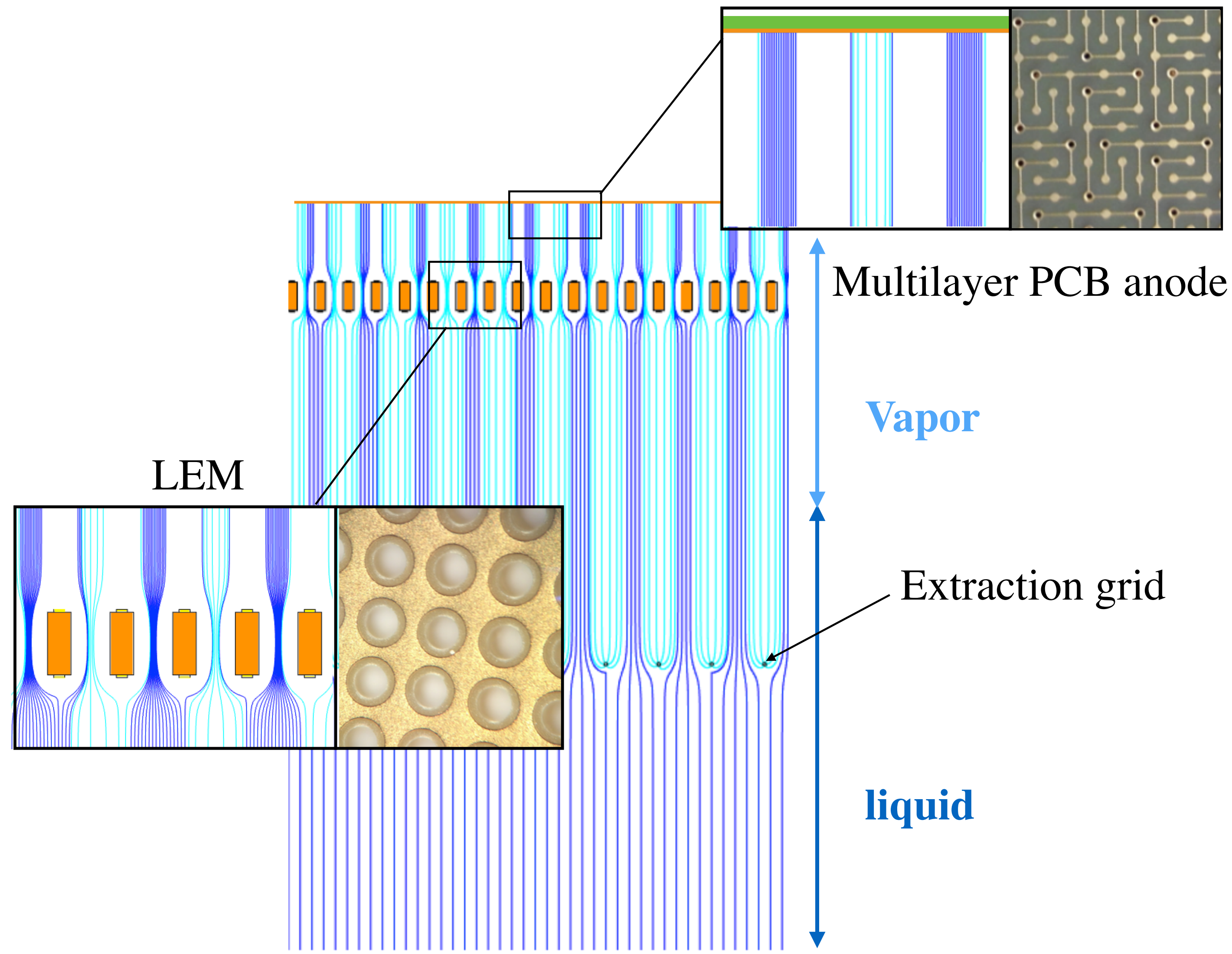






tolerance on the inter-stage distance

	distance [mm]	tolerance [mm]
anode-LEM	2	0.1
LEM thickness	1	0.01
LEM-grid	10	1
liquid level	5 (from grid)	1
x-y position of the 50 cm	500	0.1

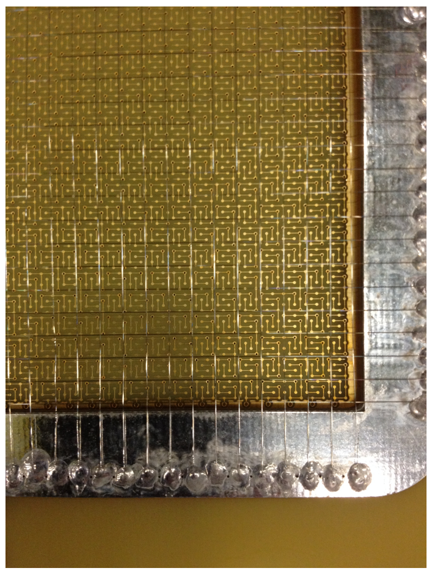


Comparison of uniformity

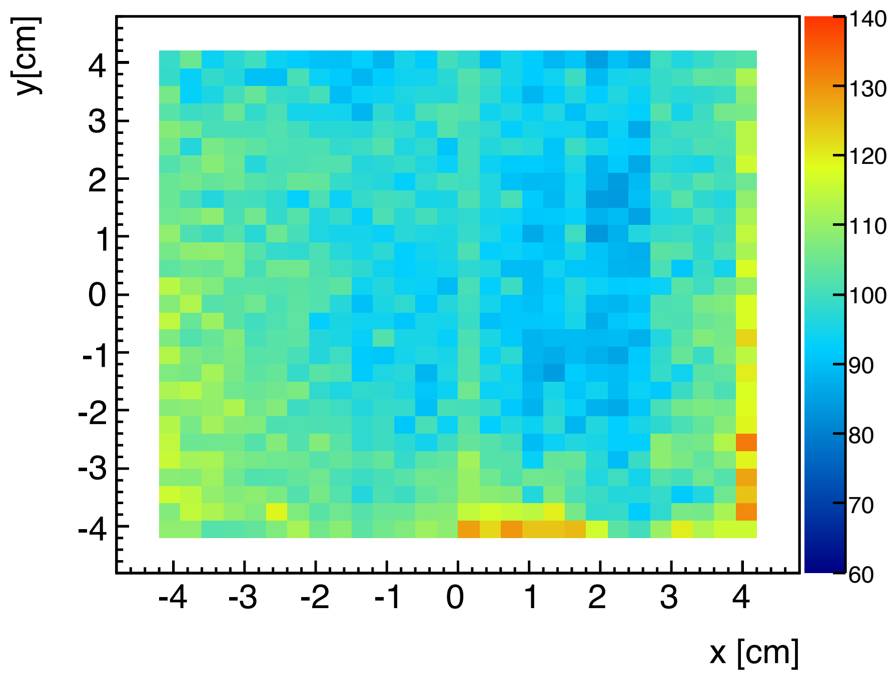
WA105

all plots normalised to <dQ/dx>=100

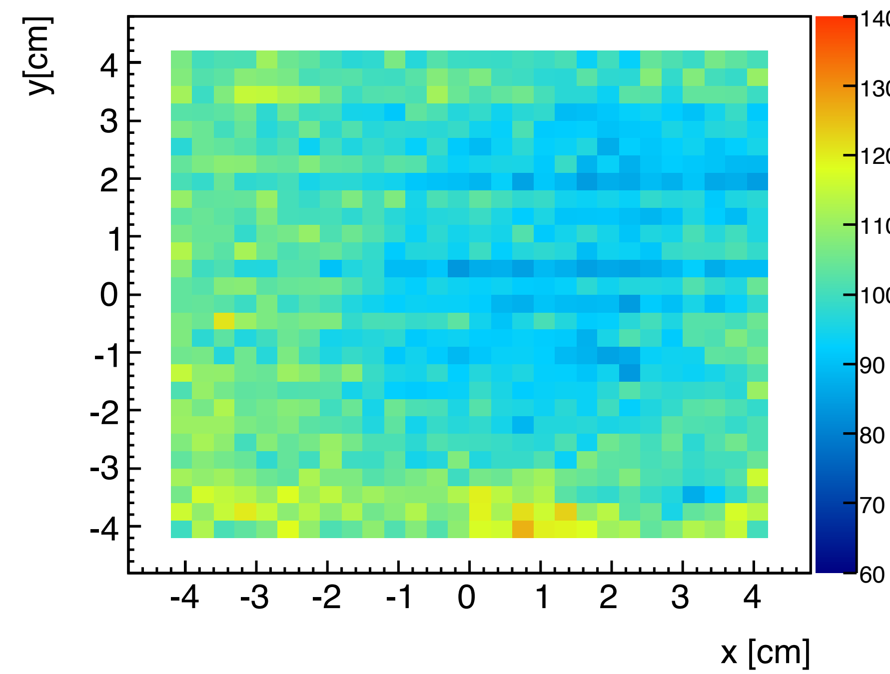
3 mm pitch in x-y



view 0

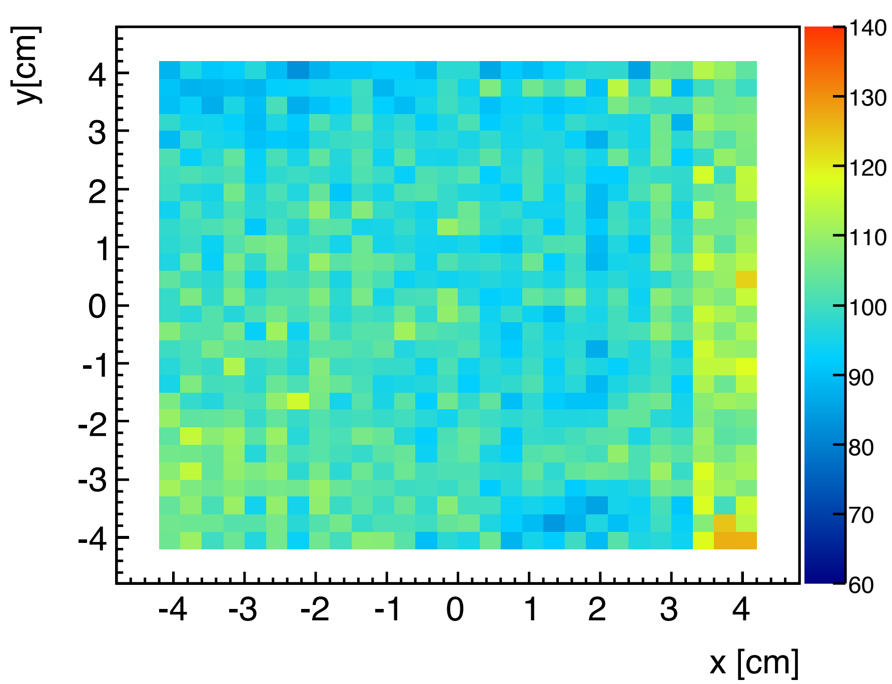


view 1

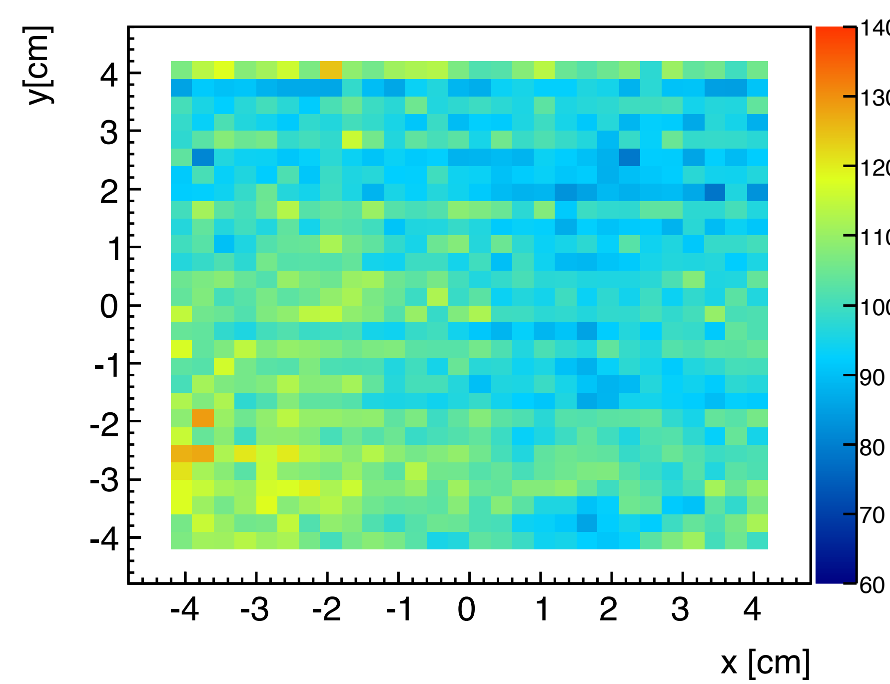


1.5 mm pitch in x

view 0



view 1



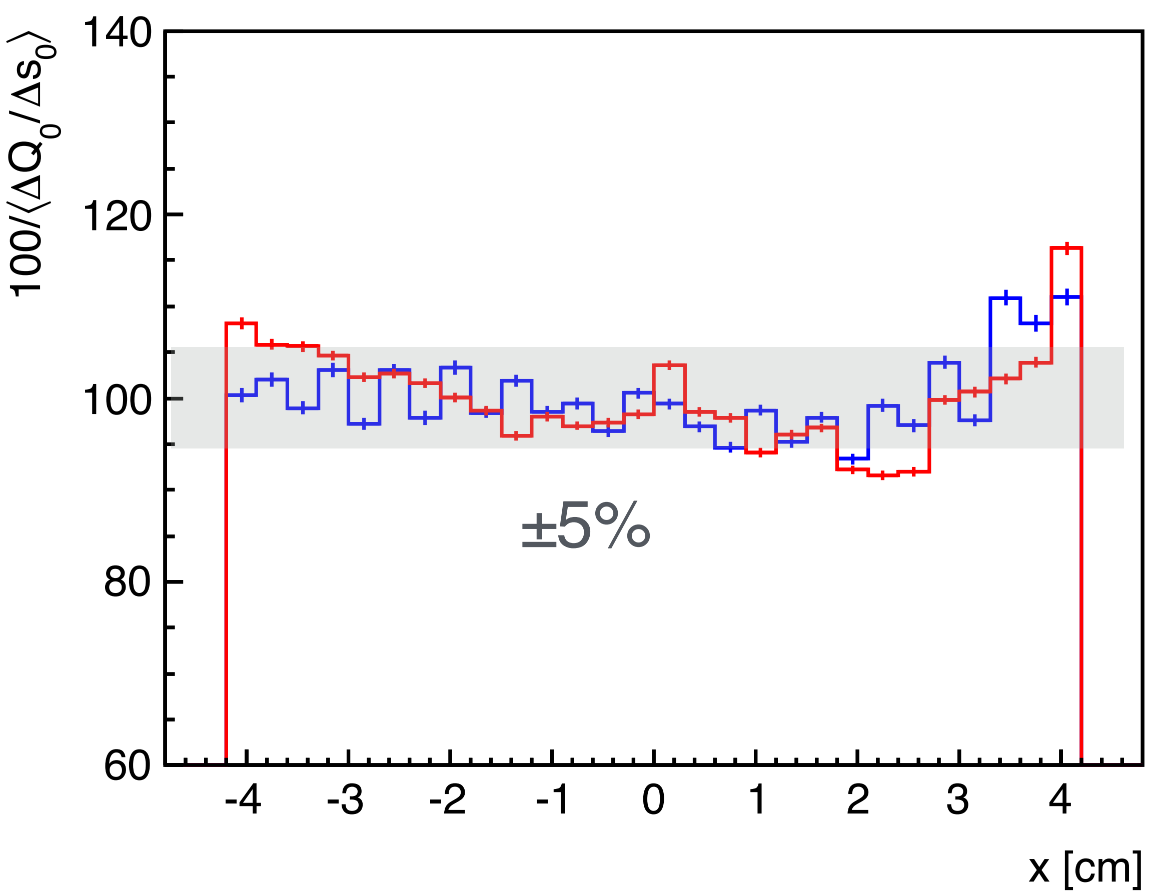
Comparison of uniformity - projections

all plots normalised to <dQ/dx>=100

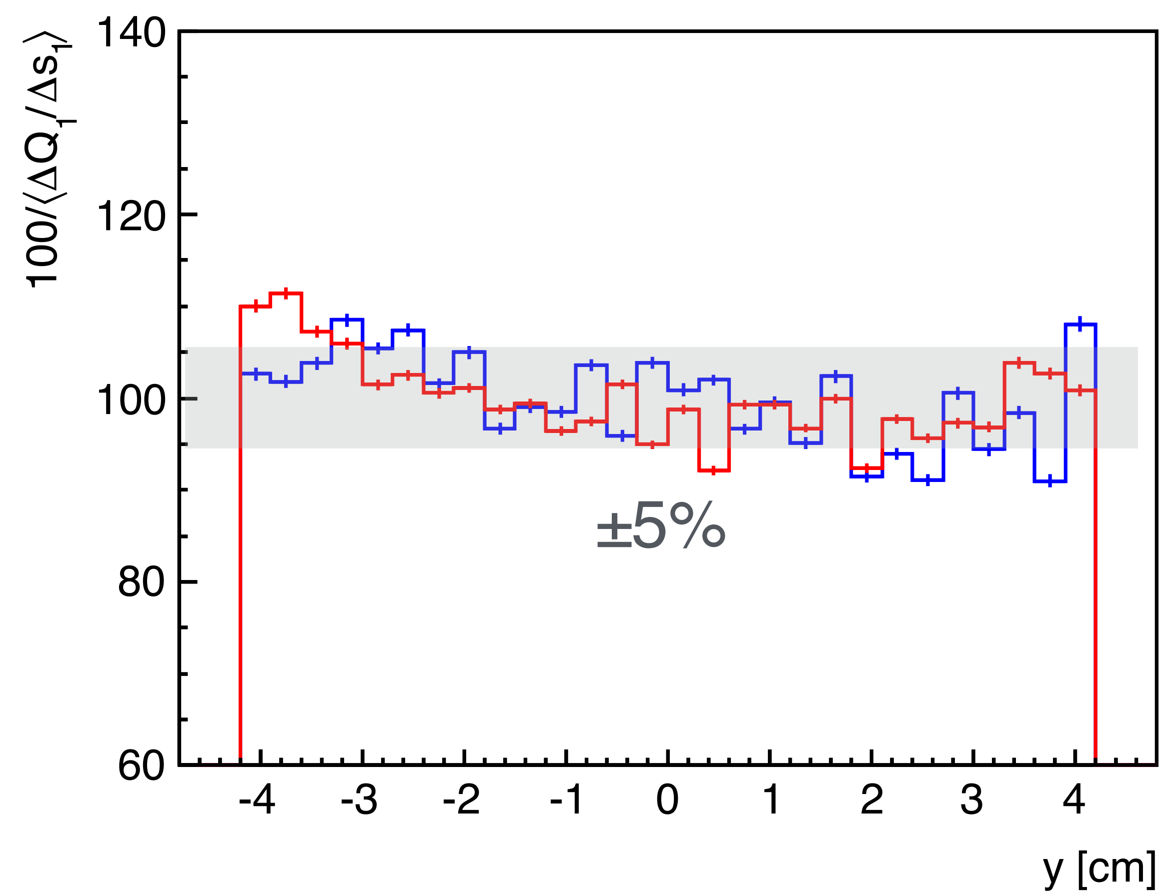
3 mm pitch in x-y

1.5 mm pitch in y

projection along x- coordinate



projection along y-coordinate



bin-to-bin fluctuations are an effect of the grid
smooth fluctuations are an effect of the LEM thickness

Tolerances on inter-stage distances