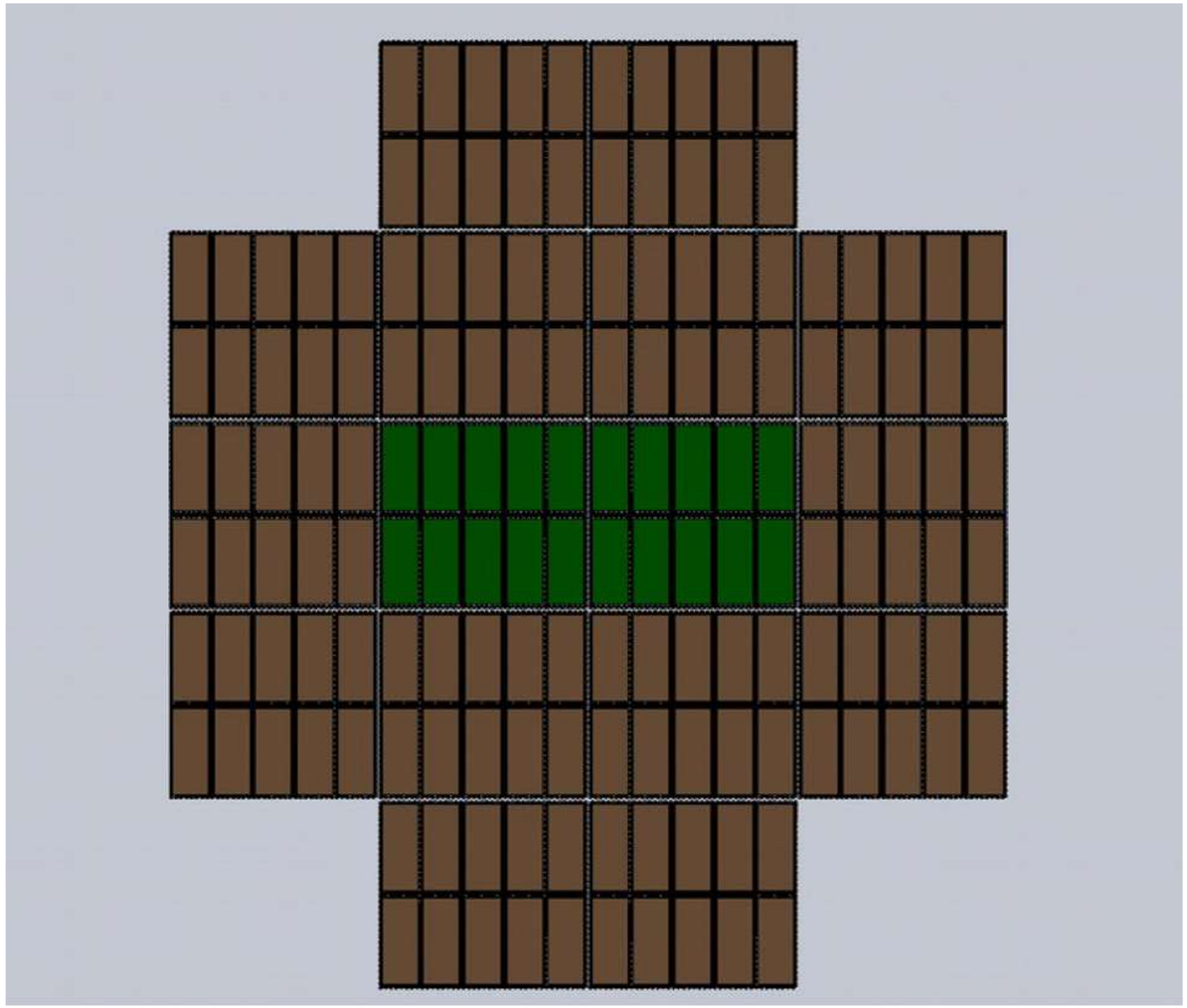
HiDRA2 – WP1

Module geometry (From call project)

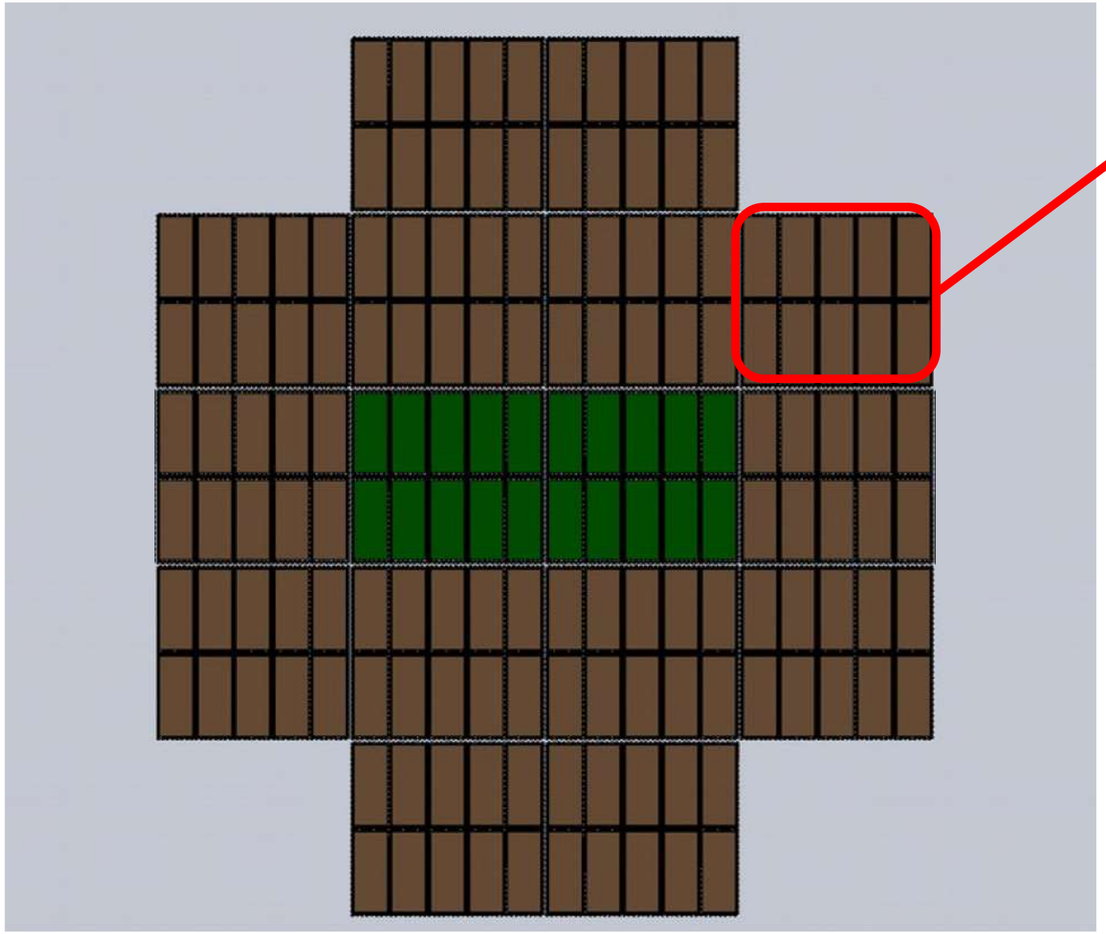
Baseline: 16 modules

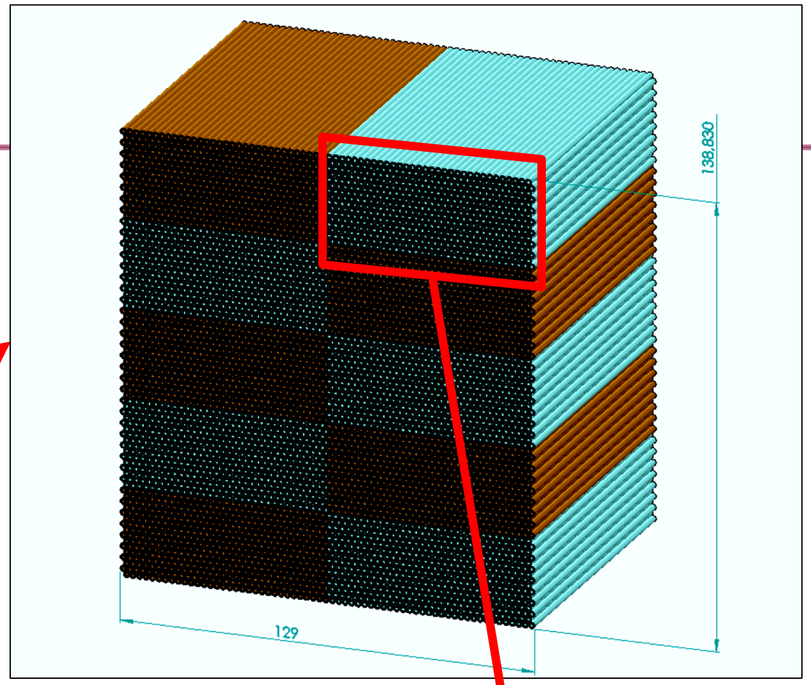
- 2 central ones with SiPMs
  → ~ 10 k SiPMs
  → ~ 20 FEE boards

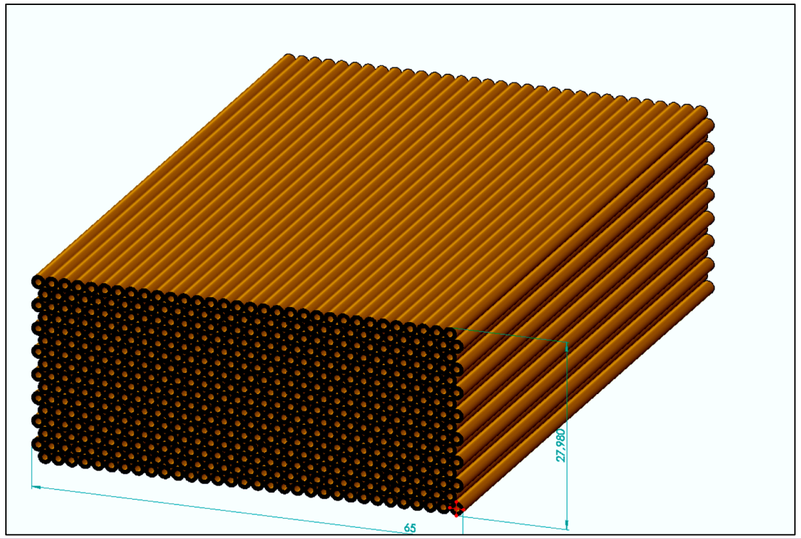
- 14 others ones with PMTs
  → 140 PMTs
  → 70 C + 70 S



Original Drawing of the call







1 Module:
2 × 5 MMs
~ 13 × 13 cm^2

1 MiniModule:
32x16 channels
512 in total
256S +256 C

Activities

WP1 Activity: Choice of baseline options for scintillating and Čerenkov fibres, choice of baseline options for absorber material and layout, choice of PMTs for external ring readout. Definition of construction procedure, including the coupling of fibres to light sensors. Construction of prototypes and modules for the full-containment calorimeter.

WP1 Description of Work and Role

- T1.1. Identification of candidates for Čerenkov and scintillating fibres [M1-12][MI,PI,PV]
- T1.2. Absorber material choice [M1-12][PI,PV]
- T1.3. PMT choice and layout optimisation [M1-12][PI]
- T1.4. Definition of Quality Control (QC) procedure and criteria for Čerenkov and scintillating fibres [M1-12][MI,PI,PV]
- T1.5. Definition of QC procedure and criteria for PMTs [M1-12][PI]
- T1.6. Dimensions and construction method of the building elements [M7-18][MI,PI,PV]
- T1.7. Dimensions and assembly procedure of single towers with a self-supporting structure [M13-18][PI,PV]
- T1.8. Definition of QC procedure and criteria for single towers [M13-18][MI,PI,PV]
- T1.9. PMT procurement and qualification [M13-18][PI]
- T1.10. Construction of full-containment prototype and the dSiPM module [M19-30][PI,PV]
- T1.11. Engineering design of projective towers [M19-36][PI]

Milestones & Deliverables

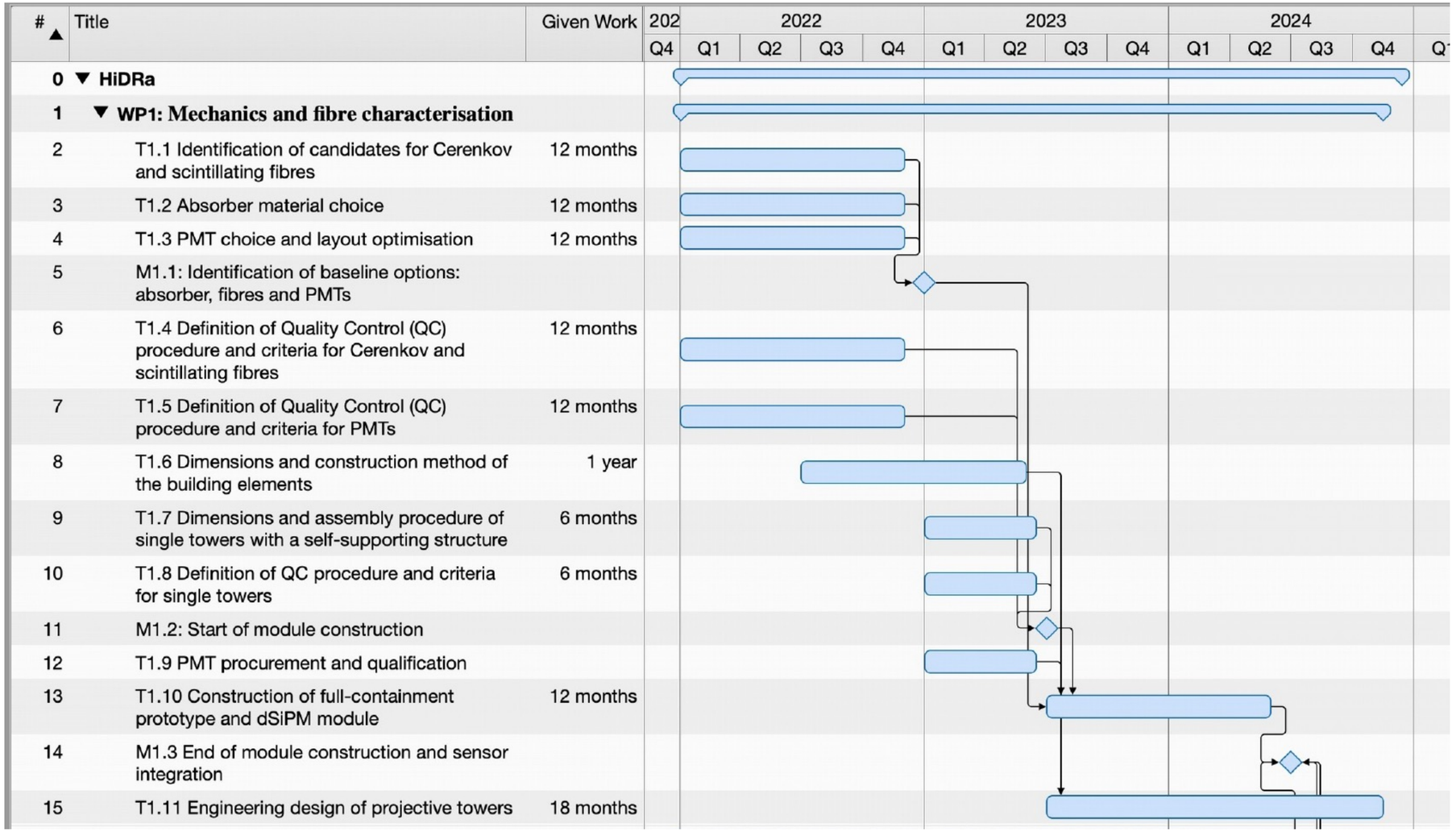
WP1 Milestones

- M1.1. Identification of baseline options: absorber, fibres and PMTs [M12]
- M1.2. Start of module construction [M19]
- M1.3. End of module construction and sensor integration [M30]

WP1 Deliverables

- D1.1. Full characterisation of chosen baseline options [M12]
- D1.2. Single tower of final dimensions built with the selected absorber and fibers and with the final procedure [M20]
- D1.3. Final prototype built and integrated with readout sensors [M30]

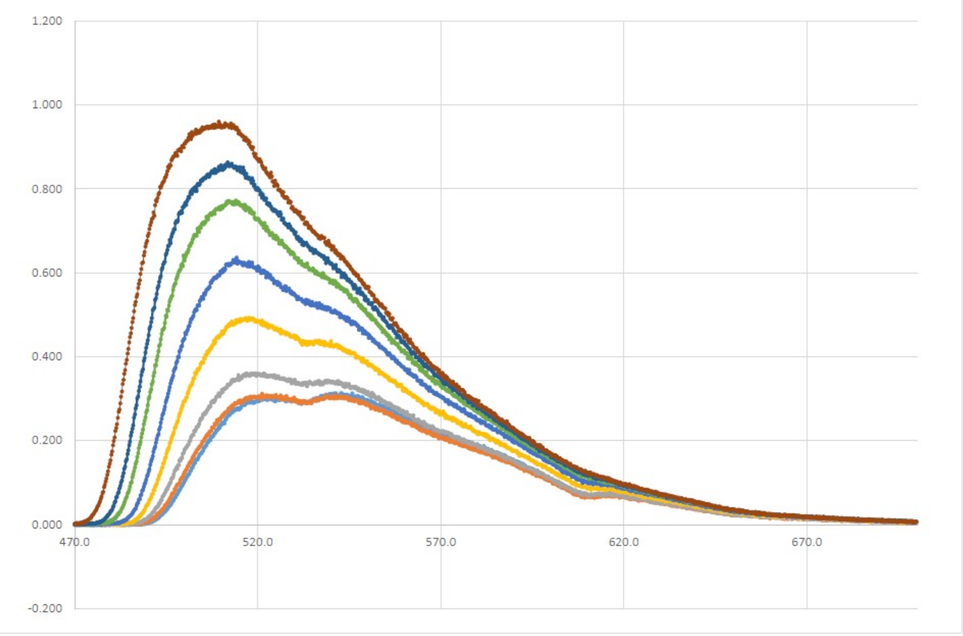
Gantt chart



#	Title	Given Work
0	**HiDRa**	
1	**WP1: Mechanics and fibre characterisation**	
2	T1.1 Identification of candidates for Cerenkov and scintillating fibres	12 months
3	T1.2 Absorber material choice	12 months
4	T1.3 PMT choice and layout optimisation	12 months
5	M1.1: Identification of baseline options: absorber, fibres and PMTs	
6	T1.4 Definition of Quality Control (QC) procedure and criteria for Cerenkov and scintillating fibres	12 months
7	T1.5 Definition of Quality Control (QC) procedure and criteria for PMTs	12 months
8	T1.6 Dimensions and construction method of the building elements	1 year
9	T1.7 Dimensions and assembly procedure of single towers with a self-supporting structure	6 months
10	T1.8 Definition of QC procedure and criteria for single towers	6 months
11	M1.2: Start of module construction	
12	T1.9 PMT procurement and qualification	
13	T1.10 Construction of full-containment prototype and dSiPM module	12 months
14	M1.3 End of module construction and sensor integration	
15	T1.11 Engineering design of projective towers	18 months

T1.1 and T1.4 Fibers

- Scintillating fibres:
  - Tested few samples from Saint Gobain
  - Best performance (attenuation length) still for Kuraray SCSF-78



T1.1 and T1.4 Fibers

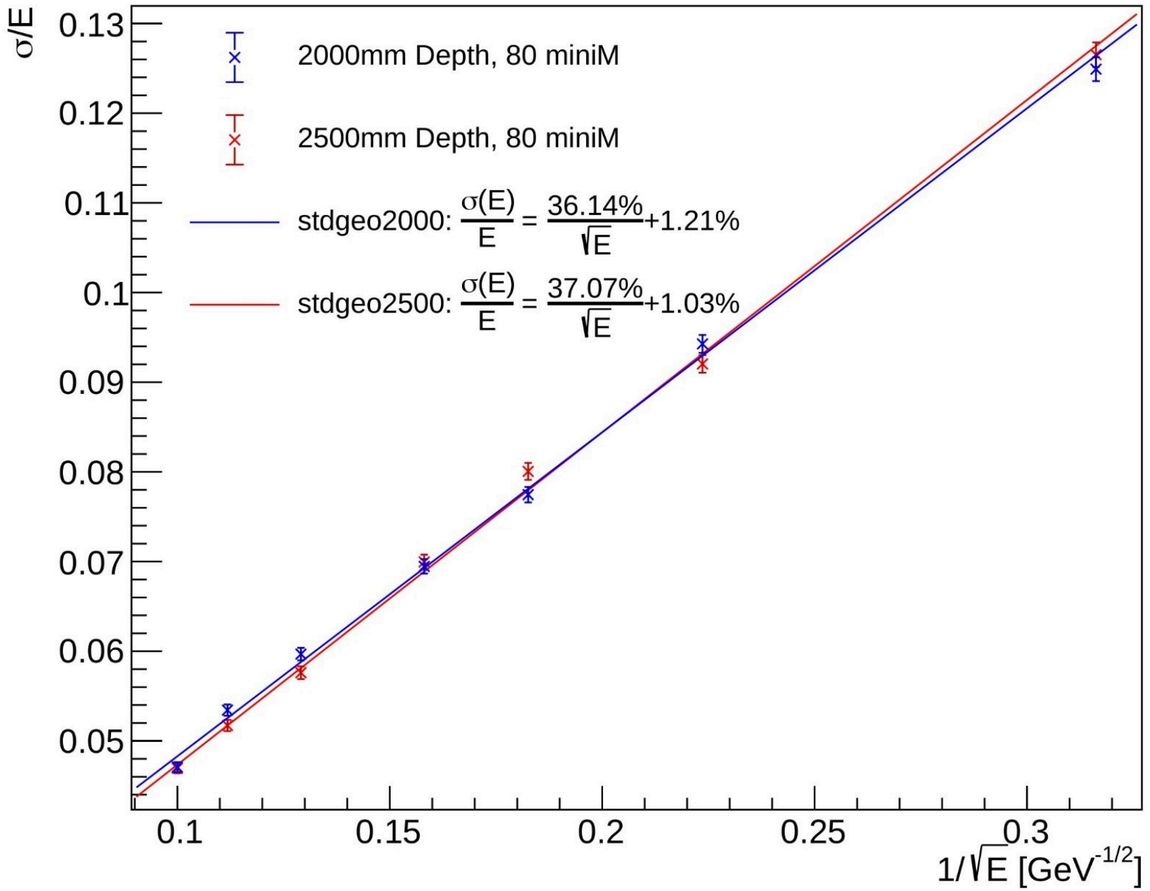
- Scintillating fibres:
  - Tested few samples from Saint Gobain
  - Best performance (attenuation length) still for Kuraray SCSF-78
  - Choice of Kuraray SCSF-78 also for better economical offer
    - Issue with timeline production due to refurbishing of production line
    - expected 50% beginning of 2023, the rest sometime(?) in 2024
- Clear fibres:
  - Mitsubishi ESKA SK-40 as used before, no tests done
  - cost even lower than foreseen

T1.2 Absorber choice

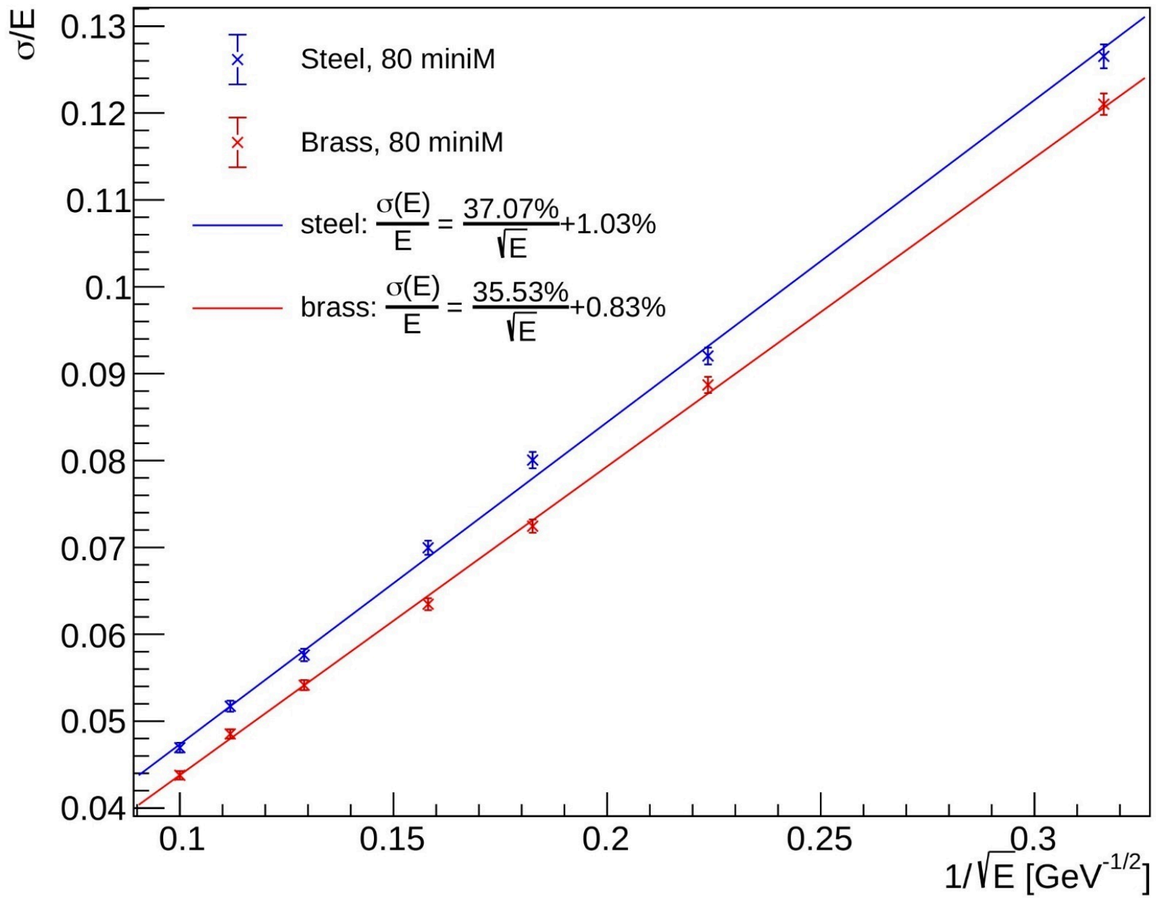
- Dimensions:
  - external diameter 2mm (+- 0.050 mm) ⟸ From SiPM dimensions
  - internal diameter 1.1 mm (-0 + 0.1 mm) ⟸ From Fiber dimensions
  - length 2.5 m ⟸ From containment studies
- Material:
  - stainless steel 304 ⟸ Cheaper than Brass, comparable performance

T1.2 Absorber Choice

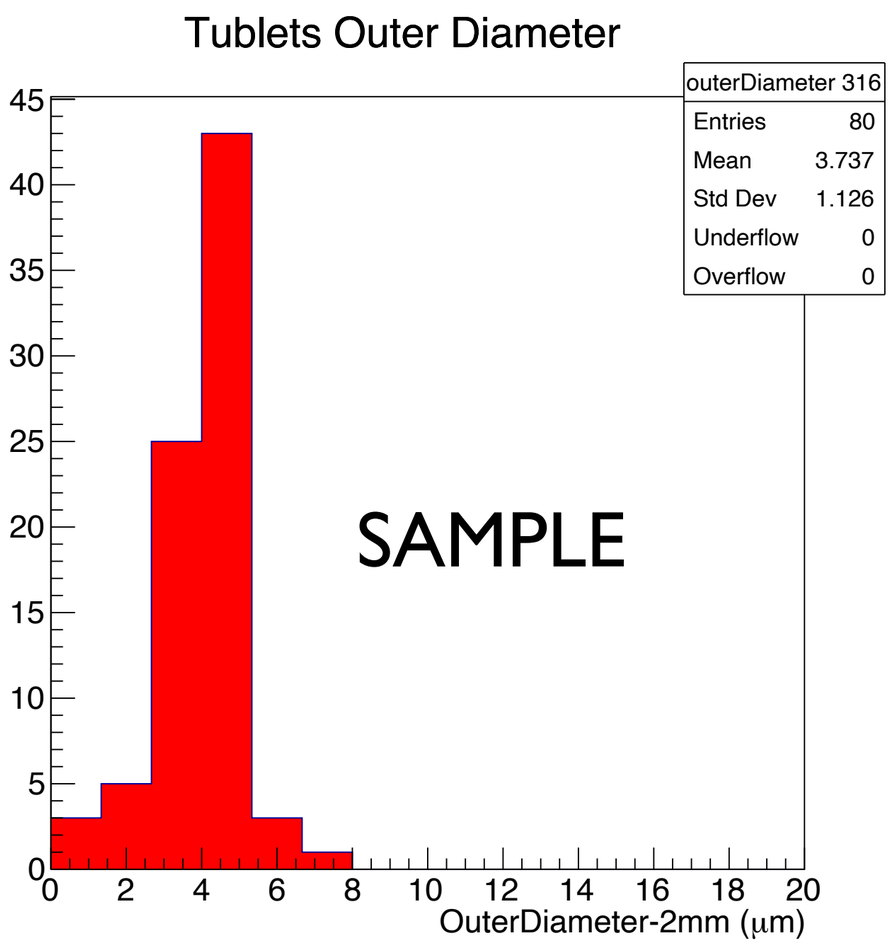
Pion resolution in [10, 100] GeV Range

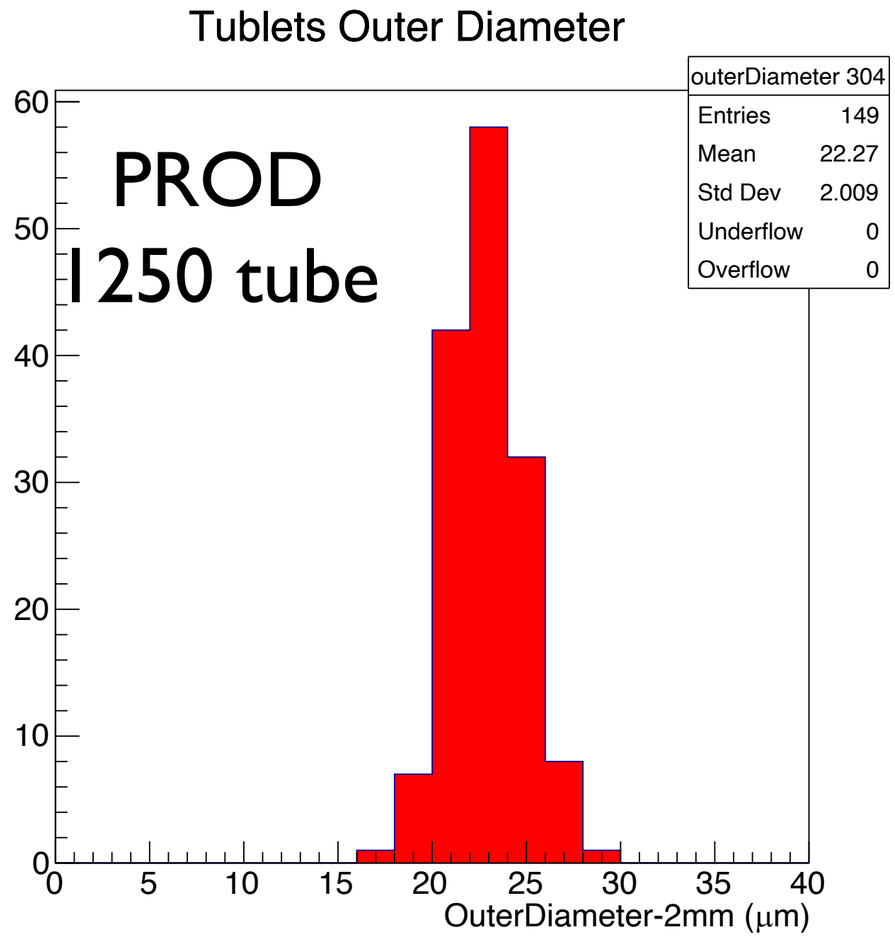


Pion resolution in [10, 100] GeV Range

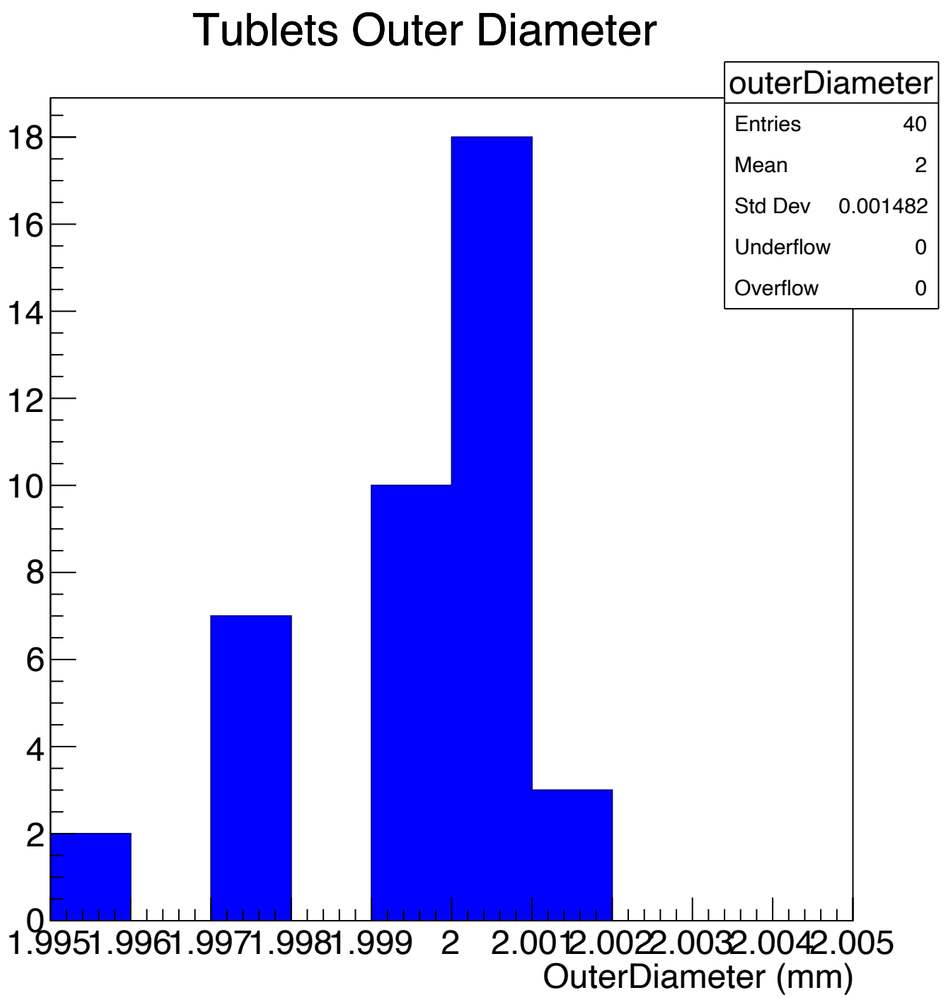


Capillary samples – swiss producer





Capillary samples – Chinese producer



SAMPLE

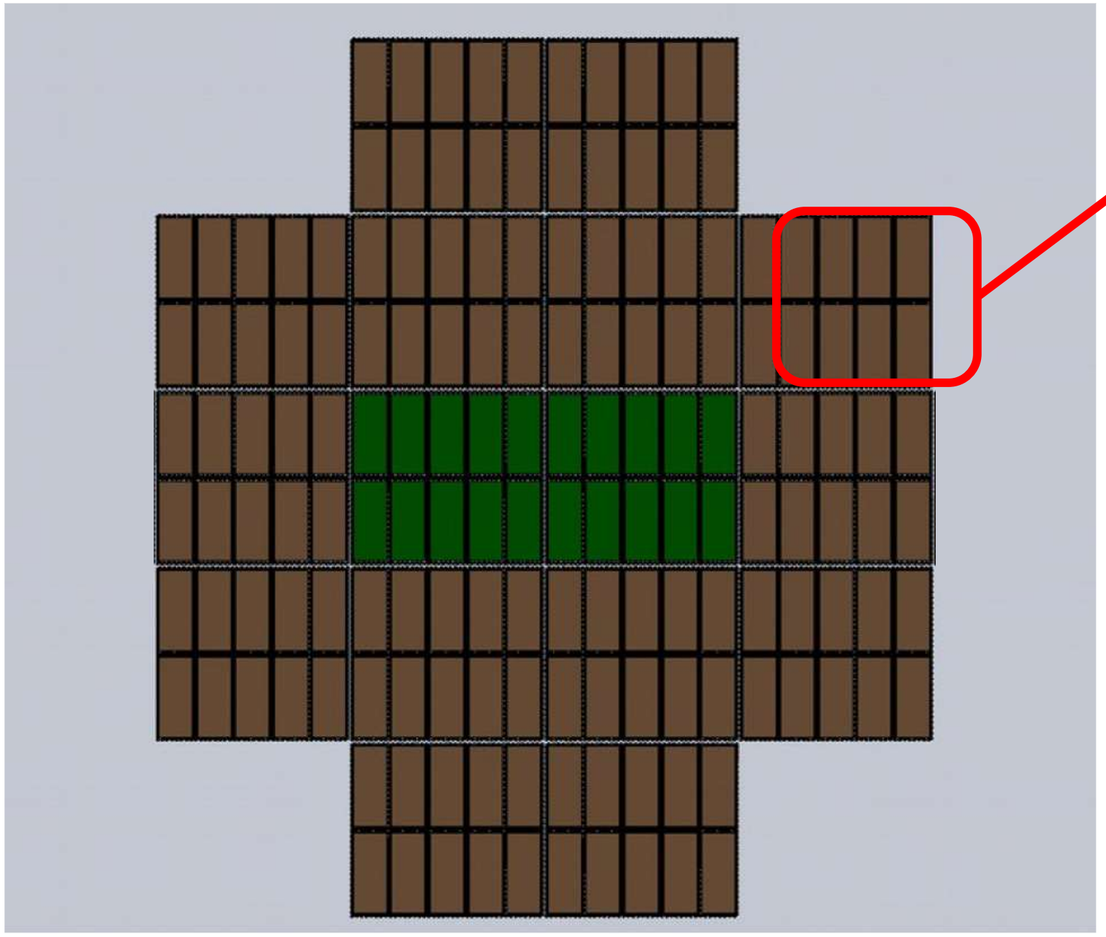
Other samples are under evaluation

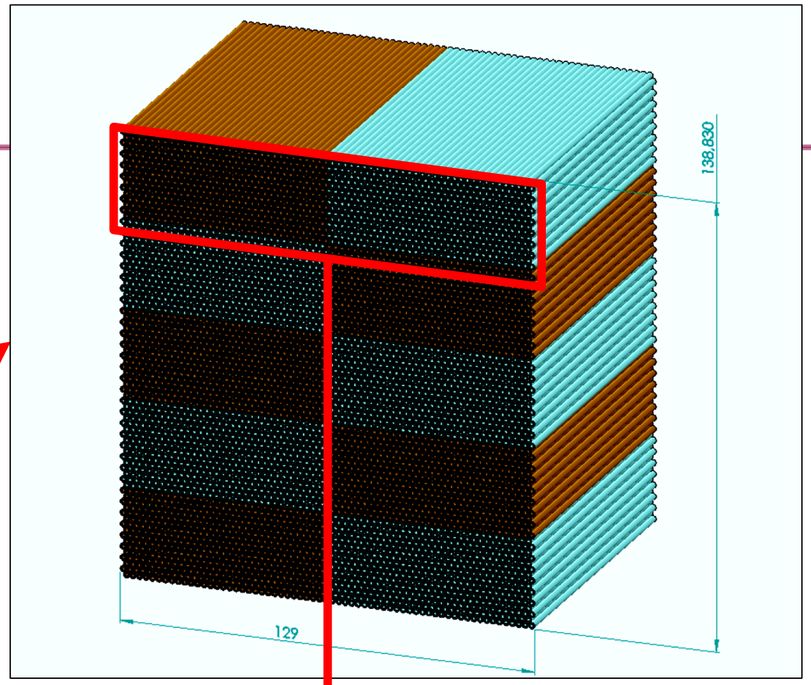
T1.3 and T1.5 PMT

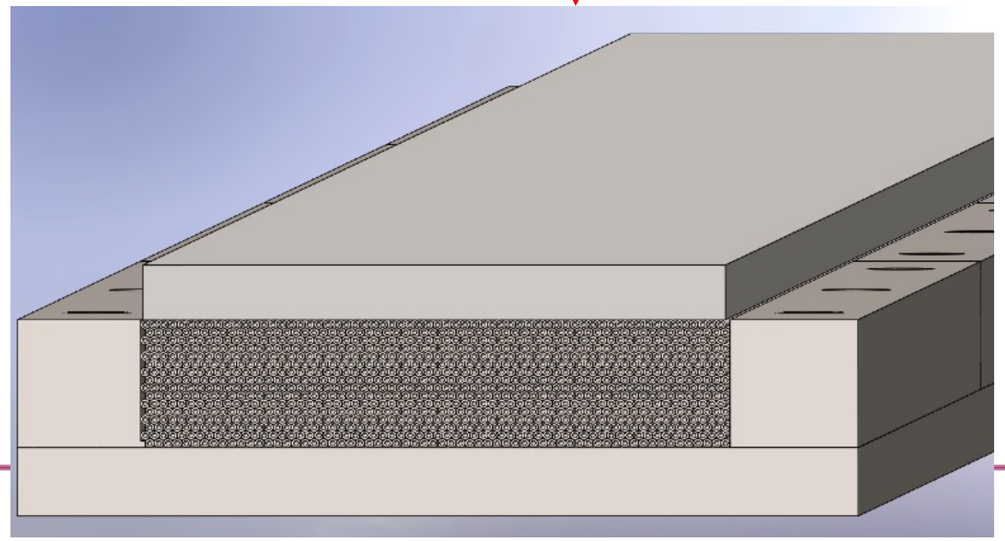
- Reuse of Hamamatsu R8900 and R8900-100
  - out of production
- New PMT R11265-200 and R11265-203
  - from data sheet very similar to previous PMT

- Under validation at Como
  - linearity (vs HV and vs light attenuation)
  - spatial uniformity

New Construction Logic







1 Module:

1 × 5 dMMs

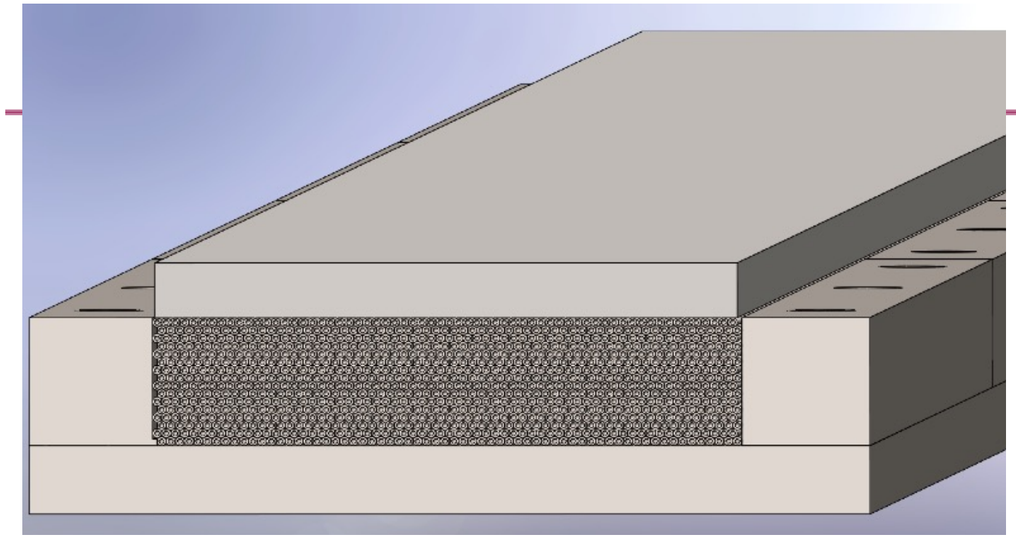
~ 13 × 13 cm^2

1 dMiniModule:

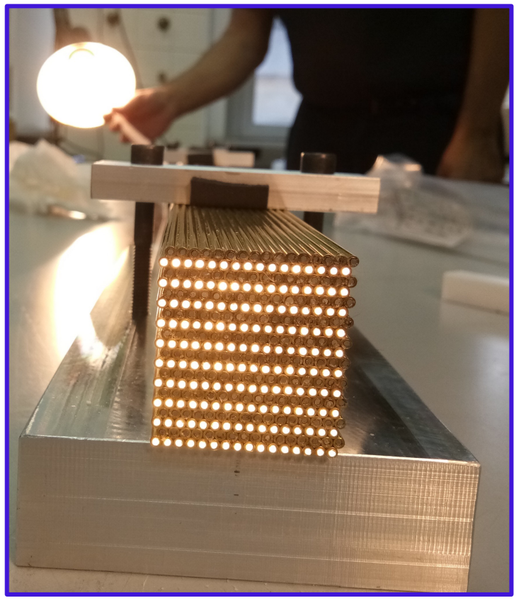
64 x 16 channels

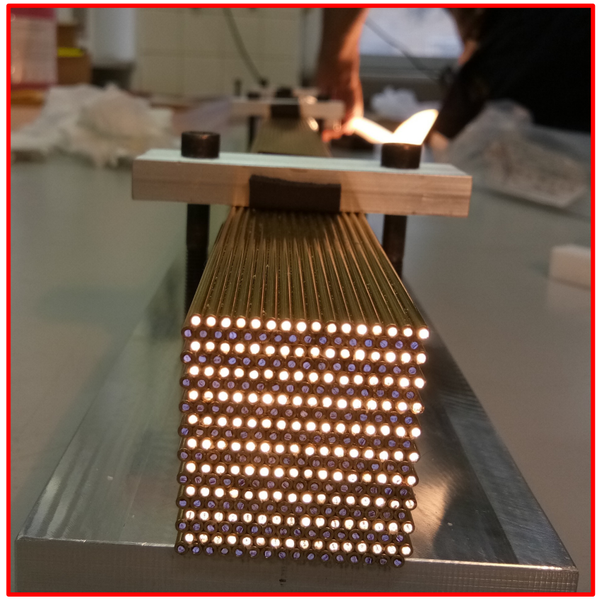
1024 in total

512 S + 512 C

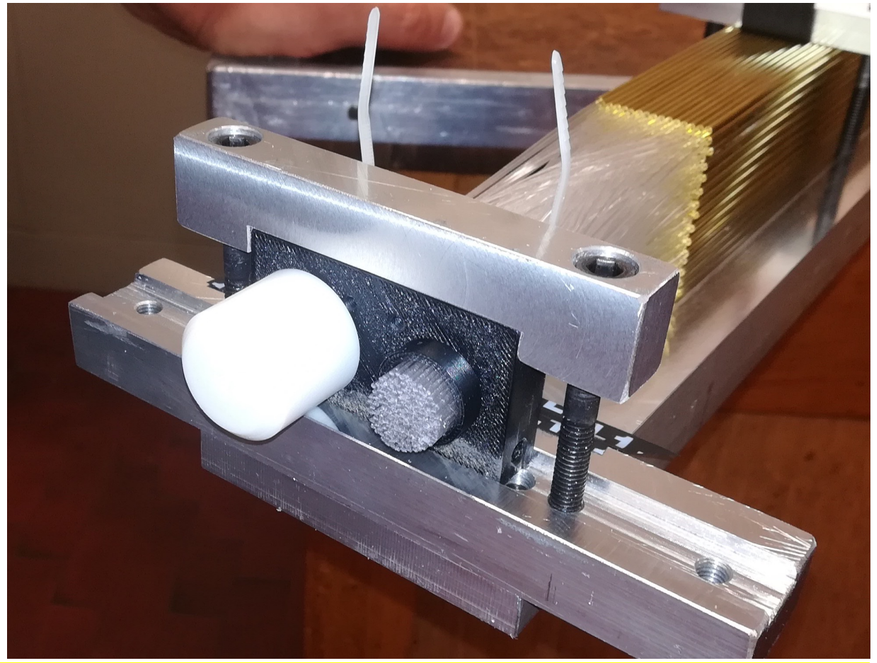


- C and S fibres are positioned per raw
- Fibres separation at the rear of the calorimeter
- Grouping to interface to PMTs





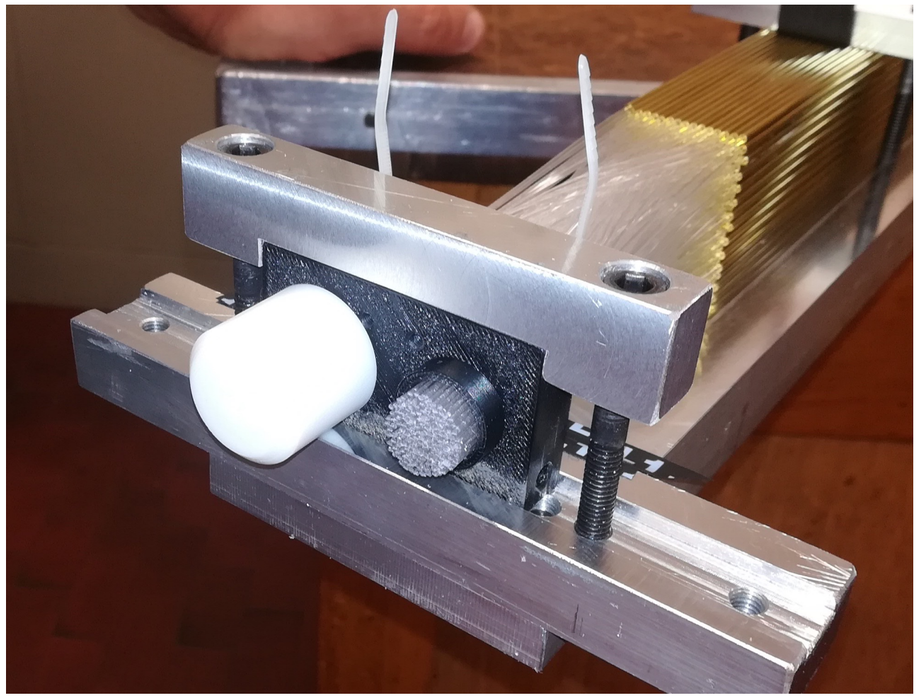
Scintillation fibers Cherenkov fibers



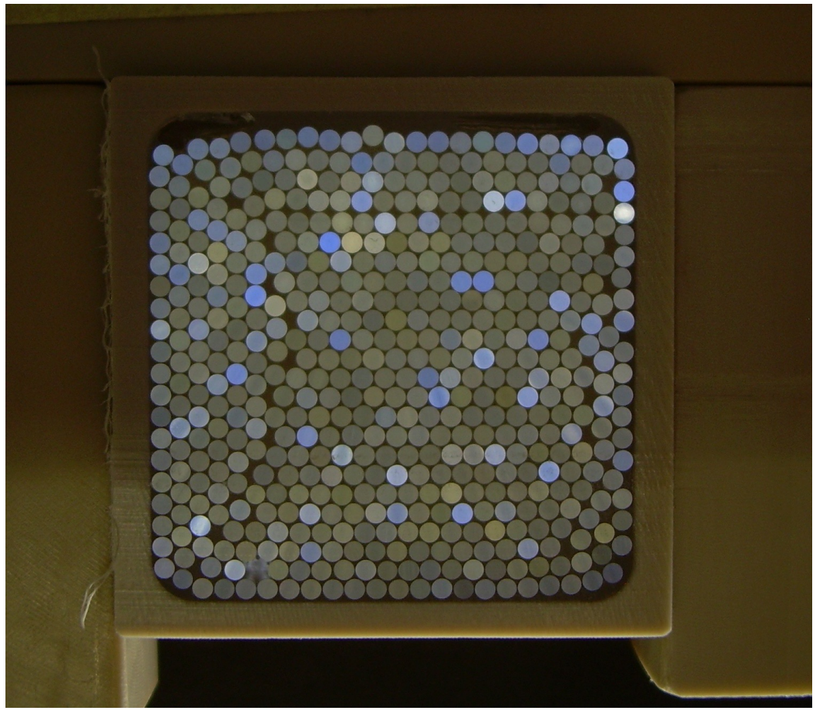
Pictures from previous prototypes to illustrate fibres disposal and grouping

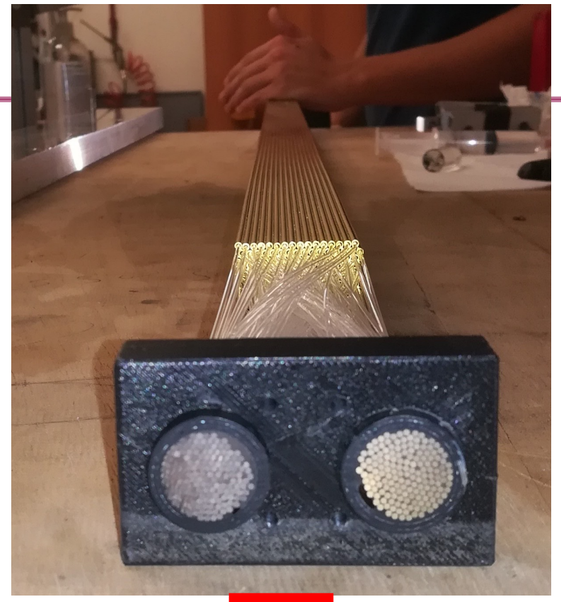
Pictures from previous prototypes to illustrate fibres disposal and grouping

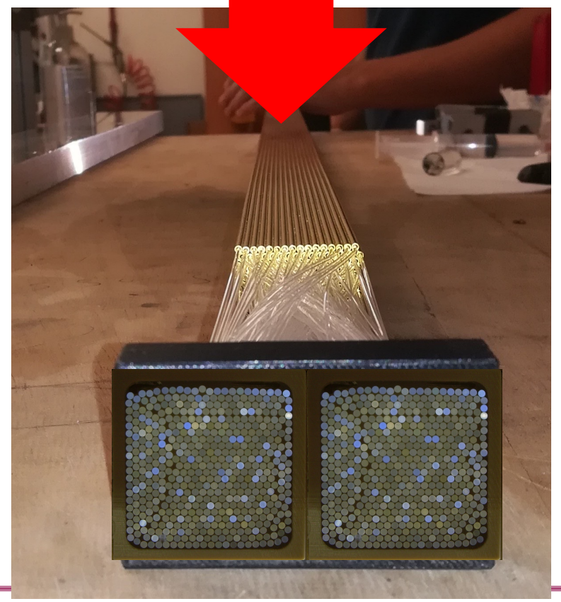
In EM prototype
256 C + 256 S fibres,
1 PMT per Tower



In RD52 prototype
525 fibres per each PMT,
either C or S

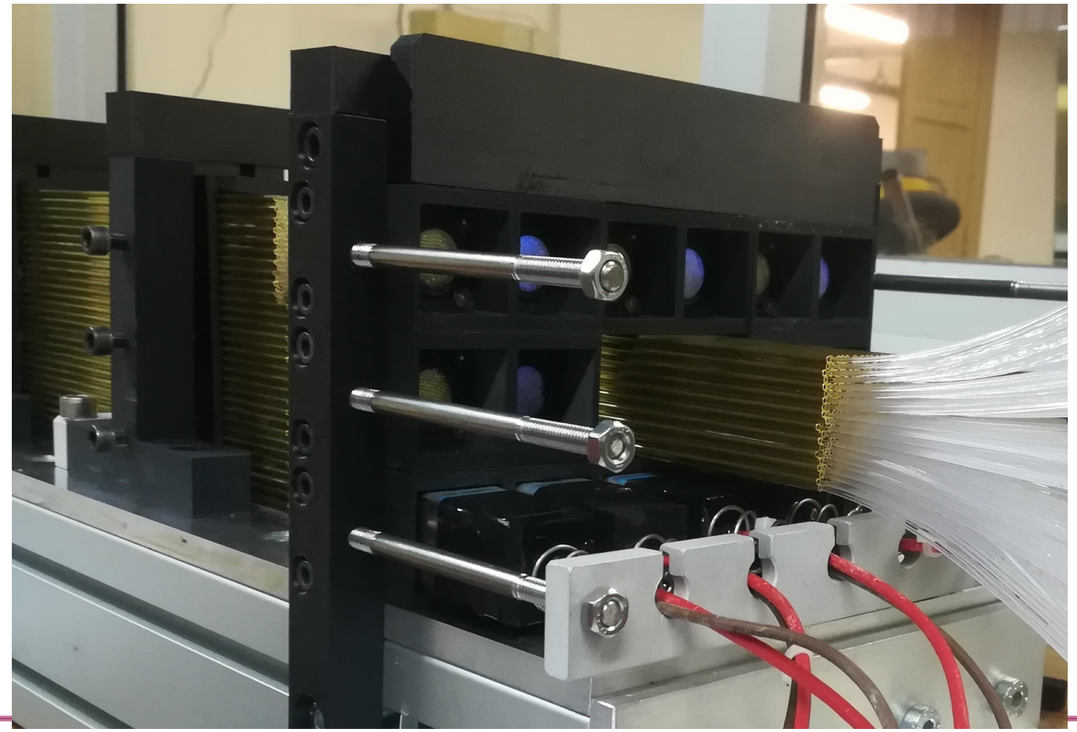






Each MM (64 x 16 channels)
1024 fibres in total 512 S + 512 C
has an interfacing tool (interfacing to a PMT_C and to a PMT_S)
which **will stay in the shadow** of the minimodule

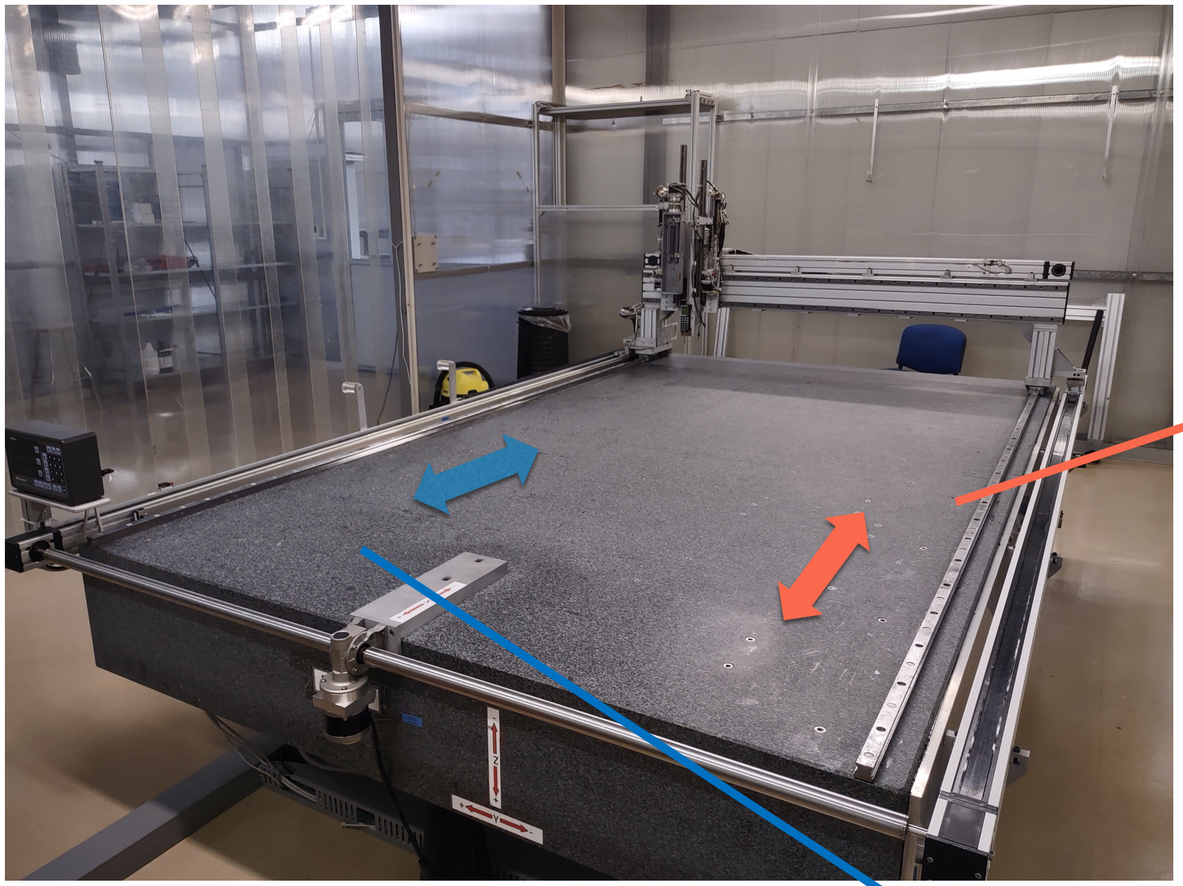
- it wasn't like that in 2020 EM Module, due to smaller towers
- There is enough space in the new MM geometry



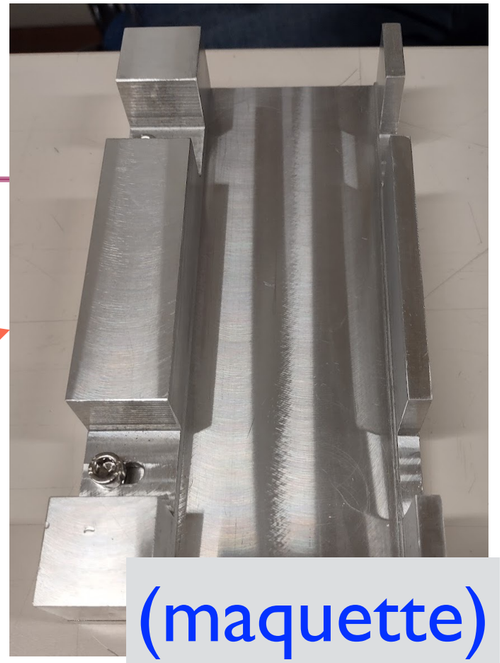
Mechanics for PMTs holder based on previous experience in RD52 and RD_FCC prototypes

Backup

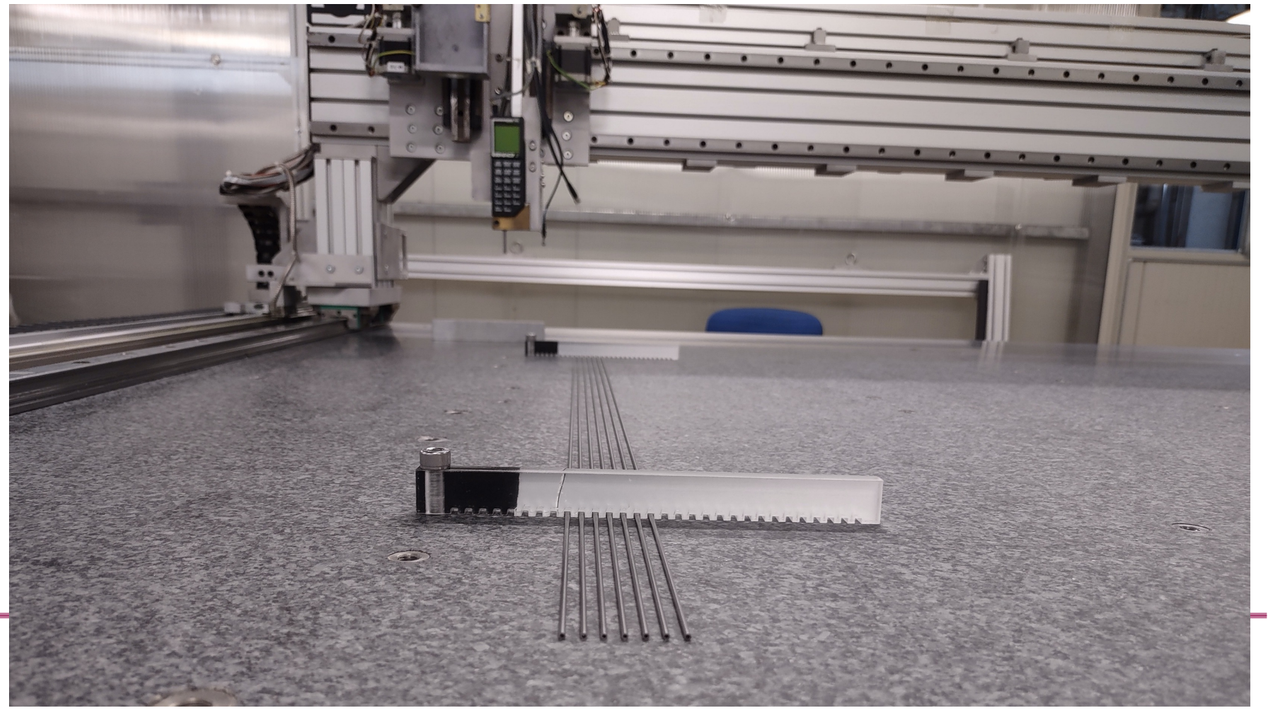
Lab for testing and production



Assembly system

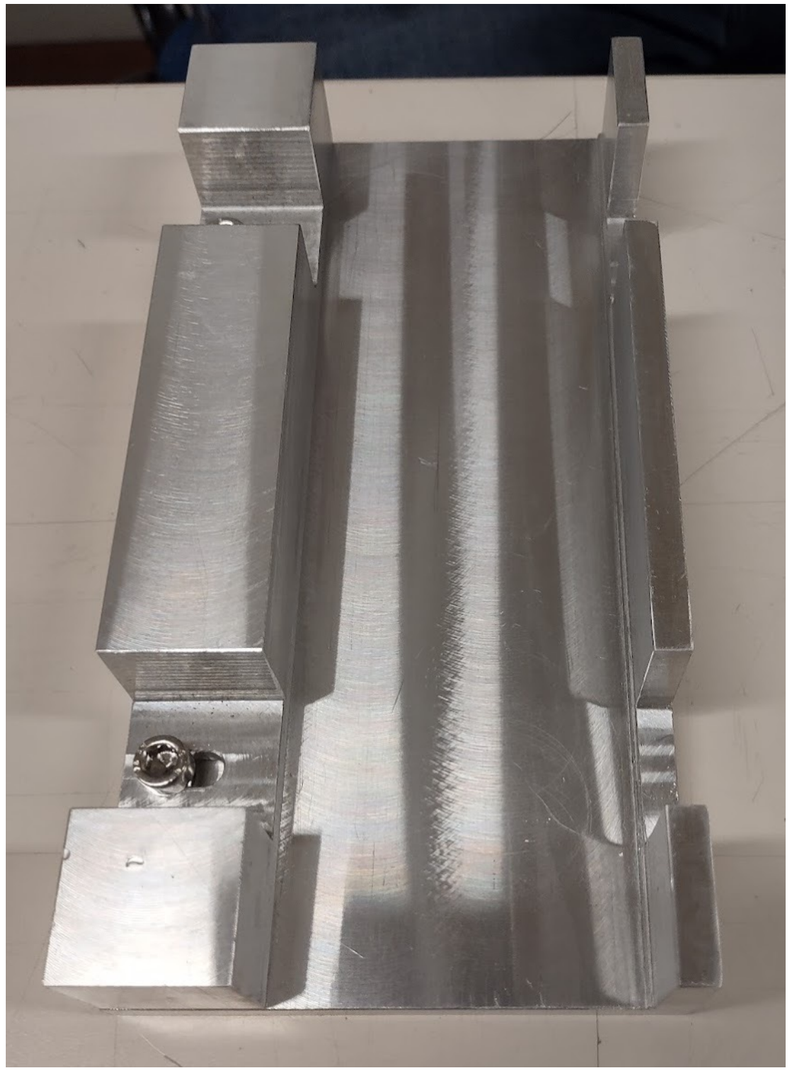


(maquette)

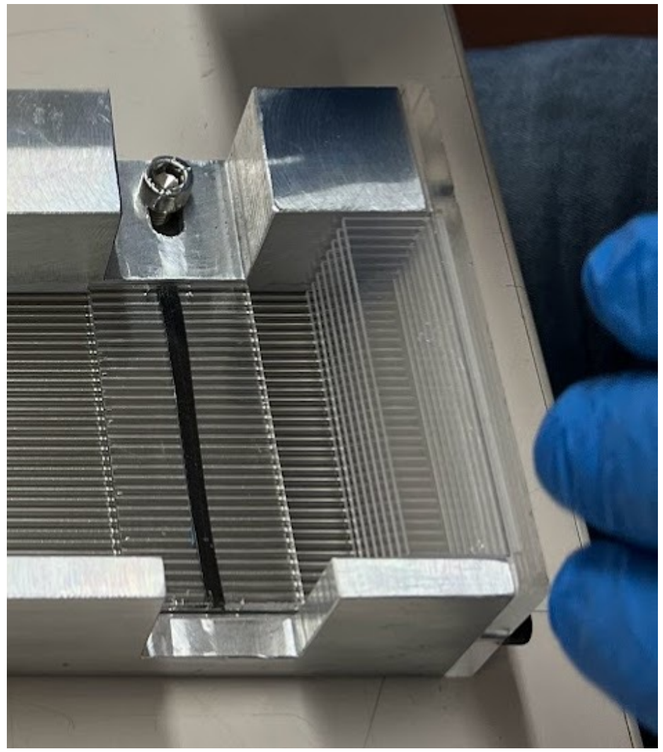


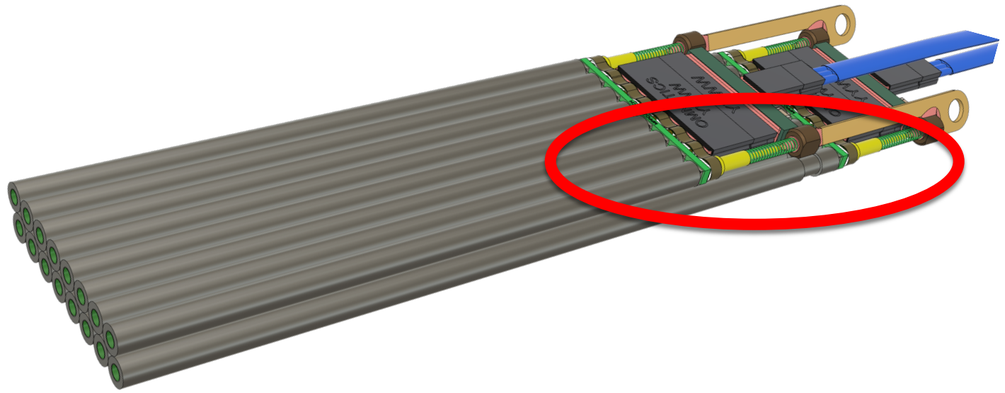
Tube Testing Station

Assembling tooling

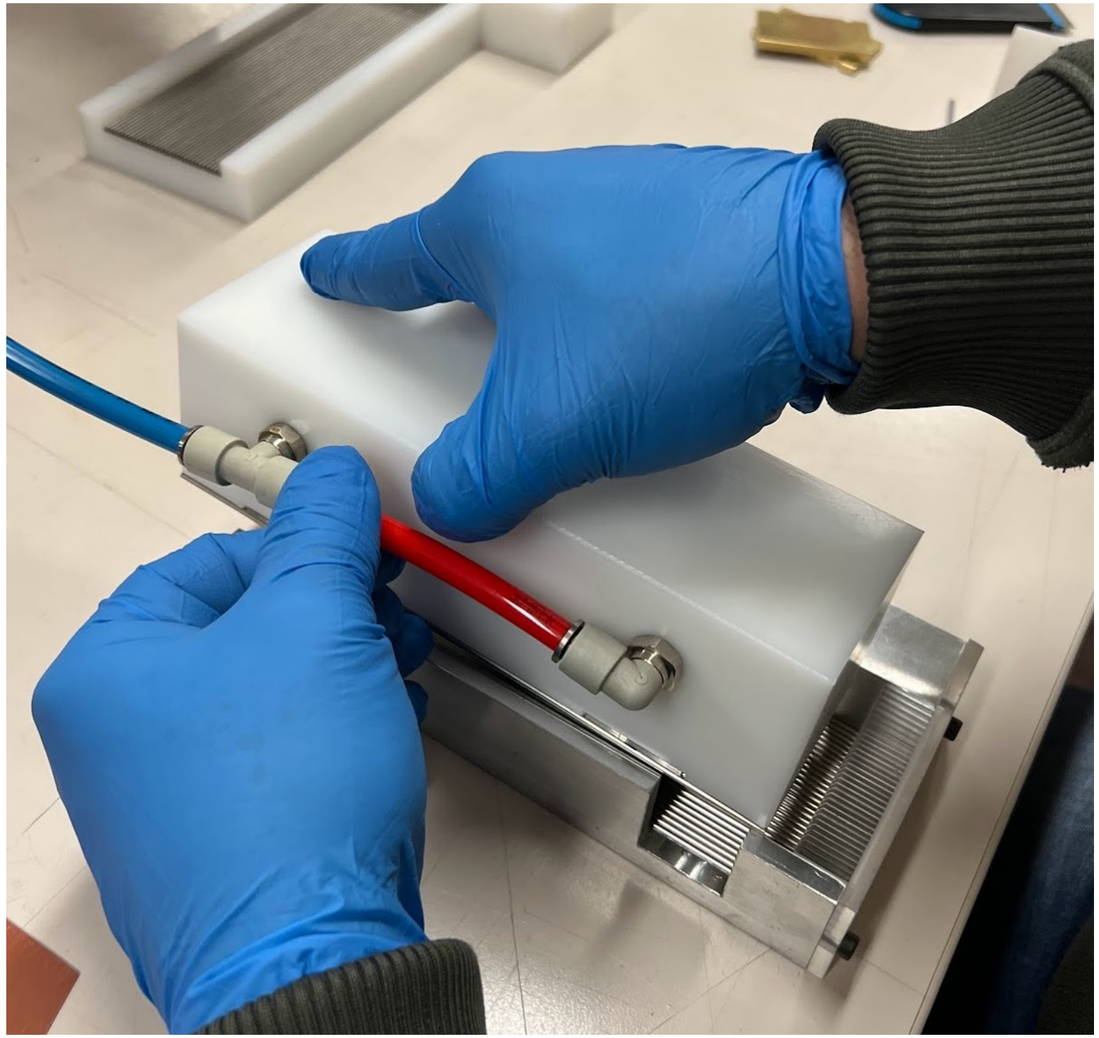


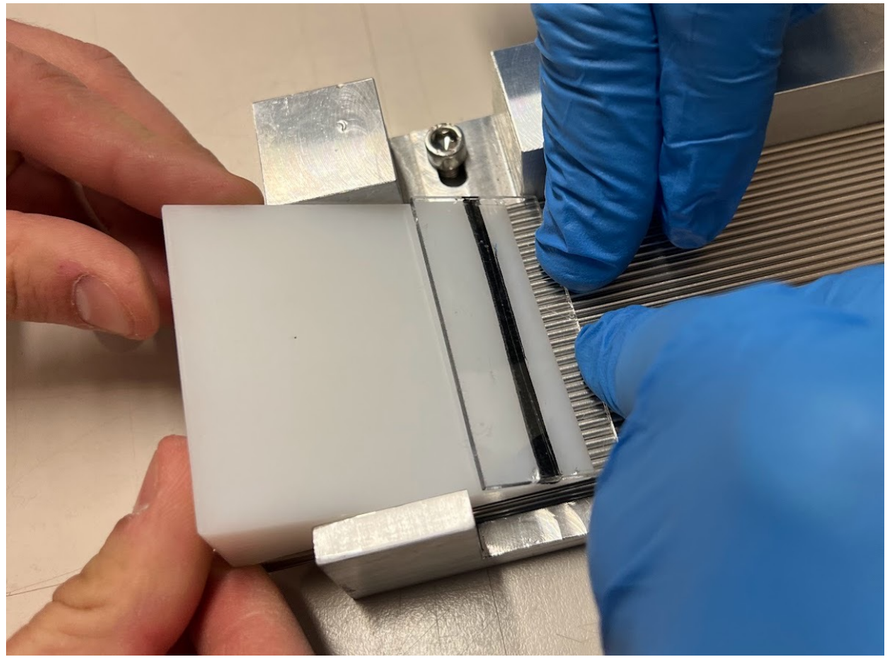
- Grinding L-shape support, worked with high precision
- Movable shoulder to define module dimensions
- Reference plate for tube staggering





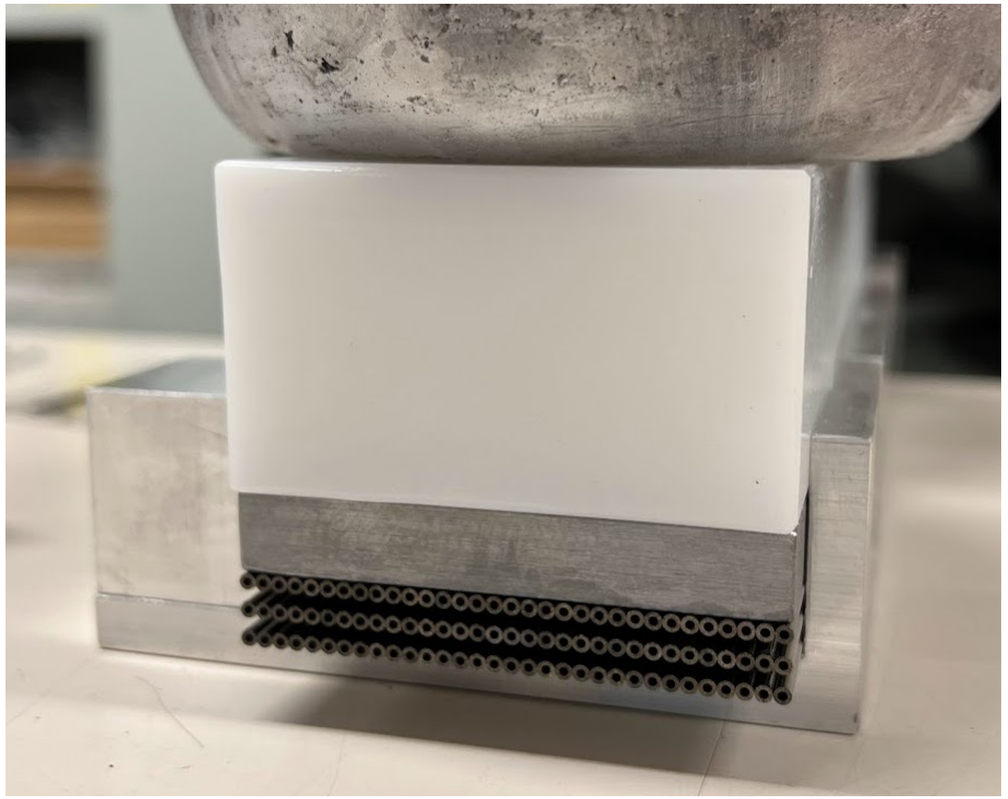
Tube gluing





Positioning of the tube layer on the previous one
Vacuum release and tool released
Detaching the plates with double-sided tapes

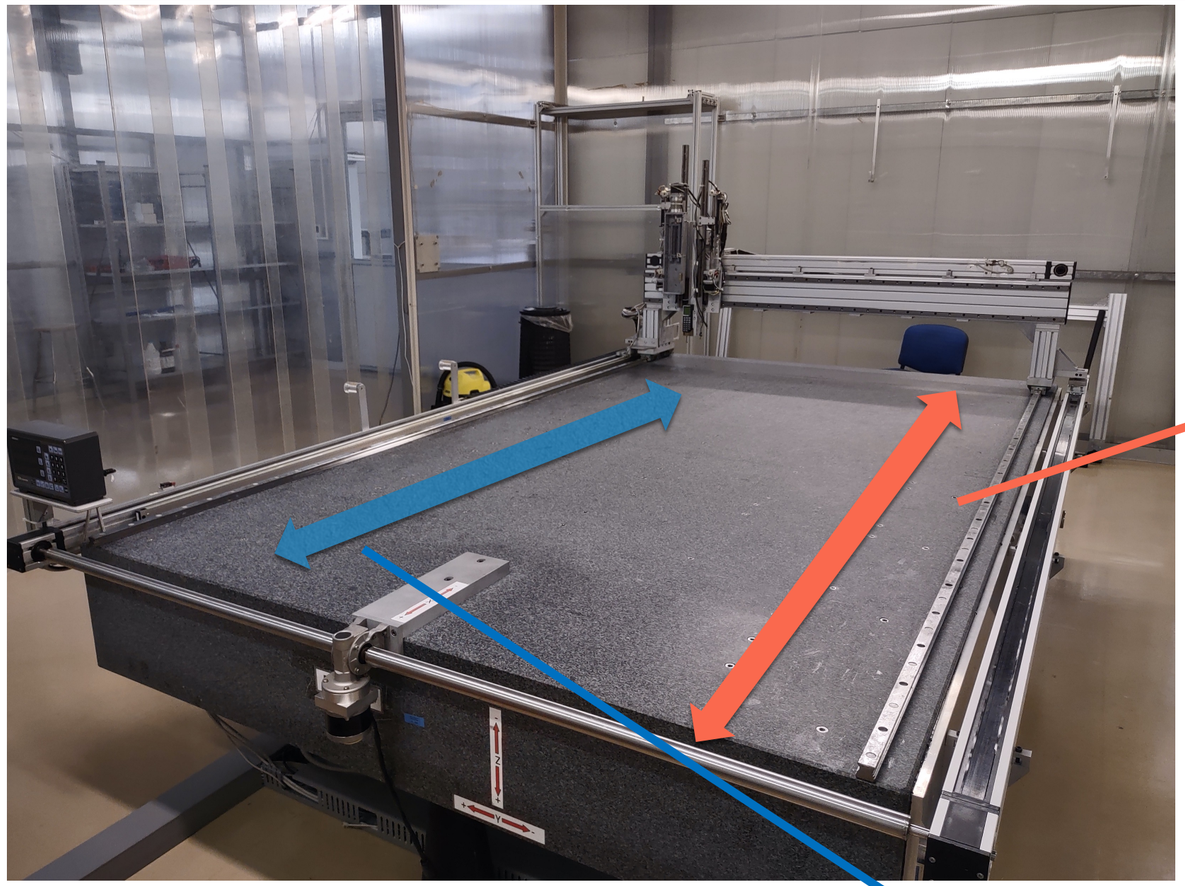
Module closure



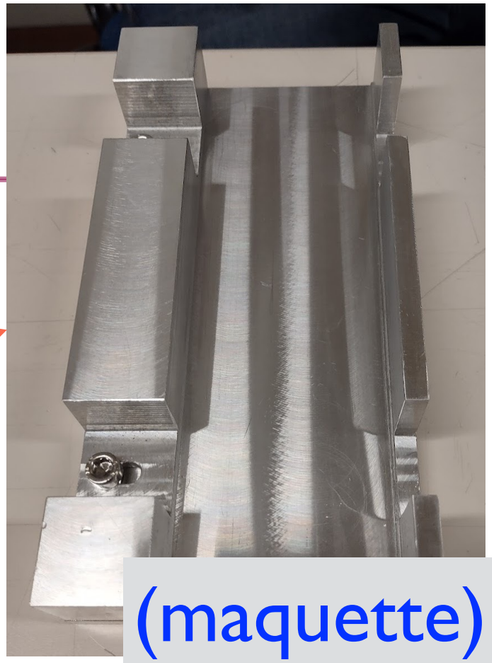
- Repeat until complete the module
  - only 6 layers done for this tests
- Add weight on the top
- Leave for glue curing

- Easy and fast procedure
- Scalable to 2.5 m long

Lab for testing and production



Assembly system



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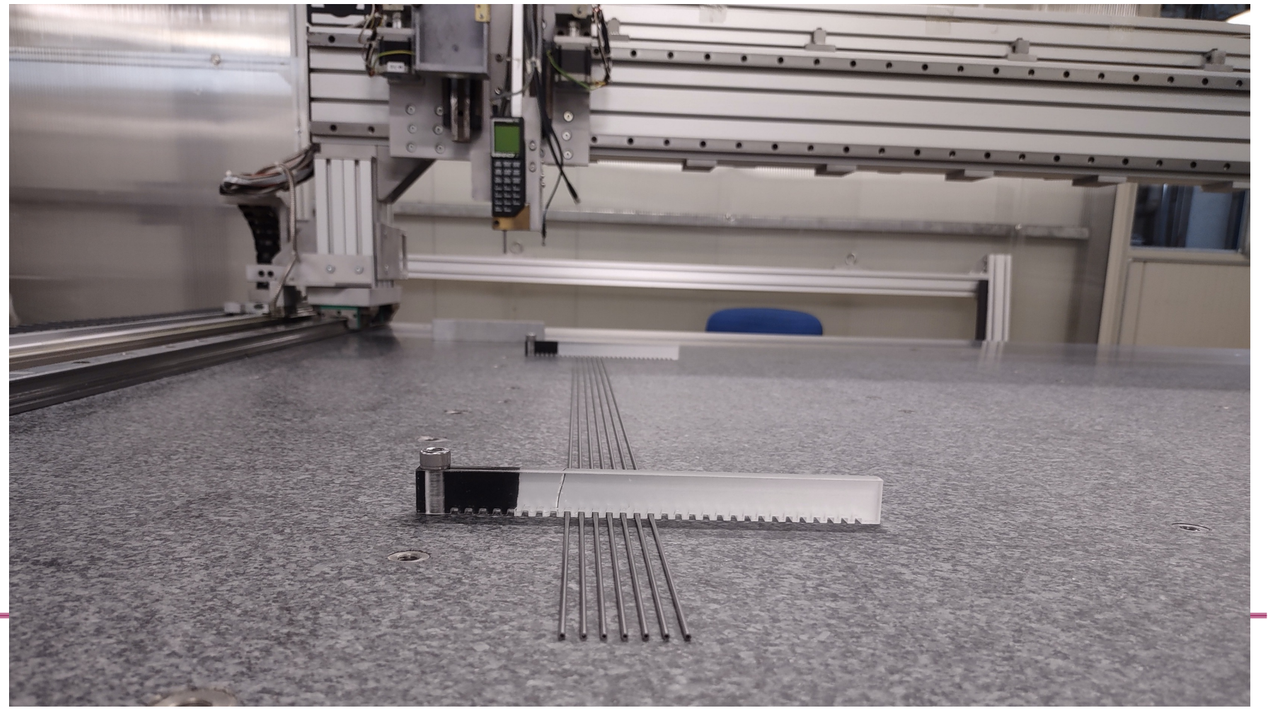
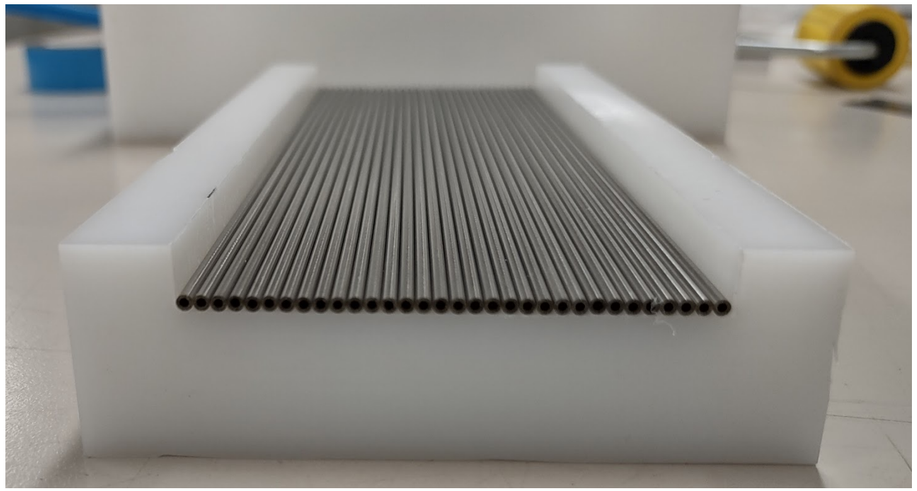
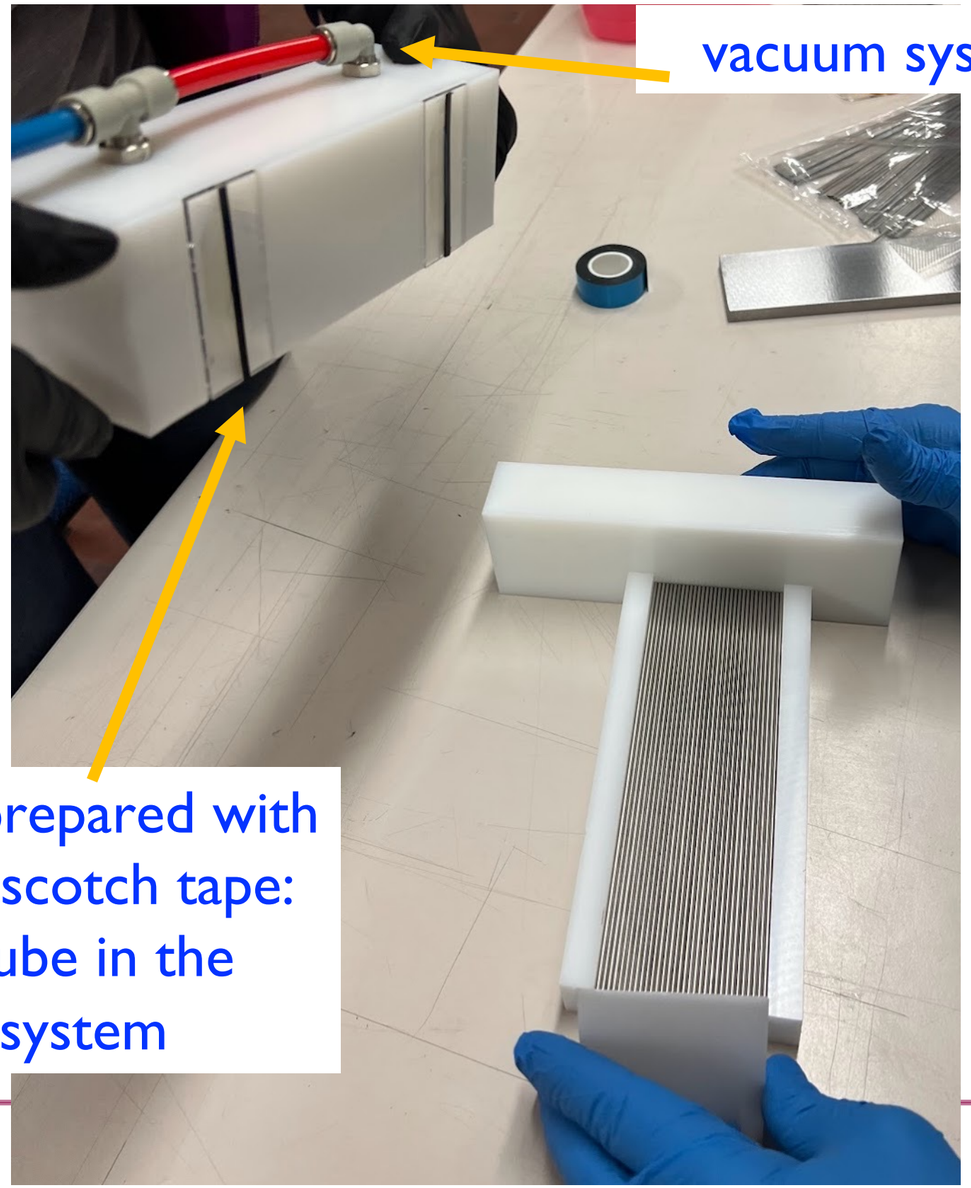


Tube Testing Station

Tube preparation and handling

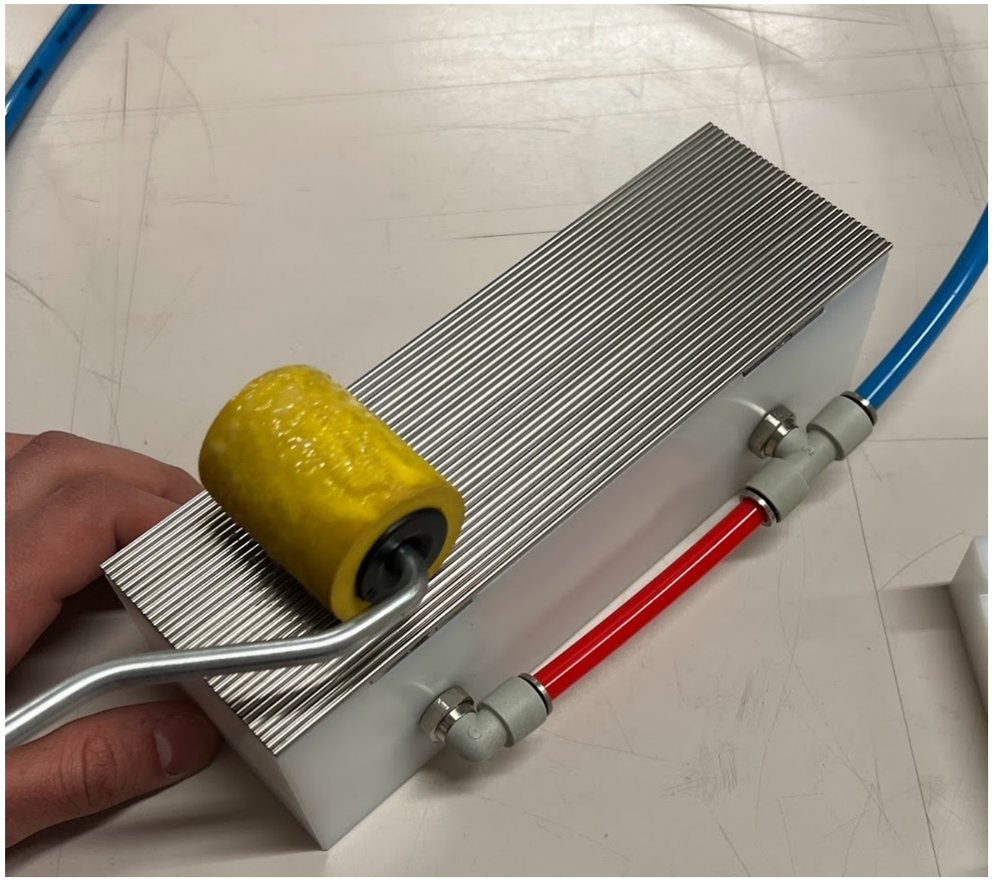


Tube are prepared on support tool, and aligned



Plastic plates prepared with double-sided scotch tape: decouple tube in the vacuum system

Tube handling and gluing



Lab for testing and production