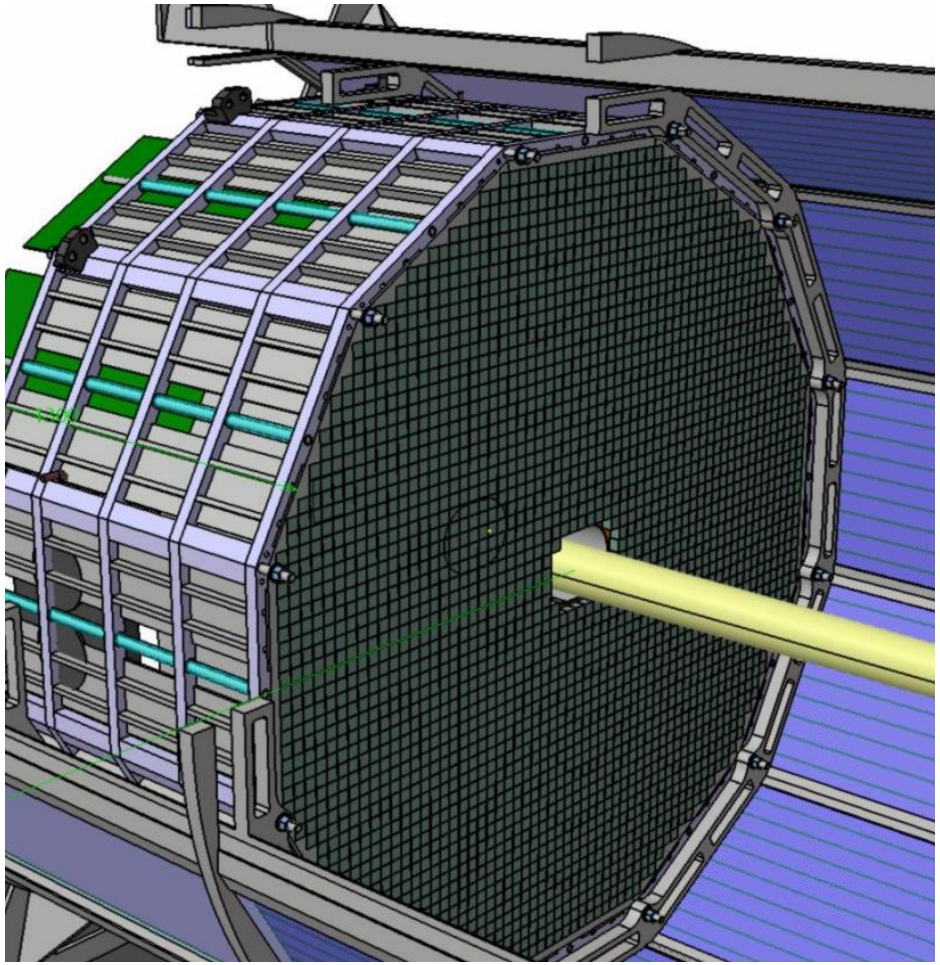


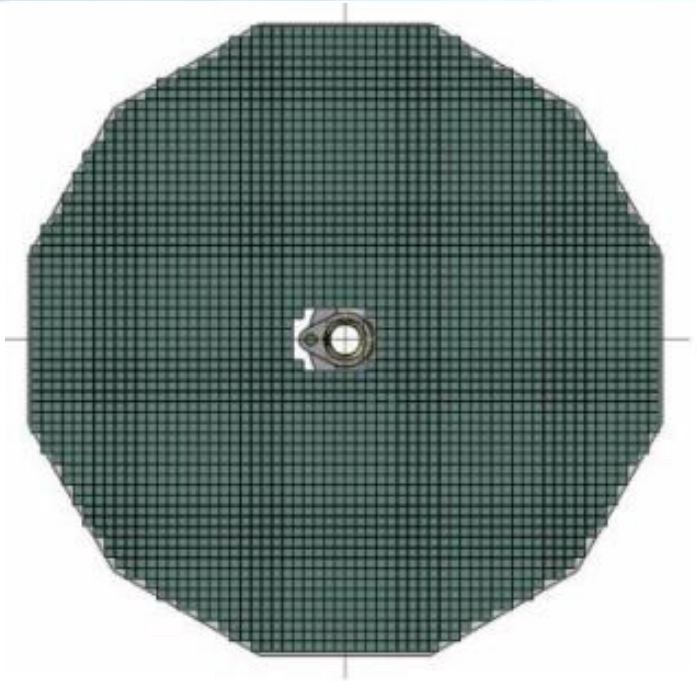
Backward ECAL Engineering Design Update

Carlos Muñoz Camacho
IJCLab (Orsay, CNRS/IN2P3)

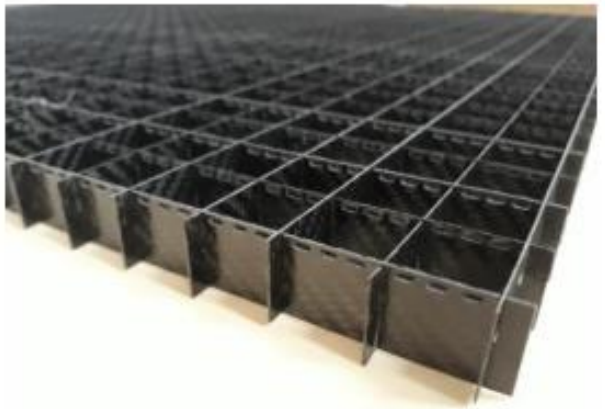
ePIC Collaboration Meeting

Lehigh University
July 24-27, 2024

Crystal configuration



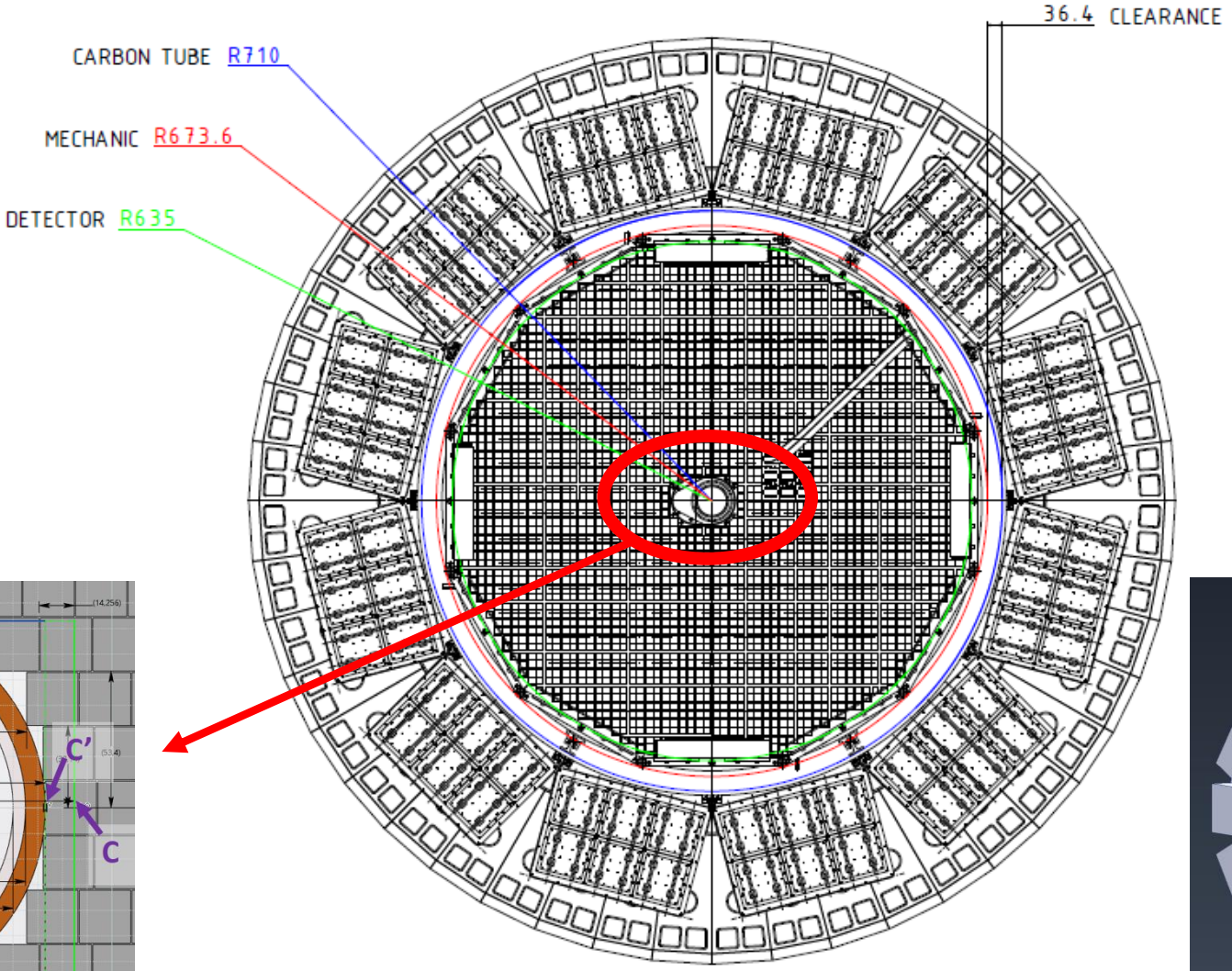
- 2x2x20 cm^3 PWO crystals
- 0.5-mm-thick C-fiber between crystals along 2 cm in the front & back; 0.5 mm of air elsewhere

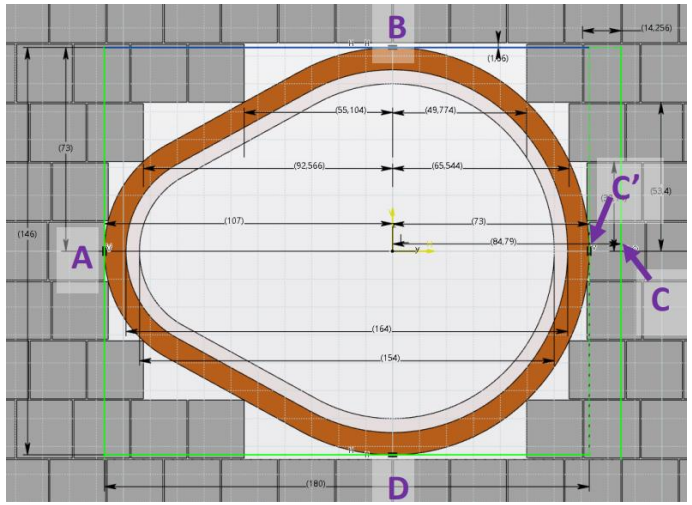


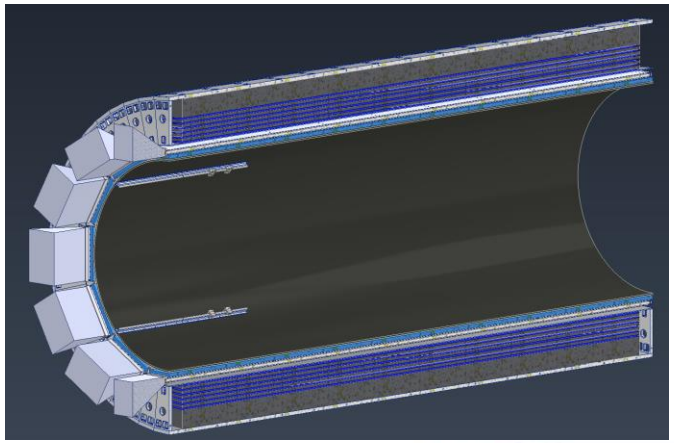
Specifications:

PWO:	8,28g/cm3
Dimension:	20x20x200 mm
Mass:	0,662 Kg
Nb:	≈ 2850 crystals
Total mass:	≈ 1900 Kg
External diameter:	≈ 123 cm
Space max:	0,5 mm (carbon plate)

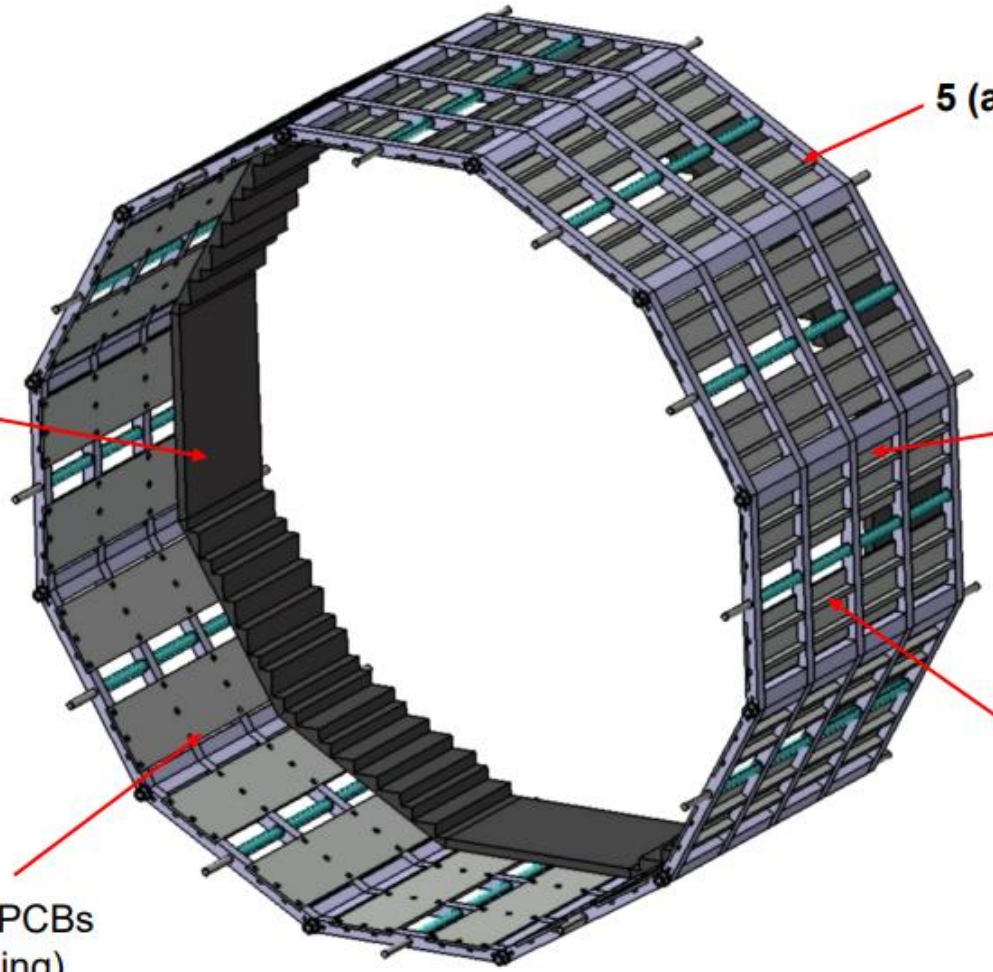
Detector volume







Mechanical structure



5 (at least) strong dodecagon frames
(to make the assembly easier)

Support structure for crystals
(can be used for cooling)

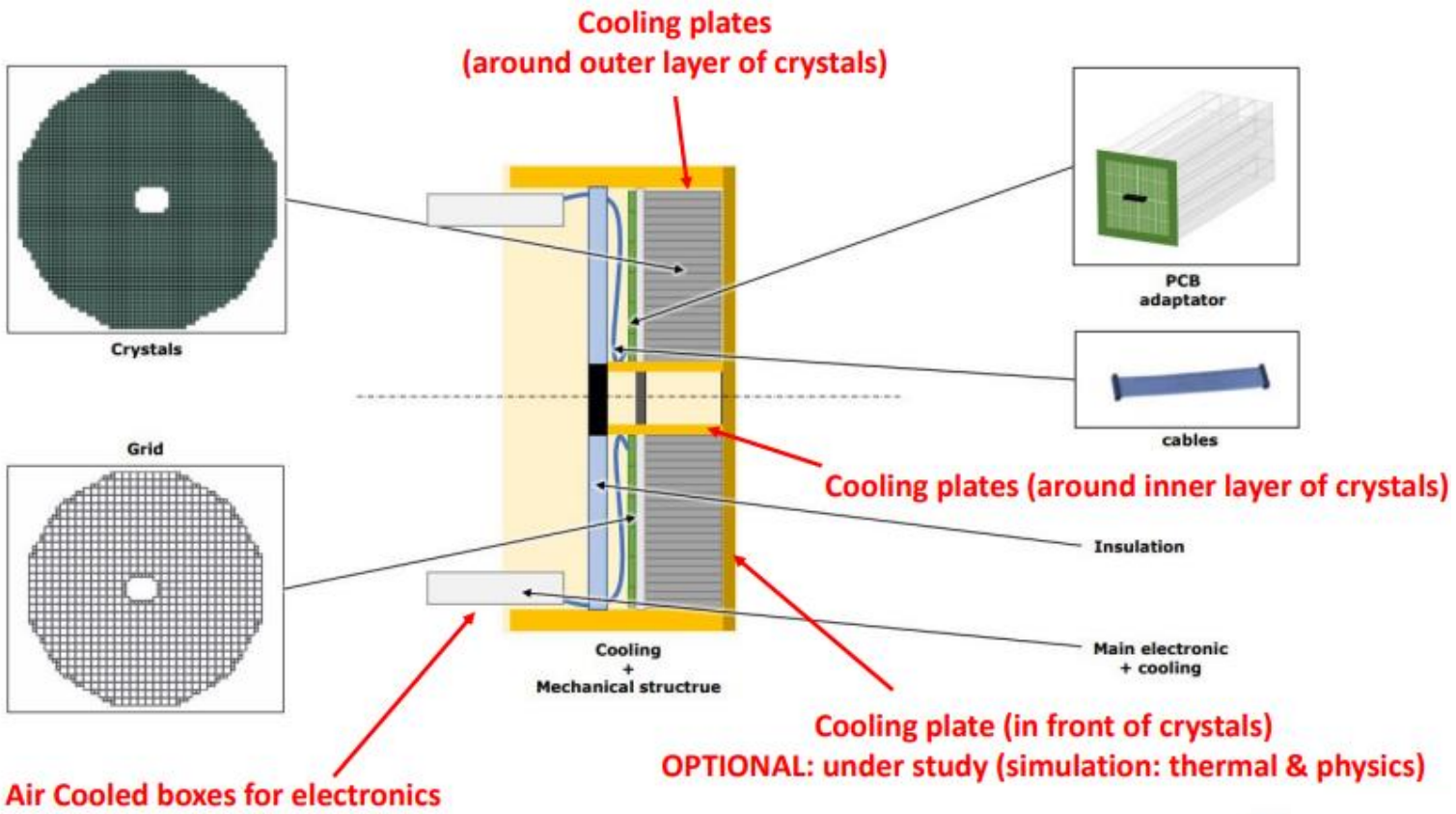
Mechanical pieces
(to reinforce the structure at the angles)

Plate
(to fasten the PCBs and the cooling)

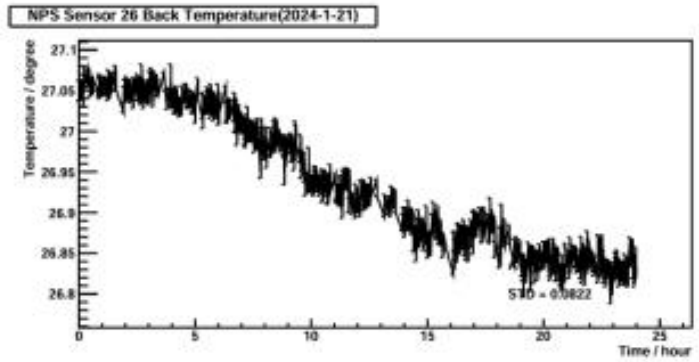
Threaded rods and struts
(to ensure a good assembly and reinforce the structure)

Cooling

- PWO light yield is very sensitive to temperature: 2%/°C
- Goal: maintain temperature of crystals constant within ±0.1°C
- Temperature gradients across the detector and along the crystals should be minimized (but is less critical)
- Main heat sources: backward ECal electronics (50-500 W), pfRICH (?), DIRC (?)



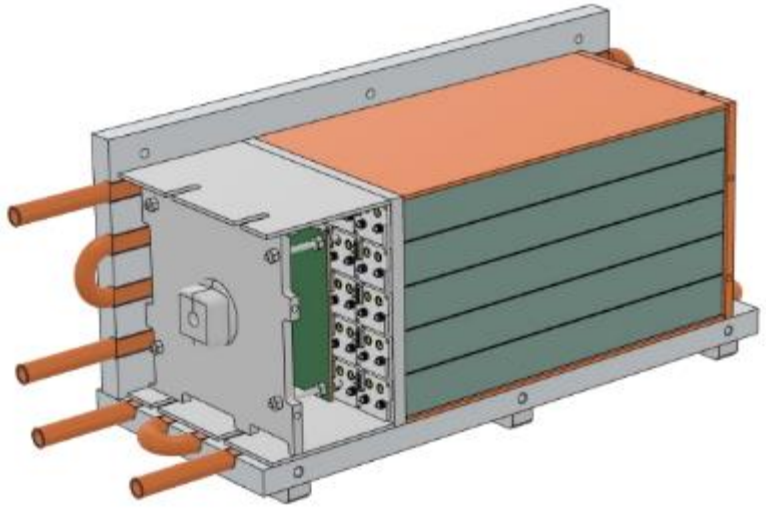
Experience from NPS (1080 PWO crystals) at JLab

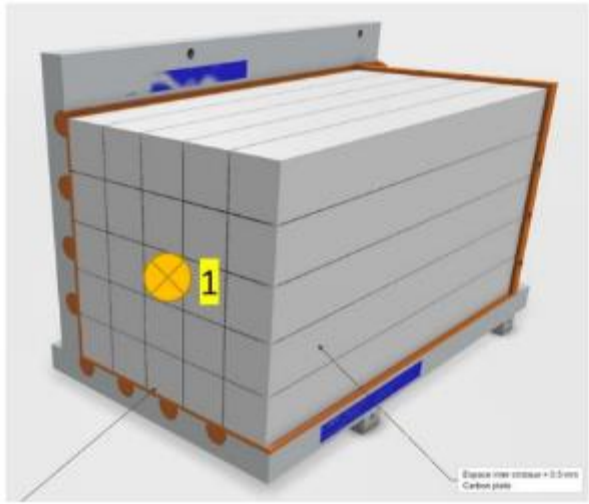


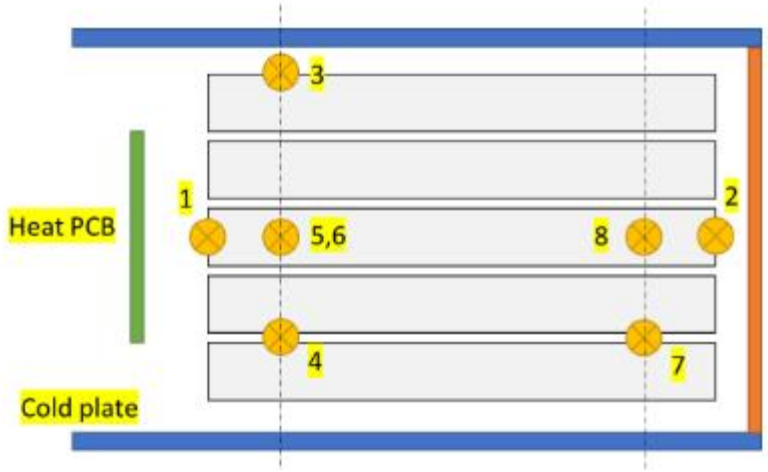
NPS voltage dividers: 500 W

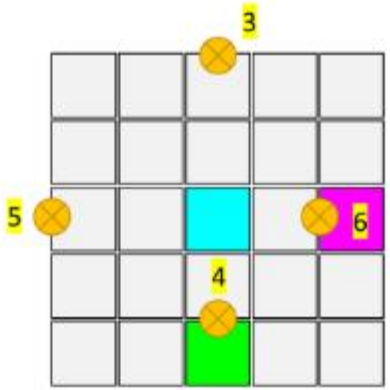
- Good stability achieved: ±0.1°C
- Very slow temperature variations: *O*(days)

Recent developments: 5x5 prototype







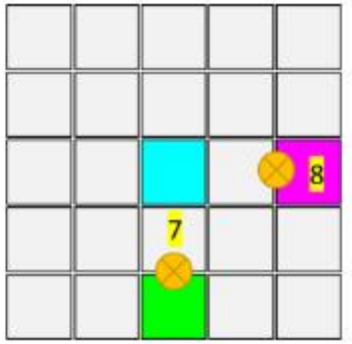


Matrix 5x5:

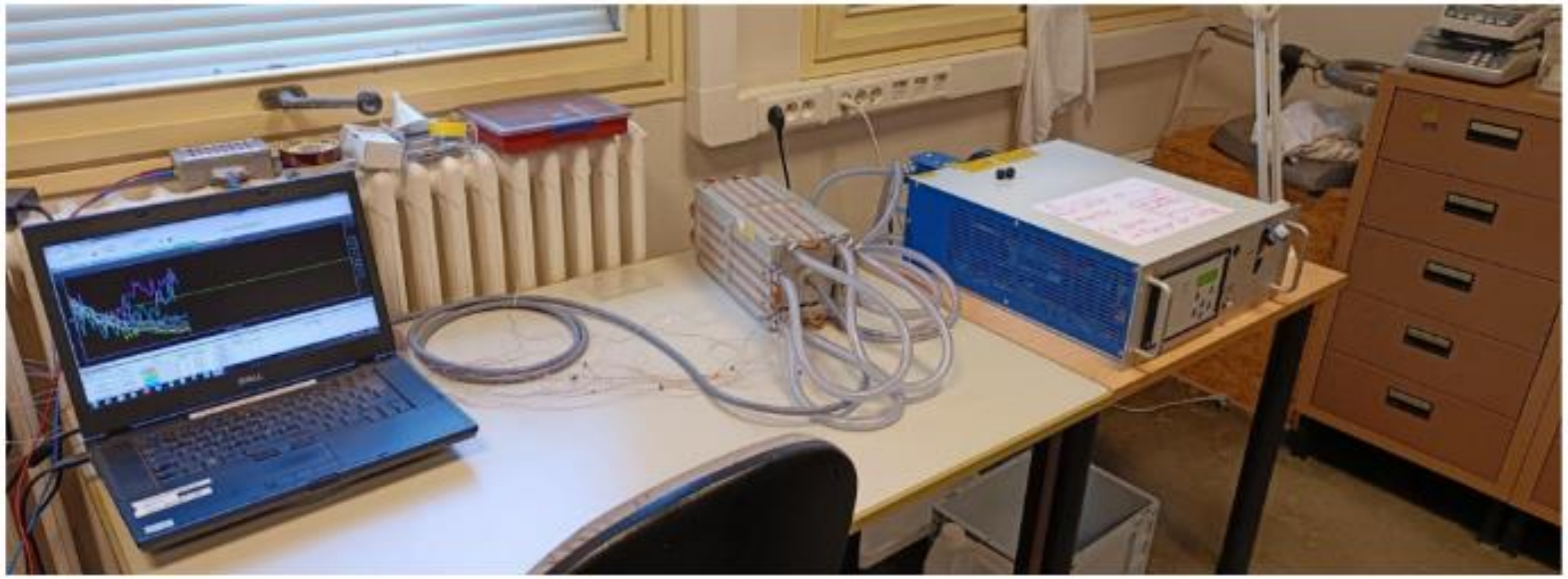
Cristal 3-3 → Sensors 1 & 2

Cristal 5-3 → Sensors 6 & 8

Cristal 3-5 → Sensors 4 & 7



Thermal studies

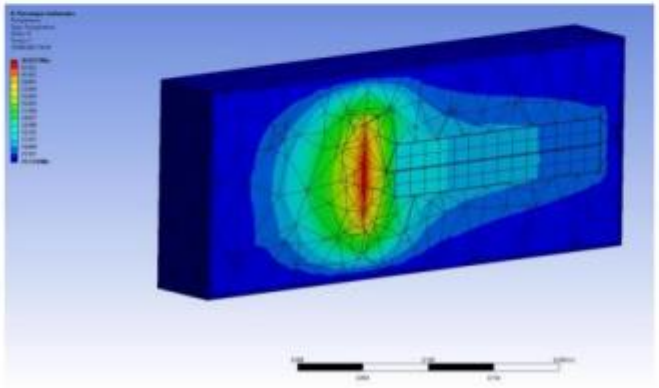


Results	Standard deviation 1 σ										
	101 (C)	102 (C)	103 (C)	104 (C)	105 (C)	106 (C)	107 (C)	108 (C)	T° pcb	T° plate	T° ext
Heat ON - Chiller OFF	0,15	0,11	0,11	0,09	0,09	0,08	0,04	0,04	0,12	0,07	0,09
Heat ON - Chiller ON	0,11	0,08	0,07	0,07	0,06	0,06	0,05	0,05	0,08	0,07	0,26
Heat OFF - Chiller ON	0,05	0,06	0,04	0,04	0,03	0,03	0,02	0,02	0,04	0,03	0,12
Heat ON cycle - Chiller ON	0,57	0,09	0,06	0,07	0,13	0,06	0,08	0,07	8,83	0,65	0,14
Heat OFF - T chiller = 19°C → 0°C	2,05	1,99	1,99	2,06	1,99	2,06	2,04	2,03	1,62	1,90	0,76

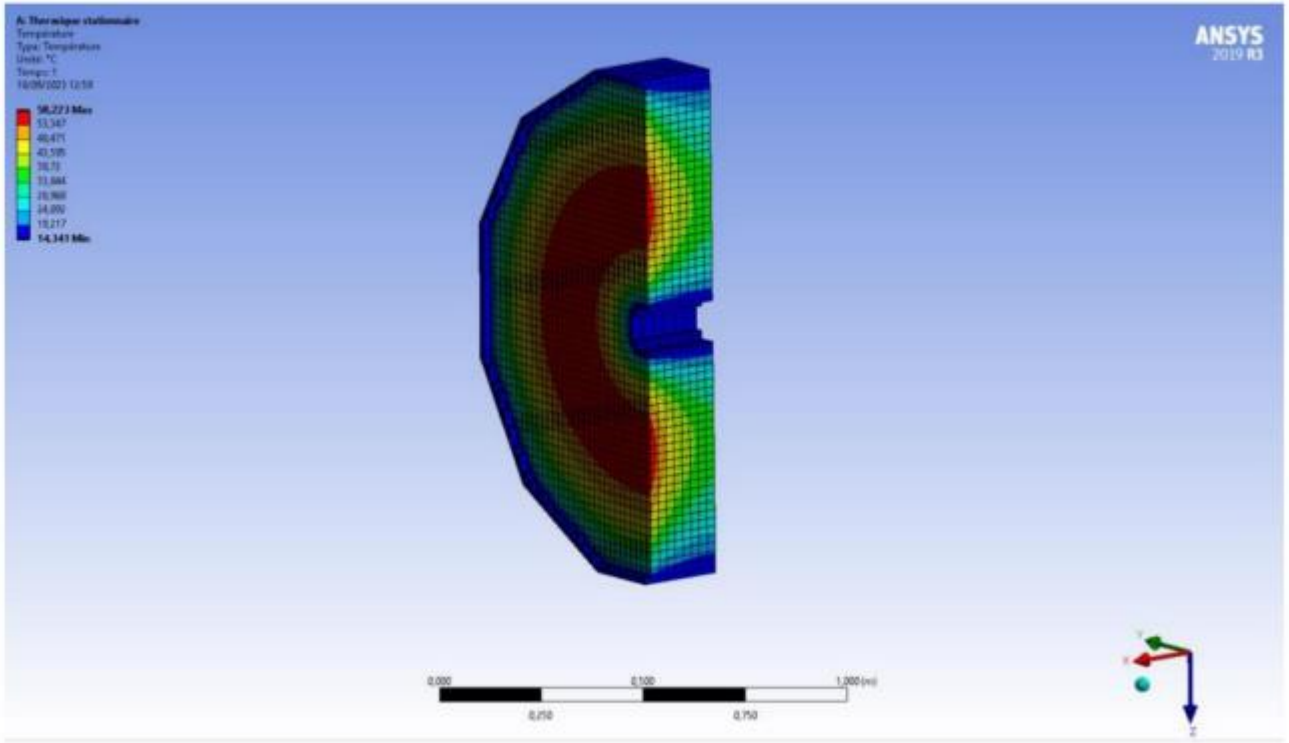
Thermal simulations

ANSYS simulations ongoing:

5x5 prototype simulation :

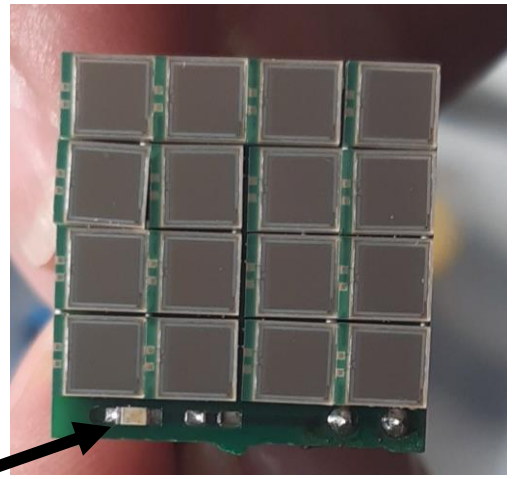


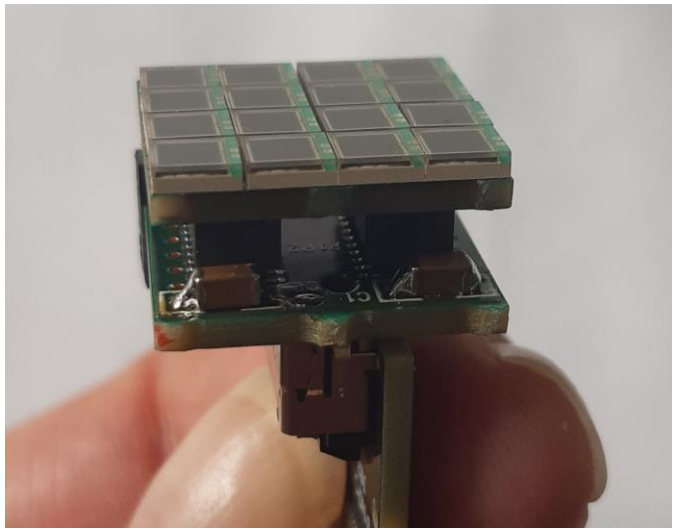
Full detector simulation

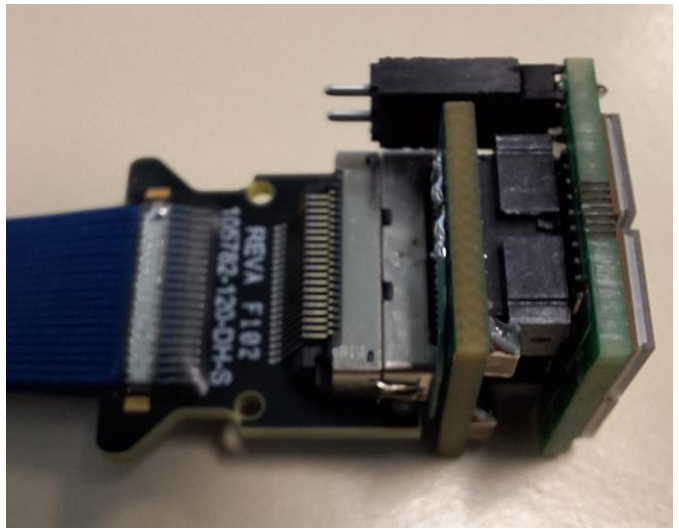


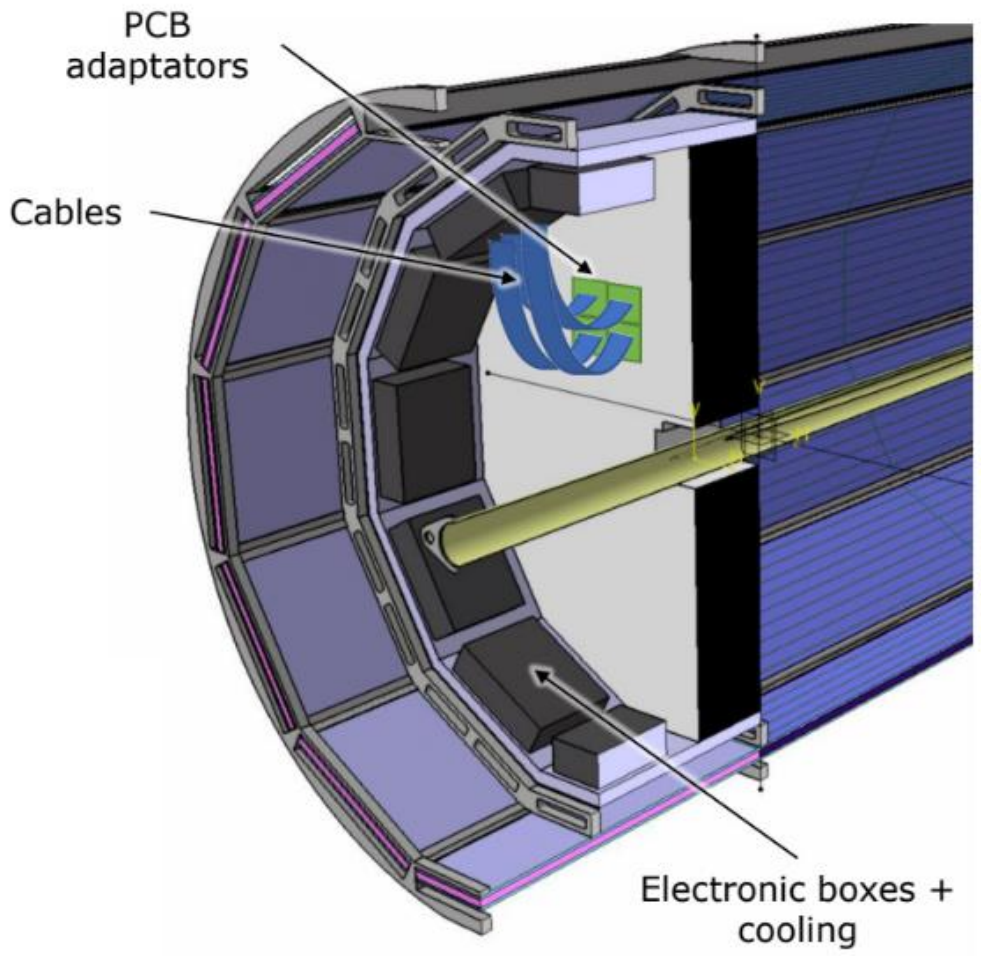
Readout

- 16 (or 4) SiPM per crystal
- Multi-conductor (ribbon) micro coax cable per crystal
- SMD LED for gain monitoring

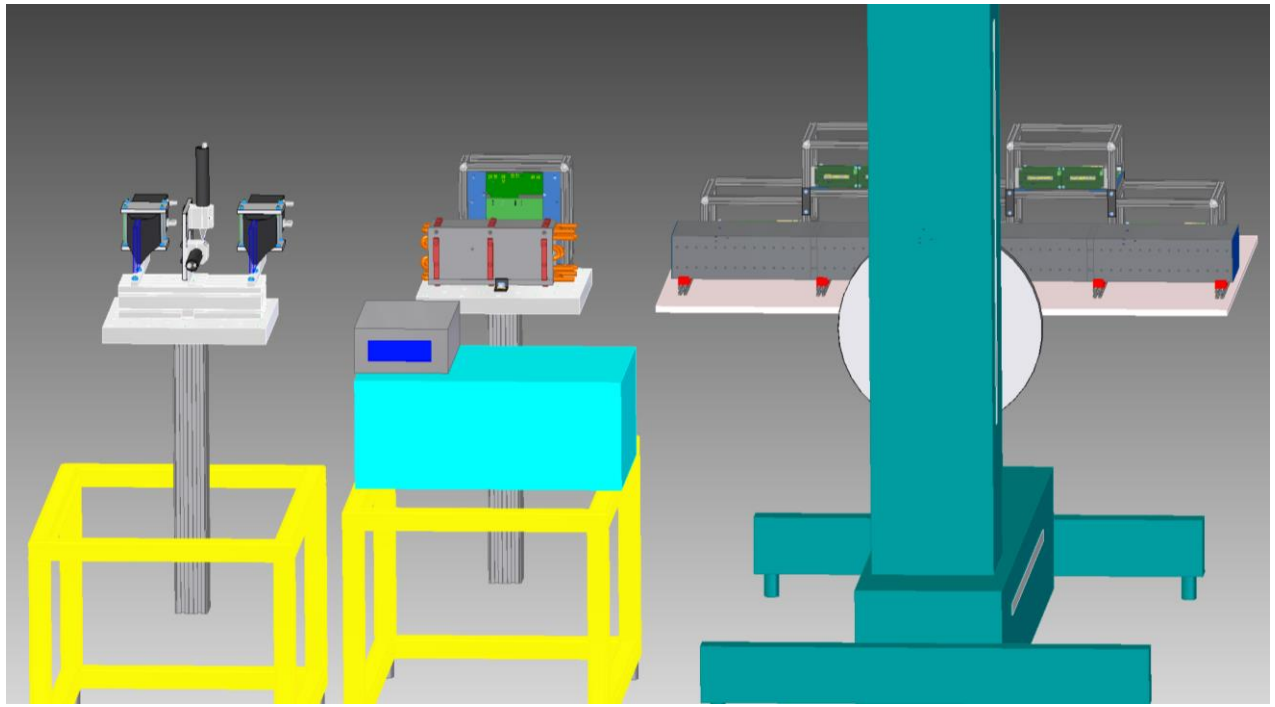








Test beams



- CERN (Aug-Sep 2024),
  in collaboration with the LFHCAL group

Detector: Prototype with 3-4 crystals instrumented (~20 readout channels), with different readout options (parallel/independent readout of all SiPM in a crystal)

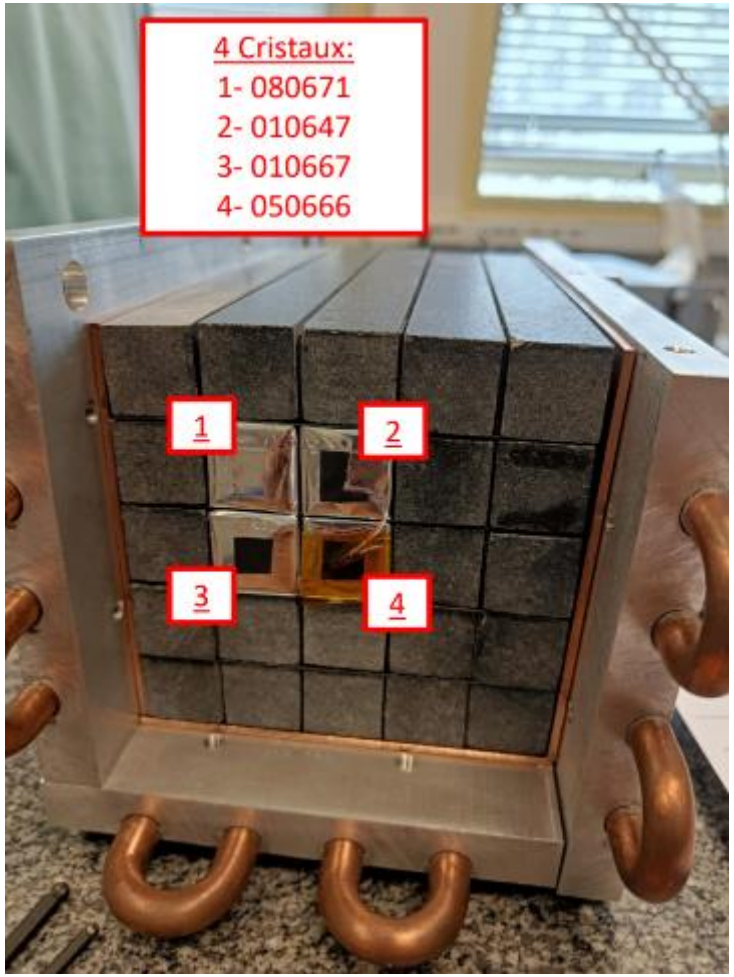
Goal: commission HGCROC readout, temperature measurements

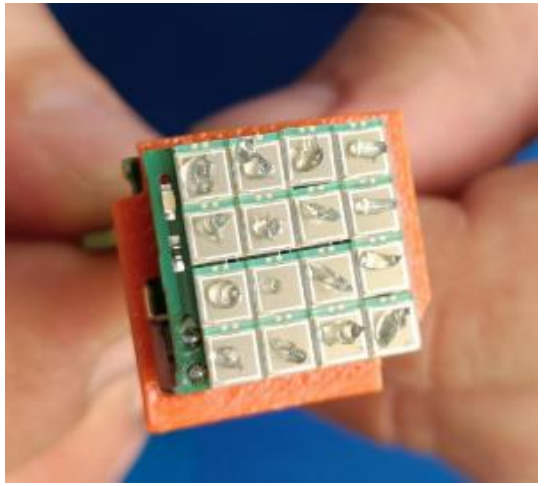
- DESY (Oct-Nov 2024): dedicated backward ECAL test

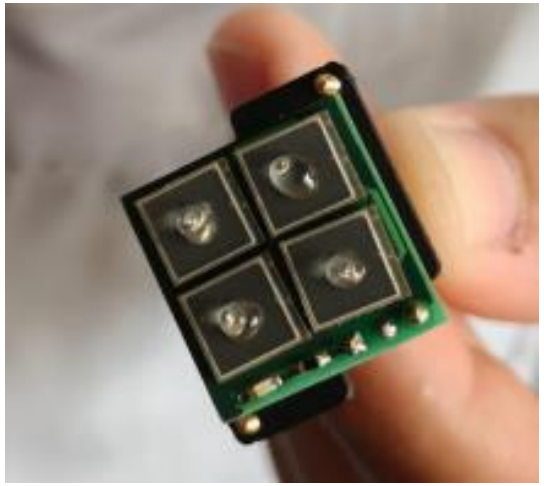
Detector: fully instrumented prototype (5x5 crystals), with both fully independent readout (400 channels) or parallel readout (25 channels)

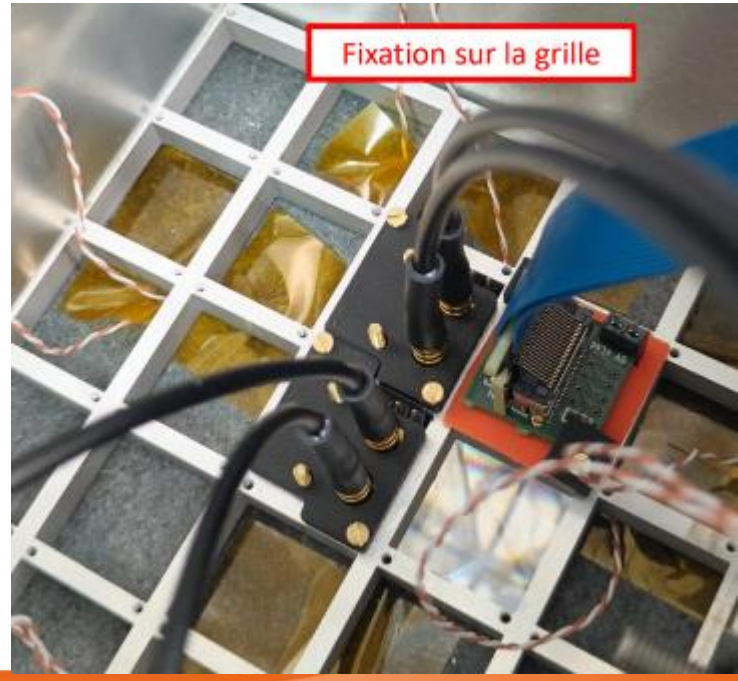
Goal: comparison of different readout options: parallel/independent, ASIC/discrete

Prototype assembled TODAY!

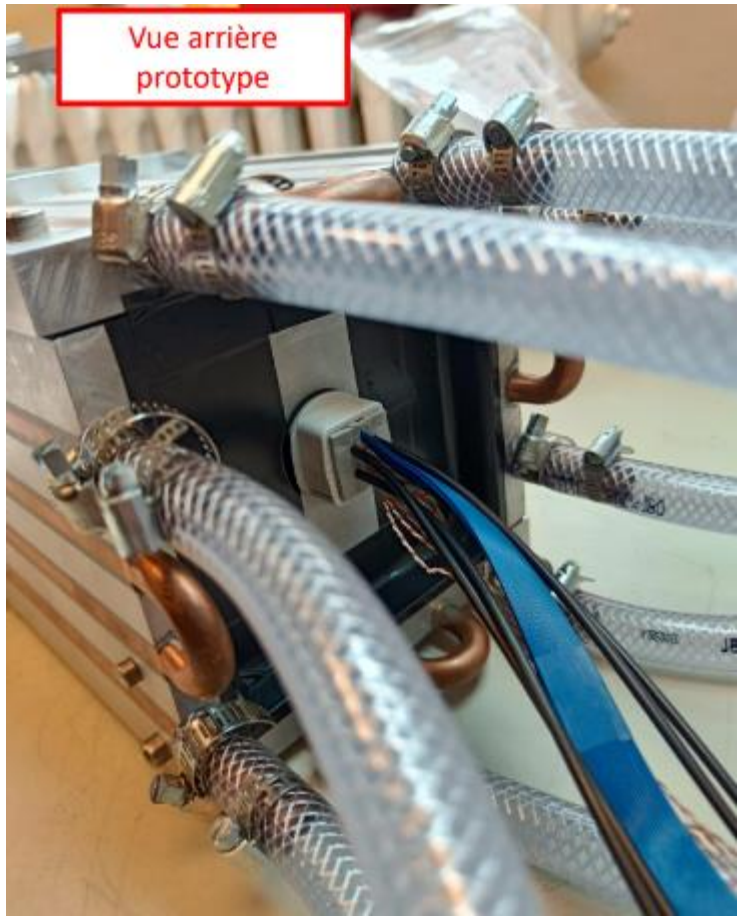








Prototype assembled TODAY!



Summary

- Mechanical conceptual design relatively advanced
- Main outstanding item: choice of front-end electronics
- Ongoing work: cooling & monitoring system

- Plan is to start final/construction drawings in 2025
- Detector construction could start in ~2026.