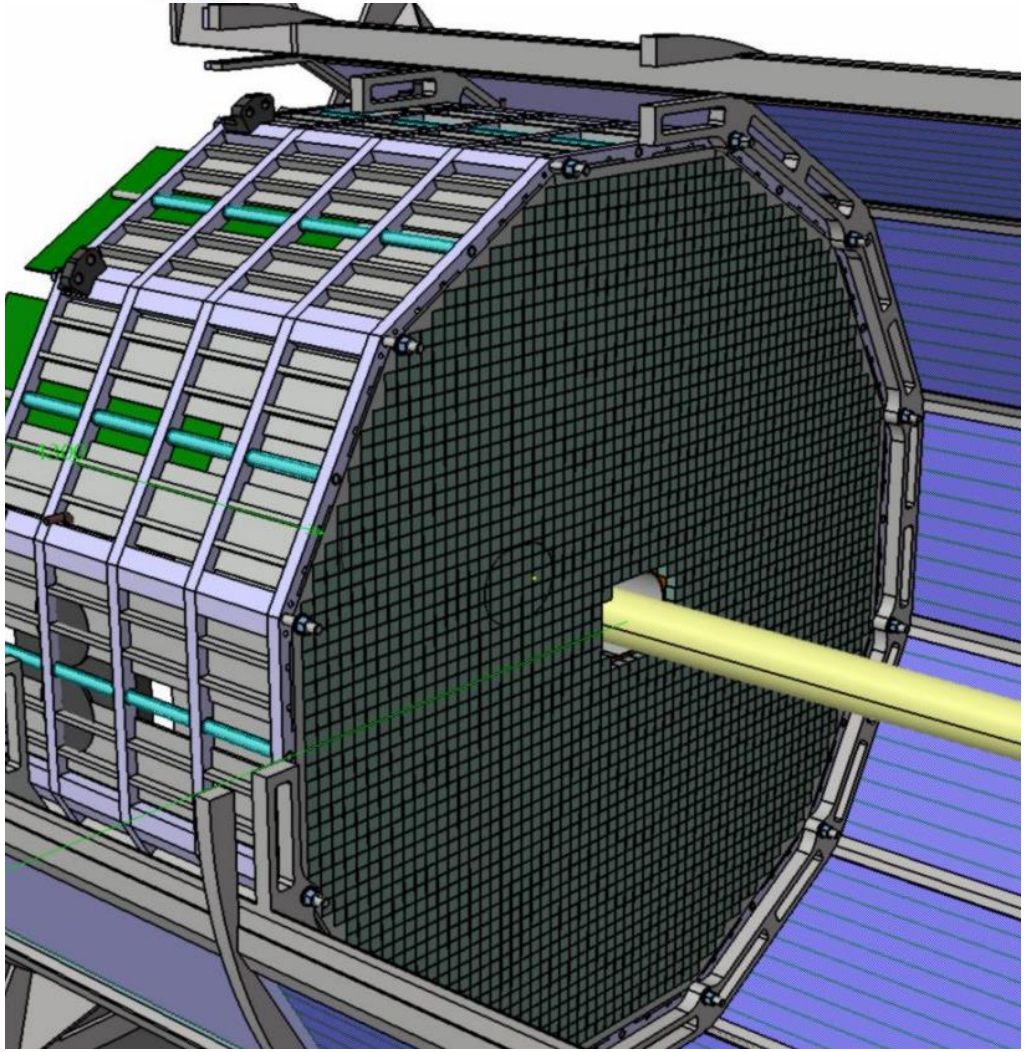


Mechanical Design

Carlos Muñoz Camacho*
IJCLab (Orsay, CNRS/IN2P3)

EIC $PbWO_4$ Crystals FDR
July 21, 2023

*** design by Julien Bettane (IJCLab)**

Requirements

❑ Physics:

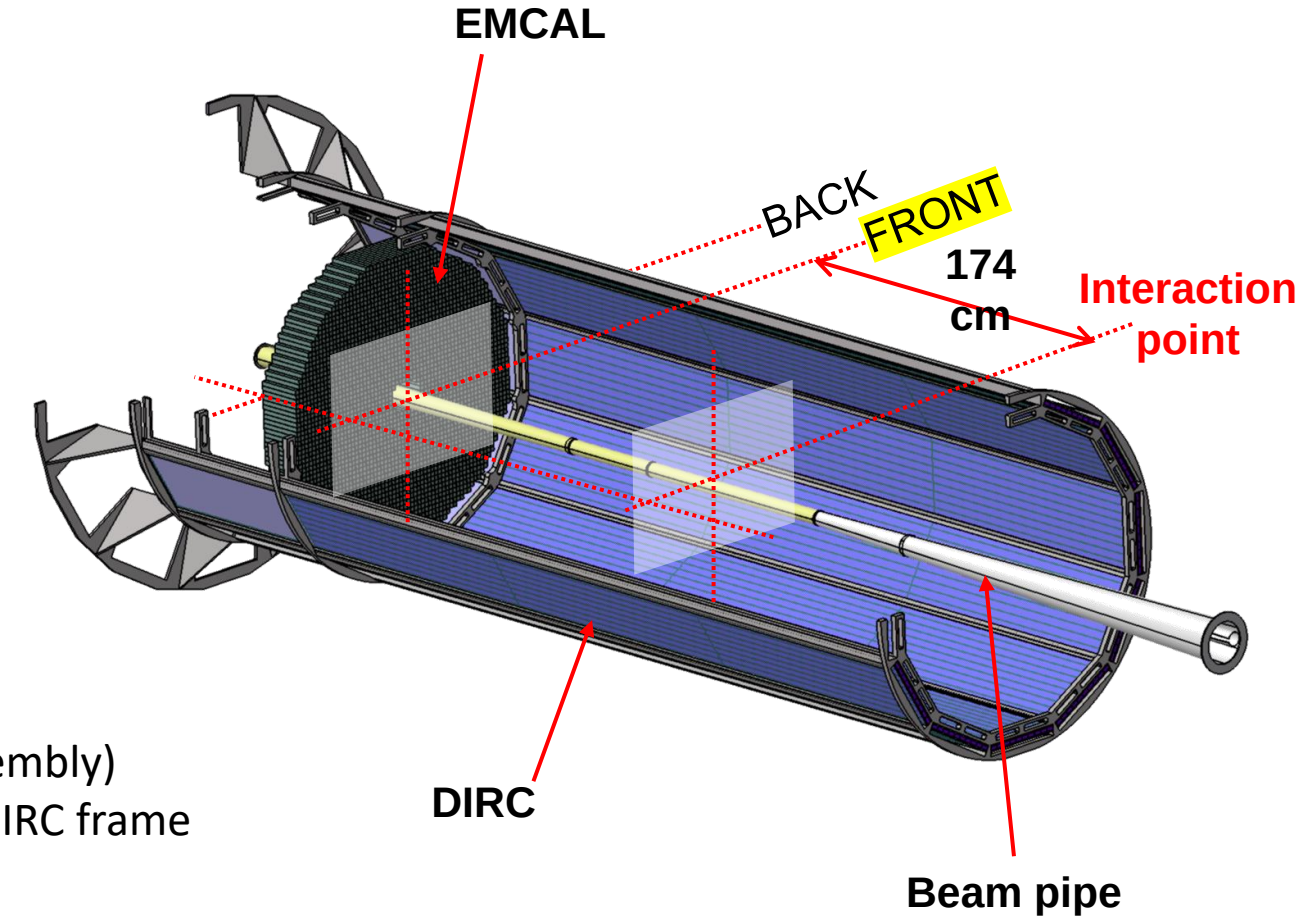
- Minimize the material & space between crystals
- Minimize material in front of the detector
- To be as close as possible to the beampipe
- Gain monitoring system (1 fiber/crystal)

❑ Thermal:

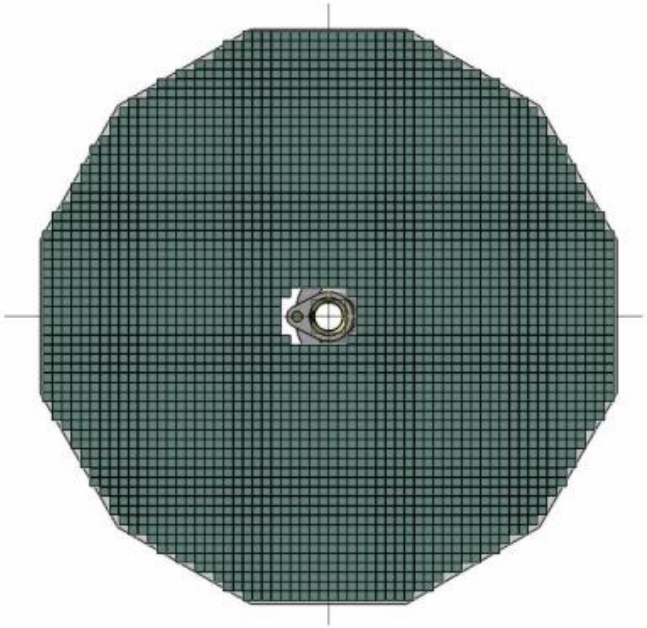
- Operation at 20°C (room temp)
- Required stability on crystal temperature: +/- 0.1°C

❑ Installation:

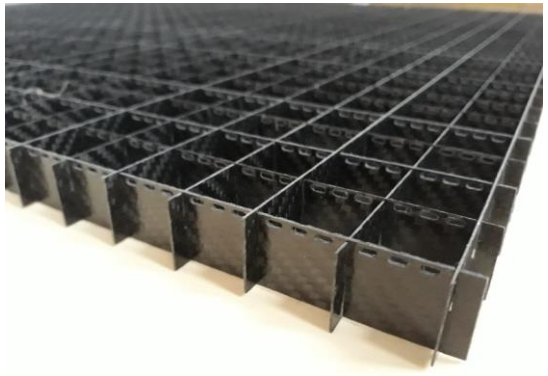
- Removal of the detector in one block (without disassembly)
- Clearance of 5 mm between the beam pipe and the DIRC frame

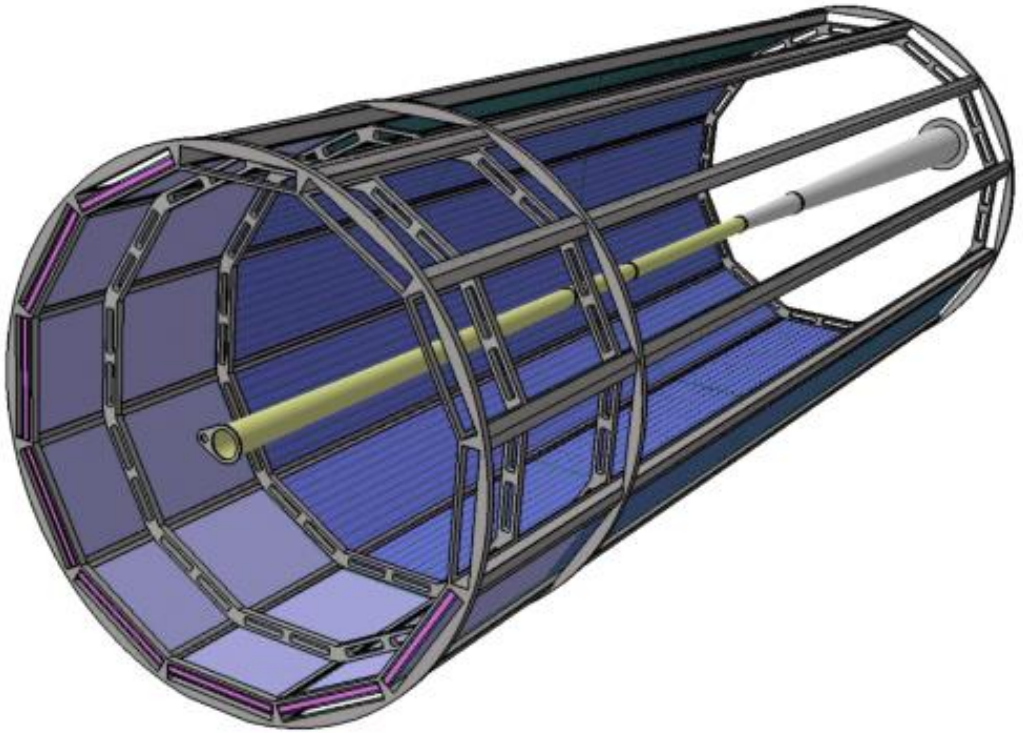


Crystal configuration



- 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)

SiPM readout and monitoring system

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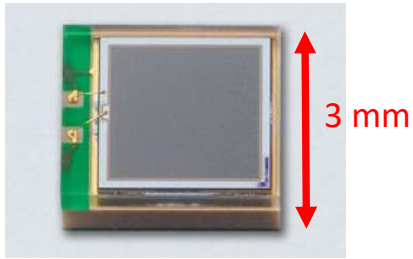
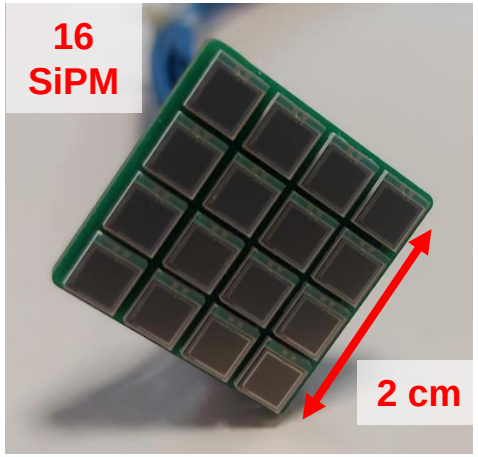
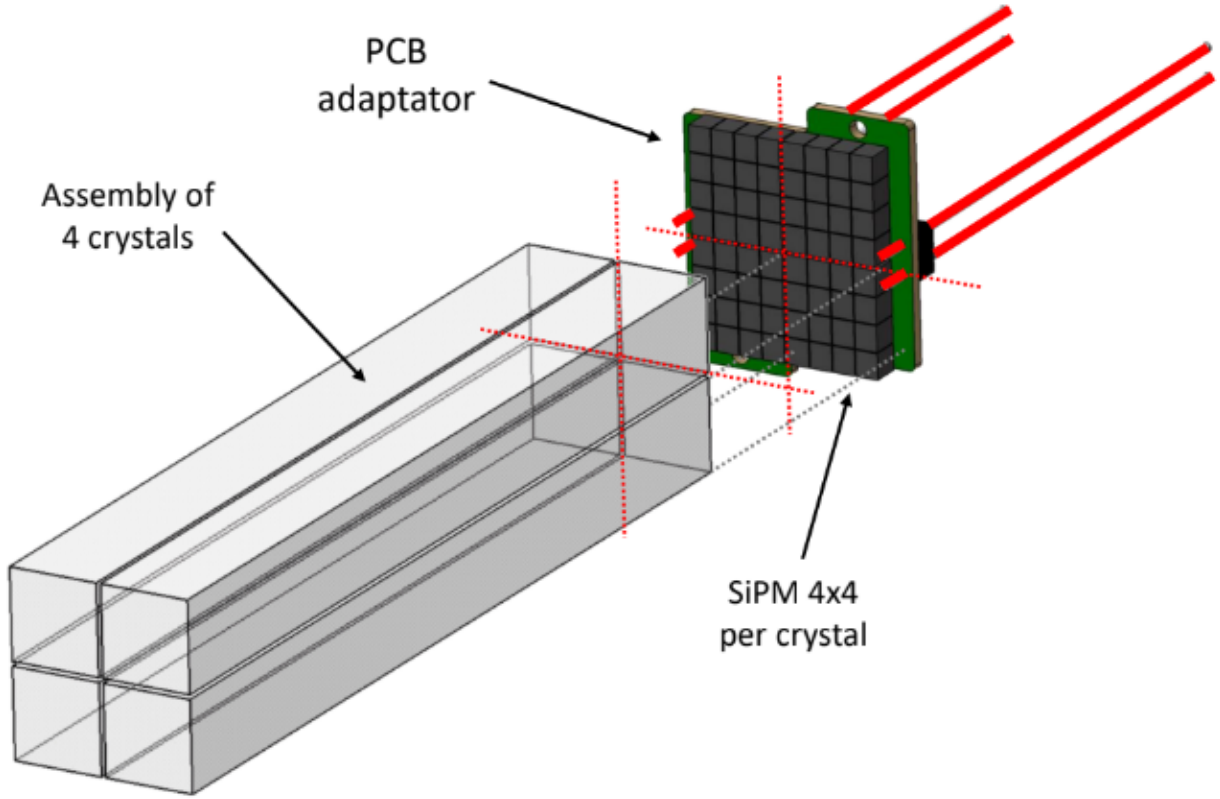
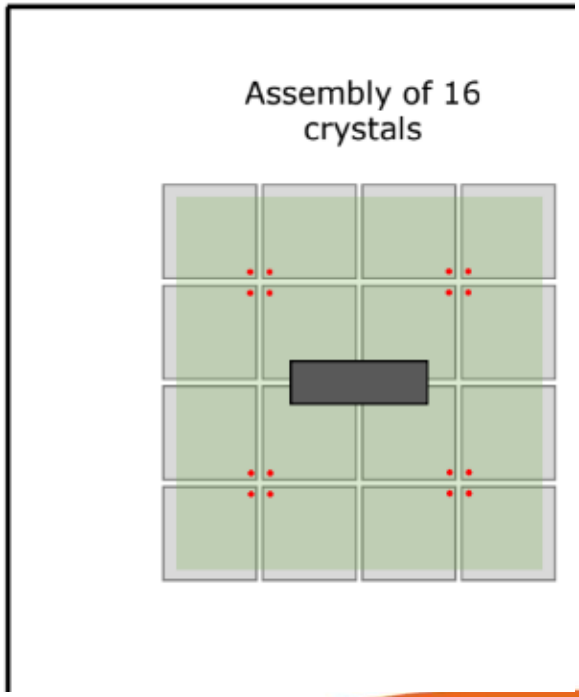
S14160-3010PS





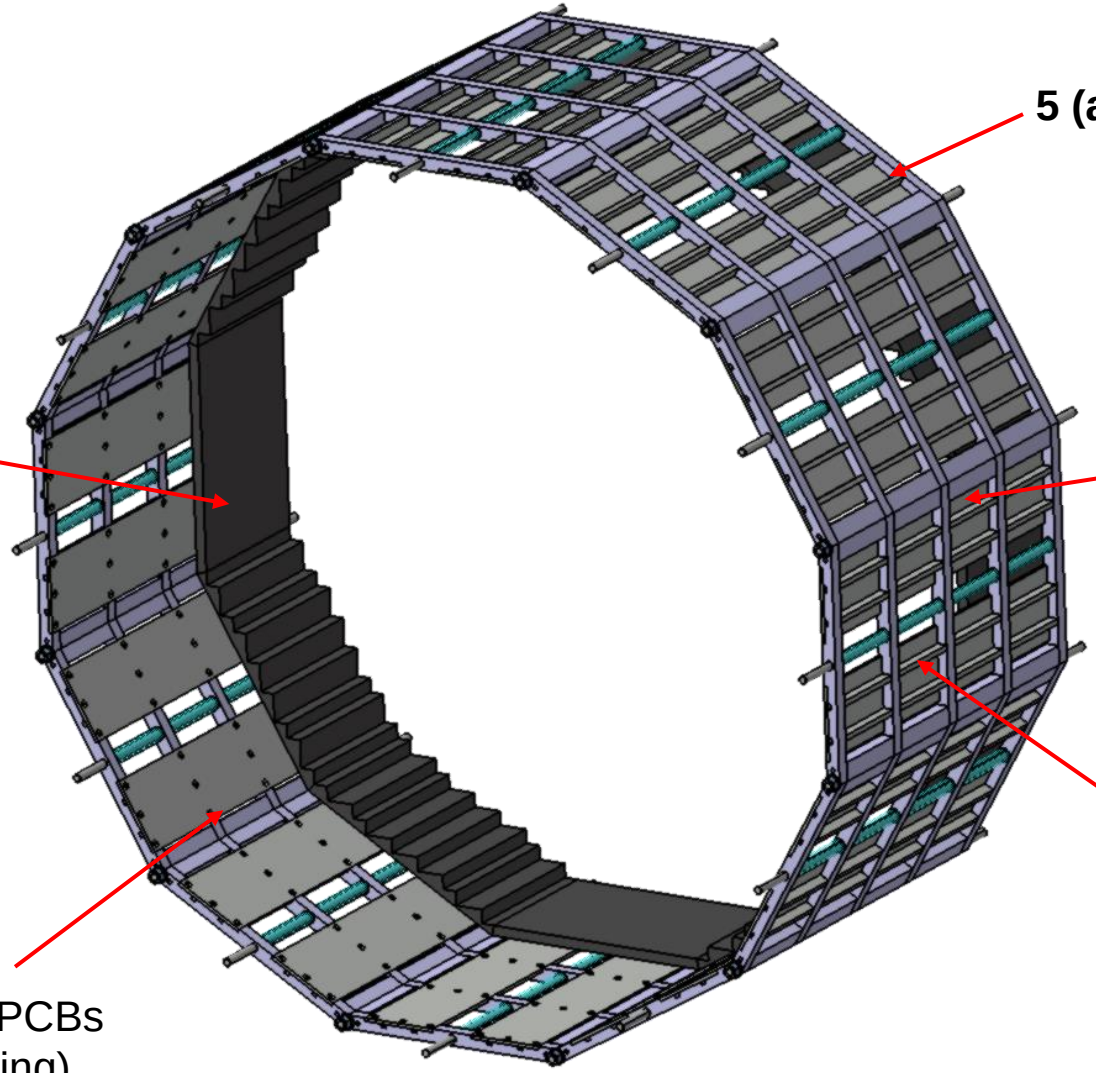


Gain monitoring with
an optical fiber
(1 per crystal)



One fiber per crystal to monitor gain variations

Mechanical structure



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

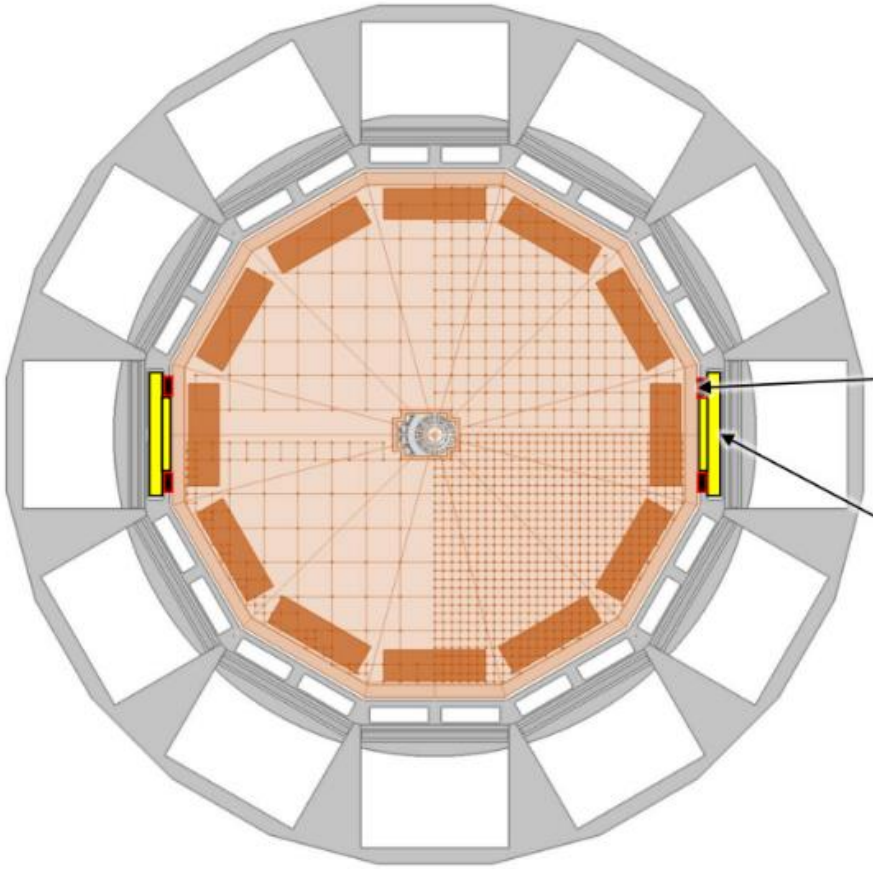
Support structure for crystals
(can be used for cooling)

Mechanical pieces
(to reinforce the structure at the angles)

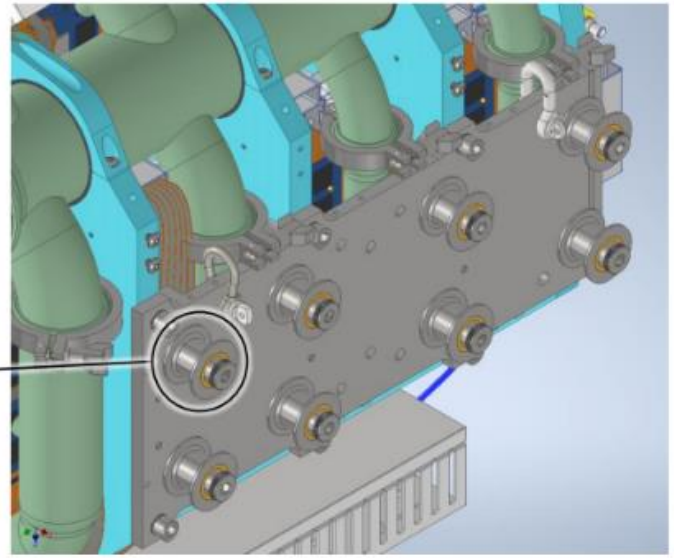
Plate
(to fasten the PCBs and the cooling)

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

Assembly into the DIRC frame using rails

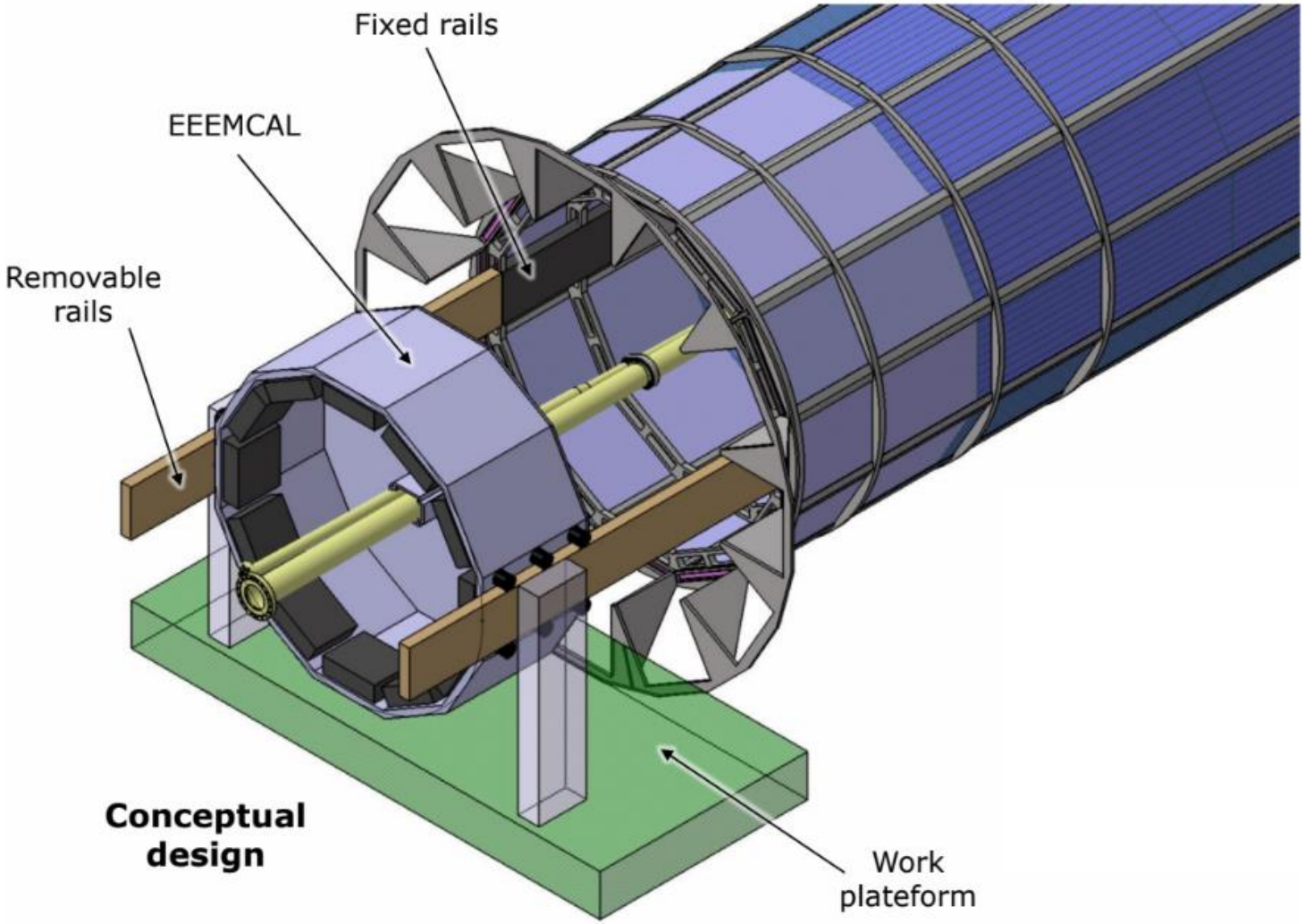


Positioning of the rails

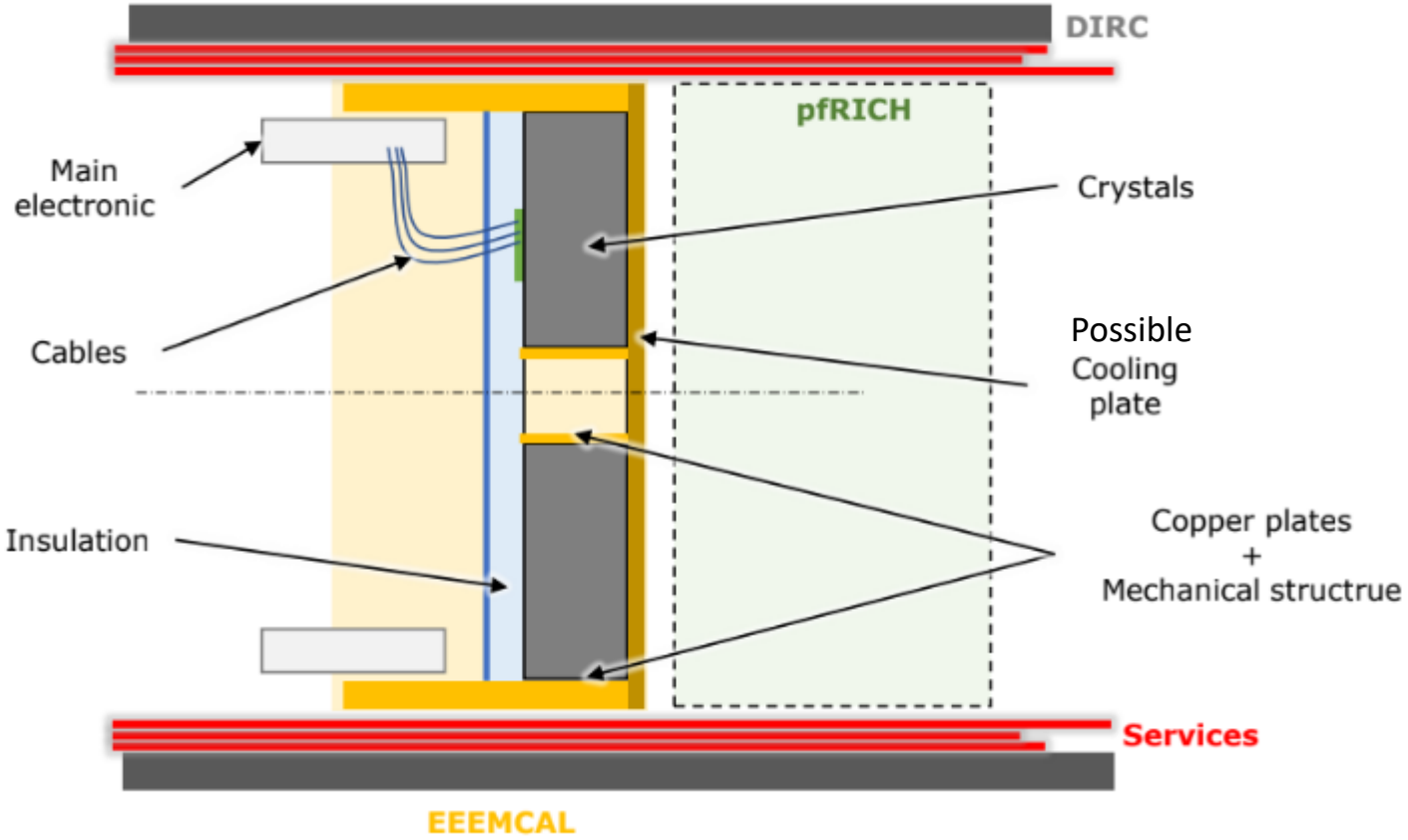


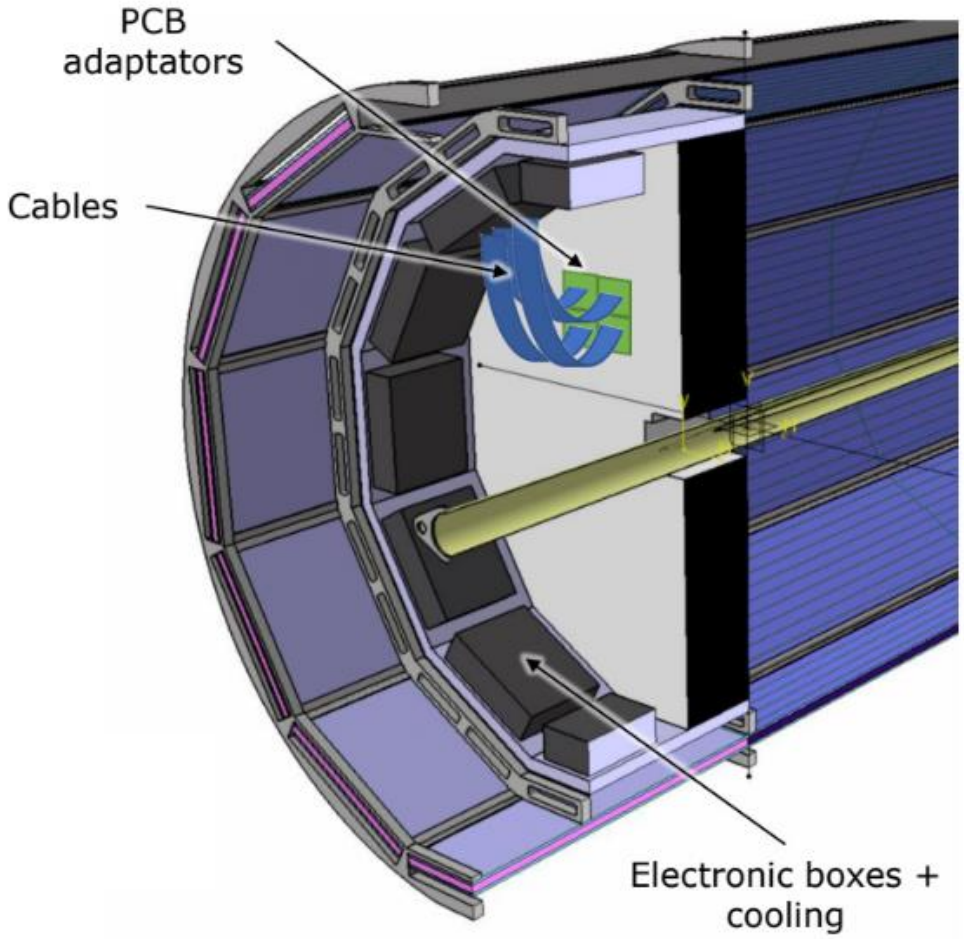
Mechanical plate with roller **STAR**
(from Rahul Sharma)

Installation and maintenance



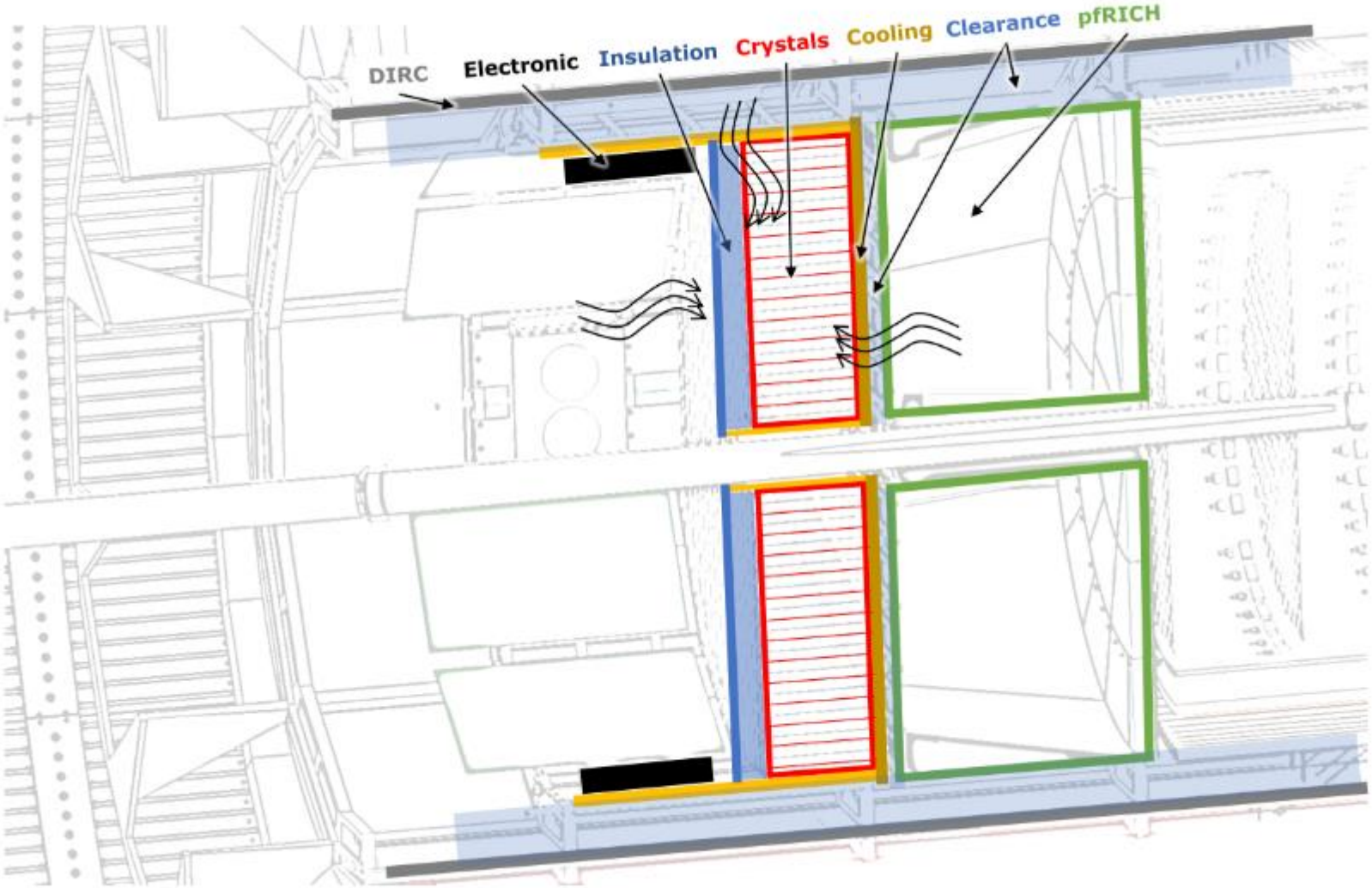
Front-end electronics and cooling





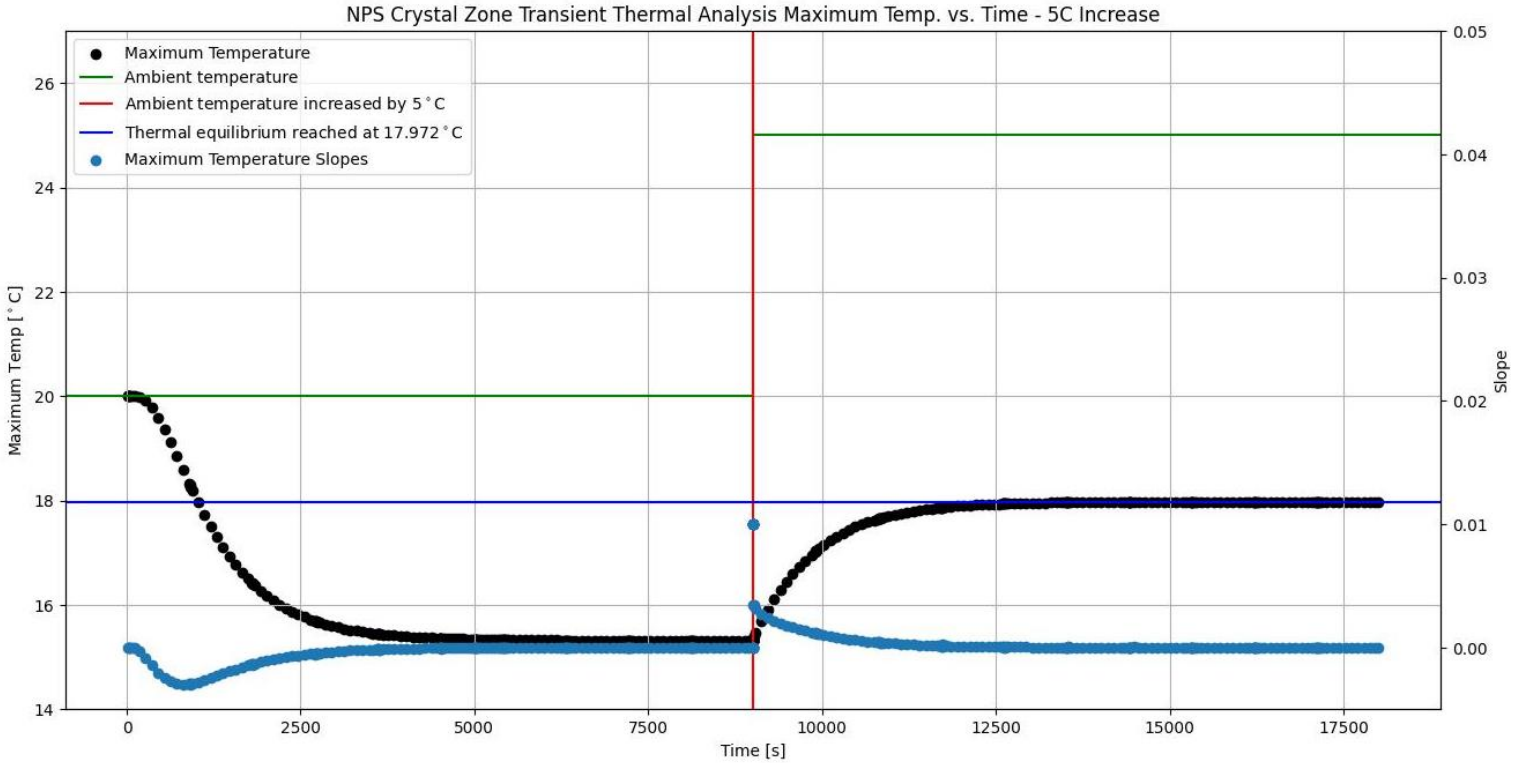
Ongoing work: thermal studies

- One of the main challenges of the design
- Simulations ongoing to quantify the effect of ambient temperature fluctuations on crystal temperature
- Also, measurements ongoing on a prototype

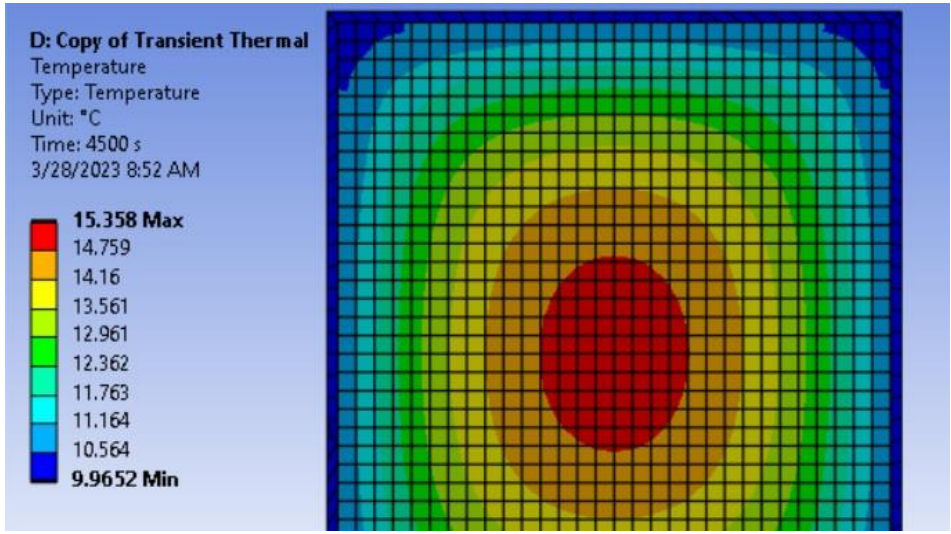


Ansys Transient Thermal Analysis

Studies by the JLab DSG for the NPS setup

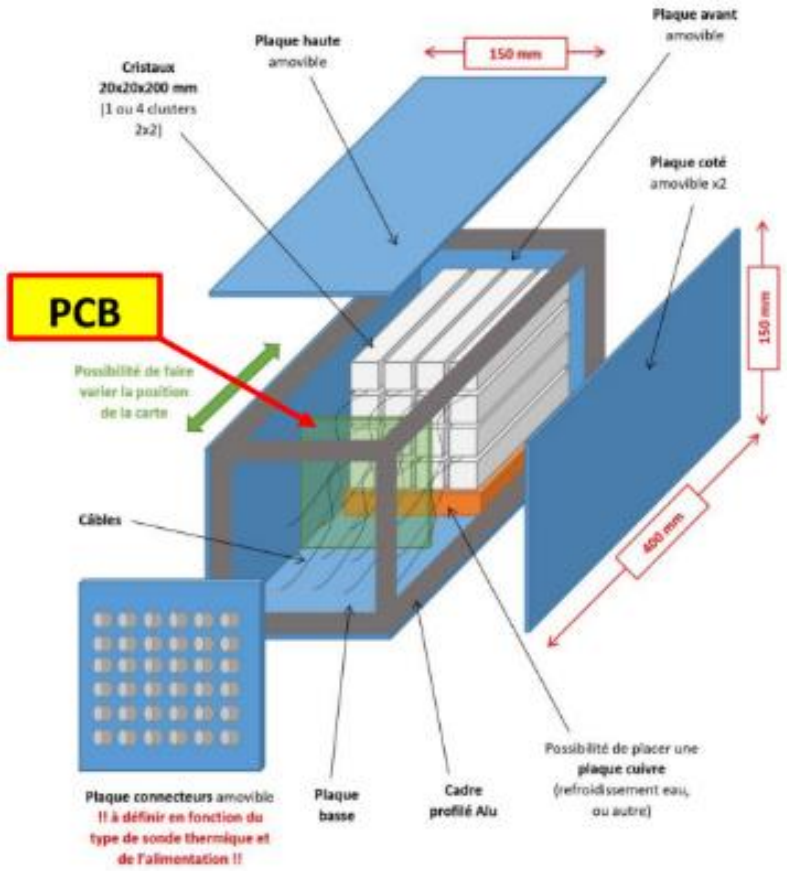


- Copper shell temp: 10°C (constant)
- Q = 0.3 W per crystal
- Ambient temp: 20°C

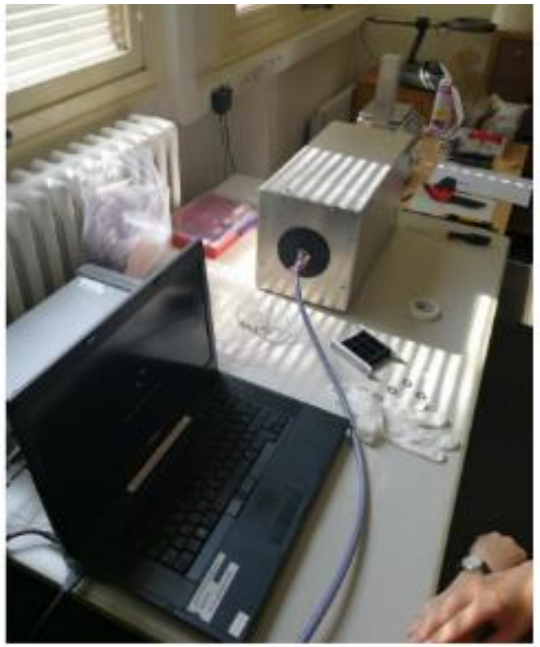


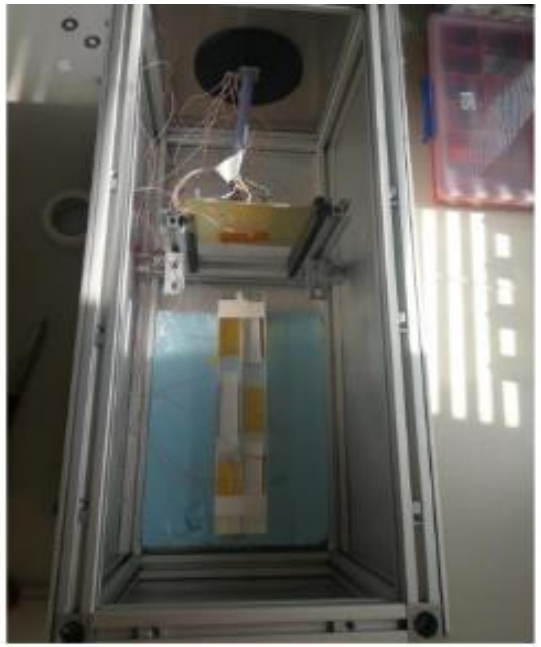
- Temperature stabilization has a **long time constant:** it takes >1h to reach equilibrium after a change
- Working with Ansys to understand the stabilization temperature (disagreement with previous steady-state simulations)

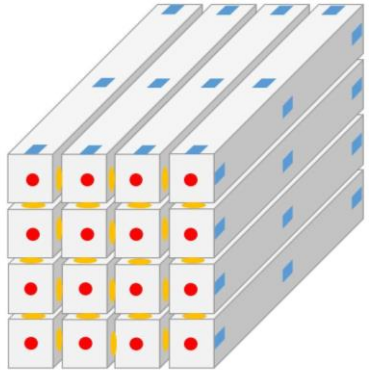
Thermal prototype



Setup of the tests



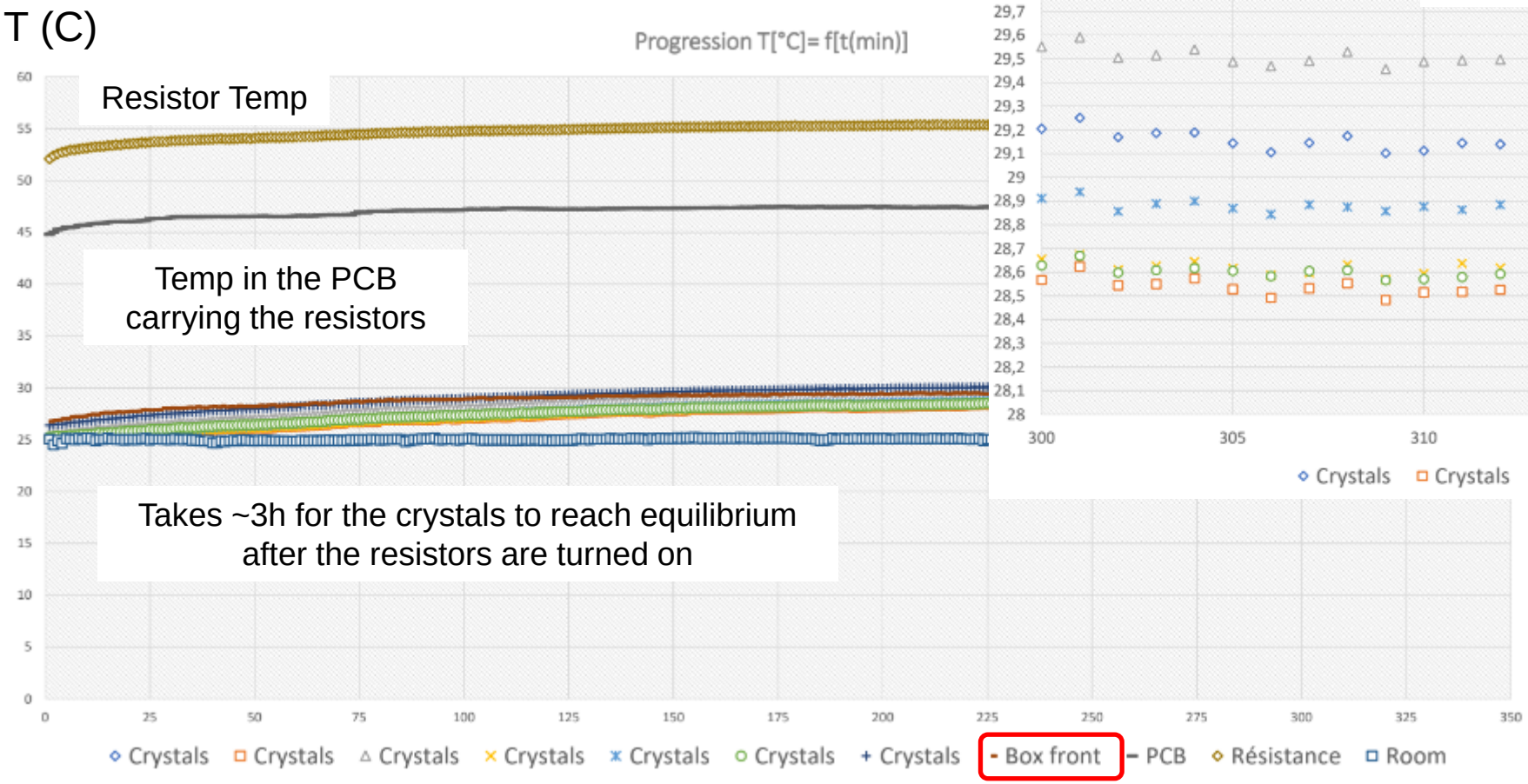




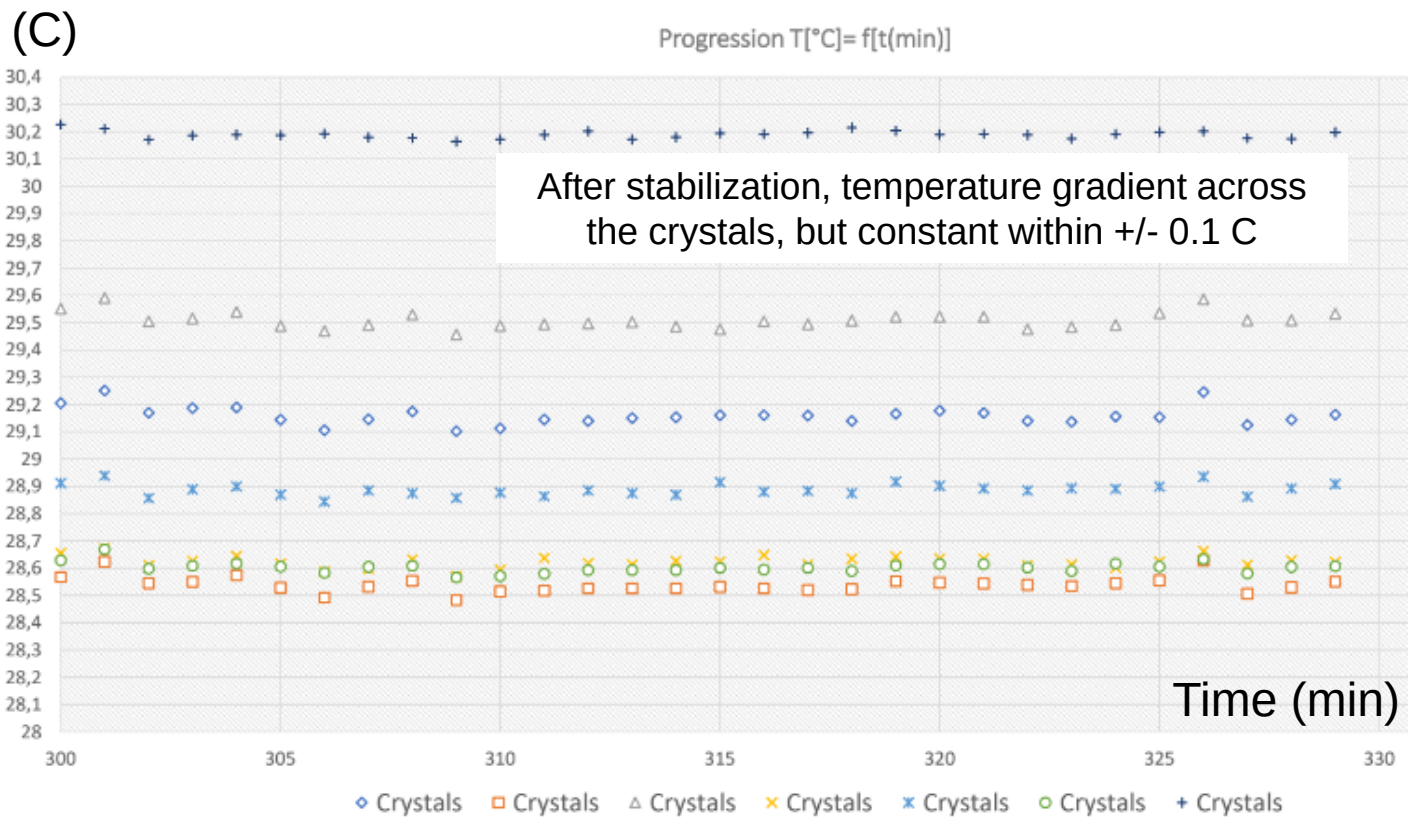
Positioning of the thermal sensors on & between the crystals

Initial measurements with prototype

250 mW at 4 cm from crystals



Ambient temperature in the box



Summary

- Advanced preliminary design of the backward endcap calorimeter presented

- Main outstanding items:
  - Final dimensions of the inner/outer radius
  - Electronics readout → Cooling
  - Thermal studies
  - Monitoring system