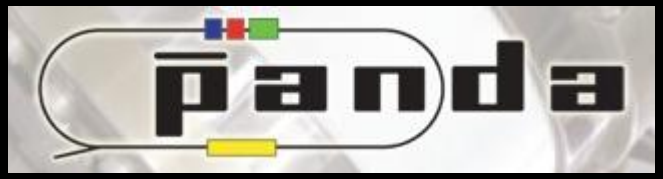
Mechanical and thermal aspects of the Backward Endcap



David Rodriguez Piñeiro Gustavo Tejerina Alvarez Jorge Sanchez Rosado

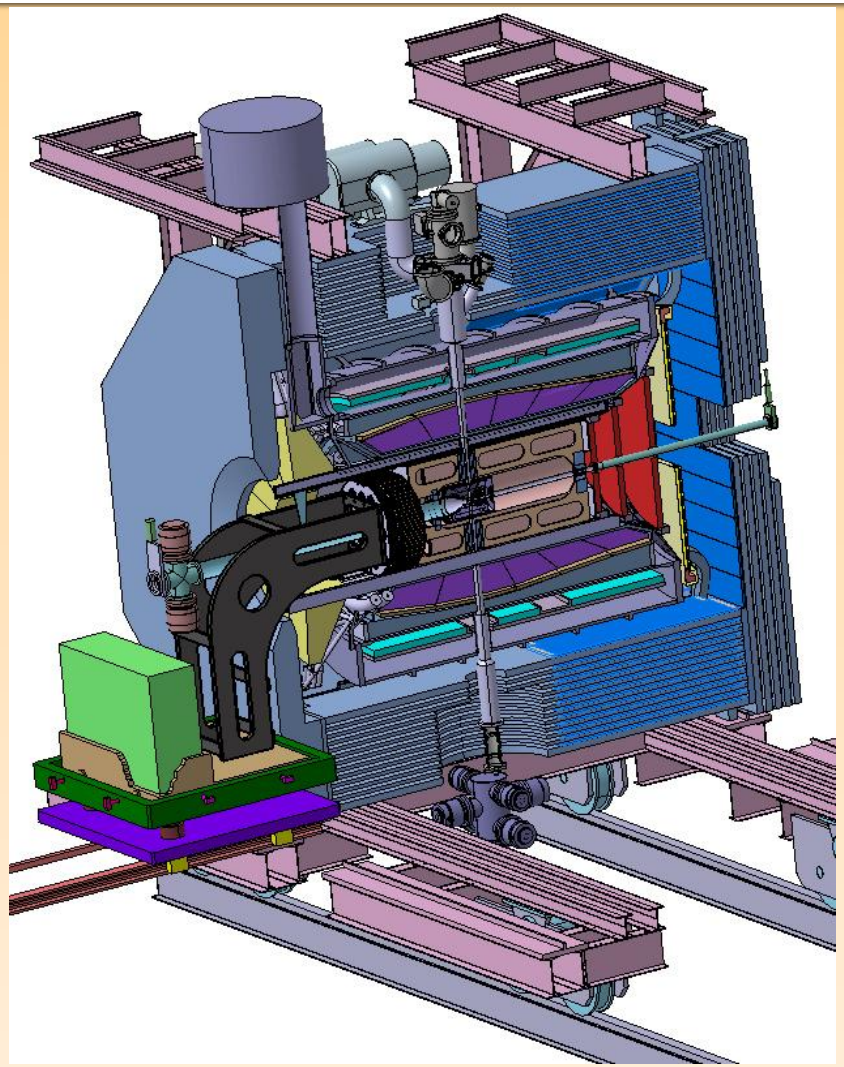
Iris Zimmermann

Outline

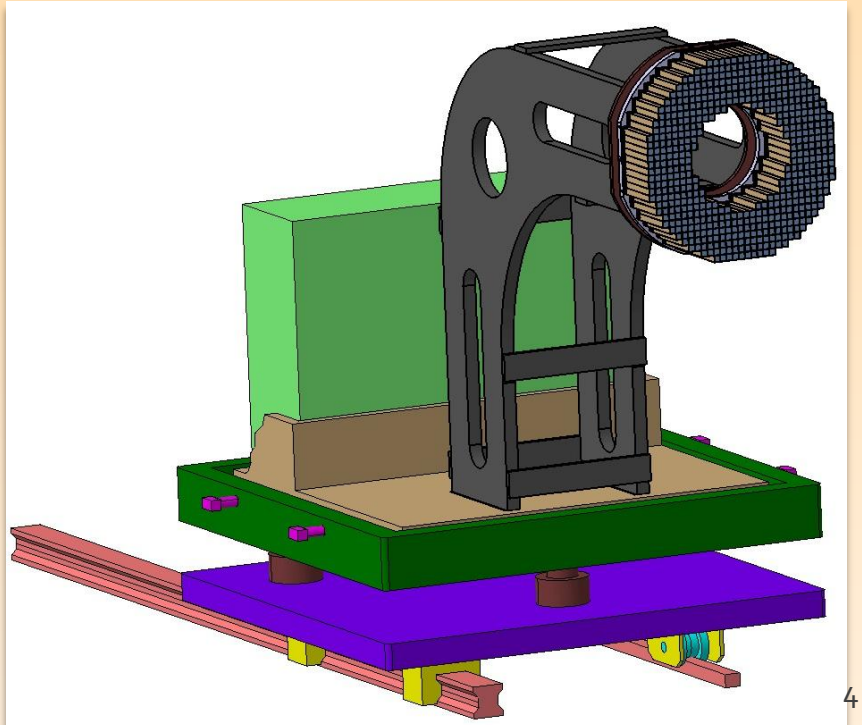
- Mechanical Design of the Backward Endcap
  - Location and support of the full system
  - The detector design
  - Insulation principle
  - Design of a Subunit (Prototype)
- Thermal Simulations on Crystal-Units
  - Studies with different materials and configurations

The Mechanical Design of the Backward Endcap

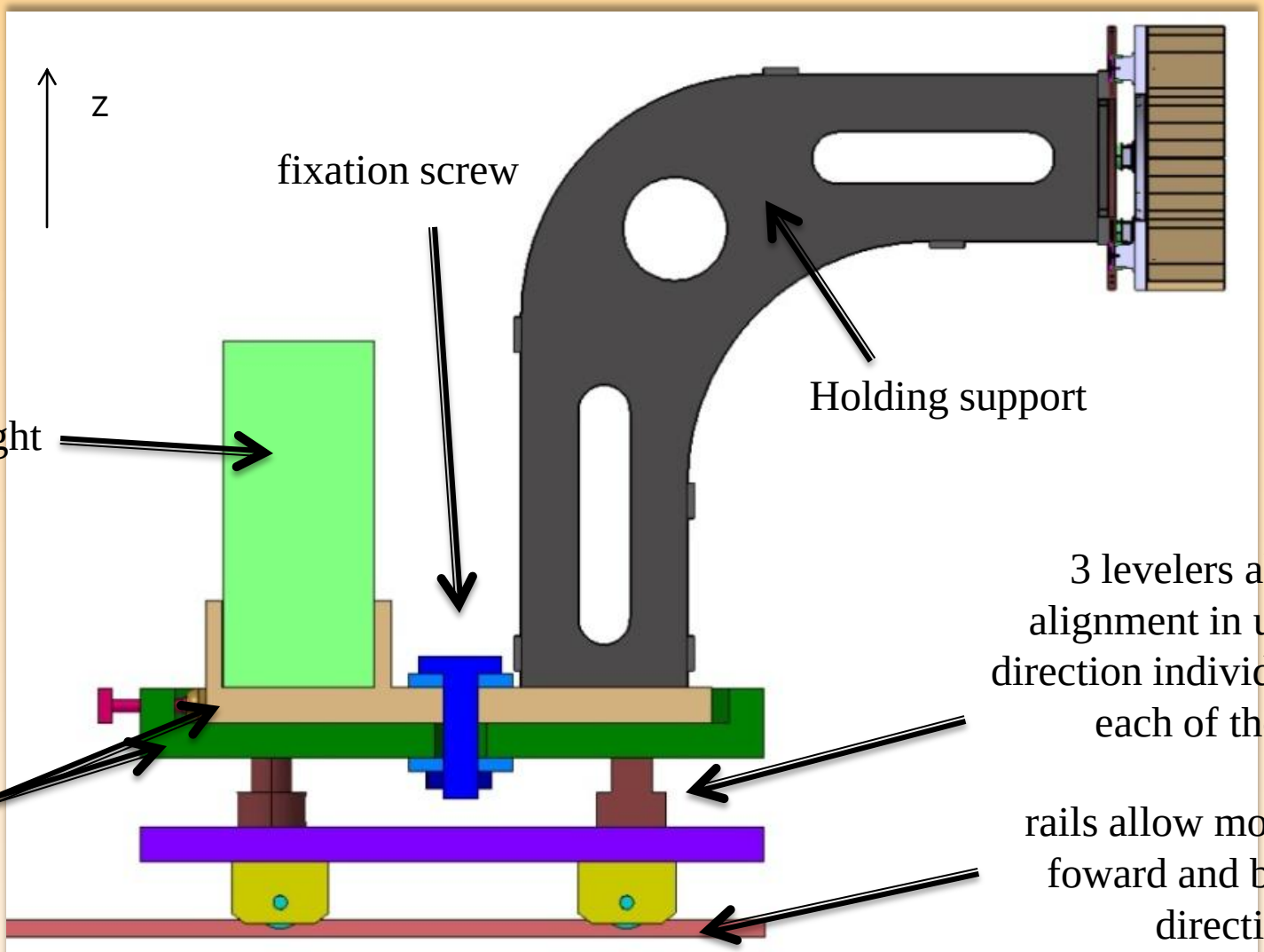
Location of the BW Endcap



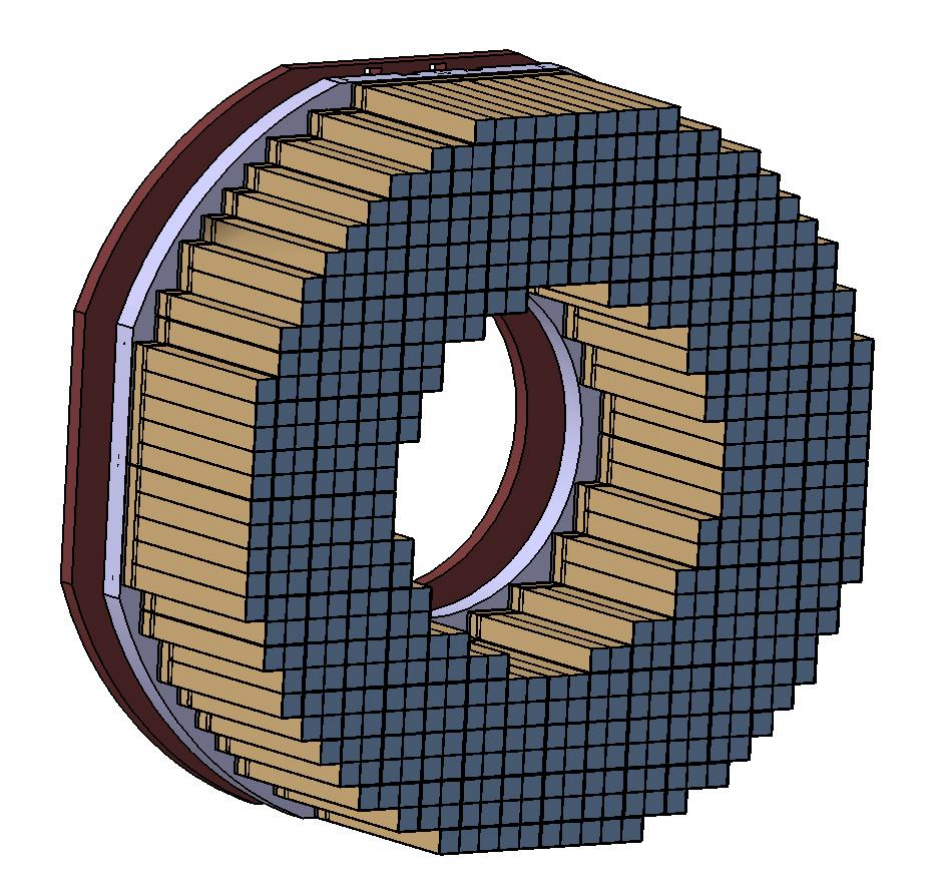
- BW Endcap inside Target Spectrometer
- **Adjustable support** for precise alignment
- Full BW Endcap system moveable through **rails**



Support of the BW Endcap



The Detector Design

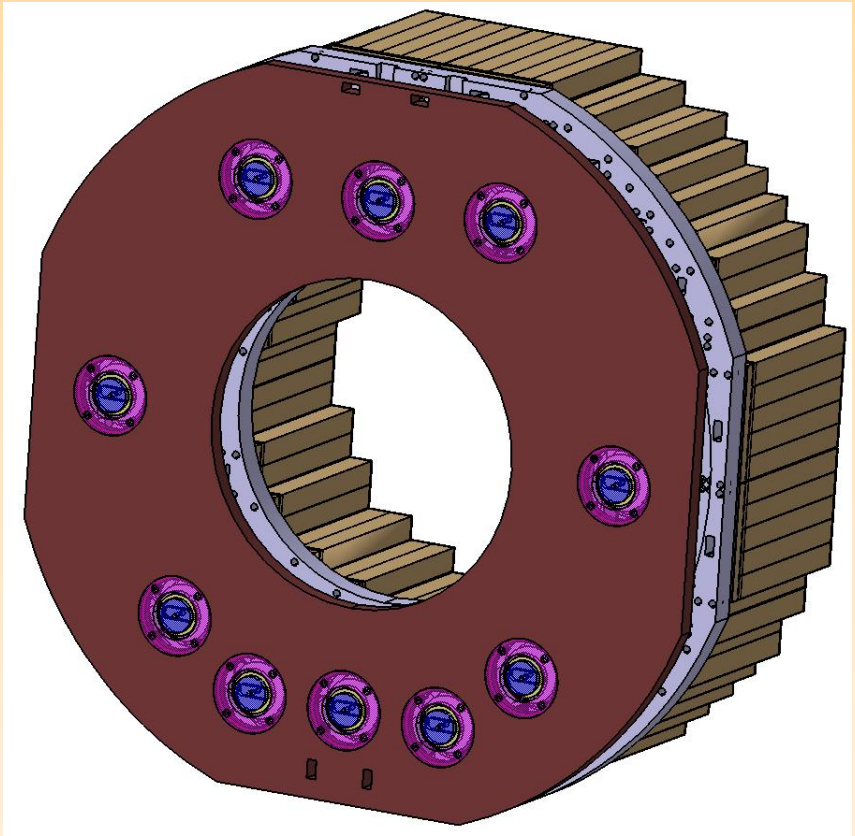


(Thermal insulation system not included)

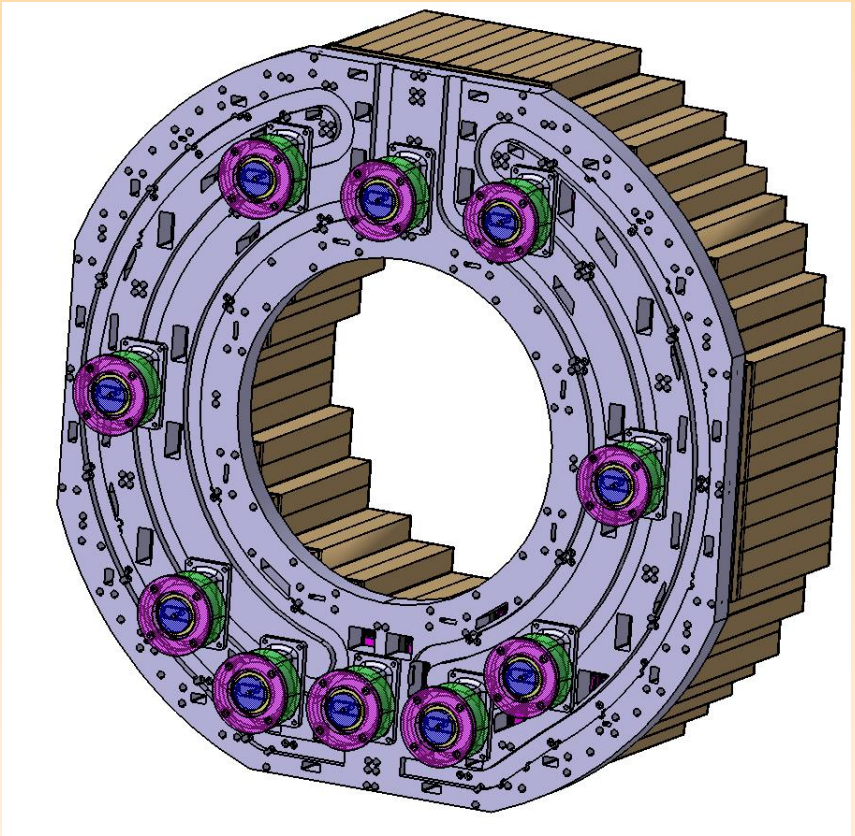
- 540 crystals (Lead tungstade $PbWO_4$)
- Crystals must be cooled (-25°C) due to the poor light yield of PWO at room temperature
- 2 mounting plates (aluminum alloy)
- Mechanical feet between them (special design allows shrinking of the cool mounting plate)
- Backside insulation: space between mounting plate will be filled with vermiculite granulate

The Detector Design

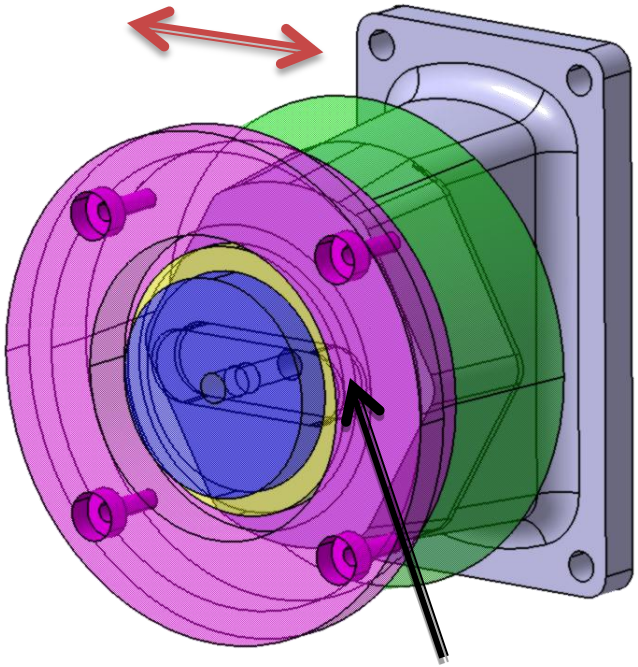
Backside with 2 mounting plates and mechanical feet (pink/blue)

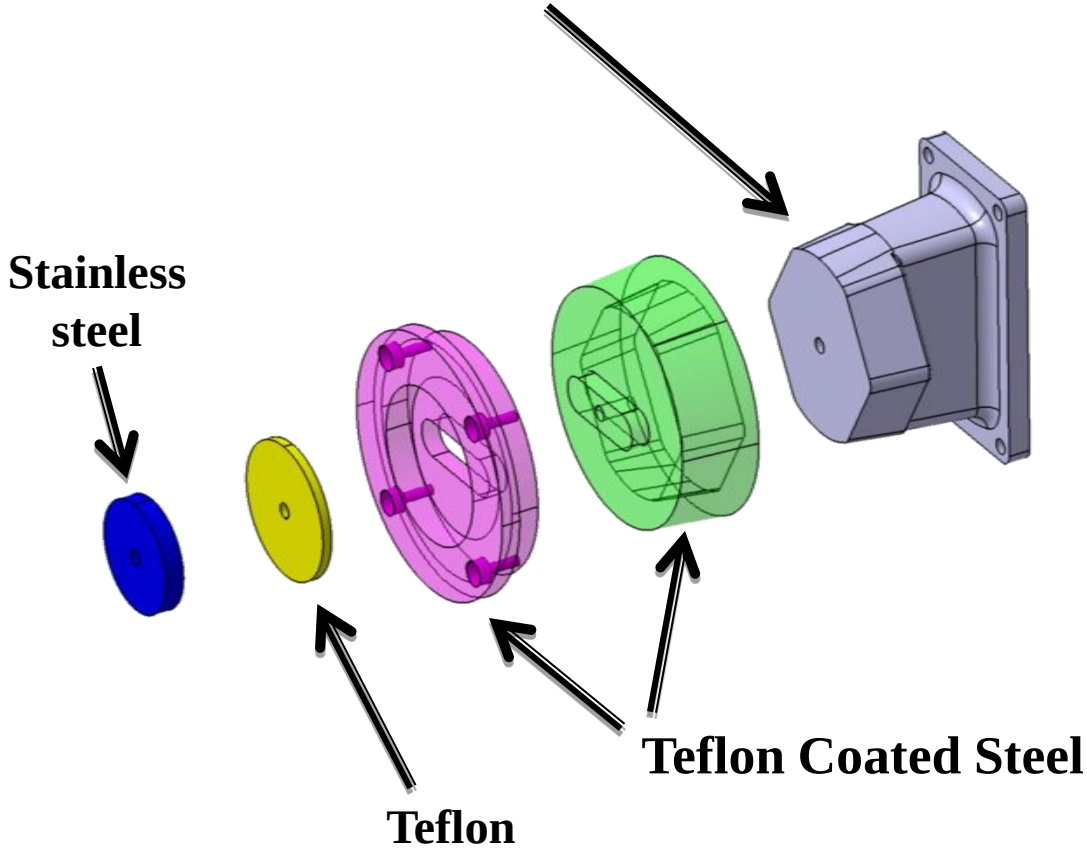


View without second plate: Pipes are placed inside the milled canals inside the mounting plate

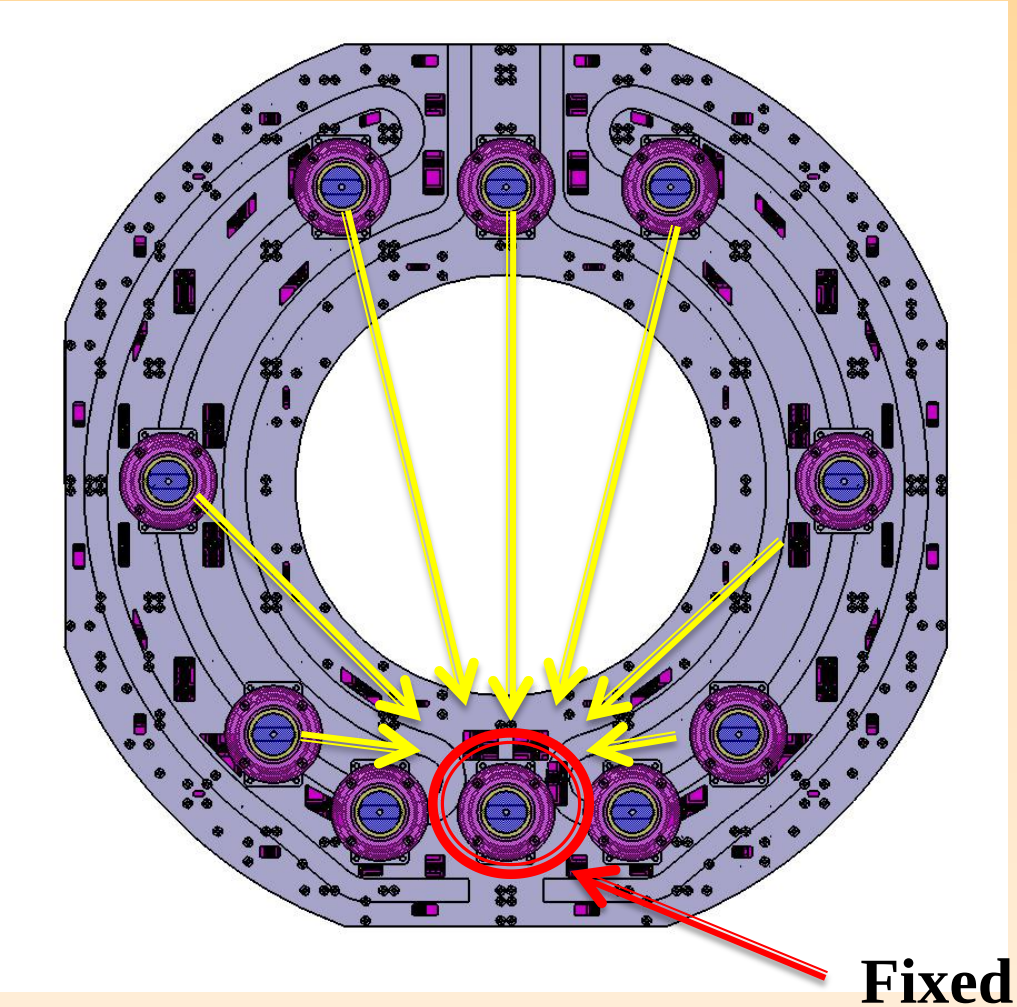


Supporting Feet





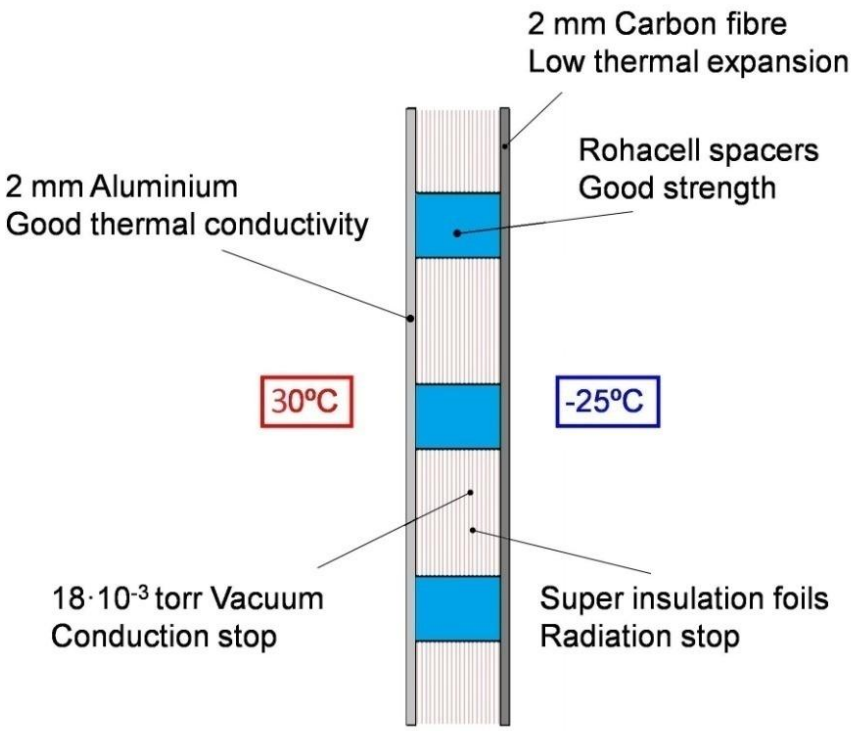
Supporting Feet

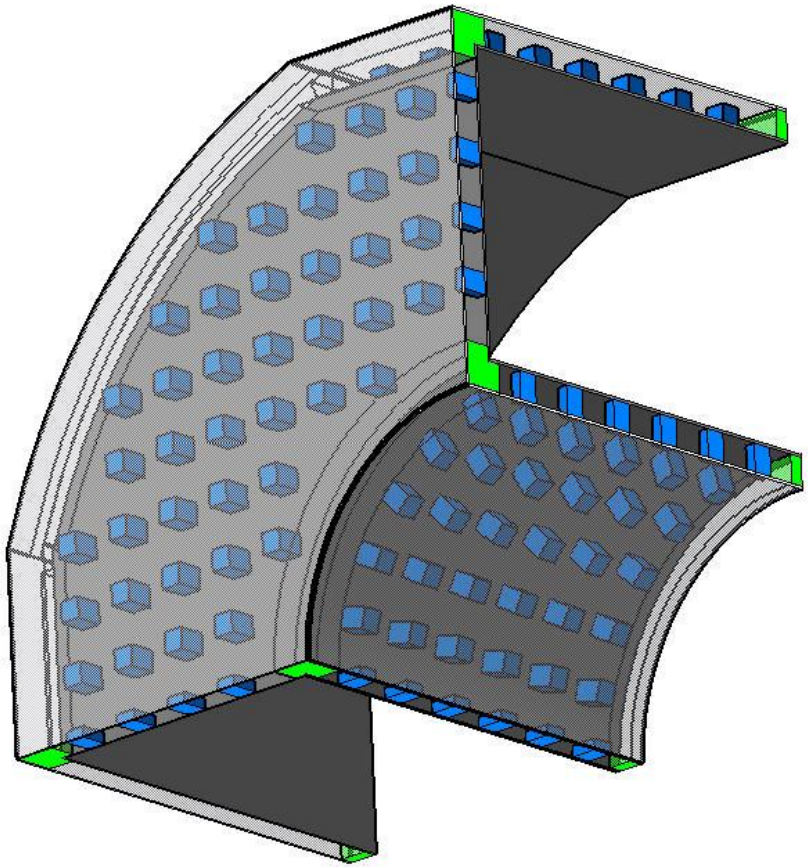


- **Slots should point directly at the fixed foot to allow shrinkage of cold parts during „cooling“ process**

The Insulation Principle

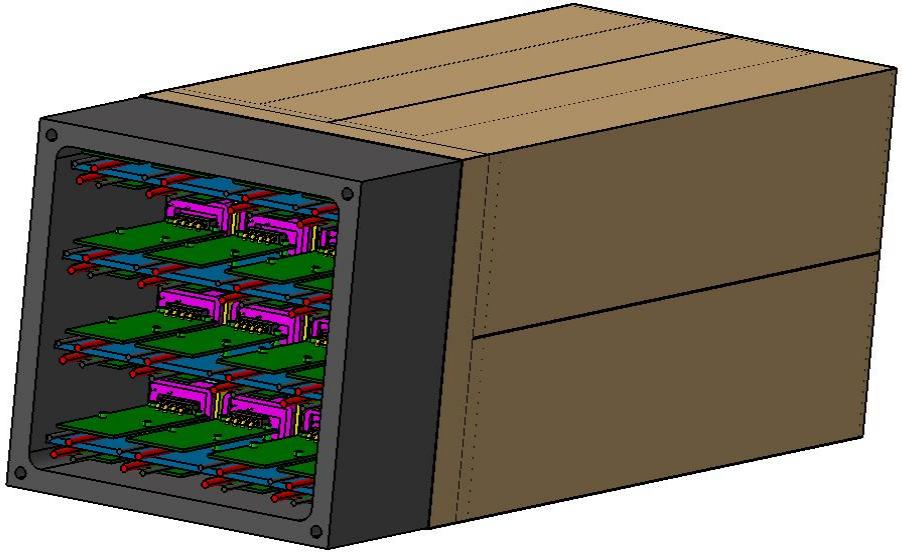
Vacuum Insulation



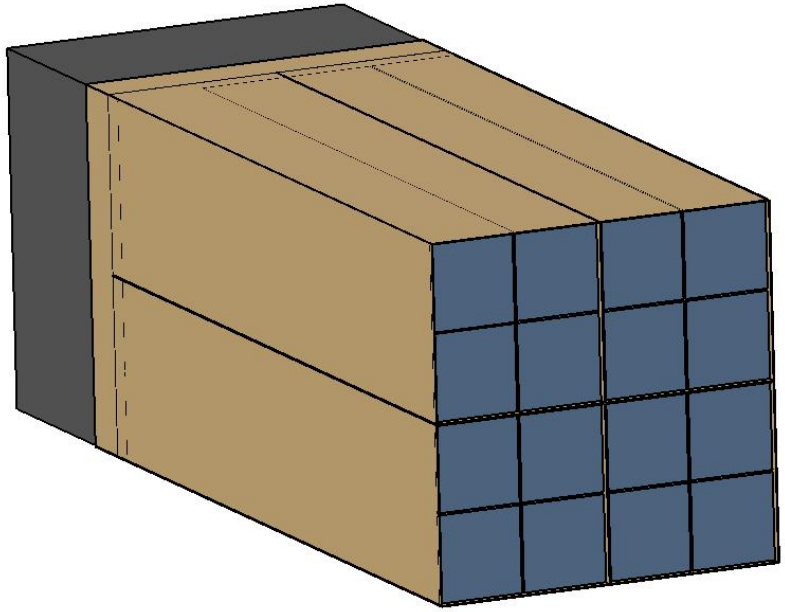


The Design of a Subunit (16 crystals) for the BW Endcap Prototype

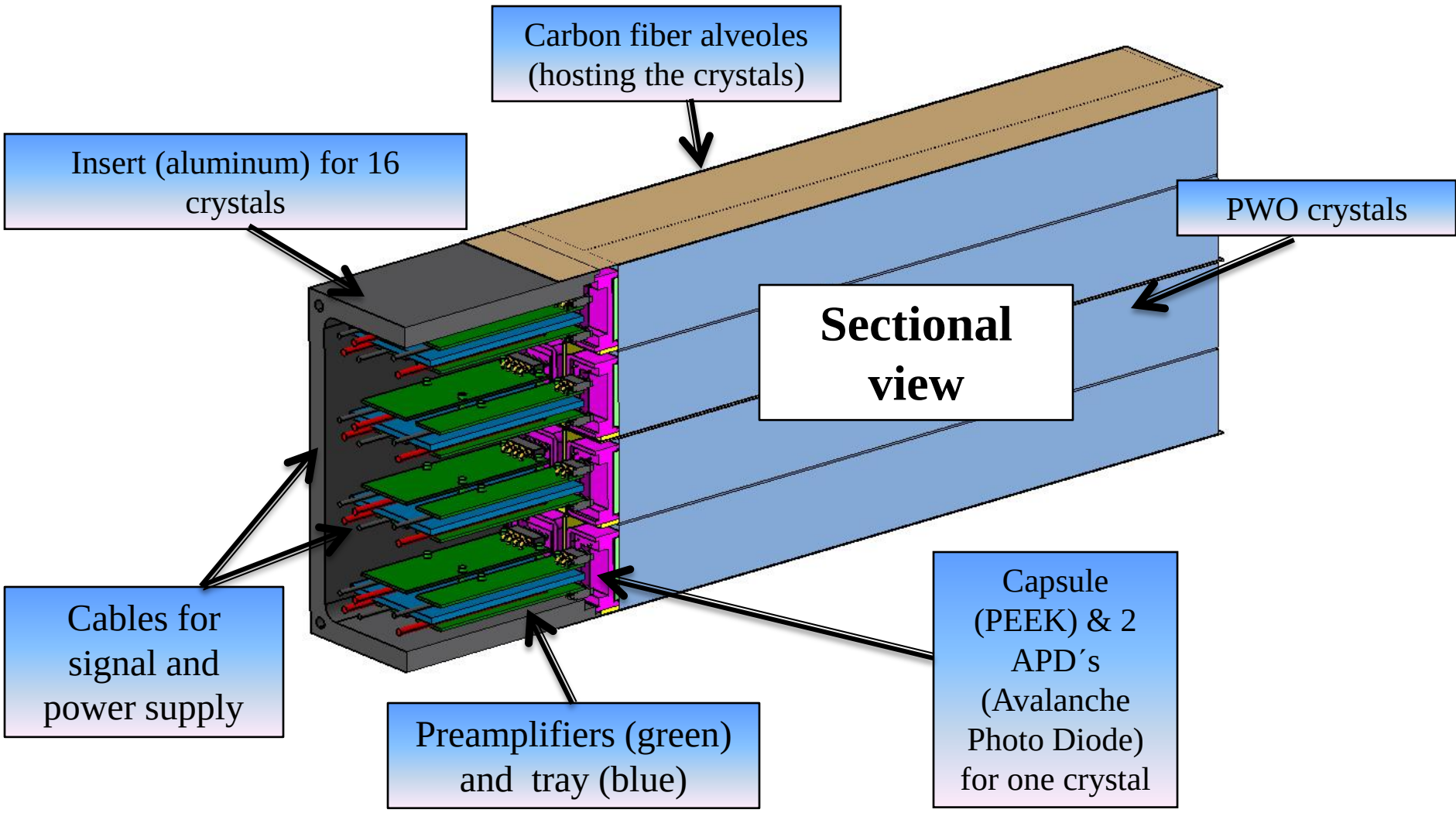
Back view:



Front view:



Detailed look on a Subunit



Thermal Simulations on Crystal-Units

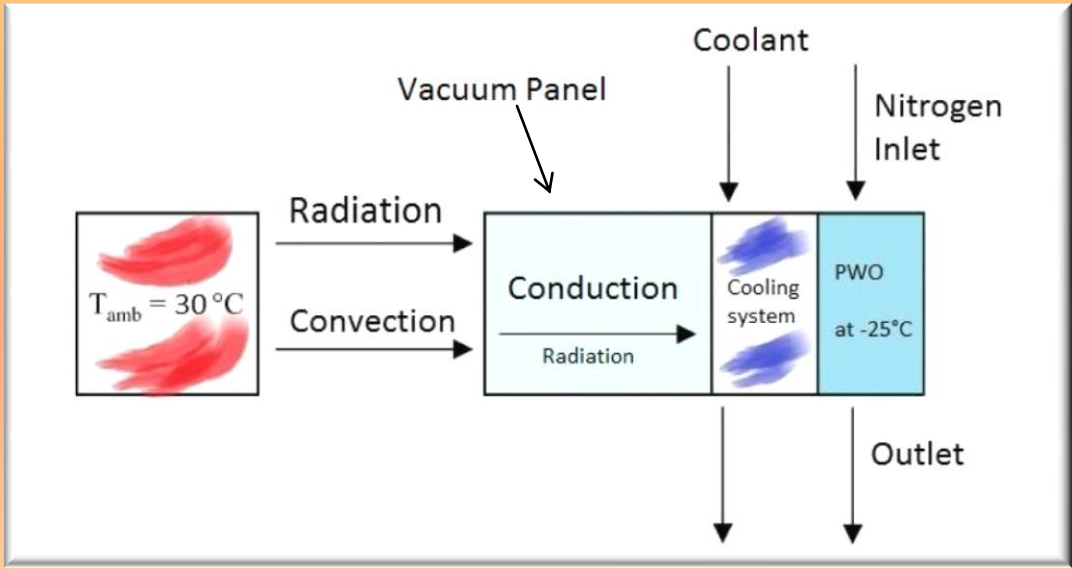
Finite Element Analysis with CAD-Software

Heat loads through the thermal insulator system

***Heat sources*:**

- Heat from outside going through the walls
- Preamplifiers for the APD´s (150 mW assumed for one crystal)
- The cables for the readout
- The feet between the 2 mounting plates

Heat transfer mechanismens



The crystals will be flushed with nitrogen to avoid icing due to air humidity .

Heat loads through insulation

Vacuum shield for insulation assumed

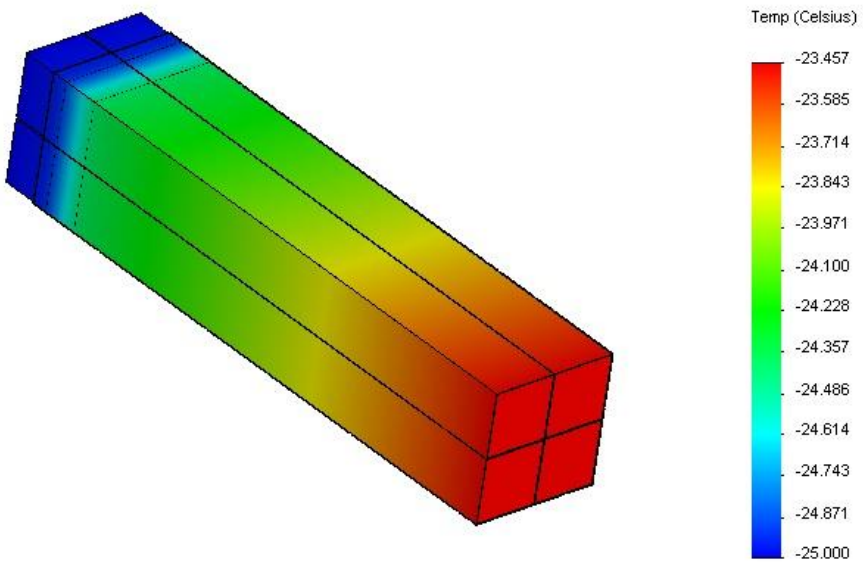
Vermiculite granulate at backside assumed

	Area [m²]	Heat load [W]	Heat load per m² [W/m²]
Front plane	0,51	6,0	11,7
Outer sides	0,98	11,6	11,7
Inner cylindrical hole	0,34	4,0	11,7
Back plane	0,51	154,4	301,2

Simulations on a Unit of 4 crystals

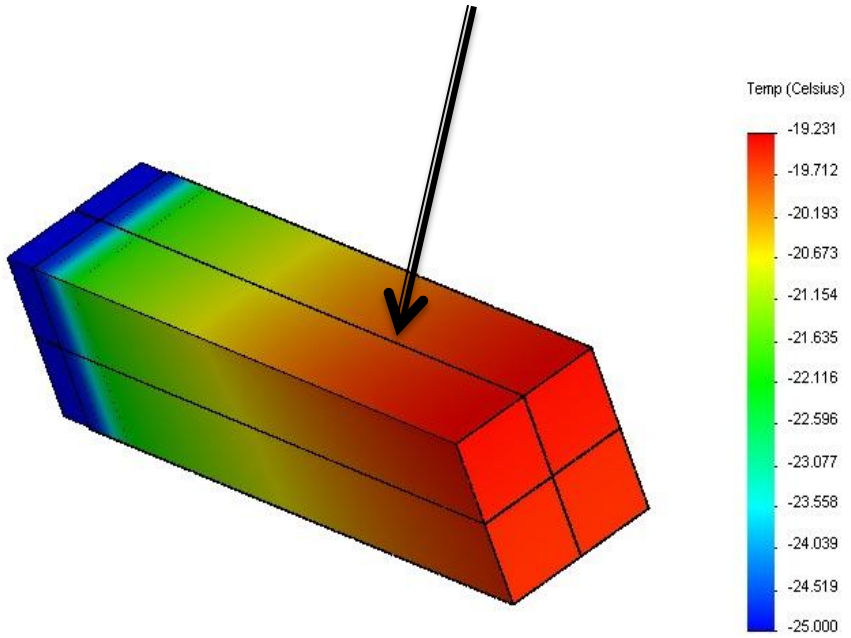
with inner cross made of carbon fiber

Cooling in the back & heat flux from the front (12 W/m²)



$$\Delta T = 1{,}54°C$$

Additional heat load at the top (12 W/m²)



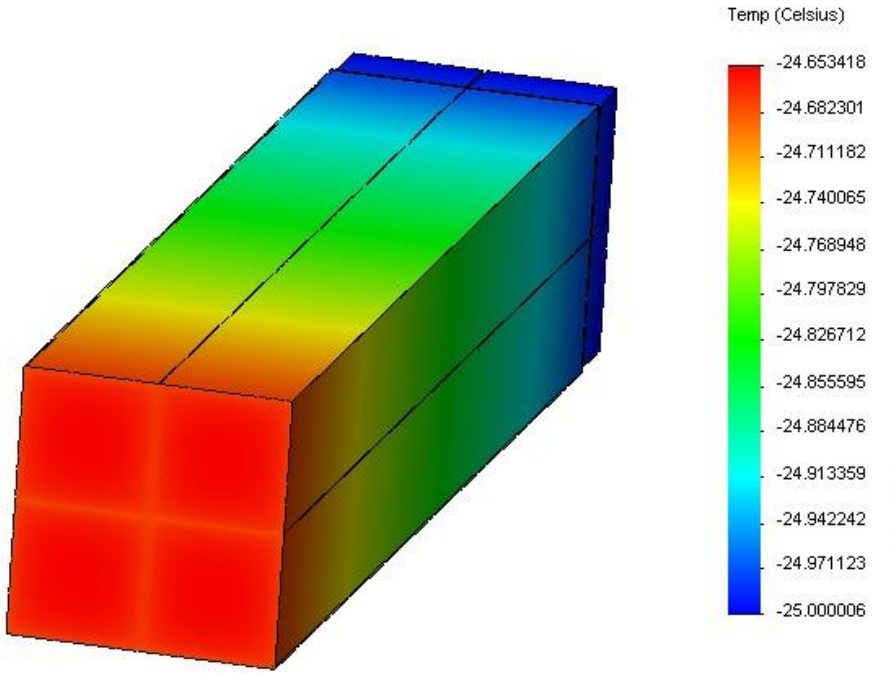
$$\Delta T = 5{,}77°C$$

Maximum temperature difference should be 2,2°C along the unit!

Improved Simulations on a Unit (4)

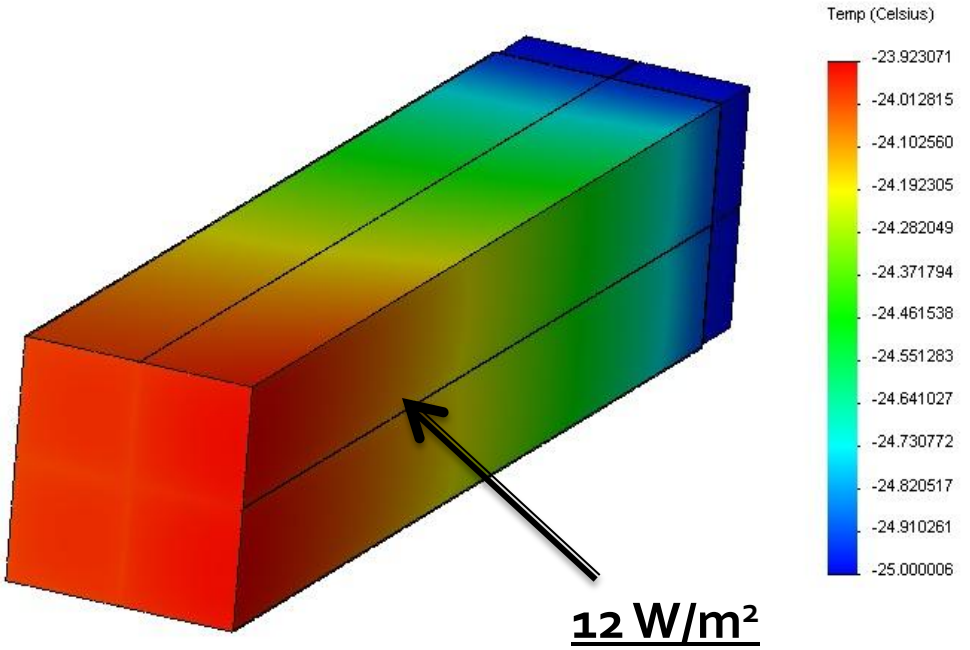
additional DF2000MA daylight film & copperfoil around each crystal

Cooling in the back & heat flux from the front (12 W/m²)



$\Delta T = 0{,}35°C$

Additional heat flux from one side (12 W/m²)



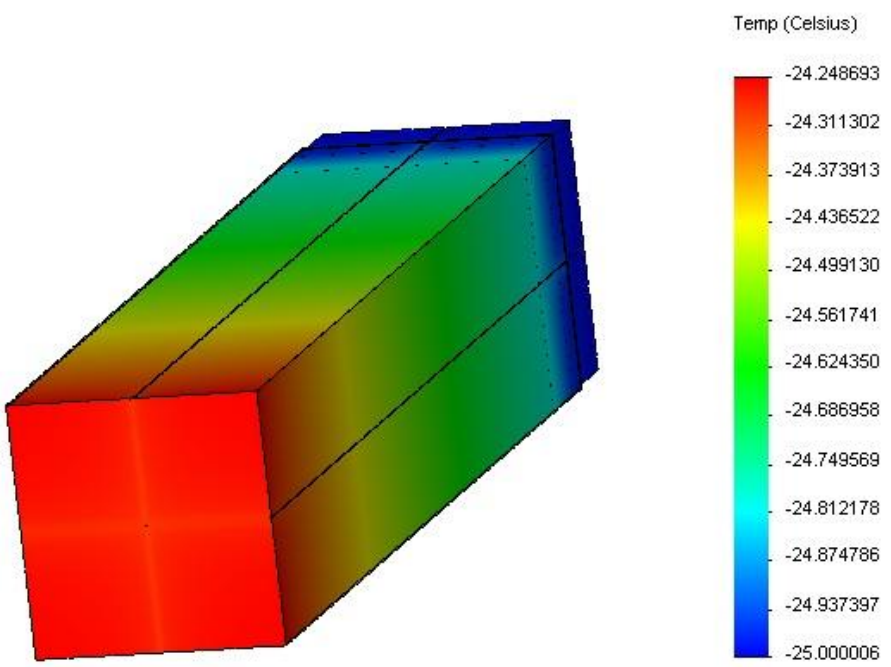
$\Delta T = 1{,}08°C$

Fulfills ΔT≤2,2°C but copper undergoes too much activation and therefore must be dropped!

Improved Simulations on a Unit (4)

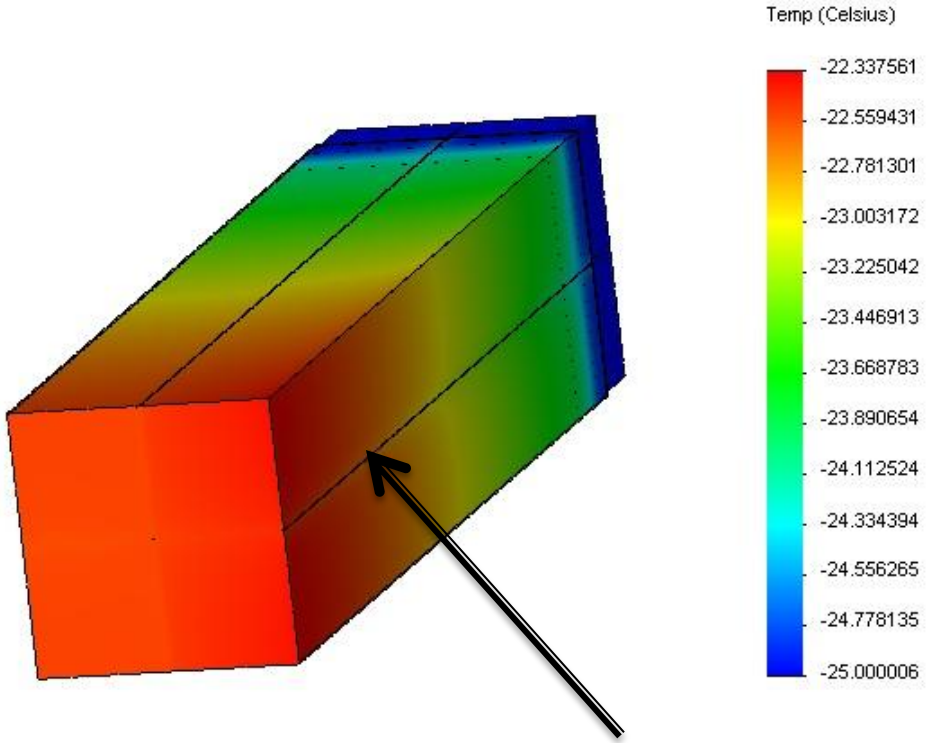
with inner cross made of aluminum

Cooling in the back & heat flux from the front 12 W/m²



$$\Delta T = 0{,}75°C$$

Additional heat load of 12 W/m² at one side



$$\Delta T = 2{,}66°C$$

Comparison

	Design of the Crystal Unit	ΔT along the Unit /°C (only front load)	ΔT along the Unit /°C (heat load at front and one side)
1)	Carbon fiber Alveole	1,54	5,77
2)	Inner cross aluminum	0,75	2,66
3)	Carbon fiber Alveole Crystals wrapped in copperfoil	0,35	1,08

The temperature difference is still not small enough
Further investigations on different configurations needed!

Summary & Outlook

- The design of both the final version and the prototype for the Backward Endcap is under development.
- Many parts are especially designed for best performance under special conditions (e.g. the shrinking of material)

- Previous configurations of crystal-units don´t deliver the necessary temperature difference so that further simulation studies are needed

- Thermal measurements on a test panel of the vacuum system will be done soon