



FACULTY OF MECHANICAL  
ENGINEERING  
UNIVERSITY  
OF WEST BOHEMIA

DEPARTMENT OF  
POWER SYSTEM ENGINEERING

# Analysis of the cooling system of SUPERMODULE7 in SLICE N1

PANDA Collaboration Meeting  
March 7, 2018

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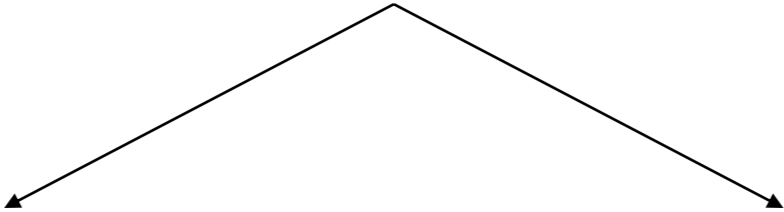
**RNDr. Daniel DUDA, Ph.D.**  
**Ing. Michal VOLF**

# Introduction

PbWO<sub>4</sub> light yield  $\uparrow\downarrow$  temperature

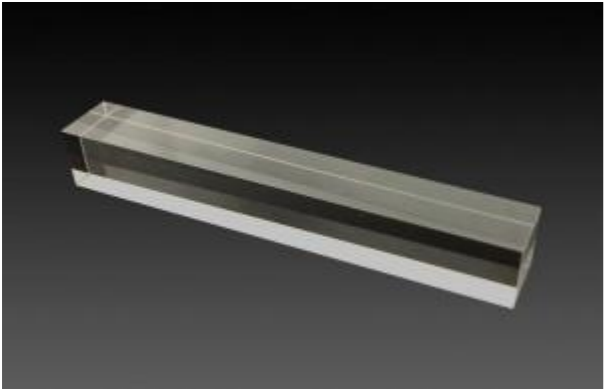


- lower temperature better
- temperature **stability**



among all crystals ... 1 K

within a single crystal ... 0.1 K



*Can this be achieved with the current design?*

# Numerical simulation procedure

**GEOMETRY PREPARATION**



**MESHING (DISCRETIZATION)**



**NUMERICAL SIMULATION**

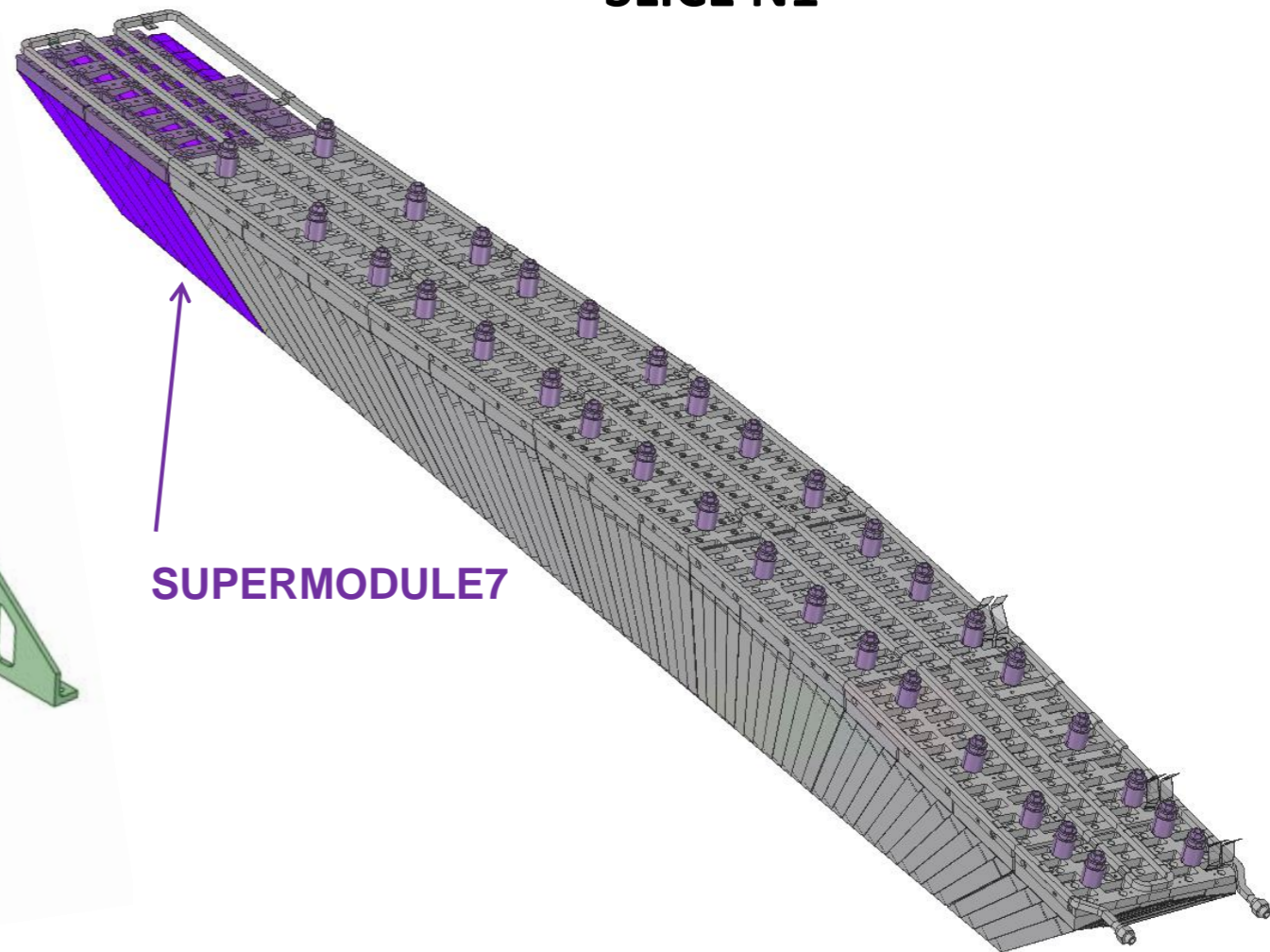
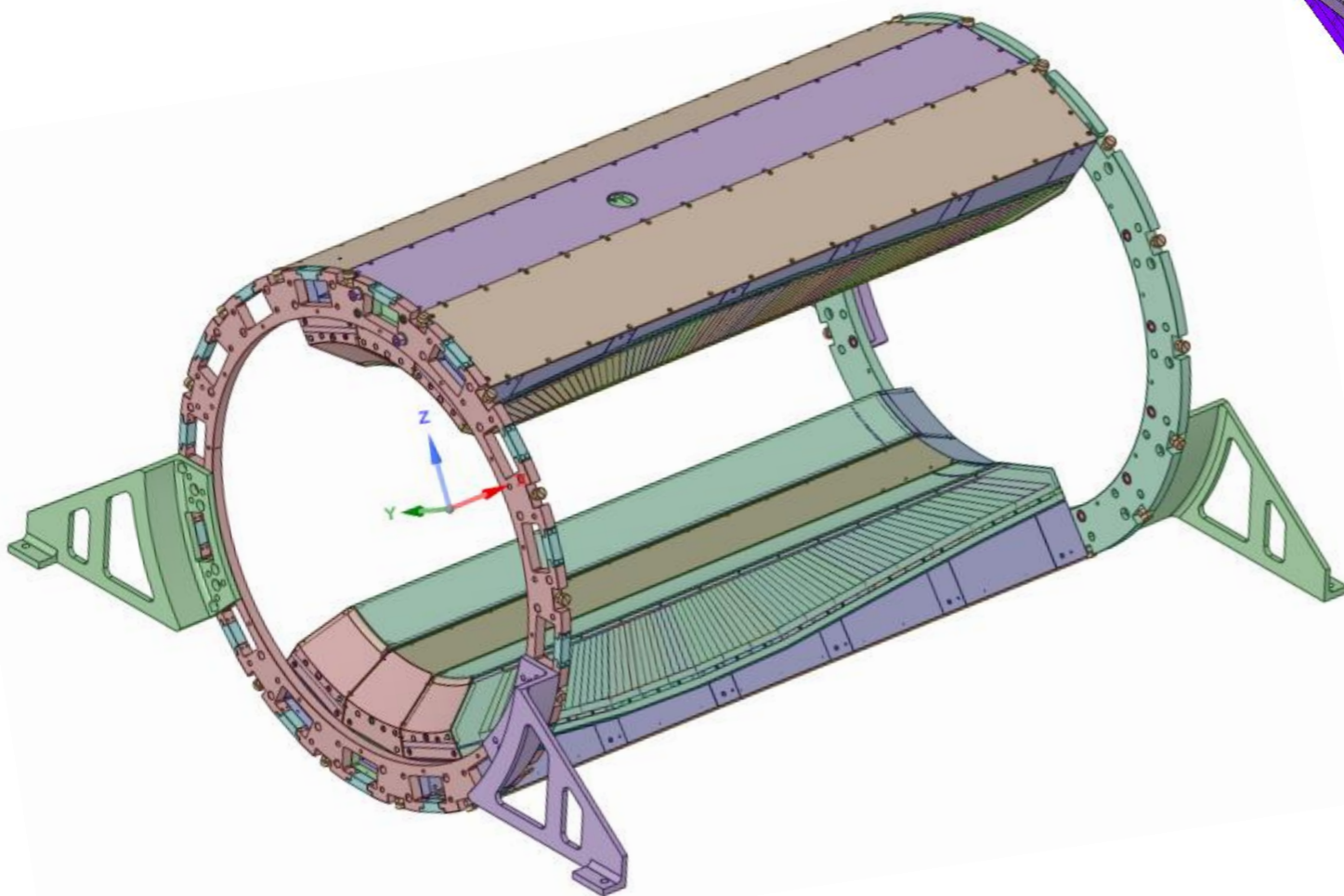


**RESULTS EVALUATION**

# Geometry

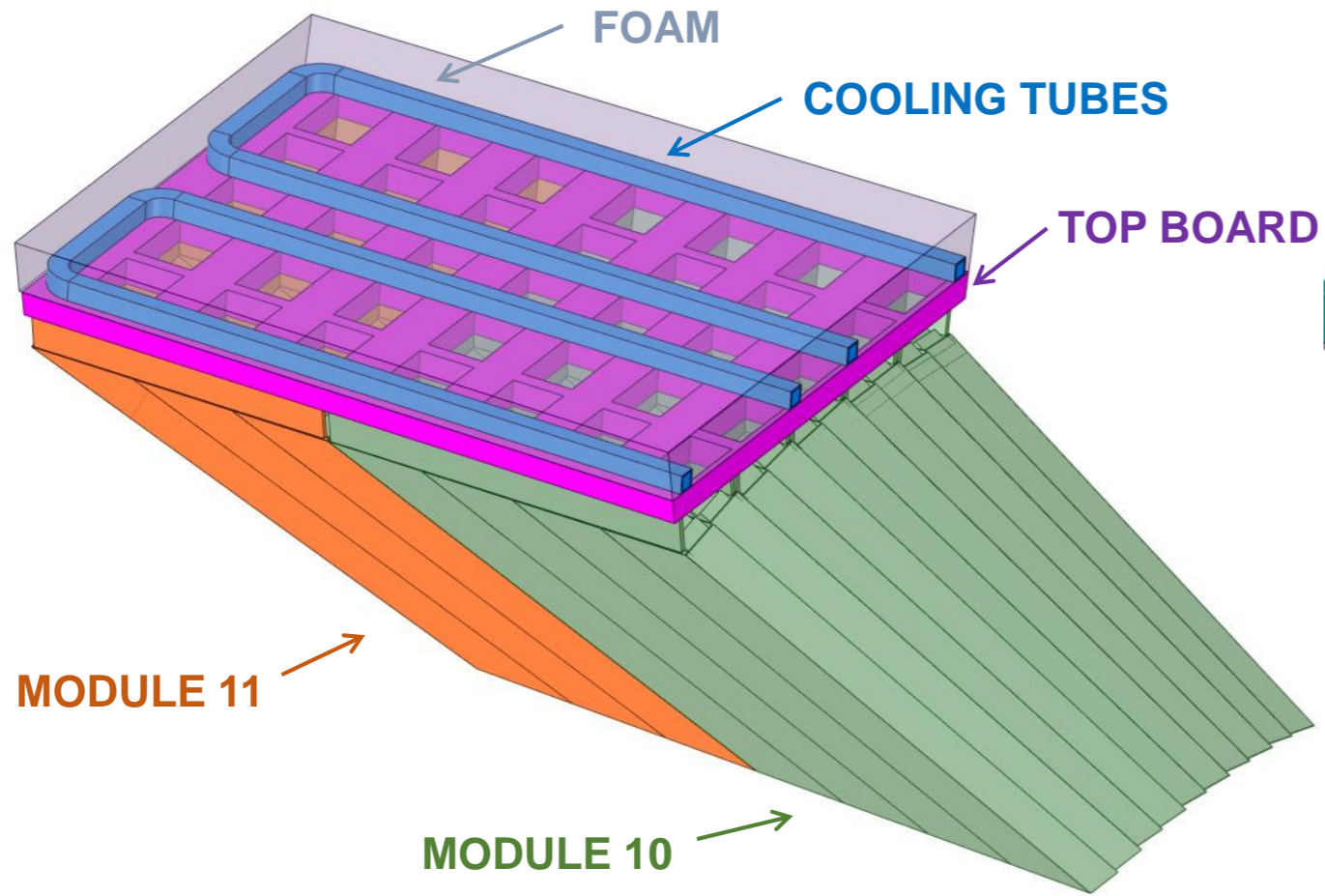
**PANDA EMC BARREL**

**SLICE N1**

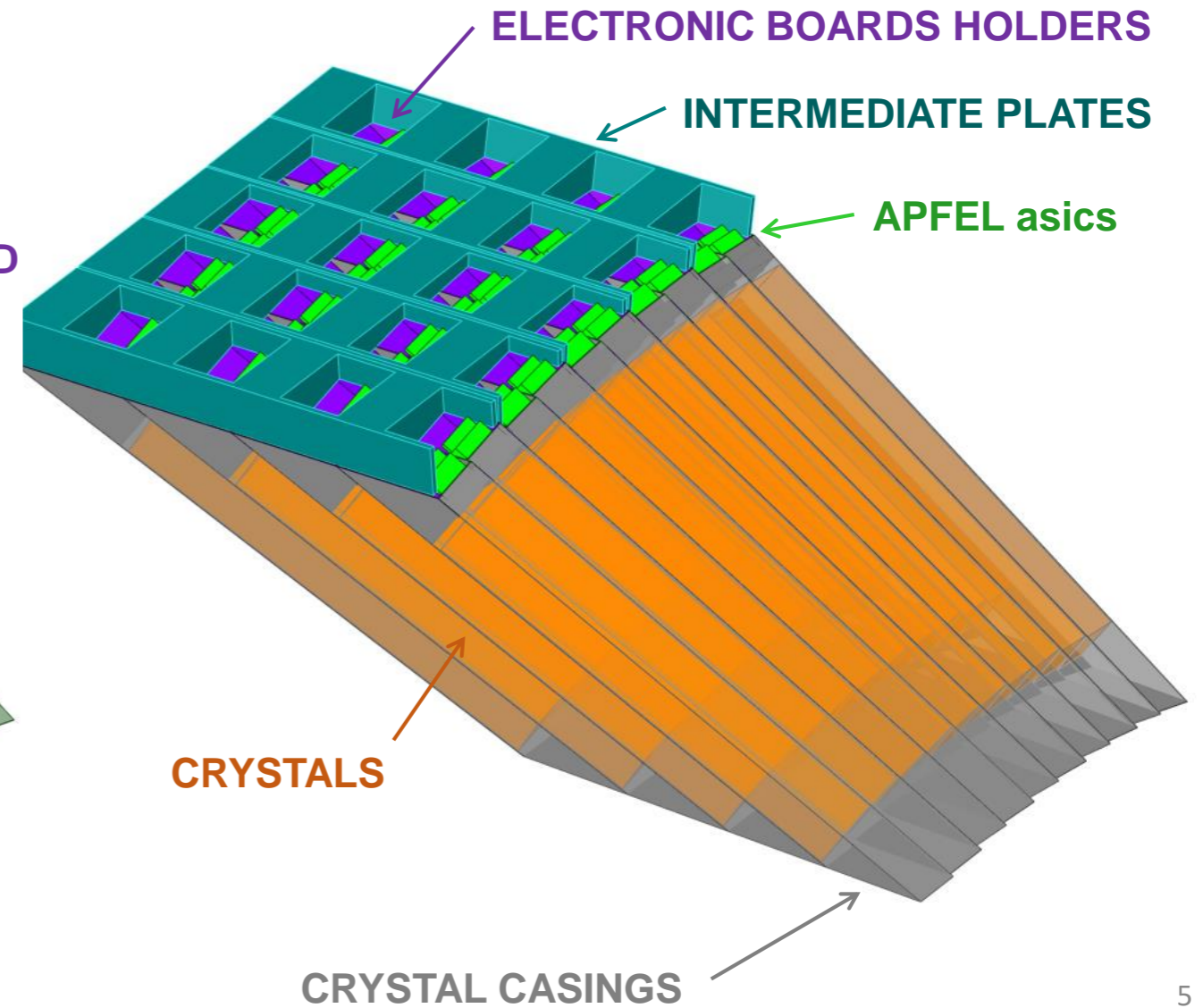


# Computational domain - solid

**SUPERMODULE 7**



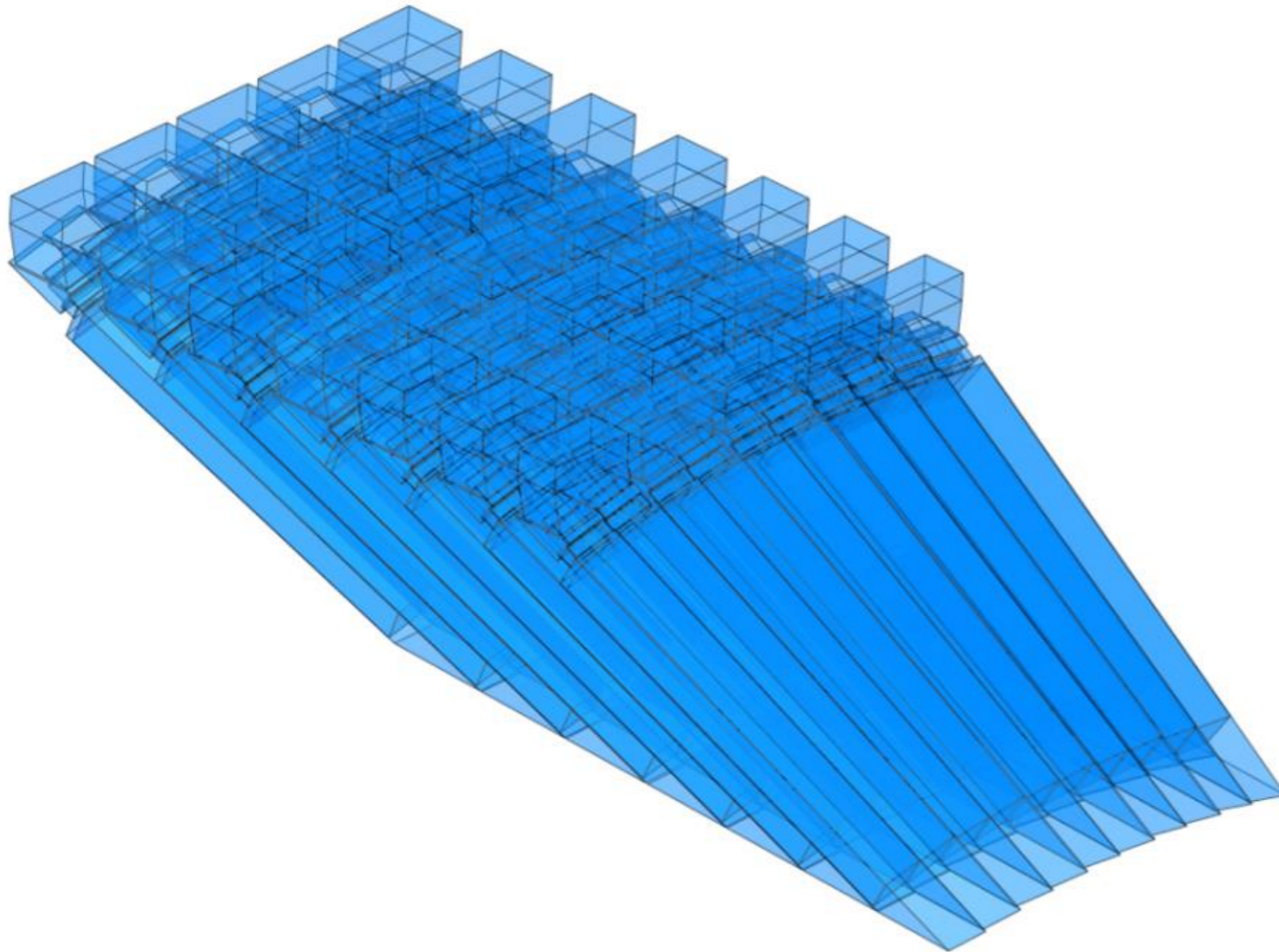
**MODULE 10**



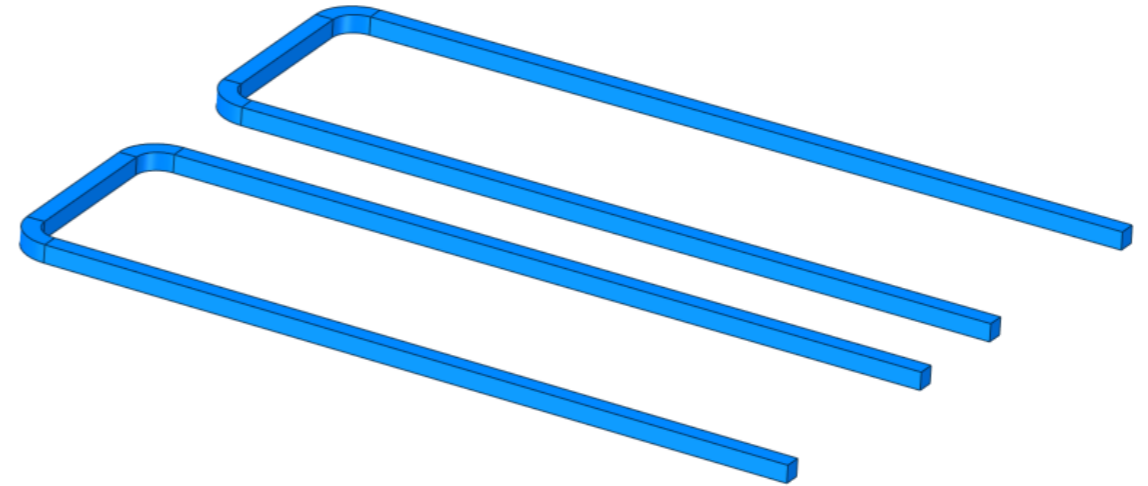
- 70 APFEL asics (30 in MODULE11, 40 in MODULE10)

# Computational domain - fluid

**AIR SURROUNDING SOLID PARTS**



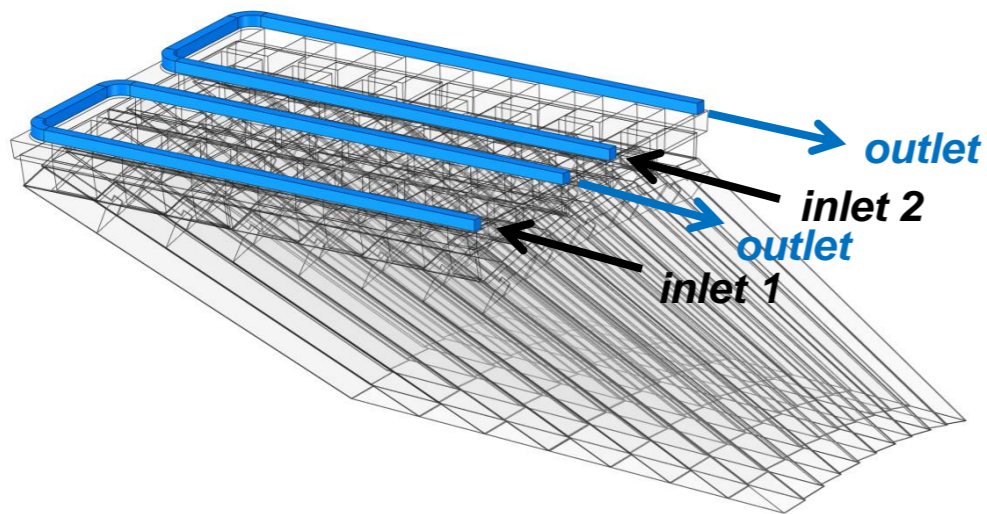
**COOLING FLUID**



# Numerical simulation settings

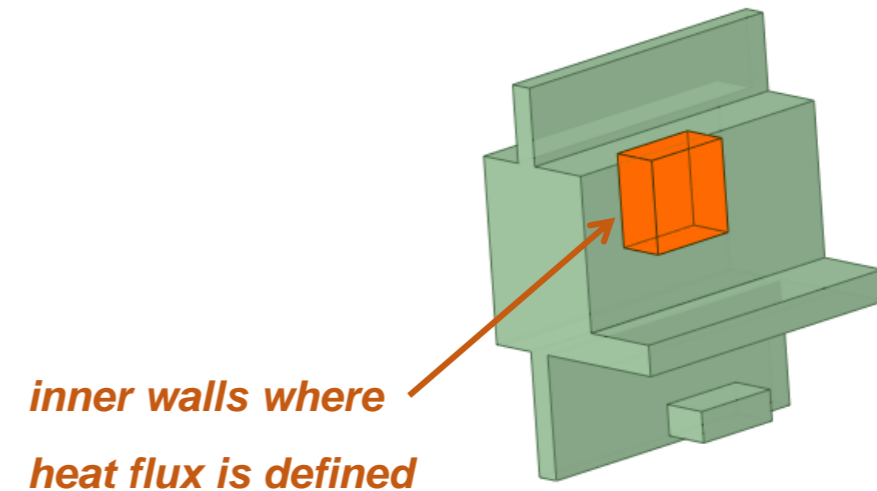
- **Steady-state** simulation
- **Shear Stress Transport k- $\omega$**  used as turbulence model
- **5% turbulence intensity on inlets**

## COOLING FLUID



**Inlet:** -25 °C; 0.07 kg s<sup>-1</sup>  
**Outlet:** 1 atm  
**Medium:** mixture of water/methanol (40/60)

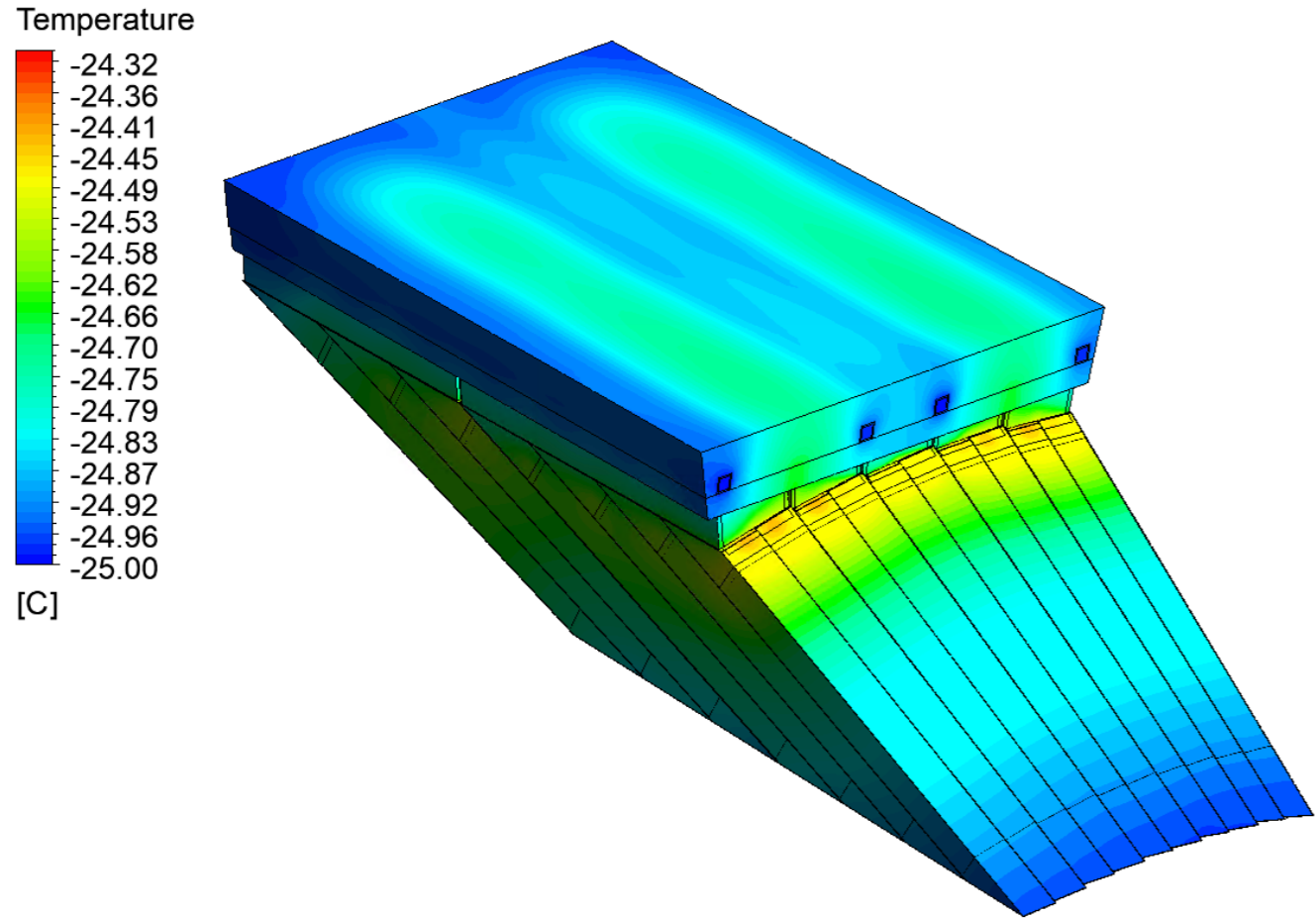
## HEAT SOURCE



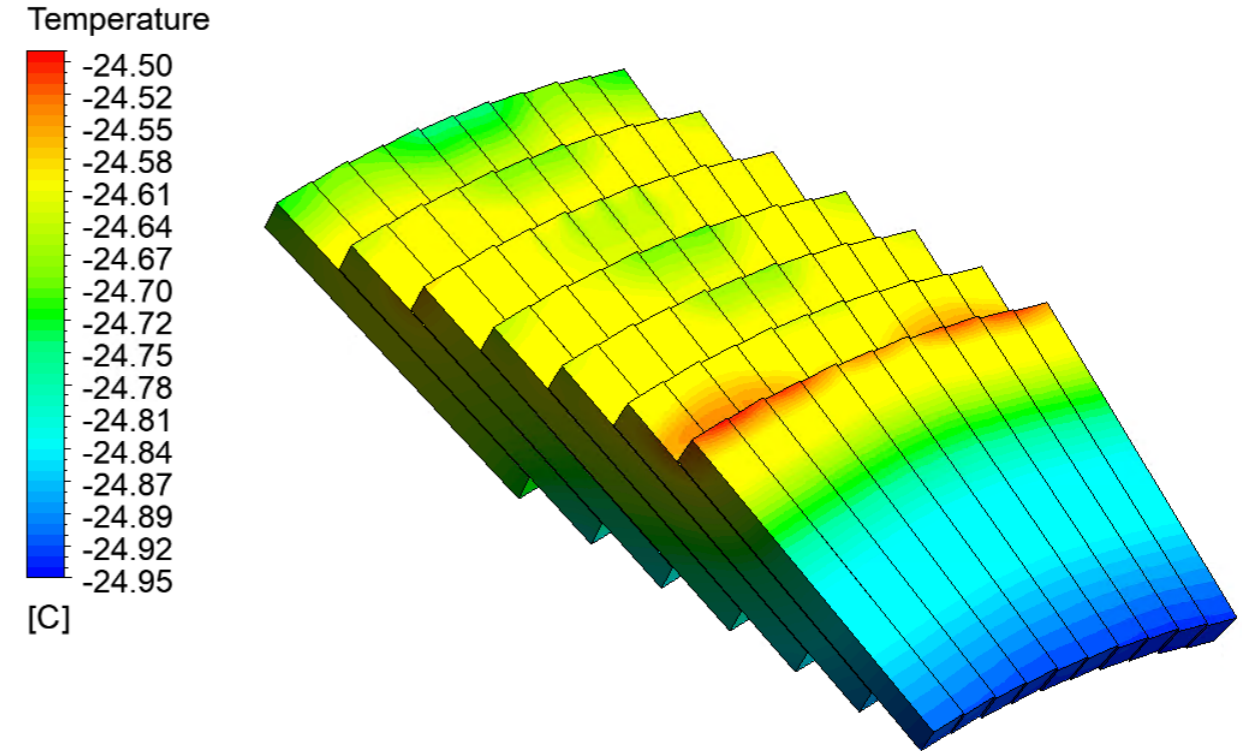
**Heat power of one APFEL asic:** 150 mW  
**Applied heat flux:** 1041.7 W m<sup>-2</sup>

# Preliminary results

Temperature field – surface of the whole domain



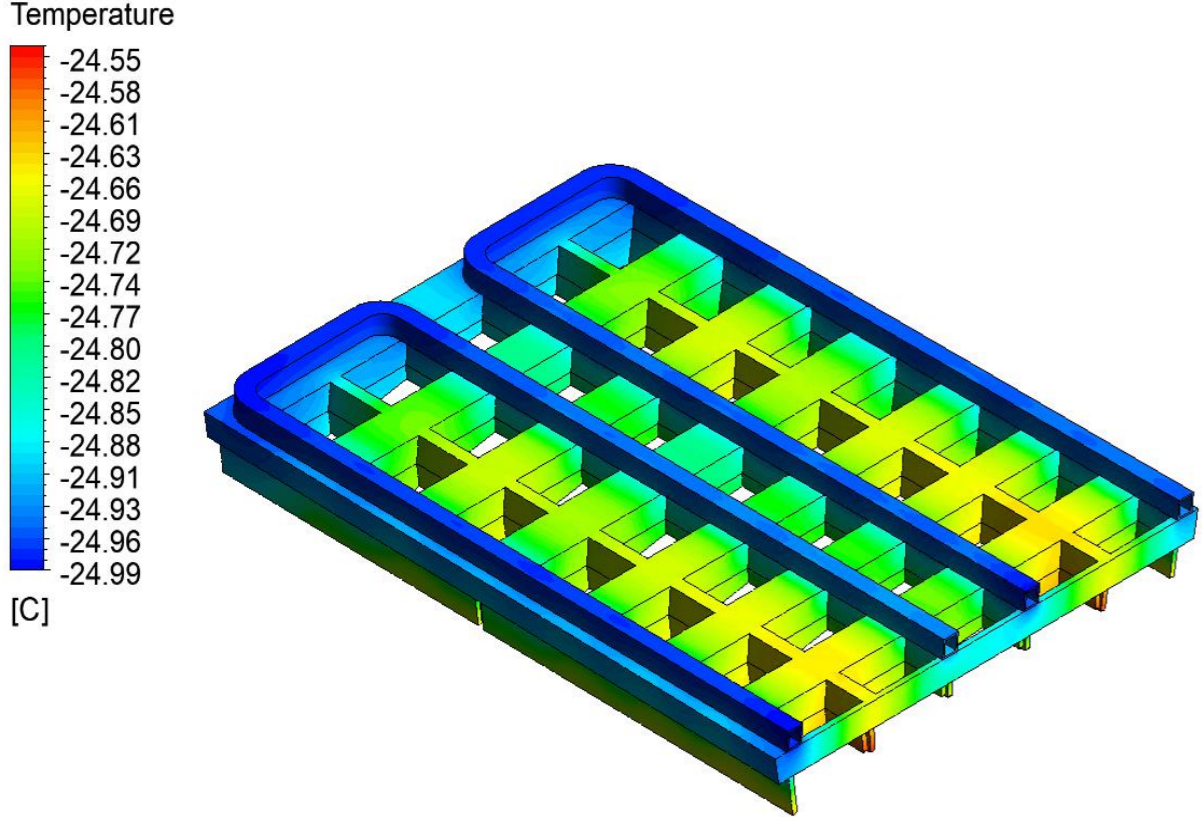
Temperature field – surface of the crystals



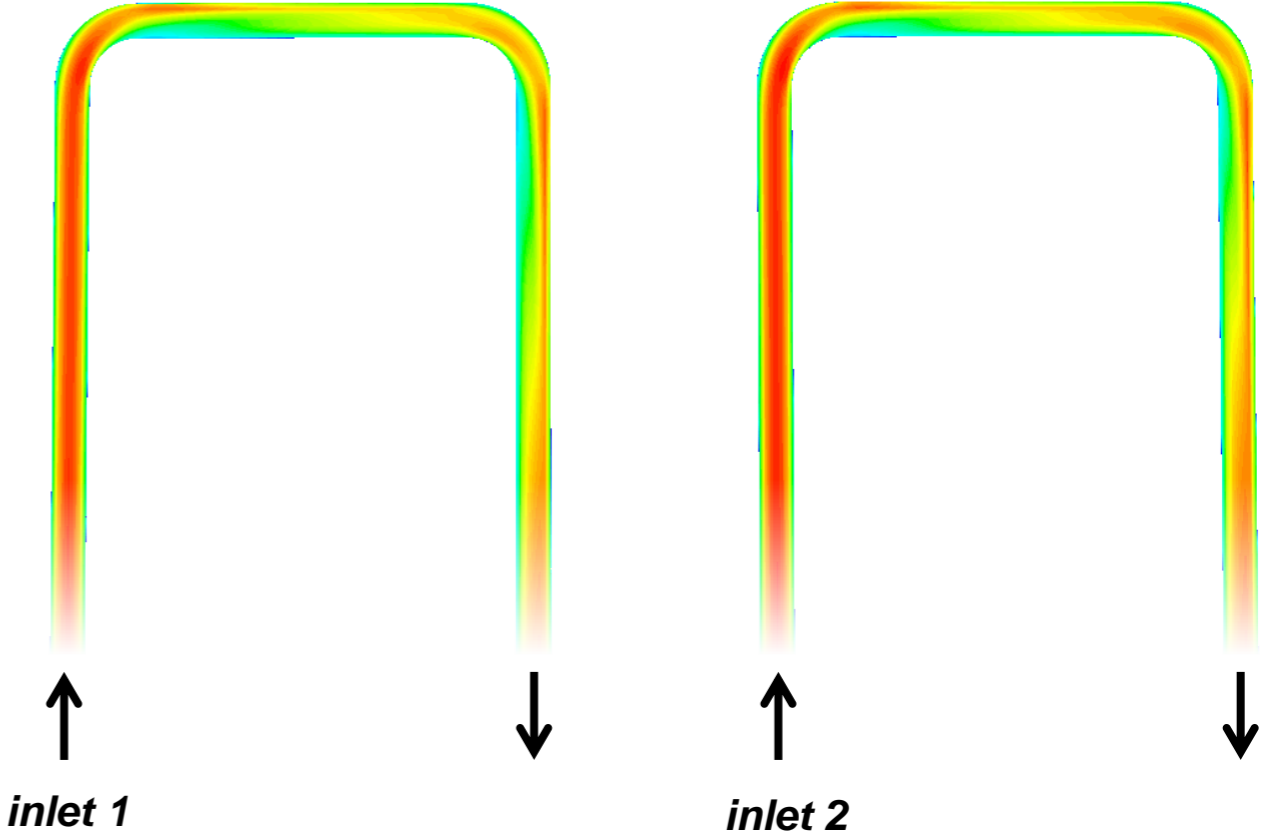


# Preliminary results

### Temperature field – surface of the cooling tubes & boards



### Velocity field – inside the cooling fluid



# Conclusion

- **Current simulation results are preliminary due to:**
    - geometry of cooling tubes has already changed
    - material properties were modified
  - **Remaining issues to resolve:**
    - crystal attachments
    - validation of results
  - **Follow-up research:**
    - 1D simulation to determine boundary conditions for cooling fluid at the inlet in each module
    - result comparison between various cooling system designs
      - propose cooling design modifications
    - include SLICE environment (its heat sources) into the simulation
    - wider the computation domain for other modules
- } to get more accurate simulation results



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# Thank you for your attention

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