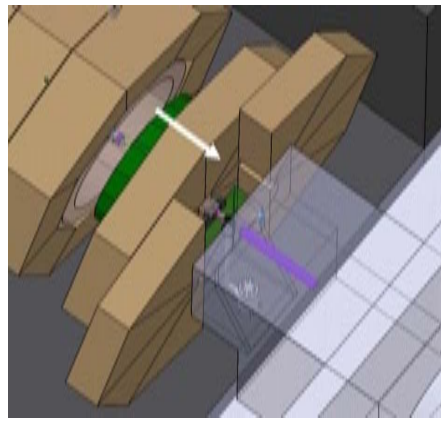
SLAB COOLING

- DEMONSTRATOR
- EUDET



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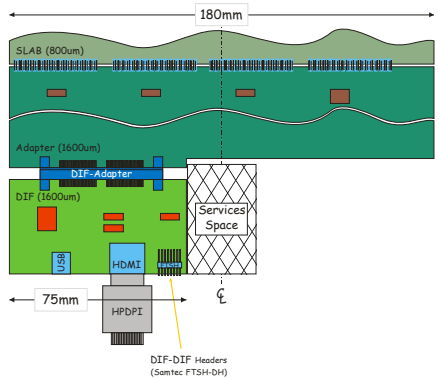
SLAB COOLING - DEMONSTRATOR

- Goal of experimental tests:
  - a real thermal test to be compared to numerical simulation,
    - In order to answer to simplification of slab's model,
    - To know more precisely transfert coefficients,
  - To verify the behaviour of the cooling system in EUDET's configuration.

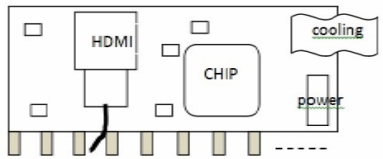
  So, dimensions of structures of the demonstrator (124mm) have to be defined, with all parameters for these first thermal tests (dimensions, nb of resistances, captors….)
  - To reproduce as precisely as possible these tests in simulations.

SLAB COOLING – EUDET- CALICE

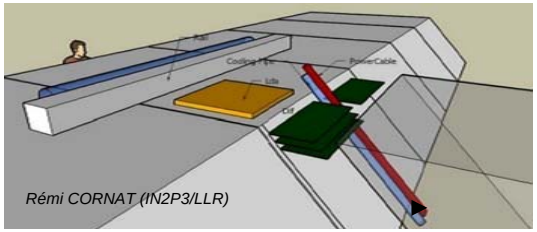
Mechanical constraints on ECAL electronics:



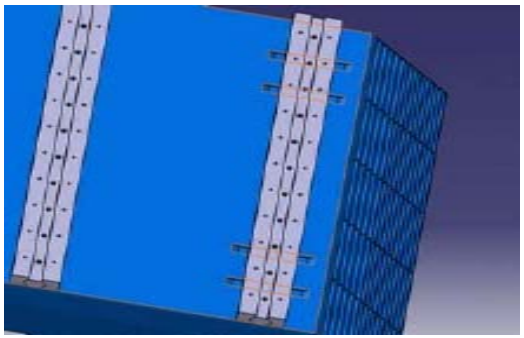
?



DIF is part of last ASU of the SLAB
Minimum Space for cooling necessary

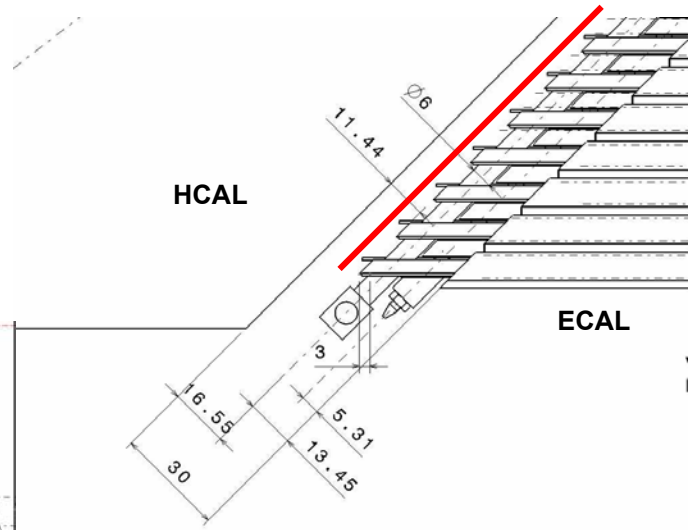


Place for cabling : DAQ + HV + GND
Service space between cooling and HCAL >1cm



Former solution: in thick composite plate

Passing trhough the rail: OK

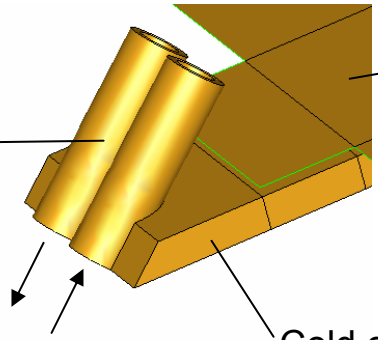


Space for HV and GND

SLAB COOLING - DEMONSTRATOR

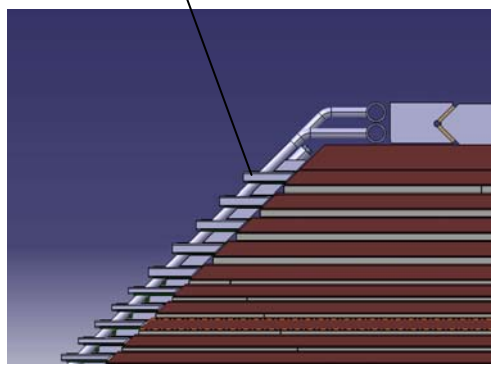
Boundary condition:

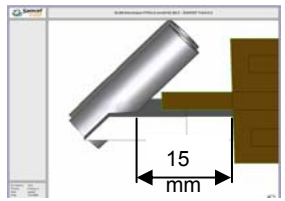
Convective flux into pipe with fluid at 20°c (h = 3445 W/m².K)



Load (for 1 half slab = 1 side)
Total wafer power (EUDET) : **0.205 W**
With 11 ASU 124.5 x 124.5
=> 0.205 / 11 = 0.018636 W / ASU

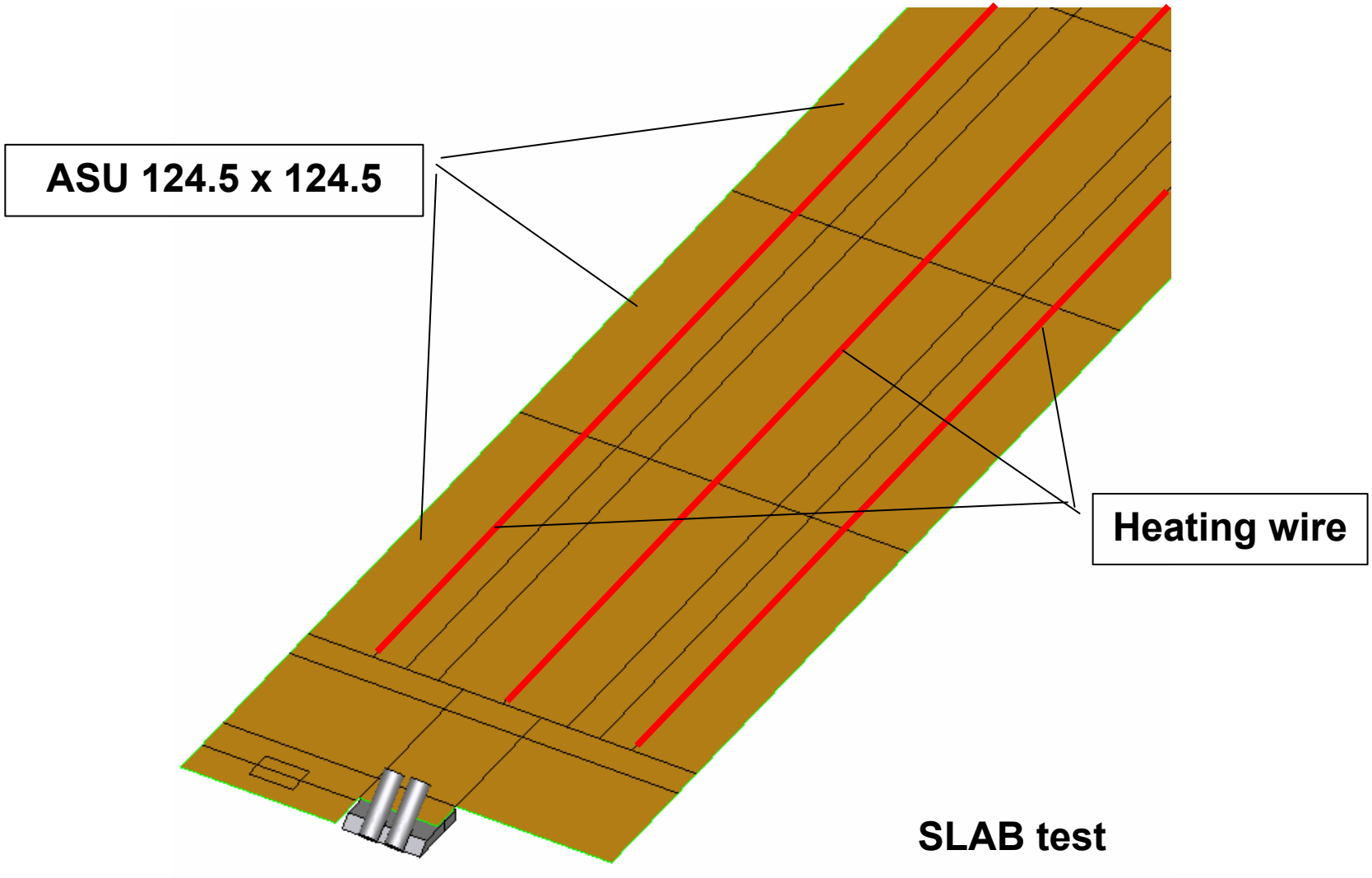
ASU 124,5 x 124,5	Power (w)	Lenght (mm)	If **3** Heat wire : Power / Heat wire (w)
1	0,0186	124,5	0,0062
2	0,0373	249	0,0124
3	0,0559	373,5	0,0186
4	0,0745	498	0,0248
5	0,0932	622,5	0,0311
6	0,1118	747	0,0373
7	0,1305	871,5	0,0435
8	0,1491	996	0,0497
9	0,1677	1120,5	0,0559
10	0,1864	1245	0,0621
11	0,2050	1369,5	0,0683





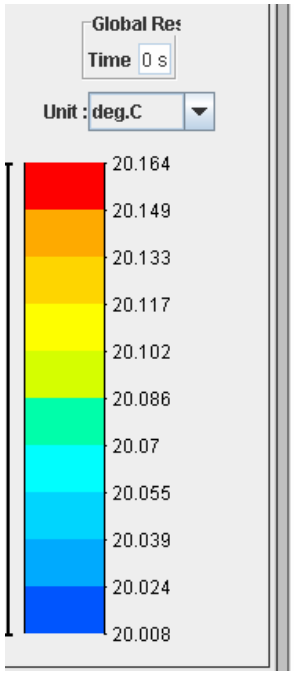
SLAB COOLING - DEMONSTRATOR

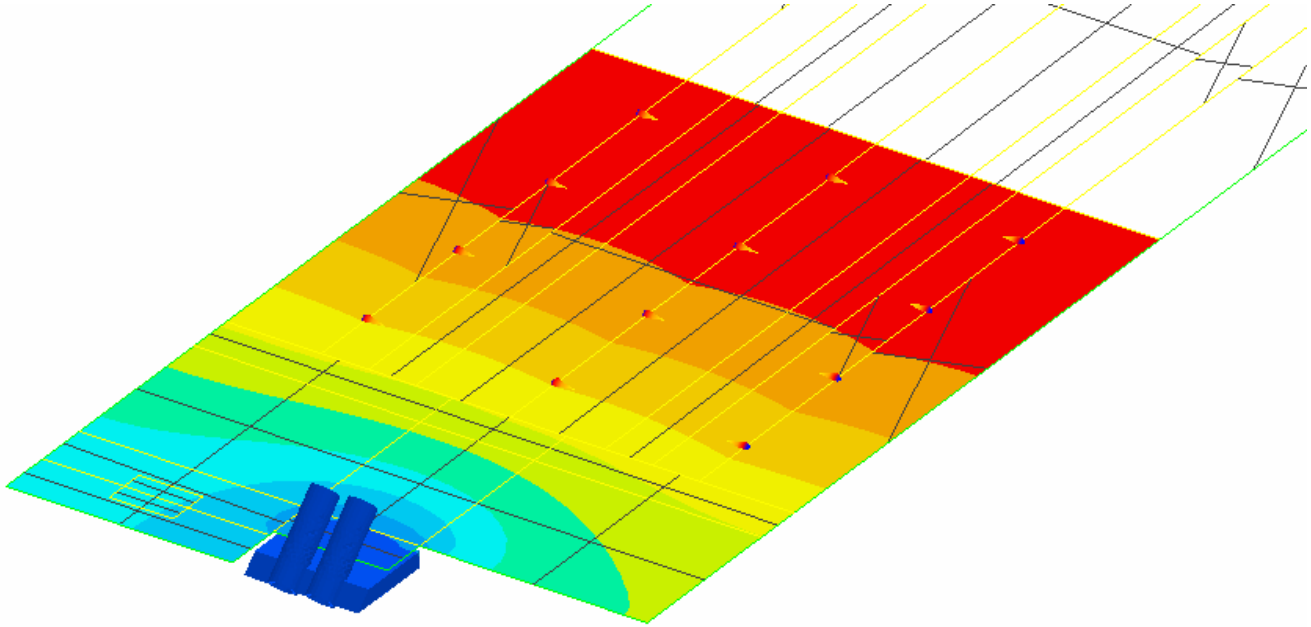
Model presentation:



SLAB COOLING - DEMONSTRATOR

Load case A : 1 ASU (power 0.0186 W)

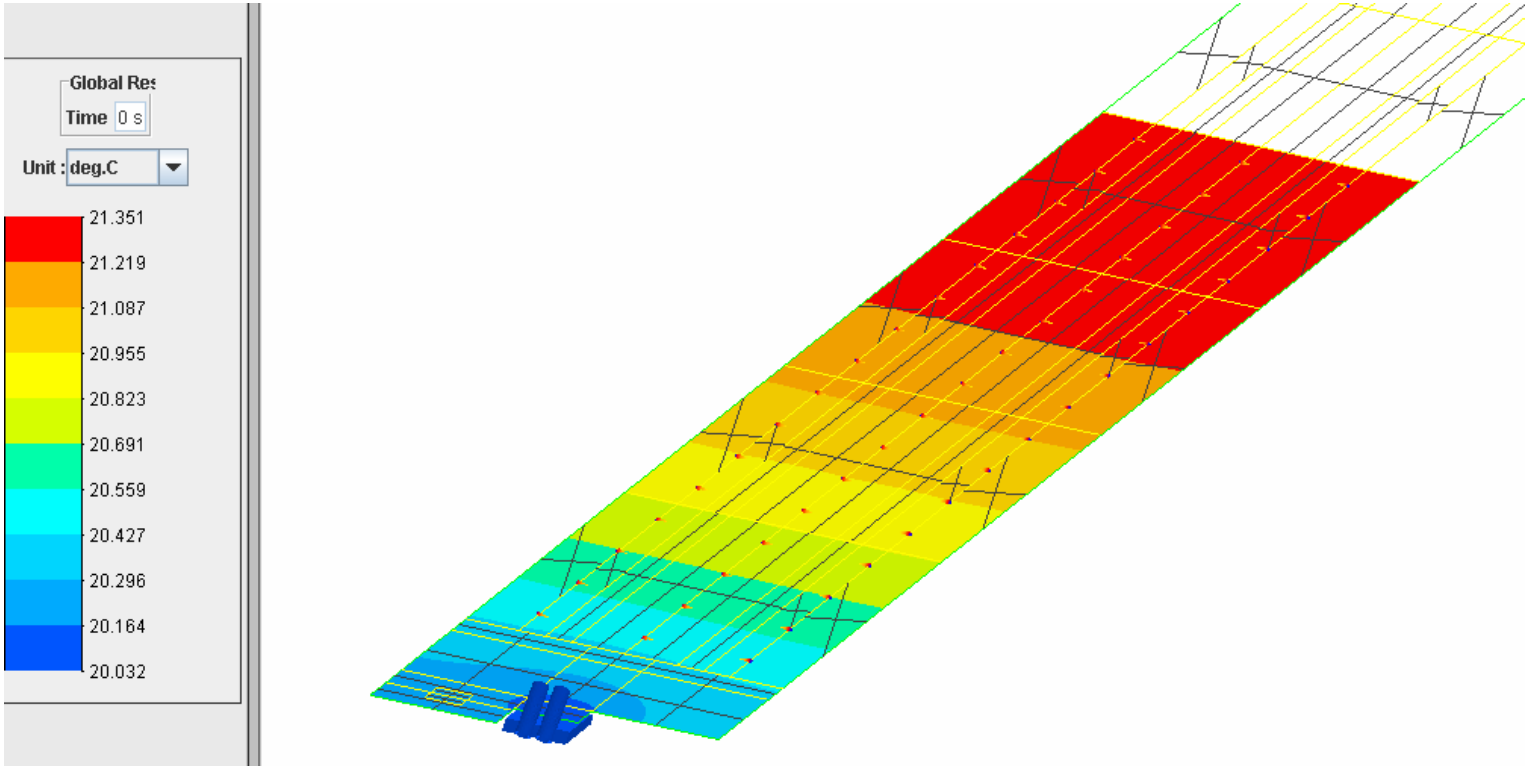




Temperature amplitude : 0.156°c => Small temperature variation => hard to measure

SLAB COOLING - DEMONSTRATOR

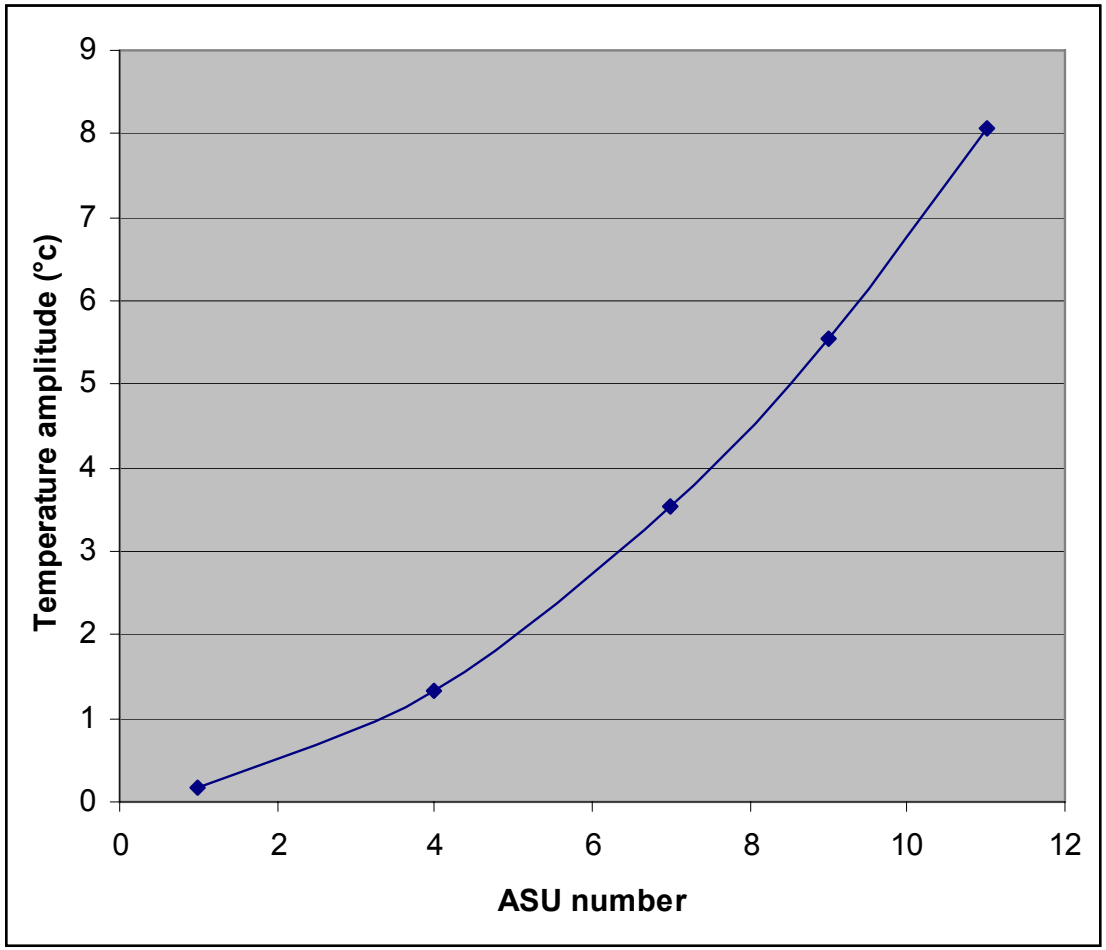
Load case B : 4 ASU (power 0.0745 W)



Temperature amplitude : 1.32°c…not enough

SLAB COOLING - DEMONSTRATOR

Temperature amplitude / ASU number

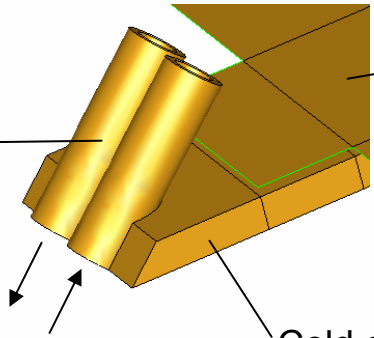


At least, ~5 or 6 ASU necessary to have convenient results

SLAB COOLING - EUDET

Boundary condition:

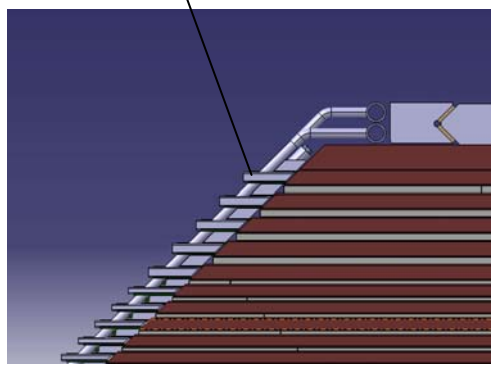
Convective flux into pipe with fluid at 20°c (h = 3445 W/m².K)



Load (for 1 half slab = 1 side)
Channel heat flux : 25 µW
Number of channel / chip : 64 (Hardroc)
Number of chip / wafer : 4
Number of wafer on ½ SLAB : 32

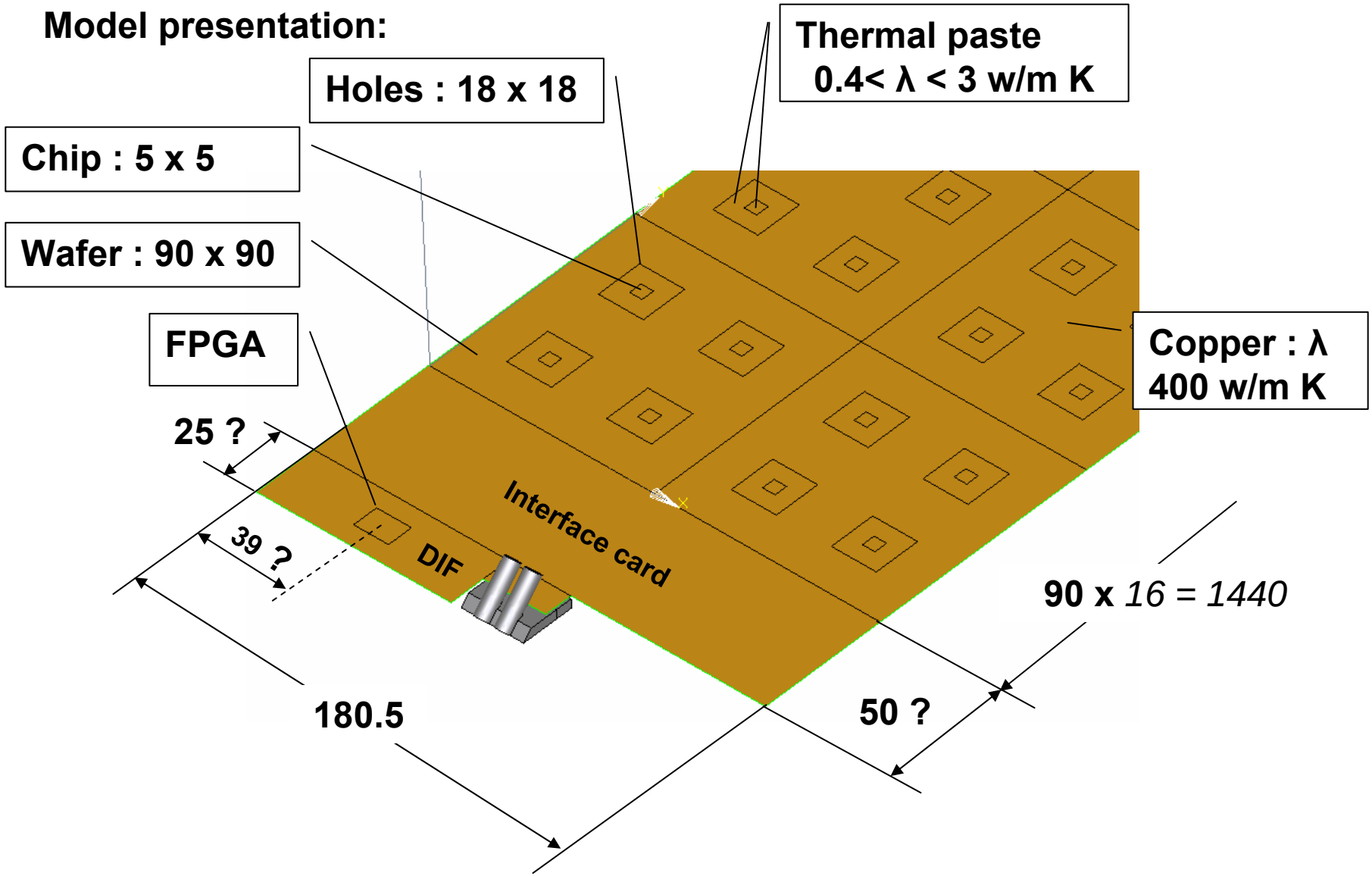
Total wafer power : 25 x 10^{-6} x 64 x 4 x 32 = **0.205 W**

FPGA power : **3 W**



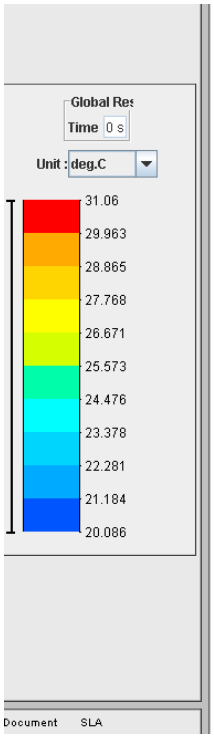
SLAB COOLING - EUDET

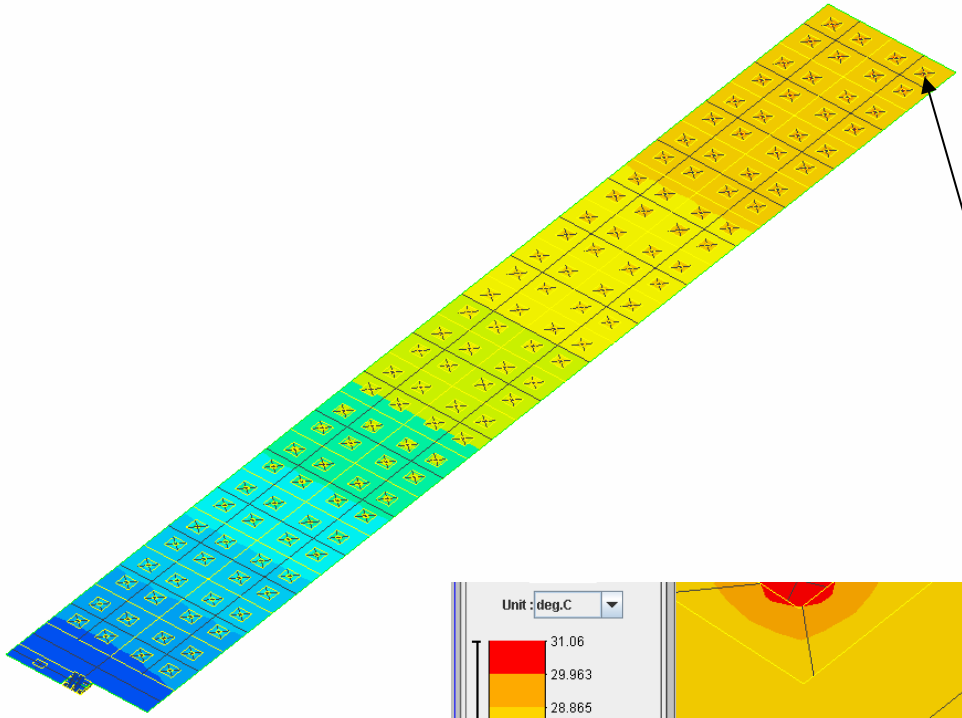
Model presentation:



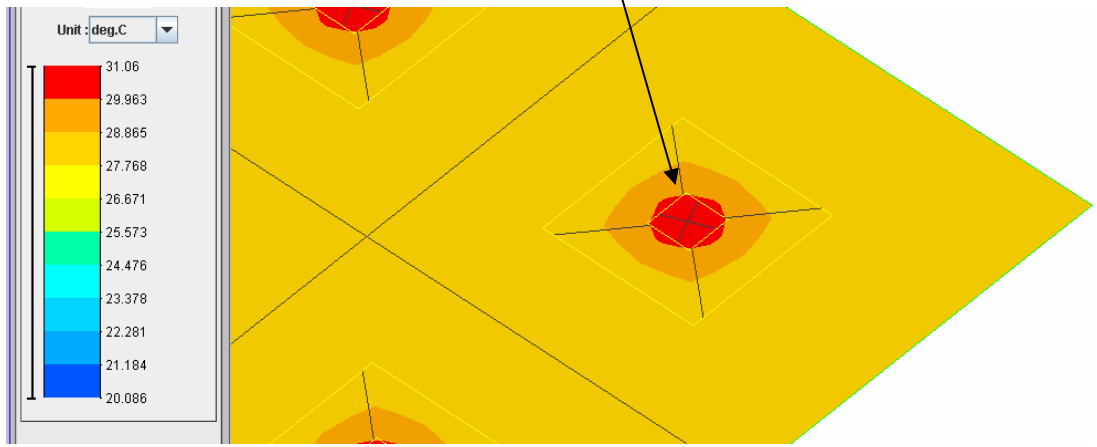
SLAB COOLING - EUDET

Load case 1 : Without FPGA, Thermic paste λ = 0.4 W/m °K, Copper thickness : 0.4 mm



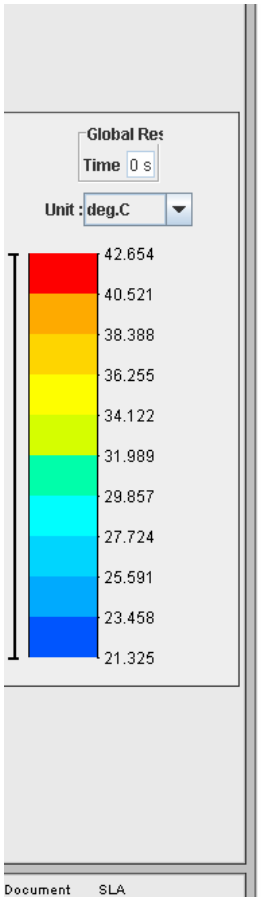


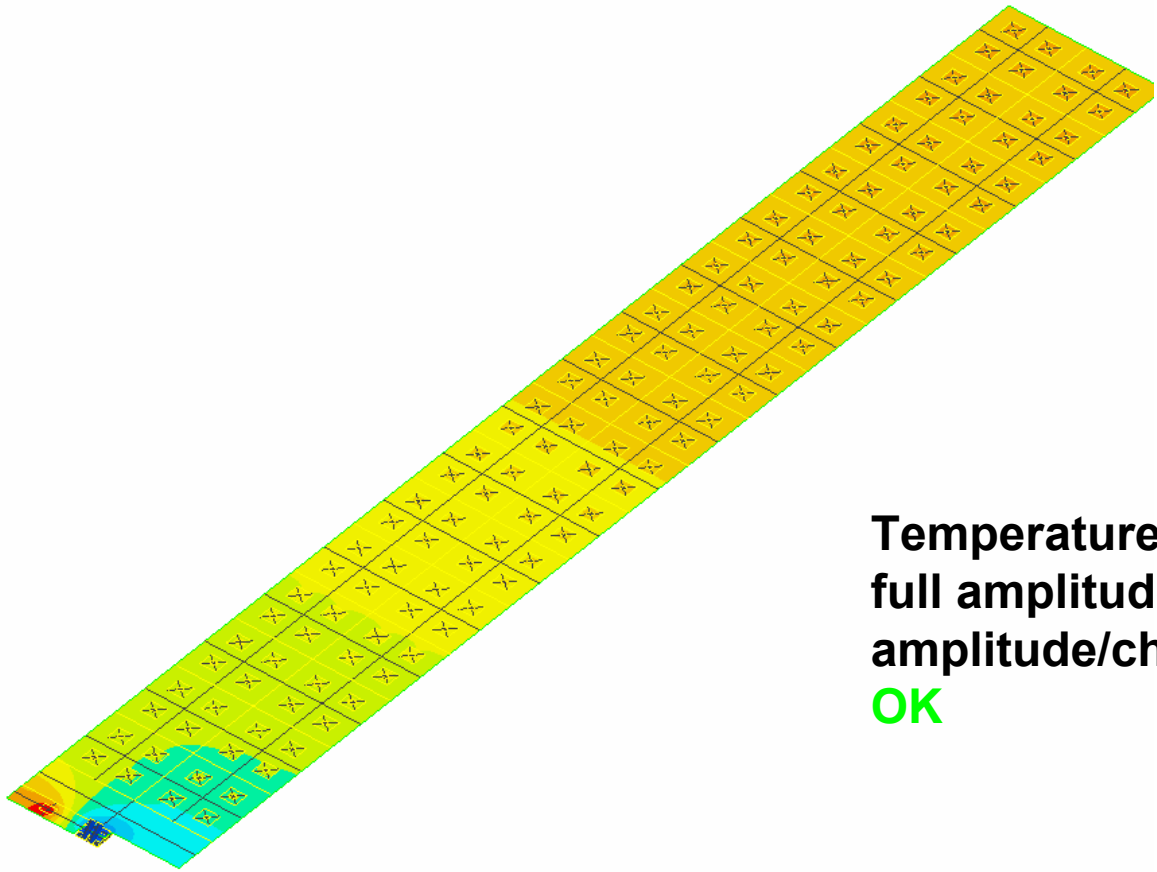
Temperature amplitude : 11 °c
OK



SLAB COOLING - EUDET

Load case 2 : With FPGA, Thermic paste λ = 0.4 W/m °K, Copper thickness : 0.4 mm



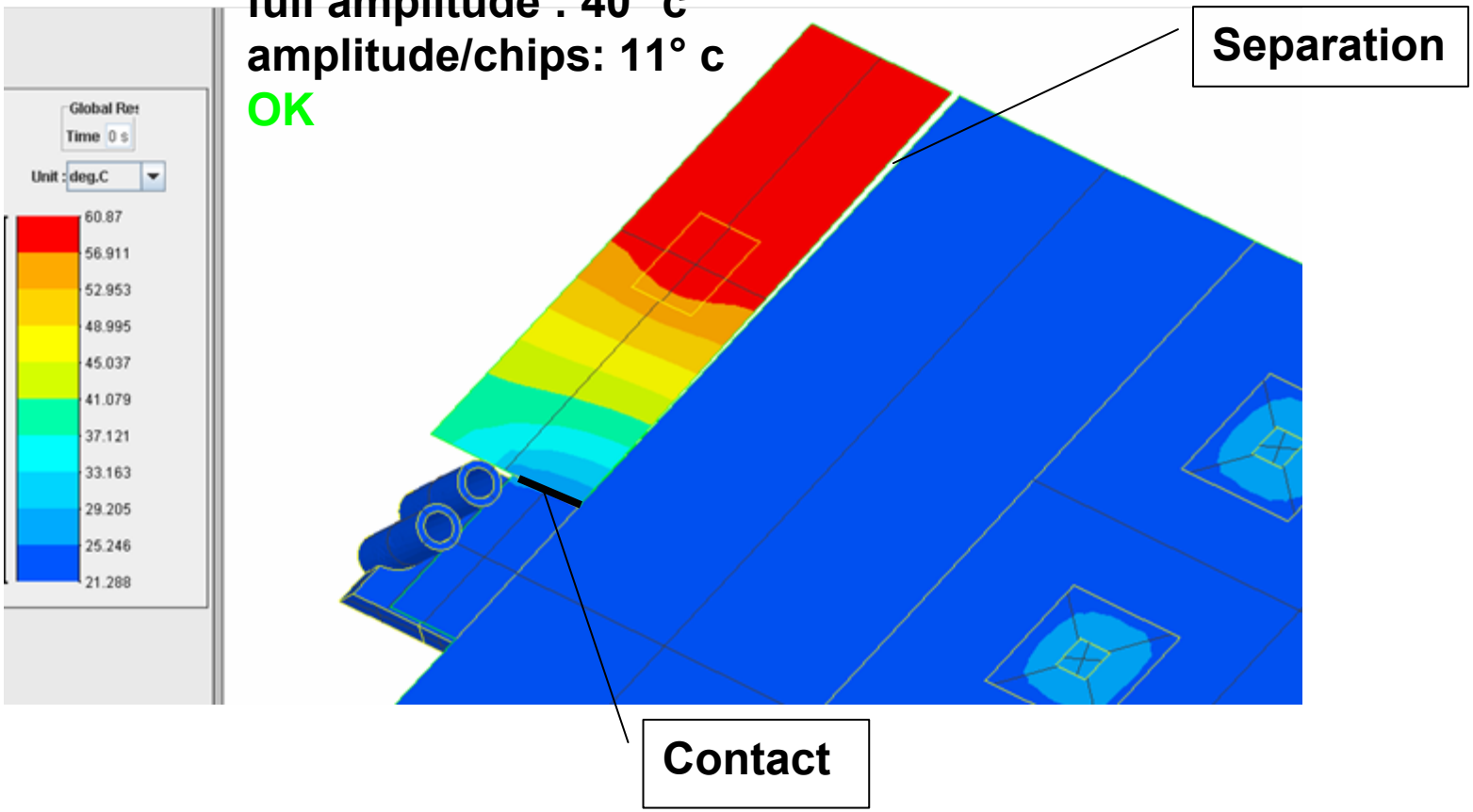


Temperature :
full amplitude : 21.3 °c
amplitude/chips: 11° c
OK

SLAB COOLING - EUDET

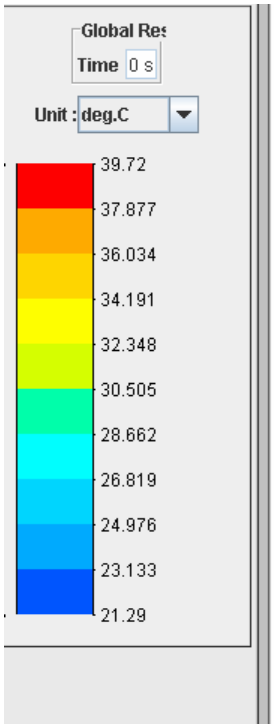
Load case 3 : With FPGA separate from the copper plate, Thermic paste λ = 0.4 W/m °K, Copper thickness : 0.4 mm

Temperature :
full amplitude : 40 °c
amplitude/chips: 11° c
OK

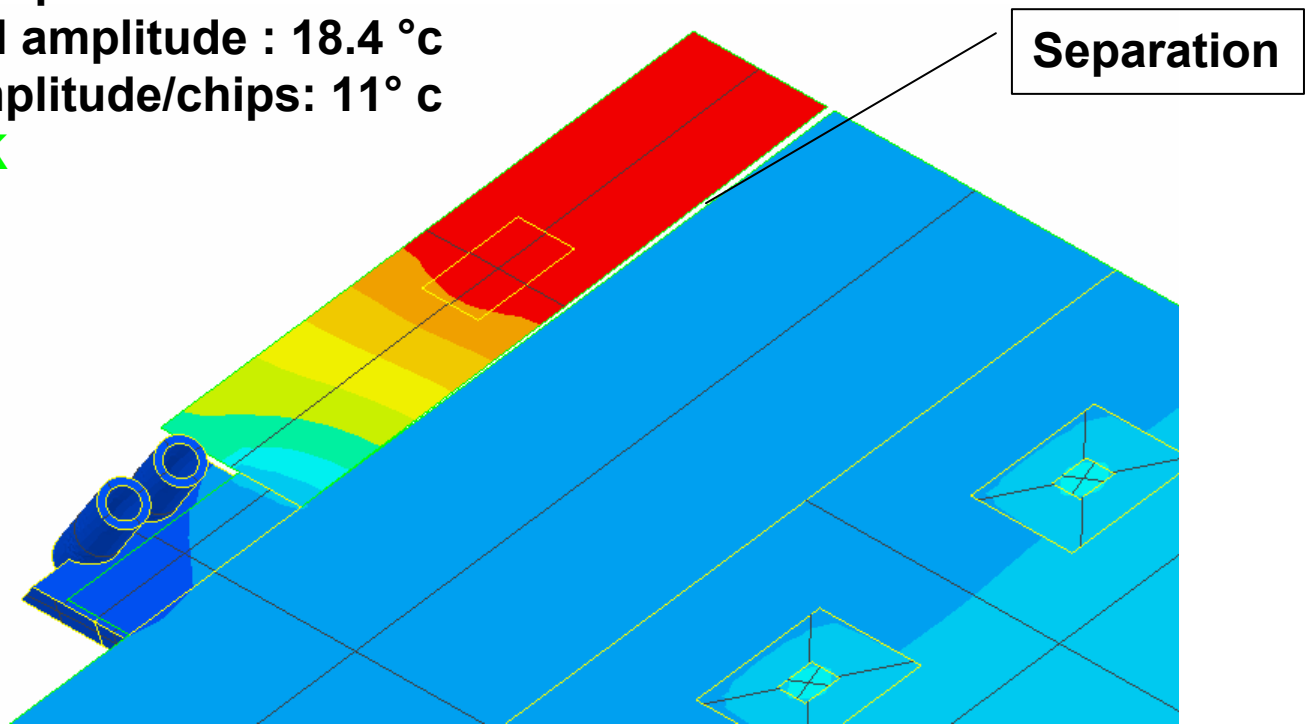


SLAB COOLING - EUDET

Load case 4 : With FPGA separate from the copper plate, Thermic paste λ = 0.4 W/m °K, Copper thickness : 0.4 mm and **1 mm** near FPGA



Temperature :
full amplitude : 18.4 °c
amplitude/chips: 11° c
OK



SLAB COOLING

Demonstrator

- *3 layers – 124.5mm - 1300 long ?*
- *Thermal simulation with 1 ASU ? (4 better): PCB dimensions (total length) to be confirmed*
- *Number of heating resistances: 3 rows corresponding to chips rows : power/surface*
- *Heat shield Geometry / Thermal insulation of slab for tests*
- *Optimization of composite sheets : studies of best parameters for thick plates*

Goal:

- **Test of cooling system: mechanical aspect and performances**
- **Optimization of simulation: conductivities, materials, geometries**

EUDET

Backend system (DIF support): **Confirmation of FPGA consumption and position…**

EUDET module: structures to be assembled and tested with cooling system.

Detector slabs **integration for thermal tests** with tuned power, copper shields with specific geometry and temperature probes.

- Interface card ? Dimensions and specificities ?
- DIF: integrated or not

Goal:

- **Simulations to be performed with demonstrator's approved values to validate the whole cooling of EUDET.**