Thermal Tests with the demonstrator (First results)

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Thermal Tests

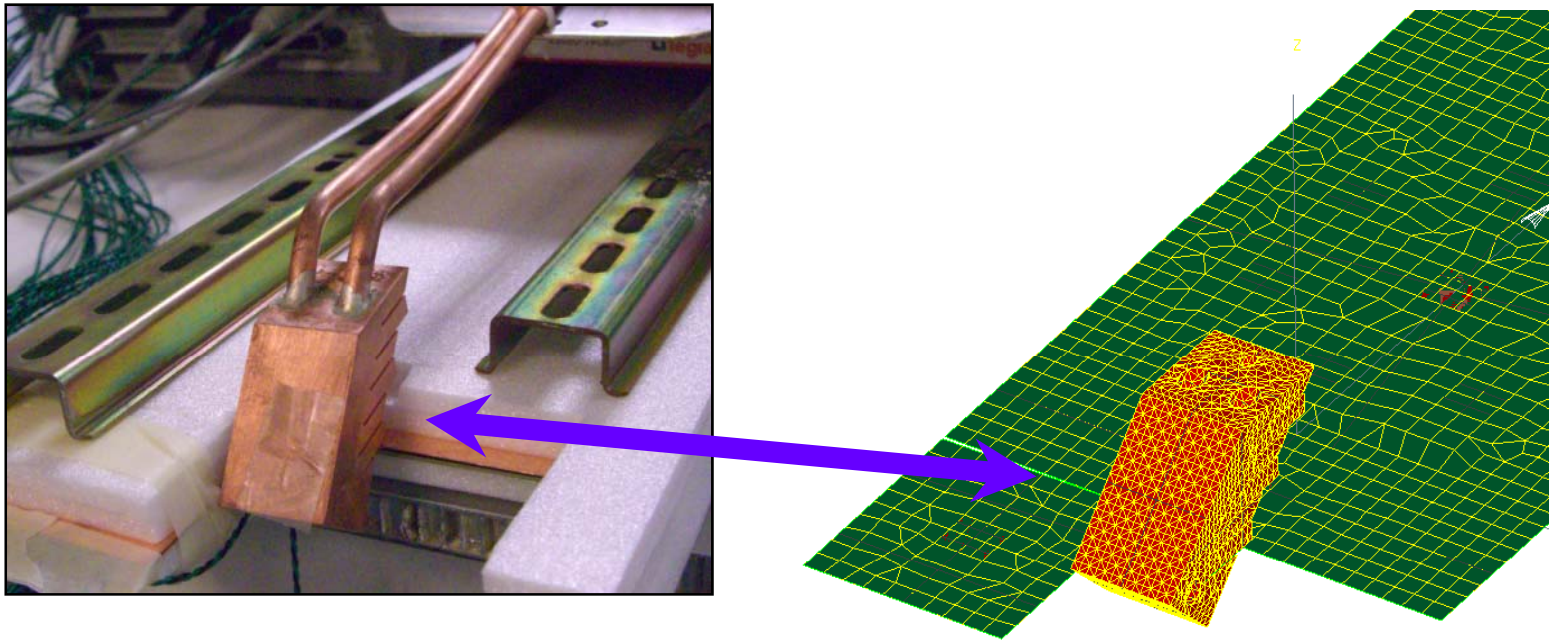
Goal of experimental tests:

=> Compare the thermal test to numerical simulation.

=> In order to answer to simplification of slab's model.

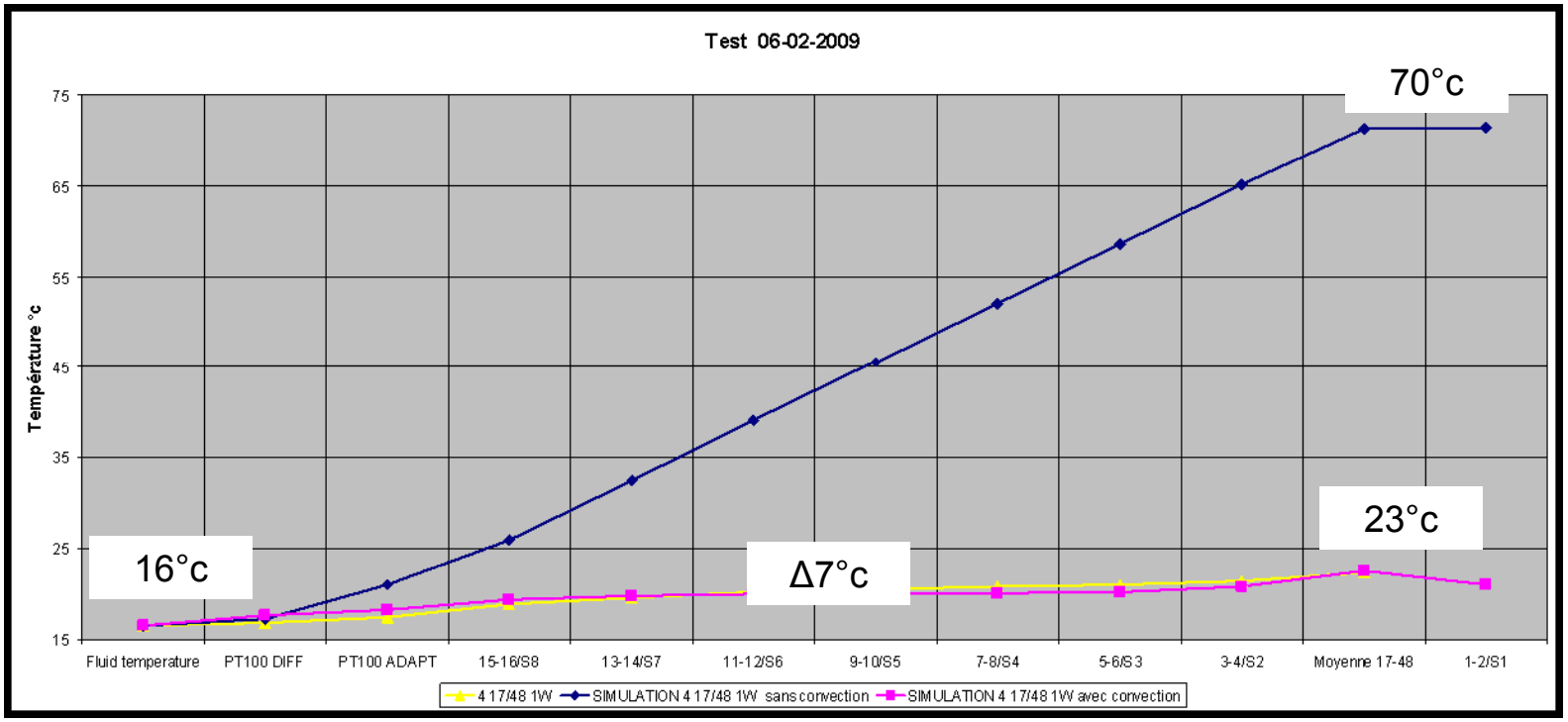
=> To know more precisely transfer coefficients.

=> To verify the behaviour of the cooling system



Thermal Tests

First tests : January 2009



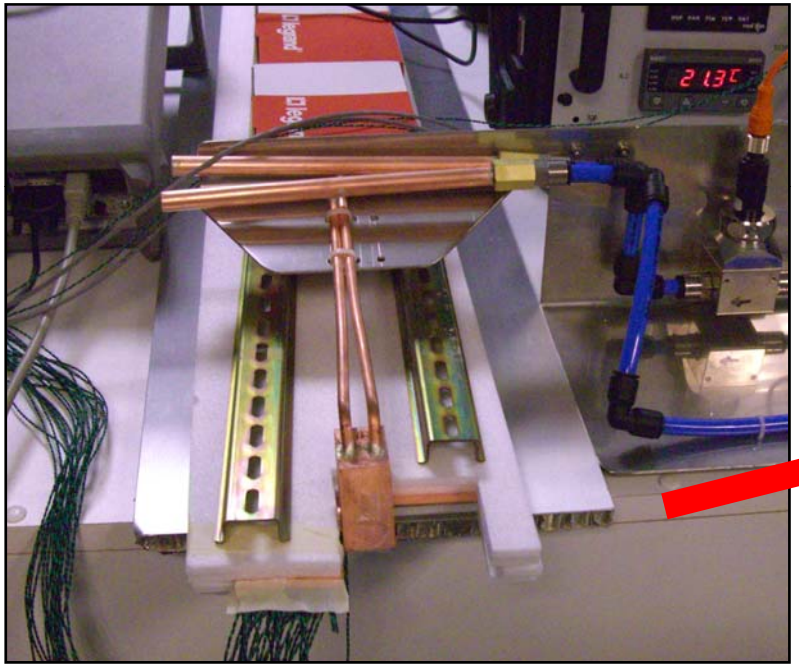
Yellow curve: TEST
Blue curve : Simulation (conduction only)
Pink curve : Conduction + convection (h = 16 W/m²) on all the plate

Conclusion => Efficient cooling but copper plate insulation have to be increased in order to determined all thermal coefficient

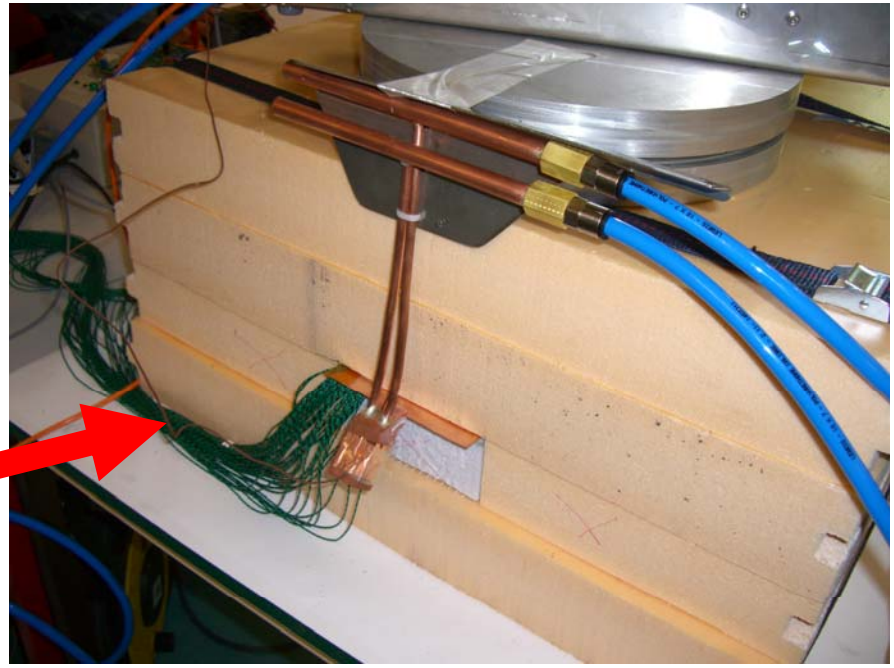
Thermal Tests

What we learnt from the first series of tests (January 2009)

Closest to the reality => we have to improve the insulation of the slab in order to avoid the thermal exchange with the room: there is not only conduction effect but convection too, t.b.d. more precisely.



January 2009



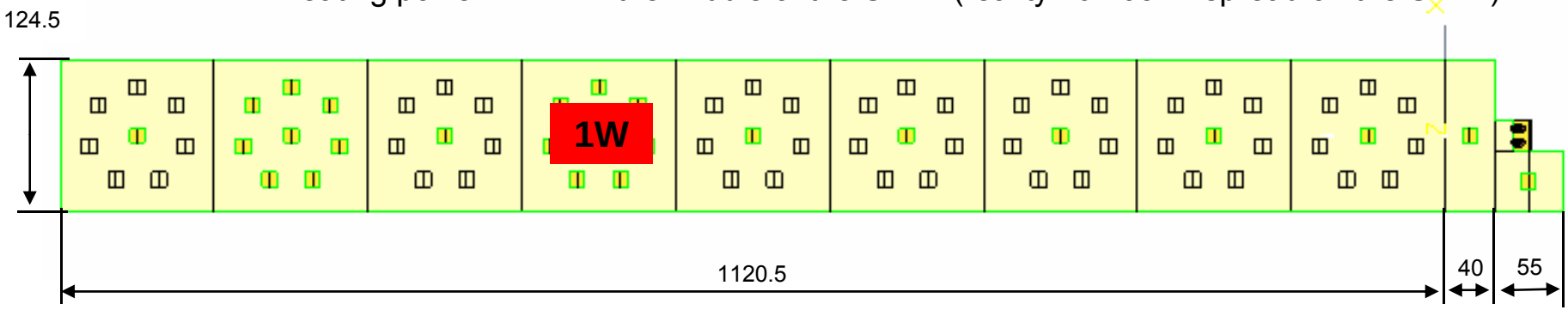
May 2009

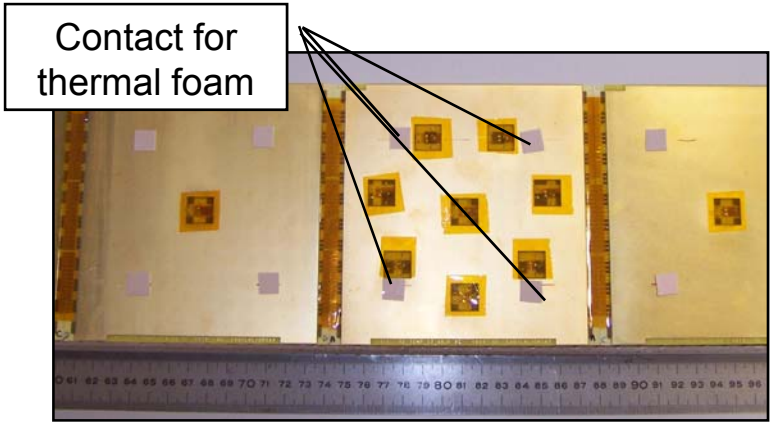
Air conduction equivalent (Air 0.0262 W/(m.K) / Polystyrene 0.03 W/(m.k))

Thermal Tests

Tests conditions:

- Thickness of the copper plate : 0.5 mm.
- Cooling temperature => same as ambient temperature room.
- Heating power : 1 W. in the middle of the SLAB (reality : 0.205 W spread on the SLAB).





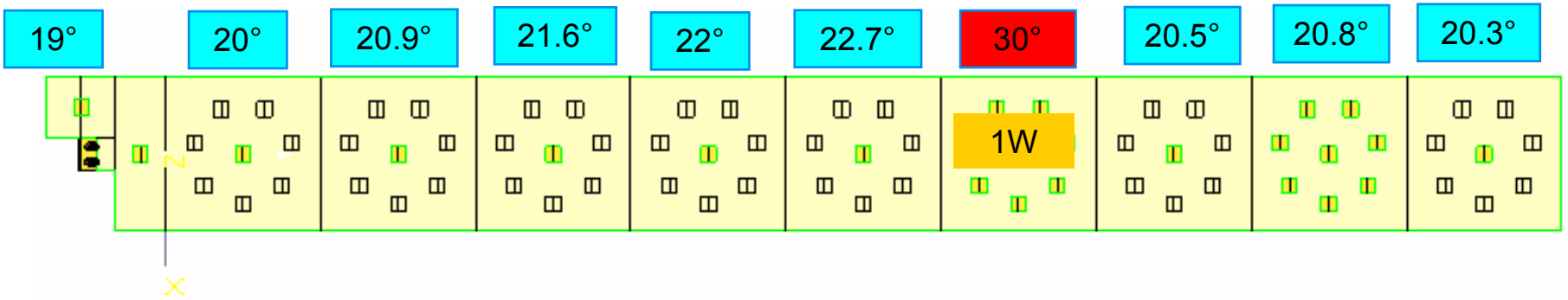
Contact for thermal foam localization : close to reality (real chip' position)

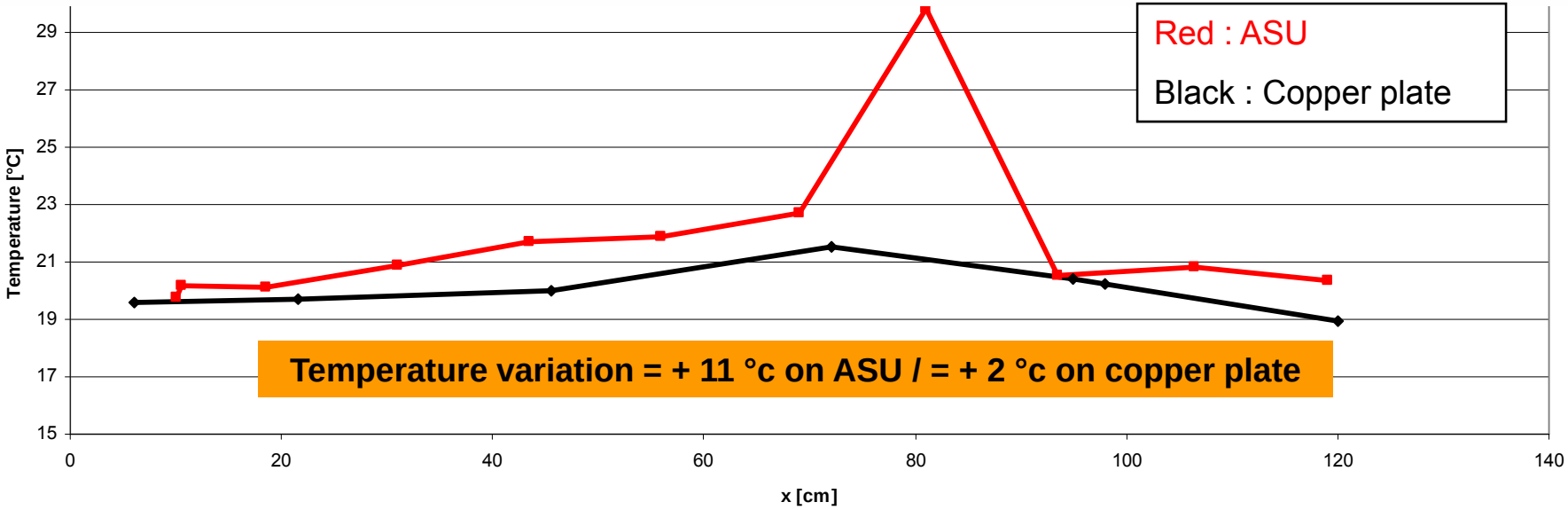
Heater is not right under thermal foam => introduce thermal resistance (conduction through pcb) => difficult to simulate this configuration

Thermal Tests

Tests results : 1W in the middle of the SLAB:

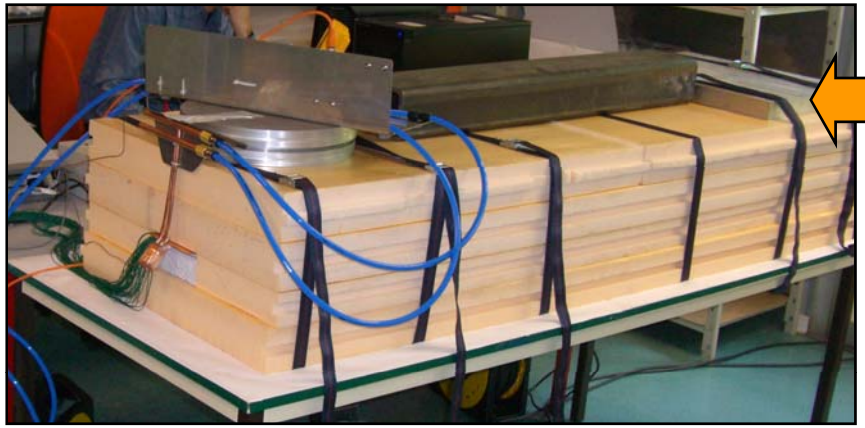
Cooling system : 19°c / room temperature :20°c

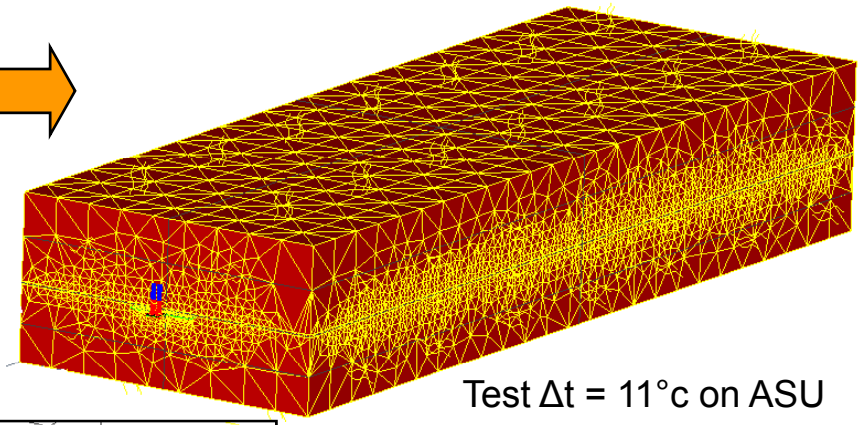




Thermal Tests

Simulations :

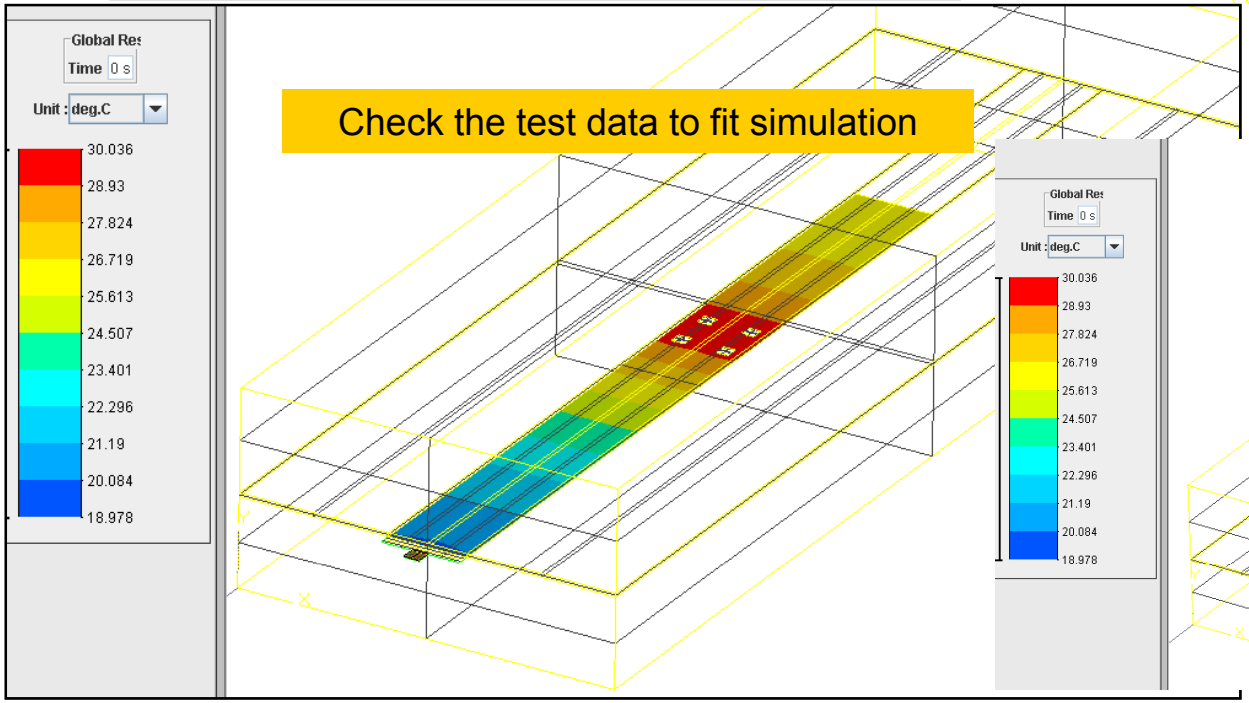




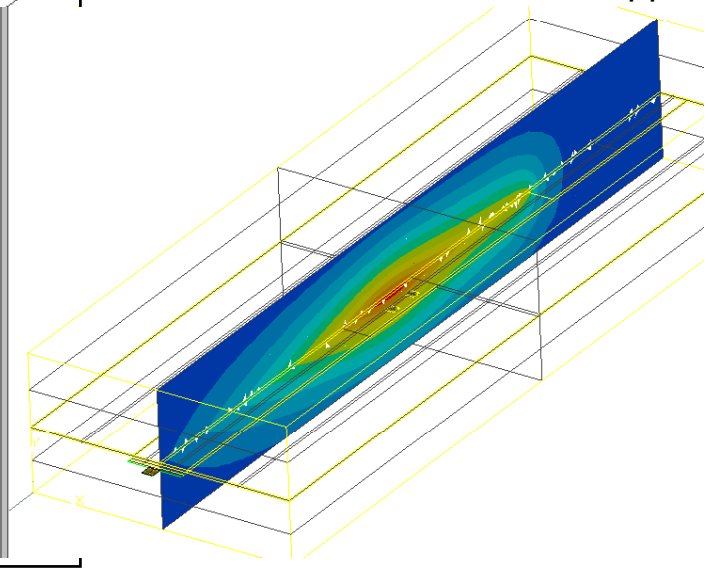
Test Δt = 11°c on ASU

Test Δt = 2°c on copper

Simulation Δt = 11°c on copper



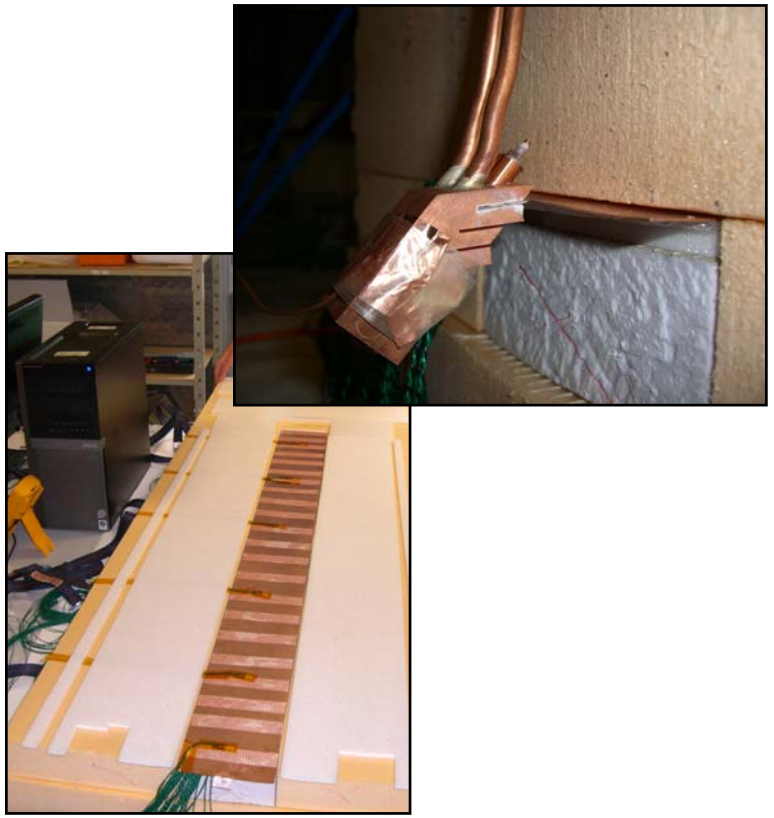
Check the test data to fit simulation



Conclusion:Thermal Tests

Test with 1W in the middle of the SLAB

- No hot point (Temperature step : 11°c)
- Cooling system is ok
- Huge polystyrene insulation but we absolutely need an other test to determine all parameters…

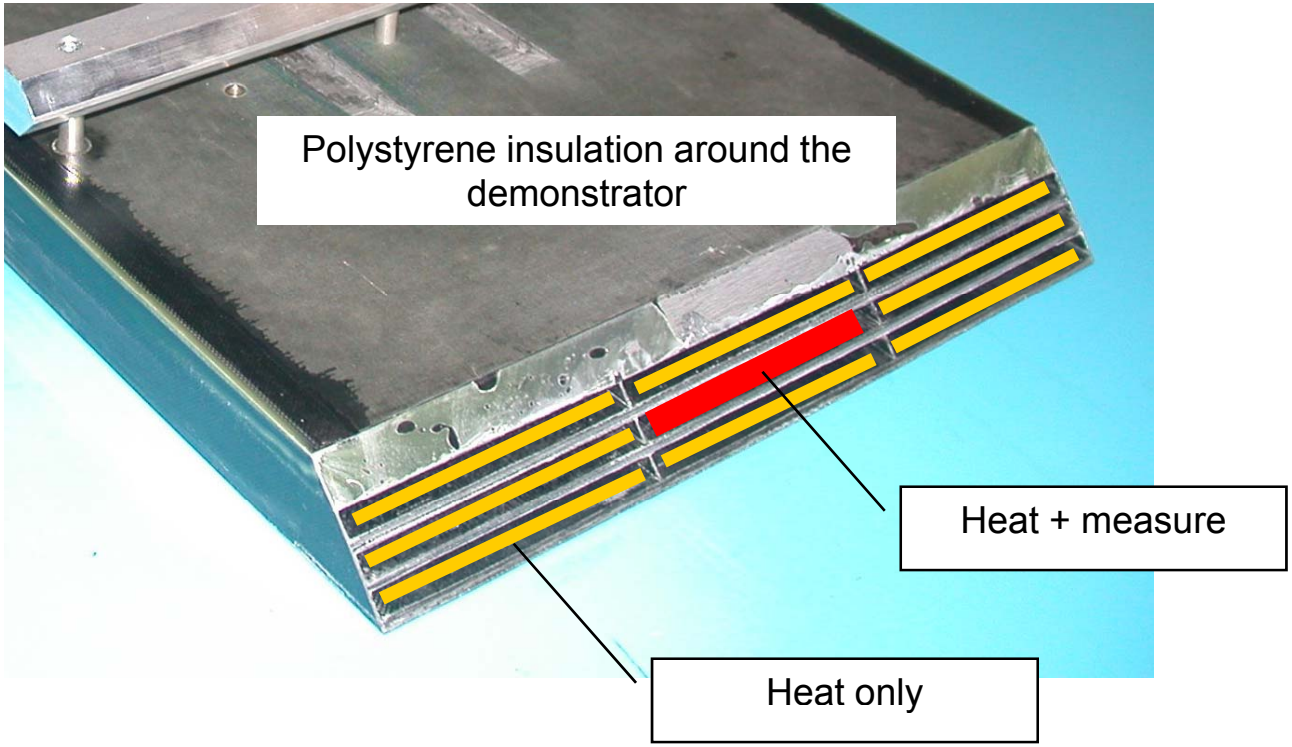


Conclusion:Thermal Tests

Next step => Heating test in the alveolar structure

Test SLAB + heating system in the other alveoli => reproduce the symmetry of the heating source

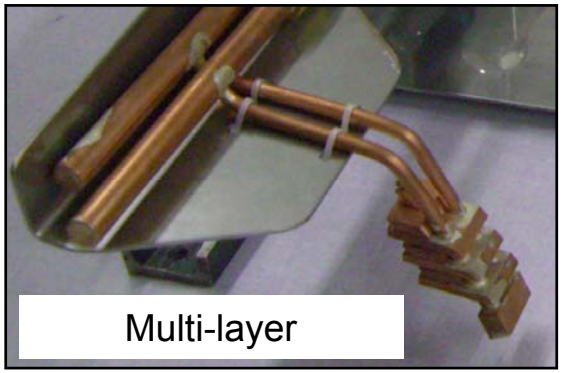
Determine the influence of the convection.

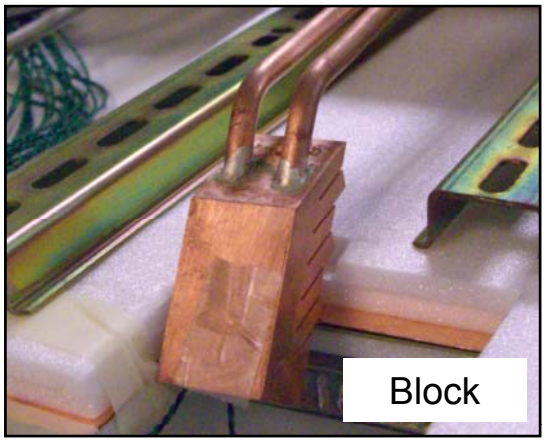


Cold plate:Thermal Tests

Thermal tests February and May:

⇒Copper block (build at the LPSC)



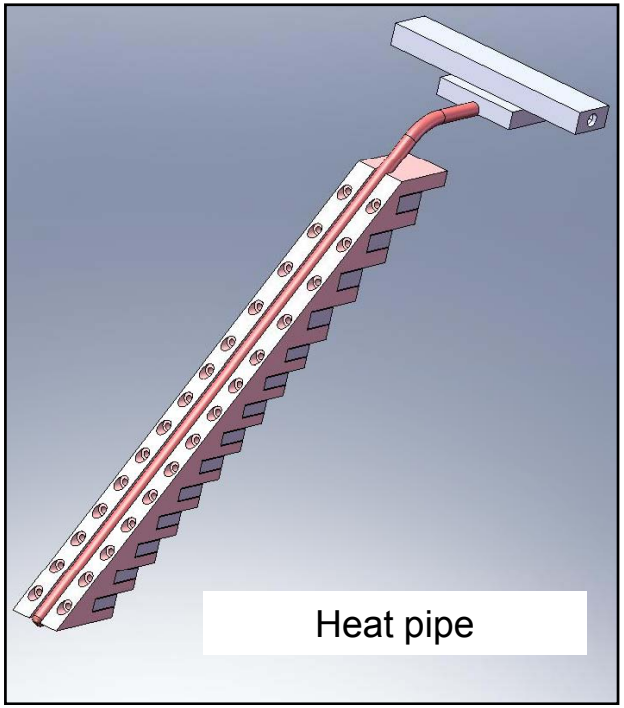


Heat pipe => tests in sept 09

Design and performance Ok (15 W)

Need to have final geometry for EUDET:

geometry 45° or 90° ?



EUDET thermal tests

Demonstrator

- Slab cooling_tests phase 2 — **May 09**
- Correlation (thermal tests) with simulations (transfer coefficients, contacts...) — **June 09**
- Thermal tests in alveolar structure — **Sept 09**

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

EUDET

- **Cooling system for EUDET** (copper type + caloduc) — **Sept 09**

⇒**What we need as soon as possible : (Availability : 3 month for caloduc machining)**

- **Angle : 45°or 90° ?**
- **Number of layer : 30 or 15 ?**
- **Power of a column : 15 W, 66 W or 100 W ?**
- **Thickness of the copper plate : 0.5 mm**

IDL Global cooling

Basic line of the ILD global cooling:

Power dissipation:

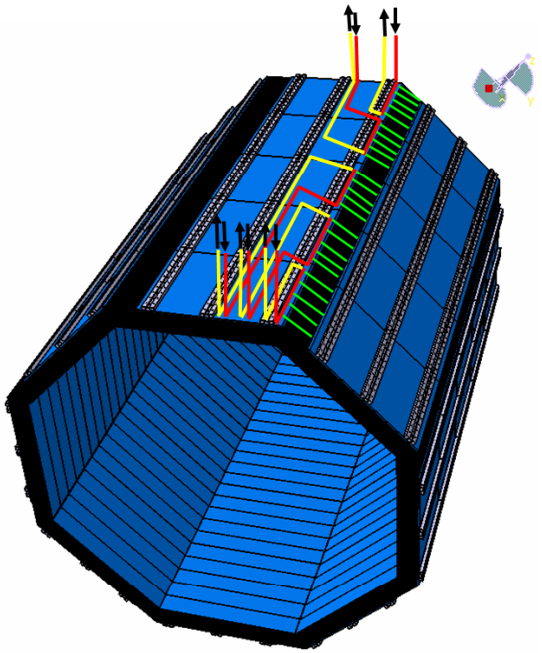
ILD => 0.5 W (1/2 SLAB) this power include : ASU, ADAPT, DIF

⇒15 W / column => 4.6 KW for the global detector

Leak less system with water at a temperature about 15 °c

Connection Water circuit / SLAB :

- Classic copper bloc with water circulation inside (<1 atm)
- Heat pipe technology



Fluid cooling per module…

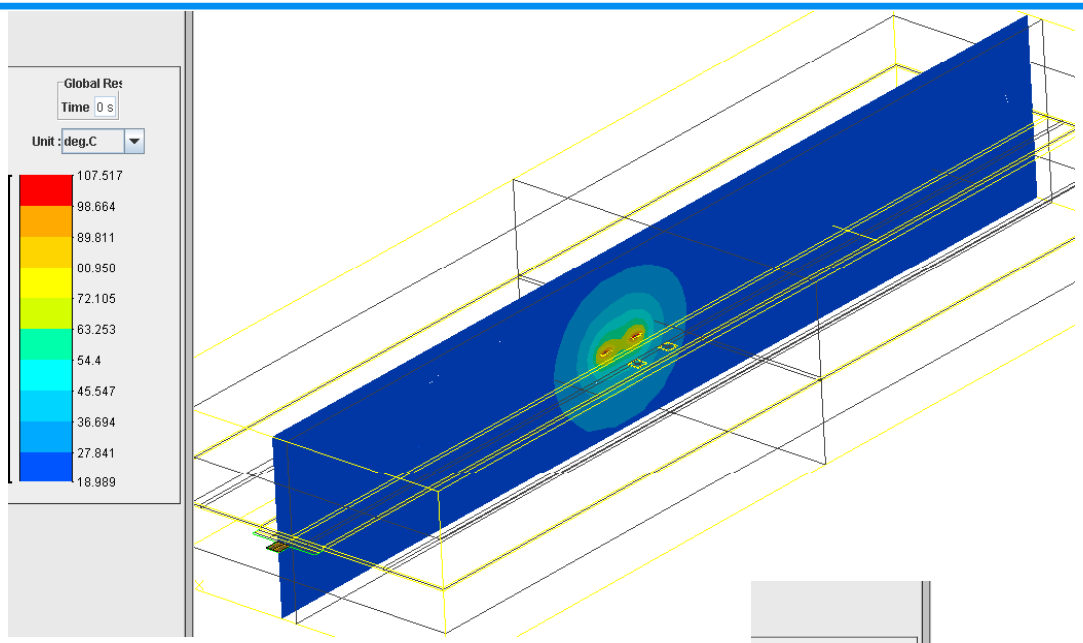
Temperature variation around the consign point : +/- 2.5°c

Maximum temperature variation in the SLAB : 9°c (1.5 m-barrel) and 19°c (2.5m – end-cap)

Maximum absolute temperature at the end of SLAB : 40°c (1.5 m) and 50°c (2.5m) (Heat-pipe system and 15W / column), but in this case, due to convection and low conduction effect, additional cooling system is to validate.

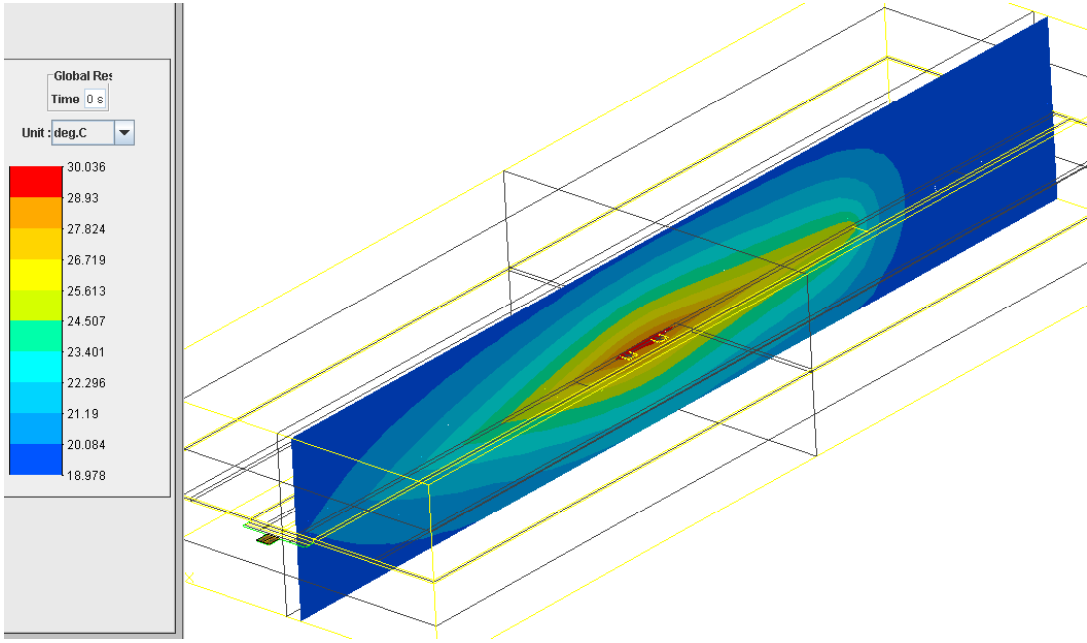
Number of column vs pipe line : 1 (need lot of space for that - to be checked).

Thermal Tests : simulation

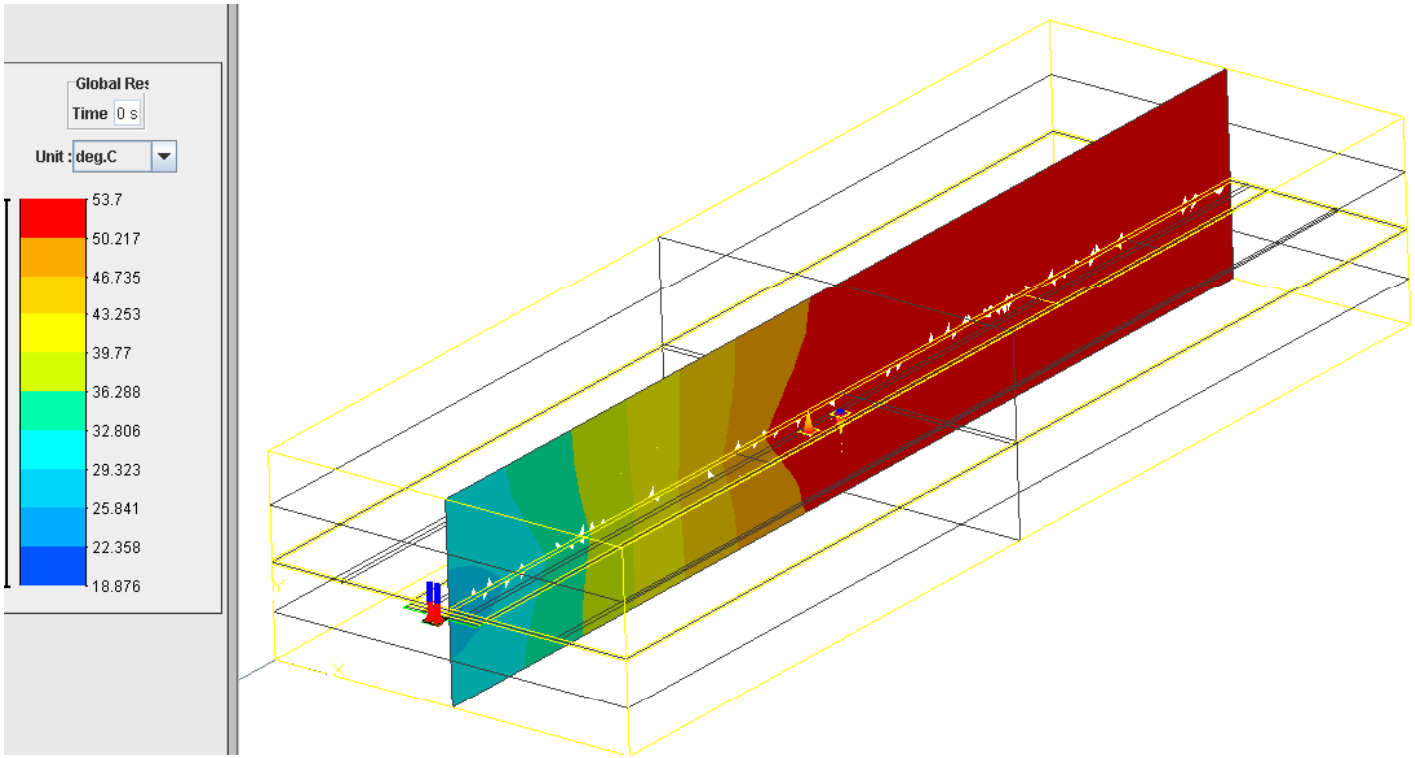


1W : polystyrene only (no copper plate) Δt = 88°c

1W : polystyrene + copper plate
Δt = 11°c



Thermal Tests : simulation



1W : polystyrene + copper plate Δt = 35°c (no exchange with the ambiant air)