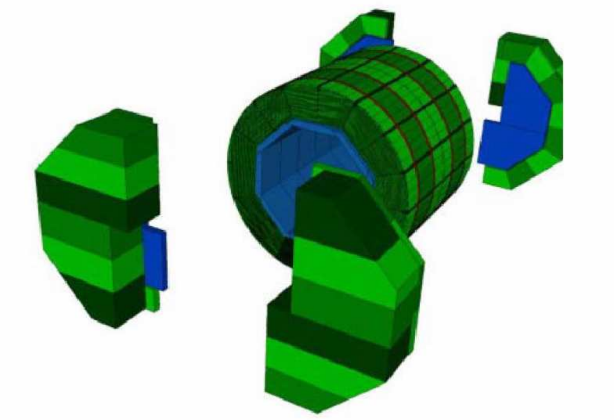
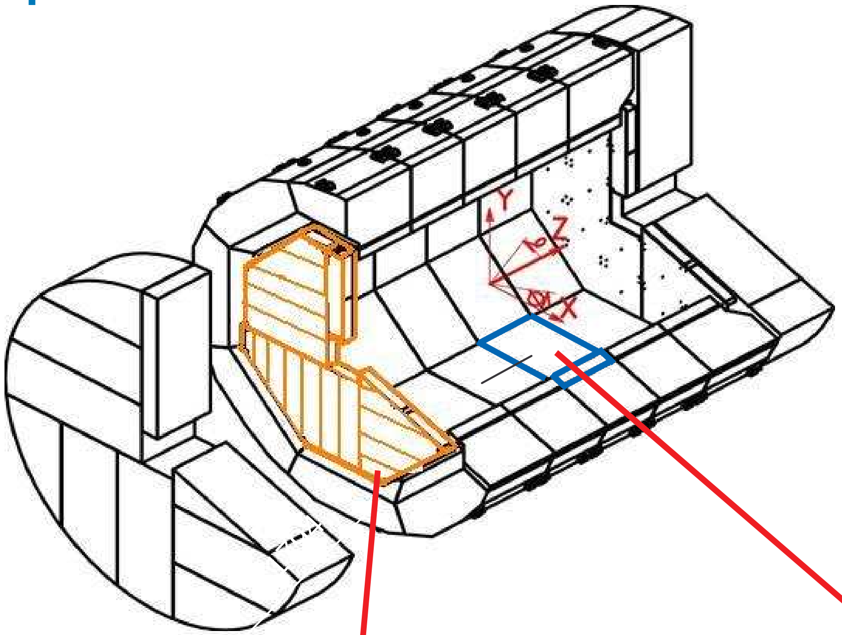
Mechanical Status of ECAL



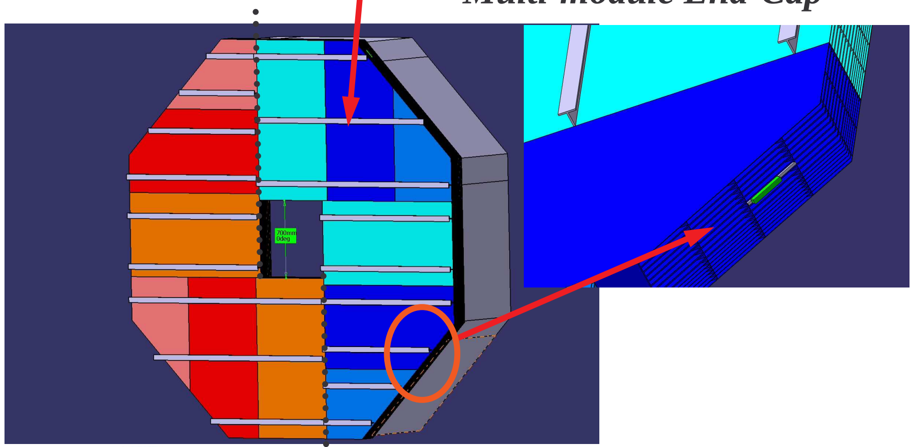
Marc Anduze – 30/10/06

ECAL - Global presentation

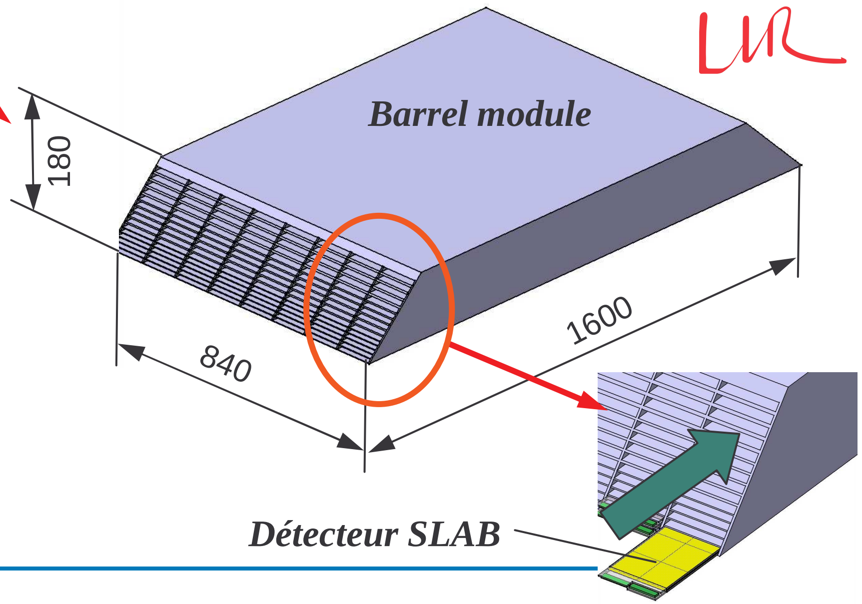


- W/Si calorimeter (24 X_0 with 29 W layers)
  Weight full ECAL: ~ 112 T (80 barrel+32 End-Cap)
- Barrel : 40 identical trapezoidal modules
- End-Cap : constituted of 12 modules (3 types)
- ECAL module : alveolar structure - carbone fibers compound including half of W plates (fixed on HCAL End-Cap with rails)
  ⇒ Minimization of dead zones
- Detection elements (detector slab) in each alveolar case (Si+W), FE chips integrated, pad size : 5×5 mm^2

Multi-module End-Cap



Opening plan for full End-Cap



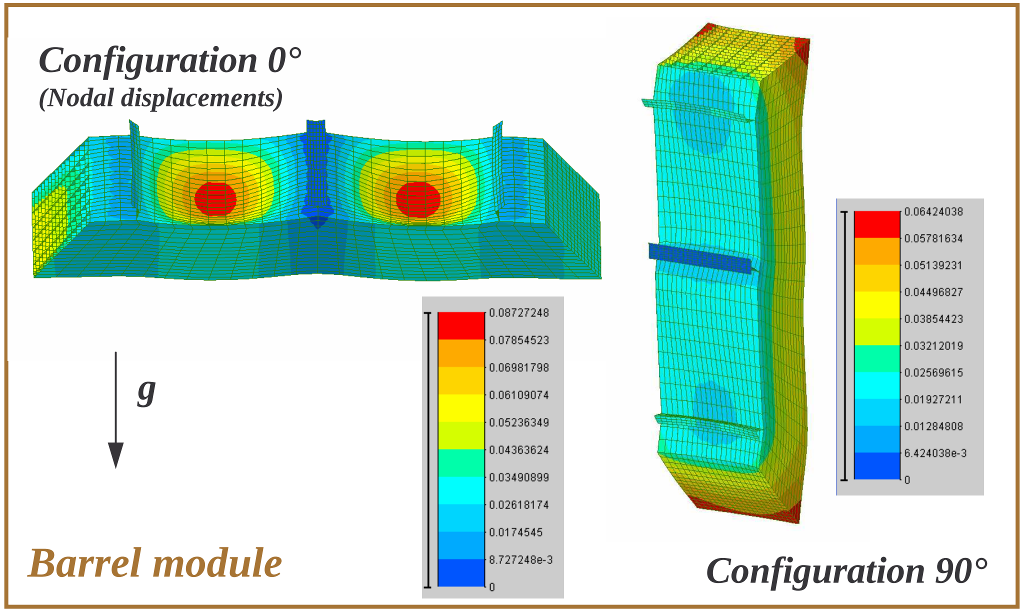
ECAL - Alveolar structure design

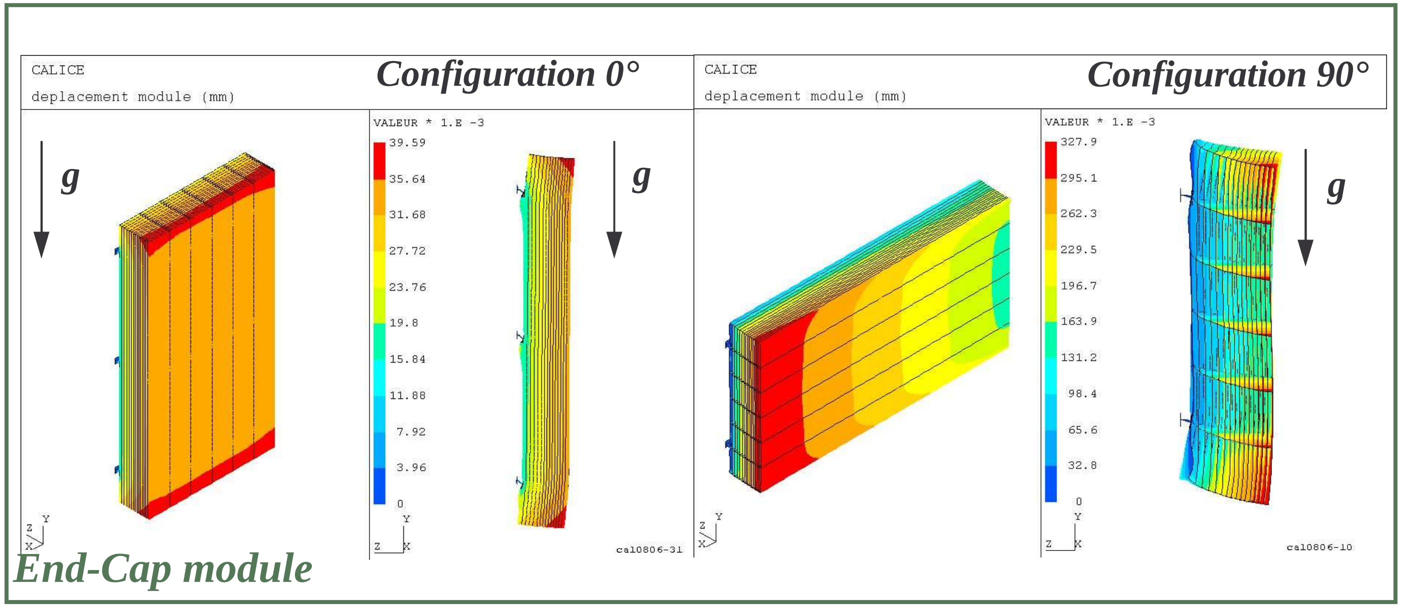
Linear Analysis

- Global simulations : global displacements and localization of high stress zone for different solutions (definition of dimensions)
- Local simulations : more precise simulations and study of different local parameters to design each part of theses structures

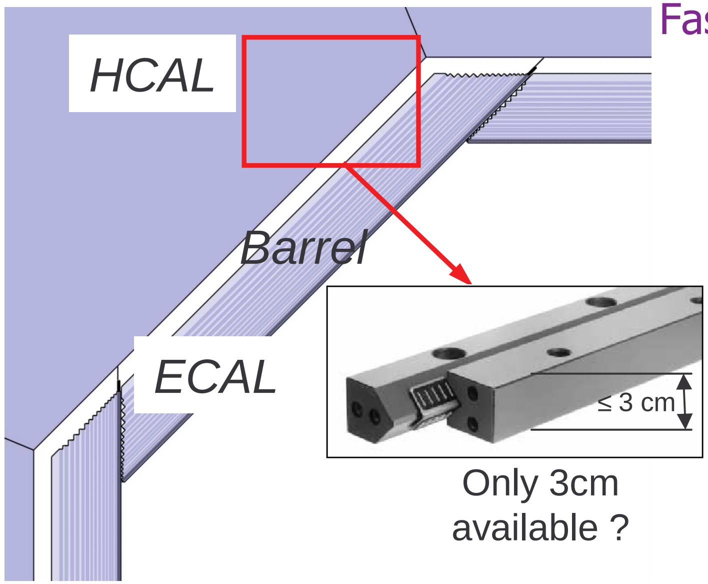
Main ISSUES :

- Dead zones : thickness of main composite sheets
- Fastening system : choice of fasteners (metal inserts, rails…)
- Thermal cooling (active or passive ?)
- Connectors ?





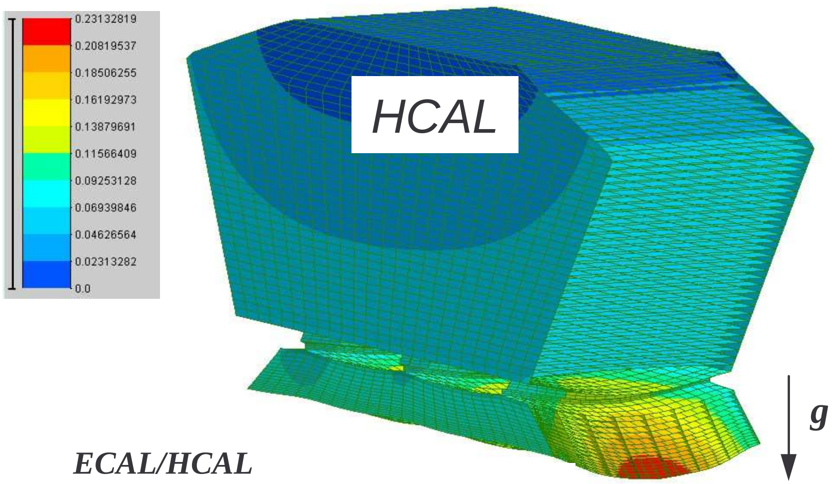
ECAL/HCAL - Interface



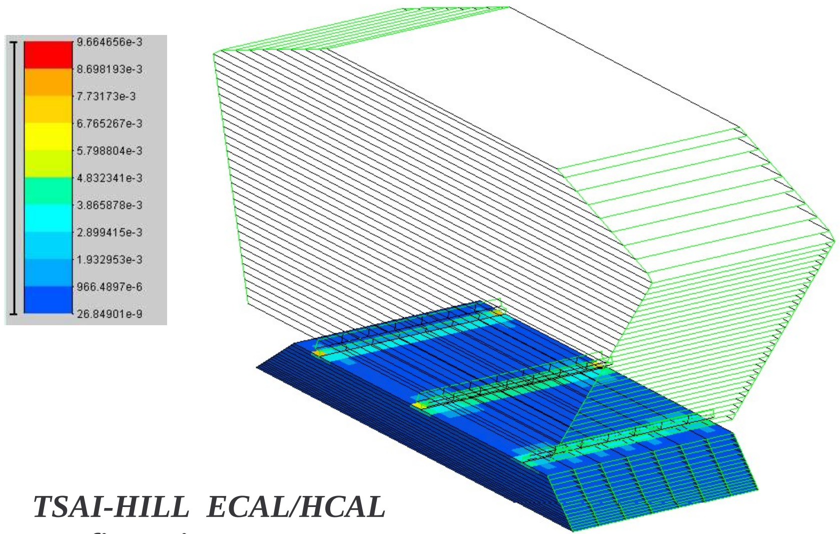
Only 3cm available ?

Fastening system ECAL/HCAL is fundamental for mechanical and thermal calculations (barrel and End-Caps):

- choice of fasteners : rails directly inside composite or metal inserts ?
- Connections set path in gap between ECAL and HCAL (via a panel for cabling interface ?)
- Rails are 1 way for positioning system (gravity support) but a second complementary system may be added for fast interchange of modules… recommendation ?
- Whole End-Cap (ECAL+HCAL) assembly behavior



ECAL/HCAL Configuration 0°



TSAI-HILL ECAL/HCAL Configuration 0°

ECAL - Thermal analysis

- Thermal analysis for interaction on FE ships

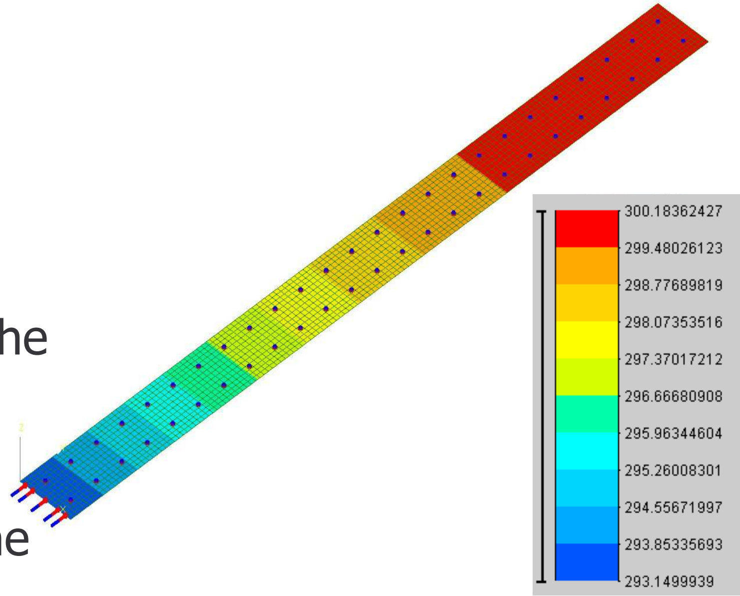
Thermal sources:

Pad size	Chan/ wafers	Ch/chip	Chip/wafer	Chip size mm²	Chan/barrel	Chan/ End-cap
5*5 mm ²	144	72	2	15x15	60.4 M	21.8 M

→ CALICE ECAL: ~ 82.2 M of channels

Assuming that the chip power is 25 µW/channel
total power to dissipate will be : 2055 W
ð external cooling OK

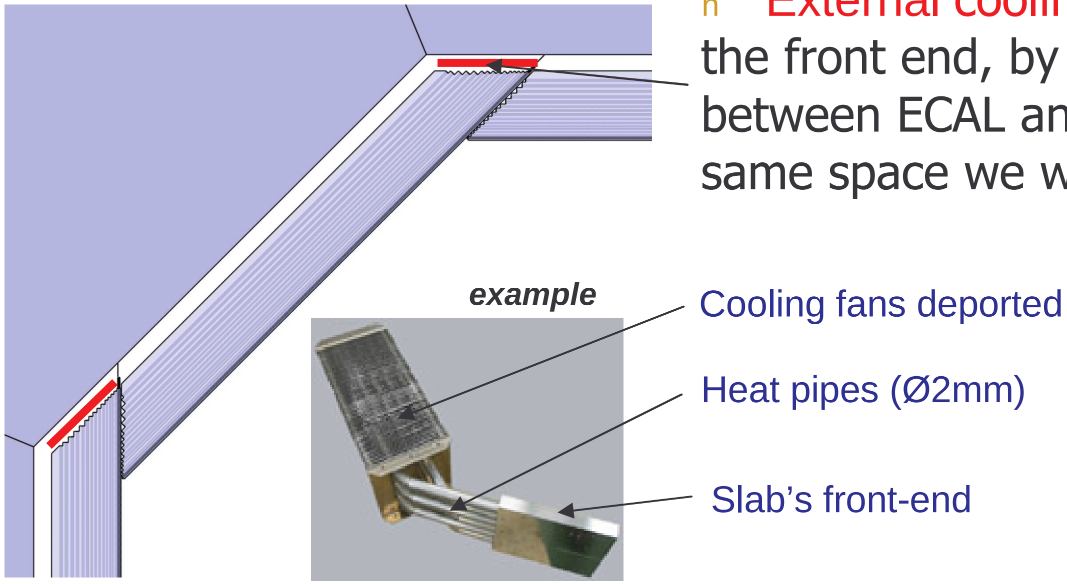
inside each slab :
necessity of cooling system but active or passive ?
Ex: Pessimist simulation of heat conduction just by the heat shield : λ = 400 W/m/K (copper) ; S = 124*0,4 mm²
L = 1,55 m ; $\Phi = 50^* \Phi_{chip}$ = 0,18 W

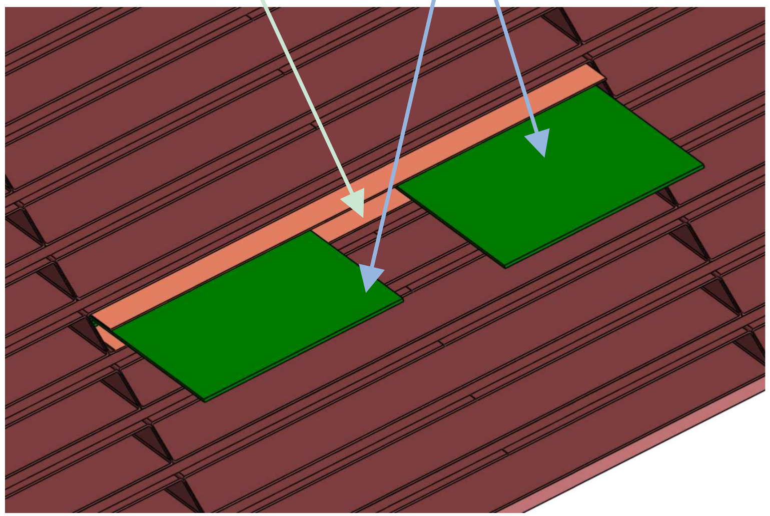


We can estimate the temperature difference along the slab layer around 7°C and without contribution of all material from slab (PCB, tungsten, carbon fibers…)
ð passive cooling OK ?

ECAL - Cooling technology

- External cooling location: for each module, on the front end, by pipes running in the space between ECAL and HCAL. Unfortunately, in the same space we will find all the slab's output/input.



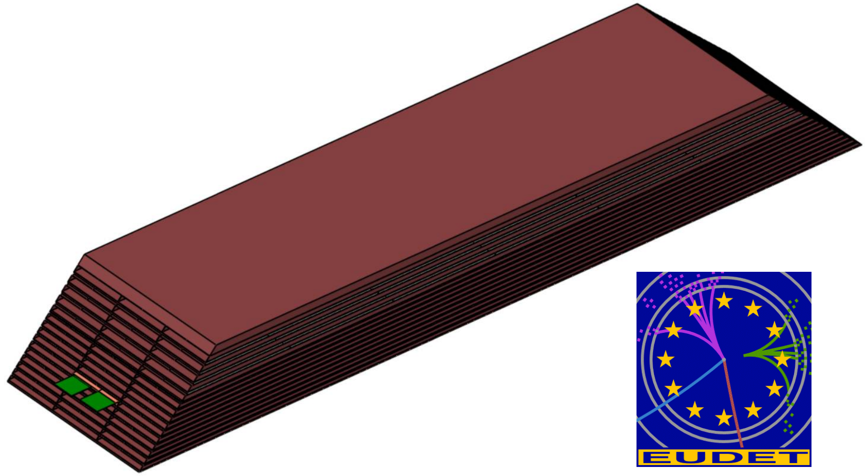


- Nearly all heat generated by the chips will go to slab's front-end. Then, some cooling option can be foreseen:

  - Thermal conductors (heat shield) can be added in the slab to carry heat more efficiently along the slab direction.
  - Thermal cooling inside : by the way of heat pipes connected to cooling fans deported ; increase the thickness of slab.

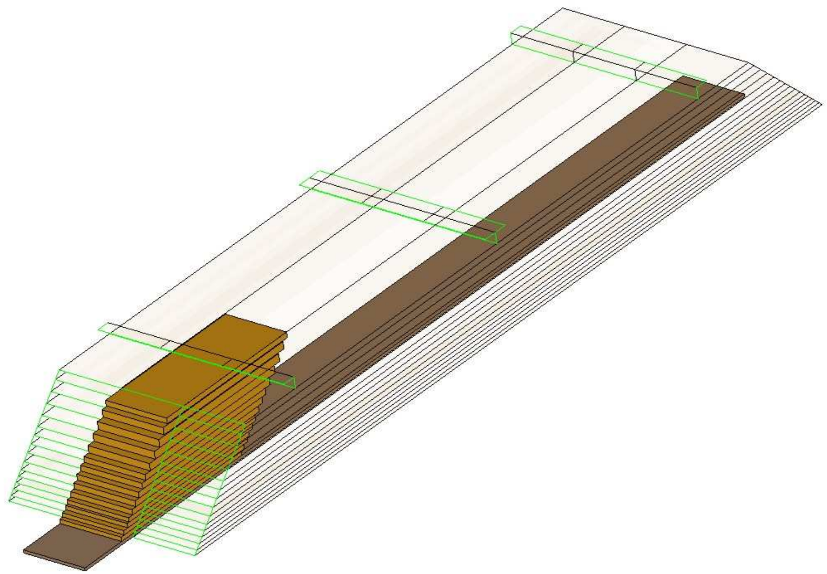
EUDET Demonstrator - Presentation

<u>*Concept : to be the most representative of the final detector module :*</u>

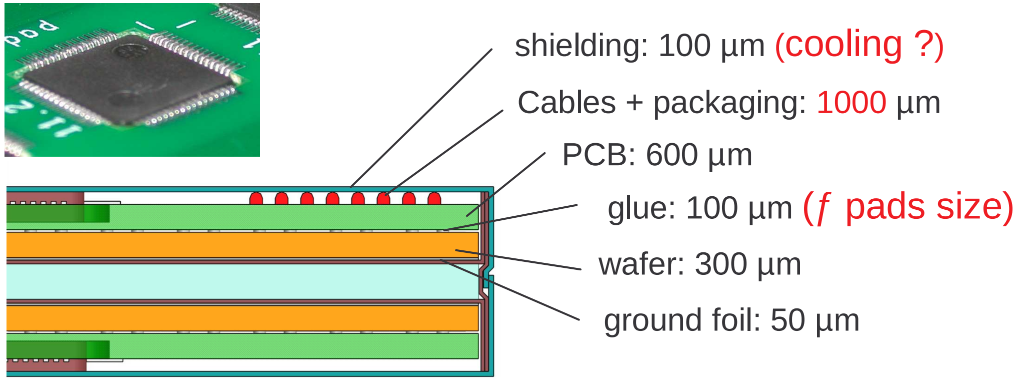


- A alveolar composite/tungsten structure with :
  - same radiator sampling :
    - 20 layers with 2.1 mm thick
    - 9 layers with 4.2 mm thick
  - 3 columns of cells to have representative cells in the middle of the structure (with thin composite sheets)
  - Identical global dimensions (1.5m long) and shape (trapezoidal)
  - fastening system ECAL/HCAL (included in the design of composite structure)

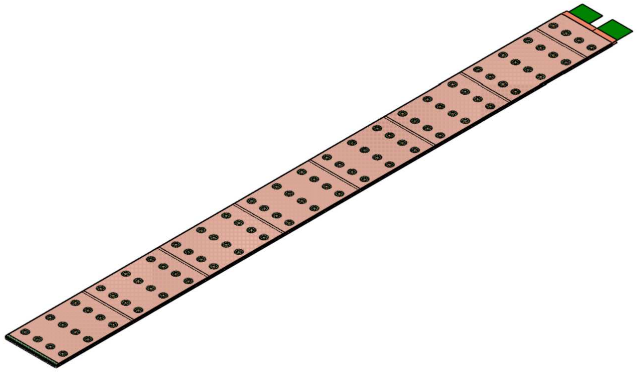
- 15 Detector slabs with FE chips integrated
  - 1 long and complete slab (L=1.5m)
  - 14 short slabs to obtain a complete tower of detection (typ. L=30 cm?) and design of compact outlet.

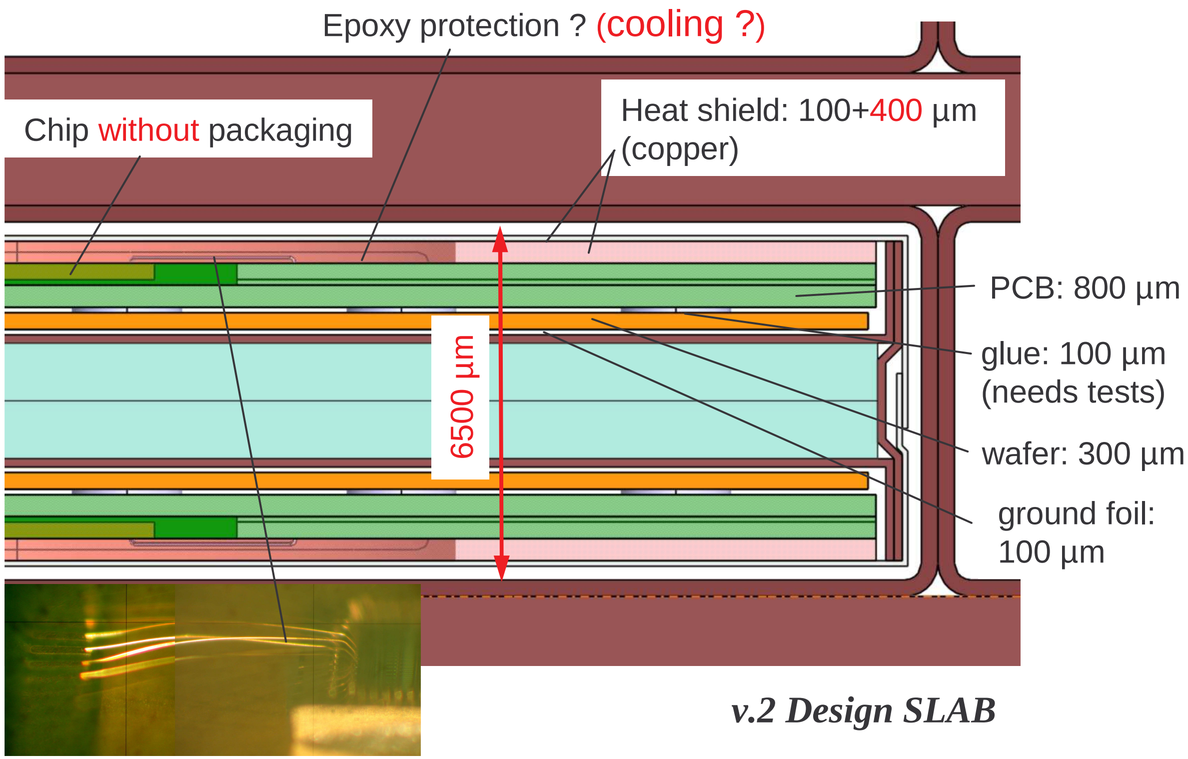


EUDET - Detector slab (1)



v.1 Design SLAB





v.2 Design SLAB

Main ISSUES :

Front End chips inside :

ð Thermal dissipation (cooling ?)

ð Chip behaviour in an electron shower

n Long structure :

ð Design and fabrication problems (composite with segmentation of W plates, mechanical behaviour …)

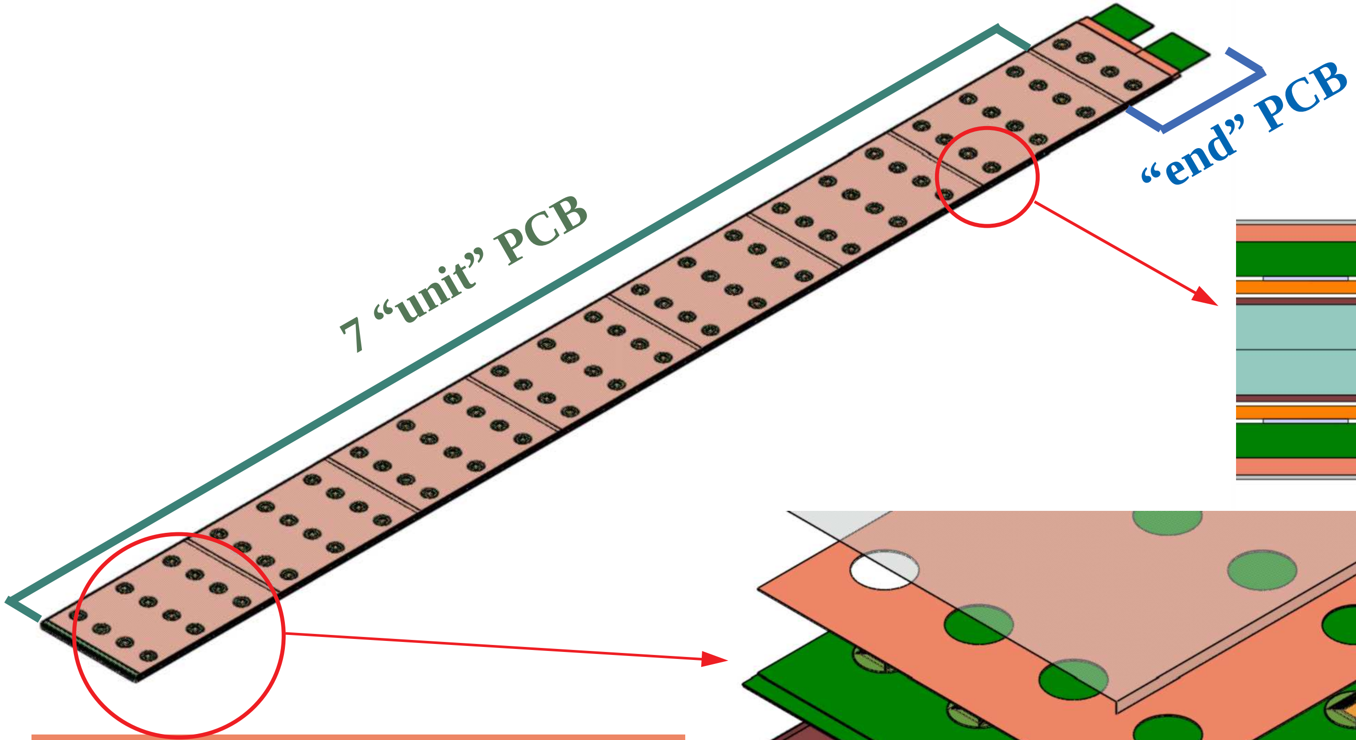
ð Segmentation of PCB (design of an interconnection)

n Diminution of the pads size

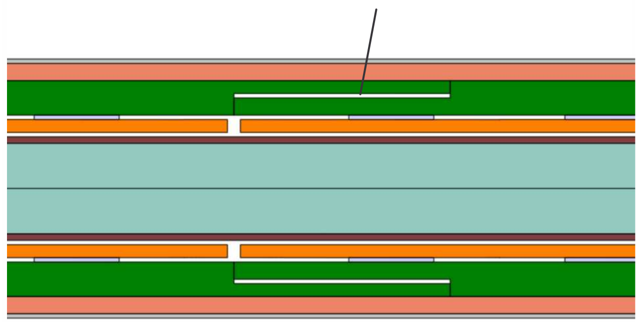
ð Increases of the number of channels (thermal cooling ?)

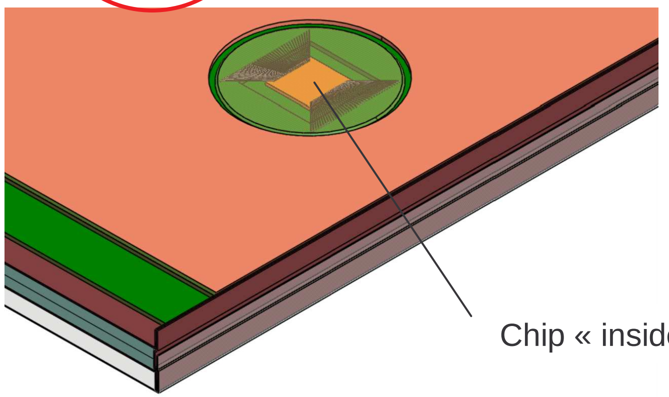
ð Size of glue dots

EUDET - Detector slab (2)

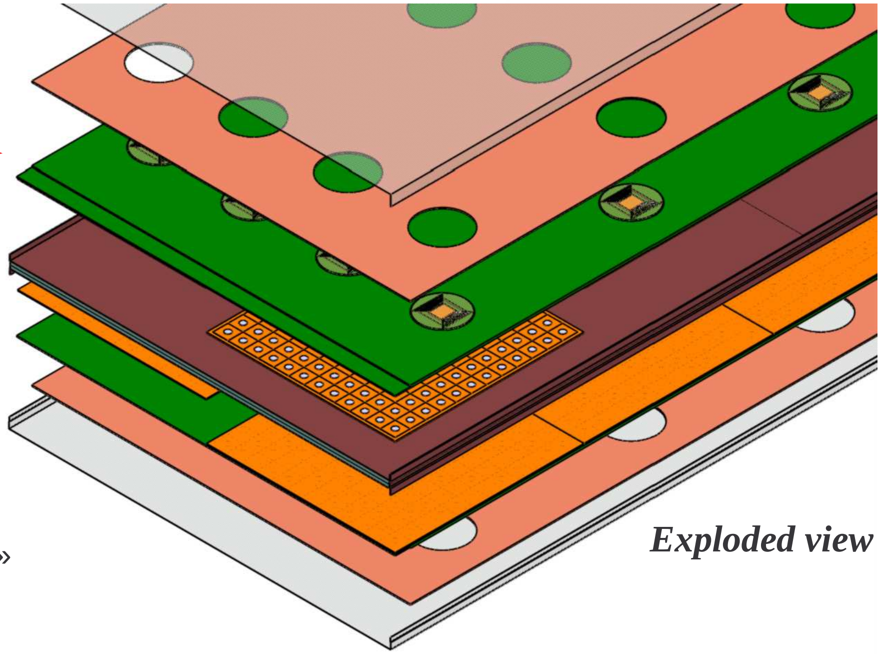


Connection between 2 PCB





Chip « inside »



Exploded view

R&D – Techno. prototypes (2006-2007)

Calorimeter for ILC

- *Long Type H structures* :

  - Design and fabrication of the long mould – (end of 2006)
  - Fabrication of validation model (1-3 samples)

- *module EUDET* :

  - 1.5 m long ; ≈ 500 Kg
  - real radiator sampling : 20 layers with 2.1 mm thick
    9 layers with 4.2 mm thick

  - Design (mechanical and thermal simulations) of the module
  - Optimization of composite sheets : studies of main parameters (thickness, shape ...)
  - Fastening system on HCAL : design and destructive tests too
  - Design and fabrication of the mould with an industrial expertise (DDL consultants)
  - Transport tools
  - Fabrication of the structure (end 2007)
  - Mechanical support for beam test in 2008