SiW Ecal EUDET Module

Roman Pöschl
LAL Orsay

- General Schedule
- Development of Different Components
- (Towards) a working prototype

EUDET Annual Meeting DESY Hamburg
September/October 2009

The groups working on the EUDET Electromagnetic Calorimeter

- What we call “EUDET Module” is in fact the <u>next SiW Ecal CALICE Prototype</u>

- Financial support by EU

Evolution of Task – JRA3 Ecal EUDET Module

2006

Conceptual Phase – Definition of Project Targets
Detection of problems with Si-Wafer Guardrings and start of investigations for remedies

2007

Decision to go for 0.5x0.5 cm^2 Si-Wafers instead of 1x1 cm^2 Wafers
Contacting and negociations with manufacturers
⇒ Wafers with dimensions of 9x9cm^2
Continuation of studies for building large alveolar Structures
Dimensions depend on wafer dimensions and constraints of challenging Very Front End Electronics

2008

Decision to go for a demonstrator to allow for validation of mechanical concept
Milestone: Design of Moulds and Alveolar Structures finished (EUDET-Memo-2008-07)
Milestone: TDR of SiW Ecal EUDET Module – Details of design fixed (EUDET-Memo-2008-11)
Delivery and Examination of 30 Si-Wafers (Hamamatsu)

2009

Demonstrator built and start of thermal studies
Demonstrator is to be taken as EUDET Deliverable!!!!
Ordering of pieces for 'real' EUDET module in autumn 2009
Next steps depend on progress of VFE
Advancing the VFE has top priority

2010-2011

Towards the EUDET Module ?

Time Scale of Project

2009

1/7/09

2010

← Studies on mechanical Integration

DAQ Integration, Wafer R&D continues

Status of the Project

…

…

EUDET Deadline:
Alveolar
Structures
and ASU 1

Tests
with ASU1

EUDET-Memo-2008-07

EUDET-Memo-2008-07

ECAL Si/W – Design and Fabrication of moulds

for the EUDET Module

M.Anduze, R. Poeschl

July 01, 2008

Covering apects of the alveolar structures

TDR of SiW EUDET Module

EUDET Report 2009-01

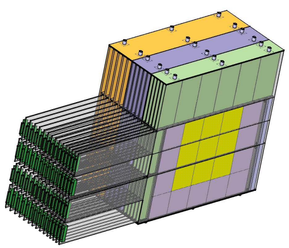
JRA3 Electromagnetic Calorimeter
Technical Design Report

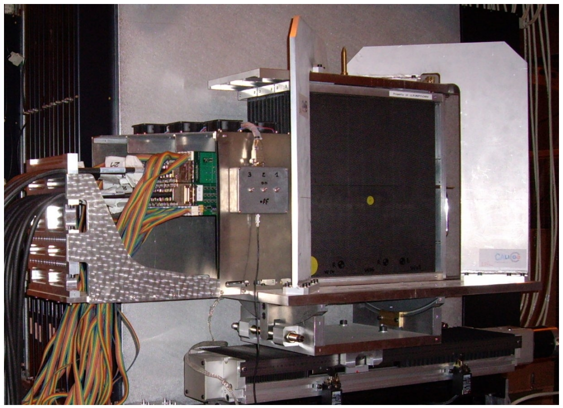
M. Anduze[1], D. Bailey[2], R. Cornat[1], P. Cornebise[3], A. Falou[3], J. Fleury[3], J. Giraud[5], M. Goodrick[4], D. Grondin[5], B. Hommels[4], R. Poeschl[3], R. Thompson[2]

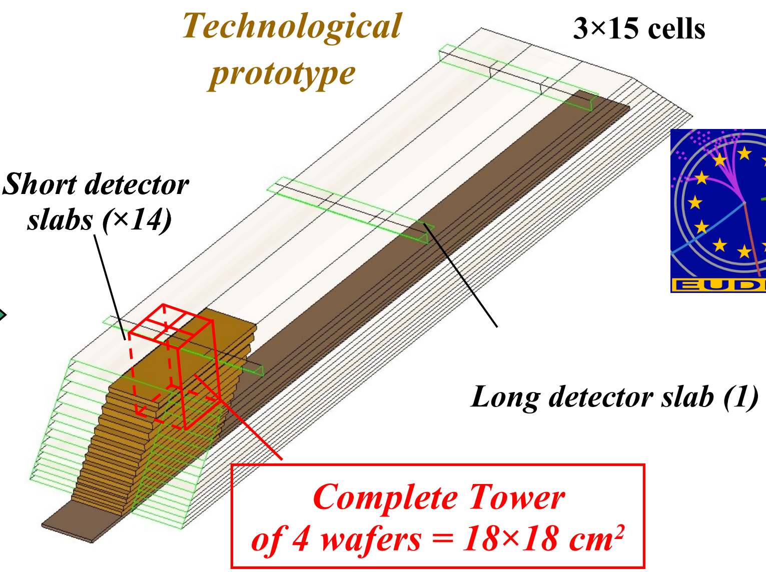
Detailed Technical Design of EUDET Module

EUDET Prototype

- Logical continuation to the physical prototype study which validated the main concepts : alveolar structure , slabs, gluing of wafers, integration
- Techno. Proto : study and validation of most of technological solutions wich could be used for the final detector (moulding process, cooling system, wide size structures,…)
- Taking into account industrialization aspect of process
- First cost estimation of one module







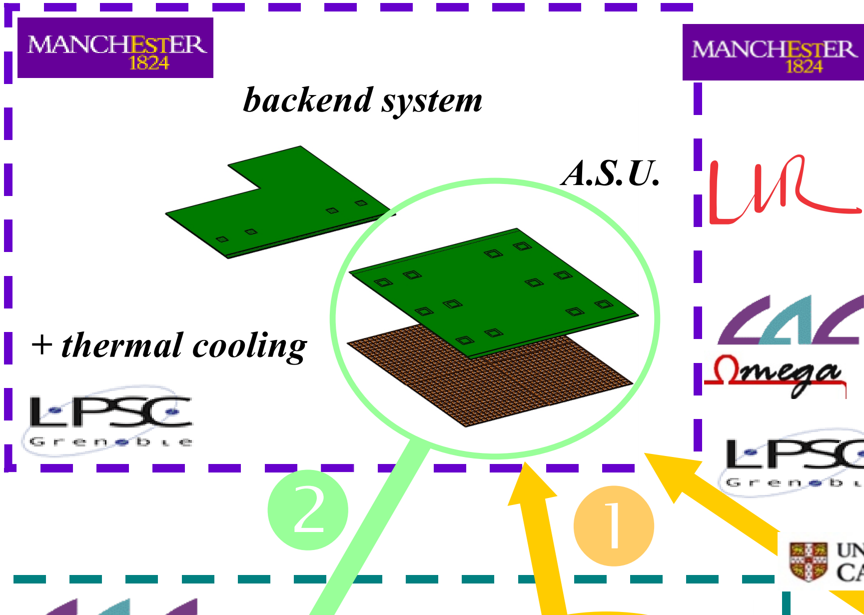
- **3 structures : 24 X_0 (10×1,4mm + 10×2,8mm + 10×4,2mm)**
- **sizes : 380×380×200 mm3**
- **Thickness of slabs : 8.3 mm (W=1,4mm)**
- **VFE outside detector**
- **Number of channels : 9720 (10×10 mm²)**
- **Weight : ~ 200 Kg**

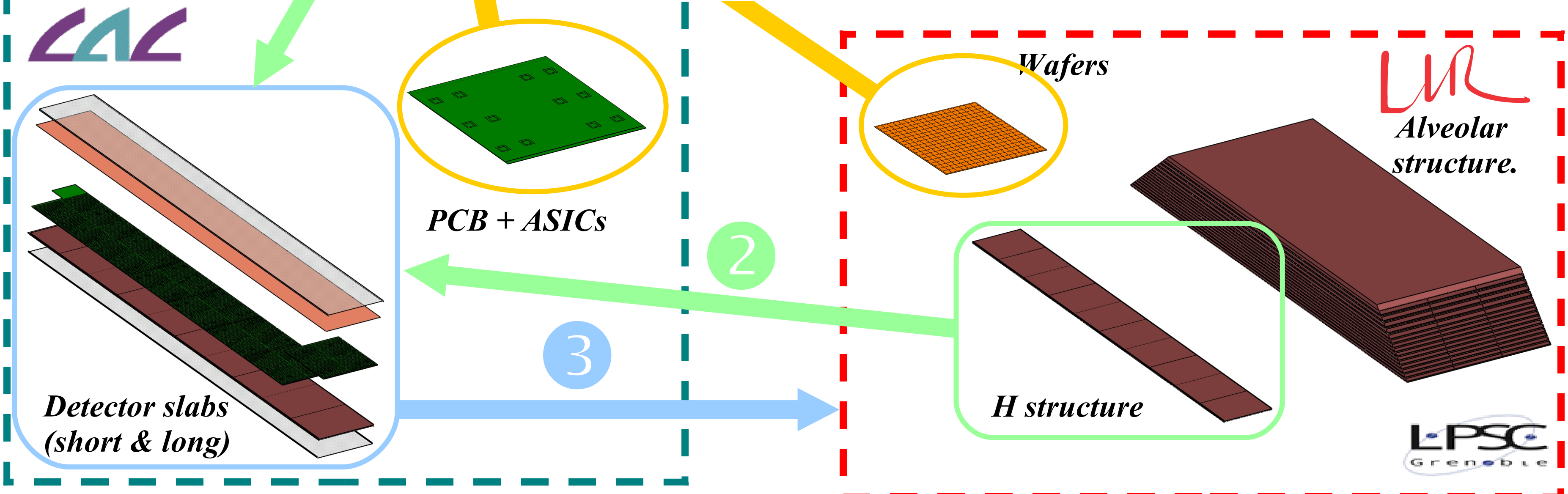
- **1 structure : ~ 23 X_0 (20×2,1mm + 9×4,2mm)**
- **sizes : 1560×545×186 mm3**
- **Thickness of slabs : 6 mm (W=2,1mm)**
- **VFE inside detector**
- **Number of channels : 45360 (5×5 mm²)**
- **Weight : ~ 700 Kg**

Parties Involved

6 Laboratories are sharing out tasks in according to preferences and localization:

- MANCHESTER 1824: Assembling of A.S.U. (industrialization, gluing and tests) + backend system (DIF support) + services
- LAL: Tests of wafers; Global Design + composite Structures
- LAL Omega + LPNHE: Thin PCB with embedded ASICs; Detector slabs integration
- LPSC Grenoble: External cooling system; Fastening system ECAL/HCAL+composite plates
- UNIVERSITY OF CAMBRIDGE: Interconnection of ASU, DIF





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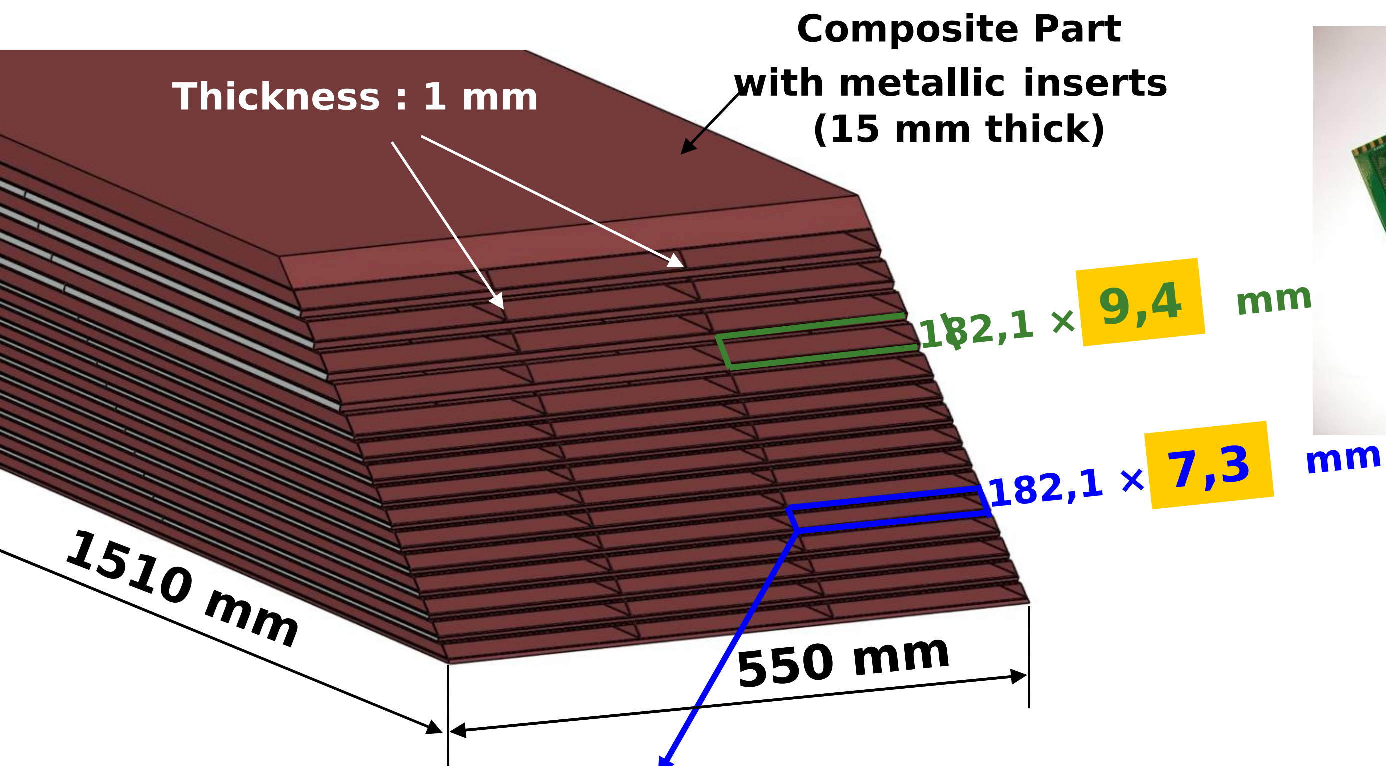
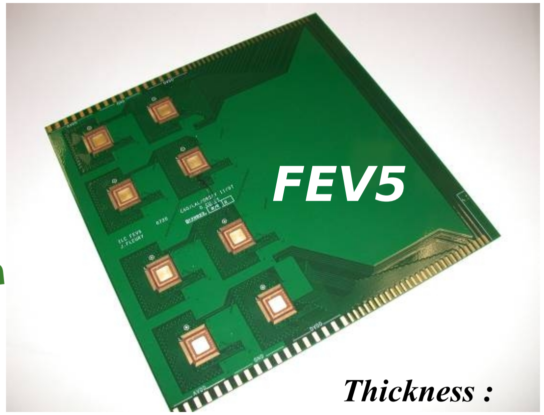
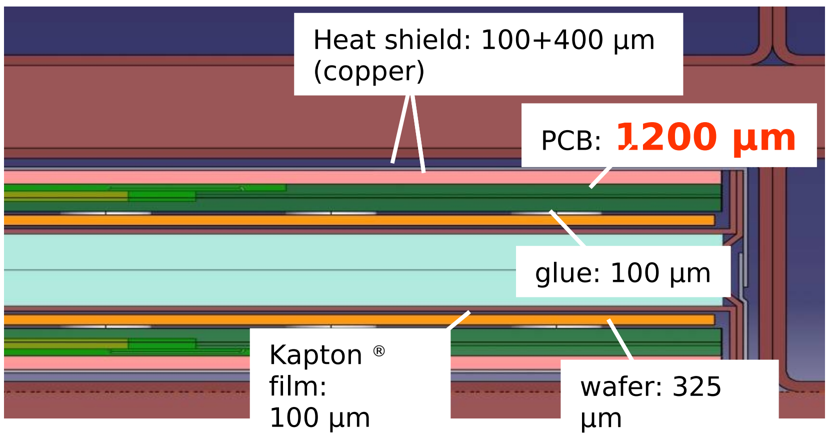
Module EUDET – Current Design (final – developped 2008)



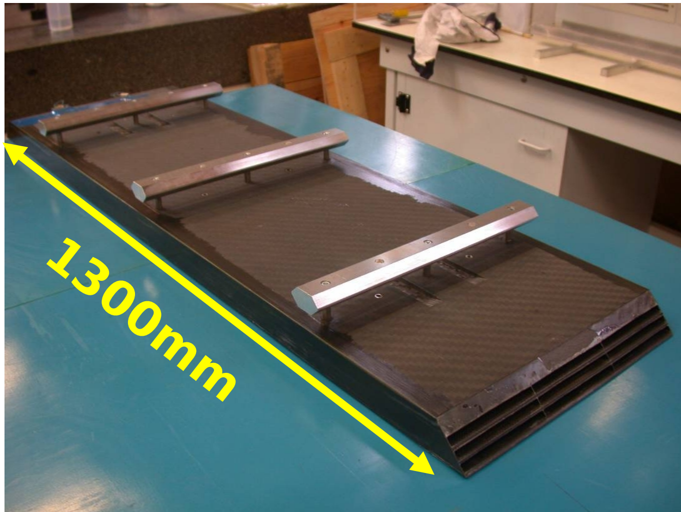


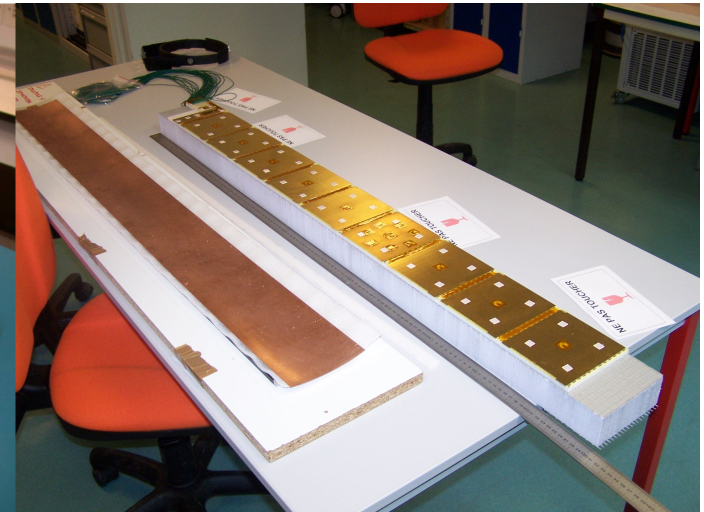
Thickness :
FEV5-1 : 1.17mm (+-0.04)
FEV5-2 : 1.19mm (+-0.04)
FEV5-3 : 1.20mm (+-0.02)

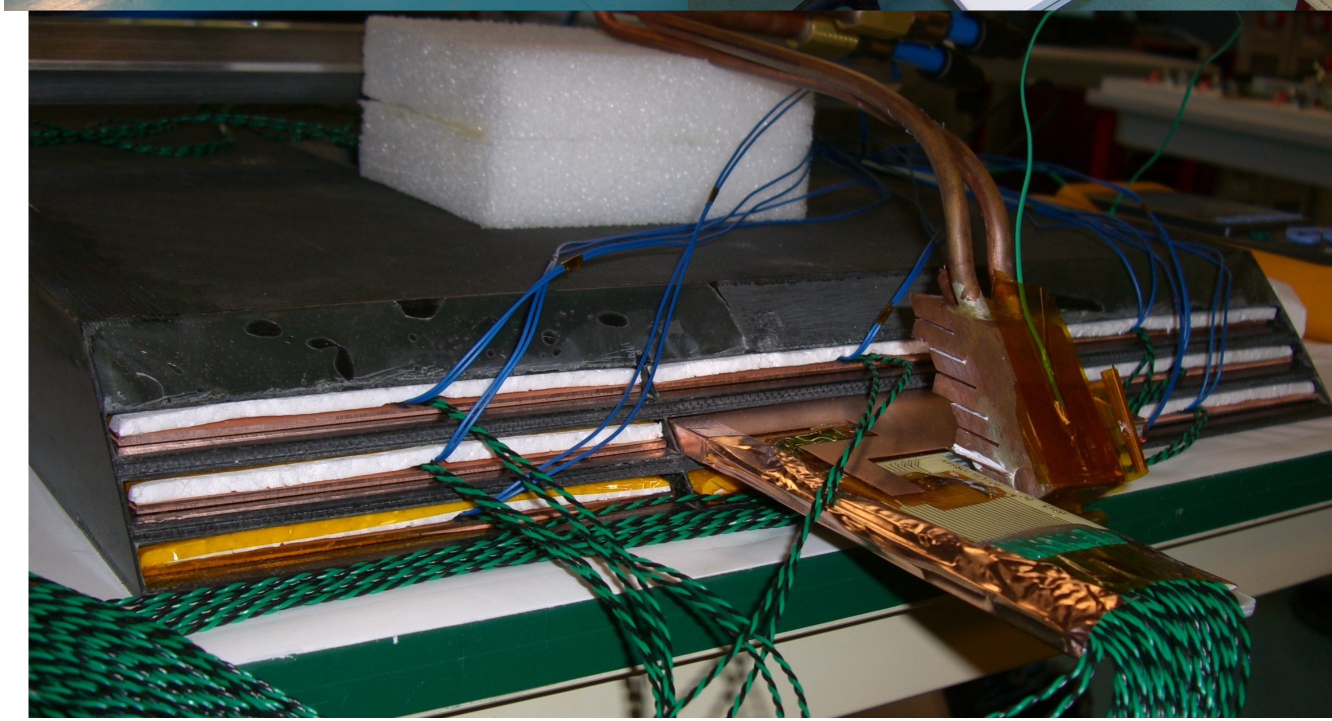


- ⇨ Gaps (slab integration) : 500 µm
- ⇨ Heat Shield: **400 µm ?** Validation with the demonstrateur
- ⇨ PCB : ~~800 µm~~ **~1200 µm**
- ⇨ Thickness of Glue : 100 µm
- ⇨ Thickness of SiWafer : 325 µm
- ⇨ Kapton® film HV : **100 µm ?**
- ⇨ Thickness of W : 2100/4200 µm (± 80 µm)

Assembly of Demonstrator



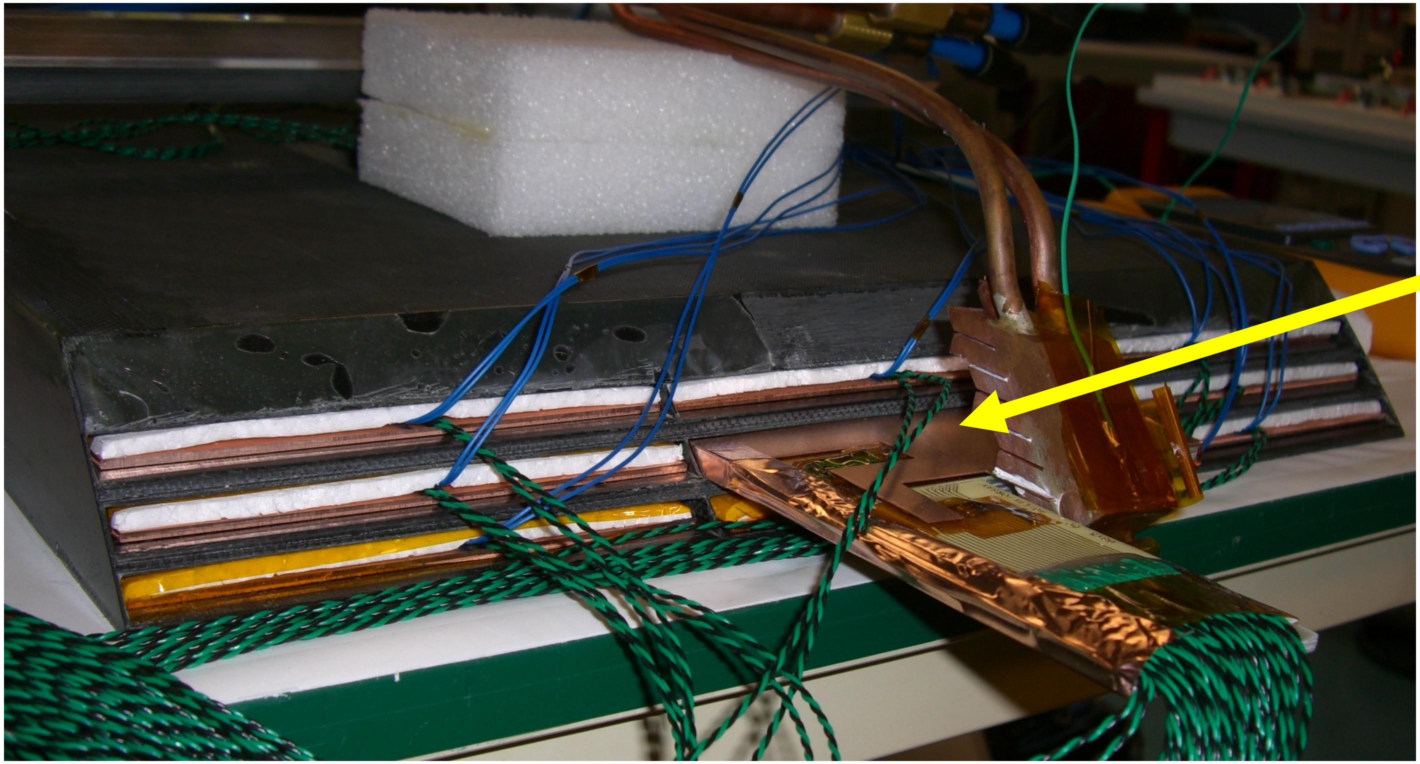




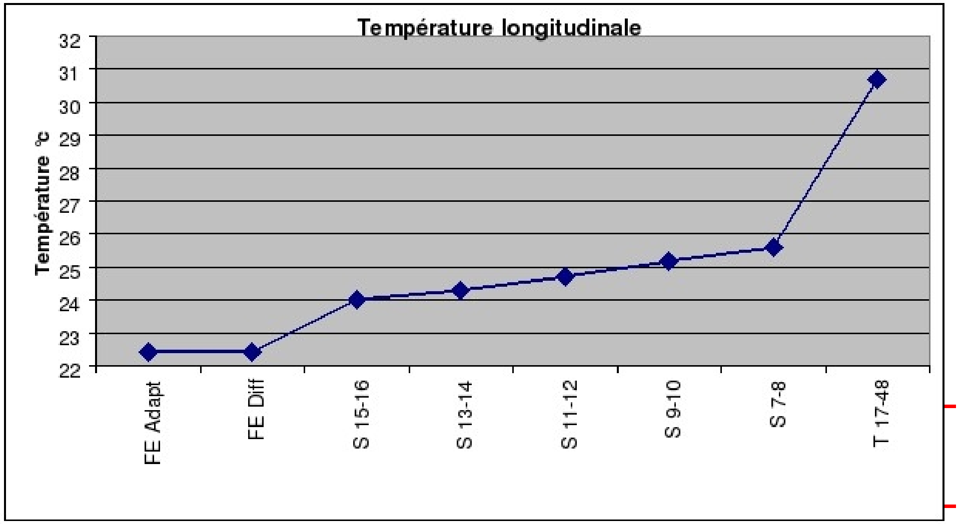
- Detector module realised (from mechanical point of view)
- Demonstrator subject to a thermal test

Thermal Test

To study thermal behaviour of detector module



Inserted Thermal Layer

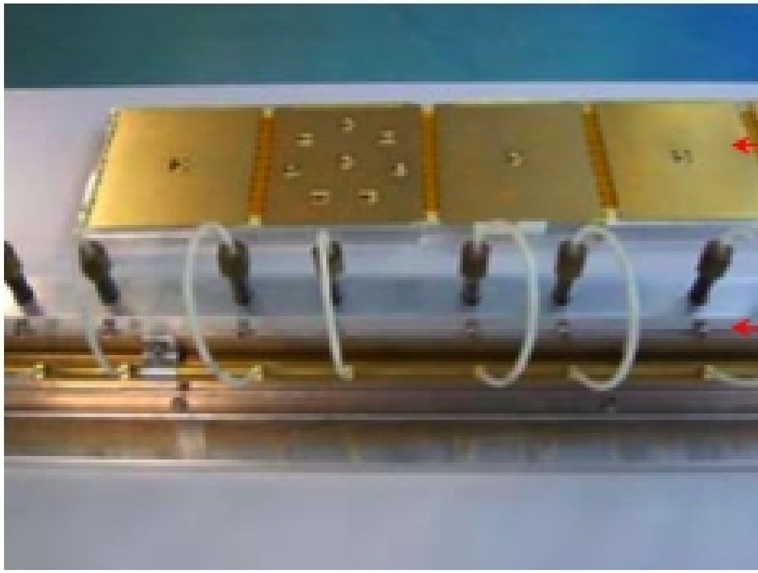


Ambient Temperature	22		
Alveolar Slot	Left	Middle	Right
External		23.5	
Upper	24.8	24.8	24.6
Lower	25	30.7	25.2
Bottom	25.1	25.2	25.1

- Detector Module realised from mechanical point of view
- Thermal test important for DBD

Assembly Tools – Handling of fragile layers

Handling by vacuum lifter



Line of ASU

Vacuum Lifter

Positioning of Vacuum Lifter on ASU Line

Vacuum Lifter

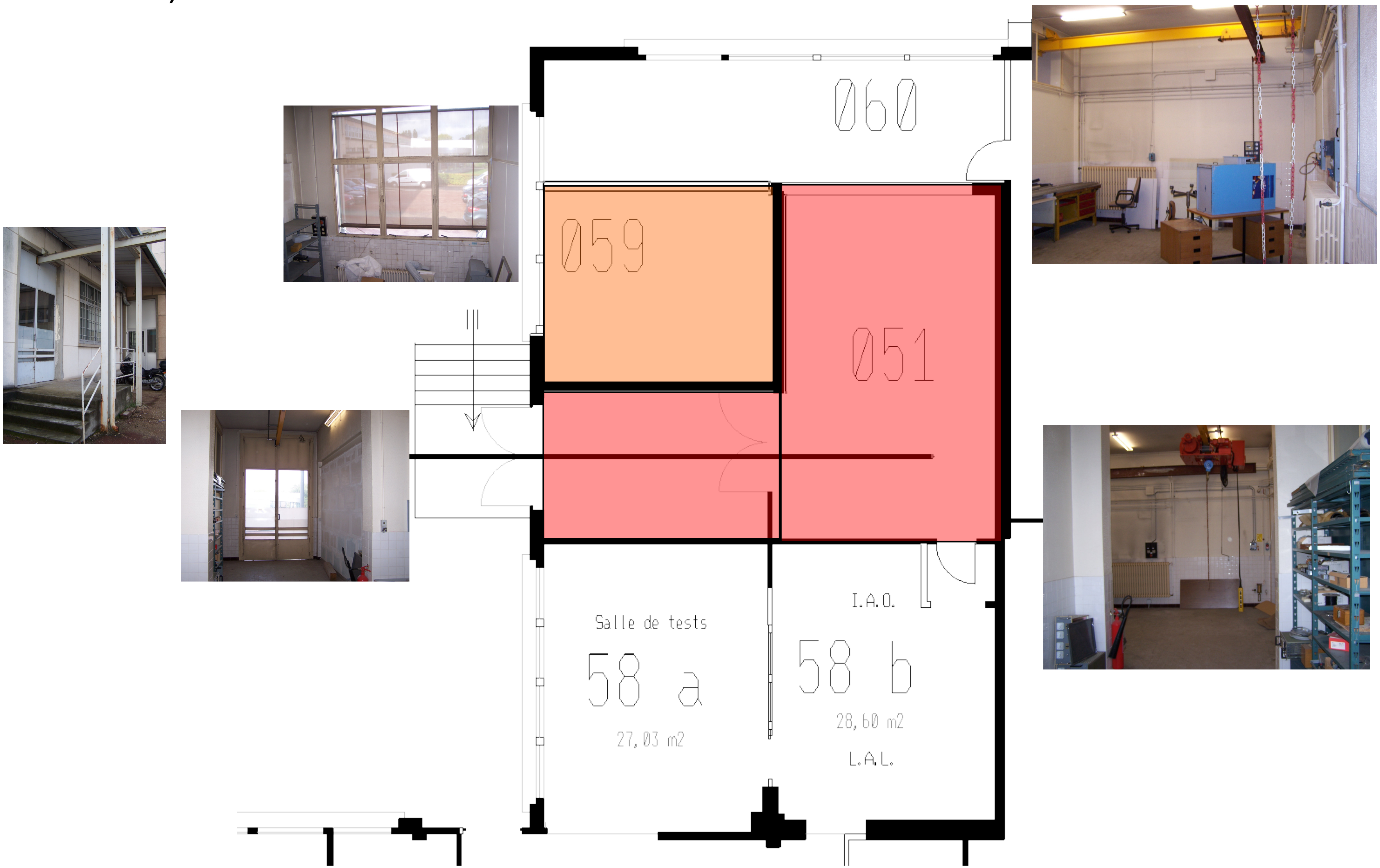
Line of ASU

(Careful) handling of ASU Line established

- Detector Assembly needs more tools and an assembly hall (to be built at LAL during autumn winter 2010/11)

LAL allocated facilities for Ecal

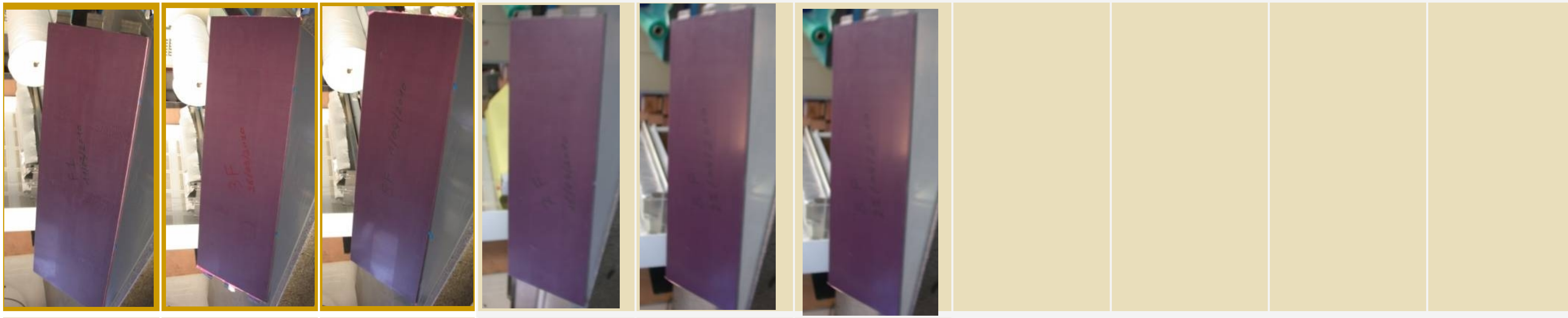
Hall present state _(hall 051:47m2 and hall 051+ hall 059:64m2)

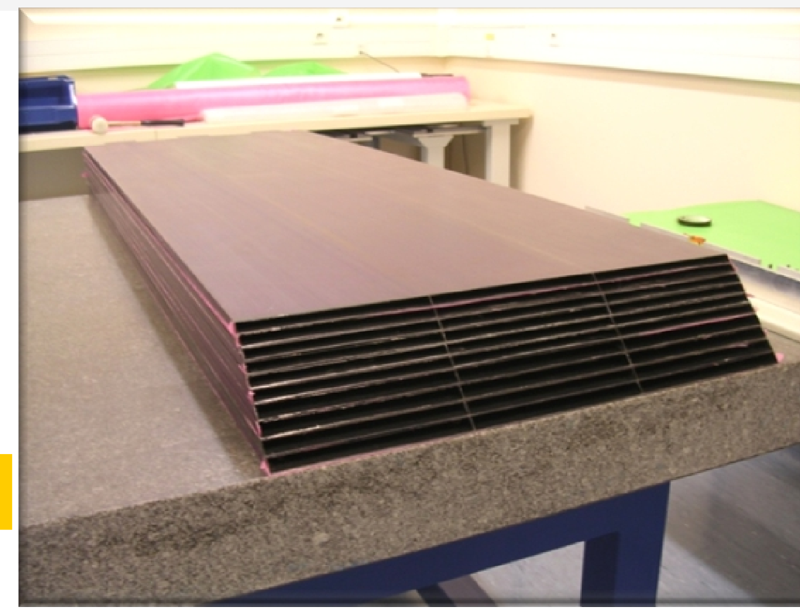


EUDET – Product layer (3/3)

Layer 7.3

⇨ 6/10 "Alveolar EUDET layer" structure : *On going*





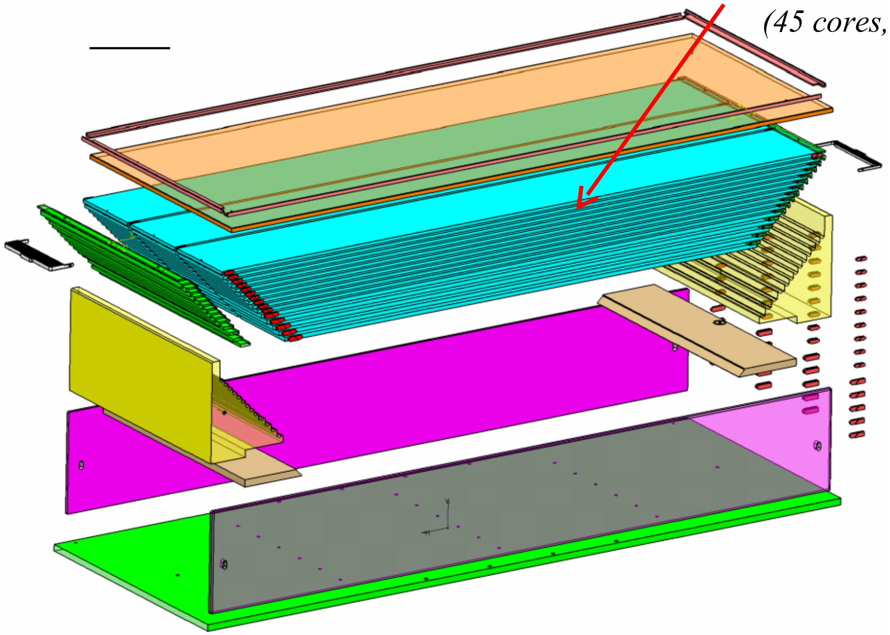
Layer 9.4

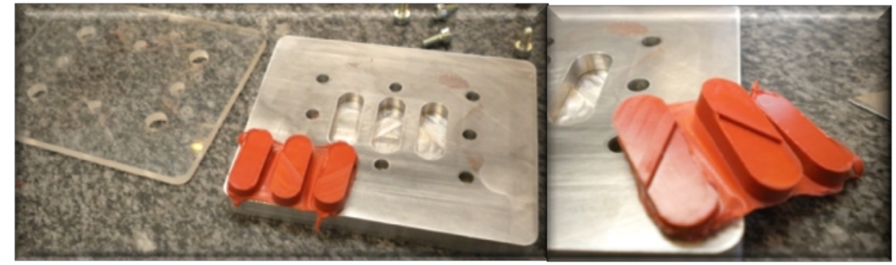
⇨ 3/5 "Alveolar EUDET layer" structure : *On going*

EUDET– Assembly Mould

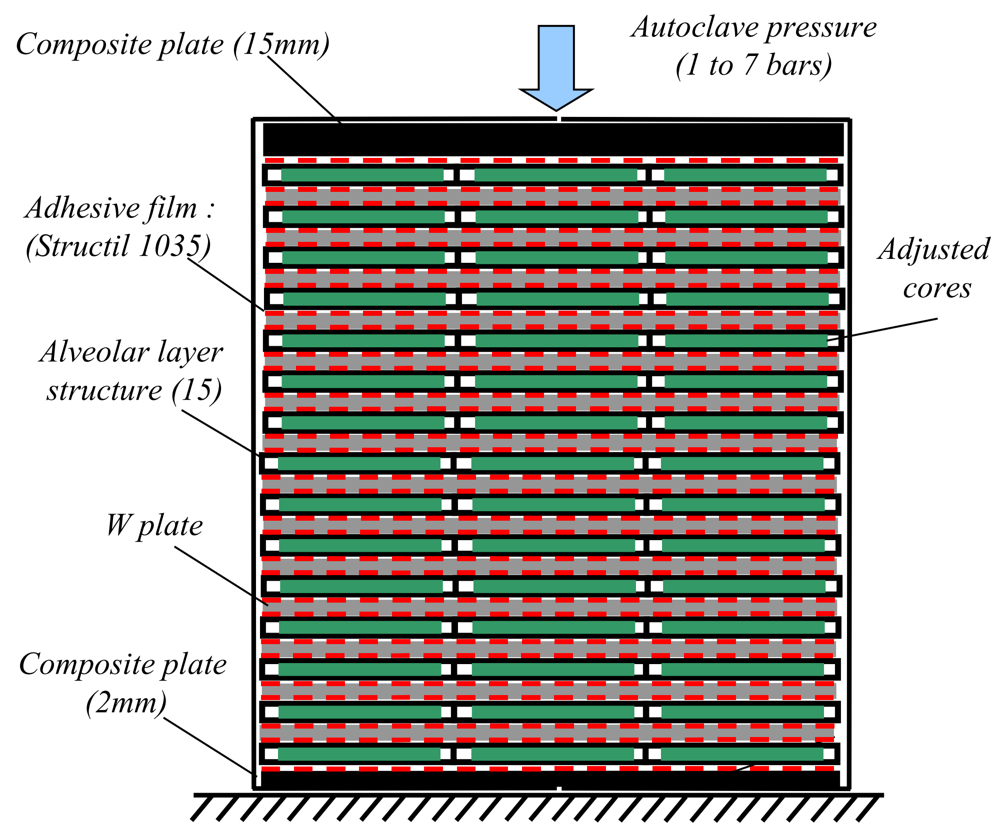
Now, here is the EUDET assembly mould :

ALUMINUM CORES (45 cores, 15 references)





Silicone part with the mould (180 Parts, 8 references)



- ⇨ Global design : *OK*
- ⇨ W and Carbon Needs : *OK*
- ⇨ Detailed design description : *OK*
- ⇨ Ordered : *OK*
- ⇨ Reception part : *July 2010*
- ⇨ Assembly : *October 2010*

EUDET Cooling system

Status of the portable cooling station for EUDET life:

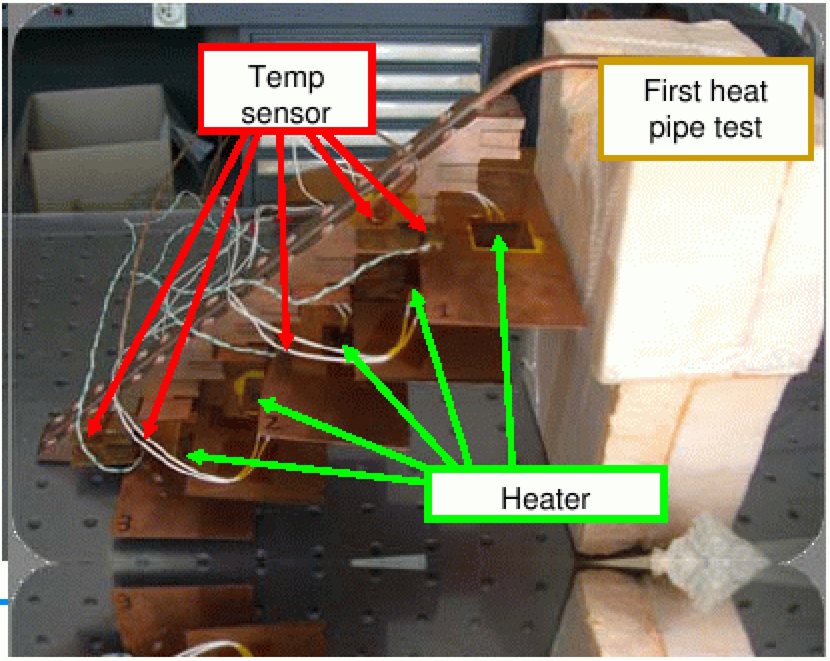
- Chiller and flow meter => ORDERED

- Important step : machining of heat pipe cooling system and water cooling system will begin after the final assembling of the alveolar structure (we need final dimension of the alveolar structure) => November 2010.

- Spring 2010 First test of heat pipe test (15 W design)
- November 2010 construction of both systems:

Heat pipe

Water cooling system for EUDET (143 W)

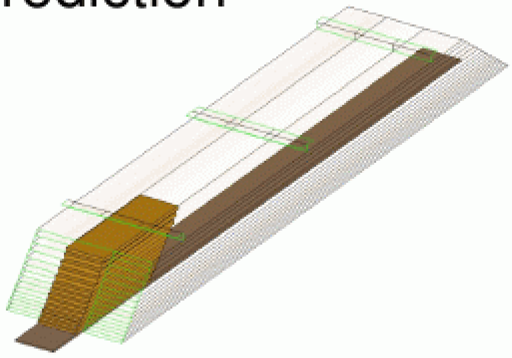


COOLING system for EUDET : march 2011

EUDET simulation

Calorimeter for ILC

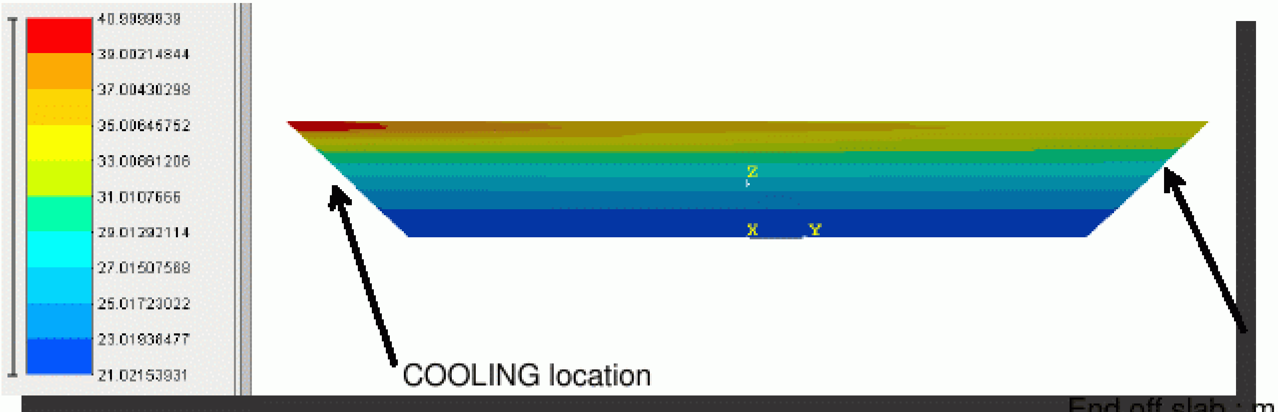
Thermal simulation with extreme power prediction



Extreme power pulsing on **ASU** => X 20 !

Initial total power for EUDET120 W => 143 W

Power on the longest SLAB : 8.2 W



COOLING location

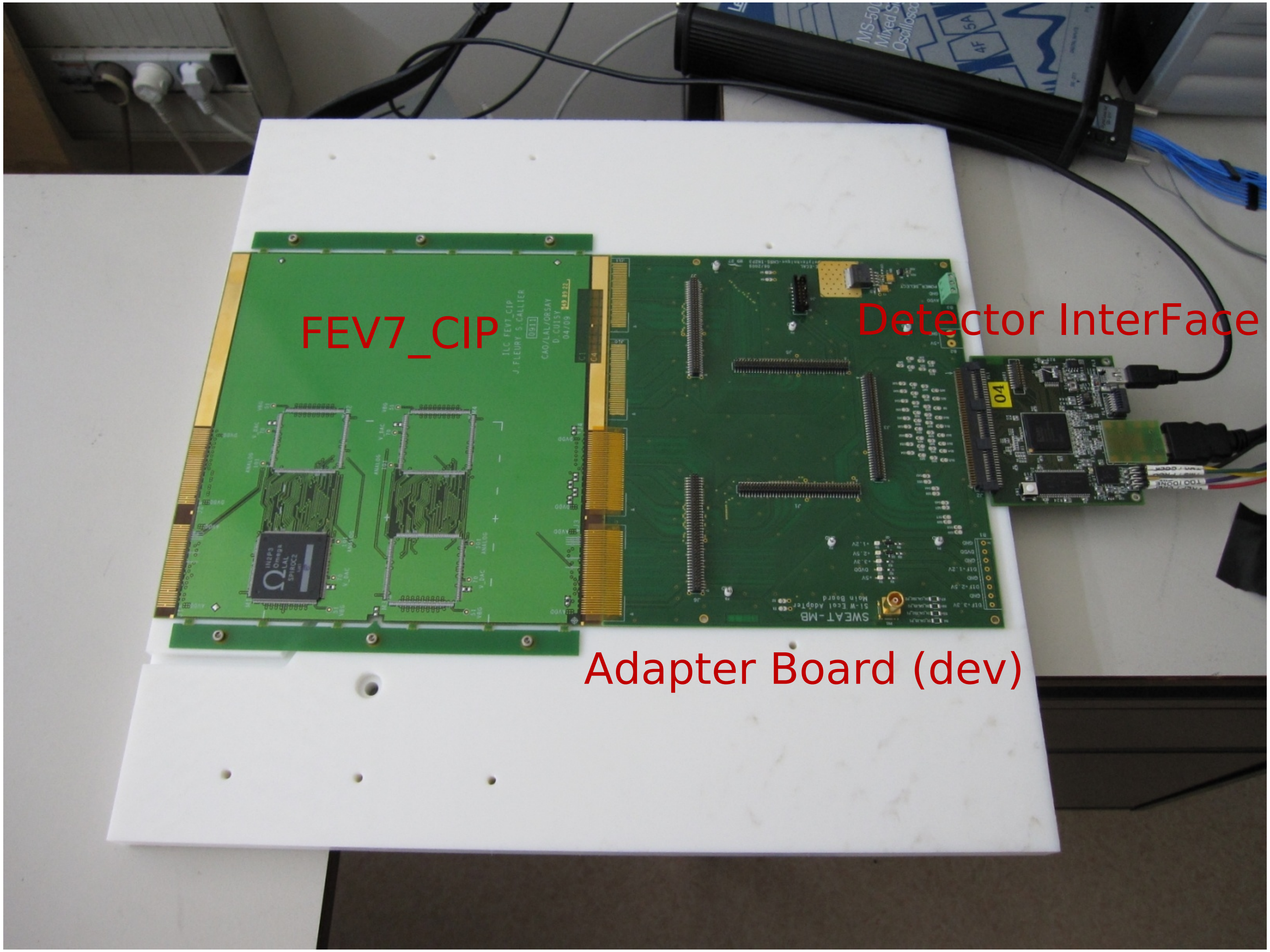
(High temp is due do ADAPT and DIFF power)

End off slab : max 35°c (natural convection reduce the temperature)

EUDET temperature estimation with natural convection

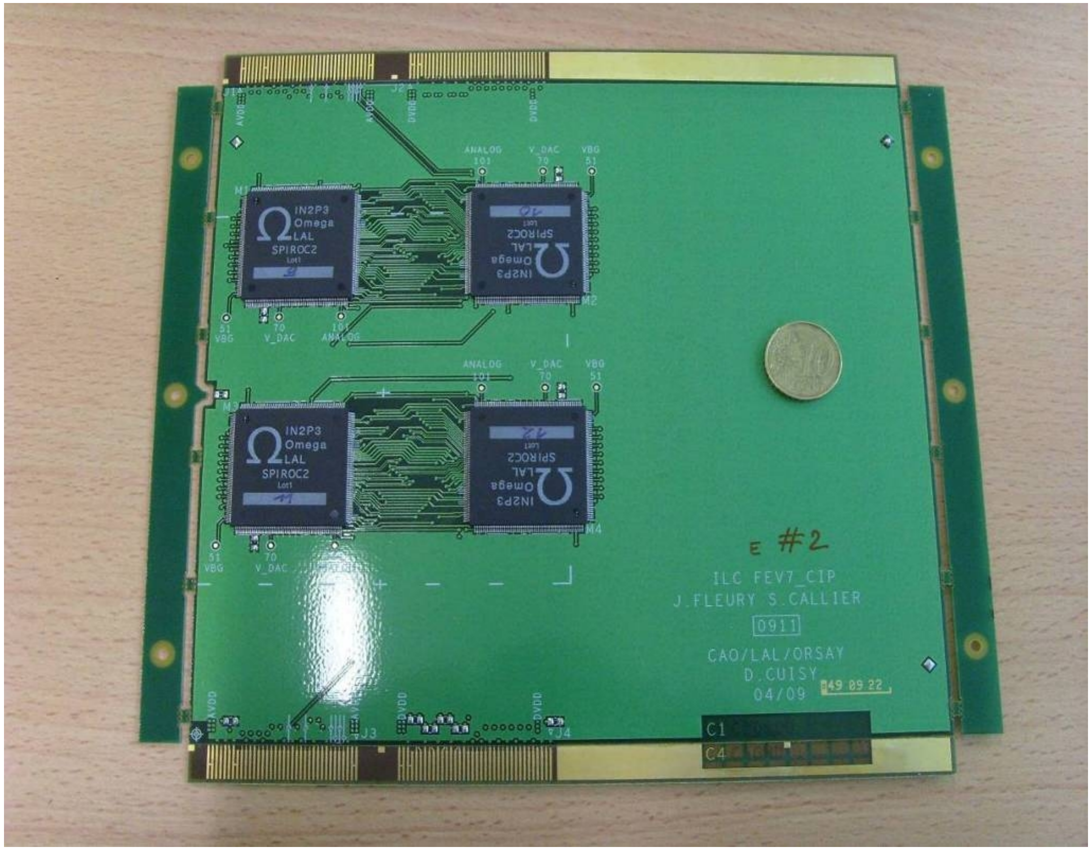
(test beam configuration)

First SLAB prototype (01/07/09)



FEV7-CIP: with SPIROC2 in TQFP208

- Easy to manufacture
- Interconnections tests: peoformed successfully (P. Cornebise)
- Perfect for DIF debug
- Fits the H structure



- 2 boards are equipped with 1 chip and 1 PCB equipped with 4 chips
- On the board access to :
  - Analogue Output
  - DAC and Bandgap Output
- On the connector, access to :
  - Every common digital line

Prototype on test bench

- CALICE DAQ about to be interfaced with the first prototype

- Expect working system during auoumn 2010

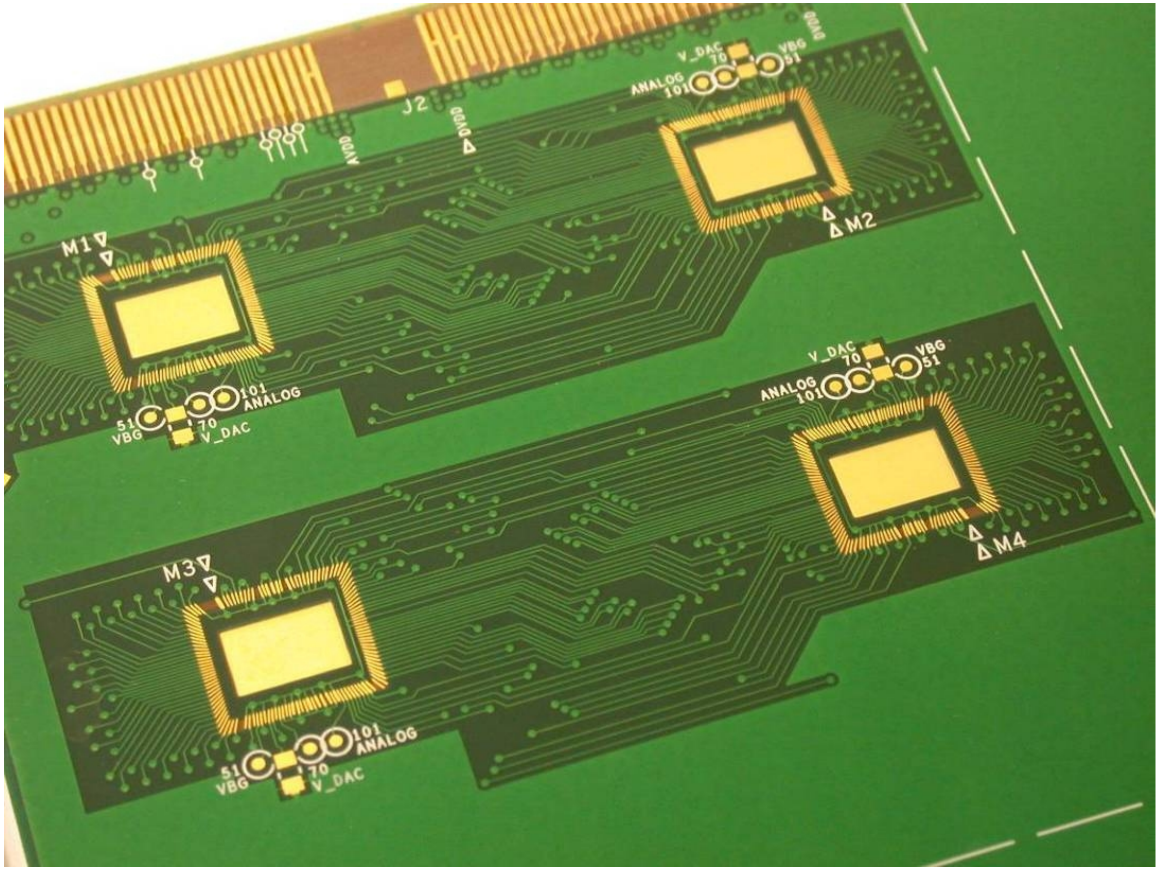
- A number of issues regarding firmware have been solved in the past year

FEV7-COB: with SPIROC2 COB

- Front End Board using Chip-On-Board (spiroc2=208 pads)

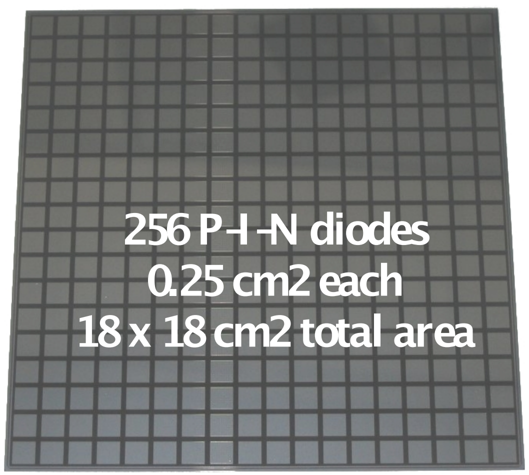
- Nearly Identical to Chip-In-Package FEV7
  - Schematics identical
  - Same number of channels
  - Same pinout on Adapter Board/Slab Connector

- Except :
  - Pads connections to chip pins
  - Position of Wafer on the bottom side
  - Thickness: thinner to comply with H alveolar structure



PIN Diodes Silicon Sensors

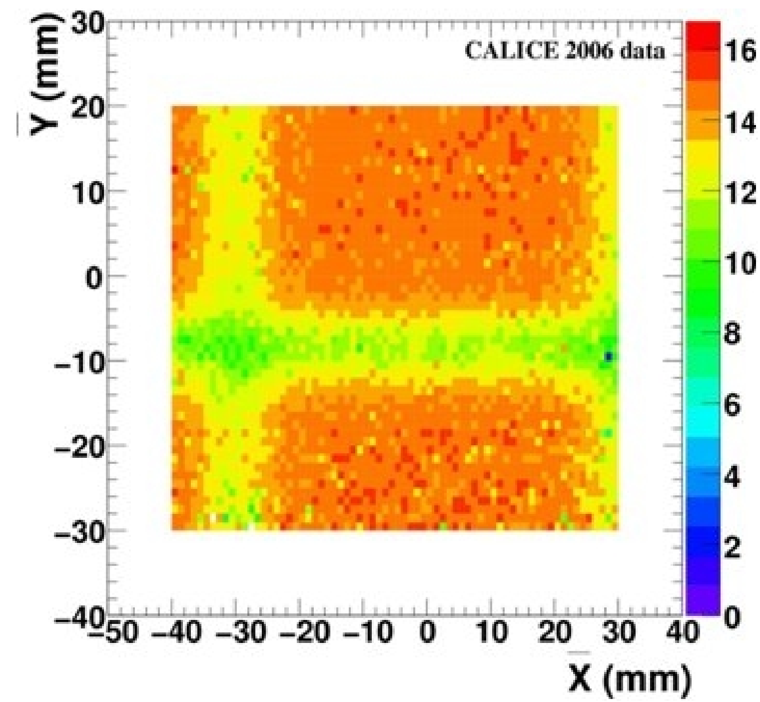
Designed for ILC : **Low cost, 3000 m2** Minimized number of manufacturing steps
Target is 2 EUR/cm2
Now : 15 EUR/cm2
Use of **floating guard-rings**



EUDET layout
Prototype from Hamamatsu

Known issues

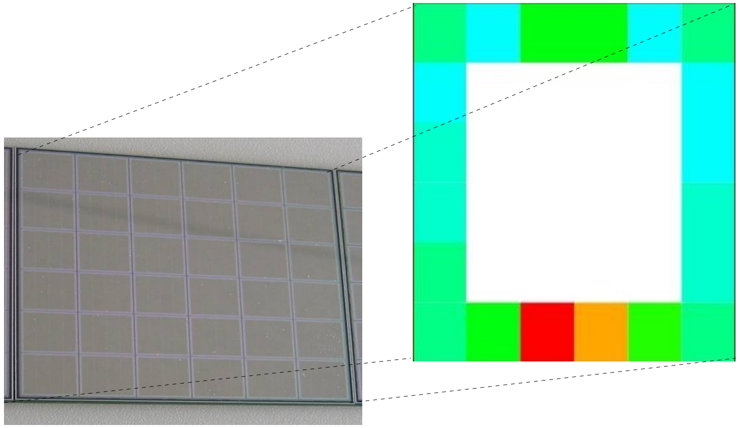
Dead space optimization
Guard-rings do not collect charges
Dead space to be reduced



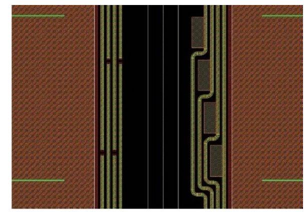
Hit map from physics prototype

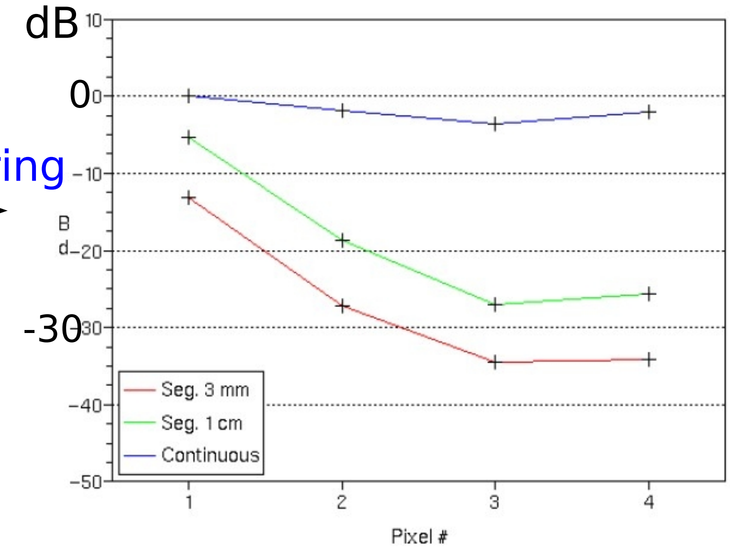
R&D for Silicon Wafers

Square Pattern in Wafer Response



Segmented Guardring



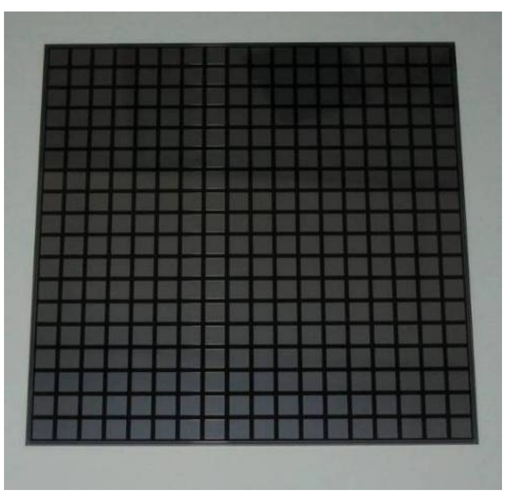


Xtalk Continous Guardring <-> Pixel

Attenuation of Xtalk

Beyond the Physics Prototype

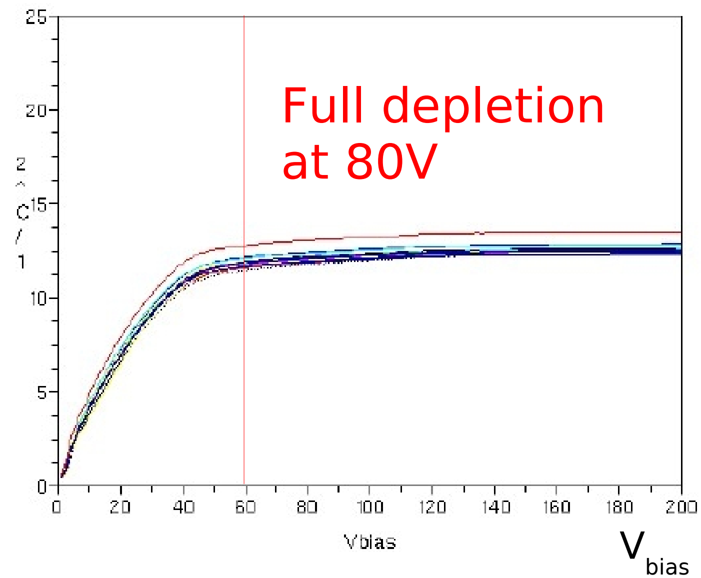
Wafers with smaller pixels



5x5 mm² pixels
~optimal "ILD width"

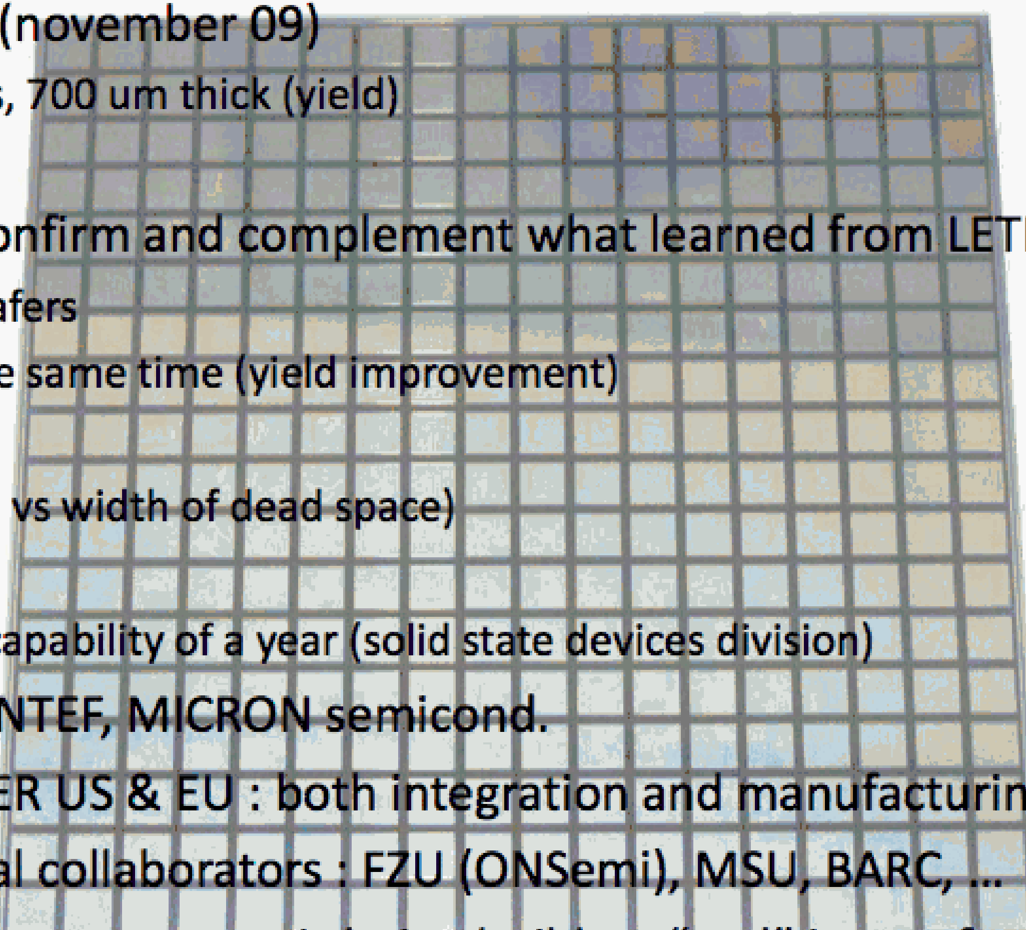
Thickness: 325 µm

Characterisation



Breakdown
at ~500 V

Industrialization

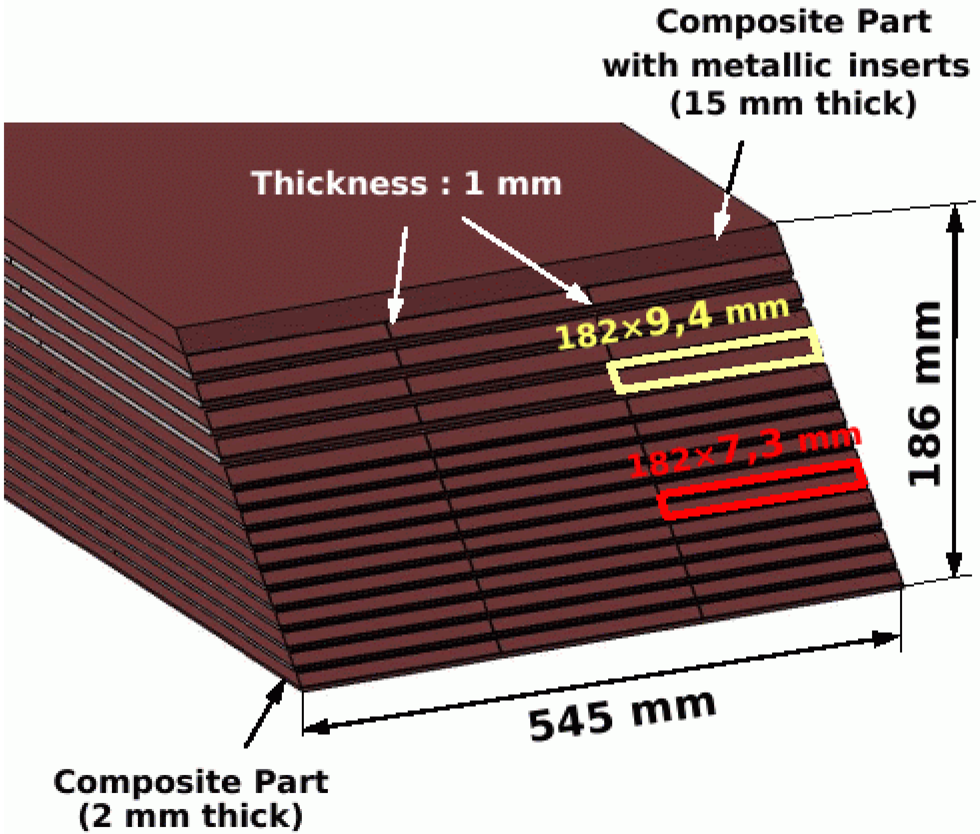


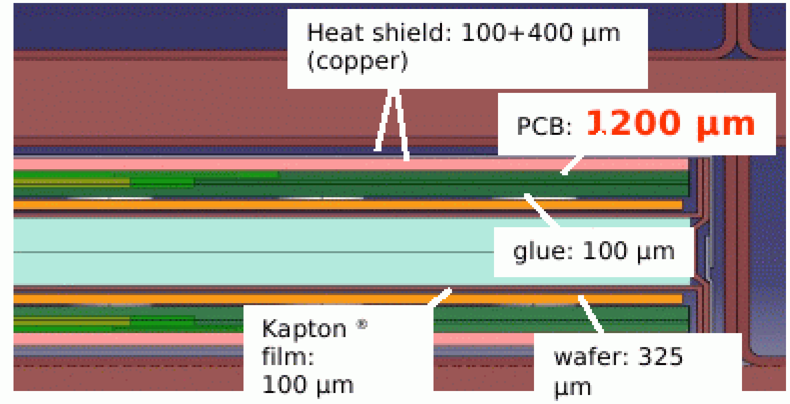
- Discussions with CEA/LETI (november 09)
  - 8 inches wafers, 4 matrices, 700 um thick (yield)
  - ST microelectronics
- Visit to HPK this month : confirm and complement what learned from LETI
  - Will use 6 then 8 inches wafers
  - 4 matrices processed at the same time (yield improvement)
  - R&D on laser sawing
  - Optimized thickness (yield vs width of dead space)
  - Optimized call of offer
  - ILD = 400% of production capability of a year (solid state devices division)
- Firsts contacts with VTT, SINTEF, MICRON semicond.
- In touch with PERKIN ELMER US & EU : both integration and manufacturing
- Not forgetting our historical collaborators : FZU (ONSemi), MSU, BARC, …
- More discussions needed but a strategy is being build on "real" inputs from manufaturers

R. Cornat: LLR

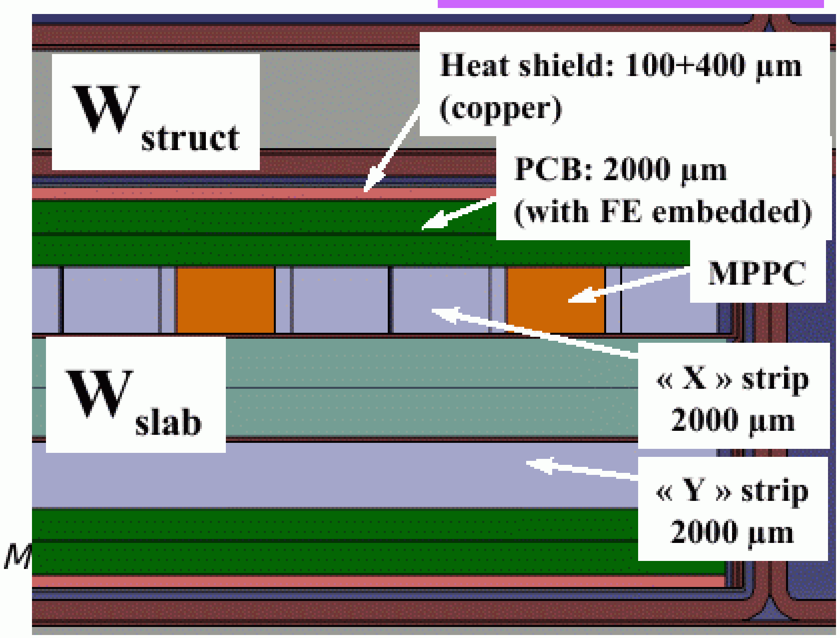
Alveolar structure (based on EUDET)

ECAL W/Si





ECAL W/Scin



Alveolar structure applicable for
alternative Ecal proposals
"TNA"

EUDET Annual M

Conclusion and Outlook

- Technical Design finished in Oct. 2008

  Preparation of Demonstrator Tests since then

- During 2010 - studies with the demonstrator
  - Measurement for thermal analysis
  - Assembly of alveolar structure finished
  - Integration tools for long slab very well advanced

Demonstrator studies
cover most if not all aspects described in EUDET proposal

Conclusion and Outlook cont'd

- Towards the EUDET Module

- Focus of getting the VFE accomplished

- “Shipping” signals out
  Interface to the DAQ is addressed

- Results with first ASU expected in the coming months
  Depends on development of DAQ interface

- Construction of Alveolar Structure for 'real' EUDET Module proceeds well

- Cost for Silicon wafers is an issue (well beyond EUDET matters)

- Beam tests with EUDET Module (or parts of it) foreseen within AIDA