Report on EUDET Mechanics

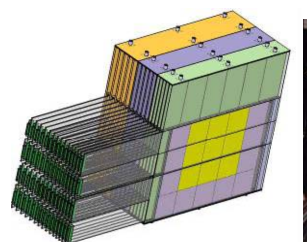
- *Global Design and composite structures:* Marc Anduze
- *Integration Slab and thermal measurements:* Aboud Falou
- *Cooling systems and thermal simulations:* Denis Grondin
- *Gluing of ASU:* David Bailey
- *Interconnect system:* Maurice Goodrick

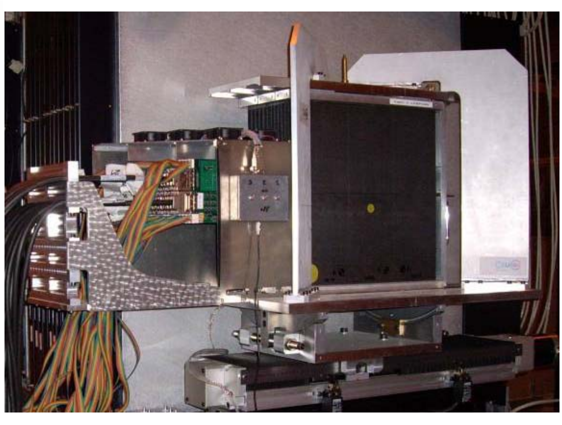
CALICE meeting - Manchester

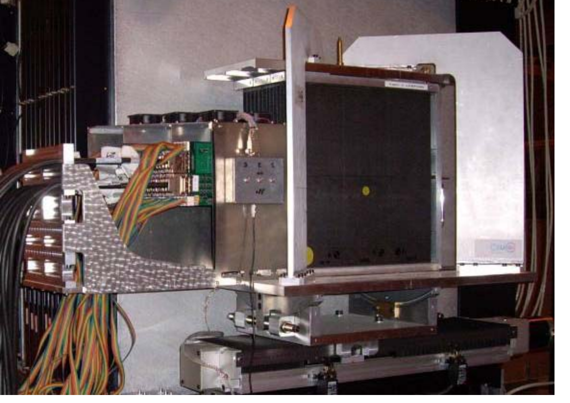
Marc Anduze – 09/09/2008

Technological prototype : EUDET module

- Logical continuation to the physics 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, sizes of structures,...)
- Taking into account industrialization aspect of process
- Finest cost estimation of one module







Physical prototype

Technological prototype

3×15 cells

Short detector slabs (×14)

EUDET

Long detector slab (1)

Complete Tower of 4 wafers = 18×18 cm²

Physical prototype	Technological prototype
• 3 structures : 24 X_0 (10×1,4mm + 10×2,8mm + 10×4,2mm)	• 1 structure : ~ 23 X_0 (20×2,1mm + 9×4,2mm)
• sizes : 380×380×200 mm3	• sizes : 1560×545×186 mm3
• Thickness of slabs : 8.3 mm (W=1,4mm)	• Thickness of slabs : 6.8 mm (W=2,1mm)
• VFE outside detector	• VFE inside detector
• Number of channels : 9720 (10×10 mm²)	• Number of chan. : ~37890 (5.5×5.5 mm²)
• Weight : ~ 200 Kg	• Weight : ~ 700 Kg

EUDET - Current design

Composite Part
with metallic inserts
(15 mm thick)

Thickness : 1 mm

182×8,6 mm

182×6,5 mm

1510 mm

550 mm

FEV5

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

+ 0.8 mm !!!
due to real PCB thickness

Heat shield: 100+400 µm (copper)

PCB: 1200 µm

glue: 100 µm

Kapton ® film: 100 µm

wafer: 325 µm

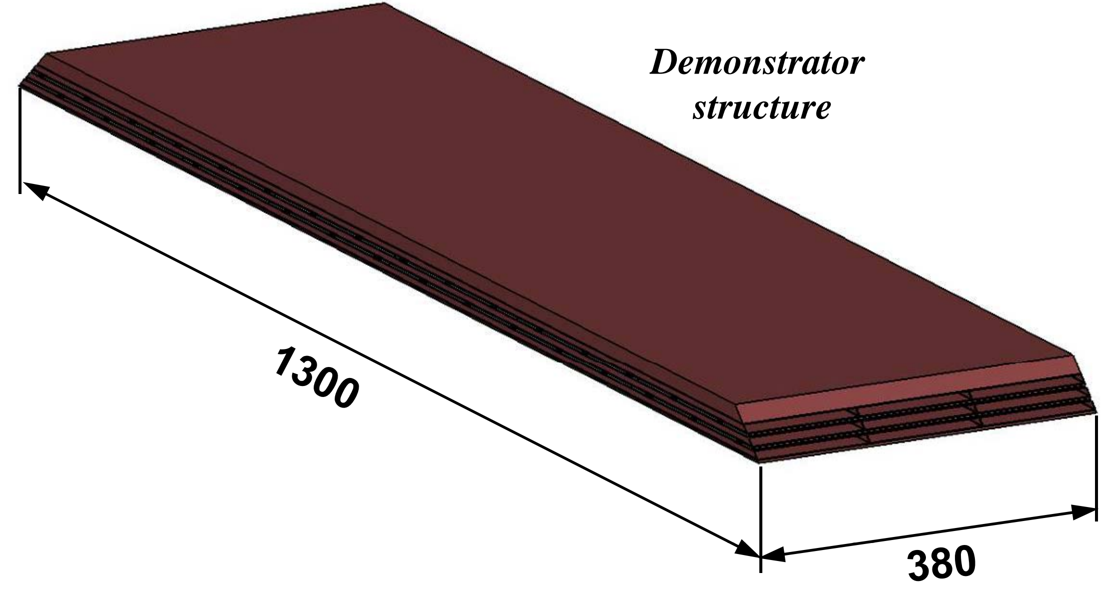
- ⇨ Gaps (slab integration) : 500 µm
- ⇨ Heat shield : **400 µm ?** Validation by the demonstrator
- ⇨ PCB : ~~800~~ µm → **1200 µm**
- ⇨ Thickness of glue : 100 µm
- ⇨ Thickness of wafer : 325 µm
- ⇨ Kapton® film HV : **100 µm ?** (Need to be tested)
- ⇨ Thickness of W : 2100/4200 µm (± 80 µm)

Demonstrator - Design

- We plan to build a first small demonstrator to validate all composite process before the EUDET module
- Width based on physic prototype (124 mm)

  ⇒ designed before the validation of all Eudet dimensions !!!
- Could be used for thermal studies and analysis : design of a thermal PCB and cooling system close to EUDET design
- First test of slab integration (with gluing, interconnection …)

• 3 alveolar layers + 2 W layers
• 3 columns of cells : representative cell in the middle of the structure
• Thermal studies support
• Width of cells : 126 mm
• Identical global length : 1.3m and shape (trapezoidal)
• Fastening system ECAL/HCAL



Demonstrator – Alveolar structure

Assembled structure : Each alveolar layer ❶ are done independently , cut to the right length and angle (❷) and bonded alternatively with W plates in a second curing step. The assembling is closed by 2 composite plates ❸ of 15 mm and 2 mm thick (from LPSC)

first test of alveolar layer

1520

top composite plate (15mm)

Adhesive film (0.2 mm)

Autoclave pressure (1 to 7 bars)

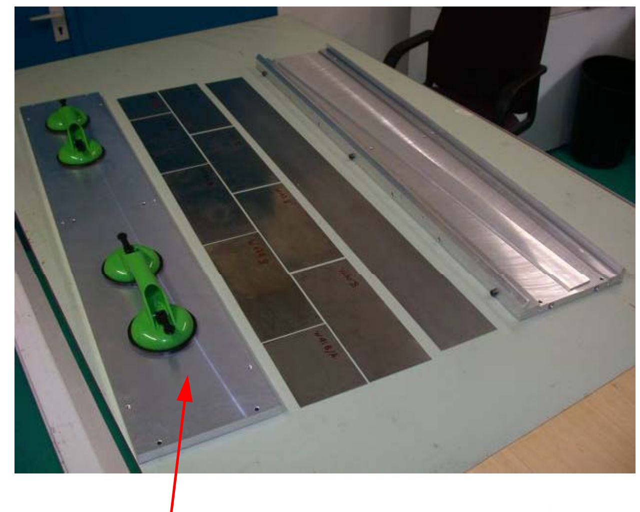
Adjusted cores

- ⇨ Global design : *OK*
- ⇨ "Alveolar layer" first test ❶ : *OK*
- ⇨ Cutting test ❷ : *OK*
- ⇨ Composite plates ❸ (15mm and 2 mm) : *OK*
- ⇨ Design assembling mould : on going

Demonstrator - H structure

Study of one mould for whole structures:

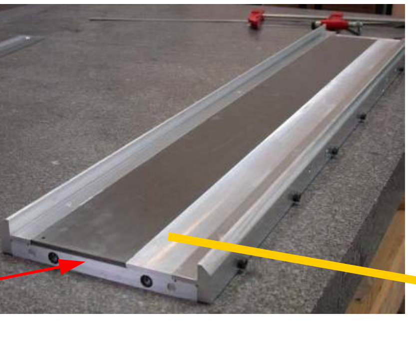
- Same principle than the mould used to do H physical prototype structures but using the autoclave)
- One long mould for both long and short H structures and 2 width (124 and 180 mm)

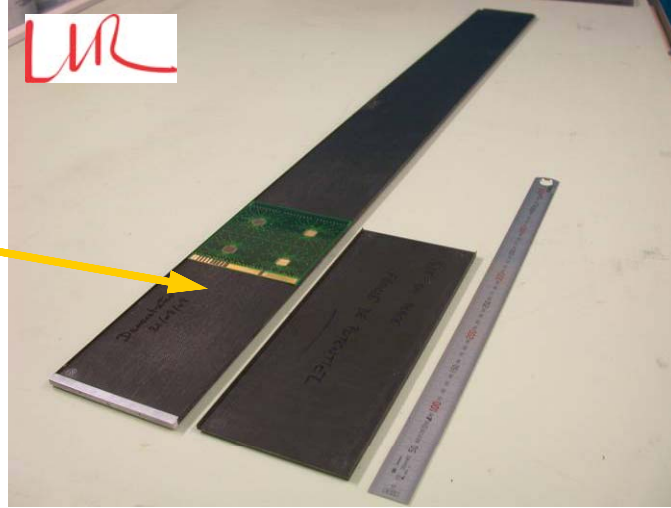


⇨ Design : *OK*

⇨ machining : *OK*

⇨ first H structure (1300×124): *OK*





H structure (180 mm)

H structure (126 mm)

Demonstrator – Thermal studies

Slab cooling tests (1 Hot ASU + 8 thermal ASU):

- Correlation with simulations (transfer coefficients, contacts …)
- Check a thermal dissipation behaviour close to EUDET design
- Validate the cooling system (400 µm copper plate drain + pipes)

Copper (400 µm)

Hot Points (for chips)

Σ_{power} : 0.2W to 1 W

Hot Point (for FPGA)

200mW to 2 W

T_1 T_2 Ti

124.5

124.5

1120 mm

Cooling system

- ⇨ Design : OK
- ⇨ Simulations : OK
- ⇨ PCB : on going
- ⇨ Copper plate : on going
- ⇨ Interconnect : on going
- ⇨ Exp. setup : on going

Simple interconnect system

8mm

5mm

Ø 0.11 mm

PCB thickness : 752.5 µm

600 µm

150 µm

0.5mm 5mm

Load case (exemple)

DIF

full amplitude : 28.5 °c
ship amplitude : 12 °c

FPGA

Load case 2 : copper 0,4mm; SHIP power : 0.205 W;
FPGA power : 2 W distributed : 55 x 77.5 (KAPTON)

EUDET – Gluing of ASU

Principle is close to the physics prototype :

- Sony Robot and precision glue dispenser tool (glue: EPO-TEK® 4110)

But more industrial:

- Vacuum system to hold PCBs and wafers during all operations
- Alignment of wafer and PCB pixels using a viewing system

Sony robot

MANCHESTER 1824

⇨ Robot adaptation and tools : *OK*
⇨ Glue dot parameters : *OK*
⇨ Tests with Cambridge PCBs: on going

Reproducible dots

Vacuum supports

MANCHESTER 1824

wafers

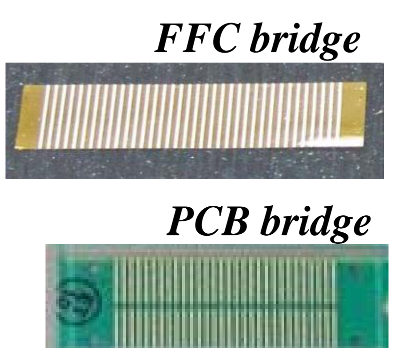
ASU

Calibrated spacers (control gap thickness)

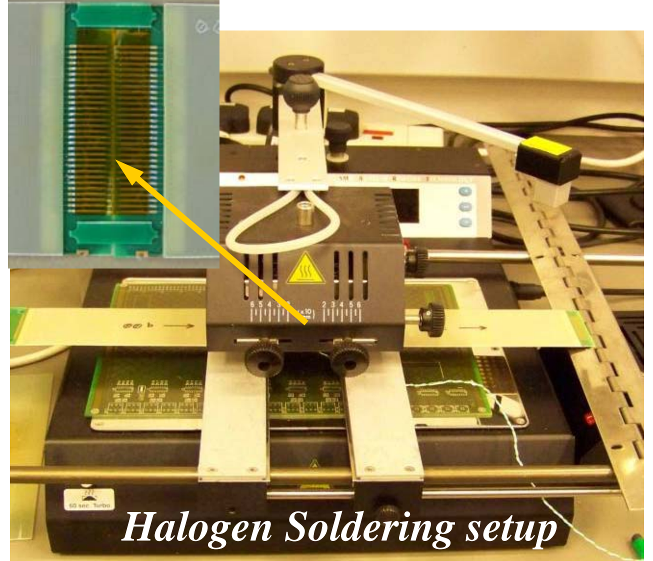
EUDET – Interconnect system

- Use "Bridges" principle to link multiple connections (30-40 each) between all adjacent ASUs (embedded in the thickness)
- Different designs tested: Short Flat Flexible Cable (electrical joint)

  Thin PCB (electrical & mechanical joint)
- Thermal Bonding process investigations :
  - good electrical behaviour (voltage drop, crosstalk)
  - Use Soldering setup with no stress and damage for wafers (temp & pressure parameters)
  - Remove and rework the joint (dismounting aspect)


FFC bridge

PCB bridge


Halogen Soldering setup

Laser soldering setup

- ⇨ Bridges design : *OK*
- ⇨ First bondings (FFC & PCB): *OK*
- ⇨ Electrical tests: **on going**
- ⇨ Re-flow system: *OK*
- ⇨ Interconnect of ASU: **on going** (with wafers glued)

Schedule

MANCHESTER 1824	Gluing tests:	
	Thermal ASUs	Nov 08
	with EUDET ASUs prototypes	Dec 08
	of EUDET wafers (Hamamastu)	Dec 08
LLR	**Assembling mould** design and fabrication	Nov 08
	Demonstrator (3 layers – 126 mm)	Dec 08
	EUDET module **structures** :	
	design needs to be fixed	Now !!!
	Final moulds design and order	Nov 08
LAL	Copper **drain & shield** design and fabrication	Nov 08
	Integration slab **tools** for demonstrator and **assembling**	Nov 08
	Thermal slab	Dec 08
LPSC Grenoble	**Experimental setup** for demonstrator	Oct 08
	Cooling pipes for EUDET	Nov 08
	Updated numerical **simulations** for demonstrator	Oct 08
UNIVERSITY OF CAMBRIDGE	Soldering setup **parameters** (pressure, temp)	Oct 08
	Interconnection tests on **ASUs + wafers**	Dec 08