Impact of HCAL mechanical stability on the ECAL Barrel design

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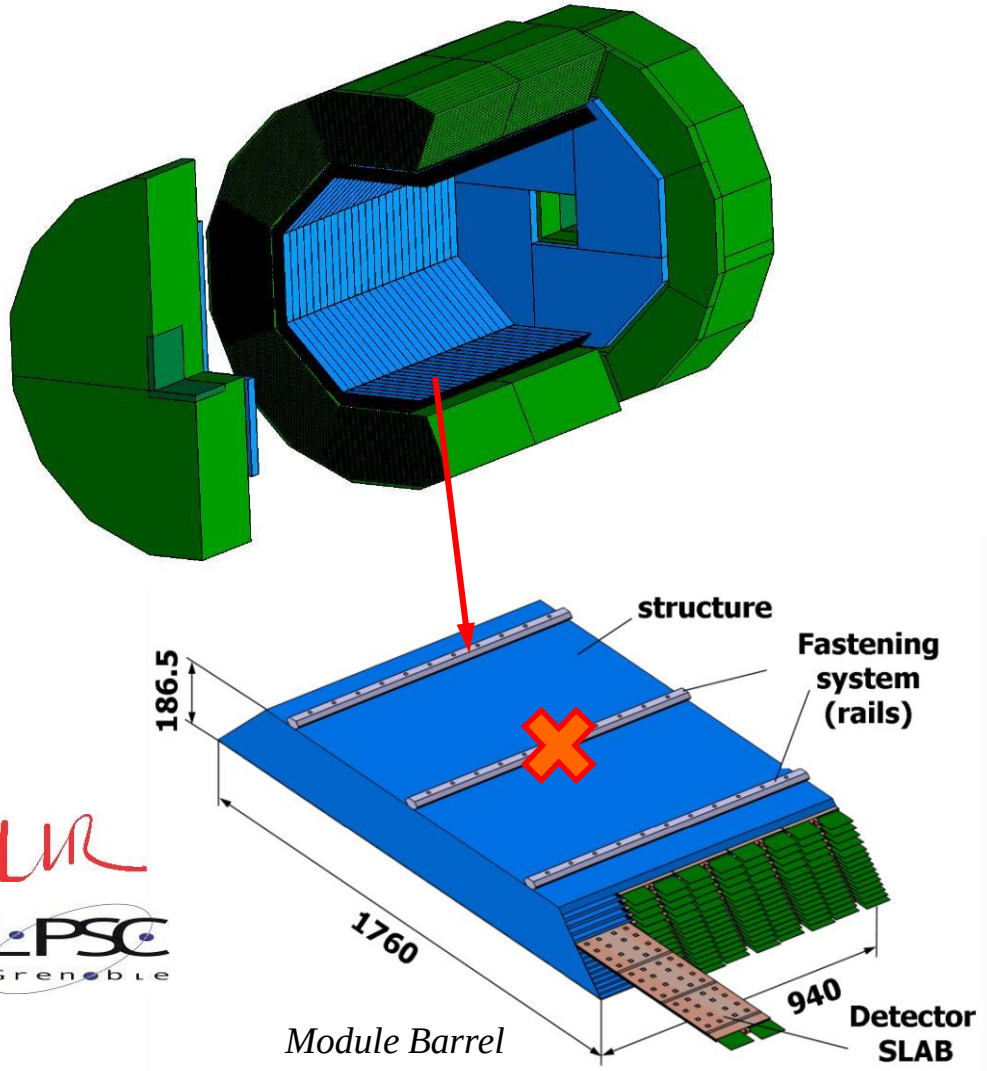
ECAL – Current baseline (1/2)



Module Barrel

- W/Si calorimeter (24 X_0 with 30 W layers)
  Weight full ECAL: ~ 132 T (100 $_{barrel}$+32 $_{End-Cap}$)
- Barrel : 40 identical trapezoidal modules
- End-Cap : constituted of 12 modules (3 types) for 4 quadrants

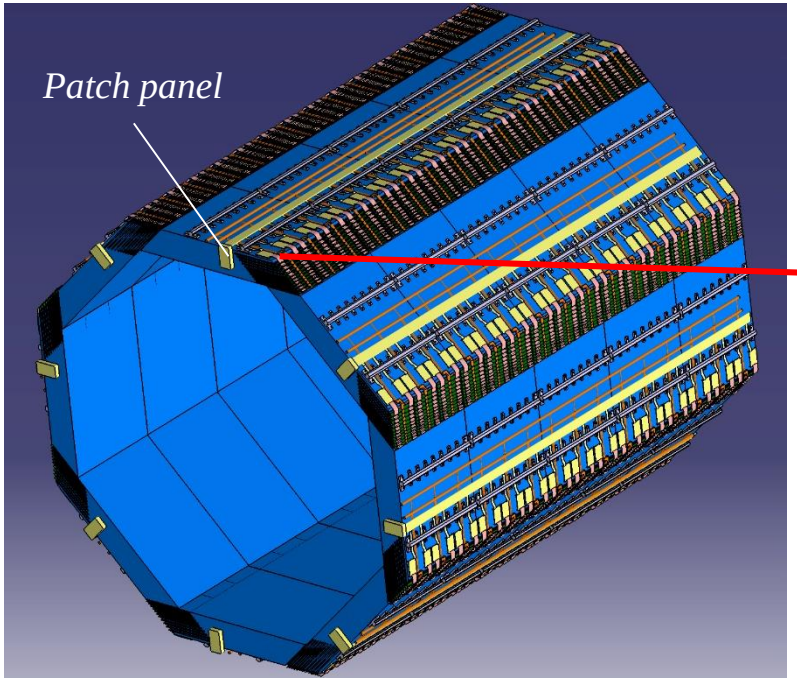
- ECAL module : alveolar structure
  - Concept of self-supporting alveolar structure which is made of composite material (Carbon fibers/Epoxy) including half of the absorber (W)
  - ECAL module is hung on the HCAL absorber by using of 2 rails

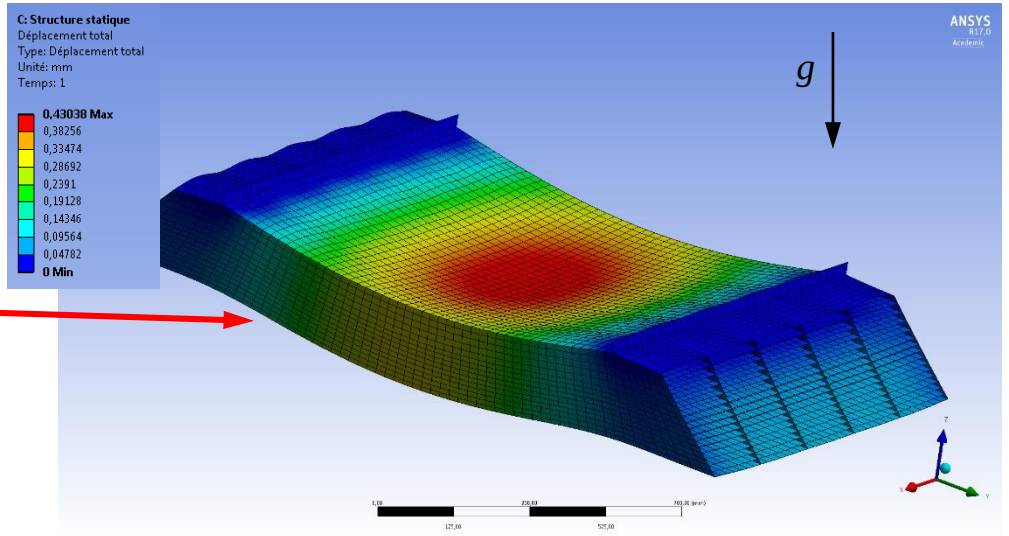
- Detection elements (detector slab) in each alveolar case (Si+W), FE chips integrated, pad size : 5×5 mm^2

ECAL – Current baseline (2/2)

Aim of the design : Obtain a suitable electromagnetic calorimeter to recognize each particle of an event (PFLOW)

For the ECAL W/Si : High Density, compactness, and granularity of this calorimeter with minimum dead zones

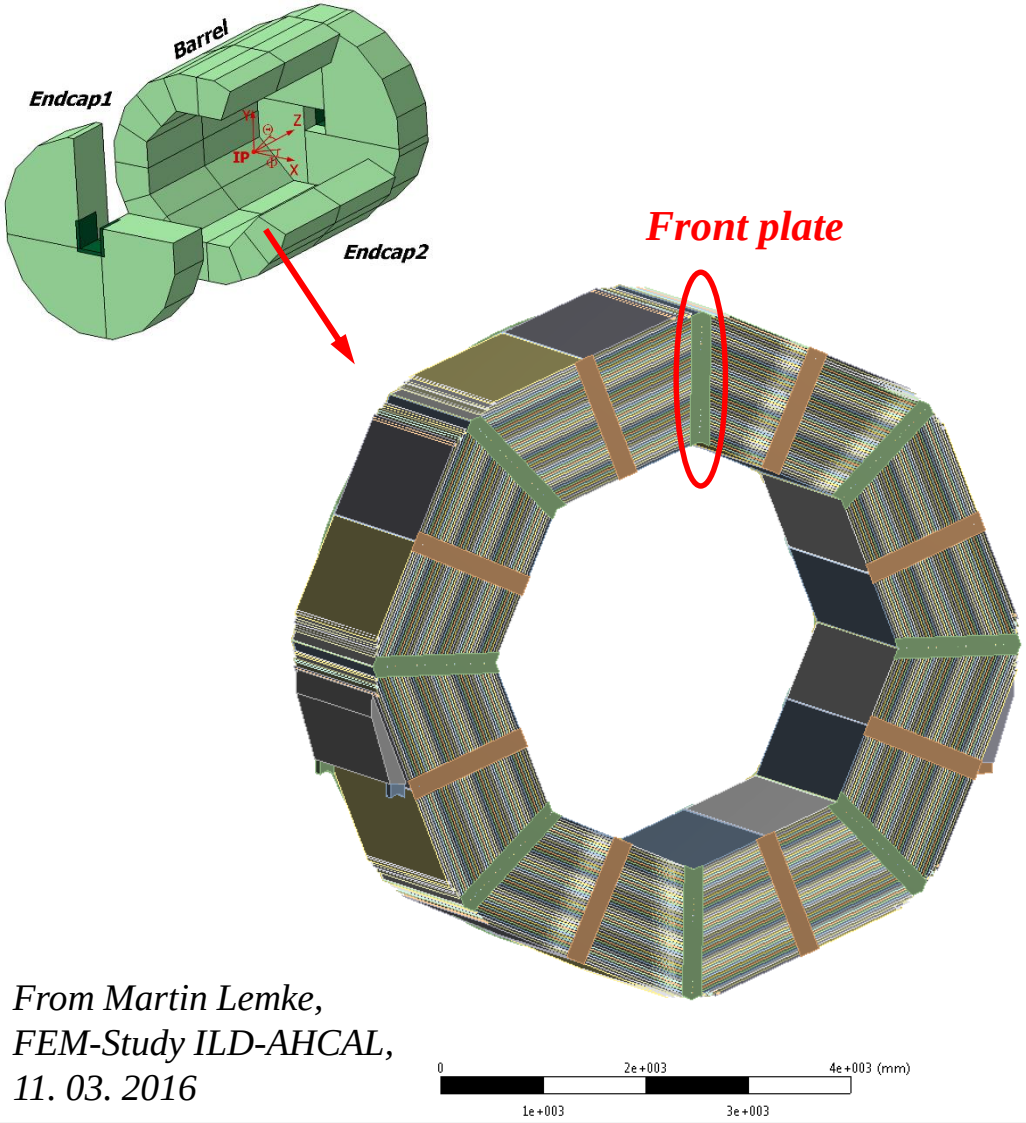




Services :
optimisation of inputs and outputs (signals & cooling)

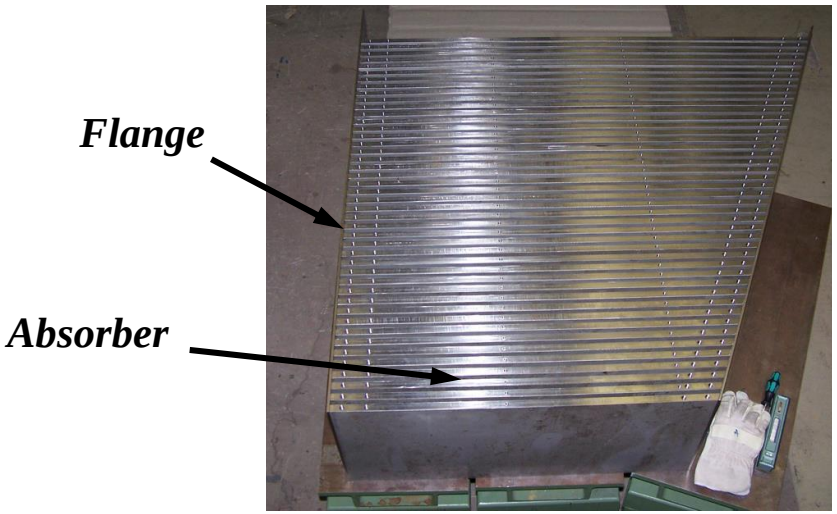
FE calculations :
- optimisation of dimensions,
- definition of all thicknesses of dead zones (ex : ribs between cells),
- Optimisation of assembly clearances and tolerances
- definition of rails position

HCAL – TESLA case (1/2)

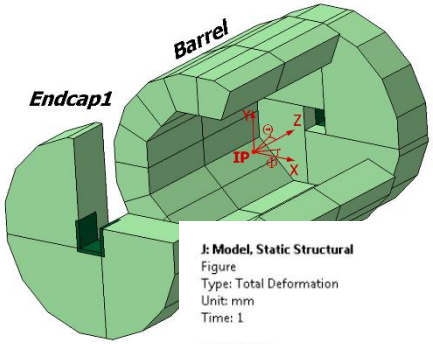


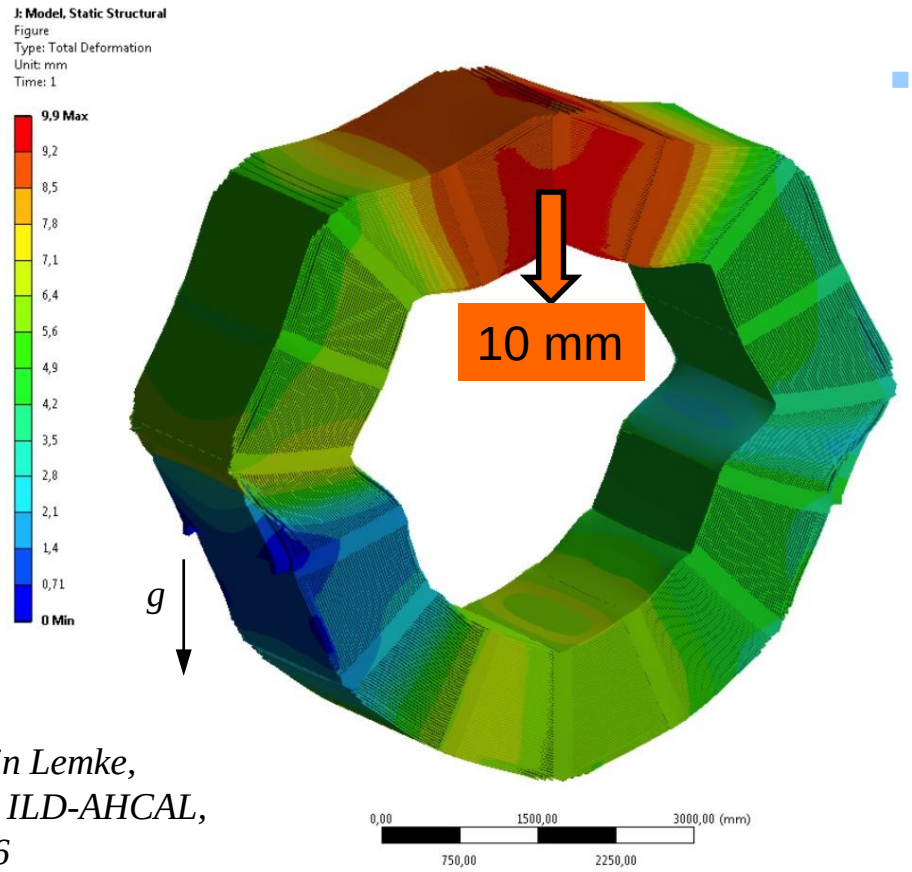
From Martin Lemke, FEM-Study ILD-AHCAL, 11. 03. 2016

- 2 wheels of 16 sub modules assembled:
  48 SS absorber plates of 16 mm thick
  + 2 flanges of 5 mm
- sub module connection by plates (10 mm thick) from the front and back side (issues) :
  - enough space to insert cassettes ?
  - air gap between wheels (dead zones) ?
- Detection elements : Cassettes with FE chips embedded and slid into "cells" of sub module



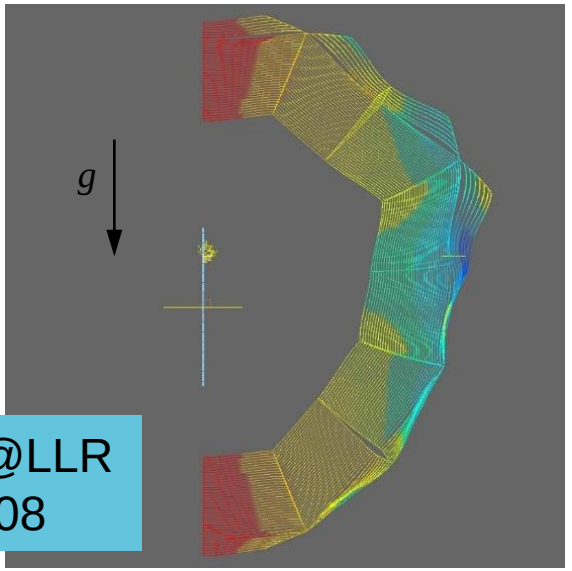
HCAL – TESLA case (2/2)





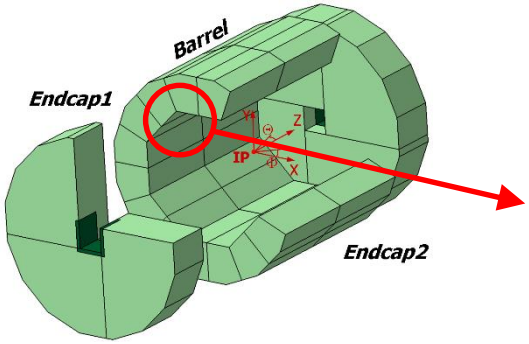
From Martin Lemke, FEM-Study ILD-AHCAL, 11. 03. 2016

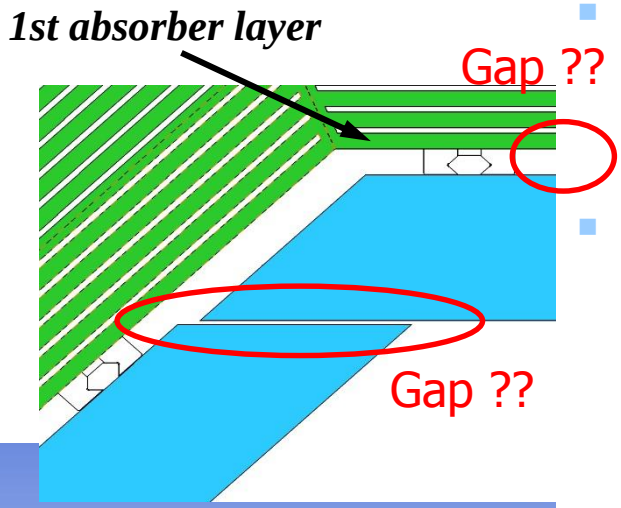
- FE calculations in static case show the flexibility of the structure
- Deformation ~10 mm
- Main mechanical behaviour : Bending (behaviour of a slender structural element subjected to an external loads applied perpendicularly to a longitudinal axis of the element)

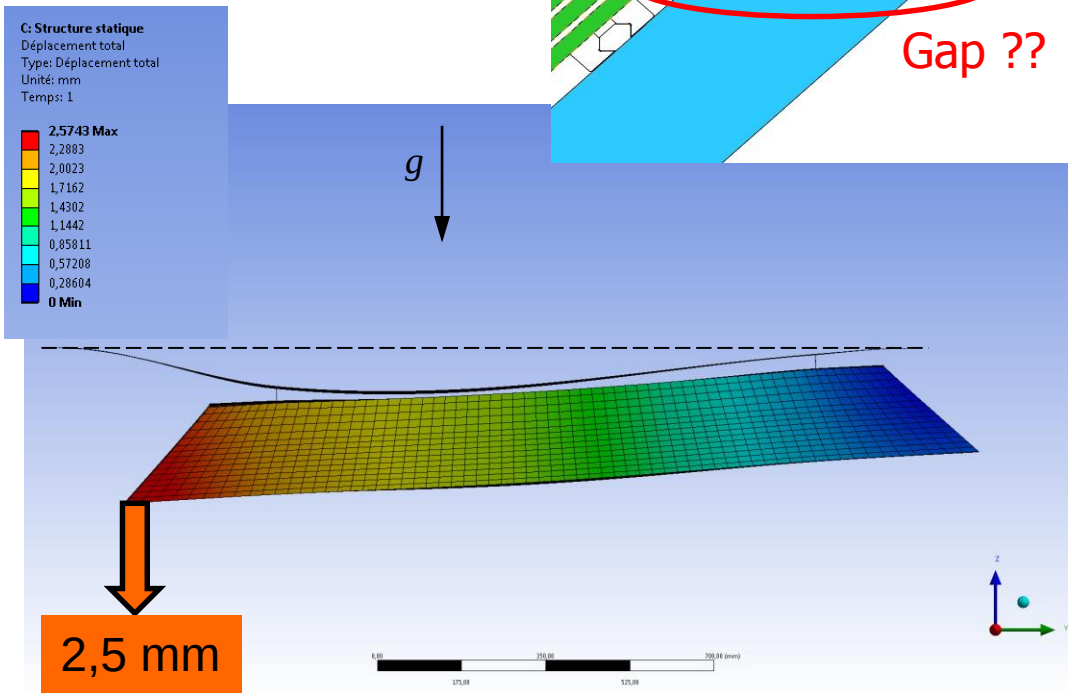


FEA @LLR 2008

ECAL with TESLA Case

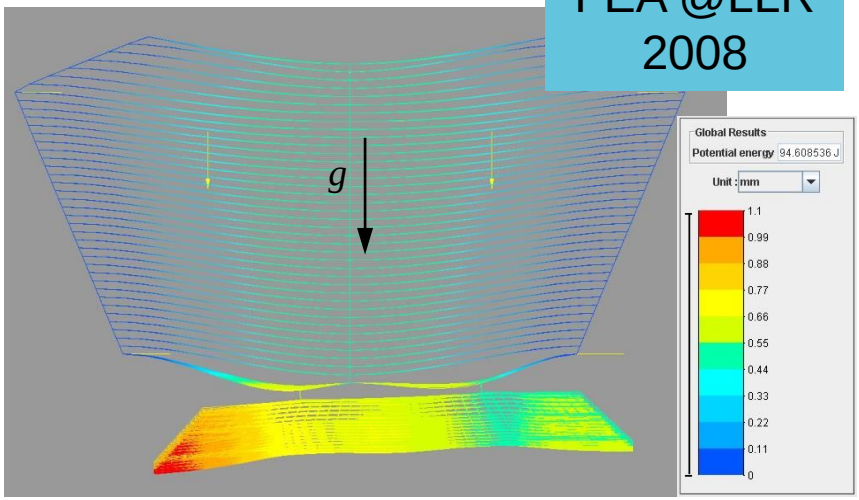




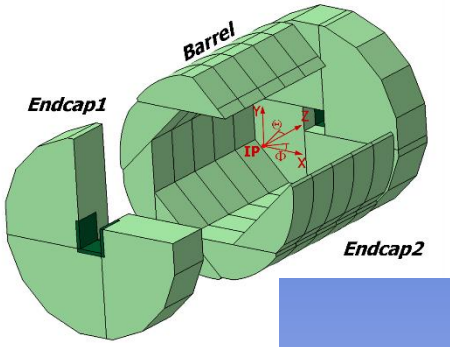


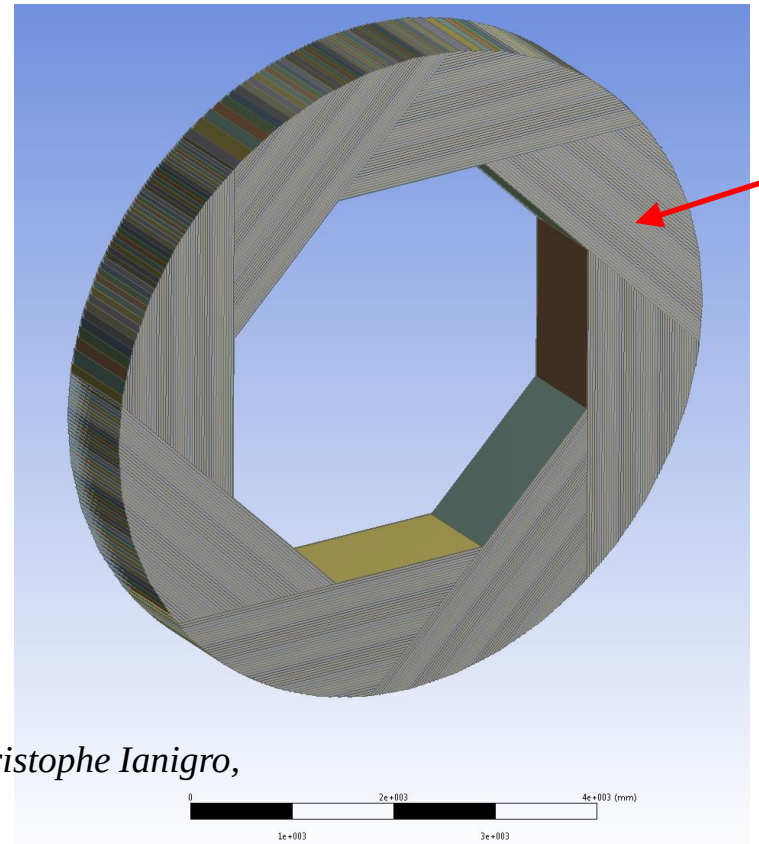
- FEA - boundary conditions :
  total weight : 2,5 t, fasten under the first absorber layer of the HCAL of 16mm thick, with 2 rails
- FEA - results :
  Significant motion of the module (2,5mm); in addition with the global deformation of the wheel, a gap of several mm between each ECAL module is needed (to be defined)

FEA @LLR 2008

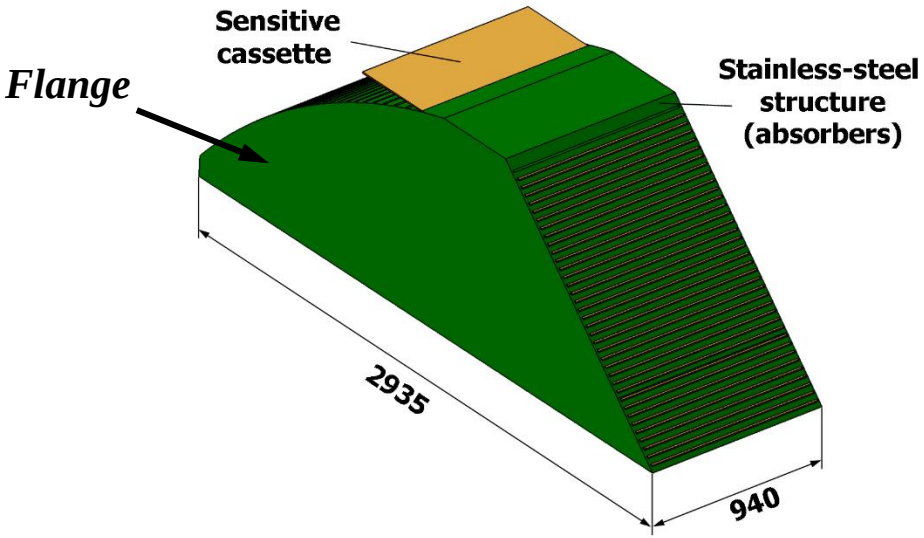


HCAL – VIDEAU case (1/2)



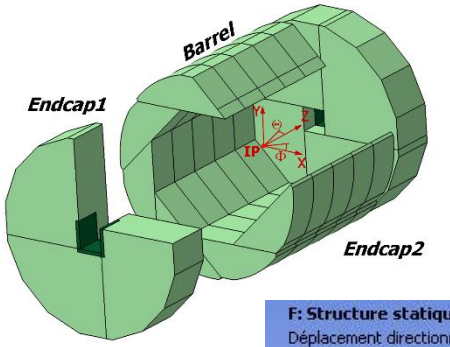


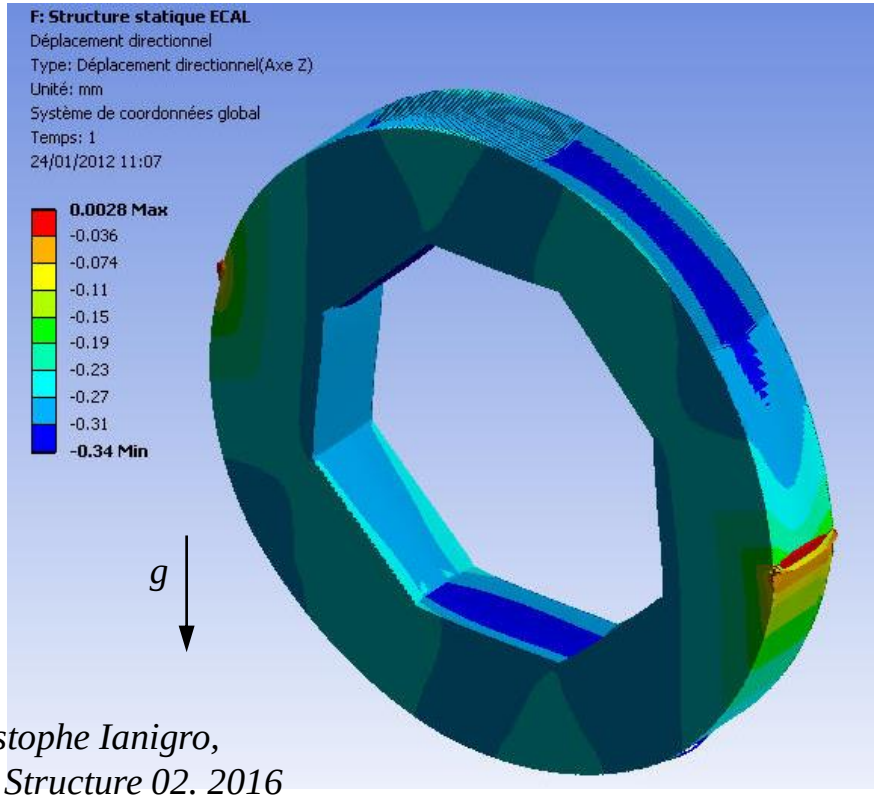
- <u>5 wheels of 8 sub modules assembled</u>: 48 SS absorber plates of 15 mm thick + 2 flanges of 10 mm
- sub module connection directly by flanges in order to obtain a rigid ring
- <u>Detection elements :</u> Cassette concept with FE chips embedded and slid into "cells" of sub module



Sent by Jean-Christophe Ianigro, 10. 2016

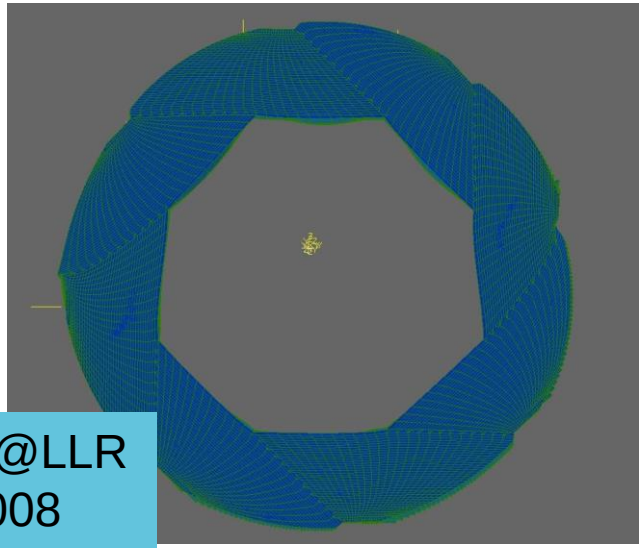
HCAL – VIDEAU case (2/2)





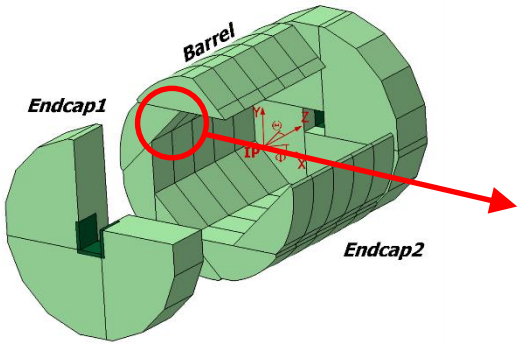
From Jean-Christophe Ianigro, ILD Mechanical Structure 02. 2016

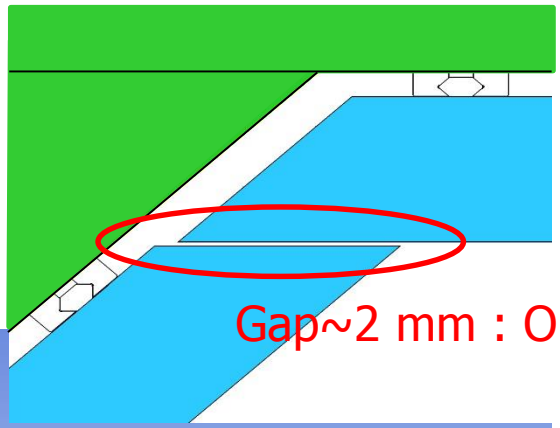
- FE calculations in static case show the stiffness of the structure
- Global deformation ~ 0,4 mm
- Main mechanical Behaviour : compression
  capacity of a structure (rings) to withstand loads tending to reduce size



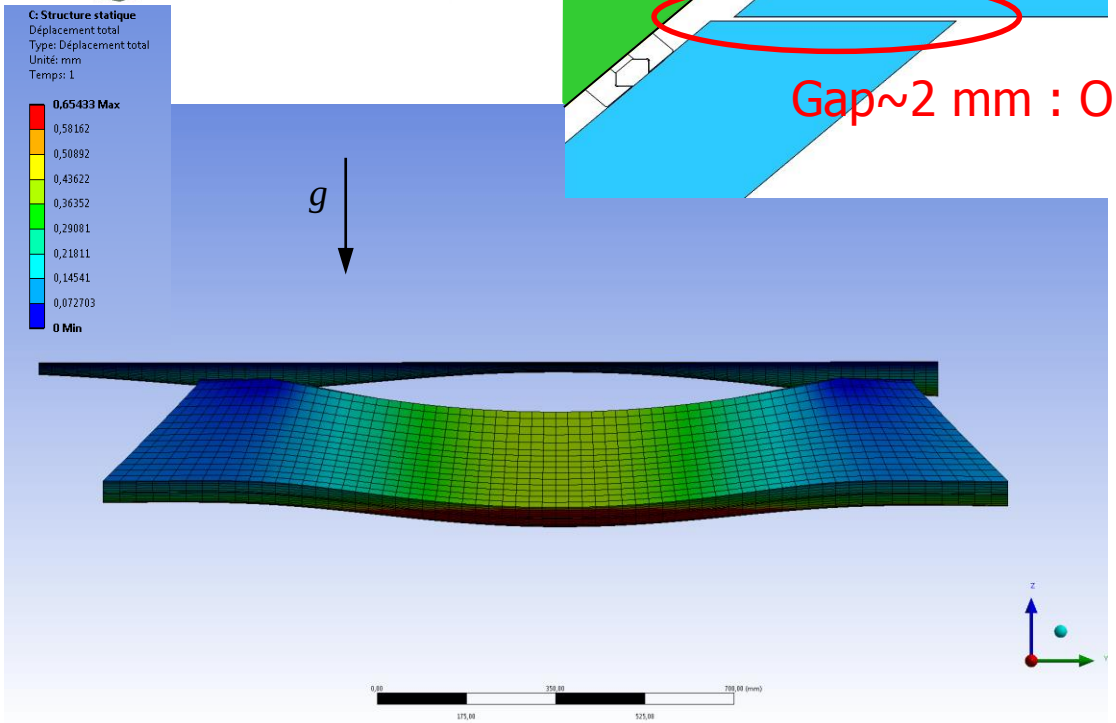
FEA @LLR 2008

ECAL with VIDEAU Case

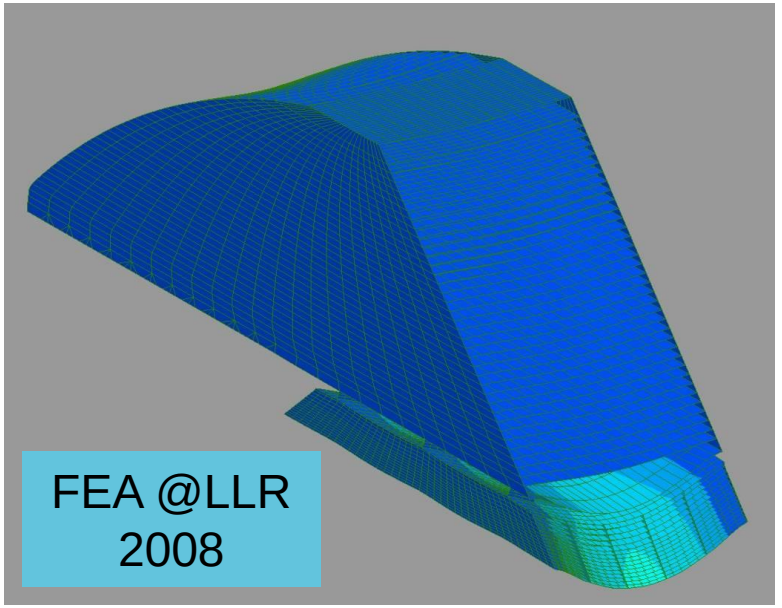




Gap~2 mm : OK



- FEA - boundary conditions :
  same compared to TESLA Case
- FEA - results :
  Deformation level close to the ECAL results (0,65 mm), confirms the stiffness of the concept. But introduction of additional stresses due to the bending effect of HCAL absorber



CONCLUSIONS

- Each concept of structure for the HCAL has an impact on the design of the ECAL Barrel

- This impact is linked to the mechanical behaviour :

TESLA Case :

PROS : no loads due to the fastening system of the ECAL. Design without take into account the fastening system.

CONS : The flexibility of the wheel and the first absorber imposes to increase the gap between each ECAL module in order to avoid contacts.

VIDEAU Case :

PROS : The concept is stiff. We can also reduce the gap to minimise dead zones

CONS : The bending of the first absorber of HCAL impacts the mechanical behaviour of the ECAL (additional stresses).

- FE analyses are required on a complete model (wheel + all ECAL modules) to study more precisely the interactions between each element