ECAL updates

on geometry and simulation

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Contributions/works by
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Denis Grondin , Christophe de la Taille, Stéphane Caillé,

General description of the mechanics

The electromagnetic calorimeter is made of 3 parts:
a Barrel, 2 End caps, 2 Rings

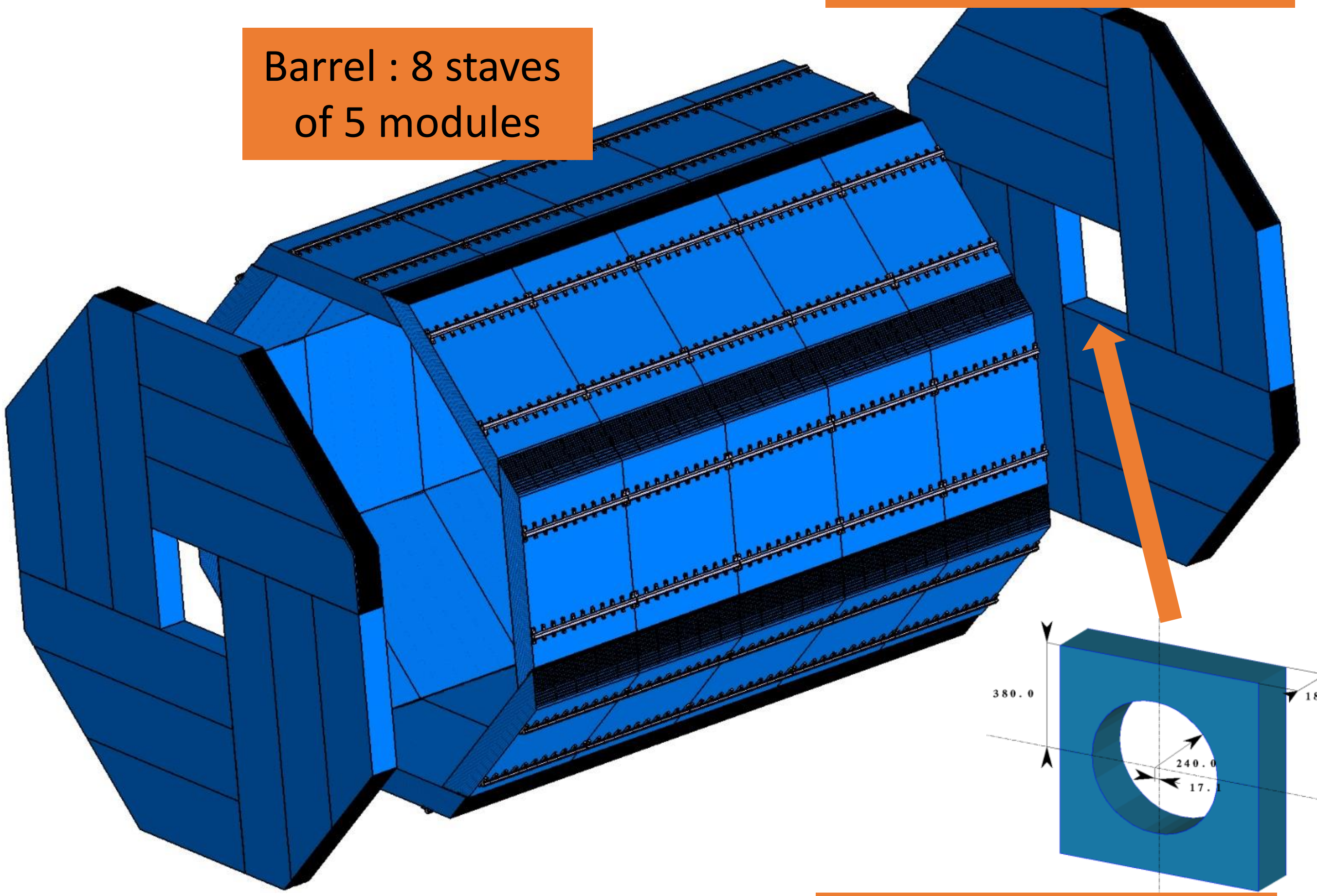
It exists in 2 official models:
- ILD (baseline but not the DBD version)

inner barrel radius at 1843mm,
barrel length at 4700mm

- SILD (small size)

inner barrel radius at 1500mm,
barrel length kept at 4700mm

Some modifications have been proposed to the baseline for the thickness
(DBD version being rather unrealistic)
and the change request is being processed.

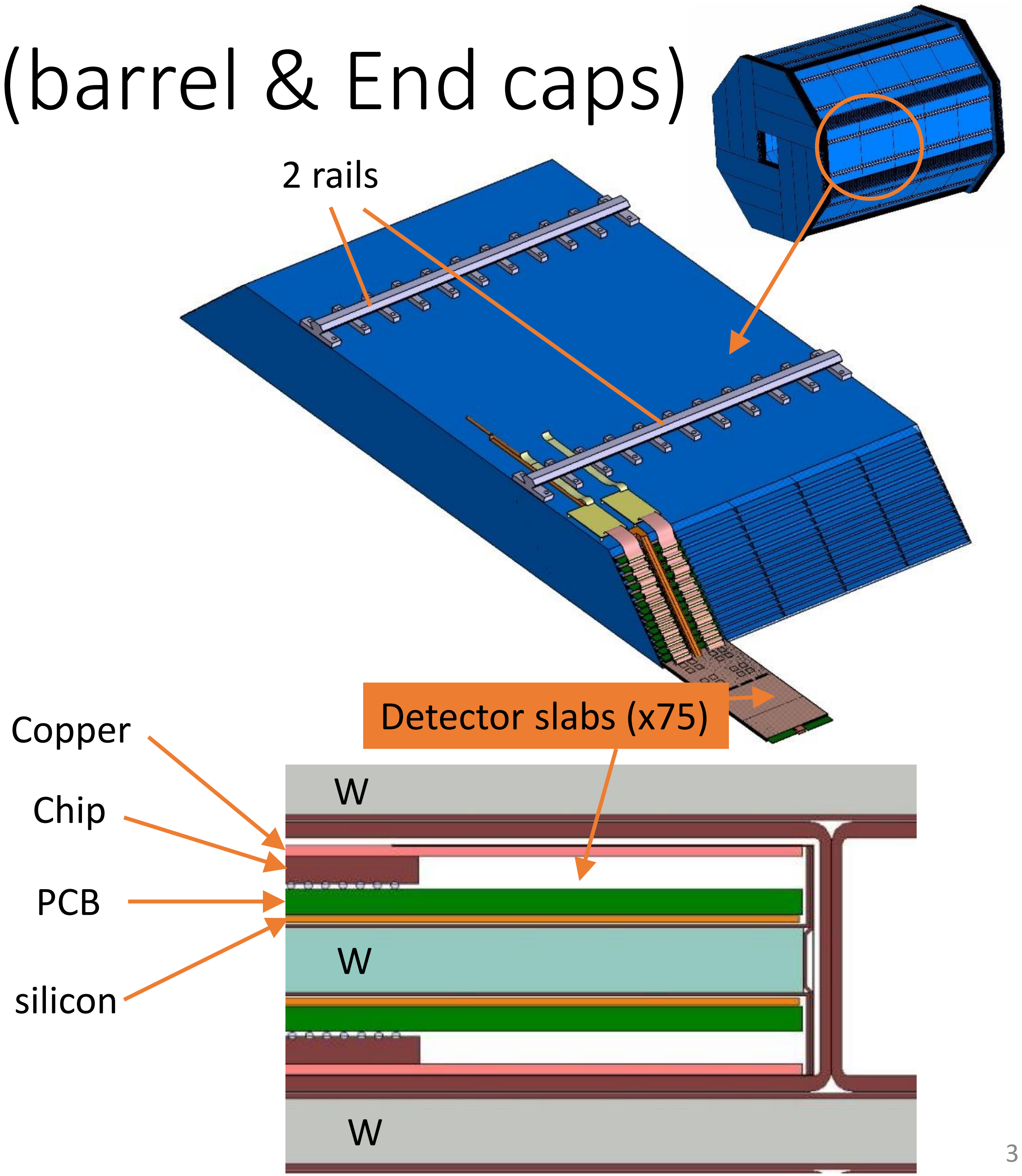


Modules thickness (barrel & End caps)

A more realistic design for the ECAL is proposed for the Baseline :

- The silicon thickness is increased to 0.525 mm to improve the energy resolution (it was that way in the simulation)
- The PCB is 1 mm thick, the chip 0.8 mm and the copper heat 0.4 mm. All this increases the alveoli thickness hence the ECal thickness itself.

The ECal thickness ≈ 223 mm, an increase of 38 mm from the DBD , Can we accept it? (under study)



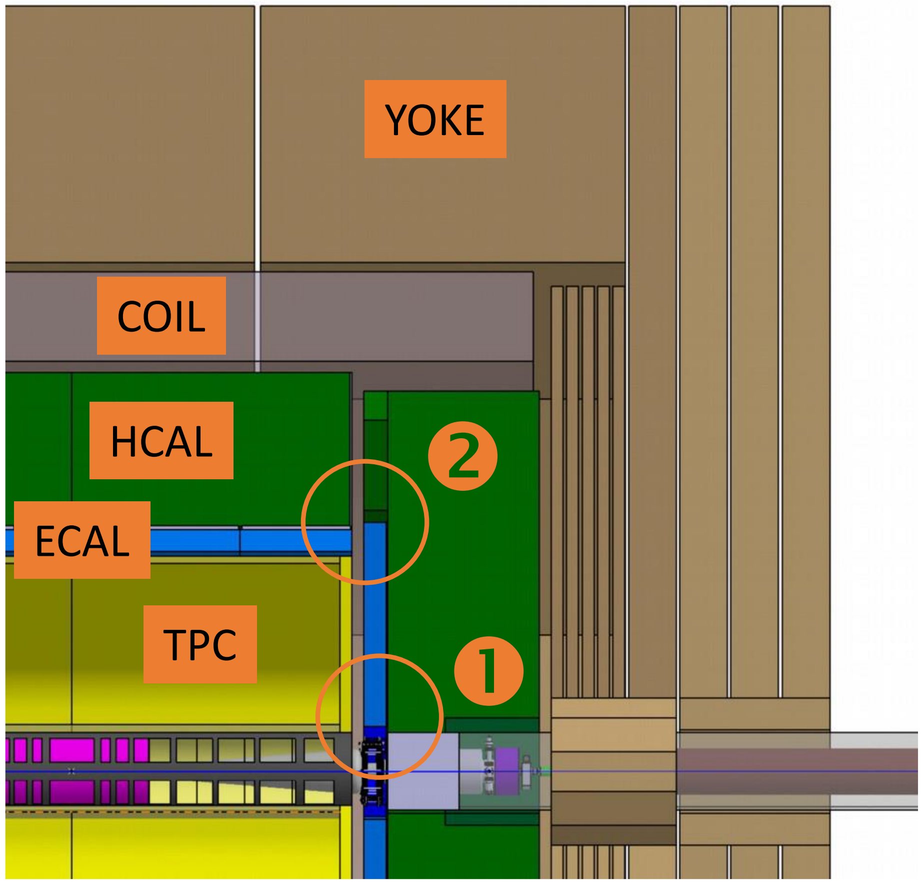
ECAL interface gaps definition

❶ Ring / end-cap

The ring is inside the end cap.
There is a clearance of 10mm between ring and end cap
The ring is fastened to the forward structure for opening not to the end cap and the services run accordingly. Not much work done, at least specific electronics may be needed

❷ End-cap / barrel

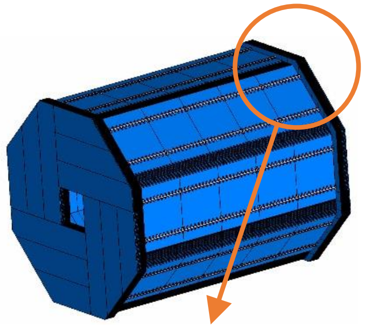
There are two parameters : the overshoot relates the end-cap radius to the barrel inner radius, the overlap is the distance barrel to end-cap.
This overlap has to contain a clearance for the move of the end-cap,
it is the place where barrel cooling and patch panels may end up
it is also the passage for TPC suspension, TPC and inner detectors services
it is a very delicate place for the reconstruction of particles crossing it:
the smaller the better but many constraints poorly defined now.

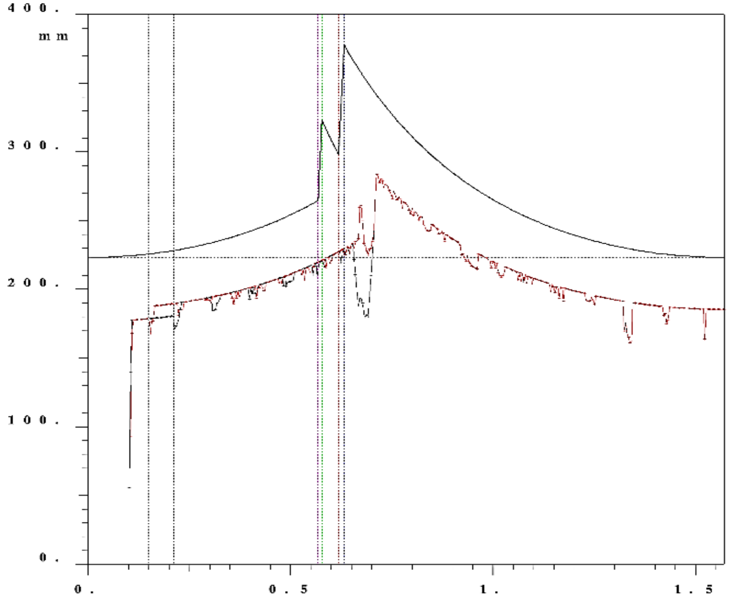


Impact on the interface gaps (Baseline)

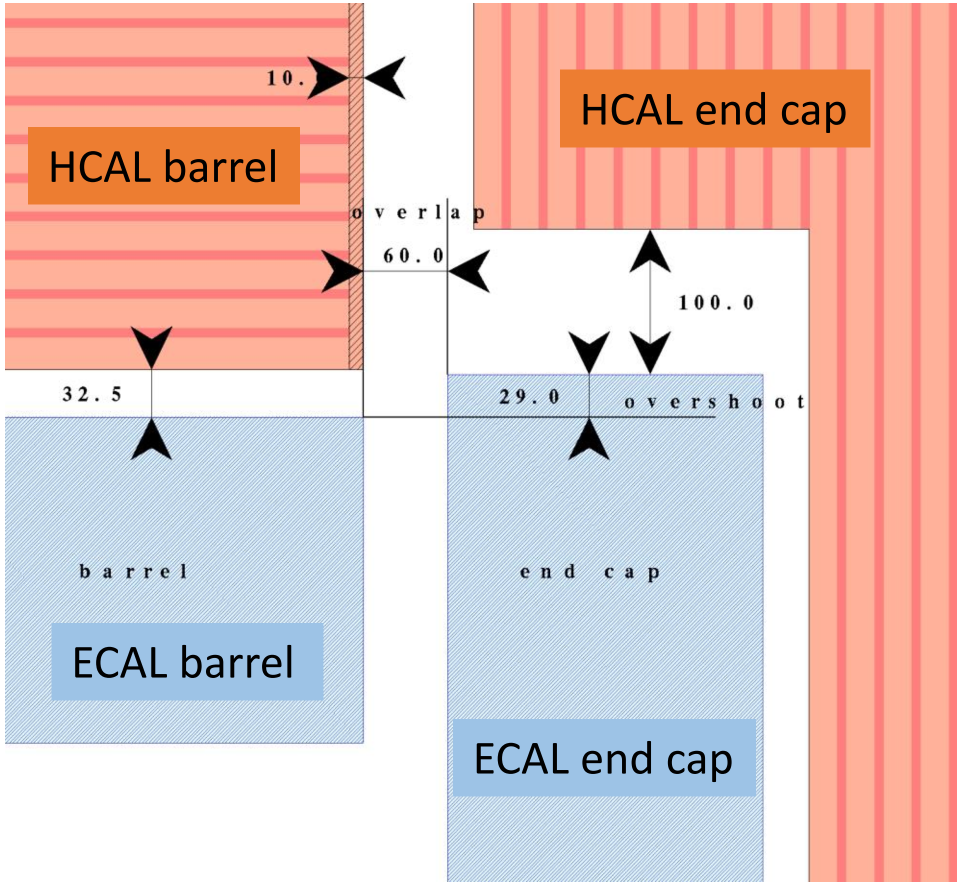
This new thickness has an impact on the overlap between Barrel and End caps.

To keep the DBD position of the L* (same position for the HCAL endcap), we have to reduce the overlap gap to 60 mm (DBD=100 mm).
However, that helps for the photon reconstruction in the transition barrel-end cap, that does not interfere with the HCal if the end cap outer radius does not reach the inner radius of the HCal barrel but that may interfere strongly with the TPC patch panels.





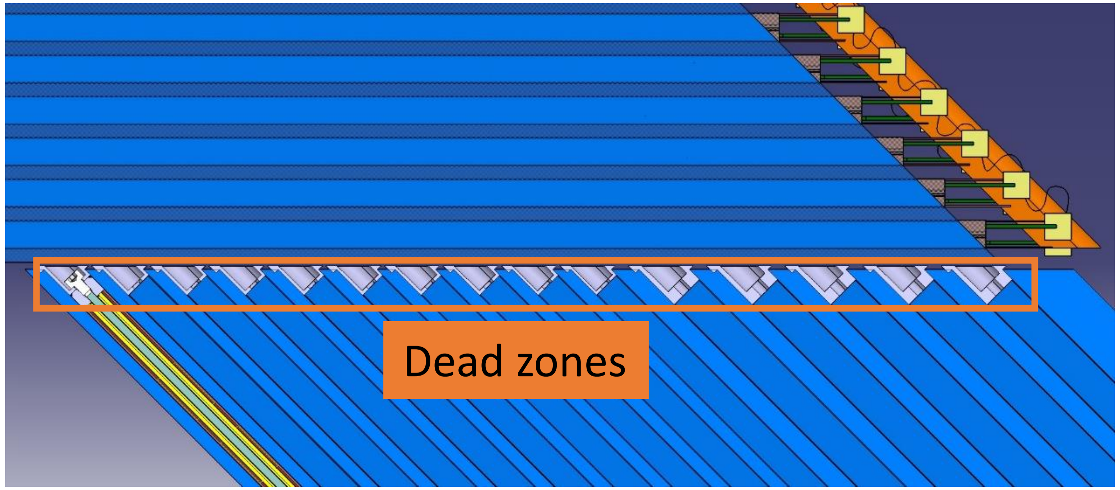
Depth of calorimeter along a projective line. The black and red curves are from the baseline as seen with MOKKA



Barrel φ & Θ dead zones (Baseline)

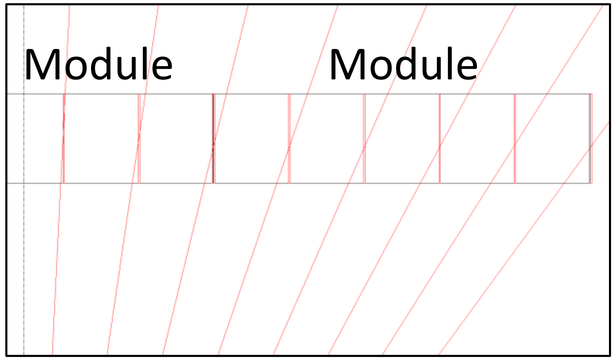
- Some plugs are used to fix each slab into the alveolus.

This contributes to define the dead zone in φ , according to the length definition of the plug (typically 8-13 mm)

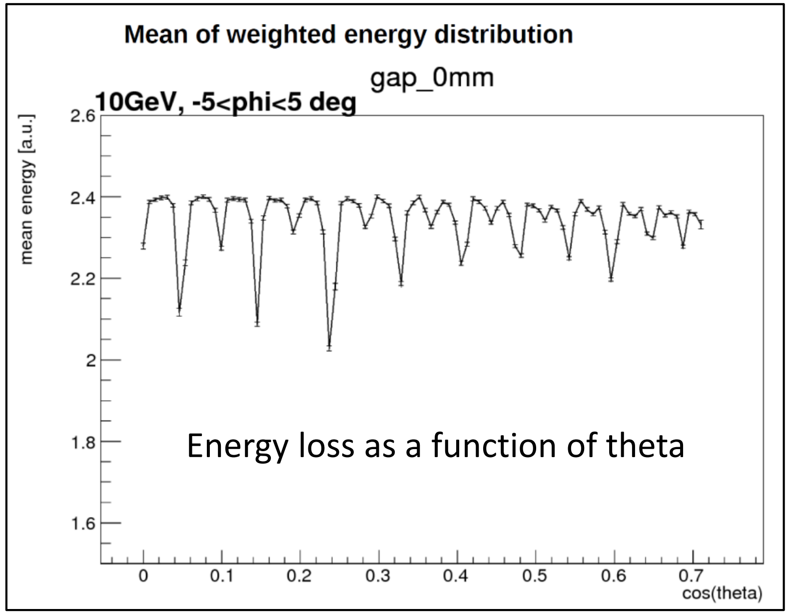


- The impact of the dead zones in Θ is linked to the module boundaries, the alveoli boundaries and the wafer boundaries :

Globally the dead zones represent 2.8 % of calorimeter volume. We observe that the inter-wafers zone at cos θ = 0 reaches 5% and is noticeable for the following alveoli columns; this would be largely cleaned by using 200mm wafers (under study)



The barrel dead zones, inter-module and inter-alveoli. The trajectories of photons going into the cracks with maximal loss are shown



ECAL-HCAL interface (Baseline)

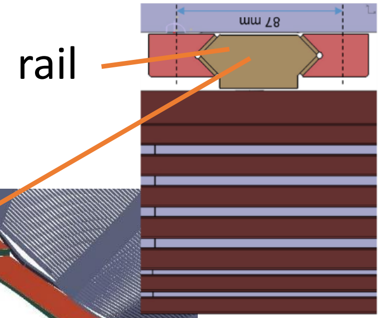
<u>The ECAL barrel is fastened to the HCAL barrel</u>

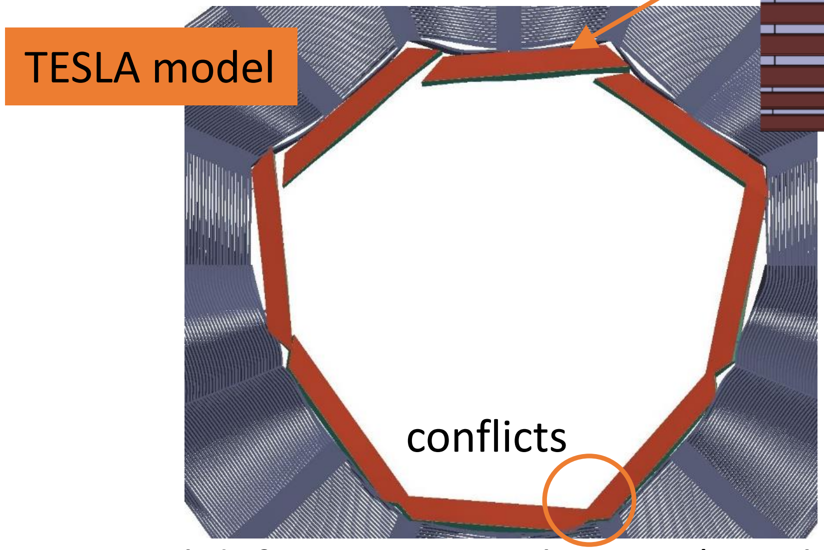
The ECal barrel is not a structure by itself : an ensemble of 8 staves fastened independently to the HCAL barrel via two male rails running along the staves and two female rails installed on the inner face of the HCAL

They follow then possible deformations of the HCal barrel.
The constraint from the ECAL is to keep within the clearances (2-2.5mm) between staves, and between staves and HCAL, alternatively these clearances can be enlarged
at the expense of the calorimeter performance.

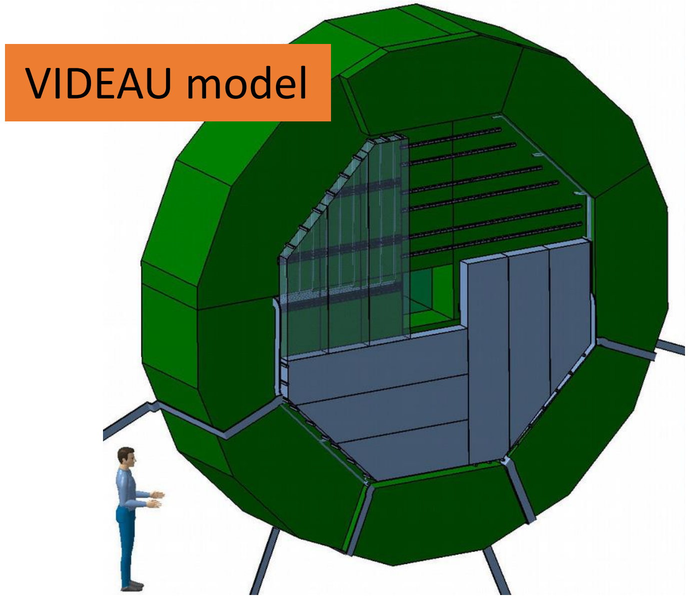
<u>The ECal end-caps are fastened to the HCal end-caps</u>

the modules are independently fastened by 2 male rails on female rails running on the front face of the HCAL end-caps
The different solutions for the HCAL end-caps should at some point be examined under this light.





Barrel deformation mechanism (simulations)



End cap rails position

ECAL Services & Cables (Baseline)

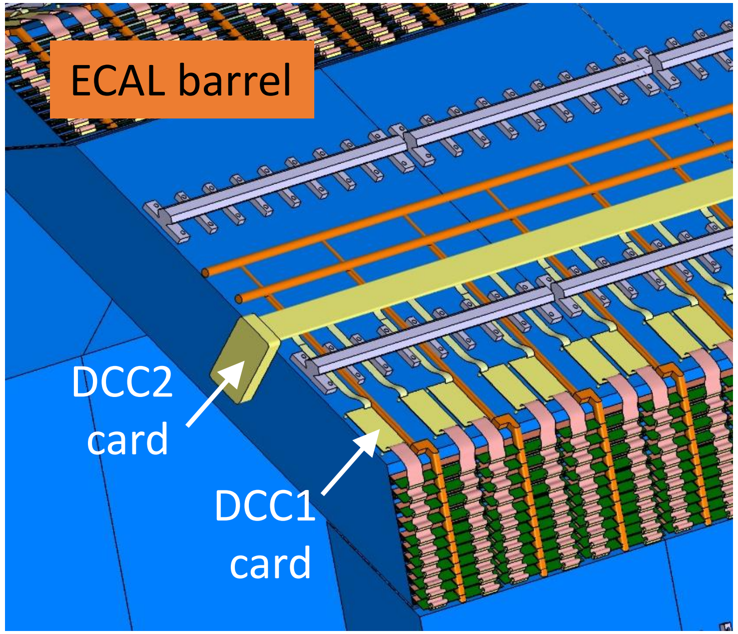
Power, cables and cooling would run between HCAL and ECAL on the back of ECAL (the way it is shown in the picture which exhibits the principle rather than any real design)

The paths of cables and cooling interfere strongly (cross).
As a working assumption the cables would run to one end of the staves and the cooling to the other end.

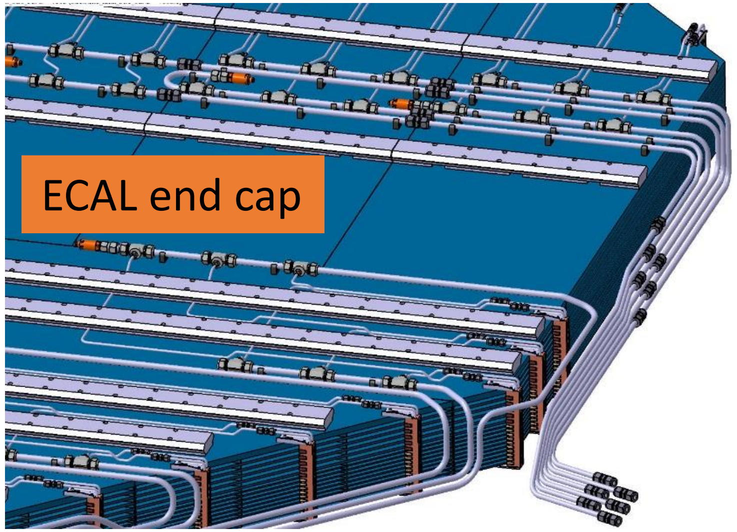
- DCC1 figures a concentration/distribution at the alveoli level
- DCC2 (or Hub2) a concentration/distribution at the stave level.

From then cables or fibres run along each sub-detectors to the outside

Same principle will apply for End cap cooling and cables



Pipes of cooling system



Silicon ECAL : Timing capability

- **20 ps** has been obtained on the FNAL prototype of HGCAL (thanks to CMS group for information) for one cell , with energy above 10 mip

- A priori, it doesn't depend on the silicon thickness

- A possible jitter on the overall detector (systematic) of **20 ps** is feasible
  (following experts from Omega)

For the PFA studies,
I propose to use in simulation a precision of 20 – 30 ps , even for mip

Simulation is ready to any official decision (Thanks to Daniel Jeans)

Just waiting for ILD official approval on the size and dimension describe in the recent proposal document from Henri Videau

Same things for mechanical modification proposed by Marc Anduze, like the plug to hang the slab

conclusion

- 2 different models (ILD and S-ILD)
- 2 different geometry of the HCAL
- New thickness for the baseline (which will be in the simulation)
- Simulation ready to move

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Closer and closer to a realistic detector description