Earthquake impact

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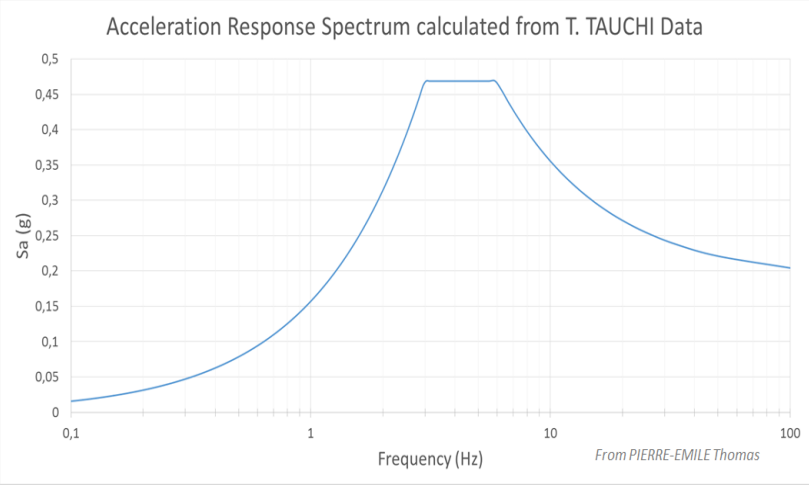
Do we want really to see ILD like that:

A study has been conducted at LLR on the possible impacts of earthquakes on the Ecal barrel

The eigenmodes for the Ecal modules are at frequencies of 30 Hz or higher.
The peak of acceleration is only reduced by a factor ~2.
Therefore a dislocation of the Ecal modules under direct excitation may not be totally unexpected.
But the acceleration spectrum is filtered by the yoke+cryostat+Hcal transfer function and a more realistic behaviour of the Ecal has still to be worked out.



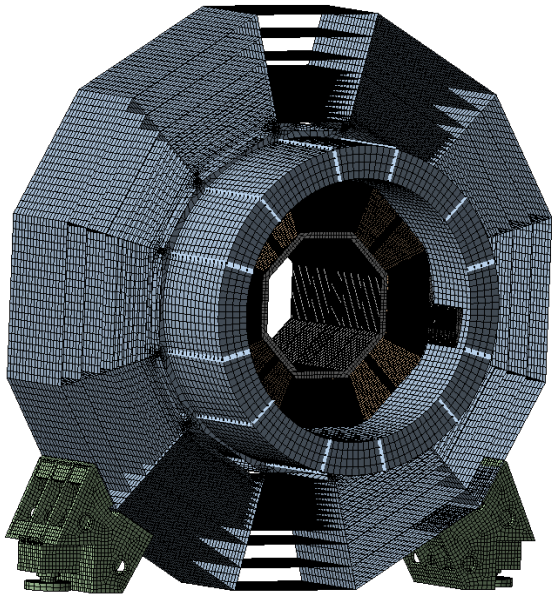
Here we work with the assumption that the Ecal stays as a block.

But the Ecal hangs on the Hcal which is a huge mass and, when fastened to the inner cryostat mandrel the Hcal+cryostat vibration eigenmodes resonate perfectly with earthquake frequencies and the generated displacements are huge and likely to break the rails on which Hcal rests.

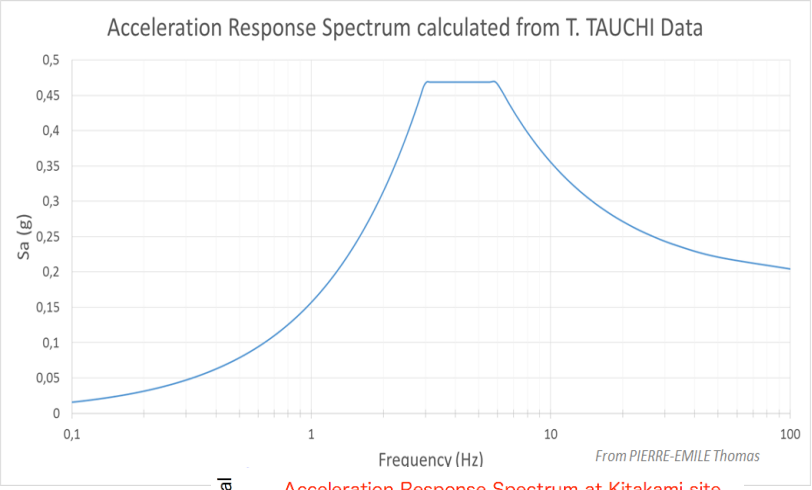
The study of the Ecal clearances when the detector is loaded and moved by earthquakes

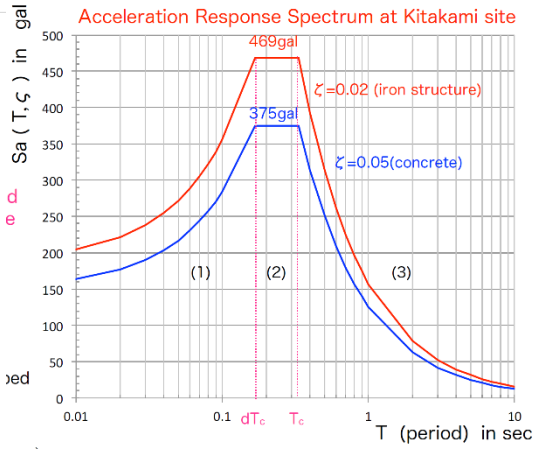
(Marc Anduze, Thomas Pierre-Emile, September 2017)

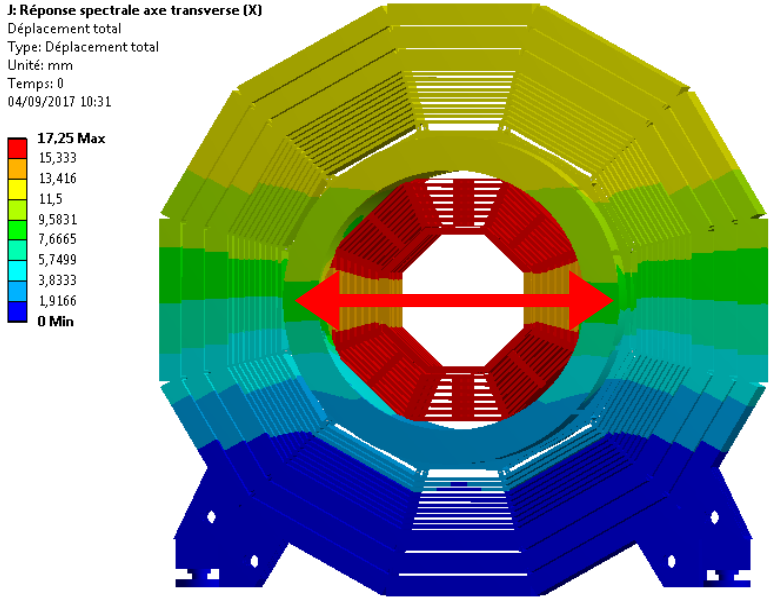
has shown, on top of the Ecal behaviour, that the transverse efforts may destroy the detector.



DESY central ILD model



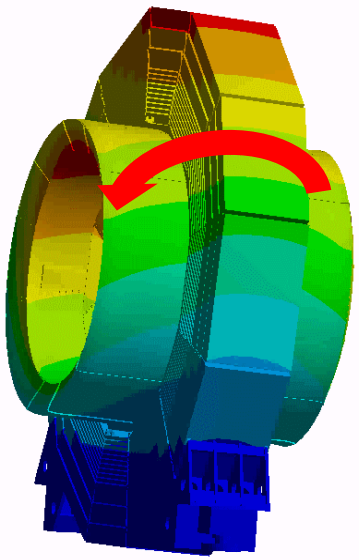




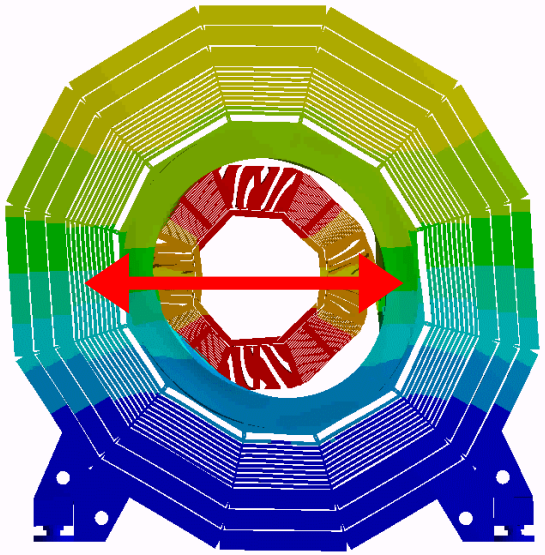
Maximum displacement:
17,3 mm
Smallest gap between ECAL rings along z:
0,98 mm
Smallest gap between ECAL module along phi: **1,89mm**

Preliminary Analysis Results: **Eigen Modes** (states of excitation/vibration under specified fixed frequencies called resonant frequencies)

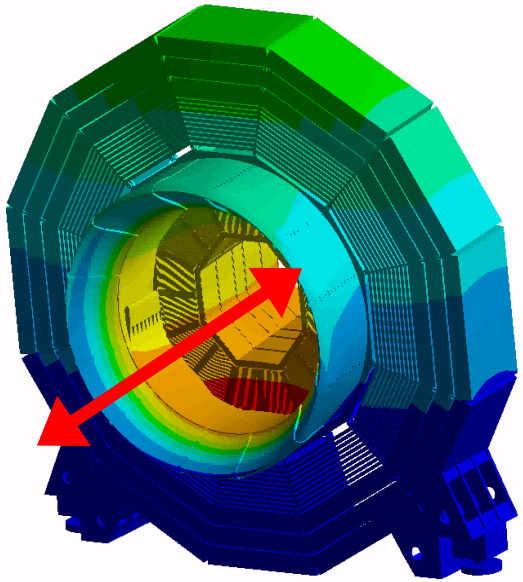
Mode 1 @ 2,3Hz



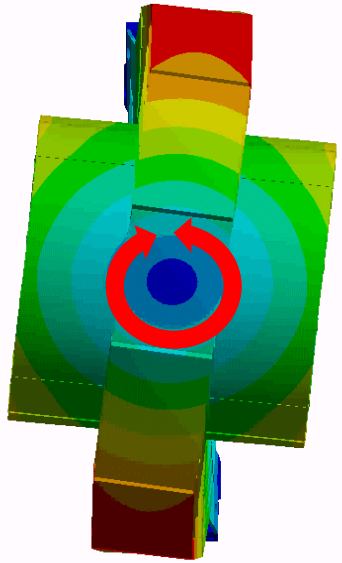
Mode 2 @ 3,05Hz



Mode 3 @ 3,8Hz



Mode 6 @ 7Hz



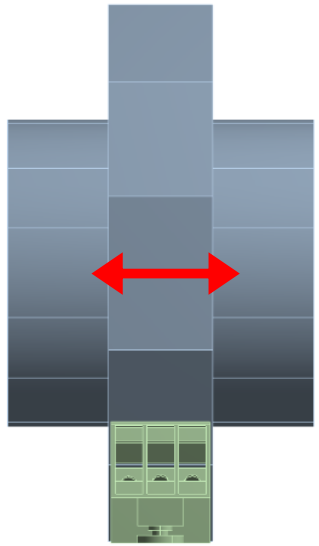
Due to the very heavy structure, 6 global modes are included into the range of earthquake peak 2-6 Hz

The modes 4 and 5 engage a fraction of the mass too small to be considered

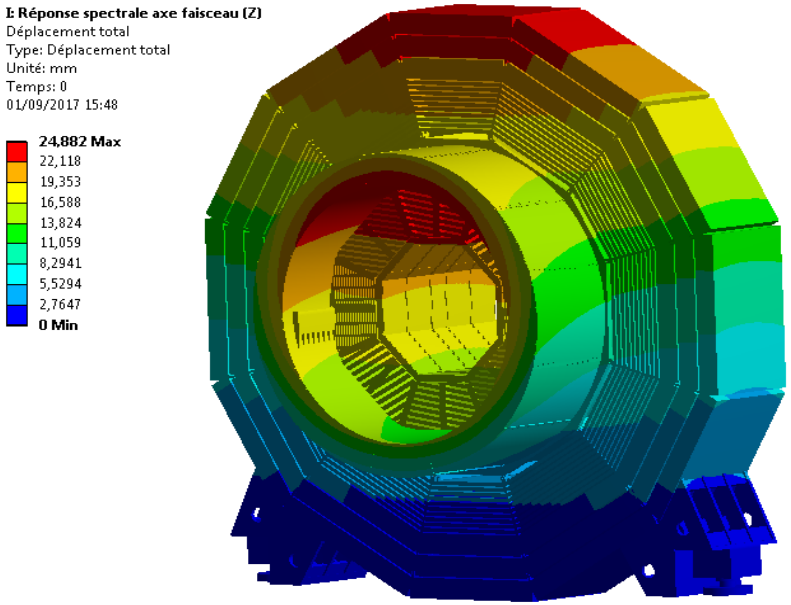
Preliminary Analysis Results: **Response spectrum - detector axis (Z) only**

With the acceleration response spectrum applied along Z axis, the fundamental mode of the structure dominates: back and forth motion of the yoke ring, followed by the mode 3 linked to a distortion of the cryostat flanges

But all the modes having a component along z are taken into account



Central ring only



Maximum displacement: **24,9 mm**

Smallest gap between ECAL rings along z: **0,98 mm**

Nominal 1mm

Smallest gap between ECAL module along phi: **2,29mm**

Nominal 2.5mm

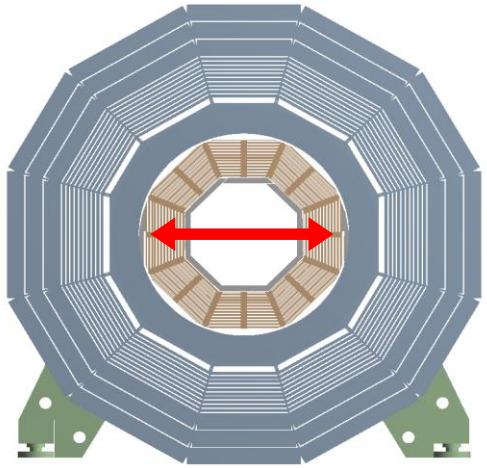
TPC oscillations!
If ISS tied to TPC poor beamtube!!

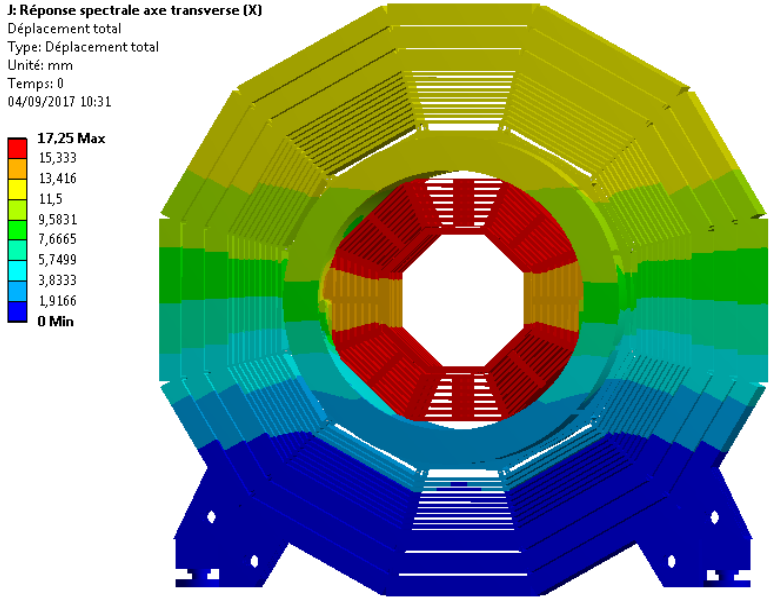
- No relative motion along Z between ECAL modules.

  The barrel follows the global motion of the YOKE+HCAL
- Fastening the 3 rings together is probably the way to increase the overall stiffness and reduce the peak displacement linked to mode 1
- thickening the cryostat flanges would help reduce the influence of mode 3.

Preliminary Analysis Results: **Response spectrum – Lateral only**

With the acceleration response spectrum applied along lateral axis, the mode 2 of the structure dominates: the displacement is lower





Maximum displacement: **17,3 mm**

Smallest gap between ECAL rings along z: **0,98 mm**

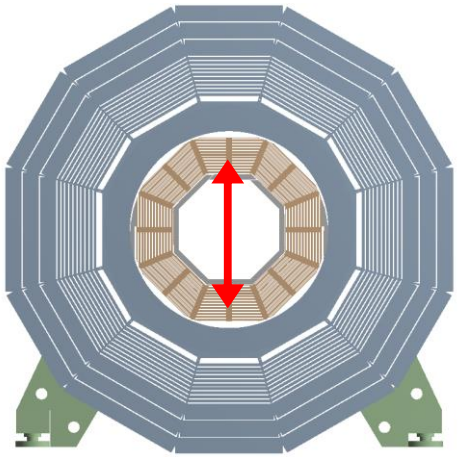
Smallest gap between ECAL module along phi: **1,89mm**

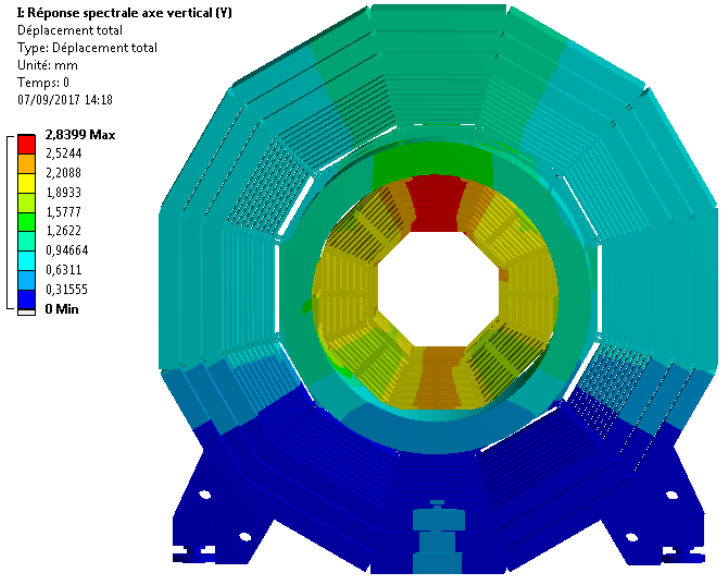
Strong effort on the fixing rail

- No significant Z relative motion between ECAL modules because complete barrel moves from left to right

Preliminary Analysis Results: **Response spectrum - Up and down only**

With the acceleration response spectrum applied along third axis, the displacement is significantly lower (less than 3 mm).





Maximum displacement:
2,9 mm

Smallest gap between ECAL rings along z: **0,98 mm**

Smallest gap between ECAL module along phi: **2,05 mm**

The yoke ring offers a good resistance to side loading
No Z relative motion between ECAL modules too
(same complete barrel behaviour)

As a conclusion

A lot still to do but

What damping brings naturally the platform?
Can we add a damping mechanism to the platform?

Should’nt we discuss a damping platform?

What can we expect for the transfer function of a damping platform ?
Could such a function be accessible that we redo seriously these calculations?