SDHCAL Status for DBD

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CALICE meeting
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Overview

CALICE criteria for technological readiness (from Roman's presentation)

- **Established performance:** energy resolution, linearity, uniformity, two particle separation
- **Validated simulation:** longitudinal and transverse shower profiles, response, linearity and resolution, for electrons and hadrons
- **Operational experience:** dead channels, noise, stability, monitoring and calibration
- **Scalable technology solutions:** power and heat reduction, low volume interfaces, data reduction, mechanical structures, dead spaces, services and supplies
- **Open R&D issues:** analysis and R&D to be completed before a first pre/production prototype can be built, cost reduction and industrialization issues

- Many results presented during last 2 days
  - M.C. Fouz's for Imad's talk on m^3 building
  - J. Puerta-Pelayo's talk for the digitisation
  - Y. Haddad talk on TB results
- + external contingencies

Established performances

- Energy resolution, linearity, uniformity, two particle separation
  - From simulation only
    - Untuned PandoraPFA gives similar perf. as the AHCAL on uds jets
- None yet: ➔ first elements in May
  - Until now commissioning: understanding of chambers, taming noise & cooling, debugging DAQ...

Validated simulation:

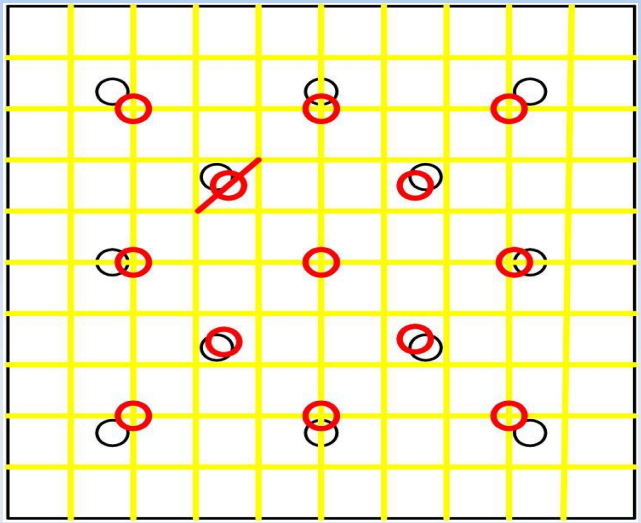
- Response from cosmic muon's soon
- Digitisation almost ready
  - 2 schemes: from hits, small cells [see presentation from Jesus on Monday]
  - Adjusted on data (Q distribution, Avalanche spread [see Yacine's presentation])

Operational experience:

- Dead channels
  - At building : ≤20ch / ASU (1536 ch.),
  - During commissioning only a few channels needed to be masked over 400k ch.
- Noise
  - ~ few Hz/cm², some pattern (border),
  - dependant on t° ➔ cooling needed
    - one side cooling solution seems OK
- Stability
  - Aging
    - 1 (one) ASIC lost out 7200 since May, 2011 with many handling in between
    - Radiations: test @ GIF no effect seen
- Monitoring, Calibration
  - Currents, Noise rates, cosmic response on going...
  - Preparation of radioactive gas solution ^{83}Kr ($\tau_{1/2}$ = 1.85h) to X-check gas distribution solution.
    Use of Calibration: for punctual calibration might be tricky for security reasons.

Scalable technical solutions:

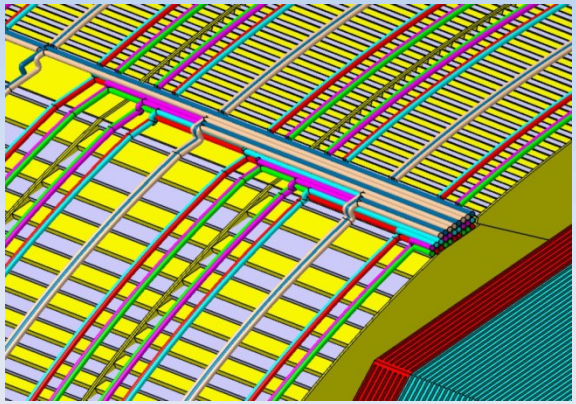
- Power & Heat reduction
  - Power pulsing test done in H2 3T field: successful
  - Power pulsing on m^3 being prepared w & w/ B field
    - H2 magnet can host ~30 chambers
- Low volume interface and large surface
  - 3mm thin sensors + 3mm readout elect. with low Xtalk ✔
  - 1×1 m^2 continuous sensors with 1 side readout ✔
    - Experience gained during building of m^3
    - to be extended to 1×3–4m

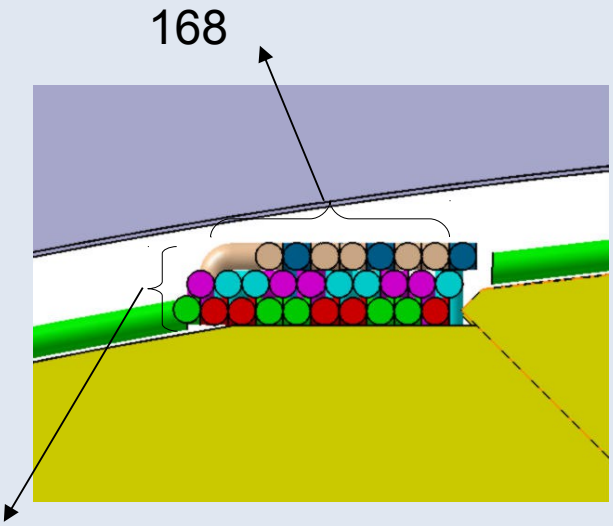


- Data reduction
  - Included 0 suppr. per ASIC; HardRoc3 will include 0-suppr per cell.
  - As of today: data volume is noise driven ➔ to be improved per cell gain adj^t
- Services & supplies:
  - Gas system with recycling : large RPC systems ⊂ CERN expertise {e.g. CMS, Atlas}

Services

- Services : Barrel





- Cooling for Dif : Blue / Red
  2 loops by module
  Ø14 for principal
  Ø4 for distribution alternative

- Gaz For GRPC : green / pink
  2 loops by module
  Ø14 for principal
  Ø4 for distribution alternative

- High Tension : Brown
  Ø14 for supply

- Data acquisition : Beige
  Ø14 for collecting

Issues : 8 zones 168 x 47

Same work done for endcaps.

Open R&D Issues

- Larger ASUs & chambers:
  - No foreseen pbm for large RPC: extrapolation 1 ➔ 3m
  - I2C solution well advanced for HardRoc3 solution for long (3m) slabs.
    - to be tested ≤ 2013

Costs

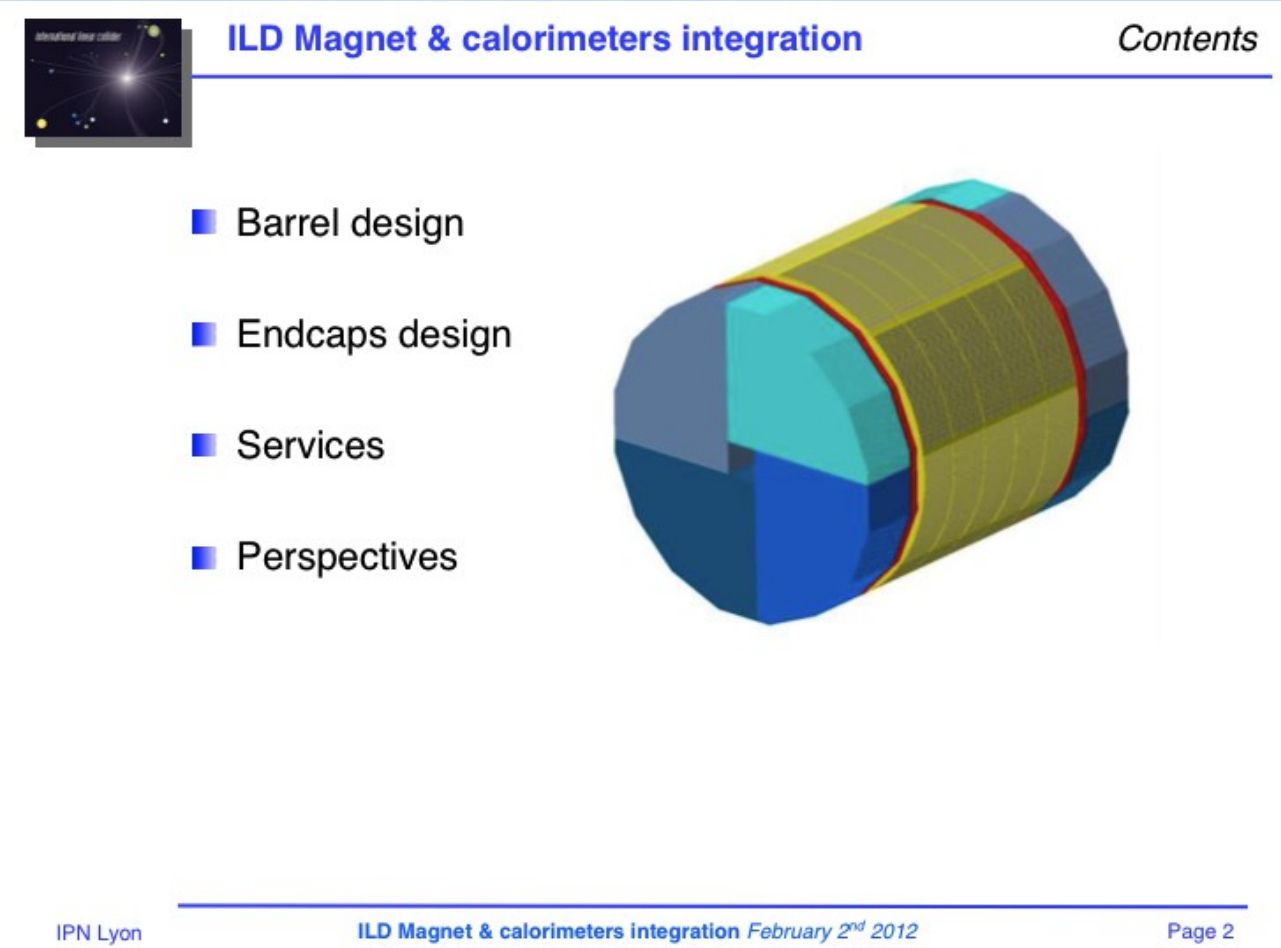
- No change since LoI ➔ stays cheap!
  - Driven (excl. Stainless steel) by readout:
    - VFE elec. (8,5M€),
    - ASU (4,4M€),
    - readout elec (2,5M€)
  - RPC (1,3M€)

  [numbers for 71M channels, 48 layers, 1cm² cells, 64 modules]

Mounting

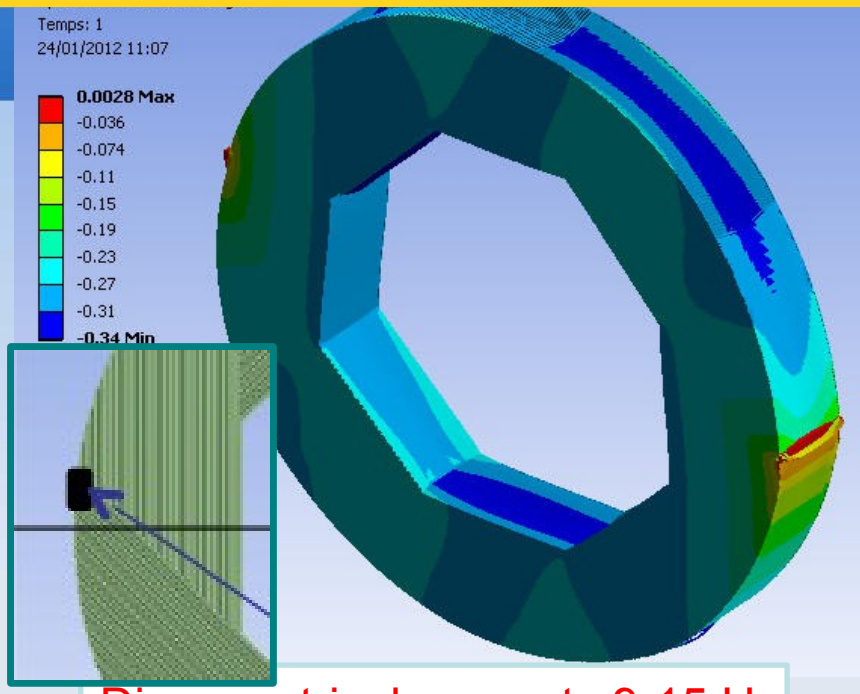
- Procedure discussed during ILD integration meeting (talk from JC Ianigro)
  Much progress in deformation (from own weight & ecal), mounting, services

  http://ilcagenda.linearcollider.org/getFile.py/access?contribId=5&sessionId=4&resId=0&materialId=slides&confId=5498



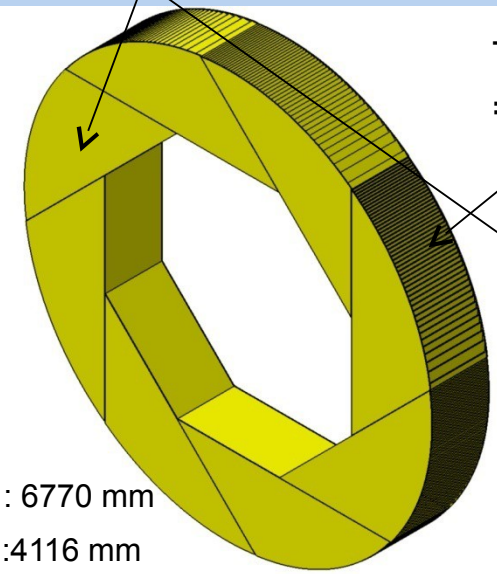
Barrel design

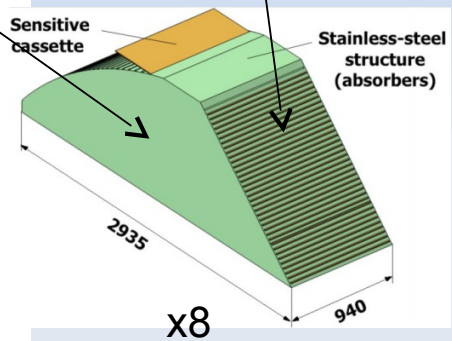
Max deformation : 0.34 mm for position around 6h, 2–10h



Thickness wheel face = 10 mm

Thickness absorbers = 15 mm





x8

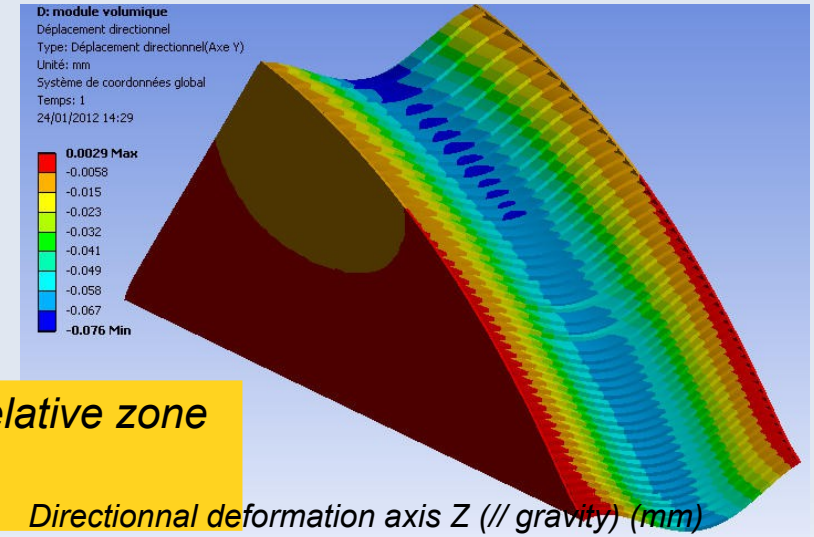
Ext. Diameter : 6770 mm

Int. Diameter :4116 mm

Lenght : 940 mm

Disymmetrical supports 9-15 H

(Max deformation : 0.45 mm for position around 8–4h for support @ 4 & 8h)



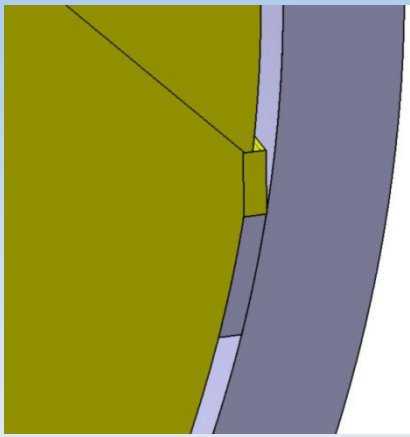
Directionnal deformation axis Z (// gravity) (mm)

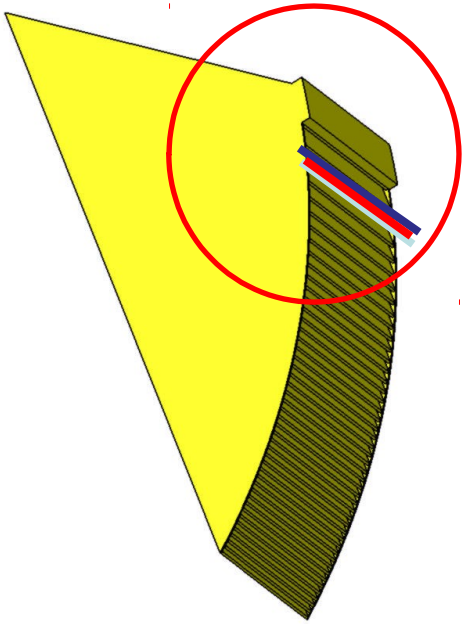
Stainless steel	1 wheel (8 mod.)	5 wheels
Weight (t):	88 t	440 t
Detectors W. (t):	36.8 t	184 t
Total Weight (t) :	124.8 t	**624 t**

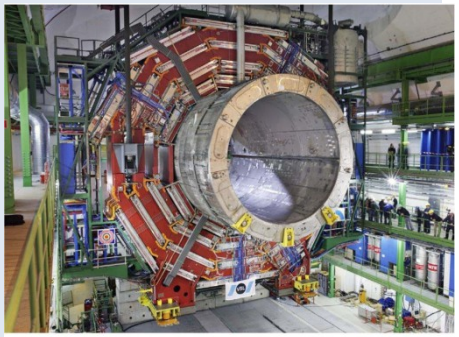
Wheel Max deformation : 0.34 mm – 0.09 mm relative zone

Module Max deformation : 0.07 mm

Barrel support

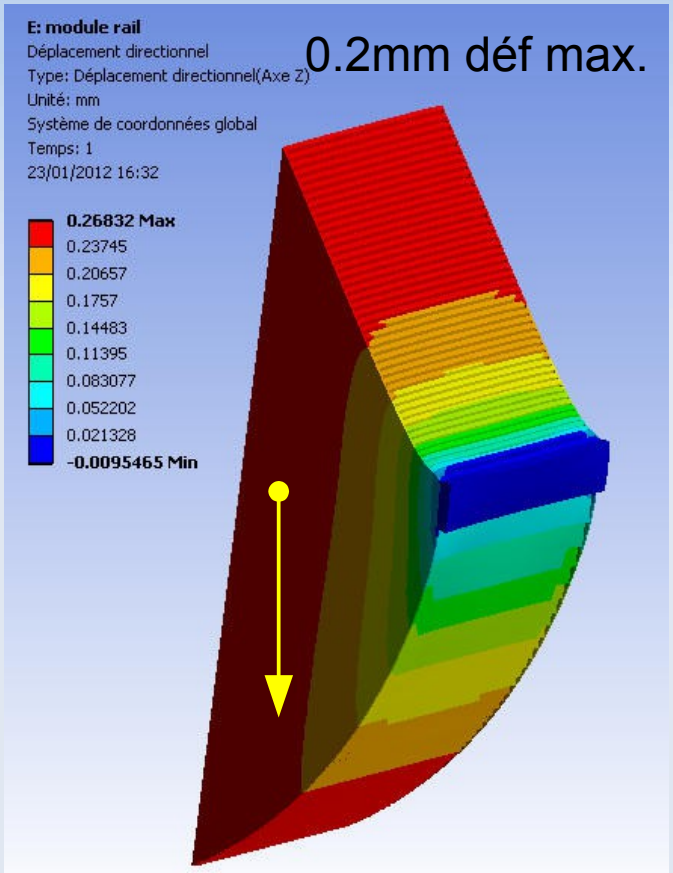






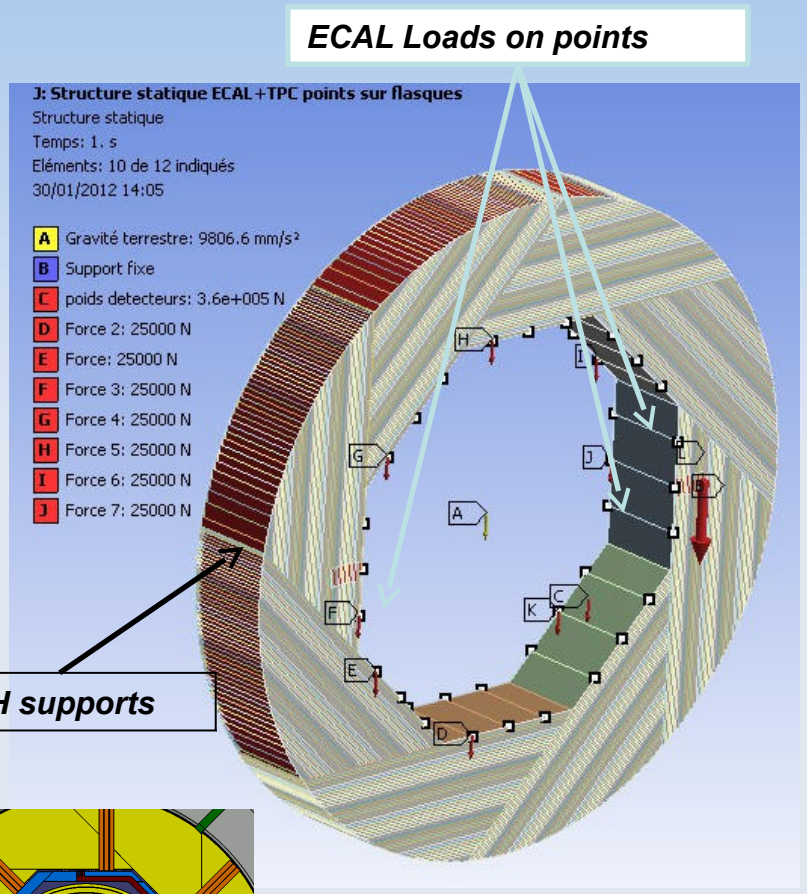
Need to reduce 2 small chambers to integrate services

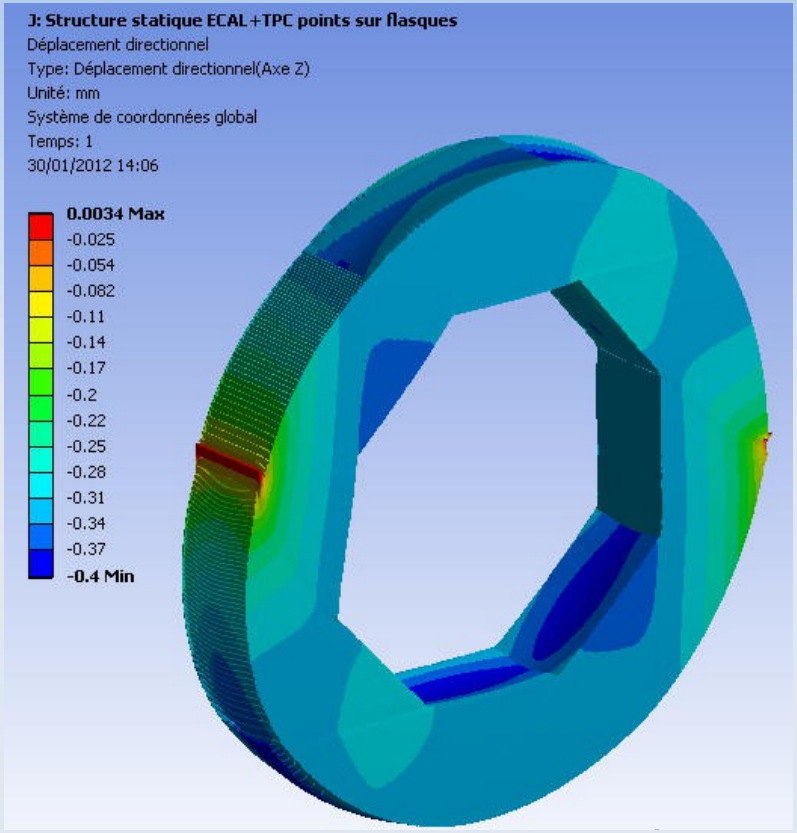
Gravity ½ wheel and Detectors mass

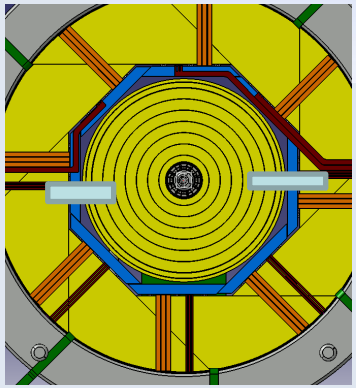


Directionnal deformation axis Z (// gravity) (mm)

ECAL & TPC impact







DHCAL with 8 x ECAL modules (8x2.5 t)

And TPC (4t)

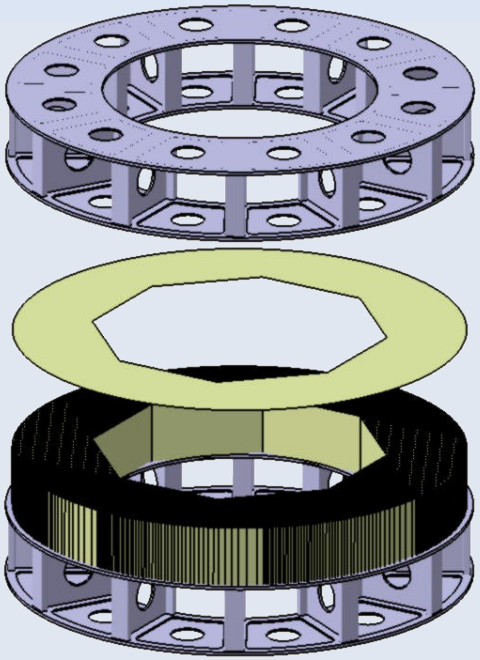
Deformation DHCAL + ECAL + TPC : +0.06 mm % DHCAL

Note: Deformation + ECAL : +0.9 mm % DHCAL if ECAL load on lines

Barrel Building

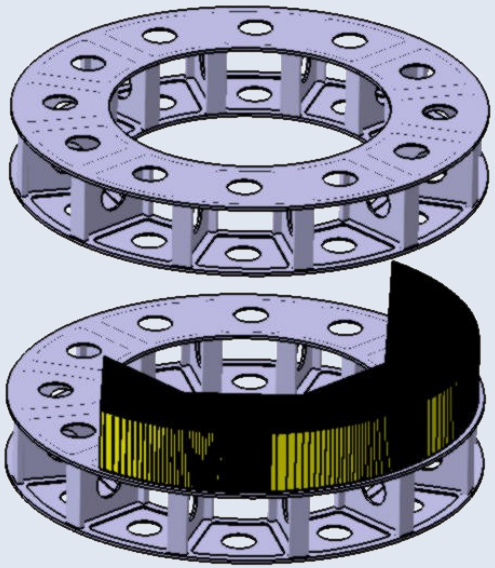
Scenario 1: Screwing method

- 1 wheel side put on a structure
- Screwing of absorbers **as m3 prototype (Ciemat)**
- 1 wheel screwed on the assembly

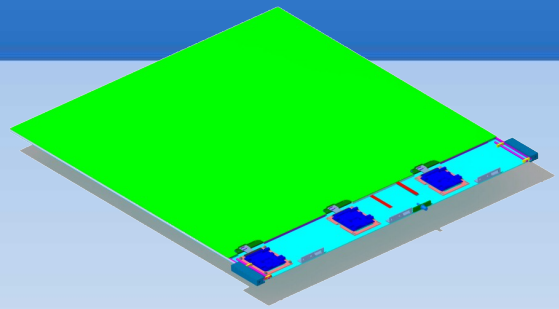


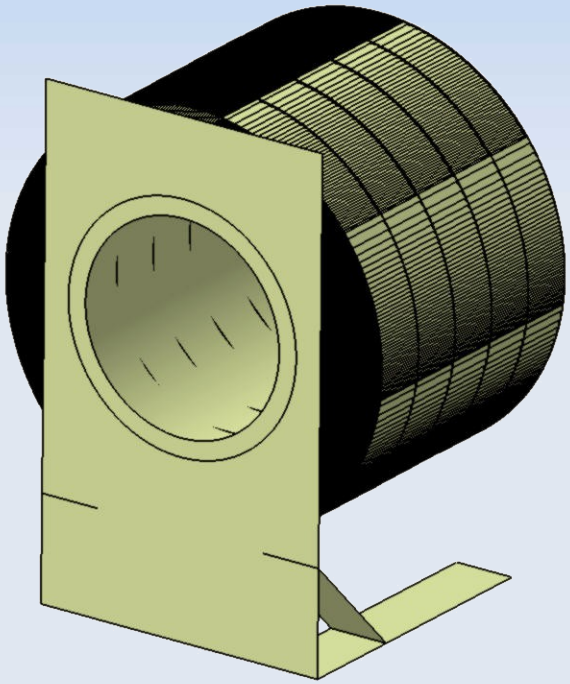
Scenario 2 : Welding Method

- 8 Modules assembling for making a wheel on specific structure
- GRPC insertion vertically all around the wheel with tool
- Services installation



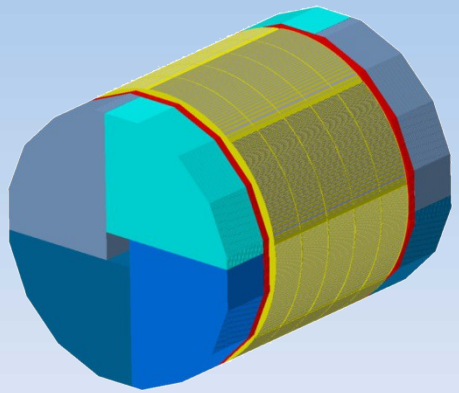
«à la H1»

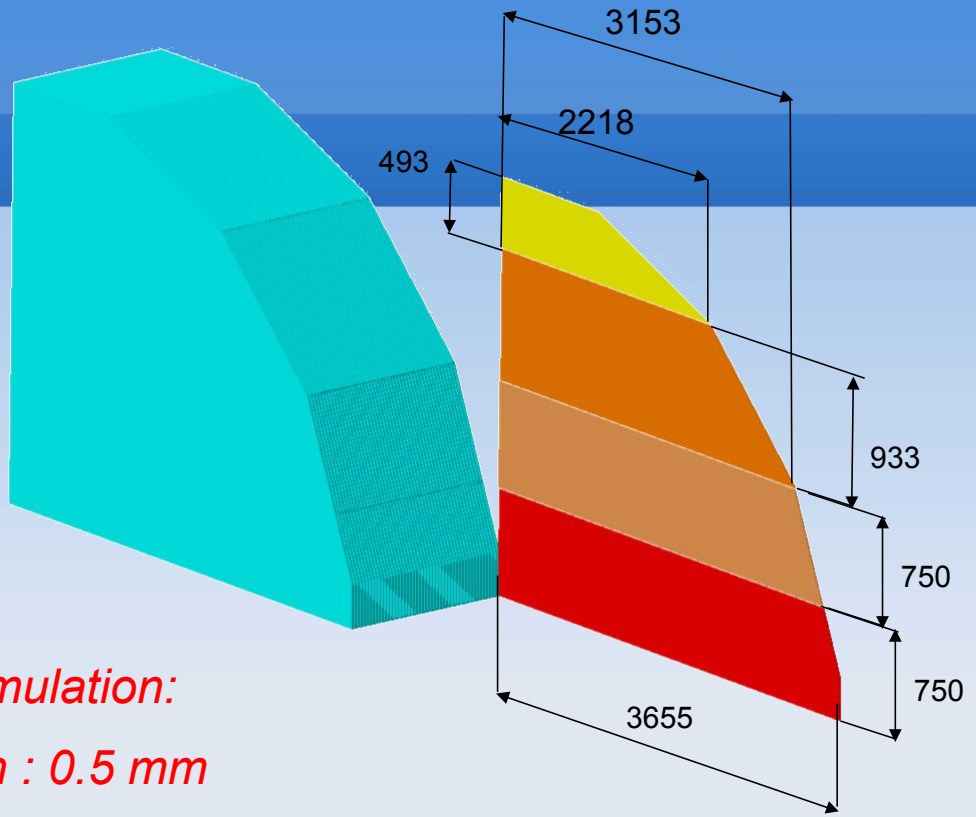




- Wheels with GRPC put one by one on the structure
- Rails on the structure for translation

Endcaps & Rings





2 endcaps + 2 rings

Material : stainless steel

+ Mechanical simulation:

Max deformation : 0.5 mm

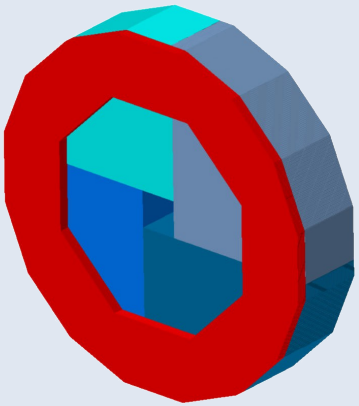
+ services...

One endcap made of 4 modules

Endcap Weight : 200 t

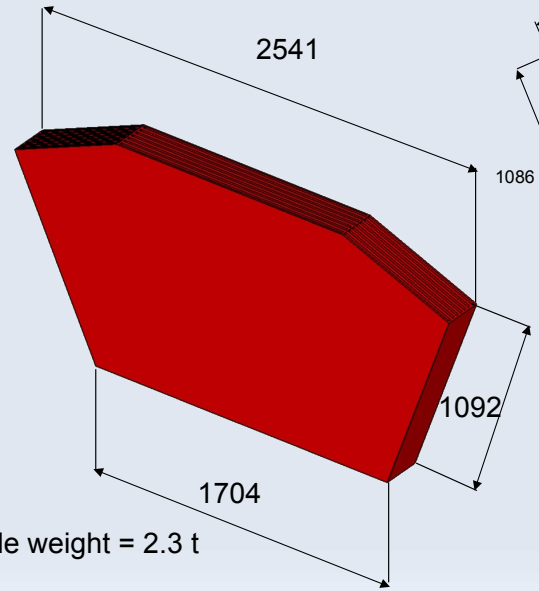
Detectors weight : 90 t

Total weight : 290 t

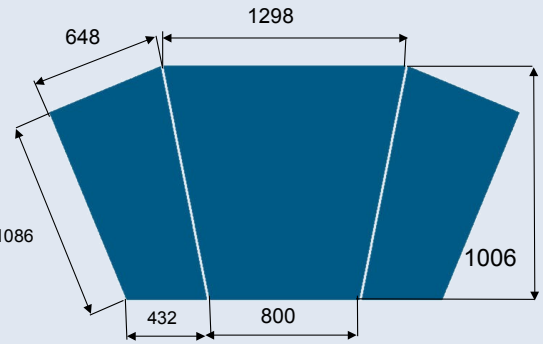


Ring weight = 18.4 t

8 modules



Module weight = 2.3 t



GRPC : S = 2.55 m²

Conclusion

- Most of ILD requirements addressed by the prototype
  - One sided controlled & readout, large & thin chambers
  - Large number of sensor production
- Arriving at the end of a long commissioning phase
  - m^3 prototype finished last June
  - Started to accumulated large sample of cosmics
  - Results of next TB eagerly waited
- Analysis will require more efforts
  - Simulation being finalised (digitisations, model)
  - Innovative methods ➔ reference numbers
- R&D on remaining points started
  - Mechanics behaviour & building in ILD
  - 1×3 m^3 chambers building and readout