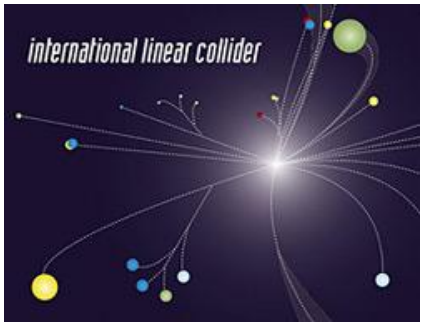


ILD Workshop 2012

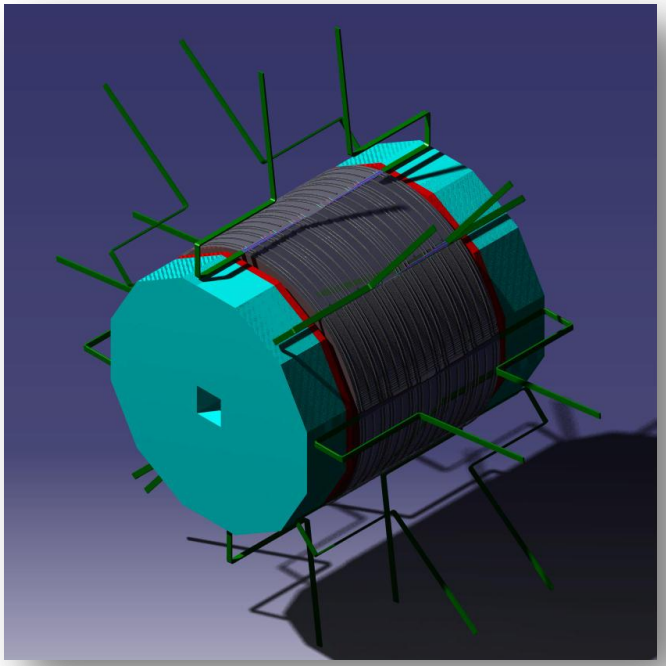
SDHCAL Barrel and Endcap issues

J.C Ianigro

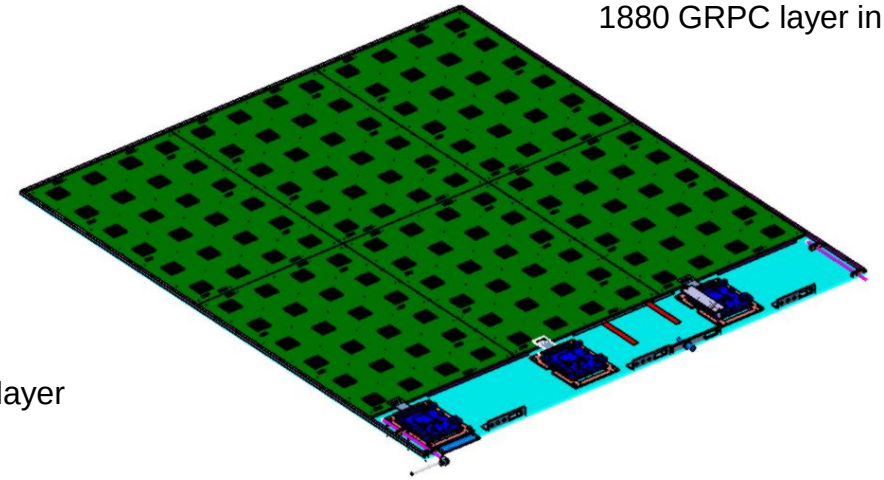
IPN Lyon

Contents

- Barrel Design
- Barrel Tooling for integration
- Endcaps
- Cooling & Services
- Perspectives



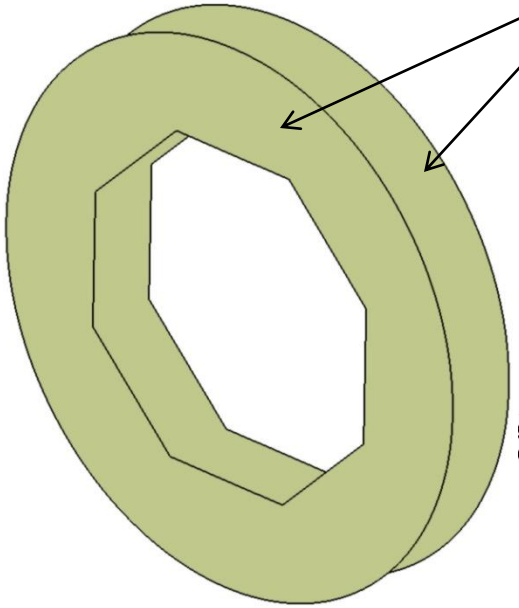
1880 GRPC layer in the barrel



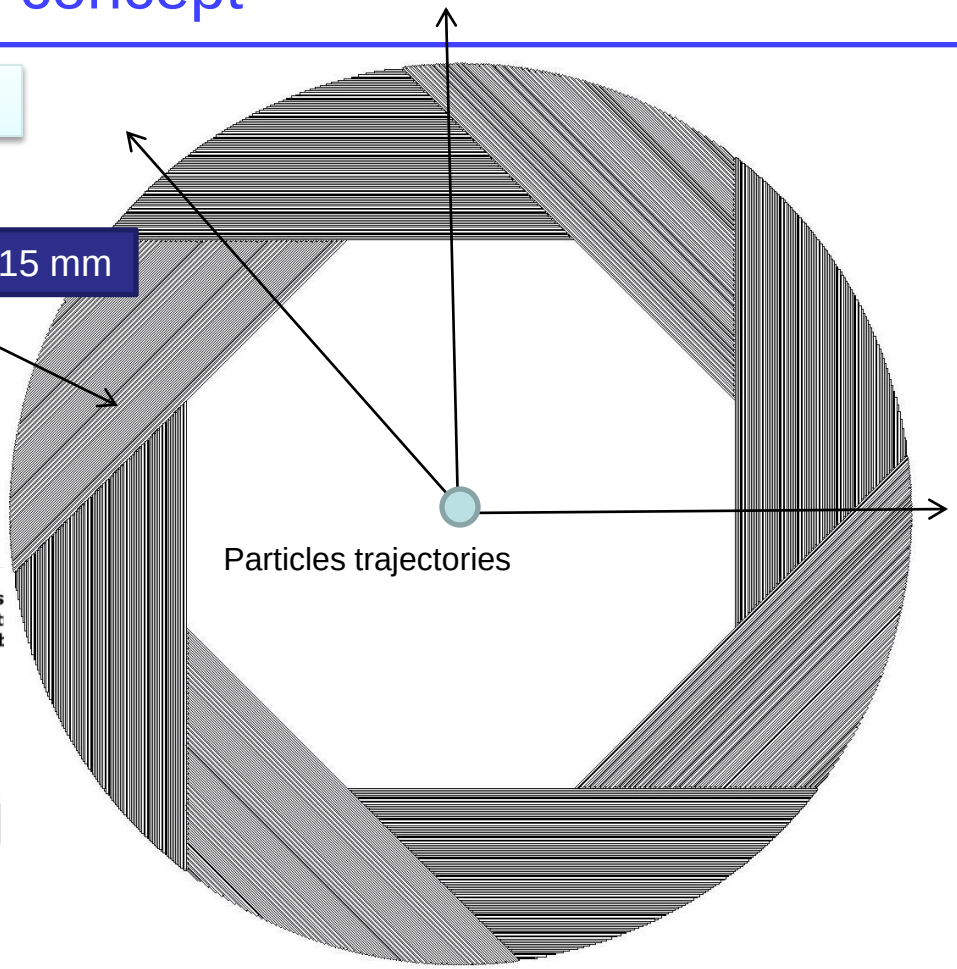
1 m² GRPC layer

Barrel design : wheel concept

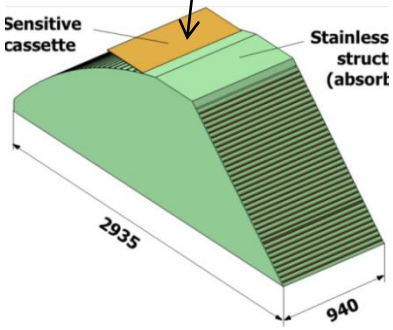
Thickness wheel face = 10 mm



8 zones x 48 plates 15 mm



47 detection layers



Ext. Diameter : 6770 mm

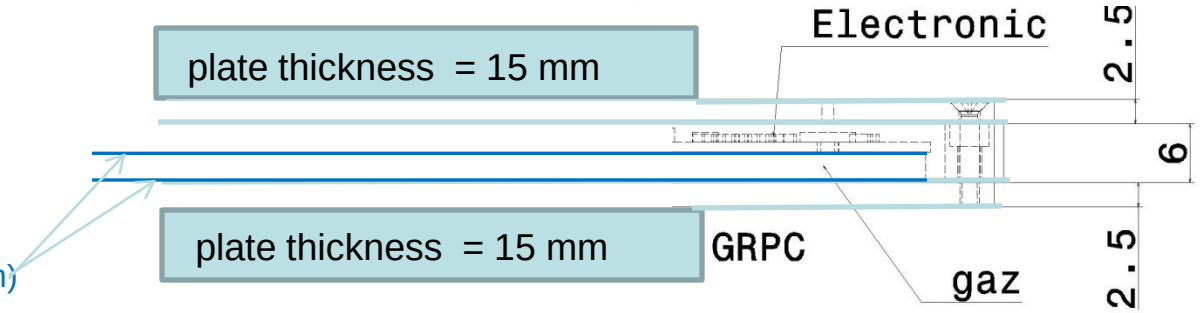
Int. Diameter : 4116 mm

Stainless steel wheel

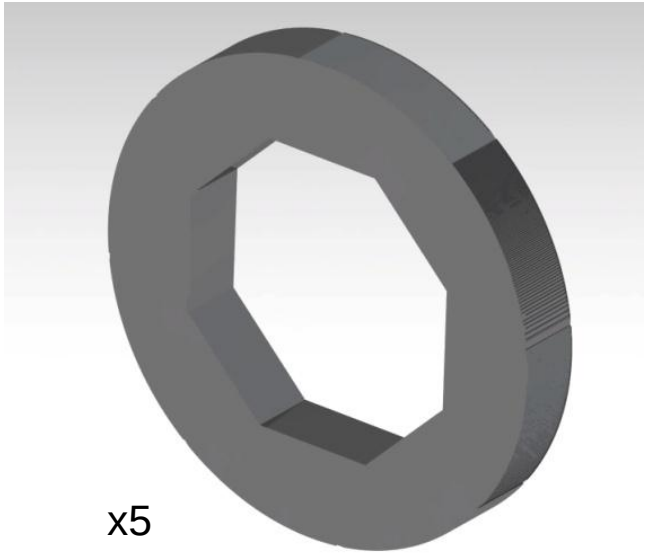
Active layer thickness : 6 mm

Layer s surface : 0.1 to 3.2 m²

Total absorber thickness : 20 mm



Barrel design : 5 wheels

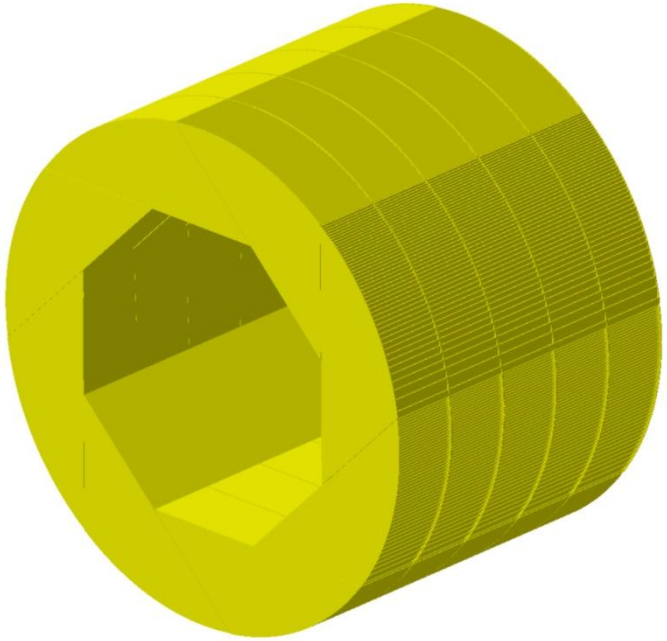


x5

Ext. Diameter : 6770 mm

Int. Diameter :4116 mm

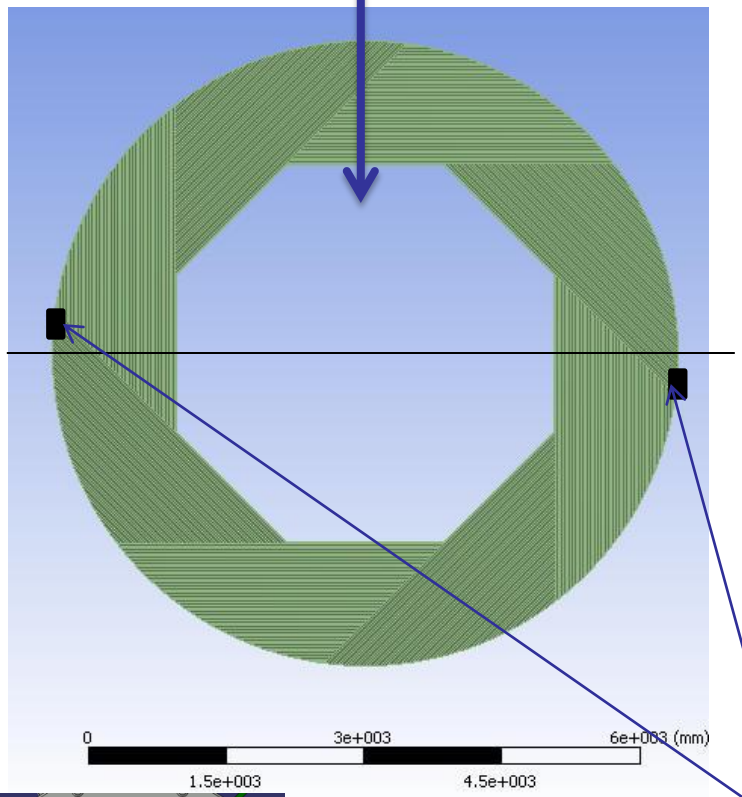
Lenght : 4700 mm

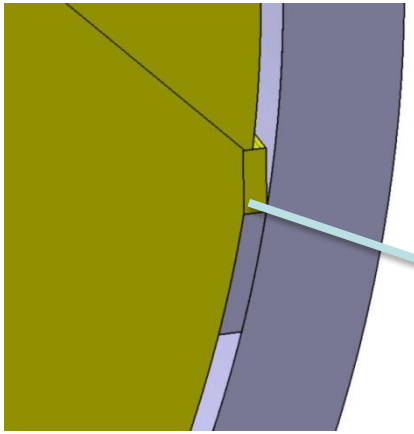


Stainless steel	**1 wheel**	**5 wheels**
Structure Weight (t):	88 t	440 t
Detectors Weight (t):	36.8 t	184 t
Total Weight (t) :	124.8 t	**624 t**

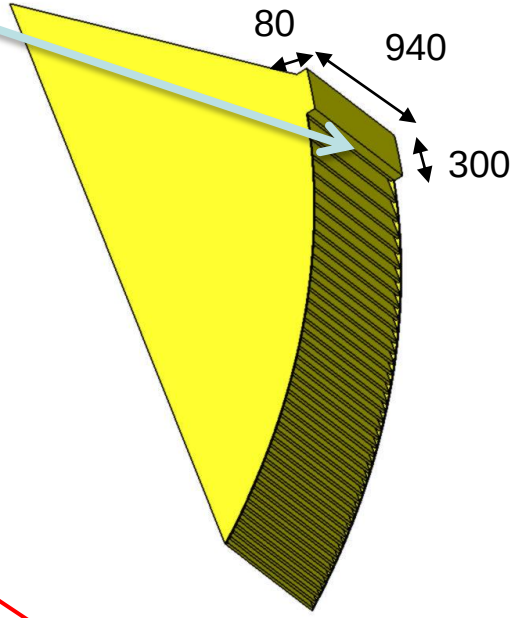
Barrel design – wheel deformation

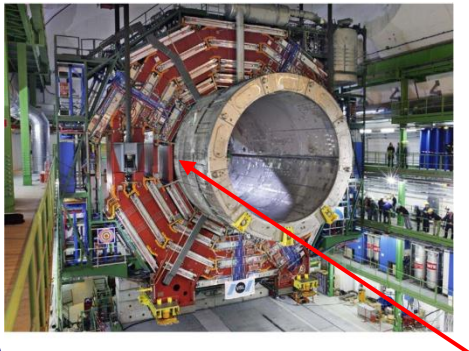
Gravity and Detectors mass

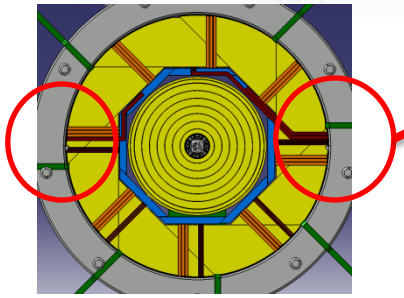




Need to keep out 1 small chambers to integrate services and rail





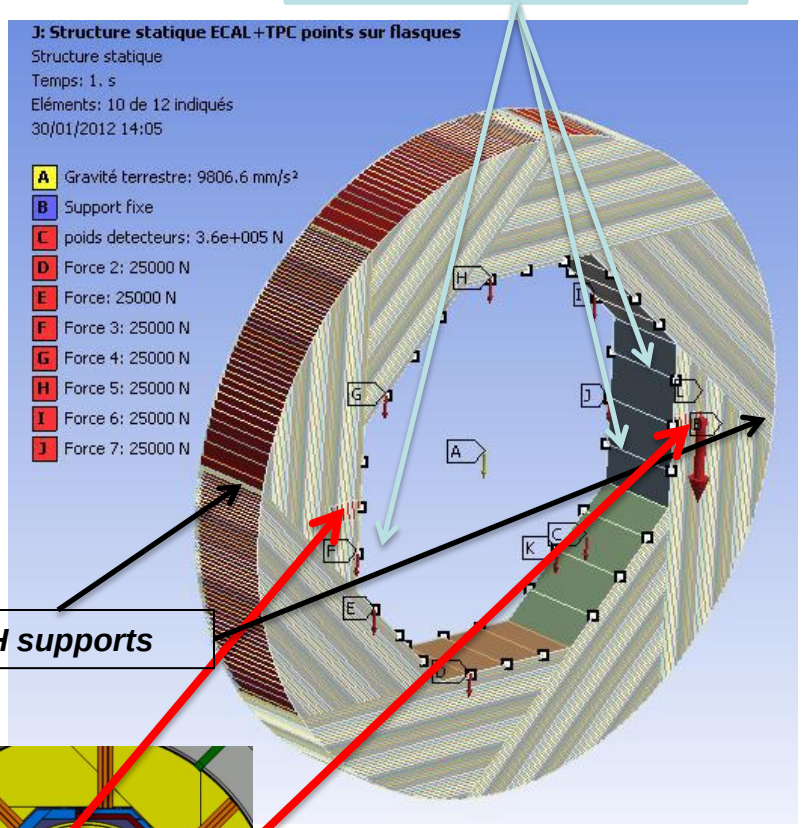


Disymmetrical supports 9-15 H

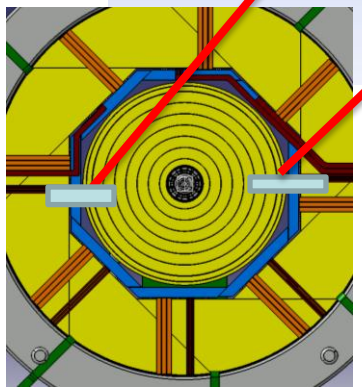
CMS barrel on 2 rails

Barrel design – wheel deformation

ECAL Loads on points

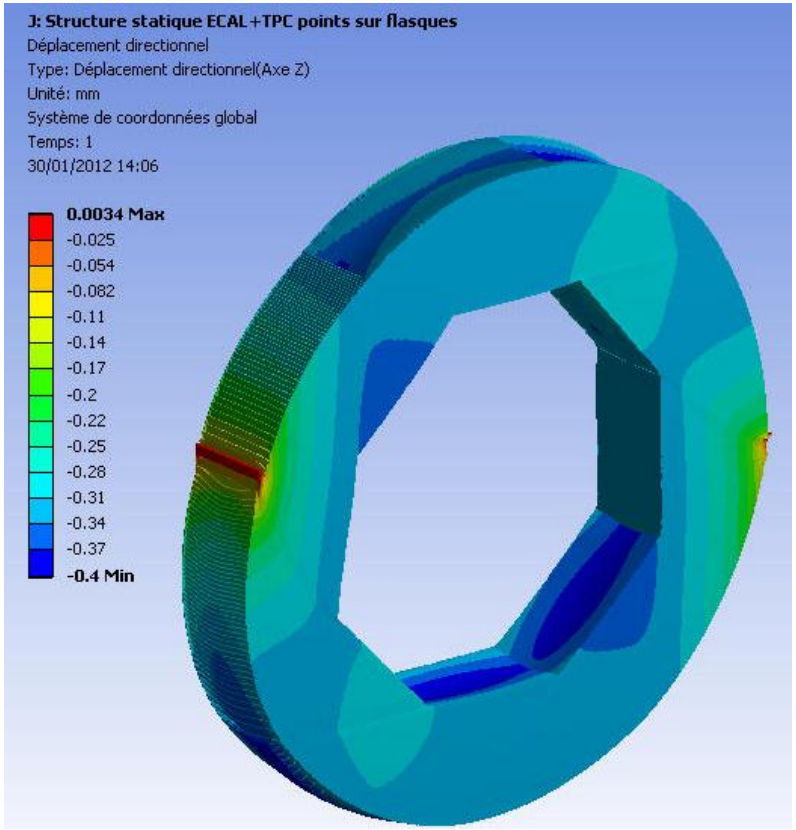


9-15H supports



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

And TPC (4t)



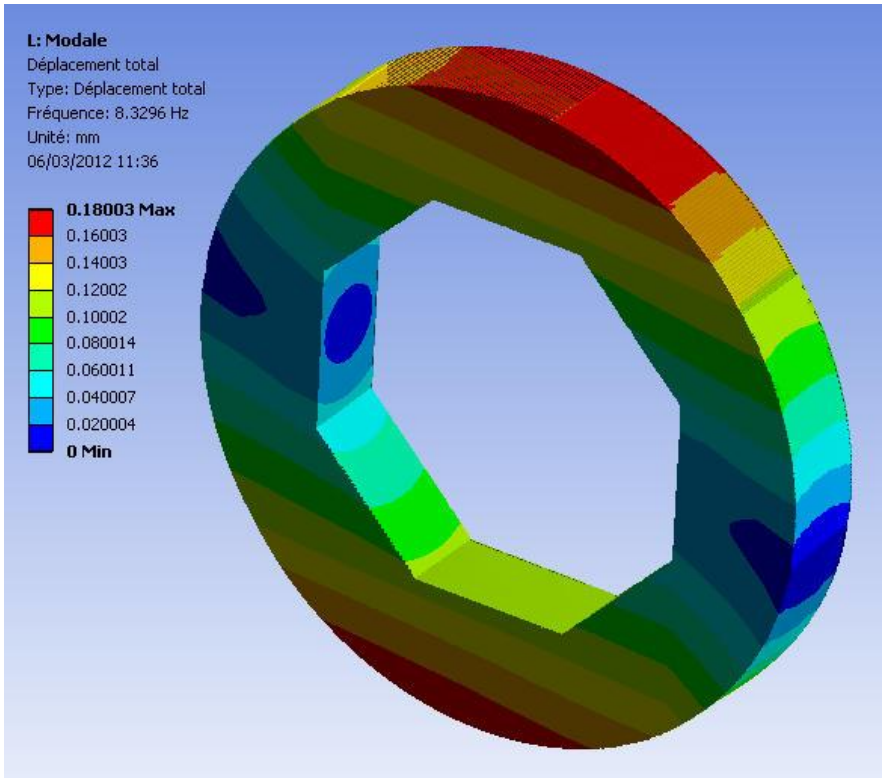
Directionnal deformation axis Z (// gravity) (mm)

Deformation max SDHCAL + ECAL + TPC = 0,4 mm

Very low deformation due to the rigidity of the 2 wheel faces

Barrel design – Modal deformation

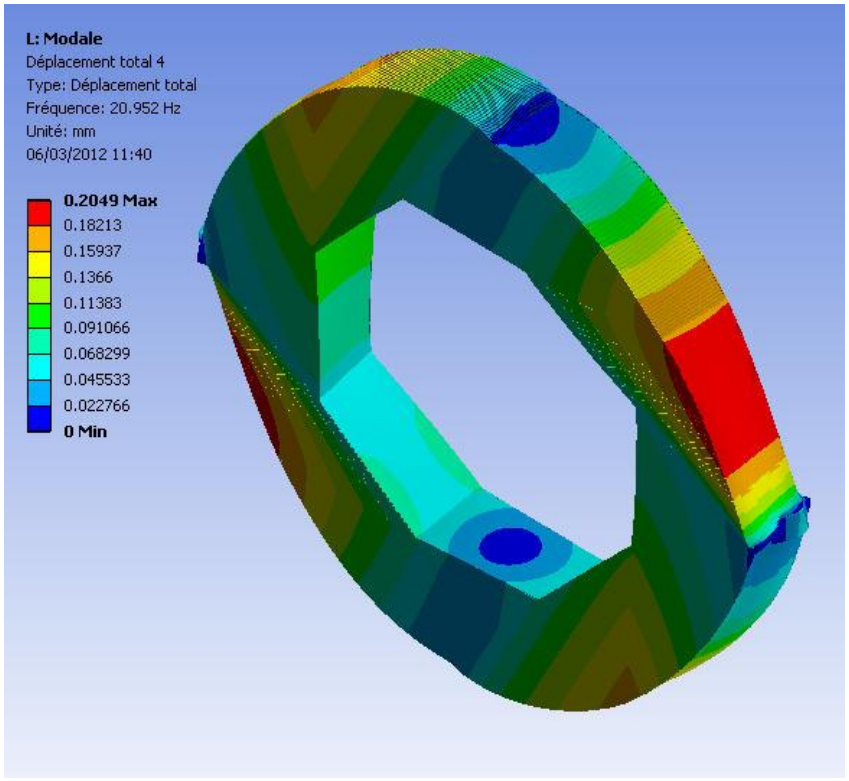
GRPC weight & Fixed-base natural frequencies :
8.3;9.3; 18.9;20.9;30.3;31.3…



Deformation DHCAL + ECAL

mode 1 – 8.32 Hz

0.18mm

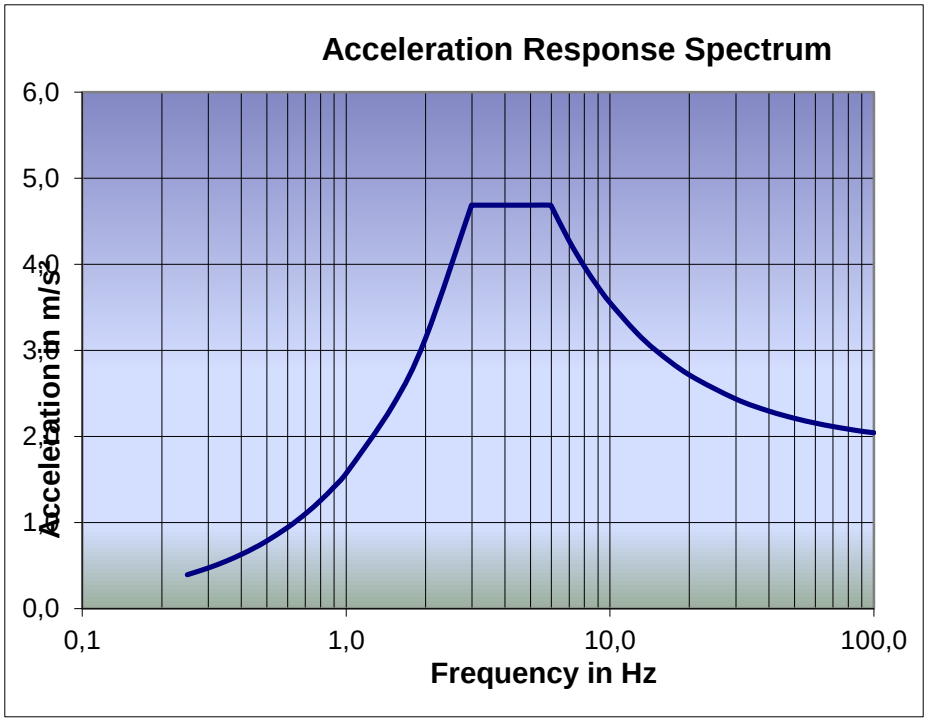


Deformation DHCAL + ECAL

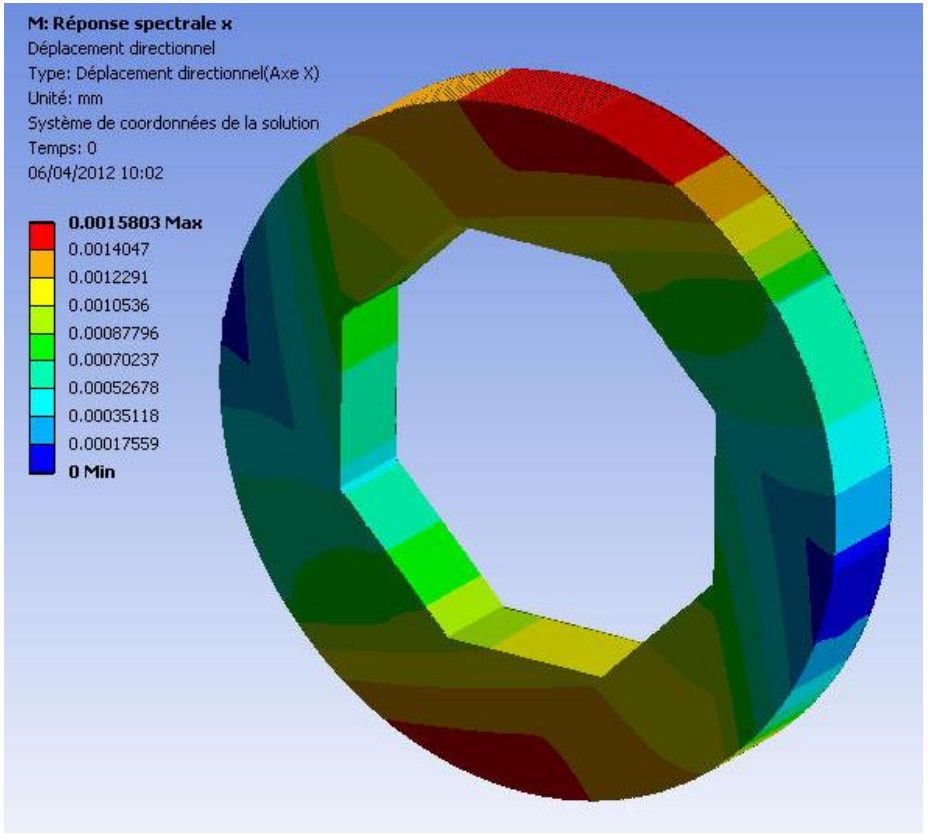
mode 4 – 20.9 Hz

0.20 mm

Barrel design – Seismic deformation



T2K spectrum with X acceleration

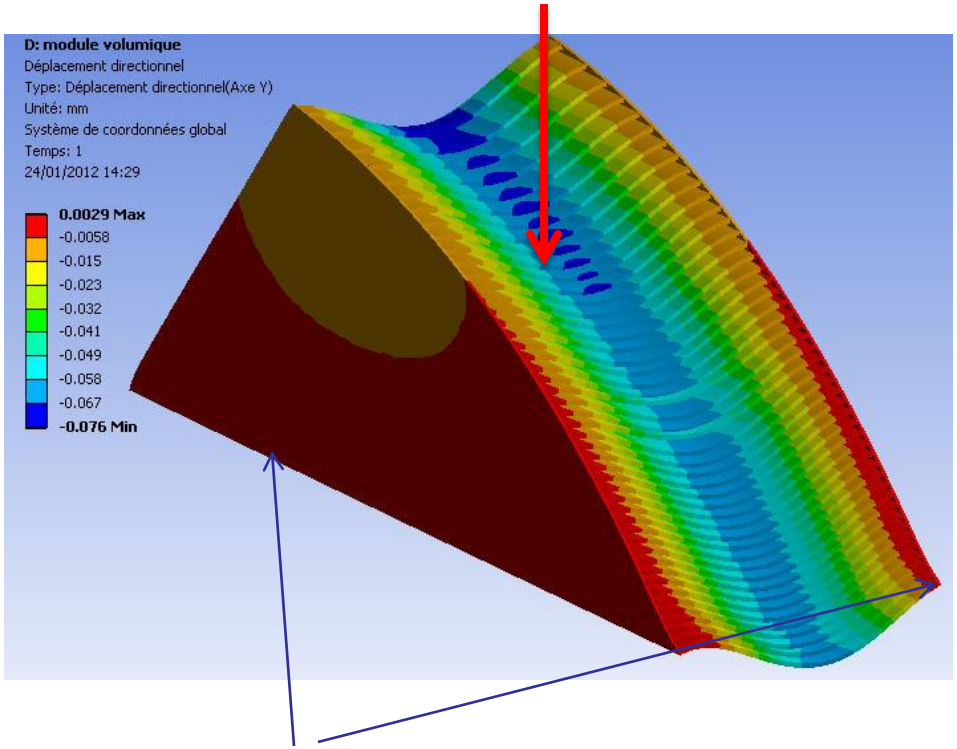


Deformation along X axis

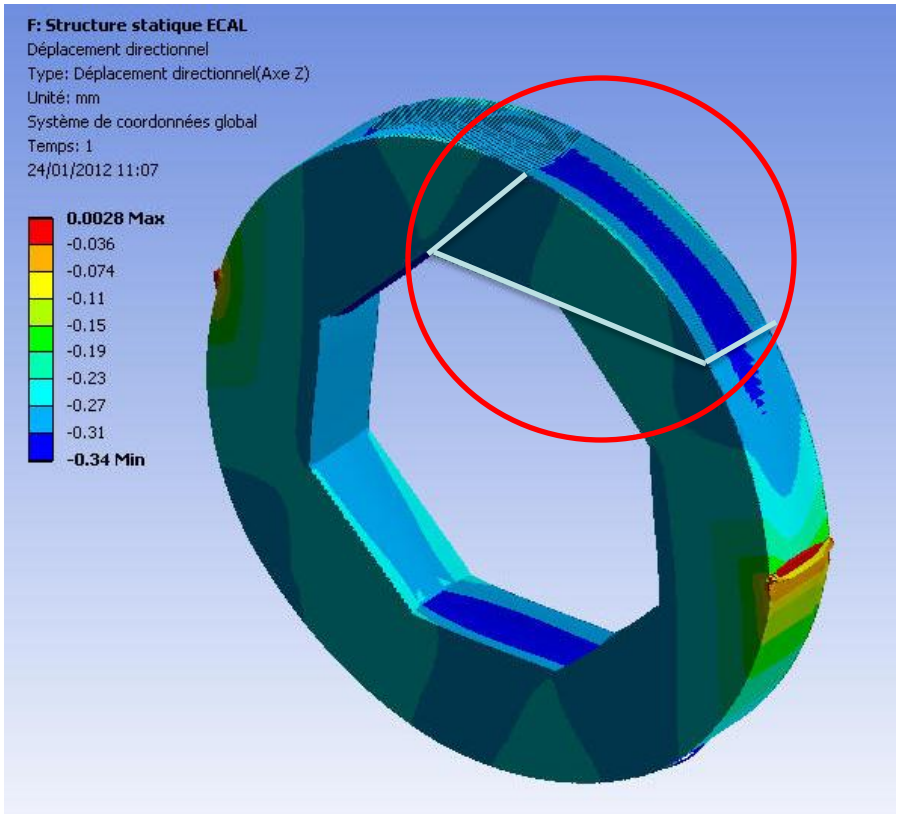
Spectrum & harmonic correlation / ILC seismic data needed in different ground level

Barrel design – absorbers deformation

Gravity and Detectors mass



symmetrical supports



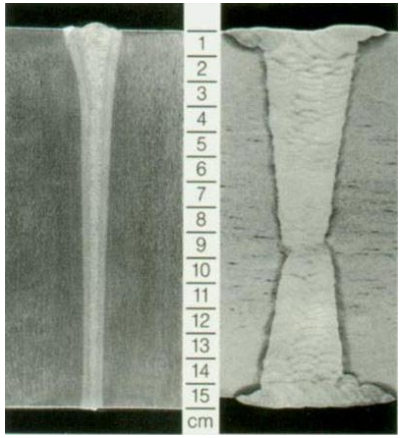
Directionnal deformation axis Z (// gravity) (mm)

Wheel Max deformation : 0.34 mm – 0.09 mm relative zone

Module Max deformation : 0.07 mm

Vision of the influence of absorbers deformation = not critical for GRPC

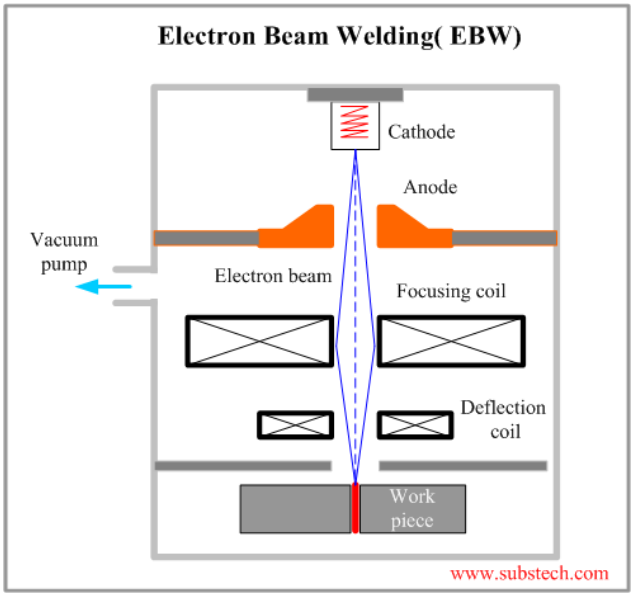
Wheel Building : no screwing



EBW vs Brazing welding

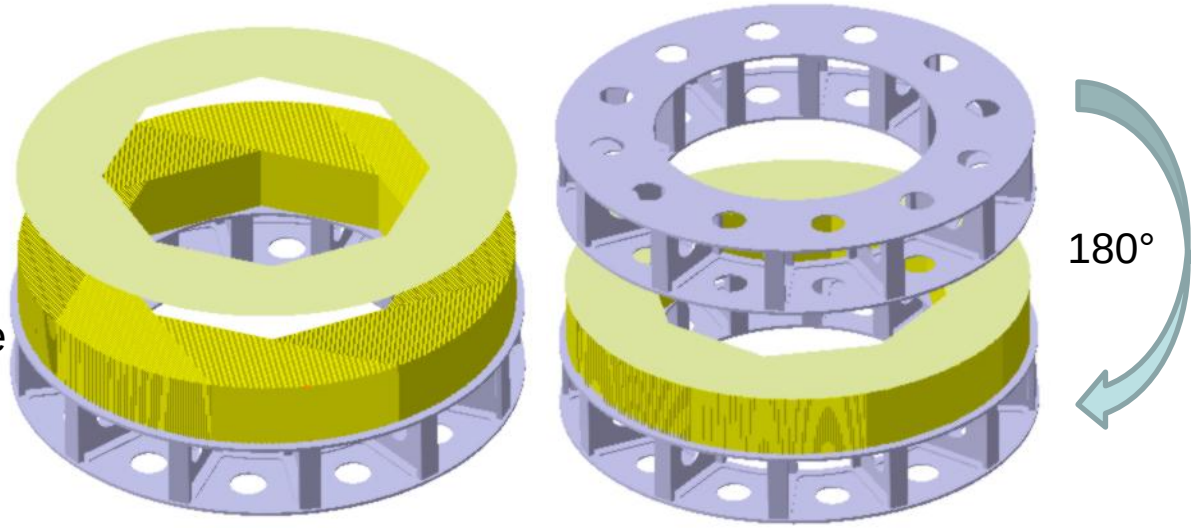
Welding method : EBW

- Tight continuous weld
- Low distortion
- Narrow weld and narrow heat affected zone
- Filler metal is not required
- high resistance (B.C of simulation)

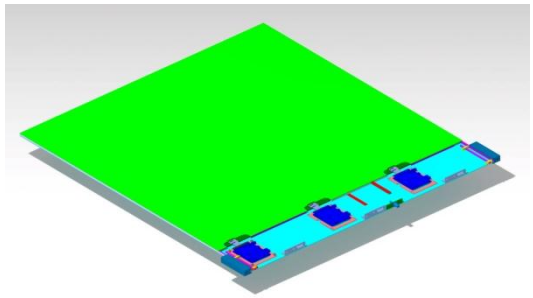


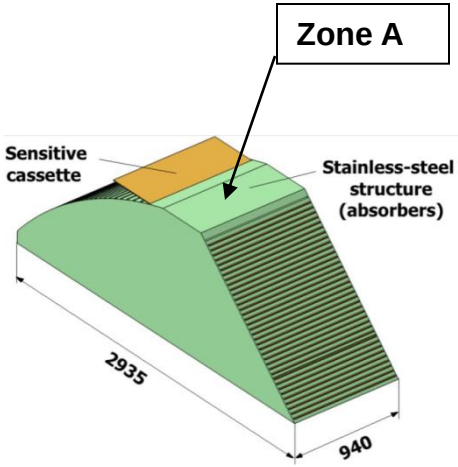
Building SCENARIO :

- 8x48 in position on specific tool
- 1 face put down
- 8*48 plates welded on one face
- One other tool in place
- 180° rotation
- 8*48 plates welded on this other face

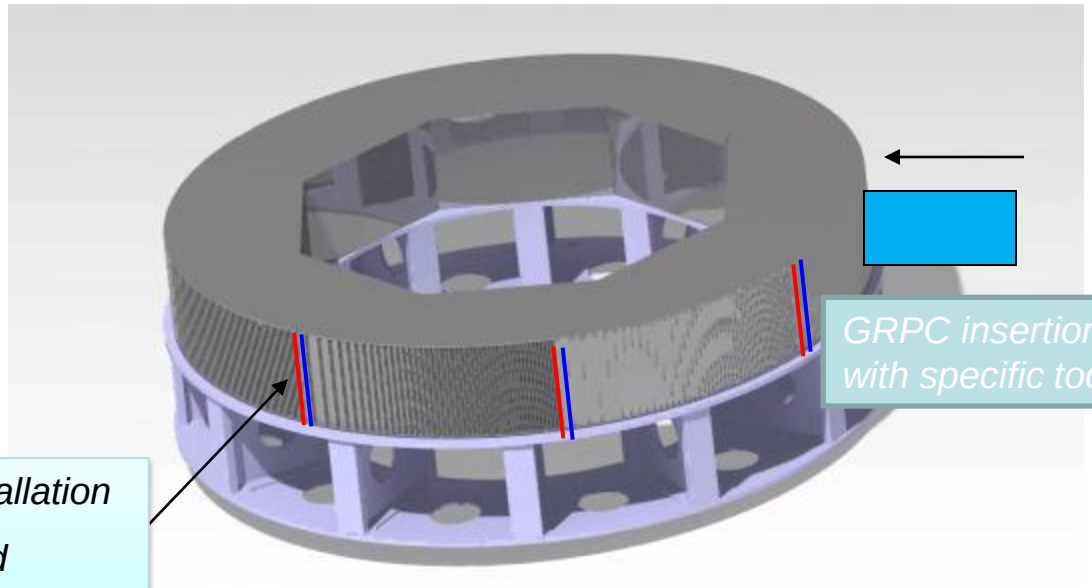


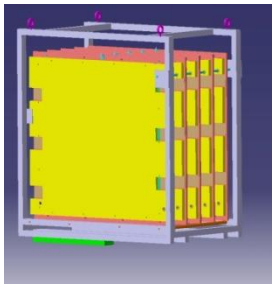
Barrel Building & GRPC Detectors insertion





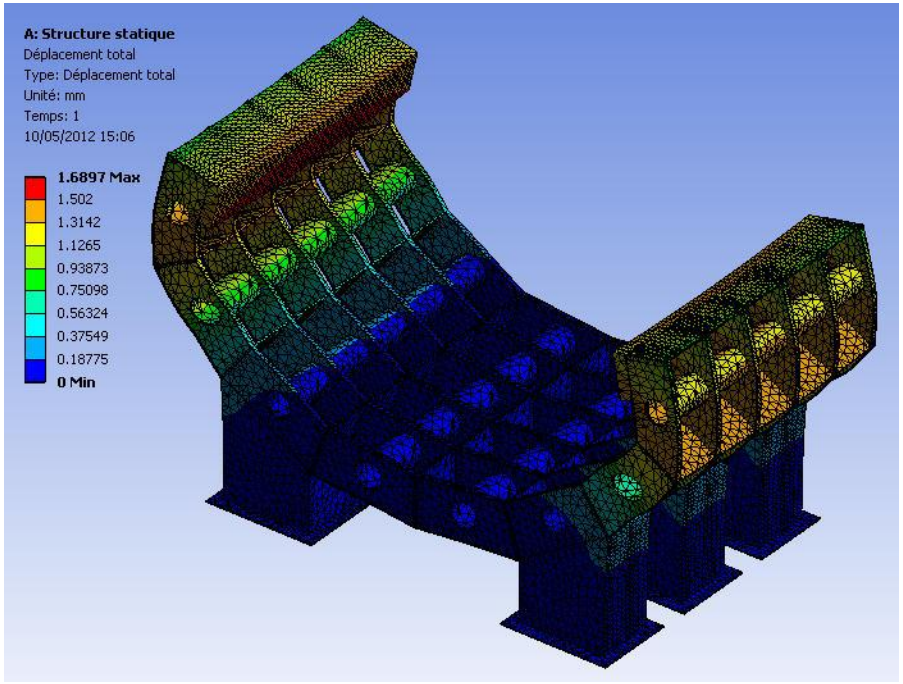
- Transport of GRPC with specific structure to construction place
- 368 GRPC insertion around the wheel
- Connection of gas, HT, data and cooling
- Services installation on each 8 spaces in zone A, so wheels ready to be connected

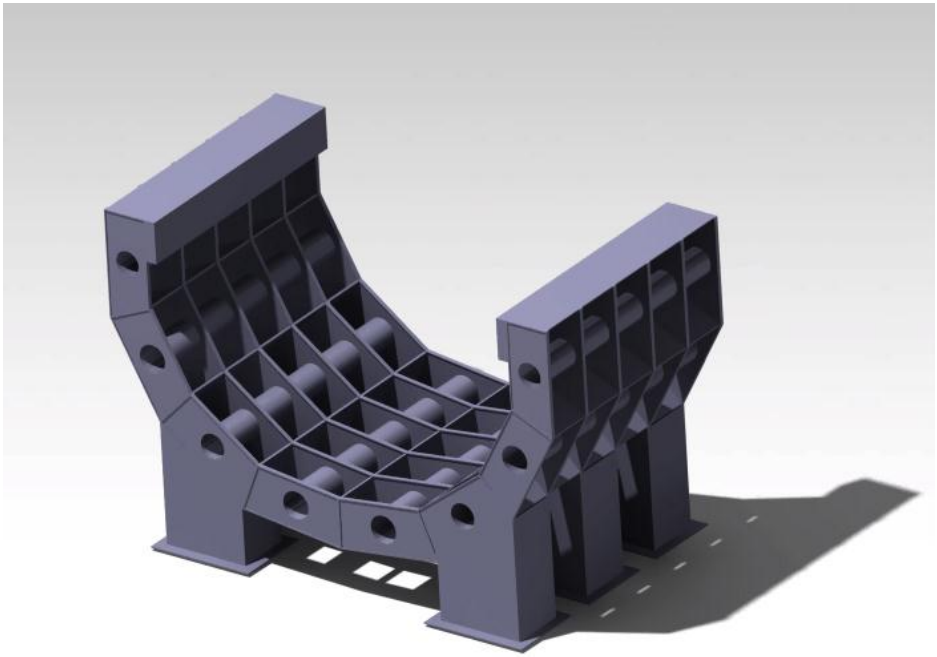




Damper transport structure for GRPC

Barrel Building & services connecting



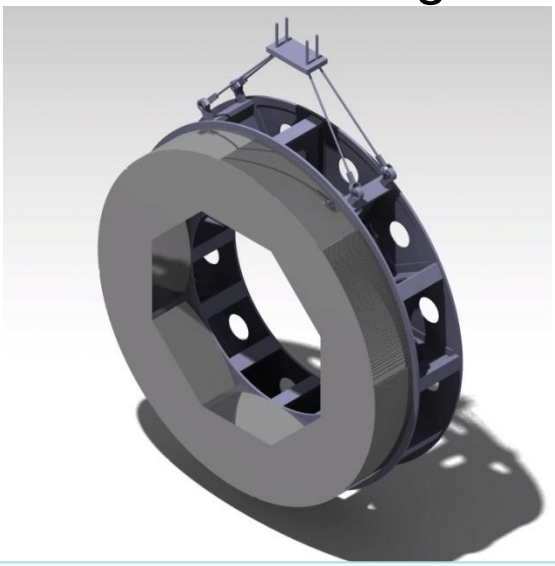


- Welded barrel support structure - steel
- Transport to the loading area and in the tunnel
- weight = 76 t
- Dimensions : 8.9 x 5.9 x 4.7 m

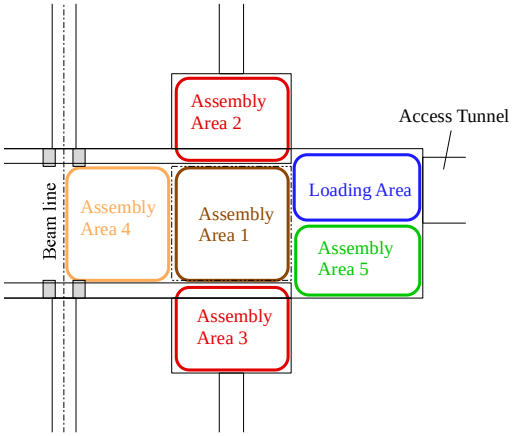
Barrel tooling : phase 2 - wheels connection

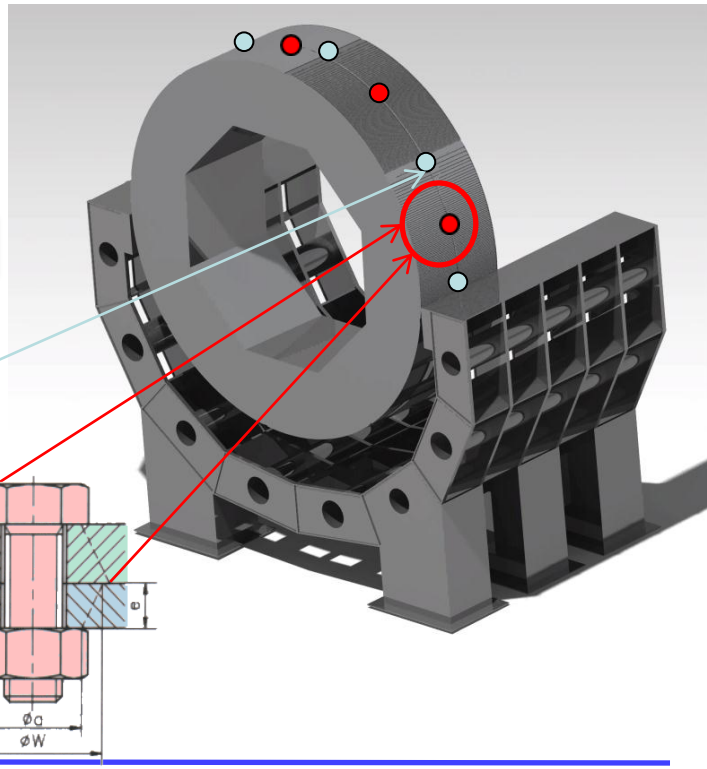
Barrel Building & services connecting

- zone needed for insertion structure : 10 x 10 m
- 5 wheels carried separatly on specific structure
- 5 Wheels bolted together
- Connection of services between the wheels in 8 zones
- Services issues on both sides of the barrel ready to be connected



Wheels carried one by one - P=200 t



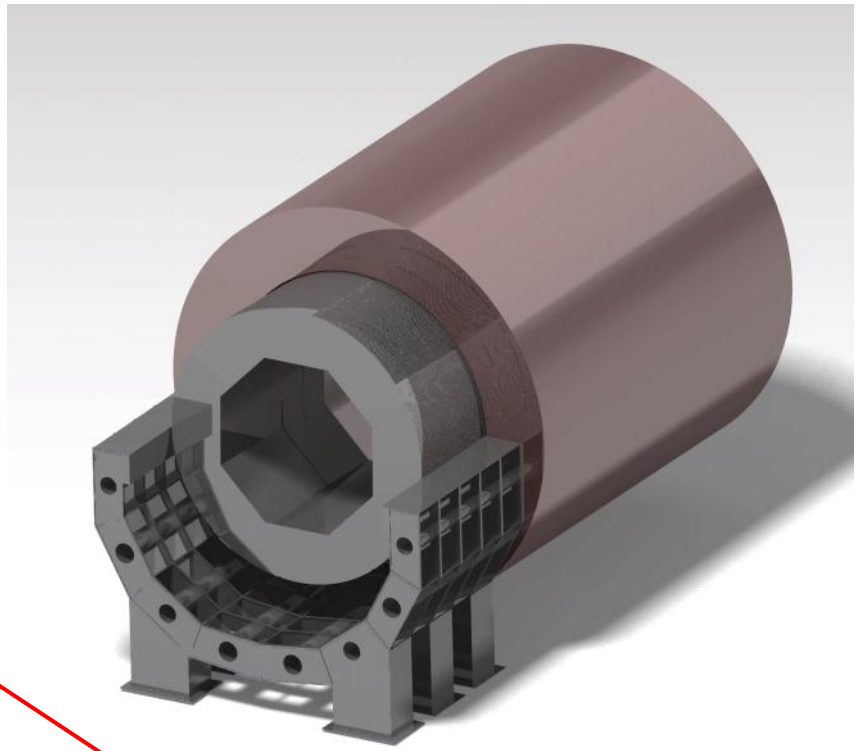


services connection in 8 zones

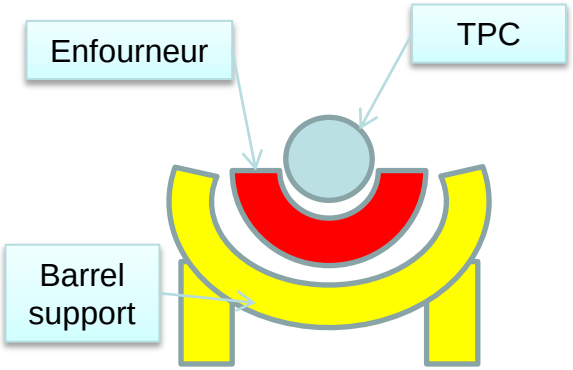
Wheels linked together by bolting on 8 points

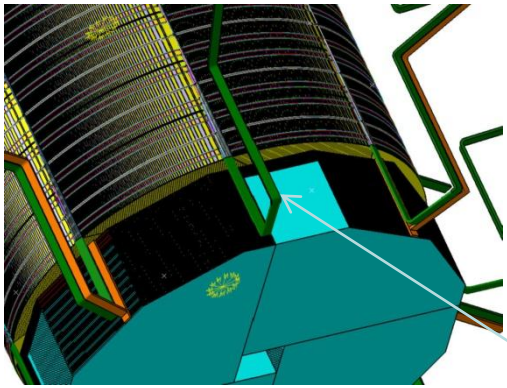
Barrel on structure inside the yoke

- Barrel with 5 linked wheels inserted
- slipping on rails inside the yoke
- barrel fixed inside the yoke on both sides
- services installation along the yoke to patch pannels



Barrel insertion





Structure could be used for TPC with another specific structure as CMS « enfourneur » (red)

Services issues

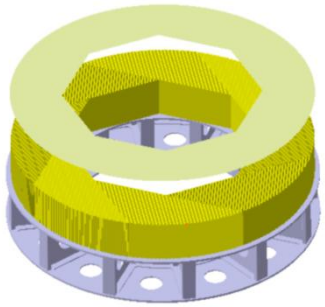
Barrel Building & services connecting : Time estimation

- On SURFACE (laboratories & industry) phase 1 :

  5 wheels construction : 6 months

  1880 GRPC production : 2 years

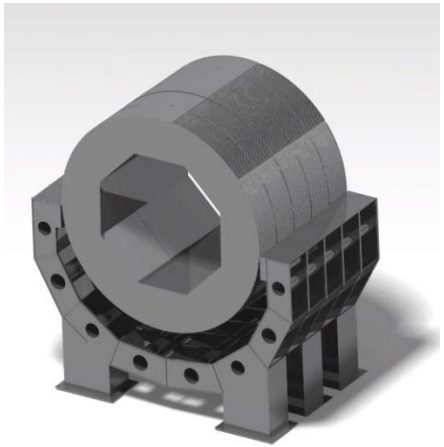
  1880 GRPC Insertion & testing : 2 years



- In the TUNNEL phase 2 & 3 :

  Barrel building, connected & tested, insertion: 6 months

  Services installation barrel to patch pannels : 5 months



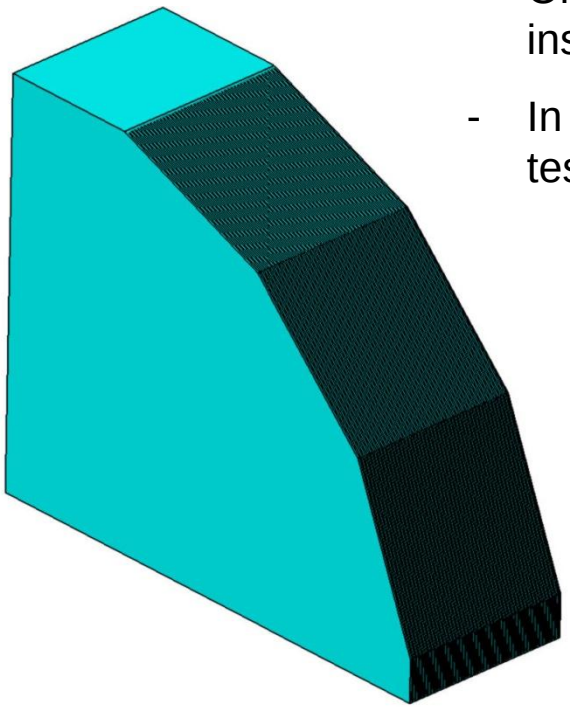
Estimation cost for the barrel mechanical structure: 6 000 K€

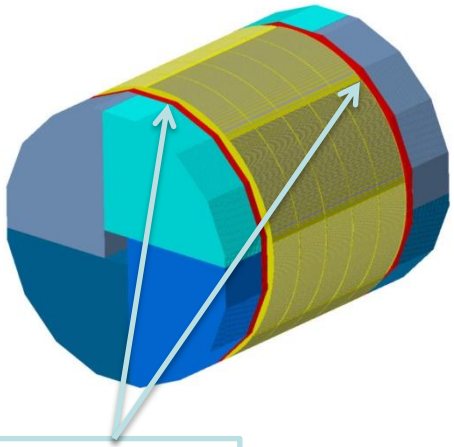
Estimation cost for the support structure : 1 000 K€

- Endcap

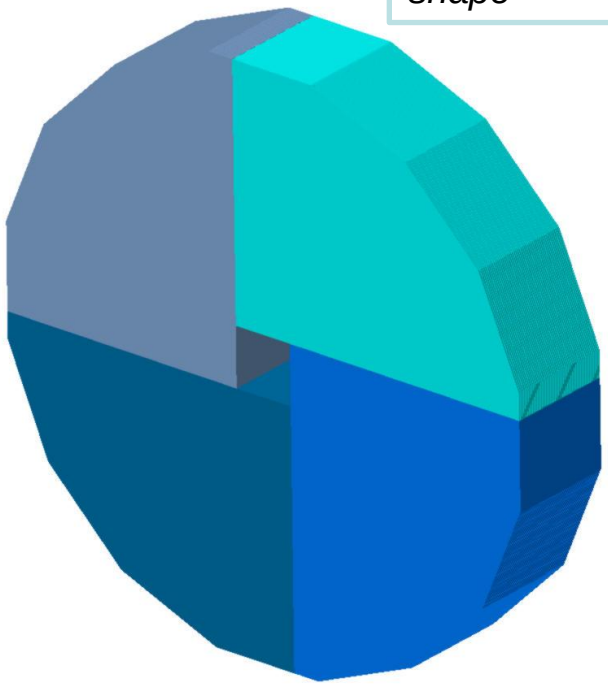
Approximately the same building and integration scenario :

- On surface : building and GRPC insertion
- In the tunnel : connections and tests





Dodecagon shape



One module

Module Weight : 50 t

Detectors weight : 22.5 t

Total weight : 72.5 t

One endcap made of 4 modules

Endcap Weight : 200 t

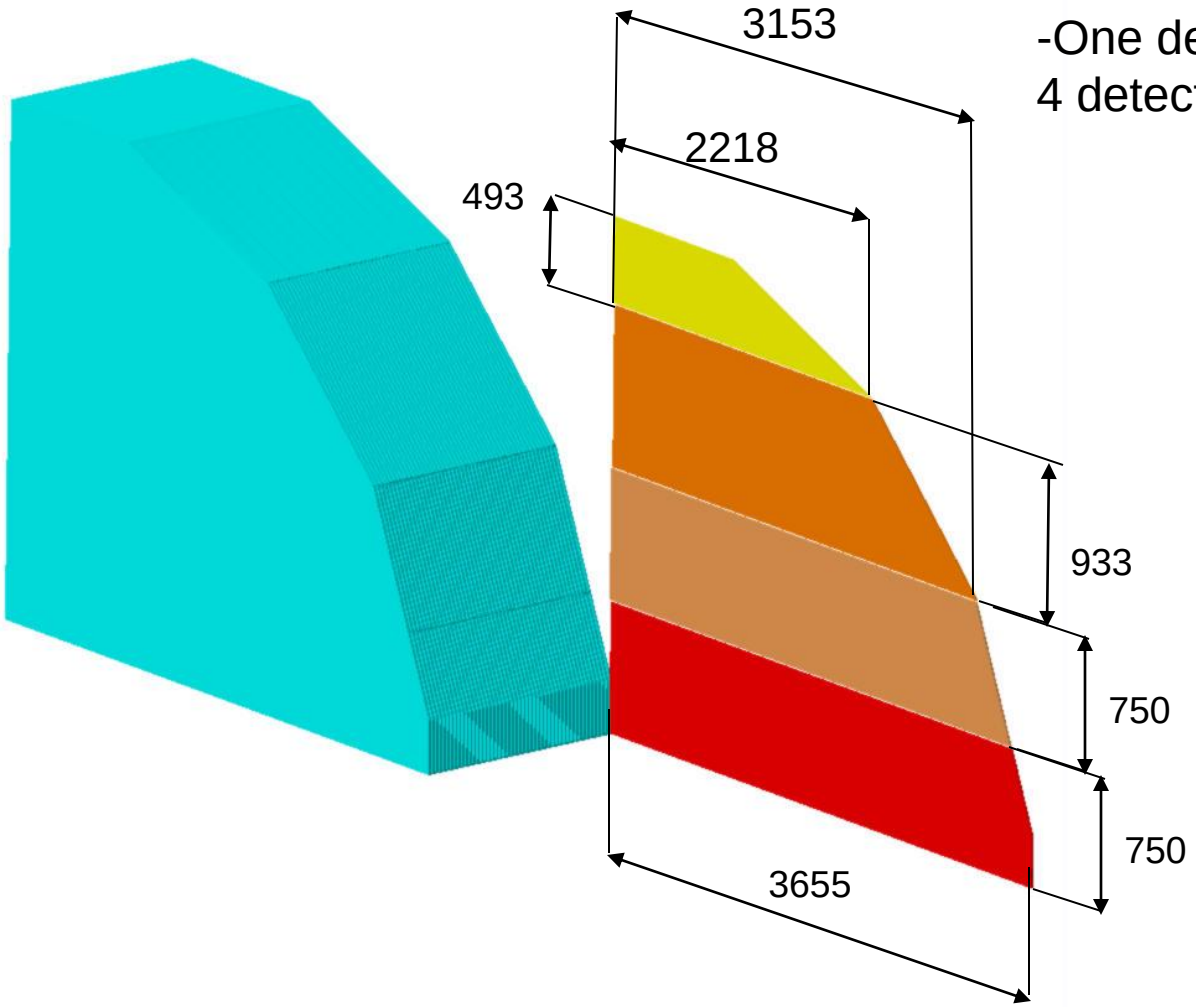
Detectors weight : 90 t

Total weight : 290 t

- One module composition

-48 detection planes

-One detection plane consisted of 4 detectors



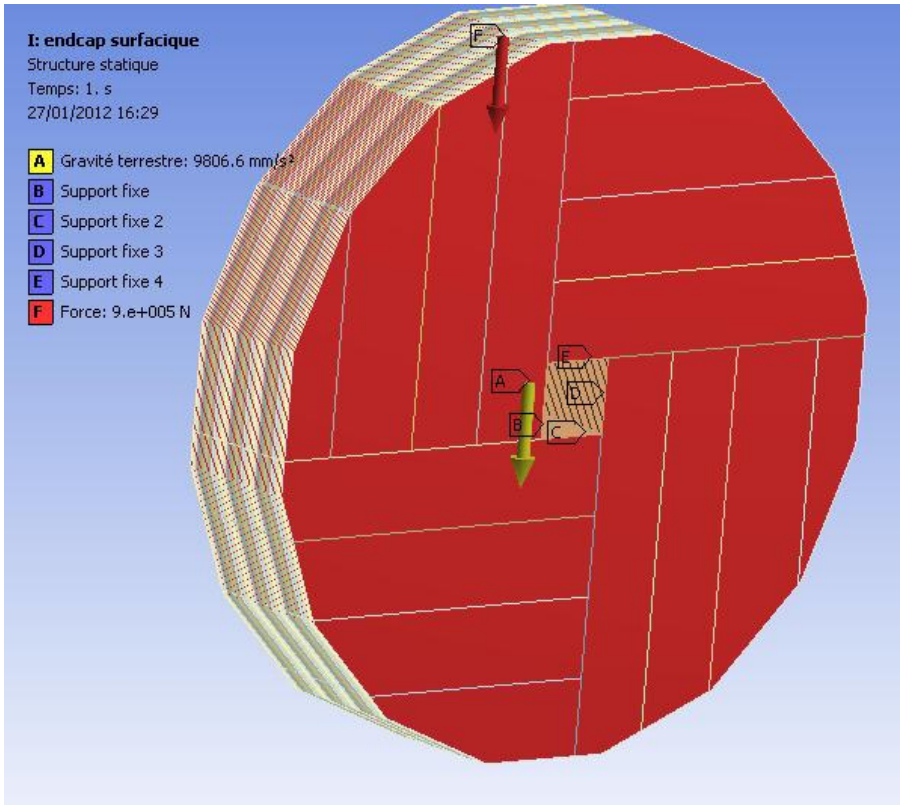
GRPC plane : S = 8.5 m²

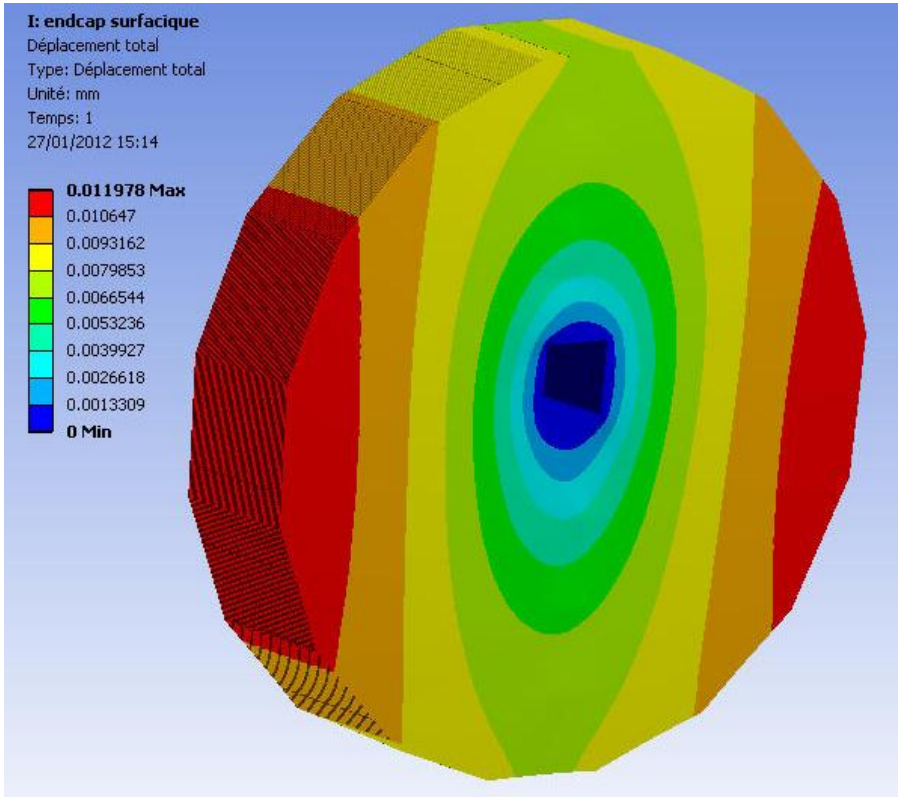
192 detectors

P = 467.5 Kg

P/module = 22.5 t

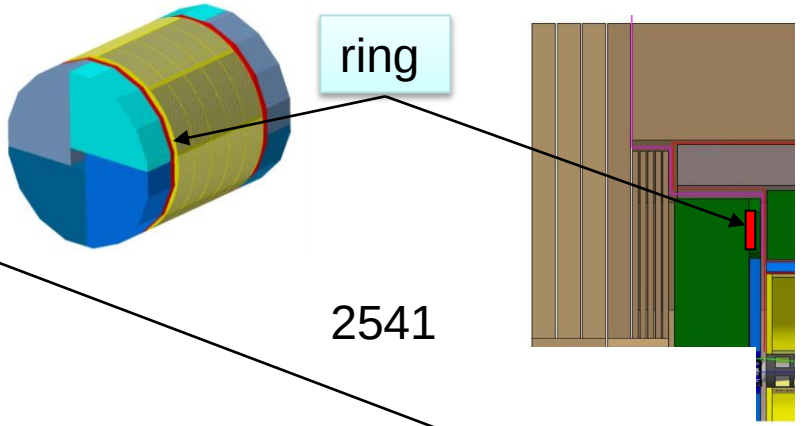
- Endcap deformation
  - Fixed by center tube (no magnetic field)

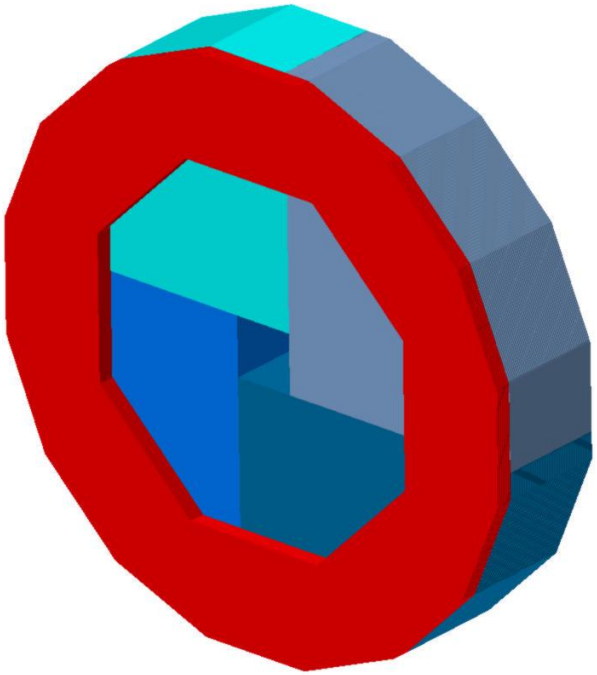




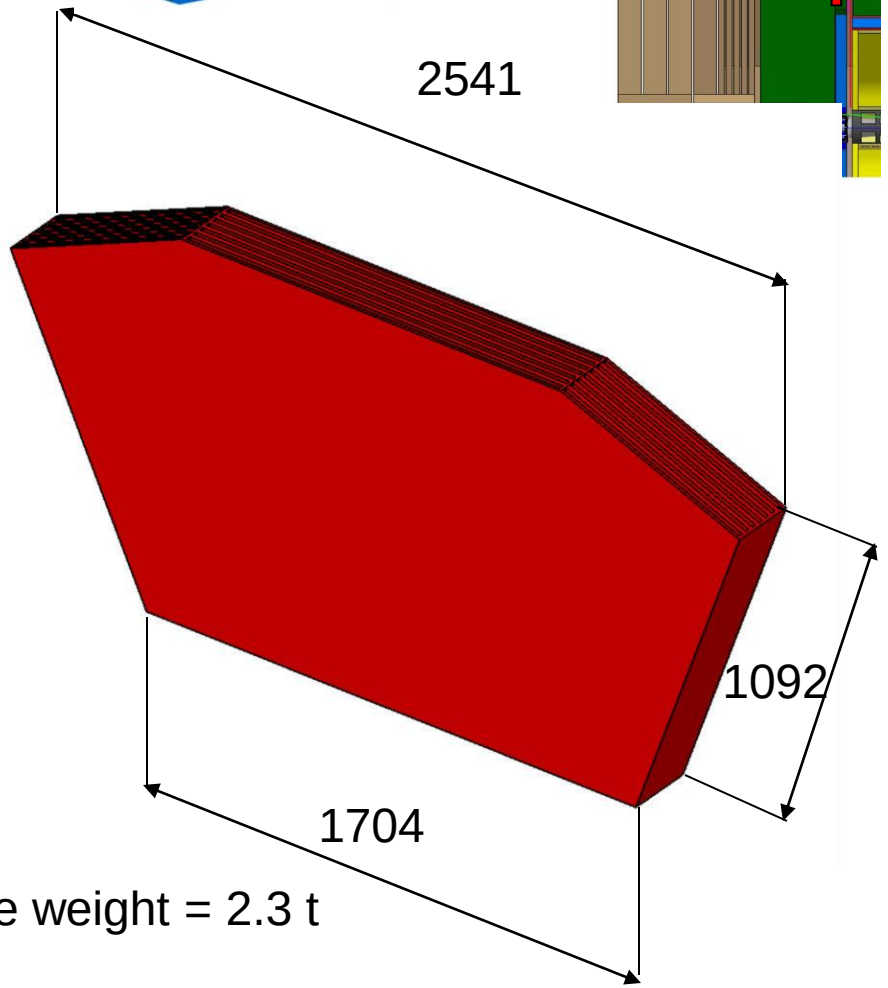
Max deformation : 0.5 mm

- Ring between barrel and endcap
  - Placed around the ECAL endcap





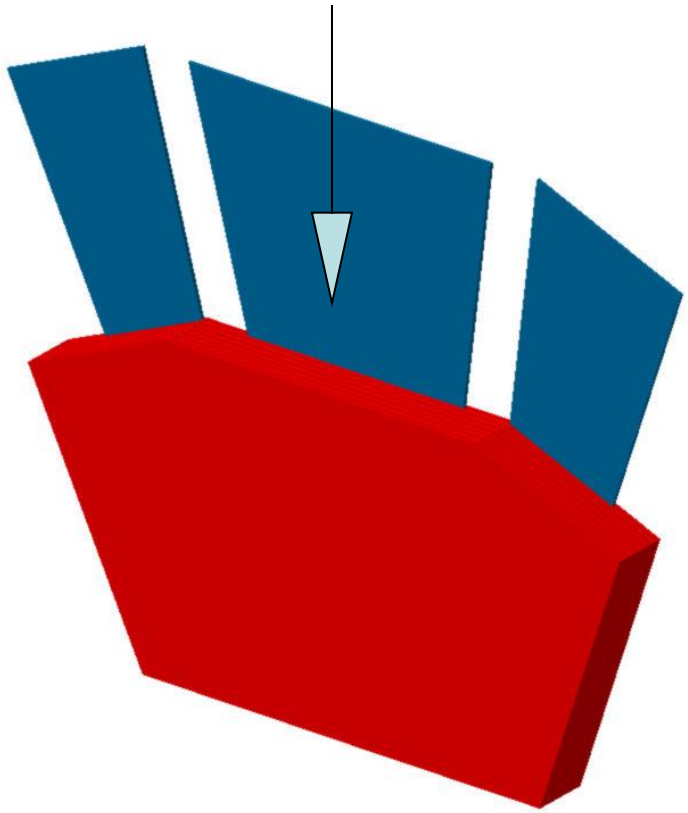
8 modules

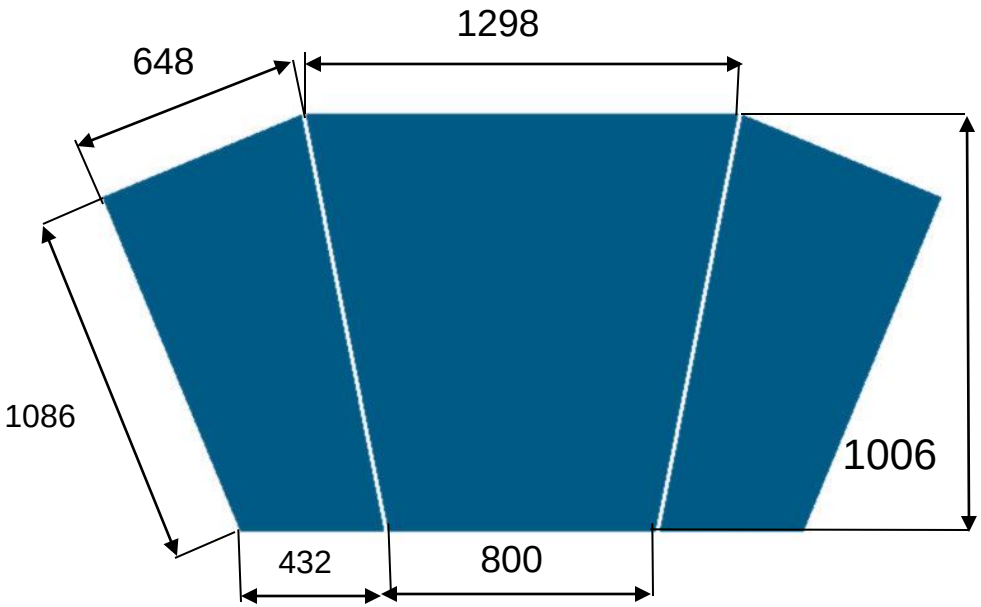


Ring weight = 18.4 t

Module weight = 2.3 t

- Ring between barrel and endcap
  - 7 GRPC planes/module ⇒ 21/module ⇒ 168 /ring



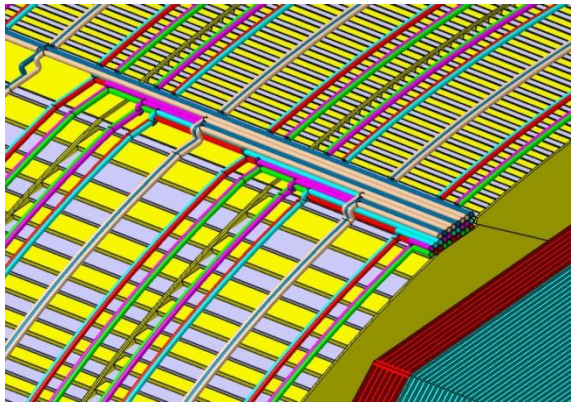


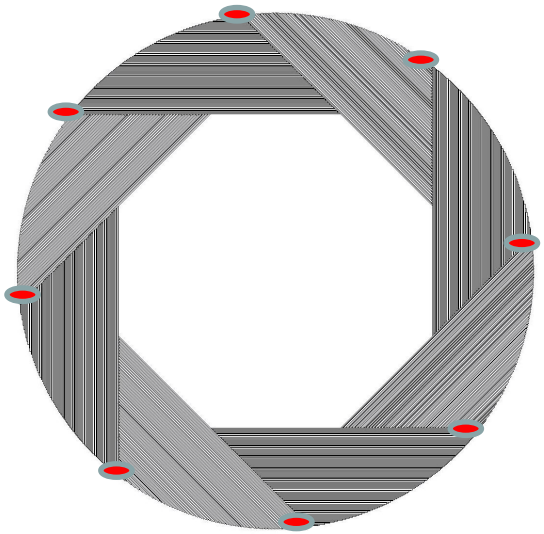
GRPC : S = 2.55 m² P = 140 Kg

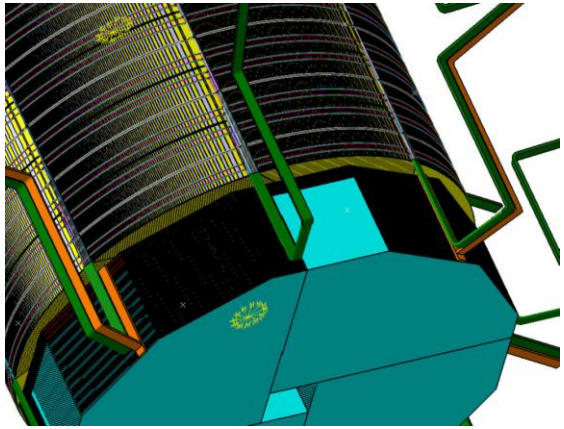
P/module = 980 Kg

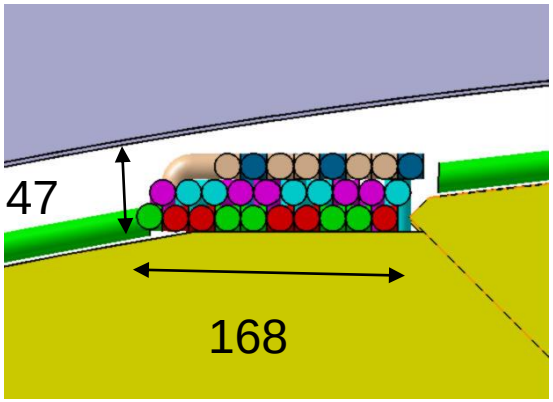
Barrel Services

- Services : Barrel









- 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

- Cooling red/blue

Issues : 8 zones 168 x 47

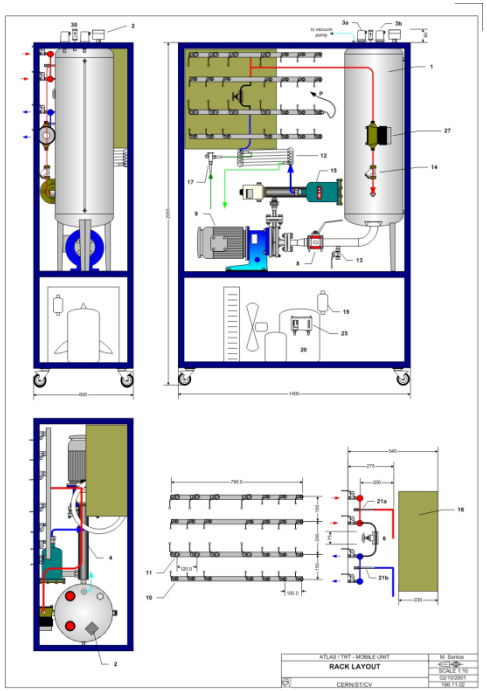
Barrel cooling

- **Cooling Options after local simulations**

  Low heat to extract: 0.3 W/m² for GRPC

  Big exchange surface – 440 t of stainless steel

  Material with good thermal conductivity



Atlas cooling plant

- **Leak-less water cooling** : no risk for electronic and other detectors, pressure between 0.8 and 1bar (cavitation), balanced network, pneumatic activators needed

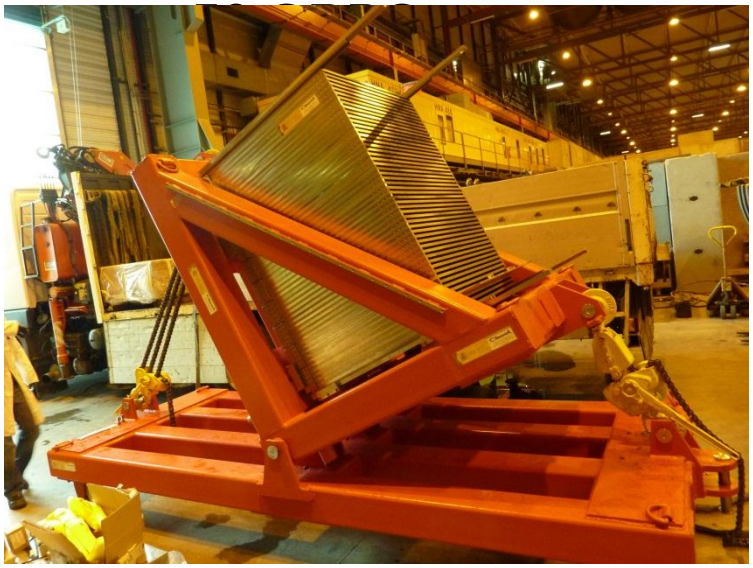
- **Bi-phasic gas** like CO2 : High Pressure (100 bars), expensive connections (no leak), small diameter tubes, important exchange coefficient

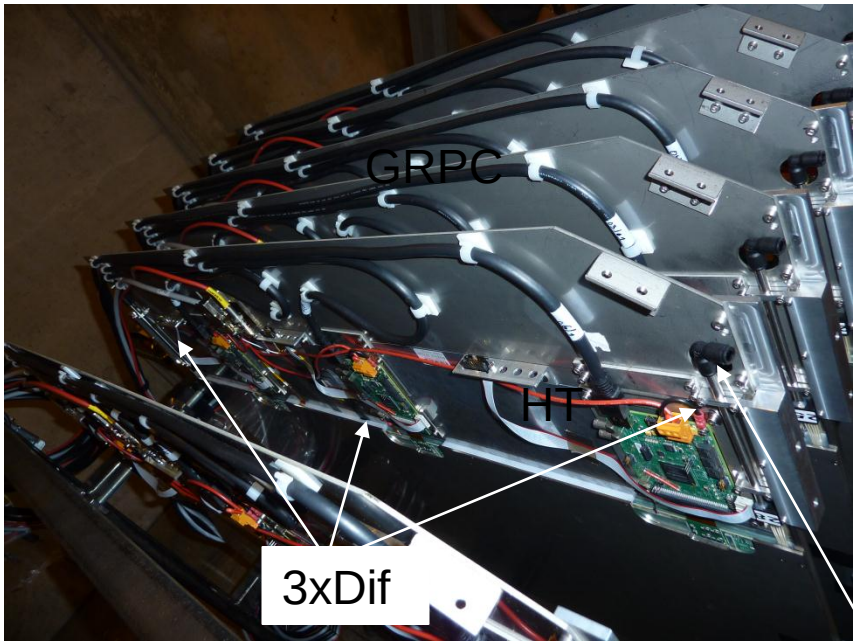
- **Mono-phasic gas** like C6F14 : limited effect in case of leak, good quality/price ratio, adapted to low heat extract, simple to use

M3 prototype

- M3 prototype :

Ciemat structure/ IPNL 50 GRPC





Gaz (1l/h)

Ciemat structure with Grpc

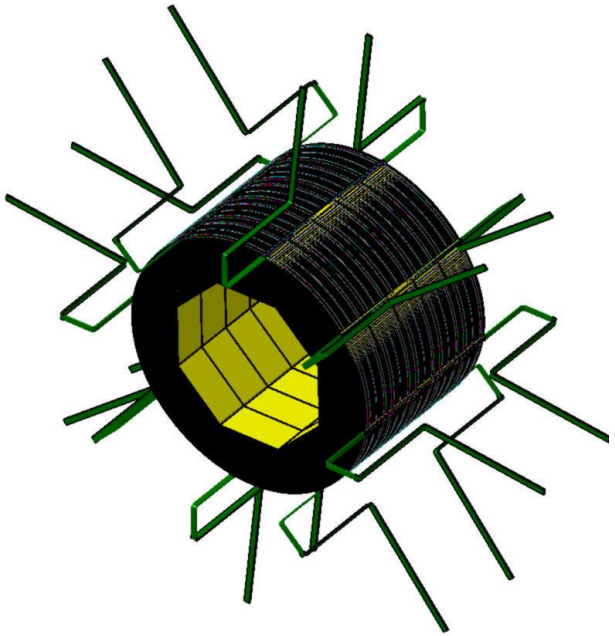
Mechanical structure

Inox 304 L

51 Absorbers

Thickness 15

ILD mechanical structure. Perspectives



- Status
  - Shape -> low deformation
  - Realistic Integration scenario
  - Good expertise with the prototype
- Simulations have to be done
  - Interaction environnment
  - Global thermal studies :
    cooling implantation
  - Final seismic studies
- Design evolution
  - Services optimization and integration
  - Patch pannels position
- Detailed planning building & precise estimation cost