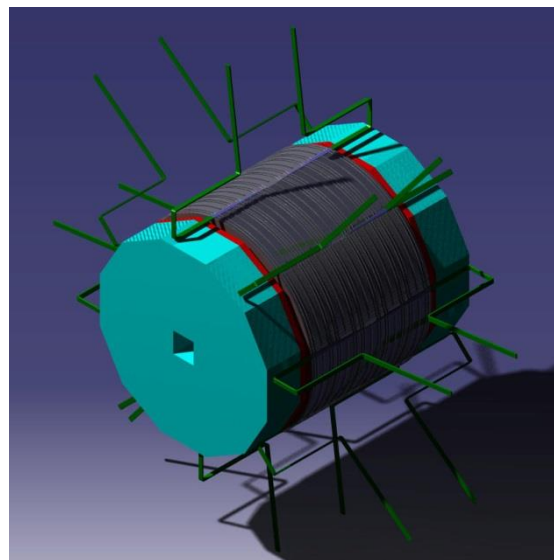




ILD technical meeting

DHCAL

- Barrel "Videau" design
- Endcaps and ring design



J.C Ianigro
- IPN Lyon -



Barrel Integration : "Videau" design

Particles trajectories

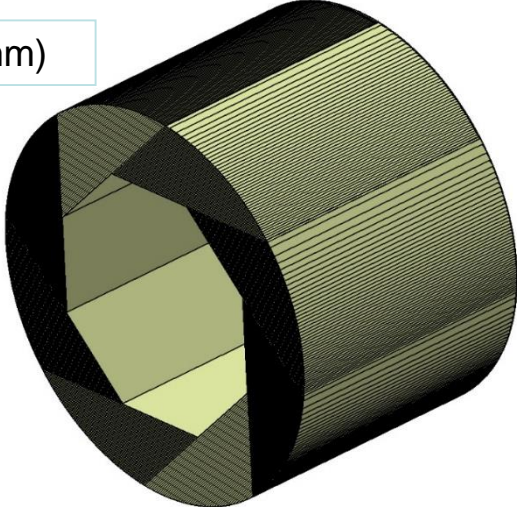
90° 8 zones x (48 GRPC 11mm/ 49 plates 15 mm)

45°

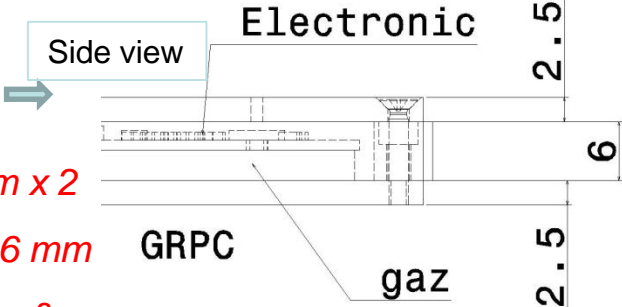
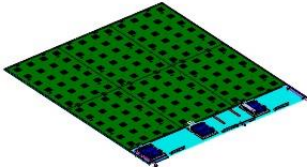
0°

Interaction Point

No Crack



Ext. Diameter :	6770 mm
Int. Diameter :	4116 mm
Length :	4700 mm
Total weight :	426 t



Stainless steel box : 2,5 mm x 2

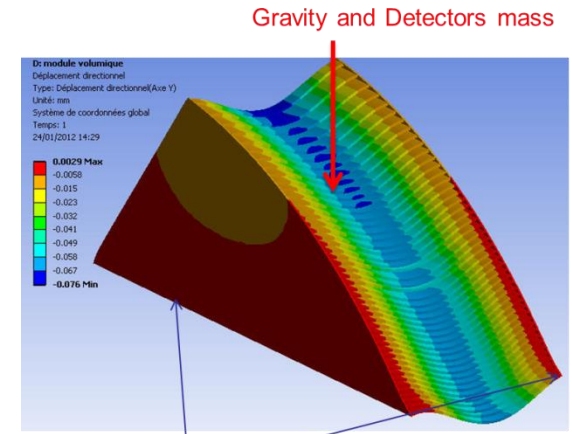
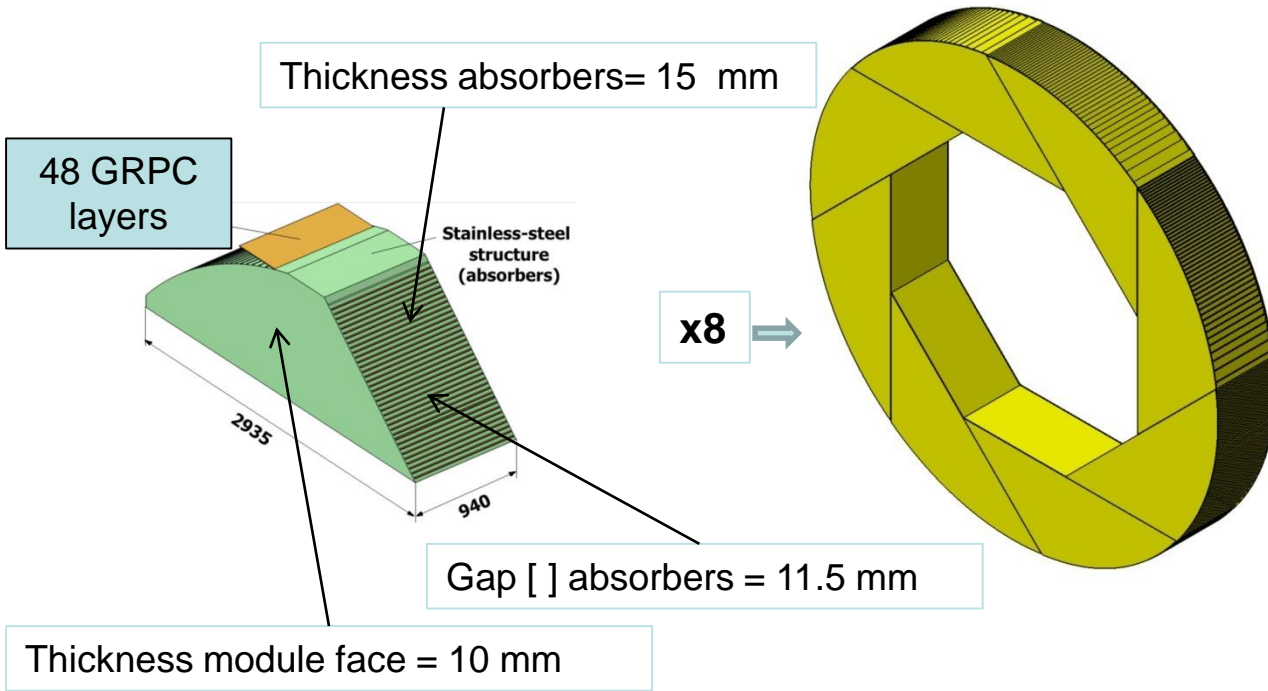
Detection layer thickness : 6 mm

Layers surface : 0.47 to 15 m²

Total absorber thickness : 15 + 5 = 20 mm



Barrel Integration : : "Videau" design



symmetrical supports

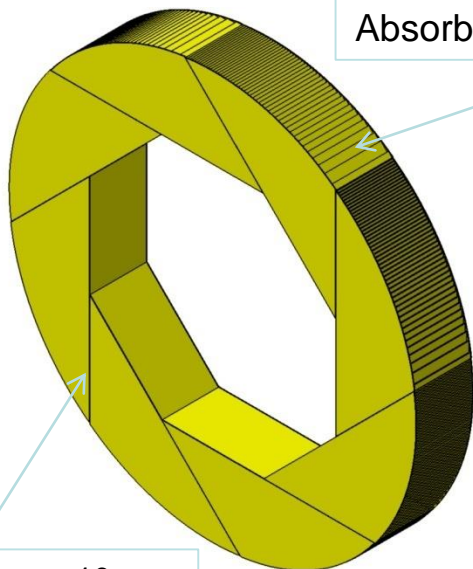
Module Max deformation : 0.07 mm

Ext. Diameter :	6770 mm
Int. Diameter :	4116 mm
Length :	940 mm

Stainless steel	1 wheel (= 8 modules)
Weight (t):	88 t
Detectors W. (t):	36.8 t
Total Weight (t) :	124.8 t



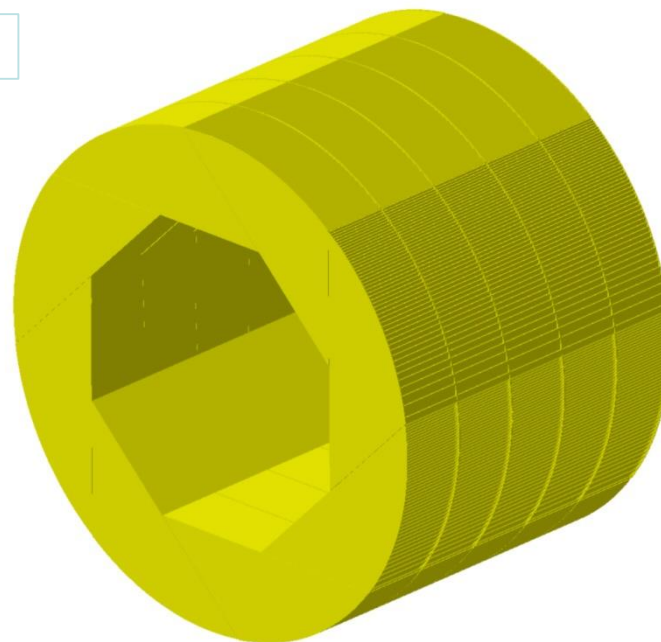
Barrel integration : : "Videau" design



Absorbers thickness= 15 mm

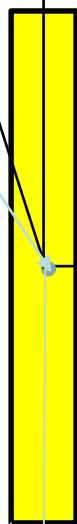
Side wall thickness= 10 mm

x 5



Wheel n°3

Interaction point : center of wheel n°3

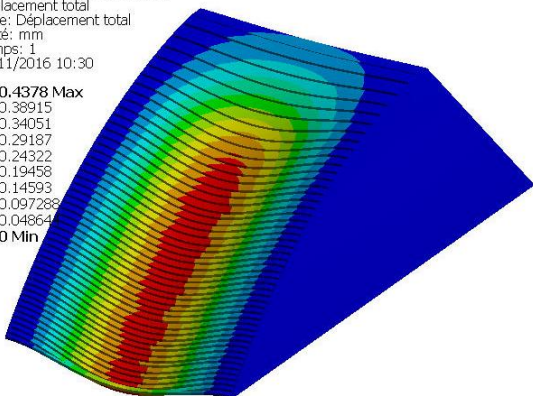


Dist /wall : 460 mm

Ext. Diameter	6770 mm
Int. Diameter	4116 mm
Length	4700 mm

F: module volumique large
Déplacement total
Type: Déplacement total
Unité: mm
Temps: 1
04/11/2016 10:30

0.4378 Max
0.38915
0.34051
0.29187
0.24322
0.19458
0.14593
0.097288
0.04864
0 Min



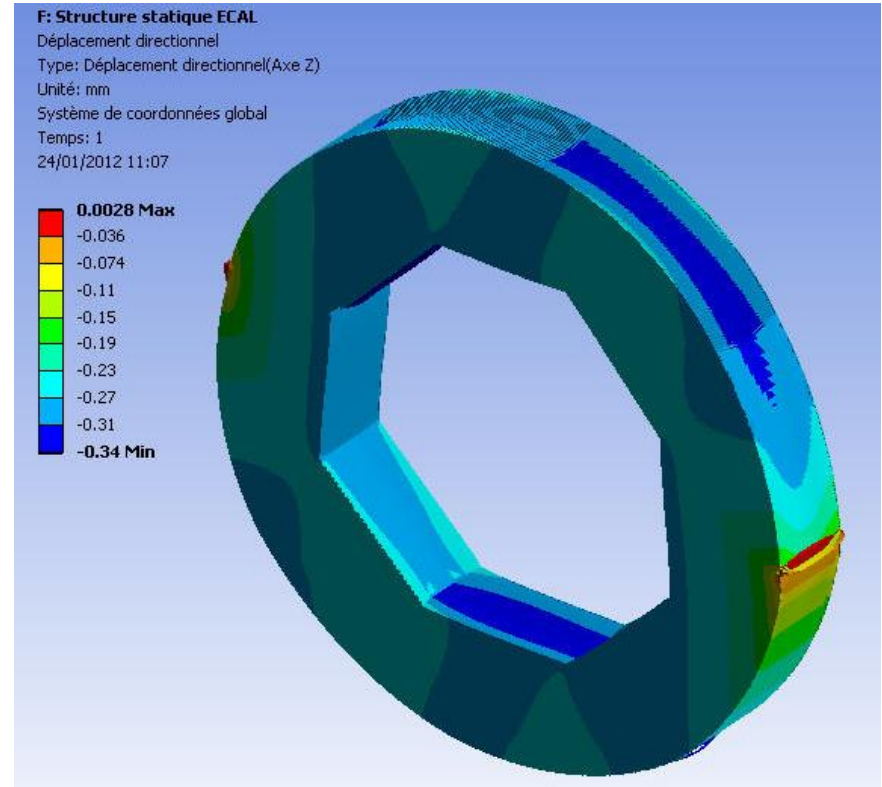
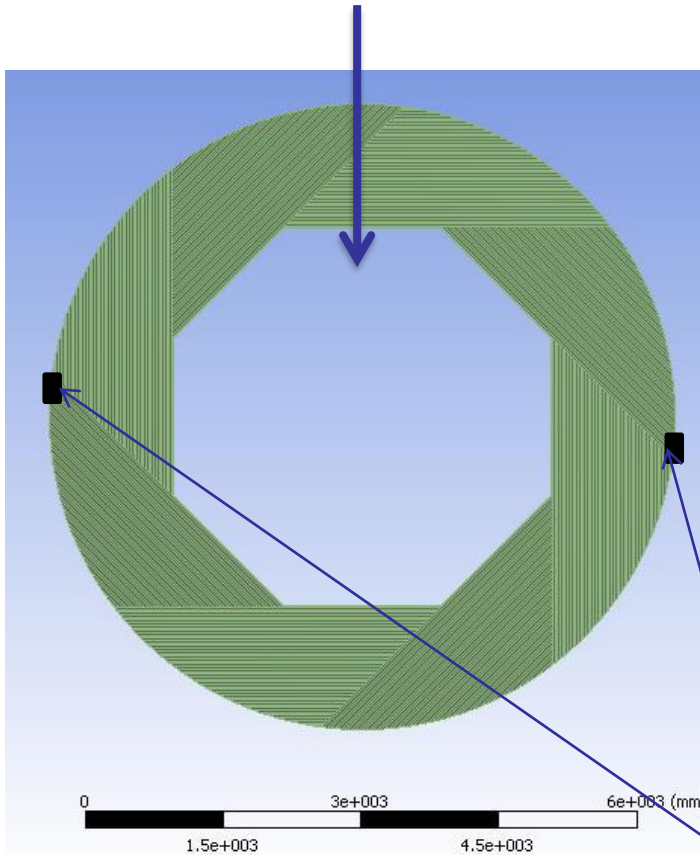
Potentiel model : 3 wheels instead of 5 wheels
 Module width : 1566 mm instead of 940 mm
 Absorbers maximal deformation : 0,44 mm instead of 0,07
 Not compatible with 0,5 mm gap for GRPC insertion

<i>Stainless steel</i>	5 wheels (Barrel)
Weight (t):	440 t
Detectors W. (t):	184 t
Total Weight (t) :	624 t



Barrel integration : : "Videau" design simulation

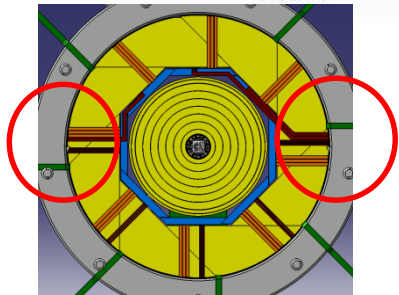
Gravity and Detectors mass



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

Disymmetrical supports 9-15 H

Max deformation : 0.34 mm for position around 9-15H

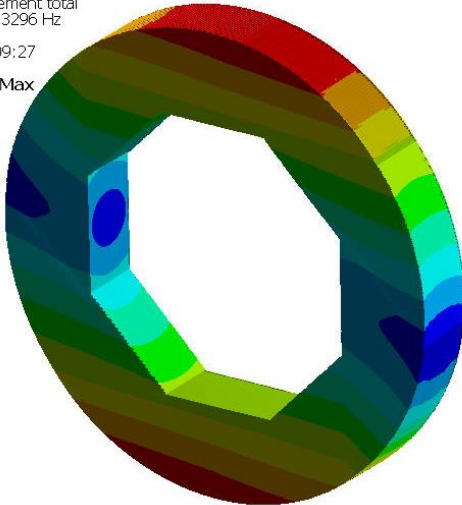




Barrel integration : : "Videau" wheel modal analysis

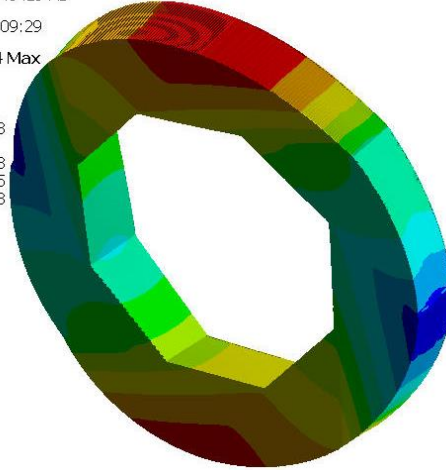
O: Modale
Déplacement total
Type: Déplacement total
Fréquence: 8.3296 Hz
Unité: mm
04/11/2016 09:27

0.18012 Max
0.1601
0.14009
0.12008
0.10006
0.080051
0.060038
0.040026
0.020013
0 Min



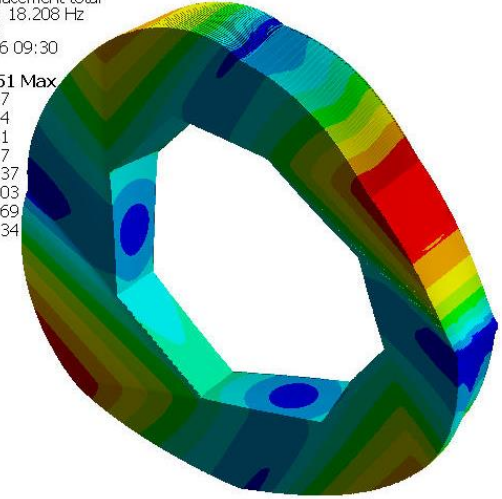
O: Modale
Déplacement total 2
Type: Déplacement total
Fréquence: 9.3429 Hz
Unité: mm
04/11/2016 09:29

0.17044 Max
0.1515
0.13256
0.11363
0.094688
0.07575
0.056813
0.037875
0.018938
0 Min



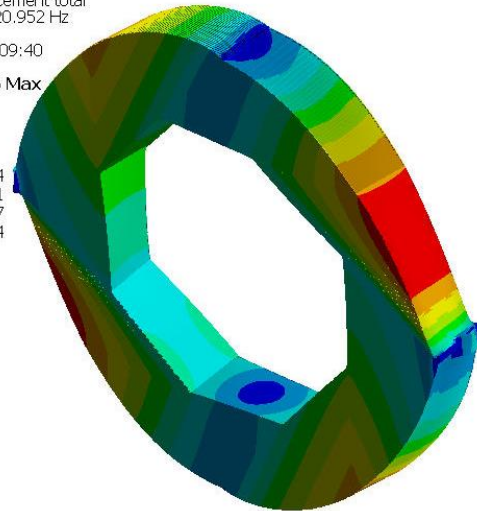
O: Modale
Déplacement total 3
Type: Déplacement total
Fréquence: 18.208 Hz
Unité: mm
04/11/2016 09:30

0.22351 Max
0.19867
0.17384
0.14901
0.12417
0.099337
0.074503
0.049669
0.024834
0 Min



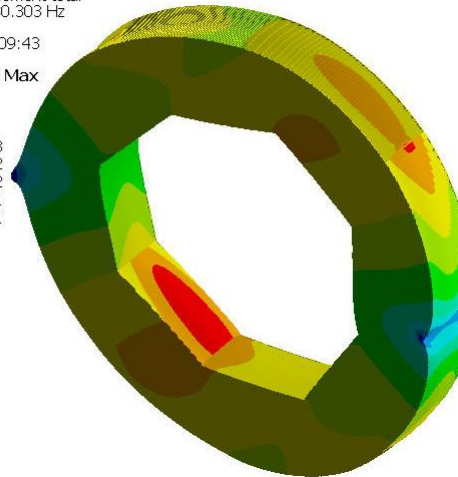
Type: Déplacement total
Fréquence: 20.952 Hz
Unité: mm
04/11/2016 09:40

0.20496 Max
0.18219
0.15942
0.13664
0.11387
0.091094
0.068321
0.045547
0.022774
0 Min



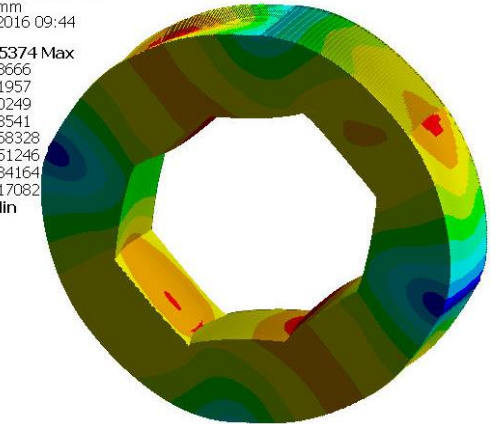
Déplacement total 5
Type: Déplacement total
Fréquence: 30.303 Hz
Unité: mm
04/11/2016 09:43

0.15435 Max
0.1372
0.12005
0.1029
0.085753
0.068602
0.051452
0.034301
0.017151
0 Min



Déplacement total 6
Type: Déplacement total
Fréquence: 31.352 Hz
Unité: mm
04/11/2016 09:44

0.15374 Max
0.13666
0.11957
0.10249
0.08541
0.068328
0.051246
0.034164
0.017082
0 Min

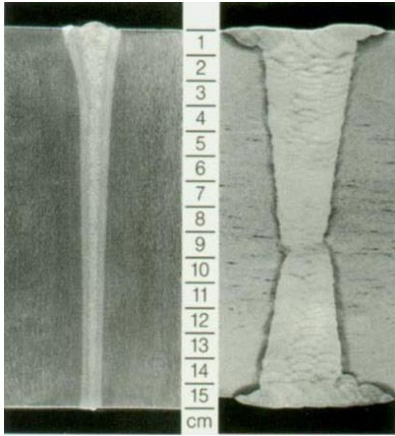


Eigen modes (Hz) : 8.3, 9.3, 18.2, 20.9, 30.3, 31.3



Barrel integration : Module built with welding

Building in Industry: 40 module parts



Welding method : Electron Beam Welding

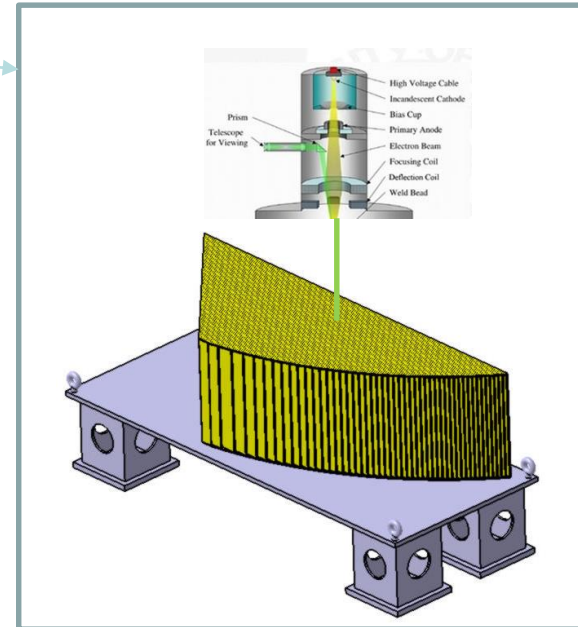
- Tight continuous weld
- Accuracy and repeatability
- Low distortion
- Narrow weld and narrow heat affected zone
- Filler metal is not required



Technology adapted to larged skin & repeatable structure

40 Modules done one by one (**weight = 11t / modules**)
 Transport in standard containers to Japanese harbour and
 by road with standard truck to Assembly Hall

Vacuum chamber



49 absorbers plates
 welded on 2 flanges



Industry



Japan



Assembly hall



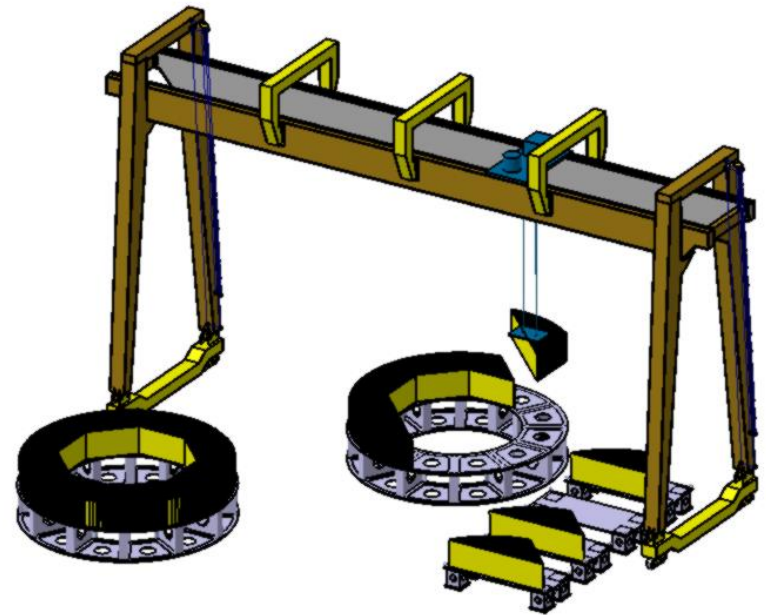
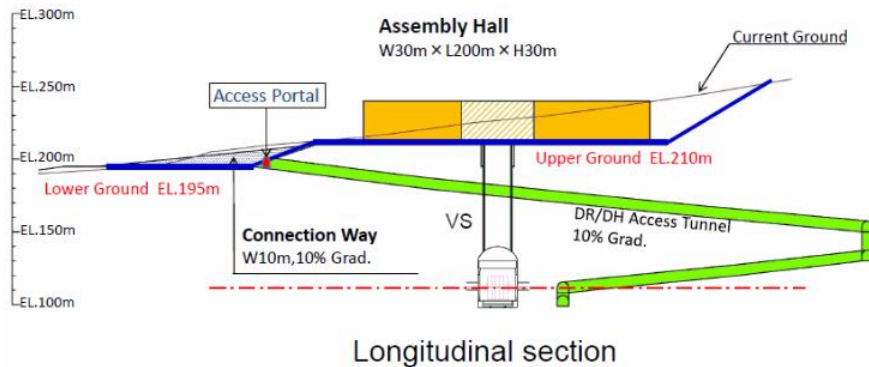
Wheel Building in assembly hall : 8 modules => 5 wheels

Building Method

• Step 1 : Modules assembly to wheel

- 8 modules in position on specific tool
- screwing one flange and rotation for other side

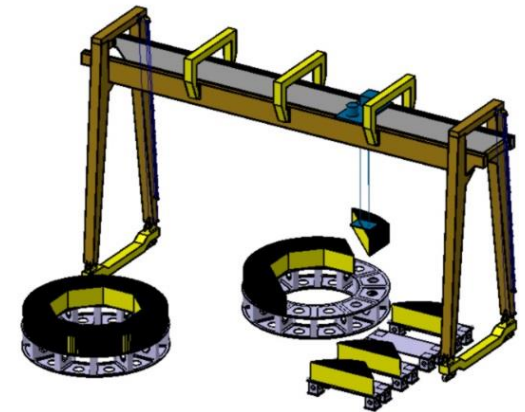
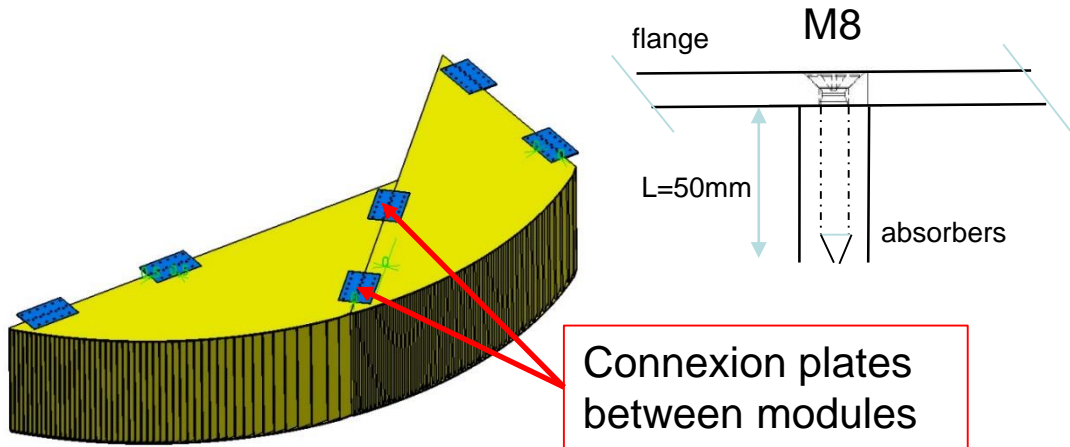
• Step 2 : Wheel on specific tool ready for receiving layers



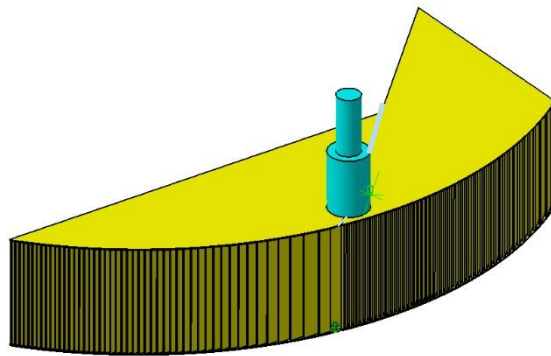
Wheel weight = 88 t



Wheel Building in Assembly hall : details



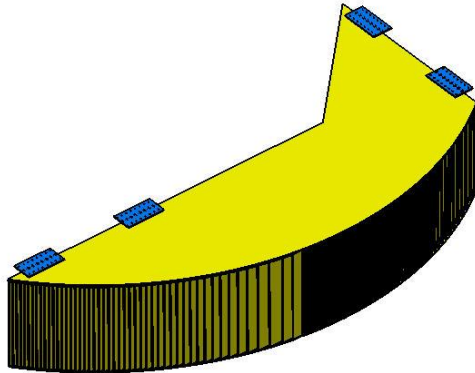
Possible alternative : mobile electron beam gun



Welding along an axis
Mobile Local vacuum
Sliding joint
Evolutive technology

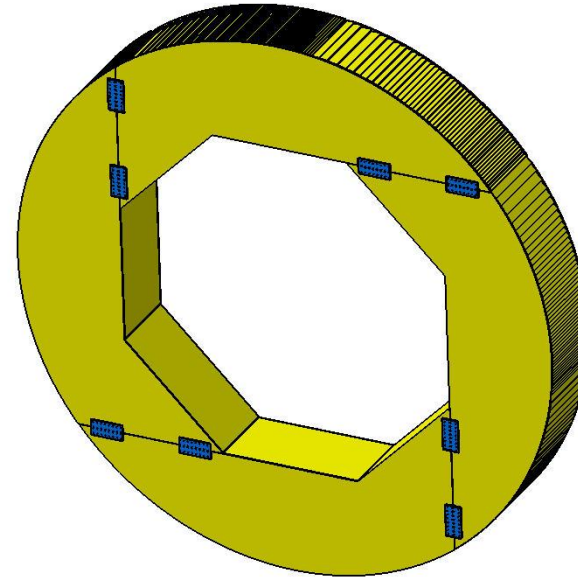


Wheel Building : other possibility with 4 super-modules for a wheel

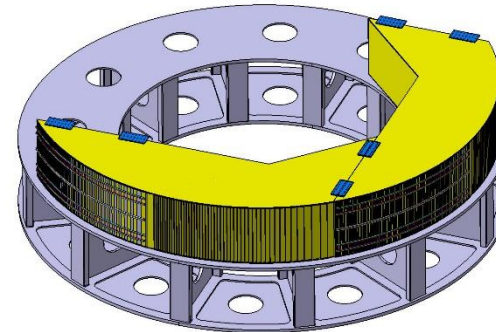


Supermodules $\frac{1}{4}$ wheel
Weight : 22 t
Size : 4742 x 2500 x 940 mm³

x 4



Electron beam welding in big vacuum chamber
Tribute to SCHIAKY

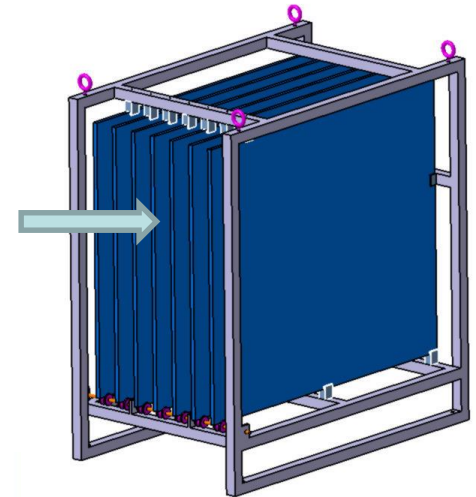
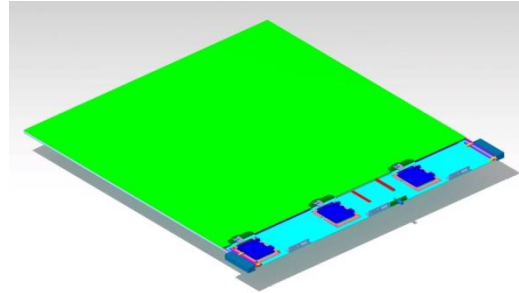


$\frac{1}{4}$ wheels super-modules on buiding structure
Screwing with connections plates or EBW mobile gun

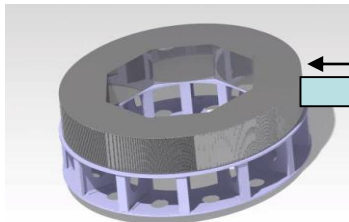


■ Barrel Building & GRPC Detectors insertion

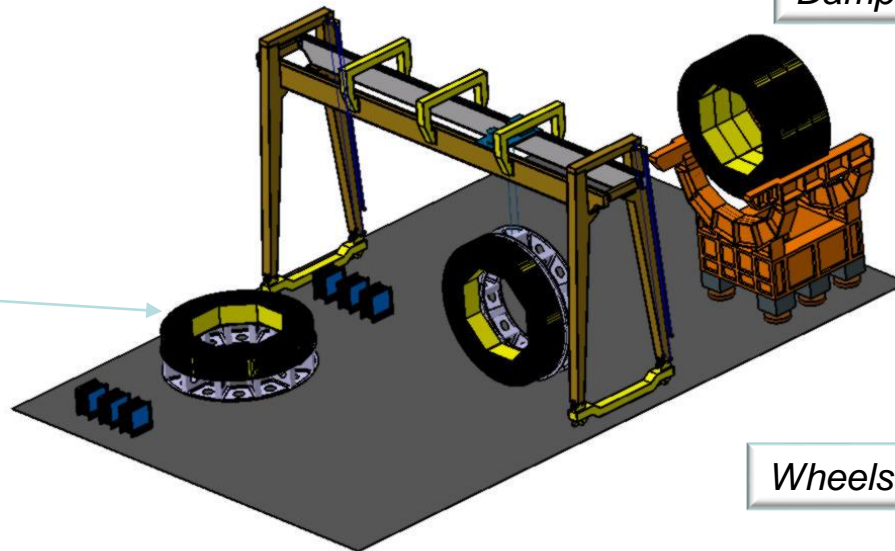
- 5 x Wheels built in Assembly hall
- **368 GRPC** insertion for **1 wheel**
- stock **1840 GRPC** for all the barrel



Damper transport structure for GRPC



*GRPC insertion
with specific tool*

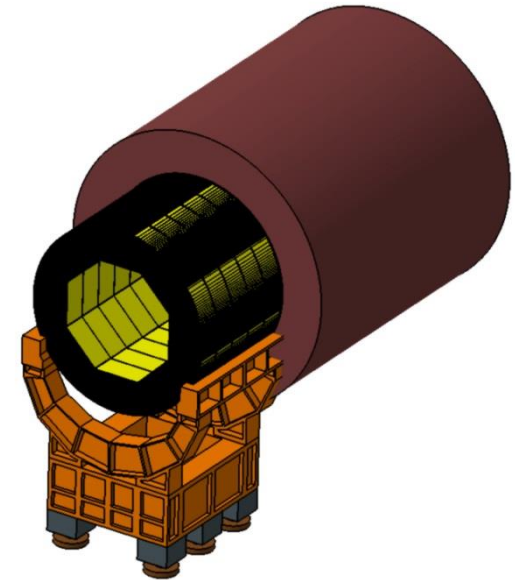


Wheels full of GRPC put on structure



■ Barrel insertion & services connecting

- Wheels put on the structure one by one
- Barrel with 5 linked wheels on same sub-structure as ECAL (similar to CMS)
- Rails inside the cryostat
- Insertion by « push-pull »
- Fixation inside the cryostat on both sides



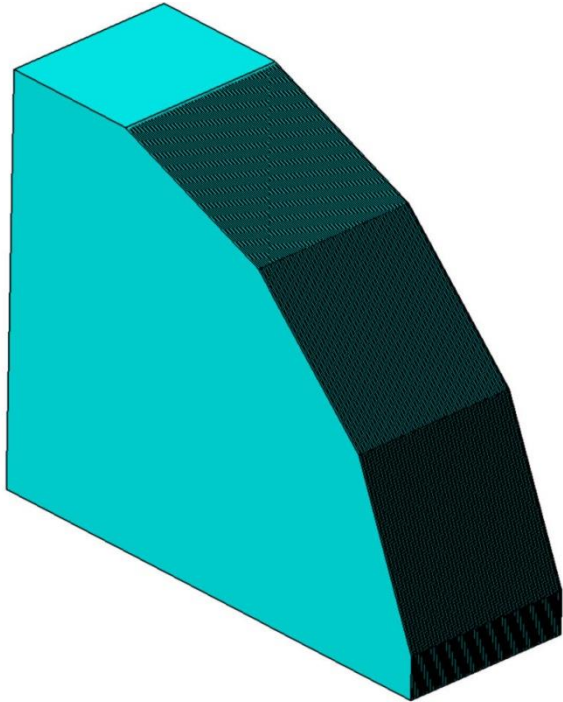
Barrel insertion



CMS « enfouneur » with ECAL insertion system



■ Endcap

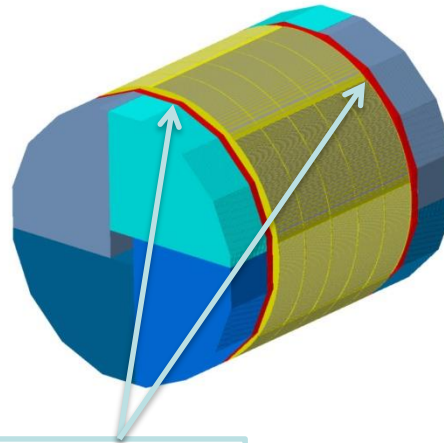


One module

Module Weight : 50 t

Detectors weight : 22.5 t

Total weight : 72.5 t



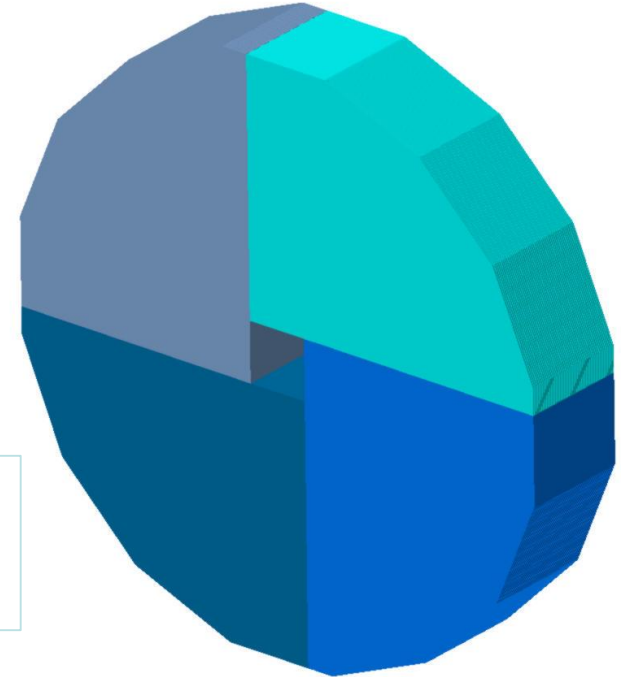
2 endcaps

Material : stainless steel

**EBW welded structure
Idem barrel
Modules built in Industry**

8 sides -> 16 sides

Encap : 48 detectors



One endcap made of 4 modules

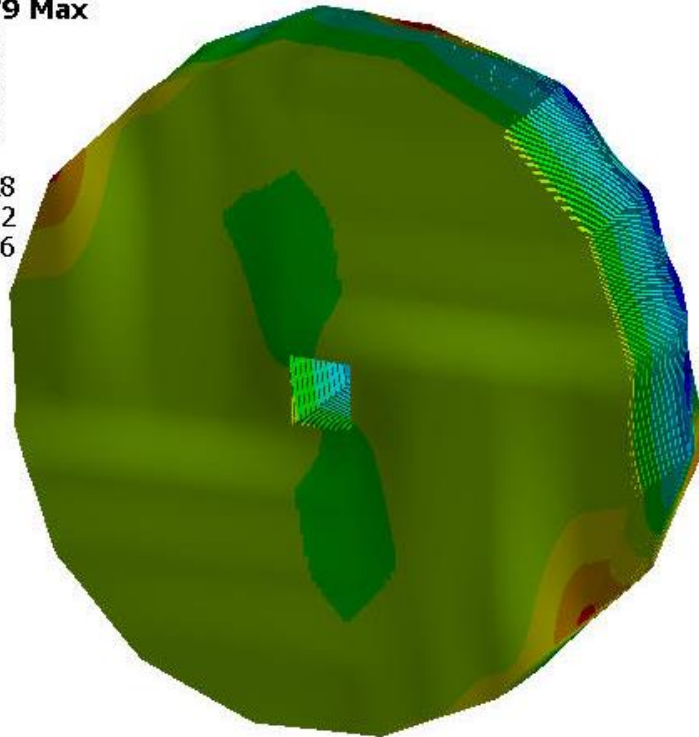
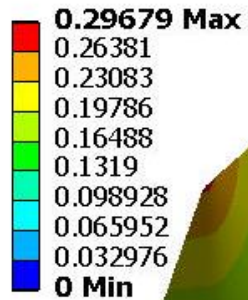
Endcap Weight : 200 t

Detectors weight : 90 t

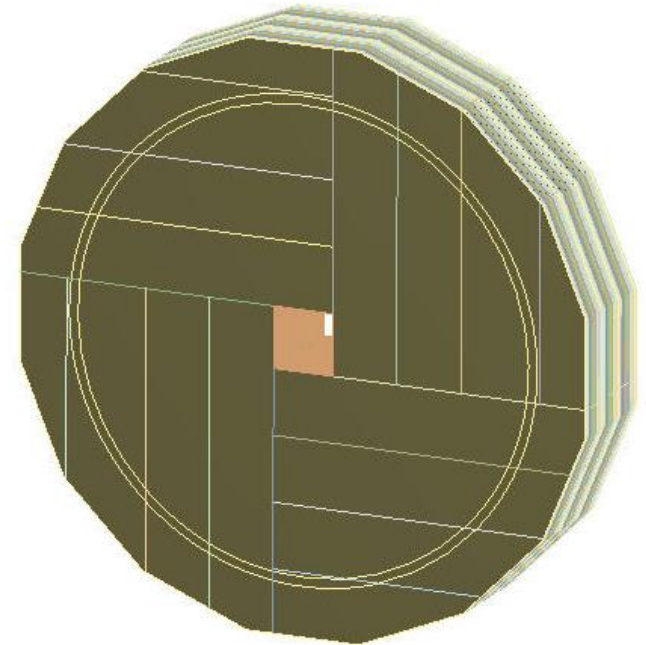
Total weight : **290 t**



■ Endcap : static simulation



Face A : barrel side



Face B : support ring

One endcap made of 4 modules
Endcap Weight : 200 t
Detectors weight : 90 t
Total weight : **290 t**



■ Endcap Building in Assembly Hall : 4 modules x 2

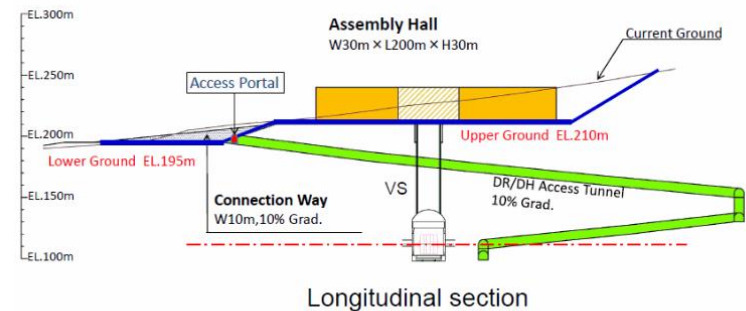
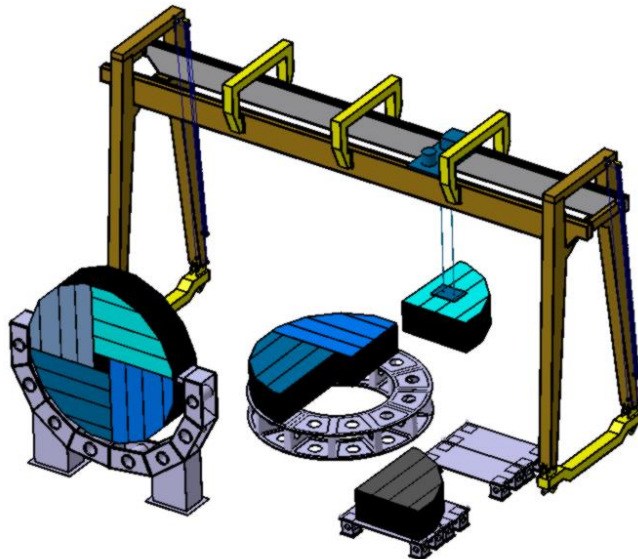
Building Method

- **Step 1** : Modules transport by normal truck to Assembly Hall
- **Step 2** : Endcap structure transport
- **Step 3** : Modules assembly on the structure
 - 4 modules in position on specific tool & screwing



Module weight = 50 t

Road to

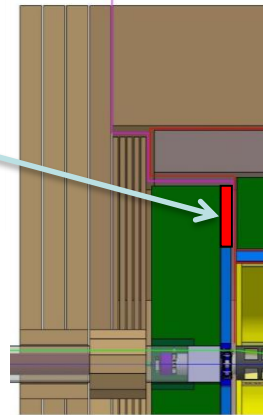
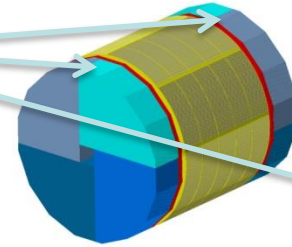




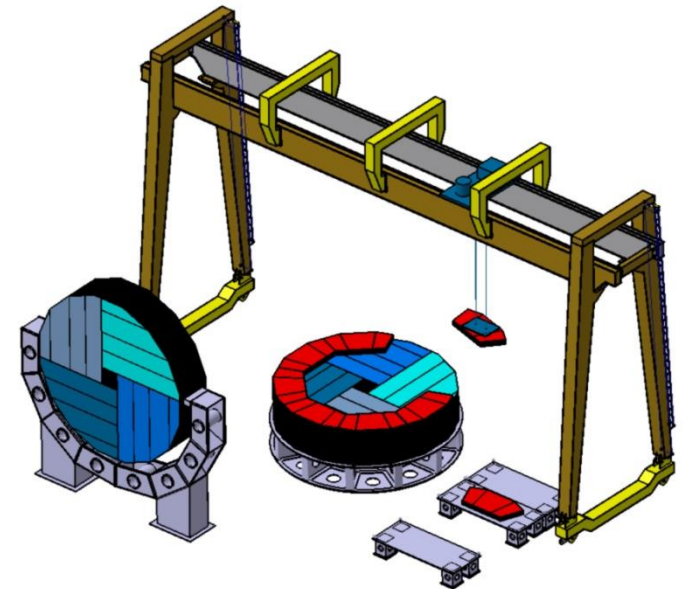
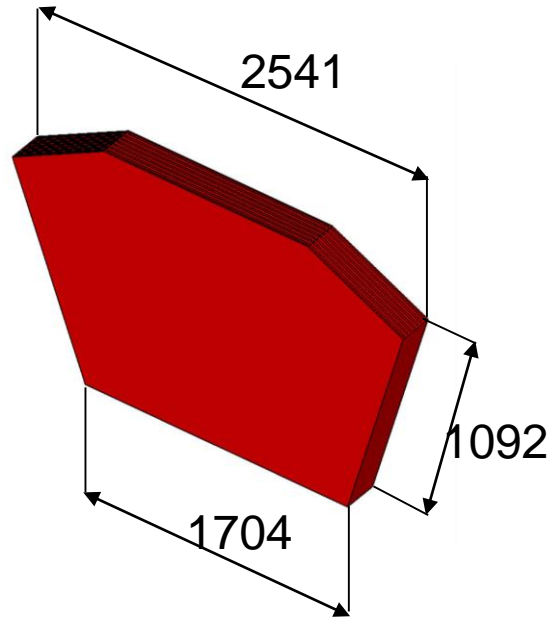
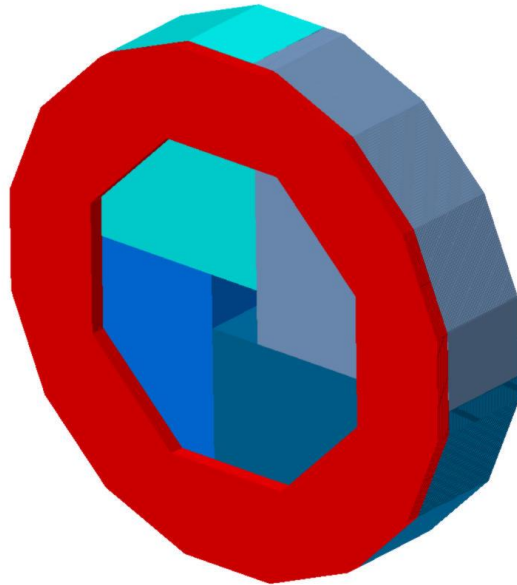
■ Ring built in Industry (EBW)

● Placed around the ECAL endcap

2 x rings



8 modules x 2



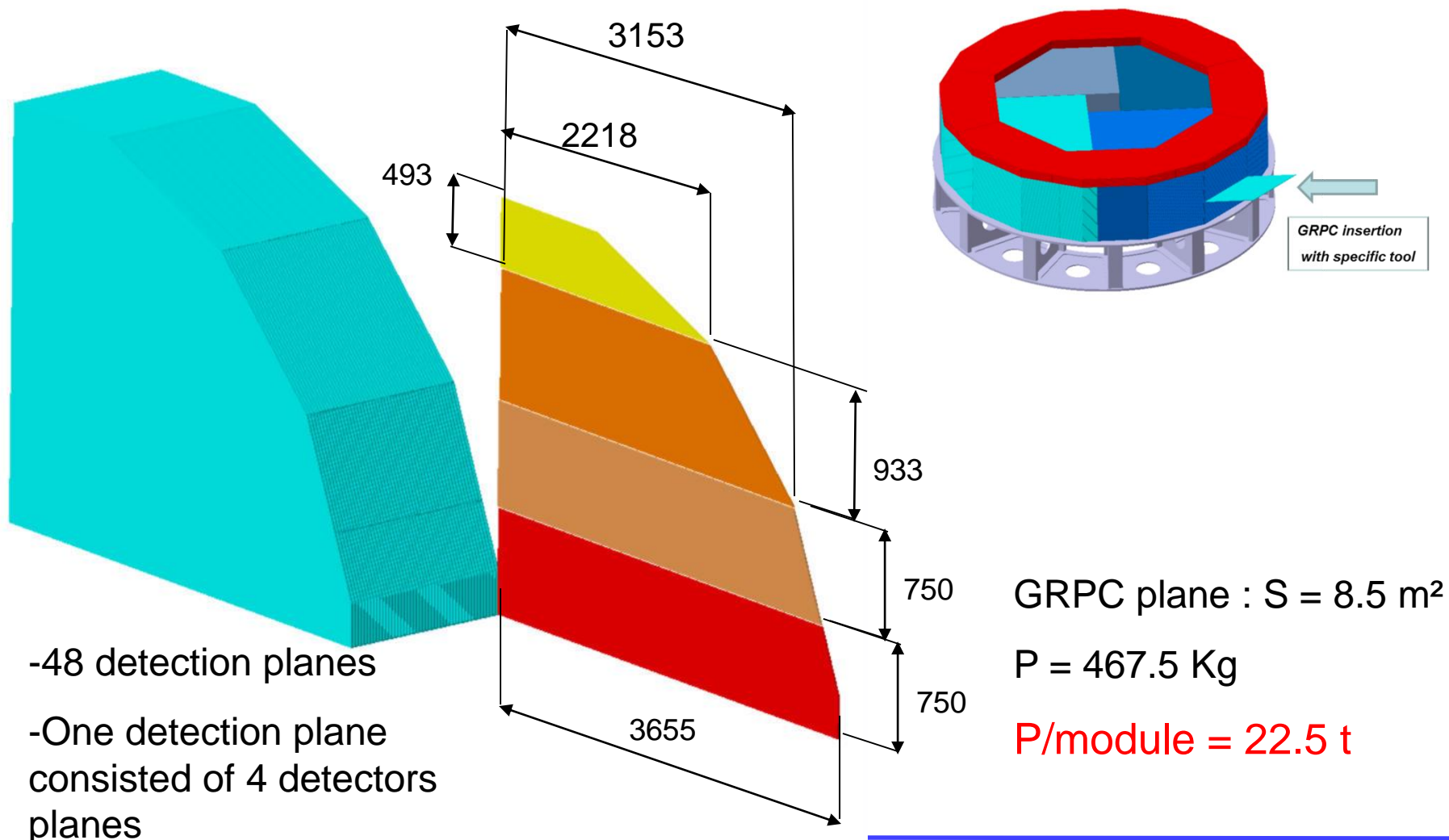
Ring weight : $2.3 \times 8 = 18.4 \text{ t}$

Ring ($18.4 + 8$) + Barrel endcap (290) = 316.4 t

Screwed on endcap



■ One module : **192 GRPC inserted in Assembly Hall**



-48 detection planes
 -One detection plane consisted of 4 detectors planes

GRPC plane : $S = 8.5 \text{ m}^2$

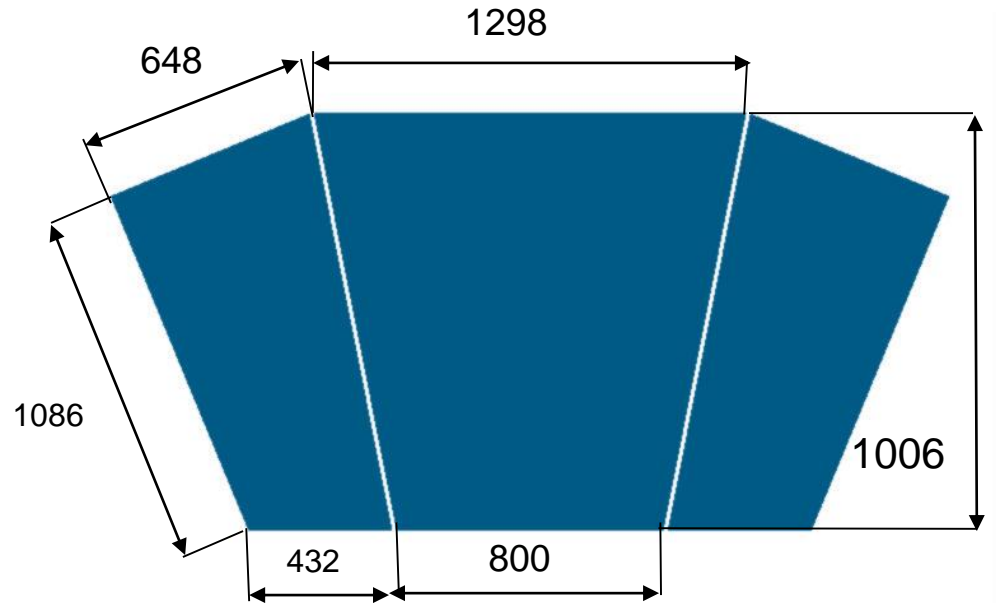
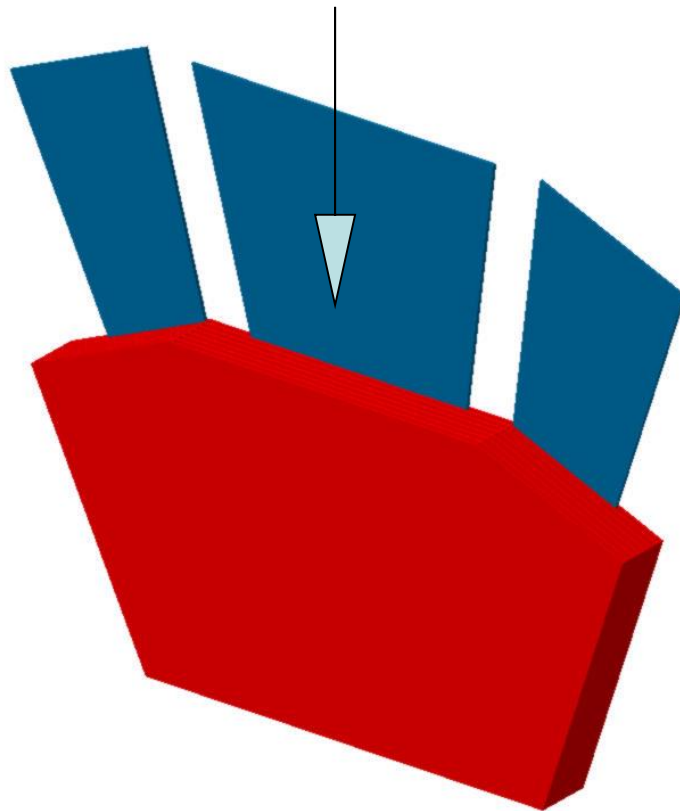
$P = 467.5 \text{ Kg}$

$P/\text{module} = 22.5 \text{ t}$



■ Ring between barrel and endcap : GRPC insertion

- 7 GRPC planes by modules \Rightarrow 21/Modules \Rightarrow **168 / Ring**



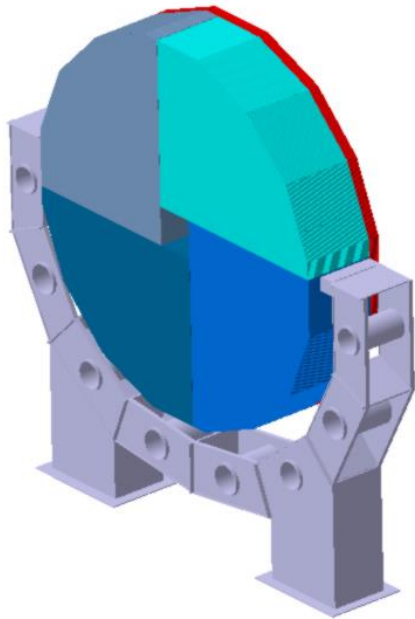
GRPC : $S = 2.55 \text{ m}^2$

$P = 140 \text{ Kg}$

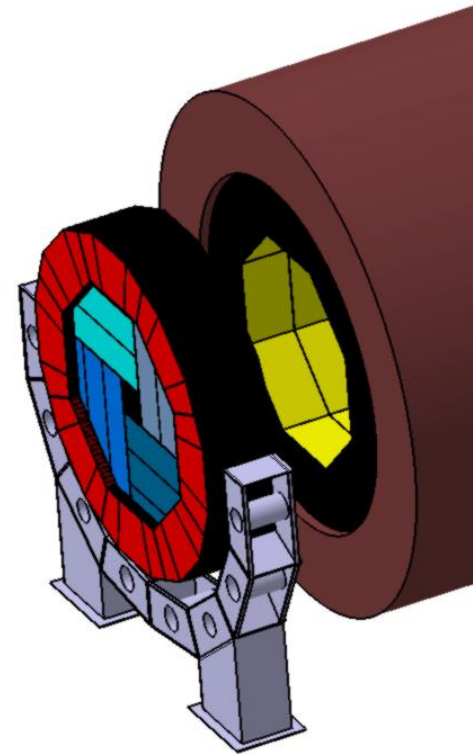
$P/\text{module} = 980 \text{ Kg}$



■ Endcap + Ring : insertion on tool



Support structure for
One endcap made of 4 modules
Total weight : 290 t



Endcap + Ring
Probably linked to Yoke Endcaps



■ **ILD design and simulation**

- Seismic simulations needed
- Specific simulations : connection of wheel module , ...
- Shape optimisation
- Cryostat rail definition and interfaces in general

■ **Scenario**

- Modules of Barrel & Endcaps made in industry
- Transport of modules to Assembly Hall
- Barrel made of 5 wheels & 2 Endcap-Ring mounting
- GRPC detectors insertion
- Barrel insertion & Endcaps-Ring installation with specific tools

■ **Surface needed for operations**

- First the barrel & then Endcaps-Ring building and services, one after the other
- 1000 m² for assembly of modules, specific structures, Services & GRPC detectors
- Zone for barrel on structure storage : 200 m²
- Crane : 1000 t