# ILD Integration Status

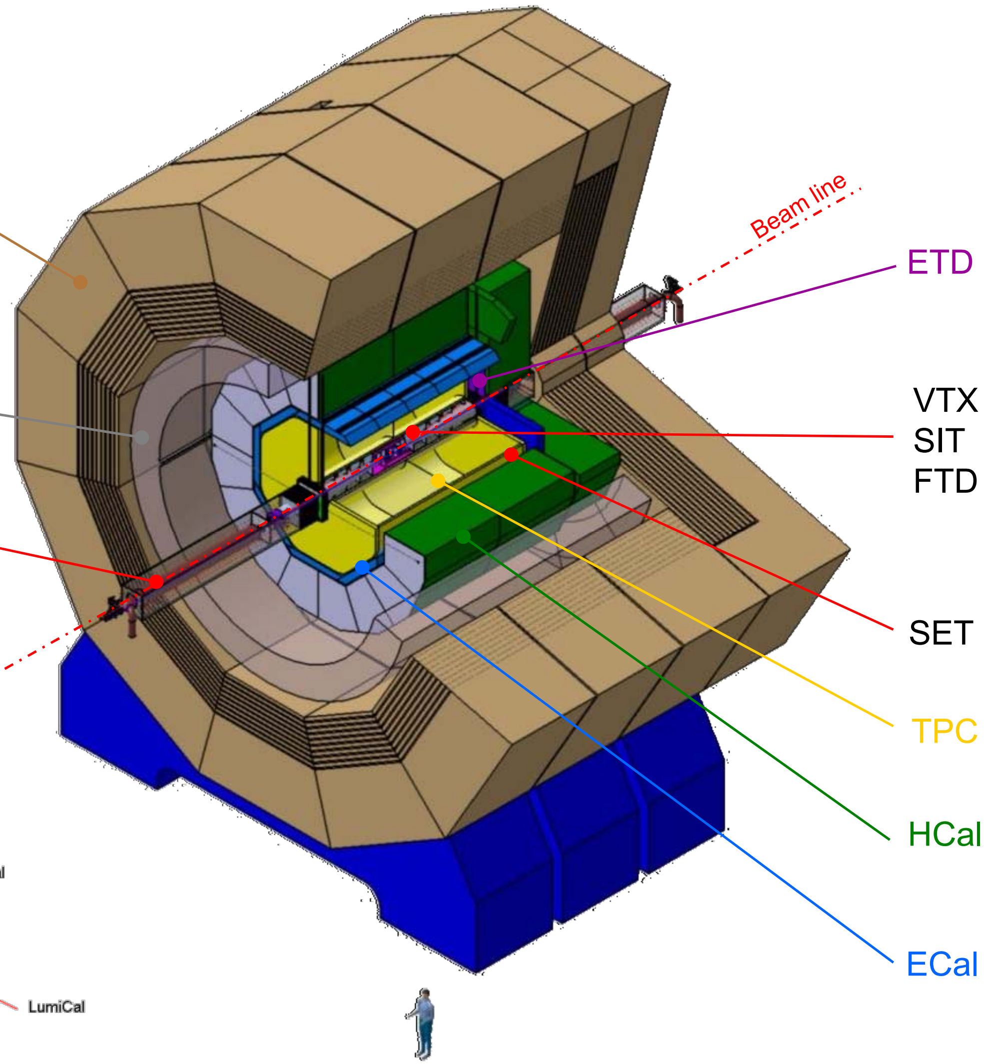
Karsten Buesser

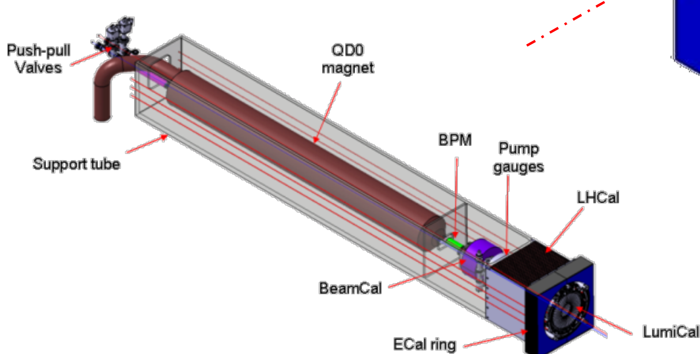
26.04.2012
KILC12

# Overview

- Central ILD mechanical model kept at LAL (C. Bourgeois, A. Gonnin)
- Detailed engineering models of subdetectors exist at many places
  - But all should (!) be in ILD EDMS
- As engineering models evolve, deviations between central model and subdetector models occur
- Try to synchronise models now for preparation of the DBD
- Try to keep simulation model (MOKKA) and mechanical model as close as possible
  - Tools for comparison exist
  - In principle there is even a task force (founded in 2010)
  - Reality shows: everything is resource driven....

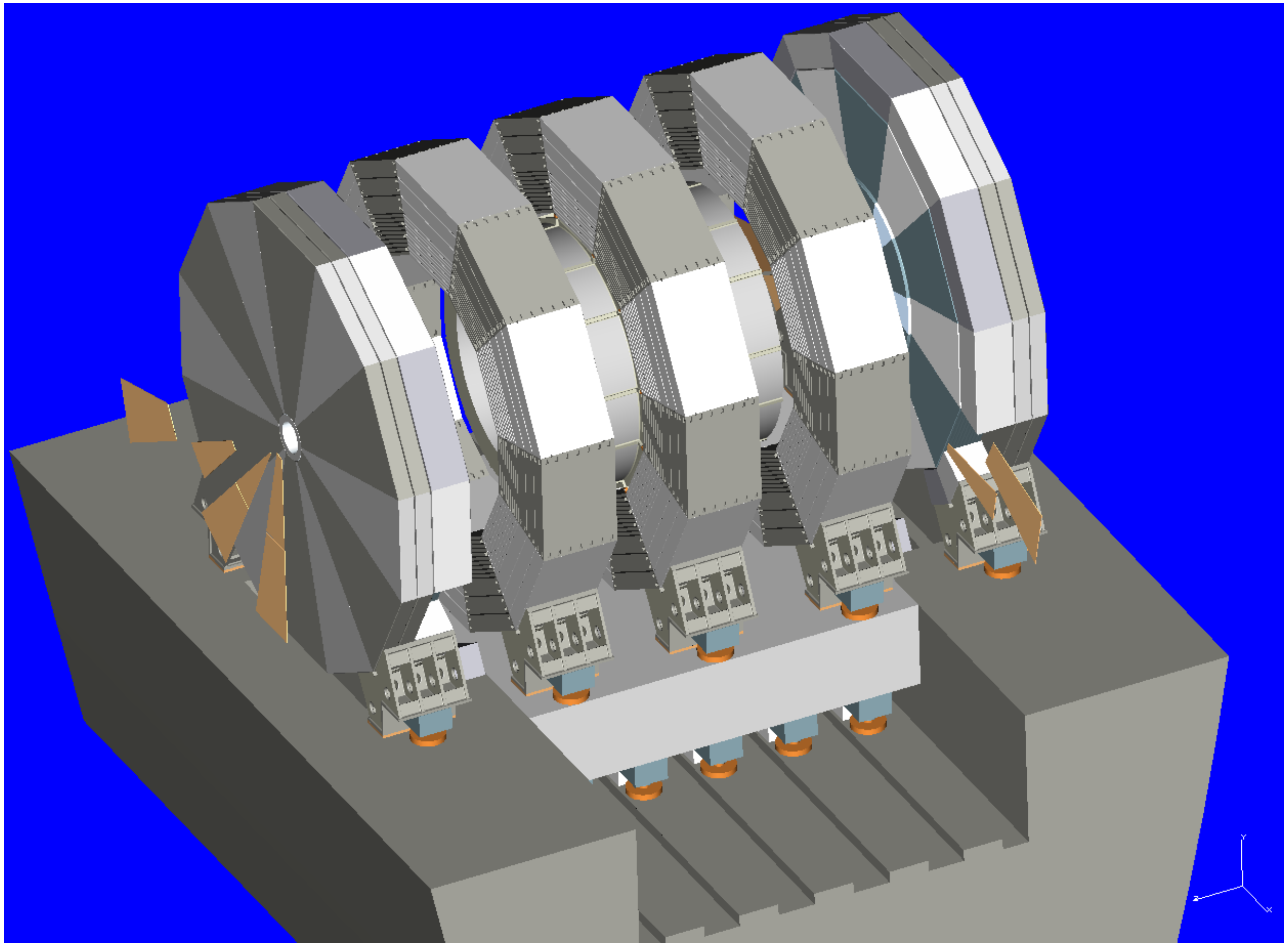
# ILD Mechanical Model




M. Joré

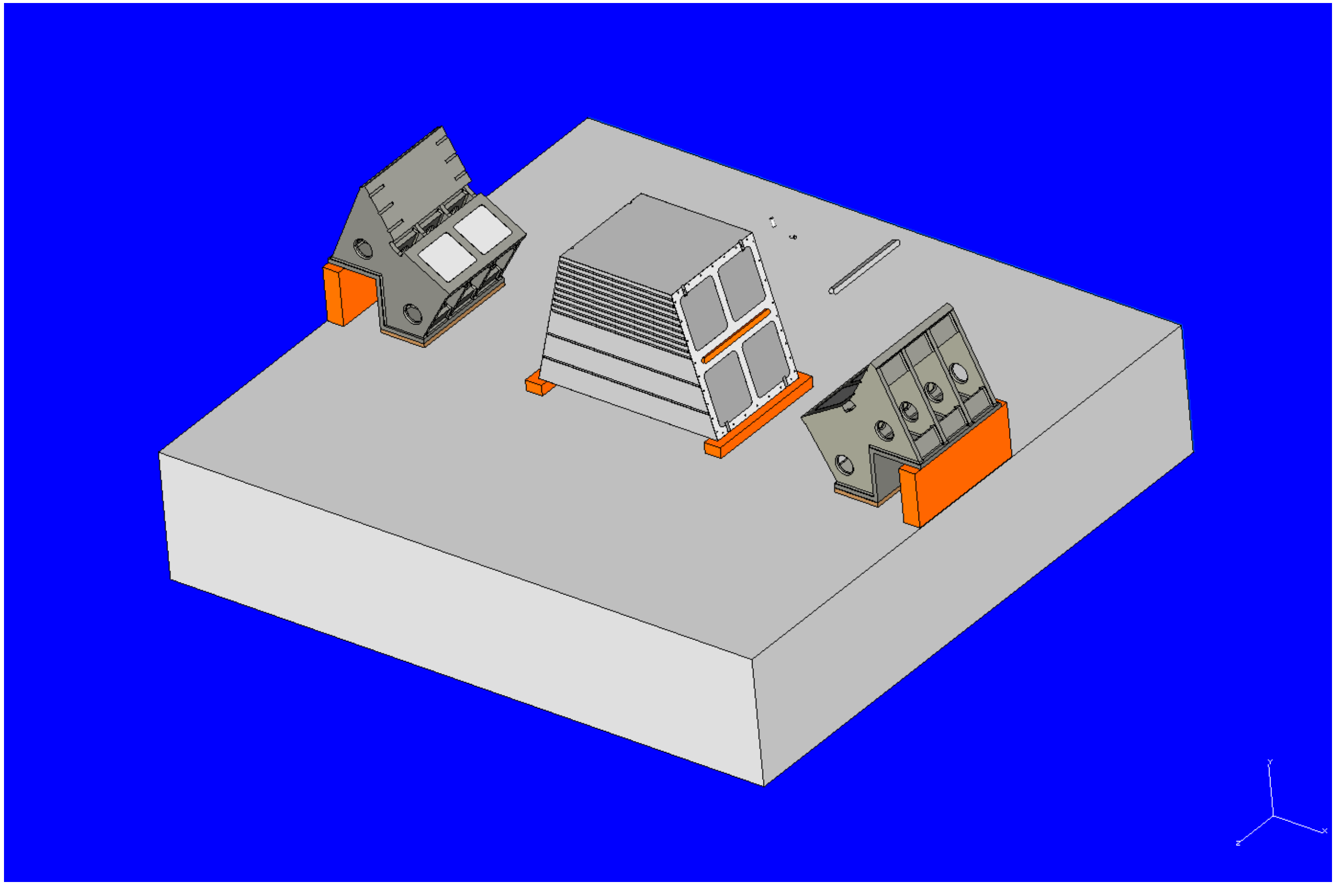
# Yoke



R. Stromhagen

# Yoke Assembly - Barrel

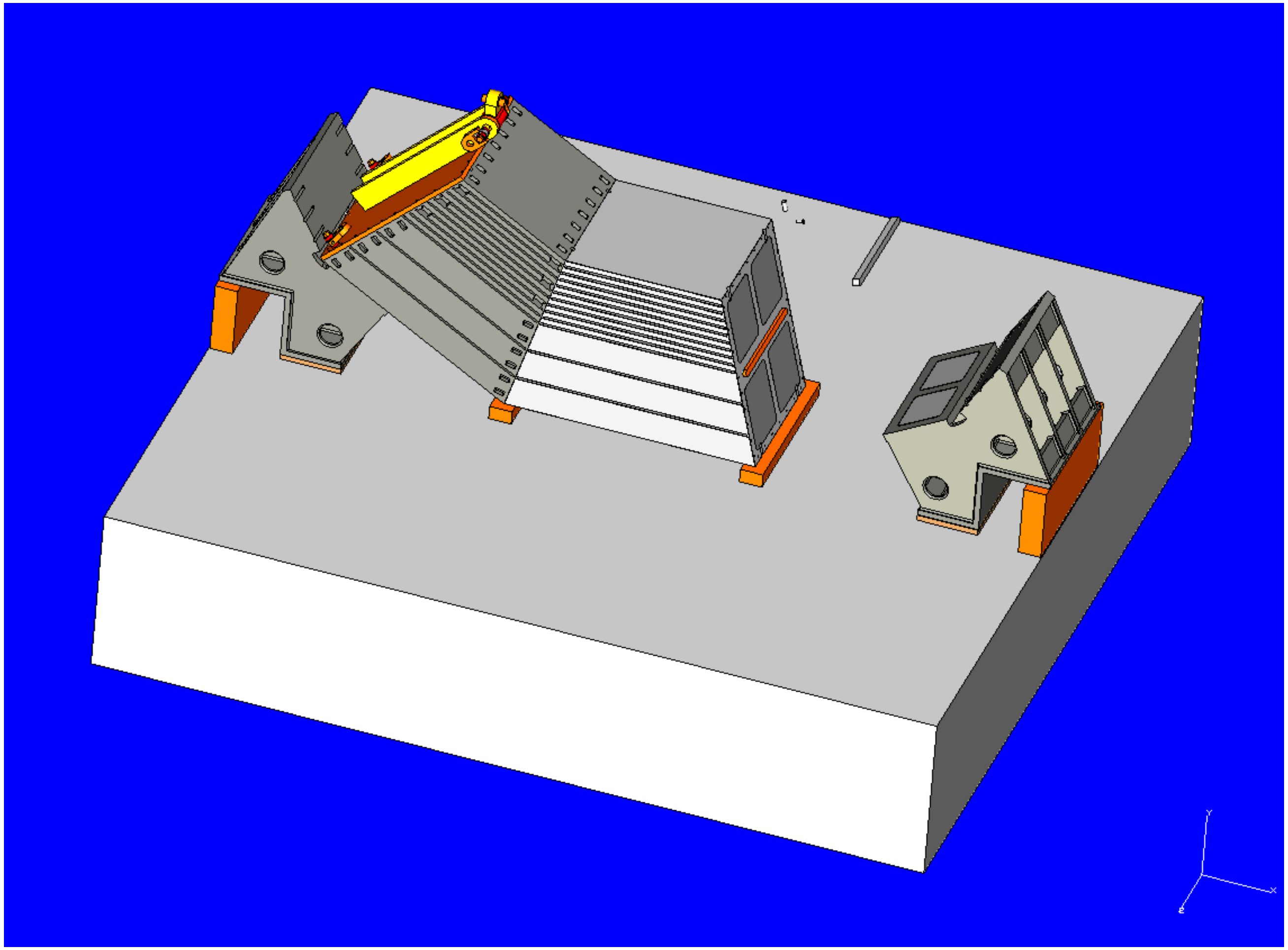
- Start with central ring on platform
- Space needed for: tools, scaffolding, surveying equipment



R. Stromhagen

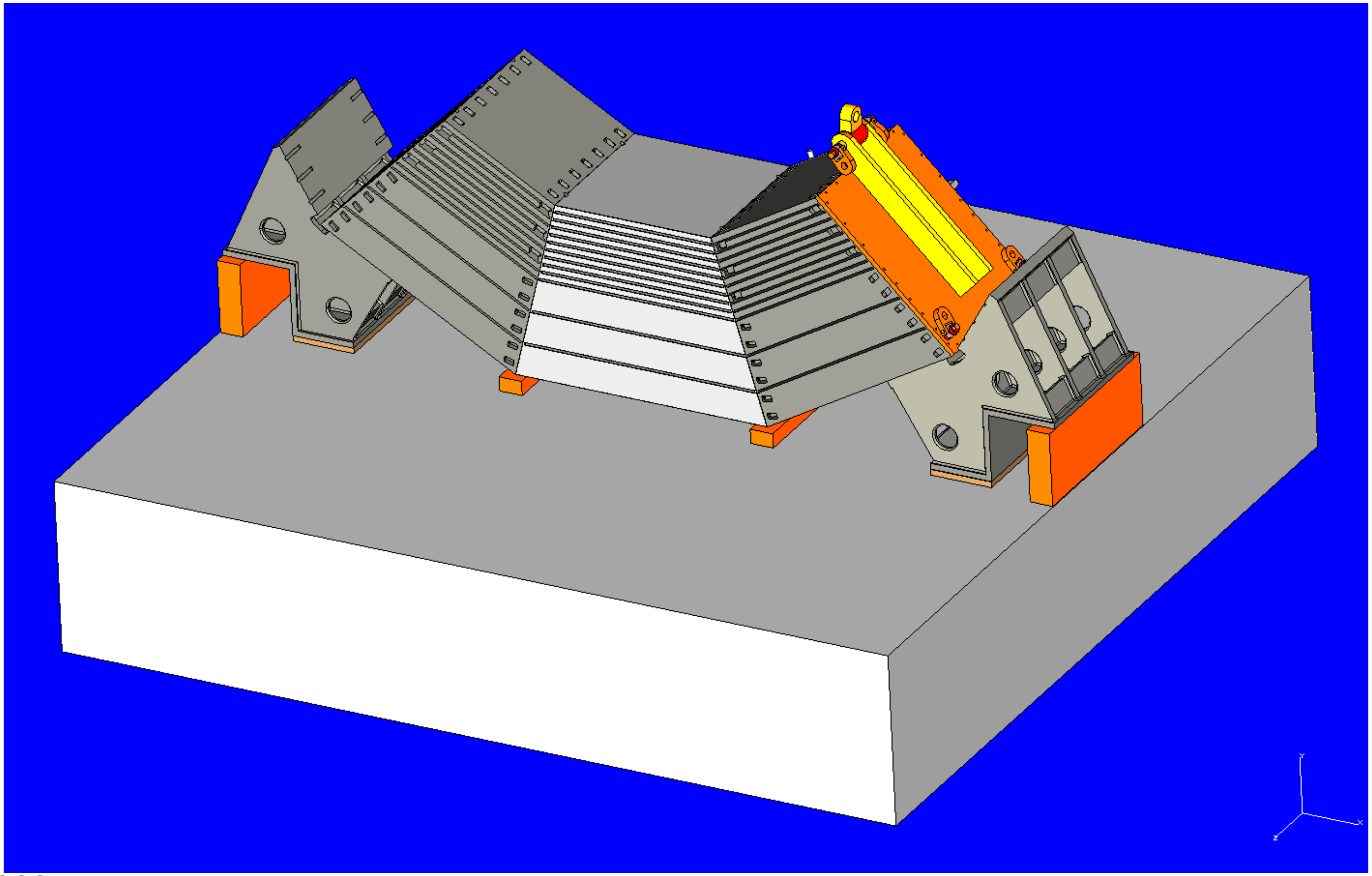
# Yoke Assembly - Barrel

- 200t crane coverage needed



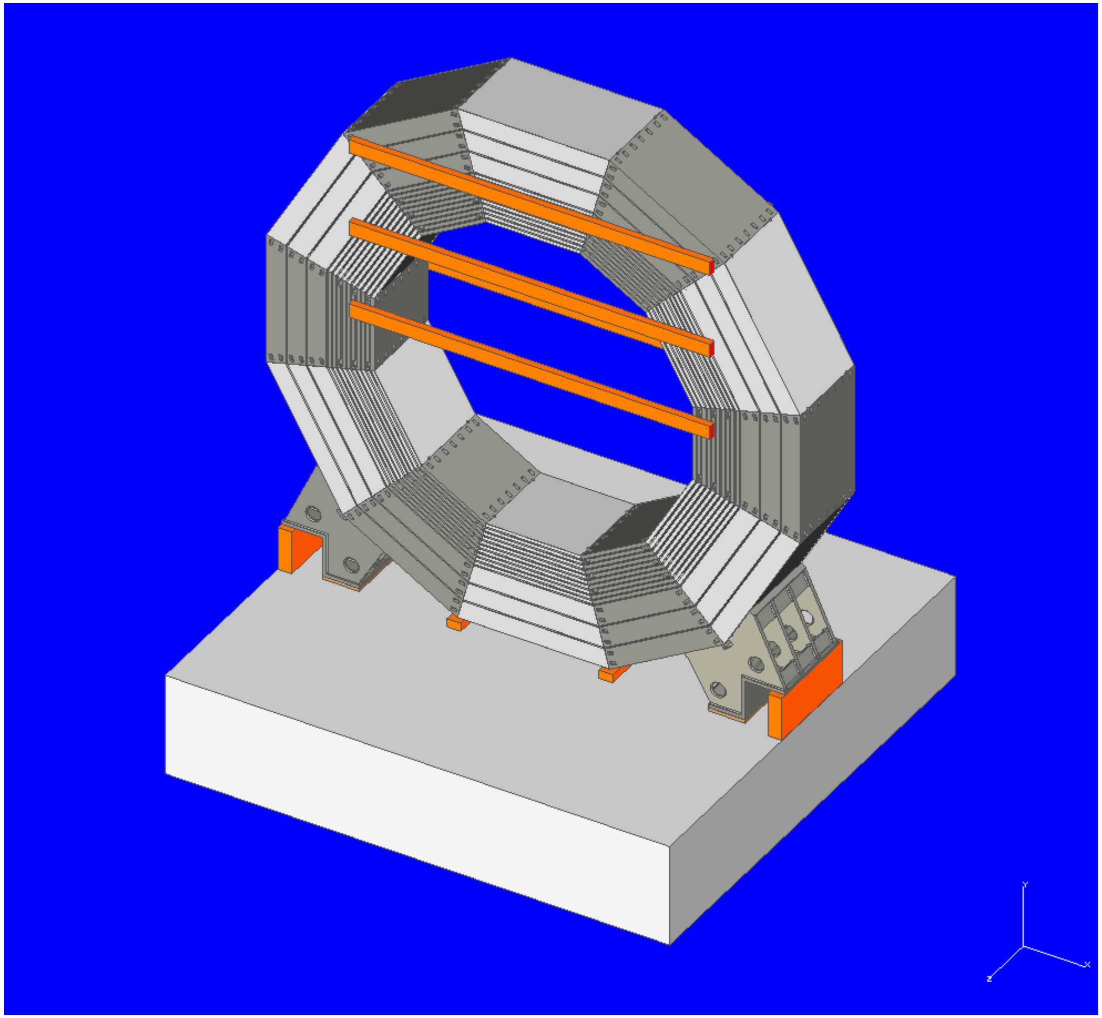
R. Stromhagen

# Yoke Assembly - Barrel



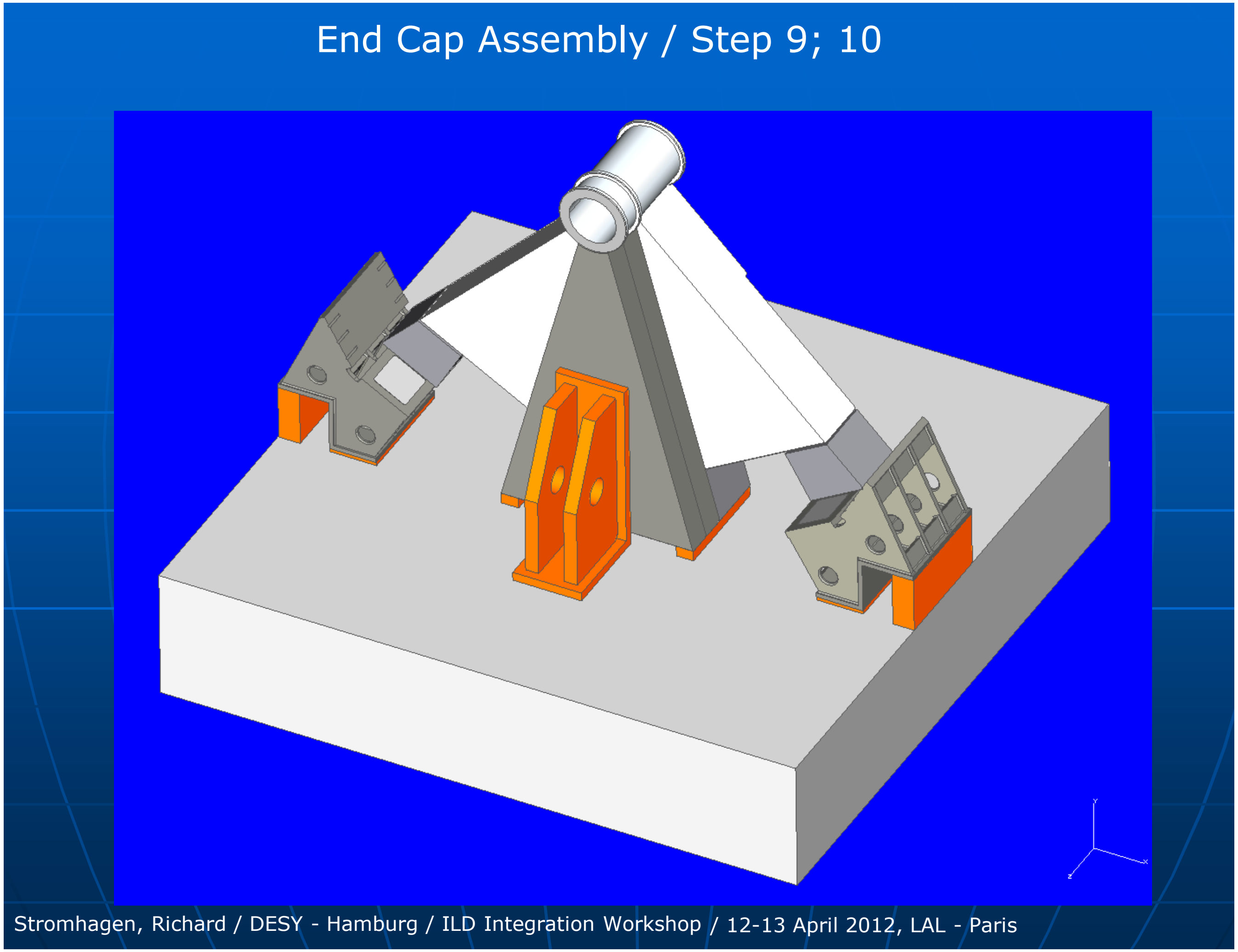
R. Stromhagen

# Yoke Assembly - Barrel

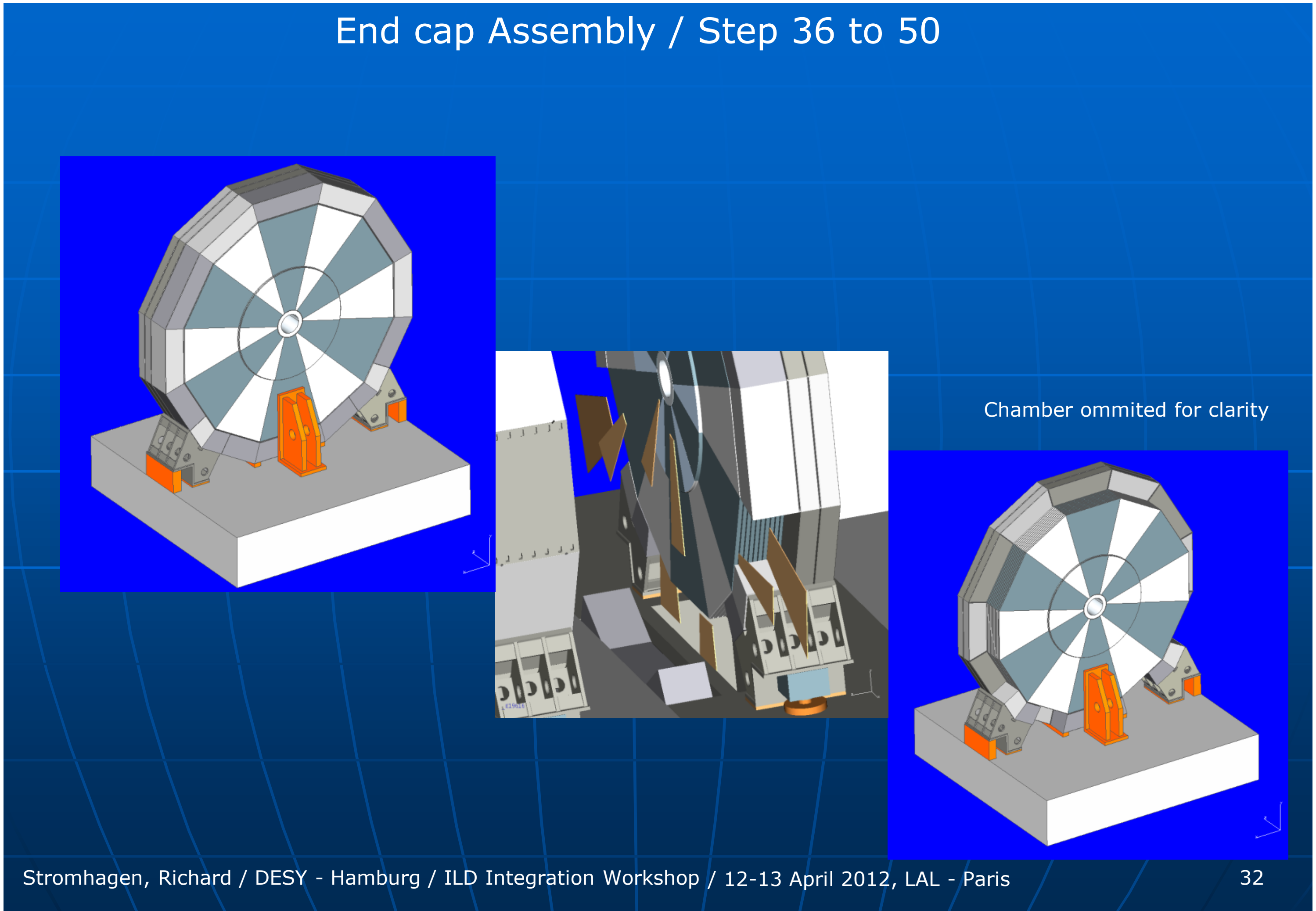



R. Stromhagen

# Yoke Assembly - Endcap

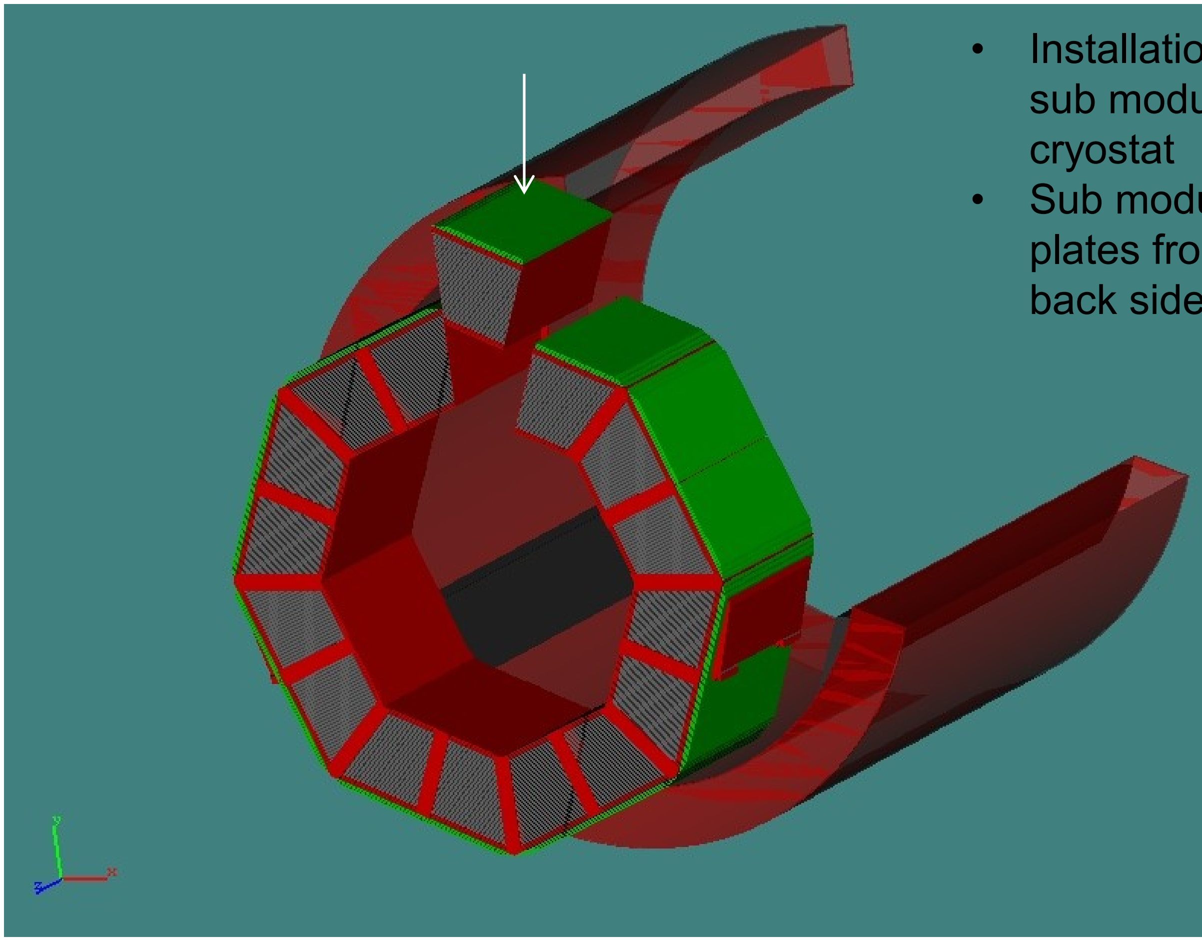


# Yoke Assembly - Endcap




R. Stromhagen

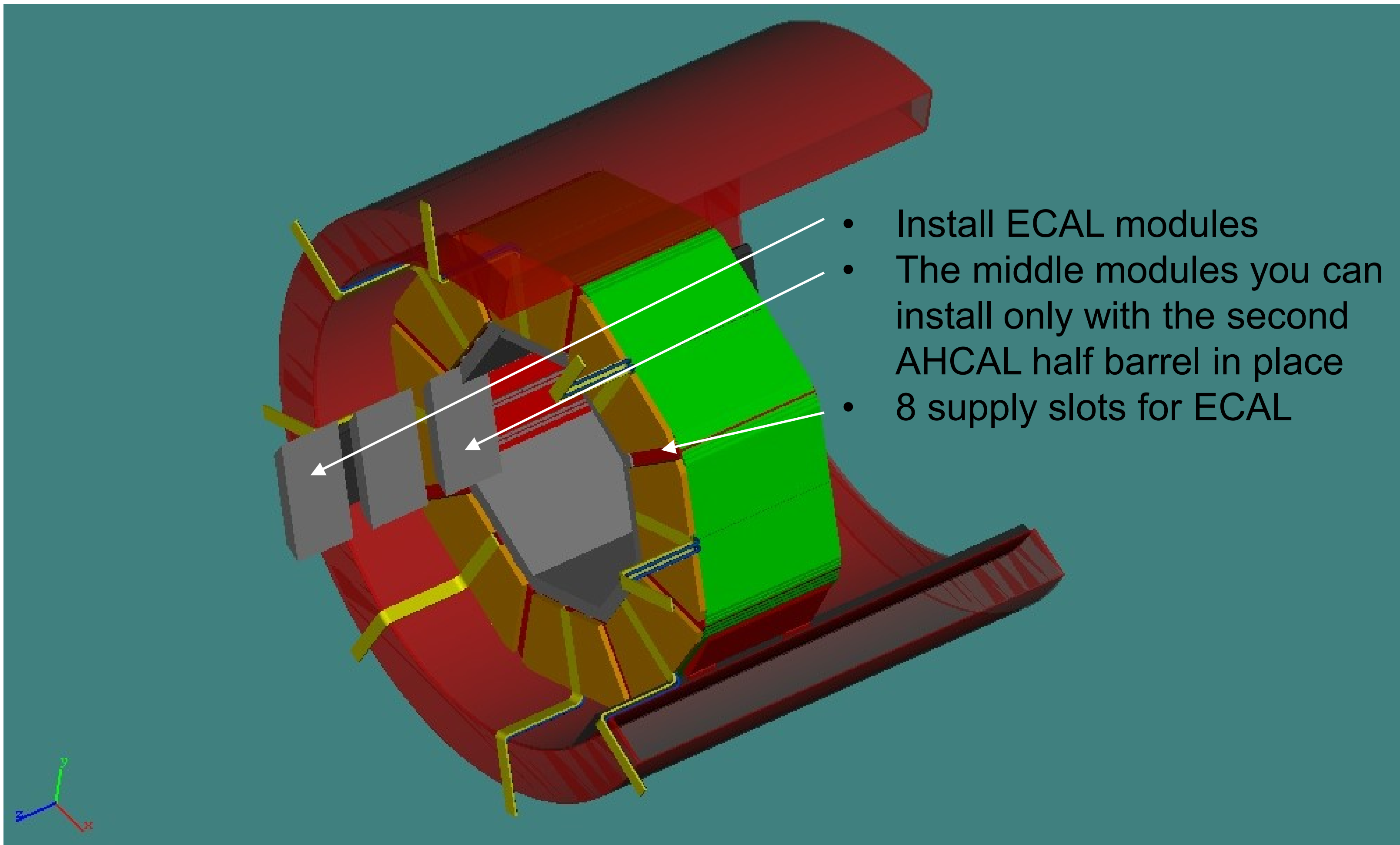
# AHCAL Installation



- Installation of last AHCAL sub module in front of the cryostat
- Sub module connection by plates from the front and back side

K. Gadow

# AHCAL/ECAL Installation



- Install ECAL modules
- The middle modules you can install only with the second AHCAL half barrel in place
- 8 supply slots for ECAL

K. Gadow

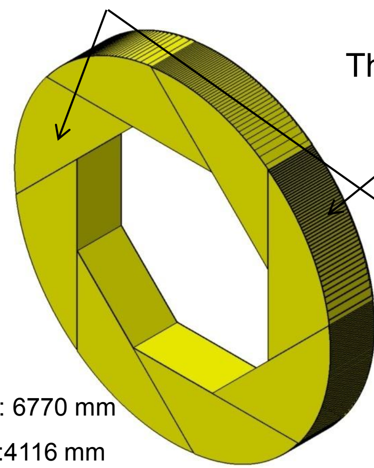
# SDHCAL Mechanical Design

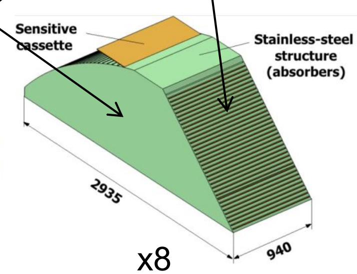
## Barrel design

| | |
|---|---|
| Ext. Diameter | 6770 mm |
| Int. Diameter | 4116 mm |
| Lenght | 4700 mm |

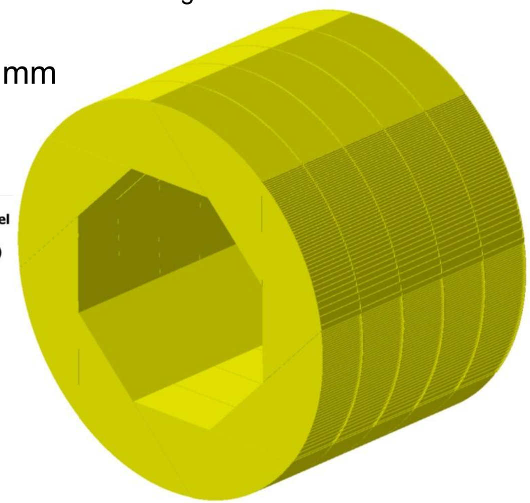
Thickness wheel face = 10 mm

Thickness absorbers= 15 mm






x8



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

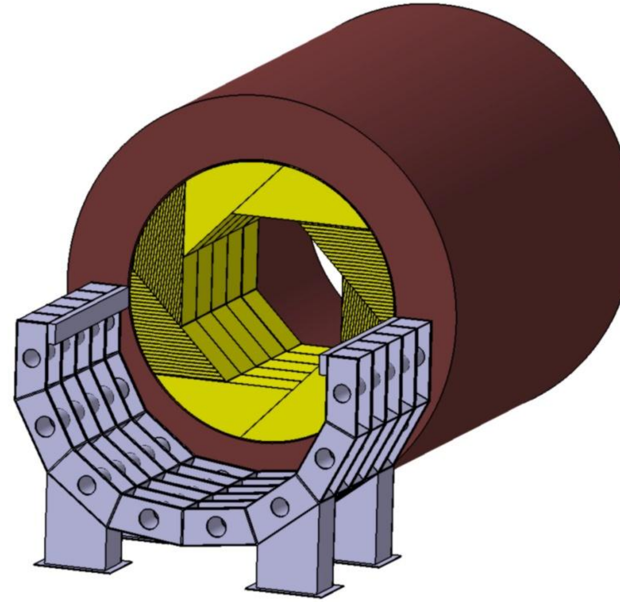
| *Stainless steel* | 1 wheel (8 mod.) | 5 wheels |
|---|---|---|
| Weight (t): | 88 t | 440 t |
| Detectors W. (t): | 36.8 t | 184 t |
| Total Weight (t) : | 124.8 t | **624 t** |

J.C. Inaigro

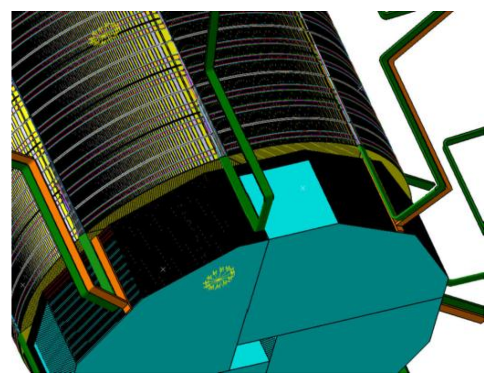
## Barrel Building & services connecting

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

*Barrel insertion*



*CMS « enfourneur »*



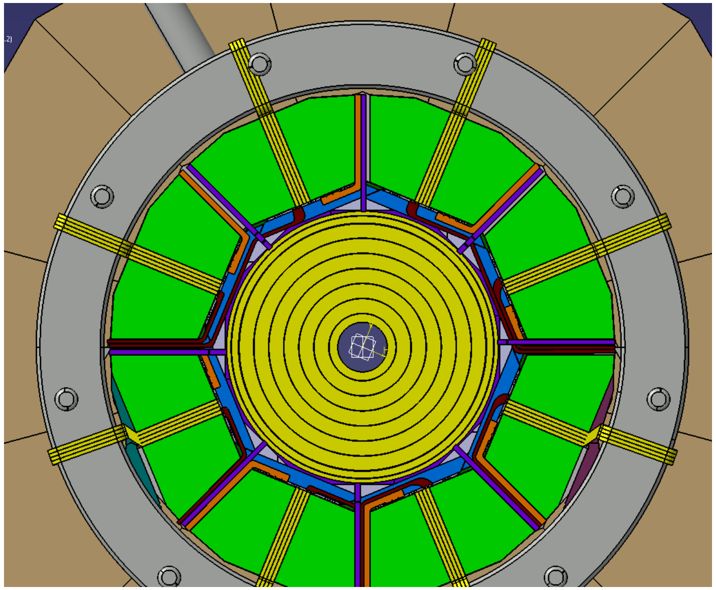
*Services issues to patch pannels*

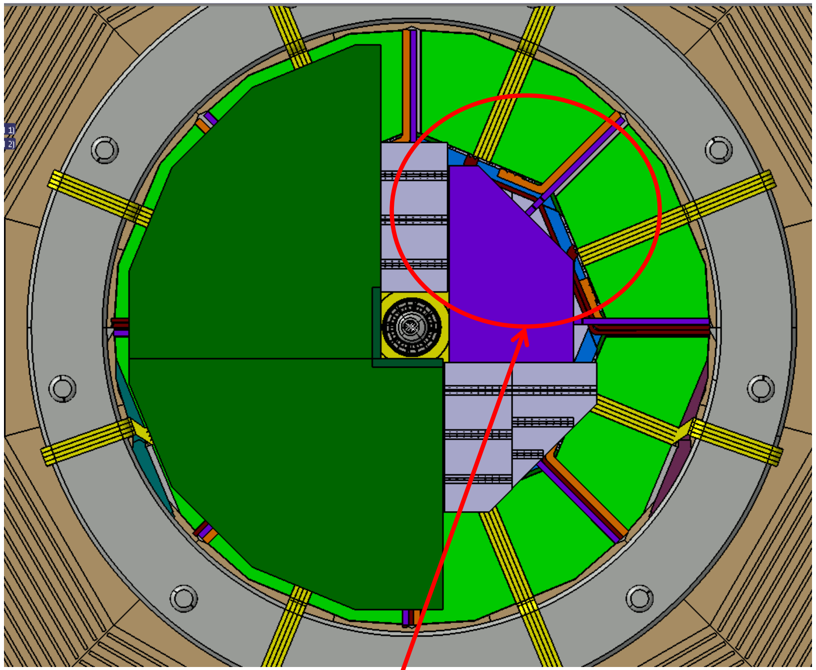
J.C. Inaigro

# AHCAL Tilt?

*Ahcal tilt*

Tilt of the Ahcal ( 22.5 °)
*(because of self load deformation)*





➢ Problem with actual shape and construction of Ecal endcaps ( + ETD?)

➢ No tilt in simulation.

C. Clerc

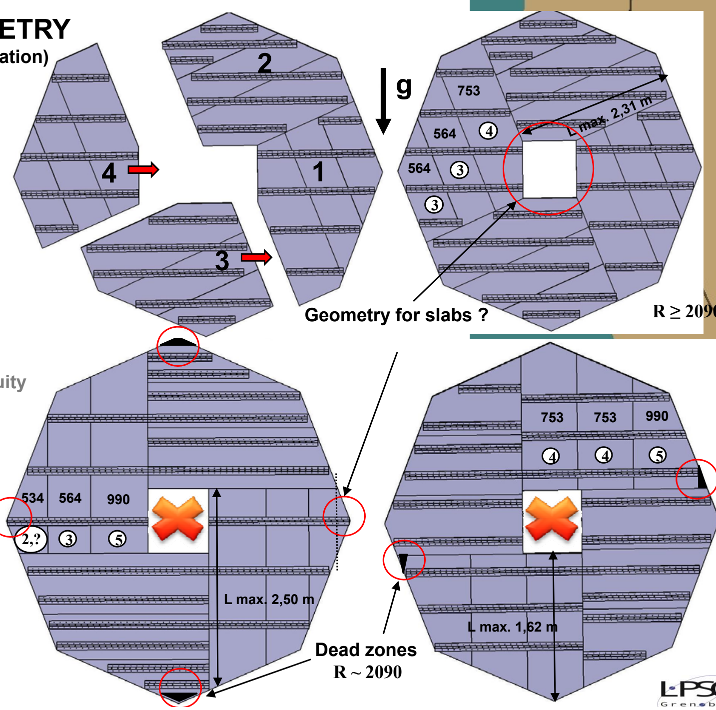
# Tilted ECAL Endcap

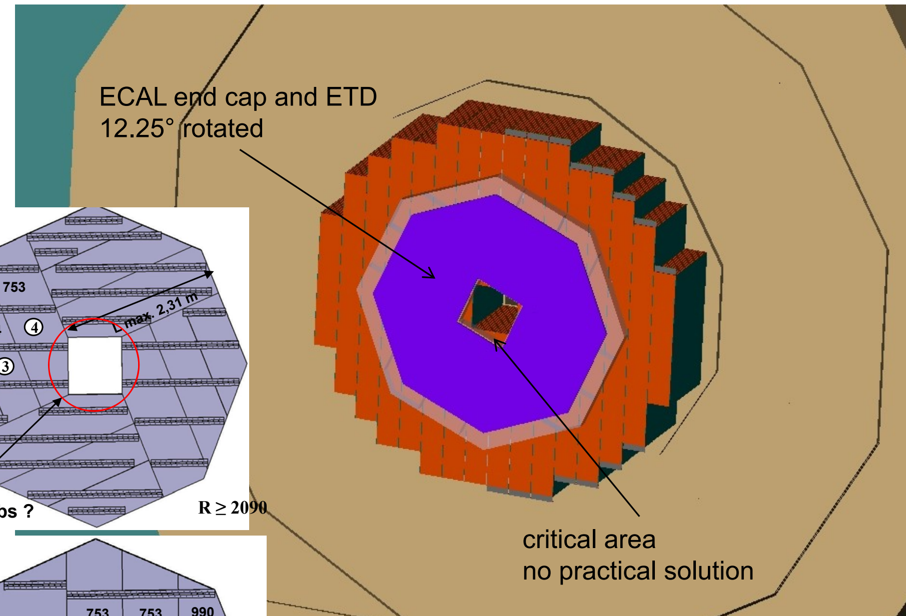
- **3 OPTIONS FOR GEOMETRY**
  **with always 4x3 modules (Segmentation)**

## Mainly: drawbacks

- Dead zones due to the geometry (both structure and slabs)
- Modular structure: 2 or more orientations with problem of slab insertion
- Fastening : Nbr of rails and discontinuity for insertion / sector of 3 modules
- Deformation of End-Caps
- Fabrication of composite modules: cost of moulds...
- Constraints / free passage for cooling and services

**Tilt not convenient !**

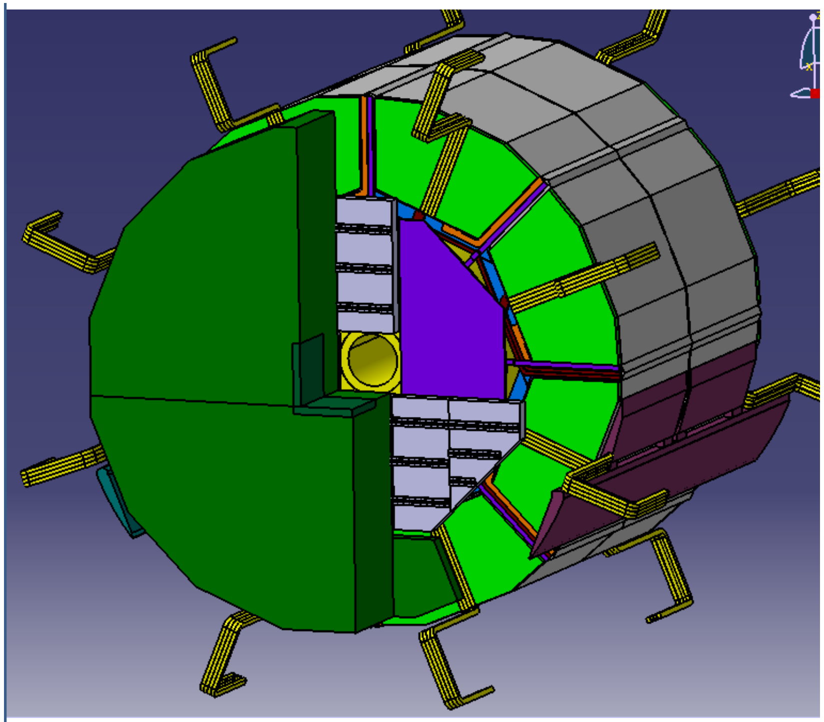


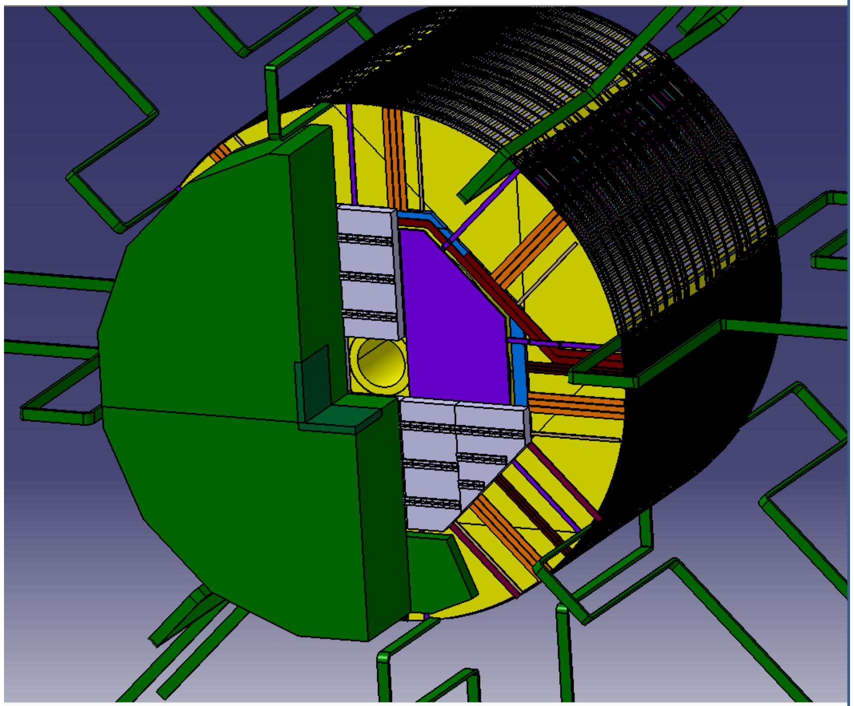

K. Gadow

D. Grondin

# HCAL Orientations



AHcal

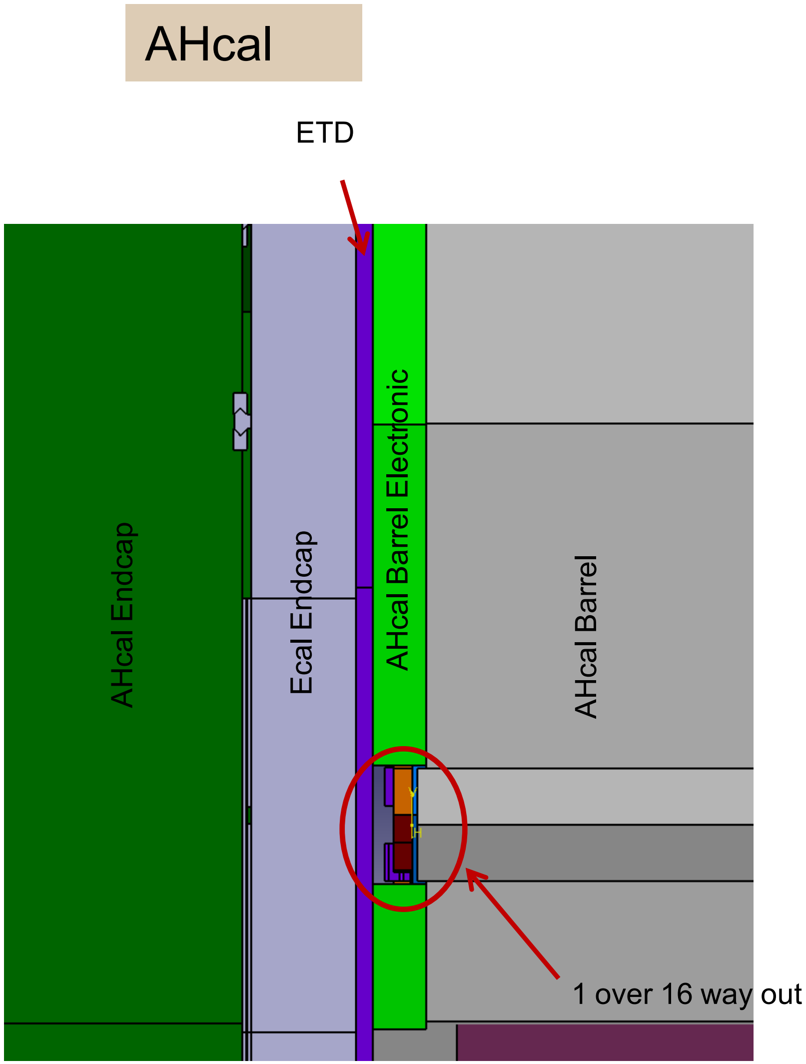


SDHcal

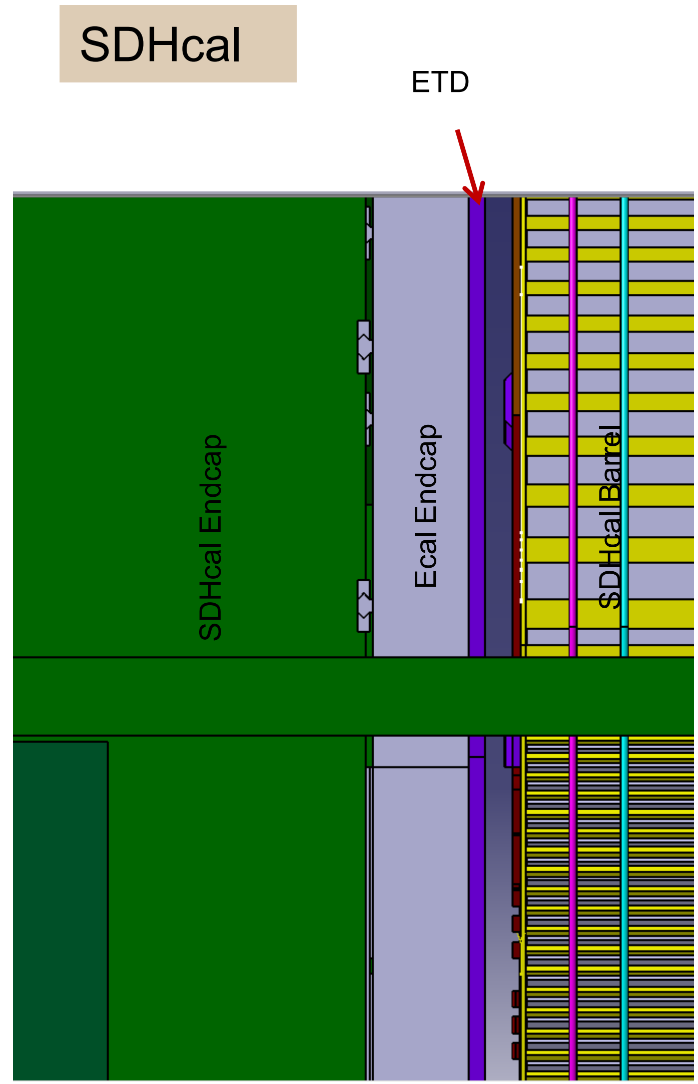
C. Clerc

- Decided to postpone final decision on AHCAL tilt
- Mechanical model will keep unrotated version, will comment in DBD

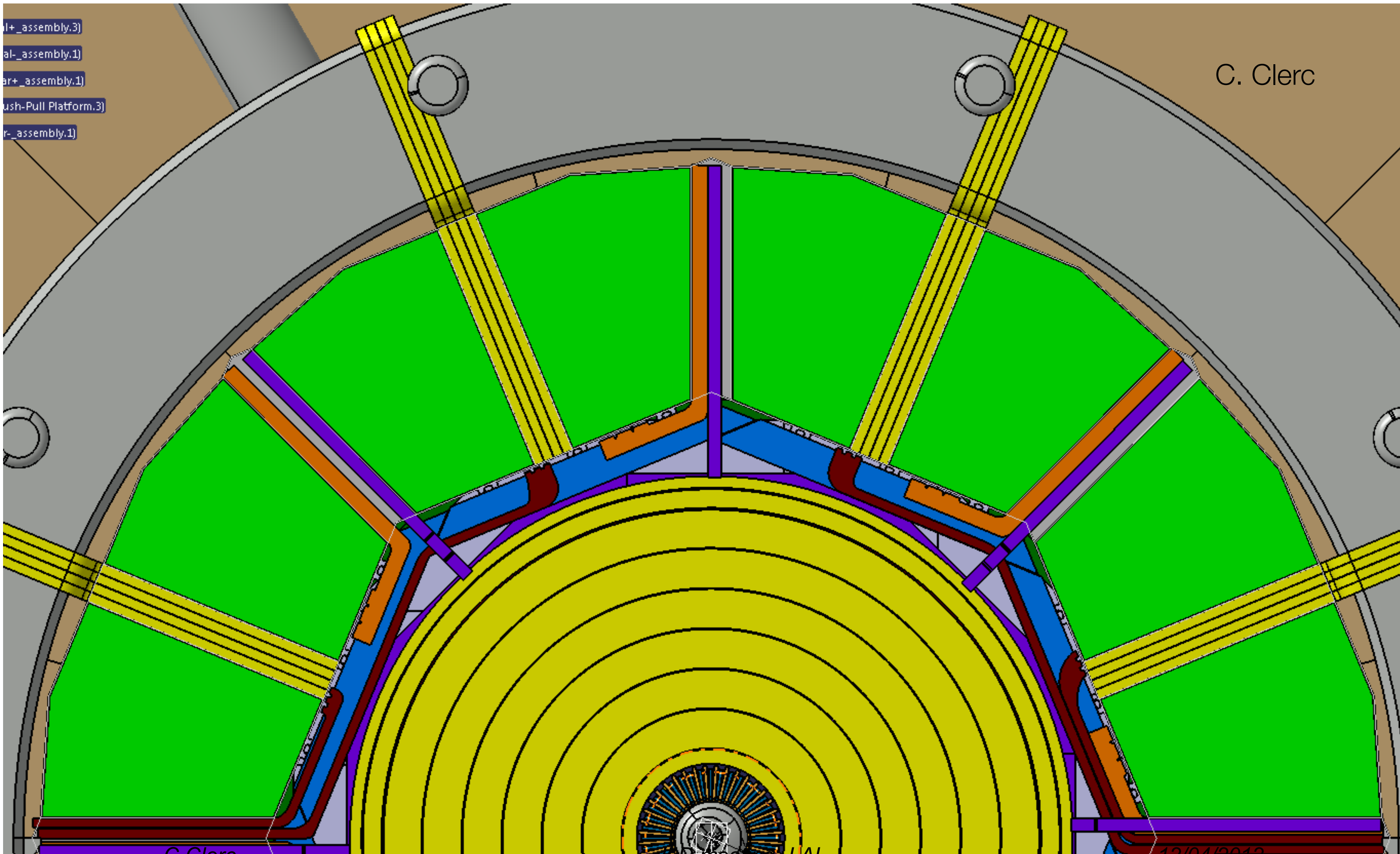
# Barrel Calo Services




C. Clerc

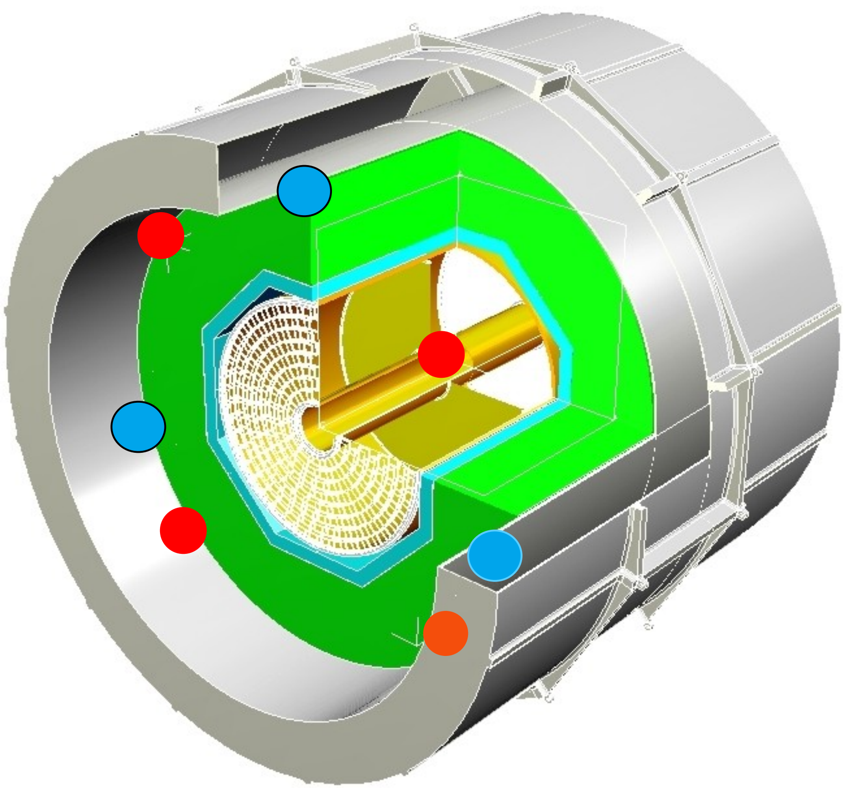


# Cable Paths

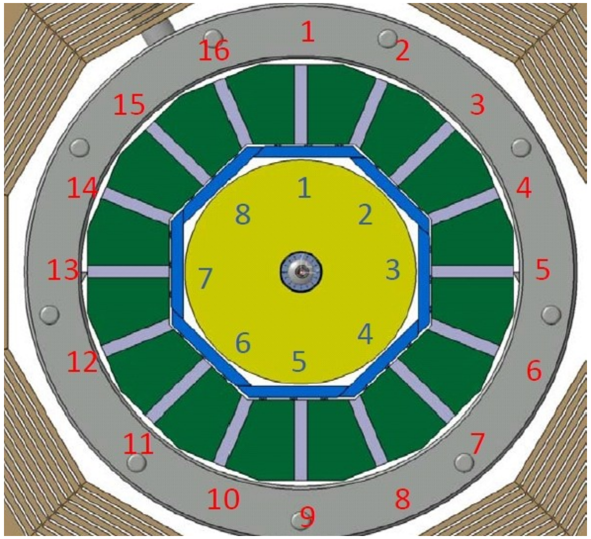


l+_assembly.3)
al-_assembly.1)
ar+_assembly.1)
ush-Pull Platform.3)
r-_assembly.1)
C. Clerc

# Fixing points of the TPC support structure



Main dimensions of the TPC (outside)
Ø Od = 3616, r=1808
Ø Id = 658, r=329
Length = 4700 incl. endplate and cabling




3 Point 3x120°, preferred gaps: 1,12, 6

4 Point 4x90°, preferred gaps: 3, 15, 11, 7 but this gaps filled 100%

Only the cryostat is foreseen to support the TPC

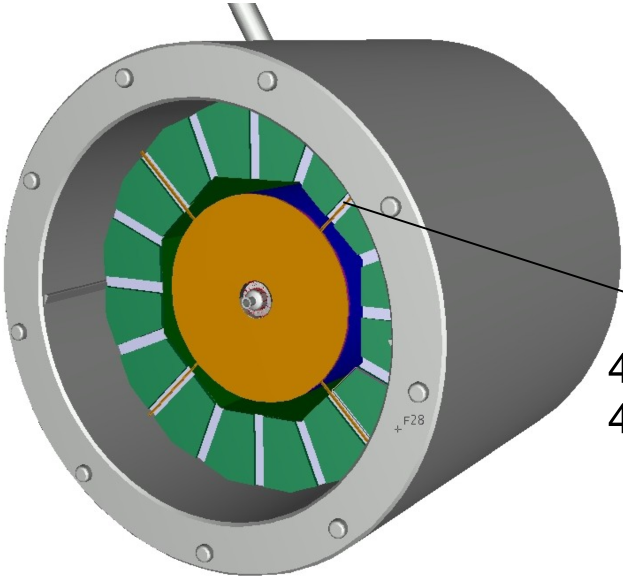
V. Prahl

# TPC Support

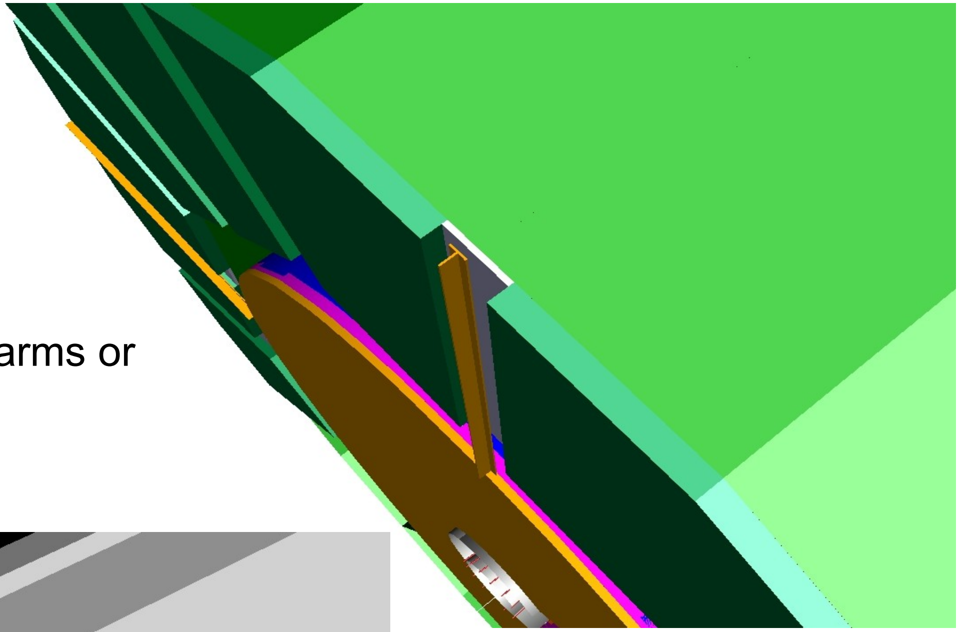
| | HCAL | Cryostat |
|---|---|---|
| 3x120° | - Accuracy<br>+ Shorter support structure<br>- HCAL deformation<br>- Seismic stability | + Accuracy<br>- Longer support structure<br>+ Cryostat deformation<br>- Seismic stability |
| 4x90° | See above<br>+ Seismic stability<br>- More space required | See above<br>+ Seismic stability<br>- More space required |
| | | |

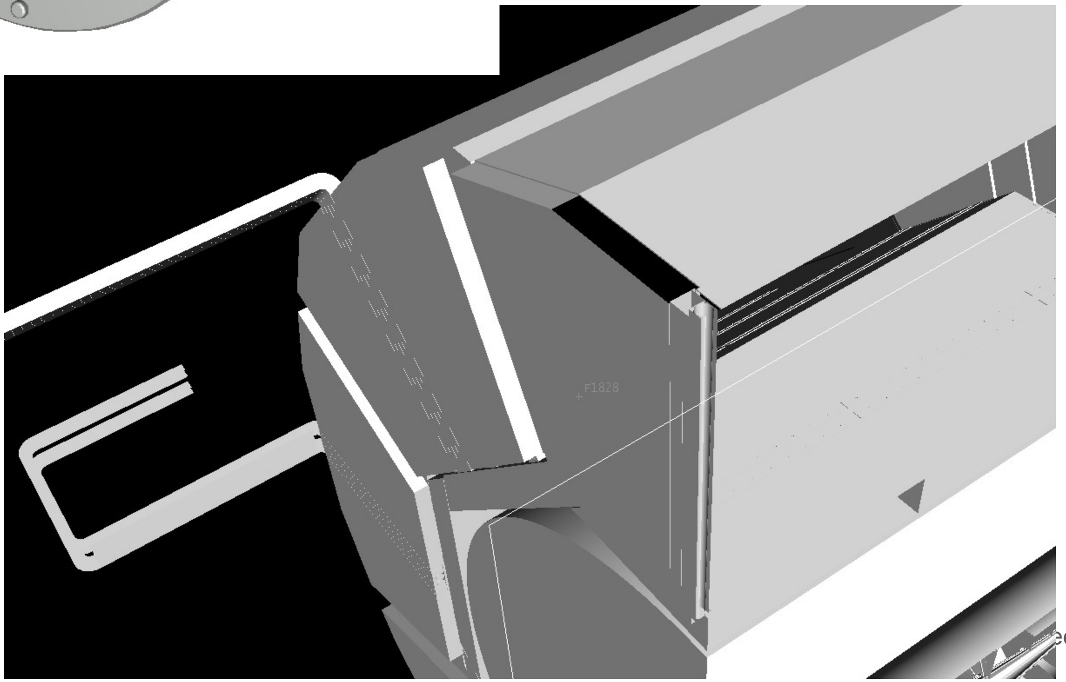
V. Prahl

# Design of the support structure



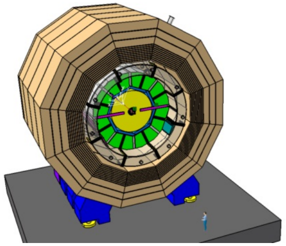
4 Cantilever arms or
4 Ropes





# Inner Detector Support

## Fixing the inner part of the TPC



### Summary of the requirements:

From the document : *"Aligning the ILD Tracker" June, 2009*

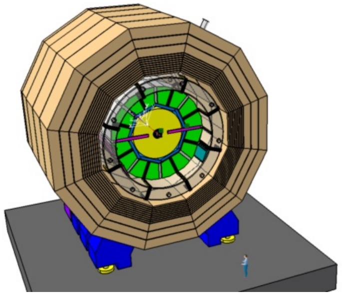
<u>Precision</u>:

- Precision of Inner Silicon ( SIT / FTD)= **5µm**
- Inner parts (SIT, Vertex, FTD, Beam Pipe) are connected to a common support structure **with 6° freedom**.

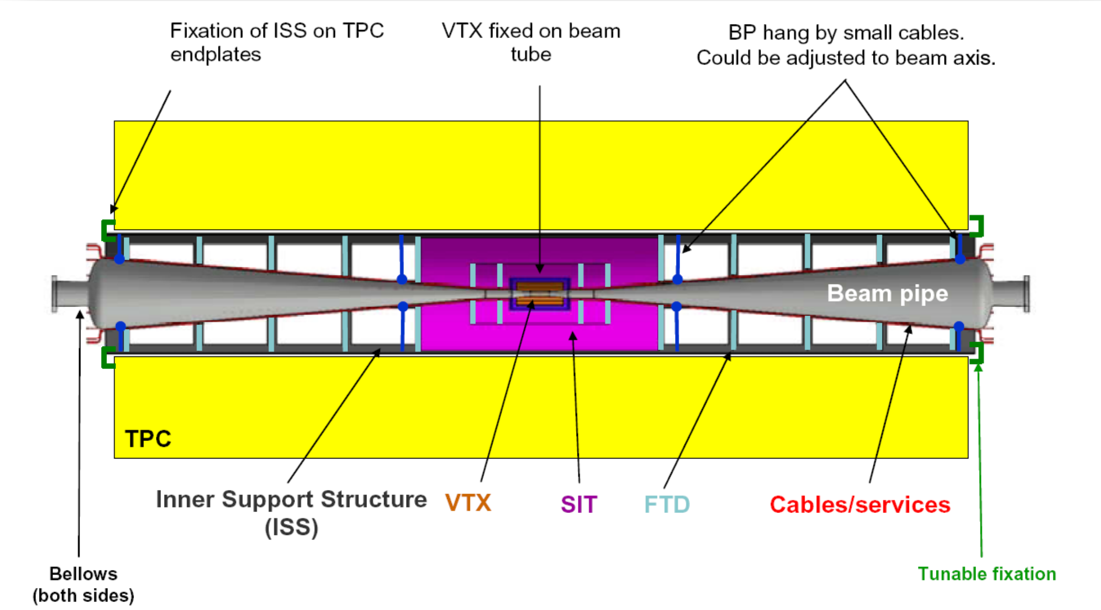
<u>Hardware systems for monitoring the position and alignment</u>:

- Planned to used a laser beams (same for the ILD detector) complemented by network of fiber optic sensors (Fiber Bragg System – FBS)

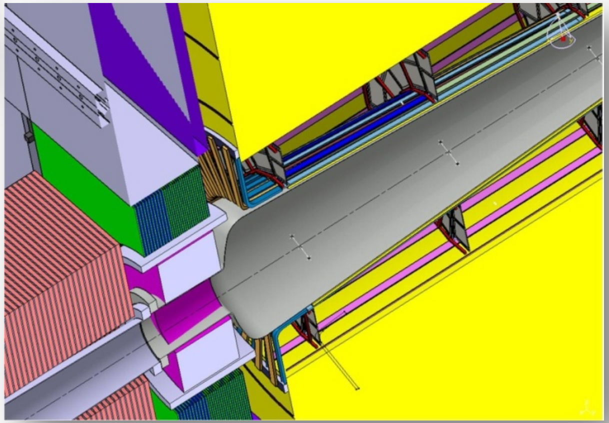
# Fixing the inner part of the TPC



## Needs to continue the study:

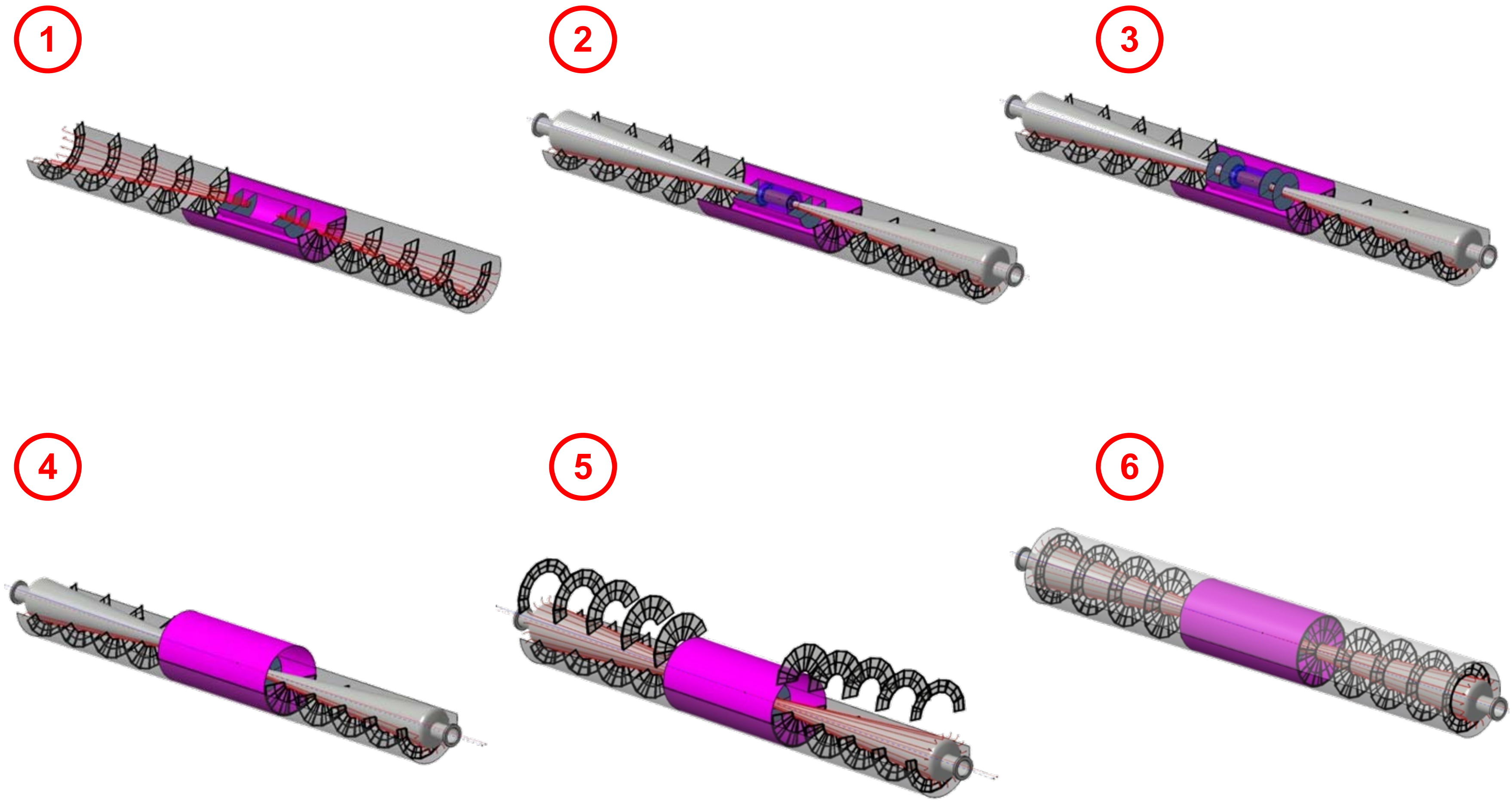



Limited access due to the services



*( See Catherine Clerc's talks )*

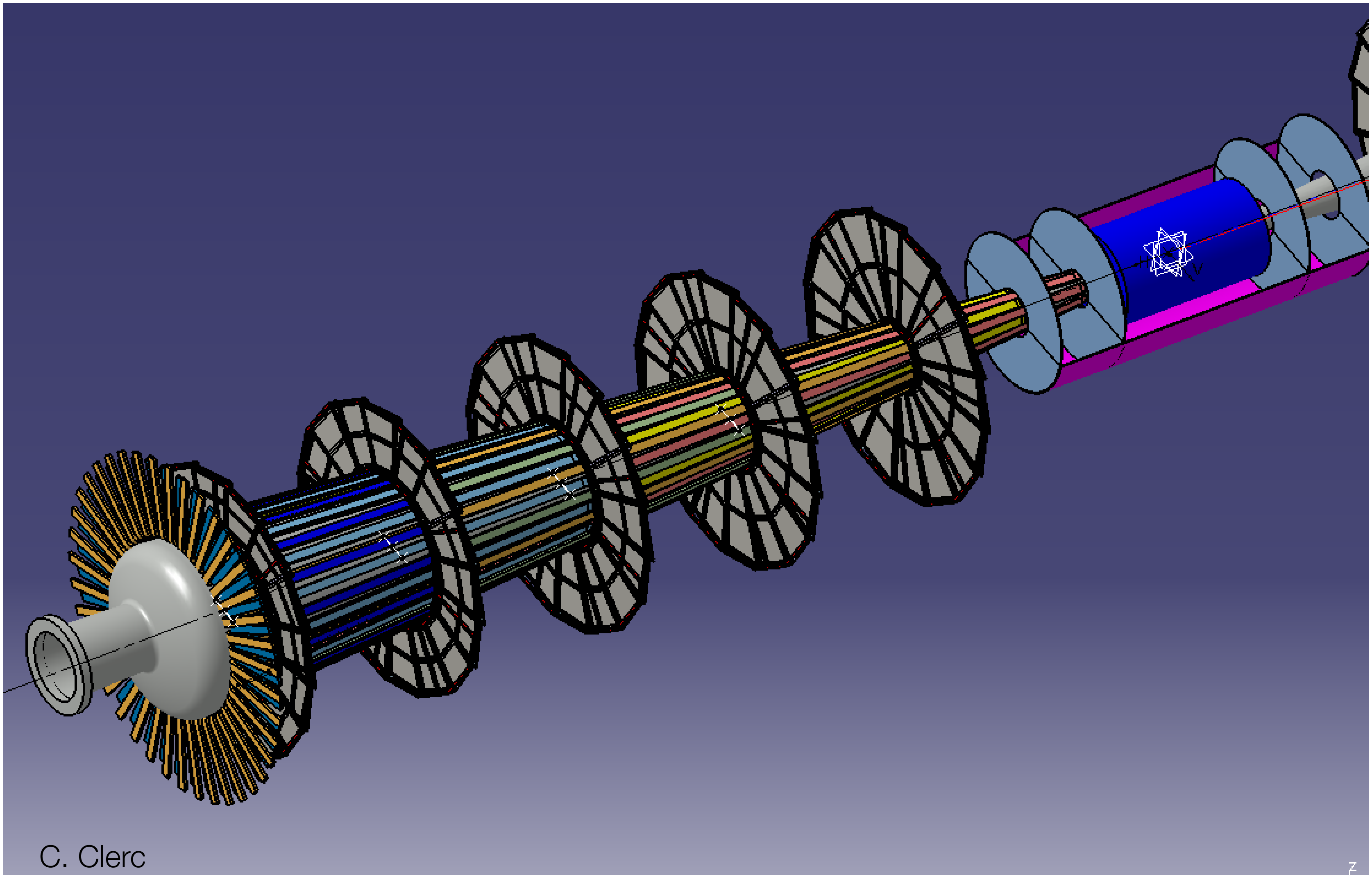
# Current assembly procedure



# Inner detectors cables :

- Estimation of the volume of cables extrapolated from FTD datas :
  - 2* 12 Volts cables AWG 15 ( chips alimentation) to the DC-DC electronic plate
  - 4 AWG 15 high voltage cable (sensors polarization)
  - 2 fibers of 300 um diameter (control of the chips and signal of the sensors)
  - I.e full inners : 448 HV+224 LV + 224 OF ( VXD not included)
  - 2580 mm$^2$ of Al at the position of FTD 7 ( single distribution, should be doubled for security reasons)

# FTD Detector Cables

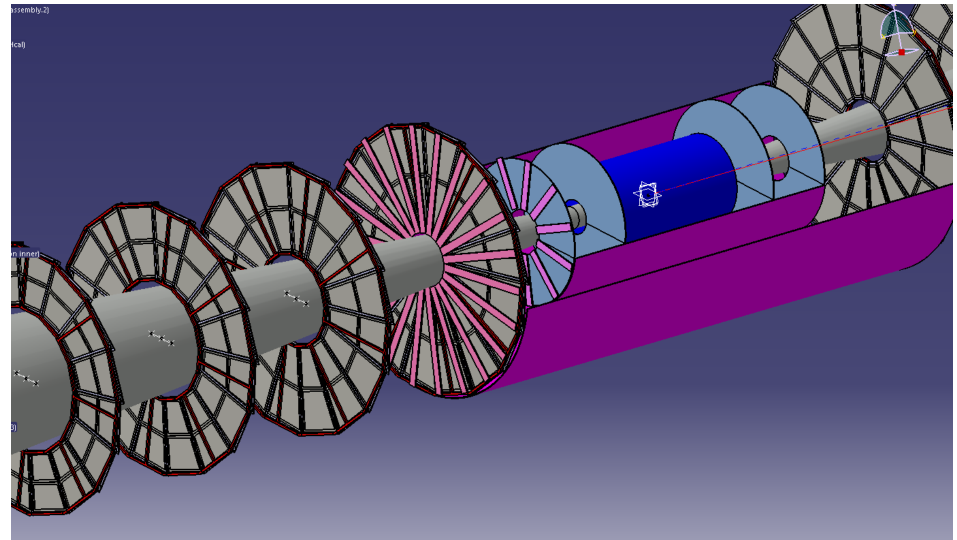


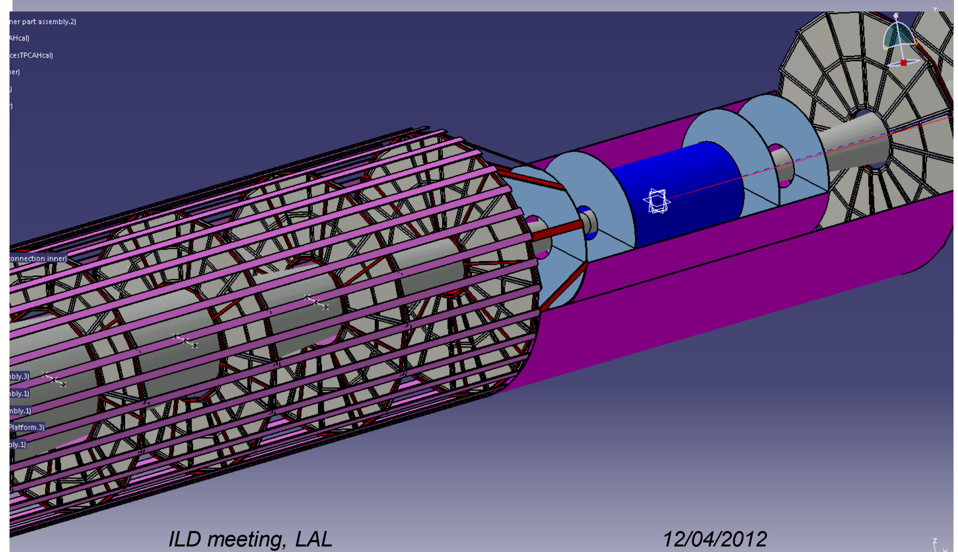
# SIT Cables

SIT, two solutions

1. Along the beampipe : they have to run on backside of FTD2 and 3 , then :
   - huge amount of material around BP
   - Material in front of the other FTD

2. Run along the inner radius of TPC



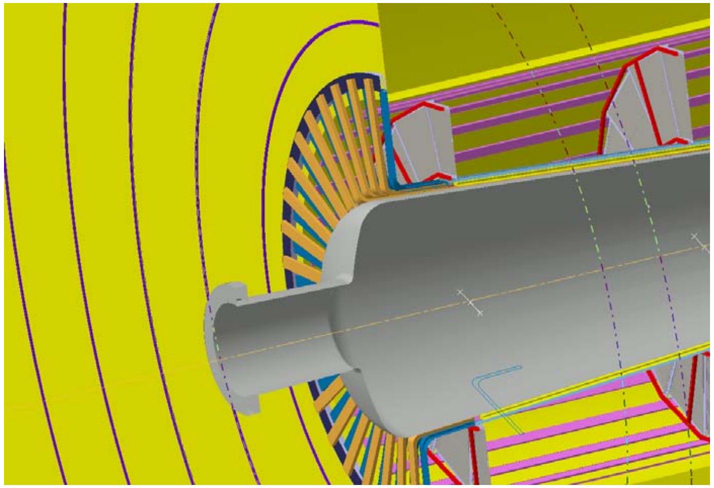


# Patchpanels

C. Clerc

1St patchpanel :

( section of 3 time the occupancy of the cables)

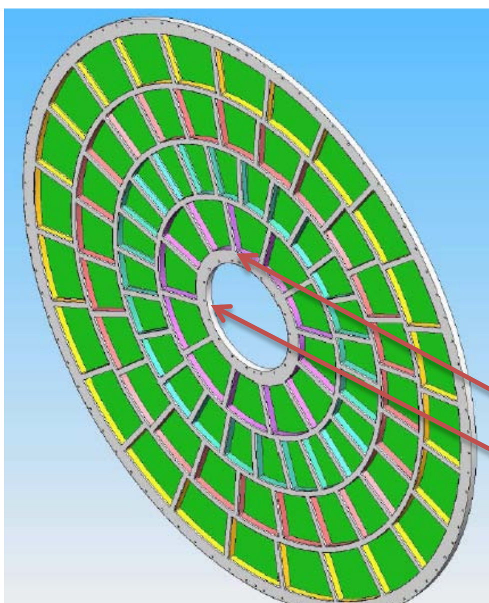


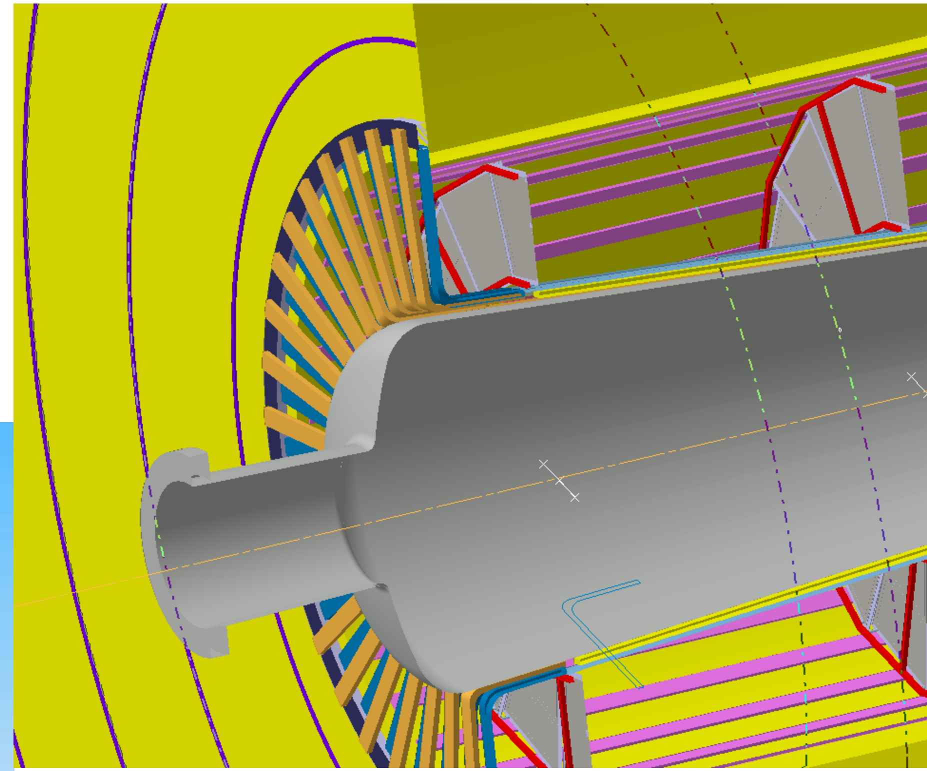
What for :

1) connectors for assembly/maintenance operations : importance of their positions
2) Optical conversion of signal ?
3) DC/DC convertor ?? ( depend if already under 12 V as proposed by FTD ( only 33 % of the cables are for LV ( 12 V), the rest : HV for Si sensor polarization)
4) Multiplexing of the power distribution in order to reduce the amount of cables along the TPC endplate ( less interference with TPC modules cabling, cooling) : but in front of the Ecal endcap : is it better to distribute and average the 2600 mm² of Al on all the surface or to have +/6 12 ways out ( 215 mm² ) ( see design of TPC endplates : 12 modules in inner radius)

# Patchpanels

C. Clerc



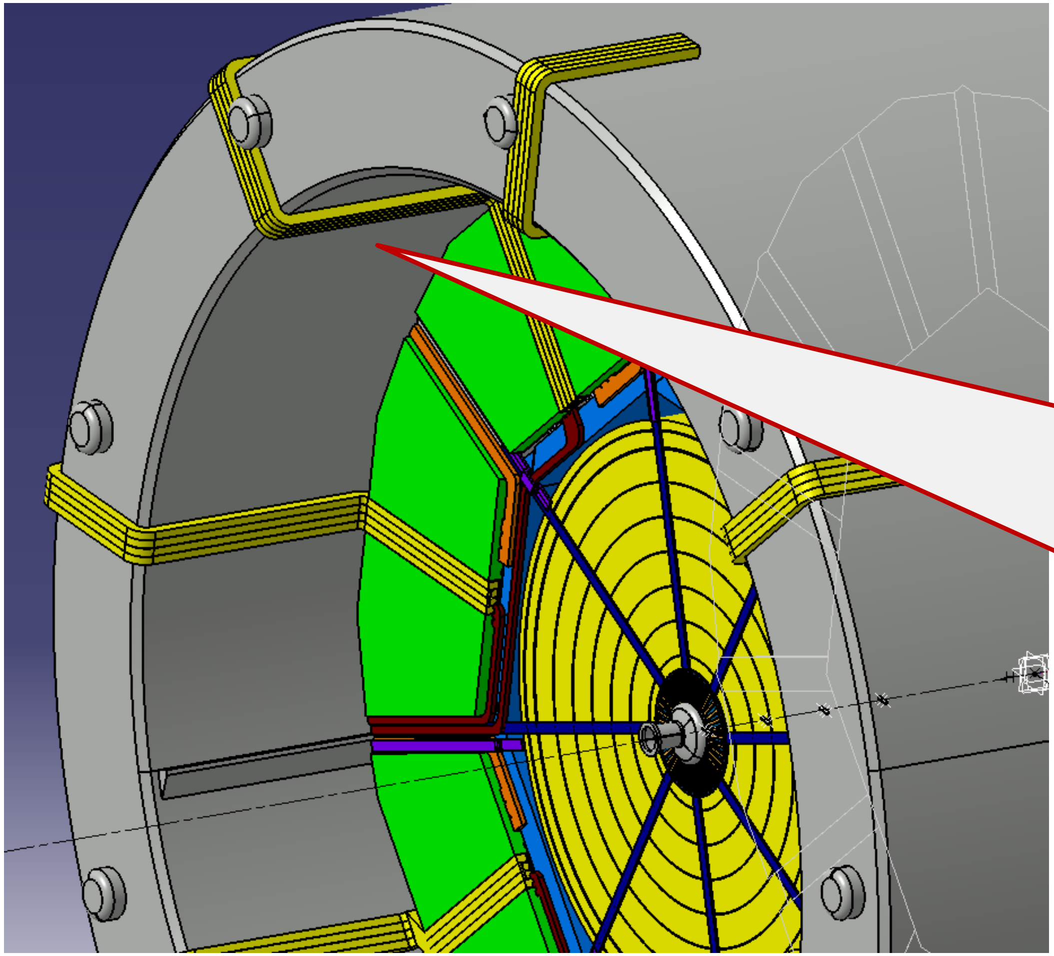


∅ Out 780

∅ In 678 of the structural ring

Ring of 5 cm enough for patchpanel
but for convertors ??

# Patchpanels



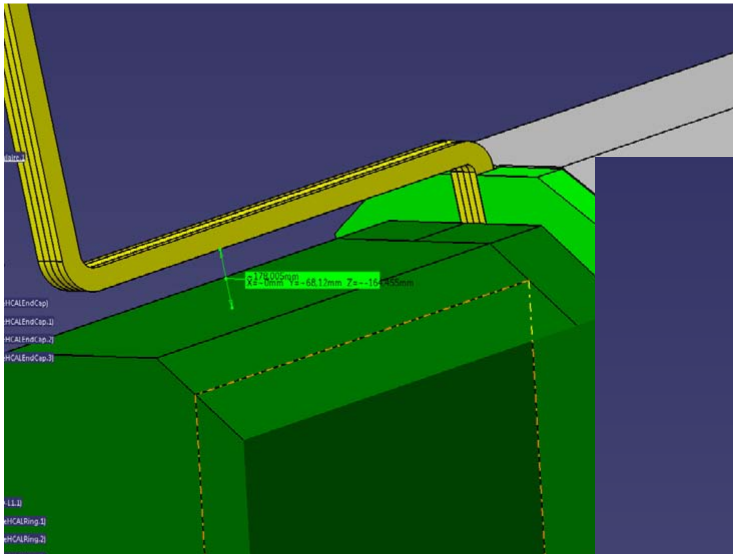
Proposition :
Use the inner radius of the coil .

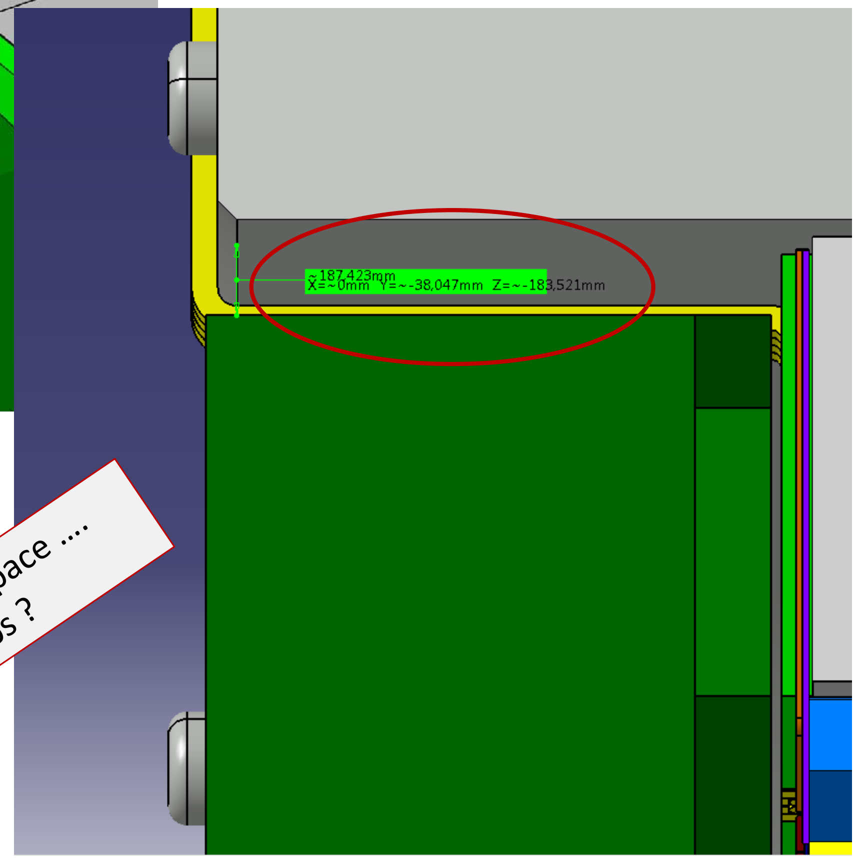
For Hcal
Ecal
TPC

Inner ?

C. Clerc

# Patchpanels






Inputs :

Rin coil = 3440 mm

Circ= 21 m

Not so much space ....
Endcaps ?

# ILD Placeholders

Overall dimensions

- These are the dimensions currently used in the simulation and corresponding to the overall detector's envelope
- All the detailed mechanical design studies were done to stick to those limits

Placeholders definition

***Placeholder 1 , corresponds to the structural occupancy, including :***

- Overall mechanical dimensions
- Front end electronic card going overboard the mechanical structure
- Tolerances :
  - ✓ for alignment,
  - ✓ mechanical deformations
  - ✓ Constructions tolerances
- Fastening system
- Room for integration's tooling

Subdetector dimensions

\+

***Placeholder2, concerns the services***

- Place and way-out for cables,
- Place and way-out for piping,
- Both should include
  - ✓ cables or pipes dimensions,
  - ✓ supports
  - ✓ Screening
  - ✓ Patch panels

in the gaps

Alignment systems ?????

C. Clerc

# ILD Dimensions

C. Clerc

| | | | |
|---|---|---|---|
| Hcal | | | **OK for DHCAl ; Numbers for AHCAL** |
| | Barrel Rin | 2058 | 2058 |
| | Barrel Rout | flat/corner=3345/3410.5 | 3396/3334 |
| | Barrel 1/2 length | 2350 ( sensitive =2330) | 2340 + 90 electronic boards |
| | thick. | | 1293 |
| | EC Rin | square 350 | ( Checked by A.Gonnin, actual model) |
| | EC Rout | octogonal 3190(sensitive+elec) | |
| | EC Zin | 2650 | |
| | EC Zout | 3937 | |
| | thick. | 1287 | |
| Hcal ring | Rin | 2190 | |
| Ecal | | W/Si, 24 X0, 29 layers, cell 0,25 cm² | No changes |
| TPC | | | No changes |
| Fcal (lumical) | | W/Si centered on outgoing beam | New datas from W.Wierba@ILDmeeting, may 2011 |
| | Rin(support/sensitive) | 76/80 | 76/80 |
| | Rout active | 196 | 195 |
| | Rout support | 240 | 280 ( the inner part of QD0 support = 287.5) |
| | Zin | 2450 | ? |
| | Zout | 2635 | |
| Bcal | | W/Si or W/diamond centered on outgoing beam 30 layers , 3,5 mm each | from L.Zawiejski@ Paris (janv2010) |
| | Rin(in/outBeams) | 13/20 | |
| | Rout | 220(support) | Rout =200(support); 150 (sensors) |
| | Zin | 3595 | Zin= 3450 with 10 cm graphite in front |
| | Zout | 3795 | Thickness 170 mm ? |

# Dimensions

C. Clerc

| | | | |
|---|---|---|---|
| ETD | | 2 layers | From A.S.N@DESY ( jul 2010 ) 3 XUV planes |
| | Rin | square 400 | 620 ? |
| | Rout | octogonal 1843 | **circular** = 1890 ( sensors)/1930 (support) |
| | Z 1st disk | 2420 (support) | |
| | Z 2nd disk | | |
| | Z 3d disk | 2450(support) | Thickness 15 per plane (i.e = 45 mm total) |
| SET | | | From A.S.N@DESy ( jul 2010 ) mechanical support |
| | Rin | 1818 | 1921 |
| | Rout | 1843 | 1938 Warning : see Ecal Rin |
| | Zout | 2350 | 2428 Warning : partly in the gap |
| VTX | | | Inner meeting@LLR (june 2010) J.Baudot |
| | R & 1/2 length | 16/62.5 | case of 5 layers : single and double sided ladders |
| | | 17.9/62.5 | VTX-SL1= 15/62,5 VTX-DL= 16-18/62,5 |
| | | 37/125 | VTX-SL2= 26/125 VTX-DL= 37-39/125 |
| | | 38.9/125 | VTX-SL3= 37/125 VTX-DL= 58-60/125 |
| | | 58/125 | VTX-SL4=48/125 |
| | | 60/125 | VTX-SL5= 60/125 |
| VTX cryo | | | |
| VTX support shell | | | |
| SIT | | LOI values | From A.S.N@DESy ( jul 2010 ) mechanical support |
| | R & 1/2 length | 165/190 | Rmin-Rmax&1/2length :172,3-179,6/ 354,2 |
| | | 309/330 | Rmin-Rmax&1/2length : 319,5-323,5/657,8 |
| Fdisk | | LOI values | in CAD |

# Dimensions

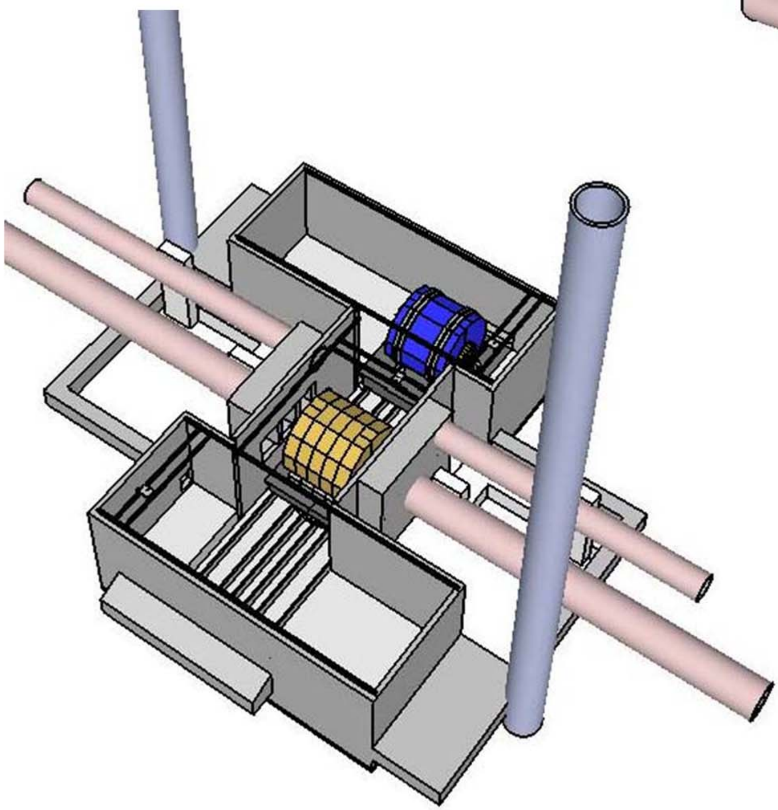
C. Clerc

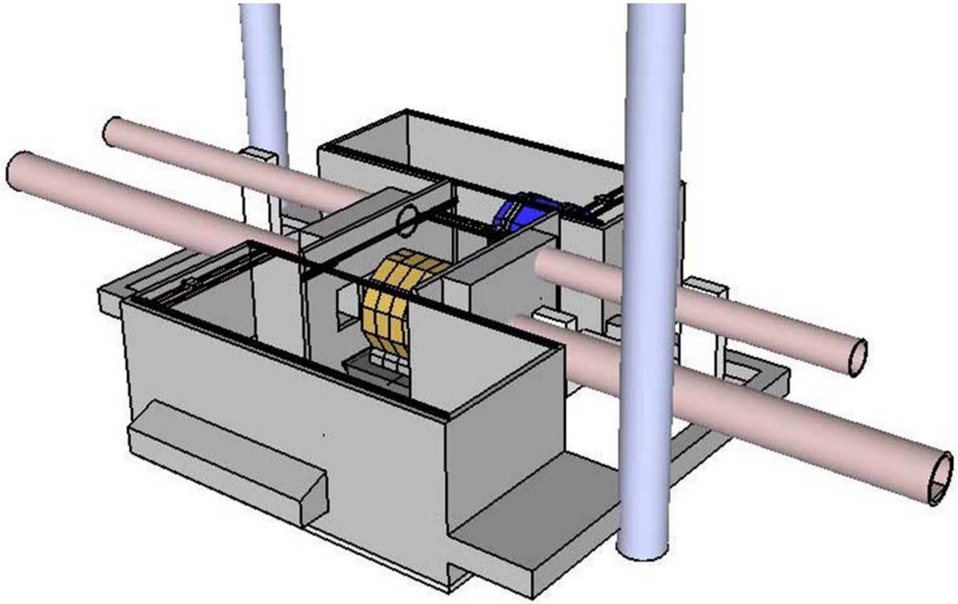
| Fdisk | | LOI values | in CAD |
|---|---|---|---|
| | Z/Rin/Rout/ | 220/24,5/160 | 220/39/169 |
| | | 380/40/160 | 371,3/49,6/169 |
| | | 660/52/304 | 644,9/70,1/308 |
| | | 1070,6/84,4/309 | 1046,1/100,3/309 |
| | | 1481,2/116,7/309 | 1473/130/309 |
| | | 1891,8/149/309 | 1848,5/160/309 |
| | | 2302,5/181,4/309 | 2250/190/309 |
| muons chamber | | | |
| | Layer thick=30mm Fe spacer=100 in the nose part and 400 in endcaps | | |
| | | 1 layer in inner yoke radius | |
| | | 1 layer at outer yoke radius | |
| | | 9 layers inside | |
| | endcap | 1 layer at outerendcap yoke position | |
| | | 10 layers inside st endcap | |

# ILD Dimensions

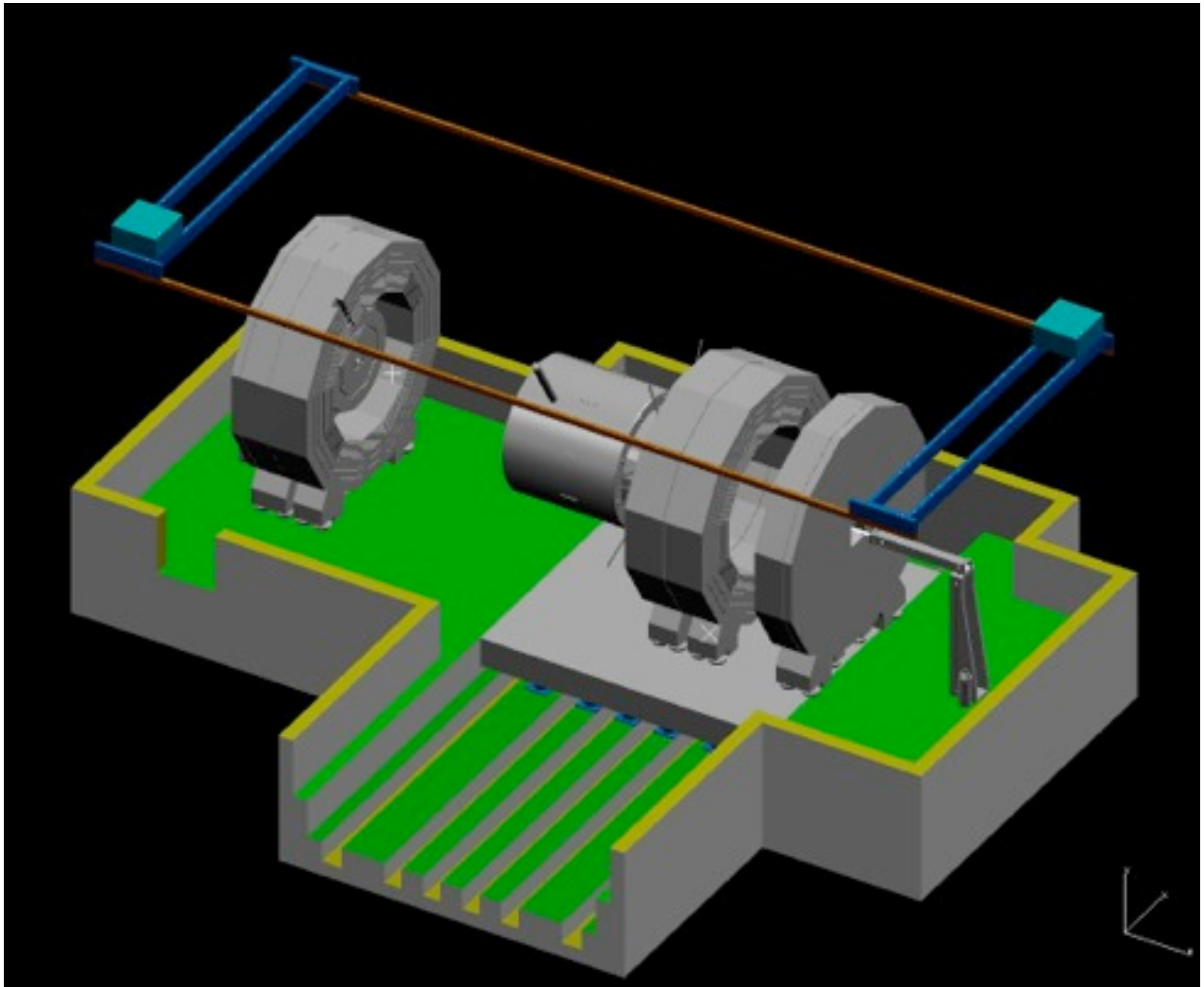
- Need to review values and compare with MOKKA model
- Need to define baseline and options (e.g. ETD, SET,...)
- Agree on placeholders for services

- Please check your subdetector dimensions and help A. Gonnin (LAL) to update the central mechanical CAD model of ILD!



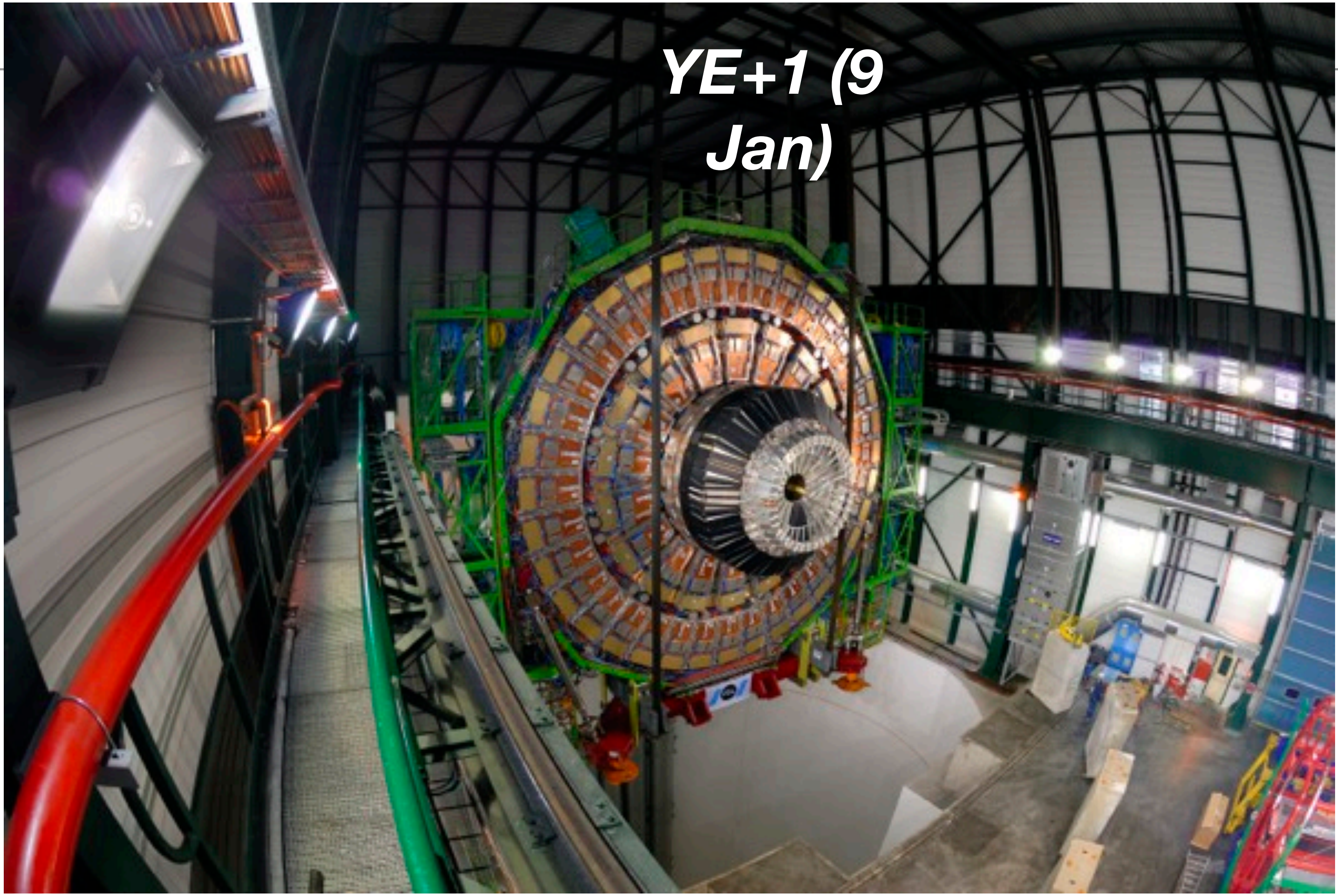


# ILD in Maintenance Region (non-mountain site)



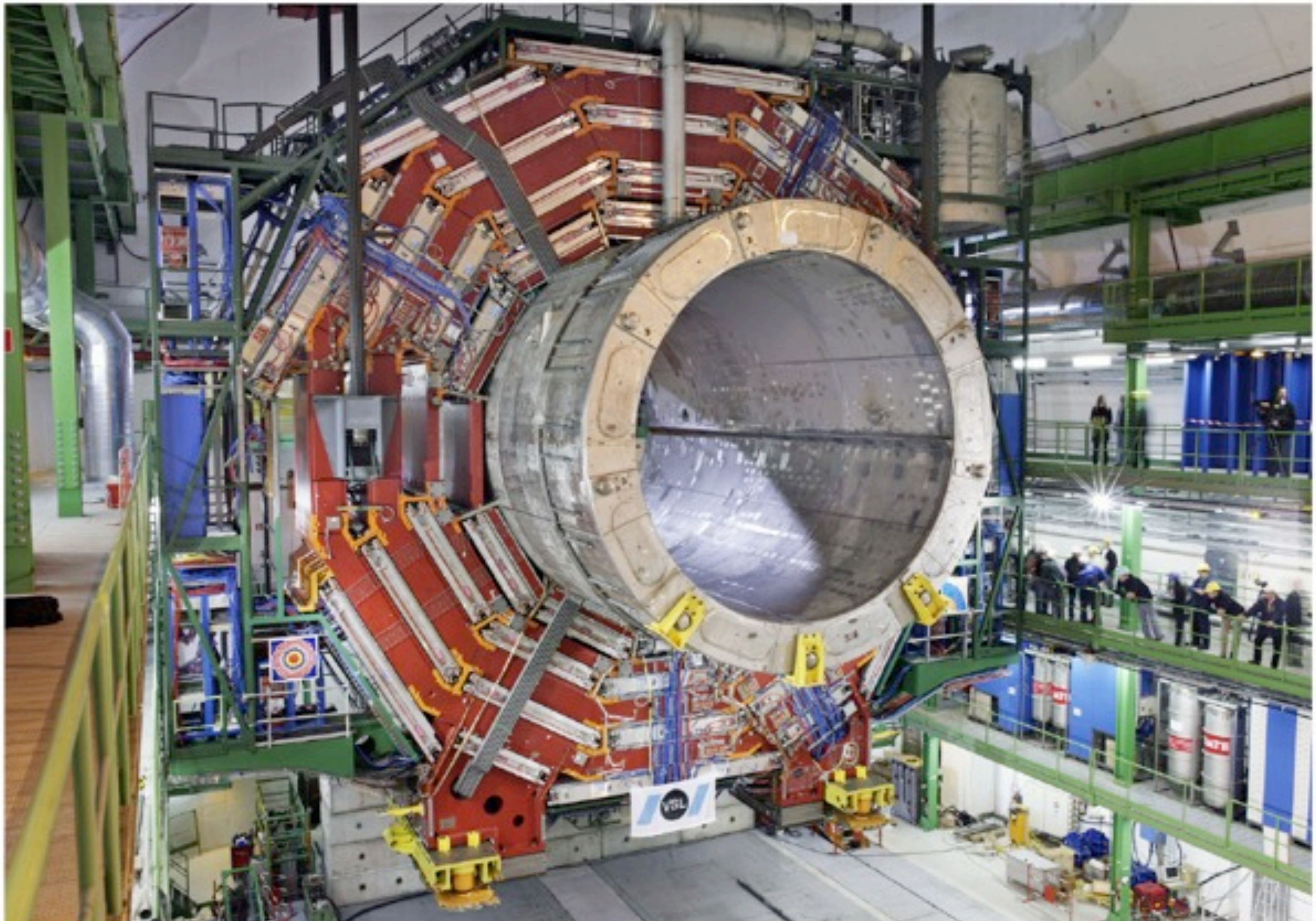
R. Volkenborn

# CMS Assembly




A. Hervé

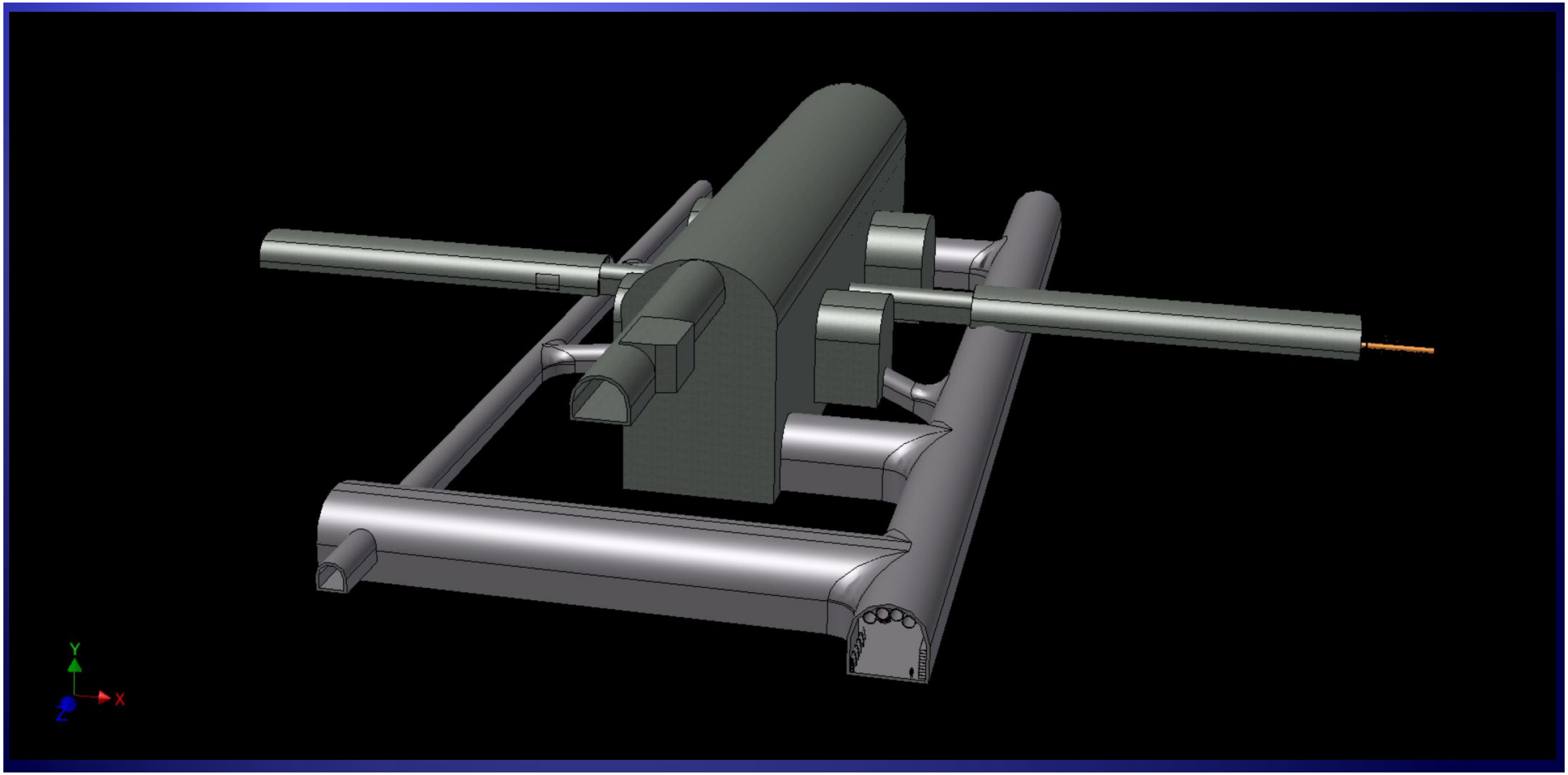
# CMS Assembly




A. Hervé

YB0 landing in the CMS experiment hall

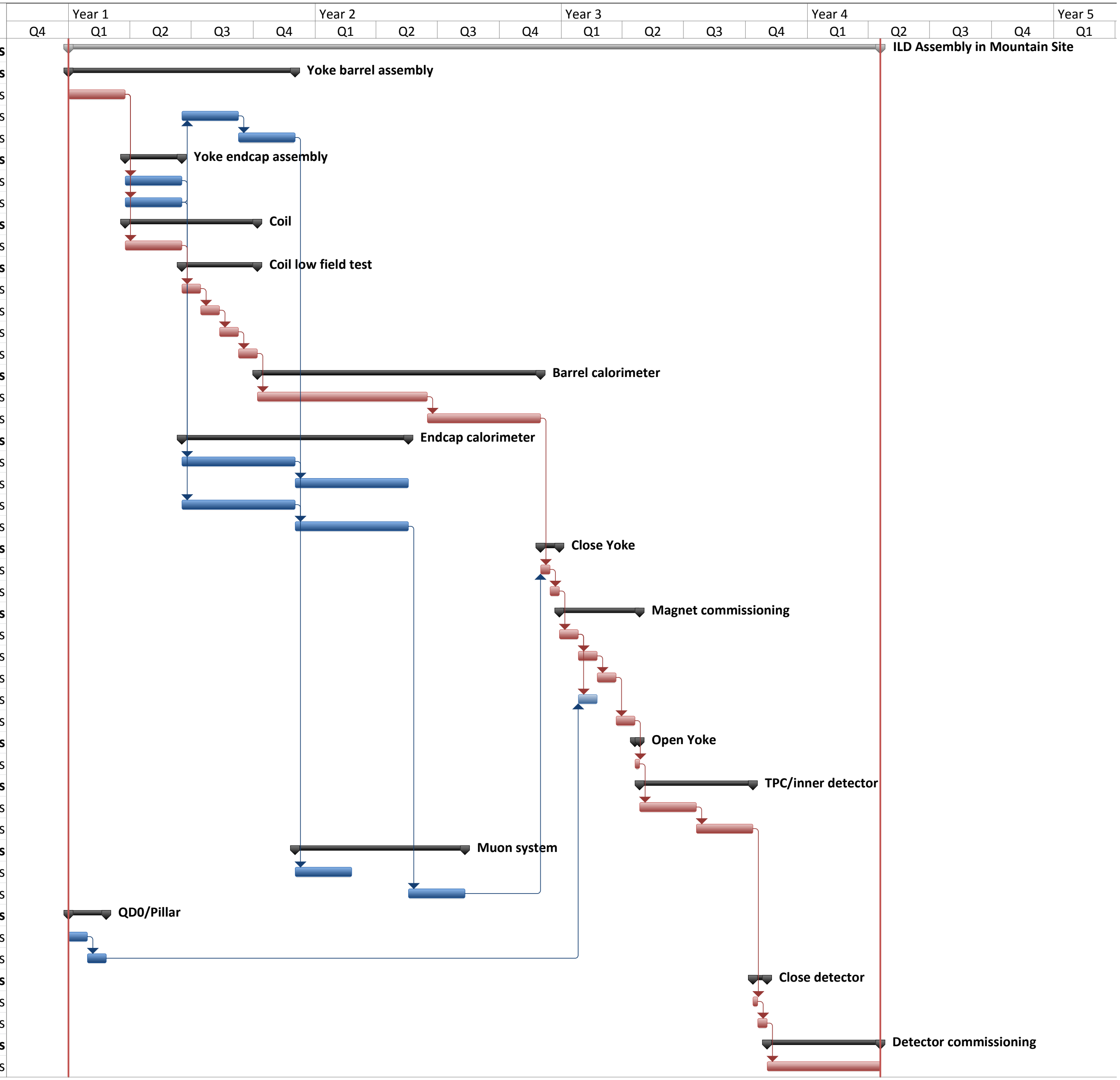
# Japanese Hall Design (Status: 22.03.2012)




G. Orukawa

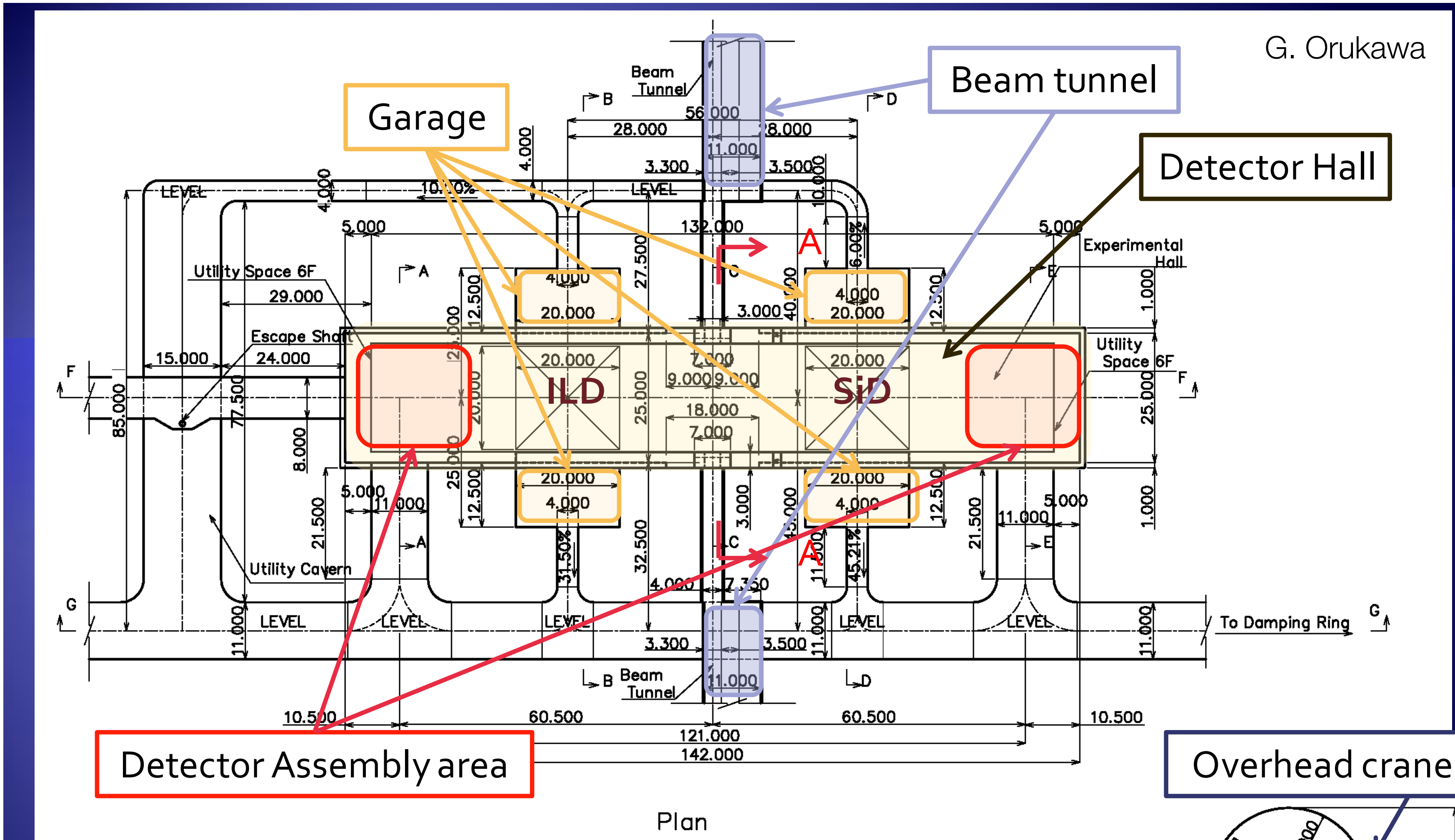
- Enlarged Alcoves
- 142 m long

| ID | Task Name | Duration |
|---|---|---|
| 0 | **ILD Assembly in Mountain Site** | **860 days** |
| 1 | **Yoke barrel assembly** | **240 days** |
| 2 | YB0 | 60 days |
| 3 | YB+z | 60 days |
| 4 | YB-z | 60 days |
| 5 | **Yoke endcap assembly** | **60 days** |
| 6 | YE+z | 60 days |
| 7 | YE-z | 60 days |
| 8 | **Coil** | **140 days** |
| 9 | Coil installation (incl. ancillaries) | 60 days |
| 10 | **Coil low field test** | **80 days** |
| 11 | Cool down | 20 days |
| 12 | Coil test | 20 days |
| 13 | Field mapping test | 20 days |
| 14 | Warm up | 20 days |
| 15 | **Barrel calorimeter** | **300 days** |
| 16 | HCAL barrel assembly/cabling | 180 days |
| 17 | ECAL barrel assembly/cabling | 120 days |
| 18 | **Endcap calorimeter** | **240 days** |
| 19 | HCAL +z endcap assembly/cabling | 120 days |
| 20 | ECAL +z endcap assembly/cabling | 120 days |
| 21 | HCAL -z endcap assembly/cabling | 120 days |
| 22 | ECAL -z endcap assembly/cabling | 120 days |
| 23 | **Close Yoke** | **20 days** |
| 24 | Move YBs | 10 days |
| 25 | Move YEs | 10 days |
| 26 | **Magnet commissioning** | **85 days** |
| 27 | Cool down | 20 days |
| 28 | High field tests | 20 days |
| 29 | Field mapping | 20 days |
| 30 | QD0 testing | 20 days |
| 31 | Warm up | 20 days |
| 32 | **Open Yoke** | **5 days** |
| 33 | Move YEs | 5 days |
| 34 | **TPC/inner detector** | **120 days** |
| 35 | TPC insertion/cabling | 60 days |
| 36 | Inner detector insertion/cabling | 60 days |
| 37 | **Muon system** | **180 days** |
| 38 | Muon chamber barrel insertion/cabling | 60 days |
| 39 | Muon chamber endcap insertion/cabling | 60 days |
| 40 | **QD0/Pillar** | **40 days** |
| 41 | QD0 mounting | 20 days |
| 42 | Forward calorimeters | 20 days |
| 43 | **Close detector** | **15 days** |
| 44 | Close YEs | 5 days |
| 45 | Install QD0/Pillars | 10 days |
| 46 | **Detector commissioning** | **120 days** |
| 47 | Detector commissioning and testing | 120 days |



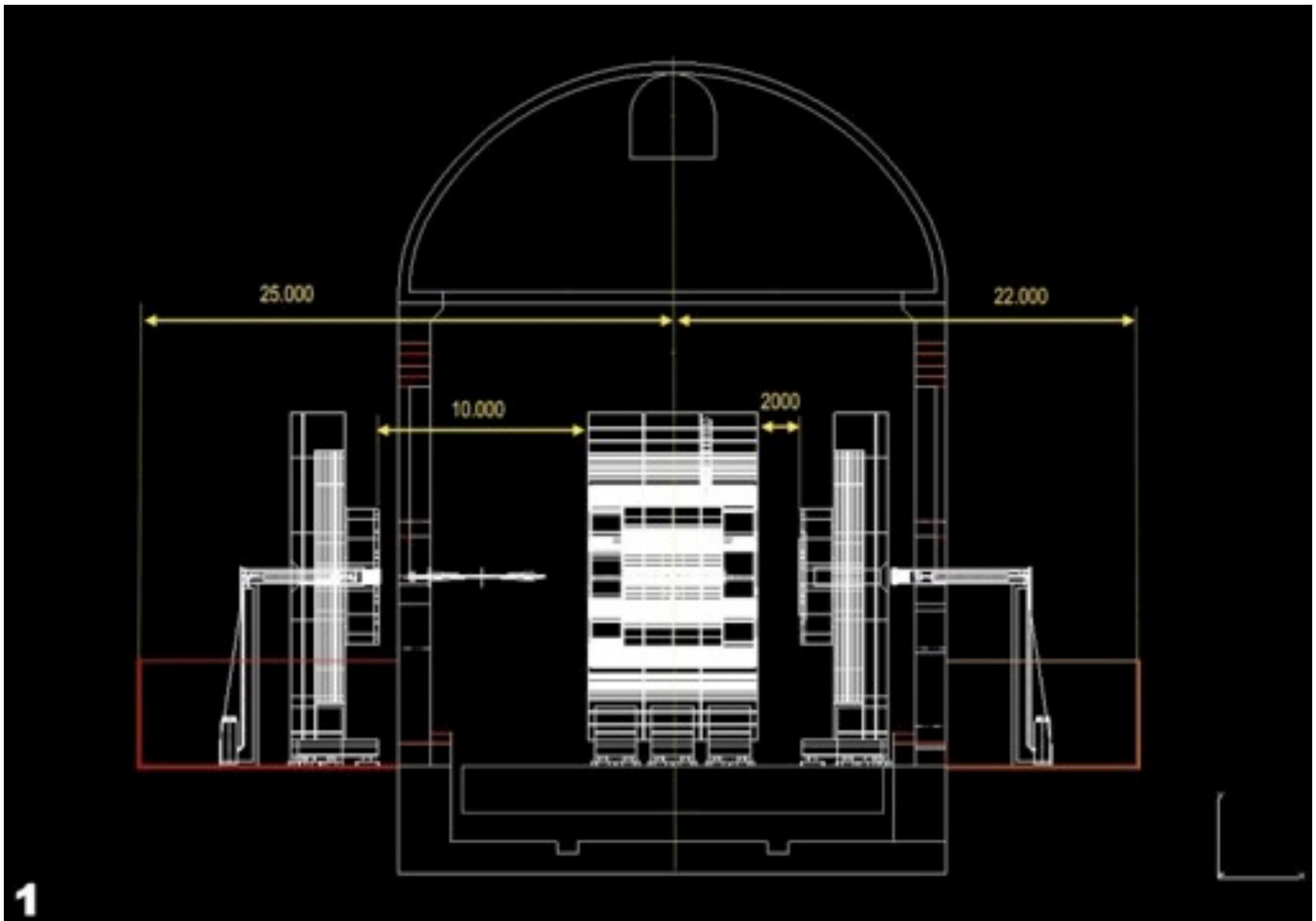
- Critical path is defined by central detector construction:
  - central yoke ring, coil, barrel calorimeter, TPC, inner detector
- Will have several coexistent major „construction sites“ at the same time in the underground hall:
  - barrel part, both endcaps
  - consecutively: two other barrel yoke rings, QD0 pillar, forward calorimeter
- Time estimate: 3.25 years
- But: need sufficient underground space!
- There are remaining open questions:
  - how does the crane and transport capacity interfere with this plan?
  - when will the cryo services underground be ready (coil test)?
  - ...

# Japanese Hall Design (Status: 22.03.2012)



# Maintenance Position (ILD Study)

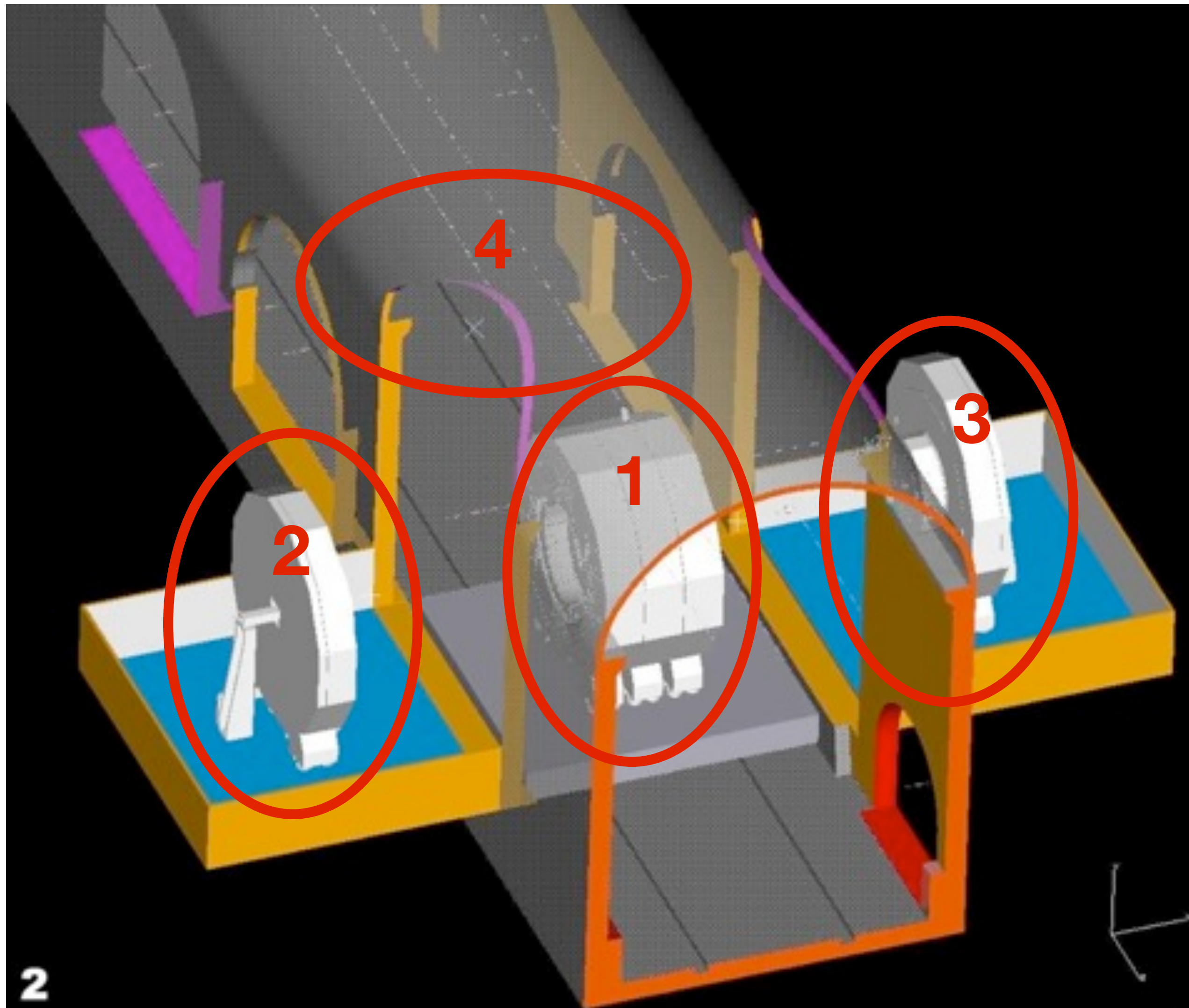
- Alcoves needed to open the detector for maintenance




R. Volkenborn

# Underground Construction Space (ILD Study)

- Need several assembly areas in the hall
- Studies on space, transportation and time requirements are on going

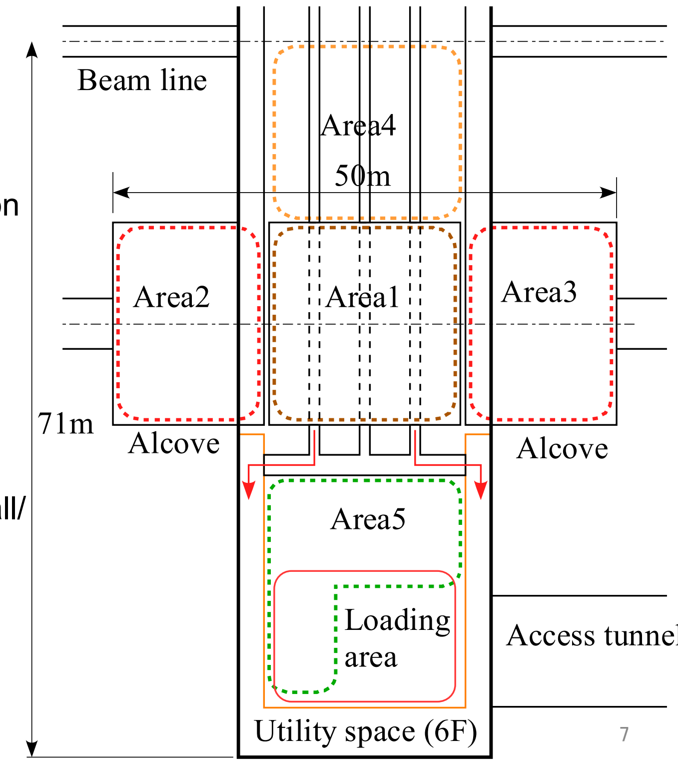



R. Volkenborn

# ILD Installation Study (Preliminary)

## Detector assembly area

- Area 1: Platform
  - YB0 assembly
  - Barrel detectors installation/cabling
  - Endcap calorimeters installation
- Area 2/3: Alcoves
  - Endcap calorimeters cabling
  - QD0 support tube assembly
  - FCAL install/cabling
- Area 4: Tentative platform on beam line side
  - YE, YB+, YB- (iron yoke and muon detector) assembly/install/cabling
- Area 5: Loading area side
  - HCAL rings assembly
  - Tooling assembly
  - Storage area



# ILD Installation Study (Preliminary)

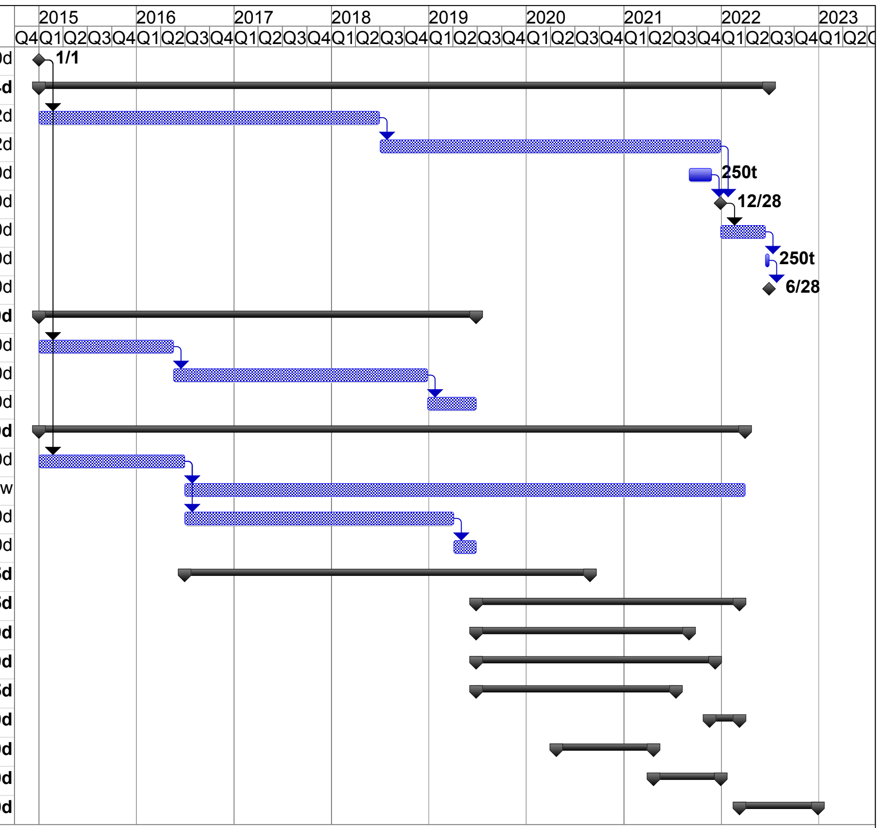
- Installation studies are still work in process
- Cross-checks with 3D models are yet to be done
- Implications of common infrastructure use (access tunnel, cranes) not studied yet
  - Might need buffer space

- Clearly: installation of ILD in the mountain site hall is a challenge!

# ILD Time Line Study

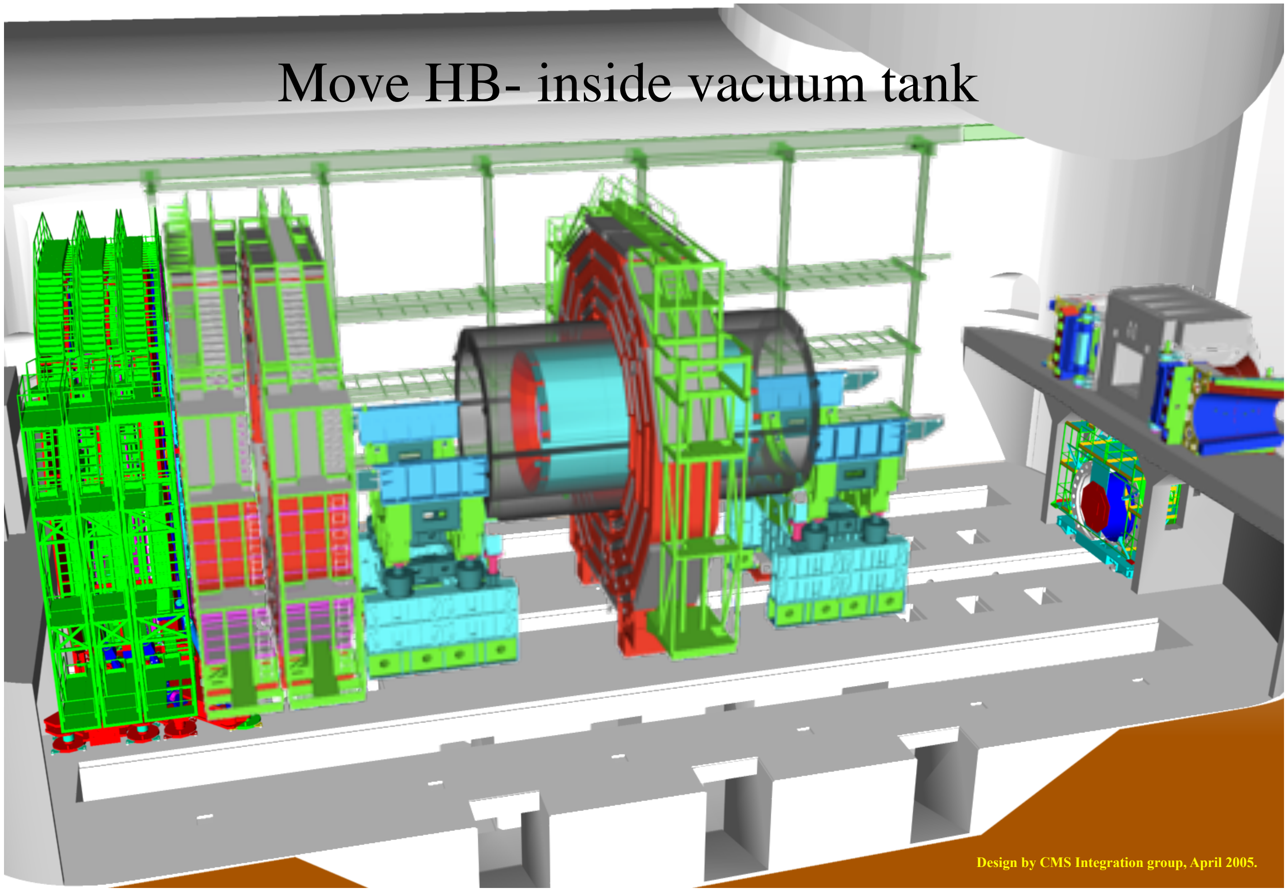
Y. Sugimoto

| ID | | Name | Duration |
|---|---|---|---|
| 1 | | Ground breaking | 0d |
| 2 | | **Beam lines construction** | **1954d** |
| 3 | | Tunnel | 912d |
| 4 | | Beamline harware install | 912d |
| 5 | | Beam line shield | 60d |
| 6 | | Start of beam commissioning | 0d |
| 7 | | BDS pre-commissioning | 120d |
| 8 | | Shield removal | 10d |
| 9 | | BDS ready for detectors | 0d |
| 10 | | **Experimental Hall** | **1170d** |
| 11 | | Access tunnel | 360d |
| 12 | | Cavern | 680d |
| 13 | | Services | 130d |
| 14 | | **Detector construction on surface** | **1890d** |
| 15 | | Surface assembly hall | 390d |
| 16 | | Detector assembly on surface | 300w |
| 17 | | Solenoid construction | 720d |
| 18 | | Solenoid surface test | 60d |
| 19 | | **Yoke pre-assembly** | **1085d** |
| 25 | | **Detector assembly in cavern** | **705d** |
| 26 | | **Yoke assembly** | **570d** |
| 38 | | **Solenoid** | **640d** |
| 49 | | **Barreal detectors** | **535d** |
| 64 | | **Barrel inner detectors** | **80d** |
| 67 | | **Endcap detectors** | **260d** |
| 76 | | **QD0/FCALs install/cabling/test** | **180d** |
| 82 | | **Commissioning** | **210d** |

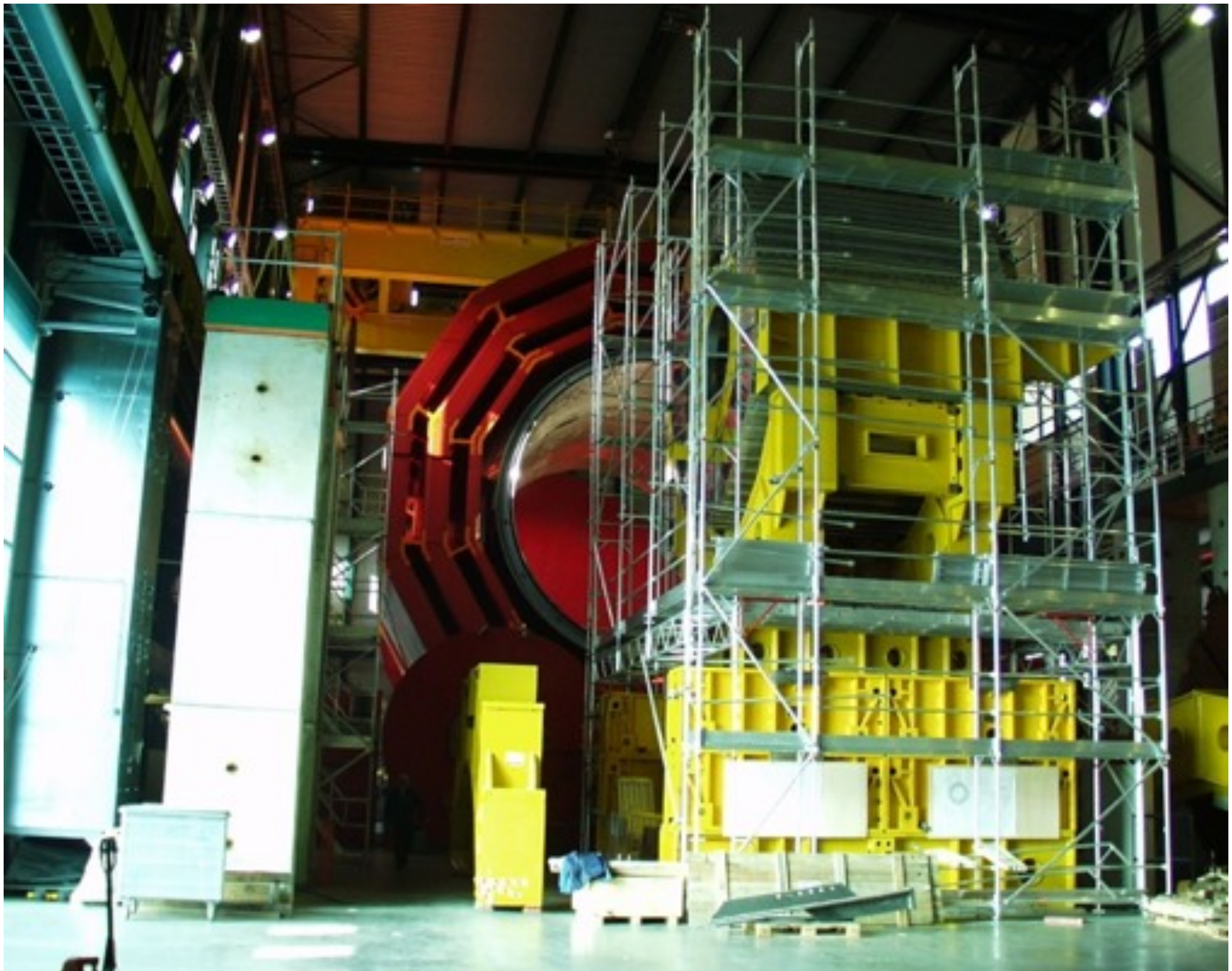



- Total construction time: ~8 years
- Detector underground construction: ~3 years

# CMS Assembly - Tooling



# CMS Surface Assembly Hall



# Summary and Outlook

- The mechanical and electrical model of ILD gets more realistic
- Some deviations between subdetector models and central model exist
- Some deviations between mechanical model and MOKKA model exist
  - Probably with littel impact (if any) on the physics

- Integration of ILD in the experimental hall is a major issue (cost drivers)