# ILD integration studies

Catherine Clerc, LLR-In2p3-Ecole polytechnique

MDI integration meetings frequency since February : each months, face to face

*Huge amount of work⇒in this presentation : focus on integration studies.*

- Recent progress of some subdetectors groups on integration studies:
  - Yoke
  - Calorimeters
  - TPC
  - Inner detectors

  *Taking into account specificities of a mountain site : access, available space, seismic considerations..*

- Services and patchpanels : highlight on inner part
- 3D CAD model status

- Conclusion(s)

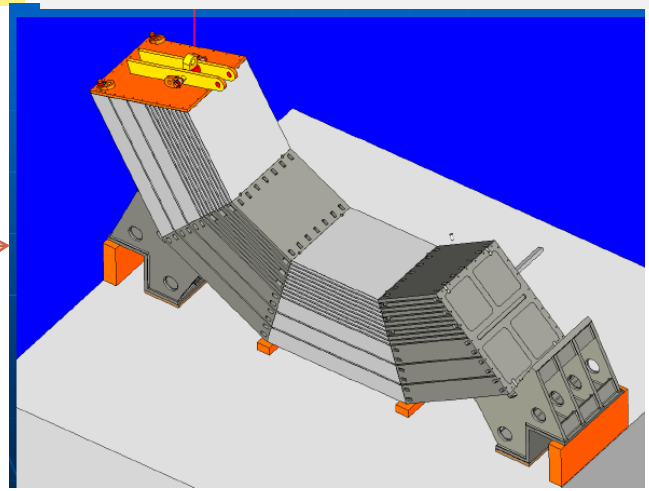
# Return Yoke, endcaps Yoke and Coil installation :

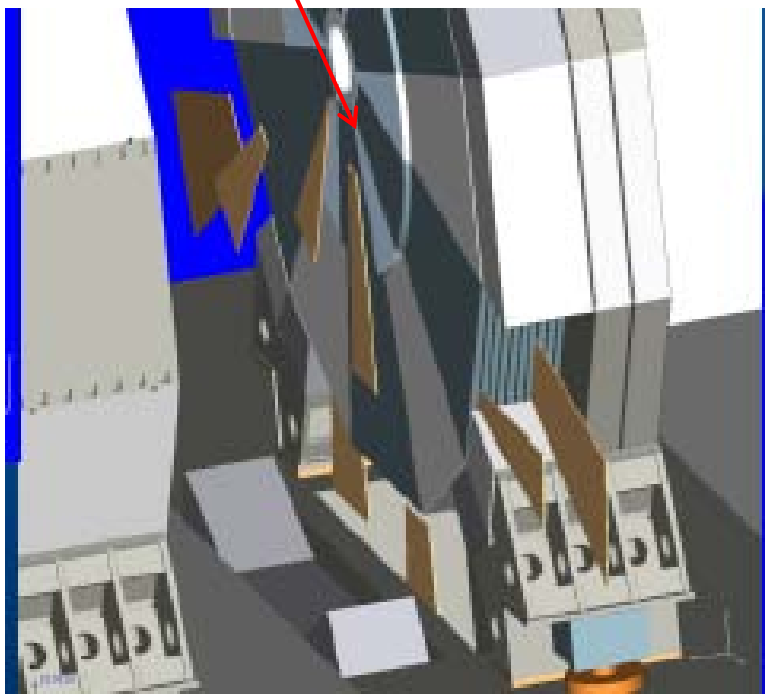
*From R.Stromhagen ( DESY)*

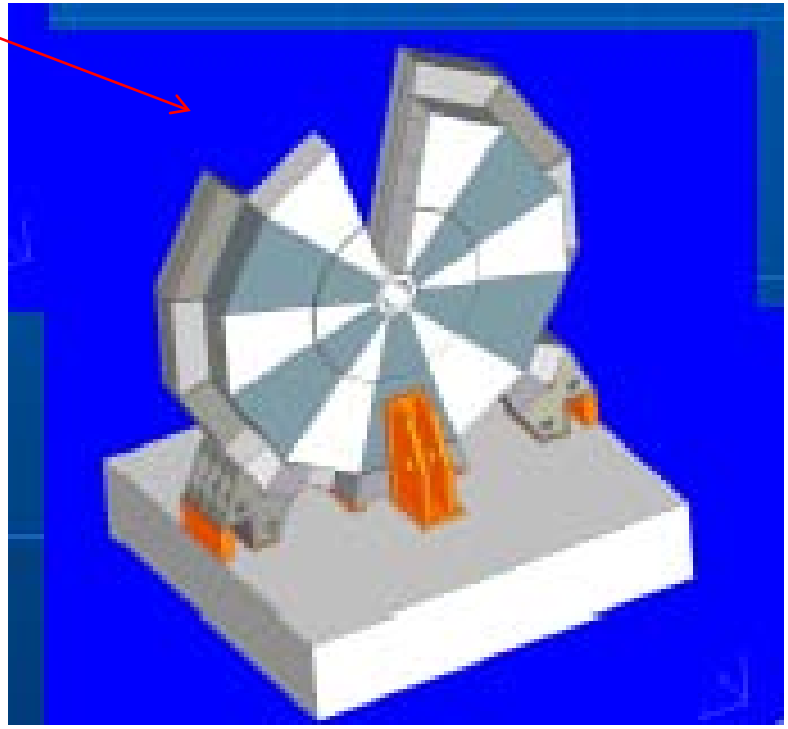
*Structure if Yoke is the same whatever the configuration of the site is*

Detailled studies of the building of :

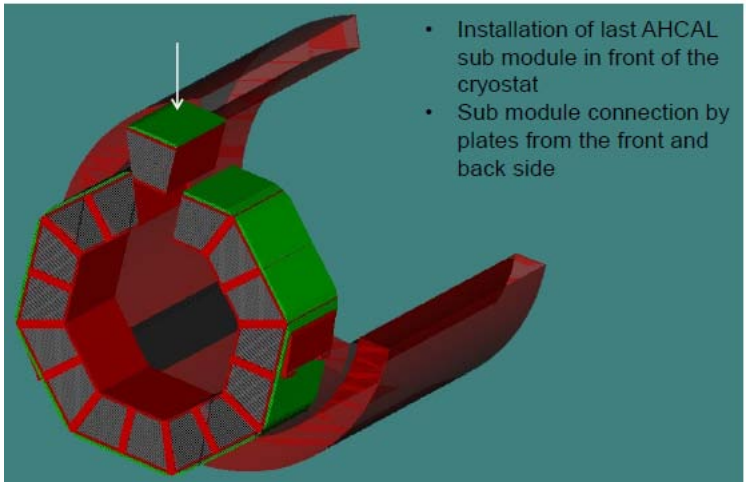
- return Yoke rings
- Endcaps
- Muons chambers insertion...

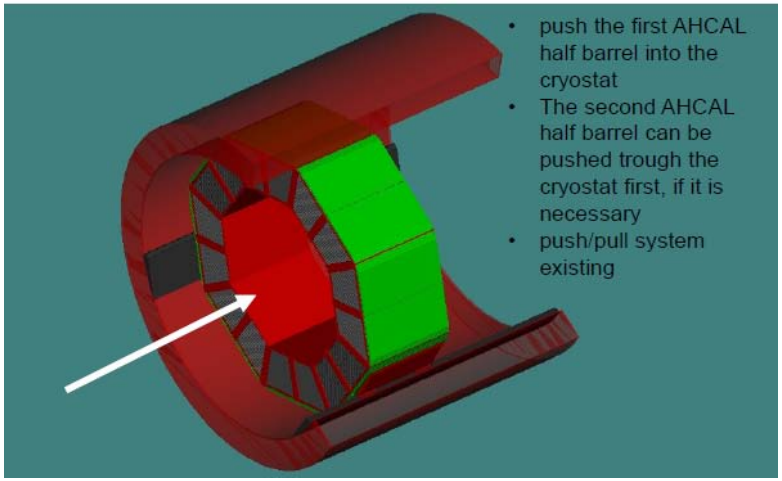


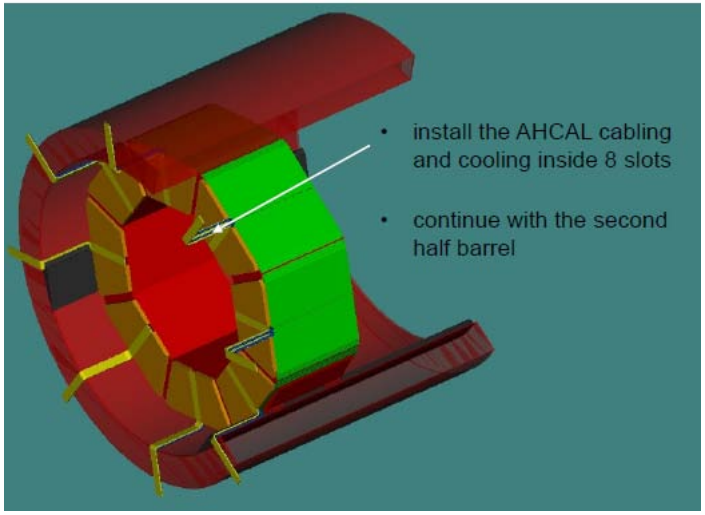




# AHcal integration sequencies

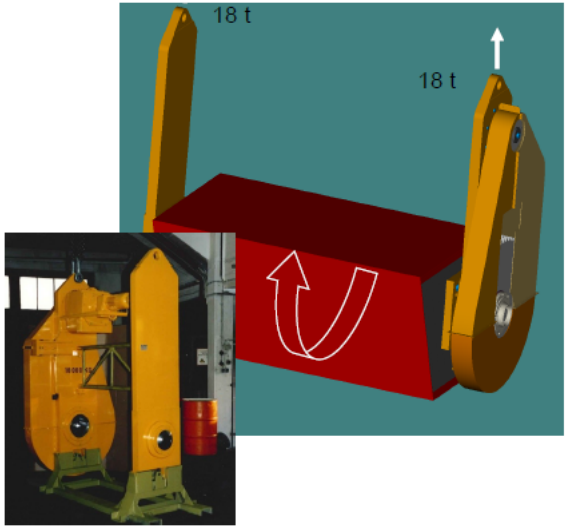


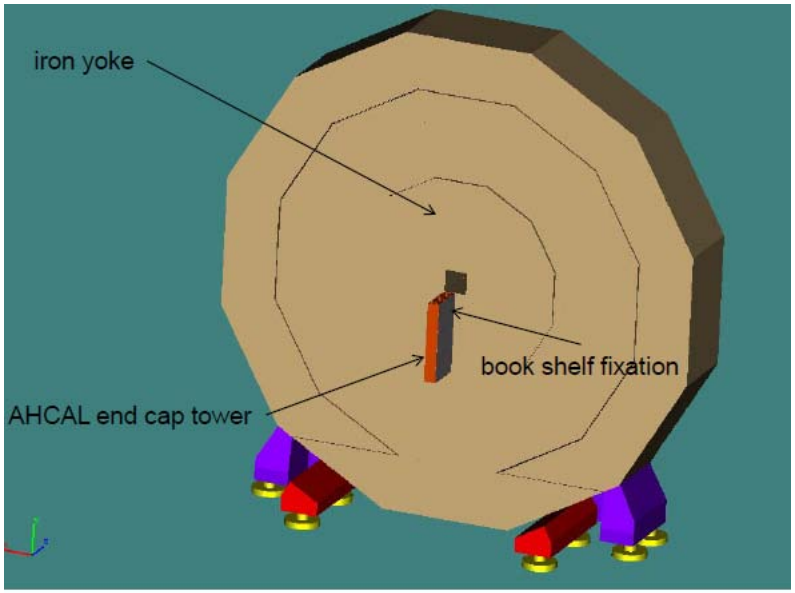

*From K.Gadow( Desy)*

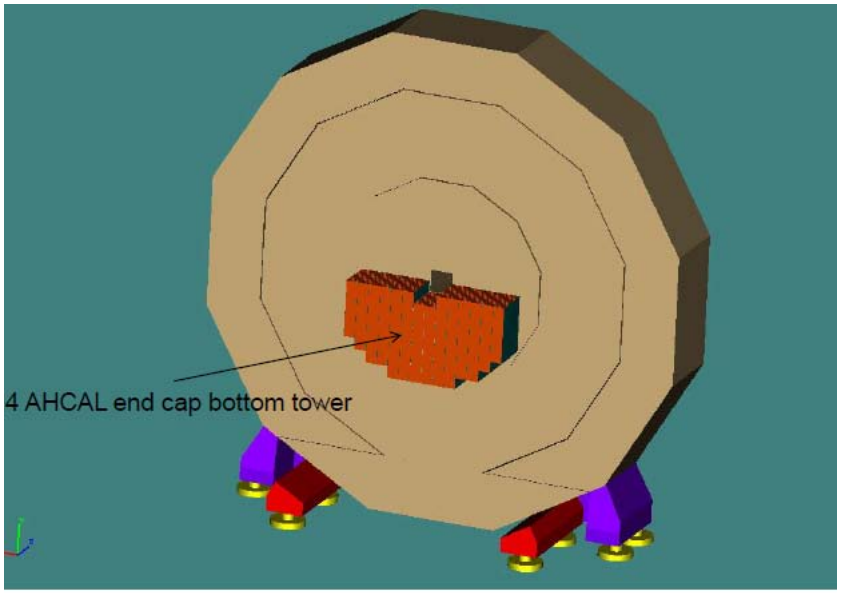
## Integration tooling

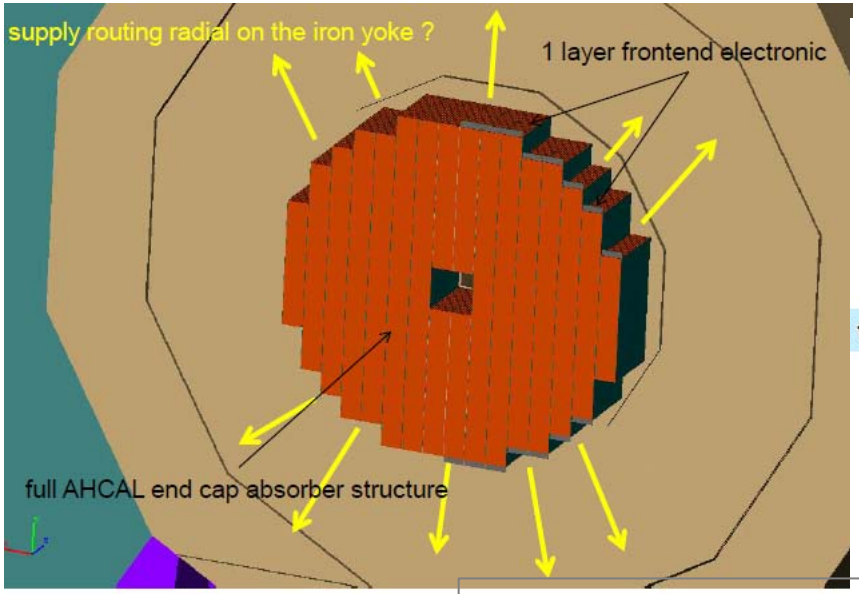


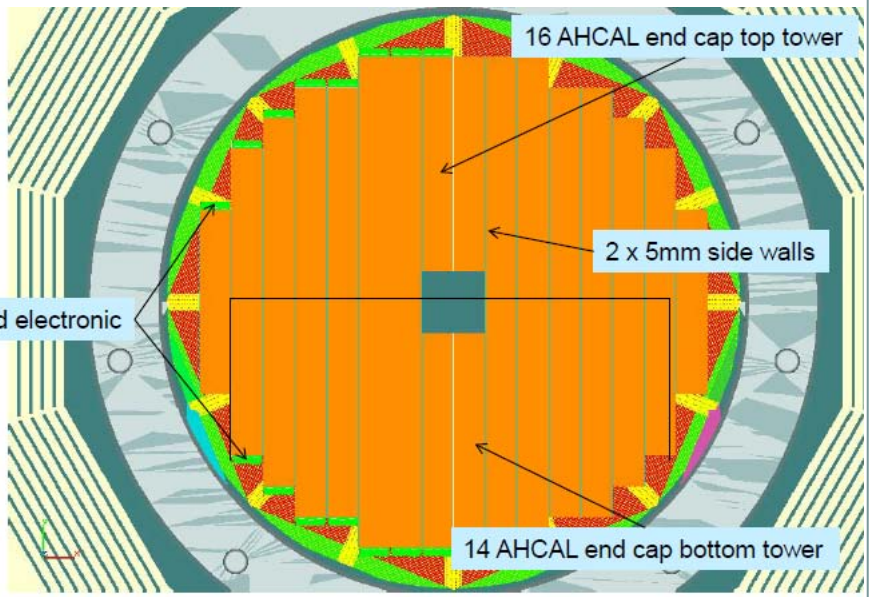

- lifting and turning tool for AHCAL barrel absorber sub-modules available
  - 2 x 18 t capacity
  - operation with 2 hooks (z angle adjustment)
  - precise motor controlled turning
  - design for adaptation for sub-modules with and without sensitive layers started
- mounting, support and insertion frame
  - one frame for everything
  - design depends on installation procedure
- push and pull tool available
  - must be modified to the rail distance and rail shape/size

# AHcal integration Endcaps studies



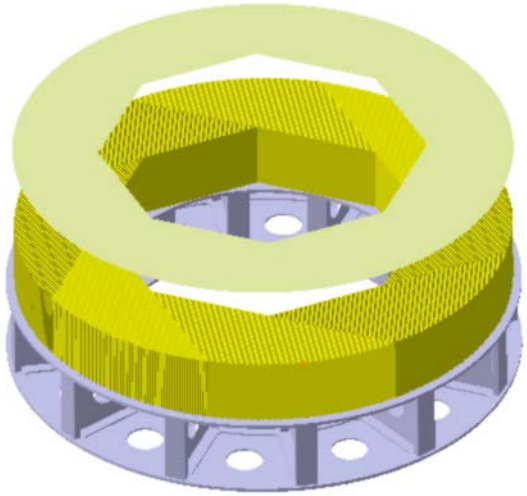



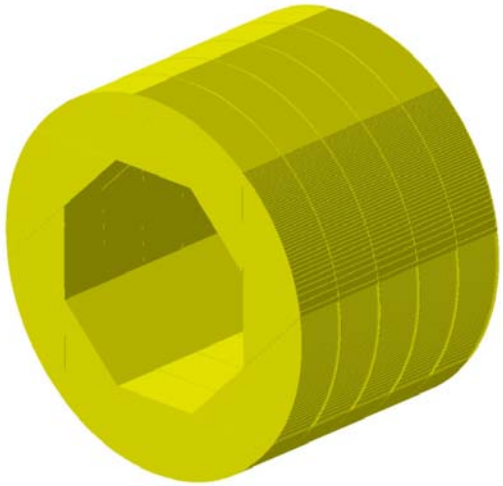

*From K.Gadow ( DESY)*

# SDHcal integration studies : the 5 wheels concept .

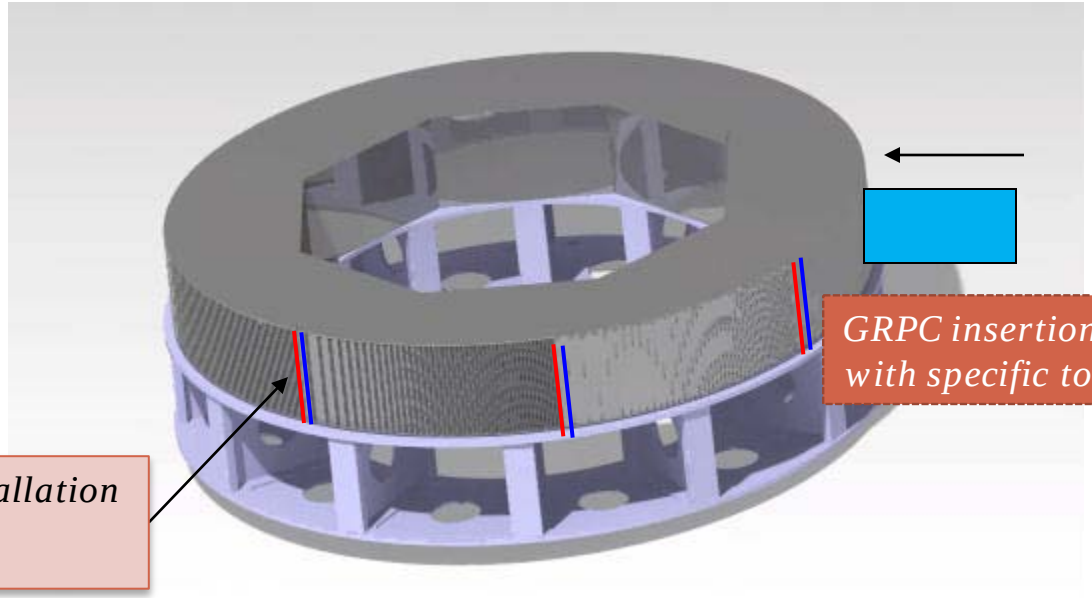
**Building SCENARIO :**

- 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





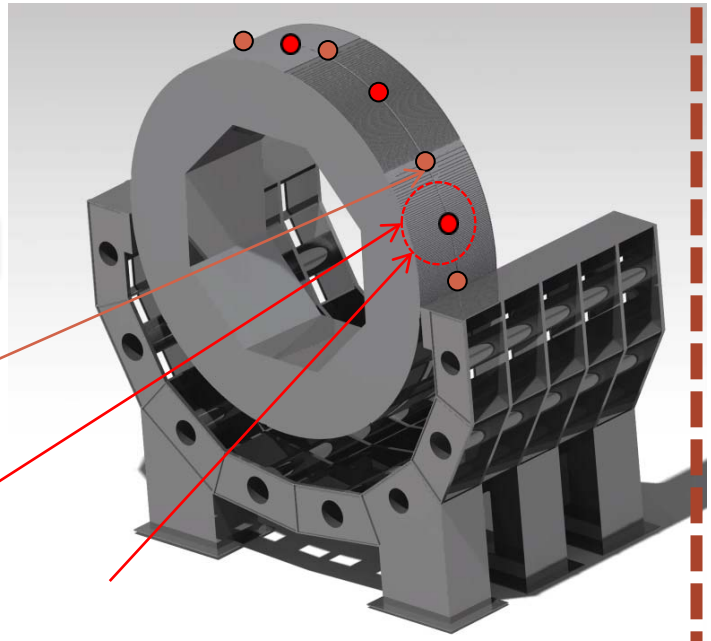
GRPC insertion




*From J.C.Ianigro (IPNL)*

# SDHcal integration, Barrel installation .

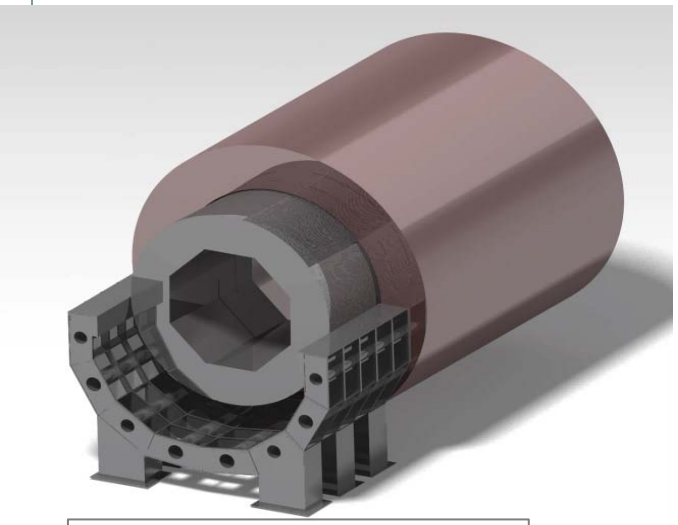
## Bolting of the 5 wheels



*Wheels carried one by one - P=200 t*

*services connection in 8 zones*

*Wheels linked together by bolting on 8 points*

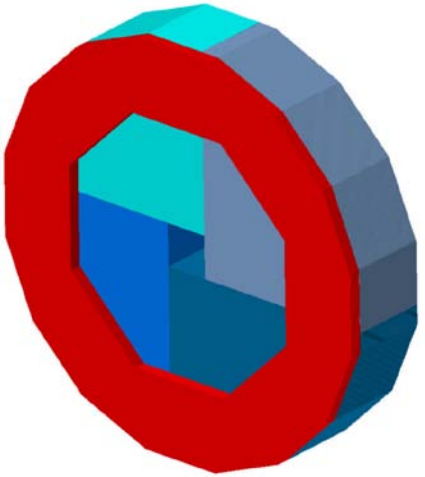


*From J.C.Ianigro( IPNL)*

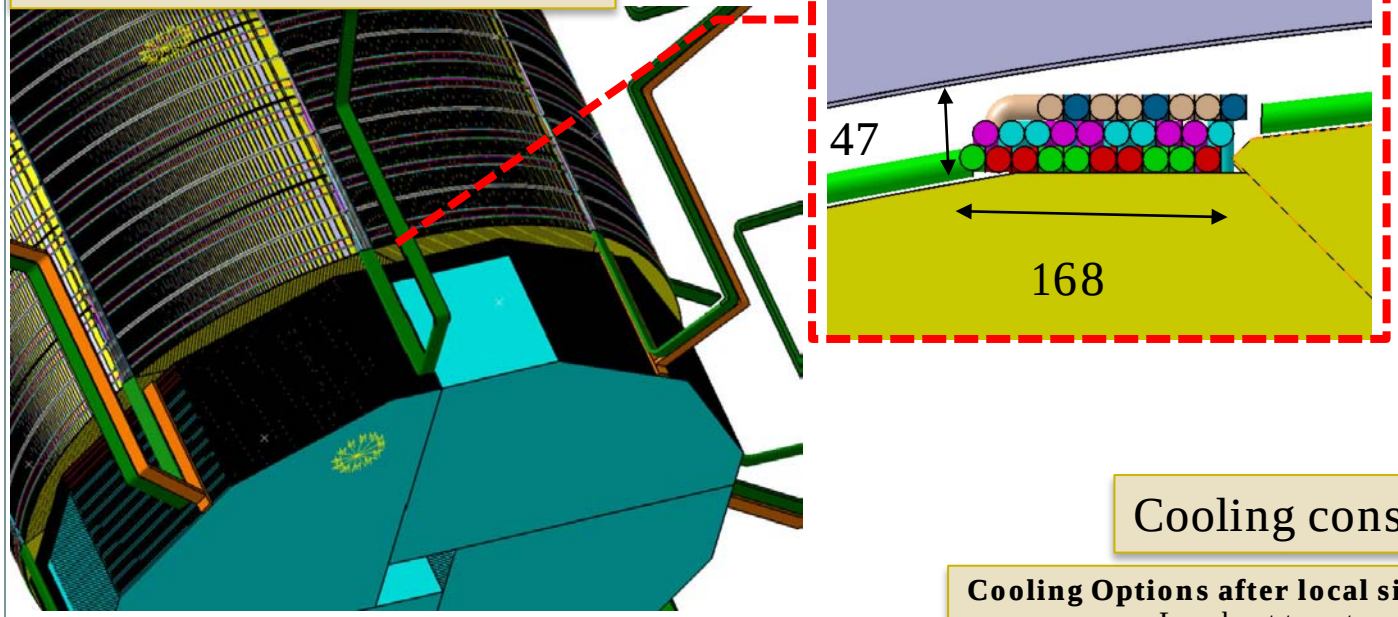
Insertion in the coil with a insertion tool «  à la CMS «

# SDHcal integration, endcap, services.

Each endcap of 4 modules + Endcap rings ( red)



## Services distribution




## Cooling considerations

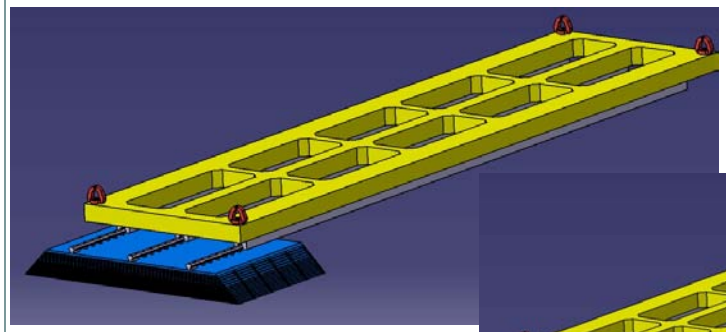
**Cooling Options after local simulations**

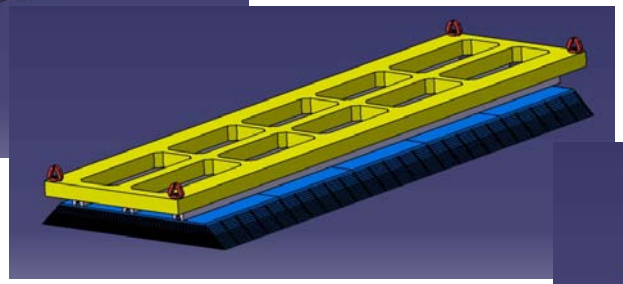
Low heat to extract: 0.3 W/m² for GRPC

**Leak-less water cooling** or
**Bi-phasic gas** like CO2 : High Pressure (100 bars),

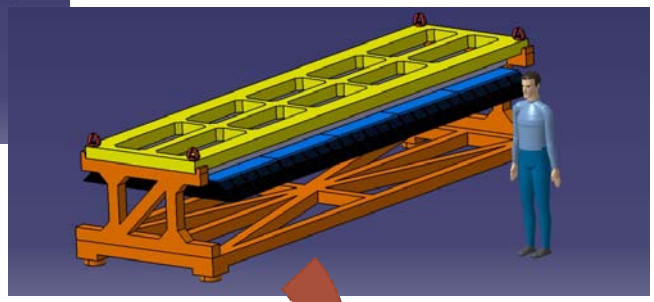
*From J.C.Ianigro (IPNL)*

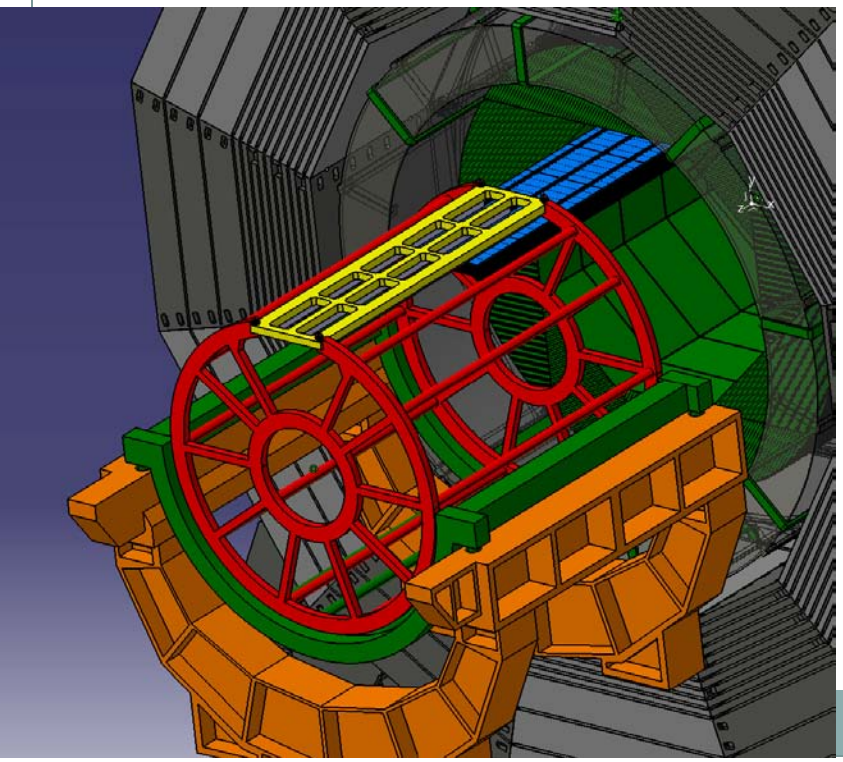
# Ecal integration scenario ( Barrel)





*From One stave*





*To full barrel …*

*From M.Anduze( LLR)*

| Task | Description / constraint | | tooling | FTE | Time |
|---|---|---|---|---|---|
| 1 | Handling of 1 ( over 40) module. Weigth :1 t | repeated 5 times | Scraft, table | 2 T | |
| 2 | Alignment | | | | 9 days |
| 3 | Module 1 in position on frame | | | 2T | |
| 4 | Stave 1 and its frame on the support structure | | | | |
| 5 | Insertion of 375 slabs per stave. 1 Slab =10 to 15 kg alignment within alveola = 500 µm over 1.8 m | | | 2 T | |
| 6 | Electrical connections up to LDA boards | | | 2 T | 2 weeks |
| 7 | Cooling blocks ( 5) up to Module edge, over LDA up to main distribution line position | | | 2 T | |
| 8 | Electrical and cooling distribution lines on top of the stave | | | | |
| 9 | Tests ( electronic and signal) | | | 2 T part-time | 2 months |

*to be repeated 8 times.*

Some parts can be done in parallel
(depends on the available manpower, because not the same qualification) :
Tasks 1-4 of stave (n+1) and Tasks 5 to 9 of the stave (n)

*Needed space :*

For a stave assembly : 7*4 m²
Per Beam , for storage : 6*3 m²

*Stave ( fully equipped)+ frame + support*

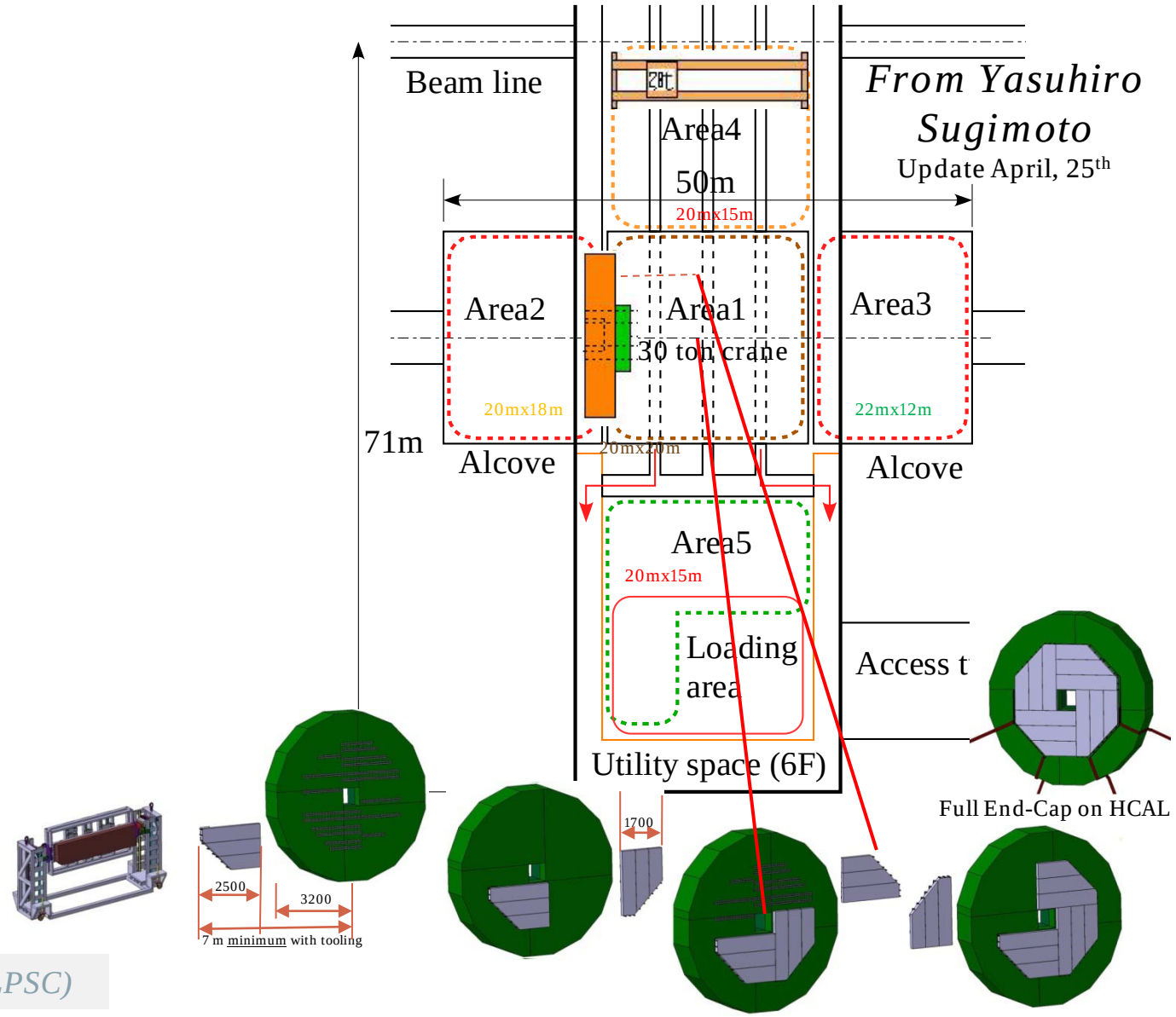
about 12 t

ILD MDI session, Kyushu University 21 May 2012

These studies include estimation of :

- the timescale ( assembly hall and experimental area
- Manpower
- Needed space for Assembly, test, storage & integration work
- Tooling

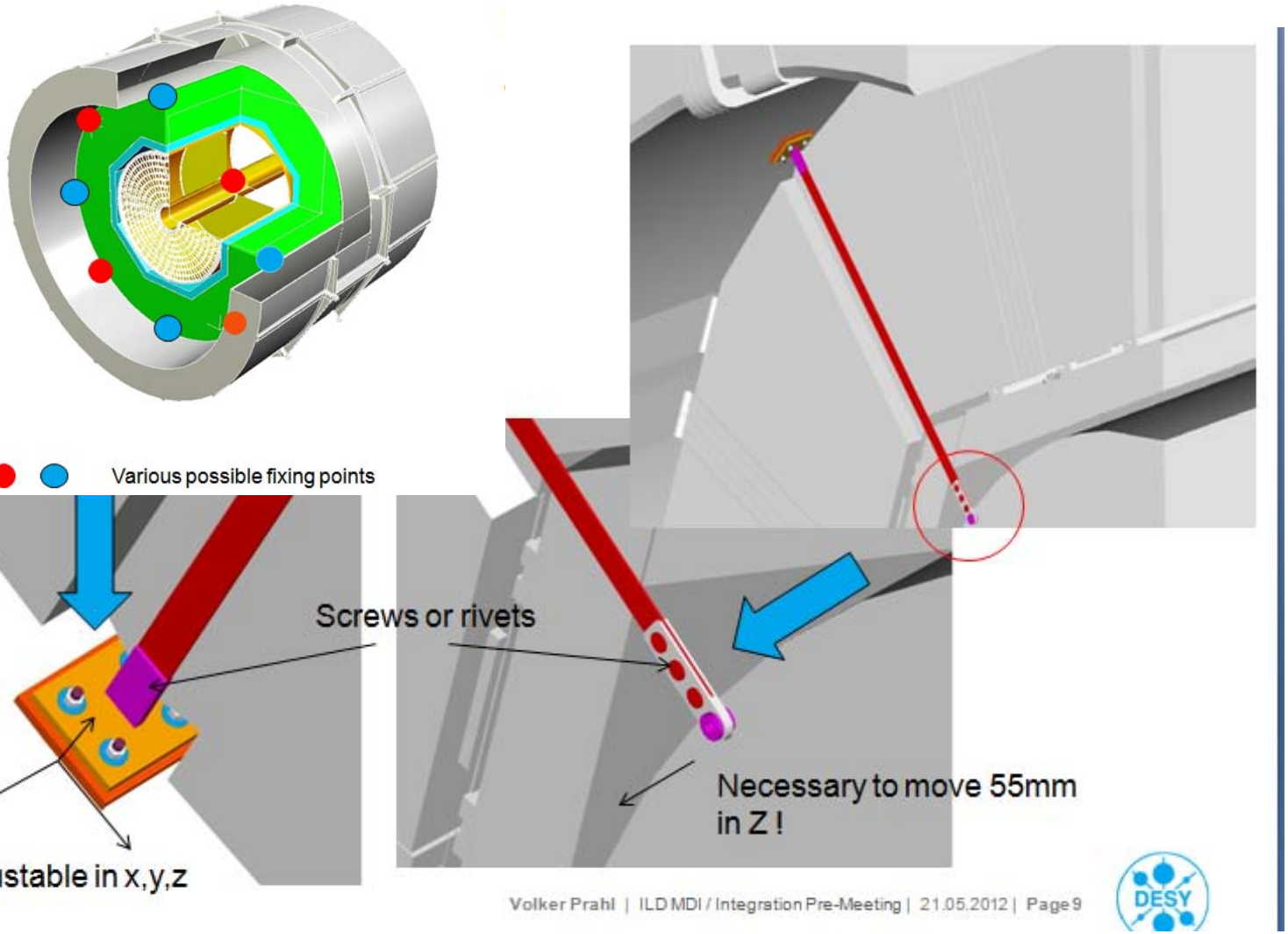
# Same studies for the endcaps




*From D.Grondin ( LPSC)*

# TPC, support structure studies

4 cantilevers arms or ropes from Coil Cryostat
Detailled design under study ( Bar support or Flat Ribbon):



# Overview of an first idea of the HV-cable routing

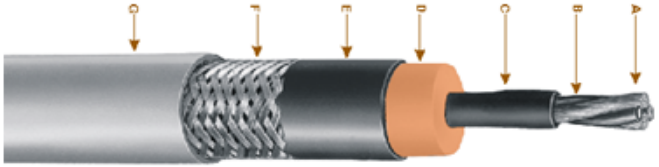
## HV Cable and routing

### Samples of HV-cables

Okonite Hi-Voltage Cable: www.okonite.com

100kV, od= 16,76mm,

bending radius = 4*od > 70mm



**A** Coated Stranded Copper Conductors
**B** Polyester Insulation
**C** Extruded Semiconducting Layer
**D** Primary Insulation – Okoguard
**E** Extruded Insulation Shield
**F** Coated Copper Braid
**G** Jacket – Okoseal

Heinzinger HVC100 Best. No.:00.220.853.9 www.heinzinger.com

100kV, od= 14mm, bending radius min. 280mm!

FUG C 2124, Mat.- No.: 0502032124

http://www.fug-elektronik.de/webdir/PDF/e/Access_data_sheet.pdf

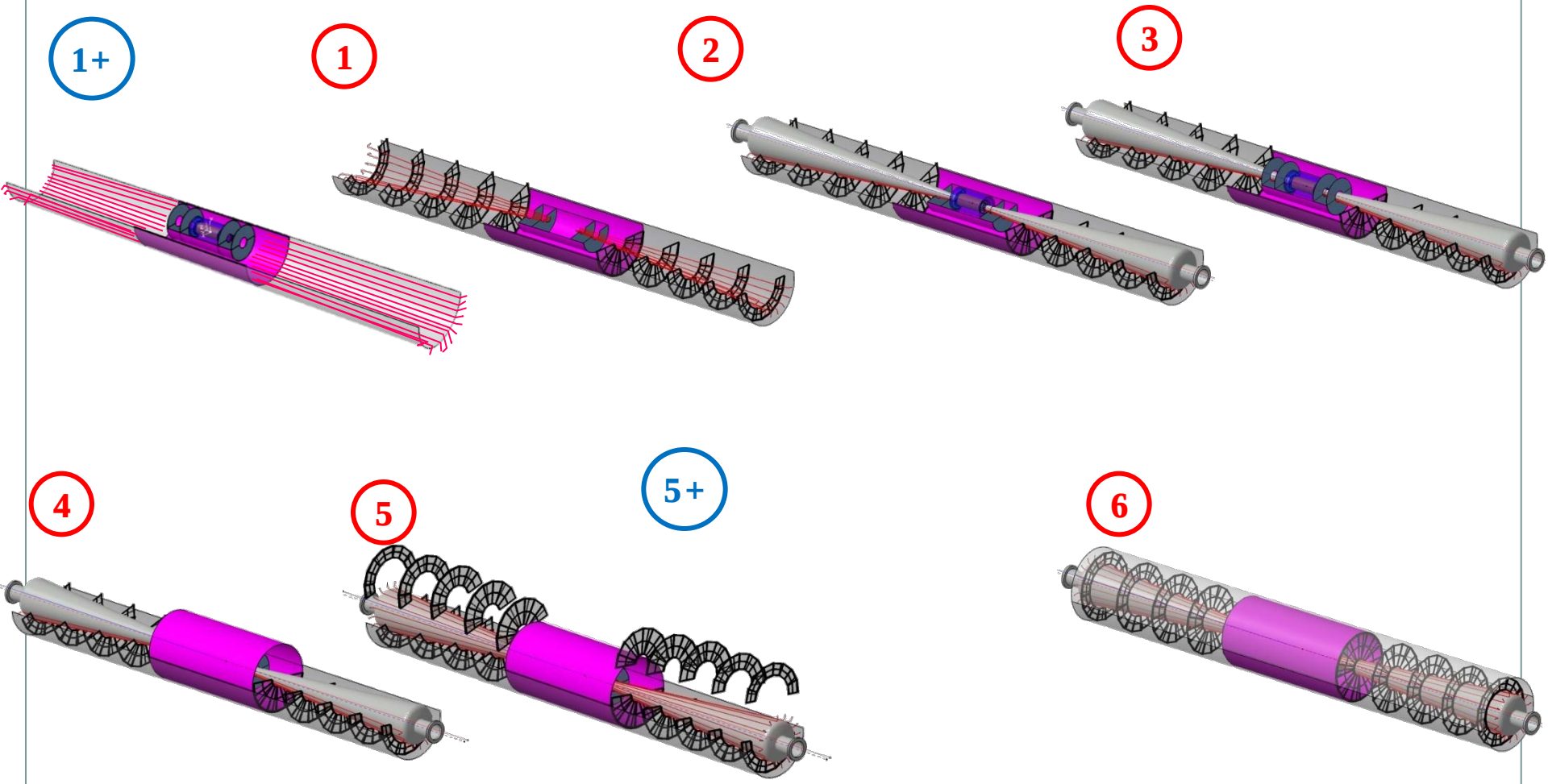
100kV, od= 11,2mm, bending radius min. 152mm

Cross section of the HV-cable: 255-300mm$^2$ necessary

Volker Prahl | ILD MDI / Integration Pre-Meeting | 21.05.2012 | Page 14

DESY

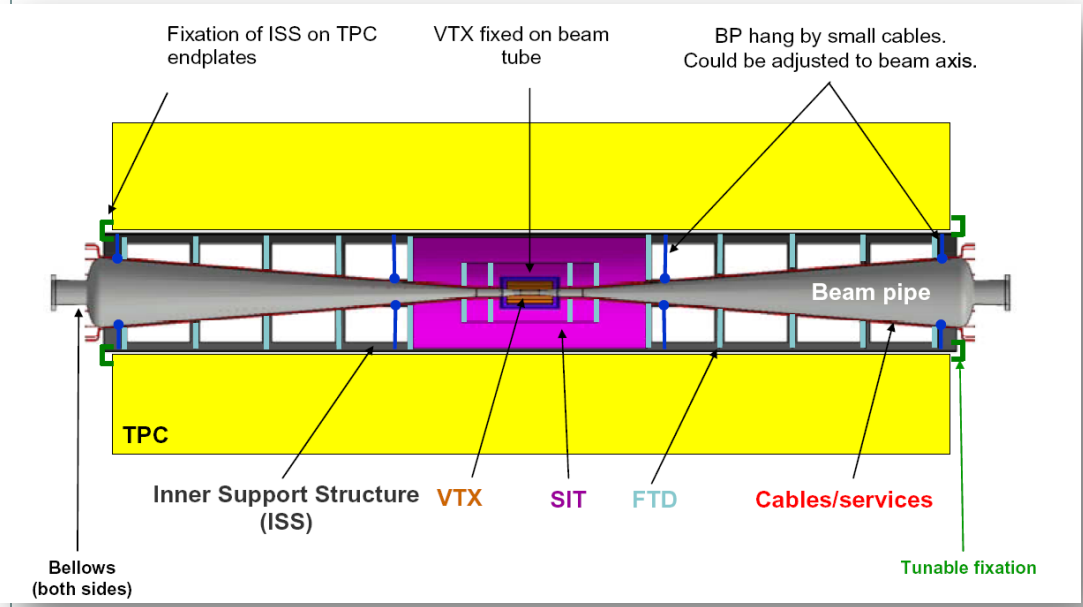
- **Assembly procedure :**

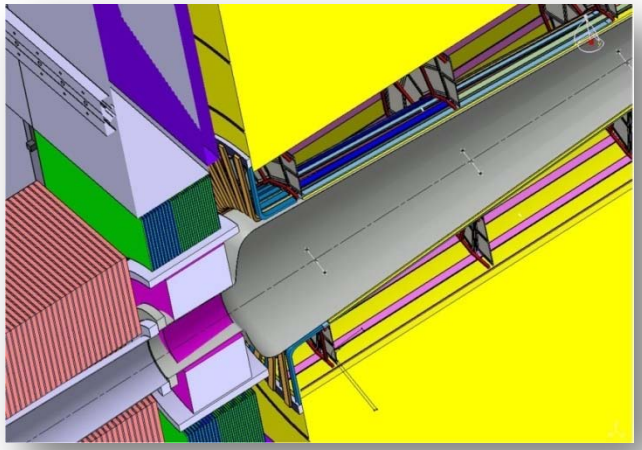



*From A. Gonnin & C. Bourgois(LAL)*

# Inner detector integration

- Integration procedure :
  - Using the same TPC insertion tool, adapt on it an apparatus to support and insert the inner parts.
  - Used the TPC center to guide and roll inside,
  - During insertion, control the deformation, stress and alignment
  - Adjusted with the TPC references
  - Fixed on TPC



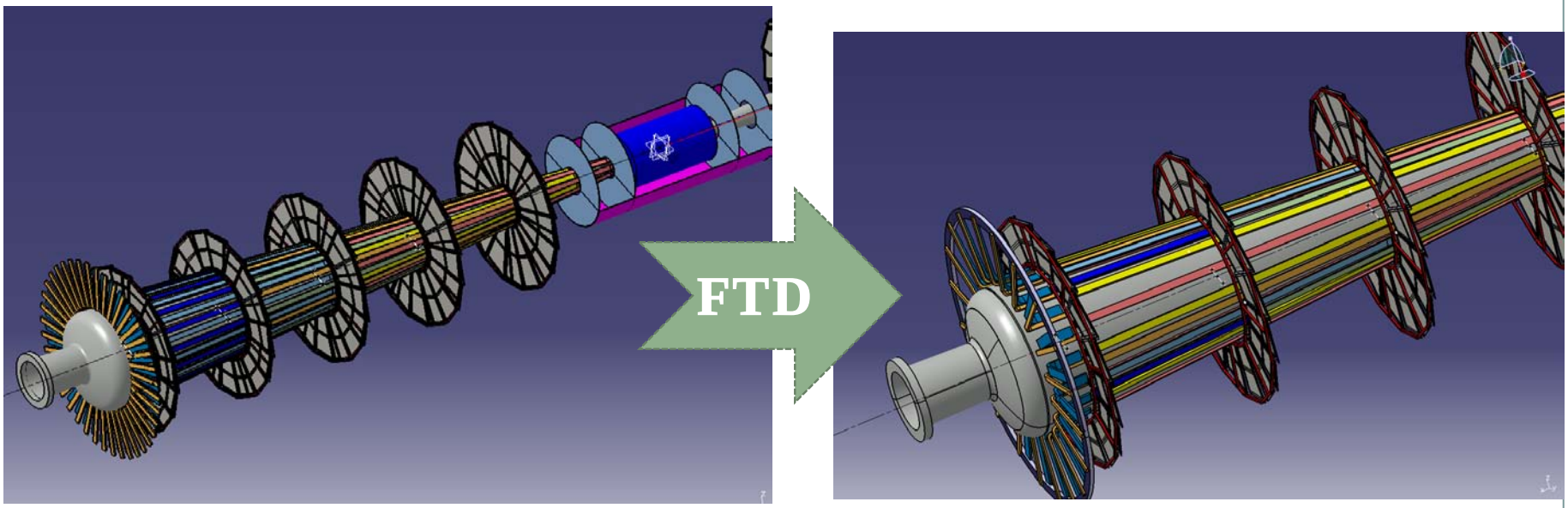



*From A. Gonnin & C. Bourgois*

Recent optimization work of the power distribution for the FTD3 to 7 :

*Thanks to D.Moya, F.Ateche, I.Alvarez, A.Ruiz Jimeno  IFCA Cantabria*

- *Reduction of the amount of cables per FTD from 98 to 16 ….*
- *Conductor section per FTD from 158  to 14.8 mm² in Cu….*

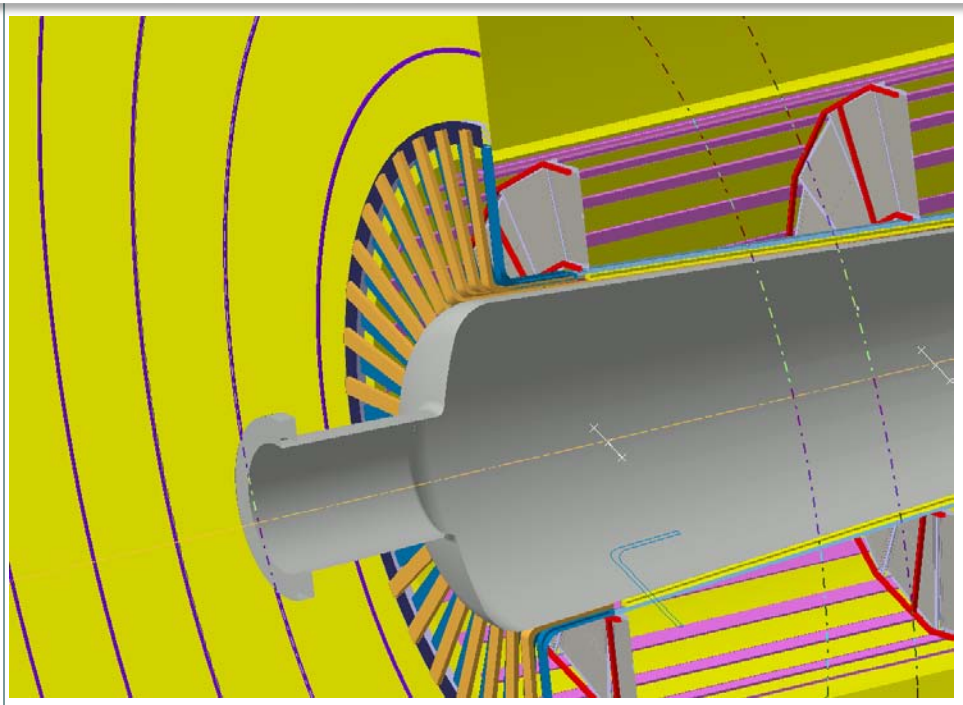


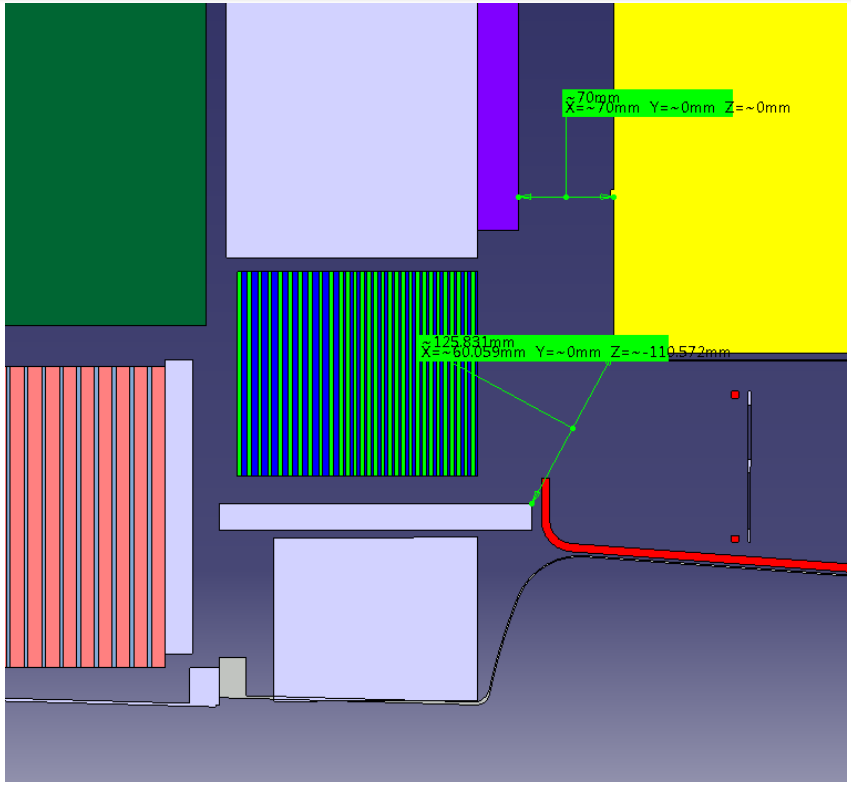
# Amount of Dead material around the beam pipe
( Al as conductor, Security margin 2 because of unknowm subdetectors, material nature...etc...).....

| | Aluminum | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | position | FTD7 | FTD6 | FTD5 | FTD4 | FTD3 | FTD 2 | FTD 1 | VTX |
| new values | eq Th of Al r | 0,85 | 0,99 | 1,22 | 1,54 | 2,18 | 2,76 | 2,00 | 0,67 |
| | X0% FCPPD | 0,95% | 1,11% | 1,37% | 1,73% | 2,45% | 3,10% | 2,25% | 0,75% |
| old values | eq Th of Al r | 2,16 | 2,39 | 2,74 | 3,20 | 4,12 | 3,45 | 2,00 | 0,67 |
| | X0% FCPPD | 2,43% | 2,68% | 3,08% | 3,60% | 4,63% | 3,87% | 2,25% | 0,75% |
| | Nbre of Cables | | | | | | | | |
| | position | FTD7 | FTD6 | FTD5 | FTD4 | FTD3 | FTD 2 | FTD 1 | VTX |
| new values | total | 514,00 | 482,00 | 450,00 | 418,00 | 386,00 | 266,00 | 126,00 | 30,00 |
| old values | total | 900,00 | 804,00 | 708,00 | 612,00 | 516,00 | 288,00 | 126,00 | 30,00 |

*This work of optimisation should be done for each detector.....*

# Patch panels positions : Inner radius of TPC endplates, what for ? :






**TPC endplate position , one patch panel needed :**

- 540 cables for power + **x?**00 for signal transmission + Cooling fluid distribution
- Inner part integration steps
- Optical conversion of Signal ???
- Reduction of the power distribution cables ?

# Patch panels positions : Inner radius of the coil:

About 2000 cables per side full detector BARREL ....

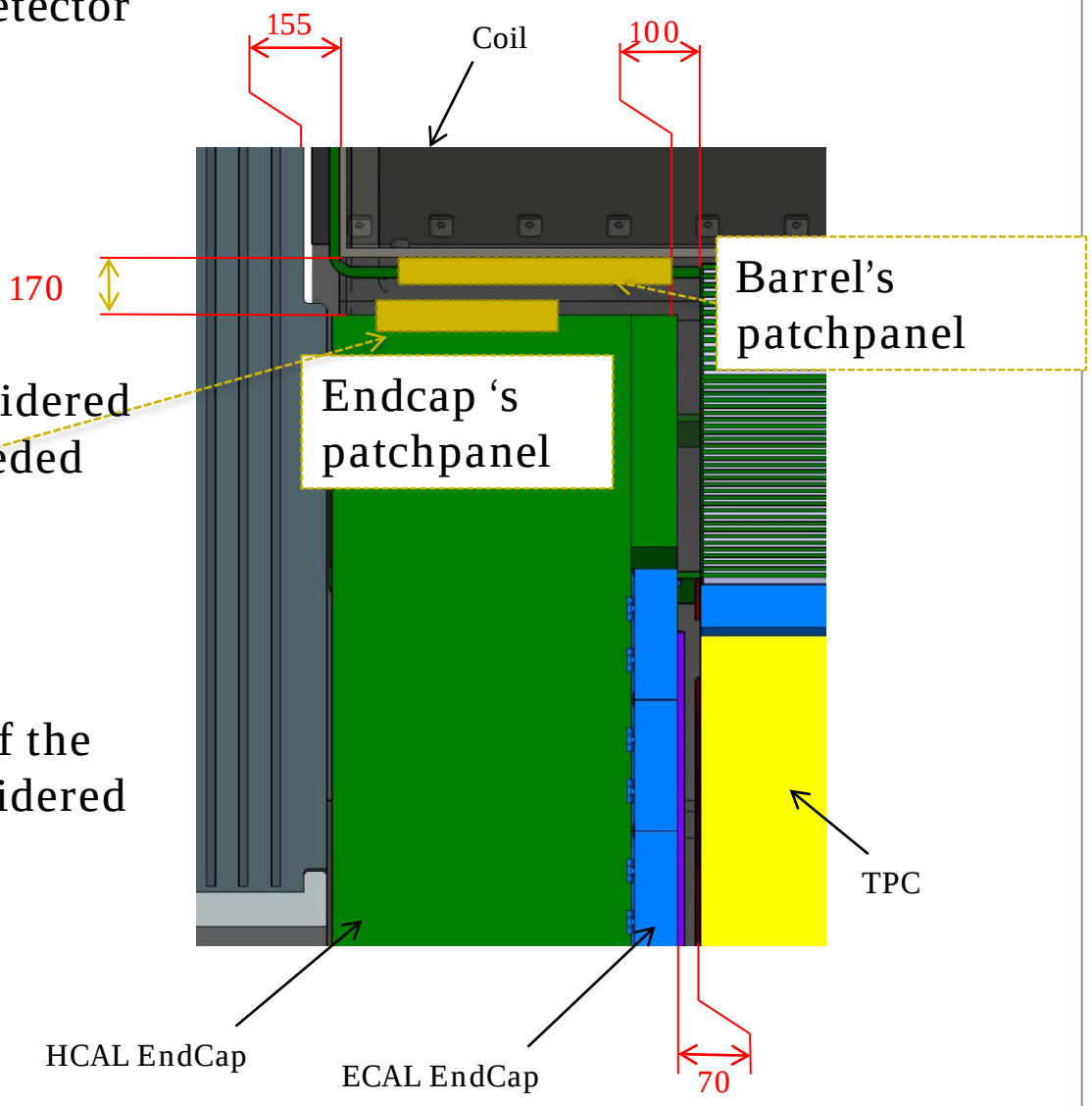
***But:***

What for the endcaps ?

Signal transmission : not yet considered and may strongly increase the needed space

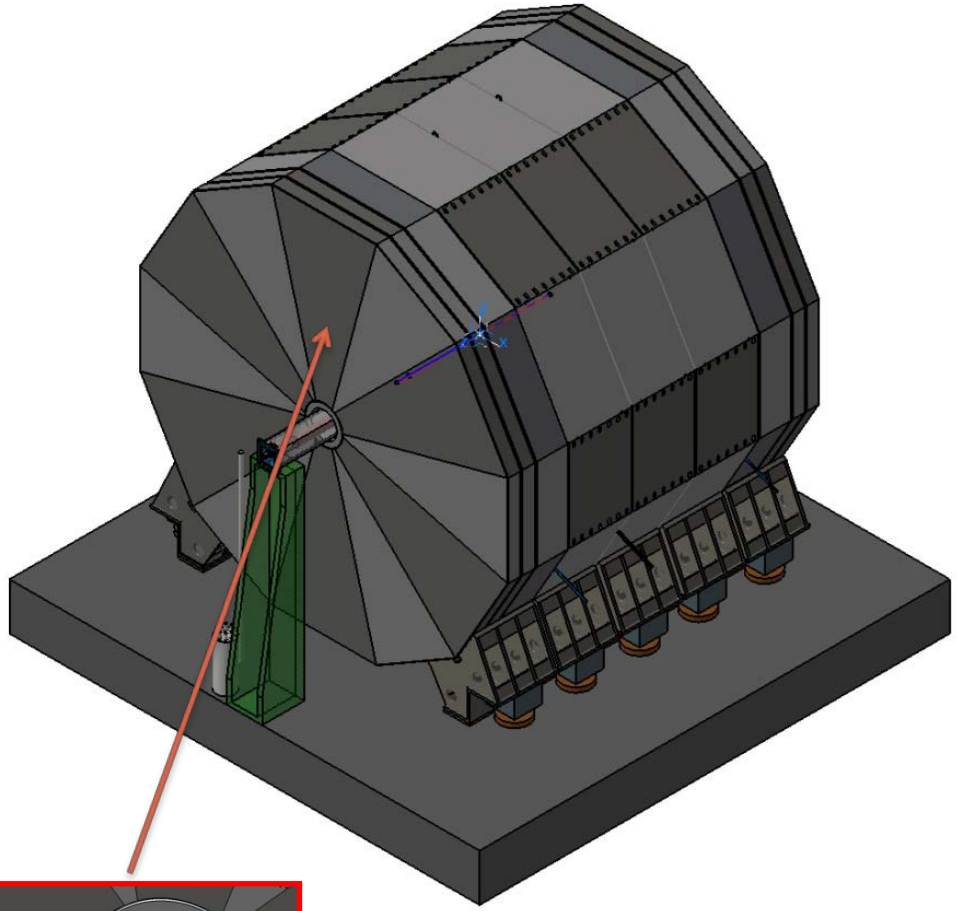
Optical conversion

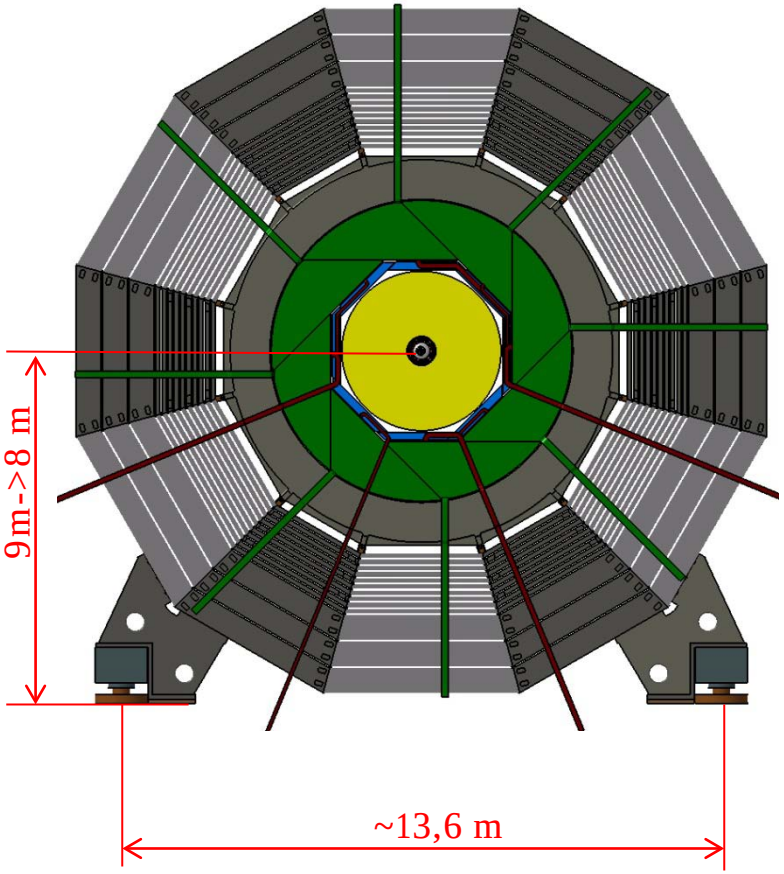
Cooling : the volume occupancy of the cooling distribution must be considered

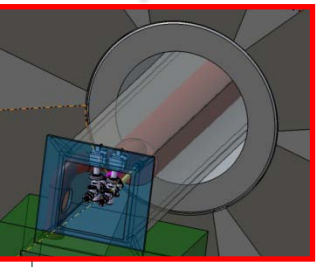


# 3D CAD model updates @LAL

Beam height /platform: decrease from 9 to 8 m





Changes in the shape of return Yoke :

- No more central supporting feet
- Shape of the central hole

*From A. Gonnin & C. Bourgois ( LAL)*

Reminder : Roadmap for DBD 2012 :

*"Complete basic mechanical integration of the baseline design accounting for insensitive zones such as the beam holes, support structure, cables, gaps or inner detector material"*

*"Develop a realistic simulation model of the baseline design, including the identified faults and limitations"*

Still some discripancies between overall mechanical model and some subdetectors engineering models :

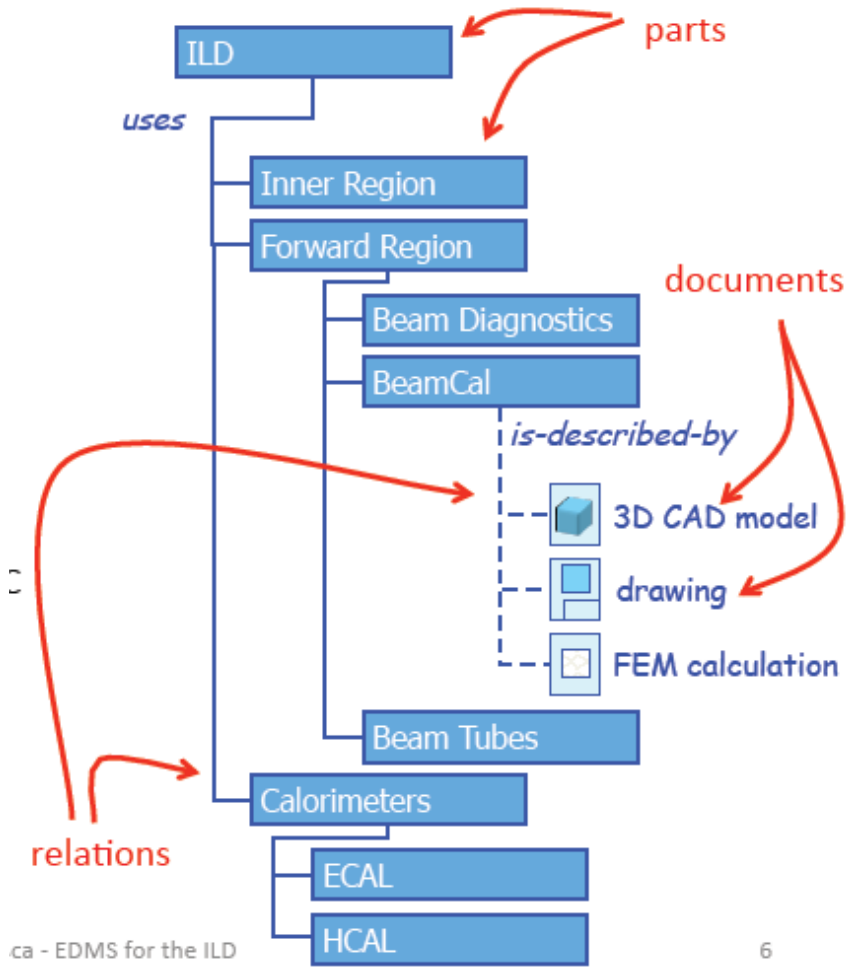
*Send updates to A.Gonnin/C.Bourgeois @ LAL*

But these models should also be in EDMS ( Contact A.Rosca ):

The idea is to have :

1. an **overall** « not to heavy « **CAD mechanical** model, @LAL
2. **detailled subdetectors models** at each relevant node of the EDMS tree structure

# Documents in EDMS

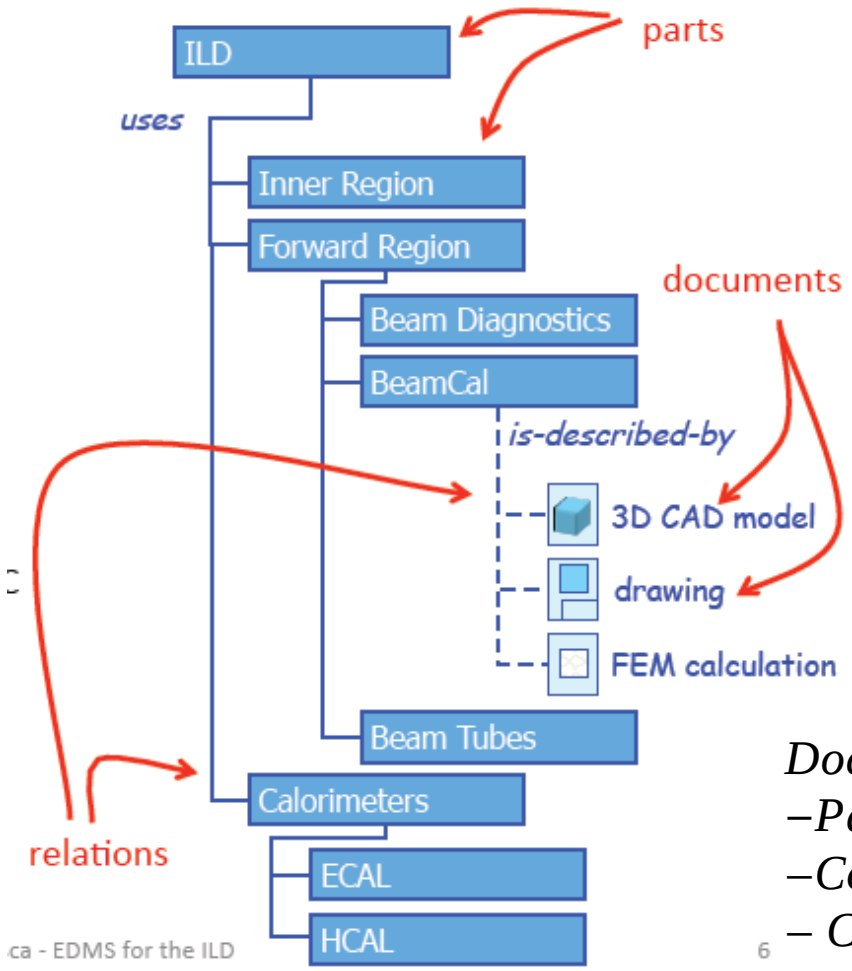



Overall CAD model

Detailled CAD model

*From A.Rosca ( DESY)*

# Documents in EDMS




Overall CAD model

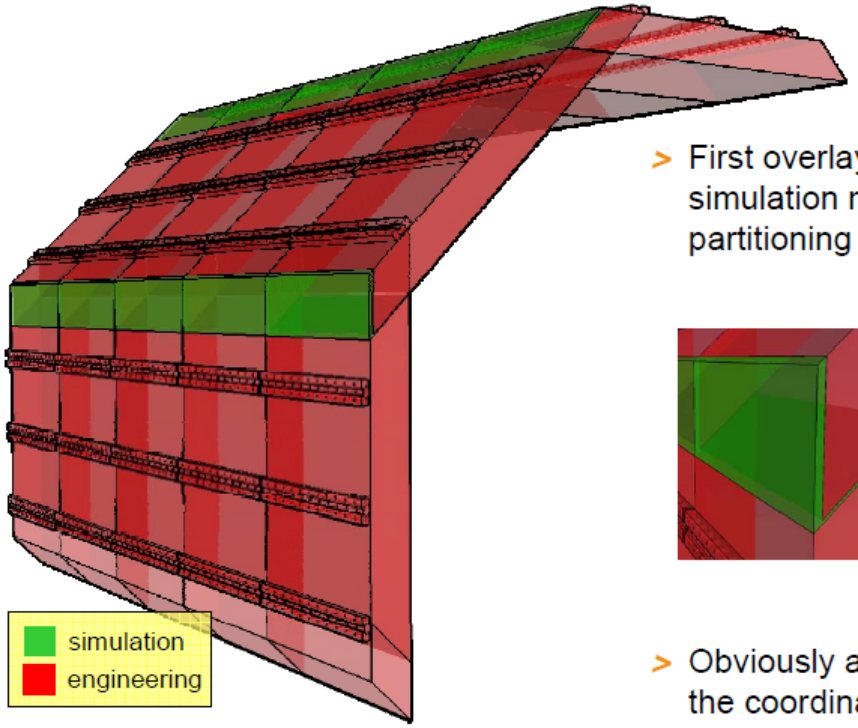
Detailled CAD model

*Documents should also be :*
*–Parameter lists*
*–Component lists*
*– Component specifications*
*– Calculations*
*_Detector description*

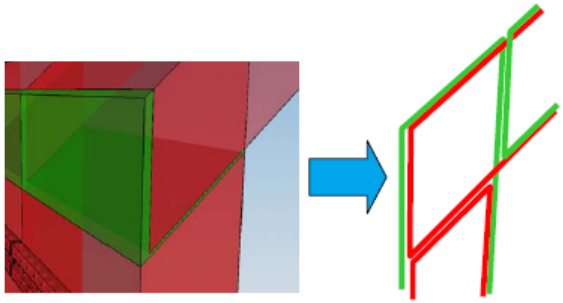
*From A.Rosca ( DESY)*

EDMS migth ease the comparison of the Simulation and Mechanical model ...

## Comparing Simulation and Detailed Model (1)




> First overlay of detailed model with simulation model revealed different partitioning of ECal into modules



> Obviously a problem of orientation of the coordinate system which can be easily remedied (rotate around X)

# Conclusion (1)

Huge amount of work on detector integration studies :

First detailled time estimate for ILD assembly : 3,25 Y

*But ...The more work is done... the more questions arise.....*

Detectors :

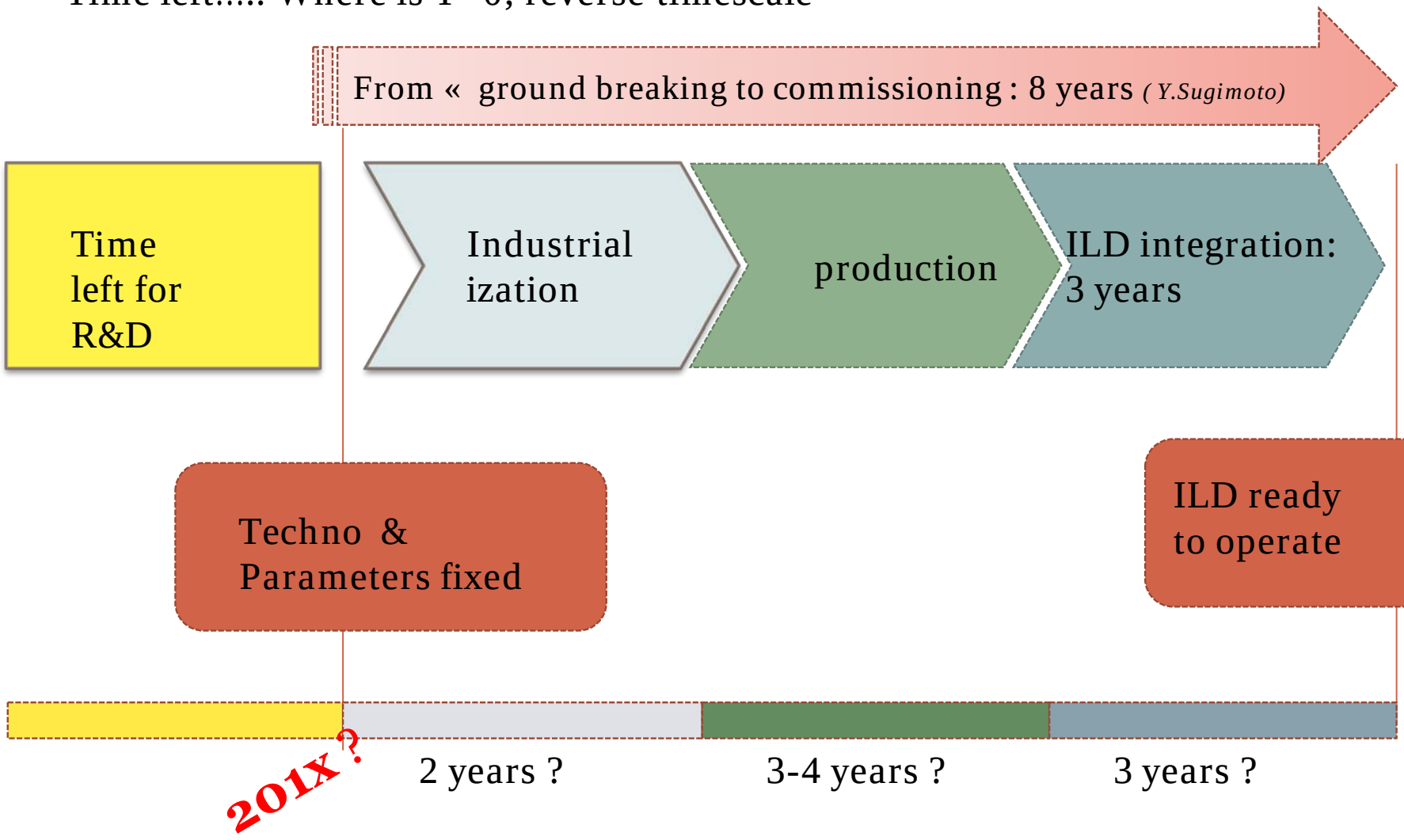
- Services : not only power distribution.... Signal + Cooling
- Update the inputs for both Barrel, Endcaps & forward region, SET, ETD...
- Alignment & calibration issues
- Pooling the distribution ?

Integration :

- Optimization & Parallelization of the integration sequences for both sites constraints ( moutain/non mountain)
- Sharing tooling for integration,
- Estimate the place for storage, tooling assembly...etc...

# Conclusion (2)

Time left..... Where is T=0, reverse timescale

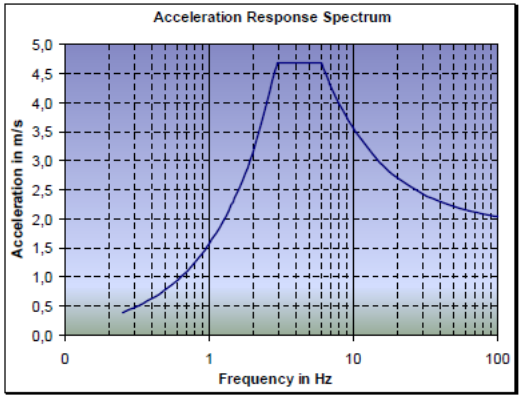


Spare

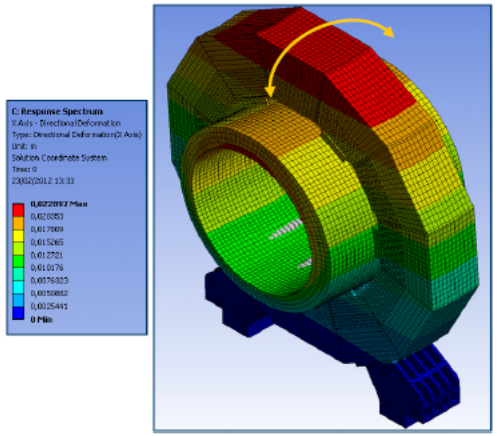
# Seismic Hazard for Japanese site consideration, coil & RY behaviour

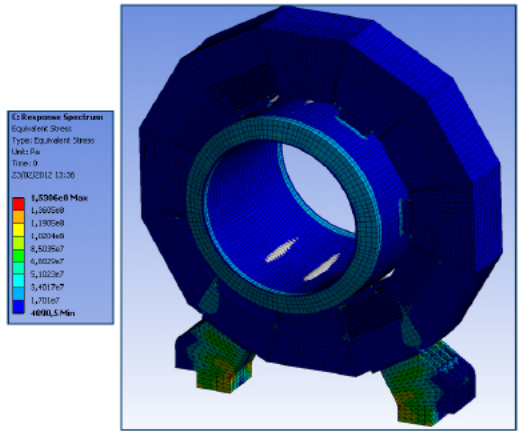
Parameters for acceleration spectrum

- Peak Ground Acceleration: 1.5 m/s²
- Damping ratio for steel structure: 2%
- Soil type: hard soil




- With the acceleration response spectrum applied along the detector axis, the fundamental mode of the structure dominates: back and forth motion of the yoke ring
- The max displacement is around 23mm, which is quite high
- The peak stress is located in the feet. The level seems acceptable but the results need to be checked with a proper design and model
- Attaching the 3 rings together is probably the way to go to increase the overall stiffness and reduce the peak displacement





*From O.Fereirra ( LLR)*