



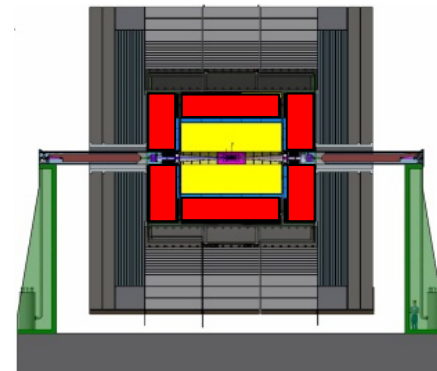
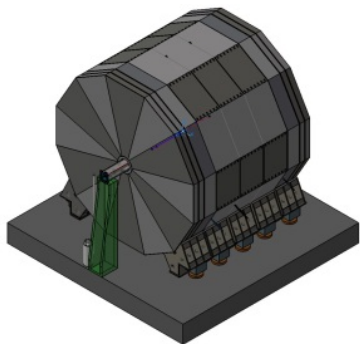
## Linear Collider days in Saclay

(27-29 November 2013)





# ILD – Integration status



## Outline

- I. STATUS
- II. MANAGEMENT INTERFACES
- III. MECHANICAL STUDIES IN France
- IV. NEXT STEPS
- V. CONCLUSION



# ILD – Integration status

## I. STATUS

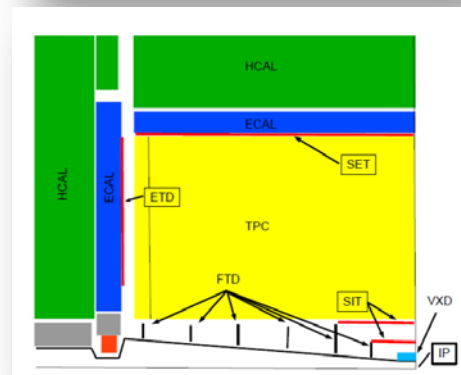
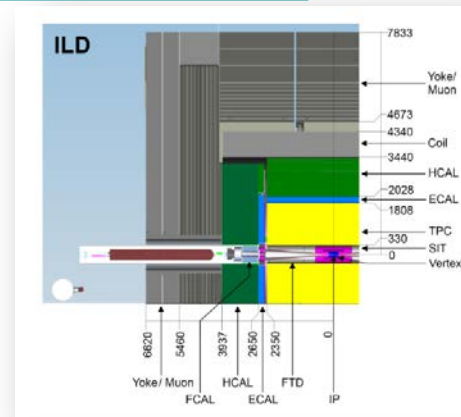
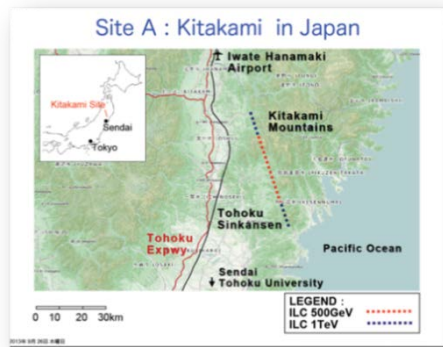
- Each sub-detector has already defined its own :
  - Placeholder,
  - Sub detectors fixations
  - Câbles
  - Cooling or gaz
  - Integration tools
  - ...

*Remark:*

*Some detectors are in competition with a different technology.*

*Now, no site-specific issues have been taken into account.*

- Now we have a proposal site in northern Japan







# ILD – Integration status

- At LAL, collect all informations from collaborators (3D model, services placeholders..) Alexandre Gonnin try to keep the last version of CATIA 3D MODEL.

**ILD – Integration Model**

- Status of 3D model
  - Since July 9<sup>th</sup> updating one part : DHCAL (red part)

ILD      ILD - Section

Meeting ILD - Cracow - 25/09/13      A. Gonnin – ILD Integration Model      2

**ILD – Integration Model**

- DHCAL : New dimensions
  - Barrel
    - Diameter      6770 mm (6821 mm)
    - Length      4700 mm
  - EndCap
    - "Diameter"      6640 mm (6380 mm)
    - Thickness      1487 mm

Meeting ILD - Cracow - 25/09/13      A. Gonnin – ILD Integration Model      3

- Each responsible of sub-detector must send a Step file when they have upgrade their design.
- At LAL, checking if there is no conflict with the other parts
- Upload on EDMS DESY a Step file of the whole experiment -> Aura Rosca (DESY) [aura.rosca@desy.de](mailto:aura.rosca@desy.de)

**ILD – Integration Model**

- Placeholders
  - Gaps don't change

Section

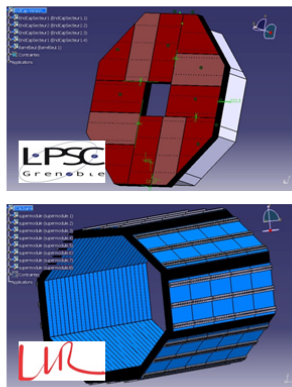
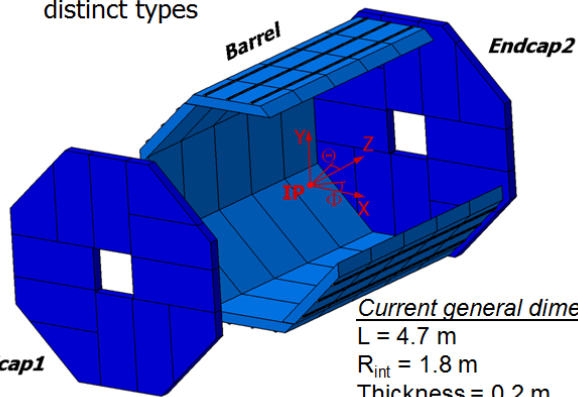
Meeting ILD - Cracow - 25/09/13      A. Gonnin – ILD Integration Model      4



# ILD – Integration status

## III. MECHANICAL STUDIES IN FRANCE:

- The **ECAL barrel** consists of 40 identical trapezoidal modules of tungsten absorber plates (~80 t) interleaved with layers of Silicon detectors with very fine segmentation of the readout (5x5 mm<sup>2</sup>)
- ECAL endcaps** : The same principle than barrel (~50 t) with 12 modules of 3 distinct types

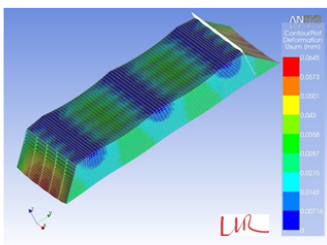
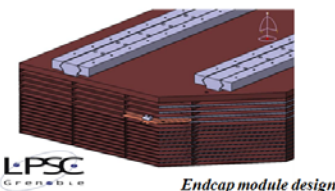
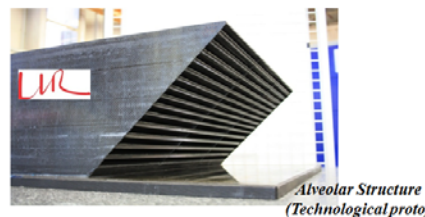
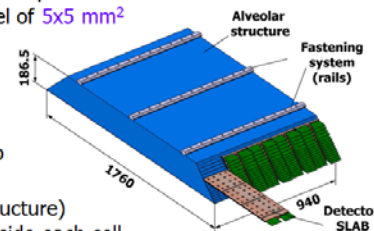


## ECAL BARREL

### Main features of the ECAL



- Multilayer calorimeter** Silicon/Tungsten as compact as possible (small Molière radius) with pixel of 5x5 mm<sup>2</sup>
- Sampling of W in depth according to the need of energy resolution : ~23 X<sub>0</sub>
- Half of the tungsten plates is incorporated into a self-supporting **alveolar composite** structure (carbon) to avoid machining step and reduce dead zone
- Half of W plates in supports (H-shaped structure) called **detector slab**, which are then slid inside each cell
- fastening system** ECAL/HCAL is included in the design (rails)

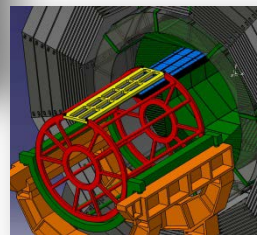


- Mechanical Simulations**
- Need to perform **mechanical simulations** with ANSYS to check all loads cases (0°, 45° and 90°)
- Need to continue **destructive tests** on materials and prototypes (typ. the thermal proto instrumented with bragg gratings) to implement correctly simulations and define all the margins of security of the model.



Marc Anduze [Anduze@lir.in2p3.fr](mailto:Anduze@lir.in2p3.fr)

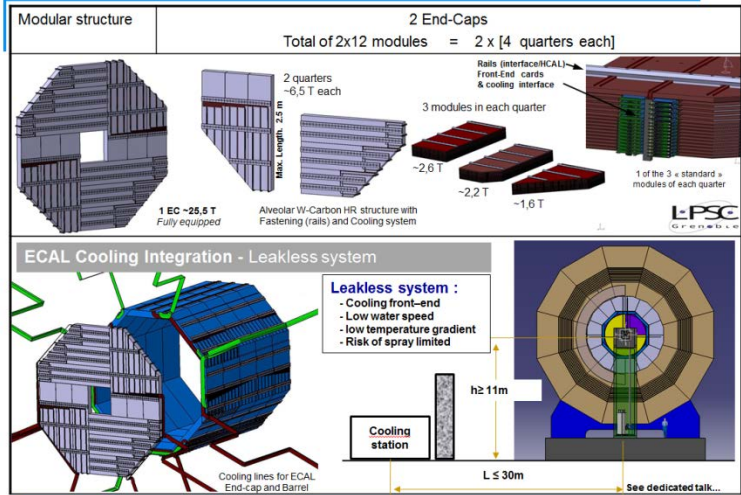
- Ecal design
  - Services
  - Integration tools
  - Calculations
  - Tests
- } Check if overlap with 3D Catia model



# ILD – Integration status

## MECHANICAL STUDIES IN FRANCE:

### Current structure of End-Caps

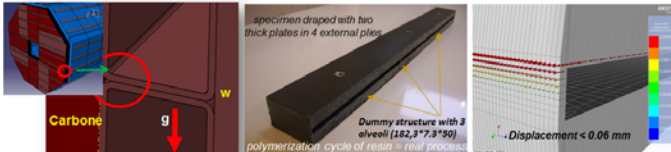


LPSC - JCL SACLAY November 28th 2013

### Evolution of skin thickness

#### Correlation of FEA simulations / shearing tests of representative structure

#### Problem of bending stress of alveoli skins / evolution of external plies



Influence of modification of external ply thickness on the first main constraint of external and internal walls  
If external plies thickness increases => **Impact on ECAL dead zone** => Optimization of deflection values

safety factor: 2,9 to 3,7 with respect to the stress induced / largest module (2,5m-25,5kN) to be improved / "seismic issues" ILD'13 meeting in Cracow

#### Tests & simulations to be performed

- Resistance of End-Caps to earthquake
- Destructive test on an existing structure (demonstrator - EUDET) / verification of bonded structures
- Destructive tests with charge & discharge cycles / weakening of the structures (resin) during repeated stresses
- Process: increase intercoat adhesion with structural adhesive film
- Process: obtaining reliable thicknesses of walls (specific long moulds, tooling development) / Draping optimization
- Reliability tests: good & uniform impregnation of parts, good compacting
- "Mass" production conception (ply book enhancement, tooling, process)

Displacements	~0.1 mm both
Main constraints	< 159 Mpa both
Shearing constraint	11.5 Mpa vs 6 (1,8/wall) Mpa for shearing tests ...

From simulations to shearing tests (ANSYS APDL / SAMCEF / ANSYS ACP)

LPSC - JCL SACLAY November 28th 2013

## SIW ECAL ENDCAP

### 2.5 m alveoli layer molding

- The end-cap layer test consisted of
- 3 long alveoli (representative of end cap module longest layers)
- Width of cell : 182,3 mm like barrel's one (for electronic uniformity)
- Thickness of cells : 7.3 mm - wall: 0.5 mm
- Length : 2.490 m



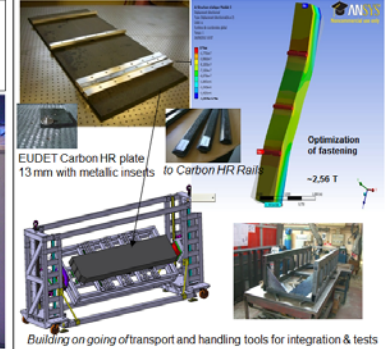
long layer of 3 alveoli demolded nov 12th with new system woven-resin (C202+ET445)

### Ongoing developments



LPSC - JCL SACLAY November 28th 2013

### Thick plates & fastening system



- Design of specific tools for long draping
- Industrialisation study of process / long alveoli layers (~540 cells: up to 2,50m)
- Continuing the mounting of the handling tool of modules & design / quarters End-Cap
- Thick composite plate for double low section rails
- Characterization, tests & optimization: positioning / bending of modules
- Towards construction of a long EC module ?



Denis GRONDIN - [grondin@lpsc.in2p3.fr](mailto:grondin@lpsc.in2p3.fr)  
Julien GIRAUD - [giraud@lpsc.in2p3.fr](mailto:giraud@lpsc.in2p3.fr)

- Ecal endcap design
  - Barrel & endcap cooling
  - molding tools
  - Calculations
  - tests
- } Check if overlap with 3D Catia model

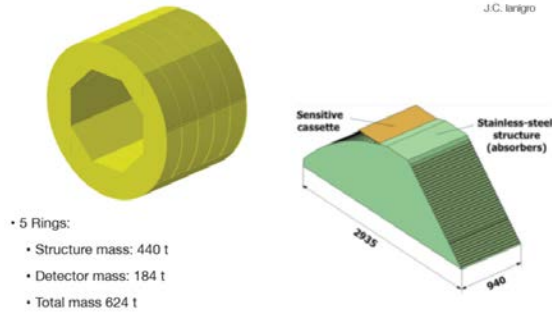


# ILD – Integration status

## III. MECHANICAL STUDIES IN FRANCE:

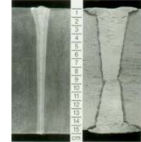
### Semi-Digital HCAL

#### Semi-Digital HCAL

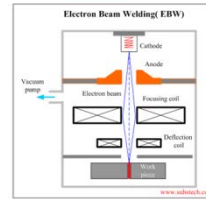


#### Barrel tooling : Phase 1 - wheel assembly & detectors integration

##### • Wheel Building : no screwing

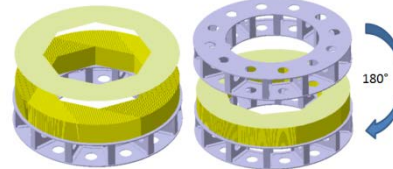


- Welding method : EBW**
- Tight continuous weld
  - Low distortion
  - Narrow weld and narrow heat affected zone
  - Filler metal is not required
  - high resistance (B.C of simulation)



##### Building Method

- 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



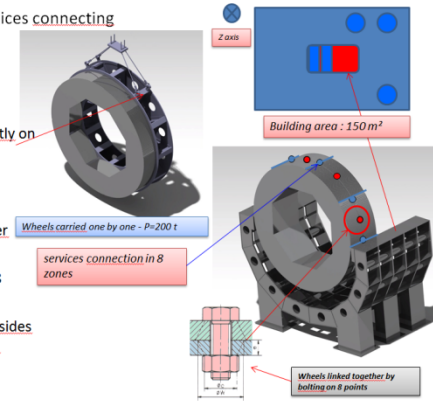
#### Barrel tooling : phase 2 - wheels connection

##### • Barrel Building & services connecting

zone needed for insertion structure : 15 x 10 m

Scenario :

- 5 wheels carried separately on specific structure
- 5 wheels on the barrel insertion structure
- Wheels screwed together
- Connection of services between the wheels in 8 zones
- Services issues on both sides of the barrel ready to be connected

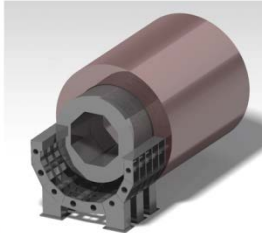


#### Barrel tooling : phase 3 – Barrel insertion

##### • Barrel on structure inside the yoke

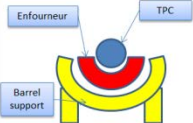
Scenario :

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



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

Services issues



Jean-Christophe Ianigro - [ianigro@ipnl.in2p3.fr](mailto:ianigro@ipnl.in2p3.fr)

- Hcal design
- Services
- Assembly tools
- Insertion tools
- Calculations

Check if overlap with 3D Catia model





# ILD – Integration status

III. MECHANICAL STUDIES IN FRANCE:

## Inner region & ILD interfaces

**Inner Region**

• **Assembly procedure :**

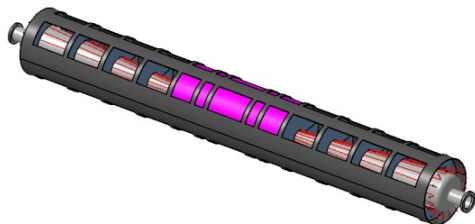
Fukuoka University, ILD meeting May 2012 A. Gonnin & C. Bourgeois 3

• **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



Christian Bourgeois - [bourgeois@lal.in2p3.fr](mailto:bourgeois@lal.in2p3.fr)  
Alexandre Gonnin – [gonnin@lal.in2p3.fr](mailto:gonnin@lal.in2p3.fr)



Inner region:

- Assembly scenario
- Alignment tools
- Fixations

Management ILD interfaces

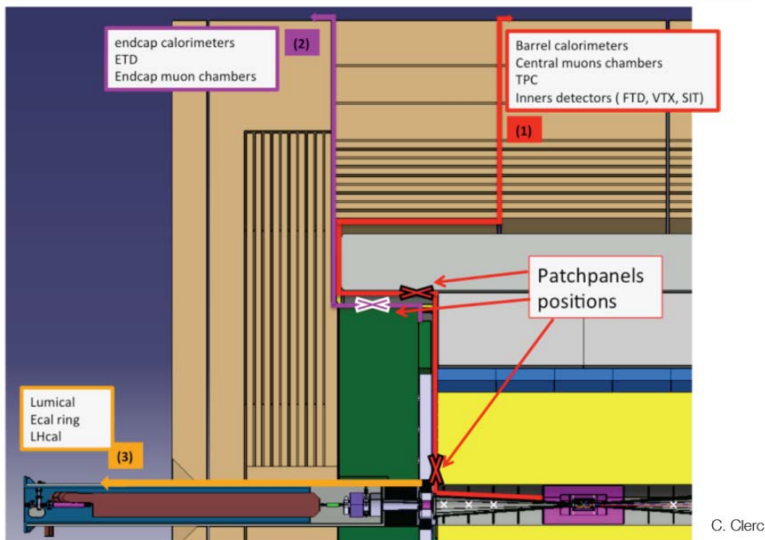


# ILD – Integration status

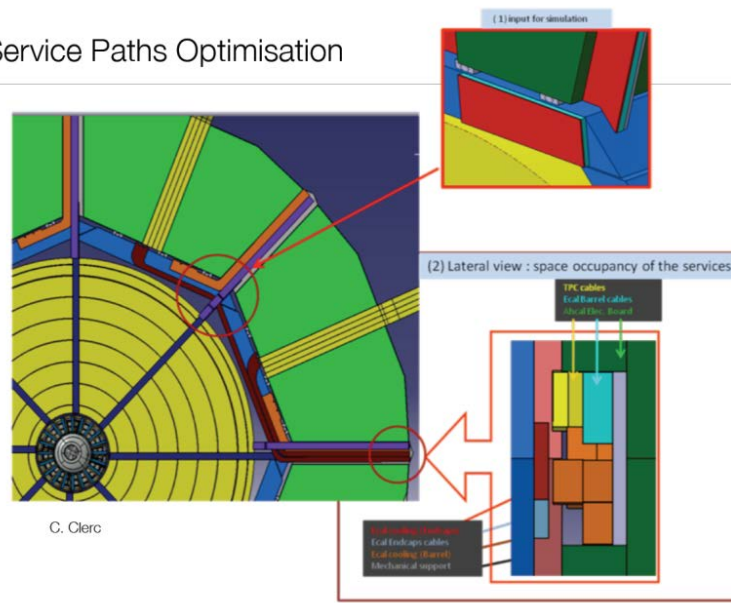
III. MECHANICAL STUDIES IN FRANCE:

## Services estimate

### Service Paths



### Service Paths Optimisation



Catherine Clerc - [clerc@poly.in2p3.fr](mailto:clerc@poly.in2p3.fr)

- Services studies
- patchpanels
- Placeholder estimate



# ILD – Integration status

## Other studies in France:

### TPC studies

Paul Colas - [paul.colas@cea.fr](mailto:paul.colas@cea.fr)  
David Attié - [David.Attie@cea.fr](mailto:David.Attie@cea.fr)  
Pierre Manil - [pierre.manil@cea.fr](mailto:pierre.manil@cea.fr)

### Vertex studies

Marc Winter - [mwinter@sbgpcs119.in2p3.fr](mailto:mwinter@sbgpcs119.in2p3.fr)

### Electronic ECAL barrel integration

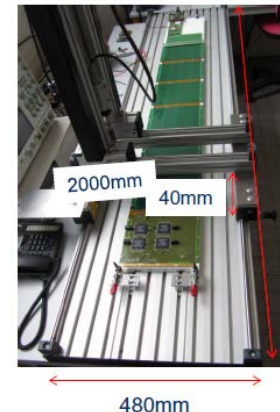
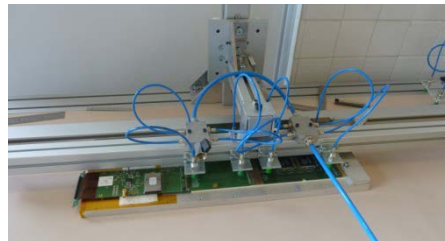
SLAB industrialisation:

Patrick Cornebis - [cornebis@lal.in2p3.fr](mailto:cornebis@lal.in2p3.fr)

- Assembly tests (6 FEV8-3C + 1FEV8 + 1Adapt Diff)
- Measurements and stubs effects (FEV 8,...)
- Soldering bench studies

Julien Bonis - [bonis@lal.in2p3.fr](mailto:bonis@lal.in2p3.fr)

- Slabs assembly procedure
- Assembly automation



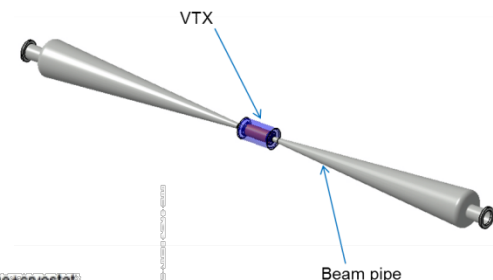
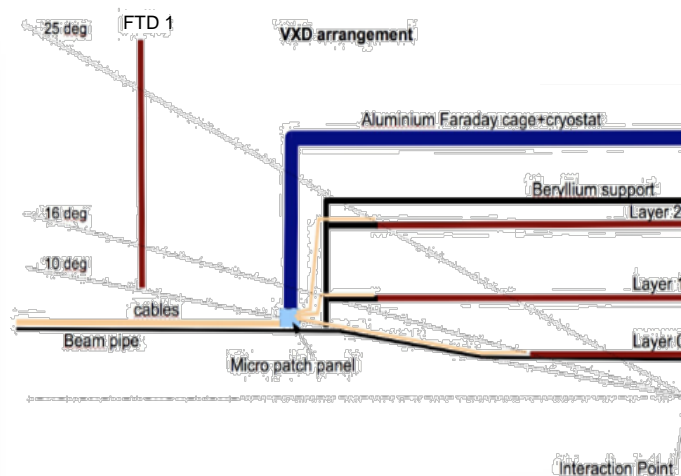
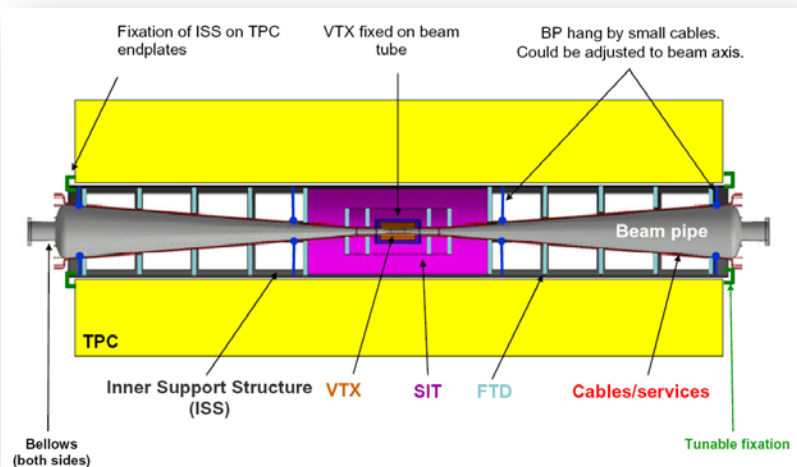


# ILD – Integration status

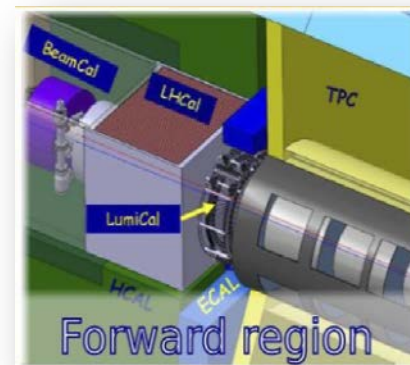
## IV. NEXT STEPS

Need more investigation for:

- Inner system: vertex detector, silicon tracking



- Forward direction, LHCAL : no information, no technological design

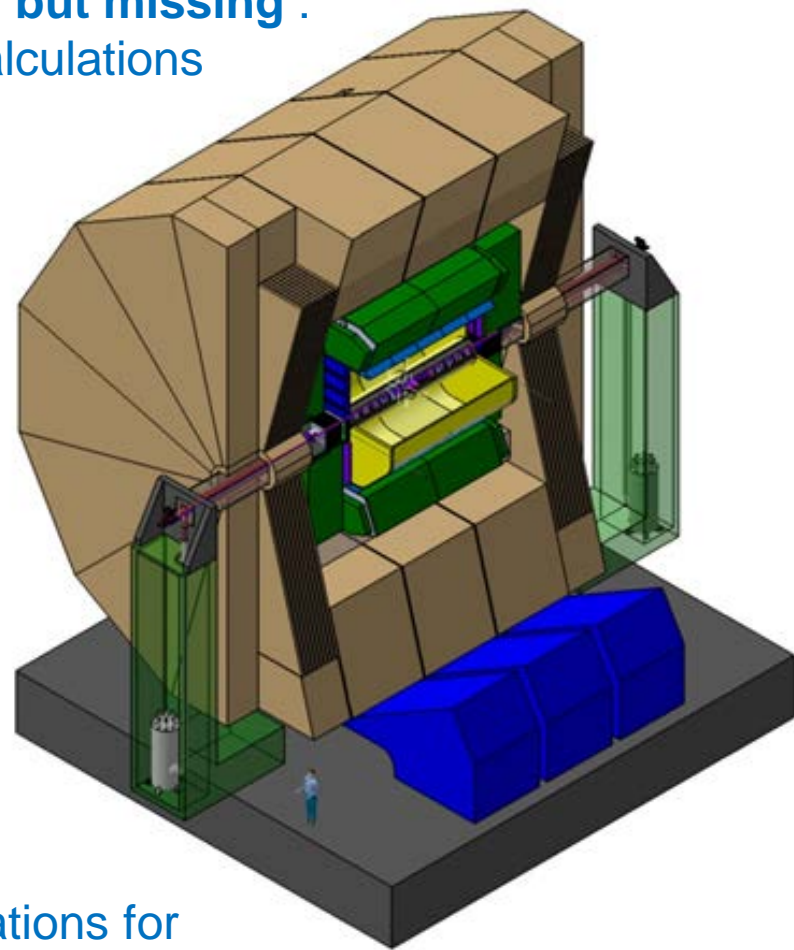




# ILD – Integration status

**On 3D model currently the gaps are respected, but missing :**

- sub-detectors fixations, sized according to the calculations (+earthquake acceleration)
- most of the services.



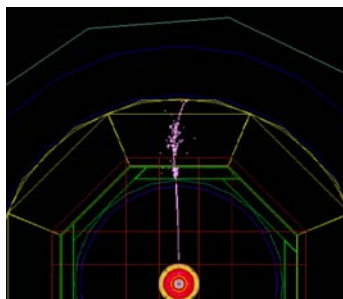
**Need to study :**

- An integration scenario : provide space and fixations for assembling tools
- An open scenario for maintenance
- Services, cables patch panel placeholders and fixations

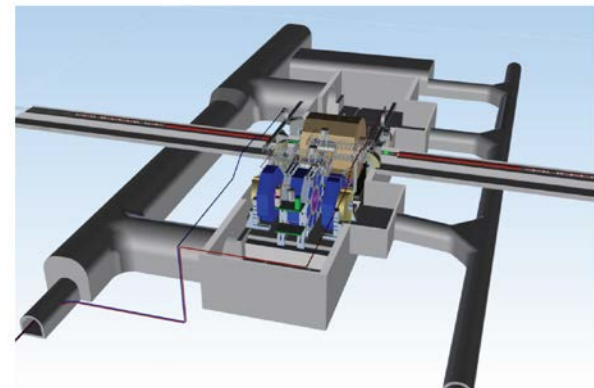


## Optimization:

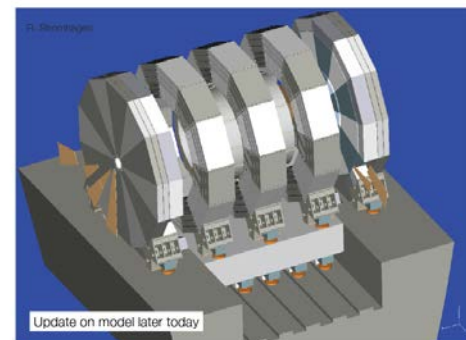
- Improvements driven by the cost efficiency and physics
- Realize full scale prototypes
- More realistic designs of mechanics, cabling, cooling
- Internal integration of the ILD engineering model
- External integration with the machine and SiD
- Validate each sub-detectors dimensions with physical simulations



ILD in its Natural Environment...



ILD Mechanical Design





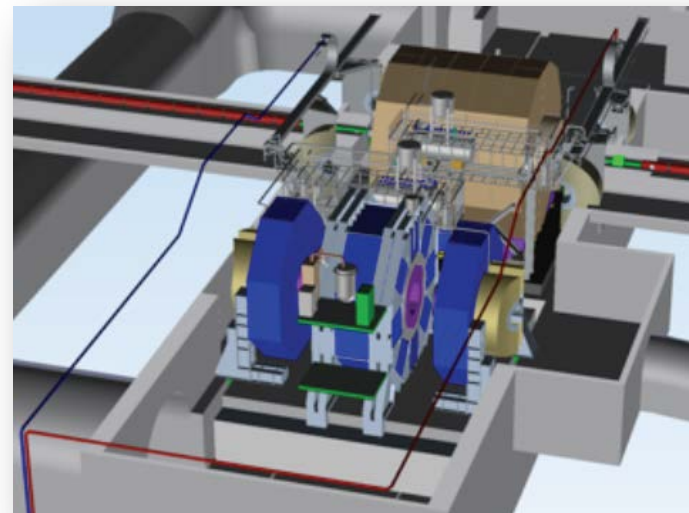
# ILD – Integration status

## Need « project » organisation:

- At the last collaboration meeting in Krakovie, different propositions were showed
- Need to identify the leaders

In october, LLR organised a technical meeting with LAL, LPNHE, OMEGA, LPSC:

- Common goal
  - Shedule for the future 2 years
  - For exchange documents, used EDMS
- Next french technical meeting end of november.





# ILD – Integration status

## V. CONCLUSION

*Many tasks must still be done...*

*until the TDR.*

