



Integration Methodologies

Jean-Pierre Corso EN/ACE-INT

2024-10-24

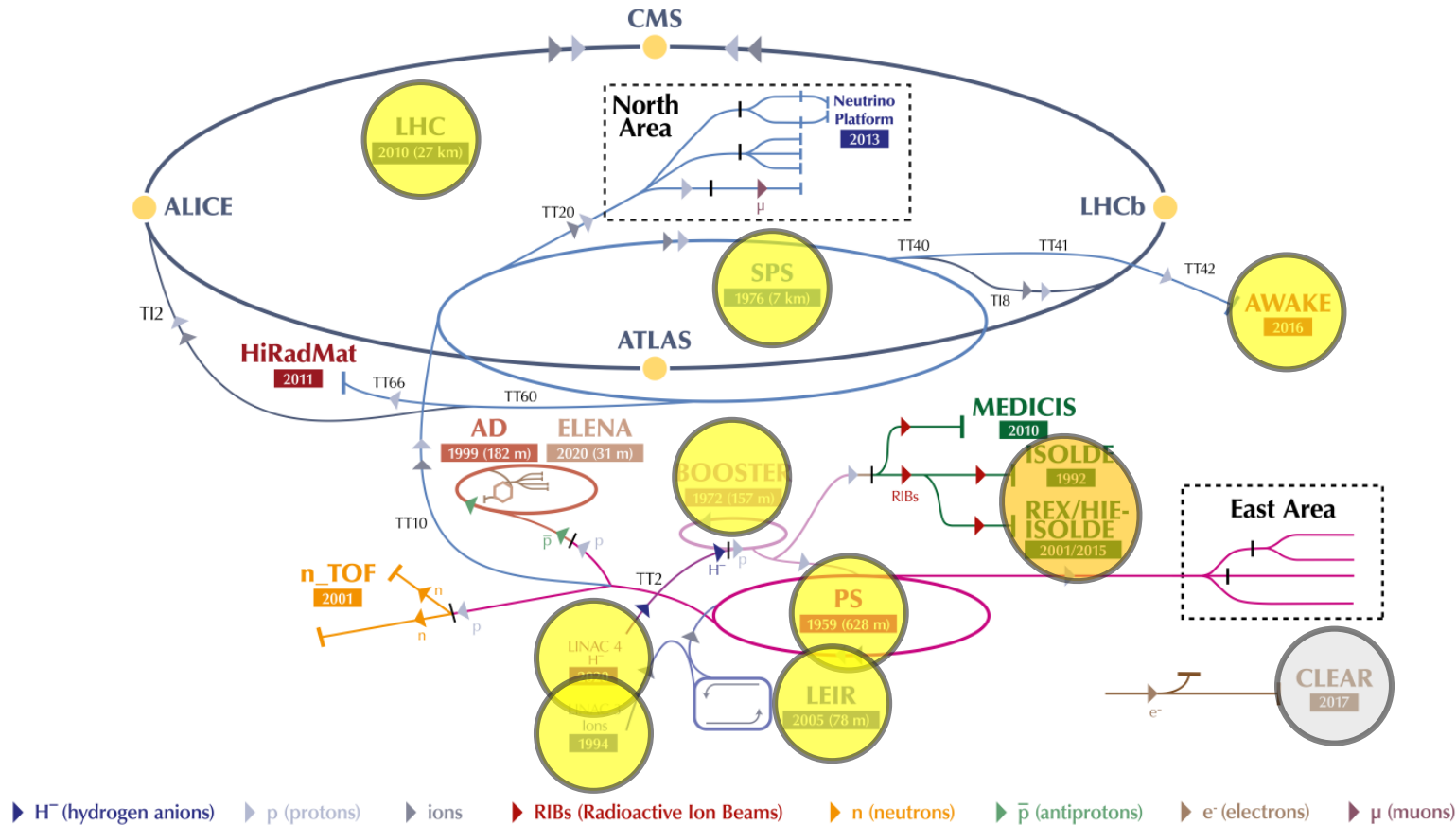
EDMS: 3177137

Content

1. Integration Team
2. LHC few characteristics
3. Integration Conventions & Methodologies
4. Integration inside Smarteam or PLM

Integration Offices EN-ACE

The CERN accelerator complex Complexe des accélérateurs du CERN



LHC - Large Hadron Collider // SPS - Super Proton Synchrotron // PS - Proton Synchrotron // AD - Antiproton Decelerator // CLEAR - CERN Linear Electron Accelerator for Research // AWAKE - Advanced WAKEfield Experiment // ISOLDE - Isotope Separator OnLine // REX/HIE-ISOLDE - Radioactive Experiment/High Intensity and Energy ISOLDE // MEDICIS // LEIR - Low Energy Ion Ring // LINAC - LINear ACcelerator // n_TOF - Neutrons Time Of Flight // HiRadMat - High-Radiation to Materials // Neutrino Platform

EN-ACE

Scope

- LHC (and SD surface buildings)
- SPS Machine, AWAKE, Transfer Lines, Surface Buildings
- PS, PSB, Linac4, LEIR, Linac3, Transfer Lines, Surface Buildings
- SM18
- ISOLDE Complex (not in ACE mandate)
 - BTY Upgrade
 - Fire Safety and Radiation Protection Improvement (FIRIA)
 - Beam Dump Replacement Study (IBDRS)
 - PUMA

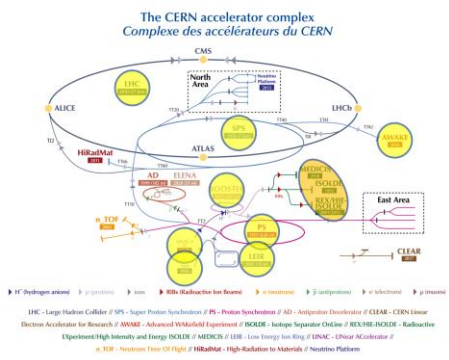
Project/Support

- HL-LHC Project
- LHC Tunnel Region Experiments (TREX)
- CNGS dismantling
- AWAKE Upgrade
- Physics Beyond Collider
 - Gamma Factory
 - Forward Physics Facility (FPF)
- SRF (new building SA18)
- MTE (new building 369)
- TG-CONS (Technical Galleries Consolidation)
- MSC workshop 867/R-H29
- EN-AA Design Office support
- NA-CONS Project (SPS side)
- PSS-CONS Project (LHC, SPS)

(Pre-)Studies

- FCC Feasibility
- SND@LHC Upgrade
- FACET

Integration Offices (EN-ACE)



SPS, AWAKE

PS, PSB, Linac3/4, LEIR

LHC	SPS	SPS - Surface	PS Complex	PS Complex - Surface	ISOLDE Complex
Jean-Pierre Corso	Frederic Galleazzi	Antoine Kosmicki	Daniel del Alamo	Daniel del Alamo	Julien Prosic*
<u>Support</u> Gabriele Valeriano**	<u>Support</u> Vincent Barozier* Melvyn Rouchouse*	<u>Support</u> Alparslan Tursun*	<u>Support</u> Jean-Michel Lacroix	<u>Support</u> -	<u>Support</u> Vincent Barozier*
ICL Accelerators meetings (LHC, SPS, cPS)					ICL ISOLDE meetings
HL-LHC	SM18	Other Surface Buildings	FCC	TG-CONS	FPF
Stephane Maridor (WP15 – Paolo Fessia)	Antoine Kosmicki	Antoine Kosmicki	Julie Coupard Fani Valchkova*	Julie Coupard	Julien Prosic*
<u>Support</u> Nicolas Joannon*	<u>Support</u> Alparslan Tursun*	<u>Support</u> Nicolas Joannon* Vincent Barozier*	<u>Support</u> Dieudonné Ngo'o Ella* Melvyn Rouchouse*	<u>Support</u> -	<u>Support</u> -

MTE, SRF, b.163, etc.

FCC, Arc Cell Mock-up

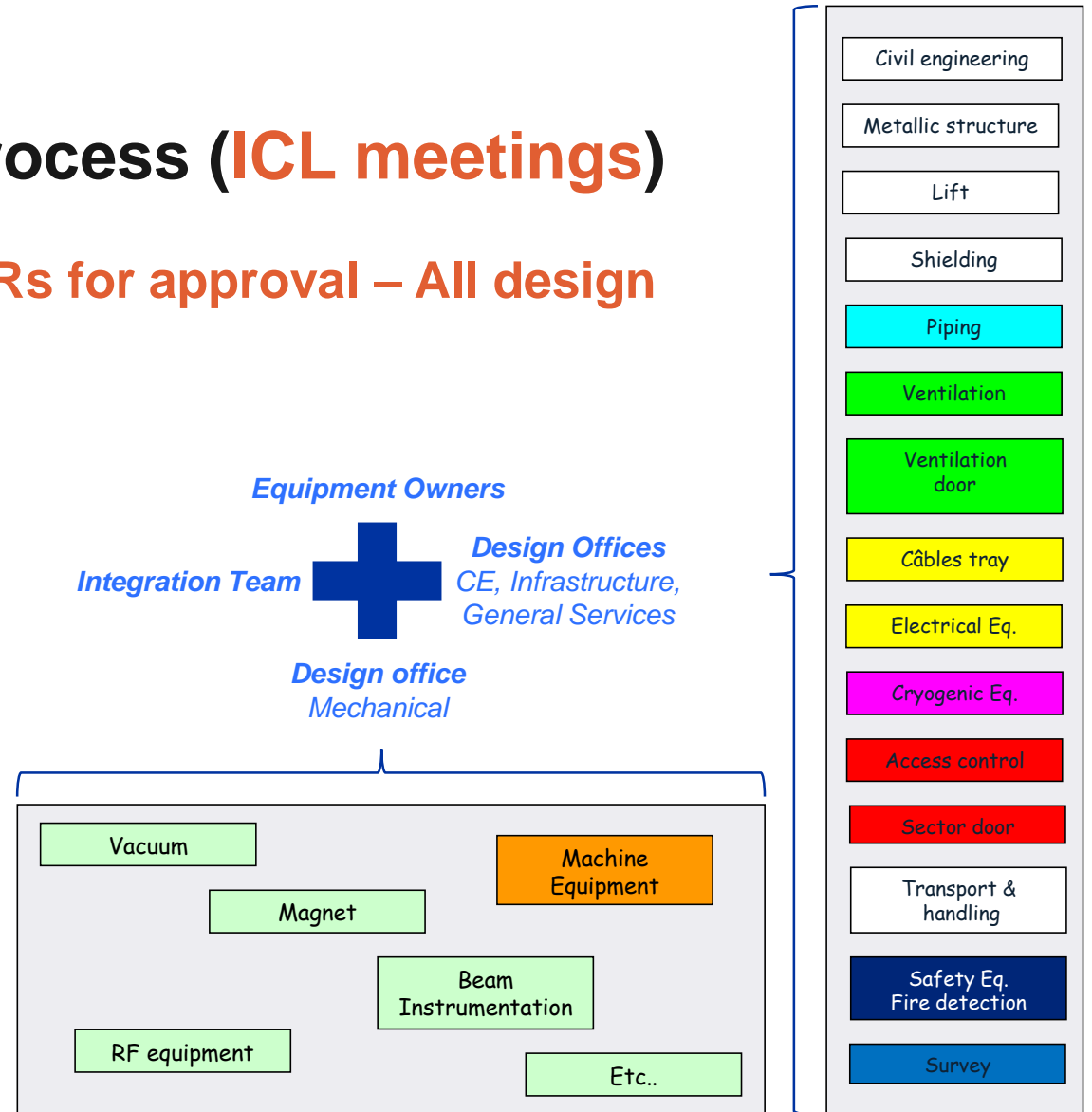
*support S265
**Graduate

Integration Studies

- Integration studies with approval process (**ICL meetings**)

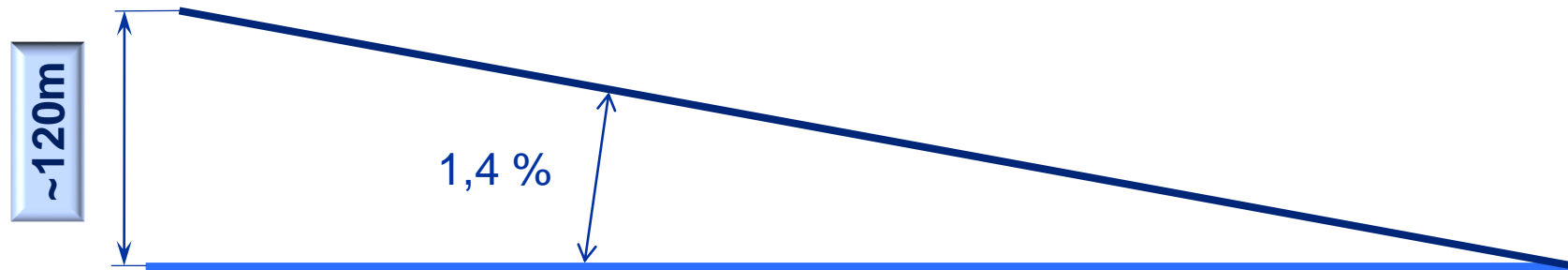
→ Validation in ICL meeting before launching ECRs for approval – All design offices and projects shall be represented

- ICL meetings on Wednesdays 10h-12h slots
 - LHC (J.P. Corso)
 - SPS/AWAKE (F. Galleazzi)
 - Linac3/Linac4/LEIR/PSB/PS (D. del Alamo)
 - Agendas: <https://indico.cern.ch/category/7466/>
 - Minutes: <https://edms.cern.ch/project/CERN-0000241820>
- Mailing-list being updated in 2023 by the Group Leaders + T-REX and HL-LHC Project
 - EN-AA / ACE / CV / EL / HE / MME
 - BE-ABP / CEM / EA / GM / ICS / OP
 - SY-ABT / BI / EPC / RF / STI
 - TE-CRG / MPE / MSC / VSC
 - IT-CS
 - SCE-SAM

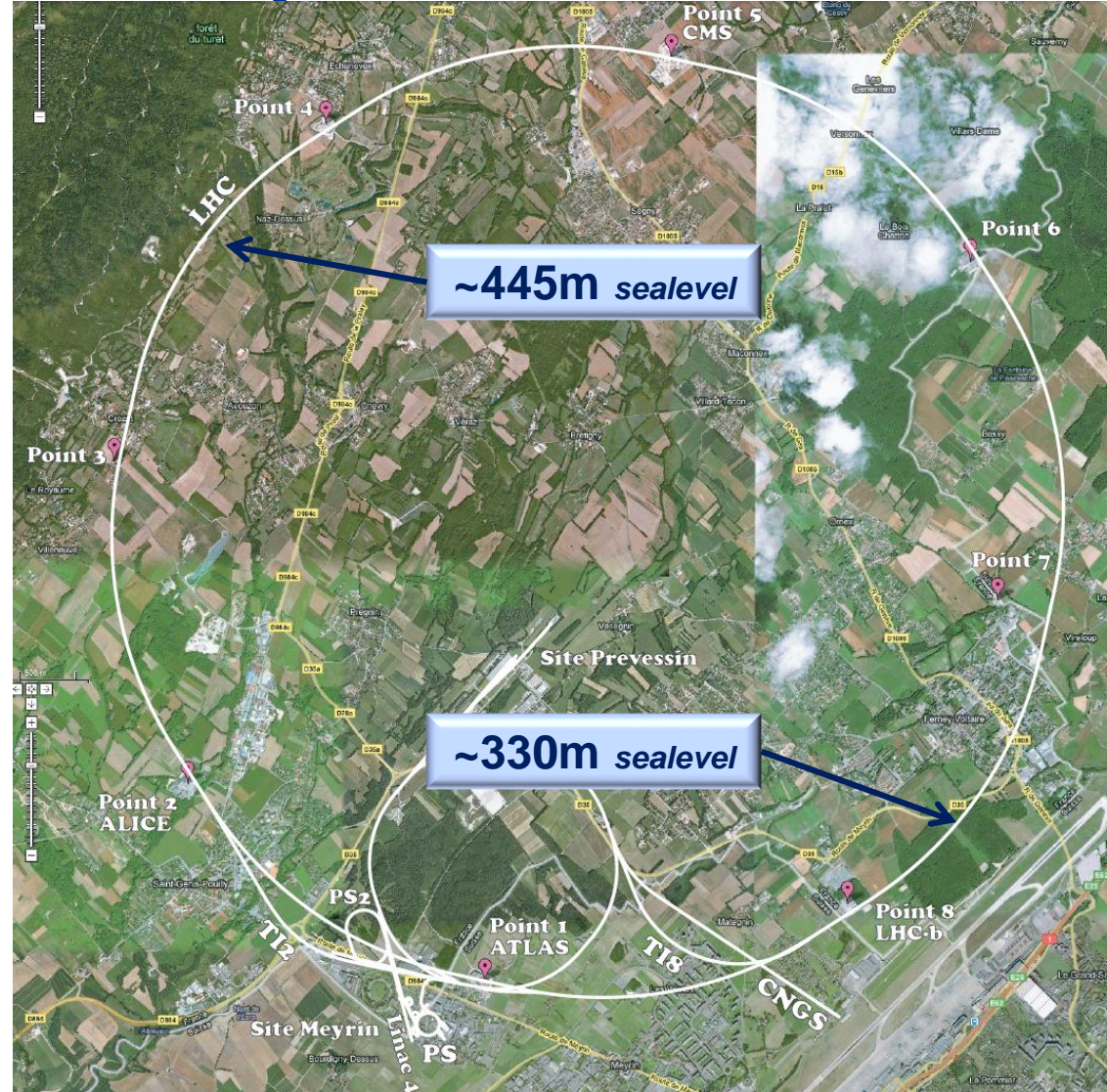


LHC Tunnel : Slope, Tilt...

- ✓ The LHC is using the tunnel excavated for the LEP in 1985.
- ✓ This tunnel is NOT horizontal !
- ✓ The machine is like a circle turned by 1,4%



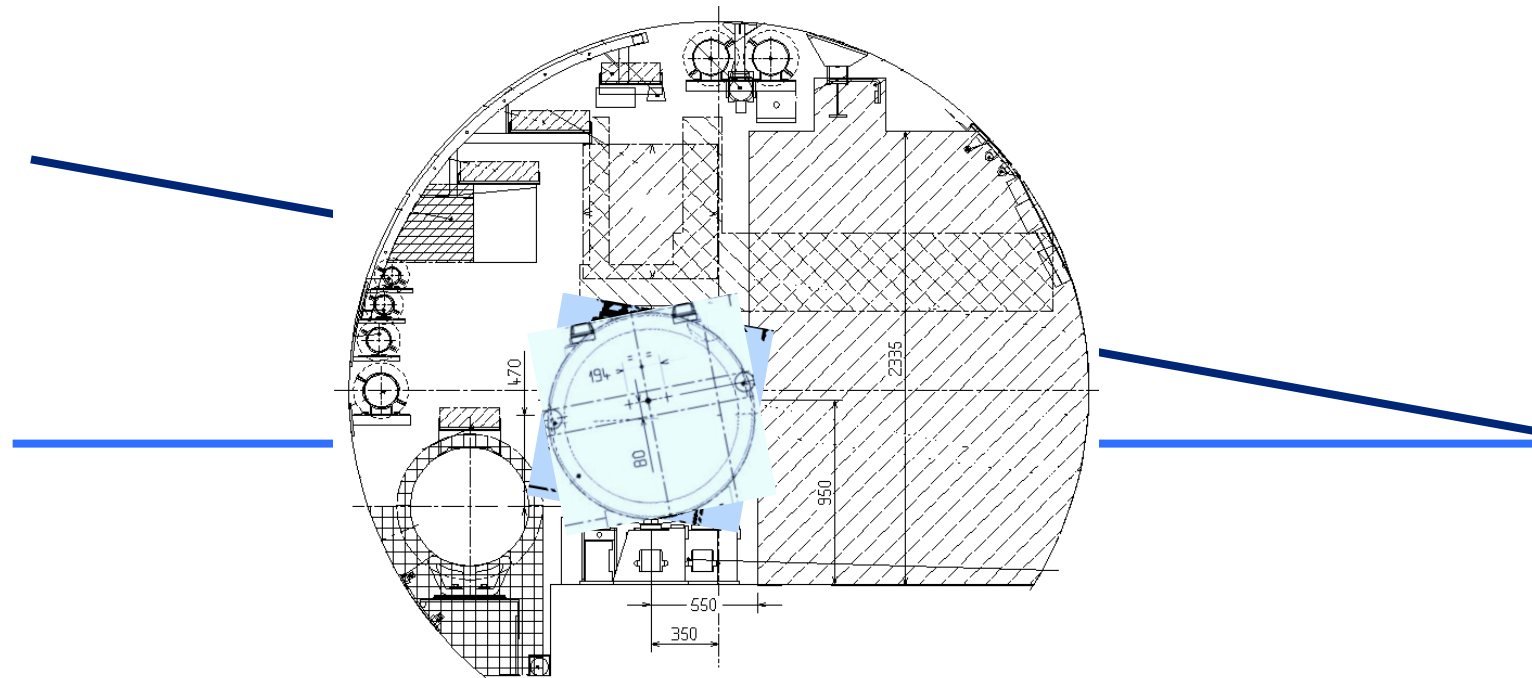
The LHC from the space



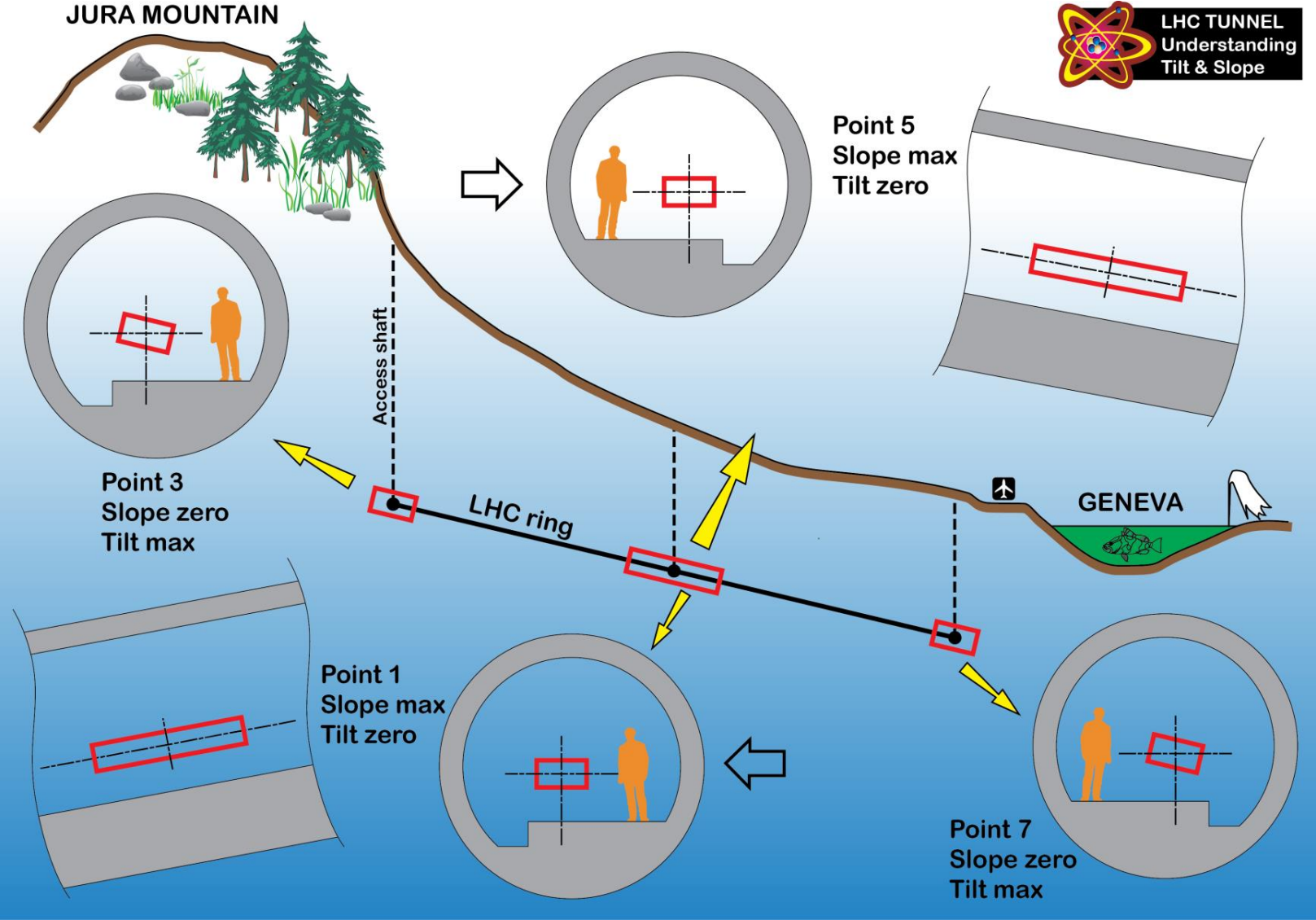
LHC Tunnel : Slope, Tilt...

The tunnel Section stays strictly horizontal everywhere along the 27km,

and magnets are positioned in the plane created by the circle, each element of the machine will have at a certain point its own slope and its own tilt...



LHC Tunnel : Slope, Tilt...



Courtesy of A.Kosmicki

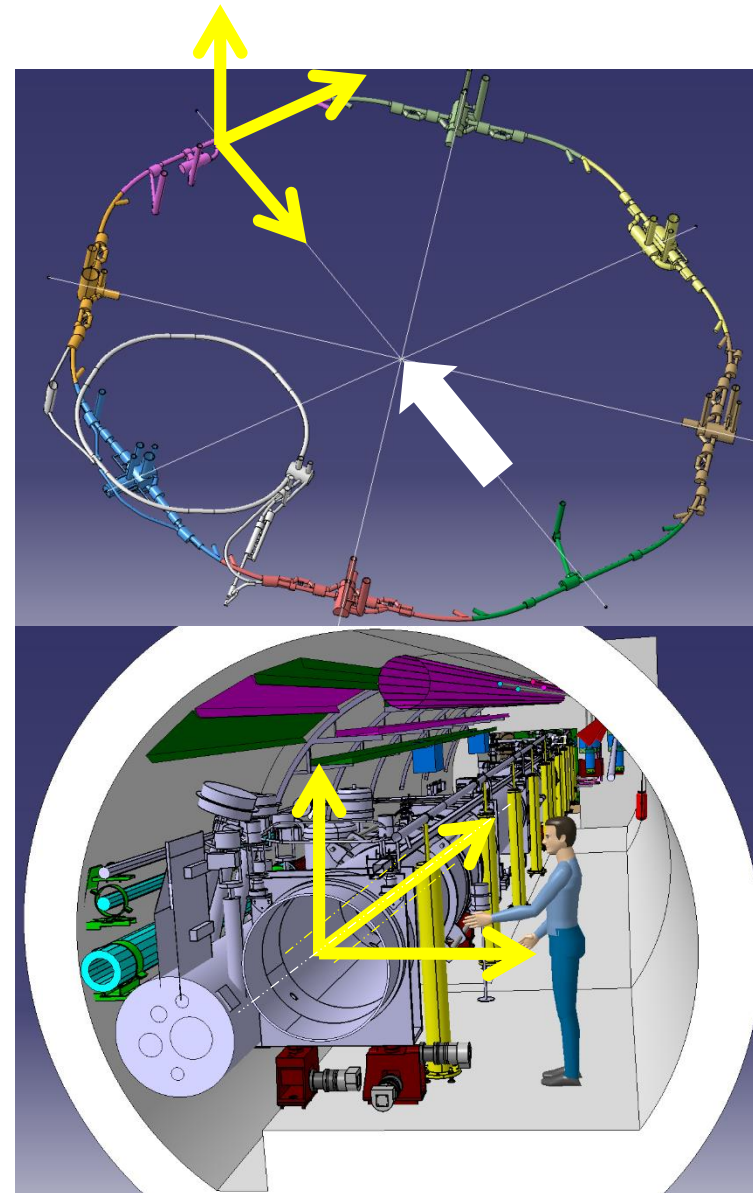
Visualization Convention

Everywhere along the 27km, if you look at the LHC machine, you might consider following postulates:

- ✓ You look
 - from Ring Center
- ✓ The reference is the medium beam axis
 - X_{axis} towards Ring Center
 - Y_{axis} towards Beam downstream(*)
 - Z_{axis} upward

(*) or following DCUM increase, i.e. on the right

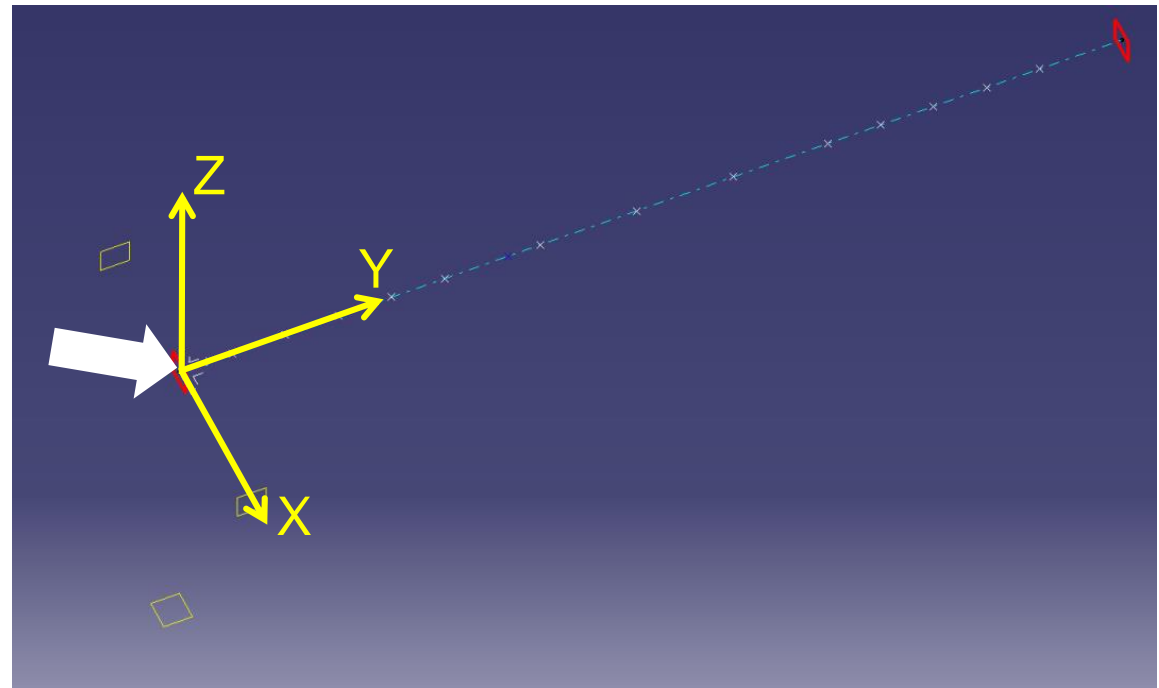
- ✓ A section of the tunnel is always shown “from left” looking downstream



3D machine model delivery

To be integrated properly, every Machine element must be delivered to our designers positioned within this rule:

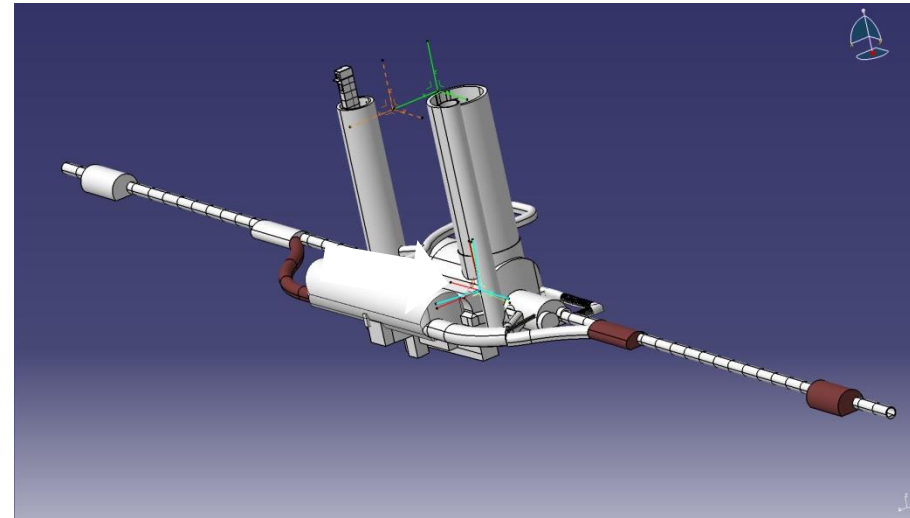
- ✓ The reference of the model(0,0,0) located on the Beam Axis, start plane upstream
- ✓ The referential axis like this:
 - X_{axis} towards you
 - Y_{axis} towards Beam downstream
 - Z_{axis} upward
- ✓ Like this, each model can be handled by all technical offices with the same referential.



3D services model delivery

To be integrated properly, every element must be provided to our designers positioned within this rule:

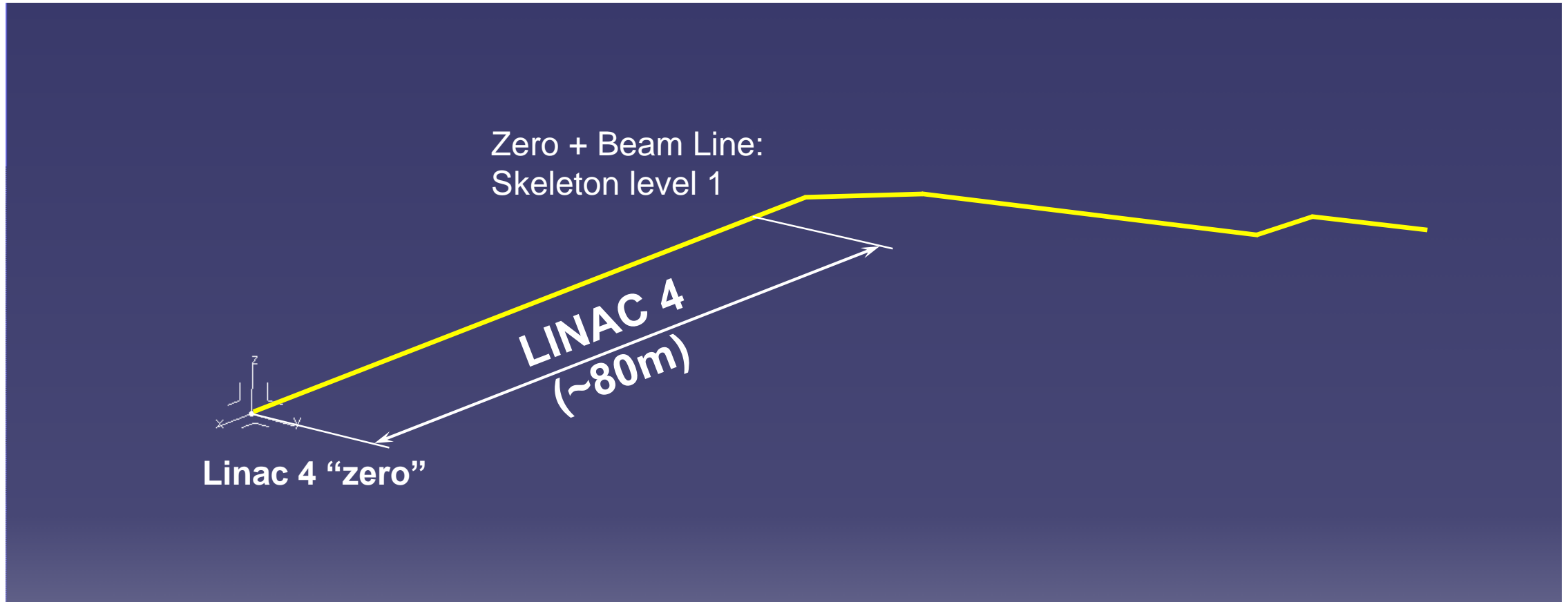
- ✓ Choose the local reference
 - ✓ See [1306899](#) & [1306901](#)
- ✓ Each model is created at its final place respect to this reference
- ✓ Like this, we can find at every time with accuracy models at their good position
- ✓ Don't forget to mention the reference axis in the title !



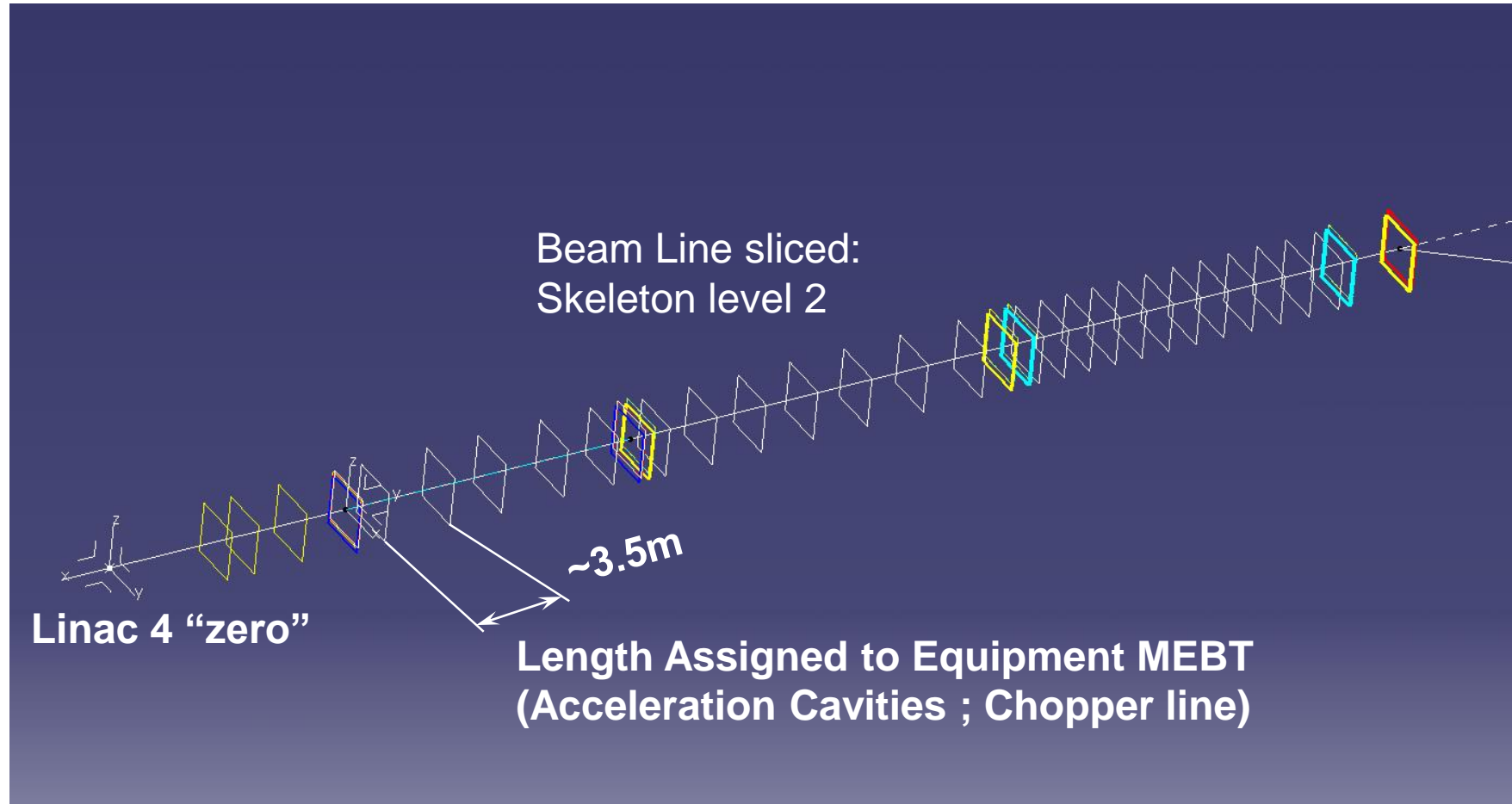
Example : **UL557-1506-Integration YETS22-23**

3D model position in space

Example of Integration with Multilayer Skeletons : Principle



3D model position in space



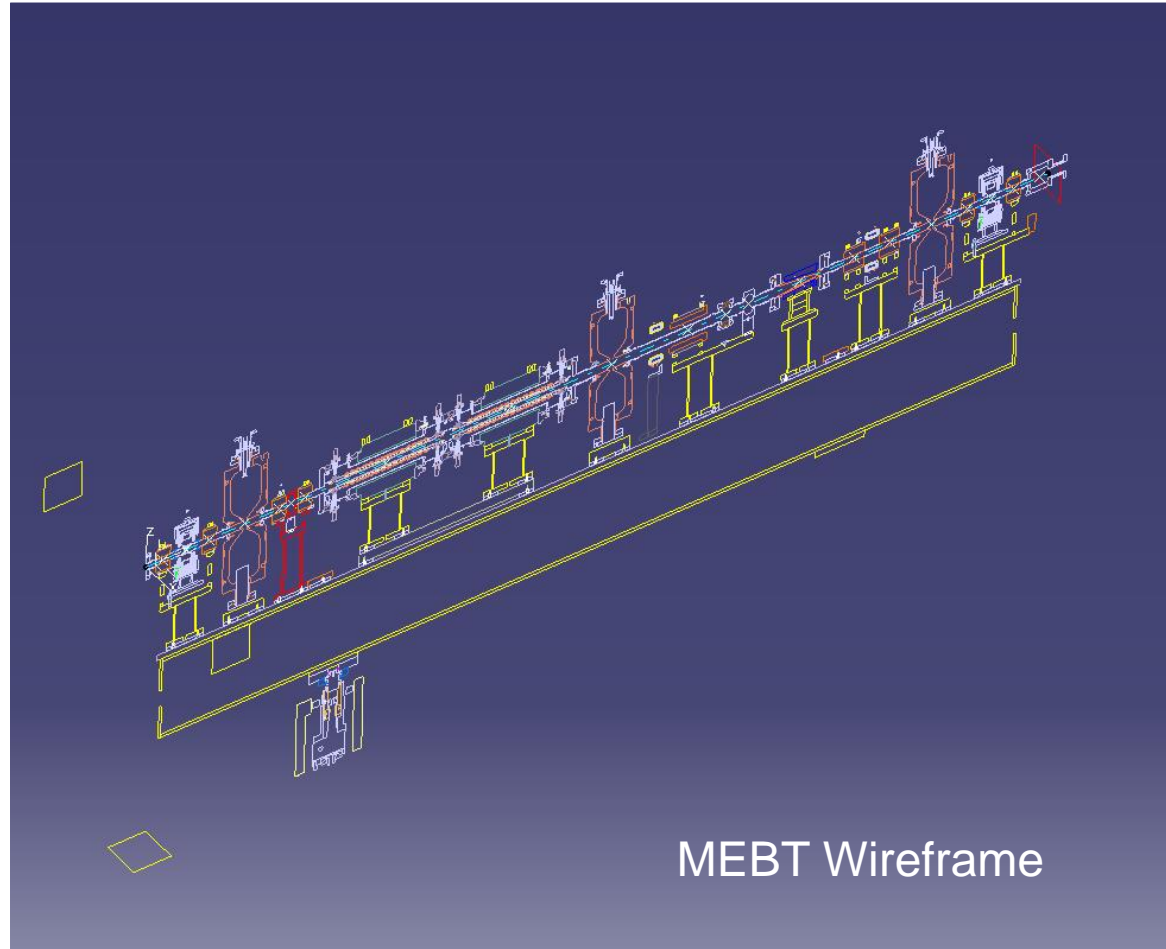
3D model position in space

Example of the Chopper line assembly of the Linac4 :

New information* can be provided by:
Optics or
Mechanical design office or
Integration design office

*

Equipment
Position
Dimension

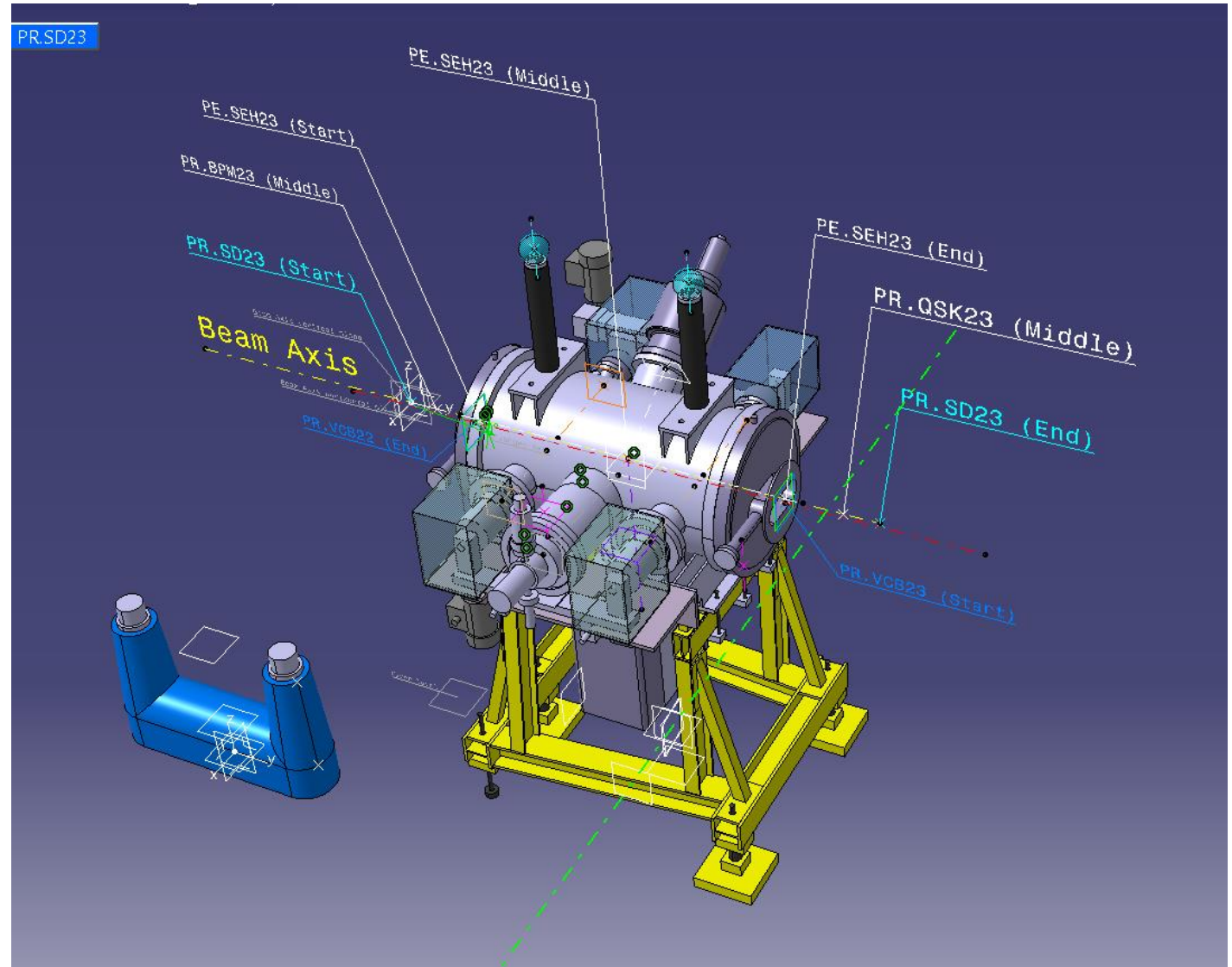


After validation the beam
line Skeleton
modification must be
done by integration
designer

Reminder various Methodo...

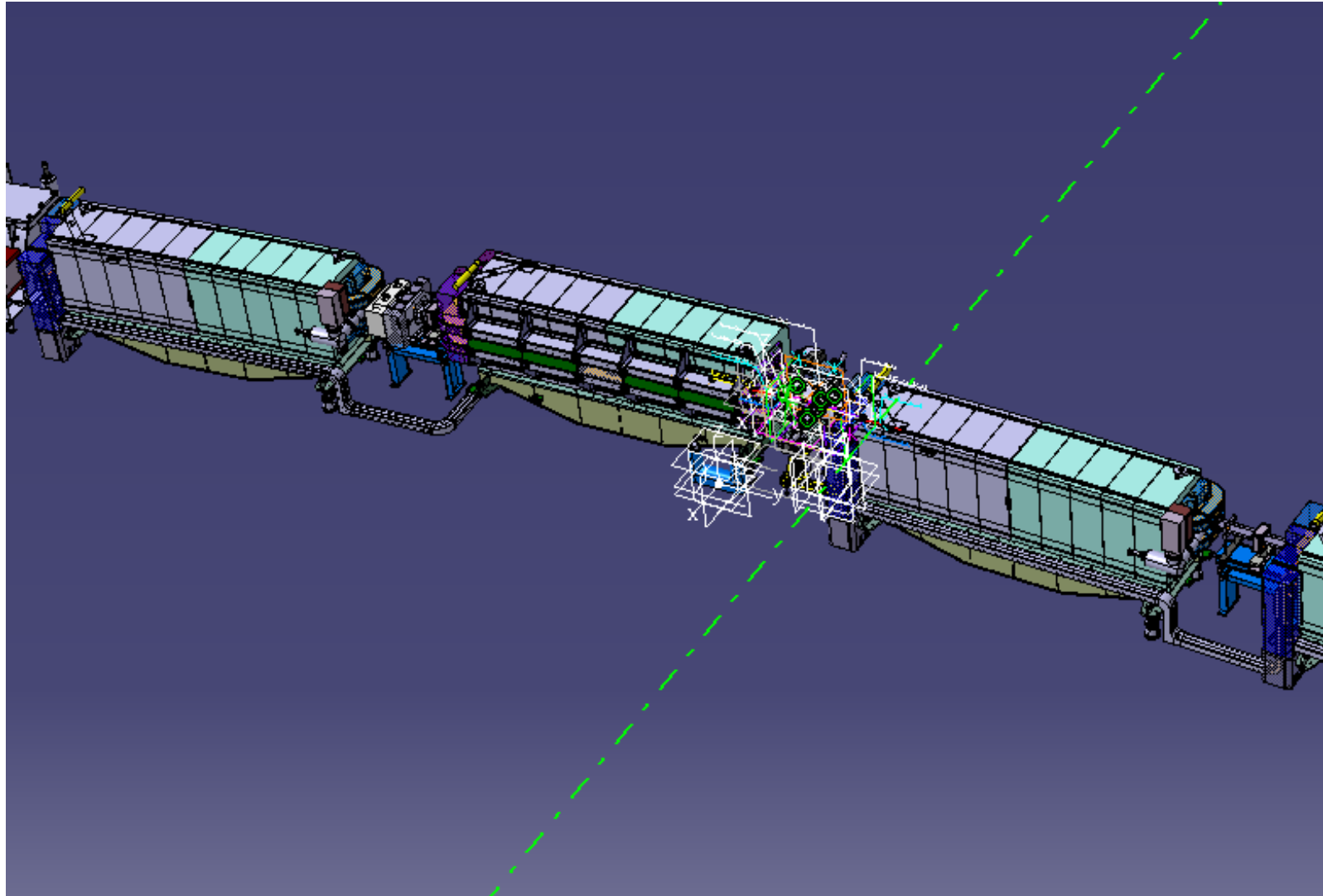
Hide or suppress
what is not useful !

Triedres
Planes
Points
Dimensions
Sections
Sketches
Etc...



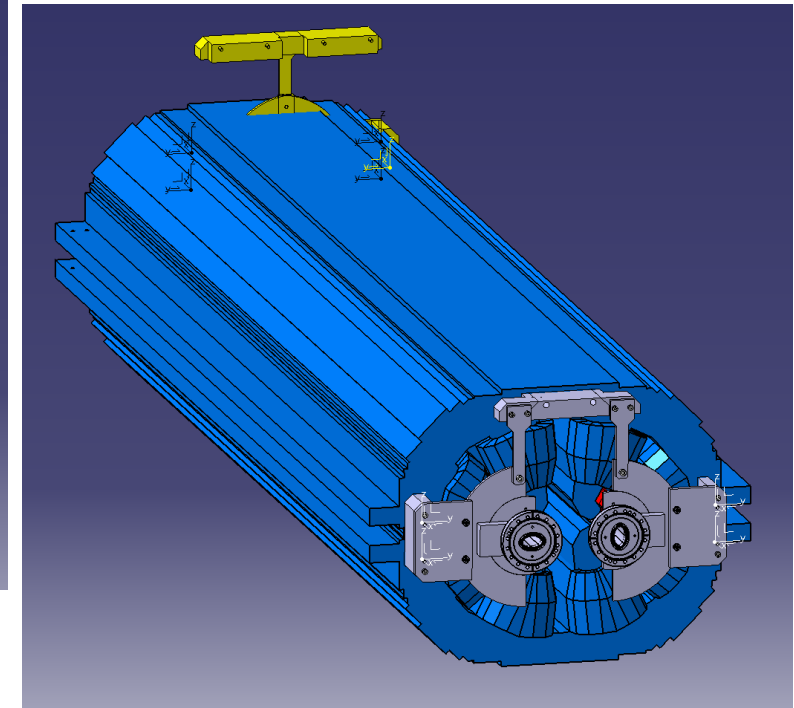
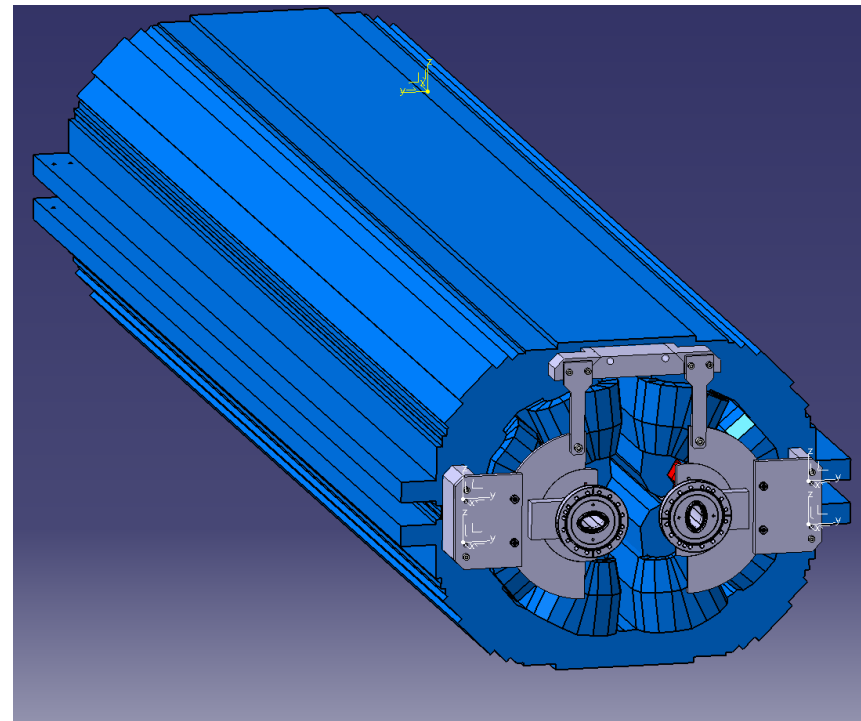
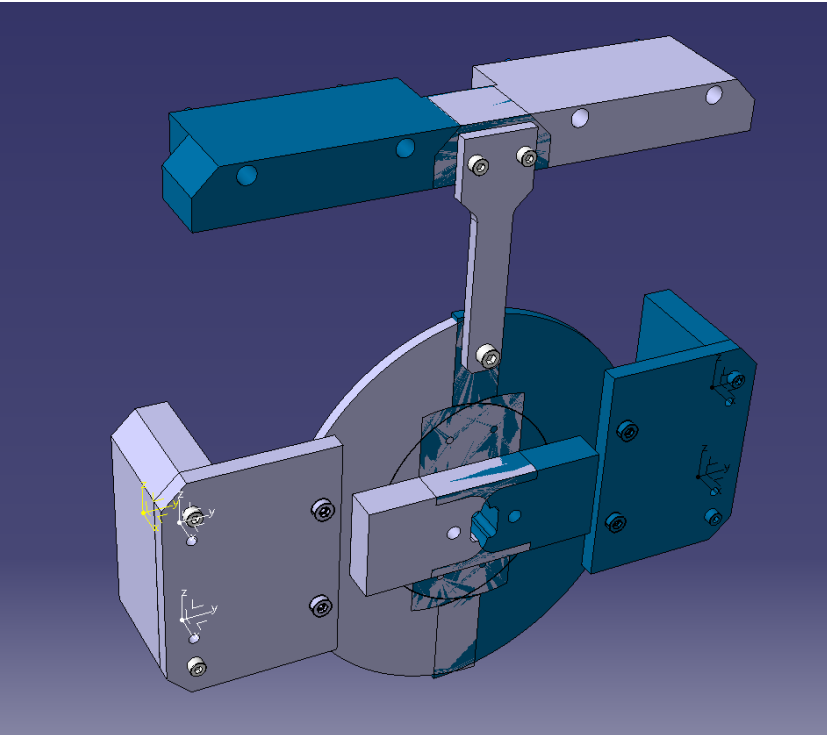
Reminder various Methodo...

To avoid that...



Reminder various Methodo...

Position of the « zero » !!!



Reminder various Methodo...

ITEM (*PART*) is hosting all

Avoid multi ITEMS !!!

ITEM is the common point for all BE

Use « professional » titles

- In case ask to your supervisor...

Finish the life cycle

- Prior we come to ask you...

Integration Timeline for Long Stops

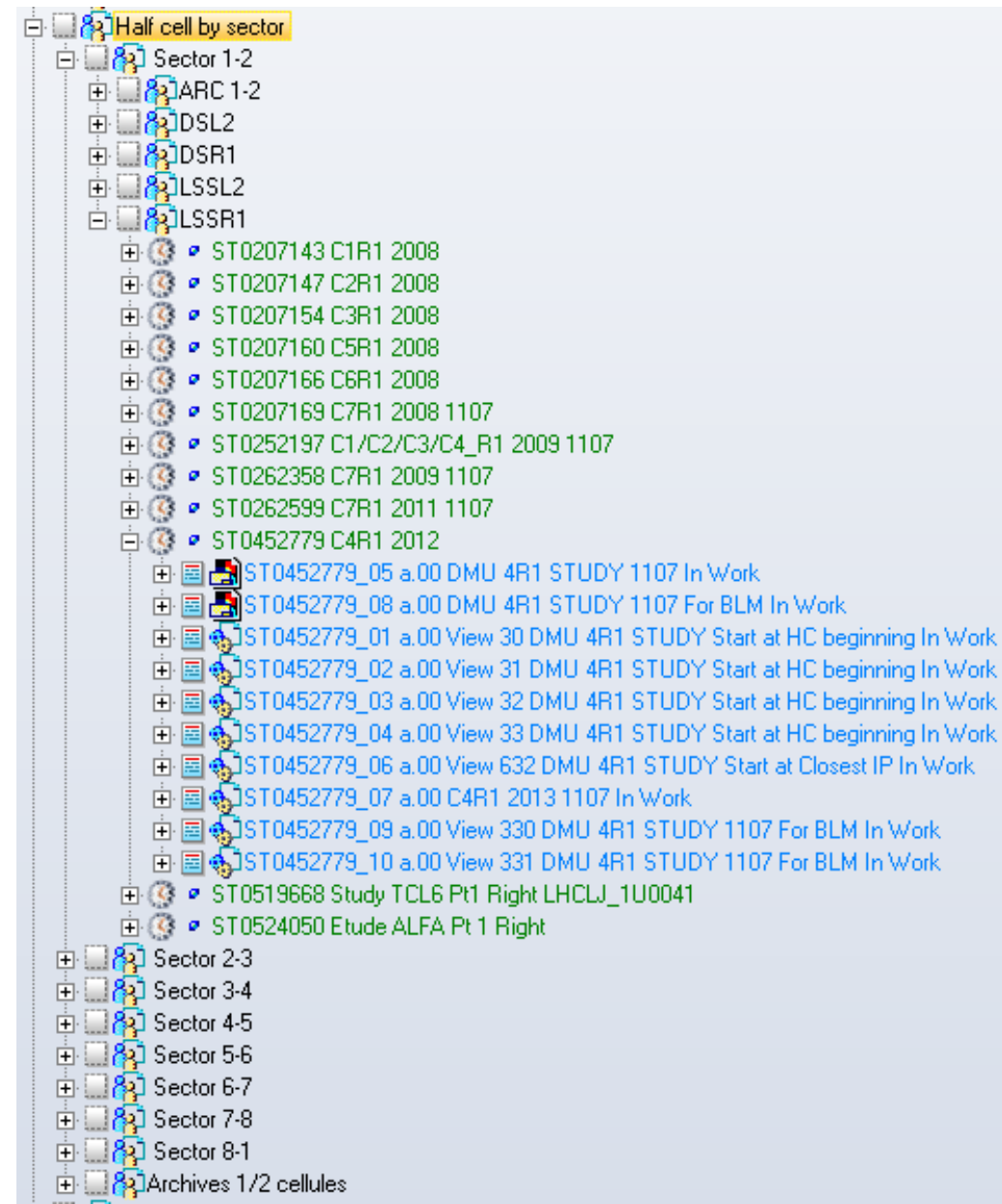
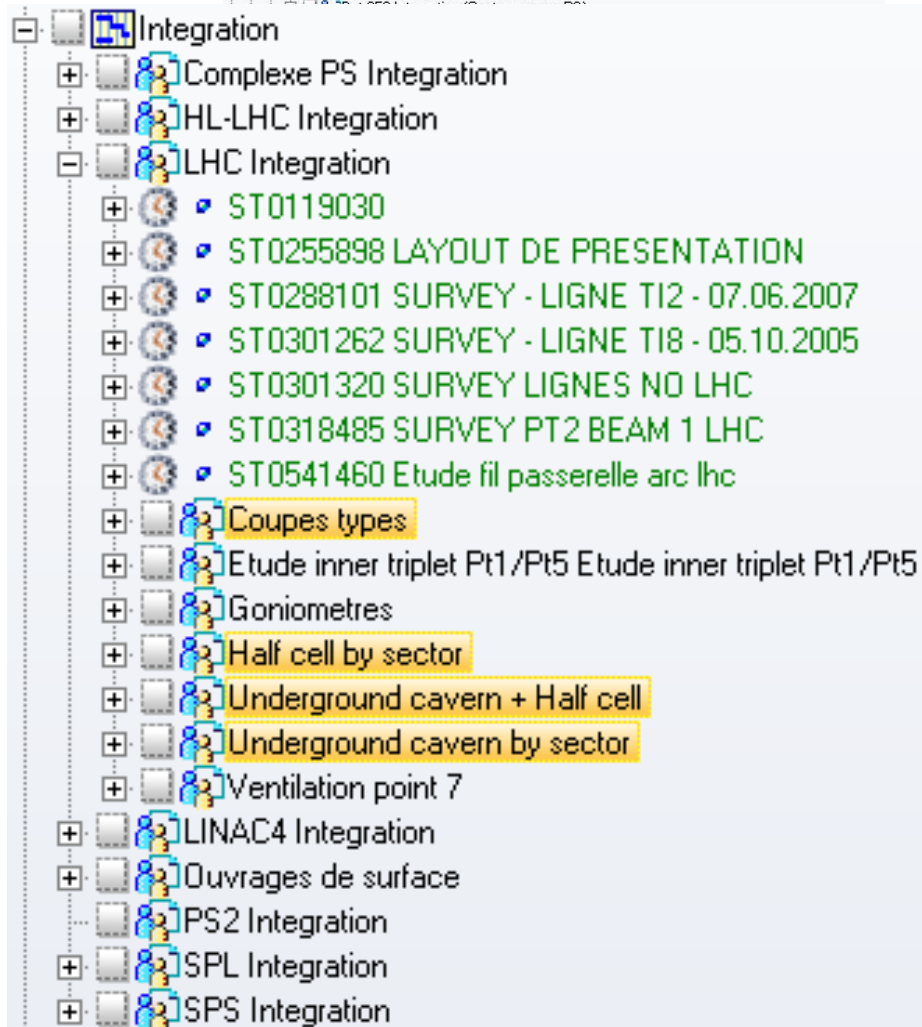
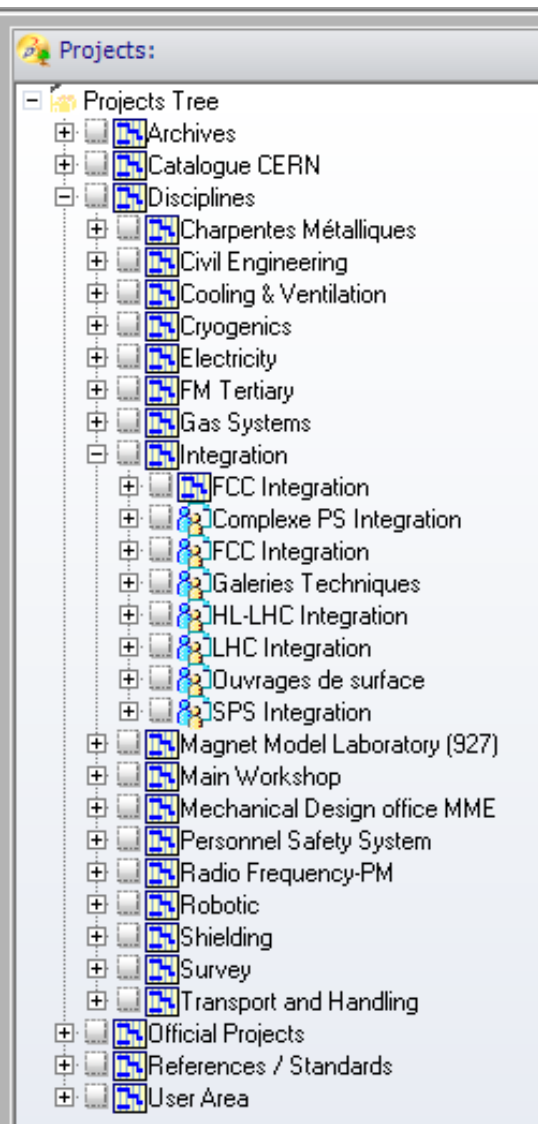
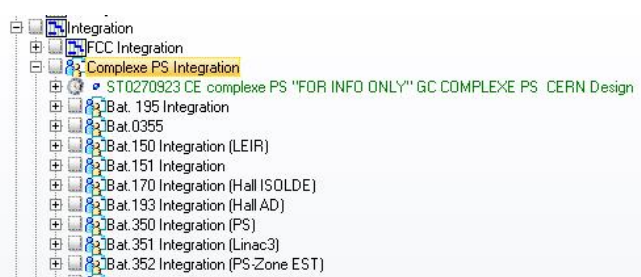
ECRs for YETS-EYETS-LS *Courtesy of ACE-CL*

Tips

Prior submitting an ECR to ACE-CL, it is **mandatory** that:

- **The changes are discussed with ACE-INT and approved by ICL (drawings and models produced and approved)**
- The optics physics simulations (if needed) are discussed with BE/ABP or SY/ABT
- The changes are presented to ACE-OSS
- The equipment alignment is discussed with Survey team

Smarteam (1/2)



Smarteam (2/2)

- Underground cavern by sector
 - ST0246318 ALVEDLE ENSEMBLE EN/EL EQI
 - Sector 1-2
 - Point 1 Right
 - PM18
 - RB16
 - RI171
 - RI172
 - RI18
 - RR17
 - RT18
 - UJ16
 - ST0054016 UJ16-1101-INTEGRATION GENERALE CERN Design
 - ST0254983 1101-UJ16 INTEG 2009/11 CERN Design
 - ST0263237 UJ16-1101-INTEG 2014/03 CERN Design
 - ST0733723 UJ16-1101-Integration-YETS2016 CERN Design
 - ST0927034 UJ16-1101-INTEG_HL_LS3 CERN Design
 - ST1136896 UJ16-1101-Integration LS2 CERN Design
 - ST1796784 UJ16-1101-Integration EYETS24-25 CERN Design

- Bat.360 Integration (PS Booster)
 - ST0600597 3102 - 361 PSB Integration PBUKS__0001 CERN Design
 - ST0790563 LIU_PSB_BRF2_Integration_2016 CERN Design
 - 360-Infrastructure
 - Booster Ring & lignes transfert
 - LIU-PSB (Booster Upgrade)
 - ST0434836 360-3102-LIU-INTEGR. INJ. AREA 360-3102-LIU-INTEGR. ZONE INJ. CERN Design
 - ST0476832 LIU-PSB DUMP AREA CERN Design
 - ST0686662 INTEGRATION BT-BTP-BTM-BTY CERN Design
 - ST0686662_01 a.00 INTEGRATION BT-BTP-BTM-BTY LS2 In Work
 - ST0686662_02 a.00 INTEGRATION BT-BTP-BTM-BTY YETS 2021-2022 In Work
 - ST0686662_03 a.00 3102 - INTEGRATION BT-BTP-BTM-BTY EYETS 24/25 In Work
 - ST0734609 Infrastructure PSB-BT-BTP-BTM-BTY CERN Design
 - ST0734609_01 a.00 3102 - Infrastructure PSB-BT-BTP-BTM-BTY - LS2 In Work
 - ST0734609_02 a.00 3102-Infrastructure PSB-BT-BTP-BTM-BTY EYETS 24/25 In Work

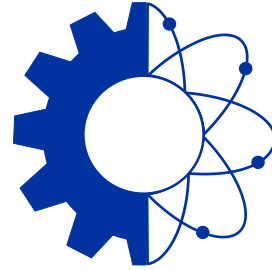
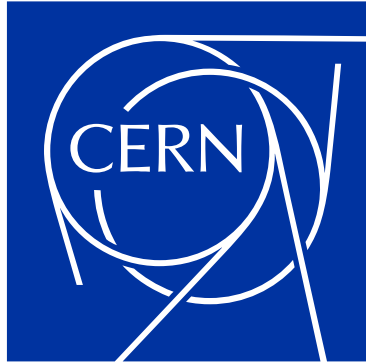
Integration Web Site

To be added in your [Favorites](#)

For everything else, contact us !

julie.coupard@cern.ch

jean-pierre.corso@cern.ch



**ENGINEERING
DEPARTMENT**

home.cern