



WP15: Integration of HL-LHC systems & equipment + LS3 planning studies

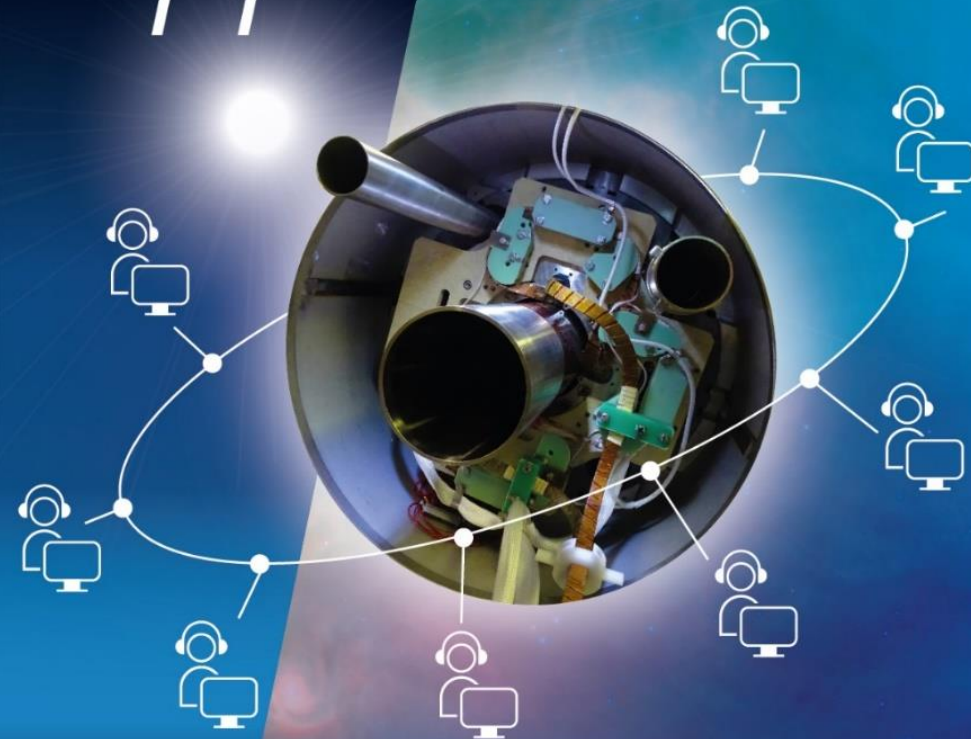
WP15 Team:

C. Bertone, P. Fessia, M. Gonzalez, J-L Grenard, S. Maridor, M. Modena, J. Oliveira, P. Pinheiro and G. Aparicio

HIGH LUMINOSITY LHC / HL-LHC

11th

HL-LHC Collaboration Meeting
CERN, 19 > 22 October 2021



The 11th HL-LHC Collaboration Meeting will be held in digital format and will take place from 19 to 22 October 2021. This format was chosen after consultations with all collaboration partners and tries to address the preferences of all HL-LHC collaborators given the persisting travel restrictions and limitations for social gatherings due to COVID-19.

Based on the traditional programme with plenary and work package parallel sessions, this meeting will serve as a technical update forum for the 5th Cost and Schedule Review, which is scheduled for 8-10 November 2021.

The main objectives will be to update all HiLumi collaborators on the results of key HL-LHC prototype tests, to highlight the progress made in the last year when all work still had to adapt to pandemic restrictions, and to update all collaborators on the latest schedule changes.

This year, all HL-LHC collaborators will be invited to follow the presentations 100% remotely. Participation in the meeting is by invitation only, and registration is mandatory and without fee.

CERN - Organizing Committee



- Oliver Brüning Project leader
- Markus Zerlauth Deputy Project leader
- Cécile Noels Project Office

For more details and registration

www.siteweb-hilumi.ch

Content

WP15 activities a wide subject!... So focusing on:

A. Integration & (De)-Installation studies:

- a) what was done/on-completion: main recent key achievements
- b) what remain as most critical open issues (on short term)

B. LS3 Planning studies:

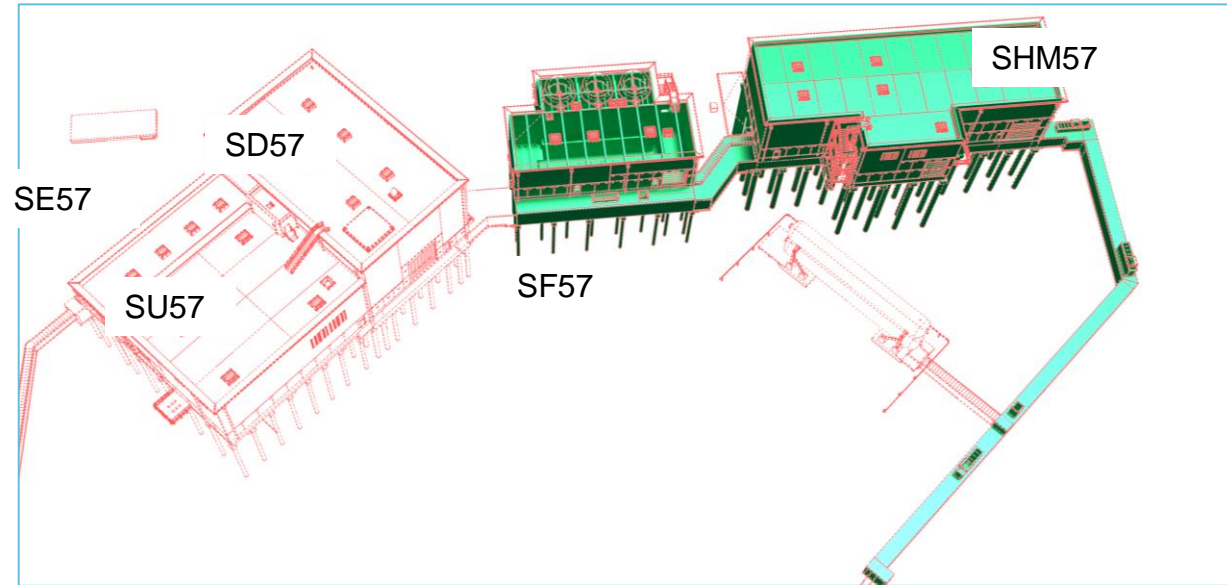
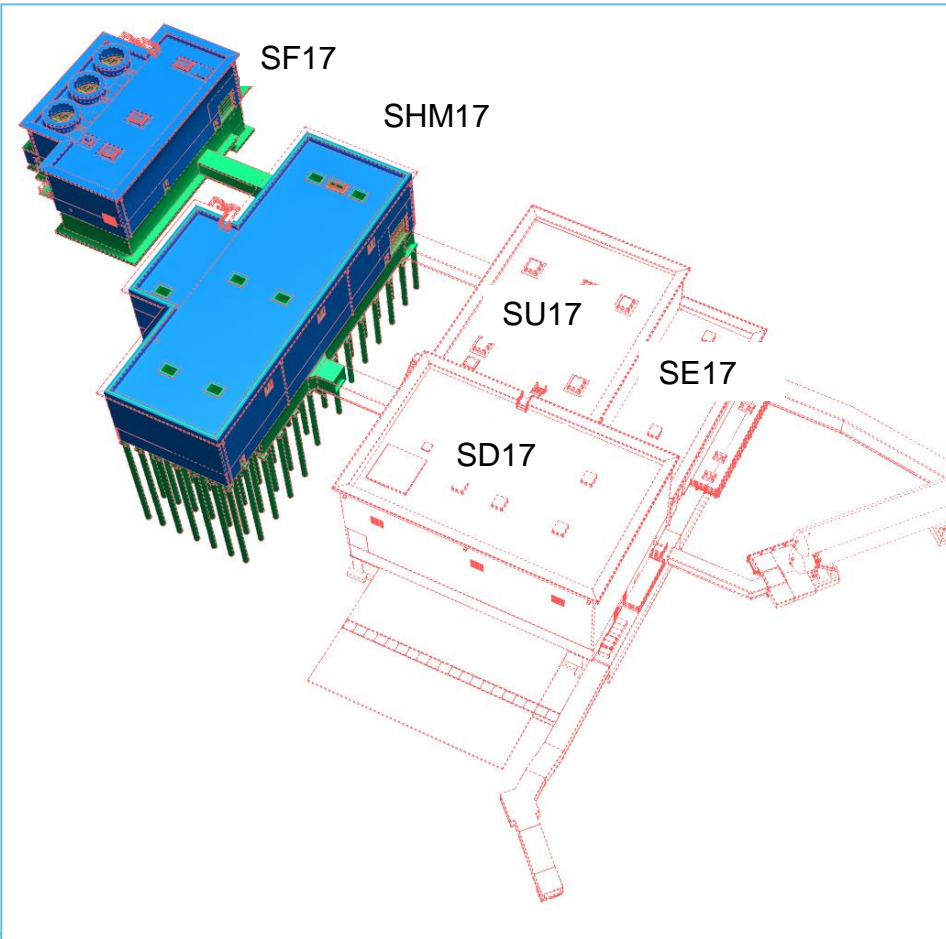
- a) what was done
- b) what is ongoing/to be done

C. Others activities/studies

- c1) Rad-hard cables layout and procurement
- c2) LDB activities
- c3) WP15.5/EN-HE Transport studies
- c4) others ...

A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement
*(moving from **surface** to **underground**...)*

a1). Integration and Final Reviews of surface Buildings.



A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement



EDMS NO. 2476229	REV. 1.0	VALIDITY DRAFT
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REFERENCE : 2476229

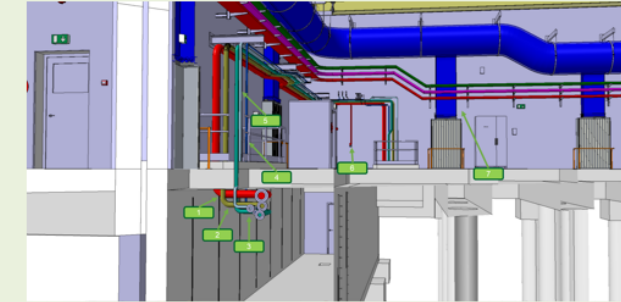
a1). Integration and Final Reviews of surface buildings.

- Set and ruling a review process to drive the transition of the buildings integration from “in work” to “ready for installation” with an important
- final validation step as: “Review of Integration for Installation”.
- The review process puts together all the intervenants (building owners, safety, services, transport, accesses, equipment owners, coordination, etc.) in order to ensure that a coherent set of data (3D models, cabling and other service requests, access procedures, etc.) is available and approved before the start of installation activities.
- Four buildings have already received the green light; they are **SF17, SF57, SHM17 and SHM57**

EN-CV (WP17.3)

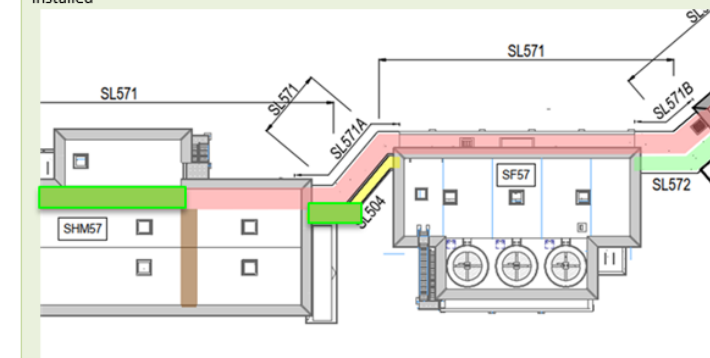
Phase I

The ventilation duct, its derivations and the diffusers and the pipes for Firefighting water, Waste water from sump SF57, Refilling water, Potable water, Compressed Air.



Phase I (partial installation)

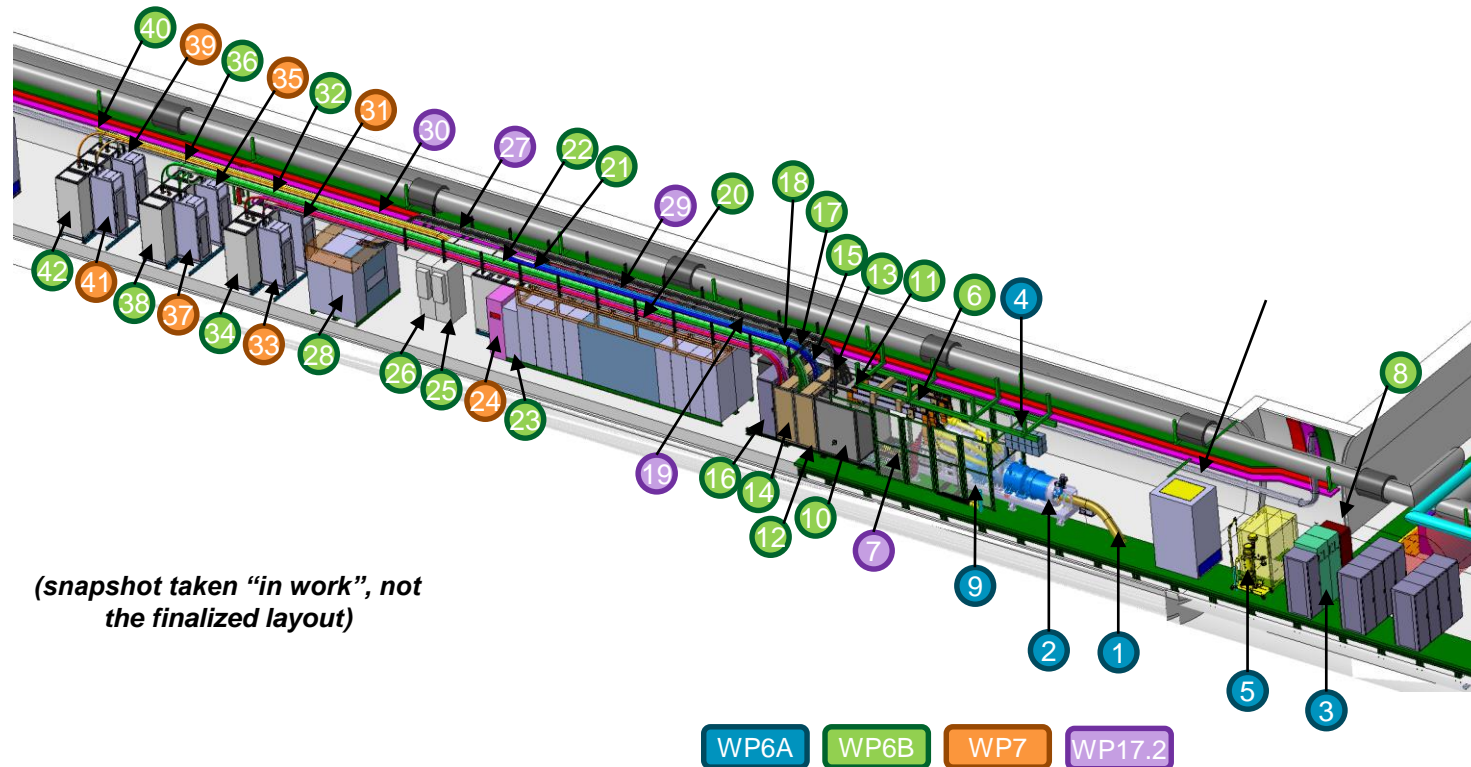
Following a proposal from TE-CRG to fully route the EN-CV's raw water in the technical galleries, it was decided by EN-CV that these would be installed in two phases as a means to ensure the possibility of two scenarios: the one comprehended in HL-LHC's baseline and the proposed one. The zones represented in darker green correspond to the portions of pipes which shall be installed



- The piping sections to be installed in Phase I will be connected to the one to be installed in Phase 2 using DN300.

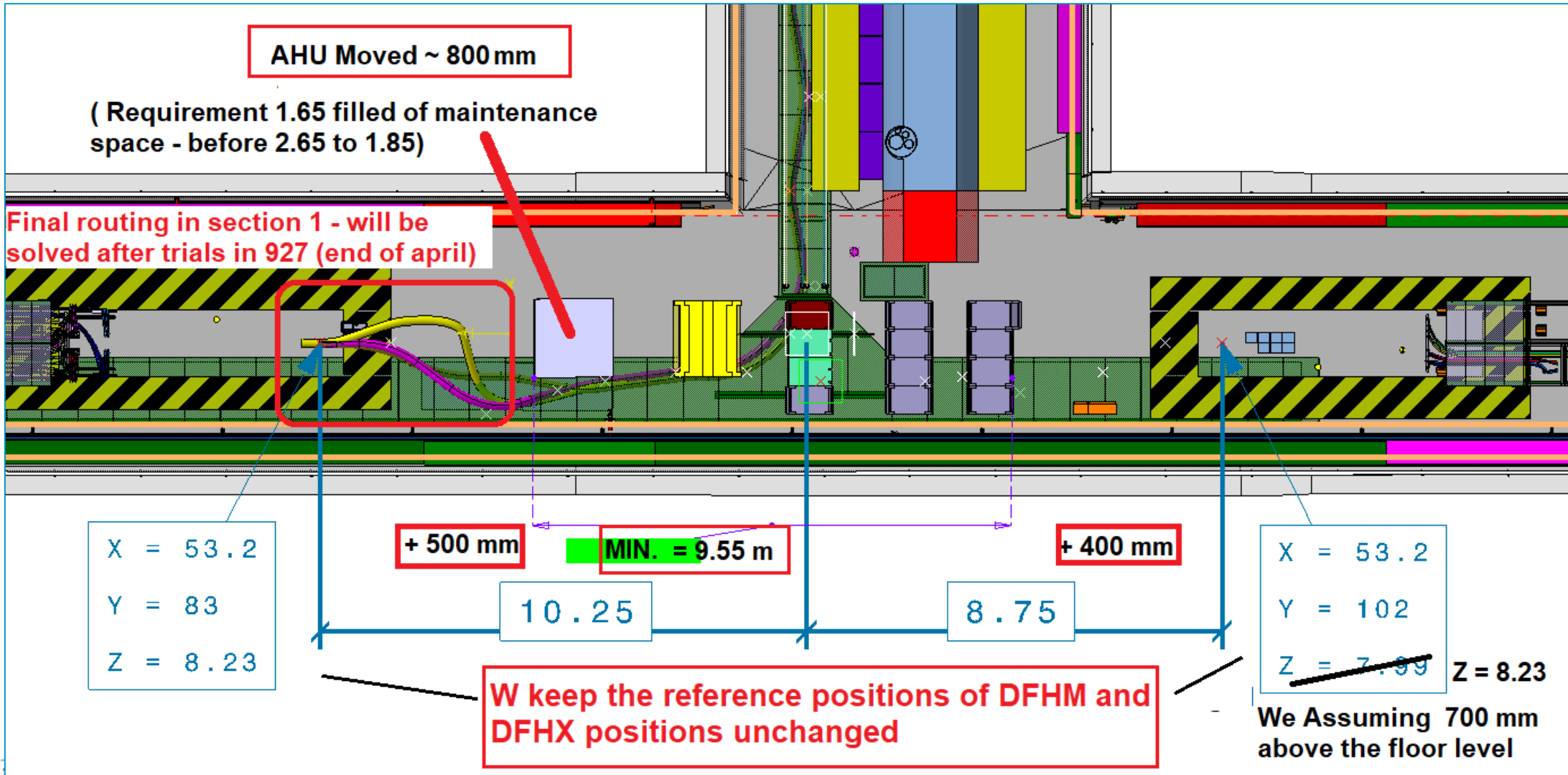
A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement

a2). Integration of the HL-LHC equipment/services in the new tech. galleries



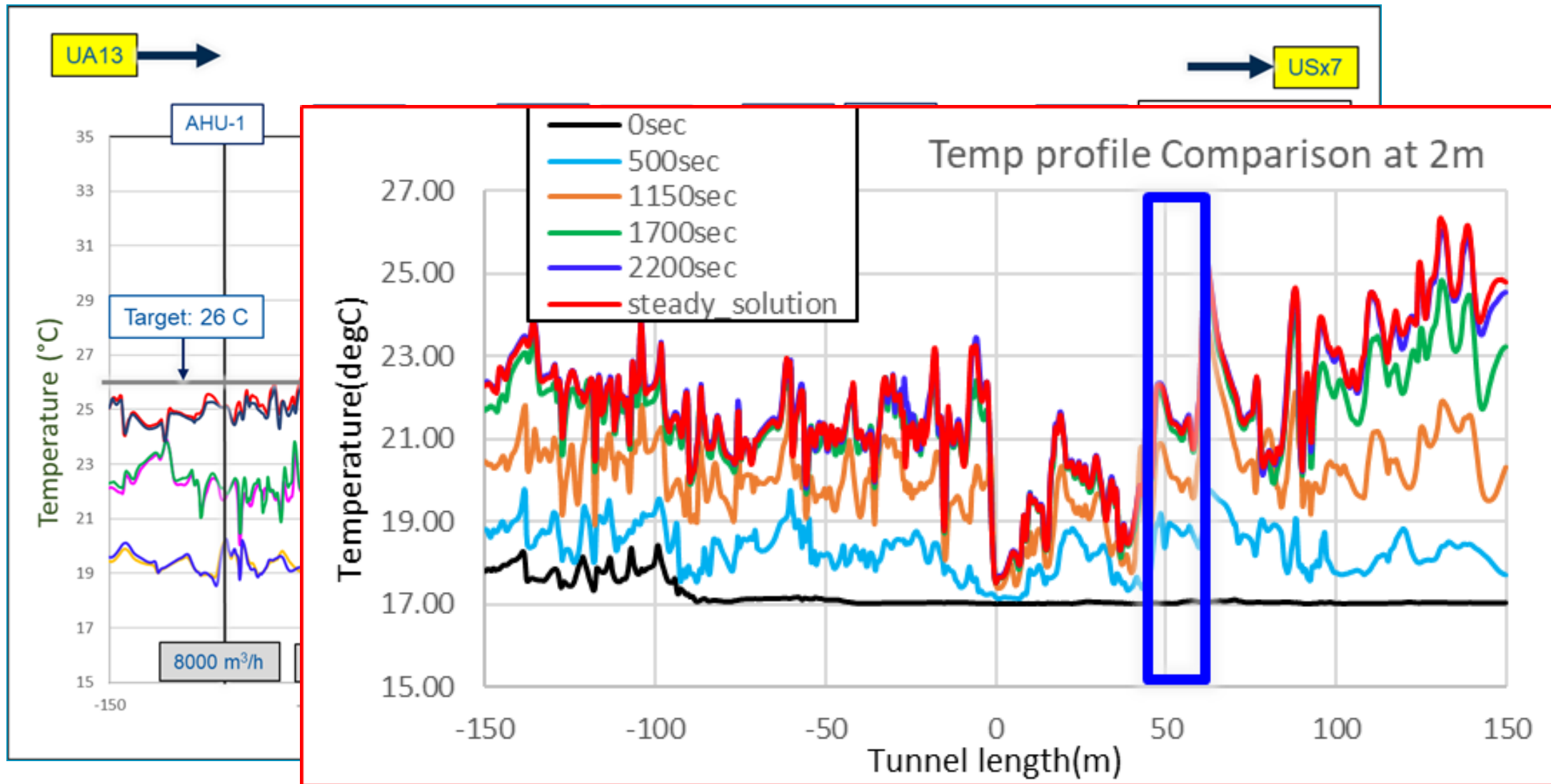
1	DSHX
2	DFHX
3	Rack control DFHX current leads
4	Transformers for DFHX current leads
5	DFHX valves and heater
6	Water cooled busbars for RQX & RD1
7	Air cooled cables for RCBX & RTQX
8	HCRYCHB FEC rack
9	IP2X grid (WP15 representation)
10	CDB 14kA RD1
11	CDB 18kA RQX
12	2 x CDB 2kA RCBX H2/V2
13	2 x CDB 2kA RTQX1/3
14	2 x CDB 2kA RCBX H3/V3
15	2 x CDB 2kA RCBX H1/V1
16	CDB RTQXA1/3
17	CDB Earthing System
18	CDB Electronics and PLC
19	RQX Water Cooled Cables
20	PC 18kA RQX Inner Triplet
21	PC 2kA RTQX3
22	PC 2kA RTQX1
23	PC 60A RTQXA1
24	Warm diodes rack
25	RYABC Rack measurement for 18kA
26	RYABC Rack measurement for 14kA
27	RD1 Water Cooled Cables
28	PC 14kA RD1
29	RTQX1/3 Water Cooled Cables
30	RCBX Water Cooled Cables
31	Energy Extraction RCBXV3
32	PC 2kA RCBXV3
33	Energy Extraction RCBXH3
34	PC 2kA RCBXH3
35	Energy Extraction RCBXV2
36	PC 2kA RCBXV2
37	Energy Extraction RCBXH2
38	PC 2kA RCBXH2
39	Energy Extraction RCBXV1
40	PC 2kA RCBXV1
41	Energy Extraction RCBXH1
42	PC 2kA RCBXH1

A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement **a2). Integration of the HL-LHC equipment/services in the new tech. galleries**



A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement

a2). Integration of the HL-LHC equipment/services in the new tech. galleries



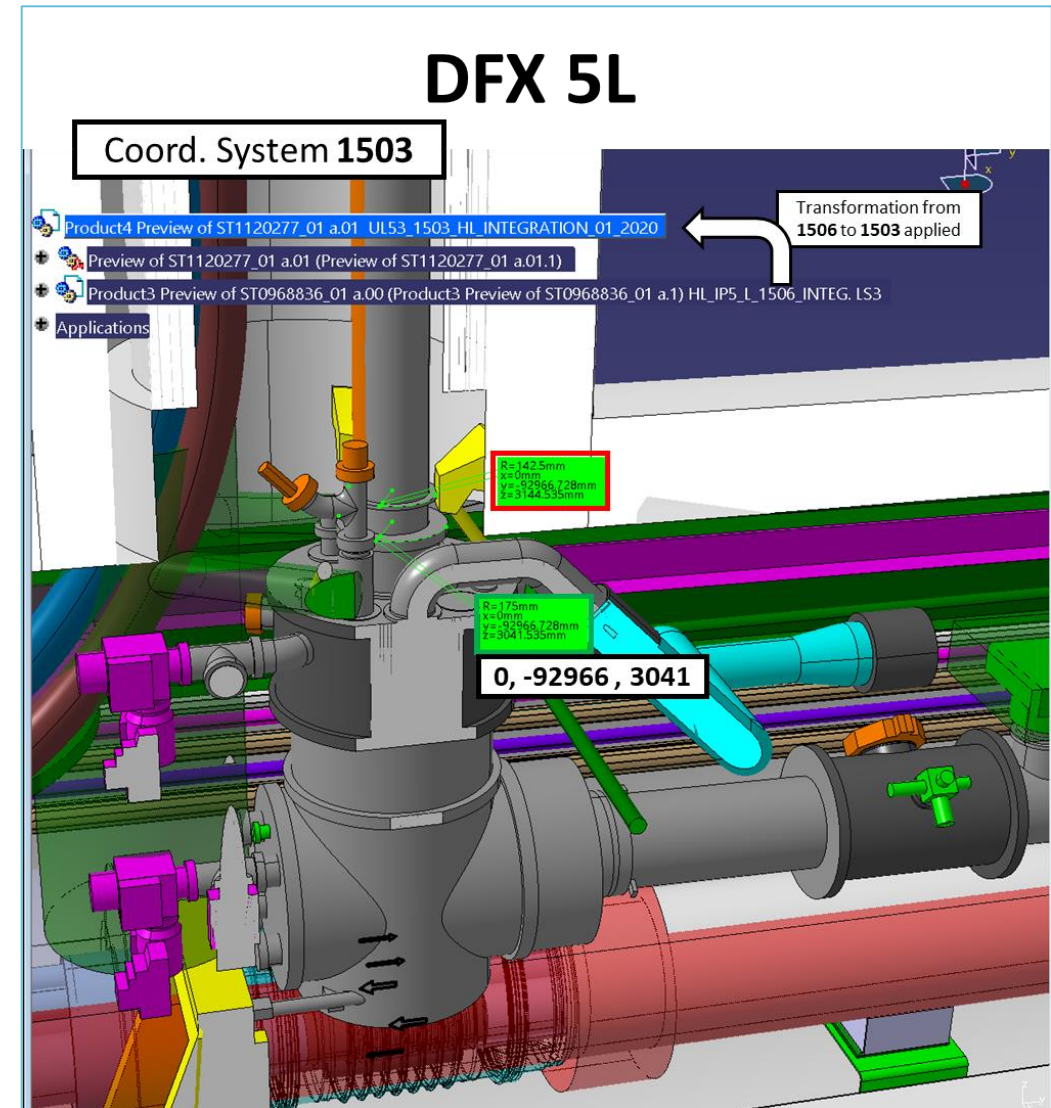
Courtesy: Rahul Hariprakash Shukla (EN-CV)

A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement

a3). Integration of equipment/services in LHC

LHC Tunnel:

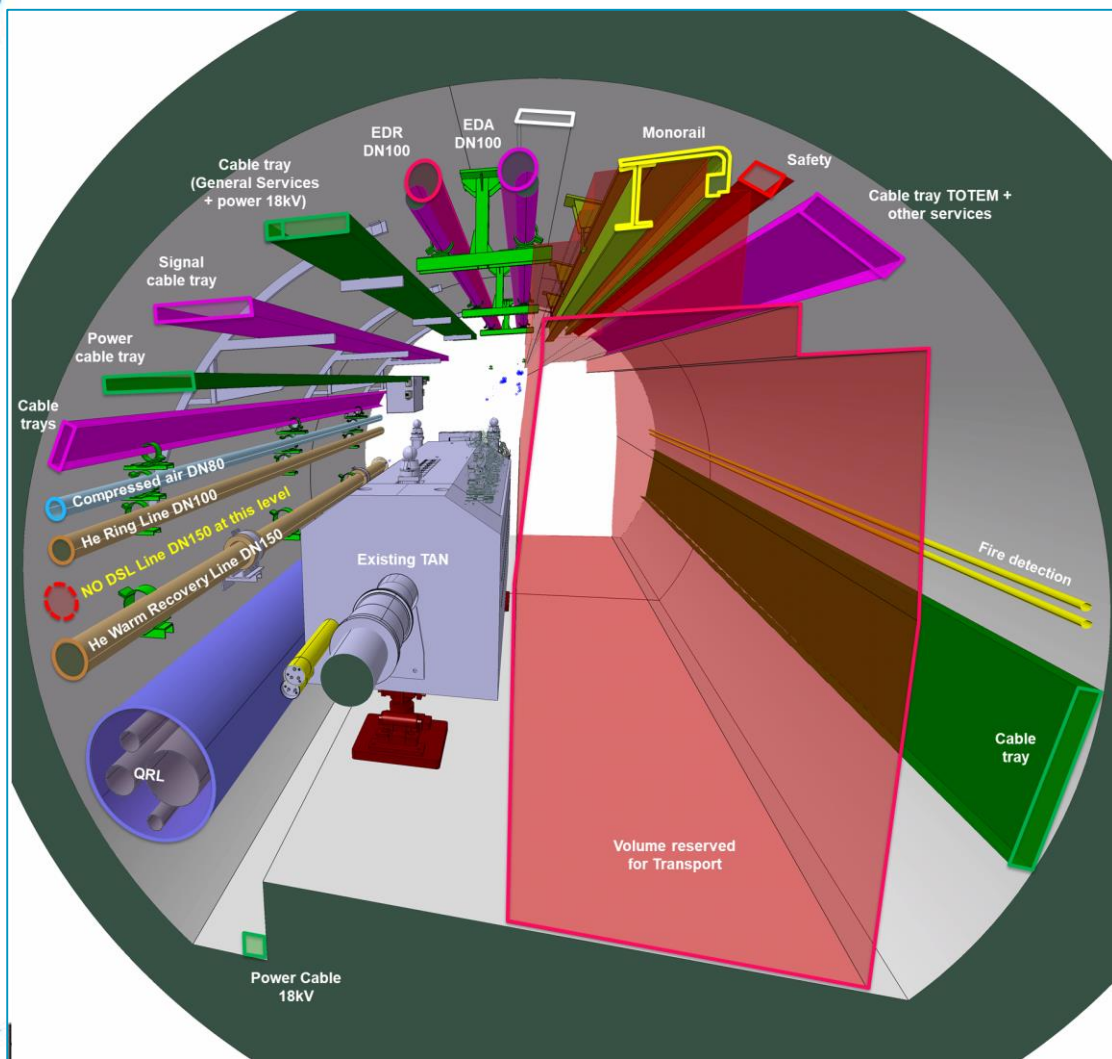
- One of the most delicate and challenging activity:
- Concerns the new machine equipment installation, taking into account major and minor equipment design changes, including maintenance required volumes, and integration of ALL services.
- In the last year WP15 has coordinated the effort of concerned teams (*EN-EL, EN-CV, Survey, TE-CRG, EN-HE + all WPs with equipment to be installed*) to review new equipment, their ancillaries, maintenance needs plus all services integration from the beam line region outward.
- Work advancing (*often with serious difficulties... "Devil is in the details!"...*)



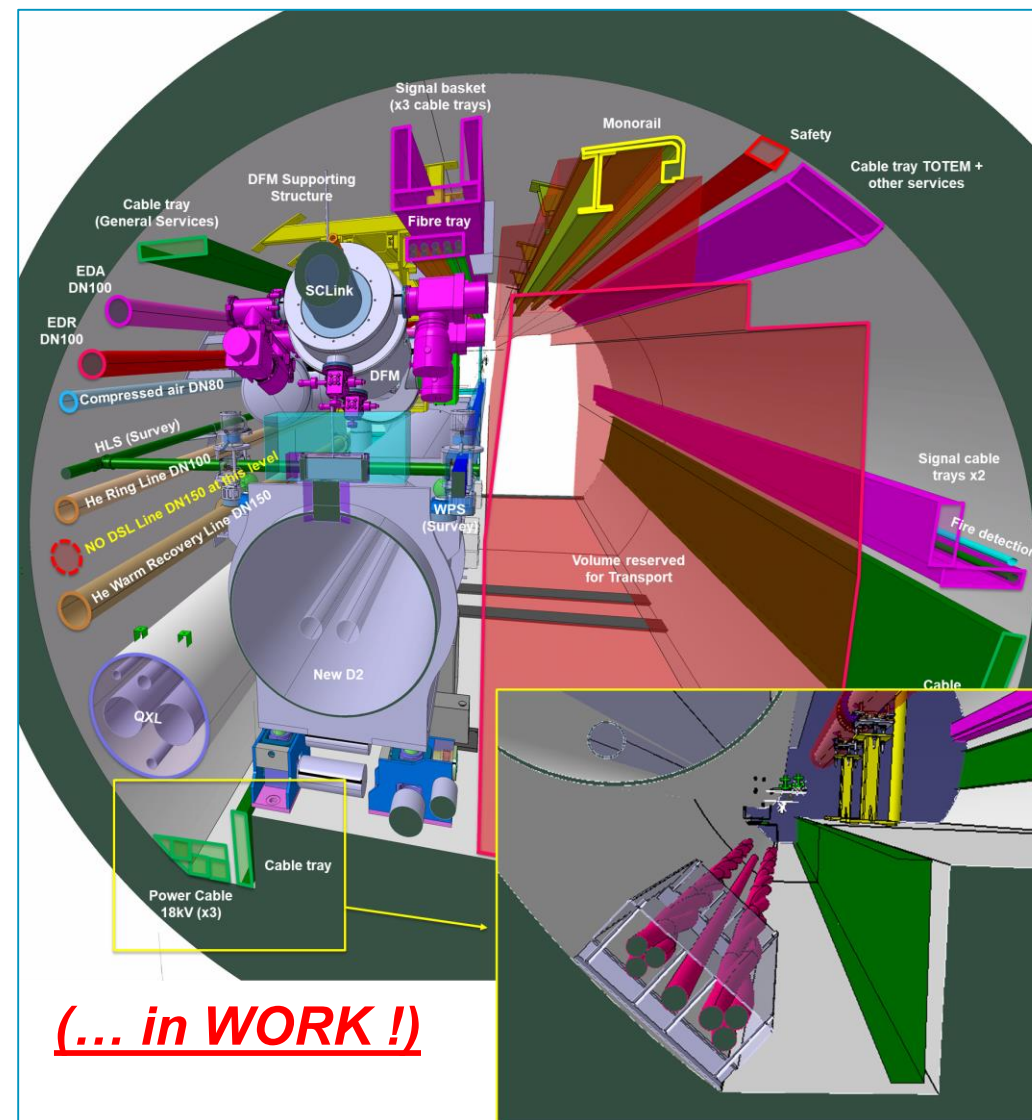
A. Integration/(De)-Installation studies: what was done/on completion: main recent key achievement

a3). Integration of equipment/services in LHC

6 cable trays (LS2)

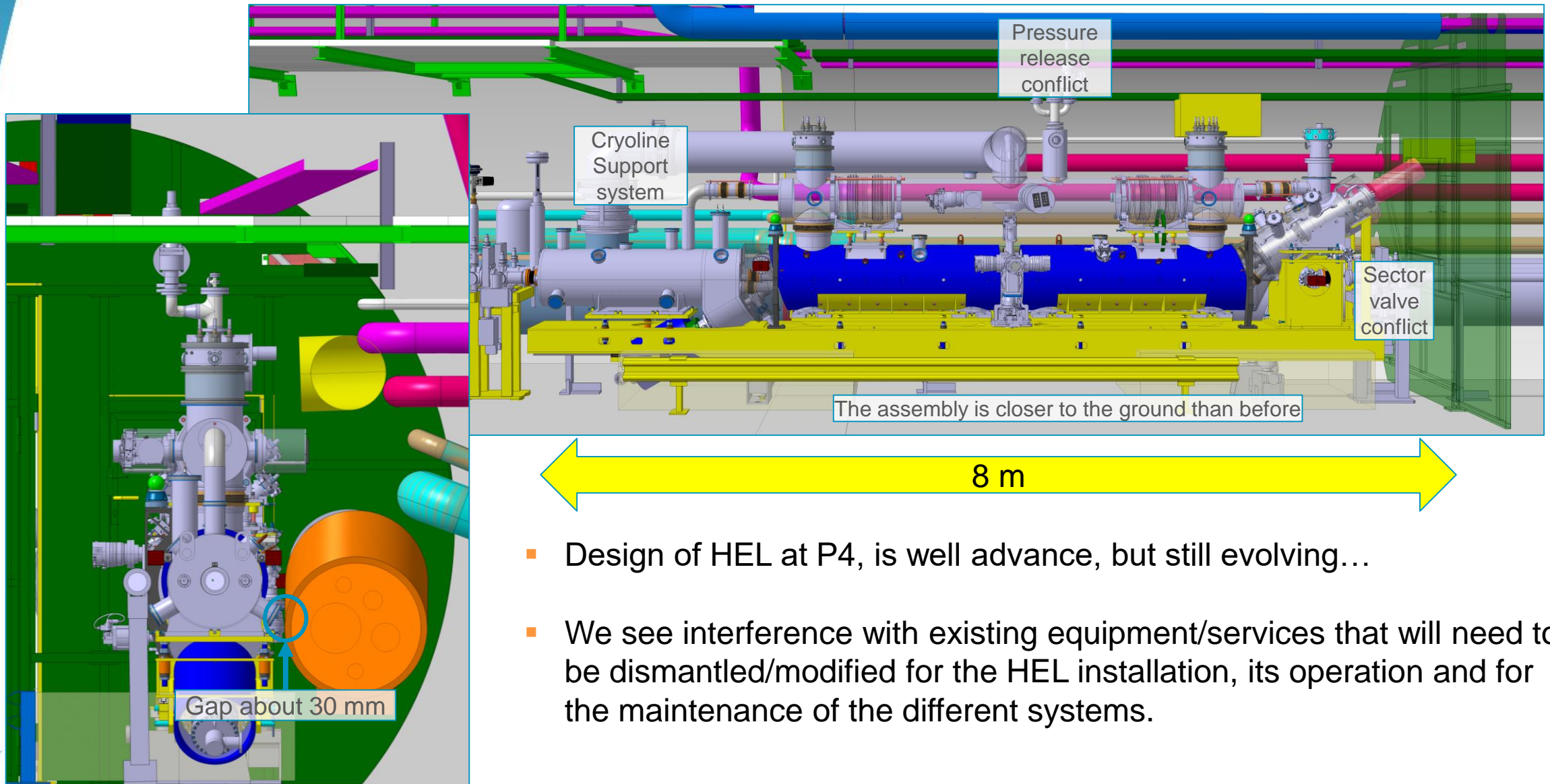


10 cable trays (LS3)



A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement

a3). Integration of equipment/services in LHC

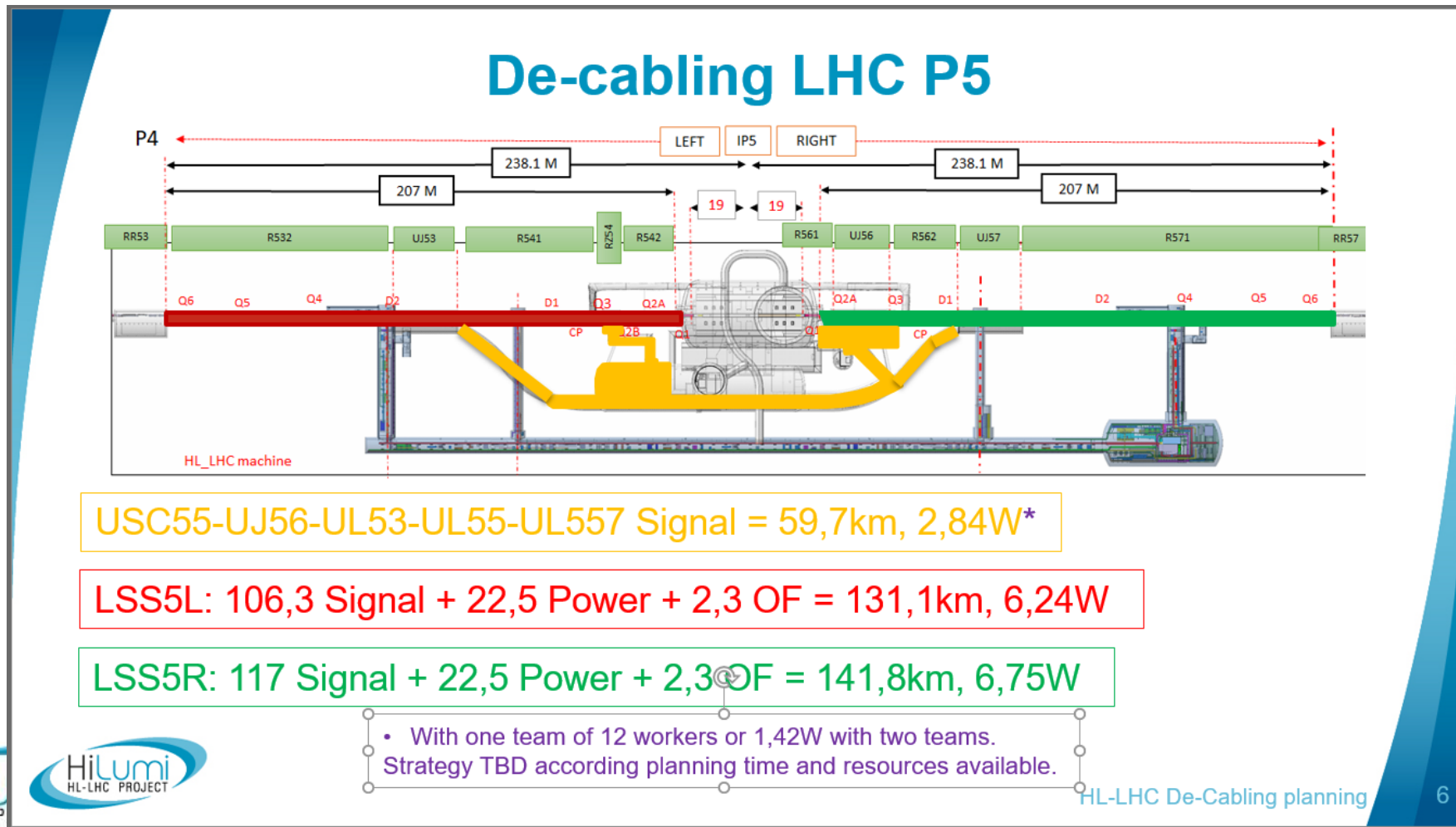


- Design of HEL at P4, is well advance, but still evolving...
- We see interference with existing equipment/services that will need to be dismantled/modified for the HEL installation, its operation and for the maintenance of the different systems.

A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement

a4). De-/Re-cabling

- A big advancement done with EN-EL after the reinforcement of their team.
 - Good advancement in the knowledge and in the work estimation for the De-&Re-cabling.
(REMINDE we have to de-cable due to upgrade of the LHC equipment BUT also due to the aperture of the vertical cores).



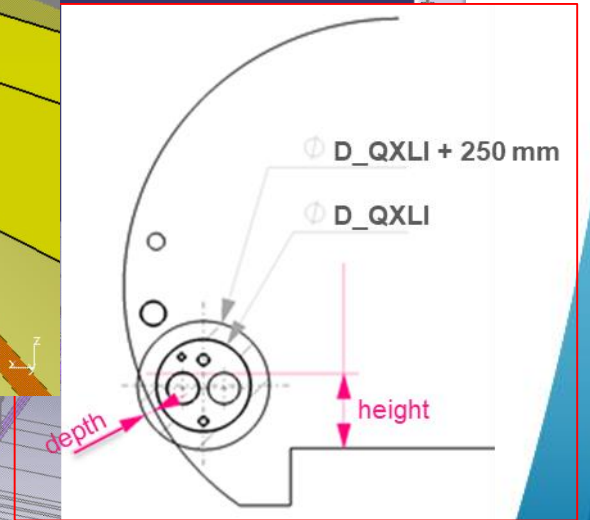
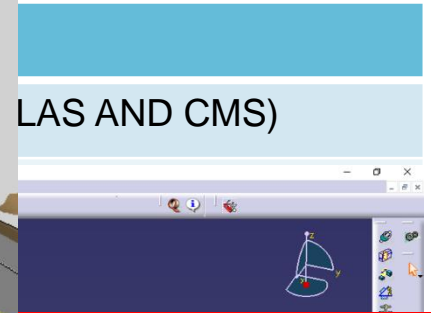
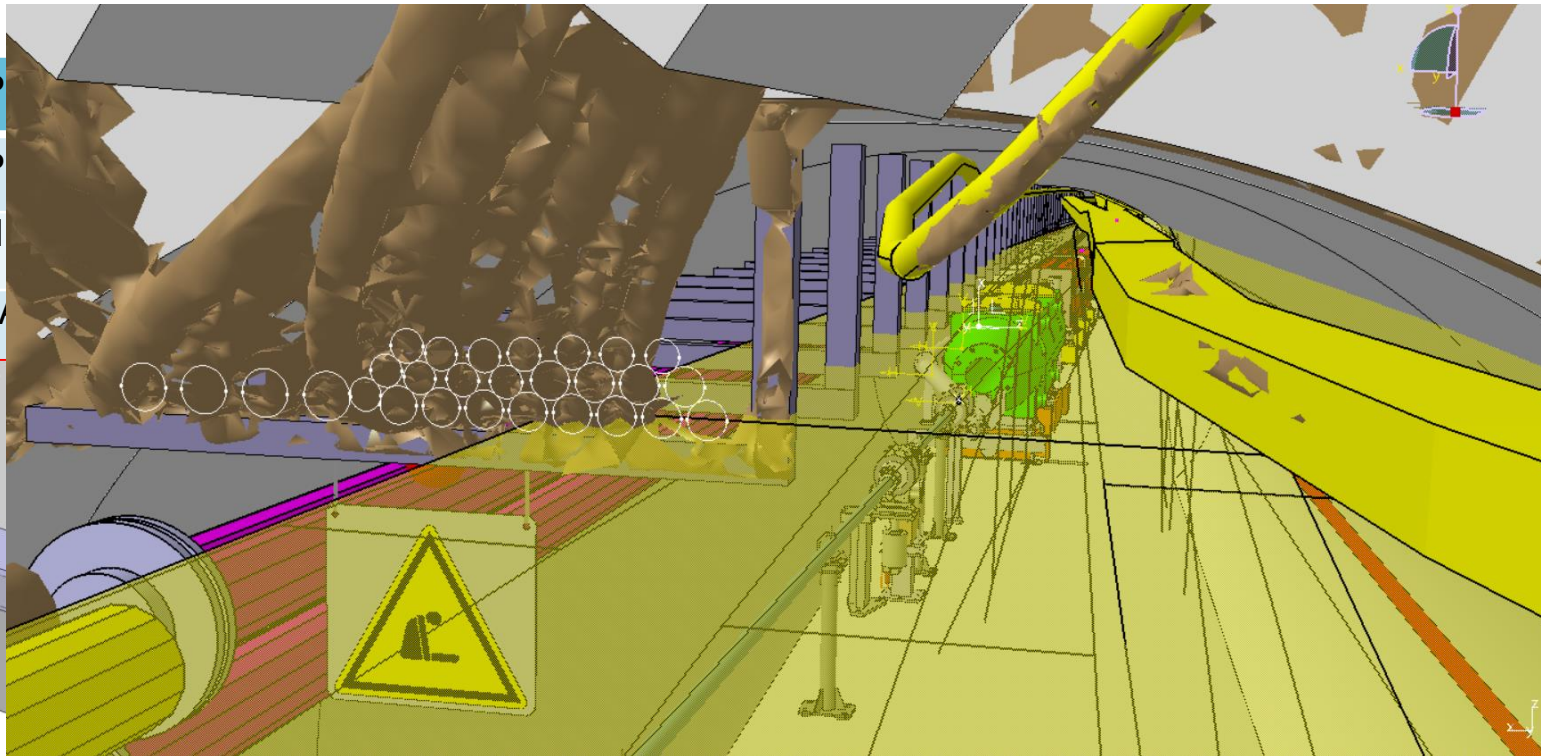
Courtesy: G. Georgiev
(EN-EL)

A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement

a5). "Minor CE works"

- Evaluation and documentation of all requests and needs for "minor" CE activities necessary for a correct LS3 HL equipment installation.
- Work will now advance together with SCE/SAM for cost evaluation and refinement of technical details and implementation

MCEW1	- P
MCEW2	- P
MCEW3	- FI
MCEW4	- R
MCEW5	
MCEW6	
MCEW7	
MCEW8	

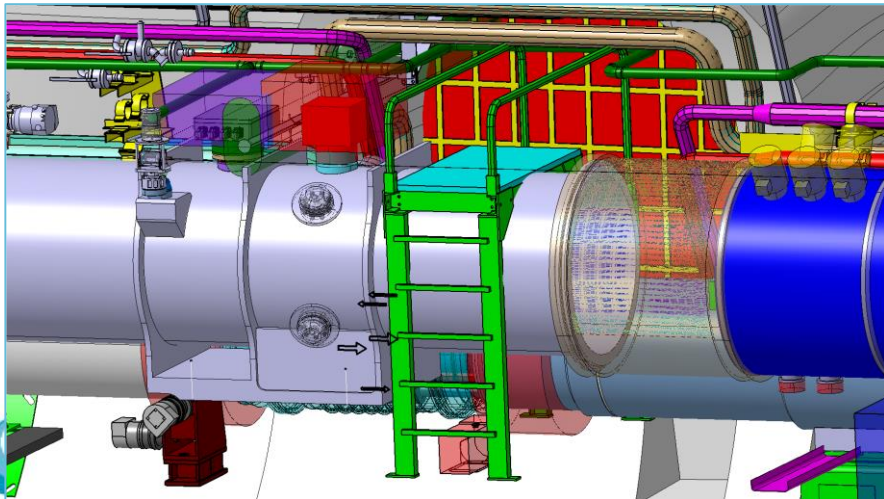
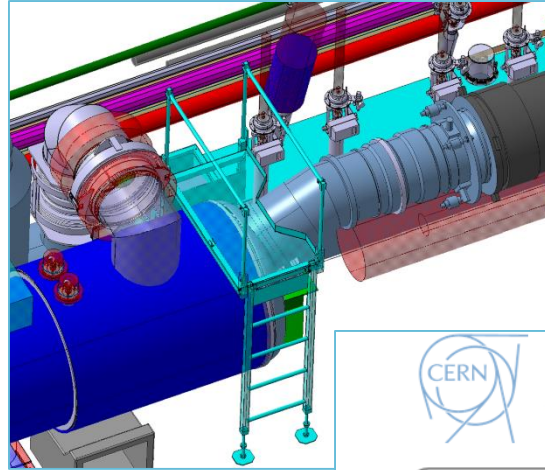


PROPOSITION DE POSITIONNEMENT DES SUPPORTS DES MONORAILS ET AUTRES SERVICES

A. Integration & (De)-Installation studies: what was done/on completion: main recent key achievement

a6). "Orphan" activities

- Example of an "orphan" activity covered by WP15: The bridges ("passerelles") needed to access QRL/QXL valve boxes, vacuum equipment (*pumping groups*) etc.
- They are essential, several are needed, their integration is not evident, but nobody was following them.
- We are now taking care globally and negotiating for their procurement with EN-ACE



EDMS NO. 2640455	REV. 0.5	VALIDITY DRAFT
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REFERENCE : LHC-J-EC-0001

HL – LHC Engineering Change Request Access bridges over beam line elements

ECR DESCRIPTION

WP Originator	WP15.2	Process	Engineering and Fabrication
Equipment	Access Bridges LHC	Baseline affected	Scope
Drawing	ST1197833_01, ST1364028_01, ST0135208_01, ST1403883_01	Date of Issue	2021-09-28
Document		CI responsible	P. Fessla
WPs Affected	WP15	Reference Document	TDR v1.0

Detailed Description

During the preparation of the integration of the 4 LSS of IP1 and IP5 it became clear that access bridges (platforms) were necessary to allow a safe access to the elements behind the beamline for operational and maintenance purposes. Such elements are, i.e., the patch panel near the QXL jumpers (WP9), elements of the vacuum system (WP12), elements of the RF system (WP4), survey sensors (WP15.4) and the UPS galleries.

In addition, it appeared that the presently used LHC access bridges could not be re-used.

The procurement and installation of such elements was identified as new scope for the project, namely for WP15.

From the procurement point of view, it was decided to request a cost evaluation from EN-ACE. EN-ACE has previously built and is maintaining similar elements in the present LHC installation, also providing the flexibility for last minute changes and on-site adjustments of the equipment, that an external supplier would not provide or only at very high additional cost.

The table 1 summarizes the new platforms that are foreseen for the Project. Figures 1, 2 and 3 provide a preliminary view of the proposed current design (optimization shall be carried out to reduce space as much as possible).

Table 1: Types of platforms in LSS5R

A. Integration & (De)-Installation studies:

b) What remain as most critical open issues (on short term)

- **a1. SURFACE Bids:** complete process of revision with “validation for installation” (*all bids. expected to be delivered by December 2022*)
- **a2. New Technical Galleries Integration:** very close to the end! → release a Version-1 (*baseline*)
- **a3. LHC Integration for HL-LHC layout:** still facing open issues and a lot of challenging/delicate details → we hope to release a Version-0 *“for Engineering Check”* by Spring-2022
- **a4. De-/Re-cabling:** work advancing steadily, future actions/revisions (e.g. a 2nd preDIC, final DIC, etc.) to be planned together with EN-EL
- **a5. “Minor CE works”:** First survey completed but something else could still appear...
Now to be analysed with SCE/SAM (*for cost evaluation and for technical refinements toward detailed preparation and scheduling*)
- **a6. “Orphan” activities:** ... be always on alert and ready!
- **a7. Other HL equipment** like the **new Dump** and the **new MKI kickers**: integration study will start as soon as the technical design will be at enough advance. **More in general** we are preparing the integration layout for **HL Optic Version1.6** with several modification planned (*next slide for details*)

a7). Toward HL Optic Version 1.6

Changes in optics/layout/drawings

P5/P1

- TAXS vacuum chamber length
- Removal warm BPM close to D1
- Change of the MQXFB magnetic lengths
- TAXN final length and position
- TAXN-Collimators layout (to be revised)
- D2: new interface with DFM
- Possible relocation of the crab cavities due to independent cool down system
- Relocation of APWL and BPTX (Final lengths and possible inclusion of 4th pickup)
- TCLMs length reduced
- Suppression MS10 ?
- Possible new TOTEM

P6

- P6: new MKIs and dump lines

P4

- P4: HEL. Moving from space reservation to real object

Changes in layout/drawings

- DCM: update wireframe and interface
- DFX: update wireframe and interface
- DFM: update wireframe and position
- D2: update wireframe with new interface for DFM
- CC latest design: update wireframe and interface
- Sector valves update (see next slide)

Changes in drawings

- Update wireframes with correct jumper height and orientation: D2, CC1, CC2, Q4
- Produce the wireframes for the left side assemblies to include directly in the SmarTeam item of the WP3 assemblies.
- Minor visual correction on the inner triplet wireframes on the bellows interconnection.
- Include a table with the vertical cores or even a visual representation.

B. LS3 Planning studies:

a) What was done

- **LS3 Activities Sequence for LSS1&5 “Version-0”** ([EDMS 2254475](#)) presented at [CSR2019](#):
 - The estimated duration results was **48 months** (*obtained from first estimations done with all WPs/Groups/Services*)
- In 2020, with an extensive work done with ALL WPs, Equipment owners, General Service teams, etc. we develop and finally present at [“TCC-Day,Nov2020”](#) a **“Version-1”** ([EDMS 2400939](#)) with a duration of **34.5 months**
- (*REMIND that in CERN Long Term Plans, the baseline duration for LS3 is **30 months***).

B. LS3 Planning studies:

b) What is ongoing/to be done

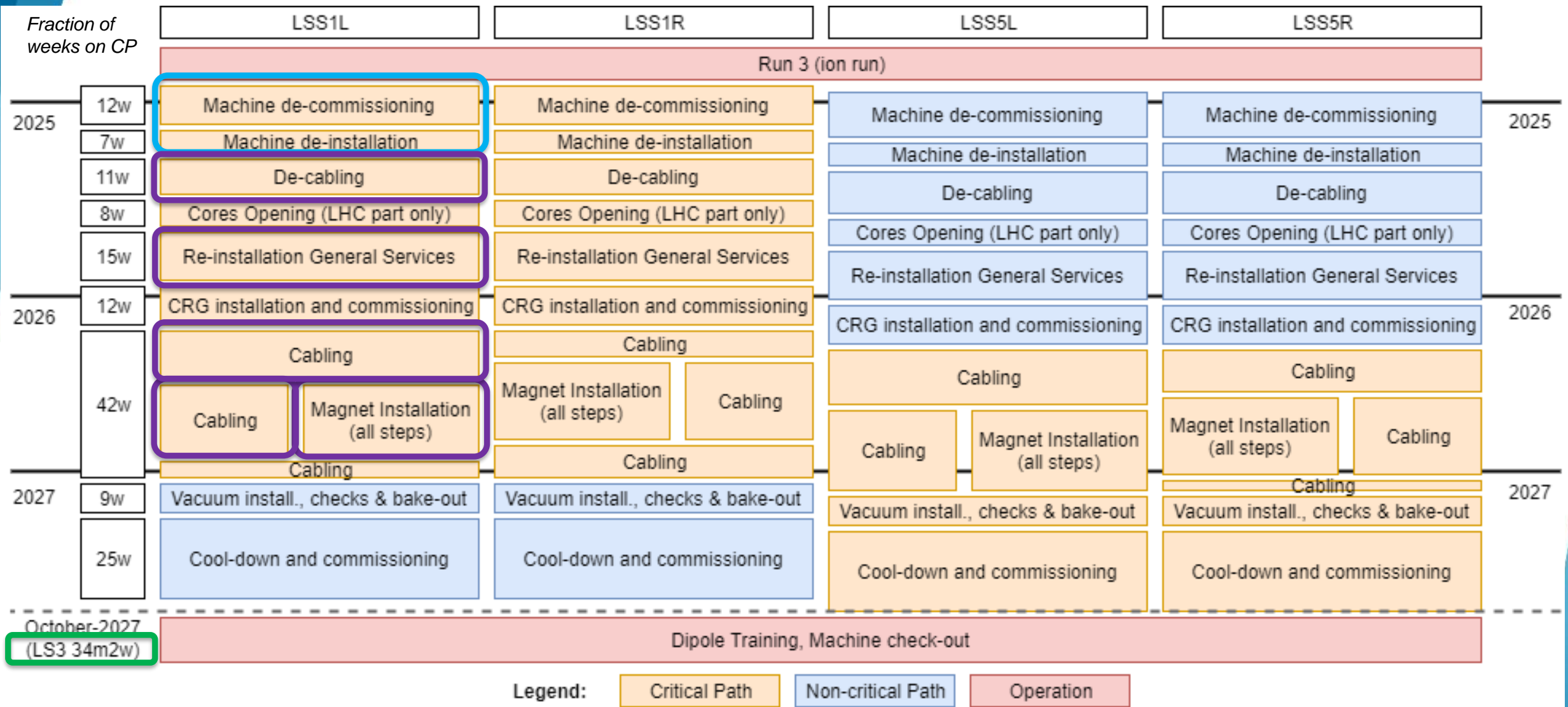
Since February 2021 a joined effort HL-WP15 and EN/ACE-OSS (with M. Bernardini, M. Barberan, E. Vergara) was started in order to advance toward a more detailed global planning for LS3 (Version-2).

The studies include:

- A more realistic evaluation of each LS3 activities at IP1&5 (including optimized boundary conditions, parallelism, cohabitations). This as results of detailed discussions organized with all LS3 intervenants, starting with Cryogenic team (warm-up), EIQA Team (electrical checks at cold and at warm), LHC equipment owner and services (LHC dismounting), etc.
- The EN/ACE-OSS experience in LHC day-by-day planning follow-up gained in previous LS campaigns.
- Will integrate any other HL activities at other LHC locations (e.g. HEL at P4, new Dump and MKI at P6, intervention for magnet transport at P2, etc.)
- Will permit the different Groups to evaluate the resources optimization in space and time during LS3
- Will include operational safety and logistic aspects as they impact the planning.
- (Up to now 16 meetings organized where we meet with several different teams: Cryo, Transport, EIQA team, EN-EL (de-/re-cabling), Magnets team, QRL teams, HSE (safety), etc.)

- In Addition: in March 21, the Directorate nominates a “Run3 Installation Coordinator” (J.P. Tock, EN-ACE GL)

LS3 schedule Version-1: simplified blocks diagram



Toward a Version-2: work with EN/ACE-OSS

Some examples:

Activity	TCC Nov 2020	2021 analysis	Δ
From “machine shut down” to “Cryo Lockout”	Total of 17 weeks	Total of 17 weeks	0 week

Activity	TCC Nov 2020	2021 analysis	Δ
Magnet dismantling LSSR1	Week 9 to 14	Week 9 to 13	- 1 week
Magnet dismantling LSSL1	Week 9 to 14	Week 11 to 13	- 1 week
Magnet dismantling LSSL5	Week 13 to 18	Week 13 to 15	- 3 week
Magnet dismantling LSSR5	Week 13 to 18	Week 15 to 17	- 1 week

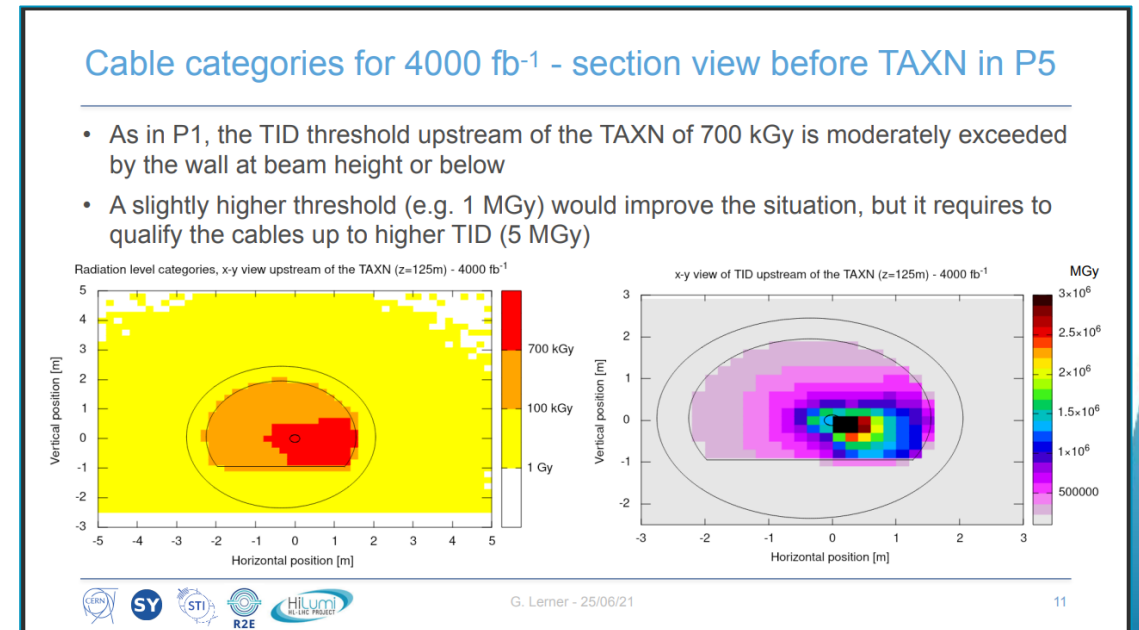
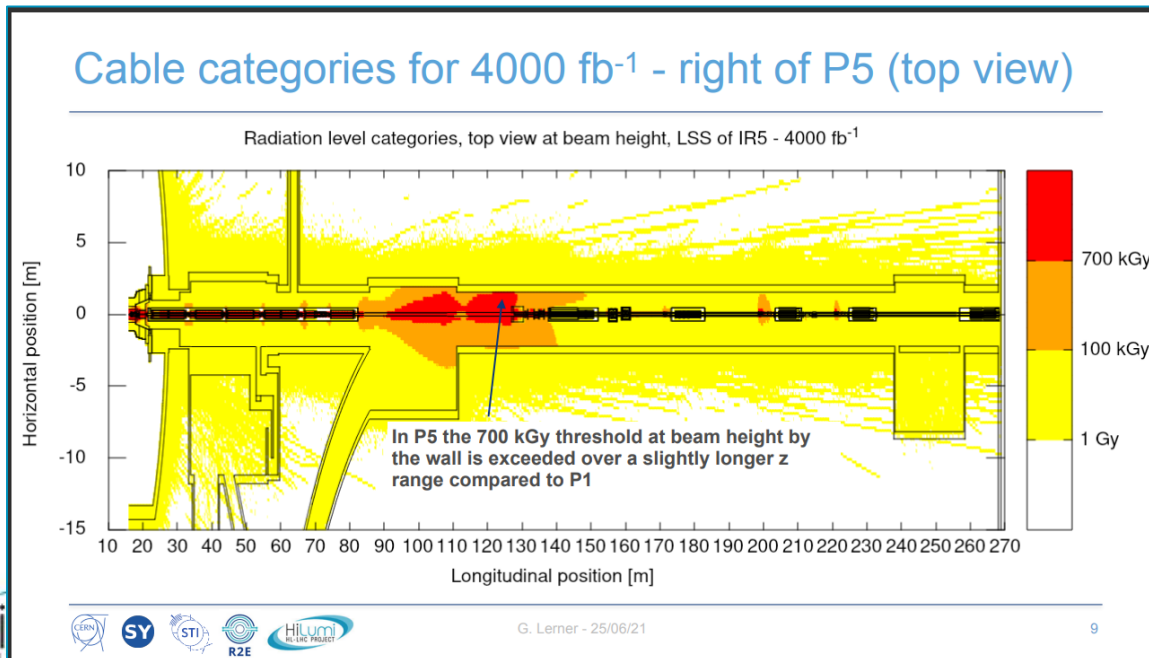
Activity	TCC Nov 2020	2021 analysis	Δ
QRL dismantling LSSR1	Week 13 to 16	Week 13 to 16	0 week
QRL dismantling LSSL1	Week 12 to 15	Week 12 to 15	0 week
QRL dismantling LSSL5	Week 16 to 19	Week 15 to 18	- 1 week
QRL dismantling LSSR5	Week 17 to 21	Week 17 to 21	0 week
DFBX dismantling LSSR1	Week 11 & 12	Week 9 & 10	- 2 weeks
DFBX dismantling LSSL1	Week 10 & 11	Week 11 & 12	+ 1 week
DFBX dismantling LSSL5	Week 15 & 16	Week 13 & 14	- 2 weeks
DFBX dismantling LSSR5	Week 15 & 16	Week 15 & 16	0 week

C. OTHERS

c1). Rad-tol, Rad-hard cables estimation

As WP15 and HL-PO we launched several actions on rad-hard cables needs in HL and their procurement:

- **On technical aspects:**
 - Working with WP10/R2E Team that is delivering more detailed simulations on expected doses for the HL-LHC layout (from Run4 on)
 - We are looking with them to mitigation solutions to optimize the share of “Standard” cables wrt “Rad-tol” and “Rad-hard” cables (*i.e. minimizing these last 2 categories*)
- **On procurement:** As HL-PO we put around the table all concerned teams (*WP15, WP10, R2E/R2M, HL Procurement Office, SCE/SSC(CERN Main Store), HSE/RP, CARE WG, etc.*) to advance with a common and efficient procurement process and looking at advantageous synergies with other project (*e.g. North Area Consolidation*).

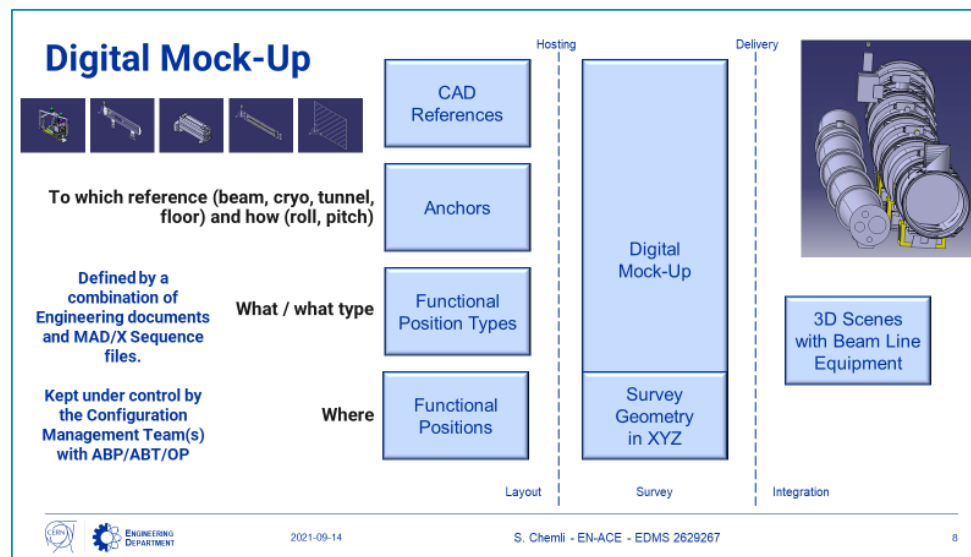
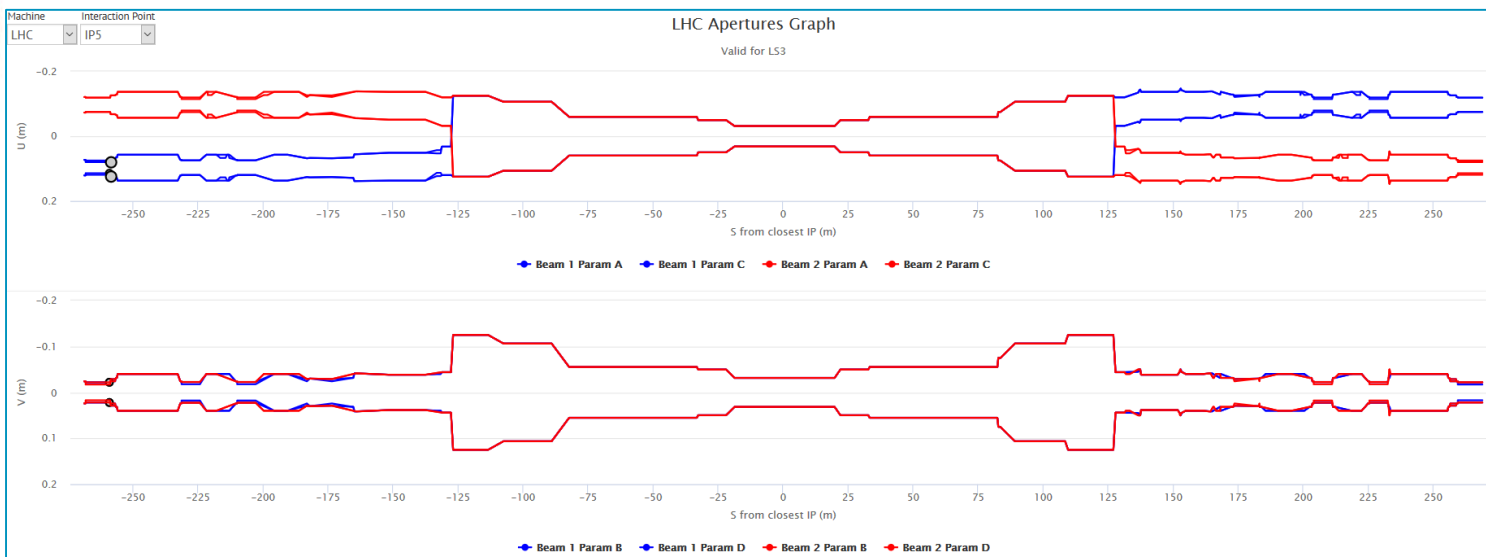


C. OTHERS

c2). Layout DB activities



- We are working since several years together with EN/ACE and BE/CSS toward the implementation of the new HL-LHC equipment and in the Layout DataBase (<https://layout.cern.ch/>).
- LDB was also subject of major changes during LS2 with the release of a new LDB structure and interface allowing the data to have a lifetime inside a timeline.
 - Create all functional position types needed to define each assembly and subassembly respecting the HL-LHC and LHC naming conventions.
 - Define the position and orientation wrt the approved layout drawing.
 - Assign to the functional positions to the proper sequence (optics B1/B2, inner/outer beam and vacuum inner/outer beam)
 - Link the equipment functional positions to the EDMS items and the assets in InforEAM.
- In collaboration with WP12 we will be able to provide a detailed aperture graph for the HL-LHC equipment.
- Automate the layout drawings creation and machine sequence in the integration 3D models with the data inserted in the Layout DB with the DMU (Digital Mock-up) tool of EN-ACE.
- Provide connection a first version of the HL-LHC circuit inside the Layout DB with the support of the MCF.



C. OTHERS

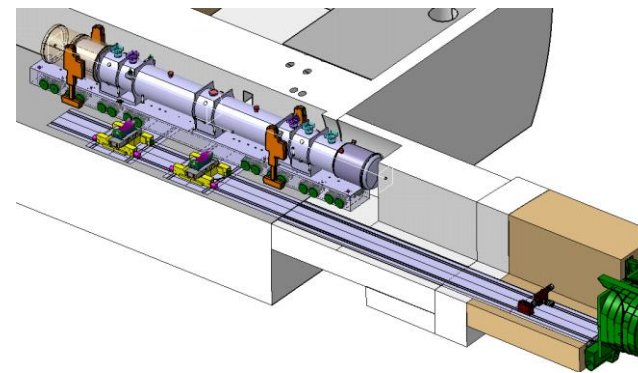
c3). HL Transport studies (on behalf of WP15.5 Team)

Since 2021 the HL Transport activity is internalize as the independent *sub-WP15.5*
I present here few slides on behalf of C. Bertone WP15.5 Leader and her Team:

- **WP15.5 studies:** new system for HL magnet transport

HL-LHC cryomagnets transport vehicles

- Merge between LHC cryomagnets vehicle consolidation and new transport system for HL-LHC cryomagnets (same installation process as for LHC)
- More details presented in HL-LHC TCC in EDMS. 2536100
- Invitation to Tender ongoing answers expected by 3rd November 2021 ? Contract shall be awarded following March 2022 Finance Committee



J-L GRENARD EN-HE

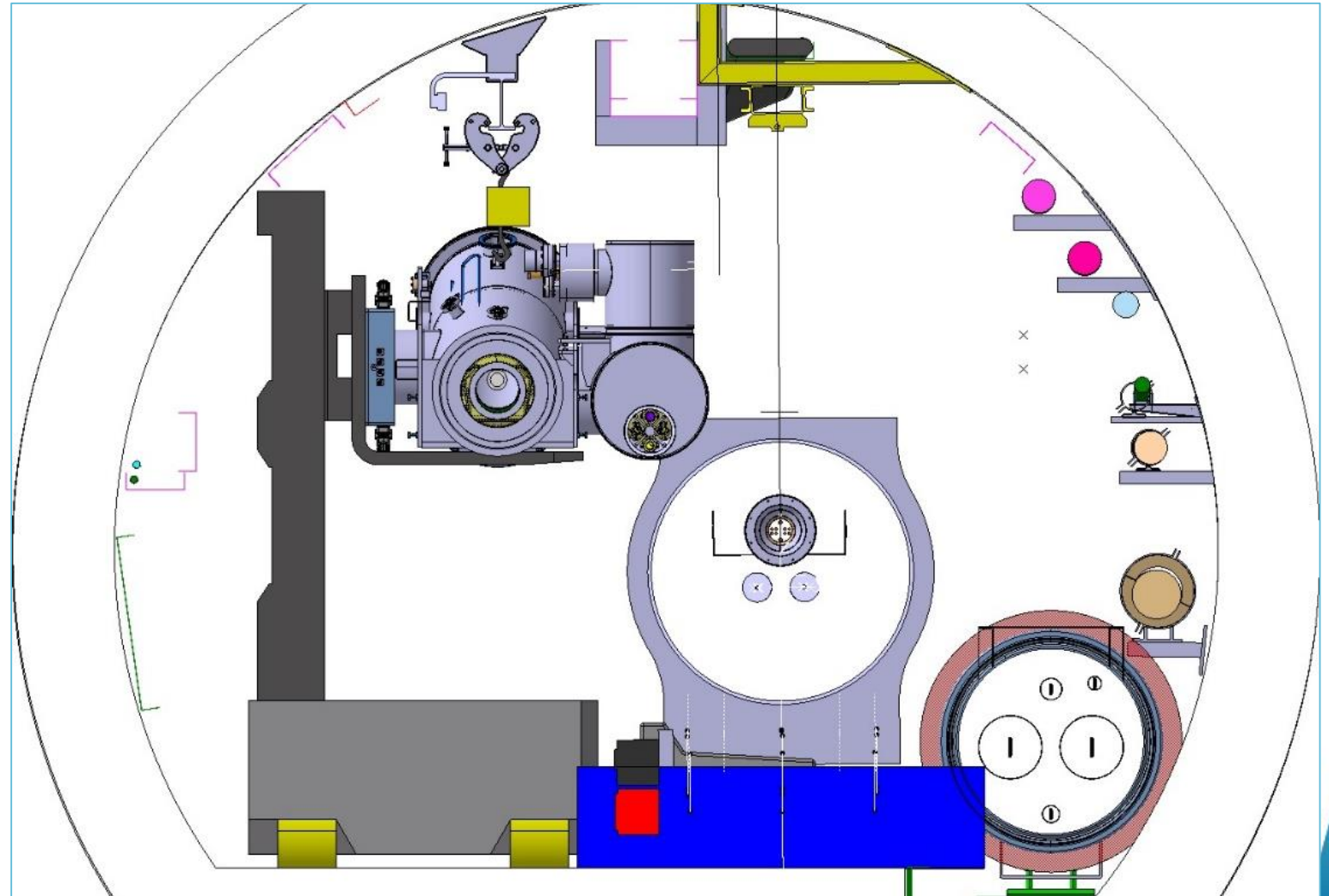
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C. OTHERS

c3). HL Transport studies (on behalf of WP15.5 Team)

- **WP15.5 studies:** Development of the lateral forklift to be used into the LHC tunnel for the elements placed over the beam line

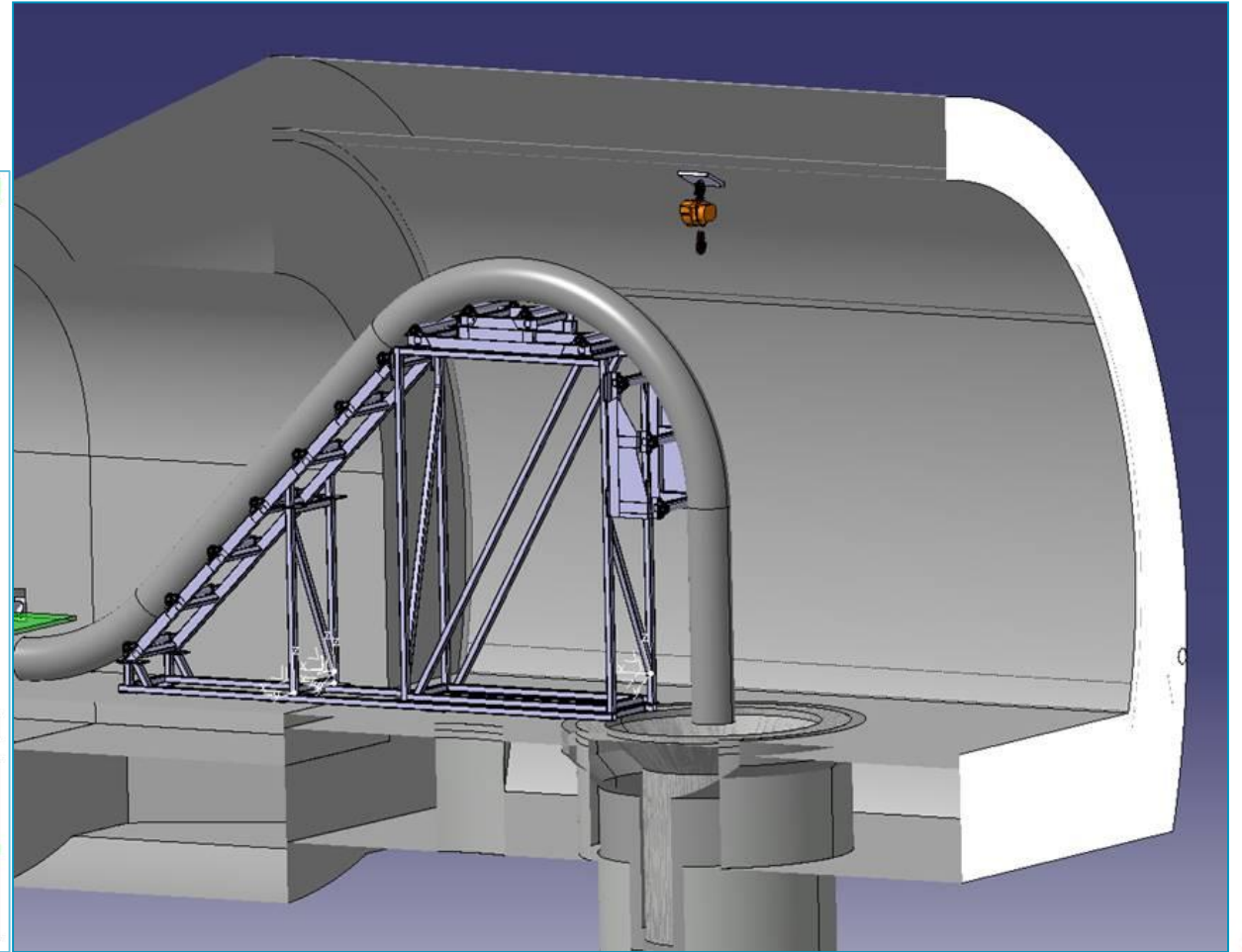
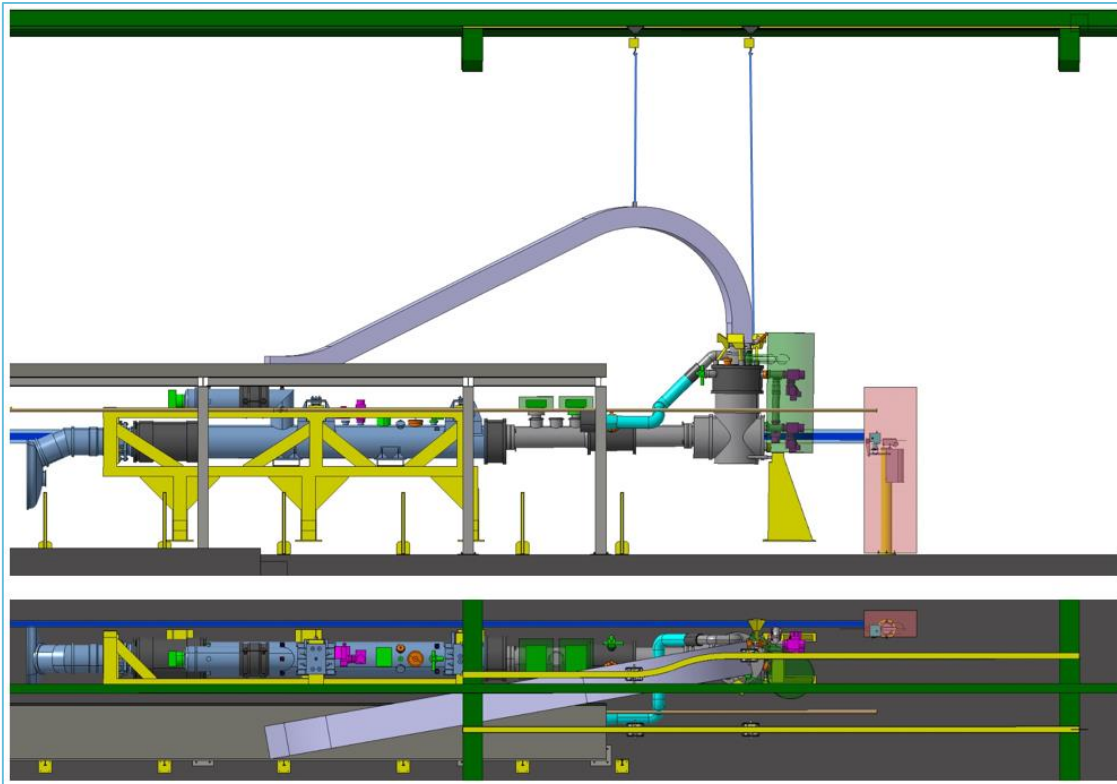
The actual dimension of the DFM has increased size in 3 dimensions, but especially width: which makes the handling operation more delicate (intermediate steps added) and the forklift more complex)



C. OTHERS

c3). HL Transport studies (on behalf of WP15.5 Team)

- Other studies: for WP6a, EN-HE is studying the tooling and installation sequence for the Sclink:
In the String and in the LHC Tunnel:



C. OTHERS

c4). “others” of OTHERS...

- **Other WP15.5 activities** (*not time for details*):
 - Launching actions for **activated waste management** during LS3,
 - Promote analysis and possible synergies on **mock-ups for LS3 equipment**,
 - **Documentation** (*ECR and others*) on different issues link with integration (e.g. *for CC final position and symmetry, procurement of bridges, cryo-valves for WP6a, ...*)
 - [HL-LHC ECR - WP4 Crab Cavities in optics version 1.6 - Shift of Civil Engineering cores, adaptation of cryogenic and of vacuum elements](#)
 - [HL-LHC ECR - WP15 Access bridges over beam line elements](#)
 - [HL-LHC ECR - WP6A CONTROLLED COOL DOWN/WARM UP FOR THE HL-LHC SC LINKS](#)

I hope to have provided you a clear hint on what DONE and what is GOING-ON inside WP15...

Thanks for the attention

