



Cold powering system integration and installation ***(DFX-DSH-DFH)***

Vittorio Parma, for the WP6a team

With contributions from: R.Betemps, Y.Leclercq, V.Maire, S.Maridor, P.Retz

International Review of the Conceptual Design of the Cold Powering System for the
HL-LHC Superconducting Magnets, CERN 3-4 July 2017

Outline

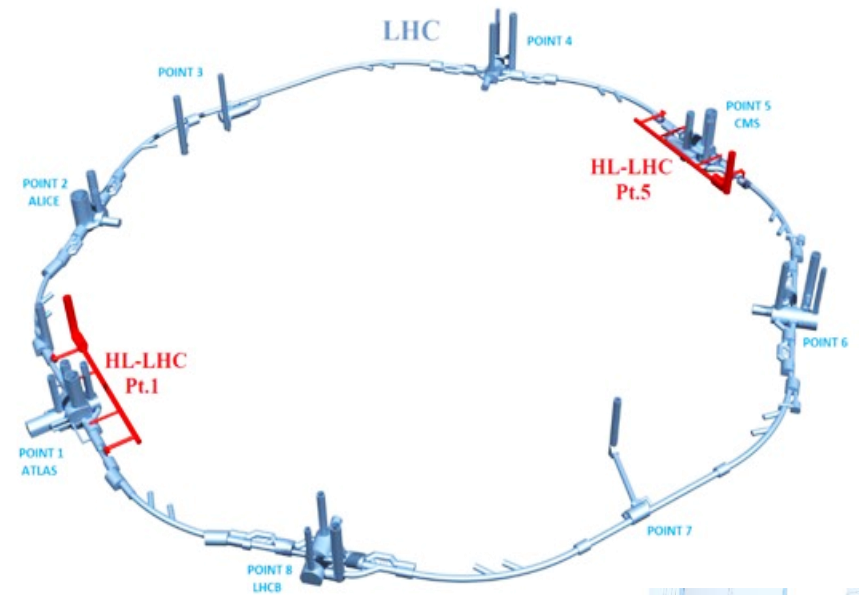
- Tunnel and new CE infrastructure;
- Overall layout of Cold Powering systems
- Installation sequence of DFX-DSH-DFHX
- Interfaces D1-DFX-DSH,
- Summary

Outline

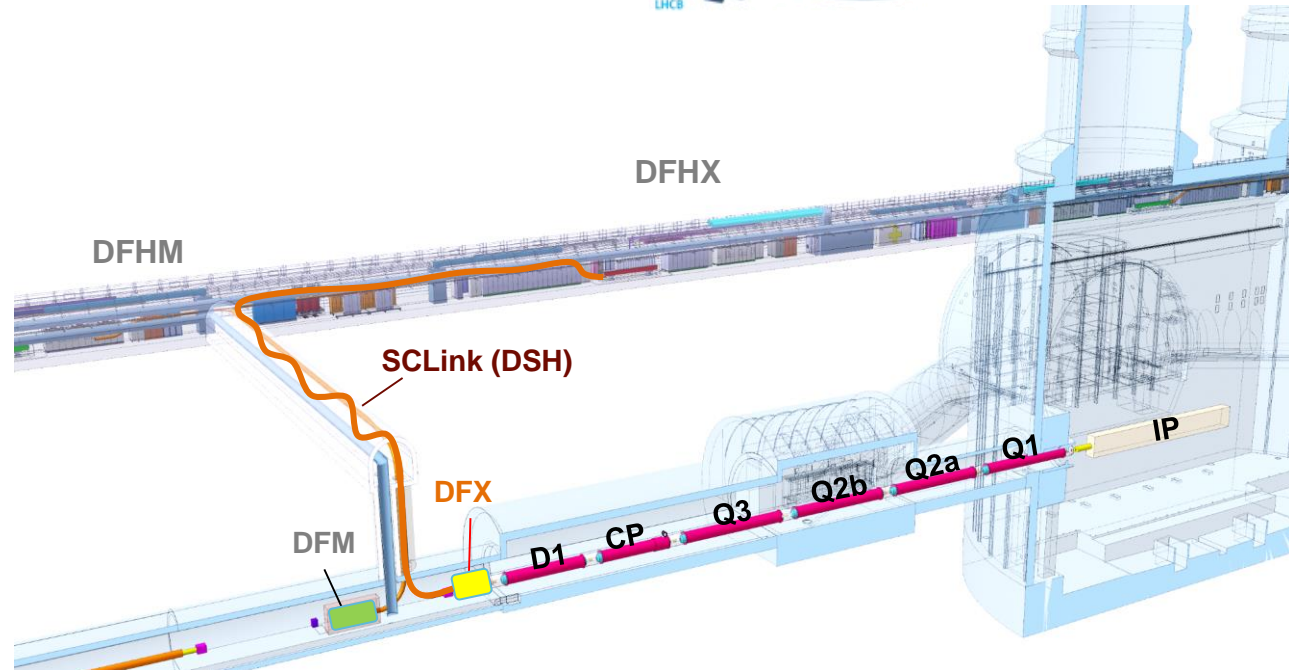
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Cold powering

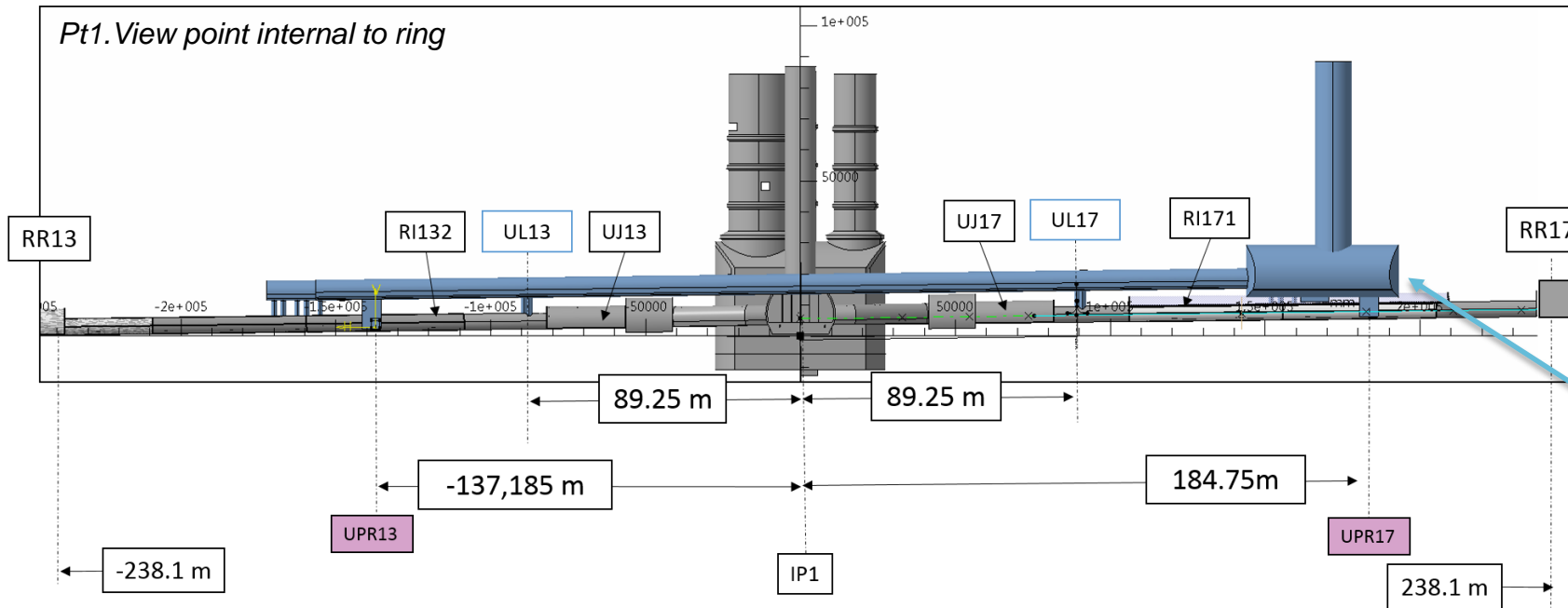
- Each high luminosity point (Pt.1-5) requires:
 - 2 cold powering systems, 1 for the focusing triplets, one for matching section quadrupoles;
- 8 cold powering systems in total
- Each cold powering line includes:
 - 1 SC link (DSH);
 - 1 DFH(X or M), connecting the SC link to the current leads
 - 1 DF(X or M), connecting the SC link to the magnets
- In total:
 - 8 SC links of 2 types (+ 2 spares)
 - 16 DF boxes (+4 spare) of 4 types



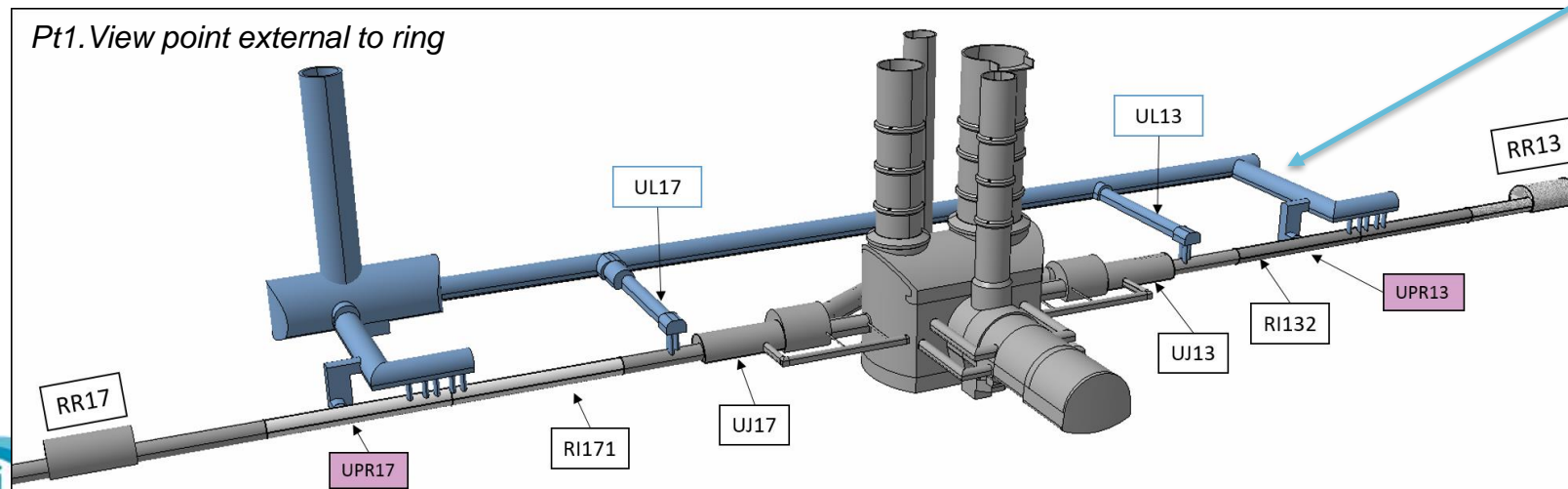
This presentation focuses on the cold powering system of the string of triplets (D1-Q1)



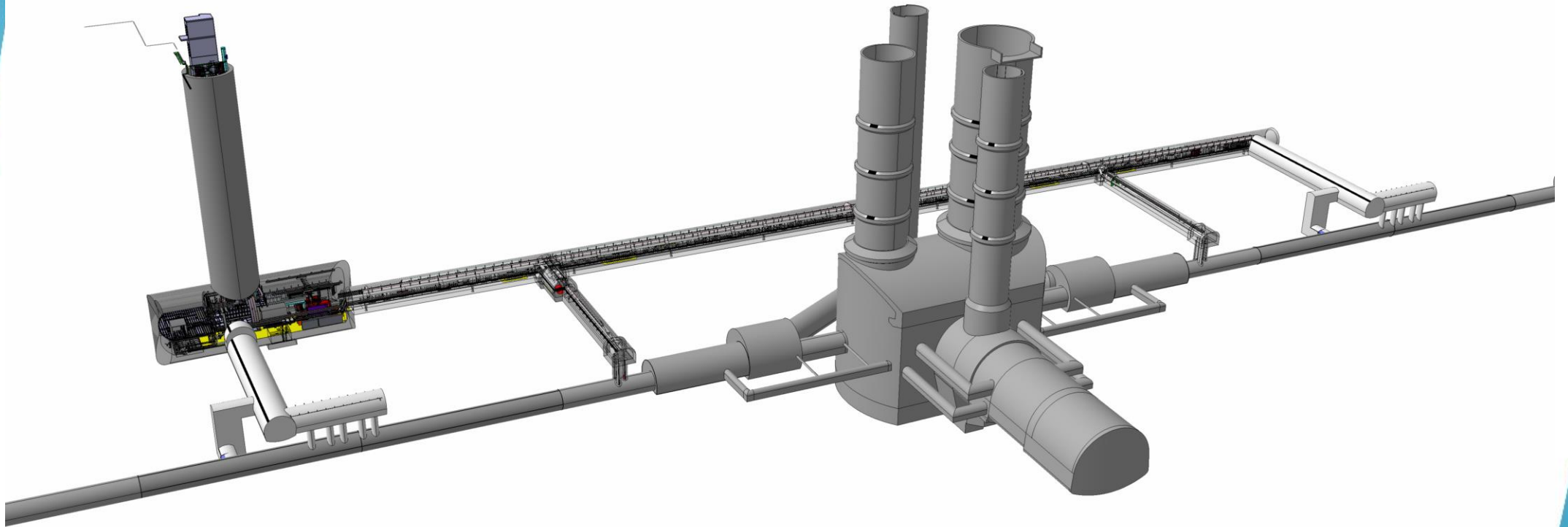
Tunnel and new CE infrastructure



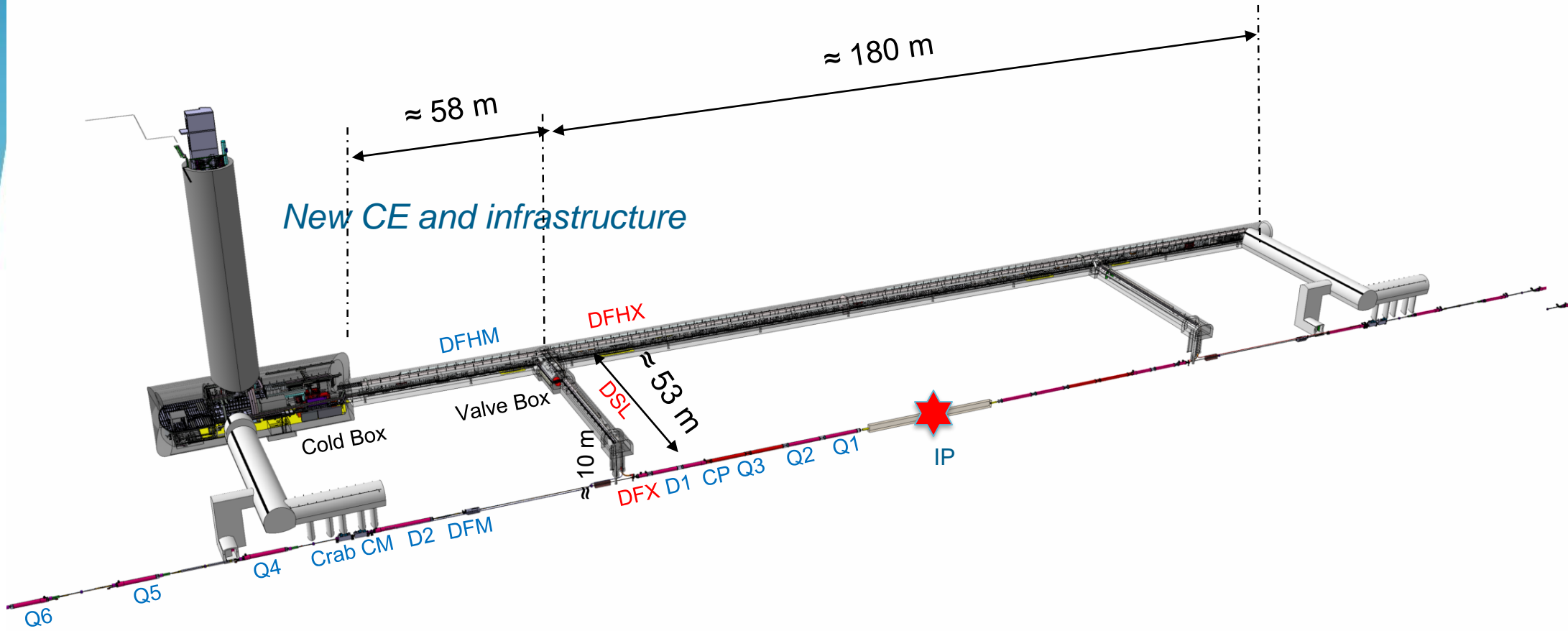
In **blue**, new CE works



Tunnel and new CE infrastructure



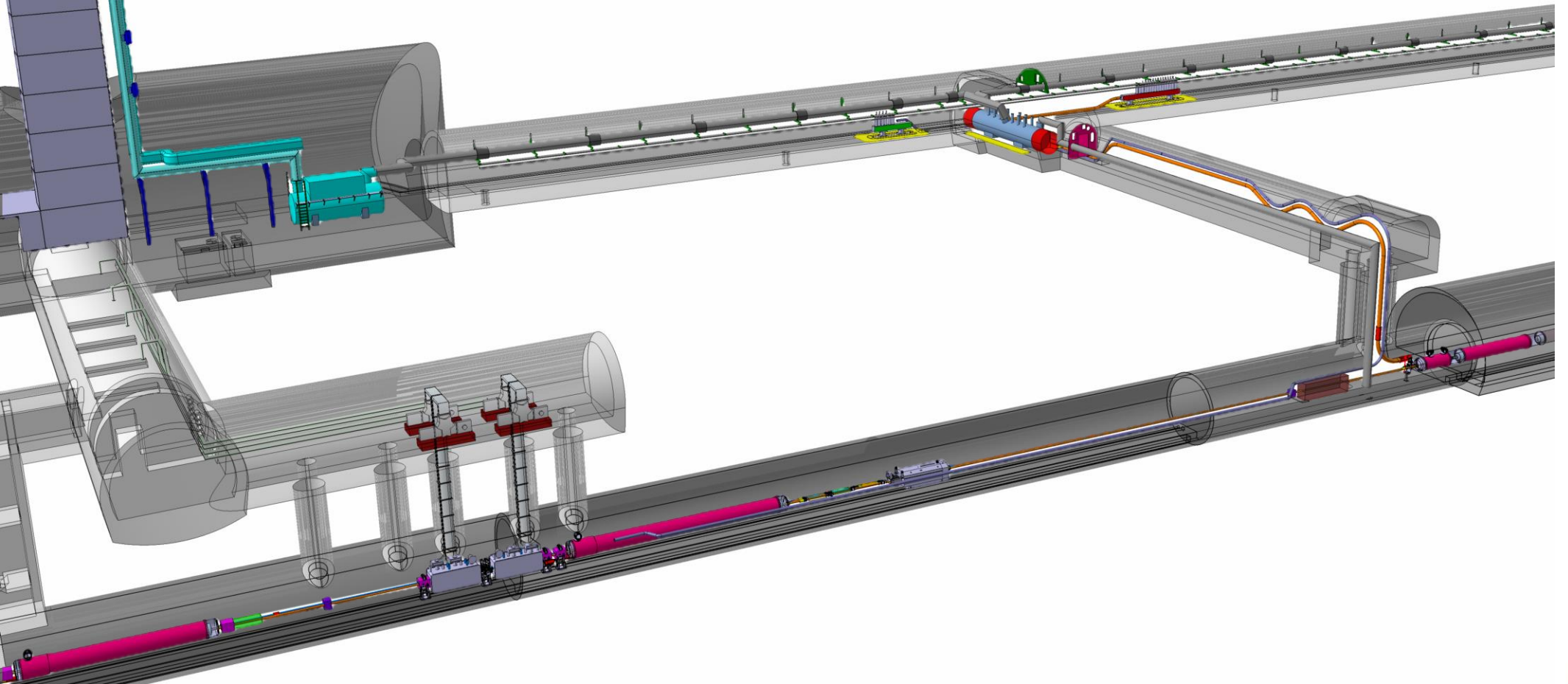
Tunnel and new CE infrastructure



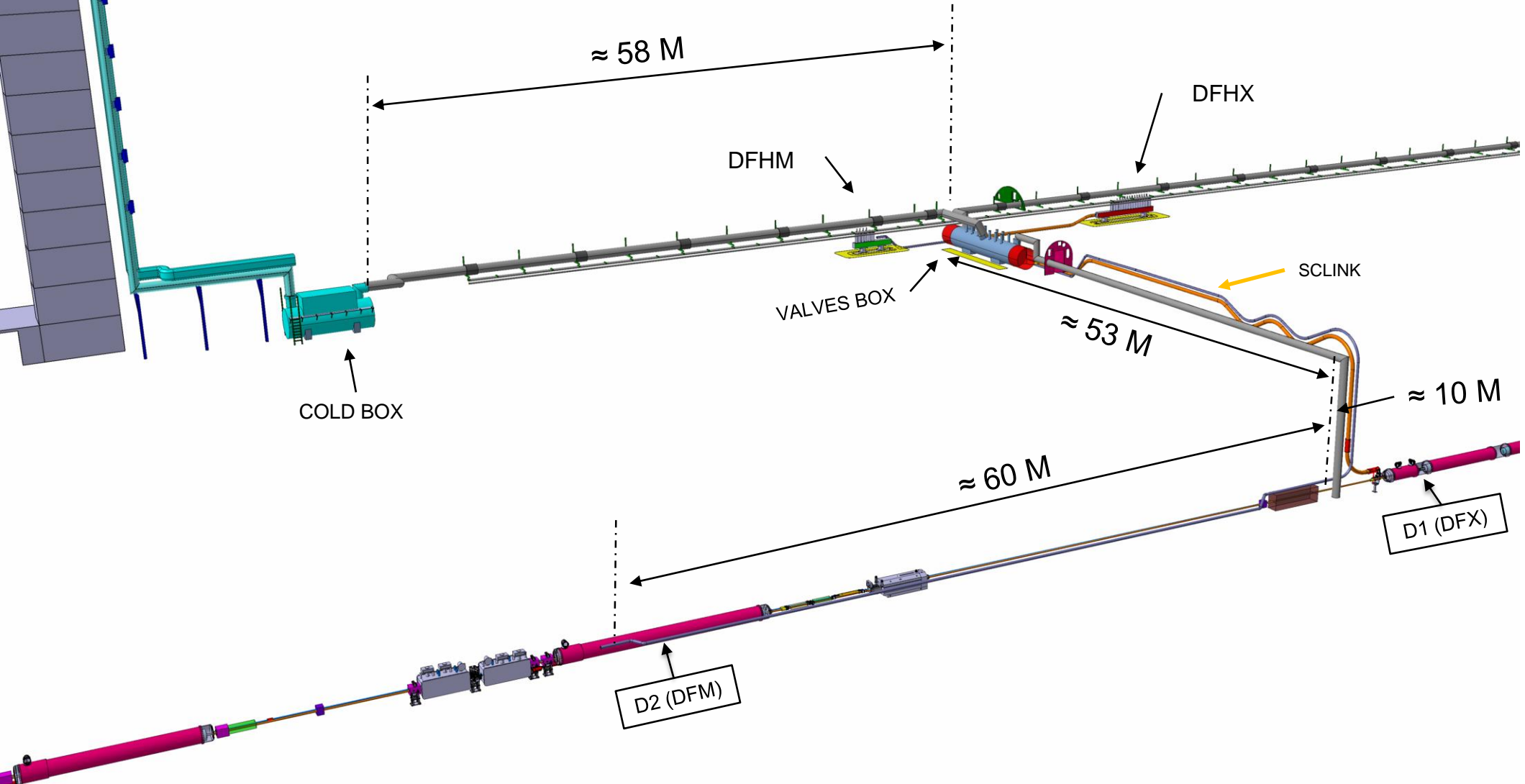
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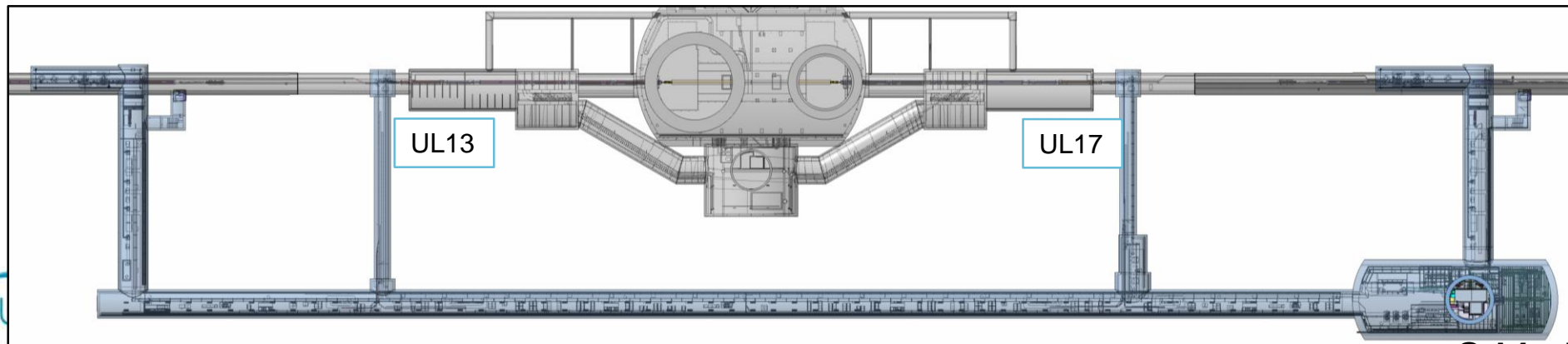
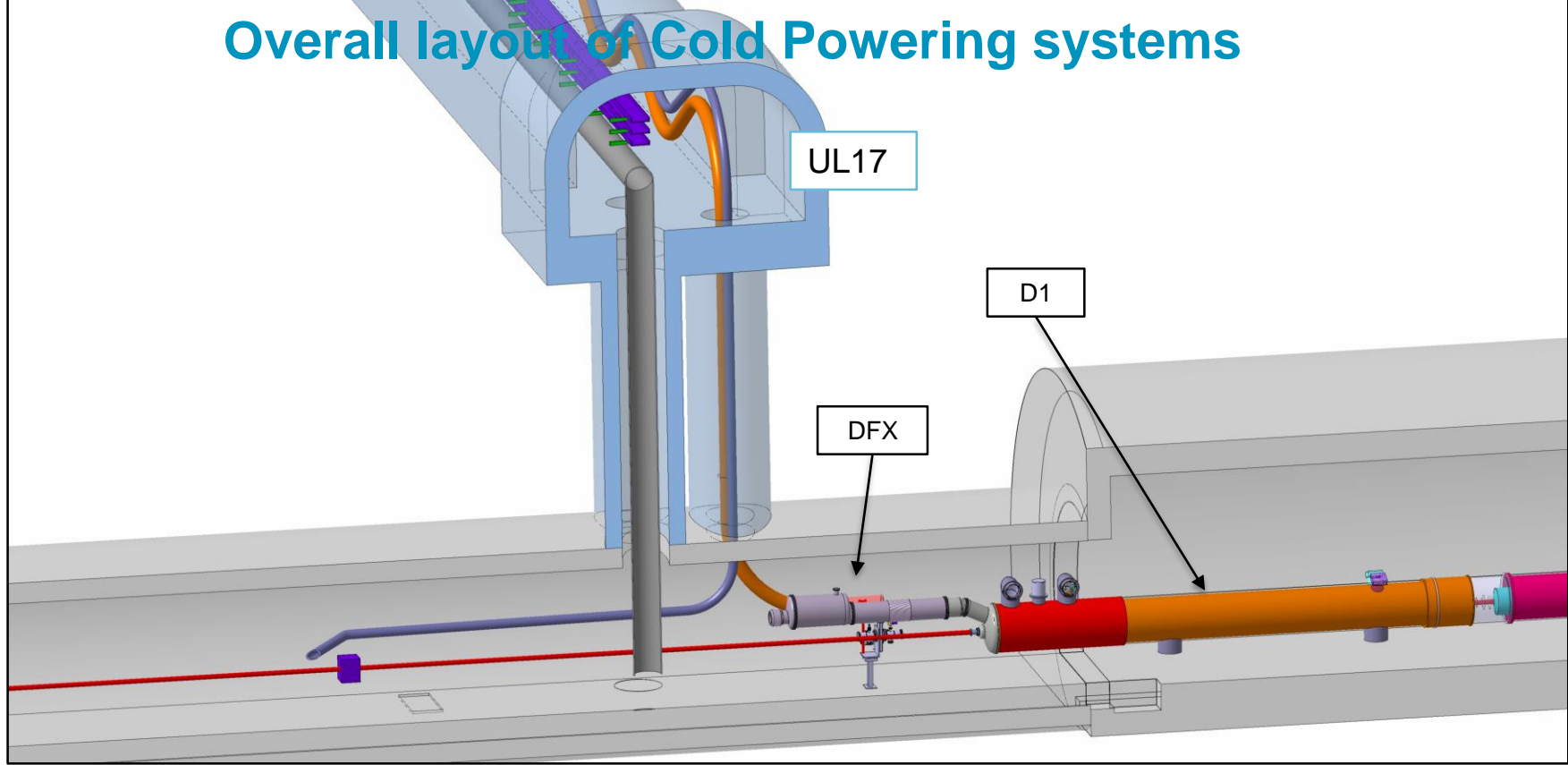
Tunnel and new CE infrastructure



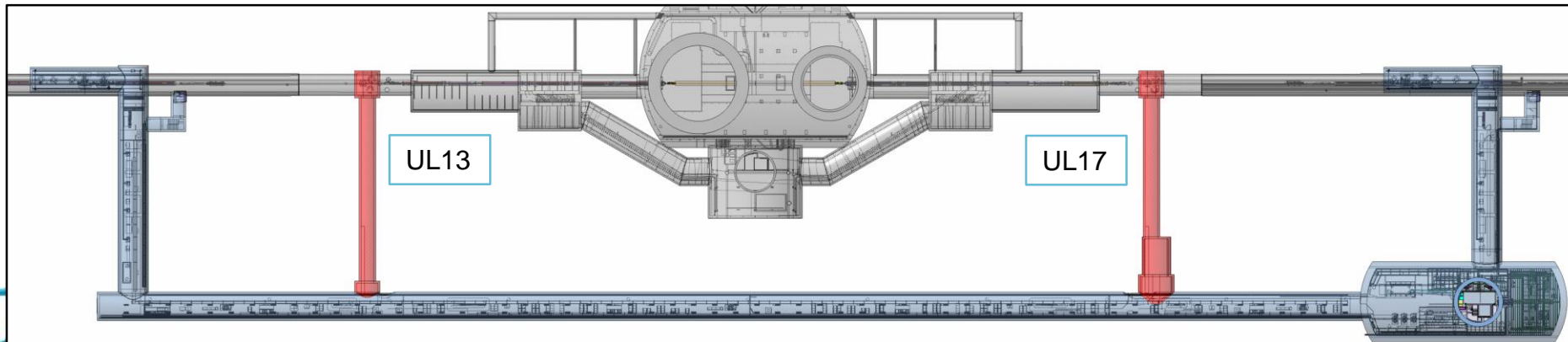
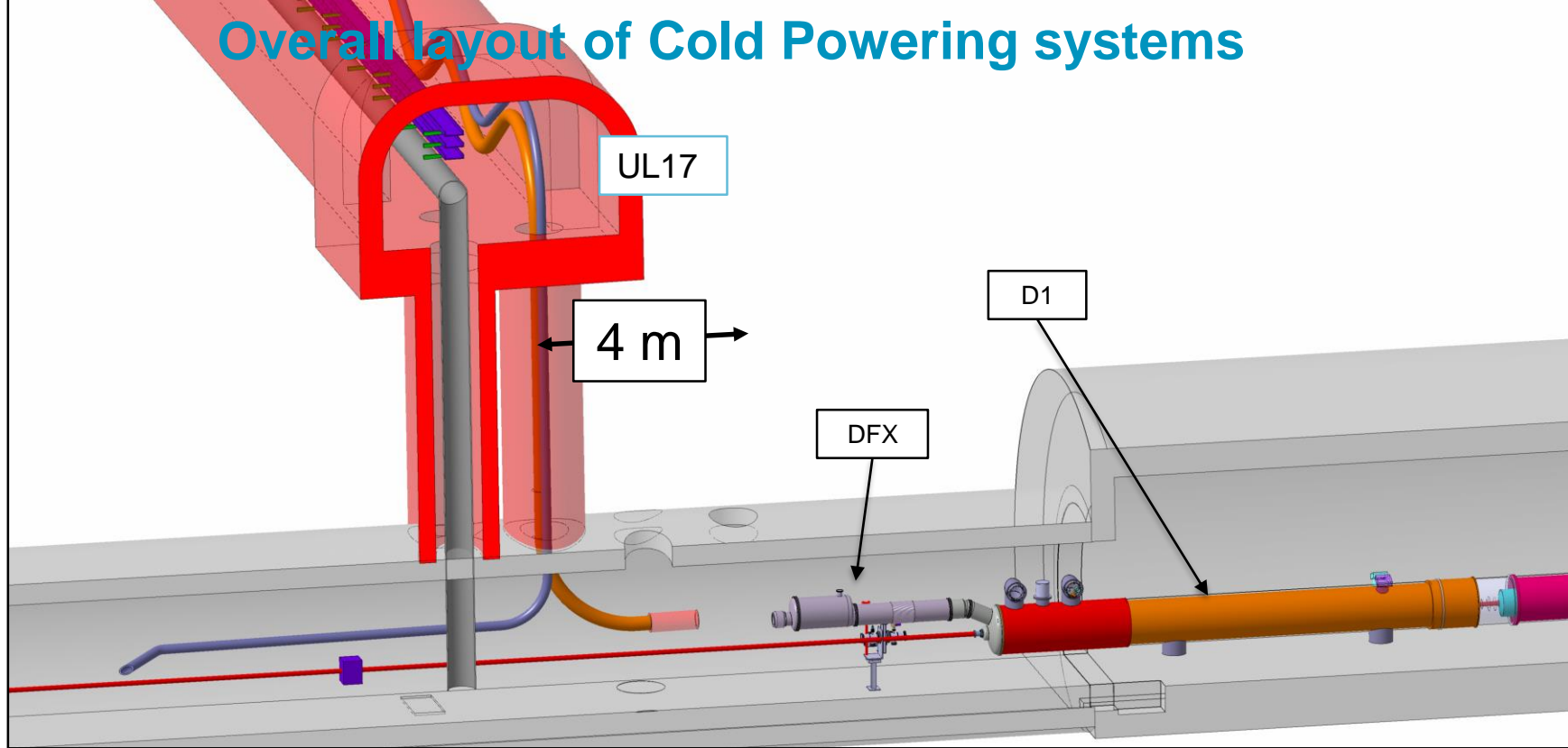
Overall layout of Cold Powering systems



Overall layout of Cold Powering systems

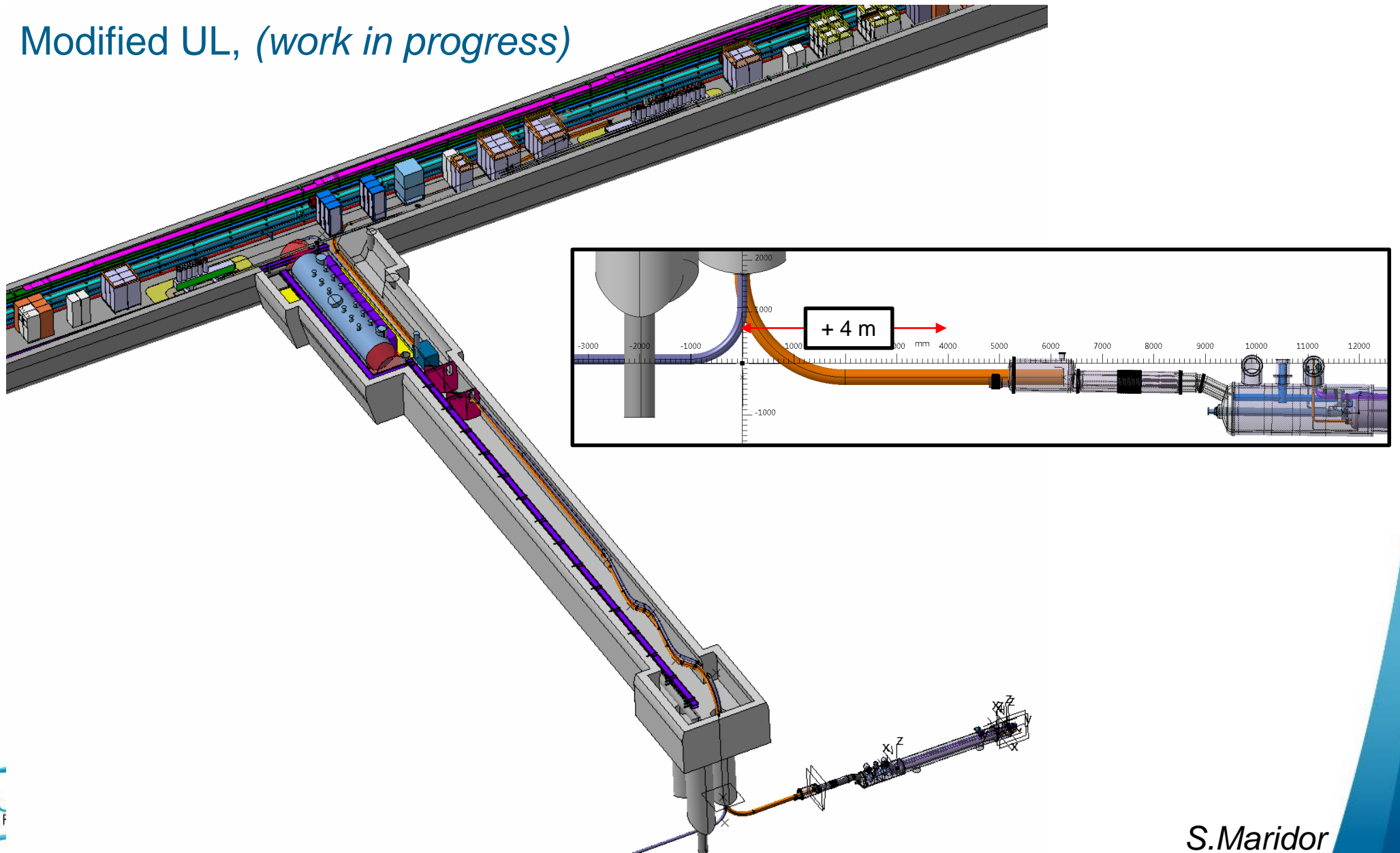


Overall layout of Cold Powering systems

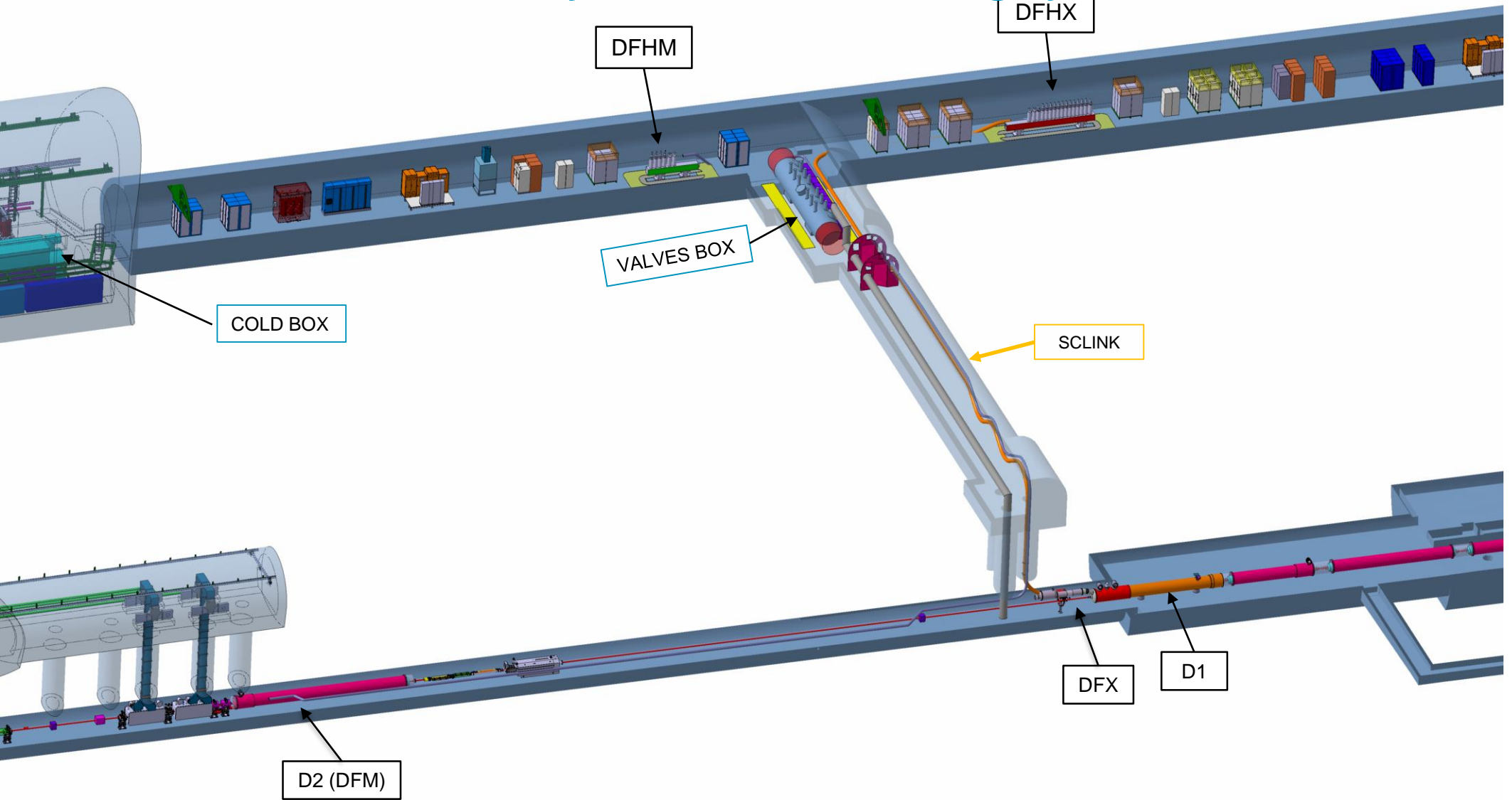


Overall layout of Cold Powering systems

Modified UL, (*work in progress*)



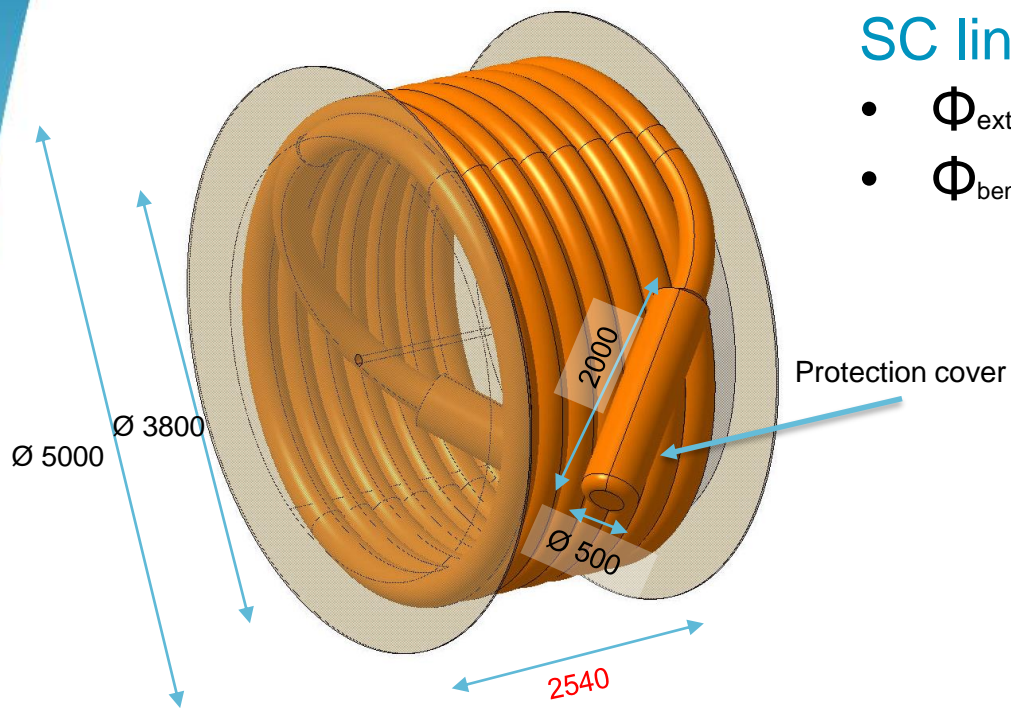
Overall layout of Cold Powering systems



Outline

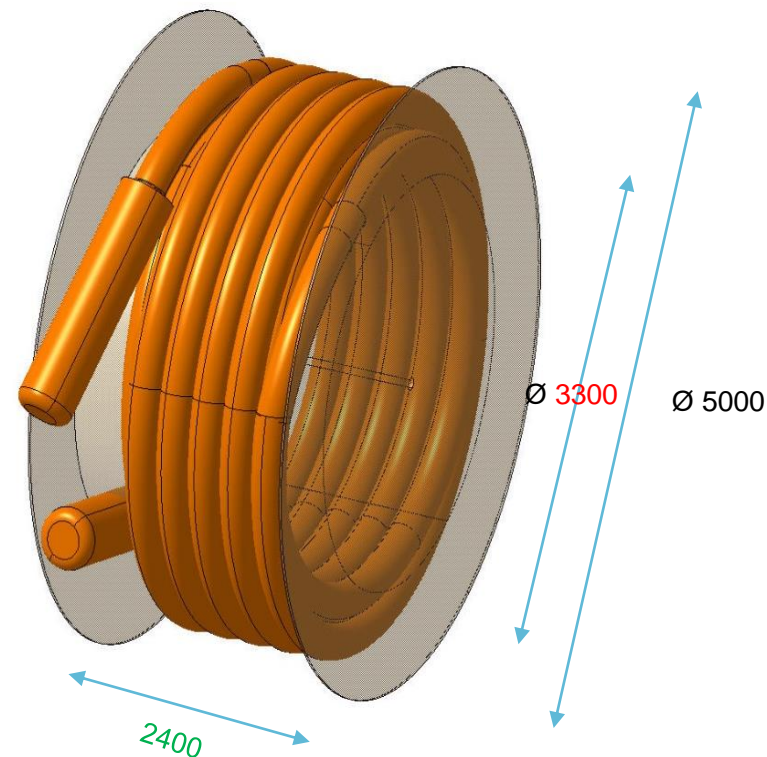
- Tunnel and new CE infrastructure
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- **Installation sequence of *DFX-DSH-DFHX***
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Spools: variants under study



SC link type A

- $\Phi_{\text{ext}} = 300 \text{ mm}$
- $\Phi_{\text{bend.}} < 3 \text{ m}$



Single-layer spool (baseline):

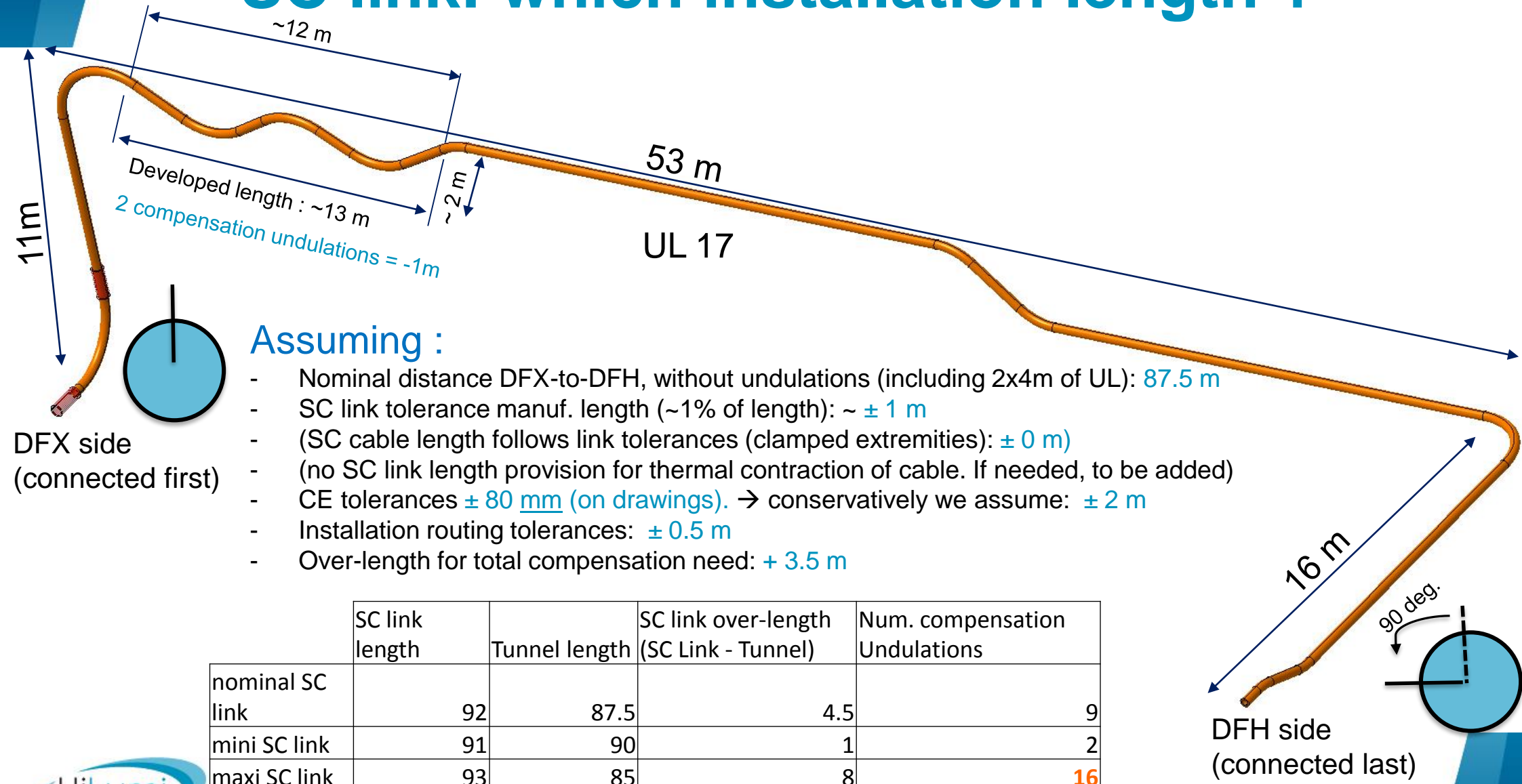
- max. link length: 95 m
- Link radius: 1.9 m
- Marginally too large for vertical shaft

Alternative: double-layer spool:

- Can accommodate a length up to: 128 m
- Link radius: 1.65 m (>1.5 m spec.)
- Better for vertical shaft

Estimate weight (~3.5-4 tons SC link + ~3 tons spool): ~ 7 tons

SC link: which installation length ?



Assuming :

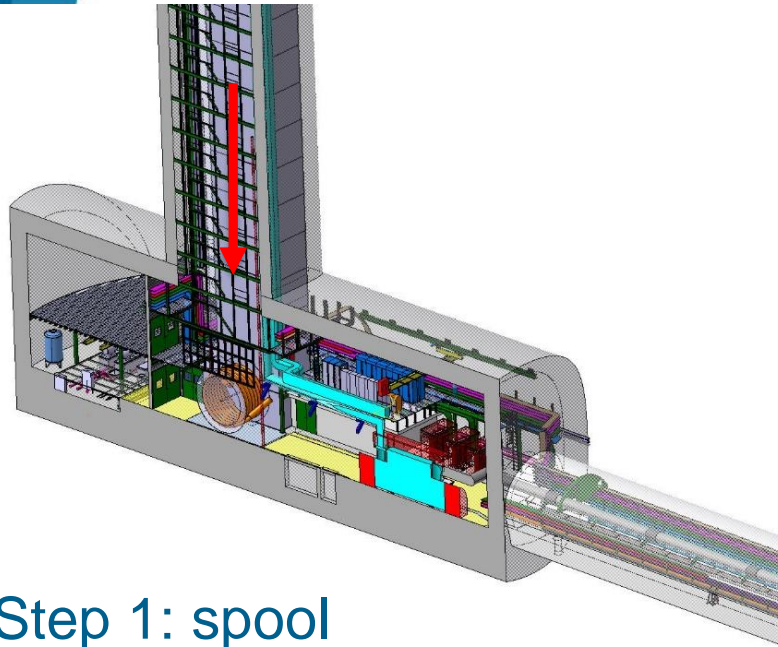
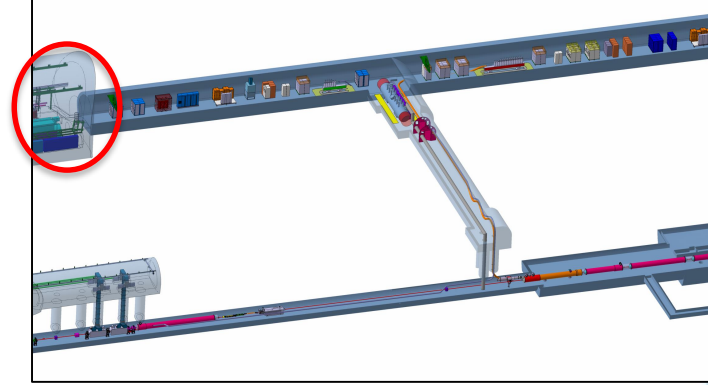
- Nominal distance DFX-to-DFH, without undulations (including 2x4m of UL): **87.5 m**
- SC link tolerance manuf. length (~1% of length): **~ ± 1 m**
- (SC cable length follows link tolerances (clamped extremities): **± 0 m**)
- (no SC link length provision for thermal contraction of cable. If needed, to be added)
- CE tolerances **± 80 mm (on drawings)**. → conservatively we assume: **± 2 m**
- Installation routing tolerances: **± 0.5 m**
- Over-length for total compensation need: **+ 3.5 m**

	SC link length	Tunnel length	SC link over-length (SC Link - Tunnel)	Num. compensation Undulations
nominal SC link	92	87.5	4.5	9
mini SC link	91	90	1	2
maxi SC link	93	85	8	16

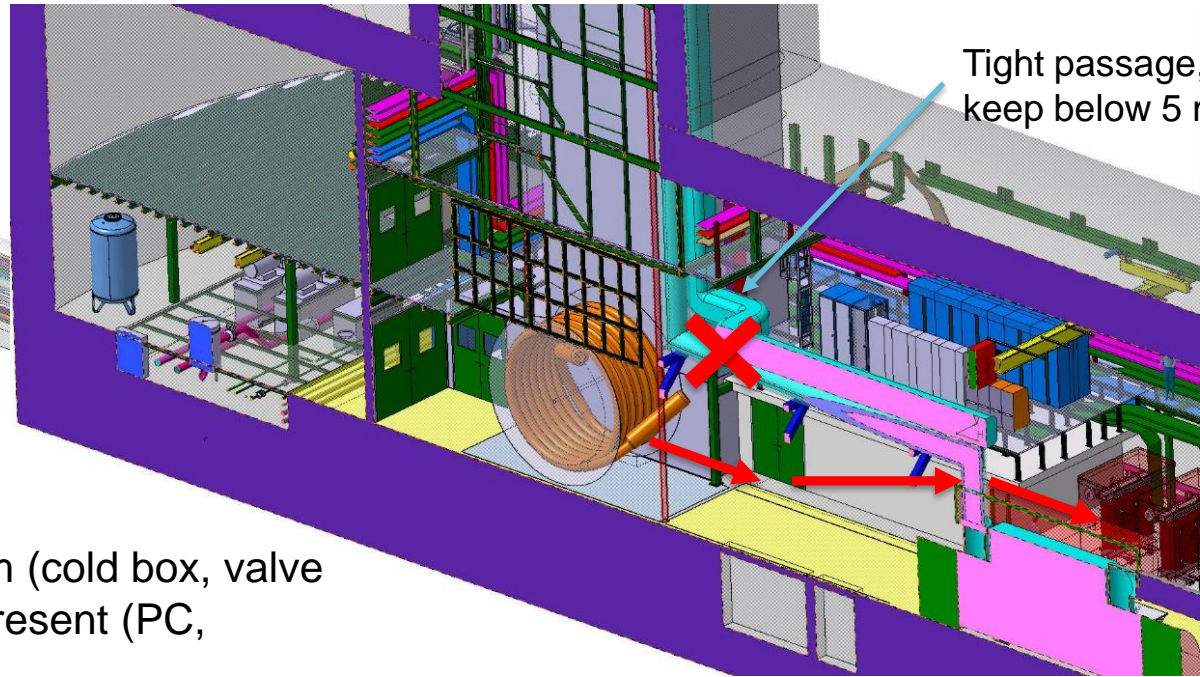
→ SC link length ~ 92 m (± 1 m)

(views S.Maridor, V.Maire)

Installation sequence



Step 1: spool lowering in shaft



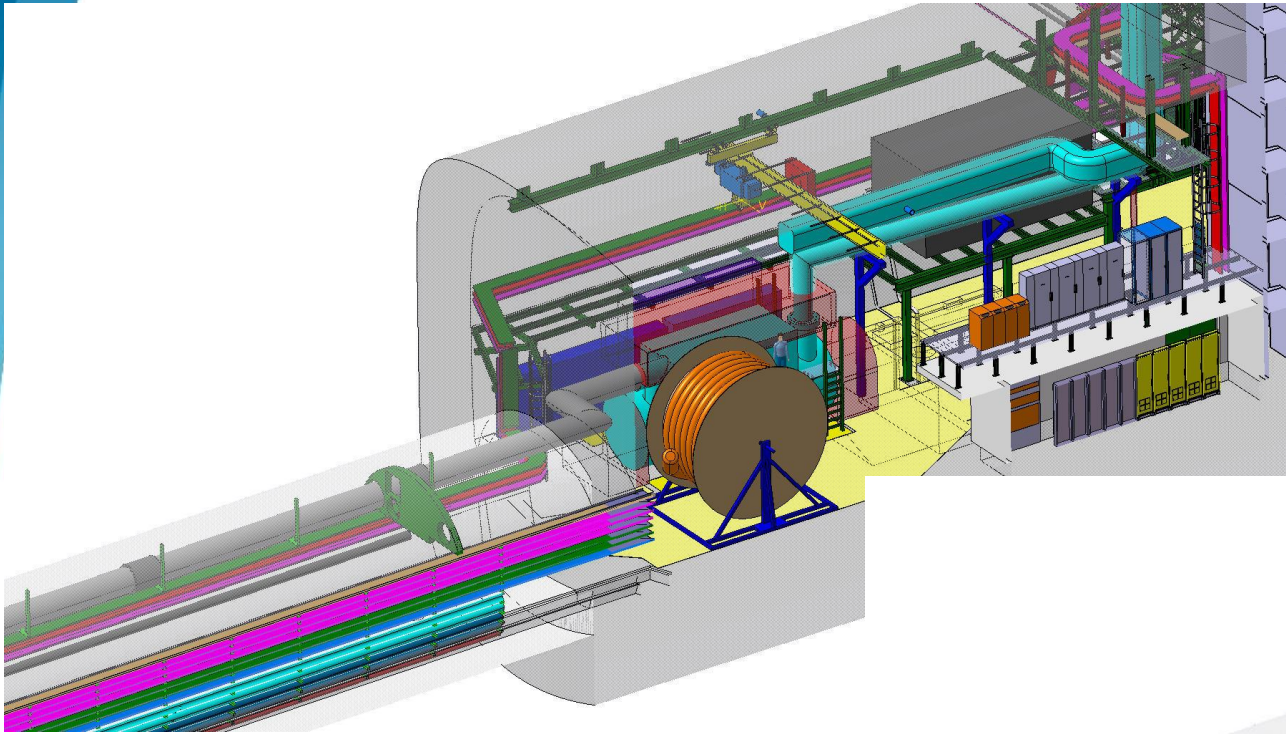
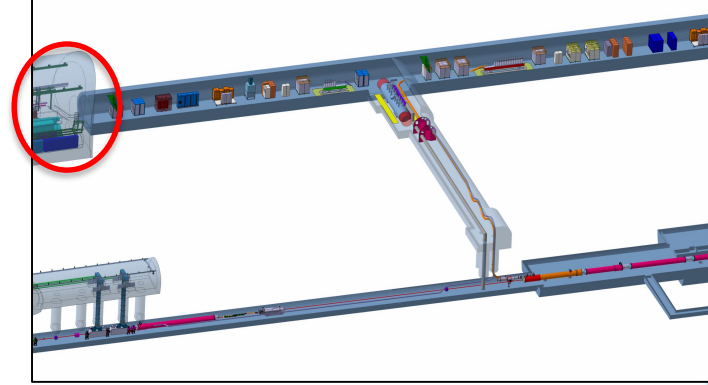
Tight passage,
keep below 5 m height

Present assumption:

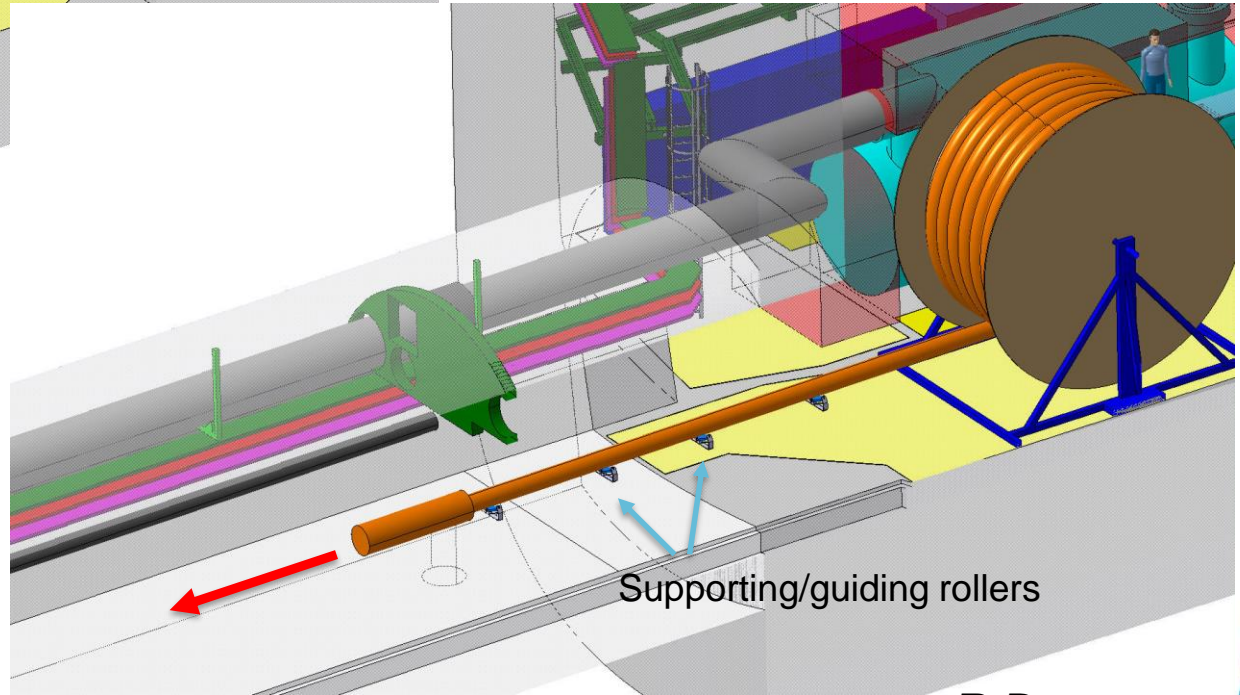
- SC link installed after cryogenic system (cold box, valve box, QXL lines), no other equipment present (PC, electronics racks .etc.)
- It may be worth considering the SC link as “last-in” “first-out” in case a full replacement becomes a credible scenario

Step 2: spool positioning

Installation sequence

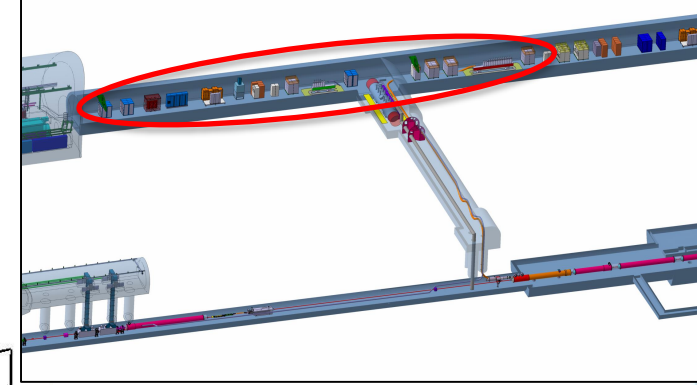


Step 3: un-spooling

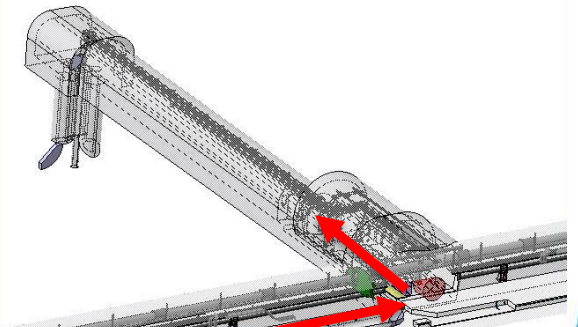
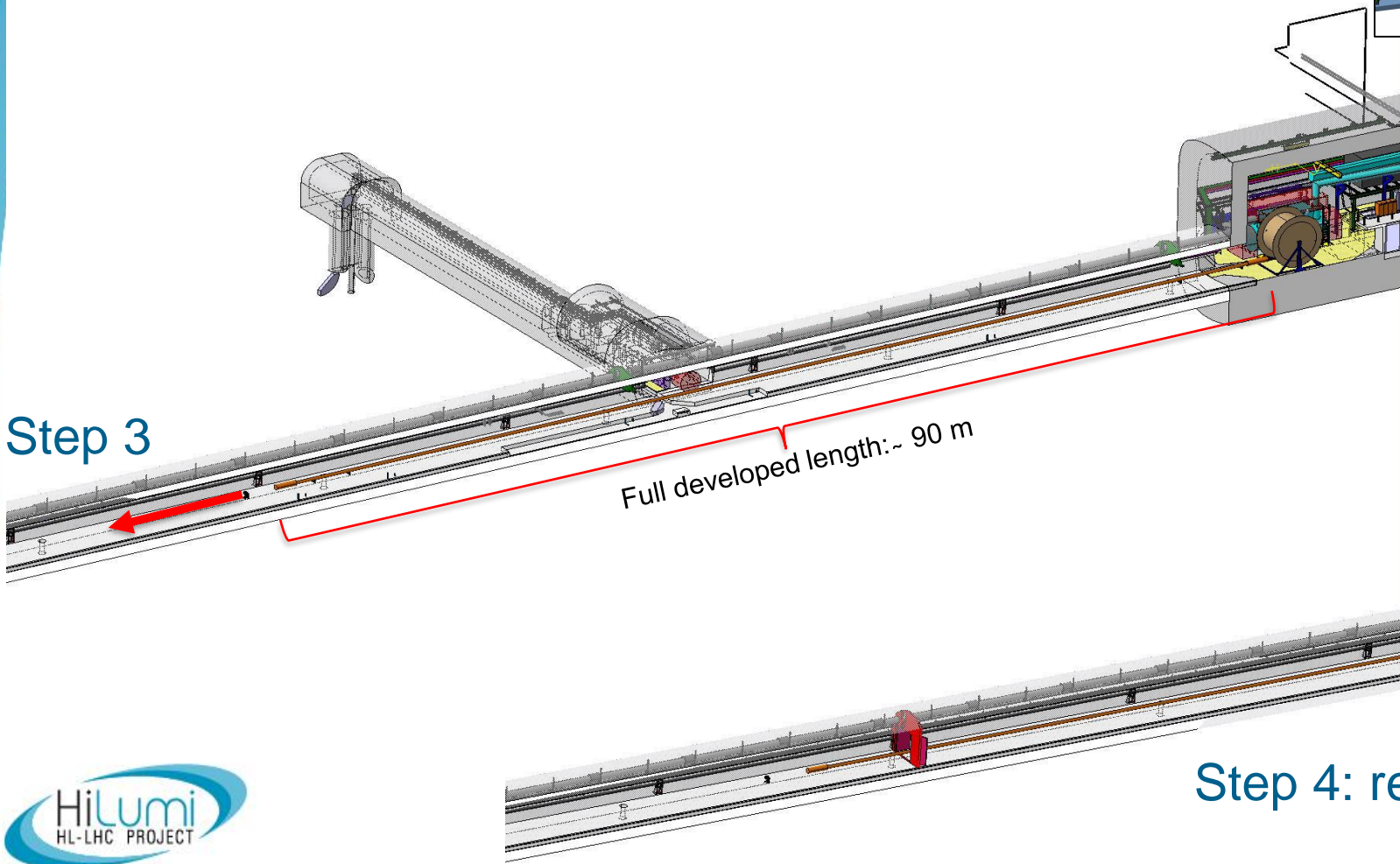


Supporting/guiding rollers

Installation sequence



Step 3

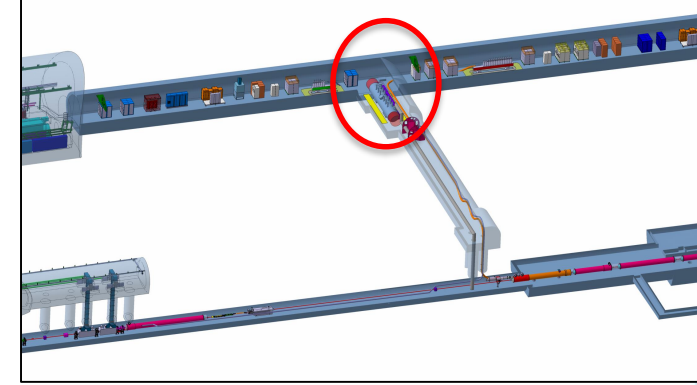
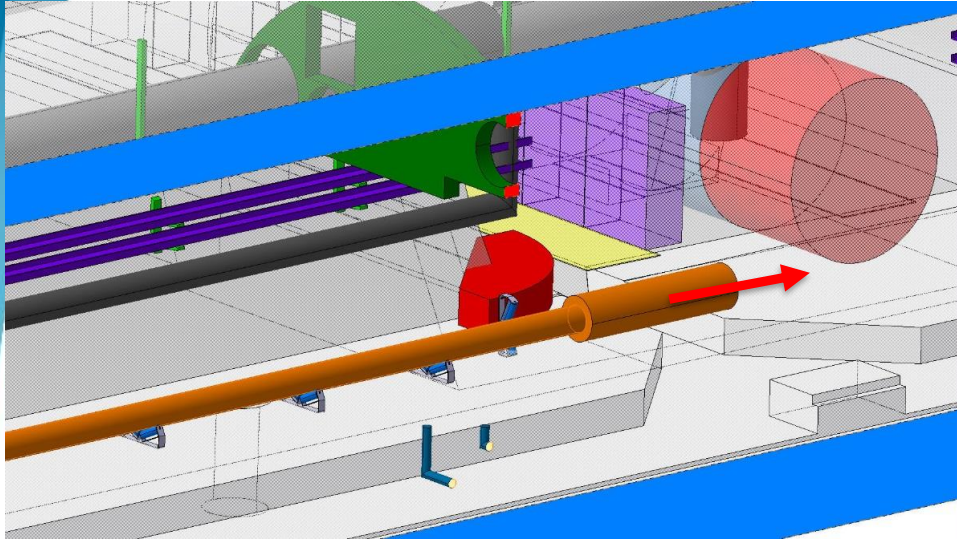


Step 4: reverse insertion in UL

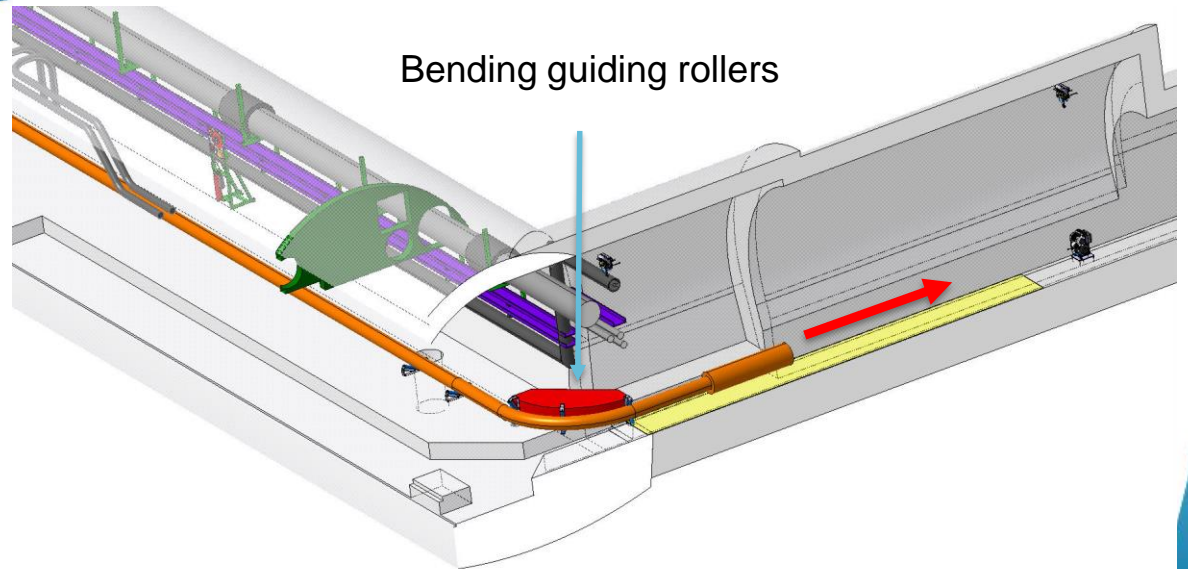


R.Betemps

Installation sequence

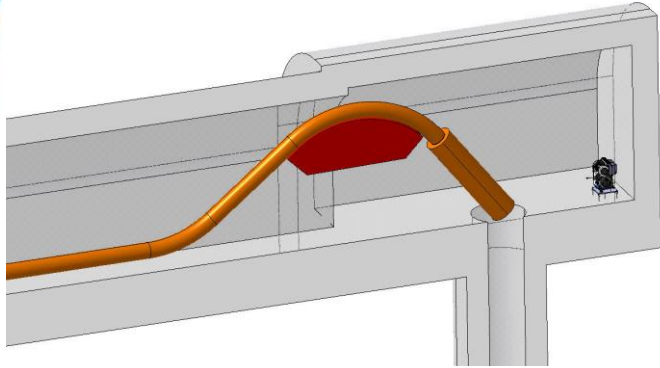


Step 4

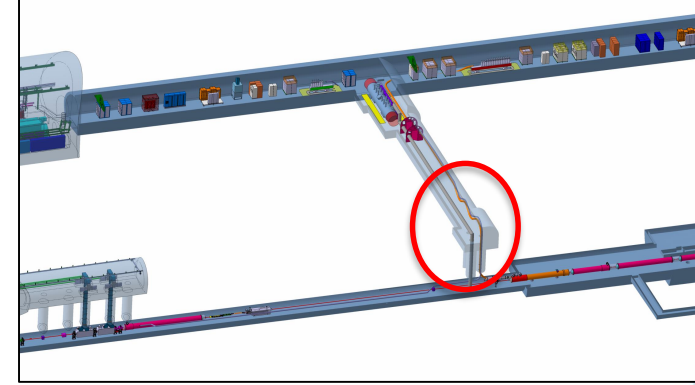
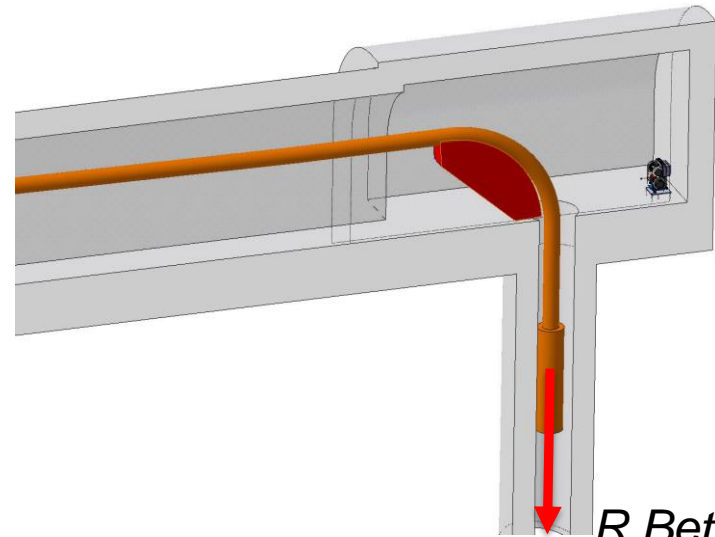
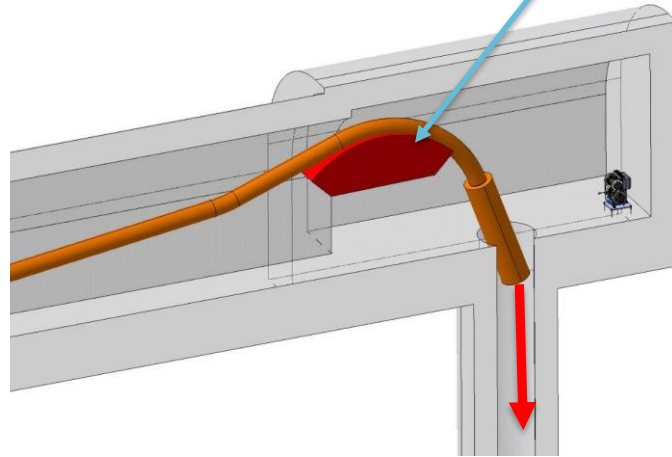


Installation sequence

Step 5: insertion in vertical shaft

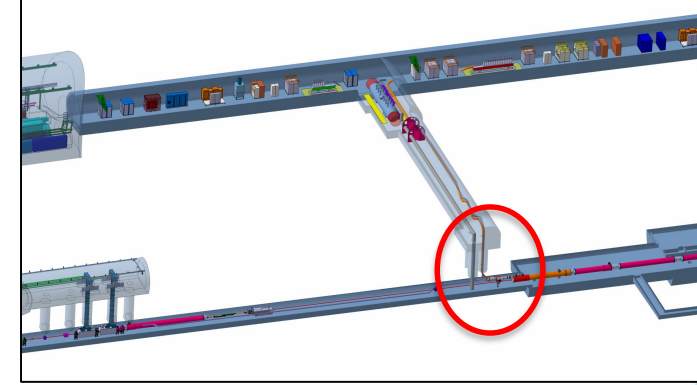
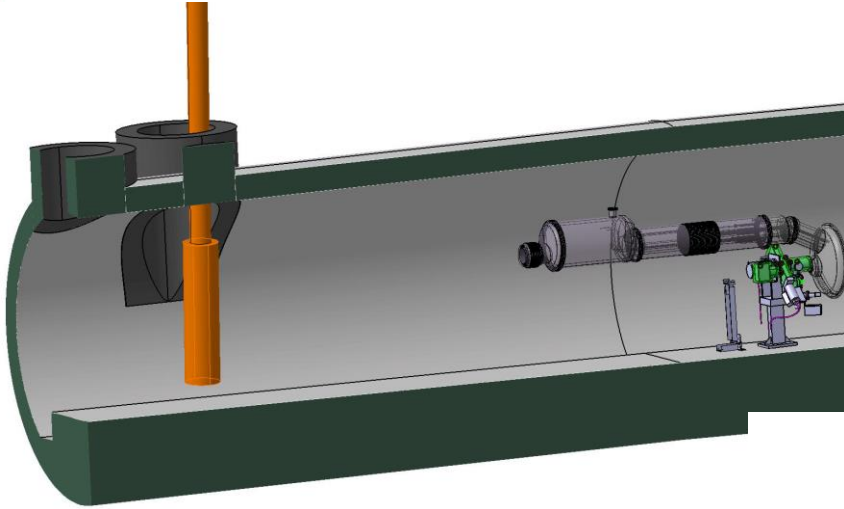


Bending guiding rollers

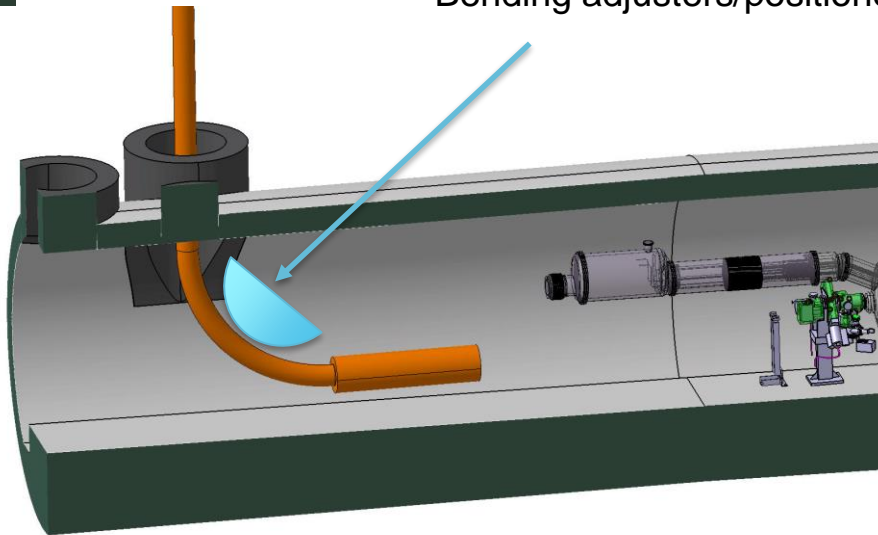


Installation sequence

Step 6: Tunnel insertion

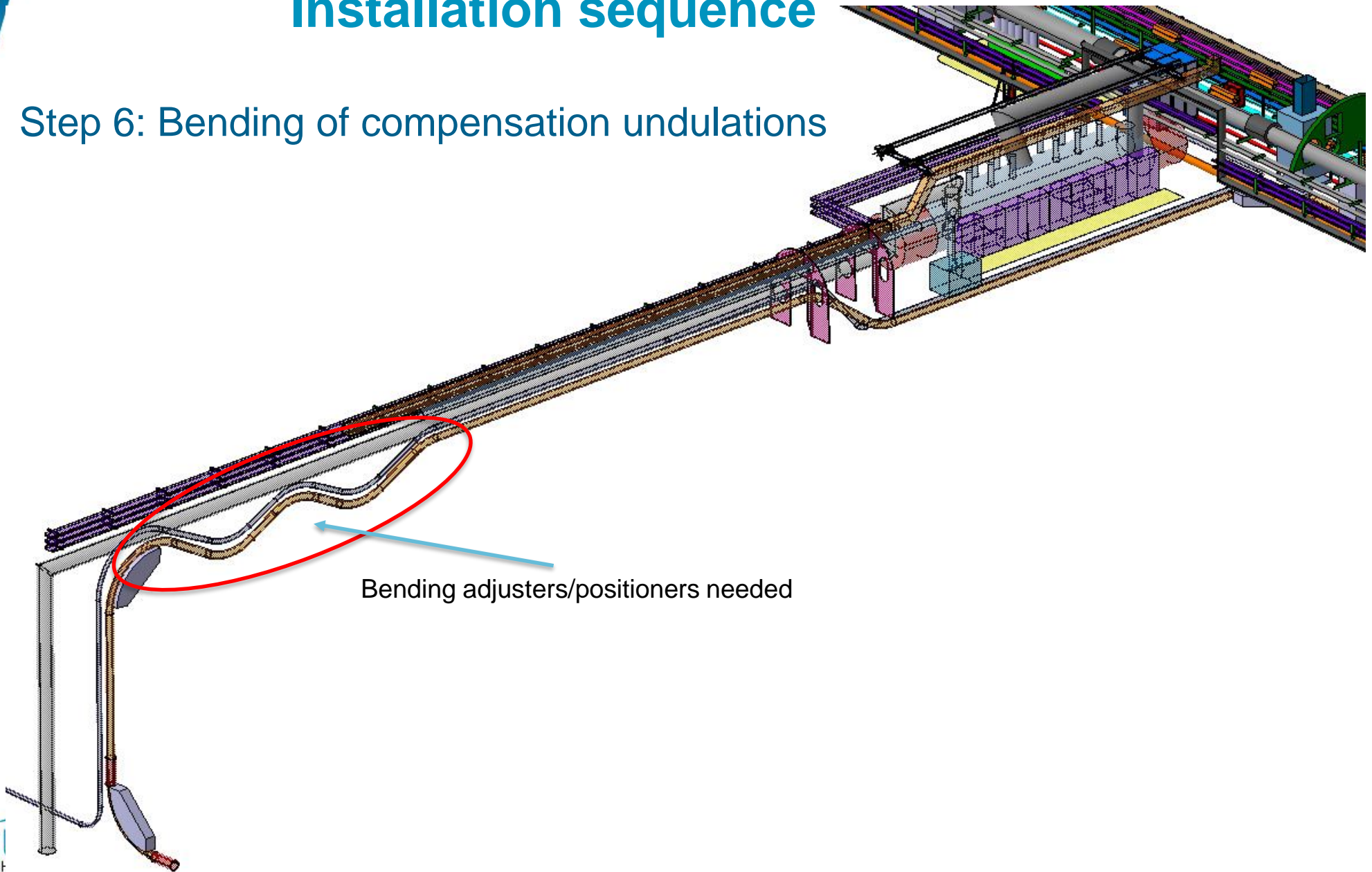


Bending adjusters/positioners needed



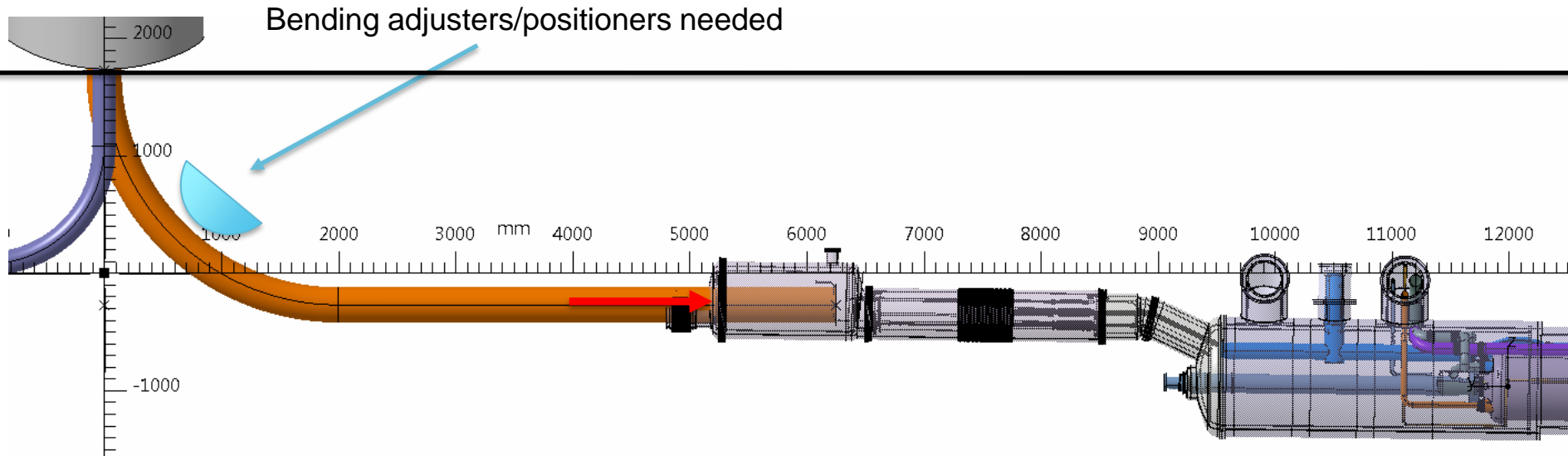
Installation sequence

Step 6: Bending of compensation undulations



Installation sequence

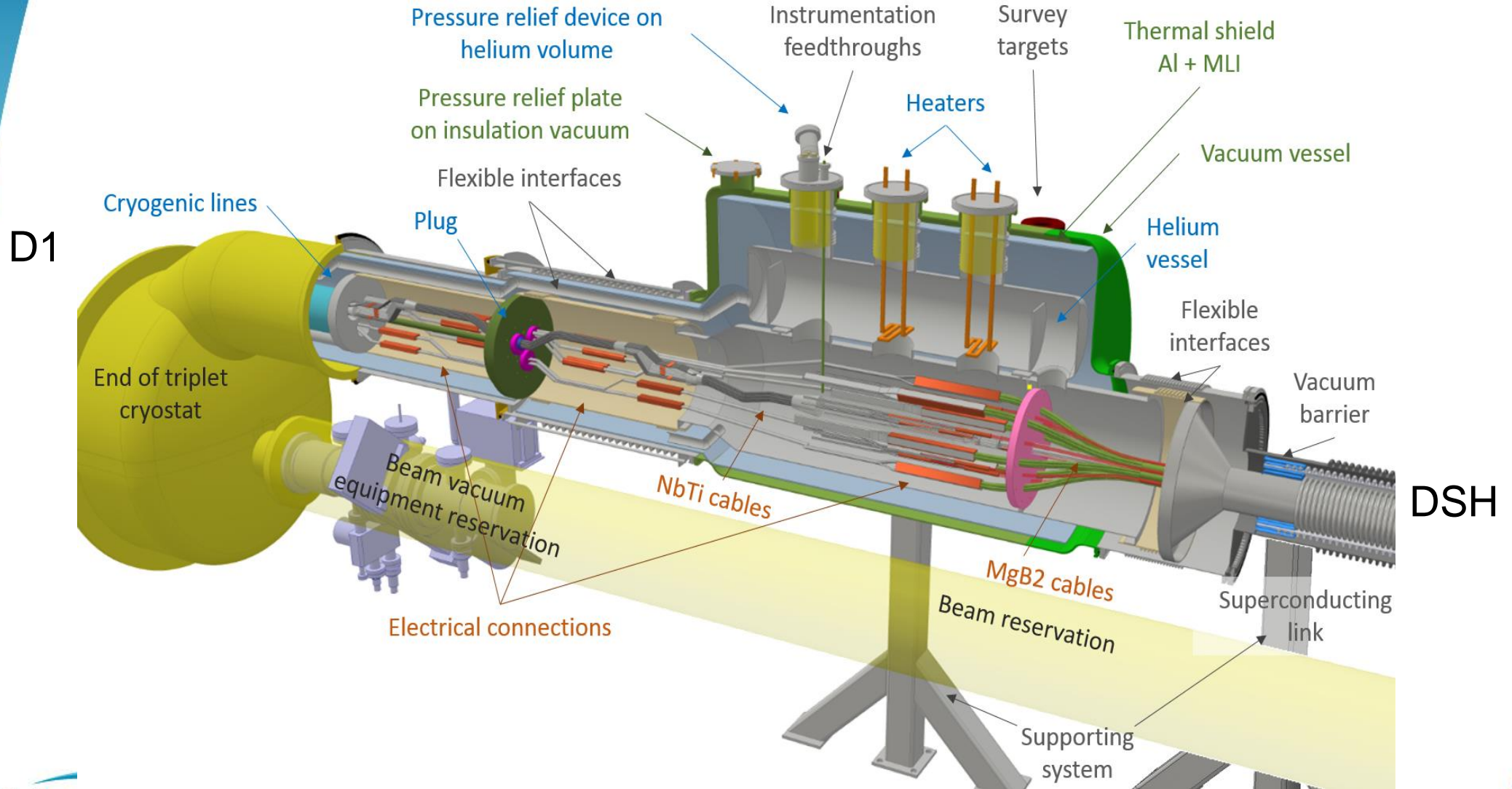
Step 7: Fine matching of DSH to DFX



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Interfaces D1-DFX-DSH



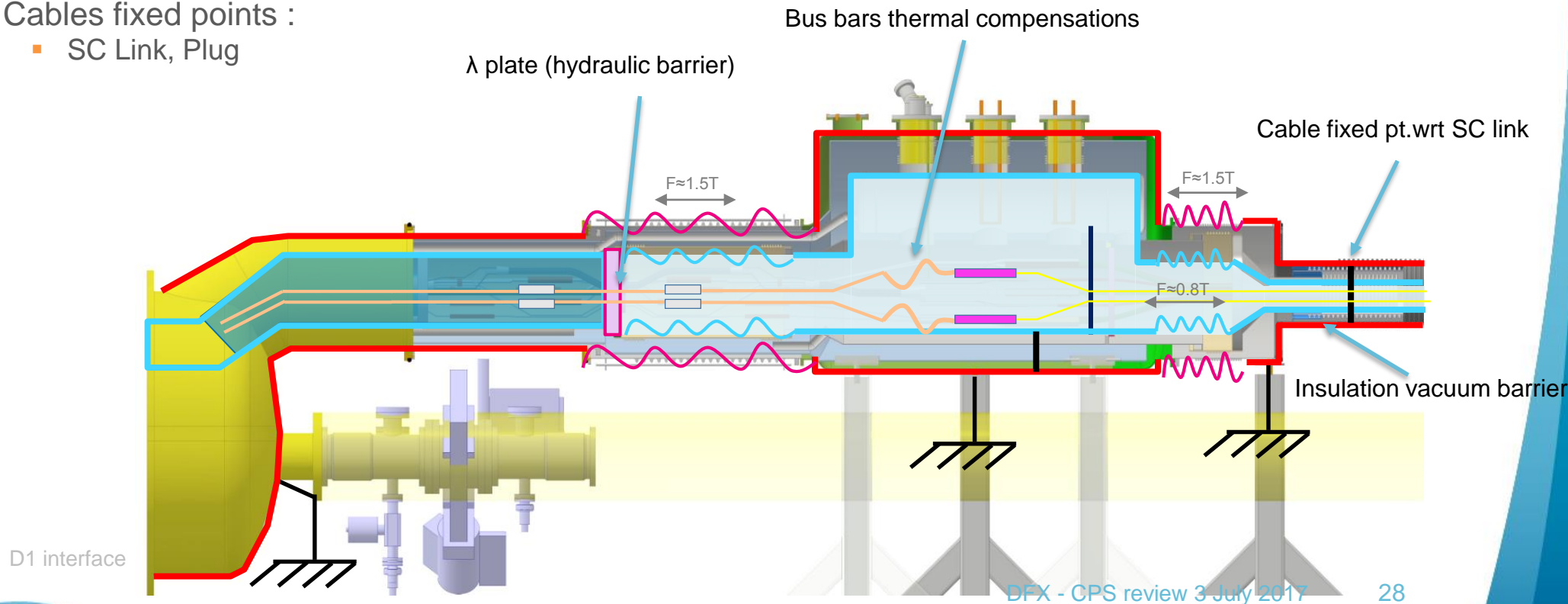
Mechanical interfaces

- Fixed points

- Vacuum envelopes :
 - SC Link, DFX, independent from D1-Beam tube
- Helium vessels
 - SC Link, DFX, independent from D1-Beam tube
- Cables fixed points :
 - SC Link, Plug

- Thermal contraction

- MgB₂ cables in SC Link
- DFX: bus bars local compensations
- D1 interface: in study



Summary

- **Preliminary integration study presented**, confirms geometrical feasibility (compatibility of tunnel passage wrt bending radia) for the baseline SC link (i.e. type A)
- **Preliminary installation sequence presented**, confirms feasibility, but more work to be done with final tunnel arrangement (requested +4 m UL movement)
- **Installation/guiding tooling will have to be studied** based on the final choice of the SC link, including stiffness and reaction forces and handling precautions; mock-up testing with the existing prototypes will be beneficial to provide rapid and practical feed-back;
- **Integration length compensation measures will have to be included** (at least in the UL) for compensation of up to ± 3.5 m; a preliminary study suggests a SC link nominal length of 92 m, but under the present conservative assumptions on tolerances a compensation of up to 8 m may be needed; adjustment tools in the UL have to be studied
- **Interface SC link/DFX: functionally clear, need to be engineered** (e.g. fixed points, compensation lyras in DFX, cable fixed point in SC link, vacuum barrier)
- **Interface DFX to D1: clear concepts**, engineering work on-going
- **DFHX installation/integration not covered**, but space allocation defined; no “hard limits” so far
- **DFHM-SC link-DFM not covered** (less critical being smaller), but integration/installation will amply profit from the DFHX-DSH-DFX work