



# LHC Environment Constraints & Integration

*Presented by P. Fessia*

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WP4 (RF): R. Calaga, O. Capatina, T. Capelli, F. Killing, E. Montesinos, G. Vandoni

WP9 (Cryogenics): S. Claudet, J. Metselaar, M. Sisti

WP12 (Vacuum): J. Hansen, R. Tavares Rego

WP 15.4 (Alignment): H. Mainaud, A. Herty

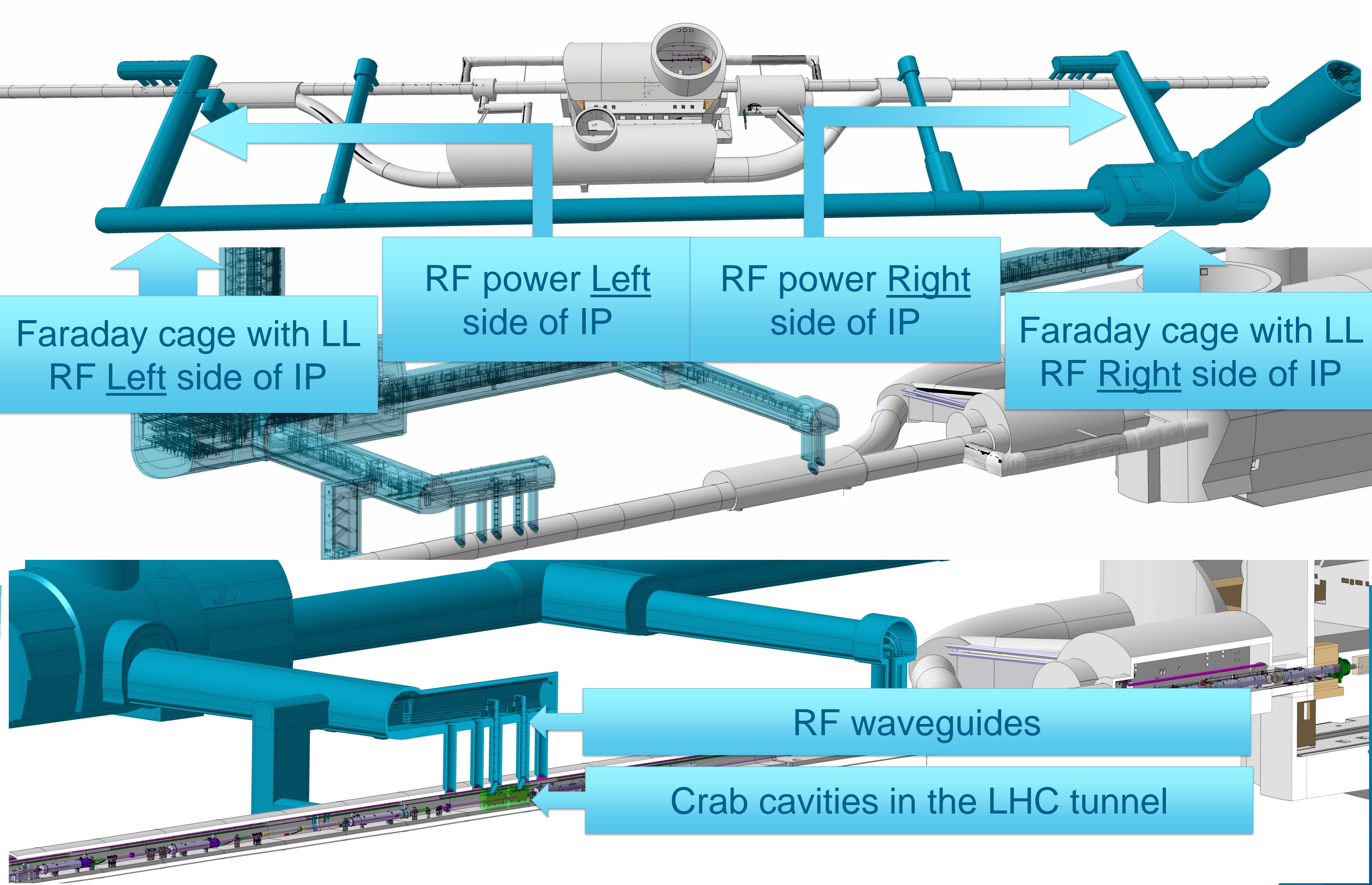
EC-CV: F. Borralho

EN-EL: P. Orlandi

Civil engineering models from WP17.1

# Summary

- General view of where the crab cavity system is integrated
- The new HL-LHC galleries
  - Low Level RF integration
  - RF powering and control integration
  - Load and circulators
- The LHC environment and some constraints
- Conclusions



Faraday cage with LL  
RF Left side of IP

RF power Left  
side of IP

RF power Right  
side of IP

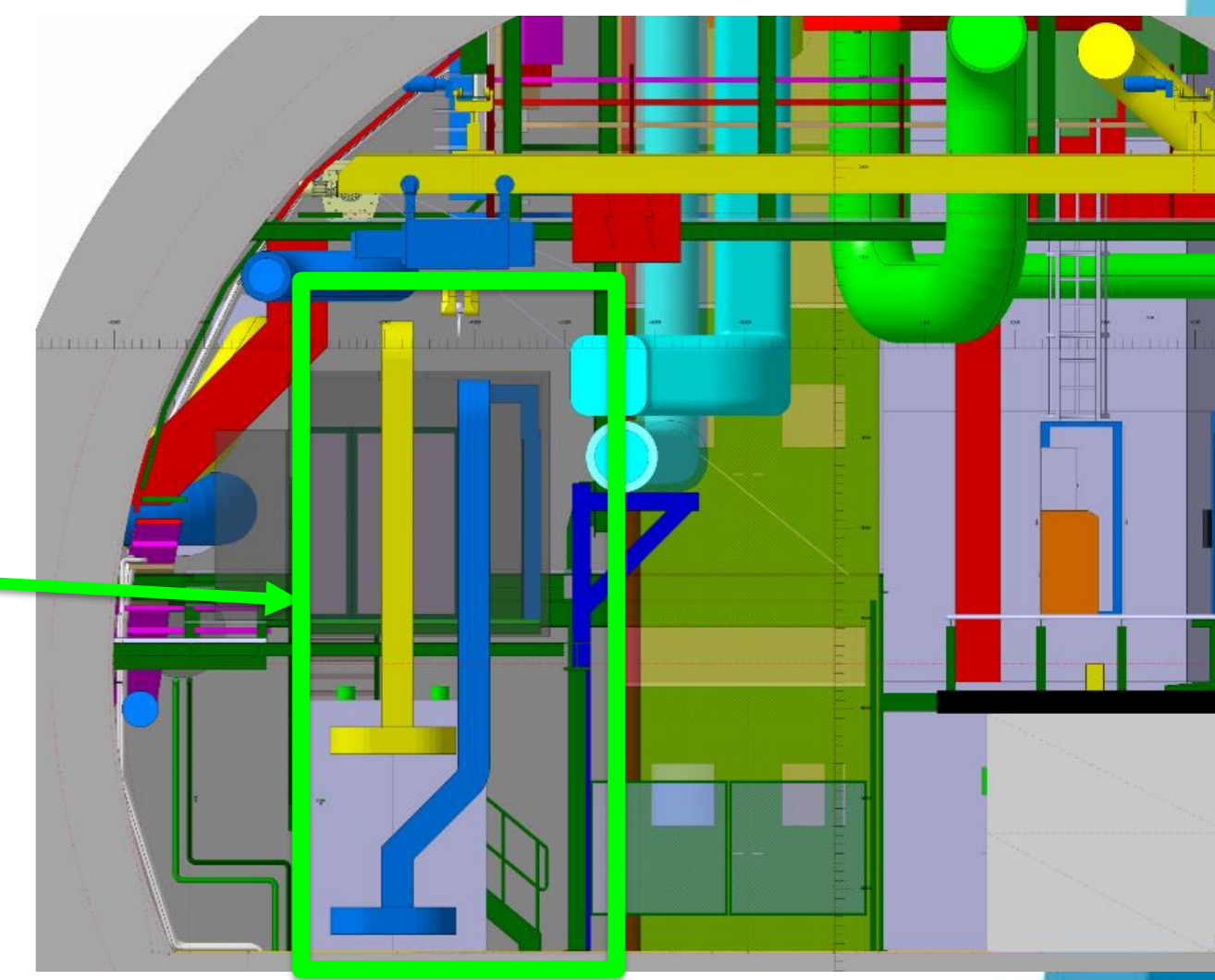
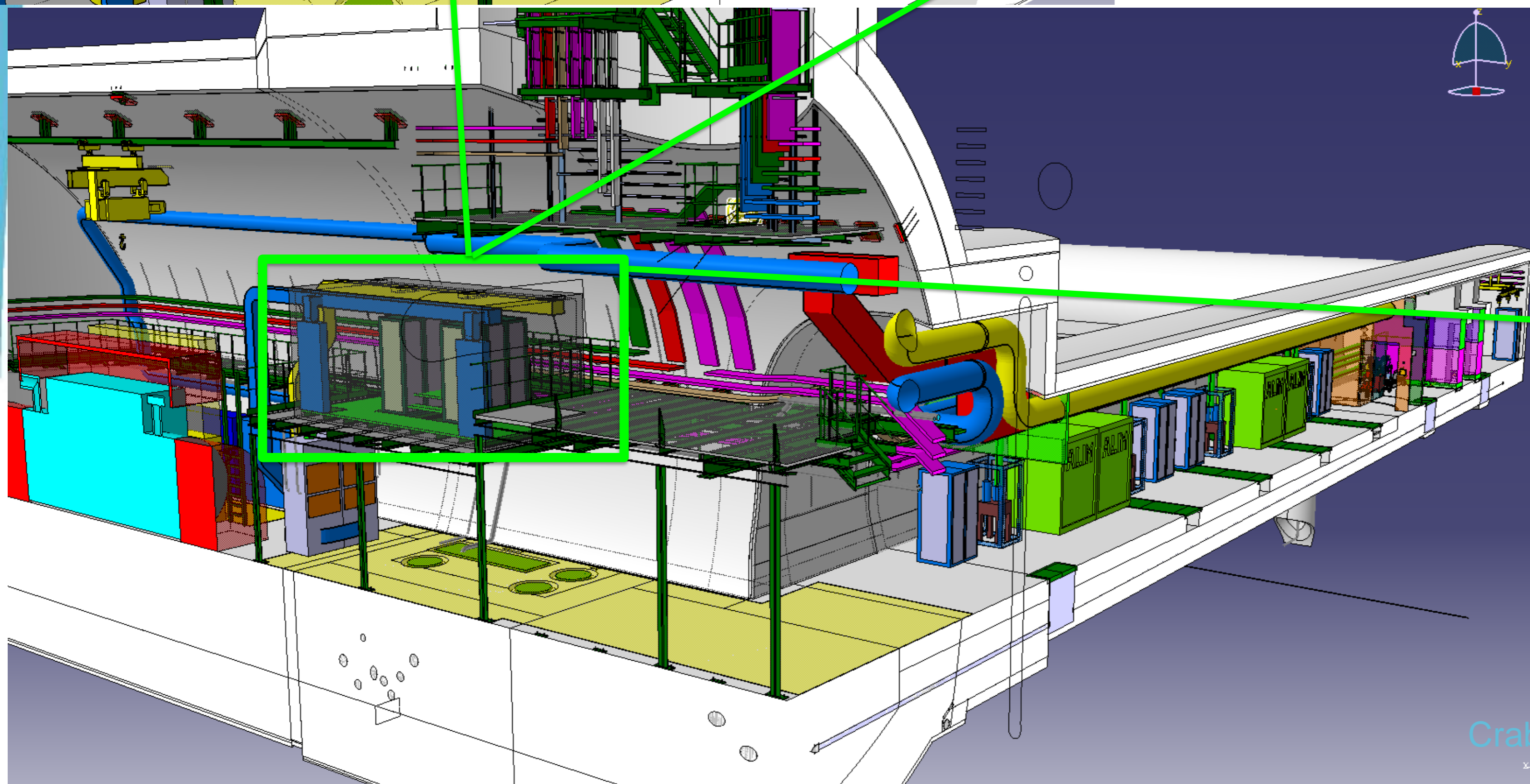
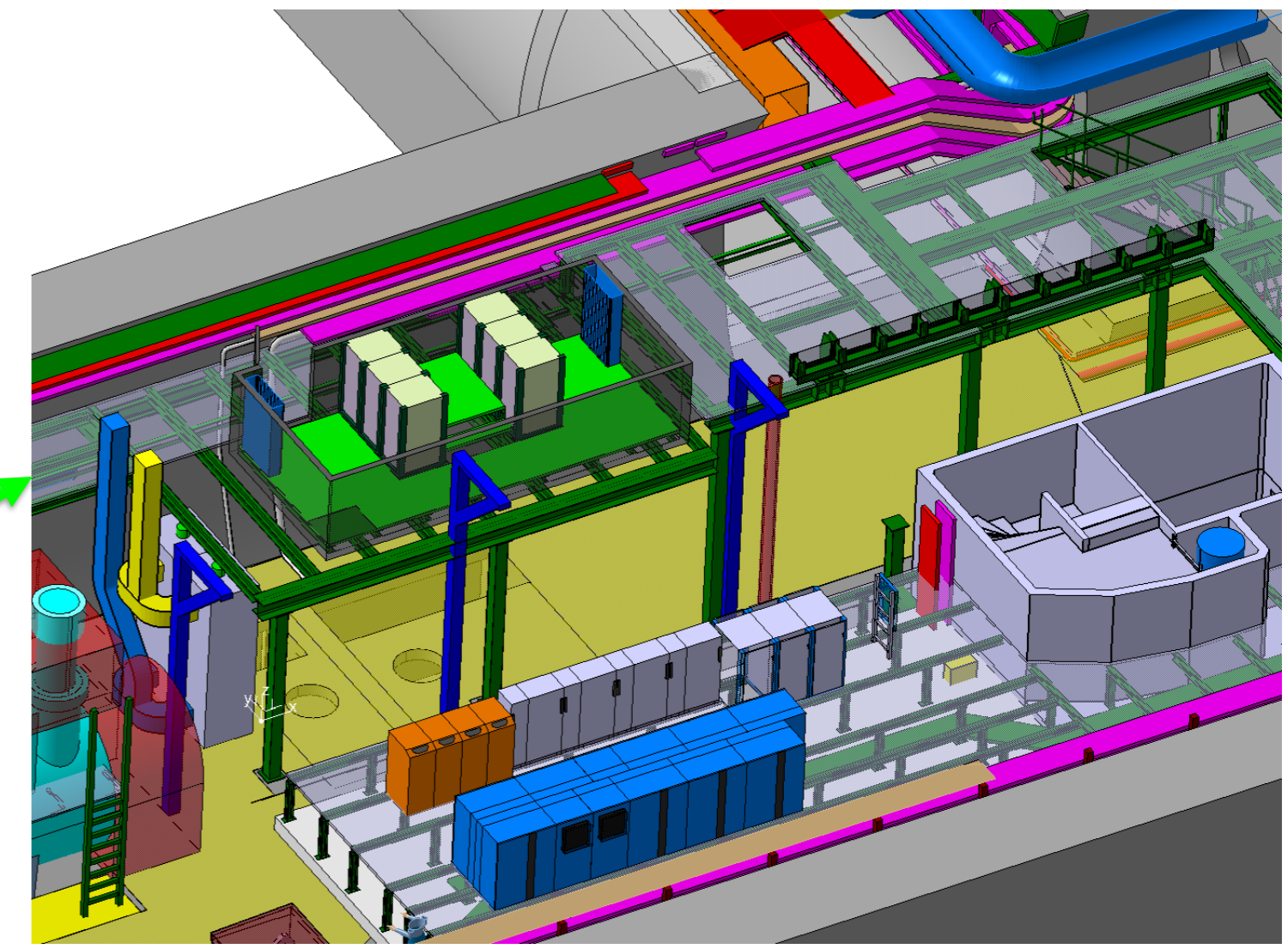
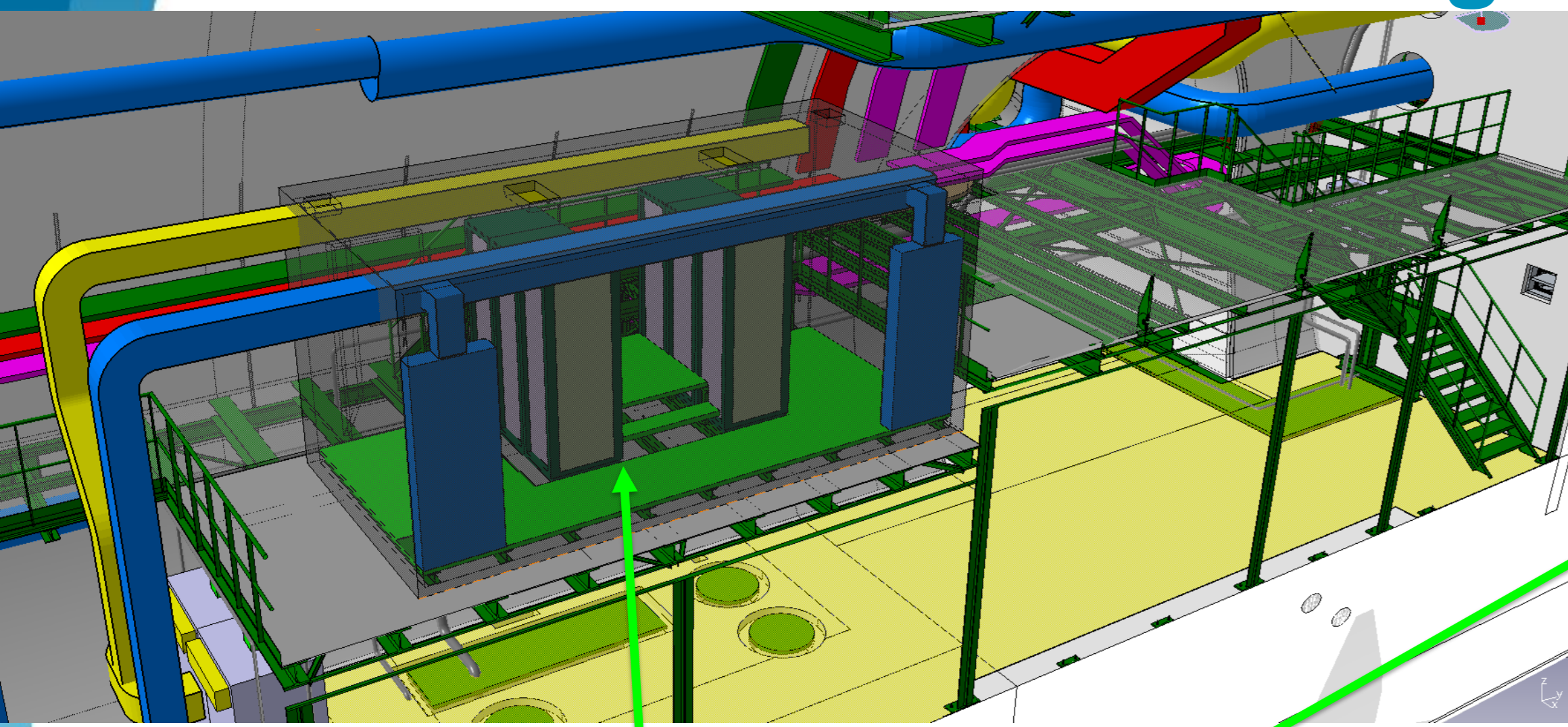
Faraday cage with LL  
RF Right side of IP

RF waveguides

Crab cavities in the LHC tunnel

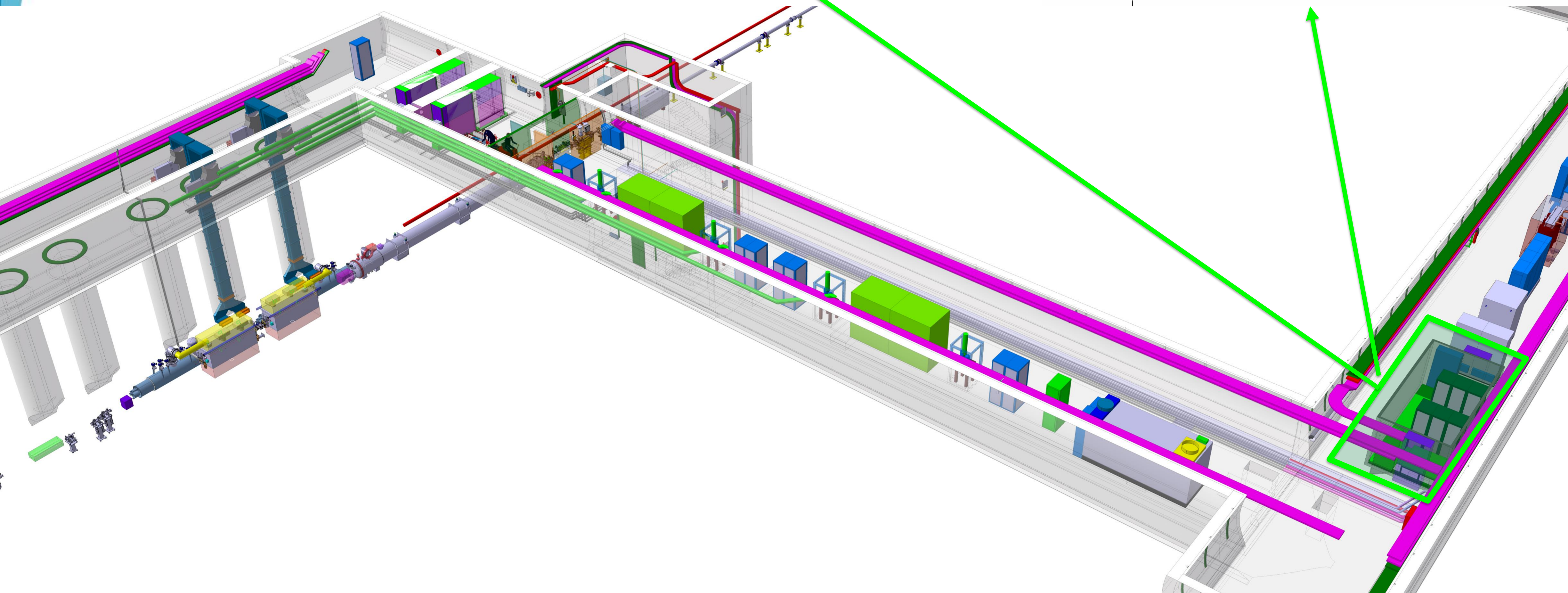
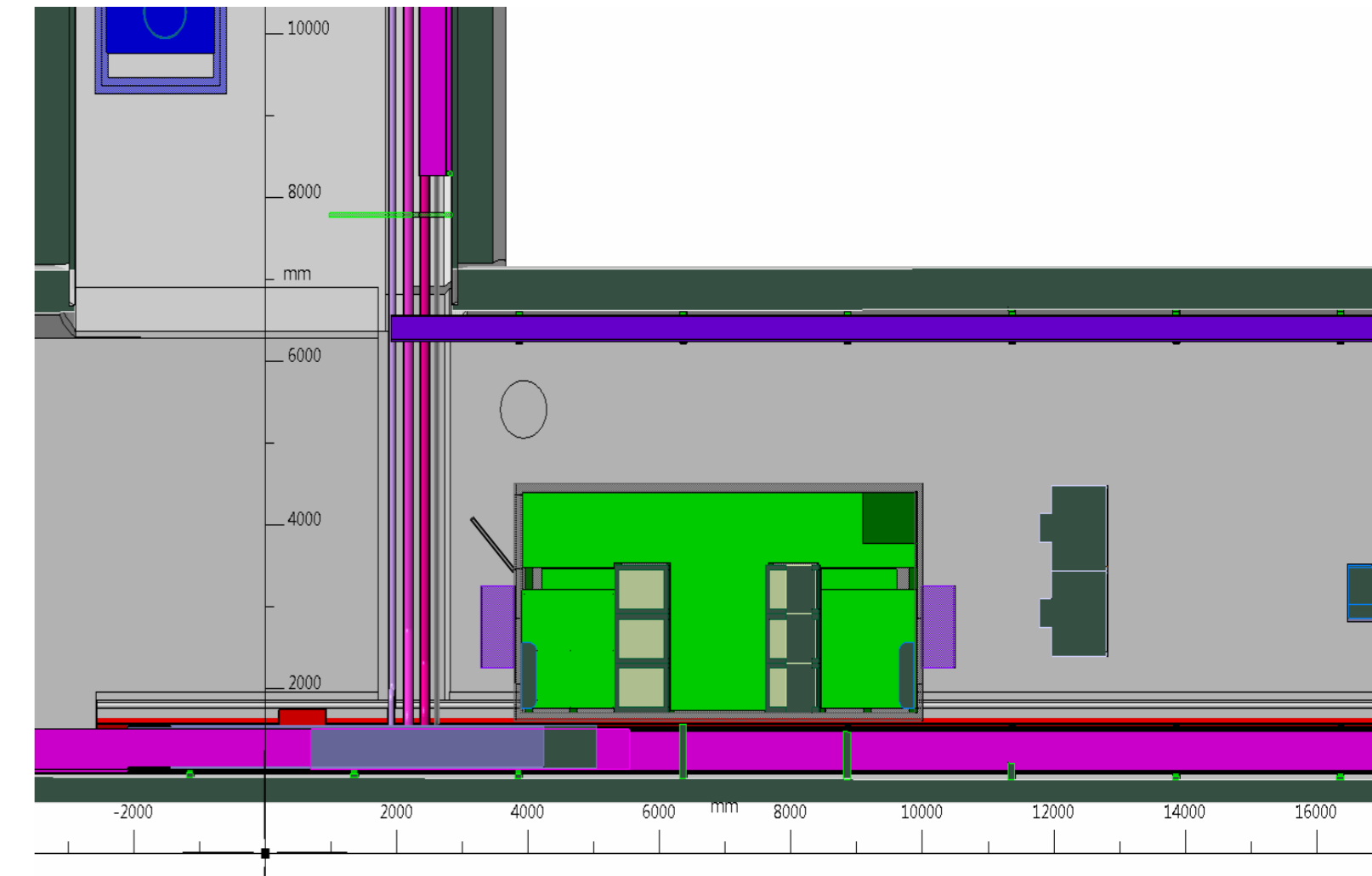
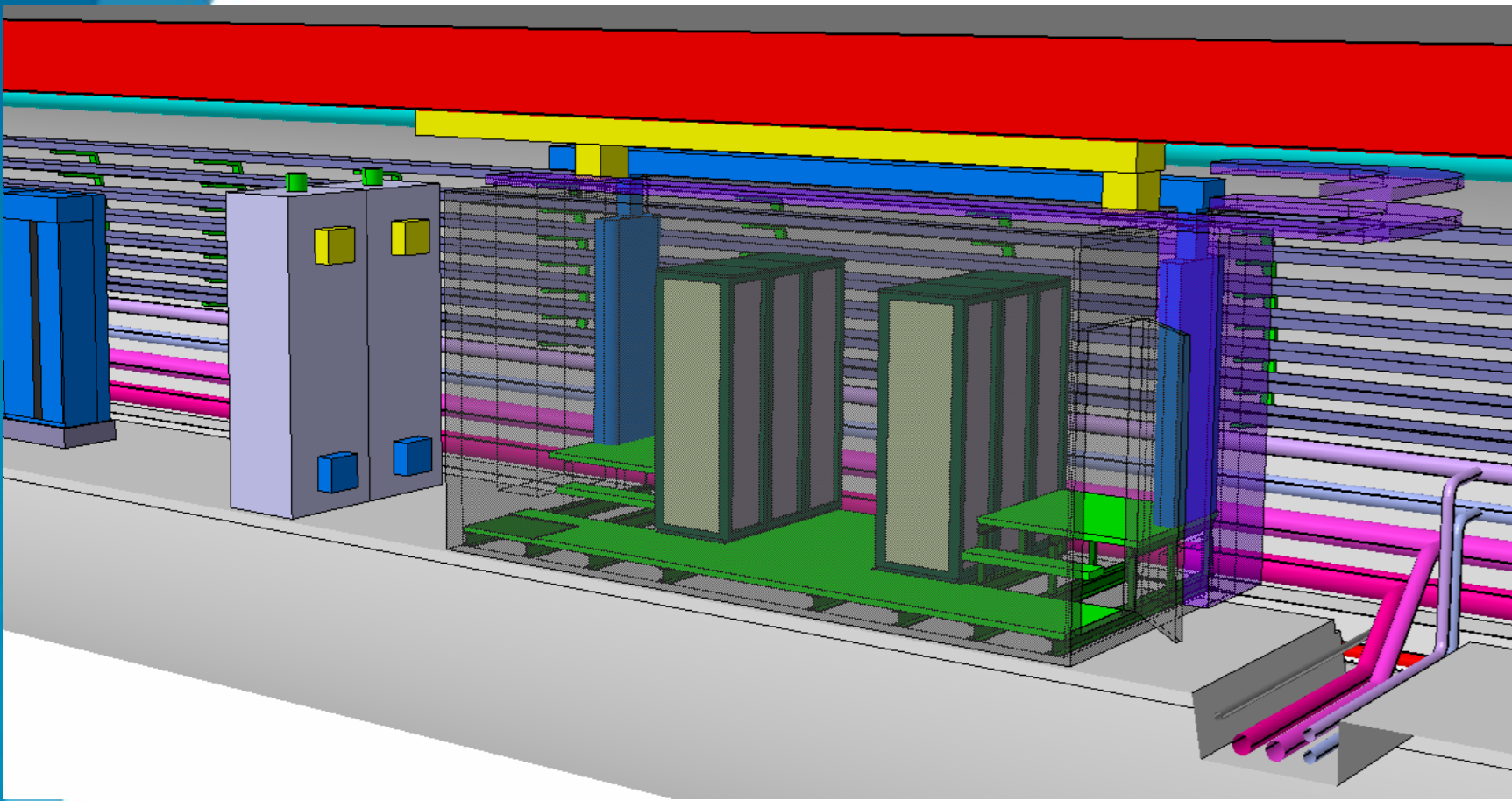
# Low level RF Faraday Cages

## Right side



# Low level RF Faraday Cages

## Left side



# RF power and control installation

To be updated when geometry SSPA will be known  
SSPA will be specified to be compliant with integration hypothesis

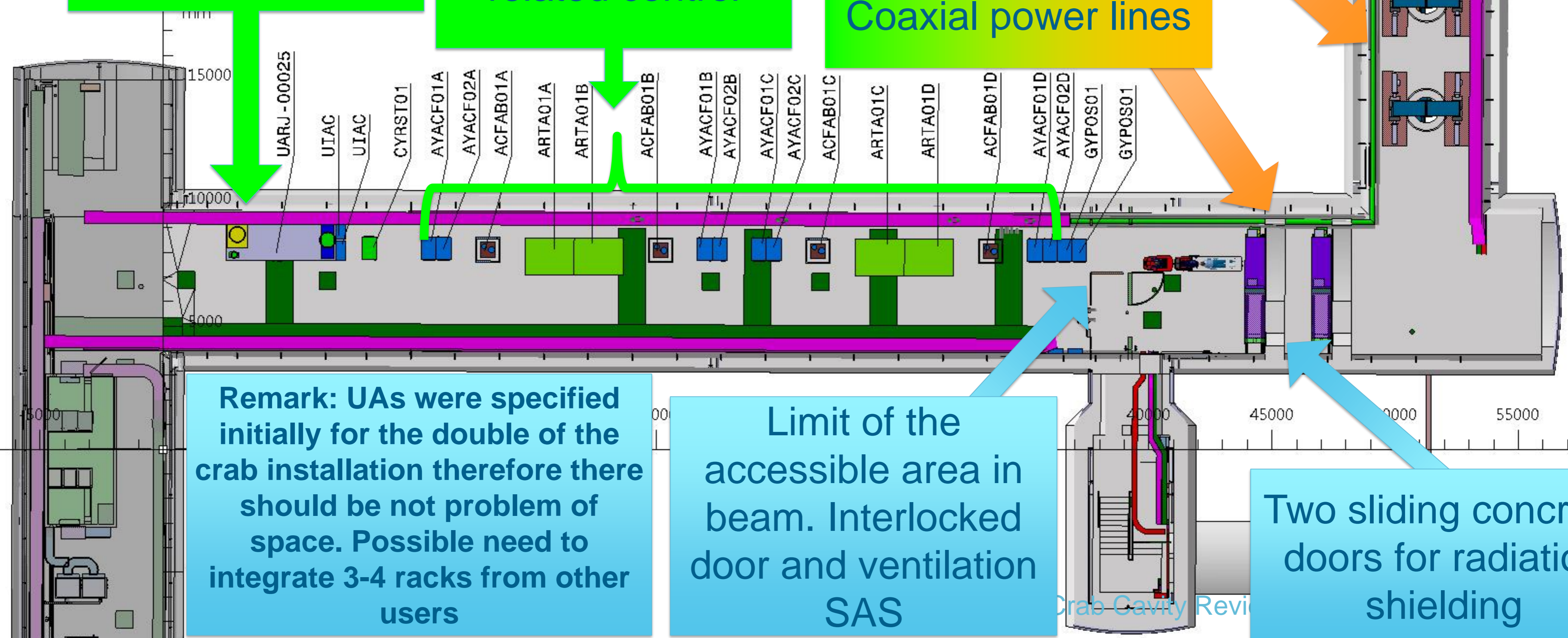
Core for cables. Mainly RF related ones

Circulator and loads And RF guide upper terminals

Coaxial power lines

Air Handling unit for the RF power

RF power and related control

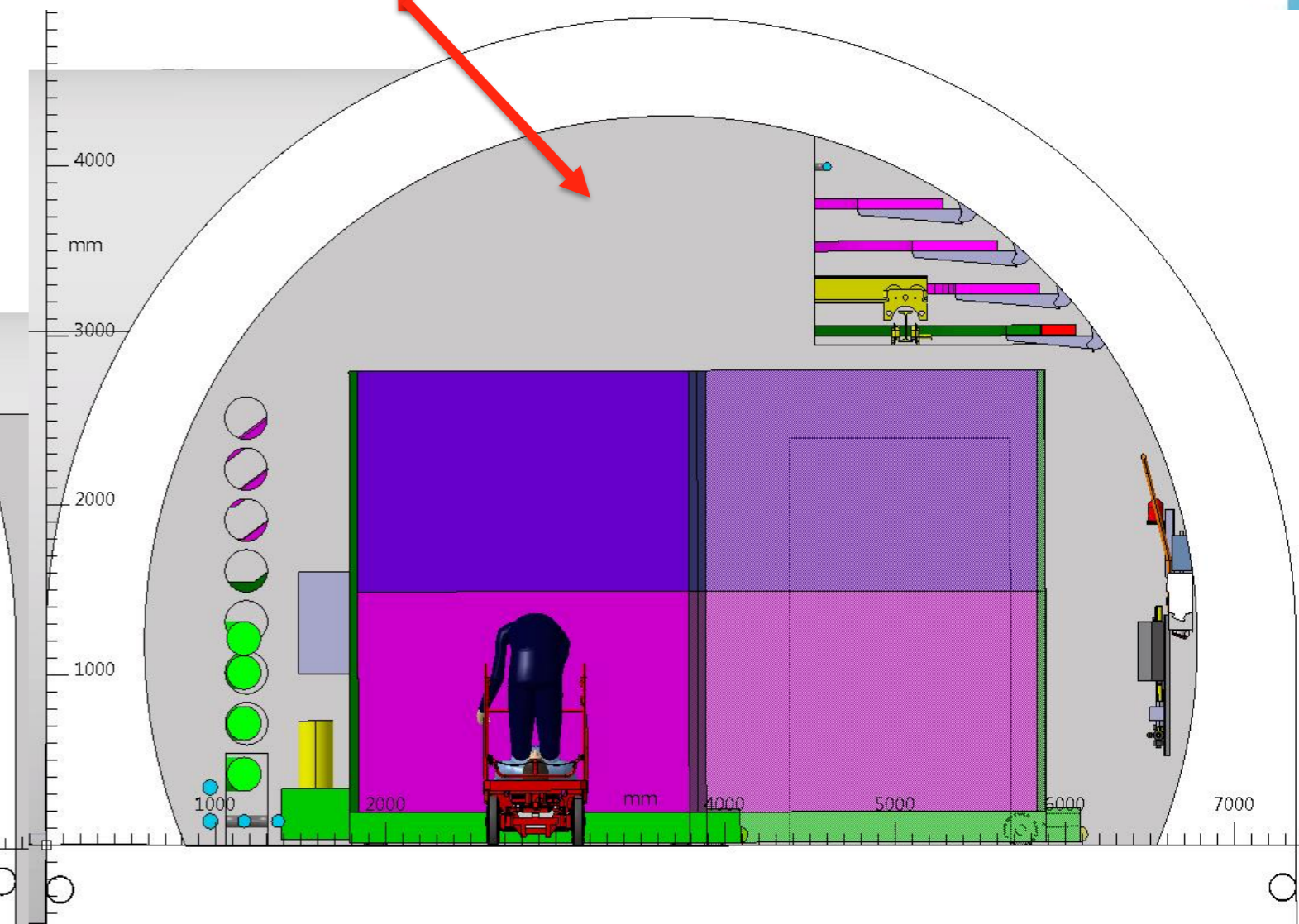
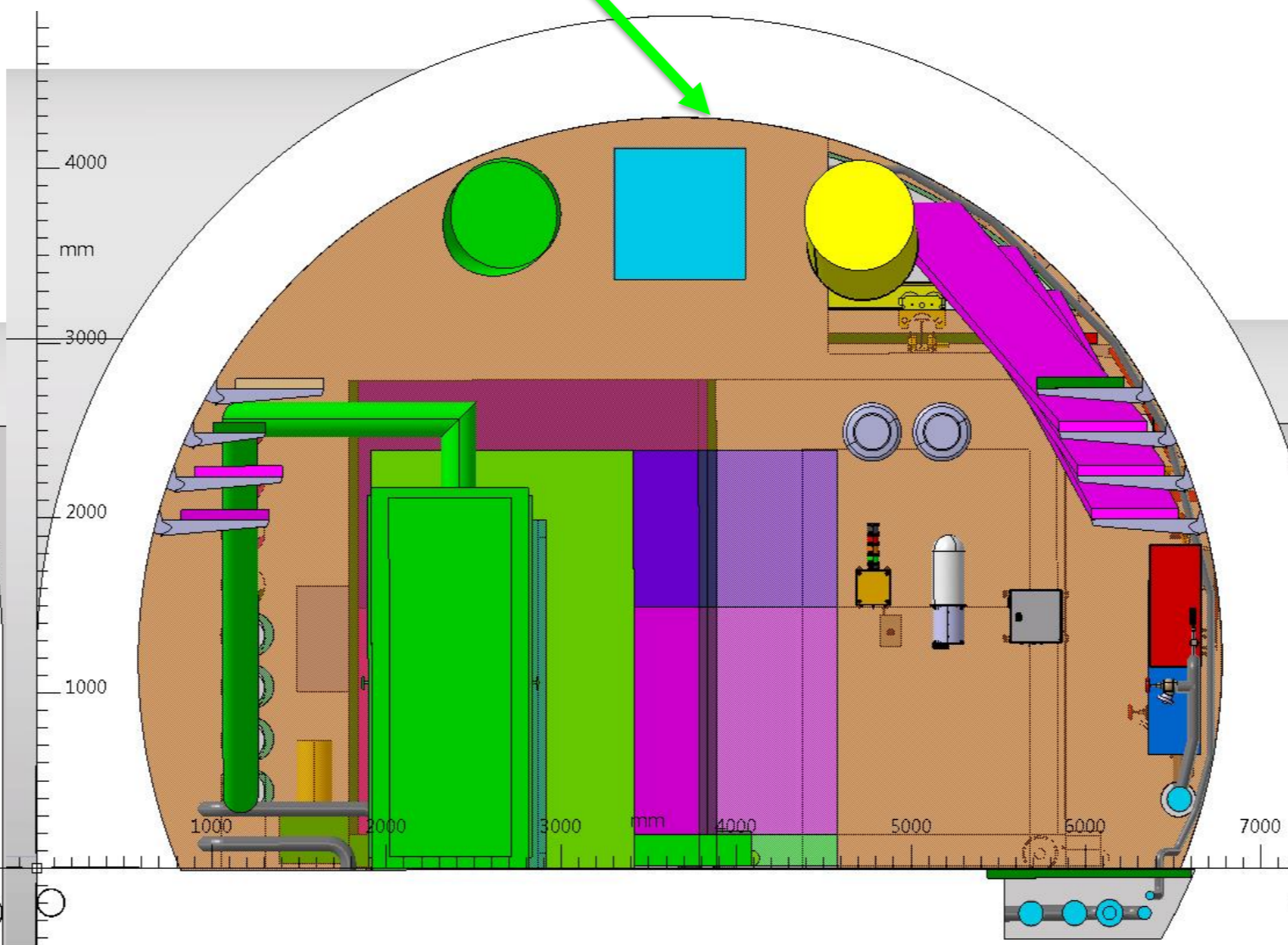
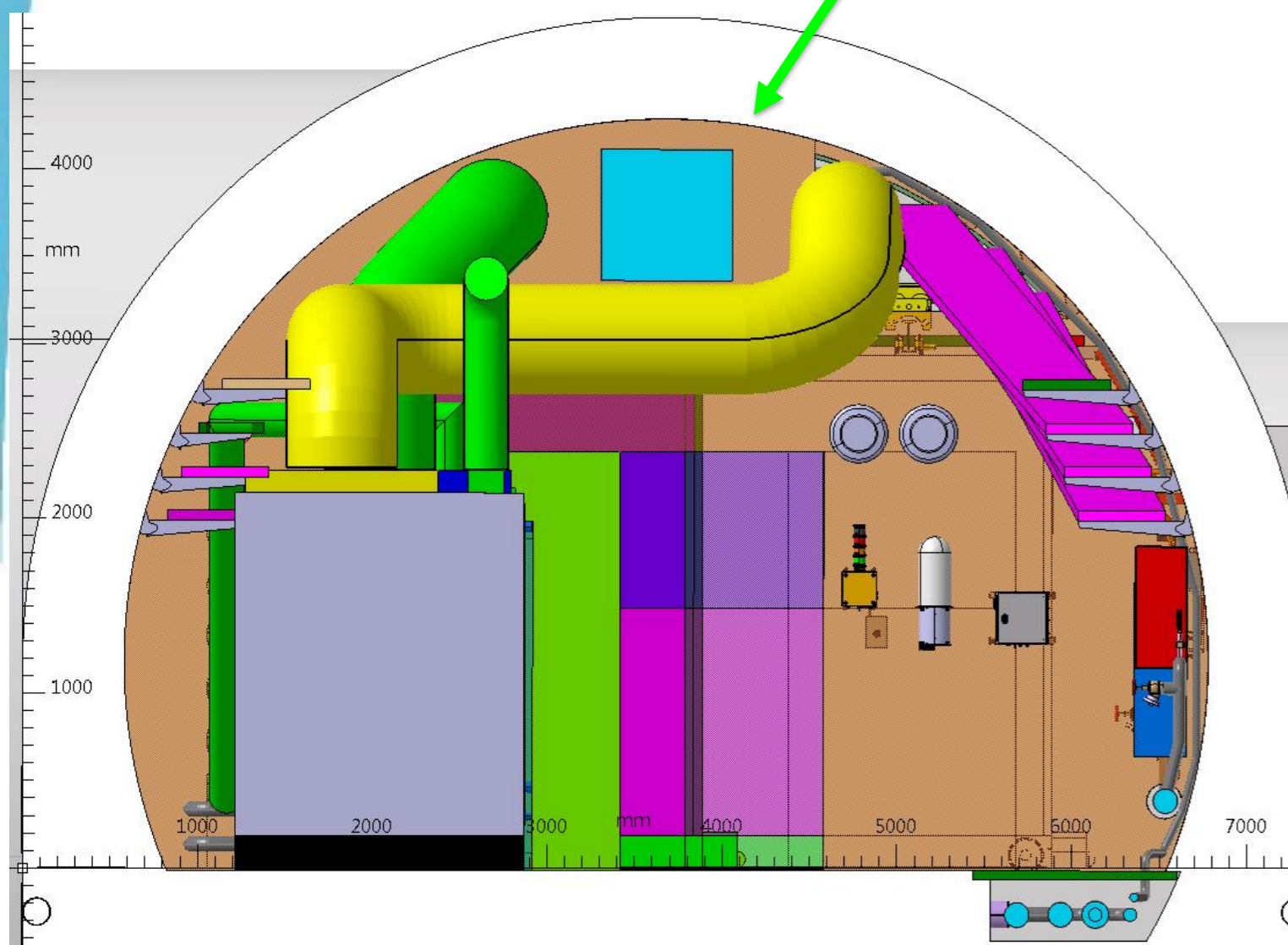
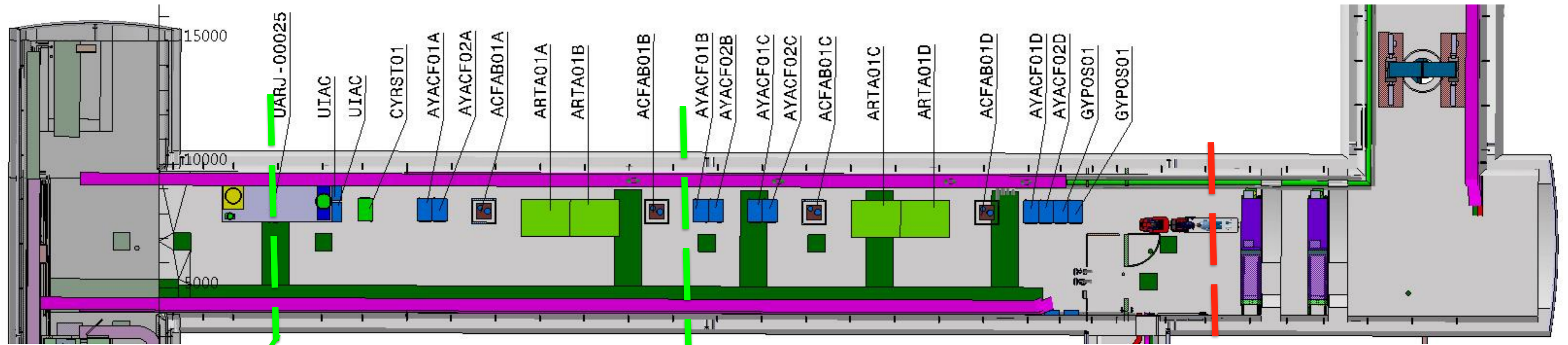


Remark: UAs were specified initially for the double of the crab installation therefore there should be not problem of space. Possible need to integrate 3-4 racks from other users

Limit of the accessible area in beam. Interlocked door and ventilation SAS

Two sliding concrete doors for radiation shielding

# Typical sections along the UA



UA entrance  
AHU for RF powering

UA mid section  
Along power unit

UA end section  
Entrance to no access area  
in beam

# LHC environment

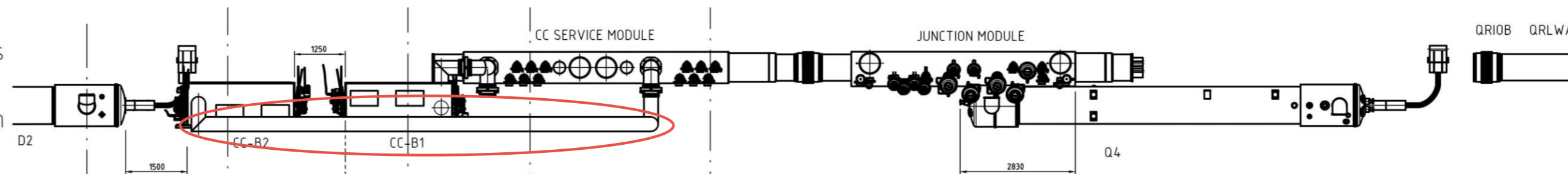


# Development of design/integration during last year

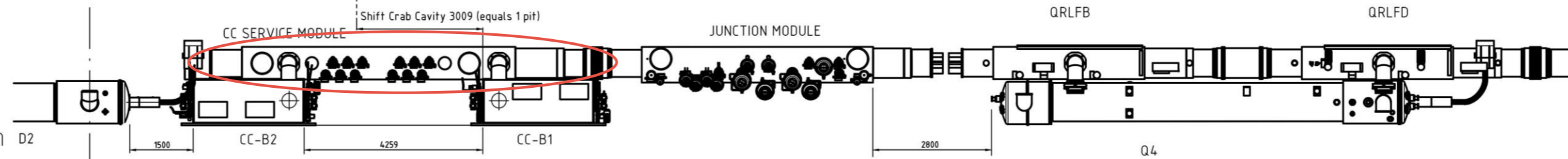
- Identify installation solution that is matching both crab cavity and the cryogenic line requirements
  - Allow interconnection respecting cryogenic line constraints (distance between jumpers)
  - Allow accessibility to the cryogenic lines
  - Provide space for the D2 interconnection of the SC link line
  - Allow to change in LS4 (+) the crossing plane between P1 and P5→swapping the crabs modules between the two points also if they have not the same dimensions
- Remark all Civil Engineering infrastructures stamped for execution February 2018→December 2018

# Analyzed solutions R5 (ref. LHCQXL\_\_0011\_v.AB)

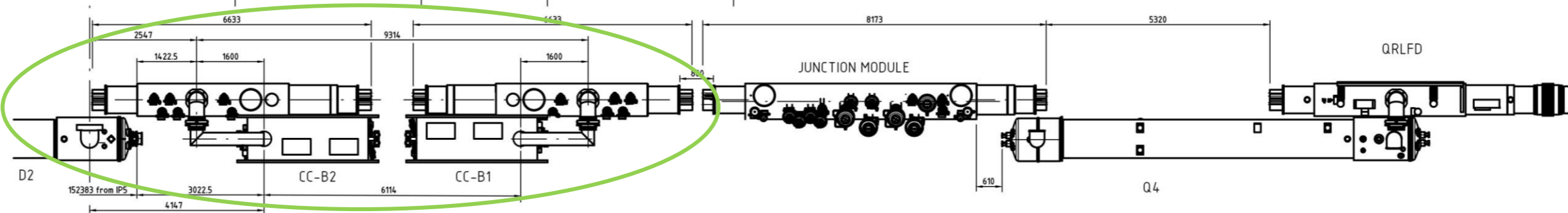
Solution 1: Crab Cavities in the baseline position, Service Module between CCs and Q4



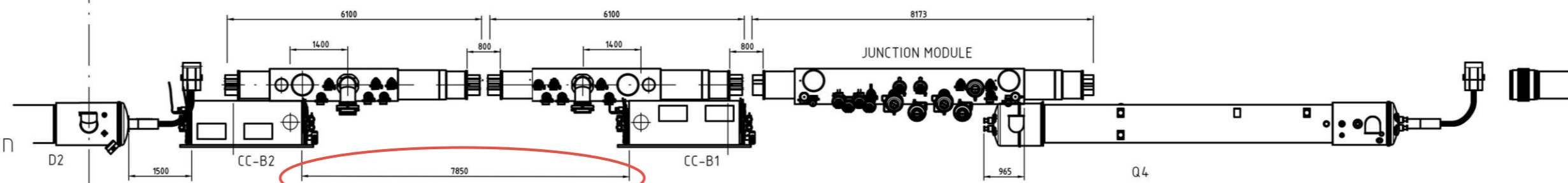
Solution 2: Crab Cavity B2 shifted, unique Service Module between CCs



Solution 3: adjacent Crab Cavities, two external Service Modules

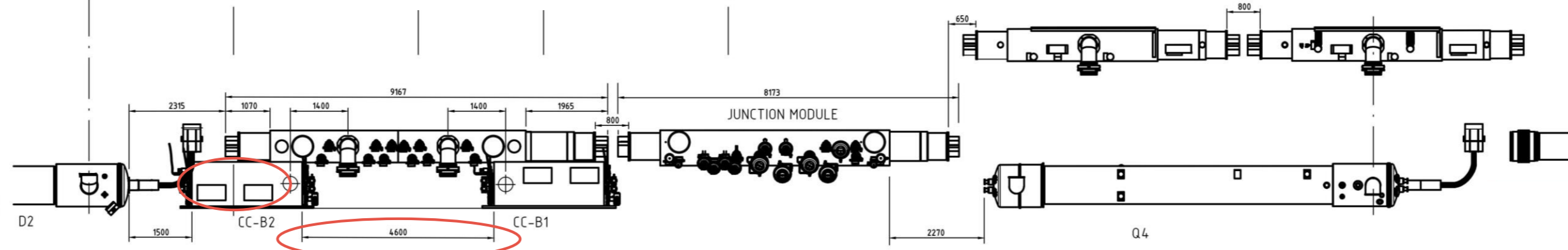


Solution 4: spaced Crab Cavities, two in-between Service Modules



7.85 m

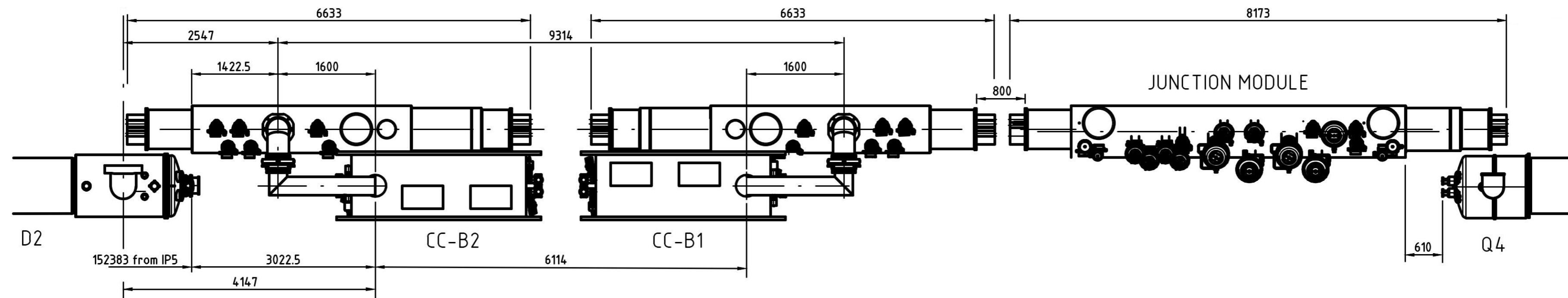
Solution 5: spaced Crab Cavities, unique Service Module (optimized)



4.6 m

# Selected configuration

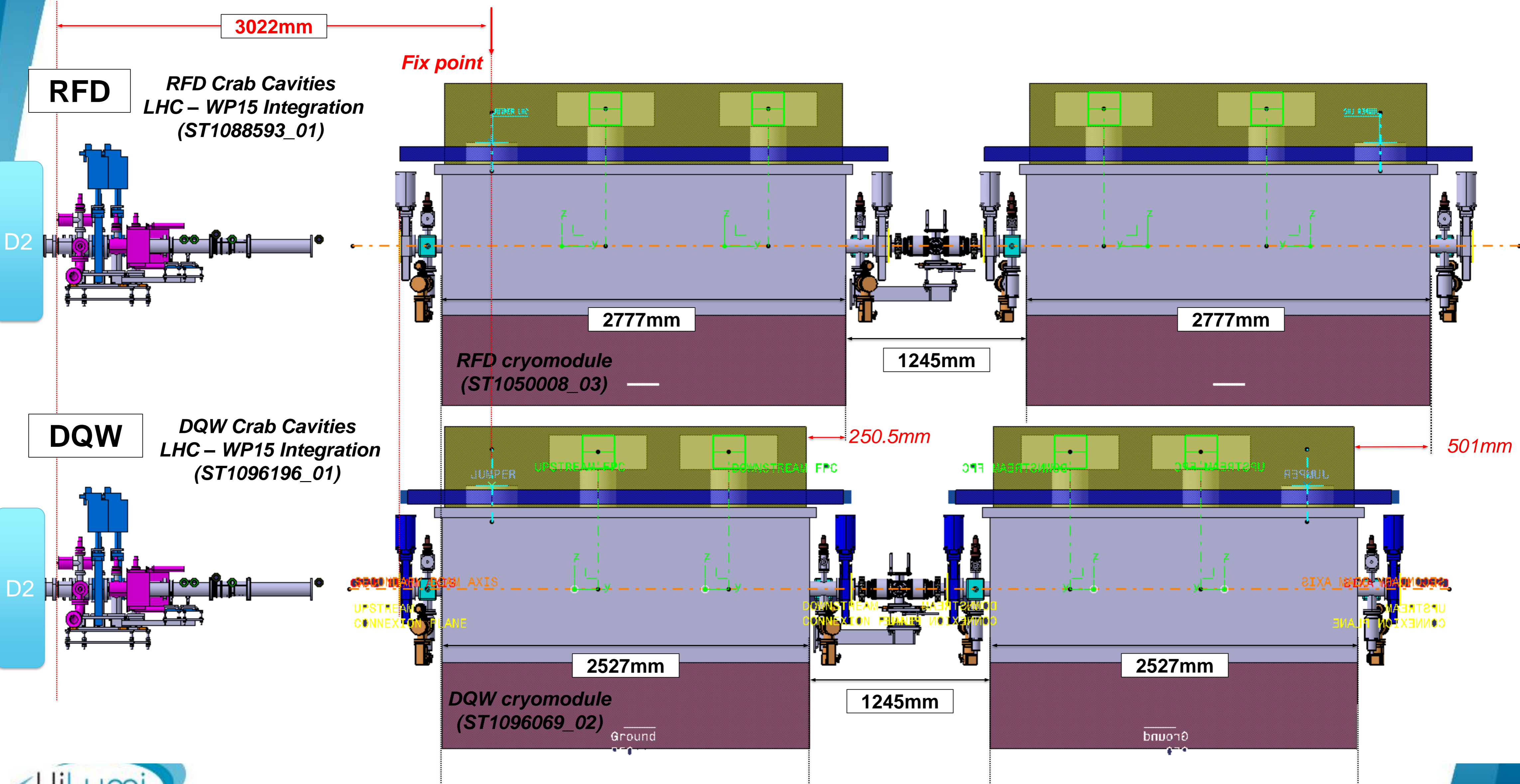
Solution 3: adjacent Crab Cavities , two external Service Modules



- Shifting from baseline position minimized (fulfilling the SM design principles)
- Distance between CC modules not depending from QXL
- No cryo-items behind waveguides
- Jumper extensions enabling CC module interchangeability
- Space reserved for the D2-DSL link crossing the SM
- Available space for access platform
- Impact on the QRL for Q4

Optics v.1.5

# RFD vs DQW (Config. Right)

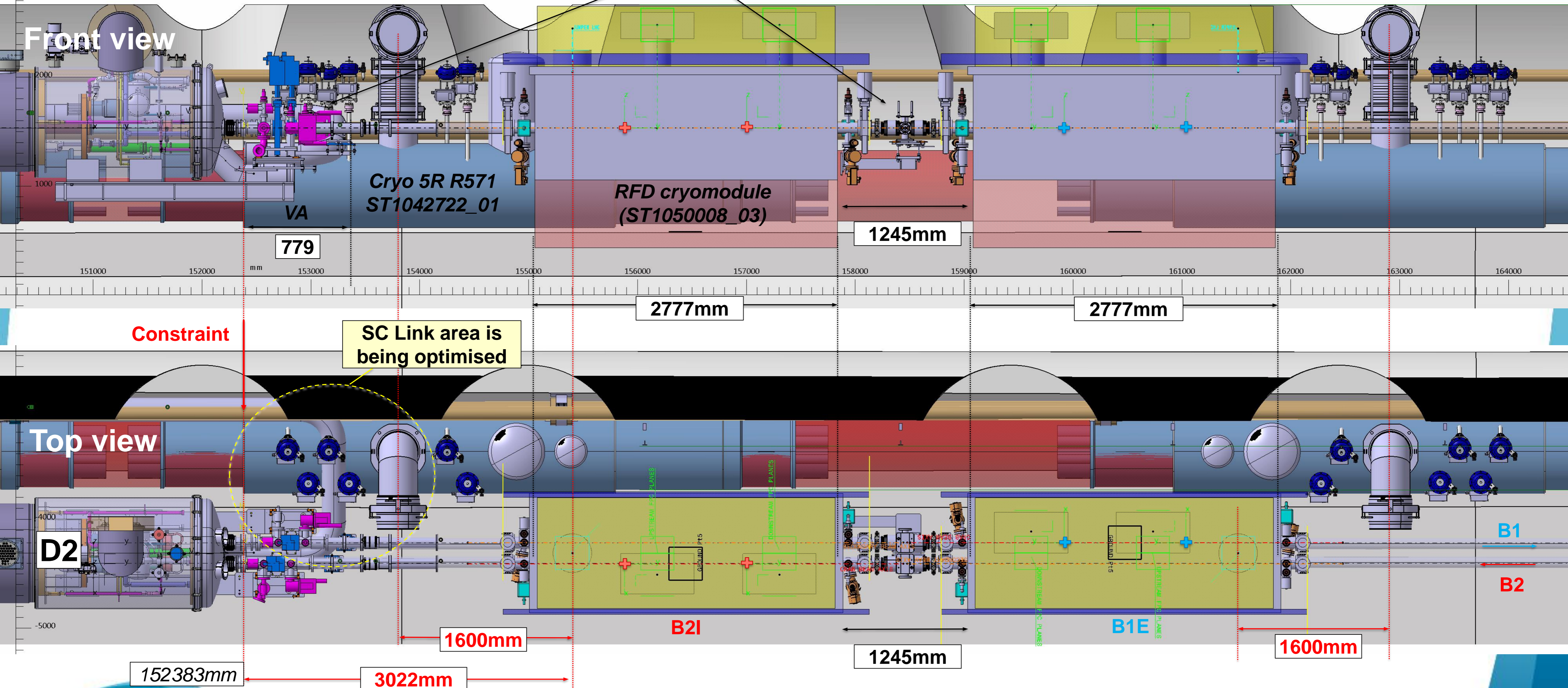


# RFD cryo-integration → P1R

Optics v.1.5

Vacuum from ST1059533\_01

HL\_IP5\_R\_1506\_INTEG.LS3 - ST0966906\_01

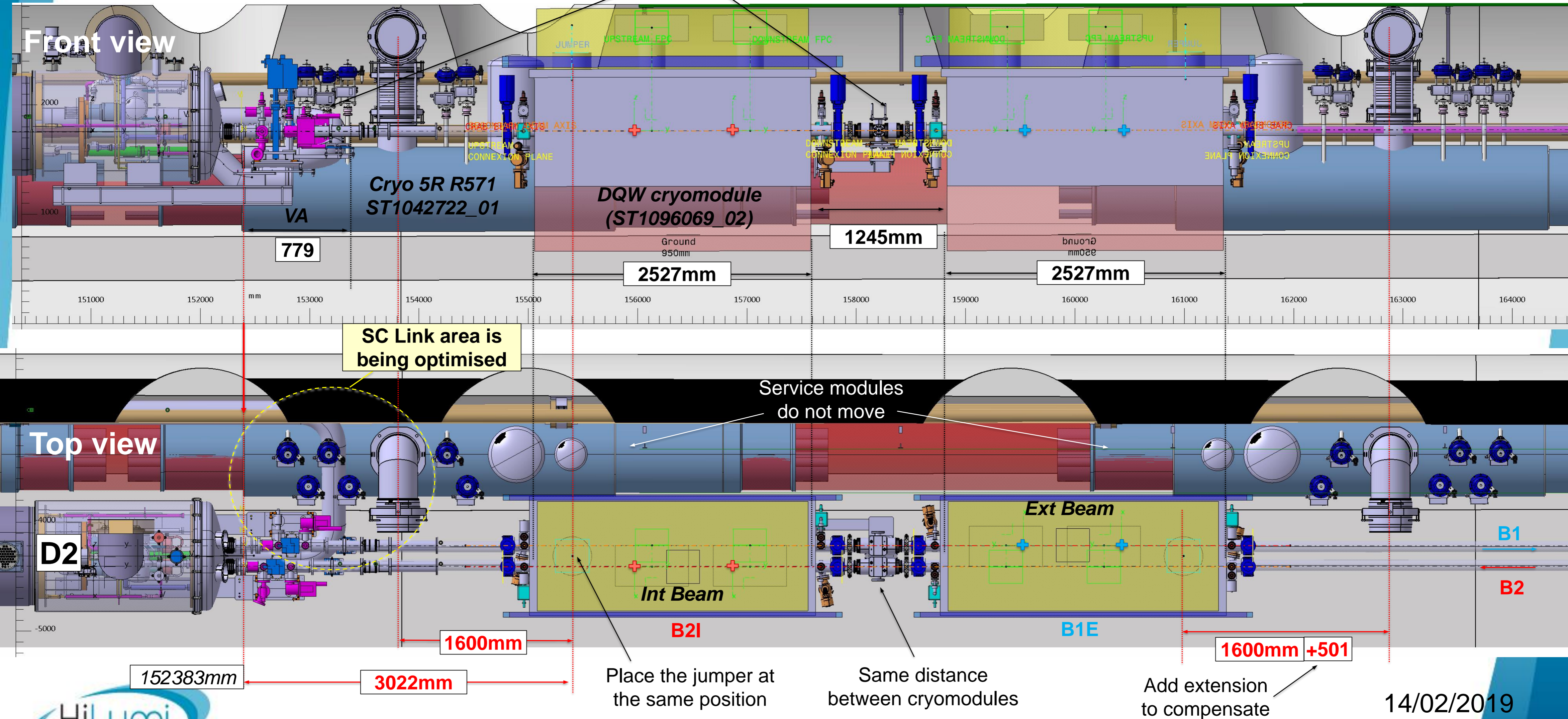


# DQW cryo-integration → P5R

Optics v.1.5

Vacuum from ST1059533\_01

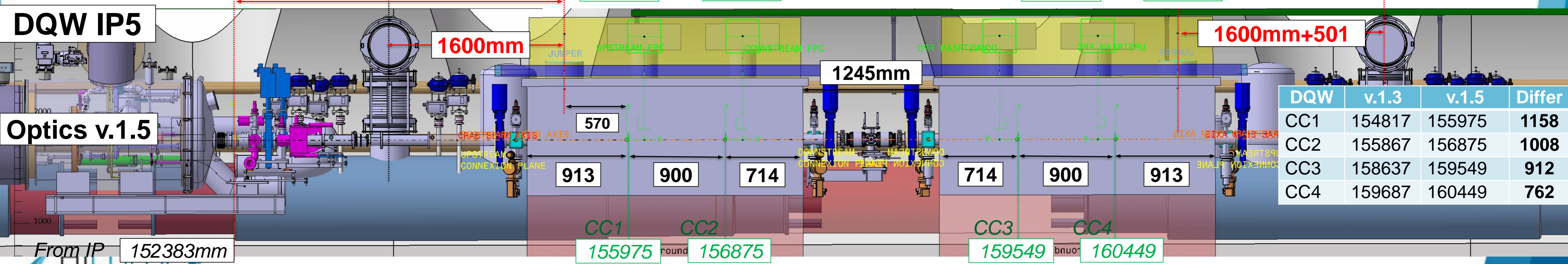
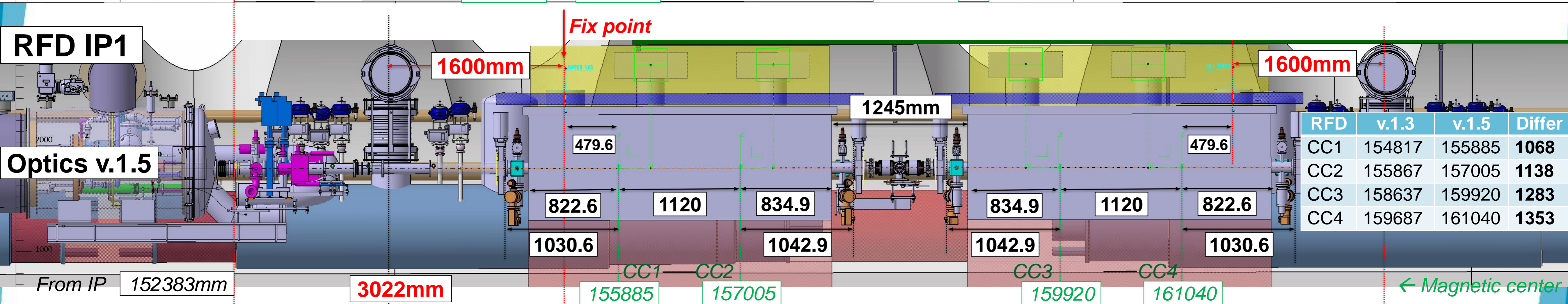
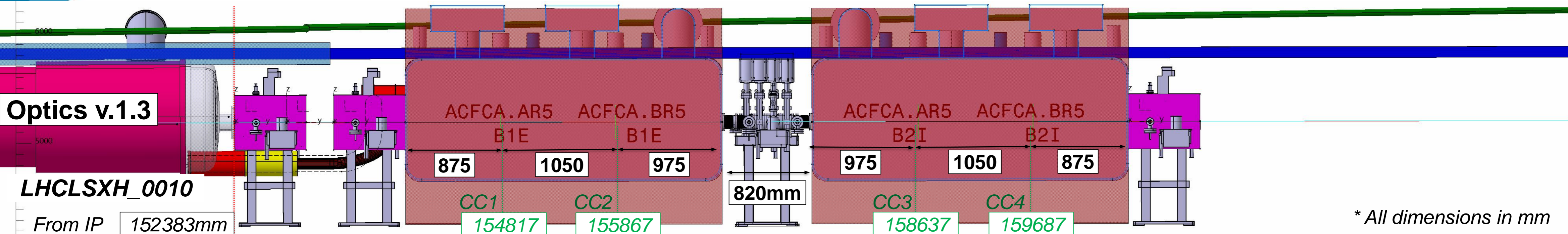
HL\_IP5\_R\_1506\_INTEG\_LS3 - ST0966906\_01



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# v.1.3 vs v.1.4



**Civil engineering has been fixed and no possibility to change. The contract for the RF cores will be assigned in a later stage, but their positions was an input for the design of the UA floors.**

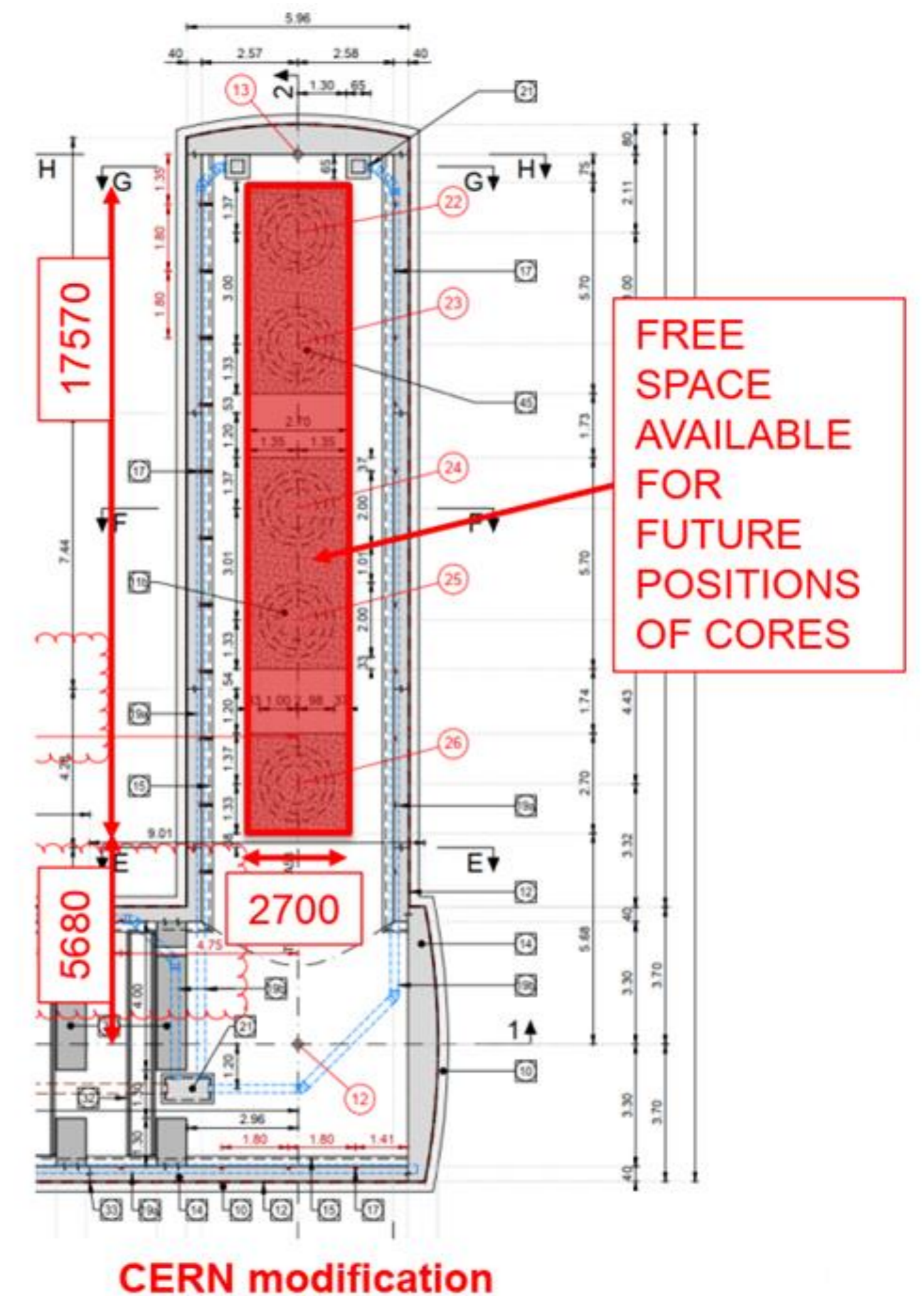
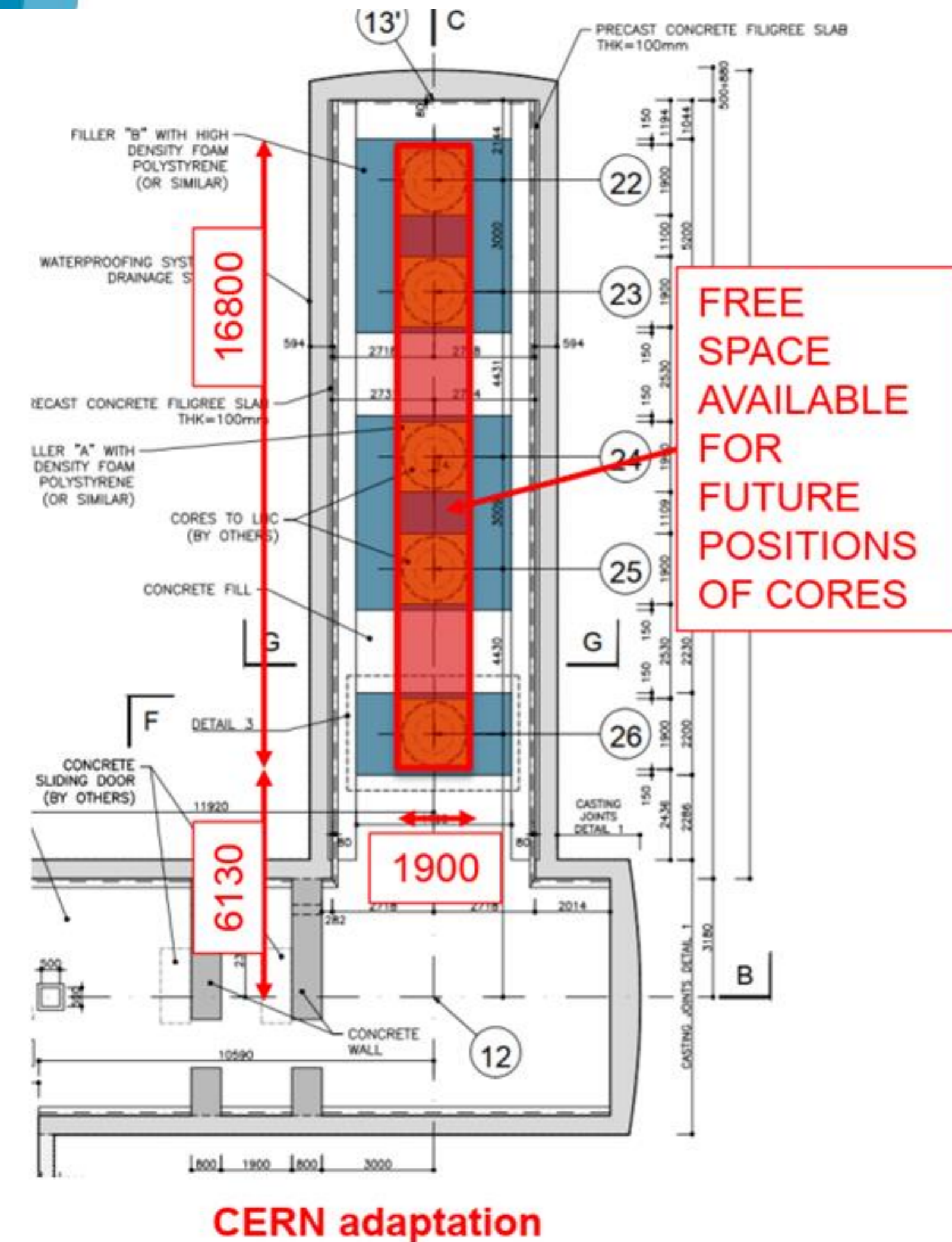


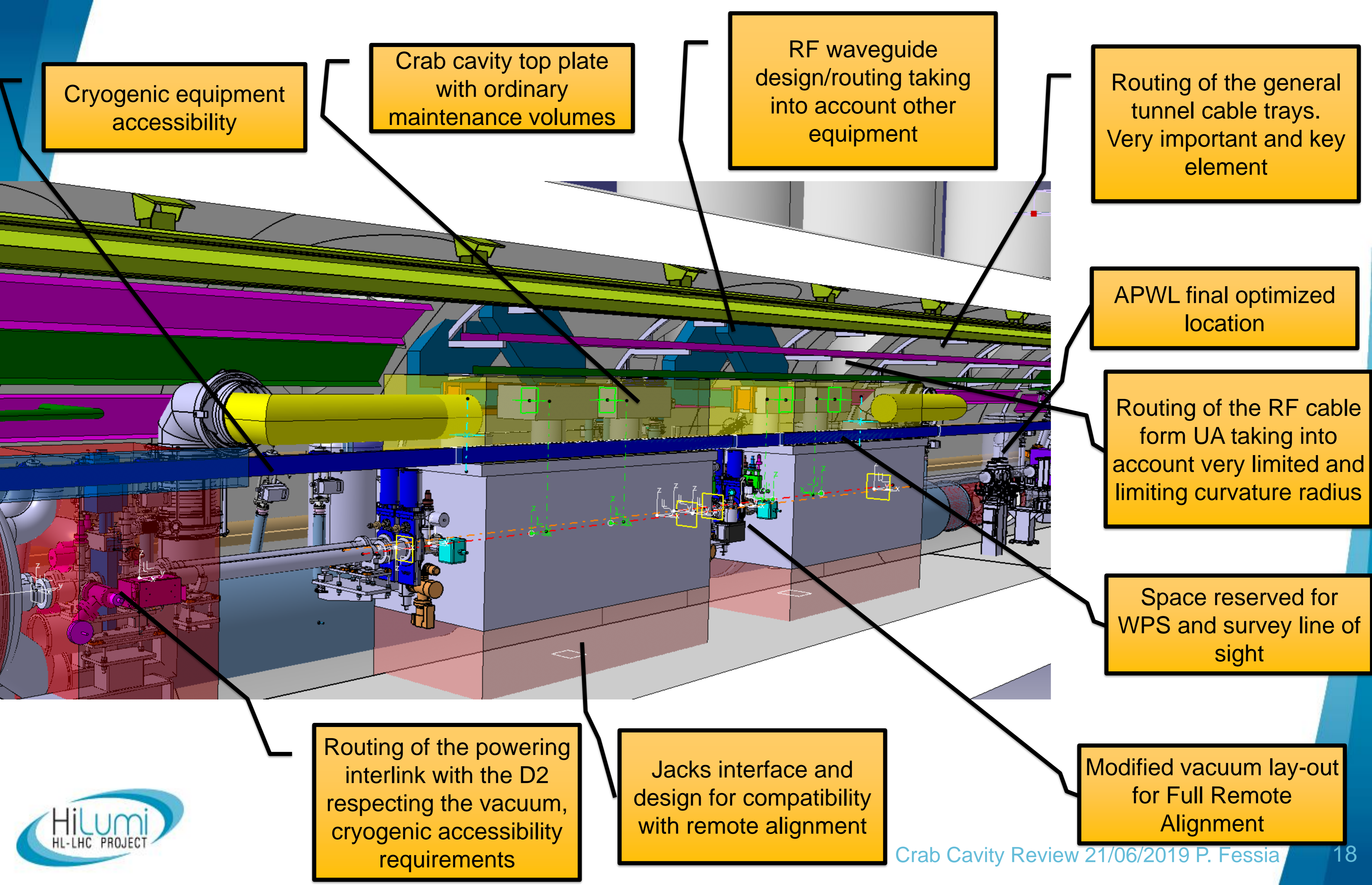
Panoramic view (08 Apr 19) - Contract T118 – CIB (P5)



# Flexibility in core position for last minute changes: longitudinal trench in the UA floors, cores to be drilled beginning LS3.

The modification of the integration of the crabs and of their positions required as well modification of the position of the cores. We decided to insert more flexibility in the UA floor design for possible trimming at later stage.





Cryogenic equipment accessibility

Crab cavity top plate with ordinary maintenance volumes

RF waveguide design/routing taking into account other equipment

Routing of the general tunnel cable trays. Very important and key element

APWL final optimized location

Routing of the RF cable form UA taking into account very limited and limiting curvature radius

Space reserved for WPS and survey line of sight

Routing of the powering interlink with the D2 respecting the vacuum, cryogenic accessibility requirements

Jacks interface and design for compatibility with remote alignment

Modified vacuum lay-out for Full Remote Alignment

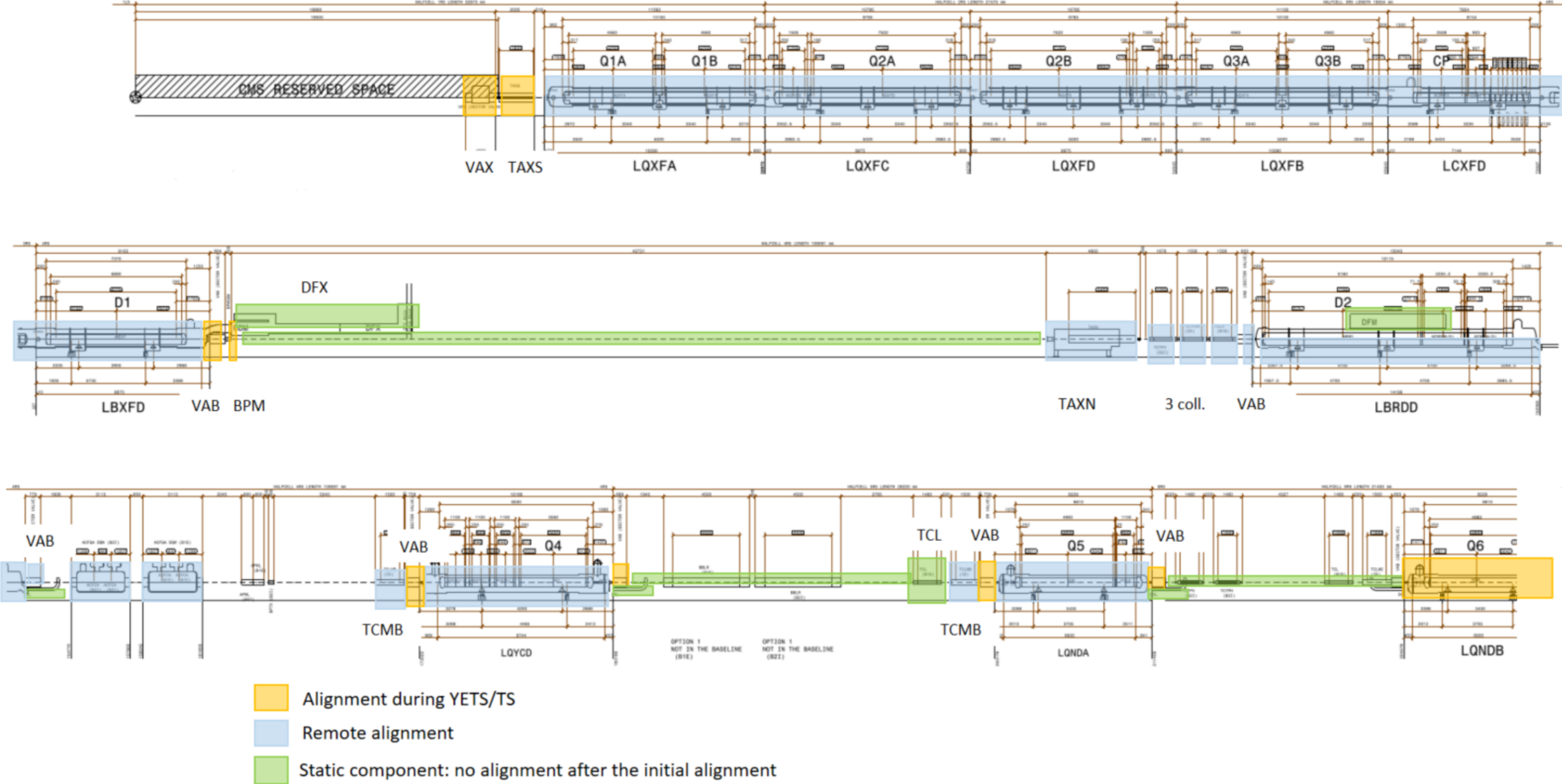


# Conclusion

- The integration of the equipment in the HL-LHC new galleries provide, by design, full accessibility in beam. It is well advanced
- The update of the integration with the real SSPA shall be performed as soon as it will be possible and it will need to respect the previously set infrastructures
- The integration in the LHC tunnel
  - Has made an important step forward with the analysis of the compatibility with cryogenic installation leading to optics revision
  - The routing of the various services in the area is now the main concern. We refer here to general services, RF services, and we need to guarantee the required ordinary maintenance volume
  - The tunnel LHC tunnel is a very limited resource and we have to use it at the best. We cannot exclude that at certain point will become the limiting factor in adding features
- Installation: we are in this moment working on building an installation planning
  - For the new HL-LHC technical galleries that are partially decoupled from the LHC tunnel activities
  - For the equipment in the LHC machine

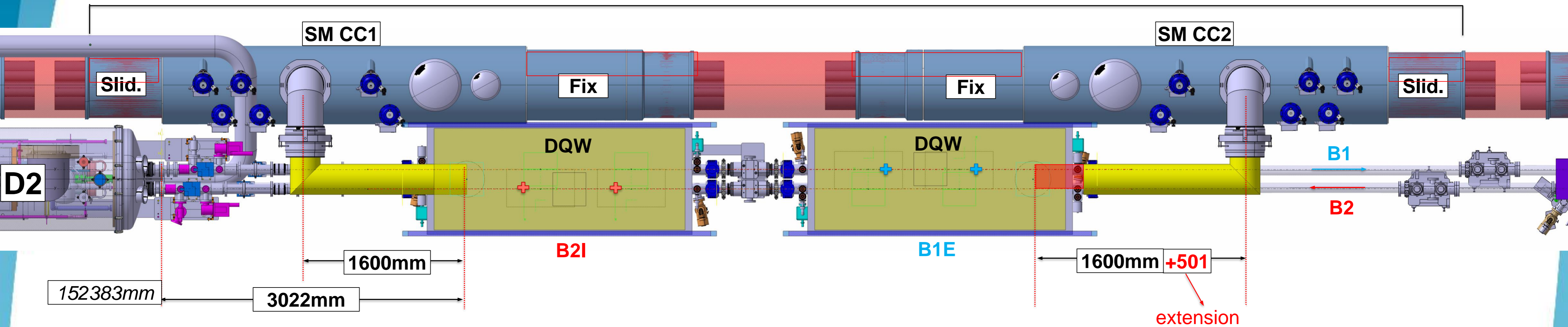
# Spare Slides

# Zoom on Full Remote Alignment System (FRAS)

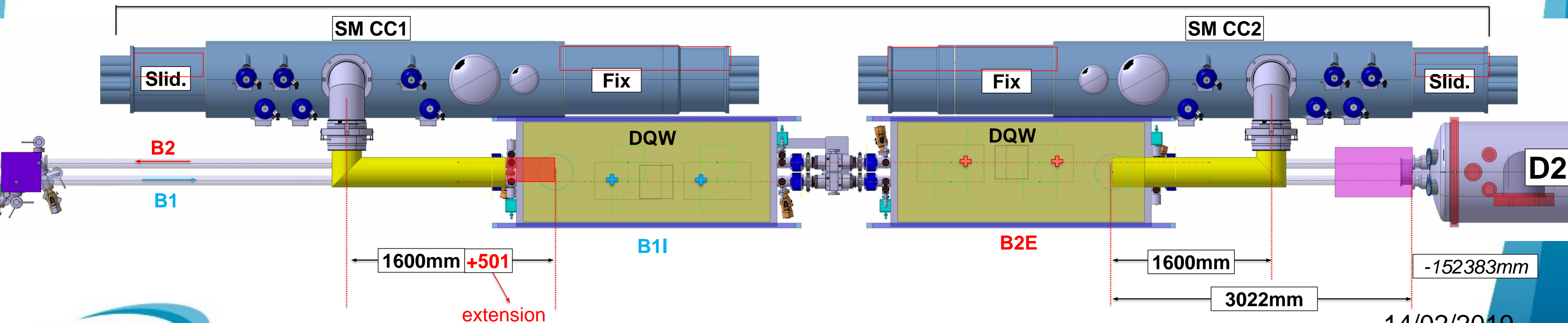


# P5 DQW cryo-integration → Right vs Left

## Solution for right side



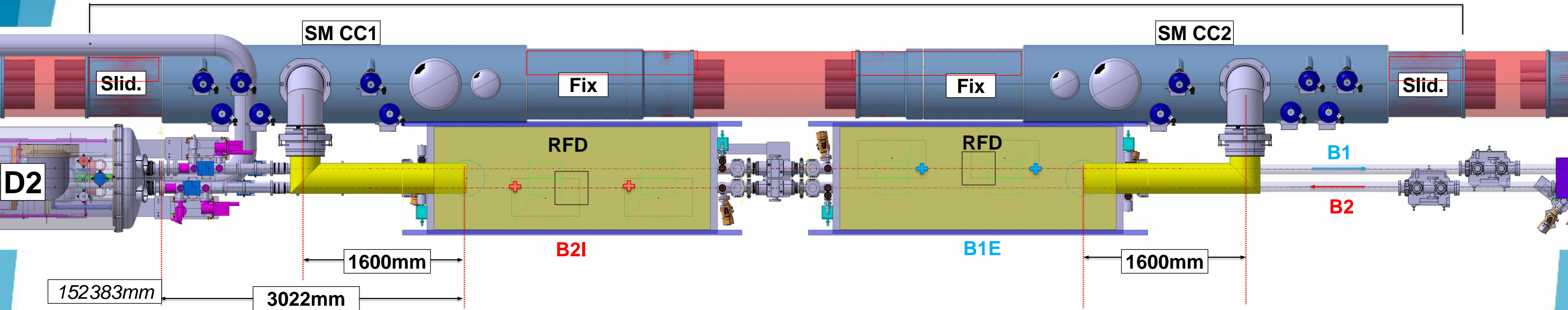
## Solution for left side



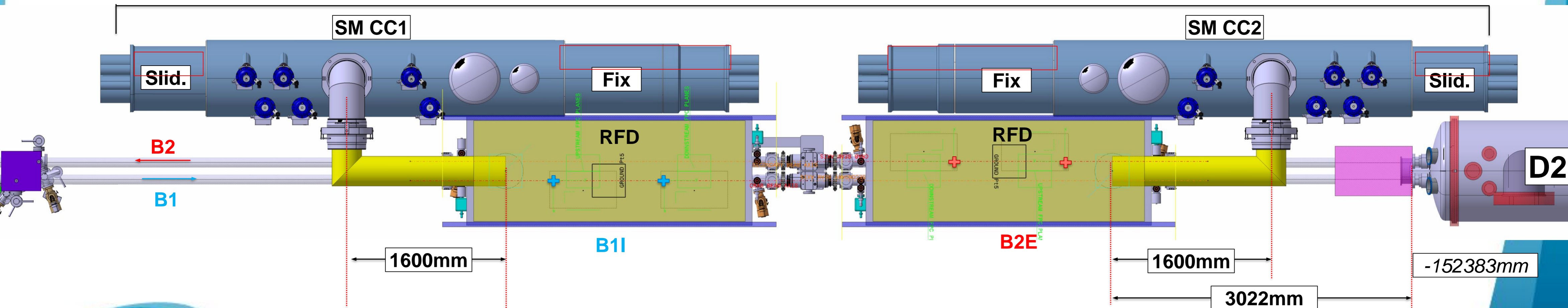
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# P1 RFD cryo-integration → Right vs Left

## Solution for right side



## Solution for left side



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