# New SRF Facility at CERN

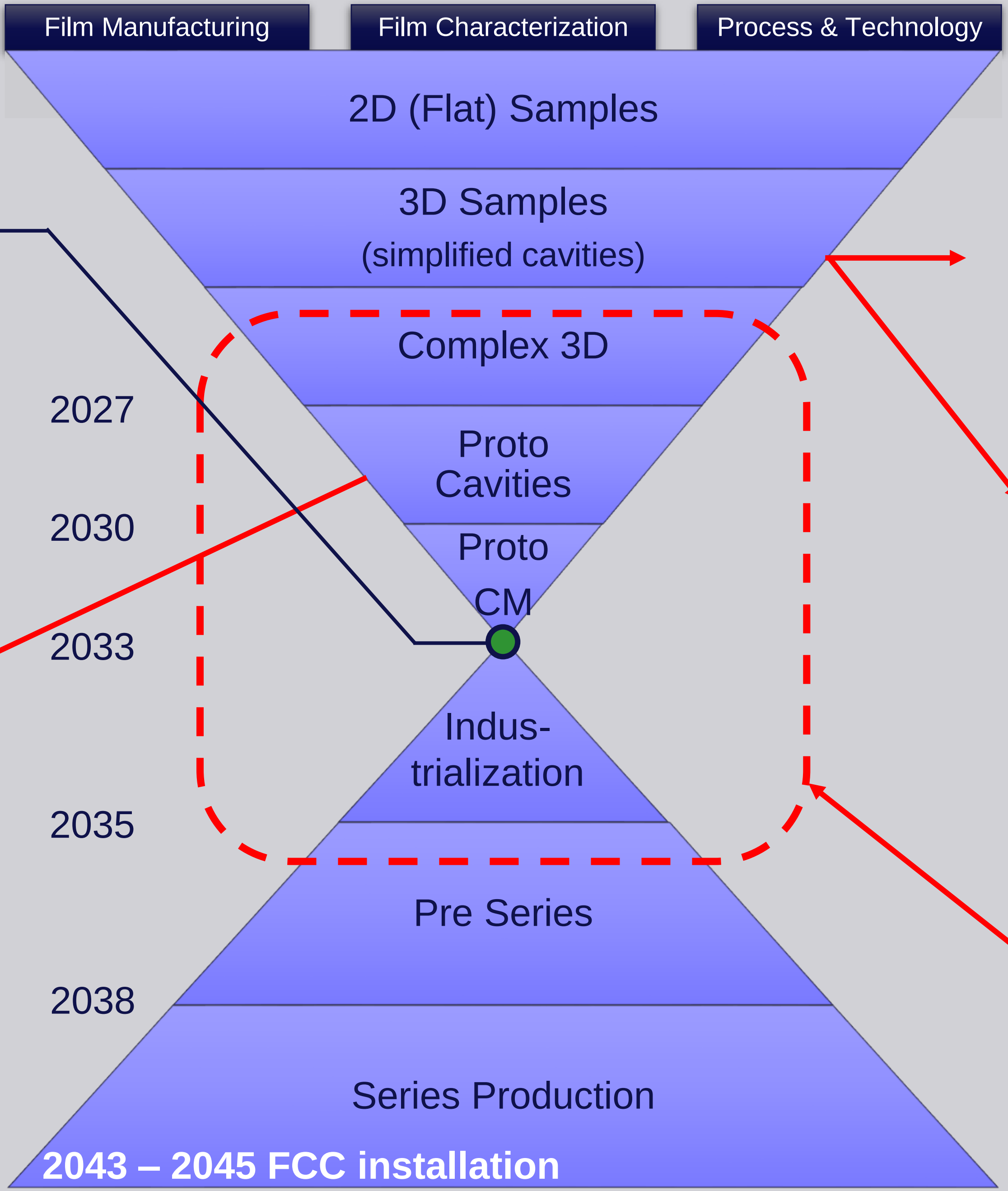
# SA18

D. Smekens

FCC Week 2023, London

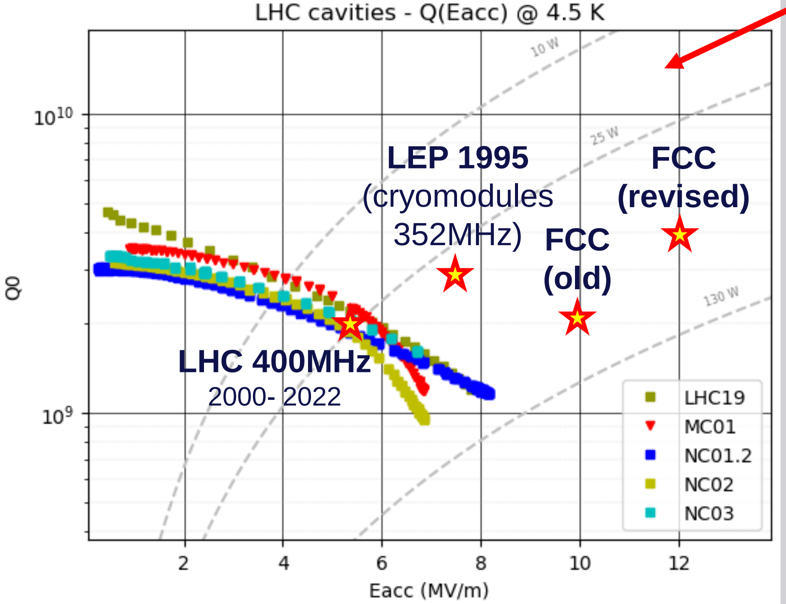
Technology R&D: SRF Technology (II), Thursday 8th June

# SA18 – Timeline (FCC-ee context)

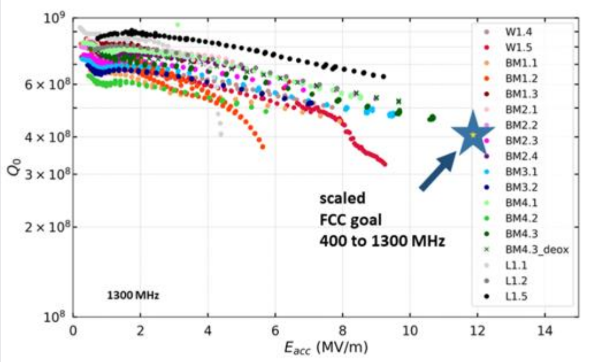



FCC 400 MHz CM
$E_{acc}$= 12 MV/m $Q_0$=3E9 @ 4.5 K

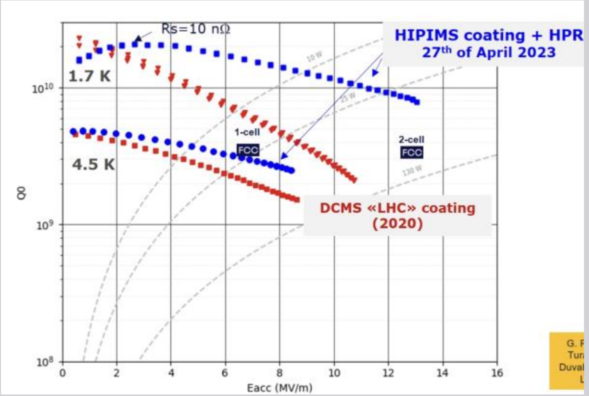
Legacy performance (LEP/LHC)



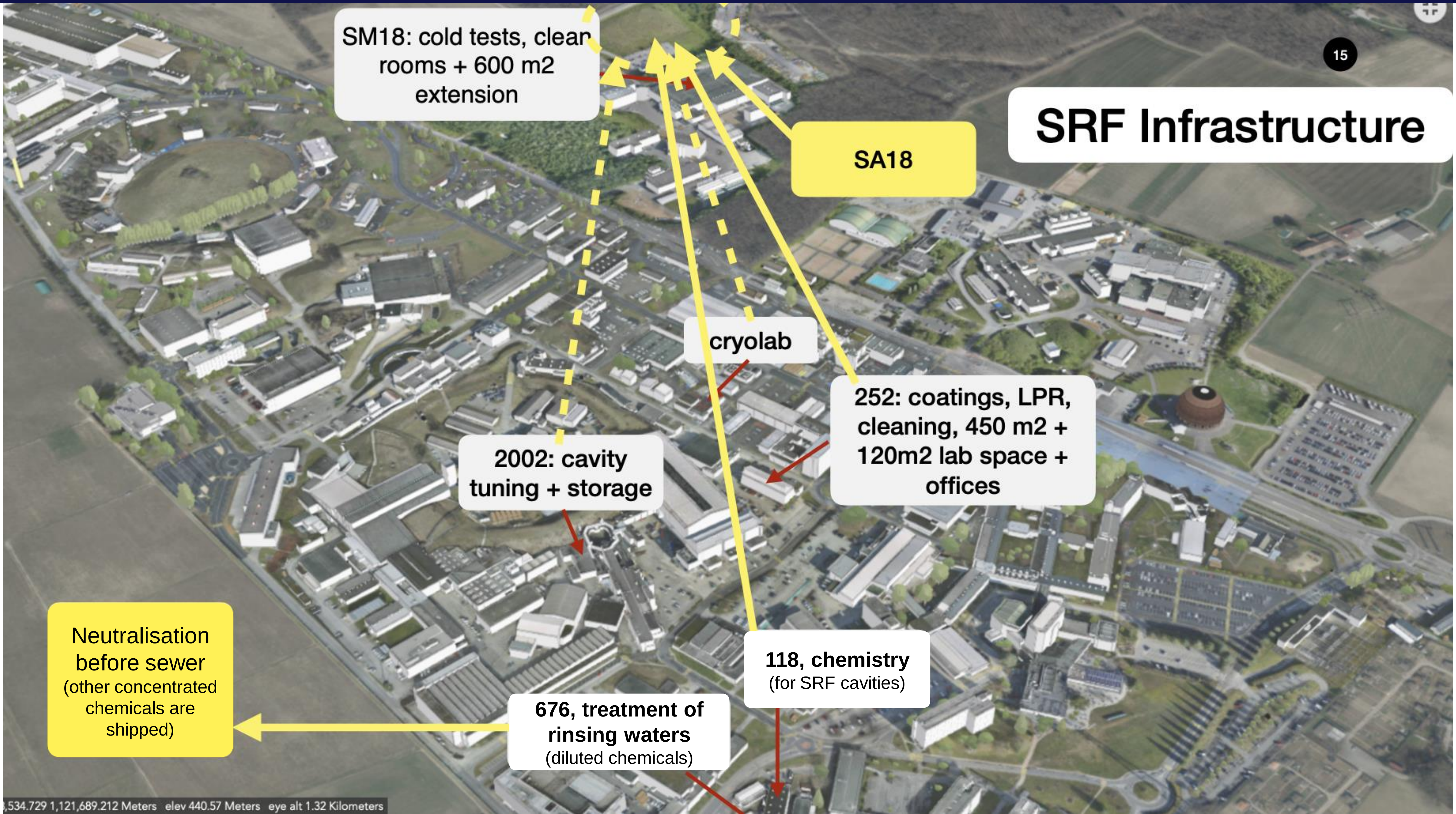

1.3GHz monocell



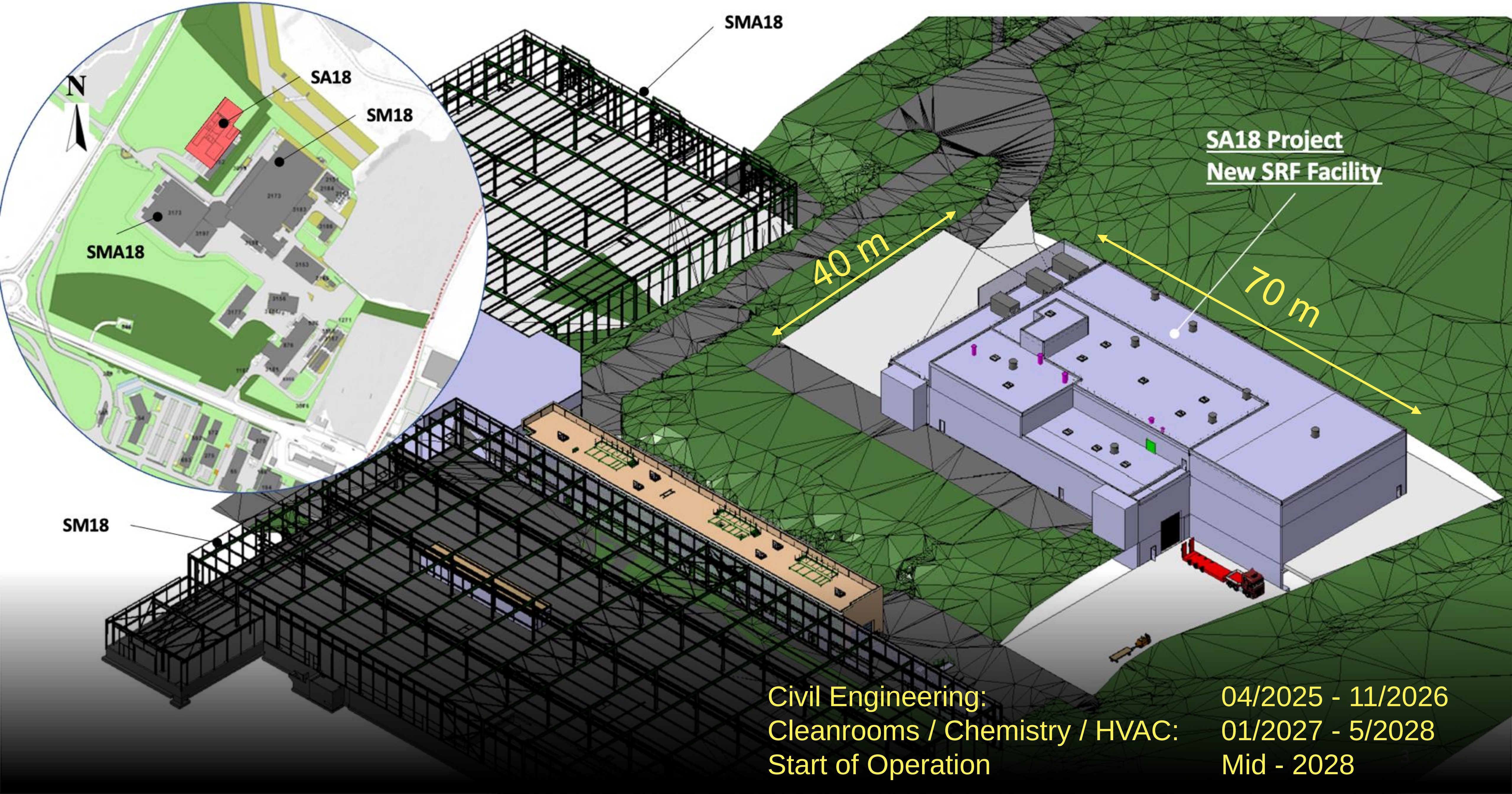

400 MHz monocell




**Processes & Infrastructure Upgrade Required**


SRF Infrastructure
15
SM18: cold tests, clean rooms + 600 m2 extension
SA18
cryolab
252: coatings, LPR, cleaning, 450 m2 + 120m2 lab space + offices
2002: cavity tuning + storage
118, chemistry
(for SRF cavities)
676, treatment of rinsing waters
(diluted chemicals)
Neutralisation before sewer
(other concentrated chemicals are shipped)
,534.729 1,121,689.212 Meters elev 440.57 Meters eye alt 1.32 Kilometers

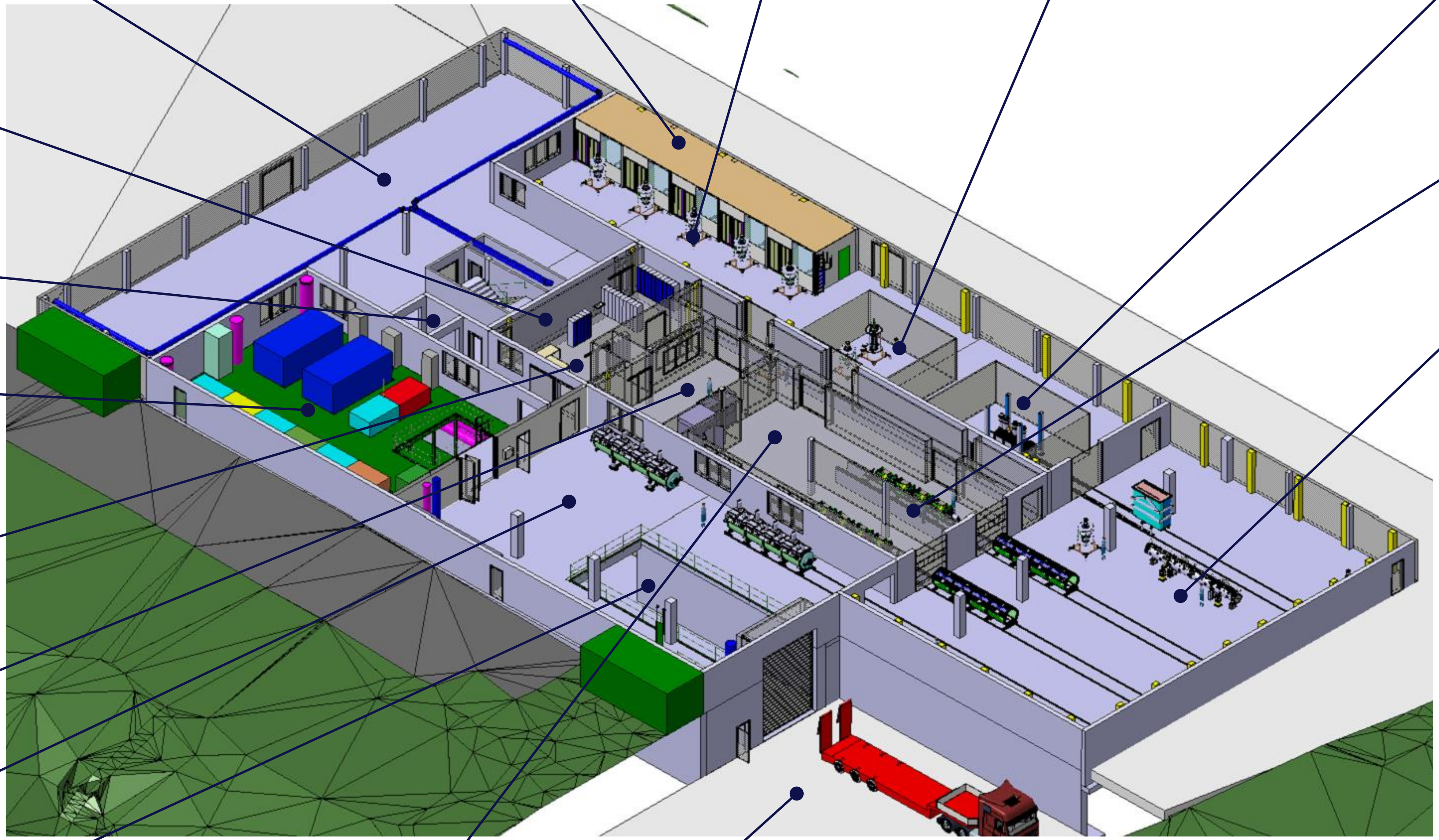
# SA18 – Overview




Civil Engineering: 04/2025 - 11/2026
Cleanrooms / Chemistry / HVAC: 01/2027 - 5/2028
Start of Operation Mid - 2028

# SA18 – Layout





**General Area**
Personnel & Visitor Entrance
Open space workstations
Control room ,meeting room,...

**Gowning Area**
Personnel access
to cleanrooms

**Freight Lift**
for personnel
and equipment

**Chemistry**
for Nb and Cu cavities

**Preparation area**
For small components
Prior to entering
cleanrooms

**QA/QC Room**
+ component washer
+ HPR for bulk Nb cavities

**Reception Hall**

**Loading Bay**
(access to basement)

**R&D & Bulk Nb**
**ISO 4**
**Cleanrooms**
Vertical airflow

**Access**
**from/to SM18**

**Sputtering Lab**
(technical gallery)

**Sputtering Lab**
Sputtering stations

**HPR & Cathode Assy**
**ISO 4 Cleanroom**

**HIE ISOLDE CM Assy**
**ISO 4 Cleanroom**

**CM Assy Lines 1&2**
**ISO 4 Cleanroom**

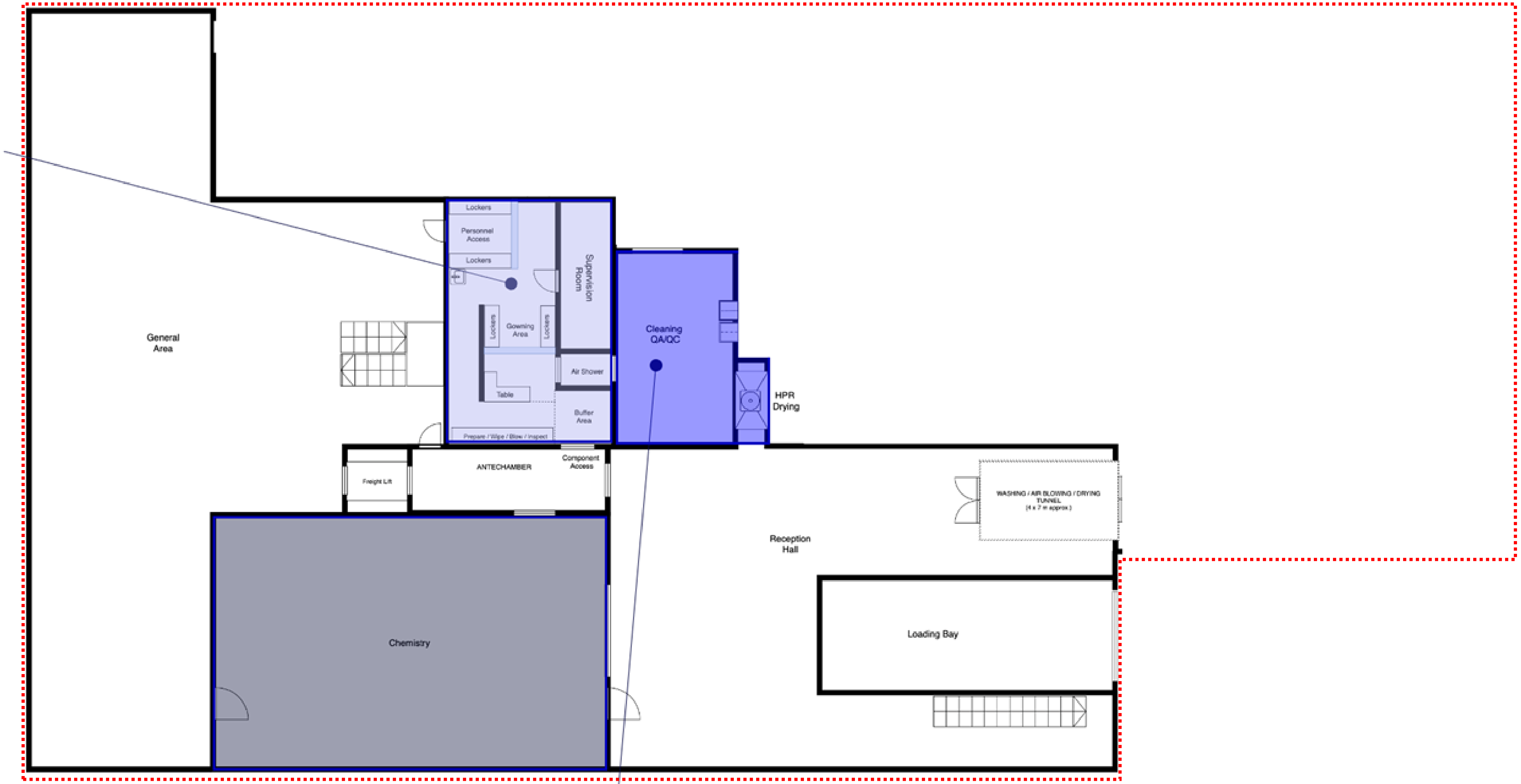
**Main Hall**
**ISO 8 Cleanroom**

# SA18 – Layout

*(animated slide, best viewed in slideshow)*



**Gowning Area**
Supervision Room
Air Shower
Preparation /
Transit Area




**QA/QC Room**
Particle Counting
Component washer
+ HPR for bulk Nb cavities

# SA18 – Layout

*(animated slide, best viewed in slideshow)*

**Sputtering Lab**
~ 400 m²

**HPR & Cathode Assy**
Horizontal Airflow, 40 m²

**HIE ISOLDE CM Assy**
Horizontal Airflow, 45 m²

**CM Assy Lines ISO 4**
Vertical Airflow 12m → 17 m long

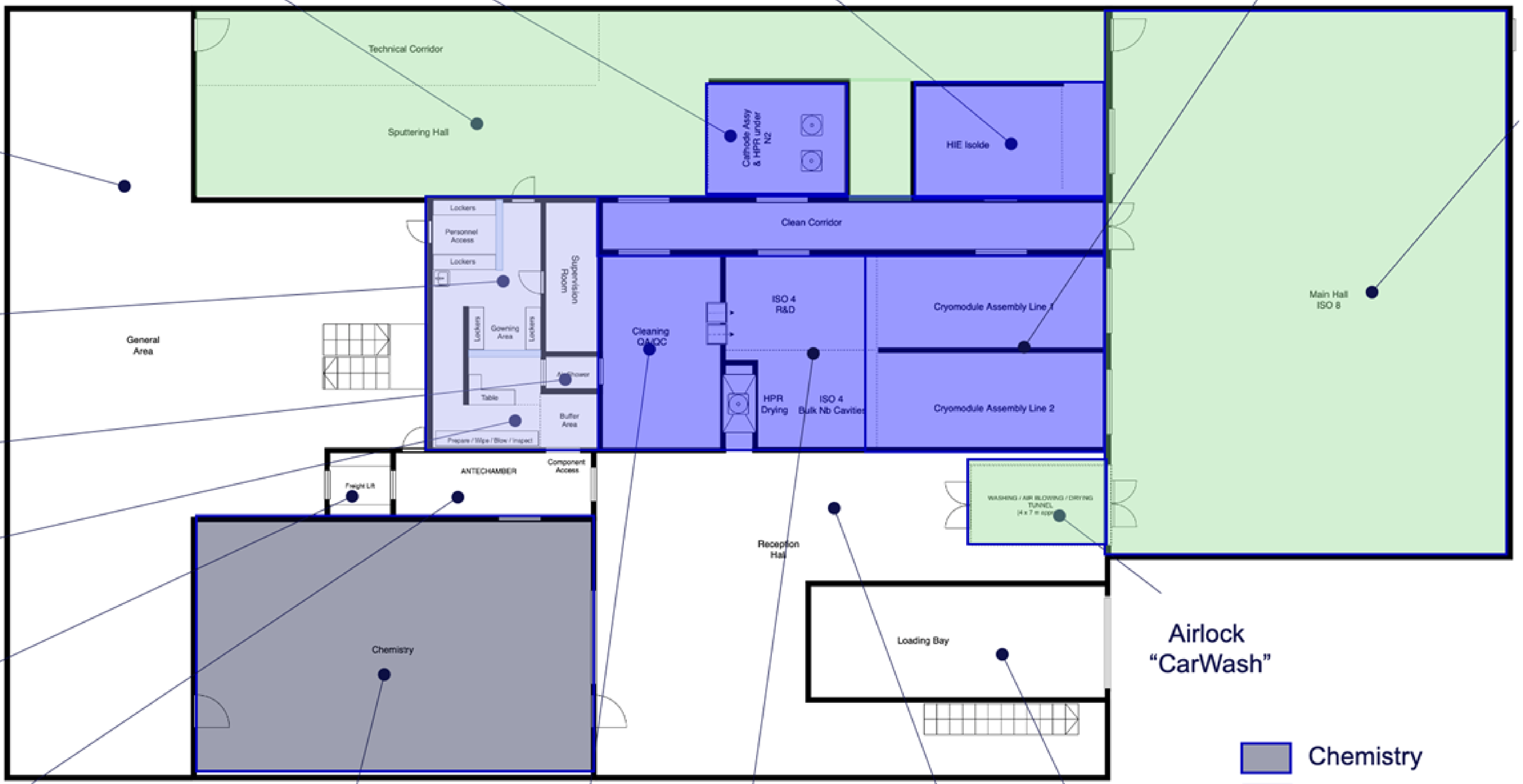
**Main Hall ISO 8**
Vertical Airflow,
Area: 550 m²
WxL: 20 x 27m
Crane: 15 T low headroom
Working height : 6 m

**General Area**
Personnel & Visitor Entrance
Open space, workstations
Control room ,meeting room,...

**Gowning Area**
Personnel access
67 m²

**AirShower**
For personnel & components

**Preparation area**
For small components




**Airlock**
**"CarWash"**

**Freight Lift**
for personnel and equipment

**Antechamber**
for personnel and equipment

**Chemistry**
for Nb and Cu cavities,
257 m² (+ 300m² basement)

**QA/QC Room ISO5**
53m² , with component washer
+ HPR for bulk Nb cavities

**Reception Hall**
Grey Area, 317m²

**R&D & Bulk Nb ISO 4 Cleanrooms**
60 m², Vertical airflow

**Loading Bay**
(access to basement)

- Chemistry
- Gowning & Prep area (ISO 8)
- ISO 4/5
- ISO 7/8

# SA18 – Chemistry

## Surface Etching Chemistry for Copper & Niobium

260 m$^2$ chemistry lab, over 2 floors.

Infrastructure designed specifically for chemistry of SRF cavities

Better control of environment, air T + RH

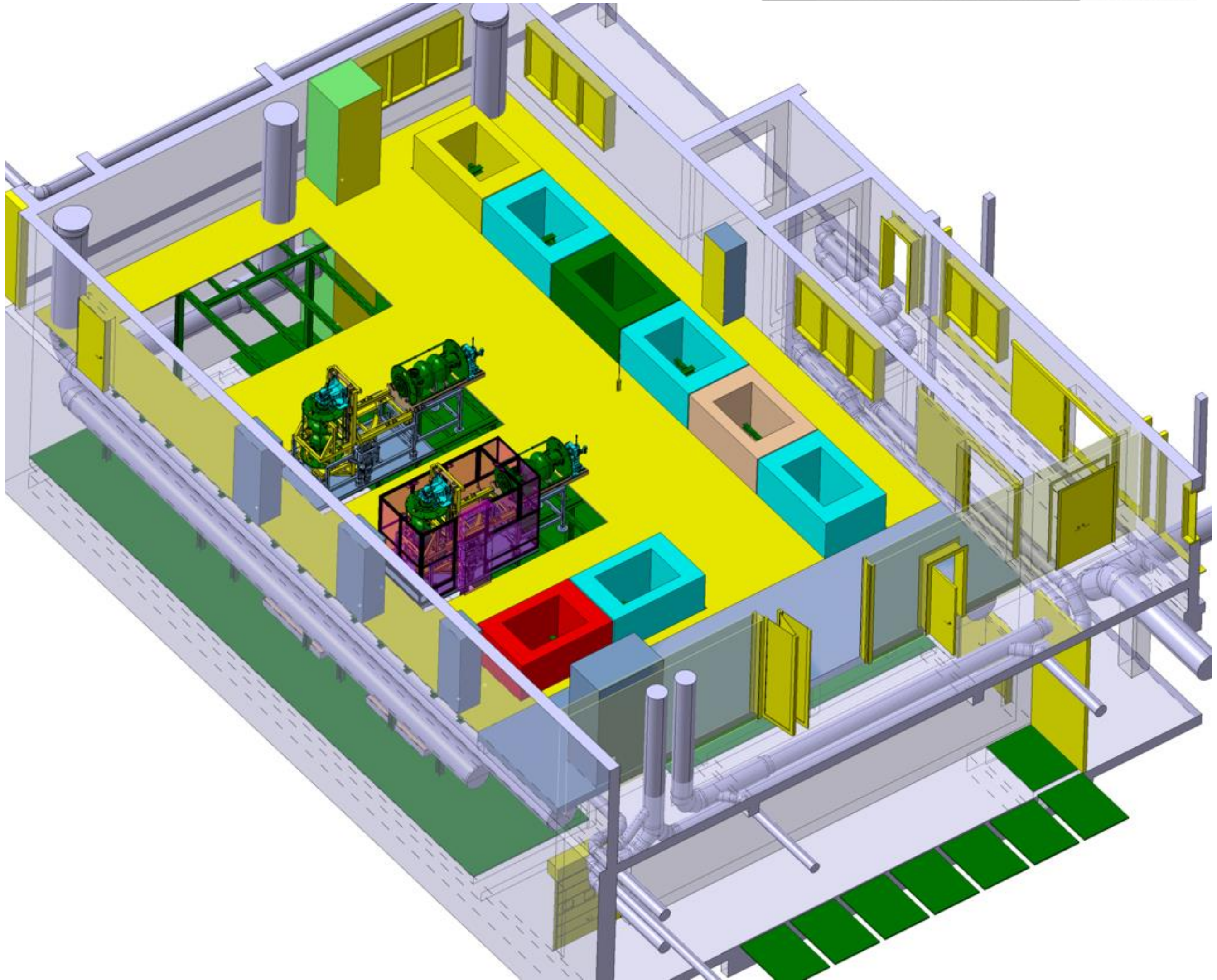
Increased working height for multi-cell cavities

Minimum delay chemistry → sputtering

Direct access to cleanrooms

Equipped with :

- EP chemical skids for Copper and Niobium, designed to leave minimum residuals in cavities
- EP to replace SUBU for copper etching
- Waste (rinsing) water treatment in situ: neutralisation + evaporator



# SA18 – Chemistry

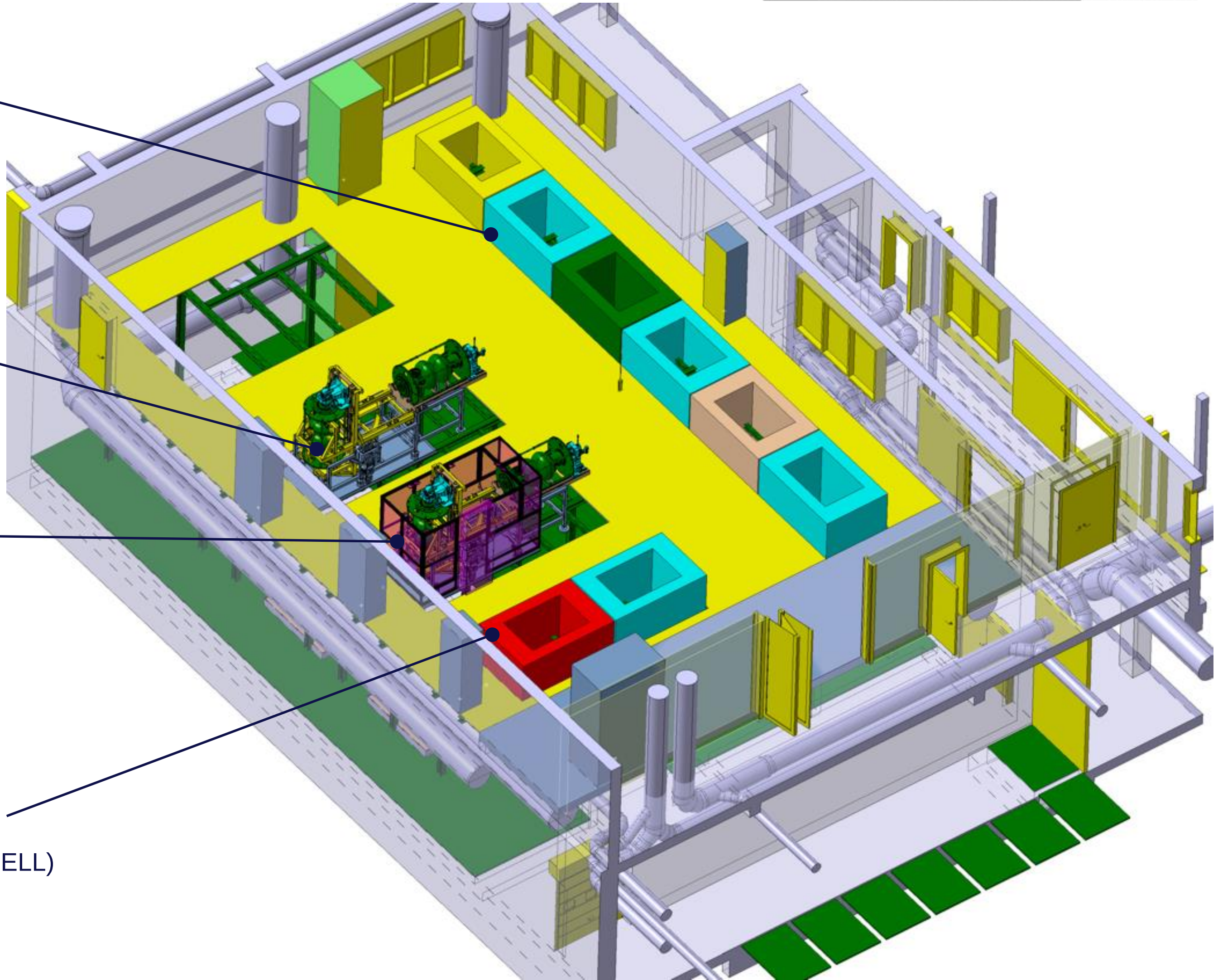
## Surface Etching Chemistry for Copper & Niobium

**IMMERSION BATHS**
- Final Degreasing
- Final Rinsing
- Stripping
- Rinsing after Passivation
- Passivation

**Cu EP by CIRCULATION**
- Electropolishing setup for Cu Cavities (tanks and circulation skid underneath at basement level)

**Nb EP by CIRCULATION**
- Electropolishing setup for Nb Cavities (tanks and circulation skid underneath at basement level)
- BCP process also possible

**IMMERSION Cu EP**
(for RF open structures e.g. SWELL)
- Copper Electropolishing bath
- Rinsing bath



# SA18 – Sputtering Hall

## Tall Hall for the cathode systems to coat large multi-cell cavities

400 m$^2$ clean ISO 8 Hall

Tall enough for multi-cell 400MHz cavities and their cathode system

High throughput possible (up to 6 sputtering stations in parallel)

Equipped with:

- ISO 4 baldachin for HPR of substrate and of coated cavities
- HPR system operating under inert atmosphere for copper substrate
- clean vacuum furnace for R&D (1.3 GHz cavity size)
- HiPIMS systems with split sputtering system (“dirty” systems inside technical gallery, only cavity bench inside ISO 8 )

# SA18 – Main Hall (ISO 8)

## Clean Assembly Hall for cryomodules

540 $m^2$ area (20m x 27 m) for clean mechanical assemblies

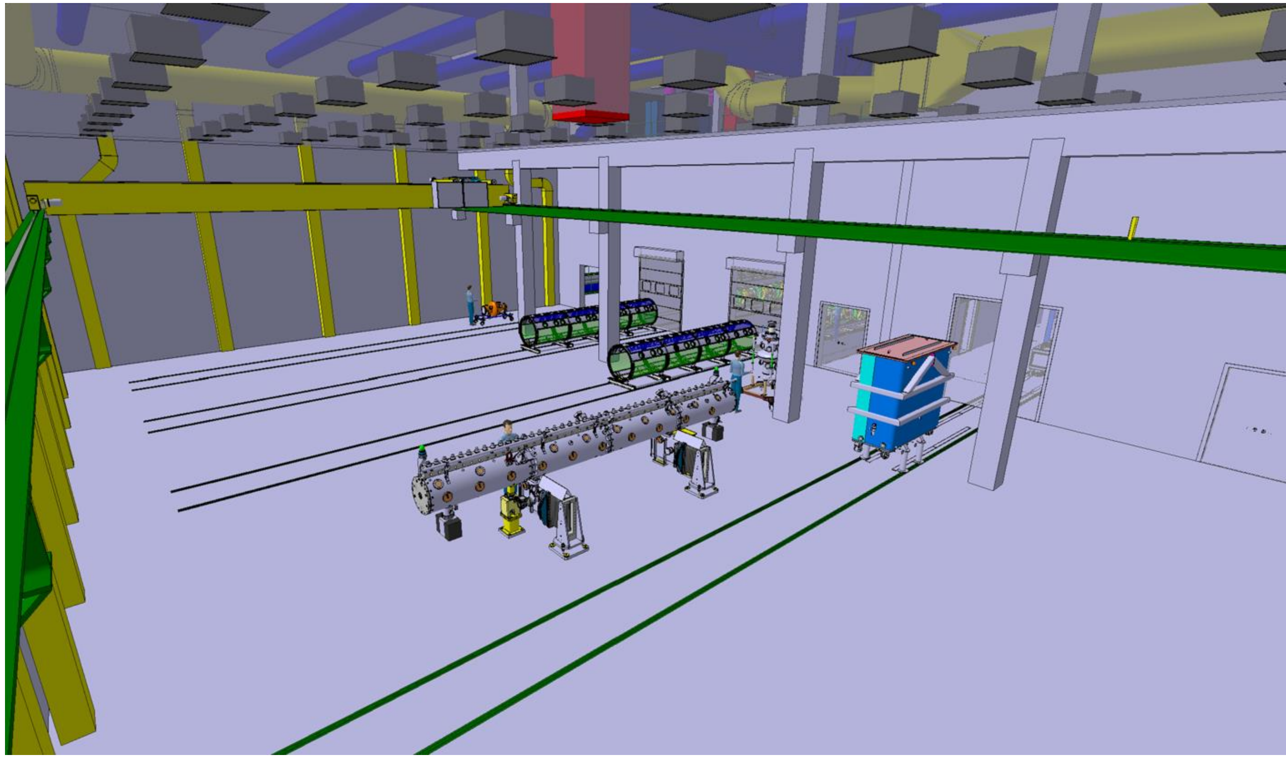
ISO 8 cleanroom with air T + RH control

Equipped with a 14m-span 15 Ton cleanroom crane

Working height under crane : 6m

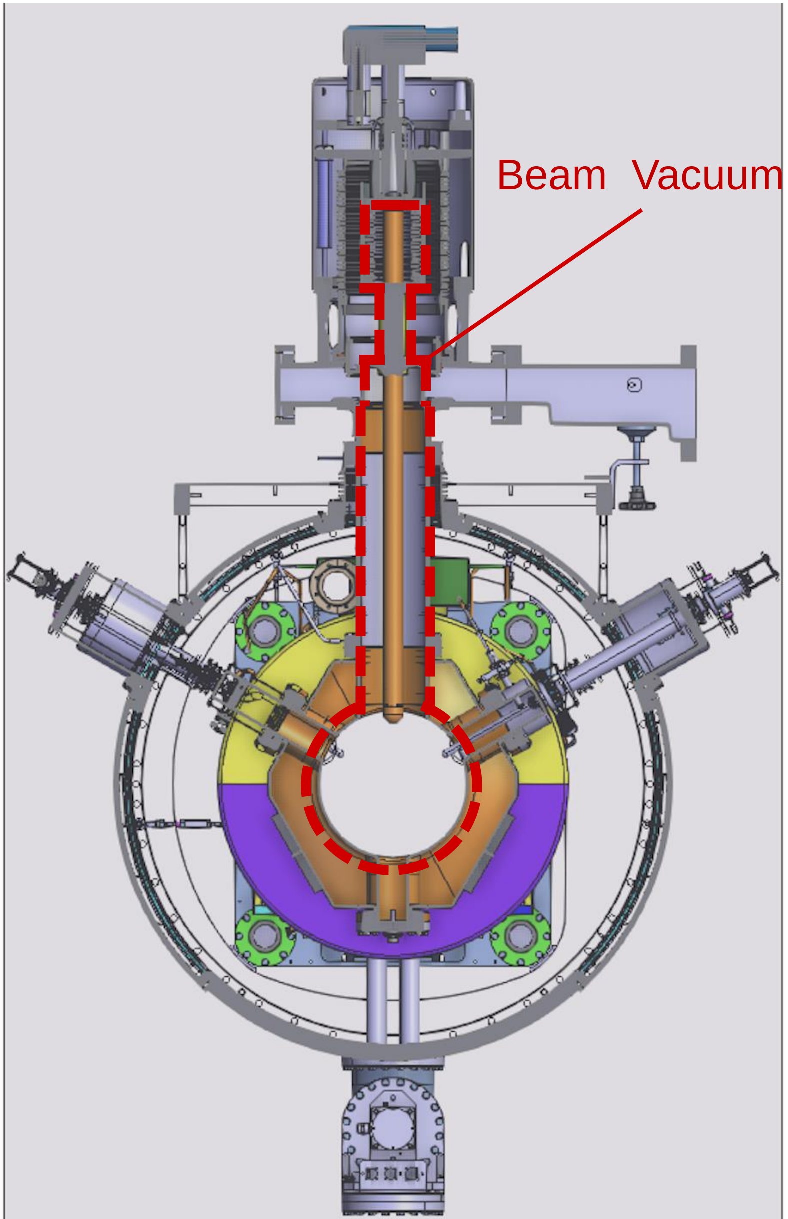
This hall:

- is an airlock at the entrance of the  ISO4 rooms to minimize air disturbance and contamination
- Interconnects all ISO 4 cleanrooms:
- Allows for gradual pressurization (+15 Pa) between atm. and ISO 4 rooms (+45Pa)
- is a large clean buffer area to prepare for work in ISO 4
- Could allow to work on up to six 12-metre long cryomodules in parallel



# Why a Large & Clean Assembly hall ? To allow for FPC installation post cryostating






LHC 400 MHz cryomodule X-section

FPC installation for the LHC Test Quarter Cryomodule, Sept. 2019

For LEP & LHC, FPCs were installed after cavity train was placed inside the vacuum vessel
For FCC, it might also be interesting to have the option to install the FPC after cryostating.

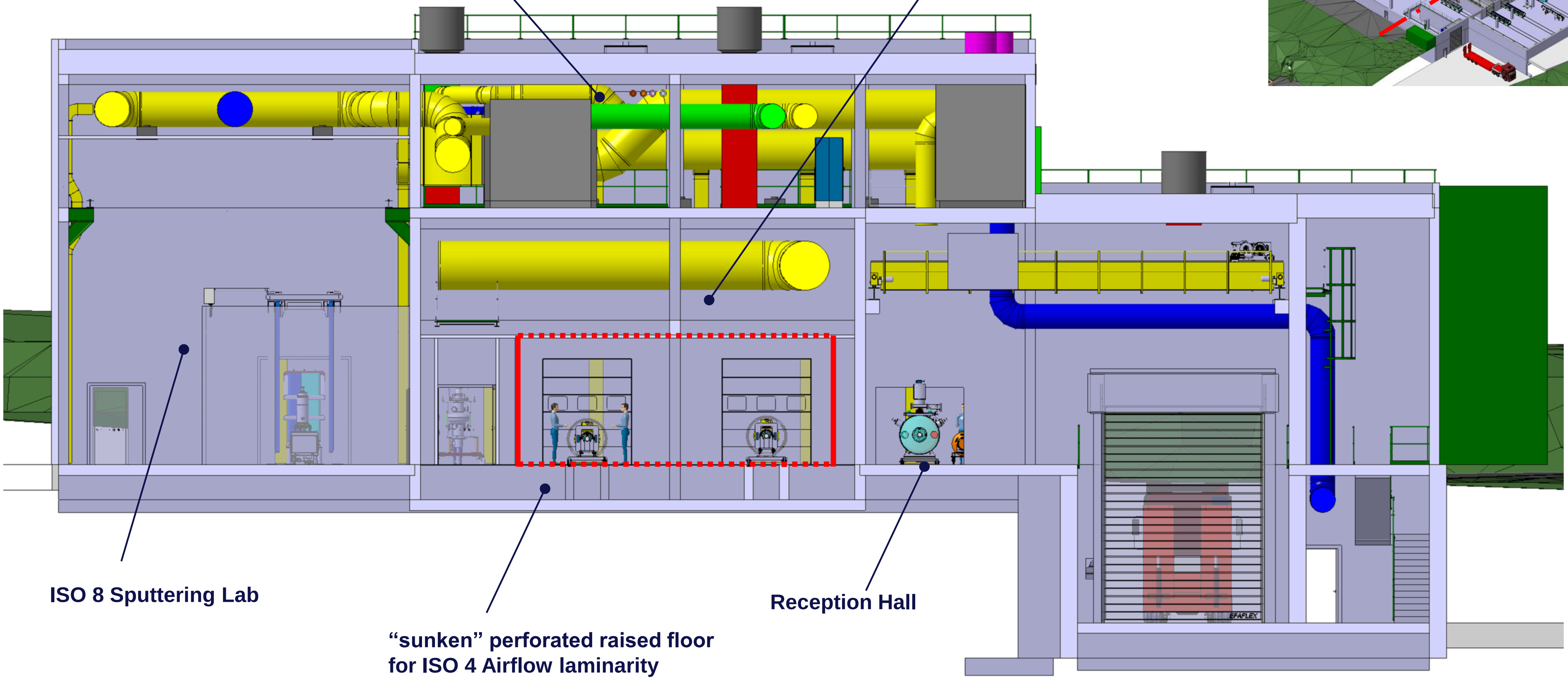
**Pros:**

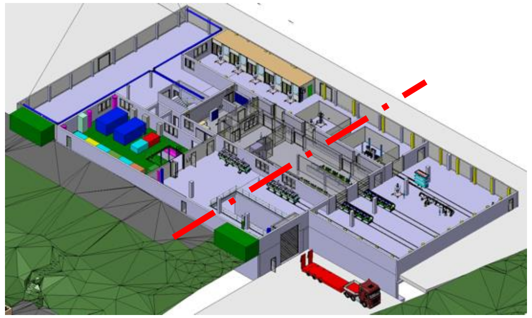
- less limiting for FPC design (FPC+DWT can be much bigger than cryostat enveloppe)
- May allow better location of the ceramic window

**Cons:**

- Requires to open the cavity after cryostating in clean conditions (ISO 4)
- Requires to keep the cryomodule external surfaces as clean as possible (ISO 8) during assembly

# SA18 – The HVAC system



# Summary

## A clean, customized infrastructure dedicated to SRF, in operation by mid 2028

Allows for a much leaner process with minimum non added-value steps than what is currently possible at CERN.

Highly critical for SRF performance, esp. for complex thin films technology more prone to defects.

For the LHC spares, 75% of cavities needed re-processing. Overall (all cavity types) the failure rate is around 50%.

→ Huge impact on R&D and prototyping due to low throughput overall

Aim: Lower failure rate, down to 20% & increased throughput at equivalent staffing level. Process not limited by infrastructure !

A custom-tailored infrastructure is essential to :

1. Achieve no-breach of cleanliness, Air T and RH control, quick clean transit over the entire process
2. Reduce risk : less process steps (e.g. transport), more automated steps (e.g. washers), more QC (better defect detection)
3. Be adapted to new/enhanced chemistry (new EP, clean substrate HPR,…) and sputtering (HiPIMS, …) technologies
4. Allow to significantly increase throughput, and / or intervene on multiple cryomodules in parallel if required
5. Make possible a greener SRF: reduced water consumption, use of sterile air instead of pure nitrogen, use of heat-pumps, …

FCC

# Thank you for your attention

Questions ?

## Acknowledgements

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