

Facility lifecycle & target surface building

1st Beam Dump Facility (BDF) Targetry Systems Advisory Committee (TSAC)
4-6 March 2025 - CERN

Jean-Louis GRENARD - Gemma HUMPHREYS – CERN – SY-STI-TCD

with the contribution of all the members of HI-ECN3 WP4

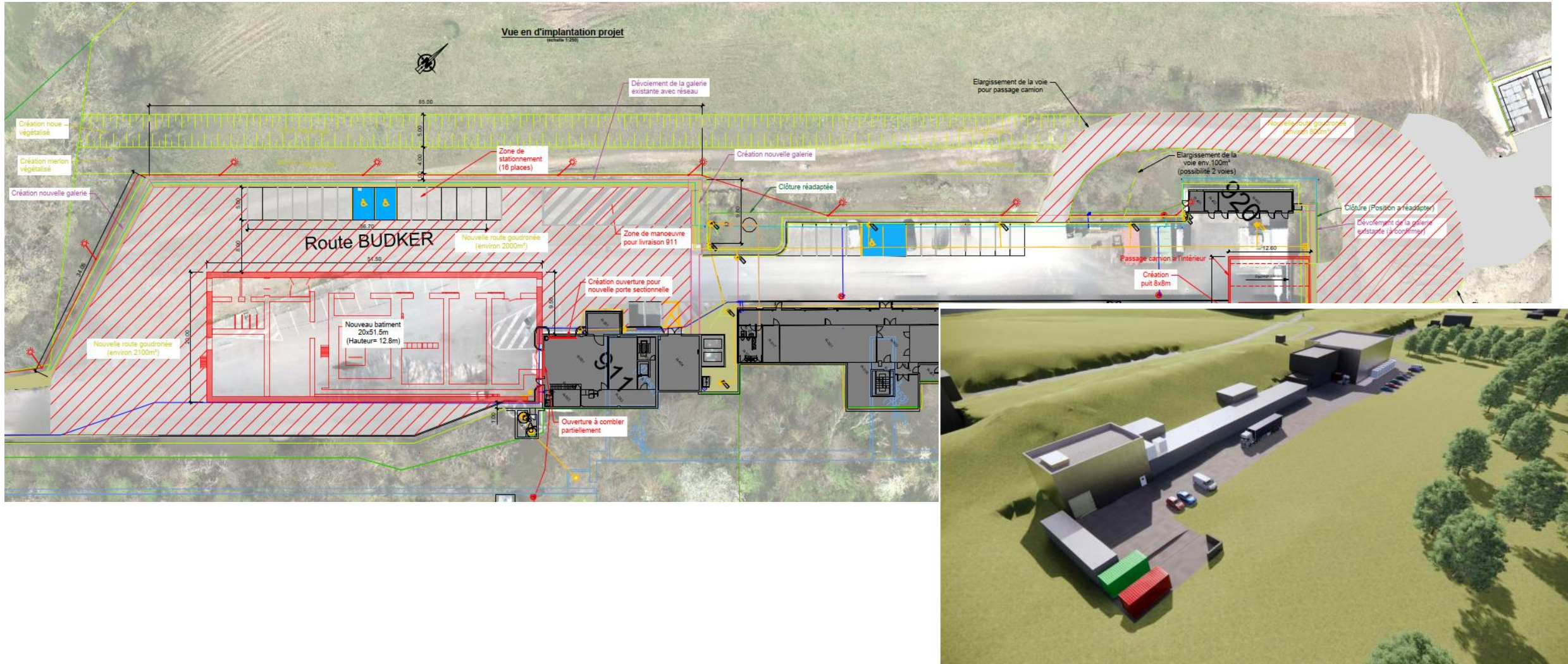


HI-ECN3.

Facility lifecycle & target surface building - goal

- **Detail the layout of the target service building**
- **Describe the entire facility lifecycle (from construction to dismantling)**
- **Present the area being part of the building to prepare the target station systems for final disposal**
- **Detail the tentative process for the final disposal of a target including tentative tools**

Service building within the BDF/SHiP complex



The target complex service building



Nuclear ventilation system of the target complex

- Air handling units, filters, dehumidifiers (outside)

Target and proximity shielding cooling systems

- Pumps, Filters, Heat exchanger, Cooling instrumentation, He circulation system
- Target controls systems
- Target monitoring (sensors), Target control valves, vacuum vessel confinement

Service cell

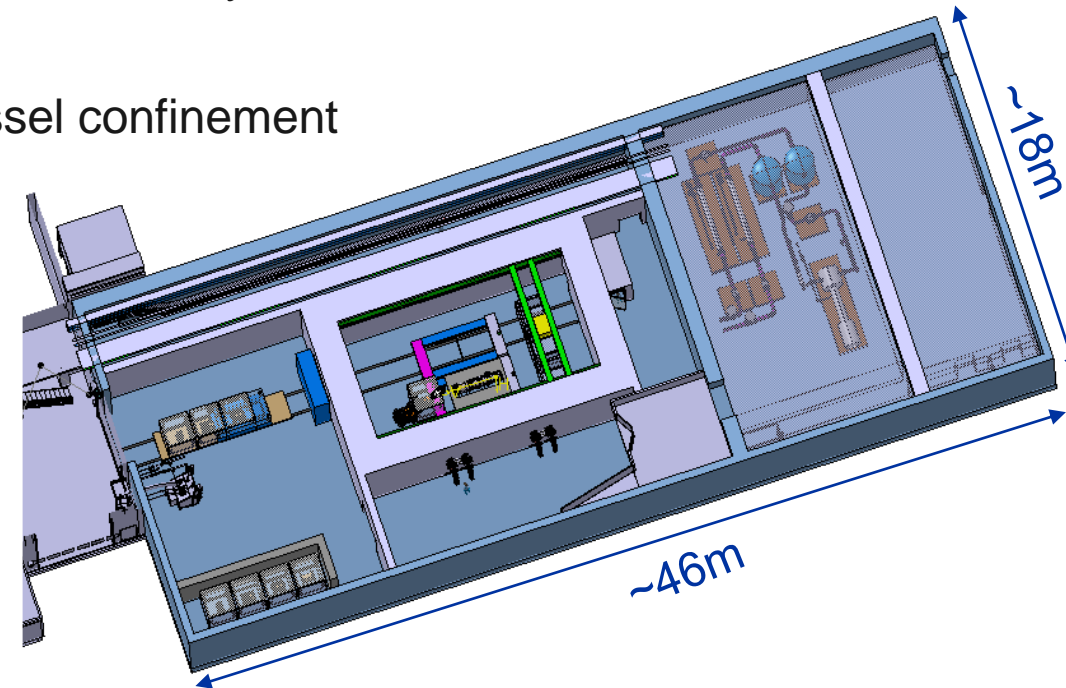
Buffer area

Safety systems

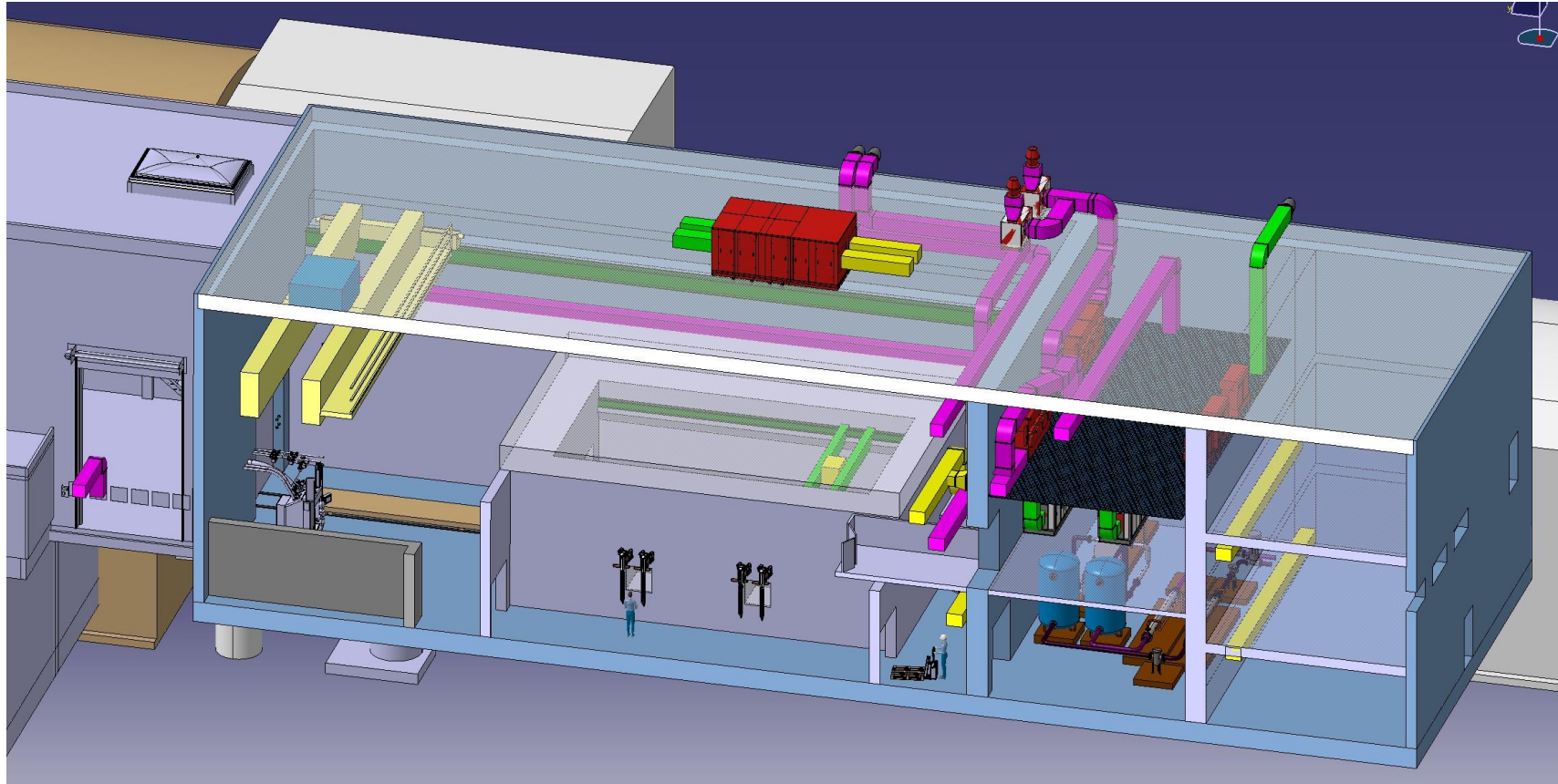
Electrical distribution system

Control and safety systems

➤ ~1000 m²

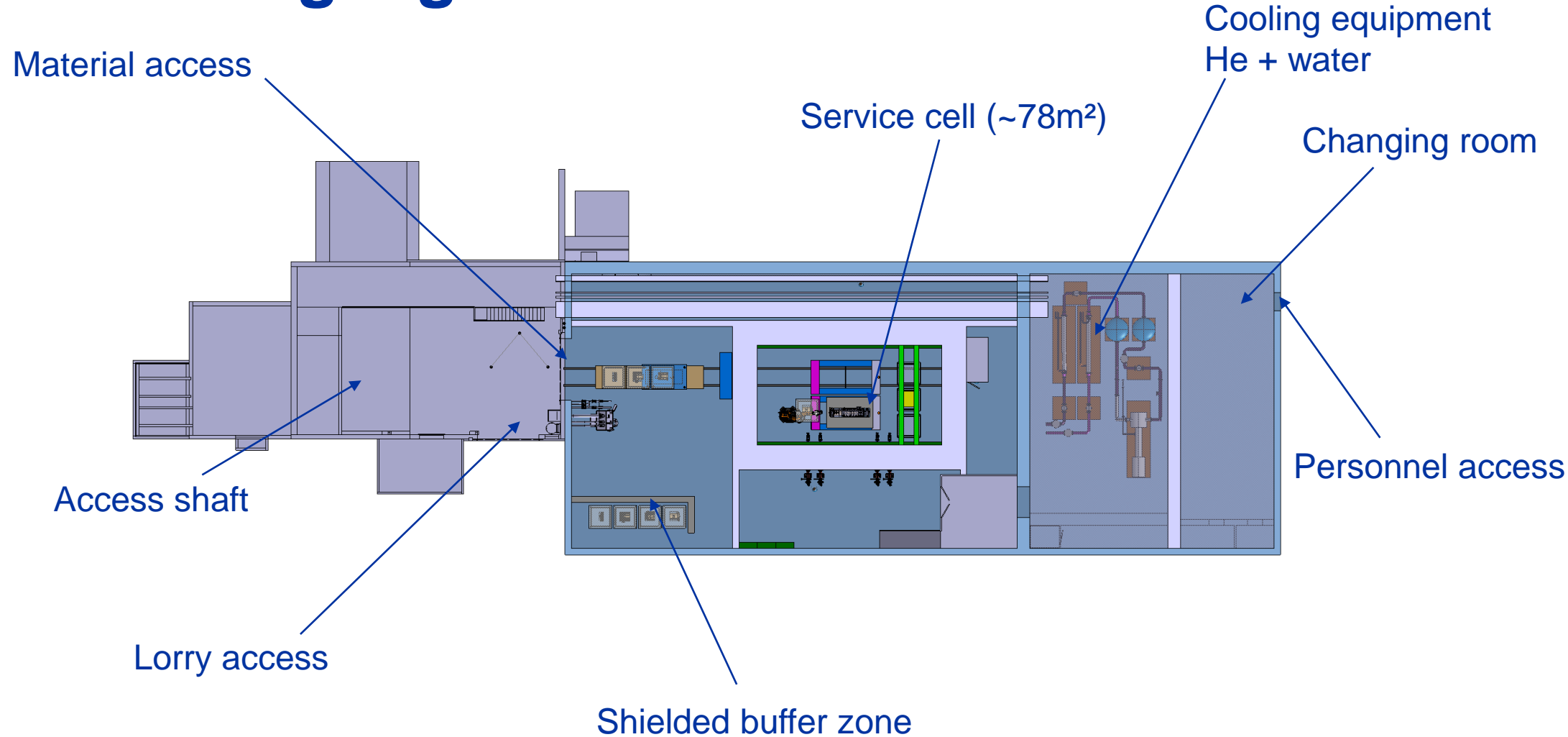


Service building - Overview

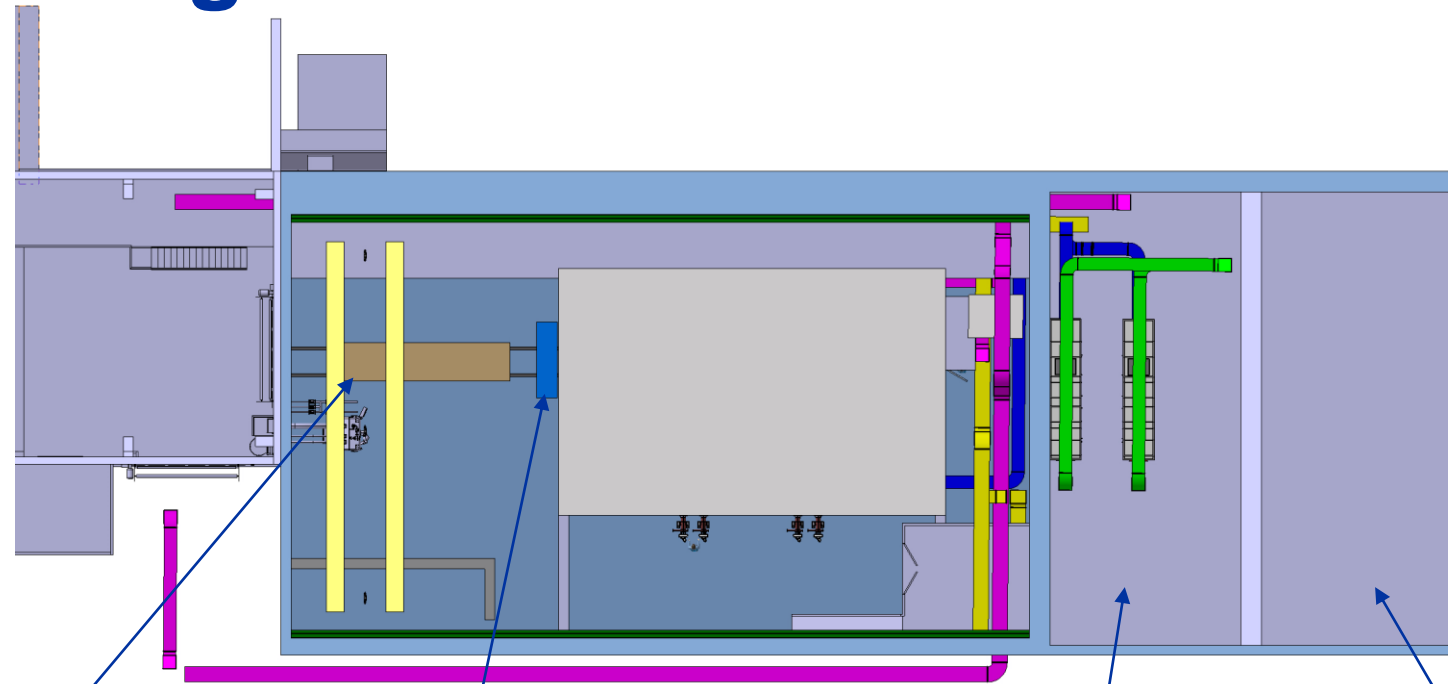


Separation of hazards discussed in **M. Aversa** talk
RP risks discussed in **C. Ahdida** talk
Ventilation system discussed in **N. Zarik** talk
Handling systems discussed in **C. Duran Gutierrez**

Service building – ground floor



Service building – 1st floor



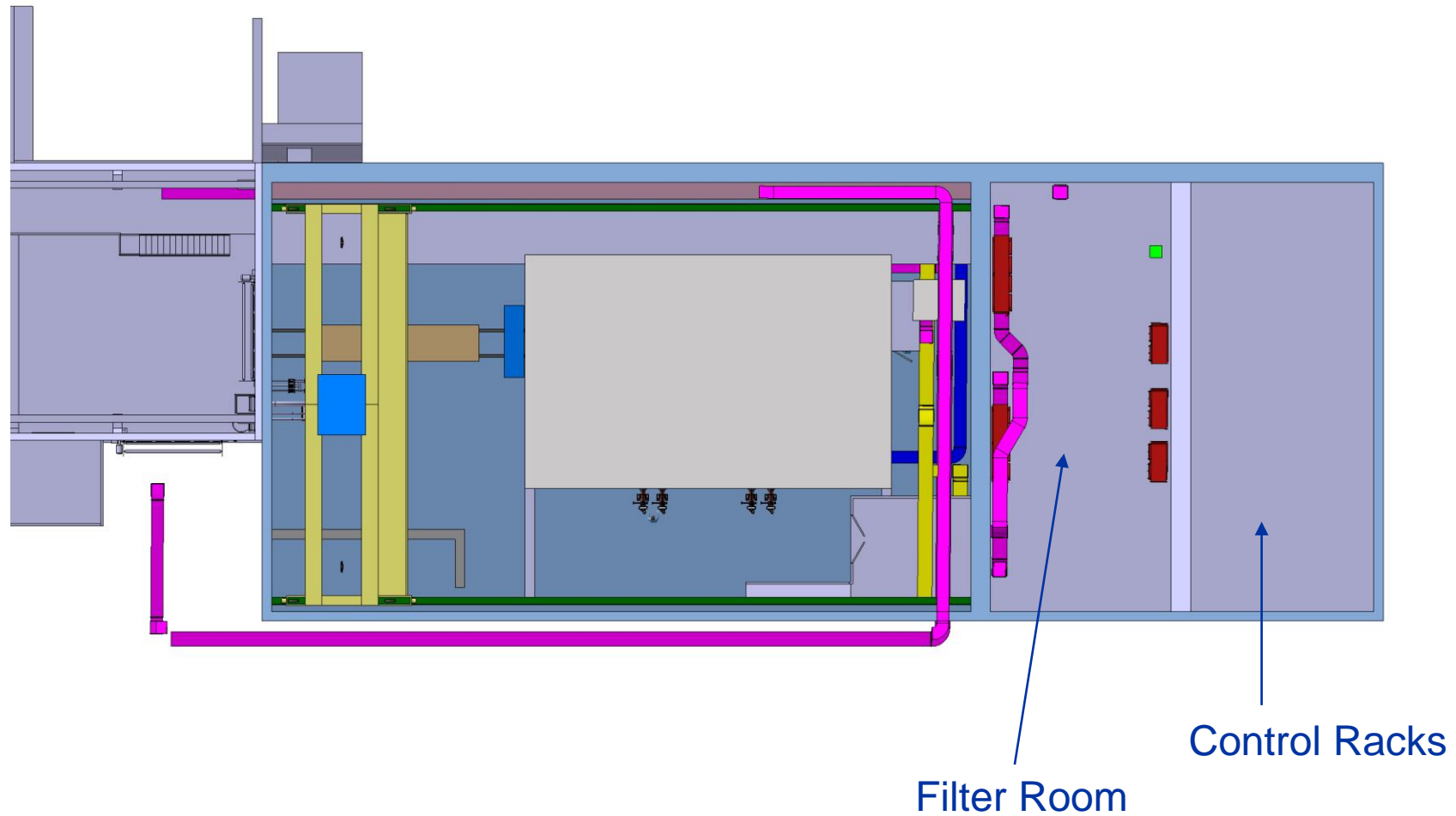
30t Overhead Traveling Crane

Mobile Shielded Door

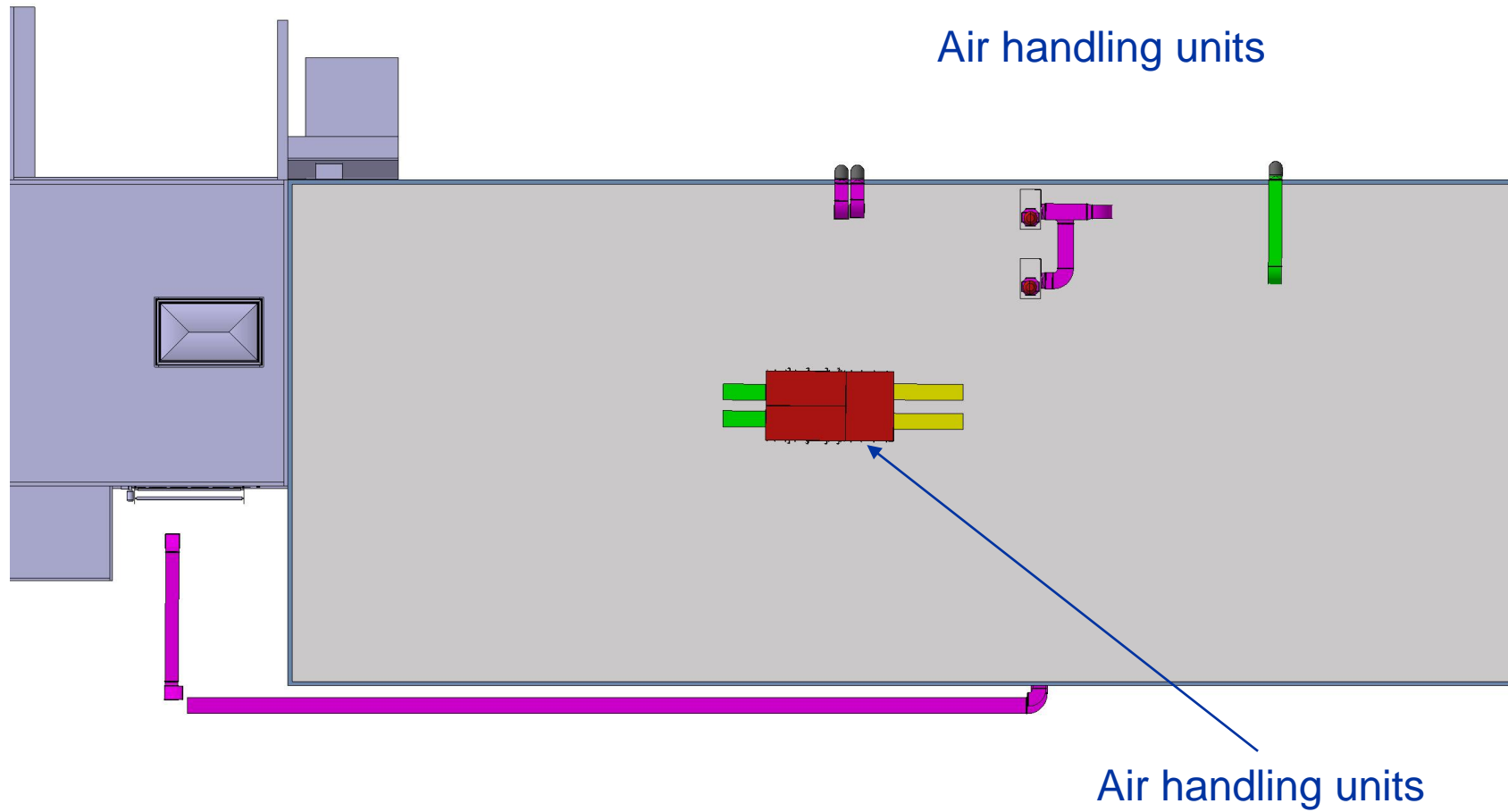
Filter Room

Power Distribution Room

Service building – 2nd floor



Service building – roof



Service building

How do we deal with target developments?

- Main difference between 2 options: cooling systems
- Most demanding is the W helium cooled version with a water-cooled proximity shielding

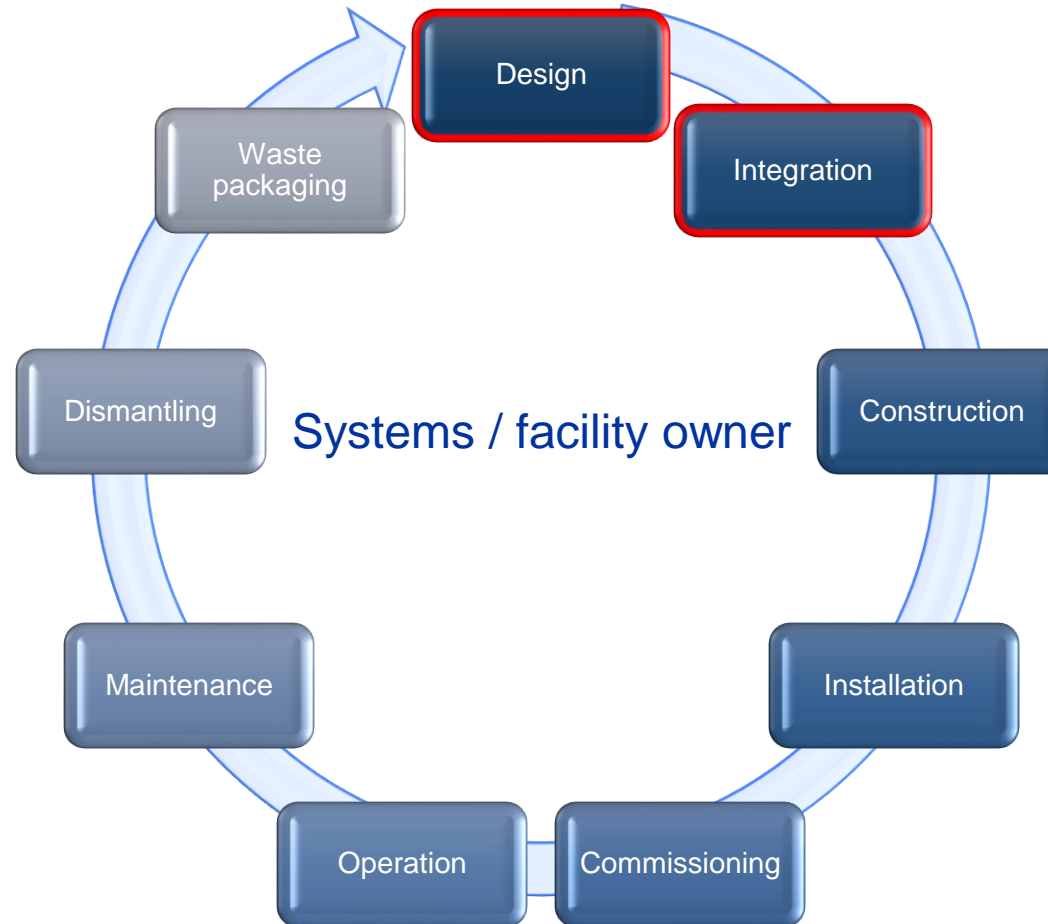
Cooling and ventilation rooms and pipes space reservations designed around this conservative approach



Target complex systems lifecycle

Different stakeholders across the lifecycle:

- Design offices
- Workshops
- Control teams
- Installation teams
- Radiation protection
- Transport and Handling
- Cooling and Ventilation
- Operation
- Robotics
- Radioactive waste management



Stakeholders brings along the lifecycle:

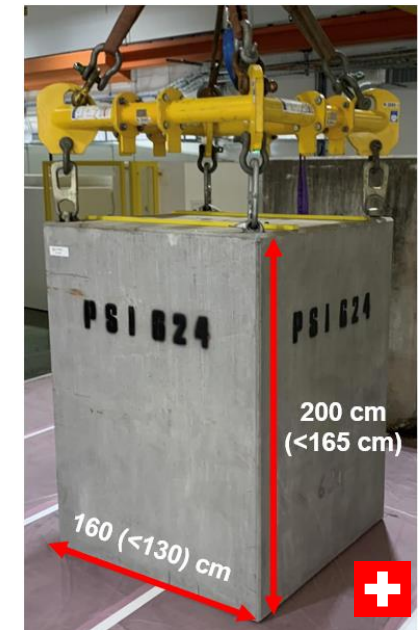
- Expertise
- Integrate their standard subsystems
- Integrate their return of experience

Target complex systems - Lifecycle

By regulations CERN must send all radioactive wastes to final repository in Host States



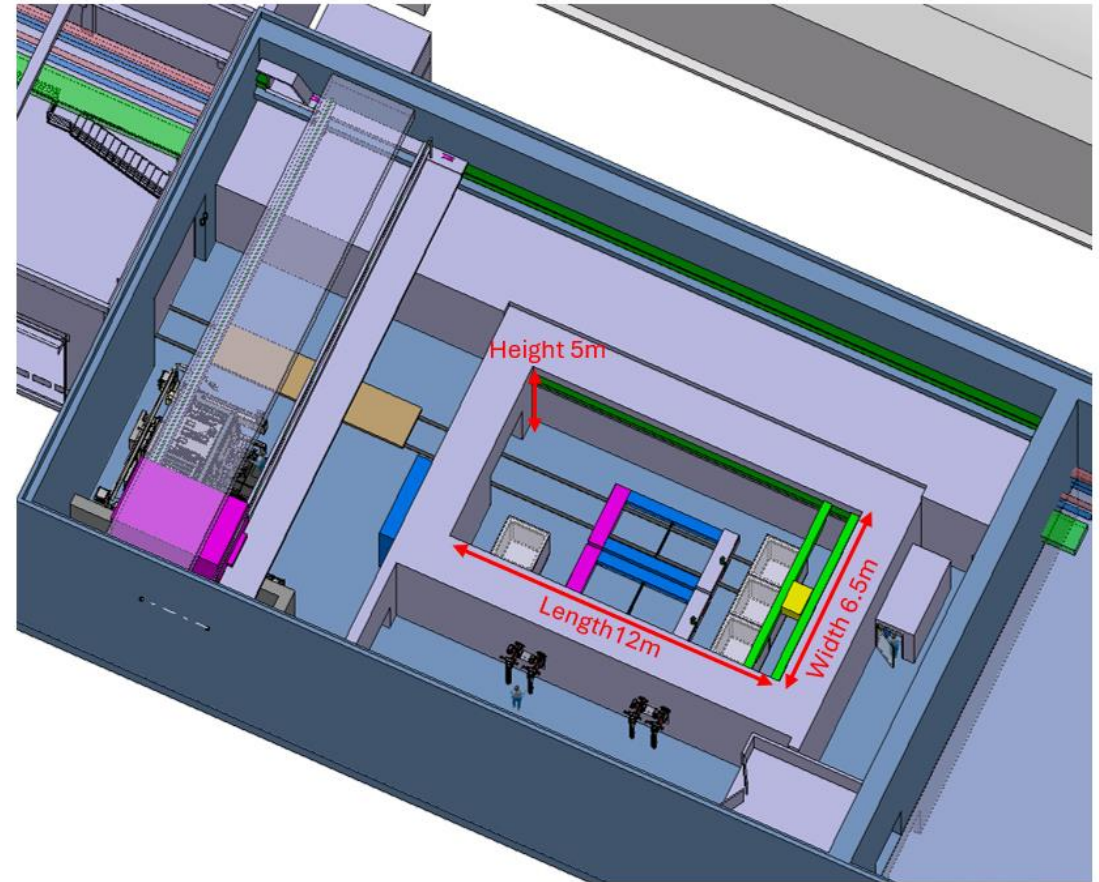
- Different requirements from the 2 host states authorities (type, size of containers...)
- Radioactive waste to be sorted safely for very long term (hundreds of years)
- (Chemical) Reactions to be considered between packing and stored material (e.g. water-aluminium cracks creation)
- Complexities of waste disposal process to final repository in **G. Dumont Talk**



Typical final repository containers

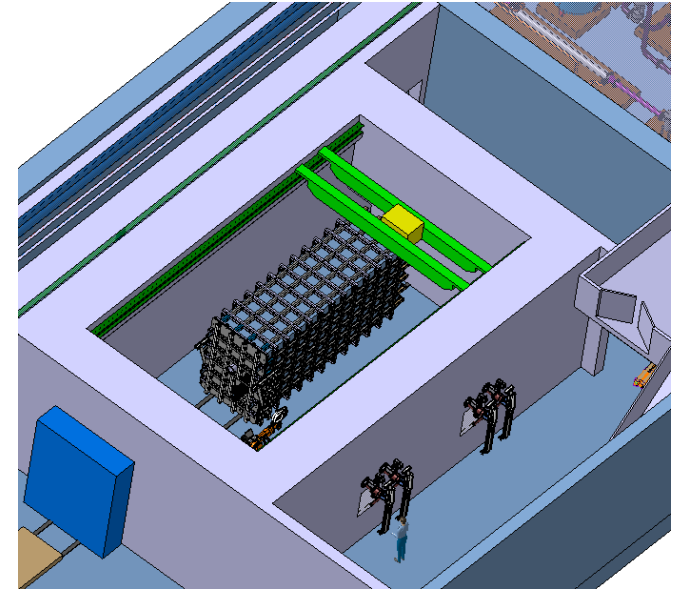
Justification for the need of BDF's own service cell in the target service building

- **Why is the service cell needed in the target service building?**
 - **Transport** of BDF waste between or outside the CERN sites would require custom-built dedicated, homologated transport cask with an **extremely long and complex certification process**
 - Would need **approval from nuclear authorities**
- **Need for dedicated service cell in high power targetry facilities**
 - **Demonstrated by their presence & use in relevant and similar facilities worldwide** (SNS, FRIB, NuMI/LBNF, SINQ), where they are used to guarantee reliable operation of the infrastructure



Justification for the need of BDF's own service cell in the target service building

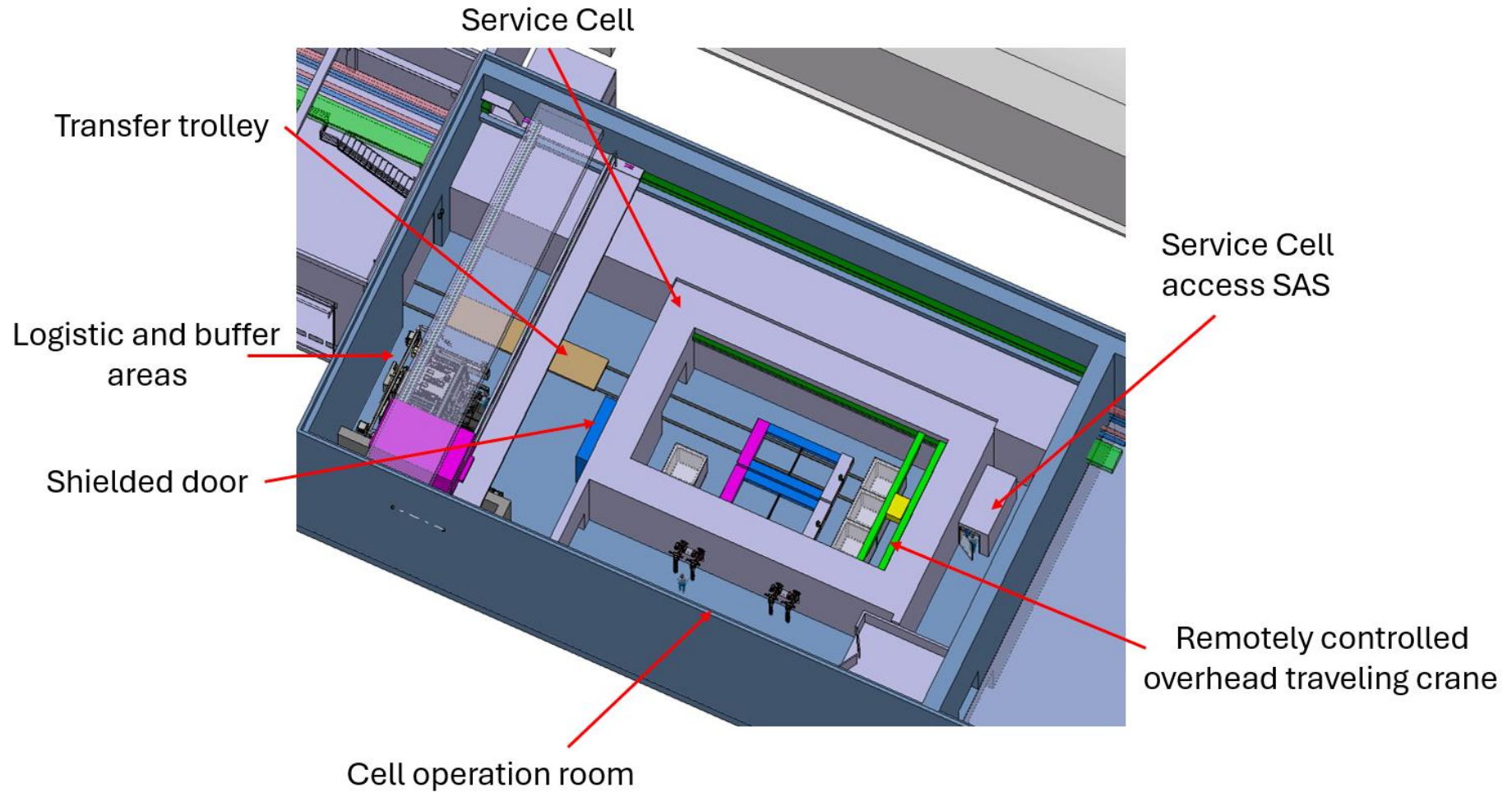
- BDF will host the highest activation equipment CERN has ever had
- Target design to be a **replaceable component** (5 y operation as target compared with 15+ years of operation for the facility)
- Host states request a dismantling plan and elimination pathway for the BDF radioactive waste
 - Demonstrating capability to **package and dispose of the target** will be a requirement from the authorities
 - Tentatively, disposal path is **cutting it and fitting in a container** for disposal in **Switzerland**
 - Other components (hadron stopper coil, proximity shielding, vacuum vessel etc.) will require **volume reduction**
 - **Currently such a large facility does not exist at CERN**



Vacuum vessel as a single component into the service cell for decommissioning

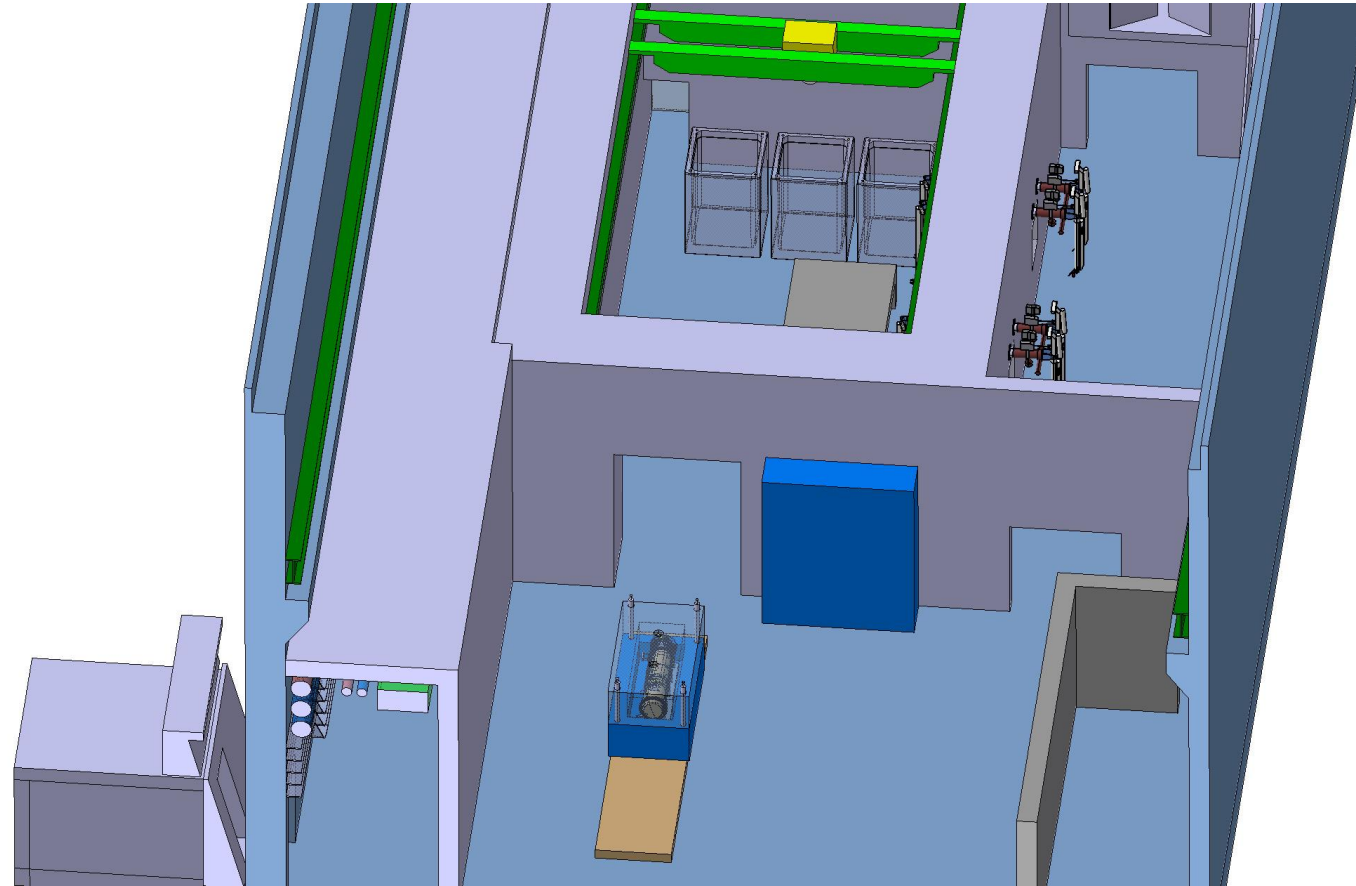
- **Moreover, service cell could be used for target autopsies and equipment repairs**
 - Identifying **failure modes and possibly repair**, to ensure facility performance and improve future design and reduce operational costs

Tentative layout of the service cell



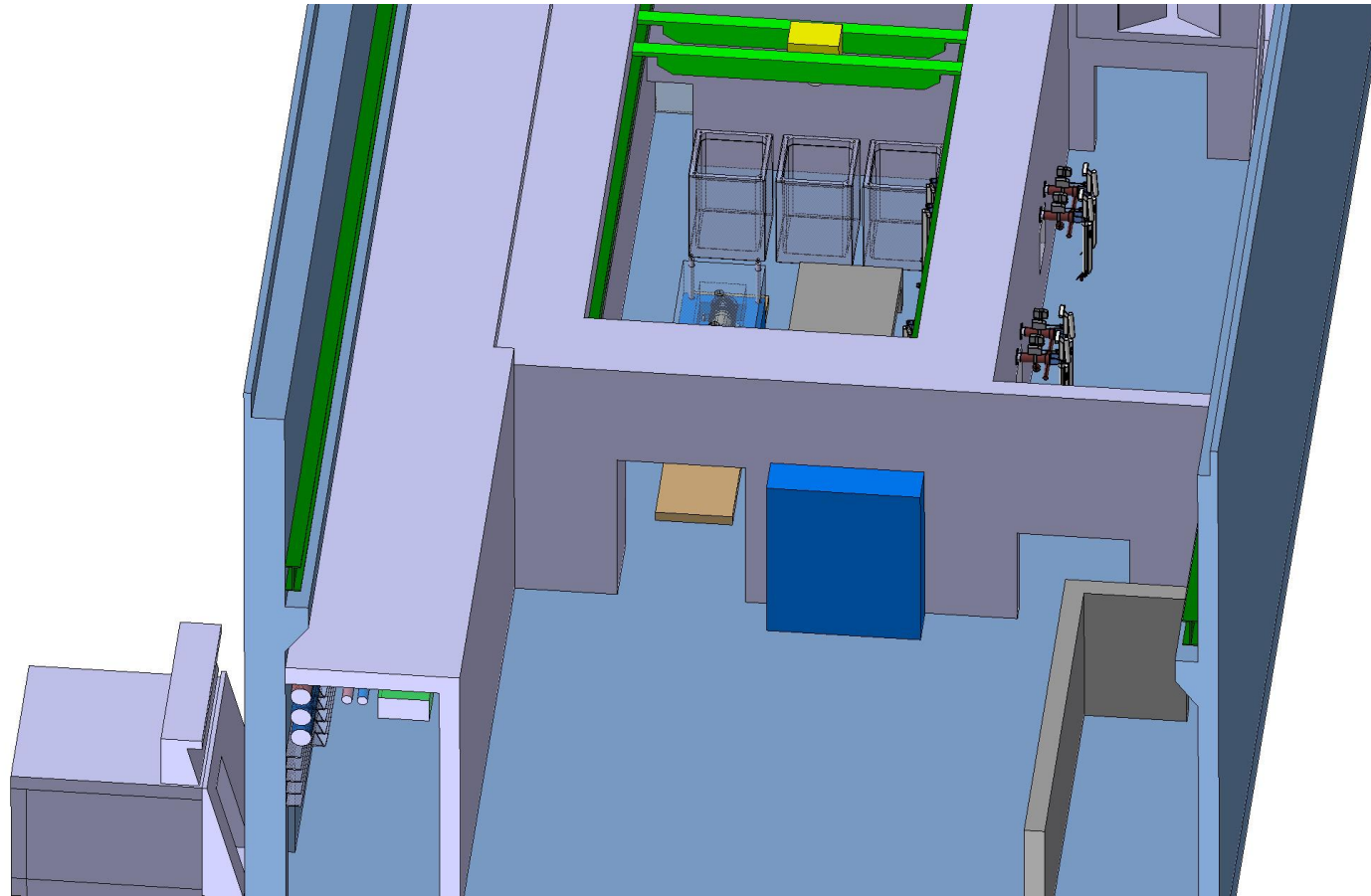
Handling systems discussed in **C. Duran Gutierrez** talk

Tentative process foreseen in the service cell



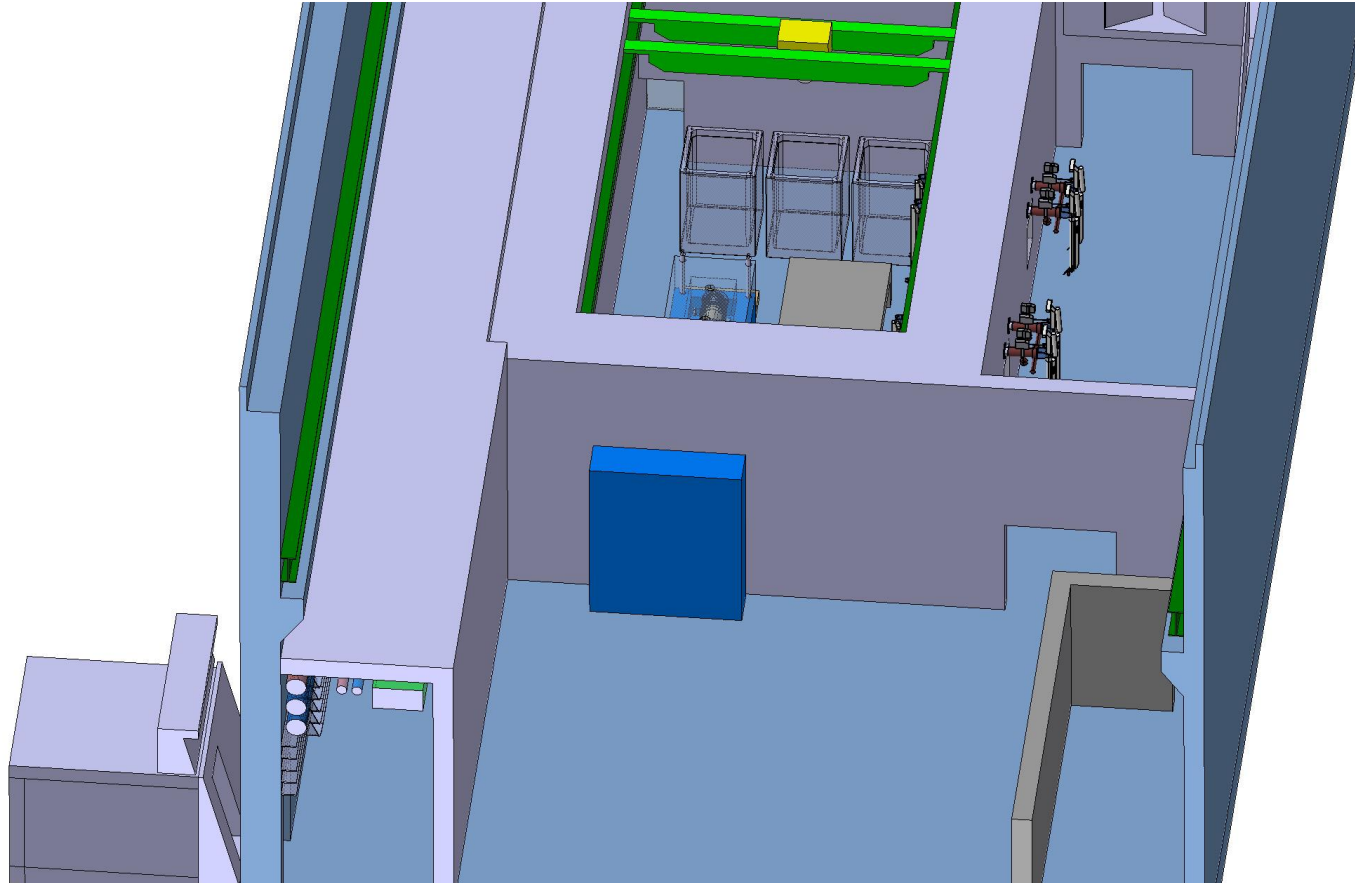
Service Cell with storage/disposal containers inside and, outside, the component to be treated

Tentative process foreseen in the service cell



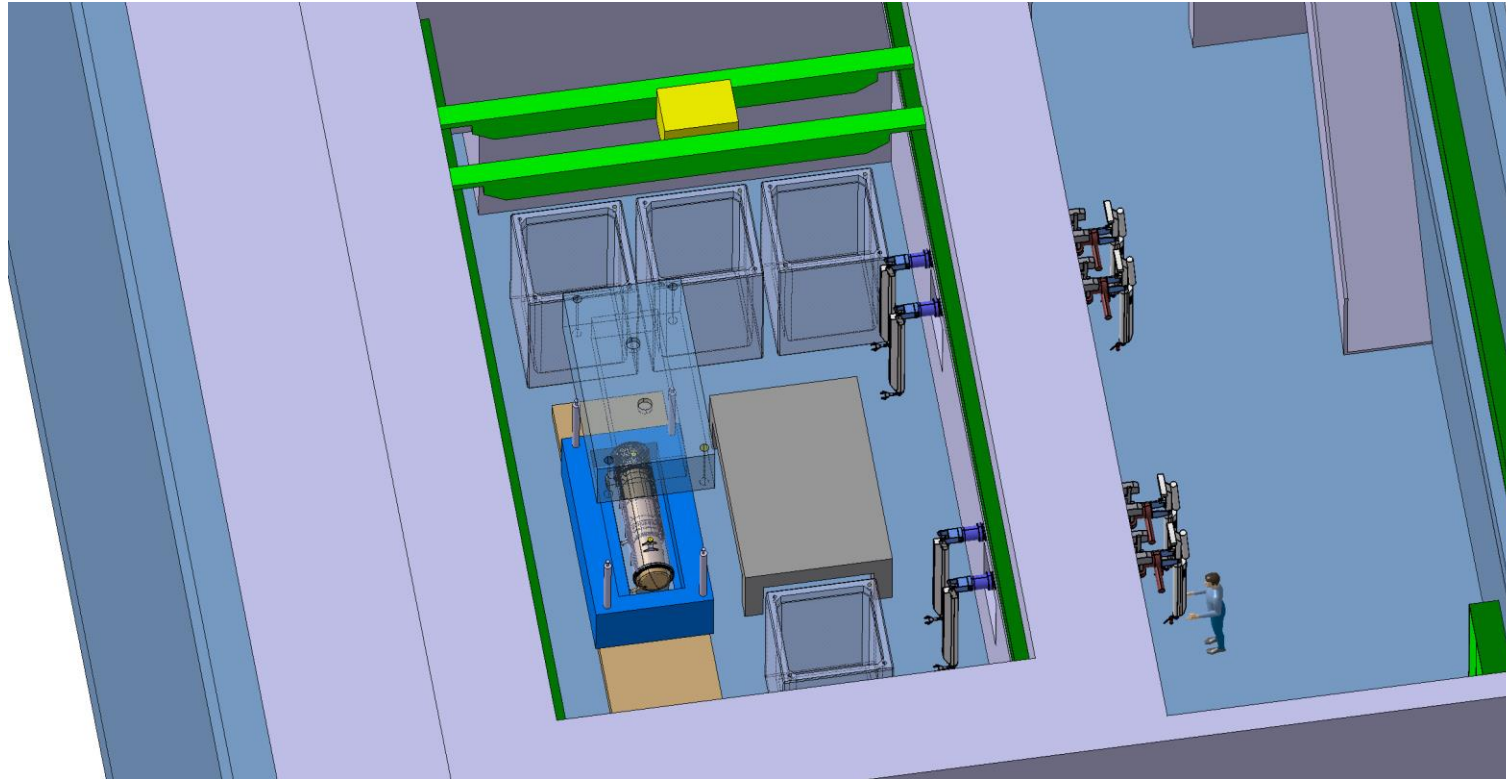
Transferring a component to the Service Cell

Tentative process foreseen in the service cell



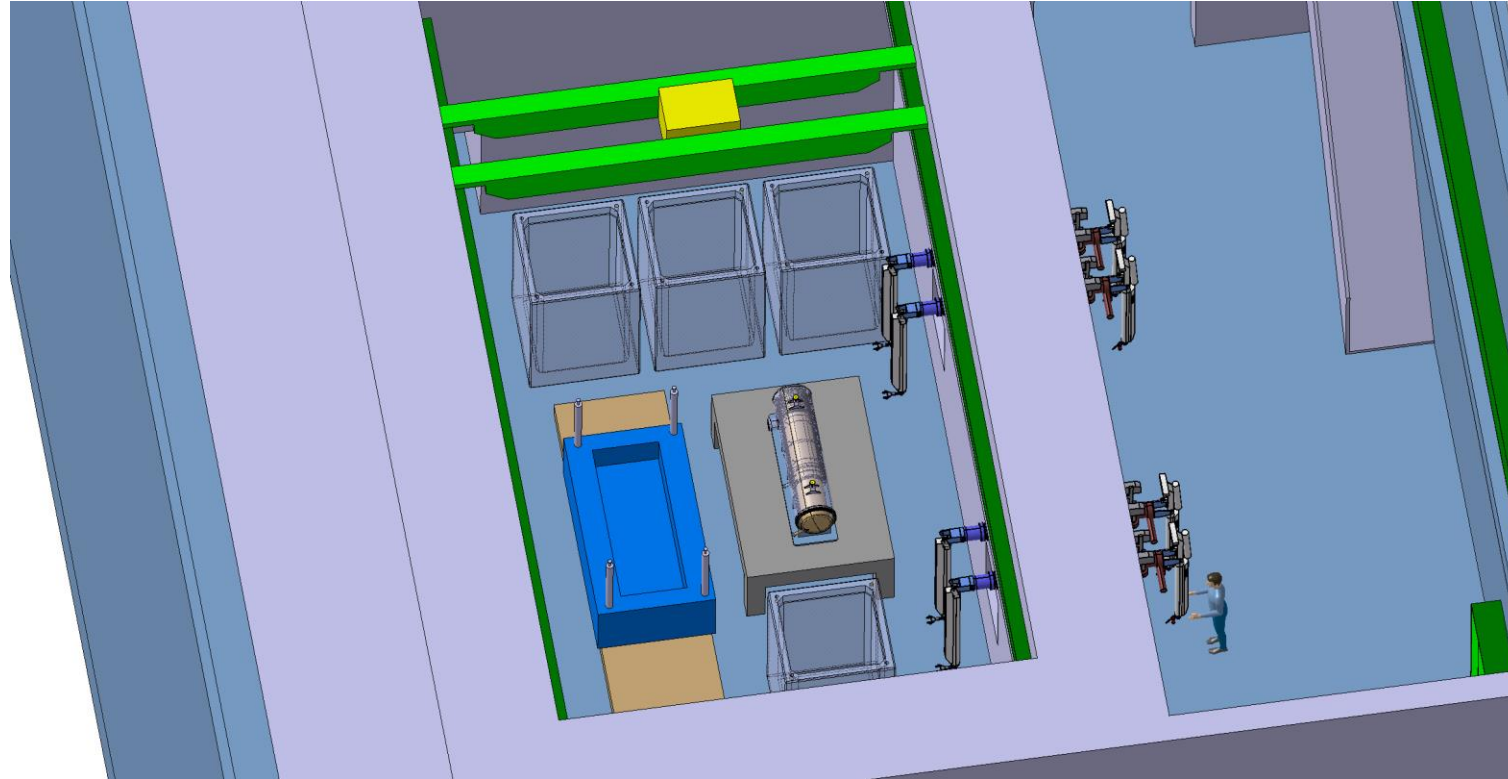
Closing the Service Cell

Tentative process foreseen in the service cell



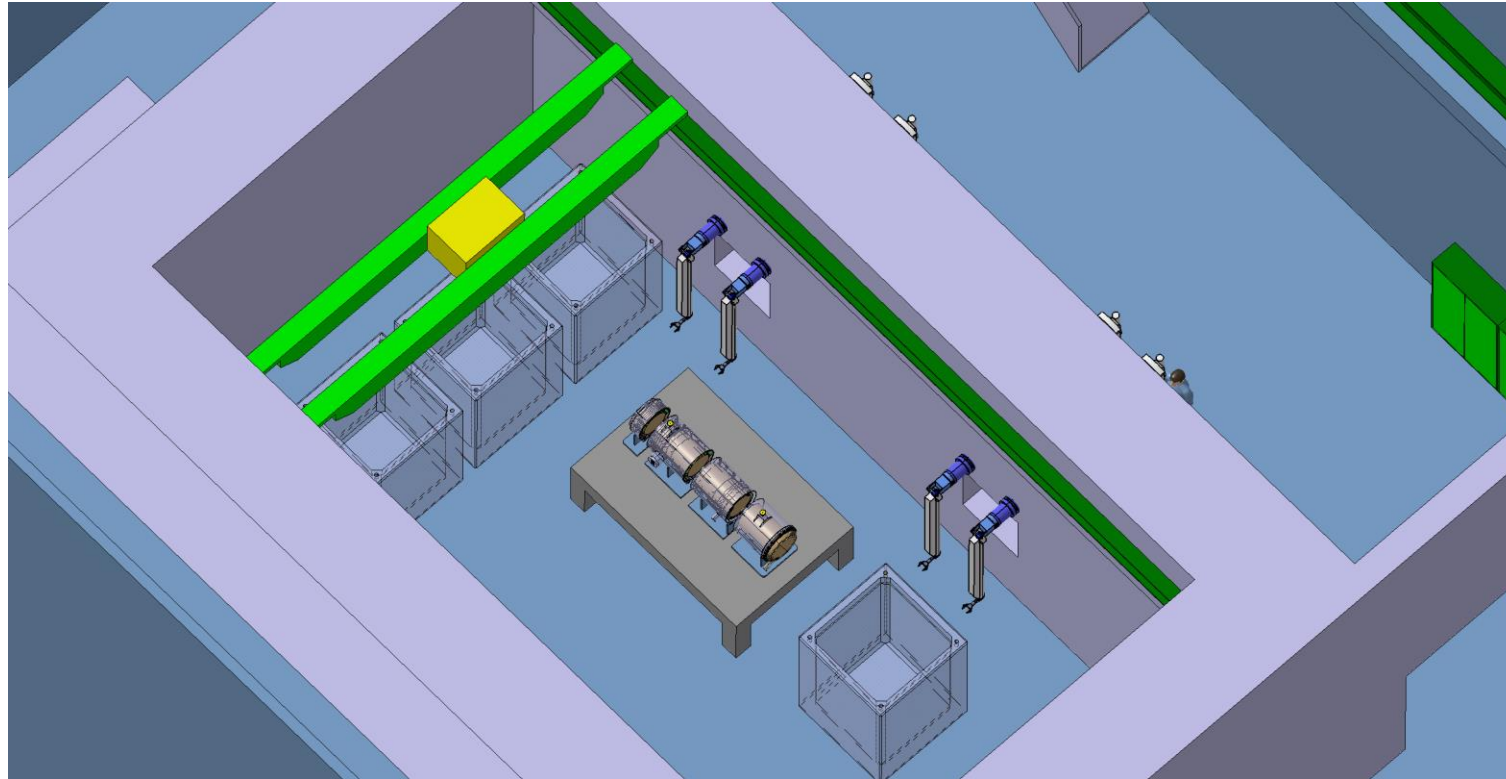
Opening the shielded cask

Tentative process foreseen in the service cell



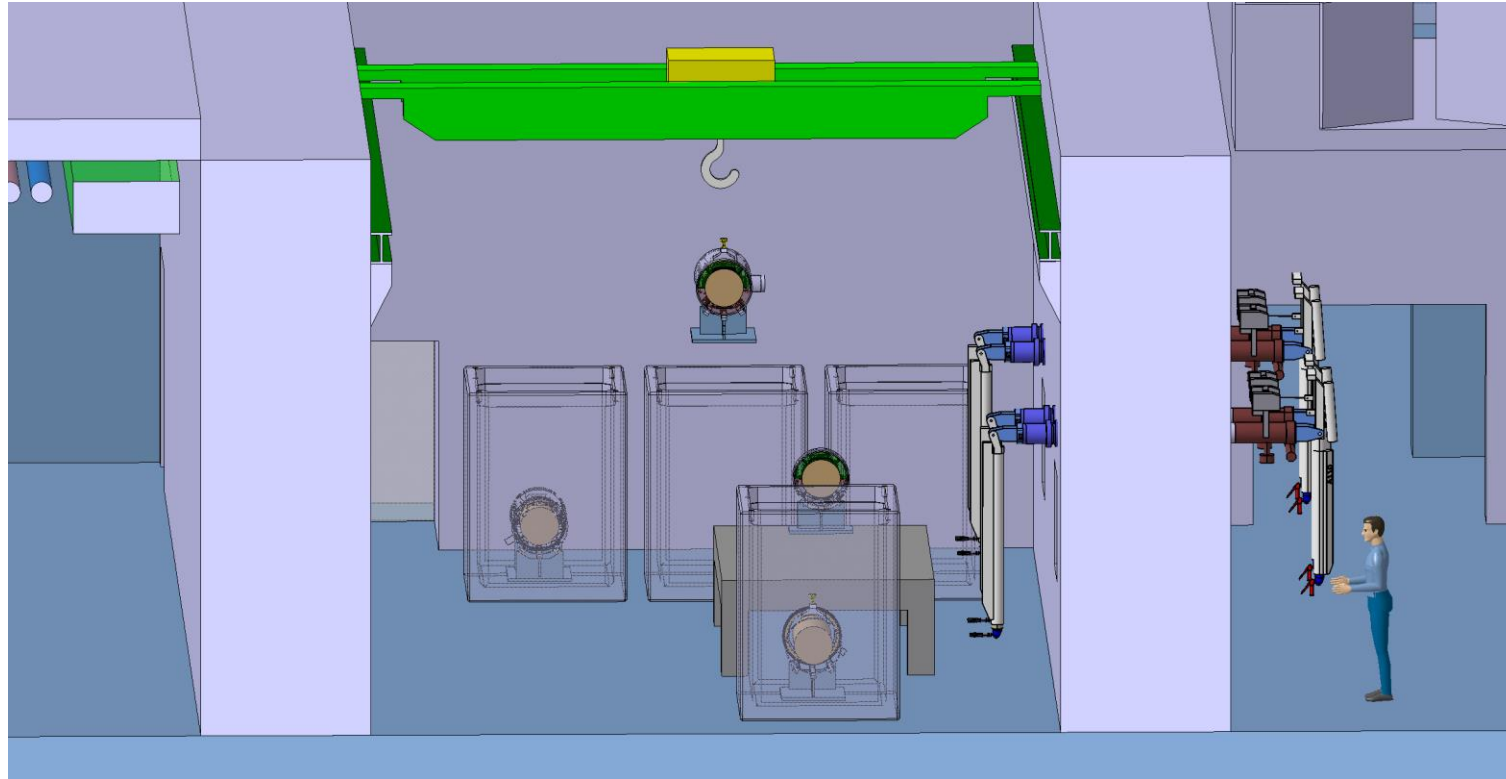
Extracting the component from the cask

Tentative process foreseen in the service cell



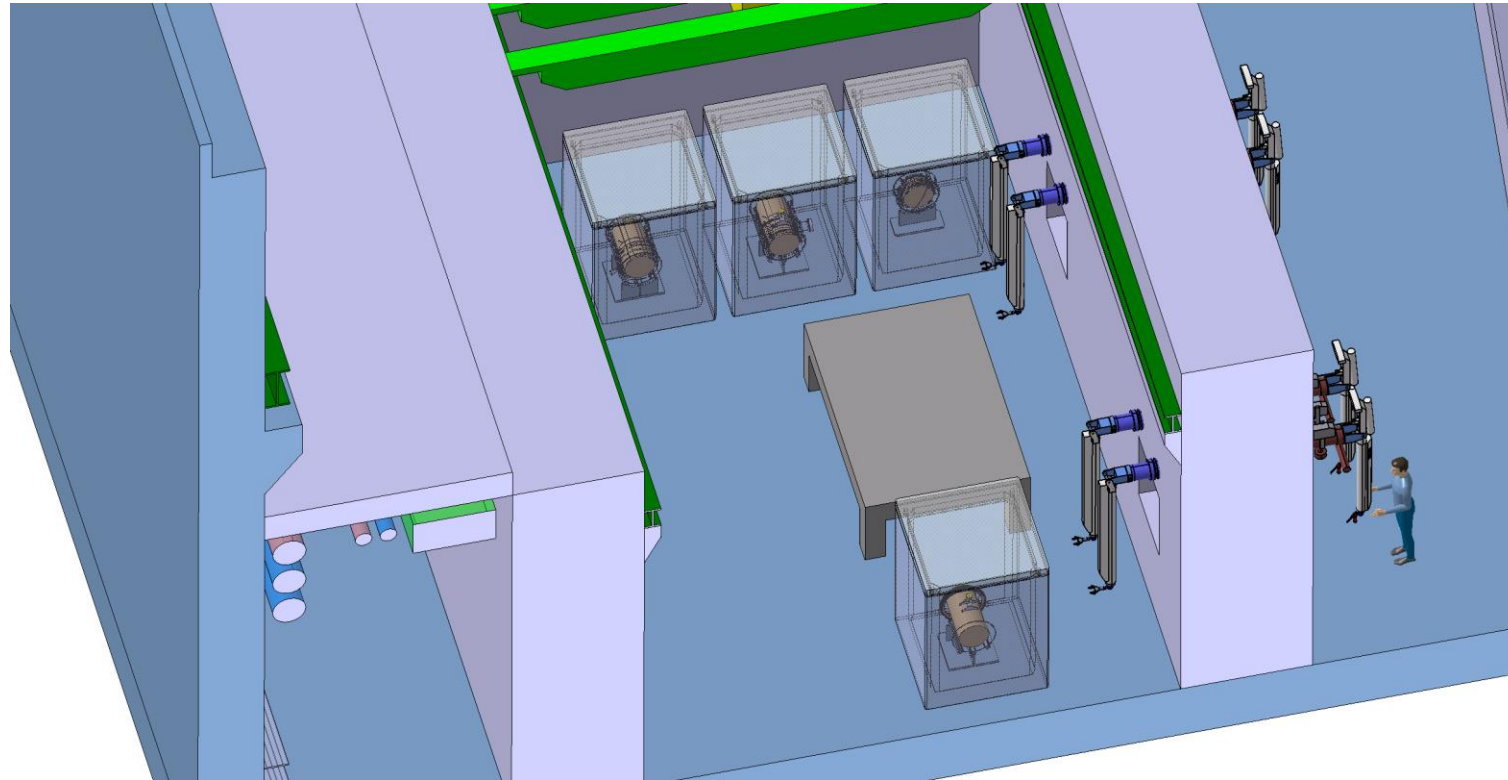
Cutting the component

Tentative process foreseen in the service cell



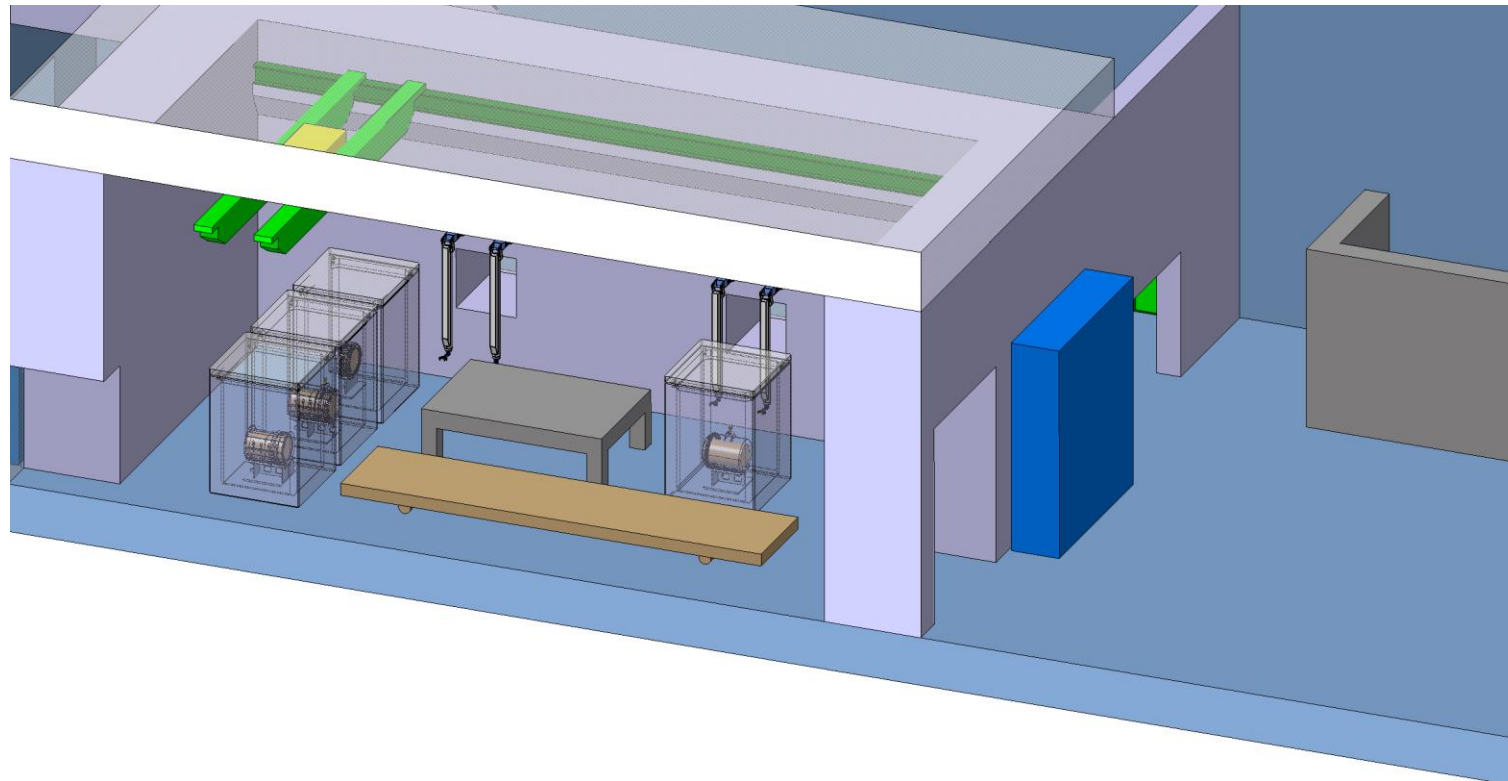
Packing the sliced component in storage/disposal containers

Tentative process foreseen in the service cell



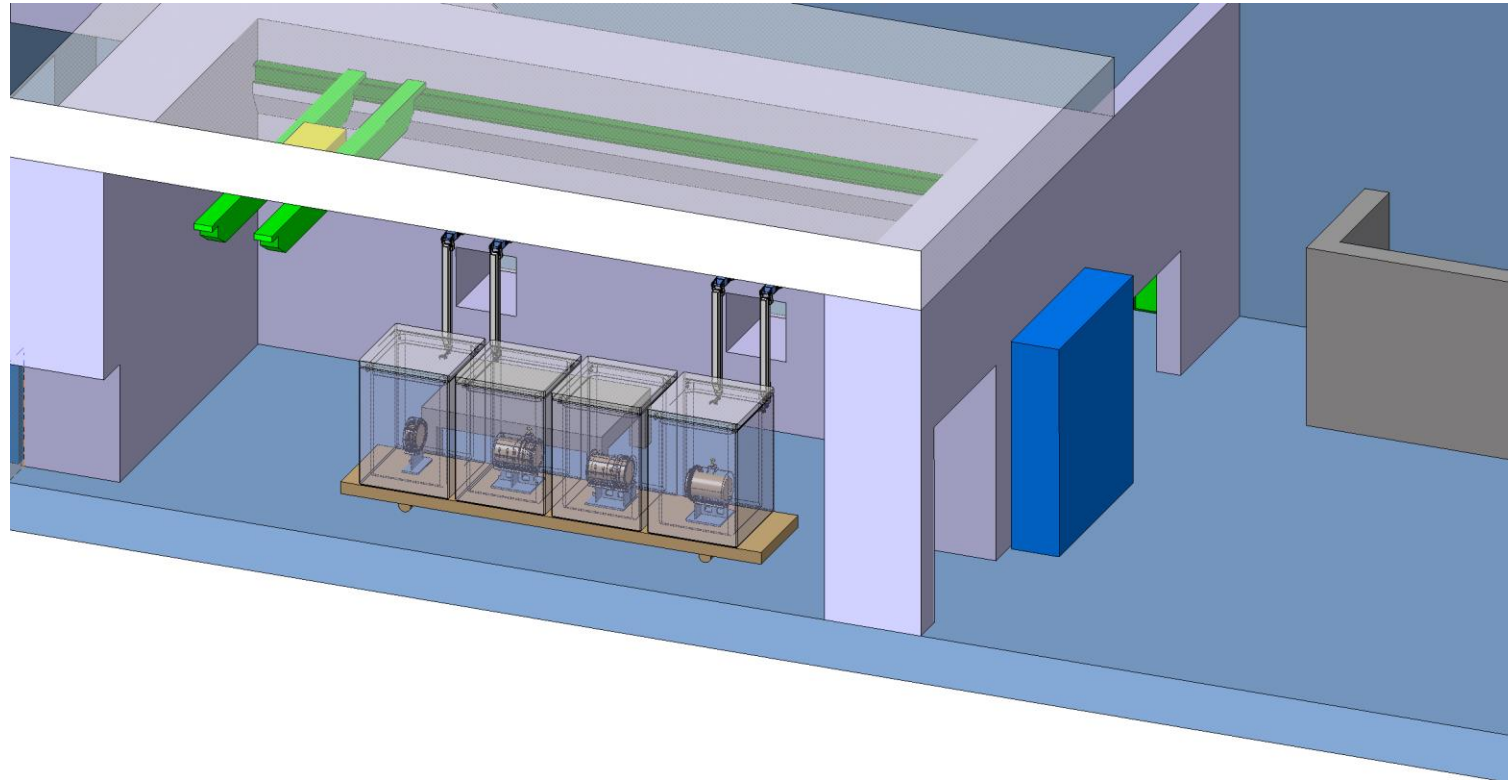
Closing the storage/disposal containers and decontamination (human intervention wearing air-fed suit)

Tentative process foreseen in the service cell



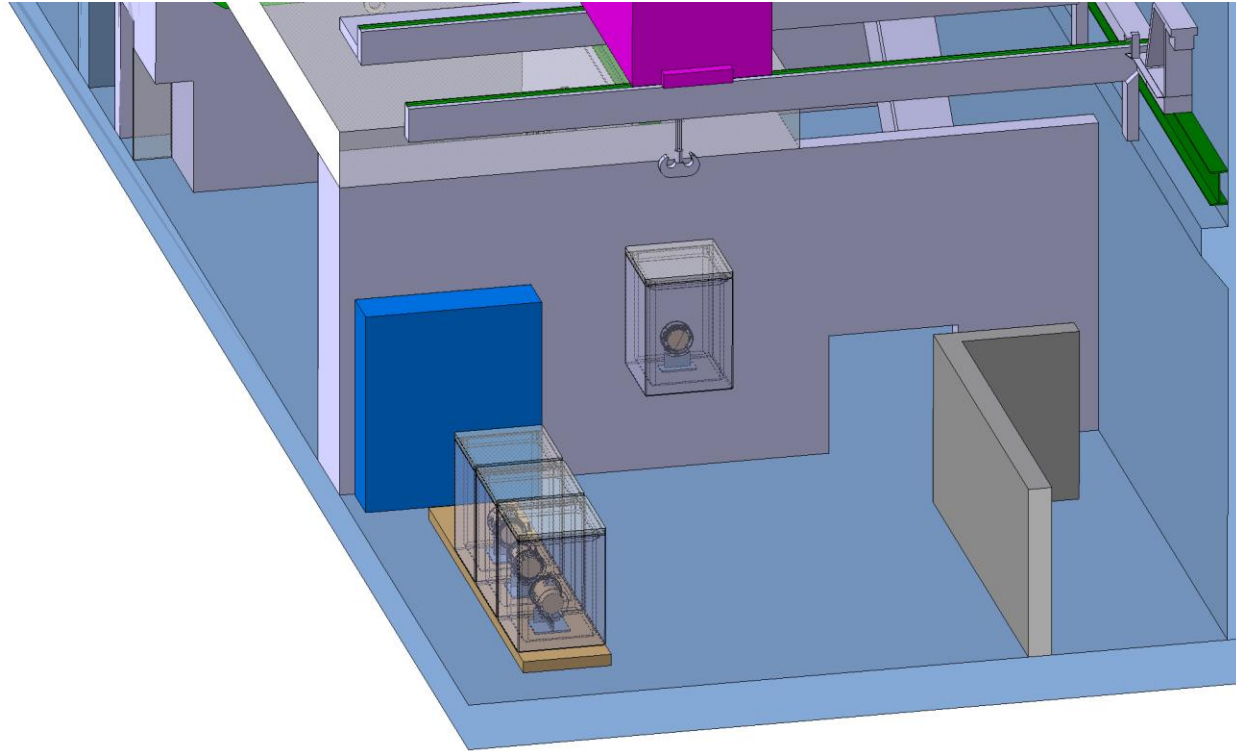
Opening the Service Cell after decontamination

Tentative process foreseen in the service cell



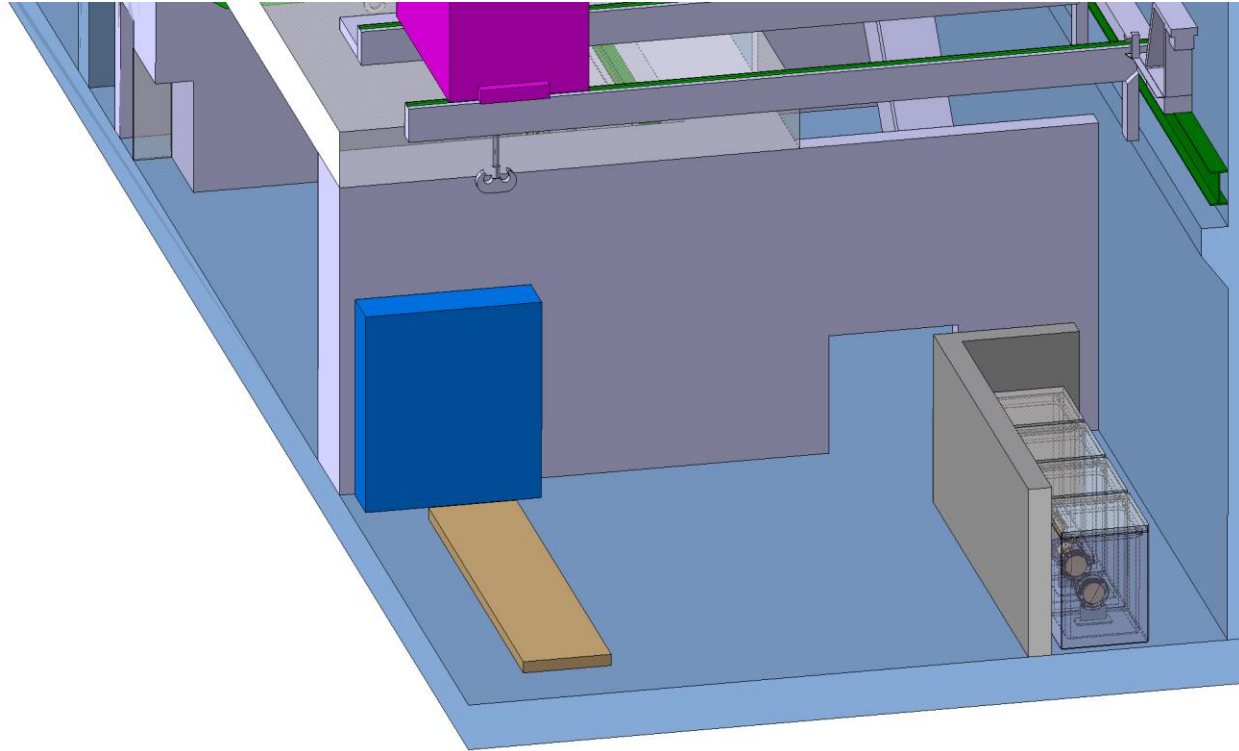
Loading storage/disposal containers onto the transfer trolley

Tentative process foreseen in the service cell



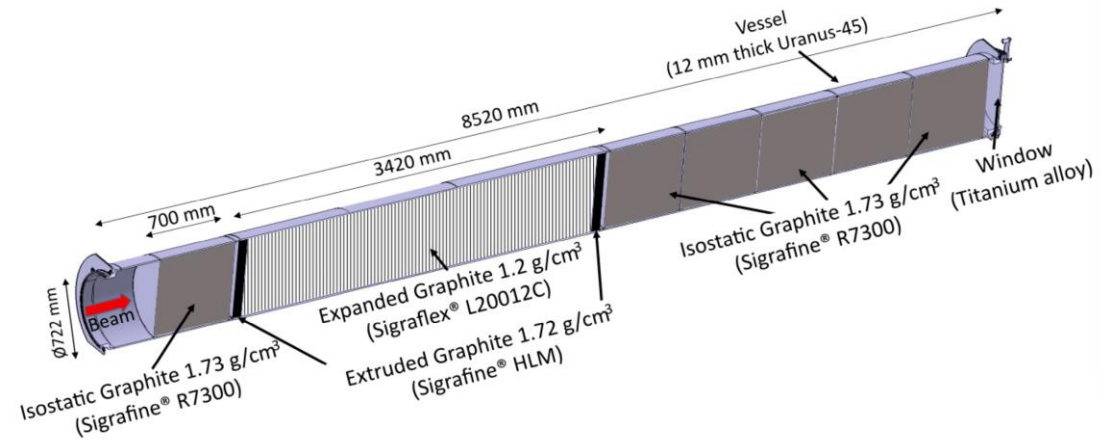
Moving storage/disposal containers out of the Service Cell

Tentative process foreseen in the service cell



Storage of storage/disposal containers in a buffer area

Similar packaging activities performed at CERN LHC TDE

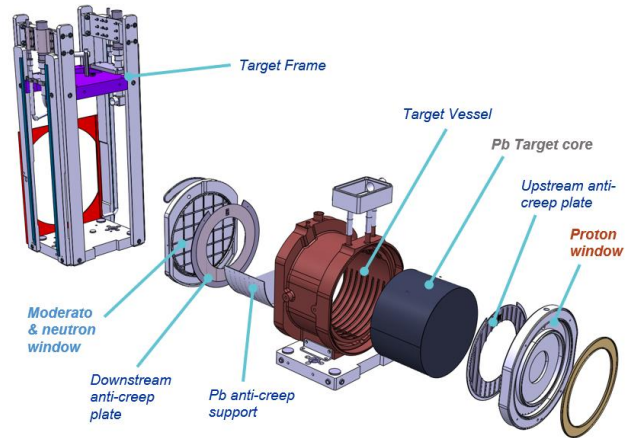
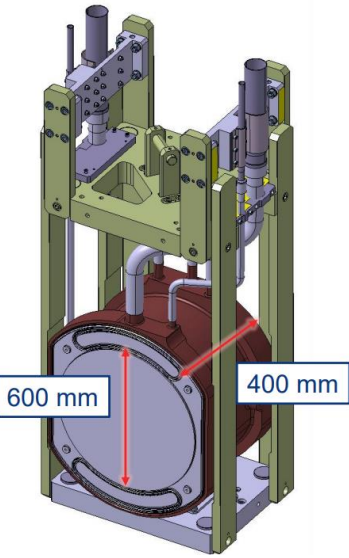


- Dedicated bunker built
- Equipment sliced in multiple parts to fit final repository container
- Samples collection for PIE



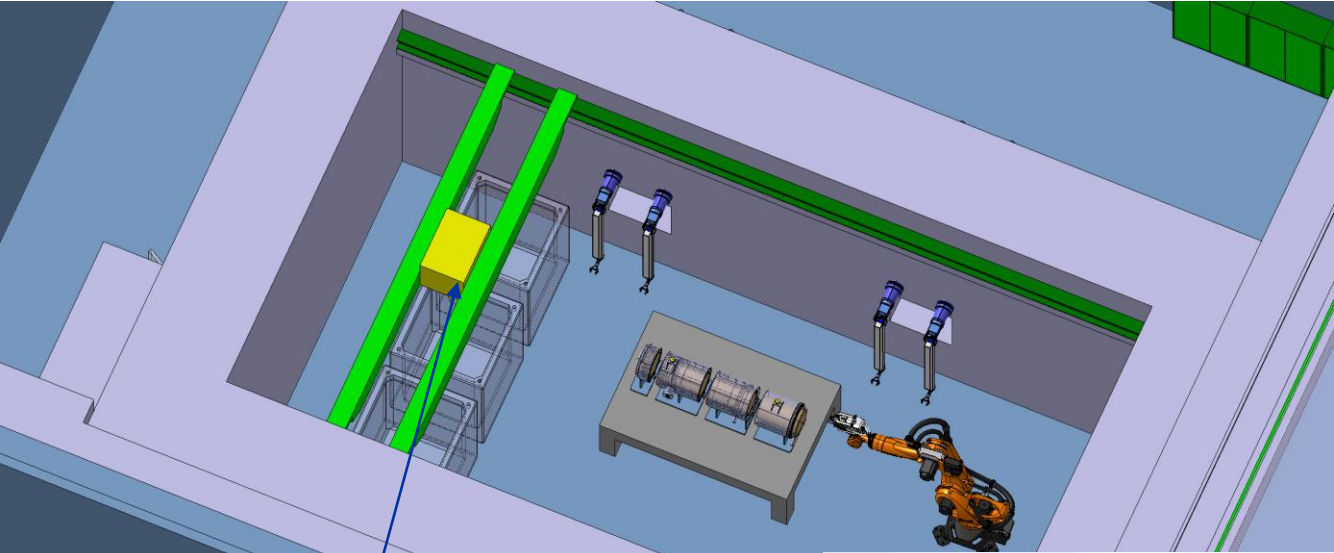
Similar packaging activities performed at CERN

n_TOF target #2



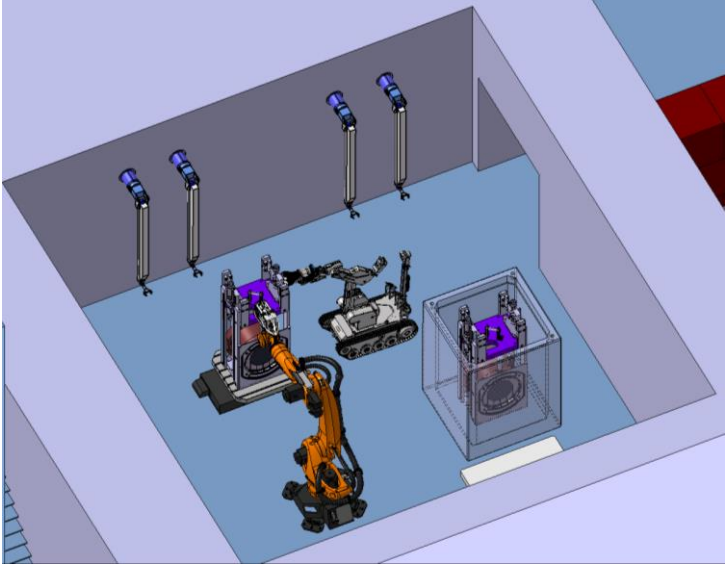
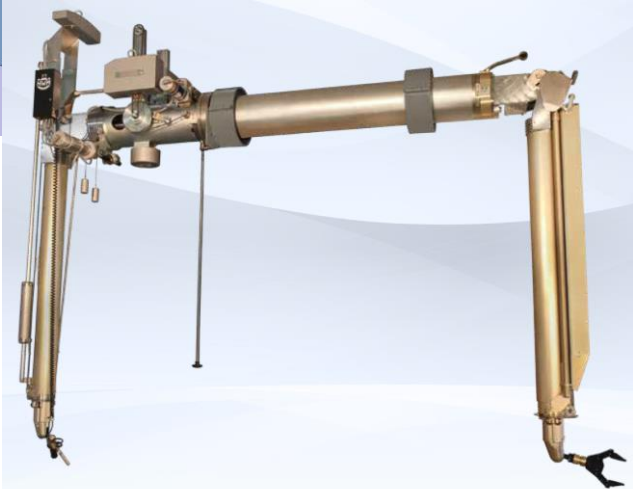
- Dedicated bunker built
- Machining with industrial robot
- Focused PIE with robotics tool

Service cell - Possible equipment - tools

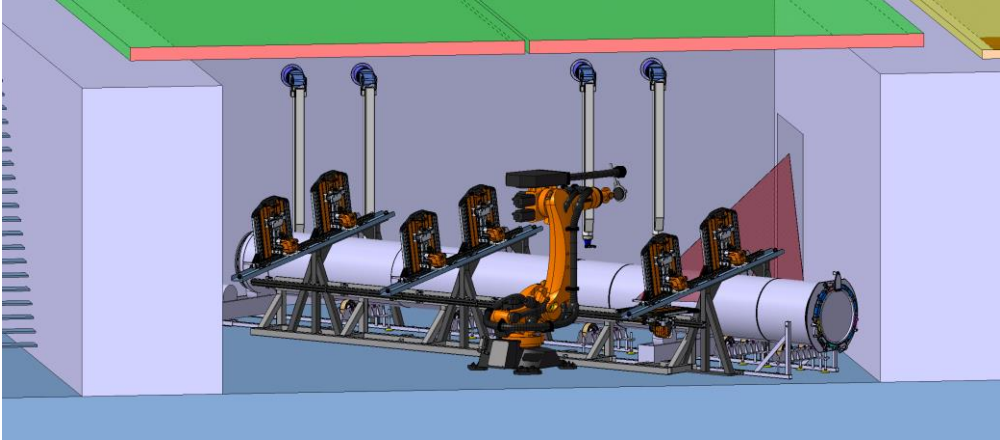


Overhead travelling crane

Master-slave manipulators



Robots (fixed and mobile)

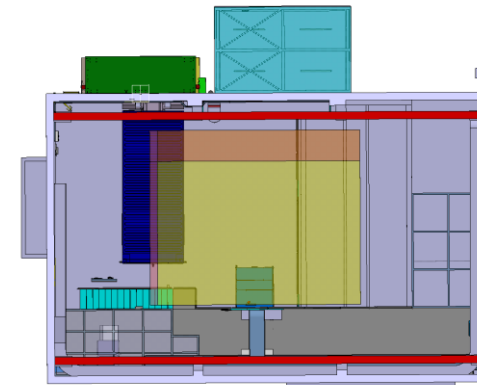
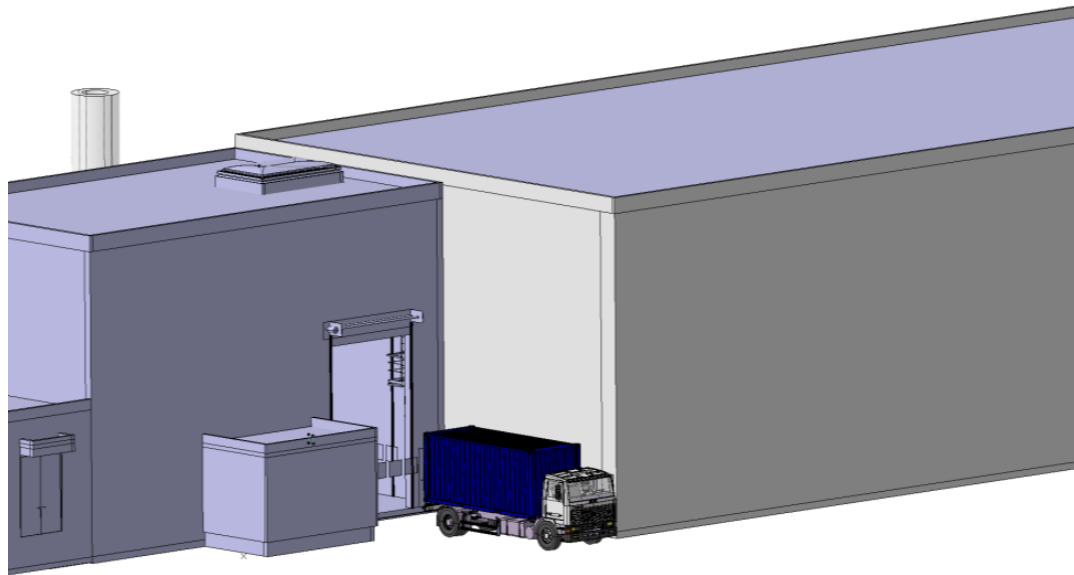


Custom built machinery

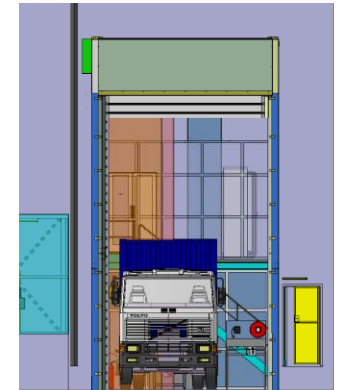
Possible robotic solutions in **S. Di Giovannantonio** talk

Toward a shipment of components for final repository

- Loading bay for certified transport container in building 911
- Any radioactive equipment needs to be packed according ADR* regulation before leaving the facility



Top view – IP-2 20'



Front view – IP-2 20'



IP2- 20' container

ADR: Agreement Concerning the International Carriage of Dangerous Goods by Road

Concluding remarks

- The **target service building** is being designed to host **utilities associated to the target station** (cooling, ventilation, control, safety system)
- We ensure **building integration** is coping with most demanding target configuration and fulfil needs of different sub systems
- We have established **tentative processes** in view of closing the lifecycle loop for the different components
- Associated **space and tools** to the close the **lifecycle loop** are incorporated in the facility

Following talks will explain in depth most relevant key features, challenge's, safety aspects, processes required for the facility



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