HIKECN3

HI-ECN3 Target complex

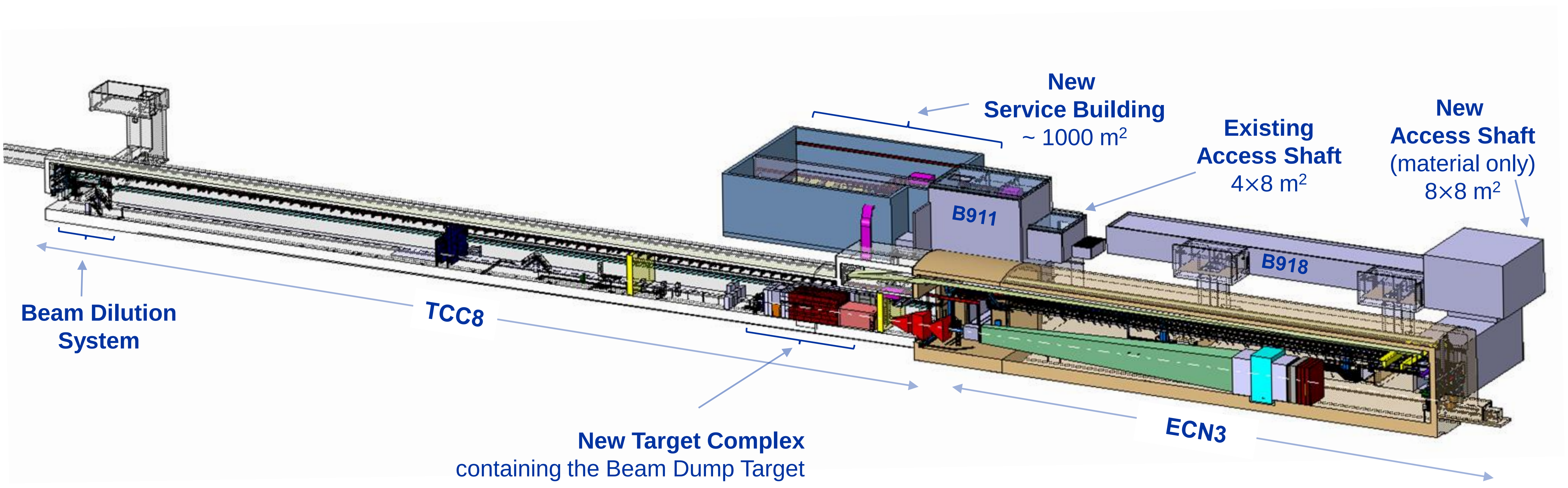
CERN – ESS exchange Lund 20th September 2024

Jean-Louis GRENARD - CERN - HI-ECN3 WP4 Target complex

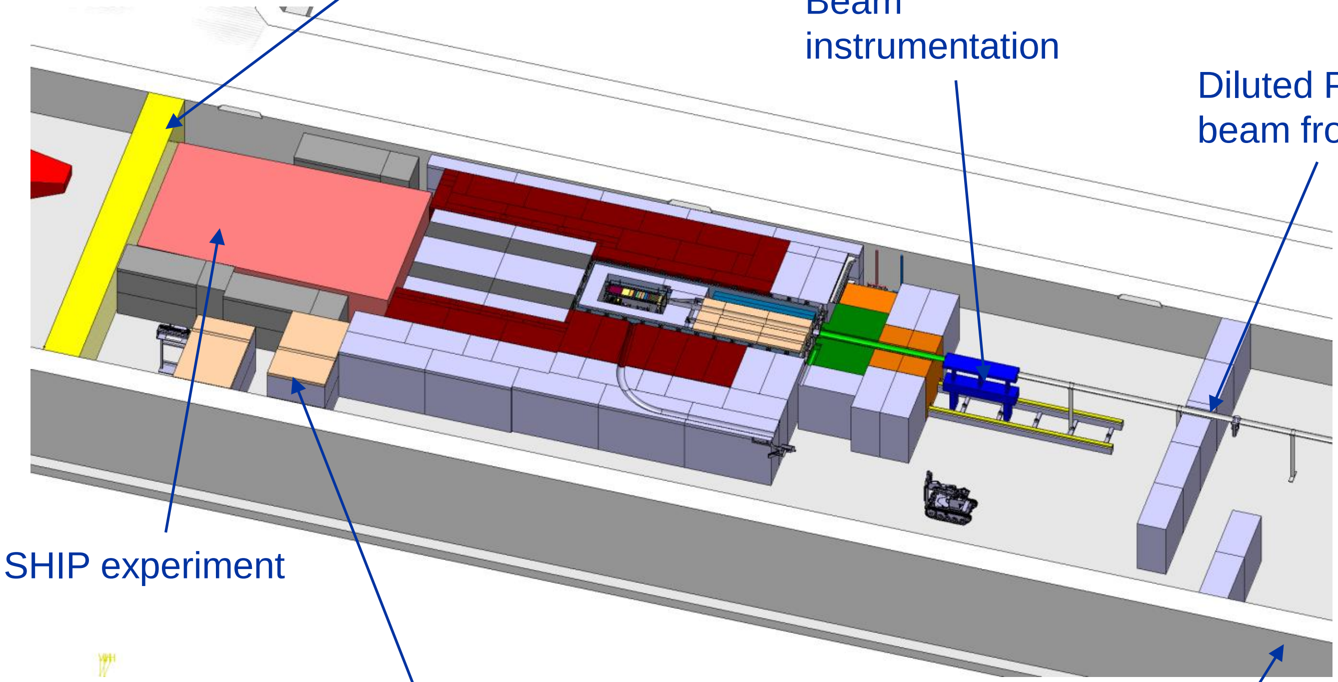
What do we call Target Complex?

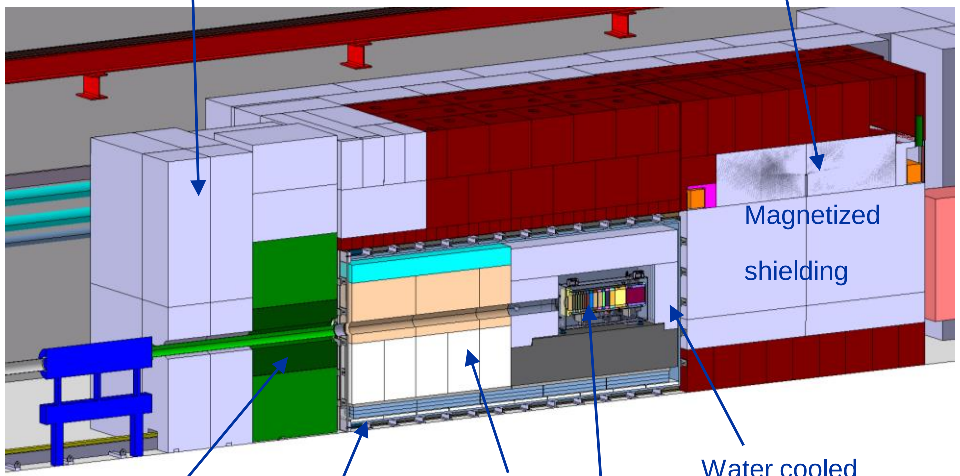
- **The target area**
  - Target station which contain the target
  - Associated shielding
  - The space to perform target maintenance activities (inspections, replacement, repair…)
  - Remote handling equipment (crane, spreaders, mobile robots)
  - Confinement(s)
- **The target service building**
  - Air handling units
  - Cooling stations
  - Controls systems
  - The space to perform preparation for target (and other activated components) final disposal and possibly post irradiation examination

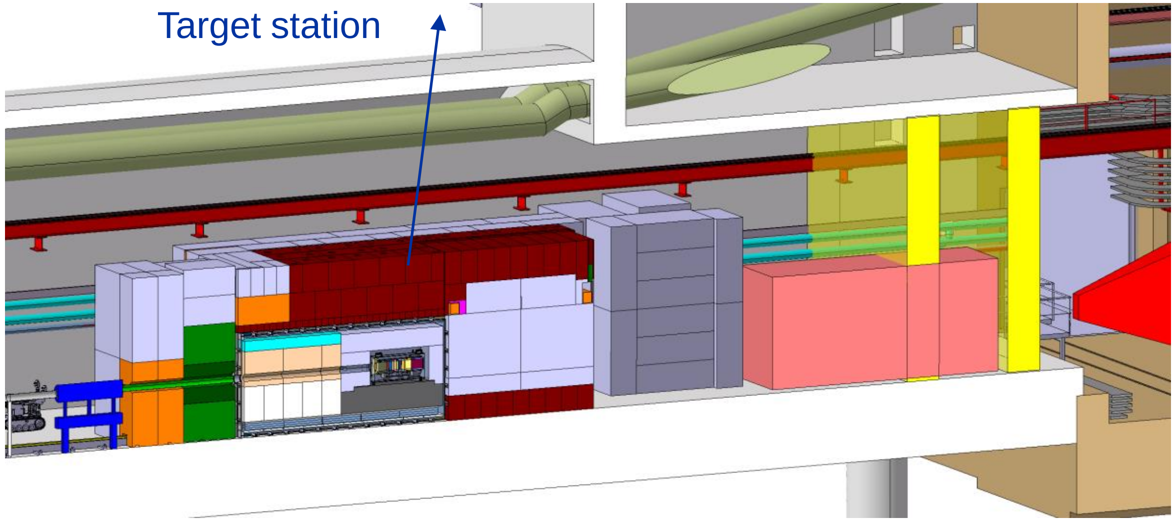
BDF/SHiP Target & Complex



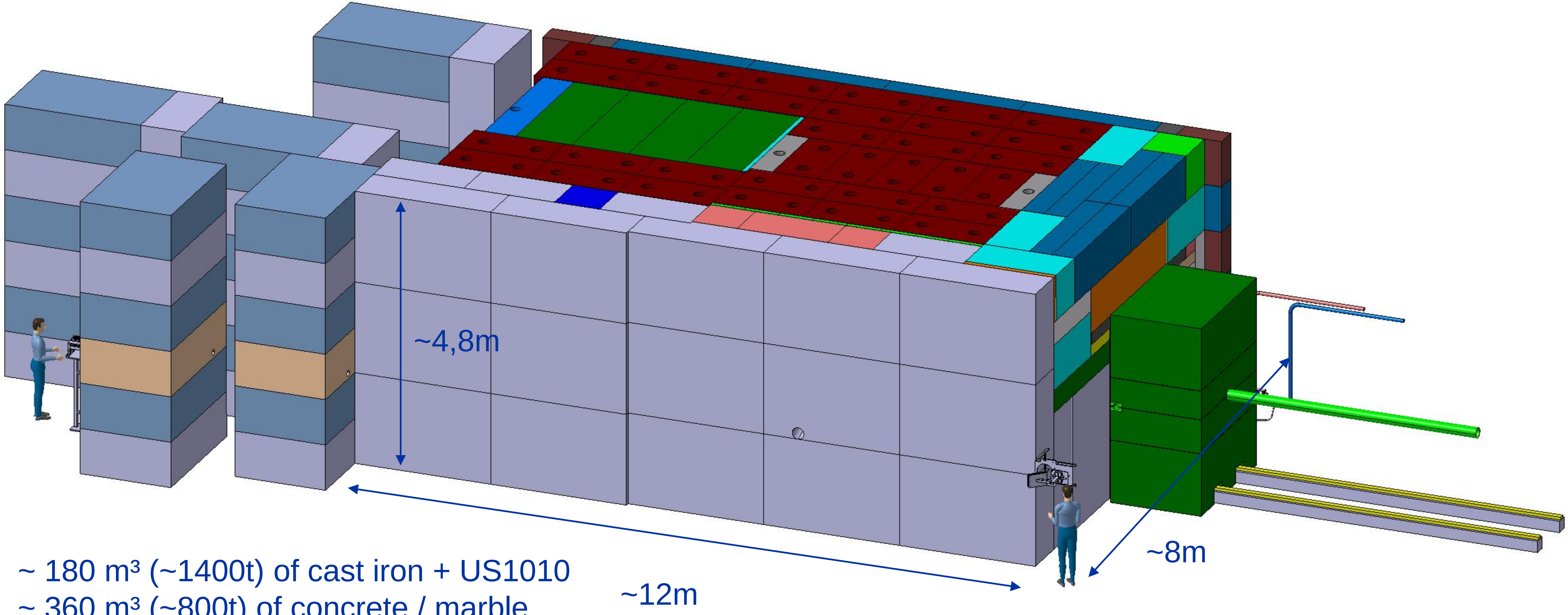
BDF Target complex integration





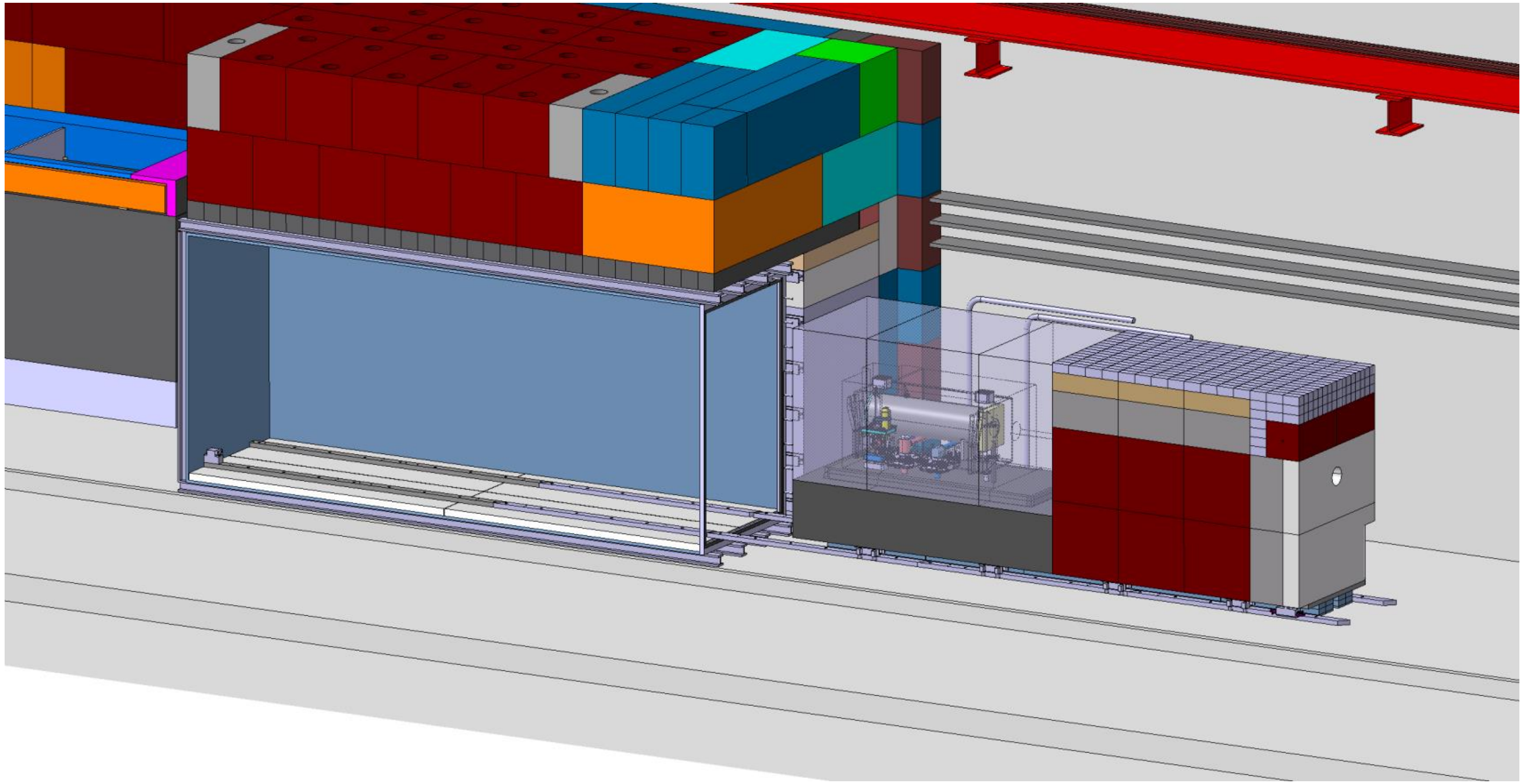


BDF Target complex integration - shielding

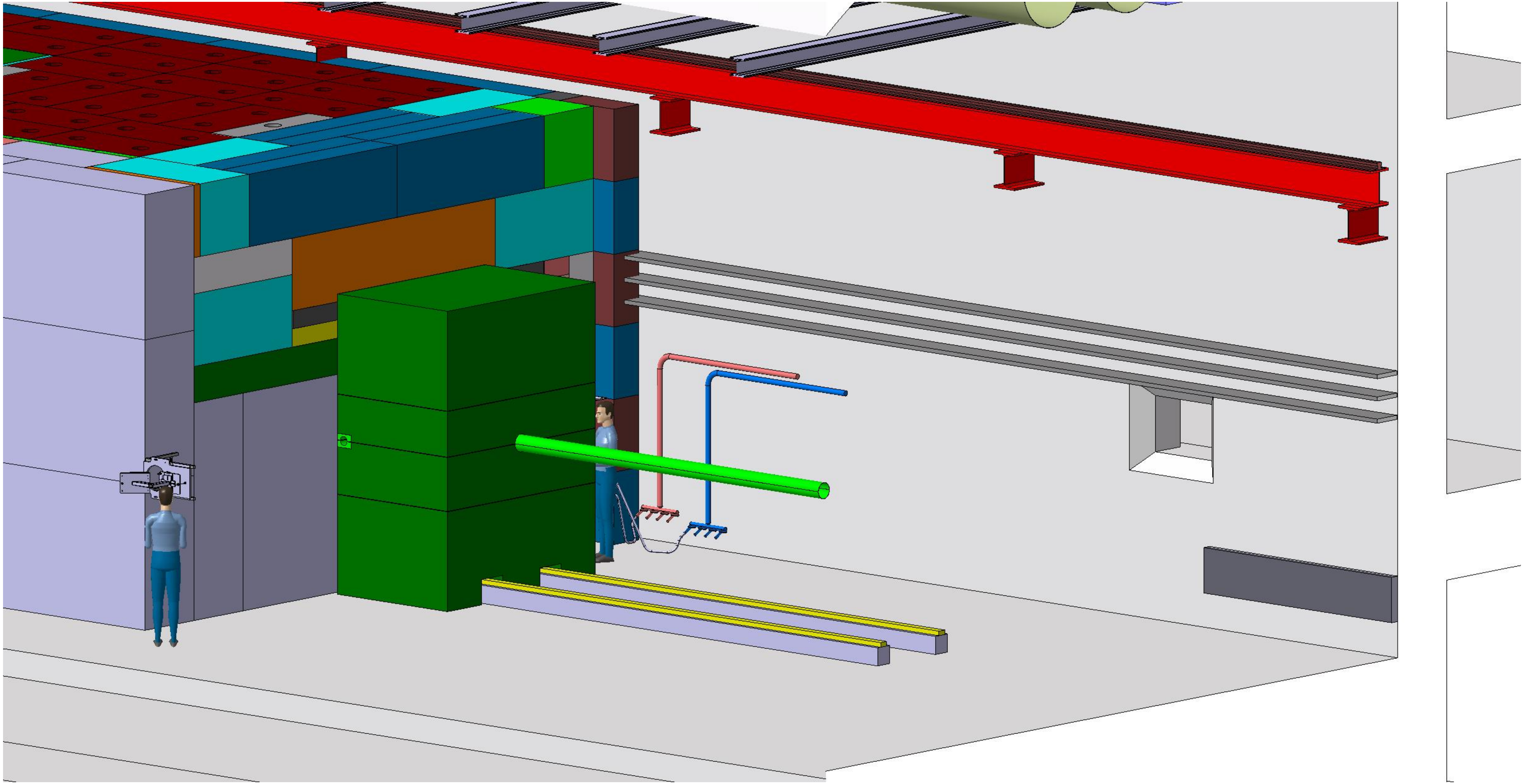


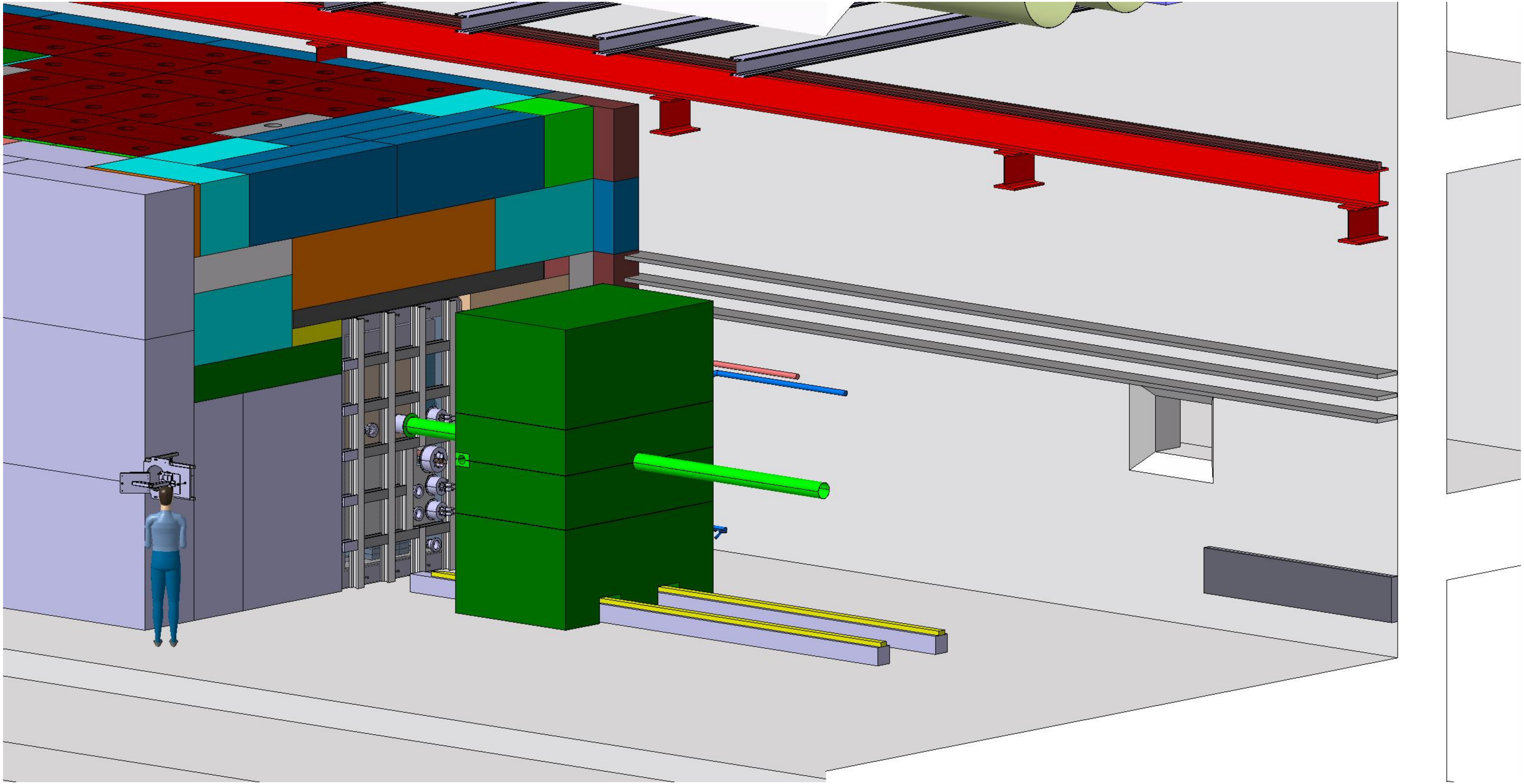
- ~ 180 m³ (~1400t) of cast iron + US1010
- ~ 360 m³ (~800t) of concrete / marble

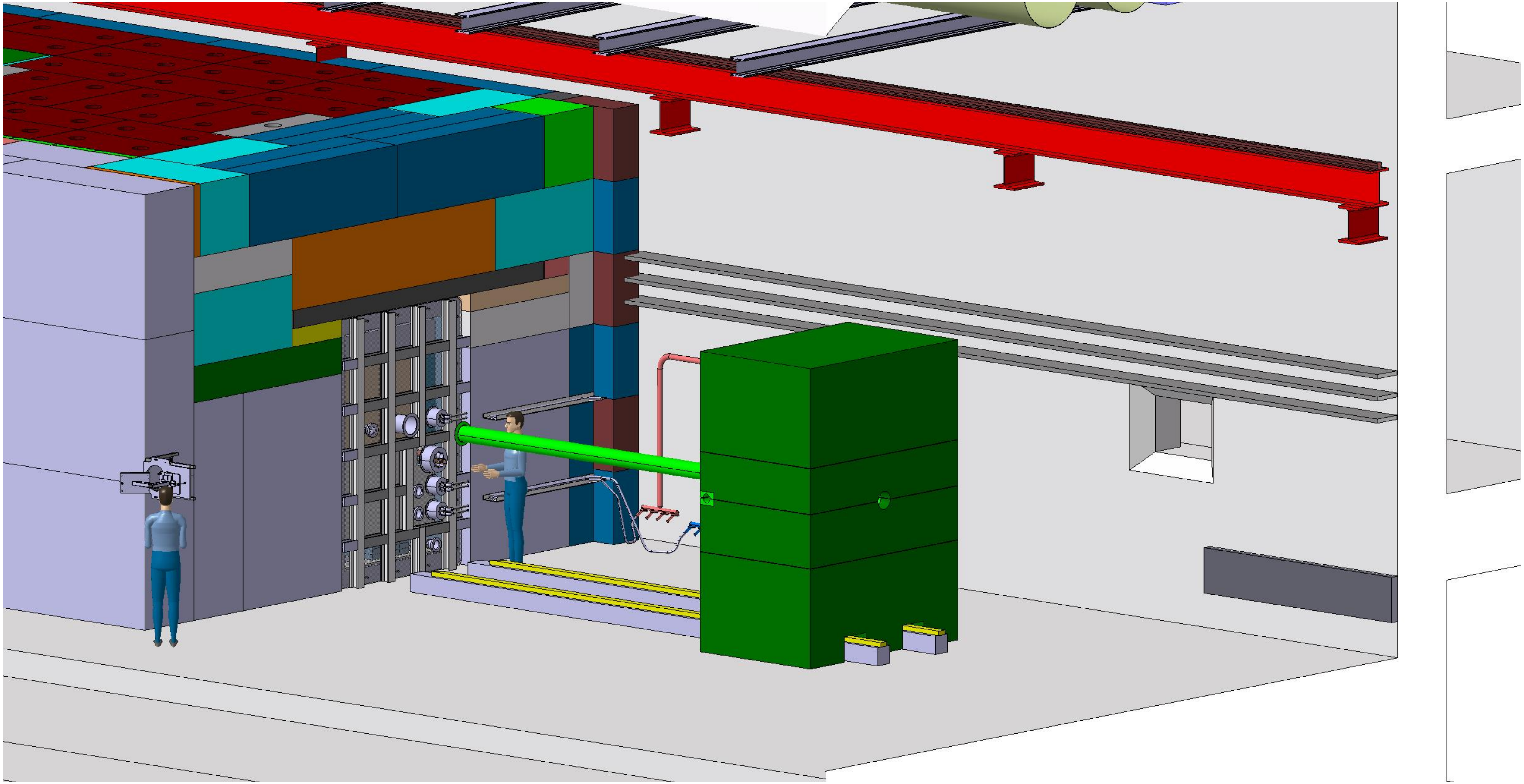
BDF Target complex integration extraction

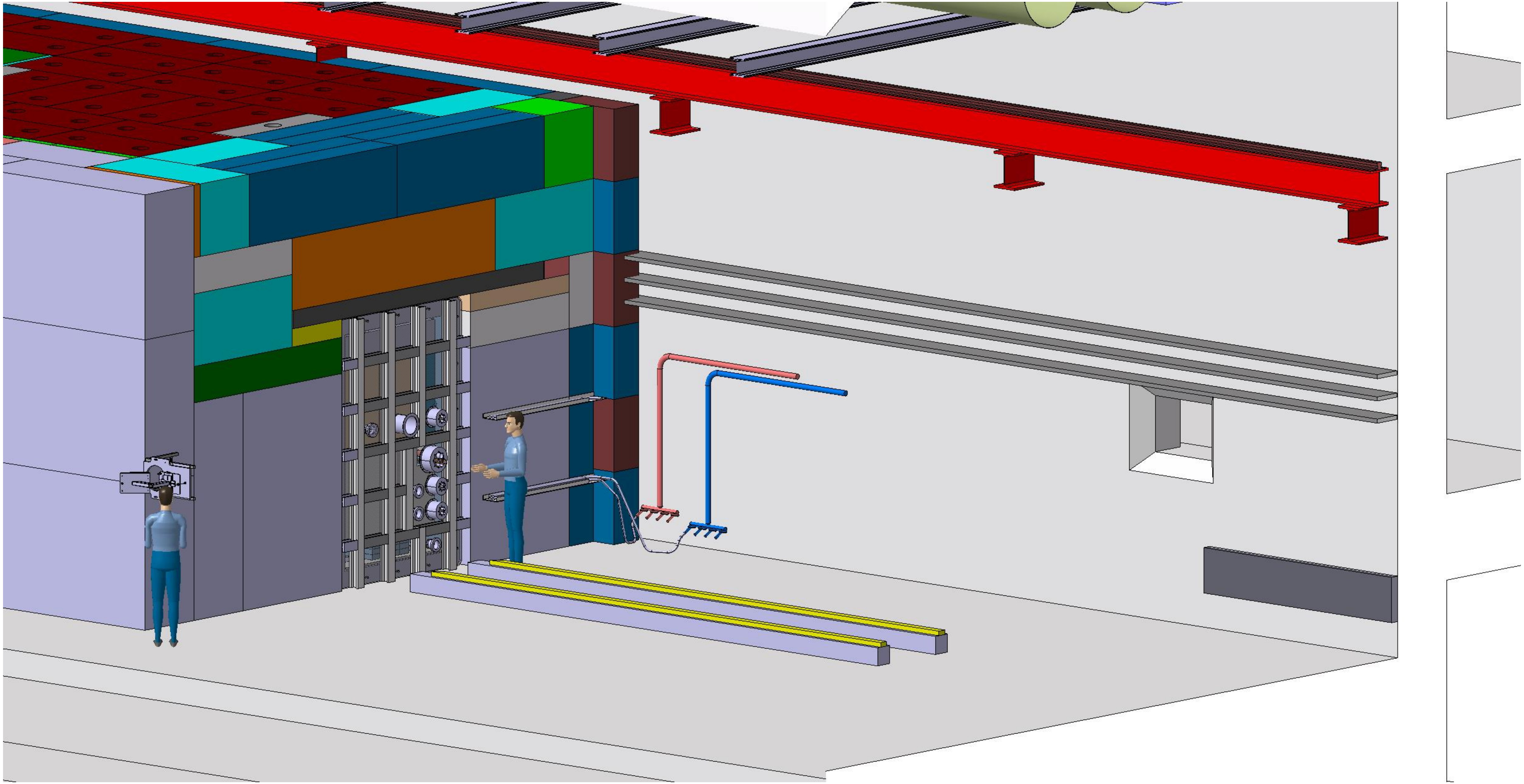


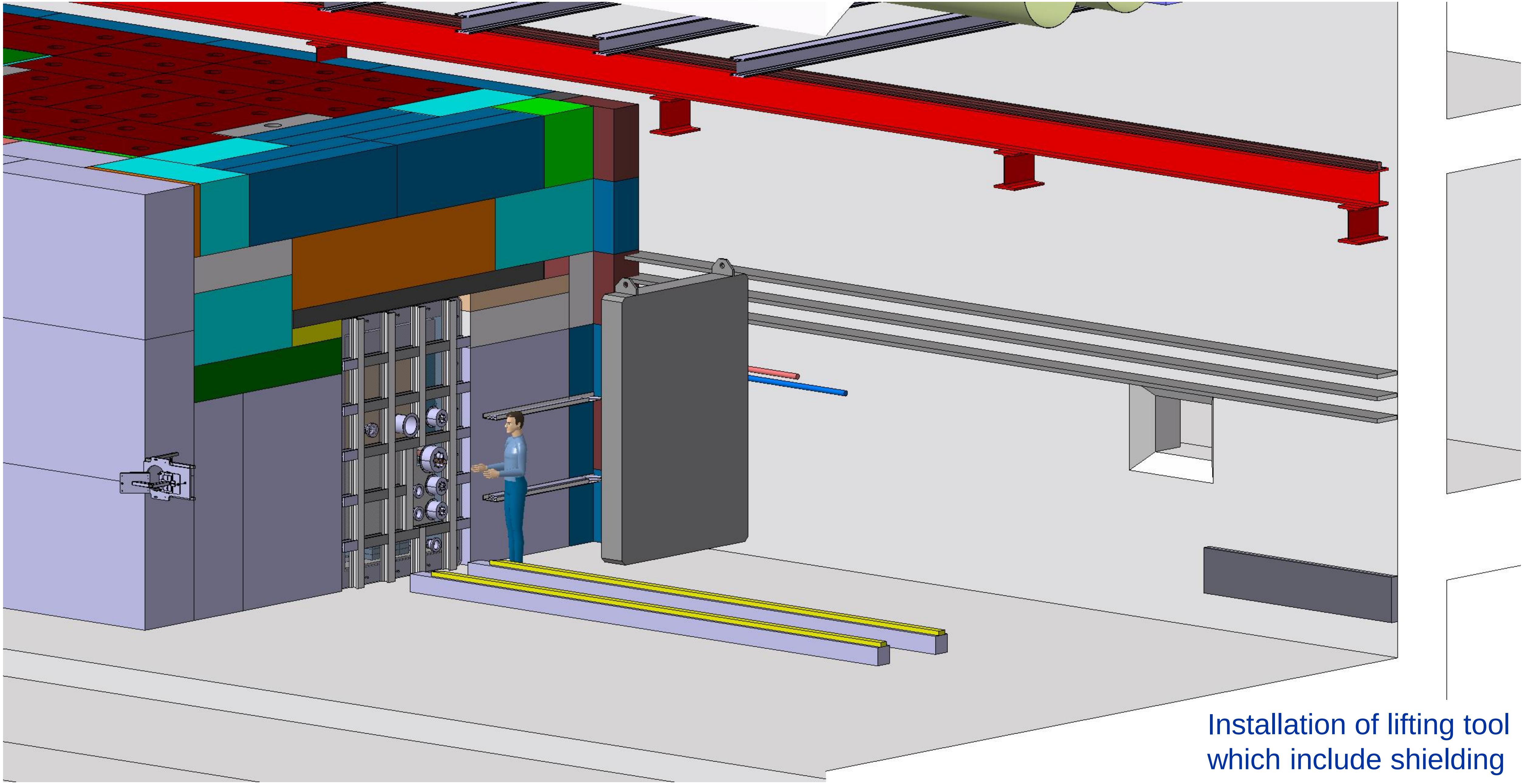
Concept similar to the ISIS target station



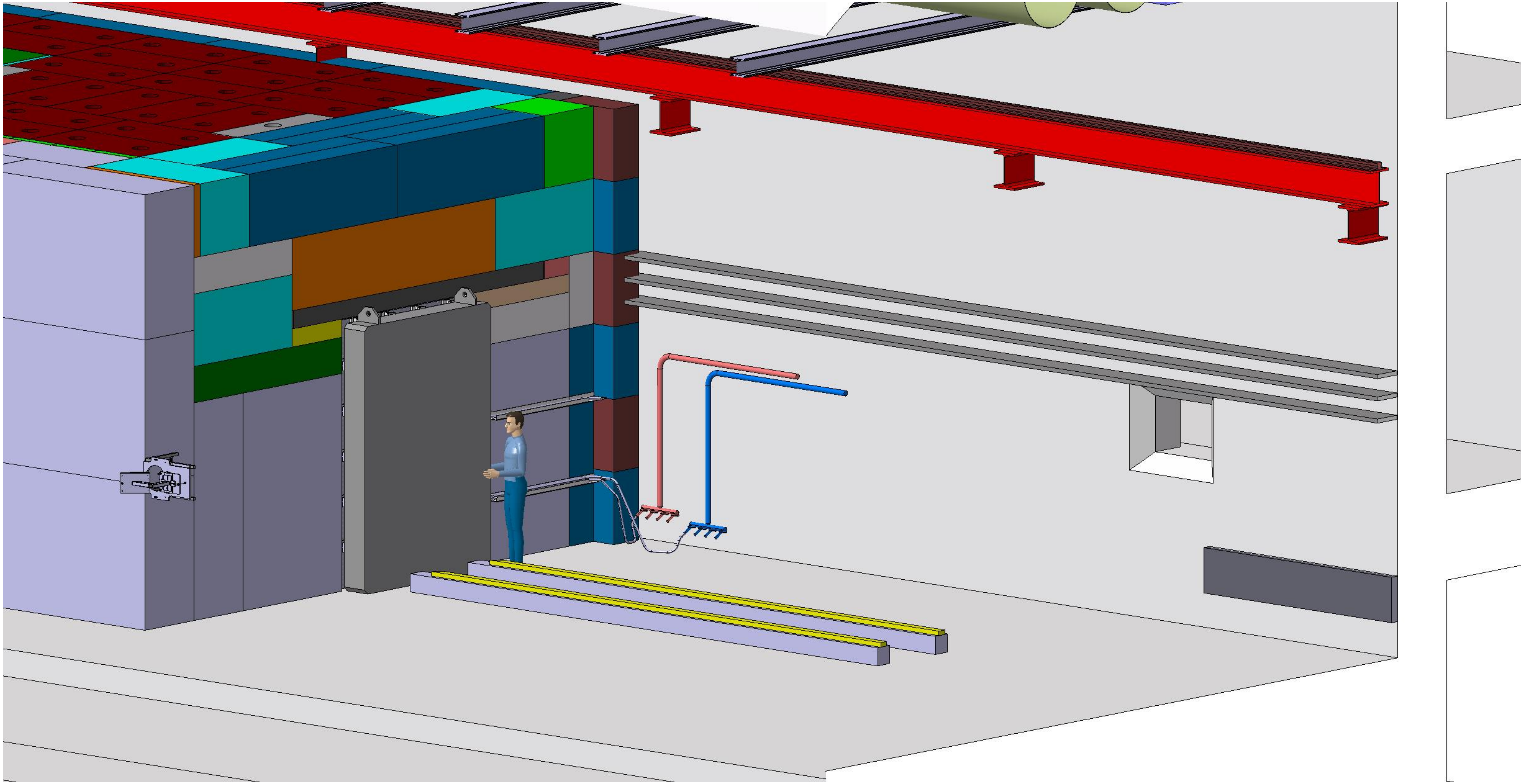


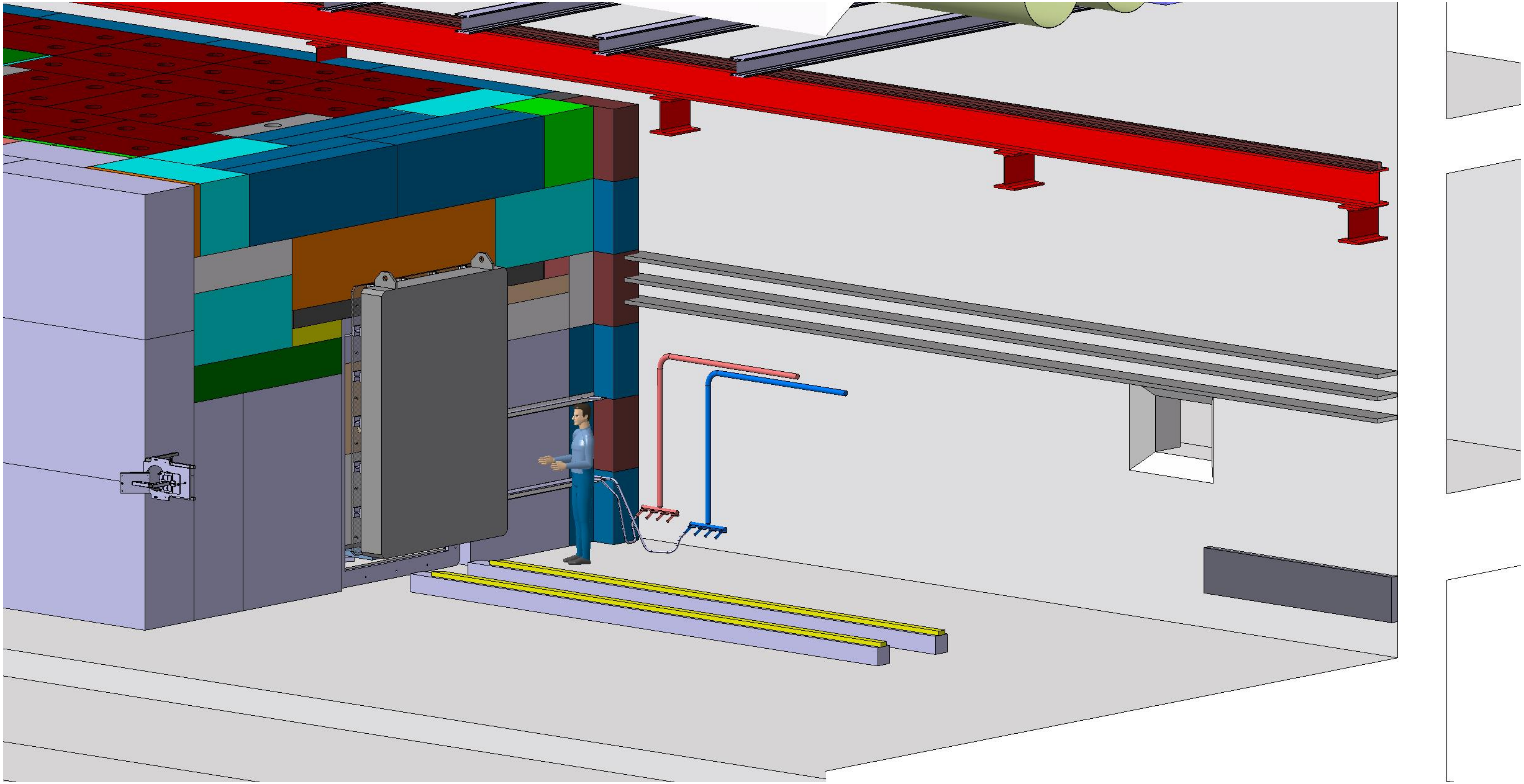


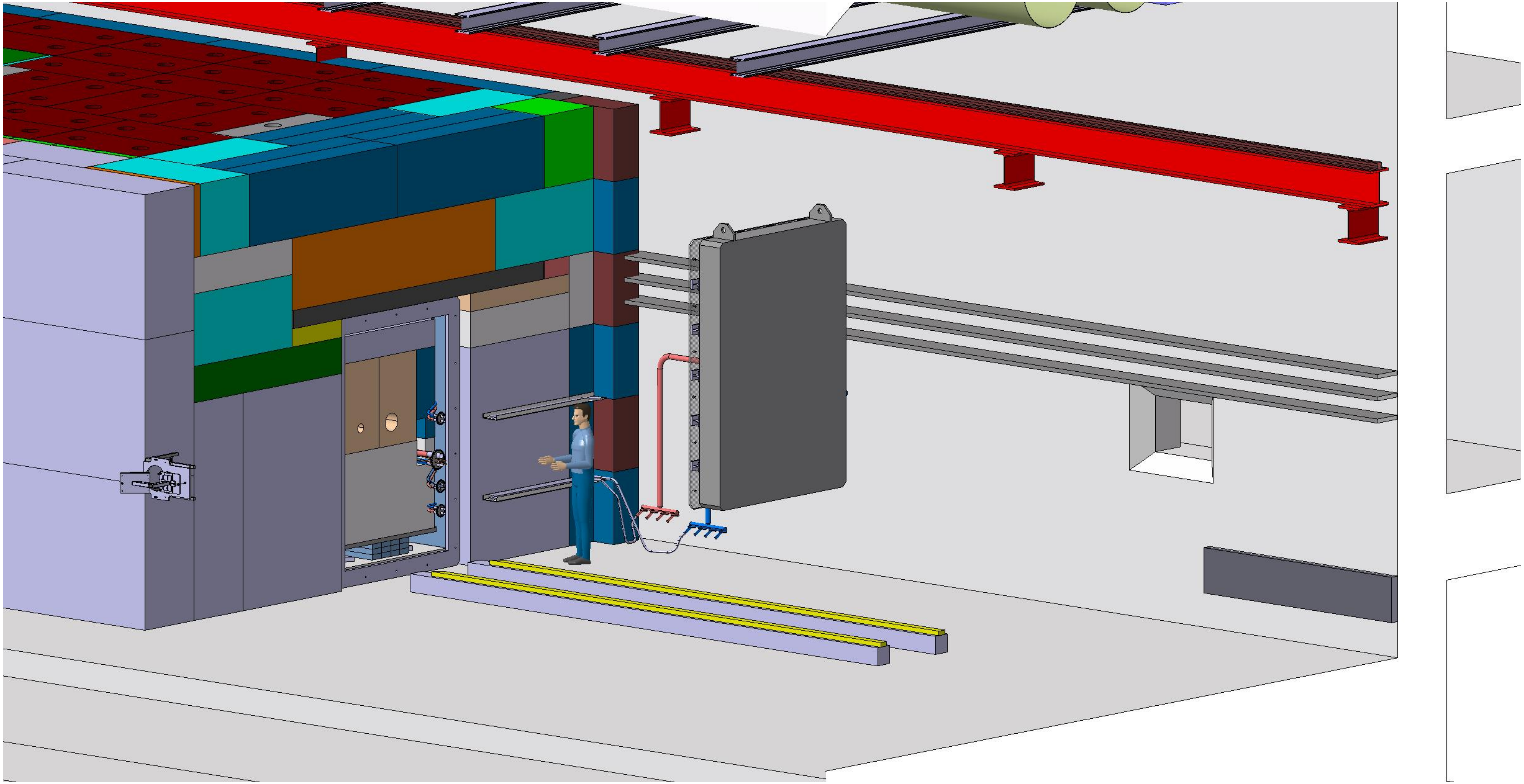


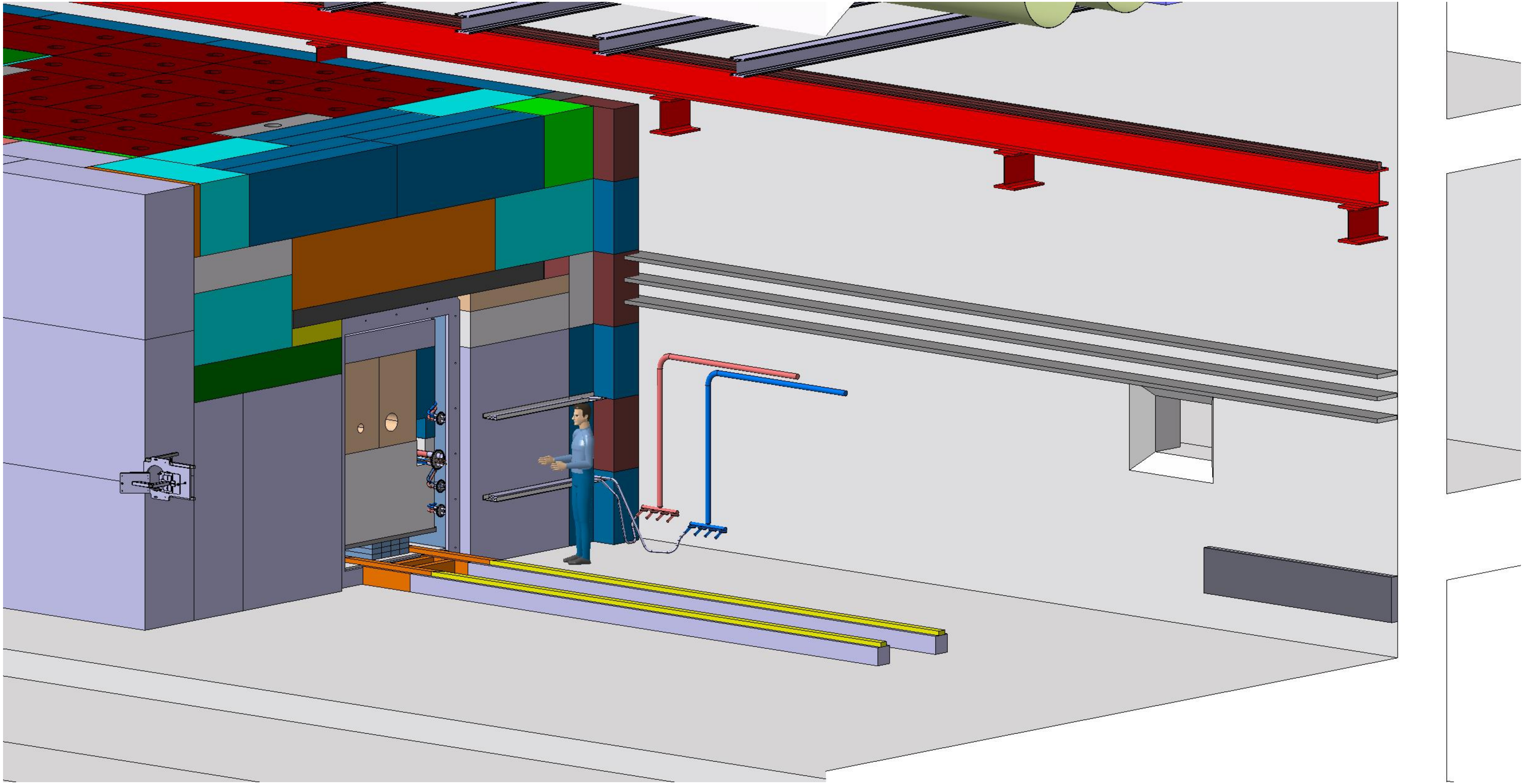


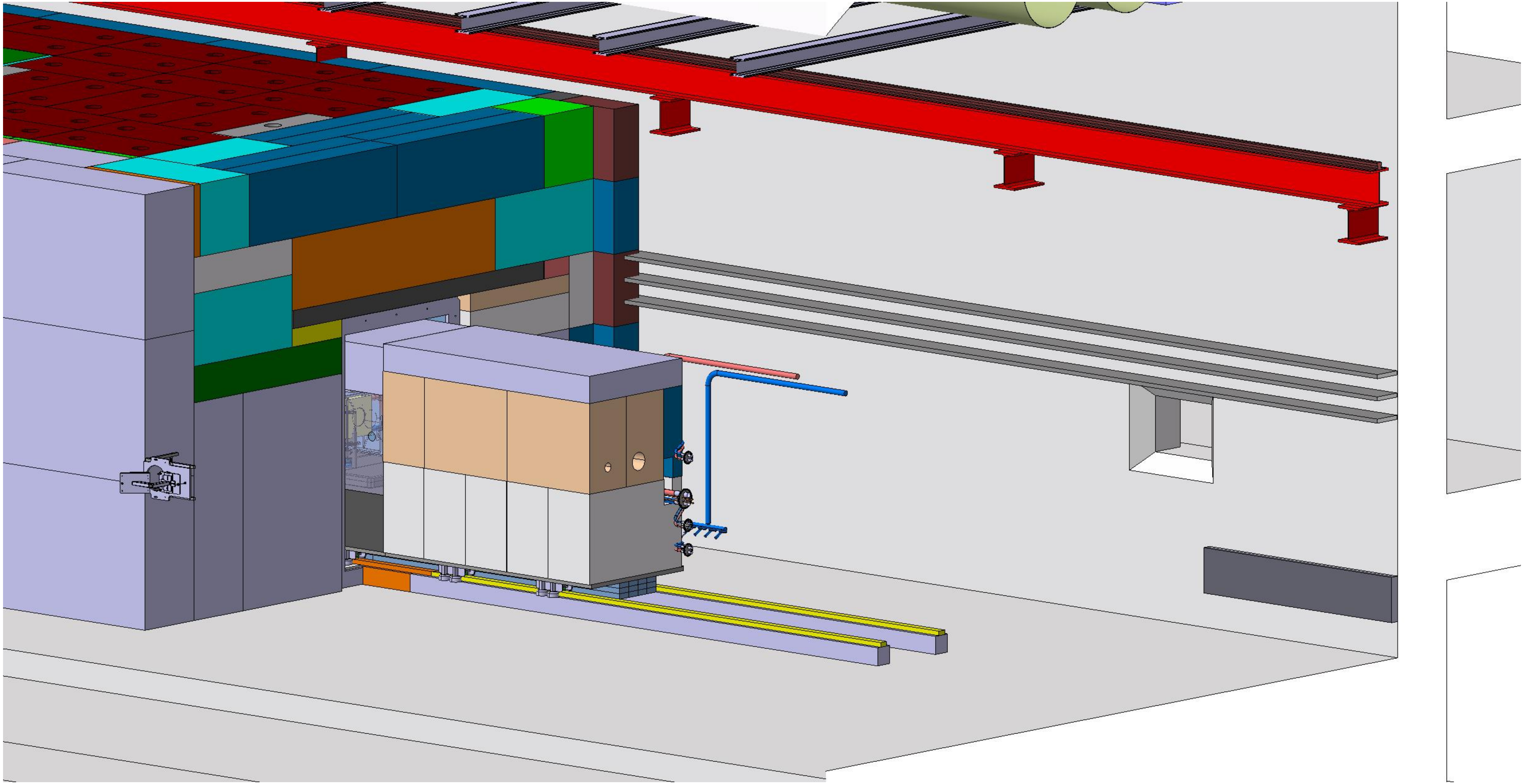
Installation of lifting tool which include shielding

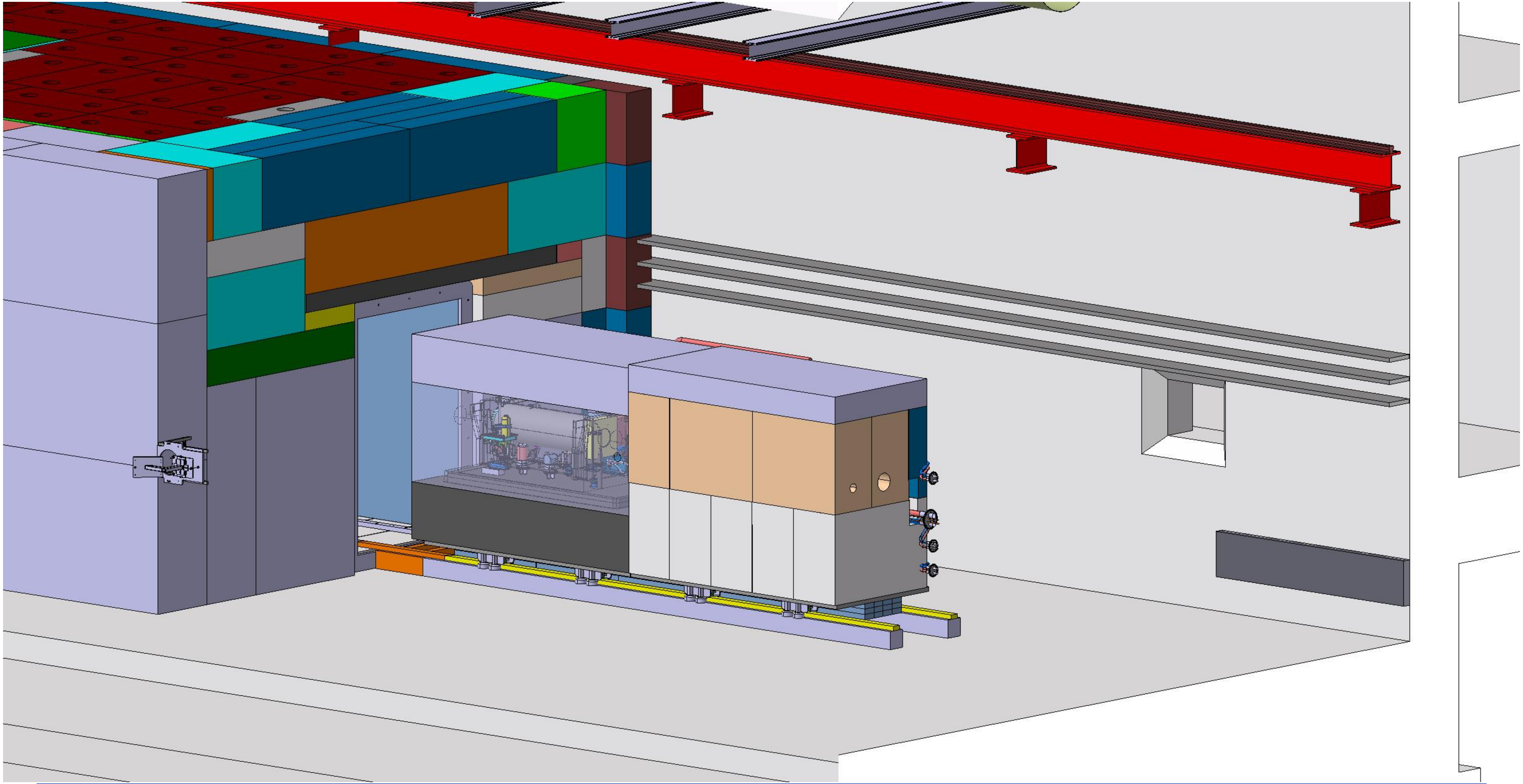


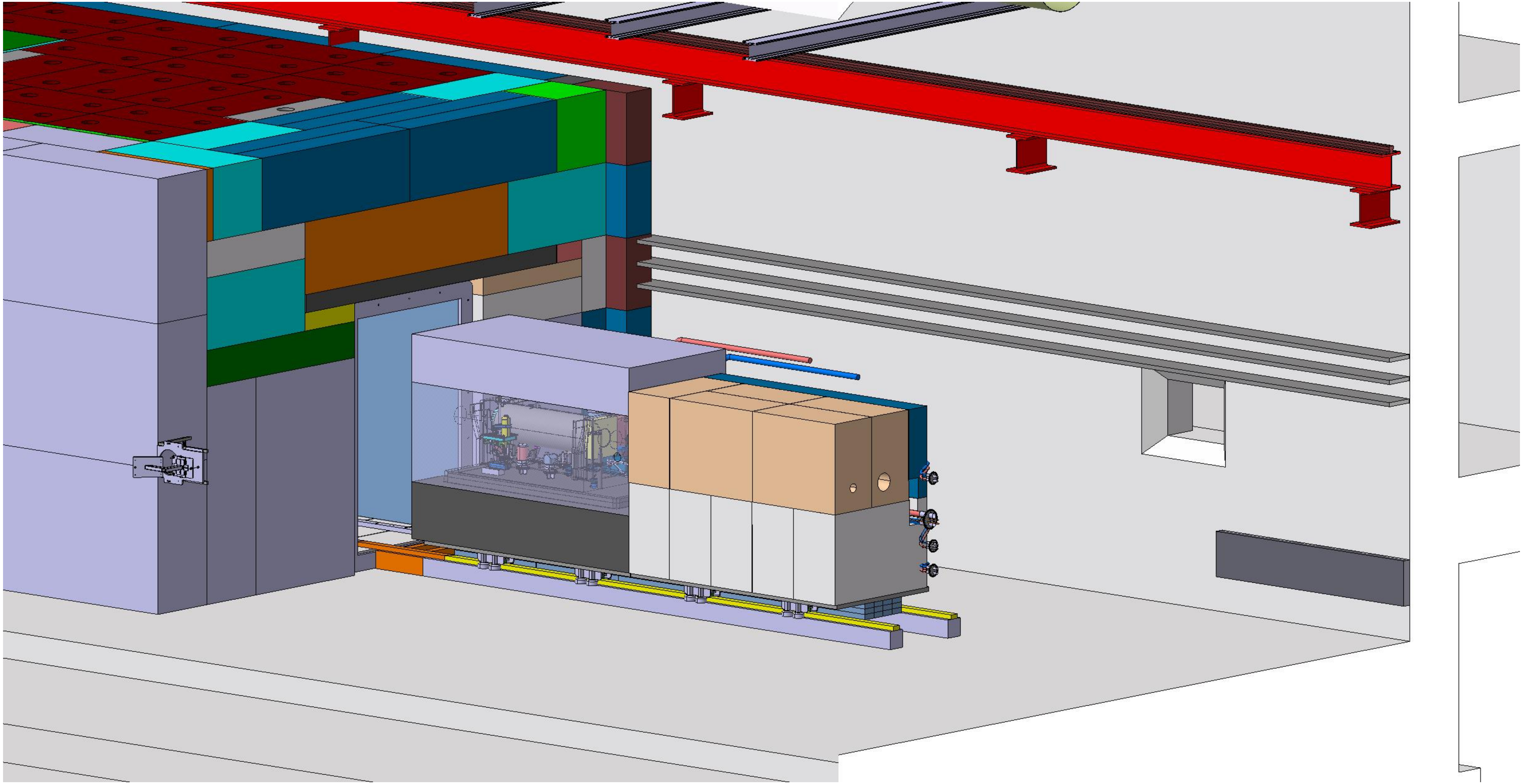


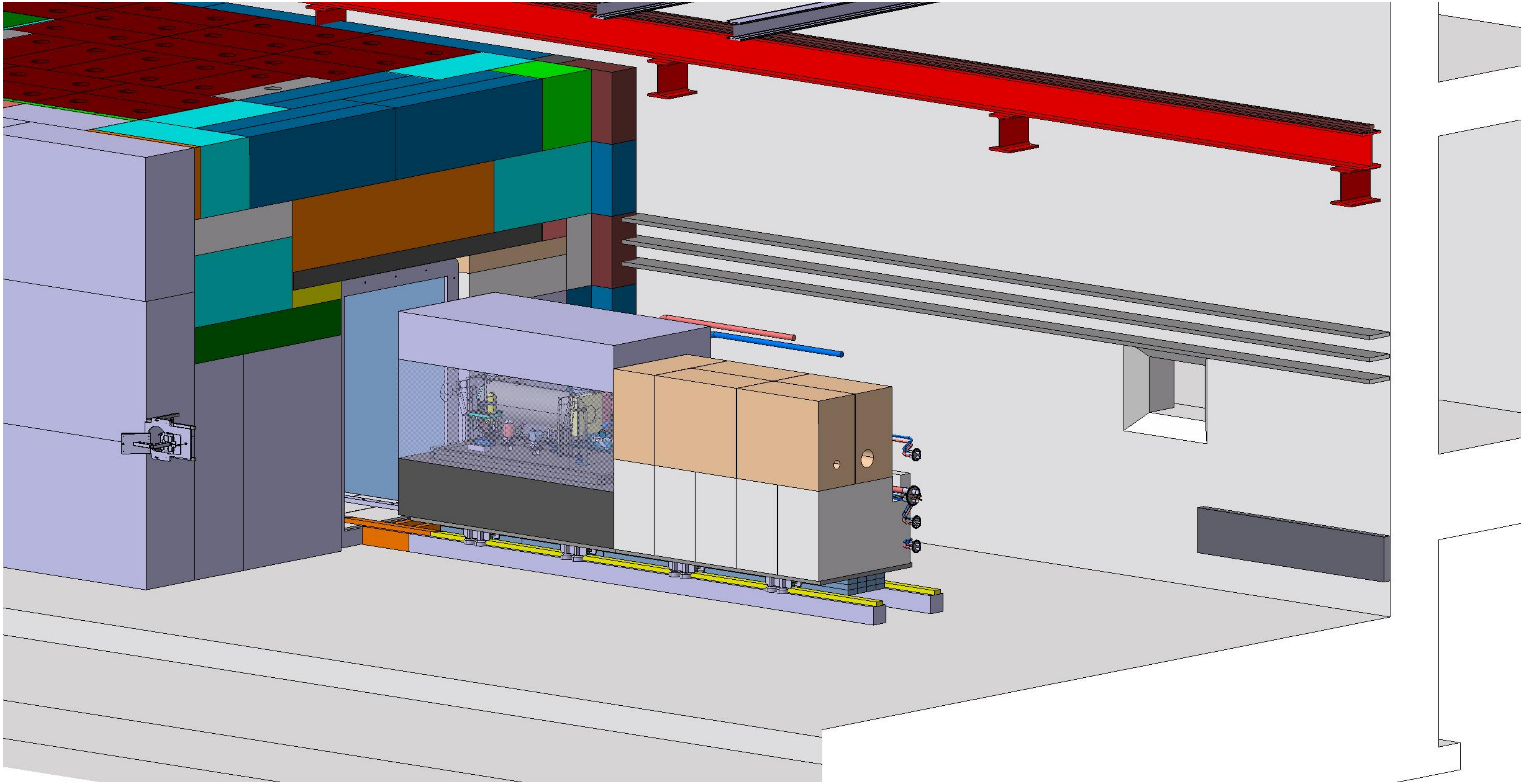


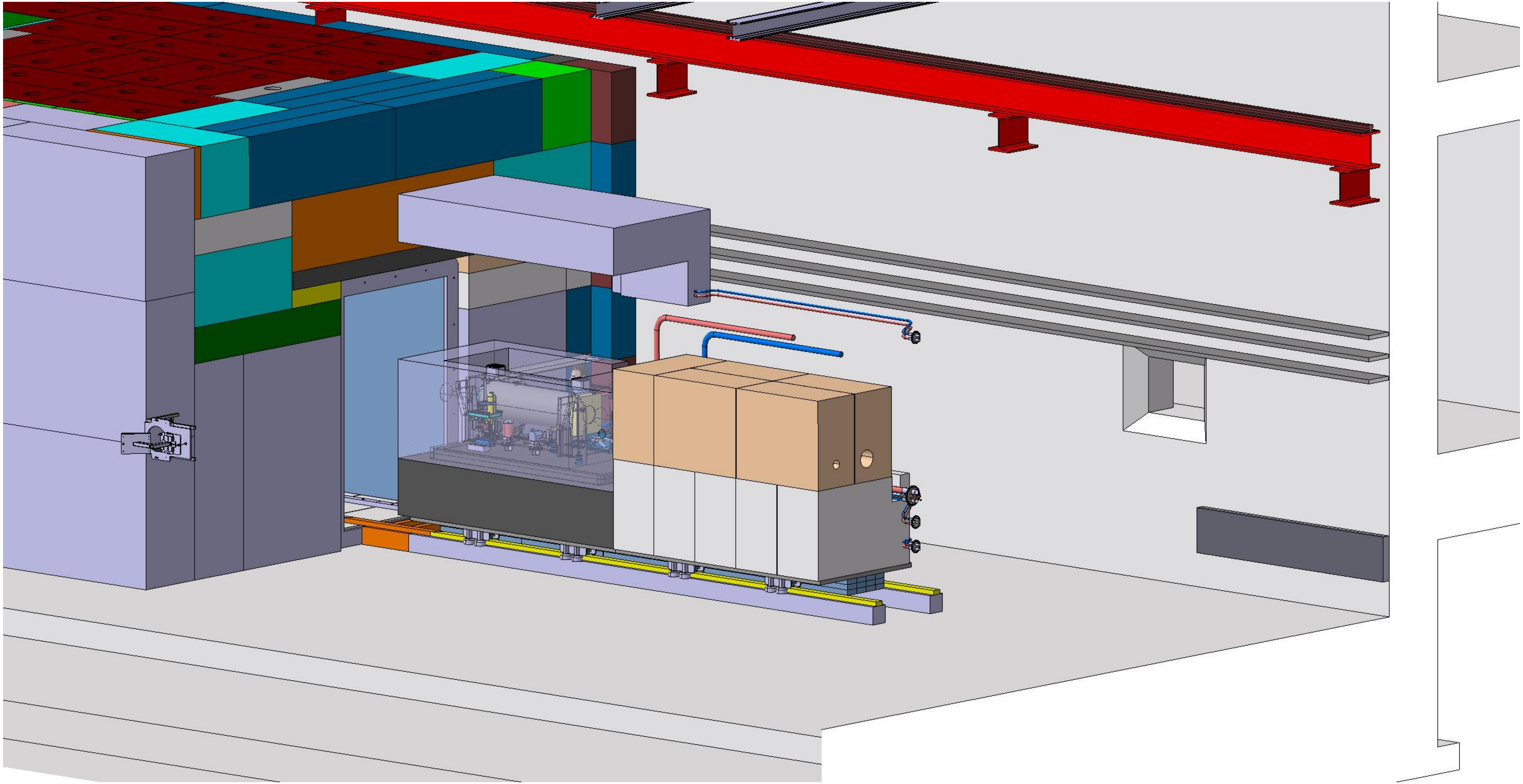


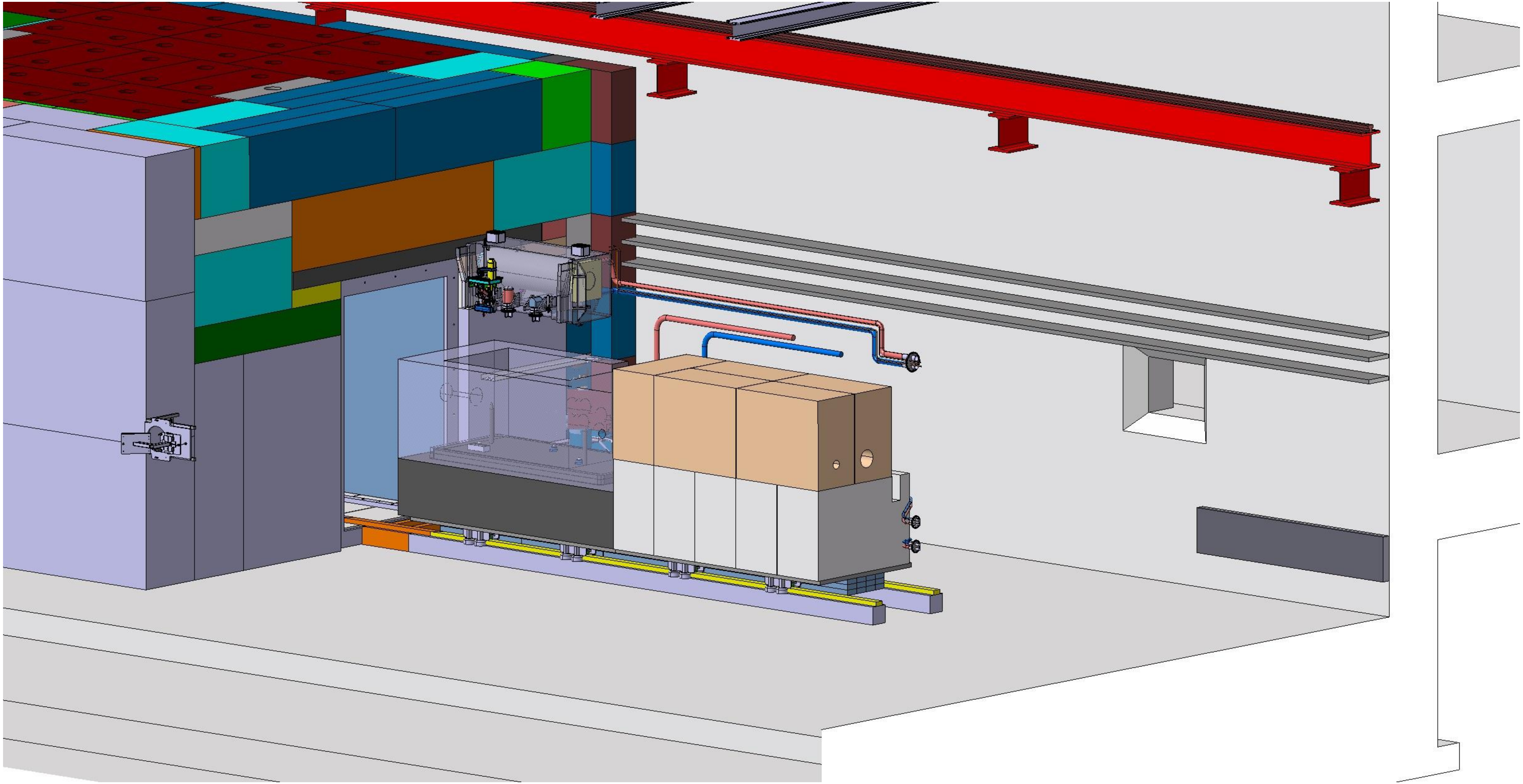




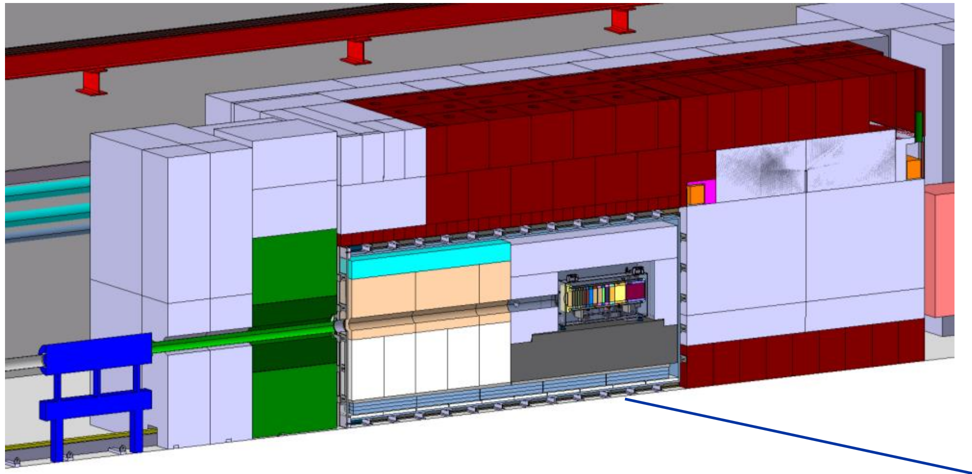


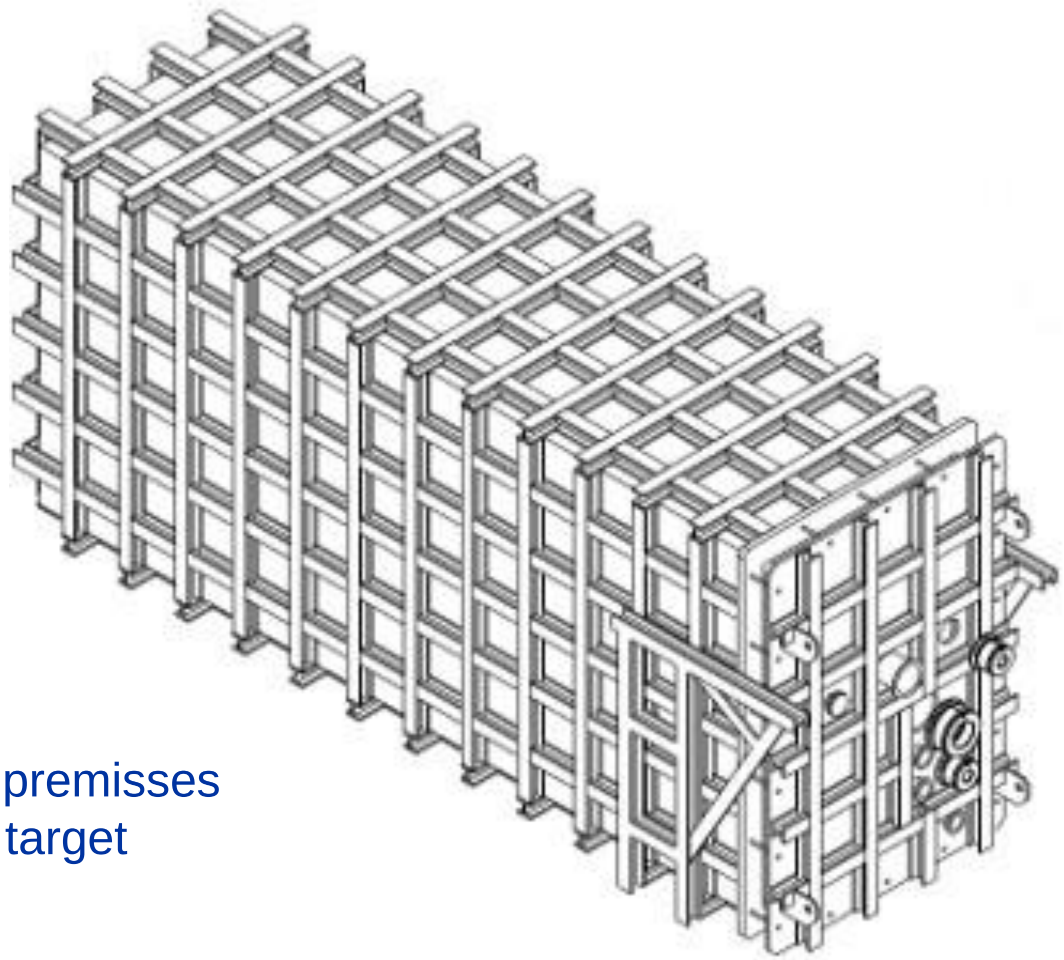






Target station vacuum confinement

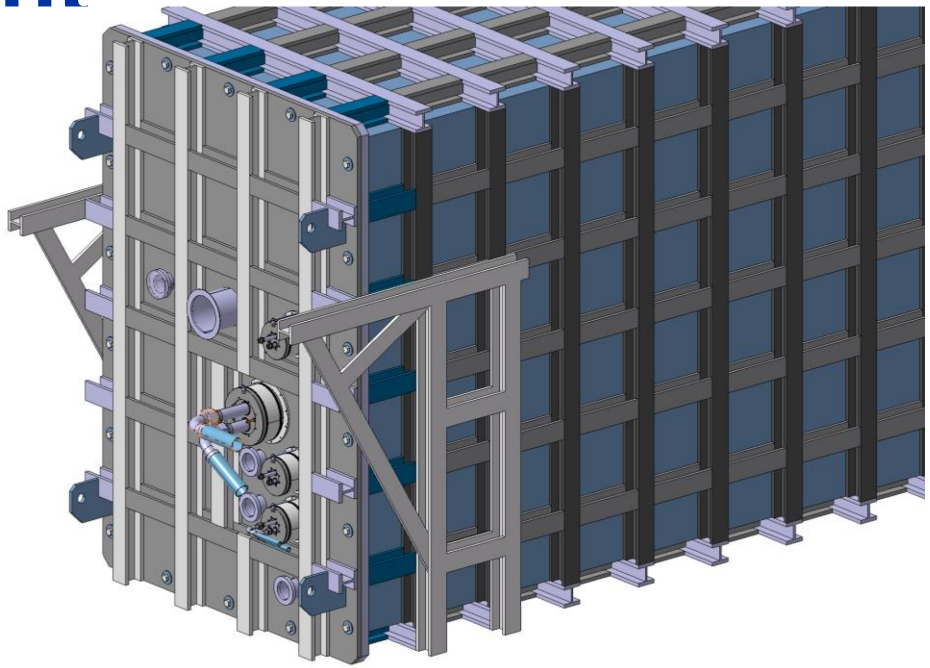


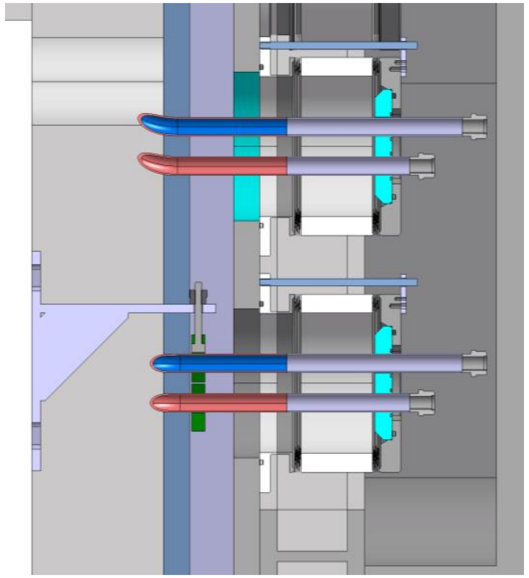


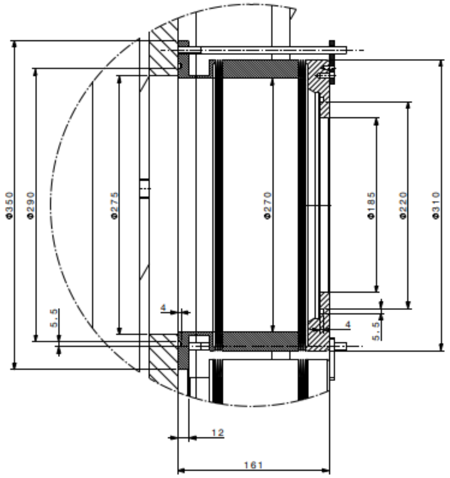
- Overall dimensions: ~6.36 x 2.05 x 2.95 m
- Can be fully fabricated and tested at a contractor premisses
- Primary vacuum to optimize air activation around target
- (Water containment in case of water leak)

Target station vacuum confinement

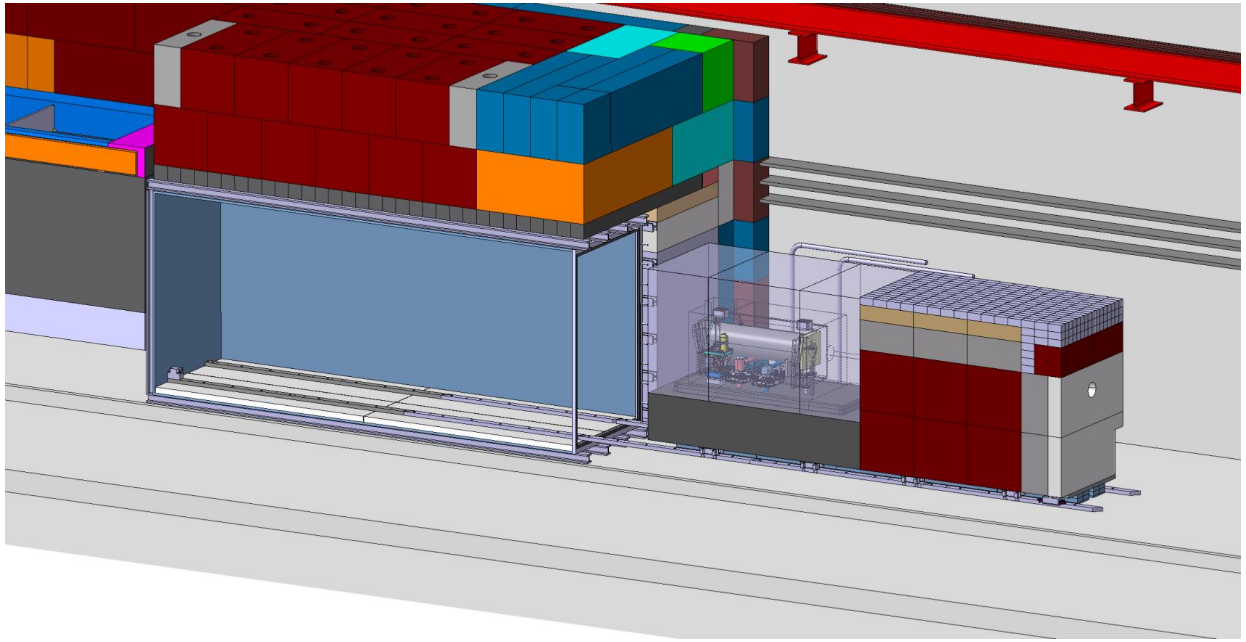
- Utilities feedthroughs
- Mechanical design ready to build a prototype
- Design of radiation tolerant gaskets
- Decommissioning plan

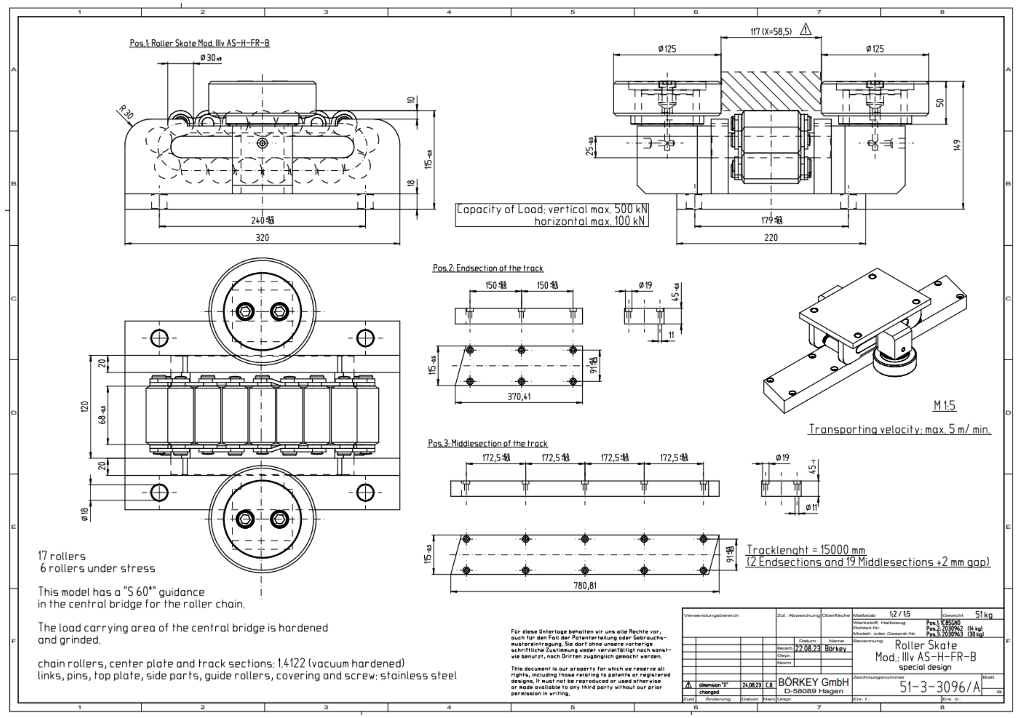






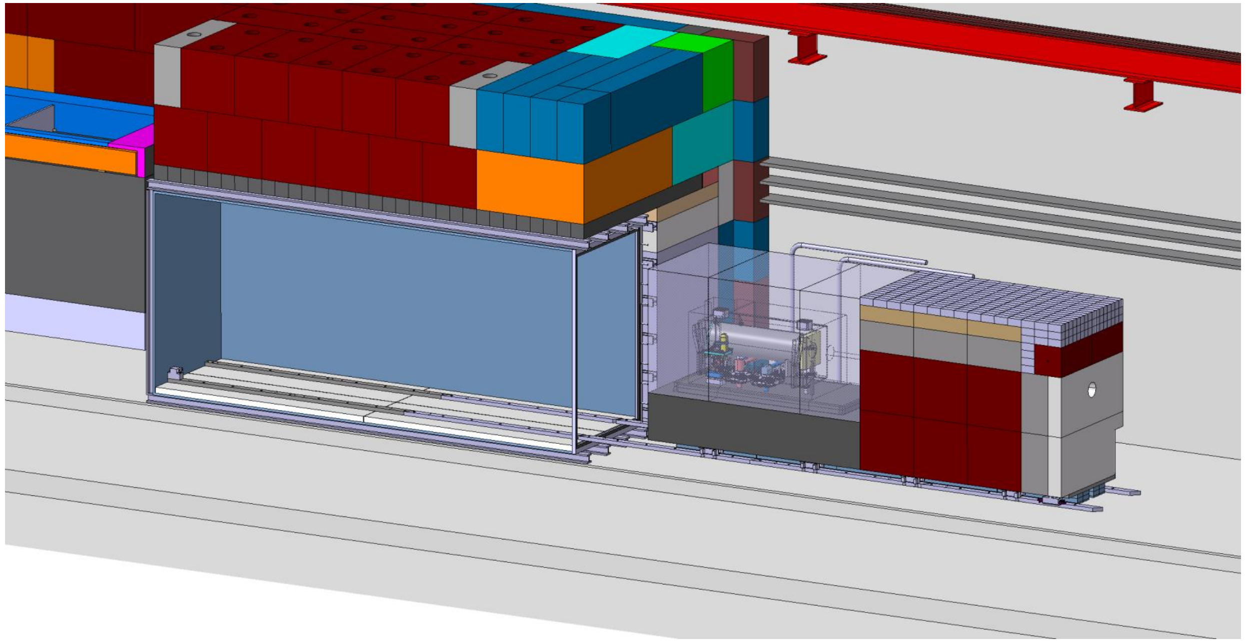
BDF Target complex integration extraction

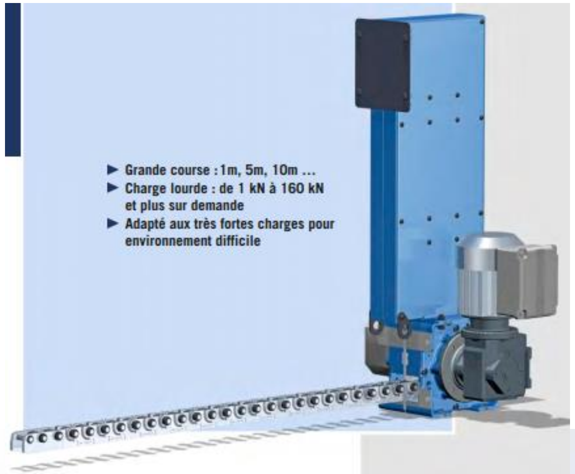


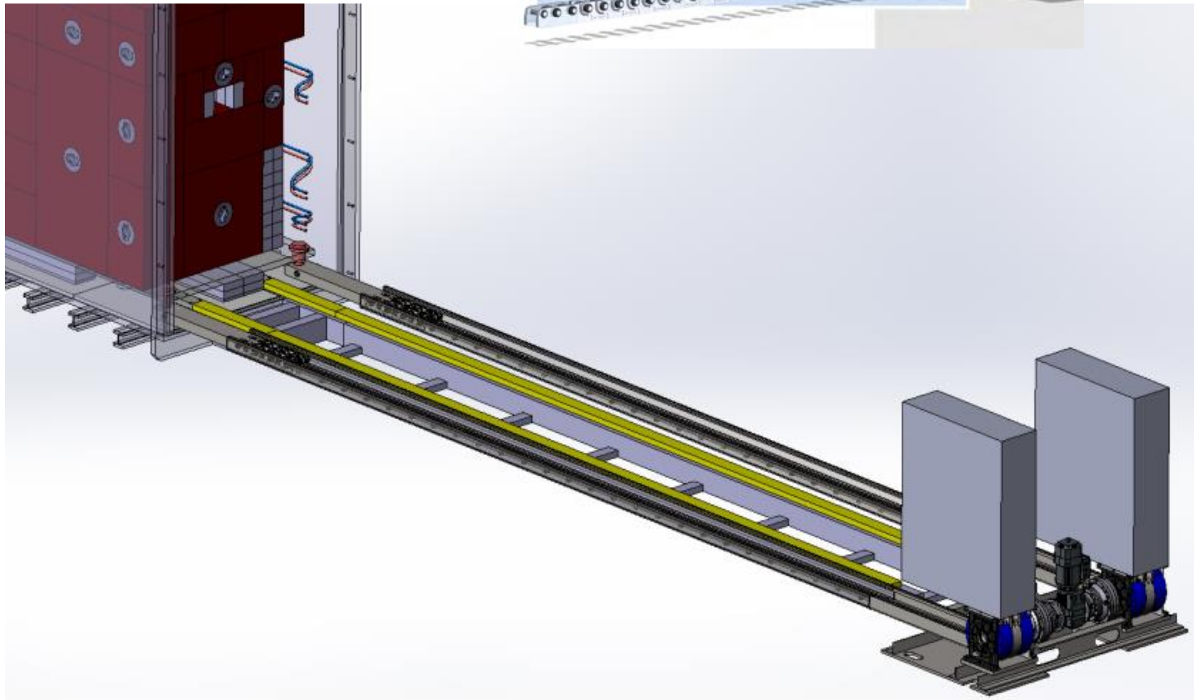


Trolley mounted on full stainless steel chain action rollers

BDF Target complex integration extraction

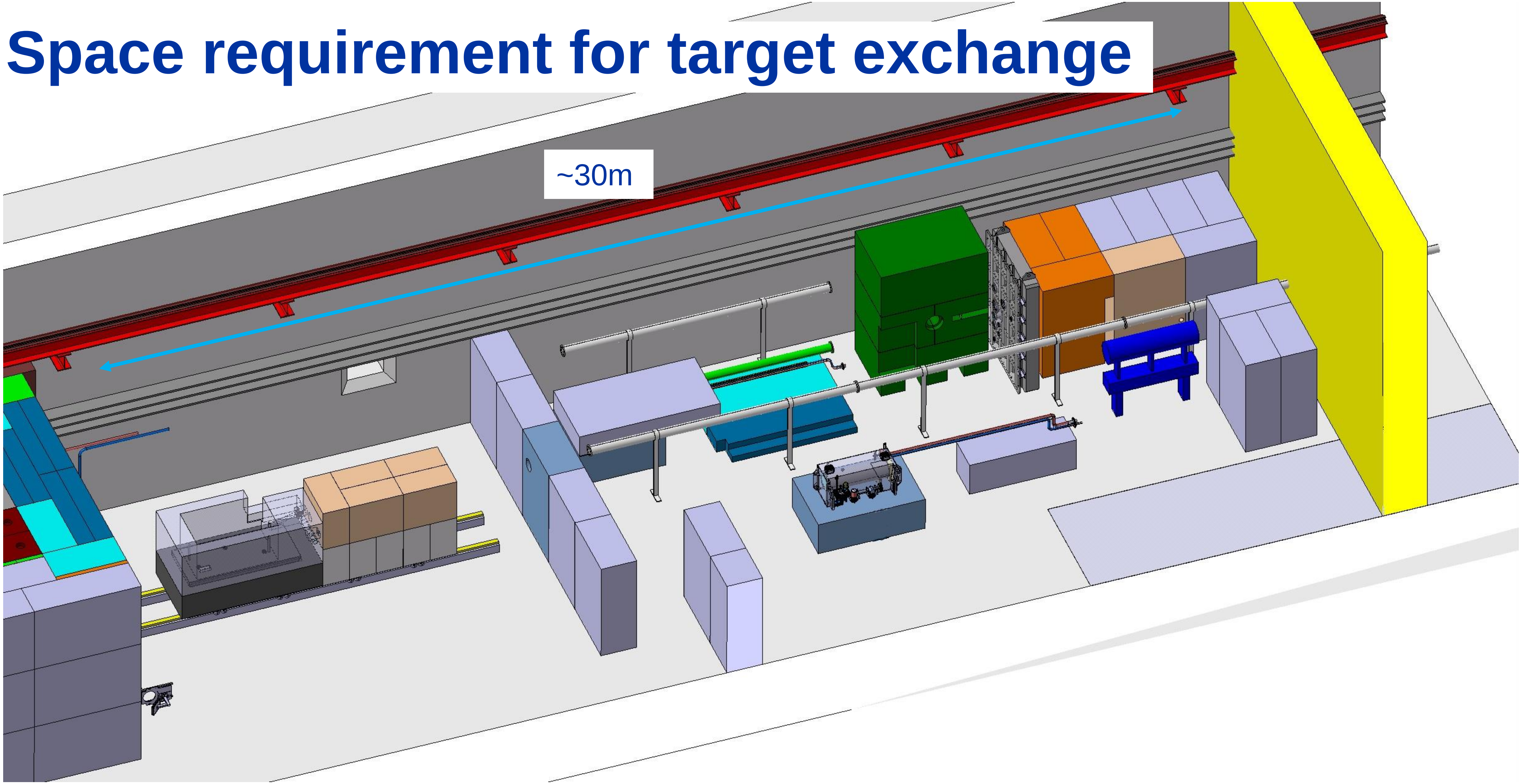






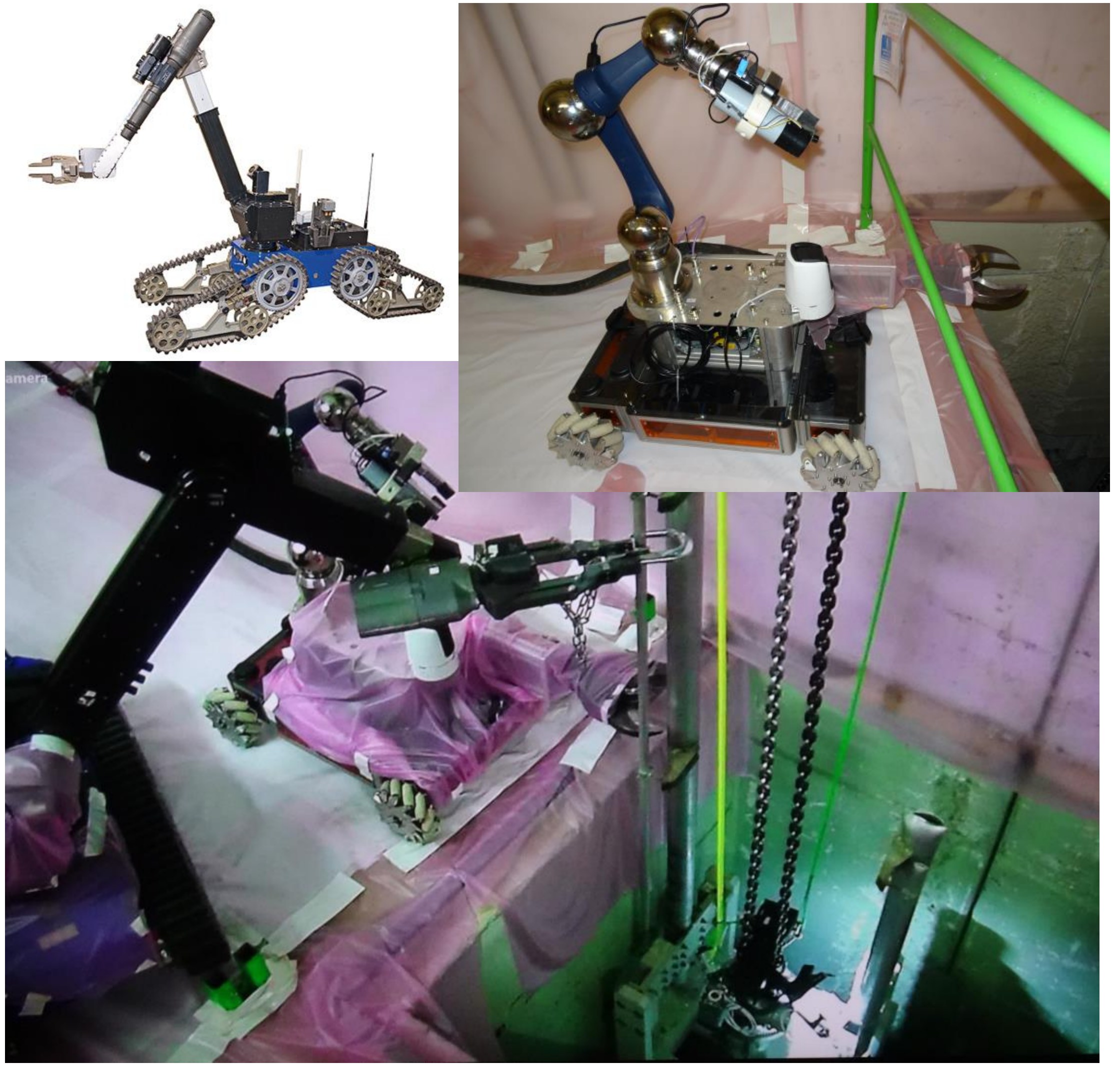
Extraction / insertion mechanism based on a motorized rigid chain
This will be installed on purpose in case of target exchange

Space requirement for target exchange



Maintenance of the target complex - few ideas

- **Target exchange**
  - Connections of utilities located in ‘’human’’ accessible environment
  - Remote handling features for the connections
  - Support of remotely controlled crane and ROVs
  - Size reduction for final disposal by shearing
  - Transfer from the underground to surface in shielded casks



n-TOF target#2 pipes reduction with ROVs

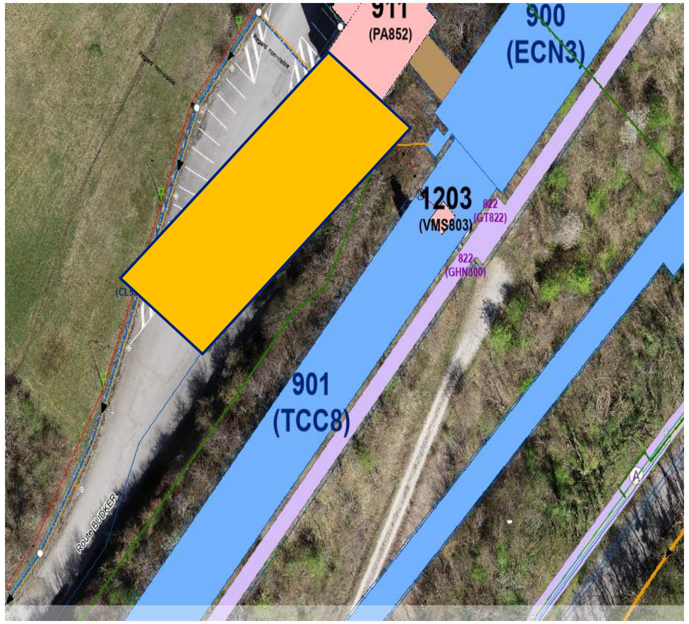
Target Complex handling

- Existing overhead travelling crane 30t capacity replaced

  - Redundancy on the 3 movements of the crane
  - Integration of a video system
  - Integration of a positioning system for the 3 movements
  - Off-board control cubicles
  - Cable festoon routing
  - Remote tools connection on the hook
  - Auxiliary hoist
  - Investigation on possibility to optimize crane size

  Ongoing specification

The target service building



Nuclear ventilation system of the target complex

- Air handling units, filters, dehumidifiers (outside)

Target 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 / hot cell

Buffer area

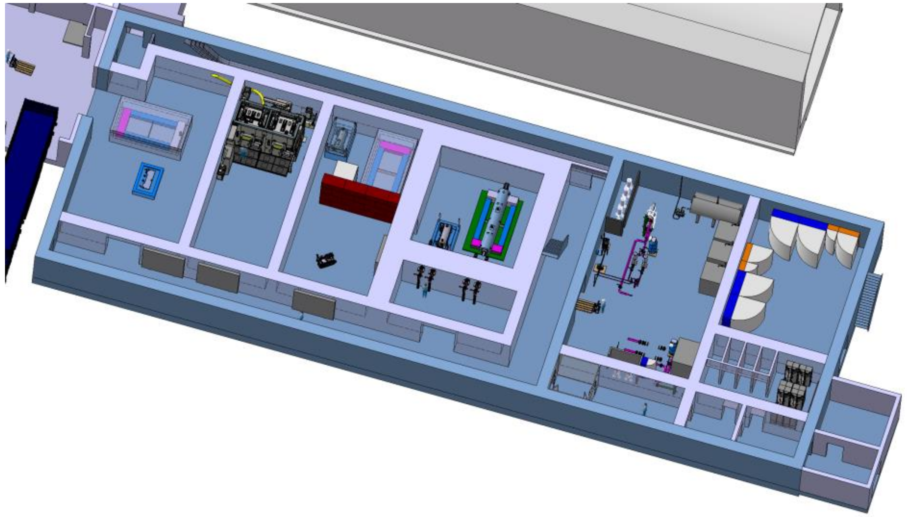
Safety systems

Electrical distribution system

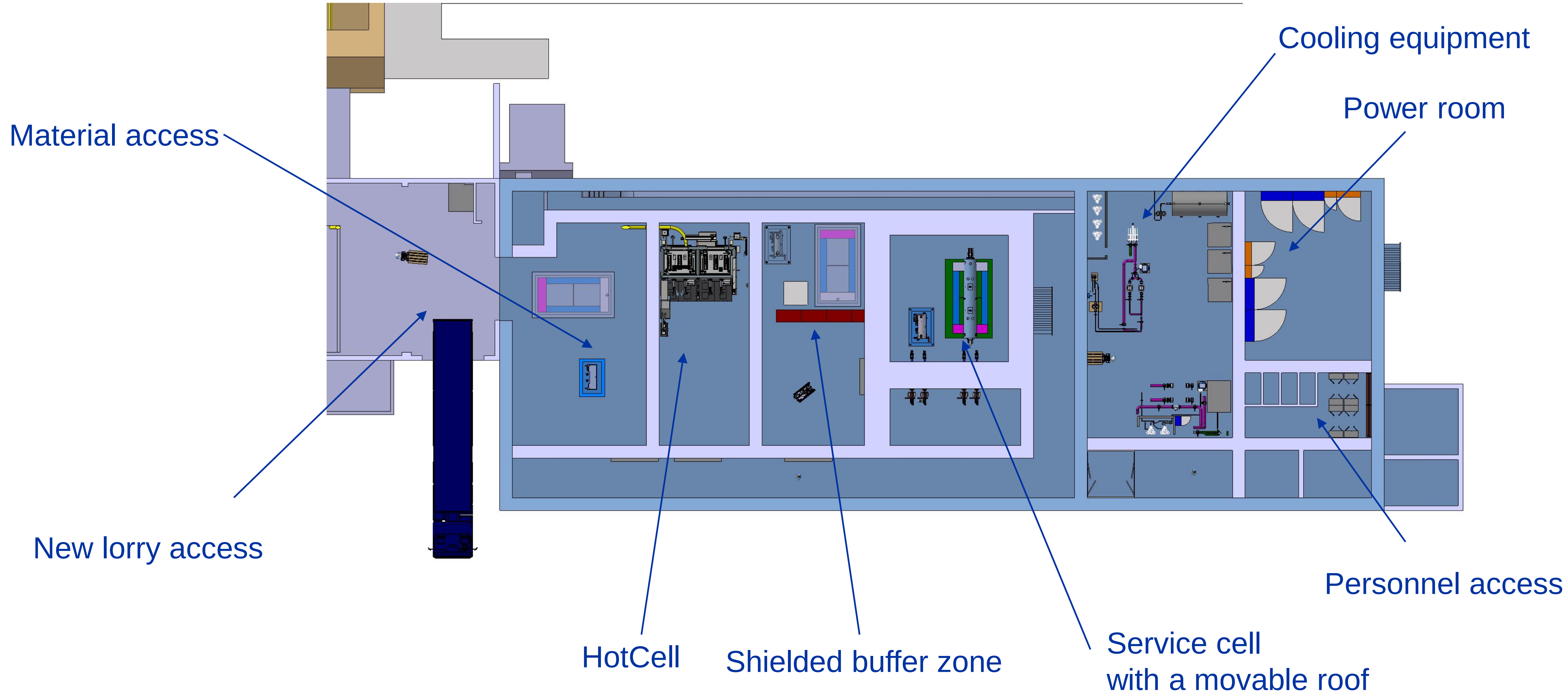
Control and safety systems

(Evaporator)

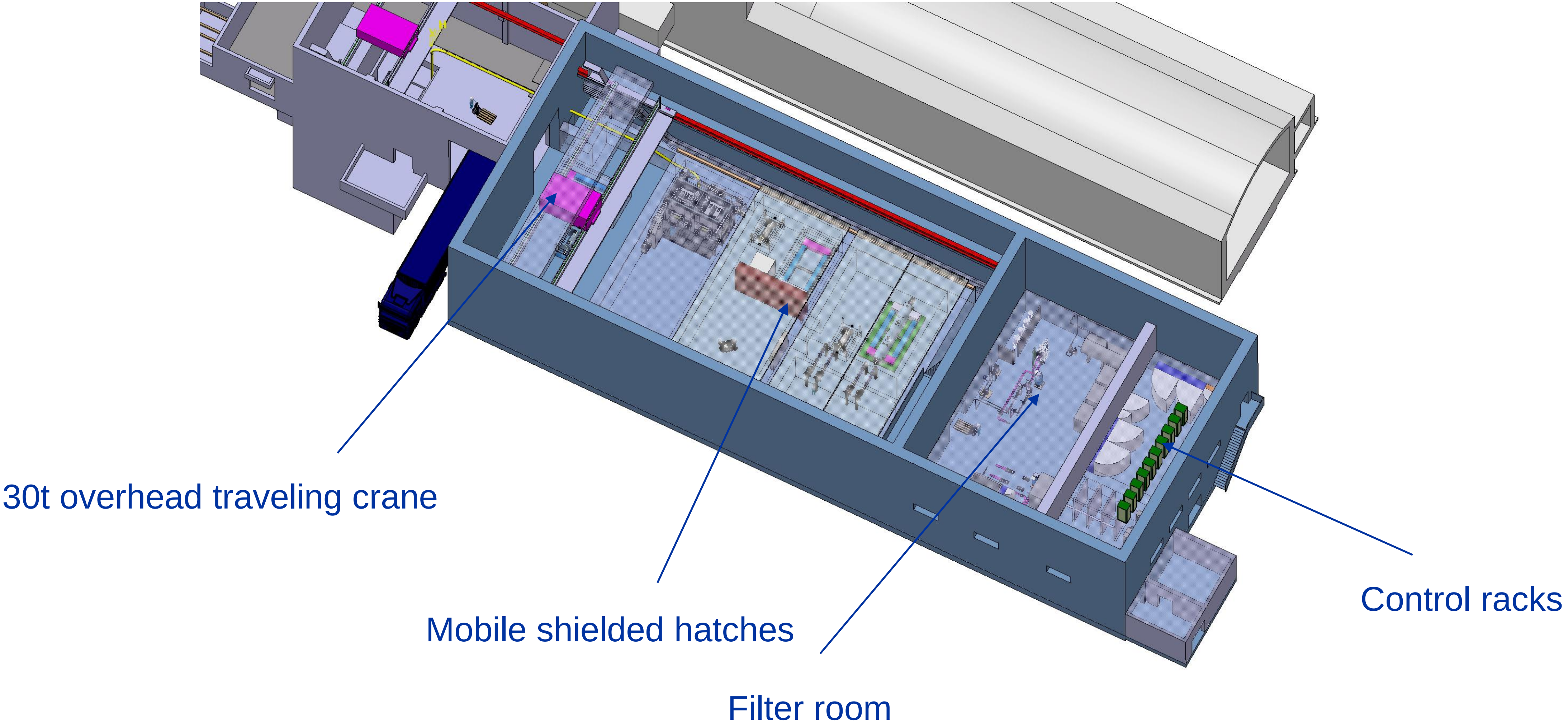
~1000m²



Service building – ground floor



Service building – 1rst level



HI-ECN3 service cell - context

HI-ECN3 project need to have a facility to prepare objects for final disposal

- BDF target
- Proximity shielding
- Hadron stopper coil

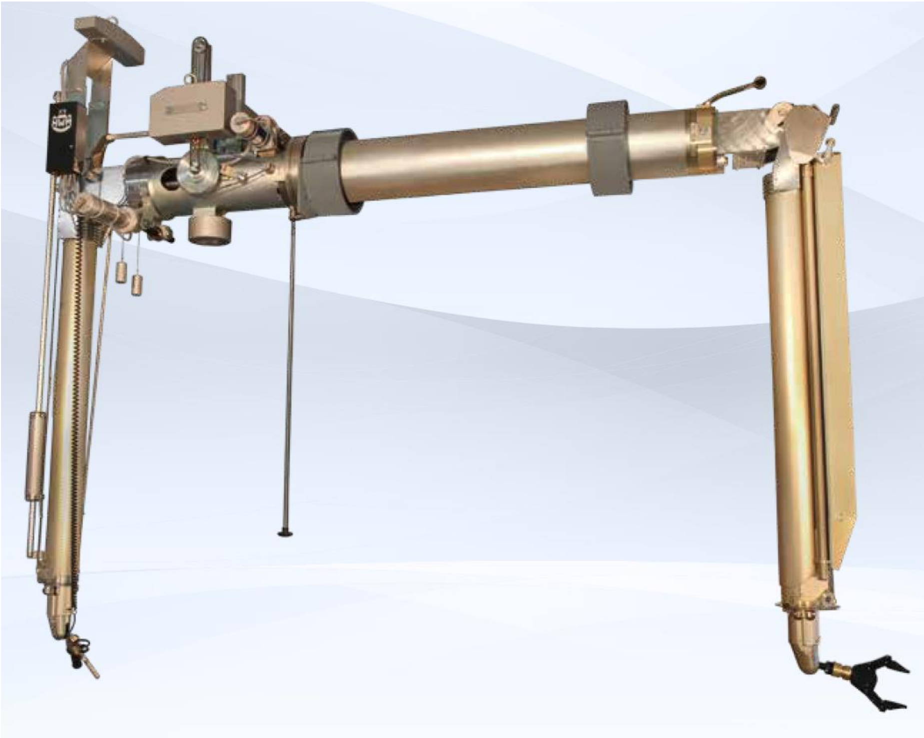
Why do we need a specific facility to prepare HI-ECN3 object for final disposal (waste packaging)?

- Level of radiation (~few Sv/h after 1year of cool down)
- Characteristics of materials (W)
- Presence of radiological critical spallation products

Main justification

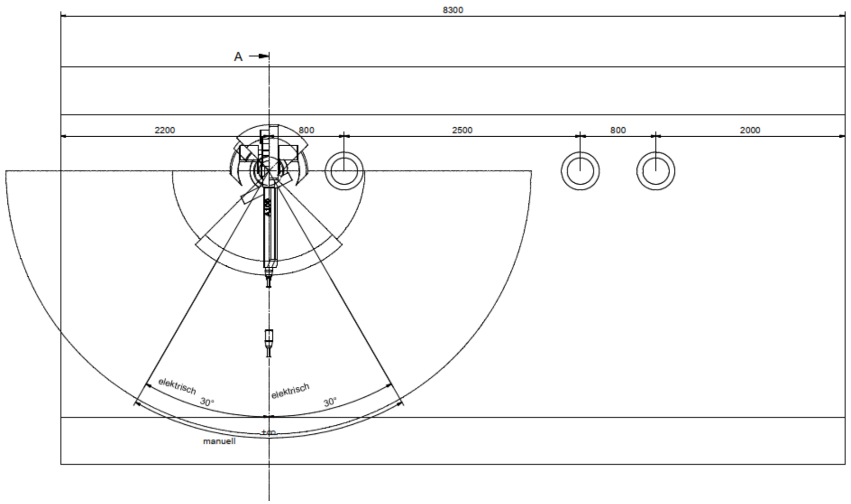
- Size and weight of the objects doesn’t fulfil elimination path requirement towards PSI (container size limitation)
- Understanding of failure modes to improve future designs
- Lessons learnt from waste packaging of highly radioactive objects (ISOLDE target, LHC TDE, n_TOF spallation targets)
- **Currently such facility does not exist at CERN**

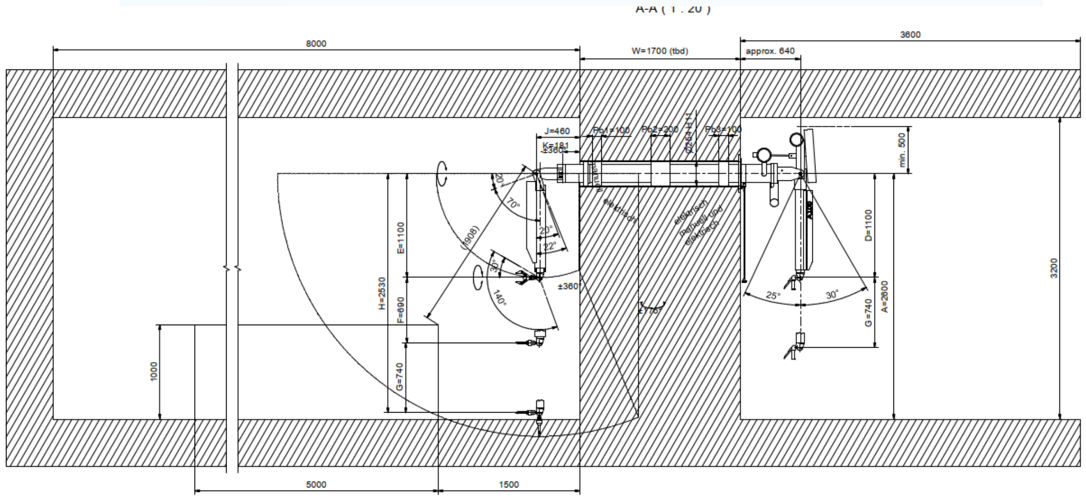
Service cell definition - design



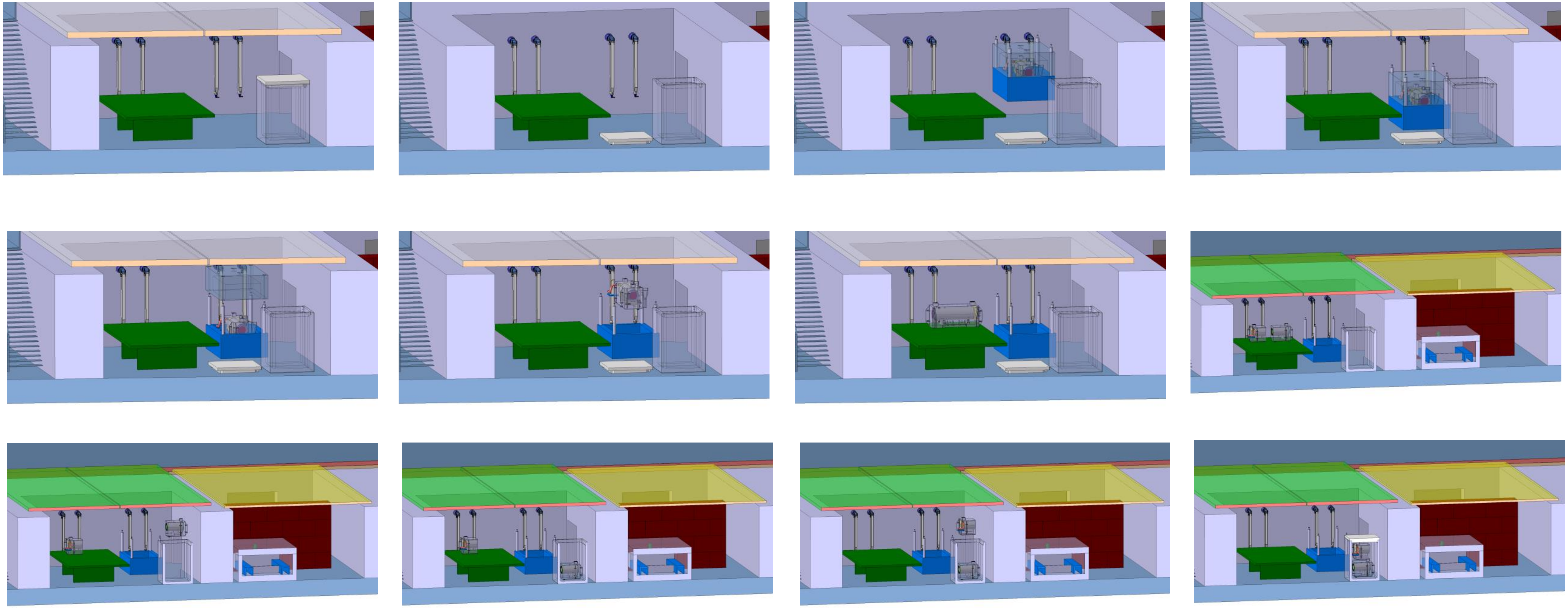
Prelimiary discussion with master slave manipulator manufacturer

→Check of volumes in integration model

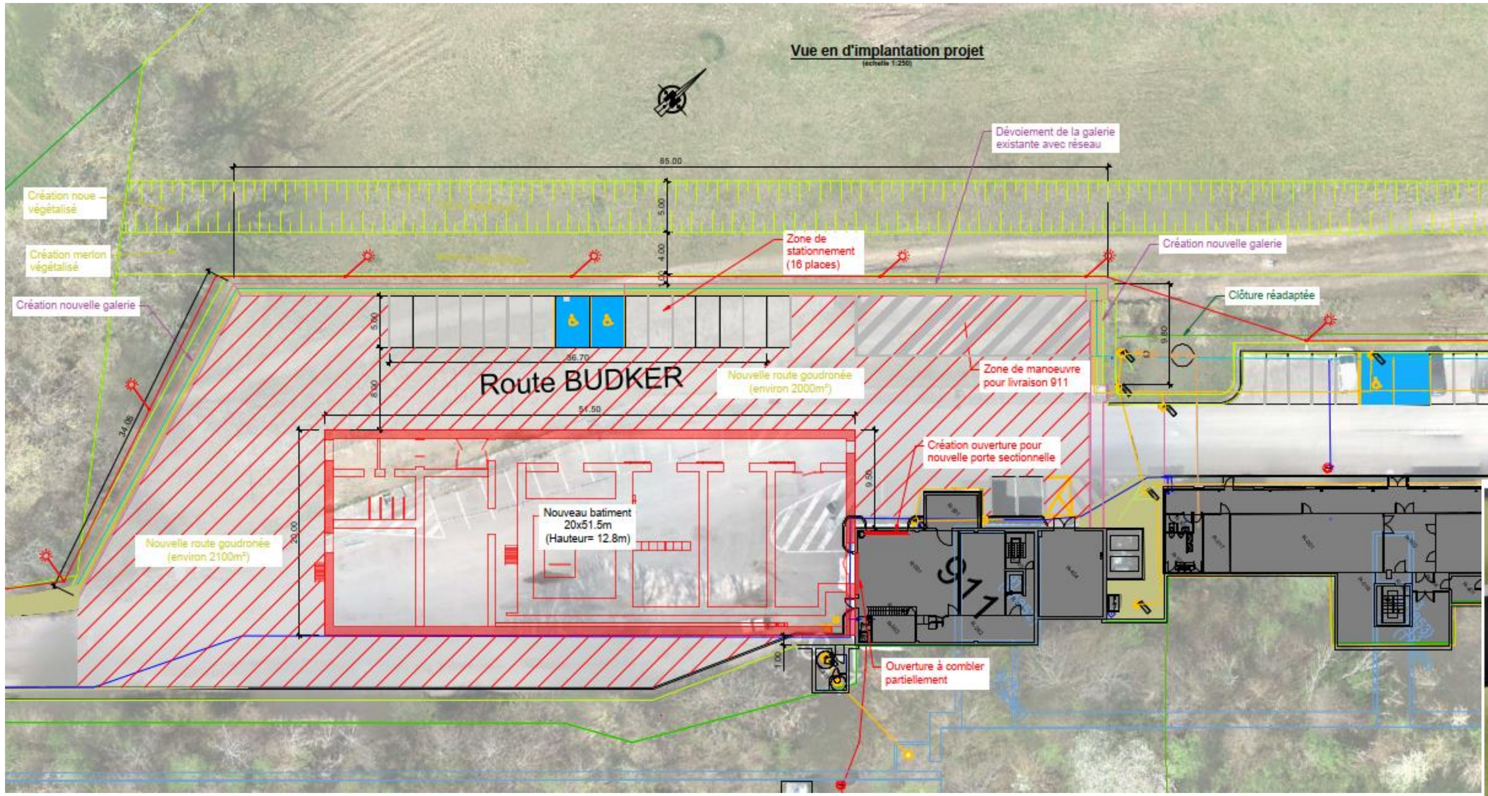




Service cell definition – BDF target waste packaging draft sequence



Service building within the BDF/SHiP complex



Systems failure scenarios

Evaluation required for operation and maintenance scenarios

- Water and/or He leak
- Vacuum leak
- Fire
- Ventilation
- Cooling
- Extraction system
- Handling tools

Subjects of concern – Target station

- Did you have any elastomers (for gaskets?) in areas with (high) radiation dose?
- Did you have any lubricant in areas with (high) radiation dose?
- Did you have any place where you have implemented measure to prevent cold welding (typically on rolling elements)
- How have you qualified sub systems? And to which extend have you over stressed your systems?
- How have you prevented the pollution of the target vessel during installation? To which extend all your systems are sensitives to dust and corrosion?

Subjects of concern – Cooled shielding

- What has made de decision for ESS to move towards a cooled shielding made out of stainless steel?
- What is the chemical composition of the stainless steel shielding?
- Did you encountered any difficulties during production?
- What QA checks have you performed typically for the quality of the welds?
- Have you identified several suppliers for those blocks? Could share the name of your suppliers?

Subjects of concern - Hotcell

- How have you define the process and workflow for the hotcell?
- What is the strategy for the final disposal of the target wheel?
- Did you intend to separate each individual W block from the wheel?
- How dose the design of the hot cell and associated process have defined the target?
- What has made decision to built a hotcell without lead glass window (Just operating with cameras)
- How did you guarantee the air tightness of the hotcell when you insert equipment?
- What are your constrains in term of final packaging for waste disposal? (Package type, shielded container)
- What are the standards you have used to design the hotcell?
- Did you intend to use your hot cell else than for the target facility?

Subjects of concern – Support building

- From which standards (as a nuclear facility) have you based your design?
- Which systems are covered by secured network (UPS and/or diesels generators)?
- What is the strategy in case of power outage?

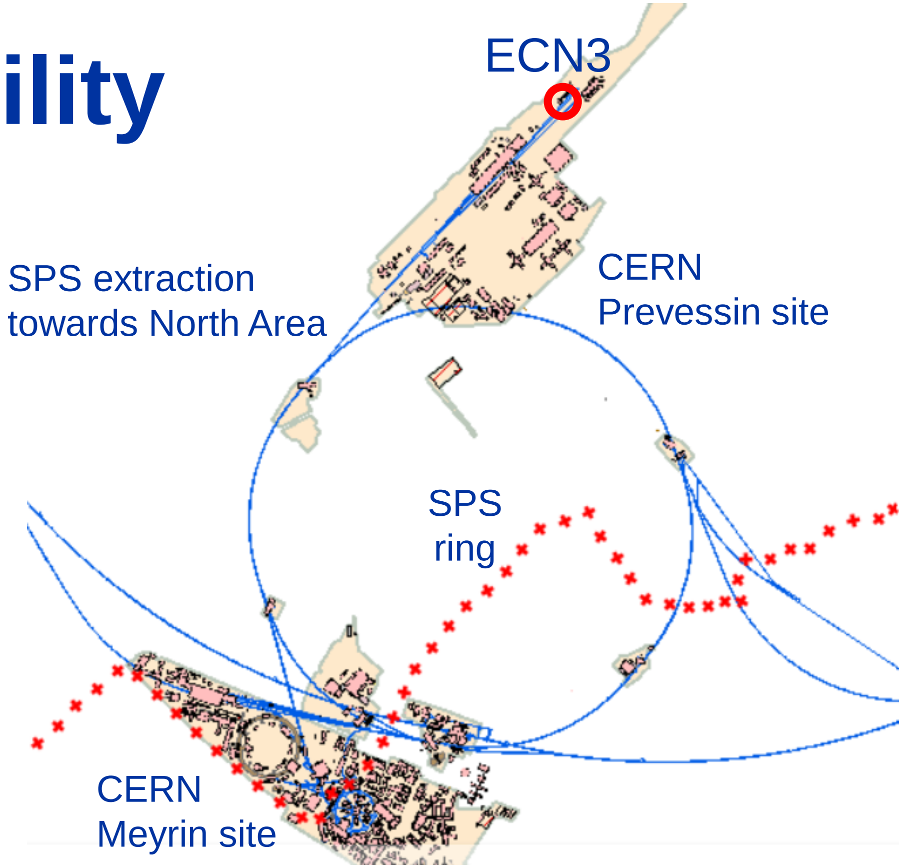
home.cern

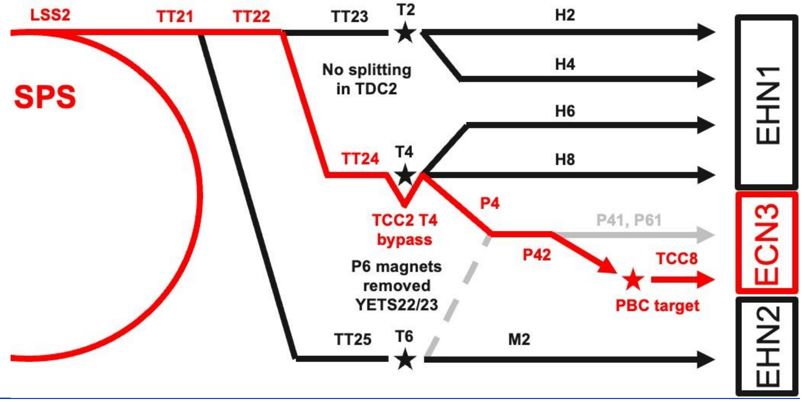
Thank you

Spares slides

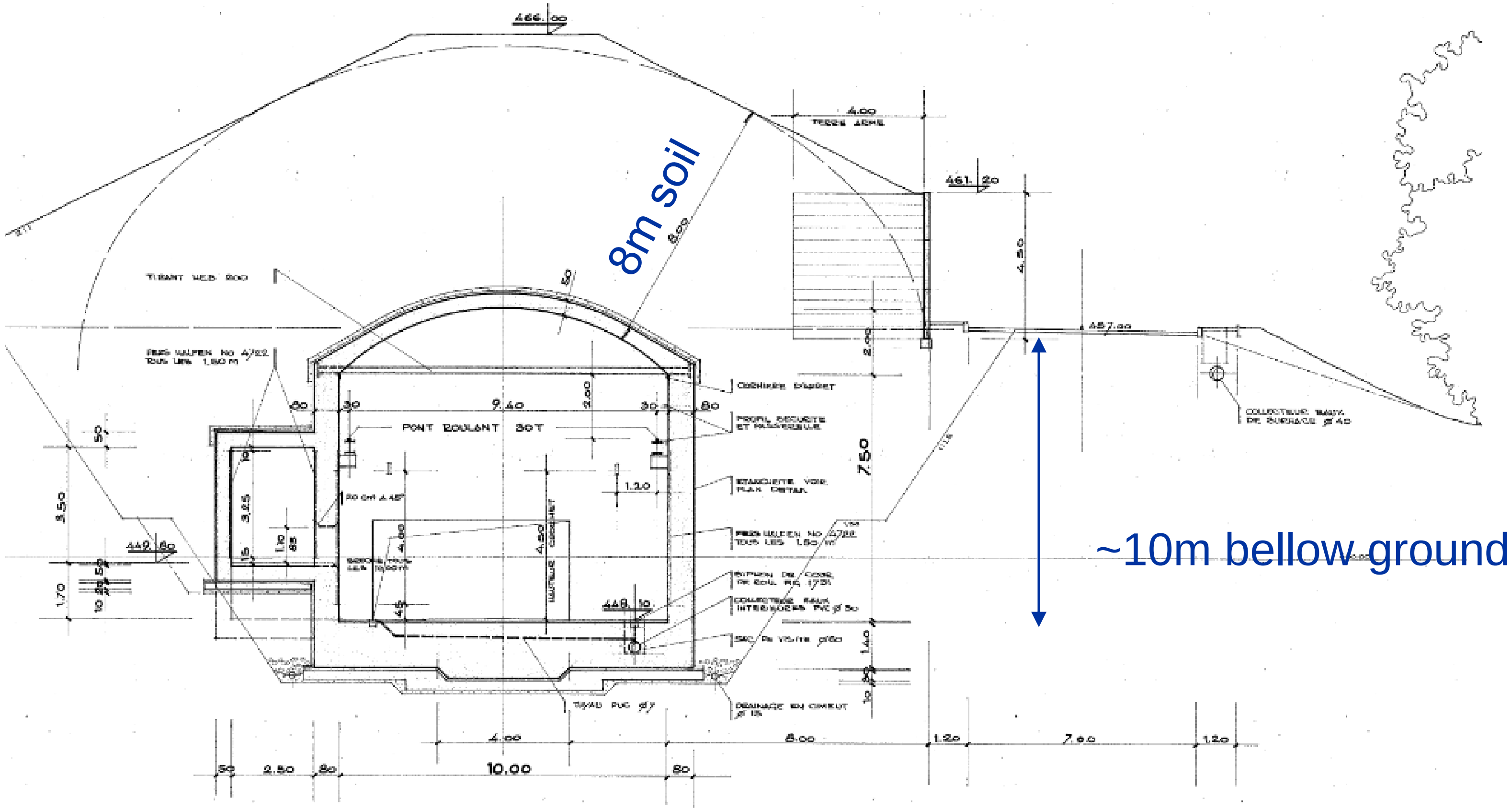
Target Complex in an existing facility

- Implementation in the SPS North Area ECN3 designed at construction in 70's for a High Intensity (NAHIF)
- Currently used by NA62 experiment
- SPS North Area beam lines and associated infrastructure being currently consolidated
- Would require the dismantling fraction of current beam line, target station, the experiment
- Only one target station can be accommodated in the cavern



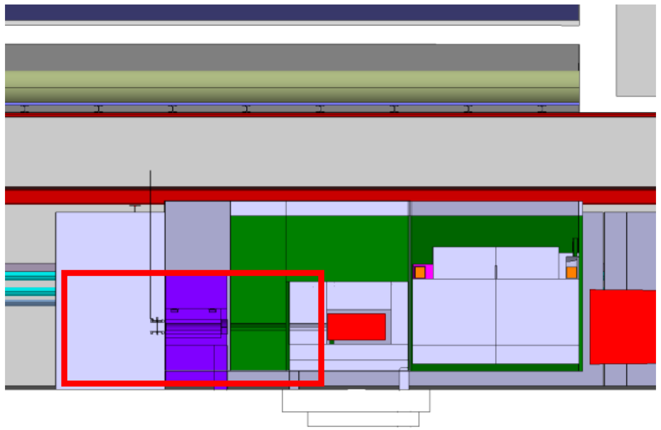


The TCC8 area



TCC8 cross section (length 170m)

Target station vacuum confinement



- Grid of HE 100 M beams (each 120 mm tall) crossing each other at 90º, 500 mm separation
- Skin thickness: 30 mm
- Boundary condition: floor beams fixed to the floor in the vertical direction.
- Max displacement 3 mm
- Max VM stress in the sheet: ~200 MPa local peak, lower elsewhere
- Max utilization factor of the beams:0.49
- Buckling factor: 0.82
- Simplified analysis using 1-d beams and 2-d shell elements
- More detail vessel design