



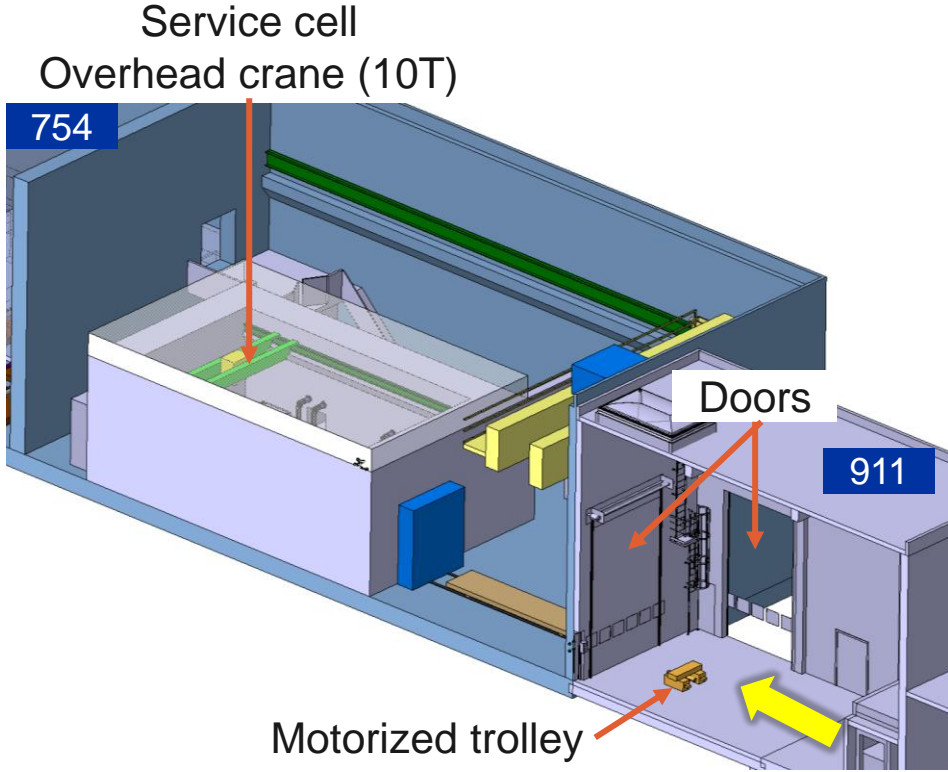
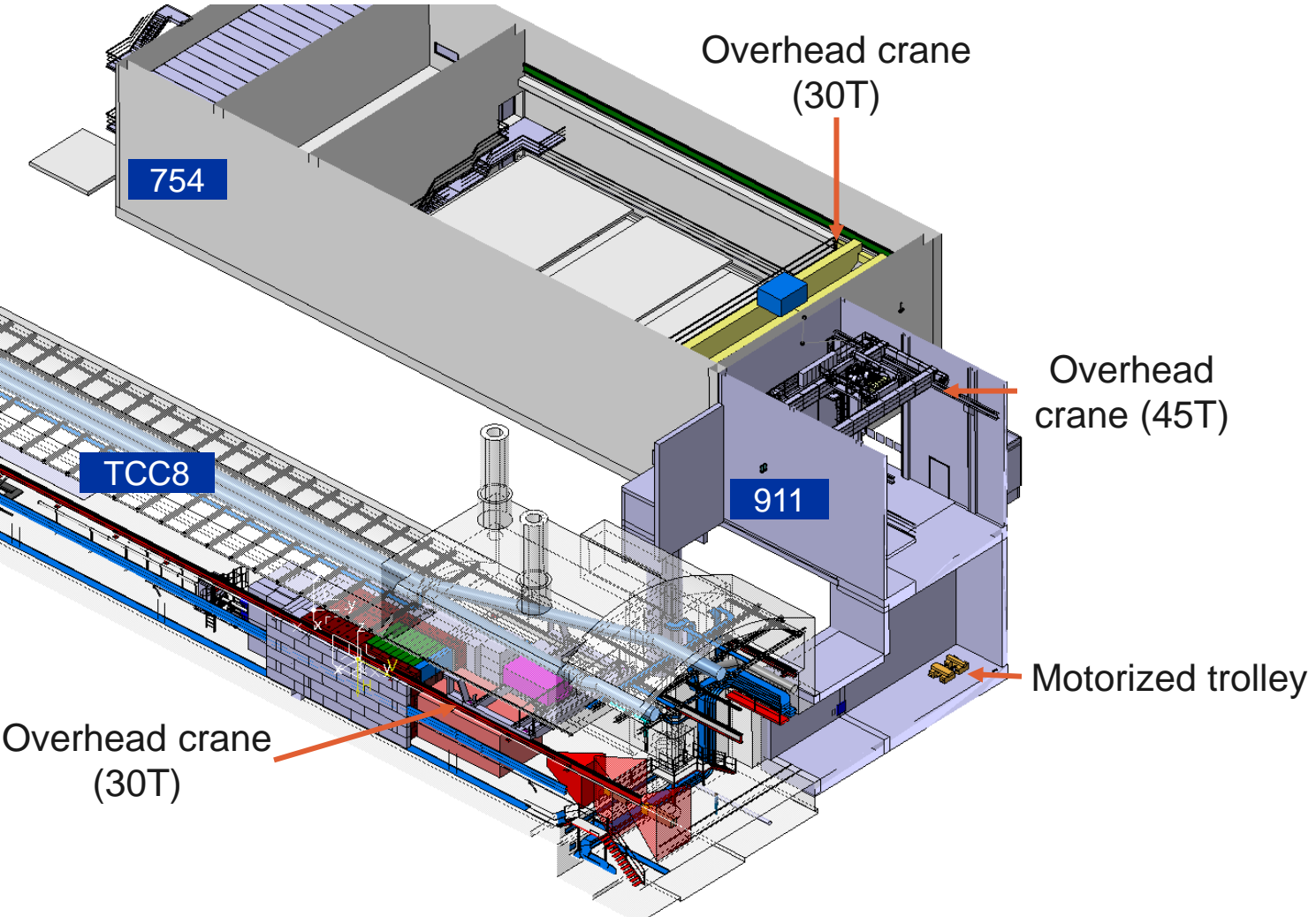
Target Systems Handling

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

Content

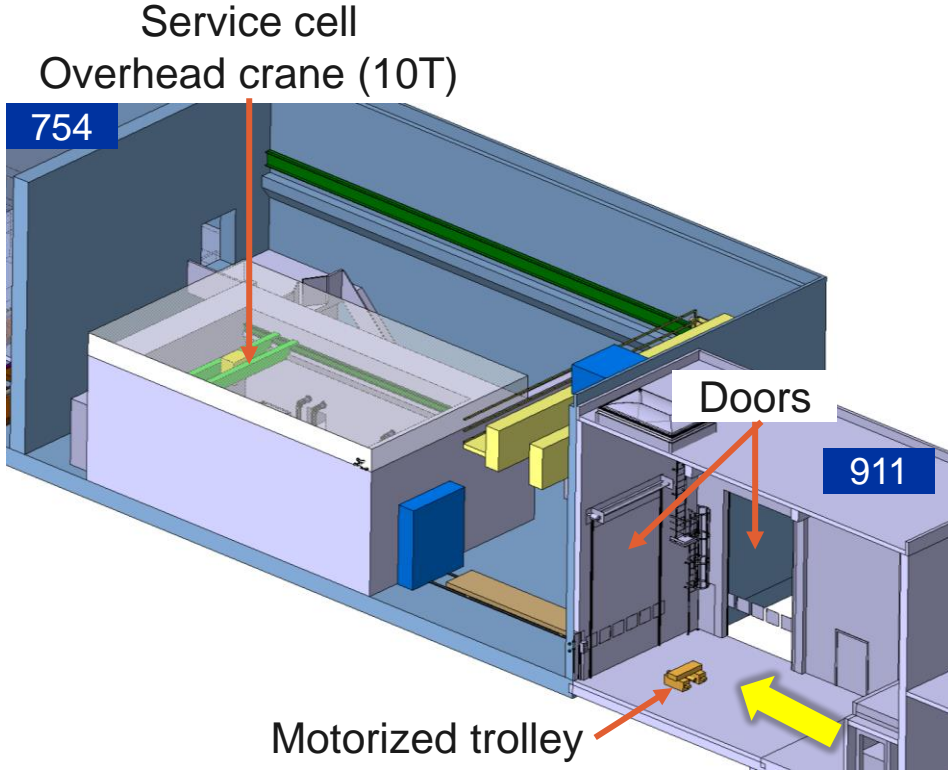
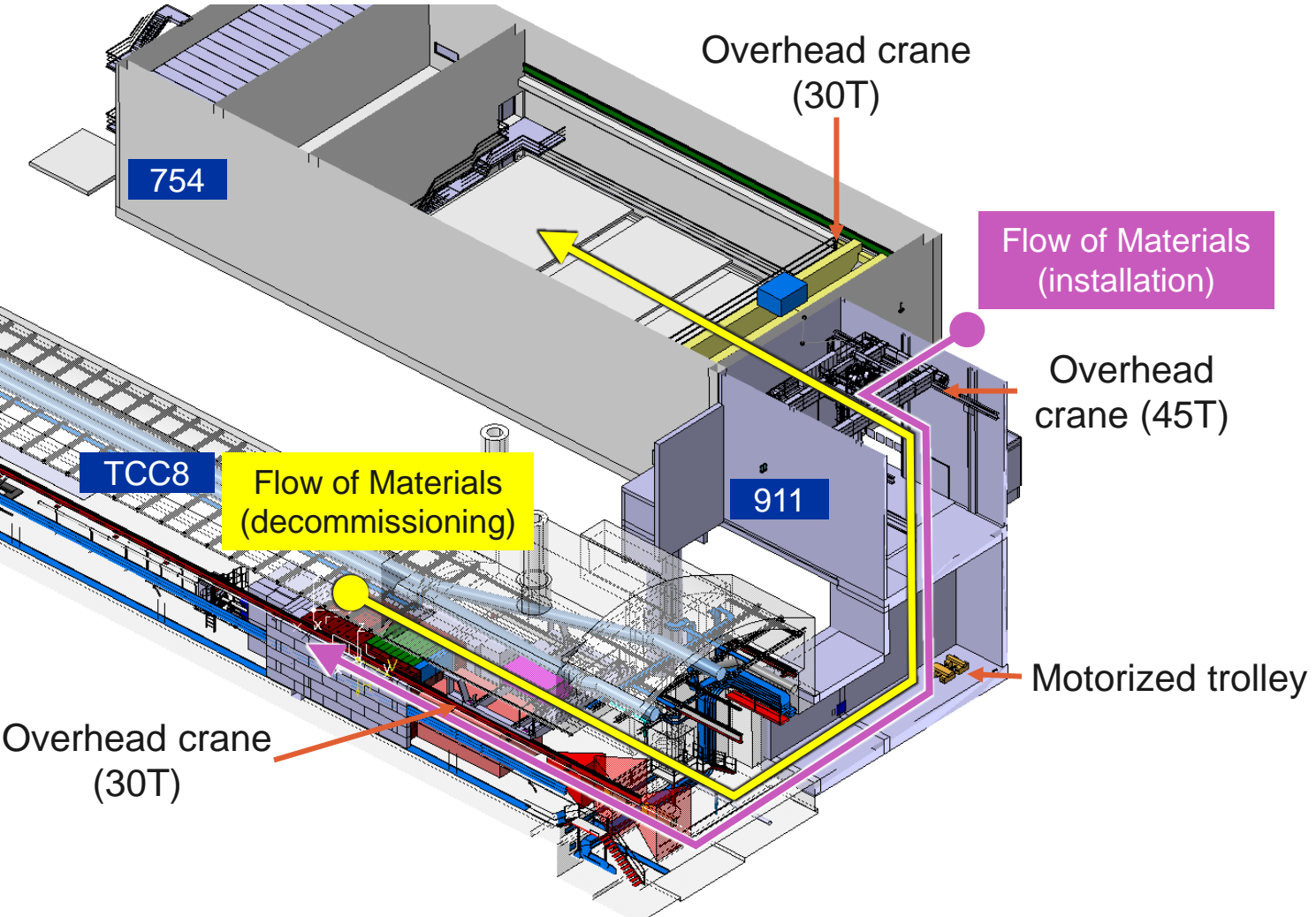
- Handling equipment to build and operate the HI-ECN3 facility:
 - Overhead cranes
 - Motorized trolleys and platforms
 - Lifting tools
- Target installation sequence
- Target maintenance and exchange sequence
- Preliminary Target area crane failure scenarios

Handling Equipment in the HI-ECN3 Facility



Handling Equipment	
Overhead cranes	4
Trolleys / platforms	2
Custom lifting Tools	Several

Handling Equipment in the HI-ECN3 Facility



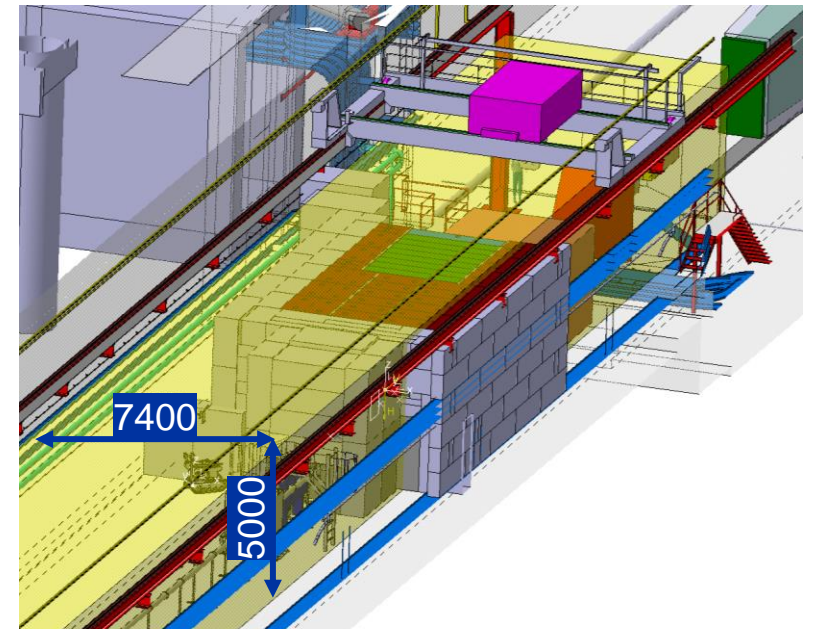
Handling Equipment	
Overhead cranes	4
Trolleys / platforms	2
Custom lifting Tools	Several

TCC8 Crane

SPECIFIC TECHNICAL ASPECTS

- Crane originally installed in 1978 and **refurbished in 2014**
- **Does not meet the requirements for the HI-ECN3 handling operations**
 - Remote handling
 - Electronic components on-board
- **Ongoing tender for a new crane**

Current overhead crane in TCC8



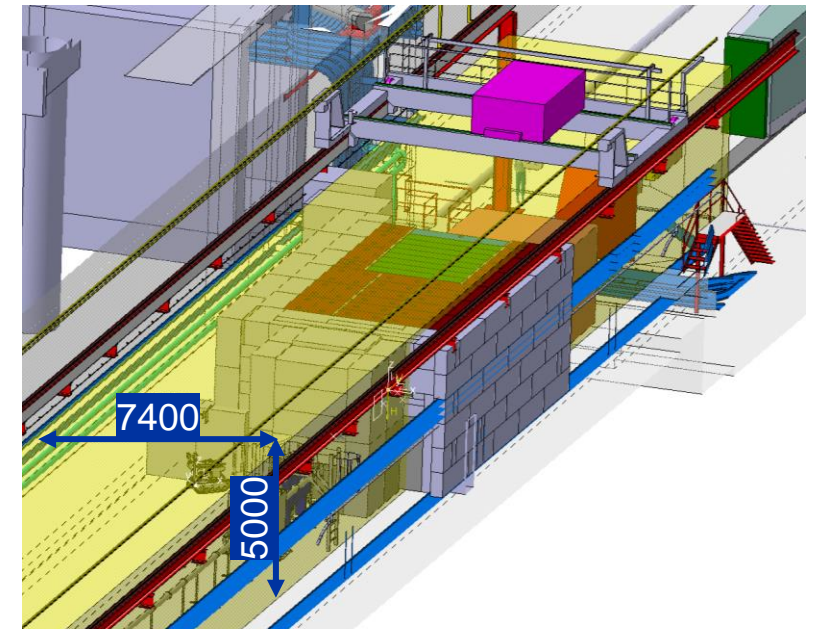
Crane coverage in TCC8

TCC8 Crane

SPECIFIC TECHNICAL ASPECTS

- Crane originally installed in 1978 and **refurbished in 2014**
- **Does not meet the requirements for the HI-ECN3 handling operations**
 - Remote handling
 - Electronic components on-board
- **Ongoing tender for a new crane**
- Design choices driven by the **constraints of the existing facility**
- **Specific technical aspects**
 - **30-tonne** capacity
 - Addition of a **5-tonne auxiliary hoist** to improve the hook coverage
 - **Mechanical redundancies** (double motor with differential unit) on all motions
 - **Emergency brake**
 - Cable reel to install a **motorized device on the hook**

Current overhead crane in TCC8



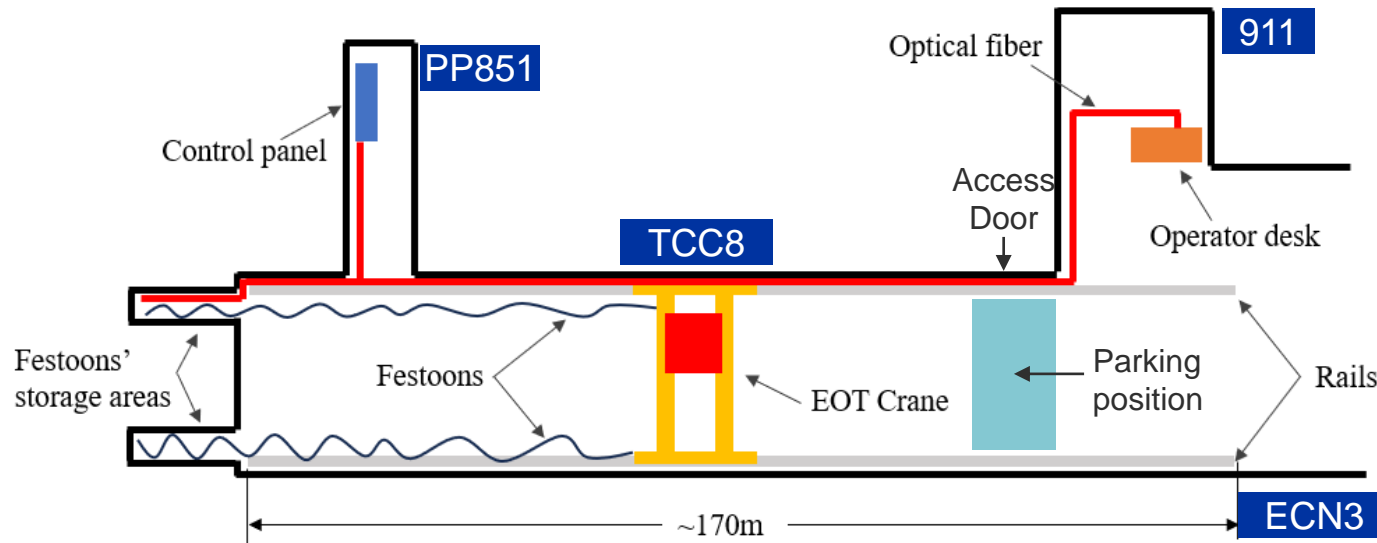
Crane coverage in TCC8

TCC8 Crane

SPECIFIC TECHNICAL ASPECTS (continued)

- Remote control panel - No electronic components on-board (except load cell)
- Remote operator desk with 4 screens

Operator desk in a similar installation



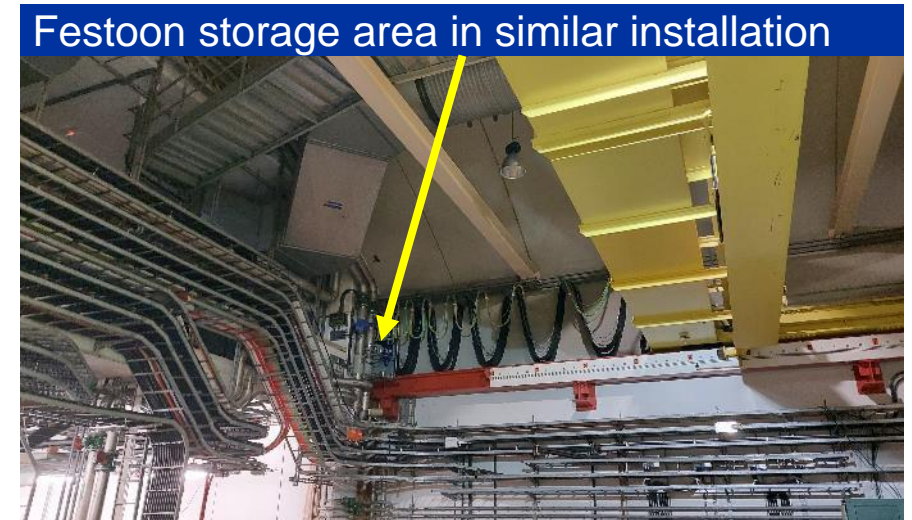
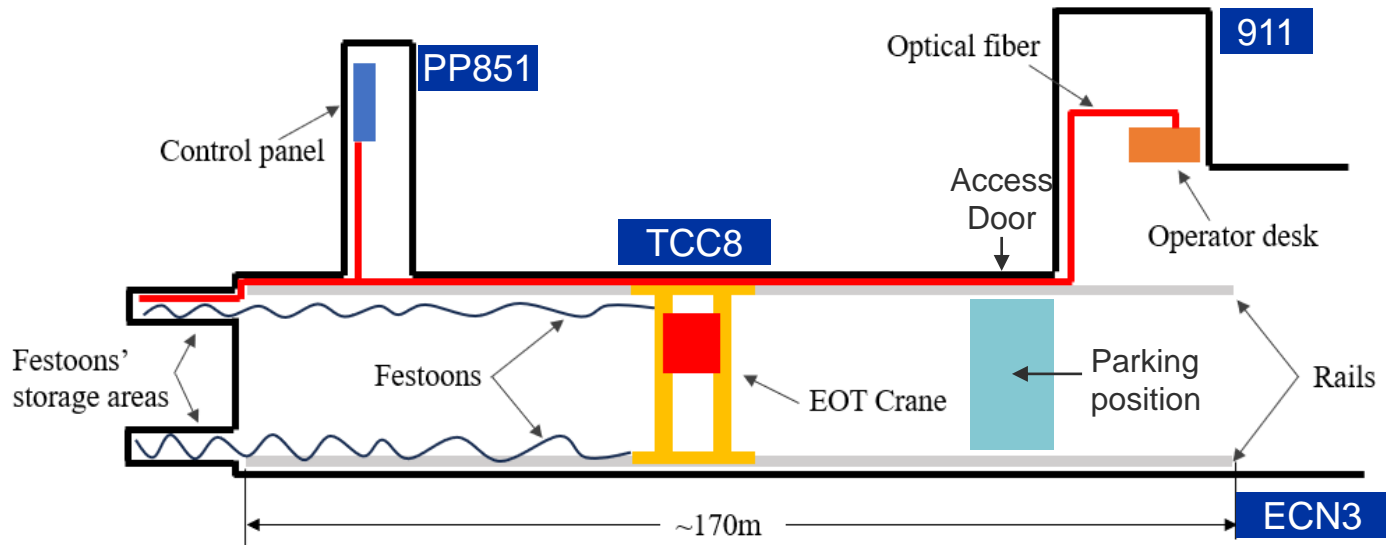
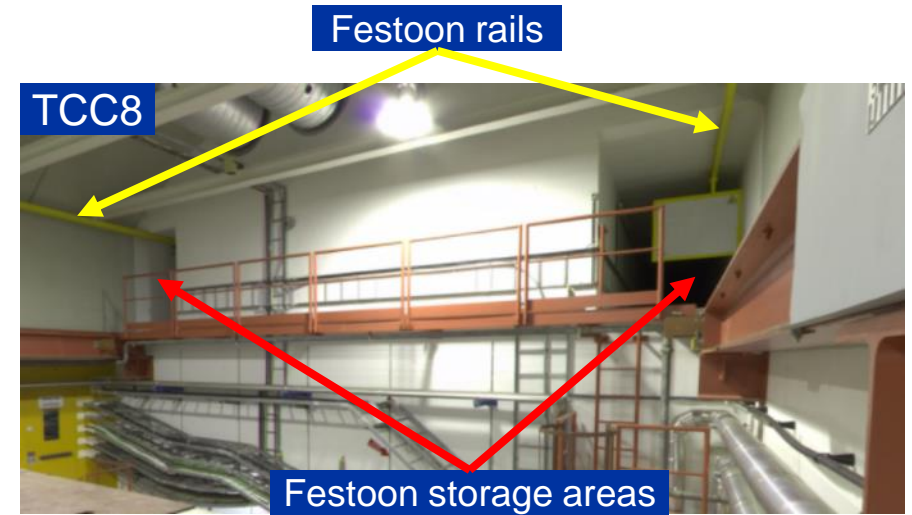
Control panel location in PP851



TCC8 Crane

SPECIFIC TECHNICAL ASPECTS (continued)

- **Remote control panel** - No electronic components on-board (except load cell)
- **Remote operator desk** with 4 screens



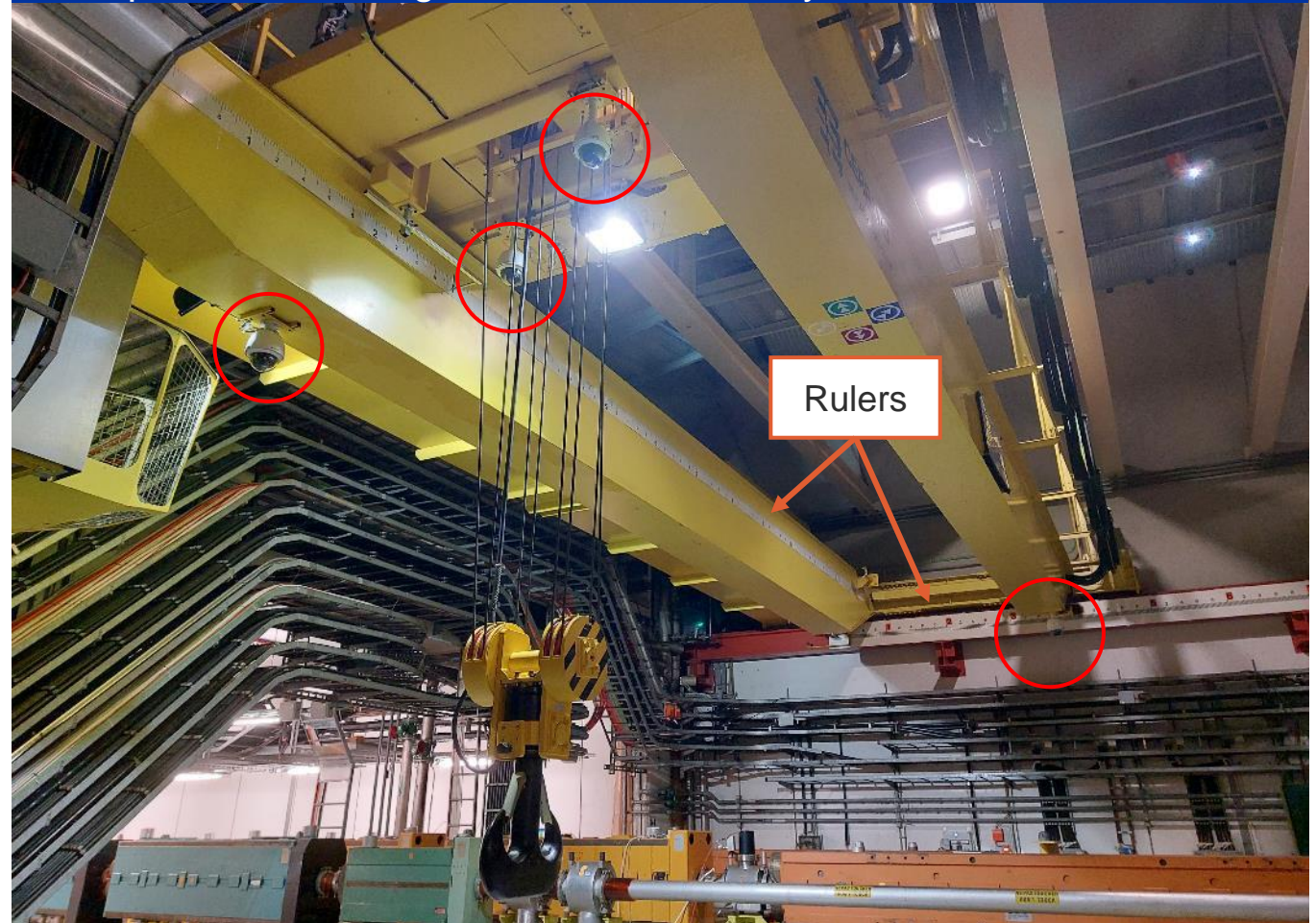
TCC8 Crane

SPECIFIC TECHNICAL ASPECTS (continued)

- **Rulers and resolvers** for verification of crane position
- **Six on-board cameras** for remote operations and redundant detection of crane position



Example of an existing crane in other facility



TCC8 Crane

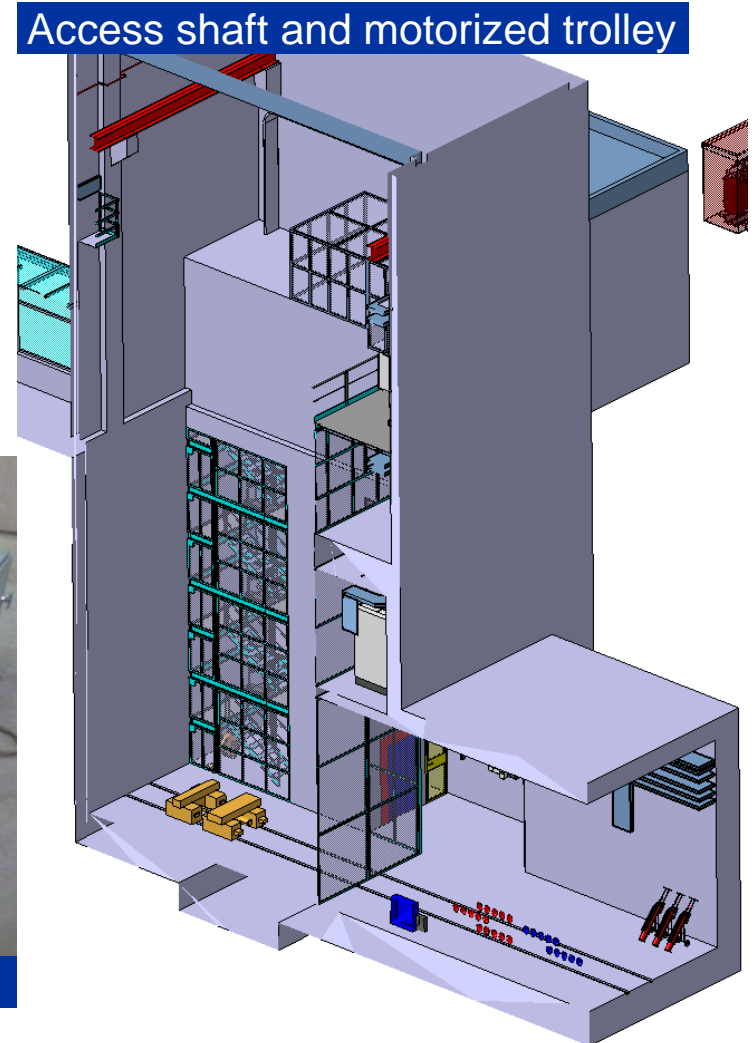
INTERFACE WITH ROBOTIC EQUIPMENT

- **Standard double hook with safety latches**
- Possibility to **manually lock the hook rotation at any position**
- **Harting-type plug** at the hook to exchange power and signals
- Possibility to **connect to the crane network**
- **Semi-automatic hook positioning in predefined points (x-y-z)**



Motorized trolley between ECN3 and shaft

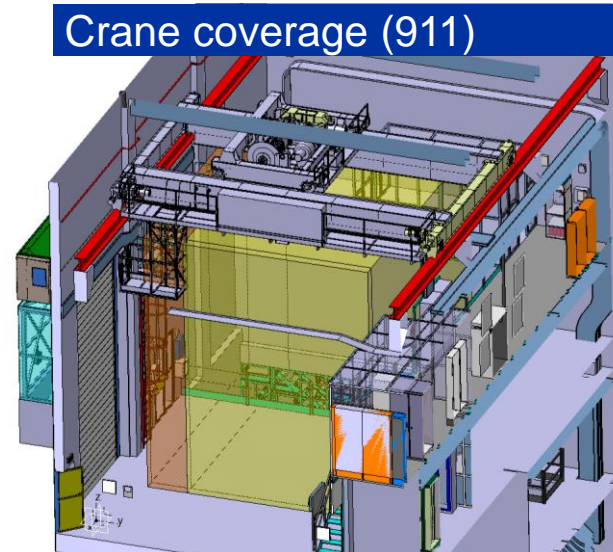
- Equipment installed during the facility's construction
- **Currently being refurbished**
 - New electrical components and cables
 - Structure reused after mechanical validation.
- **Radio - controlled**
- **New control panel in a remote position**
- Failure scenarios and reparation strategy (*under study*)
 - Manual release of the brake for emergency recovery



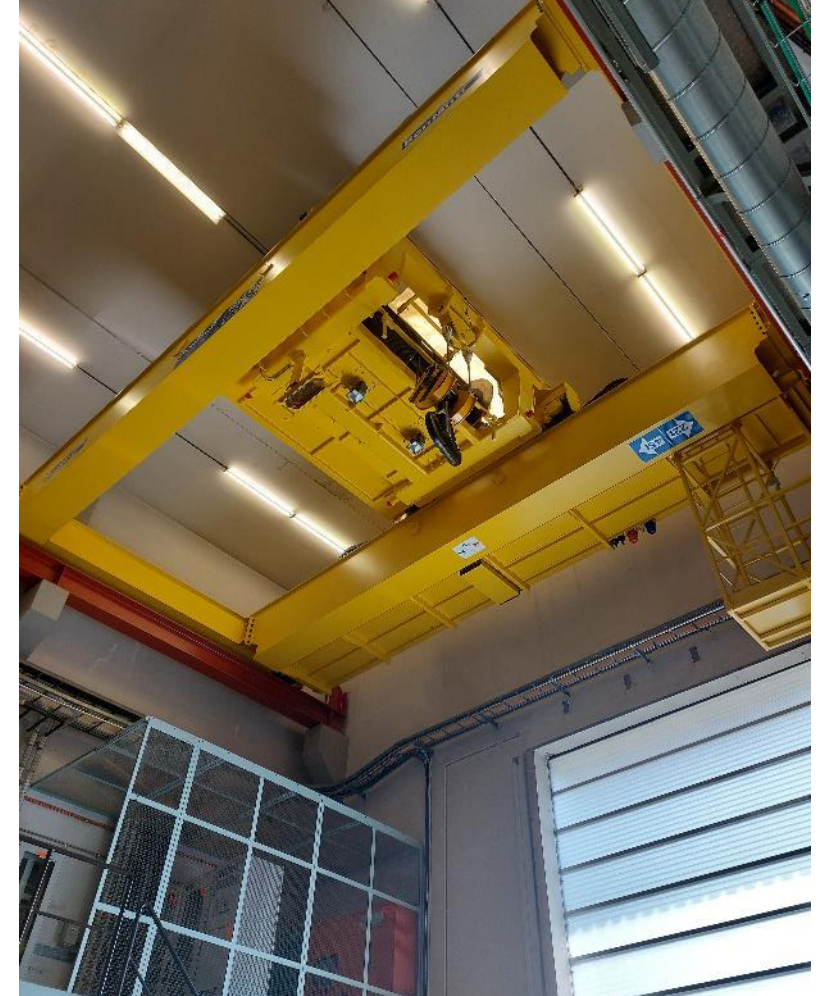
911 Crane

SPECIFIC TECHNICAL ASPECTS

- Crane installed in 2016
- **Capacity: 45 tonne (22 tonne at the extremity)**
- **Mechanical redundancy**
 - Double motor with differential unit on the hoist, giving the possibility to lower the load to the floor (building ground or shaft)
- **Emergency brake**



Overhead crane in surface building 911



Motorized trolley (buildings 911 and 754)

- **Equipment under study** (with specifications similar to those of the ECN3 trolley)
- Best guiding system to be defined:
 - Rails → Might pose an issue when sealing the service cell
 - Polyurethane wheels



Motorized platform with multidirectional wheels (Morello)

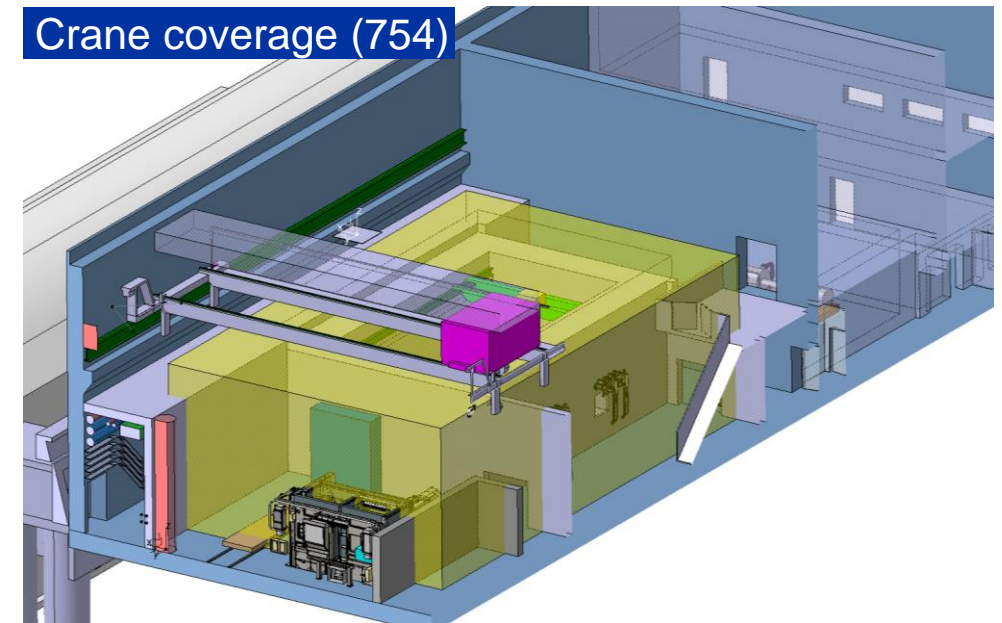


Motorized trolley with rails (like the one in ECN3)

754 Crane

SPECIFIC TECHNICAL ASPECTS

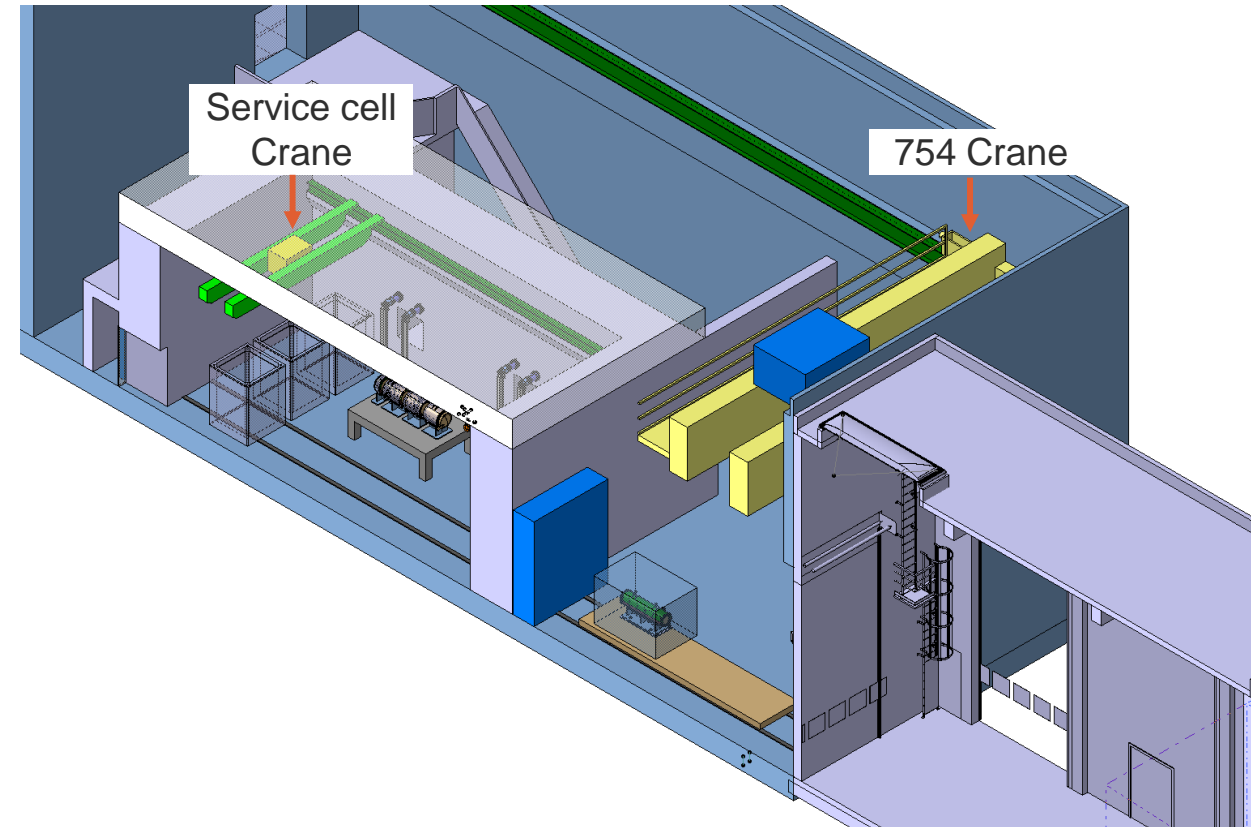
- Equipment under study
- **Capacity: 30 tonne**
 - Option for an additional 5-tonne aux hoist to expand the crane coverage
- **Mechanical redundancy**
 - Double motor with differential unit on the hoist giving the possibility to lay the load on the floor
- **Emergency brake**



Service cell crane

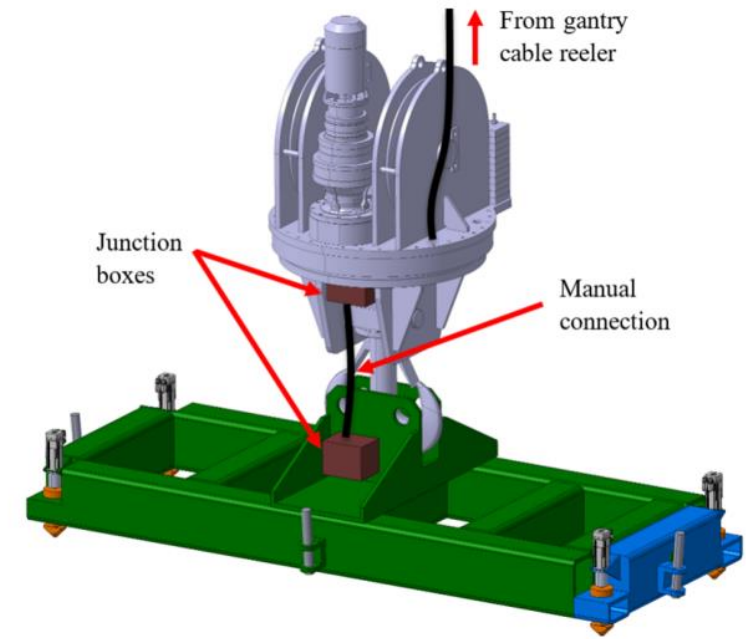
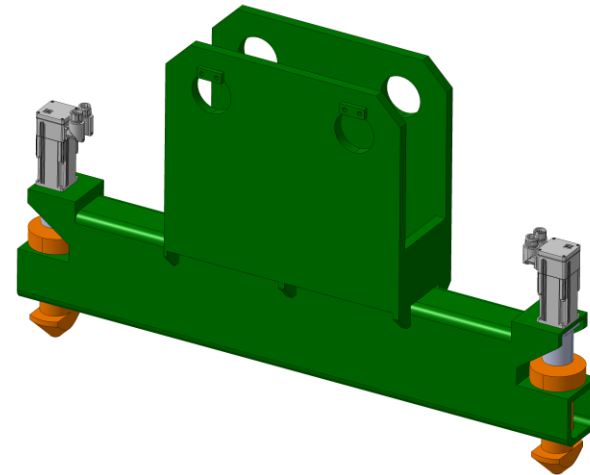
SPECIFIC TECHNICAL ASPECTS

- Equipment under study
- Capacity: 5 - 10 tonne
- Full mechanical redundancy
 - Technical specifications to be defined by the contractor of the service cell
- Full remotely controlled with vision system
- Emergency brake



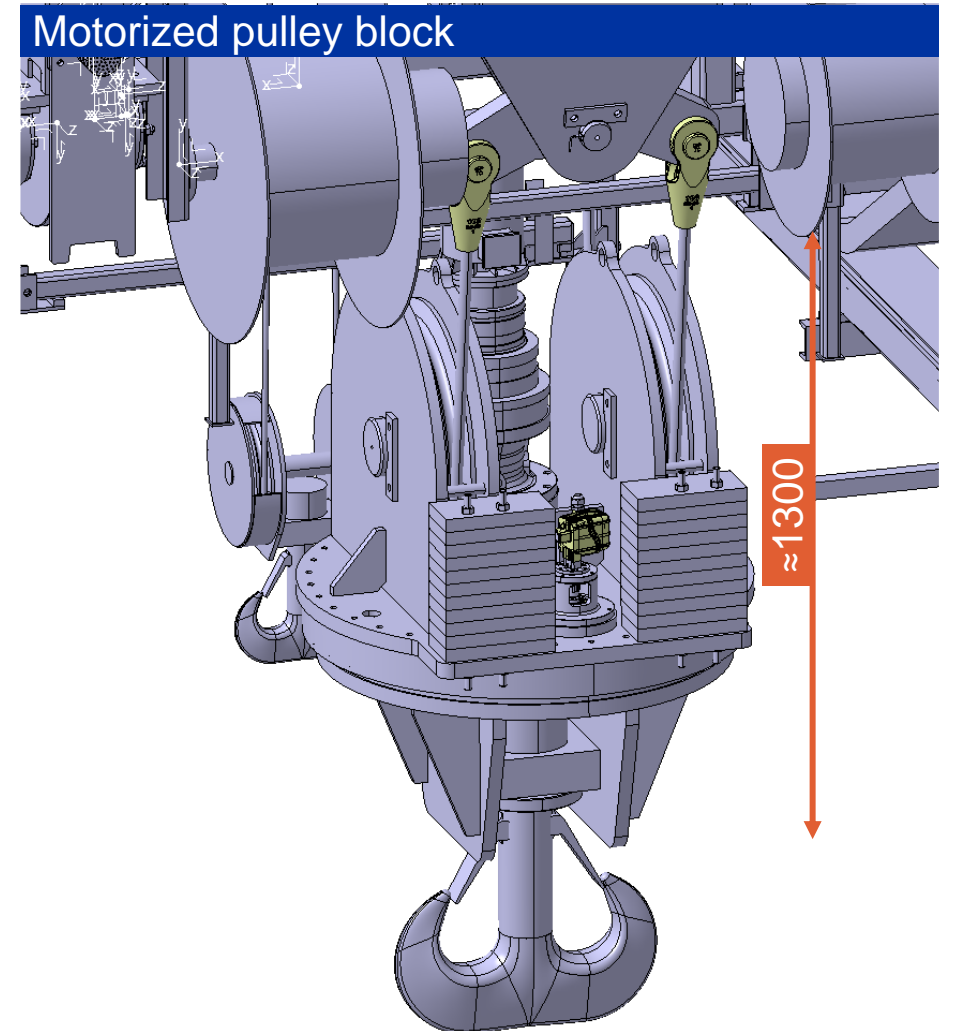
Custom designed lifting tools

- Custom designed lifting tools
- Manual mechanical and electrical connection to the crane
- Motorized locking – unlocking mechanisms for remote operation
- Motorized rotation of the lifting tool



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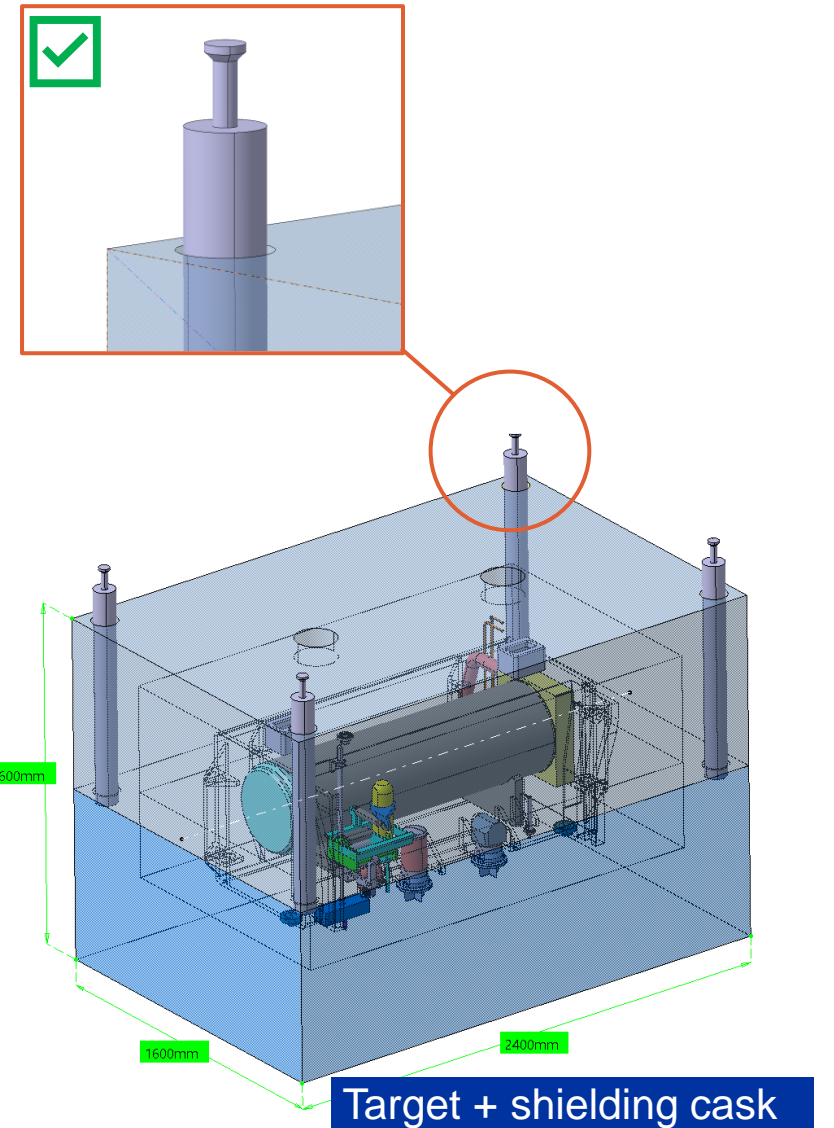
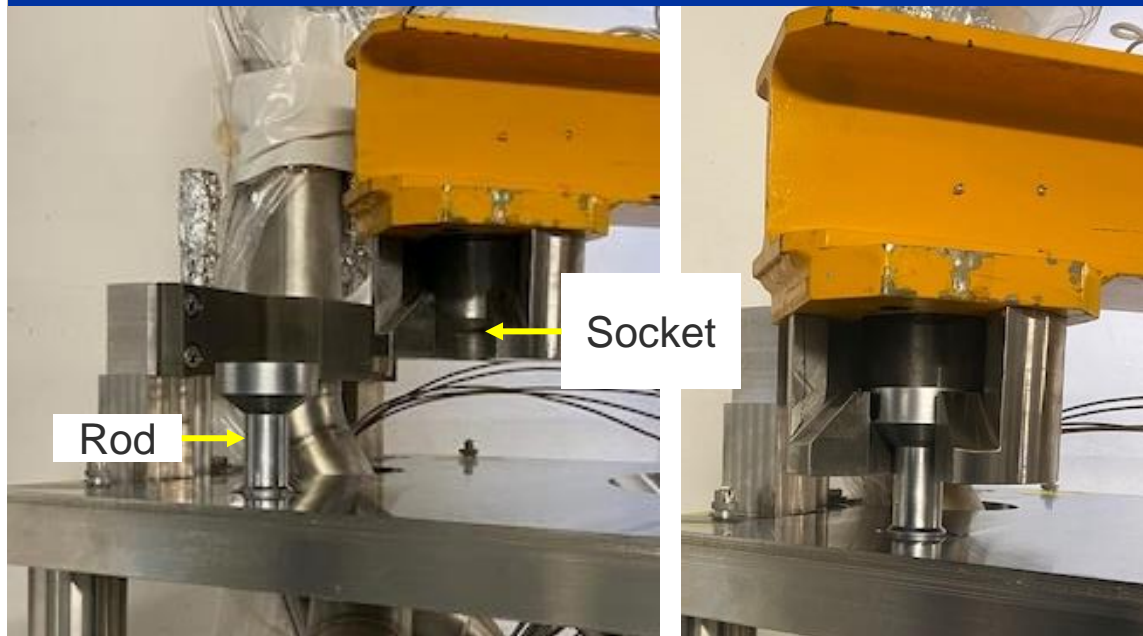


Custom designed lifting tools

CERN Remotely Compatible Lifting Interfaces:

- Mushroom-type rod (no mechanism needed)

Mushroom-type rod connection



Custom designed lifting tools

CERN Remotely Compatible Lifting Interfaces:

- Mushroom-type rod (no mechanism needed)
- Lifting hooks (no mechanism needed)

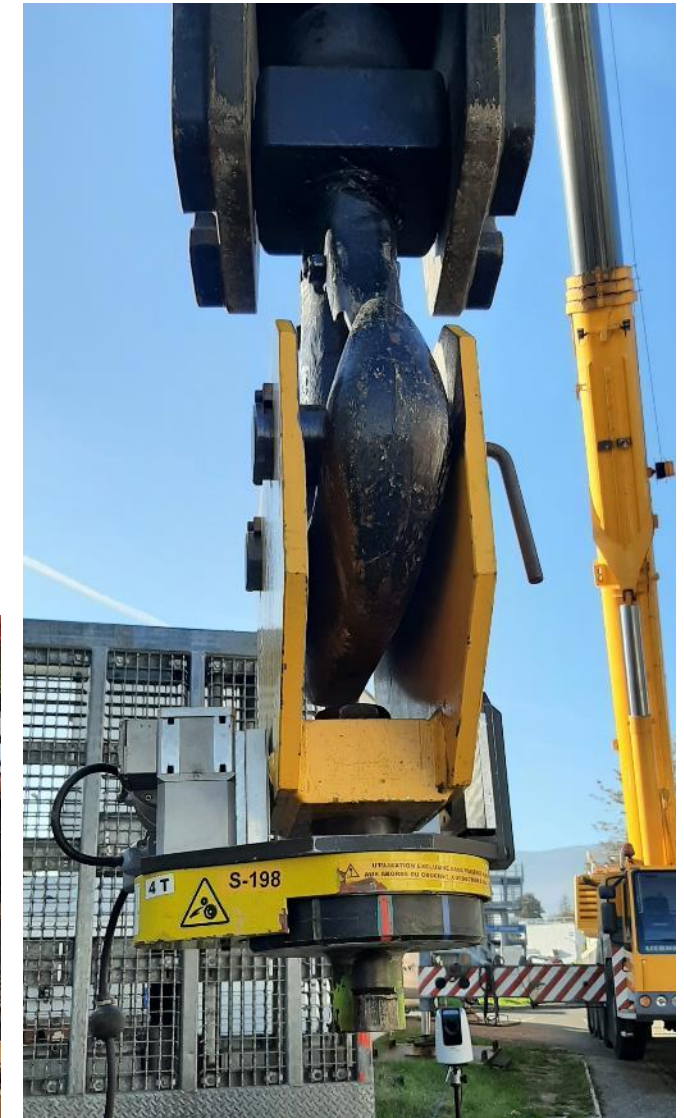


Lifting hooks and elevation axis

Custom designed lifting tools

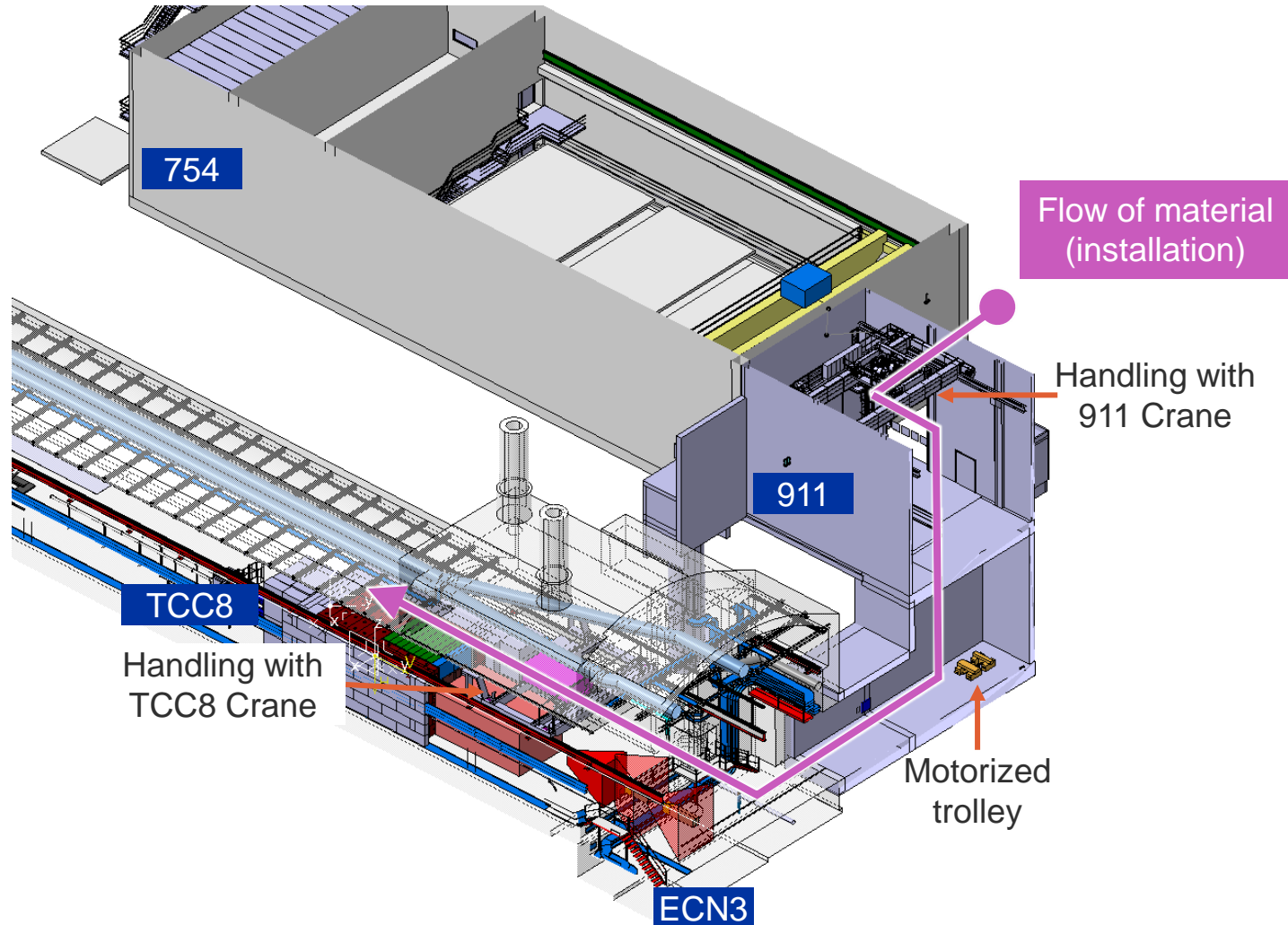
CERN Remotely Compatible Lifting Interfaces:

- Mushroom-type rod (no mechanism needed)
- Lifting hooks (no mechanism needed)
- Twist – lock mechanisms
- Design of the connectors driven by the shielding blocks that will be reused
- Solutions previously tested

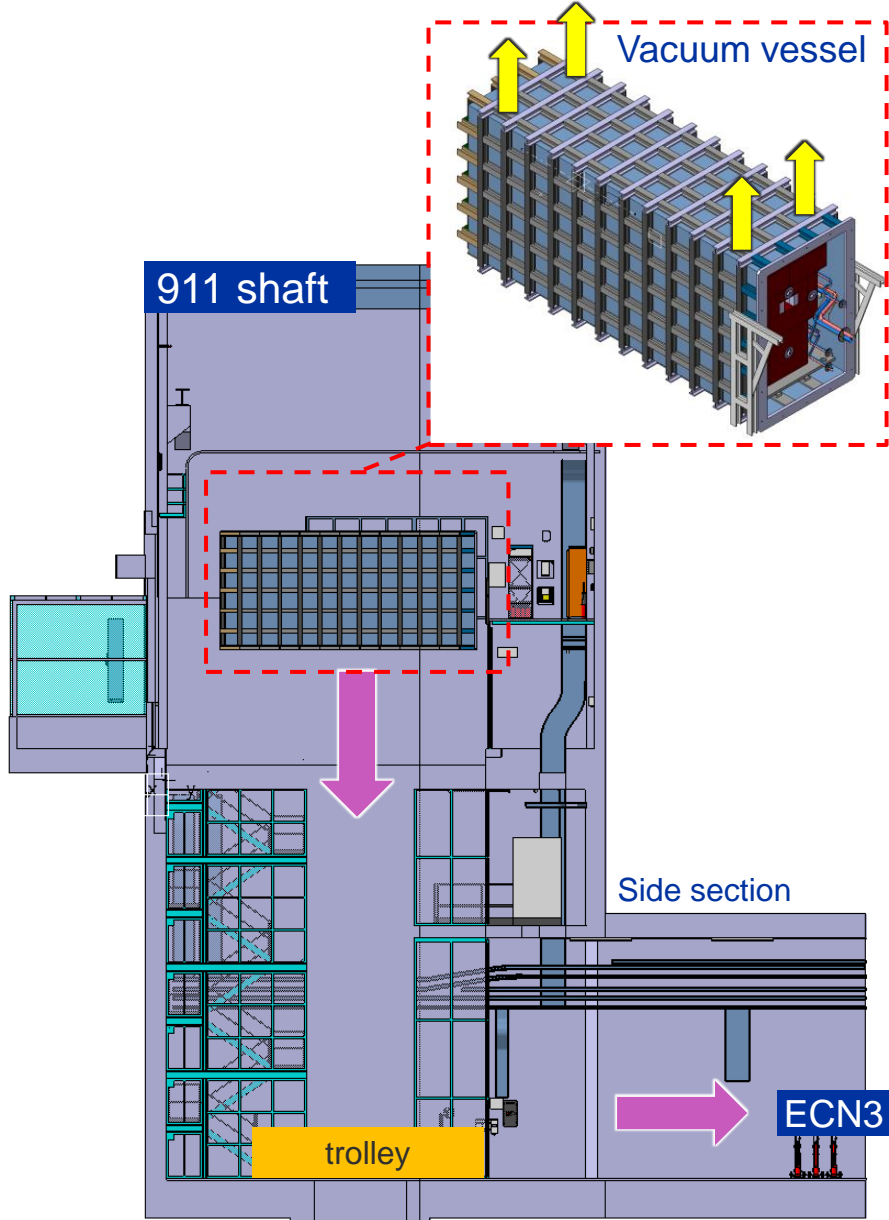
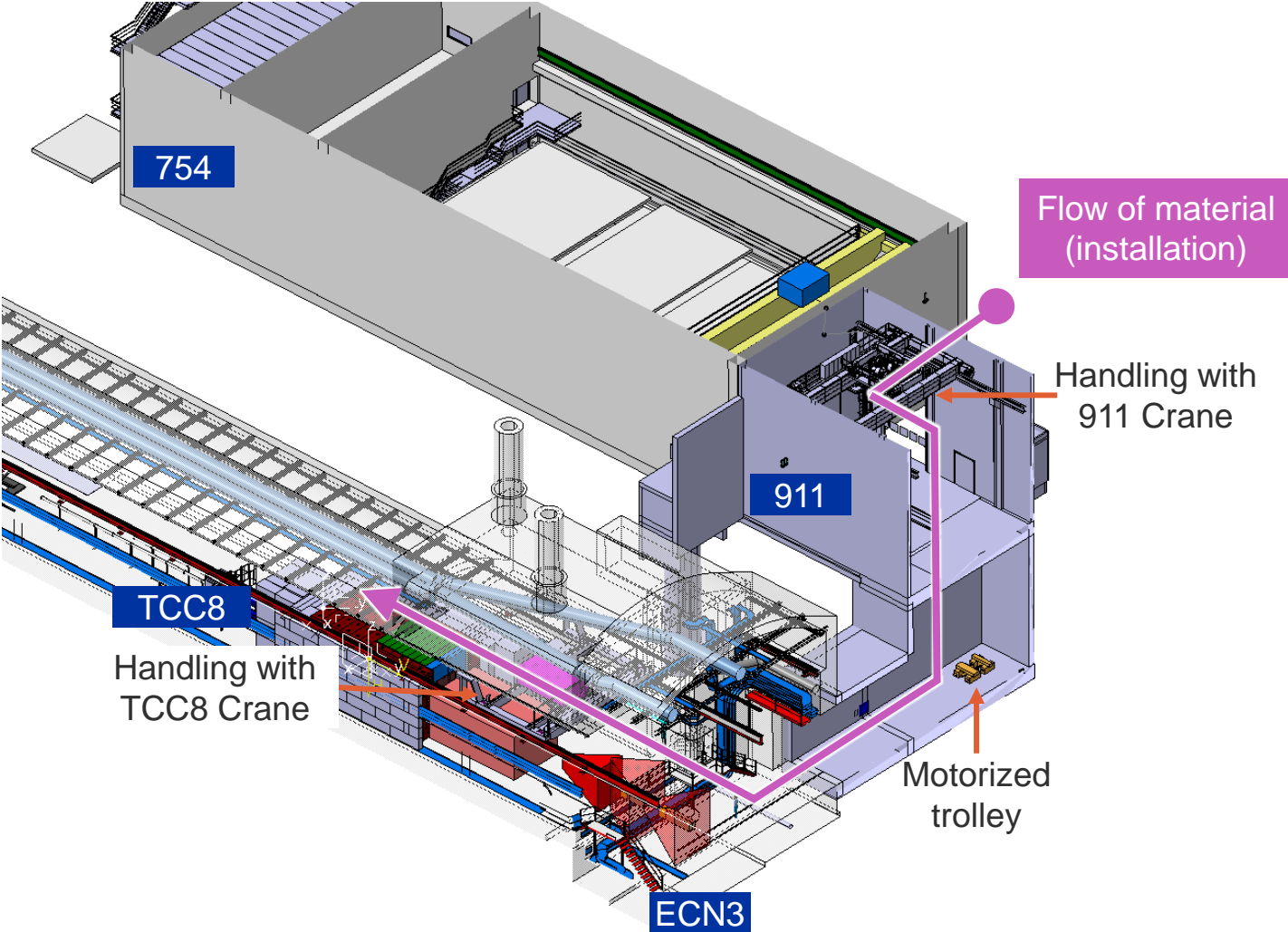


Lifting tools to handle shielding blocks remotely

Target installation sequence

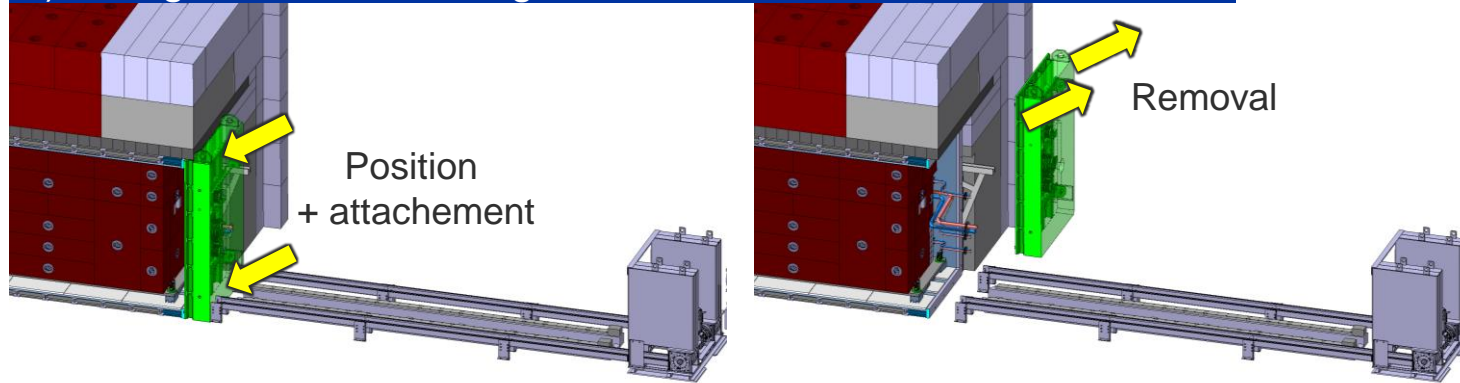


Target installation sequence

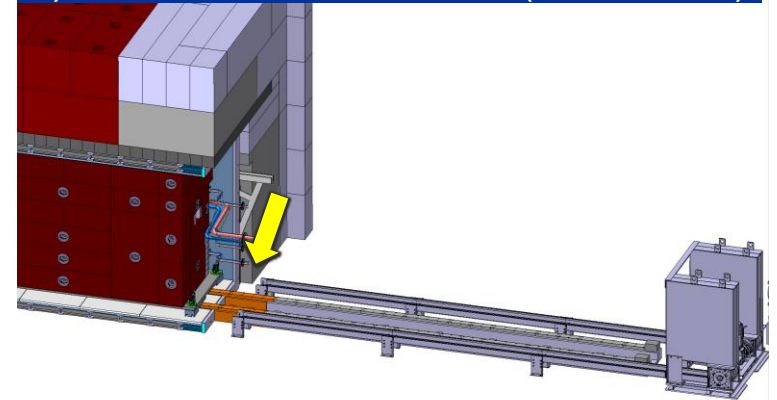


Target maintenance and exchange sequence

1) Lifting tool with shielding to remove the vacuum vessel door



2) Mobile rails installation (assistance)

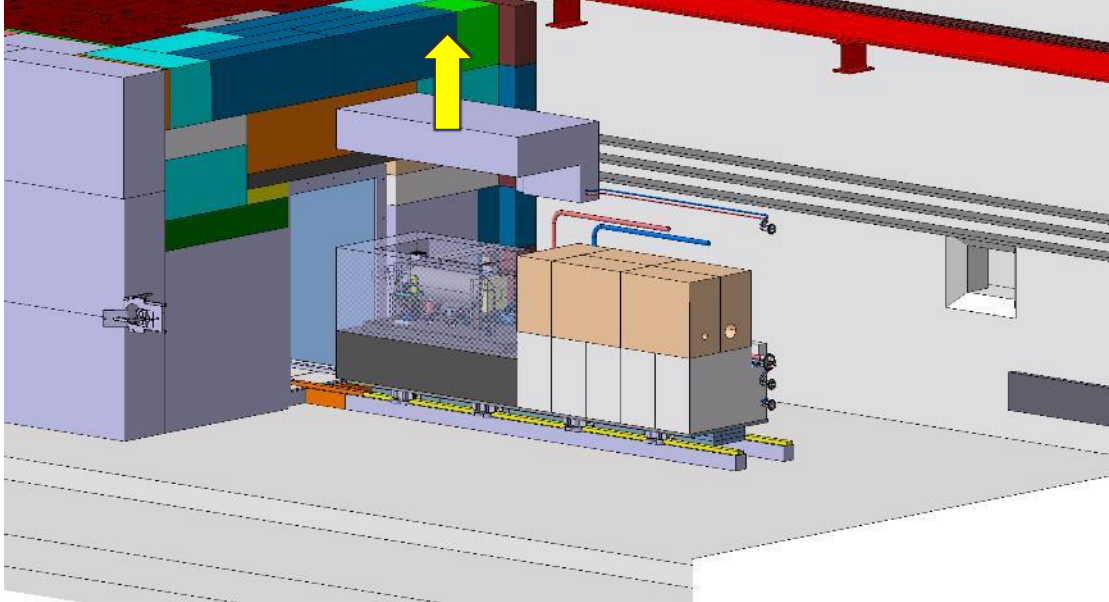


Actions

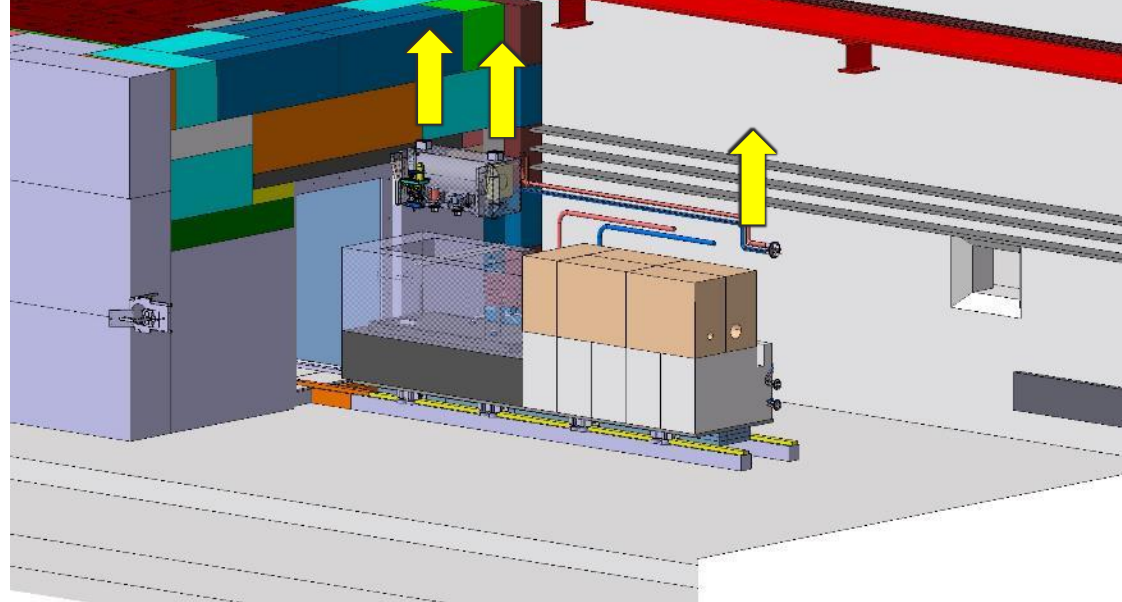
- Custom lifting tool with shielding to be handled with the crane
- Human intervention and/or robot operations to attach the lifting tool to the vacuum vessel door (*under study*)
- Door removal by remote handling (*under study*)
- Assist the mobile rails installation operation (*under study*)

Target maintenance and exchange sequence

3) Proximity shielding removal (remote)

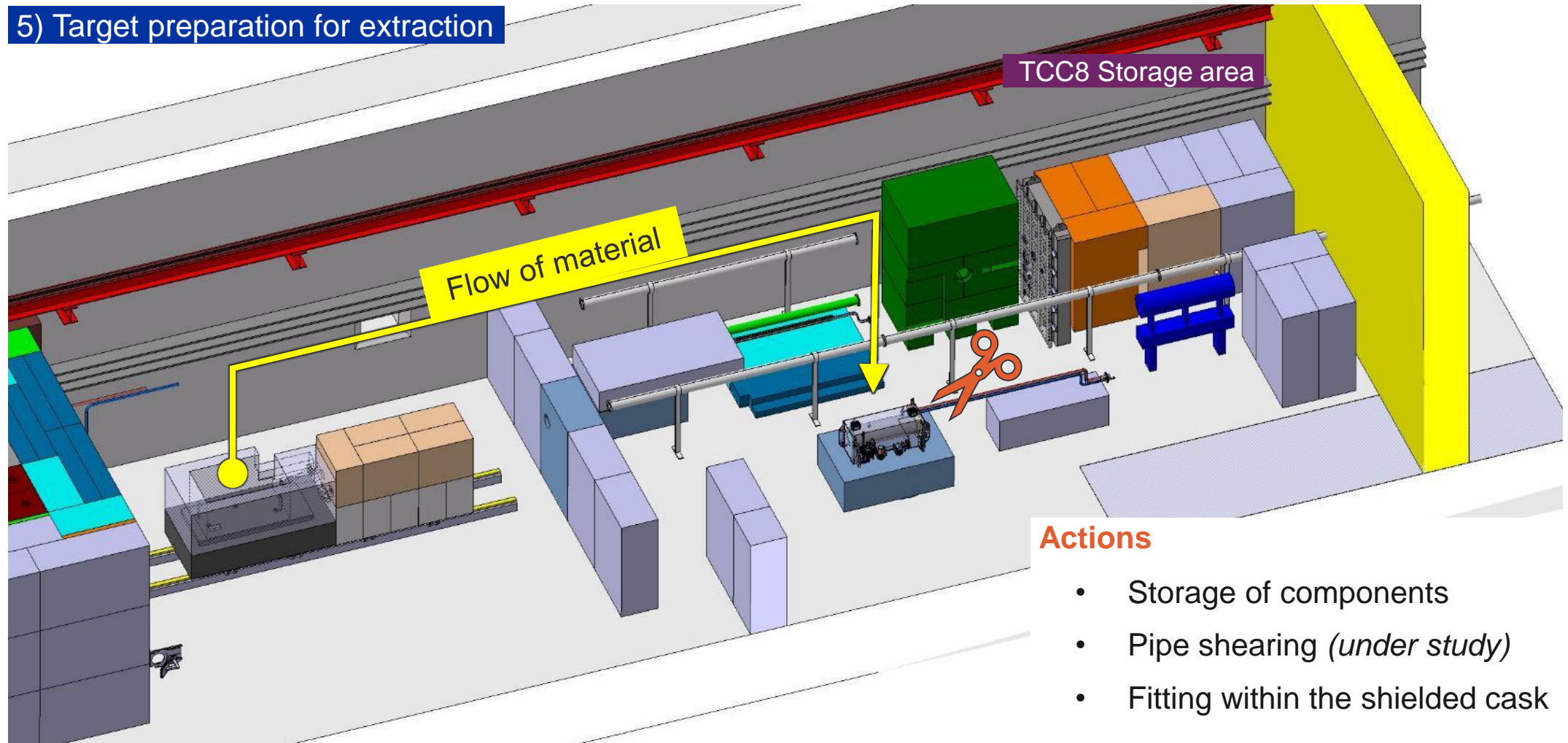


4) Target handling (remote)



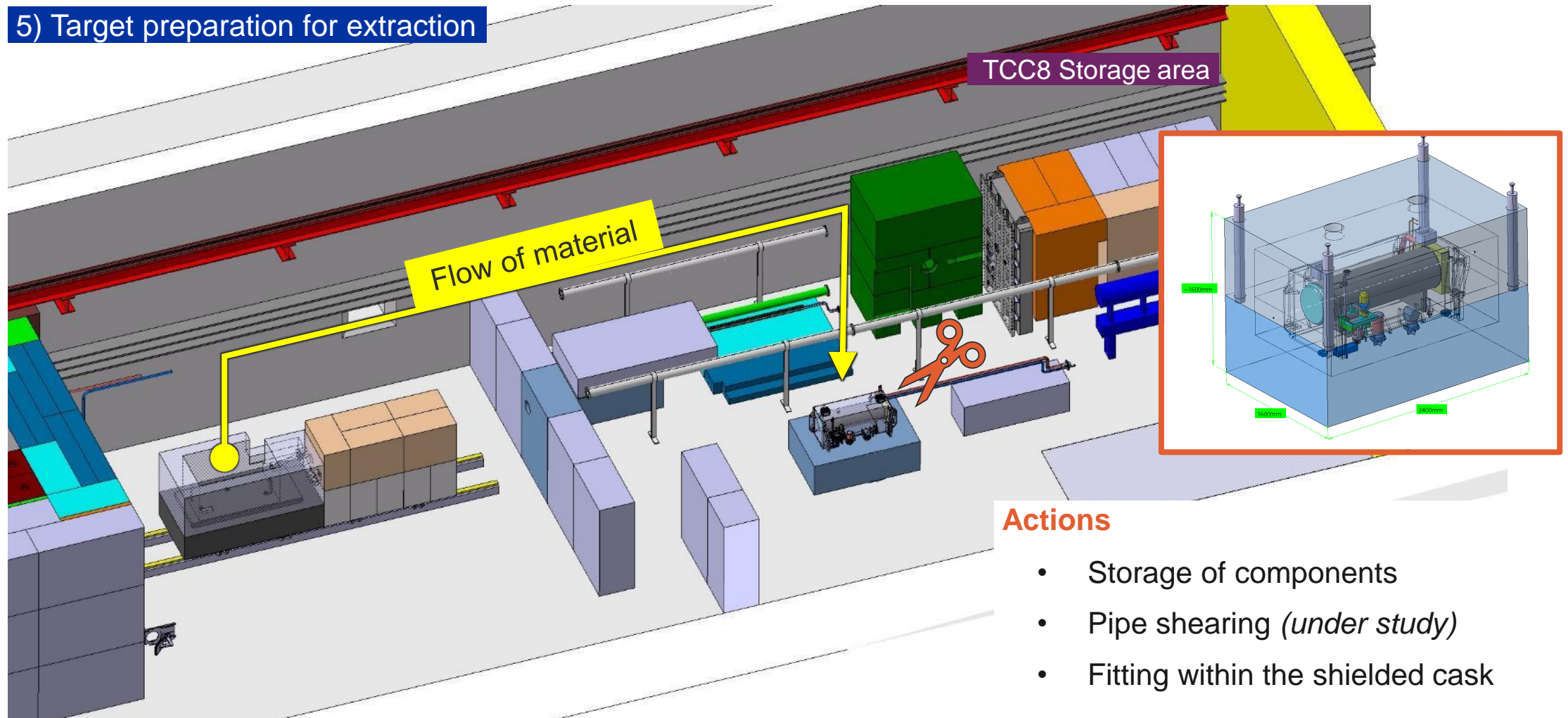
Target maintenance and exchange sequence

5) Target preparation for extraction



Target maintenance and exchange sequence

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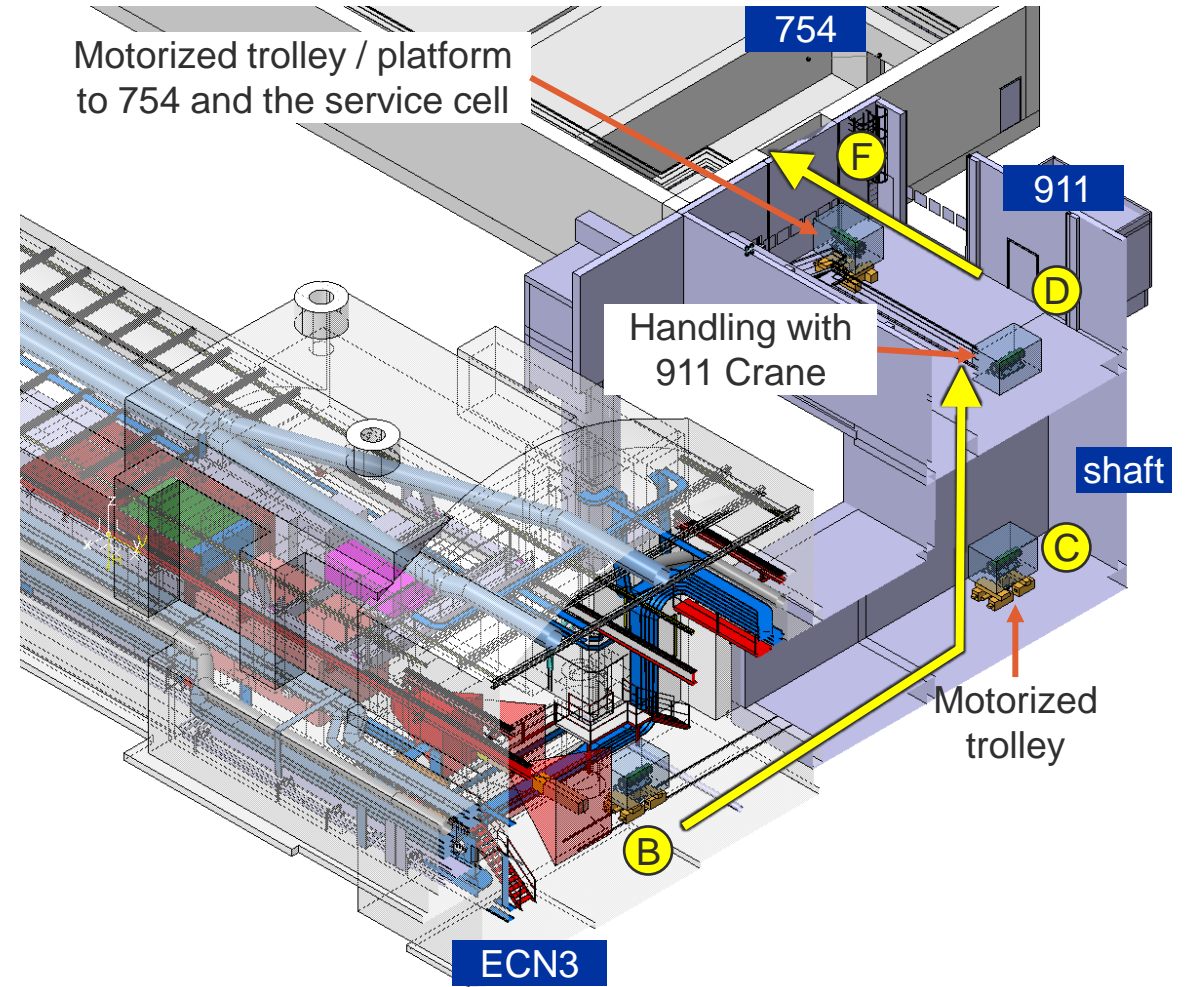
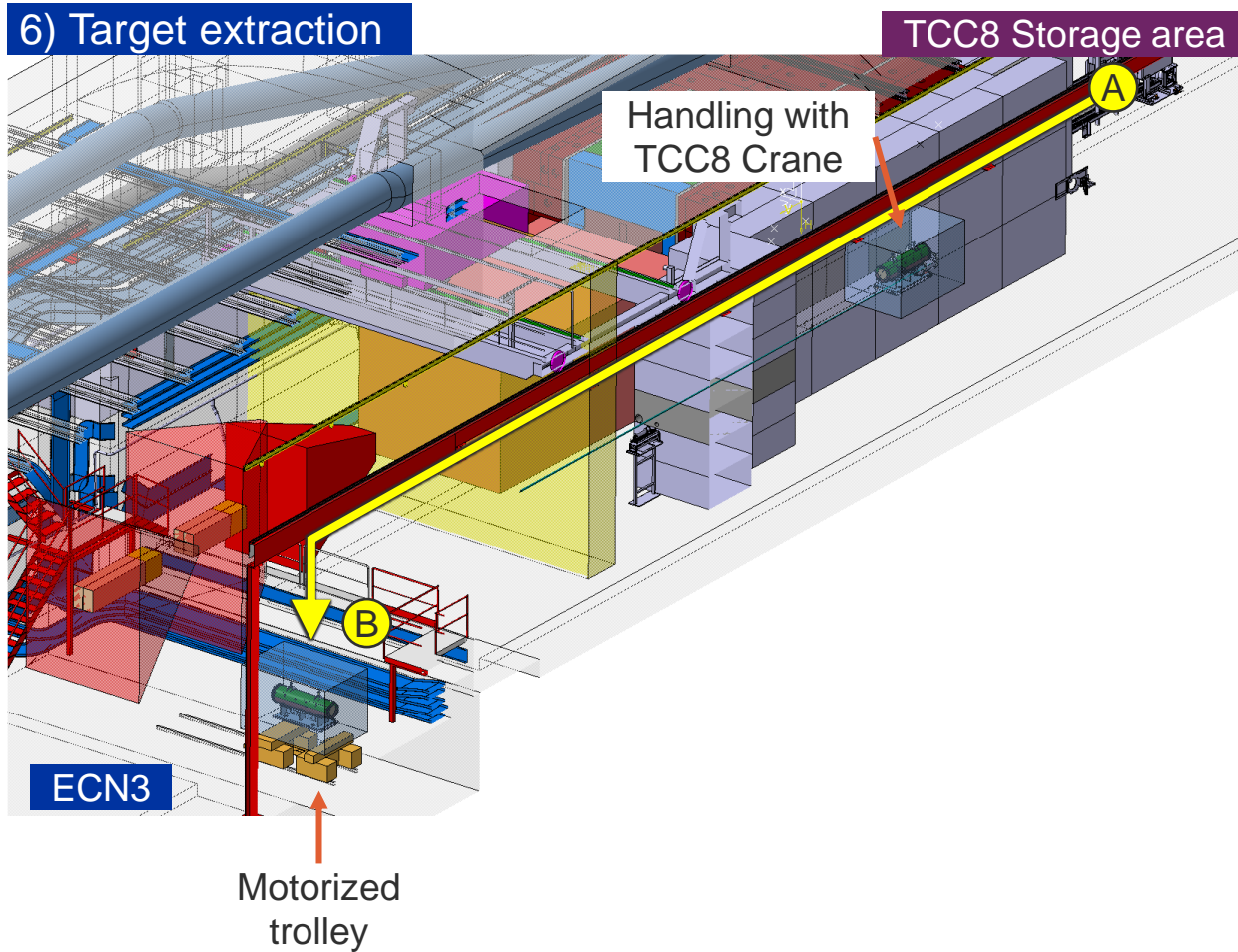


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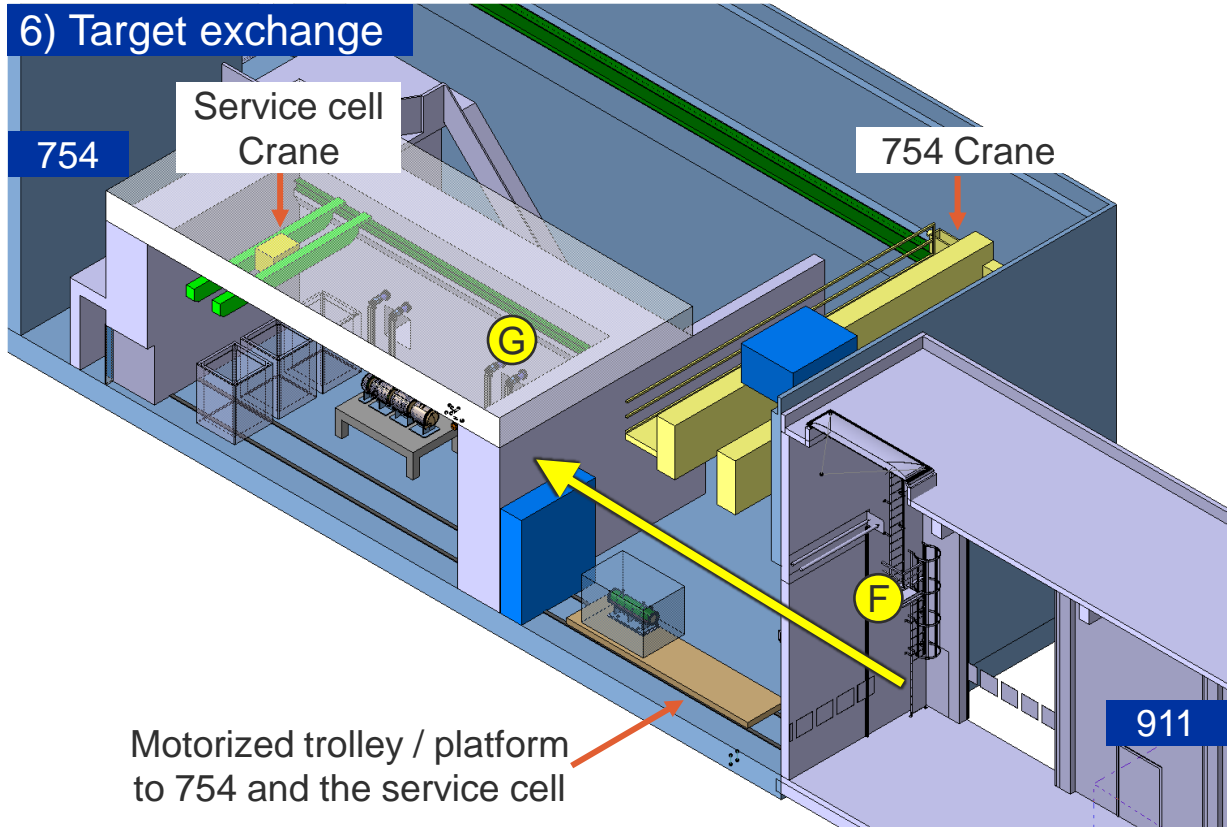
- Storage of components
- Pipe shearing (*under study*)
- Fitting within the shielded cask

Target maintenance and exchange sequence

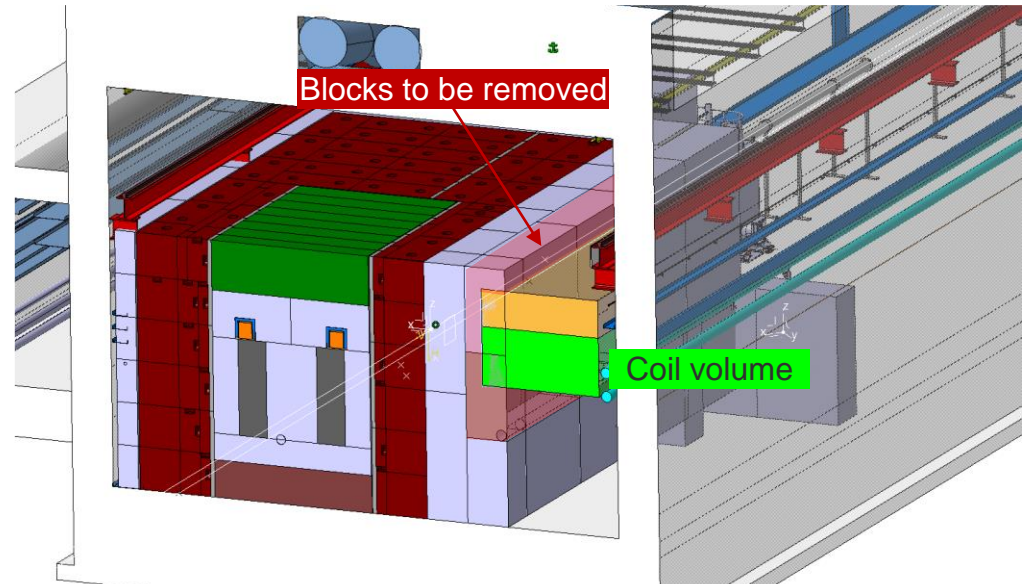
6) Target extraction



Target maintenance and exchange sequence



Coil exchange



Preliminary Target area crane failure scenarios

MECHANICAL PARTS

Fault	Probability	Severity	Consequence – Recovery method	Intervention		Duration of intervention	Preventive action
				Breakdown position	Parking zone (no exposition to radiation)		
Failure of the hoist motor	Medium	Low	Motor is not operational; emergency motor is switched on and the operation can be completed a lower speed	-	Yes	4 hours	Incoming fault can be identified during inspections (temperature measurement)
Failure of the service brake	Low	Low	The second service brake holds the load, and the operation can be completed	-	Yes (brake replacement)	4 hours	-
Hoist gearbox Failure of shaft, gear or key	Very low (1 case at CERN due to intensive use at a load exceeding capacity)	High	Drop of load is avoided by emergency brake; load slips ~40 cm before being stopped with a deceleration of 1 m/s ² . Intervention of personnel is required to manually lay the load on the ground	Yes (load laying)	Yes (gearbox replacement)	Load laying: • 2 hours Gearbox replacement: • 4 days	<ul style="list-style-type: none"> Additional inspections: noise measurement and oil analysis Oversizing: Gearbox designed as if it was used in a heavy-duty crane (continuous use at full load)
Rope failure	Very low	Medium	The entire load is sustained by the second rope (swaying); the load can be safely laid on the ground	-	Yes	1 day	Incoming fault can be identified during visual inspections
Failure of the cross-travel or long-travel motor	Medium	Low	Motor is not operational; emergency motors are switched on and the operation can be completed a lower speed	-	Yes	4 hours	Incoming fault can be identified during inspections (temperature measurement)
Cross-travel or long-travel gearbox Failure of shaft, gear or key	Very low	Low	The second motor-gearbox is used to complete the operation	-	Yes	1 day	Additional inspections: noise measurement and oil analysis
Gearbox - seized bearing	Very low (never happened before at CERN)	High	Intervention of personnel is required to mechanically disconnect the gearbox from the wheel and allow the completion of the operation	Yes (gearbox disconnection)	Yes (gearbox replacement)	Gearbox disconnection: • 2 hours Gearbox replacement: • 1 day	Incoming fault can be identified during inspections (noise measurement)

Preliminary Target area crane failure scenarios

MECHANICAL PARTS

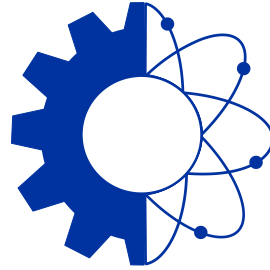
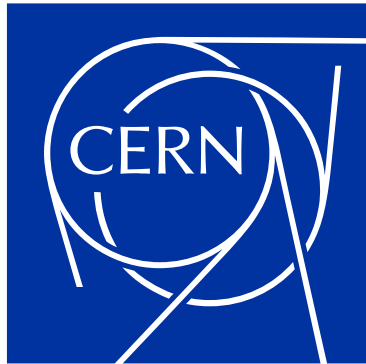
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Rope failure	Very low	Medium	The entire load is sustained by the second rope (swaying); the load can be safely laid on the ground	-	Yes	1 day	Incoming fault can be identified during visual inspections
Failure of the cross-travel or long-travel motor	Medium	Low	Motor is not operational; emergency motors are switched on and the operation can be completed a lower speed	-	Yes	4 hours	Incoming fault can be identified during inspections (temperature measurement)
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Preliminary Target area crane failure scenarios

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Gearbox – cross travel Seized bearing	Very low (never happened before at CERN)	High	Intervention of personnel is required to mechanically disconnect the gearbox from the wheel and allow the completion of the operation	Yes (gearbox disconnection)	Yes (gearbox replacement)	Gearbox disconnection: • 2 hours Gearbox replacement: • 1 day	Incoming fault can be identified during inspections (noise measurement)

Preliminary Target area crane failure scenarios

ELECTRICAL AND CONTROL SYSTEM							
Fault	Probability	Severity	Consequence – Recovery method	Intervention		Duration of intervention	Preventive action
				Breakdown position	Parking zone (no exposition to radiation)		
Thermal relay tripping or generic fault in the control system	Medium	Low	Maintenance personnel intervenes in the control panel for troubleshooting or parts replacement	-	-	Depending on the type of breakdown	-
Inverter fault	Low	Low	An override is possible for any inverter from the control panel; the operation can be completed with direct motor start-up	-	-	-	-
Load cell fault	Medium	Low	The crane is equipped with a redundant overload system (electro-mechanical switch) which guarantees that the operation can be safely completed	-	Yes	1 day	-



**ENGINEERING
DEPARTMENT**

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