



1st Beam Dump Facility (BDF) Targetry Systems Advisory Committee (TSAC)

# Overview of currently envisaged robotic tasks for Target Systems

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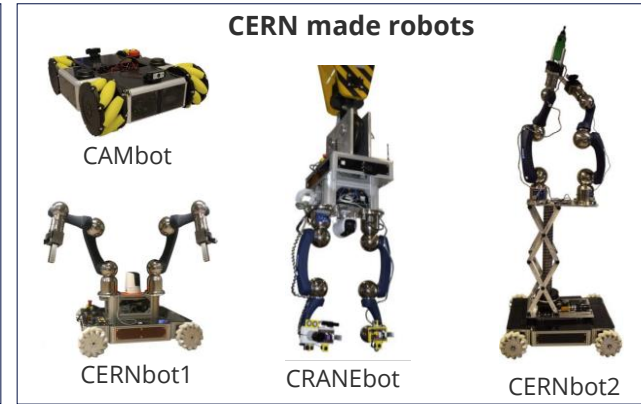
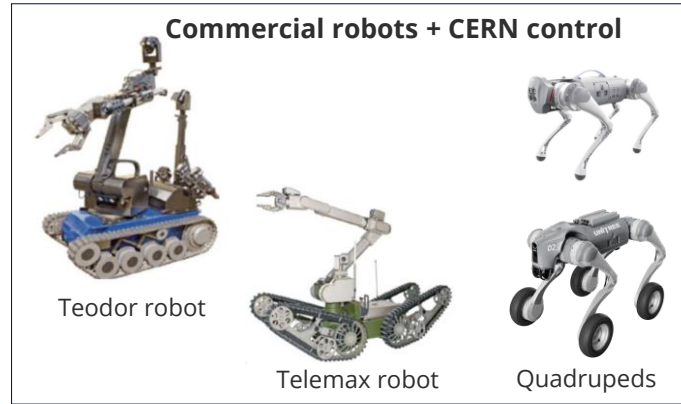
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# CERN Robotic Service within BE-CEM-MRO

## Main tasks:

- Remote maintenance
- Quality assurance
- Post-mortem analysis
- Safety
  - ✓ Reconnaissance
  - ✓ Search and rescue



4x TIM operated by TI

Operation of 3x Kuka Robots in ISOLDE-Medicis

NA80 Robot

**Robot tools**

2x SPS robot

CHARM robot





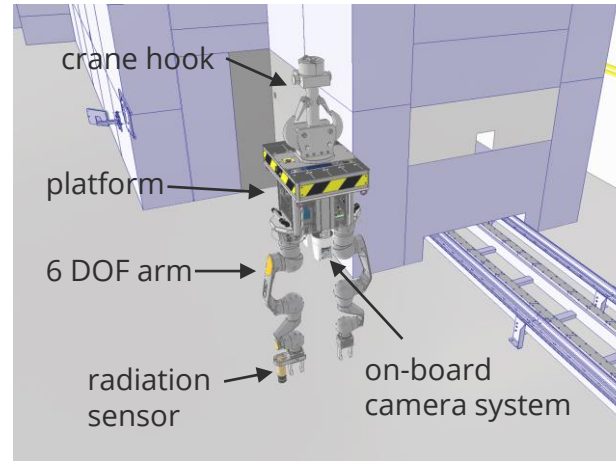
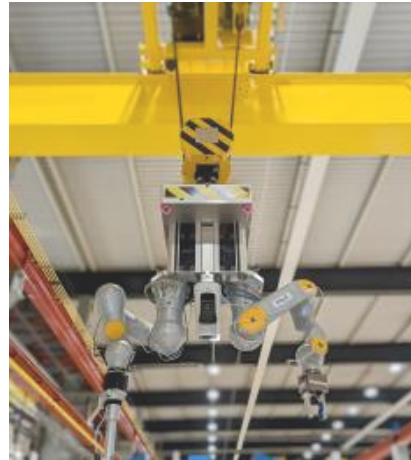
# Target complex inspection

## Setup proposal:

CRANEbot + radiation sensor

## Available features:

- ✓ HD Images
- ✓ HD video recording
- ✓ Distance detection and radiation mapping
- ✓ 3D mapping
- ✓ Thermal camera for leak detection

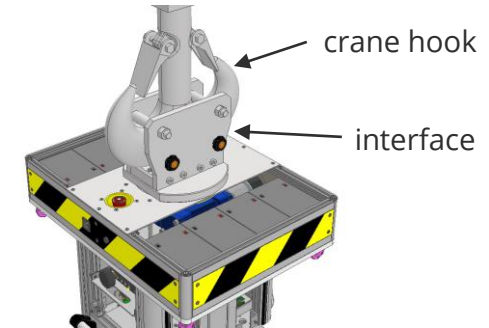


## Development needs:

- Specific crane hook interface

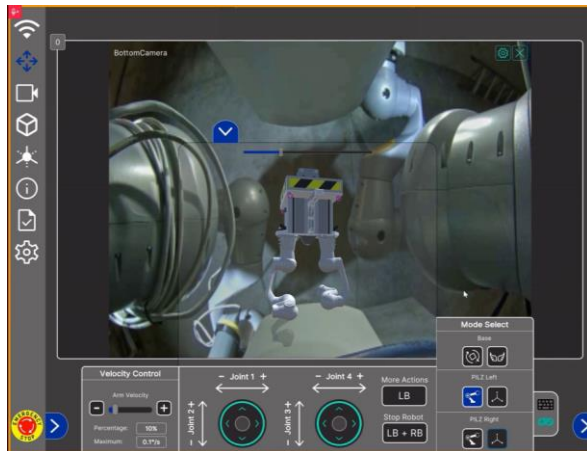
## Infrastructure needs:

- Wi-Fi or 4G/5G
- Crane ethernet connection (whished but not mandatory)

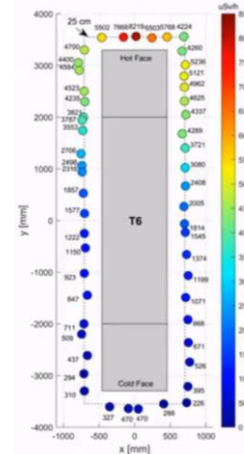


## Remote inspection examples

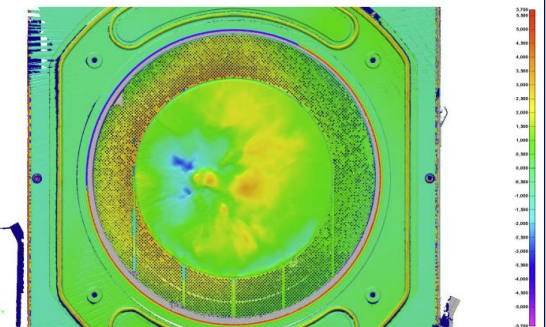
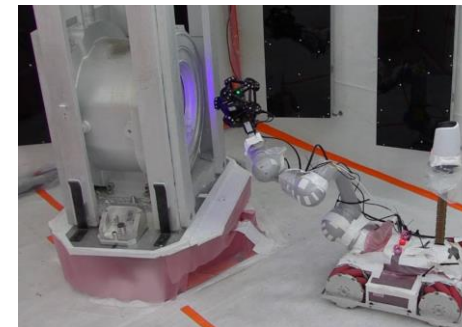
Visual inspection in CERN North Area



Radiation mapping of the VXSS vacuum chamber



n\_TOF target #2 3D scan



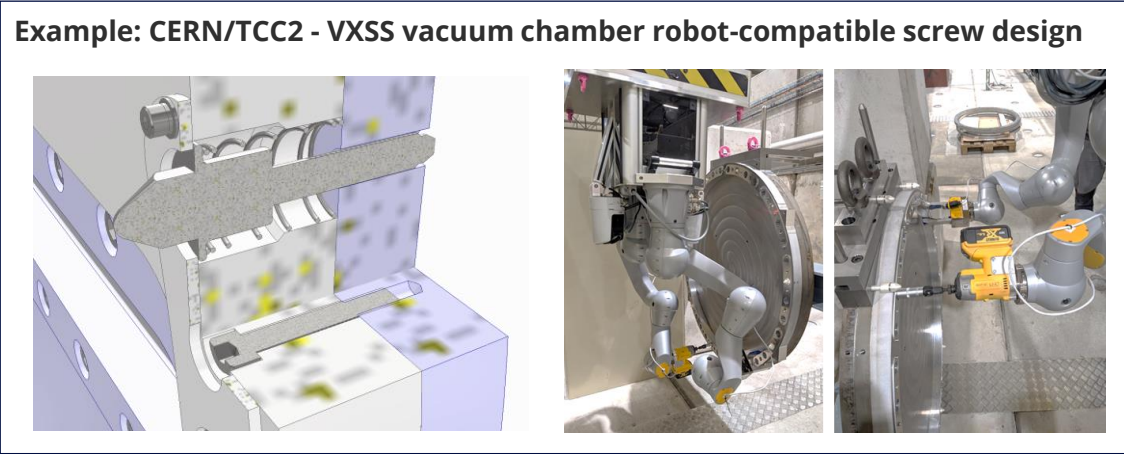
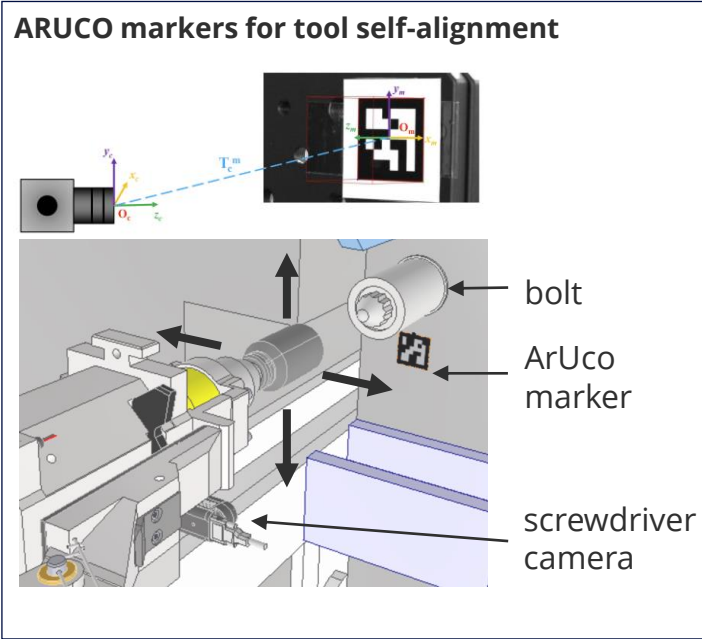
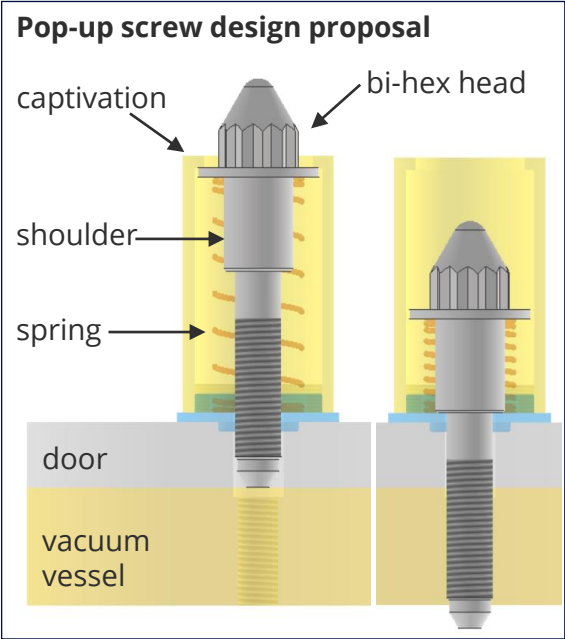
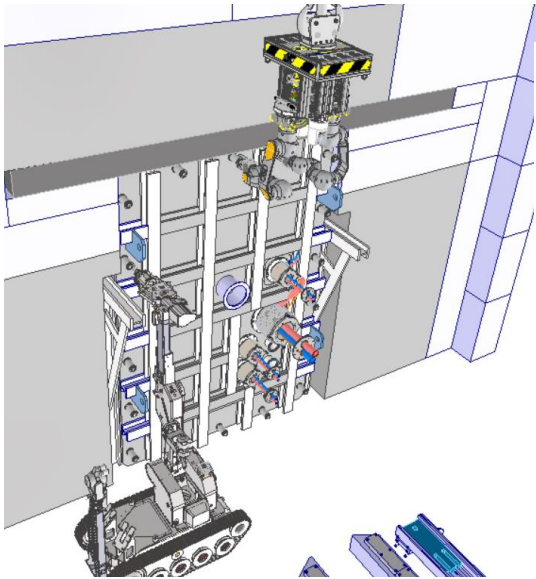
# Vacuum vessel door opening – Door bolting

**Design proposals:**

- Pop-up screw + over head captivation
- Bi-hex head
- ArUco markers
- Smartbolt integration

**Inputs required:**

- Bolt size
- Tightening torque and accuracy
- Screwing sequence





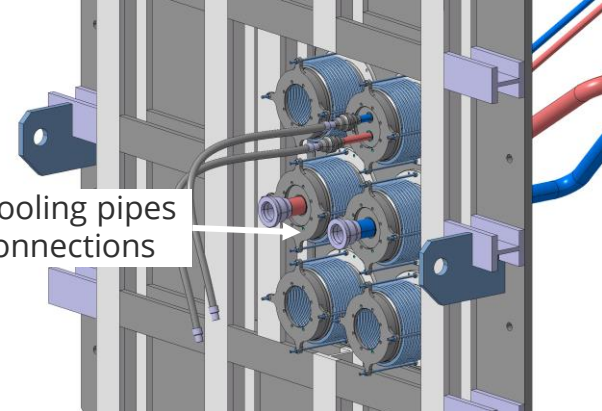
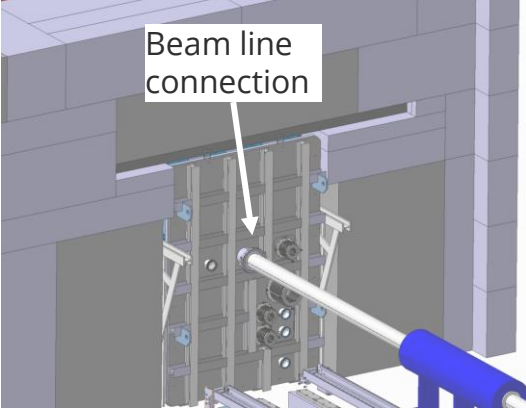
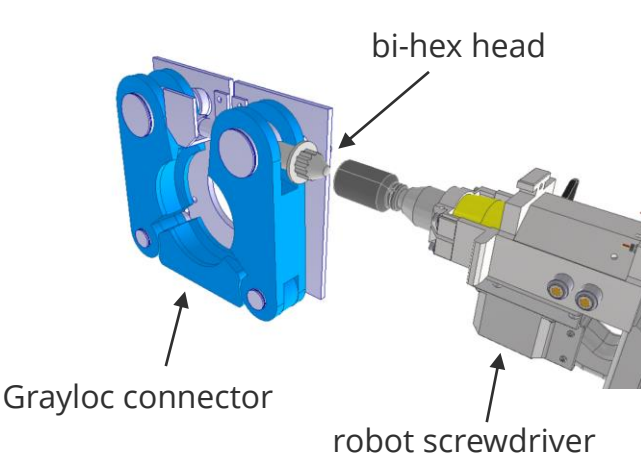
# Vacuum vessel opening - Feedthrough connections

**Design proposals:**

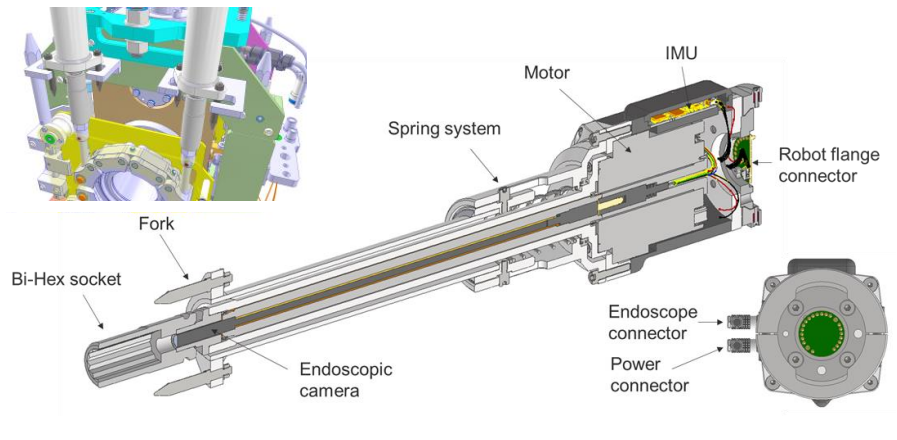
- Same hex head size of the door bolts
- Mechanical interface (torque holder)
- Other connectors: Vector Optima

**Inputs required:**

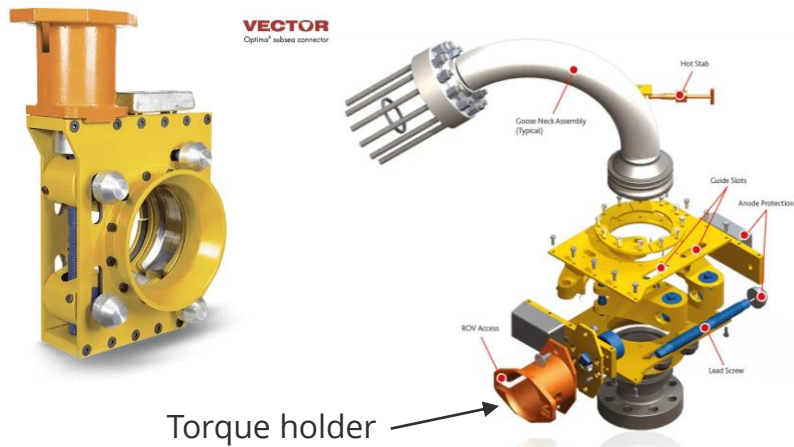
- Connector positions
- Tightening torque and accuracy



**Tool example: CERN made robotic screwdriver for UHV chain clamps tightening**



**VECTOR OPTIMA connector with integrated torque holder**



# Target trolley extraction – Push/pull chain mechanism connection

**Current design:**

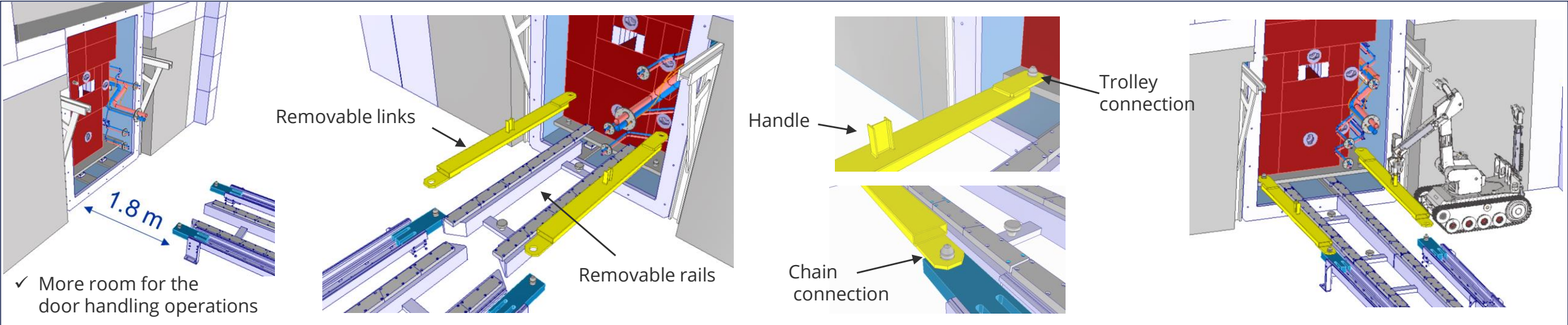
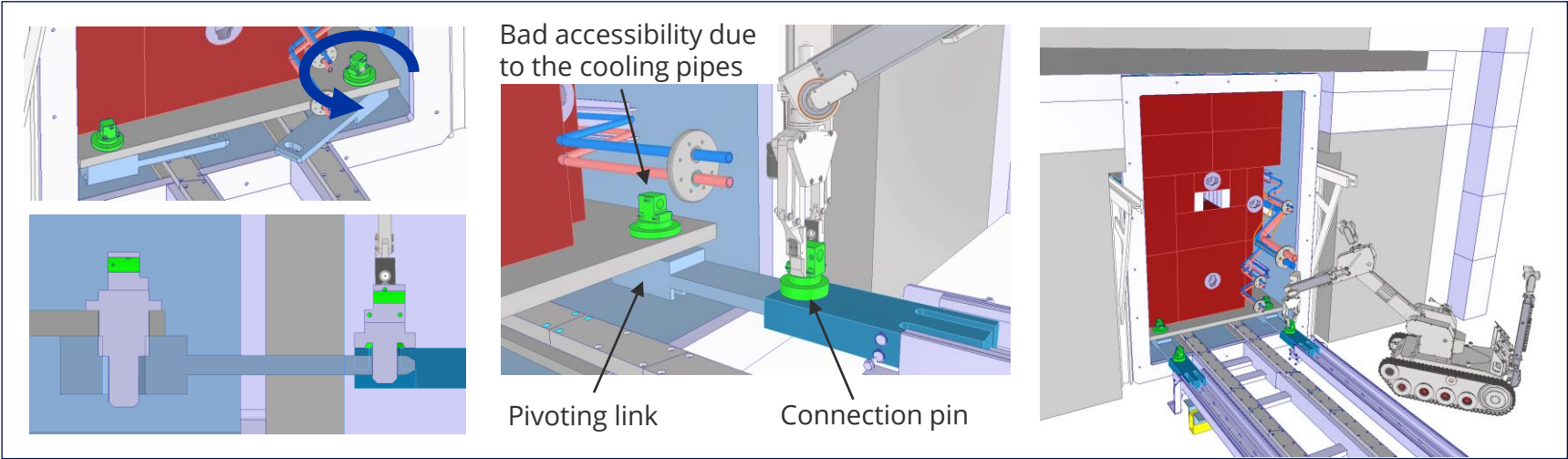
Pivoting links folded under the trolley:

- Multiple steps required
- Complex accessibility of the pivoting links interfaces

**Design proposal:**

Longer removable links:

- Simpler and more accessible connection
- More room for handling operations
- Details to be finalized





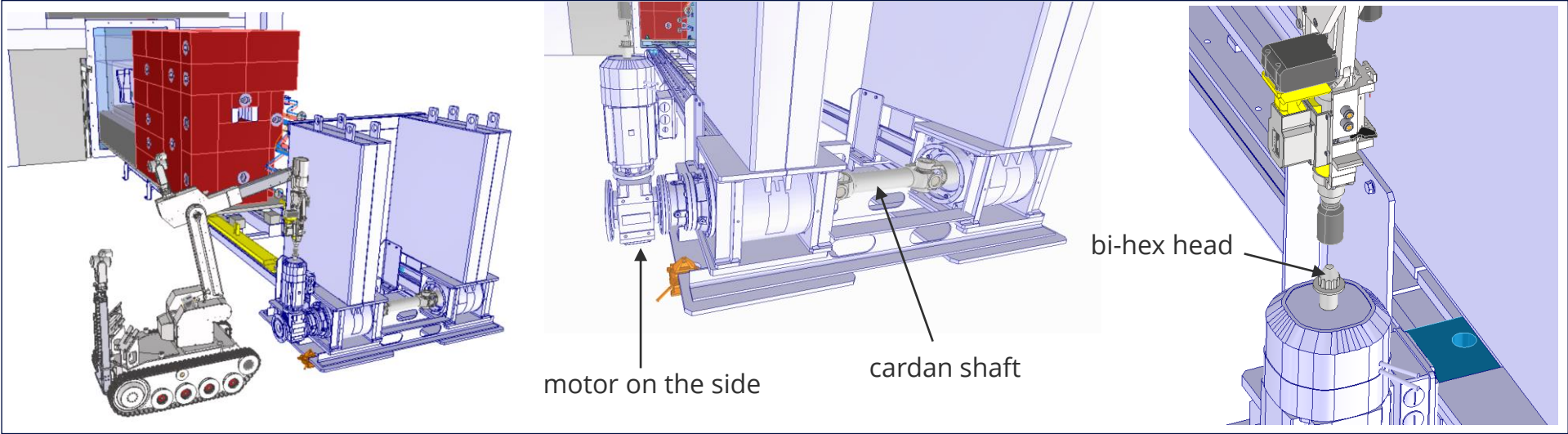
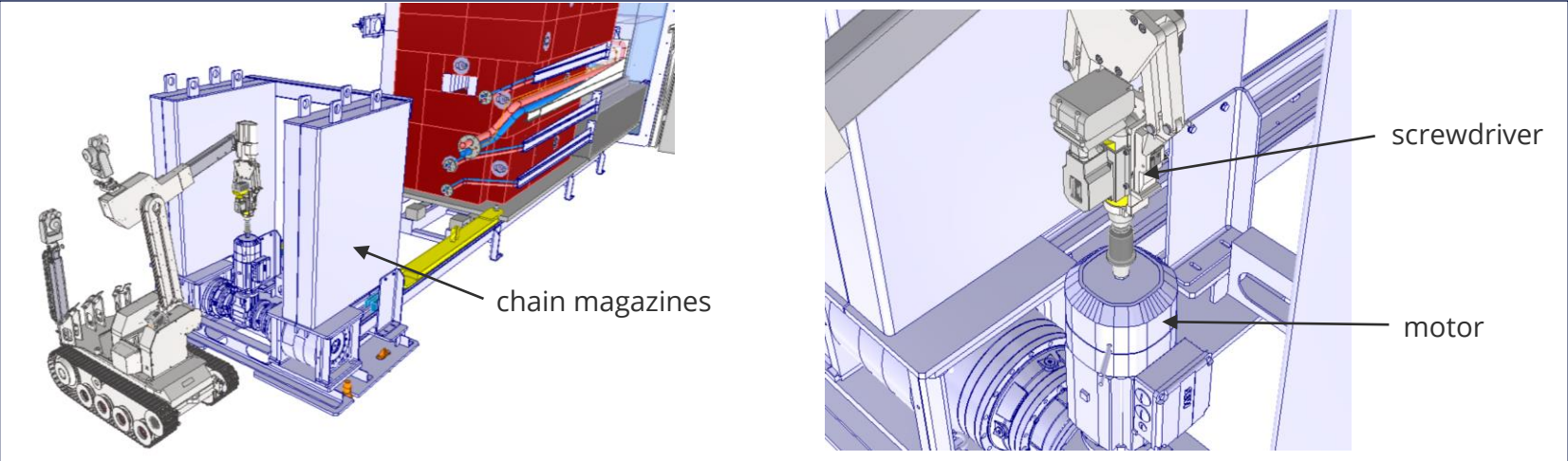
# Push/pull chain mechanism actuation - motor failure recovery scenario

**Current design:**

- Motor between the chain magazines

**Design proposals:**

- Same hex head size of the door bolts +  
1) Motor on the side + cardan shaft  
    between the chain mechanisms  
    (preferred solution for robot accessibility)  
- Details to be finalized



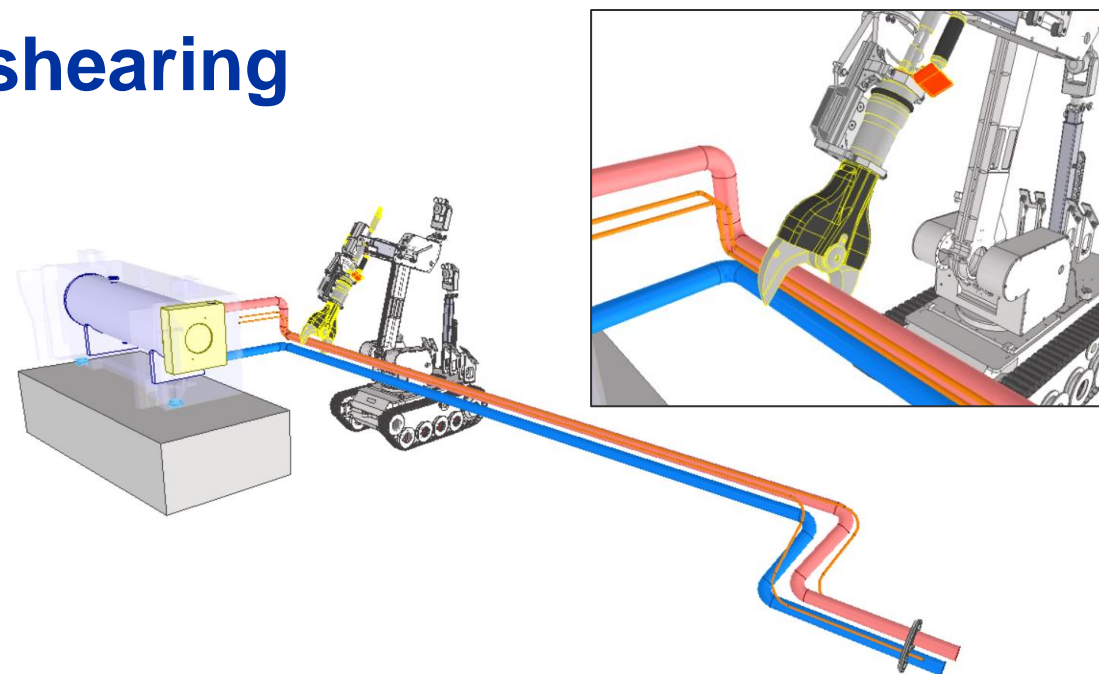
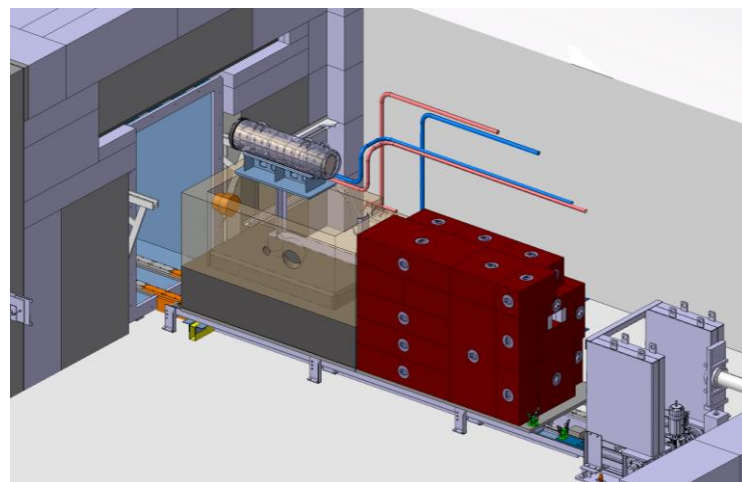
# Target final disposal - cooling pipes shearing

## Setup proposals:

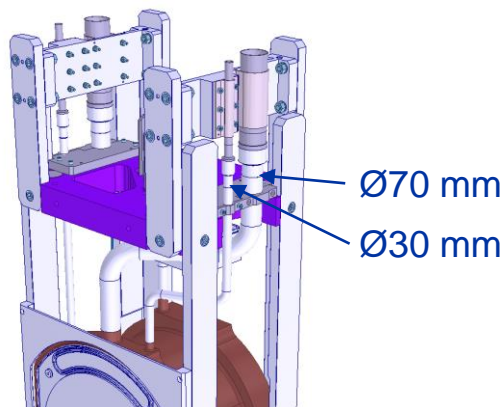
- Robot +
  - 1) Hydraulic shears
  - 2) Electric shears (preferred)
- Depending on detailed needs

## Inputs required:

- Cutting section position
- Final pipes sizes



## Tool example: n\_TOF target #2 cooling pipes cutting using hydraulic shears



## Shears comparison

F180 N + hydraulic pump – 700 bar

F130N T30 Cordless



Blade opening

180 mm

130 mm

Cutting capacity (S235JR rod)

Ø 28 mm

Ø 24 mm

# General infrastructure needs based on current requirements

- **Utilities for robot operations**

- Power sockets, compressed air (if portable solution can't be found)
- Communication: Wi-Fi, 4G/5G, ethernet
- Robot accessibility
- Navigation markers
- Vision system: environmental cameras mechanical quick connections

- **Control room**

- For the currently requested tasks, the robots can be controlled from any location at CERN. However, also in view of the control room for the service cell, these tasks could be supervised/controlled from there (currently, BE-CEM has not received any requests for the use of robots in the service cell).
- CRANEbot control station (possibly next to the crane control)



Automated gate crossing using ArUco marker in the SPS tunnel



Battery powered camera used in MEDICIS and ISOLDE



SPS robot supervision from the CERN Control Centre (CCC)



# Future works

- **Need to have finalization of the robotic requirements → optimal workforce/personnel allocation**
- **Tasks analysis**
- **Robot and tools selection/design + integration + control**
  - Robots and their topology (modularity analysis)
  - Tools definition and integration and/or development
  - Robot compatible mechanical interfaces
  - Controls for supervision of teleoperation (safety and efficiency)
- **Depending on final requirements, possible integration of a tools exchange station**
  - In-situ tool exchanger (handled by overhead crane)
  - Tool exchanger on board the robot
- **Intervention procedures, redundancy and recovery scenarios**





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