

# Engineering Development: Remote Handling & Robotics

Present and past projects, internal  
capabilities, partners and support needs

Jon M Montgomerie, October 2020

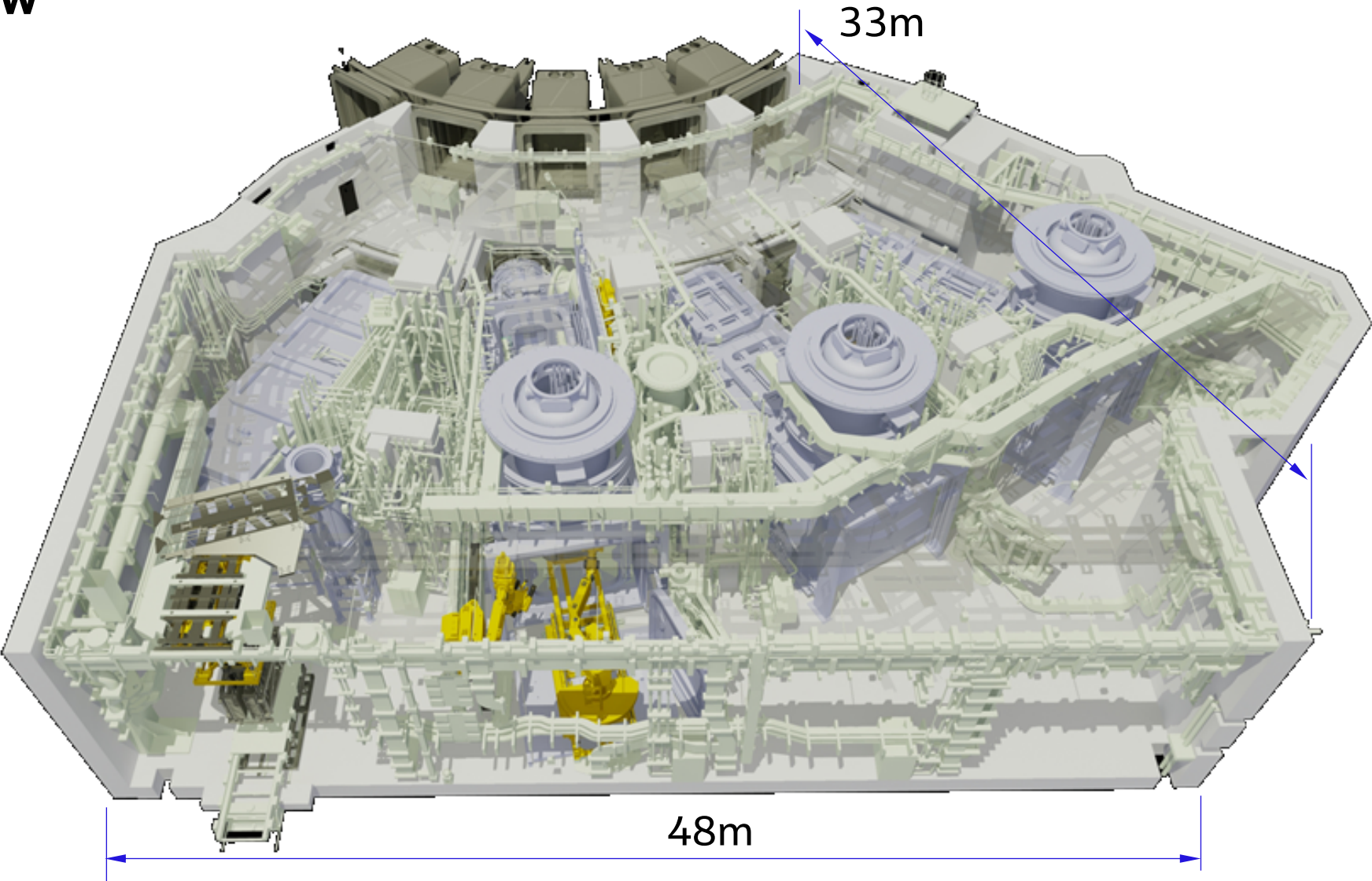
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# **Present project examples ...**

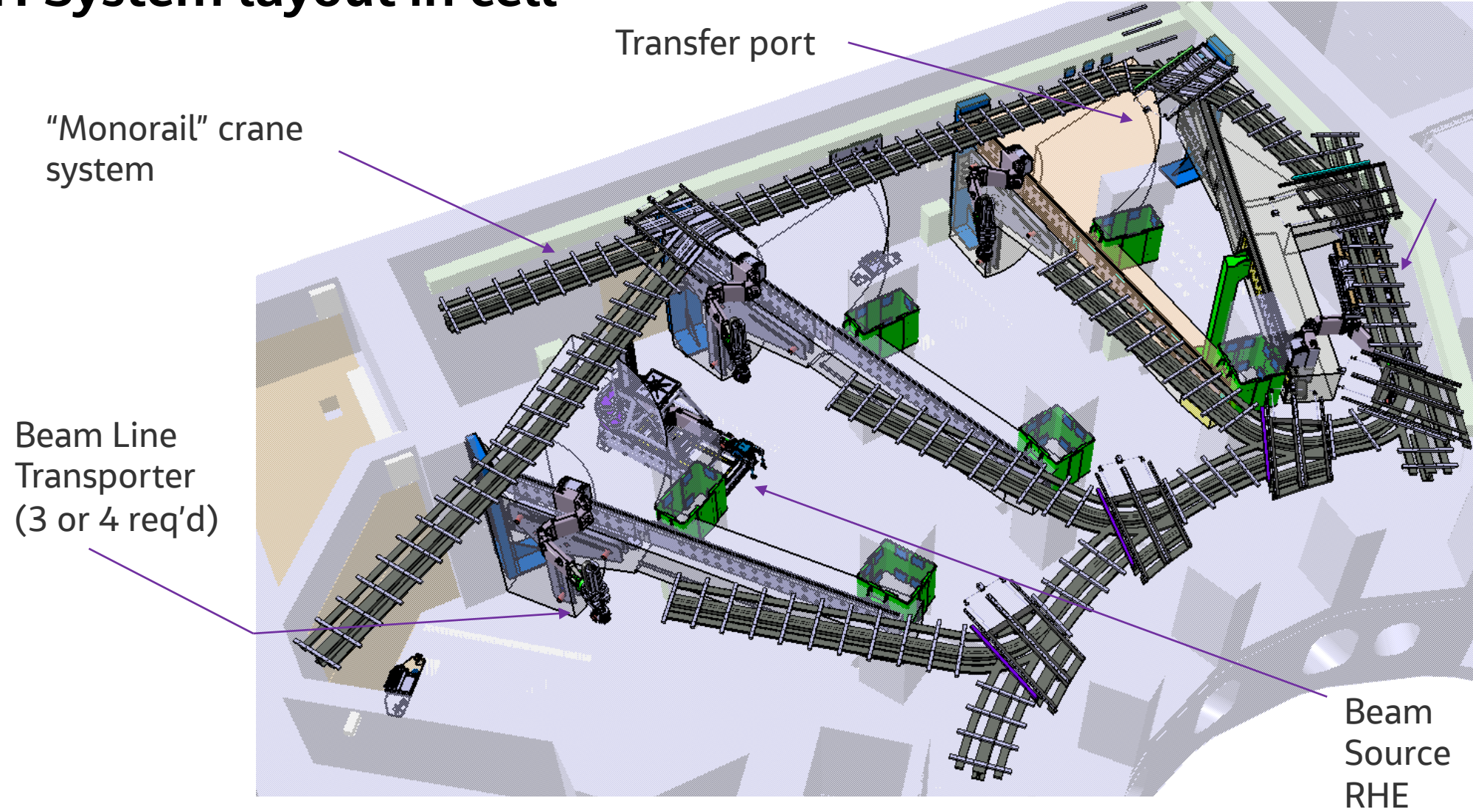
ITER Neutral Beam Remote Handling System

# NB cell overview



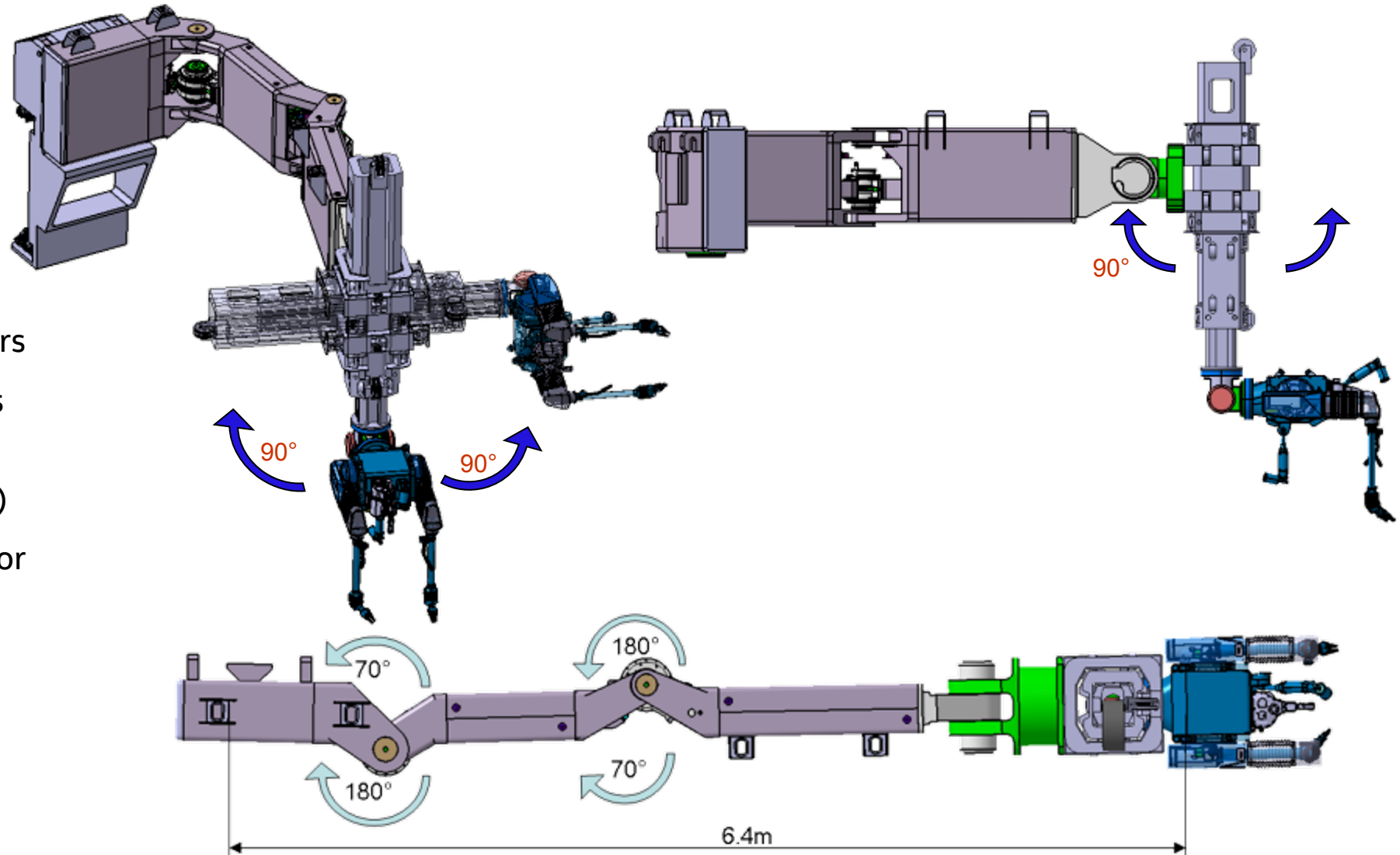


# RH System layout in cell



# Beam Line Transporter (BLT)

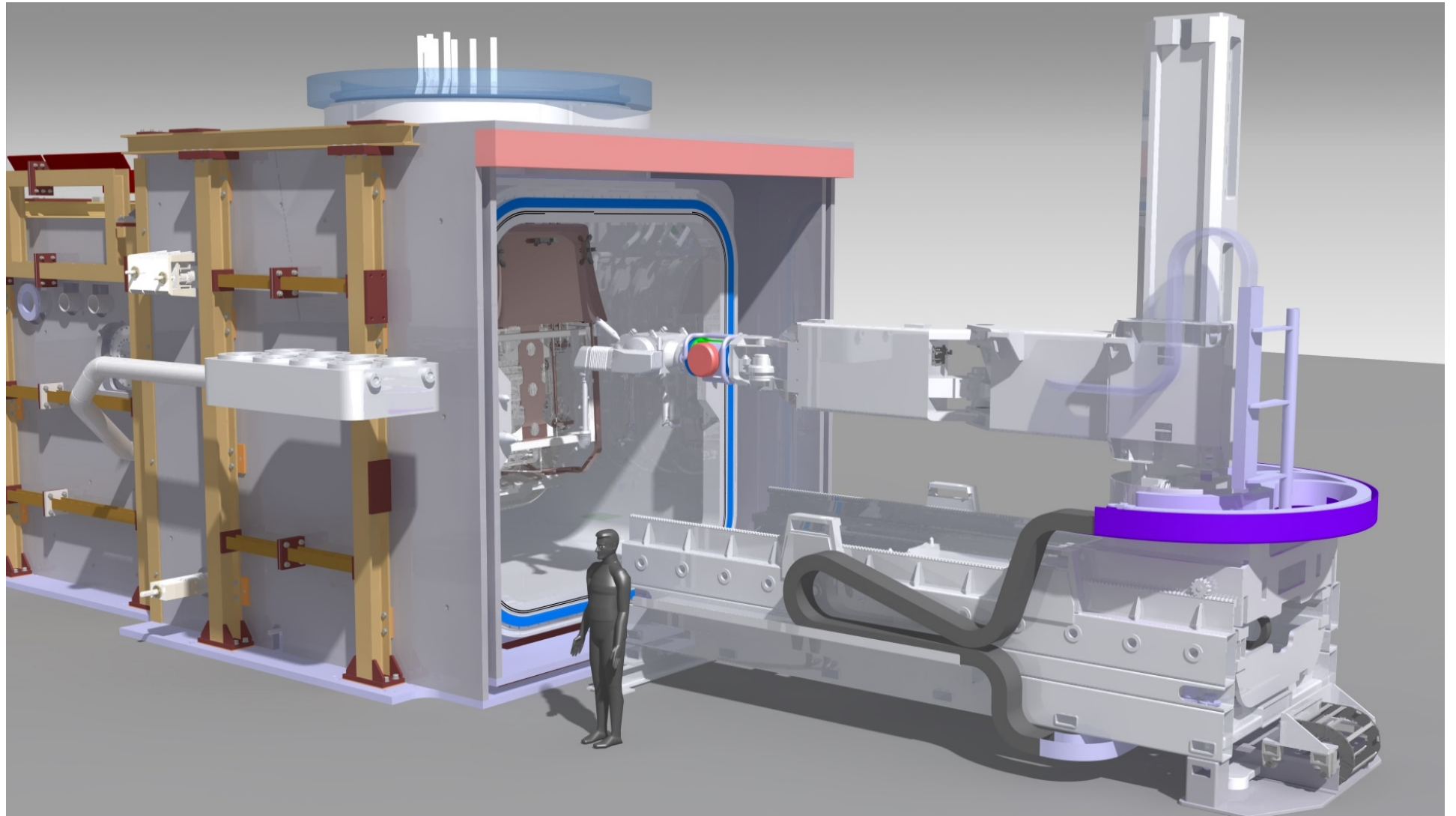
- Maximum drop: 3.3m
- Maximum reach from rail : 6.4m
- Total Mass: 7 tonnes
- Possibility of remotely interchangeable end effectors
- Standardised lifting features (1 tonne SWL)
- 8 Degrees of Freedom (DoF)
- Mounts standard manipulator module, remotely





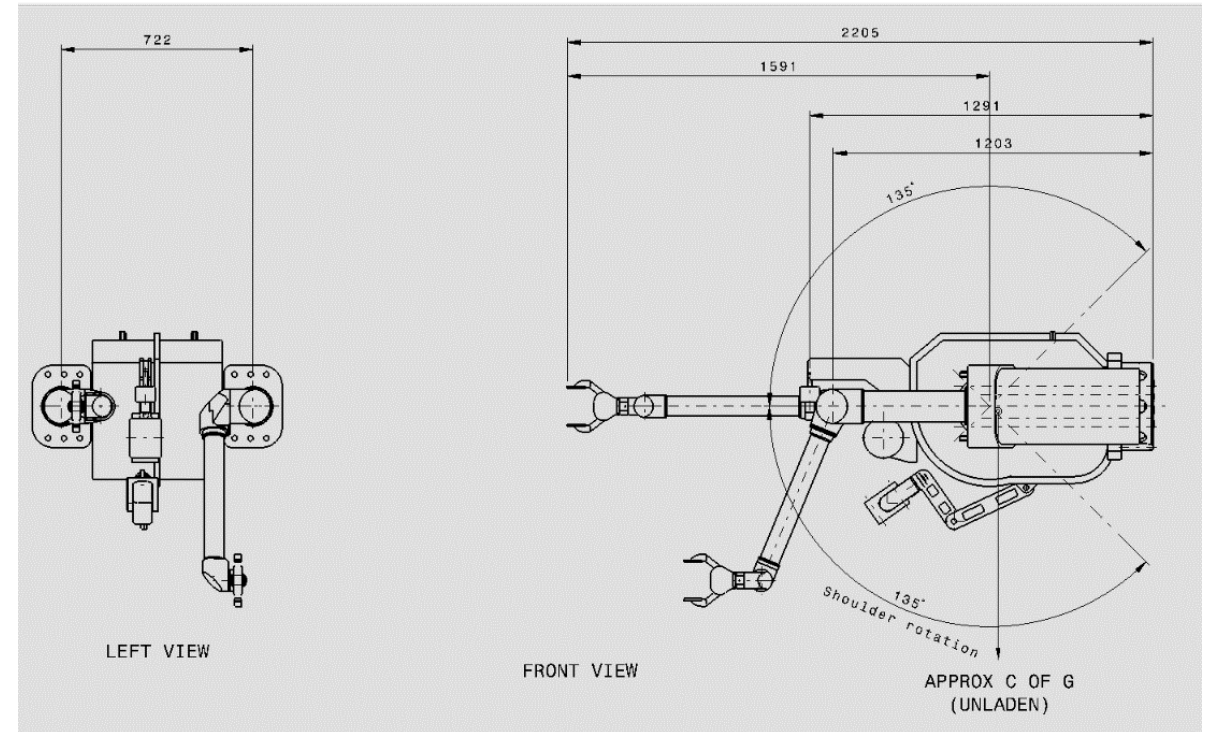
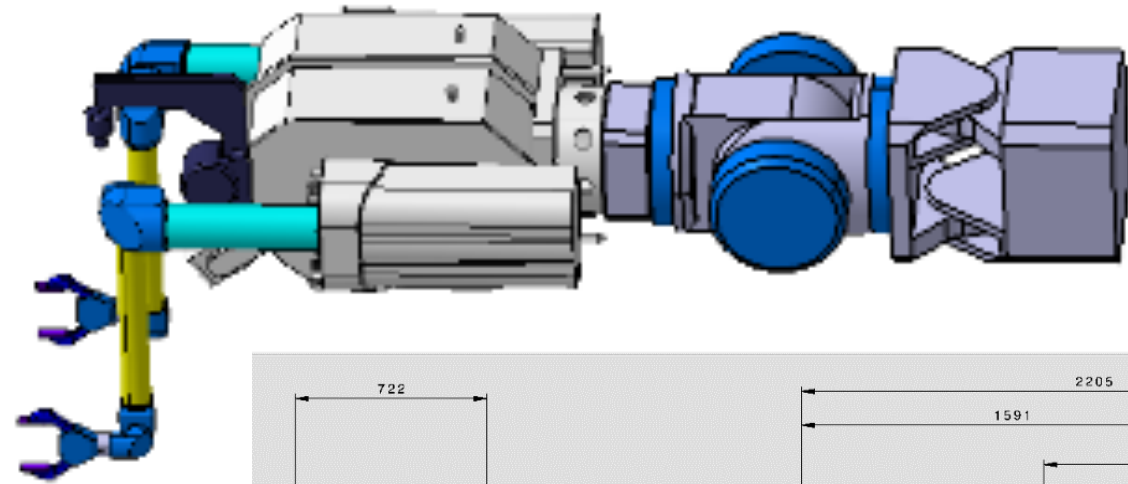
# Beam Source Remote Handling Equipment (BSRHE)

- Mast range: 3.3m
- Max. horizontal reach: 6.4m
- Total Mass: 16t
- Interchangeable end effectors
- Standardised lifting features
- Mounts standard manipulator module, remotely



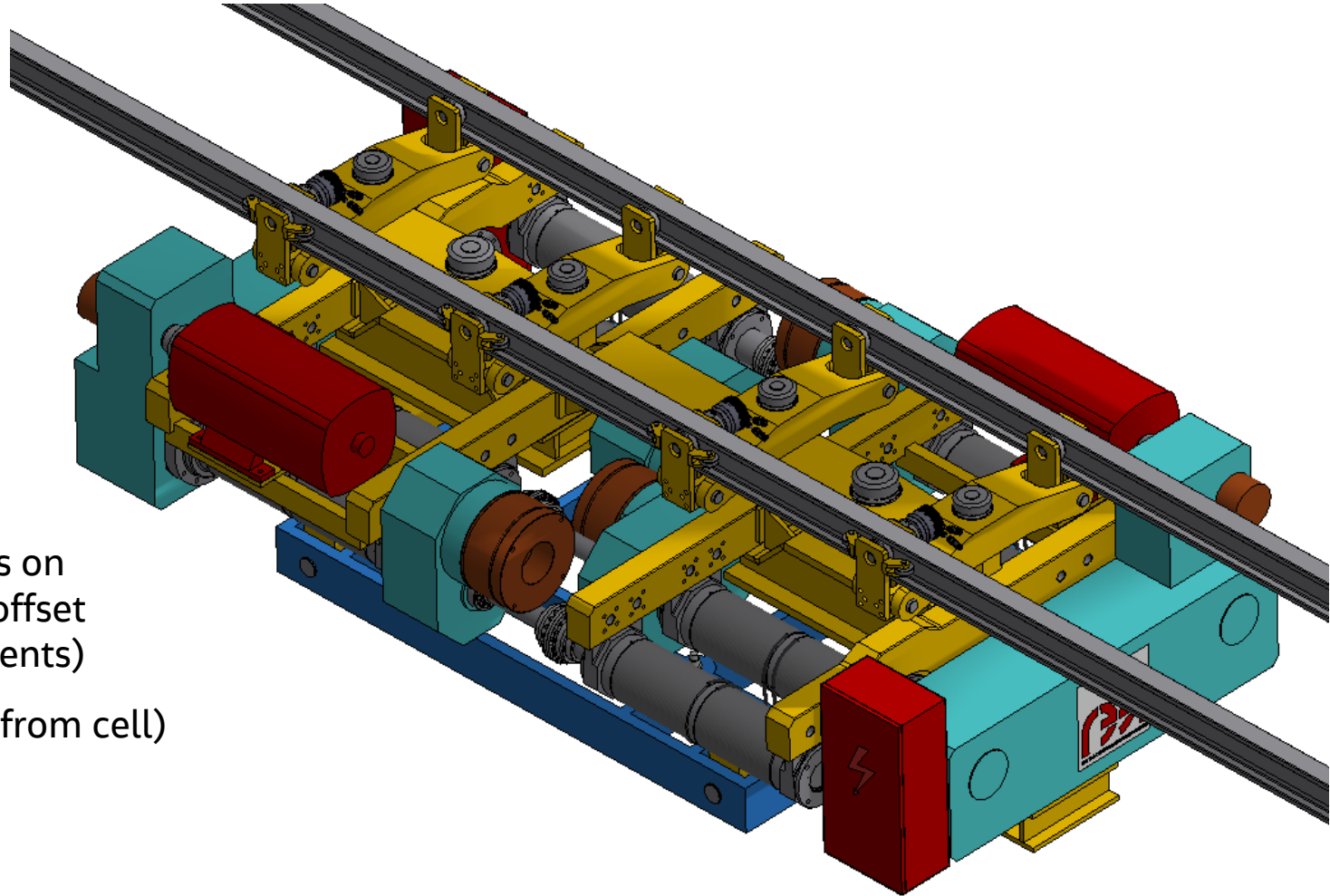
# Manipulator Module

- Dual Wälischmiller TELBOT arms
- Manipulator arm payload: 25kg (full envelope) per arm at jaw centre
- Operation: force-feedback, RMRC or automated
- Manipulator arm motions: 6 DoF, all continuous except "shoulder pitch" ( $\pm 135$  deg.), giving near-spherical envelope
- Auxiliary handling by means of front mounted winch (remotely removable)
- Module: roll/pitch/yaw (no FFB)
- Cameras: wrist camera (one each arm) and central "chest" cameras (possible 3D) on articulated arms



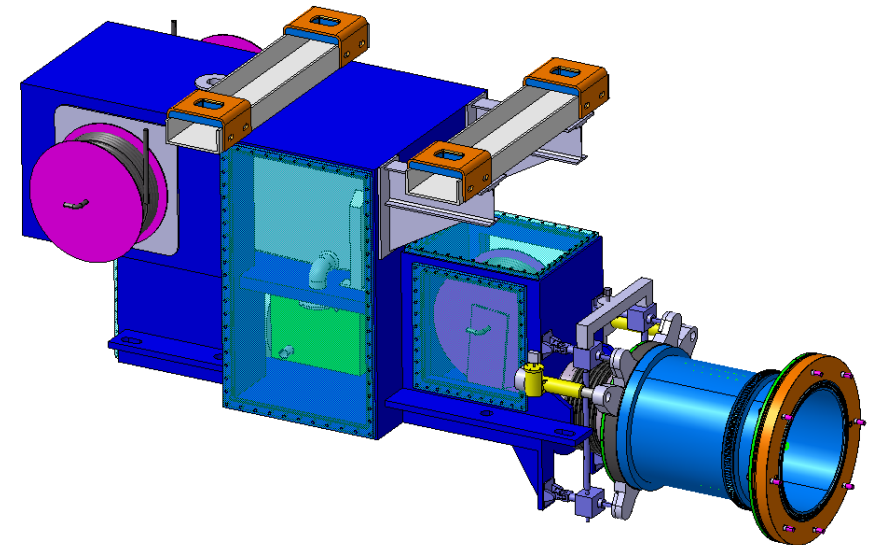
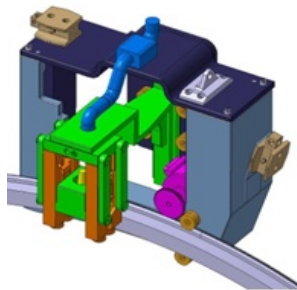
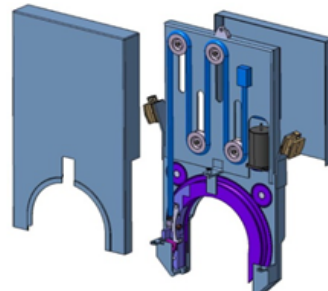
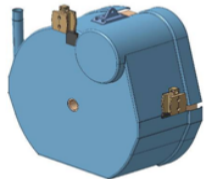
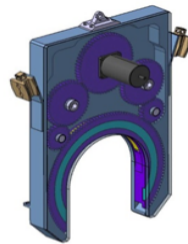
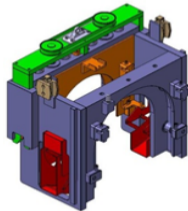
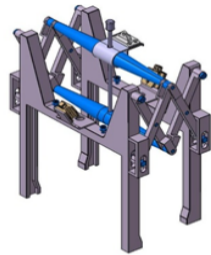
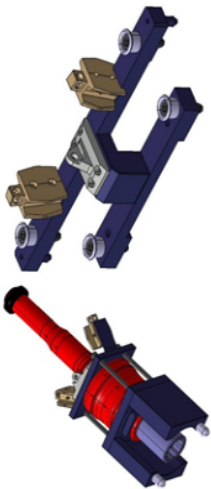
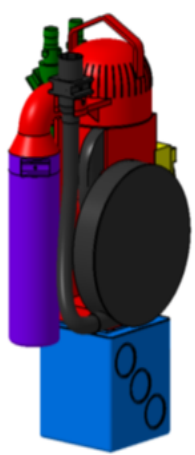
# 'Monorail' Crane

- SWL: 40 tonne
- Lifting system: wire rope
- Lifting config.: 8 rope, 16 falls, fully redundant (drives, gears, & brakes)
- Multi-articulated bogies to negotiate curves in track
- Integrated seismic dampers
- Four-point lifting via Twist-Locks on Lifting Frame to accommodate offset loads (irregular shaped components)
- Remotely recoverable (removal from cell)
- Radiation tolerant

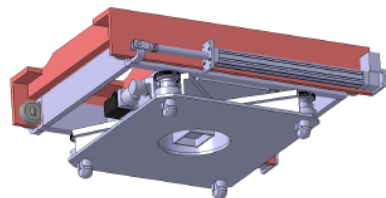




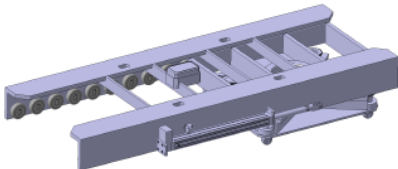
# Manipulator Tools



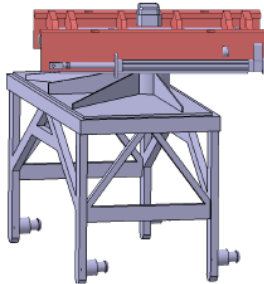
# Crane Tools



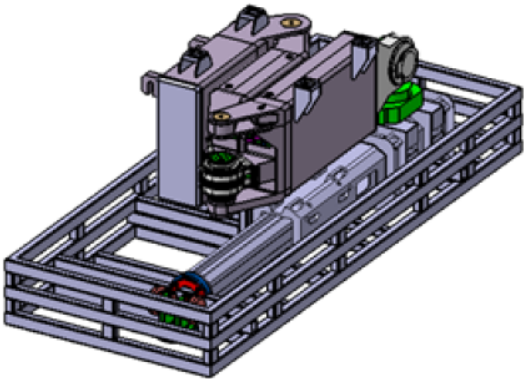
Generic lifting adaptor



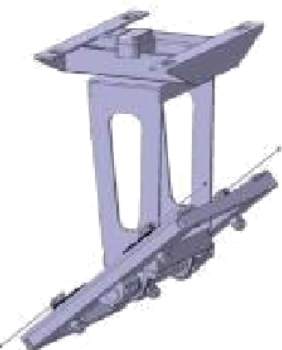
PMS #4



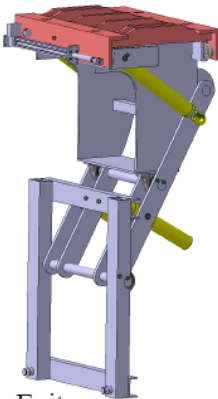
HNB Beam source



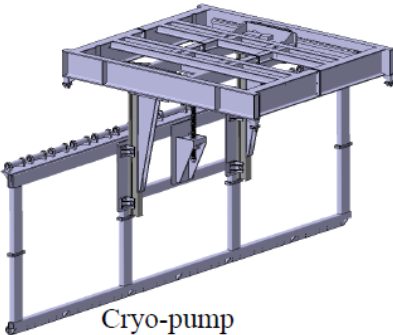
Stillage



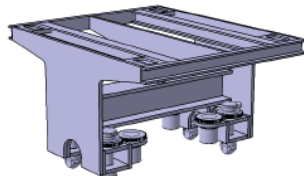
Lower ACCCS



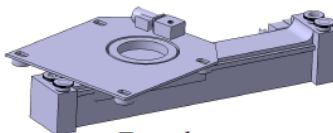
Exit scraper



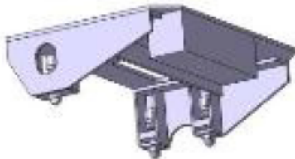
Cryo-pump



DNB calorimeter



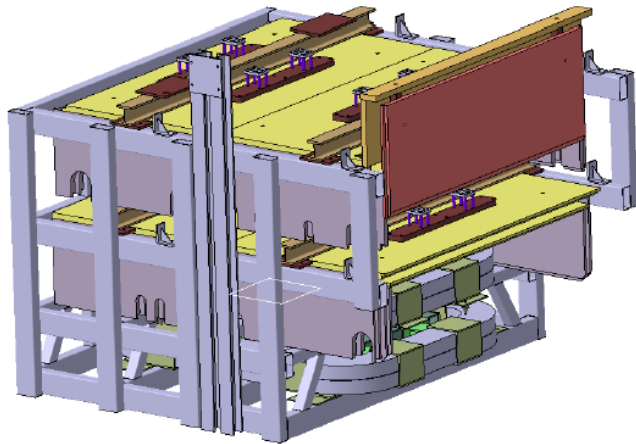
Fast shutter



Absolute valve



Adjustable bed



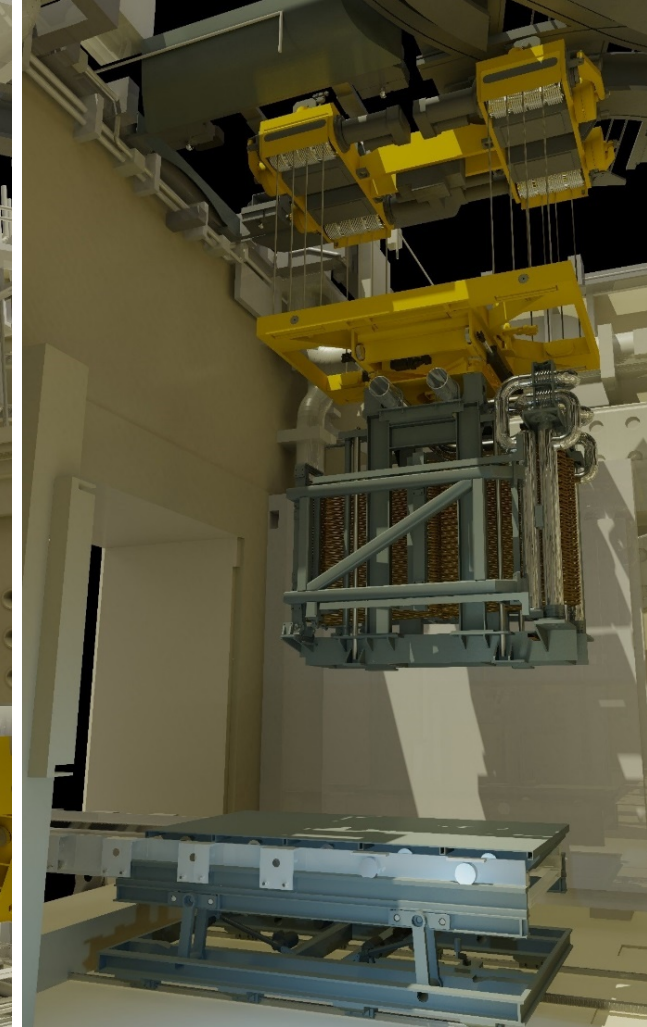
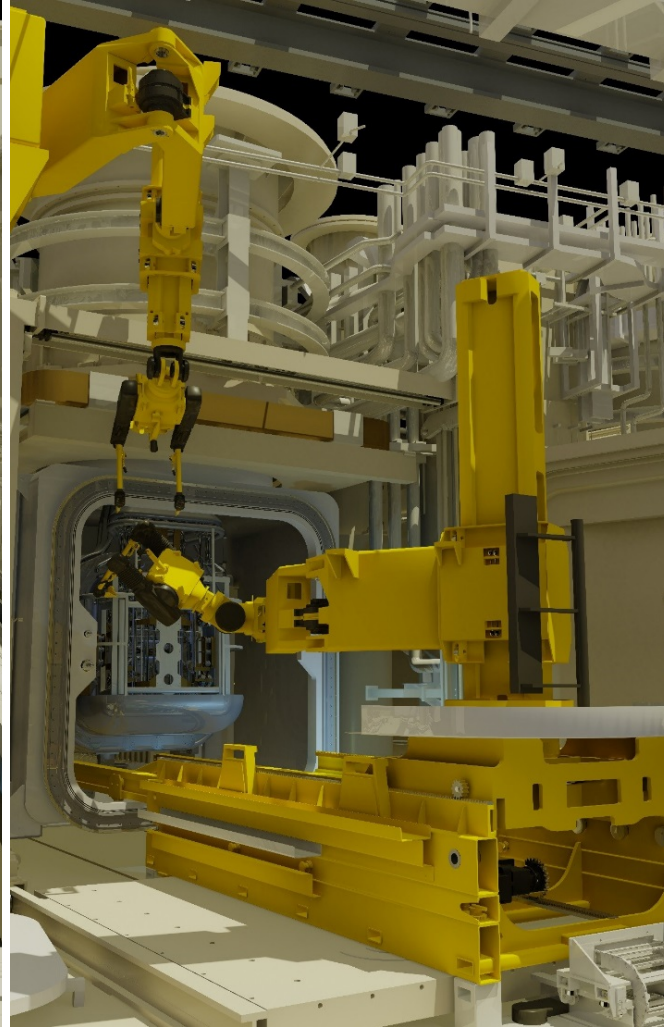
Storage rack



## Other notes

- The NB Cell is only human-accessible at the rear (behind vessel lines, where doses are below 100 $\mu$ Sv/hr threshold) even when all the vessel doors are closed and shielded – once PMS plates are removed it becomes a 'hot cell' due to elevated doses, and is zero-access.
- Once closed, the cell is 'blind' (no windows) so CCTV system is all-important for remote operations.
- Scheduled remote maintenance includes:
  - Making/breaking remote electrical and gas line connectors
  - Cutting and re-welding of coolant pipework from 50mm to 200mm dia.
  - Cleaning and inspection of vessel door seal grooves
  - Removal and replacement of vessel door 'Helicoflex' seals (BLV seal is 9m x 3m)
  - Disconnection, removal and replacement of equipment ranging from <1t up to 40t
- Many remote tasks will need to be automated, possibly using boom motions as well as the tele-robot arms.

# Neutral Beam Remote Handling System – pretty pictures!

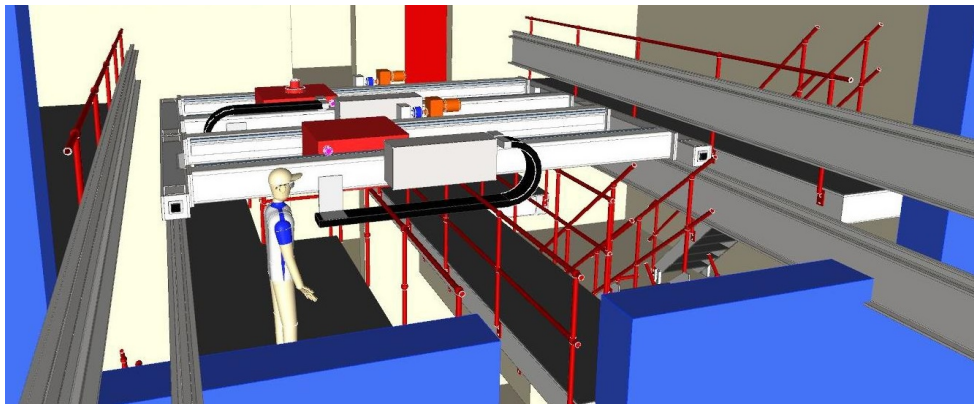


# Present project examples ...

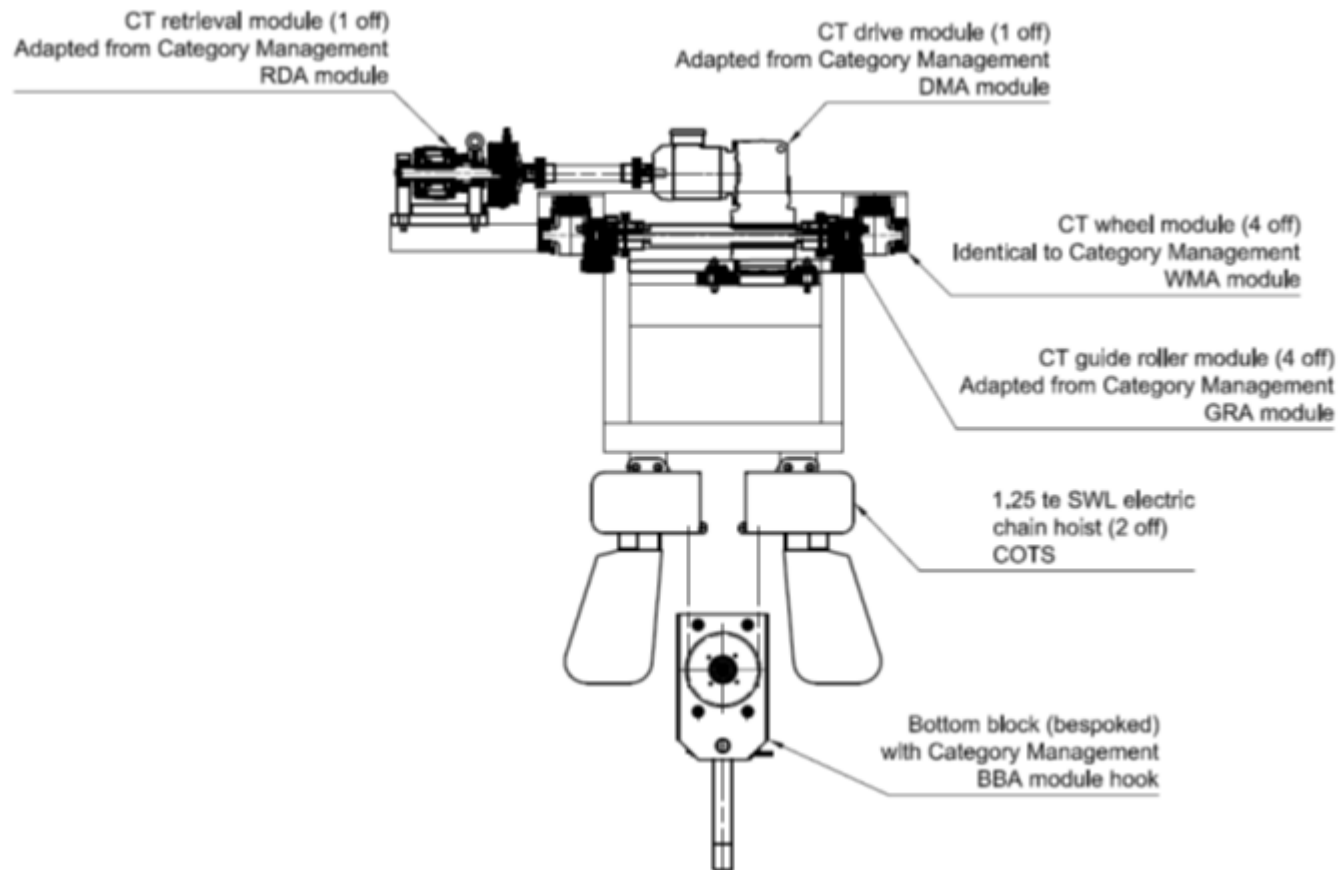
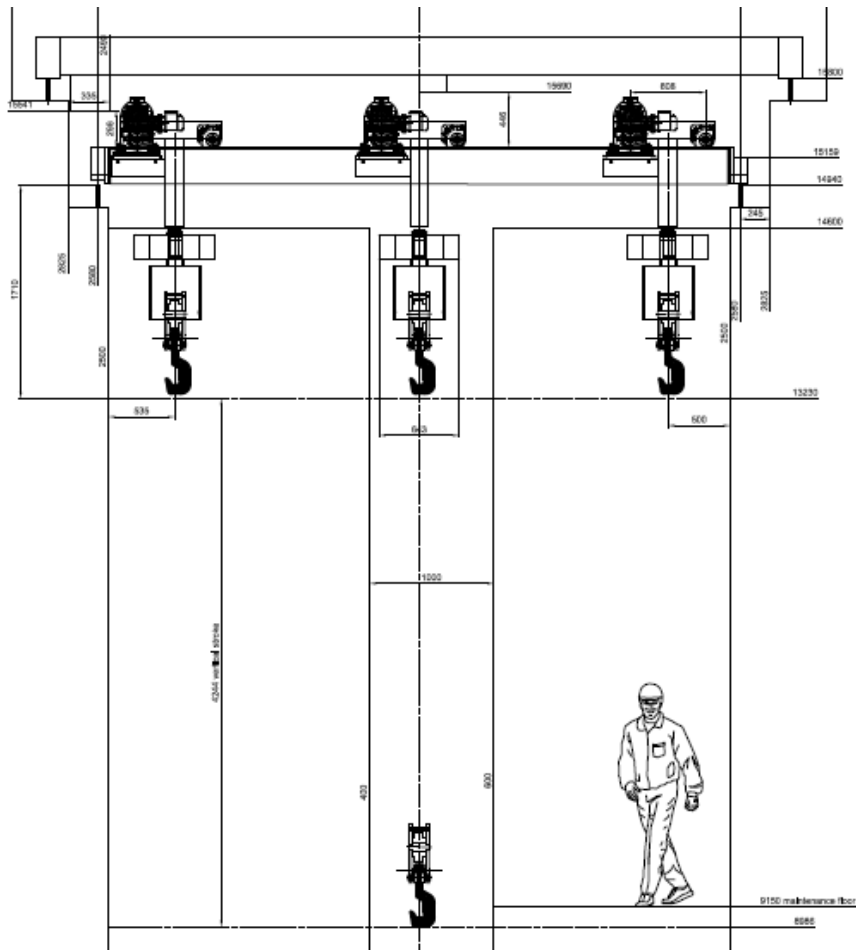
Sellafield FHP Telegrab Replacement Project  
(AGR Fuel Receipt Cell)



# Existing telegrabs



# Outline design for replacements

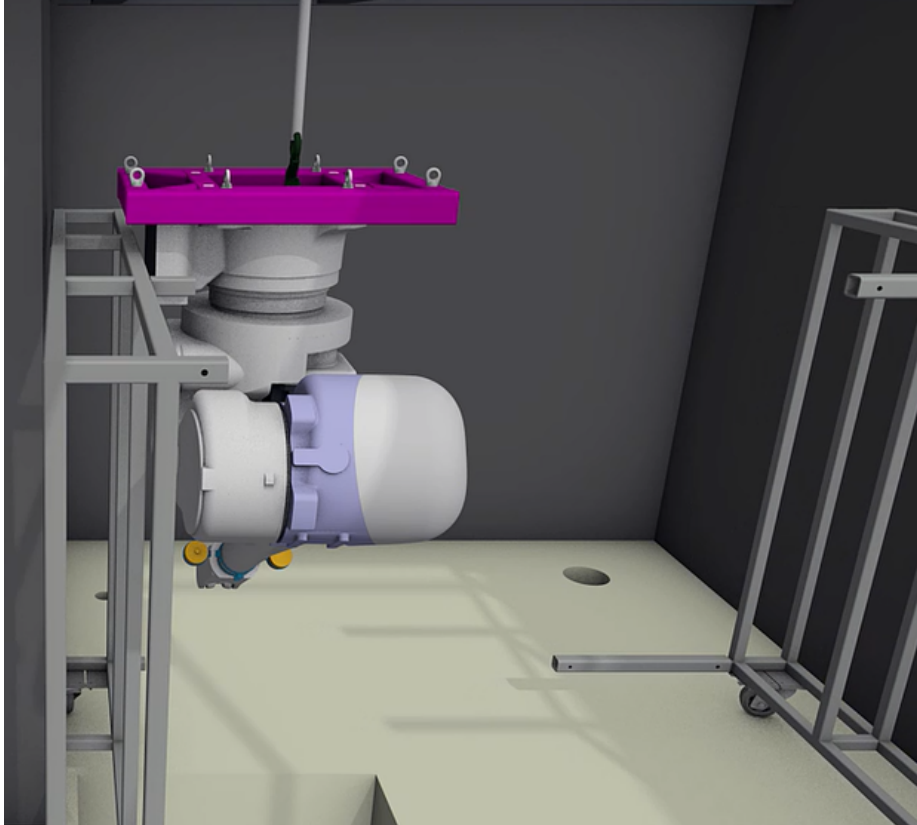


# Past project examples ...

CEA Marcoule Fosse 0

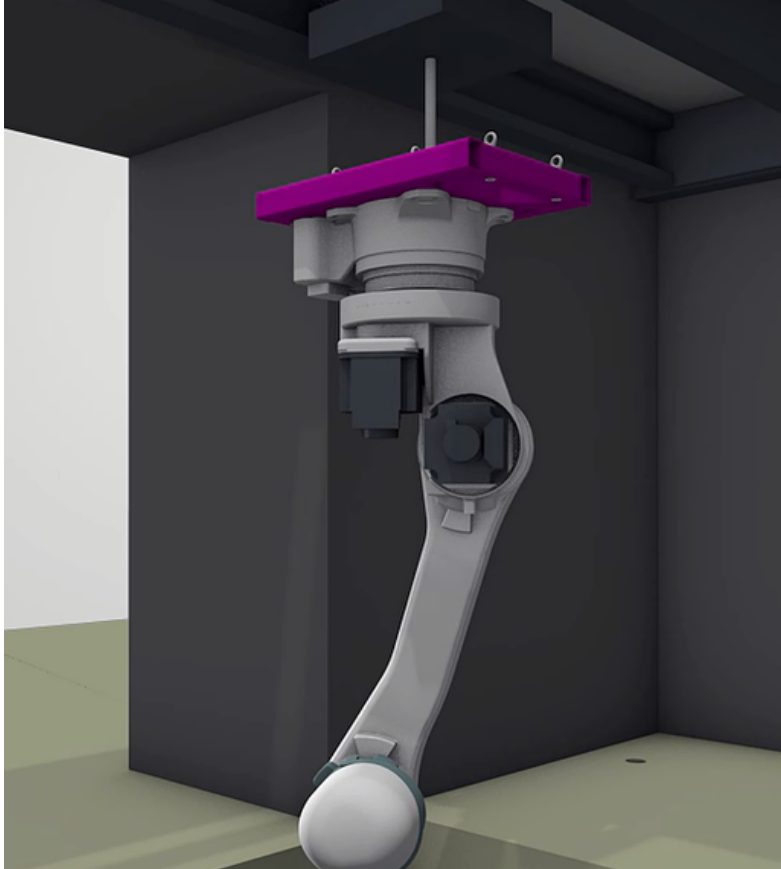


# Deployment of robot arm

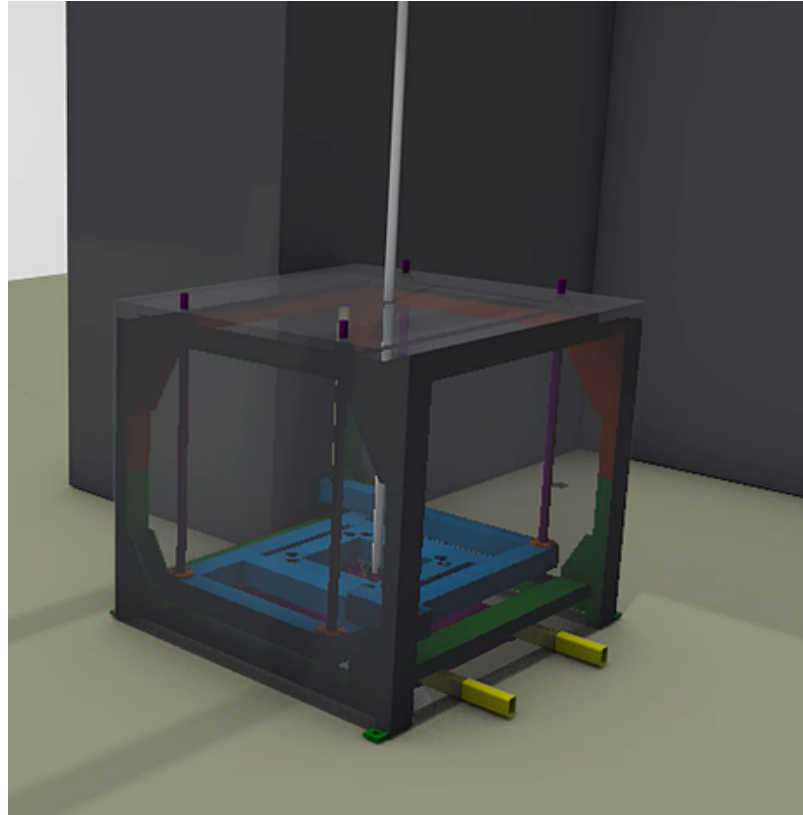




# Lowering robot into position

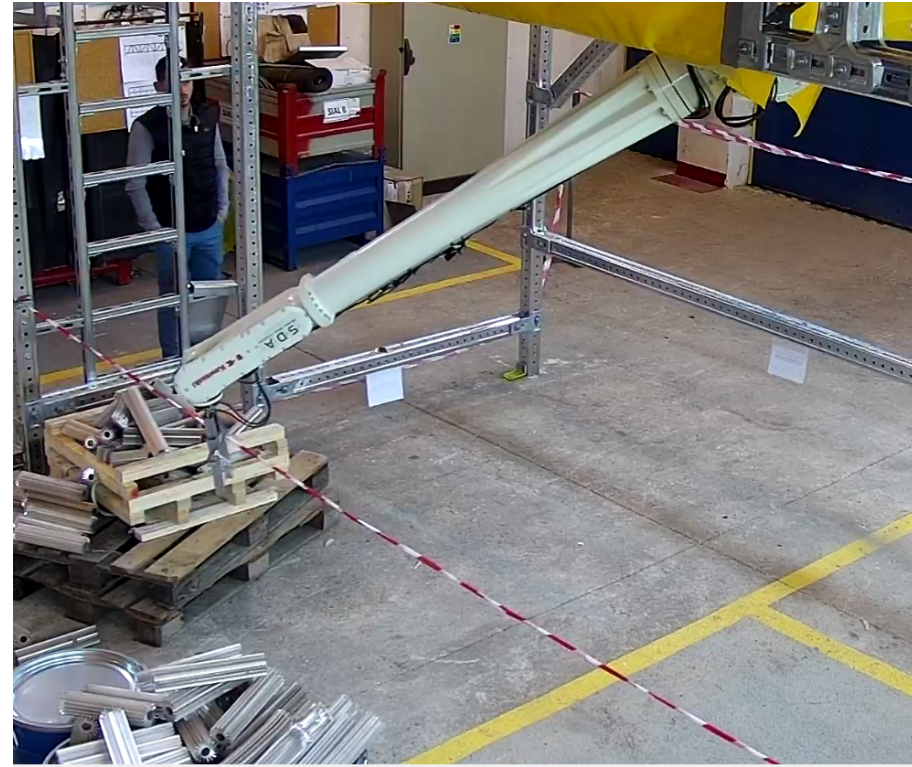
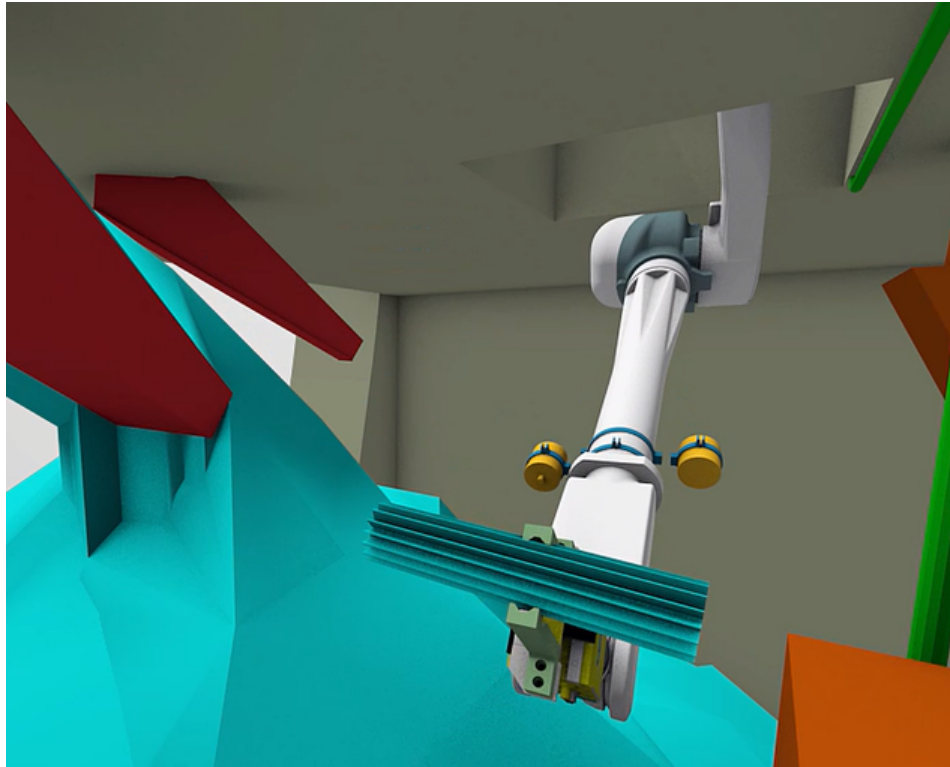


# Fixing in place and adding containment





## Waste clearance can begin ...



# Past project examples ...

InnovateUK remote nuclear decommissioning technology development programme

# Objective

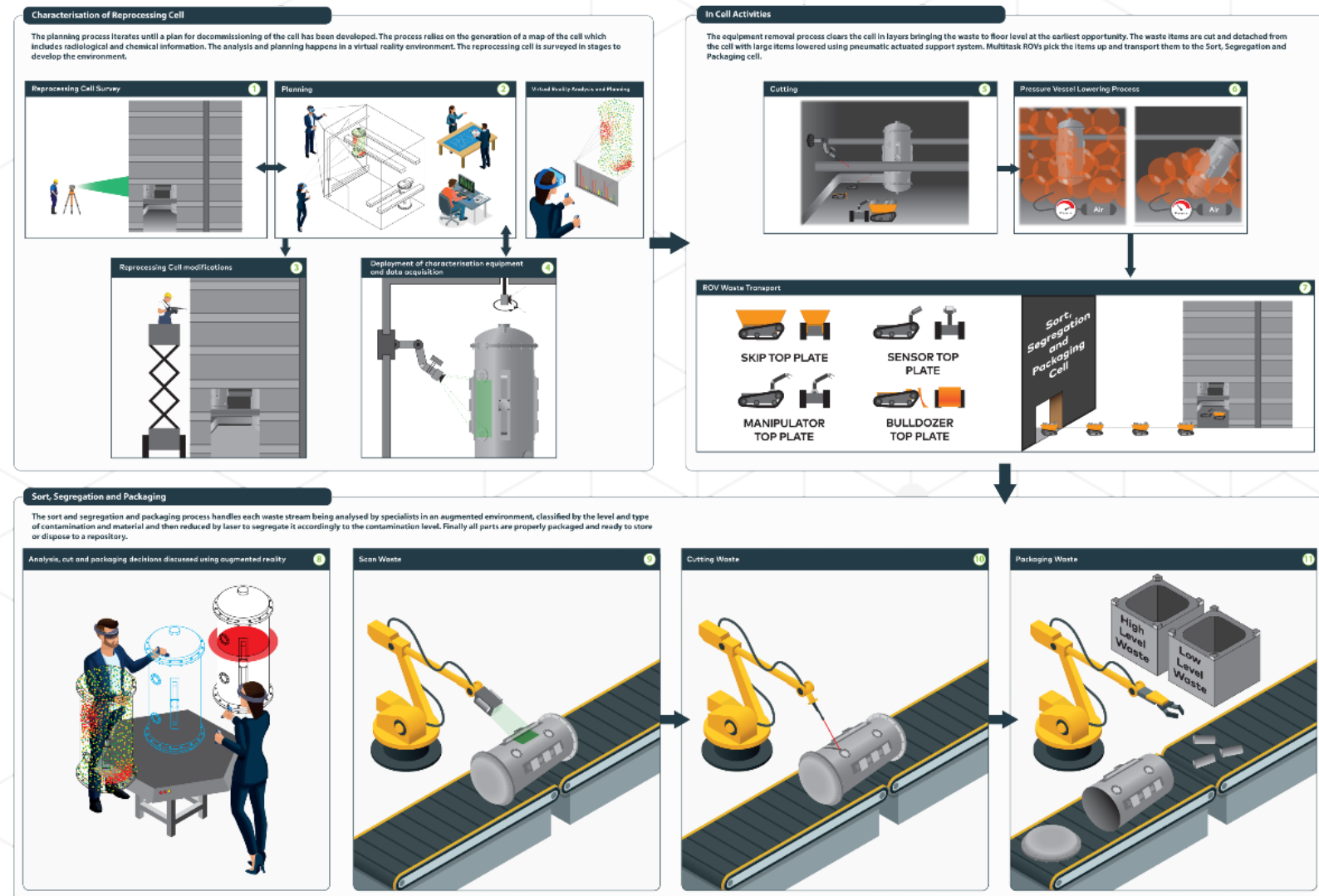
SBRI Competition initiated to develop new technologies for remotely decommissioning radioactively contaminated process cells:

- Funded by InnovateUK, NDA and BEIS.
- £1.5m to develop inactive demonstration of ideas.
- Jacobs' Eng. Dev'mnt. were winners of the competition and are now working with Sellafield Ltd. to develop an active demonstration on the Sellafield site.



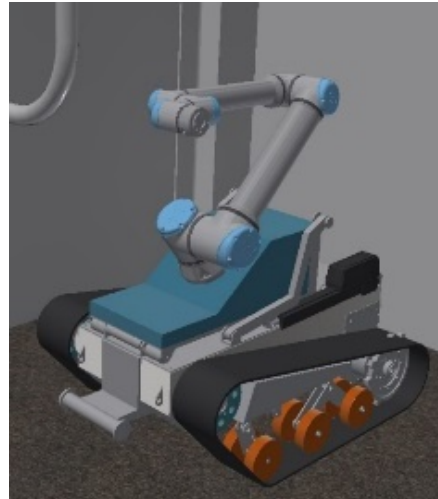
# Safer – Faster – Cheaper Decommissioning

- Automation
- Characterisation
- Visualisation and Planning
- Decontamination (if / where appropriate)
- Size reduction
- Contamination & Dose Management
- Holding
- Moving
- Waste Packing





# Some developments so far ...





# Past project examples ...

Fukushima – Hot Cell for Samples Analysis

**In House Capability**



# Jacobs

- America-based multi-national corporation providing technical, scientific, engineering and construction services
- Approximately 52,000 employees worldwide, with 11,000 in the UK
- Wide range of clients across the world in nuclear, defence, etc.
- Annual turnover of approximately \$15billion
- Consistently ranked No. 1 on both Engineering News-Record (ENR)'s 2018/2019/2020 Top 500 Design Firms and Trenchless Technology's 2018/2019 Top 50 Trenchless Engineering Firms

# Engineering Development

- Location: Jacobs' premises on Birchwood Park industrial site (nee Risley Nuclear Site)  
Staff: ~120 personnel, mix of scientists, engineers, technicians and craftsmen
- Expertise and experience in design, build and deployment of remote inspection systems, mechanical handling and remote handling equipment, automation & robotics, camera systems VR & AR
- Facilities: offices & conference facilities; manufacturing – welding & fabrication, tool-room machining & limited CNC, electrical & electronic build; extensive engineering laboratories with EOTC and headroom up to 26m, pits up to 7m deep
- Reach-back into the wider Jacobs for other disciplines such as radiation and shielding estimation, radiation mapping, computational modelling and analysis (FEA etc.), civil engineering, etc.
- Our clients in this area of work include EDF Energy (UK), Sellafield Ltd., UKAEA, Magnox, DSRL, ITER Organisation, Fusion for Energy, CEA, MHI, JNFL

# **Existing Specialist Supply Chain & Opportunities to Support**

# Specialist Supply Chain

The European Remote Handling Alliance (ERHA) was originally set up for RH projects at ITER and is led by Jacobs. Alliance members include:

- Hyde Group (precision aerospace manufacturer)
- Wälischmiller Engineering (high quality nuclear manipulators/robots, etc.)
- REEL Cranes (nuclear cranes manufacturer)
- Capula (nuclear control systems manufacturer)
- VTT and TUT (Tampere University of Technology)
- MaGyICs (developer of high-dose tolerant integrated circuits)

ERHA may or may not be the vehicle for future Jacobs ventures into the “big science” area where more advanced technology is often preferred and/or required, and other suppliers might be needed to address specific niche technology areas, augment capability we already have access to and supply particular specialist products / services.

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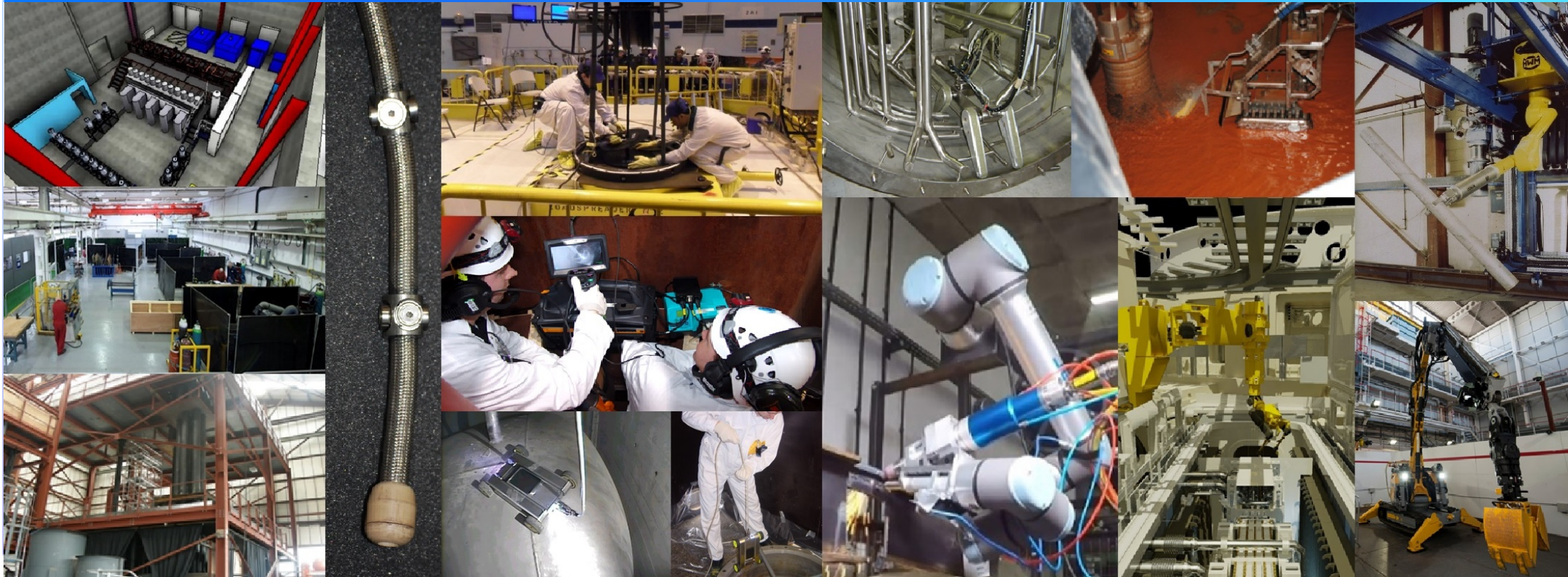
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# Thank you – any questions?

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# Jacobs

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Reinventing tomorrow.

