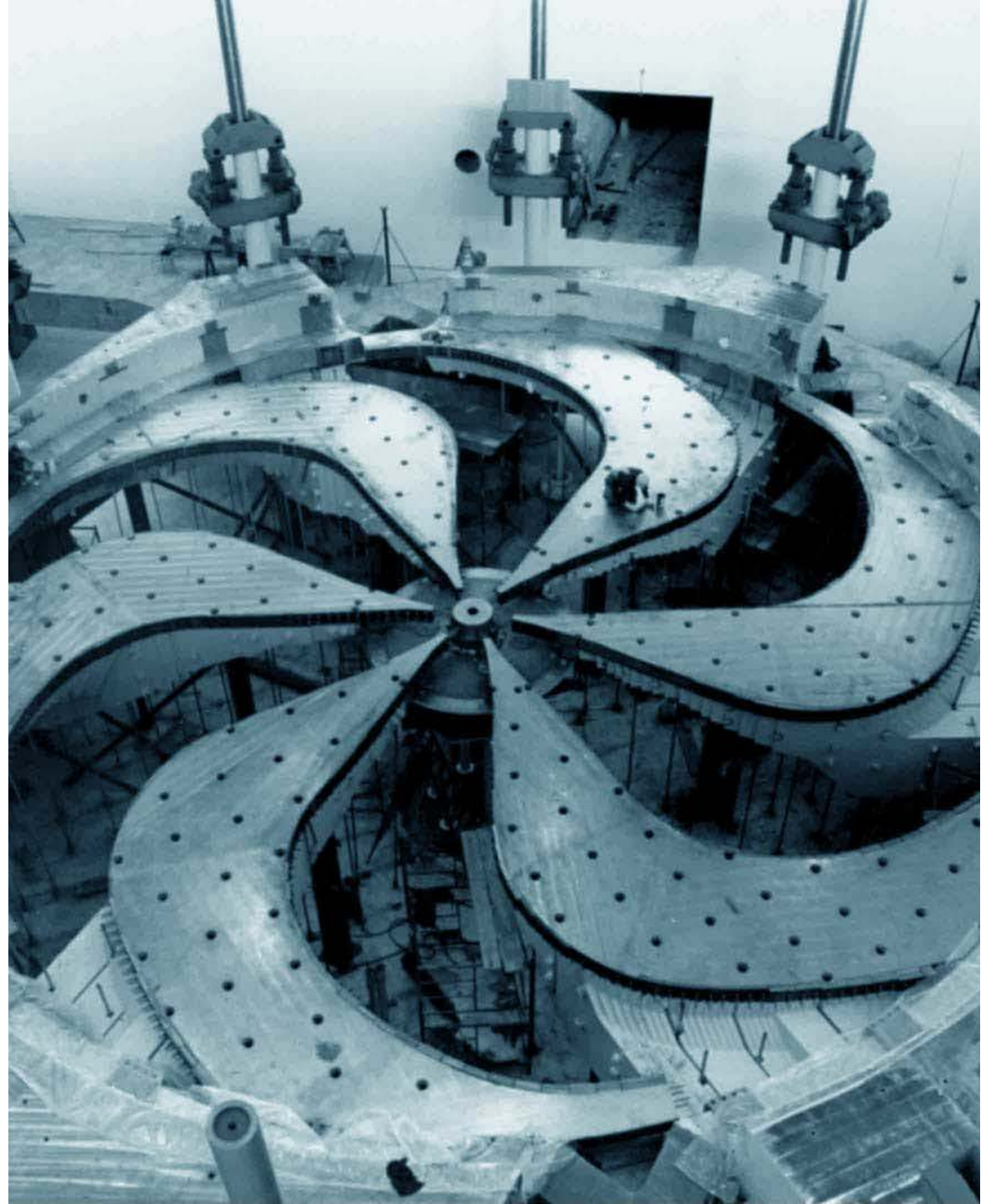


A new remote handling facility for radioactive high-power fission and spallation ISOL targets at TRIUMF

Grant Minor, P.Eng.

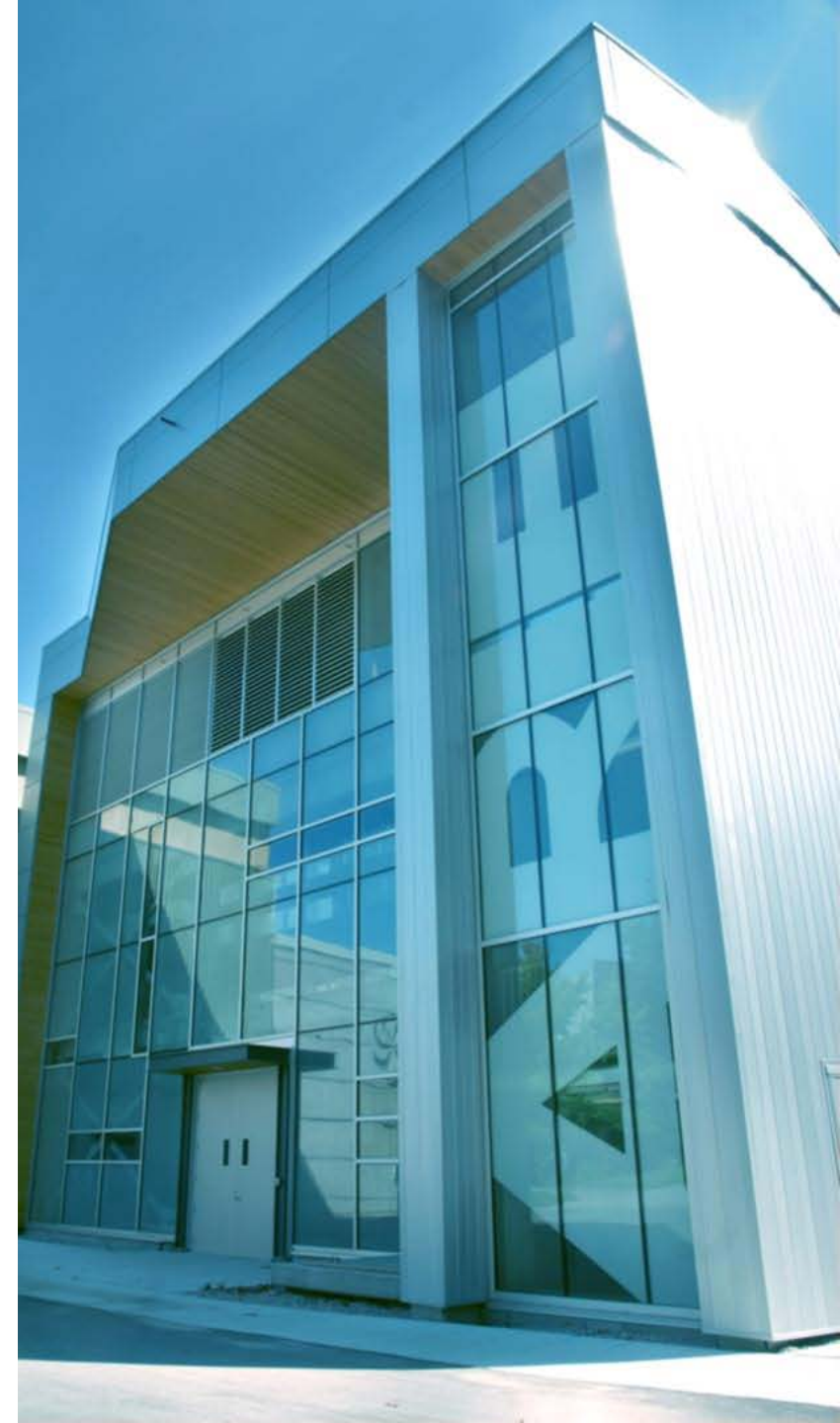
HOTLAB 2019

2019-09-08



Agenda

- Introduction to TRIUMF
- Introduction to ISAC ISOL targets and ISAC remote handling
- ARIEL Target Facility Overview
- ARIEL Remote Handling Crane
- ARIEL Remote Target Transport
- ARIEL Hot Cell 1 Facility



Introduction to TRIUMF

- Canada's particle accelerator centre
- Vancouver, BC (University of British Columbia)
- ~ 400 researchers and staff
- 520 MeV Cyclotron (1974)
- 35 MeV e-Linac (2015)



Introduction to TRIUMF – Facility Plan and High-Radiation Areas

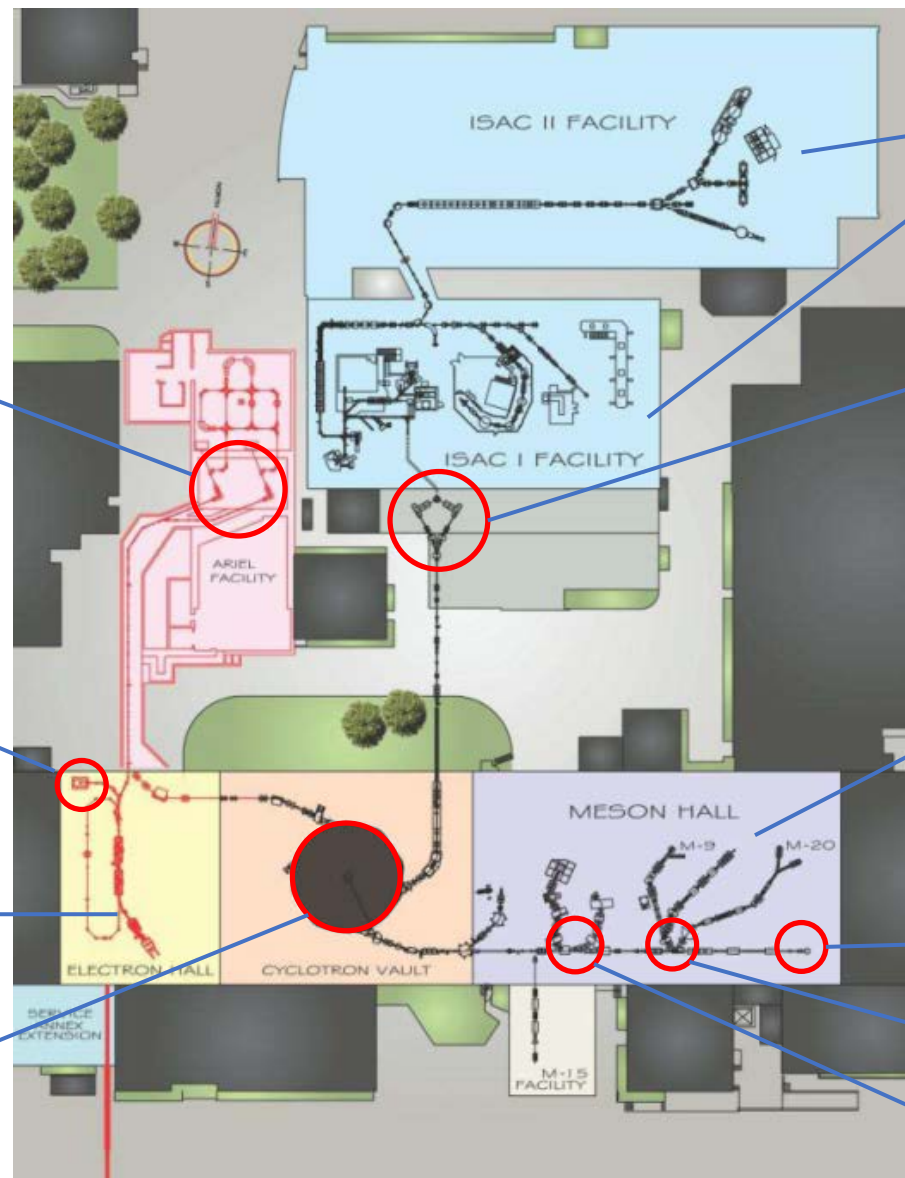
ARIEL (Advanced Rare Isotope Laboratory)
APTW / AETE target stations (in design)

- Will produce 2 additional isotope beams for ISAC I & II from the Cyclotron and the electron linac
- 3 simultaneous isotope beams total once commissioned

e-Linac 10kW tuning dump

Electron Linear Accelerator (2015)
35 MeV electrons

Cyclotron Accelerator (1974)
520 MeV protons



ISAC (Isotope Separator and Accelerator) I & II experimental facilities

ISAC ITW / ITE target stations (~1997 – 2000) produce rare isotopes for experiments in:

- Fundamental nuclear structure
- Nuclear astrophysics

Meson Hall experiments (1970's - present)

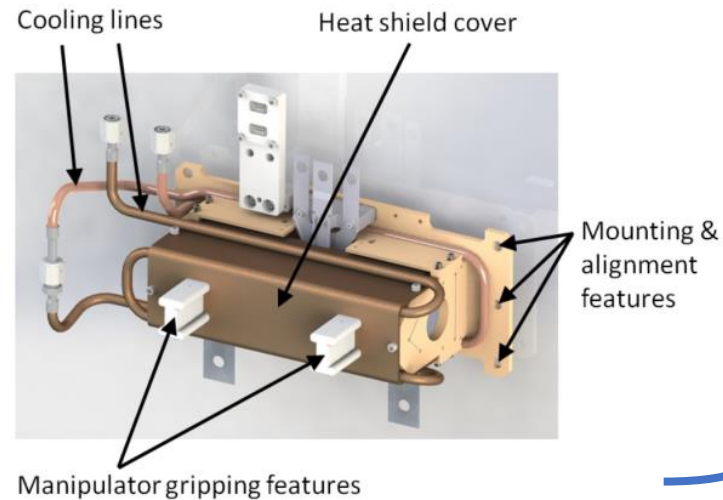
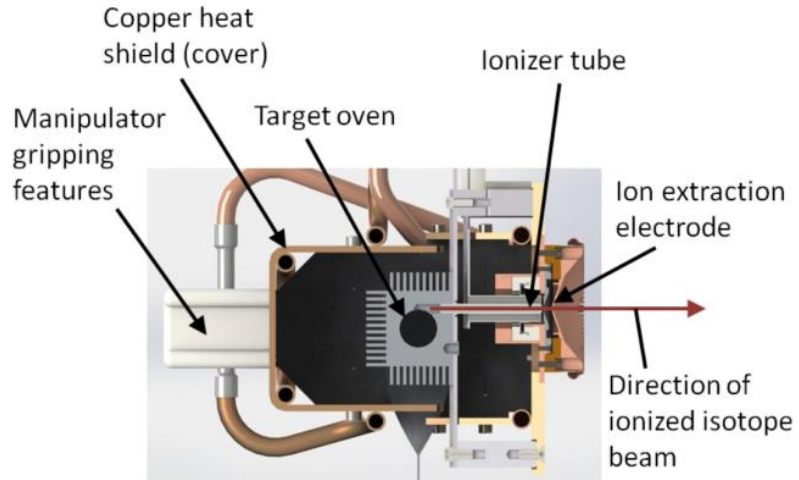
- Muon physics
- Material science
- Ultra Cold Neutron

Thermal Neutron Irradiation Facility (beam dump)

T2 Target Station

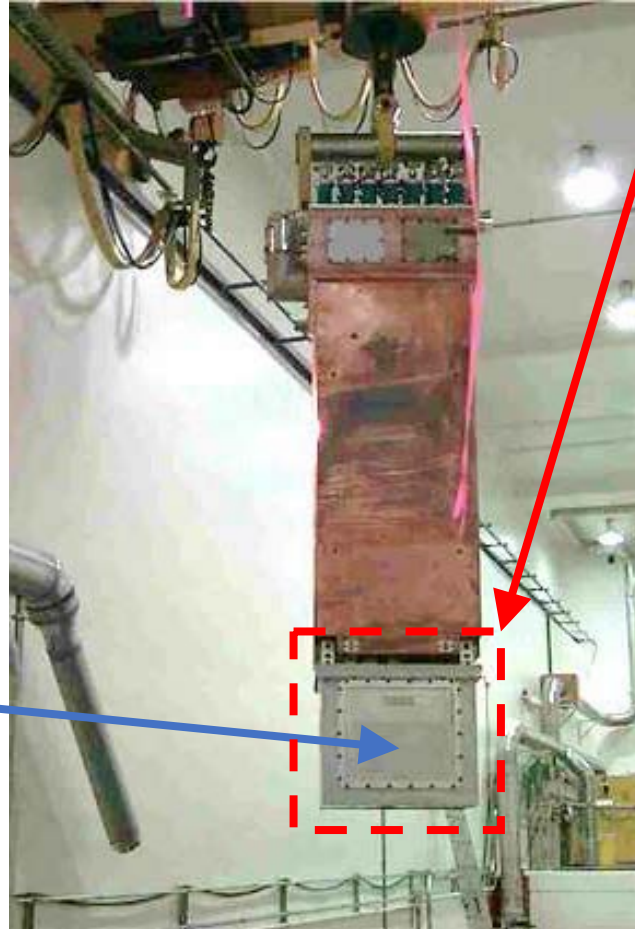
T1 Target Station

ISAC Targets and Modules



Target assembly is mounted on the extraction Front End in the Target Module containment box

20 ton (40,000 lbs) cap. Remote Handling Crane



ISAC Target module hanging from remote handling crane

Containment Box



Target module transport to target station (remote rotation of the module is required)

ISAC Target Hall – 1997 to 2000 – First-Generation Facility

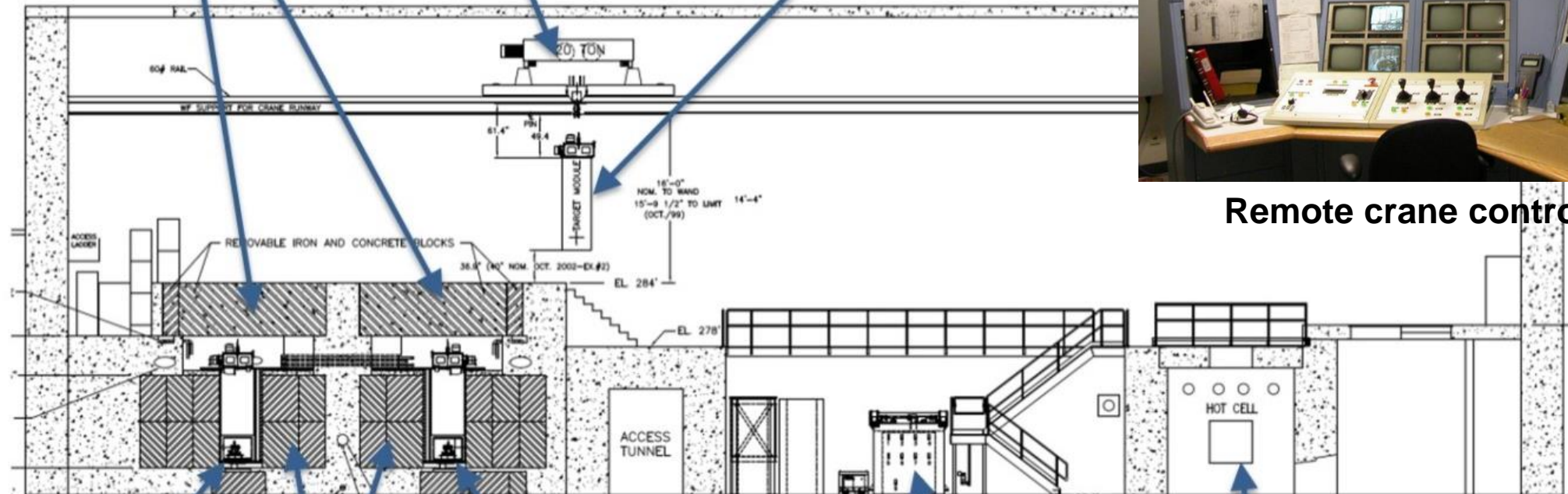
Concrete and
steel removable
blocks

Remote handling
crane

Target module



Remote crane control room



West
target
station

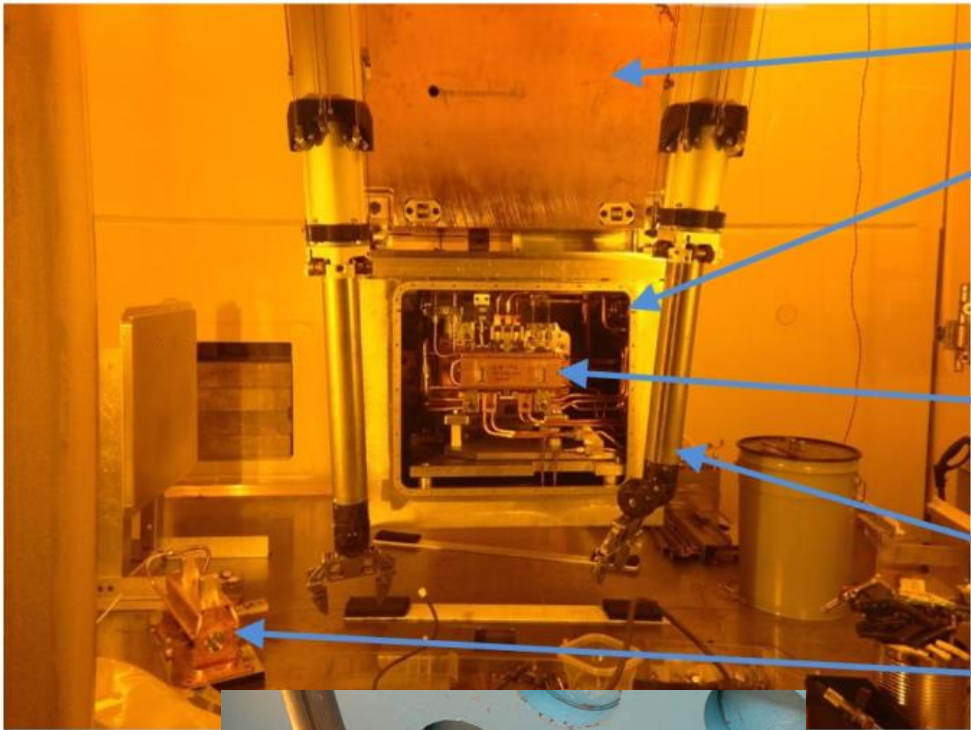
Steel
shield
blocks

East
target
station

Spent target decay
storage vault

Hot cells

ISAC Hot Cell Target Exchange and Disposal



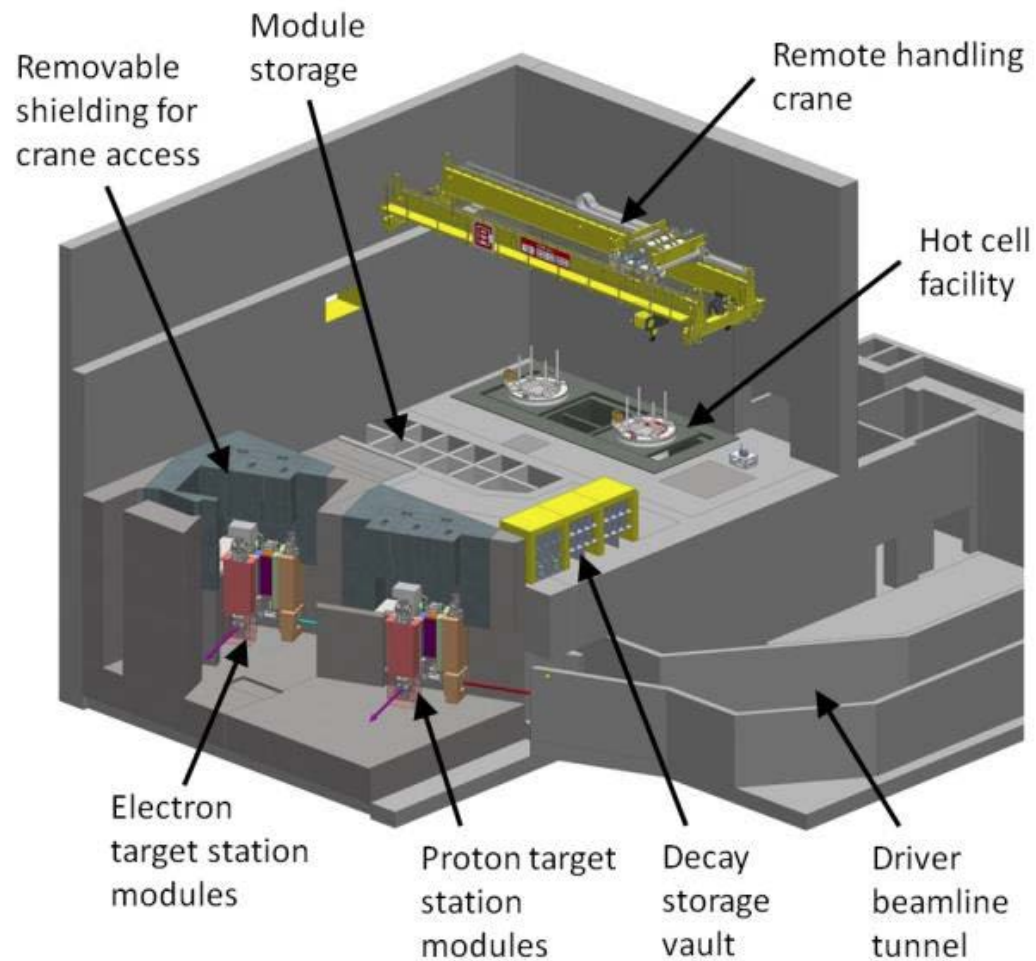
- Target module shield plug
- Target module containment box (open to expose target assembly)
- New target assembly installed on target module
- Telemanipulators
- Expired target assembly removed



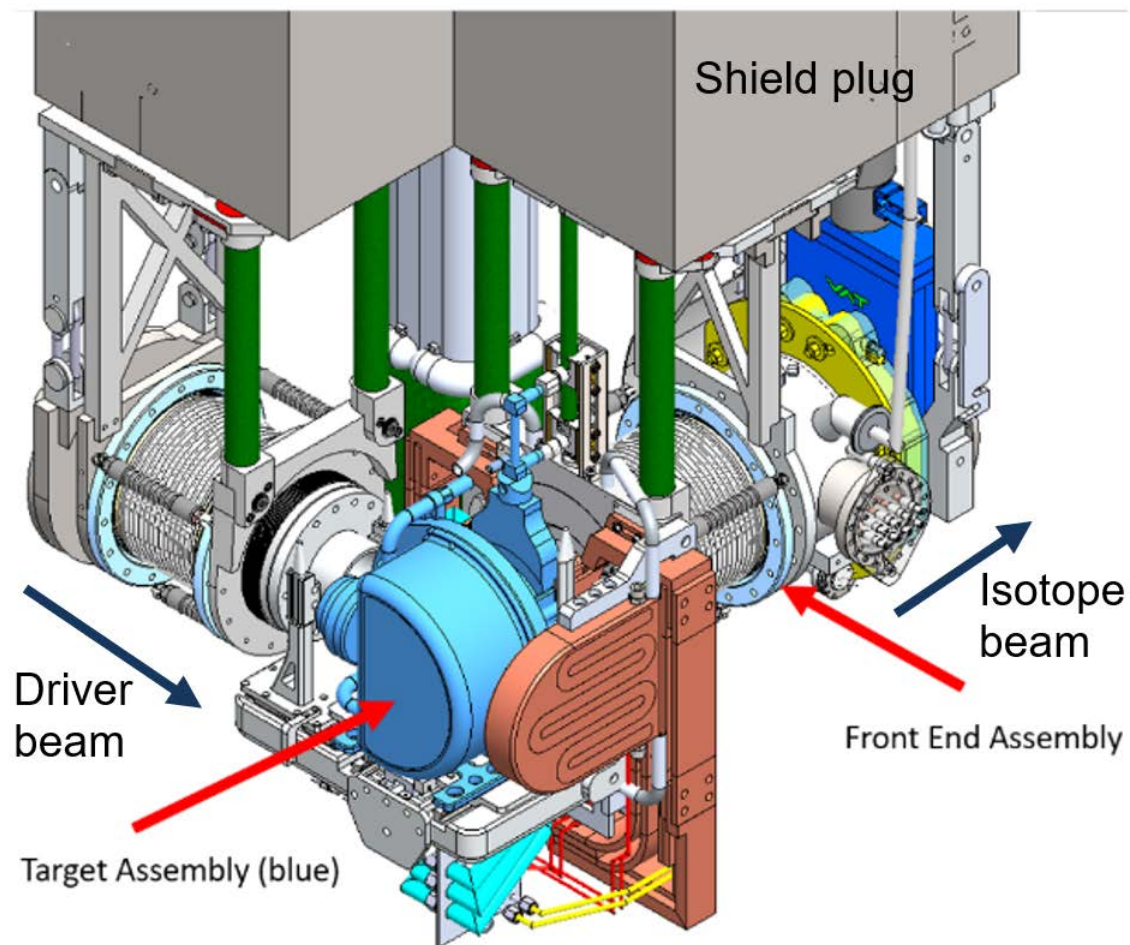
- Steel cable coil cap
- Removable cap
- Steel cable
- Cable attachment
- Spent target in 5-gallon pail
- Gasket sealing surface
- Lead-shielded steel flask body
- Removable base

ARIEL – Next Generation ISOL Target Facility Overview

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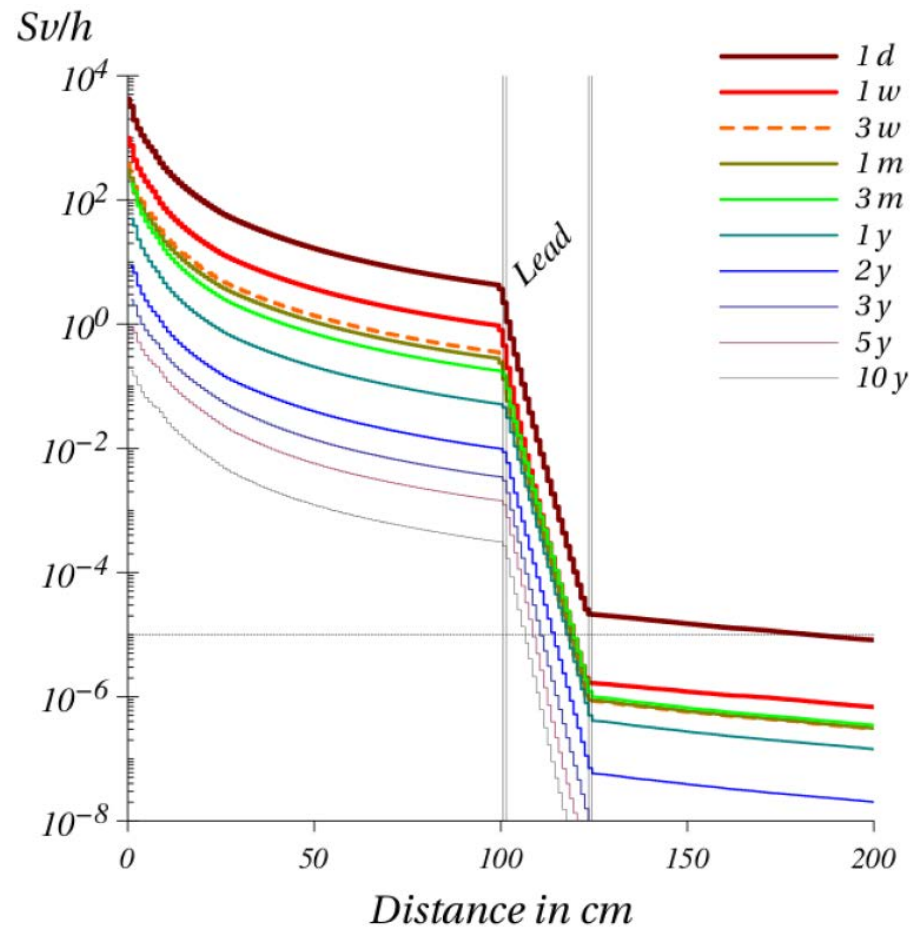


ARIEL Target Hall facility overview

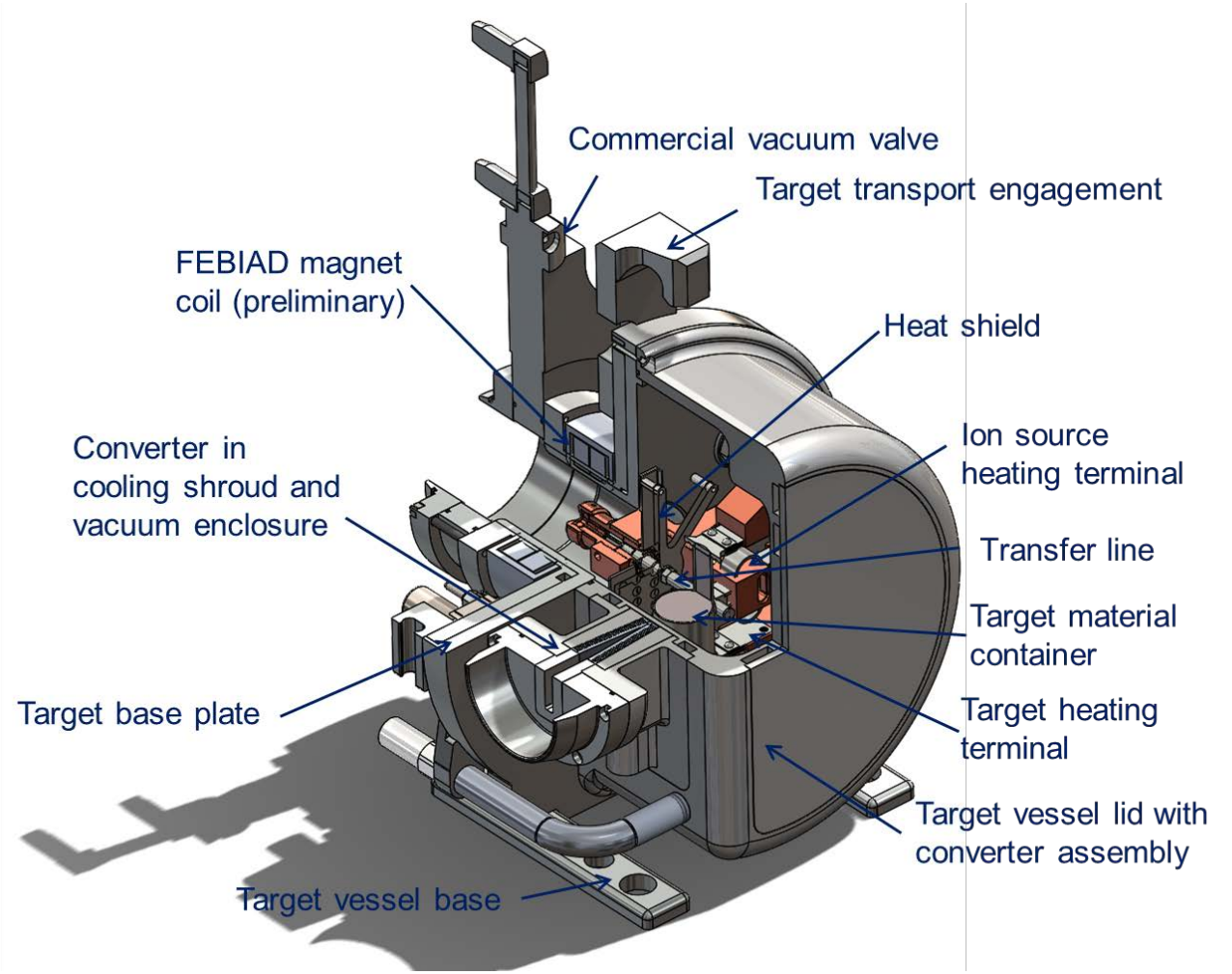


ARIEL Target Module concept

The ARIEL Next-Generation ISOL Target Assembly – Routinely Exchanged Production / Waste Item



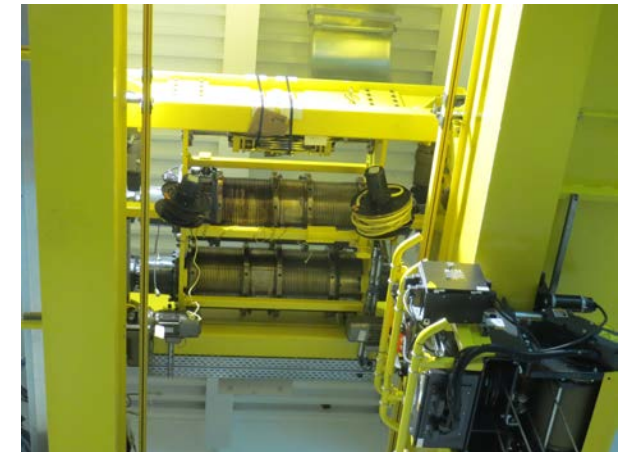
Nb target (20 g cm^{-2}) output at various time steps EOB, shielded at 1 m distance by 23 cm of lead. 50 kW and 500 h of irradiation.



ARIEL Remote Handling Crane – 20-tonne – Installed and Load Tested August 2015

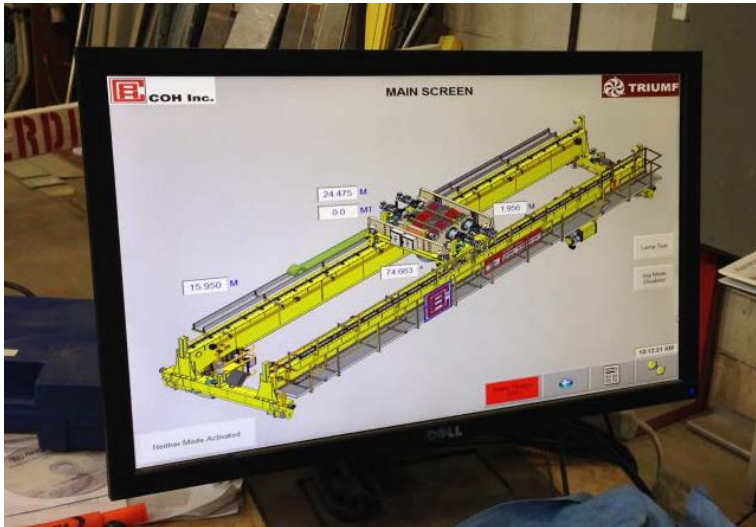


Lifting jacks for seized drive wheels



Double hoist drums with full take-up

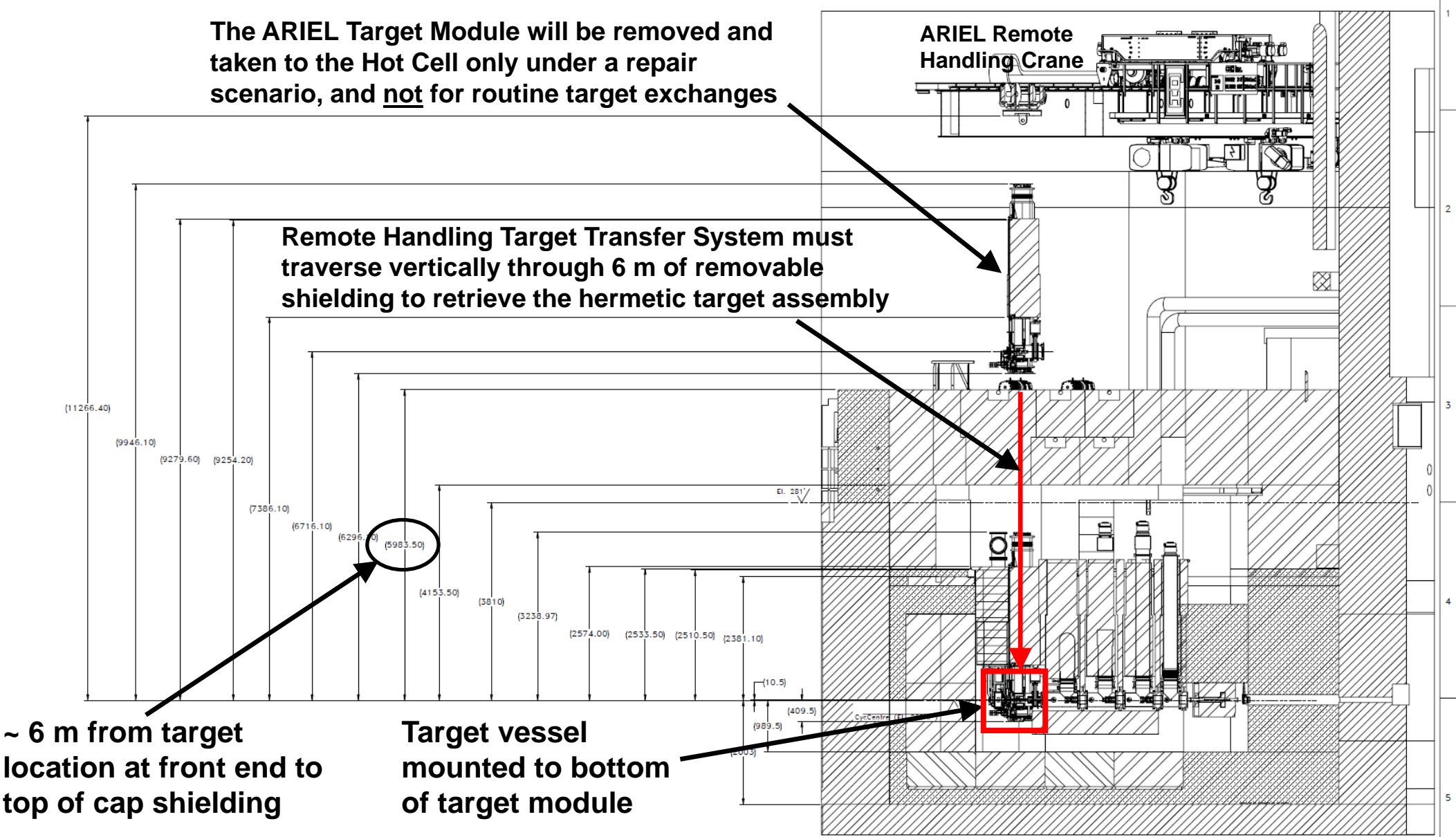
ARIEL Remote Handling Crane – Remote Controls and Camera Views



Primary Crane Functionality

- 20 MT remote main hoist
- 6.8 MT North and South aux hoists (not remote)
- Double drive motors
- Double hoist drums and hoist motors
- “True” vertical lift
- Hydraulic jacks to lift seized drive wheel (bridge and trolley)
- Controls and electronics outside the target hall
- Motorized rotation below load block
- Bridge, trolley, hoist, and rotation position encoders

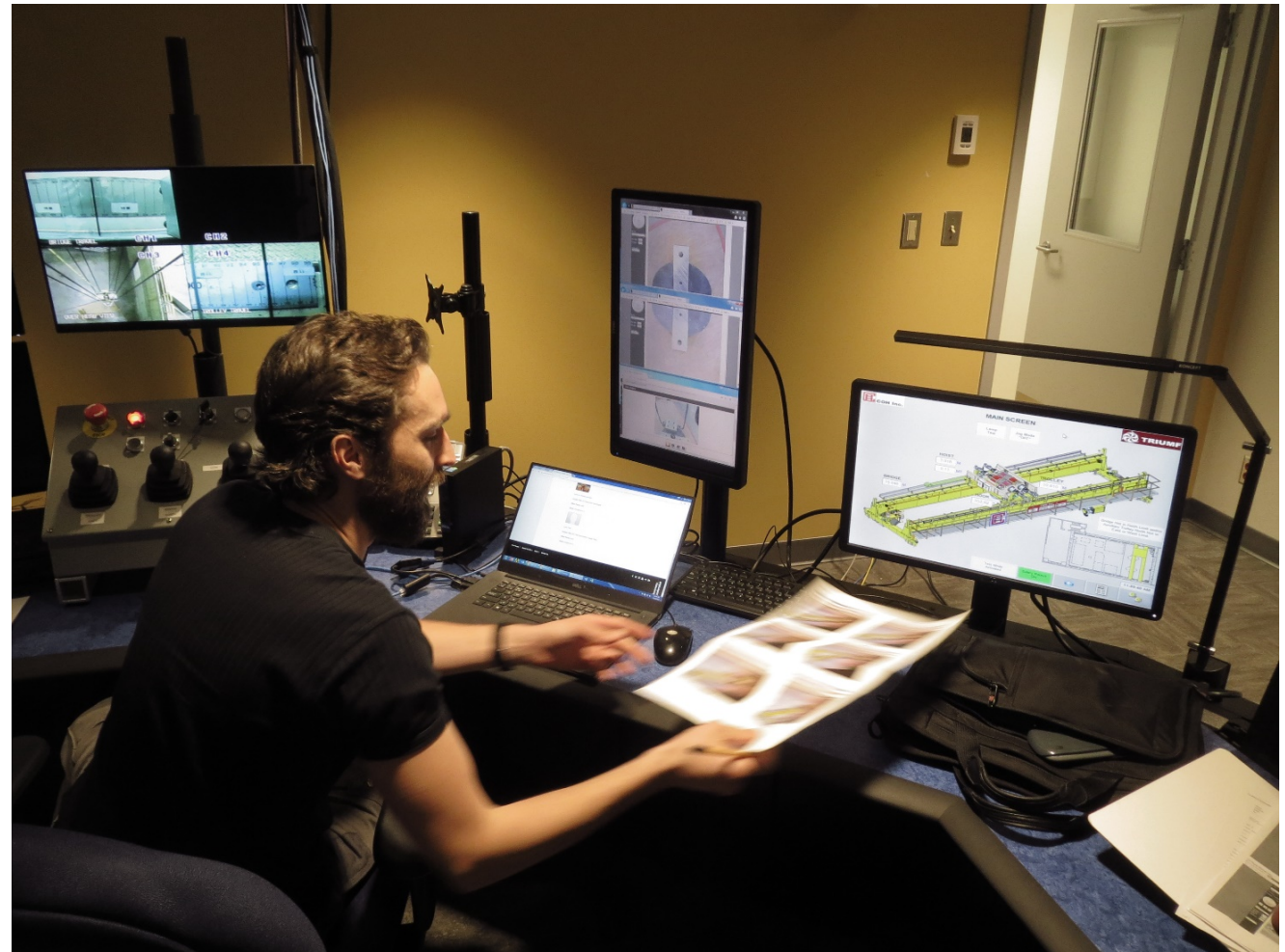
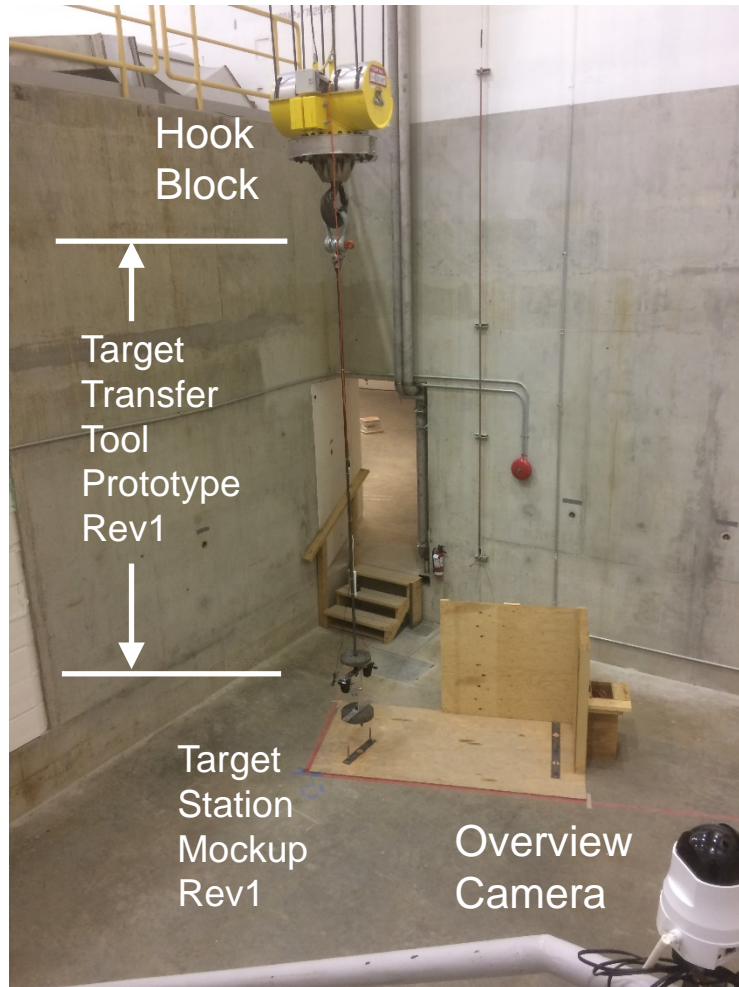
ARIEL Remote Target Transport



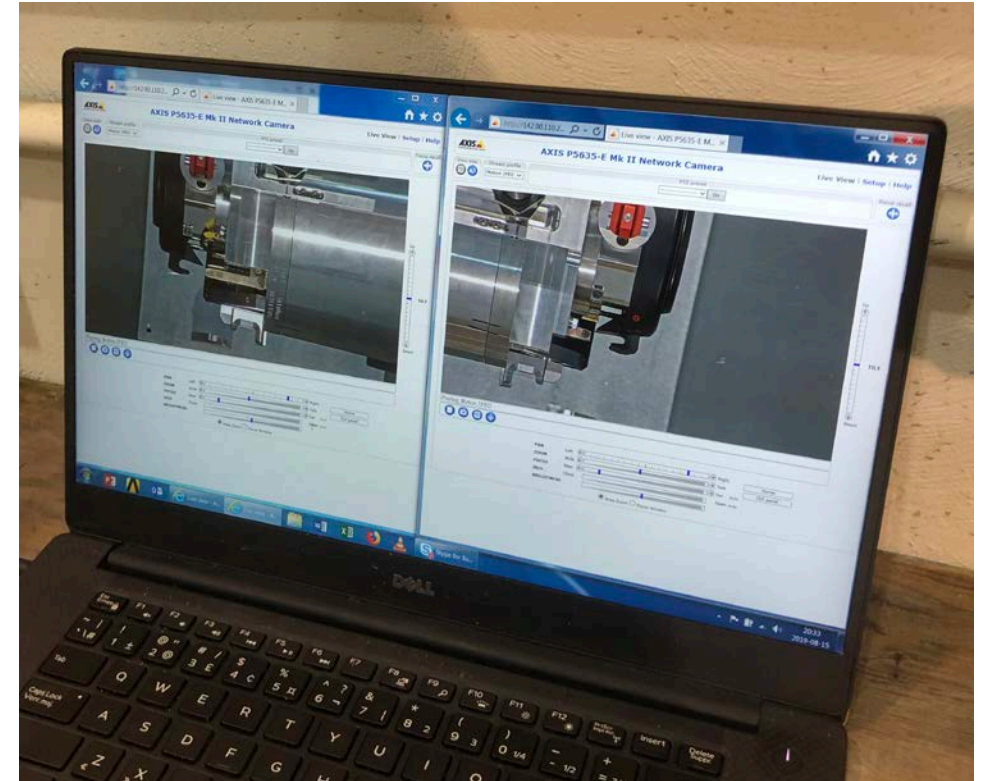
ARIEL Target Transfer System – Prototype Tests – Sept to Dec 2017 – Jason Kapalka

Successful fully remote pick-and-place of 30kg object via Remote Handling crane between 2 pinned locations 15-Dec-2017

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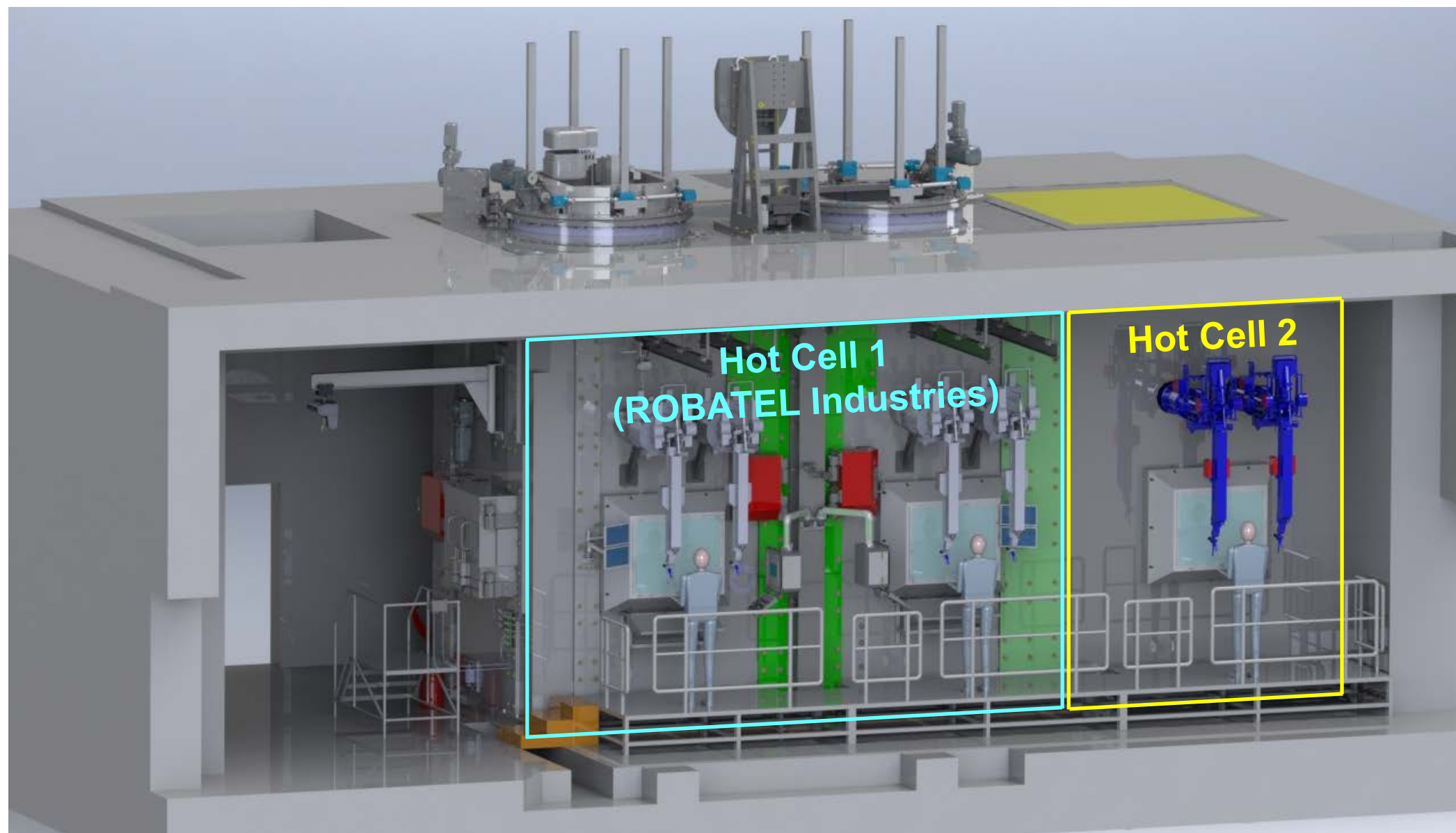


ARIEL Target Transfer Tool – Third Iteration Prototype Test – High-mounted Cameras

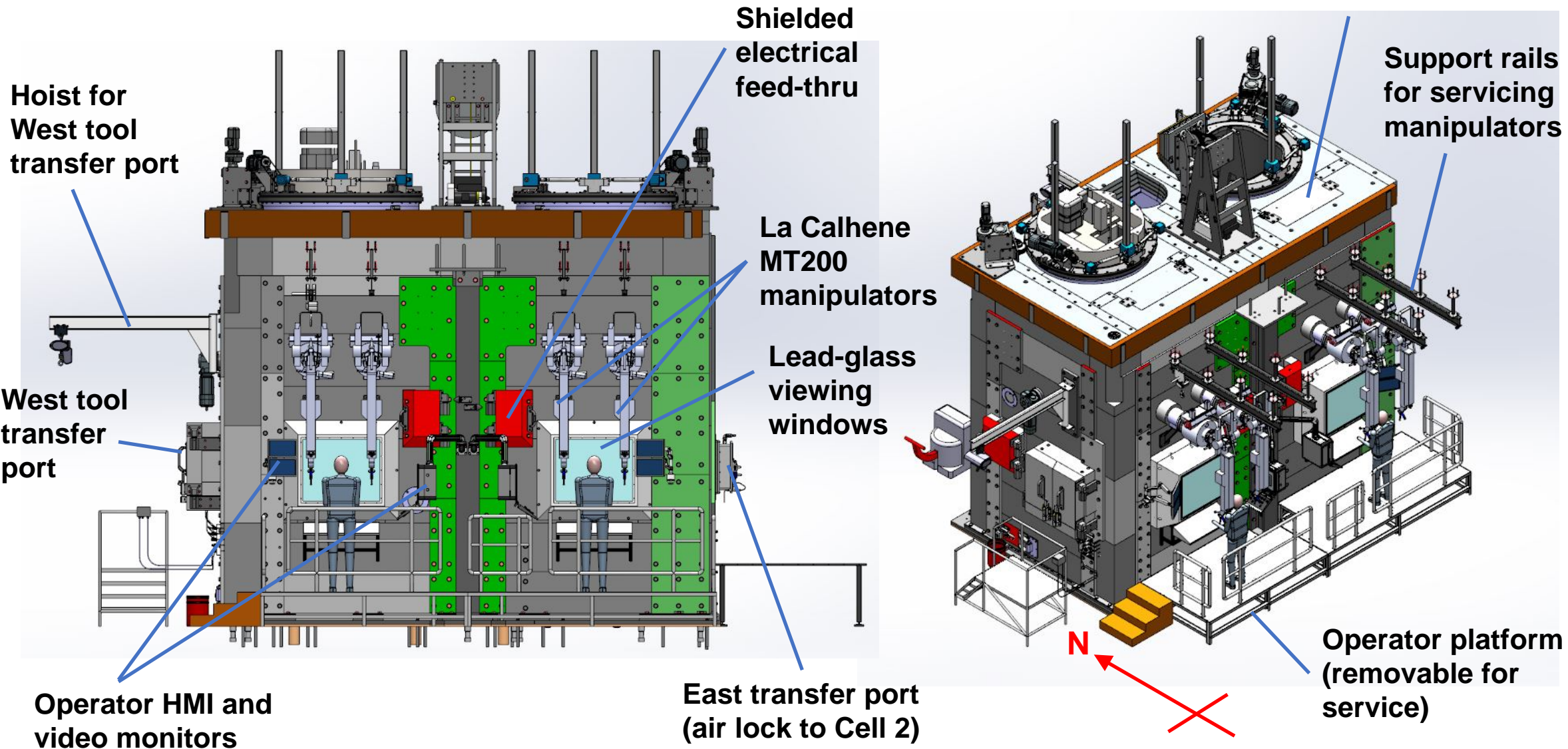


Successful remote pick-and-place of prototype target vessel onto locating pins using ARIEL Target Hall crane with Target Transfer Tool prototype – July 2019

ARIEL Hot Cell – Facility Overview

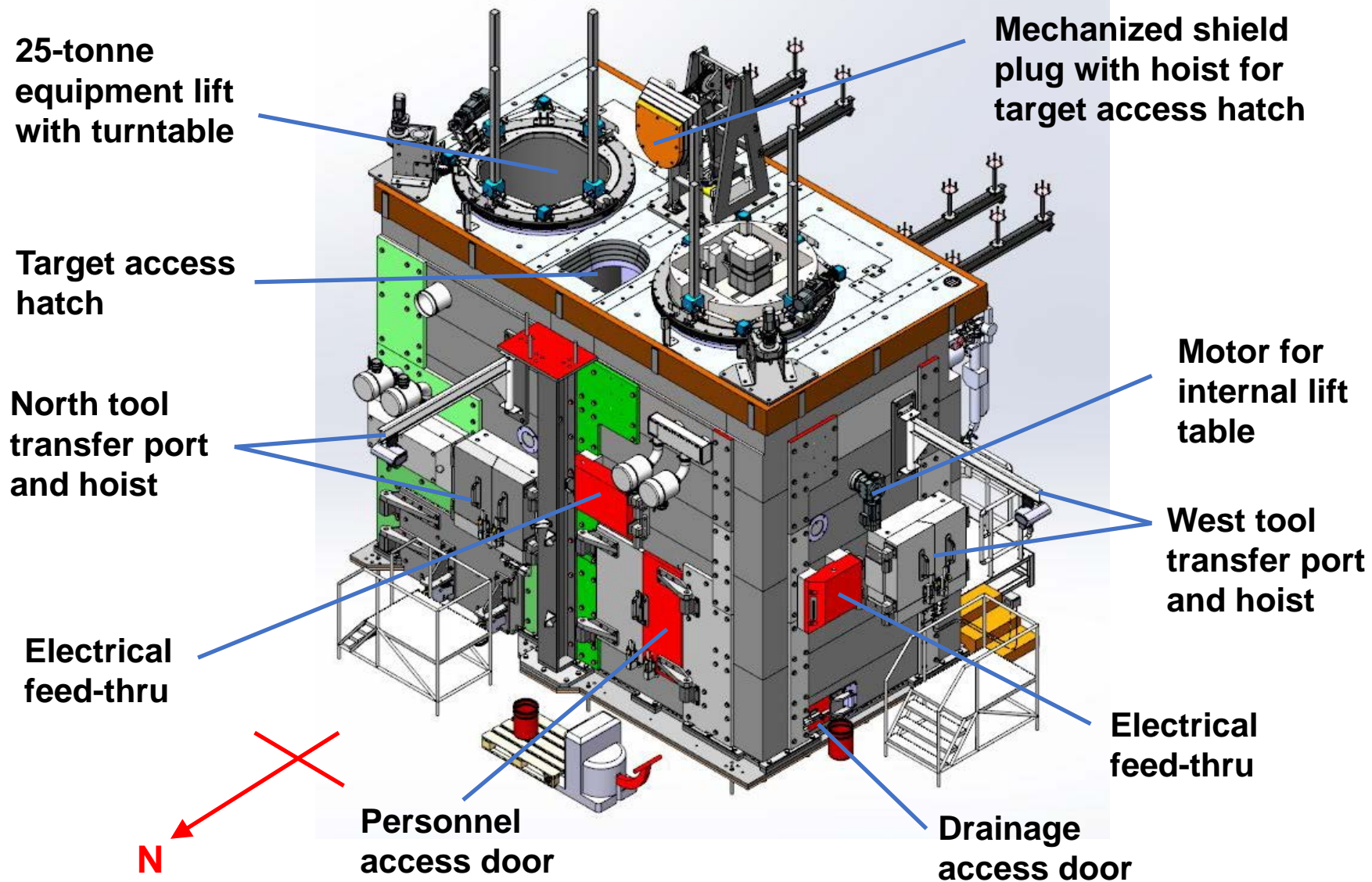


ARIEL Hot Cell 1 (ROBATEL Industries) – Features 1

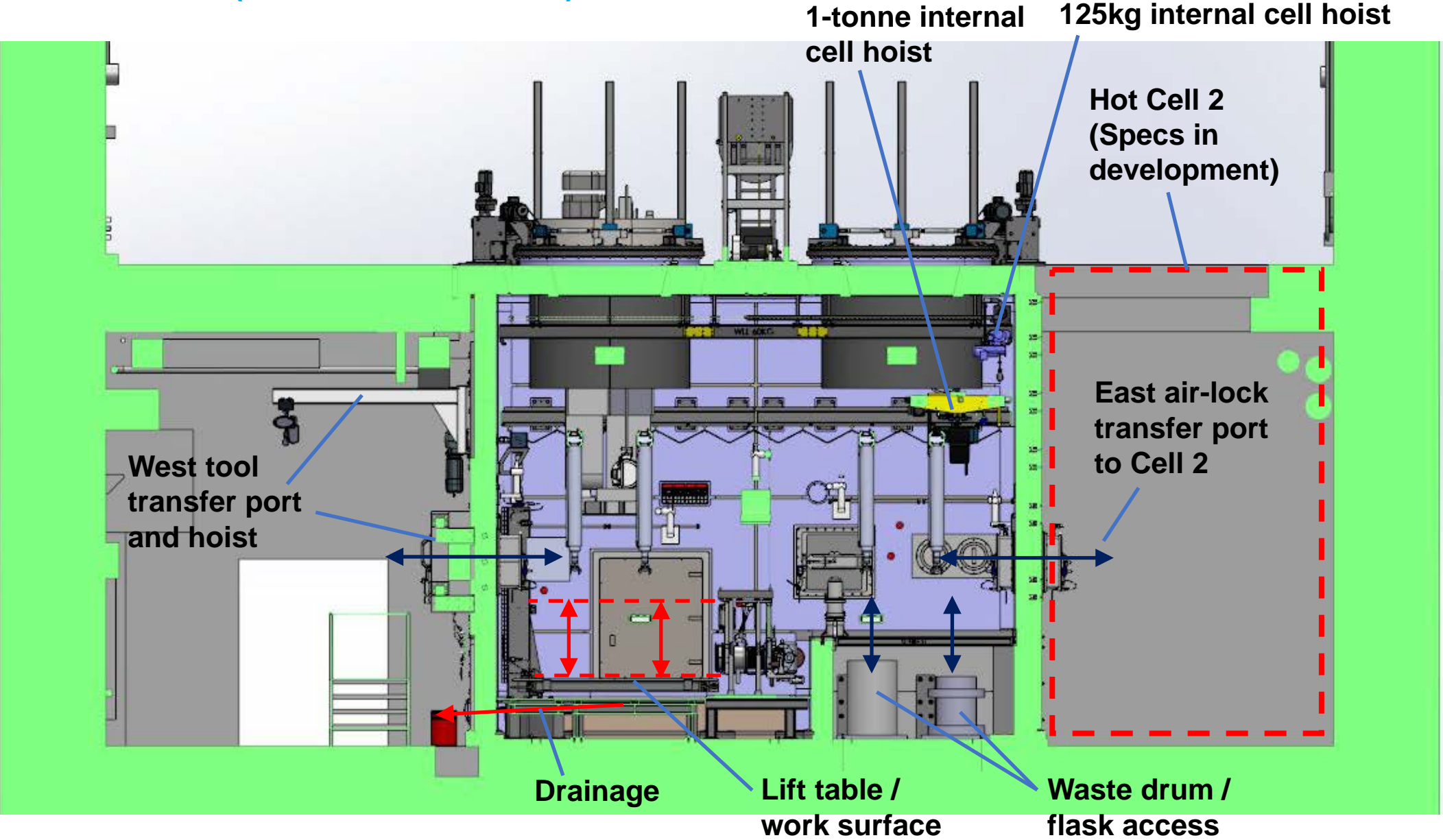


ARIEL Hot Cell 1 (ROBATEL Industries) – Features 2

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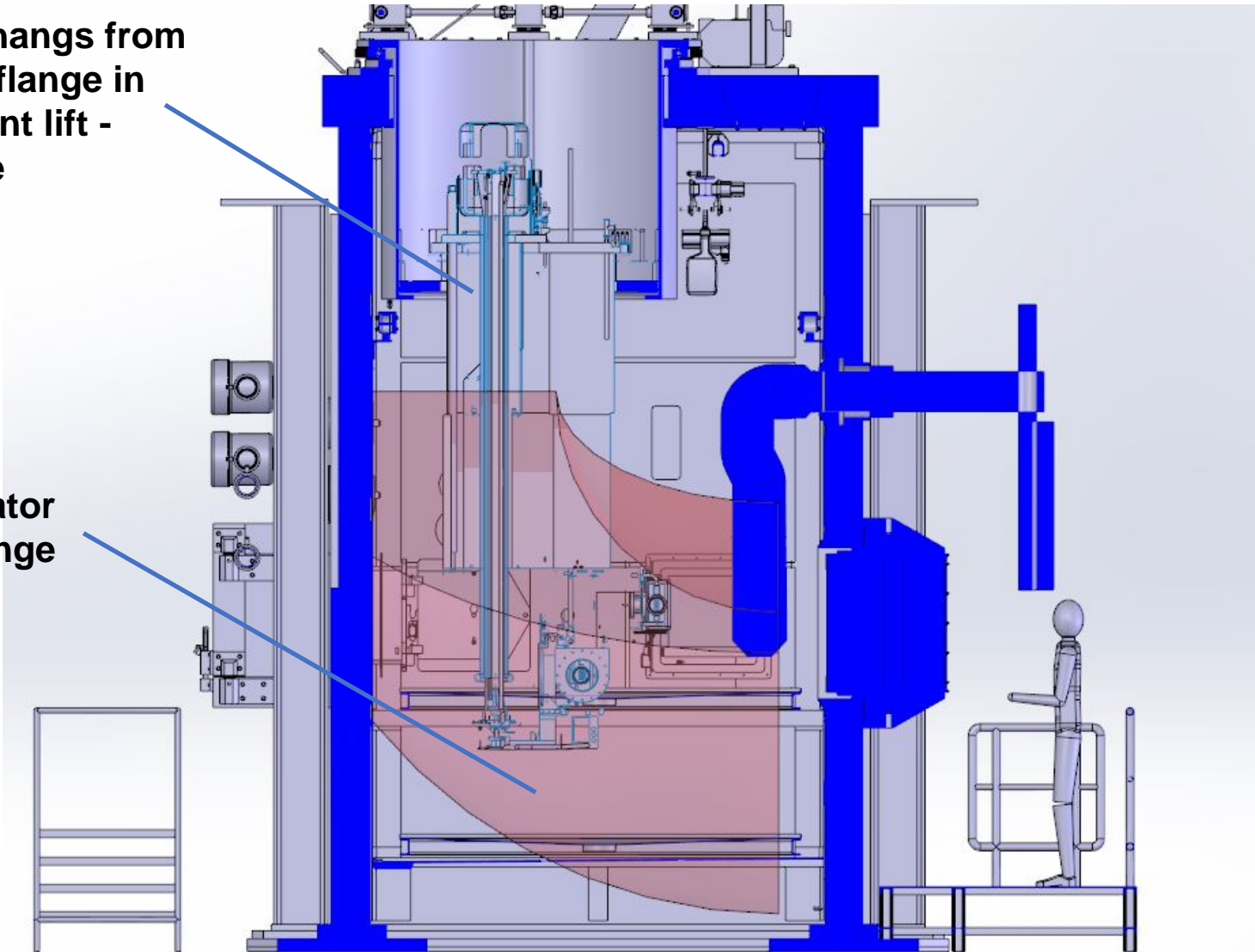
ARIEL Hot Cell 1 (ROBATEL Industries) – Features 3



ARIEL Hot Cell 1 (ROBATEL Industries) – Module Repair With Manipulators

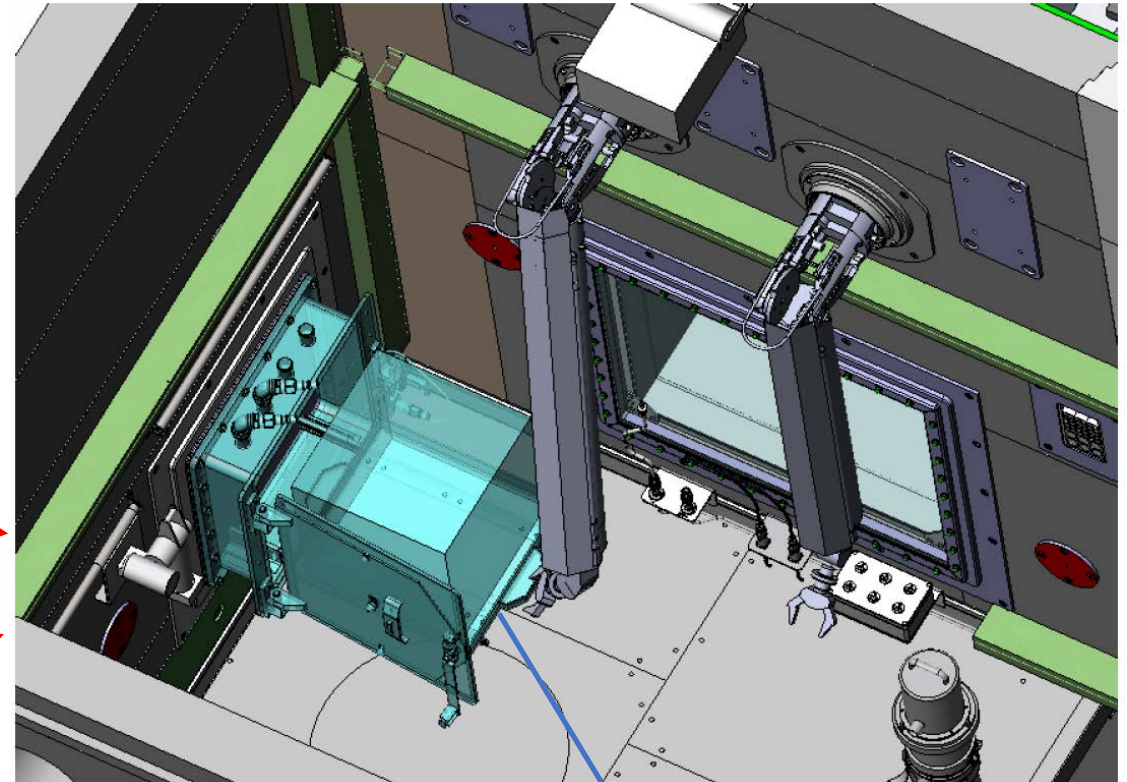
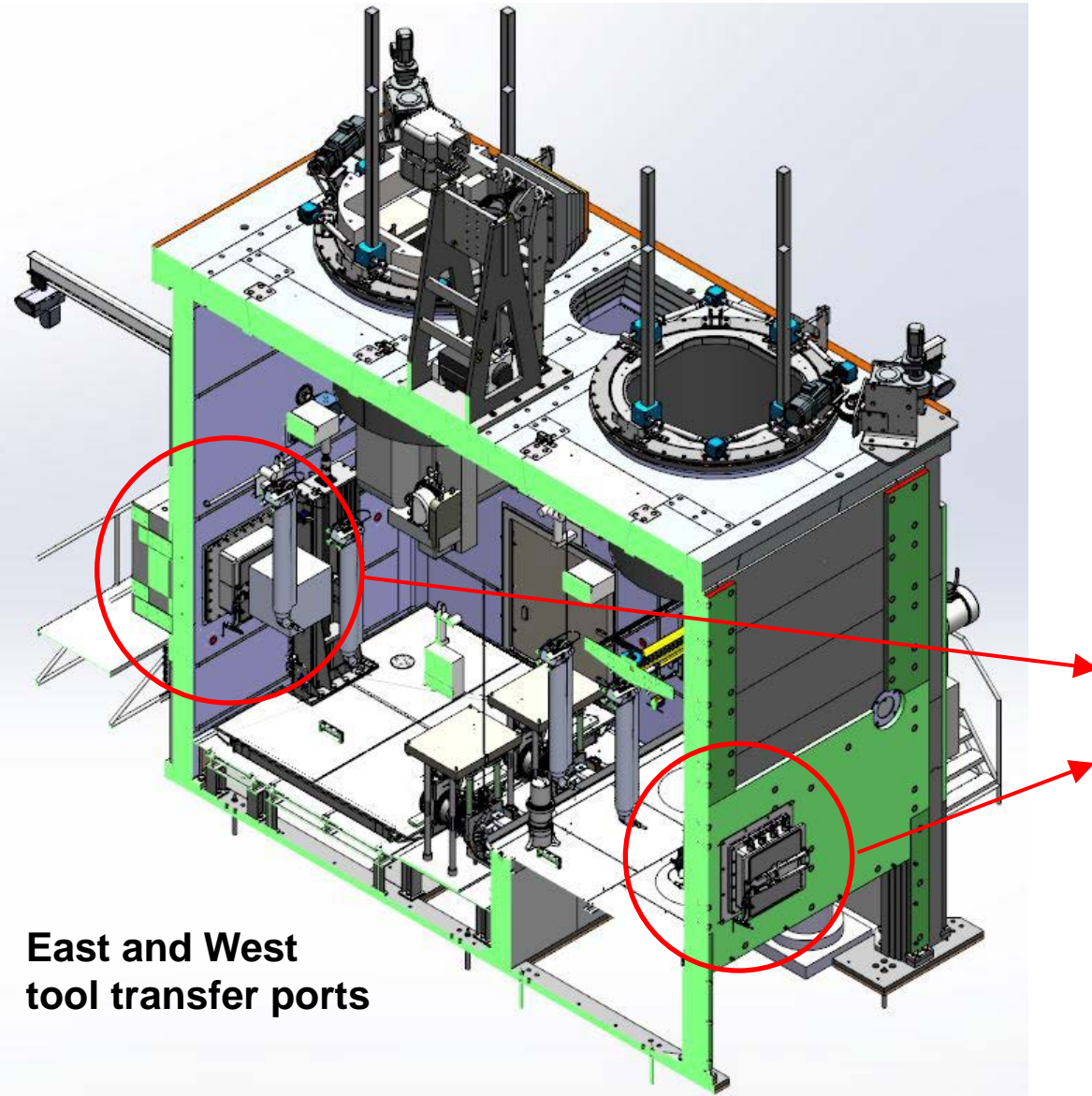
Module hangs from support flange in equipment lift - turntable

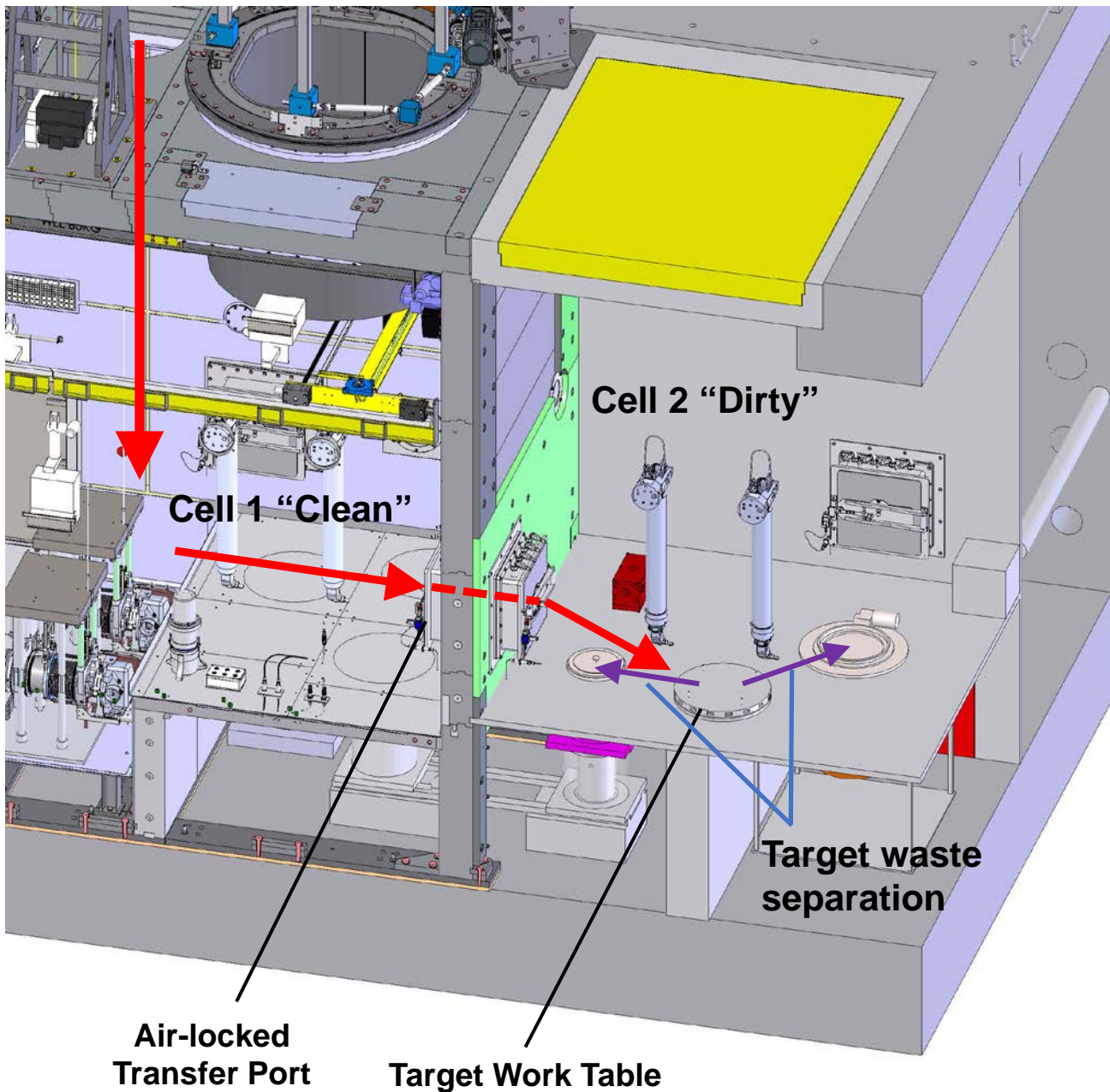
Manipulator reach range (red)



ARIEL Hot Cell 1 (ROBATEL Industries) – Tool Transfer Ports

20





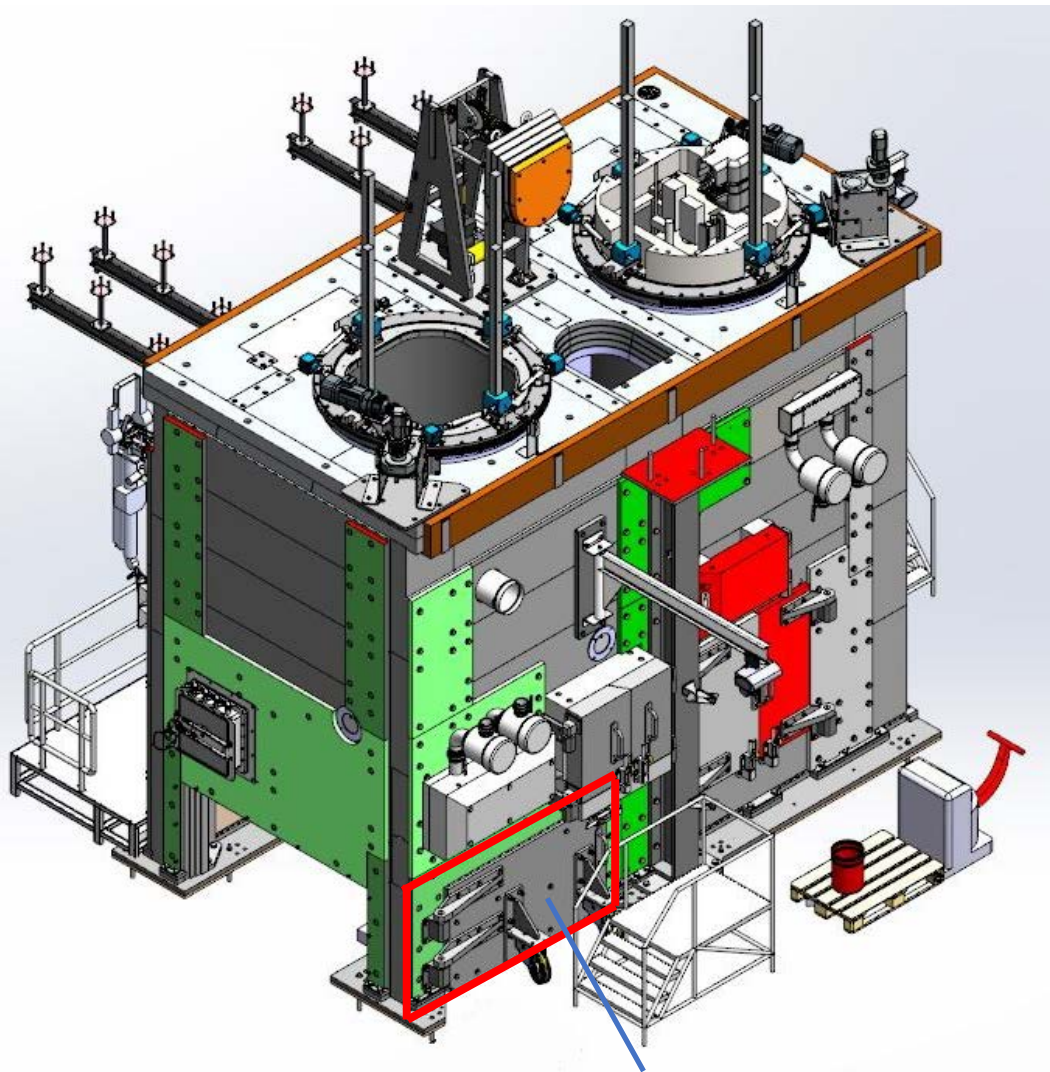
Target Waste Stream – Cell 2 (Sam Varah – TRIUMF)

21

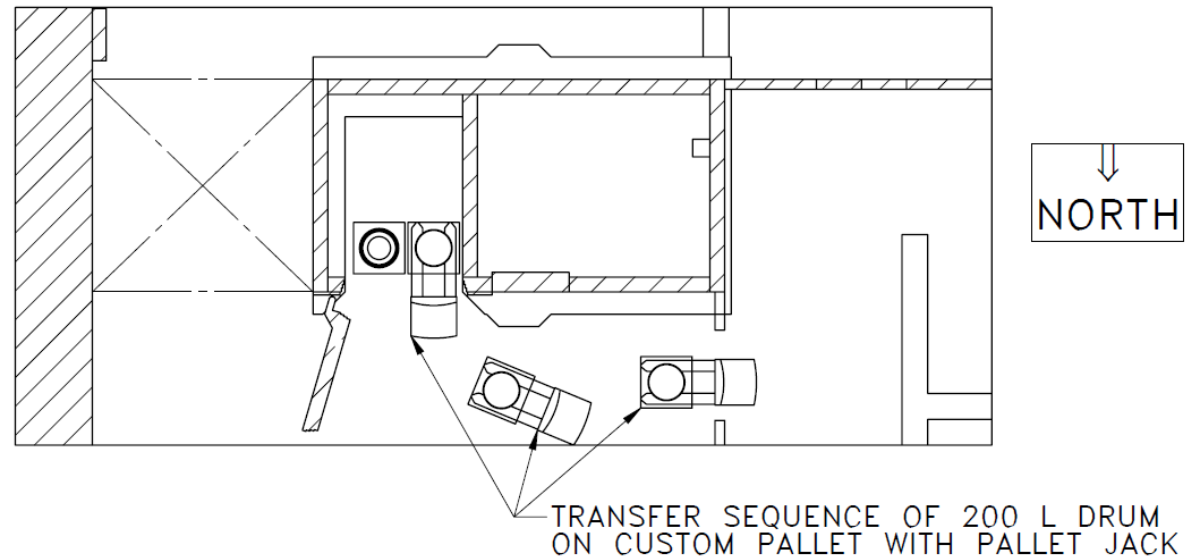
- Primary targets into Cell 1 from target hall
- Cell 1 in-cell hoist lifts target onto air-locked inter-cell transfer port tray
- Cell 1 manipulators push tray into air-lock
- Air-lock separates “clean” air in Cell 1 from “dirty” inert gas in Cell 2
- Cell 2 hoist lifts target from air-lock to work table
- Work table → locating pins
→ lockable rotation
- Target disassembled, separated into low and high active waste

ARIEL Hot Cell 1 (ROBATEL Industries) – Waste Container Access

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**Waste transfer door for
flask / drum access**



Thank you!
Merci!

Acknowledgements

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Augusto, Jason Kapalka, Don
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Gallop, Clive Mark

