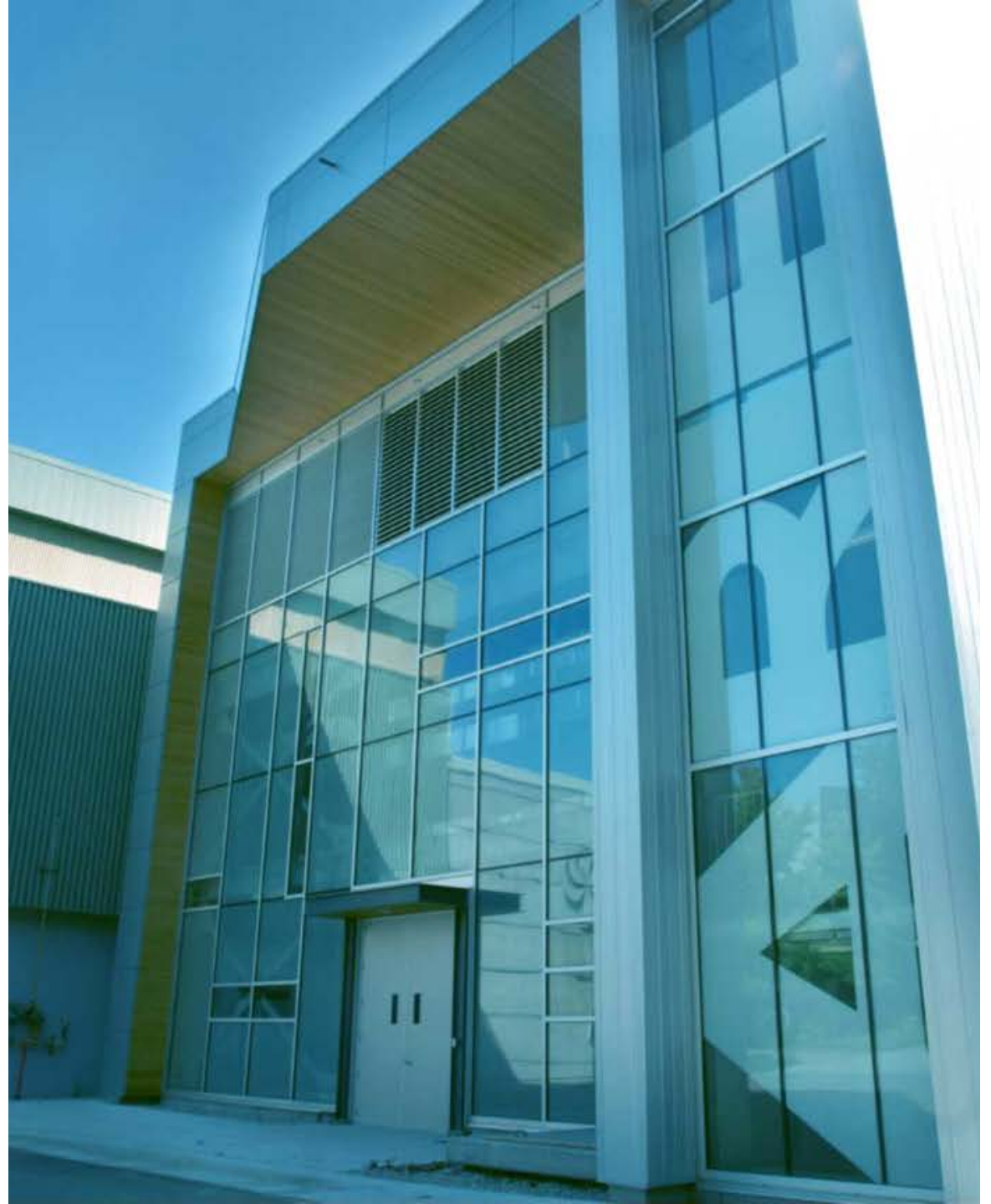


High Power ISOL Target Remote Handling Developments at TRIUMF

Grant Minor, P.Eng. | Remote Handling

High Power Targetry Workshop 2018, FRIB

June 4-8, 2018

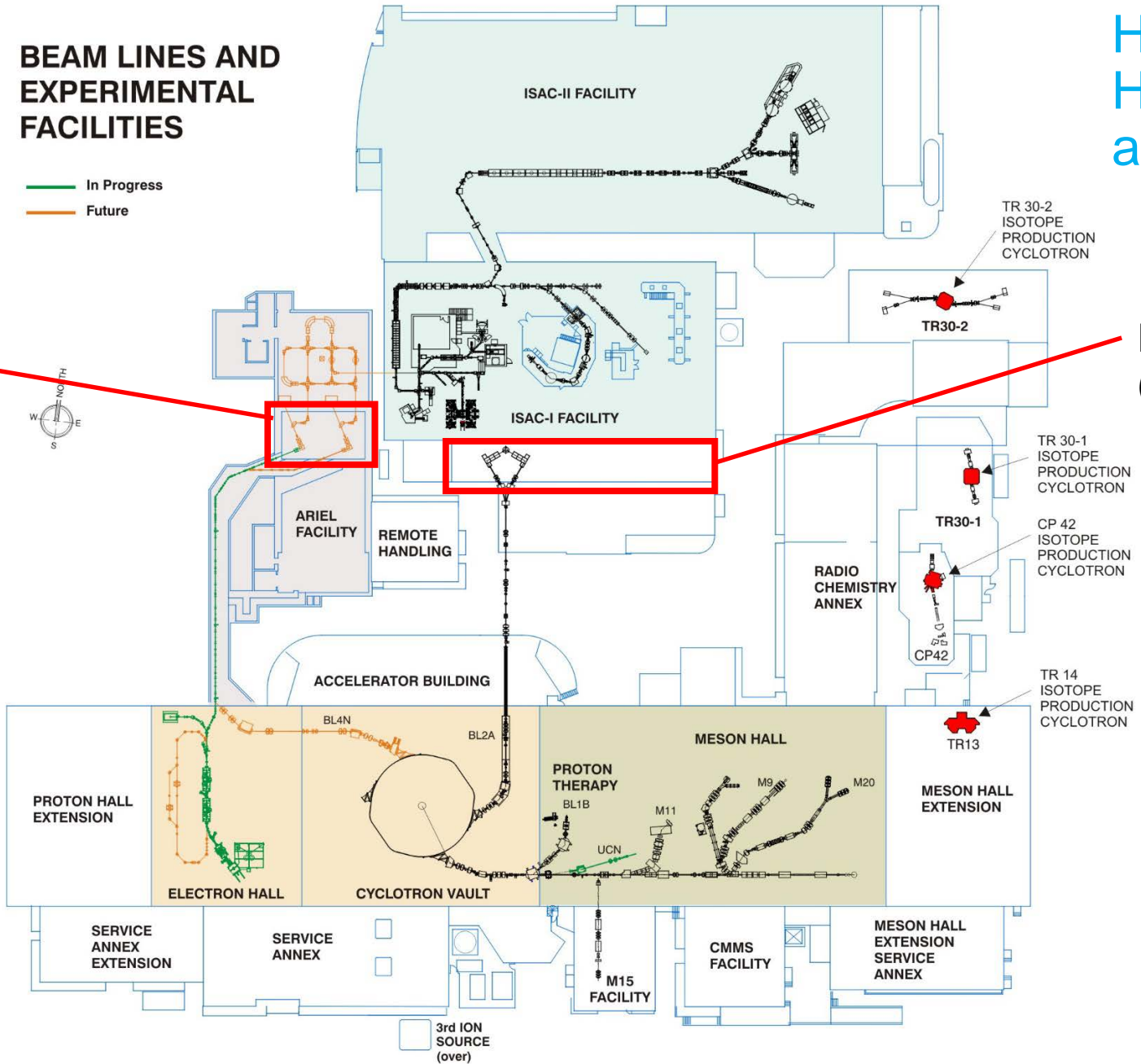


Agenda

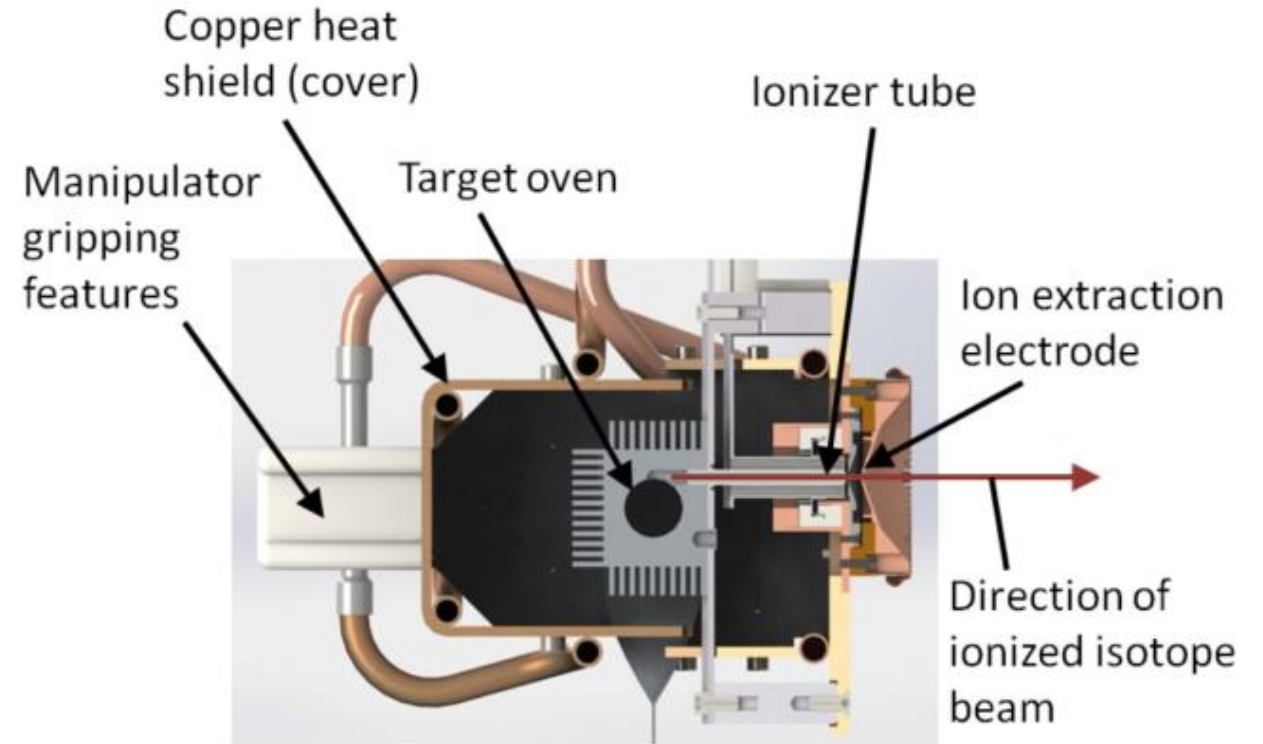
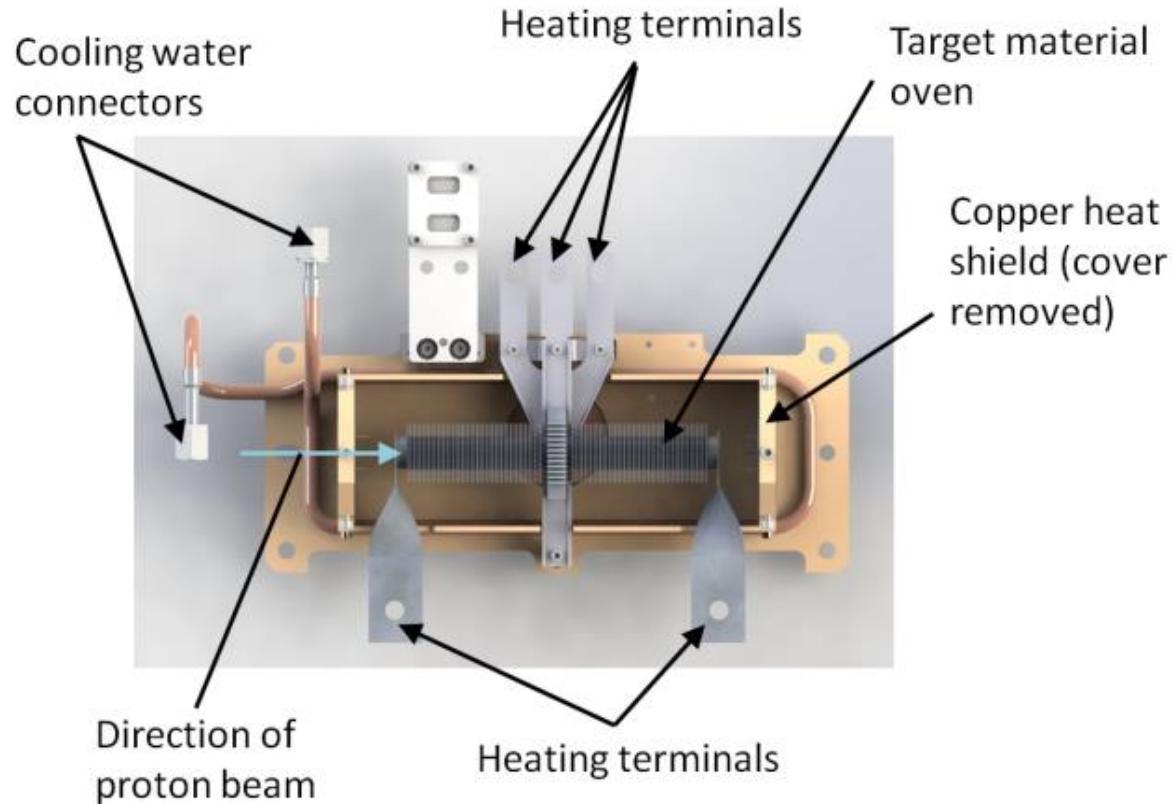
- Introduction High Power Target Handling Areas at TRIUMF
- Current ISAC Target Exchange Processes
- ISAC Target Facility Developments
- Introduction to ARIEL Target Hall Facility
- ARIEL Target Exchange System Developments

ARIEL Target Hall
(Building complete, machinery in-design, first beam ~in 2021)

ISAC Target Hall
(First beam in 2001)



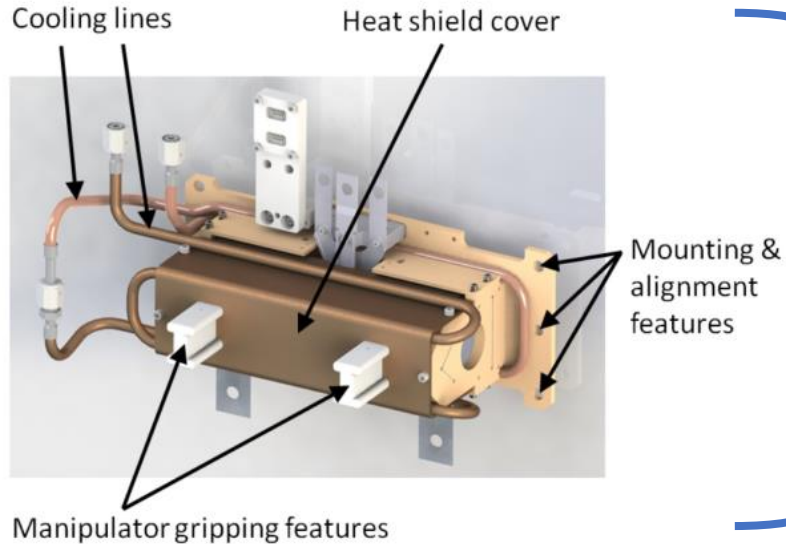
ISAC Targets - Introduction



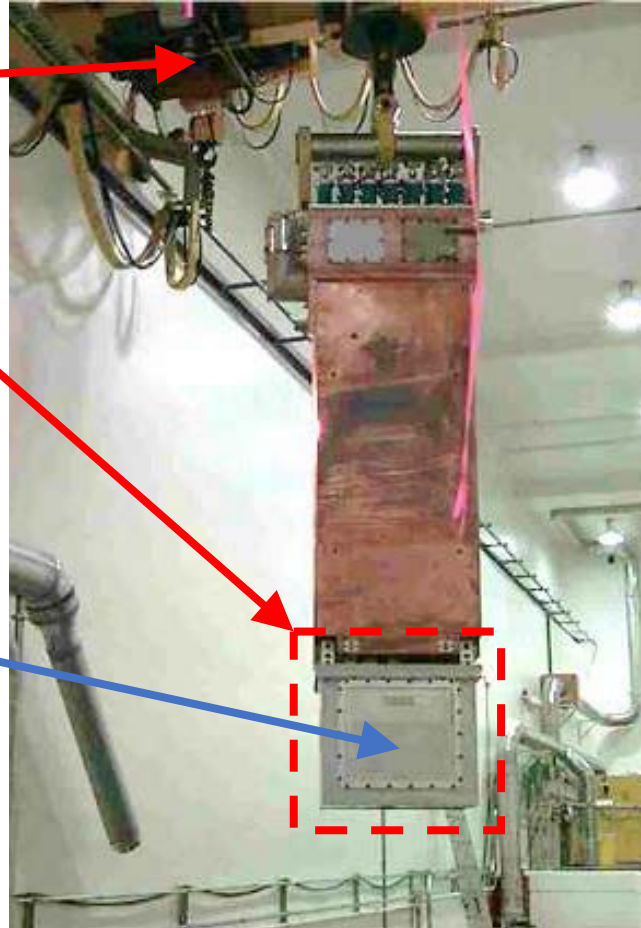
ISAC Targets Modules

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

Containment Box



Target assembly is mounted on the extraction front end in the Target Module containment box



ISAC Target Module hanging from Remote Handling crane



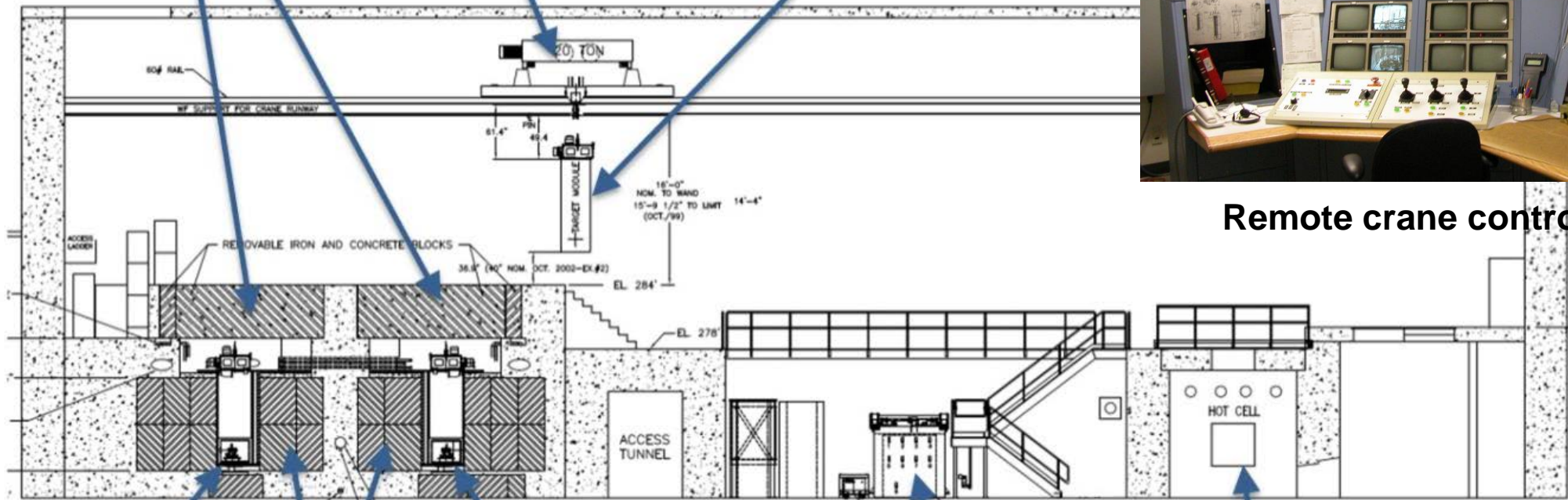
Target Module transport to target station (remote rotation of the module is required)

ISAC Target Hall

Concrete and steel removable blocks

Remote handling crane

Target module



Remote crane control room

West target station

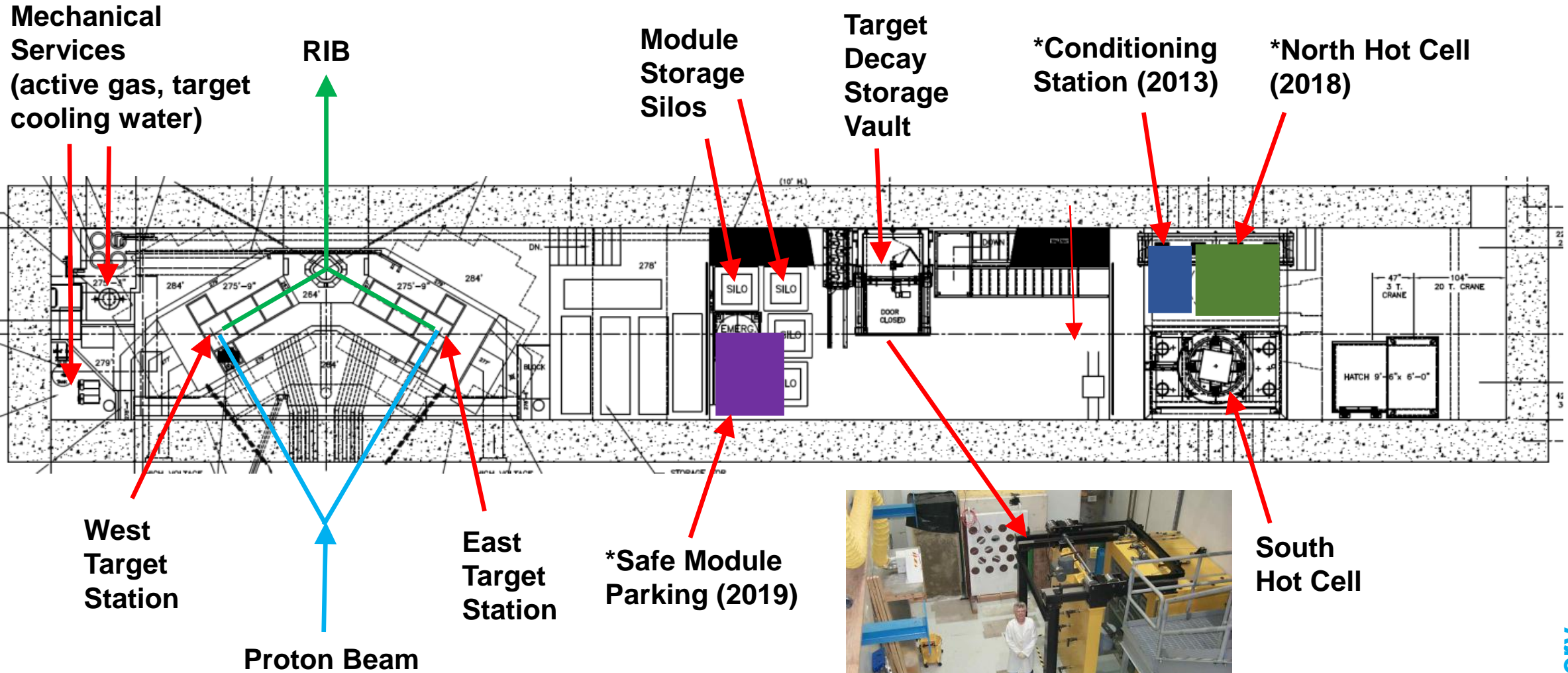
Steel shield blocks

East target station

Spent target decay storage vault

Hot cells

ISAC Target Hall – Plan View



Target Hall West View

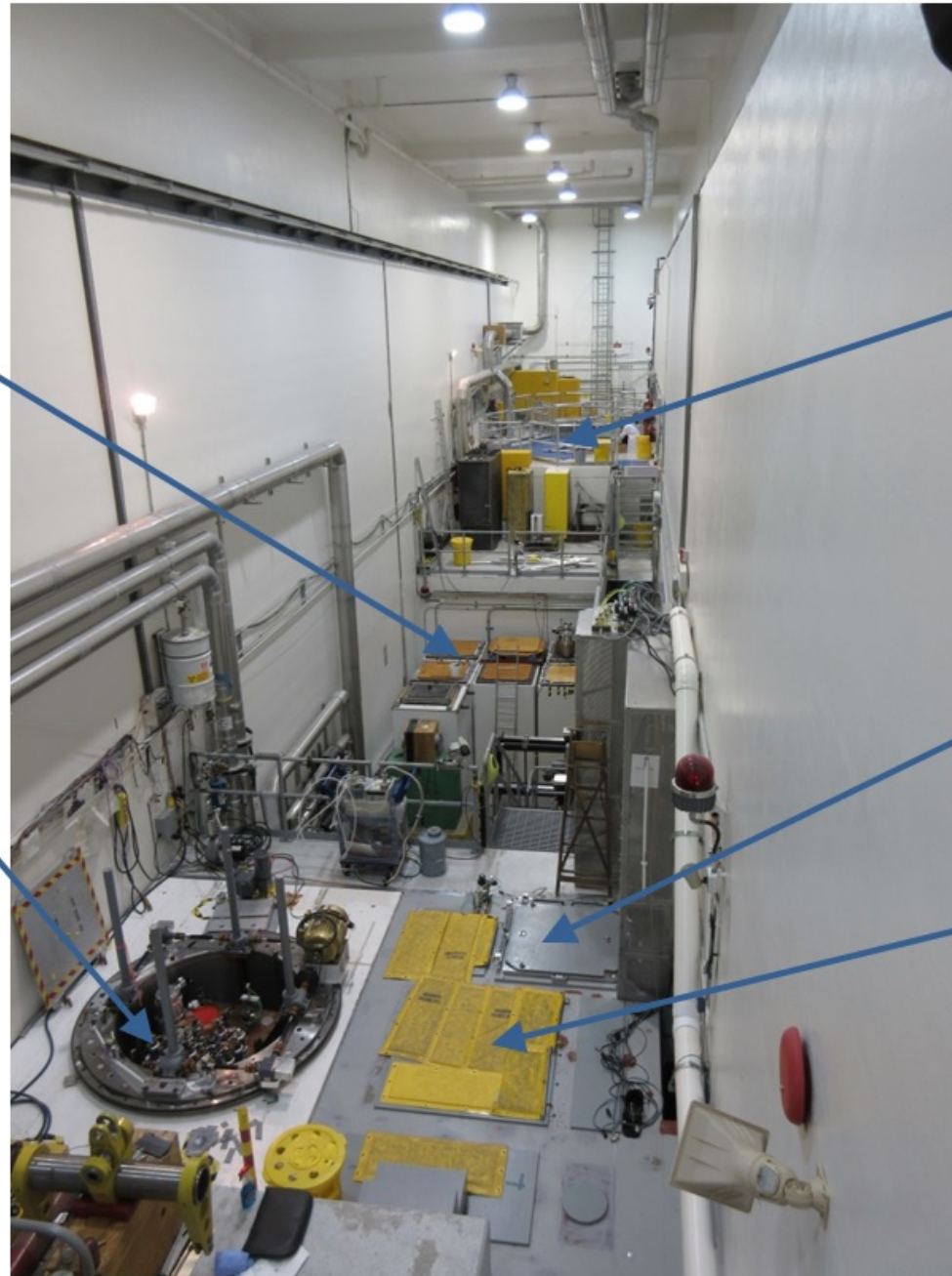
Module
storage
silos

South
hot cell

East & West
target
stations

Conditioning
station

North
hot cell



Target Hall East View

Remote
handling
crane



Connecting a Target Module in the pit

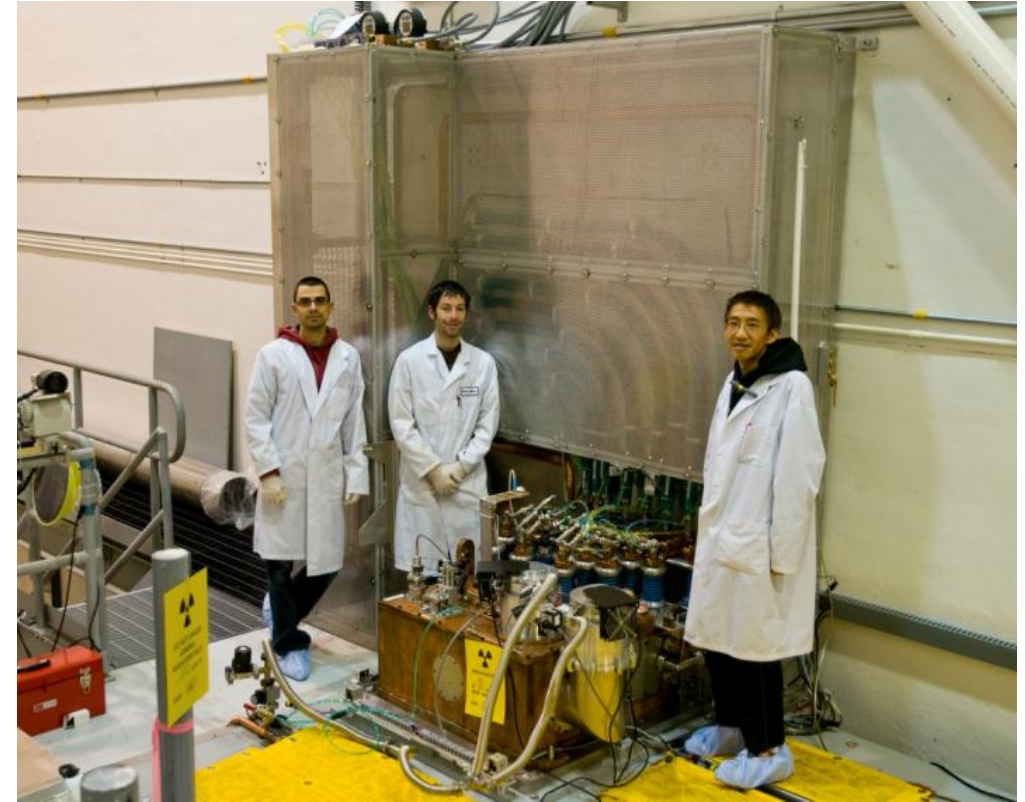
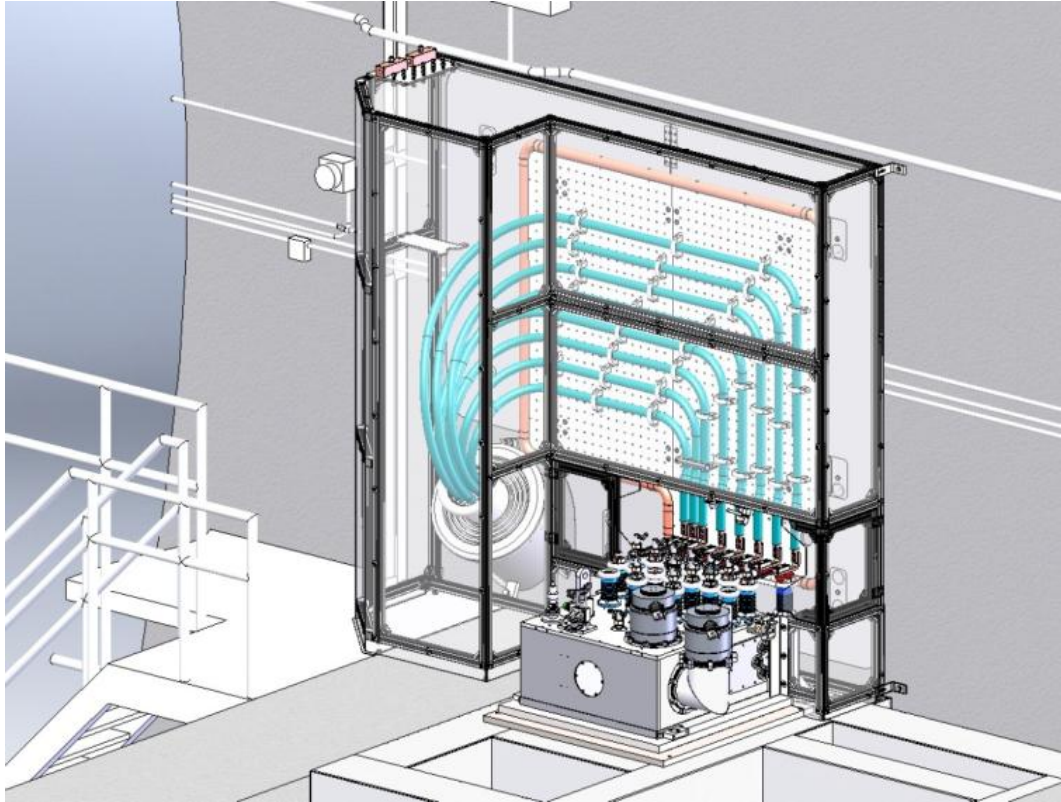


North and
South Hot
Cells

East Target
Station
(covered)

West
Target
Station

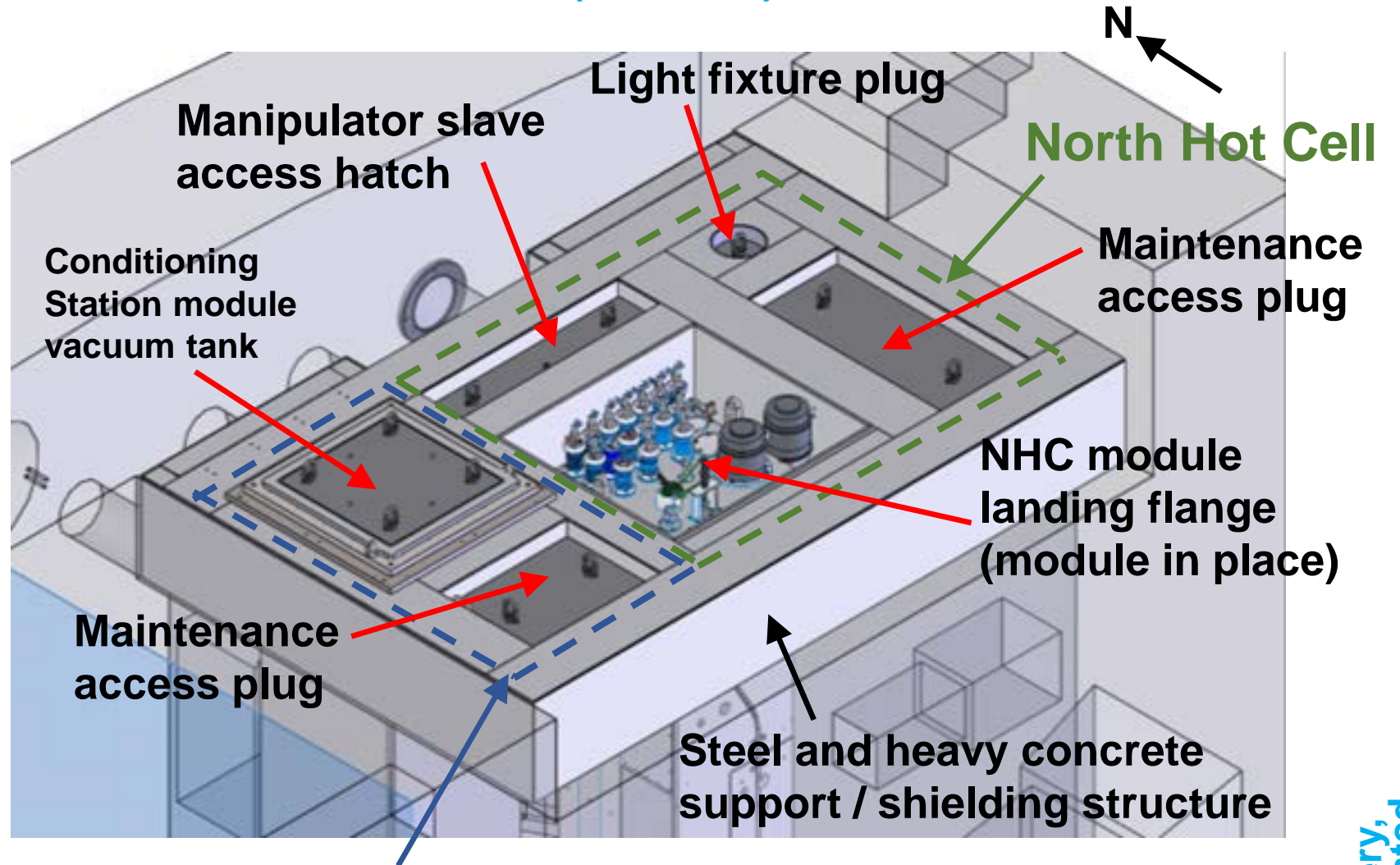
ISAC Conditioning Station (2013)



- Provides off-line vacuum vessel, high-voltage bias & high-power services for a Target Module
- Allows a target installed in a module to be conditioned and tested off-line prior to operations
- Greatly improves facility reliability through early identification of failures and off-line diagnostics

ISAC North Hot Cell (2018) – Isaac Earle

- Allows routine target exchange in parallel with repairs and development at the South Hot Cell
- Fixed module height and position (no rotation)
- Shared support structure & concrete cavity in building with Conditioning Station



Conditioning Station

North Hot Cell – Before Start of Project



North Hot Cell – Ventilation Partition and Interior Services



Ventilation duct
(nuclear exhaust)

Pre-filter
(remote
handleable)

Conditioning
Station / NHC
partition wall

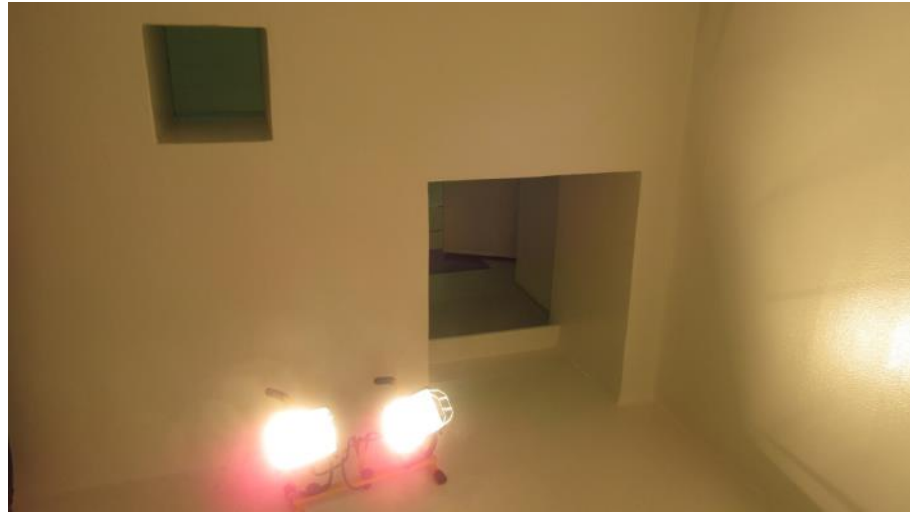
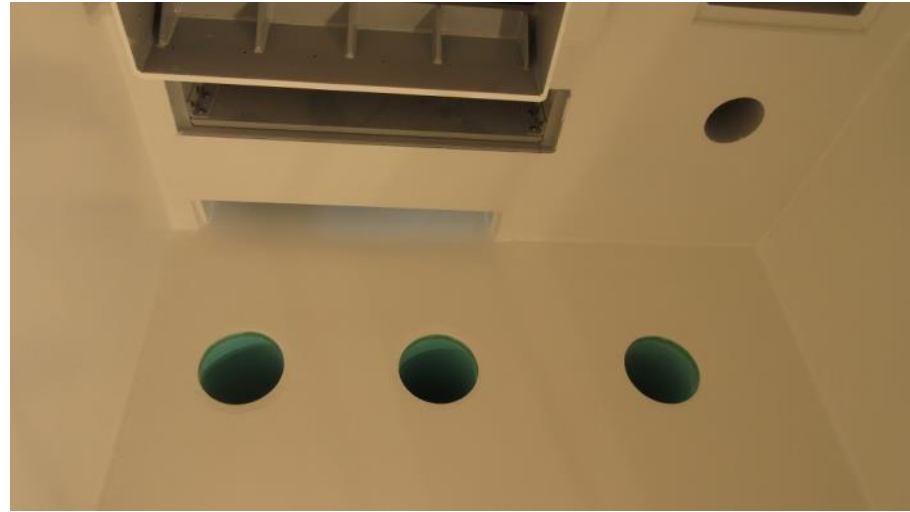
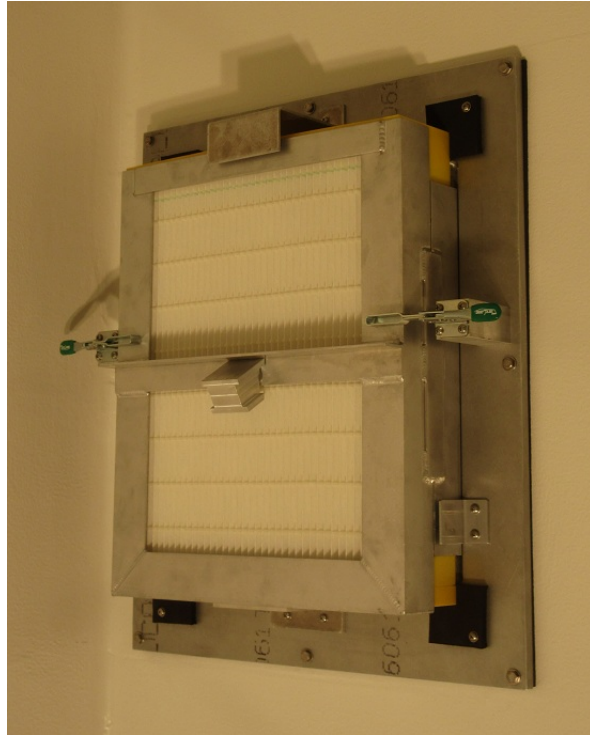
Work table with
storage hatch

Gas and
electrical
services w/
Staubli
connectors

Tool port &
shield plug

Personnel access
shield door (existing)

North Hot Cell – Interior Sealing and Finishing



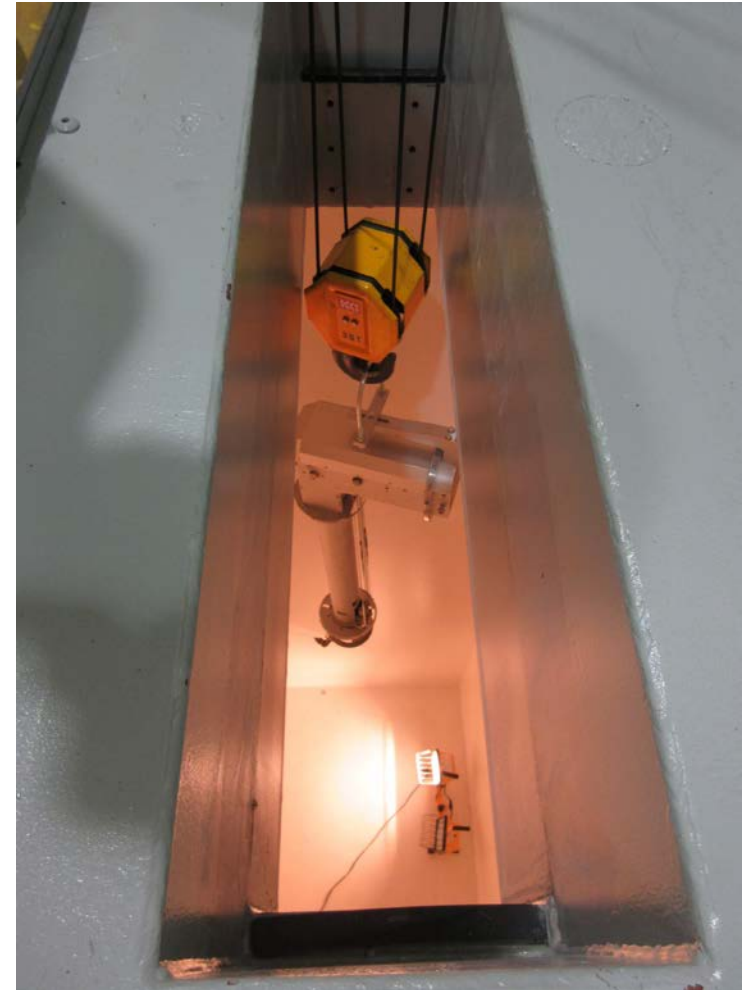
North Hot Cell – Manipulator Installation



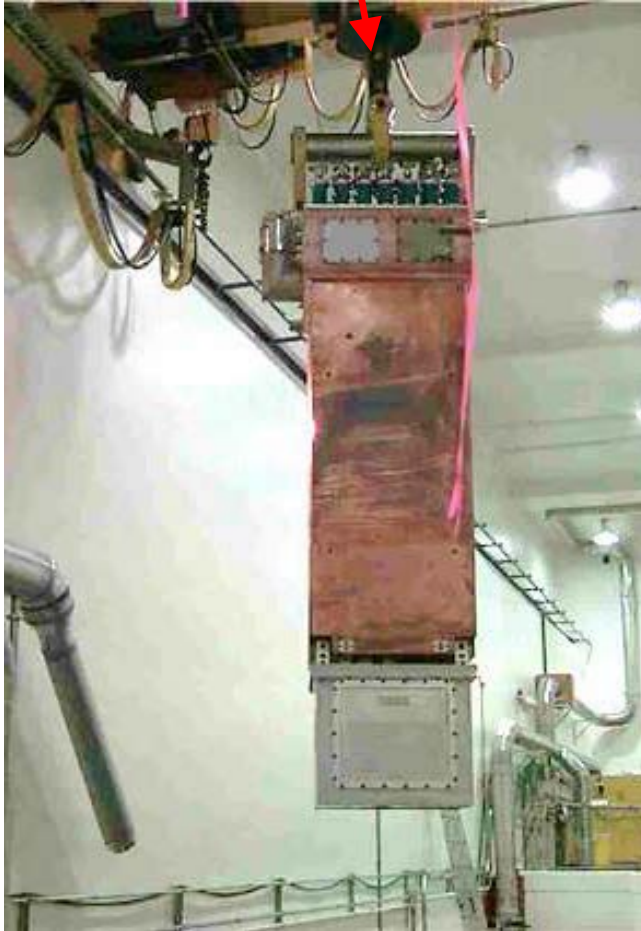
North Hot Cell – Roof Hatch Plugs and Work Table



North Hot Cell – Manipulator Slave Extraction Test

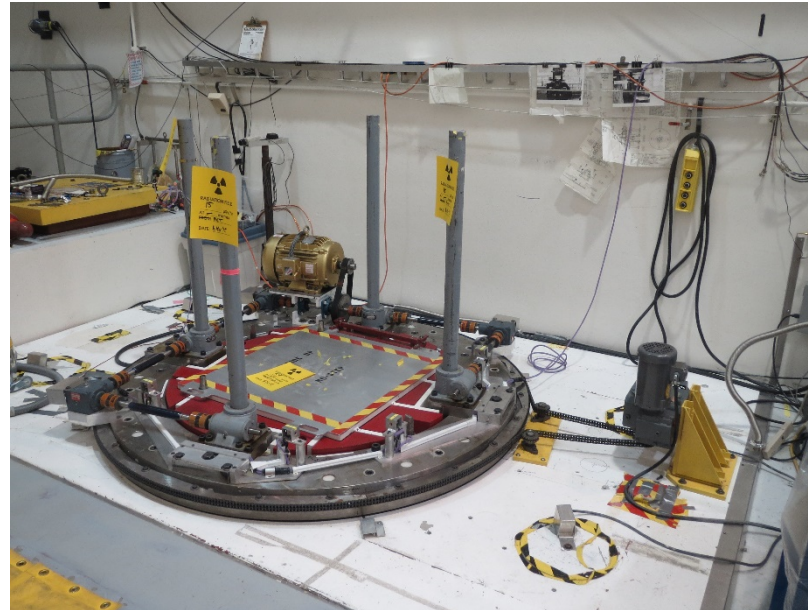


ISAC Module must be rotated on crane to align with Target Stations, Hot Cells, and Silos



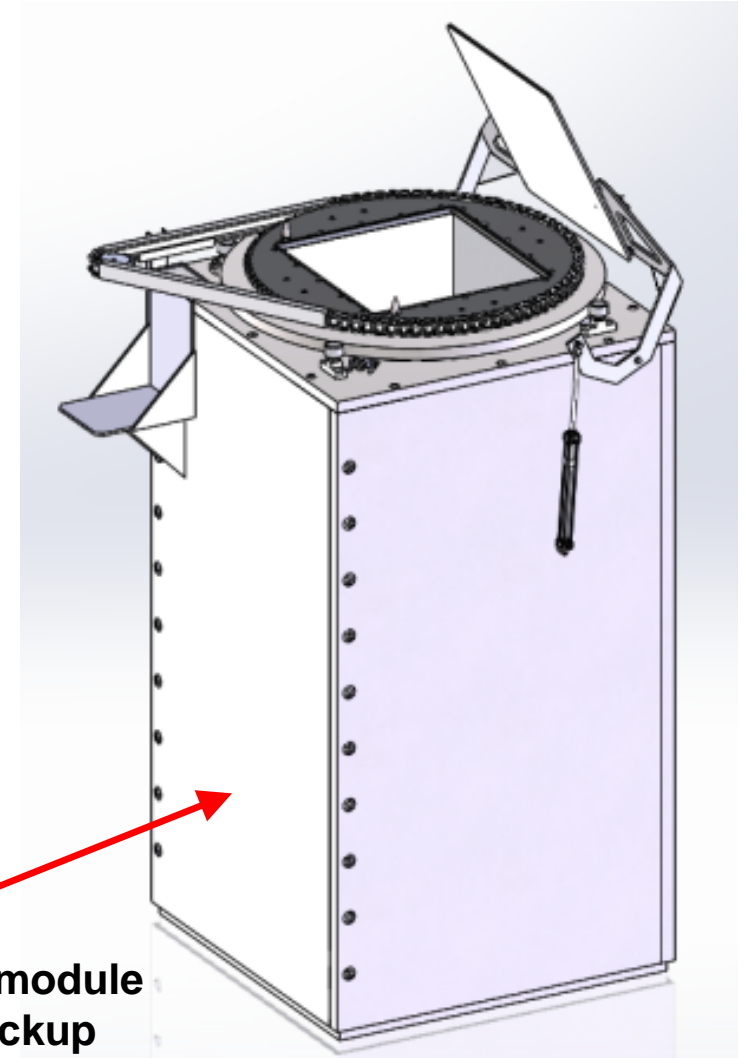
ISAC South Hot Cell turntable currently provides backup for ISAC crane rotation machinery

- Must be vacant during a module move
- Means repair operations at SHC must be interrupted for routine module moves

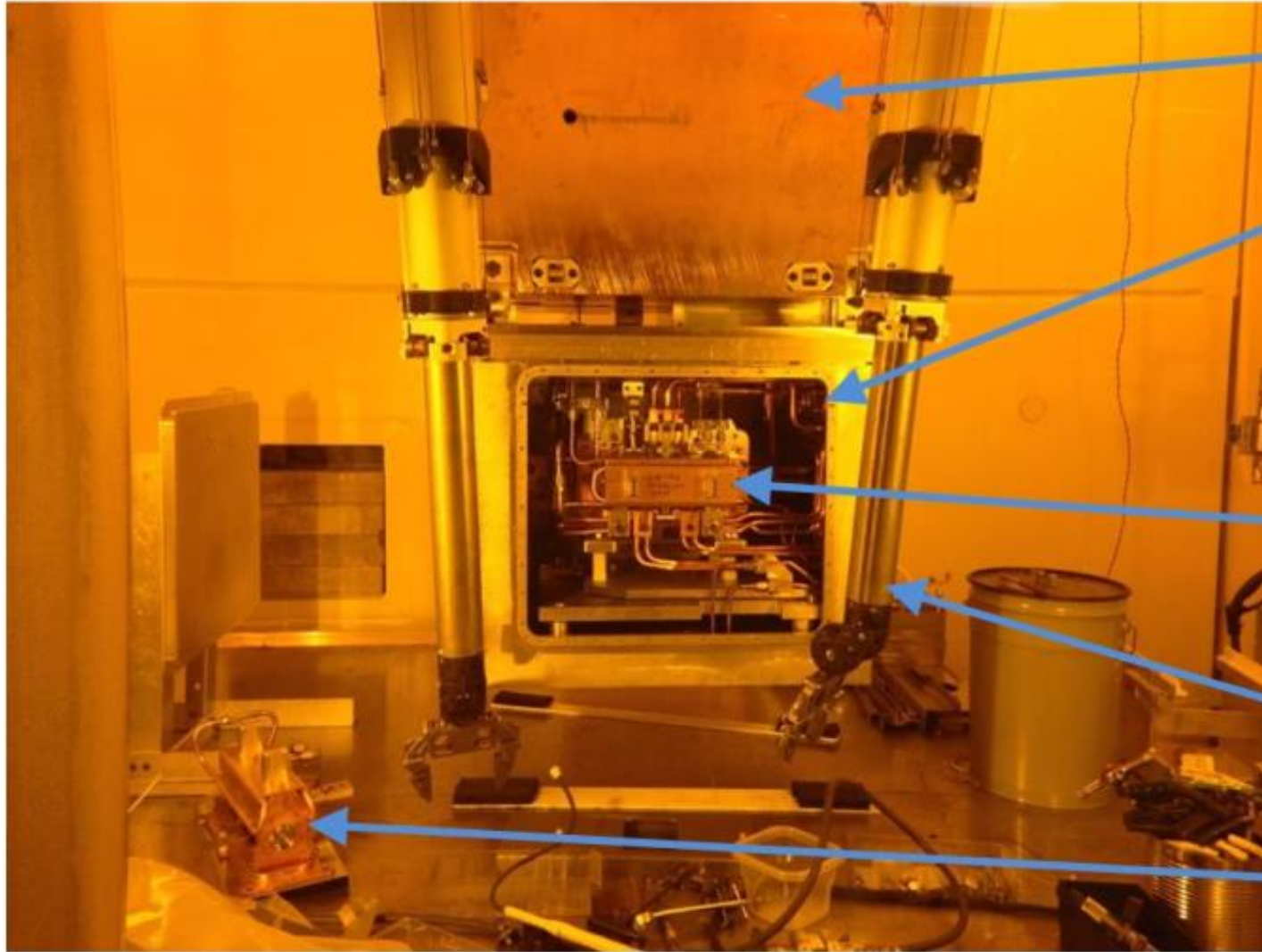


Safe Module Parking Project:

- Provides shielded landing point for active module
- Provides mechanized rotation for crane backup
- Frees the South Hot Cell for uninterrupted long-term maintenance and repair operations



ISAC Waste Target Process – Module Access in Hot Cell



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

ISAC Waste Target Process – Target Packaging



Target loaded into 5-gallon pail in the Hot Cell
After decay period, pail is loaded into Nordion F-308 shipping container (manual process!)



- 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

ISAC Spent Target Storage Vault

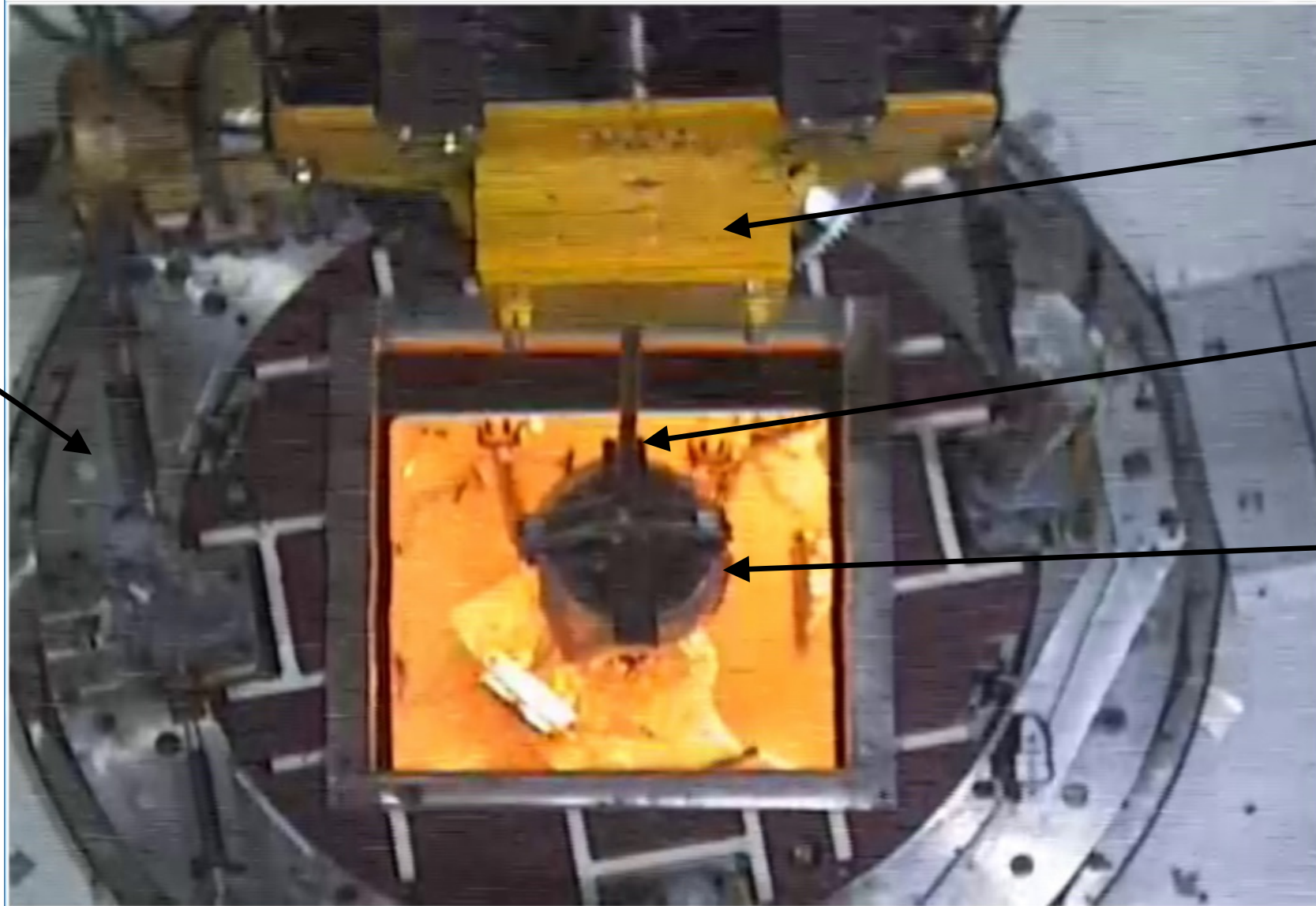


Decay storage vault door in open position

Spent target in 5-gallon pail, installed in decay storage vault drawer

Decay storage drawer (single drawer selected and pulled out with door)

ISAC Spent Target Pail Remote Crane Transport



**South Hot Cell
Turntable
Assembly**

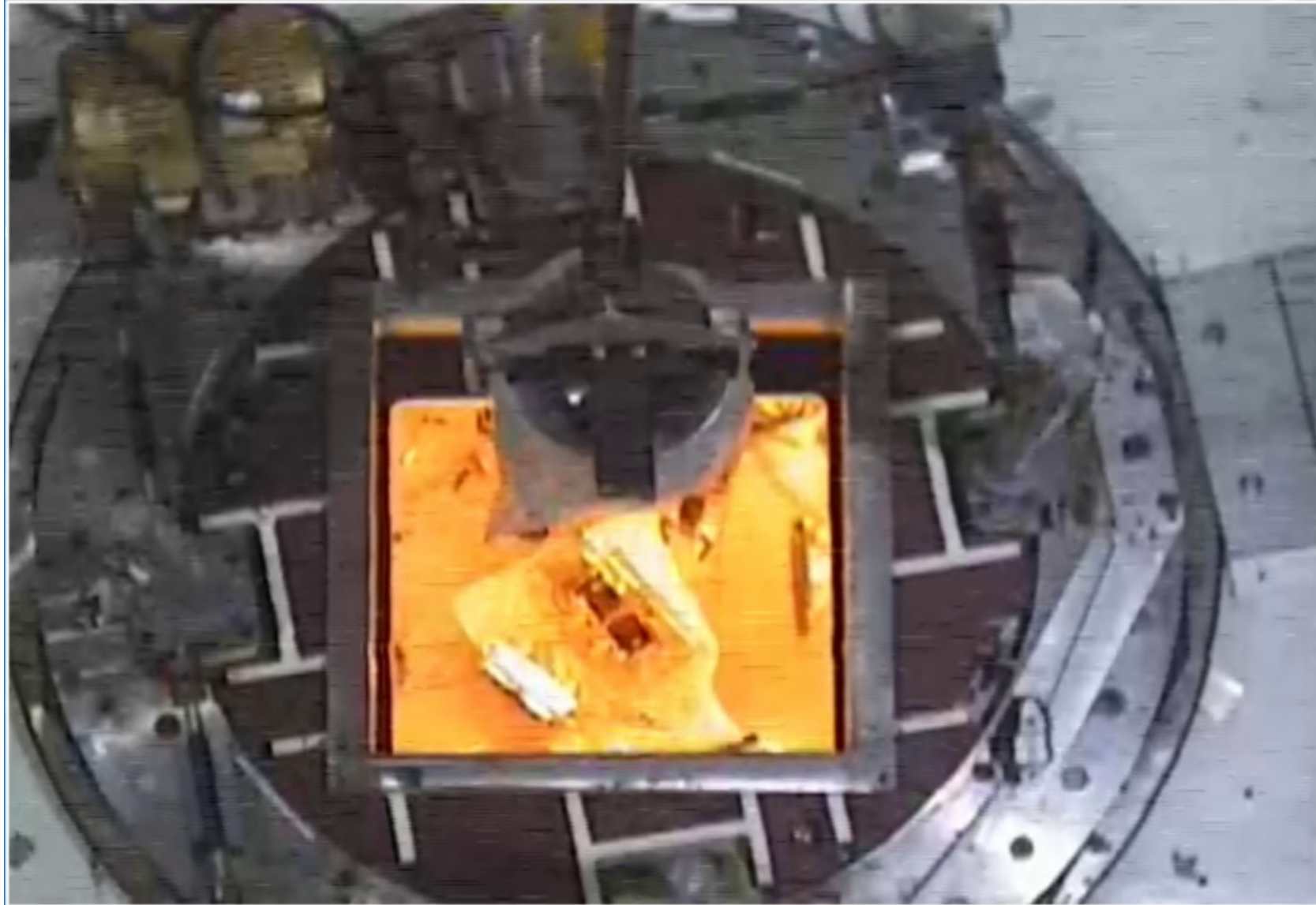
**Pail containing
spent target
being lifted
from ISAC
South Hot Cell
to Decay
Storage Vault**

**Remote Crane
Load Block**

**Pail lifting
tool**

**Spent target
in 5 gallon
pail
~ 500 mSv/h
@ 0.5m**

ISAC Spent Target Pail Remote Crane Transport



ISAC Spent Target Pail Remote Crane Transport



ISAC Spent Target Pail Remote Crane Transport



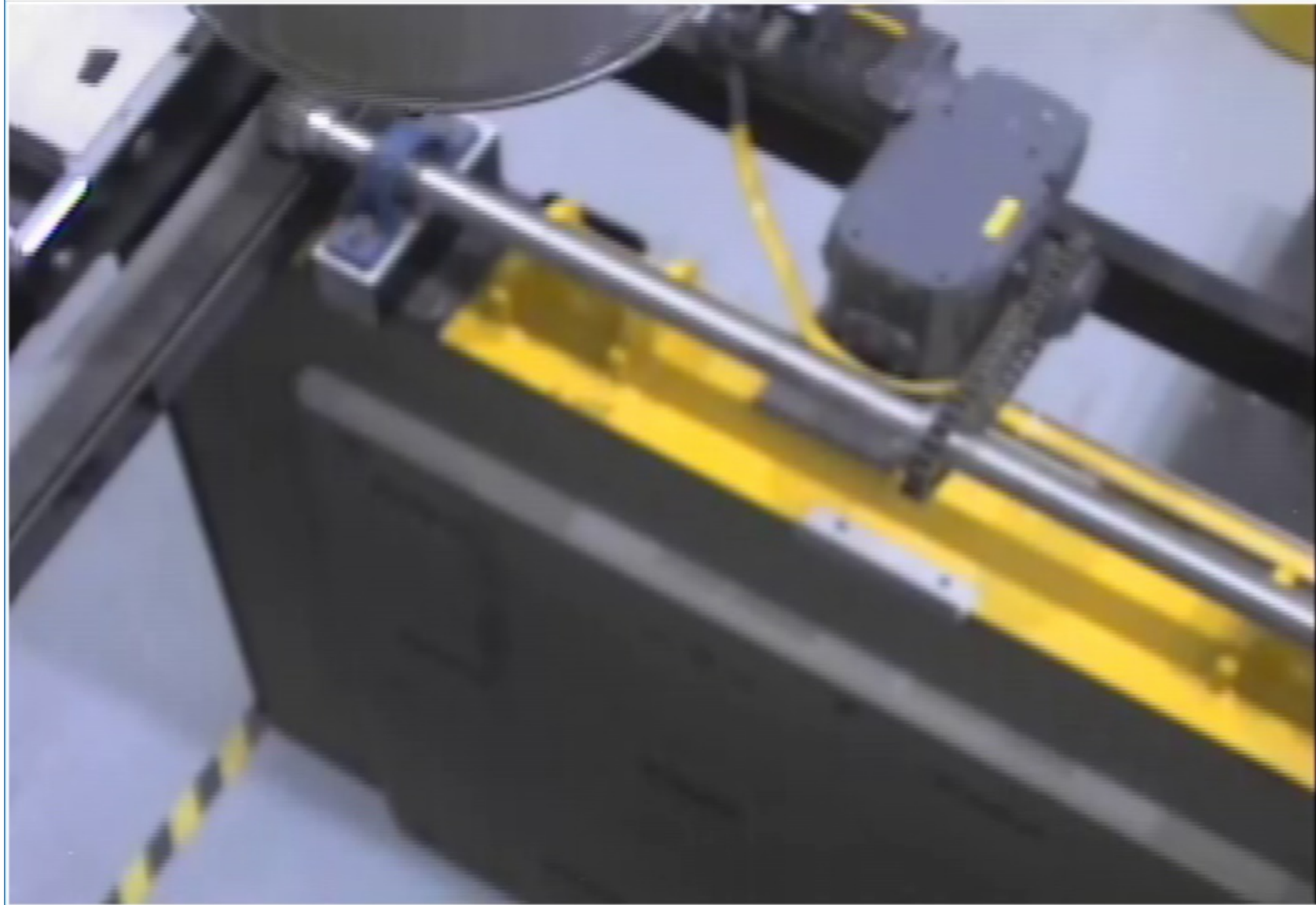
ISAC Spent Target Pail Remote Crane Transport



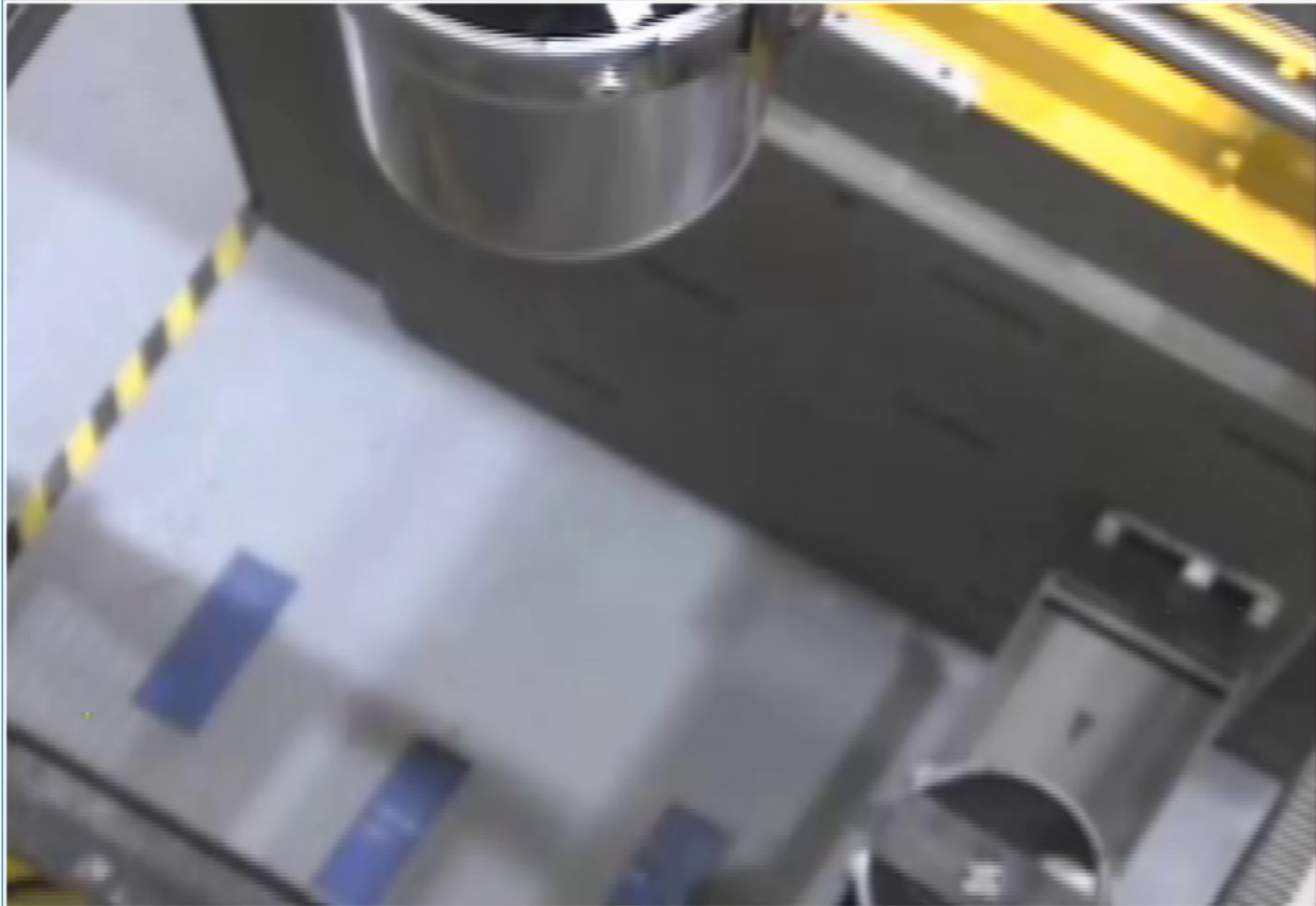
ISAC Spent Target Pail Remote Crane Transport



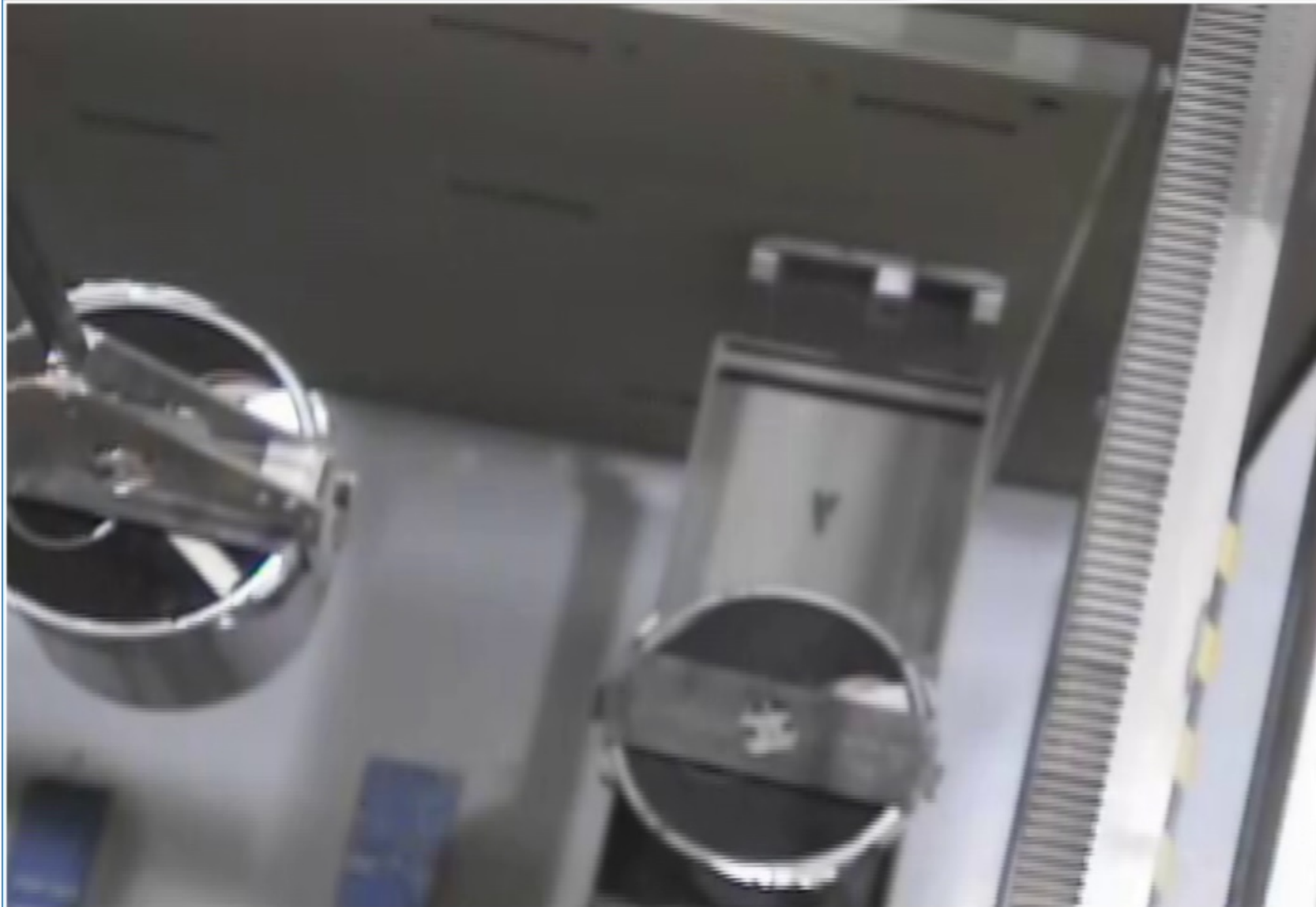
ISAC Spent Target Pail Remote Crane Transport



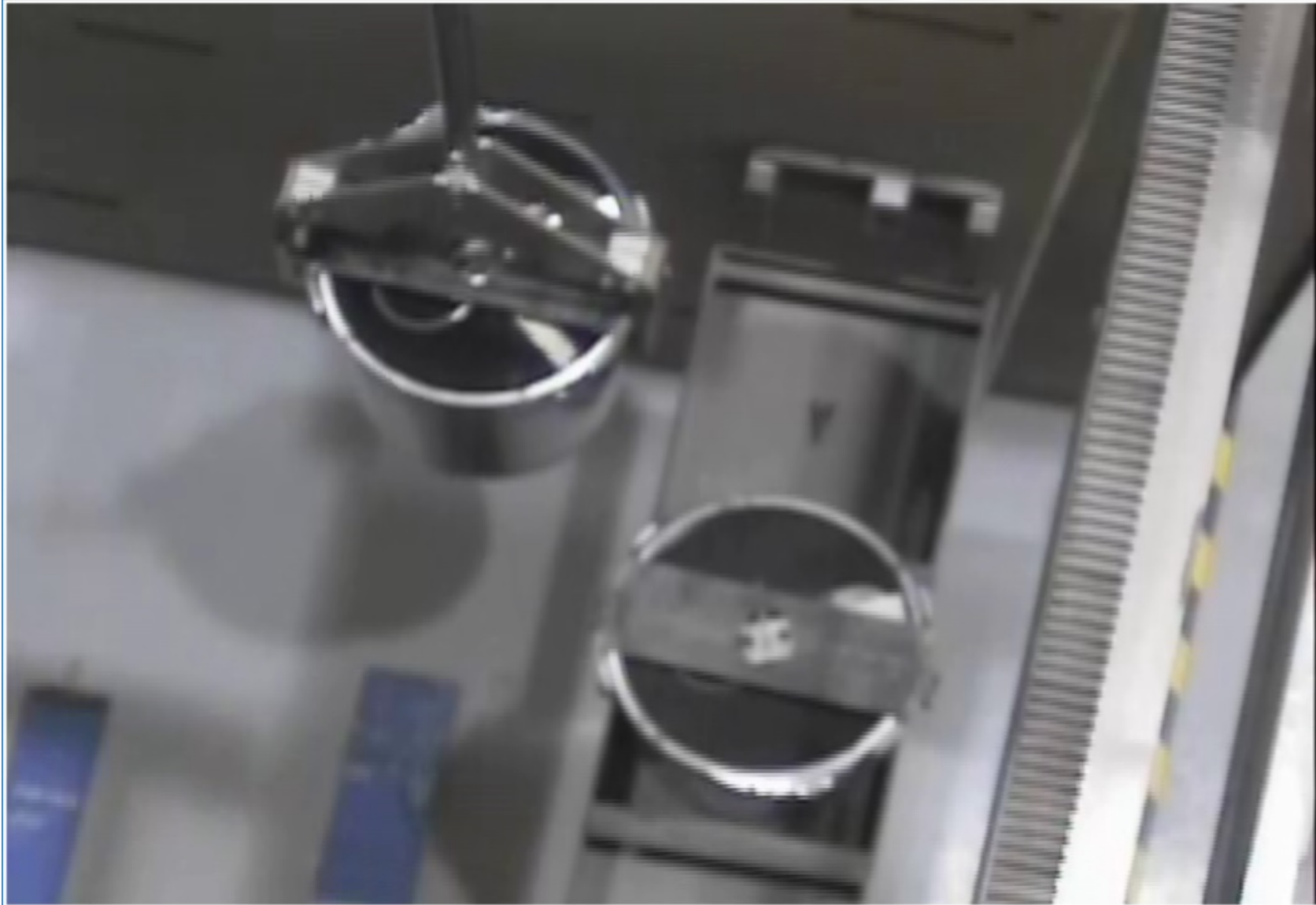
ISAC Spent Target Pail Remote Crane Transport



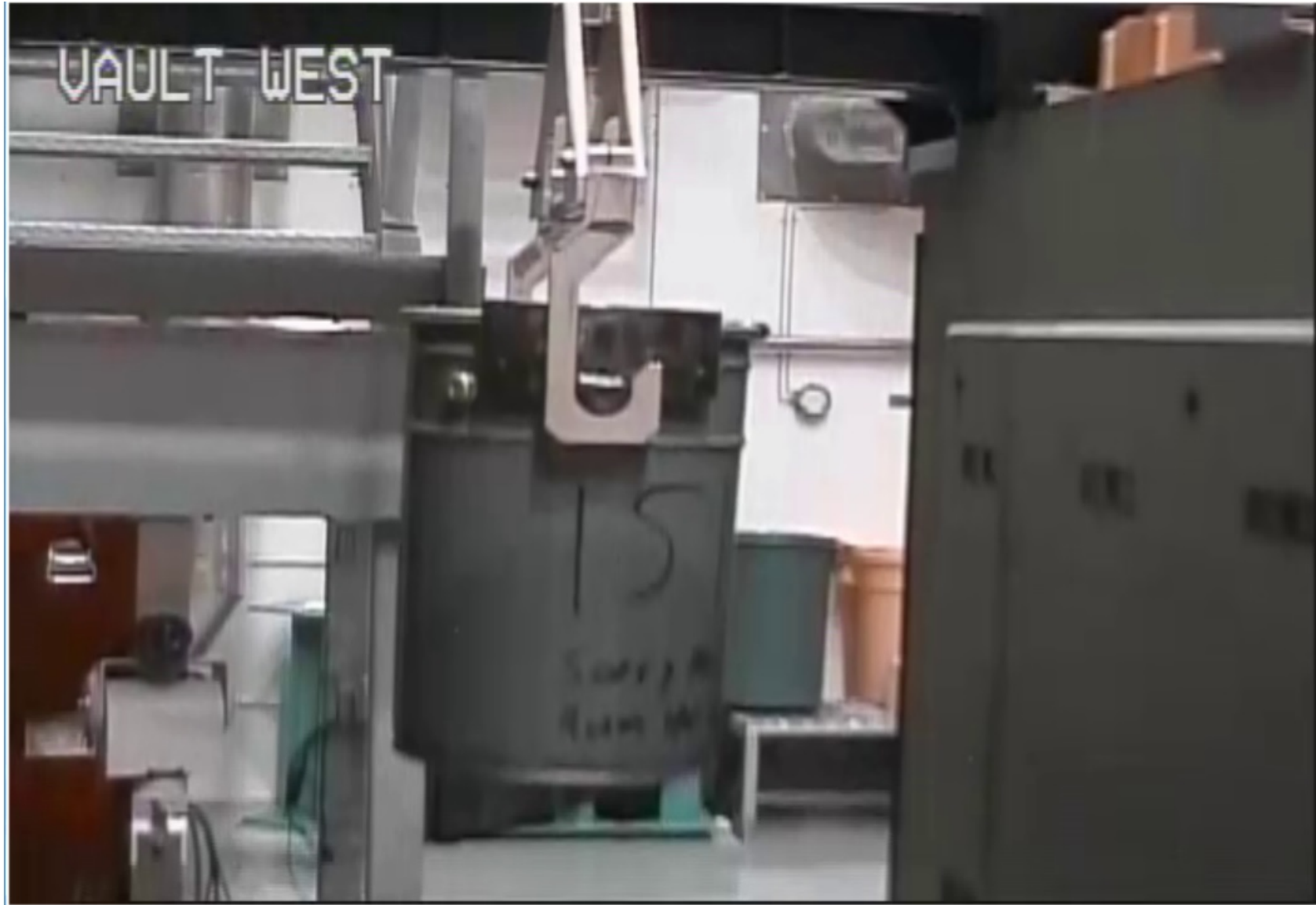
ISAC Spent Target Pail Remote Crane Transport



ISAC Spent Target Pail Remote Crane Transport



ISAC Spent Target Pail Remote Crane Transport



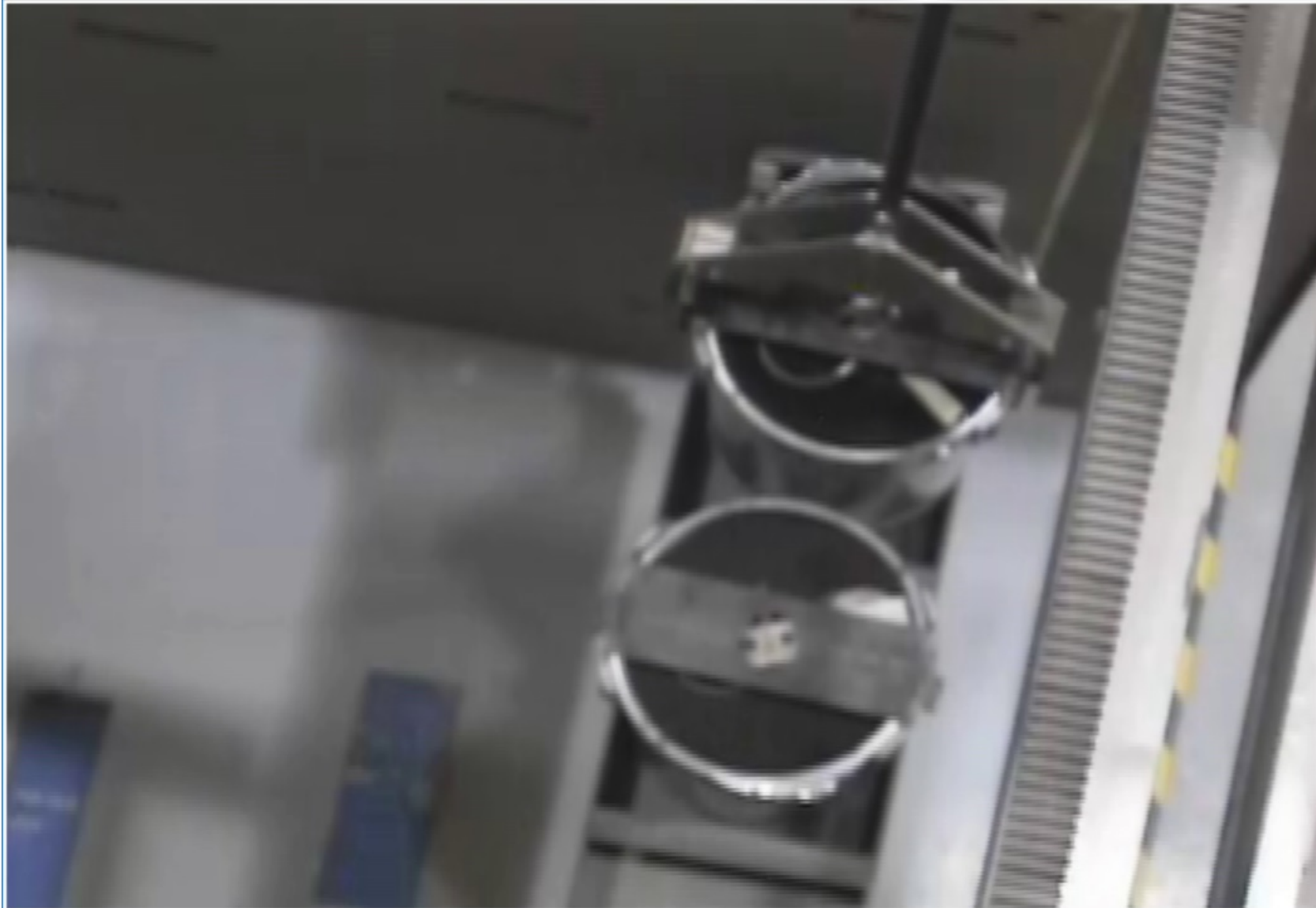
ISAC Spent Target Pail Remote Crane Transport





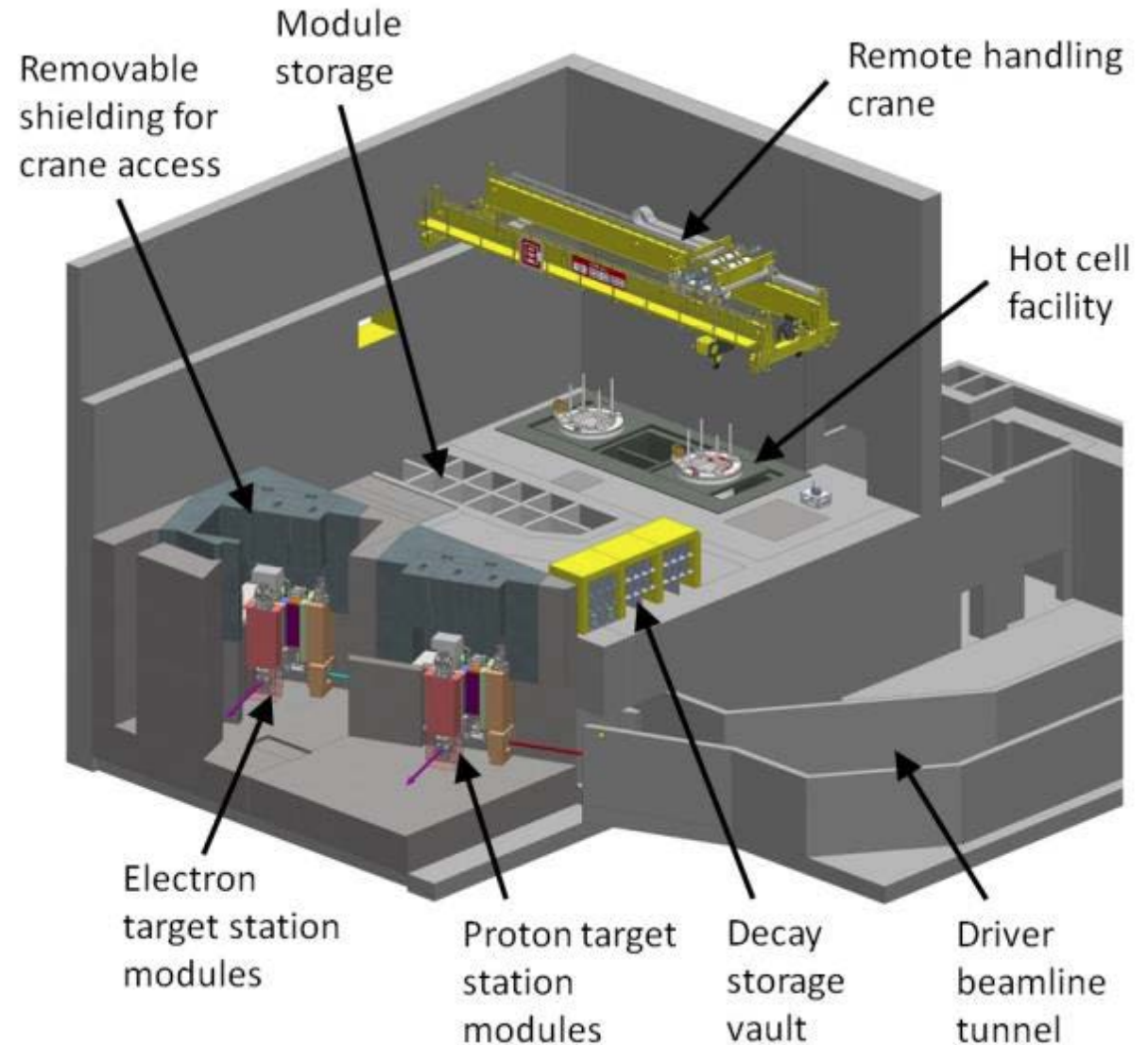
ISAC Spent Target Pail Remote Crane Transport

Δt :
1 to 2 hours
(Hot Cell to
Vault)



ARIEL Target Hall – Key Remote Handling Deliverables

- **Remote Handling Crane**
- **Hot Cell 1 Facility (ROBATEL INDUSTRIES, France, contract awarded May 2017)**
- **Target Hall Shielding Layout**
 - voids, services, materials, FLUKA simulations, engineering configuration
- **Target Transfer System**
 - **Target Station -> Decay Storage Vault -> Hot Cell**
- **Target Station & RIB Beamline Support Structure**
- **Target Decay Storage Vault**
- **Module storage**



ARIEL Target Hall Crane – Installation 2015



ARIEL Target Hall Crane – Load Test Aug 2015



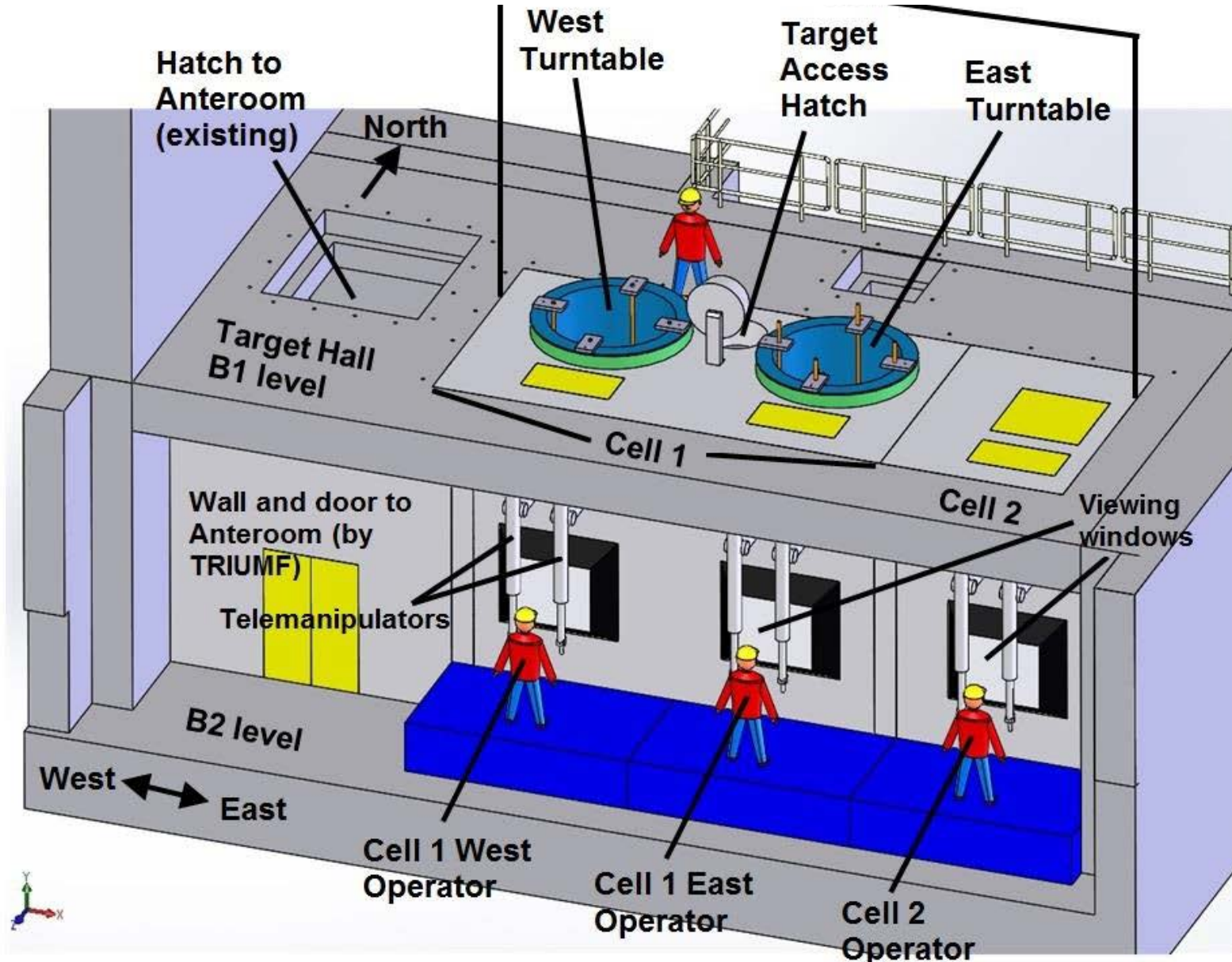
ARIEL Target Hall Crane – Remote Controls



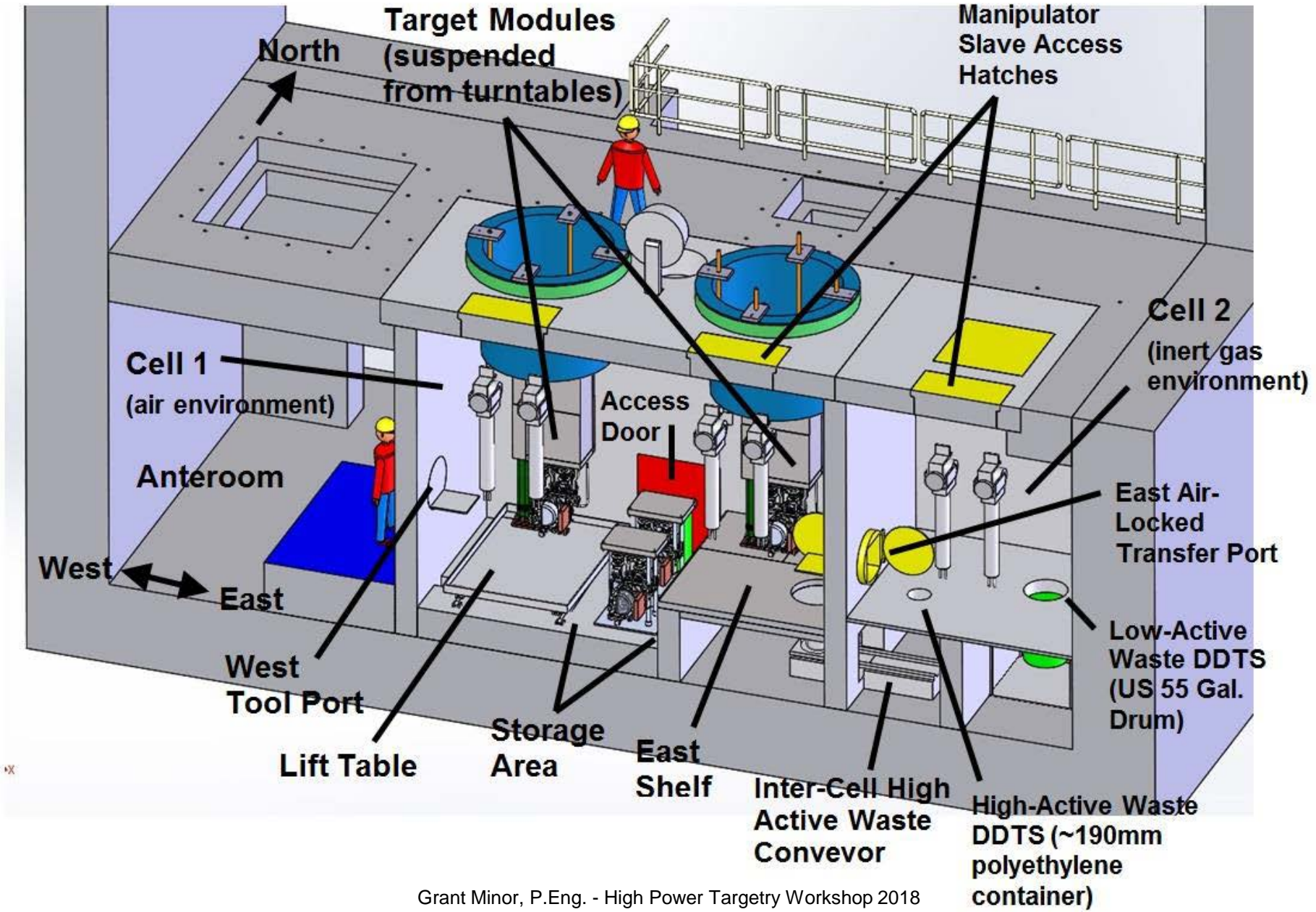
Primary Functionality

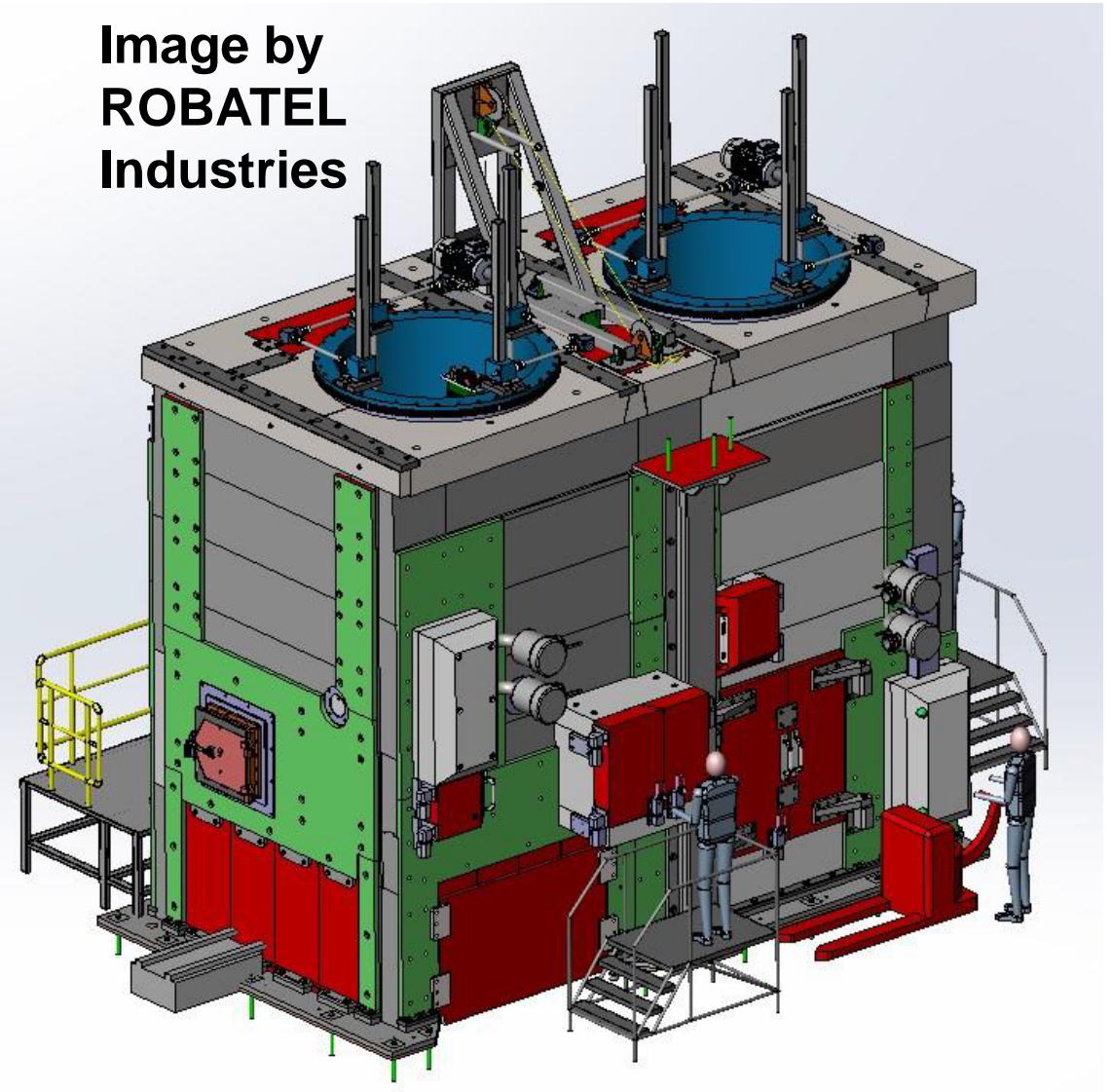
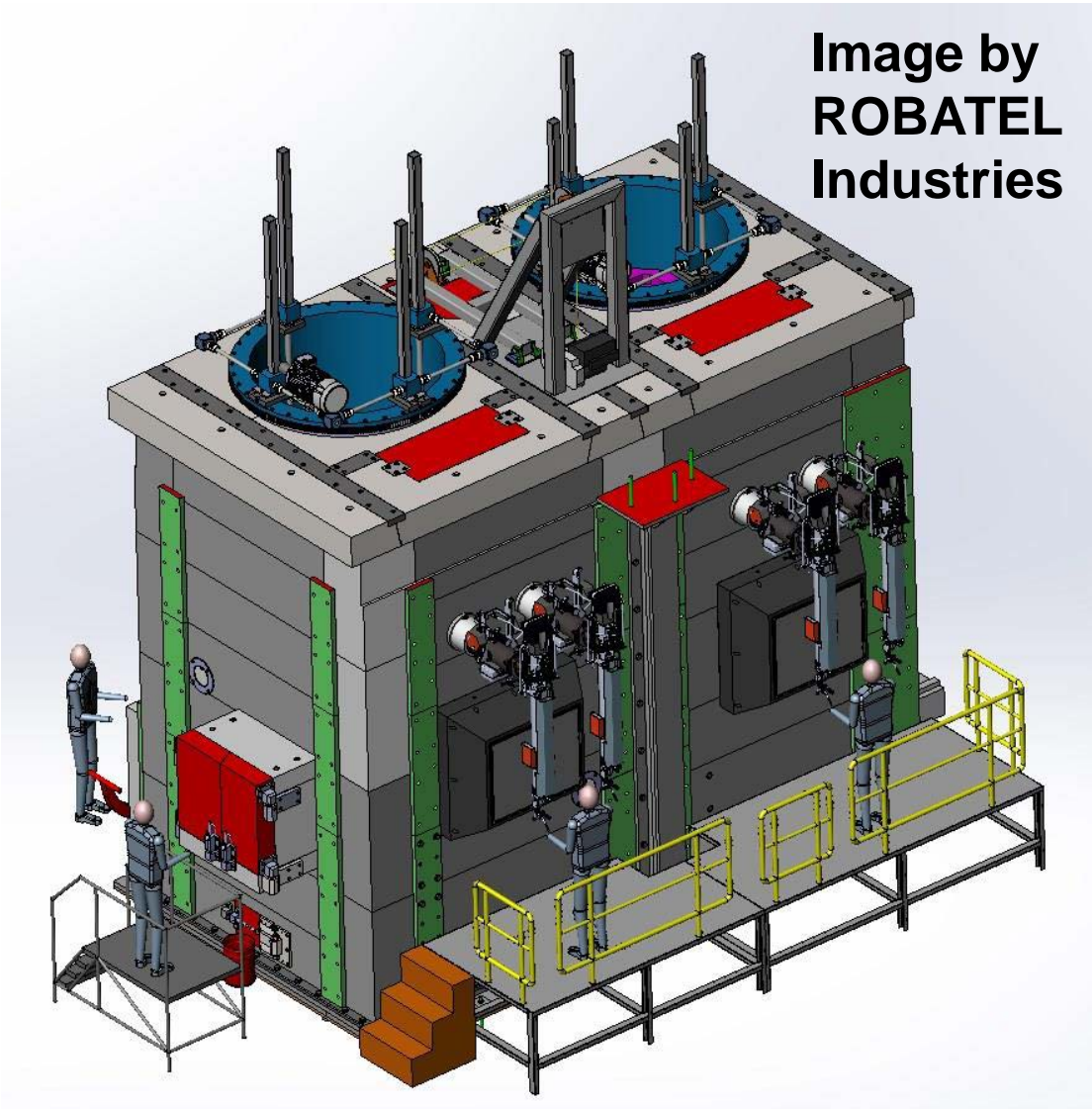
- 20 MT remote main hoist
- 6.8 MT North and South aux hoists (not remote)
- Double drive motors
- Double hoist drums and hoist motors
- “True” vertical lift
- Hydraulic jacks to lift seized drive wheel (bridge and trolley)
- Controls and electronics outside the target hall
- Motorized rotation below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





ARIEL Hot Cell Facility – General Concept & Specification





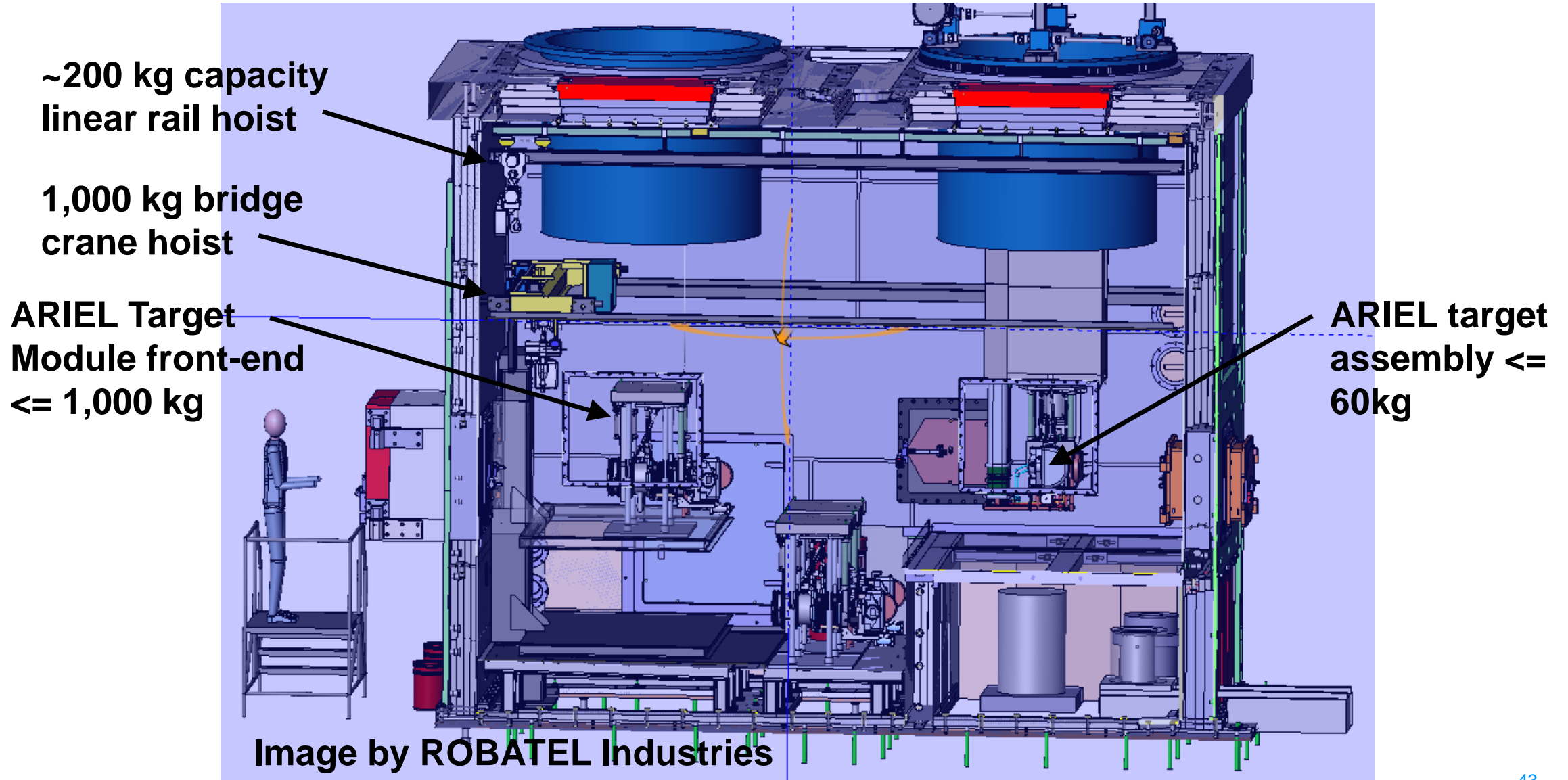
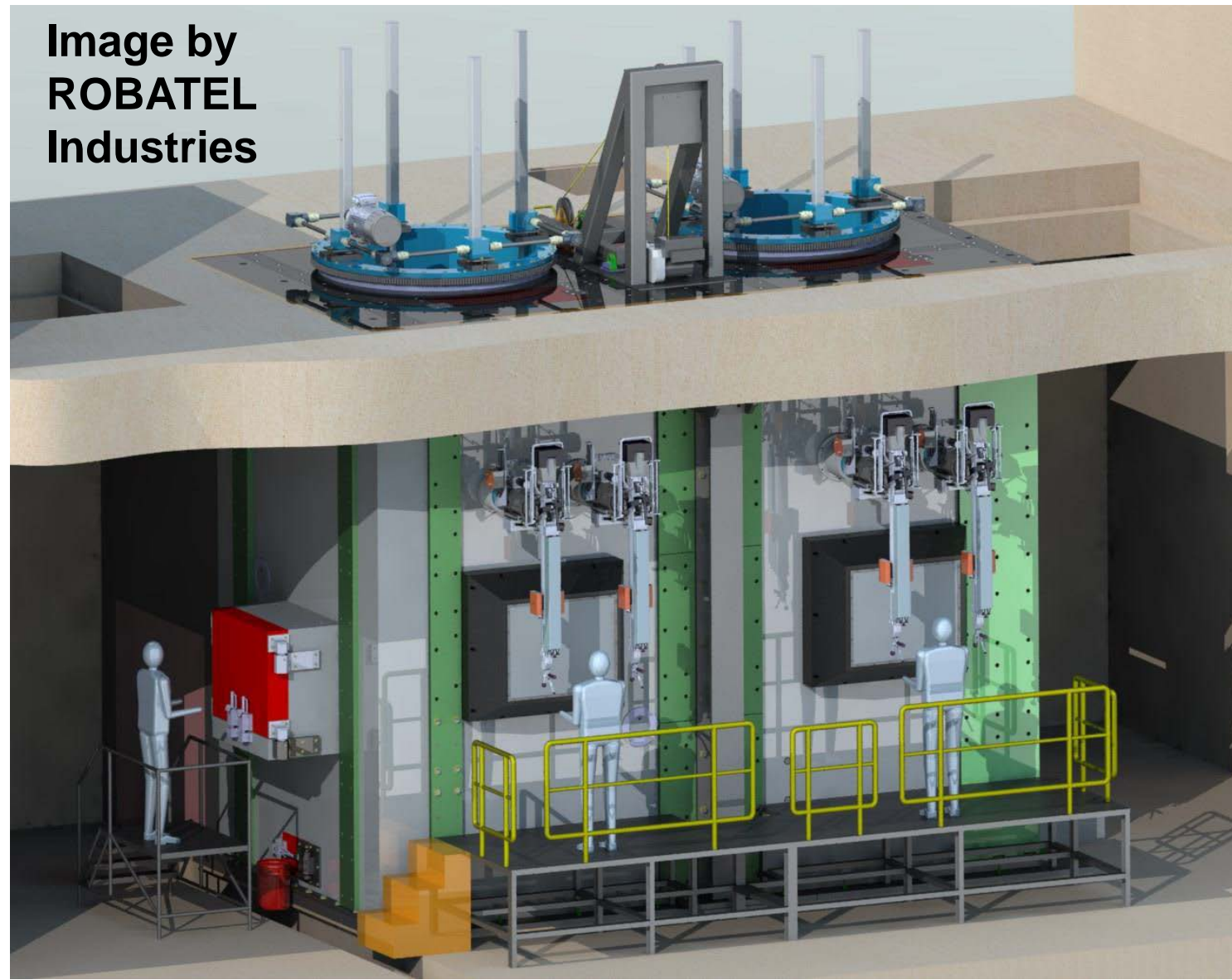
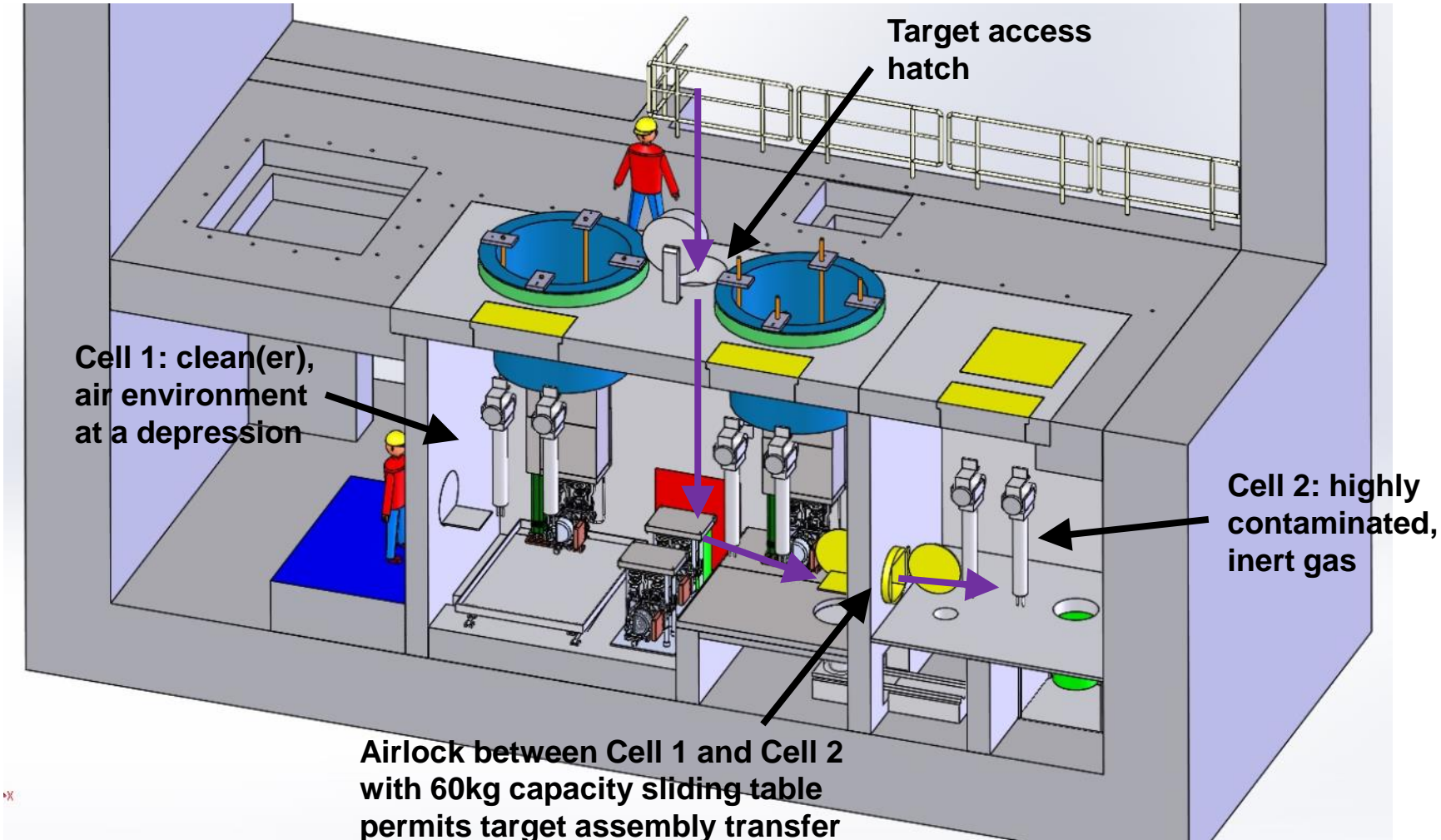


Image by
ROBATEL
Industries



Transfer of a Spent Target Assembly from Storage Vault to Cell 2 for Processing



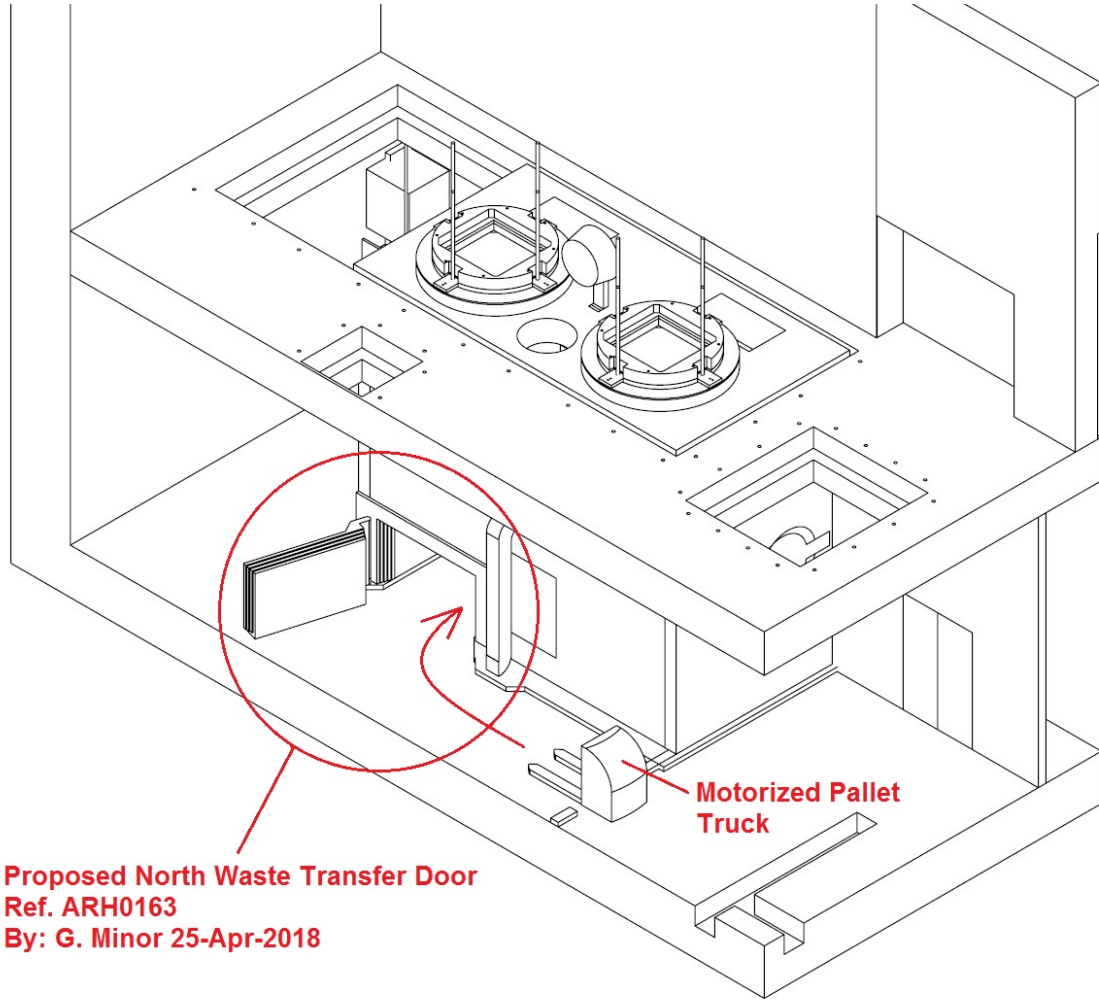
Cell 1: clean(er),
air environment
at a depression

Target access
hatch

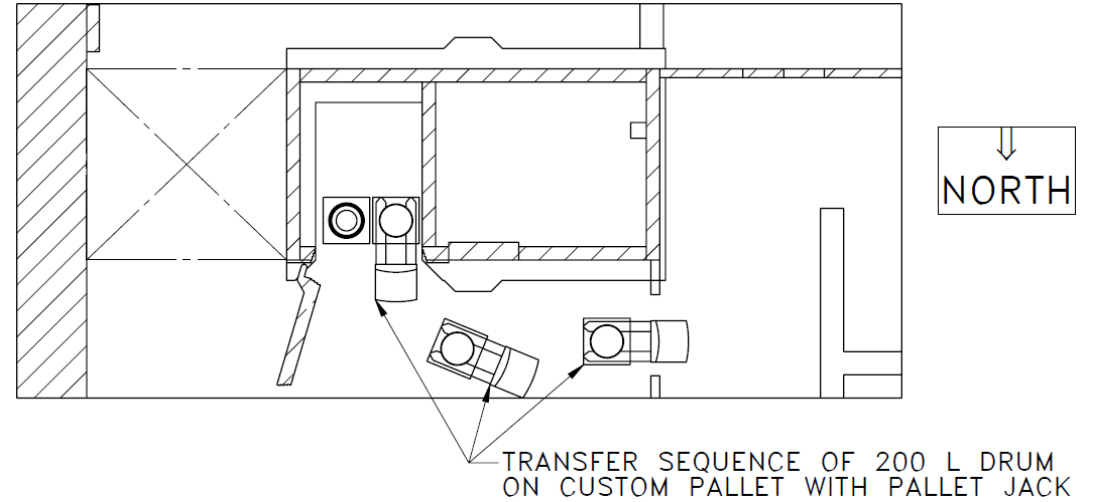
Cell 2: highly
contaminated,
inert gas

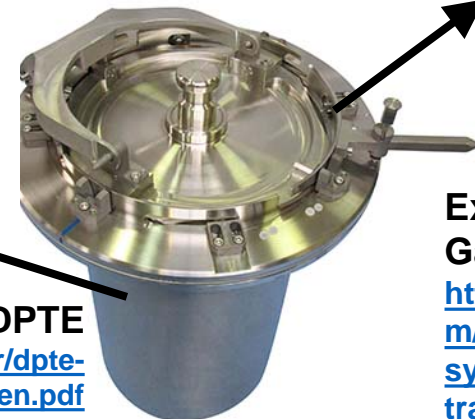
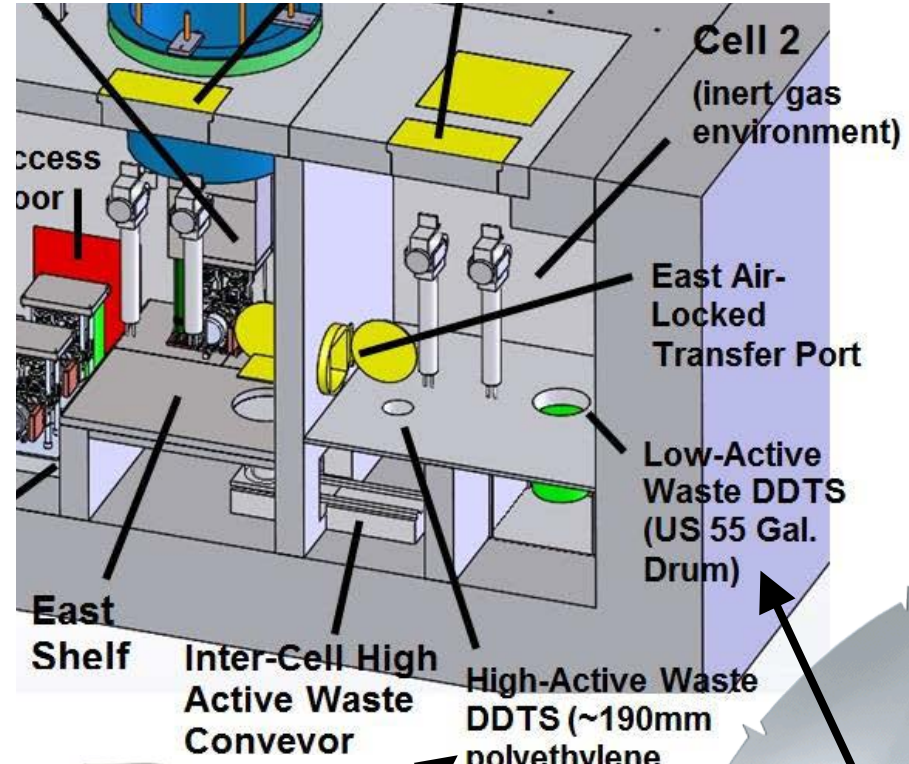
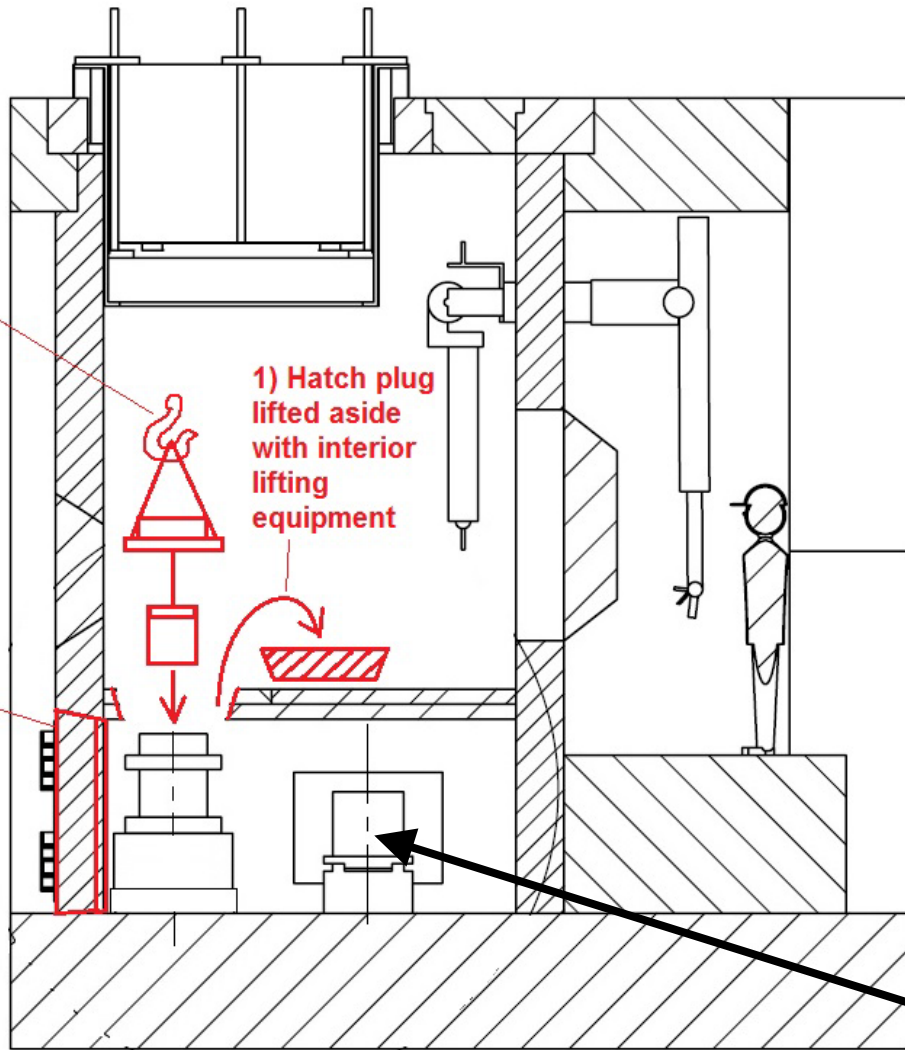
Airlock between Cell 1 and Cell 2
with 60kg capacity sliding table
permits target assembly transfer
between cells

Waste Container / Shipping Flask Access

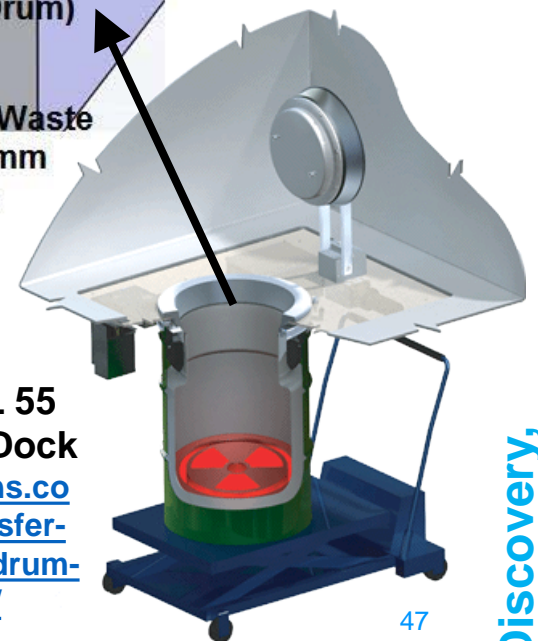


Proposed North Waste Transfer Door
 Ref. ARH0163
 By: G. Minor 25-Apr-2018





Example: CRL 55 Gallon Drum Dock
<http://crlsolutions.com/products/transfer-systems/waste-drum-transfer-system/>



Example: Getinge LaCalhene DPTE

<https://www.lacalhene.com/siteassets/la-calhene/application--products/transfer/dpte-transfer-system/getingelacalhene-dpte-transfer-system-bc-en.pdf>

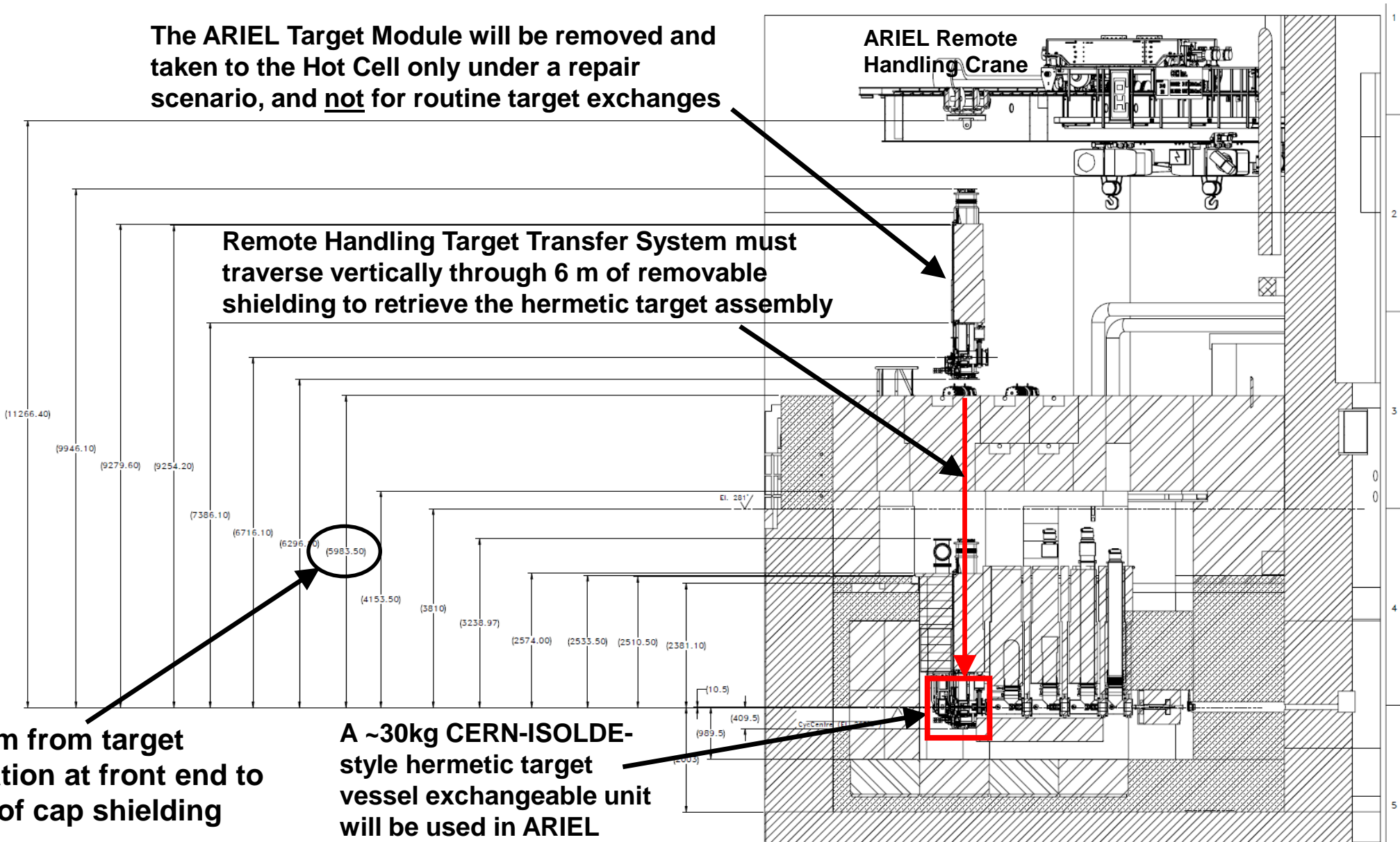
The ARIEL Target Module will be removed and taken to the Hot Cell only under a repair scenario, and not for routine target exchanges

Remote Handling Target Transfer System must traverse vertically through 6 m of removable shielding to retrieve the hermetic target assembly

~ 6 m from target location at front end to top of cap shielding

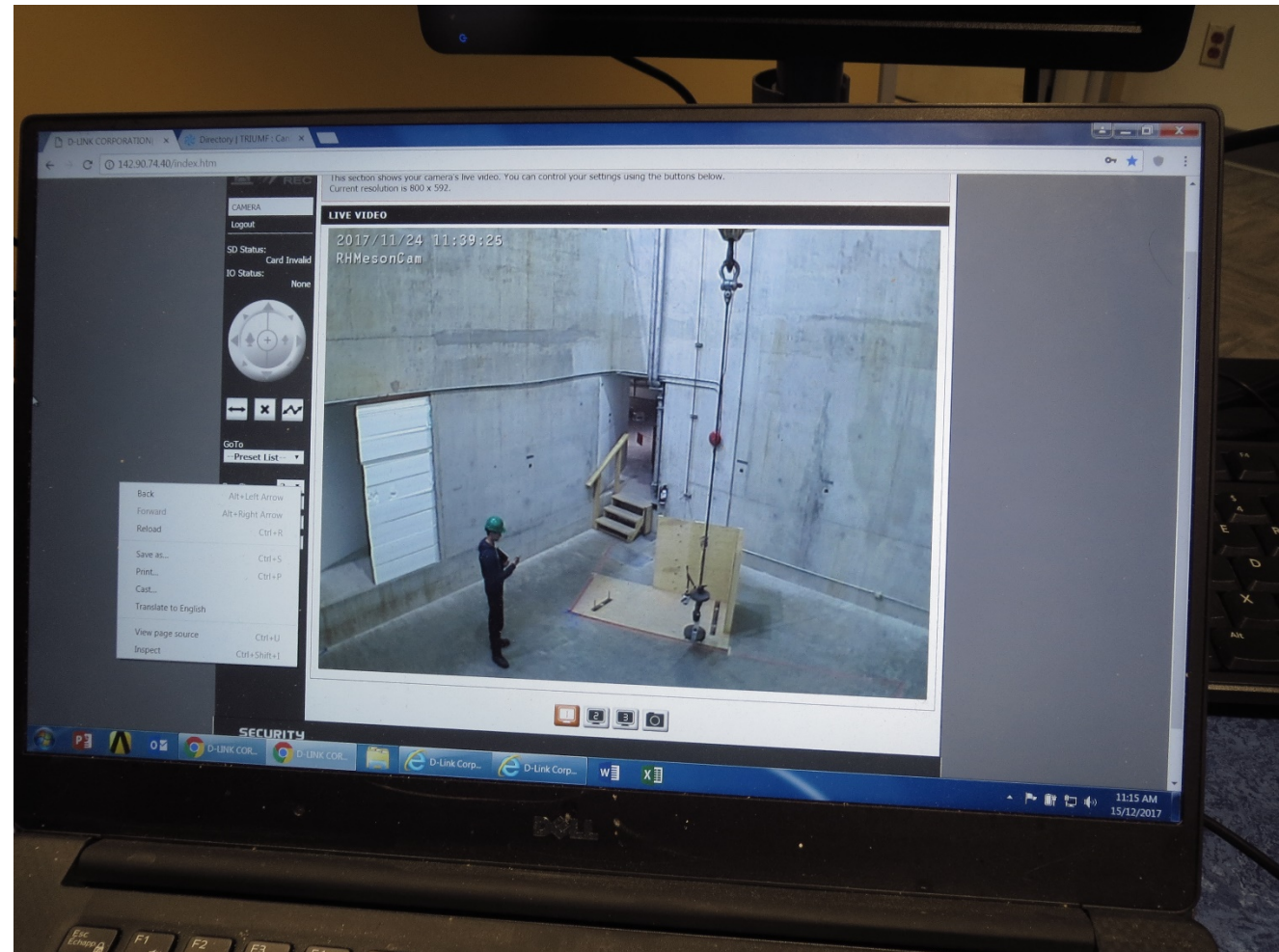
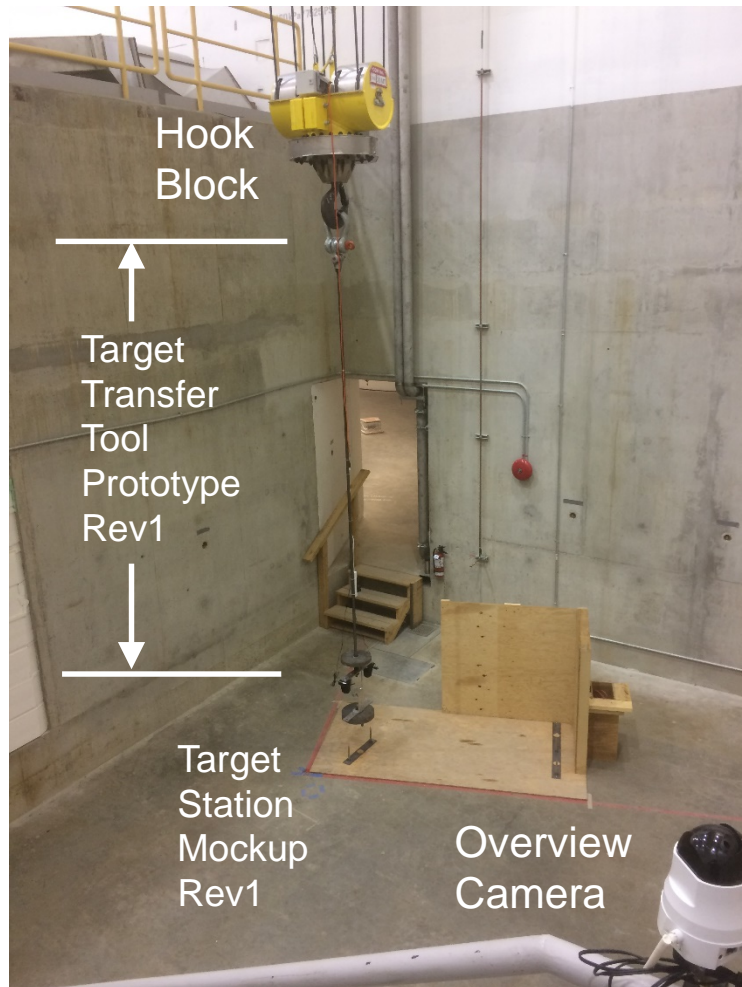
A ~30kg CERN-ISOLDE-style hermetic target vessel exchangeable unit will be used in ARIEL

ARIEL Remote Handling Crane



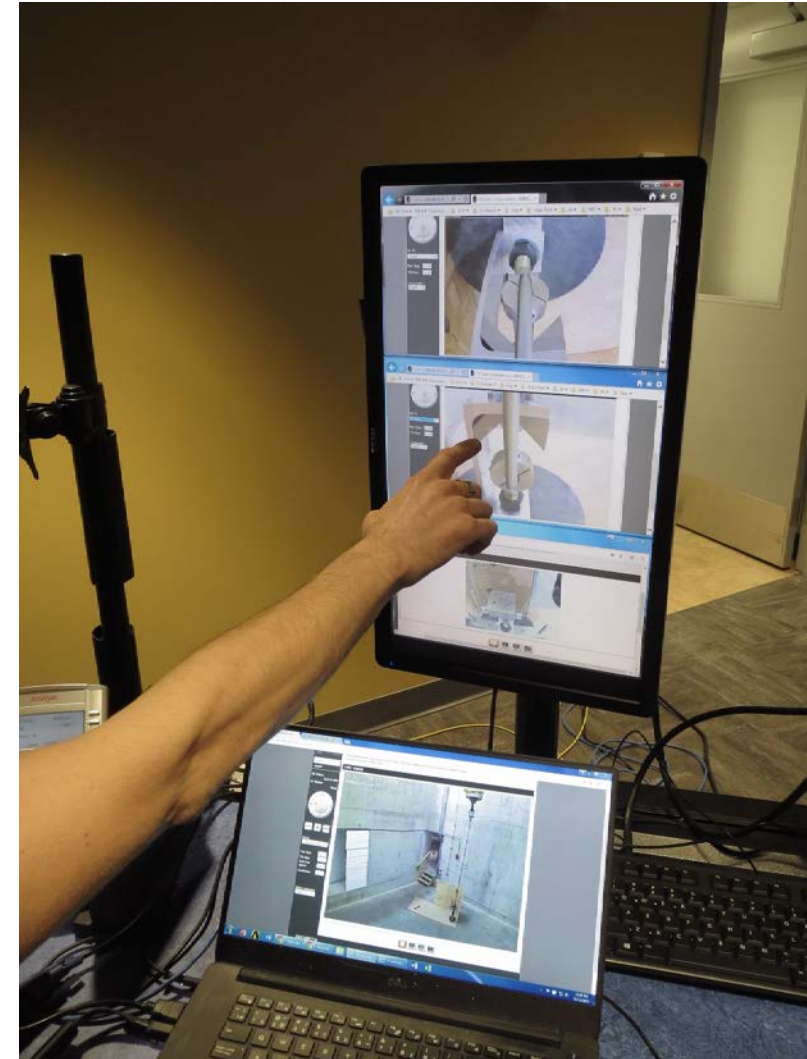
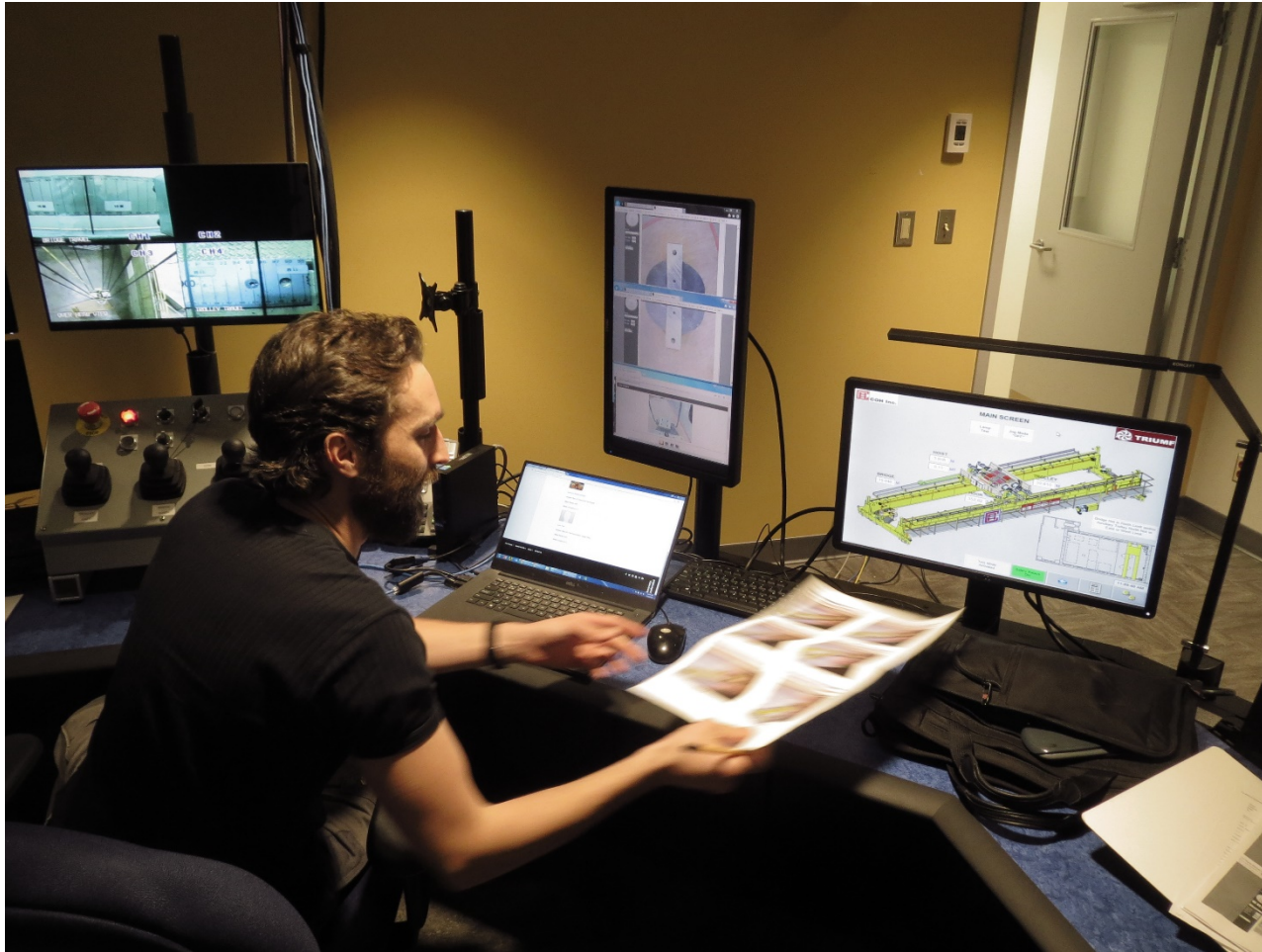
ARIEL Target Transfer System – Prototype Tests

Target Exchange Tool & Remote Handling Crane Development – Sept to Dec 2017 – Jason Kapalka



ARIEL Target Transfer System – Remote Pick-and-Place

ARIEL will use the target hall crane to perform a remote pick-and-place operation to transport the ~30kg CERN-ISOLDE-style hermetic target enclosure between the Target Station, Decay Vault, and Hot Cells. This differs from the incumbent ISAC module-based target transport system. The operational precedent for remote pick-and-place of a small item using the Remote Handling crane is set by the ISAC spent target pail handling system (see slides 22 to 35).



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

ARIEL Target Transfer Tool System - Second Iteration Prototype Test



Successful local (pendant controlled) pick-and-place of CERN-ISOLDE-style target vessel onto CERN-ISOLDE-style locating pins using ARIEL Target Hall crane with Target Transfer Tool prototype – 16-March-2018

Acknowledgements – Thank You!

- Mike Gallop
- Chad Fisher
- Clive Mark
- Travis Cave
- Don Jackson
- Jason Kapalka
- Isaac Earle
- Alex Gottberg
- Kevin Chen
- Bill Paley
- Allon Messenberg
- Alejandro Samper
- Nemanja Jovicic
- Yasmine Saboui
- Anders Mjøs
- Oliver Kester
- Bob Laxdal
- Daniel Rowbotham
- ROBATEL Industries
- COH Cranes
- Canadian Foundation for Innovation
- NSERC
- FRIB
- Many others...