



Michigan State University Facility for Rare Isotope Beams Robotics use in Accelerators, Targets and Detectors

Mike Larmann
Remote Handling Group Leader

MICHIGAN STATE
UNIVERSITY



U.S. DEPARTMENT OF
ENERGY

Office of
Science

Outline

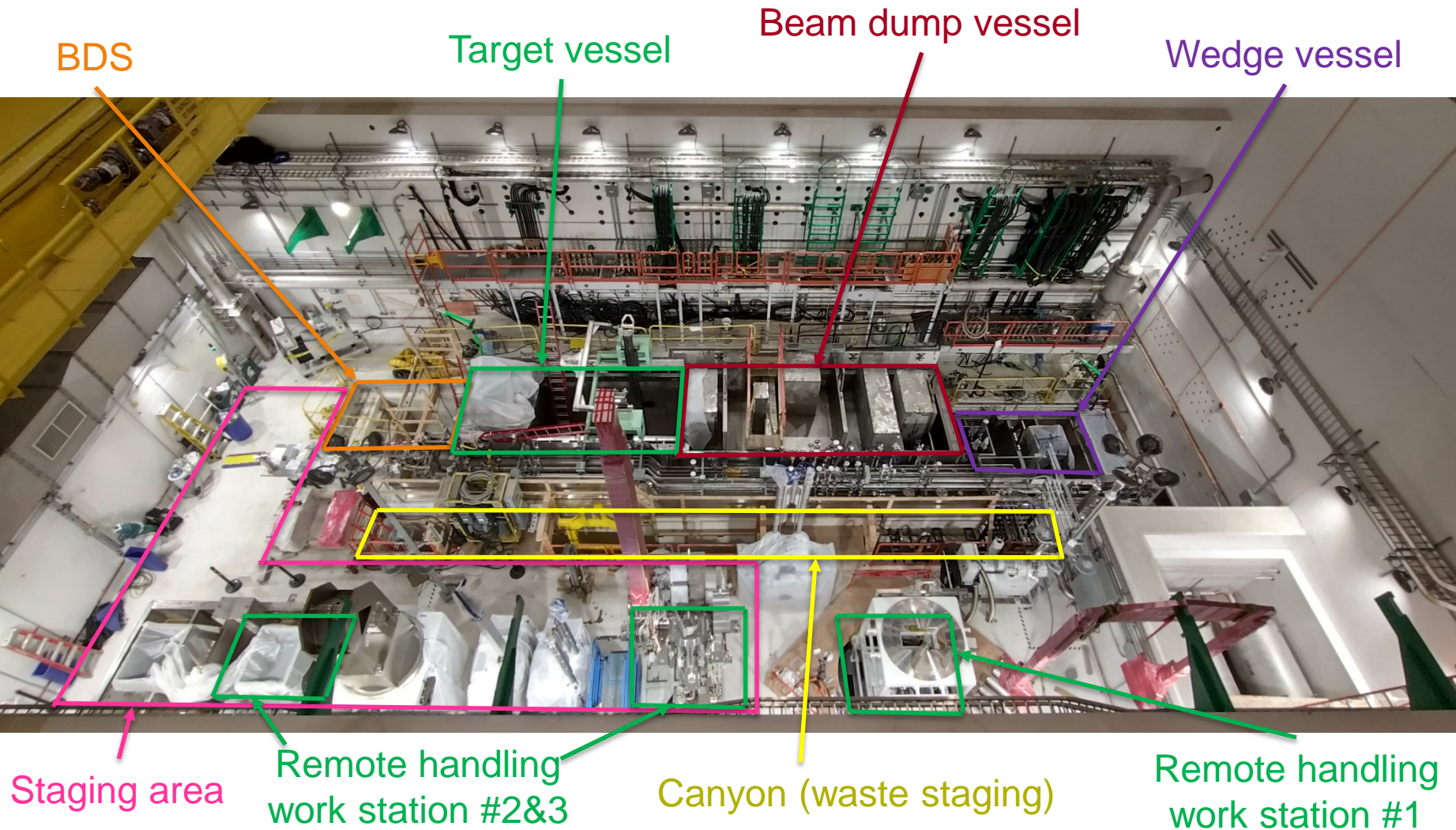
- Overview
- Current robot use
- Current remote handling equipment
- Remote handling equipment in development
- Future applications for robotics and automation



Facility for Rare Isotope Beams

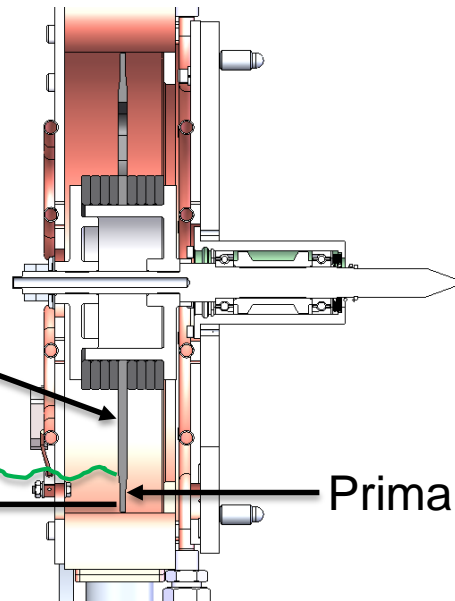
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Target Hall Overview



Target Overview

- Target disk will be changed out bi-weekly for user experiments
 - Graphite target disk spins up to 5,000rpm
 - Beam hits graphite disk and fragments into multiple isotopes, majority of primary beam passes through
 - Beam is then separated into beam of interest as it continues down the beamline
- Currently change target disks with manipulators
- Ideal application for 6 axis robot and build cell



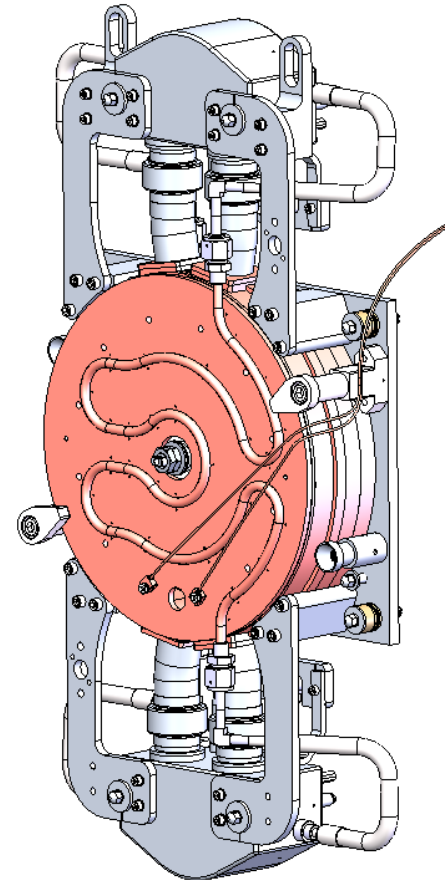
Graphite Disk
(64rem/hr @ 1meter)

New Isotopes

Secondary Beam

Primary Beam

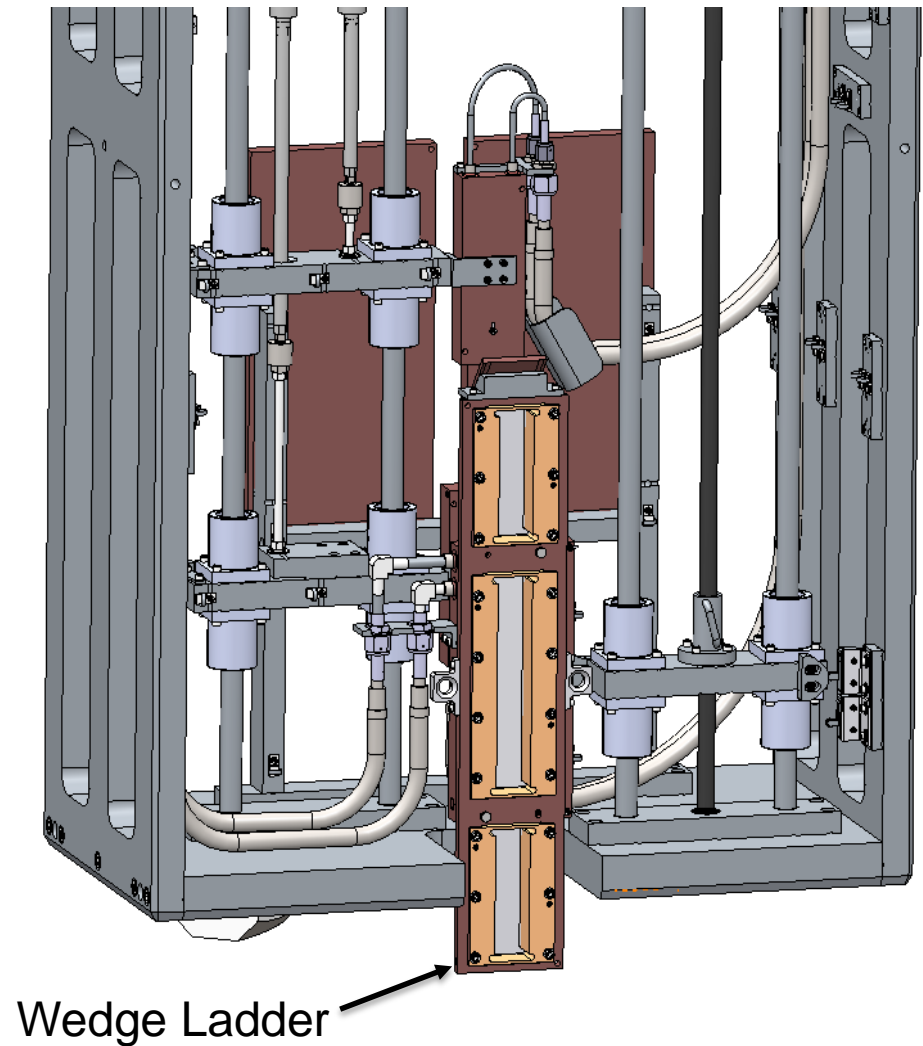
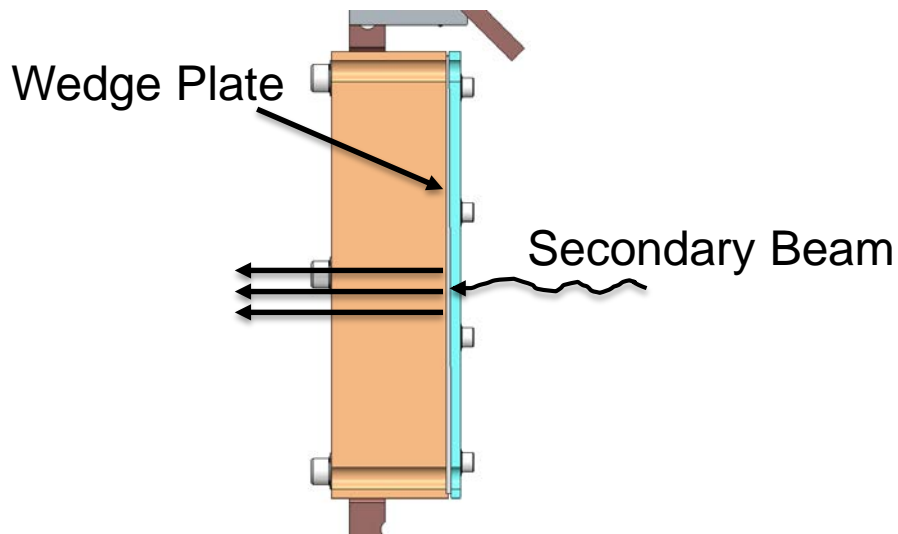
Primary Beam



Target Disk Module
Assembly

Wedge Overview

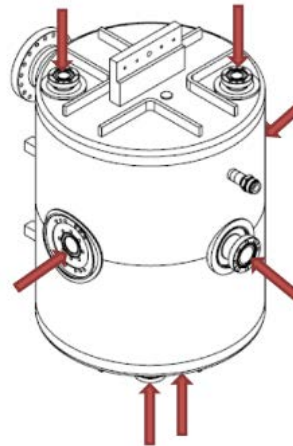
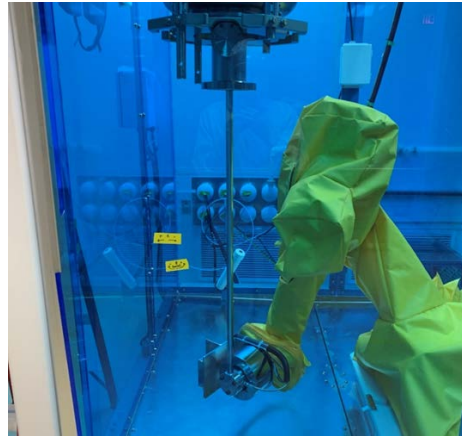
- Wedges will be changed out bi-weekly for user experiments
 - Secondary beam contains isotopes with different element numbers
 - Wedge changes momentum of the secondary beam due to energy loss in matter
 - Magnets and pre-separator separate out the unwanted isotopes
- Currently change wedges with manipulators
- Another ideal application for 6 axis robot and build cell



High Pressure Rinse Robot

(SRF and SC Magnet Department)

- FRIB Half Wave Resonator (HWR) requires cleaning through 7 ports and four rotations by a 7th-axis motor
- Elliptical support frame mounted to 7th axis and remains stationary
- Wand is attached at the wrist of robot and translates along cavity beamline axis, oscillating within a 67° travel arc
- Cavities are non-activated, but robot is able to maintain an ultra clean environment more efficiently
- Clean room rating better than class 100
- Uses Ultra Pure Water E1 grade to rinse cavities
- Cavities are used in vacuum levels of 10^{-8} (warm) and 10^{-11} (cold)



FRIB HWR cleaning through seven ports

7th axis motor

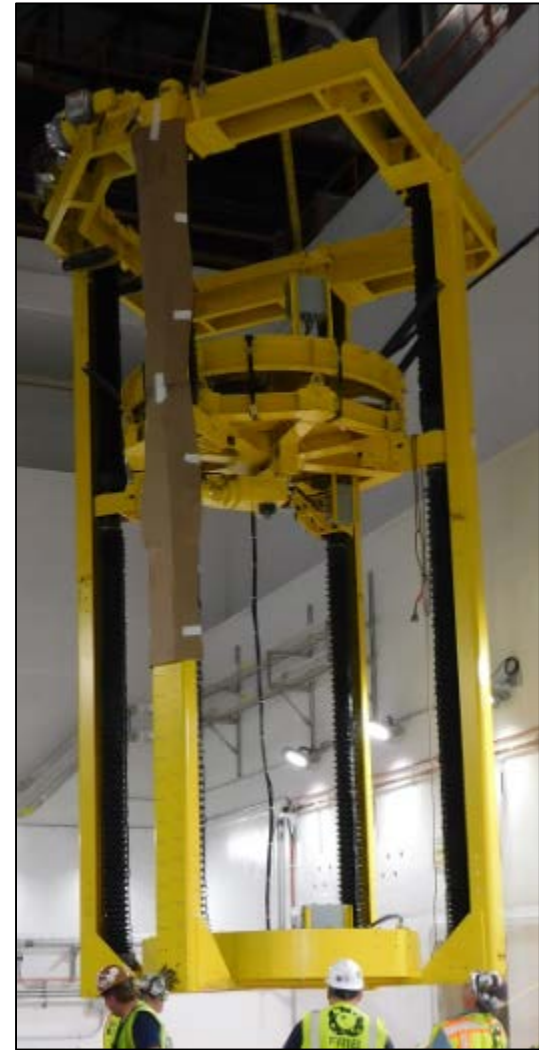


FRIB elliptical cleaning through one port

Current Remote Handling Equipment

■ Main tooling and equipment

- 20t Crane
 - » Fully automated 4 axis control through PLC and HMI
- Manipulators
 - » Standard manual through wall manipulators
- Equipment Lift
 - » Manual, controlled through HMI and PLC
 - » Height and rotational position feedback
- Torque Tools
 - » Programmable DC nutrunners, can be integrated into PLC
- Vision System
 - » Standard security grade cameras



Current Remote Handling Equipment [2]



Equipment lift (left), manipulators (right)

Manipulators utilizing torque tools to secure Beam Dump Drum

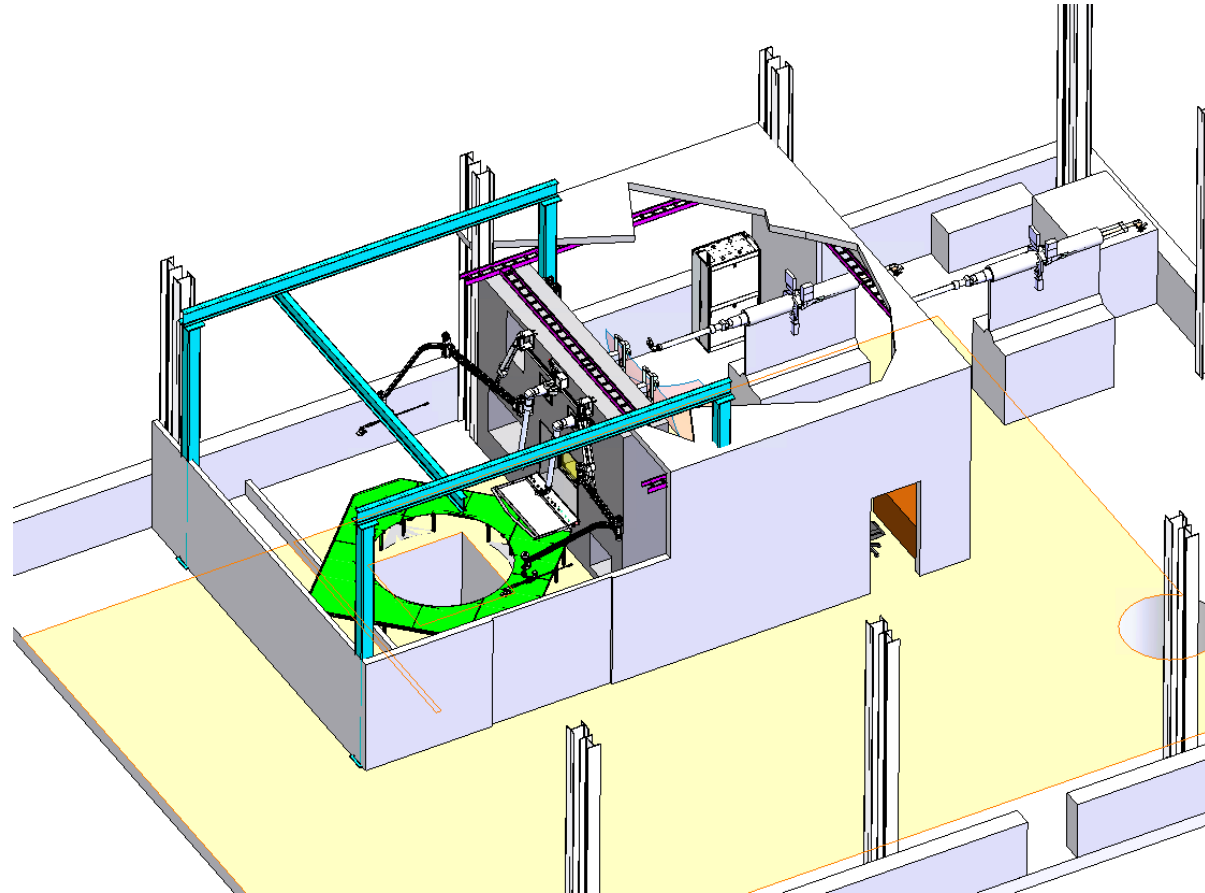


Manipulator holding torque tool with tube nut head



Equipment in Development

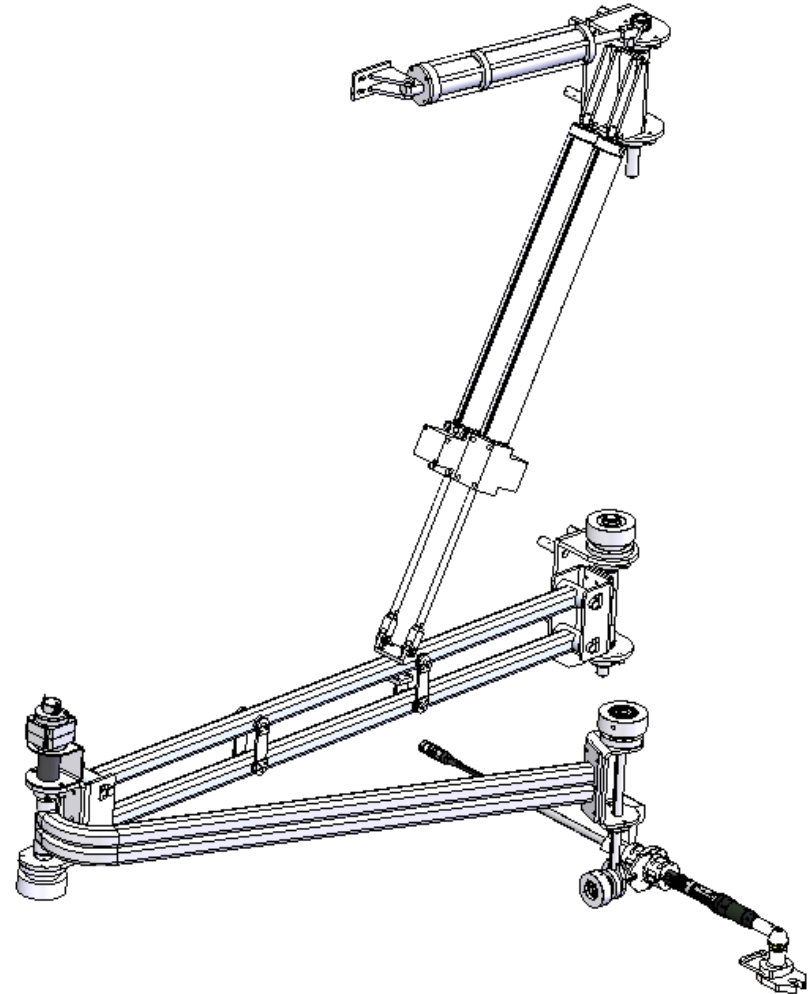
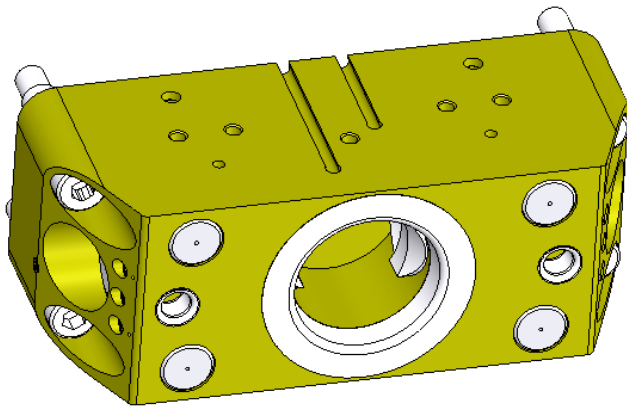
- Currently under construction
- Area that allows us to develop and test new procedures and equipment
- Allow us to develop and introduce robotics and automation without interrupting operations



Equipment in Development[2]

■ 0-g torque reaction arms

- Auto adjusts up/down force depending on which tool is engaged
- Extend and retracts from wall remotely for manipulator reach
- Uses robotic end of arm tooling (EOAT) to quick change torque tools
- Will be integrated with torque tools and be controlled with PLC



Equipment in Development[3]

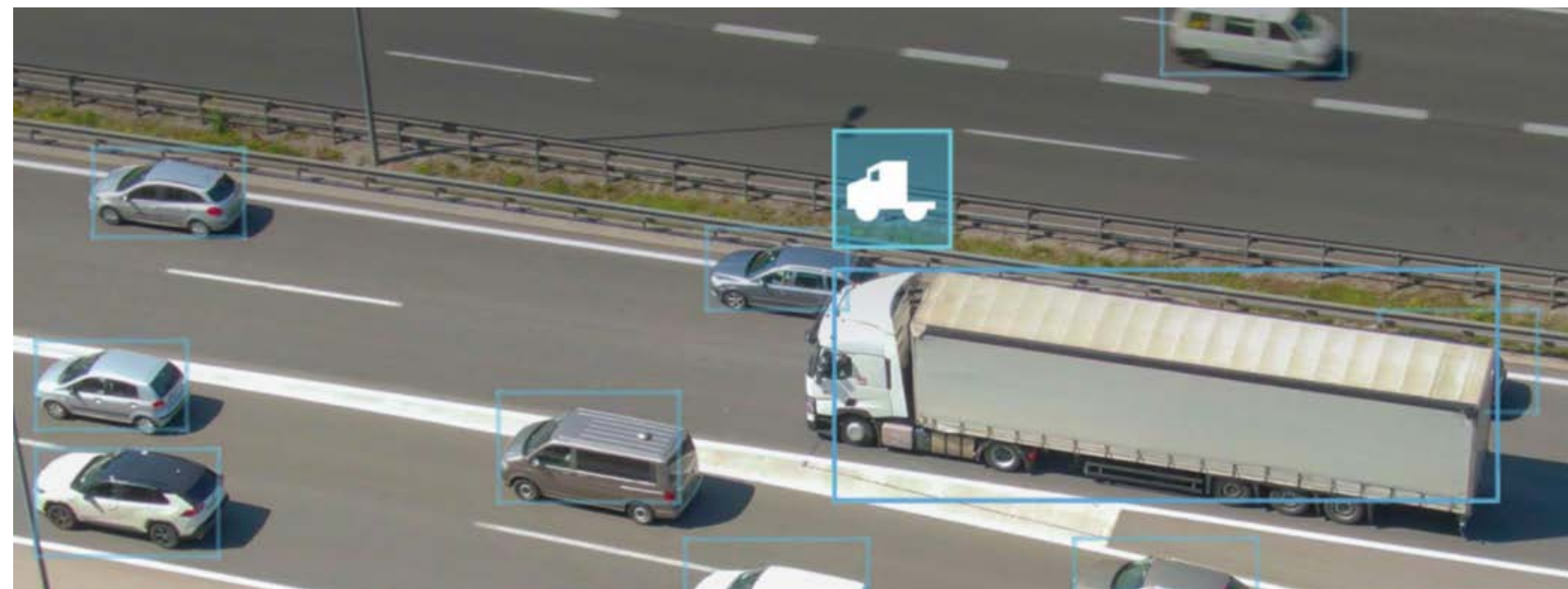
- 0-g 1ton servo hoist
 - Smaller capacity hoist that will allow direct interface with manipulators
 - Has standard up/down control and will auto sense load when stopped, transitioning into “0-g/float” mode
 - 0-g mode will allow the manipulators to grab/touch part and lift/lower with minimal effort
 - » Does this by sensing weight change from manipulator force on the part
 - Technology currently used in industry, but not rated for nuclear environment
 - Will have motor drive and controls mounted in remote location. Load sensing will be done on trolley, hoist drum, or load pins.
 - Will interface with same PLC as -g arms and torque tools



Equipment in Development[4]

■ Vision System

- Camera software and hardware with built in analytics
 - » Developing part detection for systems like shielding configuration monitoring
 - » Will work to develop “object tracking”
 - This will allow camera to follow parts as they are transported with crane or equipment lift without operator interaction



Future Applications

■ Dual 6-axis robots

- Robotic “manipulators” would be greatly beneficial for the target disk and wedge ladder replacements
- Be able to interface with existing torque tool EOAT interfaces
- Increase reliability and repeatability
- Allow for quicker target and wedge changes
- Manipulators and 0-g arms will still be present as backup in the chance of a robot failure

■ Robotic Camera Arm

- Will allow for a camera to reach the backside of the part opposite of the window as well as the sides to enable better inspection or visual access
- Will allow for almost unlimited camera views with Macro or 360 deg capabilities
- Can attach a radiation scanner to take reading where personnel is unable to gain access to
- 360 deg camera and VR goggles are a possibility, will have quick change EOAT to allow for camera change

