



U.S. Department of Energy



# Welding - Waste Package Closure System Prototype Update

Presented to:

**Nuclear Waste Technical Review Board**

Presented by:

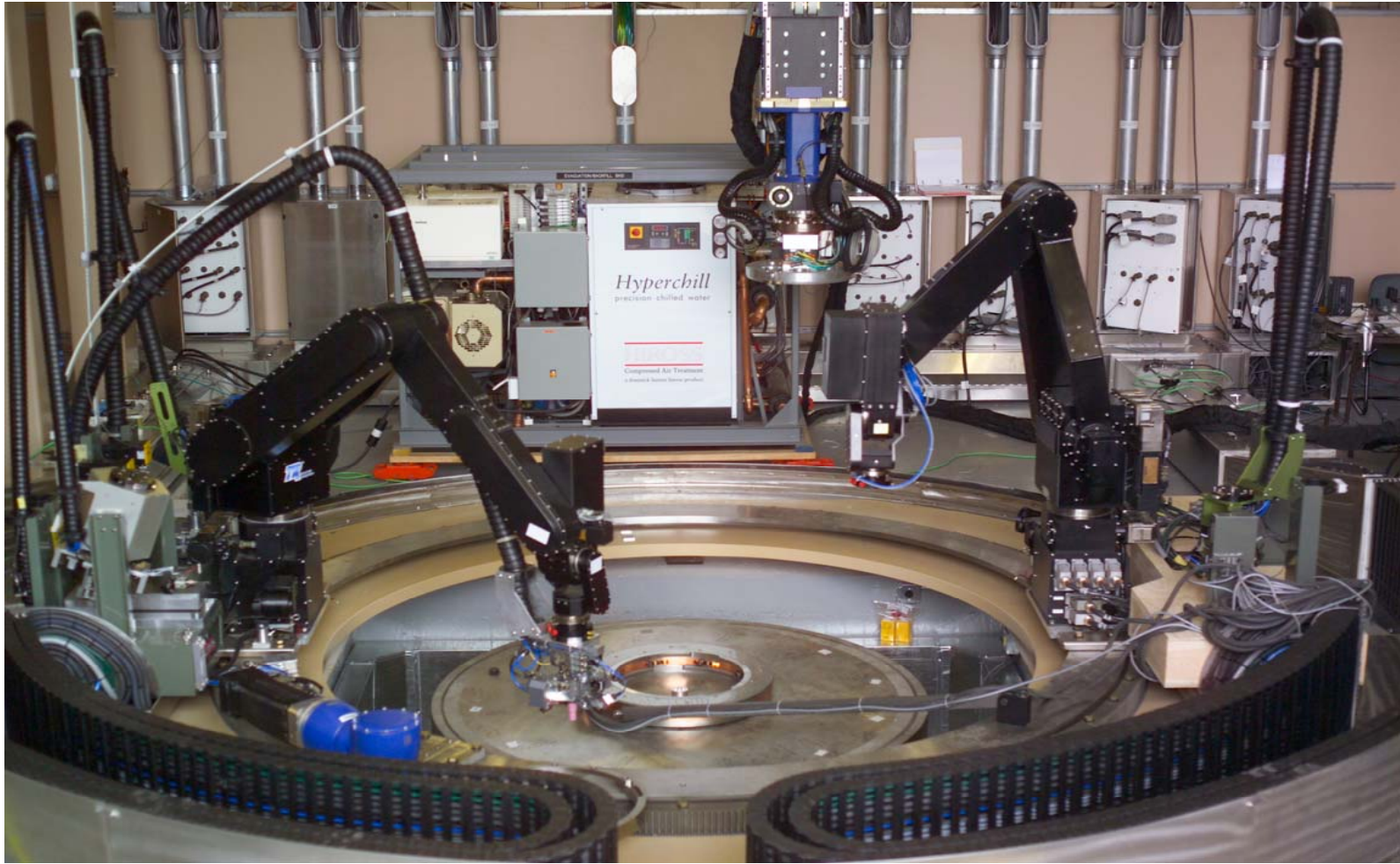
**Christopher A. White**

**Office of Technical Management, Engineering Division**

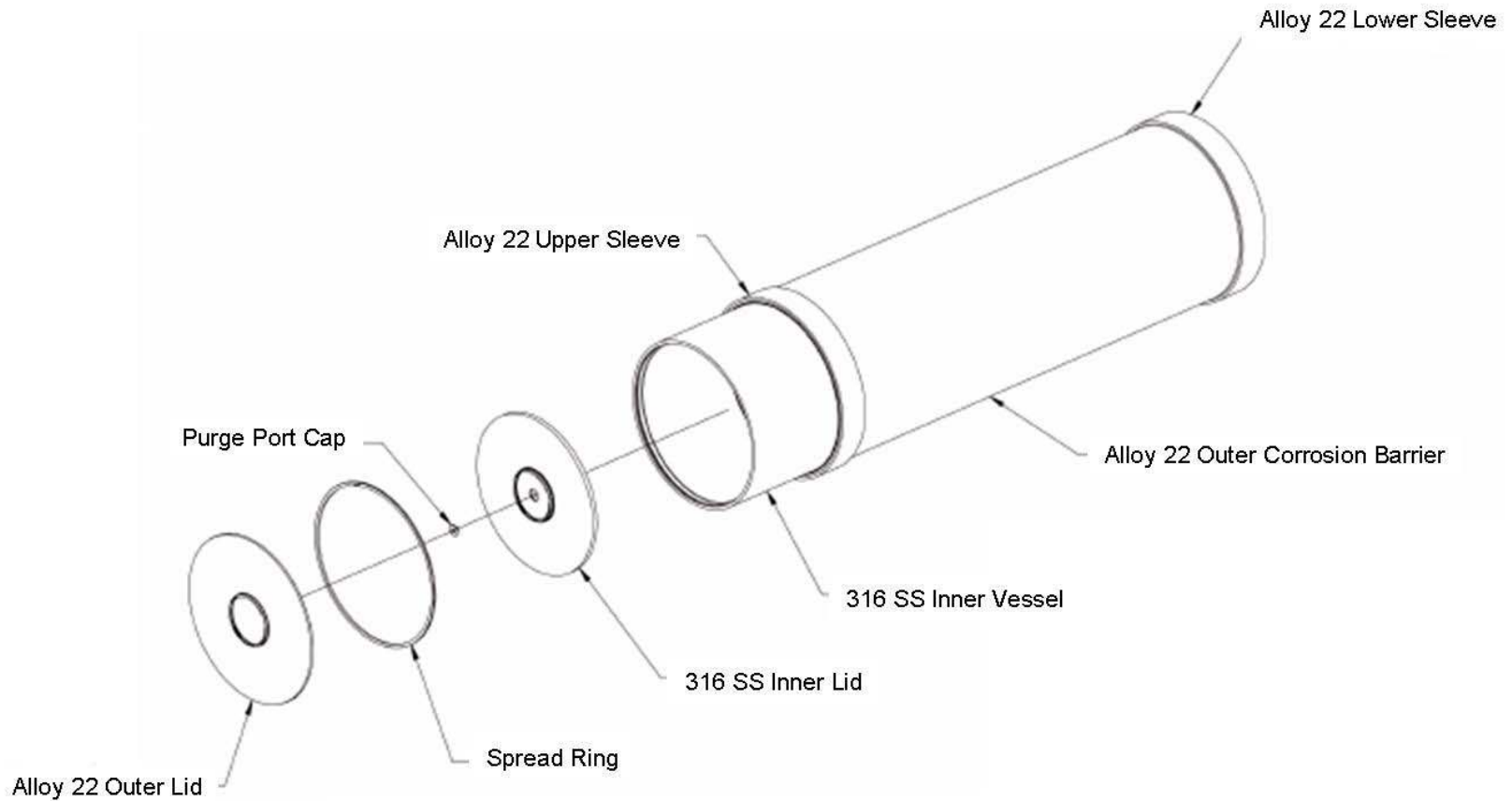
**January 28, 2009**

**Las Vegas, Nevada**

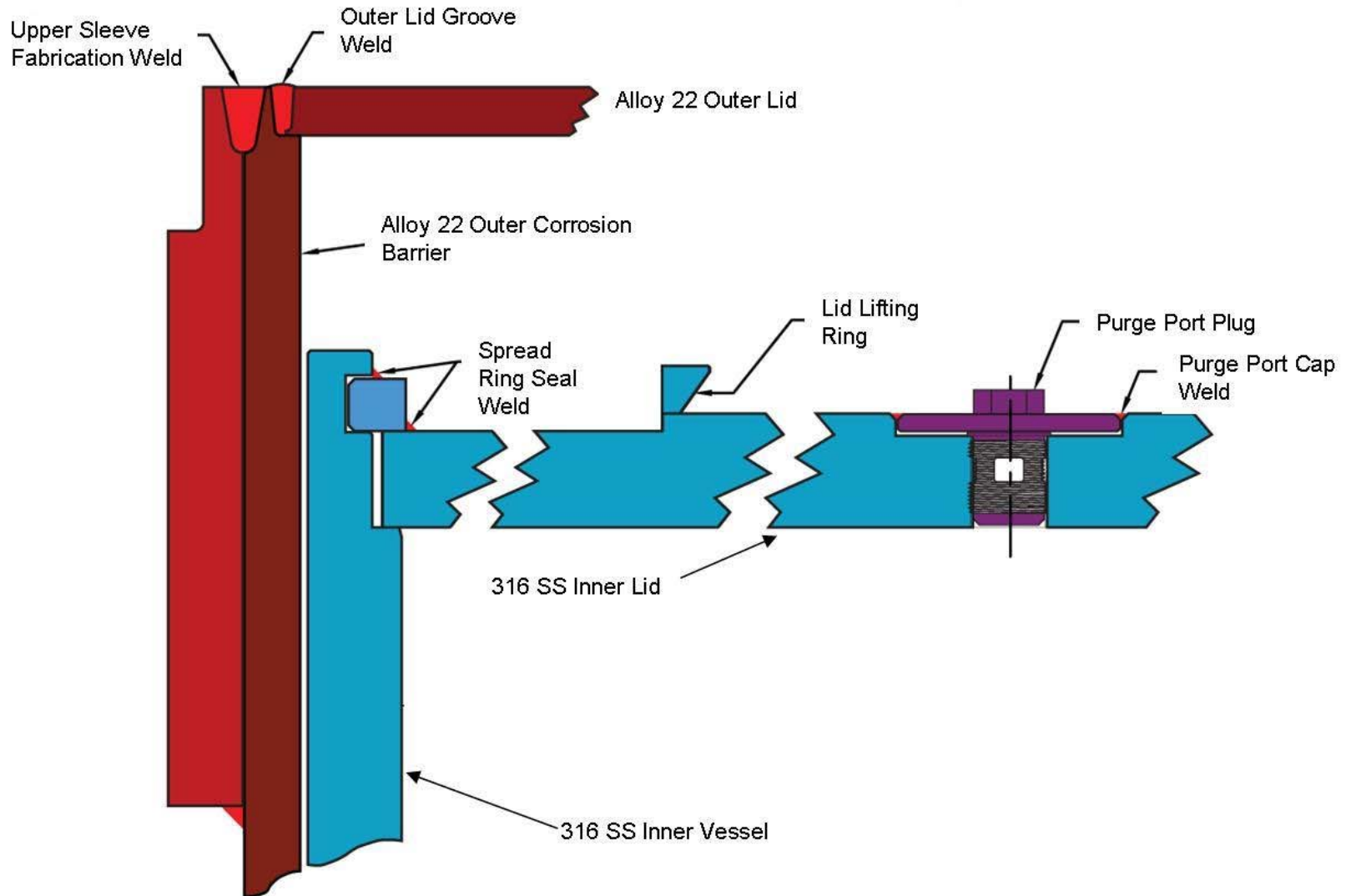
# Waste Package Closure System Prototype at Idaho National Laboratory



# Waste Package Configuration



# Waste Package Closure and Seal Welds



# Closure Systems

- **Systems included in waste package closure:**
  - **Welding inner lid (spread ring), purge port cap, and outer lid**
  - **Nondestructive examination of seal welds and closure weld**
  - **Evacuation and backfill with helium**
  - **Stress mitigation**
  - **Material handling**
  - **Control and data management**



# Waste Package Closure System Process Flow (simplified)

- **Move waste package into position for closure**
- **Weld spread ring to inner lid and waste package**
- **Evacuate and backfill waste package with helium**
- **Perform helium leak test of the inner lid**
- **Weld purge port plug**
- **Place outer lid in waste package and perform closure weld**
- **Perform controlled plasticity burnishing**
- **Process complete**

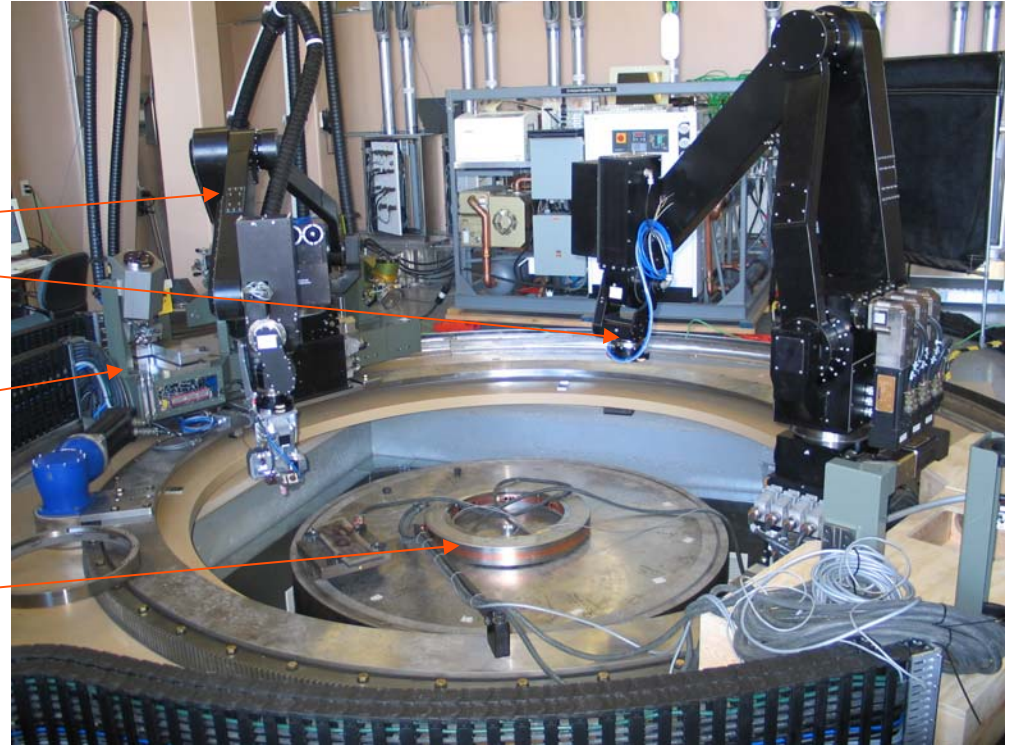


# Welding and Inspection Deployment

Robots

Tool Tray

Grounding Ring



**Two robots mounted on a rotating bearing will perform welding and inspection 180° apart to reduce distortion and increase throughput.**



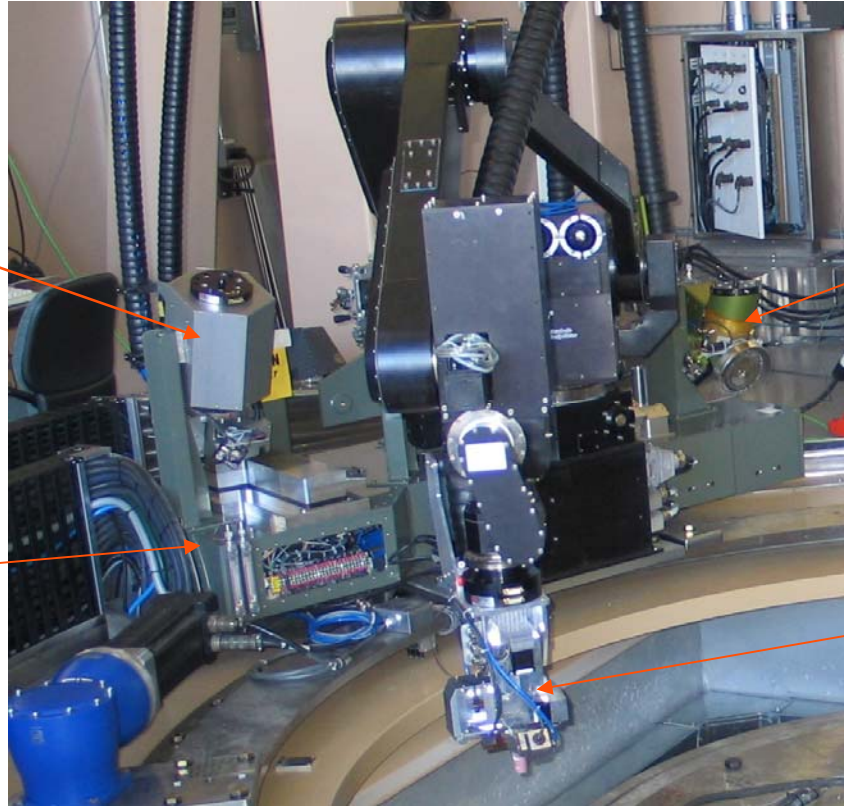
# Tool Tray and End Effectors

Ultrasonic and eddy current inspection end effector

Dressing end effector

Tool tray

Welding end effector



**Welding and inspection end effectors, stored on a tool tray mounted behind each robot, attach to the robot for deployment**



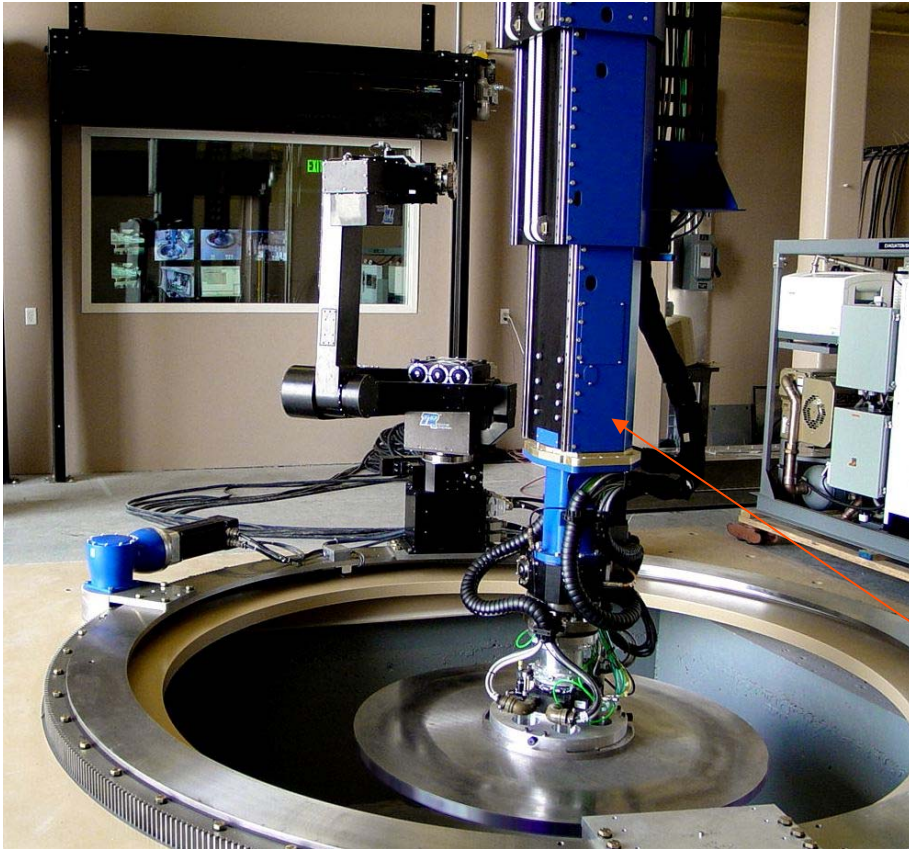


# Remote Handling

**Transfer cart and rails for movement of materials into and out of the closure room.**

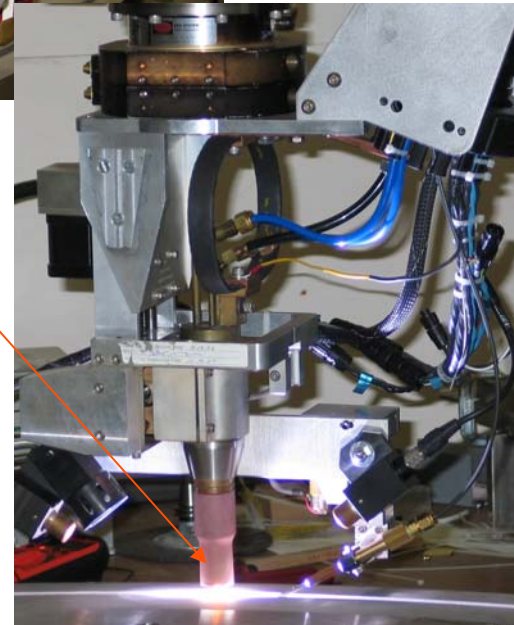
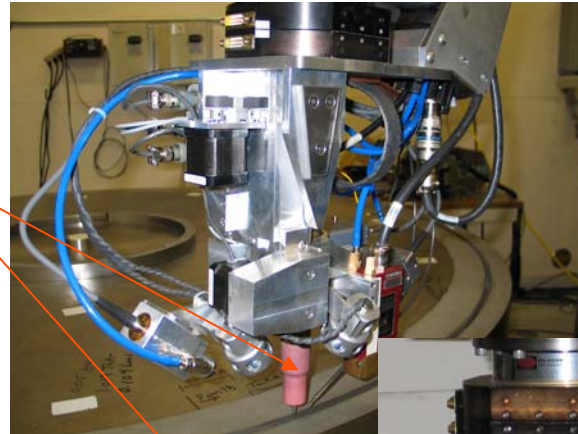


**Precision telescoping Z-mast manipulator (remote handling system) for tool and lid movement within the closure room.**



# Seal Welds

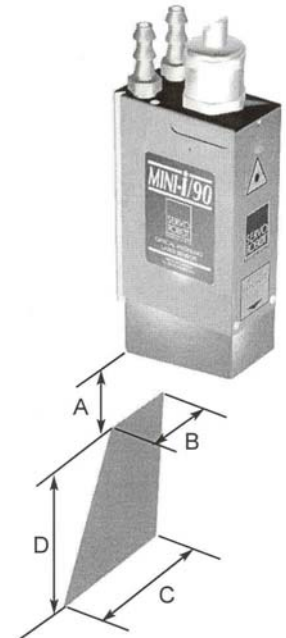
- **Weld process is gas tungsten arc welding (GTAW)**
- **Spread ring is seal welded**
- **Purge port cap is seal welded**



# Visual Inspection

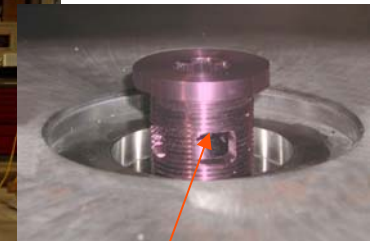
## Laser based visual inspection

- Identifies surface flaws
- Performed on all welds
- Performs seam tracking for defining weld path
- Mounts on welding end effector



# Purge Port Tool

- Purge port tool loosens a plug in the center of the inner lid
- Performs the evacuation and backfill operation
- Tightens the plug, sealed with a crushable metal seal
- Tests metal seal for helium leakage



Purge Port Plug



# Evacuation and Helium Backfill

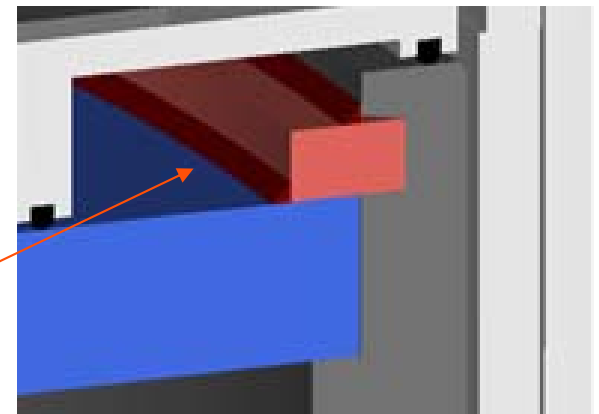
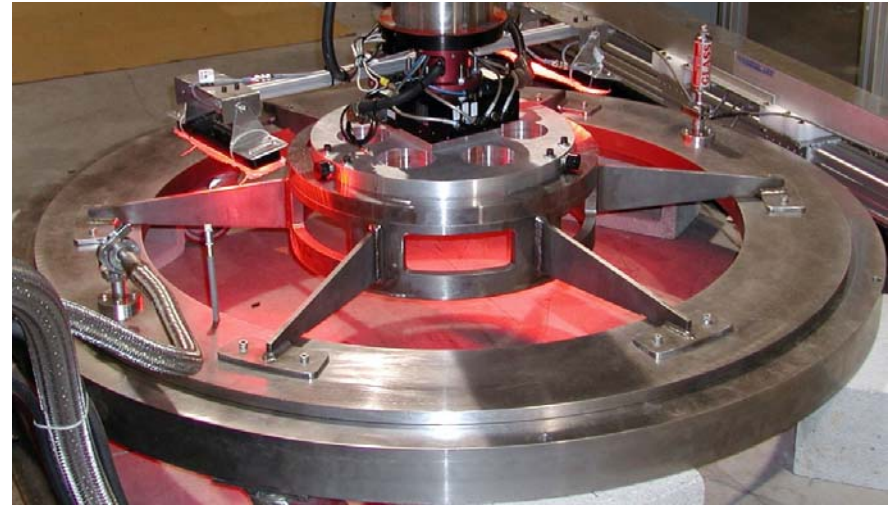


**Evacuation and backfill system connects to a purge port tool and the leak test ring**



# Spread Ring Leak Detection

- **Leak detection on spread ring welds with specially designed ring**
- **Detection of  $1 \times 10^{-6}$  cm<sup>3</sup>/sec helium leak required using a pressure differential of not less than 0.1 MPa (1 atmosphere)**
- **Mass spectrometer on evacuation/backfill system detects helium leak concentration**

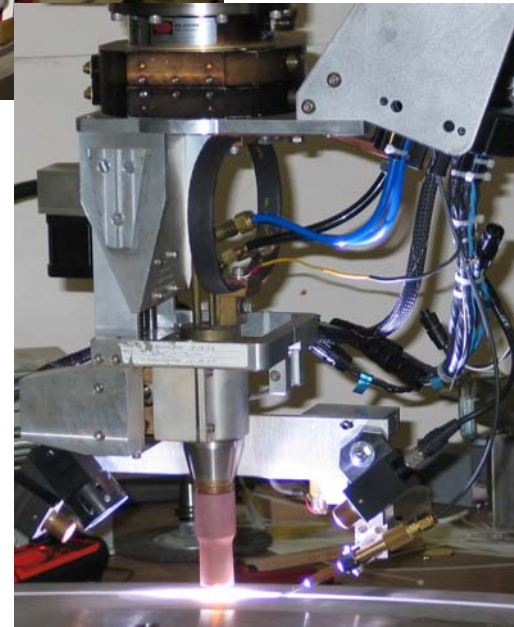
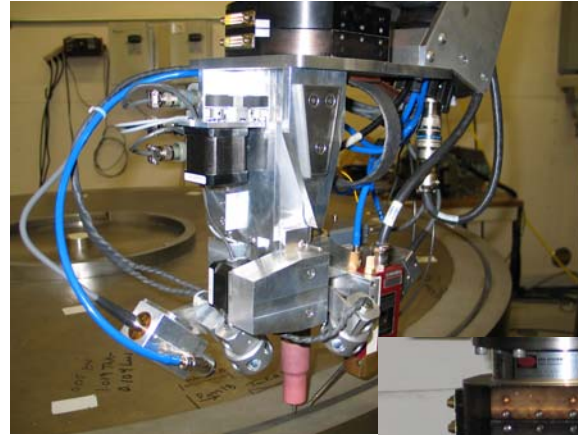


Vacuum area for spread ring leak test



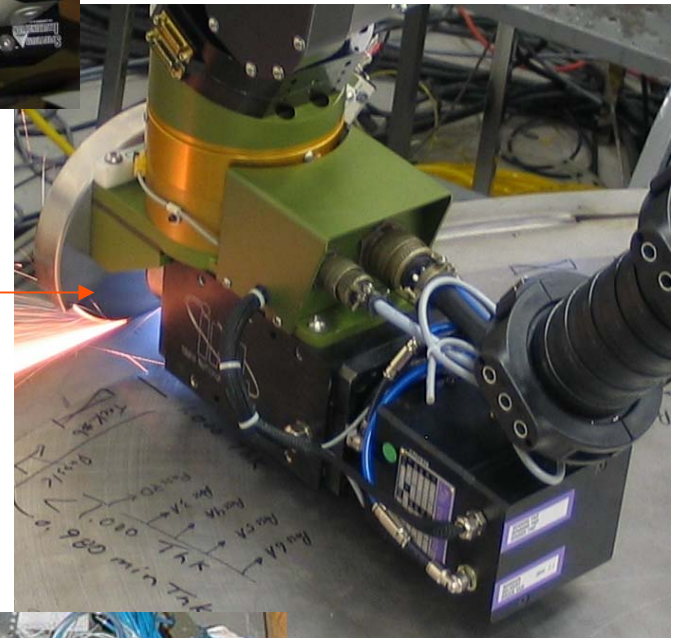
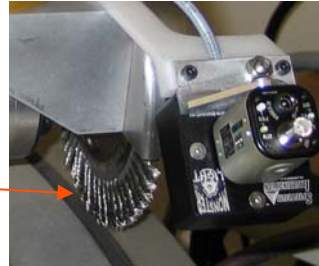
# Closure Weld

- **Weld process is gas tungsten arc welding (GTAW)**
- **Outer lid weld is a full-thickness groove weld, 1 inch thick**
- **The closure weld is performed by completing approximately 8 to 10 passes.**



# Weld Brushing and Grinding

- **Brushing after each weld pass for a clean surface**
- **Wire brush can be remotely removed and a grinding wheel installed if a flaw has been identified that requires repair**
- **Brushes and wheels are stored in a drawer in the tool tray**





# Ultrasonic/Eddy Current End Effector

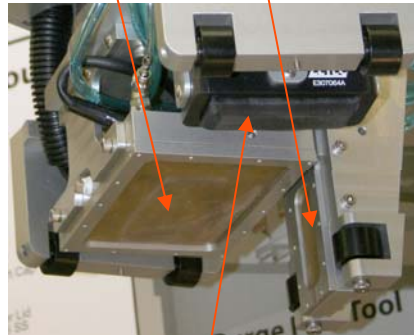
## Phased Array Ultrasonic:

- provides ability to electronically aim, steer, focus, and scan; increases inspection rates
- identifies flaws
- full volumetric inspection

## Array Eddy Current:

- increases inspection rates
- identifies surface breaking flaws

Ultrasonic inspection  
top and side vessel  
probes



Eddy current probe

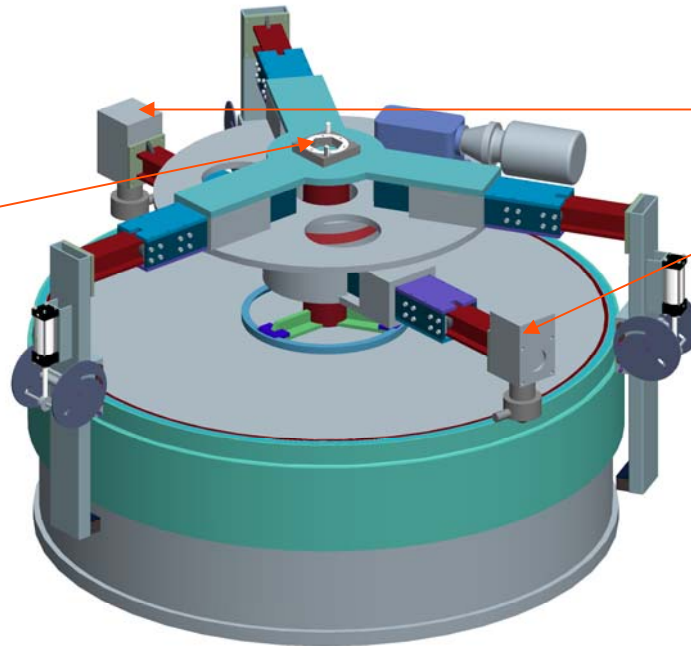


# Stress Mitigation

**Controlled plasticity burnishing technology is used to reduce residual tensile stresses in the outer lid weld.**

Model of burnishing deployment tool and end effectors

Tool interface plate for movement with Remote Handling System (RHS)



One of two burnishing end effectors



# Control and Data Management



**Electronic and control systems are located in an equipment room. (Control cabinet above is for the remote handling system. A movable control pendant is shown in front on wheels.)**



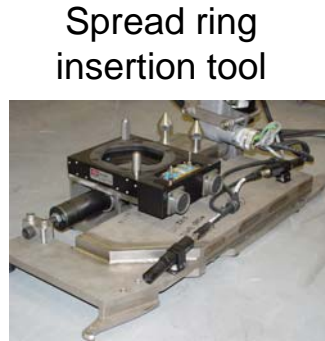
**Six work stations with multiple views (data or camera) for a fully automated and remote system. One work station for each welder (2); one for each inspector (2); one for backfilling, leak detection, material handling; and one for a supervisor who controls overall operations.**



# Other Tools and Systems



Bumpy bar code identification tool



Spread ring insertion tool



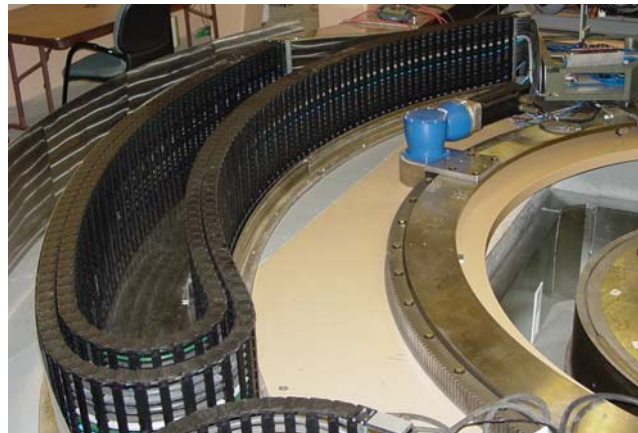
Lid handling tool and lid lifting ring



Interior of control cabinet



Machine vision system



Cable management



Utility control system (instrument air, helium, and argon/helium mixture)



# Waste Package Closure System Prototype March 2009 Demonstration

**Demonstration will include the following:**

**Completion of seal weld for the inner lid and closure weld for the outer lid using two robots**

**Heat will be applied to simulate the heat of an 18 KW Transportation, Aging, and Disposal canister**

**Non destructive examinations and controlled plasticity burnishing**

**Ability to remotely repair defects**

**Length of time to complete the closure process**



# Video of the Waste Package Closure System Prototype at Idaho National Laboratory



# Questions

