

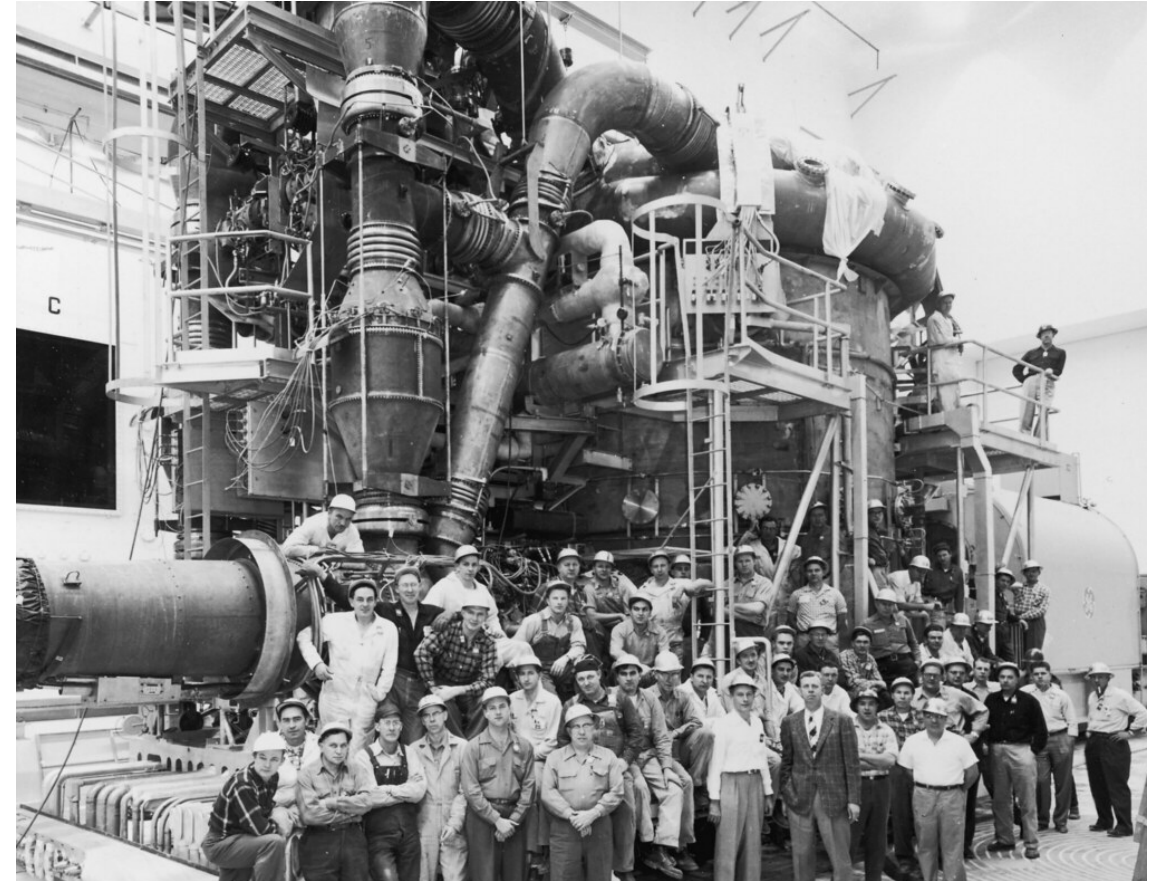
# ***INL Visual Examination Machine Periscope Upgrade***

***Philip Winston, Gregory Housley, Steven Marschmann, Collin Knight, Katelyn Wheeler***

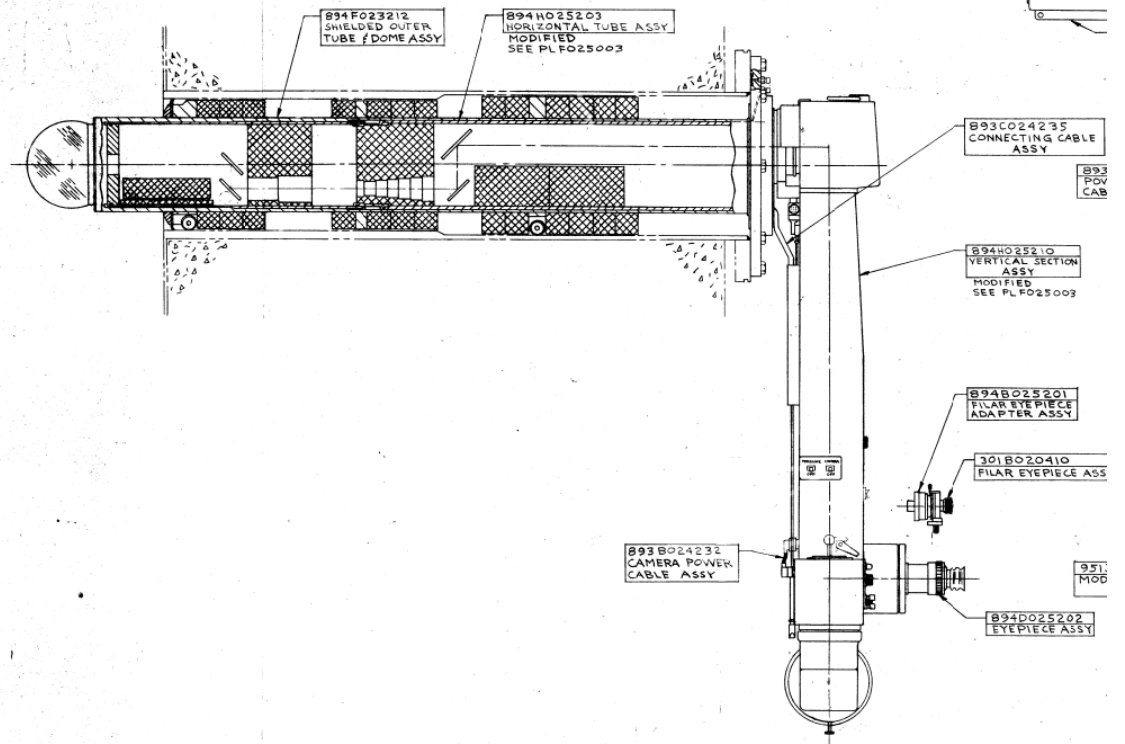
***Idaho National Laboratory***

## *Idaho National Laboratory*

- Idaho Snake River Plain (lava-sagebrush desert)
- WWII Gunnery Range
- Became National Reactor Testing Station
- 52 reactor designs built and tested
- Including EBR-1, MTR, EBR-II, PBF, ATR, TREAT

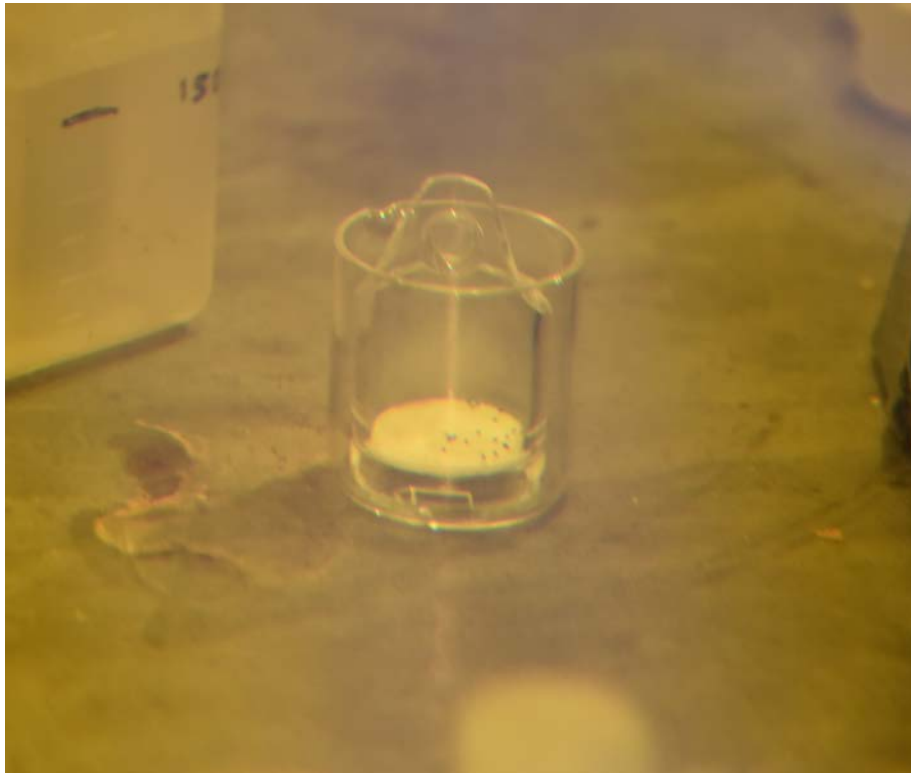


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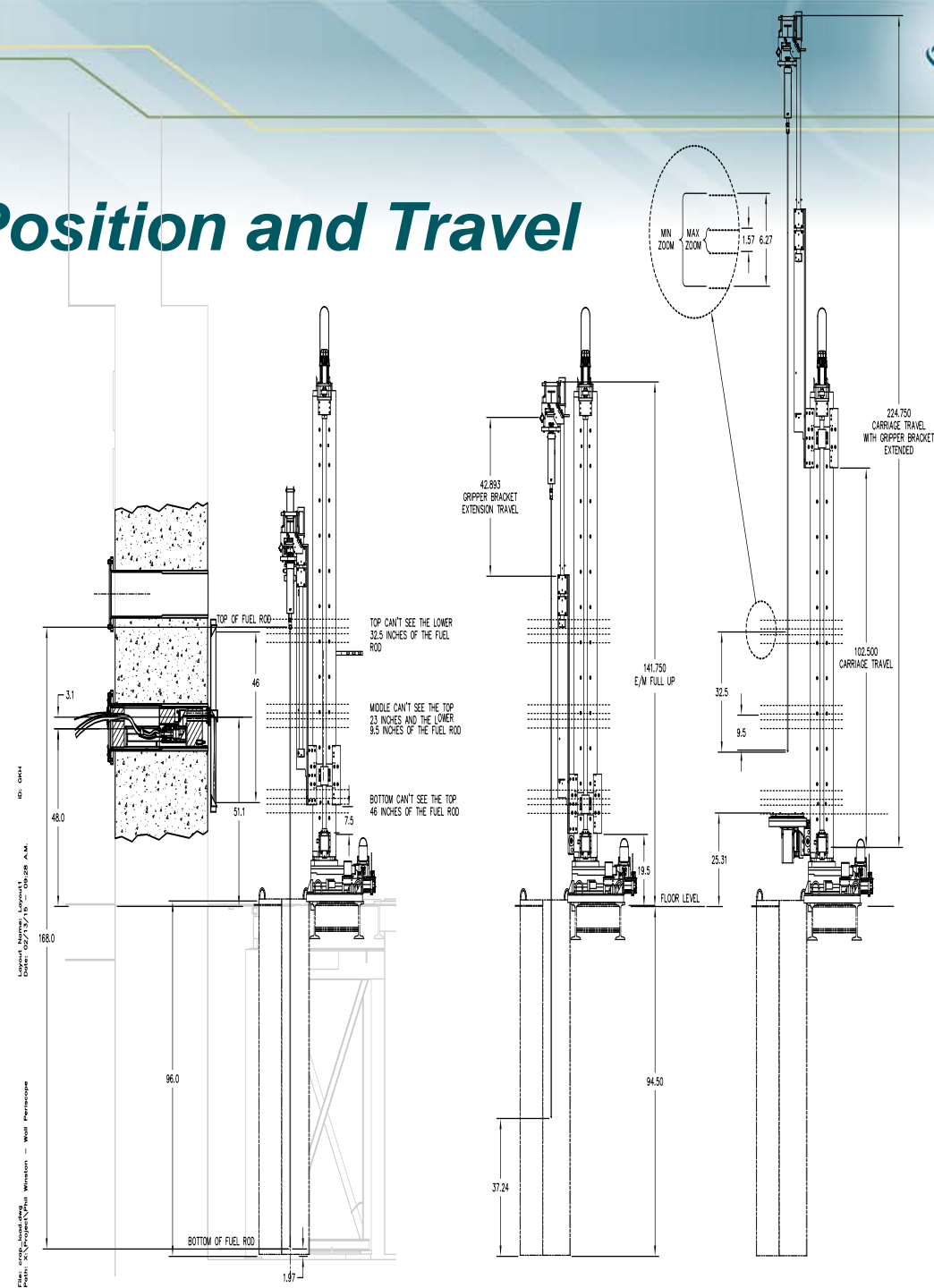
## ***Why do you need a direct view into your hot cell?***



## ***Design Replacement Premise***

- Need replacement periscope to allow clear focus and position control
  - Intended to be used to provide visual comparison of high burnup PWR fuel rods in conjunction with eddy current measurements
  - Design adaptable periscope insert independent of specific lens or camera combination
  - Design to be independent of rad hardened specialized components
  - Allow replacement with new components or technology with minimum modification
  - Use video display and digital camera with long working-distance lens inside shielded configuration
- 
- Initially started in 2013 with Used Fuel Disposition campaign funding provided by Dr. Steve Marschmann.
  - Design, Phil Winston, Greg Housley;
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- Restarted in 2018 under direction of Mr. Collin Knight
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- Planned to be deployed 2019, responsibility Ms. Katelyn Wheeler

Vertical position  
precision 76  
microns



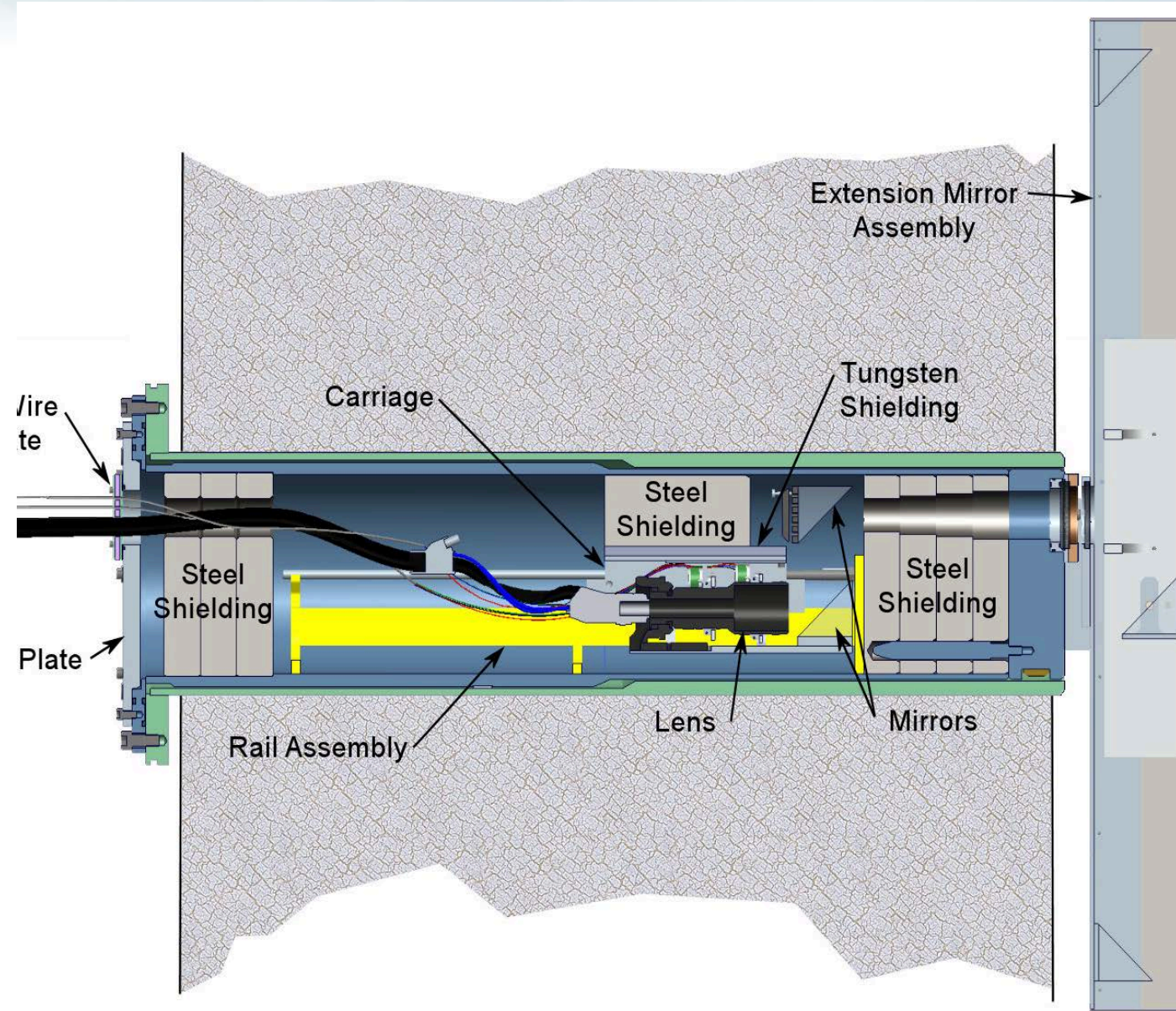
## ***Design Requirements***

- Identify defects <50 microns
- Provide display and digital image recording
- Focus on target nominal distance 44 inches from cell wall
- Be able to view 12 ft long component with stage movement of 147 in
- Feedthrough shell gas tight seal per TFR-589; Leak test 1E-5cc/sec He
- Assembled feedthrough He leak test < 5E-5 cc/sec per TPR-13438



# General Configuration

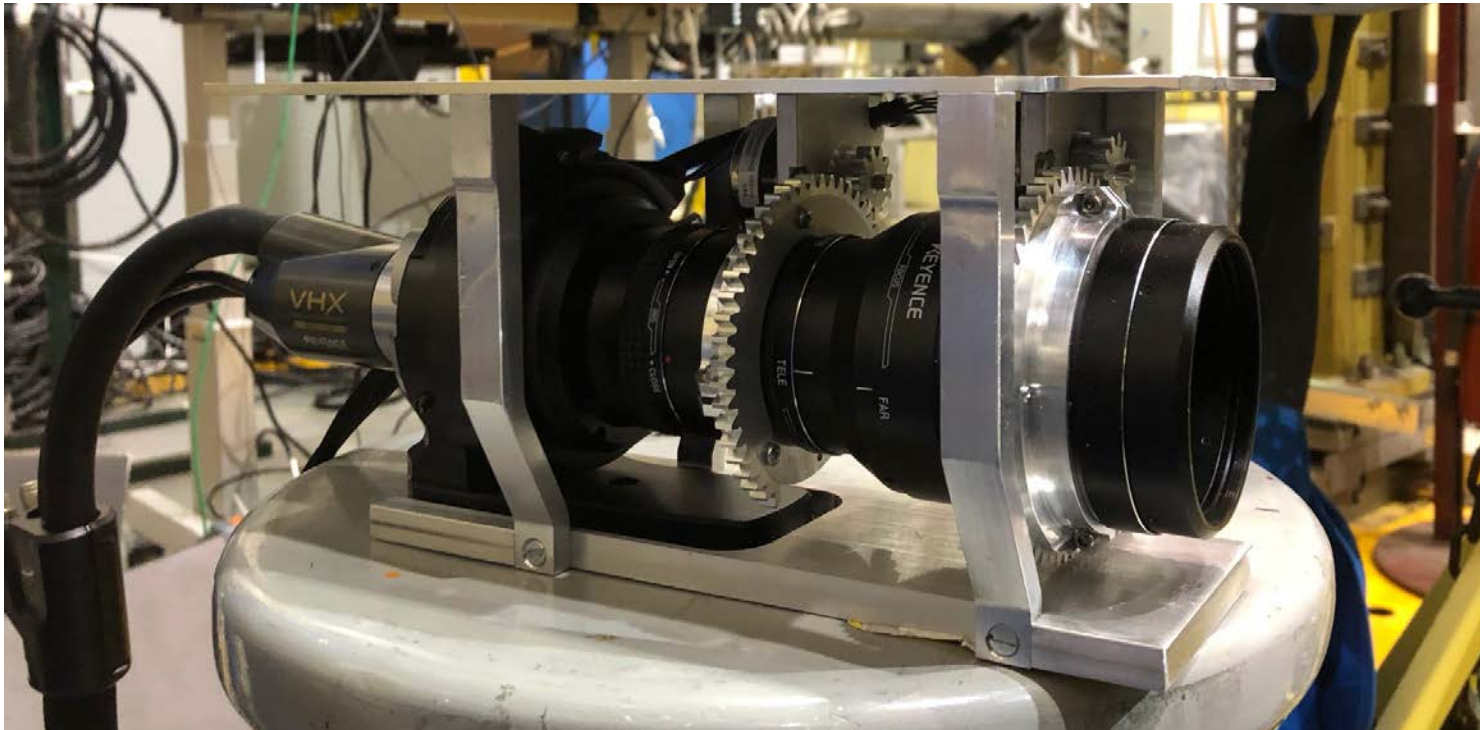
- Keyence VHX Microscope Camera
- Keyence VW-Z2 2 m WD 4:1 zoom Machine vision lens
- Differences:
  - Tungsten Shield above camera
  - Potted connection through back plate
  - Extension mirror assembly not installed





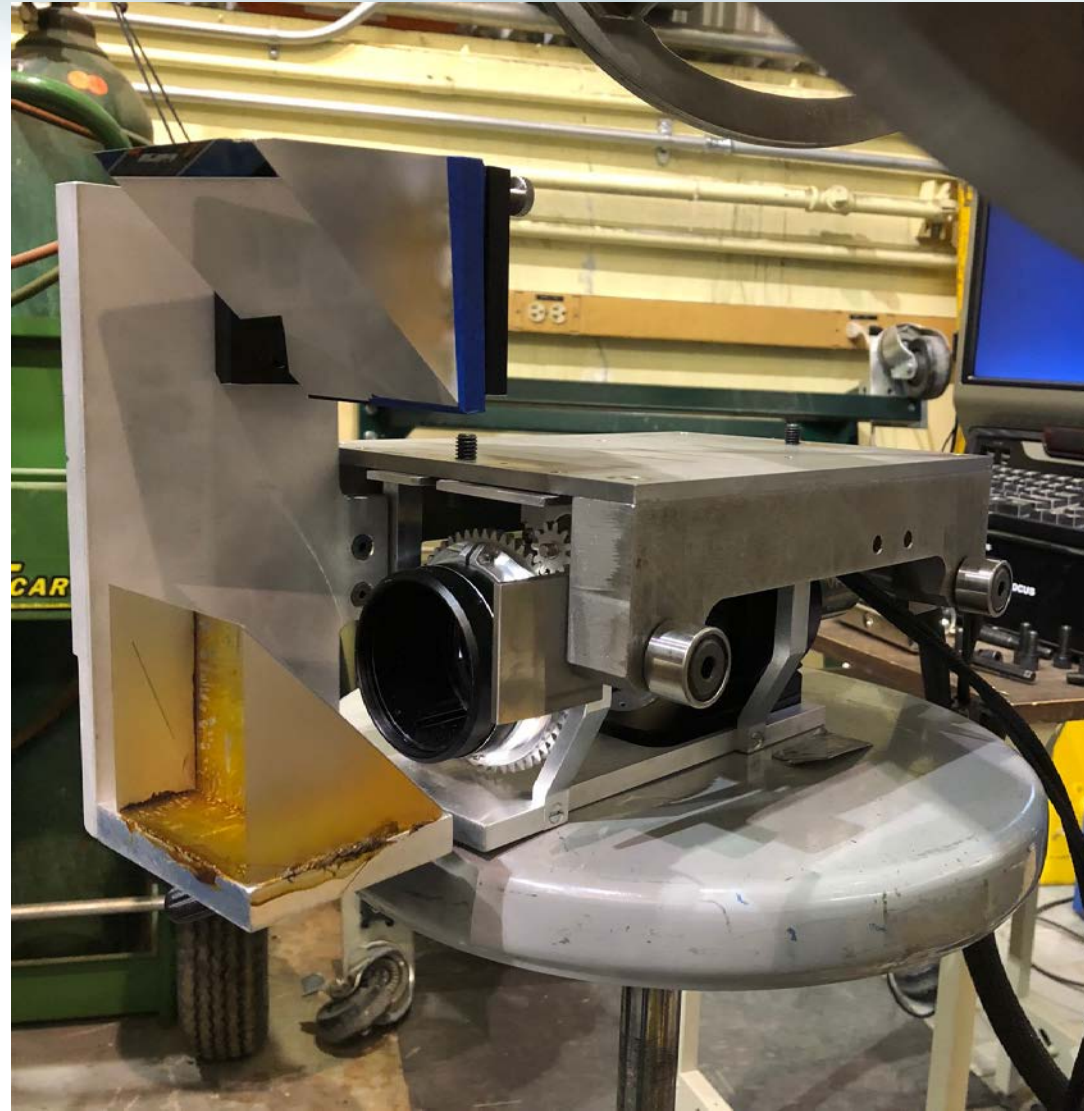
## *Components*

- Keyence VHX-2000 Microscope Camera and Monitor
- Keyence VW-Z2 Long Distance Macro Zoom Lens



## *Components*

- Front Surface Mirrors
- No concern for browning of glass





## Components

- Rail and Cart
- Camera, mirrors and shield block can be repositioned depending on optics used
- Facilitates removal of components without removing in-wall insert





## ***Shield Plates***

- Slotted/Angled 2" thick
- Carbon Steel Plates
- Individual Plates 50 lb



# *Components*

- Rail and Cart Insertion



## *Components*

- Potted Rear Plate Seal
- Used to assure that the copper and fibre optic conductors are sealed to meet the isolation criteria for the argon filled cell.





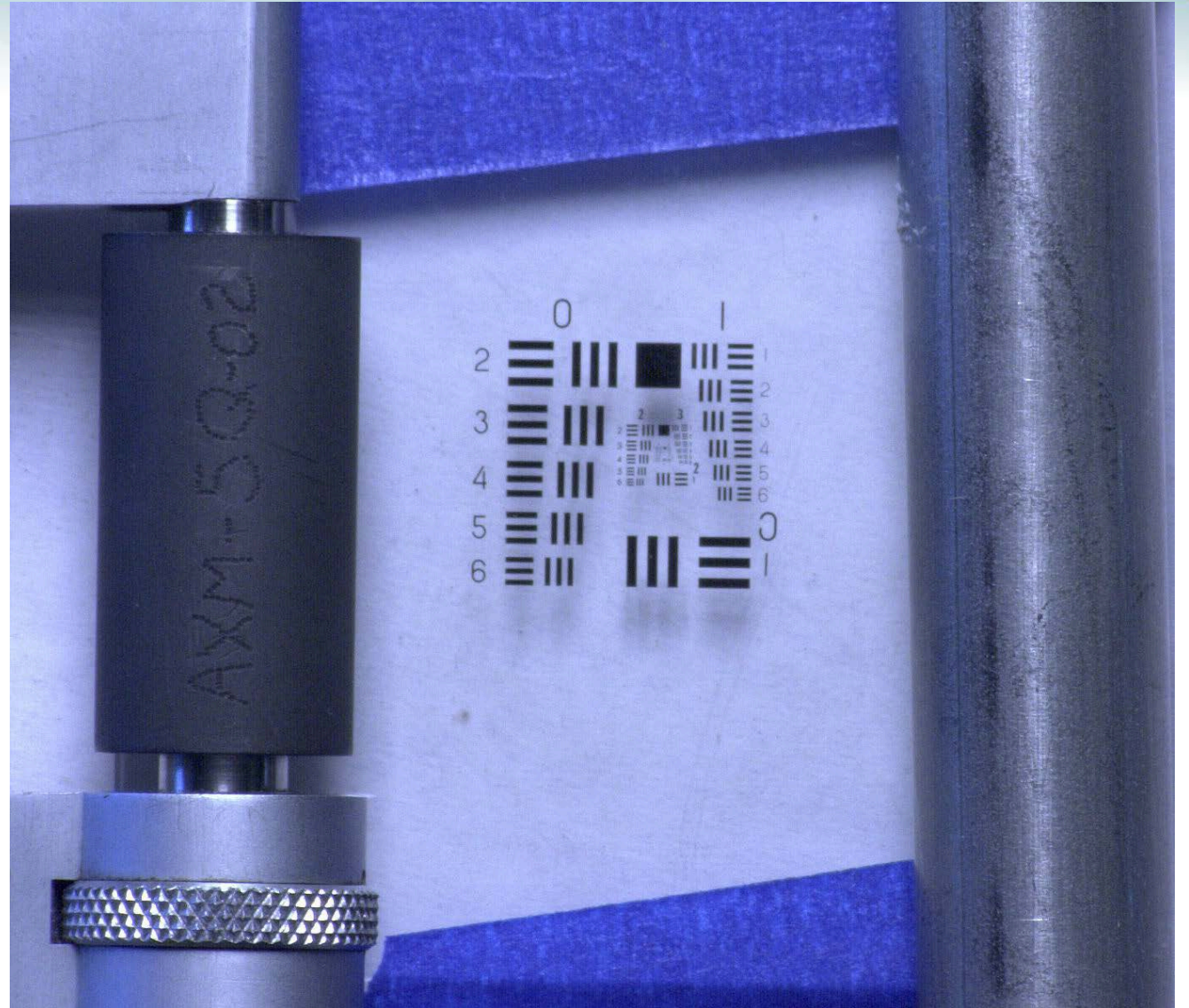
## *Components*

- Potted Rear Plate Seal
- Used to assure that the copper and fibre optic conductors are sealed to meet the isolation criteria for the argon filled cell.



# *Image Quality*

- Image @ 44" max zoom
- Target USAF 1951
- Graphite cylinder 1" long
- ½" Stainless tubing on right





## ***Front (In Cell) End***

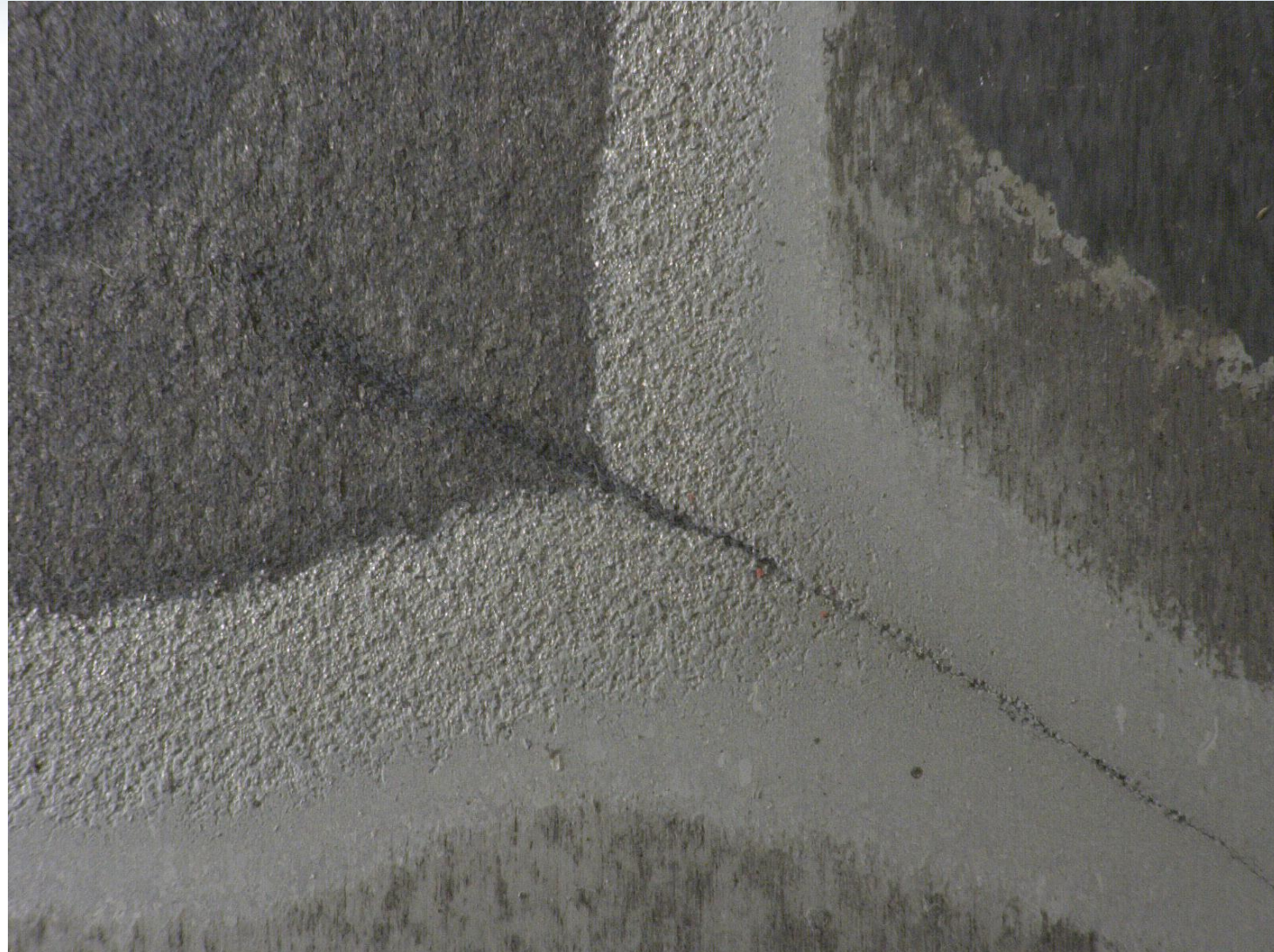
- Double O-ring seal (edge and face)
- 12.7 mm thick silica window (non browning)
- Angle steel hooks allow attachment of periscope extension or close positioning stage





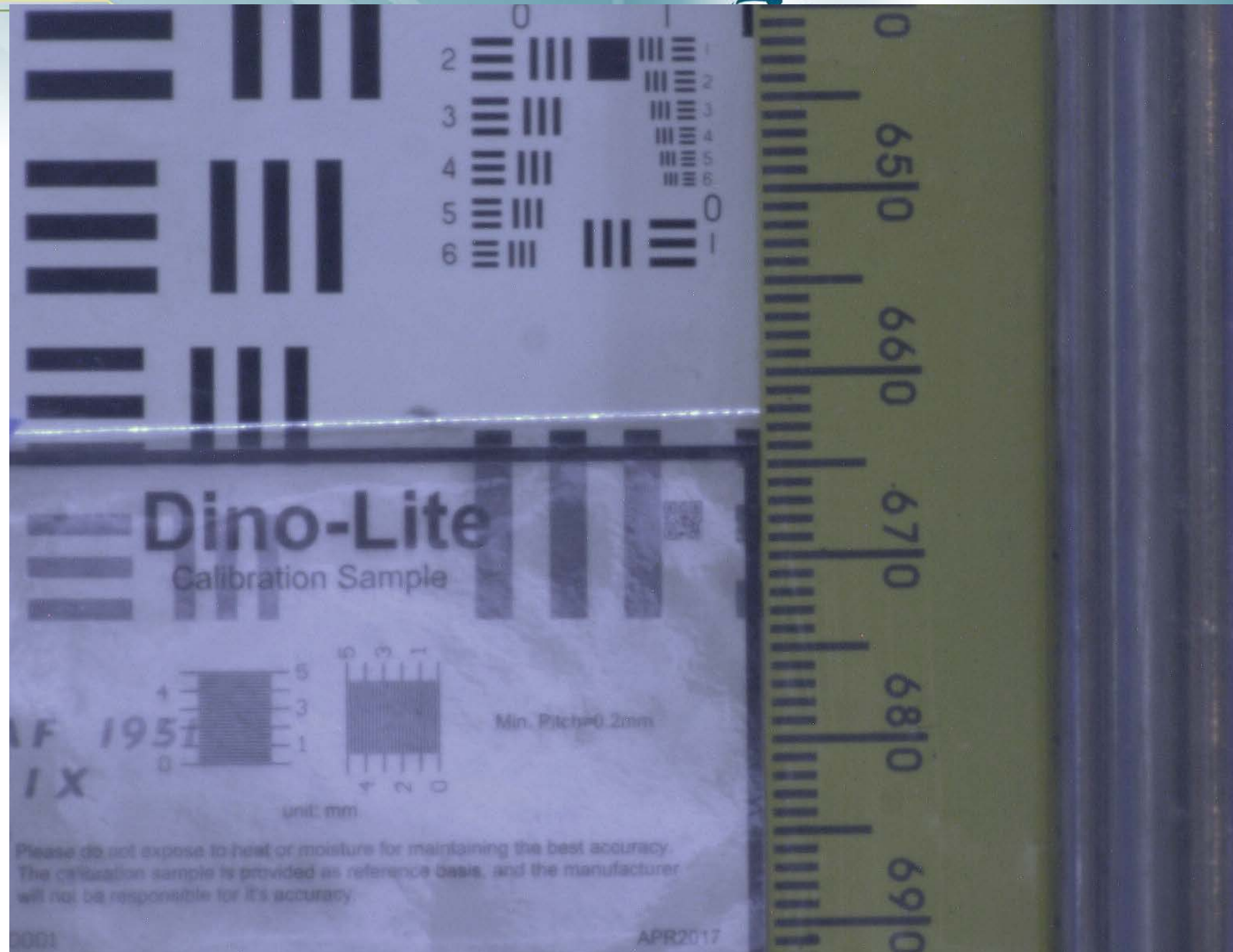
# *Image Quality*

Corrosion specimen  
2" away Full Zoom



## Image Quality

- 44" from wall; full zoom
- Dino Lite 200 micron scale
- Dummy PWR Fuel rod on right





## *Image Quality*

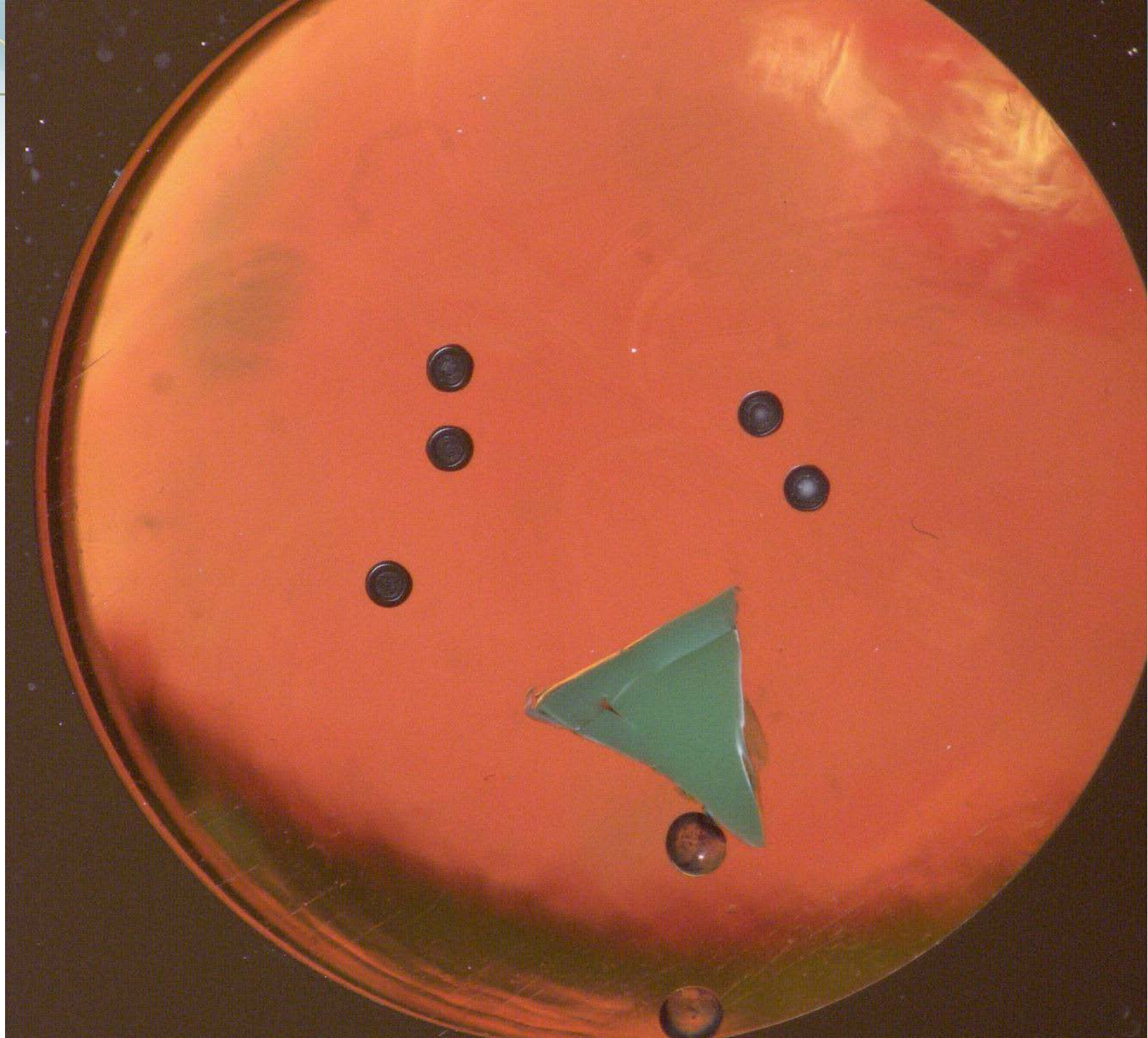
- Olympus 0.01 mm (10 micron) microscopy target
- Full zoom, 4" away from tube end
- Front Lighting





## *Image Quality*

- TRISO particles in polished met mount ; full zoom @ 2 inches
- 30-40 micron SiC layer
- 30-50 micron OPyC layer
- 40-60 micron





## ***Additional Work***

- Additional software work and/or electronic linkage to linking image data to stage position.
- A close-range positioning stage in progress for small samples needing maximum magnification.
- Supplemental In Cell Lighting has been purchased and modified



## ***Conclusions***

The system will work for the original purpose of inspecting fuel rod cladding at the 44 inch (1120mm) working distance

The system will be effective for inspecting TRISO compacts at the nominal 2 – 4 inch (50 to 100 mm) distance.

**Thanks for your attention.**

**Phil Winston**

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