INL/CON-19-54521-Revision-0

Lessons Learned Converting A Commercial Enclosure to a Uranium Handling Glovebox

July 2019

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Changing the World's Energy Future

Idaho National Laboratory

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Advanced Manufacturing

INL Initiative

Developing cost competitive techniques to manufacture components made from materials for harsh and extreme environments. Focusing on development of radiological materials, reactor systems, in-pile sensors, and hardened material systems. Applications to include advanced reactor technologies, fossil energy, clean energy, and space and defense systems.

Additive Manufacturing

Why use additive manufacturing?

- Complex Geometries
- Minimize material (weight) while maximizing strength
- Localize material characteristics
- Build with multiple materials
- In-process alloying

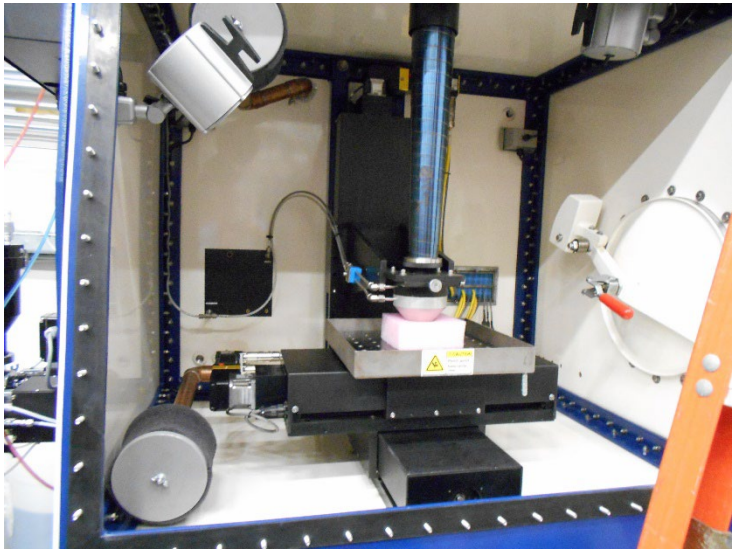
Type of Additive Manufacturing

- Powder Bed Fusion
  - Selective Laser Sintering (SLS), Electron Beam Melting (EBM)
- Directed Energy Deposition
  - Powder DED, Wire DED
- Binder Jetting
- Sheet Lamination

Optomec LENS® MR-7

- Directed Energy Deposition (DED) using Laser Engineered Net Shaping (LENS®) technology
- Uses a high power ND: YAG fiber laser to fuse powdered material into three dimensional structures
- Class 1 Laser Enclosure
- Controlled atmosphere (O_2 levels < 10ppm)
- Build area of approximately 12”x12”x12”
- Powder delivery system with 2 hoppers.
- Typically operates at a positive pressure.

Optomec LENS MR-7



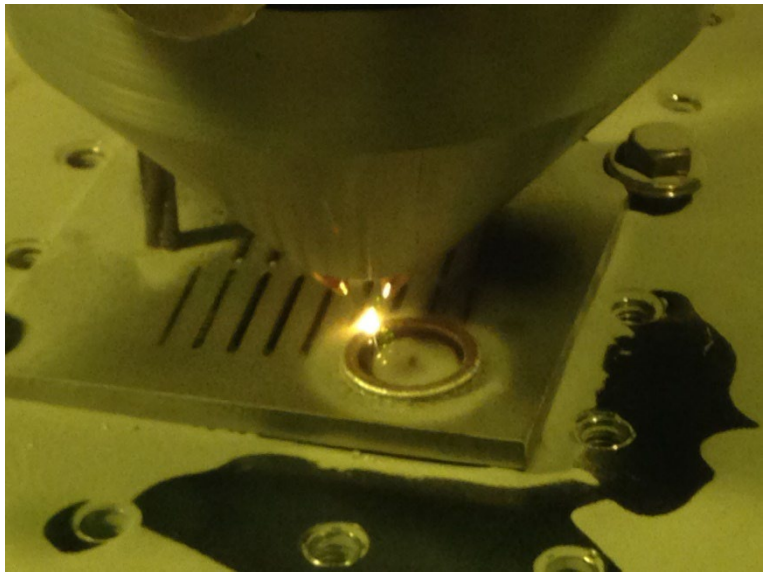
Upgrades

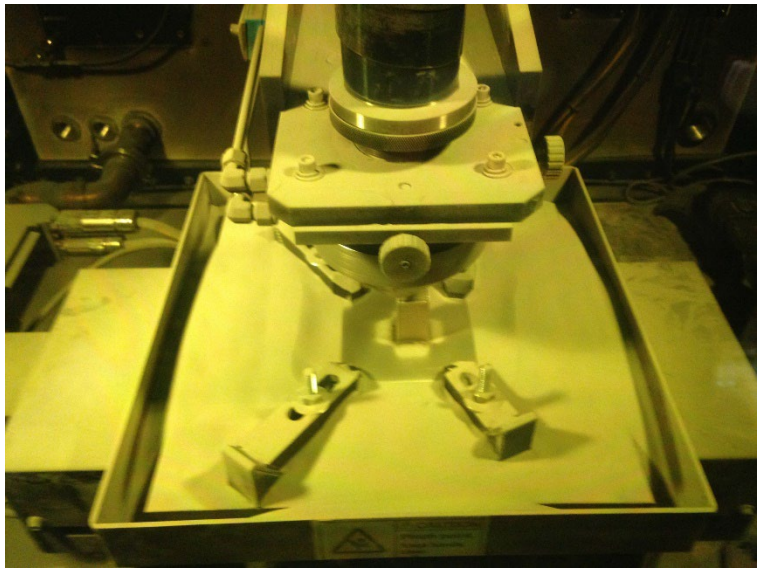
- 1 kW laser
- Thermal camera
- Glass viewing window
- Rotational Axis

Operation

- Powder is loaded into the two hoppers on the side of the enclosure
- Powder is carried to the deposition head and exits through 4 nozzles
- The laser comes down through the center of the deposition head and creates the melt pool.
- The table and deposition head move to create the 3 dimensional part.
- The finished part is passed out of the enclosure through the transfer port.

Build Pictures





Upgrades

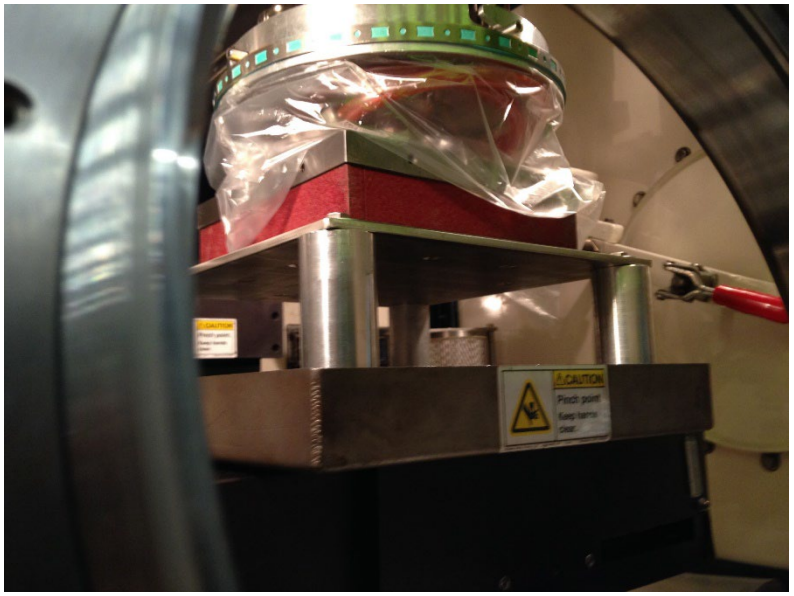
Main objective is to be able to process radiological and pyrophoric material.

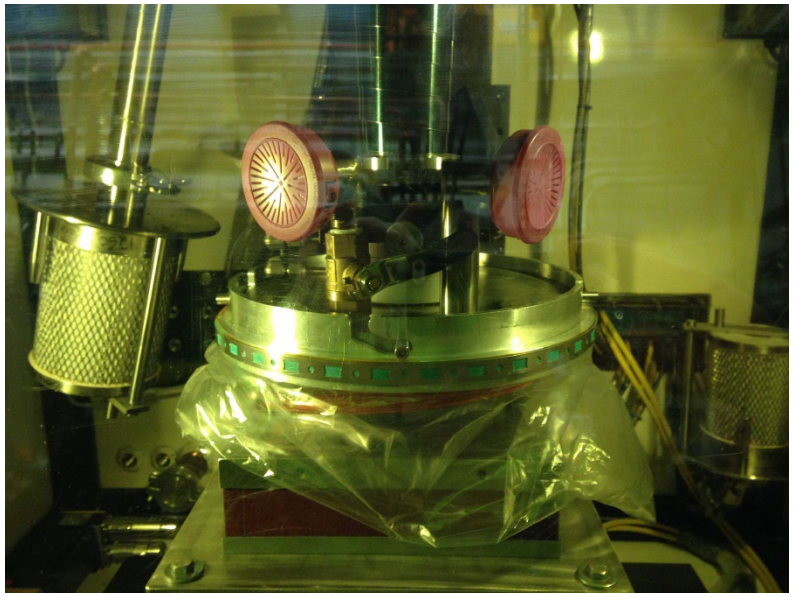
- Must pass Helium leak test
- Shall operate under a negative atmosphere

Upgrades

- Containment bag
- Powder Separator
- Magnetic/Cooing Plate
- Window Replacement
- Electrical Feed Throughs
- Hopper Relocation
- Side and Back Panel Modification

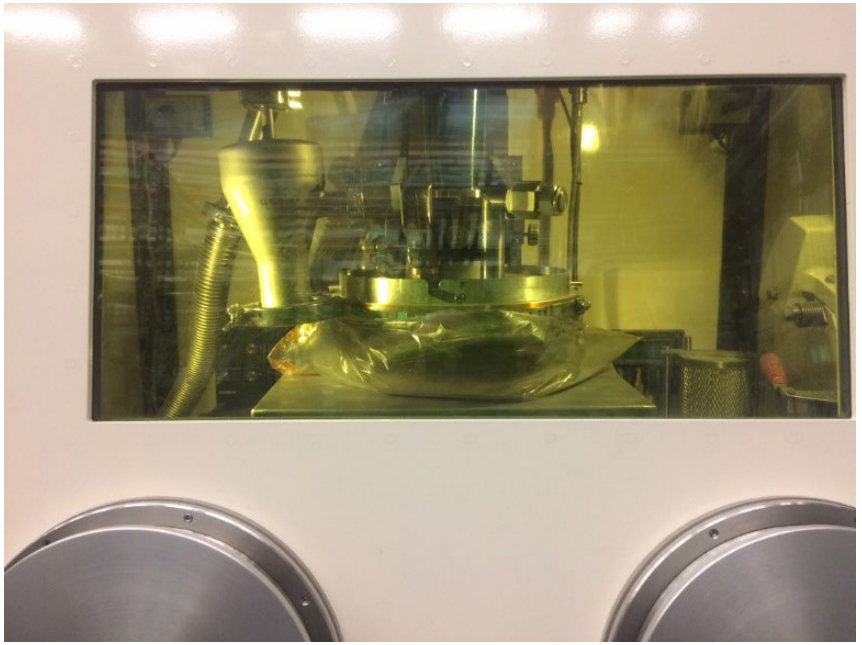
Primary Containment Bag





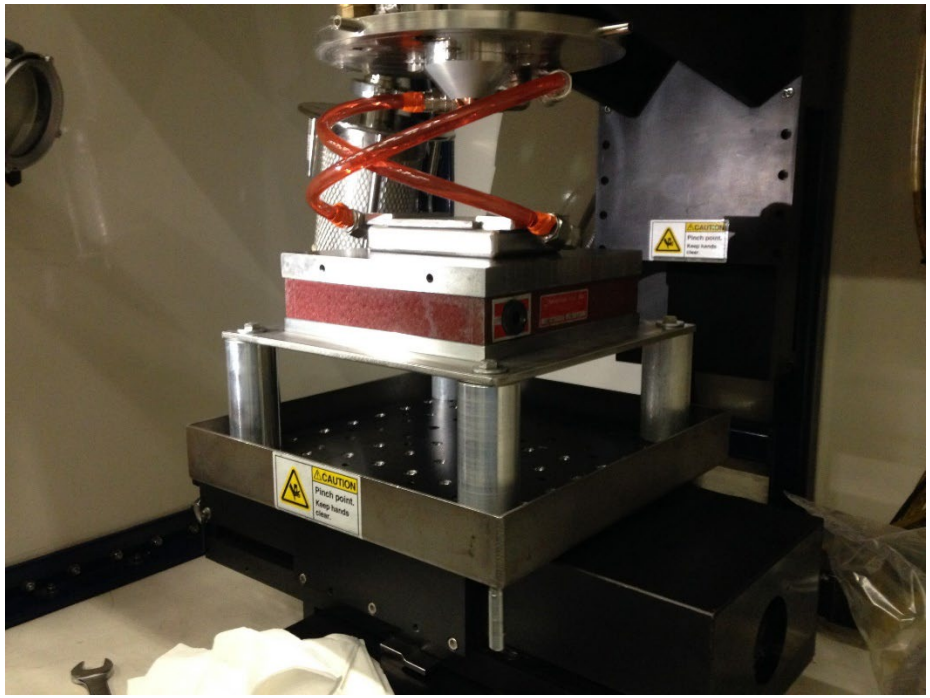
- Modified the head of the laser to accept the mounting bracket for the containment bag
- Went through multiple iterations to find a material that would withstand the heat and still be flexible enough to allow movement of head and build table
- Contains all of the overspray, eliminating lengthy cleanups and decontamination issues

Containment Bag Powder Separator



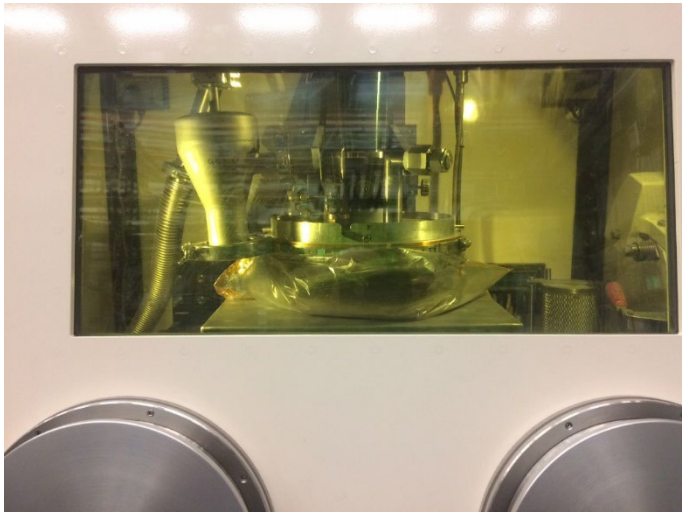
- Argon purge through center nozzle pressurizes containment bag
  - Keeps optics clean
  - Delivers powder to the build area
- Filter on containment bag clogged with particulate
- Designed and installed air/particulate separator

Magnetic/Cooling Plate



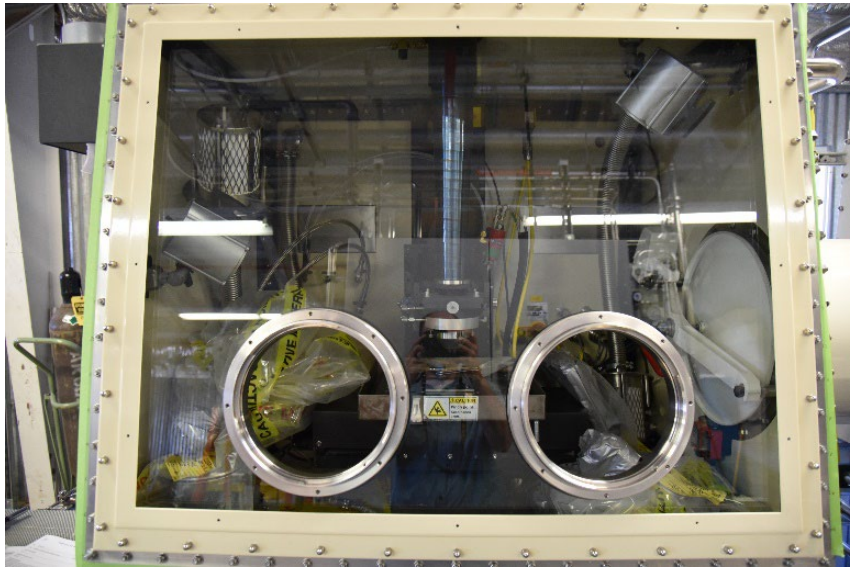
- Table added to bring build level with small window
- Magnetic plate secures build to table through containment bag
- Cooling of base plate allows operator to control cooling of part during the build

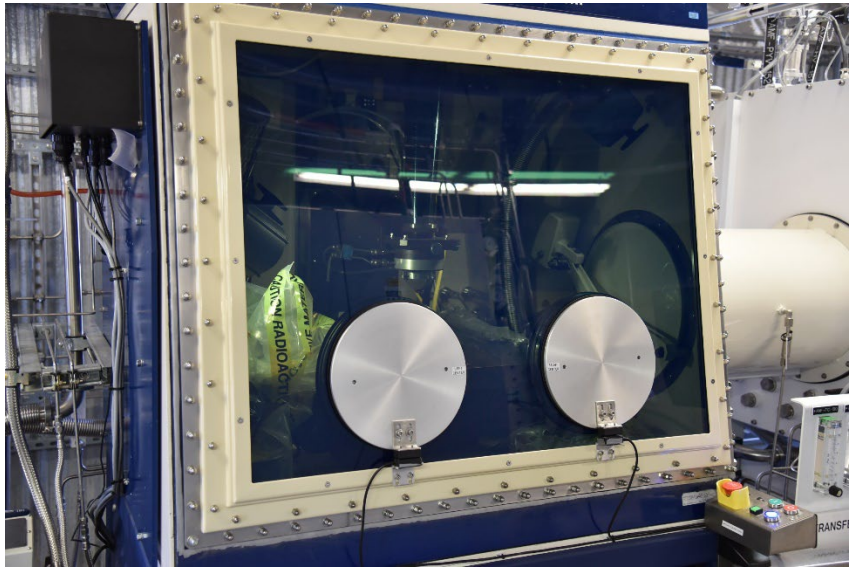
Window Replacement



- Viewing window is composed of glass (no polycarbonate).
- Very limited viewing area.

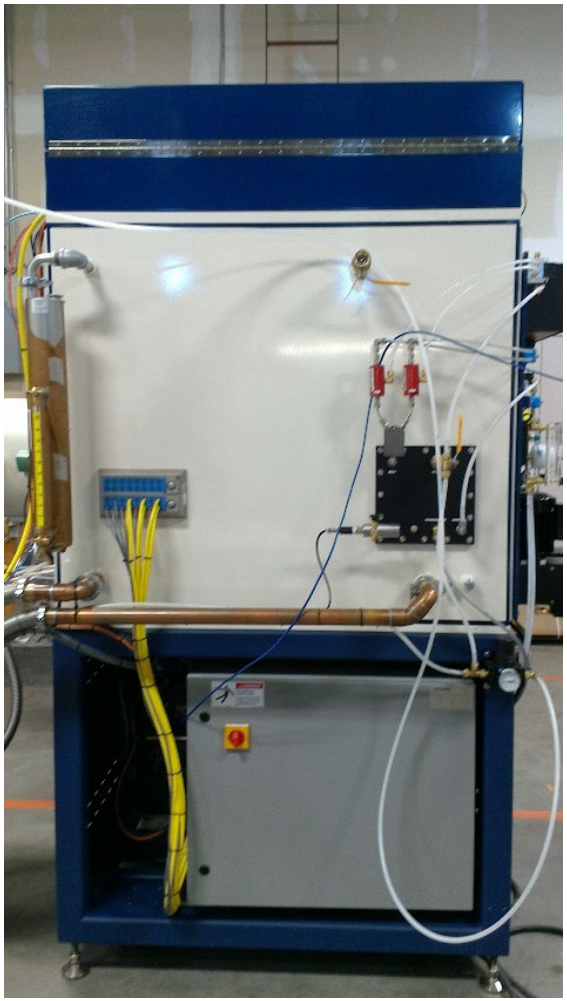
Window Replacement

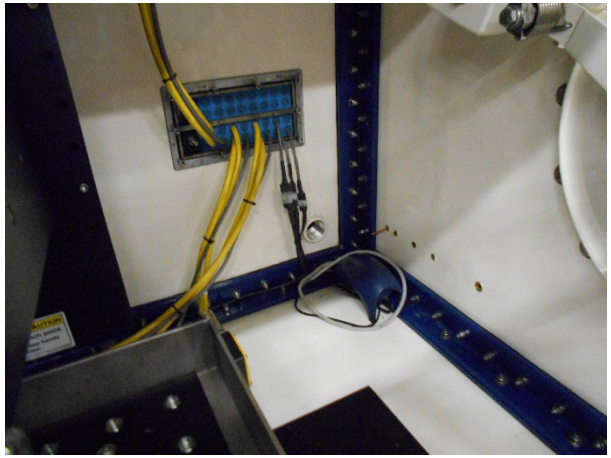




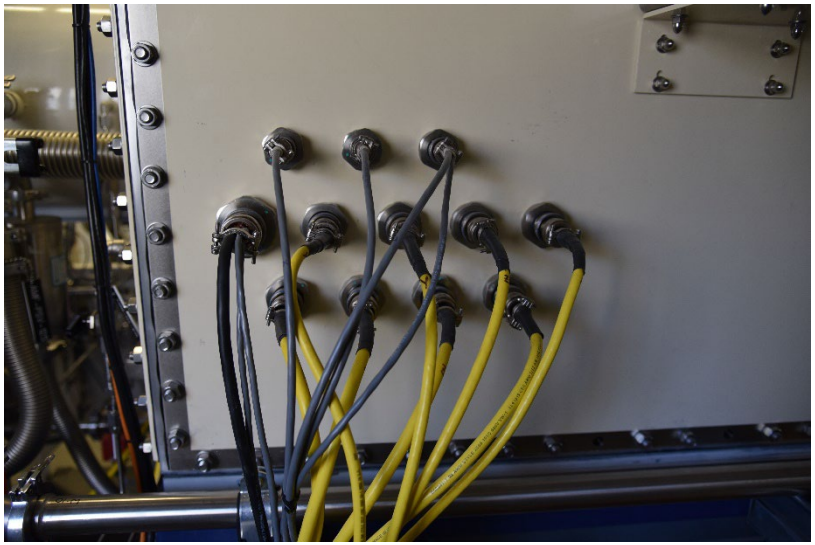
- Laminated safety glass comprises the containment boundary.
- Laser safety window made of polycarbonate provides the protection from the Class IV laser.

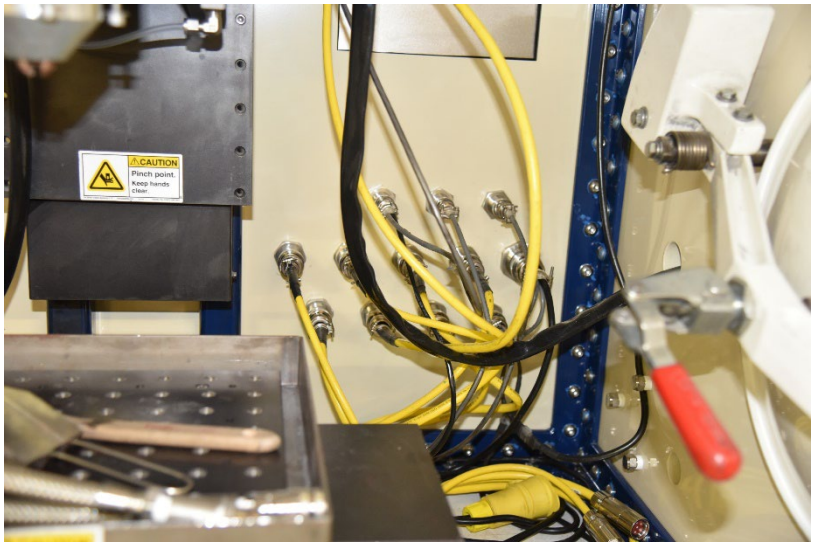
Electrical Feedthroughs



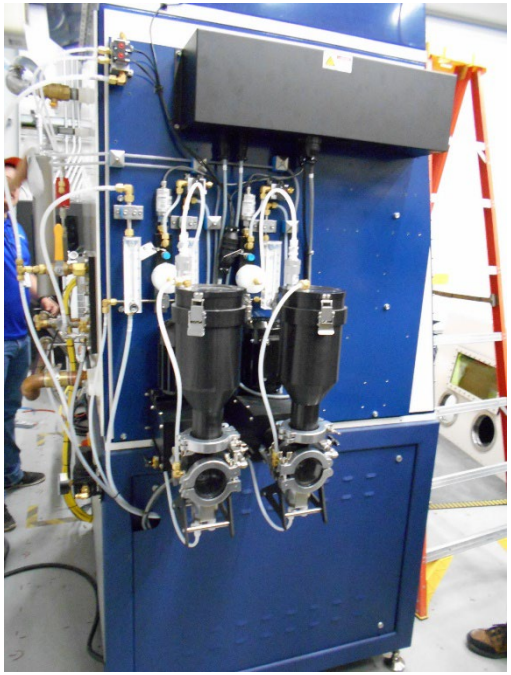


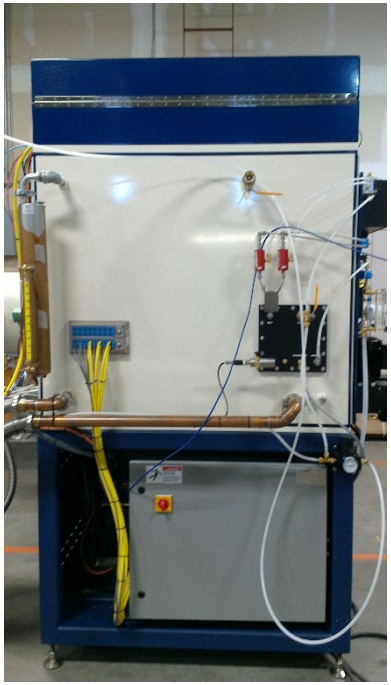
Electrical Feedthroughs

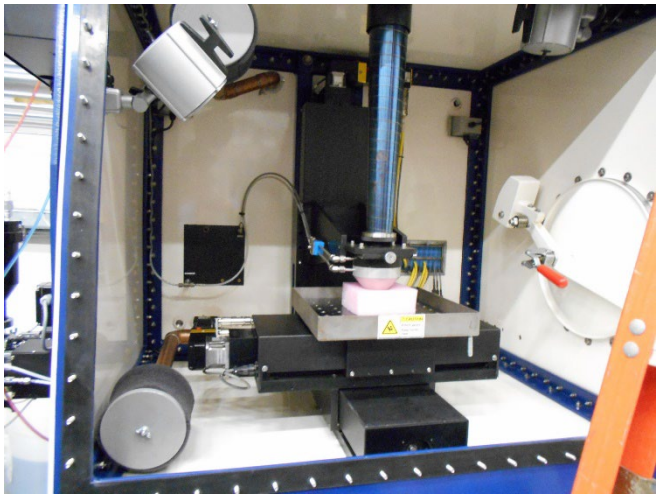




Hopper Relocation

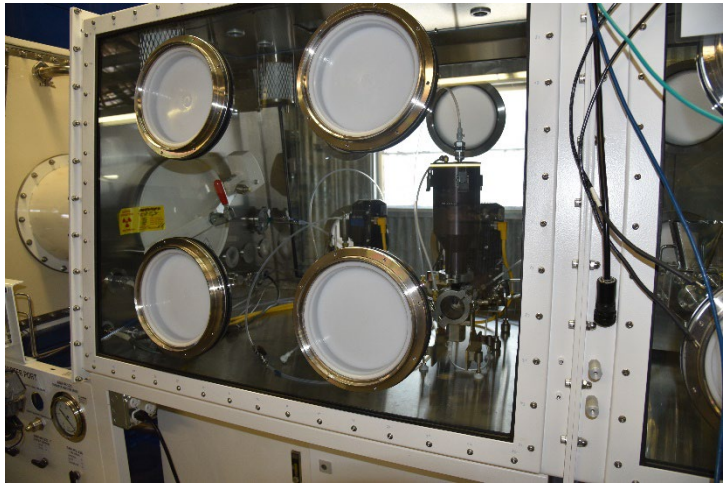


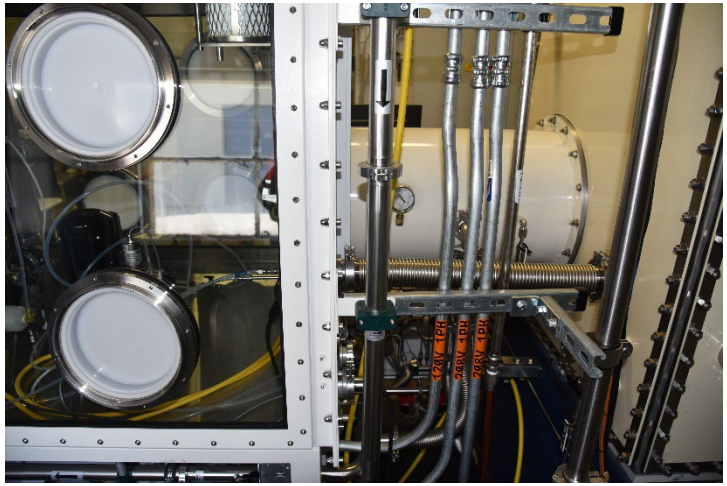


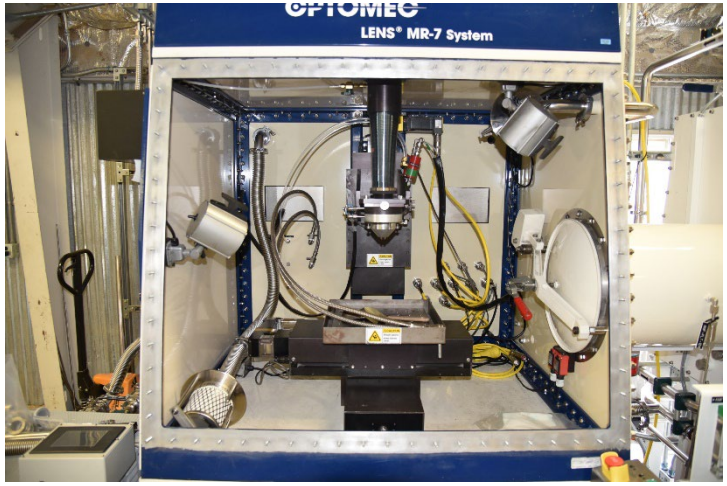


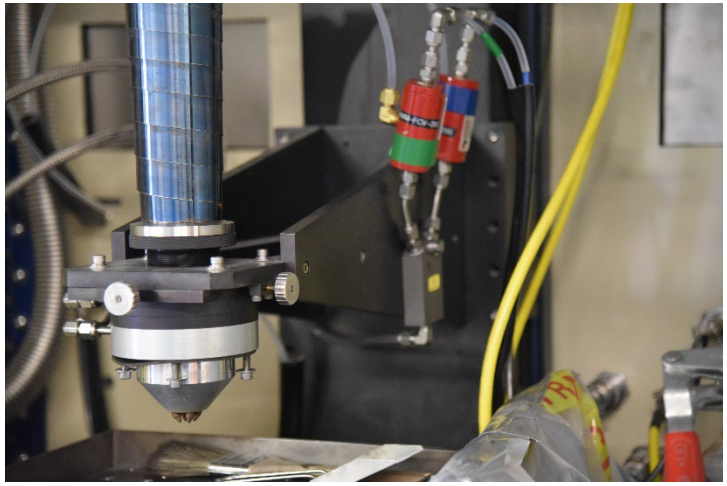
- Two hoppers allow for functionally graded material where a switch can be made from one material to the next during the build and for alloying material during the build process
- Material handled, loaded and transferred outside the enclosure

Hopper Relocation

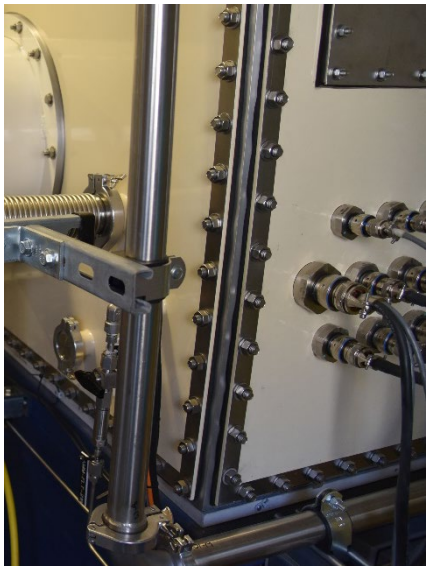








Side and Back Panel



- Studs welded to panel
- Nuts tightened from inside enclosure to seal panel to frame
- No way to reach back of enclosure to tighten nuts if leak occurs.

- New panels fabricated
- Bolts sealed and secured inside glovebox
- Nuts on outside of glovebox allow tightening of nuts
- Can remove panel if required

Questions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