Cryogenic Optical Metrology Through a Chamber Window

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The Innovation

- Flexure's innovation marries the technologies of Thermal Vacuum Chambers and Non-Contact Metrology Systems providing NASA with micron-level, three sigma uncertainties on Flight Hardware while at temperature (typically cryogenic, down to 30K) and in high vacuum (<10E-6 torr).
- This innovation provides NASA and the Aerospace Community increased capabilities for the alignment and performance verification of telescope optical surfaces and telescope optical assemblies.

NASA Applications

- Next-Generation Space Telescopes: JWST, WFIRST
- Lunar Missions to Explore the Poles
  - LCROSS and LRO discoveries show that there are ices on the moon and that the permanently shadowed regions of craters at the poles are about 40K and could have ice that has been trapped for billions of years

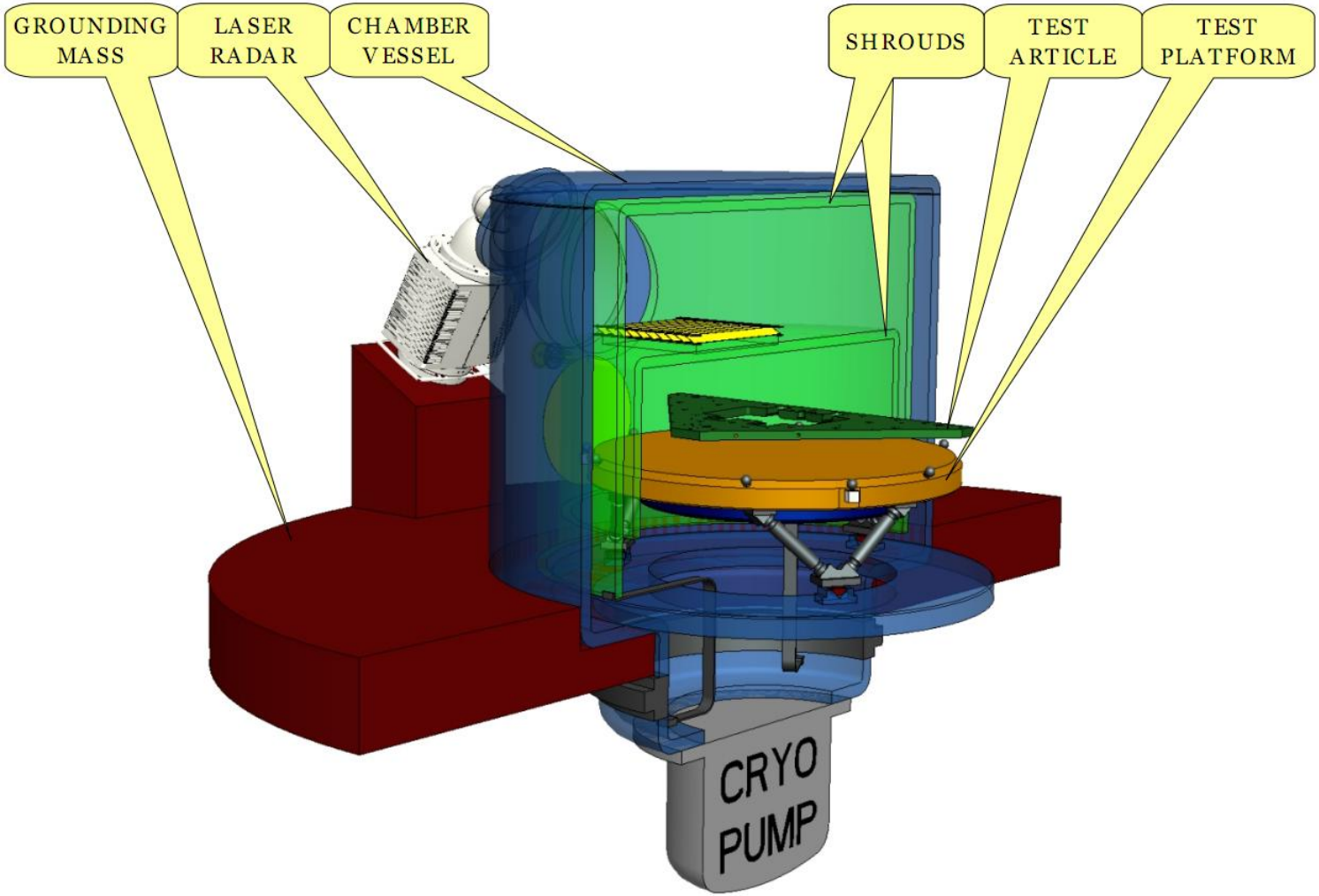
Non-NASA Applications

- Advancement of High Temperature Superconductor technologies
- E-Beam Welding Systems
- Beryllium Machining Centers
- Extreme Environment Engineering
  - High-radiation
  - Salt Water

Laser Radar

- Non-contact metrology
- Direct measurement of hardware surface
- Currently achieves about 25 mircon uncertainties for a 2-3m range
- Not cryo or vacuum compatible (must sit outside the chamber)

Conceptual Design



The Innovation Path

Dynamic Chamber Sizes (baseline)	Small [1m³ cold volume] Medium [3m³ cold volume] Large [9m³ cold volume]	
Different customer needs.	Retro-Fitted Design	Ground Up Design
What are our implementation options? How do these options change with size and facility?	Vibration Isolation?	
	Thermal Control?	
	Metrology System?	
	Control System / User Interface?	
The goal is to have numerous solutions that create flexible systems.		

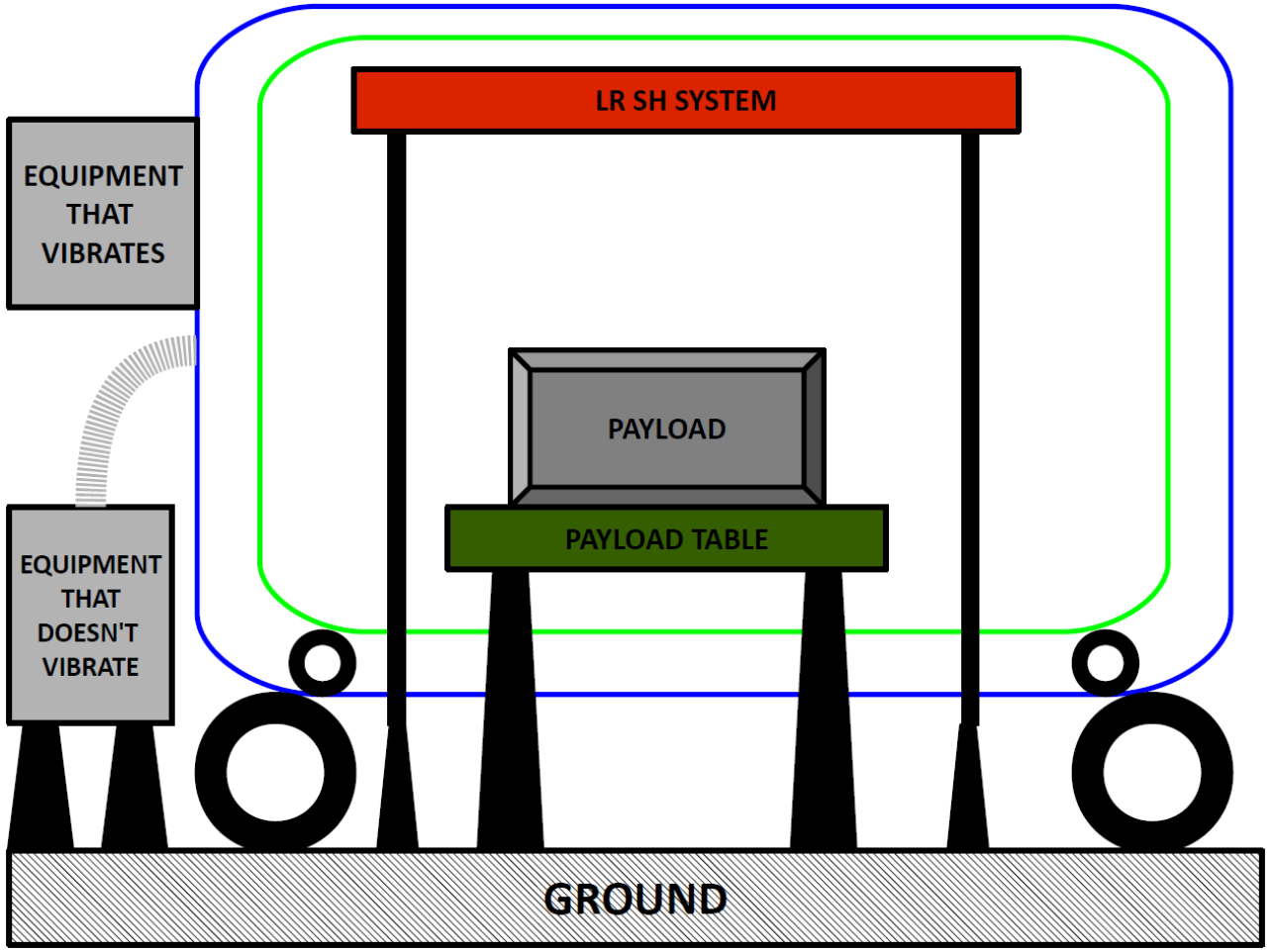
Vibration Isolation Options

- Ground-up vs. Retro-Fitted?
- Do we isolate the payload and tie the metrology system to the payload?
- Do we isolate the entire vacuum vessel and then tie the payload and metrology system to that?
- Regardless, the shroud system will have to be characterized and then isolated.

Isolate the Chamber

Vibration Isolation Concept for Ground-Up Design

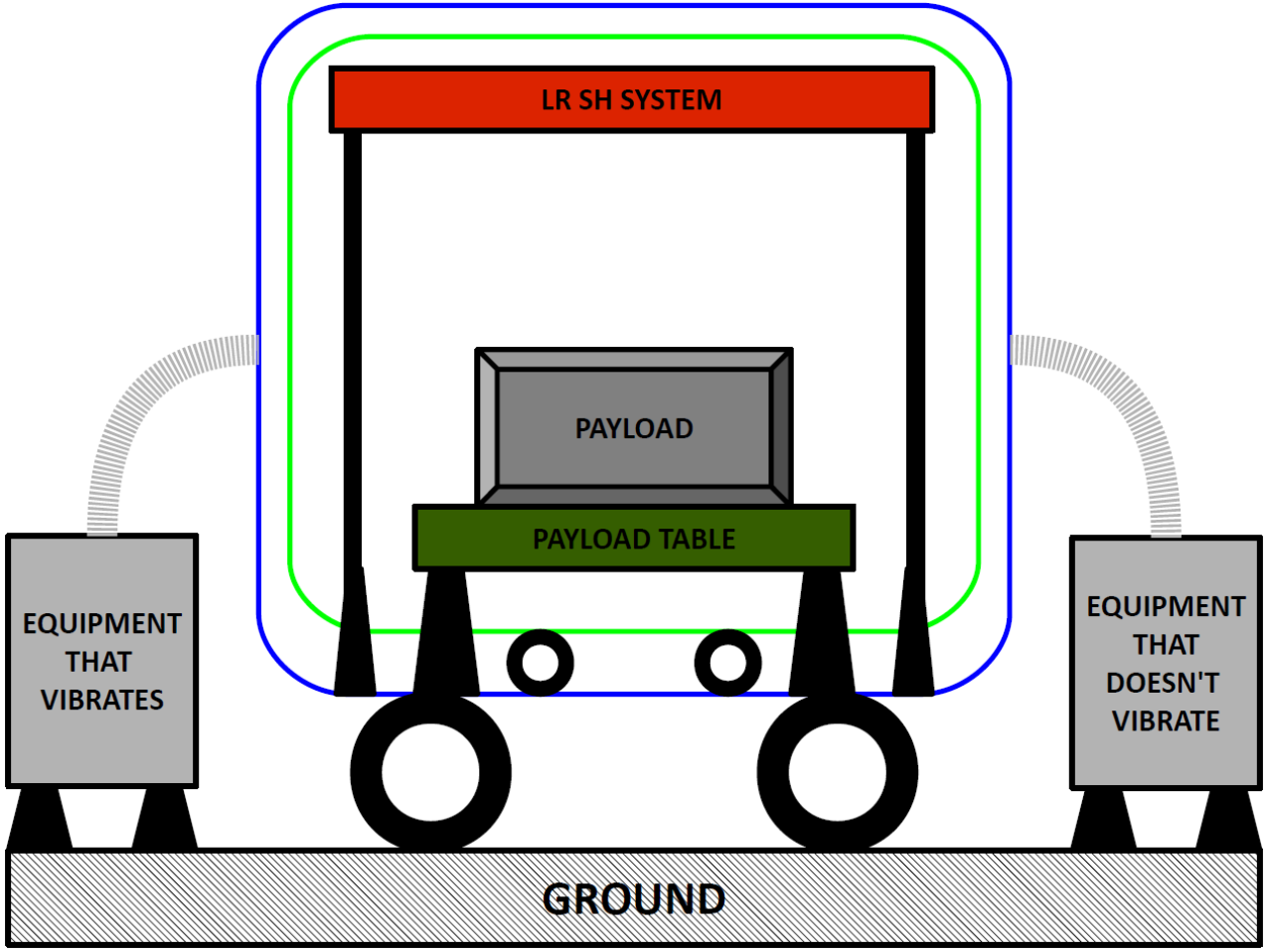
Advantages
Vibration and non-vibration system completely isolated
Disadvantages
Requires the most amount of engineering and the payload/metrology system are still susceptible to other facilities exciting the ground
Design Questions
Can the chamber be isolated yet provide a rigid interface for the payload and metrology system?



Isolate the Chamber

Vibration Isolation Concept for Ground-Up Design

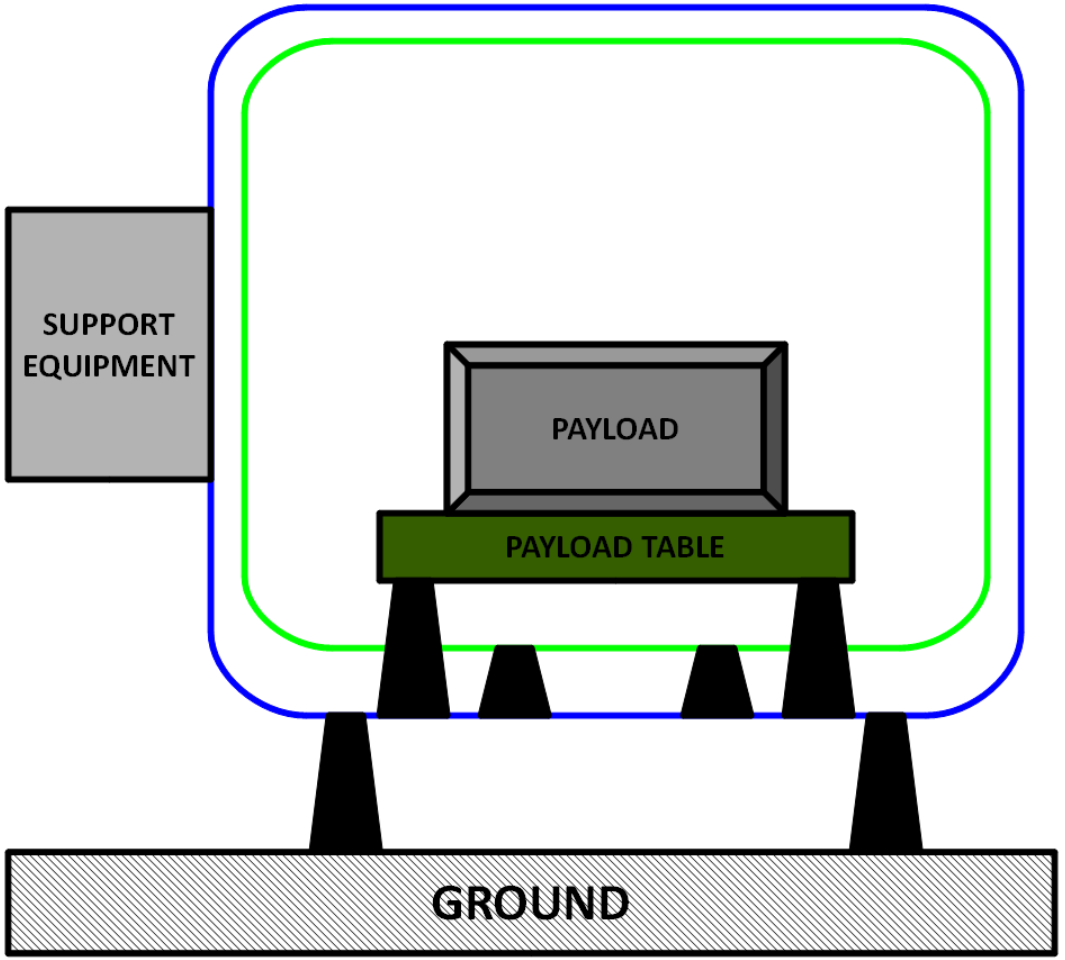
Advantages
Most flexible design solution
Disadvantages
Larger chamber designs will be difficult to isolate
Design Questions
Can the chamber be isolated yet provide a rigid interface for the payload and metrology system?



Retro-Fitted Design

Vibration Isolation Starting Point

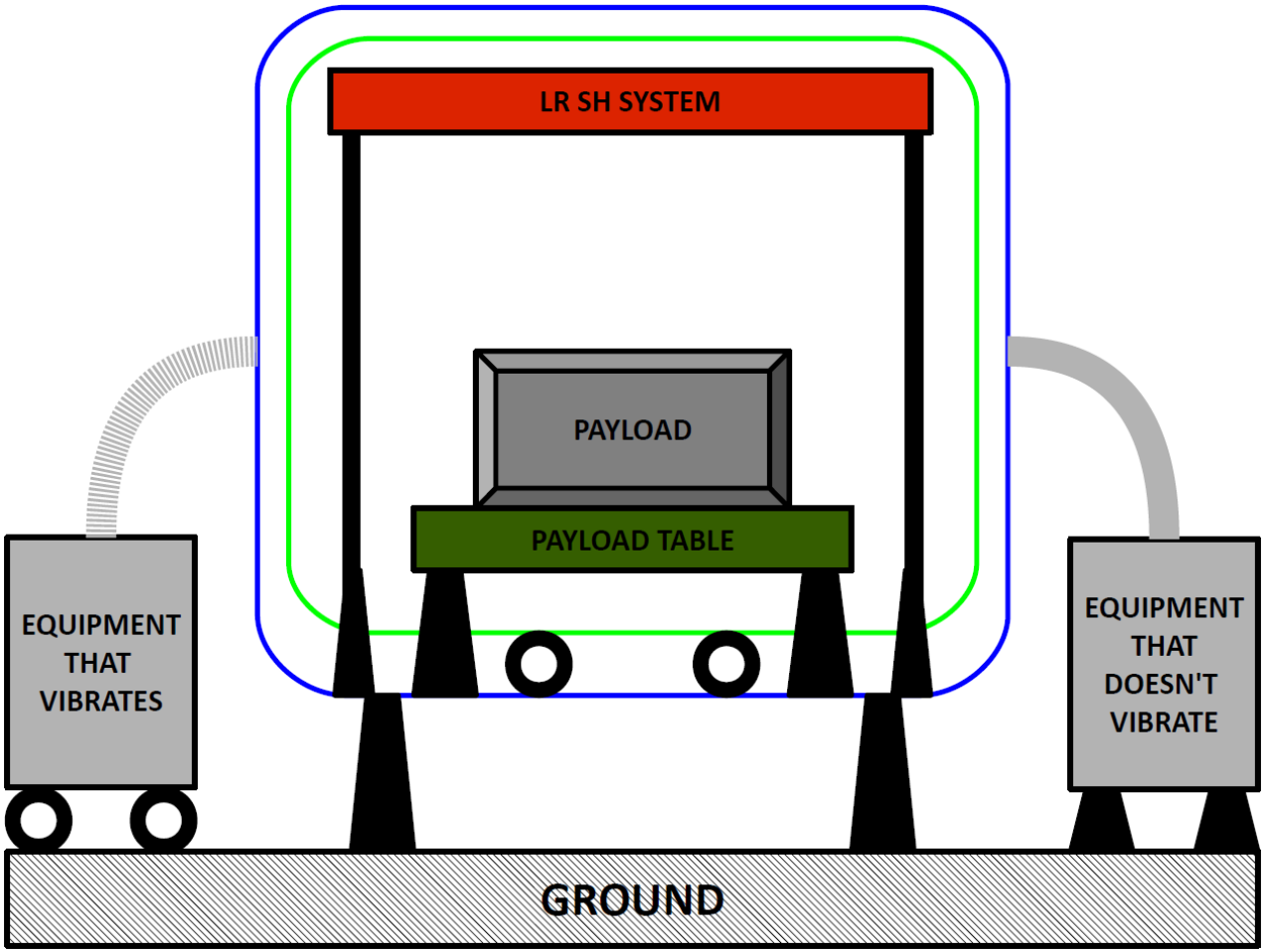
- Most retro-fitted chambers will start in this configuration
- Vibration isolation is the first design decision
- Then, major pieces of the other systems can be incorporated
- The key piece is being able to tie the metrology system to the payload



Isolate the Vibrating Pieces

Vibration Isolation Concept for Retro-Fitted Design

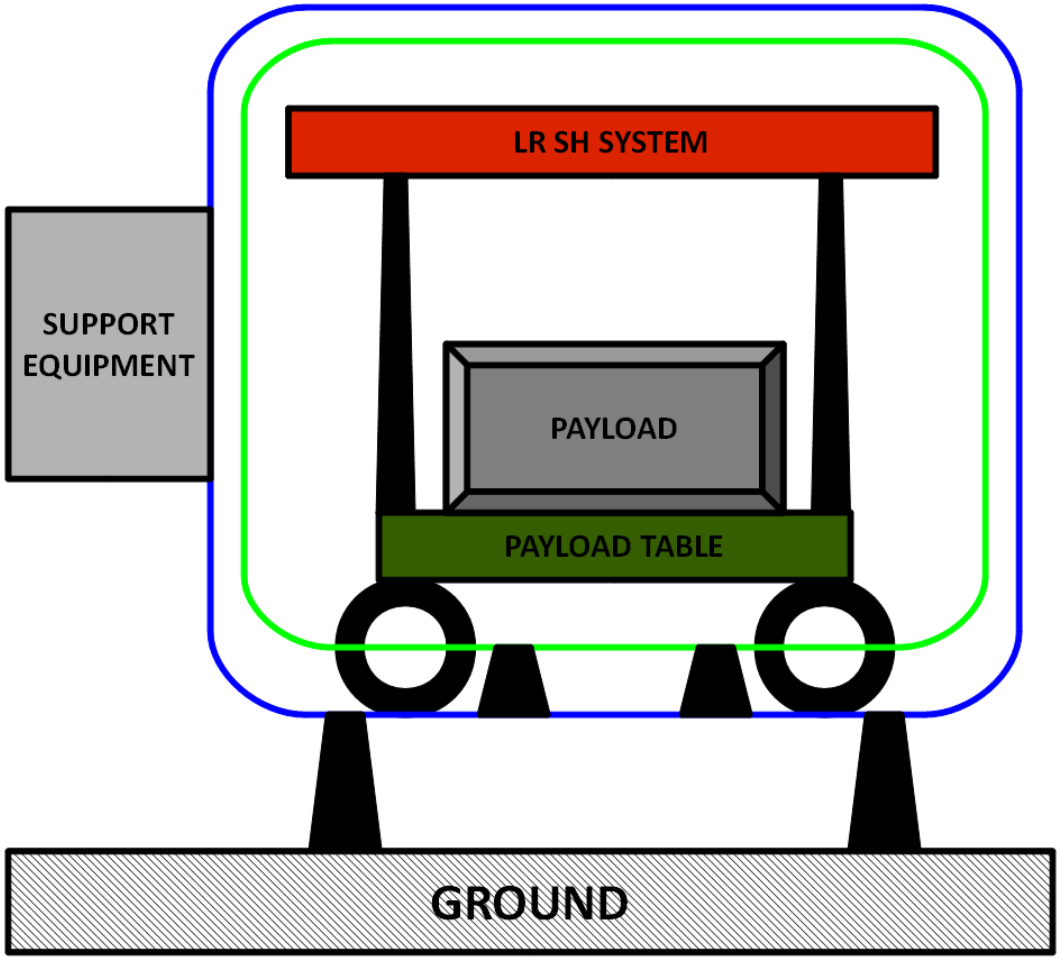
Advantages
Payload Table and Metrology System are tied together.
Disadvantages
The chamber is still susceptible to other facilities exciting the ground
Design Questions
What type of changes to pumps and other support would need to be made to make this work?



Isolate the Payload

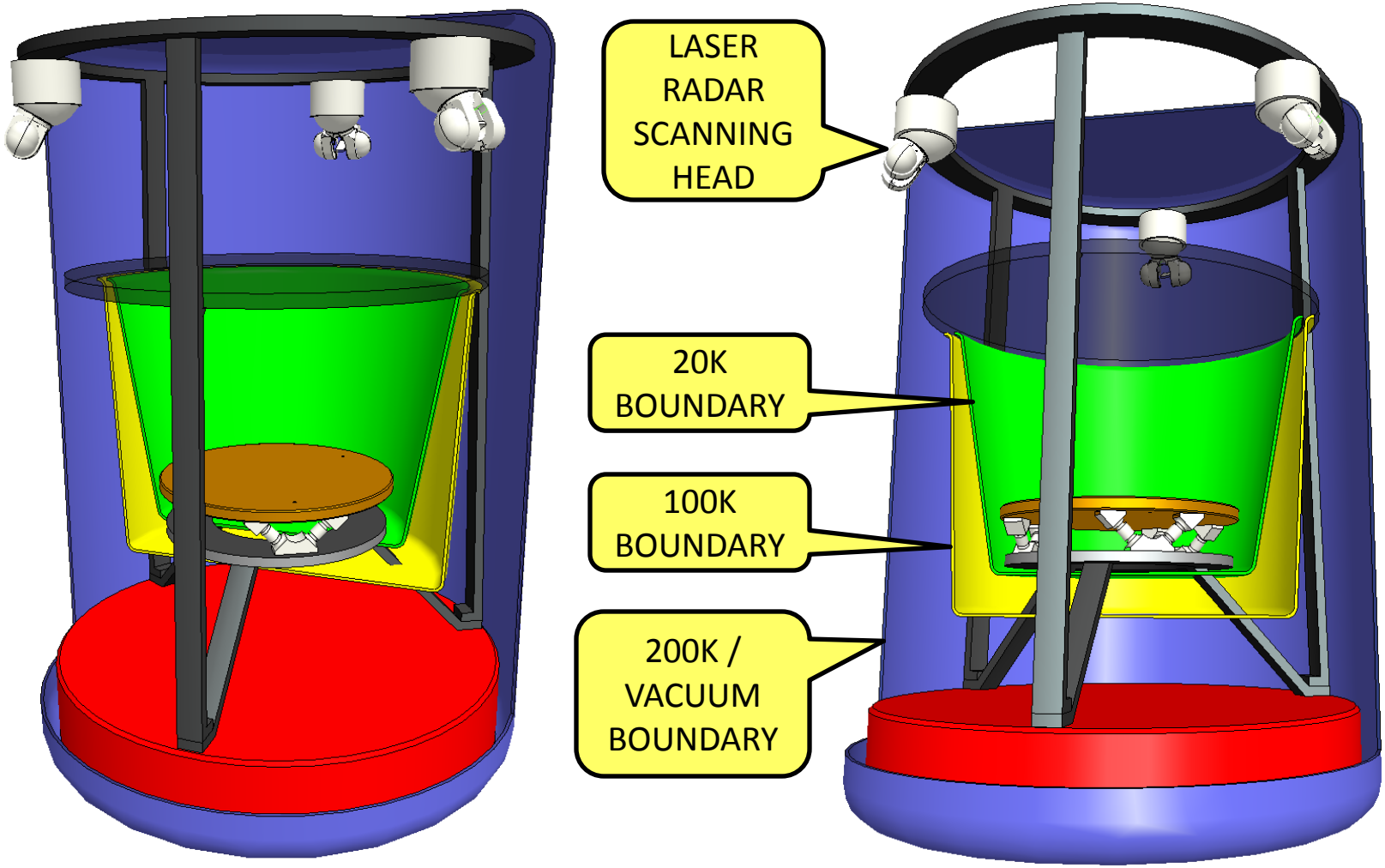
Vibration Isolation Concept for Retro-Fitted Design

Advantages
This would be the easiest implementation path. Other ground vibrations do not affect the system. The payload table and metrology system are tied together.
Disadvantages
Not sure?
Design Questions
What type of vibration isolation can be effective in vacuum and at cryogenic temperatures? Can we get the Laser Radar pieces inside the chamber?



Isolate the Payload

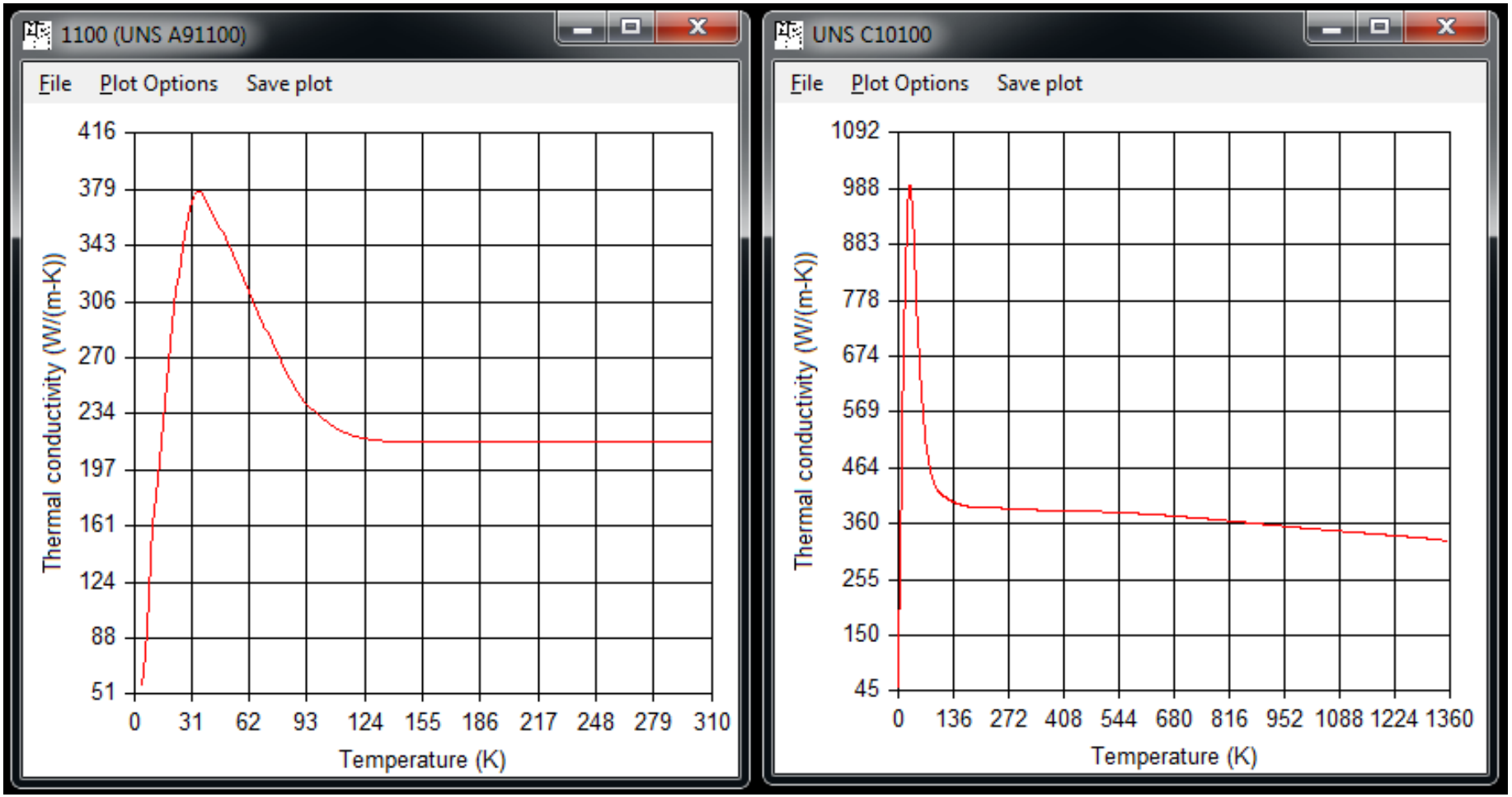
Vibration Isolation Concept for Retro-Fitted Design



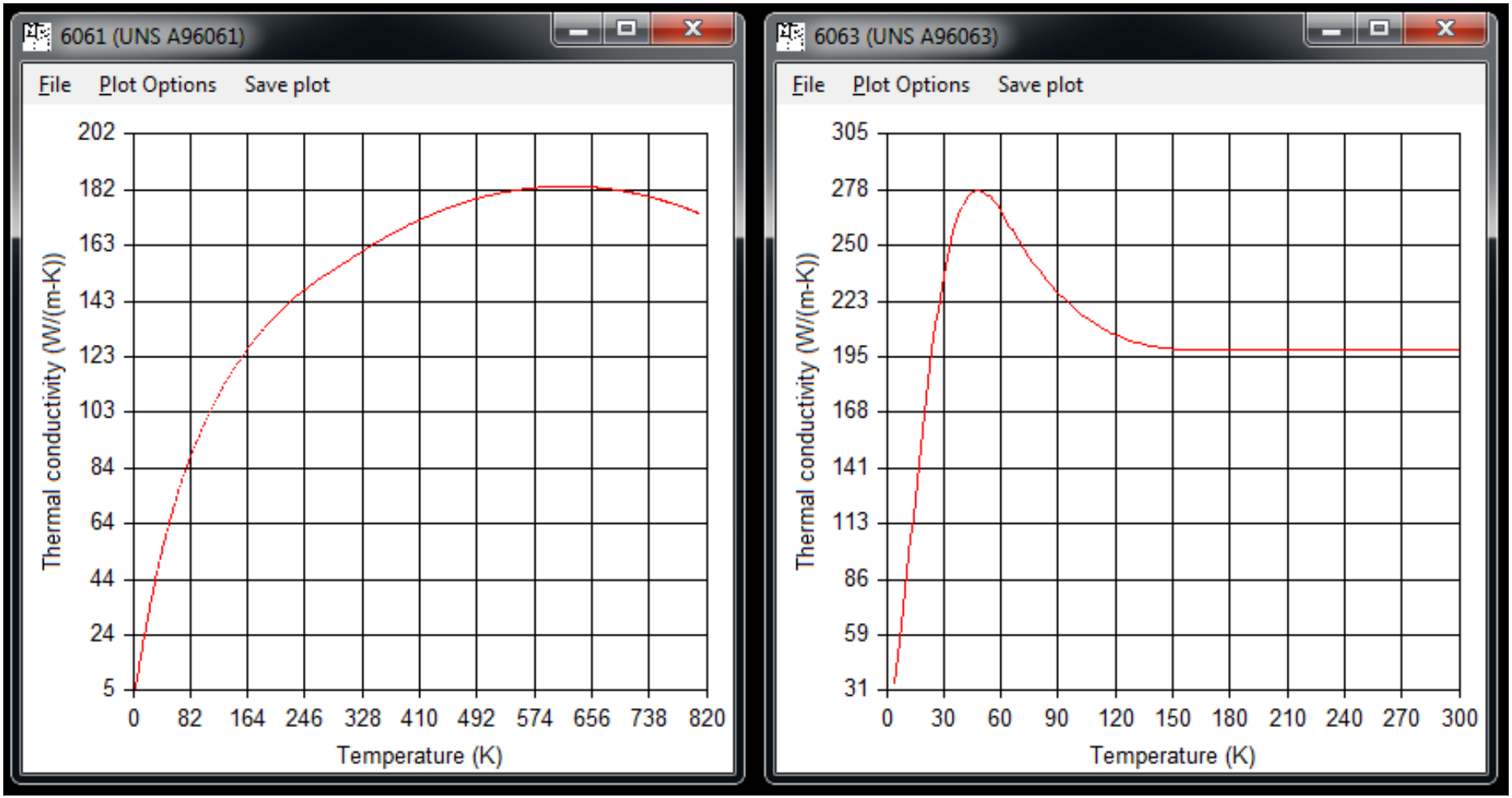
Thermal Control Options

- Exotic materials and new designs for shrouds and shields
  - AlBeMet / Beryllium / Al 6063
  - Honeycomb shields
  - Do we need to stick with the pipe-on-sheet-metal classic shroud design? Can we optimize a shroud design for gaseous Helium?
- Closed-Loop Systems
- We are probing x, y and z coordinates with an infrared laser … Can we get temperature as well?
- Can we use wireless communications to limit heat loss via electrical feedthroughs?

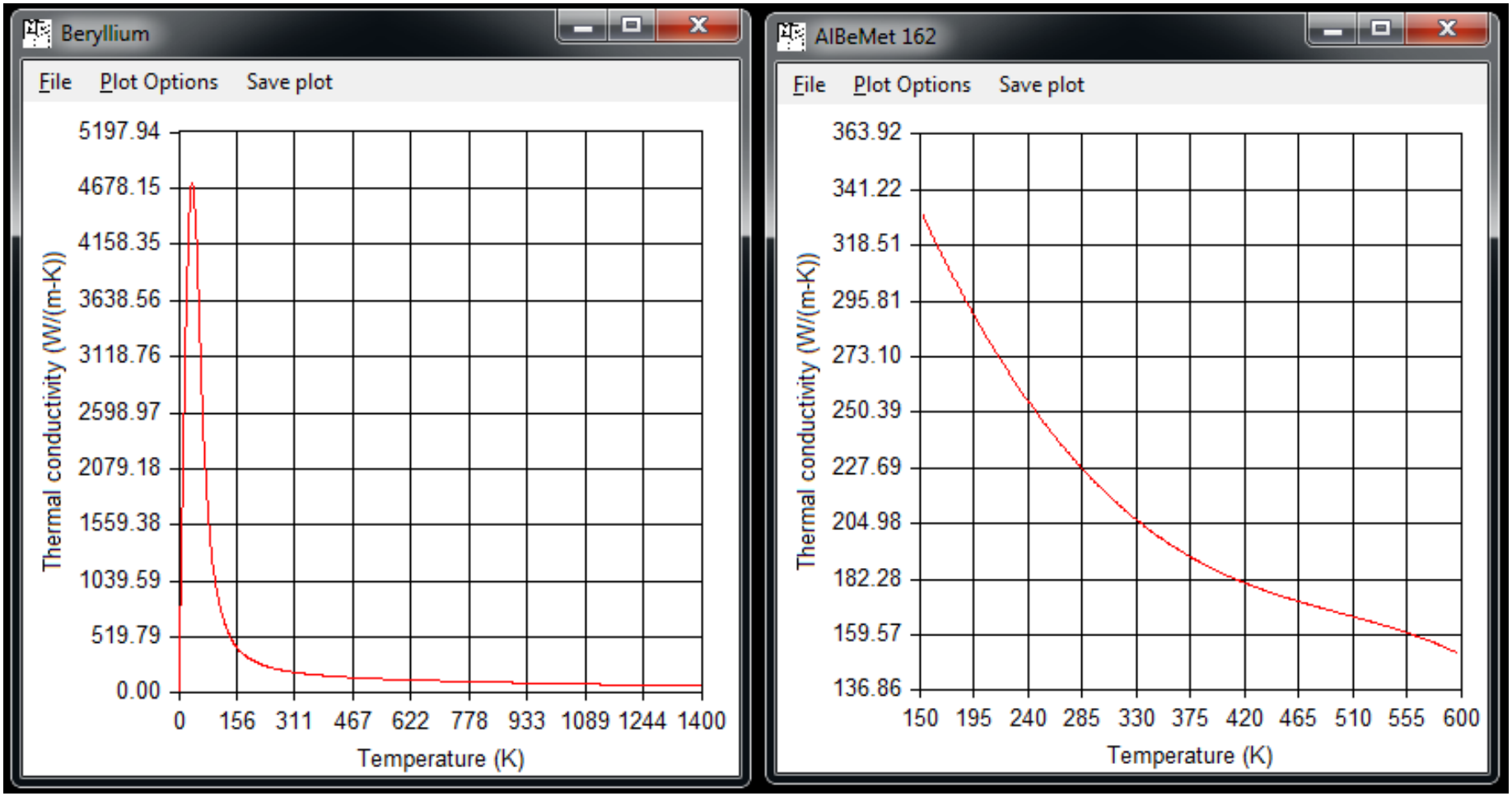
Aluminum vs Copper



Aluminum 6061 vs 6063



Exotic Materials



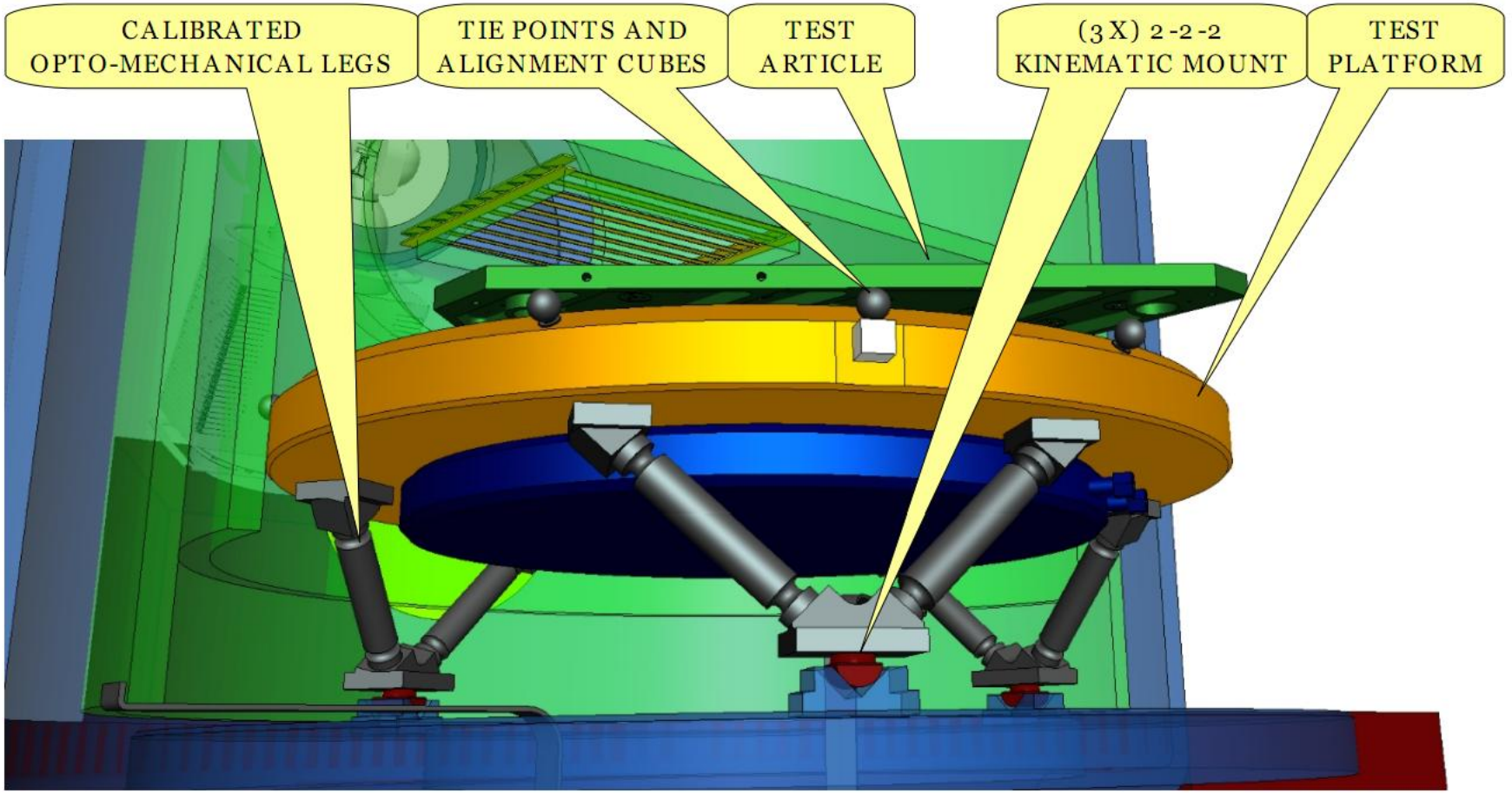
Metrology System Options

- Cryogenic and vacuum-rated scanning heads inside the chamber
- Rotary stage for multiple stations when using an “outside-the-chamber” LR
- Customize the LR for the Dynamic Chamber
  - Limited field of view “through a window” application
  - Laser enhancements
  - Optical enhancement

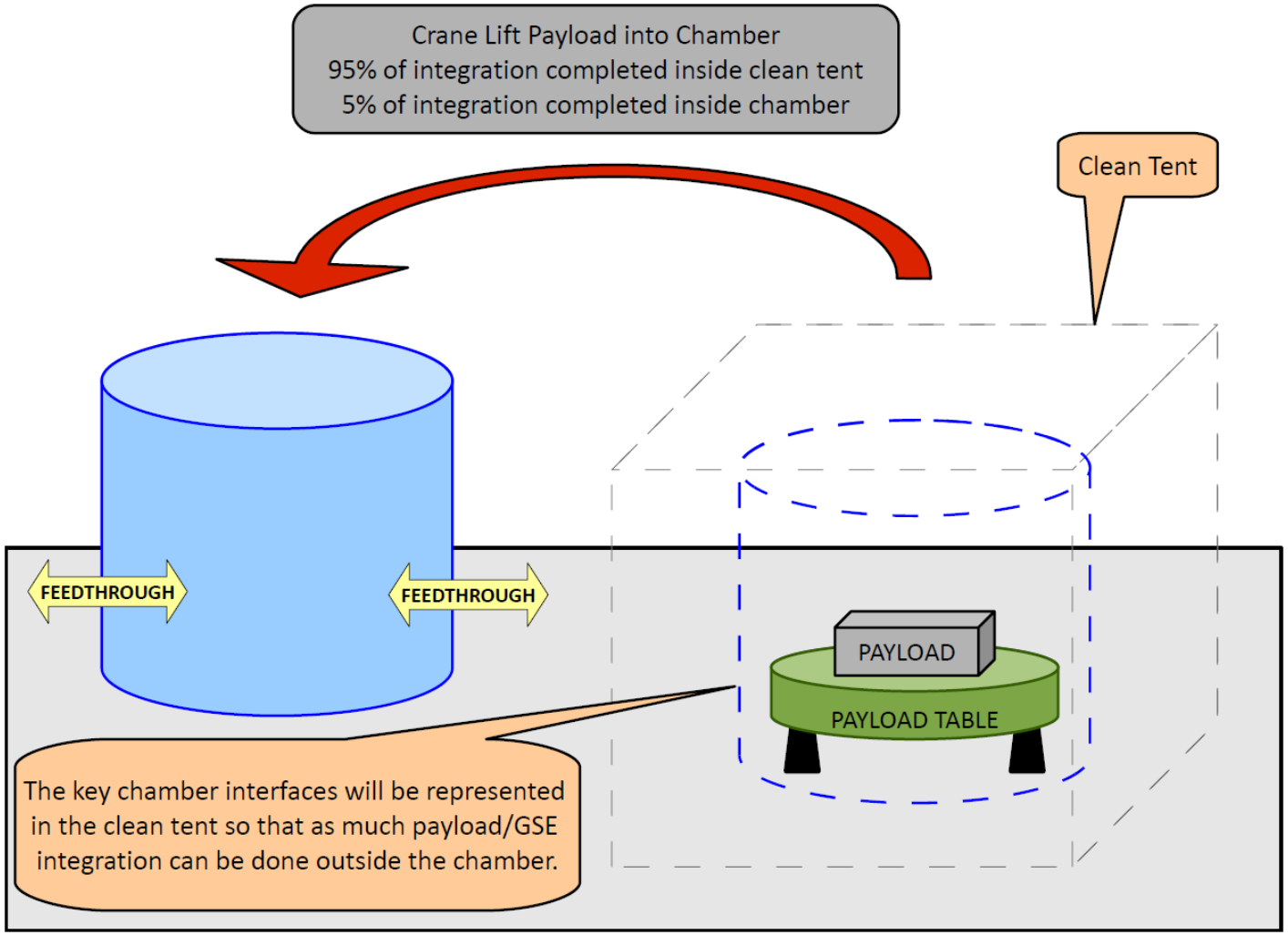
Integration Enhancements

- Kinematically mounted payload table
- Integration Module: recreates the chamber interface architecture
- Rethink the entire chamber design

Kinematically Mounted Table

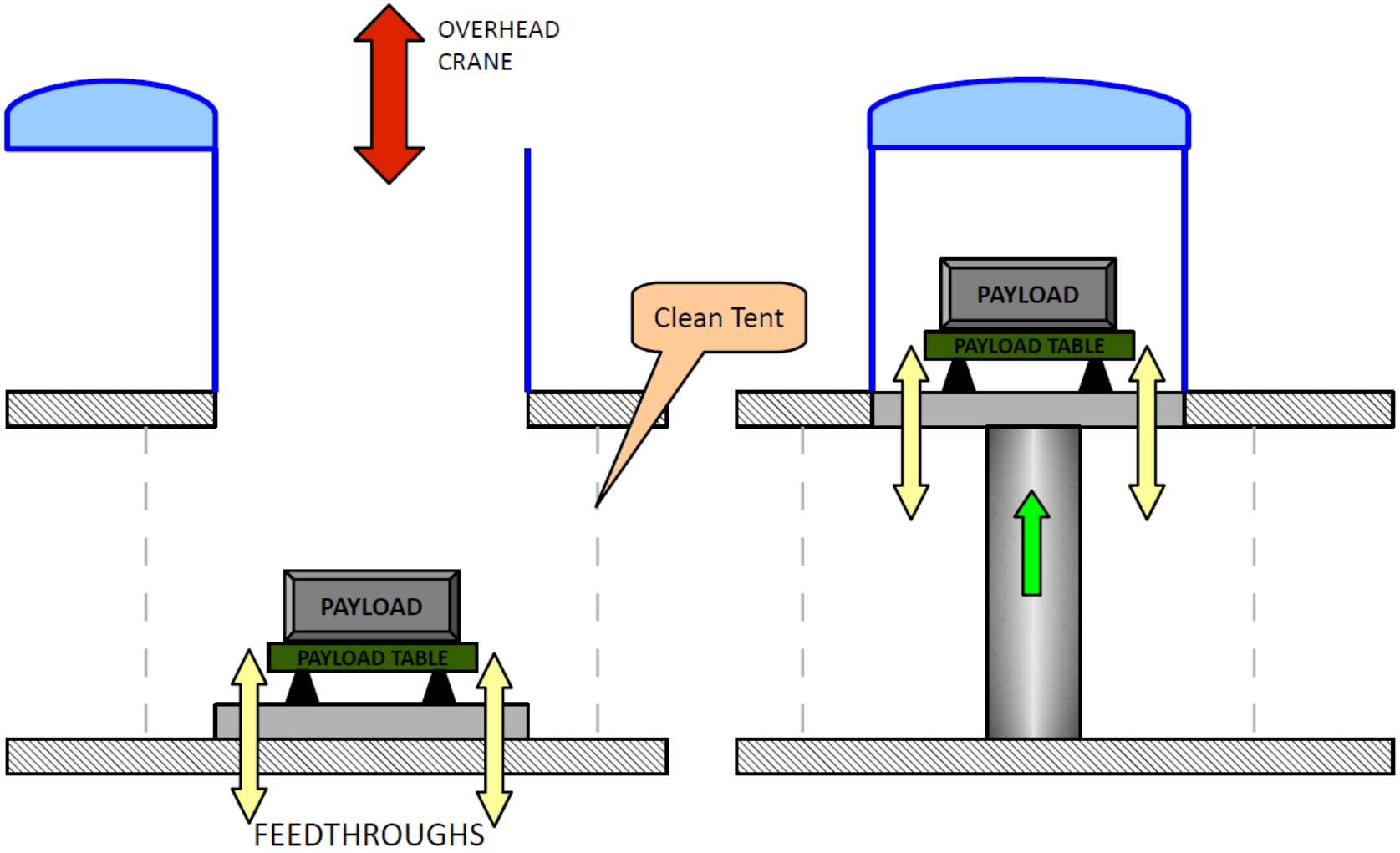


Integration Module



Integration Enhancements

How can we make our Dynamic Chamber integration-friendly?



Why I'd like to talk to you …

- If you have an application for our Dynamic Chamber (NASA or non-NASA)
- If you have concepts/innovations for any of the following that can be used to enhance our Dynamic Chamber:
  - Superconductors / HTS
  - Low Temperature Electronics / Mechanisms
  - Communications into/out of chamber
  - Thermal Mapping vs discrete temp. sensors

Why you want to talk to me …

- Flexure Engineering specializes in designing, fabricating and integrating hardware … fast!
- If you have any of the following, we can help:
  - A September 30th deadline?
  - A concept or stack of drawings and a hardware need date?
  - Opto-mechanical or mechanical design challenge?