



National Aeronautics and
Space Administration



RESEARCH FOR HUMAN EXPLORATION

Space Biology

SPACE LIFE AND PHYSICAL SCIENCES RESEARCH & APPLICATIONS

Rodent Research Capabilities Update

Dennis Leveson-Gower
Rodent Research Portfolio Lead



The Life Sciences Glovebox (LSG)



**15.9 cu.ft. of volume (75%
larger WV than MSG)**

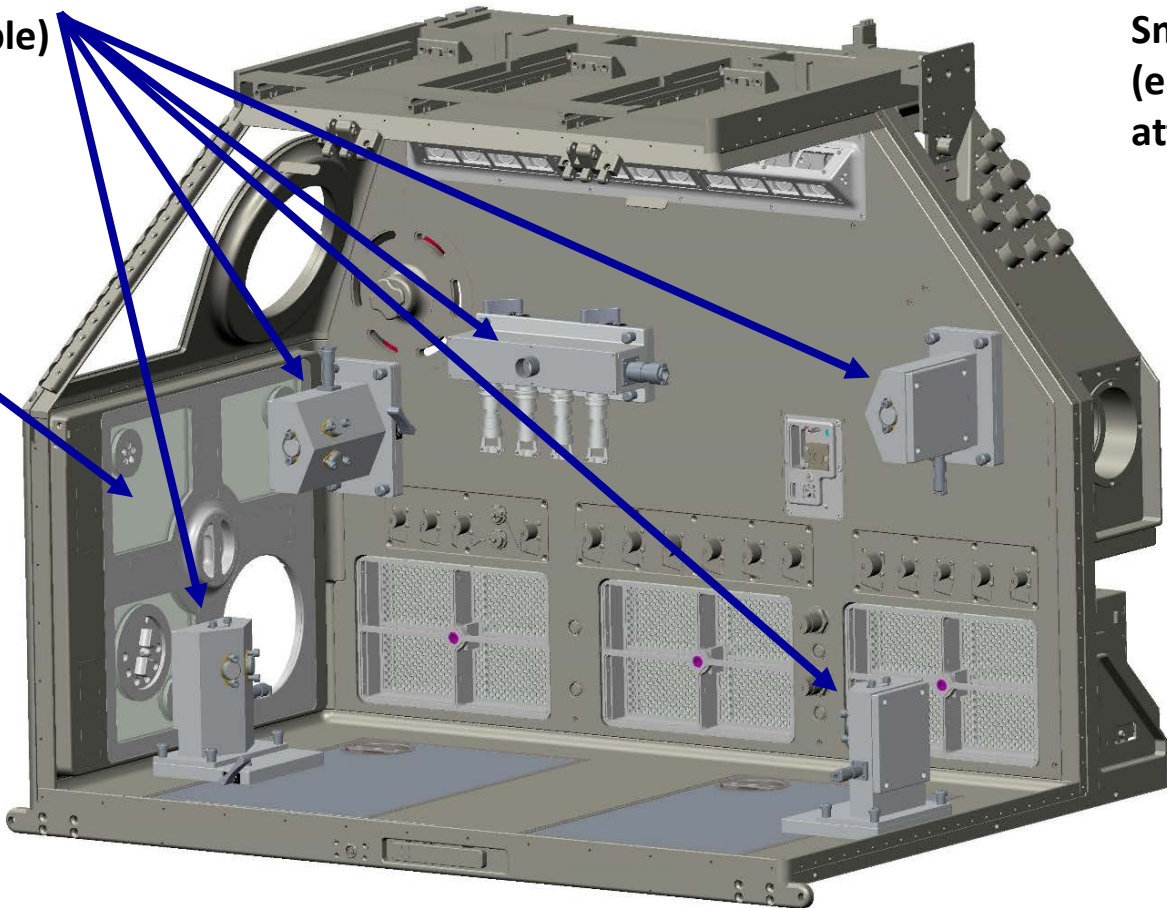


LSG Features

UV sterilization
(removable)

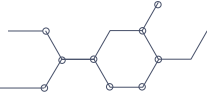
Airlock

Smooth, ferrous surfaces
(easier to clean; magnetic
attachment)



Demand Simp Rep:DECON_SYS

X.X+/-0.1
X.XX+/-0.01
X.XXX+/-0.001
ANG +0.5





LSG support of 2 crew operations

**Rapid access to work volume
for setup and cleanup**



**Two crew members can work
comfortably**



**= higher throughput, parallel
operations, more animals / day**

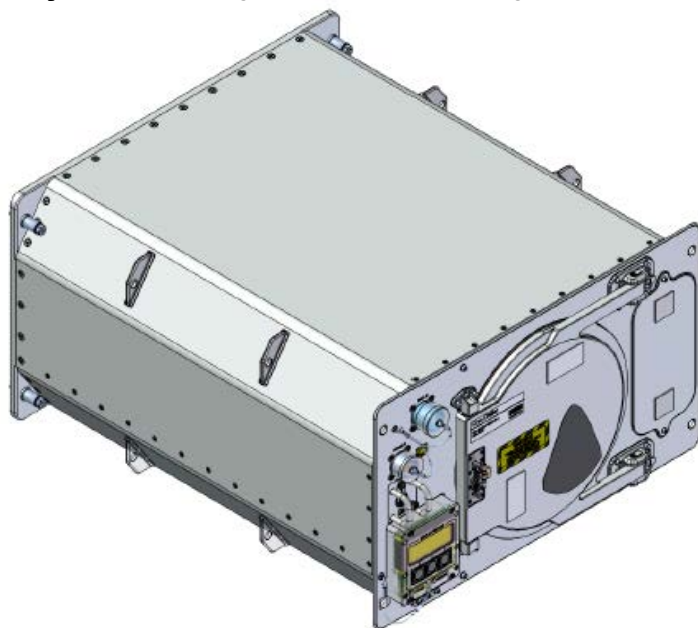




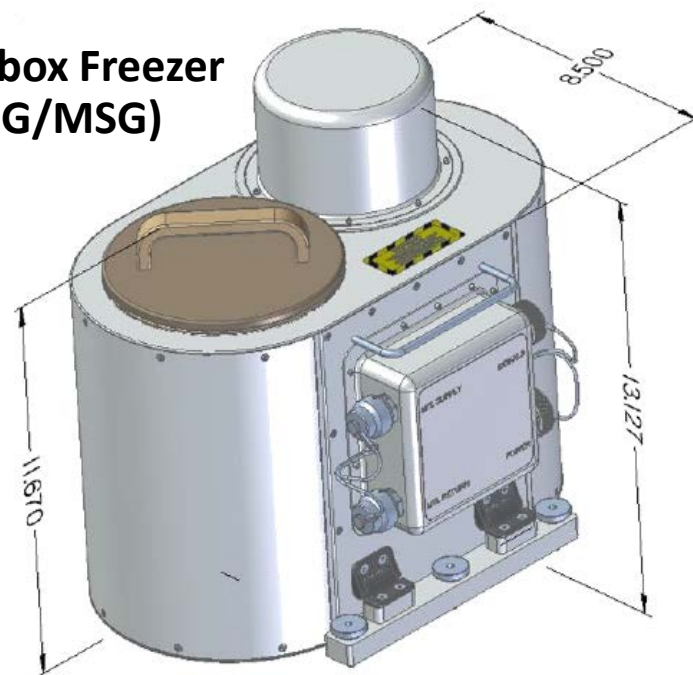
Rapid Freeze

- Freezes via -185°C copper interface
- Maintains a consistent freeze rate between samples
- Interchangeable & customizable sample cartridges
- **Scheduled to be available on ISS in late 2018**

Cryo chiller (EXPRESS rack)



Glovebox Freezer (LSG/MSG)



Dimensions in inches
Weight: ~27lb

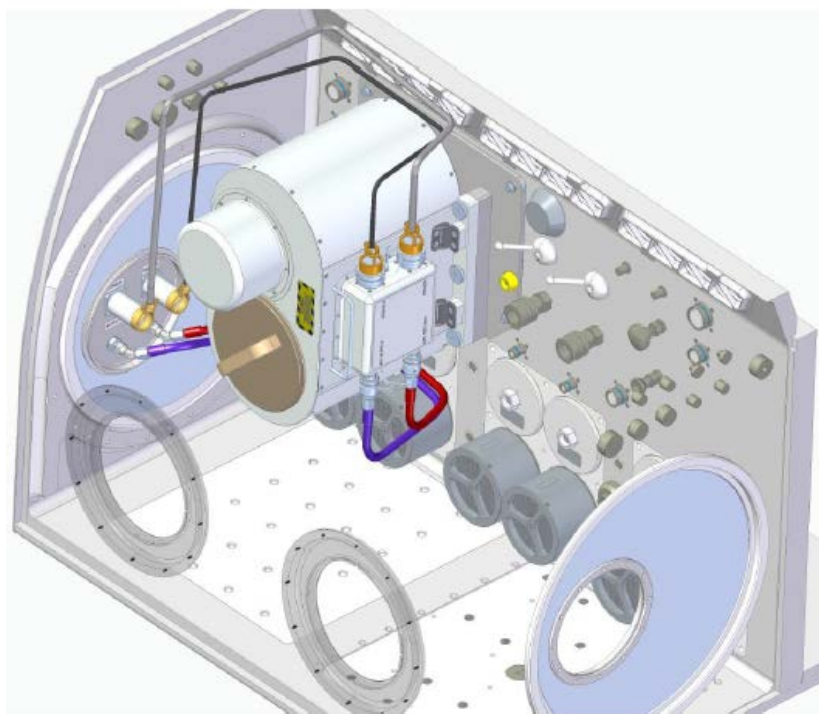
Note: Glovebox Freezer ECU not pictured



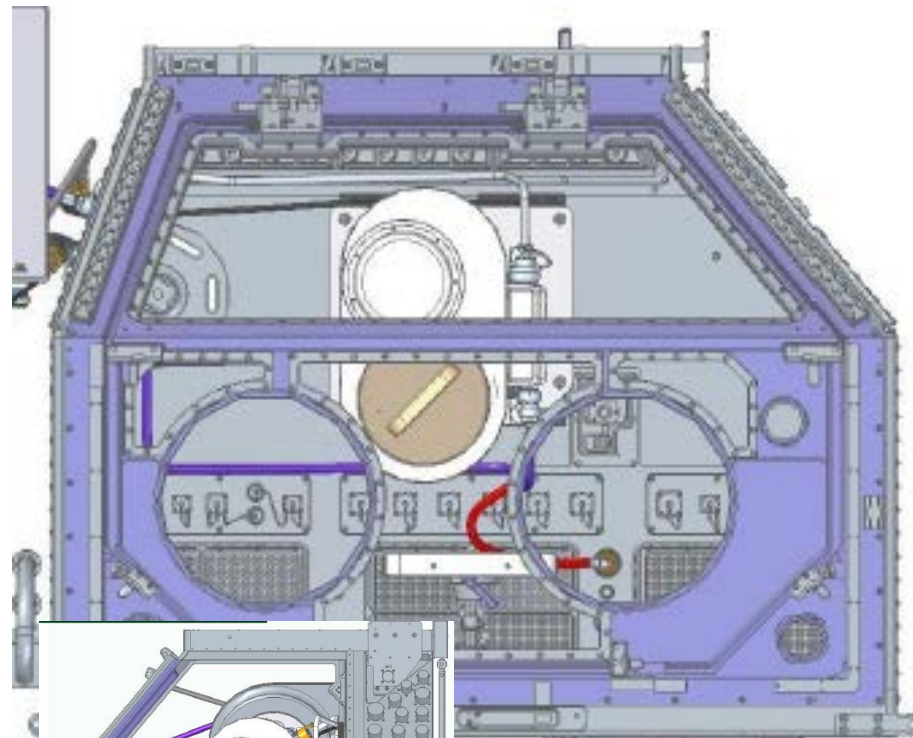


Glovebox Freezer placement

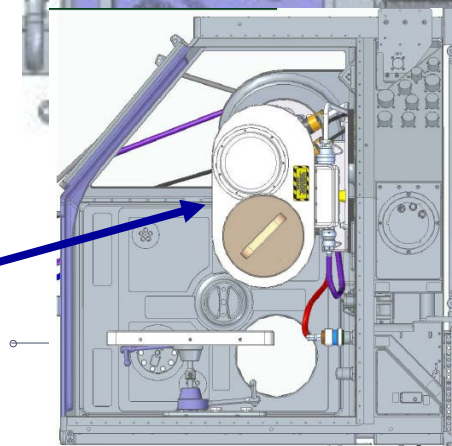
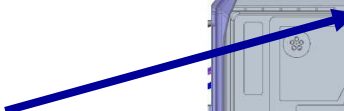
MSG (screw-mounted)



LSG (magnet-mounted)



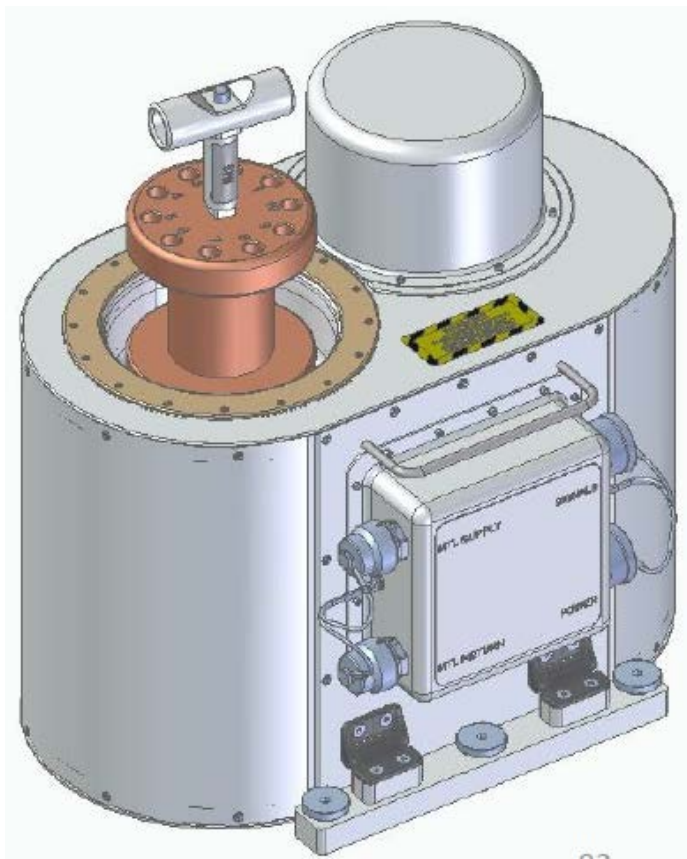
Can pivot to face
2nd crew member





Sample Cartridges

Glovebox Freezer

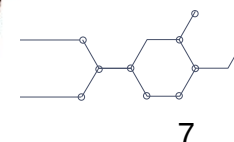
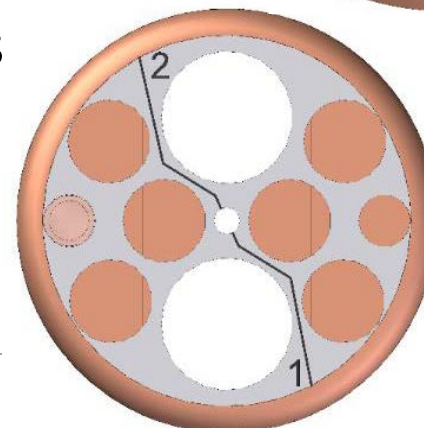
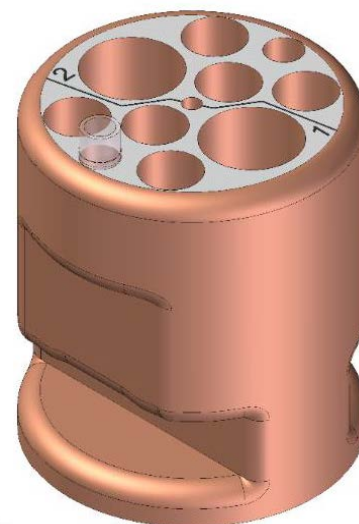


Sample Cartridge Tool



Concept for RR interface

- 2 carcasses
- 2, 1.1 mL vials (blood)
- 6, 26 mL vials

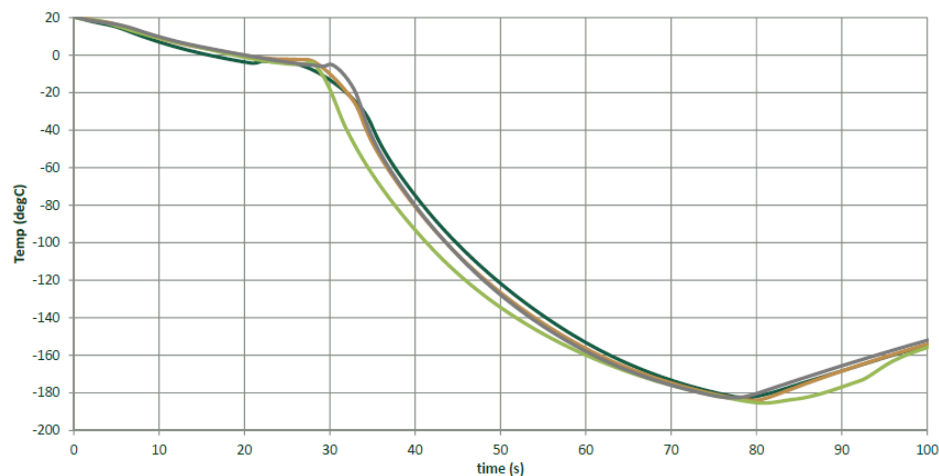




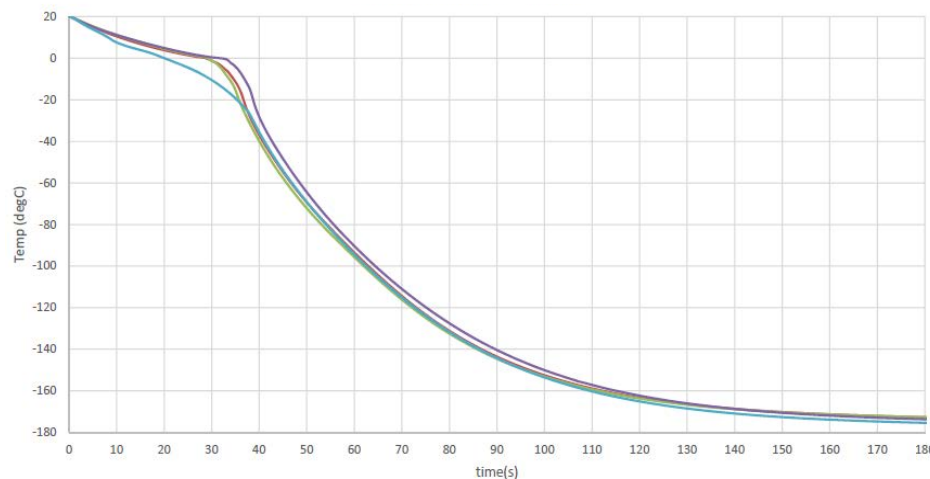
Samples in Liquid Nitrogen vs. Glovebox Freezer (GF)*

Temp (°C)	t_{LN_2} (s)	$t_{\text{GF @ -185}}$ (s)	Δt (s)
-40	32 - 35	40 - 42	5 - 10
-80	37 - 41	54 - 57	13 - 20
-120	46 - 49	73 - 76	24 - 30
-140	52 - 55	86 - 89	31 - 37

1 mL vials in LN2



1 mL vials in GF prototype



* Test data shown is based on performance testing using prototype unit; tests with qual/flight units may vary

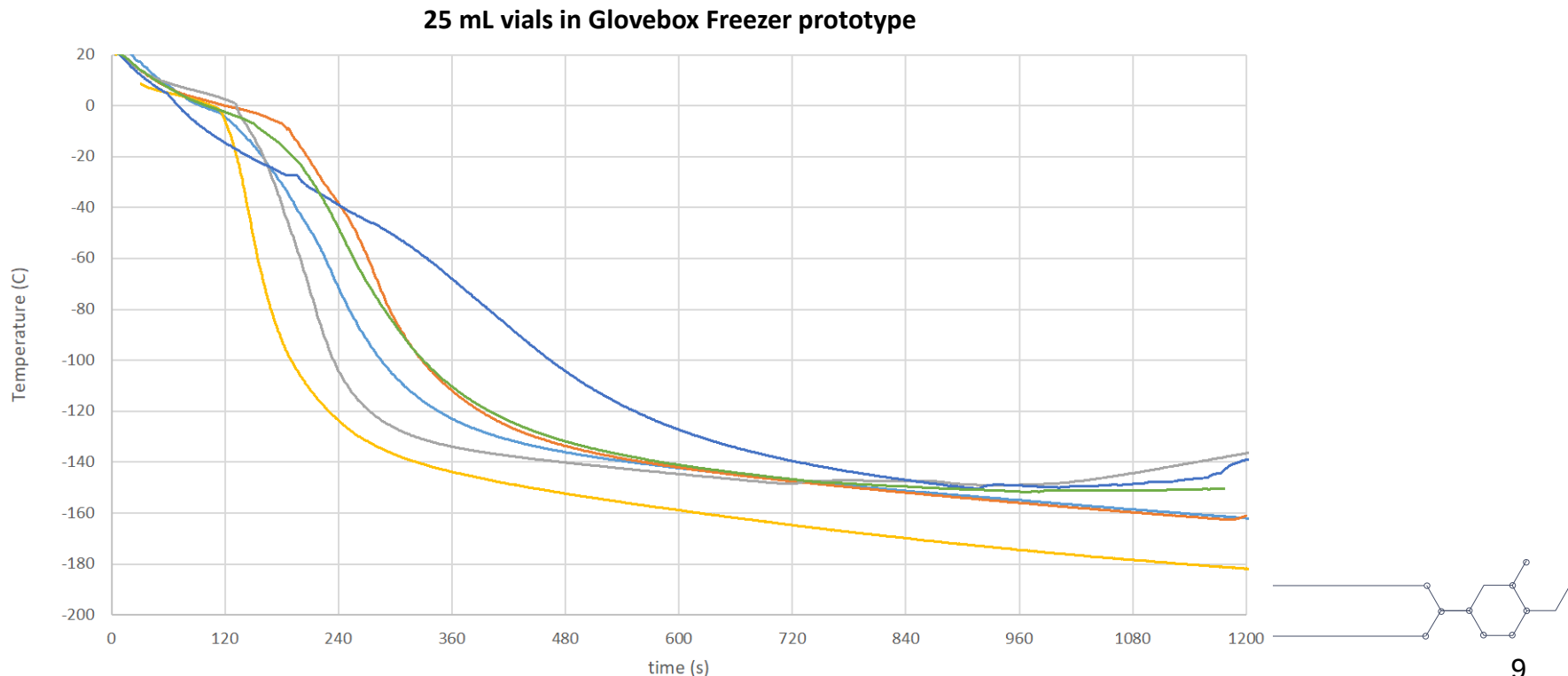




Simulated Carcass Freezing

- Samples were 25mL of DI water in a zip-lock bag folded in half and wrapped in aluminum foil
- Samples were inserted into custom 25mL interface cooled to -185°C at the base
- 6 tests were conducted and the results averaged

Result: carcass freeze rates demonstrated higher variability than with 1 mL samples.



* Test data shown is based on performance testing using prototype unit; tests with qual/flight units may vary



Mass Measurement Device

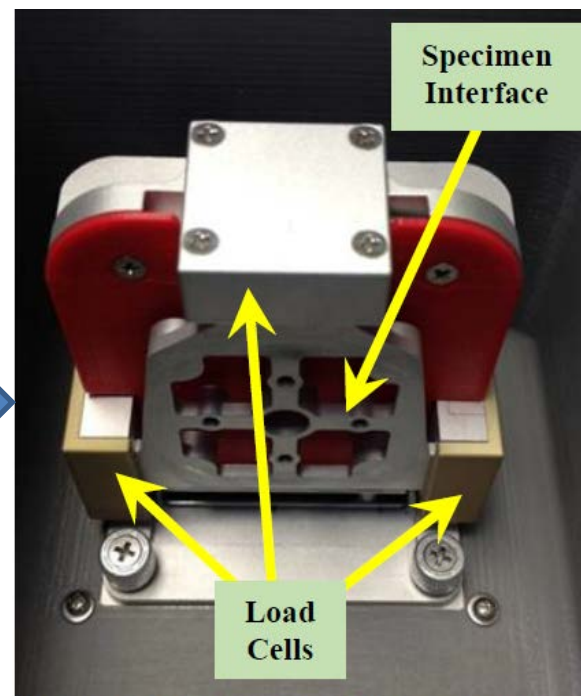
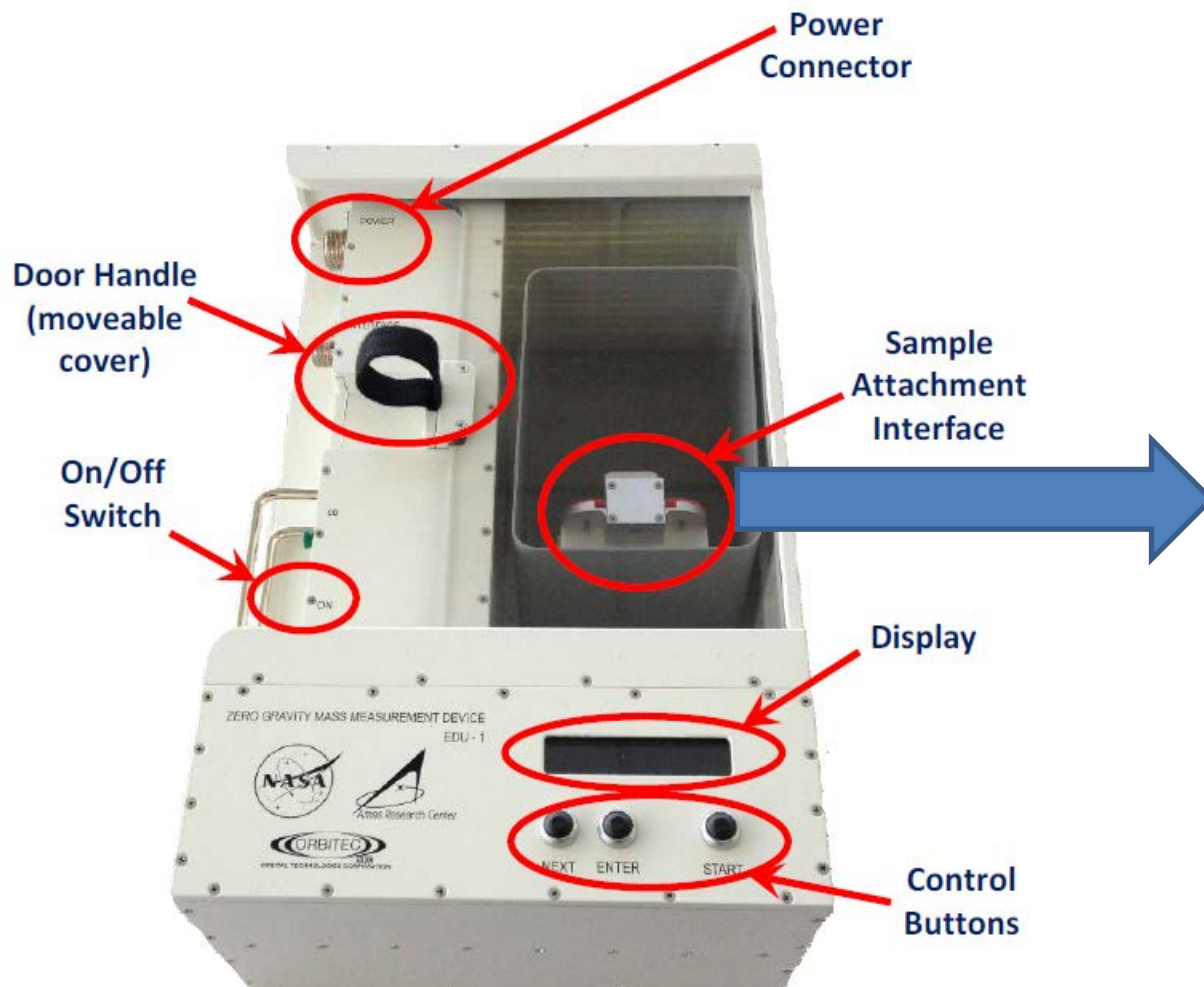
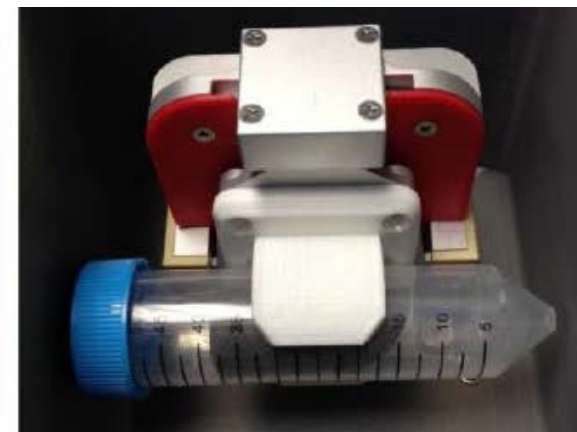
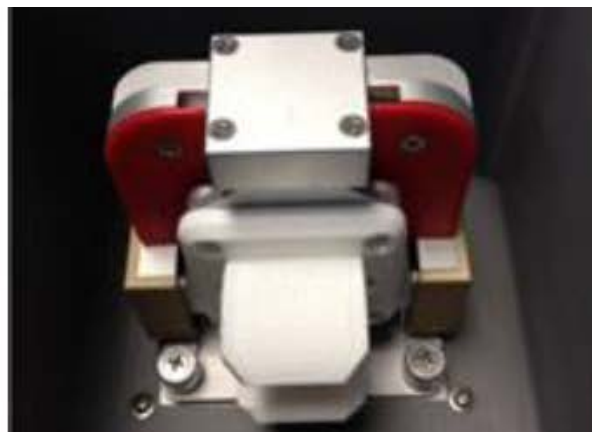
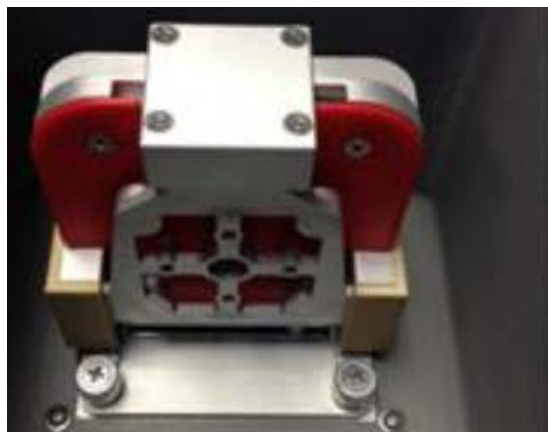


Figure 4. Specimen Interface Mounted to Load Cells, Connected to MMA.



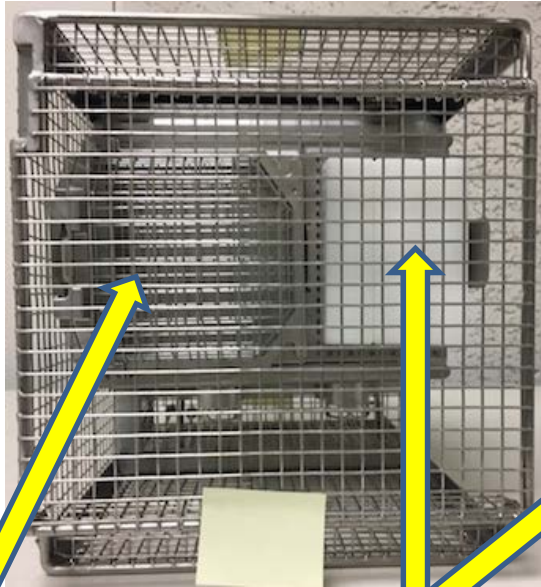


Mass Measurement Device





Habitat Configuration with Enrichment



Enrichment hut



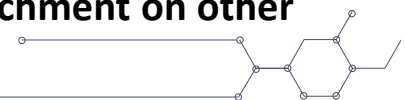
Food Bars



Divider may be removed (RR-9, RR-7)

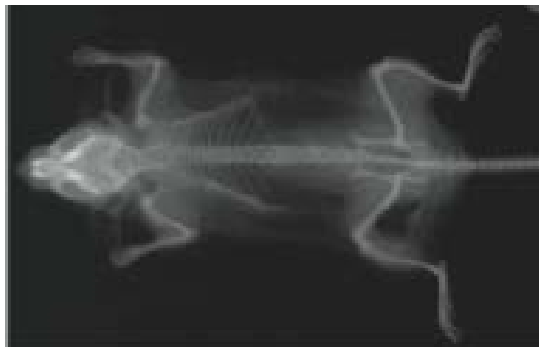


- Enrichment hut designed to house 5 large males; however, up to 9 males were observed in one hut during RR-9
- Removal of divider for RR-9 allowed all 10 animals to move freely around the entire Habitat
- Proposing to have food on one side and enrichment on other side for RR-7 (pending approval)





Additional Rodent Research Capabilities



**Bone Densitometry
(DXA) scanner**



**Thermal support for
recovery from anaesthesia**

Live Animal Return

- RR-5 (SpX-11, UCLA)
- Unberth: 7/2, ~11:38am
- Splashdown: 7/3, ~5:13am
- Boat arrival: 7/4, ~6:35am
- Depart Dock: 10:09 AM

- RR-9 (SpX-12; Loma Linda)
- Unberth: ?
- Splashdown: ?
- Boat arrival: 9/18 ~7:30 am
- Depart Dock: 10:00 AM



RFID chips and readers

Capabilities in Development

- CO2 euthanasia (5-10 mice; expected mid-CY 2018)
- Augmented Utilization Hours (up to 12.5 hours per day for experiments)



Grip strength measurement



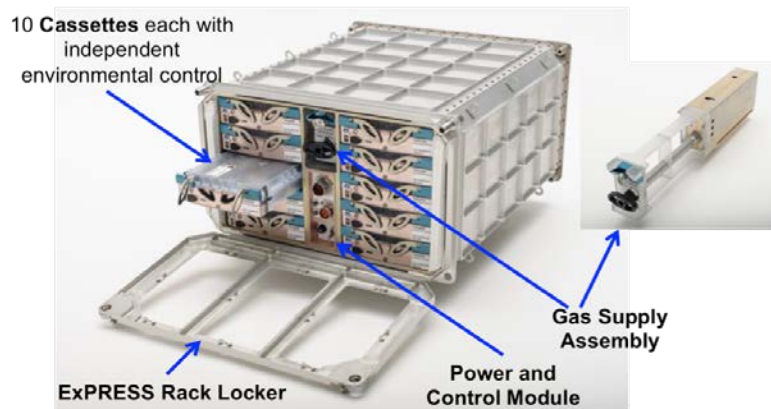
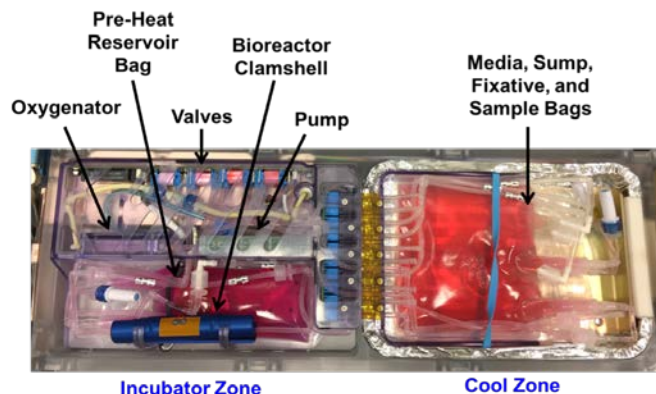


Non-Rodent Research Capabilities

Cell Science

Ex-vivo cell culture with automated:

- Temperature maintenance
- Gas dosing (pH control & oxygenation)
- Medium recirculation
- Collection of medium samples
- Injection of RNA preservative into bioreactor

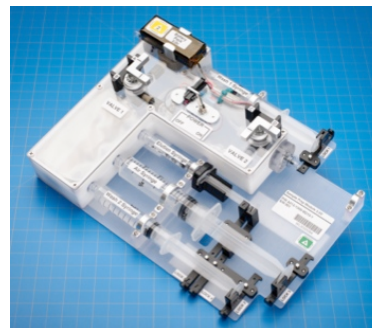


WetLab-2

- Extract DNA/RNA from cells or tissue
- Amplify and quantify multiple genes (target RNA's)
- Downlink data within two hours of session completion

Benefits:

- Improved efficiency and data quality
- Avoiding perturbing sample by fixing/freezing
- Enables 24 hr experiment/analysis turnaround



Microscopy SpaceLab

- High-resolution bright-field, fluorescence, polarized, confocal, and 3D capabilities
- Eight selectable objectives for magnifications ranging from 2X-100X



A MEMBER OF HNU-Photonics





Capabilities Requested (Survey Results)

	LOW FREQUENCY OF USE, LOW IMPORTANCE	LOW FREQUENCY OF USE, HIGH IMPORTANCE	HIGH FREQUENCY OF USE, LOW IMPORTANCE	HIGH FREQUENCY OF USE, HIGH IMPORTANCE	TOTAL	WEIGHTED AVERAGE
Improved video capability - image quality, increased recording times and views, coverage of entire habitat (no blind spots)	0.00% 0	12.50% 1	12.50% 1	75.00% 6	8	3.63
O2/CO2 monitoring in the cage area	11.11% 1	22.22% 2	11.11% 1	55.56% 5	9	3.11
Environmental sampling from Habitats (enable biomarker assessments)	11.11% 1	44.44% 4	0.00% 0	44.44% 4	9	2.78
Position tracking via RFID	44.44% 4	22.22% 2	11.11% 1	22.22% 2	9	2.11
Health monitoring microchip	0.00% 0	33.33% 3	11.11% 1	55.56% 5	9	3.22
Robotic dissections	25.00% 2	37.50% 3	12.50% 1	25.00% 2	8	2.38
Bone marrow flushing	12.50% 1	75.00% 6	0.00% 0	12.50% 1	8	2.13
Perfusion of tissues	11.11% 1	77.78% 7	0.00% 0	11.11% 1	9	2.11
Flow cytometer/hematology	12.50% 1	62.50% 5	12.50% 1	12.50% 1	8	2.25
General/standard housing - allows PIs to utilize for ground testing (Is there a better way to phrase this one?)	0.00% 0	12.50% 1	25.00% 2	62.50% 5	8	3.50
Rapid Live Animal Return (currently 48-72 hours prior to PI access)	0.00% 0	11.11% 1	11.11% 1	77.78% 7	9	3.67
Longer-arm centrifuge	22.22% 2	44.44% 4	0.00% 0	33.33% 3	9	2.44
CO2 euthanasia	33.33% 3	11.11% 1	0.00% 0	55.56% 5	9	2.78
Measure launch & landing loads	11.11% 1	55.56% 5	0.00% 0	33.33% 3	9	2.56
Mimicking of launch & landing scenarios	11.11% 1	44.44% 4	0.00% 0	44.44% 4	9	2.78
Higher n (more animals/flight)	0.00% 0	22.22% 2	0.00% 0	77.78% 7	9	3.56

