# CLDP/ISS Glovebox

## Technical Interchange Meeting

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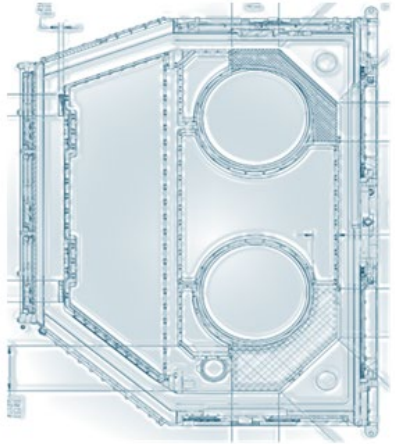
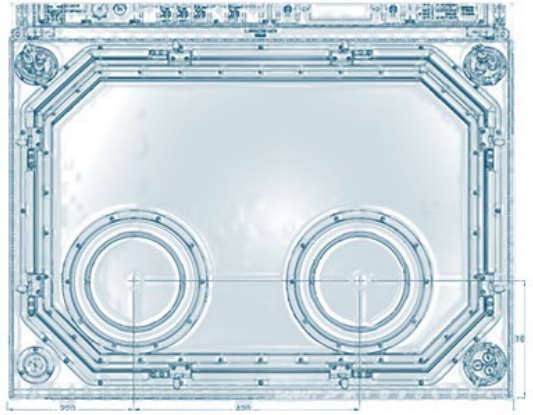
# Agenda

- Microgravity Science Glovebox (MSG) Overview
- MSG Investigation Metrics
- Life Sciences Glovebox (LSG) Overview
- LSG Investigation Metrics
- MLSG Ancillary Hardware
- Facility Comparisons
- MLSG Lessons Learned
- MLSG Timeline Summary
- Back-up Information





# Microgravity Science Glovebox • MSG

OVERVIEW

# MSG Overview - Introduction

The MSG is a flexible, multi-purpose research platform currently located in the US Lab onboard the ISS.

MSG's Work Volume provides an enclosed, laboratory-type workbench in the ISS microgravity environment.

Retractable 255-liter Work Volume allows crew "hands on" access for set-up, operation, and observation of multi-discipline experiments.

MSG provides two levels of containment and single crew operations.


Multiple mounting surfaces and operating resources provided inside Work Volume.

Investigations can be controlled on-orbit via crew or from researcher's lab on Earth.

# MSG Overview – Brief History

Developed to NASA requirements by the European Space Agency. Delivered to ISS on UF-2 (STS-111) June 2002

Operations began July 2002

- Over 97,000 operating hours (currently)
- Operated 72 different investigations
- Originally spec'd for 10 yrs/10k hours

Managed by the MLSG Project Office at MSFC

- Investigation Integration
- Facility Maintenance/Sustaining Engineering

Four units delivered to NASA

- **Flight Unit** currently in US Lab | LAB1S2
- **Engineering Unit** at PRCU | MSFC
  - Flight quality verification, Integration, training, testing and troubleshooting
- **Training Unit** at JSC | Bldg 5
  - Facility/Payload crew training
- **Ground Unit** at MSFC | Bldg 4493 (dismantled)

# MSG Overview – Major Hardware

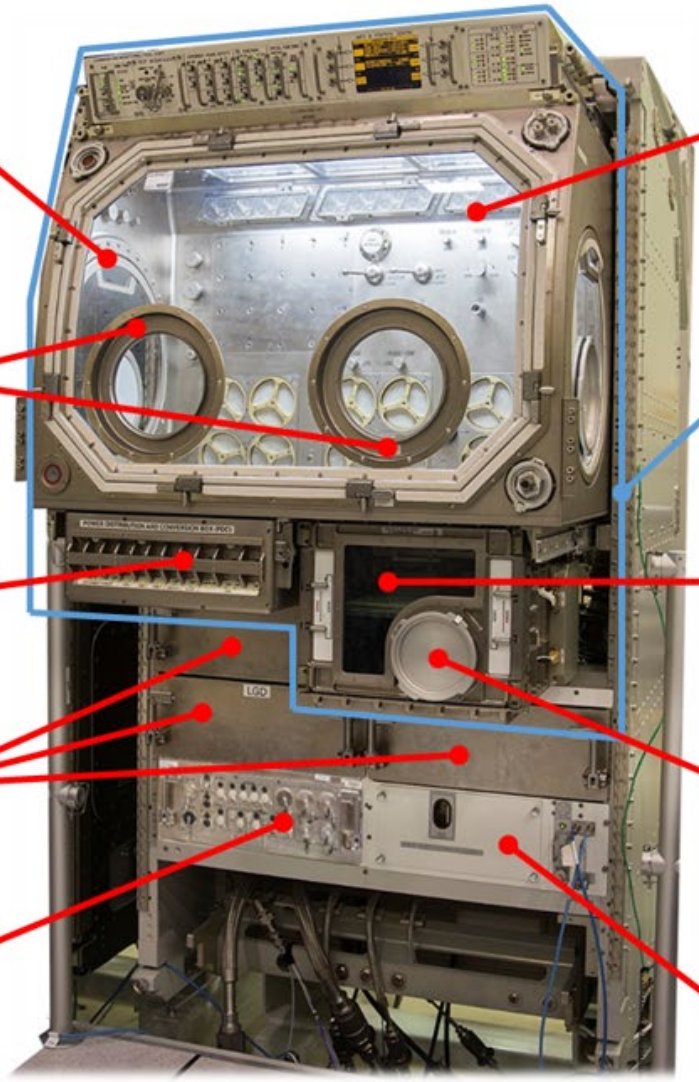
**Removable Side Loading Ports**
16" diameter on both left and right sides for helping the Crew access the Work Volume

**Glove Ports**
Four identical glove ports are located on the left and right-side loading ports and the front window

**DC Power Switching and Circuit Breakers**

**Stowage Drawers**

**Video Upgrade Equipment (VUE)**



**Removable Front Window**
Allows maximum access to the Work Volume for hardware set-up and stow

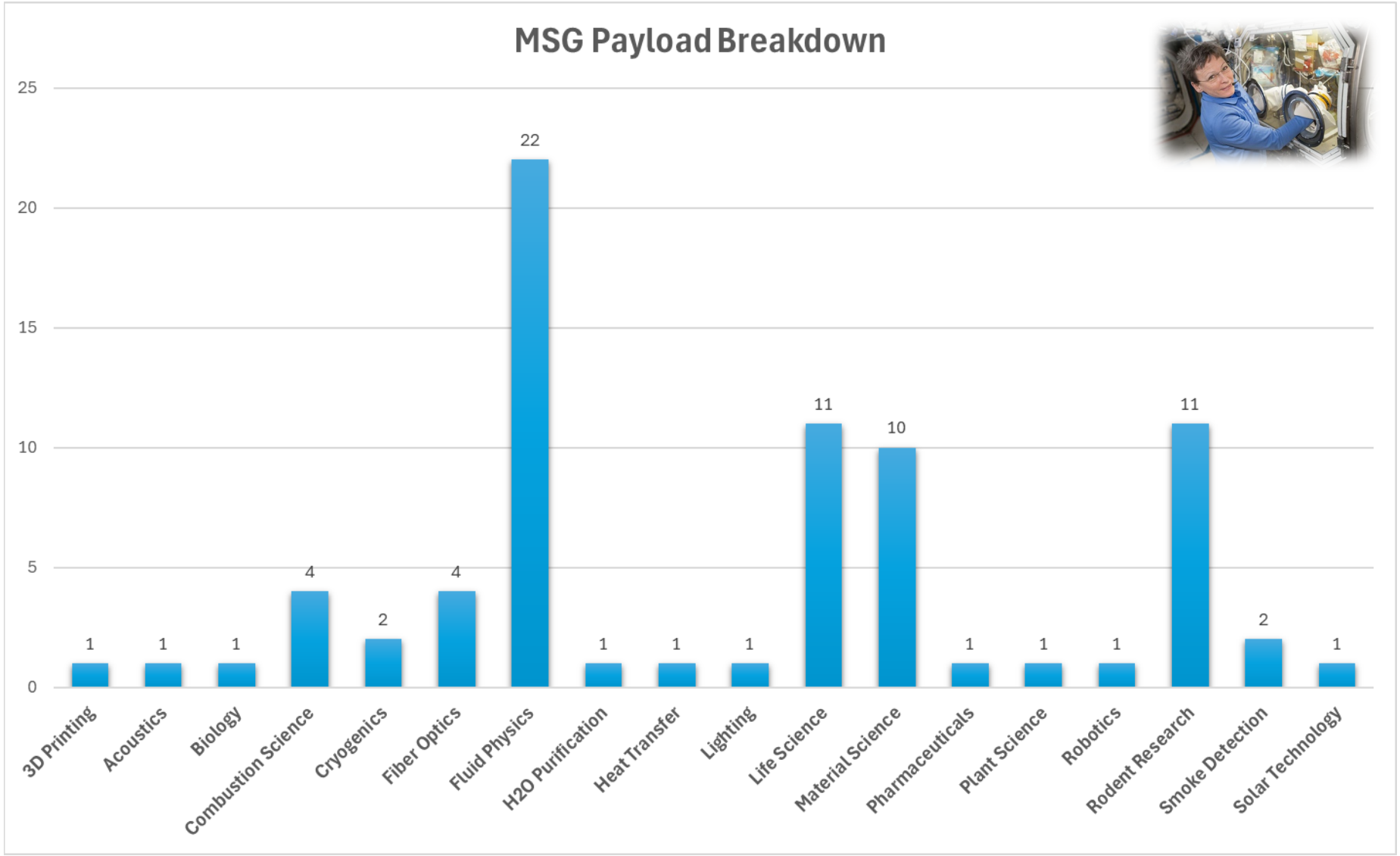
**Core Facility**
Retractable Core Facility includes the Work Volume, Airlock, Power Distribution & Switching Box, and the Command and Monitoring Panel

**Airlock**
Provides a "pass through" for hardware to enter the Work Volume without breaking containment. The lid of the Air Lock opens into the floor of the Work Volume.

**Airlock Glove Port w/Blank**
A single 4" diameter glove port can also be fitted with any of three different sized gloves or a blank

**Remote Power Distribution Assembly (RPDA)**
Area where the Exchangeable Standard Electronic Modules (ESEMs) reside

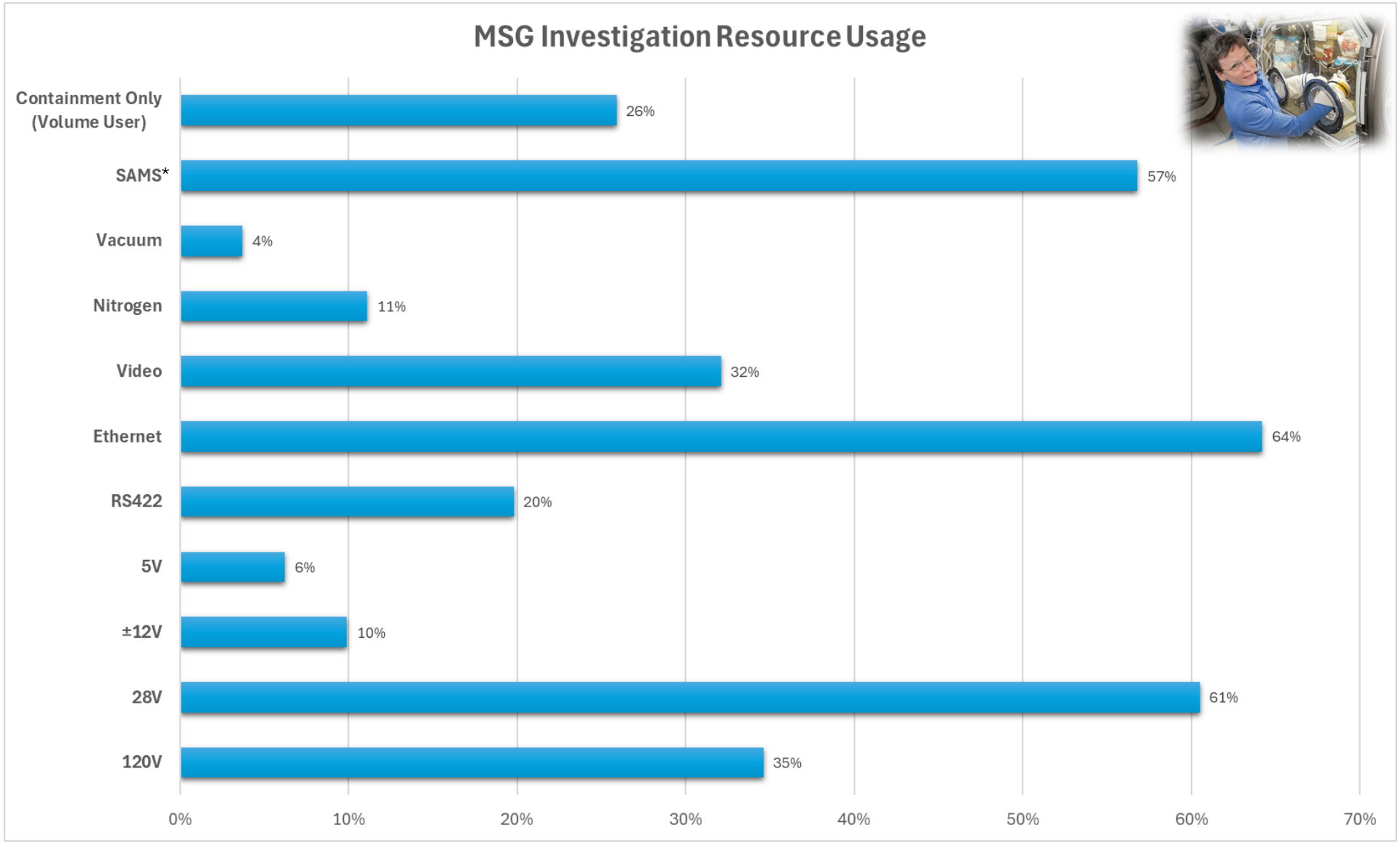
# MSG Overview - Investigation Science






MSG Payloads 2002-2025

# MSG Overview - Resource Usage






*Space Acceleration Measurement System

# Life Sciences Glovebox • LSG

OVERVIEW

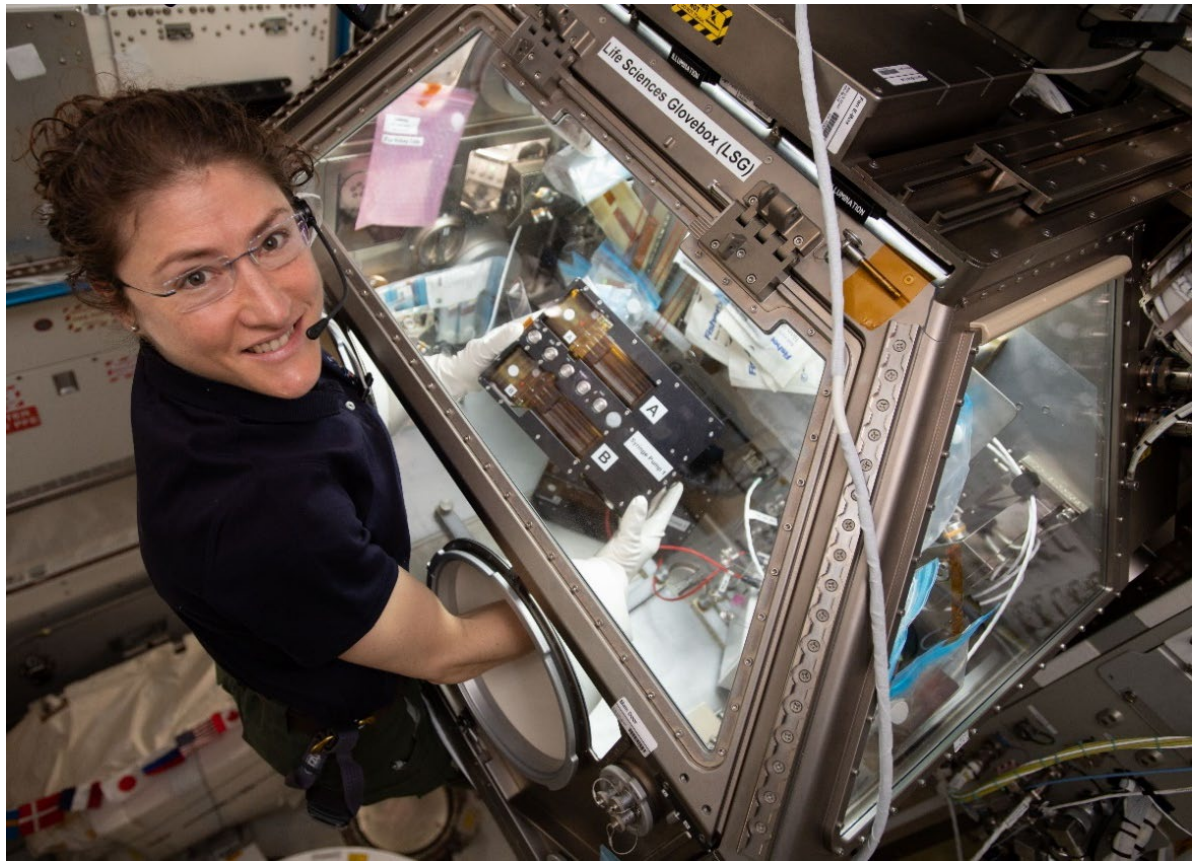
# LSG Overview - Introduction

The Life Sciences Glovebox (LSG) is a payload facility that provides a sealed environment for biological/life science payloads located onboard the ISS (JEM).

Onboard since September 2018, it launched in multiple pieces on multiple flights.

LSG provides two levels of containment and the ability for two crew members to perform simultaneous operations.

LSG major elements are integrated into an existing Zero-g Stowage Rack (ZSR) with ancillary resources (28Vdc and data) provided by an adjacent ExPRESS (Expedite the Processing of Experiments to the Space Station) rack.



# LSG Overview – Brief History

NASA contracted joint venture between Boeing and JAXA and modified into its final configuration by MSFC

Delivered to ISS on SPX-15 and HTV7 Sep 2018

Core Facility Installation and Checkout began Nov 2018

Managed by the MLSG Project Office at MSFC

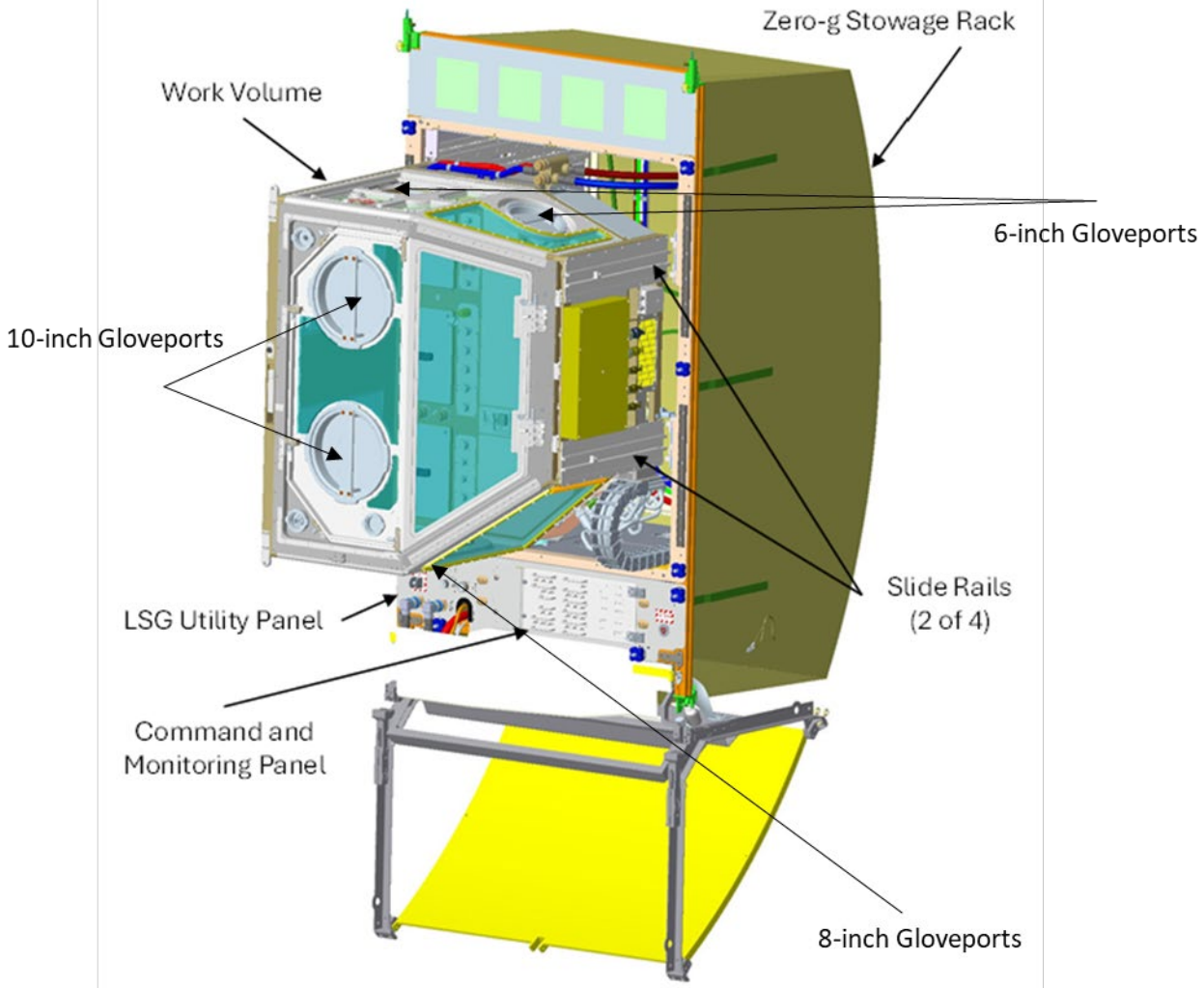
- Experiment Integration
- Facility Maintenance/Sustaining Engineering

Four Units Available

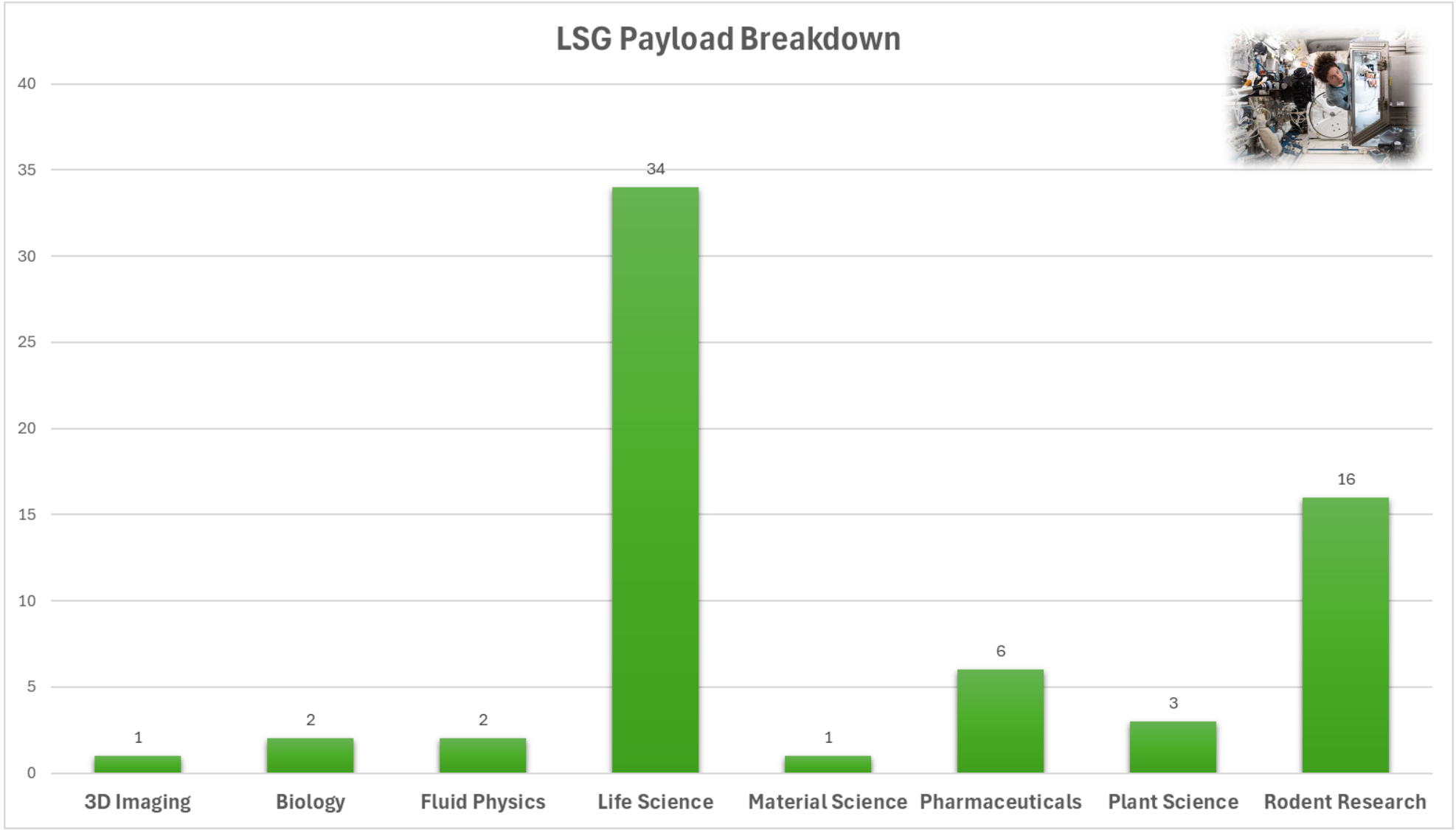
- **Flight Unit** currently located at Forward 5 in the JEM
- **Engineering Unit** at MSFC used for high fidelity verification, integration, testing and troubleshooting, payload development
- **Training Unit** at JSC used for Crew training
- **HiFi Unit** at MSFC for public relations/tours

# LSG Overview – Major Hardware

- ZSR (Zero G Stowage Rack)
  - The ZSR is a modular system of fabric and metal that acts as an outer shell for LSG
- Work Volume
  - 16 cubic feet of volume
  - Max 2 levels of containment (same as MSG)
  - Two 10” Primary Glove Ports
  - Two 8” Secondary Glove Ports
  - Two 6” Glove Ports
  - Fire Port and 2 Feedthrough Ports
  - Main Door
  - Power, Video, and Data Connections
  - Internal Ferrous Magnetic Surfaces
- Avionics Launch Package
  - Rack Power Switch
  - LSG Utility Panel
  - Command and Monitoring Panel



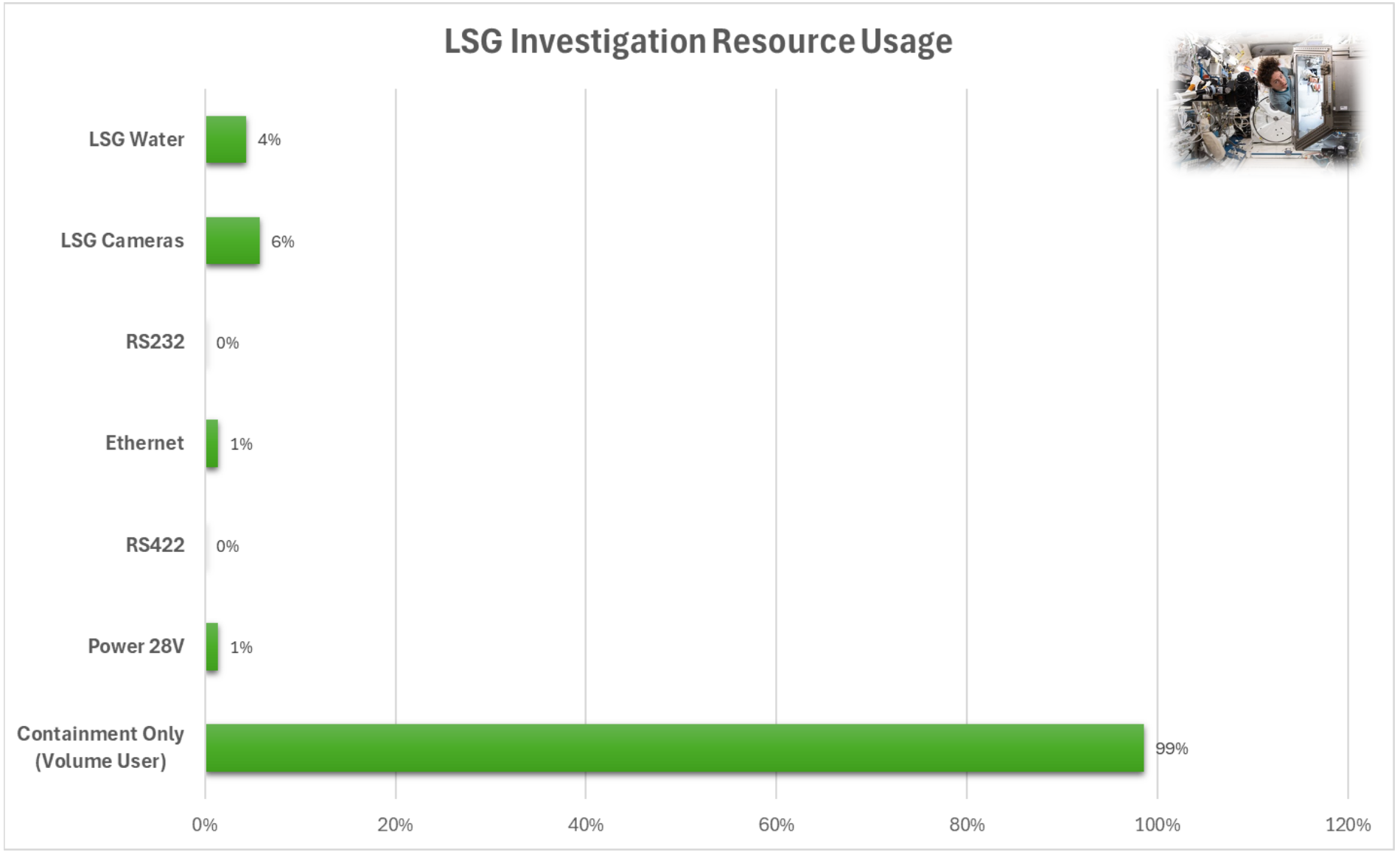
# LSG Overview - Investigation Science



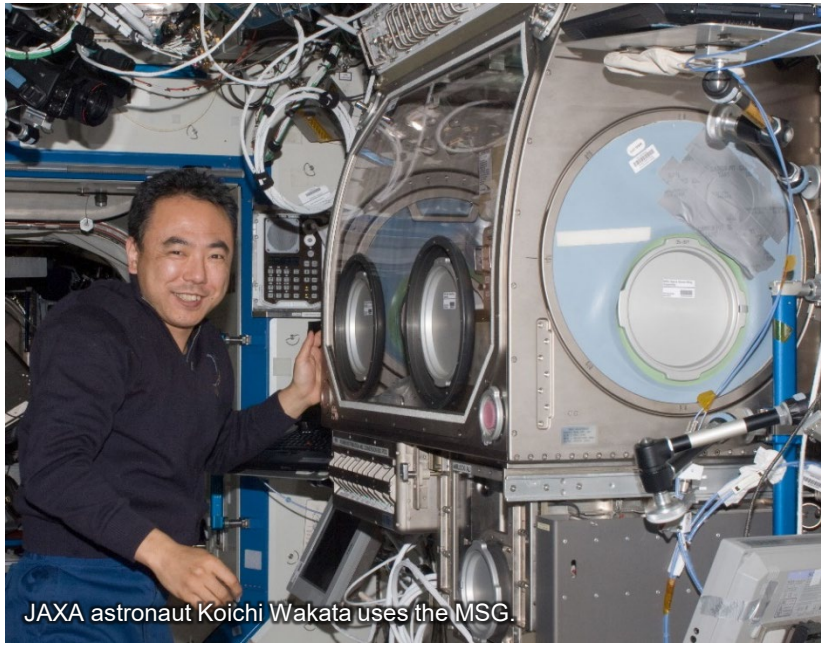



LSG Payloads 2018-2025

# LSG Overview - Resource Usage



# MLSG Facilities – Levels of Containment



JAXA astronaut Koichi Wakata uses the MSG.

ESA astronaut Paolo Nespoli installs the ESA ARTE payload in the MSG.

**1**

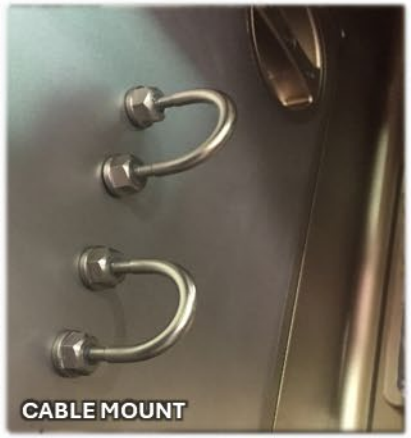
First level of containment provided by the physical barrier (a sealed Work Volume) and monitoring the differential pressure.

**2**

Second level of containment provided by continuously recirculating and filtering the air.

# MLSG Facilities – Ancillary Hardware











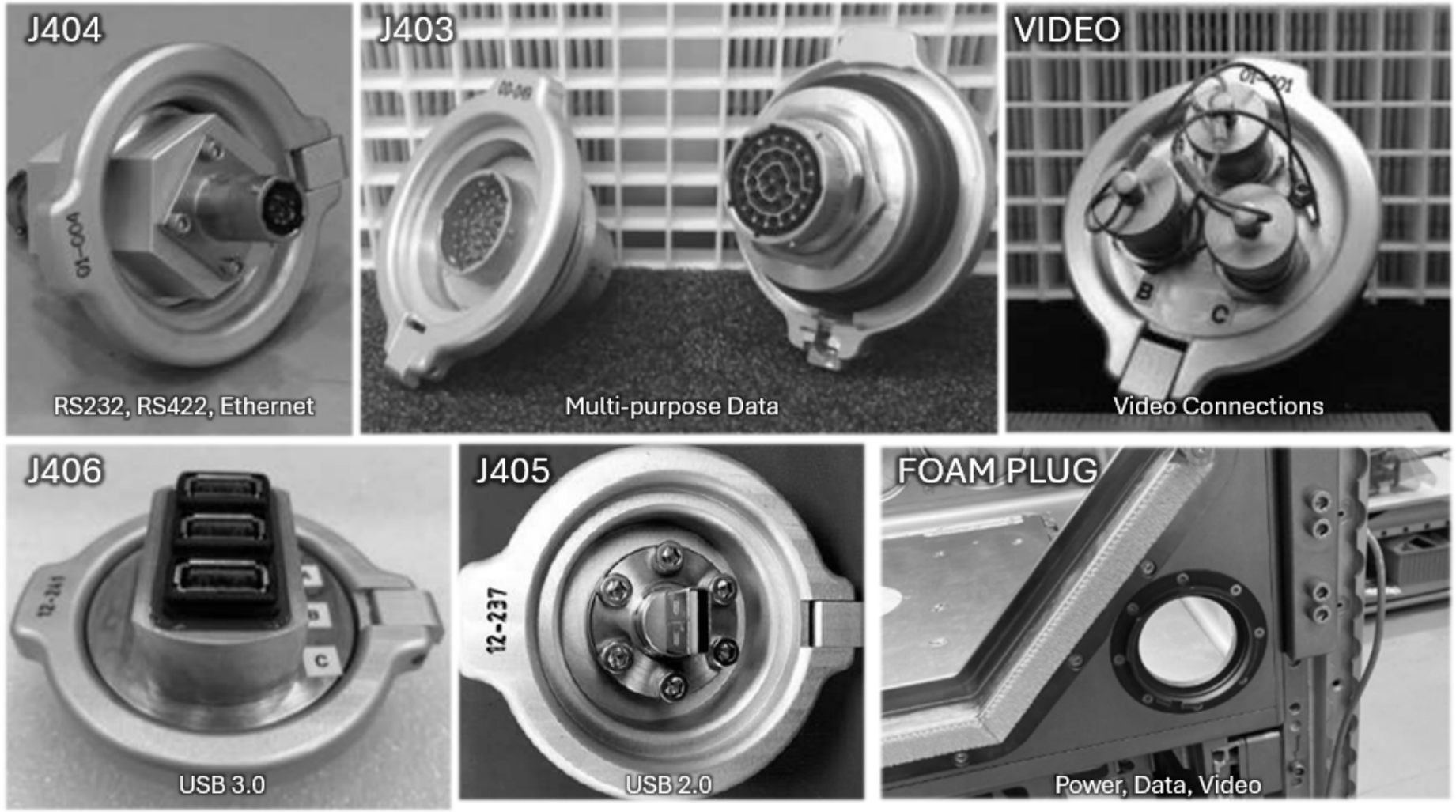
Shown are just some of the MSG and LSG facility ancillary hardware onboard ISS. Keeping track of these items and the plethora of cables, cameras, fasteners, etc., with periodic stowage audits, is necessary to realize availability to the facility and its upcoming investigations.

# MLSG Facilities – Gloves & Sleeves



The various glove configurations are designed to provide a level of containment for the crew to handle materials within the Work Volume. The sleeve materials were selected for compatibility with chemicals used in typical life science research.

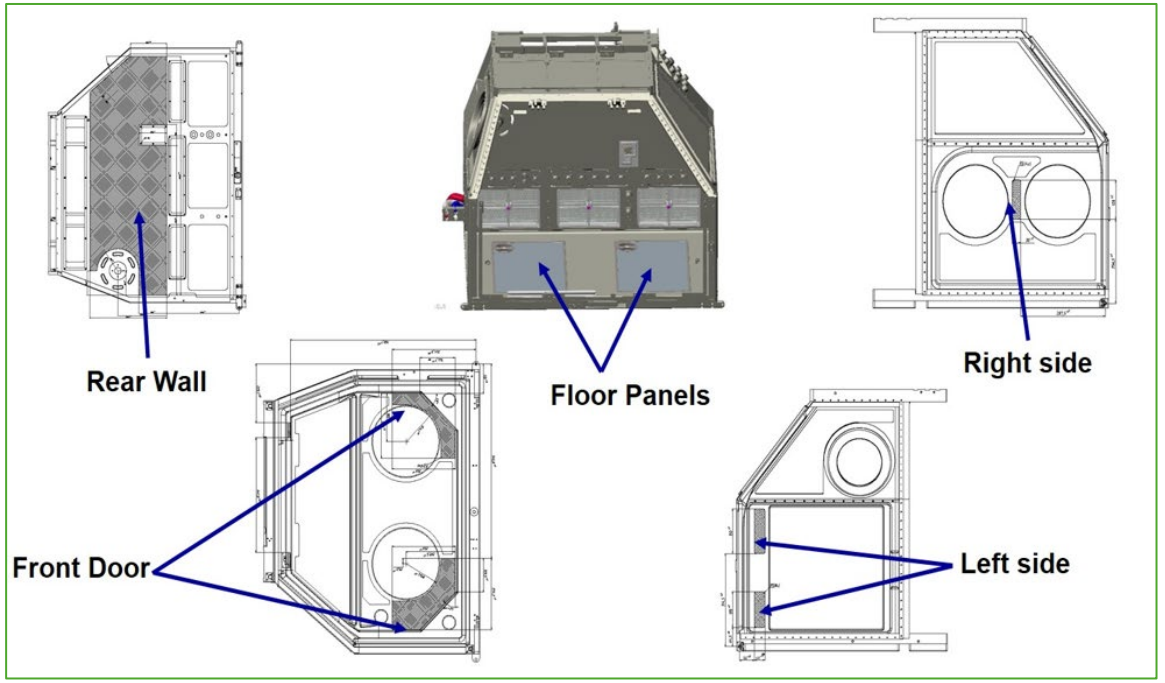
# MLSG Facilities – Shared Feedthroughs




MLSG Feedthroughs are shared assets that allow various video or data signals to be routed from inside the Work Volume to a controlling device like a laptop or video drawer without breaking containment.

# MLSG Facilities – Hardware Set-up Basics

MSG Experiment Attachment Points – M6 Helicoil holes located throughout the WV on Cold Plate, Airlock Lid, Rear Wall, Ceiling, and Side Loading Ports.




LSG uses ferrous (magnetic) surfaces for investigations to mount. This also makes clean-up from many life science and rodent research investigations much easier.

# MLSG Facilities – Resource Comparison

*This information is taken from the MSG and LSG Investigation Interface Requirement Documents (IIRDs). MSFC-RQMT-2888 and MSFC-RQMT-3712.*

| Capability/Resource | Payload Facilities | |
|---|---|---|
| | **Life Sciences Glovebox (LSG)** | **Microgravity Science Glovebox (MSG)** |
| **MAIN POWER**<br>(available to payloads) | Up to 200W w/out Moderate Temperature Loop (MTL) cooling;<br>Up to 300W with MTL. | Up to 1000W total |
| **AUXILIARY POWER** | Yes<br>Safing only. | N/A |
| **THERMAL AIR COOLING**<br>(available to payloads) | ACS (Air Circulation System) - 200W | AHU (Air Handling Unit) - 200W |
| **THERMAL LIQUID COOLING**<br>(available to payloads) | MTL via QD - 100W<br>1 connection for payloads | Heat dissipation via cold plate in Work Volume<br>800W at 100 kg/hr MTL flow<br>MTL not available directly to payloads |
| **VACUUM SYSTEM AVAILABILITY** | N/A | Vacuum Exhaust System (VES) and<br>Vacuum Resource System (VRS) |
| **LEVELS OF CONTAINMENT**<br>(Facility Provided) | 2 levels of facility provided containment<br>Physical barrier \| Air filtration-differential pressure | 2 levels of facility provided containment<br>Physical barrier \| Air filtration-differential pressure |
| **DATA**<br>(Facility Provided) | Low-rate Telemetry (LRT): Payload Health & Status (H&S)<br>RS-232, RS-422, Ethernet, USB | LRT: Payload H&S<br>RS-422, RS-232, Ethernet (MLC FTP folder or KuIP), USB |
| **PAYLOAD COMMANDING** | KuIP | S-Band/Low-Rate Telemetry (LRT) and KuIP |

# MLSG Facilities – Resource Comparison

*This information is taken from the MSG and LSG Investigation Interface Requirement Documents (IIRDs). MSFC-RQMT-2888 and MSFC-RQMT-3712.*

| Capability/Resource | Payload Facilities | |
|---|---|---|
| | **Life Sciences Glovebox (LSG)** | **Microgravity Science Glovebox (MSG)** |
| **VIDEO**<br>(Facility Provided) | 3 camera inputs - HD SDI<br>Downlink restricted by ISS capabilities | 8 camera inputs - 4 HD SDI, 4 GigE<br>Downlink restricted by ISS capabilities |
| **PAYLOAD FIRE DETECTION** | Yes - payload parameter monitoring | Yes - payload parameter monitoring |
| **PAYLOAD VOLUME** | 450L Work Volume | 255L Work Volume |
| **NITROGEN SUPPLY** | N/A | Yes<br>1 connection |
| **LOCATIONS** | JEM | US Lab |
| **EMERGENCY, CAUTION, WARNING (ECW)** | Advisory, Caution or Warning from payloads | Advisory, Caution or Warning from payloads |
| **CONTINUOUS FACILITY OPERATIONS (24/7)** | No<br>Acoustic limitations due to fan noise.<br>Dependent on Fan Speed, LSG can only be powered between 6.5 and 15 hours continuously in a 24-hour period. | Yes<br>There are no acoustic constraints by facility. |

# MLSG Facilities - Lessons Learned[1]

| MSG Airlock | MSG Video | Video Cameras | Gloves to Gloves/Sleeves | Rubber Material |
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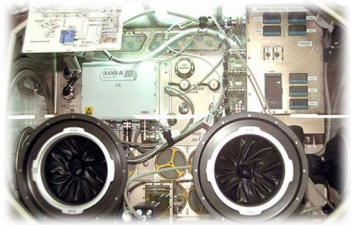
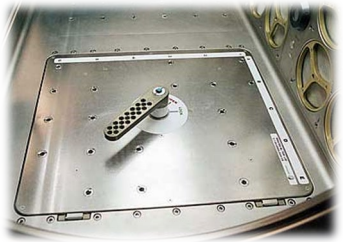
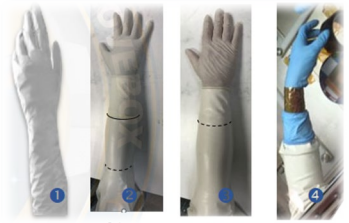
|  |  |  |  |  |
|  |  |  |  |  |
| The MSG Airlock was meant to be the safe passthrough to get items in and out of the Work Volume without breaking containment. Unfortunately, the Airlock Lid opening is in a location blocked by experiment hardware. Large payloads can not use it forcing all needed clean up equipment to be installed at set-up in the WV. | The original analog Video Drawer was outfitted with Hi8 recorders/tapes and SD cameras. Exchanging tapes for experiments was Crew intensive. Record times limited science. A digital drawer (VUE) replaced the original in 2014. Digital file tracking and downloading is much more efficient for ops/PD. | With the original analog Video Drawer, SD Hitachi cameras were used. Then the digital VUE has HD-SDI and GigE cameras. Video technology changes so quickly that keeping up would be very costly. It is more important to have interfaces that are flexible and accommodating to future technologies. | The gloveboxes have gone through an evolution of using one-piece gloves to having most gloverings mated with rubber sleeves (not gloves). The sleeves allow the Crew to use various Station or payload provided surgical gloves. This allows more dexterity to perform most functions and activities. | The rubber used to construct gloves, sleeves, and seals has changed during MSG's time onboard. Initially using Neoprene for gloves/sleeves and Norsorex for seals, engineering decided that 3-year replacement cycles were not cost effective. A switch was made to CSM rubber (gloves/sleeves) and EPDM for seals. |

# MLSG Facilities - Lessons Learned[2]

| Filters | UV Decon System | Clean-up Kit | MSG Front Window | Module Commonality |
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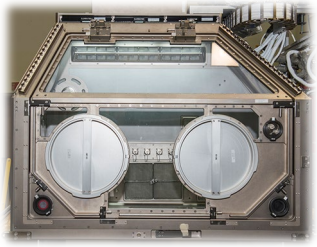
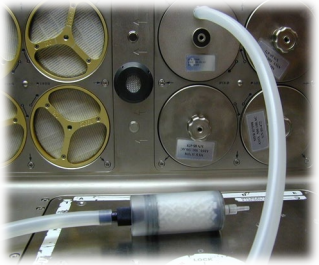
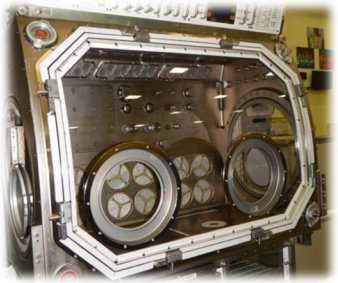
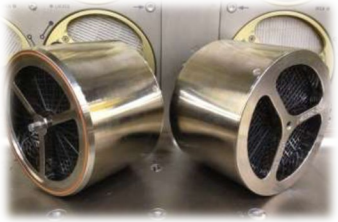
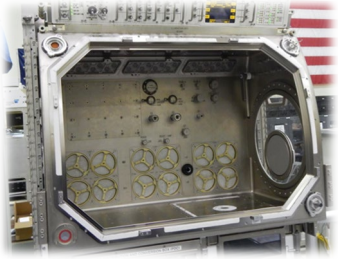
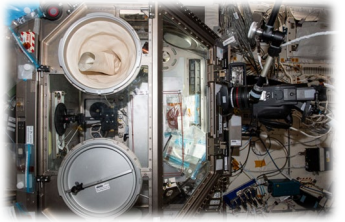
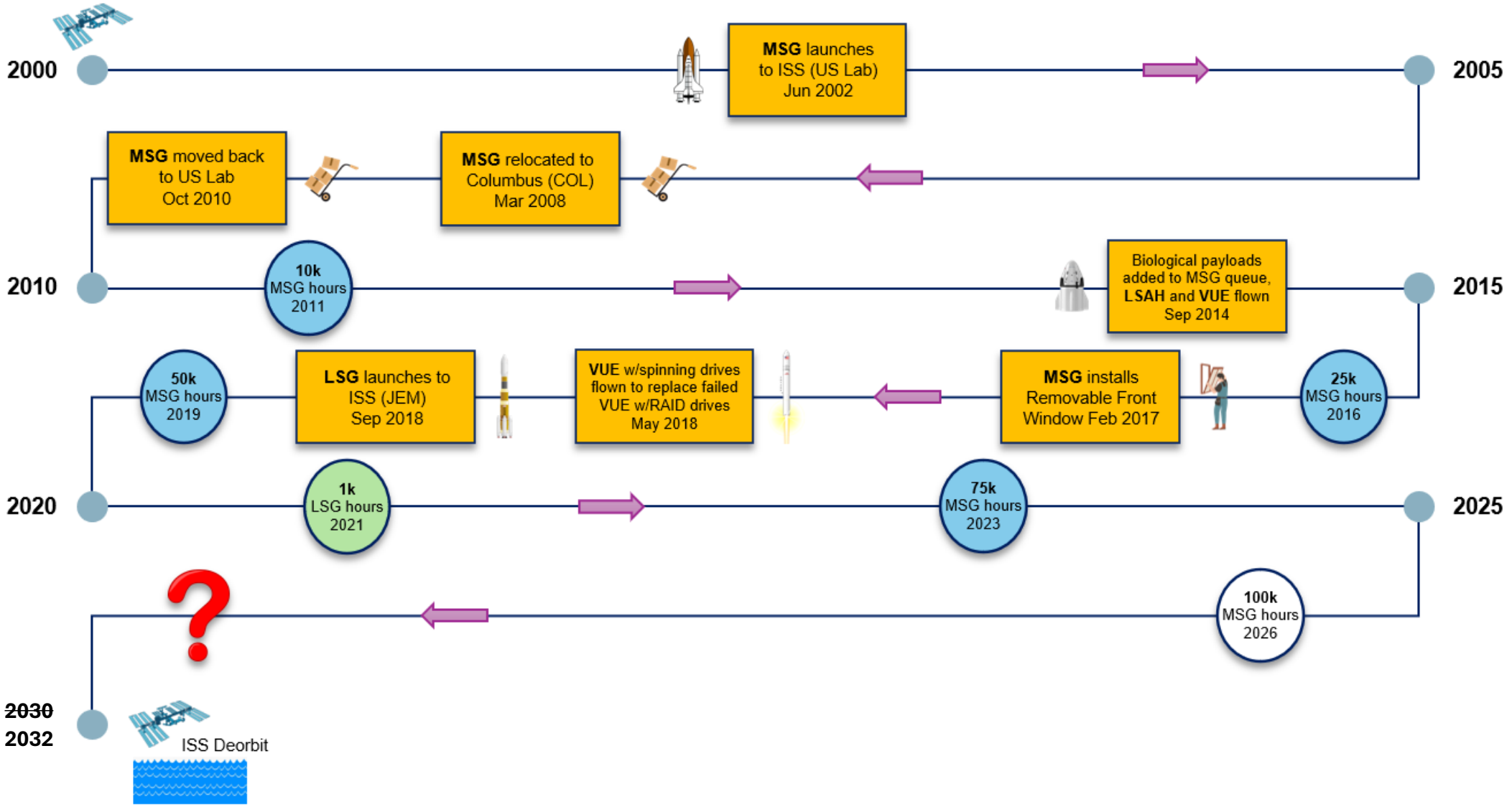
|  |  |  |  |  |
|  |  |  |  |  |
| The Air Handling Unit filters used in both facilities now take advantage of cost-effective COTS filters mated with MSFC-designed housings. MSG began using these filters in 2014 and LSG in 2019. Exchanging the original MSG/ESA filters was cost prohibitive. | In the mid-2010s, the introduction of biological and rodent research investigations in MSG (and later LSG) required the ability to improve the WV environment before or after their operations. The UV Decon System damages microbe DNA in at least 99% of the population, which inhibits their ability to reproduce. | Clean-up kits have a vital role for many types of glovebox payloads. If material release happens, the need for quick clean-up is imperative. Initially, specialized tools were used for these purposes but philosophies change, and using cheaper, effective items like dry wipes and Kapton tape have become much more common. | Prior to the installation of the MSG RFW, large items had to fit through the 16-inch Side Loading Ports. This made set-up/stow activities longer and more cumbersome. The RFW allows more flexibility in payload hardware design and reduces Crew time. | Ensure common interfaces between all modules and contractors, so your rack can work effectively in either location A or Z. MLSG facilities have encountered situations where hardware worked one way in one ISS module but differently in another ISS module. |

# MLSG Facilities - Key Event Timeline Summary



# Acronym List

| | |
|---|---|
| ACS | Air Circulation System |
| AHU | Air Handling Unit |
| AL | Airlock |
| CLDP | Commercial Low Earth Orbit Development Program |
| CMP | Command and Monitoring Panel |
| COL | Columbus Module |
| CSM | Chlorosulfonated Polyethylene |
| Decon | Decontamination |
| DNA | Deoxyribonucleic Acid |
| EPDM | Ethylene Propylene Diene Monomer |
| ESA | European Space Agency |
| EXPRESS | Expedite the Processing of Experiments to the Space Station |
| FTP | File Transfer Protocol |
| GigE | Gigabit Ethernet |
| H&S | Health and Status |
| HD | High Definition |
| HiFi | High Fidelity |
| HTV | H-II Transfer Vehicle |
| ISS | International Space Station |
| JAXA | Japan Aerospace Exploration Agency |
| JEM | Japanese Experiment Module |
| JSC | Johnson Space Center |
| KuIP | Ku-Band Internet Protocol |
| LOC | Levels of Containment |
| LRT | Low-Rate Telemetry |
| LSAH | Life Science Ancillary Hardware |

| | |
|---|---|
| LSG | Life Sciences Glovebox |
| MLSG | Microgravity and Life Sciences Glovebox (Project) |
| MSFC | Marshall Space Flight Center |
| MSG | Microgravity Science Glovebox |
| MTL | Moderate Temperature Loop |
| PCM | Power Control Module |
| PD | Payload Developer |
| PEA | Power Emitter Assembly |
| POD | Power Output Distribution |
| PRCU | Payload Rack Control Unit |
| QD | Quick Disconnect |
| RAID | Redundant Array of Independent Disks |
| RFW | Removable Front Window |
| RPDA | Remote Power Distribution Assembly |
| SD | Standard Definition |
| SDI | Serial Digital Interface |
| SPX | SpaceX |
| SSC | Subsystem Computer |
| SSD | Solid State Drive |
| USB | Universal Serial Bus |
| VES | Vacuum Exhaust System |
| VRS | Vacuum Resource System |
| VUE | Video Upgrade Equipment |
| WV | Work Volume |
| ZSR | Zero-g Stowage Rack |

# Back-up Information

# MSFC Capabilities Website


- Propulsion
- Advanced Concepts
- Space Systems
- Payload and Mission Operations
- Videos
- Materials and Processes
- Space Transportation Systems
- Specialized Test Capabilities
- Habitation