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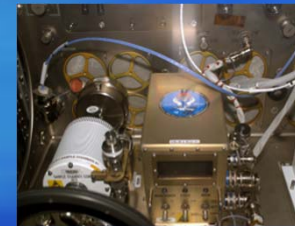
## **MICROGRAVITY SCIENCE GLOVEBOX (MSG) SPACE SCIENCE'S PAST, PRESENT, AND FUTURE ON THE INTERNATIONAL SPACE STATION (ISS)**

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Microgravity Science Glovebox

## Microgravity Science Glovebox (MSG)



# Agenda

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- Introduction
- Payload Interfaces and Resources Provided by MSG
- Overview of the Research Accomplished in the MSG Facility to Date
- MSG Operations Planned for 2013
- Life Science Ancillary Hardware (LSAH) Upgrades
- Video Upgrade Equipment (VUE)
- Conclusion





Microgravity Science Glovebox



# Introduction

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- The Microgravity Science Glovebox (MSG) is a double rack facility designed for microgravity investigation handling aboard the International Space Station (ISS).
- The unique design of the facility allows it to accommodate science and technology investigations in a “workbench” type environment
- MSG facility provides an enclosed working area for investigation manipulation and observation in the ISS. Provides two levels of containment via physical barrier, negative pressure, and air filtration .
- The MSG team and facilities provide quick access to space for exploratory and National Lab type investigations to gain an understanding of the role of gravity in the physics associated research areas.





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# Microgravity Science Glovebox (MSG)



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## MSG Facility Hardware Overview

### Removable Side Ports

16" diameter on both Left and Right sides for setting up hardware in Work Volume

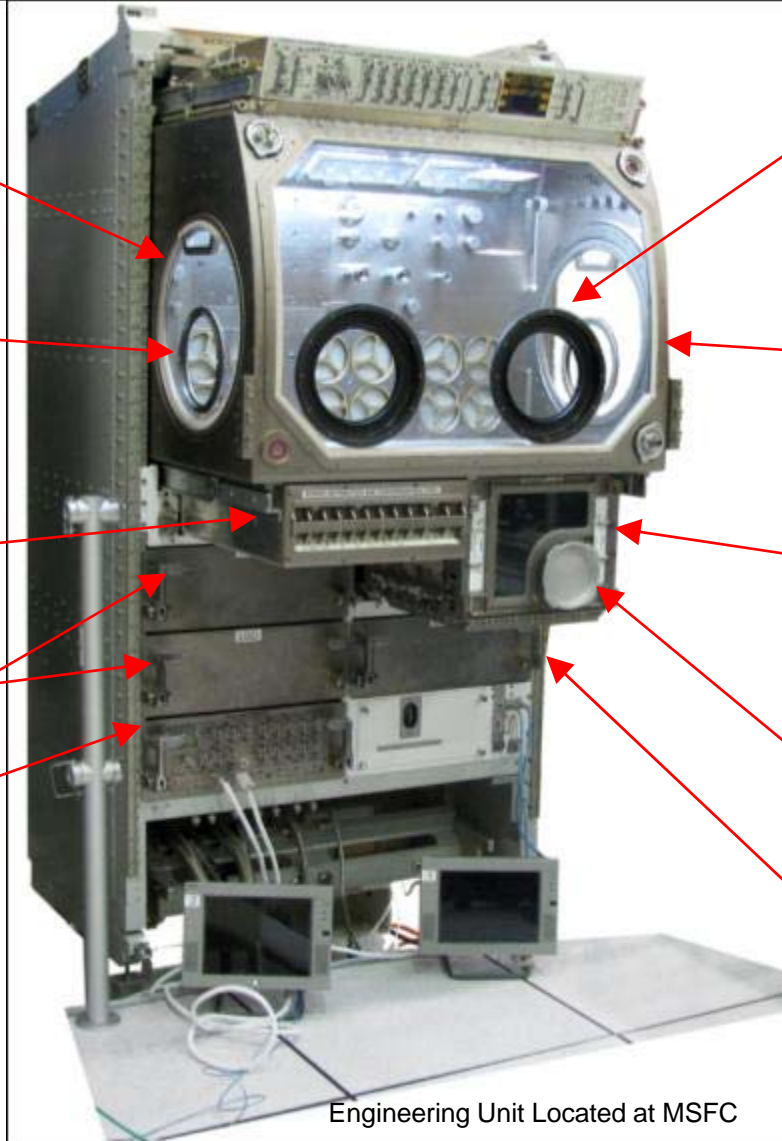
### Glove Ports

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 System Drawer



Engineering Unit Located at MSFC

### Front Window Glove Ports

Four 6" diameter glove ports can be fitted with any of three different sized gloves or blanks

### 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 up into the floor of the Work Volume

### Airlock Glove Port with Blank

A Single 4" diameter glove port can also be fitted with any of three different sized gloves or a blank

### Stowage Drawers



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# Current MSG-Provided Payload Interfaces/Resources



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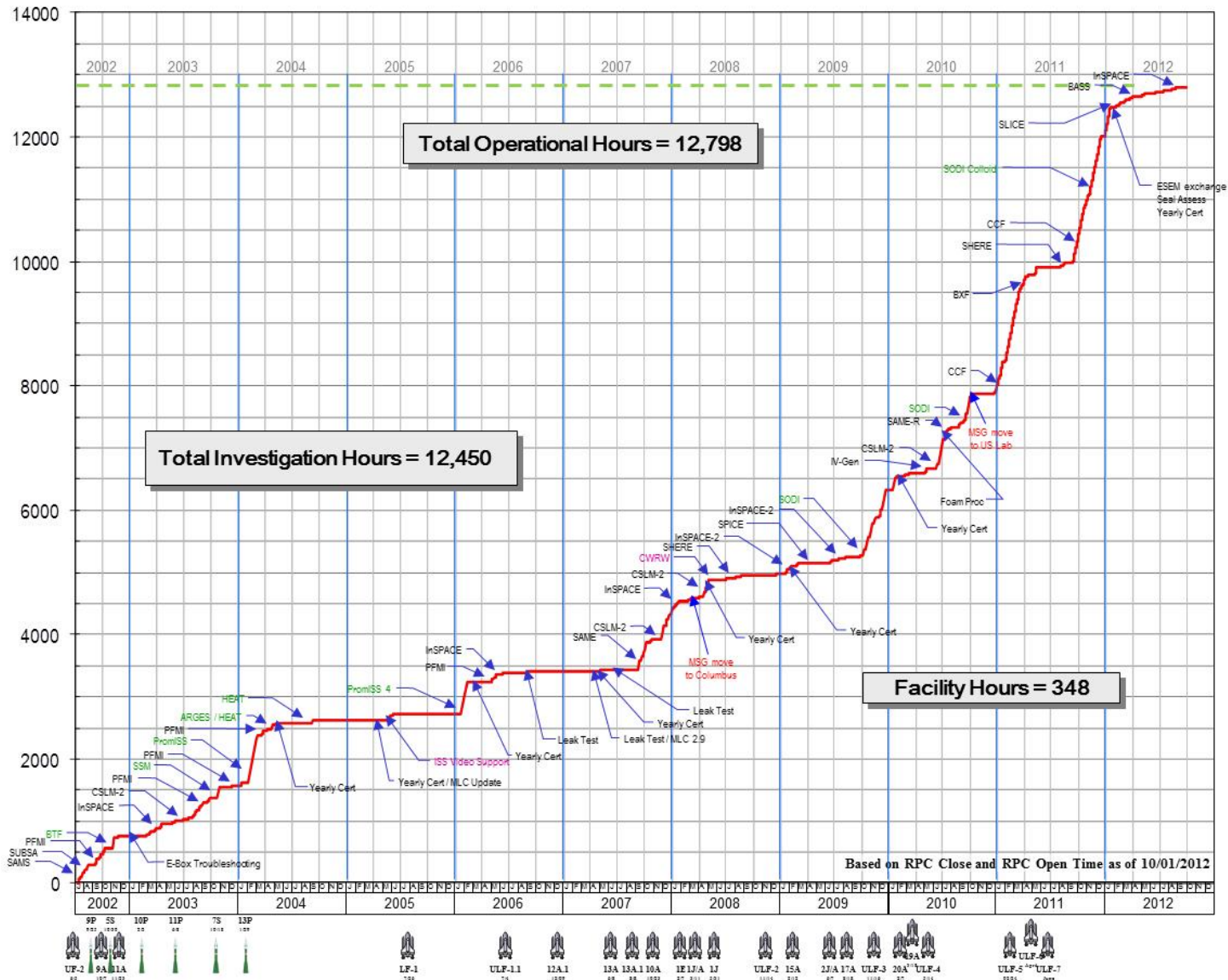
- **Work Volume(WV) - Volume**
  - 0.255 m<sup>3</sup> = 255 liters
- **Work Volume - Dimensions**
  - 906mm wide x 637mm high
  - 500mm deep (at the floor)
  - 385mm deep (at the top)
- **Maximum size of single piece of equipment in WV (via side access ports)**
  - 406mm diameter
- **Payload Attachment**
  - M6 threaded fasteners in floor, ceiling, & sides
- **Power available to investigation**
  - +28V DC at useable 7 amps
  - +12V DC at useable 2 amps
  - -12V DC at useable 2 amps
  - +5V DC at useable 4 amps
  - +120V DC at useable 8.3 amps
- **Maximum heat dissipation**
  - 1000W Total
    - 800W from coldplate
    - 200W from air flow
- **General illumination**
  - 1000 lux @ 200mm above WV floor
- **Video**
  - 4 color Hitachi HV-C20 cameras
  - 2 Sony DSRV10 Digital Recorders
  - 2 Sony GV-A500 Analog 8mm Recorders
- **Data handling connections**
  - Two RS422-to-MSG for investigations
  - One MIL-BUS-1553B-to-MSG for communication via MLC
  - Ethernet LAN 1 and LAN 2 (in US LAB)
  - MSG Laptop Computer (MLC) – IBM T61P
- **Filtration**
  - 12 HEPA/charcoal/catalyst WV filters
- **1 HEPA/charcoal/catalyst Airlock filter**
- **Up to Two Levels of Containment**
  - Physical barrier of MSG structures, gloves, etc.
  - Negative pressure generated by MSG fans.
- **Other resources available**
  - Gaseous Nitrogen
  - Vacuum (VRS & VES)



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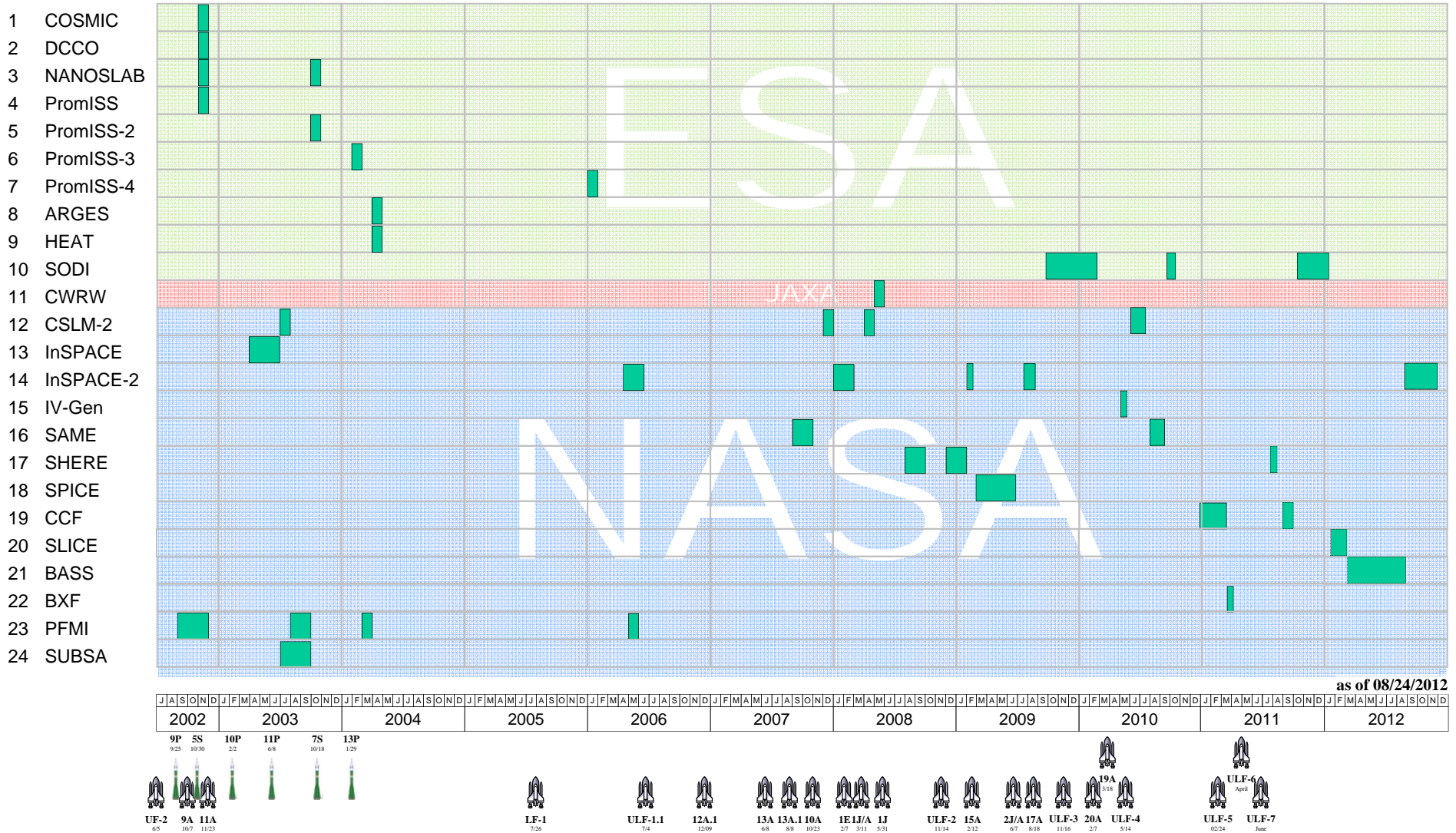
## MSG Flight Unit Cumulative Hours of Operation





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# Microgravity Science Glovebox (MSG) International Utilization of the MSG Facility





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# MSG Investigations

Payload Name & Acronym	Sponsoring Organization	Type of Investigation
Combustion Synthesis under Microgravity Conditions (COSMIC)	ESA	Combustion
Microgravity Experiment for the Measurement of Diffusion Coefficients in Crude Oil (DCCO)	ESA	Diffusion
NANOSLAB	ESA	Zeolite Crystal Growth
Protein Microscope for the International Space Station (PromISS-1,2,3, & 4)	ESA	Protein Crystal Growth
ARGES	ESA	Light Bulb Technology
HEAT	ESA	Heat Pipe Technology
Selectable Optical Diagnostics Instrument (SODI)	ESA	Diffusion and Soret Phenomena
Cell Wall/Resist Wall (CWRW)	JAXA	Plant Growth
Coarsening in Solid Liquid Mixtures-2 (CSLM-2)	NASA	Material Science
Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE-1,2, & 3)	NASA	Magnetorheological (MR) Fluids
IntraVenous Fluids GENERation and mixing (IV-Gen)	NASA	Human Health
Smoke Aerosol Measurement Experiment (SAME)	NASA	Spacecraft Smoke Detection
Shear History Extensional Rheology Experiment (SHERE)	NASA	Polymer
Smoke Point Coflow Experiment (SPICE)	NASA	Combustion
Critical Velocities in Open Capillary Channels (CCF)	NASA	Fluids
Structure and Liftoff in Combustion Experiment (SLICE)	NASA	Combustion
Burning and Suppression of Solids (BASS)	NASA	Combustion
Boiling eXperiment Facility (BXF)	NASA	Heat Transfer
Pore Formation and Mobility Investigation (PFMI)	NASA	Material Science
Solidification Using a Baffle in Sealed Ampoules (SUBSA)	NASA	Material Science



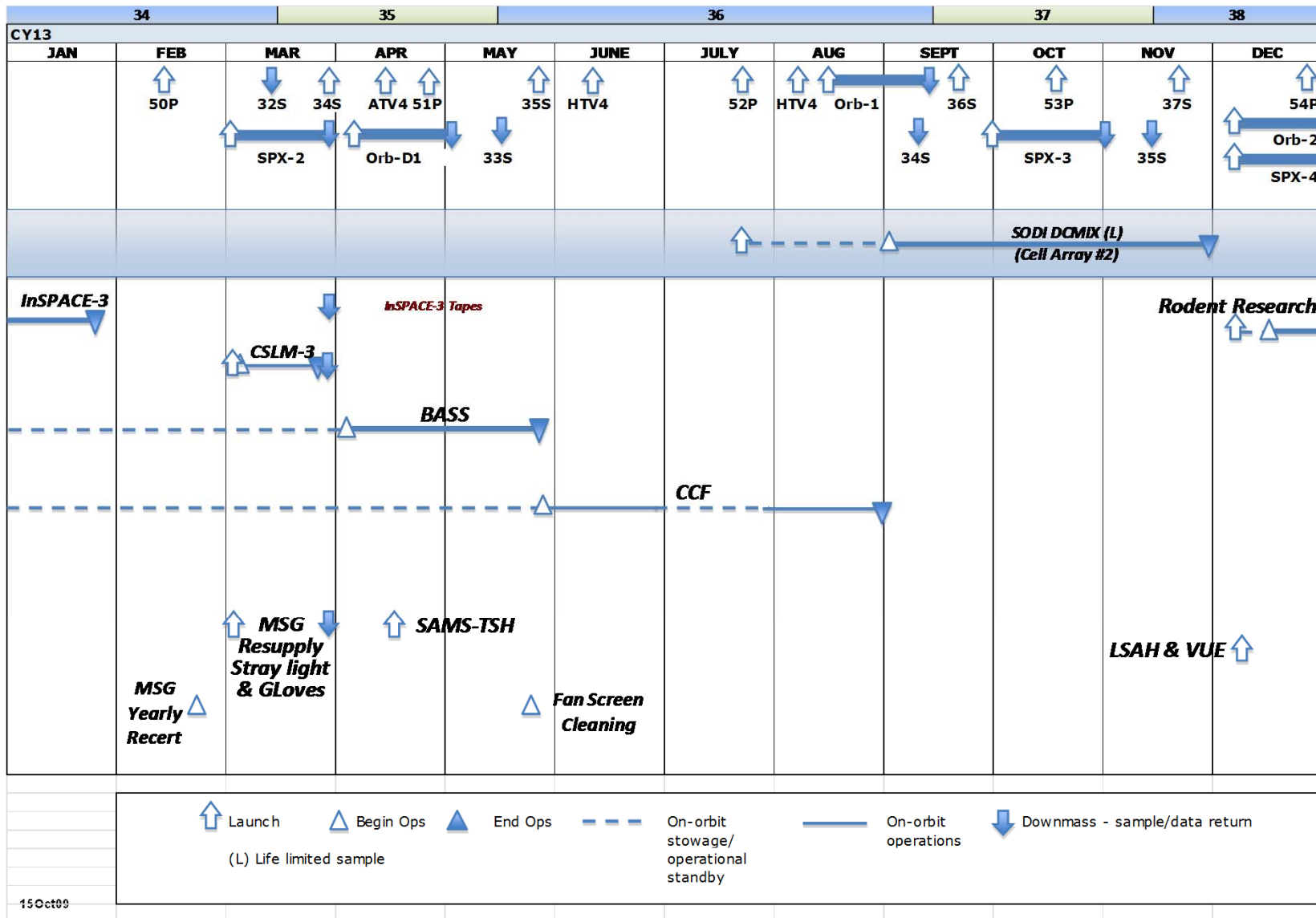


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# Microgravity Science Glovebox (MSG)



## MSG Operations Planned for 2013



15 Oct 09



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# **Life Science Ancillary Hardware (LSAH) Upgrades Available in 2014**



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## MSG LSAH Upgrades

- Materials utilized by Life Science/Biological Research payloads will require additional capabilities for handling and clean up:
  - Filtration System: a capability added to the existing MSG Work Volume air circulation system that scrubs typical life science biological and chemical contaminants from the MSG Work Volume air.
  - Decontamination System: a capability to reduce released biological contaminants (Bio Safety Levels (BSL) 1 and 2) to levels safe for crew exposure and a capability to remove released contaminants from surfaces within the Work Volume.
  - Exchangeable Glove System this is more suited for various life science activities.



MSG Life Science Filters



Decontamination System



Glove & Gauntlet Configuration



Iris & Gauntlet w/Disposable Glove





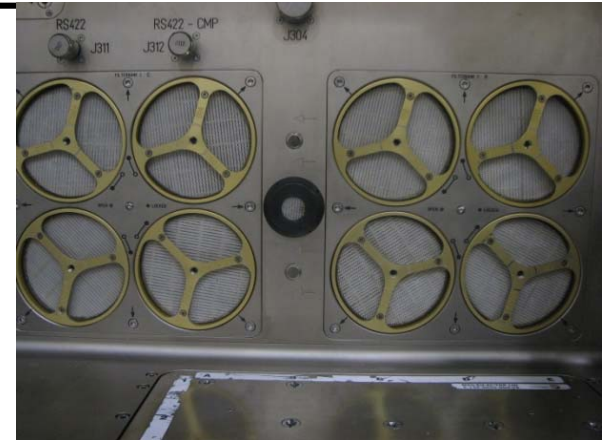
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## Biological Filters

- MSG's Air Handling Unit creates negative pressure in the Work Volume to provide one means of containment
  - Filter banks trap contaminants when air passes once through the filters
  - Current filter components trap typical material-science and combustions contaminants
- New filters will be added to the existing MSG filters
- New filters will trap typical life/biological science contaminant/materials
  - Such as preservatives, fixatives, and other byproducts



**MSG Life Science Filters**



**Sundstrom SR 299-2 ABEK1HgP3R  
Combination Filter**



In MSG's current design, each of the thirteen front filters is easily exchangeable on orbit by the crew.



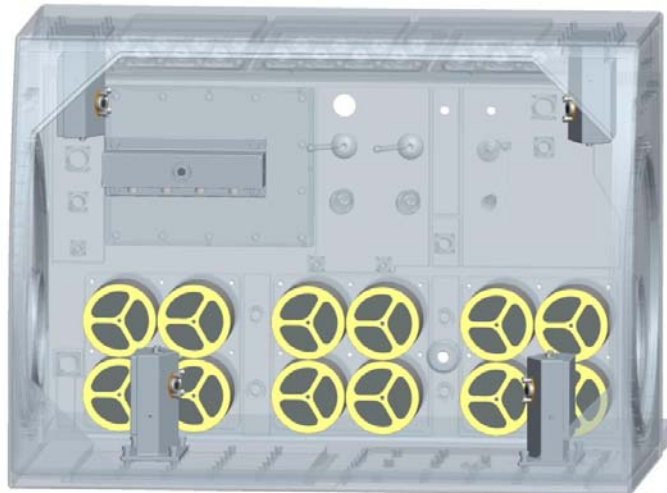
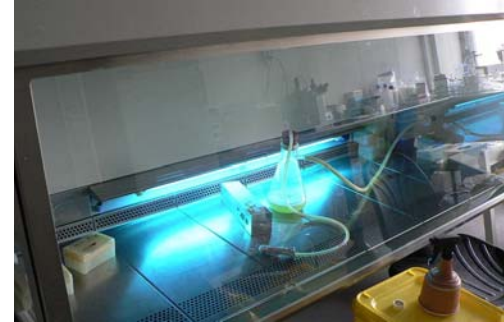
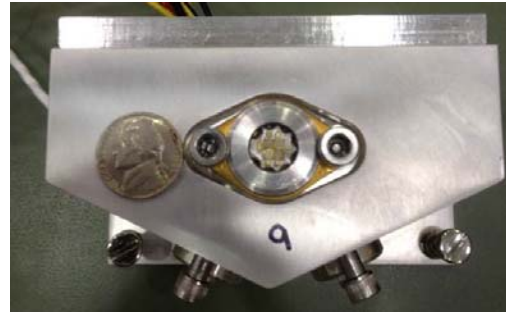
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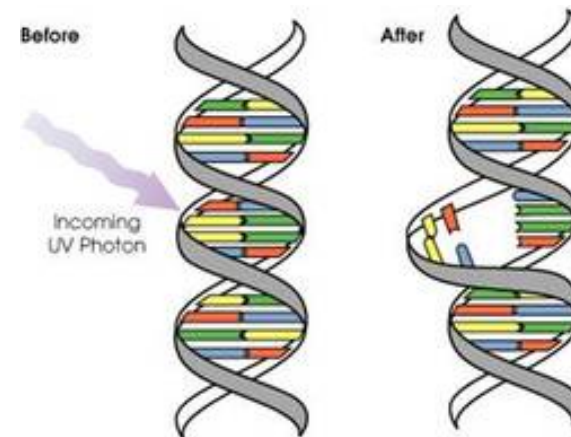
# Decontamination System

- New Decontamination Capability within MSG Work Volume
  - Decontaminate before experiment to prevent contamination of biological samples
  - Decontaminate after experiment to disinfect any released biological materials
- Ground-based labs typically use UV Light or Ozone



**MSG Decontamination System**

Ultraviolet germicidal irradiation is a sterilization method that uses ultraviolet light at sufficiently short wavelength to break down microorganisms. It is used in a variety of applications, such as food, air and water purification.





# Decontamination System

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## List of Microorganisms and Associated UV-C Kill Dosage (99%)

PATHOGEN	BIOSAFETY LEVEL	UV Dose 99% (μW-s/cm <sup>2</sup> )	PATHOGEN	BIOSAFETY LEVEL	UV Dose 99% (μW-s/cm <sup>2</sup> )	PATHOGEN	BIOSAFETY LEVEL	UV Dose 99% (μW-s/cm <sup>2</sup> )
Acinetobacter	2	3,600	Ebertelia typhosa	1	4,100	Proteus mirabilis	2	1,600
Adenovirus	2	11,800	Echovirus	2	1,600	Pseudomonas aeruginosa	1	10,500
Aeromonas	2	2,300	Eurotium (rubrum)	1	86,800	Reovirus	2	54,000
Aspergillus	2	19,200 - 896,000	Fusarium (solani)	1	62,600	Rhizopus	2	34,600 - 896,000
Bacillus anthracis	2	8,700	Haemophilus influenzae	2	7,700	Rhodoturula (spp.)	1	224,000
Bacillus magaterium sp. (spores)	1	5,200	Influenza A virus	2	6,600	Sarcina lutea	1	39,400
Bacillus magaterium sp. (veg)	1	2,500	Klebsiella pneumoniae	2	8,400	Scopulariopsis	2	578,000
Bacillus paratyphus	1	6,100	Legionella pneumophila	2	2,600	Serratia marcescens	1	21,000
Bacillus subtilis spores	2	11,000	Leptospira interrogans - infectious Ja	1	6,000	Spirillum rubrum	1	8,800
Blastomyces dermatitidis	2	28,000	Listeria monocytogenes	2	31,100	Sporothrix schenckii	2	56,000
Botrytis cinerea	1	50,000	Measles virus	2	4,400	Staphylococcus albus	1	5,720
Burkholderia cenocepacia	1	11,600	Micrococcus candidus	1	12,300	Staphylococcus aureus	2	6,600
Candida albicans	1	150,000	Micrococcus sphaeroides	1	15,400	Staphylococcus epidermis	1	57,600
Cladosporium	2	37,800 - 896,000	Mucor (mucedo)	1	120,000	Staphylococcus hemolyticus	1	5,500
Clostridium perfringens	2	27,100	Mycobacterium avium	2	16,800	Staphylococcus lactis	1	8,800
Coronavirus	2	1,400	Mycobacterium kansasii	2	16,000	Streptococcus pyogenes	2	7,500
Corynebacterium diphtheriae	2	6,500	Mycoplasma pneumoniae	2	1,700	Streptococcus viridans	2	3,800
Coxsackievirus	2	23,000	Neisseria catarrhalis	2	8,500	Trichophyton	2	112,000
Cryptococcus neoformans	2	56,000	Nocardia asteroides	2	56,000	Ustilago (Zaeae)	1	224,000
Curvularia lunata	1	112,000	Phytomonas tumefaciens	1	8,500	Vaccinia virus	2	143,000
<b>Molds</b>			<b>BIOLOGICAL AGENTS</b>			<b>Protozoa</b>		
Aspergillus flavus	2	99,000	Hepatitis A	2	8,000	Chlorella Vulgaris	1	22,000
Aspergillus glaucus	2	88,000	Salmonella typhi	2	15,200	Paramecium	1	200,000
Aspergillus niger	2	330,000	Shigella	2	4,200			
Mucor racemosus A	2	35,200	Vibrio cholerae	2	6,500	<b>Virus</b>		
Mucor racemosus B	2	35,200				Bacteriophage - E. Coli	1	6,600
Oospora lactis	1	11,000	<b>Yeast</b>			Poliovirus - Poliomyelitis	2	6,000
Penicillium expansum	2	22,000	Brewers yeast	1	8,800	Tobacco mosaic	1	440,000
Penicillium roqueforti	2	26,400	Common yeast cake	1	13,200			
Penicillium digitatum	2	88,000	Saccharomyces cerevisiae	1	13,200			



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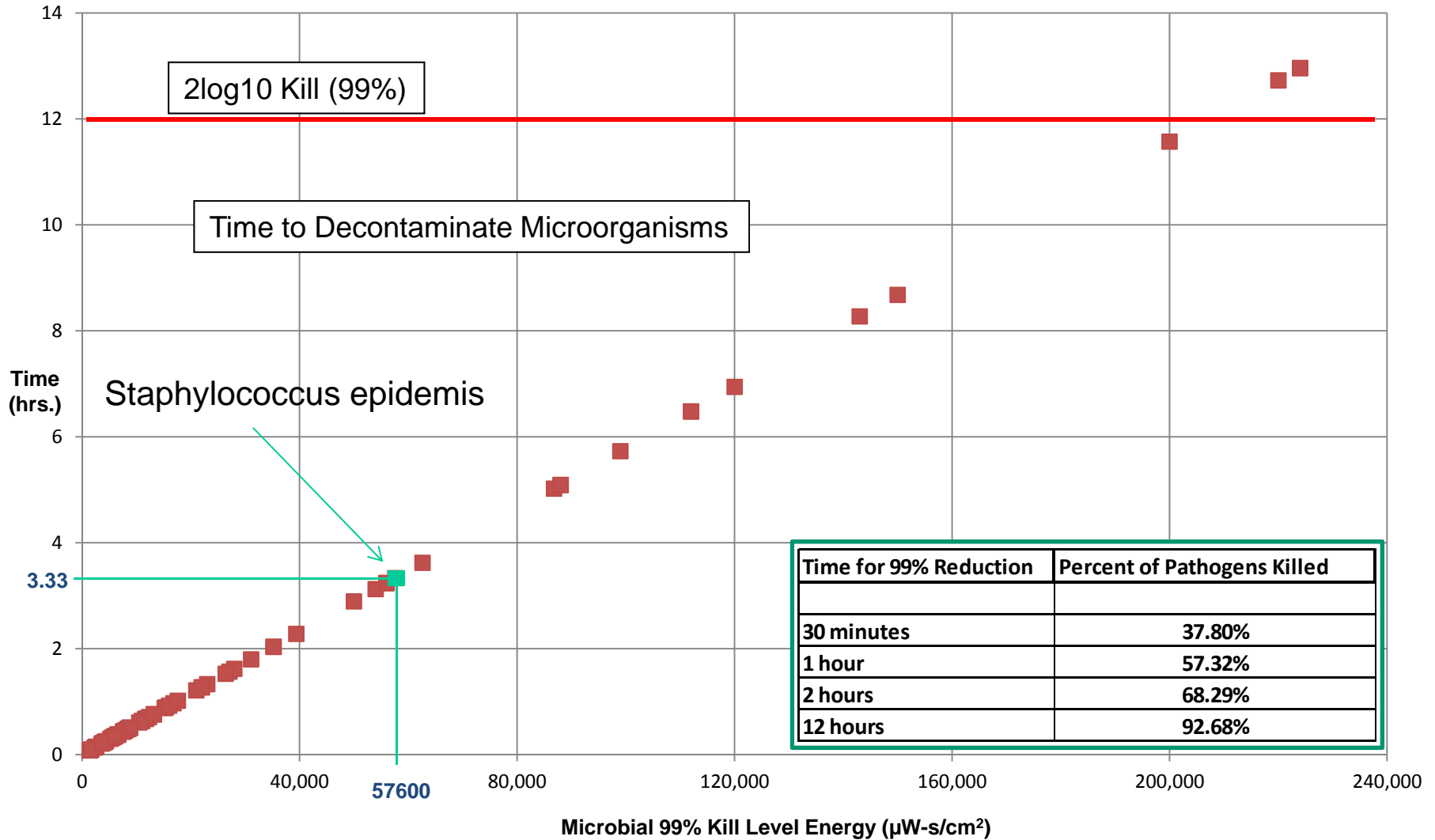
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# Decontamination System

## Microorganisms That Can Be Decontaminated Within 12 Hours





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## Dexterous/Tactile Gloves

- **Biotech Gloves**
  - Thinner Gloves that provide more dexterity and sense of touch
  - 7 mil Hypalon Glove
  - Typical exam gloves are ~6 mils
- Will adapt existing MSG design



MSG has four glove ports; two on the front window and one on each side port. Glove ring assemblies can be installed in any glove ports as required by an investigation.

Gloves will be provided in three sizes  
7,9, & 10.



MSG Glove & Gauntlet Configuration  
(7 mil Hypalon Glove, 15 mil Gauntlet)



MSG Iris & Gauntlet Configuration



MSG Iris & Gauntlet With Nitrile Disposable Glove





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# Video Upgrade Equipment (VUE) Available in 2014



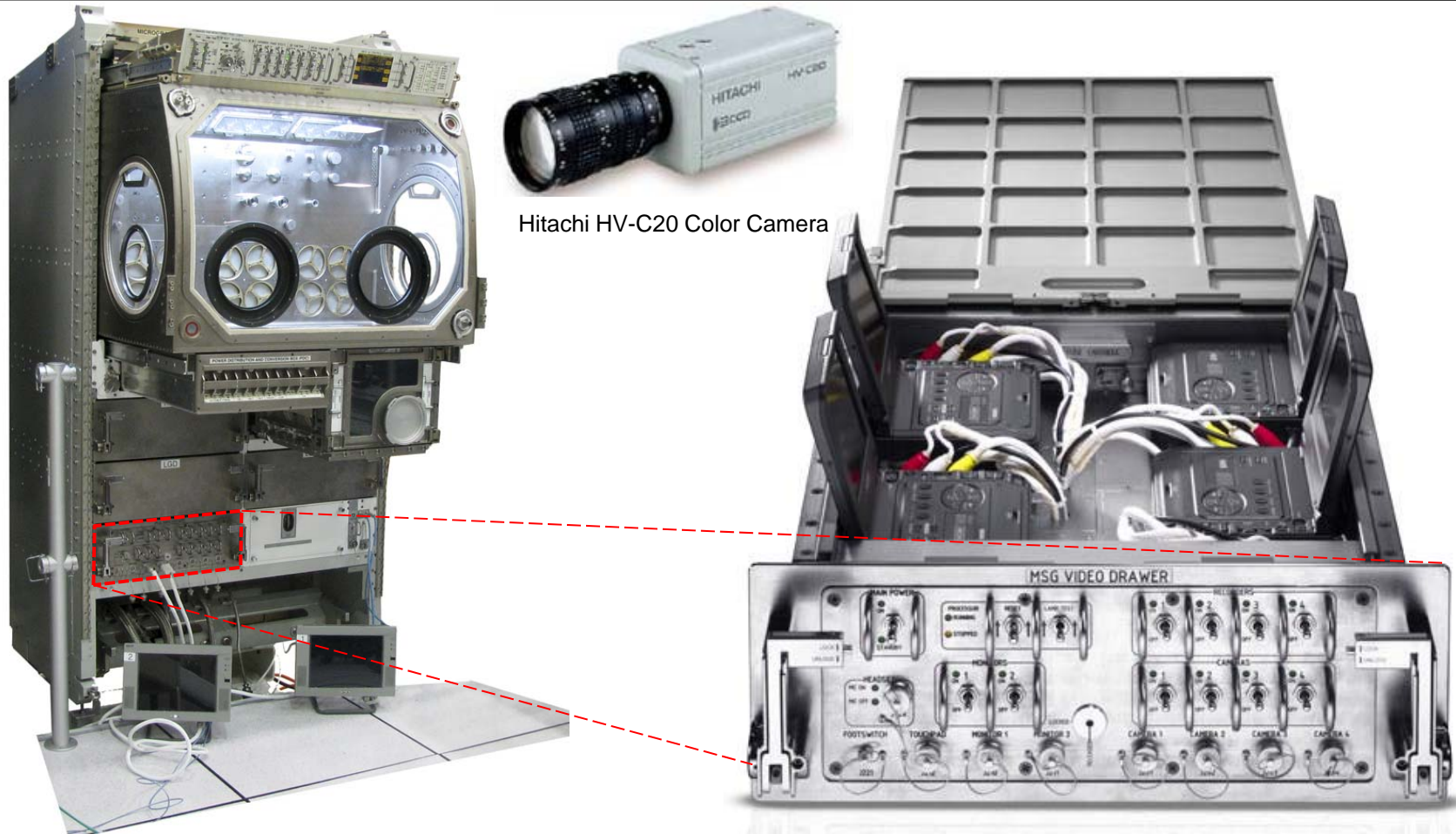
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## Current MSG Video System



Hitachi HV-C20 Color Camera

Pictured above in the bottom left drawer location of the MSG Engineering Unit, the MSG Video Drawer is shown connected to two video monitors. The Video Drawer is the main component of the MSG Video System.

In addition to accommodating 4 exchangeable video recorders, the Video Drawer contains power, communications, and remote control systems. The front panel allows for the crew to switch power to individual cameras, recorders, and monitors and to connect the various external components, including cameras and monitors.



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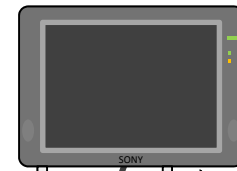
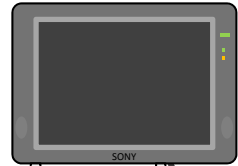


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## Typical MSG Video System Setup

The Video Drawer supports up to four cameras which can be located inside or outside the Work Volume. This example shows two cameras inside the Work Volume connected to the interior connectors of the video feed-thru.

Video Feed-thru's can be installed in any or all of the three feed-thru ports located on the upper-left, upper-right, and lower right of the Work Volume.



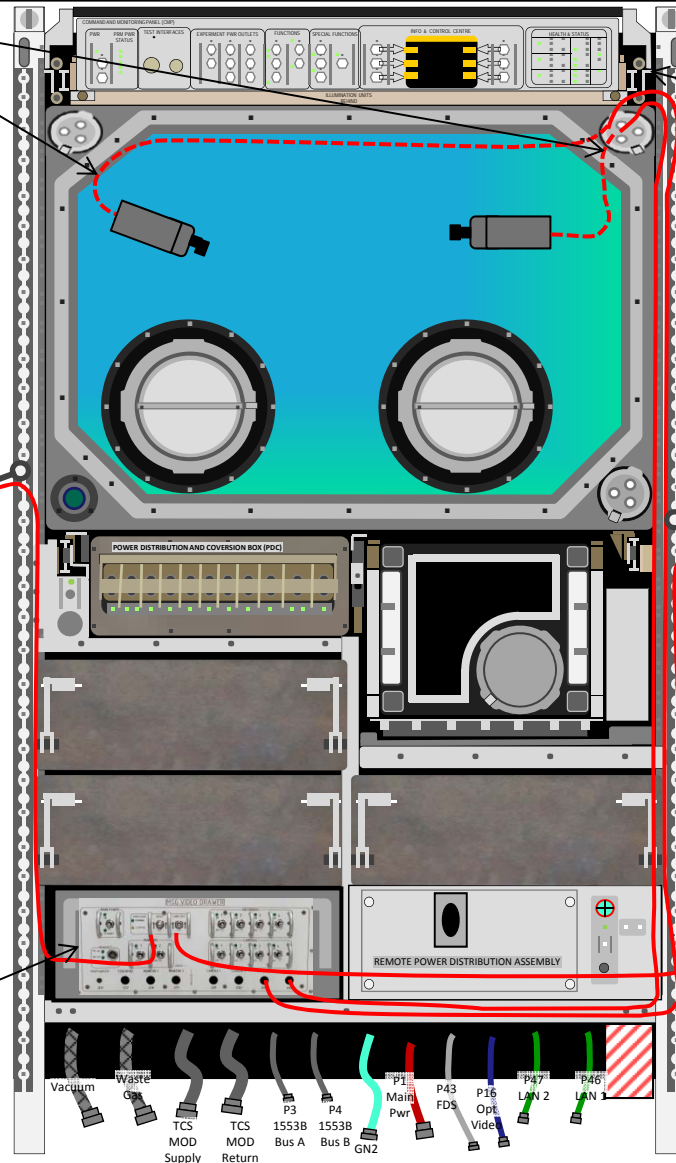
Two Video Monitors connect to the front panel of the Video Drawer. They could be located inside the Work Volume if required.

The Video Touchpad can be connected to either monitor or to the front Panel of the Video Drawer. It allows the crew to command the Video Drawer with a GUI display on the monitor.



The Video Drawer contains the video recorders, switcher, converters, and commanding system. Commands can be initiated from crew via the touchpad, from the ground, or from the experiment hardware.

W301 Video Extension Cables camera inside the work volume to the front panel of the Video Drawer via the video feed-thru.





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## Video System Overview



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- 
- The MSG Video Upgrade Equipment (VUE) will be capable of recording, storing, and transferring high definition/high resolution/high speed, color digital video data to ISS for downlinking.
  - The VUE will utilize significantly higher video resolution and speeds than the existing MSG video system thereby enhancing research observation activities
  - The MSG VUE consist of the following enhancements:
    - Powered ISIS drawer containing computer control and supporting electronics
    - High speed/high resolution cameras
    - High definition video cameras
    - GigE compatibility
    - Four terabytes of data storage via two 2 Tb Solid State RAID drives.
    - Digital video data output capabilities for ISS to ground downlink. Downlink rates - up to 6 Mbps or higher depending on available bandwidth of the ISS LAN.



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## VUE Camera Summary

Name	Type	Resolution	Sensor Size	Max Output
Prosilica 1050C	GigE	1024H x 1024V	1/2" Type CCD	1024 x 1024 w/ 8/12 Bit Color up to 109 fps
Prosilica 1910C	GigE	1920H x 1080V	2/3" Type CCD	1920 x 1080 w/ 8/12 Bit Color up to 55 fps
Flare 2KSDI	HD-SDI	2048H x 1088V (1920H x 1080V)	2/3" Type CMOS	2048 x 1088 w/ 10 Bit Color up to 30 fps
Hitachi HV C20 (Existing – to be replaced)	Analog RGB	768H x 494V	1/2" CCD	768 x 494 @30fps



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## VUE Cameras



Size w/o lens (inches)  
1.7 L x 2.5 W x 2.5 H  
(w/o connectors)



Shown with Non-VUE Lenses



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## Conclusion

- The MSG is a very versatile and capable research facility on the ISS.
- The Microgravity Science Glovebox (MSG) on the International Space Station (ISS) has been used for a large body of research in material science, heat transfer, crystal growth, life sciences, smoke detection, combustion, plant growth, human health, and technology demonstration.
- MSG is an ideal platform for gravity-dependent phenomena related research. Moreover, the MSG provides engineers and scientists a platform for research in an environment similar to the one that spacecraft and crew members will actually experience during space travel and exploration.
- The MSG facility is ideally suited to provide quick, relatively inexpensive access to space for National Lab type investigations.





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# Acknowledgements

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