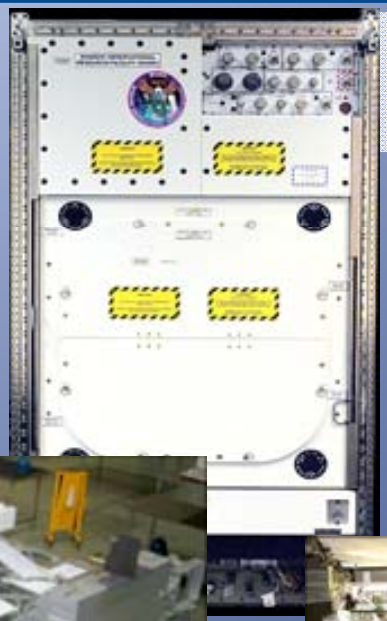
MSFC ISS Payload Ground Facilities

Material Science Research Rack

Window Observational Research Facility



ExPress Logistics Carrier

Microgravity Science Glovebox

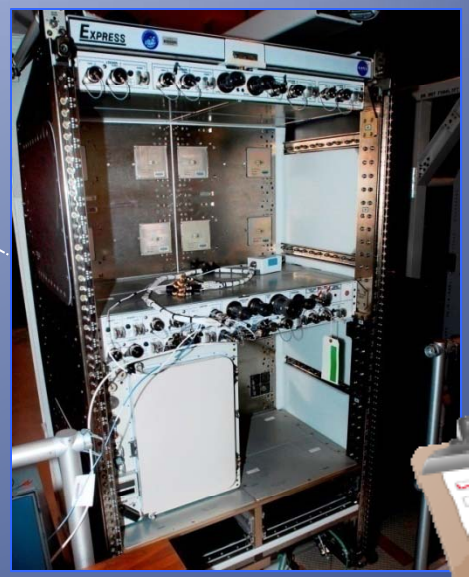
Expedite the Processing of Experiments to the Space Station (EXPRESS) Rack

Development and Testing for EXPRESS Rack & WORF Payloads

Payload Laptop runs CScS to support Payload SW development

Remote Payload Development test prior to shipment

Payload Shipment to MSFC



Payload Shipment to launch site

Offgas

Vibration

EMI/EMC

Acoustics

Additional Service s Available

ISS-Provided Common Suitcase Simulator Software (CScS)

Telescience Resource Kit (TReK) Software
- Payload ops on ISS
- Remote Payload ground ops

- Payload to Rack Interfaces verified efficiently for both Payload Developer and ISS
- Human Factors Team evaluates hardware locally
- End-to-End data flow
- Ops Cadre familiarization
- Validation of Crew Procedures

Integrated Testing for MSG Payloads

Payload Shipment to MSFC

Engineering Unit

- Payload to Rack Interfaces (elec, mech, data, s/w) verified efficiently for Payload Developer and ISS
- Labeling of all hardware per ISS standards
- Human Factors Team evaluates hardware concurrently
- End-to-End data flow
- Ops Cadre familiarization
- Validation of Crew Procedures

Add'l services available

- Offgas
- Vibration
- EMI/EMC
- Acoustics

Payload shipment to launch site

Additional MSG Ground Facilities

Ground Unit – available to Payload Developer for early development testing at MSFC

Training Unit – used for Crew Training at JSC

MSRR/MSL Ground Test Facilities

- Marshall Space Flight Center (MSFC) in Huntsville, AL
  - Payload Rack Checkout Unit (PRCU) simulates the ISS environment
  - MSRR Ground Rack provides ground testing capability
- Microgravity User Support Center (MUSC) in Cologne, Germany
  - MSL, LGF, and SQF Engineering and Science Reference Models provide sample processing program validation capability and ground testing capability
- Sustaining Engineering and Operations personnel are available to provide payload integration, ground test, and real-time on-orbit operations support

MSFC Ground Lab including PRCU

MUSC Ground Lab

ExPRESS Logistics Carrier (ELC) Payload Development & Verification Testing

- ELC Suitcase Simulator
  - Portable test environment for the development and test of ELC experiment payloads signal interfaces.
  - Interfaces are similar to Instrument Interface panel in Flight Releasable Attachment Mechanism (FRAM)

- STEP + Patch S/W
  - Portable test environment for development & test of ELC payloads

ELC Functional Equivalent Unit (FEU)

- Used by Payload Software Integration Verification (PSIV) Test Facility (located @ MSFC) to verify ELC flight S/W and the experiment payloads during ground based testing.
- Test environment for development and test of ELC experiment payloads C&DH interfaces.

ELC Simulator

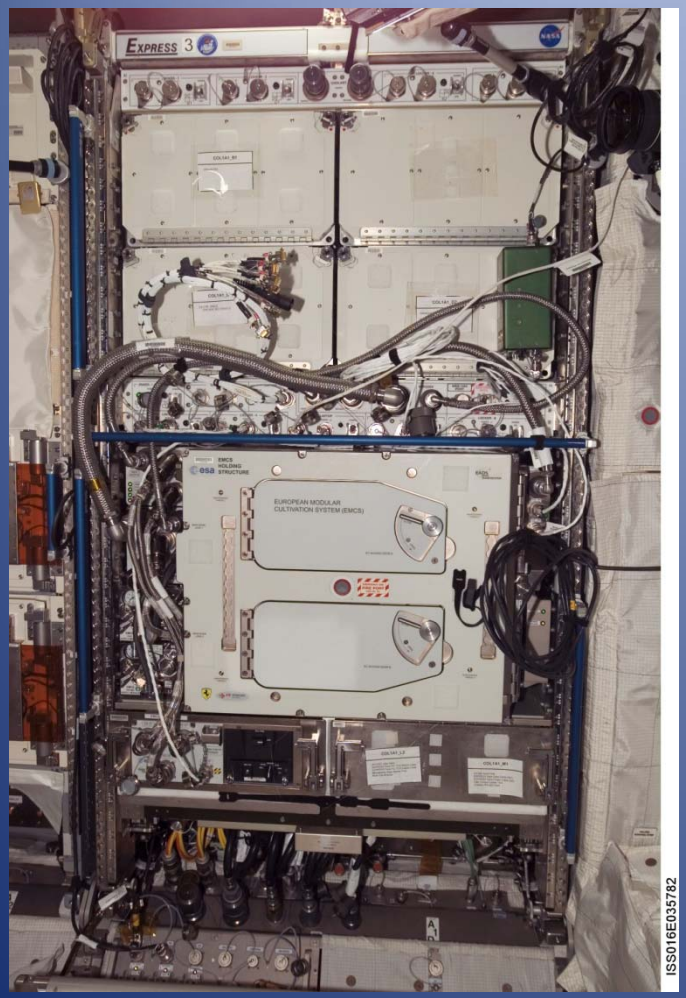
- High Fidelity Functional Unit of the ELC
- Will be used for testing and verification of the Payloads Developer's C&DH and Power Interfaces
- Perform End to End testing

Development Testing

- Development testing recommended
  - Drives out operational issues early
  - Payload Developer can draw on development test experience during payload completion
  - Final testing/verification/end-to-end data flow performed more efficiently

BACKUP

EXPRESS Rack



EXPRESS Rack 3 with European Modular Cultivation System operating in Columbus Module

- Multi-Use Facility which provides standard interfaces and resources for Middeck Locker-type and International Subrack Interface Standard (ISIS)Payloads
  - 28Vdc power
  - Ethernet, RS422 , Analog, and Discrete
  - Air and Water (2 locations per rack) Cooling
  - NTSC Video
  - Vacuum Exhaust (1 location per rack)
  - Nitrogen Supply (1 location per rack)
- Eight flight racks
  - ER1, ER2, ER3, ER4, ER5, ER6, and ER7 on-orbit
  - ER8 will launch on ULF-5, November 2010
- Trainer Racks at JSC and MSFC to support crew and ground training
- Functional Checkout Unit to support payload testing at MSFC

Window Observational Research Facility (WORF)

- The **Window Observational Research Facility (WORF)** Rack is a unique facility, designed using standard ISPR and EXPRESS heritage hardware, for use with the Destiny Module science window.
- WORF provides valuable resources ,a stable mounting platform, and a “darkroom” environment for up to five Earth science payload instruments
- WORF also provides protection for the Lab science window

Power

- Solid State Power Controller Module (SSPCM) converts station power for payload use
- 28Vdc Power (+1.5, -2.5 Vdc) provided to payloads
- Current limiting available at 5, 10, 15, 20 amp settings
- 1900 W possible but total is restricted by thermal constraints and overall vehicle capability
- 120 Vdc interface in rack not for nominal payload use (can be negotiated)

Thermal

- Avionics Air Assembly (AAA) ducted cooling (50 cfm) provides 336 W heat rejection from the payload volume. An air knife provides air flow across the window to prevent condensation
- Moderate Temp Loop (MTL) water cooling (40 lbm/hr) is available for 500 W heat rejection using the connections either on the rack front or internal connector panels.
- Passive heat rejection to the cabin air is limited and allocated based on actual payload compliment.
- Smoke detection available for air-cooled payloads

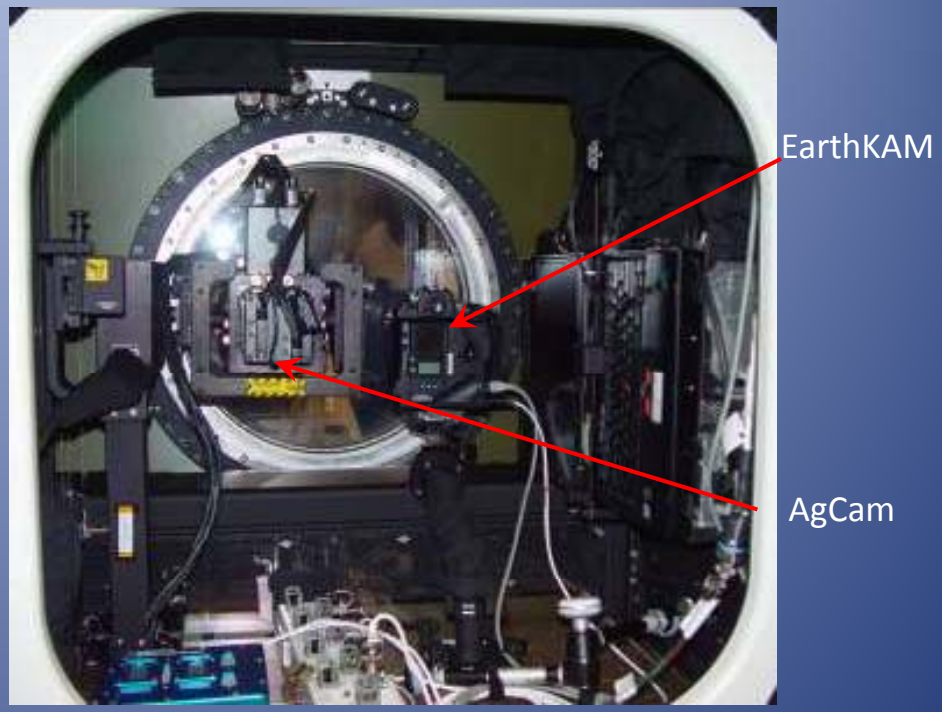
Data

- Each data connector includes pins for RS-422, Ethernet, NTSC RS-170A Video, 5 Vdc bi-directional differential discrete, +/- 5Vdc differential analog
- Pass-through connectors include SCSI-2, S-Video, Ethernet, RS-232, RS-422
- WORF Laptop Computer available for payload-specific software and/or crew interfaces
- Parameter monitoring available for water-cooled payloads

Not Available: Vacuum Resource, Vacuum Exhaust, Nitrogen, Low Temperature Loop

WORF Payloads

- WORF trainer is located at JSC Building 9
  - The trainer is used to check physical interfaces, develop installation procedures, and to train the astronauts
- WORF payload verification testing will be performed at MSFC with the Payload Rack Checkout Unit and the EXPRESS Rack FCU to simulate ISS interfaces



AgCam and EarthKAM installed together in the WORF Trainer Rack at JSC

MSG Overview

PURPOSE

- Provide an on-orbit facility that offers a sealed work environment and two levels of containment for hazardous materials processing

GOALS & OBJECTIVES

- Provide an enclosed isolated working environment with distributed resources for the implementation and observation of investigations aboard the ISS
- Provide efficient integration of payloads including International Partners and accommodate multiple payload disciplines
- Provide power to experiments (5vdc, 12vdc, 28vdc and 120 vdc) and 1000W of heat dissipation
- Provide real-time data and video downlink plus uplink of commands to experiment computer

MSG has been performing research on ISS since 2002

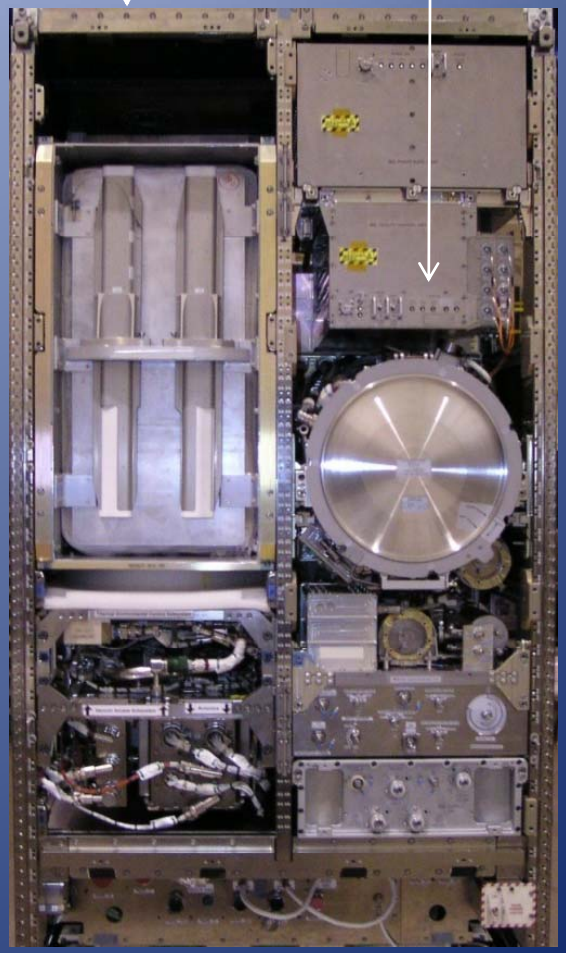
Work Volume (0.255m3)	906mm wide x 637 mm high 500mm deep (at floor), 385mm deep (at top)
Experiment Size	Max 406mm diameter (insertion through side port)
Power To Experiments (1000 watts total)	7 amps @ 28volts, 8 amps @ 5 volts 2 amps @ +12volts, 2 amps @ -12volts 8.3 amps @120 volts
Heat Dissipation	800 watts from cold plate; 200 watts from air flow
Video	4 video cameras, 4 recorders
Data Handling	Two S422, One MIL-BUS-1553B, Two Ethernet

MSRR/MSL

- Materials Science Research Rack (MSRR-1)
  - Resident in US Lab on board the ISS
  - Includes the following:
    - System resources (power, data, thermal control, vacuum, active rack isolation, etc.)
    - Materials Science Laboratory (MSL)
    - 2 Furnace Inserts - Low Gradient Furnace (LGF) and Solidification and Quenching Furnace (SQF)
  - Serves as a multi-user, multi-purpose facility for high temperature research in metallurgical solidification, semiconductor crystal growth, and measurement of thermo-physical properties of materials.
  - Highly automated facility which can be controlled by ground commanding and sample processing programs

MSRR-1 Flight Unit

MSL



LGF – SQF Furnace Inserts

Sample Cartridge Assembly

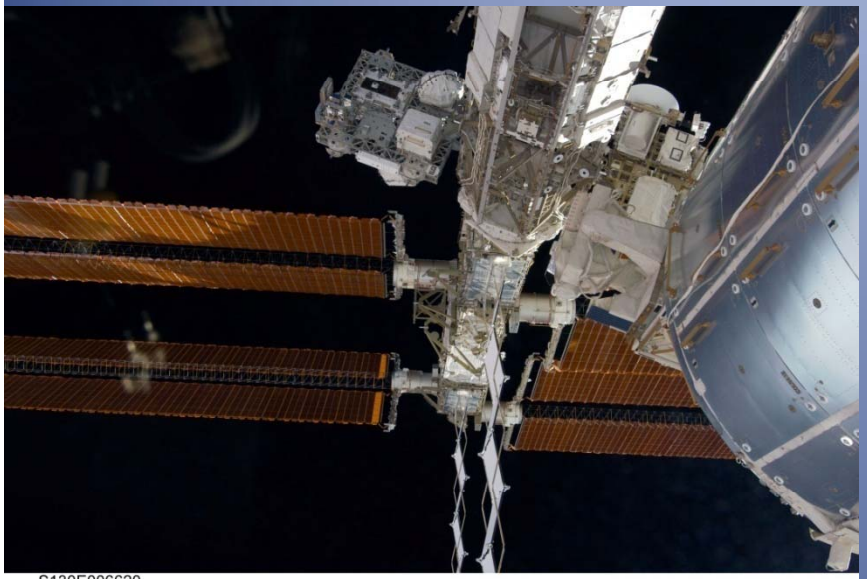
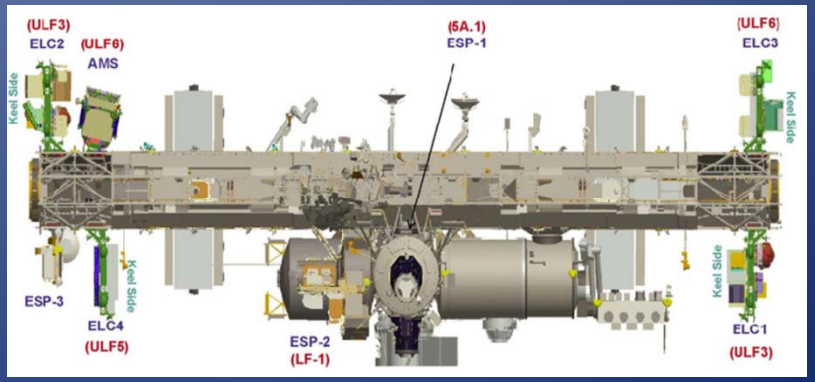
MSRR/MSL Ground Control Rooms

- MSRR/MSL ground control for on-orbit operations provided via operations teams at 2 locations:
  - Huntsville Operations Support Center (HOSC) in Huntsville, AL
  - Microgravity User Support Center (MUSC) in Cologne, Germany
- PIs/PDs can support on-orbit operations from these Ground Control Rooms or from a PI/PD provided remote "telescience" center
- Sustaining Engineering and Operations personnel are available to provide payload integration, real-time on-orbit operations, and ground test support

MSRR Ground Control Room

MUSC Ground Control Room

ExPRESS Logistics Carrier



- The 4 ExPRESS Logistics Carriers each provide 2 payload locations.
- Payload Accommodations
  - 34”W x 46”L x 49”H
  - 781 pounds maximum
- Payload Services
  - 120V primary power
  - 28V secondary power
  - Ethernet
  - 1553, analog, discrete