



International Space Station Panel

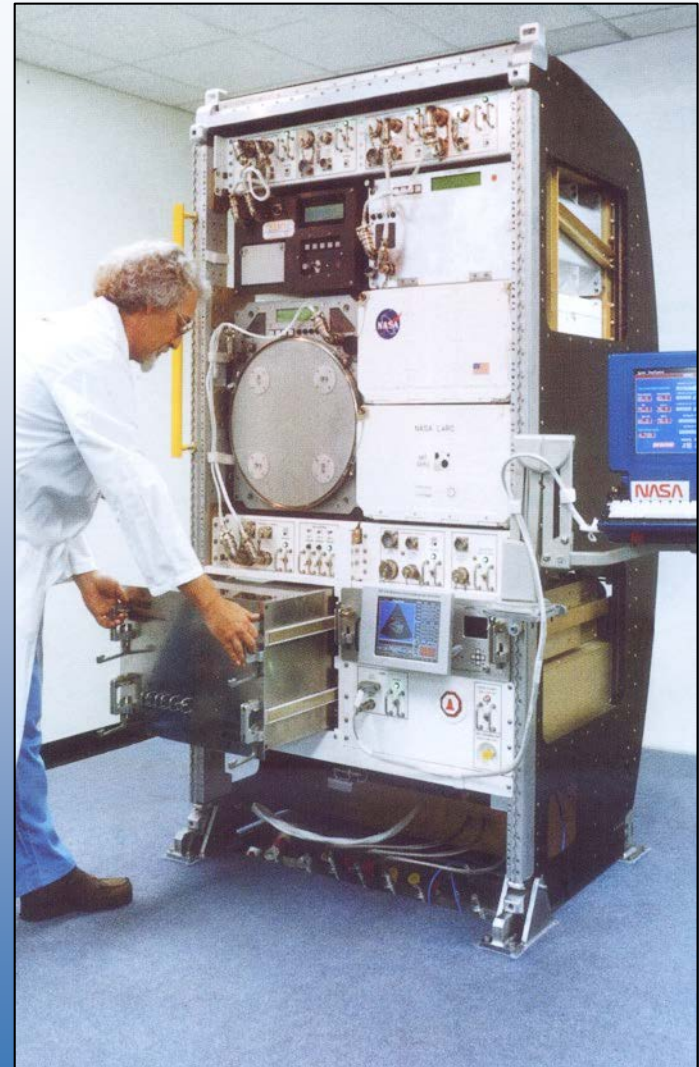
Payload Facilities

September 5, 2019

**EXPRESS Racks and
Materials Science Research Rack
Annette Sledd**

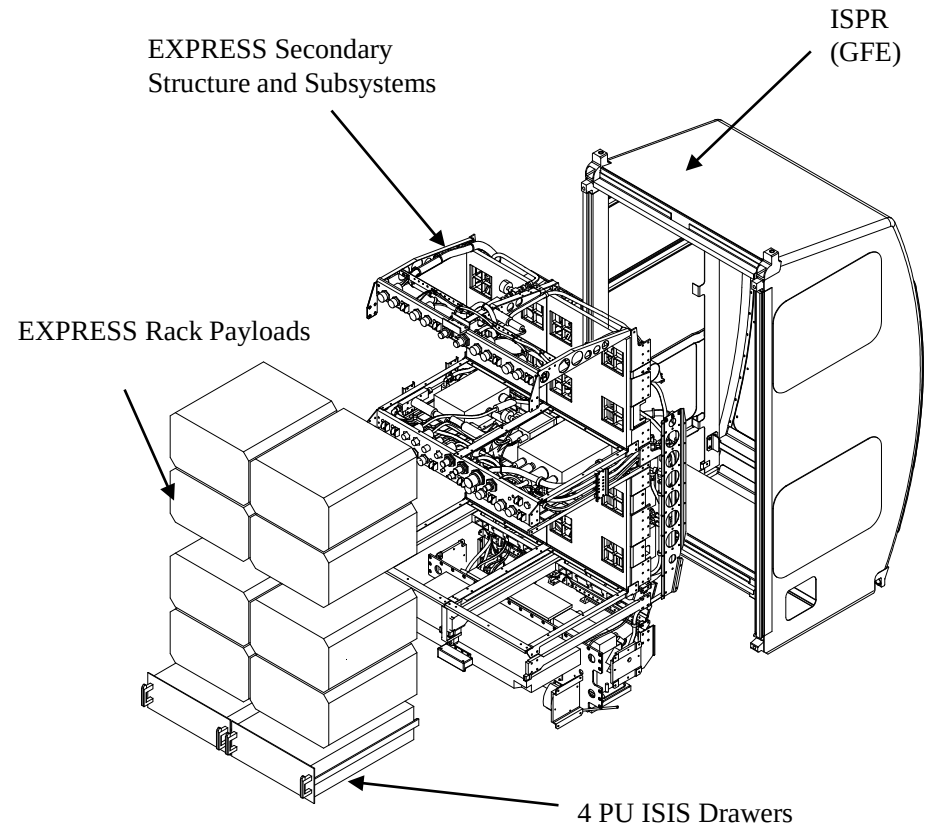
EXPRESS Rack Background

- In early years of ISS planning, Research representatives and advocates discussed a multi-use Research facility
 - Modular concept
 - Simple/standard interfaces
 - Streamlined integration processes
 - Accommodation of small experiments on the Space Station
- Early 1990's the **EXpedite the PROcessing of Experiments to Space Station** "**EXPRESS**" Rack Concept was developed
- One Year Study (1993) approved
 - Ground Demonstration Unit
 - Trade Studies for packaging, avionics, cooling
 - Operations concepts



EXPRESS Rack Flight Project

- Flight EXPRESS Rack Project approved in 1994
- Collaborative team consisting of various scientific Disciplines and sponsoring organizations (research, commercial, technology) established to develop top level requirements
- Precursor programs, Space Shuttle Middeck and SpaceLab, highly influenced the requirements
 - Physical Sciences desired Shuttle Middeck Locker-type interfaces
 - Life Sciences preferred a Standard Drawer-type interface
- Power, Data, Video, and Cooling requirements defined
- Eight EXPRESS Racks planned
- Ground support hardware to support payload testing and crew training
- Space Station/US Lab design and build occurred concurrently



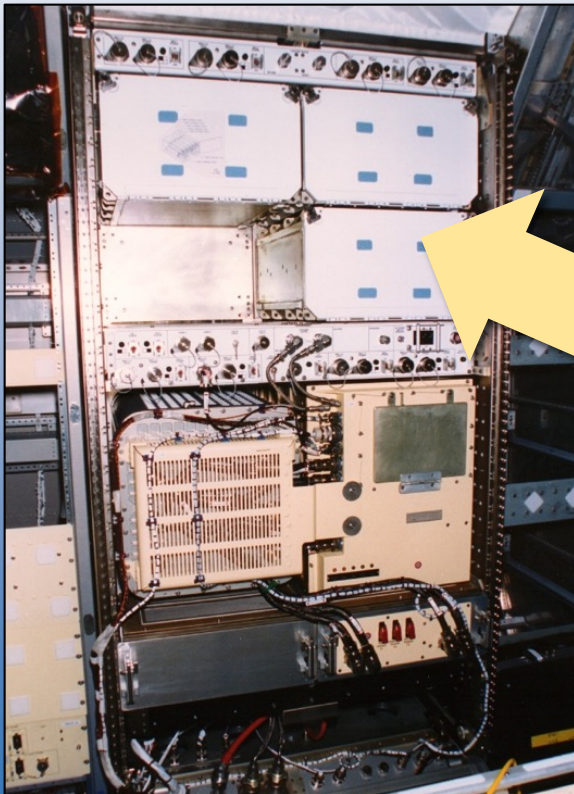
EXPRESS Rack Features



Maximizes front accessible volume for payloads with subsystems packaged efficiently in the back of the rack and behind connector panels

EXPRESS Rack Flight Demonstration

- Flight Demonstration of EXPRESS Rack approved for SpaceLab, Materials Science Lab -1
- SpaceLab provided interfacing hardware to accommodate ISS Rack structure
 - PHASE payload integrated into lower portion of rack for launch
 - Astro/PGBA launched in Shuttle Middeck and relocated to EXPRESS Rack on-orbit to validate ISS Operations concept



EXPRESS Rack Overview

8 ISS LOCKERS ACCOMMODATED

- Single, double, & quad lockers accommodated

SEAT TRACK

POWER CONNECTIONS

- 28 VDC
- Automatic failover to auxiliary power

2 ISIS DRAWERS ACCOMMODATED

- Blind mate connectors for power and data



Upper control panel (lockers 1,2,5,6):

- Power and data connections
- Power switch/indicator lights
- MTL supply and return supports water-cooled payloads

Lower control panel (lockers 3,4,7,8):

- Upper panel contents +
- Vacuum Exhaust System connection
- Nitrogen supply connection
- Rack Power Switch
- Laptop power/data/switch
- Smoke indication light
- Fireport
- ISIS drawer power switch/indicator lights

AVIONICS AIR VENTS

- Supports air-cooled payloads
- Provides smoke detection

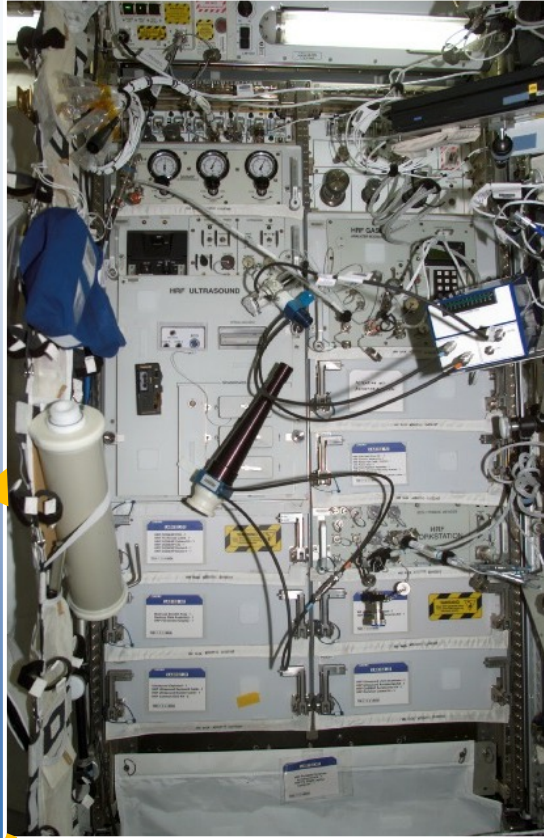
RACK-TO-ISS INTERFACES

EXPRESS and Derivative Racks

EXPRESS Rack



Human Research Facility

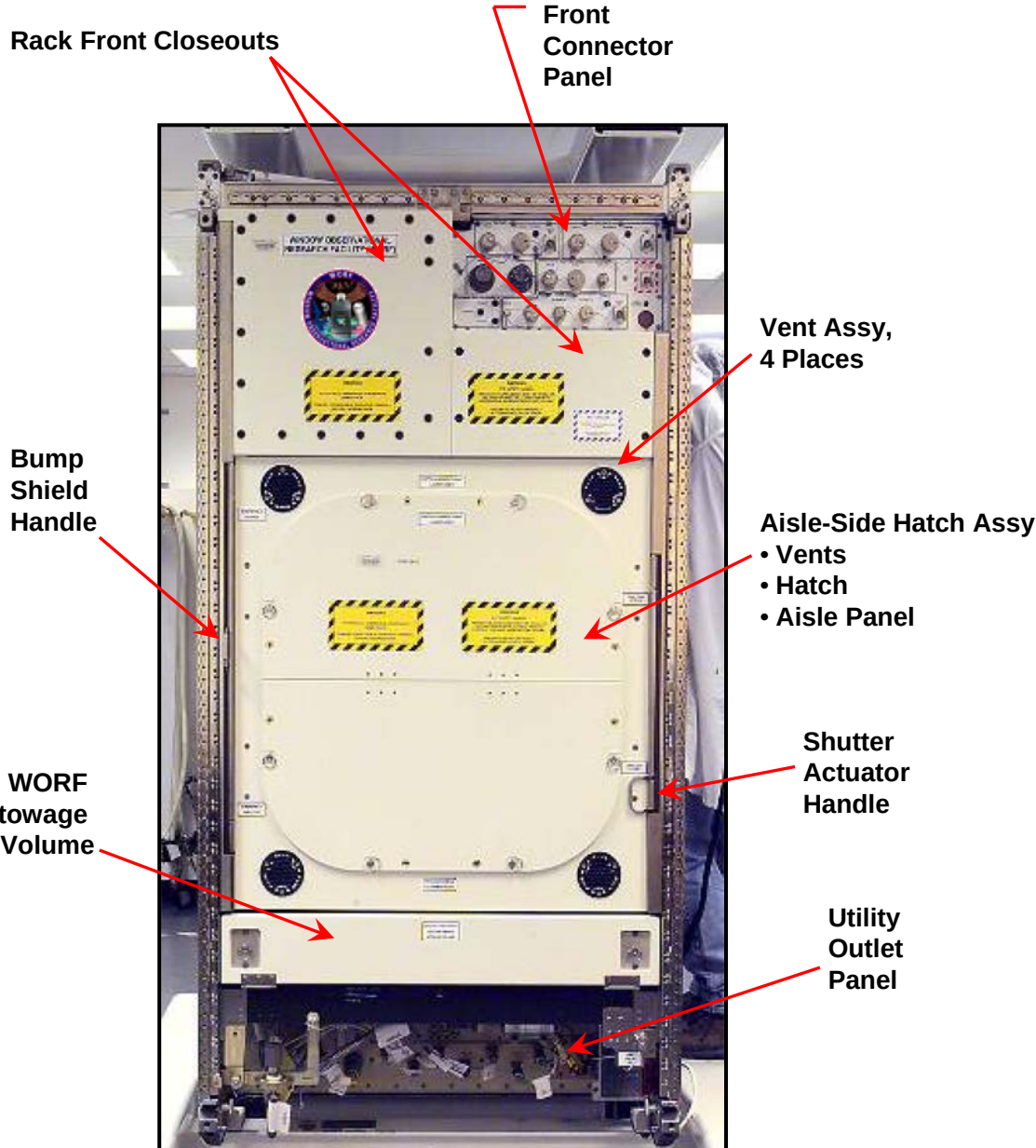


Window Observational Research Facility



- Common Avionics and Software has resulted in synergy and savings in provision of spares and software updates

Window Observational Research Facility



- The **Window Observational Research Facility (WORF) Rack** facilitates Earth Viewing Science using Optical Quality Window in US Lab
- Provides Power and Data interfaces for up to 5 payloads
 - Up to 3 internal, depending on space needed, and
 - Up to 2 external
- Provides avionics air cooling for instruments and crew comfort
- Moderate Temperature Loop Water cooling for avionics
- Provides stable mounting platform and “darkroom” environment for payload instruments
- The Bump Shield provides protection to the US Lab window when crewmembers are working inside the payload volume
- The **Shutter Actuation System (SAS)** allows the external shutter to be ground commanded open and closed

Basic EXPRESS Rack Overview

8 ISS LOCKERS ACCOMMODATED

- Single, double, & quad+ lockers accommodated

PAYLOAD MOD TEMP TCS SUPPLY/RETURN

- Supports water-cooled payloads

ETHERNET PANEL

- 10 RJ45 connectors
- 4 EXPRESS-type connectors
- 100 Mbps Hirschmann Switch

SEAT TRACK

AVIONICS AIR VENTS

- Supports air-cooled payloads
- Provides smoke detection

POWER CONNECTIONS

- 28 VDC
- Automatic failover to auxiliary power

LAPTOP POWER

120VDC to 120VAC POWER INVERTER (accommodated, not shown)

- 4 household 3-prong AC outlets
- 800W total

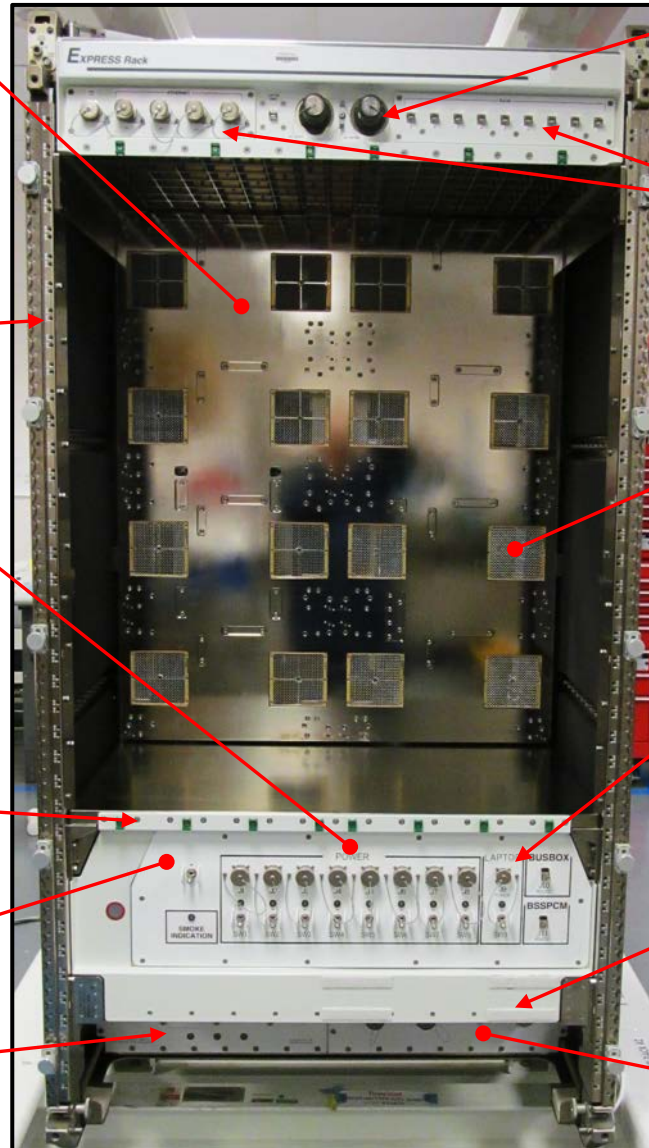
LOWER SHELF ASSY

USER PANEL

- Rack Maintenance Switch
- Payload power switches

TCS MANUAL VALVES

RACK-TO-ISS INTERFACES



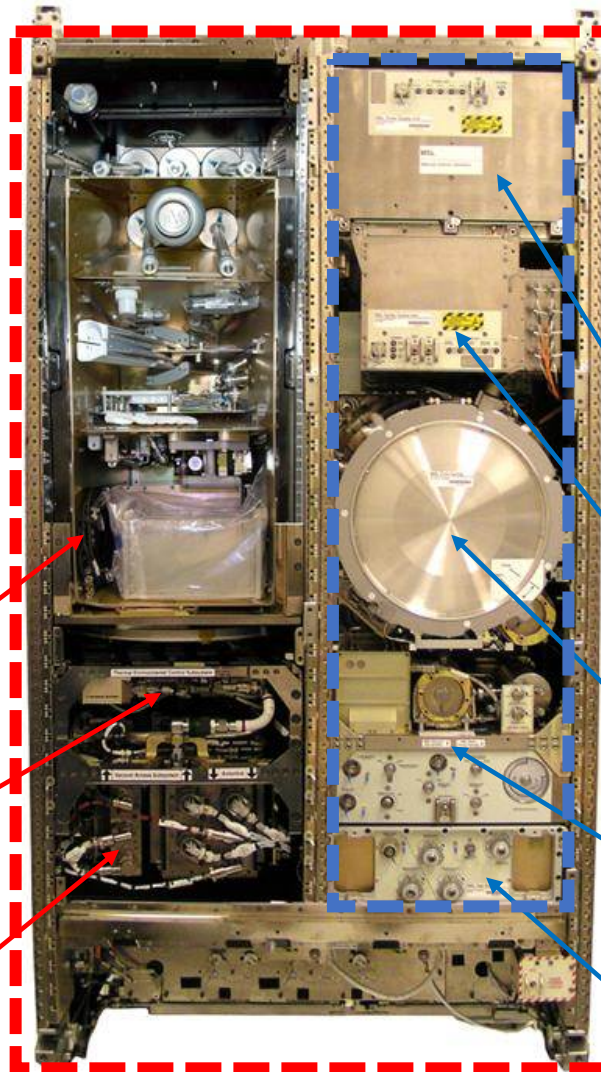
Materials Science Research Rack

NASA/MSFC

- MSRR interfaces with the ISS providing the necessary resources for MSL operations
 - Structure
 - Power
 - C&DH
 - Vacuum
 - MTL

ESA

- Materials Science Laboratory (MSL) consists of 2 furnace insert(s) and subsystems for processing of investigations



Stowage of
MSRR/Science
Hardware

Thermal &
Environmental
Control (TEC)
System Shelf

Vacuum Access
(VAS)/Avionics Shelf

Power Supply
Unit

Facility Control
Unit/Electronics

Process
Chamber/Core Facility

Vacuum Gas
Subsystem/
Internal Water
Cooling Loop

Gas Supply
Drawer

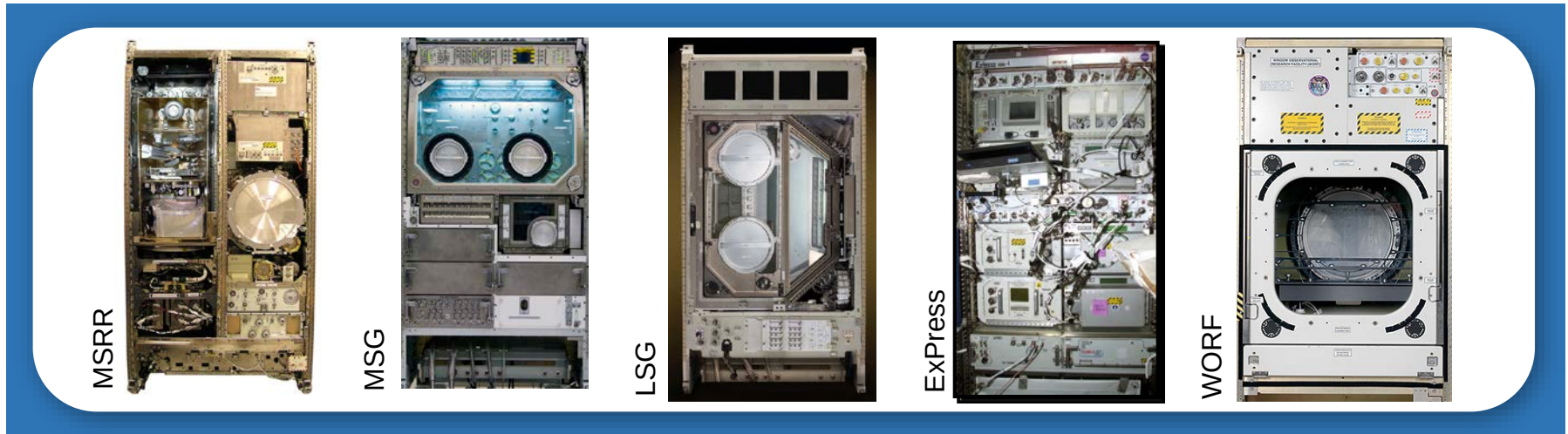
MSFC ISS Payload Facility Operational History



ISS Flights/Launch Dates												Operational Hrs
5A.1	6A	7A.1	UF-2	LF-1	ULF-1.1	ULF-2	17A	19A	ULF-7	HTV-7	HTV-9	(as of 7/31/19)
3/01	4/01	8/01	6/02	7/05	7/06	10/08	4/09	9/09	7/11	8/18	5/20	
HRF1												5,617
ER1												142,220
ER2												106,786
ER4												136,622
ER5												28,075
ER3												74,768
MSG												49,860
HRF2												3,336
ETR												
ER6												93,710
MSRR												2,326
WORF												59,494
ER7												44,173
ER8												43,273
ER9B												1,709
ER10B												6,027
LSG												161
ER11B												



Summary



- 8 EXPRESS Racks and 2 Basic EXPRESS Racks are supporting research in areas ranging from physical sciences, life sciences, plant growth research, technology development hardware, and station support hardware
- Synergy from derivative racks has reduced number of spares required to be available on-orbit
- WOLF has accommodated optical instruments in support of agriculture, humanitarian efforts in responding to natural disasters, Educational/STEM, and meteor viewing
- MSRR, collaboratively supported by NASA and ESA, facilitates high temperature materials research utilizing the microgravity environment
- Payload Facilities are supporting research, technology development, and commercial utilization of ISS