International Space Station Capabilities and Payload Accommodations

Rod Jones, Manager, ISS Payloads Office
Current Stage
International Space Station Facts

- **Spacecraft Mass**: 799,046 lb (362,441 kg)
- **Velocity**: 17,500 mph (28,200 kph)
- **Altitude**: 220 miles above Earth
- **Power**: 80 kW continuous
- **Science Capability**: Laboratories from four international space agencies – US, Europe, Japan, and Russia
Assembly Complete Configuration

International Space Station

Pressurized Laboratories

External Payload Facilities
The Microgravity Environment

The ISS is equipped with an array of sensors that monitor perturbations to the microgravity state on-orbit.

Even without the Active Rack Isolation System, vibrations are typically within ISS requirements.

While the Station is at its most “quiet” during the eight hours of crew sleep, the Active Rack Isolation System can be effective even during crew exercise.
The ISS provides coverage of 85% of the Earth’s surface and 95% of the world’s populated landmass every 1-3 days, depending on orbital track and field-of-view.
Our Windows on the Earth

**US Laboratory Window**
50-cm diameter
Telescope-quality optical glass

**Service Module Window**
40-cm diameter

**The Cupola**
80-cm diameter
(top window)
## ON Orbit Resources Provided to Payloads

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power</strong></td>
<td>30kw average</td>
</tr>
<tr>
<td><strong>Air to Ground Data</strong></td>
<td>~37.5 Mbps of video (3 lines of video at 12.5 Mbps each)</td>
</tr>
<tr>
<td></td>
<td>~8 Mbps of MRDL data (Science return)</td>
</tr>
<tr>
<td></td>
<td>~5 Mbps for payload still imagery downlink</td>
</tr>
<tr>
<td></td>
<td>~20 Mbps utilized for payload data recorded over LOS</td>
</tr>
<tr>
<td><strong>Internal Racks</strong></td>
<td>13 U.S. Lab</td>
</tr>
<tr>
<td></td>
<td>5 ESA Lab</td>
</tr>
<tr>
<td></td>
<td>6 JAXA Lab</td>
</tr>
<tr>
<td><strong>External Sites</strong></td>
<td>8 Truss ELC Platform Sites</td>
</tr>
<tr>
<td></td>
<td>5 JAXA Platform Sites</td>
</tr>
<tr>
<td></td>
<td>2 ESA Platform Sites</td>
</tr>
<tr>
<td><strong>Crewtime</strong></td>
<td>35 hrs per week (average)</td>
</tr>
</tbody>
</table>
## Upgrades In Work

<table>
<thead>
<tr>
<th>Enhanced Processor and Integrated Communications (EPIC) Project</th>
<th>Phase A will upgrade the three Command and Control (C&amp;C) MDMs and the two Guidance, Navigation, &amp; Control (GN&amp;C) MDMs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phase B will upgrade the two Payload MDMs, and add Ethernet support for the C&amp;C and Payload MDMs.</td>
</tr>
<tr>
<td>Air to Ground High Rate Communications System (HRCS) Project</td>
<td>Increase data rates internally and on the RF link (300 Mbps downlink, 7/25 Mbps uplink)</td>
</tr>
<tr>
<td></td>
<td>Combine audio and video on orbit</td>
</tr>
<tr>
<td></td>
<td>Provide two way, high quality audio</td>
</tr>
<tr>
<td></td>
<td>Open the door to internet protocol communications</td>
</tr>
<tr>
<td></td>
<td>Open the forward link to multiple users</td>
</tr>
<tr>
<td></td>
<td>Allow for the capability of transmitting &amp; recording HDTV</td>
</tr>
<tr>
<td>On Orbit External Wireless High Rate</td>
<td>100 Mbps 2-way Ethernet capability</td>
</tr>
<tr>
<td></td>
<td>1 Mbps 1553 capability</td>
</tr>
<tr>
<td></td>
<td>Up to 4 antennas attached to EVA handrails on US Lab</td>
</tr>
</tbody>
</table>
What space is available for research?

Science Rack Topology

19 NASA payload science racks at Assembly Complete

Partner

<table>
<thead>
<tr>
<th>NASA</th>
<th>Utilization Rack at Assembly Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAXA</td>
<td></td>
</tr>
<tr>
<td>ESA</td>
<td></td>
</tr>
</tbody>
</table>

National Lab is a capacity within the NASA resource
NASA Science Rack Facilities

- 2 Human Research Facility
- 6 ExPRESS Racks
  - ER1
  - ER2A
- ER3A
- ER4
- ER5
- ER7
- Microgravity Sciences GloveBox
- MELFI and MELFI-2
- Combustion Integrated Rack
- Euro. Modular Cultivation System (EMCS) In ER3A (July 2006)
- ER6 (Galley and Research)
- Fluids Integrated Rack
- EMCS
- Window Observational Research Facility
- Materials Science Research Rack
- MELFI-3
- SpaceDRUMS In ExPRESS 5
- Combustion Integrated Rack
- On-Orbit
- ULF-5

More detailed information available at [http://www.nasa.gov/iss-science/](http://www.nasa.gov/iss-science/) Click on “Facilities Catalog”
# Station to Internal Rack Resources

<table>
<thead>
<tr>
<th><strong>Power</strong></th>
<th>3, 6, or 12 kW, 114.5 - 126 voltage, direct current (VDC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data</strong></td>
<td></td>
</tr>
<tr>
<td>Low Rate</td>
<td>MIL-STD-1553 bus 1 Mbps</td>
</tr>
<tr>
<td>High Rate</td>
<td>100 Mbps</td>
</tr>
<tr>
<td>Ethernet</td>
<td>10 Mbps</td>
</tr>
<tr>
<td>Video</td>
<td>NTSC</td>
</tr>
<tr>
<td><strong>Gases</strong></td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Flow = 0.1 kg/min minimum; 517-827 kPa, nominal; 1,379 kPa, maximum</td>
</tr>
<tr>
<td>Argon, carbon dioxide, helium</td>
<td>517-768 kPa, nominal; 1,379 kPa, maximum</td>
</tr>
<tr>
<td><strong>Cooling Loops</strong></td>
<td></td>
</tr>
<tr>
<td>Moderate temperature</td>
<td>16.1 C – 18.3 C</td>
</tr>
<tr>
<td>Flow rate</td>
<td>0 - 45.36 kg/h</td>
</tr>
<tr>
<td>Low temperature</td>
<td>3.3 C – 5.6 C</td>
</tr>
<tr>
<td>Flow rate</td>
<td>233 kg/h</td>
</tr>
<tr>
<td><strong>Vacuum</strong></td>
<td></td>
</tr>
<tr>
<td>Venting</td>
<td>$10^{-3}$ torr in less than 2 h for single payload of 100 L</td>
</tr>
<tr>
<td>Vacuum resource</td>
<td>$10^{-3}$ torr</td>
</tr>
</tbody>
</table>
ExPRESS Rack Accommodations

(Expedite the Processing of Experiments for Space Station)

Middeck Locker
P/N V502-661604

Features
• 4 rear captive fastener attachments
• Friction hinge
• Dual door locks
• Installation tool guides on 4 corners
• Weight—12 lbs

International Subrack Interface Standard Drawer
Powered P/N 683-43650
Stowage P/N 683-43656

Features
• 4 PU (Panel Unit)
• Blind Connectors
• Locking Handles
• Weight—27 lbs
• Rated to at least 37 lbs

EXPRESS 8/2 Configuration
International Standard Payload Rack
Secondary Structure & Subsystems
8/2 Payload Configuration (8 Middeck Lockers, 2 Powered ISIS Drawers)
# ExPRESS Rack Resources

_(Expedite the Processing of Experiments for Space Station)_

<table>
<thead>
<tr>
<th>System</th>
<th>Middeck Locker Locations</th>
<th>ISIS Drawer Locations</th>
<th>Rack-Level Accommodation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural</strong></td>
<td>72 lbs. within cg constraints</td>
<td>64 lbs. within cg constraints</td>
<td>8 Mid deck Lockers 2 ISIS Drawers (4 Panel Unit)</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>28 Vdc, 0 – 500 W</td>
<td>28 Vdc, 0 – 500 W</td>
<td>2000 Watts 28Vdc power</td>
</tr>
<tr>
<td><strong>Air Cooling</strong></td>
<td>≤ 200 Watts</td>
<td>&lt;100 Watts</td>
<td>1200 Watts</td>
</tr>
<tr>
<td><strong>Thermal Control</strong></td>
<td>500 Watts (2 positions per rack)</td>
<td>500 Watts (2 positions per rack)</td>
<td>2 positions per rack</td>
</tr>
<tr>
<td><strong>System Water Cooling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Command and Data Handling</strong></td>
<td>RS422 Analog Ethernet 5 Vdc Discrete</td>
<td>RS422 Analog Ethernet 5 Vdc Discrete</td>
<td>RS422 Analog Ethernet 5 Vdc Discrete</td>
</tr>
<tr>
<td><strong>Video</strong></td>
<td>NTSC/RS170A</td>
<td>NTSC/RS170A</td>
<td>NTSC/RS170A</td>
</tr>
<tr>
<td><strong>Vacuum Exhaust System</strong></td>
<td>1 payload interface per rack</td>
<td>1 payload interface per rack</td>
<td>1 payload interface per rack</td>
</tr>
<tr>
<td><strong>Nitrogen</strong></td>
<td>1 payload interface per rack</td>
<td>1 payload interface per rack</td>
<td>1 payload interface per rack</td>
</tr>
</tbody>
</table>
# Cold Stowage Accommodations

<table>
<thead>
<tr>
<th></th>
<th>MELFI</th>
<th>MERLIN</th>
<th>GLACIER</th>
<th>Single and Double Coldbag with ICEPAC’s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First flight</strong></td>
<td>2006</td>
<td>2007</td>
<td>2008</td>
<td>2006</td>
</tr>
<tr>
<td><strong>On-orbit stowage</strong></td>
<td>Yes</td>
<td>Possible</td>
<td>Possible</td>
<td>No</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>On-orbit temperature (°C)</strong></td>
<td>+4, -26, -80</td>
<td>+45 to -20</td>
<td>+4 to -185</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Transport temperature (°C)</strong></td>
<td>N/A</td>
<td>+45 to -5</td>
<td>+4 to -160</td>
<td>+4 to -32</td>
</tr>
<tr>
<td><strong>Useable volume (L)</strong></td>
<td>175</td>
<td>19</td>
<td>30</td>
<td>6.8/18.7</td>
</tr>
<tr>
<td><strong>External volume</strong></td>
<td>1 rack</td>
<td>1 MLE</td>
<td>2 MLE</td>
<td>0.5/1 MLE</td>
</tr>
</tbody>
</table>
Truss Attach Site Usage
## External Research Accommodations

<table>
<thead>
<tr>
<th>Common Attachment System (CAS) Site</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mass capacity</strong></td>
<td>1360 - 8618 kg (3000 - 19000 lb)</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>3 kW each on two lines (primary, auxiliary)</td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td>Passive</td>
</tr>
<tr>
<td><strong>Low-rate data</strong></td>
<td>1 Mbps (MIL-STD-1553)</td>
</tr>
<tr>
<td><strong>High-rate data</strong></td>
<td>100 Mbps (shared)</td>
</tr>
<tr>
<td><strong>Sites available to NASA</strong></td>
<td>6 sites</td>
</tr>
</tbody>
</table>
Recent ISS Assembly Science Facilities

NASA Express Logistics Carriers (ELCs)

2 payload sites per ELC

EZC1, EZC3, & EZC4
## External Research Accommodations

**ELC Single Adapter Resources**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass capacity</td>
<td>227 kg (500 lb)</td>
</tr>
<tr>
<td>Volume</td>
<td>1 m³</td>
</tr>
<tr>
<td>Power</td>
<td>750 W, 113 – 126 VDC; 500 W at 28 VDC per adapter</td>
</tr>
<tr>
<td>Thermal</td>
<td>Active heating, passive cooling</td>
</tr>
<tr>
<td>Low-rate data</td>
<td>1 Mbps (MIL-STD-1553)</td>
</tr>
<tr>
<td>Medium-rate data</td>
<td>6 Mbps (shared)</td>
</tr>
<tr>
<td>Sites available per ELC</td>
<td>2 sites</td>
</tr>
<tr>
<td>Total ELC sites available</td>
<td>8 sites</td>
</tr>
</tbody>
</table>
Recent ISS Assembly Science Facilities

Japanese Experiment Module - Kibo

- 5 external payload sites allocated to NASA on the JEM Exposed Facility
- 6 internal active payload rack locations allocated to NASA inside the JEM Pressurized Module
## External Research Accommodations

### JEM-EF Resources

<table>
<thead>
<tr>
<th></th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mass capacity</strong></td>
<td>550 kg (1,150 lb) at standard site</td>
</tr>
<tr>
<td></td>
<td>2,250 kg (5,550 lb) at large site</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>1.5 m³</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>3-6 kW, 113 – 126 VDC</td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td>3-6 kW cooling</td>
</tr>
<tr>
<td><strong>Low-rate data</strong></td>
<td>1 Mbps (MIL-STD-1553)</td>
</tr>
<tr>
<td><strong>High-rate data</strong></td>
<td>43 Mbps (shared)</td>
</tr>
<tr>
<td><strong>Sites available to NASA</strong></td>
<td>5 sites</td>
</tr>
</tbody>
</table>
# External Research Accommodations

<table>
<thead>
<tr>
<th>Columbus External Resources</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mass capacity</strong></td>
<td>230 kg (500 lb)</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>1 m³</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>2.5 kW total to carrier (shared)</td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td>Passive</td>
</tr>
<tr>
<td><strong>Low-rate data</strong></td>
<td>1 Mbps (MIL-STD-1553)</td>
</tr>
<tr>
<td><strong>Medium-rate data</strong></td>
<td>2 Mbps (shared)</td>
</tr>
<tr>
<td><strong>Sites available to NASA</strong></td>
<td>2 sites</td>
</tr>
</tbody>
</table>
ISS Visiting Vehicles Post-Shuttle

- Cygnus (Orbital)
- Dragon (SpaceX)
- ATV (ESA)
- Progress/Soyuz (Energia)
- HTV (JAXA)
### Flight Program Working Group (FPWG)

**Crew Rotation and Port Utilization Graphic – For Reference Only**

<table>
<thead>
<tr>
<th>Year</th>
<th>Inc 23</th>
<th>Increment 24</th>
<th>Inc 25</th>
<th>Increment 26</th>
<th>Inc 27</th>
<th>Increment 28</th>
<th>Inc 29</th>
<th>Inc 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>R. Skvortsov (CDR-24)</td>
<td>107 days</td>
<td>N. Kelly (CDR-20)</td>
<td>157 days</td>
<td>R. A. Borisenko (CDR-28)</td>
<td>170 days</td>
<td>N (285)</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>N. Caldeir</td>
<td>107 days</td>
<td>R. Kaleri</td>
<td>107 days</td>
<td>N. Tanis (CDR-24)</td>
<td>107 days</td>
<td>R. Volkov (N)</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>R. Komariko</td>
<td>107 days</td>
<td>N. Olivas (CDR-25)</td>
<td>163 days</td>
<td>R. Kononenko (CDR-27)</td>
<td>157 days</td>
<td>N (285)</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>N. Wheelock (CDR-25)</td>
<td>163 days</td>
<td>N. Walker</td>
<td>183 days</td>
<td>N. Olesik (CDR-25)</td>
<td>167 days</td>
<td>E. Fezzapoli</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>N. Clearfield</td>
<td>165 days</td>
<td>N. Yurchenik</td>
<td>165 days</td>
<td>N. Furukawa</td>
<td>165 days</td>
<td>(25S)</td>
<td></td>
</tr>
</tbody>
</table>

**Stage EVA**

- **MRM2 (SM Zenith)**: 3/18, 4/4, 9/16, 10/22, 3/16, 4/1, 10/26, 10/11, 11/27, 12/24
- **MRM1 (FG/DC-1)**: 5/12, 6/22, 11/26, 12/12, 5/16, 6/1, 11/11, 11/27
- **SM-Aft**: 5/10, 6/17, 6/30, 9/2, 12/15, 12/17, 5/10, 6/23, 8/9, 10/15, 10/23
- **Node 2 Nadir**: 19A, ULF4, ULF6, ULF5, ATV2, ATV3
- **PMA-2**: Launch [8 - Cutback (25)]

**Launch Schedule**

- 22S, 37P, 4/28
- 23S, 38P, 6/28
- 39P, 9/30
- 40P, 10/27
- 41P, 12/27
- 26S, 44P, 42S

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**National Aeronautics and Space Administration**

**ISS Payloads Office**

**Rod Jones**
ATV

Upmass
- Internal
  - Powered: None
  - Late Load
    » Up to 28 bags (not CTBE) of late access
- External
  - None
- On Dock
  - Cargo: L-14 weeks
  - Late Load: L-4 weeks

Downmass
- Internal
  - Disposal only
- External
  - None

ATV-2 Racks with M-01 bags
HTV

Upmass
- Internal
  Powered: None
  Late Load
    » Maximum 3 CTBE (0.5 or 1.0 CTB), each <20 kg
    » Additional possible if negotiated in advance.
  Racks
    » Up to 8 passive racks
    » Forward Bay: ISPR compatible
    » Aft Bay racks fixed: HTV Resupply Rack
- External
  Exposed Pallet (on following chart)
- On Dock
  Cargo: L-6 months
  Late Load: L-6 weeks

Downmass
- Internal
  Disposal only
- External
  Disposal only
HTV External Pallet Configurations

Fig. 3.3.2-1 Type I-a: HCAM Type EF Payload (x 3)

Fig. 3.3.2-2 Type I-b: HCAM Type EF Payload (x 2) and FRAM Type EF Payload (x 1)

Fig. 3.3.2-3 Type I-c: HCAM Type EF Payload (x 2) and FRAM Type Cargo (x 1)

Fig. 3.3.2-4 Type II-a: HCAM Type EF Payload (x 2) and Battery Transportation Demonstration (x 1)

Fig. 3.3.2-5 Type II-b: HCAM Type EF Payload (x 2) and FRAM Type Cargo (x 1)

Fig. 3.3.2-6 Type III-a: FRAM Type Cargo (x 4)

Fig. 3.3.2-7 Type III-b: FRAM Type EF Payload (X1) and FRAM Type Cargo (X4)

NASA M-Size Cargo (Non-FRAM Type) (x 6)

TBD (Battery Transportation Demonstration)
Progress

**Upmass**
- Internal
  - Powered: Special allowance only
  - Late Load
  - Racks: None
  - Items up to 8-10 kg in vehicle containers
  - Larger items installed in special transport frames
- External
  - None

**Downmass**
- Internal
  - Disposal only
- External
  - None
Soyuz

Upmass
- Internal
  Powered: Special allowance only
  Late Load
  Racks: None
  Items up to 5 kg in vehicle containers
  Larger items installed in special transport frames
- External
  None

Downmass
- Internal
  Items up to 5 kg in container under crew seat
  Special container available for larger items if only two crew on return
- External
  None
Dragon

**Upmass**
- Internal
  - Powered: Double MLE
  - Late Load: T-12 hrs for powered MLE; TBD days for nominal
  - Racks (SpaceX-designed)
    - ~3300 kg mass
- External
  - Trunk capability

**Downmass**
- Internal
  - Powered: Double MLE
  - ~1700 kg return
  - Early destow at dock available
  - Fast boat return available
- External
  - Disposal only
Cygnus

Upmass
- Internal
  Powered: Double MLE
  Late Load: TBD
  Racks
    » 2000 kg mass (standard)
    » 2700 kg mass (expanded)
- External
  None

Downmass
- Internal
  Disposal only
- External
  None
References

- Attached Payload Interface Requirements Document, SSP 57003
- Common Interface Requirements Document, SSP 50835
- ATV-2 Cargo Summary (24 Sep 2009)
- HTV Cargo Accommodation Handbook, JFX-99102
- Requirements for International Partner Cargo Transported On Russian Progress and Soyuz Vehicles, ПЗ2928-103
- SpaceX Introduction For Payloads (OZ3, Jan 2010)
- Cygnus Fact Sheet (Orbital, 2009)
Backup

Science Facilities Overview
Science Facilities On Orbit

2 Human Research Facility (HRF) Racks -
Biomedical investigations, including ultrasound,
body mass measurement, metabolic gas analysis,
pulmonary monitoring, ambulatory blood pressure
measurement, Holter monitor, and experiment
unique hardware

- Microgravity Sciences Glovebox (MSG)
  Principally materials and fluid physics
  experiments to date

Expedition 2 crewmember
Susan Helms activating the
HRF 1 rack

Expedition 12 crewmember
Bill McArthur activating the
SLAMMD in the HRF 2 rack

Expedition 13 crewmember Jeff Williams performing the
PFMI experiment in the Microgravity Science Glovebox
Science Facilities On Orbit

- 7 Multi-User (EXPRESS) Racks - Middeck locker scale instruments in various research disciplines such as biotechnology and plant research

- 2 Minus Eighty-degree Laboratory Freezer for ISS (MELFI) - Provides thermal conditioning at +4°C, -26°C and -80°C
Science Facilities On Orbit

- **Space Dynamically Responding Ultrasound Matrix System (SpaceDRUMS)**

- **Window Observation Research Facility (WORF) (2009)**
  - Facility to support visual and multispectral remote sensing using Lab Optical Window

- **Combustion Integrated Rack (CIR) (2008)**
  - Facility dedicated to research in combustion science
Science Facilities On Orbit

- **Materials Science Research Rack (MSRR)** (2009)
  - Facility to support ESA Microgravity Science Lab furnace
- **Fluids Integrated Rack (FIR)** (2009)
  - Facility dedicated to fluid physics research, with Light Microscope Module
- **Muscle Atrophy Research Exercise System (MARES)** (2009)
  - Facility for musculoskeletal, biomechanical, neuromuscular and neurological physiology measurements
ELC1 Configuration

ELC1 Top Side

ELC1 Keel Side
ELC2 Configuration

ELC2 Top Side

ELC2 Keel Side
ELC3 Configuration

Top Side

Keel Side

Empty Payload Site

CTC
Anticipated (ULF5/HTV2)

SASA

SASA

HPGT

4TA

Rod Jones
ISS Payloads Office

National Aeronautics and Space Administration
ELC4 Configuration

Top Side

Keel Side

- Empty Payload Site
- Future FHRC Site (via HTV2)
- Future CTC-4 (via HTV2)
- Empty ORU Site
ISS Payload Integration Process

Hardware development time varies per payload 36 months to days
ISS Payload Control Centers

Payload Operations Center (POIC) - Huntsville

POIC: Responsible for execution of on-orbit NASA research

Mission Control Center—Houston
MCC-H: Responsible for flight command and control of overall vehicle

Mission Control Center—Moscow
MCC-M: Responsible for flight command and control of Russian segment.
Payload Ops Integration Center Interfaces

MCC-H, 4 IP Control Centers, 4 Telescience Support Centers, 49 Telescience Resource Kit (TReK) clients

Payload Ops Control Center Huntsville

White Sands Complex, New Mexico

Space Shuttle

TDRSS

ISS

Global Customer Support

Payload/Kuband & Voice Telemetry

Vehicle Telemetry, Voice, Video

Commands, Uplinks

Planning Products, Voice, Ops Mgmt, Other

MCCH to International Partner Services

International Partner Facilities

Russia

Europe

Japan

Italy

Canada

GRC

ARC

JSC

MSFC

NASA Telescience Support Centers

Payload User Sites TReK

Internet

Commands, Uplinks

Payload/Kuband & Ancillary Telemetry

Planning Products, Voice, Ops Mgmt
ISS Transition From Assembly to Utilization

Cumulative ISS Utilization Crewtime by All Partners

Assembly Complete
Six Crew On-orbit

Year

Total Utilization Hours Operated (Cumulative)

0 5000 10000 15000 20000 25000 30000 35000 40000 45000 50000

USOS RESEARCH CREW TIME
12 March 2010 (Data through 28 February 2010)

Legend
- Generic Groundrules, Requirements & Constraints (GGR&C) Minimum Requirement
- L-12 Month Increment Definition and Requirements Document Subscription (or Requirement)
- L-12 Month Increment Definition and Requirements Document (IDRD) Allocation
- L-1 Month Most Recent to Launch On-Orbit Operations Summary (OOS) (or most-current-to-launch IDRD until final pre-flight OOS release)
- Actuals Provided -- includes all Scheduled, Task-List, and Voluntary Science hours (IMC); docked ops utilization not included/shown*

Average Weekly Actuals Provided as Compared to
Minimum Requirements, Subscriptions, and Allocations
[POC: Rod Jones/OZ]

Status: YELLOW
Based on increase in Incrs 23 & 24 latest crewtime allocation as per L-1 Final Preflight OOS; last month

Increments

GGR&C (Min Req)
Avg weekly Total Avg weekly Total Avg weekly To Date Total
L-12 IDRD Subscription 11.3 101.7 11.3 595.0 35.0 567.0 875.0
L-12 IDRD Allocation 15.3 137.8 15.3 260.2 24.4a 395.5 610.3 27.7 969.3 33.3 833.4
L-1 OOS (or IDRD) Alloc 1.2 10.4 58.5b 995.0b 19.7c 318.8 492.0 27.8 969.3 33.3 833.4
Actuals* (to date) 12.4 111.9 34.4c 584.6c 22.7d 458.0 567.8 27.0b 675.5h -- --

Increment

Avg weekly Total Avg weekly Total Avg weekly To Date Total
INCR 19 10.7 101.7 10.7 595.0 35.0 567.0 875.0 35.0 875.0
INCR 20 -323.6 hours total, or -12.9 hrs/wk avg of Reserve crewtime for Incrs 23&24; plus -31 hours total Shuttle dock-time utilization
INCR 21 & 22 -348.0 hours total, or 12.9 hrs/wk avg of Reserve crewtime for Incrs 23&24; plus -31 hours total Shuttle dock-time utilization

Actuals* to date in 16.2 work weeks

Auxiliary Information

Rod Jones
ISS Payloads Office
### ISS Research Accommodations Status

18 April 2008 (Data through 31 March 2008)  
[POC: Rod Jones/O2]

#### Acronyms
- A = Active Rack Module System
- BLB = EXPRESS Rack Facility
- CIR = Co-Integrated Rack
- ER = EXPRESS Rack
- ESE = European Space Agency
- ETC = European Transport Carrier
- ETP = European Technology Platform
- F1 = 1.1 ISSE
- FS = S-M1
- ESA = European Space Agency
- HRF = Human Research Facility
- IDED = International Design and Engineering Development
- IN = International Expedition
- IS = International Space Station
- JAXA = Japan Aerospace Exploration Agency
- MELFI = Meckstrats from EXPRESS Rack Facility
- N-EC = Nano-Electronics Chipset
- NLPR = National Laboratory
- OPI = Operational Planning Integrator
- POE = Payload Operations Engineering Activity
- REX = Random Experiment System
- RIKI = European Billiard Game
- RSSS = Russian Soyuz System
- S-BAR = Solar Bar
- SGS = Solar Gantry System
- SIS = Space Station Integration System
- SPS = Space Shuttle Program
- SPMS = Space Station Payload Management System
- SRP = Space Station Program
- TDF = Telecommunications Distribution Facility
- TEGS = Telecommunications Equipment Ground Station
- TEL = Telecommunications Equipment
- TPE = Telecommunications Payload Equipment
- VUC = Virtual User Console
- WEC = Water Science and Technology Facility

#### Research Crew Time Total

<table>
<thead>
<tr>
<th>Increment</th>
<th>Crew Time Total</th>
<th>Average Crew Time Per Week</th>
<th>Rack Mass to Orbit (kg)</th>
<th>Research Mass to Orbit (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-13</td>
<td>2161 / 1357</td>
<td>9.4 / 4.9</td>
<td>5083.3</td>
<td>3376.2</td>
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<tr>
<td>14</td>
<td>276 / 197</td>
<td>10.6 / 7.6</td>
<td>0</td>
<td>572.5</td>
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<tr>
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<td>170.1 / 196.4</td>
<td>8.5 / 9.8</td>
<td>0</td>
<td>549.9</td>
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<tr>
<td>16</td>
<td>262.3 / 118.4</td>
<td>(92 / 78)*</td>
<td>0</td>
<td>363.8</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>(156.0 / 147.0)*</td>
<td>0</td>
<td>(183.4)*</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>(111.7 / 86.3)**</td>
<td>0</td>
<td>(337.4)**</td>
</tr>
<tr>
<td>19 / 20</td>
<td></td>
<td>(117.0)†</td>
<td>0</td>
<td>(282.4)**†</td>
</tr>
</tbody>
</table>

---

**Notes:**
- Cumulative Actual Totals (through 31 Mar 2008):
  - 3309 / 1069 hrs
  - 10.4 / 6.1 hrs
  - 9560 kg

---

**Research Crew Time Per Work Week**

- Average Crew Time Per Work Week:
  - 9.4 / 4.9
  - 10.6 / 7.6
  - 8.5 / 9.8

**Research Rack Mass**

- Mass to Orbit:
  - Increment 13: 5083.3 kg
  - Increment 14: 0 kg
  - Increment 15: 0 kg
  - Increment 16: 4476.5 kg

**Research Mass to Orbit**

- Includes: Shuttle Middel, Spacehab, Cargo Bay, Soyuz, Progress, Node 2 Harmony Module, Columbus Module, Japanese Experiment Module-Exposed Facility, Logistics Module-Pressurized Section (JEM-ELM-PS), Automated Transfer Vehicle (ATV1), N-11 Transfer Vehicle (NTV)

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**Research Rack Mass to Orbit**

- Increment 13: 3376.2 kg
- Increment 14: 572.5 kg
- Increment 15: 549.9 kg
- Increment 16: 363.8 kg

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**Research Mass to Orbit**

- Includes: Shuttle Middel, Spacehab, Cargo Bay, Soyuz, Progress, Node 2 Harmony Module, Columbus Module, Japanese Experiment Module-Exposed Facility, Logistics Module-Pressurized Section (JEM-ELM-PS), Automated Transfer Vehicle (ATV1), N-11 Transfer Vehicle (NTV)

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**Notes:**
- OOS = most recent plan for future increment
- Planning numbers from Incr 16.1-Month OOS
- Approved Payload Tactical Plan Manifest, Incr 16, 12/2008
- Approved Payload Tactical Plan Manifest, Incr 16, 12/2008
- Approved Payload Tactical Plan Manifest, Incr 16, 12/2008

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**Research Crew Time Per Work Week**

- 9.4 / 4.9
- 10.6 / 7.6
- 8.5 / 9.8

---

**Research Rack Mass**

- 5083.3 kg
- 0 kg
- 0 kg
- 4476.5 kg

---

**Research Mass to Orbit**

- 3376.2 kg
- 572.5 kg
- 549.9 kg
- 363.8 kg