International Space Station External Payload Accommodations



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ISS Technology Demonstration Office Research Integration Office



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



International Space Station (ISS) External Research Facilities







Express Logistic Carrier

ELC Single Adapter	Mass capacity	227 kg (500 lb)		
Resources (2	Volume	1 m ³		
NASA payload sites per ELC)	Power	750 W, 113 – 126 VDC; 500 W at 28 VDC/adapter		
	Thermal	Active heating, passive cooling		
	Low-rate data	*1 Mbps (MIL-STD-1553)		
	Medium-rate data	*6 Mbps (shared) - Return link (payload to ISS) only		
	Sites available per ELC	2 sites		
	Total ELC sites available 8 sites			
Propose	d C&DH Enhancement to ea	ch Research Payload site		
Research Payload ExPA (see next chart)				



Express Logistics Carriers Overview



Payload Locations Circled

ELC-1 Port lower 2 Nadir payload sites

ELC-2 Starboard upper 2 Zenith payload sites



Express Logistics Carriers Overview



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Express Pallet Adapter (ExPA) Assembly	ExPA overall Mass	255 lb	
	ExPA overall dimension	46.05" x 47" x 13.06" (H)	
	ExPA payload carrying capability	34" x 46" x 49" (H) and 500 lb"	
Adapter plate	Payload electrical interface	Power(120VDC & 28VDC): Four NATC connectors Data (1553, Ethernet): Six NATC connectors	
	Payload thermal interface	Active heating, passive cooling	
	Payload structural interface	2.756" X 2.756" Grid with 250-28 UNF Locking Inserts and 1.625" diameter Shear Boss Provisions	
	EVA compatibility	EVA handrail provisions	
	EVR compatibility	All EVR interfaces on ExPA	







Japanese Experiment Module - Kibo







JEM EF External Research Accommodations







NASA/DOD HREP payload

Mass capacity	550 kg (1,150 lb) at standard site 2,250 kg (5,550 lb) at large site	
Volume	1.5 m ³	
Power	3-6 kW,113 – 126 VDC	
Thermal	3-6 kW cooling	
Low-rate data	1 Mbps (MIL-STD-1553, two way)	
Medium-rate data	1EEE-802.3(10BASE-T, two way) *	
High-rate data	43 Mbps (shared, one way downlink)	
Sites available to NASA	5 sites	

• Ethernet bus is tested to 100BASE-T capacity.

Upgrade to 100BASE-T is being worked by JAXA







JEM-EF Detailed Accommodations by Site

Location	Viewing	Payload Size	Description / Notes	Power	Data	
1	Ram, Nadir, Zenith	500 kg	Ram field of View (FOV) obstruction by JEM module	6 kW	Ethernet, 1553, Video	
3	Ram, Nadir, Zenith	500 kg	Clear view	3 kW	Ethernet, 1553, Video	
5	Ram, Nadir, Zenith	500 kg	ICS System back-up site (negotiable?)	3 kW	1553, Video	
7	Ram, Nadir, Zenith	500 kg	ICS-dedicated	-	-	
9	Port, Zenith, Nadir	2.5 MT	Best volumetrically for large payloads (up to 2.5 MT), but not necessarily the best viewing	3 kW	Ethernet, 1553, Video	
2	Wake, Nadir, Zenith	2.5 MT	Can hold large payloads, but has an FOV obstruction by JEM module	6 kW	Ethernet, 1553, Video	
4	Wake, Nadir, Zenith	500 kg	Clear view	3 kW	1553, Video	
6	Wake, Nadir, Zenith	500 kg	Clear view	3 kW	Ethernet, 1553, Video	
8	Wake, Nadir, Zenith	500 kg	Obstruction during EP berthing, slight obstruction from camera mount	3 kW	1553, Video	
10	Wake, Nadir, Zenith	500 kg	EPMP berthing site	-	-	
11	Zenith only	500 kg	Good Zenith viewing	3 kW	Ethernet	
12	Zenith only	500 kg	Temporary stowage location	3 kW	Ethernet	





Location	Viewing	Payload Size	Power	Data
SOZ	Zenith		1.25 k/M at	
SOX	Ram	226 kg +	1.25 KW at 120 VDC	Ethernet,
SDX	Ram	CEPA	2.5 kW max	1553
SDN	Nadir			



Columbus EF





Dexterous End Effector





SSRMS attachment which the ground team or on-orbit crew can use robotically to install, remove and replace payloads and failed components



JEM RMS Payload Support







ISS Cargo Vehicles





Cargo Capacity Progress 2,250 kg (Roscosmos, The Russian Federal Space Agency)





Cargo Capacity 3,100 kg ascent

HTV (JAXA)

5,500 kg



Payload Allowable Up-Mass & Volume Summary Table

Attach Payload Location	Allowable Payload Weight (including Flight Support Equipment)	Accommodation Weight (including adapter plate)	Total Weight	Payload Volume (W x H x L)
HTV Exposed Pallet (JEM EF Payload)	979 Lb (445 Kg)	121 Lb (55 Kg)	1100 Lb (500 Kg)	31.5" x 39.4" x 72.8" (800mm x 1000mm x 1850 mm)
HTV Exposed Pallet (ExPA, CEPA Payload)	See ExPA & CEPA payload specification for ELC & CEF	See ExPA & CEPA payload specification for ELC & CEF	*See ExPA & CEPA payload specification for ELC & CEF	*See ExPA & CEPA payload specification for ELC & CEF
ELC (ExPA)	490 Lb (222 Kg)	250 Lb (114 Kg)	740 Lb (336 Kg)	34" x 49" X 46" (863mm x 1244mm x 1168 mm)
Columbus (CEPA)	388 Lb (176Kg)	250 Lb (114 Kg)	638 Lb (290 Kg)	34" x 49" X 46" (863mm x 1244mm x 1168 mm)
JEM-EF	979 Lb (445 Kg)	121 Lb (55 Kg)	1100 Lb (500 Kg)	31.5" x 39.4" x 72.8" (800mm x 1000mm x 1850 mm)

* Location constraint applies in HTV Exposed Pallet



Upgrades In Work

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



ISS as a Platform for Earth Science



All geographic locations between 51.6 North and South latitude can be observed NADIR pointing Provides coverage of 85% of the Earth's surface and 95% of the world's populated landmass every 1-3 days





ISS coverage in 24 hrs for a 70° -swath optical payload. (Courtesy of ESA)

Processing lighting (changes with subsequent passes) Well-suited for test bed concepts with hardware change out and upgrades



ISS Attitude Torque Equilibrium Attitude (TEA) & Wobble Oscillation Description

For Stage configurations (i.e.; no Orbiter or Orbiter sized vehicle docked on the ISS) in the foreseeable future, the predicted TEA ranges are: Roll: -1.0 ~ +3.0 deg Pitch: -7.0 ~ +2.0 deg

Yaw: -15 ~ +15 deg.



Momentum Manager Controller Peak to Peak Attitude Wobble Oscillation

		Peak to Peak Attitude Oscillations Per Orbit			Peak Attitude Variation from Steady-State Orbit-Average Attitude		
Performance Descriptions	Roll (X)	Pitch (Y)	Yaw (Z)	Roll (X)	Pitch (Y)	Yaw (Z)	
	(deg)	(deg)	(deg)	(deg)	(deg)	(deg)	
Non-Micro-Gravity (Assembly Stages) Non-Propulsive (Momentum Manager)							
Attitude Control Performance Requirement	10.0	10.0	10.0	+/- 5	+/- 5	+/- 5	
Micro-Gravity (Assembly Complete) Non-Propulsive (Momentum Manager)							
Attitude Control Performance Requirement	7.0	7.0	7.0	+/- 3.5	+/- 3.5	+/- 3.5	
Typical Steady-State Performance of Minimum CMG momentum oscillation							
Momentum Manager Controller	1.6	1.6	2.0	+/- 0.8	+/- 0.8	+/- 1	
Typical Steady-State Performance of Minimum Attitude oscillation							
Momentum Manager Controller	1.6	0.4	0.2	+/- 0.8	+/- 0.2	+/- 0.1	
Typical Steady-State Performance of Minimum CMG momentum & Attitude oscillation Blended							
Momentum Manager Controller	1.6	0.7	1.2	+/- 0.8	+/- 0.35	+/- 0.6	



ISS Quiescent Mode Truss Vibratory Environment For External Payload Pointing Instrument

Data measured on ISS S3 truss

- ISS quiescent mode = No thruster firings, dockings, EVA, or robotics operations
- Typical response, not worst case
- Maximum per octave band - SDMS S3B1N on-orbit accelerometer data.

- Snapshot of 3 10-minute data takes - All data taken on March 16, 26, and 27, Stbd SARJ Rotating, exercise, 3 crew.



ULF-4 analysis concluded peak ELC rotations on the order of 0.03 degrees (quiescent mode)

Data provided by Boeing, June 2010²²



- The International Space Station provides an exceptionally clean environment to external payloads and science assets
- External contamination control requirements limit contaminant deposition to 130Å/year on external payloads and ISS sensitive surfaces
 - Specified levels are lower than any previous space station (Mir, Skylab, Salyut) by several orders of magnitude
- Measurements of contaminant deposition on ISS returned hardware have demonstrated that requirements are met at ISS payload sites

Experiment	Side	Requirement (130Å/year)	Measured
MISSE 2	ram	520 Å (4 years)	50 Å
	wake	520 Å (4 years)	500 Å
Node 1 nadir window cover	nadir	390 Å (3 years)	50 Å





ISS provides:

- Launch to ISS
- Installation on ISS at identified site
- On-orbit utilities and operations support, including crew or robotics time (if needed)
- Data handling and delivery
- End-of-life removal and disposal





⁴⁹ Telescience Resource Kit (TReK) Clients



• ISS Program Scientist Toolbox: http://iss-science.jsc.nasa.gov/index.cfm



For technical questions associated with International Space Station Payloads:

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Customer Service Helpline :The International Space Station Payloads Office has both a phone and an email customer service helpline that Payload Developers and others interested in doing research can contact to get assistance. The phone is staffed during regular business hours, or messages may be issued after hours, and a representative will return the call on the next business day. Phone: 281-244-6187, email: jsc-iss-payloads-helpline@mail.nasa.gov."