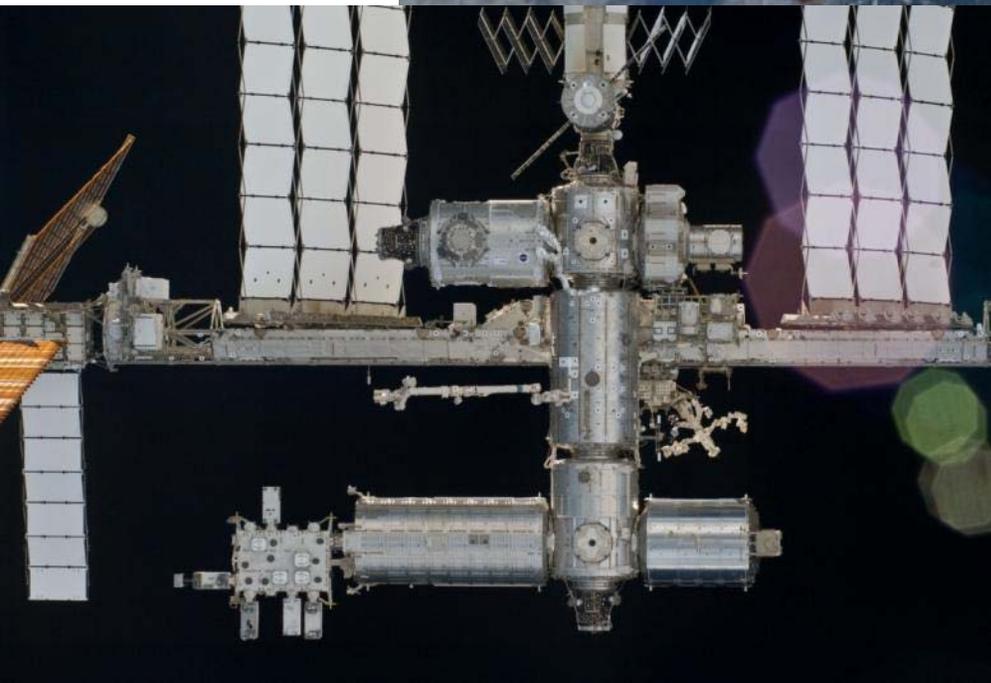


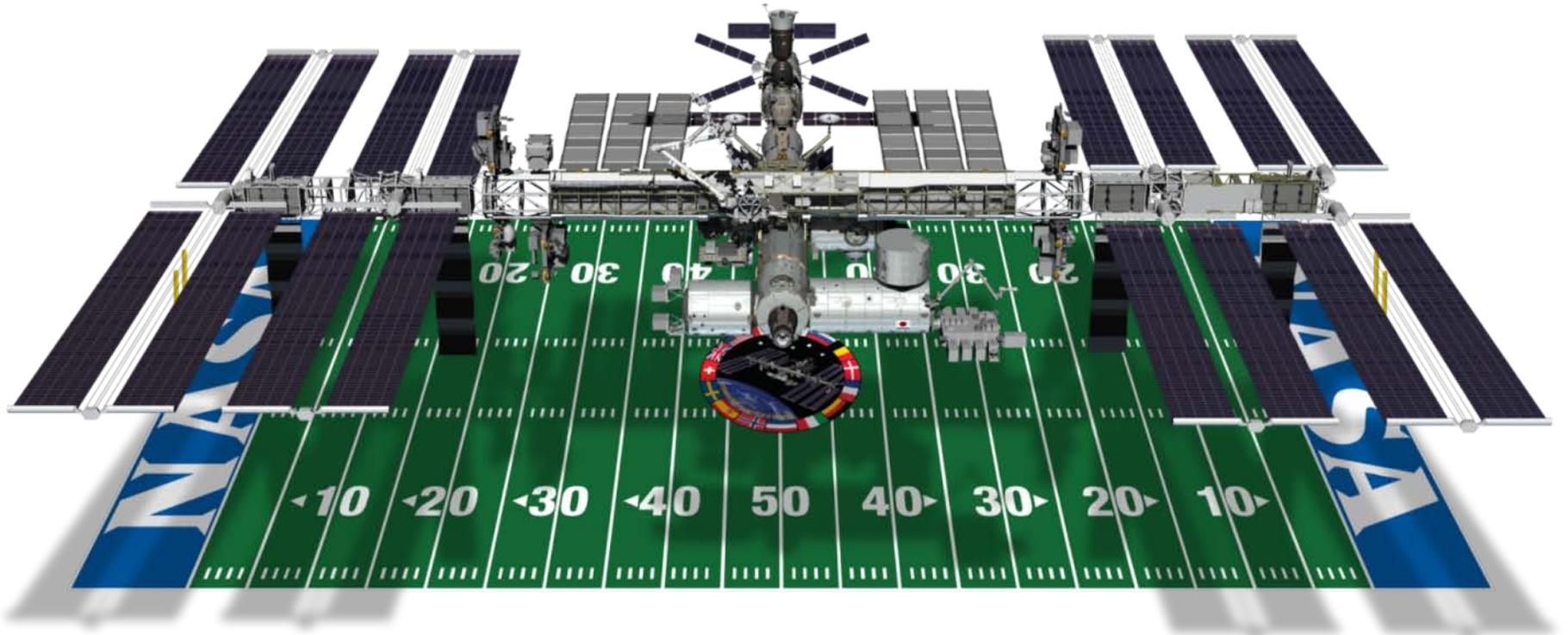


# International Space Station Capabilities and Payload Accommodations



Current Stage

# International Space Station Facts



**Spacecraft Mass: 799,046 lb (362,441 kg)**

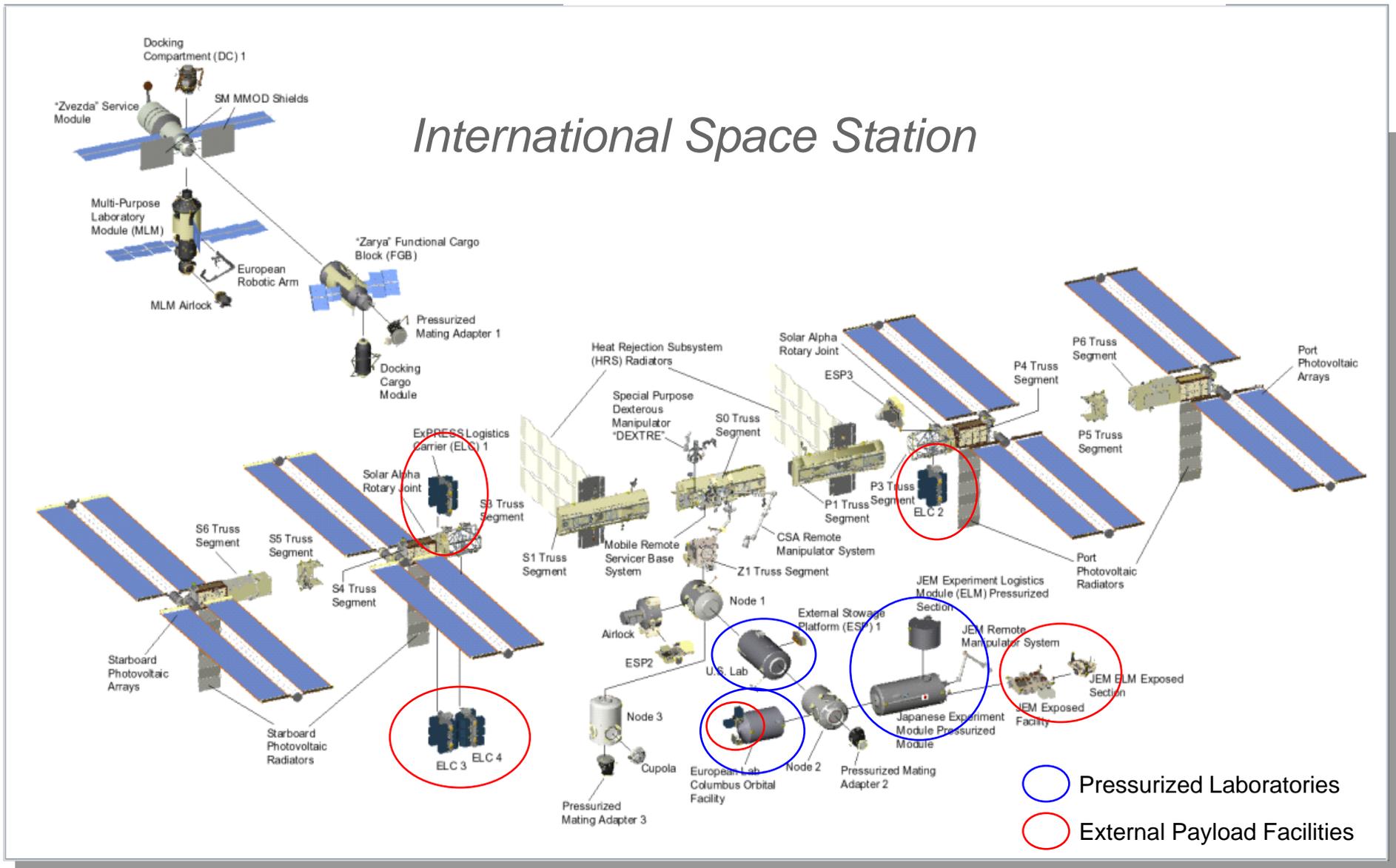
**Velocity: 17,500 mph (28,200 kph)**

**Altitude: 220 miles above Earth**

**Power: 80 kW continuous**

**Science Capability: Laboratories from four international space agencies –  
US, Europe, Japan, and Russia**

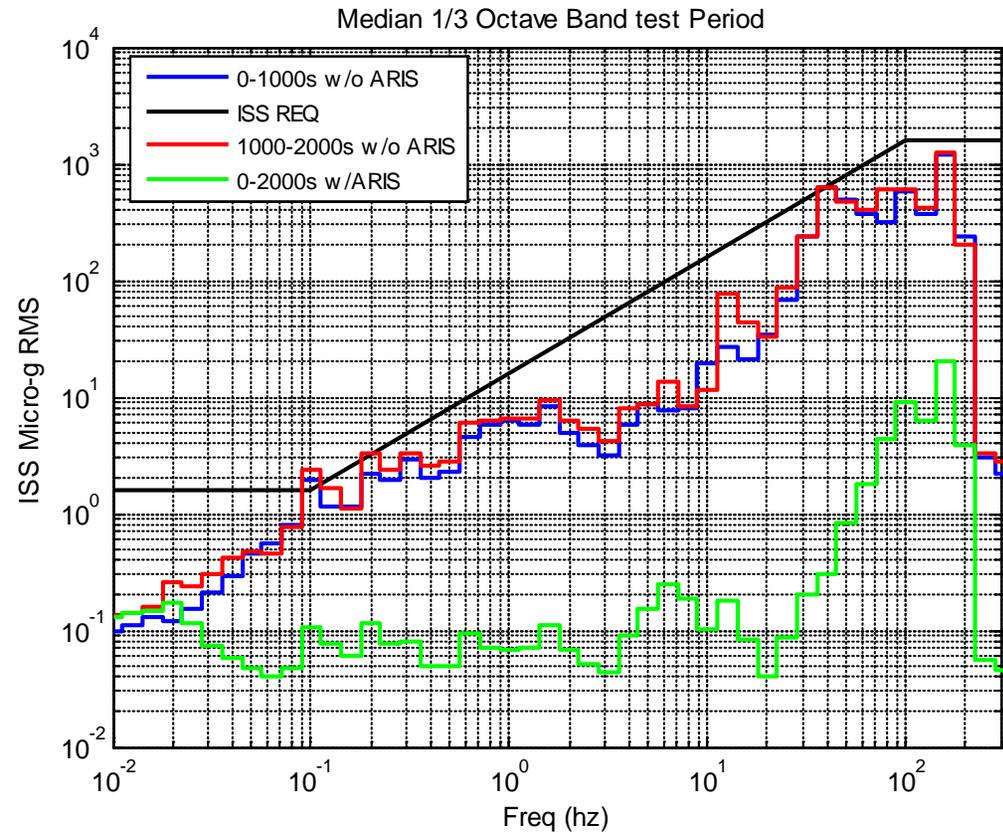
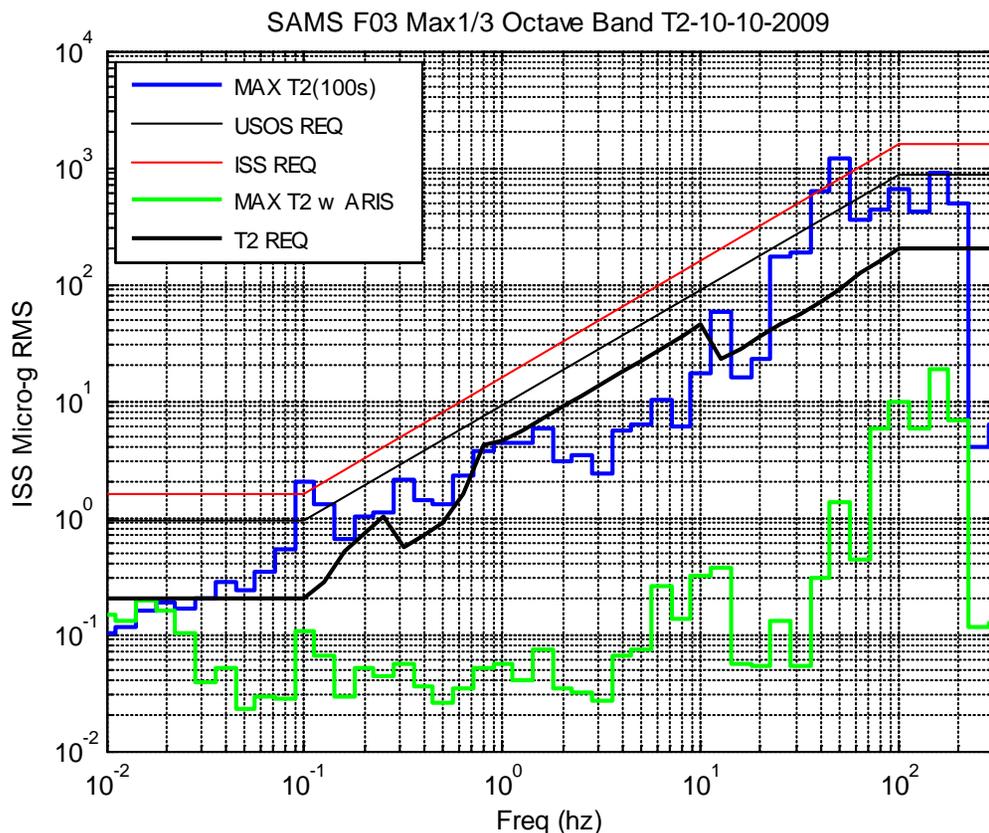
# Assembly Complete Configuration



# 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.

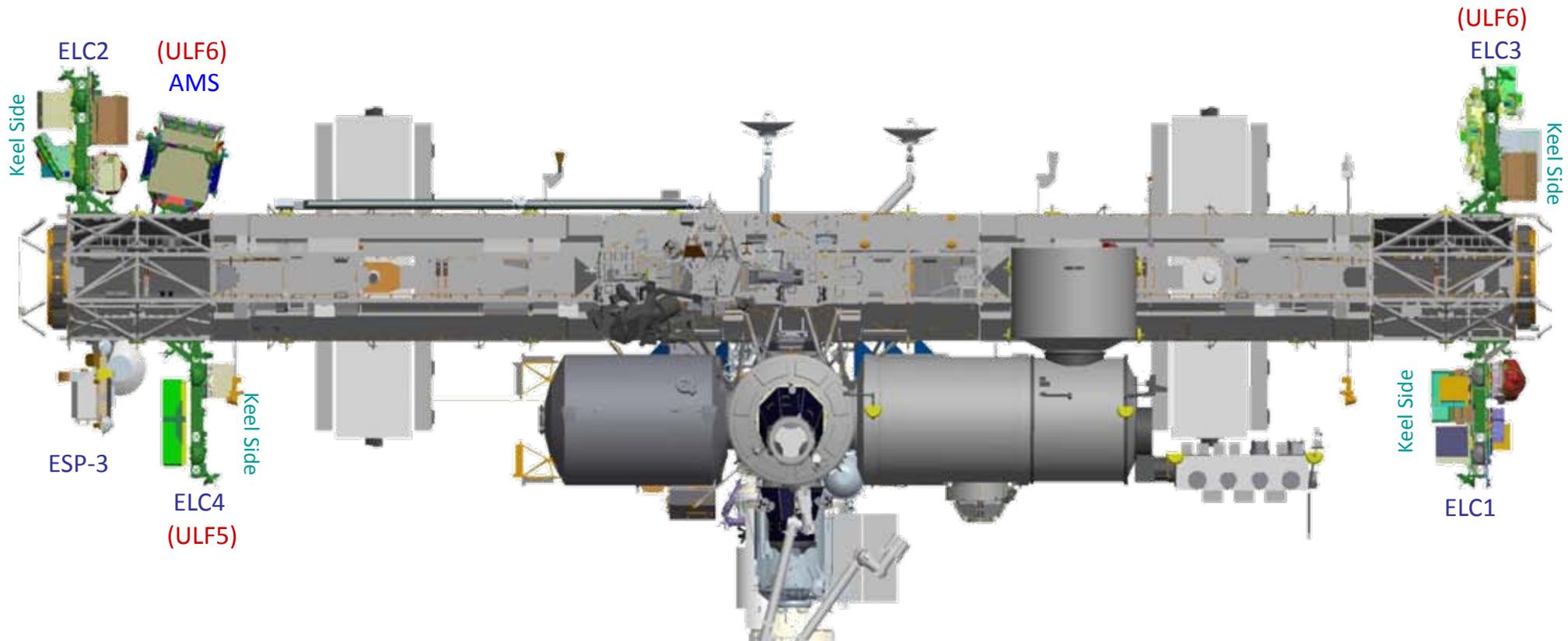
# On Orbit Resources Provided to Payloads

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

# Upgrades In Work

<b>Enhanced Processor and Integrated Communications (EPIC) Project</b>	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.
<b>Air to Ground High Rate Communications System (HRCS) Project</b>	Increase data rates internally and on the RF link (300 Mbps downlink, 7/25 Mbps uplink)
	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
<b>On Orbit External Wireless High Rate</b>	100 Mbps 2-way Ethernet capability
	1 Mbps 1553 capability
	Up to 4 antennas attached to EVA handrails on US Lab

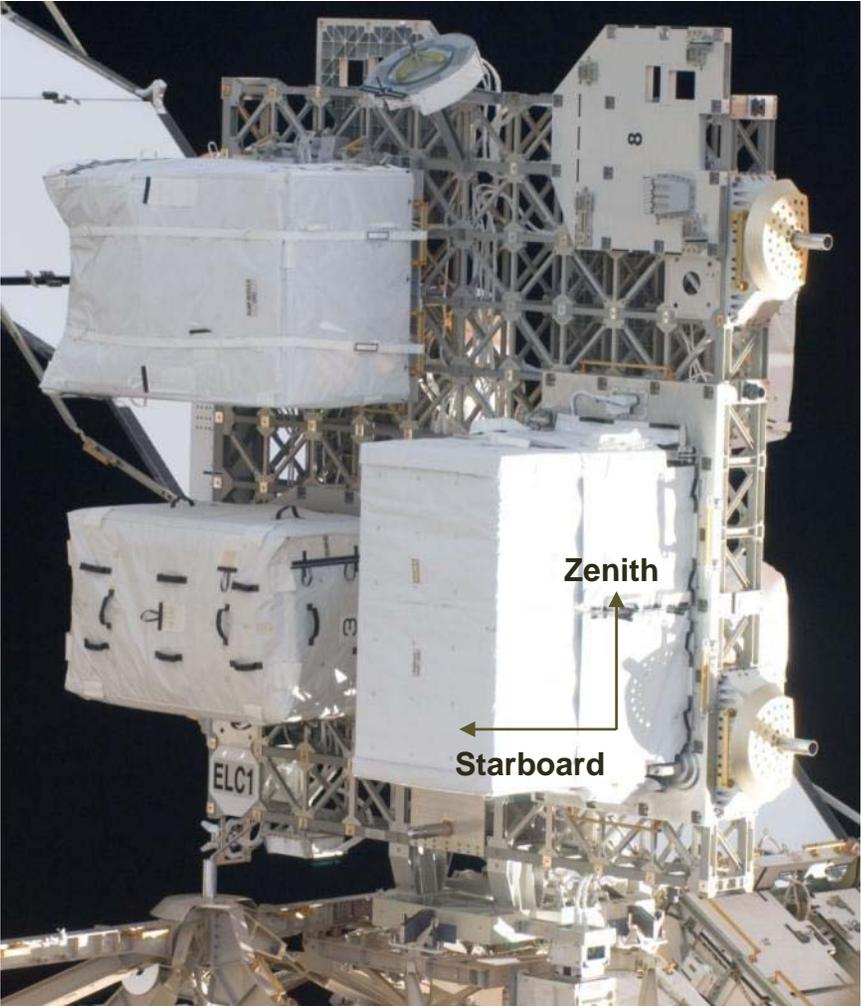
# Truss Attach Site Usage



# Recent ISS Assembly Science Facilities

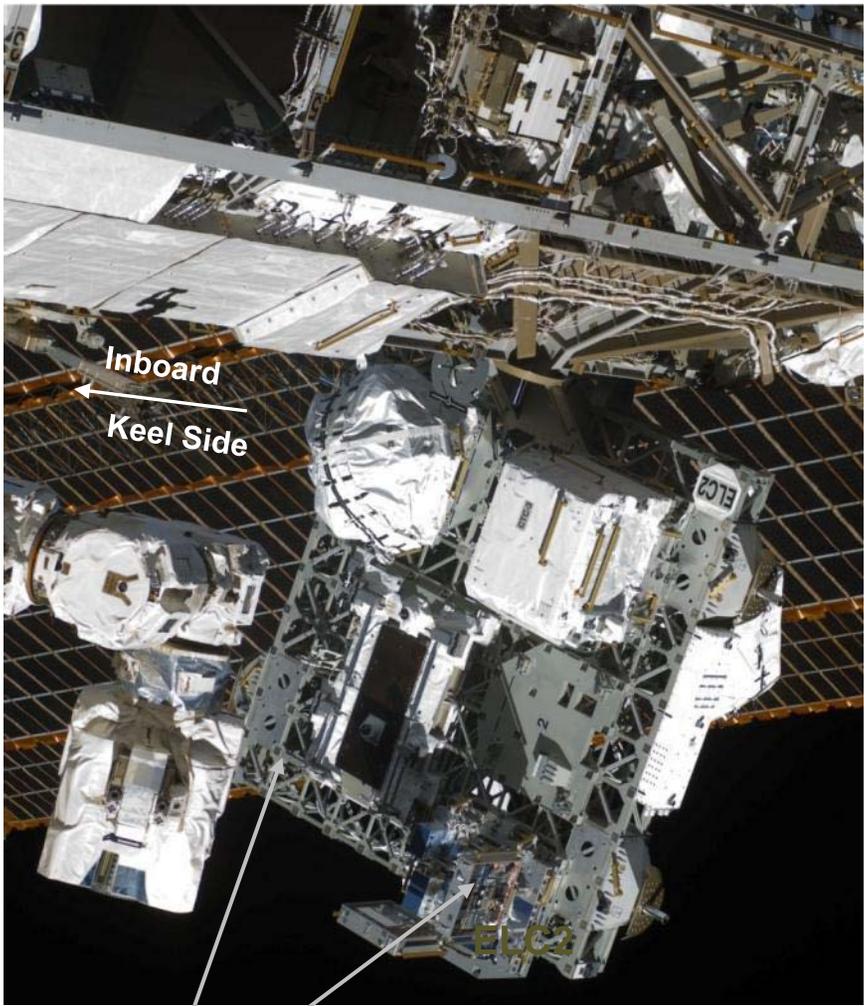
## *NASA Express Logistics Carriers (ELCs)*

S3 Truss



ELC1, ELC3, & ELC4

P3 Truss

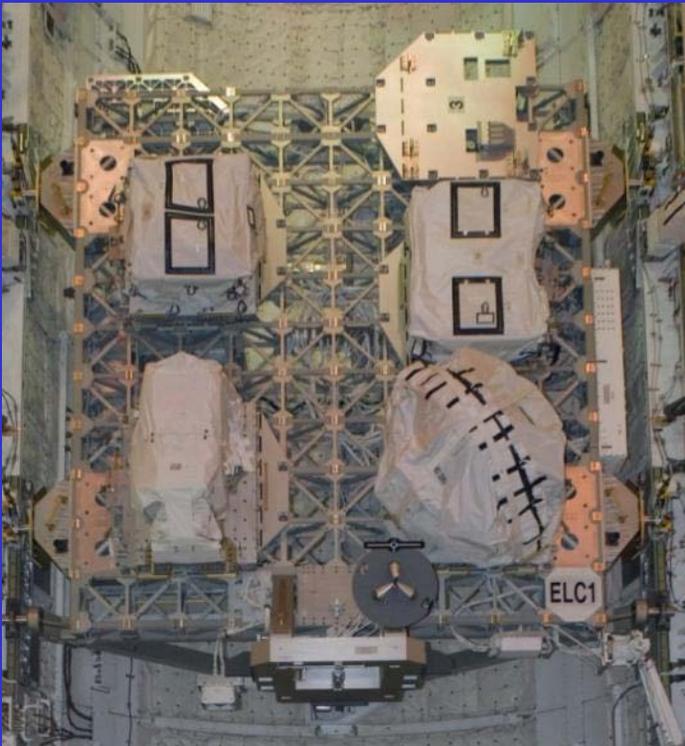


ELC2

*2 payload sites per ELC*

# External Research Accommodations

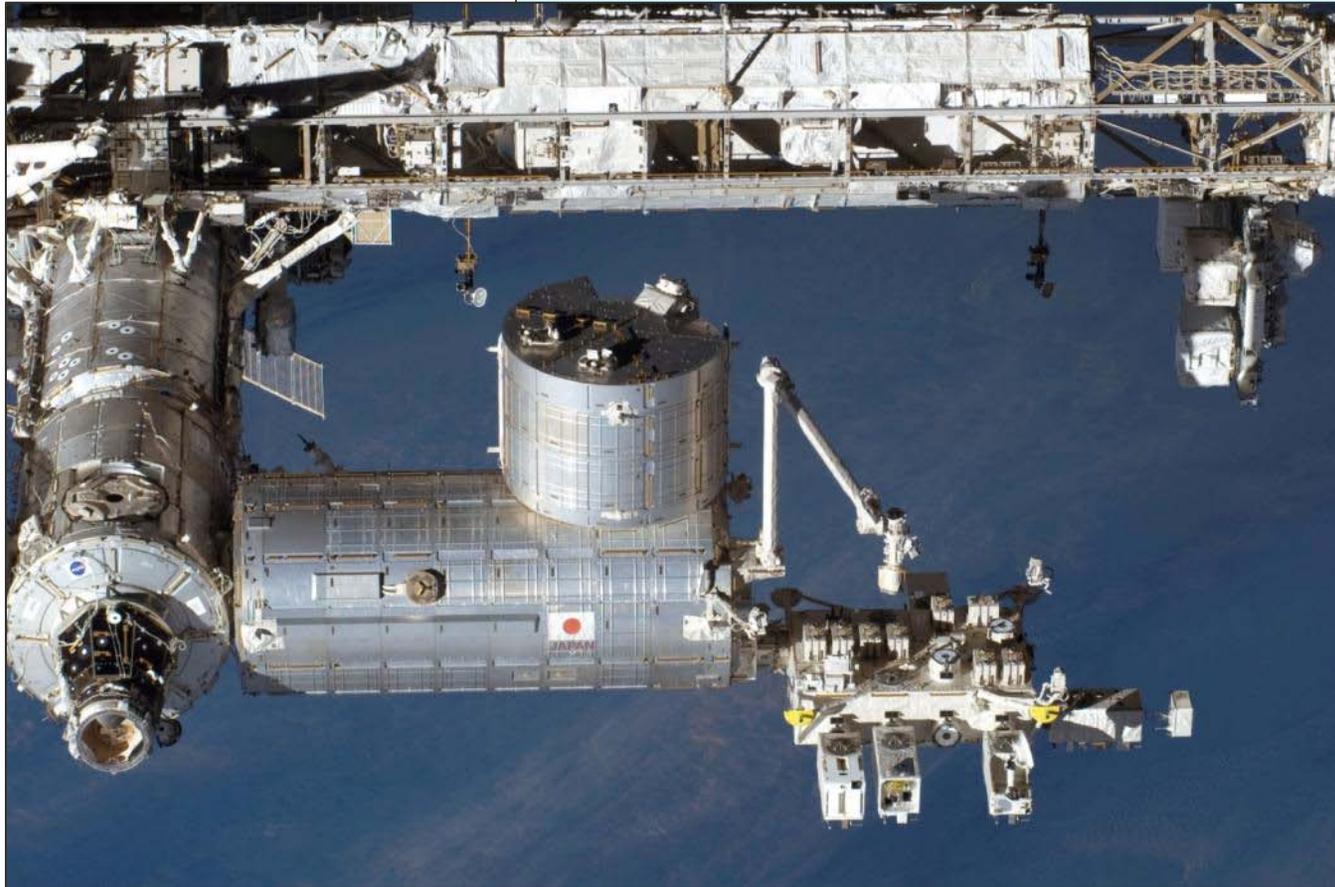
## ELC Single Adapter Resources



<b>Mass capacity</b>	<b>227 kg (500 lb)</b>
<b>Volume</b>	<b>1 m<sup>3</sup></b>
<b>Power</b>	<b>750 W, 113 – 126 VDC; 500 W at 28 VDC per adapter</b>
<b>Thermal</b>	<b>Active heating, passive cooling</b>
<b>Low-rate data</b>	<b>1 Mbps (MIL-STD-1553)</b>
<b>Medium-rate data</b>	<b>6 Mbps (shared)</b>
<b>Sites available per ELC</b>	<b>2 sites</b>
<b>Total ELC sites available</b>	<b>8 sites</b>

# Recent ISS Assembly Science Facilities

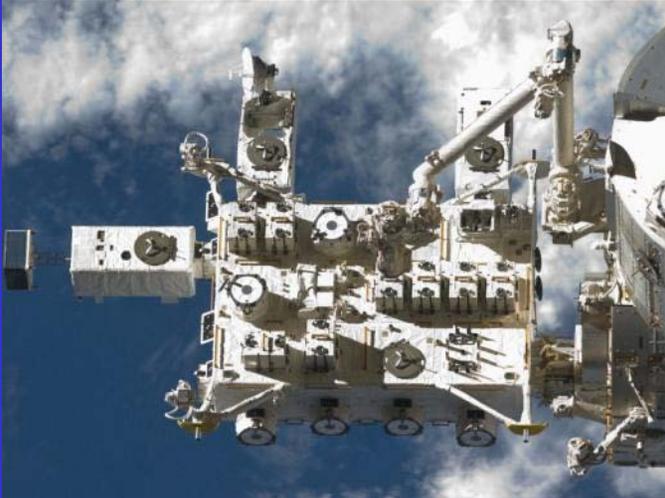
## *Japanese Experiment Module - Kibo*



- *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



<b>Mass capacity</b>	<b>550 kg (1,150 lb) at standard site 2,250 kg (5,550 lb) at large site</b>
<b>Volume</b>	<b>1.5 m<sup>3</sup></b>
<b>Power</b>	<b>3-6 kW, 113 – 126 VDC</b>
<b>Thermal</b>	<b>3-6 kW cooling</b>
<b>Low-rate data</b>	<b>1 Mbps (MIL-STD-1553)</b>
<b>High-rate data</b>	<b>43 Mbps (shared)</b>
<b>Sites available to NASA</b>	<b>5 sites</b>

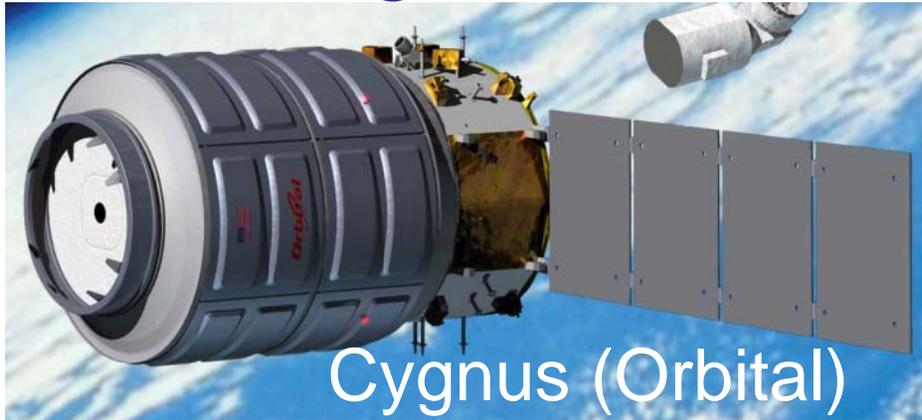
# External Research Accommodations

## Columbus External Resources



<b>Mass capacity</b>	<b>230 kg (500 lb)</b>
<b>Volume</b>	<b>1 m<sup>3</sup></b>
<b>Power</b>	<b>2.5 kW total to carrier (shared)</b>
<b>Thermal</b>	<b>Passive</b>
<b>Low-rate data</b>	<b>1 Mbps (MIL-STD-1553)</b>
<b>Medium-rate data</b>	<b>2 Mbps (shared)</b>
<b>Sites available to NASA</b>	<b>2 sites</b>

# ISS Visiting Vehicles Post-Shuttle



Progress/Soyuz (Energia)



HTV (JAXA)



# 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

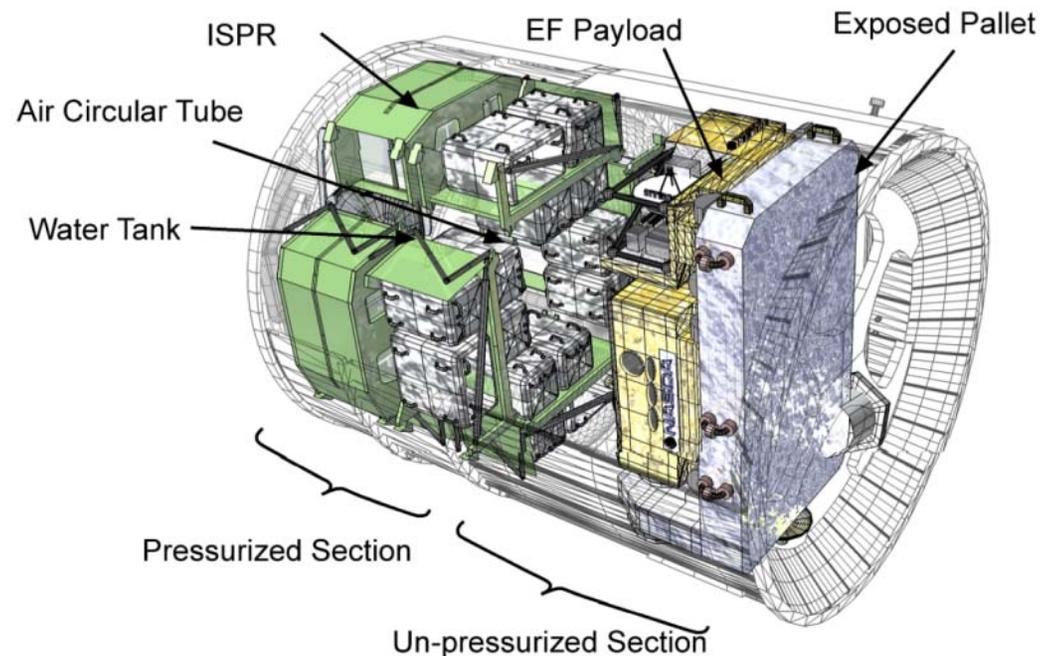
## Downmass

- Internal

Disposal only

- External

Disposal only



# HTV External Pallet Configurations

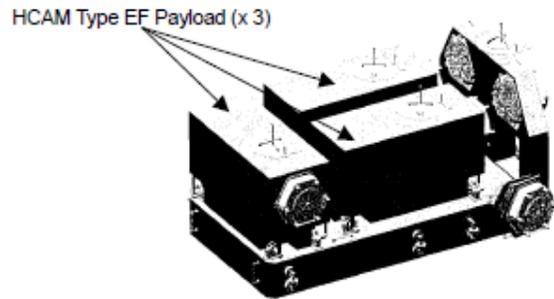


Fig. 3.3.2-1 Type I-a: HCAM Type EF Payload (x 3)

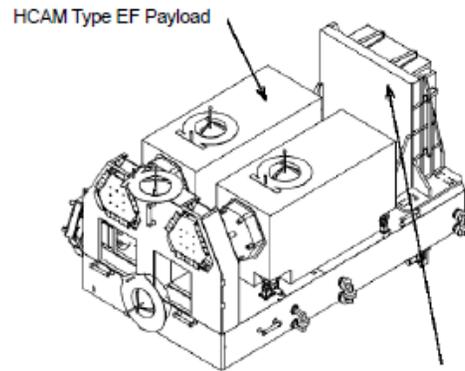


Fig. 3.3.2-4 Type I-c: HCAM Type EF Payload (x 2) and Battery Transportation Demonstration (x 1)

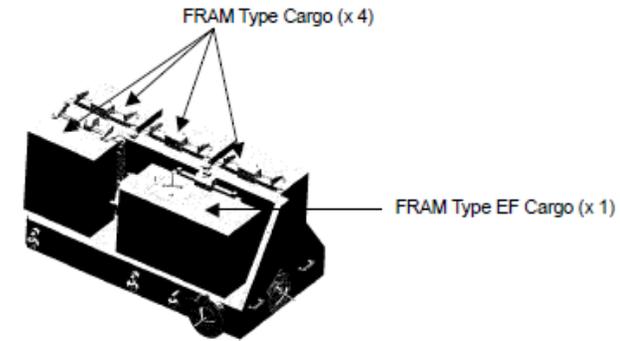


Fig. 3.3.2-6 Type III-b: FRAM Type EF Payload (X1) and FRAM Type Cargo (X4)

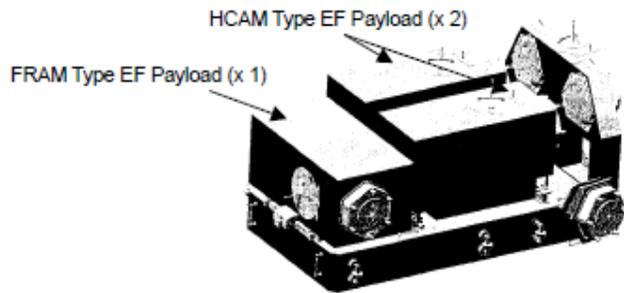


Fig. 3.3.2-2 Type I-b: HCAM Type EF Payload (x 2) and FRAM Type EF Payload (x 1)

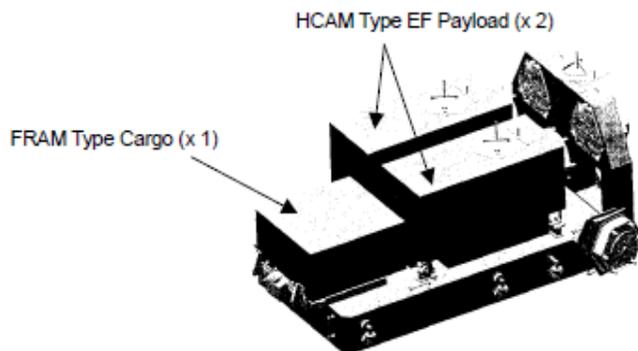


Fig. 3.3.2-3 Type I-b': HCAM Type EF Payload (x 2) and FRAM Type Cargo (x 1)

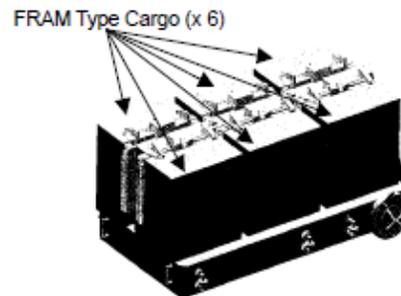


Fig. 3.3.2-5 Type III-a: FRAM Type Cargo (X6)

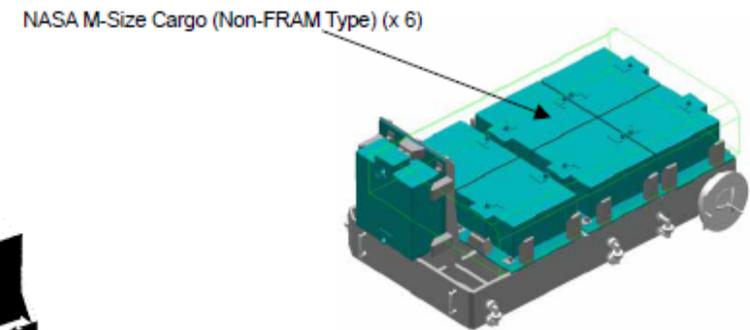


Fig. 3.3.2-7 Type III-c: Non-FRAM Type Cargo (X6)

# 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

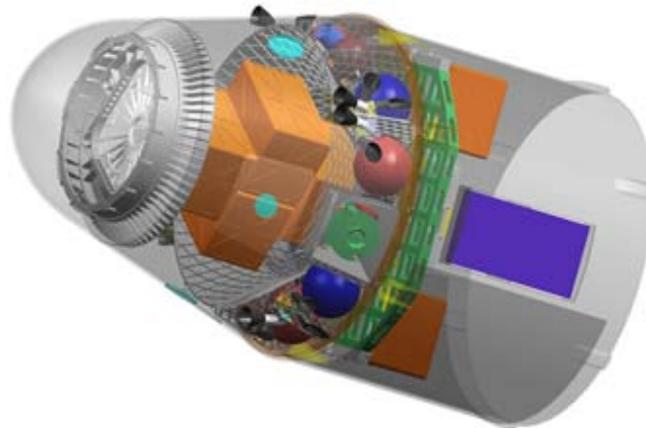
~1700 kg return

Early destow at dock available

Fast boat return available

- External

Disposal only



# ISS Feasibility Assessments

## Data Required

- Upmass needed
- Power consumption
- Data rates
- Pointing/viewing needs
- Lifetime required on orbit
- Return plan

## Timeline

- Initial 1 hr telecon set up after contacting Marybeth Edeen
  - Contact information in the AO
- 2-3 follow on telecons after initial data exchange
- Draft feasibility letter provided ~ 3 weeks after initial contact
- Final letter approved and signed ~4 weeks after initial contact

# ISS Feasibility Assessment Evaluation Criteria

- In performing the feasibility assessments, the ISS payloads office looks at whether or not the proposed payload meets the standard interfaces or requires significant non-standard integration
- For example, the volumes are defined for each platform but there are specific dimensions that make up those volumes
  - Working with the proposer, we will evaluate the dimensions and determine if the payload is within the standard dimensions or exceeds those dimensions in one or more areas
  - If it exceeds the standard interfaces, we will provide an evaluation of how simple or hard it will be to accommodate those non-standard interfaces
  - The proposer will be made aware of any non-standard interfaces to determine if they can redesign to stay within the standard interfaces
  - A lot of times, non-standard interfaces CAN be accommodated but it requires additional work

# ISS Payload Requirements

- ISS payload requirements do not flow from NPR 8705.4 and thus the Class A/B/C/D levels are not directly applicable
- For the ISS requirements, payload success is not part of the requirements set, although it may very well be a requirement for the Science Mission Directorate
- Many requirements of Class D payloads are acceptable to ISS, however, in a number of areas, the man rating requirements will be stricter and more like Class A requirements
- If a payload is selected for an ISS mission of opportunity, the ISS payloads office will work with the payload developer to develop the set of requirements that must be verified to fly on an ISS transportation vehicle and on the ISS

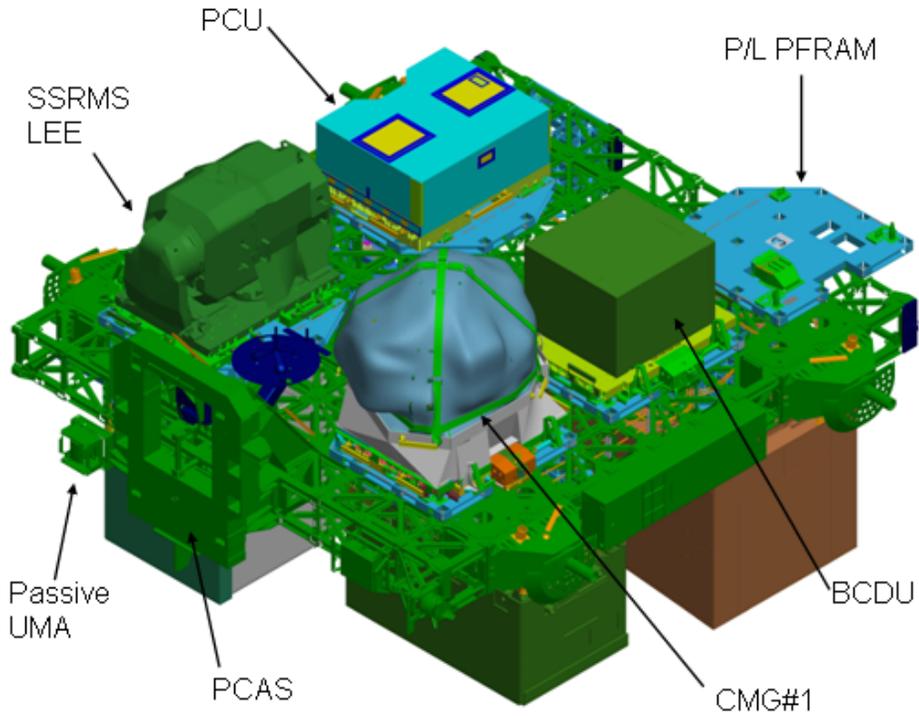
# References

- ISS Program Scientist Toolbox - <http://iss-science.jsc.nasa.gov/index.cfm>
- ISS National Laboratory Office - [http://www.nasa.gov/mission\\_pages/station/science/nlab/index.html](http://www.nasa.gov/mission_pages/station/science/nlab/index.html)
- Advanced Avionics Development Office - <http://iss-www.jsc.nasa.gov/nwo/avionics/aado/home/web/>
- 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](#), П32928-103
- SpaceX Introduction For Payloads (OZ3, Jan 2010)
- [Cygnus Fact Sheet](#) (Orbital, 2009)

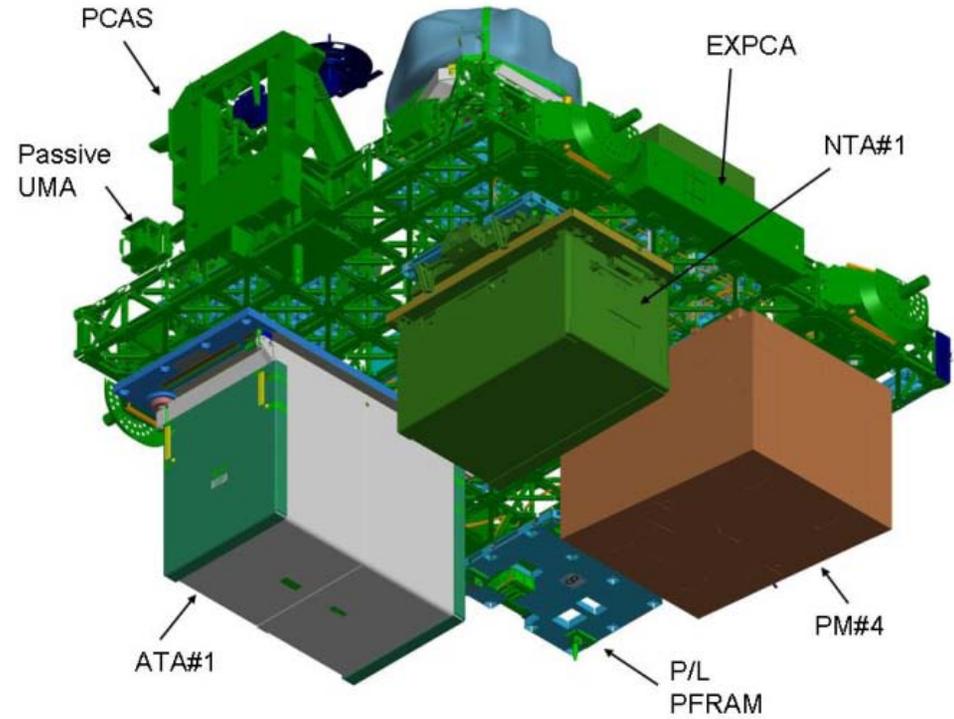
# Backup

## Science Facilities Overview

# ELC1 Configuration

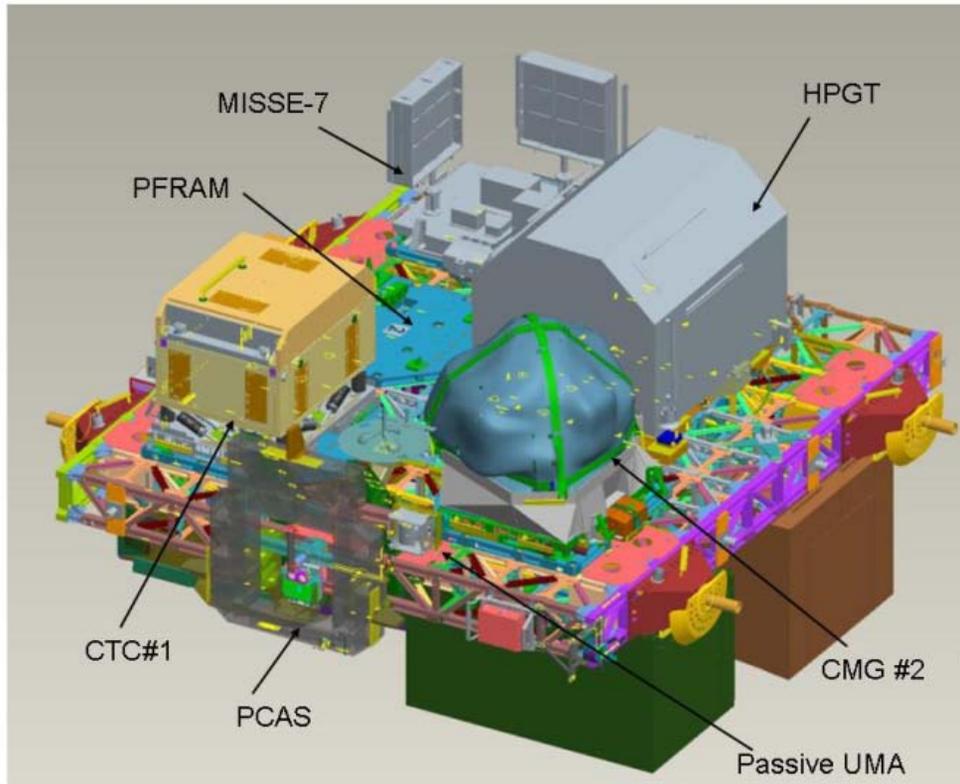


ELC1 Top Side

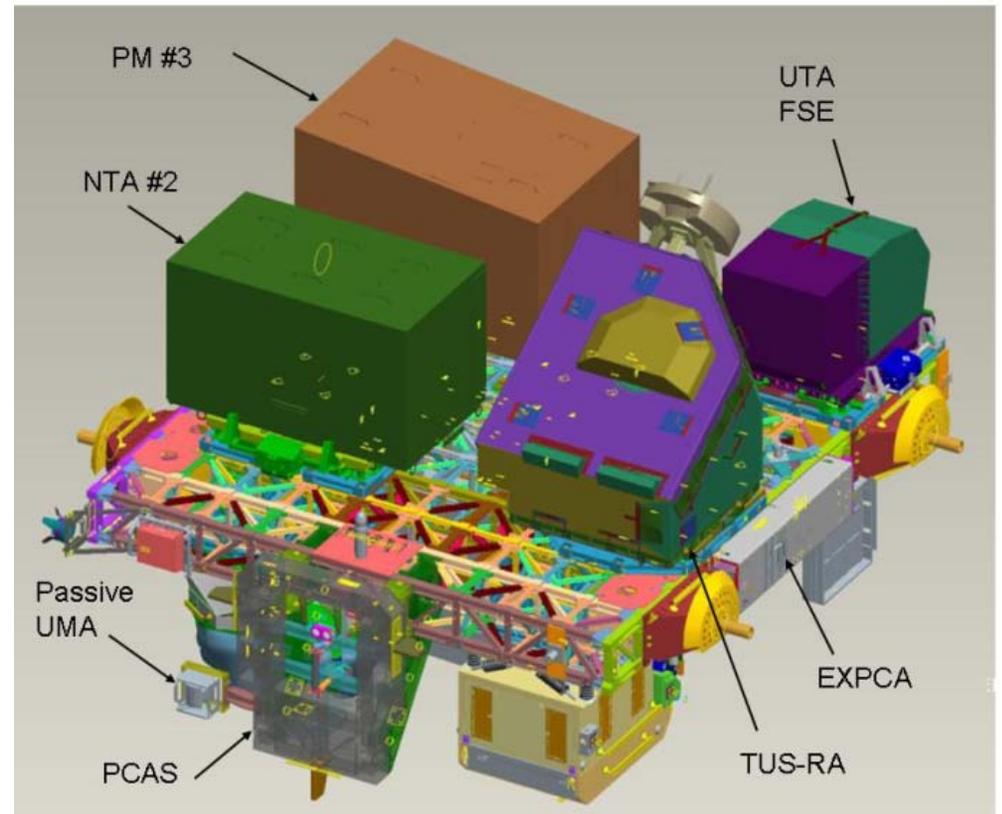


ELC1 Keel Side

# ELC2 Configuration



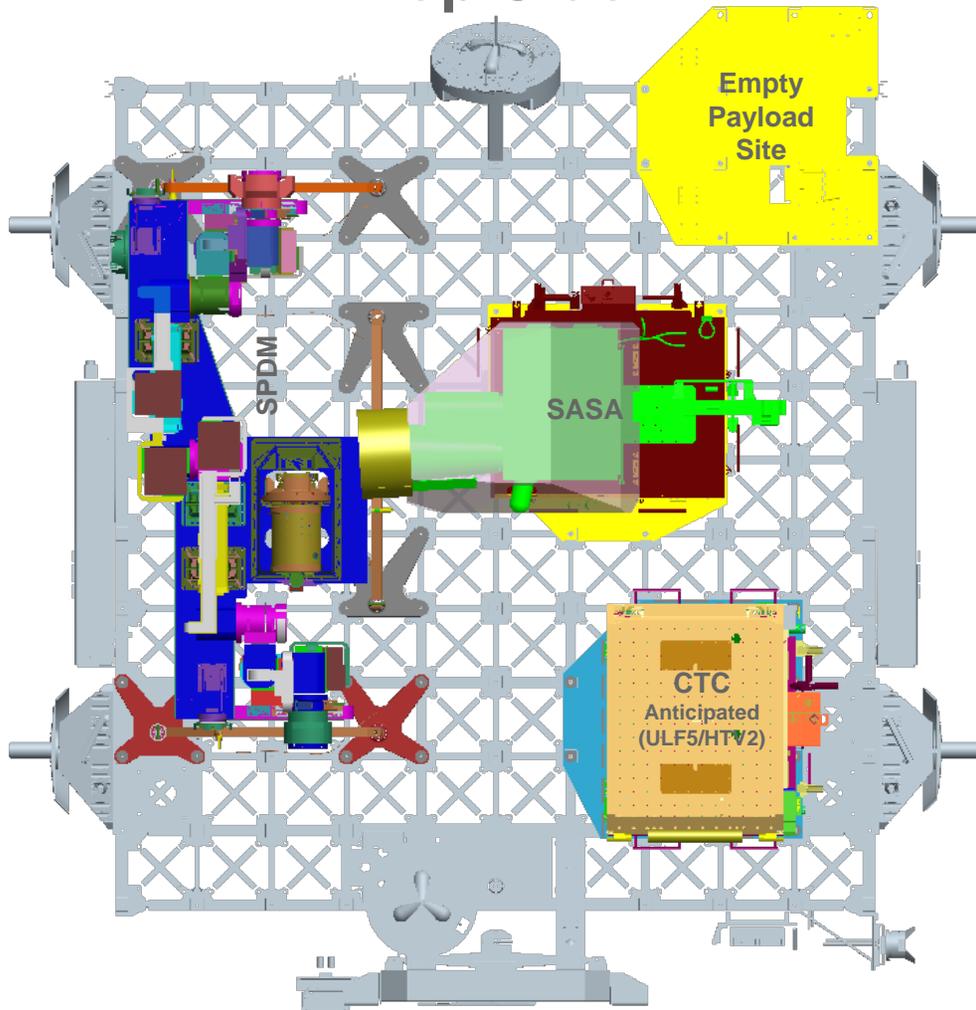
ELC2 Top Side



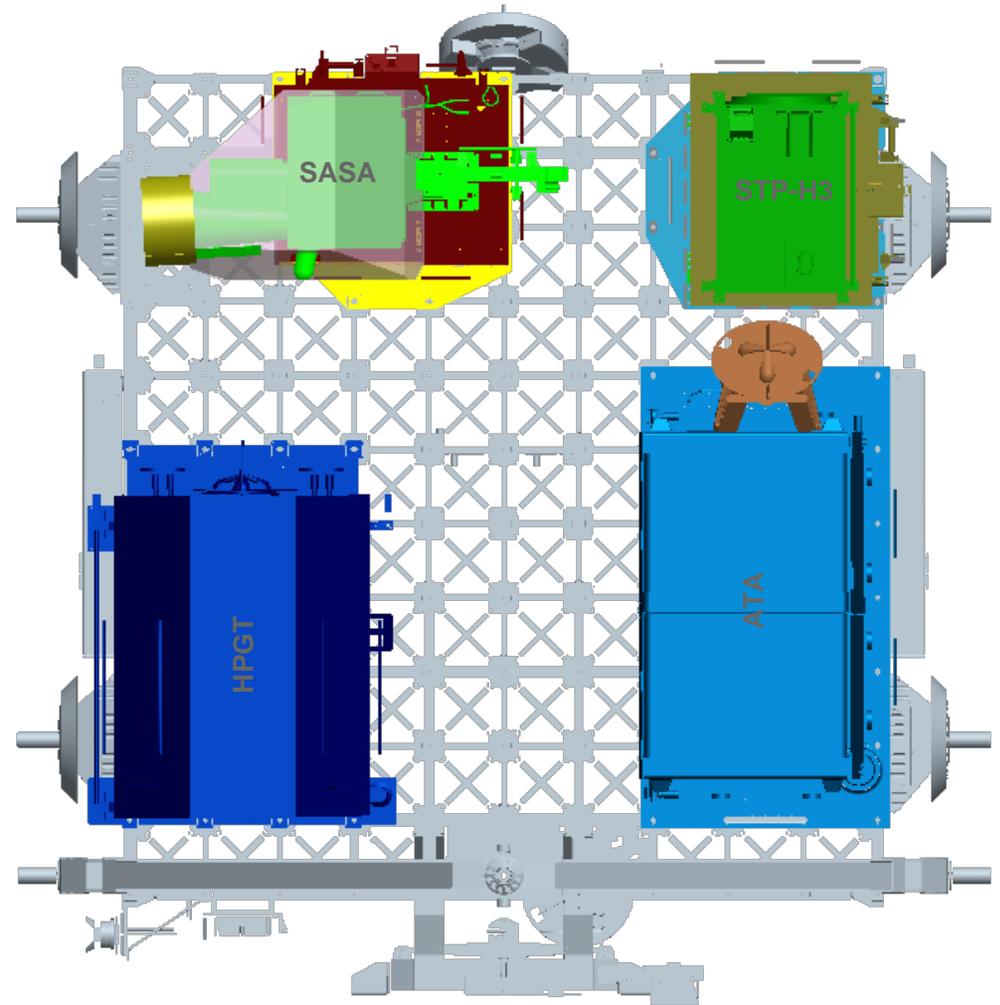
ELC2 Keel Side

# ELC3 Configuration

## Top Side

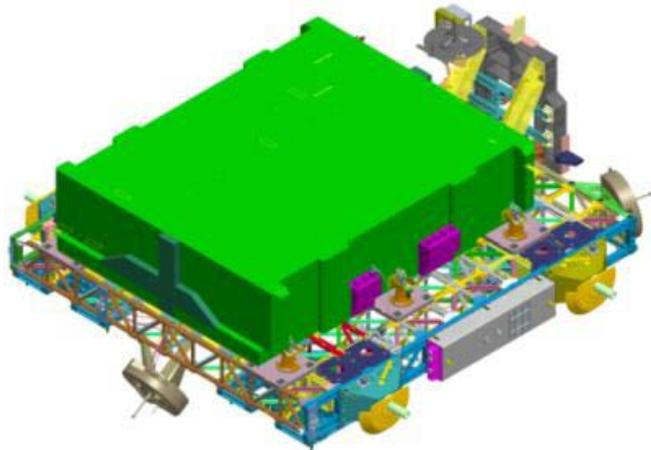
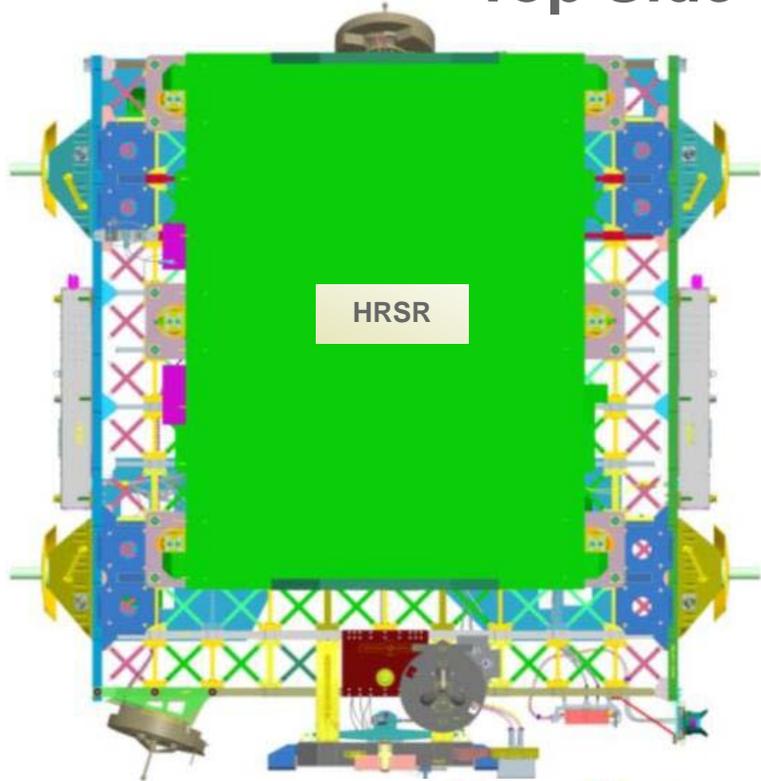


## Keel Side

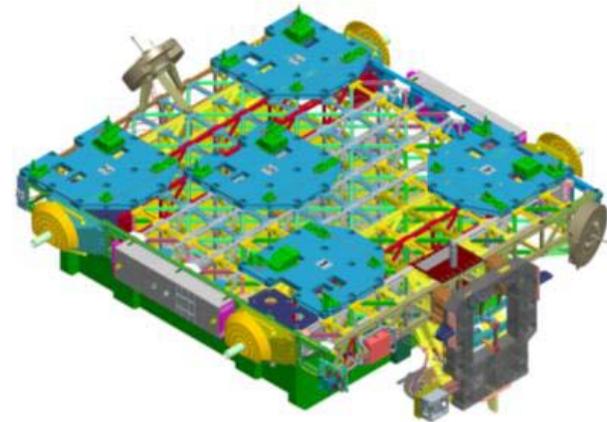
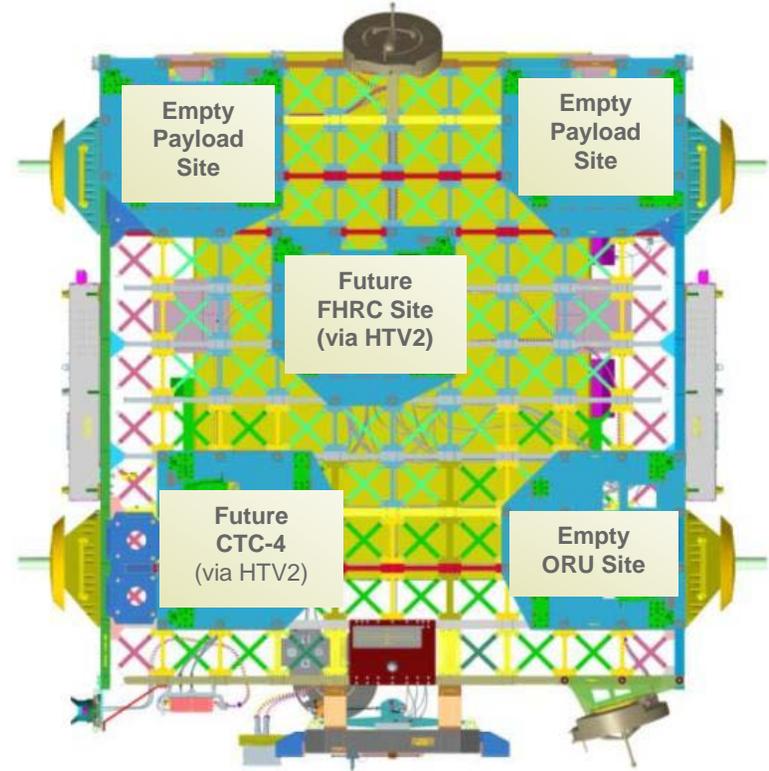


# ELC4 Configuration

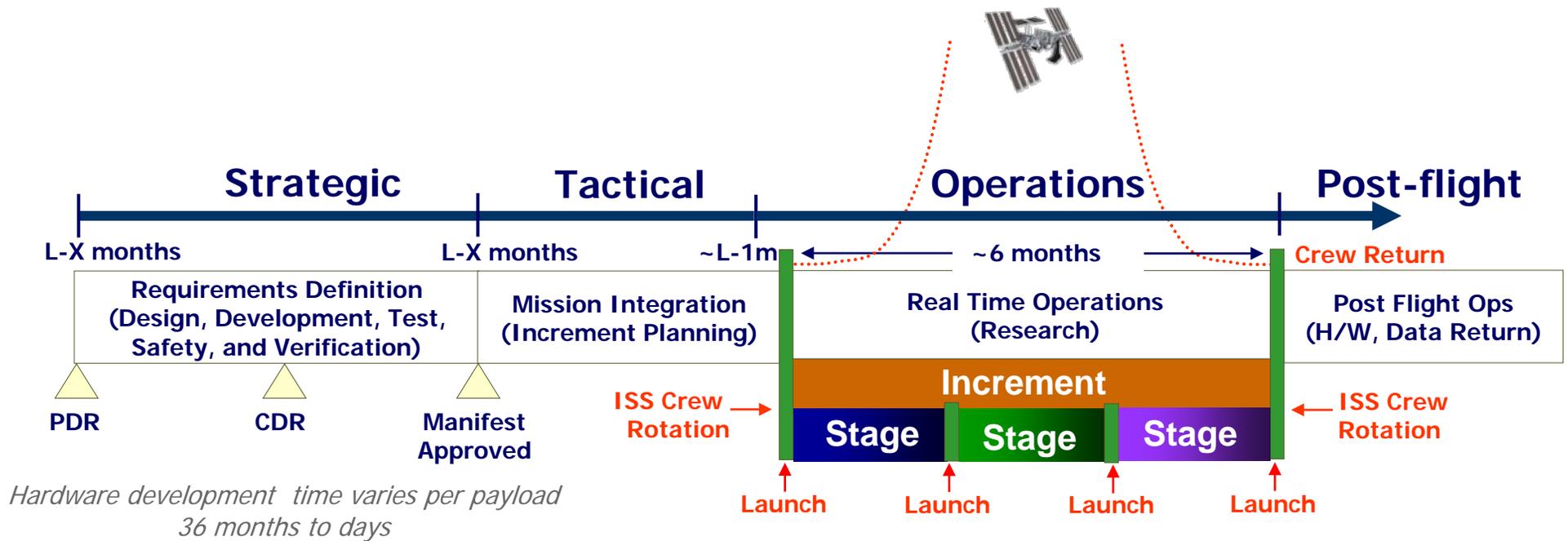
## Top Side



## Keel Side



# ISS Payload Integration Process



# 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

