HTV2 (KOUNOTORI 2)
Mission Press Kit

January 20, 2011 (Revision A)

Japan Aerospace Exploration Agency

Revisions History

No.	Date	Page revised	Reason for the revision
NC	2011.01.14	－	
A	2011.01.20	1-1 1-7 2-1	Launch was postponed to January 22, 2011.
		1-9	HTV2 mission timeline was rescheduled due to launch delay.

Table of Contents

1. HTV2 Mission

1.1 HTV2 Mission Overview

The H-II Transfer Vehicle (HTV) is JAXA's unmanned cargo transfer spacecraft that delivers supplies to the International Space Station (ISS).

The HTV made its first flight to the ISS in September 2009. The HTV1 (Technical Demonstration Vehicle) demonstrated its autonomous and navigation flight capabilities, while delivering 4,500 kg of cargo and supplies to the ISS. In November 2010, the HTV was nicknamed "KOUNOTORI" (White Stork) based on the result of JAXA's online HTV nicknaming contest.

The HTV2 is scheduled to launch on January 22, 2011. Major objectives of the HTV2 Mission are as follows.

(1) Cargo Delivery
- Delivers 5,300 kg of cargo/supplies to the ISS
- Delivers potable water, cargo transfer bags containing food and experiment samples, and JAXA's two science racks, KOBAIRO Rack and the Multi-purpose Small Payload Rack (MSPR), aboard the HTV Pressurized Logistics Carrier (PLC)
- Delivers NASA's two unpressurized orbital replacement units (ORUs), the Cargo Transport Container (CTC) and the Flex Hose Rotary Coupler (FHRC), using the HTV Exposed Pallet (EP)

(2) Trash Loading (Trash Disposal Support)

(3) Verification of Design/Operational Changes

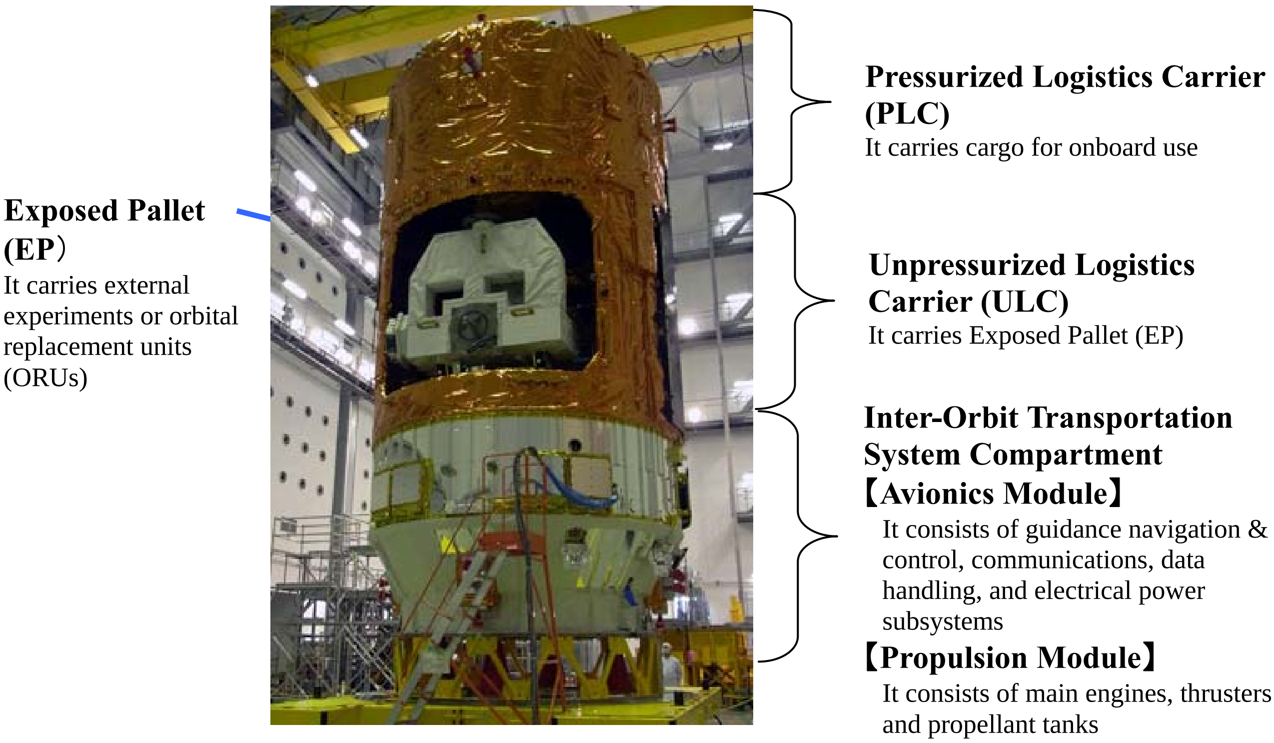


Fig. 1-1 HTV (KOUNOTORI) Overview

1.2 Comparison between HTV2 and HTV1

Based on the results of the HTV1 Mission, some modifications were made to the HTV's original configuration. The following table shows the difference between the HTV1 and the HTV2.

Table 1.2-1 Specifications of HTV1 and HTV2

		HTV1 (Mission Result)	HTV2
Cargo Capacity			
	Pressurized Cargo	3,600 kg	4,000 kg
	Unpressurized Cargo	900 kg	1,300 kg
	Total Cargo Up-Mass	4,500 kg *1)	5,300 kg
Total Mass		16,000 kg	16,000 kg
Target Orbit			
	Altitude (circular orbit)	347 km (perigee 330km)	Approx. 350 km
	Inclination	51.6 degrees	51.6 degrees
Mission Duration			
	Rendezvous Flight (Solo flight)	8 days *2)	7 days
	Berthed Operations	43 days (Nominal berthing duration is up to 30 days)	30 days (Note: Berthing operations period may be extended up to 60 days)
	Contingency Reserve	-	7 days

*1) HTV1 Mission's total cargo up-mass was adjusted to 4,500 kg since it had to carry extra batteries and extra propellant for rendezvous flight demonstrations.

*2) Duration of the HTV1's rendezvous flight (solo flight) was extended by one day (Original plan was 7 days).

1.3 Major Design/Operational Changes

(1) Design Change (Please see Fig. 1.3-2)

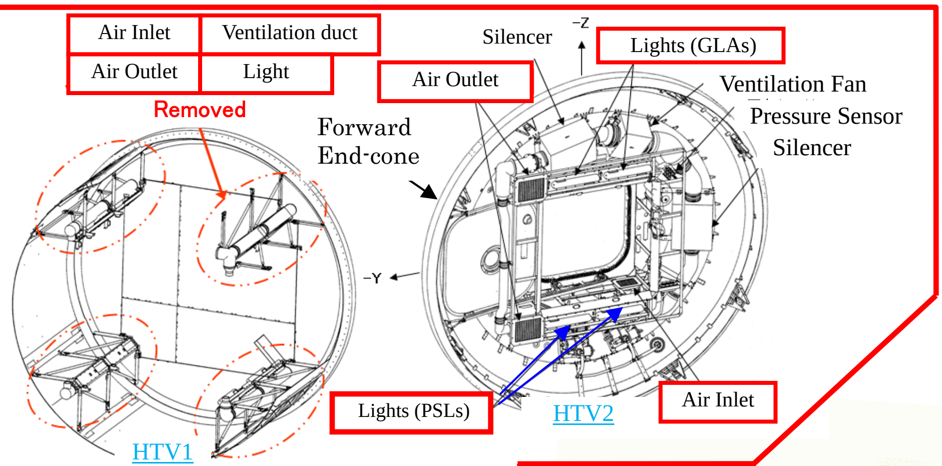
・Cargo Space of the Pressurized Logistics Carrier (PLC)

To make additional cargo loading space in the PLC, ventilation ducts and lights inside the PLC were relocated. In addition, the HTV Resupply Rack (HRR) was modified to accommodate more cargo transfer bags. Furthermore, rack standoff spaces are made available as cargo space. These modifications enable the HTV2 Mission to carry more Cargo Transfer Bags (CTBs).

・Use of Japanese Product

Of four lights in the PLC, two lights were replaced to domestic (Japanese) LED lights, called Permanent Solid-state Lighting (PSL) (The rest are the station's common lights, called General Luminaire Assembly (GLA)). For reuse purpose, these PSLs and GLAs will be removed and stowed in the ISS before the HTV2 departs from the ISS. In addition, the Proximity Link System (PLS) String B Transponder (transmitter & receiver) was replaced to a domestic (Japanese) transponder.

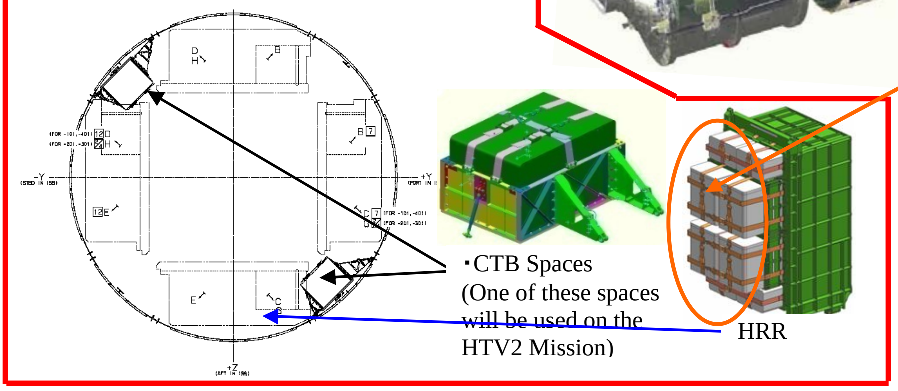
Fig. 1.3-1 New Locations of Lights on board the PLC (HTV2)

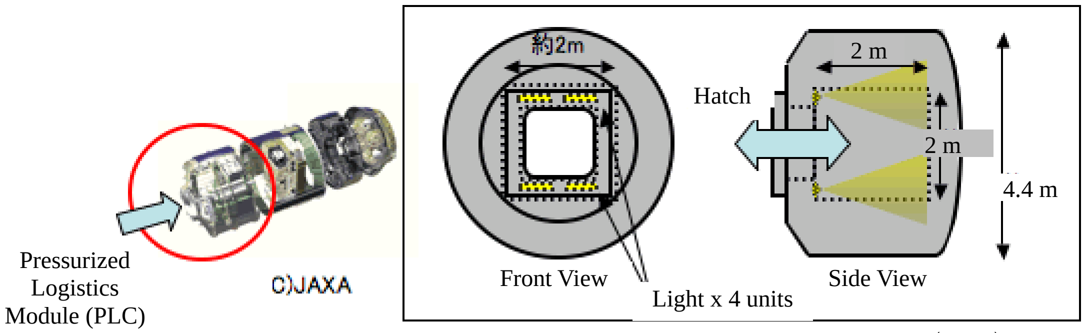


【Pressurized Logistics Carrier (PLC)】

- Ventilation ducts and lights were relocated to the forward End-cone near the hatch opening (to enhance cargo capacity).
- Two of the four lights were replaced to the PSLs (LED lights).
- HRR was modified to accommodate additional CTBs (to enhance cargo capacity).

Additional CTBs are installed here





HTV Pressurized Logistics Module (PLC)

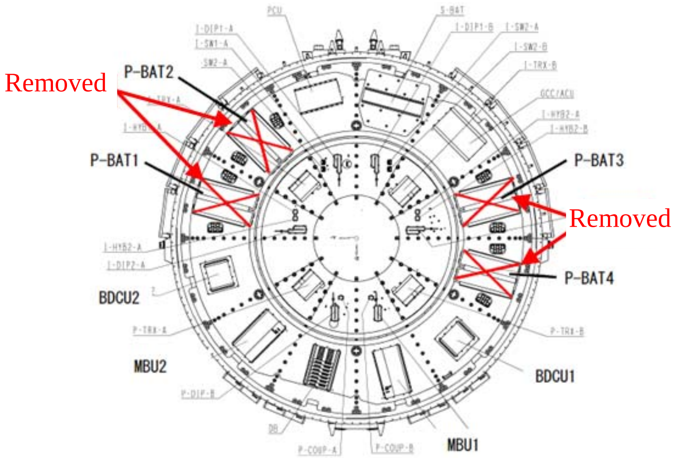
【New Lighting】 High-power LED20, Power Consumption: Approx.29W

Source: HTV LED Lights (Panasonic Denko Press Release)
http://panasonic-denko.co.jp/corp/news/0811/0811-1.htm

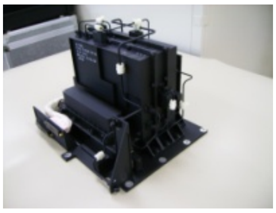
Fig. 1.3-2(1/2) Modifications

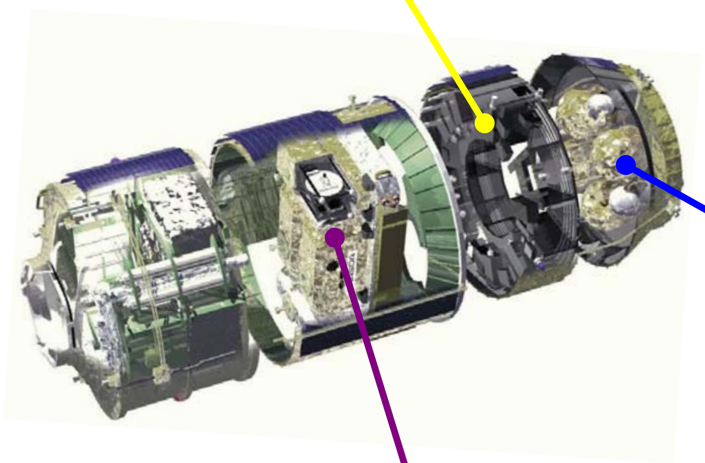
【Avionics Module】

- Total number of Primary Batteries (P-BATs) was reduced (from eleven to seven units).
- Energy density of the P-BAT was enhanced (from 175 Ah to 200 Ah).
- Rendezvous Flight Software (RVFS) was modified (Modification of differential navigation processing, etc.).
- Space Integrated GPS/Inertial Navigation System (SIGI) software was modified (Modification of Kalman Filter).
- Proximity Link System String B (PLS-B) Transponder was replaced to a Japanese transponder. (See the picture below)



Upper Deck





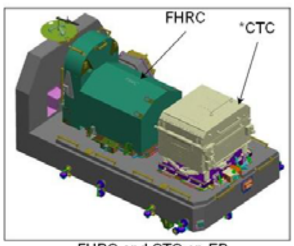
【Propulsion Module】

- Injection temperature sensors of the earth-facing RCS thrusters were modified. (To increase the upper measurement range)

【Exposed Pallet】

- Type I
- Unpressurized Payloads (FHR, CTC)

FHRC : Flex Hose Rotary Coupler
CTC : Cargo Transportation Container



FHRC and CTC on EP_{FM1}

Fig. 1.3-2(2/2) Modifications

(2) Cargo Capacity

・<u>Exclusion of Rendezvous Demonstrations</u>

Since flight demonstrations are not included in the HTV2's mission objectives, the HTV2 will not carry extra batteries and extra propellant. Therefore, the HTV2 can carry up to 6,000 kg of cargo as it is designed.

・<u>Payload</u>

- The HTV PLC carries JAXA's two science racks.
- The HTV ULC carries NASA's two Orbital Replacement Units (ORUs) (FHRC and CTC).
- The HTV2 will deliver potable water to the ISS. Purified water, which meets NASA's potable water quality requirements, will be prepared at the Tanegashima Space Center (TNSC) (For this purpose, a pure water production system was introduced at TNSC). The purified water, in which a small amount of iodine (sterilizing agent) is added, will be packed in NASA's Contingency Water Container-Iodine (CWC-I). In the future, the HTV is expected to deliver up to 600 kg of potable water to the ISS. The HTV2 Mission will deliver approximately 80 kg of water (four CWC-I bags) to the ISS.

Fig. 1.3-3 Water Loading System Introduced at Tanagashima Space Center

(3) Others

・ESA's Automated Transfer Vehicle-2 (ATV-2), called "Johannes Kepler", is scheduled to be launched to the ISS while the HTV2 is berthed to the ISS. Therefore, for a short period of time, the ATV-2 and the HTV2 will berth to the ISS at the same time. The launch of the ATV-2 is scheduled on February 15, 2011. The ATV-2 will be docked to the aft port of the Zvezda service module on February 23, 2011. The ATV-2 is scheduled stay at the ISS until June 2011. (This information is as of January 2011.)

1.4 HTV2 Mission Profile

Table 1.4-1 HTV2 Mission Profile

Updated January 20, 2011

	Mission Details	
HTV Flight Number	HTV2 (KOUNOTORI-2)	
Scheduled Launch Time	January 22, 2011, 2:37:57 p.m. (Japan Standard Time: JST) January 22, 2011, 5:37:57 a.m. (UTC)	
Launch Period	January 22 through February 28, 2011	
Launch Site	Launch Pad 2 (LP2), Tanegashima Space Center (TNSC)	
Scheduled Berthing Time	January 28, 2011 Around 4:30 a.m. (JST) January 27, 2011 Around 7:30 p.m. (UTC) Note: "Completion of berthing" is defined as the time when all the electrical cables and communications lines are mated.	
Scheduled Unberthing Date	March 28, 2011 (JST) * *In view of the current STS-133 Mission timeline, extension of berthing duration (up to 60 days) is under discussion.	
Altitude	Insertion: 200 km x 300 km (elliptical orbit) Rendezvous: Approx. 350 km	
Inclination	51.6 degrees	
Payload	Pressurized Logistics Carrier (PLC)	Supplies for onboard use HTV Resupply Rack (HRR) x 6 JAXA's science rack x 2
	Unpressurized Logistics Carrier (ULC)	NASA's unpressurized Orbital Replacement Units (ORUs) (FHRC and CTC)

You will find more information about the HTV2 Mission at the following websites:
http://iss.jaxa.jp/en/htv/index.html
http://www.jaxa.jp/countdown/h2bf1/index_e.html

Note: The HTV2 Mission schedule, including the berthing duration, may vary depending on the ISS's operations timeline.

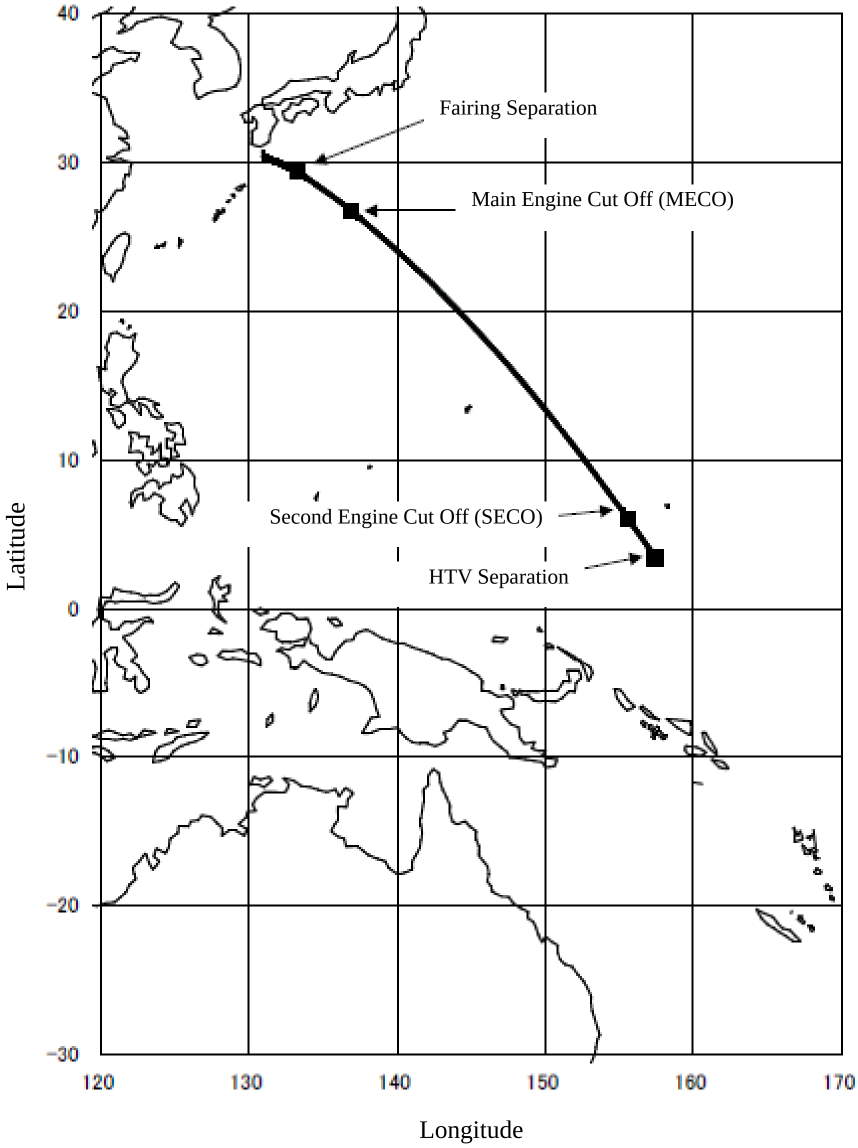


Fig. 1.4-1 Flight Path of the H-IIB 2 Launch Vehicle

1.5 HTV2 Mission Summary Timeline

Table 1.2-1 HTV2 Mission Timeline /Updated January 20, 2011

Flight Day	HTV2 Mission Events
FD1	Launch/Orbit insertion, post-insertion auto sequence (the HTV subsystem activations, attitude control, self-check, TDRS communications establishment, initiation of communication with the HTV Mission Control Room (MCR), rendezvous maneuver
FD1 to FD5	Rendezvous flight
FD6	ISS Proximity Operations/Final Approach Capture by the SSRMS Berthing to the ISS ▪ HTV is berthed to the Common Berthing Mechanism (CBM) at the nadir port of Harmony ▪ Vestibule outfitting ▪ Activation of HTV power supply from the ISS / Switching of the communications line (from the wireless communications to the wire communications)
FD7	Crew ingress ▪ Removal of the Controller Panel Assemblies (CPAs) ▪ HTV PLC hatch open ▪ Activation of the Inter-Module Ventilation (IMV) ▪ Transfer of the Portable Breathing Apparatus (PBA), and the Portable Fire Extinguisher (PFE) in the PLC
	Cargo transfer from the HTV to the ISS
	Removal of the Exposed Pallet (EP) from the HTV Unpressurized Logistics Carrier (ULC) / Temporary installation of the EP on Kibo's Exposed Facility (EF)
	Transfer of NASA's two unpressurized ORUs to temporary installation locations (This task will be performed using the DEXTER)
	Reinstallation of the EP into the ULC
	Relocation of the HTV to the zenith port of Harmony
	Relocation of the HTV to the nadir port of Harmony
Unberthing -1 day	Preparation for HTV Unberthing Operations Removals of lights, smoke detectors, PFEs, and PBAs, installation of CPA on the CBM, cable de-mating, hatch closure, switching the communications line (from the wire communications to the wireless communications)
Unberthing Day	Unberthing Operations ▪ Deactivation of HTV power supply from the ISS ▪ Vestibule de-outfitting ▪ Capture of the HTV by the SSRMS ▪ CBM bolts release ▪ SSMRS moves the HTV to the release position ▪ Activation of the HTV's Guidance Navigation Control (GNC), Priming of HTV's propulsion system ▪ The SSRMS releases the HTV, the HTV departs from the ISS
Reentry Day	Deorbit maneuvers / Reentry

Note: The HTV2 Mission schedule, including berthing duration, may vary depending on the ISS's operations timeline.

The HTV2 Mission Major Events

On the HTV2 Mission, the HTV will be berthed to the ISS on FD8. While the HTV stays at the ISS, supply/cargo transfer between the HTV and the ISS will be performed. The HTV will then be loaded with trash and used materials, and unberthed from the ISS. Finally, the HTV will reenter the Earth's atmosphere.

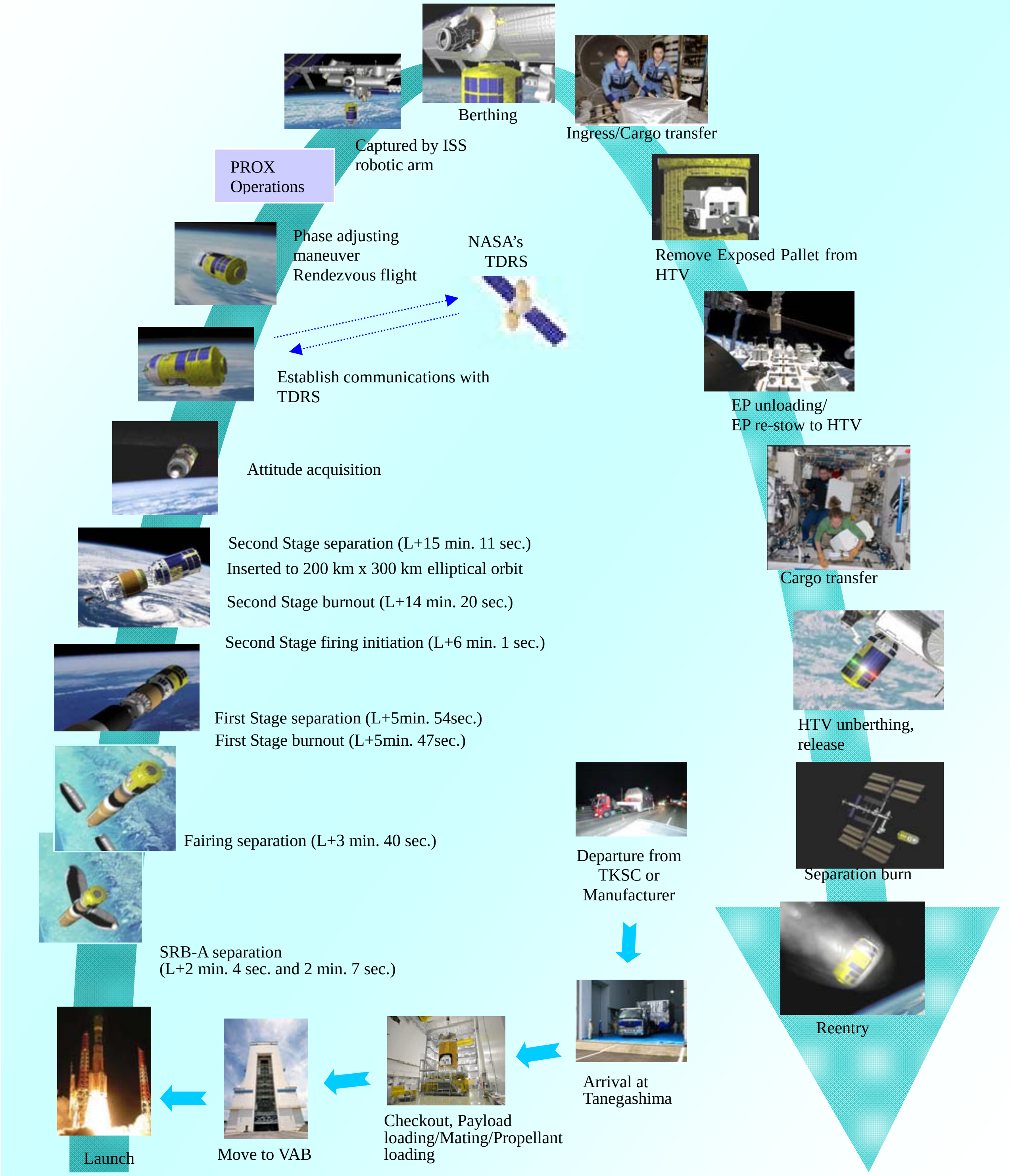


Fig. 1.5-1 HTV1 Mission Event Sequence

1.6 HTV2 Mission Timeline

The following pages show a day-by-day schedule of the HTV2 Mission.

Definition of HTV Mission Flight Day (FD):
HTV Mission's Flight Day (FD) is based on the ISS crew timeline. Thus, there may be a slight difference in the day count between the Mission Elapsed Time (MET) and the FD.

Note: The HTV2 Mission schedule, including berthing duration, may vary depending on the ISS's operations timeline.

Updated January 20, 2011

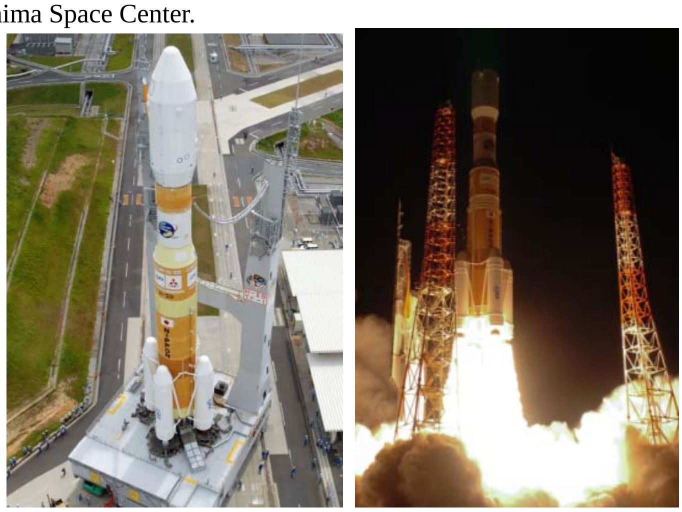
FD1

Major Objectives

- Launch/Orbit Insertion
- Post-Insertion Auto Sequence (activation of the HTV subsystems, establishment of three axis stabilized attitude control, self-check, acquisition of TDRS communications and initiation of communications with the HTV Mission Control Room (HTV MCR)
- Rendezvous Flight

- Launch/Orbit Insertion

The HTV will be launched from the Tanegashima Space Center (TNSC) aboard the H-IIB launch vehicle. Launch opportunity is once a day as its launch time has to be adjusted and scheduled for when the ISS orbital plane is passing over the Tanegashima Space Center.

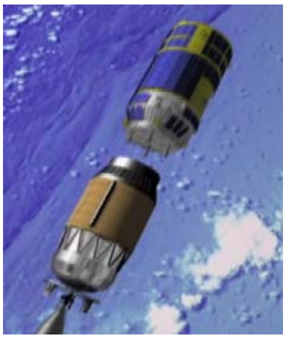


Lift-off of the H-IIB launch vehicle (HTV1)

Solid Rocket Boosters (SRB-A) separation will occur two at a time, 2 minutes 6 seconds and 2 minutes 9 seconds after launch. The fairing will separate 3 minutes 40 seconds after launch. Propellant of the First Stage will be spent in 5 minutes 47 seconds and First Stage separation will occur 5 minutes 54 seconds after launch. Thereafter, the Second Stage will ignite to insert the HTV into an elliptical orbit with an altitude of 200 km (perigee) x 300 km (apogee) and an inclination of 51.6 degrees. The Second Stage will burn out after 14 minutes 21 seconds and separate from the HTV15 minutes 11 seconds after launch.

Fairing Separation

First Stage Separation



Second Stage Separation

- Post-Insertion Auto Sequence

Once the HTV is separated from the Second Stage of the H-IIB launch vehicle, the HTV will automatically activate the HTV subsystems, stabilize its attitude, and perform self-checks on the HTV components. Then, the HTV will establish communications with NASA's Tracking and Data Relay Satellite (TDRS) and initiate communications with the HTV Mission Control Room (HTV MCR) at Tsukuba Space Center (TKSC).

FD2 to FD5

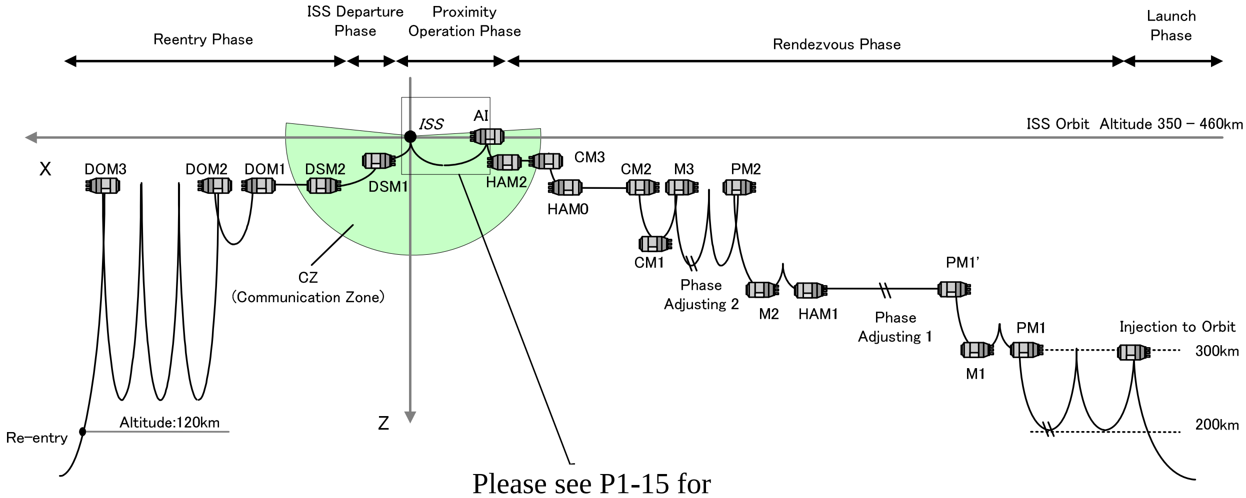
Major Objectives

- Far Field Rendezvous Flight

- HTV Rendezvous Flight

HTV will fly to the ISS by gradually increasing its orbital altitude.

HTV1's Rendezvous Flight (Solo Flight)



Please see P1-15 for enlarged view

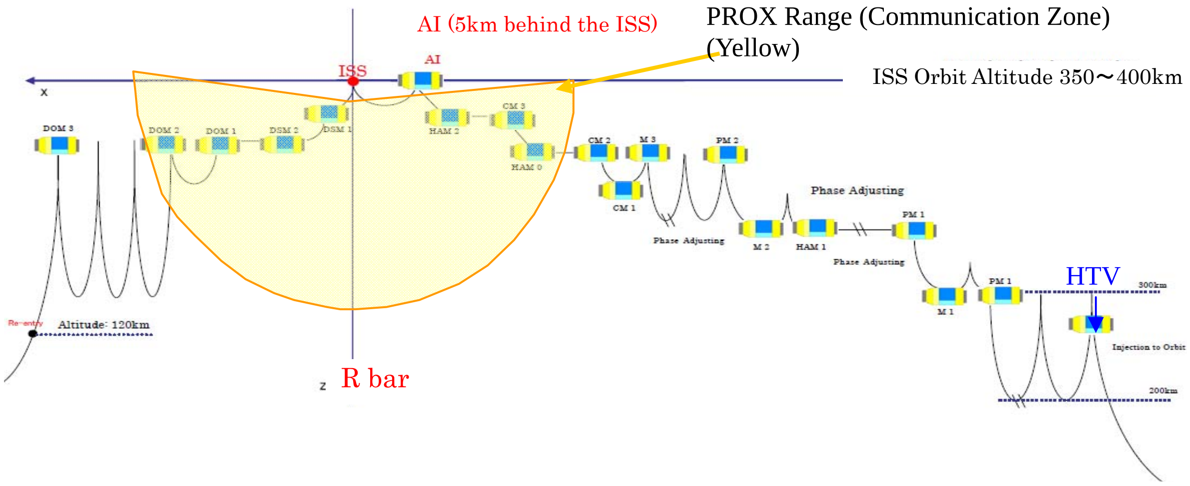
FD6

Major Objectives

- Proximity Operation
- Final Approach to the ISS
- Capture by the Space Station Remote Manipulator System (SSRMS)
- Berthing to the Common Berthing Mechanism (CBM) at the Nadir Port of Harmony (Node 2)
- Activation of HTV Power Supply from the ISS, Switching of the Communications Line (from wireless communications to wire communications)

● Proximity Operation

After the HTV reaches the "proximity communication zone", where the HTV can directly communicate with the ISS, the HTV will establish communications with the Proximity Communication System (PROX). The HTV will continue to approach until it reaches the "Approach Initiation (AI) point", 5 km behind the ISS. At this point, the HTV will maintain this distance from the ISS.



From 90 minutes before the HTV reaches the AI point, HTV integration operations by the HTV MCR and the Mission Control Center at NASA's Johnson Space Center (JSC) in Houston (MCC-H) will begin. The HTV may have to adjust and reschedule its flight timeline up to 24 hours since the HTV proximity operation* will have to be performed during ISS crew on-duty hours. (*From 90 minutes before the HTV arrives at the AI point until the HTV berths to the ISS.)

● Final Approach

After final approach is approved by the MCC-H, the HTV MCR will command the HTV to begin the AI Maneuver (final approach to the ISS).

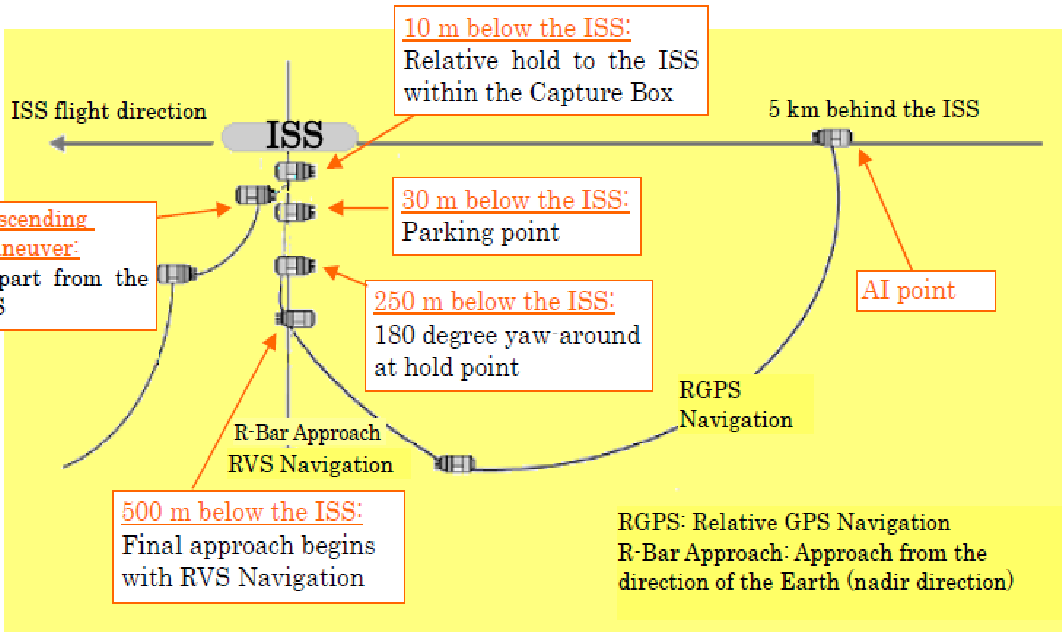
The HTV will move from the AI point to a point 500 meters below the ISS (RI point) guided by the Relative GPS Navigation. Using a laser called "Rendezvous Sensor (RVS)", the HTV will move closer to the ISS.

The HTV will hold its approach at 250 m below the ISS (hold point) and at 30 m below the ISS (parking point). Eventually, the HTV will stop 10 m below the ISS and maintain its distance from the ISS.

During this phase, the ISS crew can send commands such as "HOLD", RETREAT", and "ABORT", to the HTV if an emergency occurs.

At the hold point, the HTV will perform a 180-degree turn (yaw-around) to change the directions of the main thrusters to the opposite direction. This maneuver allows the HTV to perform a Collision Avoidance Maneuver (CAM), which safely moves the HTV away from the ISS in a forward direction, in case of emergency.

FD6 (Continued)



- Capture by the SSRMS

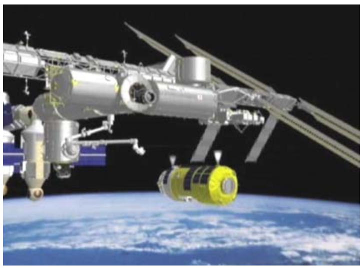
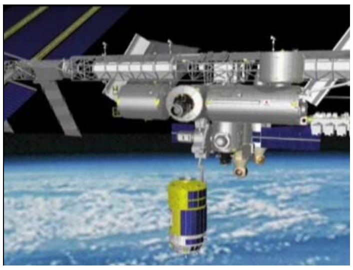
Once the HTV MCR confirms that the HTV has reached 10 m below the ISS and is maintaining this distance from the ISS, the ISS crew will send commands to disable the HTV thrusters (free drift state). Then the station's robotic arm (SSRMS) will grapple the grapple fixture (FRGF) of the HTV. The SSRMS operations related to the HTV2 Mission will be mainly performed by NASA astronaut Catherine Coleman and ESA astronaut Paolo Nespoli (ISS Expedition 26 crew).


Capture of the HTV (HTV1)


Grapple Fixture (FRGF)

- Berthing to Harmony (Node 2)

The HTV being grappled by the SSRMS will be berthed to the Common Berthing Mechanism (CBM) at the nadir port (earth facing side) of Harmony.


FD7

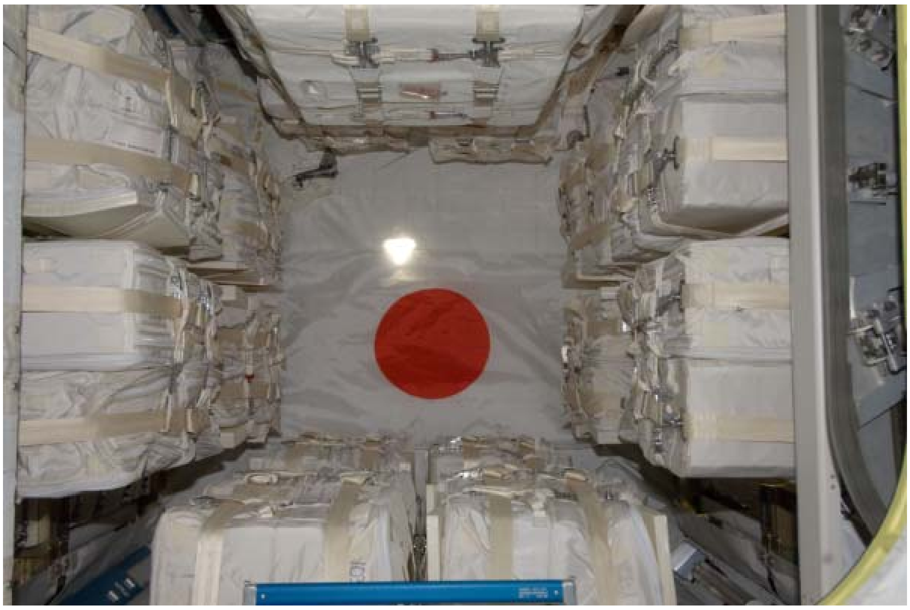
Major Objectives

- Crew Ingress
  - Removal of the Controller Panel Assemblies (CPA)
  - Hatch Opening
  - Activation of the Inter-Module Ventilation (IMV)
  - Transfer of the Station's Portable Breathing Apparatus (PBA), and Portable Fire Extinguisher (PFE)

- Crew Ingress

In preparation for ingress, the ISS crew will perform vestibule outfitting (removal of the Controller Panel Assemblies (CPAs) and cable connections) between the Pressurized Logistics Carrier (PLC) and Harmony. After completing vestibule outfitting, the HTV MCR will turn on the lights in the PLC, equalized the air pressure of the PLC, and then open the hatch of the PLC.

Once the hatches are opened, the Inter-Module Ventilation (IMV) will be activated and air between Harmony and the PLC will be circulated. ISS crew will then enter the PLC and deploy emergency procedure manual, the station's Portable Breathing Apparatus (PBA) and Portable Fire Extinguisher (PFE) in the PLC.



Inside of the HTV PLC (HTV1)

The temperature inside the PLC will be maintained at 15.6 degrees Celsius prior to the hatch opening.

PLC Cargo Transfer Operations

Major Objective

- Cargo Transfer (from HTV to ISS)

- Cargo Transfer (from HTV to ISS)

The ISS crew will transfer JAXA's two science racks, water bags (Contingency Water Container-Iodine: CWC-I), and cargo transfer bags (CTBs) to the ISS.

Cargo Transfer Bags (CTBs) Being Installed in the HTV Resupply Rack (HRR)

CTB Containing Food, Commodities, and Experiment Samples

ISS Crew Checking Transfer Checklists during Cargo Transfer Operations

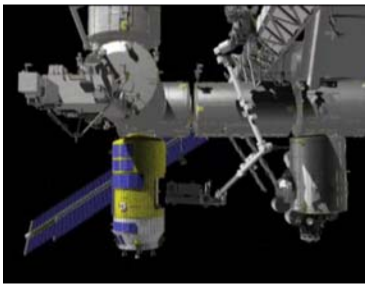
Exposed Pallet (EP) Transfer Operations

Major Objective

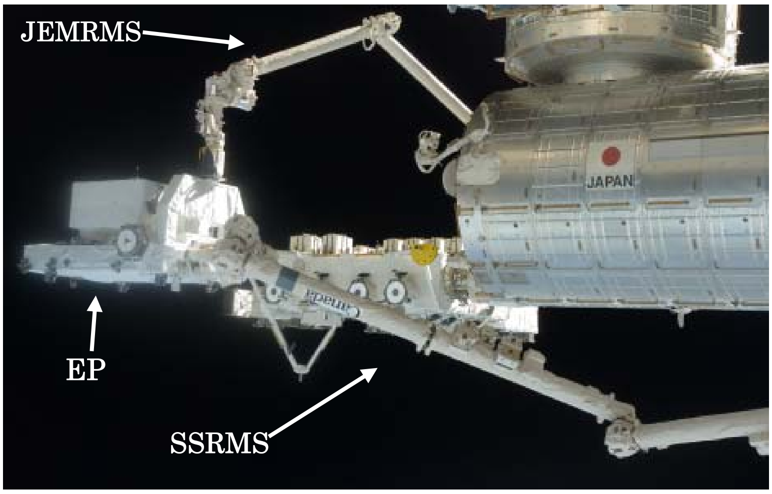
- Removal of the Exposed Pallet (EP) from the HTV Unpressurized Logistics Carrier (ULC)
- Temporary Installation of the EP on Kibo's Exposed Facility (EF)

- Removal of the Exposed Pallet (EP) from the ULC / Temporary Installation of the EP on Kibo's Exposed Facility (EF)

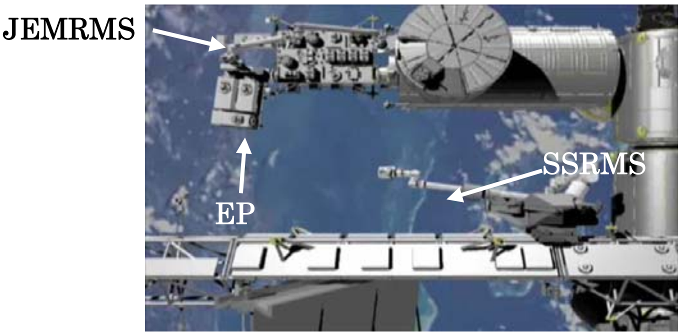
The Exposed Pallet (EP) will be removed from the HTV Unpressurized Logistics Carrier (ULC) by the SSRMS. The EP will then be handed over to Kibo's robotic arm (JEMRMS). The JEMRMS will attach the EP on Kibo's Exposed Facility (EF) for unloading of the two unpressurized ORUs.



SSRMS removes the EP from the ULC (Images)



EP Being Handed Over from the SSRMS to JEMRMS (HTV1)



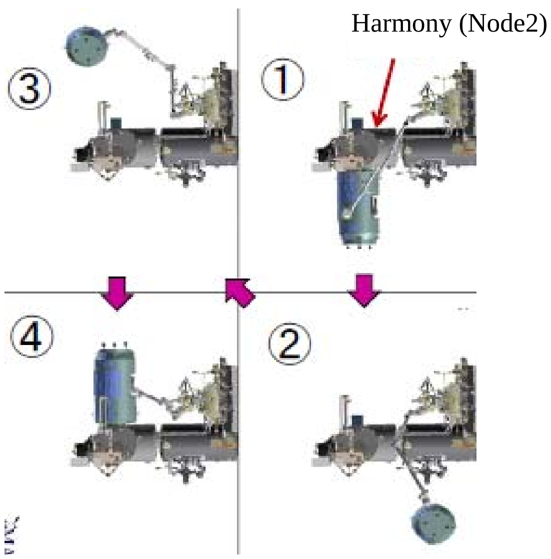
HTV Relocation (Preparation for STS-133 Arrival)

Major Objectives

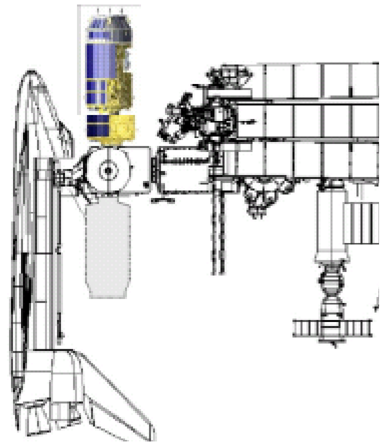
- Relocation of the HTV (from the Nadir Port to the Zenith Port of Harmony)
- STS-133 Arrival / STS-133 Docked Operations / STS-133 Departure
- Relocation of the HTV to the Nadir Port of Harmony

- Relocation of the HTV to the Zenith Port of Harmony

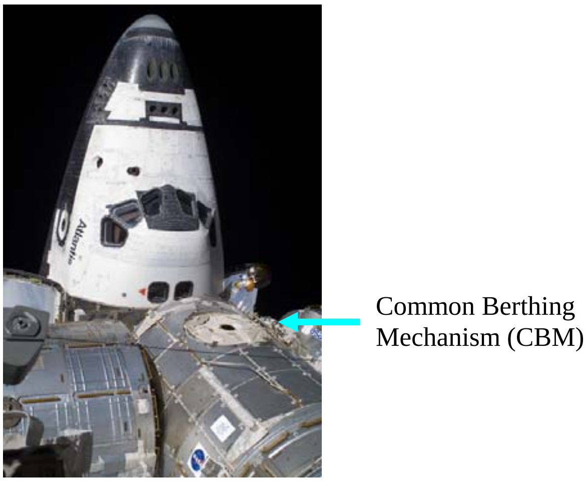
During the HTV2 Mission, the Space Shuttle Discovery (STS-133) will arrive at the International Space Station (ISS). Before Discovery arrives, the HTV2 will have to be relocated to the zenith port of Harmony to make clearance for the robotic operations by the SSRMS (such as removal of the STS-133 mission payloads from the shuttle's cargo bay).



Left: HTV Relocation (Image Credit: NASA)



Right: Clearance between the HTV and the Shuttle's Cargo Bay (Image Credit: NASA)



CBM at the Nadir Port of Harmony

- Relocation of the HTV to the Nadir Port of Harmony (from the zenith port)

After the STS-133 Mission's docked operations is completed, the HTV will be returned to the nadir port of Harmony.

*During the relocation, HTV's berthing/unberting and hatch opening/closing will be conducted. Please see P1-15, P1-16, P1-23, and P-24 for HTV's berthing/unberthing procedures and PLC ingress preparations.

Transfer Operations by DEXTER (SPDM)

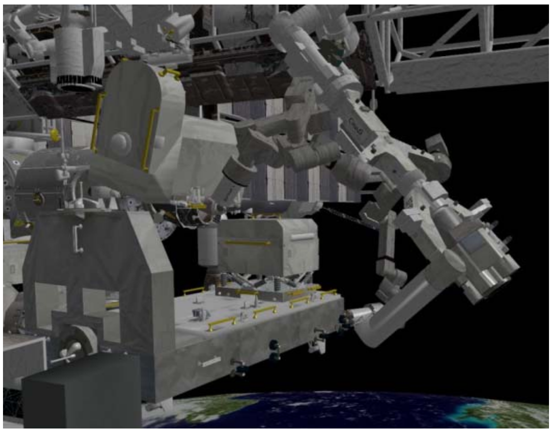
Major Objective

- Transfer of Two Unpressurized ORUs (FHRC and CTC)

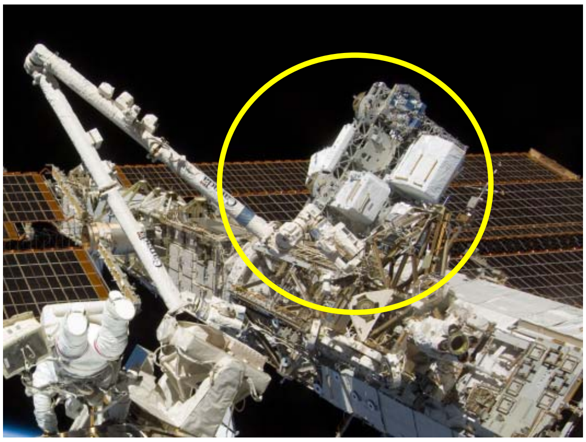
- Transfer of Two Unpressurized ORUs (FHRC and CTC)

  Using the Canadian Special Purpose Dexterous Manipulator (SPDM) called DEXTER, the FHRC and the CTC will be removed from the EP. These ORUs will be moved to their temporary installation locations by the DEXTER. After the STS-133 Mission is completed, these ORUs will be stored on the Express Logistics Carrier 4 (ELC4).

FHRC (Left) and CTC (right) Attached on the EP



DEXTER (SPDM) Grappling the FHRC (Image)



【Reference】Unpressurized Orbital Replacement Units (ORUs) Installed on the ELC-2
Note: The ELC-2 was installed on the ISS starboard truss on the STS-129 Mission

Reinstallation of the Exposed Pallet (EP)

Major Objectives

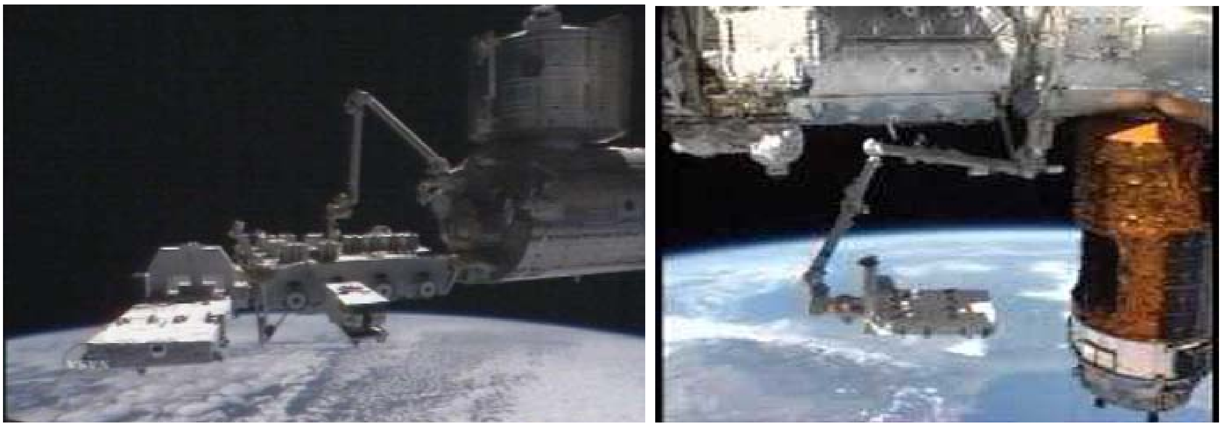
- Reinstallation of the Exposed Pallet (EP) into the ULC

- Reinstallation of the Exposed Pallet (EP) into the ULC

After the unpressurized ORUs are unloaded, the EP will be re-stowed in the HTV Unpressurized Logistics Carrier (ULC).

First, Kibo's robotic arm (JEMRMS) will remove the EP from the EF. Then the EP will be handed over to the SSRMS. Finally, the EP will be reinstalled into the ULC.

Note: The SSRMS will not be able to move the EP if the HTV is berthed to the zenith port of Harmony. This SSRMS operation is only possible when the HTV is berthed to the nadir port of Harmony.



EP being reinstalled into the HTV ULC (HTV1)

Trash Loading

Major Objectives

- Trash Loading (from ISS to HTV)

- Trash Loading (from ISS to HTV)

The station's discarded items will be loaded into the PLC.

The Permanent Multipurpose Module (PMM), which will be launched on the STS-133 Mission, will carry many supplies and cargo. The HTV will support disposal of their empty containers, including resupply racks, cargo transfer bags and packages.
(Note: The trash loading activities may vary depending on the ISS's operations timeline)

Trash list will be prepared a few weeks before HTV unberthing.

Cargo Transfer (HTV1)

Unberthing Preparation (Activities on the Day before Unberthing)

Major Objectives

- Preparation for HTV Unberthing (Removal of lights, smoke detectors, portable fire extinguishers, and portable breathing apparatuses, installation of CPAs on the CBM, cable/wire de-mating, deactivation of IMV system)
- Vestibule De-outfitting/Hatch Closure

● Preparation for HTV Unberthing/Vestibule De-outfitting/Hatch Closure

For reuse purposes, lights and smoke detectors carried onboard the HTV will be removed and transferred to the ISS before hatch closure. Safety tolls deployed inside the PLC, such as portable fire extinguishers (PFEs) and portable breathing apparatuses (PBAs), will also be removed and transferred to the ISS. Lastly, ISS crew will de-mate cables in the vestibule and close the hatches between the HTV and Harmony. Then, the Inter-Module Ventilation (IMV) system will be deactivated.

Left: Portable Fire Extinguisher (PFE)

Right: Portable Breathing Apparatus (PBA)

● Installation of the Controller Panel Assemblies (CPAs)

ISS crew will install the Controller Panel Assemblies (CPAs) which will control the actuators of the 16 bolts on the CBM (active half).

Four silver boxes seen in the picture are the CPAs

Unberthing Operations (Activities on the Unberthing Day)

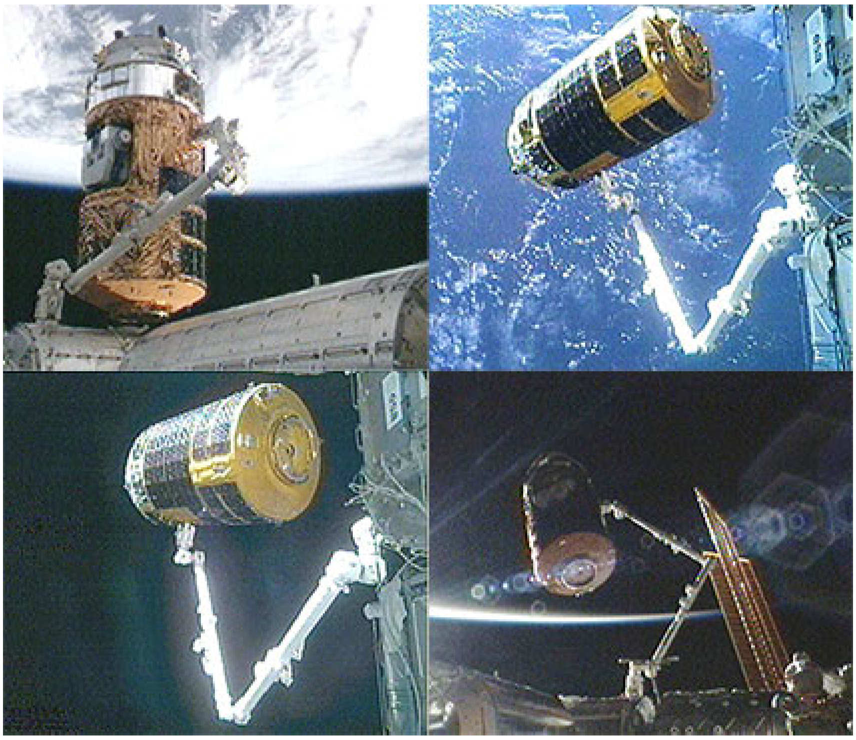
Major Objectives

- Deactivation of HTV Power Supply from the ISS
- Vestibule Cable De-mating
- HTV Unberthing

● Unberthing and Release of the HTV

The HTV will be unberthed from the ISS and released into space according to the following procedures:

1 The HTV will be grappled by the SSRMS
2 The Common Berthing Mechanism (CBM) between the HTV and Harmony will be demated
3 The SSRMS will move the HTV to the release position
4 HTV Guidance Navigation Control (GNC) will be activated
5 HTV Propulsion System will be activated
6 The SSRMS will release the HTV, and the HTV will perform departure maneuver



HTV1 Release

Reentry Operations

Major Objectives

- Deorbit Maneuvers
- Reentry

- Deorbit Maneuvers / Reentry

The HTV will conduct deorbit maneuvers, and then, reenter the Earth's atmosphere.
(Please see Section 2.5.4)

HTV Reentry (Image)

【Reference】ATV-1's Reentry Photographed from an Airplane (http://atv.seti.org/)

1.7 Payload

The HTV2 Mission will deliver approximately 5,300 kg of cargo/supplies to the ISS.

After the cargo and supplies are unloaded, the HTV2 will be loaded with various empty containers, packages and resupply racks*.

*Note that the trash loading schedule may vary depending on the ISS's operations timeline.

The above picture was taken during cargo loading activities (HTV2)
Fig. 1.7-1 HTV Pressurized Logistics Carrier (PLC)

Two unpressurized payloads (or ORUs) are installed on the EP
Fig. 1.7-2 HTV Exposed Pallet (EP) (HTV2)

1.7.1 Payload Carried on the PLC

The HTV PLC will carry about 4,000 kg of cargo on the HTV2 Mission.

- HTV Resupply Racks (HRRs) (x 6)
  *The HRRs accommodates the Cargo Transfer Bags (CTBs) that contain various supplies, including space food (food in retort pouch, rehydrating food, snacks, rehydrating beverage, and Japanese space food), four water containers filled with potable water, experiment samples, spare parts, and other daily commodities for the ISS crew (such as clothes, soap, and shampoo).

- JAXA's Science Racks (x 2)
  *KOBAIRO Rack: (weight: 723kg)
  *Multi-purpose Small Payload Rack (MSPR) (weight: 580kg)

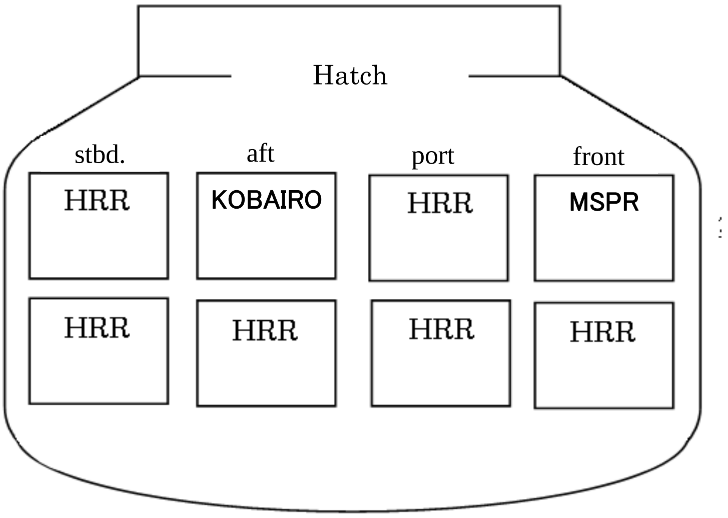


Fig. 1.7.1-1 PLC Rack Layout (HTV2)

HTV Resupply Rack (HRR)

Food, daily commodities, and experiment samples are packed in the CTBs. The CTBs are installed in the HRRs

Fig. 1.7.1-2 (1/2) Cargo/Supplies (HTV2)

Contingency Water Container-Iodine (CWC-I) mounted on a cushion plate

Fig. 1.7.1-2 (2/2) Cargo/ Supplies (HTV2)

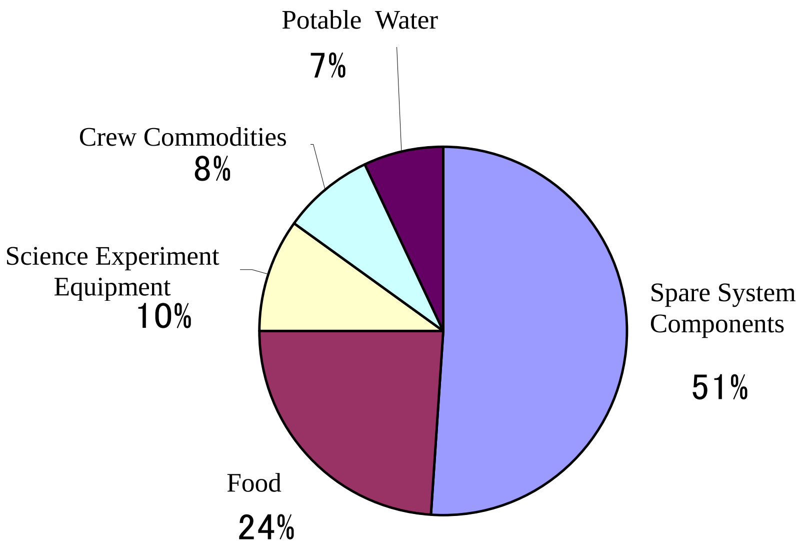


Fig. 1.7.1-3 Cargo Ratio (HTV2)

Fig. 1.7.1-4 CTBs Being Installed in a HRR

Several sizes of CTBs are available to accommodate various sizes of goods

Fig. 1.7.1-5 Cargo Transfer Bags (CTBs)

This picture was taken during cargo loading activities.
More CTBs will be installed on the front side of the HRRs.

Fig. 1.7.1-6 Cargo Layout inside the PLC (HTV2)

(1) KOBAIRO Rack

KOBAIRO Rack accommodates JAXA's Gradient Heating Furnace (GHF). The GHF is a vacuum furnace that contains three heating blocks (main block, end block and sub block). Temperature in each block can be independently controlled, thus experiments in various temperature profiles will be realized. The GHF has an automatic sample exchange system that accommodates up to 15 sample cartridges. The GHF is capable to generate gradient heating conditions with temperatures up to 1600 degrees Celsius. Investigators on the ground will be able to perform unidirectional solidification and or unidirectional crystal growth experiments using the GHF.

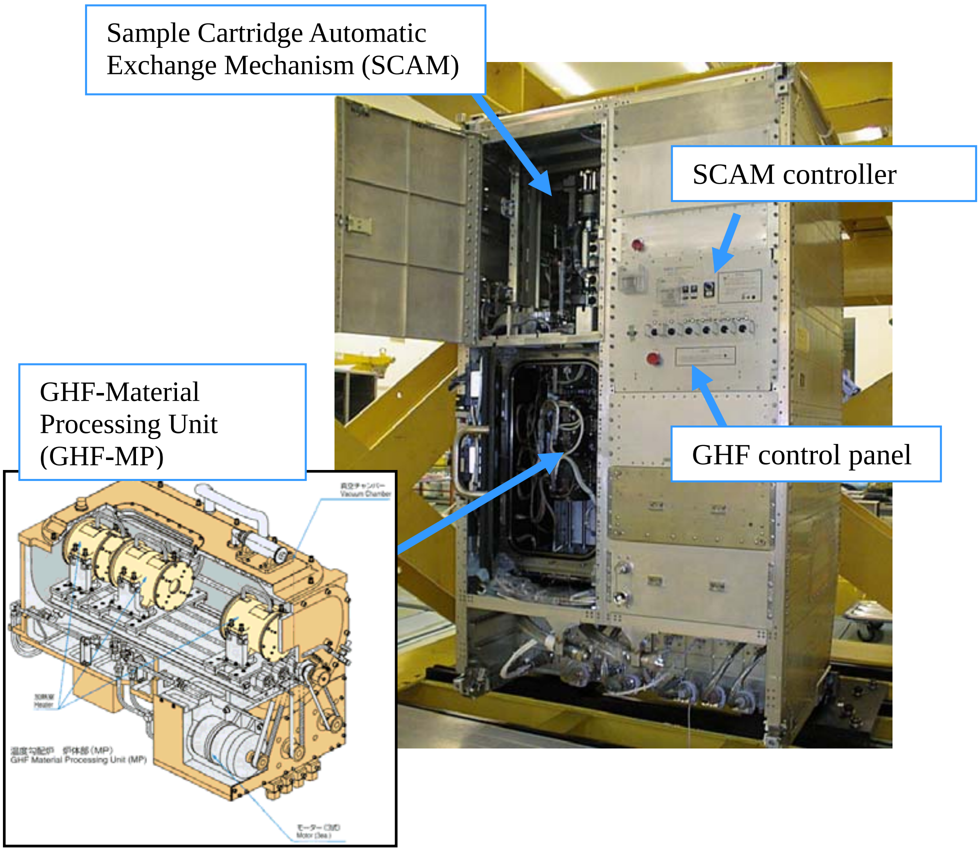
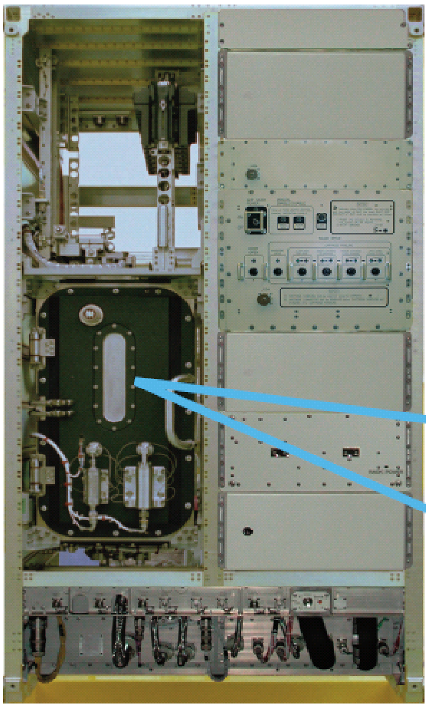
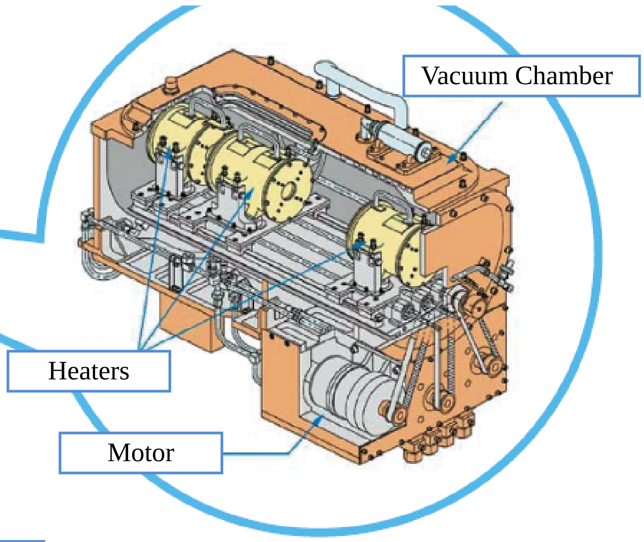


Fig. 1.7.1-7 KOBAIRO Rack

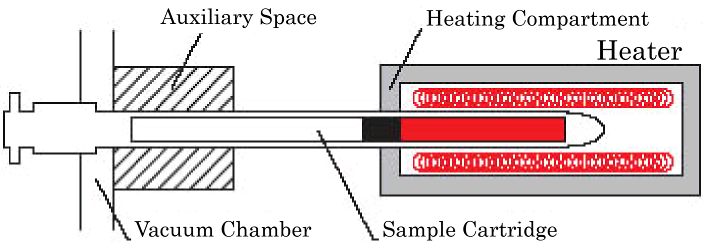
Fig. 1.7.1-8 Astronaut Furukawa and the Gradient Heating Furnace (GHF)
Astronaut Furukawa pulling out a sample cartridge from the GHF during a preflight training session



The GHF contains three heating blocks. Temperature inside each block can be independently controlled, thus various temperature profiles can be realized for high quality crystal growth experiments. GHF has an automatic sample exchange system that can accommodate up to 15 sample cartridges.

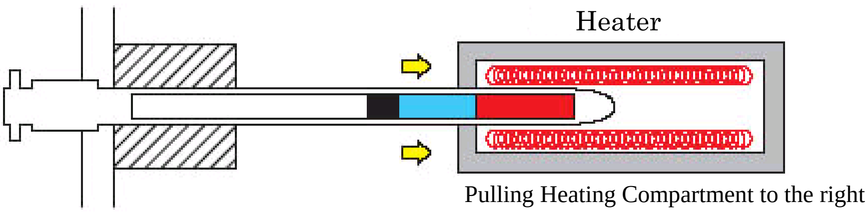


Early Crystallization Stage



<u>Sample cartridge will be heated by giving a temperature gradient</u>

Crystal Growth Stage



<u>When pulling the heating compartment slowly to the right, crystal growth in the cartridge will stretch toward the right (image).</u>

Fig. 1.7.1-9 Diagram: How to Heat Sample Cartridges in the KOBANRO Rack

Fig. 1.7.1-10 KOBAIRO Rack (before Installation to the HTV PLC)

Fig. 1.7.1-11 Test Sample Cartridge for In-Flight GHF Checkout

You will find more information about KOBAIRO Rack at the following webpage.
http://kibo.jaxa.jp/en/experiment/pm/ghf/

(2) Multi-purpose Small Payload Rack (MSPR)

JAXA's Multi-purpose Small Payload Rack (MSPR) is designed to accommodate small experiments in various science fields. The MSPR provides an ideal platform for various kinds of experiments. Electrical power and data communications will be supplied to the experiment inserted in the MSPR, so investigators (uses) can develop innovative experiments of their own.

The MSPR provides three different work spaces, the Work Volume (WV), the Work Bench (WB), and the Small Experiment Area (SEA). The WB has a worktable for sample preparation, experiment setup and maintenance. The WV, which measures 900 mm x 700 mm x 600 mm, accommodates experiments.

The Chamber for Combustion Experiment (CCE), a removable component of the MSPR, is available for investigators who plan to conduct combustion experiments in space. The CCE allows the investigators in combustion research to develop their experiment less trouble because the CCE can provides all the necessary resources, such as gas supply, exhaust, electrical power, and data communications, to the experiment through the MSPR.

The HTV2 Mission will deliver the CCE together with the MSPR.

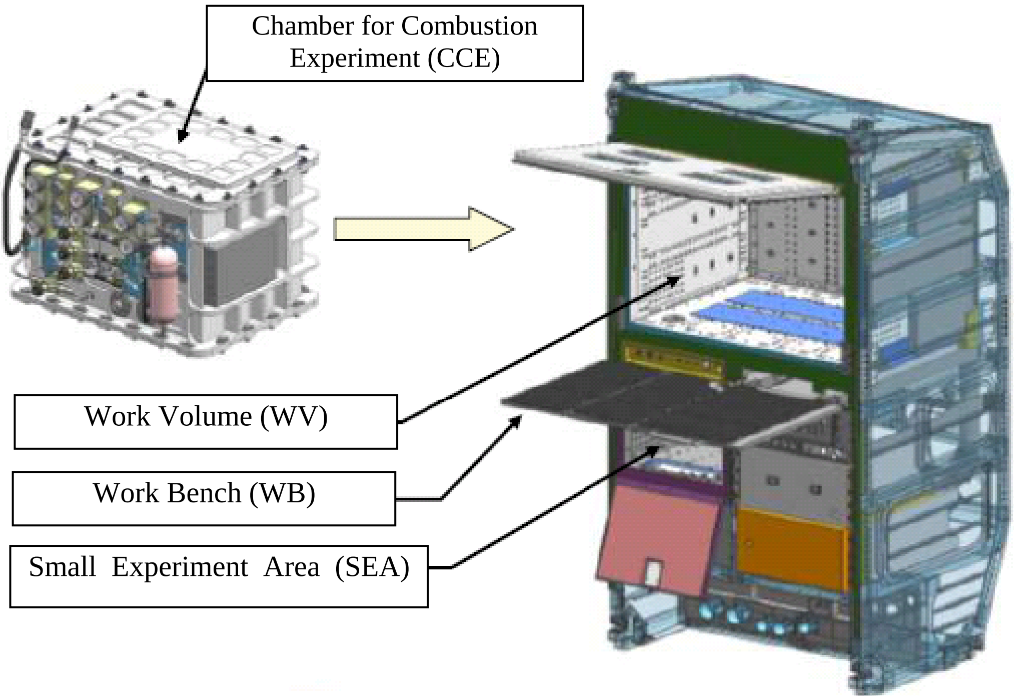


Fig. 1.7.1-11 Multi-purpose Small Payload Rack (MSPR) (Image)

In the future, the AQuatic Habitat (AQH) will be operated using the MSPR. The AQH will breed medaka and zebra fish for ninety days in space. The AQH hardware is scheduled to be delivered to the ISS on the HTV3 Mission.

Note: Some old documents use MPSR for acronym of the Multi-purpose Small Payload Rack, however, its acronym is currently "MSPR."

Fig. 1.7.1-12 Multi-purpose Small Payload Rack (MSPR)

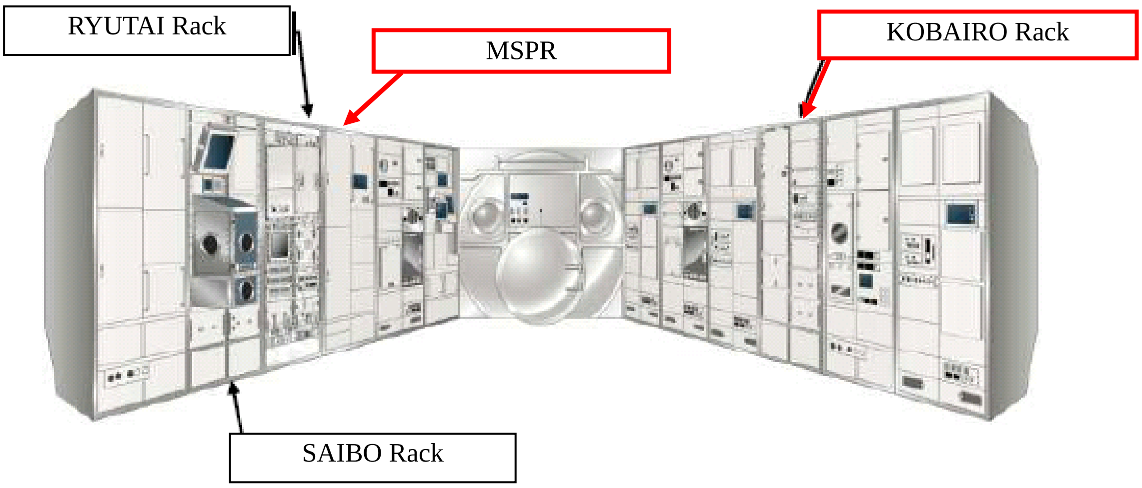


Fig. 1.7.1-14 Layout of the Science Racks on board Kibo

(3) Science Payloads

The followings are JAXA's science experiment equipment which will be delivered on the HTV2 Mission.

- Sample Cartridges for the Hicari experiment (the Growth of Homogeneous SiGe Crystals in Microgravity by the TLZ* Method). The Hicari experiment will be the first experiment to be performed in the GHF.

* TLZ (Traveling Liquidus-Zone)

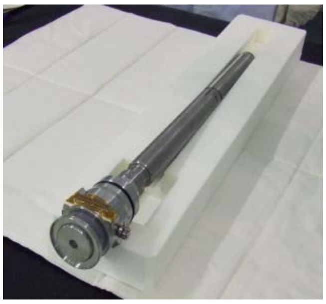


Fig. 1.7.1-15 Hicari's Sample Cartridge

- Sample Cartridges for the Marangoni UVP*/MaranGogniat experiment (Spatio-temporal Flow Structure in Marangoni)

* UVP (Ultrasonic Velocity Profiler)

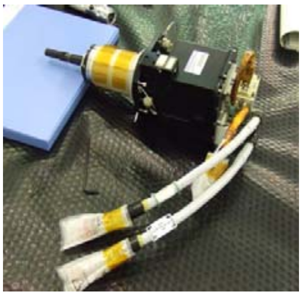


Fig. 1.7.1-16 Marangoni UVP/MaranGogniat's Sample Cartridge

- Sample Kit for the Hair experiment (Biomedical analyses of human hair exposed to a long-term space flight)

- Medical equipment and tools for in-flight Crew Medical Operations

The HTV2 Mission will also deliver NASA's science experiments.

(4) Plant Seeds for Asian Communities

On the HTV2 Mission, plant seeds for Asian communities will be delivered to the ISS in the light of the increasing awareness of/interest in Kibo Utilization by the Asian communities. This mission is called "Space Seeds for Asian Future: SSAF 2010-2011". The seeds flown aboard the ISS will be returned to the ground on the STS-134 Mission (ULF6). Then, the seeds will be distributed to space-related organizations and communities in Asian countries.

These space-flown seeds will be utilized in education programs or science research activities of the following organizations.

<u>Indonesia</u>
Seed: Tomato (*Solanum lycopersicum*) and Impatiens (*Impatiens balsamina*) seeds
Sponsor: National Institute of Aeronautics and Space (LAPAN)

<u>Malaysia</u>
Seed: Chili pepper (Capsicum) seeds
Sponsor: Malaysian National Space Agency (ANGKASA)

<u>Thailand</u>
Seed: Chili pepper (Capsicum) seeds
Sponsor: National Science and Technology Development Agency (NSTDA)

<u>Vietnam</u>
Seed: Salvia splendens, Impatiens (*Impatiens balsamina*) and Antirrhinum majus (*Antirrhinum majus Antirrhinum*) seeds
Sponsor: Space Technology Institute (STI) of the Vietnam Academy of Science and Technology (VAST)

<u>Mission Logo</u>

Seeds packed in a storage bag

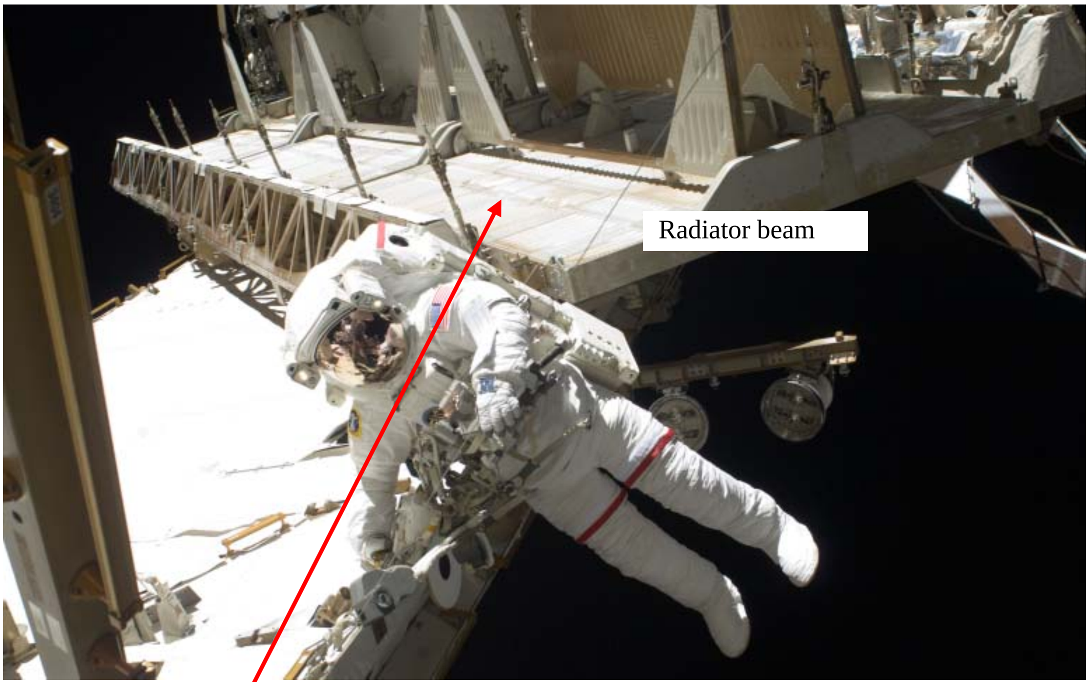
1.7.2 Payload Carried on the HTV ULC

The HTV ULC will carry NASA's unpressurized Orbital Replacement Units (ORUs) on the HTV2 Mission.

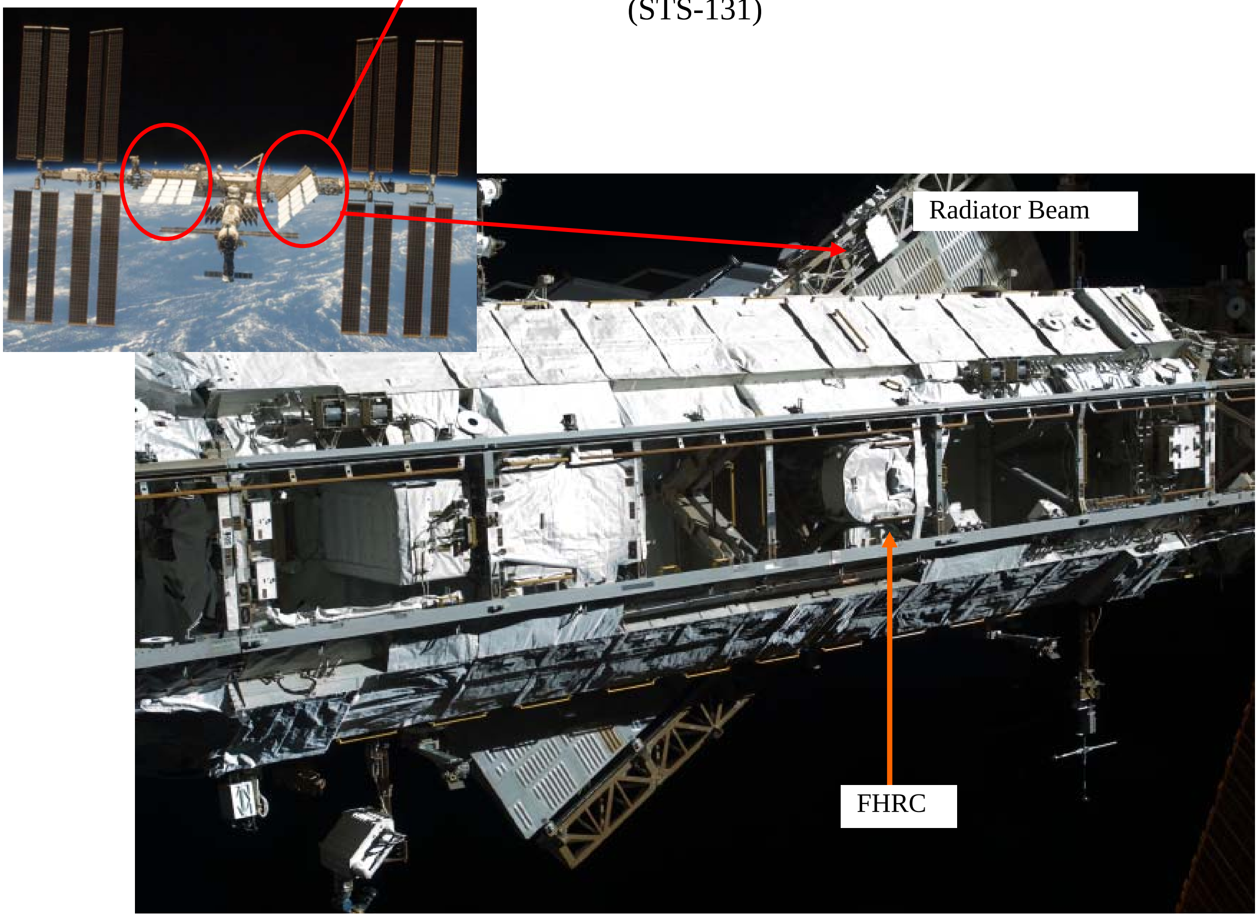
- Flex Hose Rotary Coupler (FHRC)
- Cargo Transport Container (CTC)

(1) Flex Hose Rotary Coupler (FHRC)
The FHRC is a component of the station's External Thermal Control System and facilitates the transfer of liquid ammonia across the rotating Thermal Radiator Rotary Joints (TRRJs) located on S1 and P1 trusses to the ISS radiators through the ammonia coolant loops.
Two FHRC ORUs, which were delivered to the ISS on the STS-114 (LF-1) and the STS-126(ULF-2) Missions, are stored on the ISS exterior. The third FHRC ORU, which will be delivered on this HTV2 Mission, will be stored on the EXPRESS Logistics Carrier-4 (ELC-4). The ELC-4 will be launched to the ISS on the STS-133 (ULF-5) Mission.

Fig. 1.7.2-1 Flex Hose Rotary Coupler (FHRC)



(STS-131)



(STS-119)

Fig 1.7.2-2 Locations of the Radiator and the FHRC

(2) Cargo Transport Container (CTC)

The Cargo Transport Container (CTC) is a box containing small ORUs, which will be replaced by the Canadian Special Purpose Dexterous Manipulator (SPDM), DEXTRE.

The CTC will carry smaller ORUs, such as Remote Power Controller Module (RPCMs) and Video Distribution Unit (VDUs). The first CTC was delivered on the STS-129 Mission and has already installed on the ISS. The HTV2 Mission will deliver the second CTC, and it will be stored on the ELC-4. The third CTC is scheduled to be launched on the STS-134 (ULF-6) Mission.

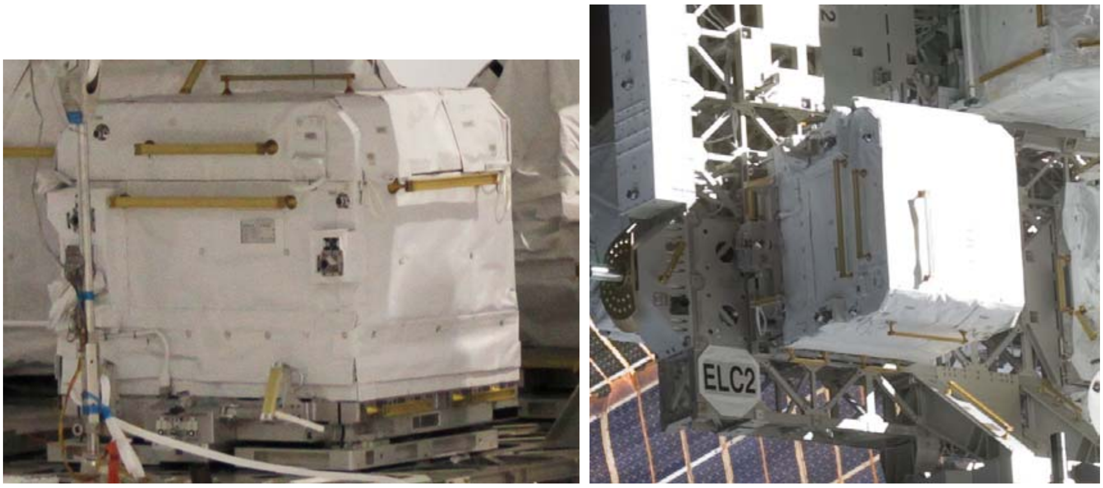


Fig 1.7.2-3 CTC

Fig. 1.7.2-4 Layout inside the CTC (STS-129)
Boxes attached inside are spare RPCMs (Total of 10 units).

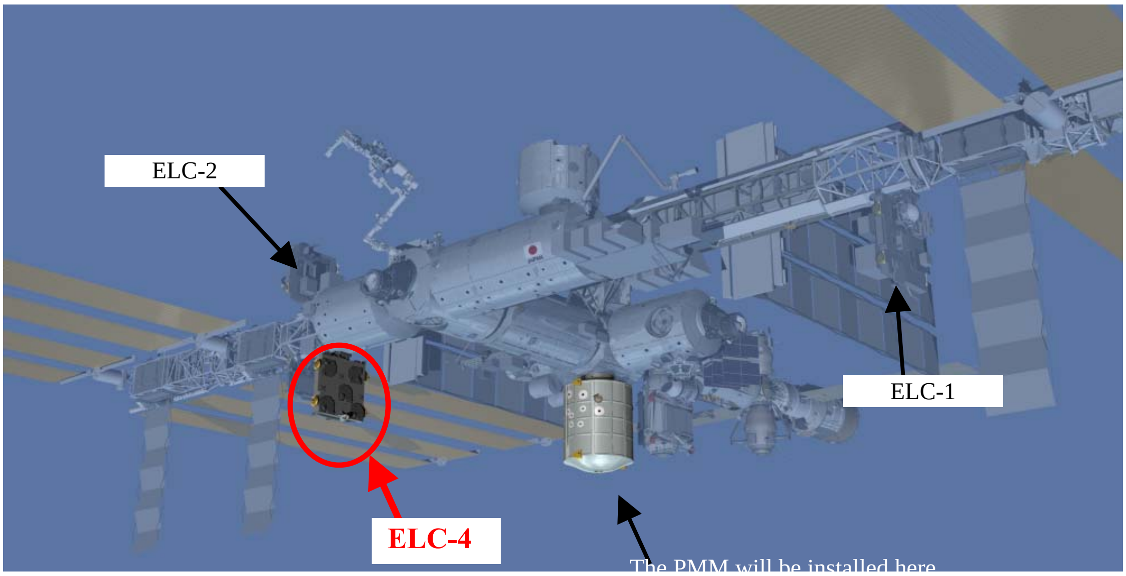


Fig. 1.7.2-5 Location of the ELC-4

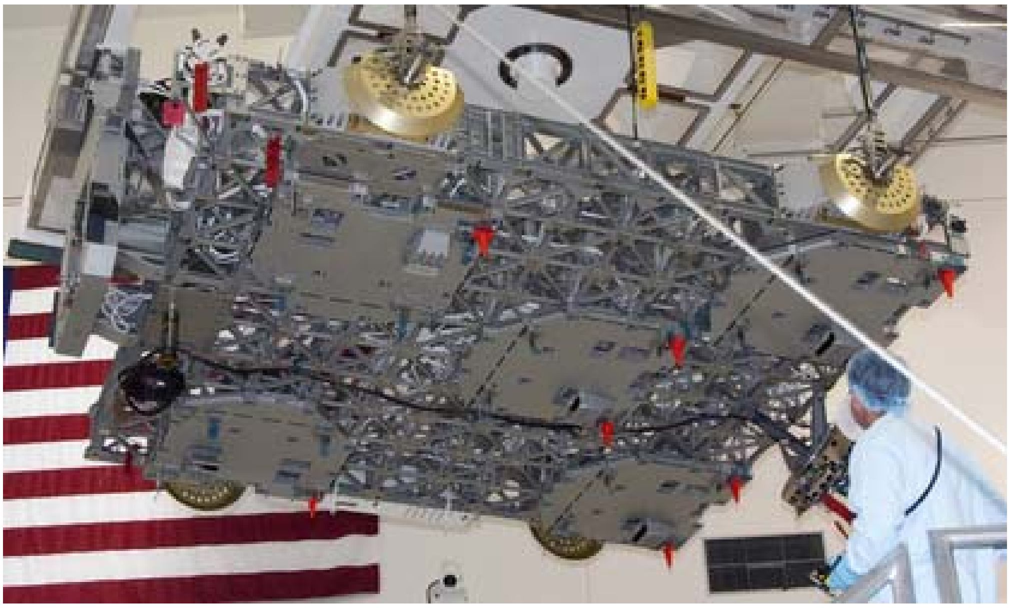


Fig. 1.7.2-6 ELC-4

(3) Transfer Operations

First, the Exposed Pallet (EP) will be removed from the HTV Unpressurized Logistics Carrier (HTV ULC) by the Space Station Remote Manipulator System (SSRMS). The EP will then be handed over to Kibo's robotic arm (JEM Remote Manipulator System: JEMRMS), and will be attached on Kibo's Exposed Facility (JEM-EF) by the JEMRMS.

After that, Canadian Special Purpose Dexterous Manipulator (SPEDM) "DEXTER", being grappled by the SSRMS, will remove the FHRC from the EP to store it on the ELC-4*. The DEXTER will transfer the CTC in the same procedure.

* Due to delay of STS-133 launch, the FHRC and CTC will be installed to temporary locations outside of the ISS. After the ELC-4 is deployed on the ISS, these ORUs will be stored on the ELC-4.

When these ORUs are unloaded from the EP, the SSRMS will ungrapple DEXTER. The EP will be reinstalled into the HTV ULC by the SSRMS.

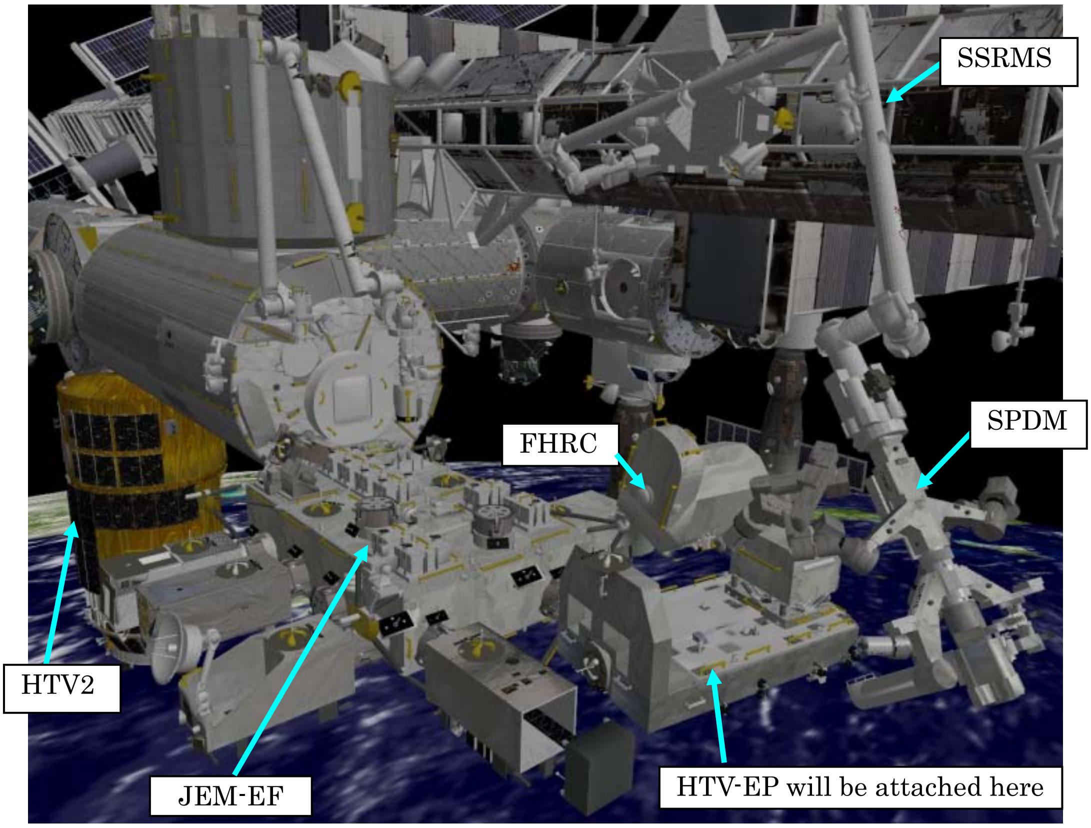


Fig. 1.7.2-7 DEXTER (SPDM) Holding the FHRC (Image)

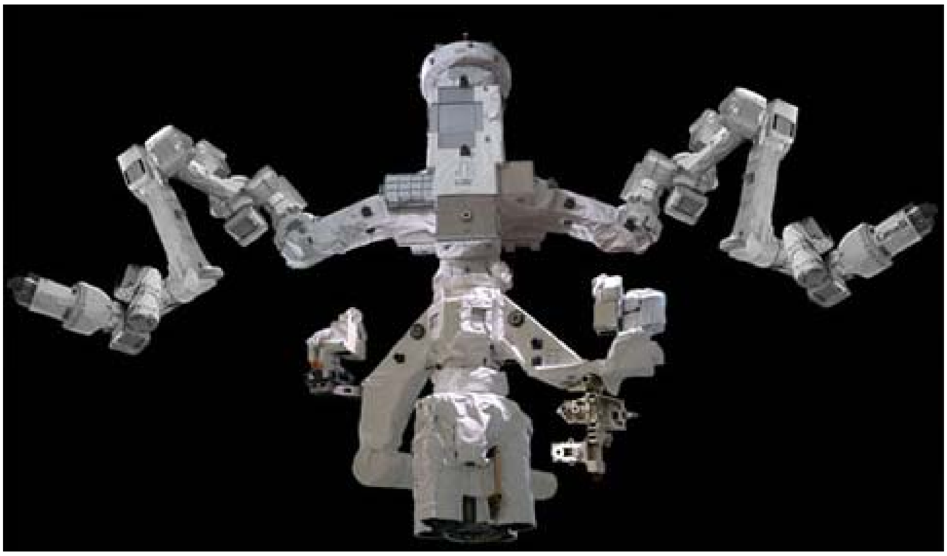


Fig. 1.7.2-8 DEXTRE (SPDM)

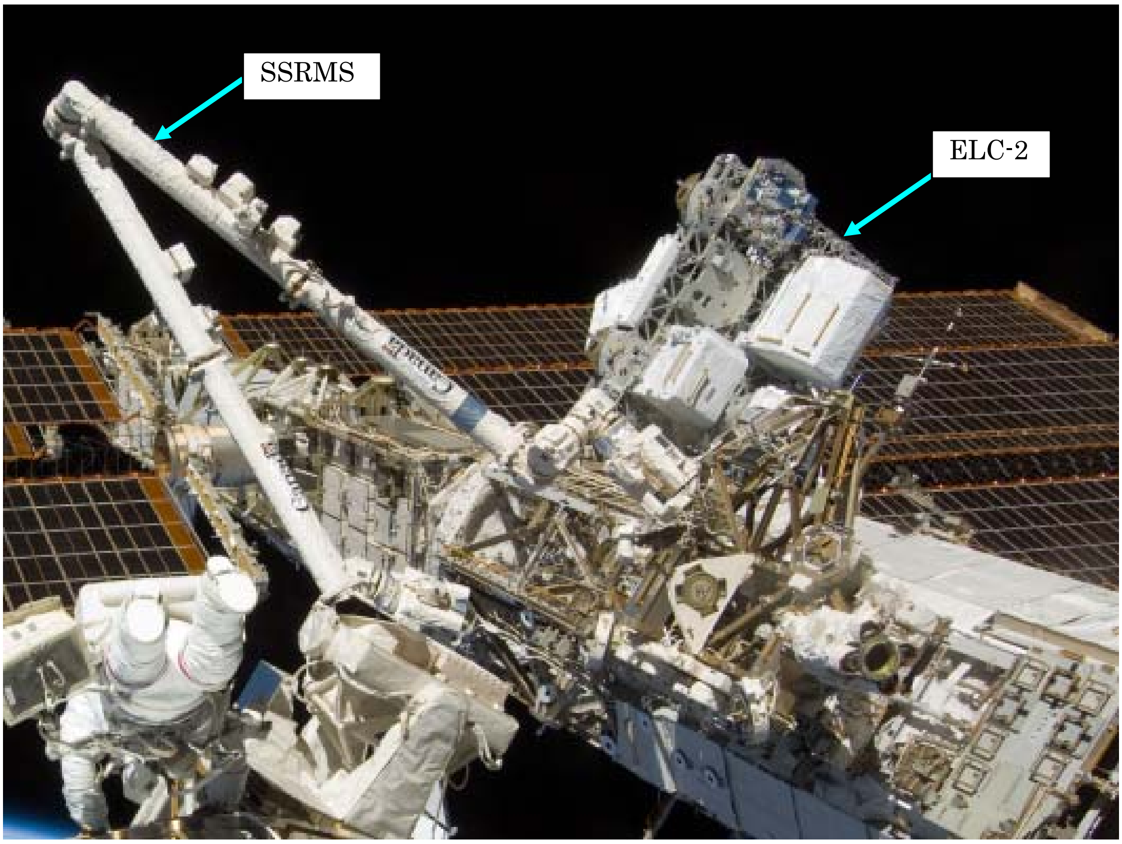


Fig. 1.7.2-9 ELC-2 Installed on the ISS Truss during the STS-129 Mission.

1.8 HTV2 Operations Control

After separating from the H-IIB launch vehicle, the HTV will automatically activate the HTV subsystems, stabilize its attitude, and perform self-checks on the HTV components. Then, the HTV will establish communications with the TDRS and initiate communications with the HTV MCR at TKSC.

Once communications between the HTV and the HTV MCR is established, HTV flight control by the HTV MCR will begin. The HTV MCR will monitor HTV's telemetry and flight data, and send commands for controlling the HTV subsystems and maneuvering its flight.

From 90 minutes before the HTV reaches 5 km behind the ISS (Approach Initiation (AI) point), the HTV MCR and MCC-H will collaboratively operate the HTV mission.

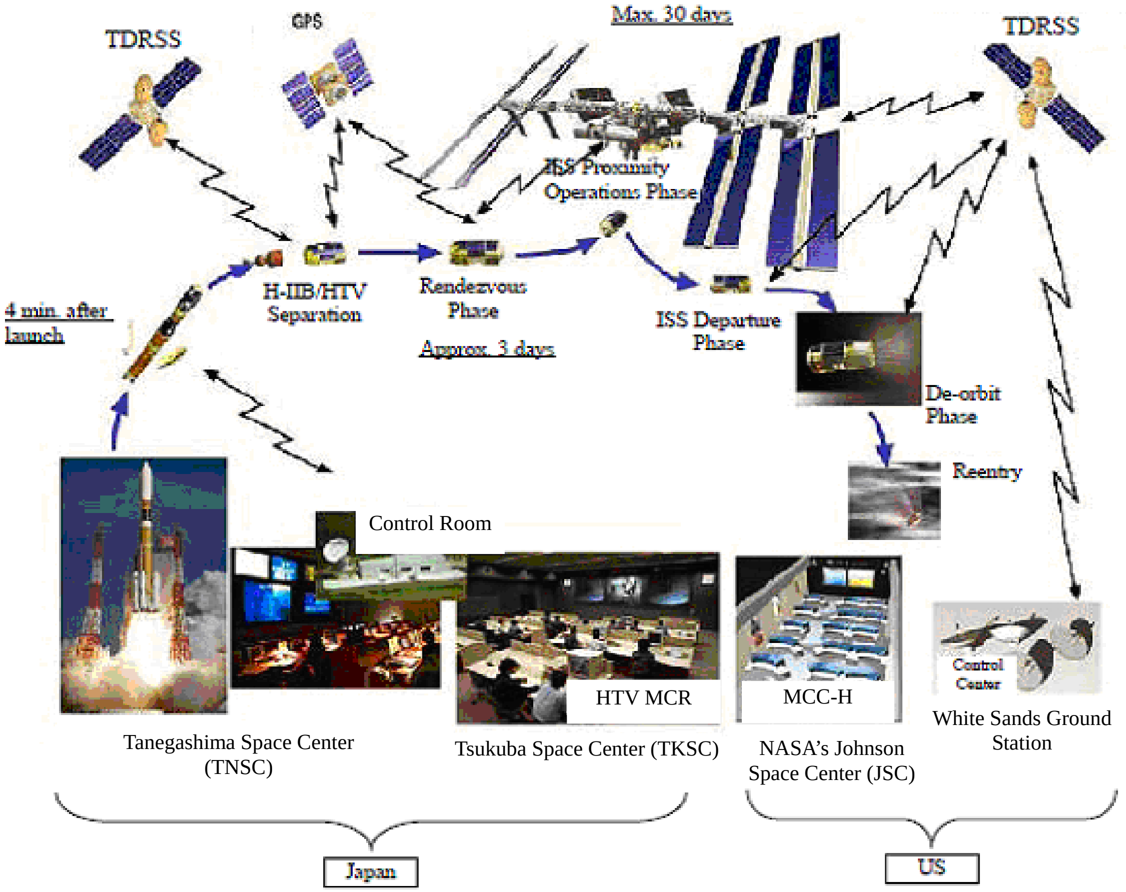


Fig. 1.8-1 HTV Operation Control Overview

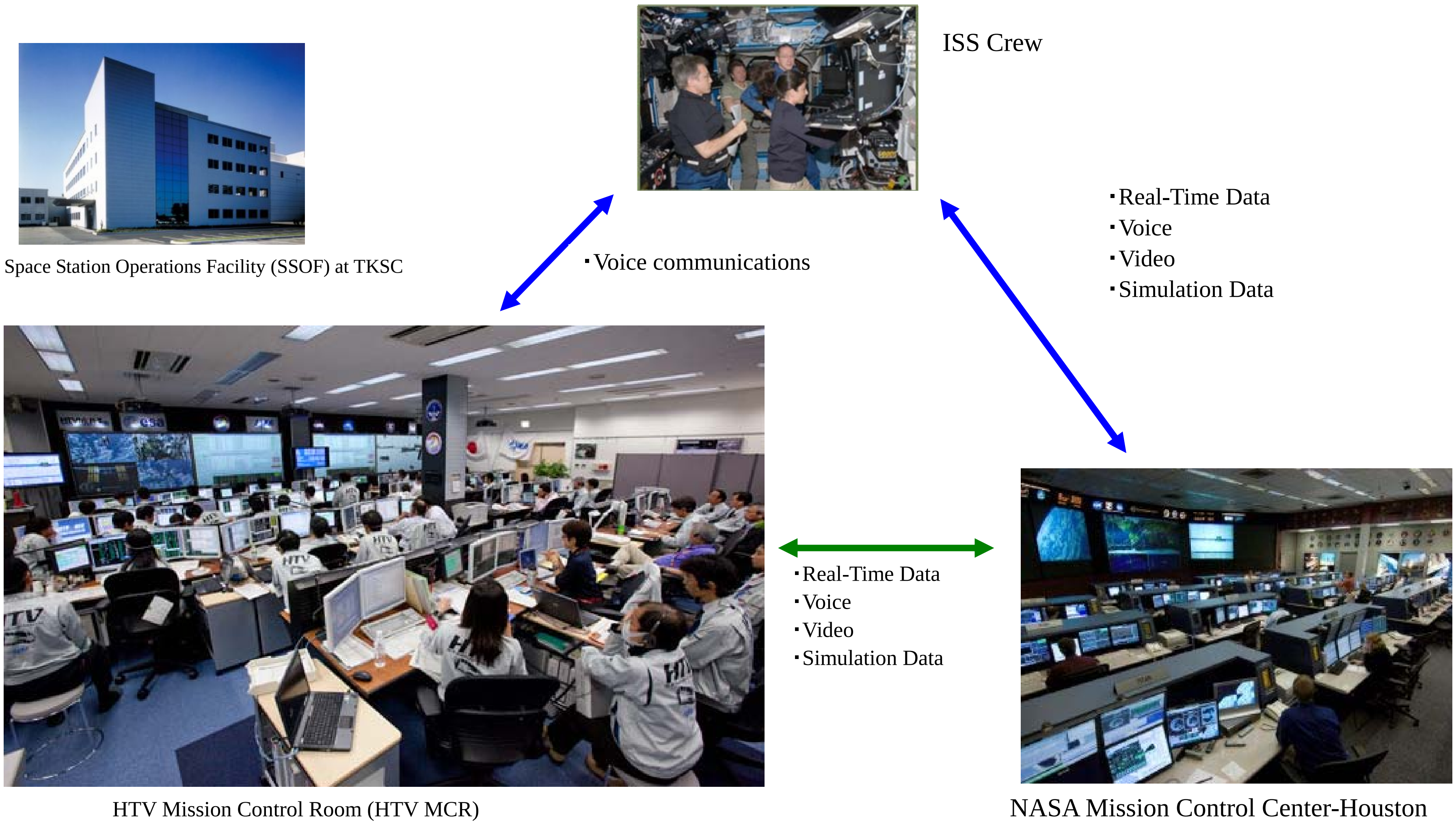


Fig. 1.8-2 JAXA-NASA Communications Diagram during the HTV Mission Operations

The HTV Flight Control Team (HTV FCT) monitors and controls the HTV around the clock in a three-shift per day schedule.

The roles and responsibilities of the HTV FCT are as follows:

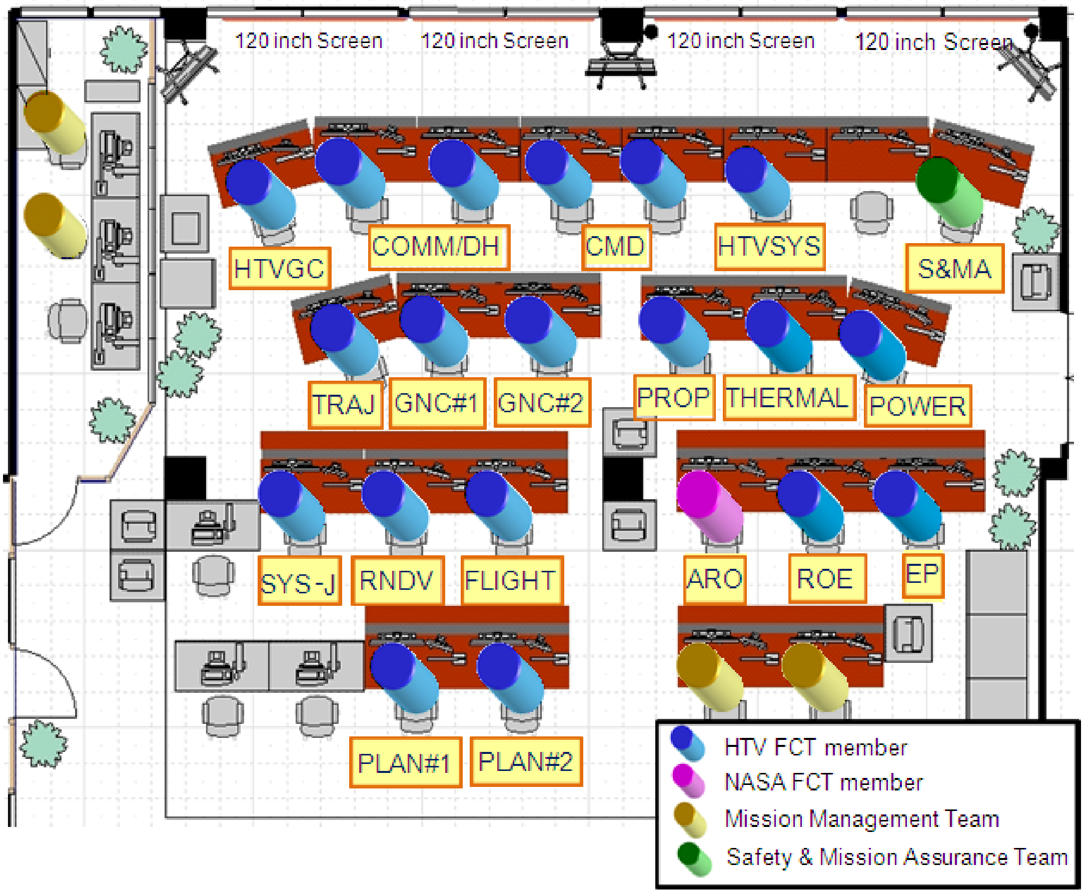


Fig. 1.8-3 Layout of the HTV Operations Control Room

<u>HTV-FLIGHT</u>:

HTV-FLIGHT will oversee the overall operations of the HTV. HTV-FLIGHT has the authority to make final decisions during the mission. On the HTV2 Mission, Tanabe, Uchiyama, and Maeda will serve as the HTV flight directors (HTV-FLIGHT).

Yamauchi and Asou, who served the flight directors on the HTV1 Mission, will also assist the HTV2 Mission.

<u>HTVSYS</u>:

HTVSYS is responsible for HTV's system operations. HTVSYS monitors system telemetry data of the HTV and coordinates with NASA's Mission Control Center (MCC-H).

CMD:
CMD is responsible for sending commands to control HTV's flight according to HTV flight operations procedures.

HTVGC:
HTVGC is responsible for managing the facilities and networks to be used for HTV operations.

PLAN:
PLAN is responsible for planning HTV's flight operations. PLAN will amend or modify the operations plans during the mission when necessary.

SYS-J:
SYS-J supports HTV-FLIGHT by managing HTV operations procedures.

RNDV:
RNDV is responsible for HTV's rendezvous operations. RNDV will monitor and update the status of the HTV and coordinate with NASA's MMC-H.

GNC:
GNC is responsible for HTV's Guidance & Navigation Control operations.

TRAJ:
TRAJ is responsible for HTV's orbital phase adjusting maneuvers.

POWER:
POWER is responsible for HTV's electrical subsystem.

THERMAL:
THERMAL is responsible for HTV's thermal control subsystem and environment control subsystem of the HTV Pressurized Logistics Carrier (PLC).

COMM／DH:
COMM/DH is responsible for HTV's data handling and communications subsystems.

PROP:
PROP is responsible for the propulsion system of the HTV.

EP:

EP is responsible for the Unpressurized Logistics Carrier and the Exposed Pallet (EP) of the HTV.

ROE:
ROE will make independent assessment of reentry planning. ROE will also monitor and assess safety status during HTV reentry.

ARO:
ARO is NASA's rendezvous expert, and ARO will support and coordinate international coordination between JAXA and NASA.

S&MA:
S&MA will make independent assessment on the HTV operations from the standpoint of safety and mission assurance. S&MA will provide the HTV FCT safety or risk assessment reports.

2. HTV Overview

2.1 Summary

The H-II Transfer Vehicle (HTV) is Japan's unmanned cargo transfer spacecraft that delivers cargo/supplies to the International Space Station (ISS). In November 2010, the HTV was nicknamed "KOUNOTORI".

The HTV is launched from the Tanegashima Space Center (TNSC) aboard an H-IIB launch vehicle. The HTV delivers up to 6,000kg of cargo to the ISS. Once the HTV arrives at the ISS, the cargo/supplies are transferred to the ISS. The HTV was then loaded with trash and discarded items, such as empty package, empty resupply racks, used experiments, and used clothes. Finally, the HTV undocks and departs from the ISS, and reenters the atmosphere.

The HTV1 (Technical Demonstrations Vehicle), the HTV maiden flight vehicle, was launched on September 11, and arrived at the ISS on September 18, 2009. After 53 days of berthed operations, the HTV1 was unberthed from the ISS on October 31, 2009. The HTV1 performed deorbit maneuver and reentered the Earth's atmosphere on November 2, 2009.

With some modifications to its original configuration, the second HTV flight vehicle (HTV2) is set to launch on January 22, 2011.

Fig. 2.1-1 HTV1 photographed from the ISS

2.2 Objectives and Significance

The HTV has the following three primary objectives:

1. To fulfill Japan’s role in the International Space Station (ISS) Program
   - After retirement of the Space Shuttle, it will be a crucial orbital cargo transport system which can deliver pressurized and unpressurized cargo to the ISS.

2. To demonstrate Japan’s Space Engineering Technologies
   - It will assist establishing Japan’s autonomous orbital transportation capabilities.
   - Annual launch of the H-IIB launch vehicle will facilitate technology maturation on Japan’s space launch capability.

3. To accumulate technologies and know-how on human spaceflight systems
   - It will assist acquisitions of safe and reliable space engineering technologies required for human spaceflight systems.
   - It will facilitate accumulations of technologies and know-how indispensable for Japan’s human spaceflight development activities.

The HTV is a masterpiece of Japan’s space engineering, built on an integrated technology of Japan’s own launch vehicle, satellite, and manned spaceflight systems.

Currently, Russia’s Progress spacecraft, the European Space Agency’s (ESA’s) Automated Transfer Vehicle (ATV), and NASA’s space shuttle (scheduled to retire in 2011) are delivering supplies to the ISS. In addition, some potential new commercial cargo spacecrafts are in various stages of development (with the support of NASA’s Commercial Orbital Transportation Service (COTS) program).

The HTV features an extensive cargo transportation capability that can deliver both pressurized and unpressurized cargo at once. The HTV also has the following features:

Cargo Transfer Capability
- The hatch of the HTV Pressurized Logistics Carrier (PLC) (a doorway to the ISS) is wide enough to transfer an International Standard Payload Rack (ISPR) into the ISS.
- HTV Unpressurized Logistics Carrier (ULC) enables accommodation of unpressurized payloads, including external experiments and unpressurized orbital replacement units (ORUs) that are to be used outside of the ISS

Unique Rendezvous Flight Techniques
- HTV uses Japan’s unique rendezvous flight techniques.

2.3 Background

In March 1988, Japan, the United States (U.S.) and the member countries of ESA signed the Inter-Governmental Agreement (IGA) on the International Space Station (ISS).

In June 1989, the National Diet of Japan ratified the IGA.

In July 1994, NASA proposed a change in the ISS logistics arrangement while negotiations on the Memoranda of Understandings (MOU) on the International Space Station (ISS) were ongoing. NASA recommended that the space shuttle's transportation cost be compensated by each partner's own transportation capability, instead of reimbursing actual expenditure for payload/astronaut transport.

In 1995, Japan initiated preparation of design concepts for H-II Transfer Vehicle (HTV) in order to contribute Japan's cargo transportation capability to the ISS program.

In 1996, a request for initiation of "Framework of the H-II Transfer Vehicle (HTV)" was approved by the Space Activities Commission (a review commission for Japan's space-related activities).

In 1997, development of the HTV was initiated.

In 1999, JAXA (NASDA) held an HTV Preliminary Design Review (PDR) inviting the ISS international partners.

In 2001, JAXA (NASDA) held an additional HTV Preliminary Design Review (delta-PDR) inviting the international partners (including ISS program manager) to finalize the configuration of HTV Technical Demonstration Vehicle.

In March 2004, JAXA held an internal HTV Critical Design Review.

In February 2005, JAXA held the HTV Critical Design Review (Part I) inviting the ISS international partners.

In March 2006, JAXA held the HTV Critical Design Review (Part II) inviting the ISS international partners.

On September 11, 2009, the HTV1 (Technical Demonstration Vehicle) was launched aboard the H-IIB launch vehicle.

On November 2, 2009, the HTV1 reentered the Earth's atmosphere (the HTV1 Mission successfully completed).

2.4 Configuration

The H-II Transfer Vehicle (HTV) consists of a Pressurized Logistics Carrier (PLC), an Unpressurized Logistics Carrier (ULC), an Exposed Pallet (EP), an Avionics Module, and a Propulsion Module.
Cargo and supplies are loaded inside the PLC and on the EP, which is installed in the ULC.

Proximity Communication System (PROX) equipment that enable radio frequency (RF) communications between the HTV and the ISS, as well as PROX antennas and Laser Radar Reflector (LRR) are installed in the Japanese Experiment Module, Kibo, and are to be used when the HTV arrives within the ISS proximity range.

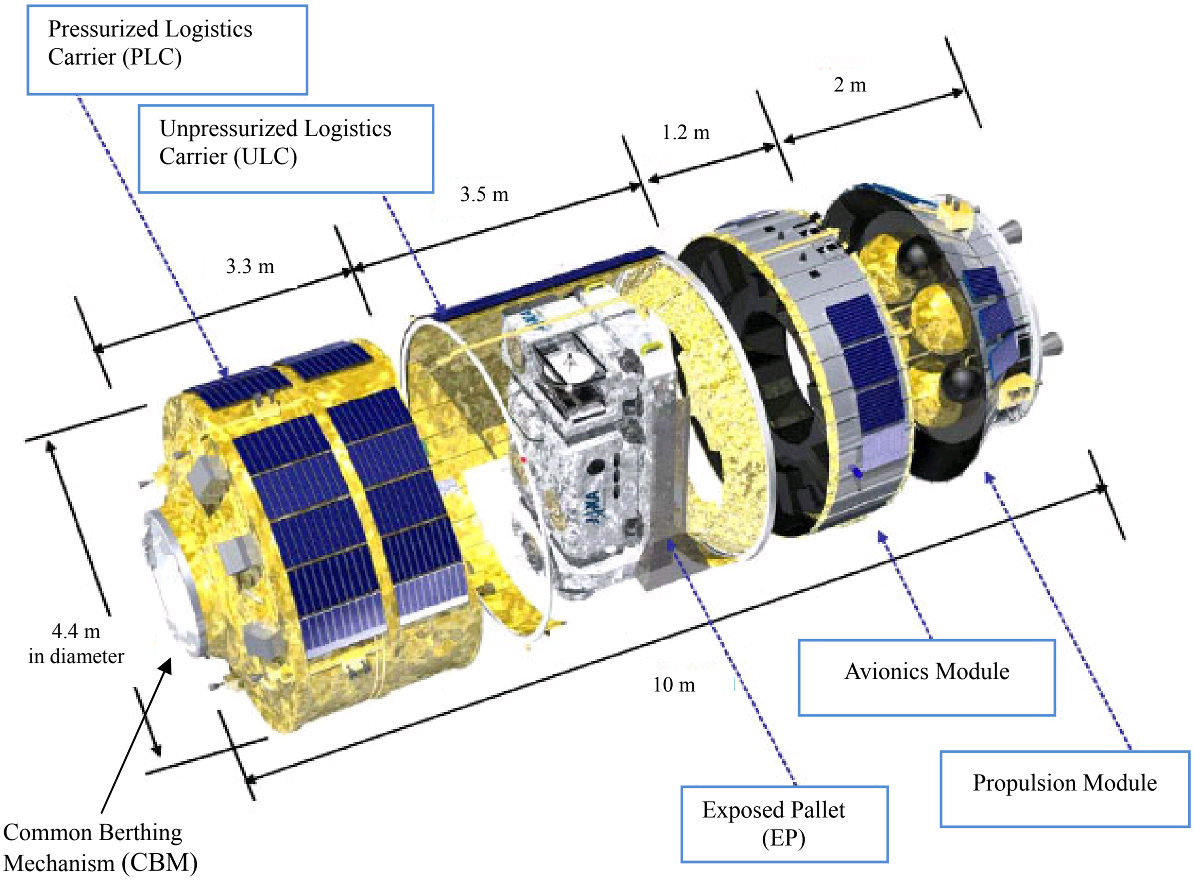


Fig. 2.4-1 HTV Configuration

Table 2.4-1 HTV Specifications

	Specifications	
Length	9.8 m (including the length of the main thruster)	
Diameter	4.4 m	
Dry Mass	10,500 kg (excluding supply/ cargo mass)	
Total Mass	16,500 kg	
Propellant	Fuel	MMH (Monomethylhydrazine)
	Oxidizer	MON-3
Cargo Capacity*1) (For Supply)	6,000 kg	
	<u>PLC</u>: 5,200 kg (Pressurized cargo, including food, clothing, potable water for crew, experiment racks, experiment equipment which are used inside the ISS)	
	<u>ULC</u>: 1,500 kg (Unpressurized cargo including exposed experiments, orbital replacement units (ORUs) to be used outside of the ISS)	
Cargo Capacity (For Trash)	Up to 6,000 kg	
Target Orbit to the ISS	Altitude: 350km to 460km Inclination: 51.6 degrees	
Mission Duration (Nominal)	Rendezvous (solo) flight: 5 days Berthed Operations: 30 days Reserve: 7 days	

*1) HTV is not designed to carry more than 6,000 kg of cargo. Therefore, cargo weight for both the PLC and ULC will be balanced to meet the HTV's total cargo capacity.

2.4.1 Pressurized Logistics Carrier (PLC)

The Pressurized Logistics Carrier (PLC) carries cargo for onboard use (experiment racks, cargo transfer bags, food, and clothes etc.). Internal air pressure of the PLC is maintained at one atmospheric pressure (1 atm). The temperature inside the HTV PLC is controlled during the solo flight and berthing phases. Once it is berthed to the ISS, internal air will be circulated between the PLC and the ISS through the Inter-Module Ventilation (IMV) system.

The PLC is equipped with the passive half of a Common Berthing Mechanism (CBM), which enables docking to the active half of the CBM on Harmony. The PLC has a hatch (1.27 m×1.27 m) through which ISS crew members can enter the PLC for cargo unloading/trash loading while the HTV is berthed to the ISS.

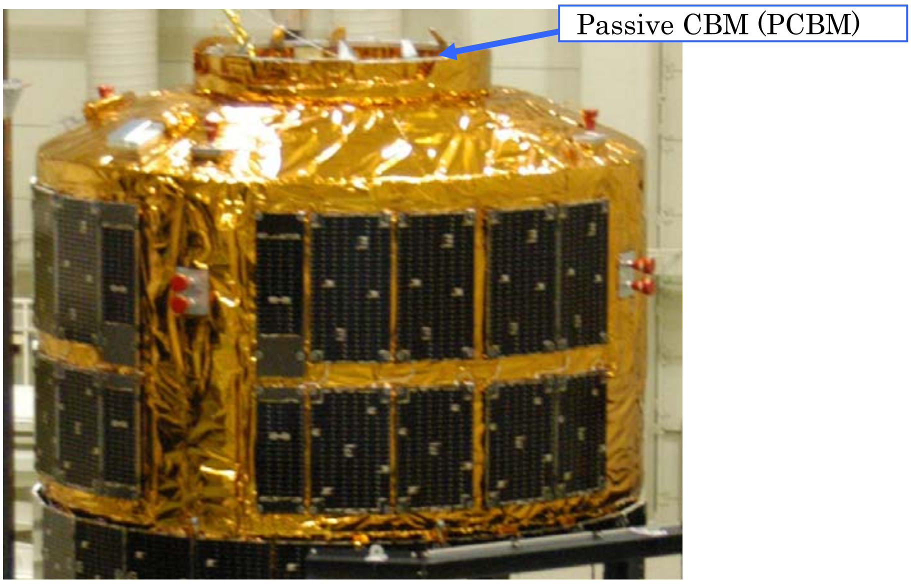


Fig. 2.4.1-1 PLC Overview (HTV1)

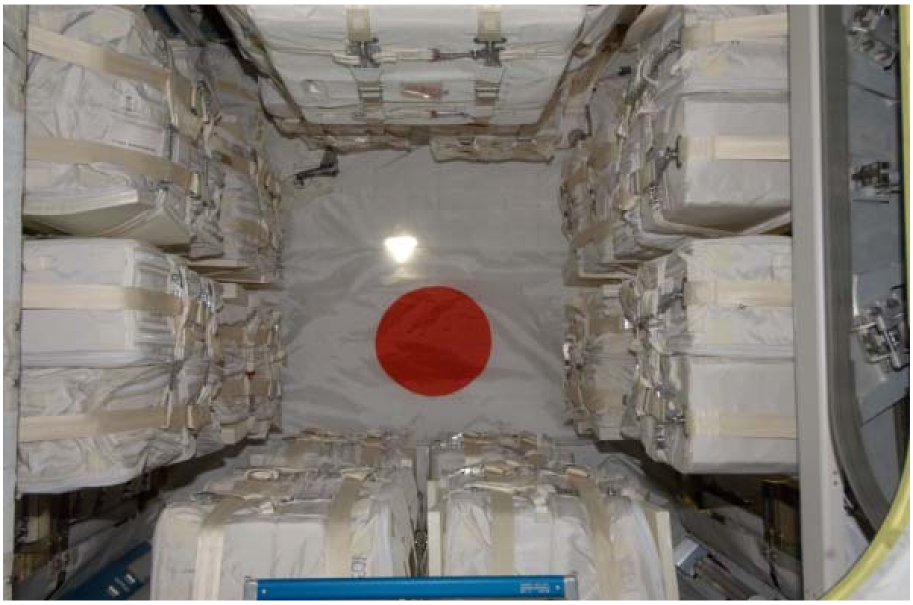


Fig. 2.4.1-2 Interior View of the PLC
(The above picture was taken by ISS crew during the HTV1 Mission)

2.4.1.1 Interior of the Pressurized Logistic Carrier (PLC)

The interior of the Pressurized Logistic Carrier (PLC) is separated into two bay areas: the first rack bay (Bay #1) located on the hatch side, and the second rack bay (Bay #2) in the rear. Each bay accommodates four racks; thus, up to eight racks can be accommodated per flight.

Fig. 2.4.1-3 Rack Layout inside the PLC
(The above picture was taken during the cargo loading activities
in preparation for the HTV2 Mission)

First Rack Bay (Bay#1)	Bay #1, located on the hatch side, accommodates the International Standard Payload Rack (ISPR) or a fixed type of HRRs*1). The ISPR is removable so that the rack can be transferred into the ISS cabin. On the HTV2 Mission, KOBAIRO Rack and MSPR*2) are installed on the Bay#1. After the racks on the Bay#1 are unloaded, NASA's two Resupply Stowage Platforms (RSPs) will be loaded there for disposal.
Second Rack Bay (Bay#2)	Bay #2, located in the rear, accommodates the fixed type of HRRs, and those HRRs will not be transferred into the ISS cabin. After the Cargo Transfer Bags (CTBs) are unloaded from the fixed type HRRs, trash and other discarded items will be loaded into them.

*1) HRR: HTV Resupply Rack
*2) MSPR: Multi-purpose Small Payload Rack

2.4.2 Unpressurized Logistics Carrier (ULC)

The Unpressurized Logistic Carrier (ULC) has a wide opening that accommodates an Exposed Pallet (EP), which carries external experiments and/or unpressurized orbital replacement units (ORUs). Since the opening is located on the side of the body, area around the opening section should experience intensified aerodynamic load during launch/ascent phases. The structures of the ULC are designed to withstand such ascent loads.

The ULC is equipped with a Flight Releasable Grapple Fixture (FRGF). The station's robotic arm (SSRMS) grapples this FRGF for berthing the HTV to the ISS.

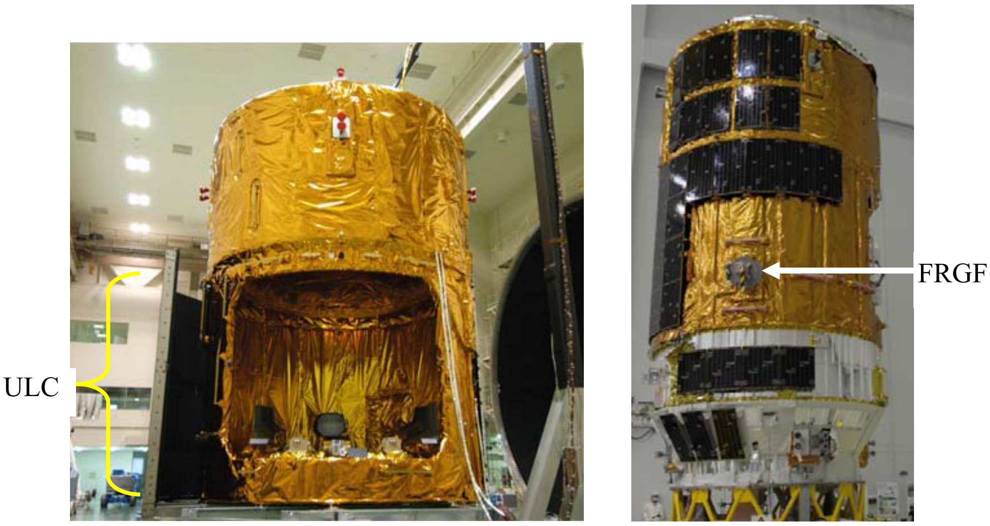


Fig. 2.4.2-1 Left: ULC before Installation of the EP (HTV1)
Right: Location of FRGF (HTV1)

After the HTV is berthed to the ISS, the Exposed Pallet (EP) will be removed from the ULC by the station's robotic arm (SSRMS). Then, the EP will be temporarily attached to the Mobile Base System (MBS) or Kibo's Exposed Facility (EF) for unloading of the carried payloads. Once the payloads are unloaded, the EP will be re-stowed in the ULC.

Fig. 2.4.2-2 EP Being Loaded (HTV2)

Fig. 2.4.2-3 EP Installed into the ULC (HTV2)

2.4.2.1 Mechanisms of Unpressurized Logistics Carrier (ULC)

- Tie-down Separation Mechanism (TSM)
  The Unpressurized Logistic Carrier (ULC) is equipped with four Tie-down Separation Mechanisms (TSMs). The TSMs are used to fasten the Exposed Pallet (EP) in the ULC during launch/solo flight to the ISS. After the HTV is berthed to the ISS, the TSMs enable removal or reinstallation of the EP to the ULC by the SSRMS.

- Hold-Down Mechanism (HDM)
  The Hold-Down Mechanism (HDM) is located inside of the opening. The HDM receives, holds, and pulls in the EP when the EP is re-stowed in the ULC by the SSRMS.

- Harness Separation Mechanism (HSM)
  The Harness Separation Mechanism (HSM) is located near the opening of the ULC. The HSM is used to separate heater power and data cables between the ULC and the EP.

- Guide Rails/Wheels
  The guide rails and wheels are devises to minimize resistive load when the EP is reinstalled into the ULC. The mechanisms also support proper alignment for re-stowing of the EP. The guide rail is located on the ULC side, and the wheel (roller) is attached on the EP side.
  Three guide rails are located near the aperture of the ULC, one each on the port side, the starboard side, and the nadir side. Nine wheels are located on the port side and the starboard side, and one on the nadir side of the EP.

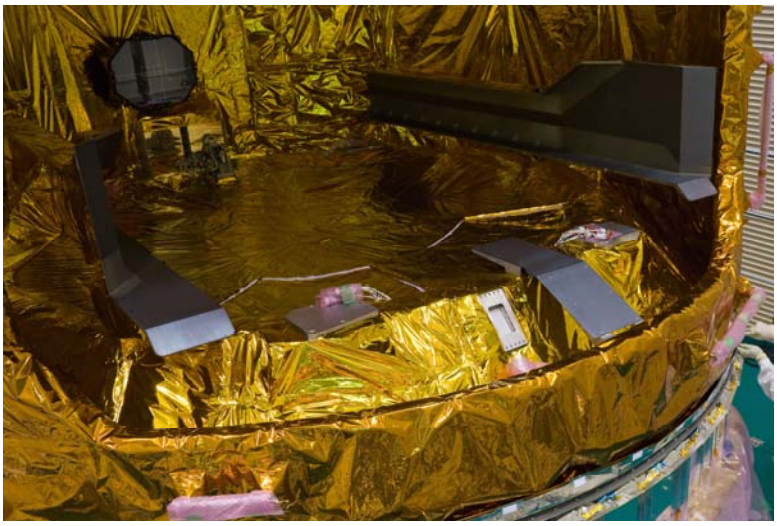


Fig. 2.4.2-4 Enlarged View: Opening of the ULC (HTV1)
Wheel on the EP (HTV2)

2.4.3 Exposed Pallet (EP)

The Exposed Pallet (EP) is used to carry unpressurized payloads, such as external experiments and orbital replacement units (ORUs), which will be operated outside of the ISS. The EP is removed from the ULC and temporarily attached to the ISS for unloading the carried payloads. After the payloads are unloaded, the EP is re-stowed in the ULC. The EP accommodates up to 1,500 kg of unpressurized cargo.

Fig. 2.4.3-1 Exposed Pallet (EP) (HTV1)

Two different types of EPs are available to meet various logistics needs.

Exposed Pallet for Kibo's Exposed Facility (EF) Payload (Type I)

This type (Type I) accommodates external experiments that will be operated on Kibo's Exposed Facility (EF).

*On the HTV2 Mission, NASA's two unpressurized ORUs with U.S. attachment mechanisms (NASA's Flight Releasable Attachment Mechanisms: FRAMs) will be delivered using this type.

*On the HTV1 Mission, two EF payloads were delivered using this Type I pallet.

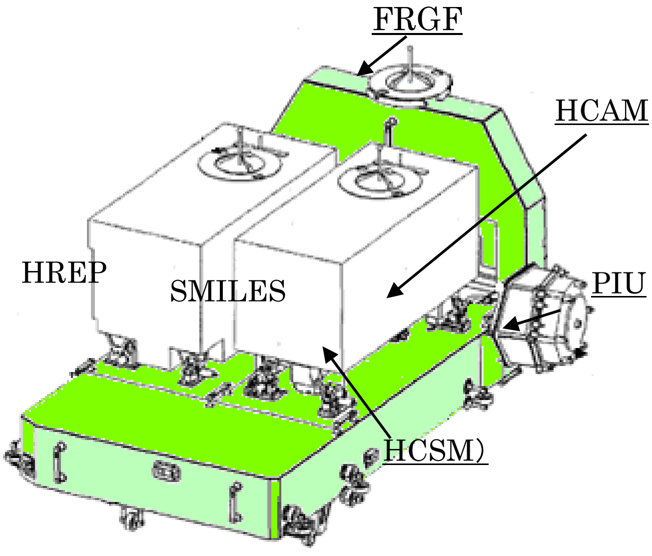


Fig. 2.4.3-2 Exposed Pallet for EF Payload (Type I)
(Note: Configuration for the HTV1 Mission)

- Exposed Pallet-Multi-Purpose (Type EP-MP)

This type (EP-MP) can accommodate some combinations of external experiment and orbital replacement unit (ORU). On orbit, the EP-MP can be attached to either the EF or the station's Mobile Base System (MBS).

The EP-MP, which attaches to the EF, carries a consolidated cargo (combination of an EF payload and an ISS-common ORU). The EP-MP, which attaches to the MBS, carries only ISS-common ORUs such as battery ORUs. This type can carry up to six batteries per fight.

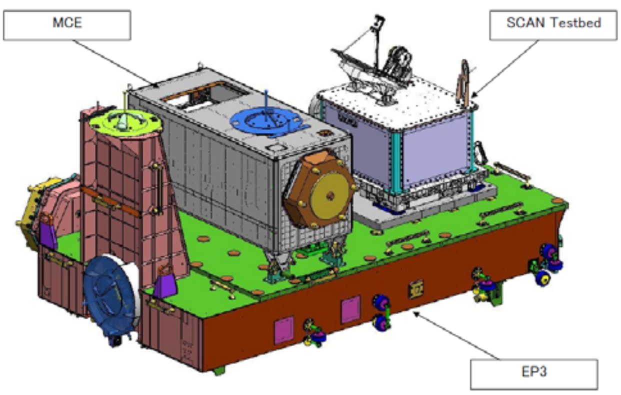


Fig. 2.4.3-3 Exposed Pallet-Multi-Purpose (Type EP-MP)
(Note: Configuration for the HTV3 Mission)

2.4.3.1 Mechanisms of Exposed Pallet (EP)

The Exposed Pallet (EP) is equipped with an EF interface (HPIU), cargo attachment mechanisms (HCAMs), connector separation mechanisms (HCSMs), a TV camera (HBCS), and two types of grapple fixtures (FRGF and PVGF). These mechanisms will enable safe and fully protected external cargo transportation activities.

- HTV Payload Interface Unit (HPIU)

  The HTV Payload Interface Unit (HPIU) is used to connect the EP to Kibo's Exposed Facility (EF). It provides an interface between the EP and the EF.

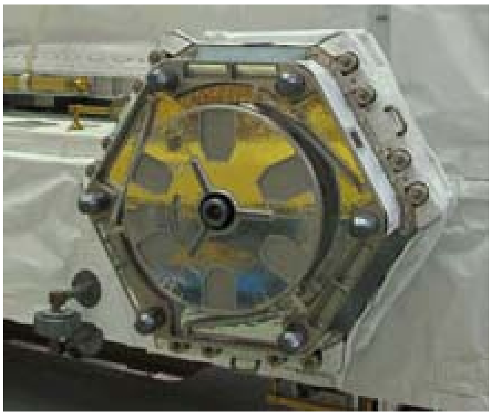


Fig. 2.4.3-4 HTV Payload Interface Unit (HPIU)

- HTV Cargo Attachment Mechanism (HCAM)

  The HTV Cargo Attachment Mechanism (HCAM) is used to fasten an EF payload while the HTV flies to the ISS. It fastens each of the four corners of an EF payload.

  Note: The HCAMs will not be used on the HTV2 Mission since the unpressurized ORUs (FHRC and CTC) are attached on the EP with NASA's Flight Releasable Attachment Mechanisms (FRAMs).

- HTV Connector Separation Mechanism (HCSM)

  The HTV Connector Separation Mechanism (HCSM) is used to separate heater power cables* between the Exposed Pallet (EP) and an EF payload or ORU.

  Note: the HCSM will not be used on the HTV2 Mission.

- FRGF/PVGF

  The Grapple Fixture is an ISS-common mechanism that the SSRMS or JEMRMS grapples and holds. The PVGF provides an interface to supply heater power and data communications between the EP and the ISS through the SSRMS.

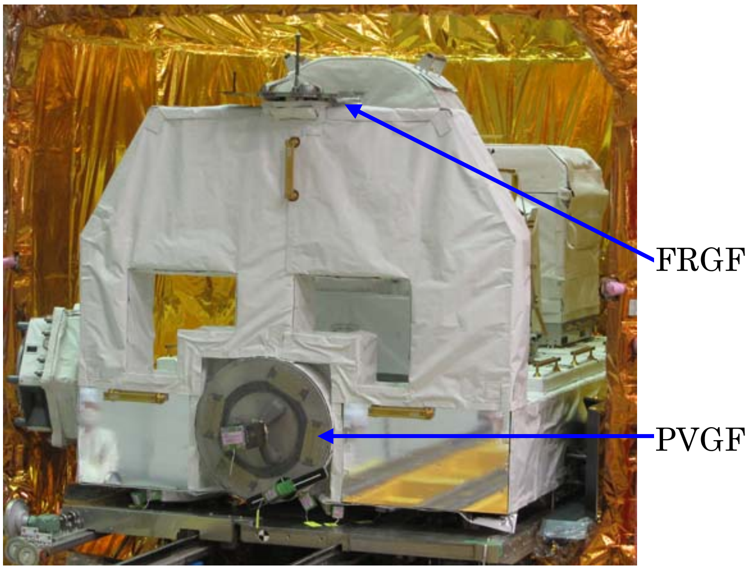


Fig. 2.4.3-5 Exposed Pallet (HTV2)

● HTV Berthing Camera System (HBCS)

The HTV Berthing Camera System (HBCS) is located on the front portion of the EP. It helps align position of the EP while the EP is re-stowed into the ULC by the SSRMS. Camera target is located on the ULC side.

Fig. 2.4.3-6 HTV Berthing Camera System (HBCS)

2.4.4 Avionics Module

The Avionics Module consists of guidance navigation & control, communications, data handling, and electrical power subsystems. These subsystems support HTV's autonomous and/or remotely controlled rendezvous flight. The Avionics Module distributes power to each component of the HTV. The subsystems of the Avionics Module are shown in Table 2.4.4-1.

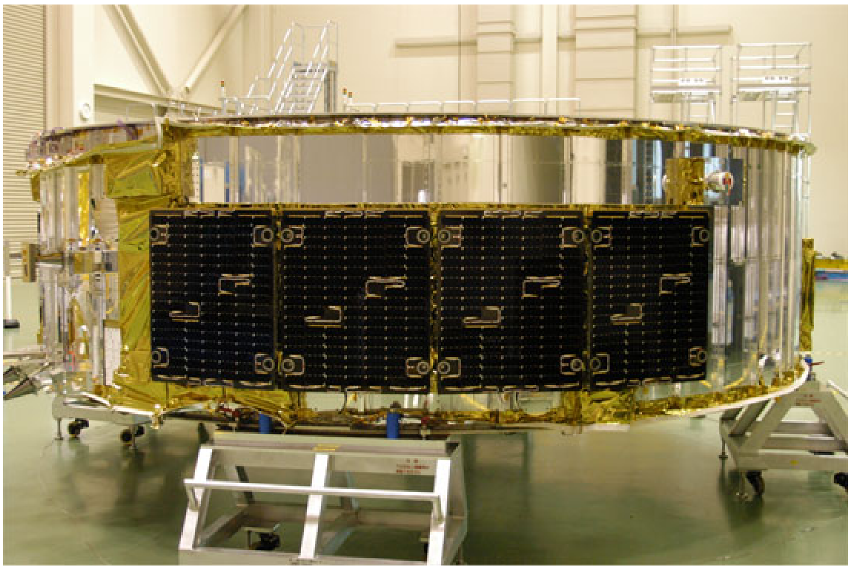


Fig. 2.4.4-1 Avionics Module (Side View) (HTV1)

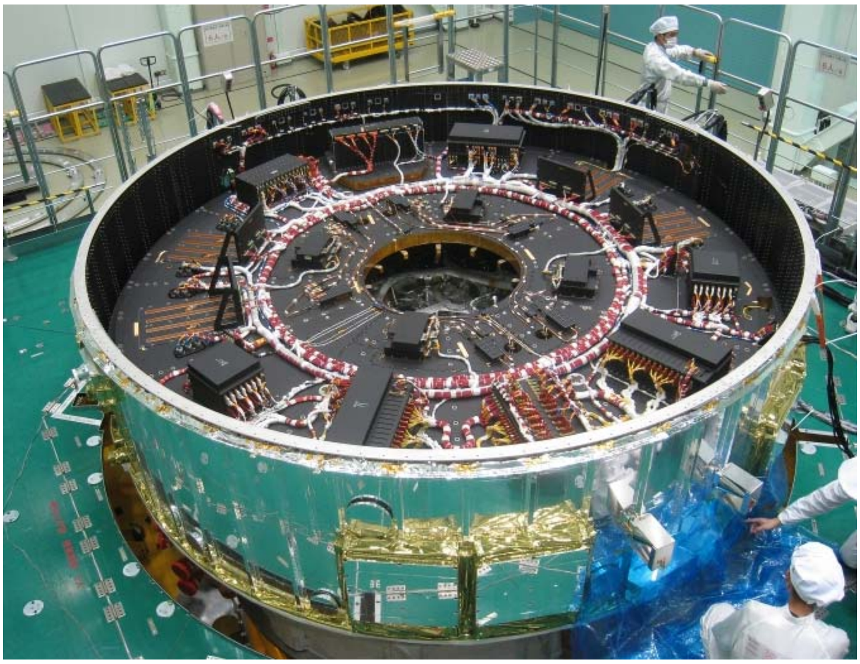


Fig. 2.4.4-2 Avionics Module (Top View) (HTV2)

The Avionics Module receives commands sent from the ground through NASA's Tracking and Data Relay Satellite (TDRS) and or the Proximity Communication System (PROX) installed in Kibo, and then, relays the commands to each HTV component. It also sends HTV's telemetry data to the ground through the TDRS and or the PROX.

Table 2.4.4-1 Avionics Module Subsystems

Navigation Control Subsystem	▪ Once the HTV is inserted into the predetermined orbit, this subsystem obtains the navigation information using the position/attitude sensors. ▪ This subsystem mainly consists of a GPS antenna, rendezvous sensors, an Earth sensor, a navigation control computer, and an abort control unit.
Communications Subsystem	▪ This subsystem consists of the Inter-Orbit Link System (IOS) that enables communications through NASA's TDRS, and the Proximity Link System (PLS) that enables direct wireless communications with the ISS within the ISS proximity range. Both communications use S-band.
Data Handling Subsystem	▪ This subsystem receives commands from the ground, and sends HTV telemetry to the ground. ▪ This subsystem supports thermal controls of the Avionics Module and Propulsion Module, environment control of the PLC, fault detection/caution and warning for HTV's equipment, and data handling/control of the other subsystems.
Electrical power Subsystem	▪ This subsystem consists of seven Primary Batteries (P-BATs), one Secondary Battery (S-BAT), and the Power Control Unit (PCU) that regulates the power generated by the solar panel while the HTV is flying in sunlight. The S-BAT is a rechargeable battery. ▪ When the HTV is flying in the Earth eclipse, the S-BAT and the P-BAT power will be provided to each system component. ▪ When the power supply from the ISS is out during the berthing phase, the power from the P-BAT will be provided to each system component of the HTV. ▪ This subsystem receives power from the ISS while the HTV is berthed to the ISS. The DC/DC converter regulates power from the ISS and distributes the converted power to each component of the HTV.
Solar Array Panel 	▪ Fifty-seven solar panels are installed on the external wall of the HTV. – PLC: 20 panels – ULC: 23 panels – Avionics Module: 8 panels – Propulsion Module: 6 panels

2.4.5 Propulsion Module

The Propulsion Module has four propellant tanks with a capacity of 2,000 kg of propellant per flight (The HTV1 carried 2,400 kg of propellant). Monomethylhydrazine (MMH) is used as fuel, and MON3 is used as an oxidizer.

The propellant will be supplied to HTV's four main thrusters (two units x two strings) and 28 Reaction Control System (RCS) thrusters (14 units x two strings) from the propellant tanks. Propulsion for orbital maneuvers (rendezvous maneuvers and altitude maneuvers) will be controlled by command signals sent from the Avionics Module.

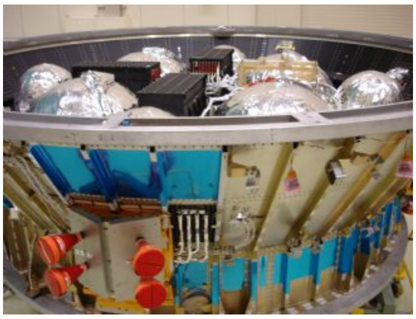


Fig. 2.4.5-1 Propulsion Module (Before installation of MLI covers)

Fig. 2.4.5-2 Propulsion Tanks

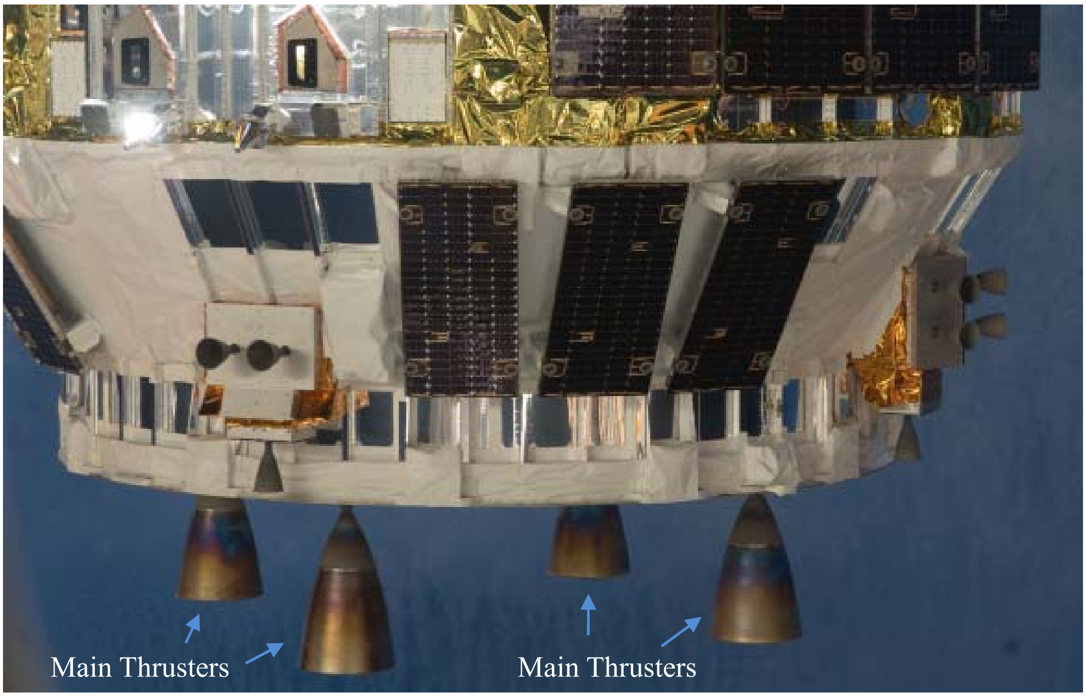


Fig. 2.4.5-3 Propulsion Module Photographed from the ISS (HTV1)

Table 2.4.5-1 Thrusters of the HTV

	Specifications	
	Main Thruster	Reaction Control System (RCS) Thruster
Numbers of Units	2 units x 2 strings (for redundancy) Total 4 units	14 units x 2 strings (for redundancy) Total 28 units *
Thrust per Unit	490N	110N

* Of the 28 units, 12 units are installed on the outer wall of the PLC.

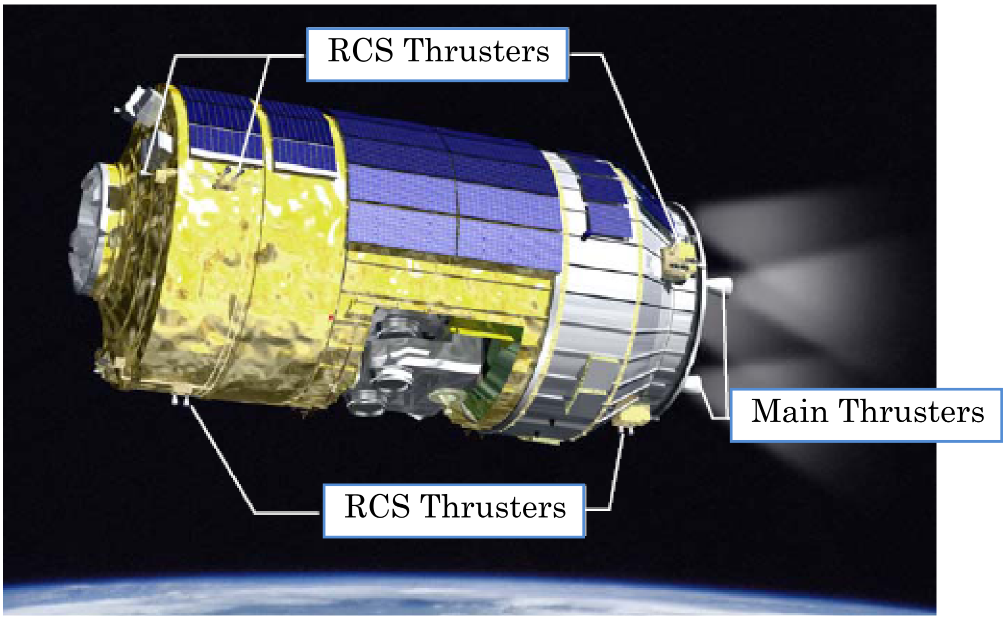


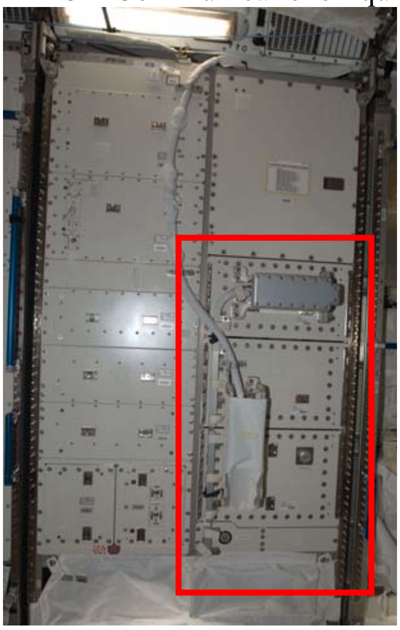
Fig. 2.4.5-5 Locations of Main Thrusters and RCS Thrusters

2.4.6 Proximity Communication System (PROX)

The HTV Proximity Communication System (PROX) is a radio frequency (RF) communications system that enables direct communications between the HTV and ISS when the HTV is in the proximity communications range. It is installed on board the ISS. The PROX consists of communication equipment, data handling equipment, PROX-GPS equipment, Hardware Command Panel (HCP), PROX antennas, PROX-GPS antennas. The PROX equipment, except for the HCP, is installed in the Inter-orbit Communication System (ICS) Rack on Kibo's Pressurized Module (PM). The HCP is deployed on the Robotics Work Station in the Cupola before arrival of HTV.

The PROX antennas are located on the side of the PM outer wall. Two units of the PROX-GPS antennas are located on the top of Kibo's Experiment Logistics Module-Pressurized Section (ELM-PS).

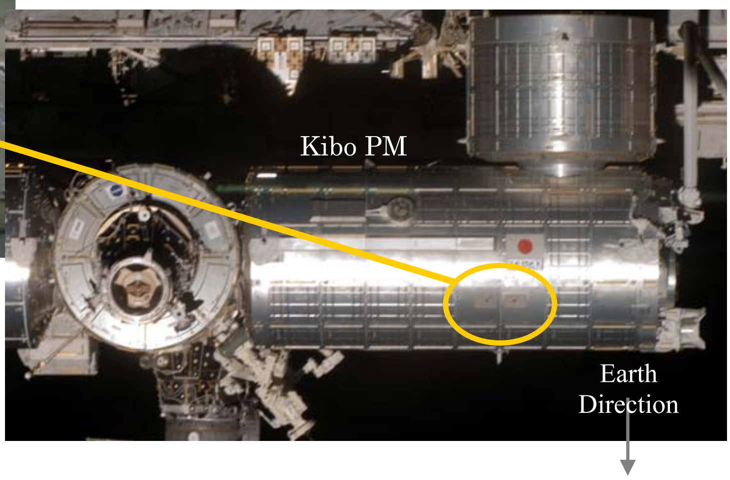
- PROX Communications Equipment



PROX communication systems are installed on the right side of the ICS/PROX Rack, which is located on the upper rack area in Kibo's PM.

- PROX Antenna

The PROX antennas support HTV's direct RF communications with the ISS during Proximity Operations.



- Hardware Command Panel (HCP)

●ABORT
This command will force the HTV to move away from the ISS

●FRGF SEP
This command will force the HTV to be detached from the SSRMS (In case the SSRMS could not ungrapple the grapple fixture (FRGF) on the HTV. In that case, the FRGF will be disengaged from the HTV.)

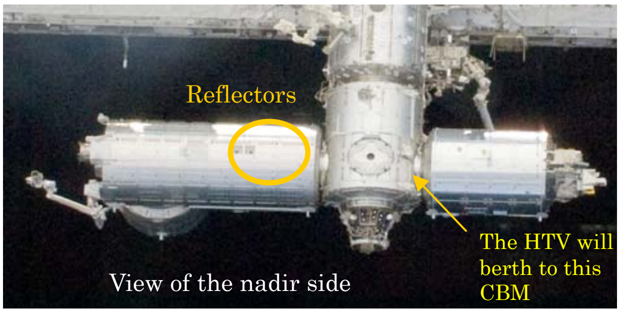
●RETREAT
This command will force the HTV to retreat to 30 m or 100 m below the ISS

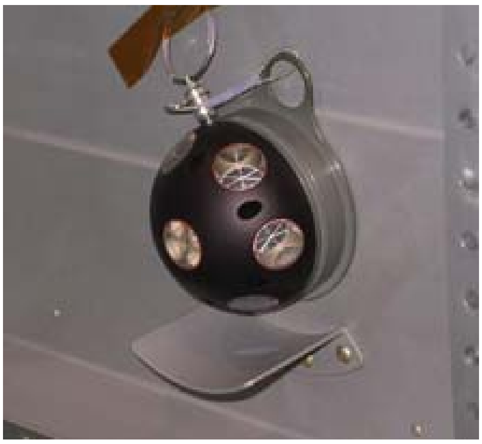
●HOLD
This command will force the HTV to hold its approach

●FREE DRIFT
This command will disable the HTV thrusters for the SSRMS to grapple the HTV

The Hardware Command Panel will be used for a contingency during the HTV's final approach. Using the HCP, the ISS crew can send commands to the HTV for immediate critical operations, such as holding the HTV's approach. The HCP is deployed on the Robotics Work Station in the Cupola before HTV's Proximity Operations.

2.4.7 Laser Rader Reflector (LRR)





The Laser Rader Reflectors (LRRs) are located on the nadir side of the PM. The reflectors will reflect the lasers beamed from the HTV's Rendezvous Sensor (RVS) when the HTV approaches from the nadir side of the ISS.

2.5 HTV Operations

2.5.1 Rendezvous Flight to the ISS

After separating from the H-IIB launch vehicle, the HTV flies to the ISS by gradually shortening the distance to the ISS conducting some height and phase adjustment maneuvers. Summary of HTV's rendezvous profile is shown in table 2.5.1-1.

1 After separated from the second stage of the H-IIB launch vehicle, the HTV will automatically establish communications with NASA's Tracking and Data Relay Satellite (TDRS) to initiate communications with the HTV Mission Control Room (HTV MCR).
2 Status of the HTV will be checked from the ground (HTV MCR), and then, the HTV will start orbital rendezvous flight towards the ISS.
3 The HTV will fly to the ISS conducting height and phase adjustment maneuvers.
4 The HTV will reach the proximity communication zone where the HTV can directly communicate with the ISS.
5 The HTV will establish communications with the Proximity Communication System (PROX).
6 While communicating with the PROX, the HTV will approach the ISS guided by GPS (Relative GPS navigation) until the HTV reaches the "Approach Initiation (AI)" point (5 km behind the ISS). At this point, the HTV will maintain this relative distance from the ISS.

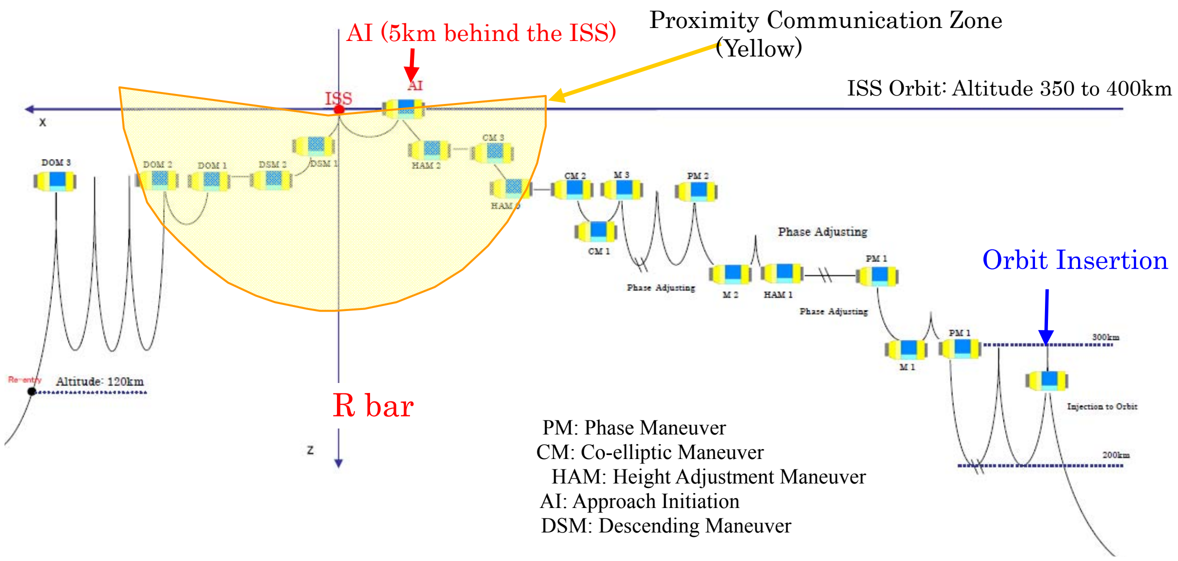


Fig. 2.5.1-1 HTV Rendezvous Profile

2.5.2 Proximity Operations / Capture / Berthing Operations

The HTV will approach the ISS from the nadir side of the ISS (from the direction of Earth). The HTV will then be grappled by the station's robotic arm (SSRMS) and berthed to the ISS. This operation phase is called "PROX Operations".

HTV's approach sequence during PROX Operations is as follows:

1. The HTV will move from the AI point to a point 500 m below the ISS guided by GPS (RGPS Navigation).
2. Using a laser sensor called Rendezvous Sensor (RVS), the HTV will approach the ISS, beaming the laser to the reflector located on the nadir side (facing Earth) of Kibo (This is called "RVS Navigation").
3. The HTV will hold its approach twice: when reaching 250 m below the ISS (hold point) and 30 m below the ISS (parking point). At the hold point, the HTV will perform a 180 degree turn-around (180° yaw-around) to prepare for a collision avoidance maneuver in case of emergency.
4. Finally, the HTV will reach 10 m below the ISS, a predetermined area for HTV grappling, called the "Capture Box". Within the Capture Box, the HTV will maintain this distance from the ISS.

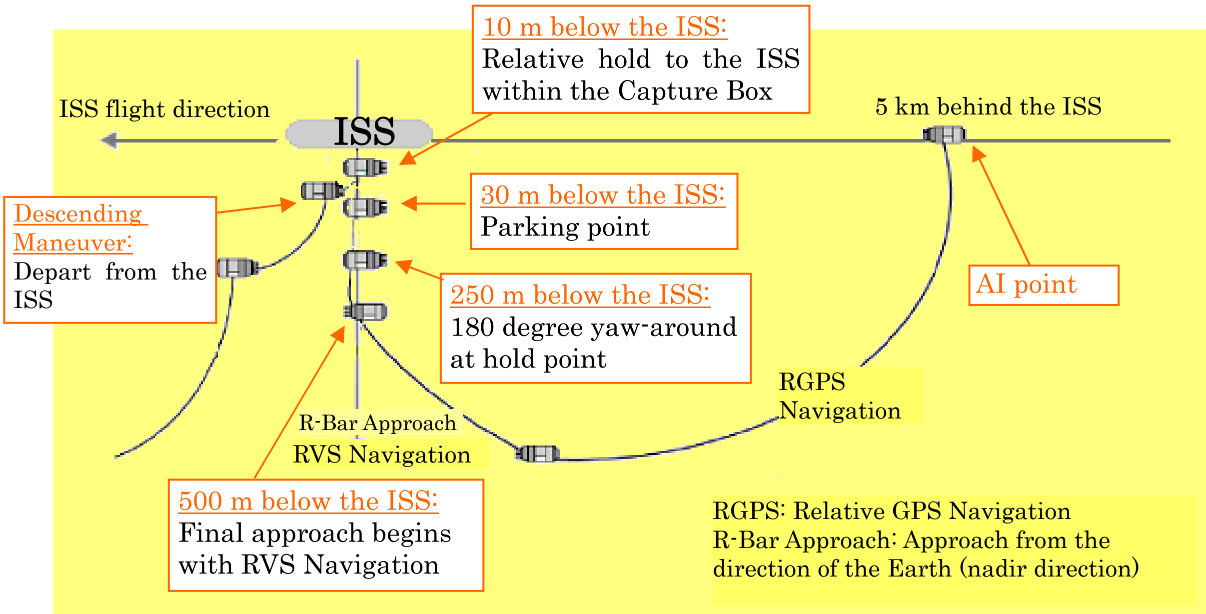


Fig. 2.5.2-1 HTV's PROX Operations

HTV's approach speed during the RVS Navigation phase is 1 to 10 meters per minute. During this phase, the ISS crew can control the HTV by sending commands such as "HOLD", "RETREAT", "ABORT", or "FREE DRIFT" using the Hardware Command Panel (HCP). If an emergency occurs and HTV's further approach can not be permitted, the ISS crew will command the HTV to depart in the forward direction of the ISS.

The HTV performs a 180 degree turn around (180˚ yaw-around) at 250 m below the ISS (hold point). This attitude maneuver is required for a Collision Avoidance Maneuver (CAM) in case of emergency.

Fig. 2.5.2-3 HTV in Free Drift (HTV1)

Fig. 2.5.2-4 Robotic Work Station (HTV1)

Once the HTV Mission Control Room (HTV MCR) at TKSC confirms that the HTV has arrived 10 m below the ISS, the ISS crew will disable the HTV thrusters (Free Drift). Then, the SSRMS will grapple the HTV.

Finally, the SSRMS will berth the HTV to the CBM located at the nadir side (facing Earth) of Harmony (Node2).

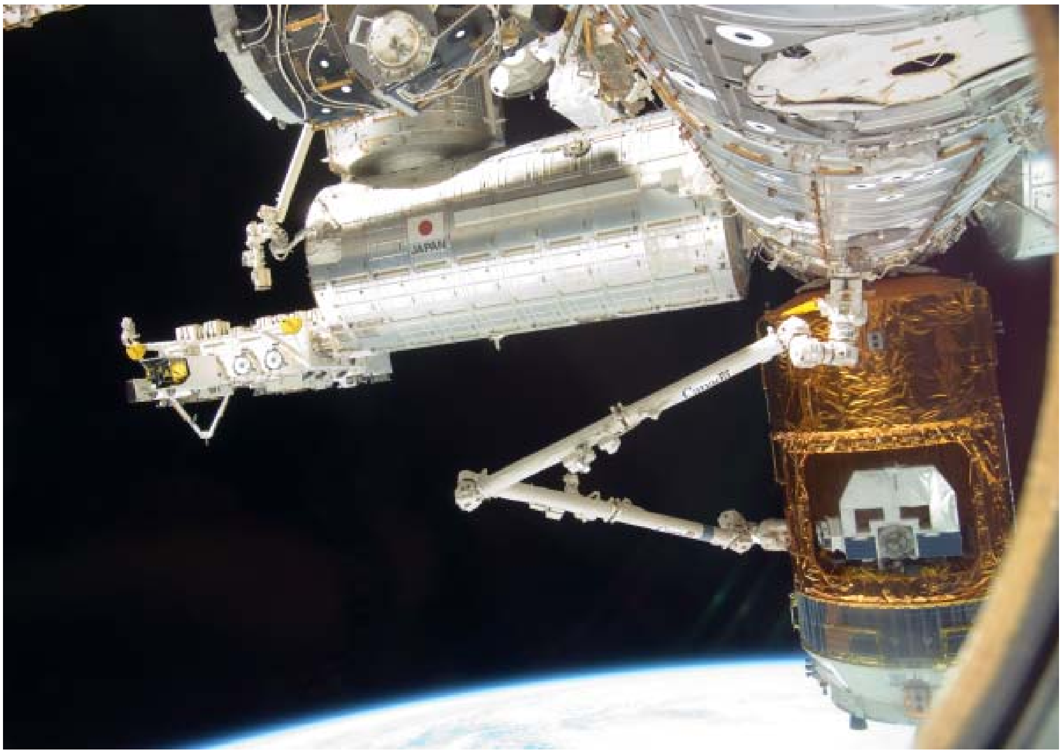


Fig. 2.5.2-5 HTV Being Berthed to the ISS (HTV1)

2.5.3 Berthed Operations

Once the HTV is berthed to Harmony, ingress preparations, such as pressure equalization between the HTV PLC and the ISS, will be performed from the Harmony side by ISS crew. Then, the HTV MCR will turn on lights inside the HTV PLC and open the hatch.

The temperature inside the PLC will be adjusted and maintained above 15.6 degrees Celsius before berthing to the ISS in order to prevent dew condensation inside the PLC.

While berthed to the ISS, power is provided from the ISS. After the hatch open, the ISS crew will enter the PLC and will begin cargo transfer from the PLC to the ISS (science racks, cargo transfer bags, potable water bags, clothing etc.).

Fig. 2.5.3-1 HTV PLC (HTV1)

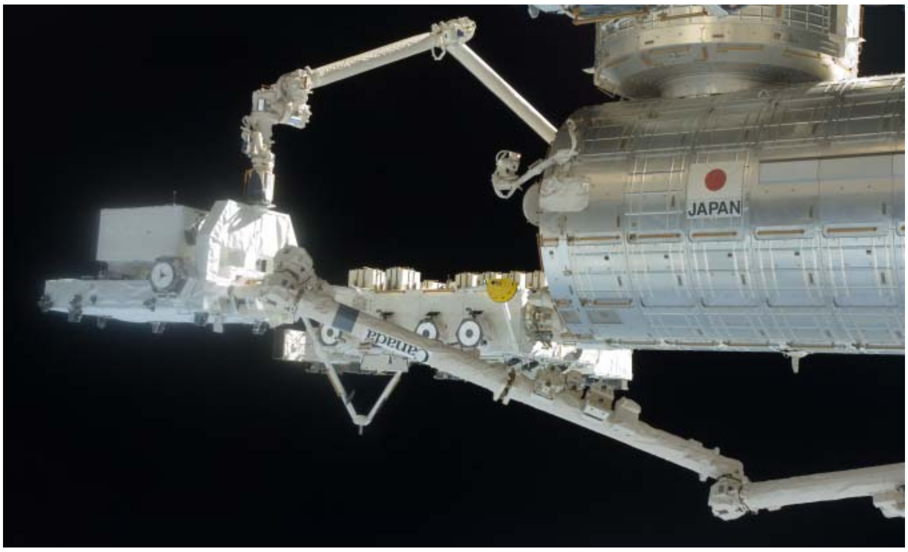


Fig. 2.5.3-2 EP Being Handed Over from the SSRMS to the JEMRMS (HTV1)

HTV's Exposed Pallet (EP) will be removed from the HTV Unpressurized Logistics Carrier (ULC) by the SSRMS. The EP will temporarily be installed on the ISS side for unloading payloads.

2.5.4 Departure from the ISS and Reentry

After being loaded with trash and discarded items, the HTV will be unberthed from the ISS. The HTV will complete its operations by reentering the atmosphere. HTV's undocking and departure sequence is as follows:

1. The hatches of the HTV PLC and Harmony will be closed by ISS crew. The HTV MCR will deactivate the electrical power supply from the ISS.
2. The station's robotic arm (SSRMS) will grapple the HTV.
3. The Common Berthing Mechanism (CBM) will be disengaged.
4. The SSRMS will move the HTV to the release point.
5. The SSRMS will release the HTV.
6. The HTV thrusters will be activated by the ISS crew, and the HTV will depart from the ISS.

Fig. 2.5.4-1 HTV Being Unberthed by the SSRMS (HTV1)

After the HTV departs from ISS orbit, the HTV will conduct two orbital maneuvers. These maneuvers will insert the HTV into the preparatory orbit for reentry. In the pre-reentry orbit, timing of deorbit maneuvers will be adjusted. The HTV will enter the atmosphere with the deorbit maneuvers. Possible HTV debris falling area is within the South Pacific Ocean, where human safety concerns are very small. Other international partners, such as ESA and Russia, used this area as an expected debris falling area for oceanic disposal of their spacecrafts (such as Russian Mir Station, Progress cargo spacecrafts, and ATV).

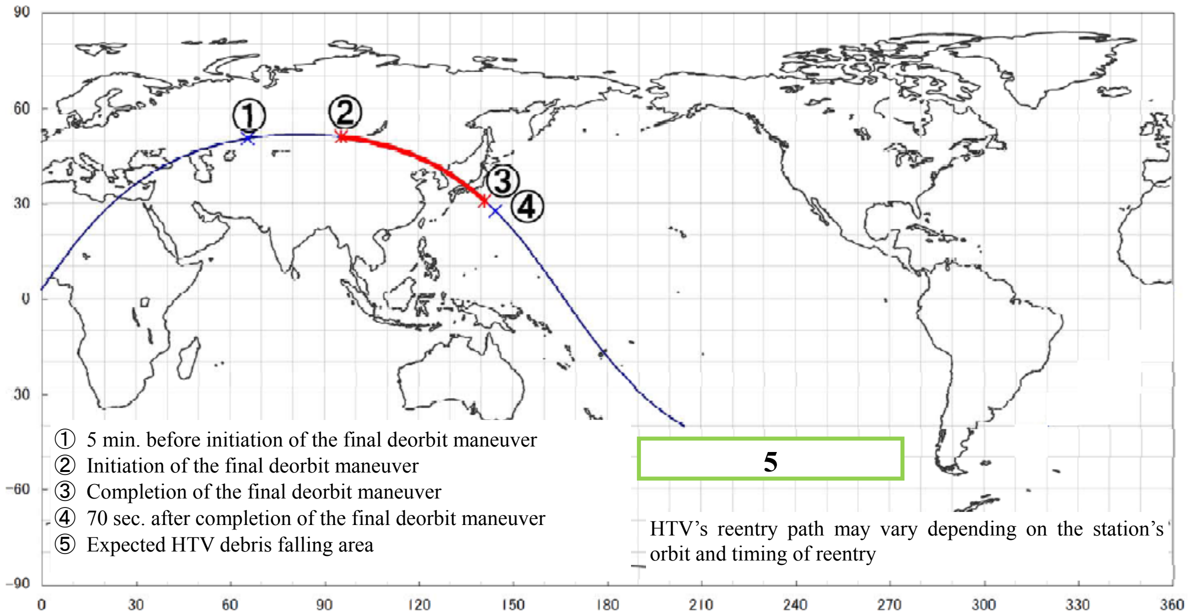
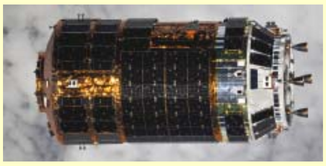


Fig. 2.5.4-2 HTV's Projected Reentry Path (Red Lines) and Expected HTV Debris Falling Area (Green Box) (HTV1)

2.6 Comparison of ISS Resupply Vehicle

Table 2.6-1 Comparison of Supply Vehicles to the ISS

Resupply Vehicle	Total Mass	Resupply Capability	Launch Vehicle	Features
HTV (Japan) 	16,500 kg	6,000 kg	H-IIB	First flight: in 2009 ・ Hatch Opening: (1.27 m × 1.27 m) ・ Accommodates both pressurized and unpressurized payloads
ATV (ESA) 	20,500 kg	7,500 kg	Ariane 5 (ES-ATV)	First flight: in 2008 ・ Docks to the aft docking port of the Zvezda service module ・ Hatch Opening: (0.8 m in diameter) ・ Has capabilities to support ISS reboost and propellant supply
Progress (Russia) 	7,200 kg	2,500 kg	Soyuz	First flight: in 1978 Cargo delivery to the ISS began in 2000 ・ Hatch Opening: (0.8 m in diameter) ・ Has capabilities to support ISS reboost and propellant supply
Space Shuttle (NASA) 	120,00 kg (Orbiter and Cargo)	Approx. 14,000 kg	Space Shuttle	First flight: in 1981 Scheduled to retire in 2011. ・ Manned Spacecraft ・ Hatch Opening: (0.8m in diameter) ・ Can berth to a hatch with a size of 1.27 × 1.27 m using a MPLM ・ Accommodates both pressurized and unpressurized payloads ・ Has a capability to support ISS reboost.
Dragon Space Exploration Technologies Corp., U.S. 	Approx. 9,800 kg	3,310 kg	Falcon 9	In Development Stage Scheduled to start its logistics flight in 2011 (Dragon capsule was successfully returned and recovered during the test flight conducted on December 9, 2010). ・ Hatch Opening: (1.27 x 1.27 m) ・ Accommodates unpressurized payloads ・ Has a capability to bring pressurized cargo back to the ground from the ISS.
Cygnus Orbital Sciences Corp., U.S. 	Approx. 5,200 kg	2,000 kg	Taurus II	In Development Stage Scheduled to start its logistics flight in 2012. Mitsubishi Electric Corp. (Japanese Company) has participated in the development. ・ Hatch Opening: (0.94 × 0.94 m)

3. HTV Mission and Kibo Utilization Schedule

3.1 HTV Launch Schedule and JAXA Astronaut Flight Schedule

On the HTV3 Mission, JAXA's Multi-mission Consolidated Equipment (MCE) and NASA's exposed experiment will be delivered to the ISS using the Exposed Pallet (EP). (Please see Fig. 3.1-2 and 3.1-3)

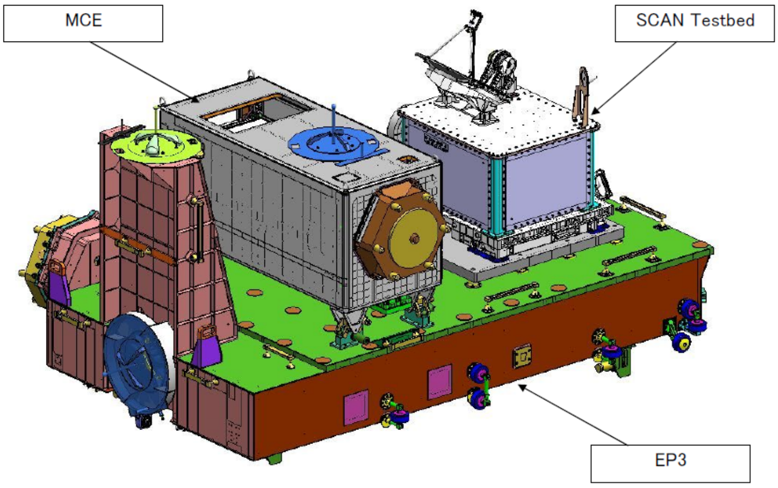


Fig. 3.1-2 Layout of the EP (HTV3) (Image)

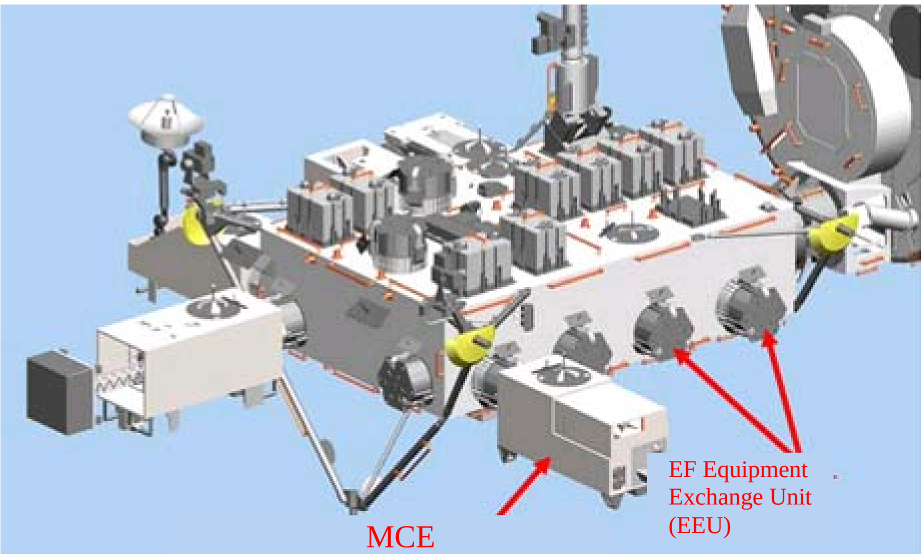
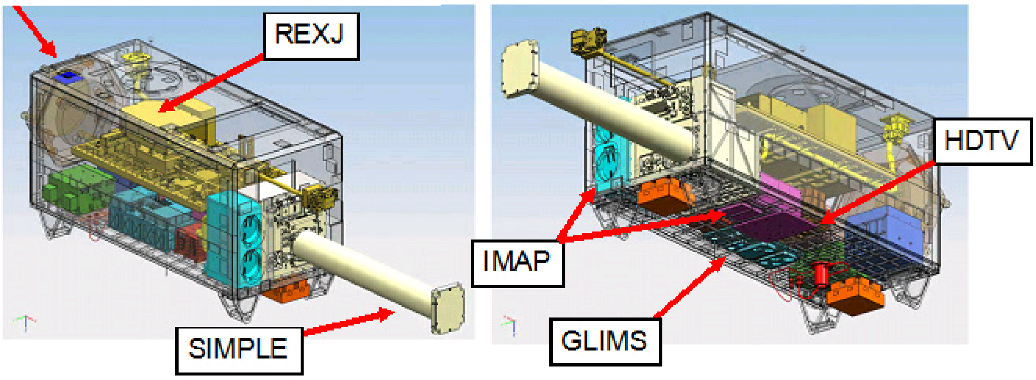


Fig. 3.1-3 (1/2) Multi-mission Consolidated Equipment (MCE)
http://kibo.jaxa.jp/experiment/ef/mce/

An interface to connect to Equipment
Exchange Unit (EEU)



MCE Specifications
Mass: Less than 500 kg
Size: 1.8 x 1.0 x 0.8 m
Science Missions:

- IMAP (Ionosphere,Mesosphere,upper Atomosphere, and Plasmasphere mapping)
- GLIMS (Global Lightning and sprIte MeasurementS on JEM-EF)
- SIMPLE (Space Inflatable Membranes Pioneering Long-term Experiments)
- REXJ (Robot Experiment on JEM)
- COTS HTDV-EF (COTS HTDV Verification)

Fig. 3.1-3 (2/2) Multi-mission Consolidated Equipment (MCE)
http://kibo.jaxa.jp/experiment/ef/mce/

HTV launch schedule (tentative) and JAXA Astronaut flight schedule (including past record) are shown in Table 3.1-1.

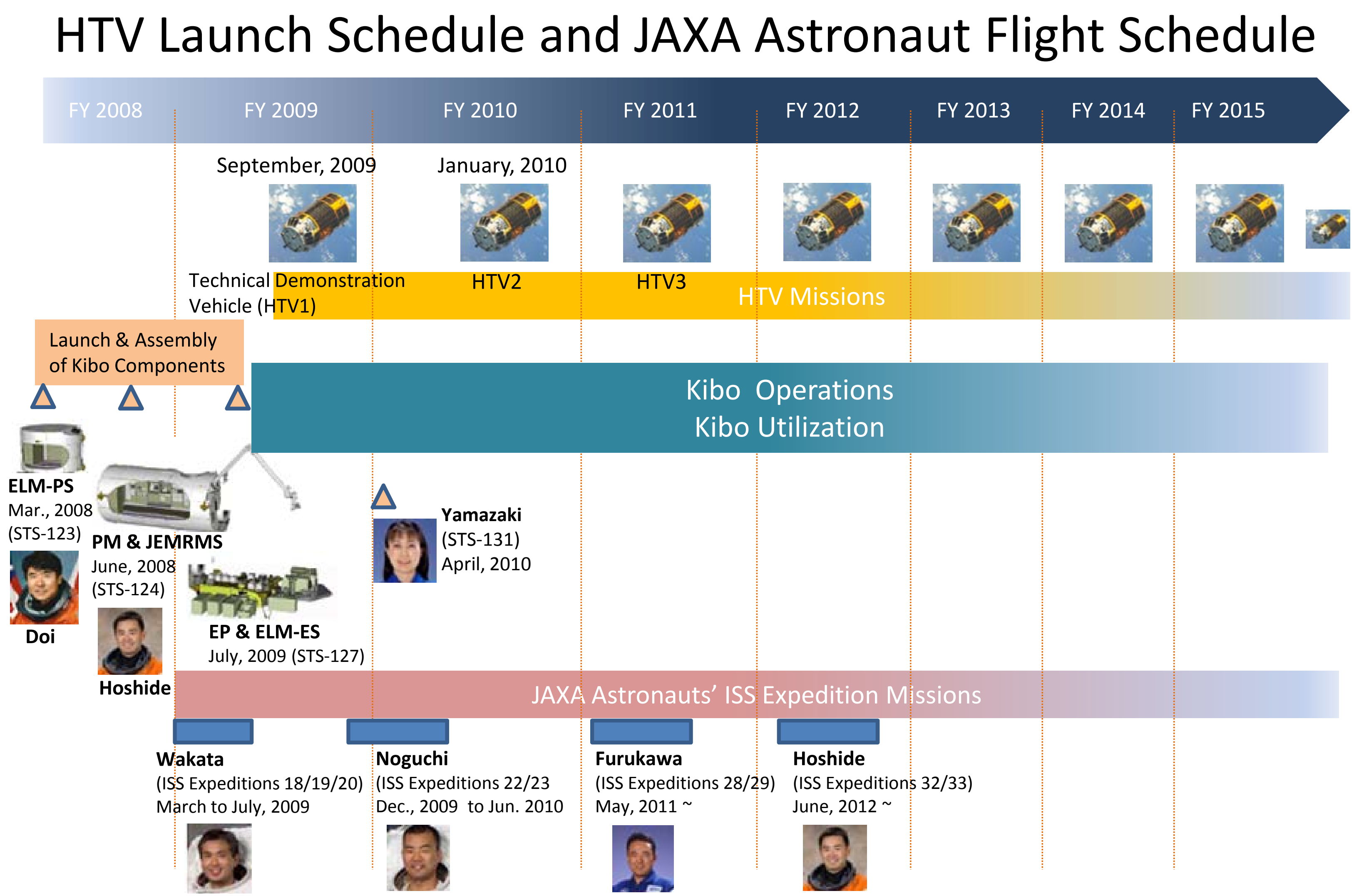


Fig. 3.1-1 HTV Launch Schedule and JAXA Astronaut Flight Schedule

3.2 Kibo Utilization Schedule

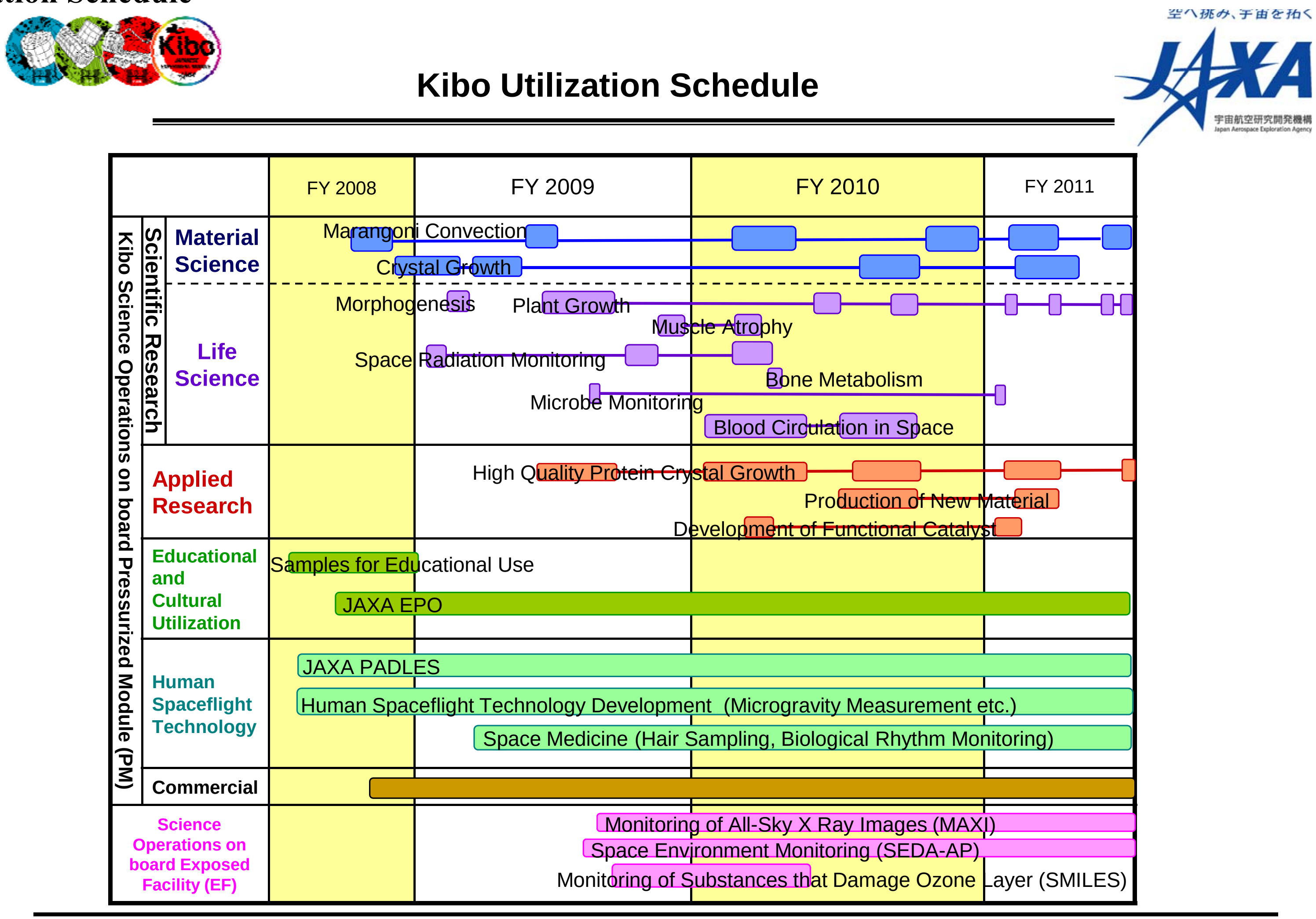
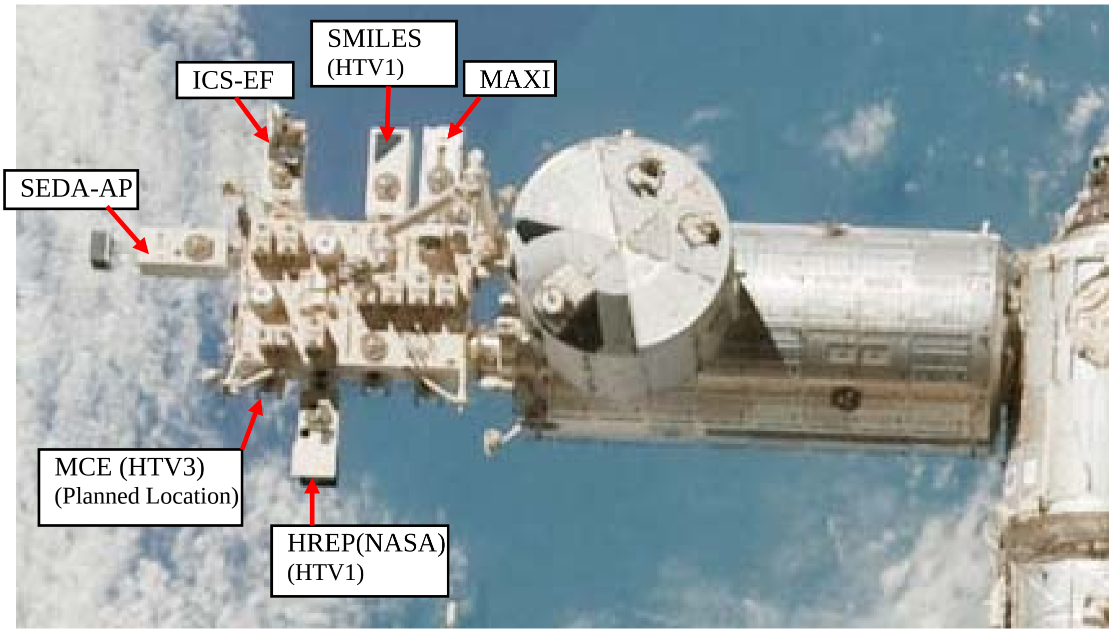
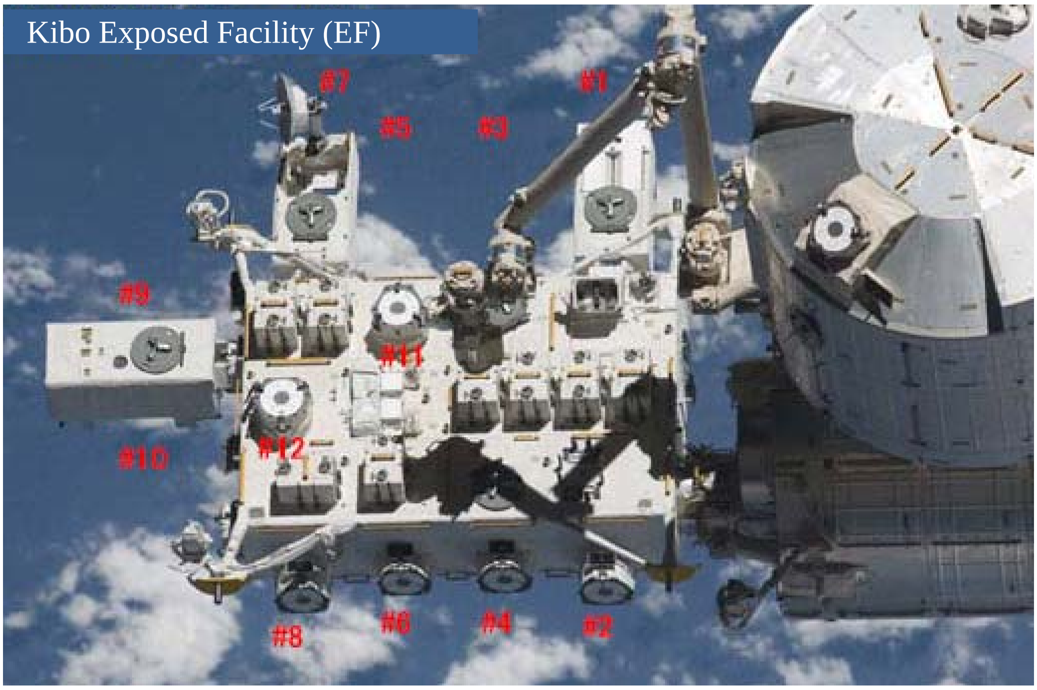


Table 3.2-1 Kibo Utilization Schedule



After HTV1 Mission (Current Layout)



Before HTV1 Mission (After STS-127 Mission)

Fig. 3.2-1 Layout of EF Payloads on Kibo's Exposed Facility (EF)

Appendix HTV/ISS Acronym

Acronym	Name
ACU	Abort Control Unit
AI	Approach Initiation
AM	Avionics Module
AQH	AQuatic Habitat
ATV	Automated Transfer Vehicle
BCS	Berthing Camera System
BDCU	Battery Discharge Control Unit
CAPCOM	Capsule Communicator
CAM	Collision Avoidance Maneuver
CBM	Common Berthing Mechanism
CCE	Chamber for Combustion Experiment
CM	Co-elliptic Maneuver
CMD	Command
COTS	Commercial Orbital Transportation Services
CPA	Controller Panel Assemblies
CRS	Commercial Resupply Services
CTB	Cargo Transfer Bag
CTC	Cargo Transport Container
CWC-I	Contingency Water Container-Iodine
CZ	Communication Zone
DMS	Data Management System
DOM	Deorbit Maneuver
DSM	Descending Maneuver
EF	Exposed Facility
EFU	Exposed Facility Unit
ELC	EXPRESS Logistics Carrier
EP	Exposed Pallet
EPC	Exposed Pallet Controller
EP-MP	Exposed Pallet - Multi-Purpose
EPS	Electrical Power System
ESA	Earth Sensor Assembly
FD	Flight Day
FD	Flight Director
FDS	Fire Detection and Suppression
FHRC	Flex Hose Rotary Coupler
FOR	Flight Operations Review
FRAM	Flight Releasable Attach Mechanism
FRR	Flight Readiness Review
FRGF	Flight Releasable Grapple Fixture
FWD	Forward
GCC	Guidance Control Computer
GF	Grapple Fixture
GHF	Gradient Heating Furnace
GHF-MP	GHF-Material Processing Unit
GMT	Greenwich Mean Time
GNC	Guidance Navigation Control
GPS	Global Positioning System
GPSR	GPS Receiver
GSE	Ground Support Equipment
GTO	Geostationary Transfer Orbit

Acronym	Name
HAM	Height Adjusting Maneuver
HBCS	HTV Berthing Camera System
HC	Hand Controller
HCAM	HTV Cargo Attachment Mechanism
HCE	Heater Control Electronics
HCSM	HTV Connector Separation Mechanism
HCP	HTV Hardware Command Panel
HDM	Holddown Mechanism
HEFU	HTV Exposed Facility Unit
HGAS	HTV GPS Antenna Subsystem
HPIU	HTV Payload Interface Unit
HRR	HTV Resupply Rack
HREP	Hyperspectral Imager for the Coastal Ocean (HICO) & Remote Atmospheric & Ionospheric Detection System (RAIDS) Experimental Payload
HSM	Harness Separation Mechanism
HTV	H-II Transfer Vehicle
HTV-FLIGHT	HTV Flight
HTV OCS	HTV Operations Control System
ICS	Inter-orbit Communication System
IMMT	ISS Mission Management Team
IMV	Inter-Module Ventilation
IOS	Inter-Orbit Link System
I/O	Input / Output
IOCU	Input / Output Controller Unit
ICS	Inter-orbit Communications System
ISPR	International Standard Payload Rack
ISS	International Space Station
ITCS	Internal Thermal Control System
JAXA	Japan Aerospace Exploration Agency
JEF	JEM Exposed Facility
JEM	Japanese Experiment Module
JEMRMS	JEM Remote Manipulator System
JPM	JEM Pressurized Module
JSC	Johnson Space Center
JST	Japanese Standard Time
KOS	Keep Out Sphere
KOZ	Keep Out Zone
LED	Light Emitting Diode
LP1	Launch Pad1
LP2	Launch Pad2
LRR	Laser Rader Reflector
MAXI	Monitor of All-sky X-ray Image
MBS	Mobil Base System
MBU	Main Bus Unit
MCC	Mission Control Center
MCC-H	MCC-Houston
MCE	Multi-mission Consolidated Equipment
MET	Mission Elapsed Time
MLI	Multi-Layer Insulation
MMH	Monomethylhydrazine
MON3	Mixed oxides of nitrogen contains 3% nitric oxide

Acronym	Name
MSPR	Multi-purpose Small Payload Rack
MT	Mobile Transporter
NASA	National Aeronautics and Space Administration
NET	No Earlier Than
ORU	Orbital Replacement Unit
PAS	Payload Attach System
P-ANT	PROX Antenna
P-BAT	Primary Battery
PBA	Portable Breathing Apparatus
PCBM	Passive CBM
PCS	Portable Computer System
PFE	Portable Fire Extinguisher
PEV	Pressure Equalization Valve
PIU	Payload Interface Unit
PLC	Pressurized Logistics Carrier
PLS	Proximity Link System
PM	Phase Adjusting
PM	Pressurized Module
PM	Propulsion Module
PMM	Permanent Multipurpose Module
POA	Payload and Orbital Replacement Unit Accommodation
POCC	Payload Operations Control Center
POIC	Payload Operations Integration Center
PROX	Proximity Communication System
Psi	Pounds per square inch
PSL	Permanent Solid-state Lighting
PSRR	Pressurized Stowage Resupply Rack
PVGF	Power& Video Grapple Fixture
RCS	Reaction Control System
RPCM	Remote Power Controller Module
RSP	Resupply Stowage Platform
RVFS	Rendezvous Flight Software
RVS	Rendezvous Sensor
S-BAT	Secondary Battery
SCAM	Sample Cartridge Automatic Exchange Mechanism
SCAN	Space Communications and Navigation
SEA	Small Experiment Area
SEDA-AP	Space Environment Data Acquisition equipment-Attached Payload
SFA	Small Fine Arm
SFA2	Second Spacecraft and Fairing Assembly Building
SIGI	Space Integrated GPS/INS(Inertial Navigation System)
SLEEPR	Structural Launch Enclosure to Effectively Protect Robonaut
SMILES	Superconducting Submillimeter-Wave Limb-Emission Sounder
SPDM	Special Purpose Dexterous Manipulator
SRB	Solid Rocket Booster
SRCA	System on/off Remote Control Assembly or Switch Remote Control Assembly
SSCC	Space Station Control Center
SSIPC	Space Station Integration and Promotion Center
SSM	Shockless Separation Mechanism
SSRMS	Space Station Remote Manipulator System

Acronym	Name
STBD	starboard
TDRS	Tracking and Data Relay Satellite
TRRJ	Thermal Radiator Rotary Joint
TSM	Tie-down Separation Mechanism
TKSC	Tsukuba Space Center
TNSC	Tanegashima Space Center
ULC	Unpressurized Logistics Carrier
ULF	Utilization and Logistics Flight
VAB	Vehicle Assembly Building
VDC	Volt Direct Current
WB	Work Bench
WV	Work Volume
ZOE	Zone of Exclusion