



Human Spaceflights to the International Space Station

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Chapter- 1

STS-88

STS-88

Mission insignia



Mission statistics

Mission name	STS-88
Space shuttle	<i>Endeavour</i>
Launch pad	39-A
Launch date	4 December 1998 03:35:34 EST (8:35:34 GMT)
Landing	15 December 1998, 22:53 EST
Mission duration	11 days, 19 hours, 18 minutes, 47 seconds.
Number of orbits	185
Orbital altitude	173 nautical miles (320 km)
Orbital	51.6°

inclination

Distance traveled 7,600,000 kilometres (4,720,000 mi)

Docking

Docking date 7 December 1998 02:07 UTC

Undocking date 13 December 1998 20:24 UTC

Time docked 6 days, 18 hours 17 minutes

Crew photo



Related missions

Previous mission



Subsequent mission



STS-88 was the first Space Shuttle mission to the International Space Station (ISS). It was flown by Space Shuttle *Endeavour*, and took the first American module, the Unity node to the station.

The seven-day mission was highlighted by the mating of the U.S.-built *Unity* node to the Functional Cargo Block (*Zarya* module) already in orbit, and three spacewalks to connect power and data transmission cables between the Node and the FGB. *Zarya*, built by Boeing and the Russian Space Agency, was launched on a Russian Proton rocket from the Baikonur Cosmodrome in Kazakhstan in November 1998.

Other payloads on the STS-88 mission included the IMAX Cargo Bay Camera (ICBC), the Argentine Scientific Applications Satellite-S (SAC-A), the MightySat 1 Hitchhiker payload, the Space Experiment Module (SEM-07) and Getaway Special G-093 sponsored by the University of Michigan.

Crew

Position	Astronaut
Commander	Robert D. Cabana Fourth spaceflight
Pilot	Frederick W. Sturckow First spaceflight
Mission Specialist 1	Jerry L. Ross Sixth spaceflight
Mission Specialist 2	Nancy J. Currie Third spaceflight
Mission Specialist 3	James H. Newman Third spaceflight
Mission Specialist 4	Sergei K. Krikalev, RKA Fourth spaceflight

Mission parameters

- Weight
 - Liftoff: 263,927 pounds (119,715 kg)
 - Landing: 200,296 pounds (90,853 kg)
- Perigee: 241 miles (388 km)
- Apogee: 249 miles (401 km)
- Orbital Period: 92.4min

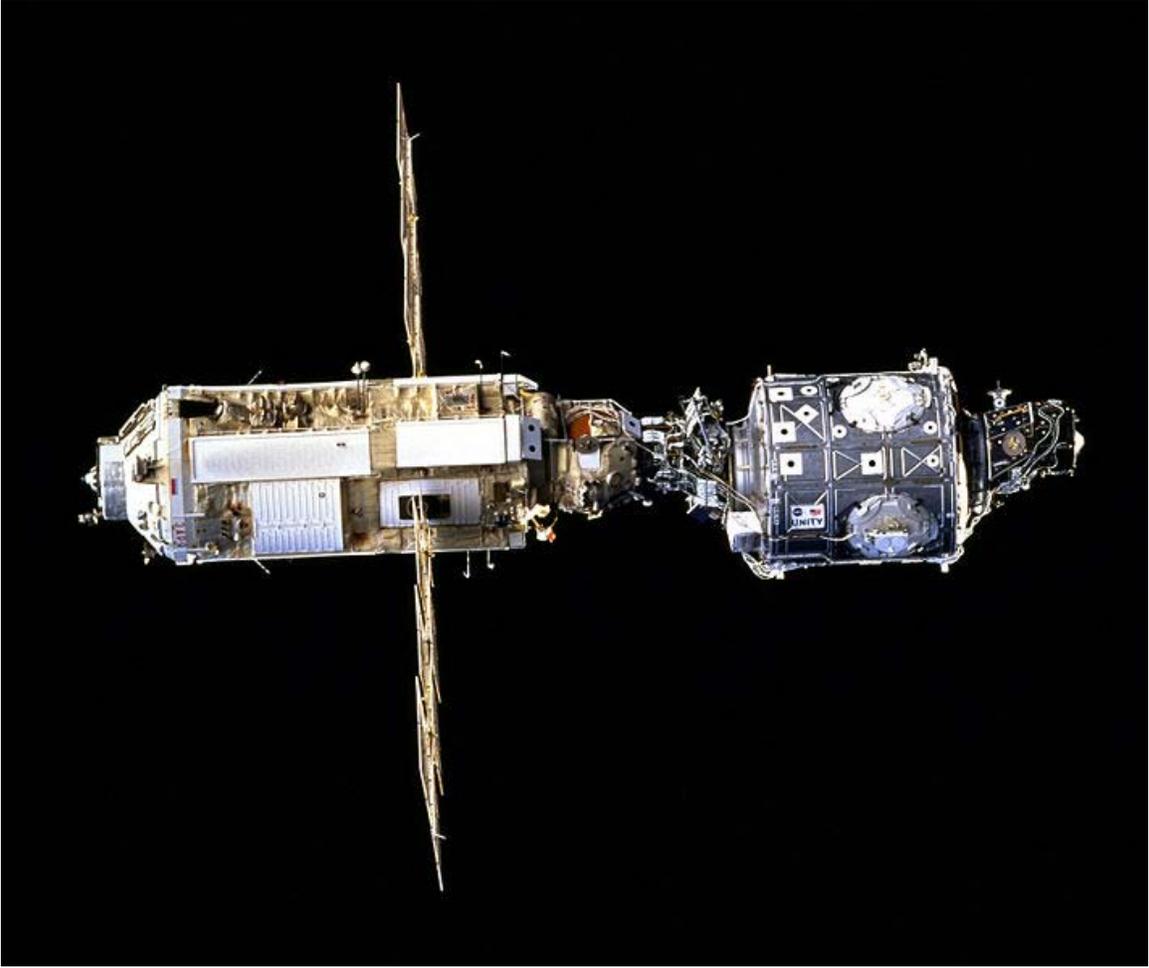
Launch attempts

Attempt	Planned	Result	Turnaround	Reason	Decision point	Weather go %	Notes
1	3 Dec 1998, 3:58:19 am	scrubbed	---	procedural		40%	unexplained master alarm
2	4 Dec 1998, 3:35:34 am	success	0 days, 23 hours, 37 minutes				

Mission highlights



STS-88 launches from Kennedy Space Center, December 4, 1998.



The ISS after STS-88 construction.

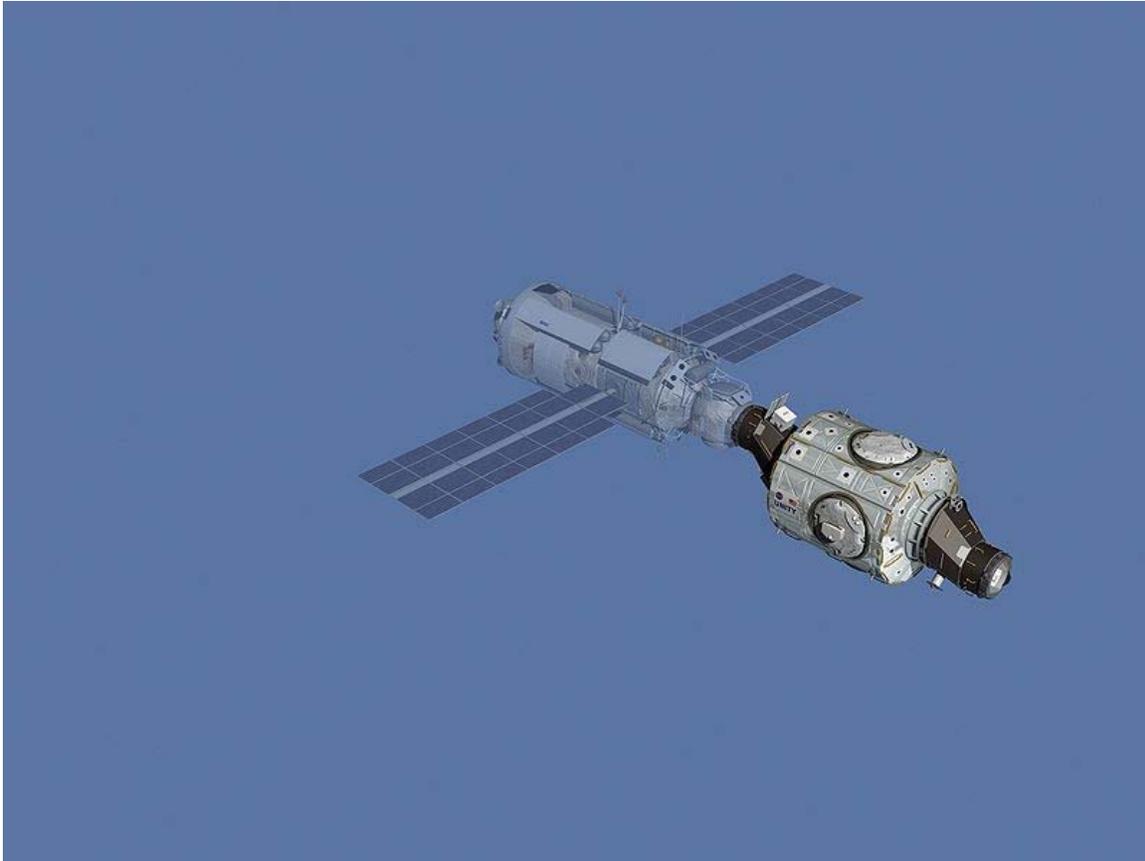


Illustration of the International Space Station after STS-88.

Node 1, named *Unity*, was the first space station hardware delivered by the space shuttle. It has two Pressurized Mating Adapters (PMA), one attached to either end. One PMA is permanently mated to *Zarya*, and the other is used for orbiter dockings and crew access to the station. *Unity* also contains an International Standard Payload Rack used to support on-orbit activities, which was activated after the fifth Shuttle/Station assembly flight.

To begin the assembly sequence, the crew conducted a series of rendezvous maneuvers similar to those conducted on other Shuttle missions to reach the orbiting FGB. On the way, Currie used the Shuttle's robot arm to place Node 1 atop the Orbiter Docking System. Cabana completed the rendezvous by flying *Endeavour* to within 10 metres (33 ft) of the FGB, allowing Currie to capture the FGB with the robot arm and place it on the Node's Pressurized Mating Adapter.

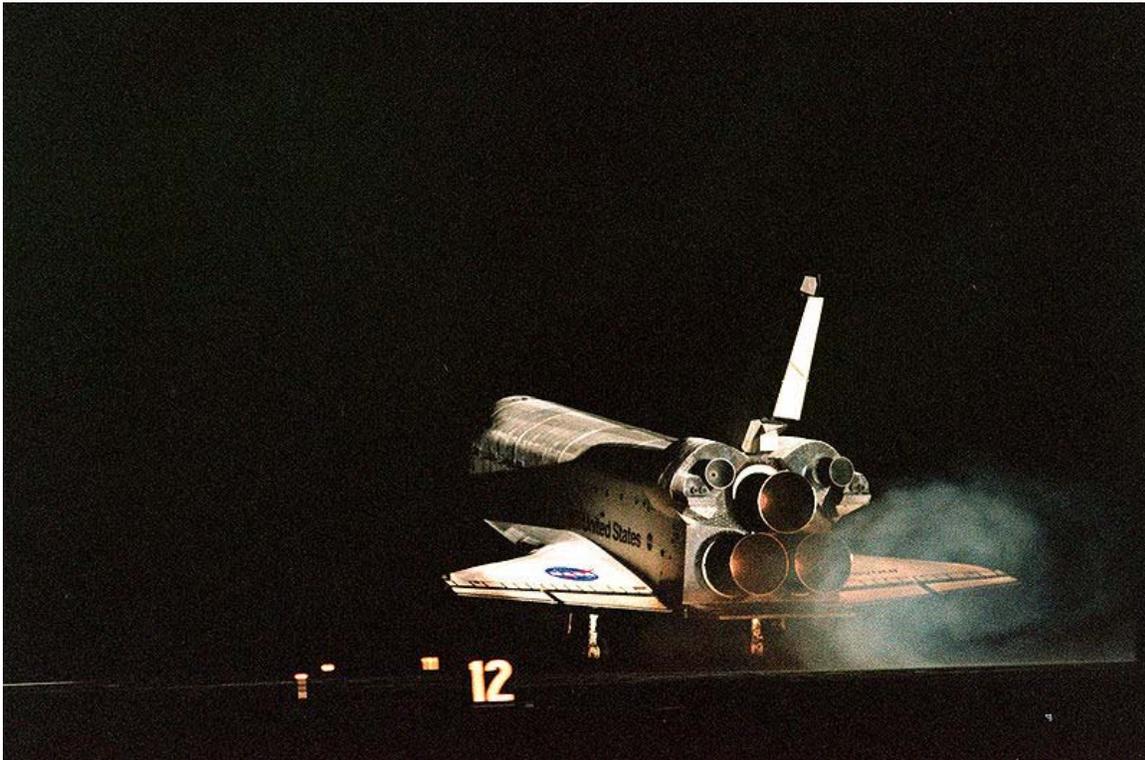
Once the two elements were docked, Ross and Newman conducted two scheduled spacewalks to connect power and data cables between the Node, PMAs and the FGB. The day following the spacewalks, *Endeavour* undocked from the two components, completing the first Space Station assembly mission.

Endeavour's astronauts toured the new International Space Station on 11 December 1998, entering the *Unity* and *Zarya* modules for the first time, and establishing an S-band communications system that enables U.S. flight controllers to monitor the outpost's

systems. Reflecting the international cooperation involved in building the largest space complex in history, Commander Robert Cabana and Russian Cosmonaut Sergei Krikalyov opened the hatch to the U.S.-built Unity connecting module and floated into the new station together.

The rest of the crew followed and began turning on lights and unstowing gear in the roomy hub to which other modules would be connected in the future. Each passageway within Unity was marked by a sign leading the way into tunnels to which new modules would later be connected.

About an hour later, Robert Cabana and Sergei Krikalyov opened the hatch to the Russian-built Zarya control module, which was the nerve center for the station in its embryonic stage. Joined by Pilot Frederick Sturckow and Mission Specialists Jerry Ross, James H. Newman and Nancy Currie, Cabana and Krikalyov hailed the historic entrance into the International Space Station and said the hatch opening signified the start of a new era in space exploration.



STS-88 lands at the Shuttle Landing Facility, December 15, 1998.

Ross and Newman went right to work in Unity, completing the assembly of an early S-band communications system that allows flight controllers in Houston to send commands to Unity's systems and to keep tabs on the health of the station with a more extensive communications capability than exists through Russian ground stations. The astronauts also conducted a successful test of the videoconferencing capability of the early communications system, which was used by the first crew to permanently occupy the station in January 2000 (Expedition 1). Newman downlinked greetings to controllers in

the station flight control room in Houston and to astronaut Bill Shepherd, who commanded the first crew and lived aboard the station with Krikalyov and Cosmonaut Yuri Gidzenko.

Krikalyov and Currie replaced a faulty unit in Zarya which controlled the discharging of stored energy from one of the module's six batteries. The battery had not been working properly in its automatic configuration, but the new unit was functioning normally shortly after it was installed.

The astronauts also unstowed hardware and logistical supplies stored behind panels in Zarya, relocating the items for use by the Shuttle crew that was to visit the station in May 1999 and by Shepherd's expedition crew. The astronauts also completed their initial outfitting of the station.

The hatches to Zarya and Unity were closed before *Endeavour* undocked from the new station, leaving the new complex to orbit the Earth unpiloted.

Mission Timeline

Launch Preparations

At 12:15 a.m. EST on Monday, June 23, 1997, an Air Force C-5 air cargo plane arrived at the Shuttle Landing Facility carrying *Unity* (Node 1). On February 1, 1998, *Endeavour* was towed to Orbiter Processing Facility Bay 1. On October 15, 1998, *Endeavour* was moved from Orbiter Processing Facility Bay 1 to the Vehicle Assembly Building. On October 21, 1998, *Endeavour* was transported atop the Crawler Transporter to Kennedy Space Center's Launch Pad 39A.

December 3–4 (Flight Day 1, Launch)

Space Shuttle *Endeavour* launched at 3:35:34 a.m. EST from the Kennedy Space Center's Launch Pad 39A. STS-88 was the first shuttle flight to the International Space Station. After launch, the crew opened the shuttle's payload bay doors, deployed the Ku-Band antenna, and activated the shuttle's Hitchhiker payload. The crew also started preparing for the multiple engine firings that will be performed to bring shuttle *Endeavour* within the Shuttle Remote Manipulator System's reach of the *Zarya FGB*. At launch, *Zarya* was 240 statute miles above the Kennedy Space Center (KSC), and the module was on its 222nd orbit of the Earth since its launch.

December 4 (Flight Day 2)

On Flight Day 2, the crew of shuttle *Endeavour* performed several tasks to get ready for the docking on Sunday and the extra-vehicular activities (EVA) to be completed on the mission. Nancy Currie conducted a photo survey of *Unity* and *Endeavour*'s payload bay, using the shuttle's robotic arm, Canadarm. Jerry Ross and Jim Newman checked out the

spacesuits they would use on the three EVAs and prepared the shuttle's airlock for use during the spacewalks. Rick Sturckow, who would be choreographing the EVAs from inside the shuttle, joined Ross and Newman to check out the SAFER units to be worn during the spacewalks in case Ross or Newman were to become separated from *Endeavour* during one of the spacewalks.

December 5 (Flight Day 3)

On Flight Day 3, Currie used Canadarm to grapple and place *Unity* onto the Orbiter Docking System at 6:45 p.m. EST. The crew pressurized PMA-2 and entered it. They put several caps over vent valves to prepare for the entrance into *Unity* later in the week. Commander Bob Cabana performed a debris avoidance maneuver to move *Endeavour* out of the way of a casing from a Delta II rocket that launched on November 6 from Vandenberg Air Force Base in California.

December 6 (Flight Day 4, Docking with Zarya)

On Flight Day 4, Bob Cabana fired *Endeavour*'s rockets several times to maneuver the shuttle within Canadarm's reach of the *Zarya FGB*. At 6:47 p.m. EST, Currie grappled *Zarya*. Later, at 9:07 p.m. EST, Cabana fired *Endeavour*'s downward jets to bring the two modules together.

December 7 (Flight Day 5, EVA 1)

During a 7 hour, 21 minute Flight Day 5 spacewalk, astronauts Jerry Ross and Jim Newman helped activate the *Unity* node, the first module to the U.S. segment of the International Space Station. They connected 40 connectors and cables running along the 35-ton, 76-foot-tall (23 m) space station. At 10:49 p.m. EST, flight controllers in Houston saw *Unity*'s systems come on.

December 8 (Flight Day 6)

On the 6th day of *Endeavour*'s STS-88 mission, Mission Specialists Jerry Ross and Jim Newman relaxed after their long spacewalk on Flight Day 5. Ross, Newman, Nancy Currie, and Sergei Krikalev prepared equipment for Flight Day 7's EVA. Commander Bob Cabana and Pilot Rick Sturckow fired *Endeavour*'s main reaction control system jets for 22 minutes to raise the ISS approximately 5 1/2 statute miles. The crew conducted interviews with ABC News, Discovery Channel, and MSNBC.

December 9 (Flight Day 7, EVA 2)

At 3:33 p.m. EST, Mission Specialists Jerry Ross and Jim Newman commenced on a 7 hour, 2 minute EVA to continue the installation of *Unity*. The two spacewalkers first installed two antennas on the outside of *Unity*. The astronauts also removed launch restraint pins on the four radial common berthing mechanisms of *Unity*. They installed

covers on *Unity*'s two data relay boxes to protect them from sunlight. Lastly, Newman freed a backup rendezvous system antenna on the *Zarya FGB*.

December 10 (Flight Day 8, Entrance into the ISS)

Flight Day 8 was a historic day as the International Space Station was opened for the first time on orbit. At 2:54 p.m. EST, Commander Bob Cabana and Russian Cosmonaut Sergei Krikalev opened the hatch to the *Unity* Node of the new International Space Station. The other members of the crew started unstowing gear and turning on the lights. At 4:12 p.m. EST, Cabana and Krikalev opened the hatch into *Zarya*. Jerry Ross and Jim Newman assembled a S-band communications system in *Unity*, and Krikalev and Nancy Currie replaced a problematic battery discharging unit in *Zarya*.

December 11 (Flight Day 9)

On Flight Day 9, Pilot Rick Sturckow and Mission Specialist Nancy Currie continued unstowing hardware in *Unity*. After turning off the lights, the crew later closed the hatches to *Zarya* and *Unity*. The crew prepared for the mission's third and final spacewalk on Flight Day 10. *Endeavour*'s crew also conducted interviews with CNN and CBS News.

December 12 (Flight Day 10, EVA 3)

At 3:33 p.m. EST, astronauts Jerry Ross and Jim Newman commenced on a 6 hour, 59 minute EVA to finish the installation of the *Unity Node* to *Zarya*. The two stowed tools on the side of *Unity* to prepare for the spacewalks on STS-96, the next mission to the ISS. Ross also freed another antenna on *Zarya*, similar to the one Newman freed on EVA-2. The spacewalkers also tested the redesigned SAFER jet packs, to be used in the event an astronaut became separated from the spacecraft during a spacewalk. After the EVA, Pilot Rick Sturckow depressurized the vestibule between *Endeavour* and PMA-2 to prepare for the undocking of the two spacecraft on Flight Day 11.

December 13 (Flight Day 11, Undocking)

On Flight Day 11, Space Shuttle *Endeavour* undocked from the International Space Station. At 3:25 p.m. EST, Pilot Rick Sturckow backed *Endeavour* 450 feet (140 m) away from the station and started a nose-forward fly-around of the station, so that *Endeavour*'s crew could take pictures of the space station. At 4:49 p.m. EST, Sturckow performed a final separation burn. Later, the crew deployed SAC-A, a small satellite for the Argentinean National Commission of Space Activities.

December 14 (Flight Day 12)

On the last full day on orbit, *Endeavour*'s crew deployed a small Air Force satellite called MightySat-1. The crew tested *Endeavour*'s shuttle's aerosurfaces and steering jets to be used on landing day and stowed equipment.

December 15 (Flight Day 13, Landing)

Flight Day 13 was landing day for Space Shuttle Endeavour and its crew of six. At 7:07 p.m. EST, *Endeavour*'s payload bay doors were closed for entry. Flight Director John Shannon gave the go for *Endeavour*'s crew to fire the orbital maneuvering system engines for the deorbit burn at 9:46 p.m. EST so that *Endeavour* could slow down to enter the Earth's atmosphere. At 10:54 p.m. EST, *Endeavour* and crew landed on the Kennedy Space Center's Runway 15. *Endeavour* wrapped up a 4.7 million mile mission, and the first to the International Space Station.

Extra-vehicular activity

Three extra-vehicular activity (EVA) spacewalks were scheduled and completed during STS-88.

	Spacewalkers	Start (UTC)	End (UTC)	Duration	Mission
EVA 1	Jerry L. Ross James H. Newman	7 December 1998 22:10	8 December 1998 05:31	7 hours, 21 minutes	Began <i>Unity</i> installation.
EVA 2	Ross Newman	9 December 1998 20:33	10 December 1998 03:35	7 hours, 02 minutes	Continued <i>Unity</i> installation.
EVA 3	Ross Newman	12 December 1998 20:33	13 December 1998 03:32	6 hours, 59 minutes	Completion of <i>Unity</i> installation.

Chapter- 2

STS-96

STS-96

Mission insignia



Mission statistics

Mission name	STS-96
Space shuttle	<i>Discovery</i>
Launch pad	39-B
Launch date	27 May 1999 06:49 EDT
Landing	6 June 1999 02:02:43 EDT, KSC, Runway 15
Mission duration	9 days, 19 hours, 13 minutes, 57 seconds
Orbital altitude	320 kilometres (170 nmi)
Orbital inclination	51.6 degrees
Distance	6,000,000 kilometres (3,700,000 mi)

traveled

Docking

Docking date 29 May 1999 04:23 UTC

Undocking date 3 June 1999 22:39 UTC

Time docked 5 days, 18 hours, 15 minutes

Crew photo



Related missions

Previous mission



Subsequent mission



STS-96 was a Space Shuttle mission to the International Space Station (ISS) flown by Space Shuttle *Discovery*, and the first shuttle flight to dock with the International Space Station. The shuttle carried the Spacehab module in the payload, filled with cargo for station outfitting. STS-96 launched from Kennedy Space Center, Florida on 27 May 1999 at 06:49 EDT

Crew

Position	Astronaut
Commander	Kent V. Rominger Fourth spaceflight
Pilot	Rick D. Husband First spaceflight
Mission Specialist 1	Tamara E. Jernigan Fifth spaceflight

Mission Specialist 2	Ellen Ochoa Third spaceflight
Mission Specialist 3	Daniel T. Barry Second spaceflight
Mission Specialist 4	Julie Payette, CSA First spaceflight
Mission Specialist 5	Valery I. Tokarev, RKA First spaceflight

Mission parameters

- **Mass:**
 - *Orbiter Liftoff:* 262,035 pounds (118,857 kg)
 - *Orbiter Landing:* 220,980 pounds (100,230 kg)
 - *Payload:* 20,056 pounds (9,097 kg)
- **Perigee:** 326 kilometres (203 mi)
- **Apogee:** 340 kilometres (210 mi)
- **Inclination:** 51.6°
- **Period:** 91.2 min

Space walk

- *Jernigan and Barry* - EVA 1
- **EVA 1 Start:** 30 May 1999 - 02:56 UTC
- **EVA 1 End:** 30 May 1999 - 10:51 UTC
- **Duration:** 7 hours, 55 minutes

Mission highlights



Space Shuttle Discovery launches on STS-96 from Kennedy Space Center, May 27, 1999.



Mission Specialist Julie Payette during emergency bailout training, January 8, 1999.

STS-96 was a logistics and resupply mission for the International Space Station.

The Integrated Cargo Carrier (ICC) carried the Russian cargo crane, known as STRELA, which was mounted to the exterior of the Russian station segment, the SPACEHAB Oceanering Space System Box (SHOSS) and a U.S. built crane called the ORU Transfer Device (OTD).

Other payloads on STS-96 were the Student Tracked Atmospheric Research Satellite for Heuristic International Networking Equipment (STARSHINE), the Shuttle Vibration Forces Experiment (SVF) and the Orbiter Integrated Vehicle Health Monitoring - HEDS Technology Demonstration (IVHM HTD).

The STARSHINE satellite consists of an inert, 483 millimetres (19.0 in) hollow sphere covered by 1,000 evenly-distributed, flat, polished mirrors, each 1 inch in diameter. The payload consists of the STARSHINE satellite, integrated with the Pallet Ejection System (PES), then mounted inside a lidless carrier. The HH equipment consists of one HH Lightweight Avionics Plate (LAP), then mounted inside a lidless carrier. Additional HH equipment consists of one Hitchhiker Ejection System Electronics (HESE), one 5.0 cubic-foot (142 L) HH canister, and one Adapter Beam Assembly (ABA). The purpose of the mission was to train international student volunteer observers to visually track this optically reflective spacecraft during morning and evening twilight intervals for several months, calculate its orbit from shared observations, and derive atmospheric density from drag-induced changes in its orbit over time.



Illustration of the International Space Station during STS-96

The Shuttle Vibration Forces (SVF) Experiment provided flight measurements of the vibratory forces acting between an aerospace payload and its mounting structure. The force transducers were incorporated into four custom brackets which replaced the existing brackets used to attach the 5 ft (1.5 m) standard canister to the side wall GAS adapter beam. The payload was activated automatically by the Orbiter Lift-off vibration and operated for approximately 100 seconds. STS-96 was the second flight of the SVF experiment.

The purpose of the Orbiter Integrated Vehicle Health Monitoring- HEDS Technology Demonstration (IVHM HTD) was to demonstrate competing modern, off-the-shelf sensing technologies in an operational environment to make informed design decisions for the eventual Orbiter upgrade IVHM. The objective of IVHM was to reduce planned ground processing, streamline problem troubleshooting (unplanned ground processing), enhance visibility into systems operation and improve overall vehicle safety.

A copy of Blizzard Entertainment's *StarCraft* real-time strategy game was also flown aboard STS-96. It resides at Blizzard's headquarters in Irvine, CA.

Wake-up calls

NASA began a tradition of playing music to astronauts during the Gemini program, which was first used to wake up a flight crew during Apollo 15. Each track is specially chosen, often by their families, and usually has a special meaning to an individual member of the crew, or is applicable to their daily activities.

Flight Day	Song	Artist/Composer	Links
Day 2	"California Dreamin"	Beach Boys	WAV MP3 TRANSCRIPT
Day 3	"Danger Zone"	Kenny Loggins	WAV MP3 TRANSCRIPT
Day 4	Themes from <i>Star Wars</i>	Space Center Intermediate Band	WAV MP3 TRANSCRIPT
Day 5	"Morning Colors"	US Coast Guard Band	WAV MP3 TRANSCRIPT
Day 6	"Amarillo by Morning"	George Strait	WAV MP3 TRANSCRIPT
Day 7	"Exultate Jubilate"	Mozart	WAV MP3 TRANSCRIPT
Day 9	"Free Bird"	Lynyrd Skynyrd	WAV MP3 TRANSCRIPT

Chapter- 3

STS-101

STS-101

Mission insignia



Mission statistics

Mission name	STS-101
Space shuttle	<i>Atlantis</i>
Launch pad	39-A
Launch date	19 May 2000 6:11 a.m. EDT
Landing	29 May 2000 KSC 2:20 a.m. EDT Runway 15
Mission duration	9 days, 21 hours, 10 minutes, 10 seconds
Number of orbits	155
Orbital altitude	173 nautical miles (320 km)
Orbital inclination	51.6 degrees

Distance traveled 4.1 million miles

Docking

Docking date 20 May 2000 04:30 UTC

Undocking date 26 May 2000 23:03 UTC

Time docked 5 days, 18 hours, 32 minutes

Crew photo



STS-101 crew (left to right): Weber, Williams, Horowitz, Usachev, Voss (in white suit), Halsell, Helms

Related missions

Previous mission



STS-99

Subsequent mission



STS-106

STS-101 was a Space Shuttle mission to the International Space Station (ISS) flown by Space Shuttle *Atlantis*. The mission was a 10-day mission conducted between 19 May 2000 and 29 May 2000. The mission was designated 2A.2a and was a resupply mission to the International Space Station. STS-101 was delayed 3 times in April due to high winds. STS-101 traveled 4.1 million miles and completed 155 revolutions of the earth and landed on runway 15 at Kennedy Space Center. The mission was the first to fly with the "glass cockpit".

Crew

Position	Astronaut
Commander	James D. Halsell, Jr. Fifth spaceflight
Pilot	Scott J. Horowitz Third spaceflight
Mission Specialist 1	Mary E. Weber

	Second spaceflight
Mission Specialist 2	Jeffrey N. Williams First spaceflight
Mission Specialist 3	James S. Voss Fourth spaceflight
Mission Specialist 4	Susan J. Helms Fourth spaceflight
Mission Specialist 5	Yury V. Usachev, RKA Third spaceflight

Mission parameters

- **Mass:**
 - *Orbiter landing with payload:* 100,369 kilograms (221,280 lb)
 - *Payload:* 1,801 kilograms (3,970 lb)
- **Perigee:** 332 kilograms (730 lb)
- **Apogee:** 341 kilograms (750 lb)
- **Inclination:** 51.6°
- **Period:** 91 min

Space walks

- *Voss and Williams* - EVA 1
- **EVA 1 Start:** 22 May 2000 - 01:48 UTC
- **EVA 1 End:** 22 May 2000 - 08:32 UTC
- **Duration:** 6 hours, 44 minutes

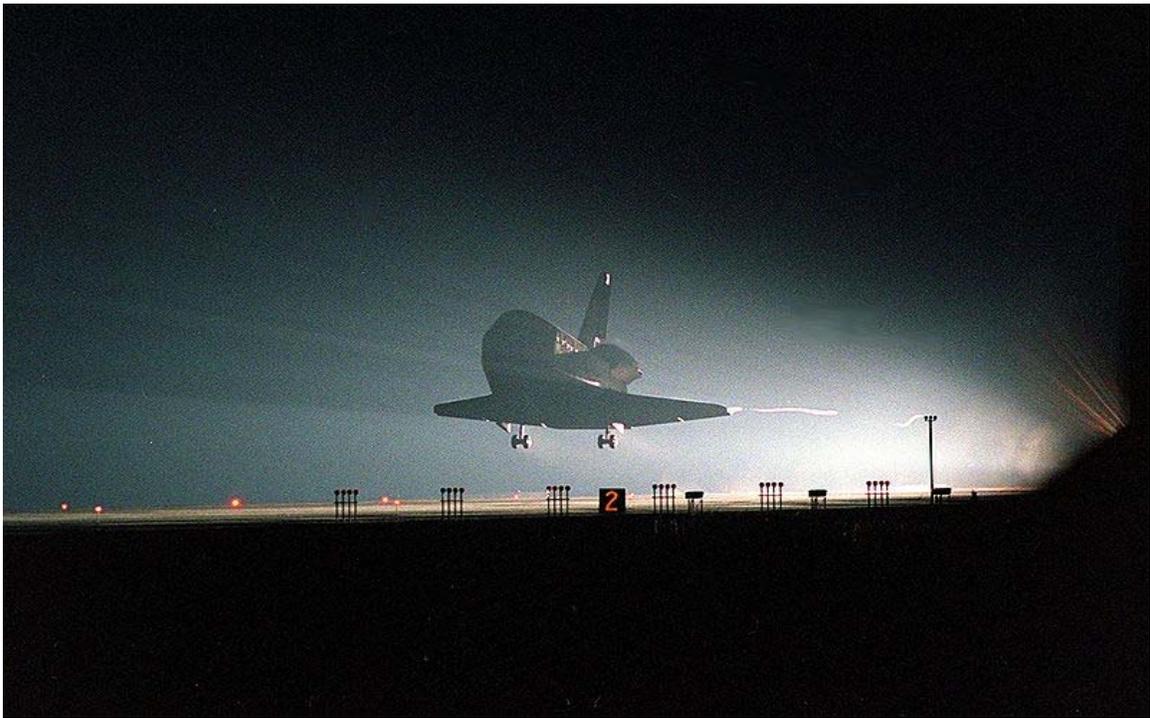
Mission highlights



STS-101 launches from Kennedy Space Center, May 19, 2000.

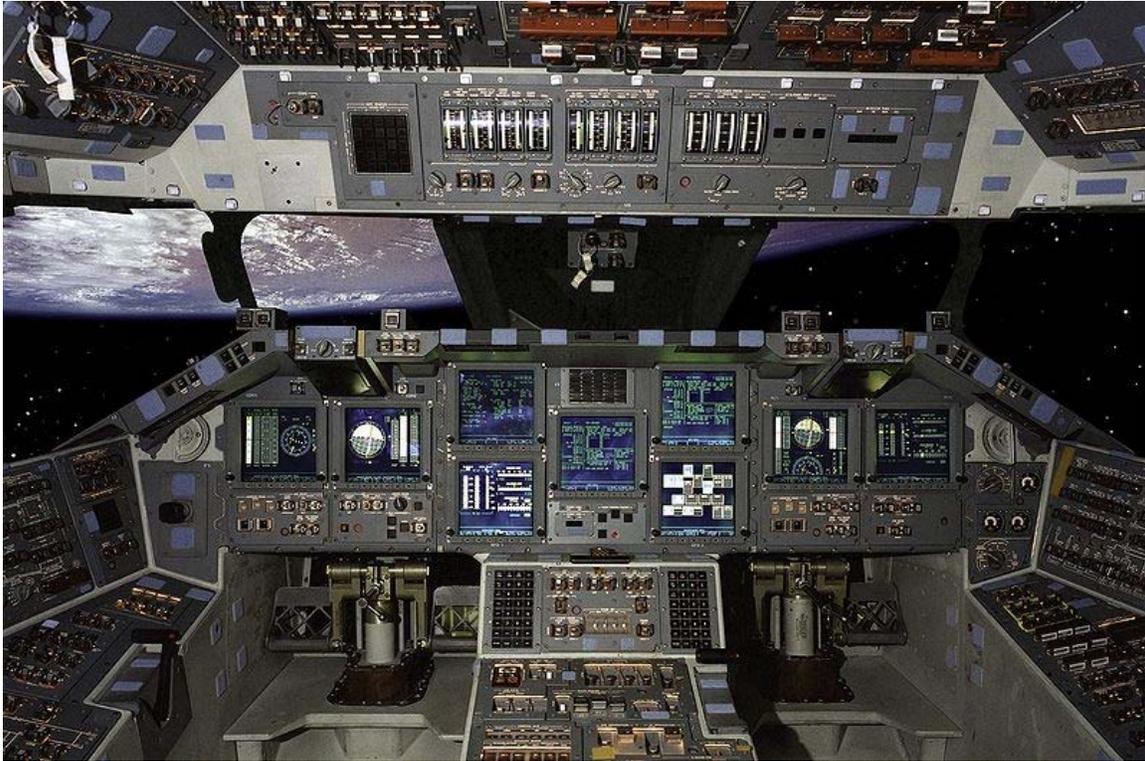


Illustration of the ISS during STS-101



STS-101 landing at the Shuttle Landing Facility, May 29, 2000.

The primary mission objectives for STS-101 was to deliver supplies to the International Space Station, with the supplies hauled up using a Spacehab double module and Spacehab Integrated Cargo Carrier pallet, perform a spacewalk and then reboost the station from 230 miles (370 km) to 250 miles (400 km).



During STS-101, *Atlantis* was the first Shuttle to fly with a glass cockpit.

Detailed objectives included ISS ingress/safety to take air samples, monitor carbon dioxide, deploy portable, personal fans, measure air flow, rework/modify ISS ducting, replace air filters, and replace Zarya fire extinguishers and smoke detectors. Critical replacements, repairs and spares were also done to replace four suspect batteries on Zarya, replace failed or suspect electronics for Zarya's batteries, replace Radio Telemetry System memory unit, replace port early communications antenna, replace Radio Frequency Power Distribution Box and clear Space Vision System target.

The mission also included incremental assembly/upgrades such as assembly of Strela crane, installation of additional exterior handrails, set up of center-line camera cable, installation of "Komparus" cable inserts and reseating the U.S. crane. Assembly parts, tools and equipment were also transferred to the station and equipment stowed for future missions.

The station was also resupplied with water, a docking mechanism accessory kit, film and video tape for documentation, office supplies and personal items. Crew health maintenance items were also transferred including exercise equipment, medical support supplies, formaldehyde monitor kit and a passive dosimetry system.

This mission was almost similar to the *Columbia disaster*. A damaged tile seam caused a breach which allowed superheated gas to enter the left wing during reentry. The gas did not penetrate deeply and the damage was repaired before the next flight. If it had penetrated deeply the Shuttle could have been destroyed during reentry.

This mission was the first mission to fly with a glass cockpit.

Wake-up calls

NASA began a tradition of playing music to astronauts during the Gemini program, which was first used to wake up a flight crew during Apollo 15. Each track is specially chosen, often by their families, and usually has a special meaning to an individual member of the crew, or is applicable to their daily activities.

Flight Day	Song	Artist	Played for	Links
Day 2	“Free Fallin”	Tom Petty	Susan Helms	WAV, MP3 TRANSCRIPT
Day 3	“Lookin' Out The Window”	Stevie Ray Vaughan		WAV, MP3 TRANSCRIPT
Day 4	“Haunted House”	Roy Buchanan		WAV, MP3 TRANSCRIPT
Day 5	"I Only Have Eyes for You"	Flamingos	Jim Halsell	WAV, MP3 TRANSCRIPT
Day 6	"I'm Gonna Fly"	Amy Grant	Scott Horowitz	WAV, MP3 TRANSCRIPT
Day 7	“Don't It Make You Wanna Dance”	Jerry Jeff Walker	Jeff Williams	WAV, MP3 TRANSCRIPT
Day 8	Untitled Russian song	Unknown	Yury Usachev	WAV, MP3 TRANSCRIPT
Day 9	“25 or 6 to 4”	Chicago		WAV, MP3 TRANSCRIPT
Day 10	“El Capitan”	John Philip Sousa		WAV, MP3 TRANSCRIPT

Chapter- 4

STS-106

STS-106

Mission insignia



Mission statistics

Mission name	STS-106
Space shuttle	<i>Atlantis</i>
Launch pad	39-B
Launch date	September 8, 2000, 8:45:47 a.m EDT
Landing	September 19, 2000, 3:56 a.m. EDT, KSC, Runway 15
Mission duration	11 days, 19 hours, 12 minutes, 15 seconds
Number of orbits	185

Orbital altitude 320 kilometres (170 nmi)

Orbital inclination 51.6 degrees

Distance traveled 7,900,000 kilometres (4,910,000 mi)

Crew photo



Related missions

Previous mission



Subsequent mission



STS-106 was a Space Shuttle mission to the International Space Station (ISS) flown by Space Shuttle *Atlantis*.

Crew

Position	Astronaut
Commander	Terrence W. Wilcutt Fourth spaceflight
Pilot	Scott D. Altman Second spaceflight
Mission Specialist 1	Edward T. Lu Second spaceflight
Mission Specialist 2	Richard A. Mastracchio First spaceflight
Mission Specialist 3	Daniel C. Burbank First spaceflight

Mission Specialist 4	Yuri Malenchenko, RKA Second spaceflight
Mission Specialist 5	Boris Morukov, RKA First spaceflight

Mission parameters

- **Mass:**
 - *Orbiter Liftoff:* 115,259 kilograms (254,100 lb)
 - *Orbiter Landing:* 100,369 kilograms (221,280 lb)
 - *Payload:* 10,219 kilograms (22,530 lb)
- **Perigee:** 233 mi (375 kilometres (233 mi))
- **Apogee:** 240 mi (386 kilometres (240 mi))
- **Inclination:** 51.6°
- **Period:** 92.2 min

Docking with ISS

- **Docked:** September 10, 2000, 05:51:25 UTC
- **Undocked:** September 18, 2000, 03:46:00 UTC
- **Time Docked:** 7 days, 21 h, 54 min, 35 s

Space walks

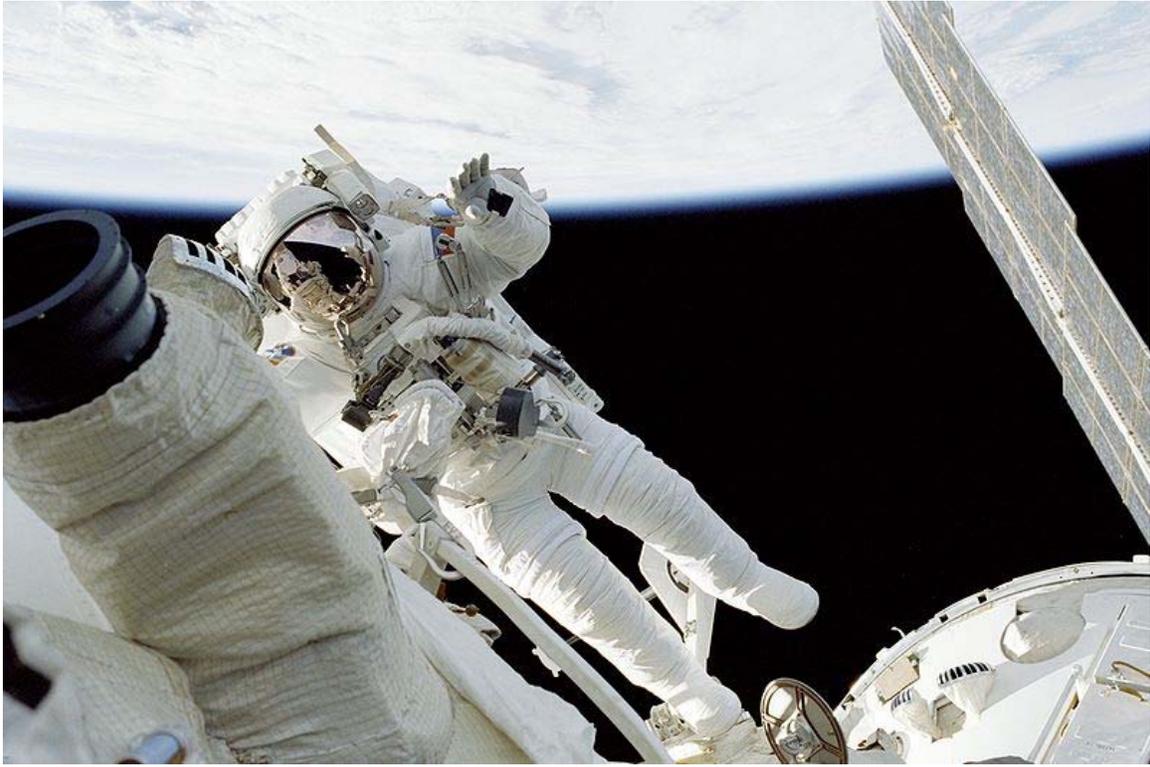
- ***Lu and Malenchenko*** - EVA 1
- **EVA 1 Start:** September 11, 2000 - 04:47 UTC
- **EVA 1 End:** September 11, - 11:01 UTC
- **Duration:** 6 hours, 14 minutes



Illustration of the International Space Station during STS-106.



Crewmembers pose for the inflight crew portrait.



Cosmonaut Malenchenko during the spacewalk conducted on September 11.

Space Station assembly flight ISS-2A.2b utilized the SPACEHAB Double Module and the Integrated Cargo Carrier (ICC) to bring supplies to the station. The mission also included two spacewalks.

Veteran Astronaut Terrence Wilcutt (Col., USMC) lead the seven-man crew, commanding his second Shuttle flight and making his fourth trip into space. During the planned 11-day mission, Wilcutt and his crew mates spent a week inside the ISS unloading supplies from both a double SPACEHAB cargo module in the rear of Atlantis's cargo bay and from a Russian Progress M-1 resupply craft docked to the aft end of the Zvezda Service Module. Zvezda, which linked up to the ISS on July 26, served as the early living quarters for the station and is the cornerstone of the Russian contribution to the ISS.

The goal of the flight was to prepare Zvezda for the arrival of the first residents, or Expedition, crew later in the fall of 2000 and the start of a permanent human presence on the new outpost. That crew, made up of Expedition Commander Bill Shepherd, Soyuz Commander Yuri Gidzenko and Flight Engineer Sergei Krikalev, launched on October 31, 2000 in a Soyuz capsule from the Baikonur Cosmodrome in Kazakhstan for a four-month "shakedown" mission aboard the ISS.

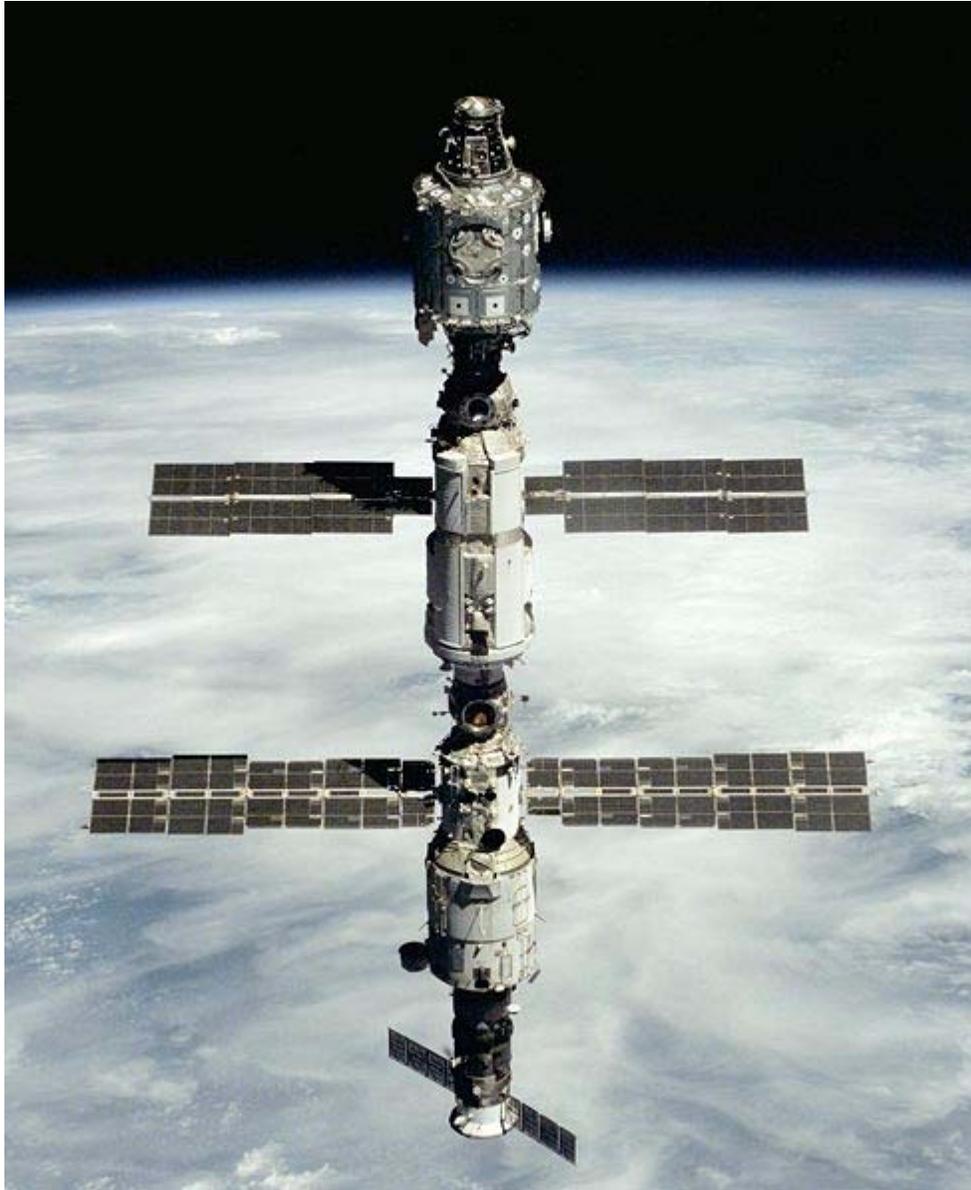
On flight day three, Dr. Ed Lu and Yuri Malenchenko (Col., Russian Air Force), who were both making their second flights into space, conducted a 6 hour and 14 minute space walk. The spacewalk's objective focused on routing and connecting nine power, data and

communications cables between the Zvezda module and the other Russian-built module, Zarya, as well as installing the six-foot-long magnetometer. The magnetometer will serve as a three-dimensional compass designed to minimize Zvezda propellant usage by relaying information to the module's computers regarding its orientation relative to the Earth.

Lu and Malenchenko used tethers and handrails along the ISS to make their way to a point more than 100 feet above the cargo bay, the farthest any tethered spacewalker has ventured outside the shuttle. They completed this with the assistance of their crewmates Burbank and Mastracchio who deftly maneuvered them around with the robotic arm. This spacewalk celebrates the sixth spacewalk in support of the station assembly and the 50th spacewalk in space shuttle history. Also this was the second joint U.S.-Russian space walk outside a Space Shuttle, following on the work conducted by Astronaut Scott Parazynski and Cosmonaut Vladimir Titov outside *Atlantis* while docked to the Mir Space Station during the STS-86 mission in October 1997. Lu, designated EV 1, wore the space suit marked by red stripes, while Malenchenko, EV 2, wore the pure white suit. This was Lu's first space walk, while Malenchenko had conducted a pair of space walks totaling 12 hours during his four-month stay aboard Mir in 1994. Dan Burbank (Lt. Cmdr, USCG), who was a spaceflight rookie, served as the space walk choreographer.

Mission Specialist Rick Mastracchio, also a spaceflight novice, was the prime robot arm operator for the mission, using the Canadian-built arm to move Lu and Malenchenko around the ISS as they conducted their assembly work. Mastracchio is backed up on arm operations by Pilot Scott Altman (Cmdr., USN), making his second flight into space.

The final member of the crew was Russian Cosmonaut Dr. Boris Morukov, making his first flight into space. Morukov was responsible for unloading supplies from the Progress vehicle during the docked phase of the flight.



The International Space Station as seen from STS-106. In view are the station's Unity, Zarya & Zvezda modules, in addition to a docked Progress spacecraft.

On flight day four the crew entered the International Space Station through Pressurized Mating Adapter-2 (PMA-2) to begin the transfer operations of more than three tons of hardware and supplies. Atlantis' crew was the first to see the interior of the Russian Zvezda service module since it was launched from the Baikonur Cosmodrome in July. Additionally, a reboost was performed using the orbiter's Reaction Control System (RCS) to place the station in a higher orbit.

Transfer of supplies and maintenance tasks continued well into the fifth day, while orbiter consumables remained above the required levels allowing managers to extend the mission one additional day.

Activities on flight day five included the installation of three batteries inside Zvezda. In order to reduce the weight for launch, Zvezda was launched with only five of its eight batteries in place.

Lu and Malenchenko spent much of flight day seven installing voltage and current stabilizers in Zvezda. Components of the Elektron system, equipment sent into orbit to separate water into oxygen and hydrogen, were installed and will be activated after the first crew arrives.

The crew transferred more than 6,000 pounds of material - including six 100 pound bags of water, all of the food for the first resident crew, office supplies, onboard environmental supplies, a vacuum cleaner and a computer and monitor - to the interior of the station.

The astronauts spent a total of 5 days, 9 hours and 21 minutes inside the station before closing the hatch on the orbiting outpost. Wilcutt and Altman commanded a series of four altitude boosts to place the station in an orbit of approximately 241 by 233 statute miles, raising the average altitude by 14 miles (23 km). After spending 7 days, 21 hours and 54 minutes linked to the station, Atlantis undocked at 11:46 p.m. EDT as Wilcutt and Altman fired Atlantis' jets to move to a distance of about 450 feet for a double-loop flyaround.

Commander Terry Wilcutt guided Atlantis to a landing at 2:56 a.m. Central time, wrapping up a 4.9 million mile mission in which more than three tons of equipment were delivered to the international outpost. Wilcutt and his crewmates, Pilot Scott Altman and Mission Specialists Ed Lu, Rick Mastracchio, Dan Burbank, Yuri Malenchenko and Boris Morukov completed the 23rd consecutive landing of a shuttle at the Florida spaceport, and the 30th landing of a shuttle at the Cape in the last 31 flights.

Chapter- 5

STS-97

STS-97

Mission insignia



Mission statistics

Mission name	STS-97
Space shuttle	<i>Endeavour</i>
Launch pad	39-B
Launch date	30 November 2000, 22:06 EST
Landing	11 December 2000, 18:04 EST, KSC Runway 15
Mission duration	10 days, 19 hours, 58 minutes, 20 seconds
Orbital altitude	320 kilometres (170 nmi)
Orbital inclination	51.6 degrees
Distance	4.476 million miles (7.203 Gm)

traveled

Docking

Docking date 2 December 2000 19:59 UTC

Undocking date 9 December 2000 19:13 UTC

Time docked 6 days, 23 hours, 13 minutes

Crew photo



Related missions

Previous mission



STS-92

Subsequent mission



STS-98

STS-97 was a Space Shuttle mission to the International Space Station (ISS) flown by Space Shuttle *Endeavour*. The crew installed the first set of solar arrays to the ISS, prepared a docking port for arrival of the Destiny Laboratory Module, and delivered supplies for the station's crew.

Crew

Position	Astronaut
Commander	Brent W. Jett Third spaceflight
Pilot	Michael J. Bloomfield Second spaceflight
Mission Specialist 1	Joseph R. Tanner Third spaceflight
Mission Specialist 2	Marc Garneau, CSA Third spaceflight
Mission Specialist 3	Carlos I. Noriega Second spaceflight

Mission parameters

- **Mass:**
 - *Orbiter Liftoff:* 120,742 kilograms (266,190 lb)
 - *Orbiter Landing:* 89,758 kilograms (197,880 lb)
 - *Payload:* 7,906 kilograms (17,430 lb)
- **Perigee:** 352 kilometres (219 mi)
- **Apogee:** 365 kilometres (227 mi)
- **Inclination:** 51.6°
- **Period:** 91.7 min

Space walks

- *Tanner and Noriega* - EVA 1
- **EVA 1 Start:** 3 December 2000 - 18:35 UTC
- **EVA 1 End:** 4 December 2000 - 02:08 UTC
- **Duration:** 7 hours, 33 minutes
- *Tanner and Noriega* - EVA 2
- **EVA 2 Start:** 5 December 2000 - 17:21 UTC
- **EVA 2 End:** 5 December 2000 - 23:58 UTC
- **Duration:** 6 hours, 37 minutes
- *Tanner and Noriega* - EVA 3
- **EVA 3 Start:** 7 December 2000 - 16:13 UTC
- **EVA 3 End:** 7 December 2000 - 21:23 UTC
- **Duration:** 5 hours, 10 minutes

Mission highlights



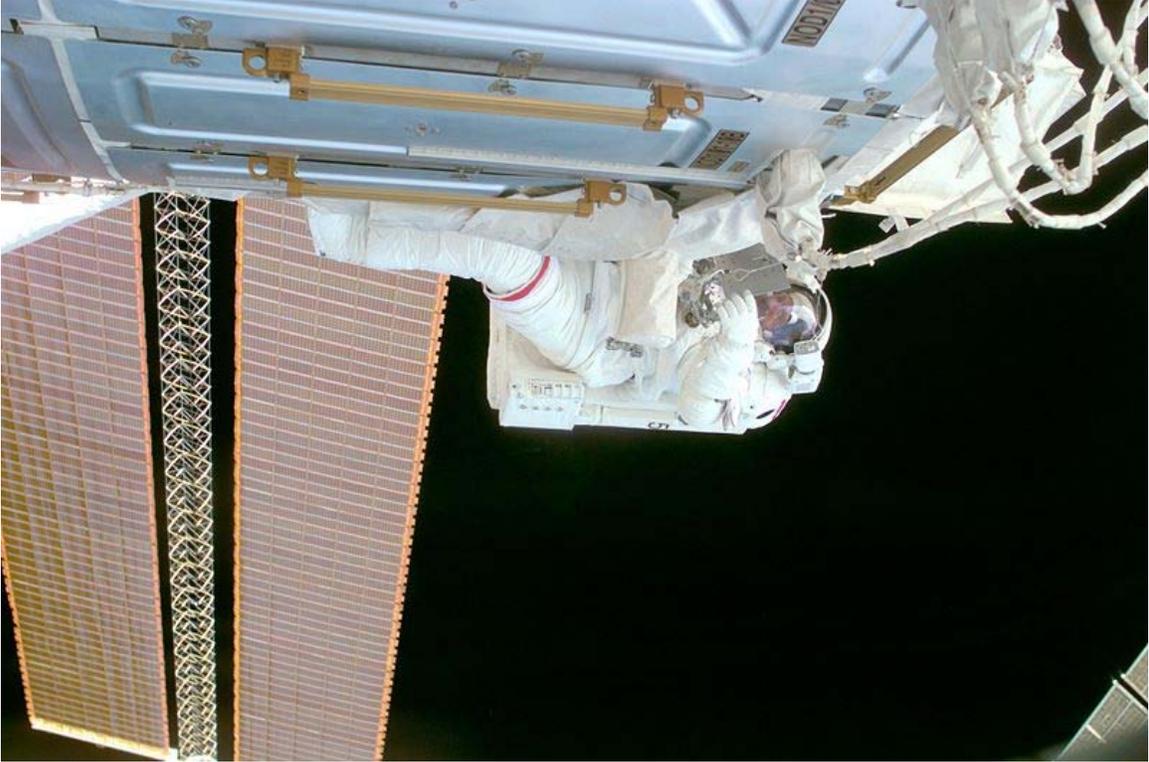
Endeavour on Launch Pad 39-B before STS-97.



Space Shuttle *Endeavour* launches from Kennedy Space Center, November 30, 2000

During the 11-day mission, the primary objective was completed, which was to deliver and connect the first set of U.S.-provided solar arrays to the International Space Station. The astronauts completed three spacewalks, during which they prepared a docking port for arrival of the Destiny Laboratory Module, installed Floating Potential Probes to measure electrical potential surrounding the station, installed a camera cable outside the Unity Module, and transferred supplies, equipment and refuse between *Endeavour* and the station.

On Flight Day 3, Commander Brent Jett linked *Endeavour* to the ISS while 230 statute miles above northeast Kazakhstan.



Tanner on the final spacewalk of the mission on 7 December 2000. Part of the new solar arrays can be seen on the left.

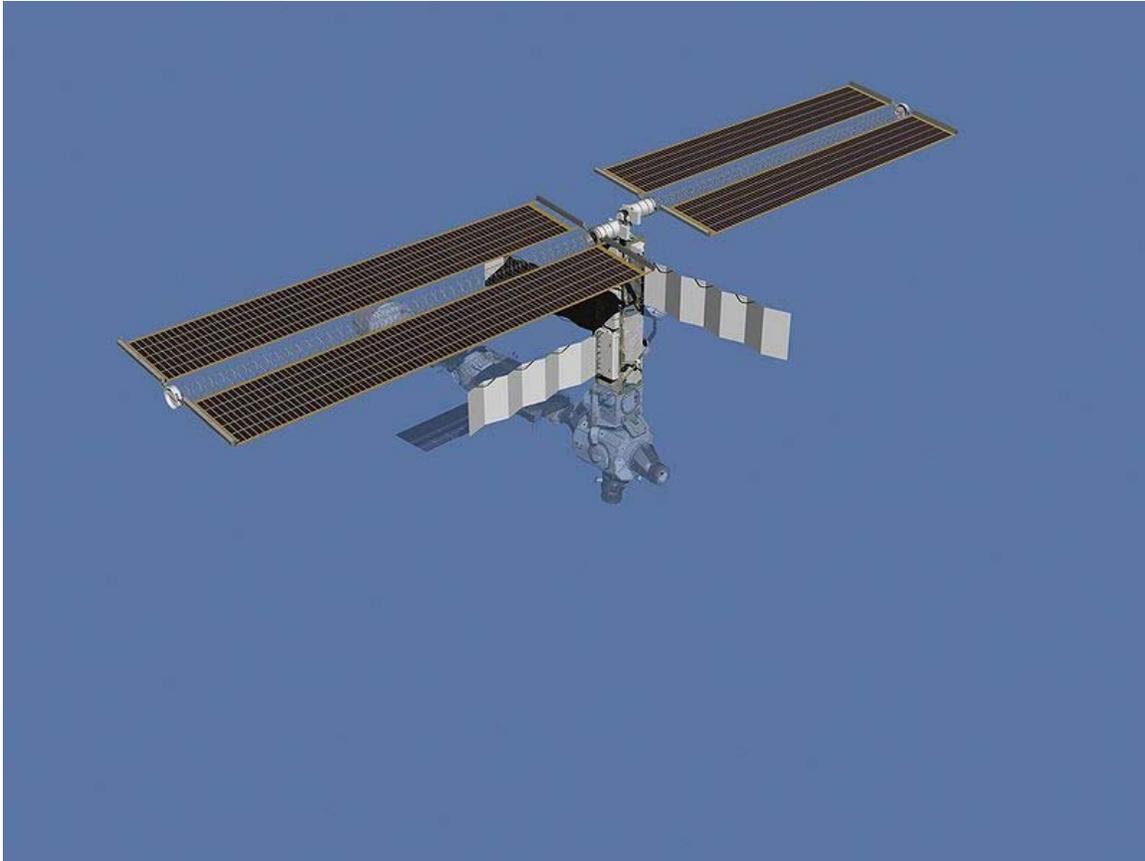


Illustration of the International Space Station after STS-97

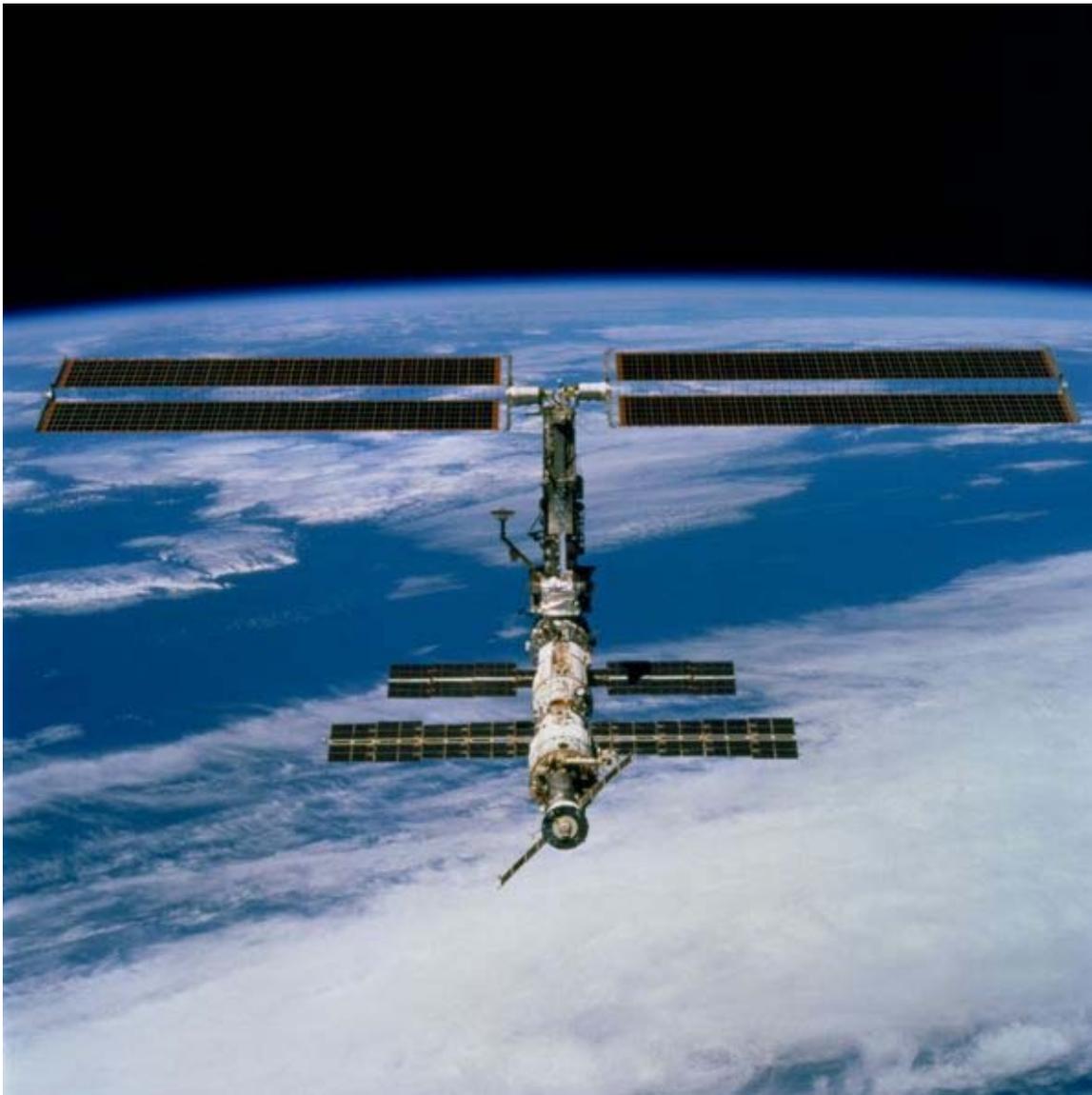
The successful checkout of the Extravehicular Mobility Units (EMUs), the Simplified Aid for EVA Rescue (SAFER) units, the Canadarm (RMS), the Orbiter Space Vision System (OSVS) and the Orbiter Docking System (ODS) were all completed nominally. Also, the ODS centerline camera was installed with no misalignment noted.

From inside *Endeavour*, Canadian Mission Specialist Marc Garneau used the Canadarm to remove the P6 truss from the payload bay, maneuvering it into an overnight park position to warm its components. Mission Specialists Joseph Tanner and Carlos Noriega moved through *Endeavour's* docking tunnel and opened the hatch to the ISS docking port to leave supplies and computer hardware on the doorstep of the Station. On flight day 4, the Expedition 1 Commander William Shepherd, Pilot Yuri Gidzenko and Flight Engineer Sergei Krikalev -- entered the Unity Module for the first time and retrieved the items left for them.

At 09:36 EST on 8 December 2000 the crew paid the first visit to the Expedition 1 crew residing in the space station. Until then the shuttle and the station had kept one hatch closed to maintain respective atmospheric pressures, allowing the shuttle crew to conduct their spacewalks and mission goals. After a welcome ceremony and briefing, the eight spacefarers conducted structural tests of the station and its solar arrays, transferred equipment, supplies and refuse back and forth between the spacecraft, and checked out the television camera cable installed by Tanner and Noriega for the upcoming mission.

On 9 December 2000 the two crews completed final transfers of supplies to the station and other items being returned to Earth. The *Endeavour* crew bade farewell to the Expedition 1 crew at 10:51 EST and closed the hatches between the spacecraft. After being docked together for 6 days, 23 hours and 13 minutes, *Endeavour* undocked from the station at 14:13 EST. Piloted by Michael Bloomfield, it then made an hour-long, tail-first circle of the station. The undocking took place 235 statute miles above the border of Kazakhstan and China. The final separation burn took place near the northeast coast of South America.

STS-97 was the 15th flight of *Endeavour* and the 101st Space Shuttle mission.



Taken from *Endeavour* on December 9, 2000 shortly after undocking. The new solar arrays are visible at the top.

Wake-up calls

NASA began a tradition of playing music to astronauts during the Gemini program, which was first used to wake up a flight crew during Apollo 15. Each track is specially chosen, often by their families, and usually has a special meaning to an individual member of the crew, or is applicable to their daily activities.

Flight Day	Song	Artist/Composer	Links
Day 2	"Stardust"	Willie Nelson	WAV MP3 TRANSCRIPT
Day 3	"I Believe I Can Fly"	R. Kelly	WAV MP3 TRANSCRIPT
Day 4	"Sunshine of Your Love"	Cream	WAV MP3 TRANSCRIPT
Day 7	"O Mio Babbino Caro"	Puccini	WAV MP3 TRANSCRIPT
Day 8	"Here Comes the Sun"	Beatles	WAV MP3 TRANSCRIPT
Day 9	"Rattled"	Traveling Wilburys	WAV MP3 TRANSCRIPT
Day 10	"Back in the Saddle Again"	Gene Autry	WAV MP3 TRANSCRIPT
Day 11	"Beyond the Sea"	Bobby Darin	WAV MP3 TRANSCRIPT
Day 12	"I'll Be Home for Christmas"	Bing Crosby	WAV MP3 TRANSCRIPT

Chapter- 6

STS-100

STS-100

Mission insignia



Mission statistics

Mission name	STS-100
Space shuttle	<i>Endeavour</i>
Launch pad	39-A
Launch date	19 April 2001, 18:40:42 UTC
Landing	1 May 2001, 16:11:56 UTC, EAFB
Mission duration	11 days, 21 hours, 31 minutes, 14 seconds
Orbital altitude	173 nautical miles (320 km)
Orbital inclination	51.6 deg

Docking

Docking date 21 April 2001 13:59 UTC
Undocking date 29 April 2001 17:34 UTC
Time docked 8 days, 03 hours, 35 minutes

Crew photo



Related missions

Previous mission

STS-102



Subsequent mission

STS-104



STS-100 was a Space Shuttle mission to the International Space Station (ISS) flown by Space Shuttle *Endeavour*. STS-100 installed the ISS Canadarm2 robotic arm.

Crew

Position	Astronaut
Commander	Kent V. Rominger Fifth spaceflight
Pilot	Jeffrey S. Ashby Second spaceflight
Mission Specialist 1	Chris Hadfield, CSA Second spaceflight
Mission Specialist 2	John L. Phillips First spaceflight
Mission Specialist 3	Scott E. Parazynski Fourth spaceflight

Mission Specialist 4	Umberto Guidoni, ESA Second spaceflight
Mission Specialist 5	Yuri Lonchakov, RKA First spaceflight

Mission parameters

- **Mass:**
 - *Orbiter liftoff:* 103,506 kilograms (228,190 lb)
 - *Orbiter landing:* 99,742 kilograms (219,890 lb)
 - *Payload:* 4,899 kilograms (10,800 lb)
- **Perigee:** 377 kilometres (234 mi)
- **Apogee:** 394 kilometres (245 mi)
- **Inclination:** 51.6°
- **Period:** 92.3 min

Mission highlights

The highest priority objectives of the flight were the installation, activation and checkout of the Canadarm2 robotic arm on the station. The operation of the arm is critical to the capability to continue assembly of the International Space Station, and was also necessary to attach a new airlock to the station on the subsequent shuttle flight, mission STS-104. A final component of the Canadarm is the Mobile Base System (MBS), installed onboard the station during the STS-111 flight.

Other major objectives for *Endeavour*'s mission were to berth the *Raffaello* logistics module to the station, activate it, transfer cargo between *Raffaello* and the station, and reberth *Raffaello* in the shuttle's payload bay. *Raffaello* is the second of three Italian Space Agency-developed Multi-Purpose Logistics Module that were launched to the station. The *Leonardo* module was launched and returned on the previous shuttle flight, STS-102, in March.

Remaining objectives included the transfer of other equipment to the station such as an Ultra-High Frequency communications antenna and a spare electronics component to be attached to the exterior during space walks. Finally, the transfer of supplies and water for use aboard the station, the transfer of experiments and experiment racks to the complex, and the transfer of items for return to Earth from the station to the shuttle were among the objectives.

Endeavour also boosted the station's altitude and perform a flyaround survey of the complex, including recording views of the station with an IMAX cargo bay camera.

All objectives were completed without incident, and reentry and landing happened uneventfully on 1 May 2001.

During this mission, astronaut Chris Hadfield made the first spacewalk by a Canadian.



Illustration of the International Space Station during STS-100



STS-100 Crew as they prepare to ride over to the shuttle just hours before the launch



STS-100's engines ignite



STS-100 Liftoff

Spacewalks

EVA #	Spacewalkers	Start (UTC)	End (UTC)	Duration
EVA 1	Scott Parazynski	22 April 2001	22 April 2001	7 hours 10
	Chris Hadfield	11:45	18:55	minutes
	Parazynski and Hadfield deployed a UHF antenna on the Destiny lab. After that, the pair began installing the Canadarm2. Parazynski and Hadfield encountered a problem ensuring the proper torque was applied to the bolt. The pair switched the Pistol Grip Tool (PGT) to manual mode and attempted again successfully.			
EVA 2	Parazynski	24 April 2001	24 April 2001	7 hours 40
	Hadfield	12:34	20:14	minutes
	Connected Power and Data Grapple Fixture (PDGF) circuits for the new arm on Destiny. Removed an early communications antenna and the transfer of a spare Direct Current Switching Unit (DCSU) from the shuttle's payload bay to an equipment storage rack on the outside of Destiny.			

Wake-up calls

NASA began a tradition of playing music to astronauts during the Gemini program, which was first used to wake up a flight crew during Apollo 15. Each track is specially

chosen, often by their families, and usually has a special meaning to an individual member of the crew, or is applicable to their daily activities.

Flight Day	Song	Artist/Composer	Links
Day 2	"Then the Morning Comes"	Smash Mouth	WAV MP3 TRANSCRIPT
Day 3	"Danger Zone"	Kenny Loggins from the soundtrack to <i>Top Gun</i>	WAV MP3 TRANSCRIPT
Day 4	"Take It From Day to Day"	Stan Rogers	WAV MP3 TRANSCRIPT
Day 5	"Both Sides Now"	Judy Collins	WAV MP3 TRANSCRIPT
Day 6	"What a Wonderful World"	Louis Armstrong	WAV MP3 TRANSCRIPT
Day 7	"Con te Partirò"	Andrea Bocelli	WAV MP3 TRANSCRIPT
Day 8	"Behind the Fog"	Russian Folk Singer	WAV MP3 TRANSCRIPT
Day 9	"Buckaroo"	Don Cain	WAV MP3 TRANSCRIPT
Day 10	"Dangerous"	The Arrogant Worms	WAV MP3 TRANSCRIPT
Day 11	"Miles From Nowhere"	Cat Stevens	WAV MP3 TRANSCRIPT
Day 13	"True"	Spandau Ballet	WAV MP3 TRANSCRIPT

Chapter- 7

STS-105

STS-105

Mission insignia



Mission statistics

Mission name	STS-105
Space shuttle	<i>Discovery</i>
Launch pad	39-A
Launch date	10 August 2001 21:10:14 UTC
Landing	22 August 2001 18:23 UTC KSC Runway 15
Mission duration	11 days 21 hours 13 minutes 52 seconds
Orbital altitude	226 kilometres (122 nmi)
Orbital inclination	51.6 degrees

Docking

Docking date 12 August 2001 18:41 UTC
Undocking date 20 August 2001 14:51 UTC
Time docked 9 days, 20 hour, 9 minutes

Crew photo



Related missions

Previous mission

STS-104



Subsequent mission

STS-108



STS-105 was a mission of the Space Shuttle *Discovery* to the International Space Station, launched from Kennedy Space Center, Florida, 10 August 2001. This mission was *Discovery's* final mission until STS-114, because *Discovery* was grounded for a refit, and then all Shuttles were grounded in the wake of the *Columbia* disaster. The refit included an update of the flight deck to the glass cockpit layout, which was already in use on the Space Shuttle *Atlantis*.

Crew

Position	Launching Astronaut	Landing Astronaut
Commander		Scott J. Horowitz Fourth spaceflight
Pilot		Frederick W. Sturckow Second spaceflight
Mission Specialist 1		Daniel T. Barry Third spaceflight
Mission Specialist 2		Patrick G. Forrester

	First spaceflight	
Mission Specialist 3	Frank L. Culbertson, Jr.	Yury V. Usachev, RKA
	Expedition 3	Expedition 2
	Third spaceflight ISS Commander	Fourth spaceflight ISS Commander
Mission Specialist 4	Mikhail Turin, RKA	James S. Voss
	Expedition 3	Expedition 2
	First spaceflight ISS Flight Engineer	Fifth spaceflight ISS Flight Engineer
Mission Specialist 5	Vladimir N. Dezhurov, RKA	Susan J. Helms
	Expedition 3	Expedition 2
	Second spaceflight ISS Soyuz Commander	Fifth spaceflight ISS Science Officer

Mission parameters

- **Mass:**
 - *Orbiter Liftoff:* 116,914 kilograms (257,750 lb)
 - *Orbiter Landing:* 100,824 kilograms (222,280 lb)
 - *Payload:* 9,072 kilograms (20,000 lb)
- **Perigee:** 373 kilometres (232 mi)
- **Apogee:** 402 kilometres (250 mi)
- **Inclination:** 51.6°
- **Period:** 92.3 min

Space walks

- *Barry and Forrester* - EVA 1
- **EVA 1 Start:** 16 August 2001 - 13:58 UTC
- **EVA 1 End:** 16 August 2001 - 20:14 UTC
- **Duration:** 6 hours, 16 minutes
- *Barry and Forrester* - EVA 2
- **EVA 2 Start:** 18 August 2001 - 13:42 UTC
- **EVA 2 End:** 18 August 2001 - 19:11 UTC
- **Duration:** 5 hours, 29 minutes

Mission highlights

The main purpose of STS-105 was the rotation of the International Space Station crew and the delivery of supplies utilizing the Italian-built Multi-Purpose Logistics Module (MPLM) Leonardo on its second flight (STS-102, STS-105). The crew also performed two spacewalks and conducted scientific experiments. The MultiPurpose Logistics Module (MLPM) taken on STS-105 contained additional scientific racks, equipment and

supplies. It is 6.4 meters long (21 ft) and 4.6 meters (15 ft) in diameter) and weighs over 4,082 kilograms (9,000 lb). An identical module named Raffaello has flown twice (STS-100 and, later, STS-108).

Aboard Leonardo were six Resupply Stowage Racks, four Resupply Stowage Platforms, and two new scientific experiment racks for the station's U.S. laboratory Destiny. The two new science racks (EXPRESS Racks 4 and 5) added further science capability to the station. EXPRESS stands for Expedite the Processing of Experiments to the Space Station. EXPRESS Rack 4 weighs 533 kilograms (1,180 lb) and EXPRESS Rack 5 weighs 544 kilograms (1,200 lb). The empty weight of each EXPRESS rack is about 356 kilograms (780 lb). EXPRESS Racks 1 and 2A were delivered aboard the Raffaello cargo module during STS-100/6A in April 2001. EXPRESS Rack 3 was brought to the station during STS-111 in 2002.

The Resupply Stowage Racks and Resupply Stowage Platforms were filled with Cargo Transfer Bags that contain equipment and supplies for the station. The six Resupply Stowage Racks contained almost 1,451 kilograms (3,200 lb) of cargo and the four Resupply Stowage Platforms contained about 544 kilograms (1,200 lb) of cargo, not including the weight of the Cargo Transfer Bags, the foam packing around the cargo or the straps and fences that held the bags in place. The total weight of cargo, racks and packing material aboard Leonardo was just over 4,990 kilograms (11,000 lb). Total cargo weight was about 3,073 kilograms (6,770 lb).

Another payload onboard is the Materials International Space Station Experiments (MISSE). This project was a NASA/Langley Research Center-managed cooperative endeavor to fly materials and other types of space exposure experiments on the space station. The objective was to develop early, low-cost, non-intrusive opportunities to conduct critical space exposure tests of space materials and components planned for use on future spacecraft. Johnson Space Center, Marshall Space Flight Center, Glenn Research Center, the Materials Laboratory at the Air Force Research Laboratory and Boeing Phantom Works were participants with Langley in the project. The MISSE experiments were the first externally mounted experiments conducted on the ISS. The experiments were in four Passive Experiment Containers (PECs) that were initially developed and used for an experiment on *Mir* in 1996 during the Shuttle-Mir Program. The PECs were transported to *Mir* on STS-76. After an 18-month exposure in space, they were retrieved on STS-86. PECs are suitcase-like containers for transporting experiments via the space shuttle to and from an orbiting spacecraft. Once on orbit and clamped to the host spacecraft, the PECs are opened and serve as racks to expose experiments to the space environment.

Other payloads onboard were part of the Goddard Space Flight Center's Wallops Flight Facility Shuttle Small Payloads Project. The SSPP system utilizes payload carrier systems such as the Hitchhiker, Getaway Specials and Space Experiment Modules to provide a low cost scientific research environment. SSPP payloads on STS-105 include the Hitchhiker payload Simplesat, The Cell Growth in Microgravity GAS Canister (G-

708), the Microgravity Smoldering Combustion experiment (MSC), and the Hitchhiker Experiment Advancing Technology Space Experiment Module-10 payload).



STS-105 launches from Kennedy Space Center, August 10, 2001.

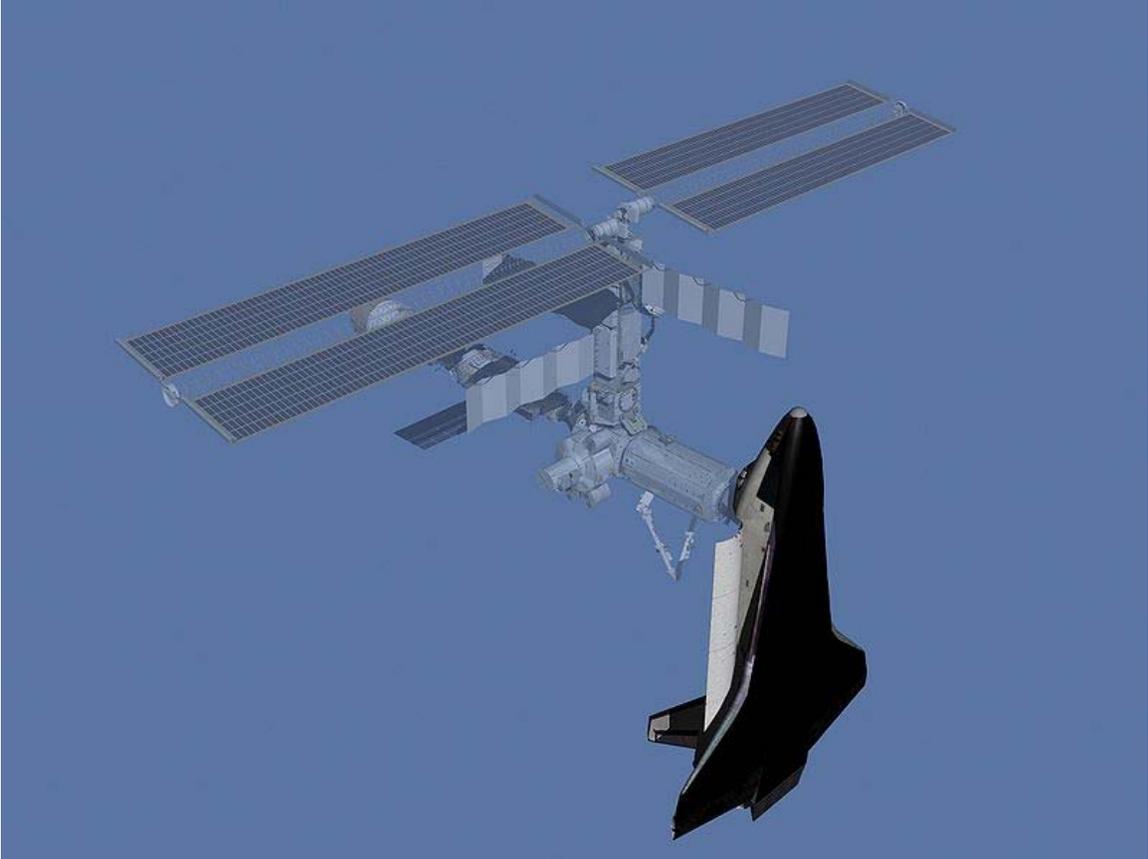
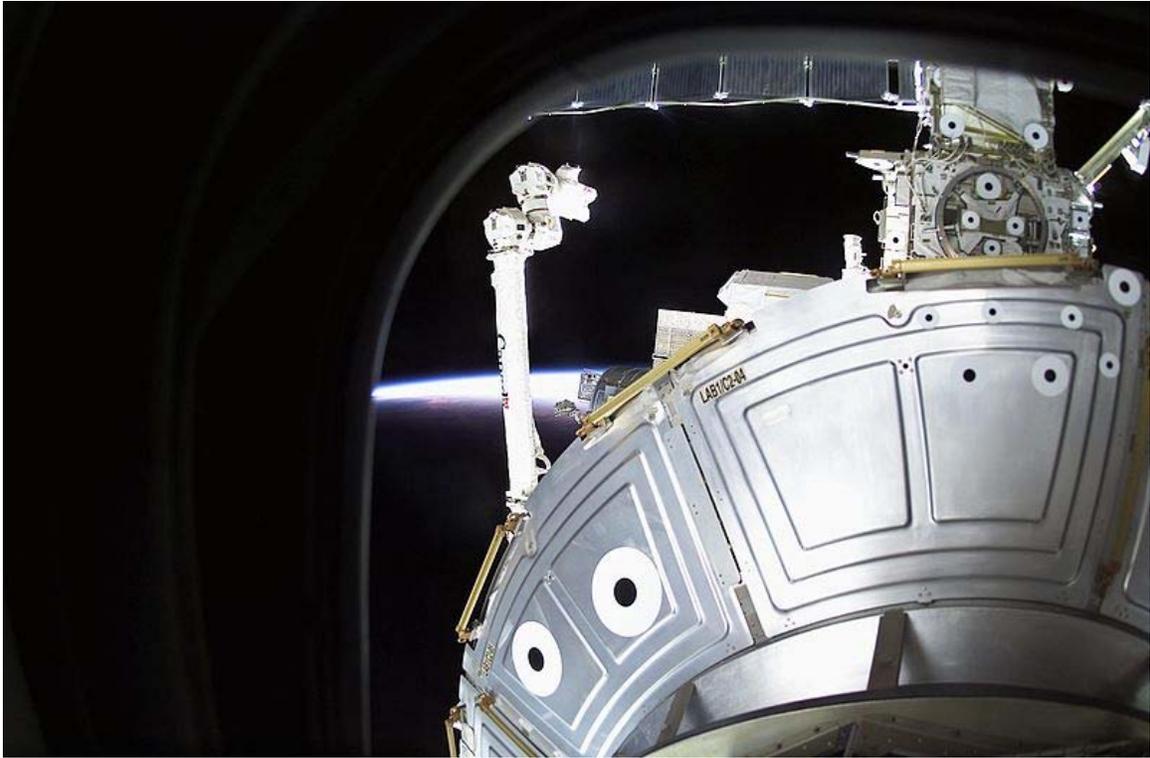


Illustration of the International Space Station during STS-105.



The Canadarm2 / Space Station Remote Manipulator System (SSRMS) being operated by a crew-member.



STS-105 lands at the Shuttle Landing Facility, August 22, 2001.

Attempt	Planned	Result	Turnaround	Reason	Decision point	Weather go %
1	9 Aug 2001, 5:37:46 pm	scrubbed ---		Weather		
2	10 Aug 2001, 5:10:14 pm	success	0 days, 23 hours, 32 minutes			

Wake-up calls

NASA began a tradition of playing music to astronauts during the Gemini program, which was first used to wake up a flight crew during Apollo 15. Each track is specially chosen, often by their families, and usually has a special meaning to an individual member of the crew, or is applicable to their daily activities.

Flight Day	Song	Artist/Composer	Links
Day 2	"Back in the Saddle Again"	Gene Autry	WAV MP3 TRANSCRIPT
Day 3	"The White Eagle"	traditional Russian folk song	WAV MP3 TRANSCRIPT
Day 4	Overture from <i>The Barber of Seville</i>	Rossini	WAV MP3 TRANSCRIPT
Day 5	"Arthur's Theme" (Best That You Can Do)	Christopher Cross	WAV MP3 TRANSCRIPT
Day 6	"Big Boy Toys"	Aaron Tippin	WAV MP3 TRANSCRIPT
Day 7	"The Marvelous Toy"	Tom Paxton	WAV MP3 TRANSCRIPT
Day 8	"Time Bomb"	Patrick and Andrew	WAV MP3 TRANSCRIPT
Day 9	"Hotel California"	The Eagles	WAV MP3 TRANSCRIPT
Day 10	"Under the Boardwalk"	The Drifters	WAV MP3 TRANSCRIPT
Day 11	"Brand New Day"	Sting	WAV MP3 TRANSCRIPT
Day 12	"East Bound and Down"	Jerry Reed	WAV MP3 TRANSCRIPT
Day 13	"Again"	Lenny Kravitz	WAV MP3 TRANSCRIPT

Media



STS-105 launches from KSC (3 mins 7 secs)



STS-105 lands at the Shuttle Landing Facility (2 mins 57 secs)

Chapter- 8

STS-108

STS-108

Mission insignia



Mission statistics

Mission name	STS-108
Space shuttle	<i>Endeavour</i>
Launch pad	39-B
Launch date	December 5, 2001 22:19:28 UTC
Landing	December 17, 2001 17:56:13 UTC KSC Runway 15
Mission duration	11d 19h 36m 45s
Orbital altitude	328 kilometres (177 nmi)
Orbital	51.6 degrees

inclination

Distance traveled 7,700,000 kilometres (4,780,000 mi)

Docking

Docking date 7 December 2001 20:03 UTC

Undocking date 15 December 2001 17:28 UTC

Time docked 7 days, 21 hours, 24 minutes

Crew photo



(L-R): Mark E. Kelly, Linda M. Godwin, Daniel M. Tani, Dominic L. Gorie

Related missions

Previous mission



STS-105

Subsequent mission



STS-109

STS-108 was a Space Shuttle mission to the International Space Station (ISS) flown by Space Shuttle *Endeavour*. Its primary objective was to deliver supplies to and help maintain the ISS.

STS-108 was the 12th shuttle flight to visit the International Space Station and the first since the installation of the Russian airlock called Pirs on the station. Endeavour delivered the Expedition Four crew to the orbital outpost. The Expedition Three crew returned to Earth on Endeavour.

While at the station, the crew conducted one spacewalk and attached the Raffaello Multi-Purpose Logistics Module to the station so that about 2.7 metric tons (3 tons) of equipment and supplies could be unloaded. The crew later returned Raffaello to Endeavour's payload bay for the trip home.

Crew

Position	Launching Astronaut	Landing Astronaut
Commander	Dominic L. Pudwill	Gorie
	Third spaceflight	
Pilot	Mark E. Kelly	
	First spaceflight	
Mission Specialist 1	Linda M. Godwin	
	Fourth spaceflight	
Mission Specialist 2	Daniel M. Tani	
	First spaceflight	
Mission Specialist 3	Yuri I. Onufrienko, RKA	Frank L. Culbertson, Jr.
	Expedition 4	Expedition 3
	Second spaceflight	Third spaceflight
	ISS Commander	ISS Commander
Mission Specialist 4	Carl E. Walz	Mikhail Turin, RKA
	Expedition 4	Expedition 3
	Fourth spaceflight	First spaceflight
	ISS Flight Engineer	ISS Flight Engineer
Mission Specialist 5	Daniel W. Bursch	Vladimir N. Dezhurov, RKA
	Expedition 4	Expedition 3
	Fourth spaceflight	Second spaceflight
	ISS Flight Engineer	ISS Soyuz Commander

Launch highlights



Space Shuttle *Endeavour* launches from Kennedy Space Center, 5 December 2001

The launch of space shuttle Endeavour on 29 November 2001 was rescheduled for 4 December 2001 to allow sufficient time for the Expedition Three crew on the space station to successfully complete a spacewalk to clear an obstruction on the latching mechanism on the Russian Progress supply vehicle.

The launch 4 December was postponed due to unsatisfactory weather conditions in the KSC area. Launch controllers counted down to the T-5 minute point and held until the remainder of the window expired. The scrub had to be called after Astronaut Office Chief

Charles Precourt, flying the Shuttle Training Aircraft, detected precipitation in a cloud mass that moved into the Complex 39 area shortly before launch.

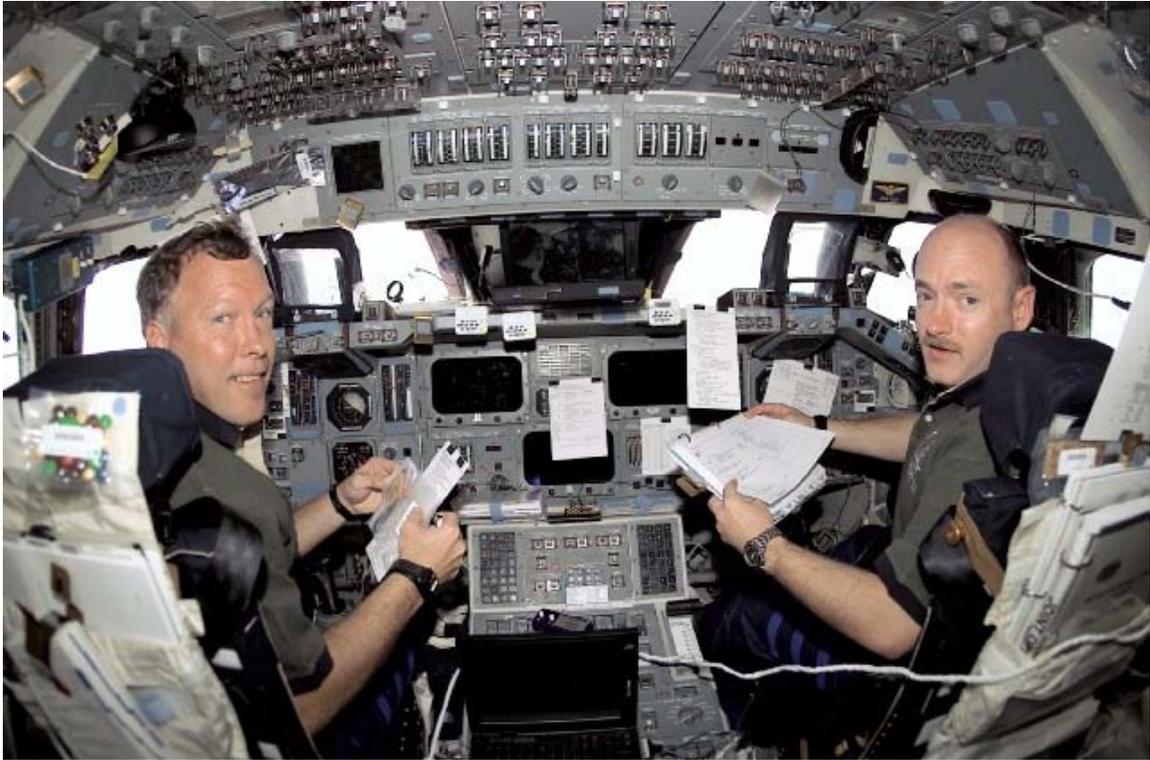
Endeavour lifted off 5 December 2001 at 17:12 EST on the final space shuttle mission of 2001 to deliver three tons of supplies and a fresh crew to the International Space Station, and return home a crew that spent four months in space.

In addition to a new station crew and supplies, Endeavour carried a host of scientific investigations, including experiments from space agencies, schools and universities across the United States, Europe and South America, as well as a small satellite that involved more than 25,000 students in 26 countries.

Mission highlights

The hatches were opened between Endeavour and the ISS Destiny Laboratory at 22:42 UTC 7 December 2001, enabling the ten crew members to greet one another. The Expedition 3 crew officially ended their 117-day residency on board the International Space Station Dec. 8 as their custom Soyuz seat-liners were transferred to Endeavour for the return trip home. The transfer of the Expedition 4 seat-liners to the Soyuz return vehicle attached to the station marked the official exchange of crews.

Endeavour Pilot Mark Kelly and Mission Specialist Linda Godwin used the shuttle's robotic arm to lift the Raffaello Multi-Purpose Logistics Module from the shuttle payload bay and attach it to a berth on the station's Unity node. The crews began unloading supplies the same day.



S108E5066 2001:12:07 17:33:13

Dominic L. Gorie STS-108 commander, and pilot Mark E. Kelly are in their respective stations during rendezvous operations with the ISS. Gorie brought Endeavour to a gentle linkup with the ISS as the two craft sailed over England.

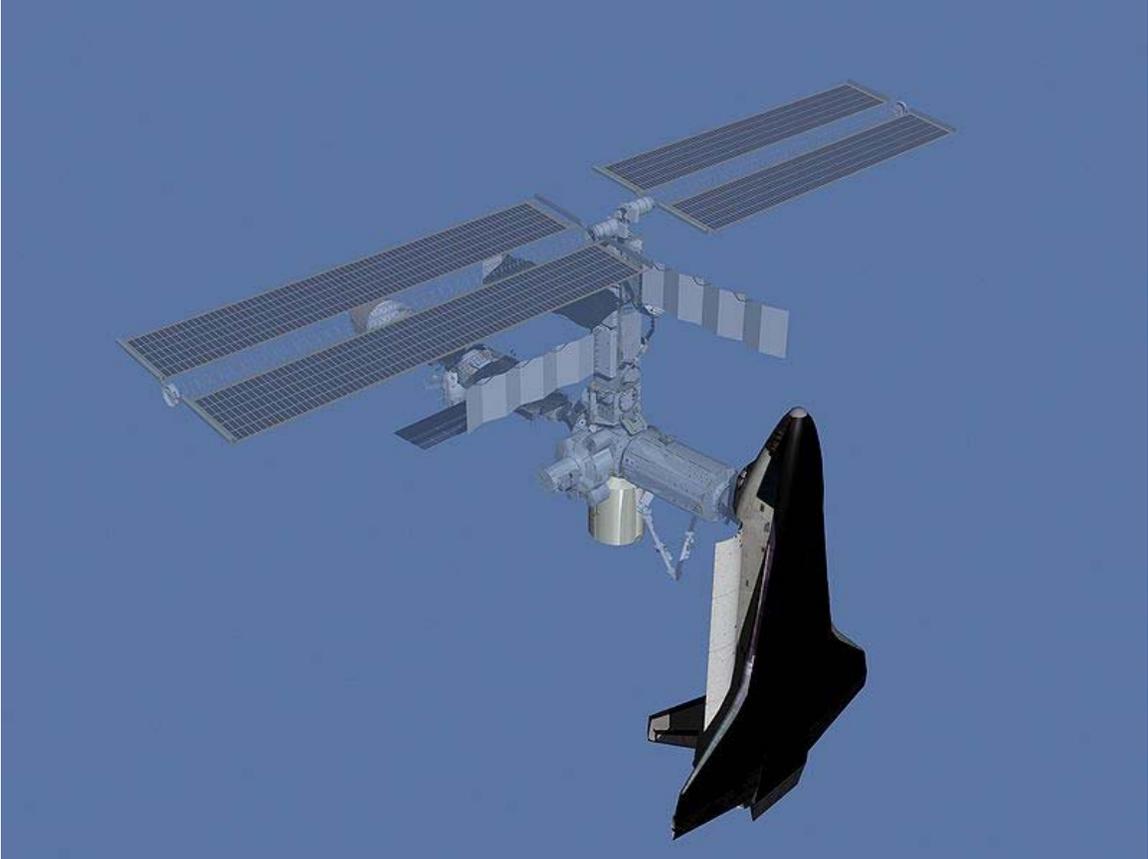
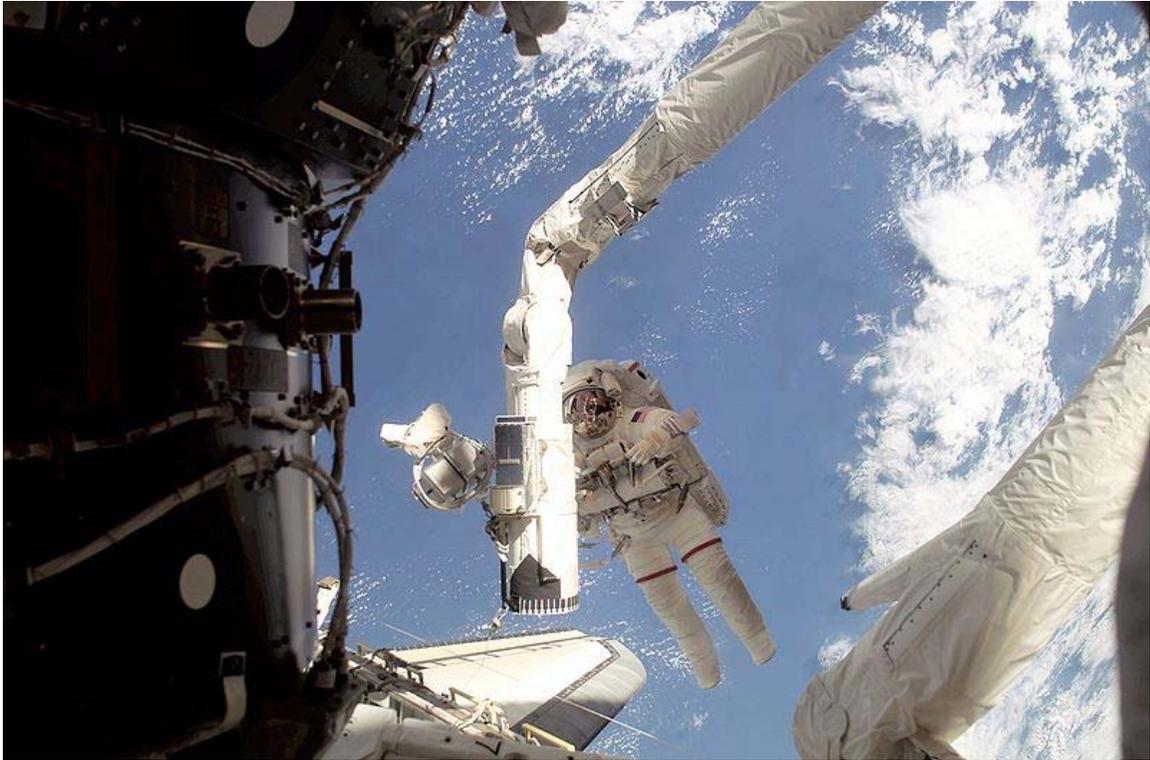


Illustration of the International Space Station during STS-108



(10 December 2001) --- Astronaut Linda M. Godwin, STS-108 mission specialist, is pictured near the end of the Space Shuttle Endeavour's remote manipulator system (RMS) arm during the four-hour session of extravehicular activity (EVA). Astronaut Daniel M. Tani (out of frame), mission specialist, joined Godwin on the space walk.



STS-108 crew with ISS Expedition 3 and 4 crews



STS-108 lands at the Shuttle Landing Facility at Kennedy Space Center.

EVA: 4 hours, 12 minutes — Endeavour astronauts Linda Godwin and Dan Tani completed a four-hour, 12-minute spacewalk to install insulation on mechanisms that rotate the International Space Station's main solar arrays. The two spacewalkers stopped at a stowage bin to retrieve a cover that had been removed from a station antenna during an earlier flight, and after its return to Earth, may be reused. Godwin and Tani also performed a "getahead;" task, positioning two switches on the station's exterior to be installed on a future shuttle mission, STS-110. The spacewalk completed a record year with 18 spacewalks conducted: 12 originating from the shuttle and six from the station.

Mission managers extended Endeavour's flight to a duration of 12 days to allow Endeavour's crew to assist with additional maintenance tasks on the station, including work on a treadmill and replacing a failed compressor in one of the air conditioners in the Zvezda Service Module.

The astronauts and cosmonauts completed the transfer of more than 5,000 pounds of supplies and material from Endeavour's mid-deck and the Raffaello Multi-Purpose Logistics Module to the station. The transferred items included more than 850 pounds of food, 1,000 pounds of clothing and other crew provisions, 300 pounds of experiments and associated equipment, 800 pounds of spacewalking gear, and 600 pounds of medical equipment. In turn, the crew packed up the Raffaello module with items bound for a return trip to Earth.

On 12 December 2001, the crew and Mission Control noted a transient problem with one of the shuttle's three inertial measurement units (IMUs), the primary navigation units for the shuttle. Only two of the three IMUs were on line at the time, with the third unit off line to save electricity. The IMU that experienced a problem, designated IMU 2, was immediately taken off line and the third IMU brought on line. IMU 2 operated well after that, but it remained off line and was considered failed by flight controllers. The loss of one IMU had no impact on Endeavour's mission, and the other two units operated in excellent condition.

A formal change of command ceremony took place December 13 as Expedition 3 ended its residence and Expedition 4 began theirs.

Flight controllers planned slight changes to Endeavour's departure from the station 15 December 2001, allowing time for a small jet firing by the shuttle to boost the station's future path away from a piece of space debris that could pass near the complex. Mission Control was notified that a spent Russian rocket upper stage launched in the 1970s could pass within three miles of the station if Endeavour did not perform the engine firing. With the shuttle reboost, the station was predicted to pass more than 40 miles away from the debris.

Because the scheduled reboost used additional propellant, Endeavour did not perform a full-circle flyaround of the station after undocking. Instead, the shuttle undocked from the station, performing a quarter circle flyaround of the complex to a point about 400 feet directly above the station where it fired its engines in a final separation burn at 12:20 a.m. EST, beginning its departure from the orbiting outpost.

Endeavour's middeck carried home the results of several experiments completed during Expedition 3's stay on the station. These included the Advanced Protein Crystallization Facility, the Dynamically Controlled Protein Crystal Growth experiment and cells from the Cellular Biotechnology Operations Support System (CBOSS).

The CBOSS equipment aboard the space station will remain active during Expedition 4, growing ovarian and colon cancer cells, as well as kidney cells in microgravity.

Experiments in Endeavour's payload bay were returned for investigators around the world. The Multiple Application Customized Hitchhiker-1 (MACH-1) carried a wide array of experiments, including the Prototype Synchrotron Radiation Detector, the Collisions Into Dust Experiment-2, the Capillary Pump Loop, and the Space Experiment Module (SEM). The SEM carried experiments from Argentina, Portugal, Morocco and Australia, as well as experiments from U.S. schoolchildren. Several other canisters in Endeavour's payload bay also carried student experiments.

On its return to Earth, Endeavour's crew deployed a small satellite called STARSHINE 2 from a canister located in the payload bay. More than 30,000 students from 660 schools in 26 countries will be tracking STARSHINE 2 as it orbits the Earth for eight months.

The students, who helped polish STARSHINE's 845 mirrors, will use the information they collect to calculate the density of the Earth's upper atmosphere.

Honoring victims of the September 11 attacks

In the early morning hours of September 12, 2001, New York City Police Sergeant Gerald Kane and Detective Peter Friscia, assigned to the office of Police Commissioner Bernard B. Kerik, retrieved a large American flag that was tattered and torn and wrapped around a flag pole near in corners of Church and Chambers Street amidst the devastation of the World Trade Center site.

That American flag, a USMC flag recovered from the Pentagon, an American flag that flew over the State Capital in Harrisburg, PA on the day of Sept. 11th, the 23 shields (badges) of the fallen NYPD officers; patches, posters and an emblem from the FDNY, patches from the Port Authority of New York and New Jersey and 6,000 small American flags to honor those lost and those that served in the response and recovery efforts for 9/11 were all flown aboard Space Shuttle Endeavour.

The 6,000 smaller flags were later given to families that lost loved ones on 9/11 and the flag retrieved from the World Trade Center site is maintained by the Office of the New York City Commissioner of Records.

Mission parameters

- **Mass:** 4,082 kilograms (9,000 lb) payload
- **Perigee:** 353 kilometres (219 mi)
- **Apogee:** 377 kilometres (234 mi)
- **Inclination:** 51.6°
- **Period:** 92 min

Space walks

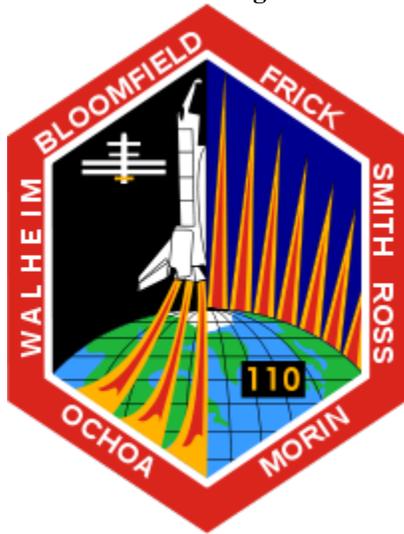
- ***Godwin and Tani*** — EVA 1
- **EVA 1 Start:** 10 December 2001 - 17:52 UTC
- **EVA 1 End:** 10 December 2001 - 22:04 UTC
- **Duration:** 4 hours, 12 minutes

Chapter- 9

STS-110

STS-110

Mission insignia



Mission statistics

Mission name	STS-110
Space shuttle	<i>Atlantis</i>
Launch pad	39-B
Launch date	8 April 2002 20:44:19 UTC
Landing	19 April 2002 16:26:57 UTC KSC Runway 33
Mission duration	10d 19h 43m 38s
Number of orbits	171

Orbital altitude 226 kilometres (122 nmi)

Orbital inclination 51.6 degrees

Distance traveled 7,240,000 kilometres (4,500,000 mi)

Docking

Docking date 10 April 2002 16:05 UTC

Undocking date 17 April 2001 18:31 UTC

Time docked 7 days, 2 hours, 26 minutes

Crew photo



In front, (L-R): Stephen N. Frick, Ellen Ochoa, Michael J. Bloomfield; In the back,

(L-R): Steven L. Smith, Rex J. Walheim, Jerry L. Ross and Lee M.E. Morin.

Related missions

Previous mission



STS-109

Subsequent mission



STS-111

STS-110 was a Space Shuttle mission to the International Space Station (ISS) flown by Space Shuttle *Atlantis*. The main purpose was to install the S0 Truss segment, which forms the backbone of the truss structure on the station.

Crew

Position	Astronaut
Commander	Michael J. Bloomfield Third spaceflight
Pilot	Stephen N. Frick First spaceflight
Mission Specialist 1	Jerry L. Ross Seventh spaceflight
Mission Specialist 2	Steven L. Smith Fourth spaceflight
Mission Specialist 3	Ellen Ochoa Fourth spaceflight
Mission Specialist 4	Lee M.E. Morin First spaceflight
Mission Specialist 5	Rex J. Walheim First spaceflight

Mission parameters

- **Mass:**
 - *Orbiter Liftoff:* 257,079 kilograms (566,760 lb)
 - *Orbiter Landing:* 200,657 kilograms (442,370 lb)
 - *Payload:* 13,132 kilograms (28,950 lb)
- **Perigee:** 155 kilometres (96 mi)
- **Apogee:** 225 kilometres (140 mi)
- **Inclination:** 51.6°
- **Period:** 88.3 min

Mission highlights

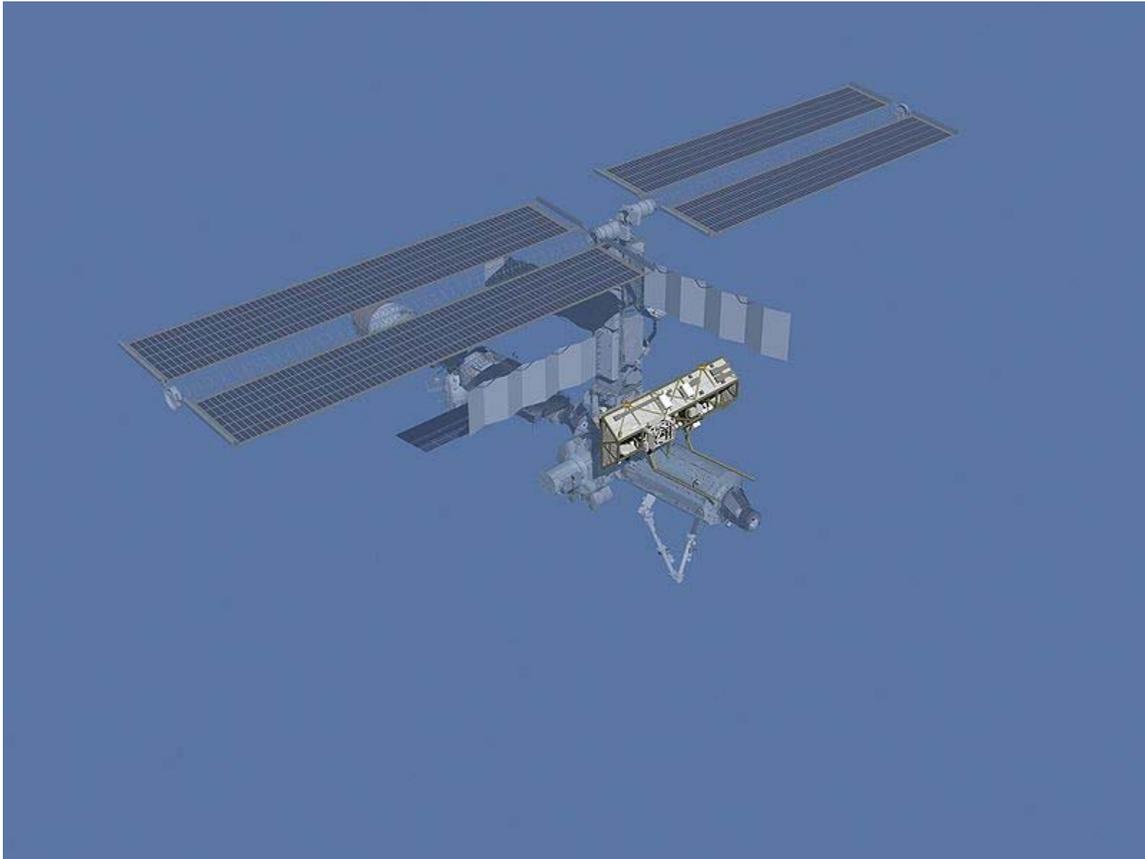


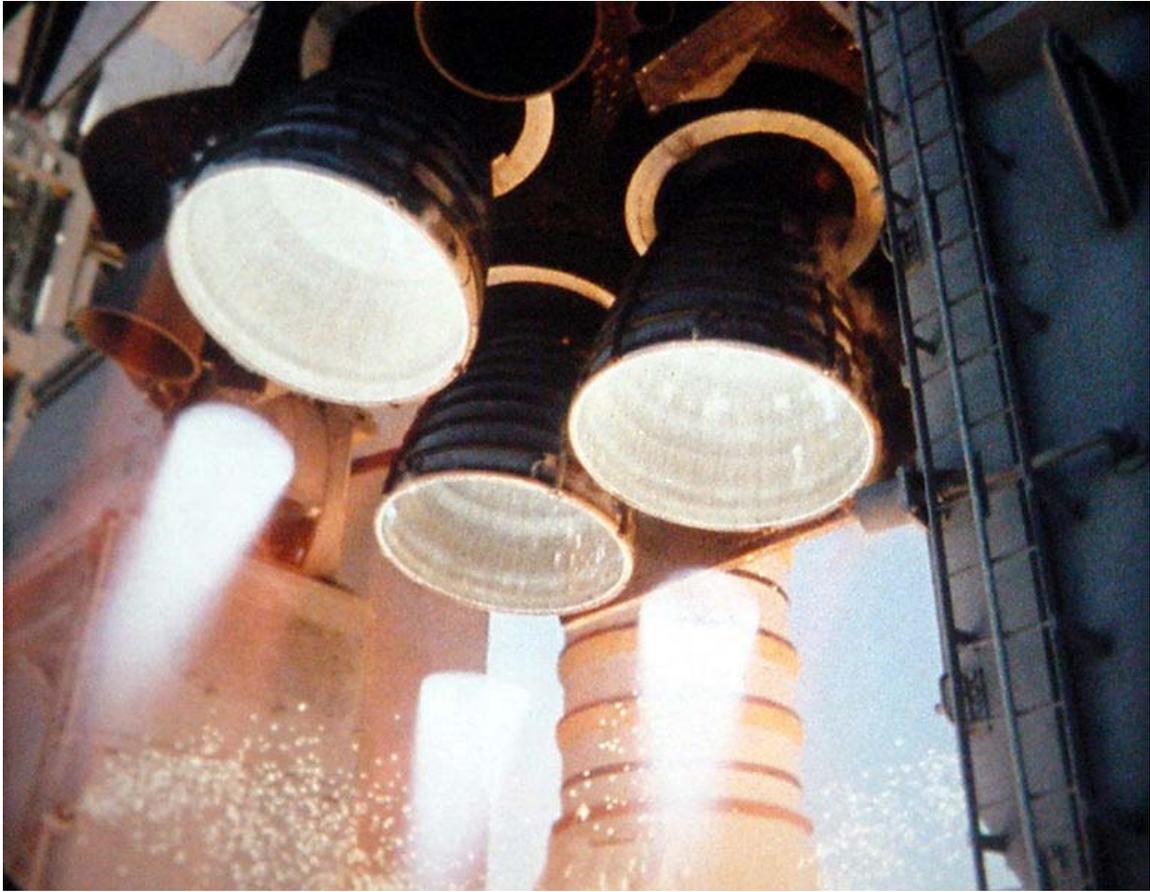
Illustration of the International Space Station after STS-110

The main purpose of **STS-110** was to attach the S0 Truss segment to the International Space Station (ISS) to the Destiny Laboratory Module. It forms the backbone of the station to which the S1 and P1 truss segments were attached (on the following missions STS-112 and STS-113, respectively).

STS-110 also delivered the Mobile Transporter (MT), which is an 885 kilograms (1,950 lb) (1,950 lb) assembly that glides down rails on the station integrated trusses. During the next shuttle mission, STS-111, the Mobile Base System (MBS) was mounted to the MT. This Mobile Servicing System (MSS) allows the Canadarm2 to travel down the length of the installed truss structure.



Space Shuttle *Atlantis* launches on STS-110, April 8, 2002



The three newly-enhanced Space Shuttle main engines ignite to launch Space Shuttle *Atlantis*, April 8, 2002



Astronaut Lee M.E. Morin on the second spacewalk



Space Shuttle *Atlantis* lands at the Shuttle Landing Facility, April 19, 2002

Flight Day 1: Launch

After a launch scrub on 4 April 2002 due to a hydrogen leak, Space Shuttle *Atlantis* successfully launched on 8 April 2002, from Launch Complex 39B.

STS-110 was the first shuttle mission to feature the upgrade Block II main engines, which featured an "improved fuel pump...a stronger integral shaft/disk, and more robust bearings". The intent of the upgrade was to increase the flight capacity of the engines, while increasing reliability and safety.

With the launch of *Atlantis*, mission specialist Jerry L. Ross became the first human to have traveled to space seven times.

Attempt	Planned	Result	Turnaround	Reason	Decision point	Weather go %	Notes
1	4 Apr 2002, 5:17:51 pm	scrubbed	---	technical	4 Apr 2002, 9:27 am	60%	leak developed in a hydrogen fuel vent line
2	8 Apr 2002, 4:39:31	success	3 days, 23 hours, 22 minutes				

pm

Spacewalks

	Mission	Spacewalkers	Start - UTC	End - UTC	Duration	Mission
35.	STS-110 EVA 1	Steven L. Smith Rex J. Walheim	11 April 2002 14:36	11 April 2002 22:24	7 h, 48 min	Installed S0 Truss on Destiny
36.	STS-110 EVA 2	Jerry L. Ross Lee M.E. Morin	13 April 2002 14:09	13 April 2002 21:39	7 h, 30 min	Continued S0 Truss install
37.	STS-110 EVA 3	Steven L. Smith Rex J. Walheim	14 April 2002 13:48	14 April 2002 20:15	6 h, 27 min	Reconfigure Canadarm2 for S0 truss
38.	STS-110 EVA 4	Jerry L. Ross Lee M.E. Morin	16 April 2002 14:29	16 April 2002 21:06	6 h, 37 min	Install future EVA hardware

Chapter- 10

STS-111

STS-111

Mission insignia



Mission statistics

Mission name	STS-111
Space shuttle	<i>Endeavour</i>
Launch date	5 June 2002 21:22:49 UTC
Landing	19 June 2002 17:58:45 UTC EAFB Runway 22
Mission duration	13 days, 20:35:56
Orbital altitude	226 kilometres (122 nmi)
Orbital inclination	51.6 degrees

Distance traveled 9,300,000 kilometres (5,780,000 mi)

Docking

Docking date 7 June 2002 16:25 UTC

Undocking date 15 June 2002 14:32 UTC

Time docked 7 days, 22 hours, 07 minutes

Crew photo



(L-R): Philippe Perrin, Paul S. Lockhart, Kenneth D. Cockrell, Franklin R. Chang-Diaz

Related missions

Previous mission



STS-110

Subsequent mission



STS-112

STS-111 was a space shuttle mission to the International Space Station (ISS) flown by Space Shuttle *Endeavour*. STS-111 resupplied the station and replaced the Expedition 4 crew with the Expedition 5 crew. It was launched on 5 June 2002, from Kennedy Space Center, Florida.

Crew



Launched Expedition 5 crew



Landed Expedition 4 crew

Position	Launching Astronaut	Landing Astronaut
Commander		Kenneth D. Cockrell Fifth spaceflight
Pilot		Paul S. Lockhart First spaceflight
Mission Specialist 1		Franklin Chang-Diaz Seventh spaceflight
Mission Specialist 2		Philippe Perrin, CNES First spaceflight
Mission Specialist 3	Valery G. Korzun, RKA Expedition 5 Second spaceflight ISS Commander	Yuri I. Onufrienko, RKA Expedition 4 Second spaceflight ISS Commander
Mission Specialist 4	Peggy A. Whitson Expedition 5 First spaceflight ISS Flight Engineer	Carl E. Walz Expedition 4 Fourth spaceflight ISS Flight Engineer
Mission Specialist 5	Sergei Y. Treshchev, RKA	Daniel W. Bursch

Expedition 5
First spaceflight
ISS Flight Engineer

Expedition 4
Fourth spaceflight
ISS Flight Engineer

Mission parameters

- **Mass:**
 - *Orbiter Liftoff:* 116,523 kilograms (256,890 lb)
 - *Orbiter Landing:* 99,385 kilograms (219,110 lb)
 - *Payload:* 12,058 kilograms (26,580 lb)
- **Perigee:** 349 kilometres (217 mi)
- **Apogee:** 387 kilometres (240 mi)
- **Inclination:** 51.6°
- **Period:** 91.9 min

Mission highlights



STS-111 launches from Kennedy Space Center, June 5, 2002.



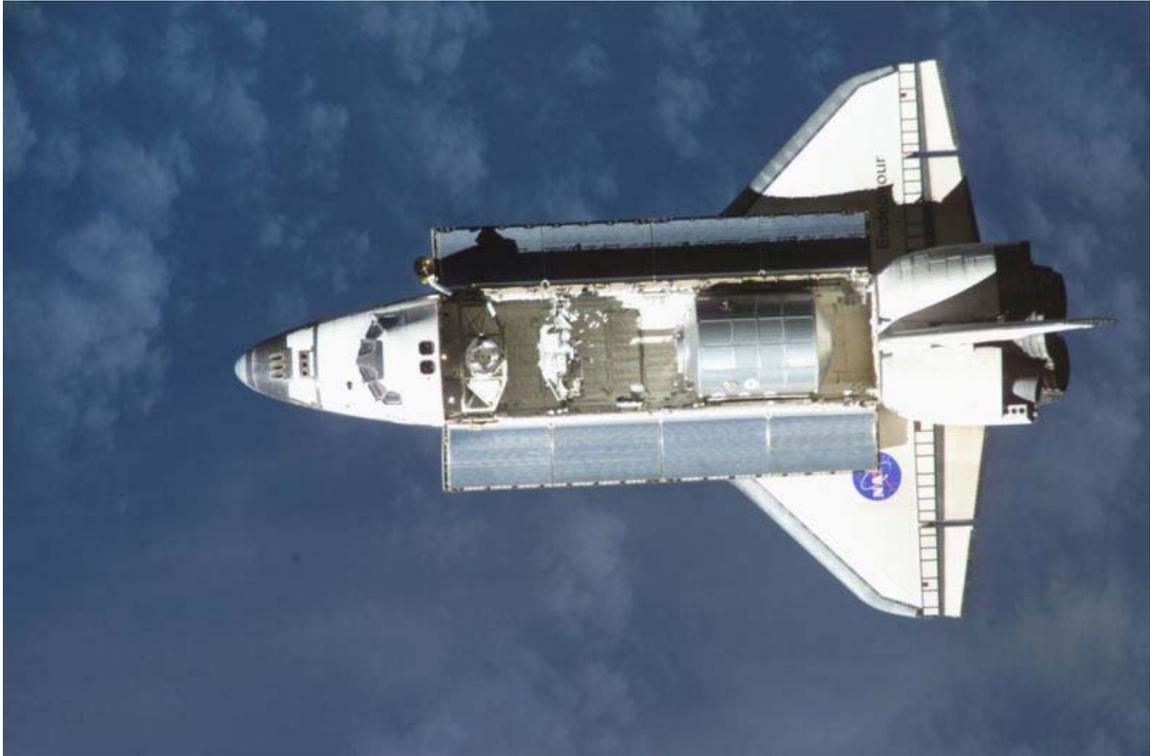
STS-111 lands at Edwards Air Force Base, June 19, 2002.

STS-111, in addition to providing supplies, rotated the crews aboard the International Space Station, exchanging the three Expedition 4 members (1 Russian, 2 American) for the three Expedition 5 members (2 Russian, 1 American).

The Multi-Purpose Logistics Module (MPLM) carried experiment racks and three stowage and resupply racks to the station. The mission also installed a component of the Canadarm2 called the Mobile Base System (MBS) to the Mobile Transporter (MT) (which was installed during STS-110); This completed the Canadian Mobile Servicing System, or MSS. This gave the mechanical arm the capability to "inchworm" from the U.S. Lab fixture to the MSS and travel along the Truss to work sites.

STS-111 was the last flight of a CNES astronaut, the French agency having disbanded its astronaut group and transferred them to the ESA.

Spacewalks



Endeavour carrying the MPLM on its approach to the ISS on STS-111

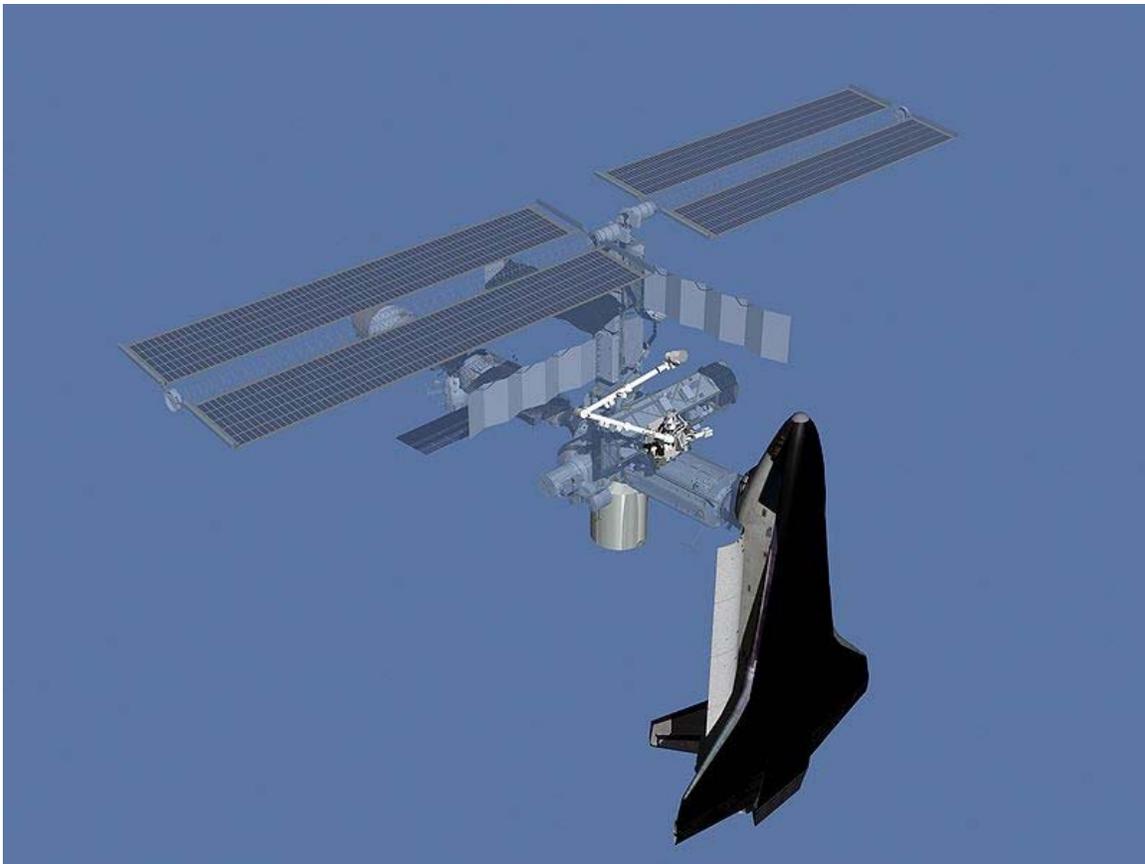


Illustration of the International Space Station during STS-111

	Mission	Spacewalkers	Start - UTC	End - UTC	Duration	Mission
39.	STS-111 EVA 1	Franklin R. Chang-Diaz Philippe Perrin	9 June 2002 15:27	9 June 2002 22:41	7 h, 14 min	Attached Power and Data Grapple Fixture to P6 Truss
40.	STS-111 EVA 2	Franklin R. Chang-Diaz Philippe Perrin	11 June 2002 15:20	11 June 2002 20:20	5 h, 00 min	Attached Mobile Base System to Mobile Transporter
41.	STS-111 EVA 3	Franklin R. Chang-Diaz Philippe Perrin	13 June 2002 15:16	13 June 2002 22:33	7 h, 17 min	Replace Canadarm2 wrist joint

	Attempt	Planned	Result	Turnaround	Reason	Decision point	Weather go %	Notes
1		30 May 2002, 7:44:26 pm	scrubbed	---	weather		40%	thunderstorms and electrical activity
2		31 May 2002,	scrubbed	0 days, 23 hours, 37	weather	31 May 2002,	80%	scrubbed before tanking had

	7:21:52 pm	minutes	9:45 am	begun, concerns of continued bad weather including hail
3	5 Jun 2002, 5:22:48 am	success	4 days, 10 hours, 1 minutes	initial plans for Monday launch were delayed due to nitrogen valve problems

Chapter- 11

STS-114

STS-114

Mission insignia



Mission statistics

Mission name	STS-114
Space shuttle	<i>Discovery</i>
Crew size	7
Launch pad	LC-39B
Launch date	26 July 2005, 14:39:00 UTC
Landing	9 August 2005, 12:11:22 UTC
Mission duration	13d 21h 32m 48s
Number of orbits	219
Orbital altitude	226 kilometres (140 mi)
Orbital inclination	51.6 degrees
Distance traveled	9,300,000 kilometres (5,780,000 mi)

Docking

Docking date 28 July 2005 11:18 UTC
Undocking date 6 August 2005 07:24 UTC
Time docked 8 days, 19 hours, 54 minutes

Crew photo



Back (L-R): Robinson, Thomas, Camarda, Noguchi

Front (L-R): Kelly, Lawrence, Collins

Related missions

Previous mission

STS-107 

Subsequent mission

STS-121 

STS-114 was the first "Return to Flight" Space Shuttle mission following the Space Shuttle *Columbia* disaster. The Space Shuttle *Discovery* launched at 10:39 EDT (14:39 UTC), July 26, 2005. The launch, 907 days (approx. 29 months) after the loss of *Columbia*, was approved despite unresolved fuel sensor anomalies in the external tank; those anomalies had prevented the shuttle from launching on July 13, its originally scheduled date.

The mission was completed on 9 August 2005. Due to the poor weather at Kennedy Space Center, Florida, the shuttle landed at Edwards Air Force Base, California, a secondary landing site.

The problem that resulted in the destruction of *Columbia* — debris separating from the external tank during ascent — unexpectedly recurred during the launch of *Discovery*. As a result, NASA decided on 27 July 2005 to postpone future shuttle flights pending additional modifications to the flight hardware. On 4 July 2006, NASA resumed shuttle flight with STS-121.

Crew

Position	Astronaut
Commander	Eileen Collins Fourth spaceflight
Pilot	Jim Kelly Second spaceflight (USAF call sign "Vegas")
Mission Specialist 1	Soichi Noguchi, JAXA First spaceflight
Mission Specialist 2	Stephen Robinson Third spaceflight
Mission Specialist 3	Andy Thomas Fourth spaceflight
Mission Specialist 4	Wendy Lawrence Fourth spaceflight
Mission Specialist 5	Charlie Camarda First spaceflight

Original crew

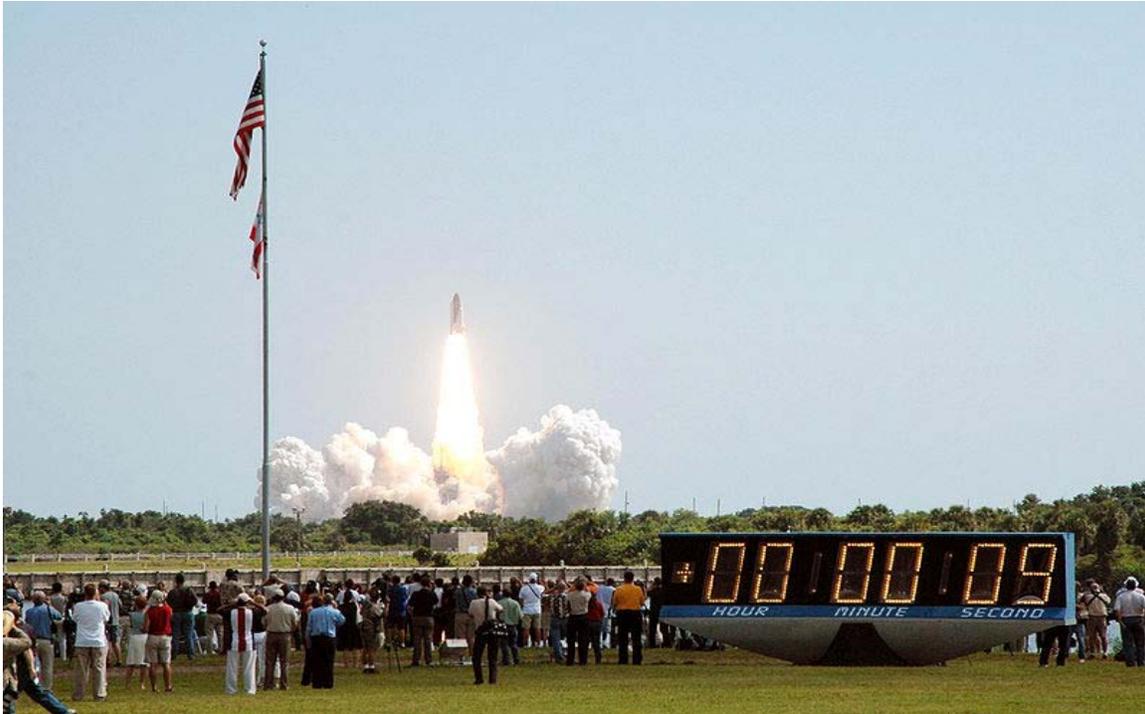
This mission was to carry the Expedition 7 crew to the ISS and bring home the Expedition 6 crew. The original crew was to be:

Position	Launching Astronaut	Landing Astronaut
Commander	Eileen M. Collins	
Pilot	Jim Kelly	
Mission Specialist 1	Soichi Noguchi, JAXA	
Mission Specialist 2	Stephen Robinson	
Mission Specialist 3	Yuri I. Malenchenko, RKA Expedition 7 ISS Commander	Ken Bowersox Expedition 6 ISS Commander
Mission Specialist 4	Ed Lu Expedition 7 ISS Flight Engineer	Nikolai Budarin, RKA Expedition 6 ISS Flight Engineer
Mission Specialist 5	Alexander Y. Kaleri, RKA Expedition 7 ISS Flight Engineer	Don Pettit Expedition 6 ISS Flight Engineer

Mission highlights



July 26: Shuttle *Discovery* STS-114 launch.

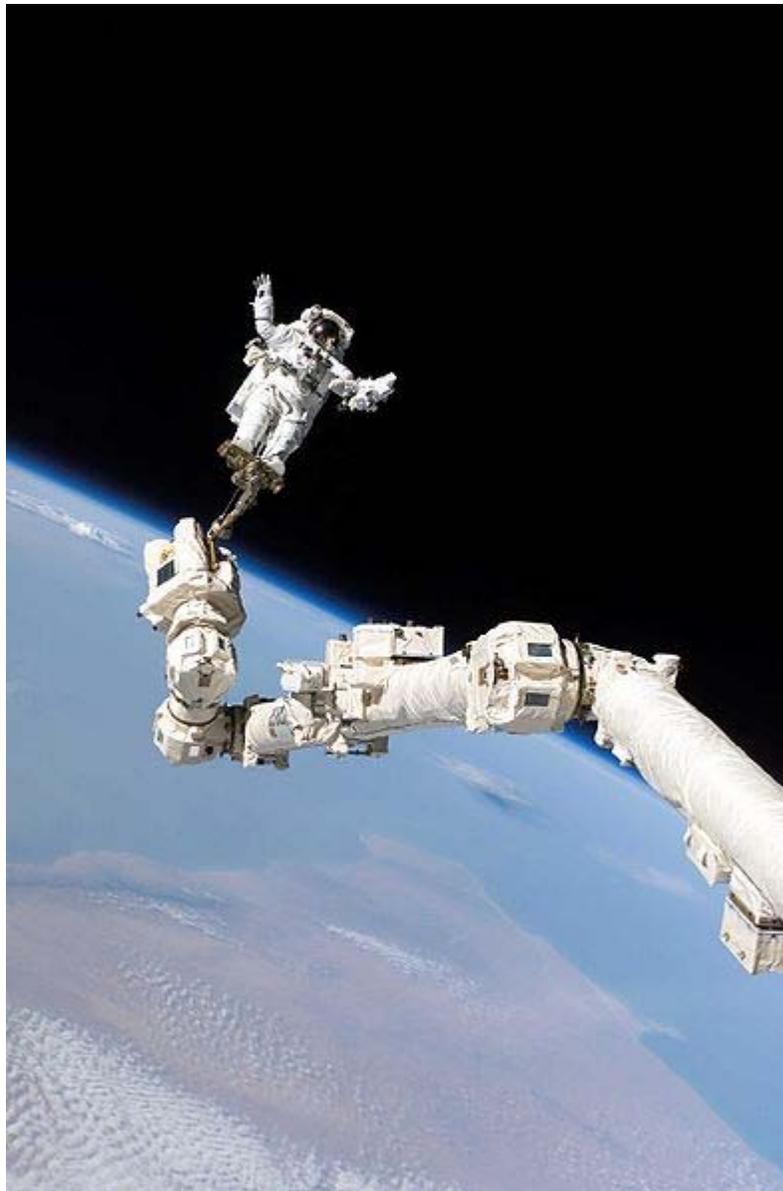


Space Shuttle *Discovery* rose from the pad at Kennedy Space Center, Florida, 10:39 a.m., July 26, 2005.

STS-114 marked the return to flight of the Space Shuttle after the *Columbia* disaster and was the second Shuttle flight with a female commander (Eileen Collins, who also commanded the STS-93 mission). The STS-114 mission was initially to be flown aboard the orbiter *Atlantis*, but NASA replaced it with *Discovery* after improperly installed gear was found in *Atlantis*' braking system. Seventeen years prior, *Discovery* had flown NASA's previous Return to Flight mission, STS-26.

The STS-114 mission delivered supplies to the International Space Station. However, the major focus of the mission was testing and evaluating new Space Shuttle flight safety techniques, which included new inspection and repair techniques. The crewmembers used the new Orbiter Boom Sensor System (OBSS) — a set of instruments on a 50-foot (15 m) extension attached to the Canadarm. The OBSS instrument package consists of visual imaging equipment and a Laser Dynamic Range Imager (LDRI) to detect problems with the shuttle's Thermal Protection System (TPS). The crew scanned the leading edges of the wings, the nose cap, and the crew compartment for damage, as well as other potential problem areas engineers wished to inspect based on video taken during lift-off.

STS-114 was classified as Logistics Flight 1. Besides delivering supplies, the Shuttle replaced one of the ISS's Control Moment Gyroscopes. STS-114 also carried the *Raffaello* Multi-Purpose Logistics Module, built by the Italian Space Agency, the External Stowage Platform-2 and deployed the MISSE 5 to the station's exterior.



Stephen Robinson on the third spacewalk

The crew conducted three spacewalks while at the station. The first demonstrated repair techniques on the Shuttle's Thermal Protection System. During the second, the spacewalkers replaced the failed gyroscope. On the third, they installed the External Stowage Platform and repaired the shuttle, the first time repairs had been carried out during a spacewalk on the exterior of a spacecraft in flight. On August 1, it was announced protruding gap fillers on the front underside of the shuttle would be inspected and dealt with during the third spacewalk of the mission. The spacewalk was conducted on the morning of August 3. Robinson easily removed the two fillers with his fingers. Later on the same day, NASA officials said that they were looking closely at a thermal blanket located next to the commander's window on the port side of the orbiter. Published reports on 4 August 2005 said wind tunnel testing demonstrated that the orbiter is safe to re-enter with the billowed blanket.



July 12, 2005: STS 114 at night the day before its original planned launchdate.

On 30 July 2005, NASA announced that STS-114 would be extended for one day, so that *Discovery's* crew could help the ISS crew maintain the station while the shuttle fleet is grounded. The extra day was also used to move more items from the shuttle to the ISS, as uncertainty mounted during the mission as to when a shuttle will next visit the station. The orbiter's arrival also gave the nearly 200-ton space station a free altitude boost of about 4,000 feet (1,220 m). The station loses about 100 feet (30 m) of altitude a day.

The shuttle hatch was closed the night before it undocked from the ISS. After undocking, the shuttle flew around the station to take photos.

Atmospheric reentry and landing was originally planned for 8 August 2005, at Cape Canaveral, but unsuitable weather postponed the landing until the next day, then moved it to Edwards Air Force Base in California, where *Discovery* touched down at 08:11EDT (05:11 AM PDT, 12:11 UTC).

Launch sequence anomalies



Foam flying off shuttle's fuel tank

Around 2.5 seconds after lift-off, a large bird struck near the top of the external fuel tank, and appeared in subsequent video frames to slide down the tank. NASA did not expect this to hurt the mission because it did not hit the orbiter, and because the vehicle was traveling relatively slowly at the time.

A small fragment of thermal tile, estimated to be around 1.5 inches (38 mm) in size, was ejected from an edge tile of the front landing gear door at some point before SRB separation. A small white area appeared on the tile as the piece detached, and the loose shard could be seen in a single frame of the video. It is unknown what object (if any) struck the tile to cause the damage. The damaged tile was inspected further when the images from the umbilical camera were downloaded on day three. Engineers requested that this area be inspected by the OBSS, and flight managers scheduled the operation for 29 July 2005. This represented the only known possible damage to *Discovery* that could have posed a risk during re-entry.

At 127.1 seconds after liftoff, and 5.3 seconds after SRB separation, a large piece of debris separated from the Protuberance Air Load (PAL) ramp, which is part of the external tank. The debris was thought to have measured 36.3 by 11 by 6.7 inches (922 by 279 by 170 mm) – and to weigh about 0.45 kilograms (0.99 lb), or half as much as the piece of foam blamed for the loss of *Columbia*. The debris piece did not strike any part of the *Discovery* orbiter. Images of the external tank taken after separation from the orbiter show multiple areas where foam insulation was missing.



Handheld still image taken by *Discovery's* crew of the external fuel tank as it was jettisoned after launch. In this still image, the area of missing foam on the tank is indicated by a light spot near the upper edge of the tank just below the liquid oxygen feedline.

Around 20 seconds later, a smaller piece of foam separated from the ET and apparently struck the orbiter's right wing. Based on the mass of the foam, and the velocity at which it would have struck the wing, NASA estimated it only exerted one-tenth the energy required to cause potential damage. Laser scanning and imaging of the wing by the OBSS did not reveal any damage.

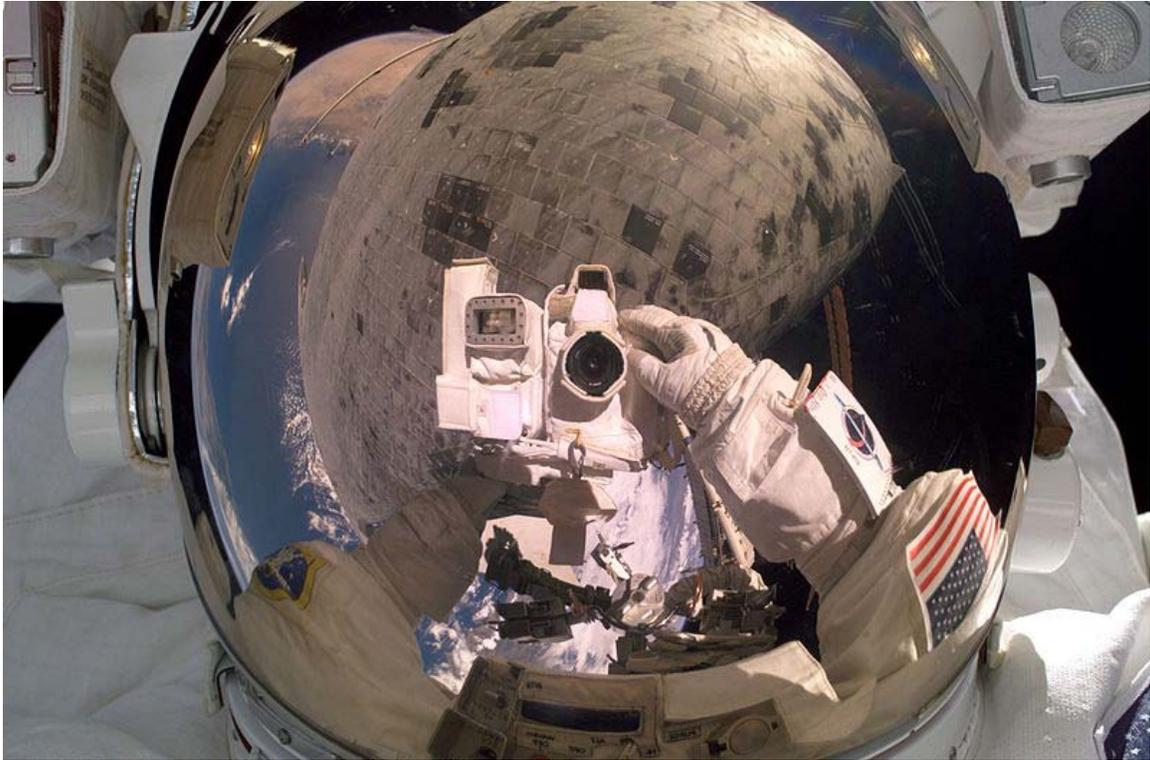
On 27 July 2005, NASA announced that it was postponing all Shuttle flights until the foam loss problem can be resolved.

On 5 August 2005, USA Today reported that NASA was looking into extensive handling as a possible explanation for the loss of foam on the external tank. NASA Administrator Michael Griffin stated that the earliest the next shuttle could launch is 22 September 2005, but that's only "if next week, the guys have a eureka moment on the foam and spot why this big chunk came off." Later in August, it became clear that a September launch date would not be possible, and that the earliest date for the next launch would be in March 2006. However, because Hurricane Katrina hit the Gulf Coast, the next launch was delayed further. With the destruction suffered by Lockheed's Michoud Assembly Facility and NASA's Stennis Space Center in Mississippi due to Hurricane Katrina and the subsequent flooding, the launch of the next shuttle mission (STS-121) was further delayed until 4 July 2006.

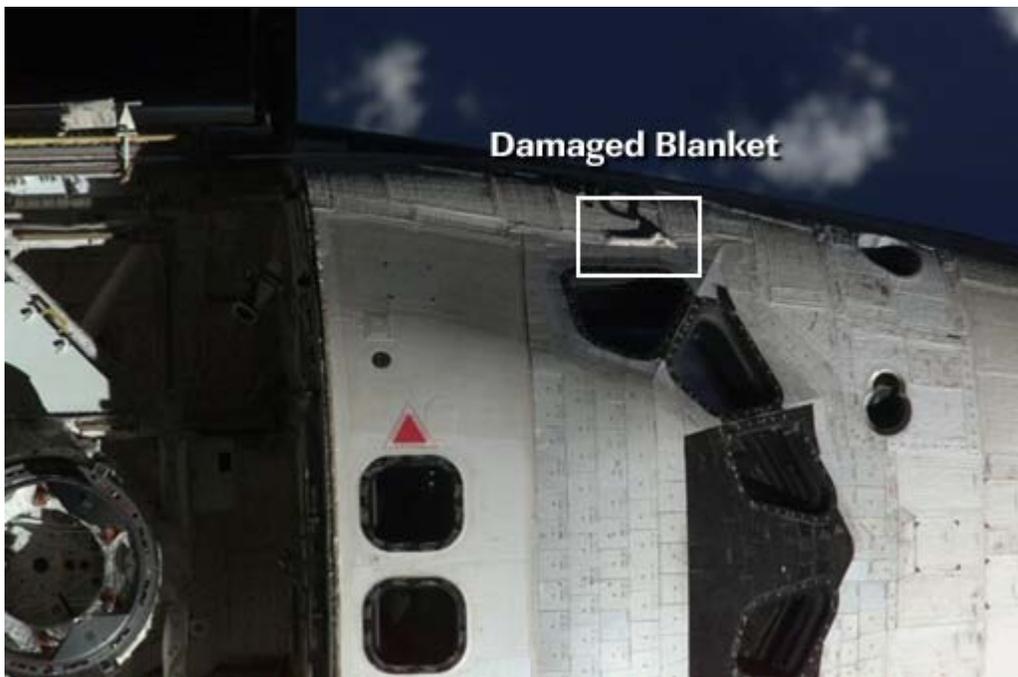
In-flight repair



Discovery's underside floats over the Earth in this first-of-its-kind view, taken during astronaut Steve Robison's dramatic spacewalk. Riding the International Space Station's robot arm, he ventured under the Shuttle to remove a pair of gap fillers sticking out between tiles on the orbiter's heat shield.



Astronaut Steve Robison turns the camera on himself during his historic repair job "underneath" Discovery. The Shuttle's heat shield is reflected in his visor.



Damaged thermal blanket

On the third EVA of the mission, two areas on the underside of the shuttle where photographic surveying identified protruding gap fillers were dealt with. According to NASA, the gap fillers, which each serve different purposes, are not required for reentry. One filler prevents "chattering" of tiles during ascent, which would occur due to the sonic booms from the noses of the solid rocket boosters and the external fuel tank. The other, in a different location where there is a wider gap between tiles, simply functions to reduce the gap size between tiles, which in turn reduces heat transfer to the shuttle. Even without this filler NASA did not expect the increased heat to cause a problem during reentry (it is present to avoid a level of heating which would only be problematic if experienced many times over a vehicle's design life). Since the gap fillers are not necessary for re-entry, it was acceptable to simply pull them out. An overview of the situation, including procedures for dealing with the protrusions were sent electronically to the crew and printed aboard the shuttle. The crew were also able to watch uploaded videos of NASA personnel on the ground demonstrating the repair techniques. Both the videos and 12-page procedure document were also made publicly available via NASA's website.

During the third EVA both the fillers were successfully removed with less than a pound of force without the need to use any tools. Stephen K. Robinson gave a running commentary of his work: "I'm grasping it and I'm pulling it and it's coming out very easily" ... "It looks like this big patient is cured".

If it were not possible to pull the fillers out then the protruding sections could have been simply cut off. The gap fillers are made of a cloth impregnated with ceramic - they are stiff and can be easily cut with a tool similar to a hacksaw blade. Protruding gap fillers are a problem because they disrupt the normally laminar air flow under the orbiter during reentry, which causes turbulence at lower speeds. A turbulent air flow results in a mixing of hot and cold air which can have a major effect on the shuttle temperature.

The decision to make the repair balanced the risks of the EVA with the risks of leaving the protruding gap fillers as they were. It is thought that gap filler protrusions of a similar magnitude were present on previous missions, but they were not observed in-orbit. Consideration was also given to the risks of elements of the procedure which would involve the ISS arm being used to carry Stephen K. Robinson below the shuttle, possibly the use of a sharp tool which has potential to damage the EVA suit or shuttle tiles. The possibility of making things worse by attempting a repair was given serious consideration. Cameras on the shuttle arm and on Robinson's helmet were used to monitor the activities under the shuttle.

Protruding gap fillers had been identified as an issue on previous flights, notably STS-28. A post-flight analysis identified that gap filler was the likely cause of the high temperatures observed during this re-entry. Protruding gap fillers were also seen on STS-73.

A further in-flight repair was considered to remove or clip a damaged thermal blanket located beneath the commander's window on the port side of the orbiter. Wind tunnel

testing by NASA determined that the thermal blanket was safe for re-entry, and plans for a fourth spacewalk were cancelled.

Mission timeline

This timeline is a summary.

July 13, 2005

- 11:55 EDT - The countdown clock was restarted after a programmed 3 hour hold.
- 12:01 EDT - To loud applause and cheers, the crew entered the traditional Astrovan to make their way to the pad.
- 12:30 EDT - The crew arrived at Pad 39B and proceeded into the White Room for boarding.
- 13:32 EDT - Problem with LH2 fuel level sensor reported. Launch Director orders launch scrubbed.
- 13:34 EDT - Crew egress began.
- 13:59 EDT - Crew egress completed.

July 14, 2005

- 14:00 EDT - Technical meeting of Mission Management Team to discuss troubleshooting efforts following the draining of the External Tank (ET) the previous night.
- 14:45 EDT - Press conference, earliest possible liftoff moved to Sunday, July 17. During this press conference it was confirmed that the preparations of *Atlantis* for the next scheduled flight STS-121 are not being delayed while troubleshooting the sensor problem on Discovery. This may impact the contingency planning for the mission.

- 10:47 EDT: T +8 minutes, main engine shutdown and fuel tank separation as planned.

July 28, 2005

- 07:18 EDT: T +01:20:39 Orbiter docked with ISS after performing the first-ever Rendezvous Pitch Maneuver

July 30, 2005



Soichi Noguchi on his first EVA

- 05:46 EDT: T +03:19:07 Noguchi and Robinson begin first spacewalk
- 12:36 EDT: T +04:02:57 Spacewalk completed successfully (duration 6 h 50 min)

August 1, 2005

- 04:44 EDT: T +05:18:05 Noguchi and Robinson begin second spacewalk to replace CMG
- 11:14 EDT: T +06:00:35 Spacewalk completed successfully (duration 6 h 30 min)

August 3, 2005

- 04:48 EDT: T +07:18:09 Noguchi and Robinson begin third spacewalk. Robinson to remove two protruding gap fillers between thermal insulation tiles. Noguchi

installs amateur radio satellite PCSat2 along with the MISSE 5 experiment to test solar cells.

- 10:49 EDT: T +08:00:10 Spacewalk completed successfully (duration 6 h 1 min)

August 6, 2005

- 01:14 EDT: T+10:14:35 Orbiter crew bids farewell to ISS crew. Hatches between orbiter and ISS closed
- 03:24 EDT: T+10:16:45 Orbiter undocks from ISS

August 8, 2005

- 03:20 EDT: T+12:16:41 Mission Control waves off the first of two landing opportunities for Space Shuttle *Discovery* due to low clouds over Kennedy Space Center
- 05:04 EDT: T+12:18:25 Mission Control waves off the second landing attempt, delaying the landing for another day. Landing is now tentatively scheduled for 05:07 EDT August 9 at Kennedy Space Center. In the event of inclement weather in Florida, NASA will land *Discovery* at Edwards Air Force Base in California, or, as a last resort, White Sands, New Mexico.

August 9, 2005



Discovery touches down.

- 03:12 EDT: T+13:16:33 Mission Control waves off the first landing opportunity for *Discovery* due to bad weather.
- 05:03 EDT: T+13:18:24 Mission Control waves off the second landing opportunity due to thunderstorms within the 30-nautical-mile (56 km) "safety zone" around KSC. Shuttle *Discovery* will now land at Edwards Air Force Base in California. The previous landing at Edwards Air Force Base was STS-111 on June 19, 2002. The last previous night landing at Edwards was STS-48 on September 18, 1991.
- 06:43 EDT: T+13:20:04 Capcom (Ken Ham), tells *Discovery* that "it's time to come home".
- 07:06 EDT: T+13:20:27 *Discovery* begins its 2-minute, 42-second retrograde deorbit burn over the Western Indian Ocean to the north of Madagascar.
- 07:09 EDT: T+13:20:30 Deorbit burn completed as planned, slowing the shuttle by 186 mi/h (300 kilometres (190 mi)/h).
- 07:28 EDT: T+13:20:49 APU are activated to power the shuttle's control surfaces
- 07:40 EDT: T+13:21:01 *Discovery* begins to feel the effects of the Earth's atmosphere.
- 08:08 EDT: T+13:21:29 Commander Eileen Collins takes control of *Discovery* for final approach to Runway 22.
- 08:11 EDT: T+13:21:32 *Discovery* touches down at Edwards Air Force Base. NASA commentator: "and *Discovery* is home."
- 08:12 EDT: T+13:21:33 Eileen Collins reports "Wheel stop."
- 10:13 EDT: Crew leaves shuttle.

Wake-up calls



Discovery photographed from the International Space Station as it performs the first ever Rendezvous pitch maneuver.

NASA began a tradition of playing music to astronauts during the Gemini program, which was first used to wake up a flight crew during Apollo 15. Each track is specially chosen, often by their families, and usually has a special meaning to an individual member of the crew, or is applicable to their daily activities.

- Day 2: "I Got You Babe", Sonny and Cher, From the movie "Groundhog Day", played for the entire crew. WAV MP3
- Day 3: "What A Wonderful World", Louis Armstrong, played for Charles Camarda. WAV MP3
- Day 4: "Vertigo", U2, played for Jim Kelly. WAV MP3
- Day 5: "Sanpo" ("Stroll"), from the movie "Tonari no Totoro", composed by Joe Hisaishi and performed by the Japanese School of Houston, played for Soichi Noguchi. WAV MP3
- Day 6: "I'm Goin' Up", Claire Lynch, played for Wendy Lawrence. WAV MP3
- Day 7: "Walk of Life", Dire Straits, played for Steve Robinson. WAV MP3
- Day 8: "Big Rock Candy Mountain", Harry McClintock, played for Andy Thomas. WAV MP3
- Day 9: "Faith of the Heart", Title song of *Star Trek: Enterprise*, Diane Warren performed by Russell Watson, played for Commander Eileen Collins. WAV MP3

- Day 10: "Amarillo by Morning", George Strait, played for the entire crew. WAV MP3
- Day 11: "Anchors Aweigh", The United States Navy, played for Wendy Lawrence. WAV MP3
- Day 12: "The Air Force Song", played for Jim Kelly in congratulations on his promotion to Air Force Colonel. WAV MP3
- Day 13: "The One and Only Flower in the World", SMAP, played for Soichi Noguchi. WAV MP3
- Day 14: "Come On Eileen", Dexys Midnight Runners, played for Eileen Collins. WAV MP3
- Day 15: "Good Day Sunshine", The Beatles, played for the entire crew. WAV MP3

Crew salute to Husband family

On flight day 10, the entire STS-114 crew, and the crew of Expedition 11 gathered to wish Rick Husband's son Matthew, a happy birthday. Rick Husband was the commander of *Columbia* on STS-107.

“ We know it's still August third down there on the planet Earth, and from the Shuttle Discovery we would like to say "Happy birthday" to Matthew Husband, who is ten years old today. And Houston, that wake-up music sure makes me think of Rick Husband's mom, who lives in Amarillo, so we'd like to say "Hi" to Mrs. Husband, too. -*Commander Eileen Collins and Pilot Jim Kelly* ”

Mission parameters



Space Shuttle *Discovery* launches from launch pad 39B at Kennedy Space Center as part of the STS-114 mission

- **Mass:**
 - *Orbiter Liftoff:* 121,483 kilograms (267,820 lb)
 - *Orbiter Landing:* 102,913 kilograms (226,880 lb)
- **Perigee:** -
- **Apogee:** 350.8 kilometres (218.0 mi)
- **Inclination:** 51.6°
- **Velocity:** 27,661 kilometres (17,188 mi)/h
- **Period:** 91.6 min

Contingency planning



STS-114 launch as viewed from the pond near the NASA Kennedy Space Center

Since the loss of *Columbia* in STS-107, it had been suggested that on future shuttle missions there would be a planned rescue capability involving having a second shuttle ready to fly at short notice. Even prior to the sensor problem causing the delay in the launch, a rescue option (called STS-300 by NASA) had been planned, which involved the crew of STS-114 remaining docked at the International Space Station until *Atlantis* could be launched with a four-person crew to retrieve the astronauts. *Discovery* would then be ditched by remote control over the Pacific Ocean, with *Atlantis* bringing back both its own crew, as well as that of *Discovery*.

A further option for rescue would be to use Russian Soyuz spacecraft. Nikolay Sevastyanov, director of the Russian Space Corporation Energia, was reported by *Pravda* as saying: "If necessary, we will be able to bring home nine astronauts on board three Soyuz spacecraft in January and February of the next year".

Chapter- 12

Soyuz TMA-2 & Soyuz TMA-3

Soyuz TMA-2

Soyuz TMA-2

Mission insignia



Mission statistics

Mission name	Soyuz TMA-2
Spacecraft name	Soyuz TMA
Spacecraft mass	7136 kg
Crew size	2 launched / 3 landed
Call sign	<i>Agat</i> (Agate)
Launch pad	Gagarin's Start
Launch date	April 26, 2003 03:53:52 UTC
Landing	October 28, 2003 02:40:20 UTC Near Arkalyk

 49°55'N 66°57'E / 49.917°N
66.95°E

Mission duration 184 days, 22 hours 46 minutes, 28 seconds

Number of orbits ~3,005

Apogee 242 km [\pm 42] km

Perigee 200 km [+7, -22] km

Orbital period 1^h 18^m 38^s [\pm 22.02] ^s

Orbital inclination 51.67° [\pm 0.058]°

Crew photo



Yuri Ivanovich Malenchenko (left) and Edward Tsang Lu

Related missions

Previous mission

Soyuz TMA-1 

Subsequent mission

Soyuz TMA-3 



Soyuz TMA-2 launch

Soyuz TMA-2 was a Soyuz (Russian Союз TMA-2, *Union TMA-2*) mission to the International Space Station (ISS) launched by a Soyuz FG launch vehicle. The spacecraft docked with the ISS 2003-04-28 and undocked 2003-10-27. **Soyuz TMA-2** was the second flight for the *TMA* modification of the Soyuz spacecraft, and the 6th Soyuz to fly to the ISS.

The commander is Yuri Ivanovich Malenchenko (Russia), and flight engineer Edward Tsang Lu (USA), and after docking with the ISS they exchanged with the resident crew on ISS and became the seventh station crew, called "ISS Expedition Seven". As backup crew Alexander Kaleri and Michael Foale stood by.

Crew

Position	Launching Crew	Landing Crew
Commander	Yuri Malenchenko, RKA Expedition 7 Third spaceflight	
Flight Engineer	Edward Tsang Lu, NASA Expedition 7 Third spaceflight	
Flight Engineer	None	Pedro Duque, ESA Second spaceflight

Mission parameters

- **Mass:** 7136 kg
- **Perigee:** 200 km
- **Apogee:** 250 km
- **Inclination:** 51.7°
- **Period:** 88.7 min

Docking with ISS

- **Docked to ISS:** April 28, 2003, 05:56 UTC (to nadir port of Zarya)
- **Undocked from ISS:** October 27, 2003, 23:17 UTC (from nadir port of Zarya)

Mission highlights

Originally the Soyuz missions to the ISS were all planned to be only taxi mission to deliver a new Soyuz spacecraft as the station's lifeboat every six month with a visiting crew, but not for crew exchange. Until the Space Shuttle Columbia disaster the same was planned for Soyuz TMA-2, a visiting crew consisting of commander Gennady Padalka and ESA-astronaut Pedro Duque were to spend about one week at the station and then return with the previous Soyuz TMA-1 spacecraft. The third seat might have gone to the Chilean Klaus von Storch as a Chilean space agency (Agencia Chilena del Espacio) cosmonaut, but even before the Columbia disaster it looked like his flight would not happen, and the seat would go to the Russian cosmonaut Oleg Kotov or to deliver freight to the station.



Soyuz TMA-2 landing

During his stay on the station, Malenchenko became the first person to get married in space. His bride was in Texas where long distance marriages are legal.

The spacecraft returned to Earth on October 28, with both the "Expedition 7" crew as well as Pedro Duque on board. Duque was launched with Soyuz TMA-3 and spent only one

Soyuz TMA-3

Soyuz TMA-3

Mission insignia



Mission statistics

Mission name	Soyuz TMA-3
Spacecraft name	Soyuz TMA
Crew size	3
Call sign	<i>Ingul</i>
Launch pad	Gagarin's Start
Launch date	October 18, 2003 05:38:03 UTC
Landing	April 30, 2004 00:11:15 UTC 50.38° N, 67.20° E
Mission duration	194 days, 18 hours, 33 minutes, 12 seconds
Number of orbits	~3,170
Apogee	227 km
Perigee	193 km
Orbital period	88.6 min
Orbital inclination	51.67°

Crew photo



Related missions

Previous mission

Soyuz TMA-2 

Subsequent mission

Soyuz TMA-4 

Soyuz TMA-3 was a Soyuz (Russian Союз TMA-3, *Union TMA-3*) mission to the International Space Station (ISS) launched by a Soyuz FG launch vehicle which was the third flight for the *TMA* modification of the Soyuz spacecraft, and the 7th Soyuz to fly to the ISS.

Crew

Position	Launching Crew	Landing Crew
Commander	Alexander Kaleri, RKA	Expedition 8
	Fourth spaceflight	
Flight Engineer	Michael Foale, NASA	Expedition 8
	Sixth spaceflight	
Flight Engineer	Pedro Duque, ESA Second spaceflight	André Kuipers, ESA First spaceflight

Mission parameters

- **Mass:** ? kg
- **Perigee:** 193 km
- **Apogee:** 227 km
- **Inclination:** 51.7°
- **Period:** 88.6 min

Docking with ISS

- **Docked to ISS:** October 20, 2003, 07:16 UTC (to Pirs module)
- **Undocked from ISS:** April 29, 2004, 20:52 UTC (from Pirs module)

Specifications

- Max. altitude - 387.1 km
- Min. altitude - 357.9 km
- Period - 91.7 min
- Inclination - 65.64°.

Mission highlights



Soyuz TMA-3 launch.

The commander of the Soyuz was Alexander Kaleri (Russia). The flight engineer was Michael Foale (USA), and Pedro Duque from Spain served as the second flight engineer. After docking with the ISS they exchanged the current crew on ISS and became the eighth station crew, called "ISS Expedition Eight". During the stay on the station Michael Foale was the ISS Commander, while Alexander Kaleri was the engineer. Foale was the first American to have served on both Mir and the ISS. Pedro Duque performed some ESA sponsored science experiments under the mission name *Cervantes* and then returned with the ISS 7 crew on Soyuz TMA-2.

The backup crew was William McArthur, Valery Tokarev and André Kuipers.

Foale and Kaleri along with André Kuipers, the third seater from TMA-4 landed on April 29, 2004, near Arkalyk, Kazakhstan. A minor helium leak did not affect their mission.

Chapter- 13

Planned and Completed Human Spaceflights to the International Space Station

Soyuz TMA-02M

Soyuz TMA-02M C0103 TMA-02M

Mission statistics

Mission name	Soyuz TMA-02M C0103 TMA-02M
Crew size	3
Launch date	May 2011
Landing	November 2011

Crew photo



From left to right: Furukawa, Fossum and Volkov

Related missions

Previous mission	Subsequent mission
 Soyuz TMA-21	Soyuz TMA-22

Soyuz TMA-02M is a planned 2011 flight to the International Space Station. It will transport three members of the Expedition 28 crew to the International Space Station. TMA-02M will be the 110th flight of a Soyuz spacecraft; the first flight launched in 1967. The Soyuz will most likely remain on board the space station for the Expedition 28 increment to serve as an emergency escape vehicle.

Crew

Position	Crew Member
Commander	Sergey Volkov Expedition 28 Second spaceflight
Flight Engineer 1	Michael E. Fossum, NASA Expedition 28 Third spaceflight
Flight Engineer 2	Satoshi Furukawa, JAXA Expedition 28 First spaceflight

STS-135

STS-135

Mission insignia



Mission statistics

Mission name	STS-135
Space shuttle	<i>Atlantis</i>
Launch pad	39A
Launch date	NET 28 June 2011 15:48 EDT
Landing	NET 10 July 2011 11:18 EDT
Mission duration	12 days
Orbital altitude	TBD
Orbital inclination	51.6 degrees
Distance traveled	TBD

Related missions

Previous mission	Subsequent mission
 STS-134	None [Final Mission]

STS-135 is the last planned Space Shuttle mission. It is planned to use the hardware officially being processed for the STS-335 contingency mission, provided that the launch on need rescue mission, designated to support STS-134, is not needed.

While the mission has been authorized, it has no appropriation in the NASA budget, raising questions about whether the mission will fly at all. On January 20, 2011, program managers changed STS-335 to STS-135 on the flight manifest. This allows for training and other mission specific preparations. As of February 13, managers have told their workforce that STS-135 will fly “regardless” of what happens with the funding situation via the Continuing Resolution. Until this point, there had been no official references to STS-135 mission in NASA official documentation for the general public.

During an address at the Marshall Space Flight Center on November 16, 2010, NASA administrator Charles Bolden said that the agency needs to fly STS-135 to the station in 2011 because development of commercial rockets and spacecraft designed to transport cargo to the ISS is likely to be delayed. "We are hoping to fly a third shuttle mission [in addition to STS-133 and STS-134] in June [2011], what everybody calls the launch-on-need mission ... and that's really needed to [buy down] the risk for the development time for commercial cargo," Bolden said.

Space Shuttle *Atlantis* is to fly the 12-day mission; it would be paired with ET-138 in order to minimize chances of foam loss on a mission that does not have a Shuttle LON. STS-134 will fly with a refurbished ET-122, which is otherwise assigned to STS-335 LON. For this mission, *Atlantis* would carry the STS-335 four-person crew (the smallest of any shuttle mission since April 1983 on STS-6) and the Multi-Purpose Logistics Module (MPLM) *Raffaello* and a Lightweight Multi-Purpose Carrier (LMC). The mission is included in NASA's 2011 authorization, signed into law on 11 October 2010, but funding is dependent on a subsequent appropriation bill.

Crew

NASA announced the STS-335/135 crew on September 14, 2010. It will be the only time that a crew of four will fly to the International Space Station. The last shuttle mission to fly with just four crewmembers on board was STS-6, launched on 4 April 1983, 28 years before STS-135, aboard Space Shuttle *Challenger*. The reduced crew size allows the mission to maximize the amount of payload carried to the ISS and also allow for rescue by Soyuz to be performed if necessary. This also limits the crew selection to astronauts who conform to Soyuz ergonomics requirements.

Position	Astronaut
Commander	Christopher Ferguson Third spaceflight
Pilot	Douglas Hurley Second spaceflight
Mission Specialist 1	Sandra Magnus Third spaceflight
Mission Specialist 2	Rex Walheim Third spaceflight

Authorization

With support from both the House of Representatives and the Senate, the fate of STS-135 ultimately depends on whether lawmakers can agree to fund converting the mission from launch-on-need to an actual flight.

On 15 July 2010, a U.S. Senate committee passed the 2010 NASA reauthorization bill, authored by Senator Bill Nelson, to direct NASA to fly an extra space shuttle mission (STS-135) pending a review of safety concerns. The bill still needed the approval of the full Senate. A draft NASA reauthorization bill considered by the House Science & Technology Committee did not provide for an extra shuttle mission. On 22 July 2010 U.S. Rep. Suzanne Kosmas, during a meeting of the House Science Committee, successfully amended the House version of the bill to add an additional shuttle mission to the manifest.

On 5 August 2010, the U.S. Senate passed its version of the NASA reauthorization bill just before lawmakers left for the traditional August recess. On 20 August 2010, NASA managers approved STS-135 mission planning targeting a 28 June 2011 launch. On 29 September 2010 the U.S. House approved the Senate-passed bill on a 304-118 vote. The bill, approved by the U.S. Congress, went to President Barack Obama for his signature.

On 11 October 2010, President of the United States of America Barack Obama signed the legislation into law, allowing NASA to move forward with STS-135, though without specific funding.

As of 20 January 2011, STS-135's designation was officially changed from STS-335. It is targeting a 28 June 2011 launch date but still lacks funding.

As of February 14, 2011, NASA managers announced that STS-135 will fly 'regardless' of the funding situation in Congress.

Flight hardware

The external tank that would be used in this mission would be ET-122 or possibly ET-138. ET-122 had been damaged by Hurricane Katrina when concrete from the roof fell onto the tank, and was consequently removed from the flight manifest. However, the Michoud Assembly Facility is refurbishing the tank to return it to service in time for the potential STS-335 rescue mission. In addition, three partially-built tanks, ET-139, ET-140, and ET-141, have been prepared for accelerated completion in the event that Congress approves a shuttle extension. Finally, a previous-generation tank, ET-94, is currently in storage, but a mission using this tank would have a somewhat lower cargo upmass capability.

Payload

Atlantis would ferry extra supplies to the International Space Station. Since the ISS program has a strong likelihood of being extended to 2020, it is probable that the station will require more spare supplies after the shuttle retires. The shuttle extension would allow for the crew to maintain the completed space station, but an ISS extension is not a guaranteed shuttle program extension. Therefore, the more delivery of excess supplies for the station, the better.

Multi-Purpose Logistics Module

Multi-Purpose Logistics Module (MPLM) *Raffaello* would make up the majority of the payload. The MPLM will be filled with 16 resupply racks, which is the maximum that it can handle.

Lightweight Multi-Purpose Carrier

The Lightweight Multi-Purpose Carrier (LMC) will also be flown on this mission. The External Thermal Cooling System (ECTS) Pump Module (PM) which failed and was replaced on orbit in August 2010 is planned to have a ride home on the LMC, for a failure analysis on the ground. It has not been determined what if anything will ride up to the station on the LMC.

Down-mass payload

The failed ammonia pump module that was replaced in August 2010 is expected to be returned inside Atlantis' payload bay.

Shuttle processing

Early December 2010, ground technicians installed the main engines on Atlantis. The shuttle received the center engine on December 7, 2010, followed by the lower-right engine and the lower-left on 8th and 9th respectively inside Orbiter Processing Facility (OPF-1). To date, the event marked the last set of main engines ever to be installed on a space shuttle.

Mission timeline

Atlantis would rendezvous with the ISS on Flight Day 4 as opposed to the typical Flight Day 3 because the small crew will create more demand on each individual crew-member that cannot be met with existing timelines.

Soyuz TMA-22

Soyuz TMA-22

Союз ТМА-22

Mission statistics

Mission name	Soyuz TMA-22 Союз ТМА-22
Crew size	3
Launch date	September 2011
Landing	March 2012

Related missions

Previous mission	Subsequent mission
Soyuz TMA-02M	Soyuz TMA-03M

Soyuz TMA-22 is a planned 2011 flight to the International Space Station. It will transport three members of the Expedition 29 crew to the International Space Station. TMA-22 will be the 111th flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 29 increment to serve as an emergency escape vehicle.

This will be the final flight of a Soyuz-TMA vehicle, which has been replaced by the modernized TMA-M series.

Crew

Position	Crew Member
Commander	Anton Shkaplerov Expedition 29 First spaceflight
Flight Engineer 1	Sergei Revin Expedition 29 First spaceflight
Flight Engineer 2	Daniel C. Burbank, NASA Expedition 29 Third spaceflight

Soyuz TMA-03M

Soyuz TMA-03M

Союз ТМА-03М

Mission statistics

Mission name	Soyuz TMA-03M Союз ТМА-03М
Crew size	3
Launch date	December 2011
Landing	June 2012

Related missions

Previous mission	Subsequent mission
Soyuz TMA-22	Soyuz TMA-04M

Soyuz TMA-03M is a planned 2011 flight to the International Space Station. It will transport three members of the Expedition 30 crew to the International Space Station. TMA-03M will be the 112th flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 30 increment to serve as an emergency escape vehicle.

Crew

Position	Crew Member
Commander	Oleg Kononenko, Roscosmos Expedition 30 Second spaceflight
Flight Engineer 1	André Kuipers, ESA Expedition 30 Second spaceflight
Flight Engineer 2	Donald Pettit, NASA Expedition 30 Third spaceflight

Soyuz TMA-04M

Soyuz TMA-04M

Союз ТМА-04М

Mission statistics

Mission name	Soyuz TMA-04M Союз ТМА-04М
Crew size	3
Launch date	March 2012
Landing	September 2012

Related missions

Previous mission	Subsequent mission
Soyuz TMA-03M	Soyuz TMA-05M

Soyuz TMA-04M is a planned 2012 flight to the International Space Station. It will transport three members of the Expedition 31 crew to the International Space Station. TMA-04M will be the 113th flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 31 increment to serve as an emergency escape vehicle.

Crew

Position	Crew Member
Commander	Gennady Padalka, Roscosmos Expedition 31 Fourth spaceflight
Flight Engineer 1	Konstantin Valkov, Roscosmos Expedition 31 First spaceflight
Flight Engineer 2	Joseph M. Acaba, NASA Expedition 31 Second spaceflight

Soyuz TMA-05M

Soyuz TMA-05M

Союз ТМА-05М

Mission statistics

Mission name	Soyuz TMA-05M Союз ТМА-05М
Crew size	3
Launch date	May 2012
Landing	November 2012

Related missions

Previous mission	Subsequent mission
Soyuz TMA-04M	Soyuz TMA-06M

Soyuz TMA-05M is a planned 2012 flight to the International Space Station. It will transport three members of the Expedition 32 crew to the International Space Station. TMA-05M will be the 115th flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 32 increment to serve as an emergency escape vehicle.

Crew

Position	Crew Member
Commander	Yuri Malenchenko, Roscosmos Expedition 32 Fifth spaceflight
Flight Engineer 1	Sunita Williams, NASA Expedition 32 Second spaceflight
Flight Engineer 2	Akihiko Hoshide, JAXA Expedition 32 Second spaceflight

Soyuz TMA-06M

Soyuz TMA-06M

Союз ТМА-06М

Mission statistics

Mission name	Soyuz TMA-06M Союз ТМА-06М
Crew size	3
Launch date	September 2012
Landing	March 2013

Related missions

Previous mission	Subsequent mission
Soyuz TMA-05M	Soyuz TMA-07M

Soyuz TMA-06M is a planned 2012 flight to the International Space Station. It will transport three members of the Expedition 33 crew to the International Space Station. TMA-06M will be the 116th flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 33 increment to serve as an emergency escape vehicle.

Crew

Position	Crew Member
Commander	Oleg Novitskiy, Roscosmos Expedition 33 First spaceflight
Flight Engineer 1	Evgeny Tarelkin, Roscosmos Expedition 33 First spaceflight
Flight Engineer 2	Kevin A. Ford, NASA Expedition 33 Second spaceflight

Soyuz TMA-07M

Soyuz TMA-07M

Союз ТМА-07М

Mission statistics

Mission name	Soyuz TMA-07M Союз ТМА-07М
Crew size	3
Launch date	November 2012
Landing	May 2013

Related missions

Previous mission	Subsequent mission
Soyuz TMA-06M	Soyuz TMA-08M

Soyuz TMA-07M is a planned 2012 flight to the International Space Station. It will transport three members of the Expedition 34 crew to the International Space Station. TMA-07M will be the 117th flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 35 increment to serve as an emergency escape vehicle.

Crew

Position	Crew Member
Commander	Roman Romanenko, RSA Expedition 34 Second spaceflight
Flight Engineer 1	Thomas Marshburn, NASA Expedition 34 Second spaceflight
Flight Engineer 2	Chris Hadfield, CSA Expedition 34 Third spaceflight

Soyuz TMA-08M

Soyuz TMA-08M

Союз ТМА-08М

Mission statistics

Mission name	Soyuz TMA-08M Союз ТМА-08М
Crew size	3
Launch date	March 2013
Landing	September 2013

Related missions

Previous mission	Subsequent mission
Soyuz TMA-07M	Soyuz TMA-09M

Soyuz TMA-08M is a planned 2013 flight to the International Space Station. It will transport three members of the Expedition 35 crew to the International Space Station. TMA-08M will be the 118th flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 36 increment to serve as an emergency escape vehicle.

Crew

Position	Crew Member
Commander	Pavel Vinogradov, RSA Expedition 35 Third spaceflight
Flight Engineer 1	Aleksandr Misurkin, RSA Expedition 35 First spaceflight
Flight Engineer 2	Christopher Cassidy, NASA Expedition 35 Second spaceflight

Soyuz TMA-09M

Soyuz TMA-09M Союз ТМА-09М

Mission statistics

Mission name	Soyuz TMA-09M Союз ТМА-09М
Crew size	3
Launch date	May 2013
Landing	November 2013

Related missions

Previous mission	Subsequent mission
Soyuz TMA-08M	Soyuz TMA-10M

Soyuz TMA-09M is a planned 2013 flight to the International Space Station. It will transport three members of the Expedition 36 crew to the International Space Station. TMA-09M will be the 119th flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 37 increment to serve as an emergency escape vehicle.

The three person crew of Soyuz TMA-09M, Maksim Surayev, Karen Nyberg and Luca Parmitano represent the partner organizations of Roscosmos, NASA and the European Space Agency (ESA) in the ISS program.

Crew

Position	Crew Member
Commander	Maksim Surayev, RSA Expedition 36 Second spaceflight
Flight Engineer 1	Karen L. Nyberg, NASA Expedition 36 Second spaceflight
Flight Engineer 2	Luca Parmitano, ESA Expedition 36 First spaceflight

Soyuz TMA-11M

Soyuz TMA-11M

Союз ТМА-11М

Mission statistics

Mission name	Soyuz TMA-11M Союз ТМА-11М
Crew size	3
Launch date	November 2013
Landing	May 2014

Related missions

Previous mission	Subsequent mission
Soyuz TMA-10M	Soyuz TMA-12M

Soyuz TMA-11M is a planned 2013 flight to the International Space Station. It will transport three members of the Expedition 38 crew to the International Space Station. TMA-11M will be the 121st flight of a Soyuz spacecraft, the first flight launching in 1967. The Soyuz will most likely remain on board the space station for the Expedition 39 increment to serve as an emergency escape vehicle.

Crew

Position	Crew Member
Commander	TBD, RSA Expedition 38
Flight Engineer 1	Richard Mastracchio, NASA Expedition 38 Fourth spaceflight
Flight Engineer 2	Koichi Wakata, JAXA Expedition 38 Fourth spaceflight