

Mir Principal Expedition 17

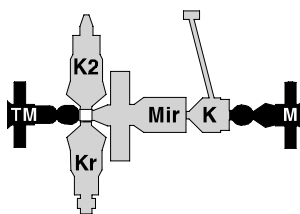
Commander Alexandr Viktorenko
 Flight Engineer Yelena Kondakova
 Cosmonaut Researcher Valeri Polyakov
 Crew code name: Vityaz
 Launched and landed in Soyuz-TM 20,
 October 3, 1994 - March 22, 1995
 169 days in space

Highlights: Mir 17 hosted the first ESA mission aboard Mir, Euromir 94, which ended November 4. Another international milestone was the rendezvous of the Space Shuttle Atlantis on its mission STS-63 with Mir. A new human spaceflight duration record was established by Polyakov with his 438-day stay on the station.

Background: In mid-November of 1994 (at the close of D.S.F. Portree's "Mir Hardware Heritage"), the Mir space station complex, shown in figure 2, included these modules:

- The Kvant astrophysics module (added April 9, 1987)
- The Kvant 2 augmentation module (added December 6, 1989)
- The Kristall technology module (added June 10, 1990)
- Soyuz-TM 20, which on October 6, 1994, had delivered two members of the Mir Principal Expedition 17 crew, Commander Alexandr Viktorenko and Flight Engineer Yelena Kondakova, and Euromir 94 astronaut Ulf Merbold. They joined Valeri Polyakov, a station resident since the beginning of Principal Expedition 15 in January 1994.
- Progress-M 25, a cargo resupply ship which had docked with the complex on November 13, 1994, to deliver water, fuel, food, and materials for repairs, including parts for the CSK-1 materials processing furnace.

**November 13, 1994 -
 February 6, 1995**

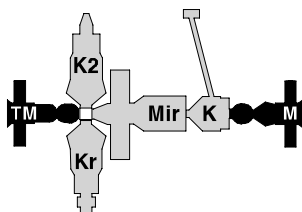


**Kvant 2
 Soyuz-TM 20 - Mir - Kvant - Progress-M 25
 Kristall**

November activities. After completion of the Euromir 94 experiment program and departure of ESA astronaut Ulf Merbold on November 4, the cosmonauts continued with medical and health studies. Progress-M 25 arrived on the 13th. The crew unloaded its cargo, then installed new equipment and oversaw the refueling of the base block tanks. The base block completed its 50,000th Earth orbit on November 18.

A busy end to 1994. Throughout December, the crew's work included physiological, medical, and astrophysical studies, as well as measurement of noise intensity in the station's habitable areas. Using the French Nausica apparatus, they measured radiation levels in low Earth orbit. They took data on micrometeorite fluxes along the velocity vector of the station as part of an experiment to determine the effects of the orbital environment on materials and equipment mounted on the exterior of the complex.¹

**November 13, 1994 -
February 6, 1995**



Continued

New communications relay satellite. The Luch-1 geostationary satellite was launched from Baikonur on December 16, 1994, as an additional relay station for Mir and TsUP communications, to become operational in 1995.

Experiments continue as new year in space begins. The Mir 17 crew continued astrophysical experiments using the Roentgen Observatory and Maria-2 equipment, technological research using the Gallar furnace, and biotechnical research using the Maksat experiments to study the effect of spaceflight on various biological cultures.²

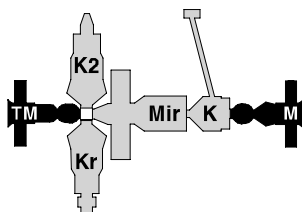
Polyakov breaks spaceflight record. On January 9, Polyakov had been aboard the station 366 consecutive days, surpassing the 365-day record set by Vladimir Titov and Musa Manarov on Mir from December 21, 1987, through December 21, 1988.³ Adding his previous 242-day Mir mission, Polyakov now had the distinction of having spent more time in space than any other person—a total of 607 days.

Test of Kurs automatic docking system. The crew entered Soyuz-TM 20 on January 11 to conduct a test of the Kurs docking system. During its docking on October 6, the Soyuz vehicle began to yaw during final approach to the forward port, necessitating a manual docking. Progress-M 24 had also experienced docking problems at this port in August.⁴ To analyze reasons for these anomalies, Viktorenko undocked the Soyuz and moved away from the station to a distance of 160 m. The Kurs was then activated, and the Soyuz was guided to a successful redocking within 26 min of the undocking. Results of the tests showed that system deviations during approach were only 0.5°, considered within acceptable limits.⁵

Habitability problems. With instructions from the Russian Mission Control Center, (TsUP), the crew worked on technical problems with the heating system, drinking water, pressure control, and a water leak in the Kristall module. On January 23, Viktorenko adjusted the station's attitude so that the Kristall solar panels could deliver maximum energy for onboard power. In addition, the crew took images of the earthquake site in Kobe, Japan.⁶

Discovery launch. Originally scheduled for February 2, the STS-63 launch was delayed by a failure in inertial measurement unit (IMU) #2. Although the Orbiter can fly with only one of its three IMUs operational, the failed unit was replaced and launch was rescheduled for 24 hr later. On February 3, at 12:22 a.m. EST, Discovery was successfully launched with its crew of six, including cosmonaut Titov. Nine hr later, at an altitude of 190 nmi, Commander Wetherbee placed Discovery on an intercept course with Mir, some 7000 nmi behind the station.⁷

**November 13, 1994 -
February 6, 1995**



Concluded

Discovery thruster problems. Two reaction control system (RCS) thruster problems occurred during launch: the failure of L2D and a leak in R1U. The redundancy of Orbiter thruster systems and the tendency of leaks to clear once thrusters are warmed up seemed assurances of Discovery's ability to comply with the flight rule that all its aft thrusters must be operational before it moves within 300 m of Mir. However, the slow R1U leak persisted despite the positioning of Discovery so that the sun would warm the leaking jet. Then on February 4 another leak was detected, this time in forward RCS thruster F1F.⁸

STS-63 Mission Highlights

February 3-10, 1995

Commander James D. Wetherbee

Pilot Eileen M. Collins

Pilot Michael Foale

Mission Specialist Janice E. Voss

Mission Specialist Bernard A. Harris, Jr.

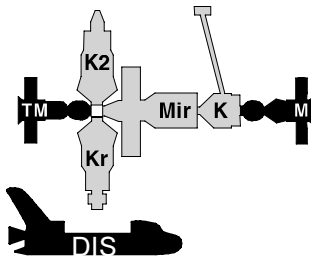
Cosmonaut Vladimir Titov

STS-63 was the first of the series of joint U.S.-Russian missions planned as part of Phase I of the International Space Station. The primary STS-63 mission objective was to rendezvous with and fly around Mir at a distance of 10 m to verify flight techniques, communications, and navigation aid sensor interfaces in preparation for the STS-71 docking of Atlantis with Mir in May. Also, NASA cooperated with the Russian Institute for Biomedical Problems to study radiobiological effects and sensory motor performance.⁹ In keeping with the theme of cooperation, Russian cosmonaut Vladimir Titov was aboard as a member of the STS-63 crew. Titov was the second cosmonaut to fly with an STS crew. Sergei Krikalev had flown on Discovery, launched exactly a year before for STS-60.¹⁰ For the STS-63 mission, Discovery, on its 20th flight, carried nine payloads, among them the Spacehab module with its 20 assorted experiments and the Spartan-204 free-flying retrievable astronomy platform.

Flight team cooperation. The concern of both U.S. and Russian ground control about the leaks inspired close cooperation between the two teams. By February 5 the Discovery crew had stopped the F1F leak by allowing pressure to build up in the manifold and then commanding the thruster to fire, thus clearing out residual fuel in the thruster. However, the same procedure did not work on the R1U thruster. As Discovery continued to draw closer to Mir, the two ground control teams reached an

agreement on proceeding with the rendezvous despite the leak. In the agreement, the right RCS manifold providing fuel to R1U would be closed before Discovery came within 300 m (984 ft) of Mir; the crew would back out to 122 m (400 ft) and hold position if any further RCS thruster capability was lost; and Discovery would go no closer to Mir than 10 m (32.8 ft) in any event.^{11,12} Vladimir A. Solovyov, director of TsUP, later said that the historic Mir/Discovery rendezvous showed both nations that “The realities of the Shuttle-Mir program are more complicated than we had thought.”¹³

February 6-8, 1995



Kvant 2
Soyuz-TM 20 - Mir - Kvant - Progress-M 25
Kristall

Discovery

Rendezvous at last. As Discovery’s crew began their early morning preparations for the rendezvous, two flight options were still being considered: one would put Discovery about 10 m (32.8 ft) from Mir at its closest point; in the other, it would approach no closer than 122 m (400 ft). Between 8 a.m. and 9 a.m. EST, the crew fired Discovery’s engines twice to decrease the rate at which the Orbiter was overtaking Mir. By 12:59 p.m. EST, when Discovery was about 518 m (1700 ft) from Mir, the Mir crew could see Wetherbee waving from his window. At 1:22 p.m. EST, Discovery matched the velocity vector of Mir and linked up orbits at 128 m (422 ft). During the hour that it stayed in this position, the crews downlinked video of each other. Vladimir Titov used a handset for ham radio communications with his countrymen.¹⁴

Closest approach. At 2:23 p.m. EST, over the Pacific Ocean at an altitude of 213 nmi, Wetherbee and pilot Eileen Collins brought Discovery within 11 m (36 ft) of Mir, where it remained stable for 10 min in a position opposite the docking port of Kristall. Wetherbee said, “As we bring our ships closer together, we bring our nations closer together.” Viktorenko congratulated Wetherbee on a flawless approach.¹⁵

Discovery fly-around. After the close encounter, Discovery backed out to 400 ft and began fly-around operations. “It was like dancing in the cosmos,” reported Wetherbee. He and his crew collected data for the May docking of Atlantis with the station and took more than 400 photographs of Mir to be used in orbital debris effects studies.¹⁶ Figure 3 is a view of the station from Discovery.

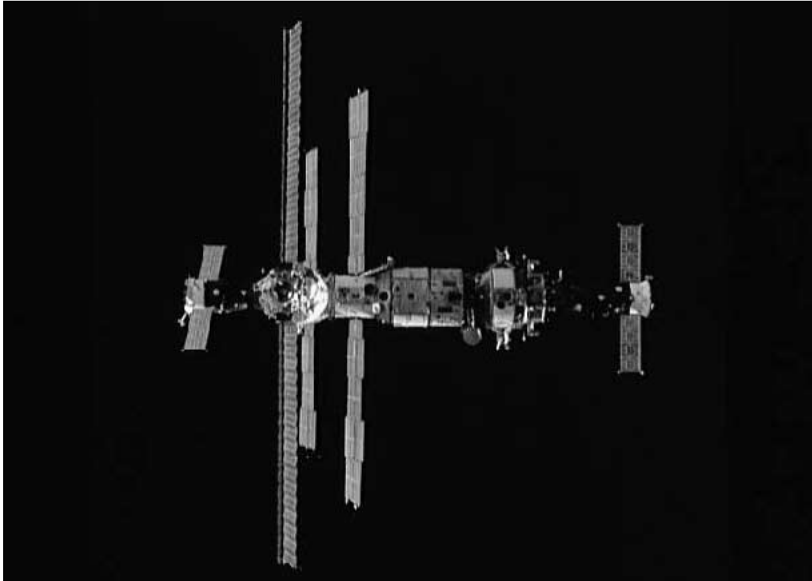


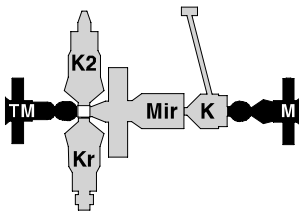
Figure 3. The Mir space station, photographed from the Space Shuttle Discovery during February 6, 1995, rendezvous operations.

February 8-16, 1995

Kvant 2

Soyuz-TM 20 - Mir - Kvant - Progress-M 25

Kristall

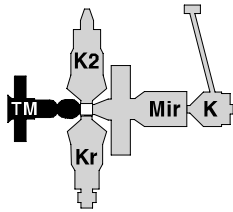


Rendezvous complete. At 4:13 p.m. EST on February 8, Discovery initiated a burn to depart to its own orbit (214 nmi x 207 nmi), where it was by 6:23 p.m. EST. According to Viktorenko, Discovery's thruster firings had not affected Mir's solar arrays.¹⁷ The two crews resumed their separate tasks, which for Discovery included release of the Spartan 204 satellite and an EVA by astronauts Bernard Harris and Michael Foale in which Harris manually manipulated the satellite to gain experience with handling of large objects in space.¹⁸ On the Mir complex, Polyakov trained at the controls of Soyuz-TM 20 as part of emergency preparedness. He also spoke with the astronauts by radio, congratulating them on their successful EVA.¹⁹

STS-63 mission ends. About 850 nmi from Discovery, Mir performed an on-orbit maneuver on February 10 that enabled the Orbiter crew to see the station like a small flashing star near the horizon. At 6:51 a.m. EST, Discovery touched down at Kennedy Space Center, completing its 20th flight.

Progress-M 26 launch. On February 15, Progress-M 26 was launched from Baikonur with a large cargo of supplies for the station and its occupants: water, food, oxygen, medical goods, fuel, oxidizers, and materials for repair of onboard systems. It also carried hardware and software for experiments by American astronaut Norm Thagard during his upcoming stint on Mir.²⁰

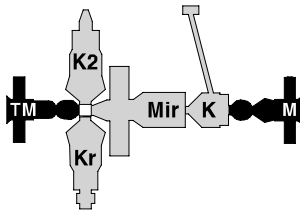
February 16-17, 1995



**Kvant 2
Soyuz-TM 20 - Mir - Kvant
Kristall**

Progress-M 25 undocks. To make room for its successor, Progress-M 25 left the Kvant docking port on February 16 for a destructive reentry over the Pacific, east of New Zealand.

**February 17 -
March 15, 1995**



**Kvant 2
Soyuz-TM 20 - Mir - Kvant - Progress-M 26
Kristall**

No docking problems for this Progress-M. On February 17, Progress-M 26 docked successfully under control of the Kurs system. The crew had to remove obstructing cargo before they could enter the module and begin unloading the supplies.²¹

Ninth anniversary of Mir launch. The Mir 17 crew celebrated the ninth anniversary of the Mir base block launch on February 19. Throughout the remainder of the month and the early part of March, they continued with astrophysics experiments. They also prepared for their departure from Mir and the arrival of the Mir Principal Expedition 18 crew.²²
