

D2 mission 20 years ago – clawed frogs and crystals in microgravity

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"Go for Spacelab activities," confirmed NASA Mission Control Center on 26 April 1993 at 18:51 CET. German astronauts Hans Schlegel and Ulrich Walter and their United States colleagues had to wait almost two months until, with this command, the D2 mission could finally begin. Leaking solid fuel rockets, payload bay doors that would not close, and a burst hydraulic line had meant numerous postponements for launch. On 22 March a faulty valve caused the onboard computer to abort the launch after the main engines had been ignited. The D2 mission, where 88 experiments would be conducted in microgravity in the Spacelab, tried the patience of every participant. A successful launch finally changed their luck; Schlegel and Walter actually carried out the first medical experiments on the way to space. There were round-the-clock shifts in the German Space Operations Center, operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), as all the experiments were being monitored and controlled from there.

Shifts in space and on the ground

"Dear Mr Schlegel, dear Mr Walter, you will surely be pleased to be able to begin your work in orbit following many years of intensive preparation, and after the delays you've encountered," came the message from German Federal Chancellor Helmut Kohl in a telex message to the astronauts. He wished them much success in completing the demanding scientific programme. The crew of the Russian space station MIR radioed: "We congratulate Columbia's US and German crew on their successful launch. Good luck on your flight!" Mission manager Hauke Dodeck from DLR is even more succinct when he speaks of the D2 mission: "It was a very busy time." Not only was the team on the ground working around the clock, the astronauts were also split into two shifts and alternated between experiment sessions. Every minute in microgravity was valuable – the mission was scheduled to last nine days.

Eighty-eight international experiments

One onboard camera looked at the Milky Way, another photographed Earth's surface. In the biolaboratory, larvae of the South African clawed frog and the tilapia splashed around as their reaction to microgravity was monitored. Tobacco, sunflowers and foxgloves were also sent on the trip into microgravity – their cells were expected to merge in space. Ulrich Walter pedalled on the bicycle ergometer and recorded the composition of his breath as he did so. Hans Schlegel grew gallium arsenide crystals in the MEDEA unit. With a total of 88 European, United States and Japanese experiments, the D2 mission surpassed its predecessor mission D1, which went into orbit in 1985. In the control centre at the DLR site in Oberpfaffenhofen, Hauke Dodeck and his team generated a status report each evening, and updated the timelines for the mission. "The DLR Space Operations Center was responsible for operation of the entire payload."

Remote-controlled robotic arm

A small die floating in weightlessness caused a sensation. On 2 May, a DLR scientist from Gerd Hirzinger's team in Oberpfaffenhofen was controlling the ROTEX robotic arm from the ground as it caught the die under remote control 300 kilometres above Earth. It was the first time in the history of spaceflight that a robot had caught an object in space while being remotely controlled. Today, 20 years later, scientists at the DLR Robotics and Mechatronics Center are working on the MIROSURGE robotic system, which is designed to support surgeons via 'remote control' during operations. 'Justin' the robot is controlled via telepresence and could help astronauts with

maintenance work in space, and under project DEOS, it would grasp defective satellites in space and repair them.



Press conference after returning from the D2 mission in 1993. The crew members, including Ulrich Walter and Hans Schlegel, report on the progress of the mission and completed experiments.

An extra day for the mission

The good news finally came on the seventh day; the energy supply was enough for a tenth day of the mission. "That was valuable time," recalls mission manager Hauke Dodeck. Among other things, the physical tests on materials were continued, the Anthro-Rack medical laboratory remained in operation, and ROTEX was used for other tasks. The extra day also helped with the development of another experiment: without physical intrusion, astronaut Hans Schlegel used ballistocardiography to measure the oscillations that the heartbeat exerts on the body – an experiment that scientists at the DLR Institute of Aerospace Medicine, the University of Witten-Herdecke, Hannover Medical School, the Belgian Royal Military Academy and the University of California repeated with astronaut Hans Schlegel on DLR's 22 parabolic flight campaign.

"Much has happened in the 20 years since the D2 mission. The Space Shuttles are no longer flying, and there is an International Space Station permanently orbiting the Earth as a research laboratory. However, the D2 mission is, and remains in hindsight, an important milestone with important research results," says Dodeck. The astronauts finally returned to Earth on 6 May 1993. But this time it was the weather that thwarted the carefully laid plans: instead of landing in Florida, the D2 crew had to touch down at Edwards Air Force Base in California.

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D2 Crew



The crew of the German D2 mission: Hans Schlegel, Ulrich Walter, Steven Nagel, Terence Herricks, Jerry Ross, Charles Precourt and Bernhard Harris.

Credit: NASA.

Launch of the Space Shuttle Columbia on the D2 mission



The Space Shuttle Columbia was launched for the 10-day D2 mission on 26 April 1993. During the mission 88 experiments were carried out in the Spacelab.

Credit: NASA.

Ulrich Walter in the Spacelab



Astronaut Ulrich Walter was part of the team launched into space with the D2 mission on 26 April 1993.

Credit: NASA.

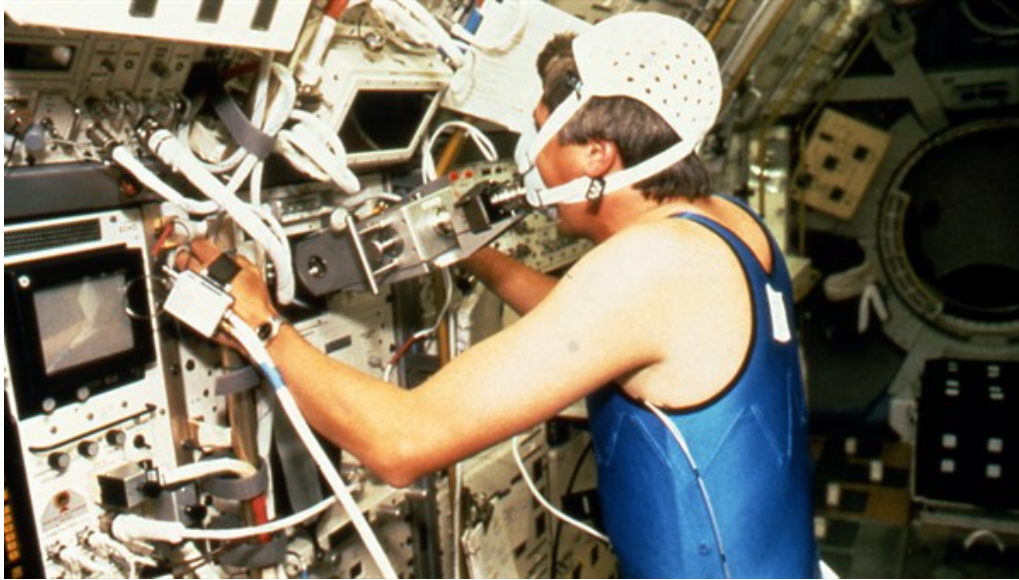
Hans Schlegel during the D2 mission



Astronaut Hans Schlegel in the Spacelab wearing an ultrasonic measurement device on his forehead. Under the AR-TISSU experiment, tissue thickness and stability along the axis of the body were studied under microgravity conditions. The picture was taken during the 1993 D2 mission.

Credit: DLR (CC-BY 3.0).

Science on the bicycle ergometer



Astronaut Ulrich Walter analysed his respiration as he rode the bicycle ergometer. The experiment is one of 88 carried out during the 1993 D2 mission.

Credit: NASA.

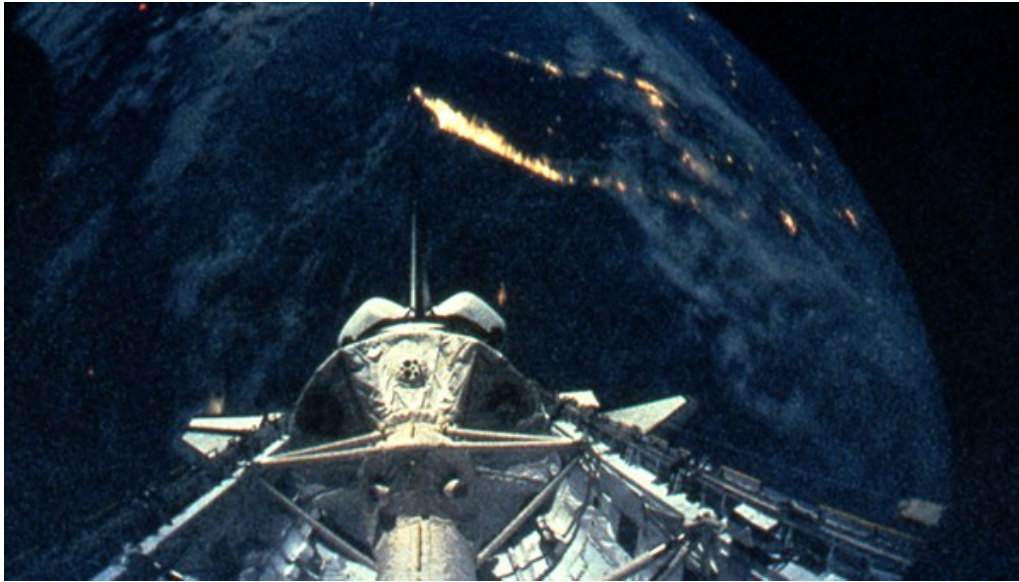
Shifts for the D2 mission



During the D2 mission, consoles at the German Space Operations Center, run by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), were manned around the clock. From there, the engineers monitored and controlled all the experiments.

Credit: DLR (CC-BY 3.0).

View of Earth



The D2 mission carried two cameras on board – one was directed towards the Milky Way, while the second took photos of the Earth.

Credit: NASA.

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