GOLDEN JUBILEE OF BIG DATA IN WEILHEIM

Fifty years ago, the term Big Data was not yet widely known. And yet, in the small town of Weilheim, Big Data was the order of the day – a ground station was set up there to receive data from space. In mid-October 1966, the then German Federal Ministry of Scientific Research (Bundesministerium für wissenschaftliche Forschung; BMwF) mandated the German research institute for aviation (Deutsche Versuchsanstalt für Luftfahrt; DVL) to design, build and operate a central station for the German ground station system (Zentralstation des deutschen Bodenstations-systems; Z-DBS). The Institute for Aircraft Radio and Microwaves at the time – today the DLR Microwaves and Radar Institute – took on the mammoth task. The approaching launch of the first German satellite, AZUR, gave momentum to the construction of the ground station in Weilheim in October 1966. This momentum would accompany the placid town of Weilheim from that moment onwards.

The DLR ground station in the Bavarian town of Weilheim has been the reliable link between satellites and Earth for half a century

By Miriam Poetter

AZUR – the first German research satellite

With the launch of the research satellite AZUR on 8 November 1969 at 02:52 CET, the Federal Republic of Germany joined the group of nations with satellites in space. AZUR weighed 72 kilograms and was launched from Vandenberg, California, on board a Scout rocket. On 15 November 1969, operation of the satellite was handed over to the control centre in Oberpfaffenhofen, which was set up especially for the task. The control centre was run by the German research institute for aviation and spaceflight (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt; DFVLR) – the precursor to DLR. The data was received by antennas at the ground station in Weilheim.

The research satellite was used to investigate cosmic radiation and its interaction with the magnetosphere, especially the inner Van Allen Belt. Earth's aurorae and time-dependent changes in the solar wind during solar flares were also on the agenda. "There was already a great deal of scientific interest in such information at the time," says Martin Häusler, Head of the Weilheim Ground Station. "More than 100 experiments were proposed, of which seven were selected for the actual mission. In addition, the German-US cooperation was intended to expand the technological capabilities of German industry and give Germany the necessary expertise in the complex management of space missions." But five weeks after the launch, the

The landmark of the Weilheim ground station: the 30-metre antenna. It was built to send commands to the HELIOS 1 and 2 spacecraft, which were launched in 1974 and 1976 respectively.

1967 Construction site

1967 Foundation

1968 Antenna construction

1968 Interior construction of the operating room

1971 VHF interferometer for measuring satellite orbits

1972 Construction work on the HELIOS command station

2016 EDRS antennas

magnetic tape storage device malfunctioned – this meant that, from that moment onwards, measurement values and control data could only be received in real time. As a result, the data stream was reduced to 80 percent of the desired volume. "Although the satellite did not reach its expected lifespan of at least one year (contact with AZUR was lost on 29 June 1970 for causes still unknown), the mission was a great success for research and industry," Häusler adds. "The first German long-term undertaking in space gave us a wealth of valuable knowledge and provided a great deal of momentum for subsequent missions."

European Data Relay System delivers enormous volumes of data

One such follow-on mission is EDRS, the European Data Relay System. Europe's data highway in space is the latest Weilheim mission to produce huge volumes of data. With EDRS, the participating countries have set themselves the goal of improving contact with research satellites in orbit in future. On 11 September 2013, two heavyweight reflectors worth several million euro were placed on the antenna bases. The two parabolic mirrors, each with a six-metre diameter, are made of aluminium and ground with a precision down to a tenth of a millimetre. The foundations penetrate three metres into Weilheim's clay soil. Two antennas have also been set up in the United Kingdom and Belgium. All of the antennas are operated from the ground station in Weilheim.

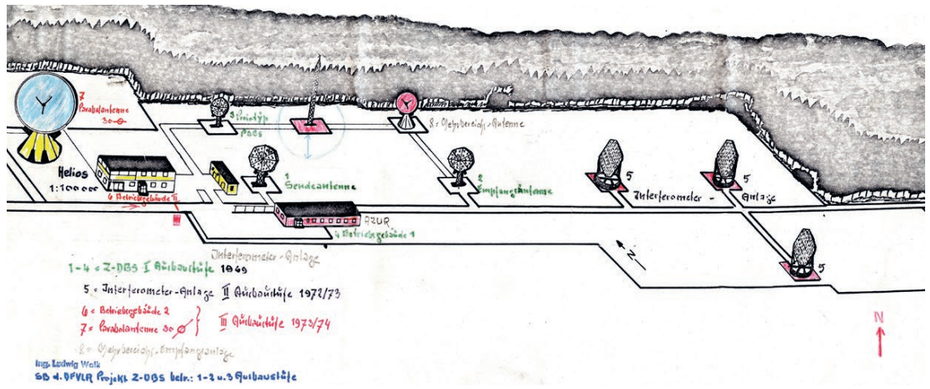
EDRS is a new space- and ground-based infrastructure that uses cutting-edge laser technology to deliver large volumes of data – up to 50 terabytes per day – in near-real time. "EDRS will dramatically improve access to time-critical data. This will, for example, shorten the response times of emergency services. Satellite connections cannot always be readily made available. Missions often have special requirements in terms of data capacity, signal processing and frequency ranges; and some satellite connections are only possible under certain circumstances," Häusler explains. To be able to meet individual mission requirements, the transmitting and receiving antennas must be adjusted. In some cases, new antennas are even designed for specific missions, for instance EDRS.

The Weilheim ground station – a big undertaking

The Weilheim satellite ground station has participated in more than 165 satellite launches, supporting DLR's own satellites, along with those of other space agencies such as NASA (USA), CNES (France) and JAXA (Japan) in addition to a few space missions to distant planets or asteroids. Commercial satellite operators such as Telesat, Intelsat, Eutelsat and SES Astra also use the Weilheim ground station to position their communications satellites and for emergency situations in satellite operation. In the last 50 years, Germany's space industry has developed a high level of competency – both for extra-terrestrial and Earth observation missions. The Weilheim ground station is operated 24 hours, seven days a week. A total of 27 staff members are employed there.

In addition to its role as a data link with space, the Weilheim ground station has a new task these days: testing satellites in orbit. In-orbit tests (IOTs) provide a satellite operator with evidence that a satellite is functioning flawlessly. Much like a certification body, the ground station tests the performance parameters of the satellite.

Aerial view of the Weilheim antenna station (2016)



Planned expansion stages of the ground station in Weilheim in a historical sketch by Ludwig Walk, special representative of the DVL administration for land acquisition and basic development of the station of the German ground station system.

OF FEEDS AND MASERS

Interview with Klaus Wiedemann, Deputy Head of the Ground Station

Mr Wiedemann, you are currently installing a combi-feed in the 30-metre antenna. What is that?
: The feed is the key element in an antenna. It determines the frequency range of the antenna. The antenna is currently being used by scientists for the Galileo navigation satellites and for the Japanese Hayabusa2 mission, which carries DLR's MASCOT lander on board.

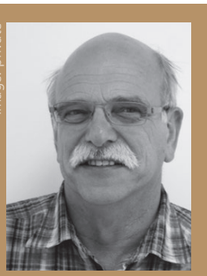
What is special about your current project?
: Since the antenna is being used for two missions, we have to repeatedly install and remove the respective feeds. The Galileo mission requires a feed for the L-band, and Hayabusa2 requires a feed for the X-band. This is very time consuming. At the moment, it is still quite manageable, as the Japanese space agency JAXA has only booked a few contact times for the Hayabusa2 spacecraft. But that will change in 2018 and we will need the combi-feed, which can receive both signals.

What was your first project in Weilheim?
: I was one of the contractors that worked for DLR in the 1970s. In 1975, I was employed by General Electric. The HELIOS mission was underway. My workstation was a container in the Eifel in Effelsberg. We used the 100-metre antenna – a radio telescope of the Max Planck Society – to receive data from the HELIOS mission. Our 30-metre antenna in Weilheim was still just a transmitting antenna at the time. When it was repurposed into a dual-purpose (transmitter and receiver) antenna in 1976, we were able to use the site in Weilheim for the HELIOS mission.

The HELIOS mission came to an end in 1986. What followed?
: After I became a permanent DLR staff member in 1990, I was responsible for the maintenance of the masers – the preamplifiers that provide low-noise reception. The masers needed to be cooled to minus 270 degrees Celsius, which significantly reduced signal noise. We achieved these low temperatures using a cooling circuit based on liquid helium. It was a very laborious process. After the HELIOS mission, which used an S-band maser, an X-band maser was installed that was used until the antenna was decommissioned in 2009. When the 30-metre antenna resumed operations in 2011, but was no longer being used for receiving signals from deep space, we removed the maser. The Max Planck Society has recently asked to use our maser. We are of course delighted to make it available to them.

Which result was most special to you?
: Spitzbergen. We carried out a compatibility test for the SAR-Lupe mission there in 2005. Before a satellite launch, you need to test whether the satellite and the ground station are compatible. Since the military satellite SAR-Lupe flies in a polar orbit, its visibility in the far north is greater than elsewhere. So, Spitzbergen is home to a polar station. All the roads were snowed in. The launch time was approaching, and we could not wait for the weather to improve. So we set off for the ground station on touring skis. That was quite an adventure.

Image: private



Klaus Wiedemann
born in 1953 in Wiesbaden, has two children and lives in Peissenberg. After his apprenticeship at the Telecommunications Office, he studied communications engineering at the University of Applied Sciences in Wiesbaden. Today, he is Deputy Head of the Weilheim ground station.

NEW TERRITORY ON THE ROAD TO HIGH TECHNOLOGY

A conversation with eyewitnesses

Miriam Poetter, responsible for communications at the DLR sites in Oberpfaffenhofen, Augsburg and Weilheim, spoke with two veteran employees – David Hounam and Winfried Poetzsch – about the first days of the Weilheim antenna station.

In the beginning, two locations were considered for the antenna station – Weilheim in Upper Bavaria and Buchheim in Baden-Württemberg. Weilheim was the one chosen. What tipped the scales?

: David Hounam A ground station requires a location with limited radio interference. The fields on which the Weilheim station was finally built are nestled entirely within a basin. That is ideal. With long wavelengths, which we initially used, even the slightest interference was noticeable. At the time we were overcautious, as we had no experience in building such stations. For example, driving a car directly into the premises was forbidden. In general, the subject of space was treated with great respect.

: Winfried Poetzsch The site consisted of many small plots of land that were purchased from farmers in 1966. Ludwig Walk, our colleague looking after the procurement, wandered from farmer to farmer and probably also had to have more than one beer with them. One of the farmers even forced him to take his ox, as he had no grazing land left for it. So we bought the animal. The ox later found a home at another farm.

Construction of the station began in 1967. What were your duties?

: Winfried Poetzsch They were varied. From 1968, I was part of the team developing the programme control unit for the transmitting and receiving station for the AZUR satellite. Later, I built the synchroniser for the high-speed data line (HSDL) for the link to the HELIOS spacecraft. That was something very special as HELIOS was the first US-German interplanetary mission. After the launches in 1974 and 1976, the two HELIOS spacecraft – built in Germany by MBB – approached the Sun, getting closer to it than the innermost planet, Mercury, and closer than any previous space probe. The probes used complementary measurements to investigate the interaction between the Sun and Earth. The HELIOS Deep Space Antenna is still the biggest antenna on the site today; the 30-metre mirror is visible from a distance.

Another project was the VHF interferometer, which David and I both worked on. VHF stands for Very High Frequency. In fact, it involved positioning three movable, diamond-shaped antennas. By tracking a transmitted signal, you can measure the orbit of a satellite from a single location with extreme accuracy. The interferometer was primarily set up for determining the orbits of the Franco-German SYMPHONIE satellites. These experimental, geostationary communications satellites were launched in the mid-1970s. The interferometer fulfilled all expectations and only became obsolete when the VHF band was dropped. These were demanding projects, but a great time.

: David Hounam I was also in the interferometer group. I was responsible for both the high-precision reception equipment and for calibrating the interferometer. In the late 1970s, the Institute of Aircraft Radio and Microwaves switched to remote sensing, and contact with the ground station in Lichtenau died off. Apart from a five-year spell with the European Space Agency in The Netherlands (ESTEC) in the 1980s, I stayed at DLR until my retirement.

What memories do you have of that early period?

: Winfried Poetzsch For many years, we commuted between Oberpfaffenhofen and Weilheim, often using just a rusty Ford Transit. All those years, it took us – quite often with a bucket of food – on the 45-kilometre stretch from the institute in Oberpfaffenhofen to Weilheim. We brought along all the tools and materials we would need on site every time.

: David Hounam The satellite launches, and especially the interferometer calibration, are unforgettable, of course. The calibrations were always carried out at night, as you had to locate a spotlight on a high-flying aircraft when doing so. However, although there were also difficulties, I most fondly recall the times with the team in Weilheim – they were particularly quick-witted and humorous.

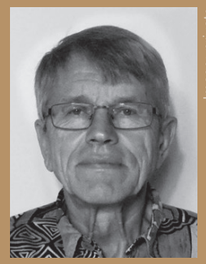
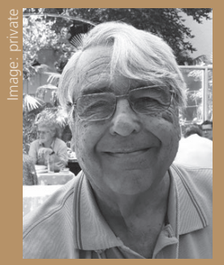


Image: private

Winfried Pötzsch
born in Leipzig in 1944, is married, has one daughter, and lives in Gilching. He joined the Institute of Aircraft Radio and Microwaves at the then German research institute for aviation (DVL) – today DLR – as an apprentice in September 1961. He subsequently went to Munich Polytechnic, came back to the institute as an engineer and became responsible for special developments in the field of computer technology.



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David Hounam
born in Darlington (England) in 1944, is married and lives in Oberpfaffenhofen. He studied physics in England. Then he and his wife moved abroad. Interesting job offers came from Germany, where there was a lack of specialised personnel in the 1960s. In 1968, the family moved to Bavaria, and Hounam began to work for the company Rohde & Schwarz in Munich. In 1971, he applied to the then DFVLR, where he soon became Head of the Microwave Systems Department.

In blue: selected missions of the early years, which were carried out together with the control centre in Oberpfaffenhofen. To date, the Weilheim Ground Station has supported more than 170 missions of various kinds.

Ochre: milestones

Red: organisational milestones