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The beautiful lunar toy from Berne

Man first walked on the moon 50 years ago. It was also one giant leap for the University of Berne whose Solar Wind Composition Experiment on the moon ultimately helped to clear up a misconception about the Big Bang.

DÖLF BARBEN

As the rocket took off, television viewers saw the three letters "U – S – A" slowly ascend. And on 21 July 1969, astronauts Neil Armstrong and Buzz Aldrin planted the American flag on the moon. Great PR for the United States. No wonder America is making the most of it 50 years on.

But the University of Berne is also entitled to celebrate, given that its Physics Institute was responsible for an experimental device used during the Apollo 11 mission. Weighing 454 grams (equivalent to a pound), the instrument was tiny compared to the nearly 3,000 metric tons of spacecraft in which it flew. Yet of trifling importance it was not. Astronaut Aldrin assembled the contraption – a simple sheet of foil along an upright, 30 centimetres wide, 140 centimetres long – even before unfurling the Stars and Stripes. Its purpose was to collect solar wind: particles such as protons and electrons which originate from the sun. After 77 minutes, Neil Armstrong rolled up the foil and took it back with him to the lunar module. He left the supporting upright on the moon. The experiment was so successful that the US space agency NASA repeated it on four other missions, increasing the length of exposure each time. Johannes Geiss, the physics professor who had developed the sail – or Solar Wind Collector (SWC) – with the help of his team, became world-famous.

Jürg Meister, 80, and Peter Bochsler, 76, worked at the Physics Institute at the time. On a return visit,

Jürg Meister (left) and Peter Bochsler with their 'old friend', the Bernese solar sail, in a windowless laboratory on the basement floor of the University of Berne Physics Institute
Photo: Adrian Moser

they recount their experiences and talk their way through a series of photos. In these pictures, young men with dated haircuts are busying around a solar wind simulator. These were the Berne scientists. Experimental physicist Meister helped to develop the SWC. Professor Bochsler was not yet directly involved at that stage, but would later succeed Johannes Geiss by becoming the Institute's co-director. Geiss himself is now over 90 and has retired from public life.

Meister and Bochsler walk into a windowless laboratory teeming with devices on the basement floor of the Institute. The SWC (the reserve sail, to be precise) stands in the middle of the room, glittering in the lamplight. Meister and Bochsler greet it almost as they would an old friend. Meister gives a little demonstration, showing how a preloaded spring draws the foil up. "Just like a roller blind."

"Incredibly good and simple"

You rolled out a sheet of aluminium foil on the moon to catch the solar wind. Then you rolled it up again. "It was an incredibly good and simple idea," says Meister. Solar wind particles travelling at speeds of several hundreds of kilometres per second – much slower than light – collide with the foil and are collected there. By melting the foil back in the laboratory, you could ascertain how many of each type of particle were captured.

Everything on the SWC had to be designed for it to be easy to use and to work perfectly. The upright – a telescopic tube with ultra-fine threads – stretched the ingenuity of the university's engineers to its limits. Then you had the roller that was hidden in the upright until it was time to pull it out. Finally, you had the foil itself, reinforced with Teflon tape to prevent tearing. "The weight specification of one pound was quite a headache," says Meister. "Everything would have been a lot easier had the desired weight been one kilogram."

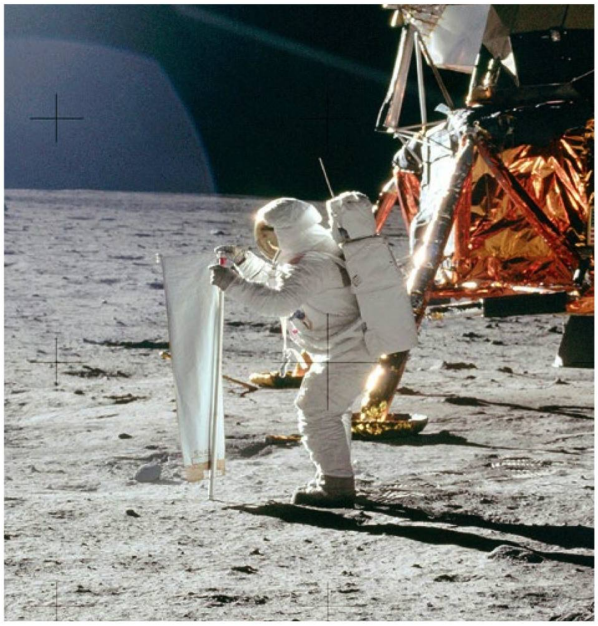
NASA left nothing to chance and instructed astronaut Don Lind to test the device in Berne. Unlike the physicists and engineers, Lind employed a spaceman's perspective. He knew what you could and could not hold on to with those big unwieldy gloves. Meister: "Lind gave us a multitude of instructions, which we painstakingly followed." For example, certain sections of the upright were roughened for gripping purposes, while key components were coloured red. "But he loved the contraption – just as if it were a big toy."

Why Berne?

But how did the only non-US experiment of the Apollo 11 mission originate in Berne of all places? "It was no coincidence," says Bochsler. The University of Berne had previously made a name for itself through its research into meteorites. This opened the door to possible experiments involving lunar rocks. In addition, Professor Geiss knew many of the NASA scientists and, according to Bochsler, "showed great skill and determination" in developing relations with NASA.

It was Jürg Meister who took the solar sail to the USA in his hand luggage. Meister was able to watch the lunar rocket taking off on three later missions – from a viewing point one and a half kilometres away. "It was an incredible and remarkably loud experience. The low frequencies reverberated in my stomach. My shirt on my skin quivered. It sounded like a huge pan full of sizzling eggs."

It was 3 a.m. in Switzerland when Neil Armstrong and Buzz Aldrin set foot on the moon. The team in Berne followed the event live on television at the Institute. "I wasn't worried," says Meister. "We had tested the sail hundreds of times, so I knew it would work without a problem." Bochsler, on the other hand, was simply hoping the guys would "get back down in one piece".



Astronaut Buzz Aldrin planted the Bernese solar sail on the moon – before unfurling the American flag. Photo: Keystone

Jürg Meister lives near Thun nowadays. After leaving the University of Berne, the young physics doctor spent time in Texas analysing data from a different Apollo experiment. On his return to Switzerland, he worked at an armament factory in Thun and specialised in armour-piercing ammunition. He continues to be fascinated by all things that fly, although aircraft and rockets are no longer his primary preoccupation. He and his wife breed butterflies. And every time he looks at the moon, he remembers he held five uprights in his hand that are still on the lunar surface. "Remarkable, don't you think?"

Peter Bochsler's travels took him to Israel. He found the USA less appealing. "Not least because of America's involvement in the Vietnam War". After returning to Berne, he continued his research into solar winds. Later measurements taken by space probes confirmed the results of the Apollo experiments.

Better understanding of the Big Bang

What did scientists learn from the Solar Wind Composition Experiment? Bochsler says it was the first-

ever time that they were able to collect solar wind particles in a systematic fashion and analyse them in a laboratory. Solar wind cannot be measured directly on Earth, because our planet's atmosphere and magnetic field deflect and shield us from it. Meteorites had previously contained the only solar wind particles that had ever been detected, although it was never clear how long the meteorites had been exposed to solar wind before they had fallen to Earth. The SWC facilitated the first-ever detailed analysis of the composition of the solar wind. It also threw up some surprises. For example, scientists discovered that solar hydrogen differs greatly from terrestrial hydrogen and meteorite hydrogen in terms of the amount of deuterium or 'heavy hydrogen' it contains.

Switzerland's celestial pioneers:

Lucerne jesuit Johann Baptist Cysat (1586–1657)  discovers new binary star systems; Lausanne scholar Jean-Philippe Loys de Cheseaux (1718–1751),  documents numerous star clusters and nebulae; Rudolf Wolf from Zurich (1816–1893)  recognises that the sunspot activity cycle corresponds with the Earth's magnetic field cycle; Fritz Zwicky (1898–1974),  the Bulgarian-born astronomer from the canton of Glarus, transforms astrophysics in the USA with his theories on extragalactic nebulae; Paul Wild (1925–2014)  , University of Berne, discovers over 90 asteroids as well as seven comets; the Zenit rocket developed by Hans Balsiger  and Ernest Kopp  flies into space in 1967; Johannes Geiss (born in 1926)  develops the Apollo 11 Solar Wind Composition Experiment at the University of Berne (see main text); in 1995, Michel Mayor  and Didier Queloz  of the Geneva Observatory discover the first planets outside our solar system, orbiting the star Helvetios (51 Pegasi); in 1992, NASA astronaut Claude Nicollier (born in 1944)  becomes the first Swiss to fly into space; Markus Griesser (born in 1949)  discovers ten main-belt asteroids and the minor planet 113390 Helvetia in 2002; Kathrin Altwegg (born in 1951)  becomes a leading figure in Swiss space science due to her involvement in the Giotto and Rosetta missions. (MUL)

Bochsler says: "We were suddenly able to clear up some discrepancies regarding the Big Bang, so the implications were quite major."

Boost for Berne

The SWC put wind in the sails of Bernese (and Swiss) space research. Firstly, Professor Geiss was adept at exploiting his fame to expand the Physics Institute, thereby laying the foundation for further successes. Berne's scientists went on to play a regular part in international projects. The Rosetta probe's rendezvous with comet Churyumov-Gerasimenko, or "Chury" for short (see also "Swiss Review" 1/2015), is still fresh in the memory. High-performance instruments from Berne were on board the probe, capturing data on the chemical make-up of this mysterious celestial body – and ascertaining, among other things, that Chury stinks of horse manure.

Exoplanets

The University of Berne is a global leader in space science. This is according to none other than Thomas Zurbuchen, the Associate Administrator for NASA's Science Mission Directorate. Citing exoplanets – the study of planets outside our solar system – as an example, Zurbuchen tells "Swiss Review" on the phone that scientists in Berne and elsewhere in Switzerland have discovered, developed and played a key role in new areas of research. He believes that it would have been wrong for them to rest on their laurels: "To make an international mark, you need to keep pushing. You don't stand still."

Zurbuchen, who grew up in the Bernese Oberland, embodies Berne's thriving space science programme to some extent. It is unlikely h is own career would have taken off as it did, had it not been for the Solar Wind Compo-

Switzerland's most powerful scientist: Thomas Zurbuchen, Associate Administrator for NASA's Science Mission Directorate.
Photo: Keystone

sition Experiment and the boost it gave Berne. At the beginning of the 1990s, Zurbuchen worked in Berne – incidentally as one of Peter Bochsler's PhD students – on the development of an instrument for an American solar probe. "It was a direct descendent of the SWC," he says. As NASA's top scientist, Zurbuchen currently manages a budget of almost USD seven million. His decisions have implications for around 10,000 scientists and engineers.

Off to Mars?

And now? Half a century since Apollo 11, the possibility of a return to the moon and a mission to Mars is on everyone's lips. NASA is at the forefront, although the issue is a contentious one. Bochsler and his former student have differing opinions. Zurbuchen knows that opponents would say that there are other, urgent matters to attend to on Earth, and that manned missions are considerably risky and much too expensive anyway. Yet he believes it is human nature to aim high and push the limits of what is possible. "Why do we want to go Mars?" he asks, before answering his own question. "Because we can." He points out that you can never predict the good that can come of such ventures either. When the first probes shot into space in the middle of the last century, no one had thought yet of satellites that record climate data or play an essential role in modern weather forecasting. "We at NASA do the most accurate global CO_2 measurements," Zurbuchen says. He also thinks that science brings people together. "For me it is one of the key reasons why we gravitate to these projects in the first place."

Bochsler acknowledges the arguments in favour of human space flight. The lunar rocks that the astronauts brought back 50 years ago were of great scientific value, he concedes. "I was one of the scientists who handled quite a lot of them," says Bochsler, who goes on to praise NASA, explaining that the US space agency distributed the rocks generously to research centres around the world. Nevertheless, he believes that unmanned probes probably would have achieved much the same findings. In his view, the immense outlay needed to fund manned projects – "often for nothing more than reasons of prestige" – inevitably means less money being available for programmes of potentially much more immediate scientific benefit. When Bochsler sees photomontages of colonies on Mars, he wonders how many "beautiful experiments" would be possible on unmanned missions using the same amount of money.

And what does Jürg Meister think? Not much, if you mean Mars. "The red planet is so far away. Most people don't even know where it is in the night sky." On the other hand, the moon means something to everyone. He believes we were quite right to fly there once. "No question." But there is no need to do it again. "We've known what it looks like up there for the last 50 years."

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DÖLF BARBEN IS EDITOR AT THE NEWSPAPER "DER BUND" IN BERN

Berne in space

Notable space projects with Bernese involvement:

1986: The Giotto probe of the European Space Agency (ESA) flies to Halley's Comet in 1986. On board is a University of Berne spectrometer carrying out the first-ever close-proximity study of a comet's dust and gas.

1990: Launch of the joint ESA/NASA Ulysses mission. The Ulysses probe observes the sun over a prolonged period of years, using a Swiss-made instrument to study the solar wind.

1995: Launch of the ESA/NASA Solar and Heliospheric Observatory (SOHO). On board is Celias, a highly sensitive ion mass spectrometer from Berne.

2004: Launch of the ESA probe Rosetta. The probe reaches comet Churyumov-Gerasimenko (Chury) ten years later, keeping it company for two subsequent years. The spectrometers developed in Berne function perfectly.

2016: The ExoMars Trace Gas Orbiter begins its journey to Mars. CaSSIS – the University of Berne's specially developed camera system – has been producing high-resolution colour images of the red planet's surface over the past year.

2018: The BepiColombo probe sets off for Mercury – a joint venture between the ESA and the Japan Aerospace Exploration Agency. The University of Berne developed and built an on-board instrument designed to produce a three-dimensional map of Mercury's surface.

2019: CHEOPS, the space telescope for observing planets outside our solar system (exoplanets), is set to launch in the second half of the year. The University of Berne oversaw its construction.