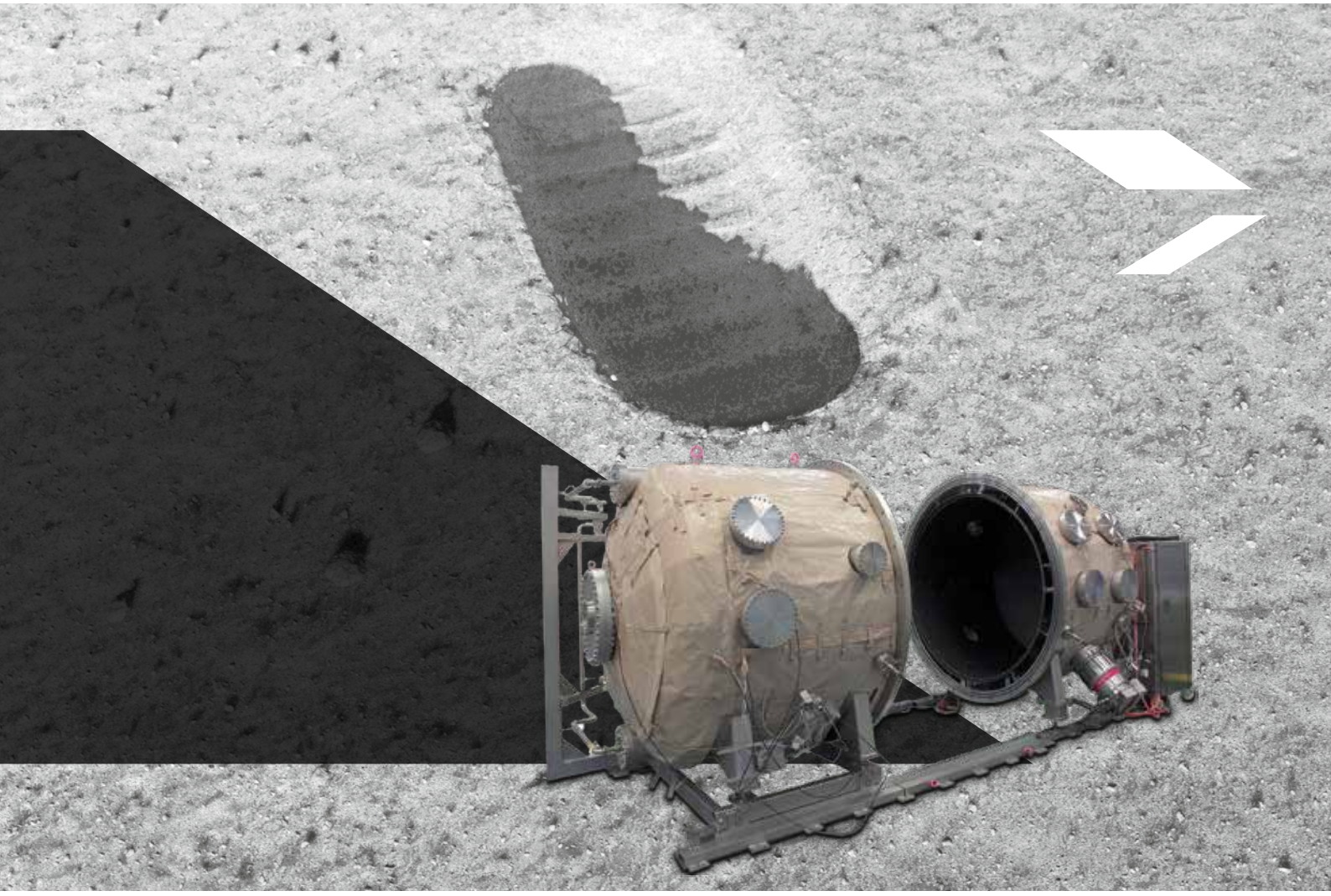
Discovering New Worlds

Vacuum chamber for “CHEOPS” space mission



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The space simulation chamber for the CHEOPS mission. The chamber is shrouded with a clean-room-compatible insulation

Since the beginning of space travel in the first half of the 20th century, scientists have gained numerous fascinating insights into our universe. The milestones of space exploration, such as when Neil Armstrong first set foot on the moon in 1969, remain unforgettable moments in our lives. However, the universe still holds many mysteries.

There are countless planets in neighboring solar systems which we know almost nothing about. They are beyond the pull of our sun’s gravity and are orbiting other stars. For this reason, they are also known as extrasolar planets - in short “exoplanets”. Up to now, with the research methods available, only the characteristics of the planets in our own solar system have been explored. The characteristics of the planets in other systems remain unexplained.

Mission to explore exoplanets

With CHEOPS (CHaracterising ExOPlanet Satellite), the European Space Agency (ESA) has now initiated a mission to deliver findings about these exoplanets. An optical telescope--weighing 300 kg, with a 30 cm aperture, and 1.2 m long--is being created in close cooperation with the Institute of Physics at the University in Bern.

Starting in 2017, the telescope will collect information about the exoplanets using the “transit method”: If a planet passes in front of its central star, the brightness of the star decreases due to the shadow cast by the planet. This process is observed through the telescope during the transit method. The diameter of the planet is derived from the decrease in brightness of the star. With earth-based instruments and another method known as the “radial velocity method“, the planet’s mass can be determined as well. If the diameter and mass are known, the density can also be calculated. This, in turn, provides clues as to whether the planet is composed of gas, ice or rock. CHEOPS therefore enables a number of important key figures to be collected about as yet unknown planets in other solar systems.

Pfeiffer Vacuum delivers vacuum chamber for space simulation

It is extremely important for the success of the CHEOPS mission that the telescope operates reliably and with high precision. This requires exact preparation and numerous tests. On Earth, these can only be carried out in simulation chambers which create the necessary space conditions. In order to test the CHEOPS telescope, the University of Bern will rely on a vacuum chamber specially designed and built by Pfeiffer Vacuum for this highly demanding application.

High demands on Pfeiffer Vacuum

In order to prepare the telescope for its use in space, the space simulation chamber must meet high demands:

- Creation of space-like conditions
- High temperature range for instrument tests at extreme temperatures
- Rapid temperature changes
- Low-outgassing chamber surfaces under vacuum
- Surfaces without particle release for tests under clean room conditions

The experts at Pfeiffer Vacuum developed a calibration and vacuum chamber-weighing 5.5 metric tons--for the CHEOPS telescope in close collaboration with scientists from the Center for Space and Habitability (CSH) of the University of Bern. From the very beginning, all specific requirements of the application were taken into consideration. This allows the necessary conditions to be created to test and calibrate the telescope and its components under real-life conditions.

The precise preparation of the chamber for its use at the University of Bern started even before its actual delivery: Since no reflections are allowed to fall on the chamber walls during the optical tests with the telescope components, the interior is coated with special black paint. This color is also optimized for absorbing the thermal radiation of the test objects. During the tests under vacuum, no chemical substance is allowed to escape from the chamber's interior coating. For this reason, the experts at Pfeiffer Vacuum set up the chamber, put it into operation and outgassed it for several weeks at 160 degrees Celsius before delivering it to the University in Bern.

After completion of this process, the chamber was dismantled again and transported to Bern along with three temperature control systems and the necessary vacuum accessories.

In the clean room laboratory of the University of Bern, the instrument components of the telescope are now gradually exposed to temperatures between minus 80 and plus 140 degrees in a vacuum. Later, the structural model and the final flight instrument will also be tested in the chamber.

Thermal vacuum chamber with a sophisticated vacuum system

The thermal vacuum chamber is 3 meters long and 1.8 meters in diameter. The two halves of the chamber can be easily pulled apart and pushed together with the use of a rail system. Thanks to the built-in vacuum and valve technology from Pfeiffer Vacuum, the chamber can be evacuated to UHV pressure. The interior surfaces of the chamber have a reflective electropolished finish.

In the center of the chamber is an optical table to mount the telescope. A temperature-controlled "shroud" surrounds the entire test volume and shields the telescope from the vacuum chamber walls. The side of the shroud facing the test object is varnished with a special black paint which was specifically developed for space applications and is therefore optimized for minimal absorption and outgassing. Just as in space, it absorbs the thermal radiation of the specimen.

The chamber can be heated up to 160 degrees Celsius using a heater that is suitably insulated for clean rooms. Two thermostats pump a special thermal fluid through tubes in the interior which allows it to cool down to as little as minus 90 degrees Celsius. By using sensitive control technology, the temperature of the thermal fluid can be controlled to a few hundredths of a degree.

With this vacuum chamber, Pfeiffer Vacuum provides the basis for a further significant step in space exploration. The vacuum chamber represents a piece of universal test equipment which the University of Bern will not only be able to use for the CHEOPS project but also for future satellite missions.

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