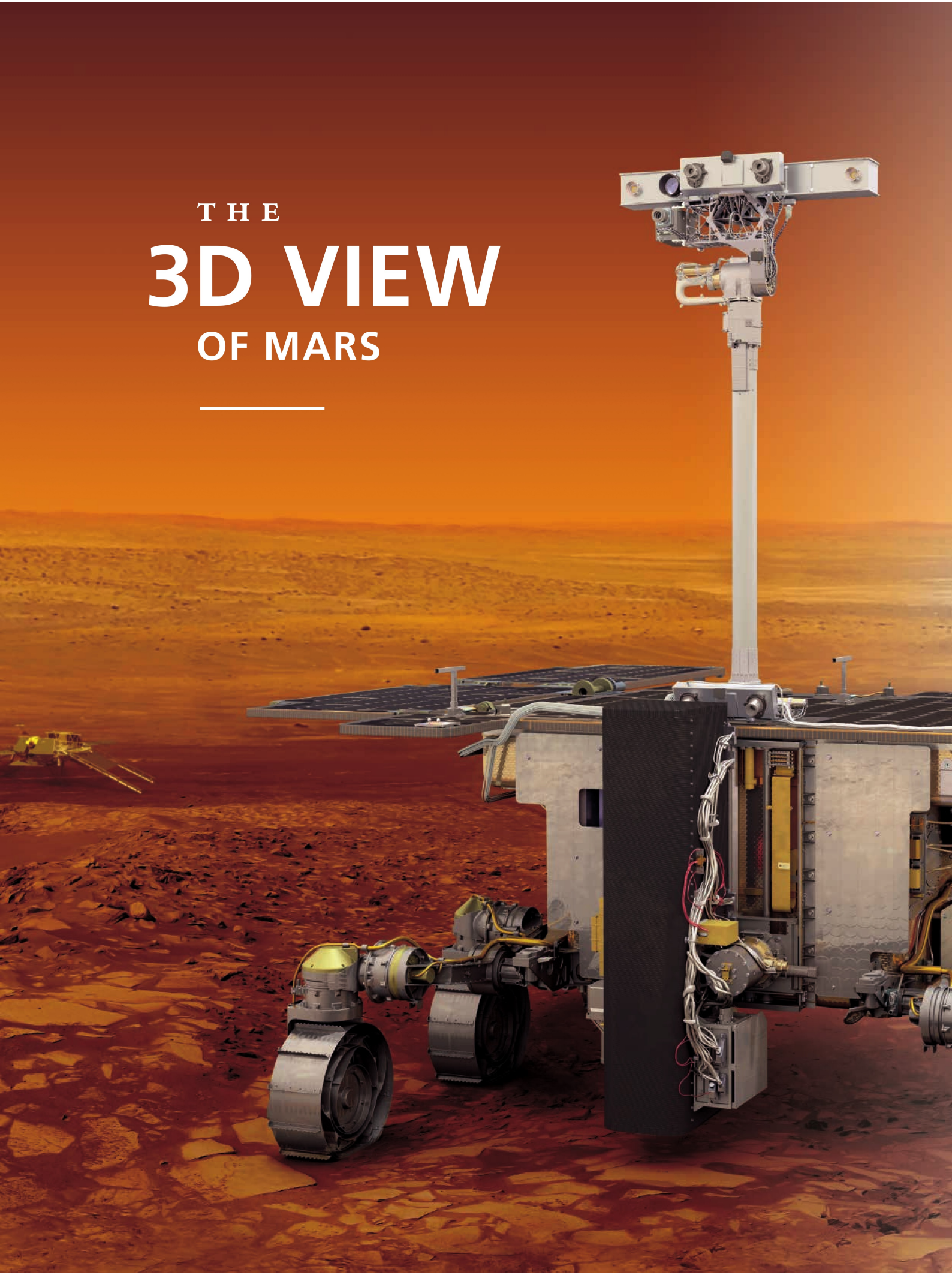
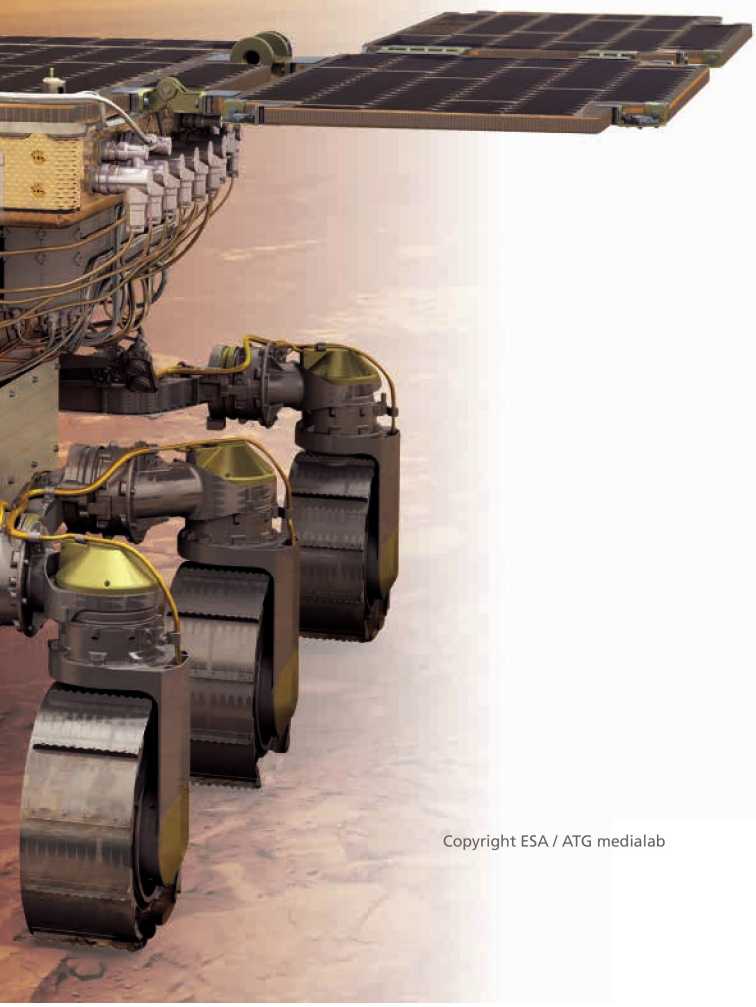

THE
3D VIEW
OF MARS

2020 is the year of the next Rover mission to Mars. The main payload of the Russian Proton rocket: the ExoMars Rover, developed by the European and Russian Space Agencies (ESA & Roskosmos). The plan is for the vehicle to be equipped with nine measuring instruments. Including one that will be mounted on a two-meter mast on the rover.
"The Panoramic Camera", which was developed by Mullard Space Science Laboratory (MSSL-UCL) in collaboration with OHB (Munich), DLR (Berlin) and TAS-CH (Zurich), will take stereo images of the planet. The so-called PanCam features two rotating filter wheels which are mounted in front of its wide-angle cameras (WAC; manufactured by Thales Alenia, Zurich) to enable it to take three-dimensional images of panoramic landscapes. A high resolution camera (HRC; manufactured by OHB/ DLR) provides detailed images of landscapes, geological structures, and soil samples. Three stepper motors from FAULHABER drive the rotation shaft for the filter change system as well as the focus of the high-resolution camera.



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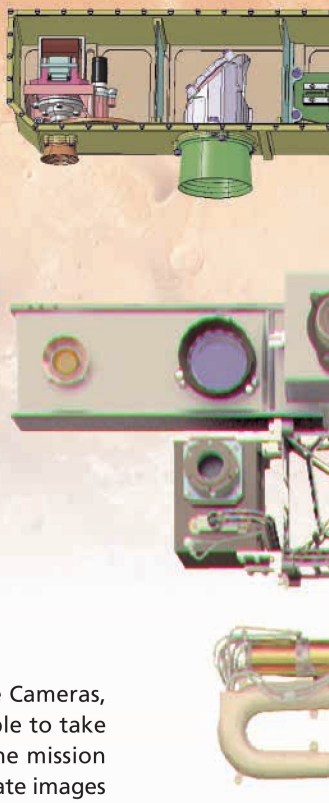
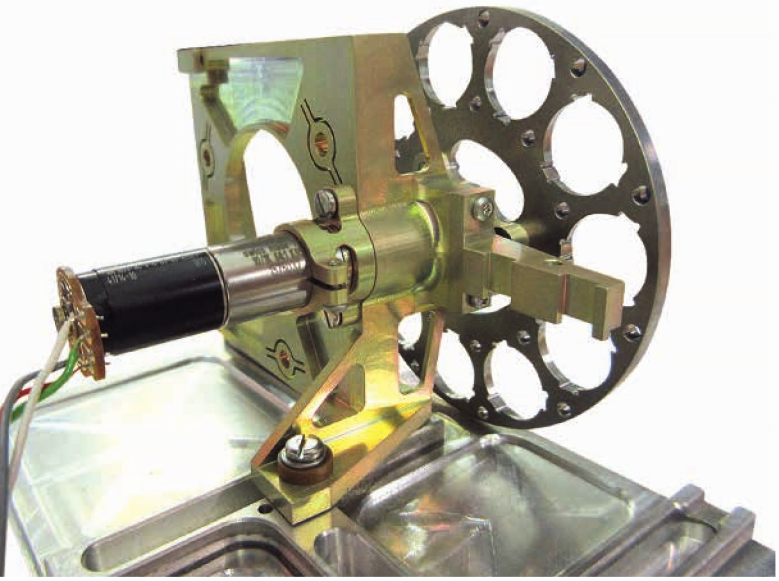
The mission is clear, as is each individual task. Needless to say, the requirements for equipment planned for use on Mars are so stringent that nothing quite compares to them. And if the mission for 2020 goes according to plan, the Rover built by ESA will start searching the surface of Mars for past or present biological activity as soon as it lands. This will require not only obtaining soil samples with a core drill, but also performing analyses with an extensive science package. Meanwhile, the ExoMars Trace Gas Orbiter will stay in orbit in order to help the rover phone home and ensure that the data and measurement results it collects can make it back home.

Improved images and protection from dust

The ambient conditions on Mars require for every single piece of equipment to deliver unrivalled performance. For starters, the Rover will be working under an atmospheric pressure of 0.00636 bar, which is equivalent to the pressure found at an altitude of 35 kilometres on Earth. And to go even further, the planet is characterized by temperature fluctuations that go from just under +20 °C to -120 °C. In addition to this, the dust kicked up by the Rover is expected to have a negative effect on the operational reliability of its high-precision measuring and analysis instrumentation, which is one of the reasons why the Panoramic Camera will be suspended two meters above the ground on its mast. “This will of course protect the lenses, but there's another important advantage in that kind of elevated position, and that’s the fact that we’ll be able to get significantly better panoramic images,” explains Jonathan Jones, a mechanical and thermal engineer at the Mullard Space Science Laboratory south of London.

PERFECTLY SUITED FOR THE HARSH CONDITIONS IN SPACE



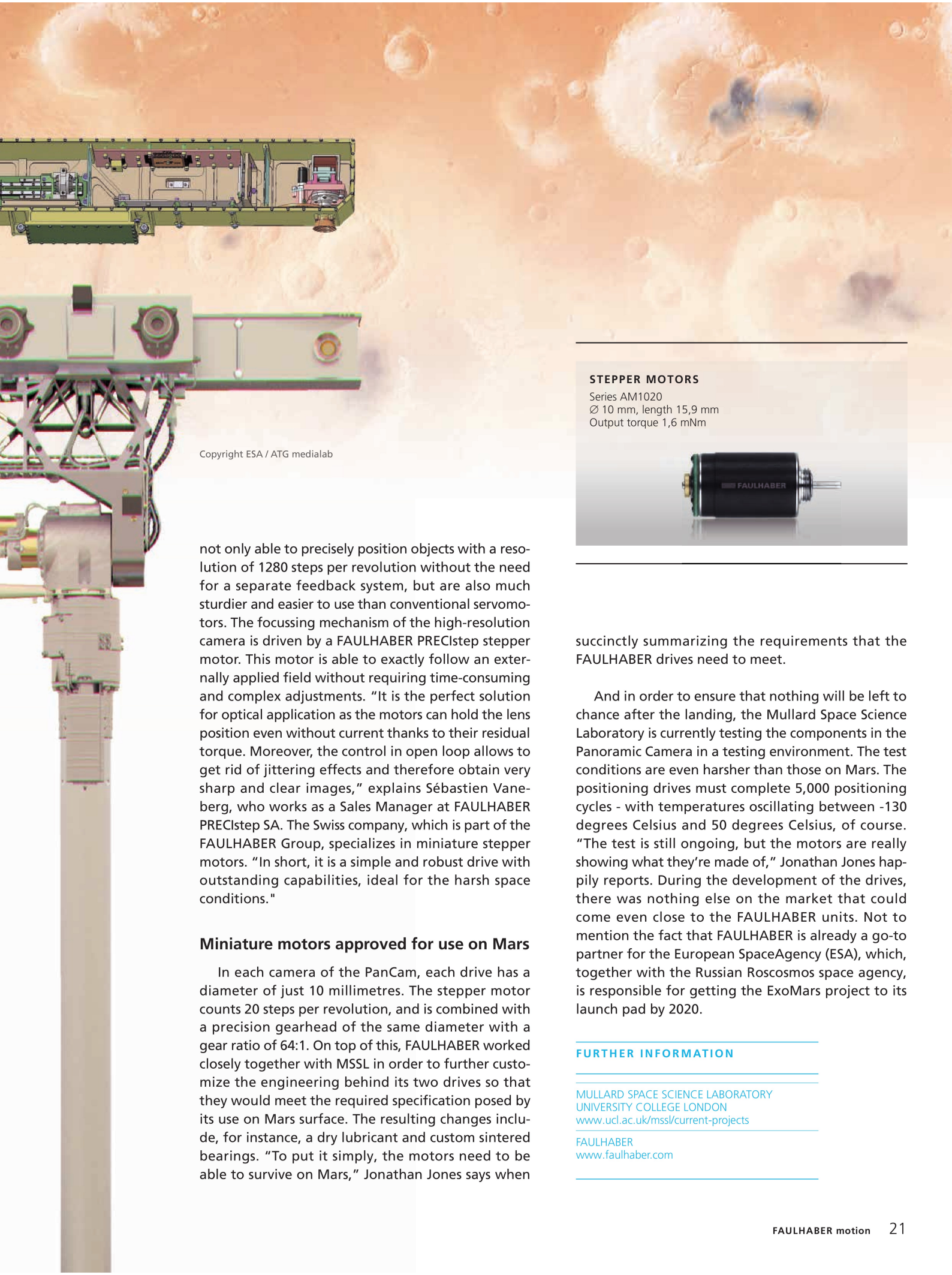


With the filters in front of Wide Angle Cameras, MSSL has created a system that will be able to take pictures at various wavelengths during the mission scheduled for 2020 and use them to generate images with varying content. "The plan is to send ten images to Earth every day," Jones says. Sure, it may sound like nothing at first, but a closer look reveals that this is actually quite an ambitious target. First, the camera generates three pictures for a single image. These are then sent to Earth and superimposed on top of each other to create the actual image. And then there are the limitations imposed by the low data bandwidth available with radio communications between the two planets, which simply makes it impossible to send more than ten images per day.

Stepper motors position lens filters

With eleven filters per wheel, it is possible for the Pancam WACs to take a wide variety of pictures under various light conditions. These filter wheels rotate in front of the two WACs, and must be brought exactly into position in order to obtain sharp images. For driving the rotating filter system, MSSL makes use of two stepper motors from the FAULHABER PRECIstep portfolio. These two units have been passing the endurance tests currently being conducted on them with flying colours.

During the development process for the Panoramic Camera, the MSSL engineers looked for motors that would not only be able to deliver reliable and precise positioning performance, but that would also be extremely compact. Stepper motors were the natural choice given these requirements, as they are



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not only able to precisely position objects with a resolution of 1280 steps per revolution without the need for a separate feedback system, but are also much sturdier and easier to use than conventional servomotors. The focussing mechanism of the high-resolution camera is driven by a FAULHABER PRECIstep stepper motor. This motor is able to exactly follow an externally applied field without requiring time-consuming and complex adjustments. "It is the perfect solution for optical application as the motors can hold the lens position even without current thanks to their residual torque. Moreover, the control in open loop allows to get rid of jittering effects and therefore obtain very sharp and clear images," explains Sébastien Vaneberg, who works as a Sales Manager at FAULHABER PRECIstep SA. The Swiss company, which is part of the FAULHABER Group, specializes in miniature stepper motors. "In short, it is a simple and robust drive with outstanding capabilities, ideal for the harsh space conditions."

Miniature motors approved for use on Mars

In each camera of the PanCam, each drive has a diameter of just 10 millimetres. The stepper motor counts 20 steps per revolution, and is combined with a precision gearhead of the same diameter with a gear ratio of 64:1. On top of this, FAULHABER worked closely together with MSSL in order to further customize the engineering behind its two drives so that they would meet the required specification posed by its use on Mars surface. The resulting changes include, for instance, a dry lubricant and custom sintered bearings. "To put it simply, the motors need to be able to survive on Mars," Jonathan Jones says when succinctly summarizing the requirements that the FAULHABER drives need to meet.

And in order to ensure that nothing will be left to chance after the landing, the Mullard Space Science Laboratory is currently testing the components in the Panoramic Camera in a testing environment. The test conditions are even harsher than those on Mars. The positioning drives must complete 5,000 positioning cycles - with temperatures oscillating between -130 degrees Celsius and 50 degrees Celsius, of course. "The test is still ongoing, but the motors are really showing what they're made of," Jonathan Jones happily reports. During the development of the drives, there was nothing else on the market that could come even close to the FAULHABER units. Not to mention the fact that FAULHABER is already a go-to partner for the European SpaceAgency (ESA), which, together with the Russian Roscosmos space agency, is responsible for getting the ExoMars project to its launch pad by 2020.

STEPPER MOTORS

Series AM1020
∅ 10 mm, length 15,9 mm
Output torque 1,6 mNm

FURTHER INFORMATION

MULLARD SPACE SCIENCE LABORATORY
UNIVERSITY COLLEGE LONDON
www.ucl.ac.uk/mssl/current-projects

FAULHABER
www.faulhaber.com

PRECISION IS A SWISS SPECIALITY

When satellites revolve around the sun, drive specialists and mechanical engineers inevitably think of planetary gearheads – the units with which speed-torque conversion can be performed with utmost precision. Within the FAULHABER Group, Swiss workmanship is a key component in the production of all geared parts. Rolla Microgear AG produces gears, output shafts, intermediate drives and sprockets made of various materials at their facilities in Grenchen. The region around Lake Biel is known as "Precision Valley" for good reason. It is the centre for watches and precision engineering in Switzerland.