What will Alexander Gerst be researching on the ISS?

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On 28 May 2014, the German ESA astronaut will be flying to the ISS for a six-month stay, during which he is expected to work on some 100 experiments

How can turbine blades be made lighter and at the same time stronger? Can an electrical conductor create a magnetic field capable of protecting a spacecraft from the solar wind? What can we learn from the physiological changes that occur in astronauts' bodies when they are in space that could be useful for people on Earth? German ESA astronaut Alexander Gerst will be taking a close look into these and other fascinating questions in the name of science on board the International Space Station (ISS) during the 'Blue Dot' mission. With the theme 'shaping the future', the 38-year-old geophysicist will be using the special conditions found in space to conduct around 100 experiments between the launch, on 28 May, and the landing, on 11 November 2014. Thirty-five experiments originate from Europe – most from German research institutes and facilities, such as the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR).

Materials testing in space

Light, yet strong materials are important for industry. On Earth, heavy components in a molten alloy sink under the influence of gravity. As the ISS is orbiting in microgravity, the constituents of an alloy are distributed uniformly in the melt. The more uniform the distribution, the higher the grade and strength of the resulting material. Until now, materials for cast components have been melted in the two furnaces of the Materials Science Laboratory (MSL). To expand this research, Alexander Gerst will install and commission a new and unique furnace, the Electromagnetic Levitator (EML), on the ISS and melt up to six samples. In this joint DLR/ESA project, the samples will float freely in the chamber and be held in position by an electromagnetic field. Many researchers – including scientists from the DLR Institute of Materials Physics in Space, German universities, the ACCESS research institute in Aachen and the metal working industry – plan to test new alloys in the oven.

Emulsions and plasmas in microgravity

Alexander Gerst will also be investigating how emulsions behave in microgravity and how these mixtures can be made more stable. Emulsions play an important role in things such as food production, the cosmetic and pharmaceutical industries, and the oil industry. Many of these special mixtures have to remain highly stable for a long time in food, cosmetics and pharmaceutical products. In the PASTA experiment, the properties of emulsions will be investigated in the FASES (Fundamental and Applied Studies in Emulsion Stability) experiment and the brand new FASTER (Facility for Absorption and Surface Tension) unit. In the University of Bayreuth's DCMIX (Diffusion Coefficients in Mixtures) experiment, Gerst will be investigating diffusion processes in fluids that consist of at least three components. The experiment is also expected to help improve our understanding of differences in the mixture of crude oil in reservoirs.

Plasma research will also be taking a major step towards the future in the Blue Dot mission. Alexander Gerst will be taking delivery of the PK-4 unit and installing it in the European Columbus Laboratory – another highlight in his mission. This successor to the German PK-3 and PK-3 Plus units will be used to investigate the physical properties of complex, three-dimensional plasmas. These plasmas consist of a cold, electrically conductive gas to which dust particles have been added. Because the particles sink and compress the complex plasma in the direction of gravity, a plasma crystal on the Earth is limited to just a few lattice planes. Only in microgravity can large, homogeneous three-dimensional structures form undisturbed and be

studied. On Earth, this research helps control the build-up of dust in the microchip manufacturing process. In addition to the newly founded DLR Complex Plasmas Research Group in Oberpfaffenhofen, scientists from the Joint Institute for High Temperatures (JIHT) in Moscow and the University of Giessen are participating in the ISS experiments.

A piece of the Starship Enterprise

Earth is exposed to continuous bombardment by high-energy particles – the solar wind. Fortunately, Earth's magnetic field protects its inhabitants from this relentless attack by the Sun. Our planetary neighbour Venus has no such natural protective shield. There, the solar magnetic field encounters the ionosphere of Venus unimpeded. This acts as a kind of electric conductor, leading to an interaction with the solar magnetic field. The DLR Space Administration's MagVector/MFX experiment will investigate such conditions. The ISS provides ideal conditions for such measurements; the Space Station is constantly moving through Earth's magnetic field at an orbital speed of around 7.5 kilometres per second, providing a permanent laboratory environment on a planetary scale for MFX. Elaborate specialised coatings for space vehicles could become a thing of the past.

Fast-forward ageing

Muscle deterioration, osteoporosis, back problems, circulatory and balance problems, increasing loss of strength and problems with the immune system – all these effects of ageing on Earth happen in microgravity, but in fast forward. For this reason, aerospace medicine experts can study illnesses and age-related problems in healthy astronauts. Alexander Gerst is one such test subject for medical and biological research. Changes in the cartilage in the knee, daily body temperature (circadian) rhythm and the properties of the skin (Skin-B) are three of the German experiments that started prior to the Blue Dot mission and that Gerst will continue.

On the hunt for the origin of life

In astrobiology, scientists research issues such as the origin of humans, the distribution and development of life and the possibilities of life beyond Earth. Alexander Gerst will help find answers to these questions in the BOSS (Biofilm Organisms Surfing Space) and BIOMEX (BIOlogy and Mars Experiment) experiments. These will include exposing microorganisms to the harsh conditions of space, such as radiation and a vacuum, in the Expose-R unit outside the ISS.

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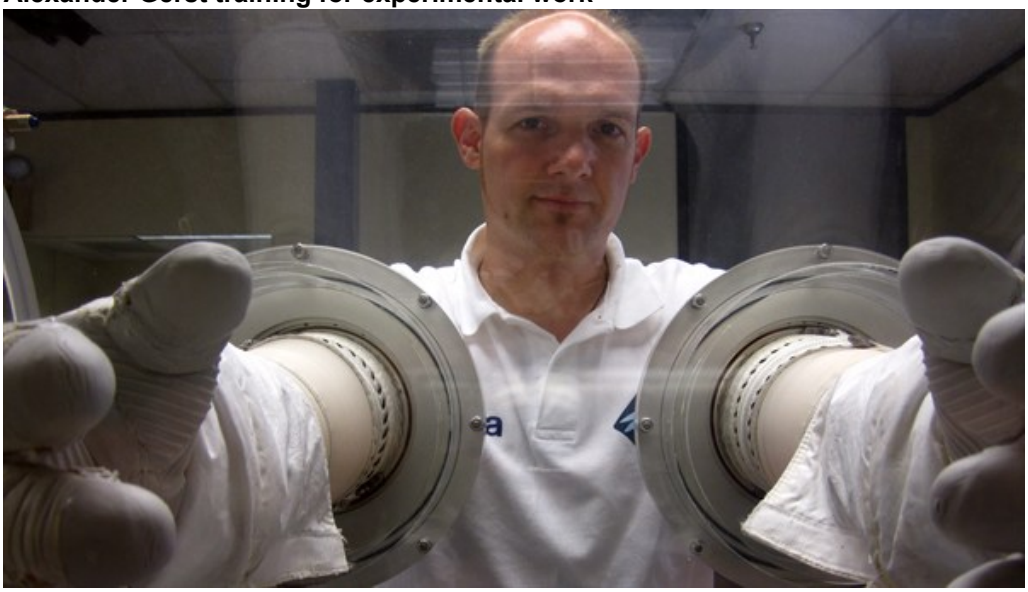
MagVector/MFX installed in the European Drawer Rack (EDR)

Alexander Gerst training at the European Astronaut Centre (EAC) in Cologne for the installation of the MagVector/MFX experiment container in the European Drawer Rack (EDR) in the European Columbus laboratory module.

Credit: DLR (CC-BY 3.0).

Alexander Gerst training for experimental work



With his hands full – Alexander Gerst dedicated a large part of his working time to science. He spent 80 hours practicing performing research under the special conditions found in space, in order to improve the future on Earth.

Credit: Gerst/ESA.

Alexander Gerst training with the Electromagnetic Levitator (EML)

Alexander Gerst being trained on the functioning of the Electromagnetic Levitator (EML) at the European Astronaut Centre (EAC) in Cologne.

Credit: DLR/Evi Blink.

Alexander Gerst training for the circadian rhythm experiment

Alexander Gerst training at the European Astronaut Centre (EAC) in Cologne for the circadian rhythm experiment.

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