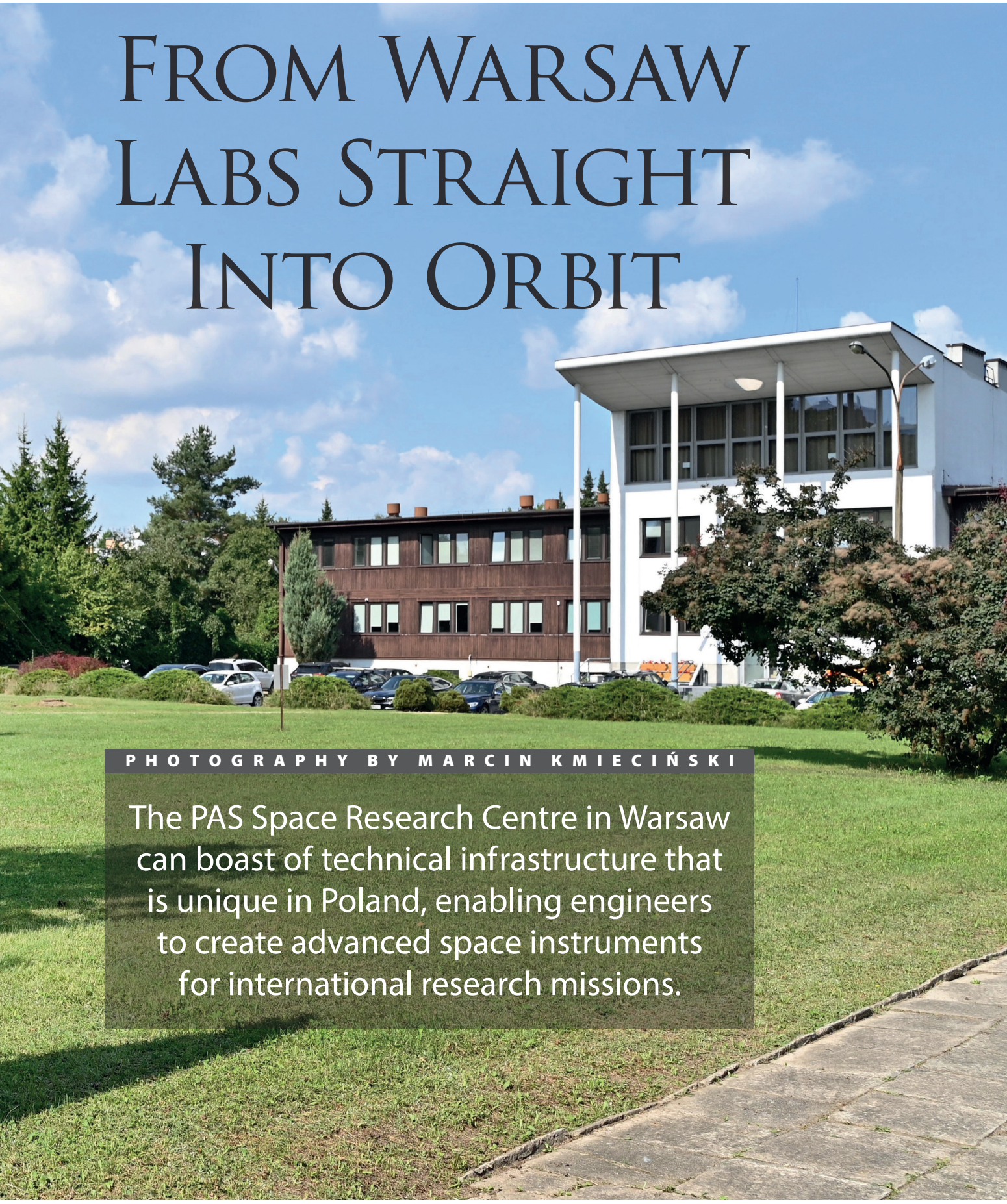
DOI: 10.24425/academiaPAS.2023.147470

From Warsaw Labs Straight Into Orbit



PHOTOGRAPHY BY MARCIN KMIECIŃSKI

The PAS Space Research Centre in Warsaw can boast of technical infrastructure that is unique in Poland, enabling engineers to create advanced space instruments for international research missions.

Ewelina Zambrzycka-Kościelnicka

is a journalist and editor specializing in popular science topics, affiliated with such magazines as *National Geographic Polska* and *Focus*. Spokeswoman for the Space Research Centre of the Polish Academy of Sciences.

ezambrzycka@cbk.waw.pl

The Space Research Centre of the Polish Academy of Sciences is the only Polish scientific research unit that is entirely devoted to using space technologies and satellite techniques to study the Earth, the area of space around it, and other celestial bodies in the Solar System.

The first Polish scientific satellites from the BRITE series, including Lem and Heweliusz, were developed in the laboratories of the PAS Space Research Centre in Warsaw. Important components and instruments for significant scientific space missions in recent decades were prepared here. Notable examples include Rosetta, the probe that was the first to land on a comet's nucleus; the Herschel Space Observatory, which among other achievements confirmed the widespread presence of water in space; and Cassini-Huygens, a twin probe that conducted groundbreaking observations of Saturn and released a lander that settled on Titan, sending back the very first images of this distant yet Earth-like world.

In recent years, the PAS Space Research Centre laboratory has been involved in building components for the X-ray telescope STIX – one of the instruments on the European Solar Orbiter mission, whose goal is to explore the poles of the Sun. Vital parts of the JUICE probe, which is heading towards Jupiter's icy moons, were also prepared here. The European Space Agency (ESA) had such a high opinion of the PAS Space Research Centre's contribution to the mission that the institute was offered a significant role in ESA's most daring mission since landing on a comet: the Comet Interceptor mission.

The role of principal investigator for one of Comet Interceptor's most significant instruments – the Dust, Field, and Plasma instrument – has been entrusted to Hanna Rothkaehl, PhD, DSc. No Polish scientist has ever held such a crucial role in a European Space Agency mission.

Next year, the institute is looking forward to the launch of the Proba-3 technological mission – a test of highly-precise satellite formation flying. For the first time in history, two satellites moving in a highly elliptical orbit – the Coronagraph satellite and the Occulter spacecraft – will maintain formation to a few millimeters (one arc second) of precision, at distances of 144 m or more, for six hours at a time. As a result, the pair will together form a virtual, gigantic satellite. This will be achieved autonomously, without relying on guidance from Earth. Besides being a technology test, the mission's scientific goal is to create an exceptionally long coronagraph – an instrument that blocks the Sun's disk, therefore allowing its corona to be studied.

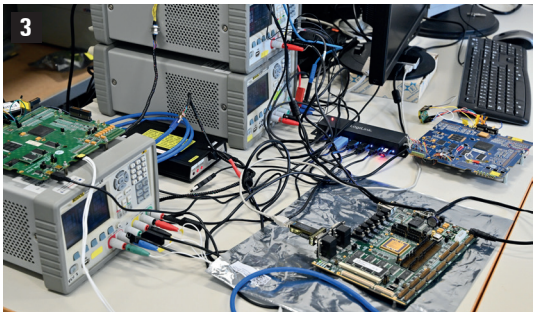
"The main part of our task was to design and construct the coronagraph's computer, the Coronograph Control Box, situated aboard the main satellite," explains Piotr Orleański, PhD, DSc – Director of the PAS Space Research Centre. "It forms the heart of the coronagraph, controlling and coordinating the operation of individual instruments, including capturing images of the solar corona. The use of a fast computer also enables the captured images to be processed before being transmitted to Earth."

The institute is responsible for the entire Coronograph Control Box: from design concept, through complete systems engineering, designing parts of the electronics, integration and testing of successive models, to the final version that will be placed aboard the satellite. To make all this work possible, the centre needed to be equipped with various types of laboratory hardware. For instance, the PAS Space Research Centre's apparatus includes a granite table where microgravity conditions can be simulated.

"If you drop a coin, you will notice that it moves vertically and does not swerve in any direction. This shows that the gravitational force does not act in any direction other than vertical. So, if we somehow prevent a body from moving in this direction and only allow movement in the plane of the floor, it will move without any influence of gravity. Of course, we would have to eliminate the friction resulting from gravity pressing the body down onto this plane. This plane is the surface of the granite table, and the friction is removed by an air cushion on which the body floats. Therefore, we have a place in the laboratory where the body moves without the influence of gravity, almost like a spacecraft in Earth orbit or deep space. Almost, because an object in space has six degrees of freedom of movement – it can rotate in three axes and move in three dimensions, while on the table, it rotates around one axis and moves in two dimensions. Despite this limitation, we can perform many experiments dealing with space mechanisms, orbital robotics, landers, and many other fields, where the main movement is precisely movement in a plane," explains Tomasz Barciński, PhD, head of the Satellite Mechatronics and Robotics Laboratory at the PAS Space Research Centre.

A renovated clean room and a new thermal-vacuum chamber, where components and instruments for space missions are tested, were brought into operation in 2022. Among these is the GLOWS instrument, or Global Solar Wind Structure, which the PAS Space Research Centre is preparing for NASA's IMAP heliospheric mission. This is also a highly prestigious commission: for the first time in history, Polish researchers are preparing their own experiment and instrument for a NASA mission.

"GLOWS instrument detectors and filters have been tested in our thermal-vacuum chamber. These tests aim to confirm theoretical assumptions and select specific detectors. The tests last several months in total, mainly in view of their complexity and due to the ongoing correction of the problems that inevitably arise during such tests," explains Karol Mostowy, ME, project manager of the GLOWS instrument. ■



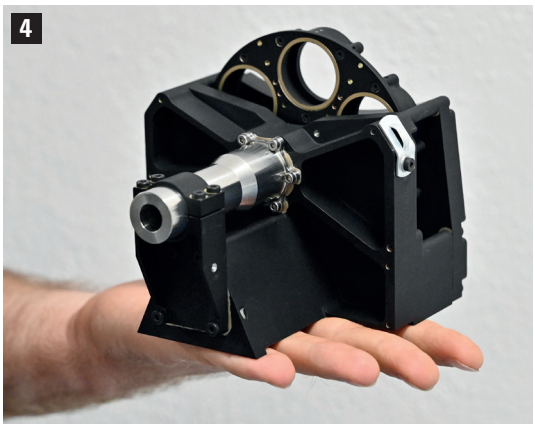


Photo 1
Thermal-vacuum chambers are set up in the clean room, which was commissioned for use in 2022

Photo 2
A special suit must be worn to work in the sterile conditions of the clean room

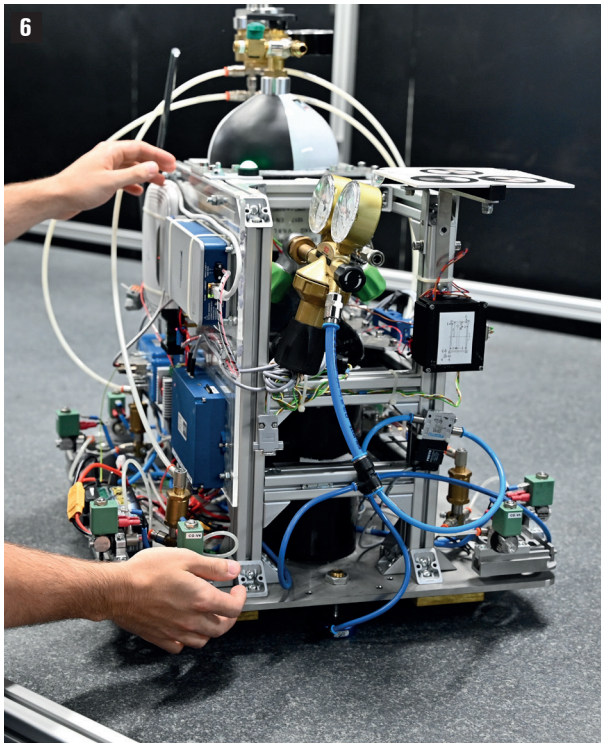
Photo 3
Tests of electronic equipment

Photo 4
A "filter wheel" used in space telescopes

Photo 5
Model of the first Polish scientific satellites BRITE

Photo 6
Tests being conducted on a granite table, unique in Poland

Photo 7
Engineering work underway



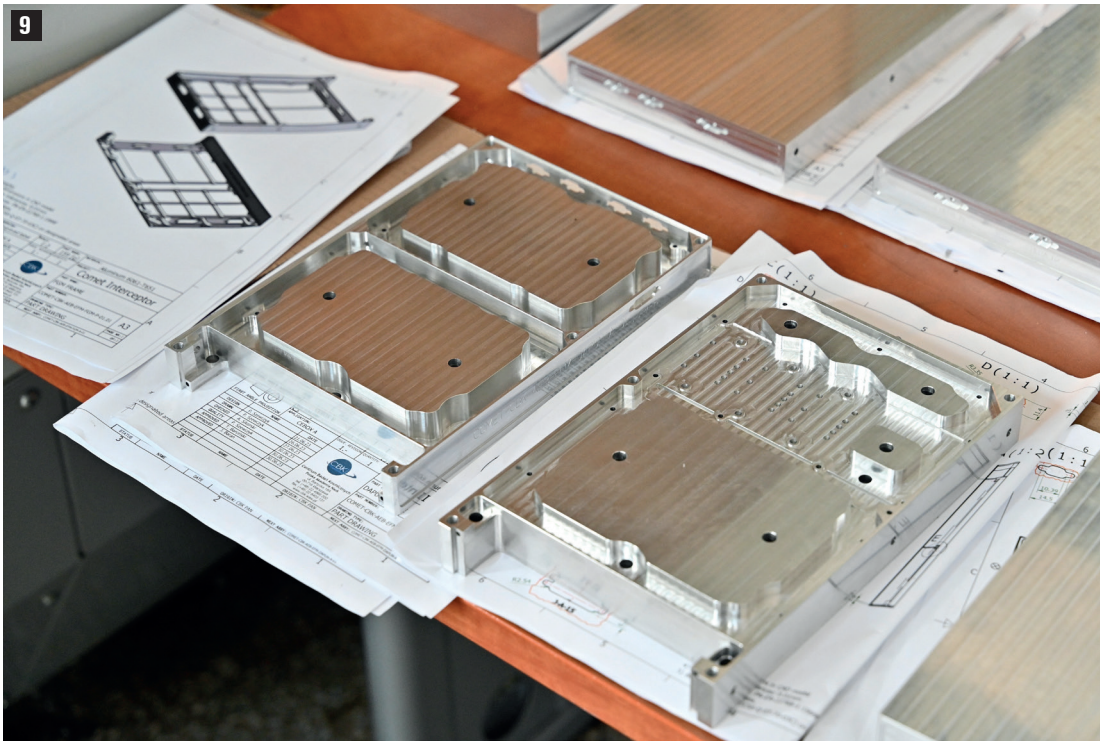


Photo 8
Every element of a space instrument, even the very smallest, must be made with incredible precision

Photo 9
Frames which, when assembled, will form the structure of the Dust, Field, and Plasma instrument (DFP) for the Comet Interceptor mission