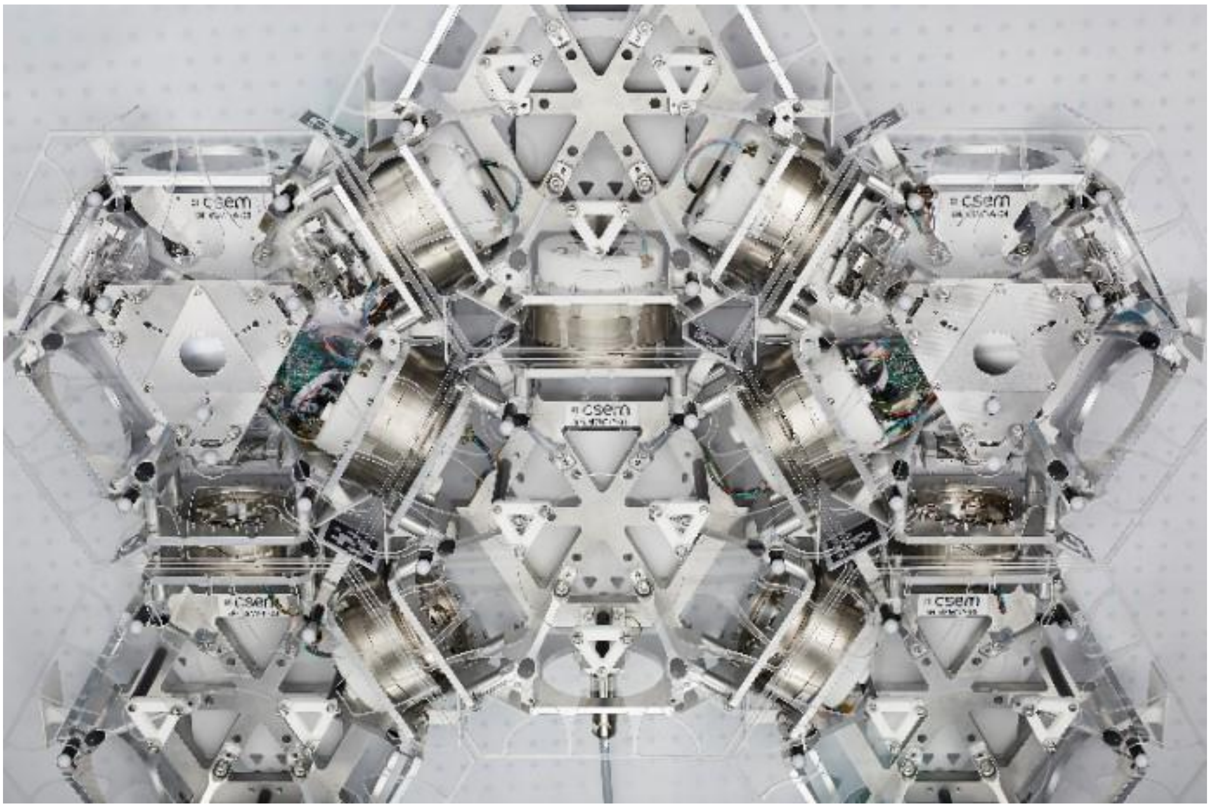
Press release

Autonomous robots will one day assemble telescopes directly in space

Neuchâtel, 14 January 2022 – **Engineers working under the EU-funded project PULSAR, have unveiled a fully autonomous robotic demonstrator, which could construct in orbit the primary mirror of a telescope from separate parts. The system, which includes components developed by CSEM, paves the way towards the assembly of giant telescopes directly in space – telescopes that would otherwise be too big to launch into orbit in a single piece. What's more, the autonomous system has the potential in the future to construct other large space structures, such as orbiting solar panels or solar sails. (Pictures and video)**



Each of the six hexagonal tiles supports a small mirror and is connected to the others to form a single, larger mirror.

Space telescopes give scientists unprecedented insight into how our universe works. The well-known Hubble Telescope led to major breakthroughs in astronomy, and hopes are now high for its successor, the James Webb Space Telescope (JWST). Launched on December 25, 2021, the satellite is en route to its destination (1.5 million kilometers from Earth), and should reach this point by January 24, 2022.

However, the potential for further discoveries is running up against a physical limit: the size of the telescope. To explore deeper and further into space, telescopes must grow to epic sizes. Given the limited payload capacity of spacecraft, sending such behemoths into space presents a real challenge.

A solution to this problem would be to send telescopes into space as separate components. These components could then be assembled by autonomous robots once the instrument is in orbit.

This approach has been examined under the EU-funded project PULSAR, which stands for Prototype of an Ultra Large Structure Assembly Robot. The project's goal is to develop the technological bricks needed to autonomously assemble large structures in space.

PULSAR is headed by the French firm Magellium and includes seven other European organizations, including CSEM. The project team has just unveiled three demonstrators, one of which is for a high-precision autonomous robotic system that would be used to assemble a telescope's primary mirror. This demonstrator can build a 1:3 scale mirror (300 mm x 180 mm) consisting of six tiles weighing 11 kg each. In the demonstrator, each tile is covered with a transparent plate but under real-world conditions, they would be equipped with a mirror.

"In the future, we will be able to assemble a 35-meter diameter mirror with many more tiles," says Julien Rouvinet, a senior engineer at CSEM. "But it doesn't make much sense for us to build a demonstrator on this scale, as the weight of this structure would be a major problem on Earth – of course in orbit the weight of this structure would not be a problem."

Tripods allow for ultra-precise adjustments

The demonstrator includes a robotic arm that connects six components together and operates them. CSEM custom-designed the six tiles, including two with tripods enabling them to adjust their positions with a precision of one micron (i.e., one-fiftieth the width of a human hair) and a repeatability better than five microns.

The tripods can achieve such accuracy thanks to the use of 3D-printed flexible joints, a first in this kind of space application. “The 3D-printed joints prevent the system’s components from rubbing against each other and wearing out, eliminating the need for lubricant,” says Rouvinet. “That means the system can operate for longer and deliver enhanced precision.” The software used to control and calibrate the system was also developed by CSEM’s engineers.

Broader applications

With the completion of the demonstrators, the PULSAR project is ending but research in this area is just getting started. “Telescopes are not the only large structures that will one day need to be assembled in space,” says Rouvinet. “And this robotic system could be used for other purposes as well, such as to repair satellites, refuel space stations, assemble solar panels or even build huge heat shields for missions to land on Mars.”

For now, all scientific eyes are on the James Webb Space Telescope, which has met the physical limits of what can be carried into space with current technologies. PULSAR, however, is not alone in its attempt to break this physical technological barrier. “NASA engineers are developing a folding telescope that could fit into the large-payload spacecraft that SpaceX intends to eventually launch,” says CSEM project manager Antoine Ummel. “Research efforts will undoubtedly step up once we receive the first images from the James Webb.”

CSEM’s 3D-printed structures were presented at ESMATS, an international symposium held by the European Space Agency (ESA), and will be on display at the 2022 International Conference on Advanced Manufacturing for Air, Space and Land Transportation, which is jointly organized by ESA and NASA.

About CSEM

CSEM—technologies that make the difference.

CSEM is a Swiss research and development center active in the fields of precision microfabrication, digitalization, and renewable energy. CSEM builds up the ties between industry and academia. It supports companies as a hub of ingenuity, a center of technological excellence and innovation, and accelerator of the digital transformation.

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Contacts

CSEM
Julien Rouvinet
Senior R&D Engineer
Tel. +41 32 720 5016
julien.rouvinet@csem.ch

CSEM
Laure-Anne Pessina
Strategic Communication Manager
Tel. +41 32 720 5226
laure-anne.pessina@csem.ch