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Press release

Technische Universität Berlin
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Mechanical engineering, Physics / astronomy, Traffic / transport
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Formation Flight in Orbit

Two satellites successfully launched from California. Technische Universität Berlin sets new standards in the development of small satellites with the NanoFF project.

On Friday, 1 December 2023 two small satellites produced by Technische Universität Berlin were successfully put into low Earth orbit from Vandenberg Space Force Base in California with a Falcon 9 rocket. The primary mission objective is a pioneering performance for TU Berlin, as project leader Jens Freymuth explains: “NanoFF is an acronym for nanosatellites in formation flight. As the name implies, we want to achieve formation flight in orbit with two highly integrated CubeSats, which are standardized small satellites measuring approximately 20x10x10 cm. Both will be deployed in Earth orbit, with one flying ahead and the other following, in order to enter a stable helix orbit. We have never done something like this before, it is completely new for us.” The two satellites are numbers 28 and 29 in the 30-year history of small satellite development at TU Berlin. As such, TU Berlin is the leading university worldwide in terms of the number of satellites in Earth orbit.

The upcoming mission represents multiple important advancements.

Active propulsion system:
For the first time, TU Berlin satellites will carry an active propulsion system. The hot water propulsion system does not contain any hazardous substances and allows precise manoeuvring of both satellites in orbit.

Formation flight:
By using their miniaturized propulsion system, both satellites can assume a specific formation and operate in active formation flight. This represents an innovation in space technology for satellites of this size.

Compact size:
Measuring only 20x10x10 cm and weighing just 3.2 kg per satellite, they represent an advancement in the miniaturization of satellite technology.
Thanks to the highly integrated and compact design, the same range of functions can be implemented on small satellites in the future. The costs saved during the development and launch open up new opportunities for applications in different business areas. In this way, small companies and startups can also demonstrate their technologies in Earth orbit and reduce the development timelines of new technologies. The propulsive formation flight also allows for constellations of small satellites that, in the future, could deliver stereo images of the Earth for topographical analysis, and measurements of mountains and glaciers. These images are important to analyze the consequences of climate change. Furthermore, satellites in formation flight can triangulate signal sources on Earth. This can be very useful for applications like the localization of interferences in remote places, or to locate people that need to be rescued from the sea or ocean.

Payload volume:

Compared to other small satellites, the TUBiX-5 satellite bus of the NanoFF satellites offers a particularly high payload volume compared to the overall volume. This means that a particularly large number of scientific experiments can be accommodated in relation to the size of the satellite. The NanoFF satellites carry four high resolution Earth observation cameras in different spectral channels as a technology demonstration payload. They can be used for example to analyze vegetation.

Demonstration of new technologies:
The satellites are furthermore equipped with deployable solar panels to generate enough energy for the different experiments. To estimate their position with high accuracy, the satellites are equipped with GNSS receivers and laser retroreflectors, with which they can be located from the Earth. Furthermore, three newly developed star trackers are being tested. They can estimate the orientation of the satellite in space with high accuracy using their built-in star catalog.

Sustainable space travel:
Both NanoFF satellites will re-enter the Earth's atmosphere and fully burn up within five years of completing their scientific mission. This period is less than the internationally recognized guideline of 25 years. Furthermore, satellites can use their propulsion system to alter their orbit as necessary to avoid collisions or accelerate re-entry. In this way, small satellites with propulsion systems and formation flight capabilities could help in the future to actively remove space debris or repair defective spacecraft - which is an active area of research of the Chair of Space Technology at TU Berlin.

Rocket launch with orbital transfer vehicle:
The launch was carried out together with the company D-Orbit. The nanosatellites were not placed in a typical deployment container during launch; instead, they were inside a spacecraft called ION, which separates from the Falcon 9 rocket and can slightly alter the orbital parameters to bring each customer to a specific orbit. The launched satellites are therefore not constrained to the orbit of the primary payload. Instead, special customer requirements can be realized. For the NanoFF mission in particular there were precise requirements with regards to the deployment time, orientation, and separation parameters.

What's next?
The satellites will separate from the ION spacecraft a few days after the rocket launch.
Immediately after the deployment, the project team will establish radio communications using ground stations in Berlin as well as in the polar regions. In the routine phase, the primary mission objective of formation flight, as well as the range of scientific experiments and innovative payload, will be demonstrated. "After such a long development period, I am very much looking forward to the first picture of the cameras from orbit," said Sascha Kapitola, payload and operations engineer, "and of course I hope that the satellites can take pictures of each other." Since its beginning, as many as 30 researchers have participated in the project, which is funded by the Federal Ministry of Economic Affairs and Climate Action. The operational phase and realization of the mission objectives will continue until at least September 2024. Finally, the satellites will be further used in a number of projects including student operations.

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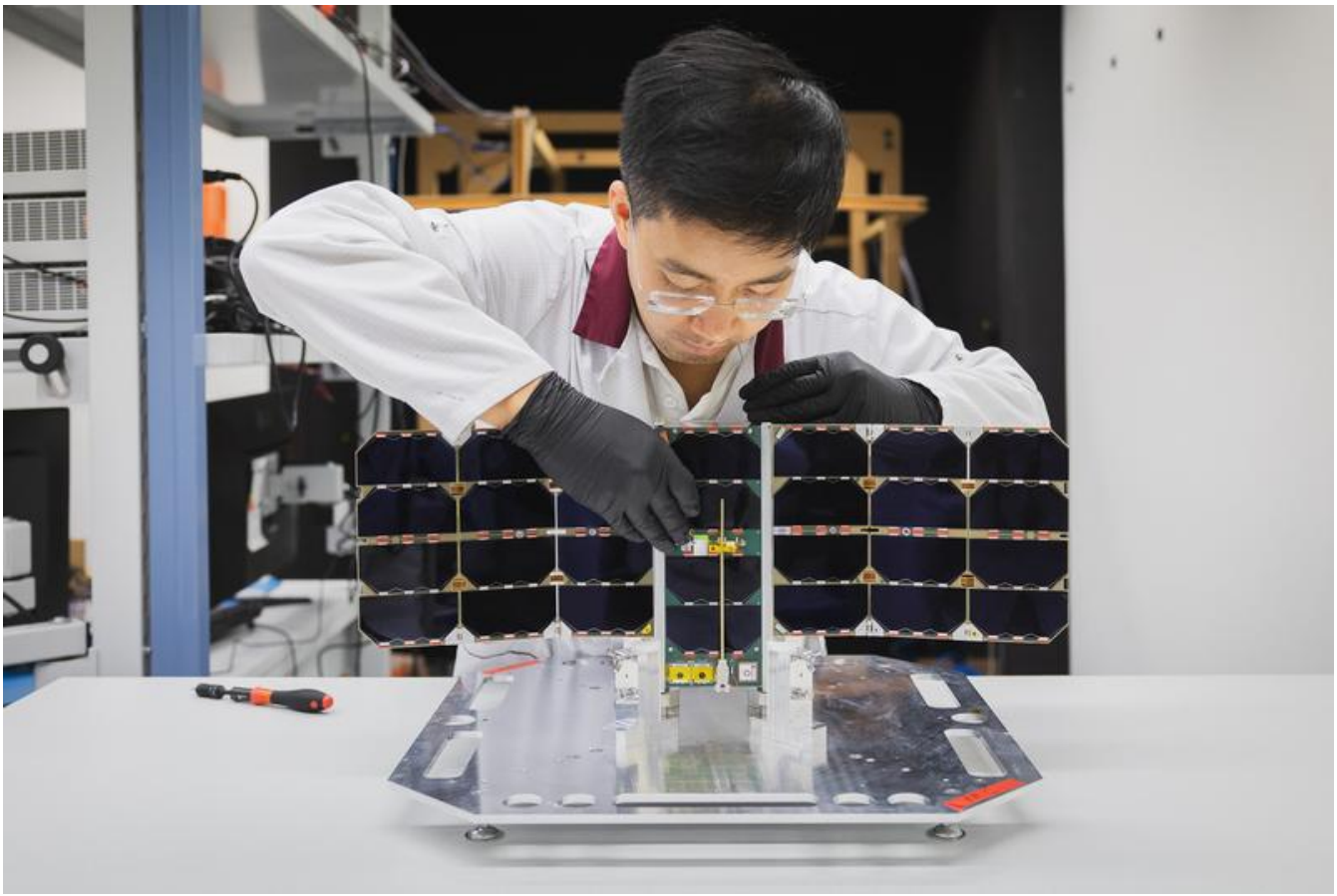
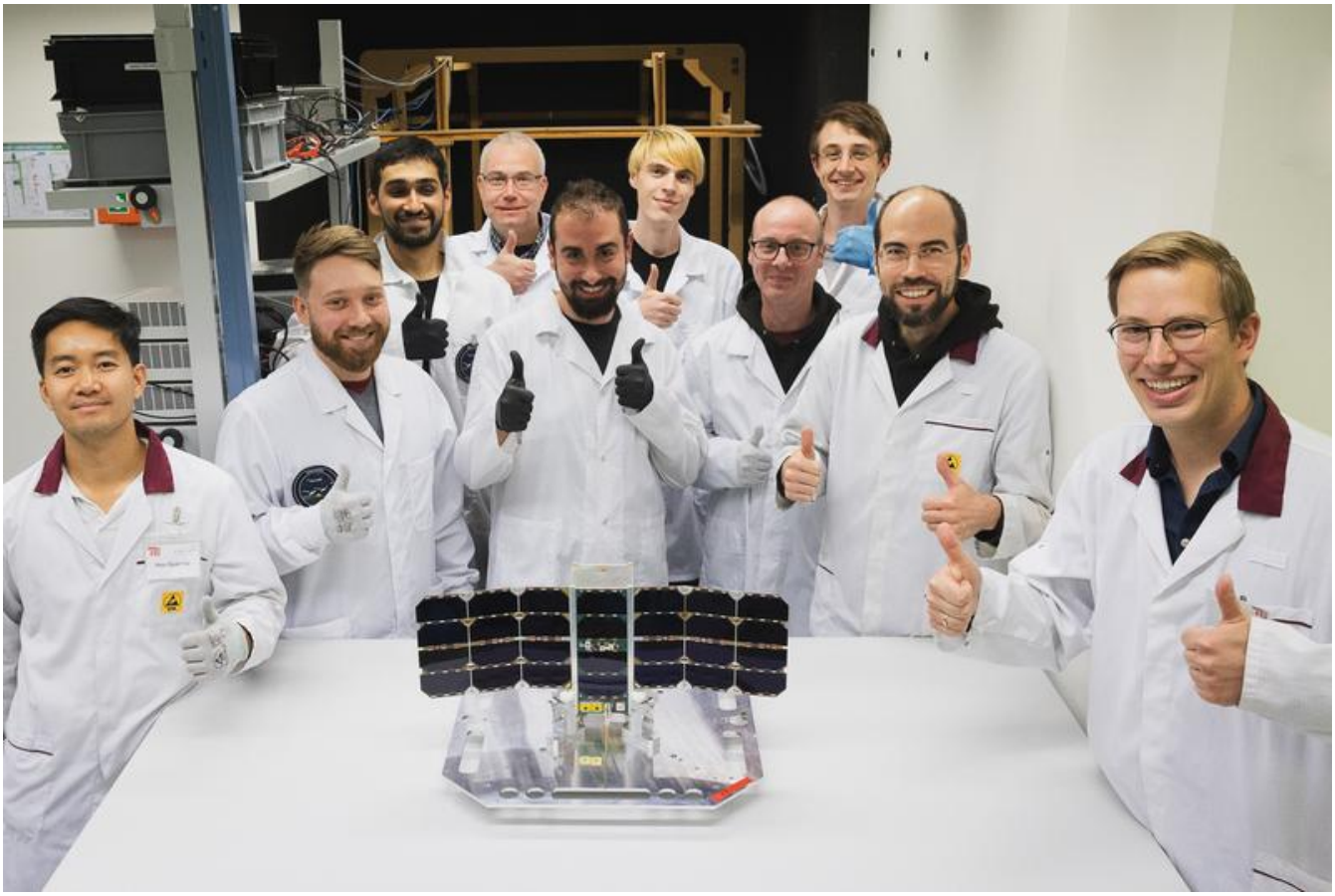


NanoFF satellite with deployed solar panels
Kevin Fuchs
TU Berlin/Kevin Fuchs



TU Berlin's NanoFF team
Kevin Fuchs
TU Berlin/Kevin Fuchs