

Singapore university satellite CRIMSON-1 reaches orbit to trial perovskite solar cells and onboard AI

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Nanyang Technological University, Singapore (NTU Singapore) has launched a satellite carrying locally developed perovskite solar cells for testing in space, along with artificial intelligence (AI) capabilities designed to analyse images directly in orbit.

The CRIMSON-1 satellite will collect real-world performance data on lightweight perovskite solar cells in the space environment. It will also test technologies that could help future spacecraft analyse raw data before sending it back to Earth.

CRIMSON-1 is the 14th NTU satellite to be launched and is among the first projects supported by the National Space Agency of Singapore (NSAS) under Singapore's Space Access Programme (SAP), part of the national Space Technology Development Programme.

The programme gives Singapore researchers and companies opportunities to test technologies such as advanced materials, solar cells and edge computing systems in orbit, build flight heritage, and shorten the path from laboratory development to validation in space.

The satellite is also supported by the Infocomm Media Development Authority (IMDA), which secured satellite spectrum and orbital resources from the International Telecommunication Union for its operation.

CRIMSON-1 was launched on a SpaceX Falcon 9 rocket on the Transporter-18 rideshare mission from Vandenberg Space Force Base in California on October 1.

Scientists from the NTU Satellite Research Centre (SaRC) worked with launch integrator Exolaunch, which provided launch capacity, mission management, satellite integration and deployment services, and deployed the satellite using its EXOpod Nova system.

Ngiam Le Na, Chief Executive of the National Space Agency of Singapore, said perovskite solar cells offer an advantage over conventional solar panels because their thin, lightweight properties suit space applications where mass is at a premium. She said missions like CRIMSON-1 give homegrown innovations a route to the flight heritage needed to move toward commercial application, and that letting researchers and companies test and validate technologies in orbit helps them build the credibility and track record needed to compete in the global space economy.

Since 2022 the Singapore government has set aside S\$210 million under the Space Technology Development Programme to support research and development in space technologies and build national capabilities.

NTU Deputy President and Provost Professor Christian Wolfrum said CRIMSON-1 carries next-generation perovskite solar cells and edge AI computing into orbit, technologies that can only be validated under real space conditions, and that NTU's satellite programme has been doing this kind of work for three decades.

Wolfrum said this is possible because NTU brings satellite engineering, artificial intelligence and advanced materials research together in one place. He added that the satellite was developed with local industry partners, so each mission builds capability across Singapore's space sector as well as in the university.

Testing perovskite solar cells in orbit

CRIMSON-1 will test several next-generation perovskite solar cells developed by NTU researchers and by Singfilm Solar, a deep-tech spin-off from the National University of Singapore (NUS).

Perovskites are a class of materials that can be used to make lightweight solar cells with high power-generation efficiency from commonly available materials.

NTU has worked on perovskite solar cells since a 2013 paper in Science in which a team showed that electrical charges could travel unusually long distances through perovskite materials, helping to explain their high solar-cell efficiency. NTU researchers have since scaled perovskite solar cells up toward module sizes suited to industry applications and developed prototypes aimed at improving performance and stability.

For space use, however, new solar technologies must show they can survive the physical stresses of a rocket launch and endure conditions in space while generating consistent power. CRIMSON-1 will test the durability and efficiency of the cells after their journey from the ground and measure how much electrical power they generate in low Earth orbit.

The mission is also the first time Singfilm's technology has flown in space, and will provide data to support further development and validation of its solar technology for space applications.

NUS Assistant Professor Hou Yi, founder of Singfilm Solar, said the mission is the first spaceflight of a flexible perovskite solar module built on ultrathin glass and the first deployment of a Singapore-made solar module in orbit. He said it will provide data on how the technology performs in space, helping the company advance lightweight solar power for future satellites and explore its use for space-based AI data centres.

Building on NTU's satellite record

The mission is led by the NTU Satellite Research Centre, where Singapore's satellite and space programmes began. It is one of the few university-based centres in the world with end-to-end capabilities covering spacecraft engineering, launch preparation, mission control and in-orbit operations.

Since the 2011 launch of X-SAT, Singapore's first locally built satellite, NTU has designed, built, tested and operated satellites ranging from small CubeSats to larger spacecraft, and has launched 14 satellites.

VELOX-AM, NTU's 13th satellite, was launched in July 2023, completed its mission and deorbited in August 2026. Data and lessons from past missions helped prepare the way for CRIMSON-1 and for NTU's continuing development of future satellite operations.

Alongside SaRC's engineering work, NTU's Earth Observatory of Singapore (EOS) applies satellite data to practical problems, from rapid mapping of earthquakes, floods and other disasters to monitoring climate change and land subsidence.

Developing AI for future satellite operations

A second CRIMSON-1 experiment will test edge AI computing, in which data collected by a satellite is analysed on board instead of all raw images being transmitted to Earth, which takes time and bandwidth.

During the mission the satellite will run AI-based image-processing tasks in orbit while researchers study how well its computing system manages heat and power consumption under heavy workloads.

Analysing images in space could let future satellites identify useful information before transmitting, reducing the amount of raw data sent over limited satellite communications links.

While CRIMSON-1 tests AI processing in orbit, SaRC is also examining how AI could help manage growing numbers of satellites from the ground. Earlier this year NTU and Japanese technology company Fusic Co., Ltd. announced a collaboration to explore AI-enabled ground systems that could assist satellite operators with mission scheduling, ground-station allocation, routine operations and earlier detection of technical problems.

Together the two efforts will examine how AI could support both sides of future satellite operations: processing information autonomously aboard spacecraft and helping human operators manage missions from Earth.