**NEWS RELEASE**

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# NTU Singapore launches three new satellites to test 3D-printed satellite parts, monitor the atmosphere and assess new space materials

Three new satellites built by **Nanyang Technological University, Singapore (NTU Singapore)** have blasted off into orbit, which will be used to conduct orbital experiments such as testing 3D-printed parts in space, measuring atmospheric data, and evaluating new space materials.

The satellites - **VELOX-AM**, **ARCADE** and **SCOOB-II** - serve as demonstrations of NTU's leading capabilities in satellite engineering and undergraduate space engineer training. Since 2011, NTU has successfully built, launched and operated 13 satellites, including these three launched on Sunday morning (30 July) by the Indian Space Research Organisation on the Polar Satellite Launch Vehicle.

The launch vehicle also carried a microsatellite from NTU spin-off **Aliena**, which will test a next-generation propulsion engine.

Both VELOX-AM and ARCADE are micro-satellites weighing 22kg and 27kg respectively, developed in collaboration with NTU's partners. SCOOB-II is the second cube satellite designed and built by NTU students under the Student Satellite Series, which offers engineering undergraduates real-world learning opportunities on satellite design.

**Professor Luke Ong, NTU Vice President (Research)**, said: "Progressing towards microsatellites in the 25kg range allows NTU to meet application and mission-specific requirements more effectively. The University's satellite development programme involves leveraging the multi-disciplinary expertise of NTU faculty and researchers from various schools in contributing to the advancement of Singapore's space industry. Additionally, NTU collaborates closely with local and international partners to introduce innovative technologies to further enhance the capabilities of Singapore's space sector."

**Mr Ronald Tong, Acting Executive Director, Office for Space Technology & Industry (OSTIn)**, said: “The successful launch of NTU’s satellites marks another milestone in Singapore’s space journey, harnessing our strengths in science, engineering, manufacturing and undergraduate education. The launch reflects Singapore’s robust space research community and will contribute to various applications including the study of the Earth’s atmosphere. As Singapore’s national space office, OSTIn will continue to support the development of our space ecosystem, including the nurturing of more science, technology, engineering, and math (STEM) talent.”

**NTU and A*STAR to test 3D-printed parts in space onboard the VELOX-AM**

The VELOX-AM (Additive Manufacturing) satellite is a collaborative endeavour with Singapore’s **Agency for Science, Technology and Research (A*STAR)** aimed at testing, for the first time, how additive manufacturing, or 3D-printed parts, can be used effectively to produce complex satellite components.

The 50 cm x 30 cm x 50 cm satellite carries a 3D-printed main structure panel. NTU built the satellite body, while A*STAR’s Advanced Remanufacturing and Technology Centre (ARTC) developed and 3D-printed structural parts that have undergone rigorous high shock requirement tests to simulate the forces of a satellite launch.

These 3D printed parts were produced with an end-to-end manufacturing process, ensuring the consistent performance of components to withstand extreme space environmental conditions. A*STAR’s Institute of High Performance Computing analysed the mechanical performance to determine how the 3D printed parts will react to forces during launch and while in orbit.

Another 3D-printed experimental payload onboard the VELOX-AM is a functionally tested module which houses a phase-change material to allow better satellite thermal control. This material changes its form between liquid and solid states to absorb and release heat energy, aiding energy conservation.

**Dr David Low, Chief Executive Officer at A*STAR’s ARTC**, said: “Leveraging advancements in additive manufacturing, A*STAR has produced complex satellite components that meet the design, functionality and performance requirements that allow the VELOX-AM to withstand large forces during launch, and to maintain high performance while in orbit. This collaboration with NTU Singapore presents an exciting opportunity to study how 3D-printed parts can function in space. We look forward to more of such collaborations, to unlock the potential of advanced manufacturing capabilities in supporting Singapore’s space missions.”

The last experiment VELOX-AM is conducting in space revolves around shape-memory polymers, which are materials that can hold ‘memories’ of their previous

shapes. These materials can be deformed, such as by twisting or folding, and can return to their original shape by applying heat to them.

This technique holds promise for applications on solar panels and antennas. For instance, solar panels can be folded very compactly to be brought up onto a space station, where they can be heated to unfold back to their original, larger size.

**Studying the atmosphere with ARCADE (Atmospheric Coupling and Dynamics Explorer)**

The ARCADE (Atmospheric Coupling and Dynamics Explorer) satellite aims to measure data for atmospheric coupling studies.

The 32 cm x 32 cm x 32 cm satellite is an international collaboration with partners from Germany, India, Taiwan and the United States. It is the fourth satellite in the **International Satellite Program in Research and Education (INSPIRE)** series, an international consortium of space-faring universities.

The satellite carries four instruments: an imager for atmospheric gravity waves; a plasma probe for measuring ionospheric plasma density and velocity; an atomic oxygen instrument to study atomic oxygen degradation of materials at low Earth orbit; and an optical imager for Earth imaging.

Also onboard the satellite are newly developed flexible perovskite solar cells, which will be used in experiments to test their performance in Low Earth Orbit for potential applications in curved, rollable solar panels.

In conjunction with its electric propulsion thruster, the satellite can deorbit into a region of space that has been very rarely explored. This ambitious mission aims to perform experiments and meet scientific objectives at a fraction of the cost of larger missions usually performed by bigger satellites that are usually above 400kg, or almost twenty times heavier.

**SCOOB-II – training of future space engineers**

SCOOB-II is the second satellite built under **NTU's Student Satellite Series** which aims to provide real-world satellite learning opportunities for engineering undergraduates. The first satellite, SCOOB-I, was launched in July 2022, where it successfully demonstrated space technologies developed by students at NTU's Satellite Research Centre (SaRC) such as sensors to observe the Sun.

Also developed at SaRC, the 4.1kg shoebox-sized SCOOB-II satellite carries a payload which demonstrates advanced electronics test operations in space. Measuring 34cm x 10cm x 10 cm, SCOOB-II, as a continuation to SCOOB-I, has an additional two deployable solar panels that will help to generate about three times the power generated from SCOOB-I, allowing it to carry a more power-demanding payload.

SCOOB-II also carries an improved attitude determination control system that helps the spacecraft point at the sun to absorb maximum solar energy to charge its onboard battery.

**NTU final-year PhD student Saleem Amitha** has worked on both SCOOB-I and SCOOB-II since 2019. The experience led her to gain extensive knowledge and hands-on expertise in various aspects of satellite design, development, and testing, together with an in-depth understanding of different satellite systems.

Ms Amitha said: “I feel an incredible sense of pride and excitement knowing that my work will soon be in space. The opportunity to see the culmination of my efforts and expertise manifested in a tangible form, orbiting the Earth, is truly awe-inspiring. Throughout my journey, I encountered various challenges and problem-solving opportunities, which have further strengthened my skills in troubleshooting, adapting to unforeseen circumstances, and collaborating effectively within a team of experts.”

**NTU spin-off Aliena’s new satellite to test all-electric propulsion engine**

On top of the three NTU satellites, a microsatellite carrying a cutting-edge propulsion engine from NTU spin-off **Aliena** was also successfully launched on Sunday morning.

The ORB-12 STRIDER will be used to demonstrate next-generation propulsion systems through the world’s first multi-modal all-electric propulsion engine.

This engine comprises Aliena’s flagship multi-stage-ignition compact (MUSIC) Hall thruster, the first of its kind to be developed locally in Singapore. The thruster uses an electric field to accelerate ions from the propellant, allowing the engine to consume a fraction of power compared to traditional engines in manoeuvring the satellite in space.

**Aliena chief executive officer and co-founder Dr Mark Lim** said: “It is with great pride that we see the ORB-12 STRIDER manifested alongside satellites from our co-founders’ alma mater, NTU Singapore. This launch will provide space legacy to our systems to drive further commercial traction, and gather orbital data that will be beneficial as we gear up for our flight on an NTU mission at Very Low Earth Orbit.”

The ORB-12 STRIDER satellite was developed under an international collaboration coordinated by Singapore-based Aliena, including Orbital Astronautics (United Kingdom) as bus providers and Aurora Propulsion Technologies (Finland) as subsystem co-developers.

For further information on the new satellites, see Annex A.

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***About Nanyang Technological University, Singapore***

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Medicine, Humanities, Arts, & Social Sciences, and Graduate colleges.

NTU is also home to world-renowned autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Under the NTU Smart Campus vision, the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources.

Ranked amongst the world's top universities, the University's main campus is also frequently listed among the world's most beautiful. Known for its sustainability, over 95% of its building projects are certified Green Mark Platinum. Apart from its main campus, NTU also has a medical campus in Novena, Singapore's healthcare district.

For more information, visit www.ntu.edu.sg

**ANNEX A**

**About NTU Satellite Research Centre (SaRC)**

- **Birthplace of Singapore's satellite programmes**
- **24 years of satellite expertise**

NTU Singapore made its first foray into space more than 20 years ago, with a communication payload codenamed Merlion, which was mounted on a main satellite body developed by the University of Surrey. It was launched in 1999, making this year the 24th year anniversary milestone since NTU begun its space mission.

Since then, NTU has designed, built and sent 13 Singapore satellites into Earth's orbit. In 2011, NTU launched Singapore's first locally built satellite into space. Named the X-SAT, it was a 106kg microsatellite that NTU had built in collaboration with DSO National Laboratories.

The success of X-SAT had resulted in a joint venture between ST Engineering, DSO National Laboratories and NTU, to form ST Engineering Satellite Systems, as it is known today.

In 2015, ST Engineering Satellite Systems launched TeLEOS-1, Singapore's first commercial earth observation satellite along with five other satellites from the nation including VELOX-II, NTU's first satellite to carry a commercial payload that could communicate with other satellites and VELOX-CI, a 123kg micro satellite used to study the tropical climate.

Since 2009, NTU has also been running Singapore's first and leading satellite programme for undergraduates and postgraduates, where student-built pico-satellites (the size of a small cube) was successfully launched and tested to operate well.

Previously launched NTU satellites include:

- **X-SAT**, Singapore's first locally built satellite launched in April 2011. The fridge-sized micro-satellite weighing 105kg is built by NTU and DSO National Laboratories.
- **VELOX-PII**, an NTU student-built nanosatellite satellite launched in November 2013. It is the size of a 10cm cubic box weighing 1.3kg.
- **VELOX-I**, a 4.5-kilogramme satellite built by students and research staff to demonstrate advanced satellite technologies designed by NTU. It tested an inter-satellite communication system that could communicate with the 193-grams **VELOX-PIII** satellite which it piggybacked. These two satellites were launched in June 2014.
- **VELOX-II,** a 12kg nanosatellite that demonstrated Inter-Satellite Data relay System (IDRS) which is owned and developed by Addvalue Innovation Pte Ltd. It

was launched in 16th Dec 2015 and is NTU's first satellite to carry a commercial payload.

- **VELOX-CI**, a 123-kg microsatellite, supported by Singapore's EDB, is designed to evaluate a new precise navigation system and to measure atmospheric parameters for studying the tropical climate. It was launched in 16th Dec 2015 together with VELOX-II and four other satellites on a rocket from India.
- **AOBA VELOX-III,** a 2kg nanosatellite built with Japan's Kyushu Institute of Technology (Kyutech). This was launched in 9th Dec 2016 and released from International Space Station 16th Jan 2017. The satellite demonstrated the first pulsed plasma micro-propulsion system for nanosatellites.
- **SPATIUM-1** was the first nanosatellite that demonstrated a chip-scale atomic clock working in Low Earth Orbit. The 2.6kg nanosatellite is a joint program with Japan's Kyushu Institute of Technology (Kyutech). The launch was in 23rd Sep 2018 and it was deployed from International Space Station on 6th Oct 2018.
- **AOBA VELOX-IV,** a 2.9kg nanosatellite built with Japan's Kyushu Institute of Technology (Kyutech). This was launched in 18th Jan 2019. The main objective of this mission is the technological demonstration of taking earth glow images in Low Earth Orbit by using a low-light camera and pulsed plasma thruster (PPT) towards observation of the lunar horizon glow in future moon missions.
- **SCOOB-I**, a 1.7kg nanosatellite packing several NTU innovations that have not been tested in space before. Launched in 30th June 2022, it carries a solar spectrum sensor to make observations of the Sun in 18 channels from ultraviolet to infrared, and an Earth imaging sensor and camera capable of discerning objects on Earth 25 to 30 metres in length.
- **VELOX-AM** is a 25kg technology demonstration microsatellite for Additive Manufacturing launched on 30 July 2023. It contains payloads made from 3D-printed materials, including the main structure panel and antenna, and will be used to test how 3D-printed materials can stand up to the rigours of space launch and flight.
- **ARCADE (**Atmospheric Coupling and Dynamics Explorer) is a 25kg experimental satellite, launched on 30 July 2023. The fourth satellite in the INSPIRE series, it carries imaging tools for at measuring atmospheric data, such as a plasma probe for ionospheric plasma density and velocity measurements, an atomic oxygen instrument to study the atomic oxygen degradation of materials in Low Earth Orbit and perovskite solar cells, and an optical imager for Earth imaging.
- **SCOOB-II** is a 4.1kg shoe box-sized satellite that carries a high-power payload which demonstrates advanced electronics test operations in space. Launched on 30 July 2023, it carries an improved attitude determination control system that helps the spacecraft to point at the sun.

For more information, visit
https://www.ntu.edu.sg/sarc/research capabilities/satellites