New Zealand's first science satellite mission

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Te Pūnaha Ātea Auckland Space Institute space.ac.nz The University of Auckland

Exciting Times for Small Satellites in New Zealand

New Zealand has been a space-faring nation since 2017. Rocket Lab USA provides access to orbit for its clients, launching from the east coast of the North island. Joining the select club of nations that can reach space has spurred significant interest in New Zealand's economic, research and cultural spheres.

As university educators we seek to provide our students with the opportunity to develop the skills necessary to contribute to local and international space economy. We present here an introduction to New Zealand's first science satellite, APSS-I, and Te Pūnaha Ātea Auckland Space Institute.

The Auckland Programme for Space Systems

The Auckland Programme for Space Systems (APSS) is a programme for undergraduate students operated by the University of Auckland, in New Zealand.

The programme is unique in that it is focussed on the student experience and is using the allure of space as the hook to gain student interest. Students themselves decide the mission through a competition environment.

All faculties across the university are encouraged to participate. This opens the project beyond traditional science and engineering. The main goal is to provide an opportunity for students to experience working in a complex, cross discipline, unfamiliar, problem solving environment.

At the heart of the APSS Programme is a competition to design a CubeSat mission that will collect data from orbit that services a New Zealand societal need. The competition is held every year and each student team has nominally two years to enter and win the competition, design, build, test and operate their satellite.

APSS-I is ready to fly, APSS-II is being integrated now, and the APSS-III team is finalising its payload definition. The fourth iteration of the APSS programme competition is scheduled to start in the latter half of 2020, or early 2021.

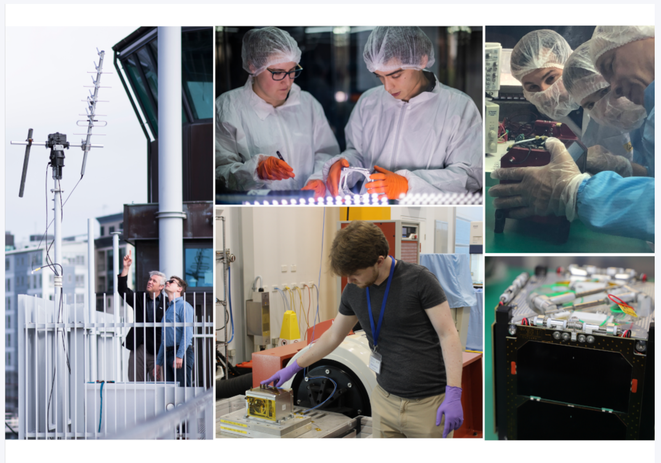

Figure 1. Clockwise, from left: The UoA ground station antenna, APSS-I students, Rocket Lab Fit Engineer Carl Campbell testing APSS-I in Rocket Lab's 1U Maxwell dispenser, the dual Langmuir probe payload, testing the APSS-I engineering model at the AITC.

APSS-I

APSS-I is a science mission designed to measure electron density in the ionosphere. Our mission aims to provide additional data on the interaction between the ionosphere and external phenomena such as the solar wind or telluric properties or activity.

APSS-I is a 1U CubeSat comprising commercial-off-the-shelf hardware and custom-made components. Our COTS hardware supplier for APSS-I was Clyde Space, who provided the EPS, solar panels, transceiver and antenna deployment module. Our science payload comprises two Langmuir probes driven by a custom designed OBC, the heart of which is a Raspberry Pi 3B+.

We conducted thermal vacuum and vibration tests at the Advanced Instrumentation and Technology Centre (AITC), Canberra, Australia over two test campaigns. Ground segment support will be provided by the Awarua Satellite Ground Station.

APSS-I is scheduled to launch on Rocket Lab's SSO Rideshare-1 mission into a 400km Sun-synchronous orbit.

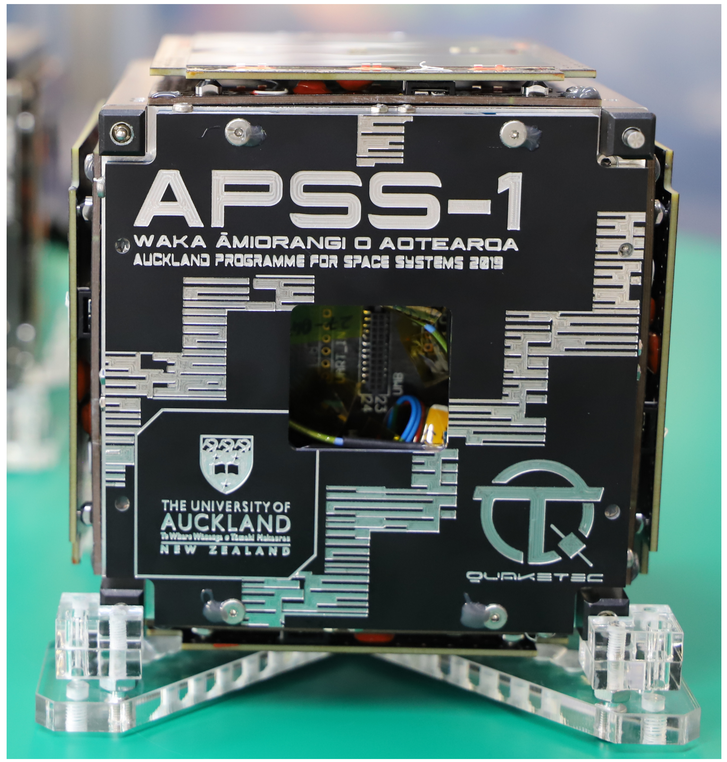

Figure 2. The APSS-I satellite.

Te Pūnaha Ātea Auckland Space Institute

Te Pūnaha Ātea Auckland Space Institute is a multi-faculty Space Science and Engineering initiative at the University of Auckland. As New Zealand starts to define its place in the fast-growing international space sector, we are ensuring that researchers and students are equipped with the knowledge to participate in an industry that will have a strong impact on our technological, economic and social future.

The Auckland Space Institute is committed to expanding our innovative capacities to the frontiers of space. Our key research areas are:

Synthetic Aperture Radar Technology Development

This project is developing the underlying science and technology needed to provide NZ with an overhead monitoring capability using space-based assets. Our academic staff have won contestable funding from the Science for Technological Innovation National Science Challenge, and the Ministry of Business, Innovation and Employment (MBIE) Catalyst Fund to develop novel miniature synthetic aperture radar hardware and software for small satellites. A growing research group involves collaboration with MBIE, the German Aerospace Center (DLR), and Environment Canada.

Plasma Micro-propulsion Technology Development

We are working with collaborators at the Space Physics, Plasma and Propulsion Laboratory at the Australian National Laboratory (ANU) and Stanford University, USA to develop and test novel miniature satellite electric propulsion systems. Our work includes improving the Technology Readiness Level of ANU's Pocket Rocket to enable the first space flight of the propulsion system in a CubeSat. In conjunction with this work, we are investigating optimal flight trajectories for low delta-v thrust systems to enable interplanetary exploration with small satellites.

Materials Science for Sample Return

The Institute is leveraging existing national expertise in light-metals technology to develop new materials for ablation and thermal insulation, to enable satellite sample return missions. We are also developing micro-fluidics devices for chemical and biological processing in low Earth orbit.

Deployable structure research

Along with our commercial and academic collaborators, our team is developing reliable, lightweight and strong deployable structures, suitable for use on small, CubeSat scale satellites. Our current research projects include the creation of a mechanism to deploy a high gain reflectarray antenna, to further our SAR research goals. We are also working on orbit debris mitigation solutions, including electromagnetic tethers and drag sails.

Enabling Life Sciences Research

We advise on aerospace solutions for providing data on ecological, environmental and biological research projects. We work with our collaborators on the high frequency imaging of extensive tidal coastlines, megafauna migration and distributed sensor networks. Our work also supports our collaborators' research into the long term effects of microgravity on human microbiota and protein crystal synthesis.

Australasian Optical Communication Ground Station Network

The next evolution in space-ground communication will be using coherent light and adaptive optics systems. Working with collaborators in Australia, Germany, Japan and the US, the Institute seeks to support the creation of an optical ground communication network, with nodes across Australia and New Zealand.

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