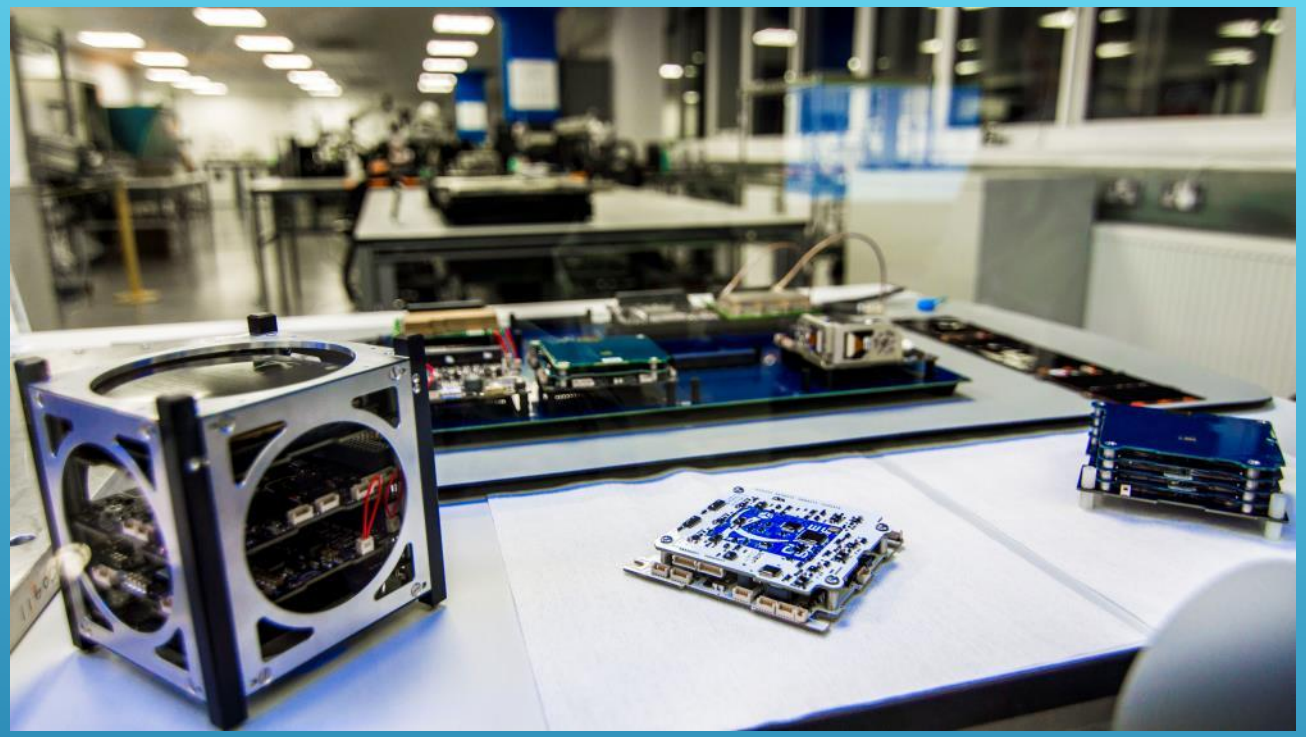
AUCKLAND PROGRAMME FOR SPACE SYSTEMS

Prepare For The Future

United Nations / South Africa
Symposium on Basic Space Technology
Stellenbosch, December 2017

Jim Hefkey, The University of Auckland, New Zealand



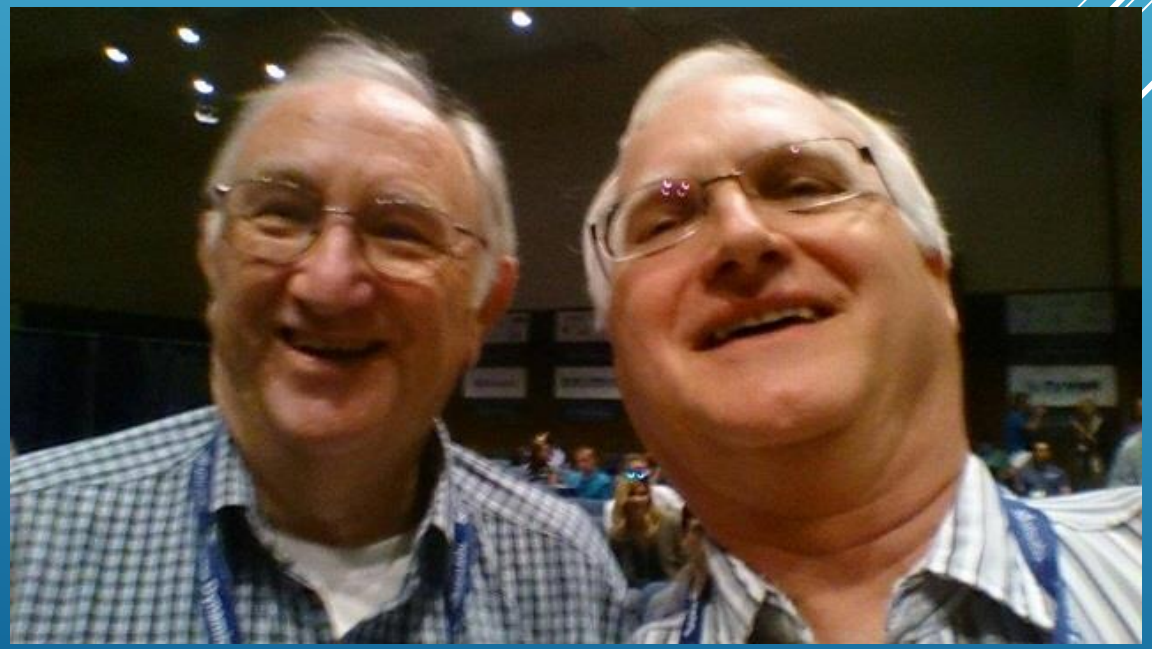
AUCKLAND PROGRAM FOR SPACE SYSTEMS

AUCKLAND PROGRAM FOR SPACE SYSTEMS

- **STUDENT-LED CROSS FACULTY PROGRAM**
- **DEFINE A PROBLEM OR A NEED TO BENEFIT SOCIETY**
- **FORM THEIR OWN MULTI-DICIPLINARY TEAM**
- **DEVELOP A SOLUTION TO THAT PROBLEM UTILISING A CUBESAT**
- **SUBMIT A FORMAL PROPOSAL WHICH INCLUDES A BUSINESS PLAN**
- **SUBMIT A POSTER AND VIDEO**

AUCKLAND PROGRAM FOR SPACE SYSTEMS

- A PROGRAM FOR UNDERGRADUATES
- LEARNINGTO WORK ON COMPLEX PROBLEMS WITH PEOPLE THAT DO NOT THINK THE SAME WAY
- BEING CREATIVE
- THESE QUALITIES ARE TRANSFERRABLE TO ANY INDUSTRY – SPACE IS ONLY THE HOOK TO GET STUDENTS INTERESTED



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Dr John Cater
Engineering Lead FoE

AUCKLAND PROGRAM FOR SPACE SYSTEMS

Jim Hefkey
Programme Director FoE

AUCKLAND PROGRAM FOR SPACE SYSTEMS

- **INVITED STUDENTS FROM ALL FACULTIES ACROSS THE UNIVERSITY**

Learning to think like an artist means:

- looking at things more closely than most people do
- making connections between different things and ideas
- going beyond ordinary ways of thinking and doing things
- looking at things in different ways in order to generate new perspectives
- taking risks and exposing yourself to possible failure
- arranging things in new and interesting ways
- working hard and at the edge of your potential
- persisting where others may give up
- concentrating your effort and attention for long periods of time
- dreaming and fantasizing about things
- using old ideas to create new ideas and ways of seeing things
- doing something simply because it's interesting and personally challenging

COMMON GROUND

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- **Flipped Classroom**
  - **Put resources online for self study**
  - **Provide lab and learning space and structured exercises**

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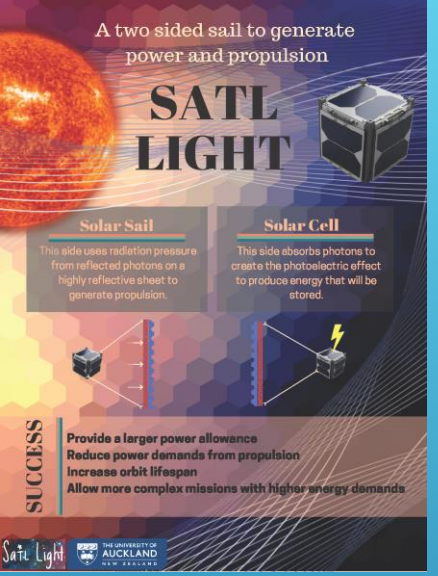
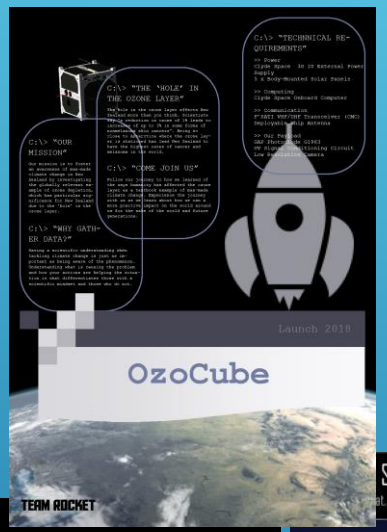

A two sided sail to generate power and propulsion
SATL LIGHT
Solar Sail
This side uses radiation pressure from reflected photons on a highly reflective sheet to generate propulsion.
Solar Cell
This side absorbs photons to create the photoelectric effect to produce energy that will be stored.
SUCCESS
Provide a larger power allowance
Reduce power demands from propulsion
Increase orbit lifespan
Allow more complex missions with higher energy demands
Sat Light
THE UNIVERSITY OF AUCKLAND

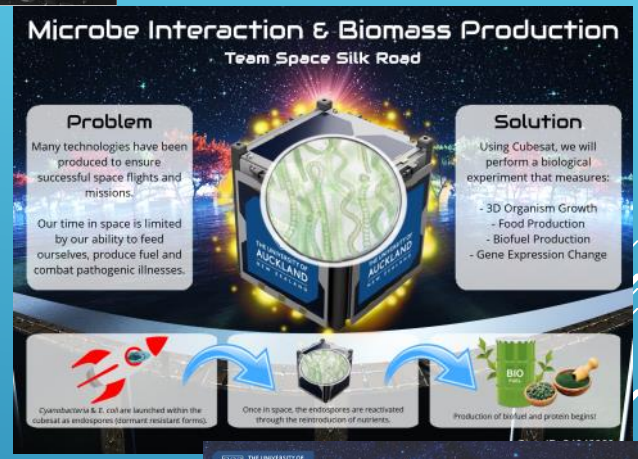

WAI-SAT
WATER ASSESSMENT IMAGING SATELLITE
Mission Objective
To increase the number of rivers, lakes and waterways receiving regular water quality assessment in New Zealand. In doing this we aim to lower the cost of water monitoring in New Zealand, increase awareness and education about New Zealands waterways.
How?
We aim to address this issue by creating WAI-Sat, a 1U CubeSat which will provide data on selected water quality identifiers. WAI-Sat will feature a monospectral imaging device, similar to the CubeSat pictured below.
Why?
New Zealand markets itself off its "Clean, Green" image. It is what keeps our Tourism, Film and Farming industries running.
Because of this, figures such as those released in 2013 stating that 61% of New Zealand's monitored waterways were rated as "poor" or "very poor" quality really hit home.
When we were tasked with solving a problem with a 1U CubeSat we instantly jumped to the idea of water quality assessment. When we looked into how we could help in this field we saw that although New Zealand has over 180,000 kilometers of rivers, we only have 77 water quality assessment sites.
In producing WAI-Sat we hope to increase the overall total of New Zealand's waterways receiving regular assessment. In doing this we hope to bring down assessment costs and provide a path to identifying problem areas.
We aim to use the WAI-SAT as a proof of concept for the implementation of larger CubeSat (2U – 3U) which will implement larger hyperspectral imaging devices designed to monitor a larger range of water quality identifiers.
Design concept for APSS
THE UNIVERSITY OF AUCKLAND

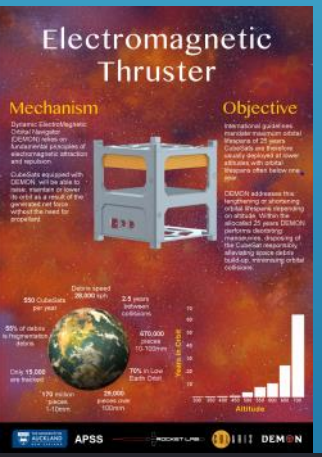

Half the world will have a fresh water crisis by
2030
2.8 billion
lack access to fresh water
Scan for subterranean fresh water from
SPACE
No Water.
No Life.
No Blue.
No Green.
- Sylvia Earle


SPECTRA
OUR MISSION
Determine which debris is worth salvaging by using reflectance spectroscopy to document the chemical composition of space debris.
When there is no known debris available, Spectra is able to use the spectrometer to gather data about the Earth's atmosphere.
APPROACH
Spectrometer is used to measure wavelengths of electromagnetic radiation emitted by debris pieces.
Data collected will be sent back to earth and compared with existing database which allows accurate logging of the properties of a piece of debris.
POINT OF DIFFERENCE
Spectra aims to inspire other organisations to use this technology on a much larger scale and open up a new chapter in commercial spaceflight for New Zealand's aerospace industry.
Team 17.13

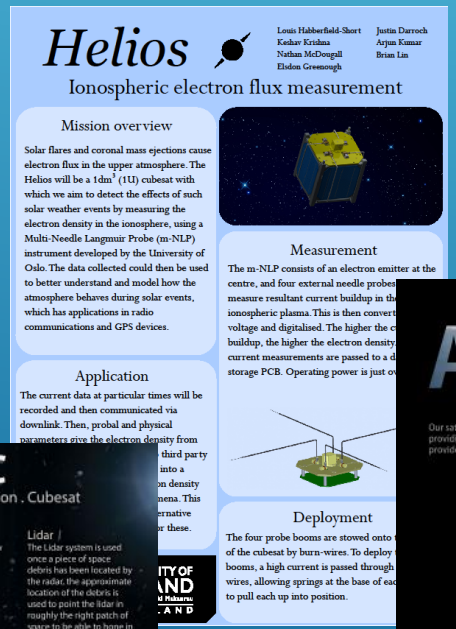

APSS
WALL-E 3.0
THE UNIVERSITY OF AUCKLAND
Feasibility of Total Electron Content as a Precursor to Earthquakes
Measure Total Electron Content (TEC):
1. Directly via Langmuir probe
2. By measuring the phase shift in radio waves
Ionosphere
TEC disturbance propaga-
Pacific Plate
Australian Plate
Epicenter
OBJECTIVE:
Compare collected CubeSat data with NZ earthquake event history from GeoNet to establish if there is a relationship
Mission duration: 5 months
Mission cost: $88,500 NZD

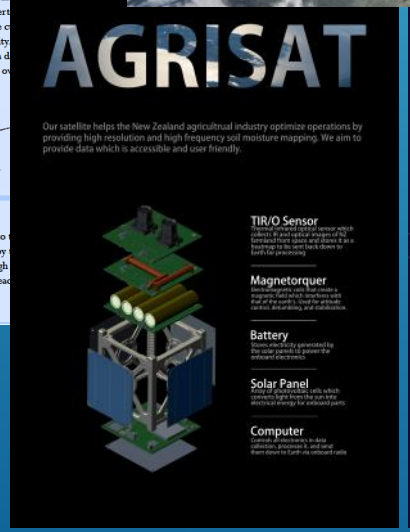

C:\> "THE "HOLE" IN THE OZONE LAYER"
C:\> "TECHNICAL REQUIREMENTS"
C:\> "OUR MISSION"
C:\> "COME JOIN US"
C:\> "WHY GATHER DATA?"
Launch 2018
OzoCube
TEAM ROCKET

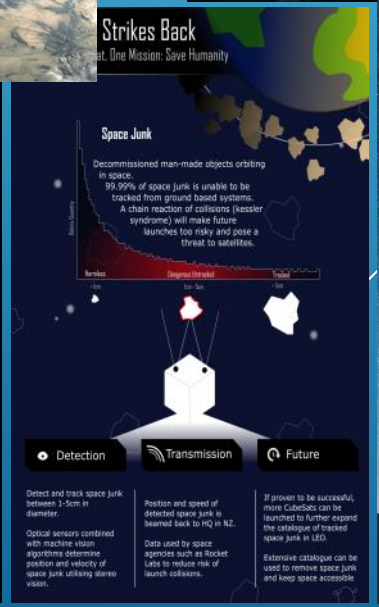

Microbe Interaction & Biomass Production
Team Space Silk Road
Problem
Many technologies have been produced to ensure successful space flights and missions.
Our time in space is limited by our ability to feed ourselves, produce fuel and combat pathogenic illnesses.
Solution
Using Cubesat, we will perform a biological experiment that measures:
- 3D Organism Growth
- Food Production
- Biofuel Production
- Gene Expression Change
Cyanobacteria & E. coli are launched within the cubesat as endospores (dormant resistant forms).
Once in space, the endospores are reactivated through the reintroduction of nutrients.
Production of biofuel and protein begins!


Electromagnetic Thruster
Mechanism
Objective
APSS
ROCKET LAB
DEMON


ELECTRO DYNAMIC TETHERS
WHAT WE AIM TO SOLVE
THE CONCEPT
WHAT ARE ED TETHERS?


Helios
Ionospheric electron flux measurement
Louis Habberfield-Short
Keshav Krishna
Nathan McDougall
Elsdon Greenough
Justin Darroch
Arjun Kumar
Brian Lin
Mission overview
Solar flares and coronal mass ejections cause electron flux in the upper atmosphere. The Helios will be a 1dm³ (1U) cubesat with which we aim to detect the effects of such solar weather events by measuring the electron density in the ionosphere, using a Multi-Needle Langmuir Probe (m-NLP) instrument developed by the University of Oslo. The data collected could then be used to better understand and model how the atmosphere behaves during solar events, which has applications in radio communications and GPS devices.
Application
The current data at particular times will be recorded and then communicated via downlink. Then, probal and physical
Measurement
The m-NLP consists of an electron emitter at the
Deployment
The four probe booms are stowed onto
booms, a high current is passed through
wires, allowing springs at the base of ea
to pull each up into position.

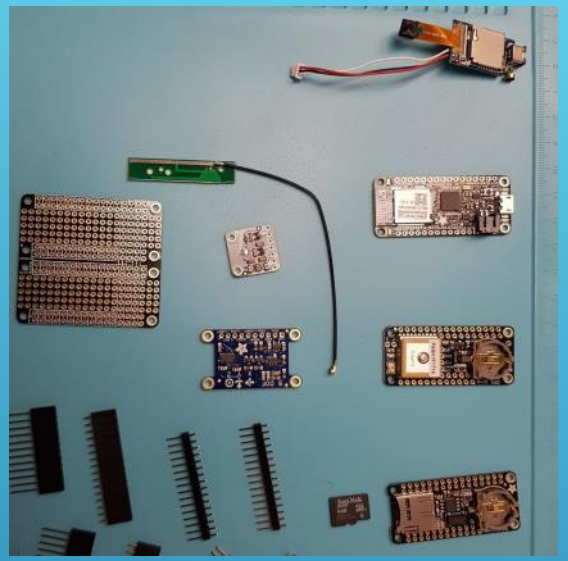

AGRISAT
Our satellite helps the New Zealand agricultrual industry optimize operations by providing high resolution and high frequency soil moisture mapping. We aim to provide data which is accessible and user friendly.
TIR/O Sensor
Magnetorquer
Battery
Solar Panel
Computer


Strikes Back
Space Junk
Decommissioned man-made objects orbiting in space.
99.99% of space junk is unable to be tracked from ground based systems.
A chain reaction of collisions (kessler syndrome) will make future launches too risky and pose a threat to satellites.
Detection
Transmission
Future
Detect and track space junk between 1-5cm in diameter.
Optical sensors combined with machine vision algorithms determine position and velocity of space junk utilising stereo vision.
Position and speed of detected space junk is beamed back to HQ in NZ.
Data used by space agencies such as Rocket Labs to reduce risk of launch collisions.
If proven to be successful, more CubeSats can be launched to further expand the catalogue of tracked space junk in LEO.
Extensive catalogue can be used to remove space junk and keep space accessible


THE UNIVERSITY OF AUCKLAND
DT-SAT
ENDEAVORING TO REDUCE SPACE DEBRIS
Mission Statement
The Debris Tracking CubeSat (DT-SAT) will track positions, velocities and trajectories of orbital space debris. The DT-SAT will use radar to track the debris before communicating this data to Earth.
Operation
DT-SAT will utilise the data to conduct statistical analysis of the path of space debris, to determine the risk of debris collision with functional satellites. The information computed can be passed onto the responsible companies associated with the satellites concerned.
Value
To reduce the risk to operational spacecraft in the Earth's orbit therefore allowing for the continual advancement into the Space Age.
Technical Specifications
- POWER -
- COMPUTATION -
- COMMUNICATION -
- OPERATIONS -
BAM! AND THE JUNK IS GONE


SPACE JUNKIES
Problem
Space debris is a growing problem. There is a vast amount of debris orbiting Earth, and more is being created every day. Every collision creates hundreds to thousands of pieces of space junk. Even flecks of paint can cause devastating damage.
There are already numerous ground-based tracking systems for large space debris, but there is a gap in our tracking and understanding of small debris in the mm-cm range. This problem grows exponentially, so a solution must be found soon, before the problem becomes irreparable.
Solution
We propose a proof-of-concept CubeSat. It will be used to detect debris in the untracked size range. We will implement this by Pulse-Doppler radar system. This will allow us to detect these small objects, but also determine its location and velocity. We can use this information to help satellites avoid potential impactors.
We will create a community-focused website to educate the public about the dangers of space debris, and also inform them of our work. The website will create awareness of this neglected issue and allow the public to intuitively interact with our findings.
12
Protecting our satellites. Protecting our future.


R.E.L.I.C
Radar . Extrapolated . Lidar . Information . Cubesat
Radar
The radar is used as our primary method for identification of space debris in low earth orbit. Wide sweeps of sections within low earth orbit are taken in order to roughly approximate locations of each piece of space debris
Mission
To identify and classify space debris in low earth orbit
Lidar
The Lidar system is used once a piece of space debris has been located by the radar. the approximate location of the debris is used to point the lidar in roughly the right patch of space to be able to hone in on the exact location of the debris. The lidar can then collect data from the debris
Solar Panels
The solar panels are used to allow the instruments on-board the cubsat function throughout the duration of the mission, to avoid running low on power instruments such as the Lidar system will remain dormant and only activated for instances they are needed
Data Transmission
The data collected by the cubesat's lidar system can be transmitted to a ground based receiver, from there the data can be processed and turned into position, velocity and trajectory information which is used for mapping the debris
Battery
The battery stores electricity generated by the solar panels and distributes it to the instruments onbord the cubesat




space.ac.nz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space.ac.nz
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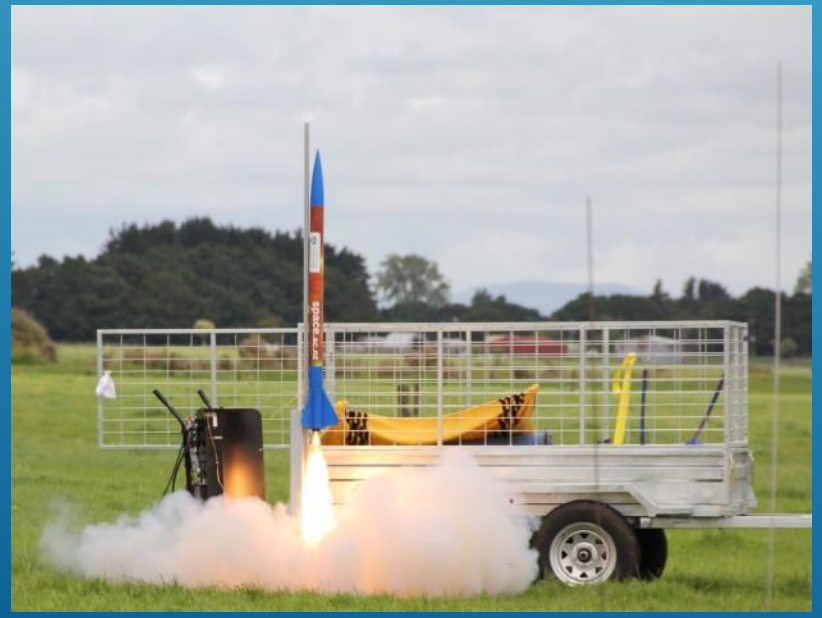
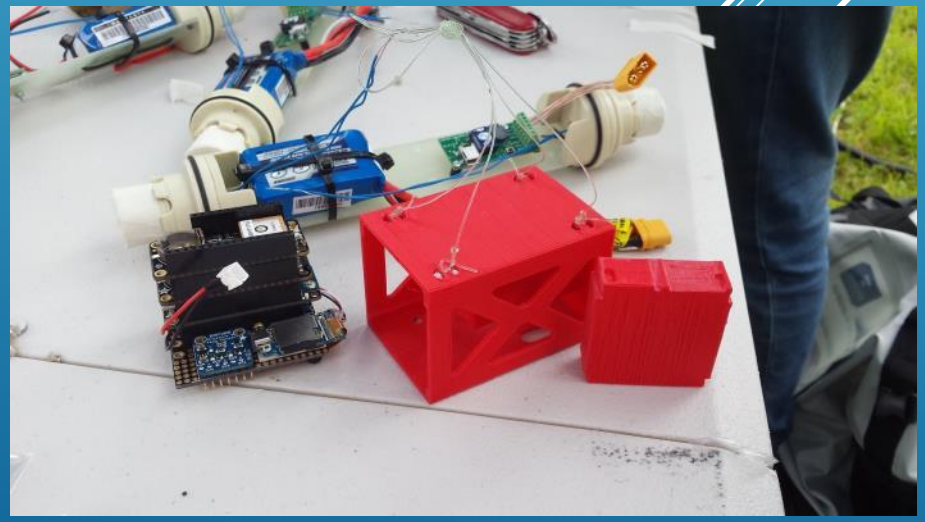


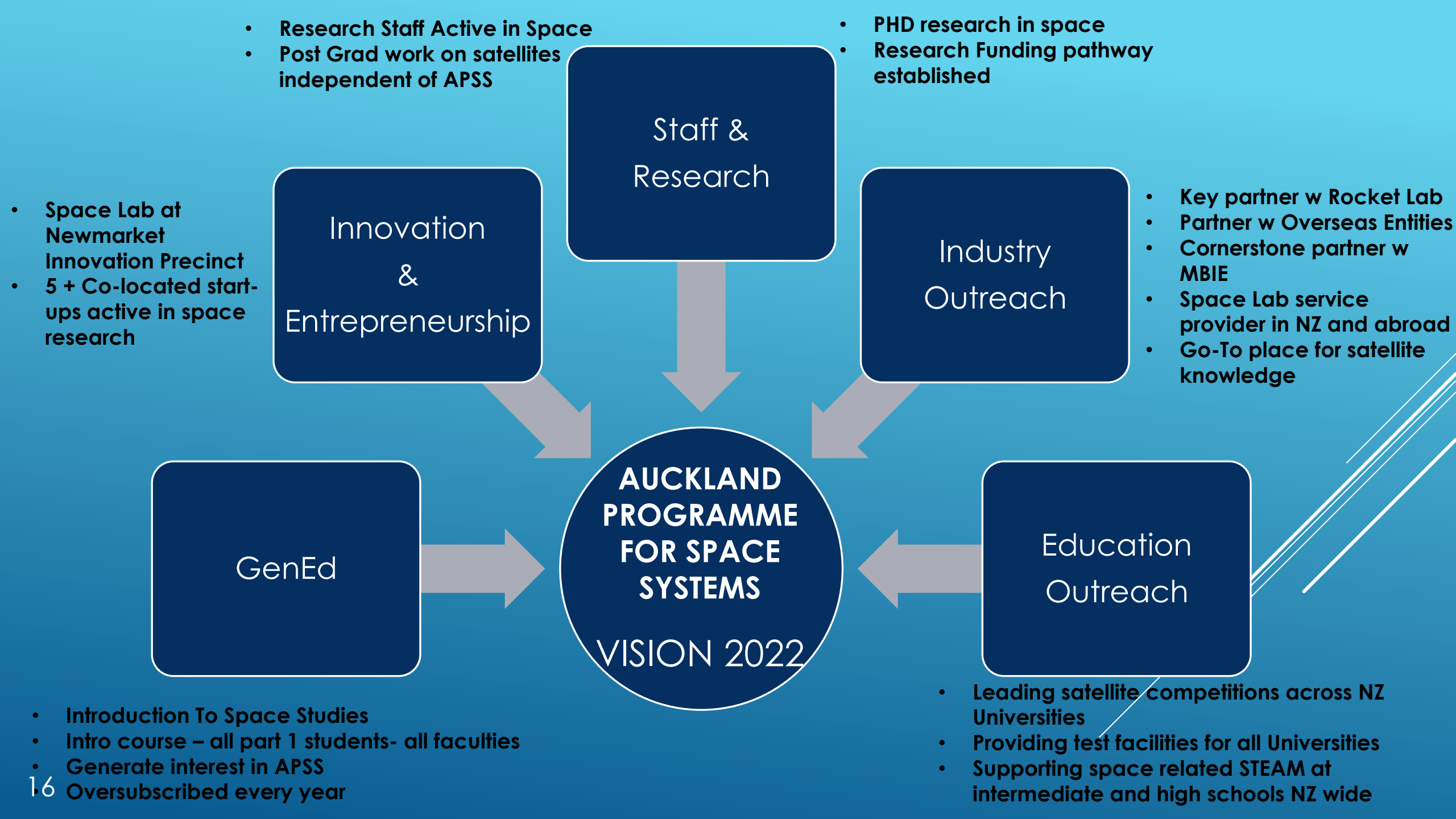


P-SAT 2017

UNPACKING 1U "QUAKESAT"

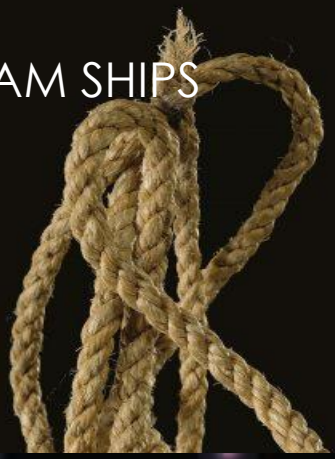
ENCOURAGING OUTCOMES

- Creating opportunity for students
- Student leadership
- Want more structure to help retention
- Student business start-ups


Research Staff Active in Space
Post Grad work on satellites independent of APSS
PHD research in space
Research Funding pathway established
Staff & Research
Space Lab at Newmarket Innovation Precinct
5 + Co-located start-ups active in space research
Innovation & Entrepreneurship
Industry Outreach
Key partner w Rocket Lab
Partner w Overseas Entities
Cornerstone partner w MBIE
Space Lab service provider in NZ and abroad
Go-To place for satellite knowledge
GenEd
AUCKLAND PROGRAMME FOR SPACE SYSTEMS
VISION 2022
Education Outreach
Introduction To Space Studies
Intro course – all part 1 students- all faculties
Generate interest in APSS
Oversubscribed every year
Leading satellite competitions across NZ Universities
Providing test facilities for all Universities
Supporting space related STEAM at intermediate and high schools NZ wide

http://www.gjenvick.com/DigitalAssets/Photographs/CunardLine/1912/LaconiaAtFullSteam-TransatlanticVoyage-500.jpg

100 YEARS AGO – STEAM SHIPS



TODAY – SPACE SYSTEMS

APSS

100 YEARS AHEAD – SUB-MARINE SETTLEMENT

https://discoveryenterprise.files.wordpress.com/2009/10/uwcity2.jpg

https://www.nzgeo.com/wp-content/uploads/2010/07/104_Hooks_Bodyimage5-1600x1067.jpg

THANK YOU

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