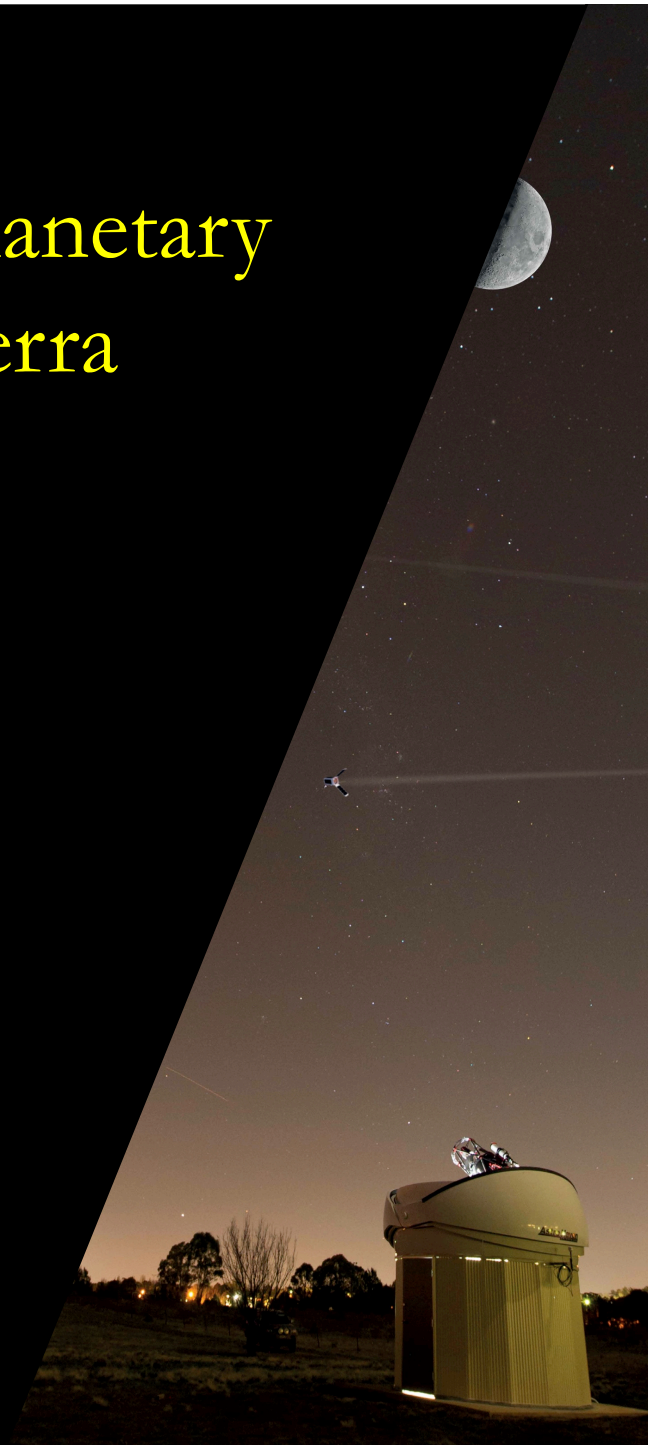
CubeSat-based research for planetary missions at UNSW Canberra

Professor Russell Boyce
Chair for Space Engineering
UNSW Canberra



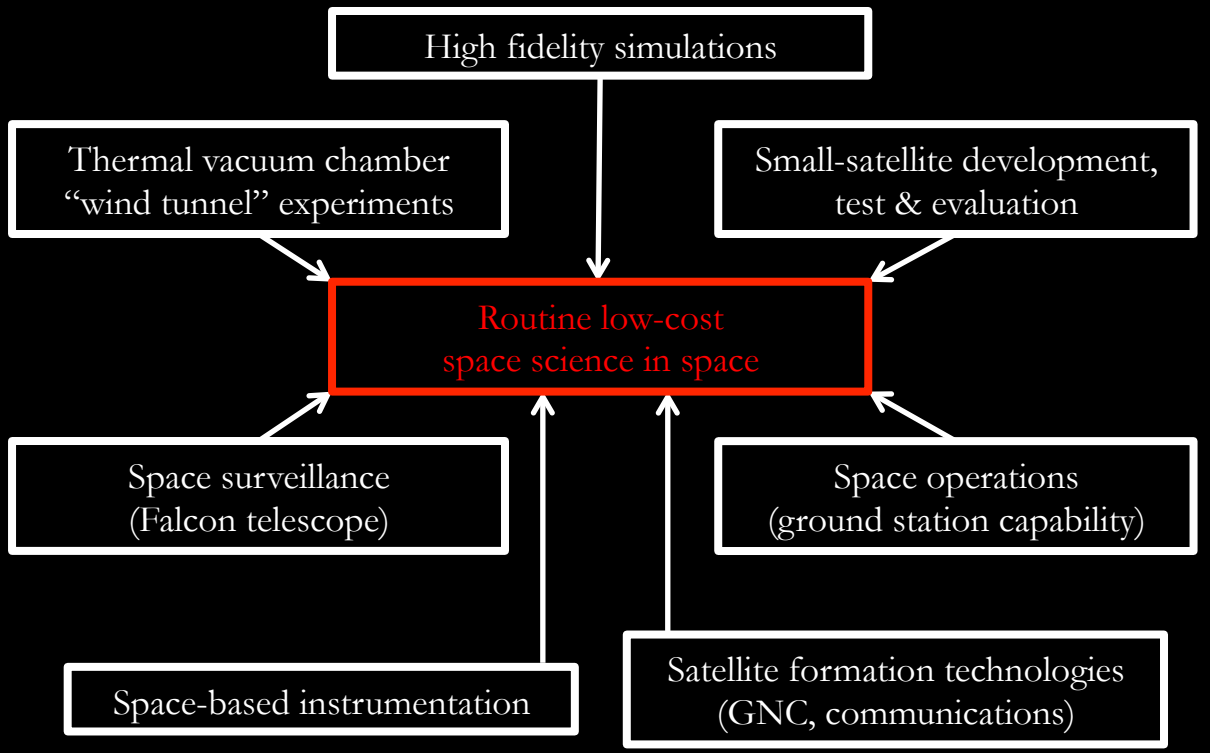
UNSW AUSTRALIA
Canberra

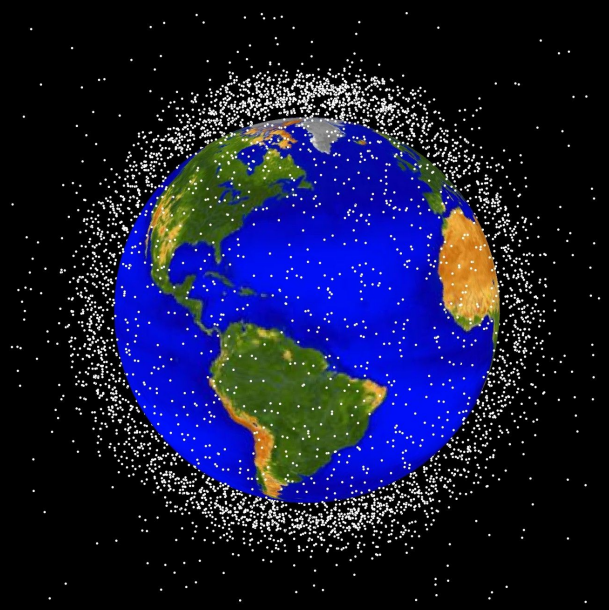
space.unsw.adfa.edu.au

Regular low-cost space science in space

Ultimate aim : to routinely develop and fly low-cost in-orbit missions for performing innovative S&T in space, in ways that make sense for Australia.

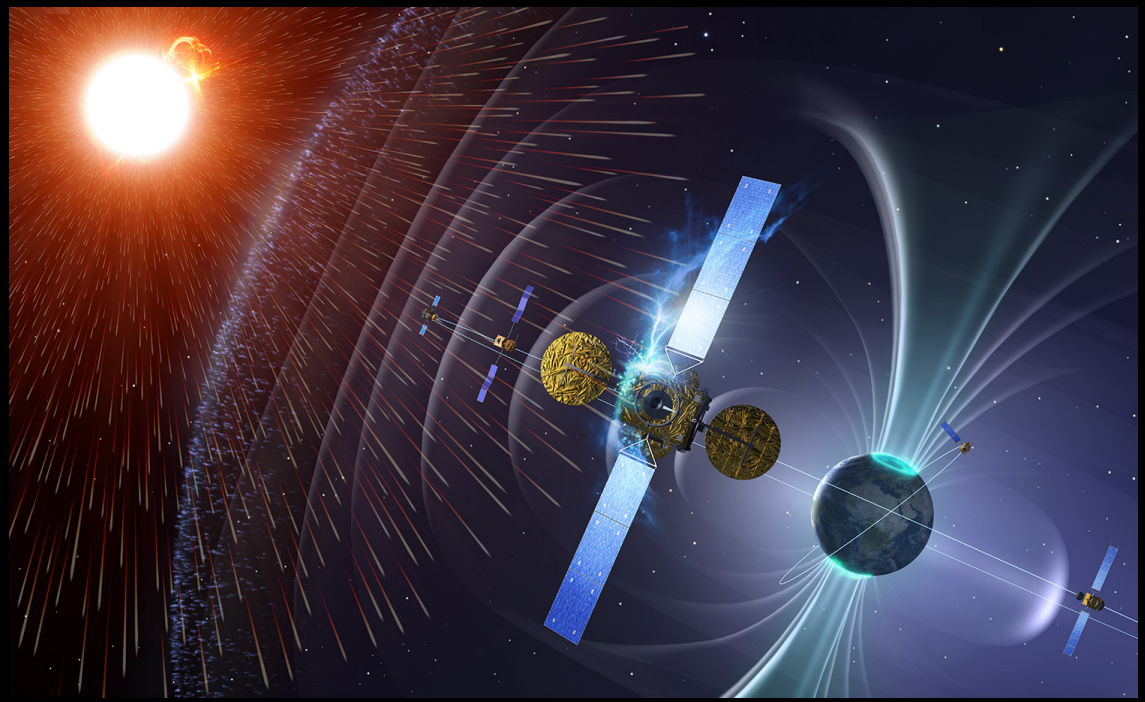
The capability rests on 7 areas of activity, ranging from engineering to operations to science, and building on existing in-house expertise.





The science of the interaction between space objects and their environment – the missing piece of Australia's Space Situational Awareness contribution.

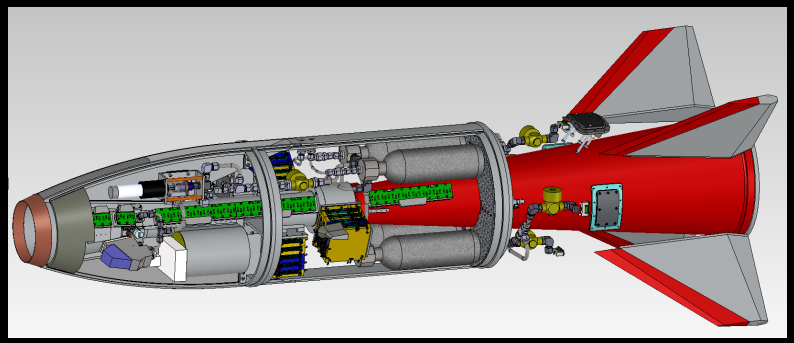
That science is a capability building vehicle for regular in-orbit space research

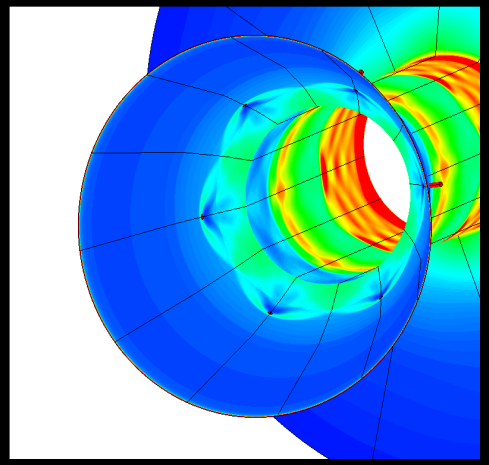


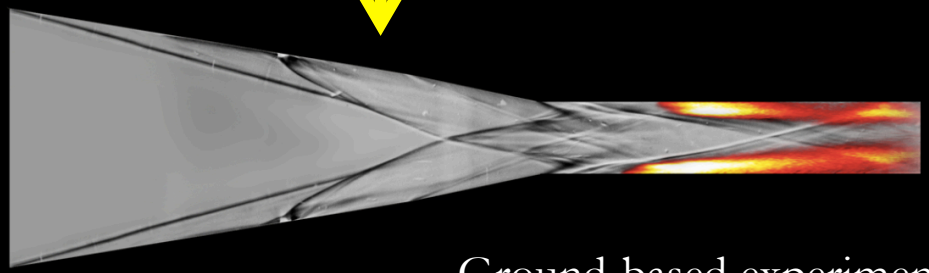
Building on our hypersonics research approach …

Scientific flight experiments

High fidelity physics-based simulations



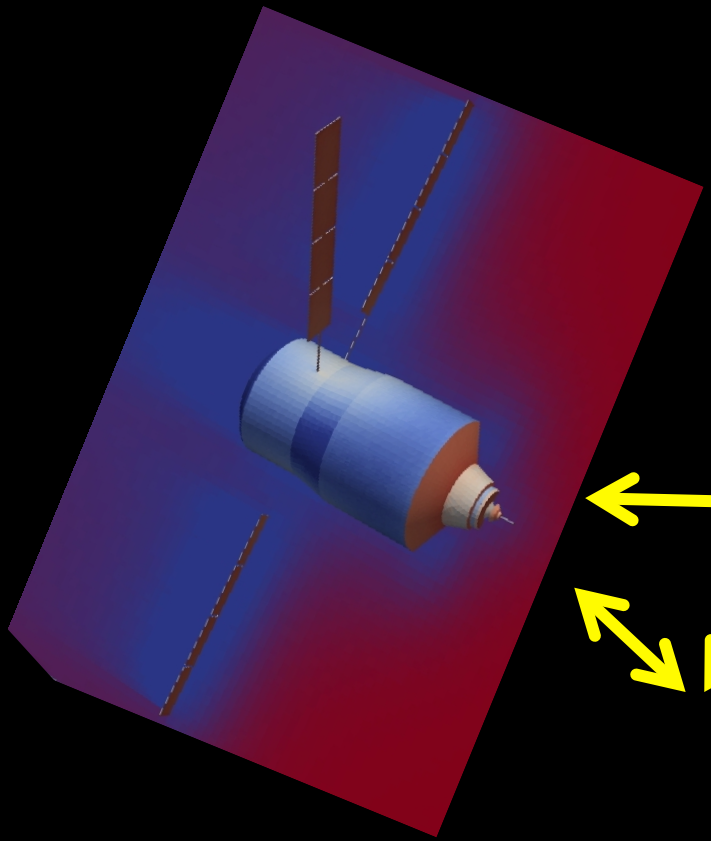


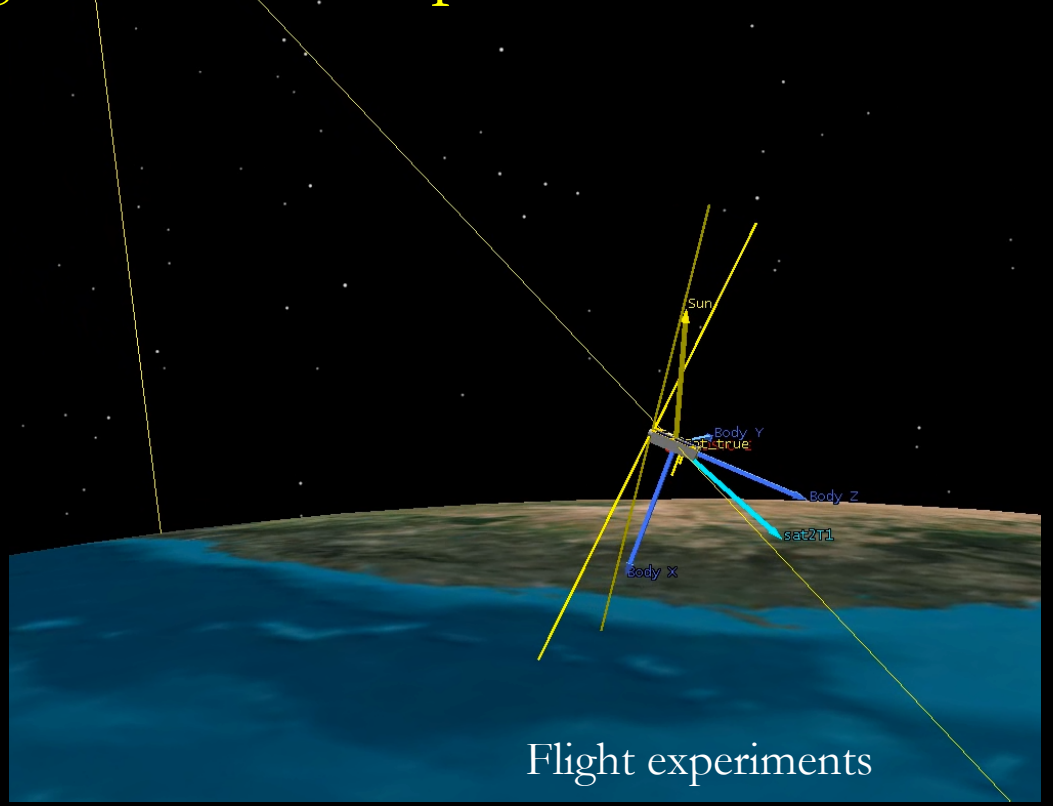


Ground-based experiments employing advanced diagnostics

… and bringing it to bear on space research.

High fidelity physics-based
supercomputer simulations





Flight experiments

Benchmark-quality
ground-based experiments
with advanced diagnostics

Enablers for flight missions – the team

50+ years experience in sub-orbital, orbital and deep space missions

Flight team

• Spacecraft Project Lead / Systems Engineer	Dr Doug Griffin
• Flight Software Engineer	Mr Arvind Ramana
• Spacecraft Electronics Engineer	Mr Igor Dimitrijevic
• Spacecraft Mechanical Engineer	Mr Simon Barraclough
• Mechanical Engineer	Dr Sebastian Oberst
• Test & Evaluation Engineer (50%)	Dr Philippe Lorrain
• Space-based Instrumentation Scientist	Dr Joe Kurtz
• Space-based Instrumentation Electronics Engineer (50%)	Dr Mark Aizengendler

Research team

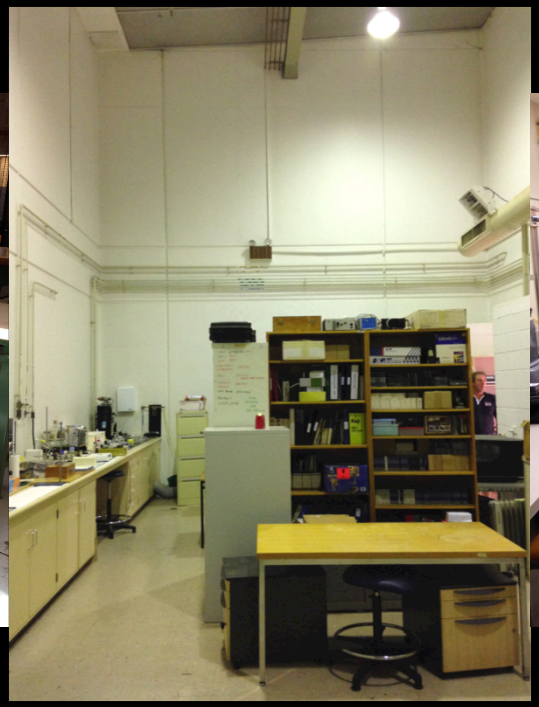
• Computational simulations research fellow	Dr Melrose Brown
• Experimental research fellow (50%)	Dr Philippe Lorrain
• Space surveillance (research fellow)	Dr Manuel Cegarra
• Formation flying research fellow (to be appointed)	
• currently 4 PhD students	Pandey, Bright, Capon, Smith

Academic team

- 11 academic staff ranging from Level B to E and from part-time to full-time engagement

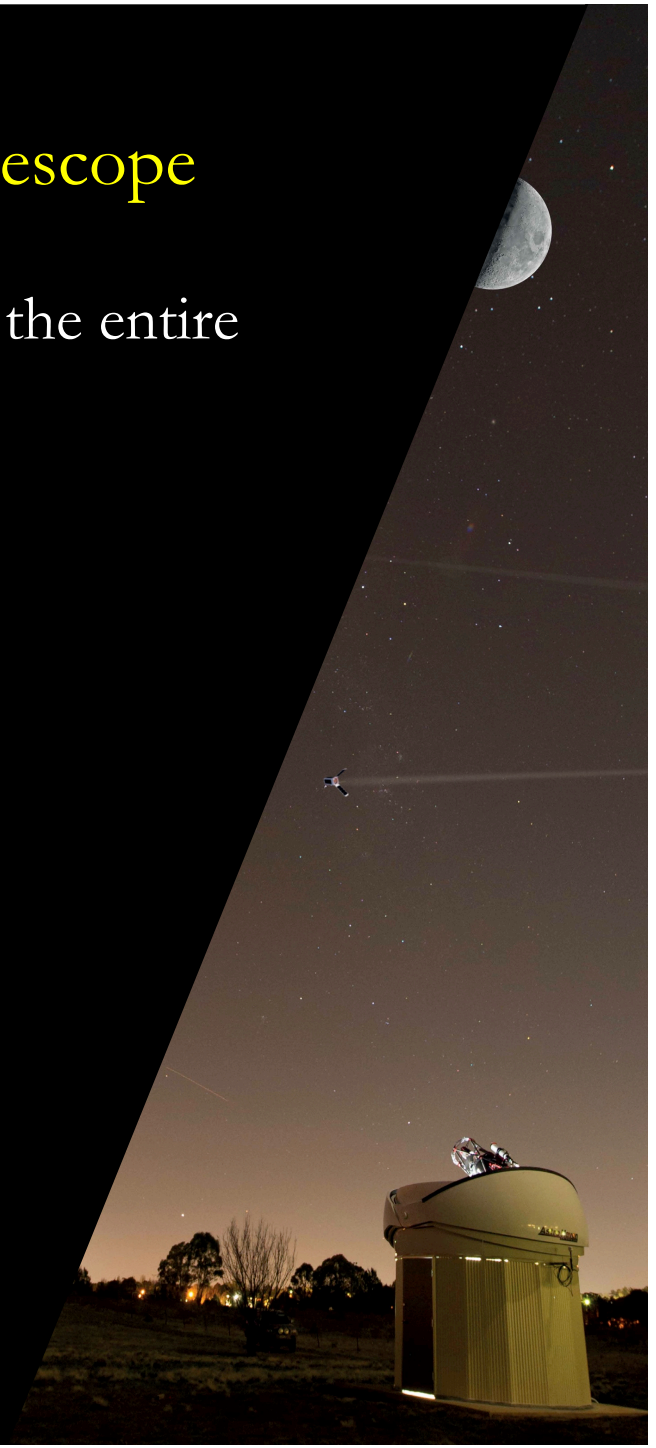
Enablers for flight missions – integration and test facilities

Clean room for development, assembly and integration, and thermal vacuum chamber lab for some of the test and evaluation.



Enablers for flight missions – Falcon Telescope

Optical surveillance and tracking; ability to task the entire global Falcon Telescope Network



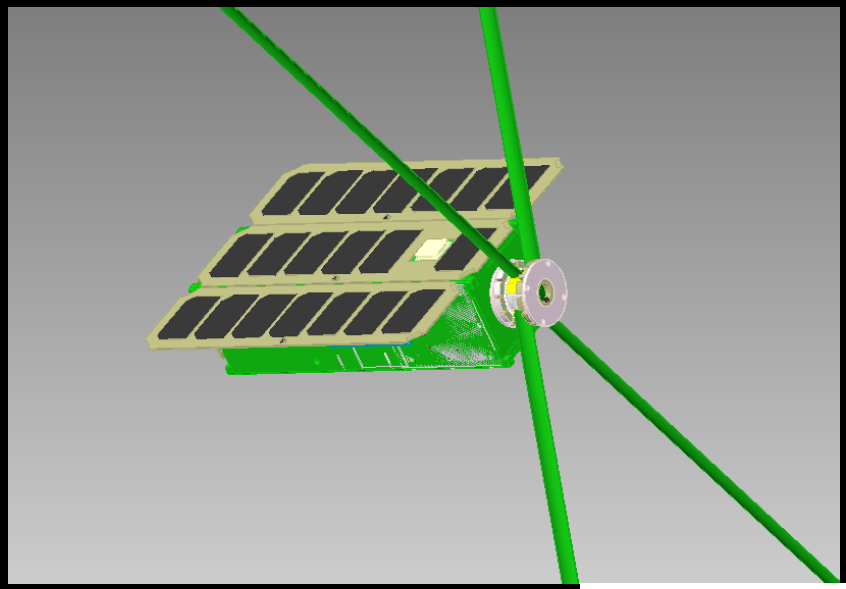
Regular in-orbit space research

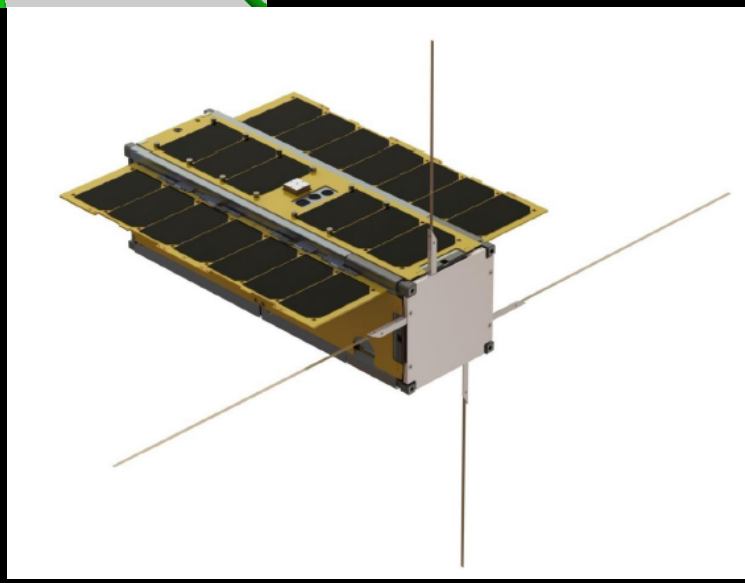
Flight 1 (2016)
- One cubesat

Flight 2 (2017)
- One cubesat

Flight 3 (2018)
- Two cubesats

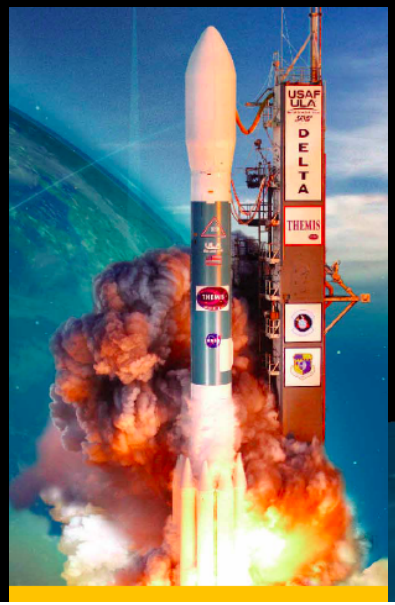
Flight 4 (2020)
- Four cubesats

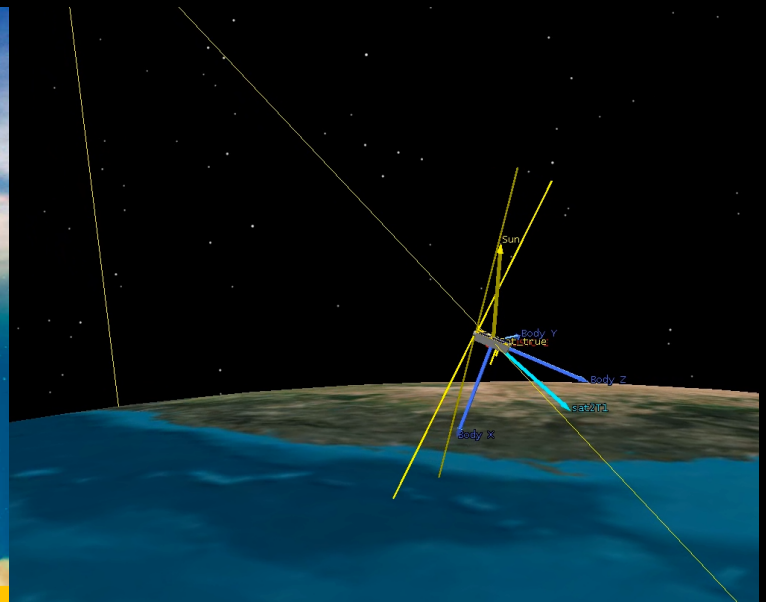




Flight missions – Flight 1

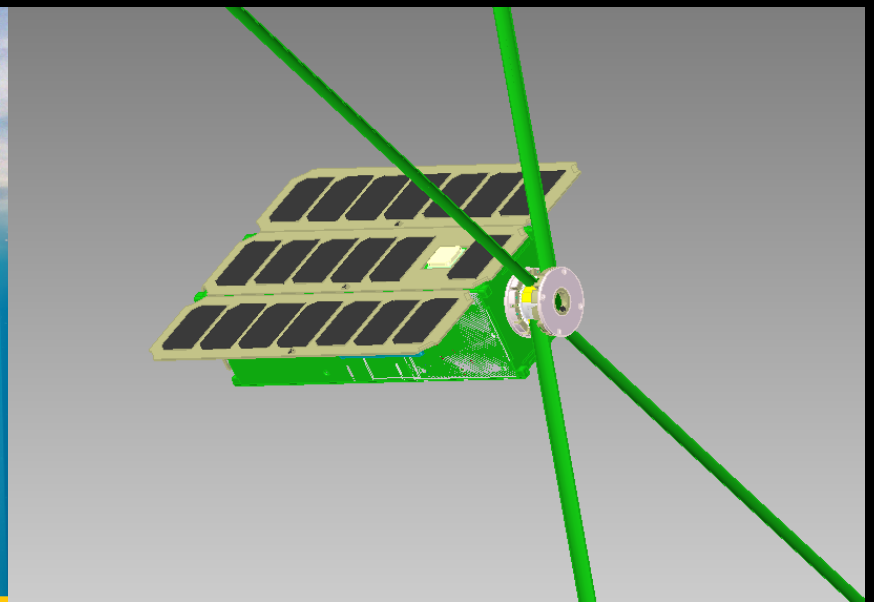
- Buccaneer Risk Mitigation Flight
    - UNSW Canberra-led flight in collaboration with DSTO
    - One 3U cubesat (Pumpkin), with HF radio antenna deployed
- Risk mitigation for DSTO's antenna deployment
- "Get our hands dirty" opportunity for UNSW Canberra
- Conduct astrodynamics measurements
- Obtain light curves with Falcon telescope
- Procuring hardware in 2015, launch on Delta II in Nov 2016





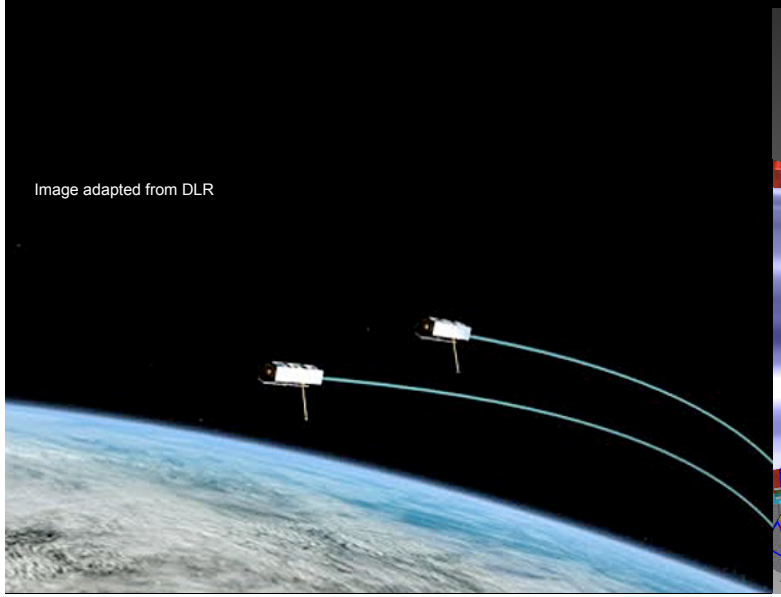
Flight missions – Flight 2

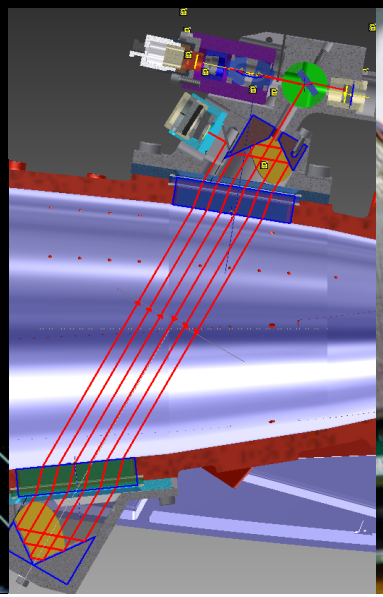
- Buccaneer Main Flight
    - DSTO-led flight in collaboration with UNSW Canberra
    - One 3U cubesat (Pumpkin), with HF radio receiver and antenna deployed
- Second "get our hands dirty" opportunity for UNSW Canberra
- Conduct astrodynamics measurements
- Obtain light curves with Falcon telescope
- Procuring hardware in 2015, launch on Atlas V in Nov 2017

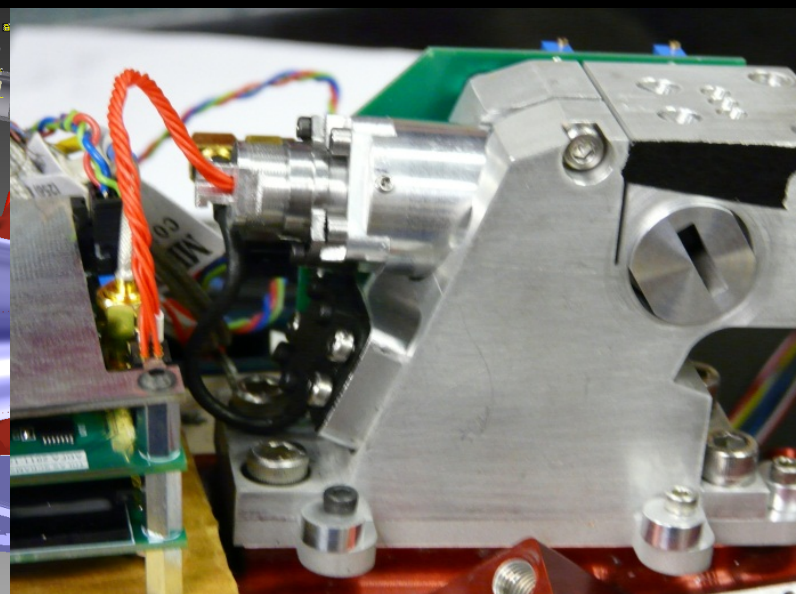


Flight missions – Flight 3

- Two 3U cubesats
- Space instrumentation flight
    - Diode-laser-based limb sounder
      (extending UNSW's flight instrument from SCRAMSPACE)
- First experience in operating a formation, including comms
- Start development in 2015, launch in 2018

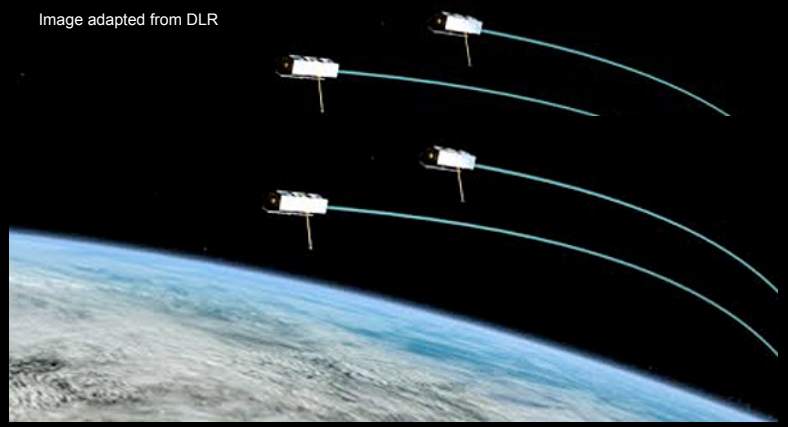






Flight missions – Flight 4

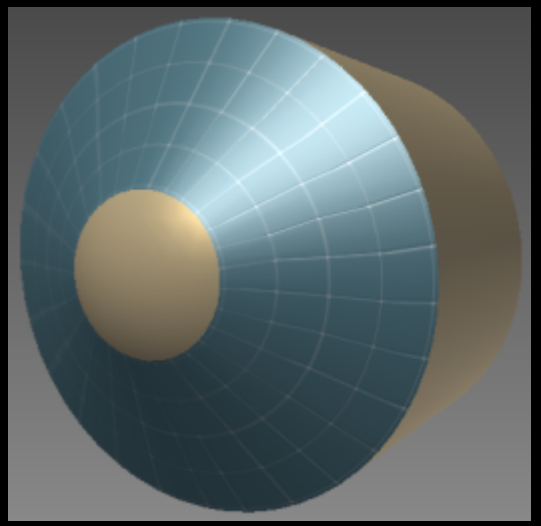
- Four 3U cubesats
- Satellite formation mission, demonstrating formation GNC and communications
- Multiple fundamental aerodynamic shapes, collect high fidelity data
- Start development in 2015, launch in 2020



"VAPR": Venus Atmospheric Pathfinder Research Vehicle

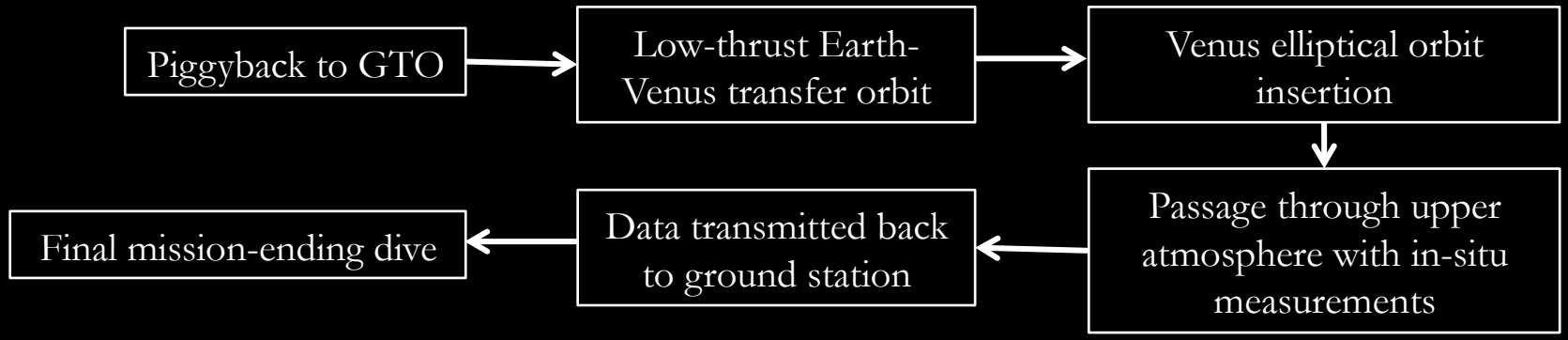
• *VAPR will provide a low-cost pathfinder mission to Venus to conduct upper atmosphere density and species concentration measurements.*

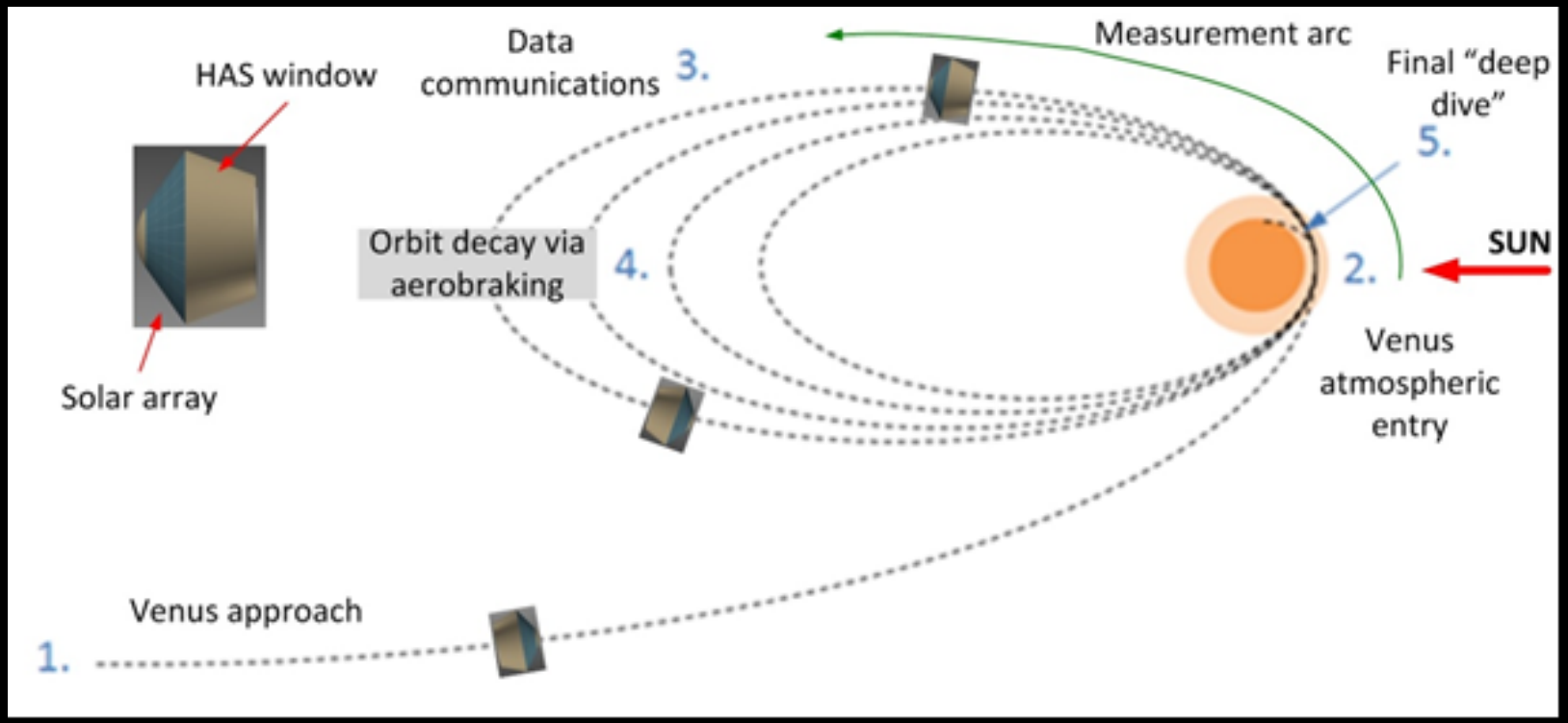
- Spacecraft mass <50 kg
- Estimated cost an order of magnitude lower than next cheapest Venus mission
- Payload:
  - Accelerometer for atmospheric density measurements
  - Heterodyne Absorption Spectrometer for Xe measurements
- Key engineering challenges:
  - Low-thrust trajectories
  - Long-distance, low-power communication
  - In-situ Venus atmospheric measurements
  - Radiation shielding and solar array temperature management
- To be presented at the 3rd UNISEC-Global Meeting in July 2015



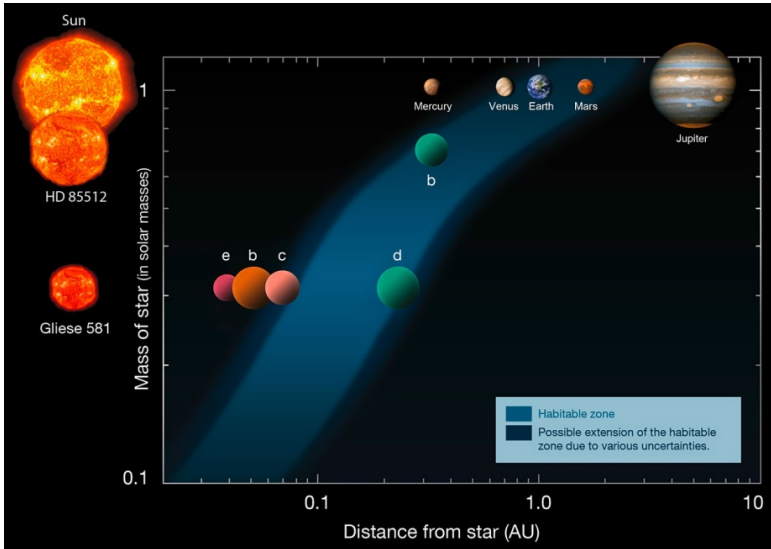
Conceptual Design

VAPR Concept of Operations





Concept of Operations



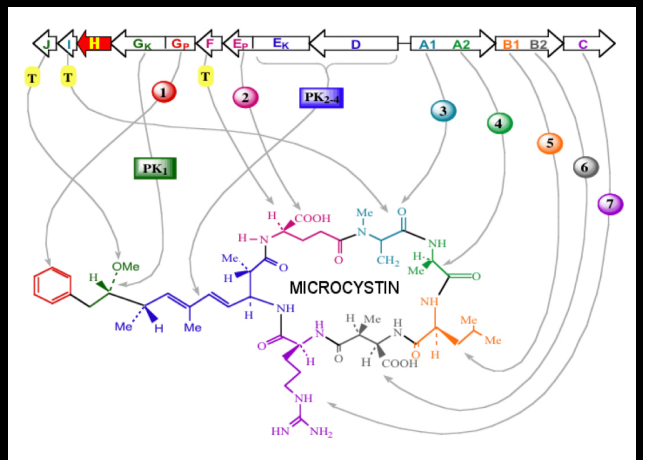
Astrophysics : exploration of almost every aspect of the hunt for, and study of, planets outside our Solar System.

Stromatolites and the origin of oxygenic photosynthesis. Habitats of early life on Earth and the co-evolution of the Earth system and the biosphere.

AUSTRALIAN CENTRE *for* ASTROBIOLOGY

Biologists, geologists, physicists and science researchers at UNSW and other organisations around the world, who investigate the history and evolution of life on Earth, the evolving planetary system, and search for habitable worlds outside our solar system.

ACA's Mars Yard at the Powerhouse Museum in Sydney., where students conduct scientific programs virtually through the NBN, using specifically designed Rovers built at the University of Sydney.



Genetics of toxic cyanobacteria (blue-green algae).

Summary

- UNSW is rapidly building self-sustaining capability for cubesat missions, initially for near-Earth purposes, but with a mind to apply the capability to participating on planetary missions that involve planetary physics, biology, geology and associated technologies.

- Our team includes a wealth of deep-space science mission experience

- We look forward to opportunities for partnership