

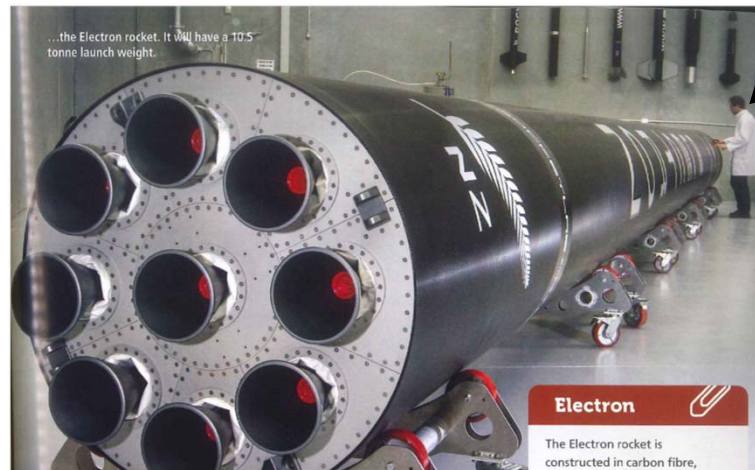
UC Rocketry history

- Started in 2009/2010 – UC summer project, Malcolm Snowdon and Avinash Rao, 2 launches (Ellen 1 and Lisa I)
- > 50 launches from 2009-2017 (Kaitorete Spit, Tekapo, Mangakahia), Waikaia Southland (planned)



STACY SQUIRES/The Press
ROCKET MEN: Avinash Rao, left, and Malcolm Snowdon launched their rocket about 700 metres into a clear blue sky above North Canterbury yesterday.

Malcolm



Malcolm

Launch into orbit
by Rocket Lab
(Mahia peninsula)



Student training/employment

- UC Rocketry (since 2011) ➔ 5 Masters students, 4 PhD students, 3 undergraduates
- Several postgraduates in key leadership roles for propulsion, GNC and avionics
- A number of other UC undergraduate engineers have also been hired at Rocket Lab



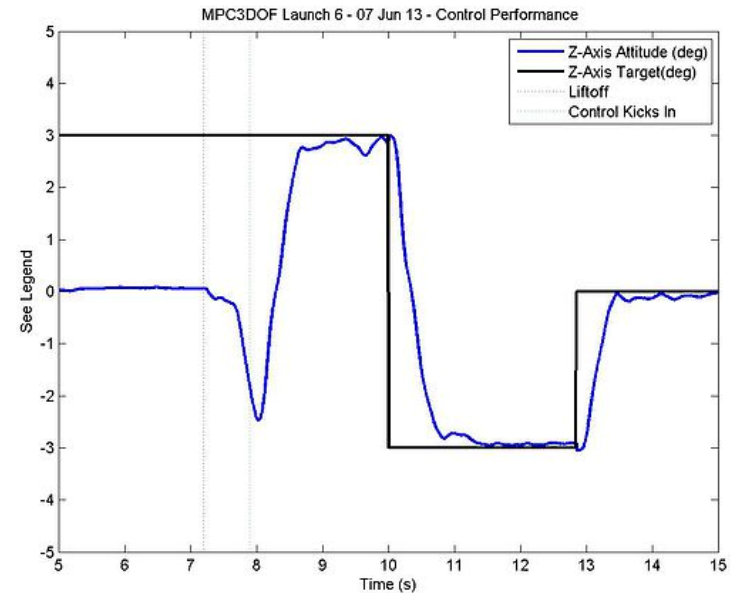
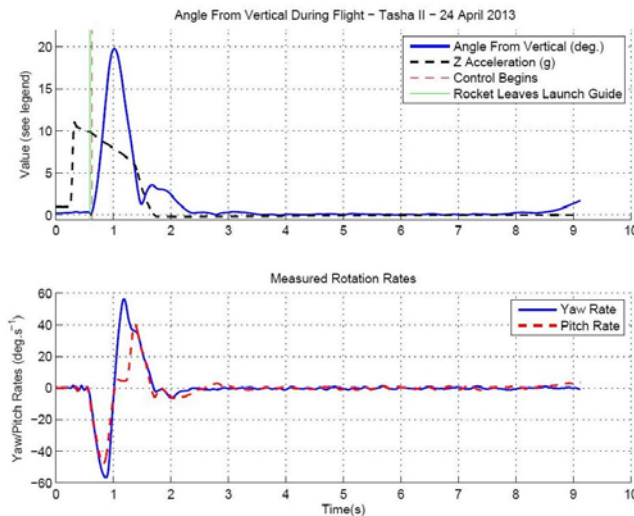
Launch operators

- 5 launch operators at Mahia Peninsula
- 4 in charge of teams:
 - Avinash Rao (PhD) – Director of Mission Delivery and Planning
 - Lachlan Matchett (ME) – VP of propulsion
 - Adam Slee (ME) –Launch Conductor
 - Hoani Bryson (ME) – Team Leader in Avionics



Research highlights

- Control capability = ~ 0.1 deg (pointing)
- Successfully stabilized aerodynamically unstable vehicle
- Research foundation for GNC on Electron



- Developed orbital trajectory optimization capability for Rocket Lab
- Designed original orbital trajectory of Electron from Birdlings Flat
- Passed knowledge on to students (Callaghan)

Satellite propulsion and ADACS research

- The NZ Government, Ministry of Business Innovation and Employment are looking to fund space research in NZ
- Robinson Institute at Victoria University Wellington, University of Auckland and University of Canterbury are placing a combined bid for a project titled:
“High-magnetic-field plasma propulsion systems enabling next generation small satellite missions”
- Idea is to use propulsion system elements like dynamo and magnetic field to develop an ADACS without using any excess energy
 - ➔ Could either significantly reduce the mass of existing satellite ADACS for an existing torque
 - ➔ Or significantly increase the torque for the same mass
- The use of Astrobees would help de-risk the mission in case there is a launch or satellite failure during the final launch with Rocket Lab. Proving the concept of the thruster on Astrobees would enable investors to have confidence to further develop the project.

Astrobee proposal

Ground tests – Simulator, Astrobee Micro Gravity Test Facility and Granite table labs

- Software-in-the-loop thruster + astrobee hardware: multiple thrusters to simulate impact of both the dynamo's and magnetic field dynamics
 - Develop model that maps astrobee thruster actuation dynamics onto dynamo/magnetic field actuation dynamics, apply in both simulator and hardware
 - Also program astrobee thruster responses to simulate a 6U cubesat response including inertia (that is, essentially changing the effective inertia of the Astrobee)
- Implementation of thruster prototype in the astrobee payload bay
 - Dynamos only (turn off magnetic field) and simulate magnetic field from thrusters
 - turn off astrobee ADACS and use payload to perform ADACS (totally self-contained)
 - interface payload commands to thrusters to mimic smaller inertia for 6U cubesat compared to Astrobee

ISS

- Apply software-in-the-loop + astrobee hardware onboard ISS
 - Compare results with ground tests and update software as required (iterate)
- Implement thruster prototype as ADACS of astrobee (dynamos on/magnetic field off and dynamos on/magnetic field on)

Control testing (ground tests and ISS)

- Attitude step responses with disturbances simulated by Astrobee thrusters:
- Guidance maneuver to change orbit trajectory slightly.
- De-tumbling tests
- Characterise maximum torques available and limitations of actuation
- Analyse experiments and design improvements including updating model parameters

Research questions:

- Can astrobee thrusters be programmed to mimic a 6U cubesat response?
- Are the thrusters suitable for simulating magnetic field changes over time at the required speed?
- What impact do time-lags in the astrobee actuation system have on the simulation of the 6U cubesat?
- Can the new thruster system control the astrobee?