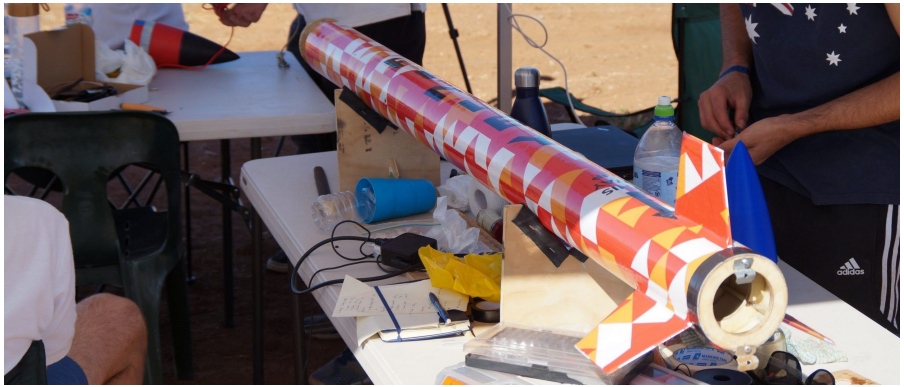
ARES Workshop - Project Phobos Part 1

Cas Kent & Ann Phan

Australian Universities Rocket Comp.



Australian Youth Aerospace Association (AYAA)

“Design, build and launch a high-powered solid fuel rocket to a target height of either 10,000ft or 30,000ft. In 2020 teams can also design a 2kg CubeSat payload.” Source: **aurc.ayaa.com.au**

2020 comp. was **online** only

2021 comp. launch - **QLD ~October**

AURC Competition Requirements

Rocket Requirement

Must design and build a single-stage rocket

Must have a commercial-off-the-shelf (COTS) solid rocket motor

Must carry a 2kg payload

Must reach to a target height of 10,000 ft above ground level

Must carry radio beacon or similar transmitter aboard each recoverable assembly

Team Requirement

Require individual team members to attempt and complete certification Levels 1 and 3

Min 1 member must obtain QLD explosives licenses for HPR rocket motors (>62.5g)

Disqualification if:

- Found guilty of cheating or plagiarism
- Consistent failure to meet deadlines
- Breach safety protocols
- Fail to comply with the AURC Rules, Standards & Guidelines

Project Phobos
2021 Unimelb AURC team

Version 0.6.3

Goals

Fibreglass airframe

Length: **1800mm** Diameter: 146mm

Real time **telemetry** and video

CO_2 **parachute** ejection system

Weather balloon for pre-launch conditions

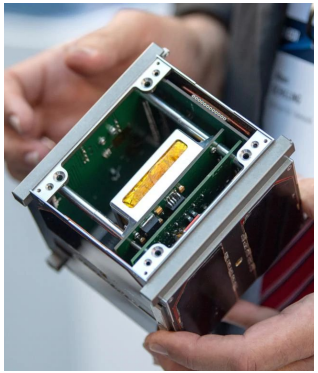
Reaction wheel to stabilise roll

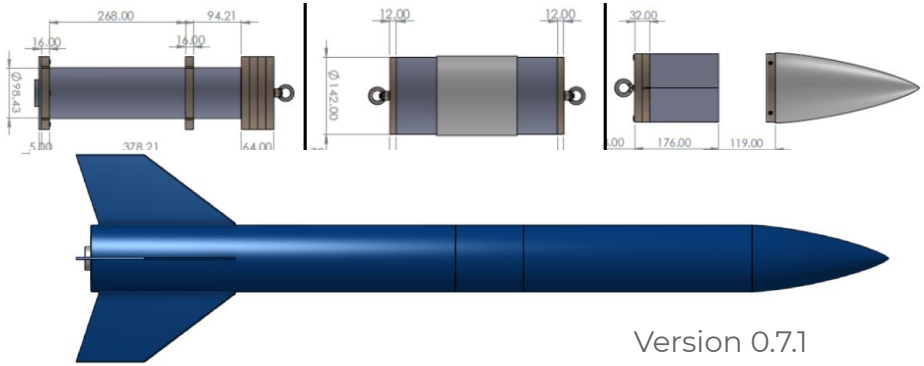
Requirements

10,000ft. with **CubeSat** payload

Fully **recoverable**

Altitude logging, tracking beacon





Version 0.7.1

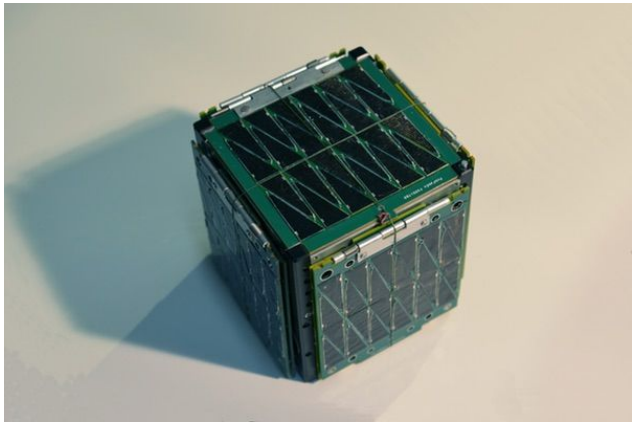
Payload

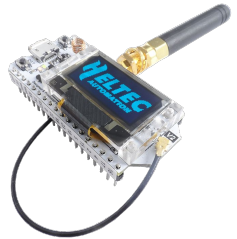
2 kg CubeSat with the dimensions of 1U (100mm x 100mm x 100m)

Records and transmits positional data of the rocket during flight

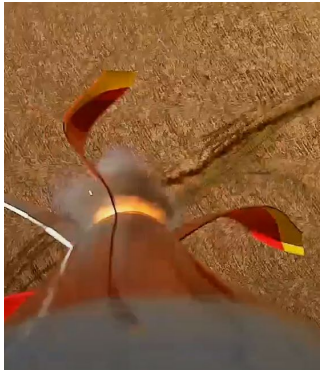
Provides ground-truth data which may be used to improve future simulations

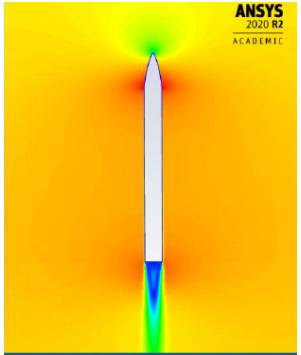
Payload will have an off-the-shelf GPS system, microcontroller and antenna

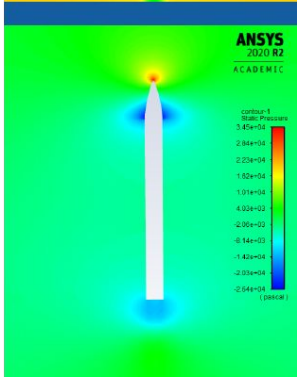




Project Phobos Subsystems







Aerodynamics (External Structures) - Jack Li

Responsibilities:

Design of exterior rocket body including fuselage, nose cone and fins

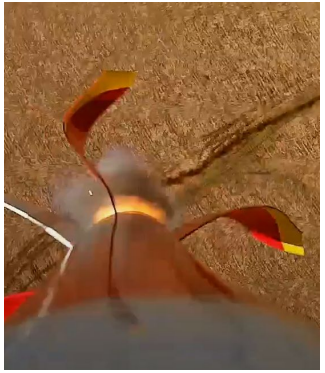
CFD Simulation for drag reduction and determining pressure acting on rocket

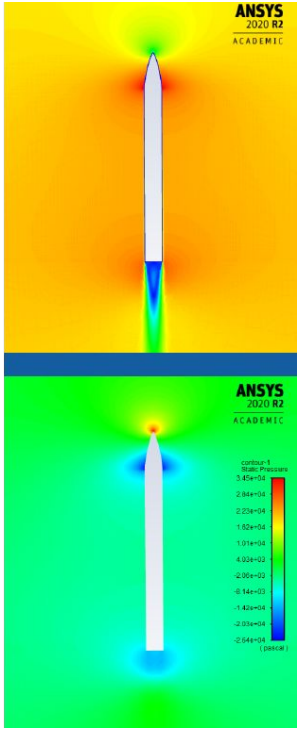
Design fins to reduce flutter and maximise stability

Minimise drag

Withstand dynamic pressure

Project Phobos Subsystems





Aerodynamics (External Structures) - Jack Li

Progress:

Fibreglass airframe instead of carbon fibre

Ansys CFD initial model and simulation

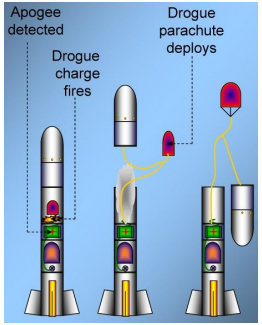
Plan for 2021:

CFD and fin flutter simulations

Select materials for airframe

Manufacture and test airframe

Project Phobos Subsystems

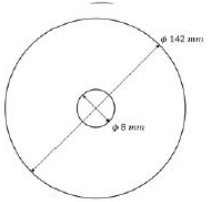


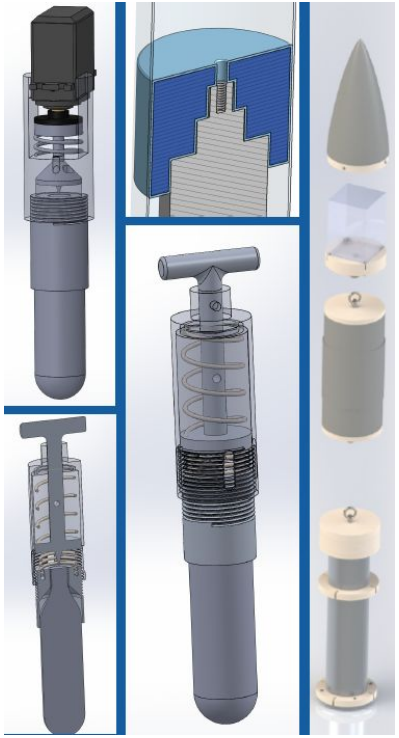
$$C_1 = -\frac{bV(a^2 - b^2 - 2a^2 \ln a + 2b^2 \ln b)}{2D\,(a^2 - b^2)}$$

$$C_2 = -\frac{a^2 b^2 V(\ln a - \ln b)}{2D\,(a^2 - b^2)}$$

$$C_3 = -\frac{Va^2 b(4b^2 \ln(a)^2 - a^2 + b^2 - 2b^2 \ln a + 2b^2 \ln b - 4b^2 \ln a \ln b)}{8D\,(a^2 - b^2)}$$

A MATLAB script (see google drive) was written to solve this problem for a polycarbonate bulkhead with a thickness of 10 mm, poisson's ratio of 0.333 and a Young's modulus of 1.8 GPa and force of 900 N.





Internal Structures - Kian Pardoe-Collins

Responsibilities:

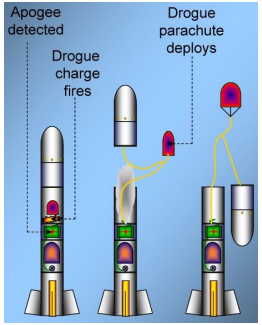
Design bulkheads and avionics bay

Fin and nose cone connectors

Determine method for ejection of parachutes

Calculate and simulate forces exerted on components

Project Phobos Subsystems



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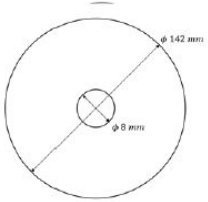
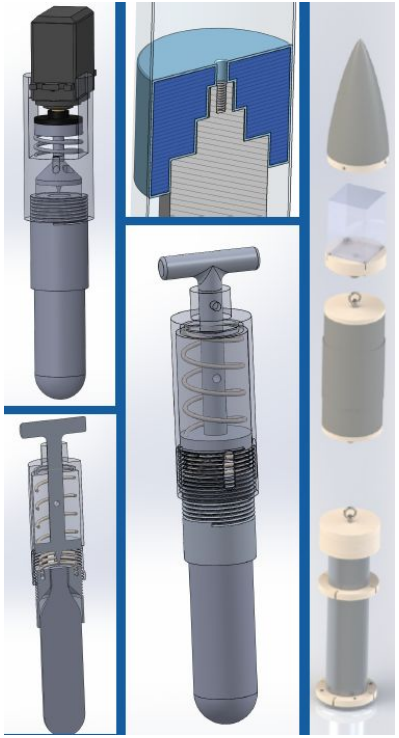




Internal Structures - Kian Pardoe-Collins

Progress:

Internal layout determined

Minimum viable products for major components

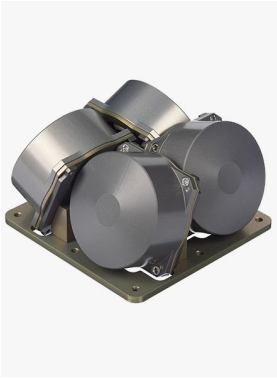
CAD models for components developed

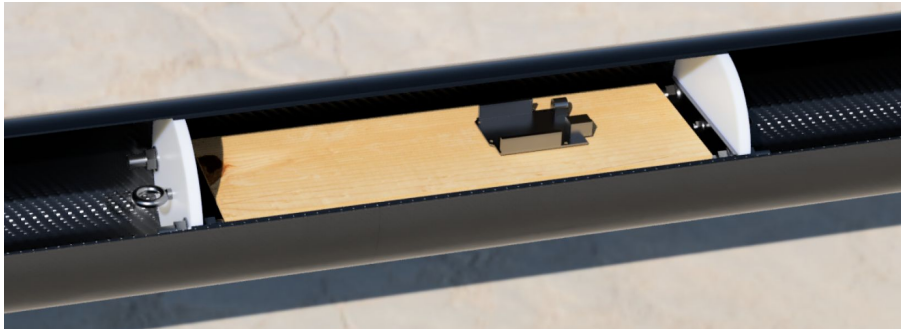
Plan for 2021:

Ansys FEA simulations on load-bearing components incl. composite materials

Manufacture and test bulkheads, parachute ejection system and avionics bay

Project Phobos Subsystems





Avionics & Payload - Grace Brown

Responsibilities:

1U CubeSat payload - 100mm x 100mm x 100mm

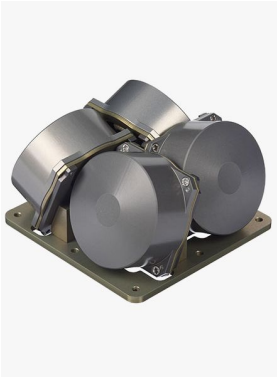
Central avionics bay

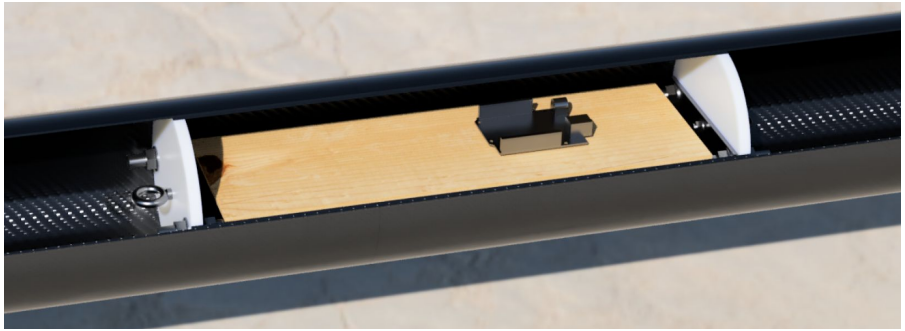
Design of onboard telecommunication, sensors and flight tracking system

Reaction wheels for flight stability and control

Alternative functionality for payload?

Project Phobos Subsystems





Avionics & Payload - Grace Brown

Progress:

Research suitable IMU, accelerometer, gyroscope, altimeter, GPS, batteries, data storage

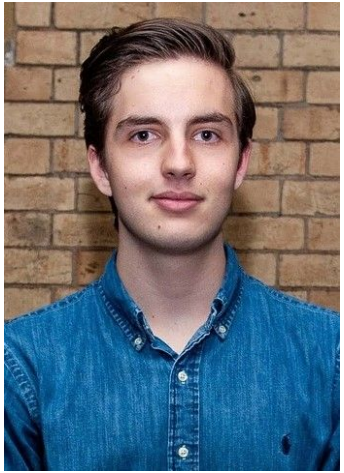
Reaction wheel research - what they are, how to implement, PID control, relevant hardware (DC motor with encoder)

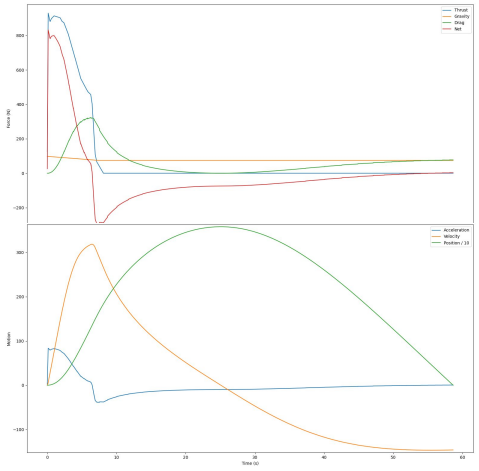
Plan for 2021:

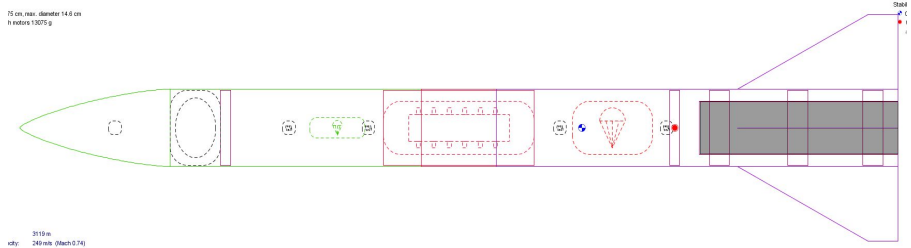
Continue research and development for relevant hardware

Manufacture and test components

Project Phobos Subsystems







Simulations - Harry Stuart

Responsibilities:

Development of trajectory simulation software

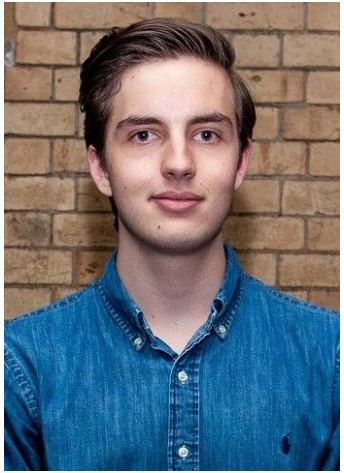
Design of weather balloon to collect environmental data at varying altitude

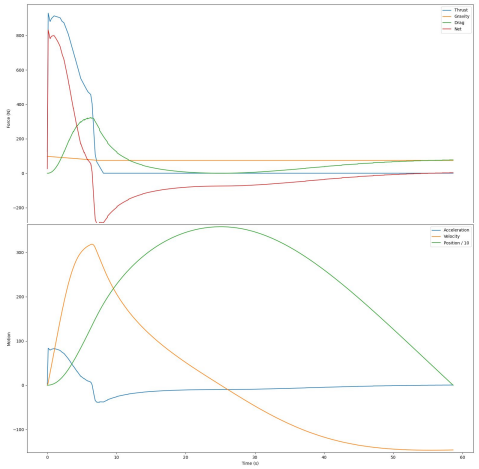
Incorporate real time avionics and environmental data

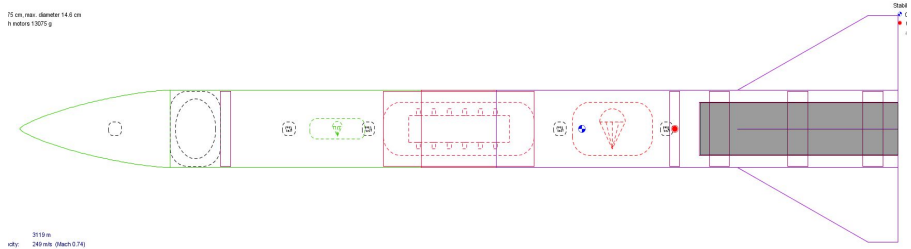
Calculate ballast required for 10,000 ft. apogee

Determine confidence intervals for apogee

Project Phobos Subsystems







Simulations - Harry Stuart

Progress:

OpenRocket simulation of forces and motion

Custom Python software built from the ground up, incorporating drag, thrust and gravity in 2D

Plan for 2021:

Continue developing custom Python software

Real time apogee confidence intervals

2020/2021 AURC Schedule

AMRS L3 Documentation Progress Report 1 Open Rocket Simulation	P/ F 100 P/F
Progress Report 2	100
Modelling & Simulation Approach	50
Payload Report	50
Progress Report 3	100
Modelling & Simulation Results	100
Final Report	200
Presentation Scrutineering Flight Recovery Payload Inspection	500

L1 Certification
Encouraged for team members. Allows better understanding of manufacturing process and safety awareness.

L2 Certification
Team members required to complete L2 to participate in the competition.

Prototyping and Manufacturing
Scheduled for early 2021 to gain access into workshop space for the design and manufacture of the rocket.

ARES Capstone Project

Three capstone projects currently offered which will work in collaboration with ARES.

The successful completion of the capstone will aid in next year's AURC competition.

One project includes developing and constructing a small **hybrid rocket engine**

We will aim to offer **more Capstone projects in Sem 2 and 2022**

ARES Capstone Project

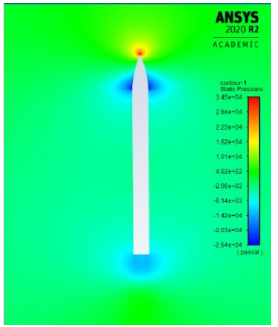
Two capstone projects offered which will work in collaboration with ARES.

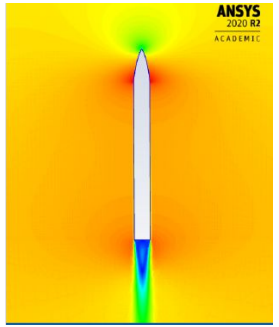
The successful completion of the capstone will aid in next year's AURC competition.

Aerodynamics & CFD - Developing and Testing an Airframe for an Aerodynamically Efficient High-Powered Rocket (HPR)

Semester 1 & 2 2021

1. Design the airframe by conducting various CFD simulations and physical testing
2. Investigate the surface smoothness to correlate with known drag coefficients.
3. The structural integrity of the airframe will be tested in-lab and by conducting test flights with ARES



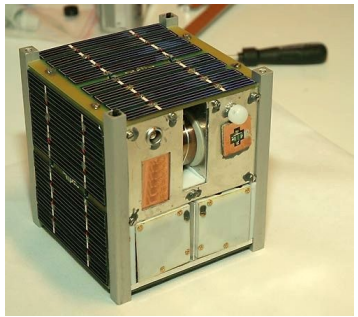


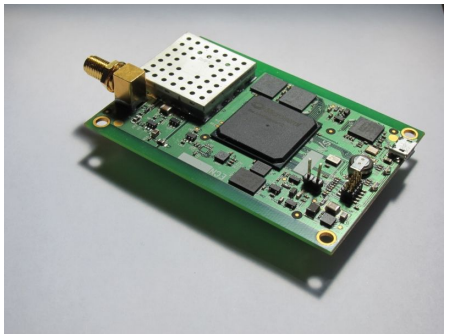
ARES Capstone Project

High-Powered Rocket Navigation in a GPS-denied Environment

Semester 1 & 2 2021

1. Build a payload that is capable of logging the altitude, attitude and velocity of the rocket without a GPS signal.
2. Include a standardised on-board ‘GPS truth’ signal.
3. Points awarded for accuracy compared to the GPS truth signal, innovation, cost and complexity.





Meet Team Leads?
Start Week 3 Early?

Next week - Rocket science!

See you next week! :)