

NATIONAL ROCKETRY CHAMPIONSHIP

Preliminary Design Review

TEAM URSA

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Introduction

- Team Ursa – Part of the Aurora Initiative at QMUL
- All team members new to NRC

Goals

- Meet the target apogee exactly through thorough calculations and conditions testing with simulations and modelling
- Systems engineering approach for development process
- Professional and Skills Development



Project Plan

- Weekly team meetings
- Internal Deadlines at least 3 days before.
- Key Dates (PDR 12th Dec, CDR 19th Feb, MRR 10th Apr, FRR 2nd Jun, Launch 17th Jun)

Task	Start Date	Finish Date	Completed?	W/C 03/11	W/C 10/11	W/C 24/11	W/C 01/12	W/C 15/12	W/C 08/12	W/C 15/12	W/C 22/12	W/C 29/12	W/C 05/01	W/C 12/01	W/C 19/01	W/C 26/01	W/C 02/02	W/C 09/02	W/C 16/02	W/C 23/02	W/C 02/03
Key Dates?				First Team Meeting	First Assigned Tasks				Motor Order form due 5th December	PDR Due on the 12th December		Christmas Break	Christmas Break	Exam Week	Exam Week	Exam Week	Exam Week		CDR Due on 19th		
Propulsion																					
Research Different Motors in-line with requirements. Motor Selection Process. (Costs/impulse to burn time/etc) into airframe. (Clamp/mounts)	21/11/2025	05/12/2025	Yes																		
	28/11/2025	05/12/2025	Yes																		
	05/12/2025	TBC	No																		
Avionics																					
Research battery options with known voltage requirements for payloads. Flight Computer research. Telemetry systems research between ground station and launch vehicle. Avionics Bay preliminary layout. Data acquisition methods following requirements. Determine which data to record. Preliminary PCB Design with KiCad. Cost analyses for all components. Research activation/deactivation methods.	21/11/2025	28/11/2025	Yes																		
	28/11/2025	05/12/2025	Yes																		
	28/11/2025	TBC	No																		
	05/12/2025	TBC	No																		
	28/11/2025	TBC	No																		
	05/12/2025	TBC	No																		
	05/12/2025	TBC	No																		
	28/11/2025	TBC	No																		
Airframe + Recovery																					
Research Nosecone designs/materials. Research main body materials and ideal dimensions. Parachute research. (Materials and Governing Equations) Fin design and materials research. Recovery System research. Research importance of bulkhead + wadding placement throughout body. Model drag coefficients on nose cone/fin designs. Model rocket on Solidworks (primarily nosecone/body/payload bays/fins/motor) Launch simulations on OpenRocket.	21/11/2025	05/12/2025	Yes																		
	21/11/2025	05/12/2025	Yes																		
	21/11/2025	28/11/2025	Yes																		
	28/11/2025	TBC	No																		
	21/11/2025	TBC	No																		
	28/11/2025	12/12/2025	No																		
	05/12/2025	TBC	No																		
	28/05/2025	10/12/2025	Yes																		
	05/05/2025	10/12/2025	Yes																		



Budget

- Cost Analysis run using Matlab throughout the year.
- Current budget estimates around £200–£250. This will be updated by the CDR, with a full cost breakdown and projection.
- Most expensive components: Altimeter, Microcontroller, Motor and Parachutes.
- In-house manufacturing of fins, nosecone, body, etc to reduce costs.



Motor Selection process

A good rocket motor must fulfil three criteria:

1. A speed of no less than 20ms^{-2} on exiting the launch rail (as dictated by requirement RS-TSN-SMN-001)
2. Have a thrust to weight ratio of roughly 5:1 with the total weight of the rocket itself (*Motor selection*. (n.d.). <https://info-central.rocketlabdelta.com/propulsion/motor-selection/>)
3. Have a suitable burn time to allow us to reach our target altitude of 2200 feet (as dictated by requirement RS-MRD-MIS-001)



Final choice: Motor

We selected the Aerotech G74 for the following reasons:

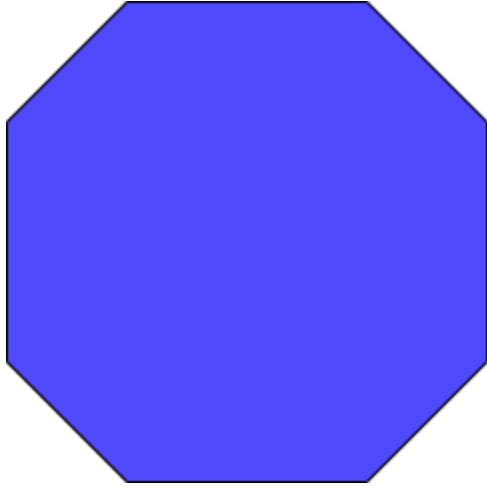
1. It features the highest thrust-to-weight out of all of the motors a crucial factor in ensuring we accelerate to 20ms^{-1} before exiting the launch rail
2. Has an impulse under 130Ns (compliant with requirement MRD-MIS-004)
3. Reasonable delay time for recovery system deployment (6/9s)
4. Lightweight (approx 88 grams)
5. Small length of around 83mm allowing us to more effectively allocate internal space.



G74-9W photo found on Apogee Rockets
(<https://www.apogeerockets.com>)



Launch Vehicle Design: Recovery



For our recovery system we have chosen to produce flat octagonal parachutes

- Ease of fabrication
- Packing consistency
- Middle ground of Drag Coefficient (0.7-1)

Main parachute diameter: $d = 2.663 \cdot \sqrt{m}$

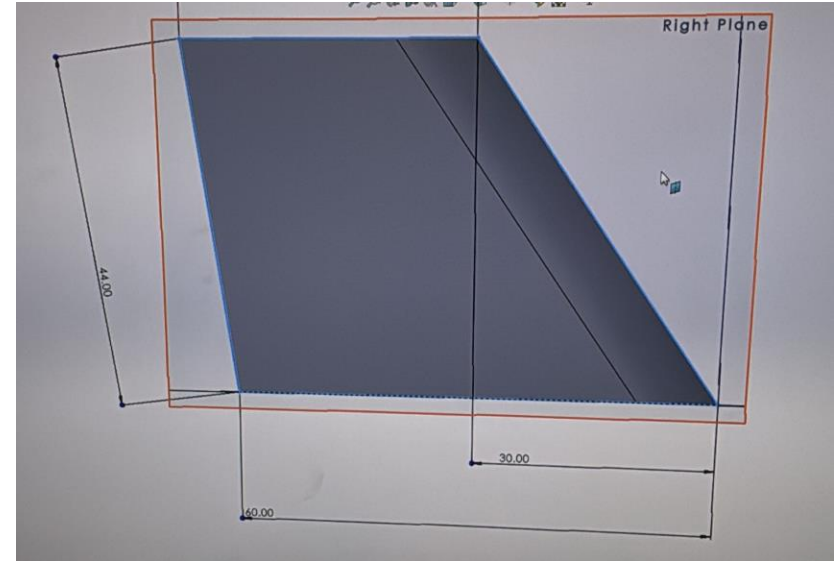
Materials: Ripstop Nylon (Parachute), Kevlar (Shock Cord)

Deployment: Dual deployment with drogue deployed at apogee and main parachute deployed by second charge.



Launch Vehicle Design: Airframe

- **Compared fin planforms:** rectangular vs. tapered vs. swept.
- **Selected swept fin design** for reduced drag and improved stability
- **Assessed materials:** balsa, plywood, fiberglass→ chose birch plywood for strength-to-weight
- **Checked UKSEDS requirements:** $\leq 2^\circ$ alignment tolerance and 2x load safety factor.
- **Initial sizing completed** based on stability and manufacturability limits.
- **Analysed fin aspect ratio** to balance stability vs. structural load
- **Considered fin thickness** for flutter resistance during max-Q
- **Evaluated number of fins (3 vs 4): 3 fins** for reduced drag, lighter weight, and sufficient stability as the chosen configuration.

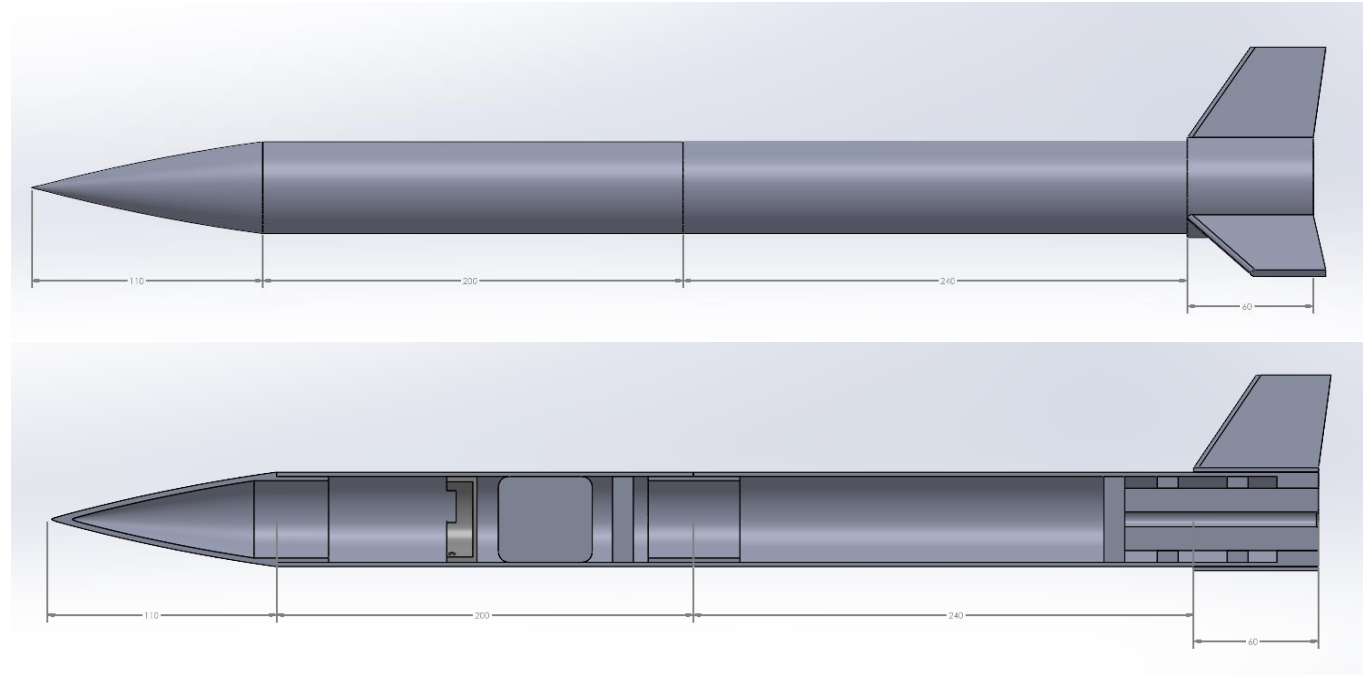


Fin design on SolidWorks



Launch Vehicle Design: Airframe

- Parabolic Nosecone design chosen
- Swept fin design
- Friction fit shoulder and coupler
- Customer payload adapter fitted

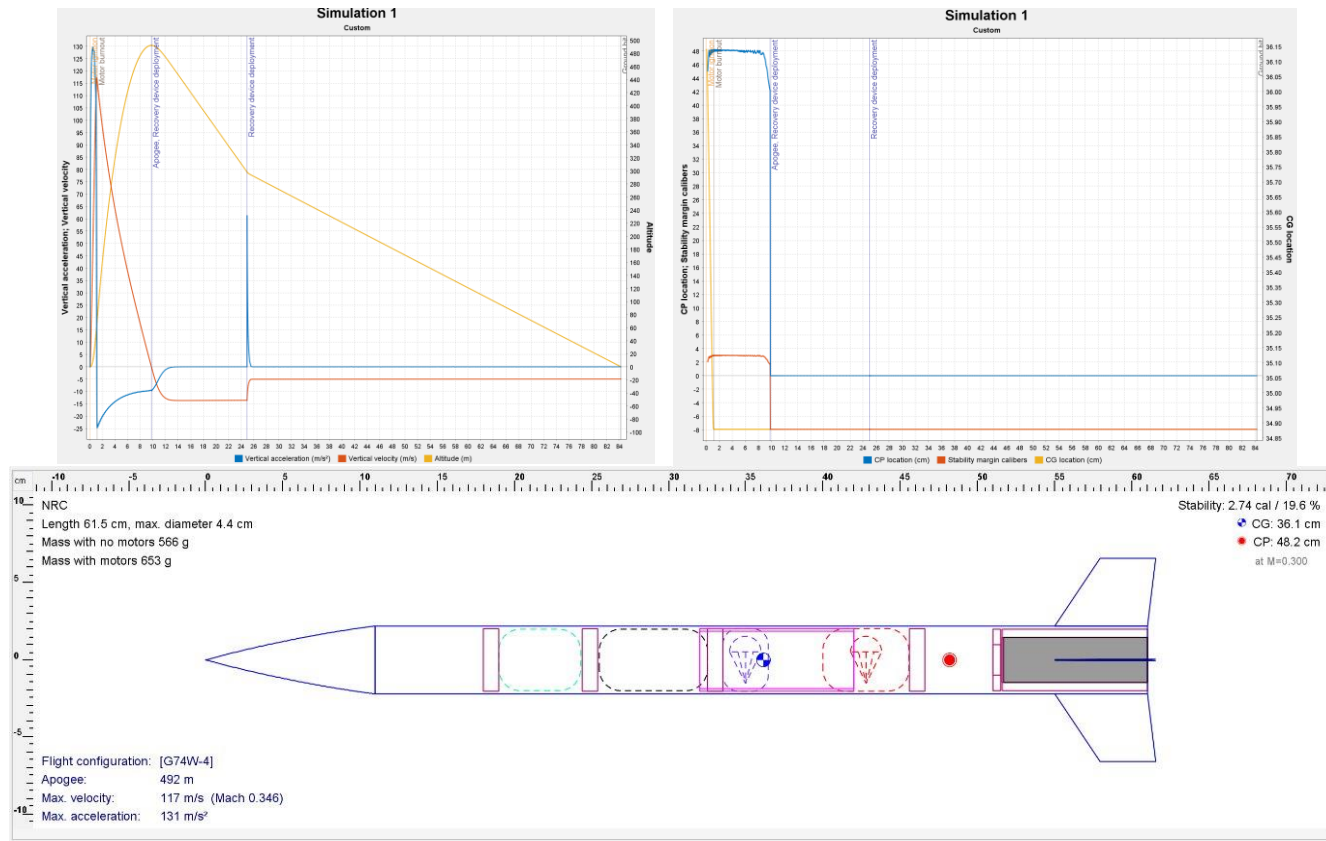


Preliminary rocket design on SolidWorks.



Launch Vehicle Simulation

Vertical motion against time on left, stability against time on right.



Queen Mary
University of London



Rideshare Payload Design Overview

Purpose

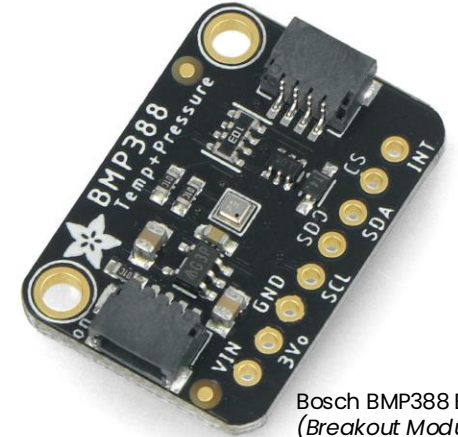
- Custom PCB payload meeting (NRC RPD-001 → RPD-006).

Architecture

- MCU + Bosch BMP388 barometer (altitude).
- Additional sensor: temperature + acceleration (RPD-006).
- Team Ursa logo on PCB silkscreen (RPD-005).

Core Functions

- Altitude-time logging (RPD-002).
- Onboard apogee detection + internal storage (RPD-003, RPD-004).



Bosch BMP388 Barometer
(Breakout Module for Prototyping)



Rideshare Payload Design Overview

Power

- Powered from main 2S 1500 mAh LiPo via 5 V / 3.3 V regulation.
- Load $\approx 0.3\text{--}0.5\text{ W}$ $\rightarrow$ negligible vs 8.6 Wh system requirement.

Integration

- Mounted in dedicated rideshare bay ($\geq 100\text{ g}$).
- Multi-core wiring (ESS-003).
- Electrically isolated from recovery electronics (RRS-005).



Rideshare Payload Design: Altimeter

We considered several options but decided on the Nano V1 tidy.

- Barometric (RPD-002 | Rev: A)
- Maximum operational altitude of 30 000ft (9.2km)
- Built in battery life of over 5 hours
- It records flight log data continuously
- Micro USB port for data transfer
- Compatible with Altimeter Cloud – used to plot a graph of altitude against time (RPD-003 | Rev: A)

Cost: £44.99



Nano V1 Tiny altimeter photo found on Model Rockets (<https://modelrockets.co.uk>)



Risk and Mitigation

Risk	Impact	Likelihood	Level	Mitigation
Structural / Thrust Ring Failure	High	Medium	High	Strengthen coupler + fin interfaces; design and test G74 thrust ring; update OR stability.
Recovery System Underperformance	High	Medium	High	Validate chute size; ground ejection tests; early drop tests.
Avionics Isolation / Wiring Issues	Medium	Medium	Medium	Strict ESS-003 compliance; separate recovery battery; wiring reviews.
Rideshare PCB Firmware or Sensor Failure	Medium	Medium	Medium	Bench-test components; validate apogee detection + logging routines.
Schedule / Manufacturing Delays	Medium	Medium	Medium	Internal deadlines ahead of milestones; parallel work across subteams.

Table A – Risk Matrix



Next Steps: Critical Design Process

Goal

- Develop a fully validated, flight-ready design meeting all NRC requirements.

Focus Areas

- Finalise structures, stability analysis & thrust-ring design (SMN, SAR).
- Refine dual-deployment recovery performance through drogue/main sizing, sequencing & early testing (RRS).
- Complete avionics isolation, power validation & wiring compliance (ESS, CPD).
- Finalise rideshare PCB design, firmware & ground-test verification (RPD).

CDR Output

- Updated models, subsystem tests & full requirements traceability (ALL).



Next Steps

- Continued modelling with OpenRocket to reach a good range of apogees, and ideally the 2200ft target.
- Review PDR feedback
- Finalise design choices for CDR based on feedback and OpenRocket results



Thank You

