Team 5
Green Origin
Final Project PDR

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Overview

- Key design features with diagram
- CAD
- Trajectory analysis
- Stability analysis
- Recovery
- Manufacturing and testing plans
- Budget
- Gantt Chart/Next steps

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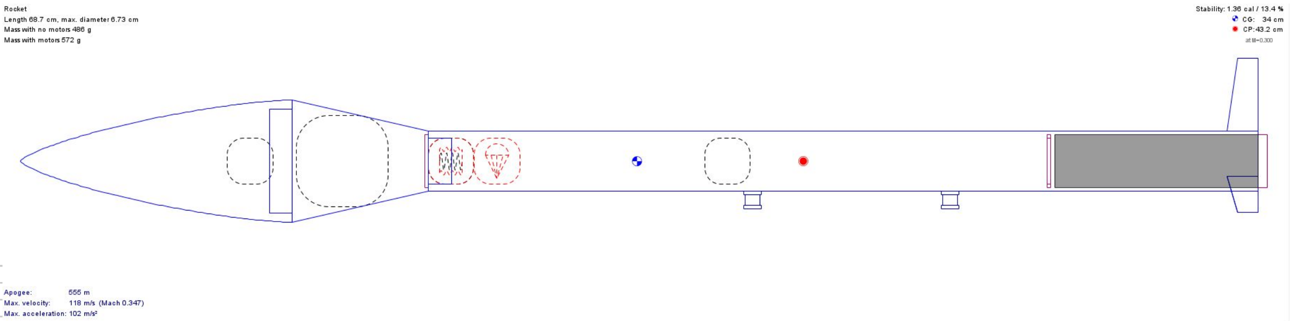
Key Design Features

- Minimum diameter rocket
  - ~30 mm body tube diameter
  - Necessitates purchasing custom mandrel
- High aspect ratio fins
  - Increases restoring force
- Aerotech F67-9C motor
  - High thrust with short burn time
  - Compliments the low drag nature of minimum diameter rockets



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Custom Mandrel

- 6063 aluminum tube
  - Dimensions (ODxIDxL): 30mm x 26mm x 400mm
  - Vendor: uxcell
  - Ready for purchase + 2 day shipping
  - Cost: $14.34

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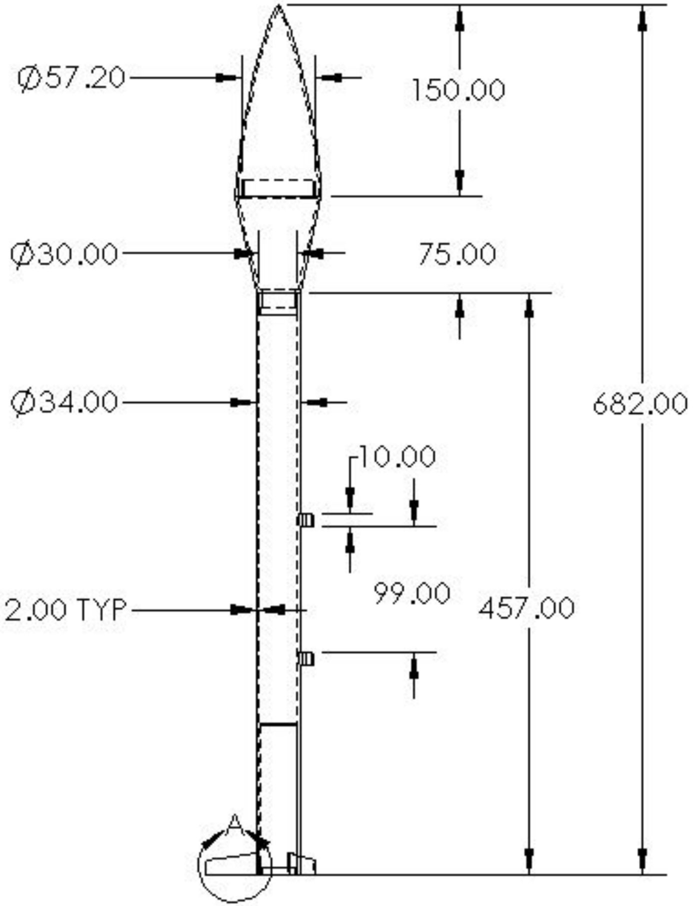
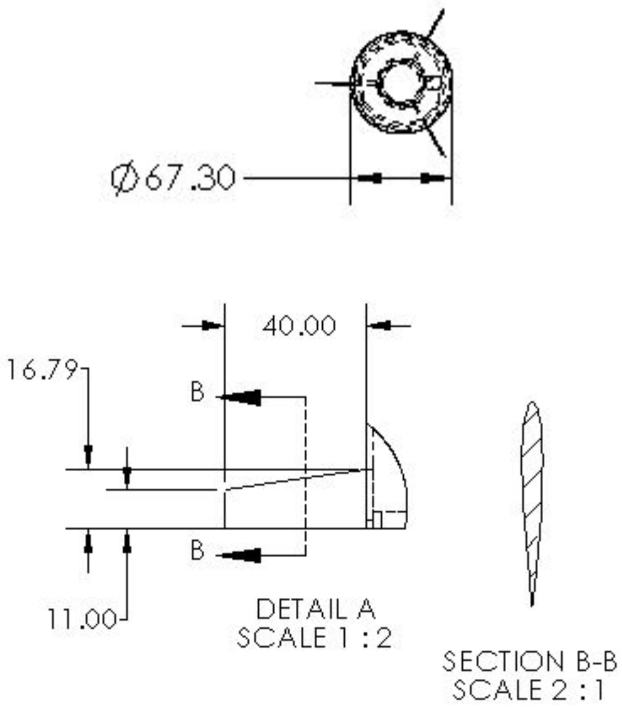


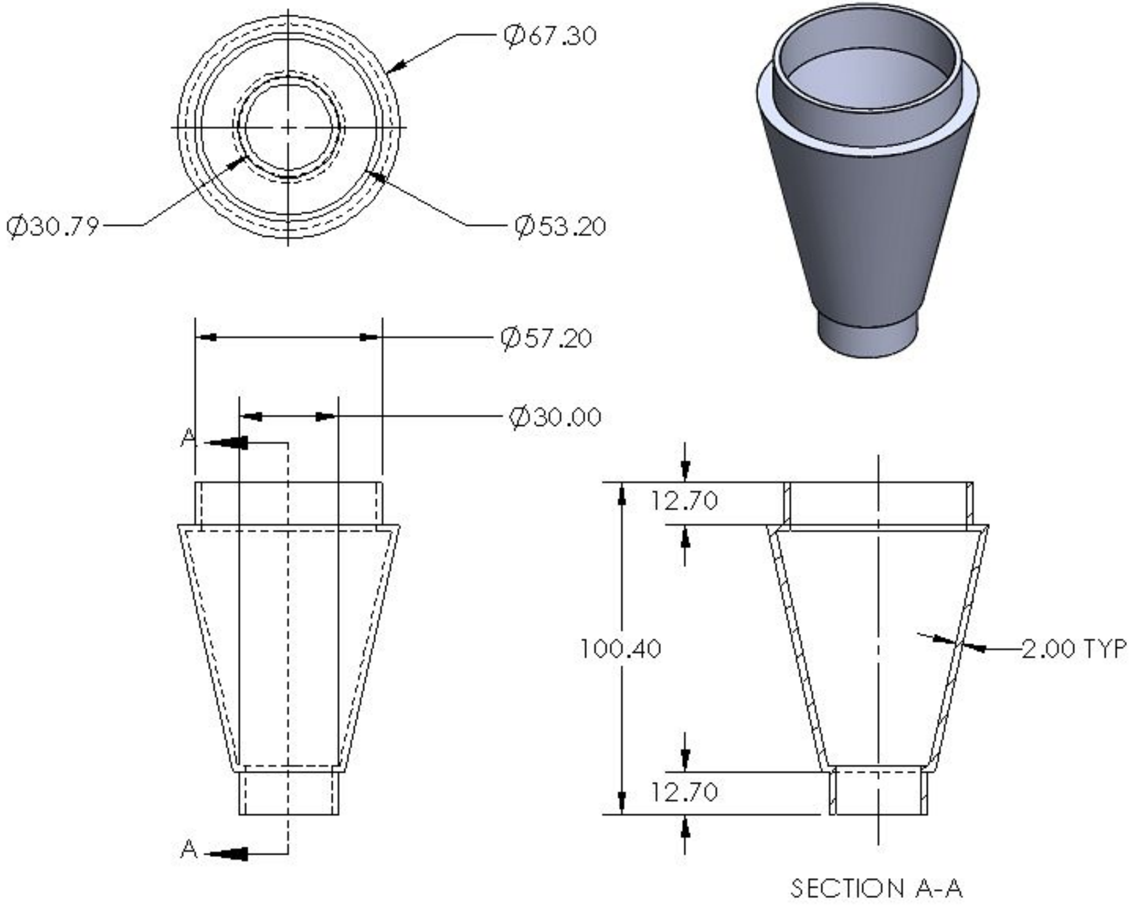
CAD



All dimensions are in millimeters

3D Printed Component

All dimensions are in millimeters



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Trajectory Analysis

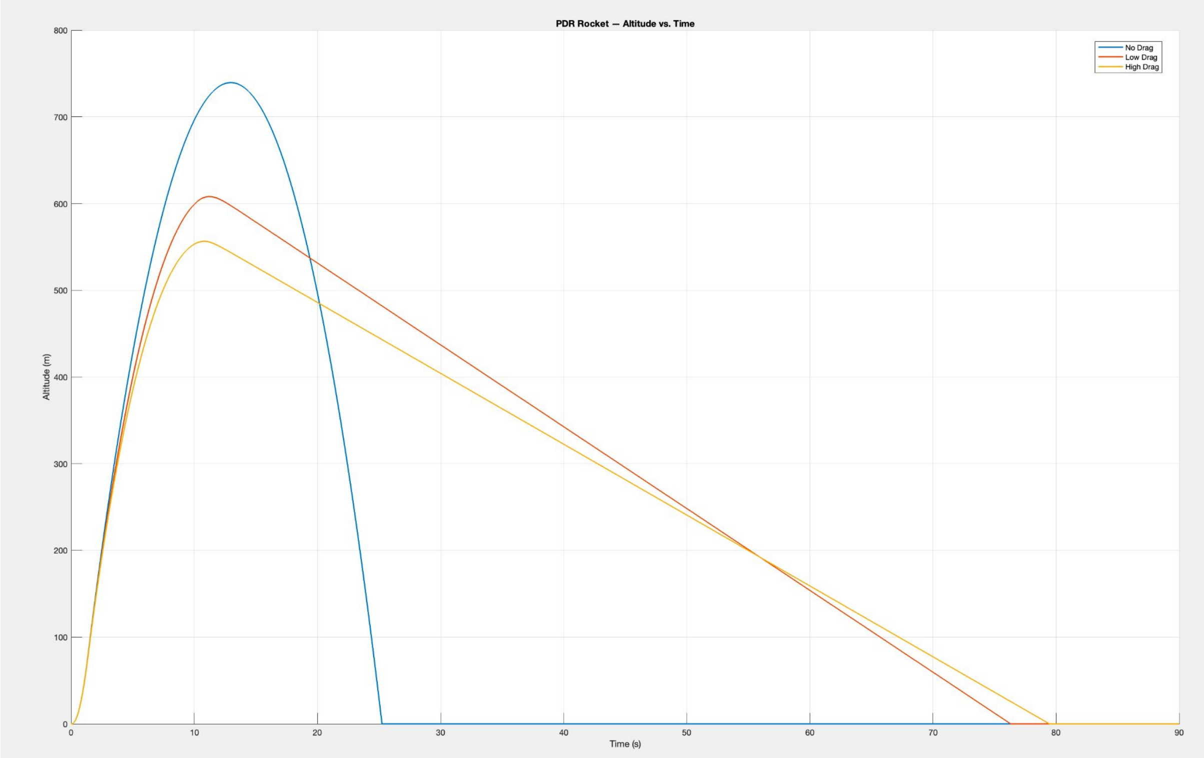
Trajectory comparison for different drag cases: Altitude vs. Time

No Drag (blue line):
Apogee: 739.5 m

Low Drag (red line):
Apogee: 608.0 m

High Drag (orange line):
Apogee: 556.4 m

Open rocket model:
Apogee: 568 m



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Trajectory Analysis

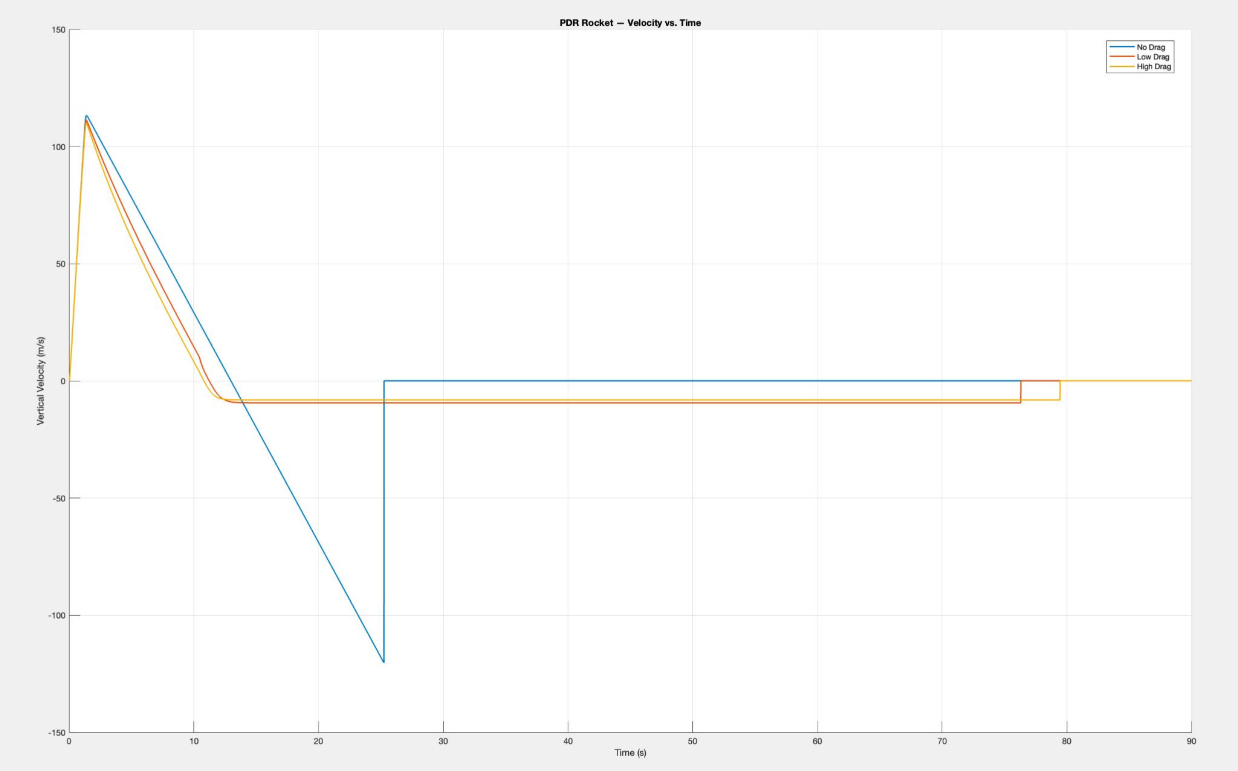
Trajectory comparison for different drag cases: Velocity vs. Time

No Drag (blue line):
- Off-rail speed: 16.4 m/s
- Burnout speed: 112.9 m/s
- Descent speed: 24.6 m/s

Low Drag (red line):
- Off-rail speed: 16.4 m/s
- Burnout speed: 110.5 m/s
- Descent speed: 9.8 m/s

High Drag(orange line):
- Off-rail speed: 16.4 m/s
- Burnout speed: 109.2 m/s
- Descent speed: 3.6 m/s

Open rocket model:
- Off-rail speed: 13.7 - 17 m/s
- Burnout speed: 117 m/s
- Descent speed: 3.81 m/s



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Trajectory Analysis

Trajectory Comparison for different drag cases: Acceleration vs. Time

Thrust Phase:

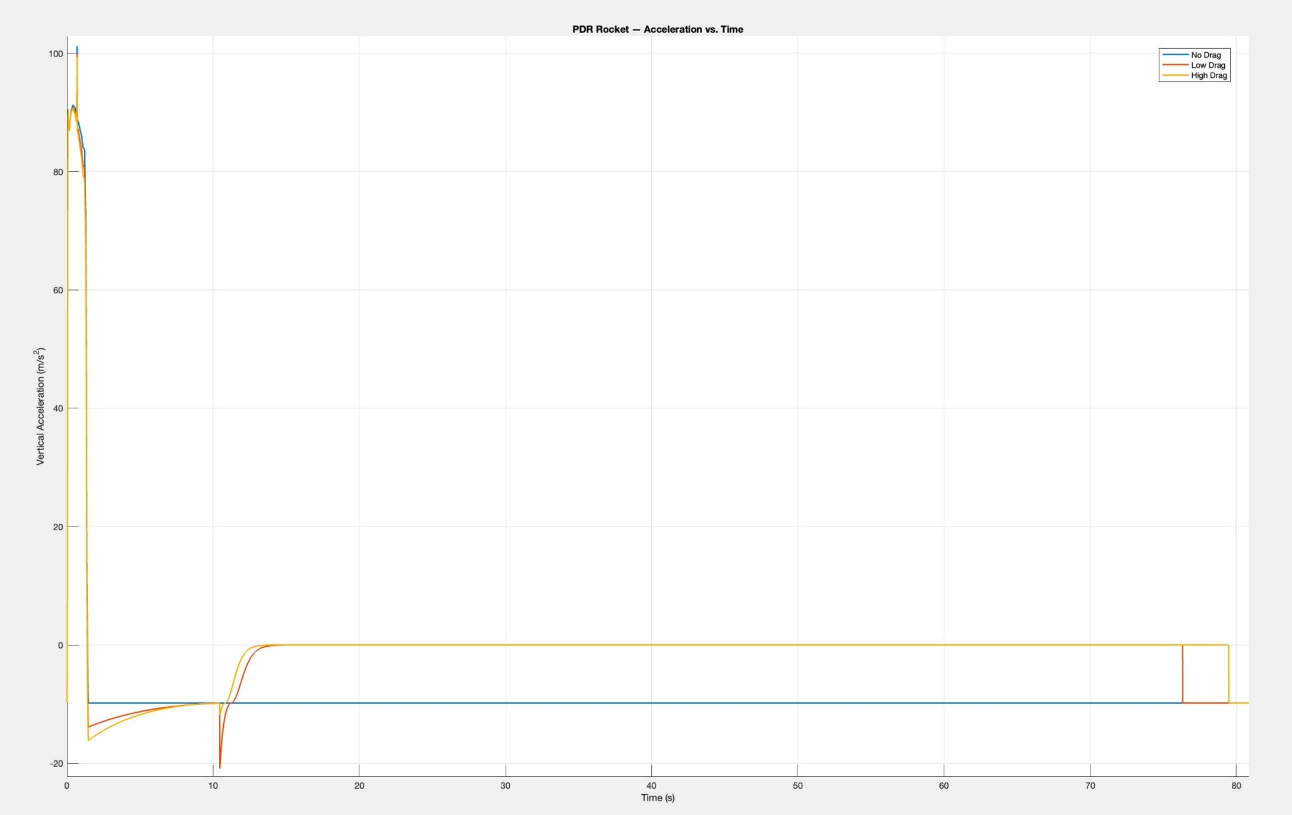
- Peak accelerations around 100 m/s²

Coast Phase:

- Free- fall deceleration at about –9.8 m/s² (gravity) plus minor drag deceleration

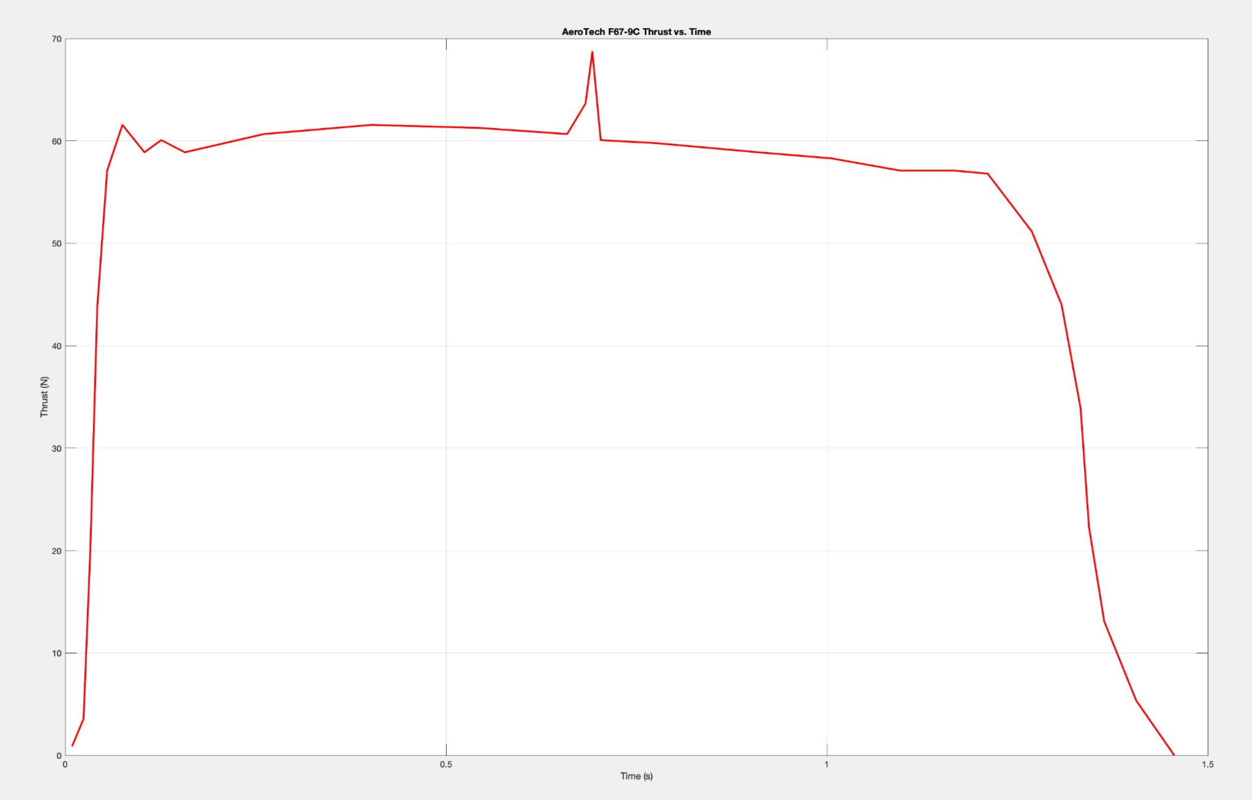
Descent Phase (post-chute):

- Low drag: about –2 m/s² steady descent
- High drag: about –1 m/s² gentler fall



Trajectory Analysis

Thrust curve for F67-9C engine (pulled from thrustcurve.org)



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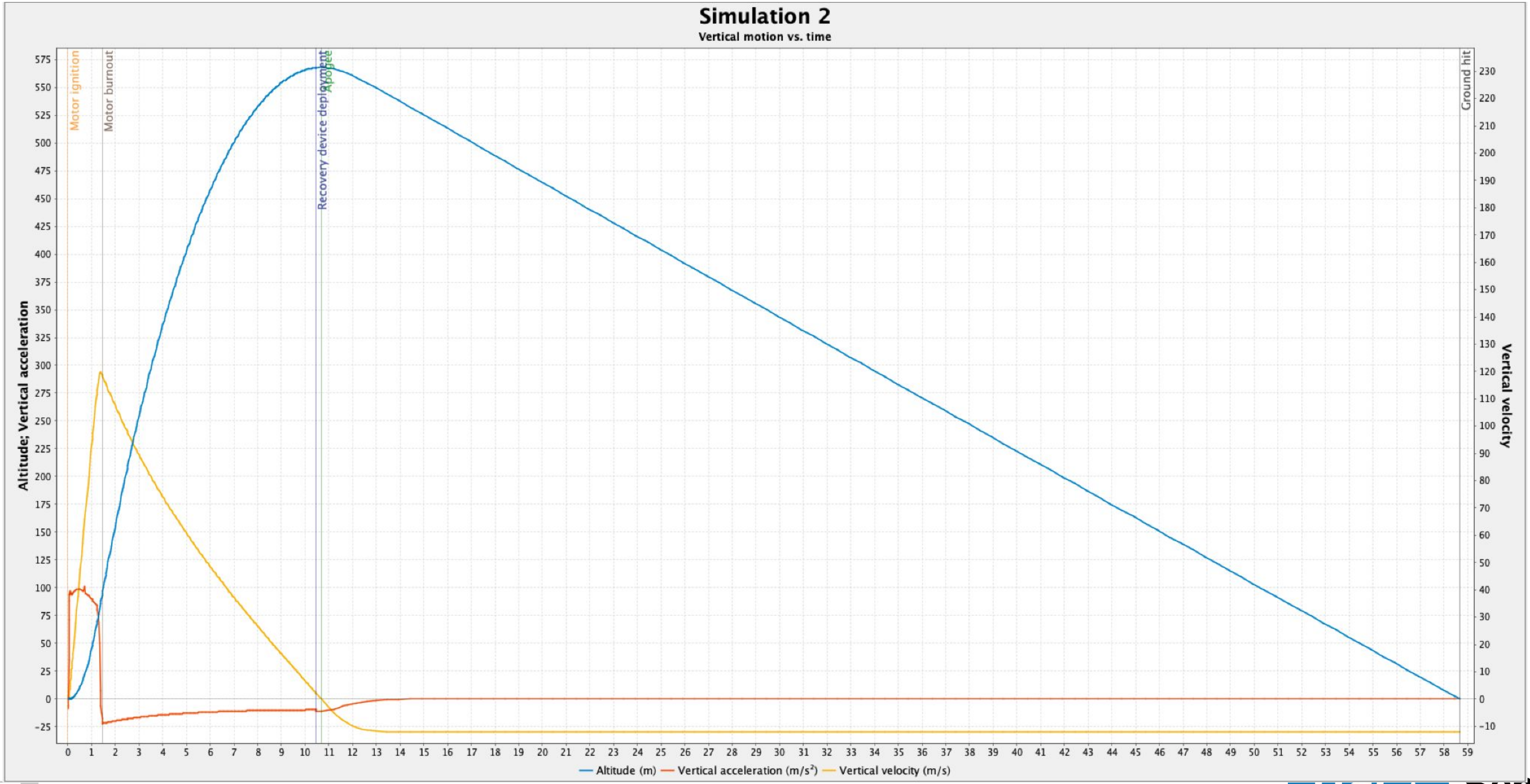
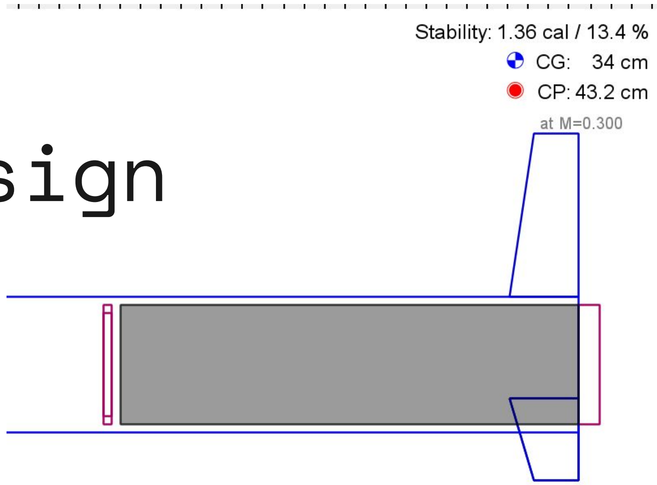
Trajectory Analysis

Open Rocket simulation model very close to our matlab model



Aero - Fin Design



- Fin Parameters
  - Root chord = 1.7 cm, tip chord = 1.1 cm
  - Semispan = 4 cm
  - Thickness = 14.2%
    - High thickness to prevent fluttering at high velocities
  - Aspect ratio = 5.7 , taper ratio = 64.7%
  - Compared to very low aspect ratio fin designs from CoDR, higher AR allowed significantly lower fin area to achieve similar stability margin
  - Airfoil: depend on manufacturing methods selected, could be quasi-airfoil profile by sanding or a NACA 0014 airfoil if molds would be utilized
- Stability
  - Stability Margin = 1.36 cal
    - Worst case scenario, actual margin could be even better since payload and fairing weights are likely underestimates
  - No dynamic stability issue from Open Rocket simulation

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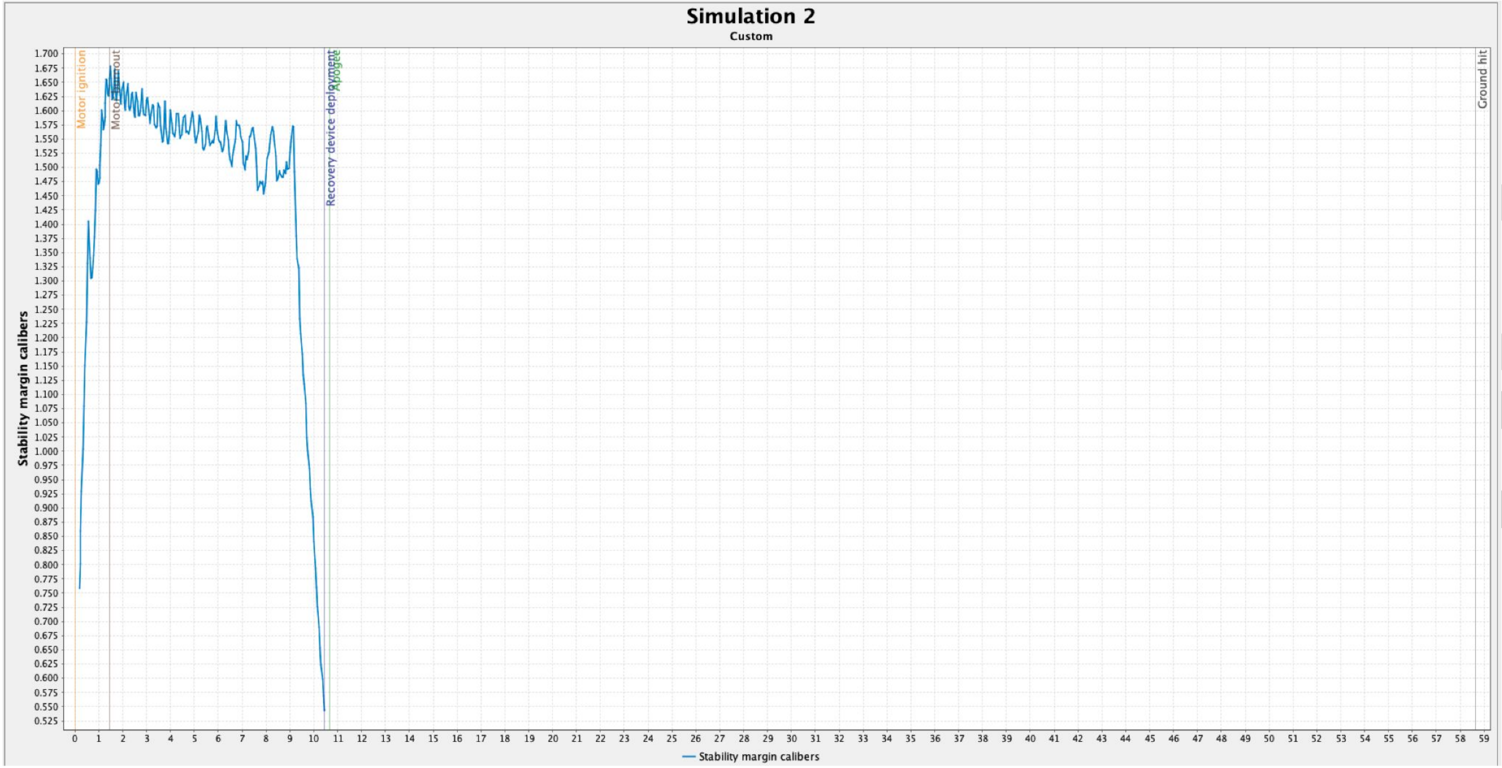
Stability Analysis

Open Rocket stability plot

Stability Margin = 1.36 Cal (openRocket)

CG : 34 cm from tip of nose cone.

CP: 43.2 cm



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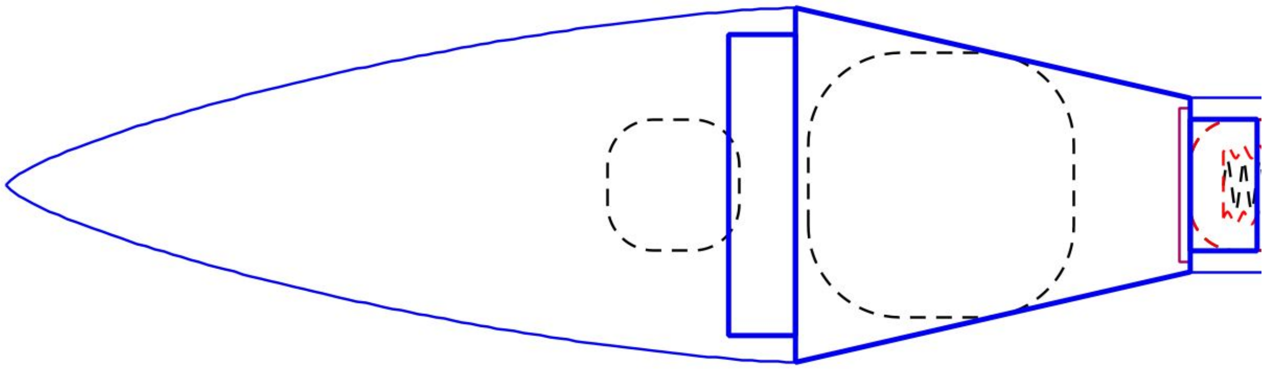
Aero - Fairing/Nose Cone

- Nose cone shape: Haack series
  - All else equal, this shape provides the best apogee (568 m)
  - Other competitive choices are power series (566 m) and parabolic series (565 m)
- Nose cone length: 15 cm, base diameter = 6.73 cm
- Transition section length: 7.5 cm



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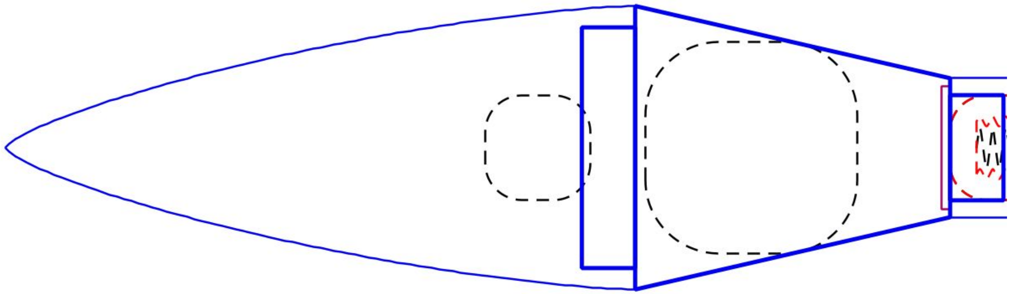
Recovery System

- Transition design
  - Material: PLA
  - Length: 7.5 cm
  - Taper: diameter 6.73 cm to 3.175 cm
- Ideas for egg safety
  - Cushioning made from packed paper towel, foam, or stuffing around egg
  - Centering rings in the transition to act as stabilization



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Manufacturing Plan

Phase 1: Pre-Fabrication

a) “Purchase” composite materials (Carbon Fiber + Fiberglass)
b) Purchase mandrel
   i) Must be long enough for entire body

Phase 2: Machine Fabrication

a) Print 3D part molds/parts (nosecone + transition section)
b) PLA/Resin print fins
   i) Cheaper, weight difference negligible with fiberglass fins
   ii) Alternatively, fiberglass layup fins and sand to airfoil, with consideration for sanding jig if desired
c) Laser cut plywood bulkheads/centering rings

Phase 3: Manual Fabrication

a) Layup composite (Fiberglass nosecone + carbon fiber body tube)
b) Clean up parts (Cut/Sand to tolerance)
   i) Ensure fit of all parts or redo above processes

Testing Plan

Aerodynamics testing

a) CFD analysis of aerodynamics surfaces (nosecone/fins)
   i) Wind Tunnel testing conducted pre-CDR -> drag data can be taken at this point as well

Separation Testing

a) Alleyway test blowing the nosecone out
   i) Fine-tune coupler fit tightness
   ii) Ensure egg is protected from charge force

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Budget Allocation

Item	Relevance	Quantity	Unit Price	Total
Carbon Fiber (in²)	Airframe (2 Layers)	144	$0.16	$23.04
Fiberglass (in²)	Nosecone (3 layers)	99	$0.11	$10.89
Mandrel	Airframe fabrication	1	$14.34	$14.34
Total				$48.27

Updated Gantt Chart

Color Code	
(blue)	Planned
(green)	Complete
(yellow)	In Progress
(red)	Hard Deadline

Team Project Tasks	Week 1	2	3	4 Before PDR	4 After PDR	5	6	7	8	9 Before CDR	9 After CDR	10
Complete Machine Shop Training	In Progress	In Progress	In Progress	In Progress	Hard Deadline							
Complete Lab Safety Training	Complete	Complete										
Fabricate Assembly Bench Fixutres	Complete											
Assign Team Member Roles		Complete										
Create Gantt Chart for Project Management		Complete										
Build and Launch Low-Power Kit Rocket	Complete	Complete										
Trajectory Analysis and Stability Analysis Code Development		Complete	Complete									
Preliminary CAD Design			Complete	Complete								
Preliminary Design Review (Thursday, Week 4)				Hard Deadline								
Preliminary Aerodynamic/Stability Analysis				Planned								
Test Plan				Complete								
Fabrication Plan				Complete								
Budget Review				Complete								
Bill of Materials (4/25)					Hard Deadline							
Order Materials					Hard Deadline							
Revise Design					Planned							
3D print one component (e.g. fin, nosecone, motor retention)						Planned						
Fabricate Design						Planned	Planned					
CFD Analysis						Planned	Planned					
Build Review								Hard Deadline				
Test Strength, Stability, Drag, Iterate Design								Planned				
Test Recovery System									Planned			
Iterate Design, reTest, and reAnalyze										Planned	Planned	
Finalize Trajectory Analysis, Aerodynamic Analysis and Fabrication										Planned		
Critical Design Review (Tuesday, Week 9)										Hard Deadline		
Launch Day (Saturday in Week 9)											Hard Deadline	
Final Report (due June 12th)												Hard Deadline

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Thanks

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