University of Central Florida 2023-FRR-Presentation

Project Managers

Nathan Stahl
Aerostructures Manager

Alejandra Morales
Systems Manager

Emilio Pereira
Payloads Manager

Progress on Requirements

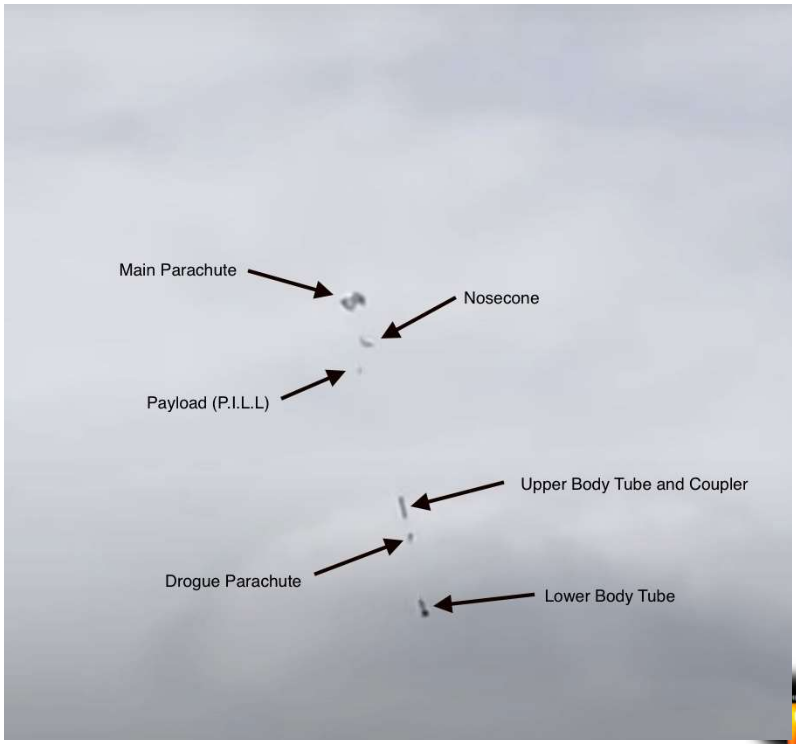
Section	Completed	In Progress	Incomplete
General Requirements	10	1	0
Vehicle Requirements	18	1	0
Recovery System Requirements	12	0	0
Payload Experiment Requirements	2	1	0
Safety Requirements	4	0	0
Final Flight Requirements	0	2	0

Full Scale Flight

Launch Date	3/4/2023
Temperature	85°F
Weather	Partly Cloudy
Launch Wind Speed	15mph SW
Launch Location	Spaceport Rocketry Association, Palm Bay, FL
Predicted Apogee	5040ft
Recorded Apogee	4215

Payload Demonstration Flight

Launch Date	3/18/2023
Temperature	86°F
Weather	Partly Cloudy
Launch Wind Speed	14mph NW
Launch Location	Spaceport Rocketry Association, Palm Bay, FL
Predicted Apogee	4044ft
Recorded Apogee	4088ft



Payload Demonstration Flight

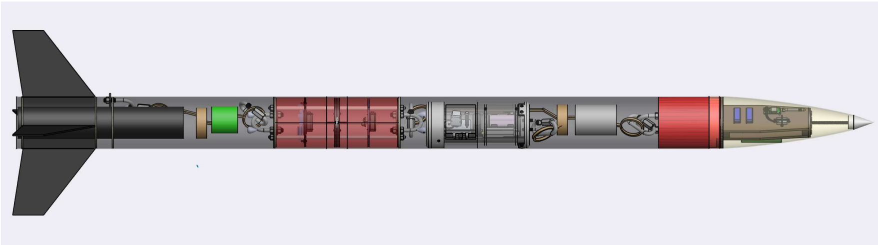
- Payload Retention System functioned as intended
- Successful Main Deployment
- Rocket fell in a canal
- All electronics have been lost and are currently in the process of being recovered or replaced

Payload Demonstration Flight

Vehicle Design

Vehicle Design

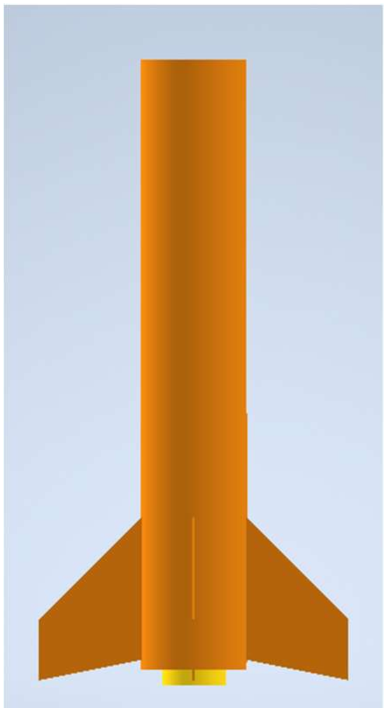
- Dual deployment with GPS tracking in the nosecone
- Student Developed Composite Body

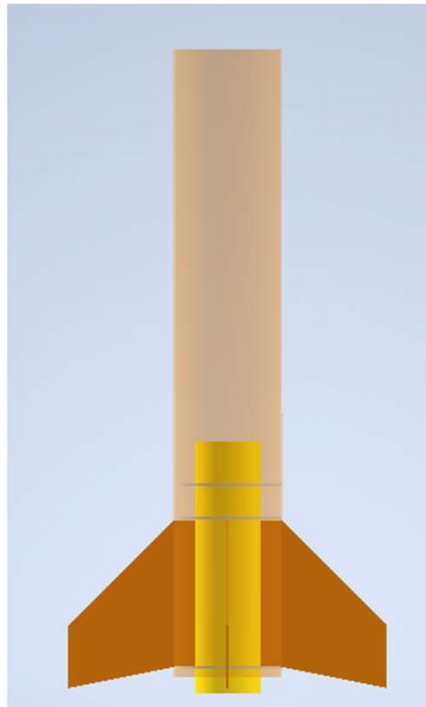


Rail Exit Velocity	87.2 ft/s
Thrust-to-Weight Ratio	11:1
Maximum Velocity	633 ft/s
Maximum Acceleration	9.57G
Descent Time	72.38s
Highest Kinetic Energy Upon Landing	40.85 ft-lbs
Max Drift	2331'

Vehicle Name	Asclepius
Apogee	5507
Vehicle Length	87"
Expected Lift-off Weight	26.3 lbs
Body Tube Outer Diameter	5.1"
Body Tube Inner Diameter	5.00"
Launch Pad Stability	2.74 cal
Launch Pad CoM	51.049" aft of tip
Launch Pad CoP	65.023" aft of tip

Separation Points



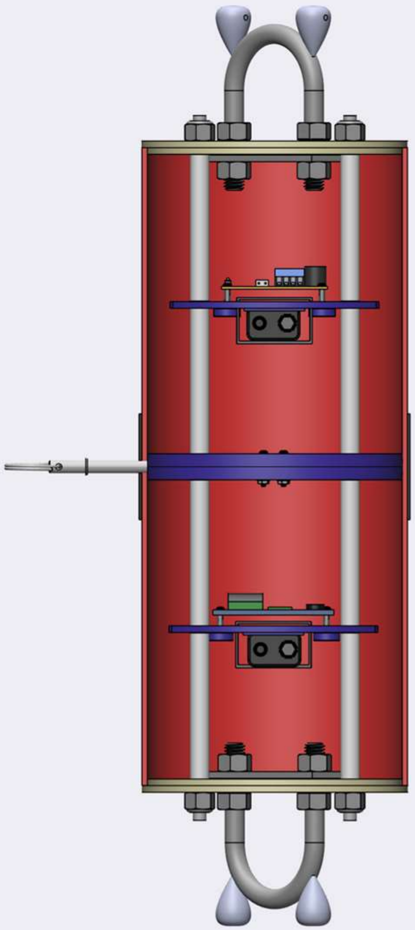


- Estimated Weight: 4 lbm
- Overall length of 34"
- Contains fins, motor tube, motor, centering rings, tail cone and motor retainer
- Booster tube made from Carbon Fiber

Booster Section

Fins

- 4 swept trapezoidal fins
- Dimensions
  - Height: 5.5"
  - Root Cord: 7"
  - Tip Cord: 3"
  - Sweep Length: 5"
- Epoxied in
- G10 Fiberglass Plates

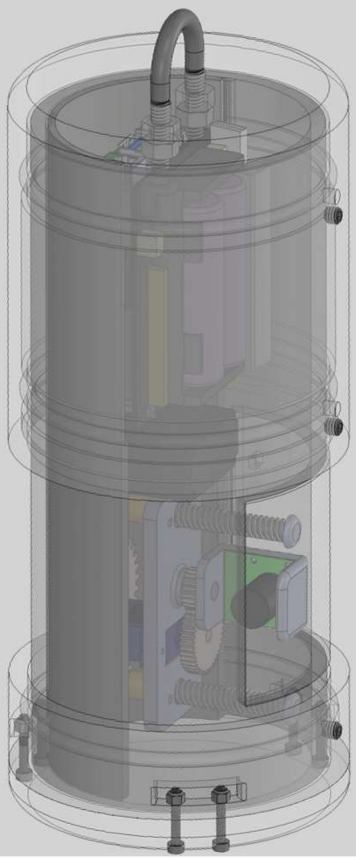


Overall Avionics Bay Design

- 12'' in length
- 2'' switch band
- Currently 2.3 lbm
- Forward bay for main parachute and Aft bay for drogue parachute
- Connects to rocket with shear pins
- Uses primary and redundant altimeters and free-floating charges
- Utilizes 3D printed plate support structure

Payload

- 3.47lbs
- 10" Length
- 4.5" OD
- Contains Primary Experiment
- Connected to main Kevlar shock cord with 4" section of nylon shock cord

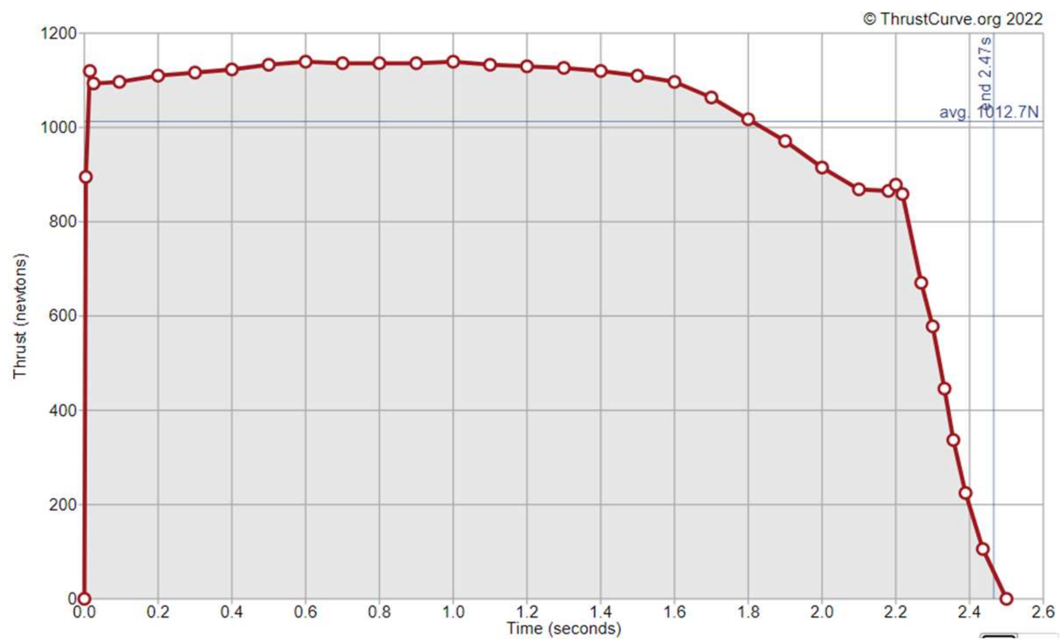


Nosecone

- 3.5 lb
- 16" Length
- 5.1" OD
- Houses the telemetry unit

Final Motor Choice – Aerotech K1000T

Motor Brand/Designation	**AeroTech K1000T**
Max/Average Thrust (lb)	1674N/1066N
Total Impulse (lbf-s)	2511.5Ns
Mass Before/After Burn (oz)	2602g/1392.5g
Liftoff Thrust (N)	1105N

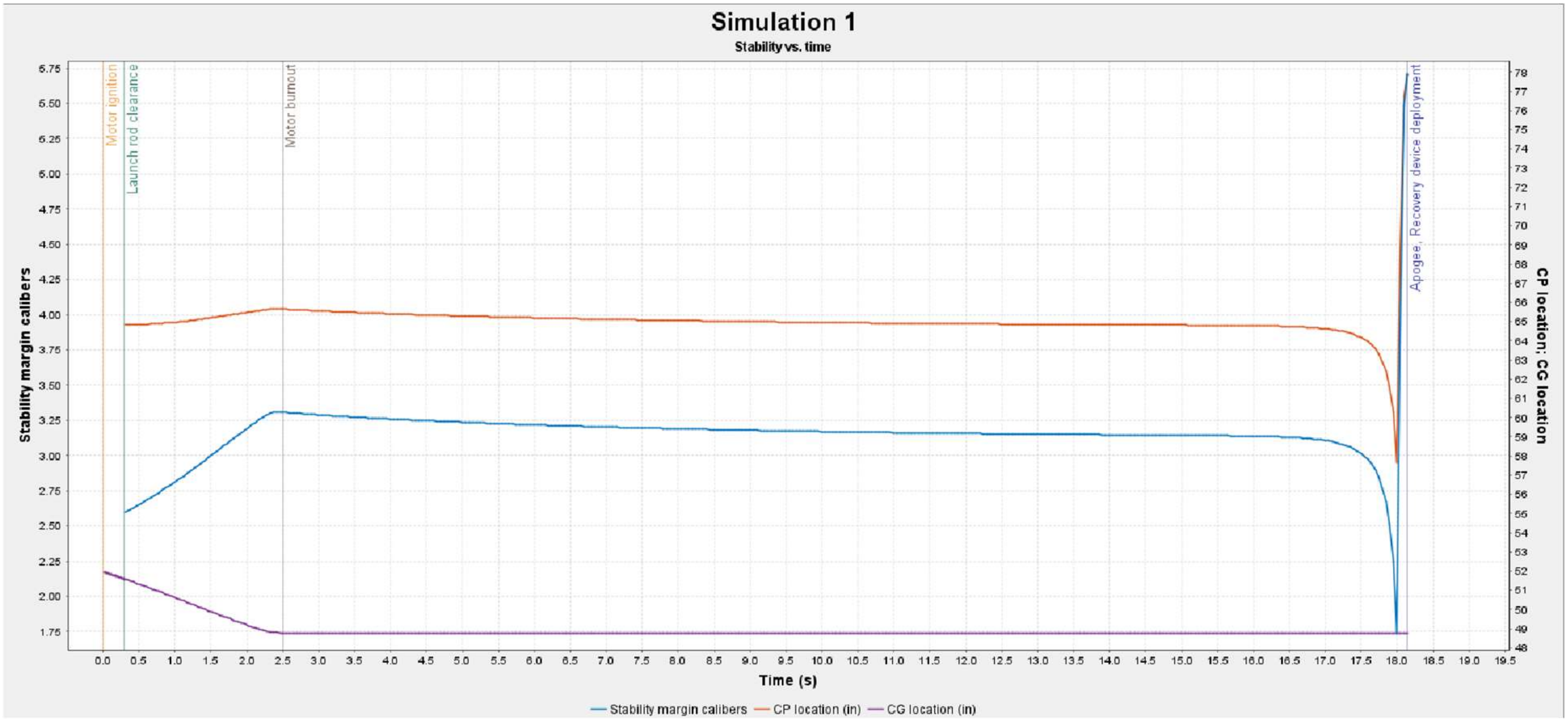


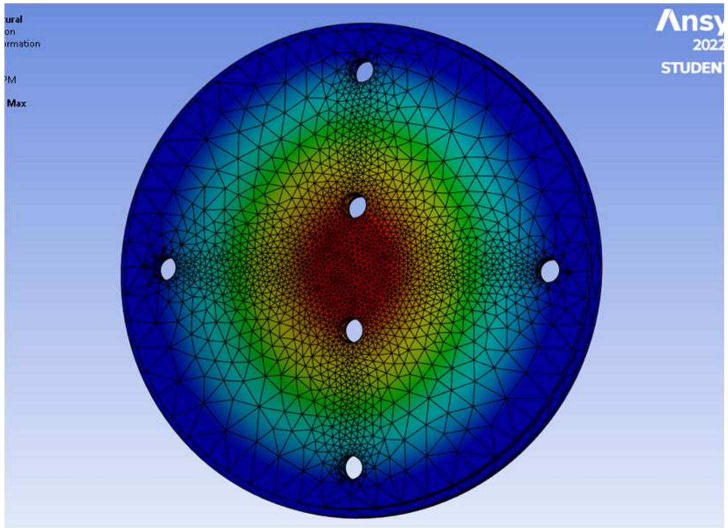
Altitude/Drift Predictions

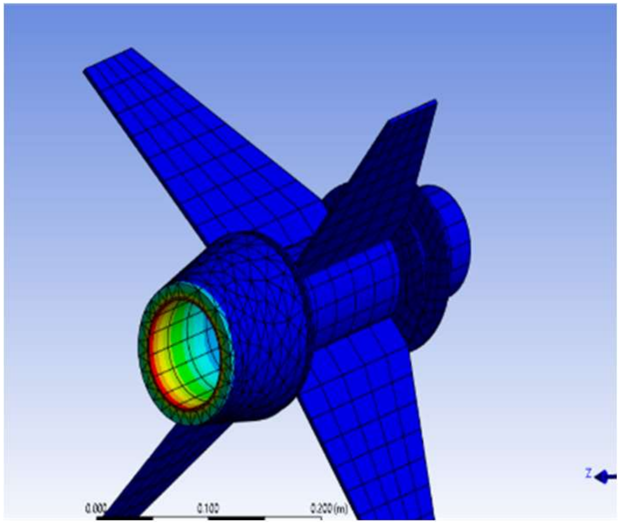
5mph Wind Speed	Apogee (ft)
Launch Angle	
0	5205
5	5152
10	5077
15	4972

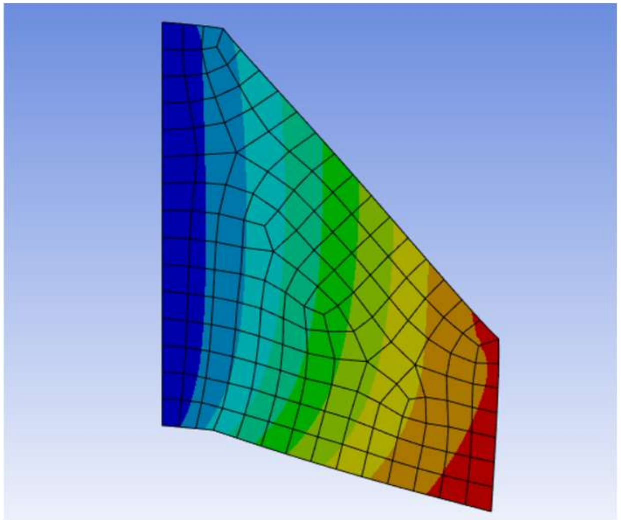
	Drift Distance (ft)
Wind Speed (mph)	OpenRocket
0	9.75
5	25
10	240
15	450
20	550

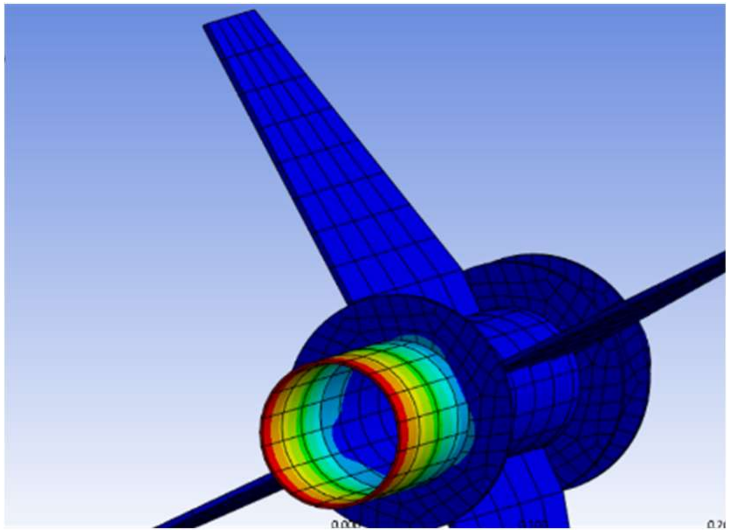
Stability and Flight Criteria









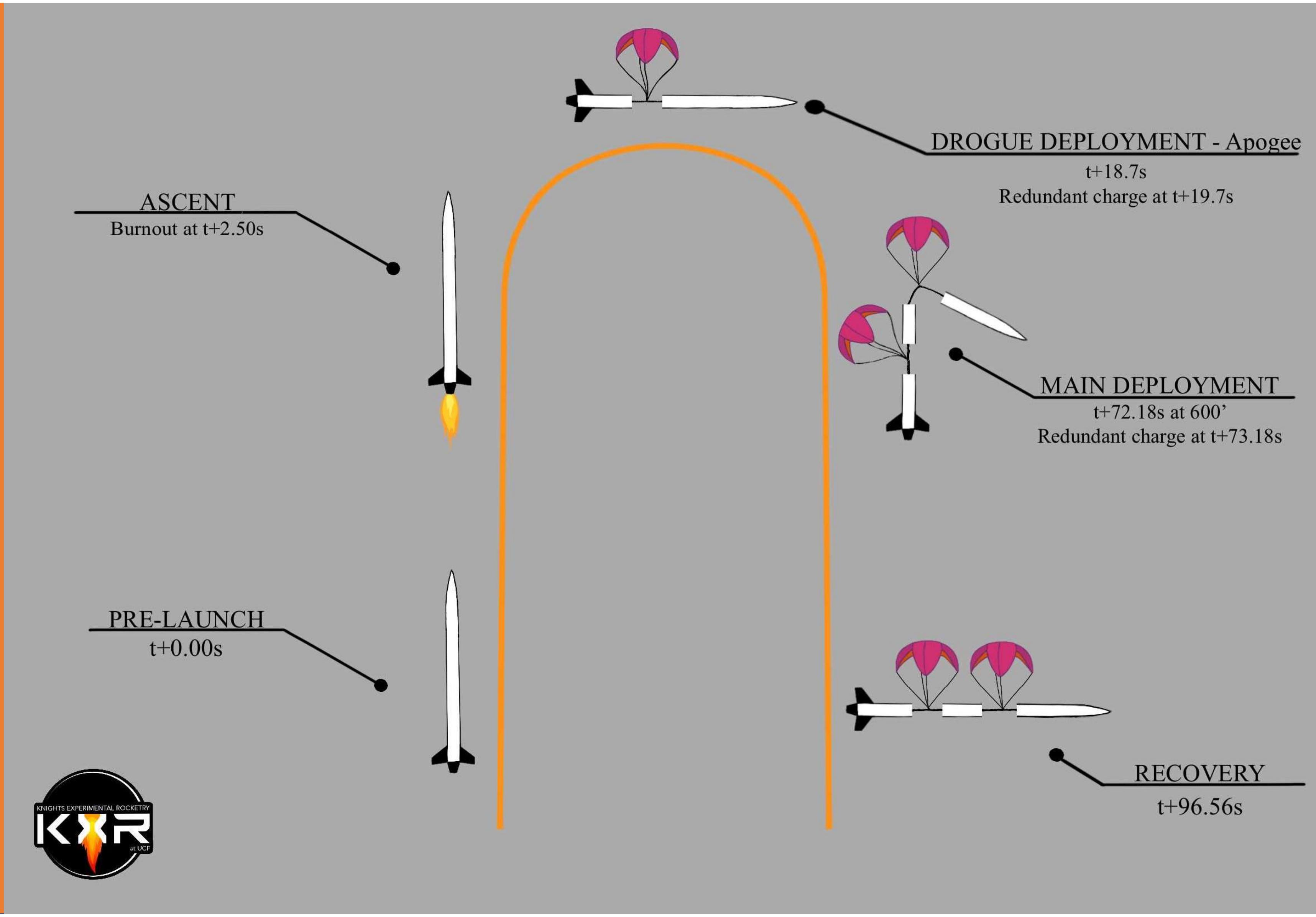


FEA

Mass Margins

Section	Expected Mass (lb)	Current Mass (lb)
Nose Cone	3.1	3.5
Upper Tube	2.9	2.7
Payload	5	5.1
Coupler	3.8	2.3
Lower Tube	4.6	5.9
Motor	6.6	6.6
Total	26	26.3

Recovery Design

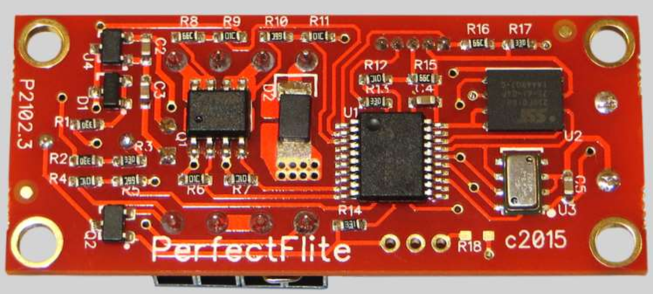

DROGUE DEPLOYMENT - Apogee
t+18.7s
Redundant charge at t+19.7s
ASCENT
Burnout at t+2.50s
MAIN DEPLOYMENT
t+72.18s at 600’
Redundant charge at t+73.18s
PRE-LAUNCH
t+0.00s
RECOVERY
t+96.56s
KNIGHTS EXPERIMENTAL ROCKETRY

Slide 21

JA0 On this slide, simply state the main idea.
Main Idea: Flight diagram with time intervals taken from the Vertical Motion vs TIme graph plotted by OpenRocket.
Jericho Antoine, 2023-02-01T14:19:05.042

Primary Altimeter

- StratoLoggerCF
  - 9V Alkaline Battery
  - Easily Programmable
  - Better for Flight Data
    - Battery, temp, velocity, altitude, etc.



Redundant Altimeter

- RRC2+
  - 9V Alkaline Battery
  - Large success with RRC2+ in past projects
  - Cohesive Flight Data
  - Easily Programmable

JA1

Drogue Parachute

- **30" Ultra x-form Parachute**
  - **TopFlight**
- CD: .725
- Materials: Ripstop Nylon
- Weight: 2.4 oz
- Packing Volume: 16.40^3

Main Parachute

- **84" Standard Parachute**
  - **Rocketman**
- CD: .97
- Materials: Ripstop Nylon
- Weight: 8 oz
- Packing Volume: 45.94^3

Slide 23

AZ0 update to new chutes
Aleksandr Zhuchkan, 2023-01-08T22:25:45.625

JA1 Mention that the snatch force for main is 561.977 lbf at 100 ft/s
Jericho Antoine, 2023-02-01T17:42:31.403

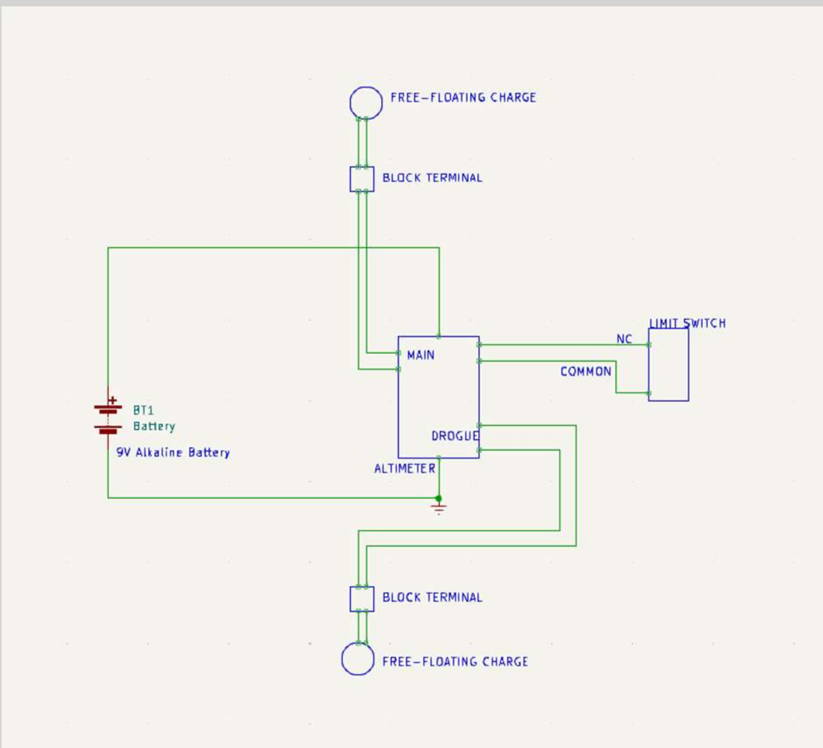
Heat Shielding

- **Nomex Blankets**
- **Heat-Resistant Epoxy Coating**

Attachment Hardware

- **Drogue Shock Cord**
  - Kevlar
  - 360 inches
- **Main Shock Cord**
  - Kevlar
  - 300 inches
- **PILL Shock Cord**
  - Kevlar
  - 48 inches
- **Harness/Airframe Interfaces**

Wiring Diagram



Ejection Charges

- **Ejection Charge Type**
  - FFFFg Black Powder
- **Ejection Charge Locations**
  - Forward AEB Bulkhead
  - Aft AEB Bulkhead
- **Drogue**
  - 3.5g
- **Main**
  - 4.5g

AZ0

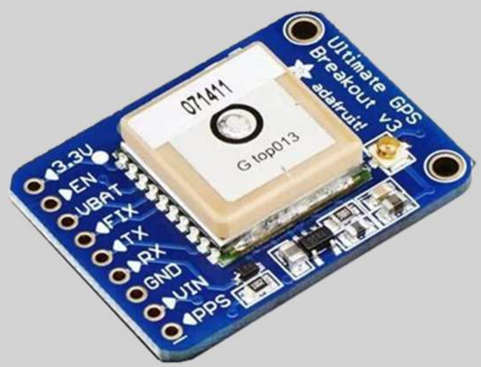
Tracking Devices

Featherweight GPS

- Frequency Channel 24B
- Extremely long range
- Independent of all other avionics

Adafruit Ultimate GPS

- Frequency: 443.2mHz (KQ4FDO)
- Part of SRAD flight computer
- Long range



Slide 26

AZ0 add an image possibly

Aleksandr Zhuchkan, 2023-01-09T05:20:00.861

JA1

Avionics and Recovery Testing

Test	Description	System Under Test	Status
Altimeter and Battery Drain Test	Altimeters are hooked up to their respective batteries and are ran until the battery is dead to test the endurance of the system	Stratologger CF and RRC2+ Altimeters, 9V Alkaline Batteries	Complete
Parachute Drop Test	Both Drogue and main parachutes are attached to a weight and dropped from a height to test parachute functionality	Drogue and Main Parachute	Complete
Altimeter Ejection Vacuum Test	Altimeters are tested for reliability and pass if they consistently ignite both ejection charges at the appropriate time	Stratologger CF and RRC2+ Altimeters	Incomplete
Black Powder Ejection Charge Test	Black powder ejection systems are tested to fulfill the appropriate separation between stages	Drogue and Main Parachute, Ejection Charge System	Complete

Slide 27

JA0 Objective Main Idea: Define the word appropriate for body tube separation.
Jericho Antoine, 2023-02-01T17:56:40.031

JA1 Success Criteria Main Idea: In order for our test to be deemed successful, an appropriate body tube separation must occur whilst following all safety protocols listed by our safety officer.
Jericho Antoine, 2023-02-01T18:00:05.930

Altimeter Continuity and Battery Drain Test

- Objective: Altimeters fulfill the requirements for pad and flight duration
- Success Criteria: Both altimeters must maintain continuity for at least 3 hours.
- Methodology: Wire each respective system and connect to batteries. Check for continuity and battery drain.
- Results: Both altimeter systems passed the continuity and battery drain test

Parachute Drop Test

- Objective: Parachutes fulfill necessary requirements that they open consistently to allow for full deployment after ejection
- Success Criteria: Both parachutes must fully deploy
- Methodology: Drop and video record drogue and main attached to a weight and drop from the top of a parking garage to simulate ejection
- Results: Both the drogue and main parachute passed the test

Altimeter Ejection Vacuum Test

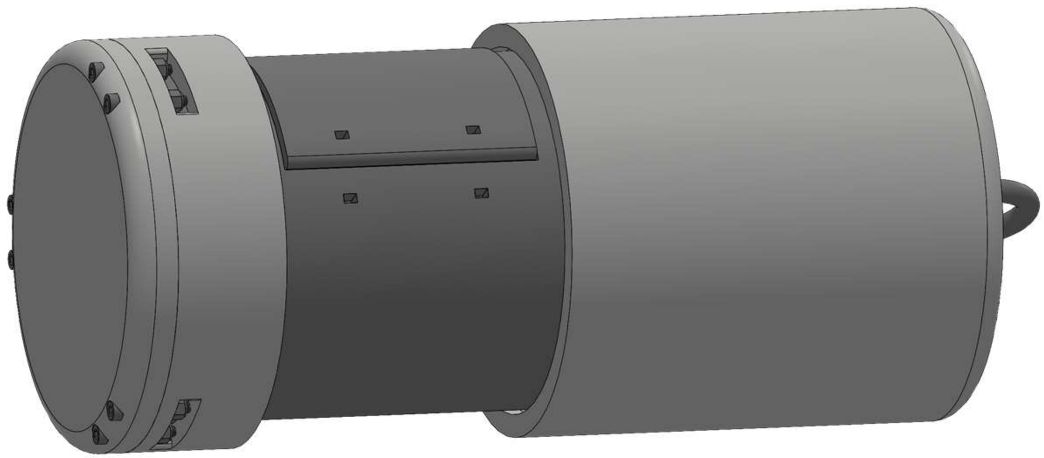
- Objective: Altimeters fulfill the requirements that they consistently ignite both ejection charges at appropriate times
- Success Criteria: both altimeters must ignite the drogue parachute charges at apogee or 1s after apogee and the main parachute charges at the correct altitude
- Methodology: simulate a flight with both altimeter systems in a homemade vacuum chamber, recording event data.
- Results: TBD

Black Powder Ejection Test

- Objective: Black powder ejection systems fulfill the requirements that they create appropriate separation between airframe sections
- Success Criteria: Both black powder canisters must separate the correct airframe sections the appropriate amount while not damaging electronic components or the airframe, as well as fully eject parachutes
- Methodology: ignite both black powder charges from a distance with full vehicle on the ground.
- Results: both black powder ejection systems passed this test

Payload Design

PILL Overview



- PILL Mission Objectives:
  - House and deploy a camera capable of rotating 360° about the z-axis, whilst self-orienting itself parallel to the horizon
- Sub-system Breakdown
  - Experiments
  - Telemetry
  - Ground Station

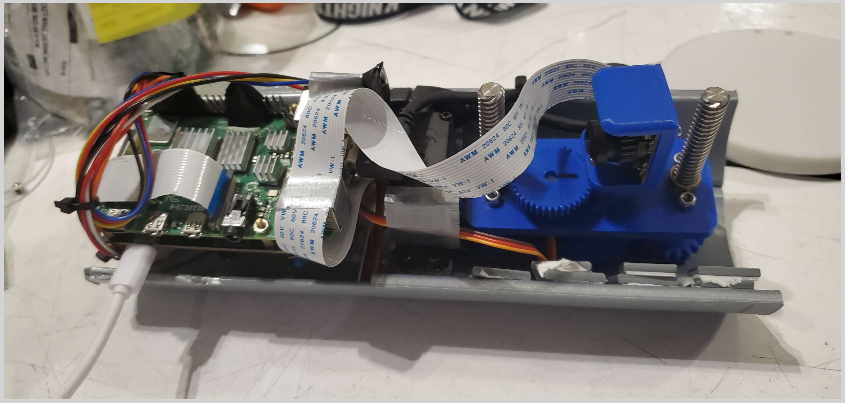
PILL As-Built Design

Lead Elevator

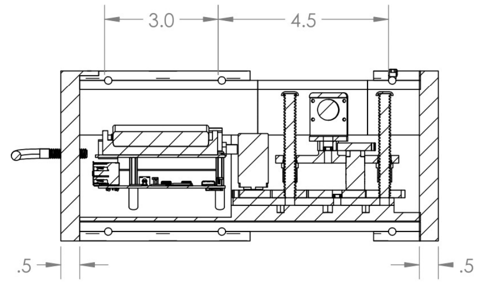
- Actuating Mechanism
- Rotation Mechanism
- Camera

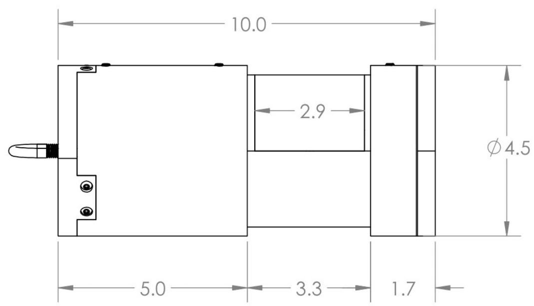
Electronics Housing

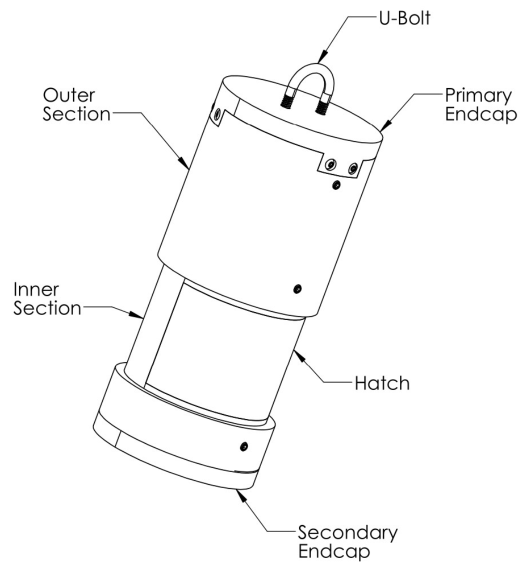
- RTC
- Raspberry PI
- BNO055
- RAFCO system



REVISIONS				
Zone	Rev	Description	Date	By
-	1	Intial Release	12/30/2022	Jake Goldberg







1 inch

10mm

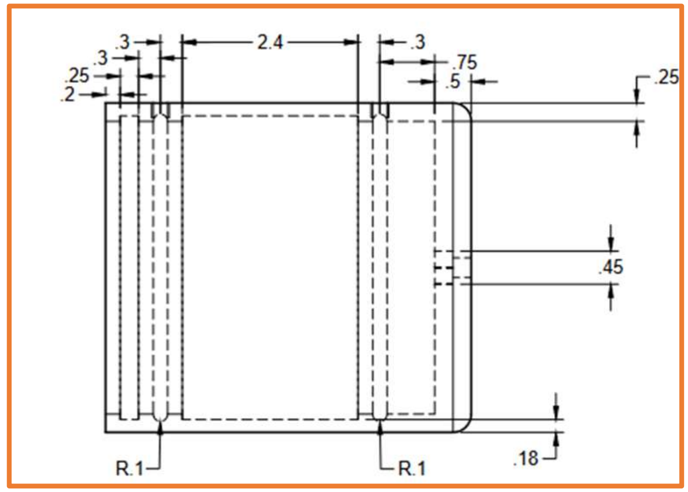
UNLESS OTHER WISE SPECIFIED: DIMENSIONS ARE IN INCHES SURFACE FINISH: N/A TOLERANCES: ±[.005-IN] DEBURR AND BREAK SHARP EDGES	MATERIAL: N/A FINISH: N/A		EXPERIMENTS	NASA SL
	NAME	DATE	SIGNATURE	TITLE P.I.L.L.
DRW'N	KEANU BRAYMAN	1/6/2023		
CHK'D	KEVIN LAURIE	1/7/2023		
APRV'D	KEVIN LAURIE	1/7/2023		
MFG'D				PART NO. N/A
DO NOT SCALE DRAWING	SHEET 1 OF 1	SCALE: 1:3	WEIGHT: 5 LB	KXR STANDARD DWG V3.0

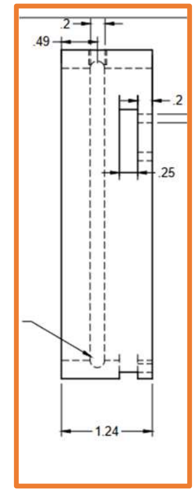
Descent and Landing As-Built Design Payload (Integration)

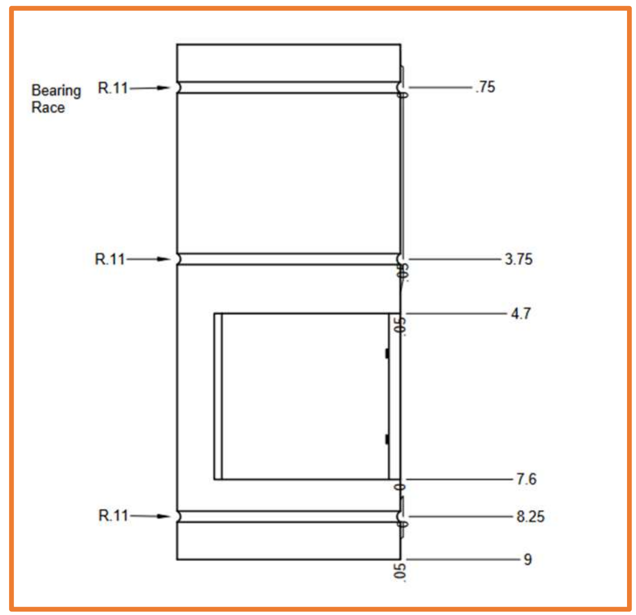
- Payload (PILL) is attached to main shock cord by an extra 4ft of shock cord
- Payload is pushed out with the main parachute
- Main parachute deploys
- Payload remains attached to the shock cord
- Payload and rocket reach touchdown
- Camera Exits Payload housing

Self-Orientation As-Built Design

- Ball bearing mechanism to orient inner tube
- Dry lubricant for rotation
- Ballast on inner sled for low center of gravity
- Grooves with cap for ball bearing insertion
- Plastic pellets and metal ball bearings utilized as options

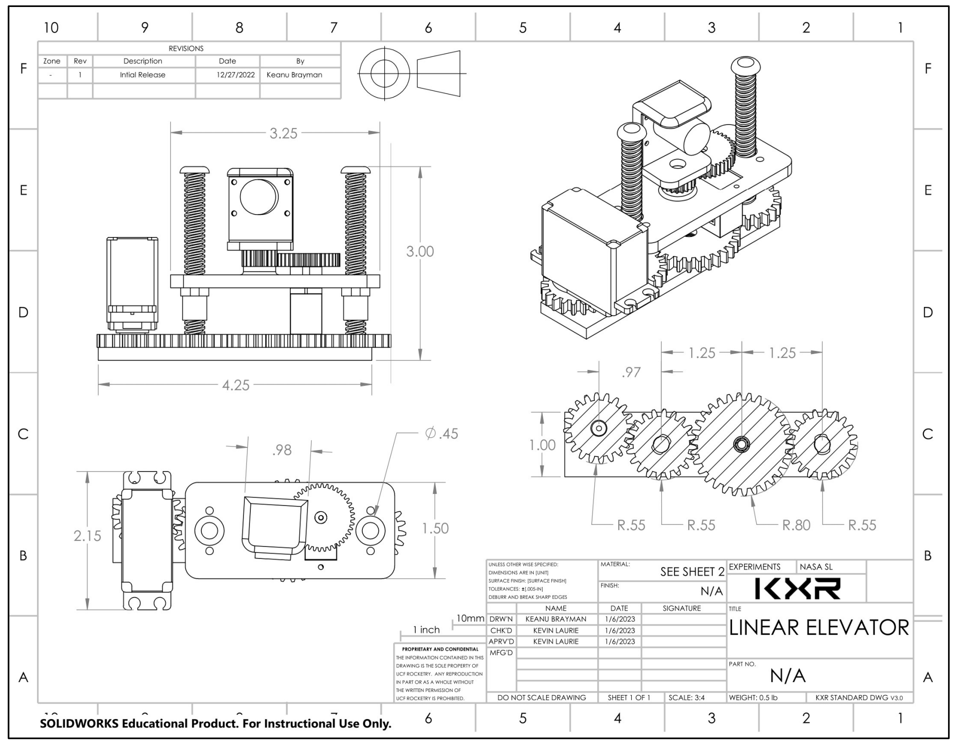






Panoramic Image Capture As Built Design

- Approximately 2.5” in additional height
- Removes distortion from previous designs
- Rotates 360 degrees about z-axis
- Utilizes IMU to prevent early acceptance of RAFCO commands
- Smarza PI 4 Cam for FOV requirements



ADSAB As-Built Design

- Dual sleds for better use of space
- Simpler Design
- Allows for proper taper along Von Karmaan line
- Hoists
  - 2200mAh LiPo
  - Flight Computer
  - GPS

Payload Demonstration Flight / Testing

Payload Demonstration Flight
Location: Palm Bay with Spaceport Rocketry Association
Date: March 18, 2023

List of tests to be completed

- Battery Longevity Test
- Camera, IMU, Limit Switch, RTC Test
- Radio Test
- Self Orientation Test
- Software Test
- Ground Test
- PILL Drop Test
- Hinge Seal Test
- Dry Lubricant Seepage Test
- PILL Ejection Test

Battery Longevity Test

- Objective: Measure how long the battery lasts
- Success Criteria: Battery lasts for more than 3 hours
- Methodology: connect pi to a display, run a diagnostic script, and check the battery indicator every 10 minutes . When Pi dies, stop clock
- Results: Sufficient to meet requirement 2.6
- Conclusions: Add OLED to accurately measure charge on launch day

Camera, IMU, , RTC Test

- Objective: Test that the camera works with the RTC
- Success Criteria: RTC gives correct output and works with camera, IMU correctly measures every couple of seconds.
- Methodology: Check that RTC is installed onto Pi and that the RTC prints onto the photo. Verify that input is properly being read.
- Results: Able to accurately initialize RAFCO commands to meet requirement 4.2.3.3
- Conclusions: Code to detect ground hit and leave no possible room for error

Radio/ground station test

- Objective: Be able to receive signals from ground station to pi
- Success Criteria: The pi receives signals from the ground station and performs the appropriate commands
- Methodology: Send a message from ground station on the radio frequency. Test if Pi can scan message into certain components
- Impact of Results: Knowledge gained from this test will allow us to have a deeper understanding of how to perform the radio commands and how to implement them.

Camera Deployment

- Objective: Test if the camera deploys properly
- Success Criteria: .Camera deploys and script runs
- Methodology: Connect survey and camera inside of the PILL. Set PILL on level surface and run code.
- Results: Successfully raises camera up to desired height of 2.5” out of payload body
- Conclusions: Fix tolerancing on camera mount to prevent catching

Physics/Self orientation

- Objective: Test if the PILL ends upright after landing
- Success Criteria: PILL is in upright position, ready to deploy the camera
- Methodology: Roll PILL on multiple surfaces, drop PILL on multiple surfaces and observe if PILL self orients.
- Results: Able to self-orient properly under high velocities
- Conclusions: Sand grooves for bearings and speak with UCF machine shop to fix design

Code test

- Objective: Determine if the code for camera functions as it should.
- Success Criteria: The code is able to run and perform the required actions for the camera
- Methodology: Run code that turns camera on and verify the images are saved onto SD card after camera takes pictures of surrounding area.
- Results: Successful, camera overlay works as expected and is able to do perform all commands described in requirement 4.2.2

Ground Test

- Objective: Observe and analyze the performance of the experimental payload when deployed from upper body tube.
- Success Criteria: the payload can successfully eject from upper body tube.
- Methodology: troubleshoot software, attach payload to nylon shock cord and to main parachute. Perform ground test on payload.
- Results: Payload is successfully able to deploy

PILL Drop Test (a,b,c)

- Objective: Observe the effects and performance of all components of experimental payload when dropped from a high altitude
- Success Criteria: Payload is fully functional upon impact with the ground.
- Methodology: Prepare all electrical and mechanical components of the payload. Attach then drop payload while attach to main parachute. Observe all components of the payload
- Impact of Results: The impact of the results gathered from this experiment is the understanding of the all systems being used and their effects from being under high stress

Hinge Seal Test

- Objective: To test the quality of the hinge seal
- Success Criteria: No debris let into the inner tube during test procedure and the seal can be broken easily with the linear actuator
- Methodology: Seal the PILL using differently sealing techniques/materials. Blow dirt at the seal directly. Open and inspect debris.
- Results: No charring was observed on the Payload, nor inside of it.

Dry Lubricant Seepage Test

- Objective: To test the application of dry lubricant to prevent seepage onto other components during flight
- Success Criteria: No seepage of dry lubricant anywhere outside of the two outer housings
- Methodology: Weigh and apply appropriate amount of lubricant. Roll the outer rubes for 3 minutes and observe lubricant seepage .
- Results: Dry and Wet lubricants did not seep out of grooves.

Safety

Safety

During Manufacturing

- Use of Manufacturing Process Plans
- Safety debriefings prior to each session
- Proper storage and use of equipment
- Anonymous forum to voice concerns

Launch Checklists

- Inventory
- Verifications of proper internal assembly, electronics configuration, and airframe assembly
- Aid in communication between systems prior to integration
- Useful in tracking progress

Timeline

Timeline

- **6 February** — Vehicle Design Manufacturing Ends
- **14 February** — All recovery tests complete
- **4 March** — Vehicle Demonstration Flight
- **6 March** — FRR
- **11 March** — Payload Testing Complete
- **15 March** — Flight Computer and Ground Station complete
- **18 March** — Payload Demonstration Flight
- **15 April** — Launch Day
- **1 May** — PLAR

Business

Business

Expected Costs	
Aerostructures	$ 2,300.53
Payload	$ 1,852.25
Propulsion	$ 1,201.35
General	$ 225.00
Total Rocket	$ 5,579.13
Rocket with 25% buffer	$ 6,973.92
Travel	$ 7,761.92
Travel with 25 % Buffer	$ 9,702.40
Total	$ 16,676.32

Funding Source	
FSGC / KXR	$ 3,000.00
SG FAO Bill	$ 3,000.00
SG CRT Bill	$ 3,000.00
Student Travel Fees	$ 5,100.00
Total	$ 14,100.00

Outreach

Outreach

STEM Engagement
STEM Day
STEM Seminar
Intro to Engineering

Social Media
Instagram: ucf_rocketry
Website: https://kxrucf.com/index.html
LinkedIn: https://www.linkedin.com/company/knightsexperimentalrocketry/

Workshops
Arduino
OpenRocket
OpenMotor
Python
Solidworks
Manafacturing

Q&A

knightsrocketry@gmail.com