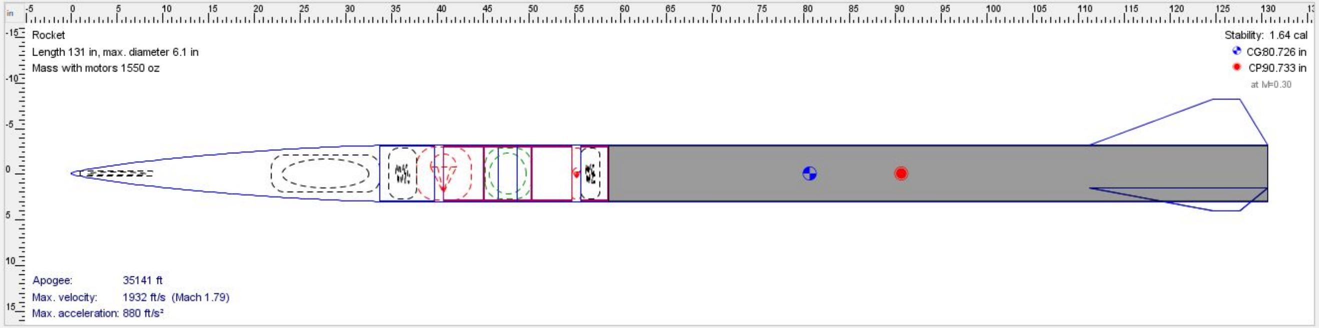
Asterion Preliminary Design Review

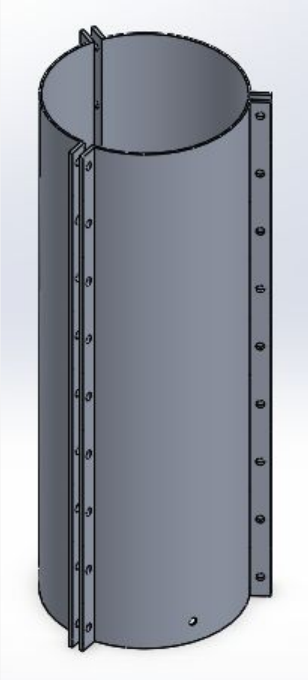
Vehicle Dimensions

- The overall length of the rocket is currently at 131 inches, or about 11 feet.
- The airframe diameters are currently 6.1 inches.
- We will use the Von Karman nose cone design, with a 5:1, length:diameter ratio.



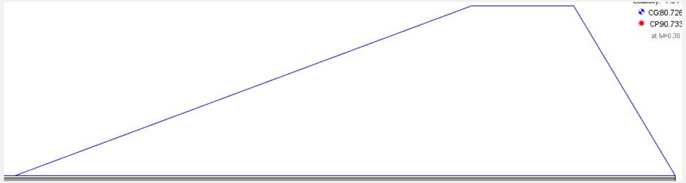
Materials

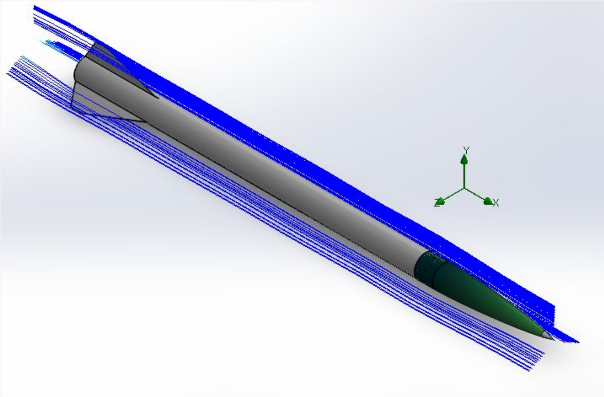
- Nose cone: Fiberglass
- Upper airframes: Fiberglass
- Bulkhead: Aluminum
- Fin Can: Aluminum or Steel
- Fins: Carbon Fiber



Stability

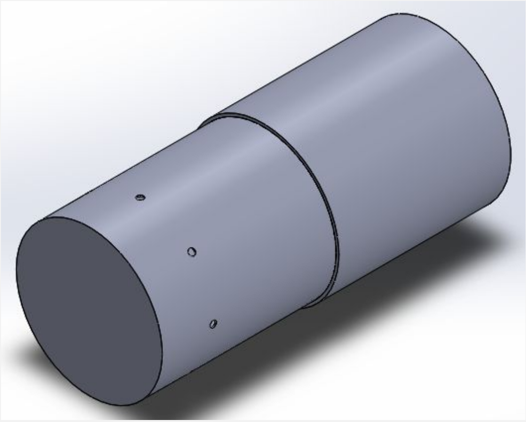
- We are aiming for a rocket caliber around 2. This should give us a very smooth and straight flight.
- The flutter velocity for a 0.25 inch fin thickness is 2112.6 ft/s, this is greater than our current maximum projected velocity of 1951 ft/s.





Aluminum Bulkhead

- With the thrust of the motor around 3,000 pounds, we need a sturdy piece in the rocket that will stop the motor from moving upwards in the rocket. This will be done with an aluminum bulkhead that will be inserted into the lower airframe.

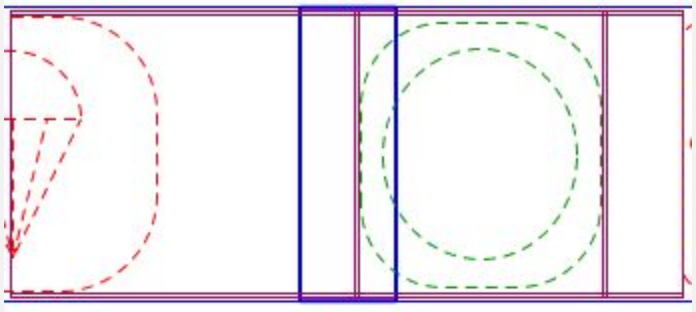


ABS

In order to be more precise with hitting a target altitude we will use an adjustable ballast system, where weights will be stored in the nose cone. SOAR has successfully used this method in the past, and it is something that will be helpful in our pursuit of hitting 30,000 feet in altitude.

Main Coupler

The main coupler will house the avionics bay (green area in image below). There will be an aluminum bulkhead at the upper end of the avionics bay for recovery purposes. We will also attempt to utilize as much free space as possible around the avionics bay for parachutes.



Motor Details

O6300 Contrail Hybrid Motor

2850 lbs peak thrust

1428 lbs average thrust

Roughly 4.3 seconds burn time

Solid PVC grain and Liquid/Gaseous Nitrous Oxide as oxidizer

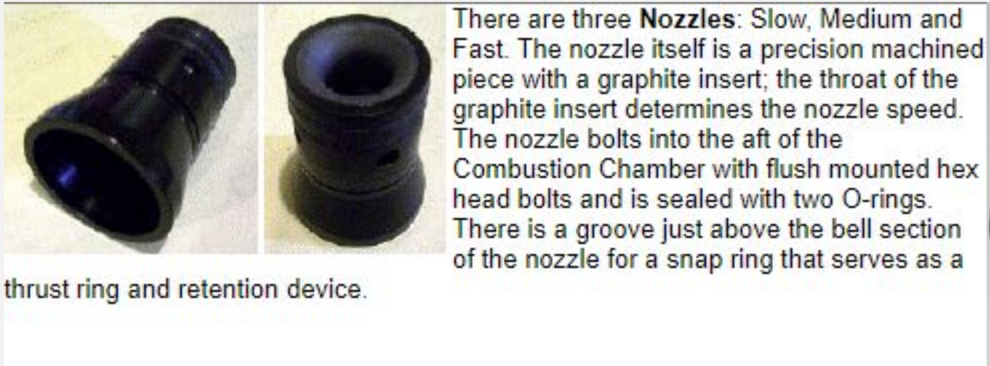
63lbs loaded 11lbs of nitrous in tank

6 feet long by 6 inches diameter

Total Impulse 28197 Ns

Motor Retention

Current design involves an aluminum bulkhead to stop forward progression. Some form of coupling will be engineered once the motor physically arrives and accurate measurements can be taken.
Lower end retention may be done by screw ring with snap ring combo.


There are three **Nozzles**: Slow, Medium and Fast. The nozzle itself is a precision machined piece with a graphite insert; the throat of the graphite insert determines the nozzle speed. The nozzle bolts into the aft of the Combustion Chamber with flush mounted hex head bolts and is sealed with two O-rings. There is a groove just above the bell section of the nozzle for a snap ring that serves as a thrust ring and retention device.

Motor Filling Procedures

1 All non-essential personnel leave the area
2 Fill hoses and ignitor wires are connected to GSE
3 Altimeters are ARMED and payload is turned ON (Avi lead retreats small distance (50 feet)
4 Ground Support Equipment is turned ON
5 Leak test is performed via quick fill of tank
6 GSE is ARMED and ALL personnel leave the area
7 Fill command is given from safe distance
8 Safety monitor (IREC's Launch master) is informed of ready to launch state upon motor reaching full tanks. (1st propulsions mate will confirm with binoculars)
9 Countdown is given while tanks are continuously topped off.
10 Ignition command is given and fill command stops as soon as the motor produces thrust.

Essential Personnel for LAUNCH

Avionics Lead: Arming Altimeters and Payload

Propulsion Lead: Controlling GSE and connecting motor. Filling motor and issuing launch commands. (Fill / Vent / Safety Lockout Keys / Ignition)

Safety Supervisor: Ensures all systems are connected in order and correctly operating. Ensures Avionics Lead and Propulsions Lead do not accidentally trip over wires. Completes Launch checklist. Ensures NO other personnel are present before launch arming procedure begins.

Avionics

- Asterion will feature one Avionics bay which will consist of all the COTS flight computer systems on-board
- The Avionics Bay will mainly comprise of two altimeters and their corresponding GPS telemetry systems
- The Altus Metrum TeleMega will serve as the primary altimeter, while MissileWorks RRC3 Sport altimeter will be used for redundancy
- The Avionics bay is currently 5.5 inches in diameter and 5 inches in length and simulated weight is about 4.5 lbs

Altimeters

Altus Metrum "TeleMega"

- Barometric Sensor ranges till 100k feet MSL
- Optimized to work with primary LiPo batteries upto 12V
- Consists of on-board non-volatile memory for flight data storage along with a GPS receiver

MissileWorks "RRC3" Sport

- Barometric Sensor ranges till 40k feet MSL
- Optimized to work with 9V battery power
- Connects to a RTx/GPS System for its real-time tracking and telemetry capabilities

Parachute Deployment

- At the Apogee, Telemega will fire the e-matches to deploy the drogue parachute
- In case of a failure to deploy the drogue using the primary altimeter, the secondary altimeter RRC3 will fire the e-matches after a delay of 2 seconds
- Both the altimeters will fire the e-matches for the main parachute at a height of 1000 ft AGL

GPS / Telemetry Systems

MissileWorks RTx/GPS Systems

- GPS ranges till 160k feet (50k meters)
- Optimized to work with 10V battery power
- Radio operational ranges: 902 to 928 MHz

Altus Metrum TeleMega

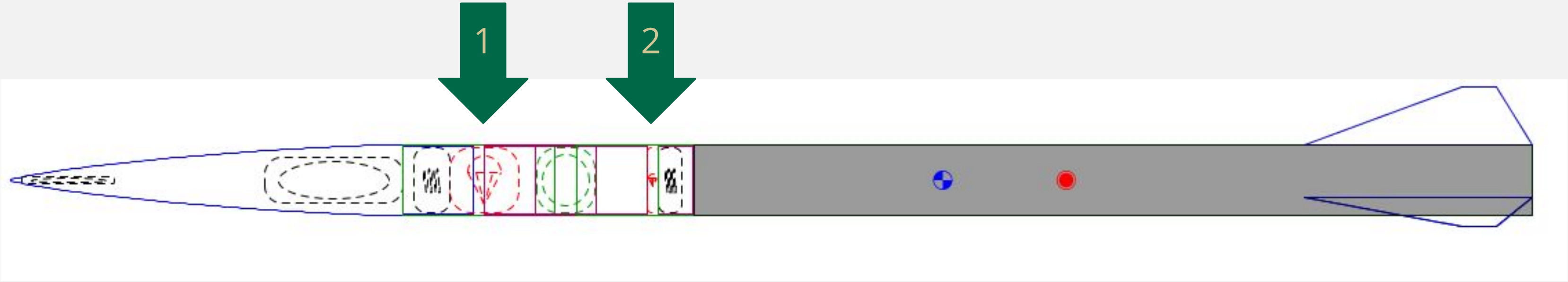
- GPS ranges till 65k feet with a 3-element Yagi antenna
- Optimized to work with primary LiPo batteries upto 12V

Recovery

Parachute Name	Rocketman Standard 48 inch	Rocket Man High Performance CD 2.2 144 inch
Purpose	Drogue	Main
Deployed At	Apogee	1,000 feet AGL
Material	Low Porosity 1.1 Mil-Spec Ripstop Nylon	Low Porosity 1.1 Mil-Spec Ripstop Nylon
Diameter (in)	48 inch	144 in
Drag Coefficient	0.97	2.2
Number of Shroud Lines	4	14 Panel, 28 Total Lines
Line Material	Nylon	250 lb Flat Nylon
Bridal	Swivel	3,000 lb Swivel
Maximum Velocity (ft/s)	-155.55 ft/s	-18.75 ft/s
Event Velocity (ft/s)	-85.5 ft/s @ Main Deployment	-18.1 ft/s @ Ground Hit

Recovery Subsystem Location

1. Rocketman High Performance CD 2.2 144 inch- Main Parachute
    - Attached to Nose Cone Shoulder Bulkhead via Galvanized Steel U-Bolt ½”-13 Thread Size, 3” ID
    - Attached to Avionics Bay with a Galvanized Steel U-Bolt ½”-13 Thread Size, 3” ID
    - Y-Harness using 30’ Rocketman 2520 lb Braided Kevlar Y-Harness
    - Quick Links to be used will be WestMarine Galvanized Steel Quick Link 5/16” Wire Diameter, 2-15/16”L, 3450 lb Yield
2. Rocketman Standard 48 inch - Drogue Parachute
    - Attached to Avionics Bay with a Galvanized Steel U-Bolt ½”-13 Thread Size, 3” ID
    - Attached to Motor Bulkhead with a Galvanized Steel U-Bolt ½”-13 Thread Size, 3” ID
    - Y-Harness using 30’ Rocketman 2520 lb Braided Kevlar Y-Harness
    - Quick Links to be used will be WestMarine Galvanized Steel Quick Link 5/16” Wire Diameter, 2-15/16”L, 3450 lb Yield

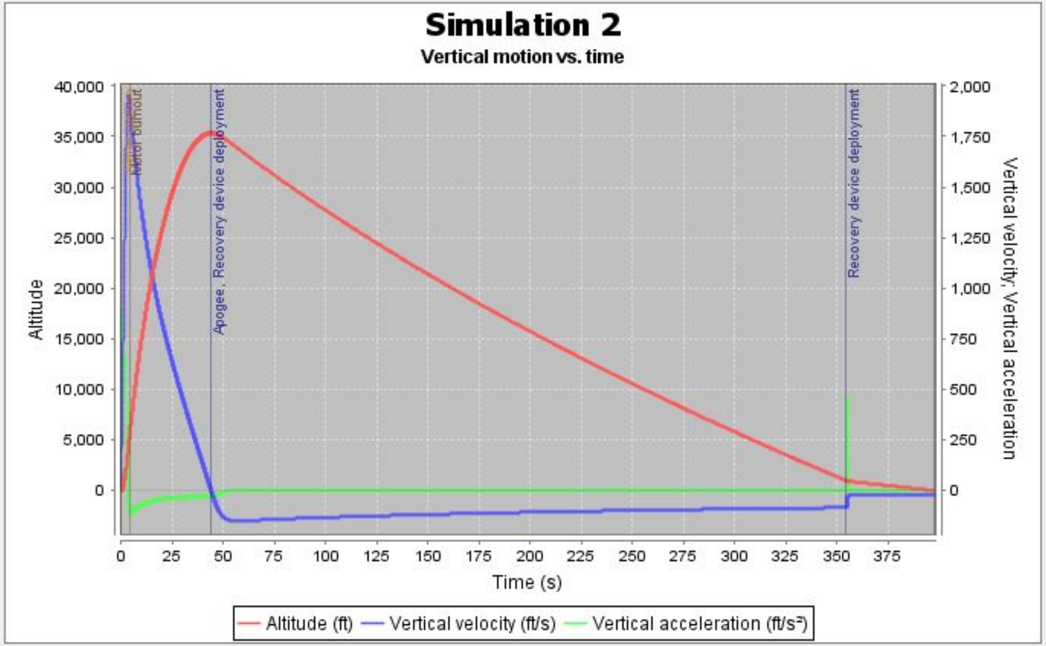


Deployment

- Ematches Ignite 1 Gram of Black Powder in respective PVC Wells
- Parachute Bay Pressurizes
- 3x 4-40 Nylon Shear Pins shear causing Rocket to decouple
- Parachute is deployed.
- Process is the same for both Main and Drogue

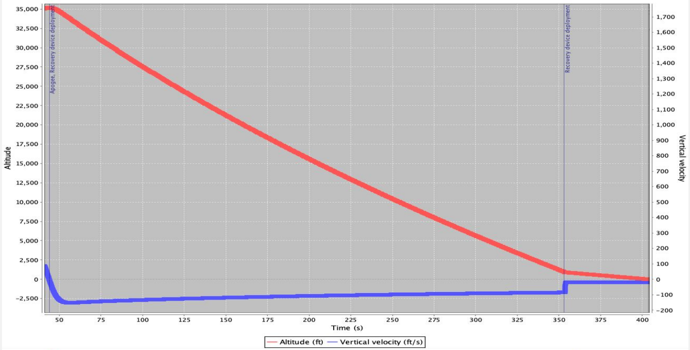
Flight Predictions

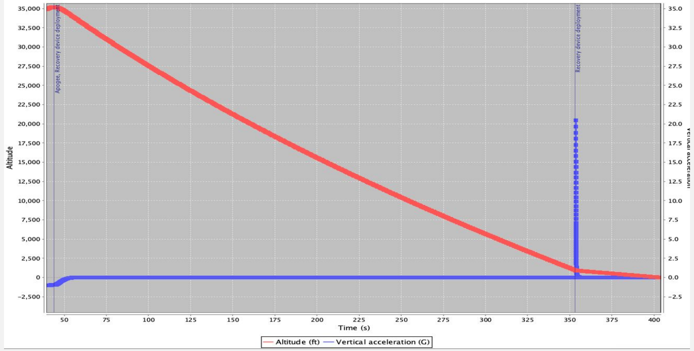
	Major Numbers
Predicted Apogee (ft)	35,317 ft
Maximum Velocity (ft/s)	1,951 ft/s
Maximum Acceleration (ft/s^2)	891 ft/s^2
Total Flight Time (s)	397 s



Recovery Predictions

	Drogue	Main
Descent Velocity (ft/s)	-155.55 ft/s decelerating to -85.5 ft/s at Main Deploy	-18.1 ft/s, very little variance during descent
Descent Time (s)	360 Seconds after Deployment Charge to Ground Hit	51 Seconds after Deployment Charge
Kinetic Energy at Landing	N/A	489.3 ft-lbf





Drift Predictions

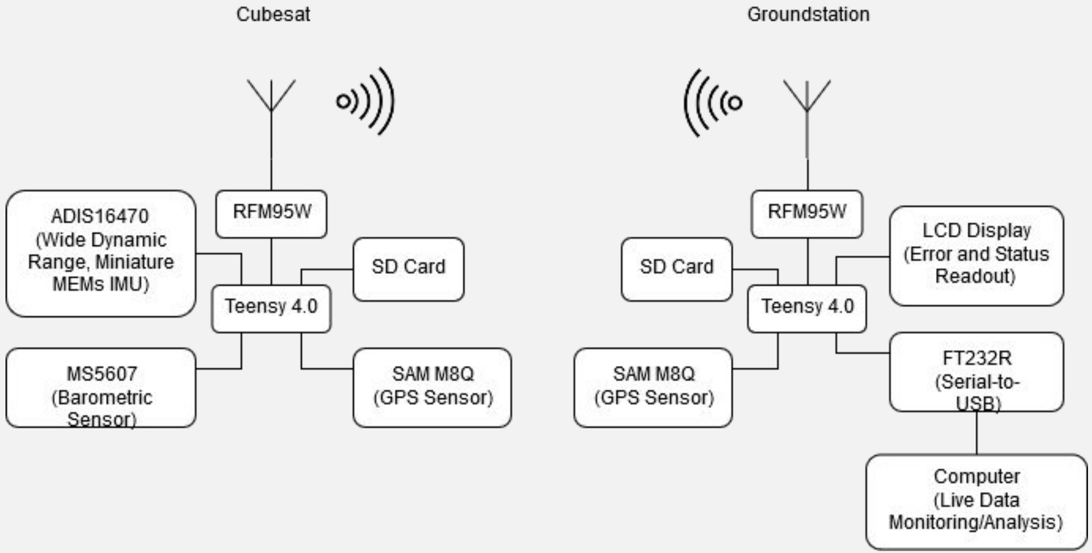
Wind Speed (mph)	Drift (feet/miles)
0	125/0.02
10	1154/0.22
20	2780/0.53
30	11887/2.25
40	16567/3.13
50	22329/4.22
60	27821/5.27

Method

Used OpenRocket Parachute Simulations, and assumed average wind speeds over the entire altitude range based on measurements from the Aviation Weather Center.

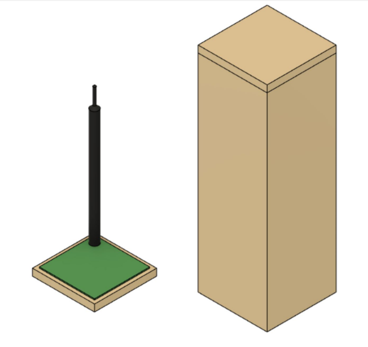
Payload Intro

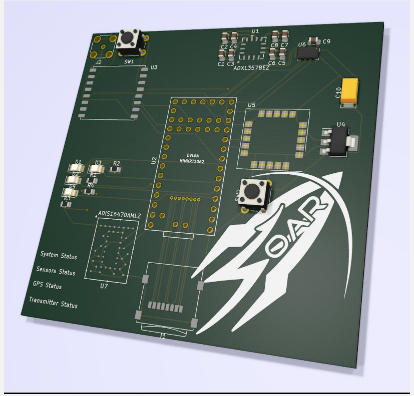
The Payload will consist of two systems, the Cubesat and the Ground Station.



Cubesat Payload

The Cubesat payload will rely on several high end sensors to accurately determine the position of the rocket and relay that information back to the ground station in real-time. There is also a redundant microSD storage to ensure data is protected and able to be retrieved in case of failure of wireless communications. The payload casing has a base of 10cm x 10cm with a height of 30cm and will be made out of fiberglass.





Ground Station

The ground stations will track the rocket from launch to apogee and then to decent using the information relayed by the rocket. This will allow for real time data collection via a yagi antenna at ranges and conditions far beyond the requirements for Asterion.