Tacho Lycos PDR Presentation

November 15, 2018

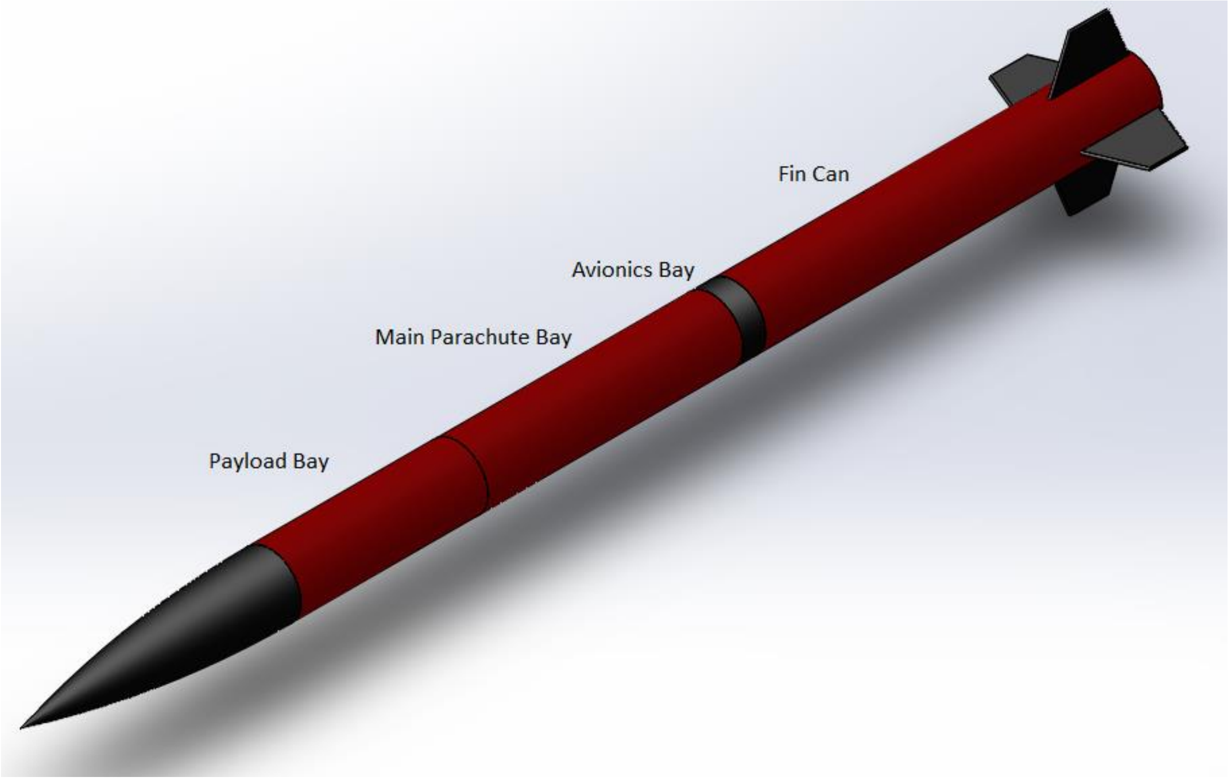
Overview

- Vehicle Leading Design
- Propulsion
- Structures
- Recovery and Avionics
- Payload
- Requirements Verification

Vehicle Leading Design

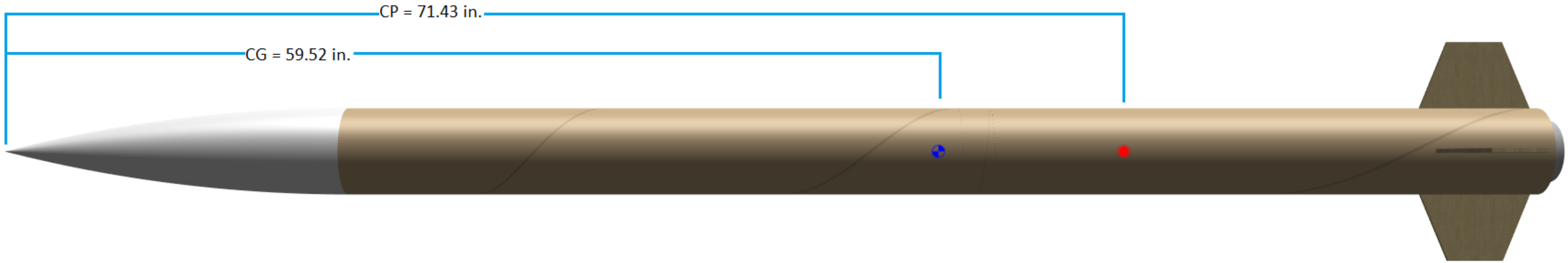
Dimensions

- Length: 99 in
- Diameter: 5.5 in
- Launch weight: 43.4 lb
- Empty weight: 38.8 lb



Aerodynamics

- CP:71.43 inches from nose
- CG:59.52 inches from nose
- Stability Margin: 2.16 caliber



Propulsion

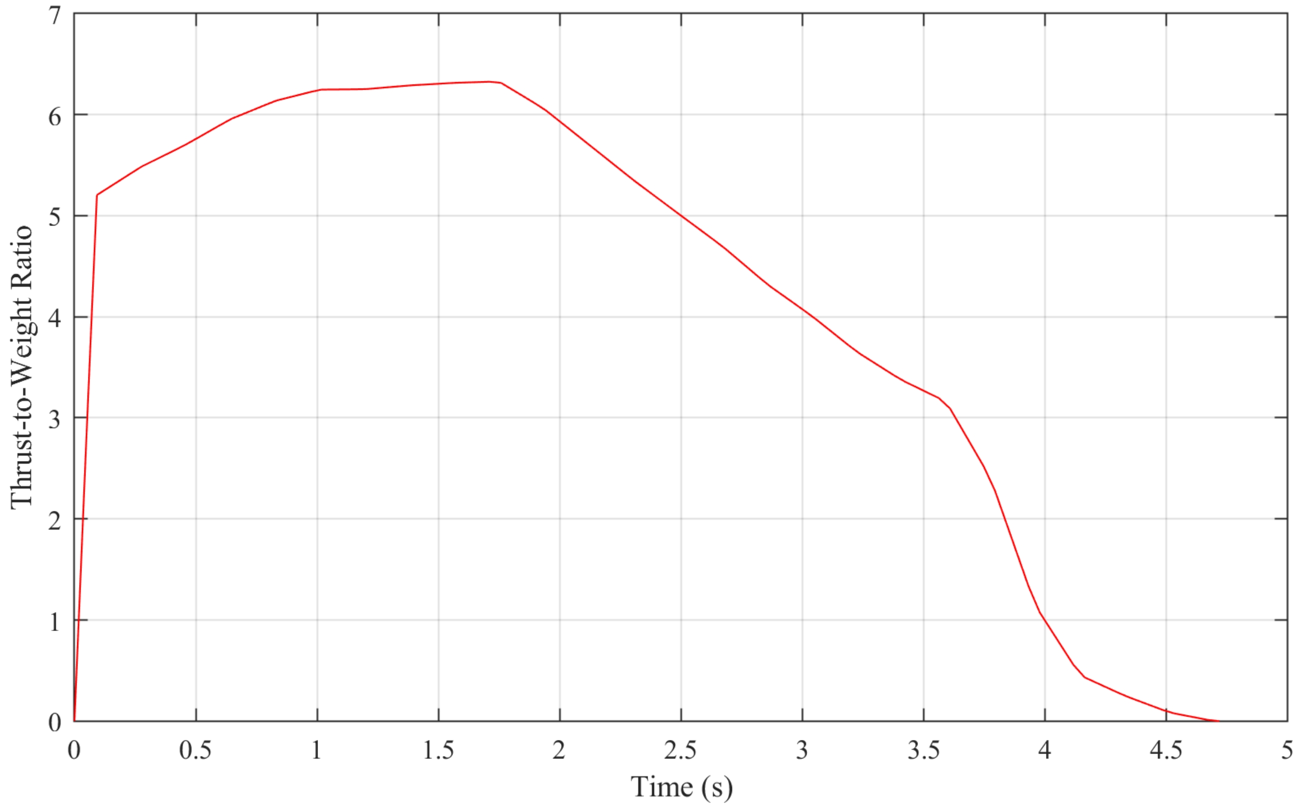
Motor Selection

- Leading Selction:
  - Aerotech L850W
- Alternatives
  - Aerotech 1390G
  - Aerotech 1520T
- All require RMS 75/3840 Motor Casing

Motor	Lowest Apogee (ft.)	Highest Apogee (ft.)
L850W	3788	4209
L1150R	3591	3902
L1390G	4282	4792
L1520T	4586	4812

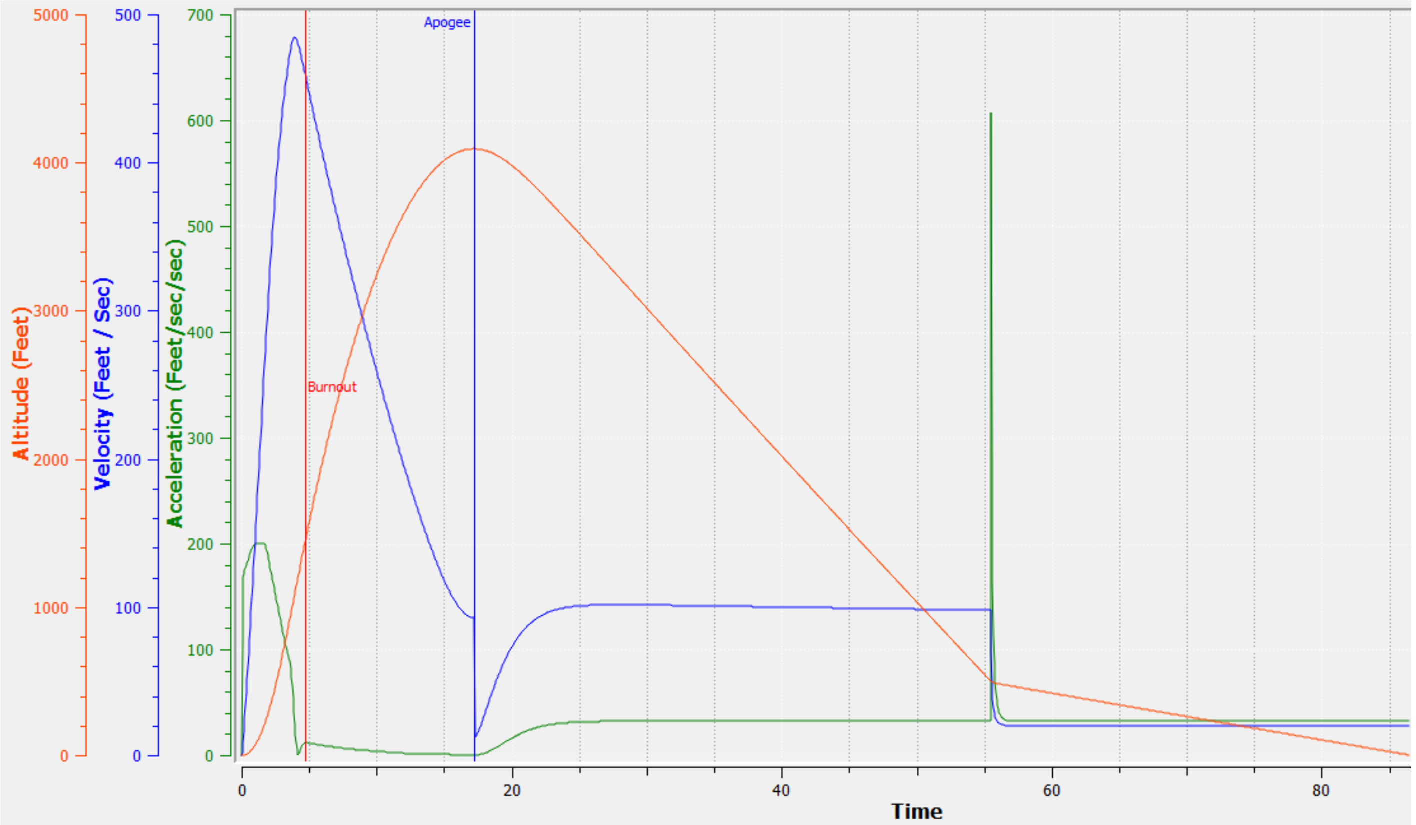
Flight Simulation Results

- Rail Exit Velocity
  - 59.2 fps
- Thrust to Weight Ratio
  - 5.26 at rail exit



Mission Performance Predictions

- Apogee: 4090 ft
- Max Velocity: 484 f/s
- Max Acceleration: 200 ft/s^2



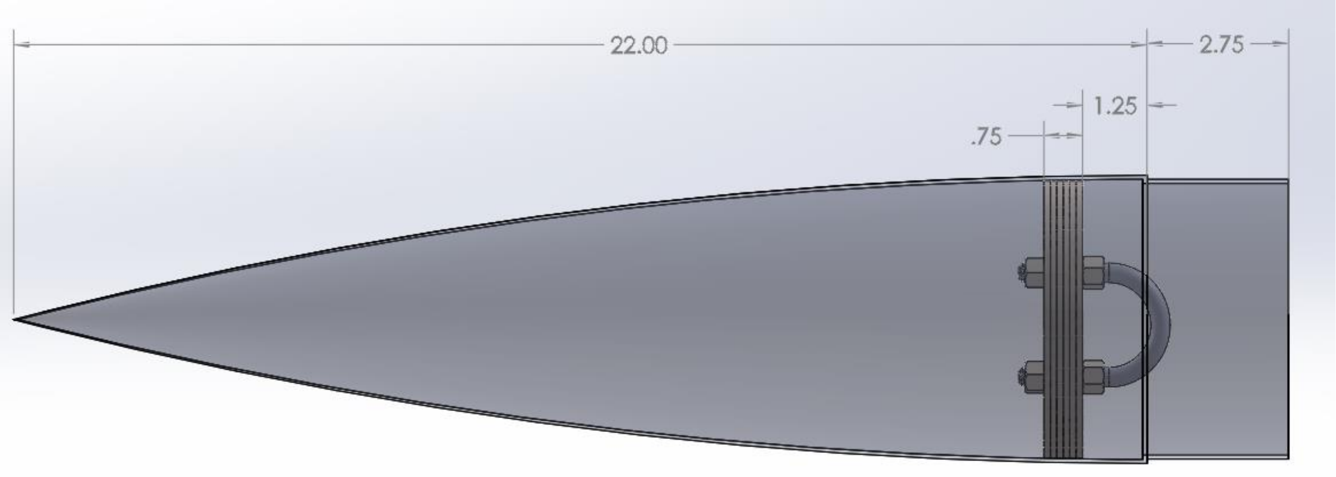
Structures

Body Tube Material

- Fiberglass
  - Strongest commercially available material
  - Immune to moisture: does not require sealing
  - Already smooth surface: does not require wood filler
  - Reduced fabrication time and room for error
  - Will make launch vehicle as durable as possible – more reusable and therefore worth extra weight and cost

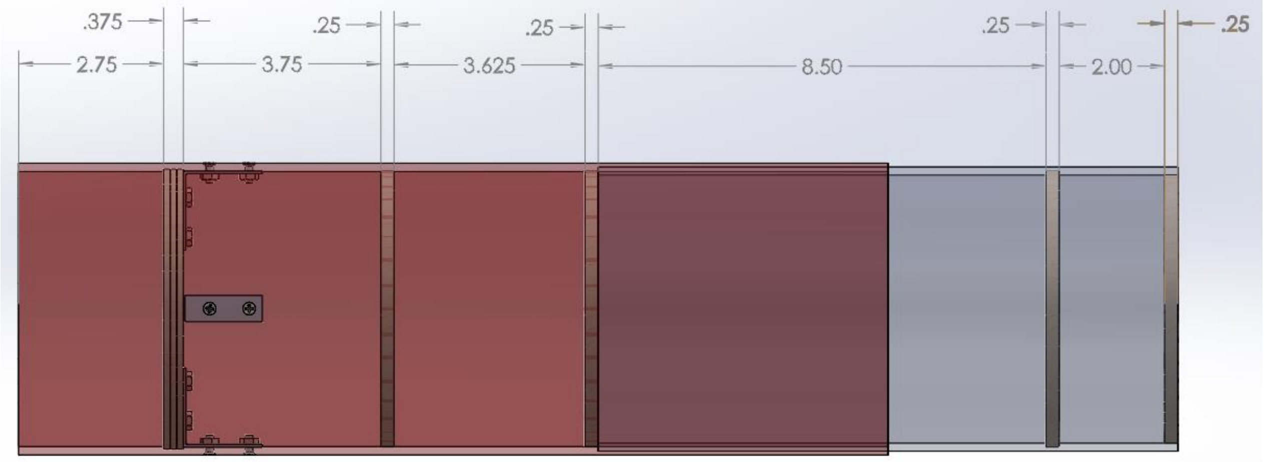
Nose Cone

- Permanent bulkhead
  - Recessed 4.75 inches from end of shoulder
  - Has U-bolt which secures shock cord attached to main parachute
  - More difficult to manufacture properly but is worth the added payload space
- 4:1 Ogive Shape
  - Heavier than 5:1 Conical
  - Requires no nose ballast



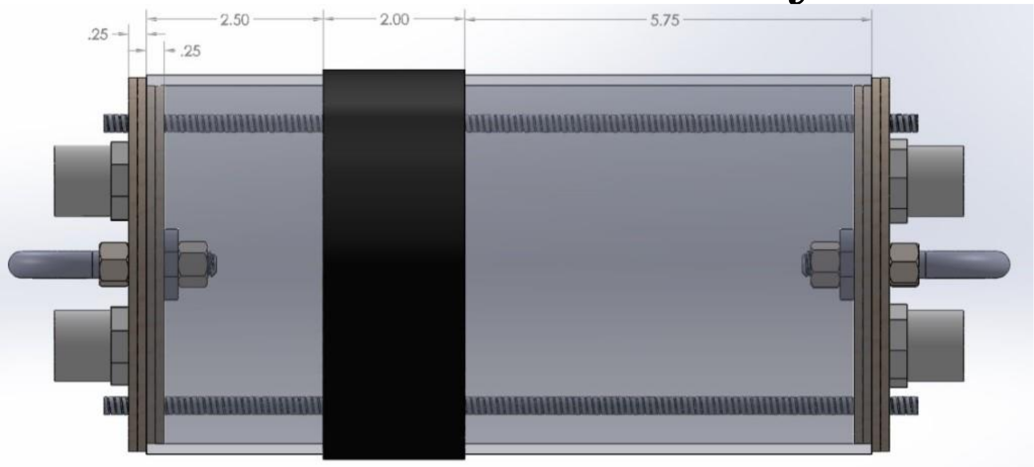
Payload Bay

- Removeable bulkhead at forward end mounted on L-brackets
- 4 centering rings spread throughout to support payload deployment, including one at end of coupler
- Shock cord will be routed through all centering rings and removeable bulkhead from main parachute to nose cone
- Easier to manufacture
- Better payload access
- No disruptions on outside of airframe



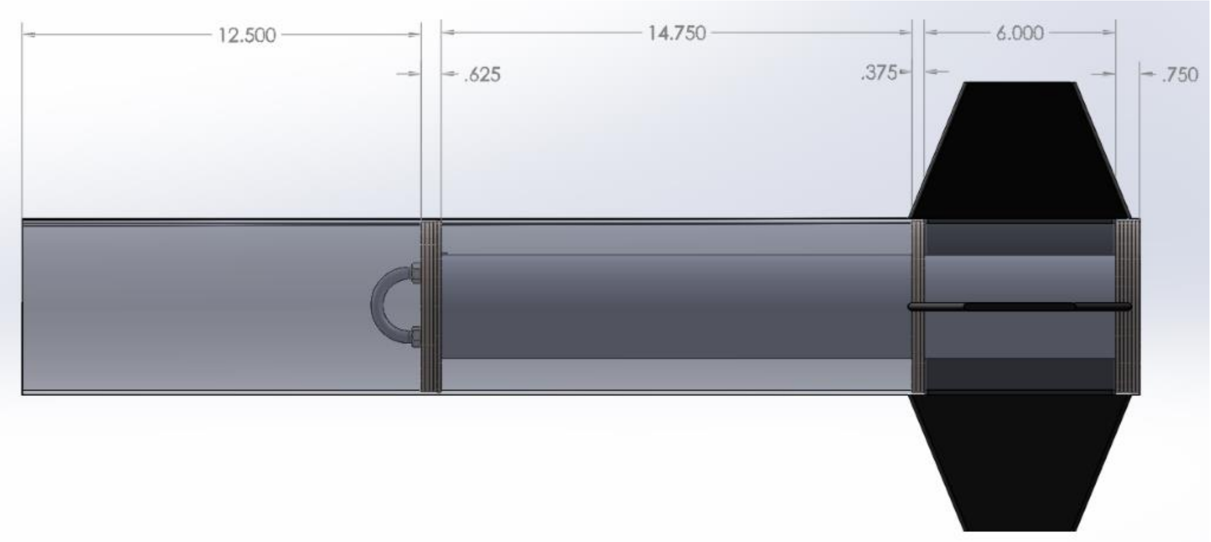
AV Bay

- 10.25 in of coupler with 2 in body tube band
- Bulkheads have two layers of body tube ID, two layers of coupler ID
- Two ¼ in threaded rods secure bulkheads and AV sled
- AV bay can be prepared in parallel with other launch day preparations
- Easy access to blast caps and U-bolts
- No disruptions in airflow over airframe



Fin Can

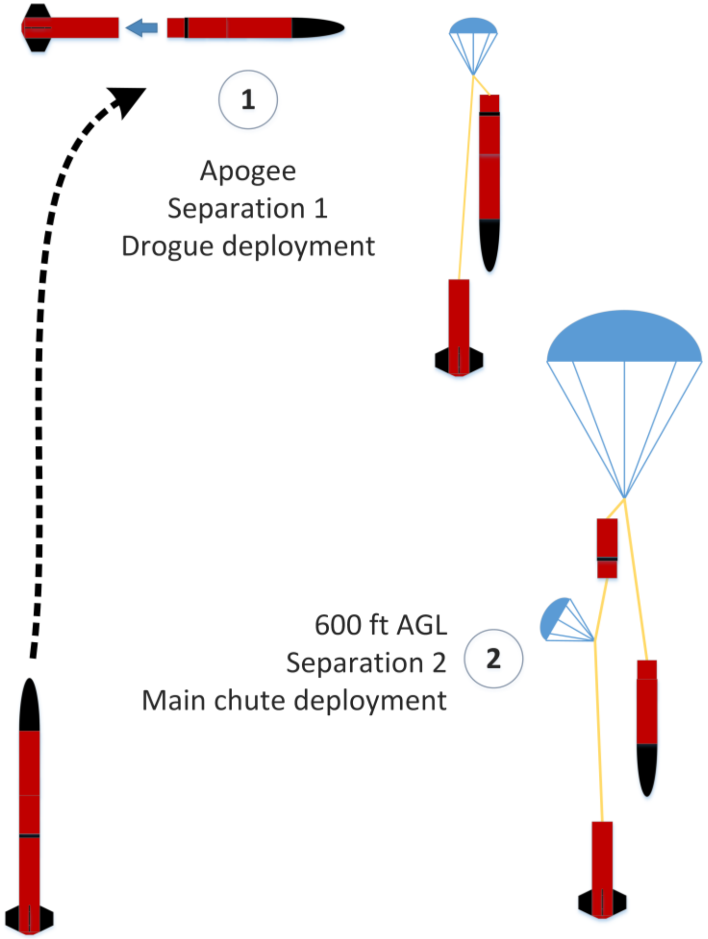
- Has 12.5 in section to house drogue parachute
- Motor tube secured by engine mount at aft end of fin can, centering ring located forward of fin tabs, and bulkhead at forward end of motor tube
- Shock cord secured to U-bolt in forward bulkhead
- No single point of failure by using U-bolt
- Shock cord is interchangeable



Recovery and Avionics

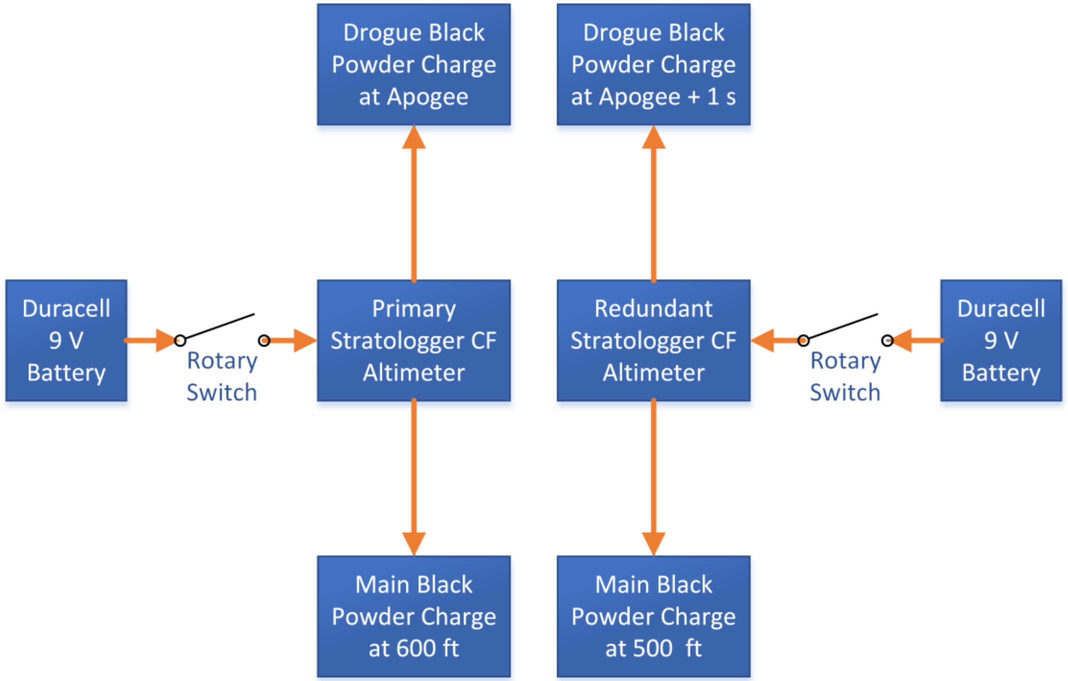
Recovery Overview

- Drogue deployed at apogee
  - Redundant charge at apogee + 1 second
- Main parachute deployed at 600 ft AGL
  - Redundant charge at 550 ft AGL



Avionics

- Dual-redundant recovery avionics system
- Primary and redundant PerfectFlite StratoLoggerCF altimeters
- Primary altimeter deploys drogue at apogee and main at 600 ft AGL
- Redundant altimeter deploys drogue at apogee + 1 second and main at 550 ft AGL



Leading Alternative Parachutes

- **Drogue:** 24 inch Fruity Chutes Classic Elliptical
  - Diameter: 24 inches
  - Drag coefficient: 1.46
  - Descent velocity: 86 ft/s
- **Main Parachute:** 120 inch Fruity Chutes Iris UltraCompact
  - Diameter: 120 inches
  - Drag coefficient: 2.12
  - Descent velocity: 14 ft/s

Wind Effect on Apogee, Descent Time, and Drift

Wind Speed	Apogee	Descent Time	Drift Distance
0 mph	4259 ft AGL	85 s	0 ft
5 mph	4245 ft AGL	85 s	624 ft
10 mph	4199 ft AGL	85 s	1240 ft
15 mph	4119 ft AGL	84 s	1839 ft
20 mph	4006 ft AGL	82 s	2414 ft

- The leading alternative recovery system for the leading alternative launch vehicle:
  - Meets 90 second descent time limit
  - Meets 2500 ft drift limit

Kinetic Energy at Landing

- All sections meet 75 ft-lbs KE limit with leading alternative main parachute

Section	Mass	Kinetic Energy
Nosecone	0.4594 slugs	45.4 ft-lbs
Midsection	0.3046 slugs	30.1 ft-lbs
Fin Can	0.4432 slugs	43.8 ft-lbs

Payload

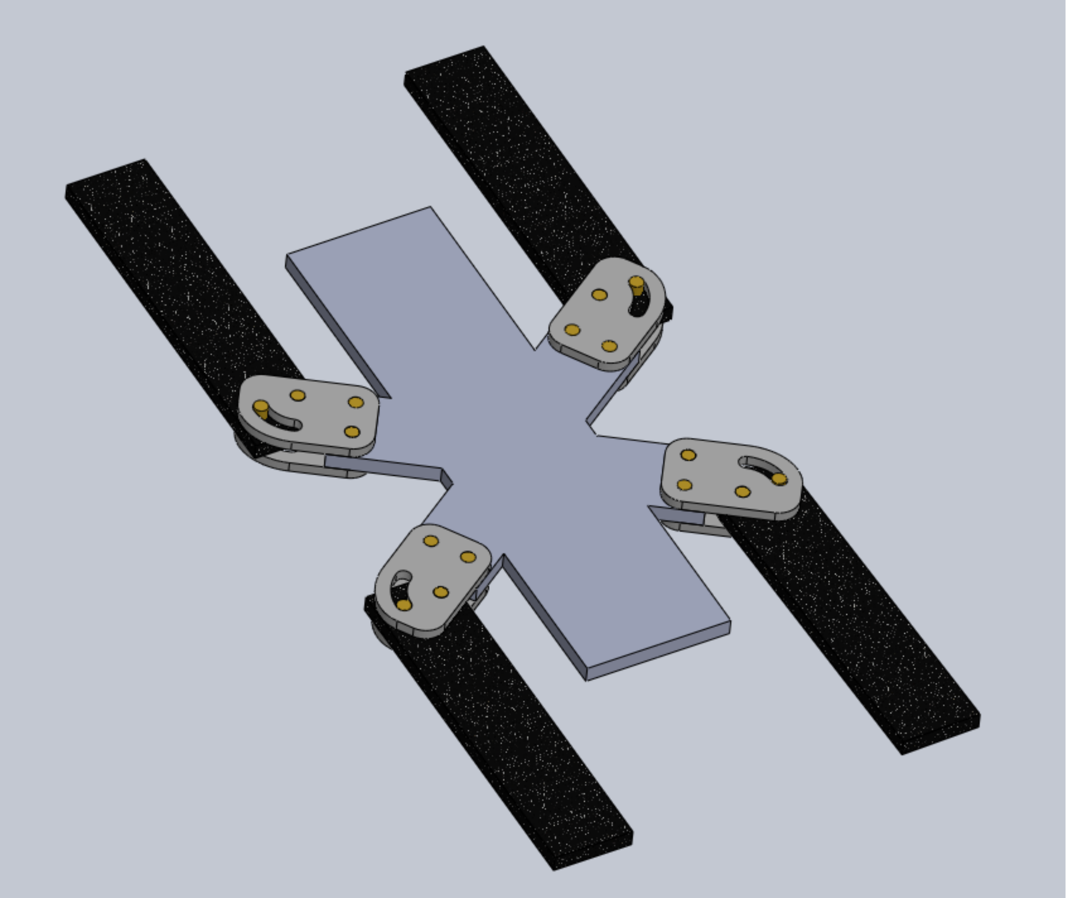
"The Eagle and the Egg"

Payload Leading Design

- Payload UAV will use a QAVR-220 carbon fiber quadcopter frame.
- To fit the UAV into the proposed 5.5 inch rocket body, a set of hinges will be added to the arms, allowing them to fold.
  - Proposed hinge design allows arms to decrease UAV width from about 8¼" to nearly 4".
  - This allows space for the payload deployment system to be more flexible in design process.

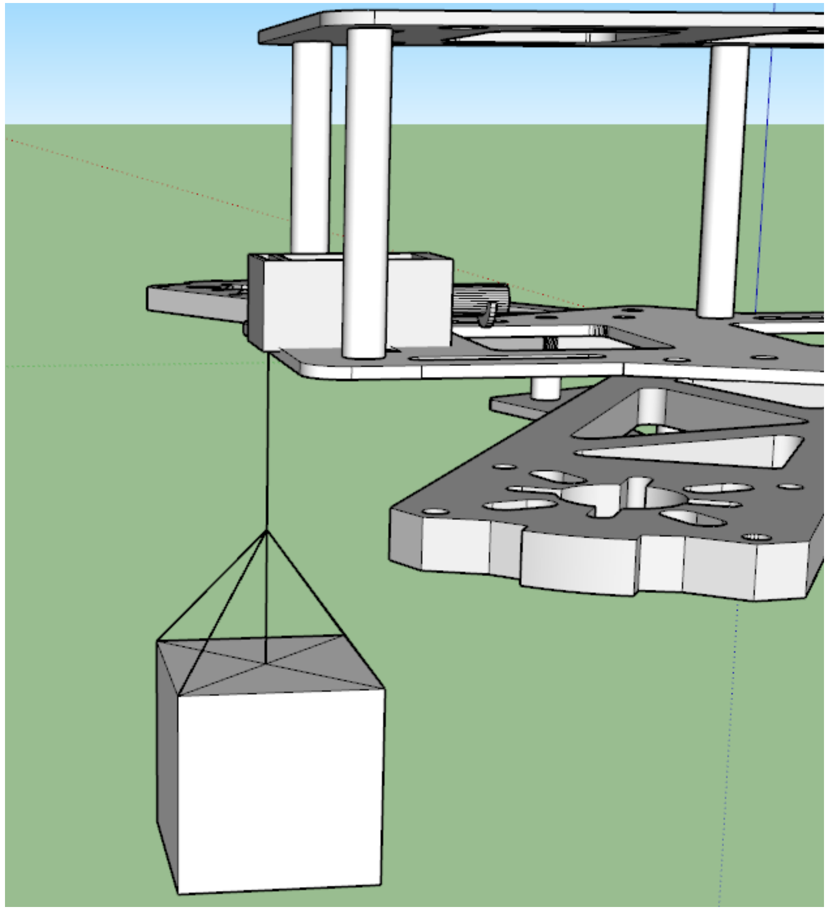
Leading Hinge Design

- Leading hinge mechanism can be 3D-printed for rapid prototyping and construction.
- Two hinges will sandwich each quadcopter arm, creating a pivot joint close to the body.
- Arms will fold parallel to UAV center section.
- Two-blade propellers will be used as they can sit parallel to rocket body as well.



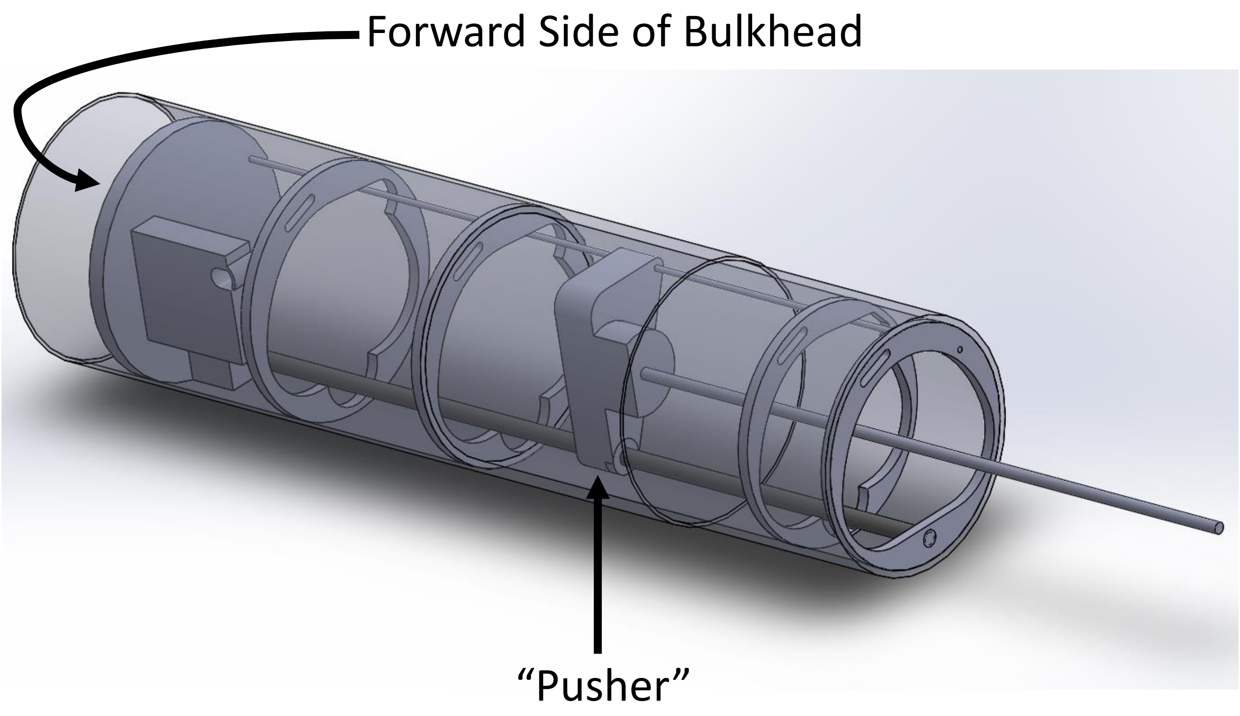
Leading Beacon Delivery System

- The Navigational Beacon will be suspended from a 5V solenoid actuator.
- The actuator will be constantly powered to ensure the security of the beacon
- When activated, the solenoid will push its arm forward, activating the deployment system.



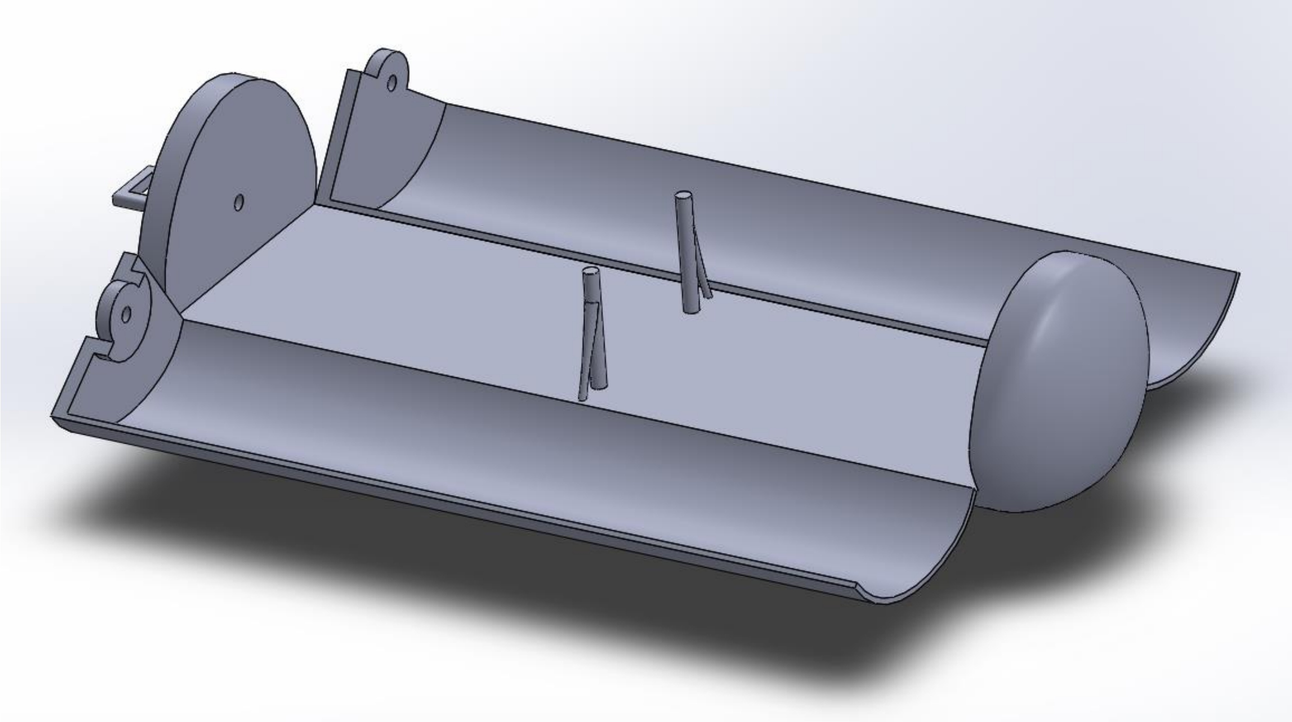
Payload Integration

- Components
  - Removable Bulkhead
    - Electronic Latch
    - Stepper Motor
    - Arduino Uno (forward)
    - Battery (forward)
  - 4 Centering Rings
  - Threaded, Secondary, and cantilevered rods
  - "Pusher"



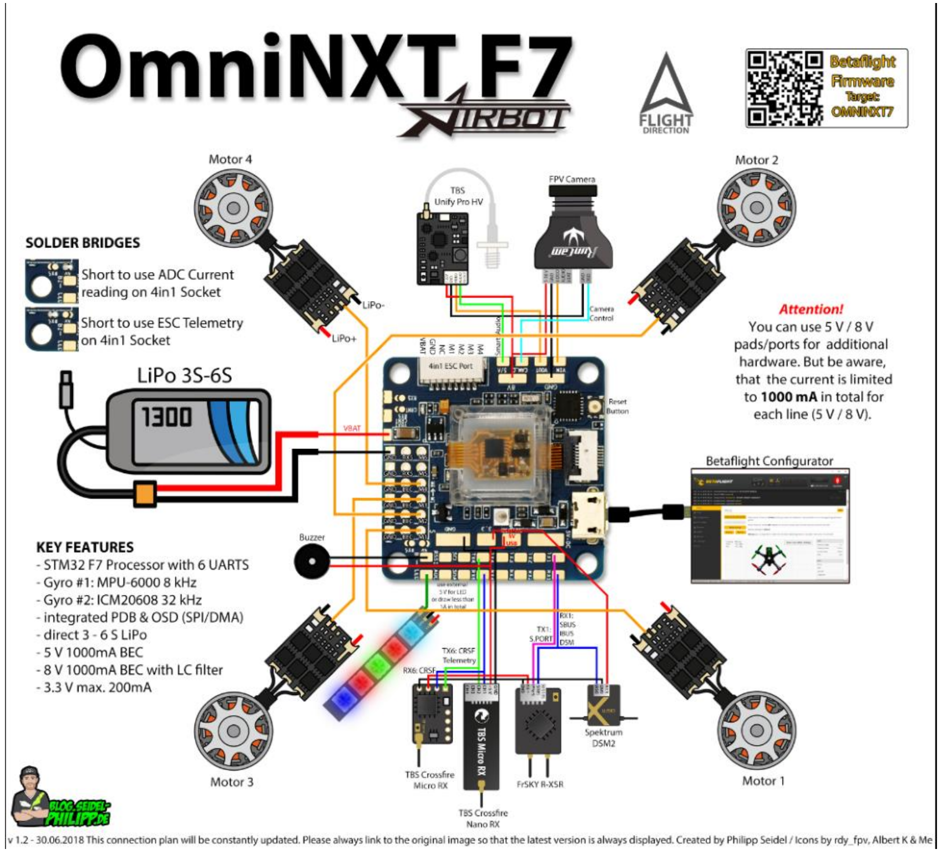
Payload Integration - Pod

- The pod will house the UAV, protect it during flight, and assist it in deployment.
- The Pod will be entirely supported by the cantilevered beam when self-righting.
- The levers inside the pod fit between the arms and rotors of the UAV, and push the flaps open when the pod has dropped to the ground.



Payload Control

- As few electronic components as possible will be used
- UAV will be in a low-power state while in the rocket and engaged once deployed
- UAV will carry a camera for guidance to the FEA



Requirements Verification

Team Derived Requirements

- The launch vehicle shall utilize a motor compatible with a motor casing already in the team's possession
  - Allows more budgetary freedom
  - The team will use a motor compatible with the Aerotech 75/3840
- The launch vehicle shall not exceed a velocity of Mach 0.7
  - Speeds above Mach 0.7 increase risk of fin flutter and therefore fin cracking
  - RockSim will be used to model the flight profile and verify that velocity does not exceed Mach 0.7

Requirements Compliance Plan

- Electronic systems will be tested to verify functionality for a minimum of two hours
- Recovery electronics will be tested near the payload electronics to confirm that recovery electronics are adequately shielded
- The UAV flight control will be tested to verify it is incapable of transmitting commands while in an unarmed state
- On board transmitters will be tested to verify they do not exceed 250 mW of power

Requirements Compliance Plan

- Ground ejection tests will be performed prior to launch for both main and drogue deployment
- A qualification launch will be performed to ensure all systems perform as designed
- A payload retention test will be performed to verify that it will be retained throughout all flight regimes
- The team has access to both a subsonic wind tunnel and vacuum chamber in order to test the function of altimeters
- A tensile test machine will be performed to verify nose cone bulkhead strength

Questions?