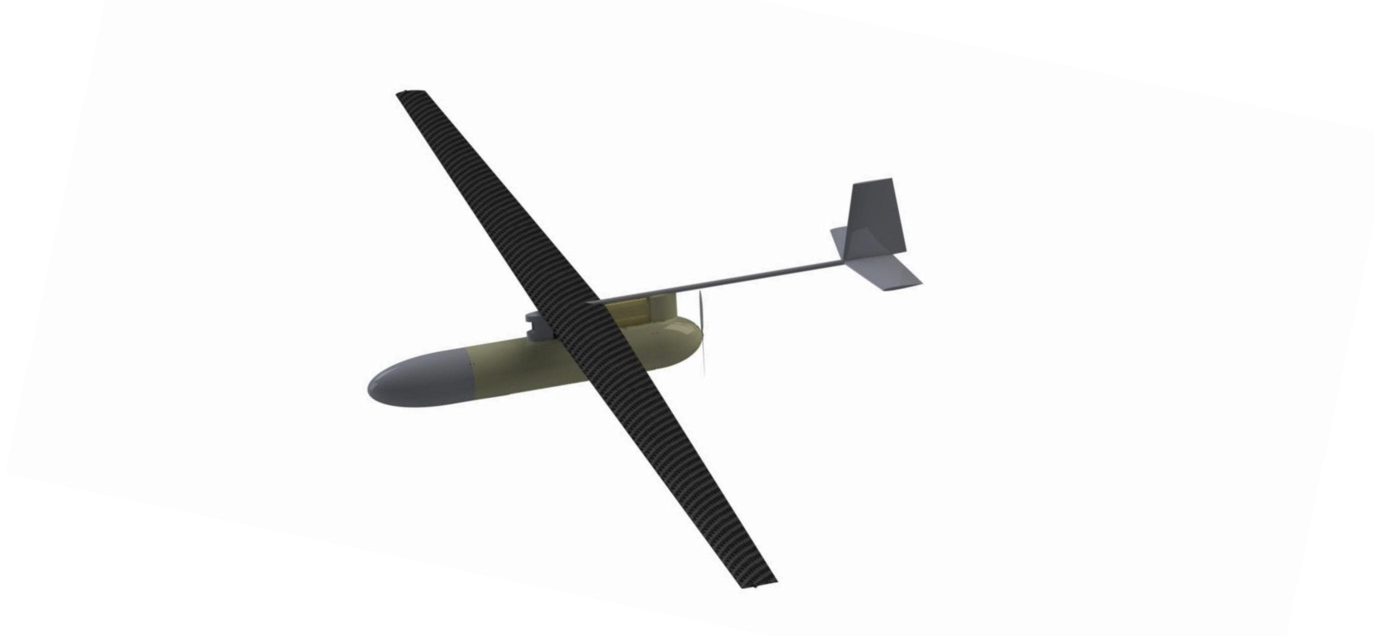


Preliminary Design Review

Jungle Hawk Owl

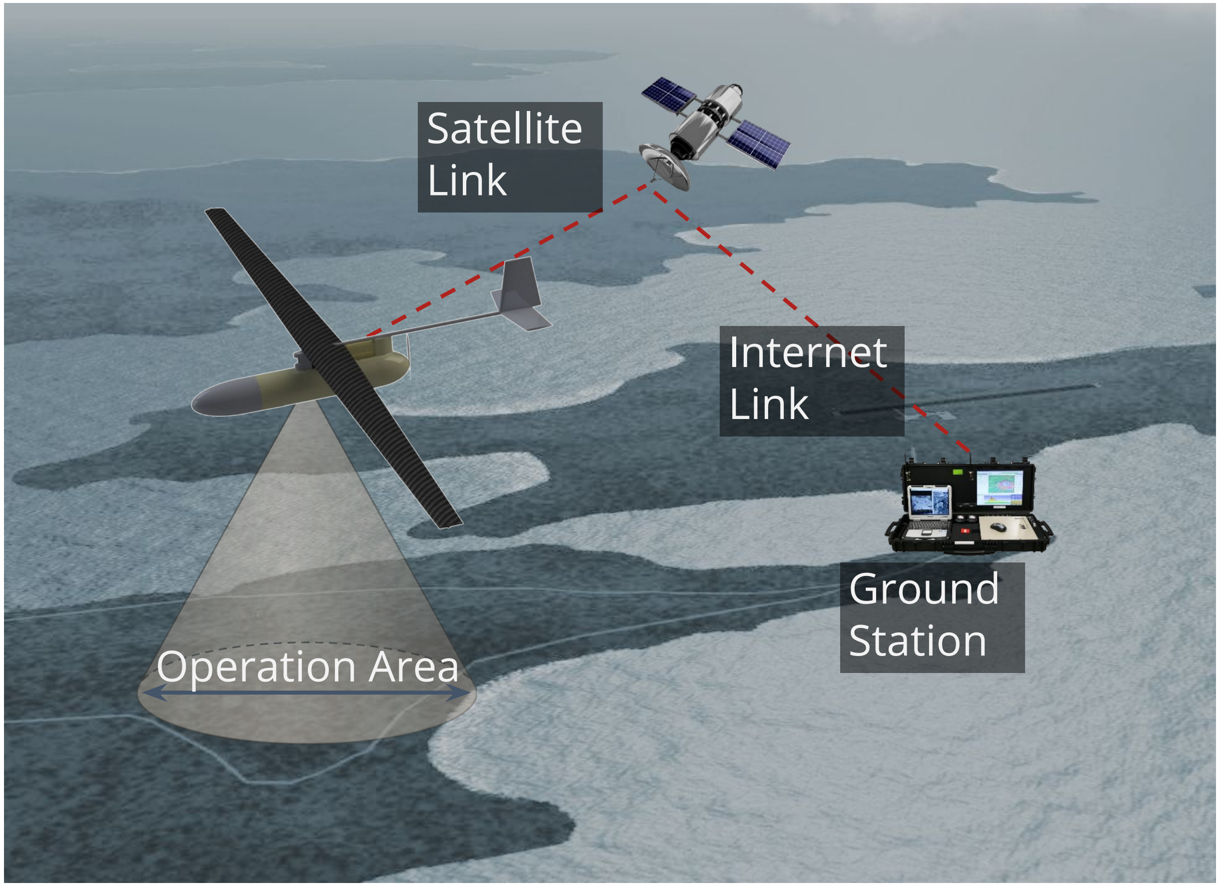
Gas MALE

16.82

11/09/2016

Mission Objective

Design and build a low-cost, medium-altitude, long-endurance aircraft to provide communication capabilities for disaster areas with lack of infrastructure



Requirements

(green)	Driving Design Requirements
(blue)	Achievable Requirements

Specifications	Threshold	Objective
Payload	S: 1 ft^3 W: 10 lbs P: 100 W average	Accommodate higher mass and volume payloads without increasing vehicle size
Payload Modularity	Modular removable payload	
Endurance	5 days on station	
Range to Station	100 nmi	600 nmi
Station Keeping	24/7 coverage of fixed 100 km diameter footprint with 5° ground terminal elevation level	
Launch and Recovery	Standard airfield	Aircraft Carrier
Latitude	+/- 60°	
Availability	94%	99%

Design Overview and Performance

Aerodynamics

Structures

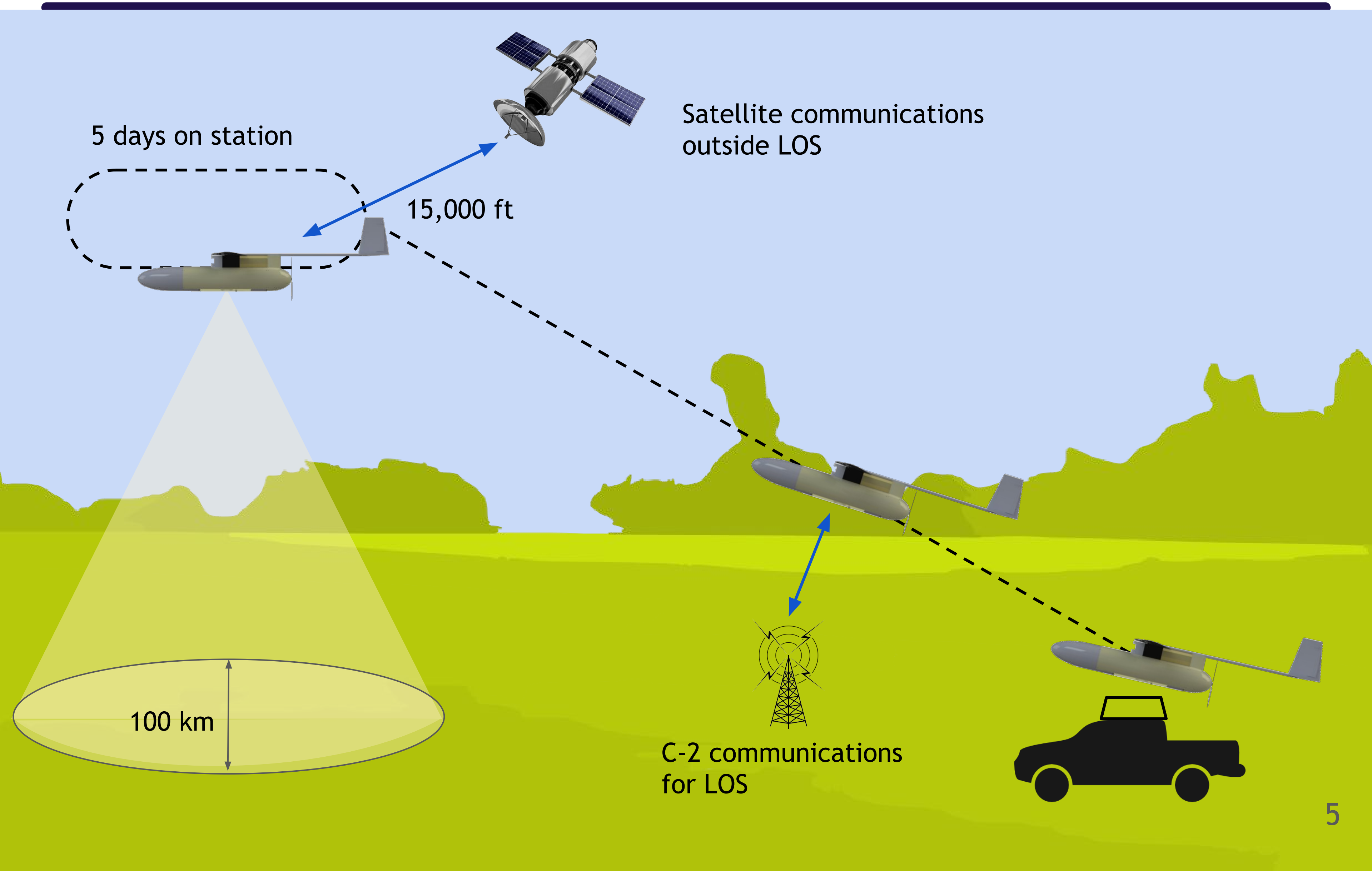
Propulsion

Avionics

Flight Operations

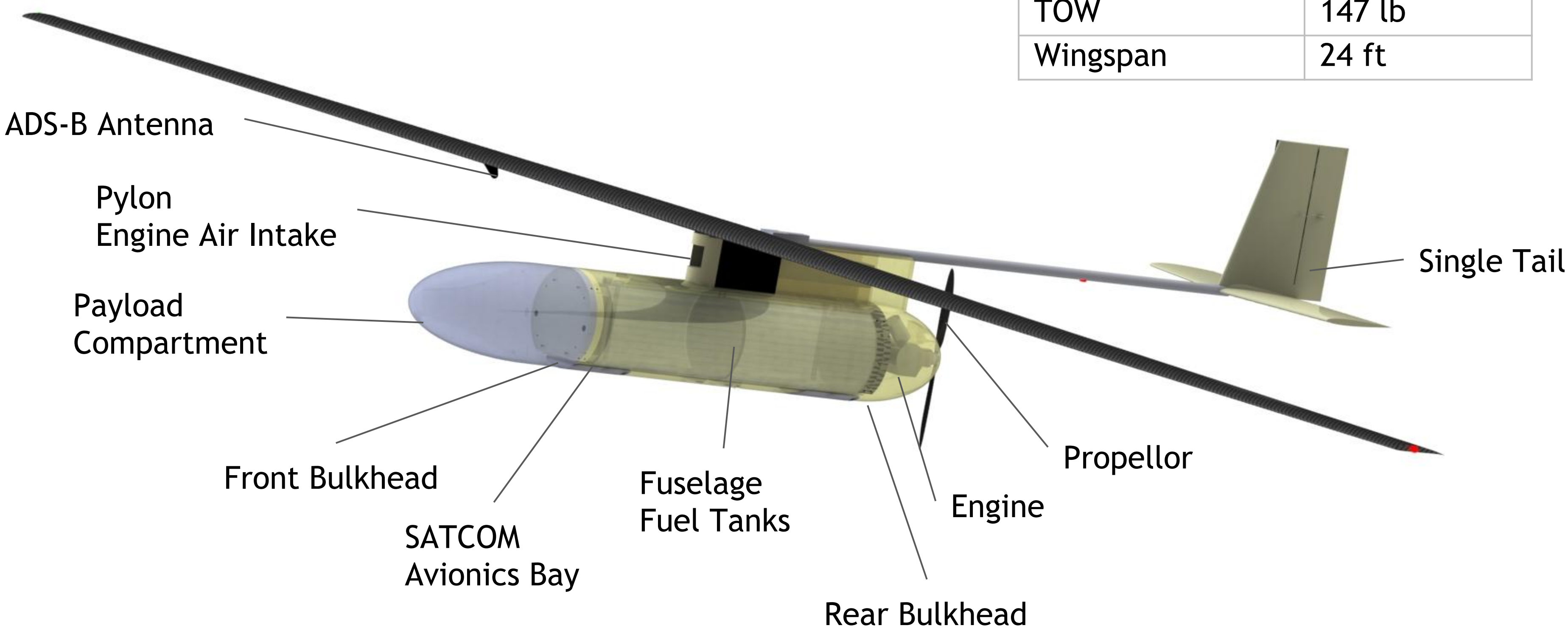
Development Plan

Concept of Operations



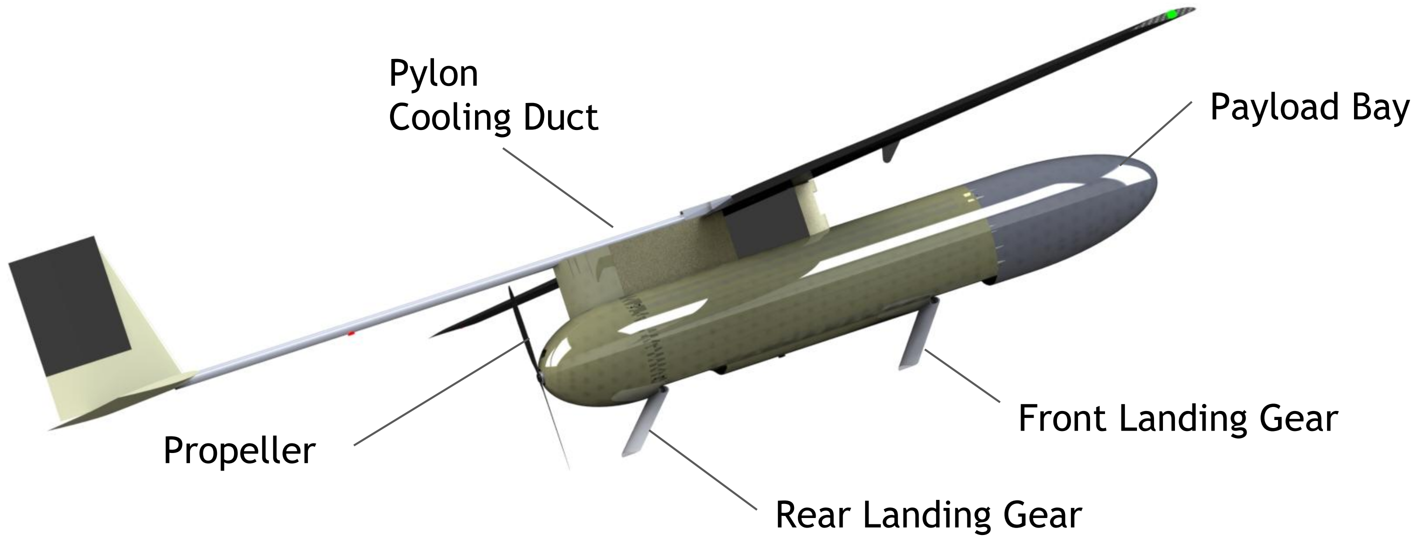
Current Vehicle Design

Specifications	
Dry Weight	57 lb
TOW	147 lb
Wingspan	24 ft

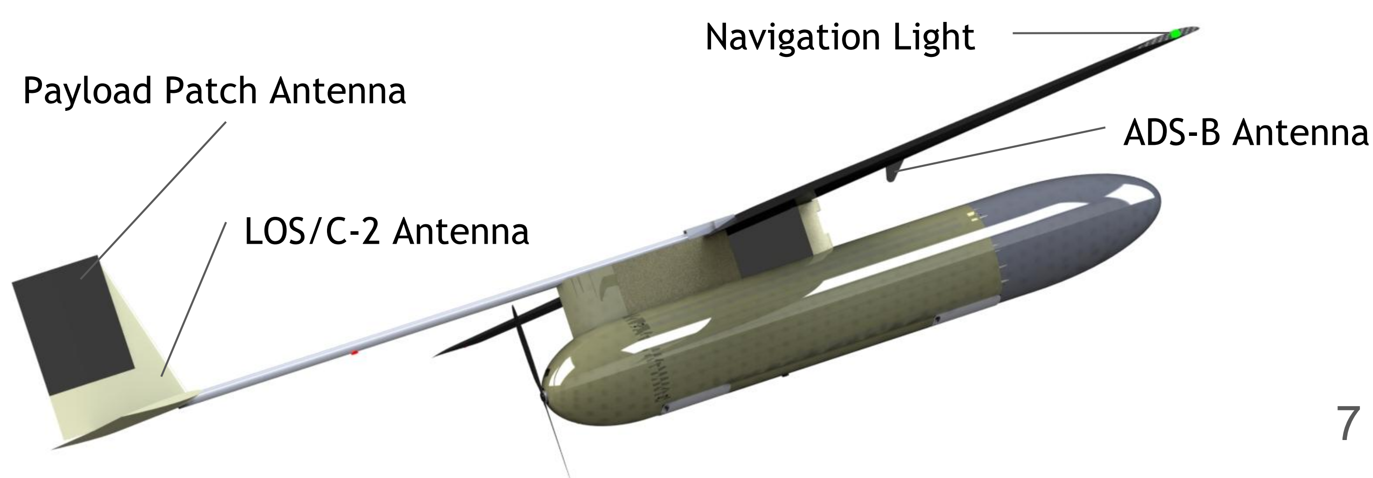


Current Vehicle Design

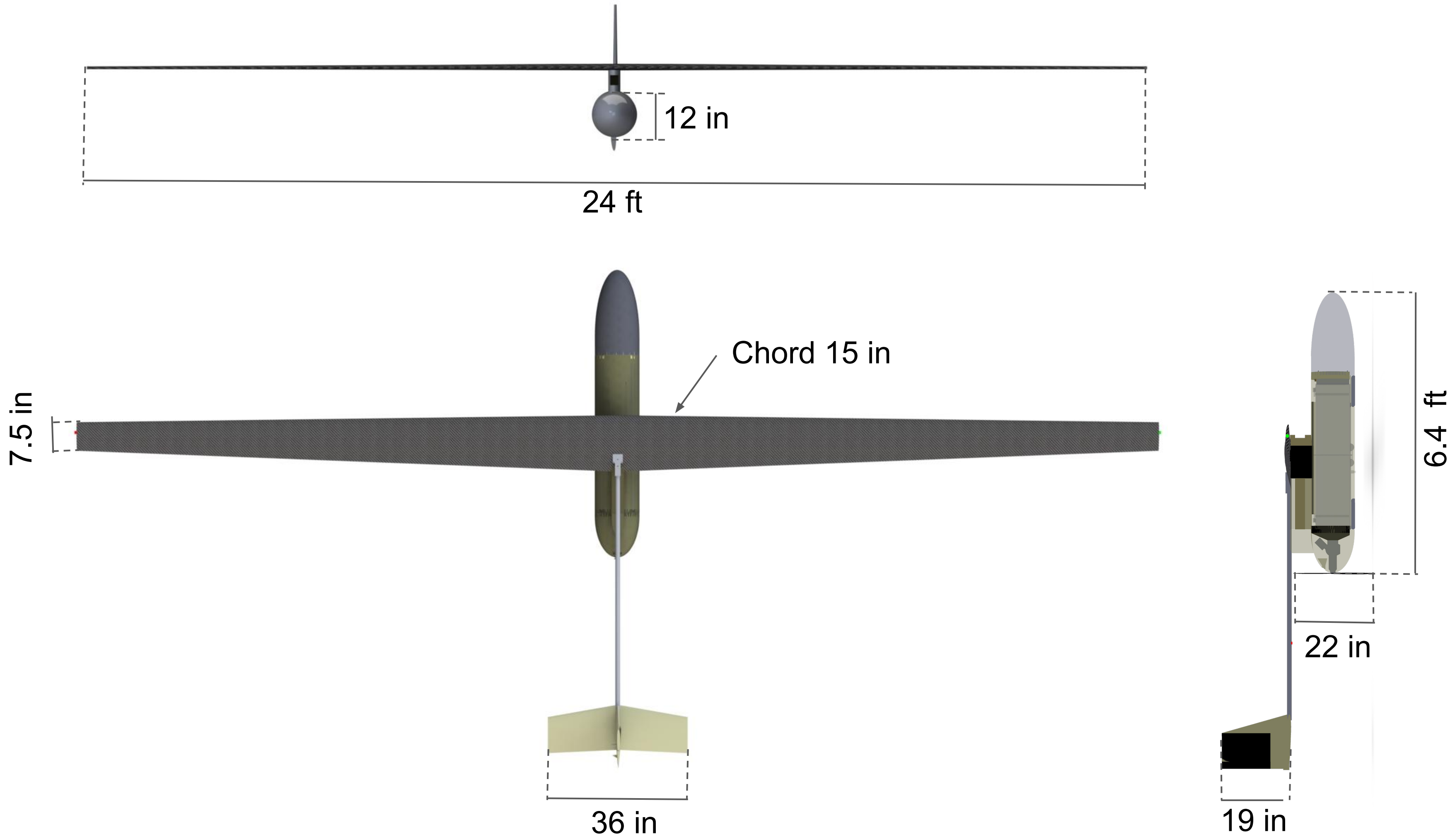
Landing Gear:
Deployed



Landing Gear:
Nominal
Operations

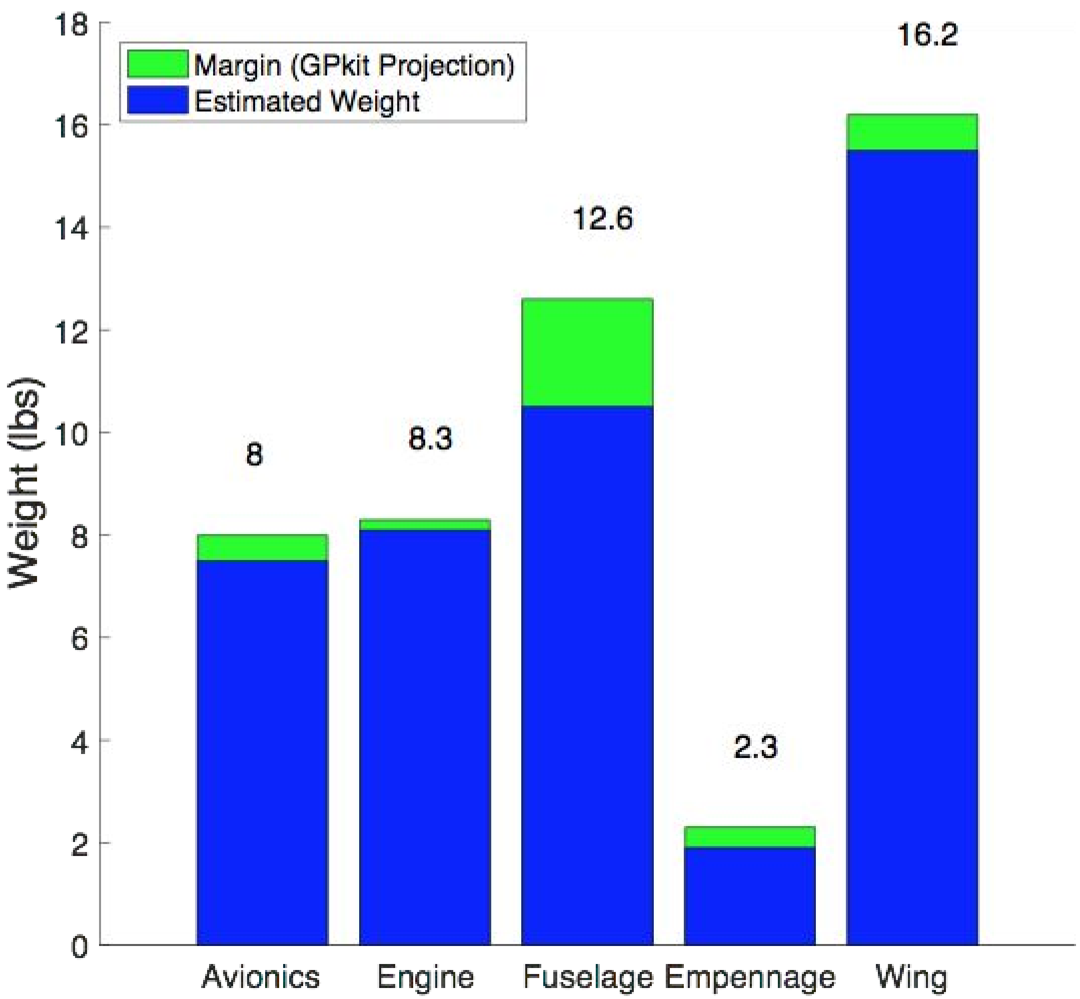


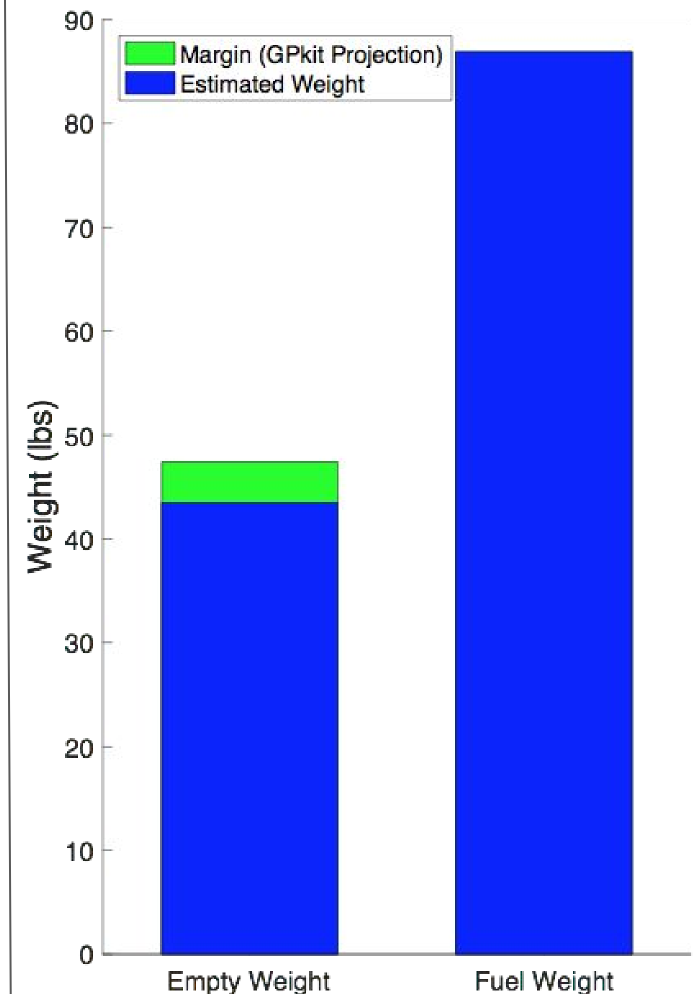
Current Vehicle Design



Performance Estimates

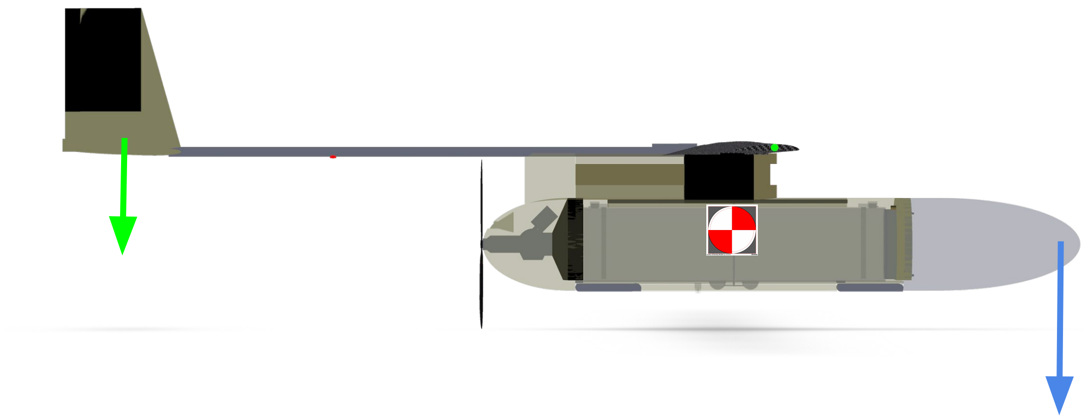
Weight Budget





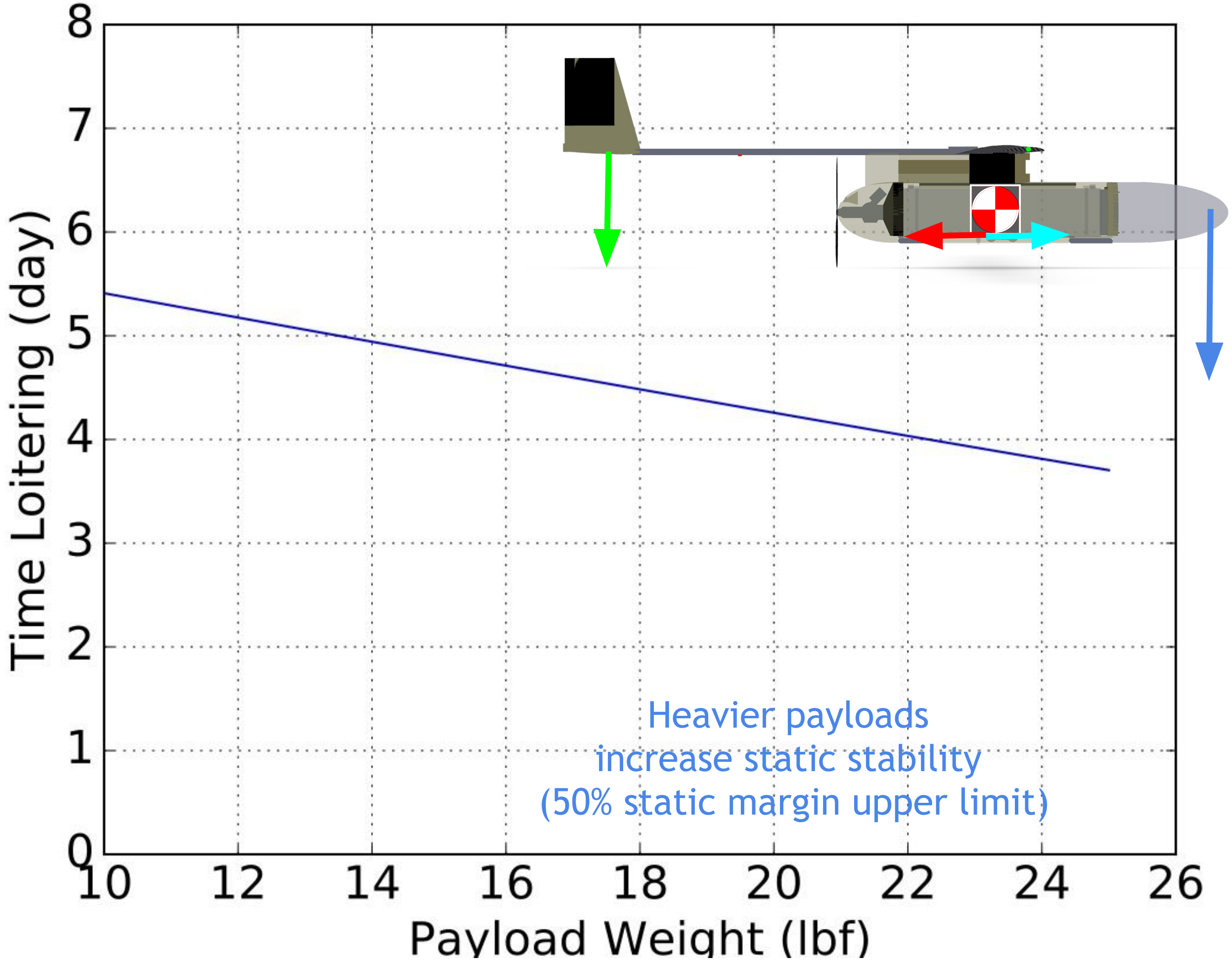
Accommodating Heavier Payloads

- To accommodate heavier payloads, ballast will be added to the tail
- Center of gravity and stability will not change.
- Ease of manufacturing. Aircraft remains the same size.
- Increased performance cost

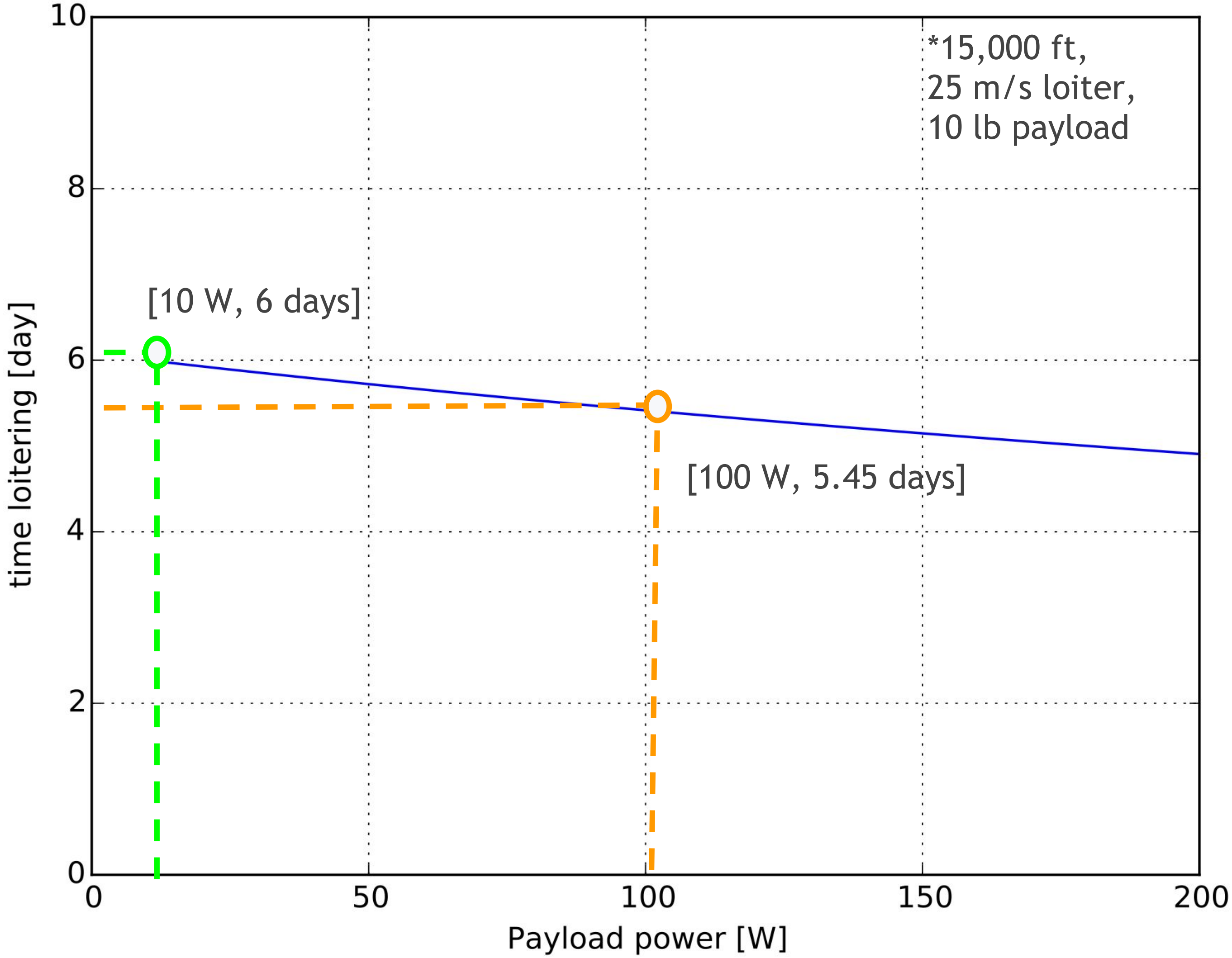


Payload Weight vs. Endurance - With Ballast

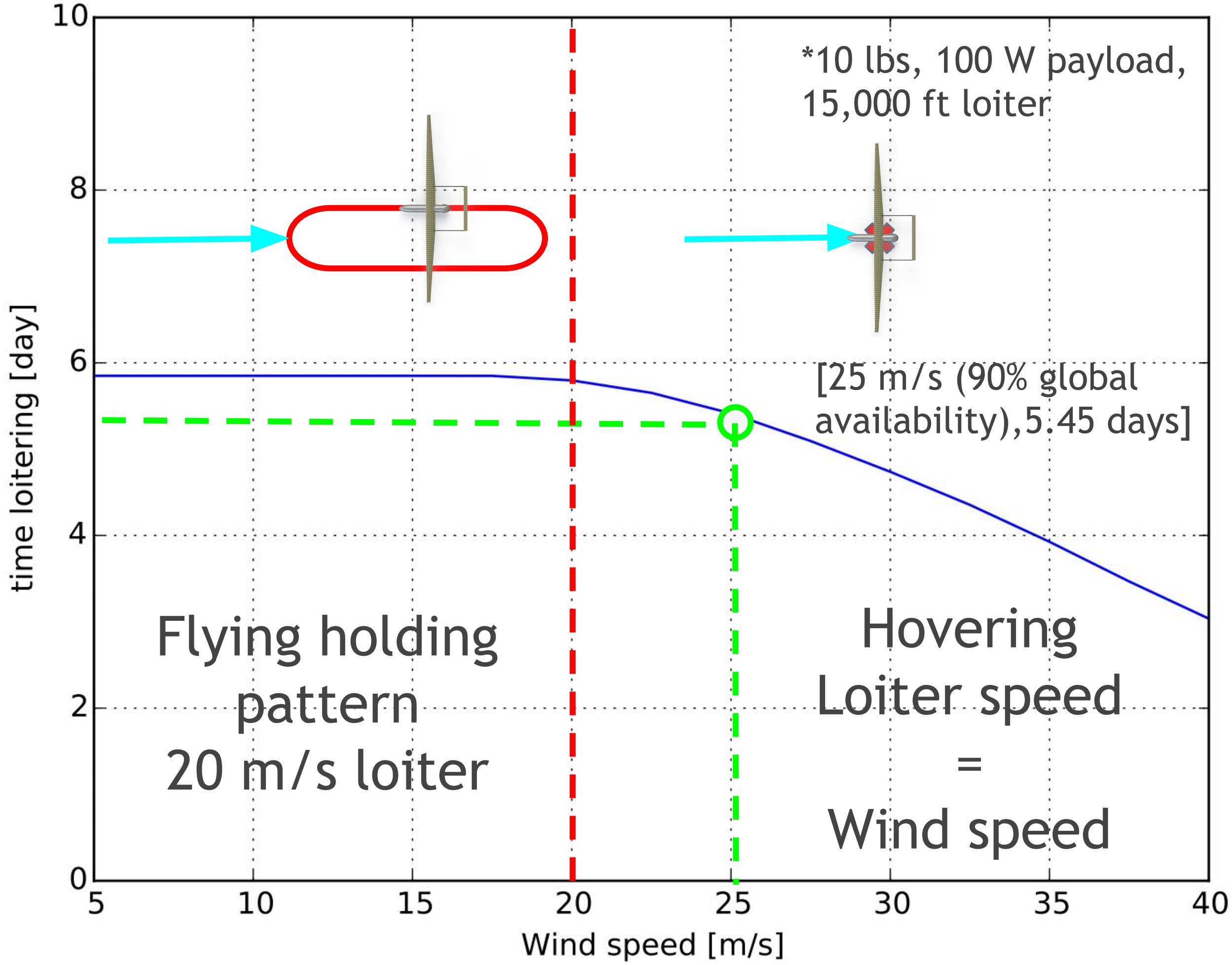
*15,000 ft, 25 m/s loiter, 100 W payload, 1 ft^3 box for payload



Payload Power vs. Endurance



Wind Velocity vs. Endurance



Design Overview and Performance

<u>Aerodynamics</u>

Structures

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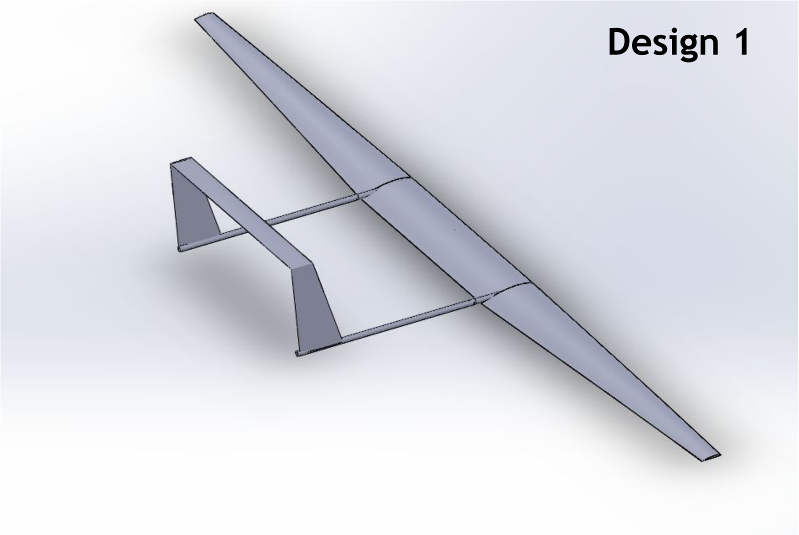
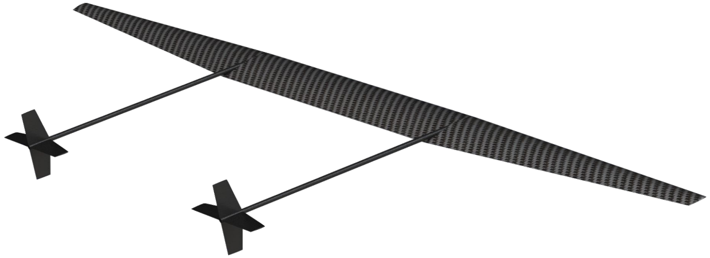
Aerodynamic Design: Tail

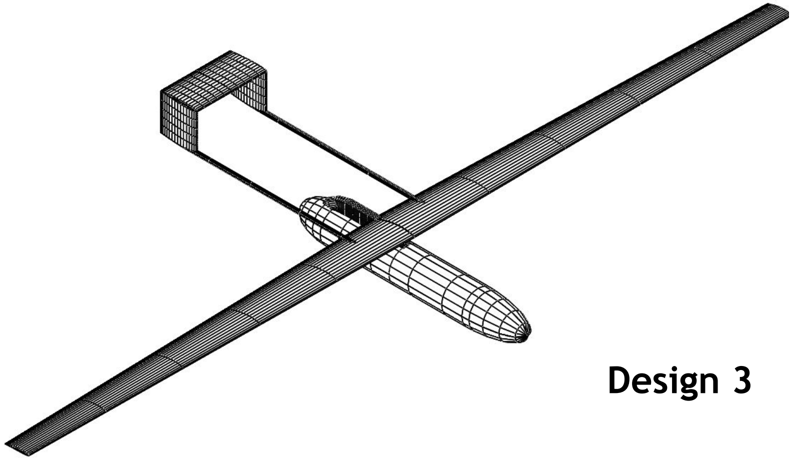
Considered Tail Designs



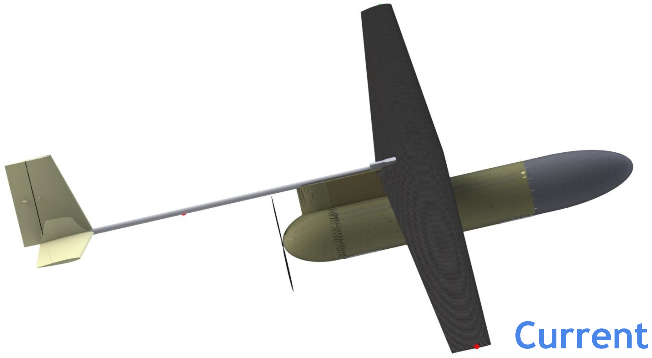
Design 1



Design 2

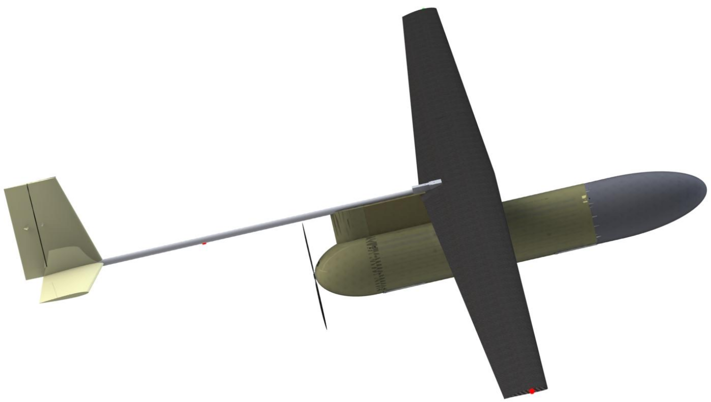


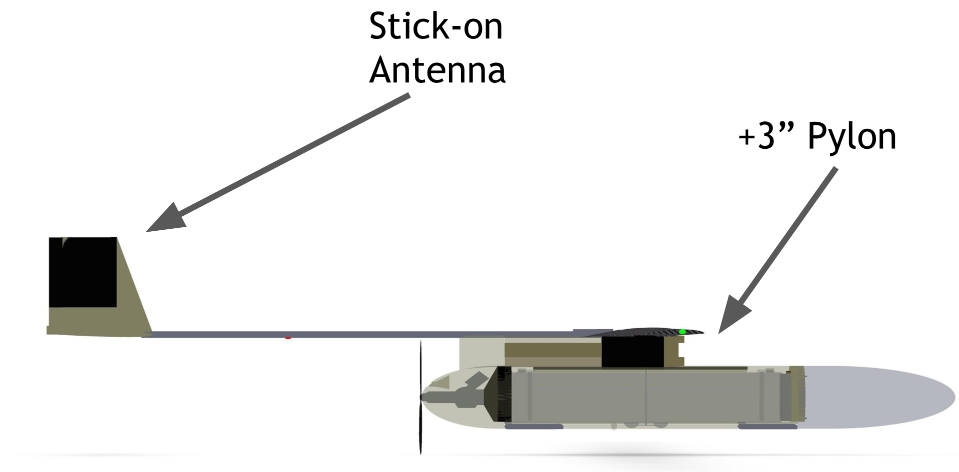
Design 3



Current Design

Aerodynamic Design: Tail





Benefits of a Single Tail

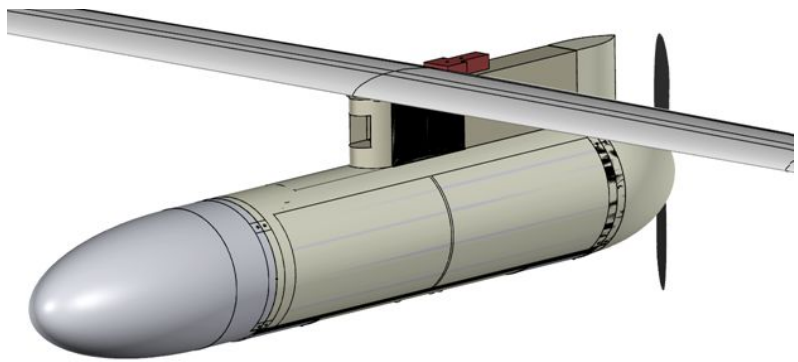
- Less Drag
  - 36% less
  - CD_{Single} = 0.0041 vs CD_{Pi} = 0.0063
- Room for Stick-on Antenna
- Less Complexity
- Tail Strike Clearance

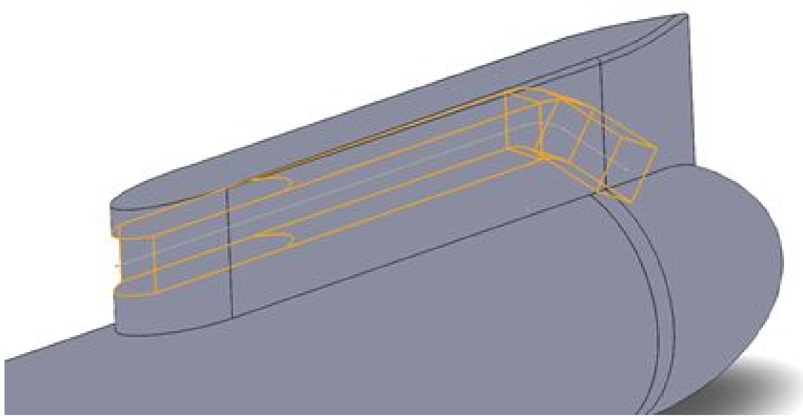
Drawbacks

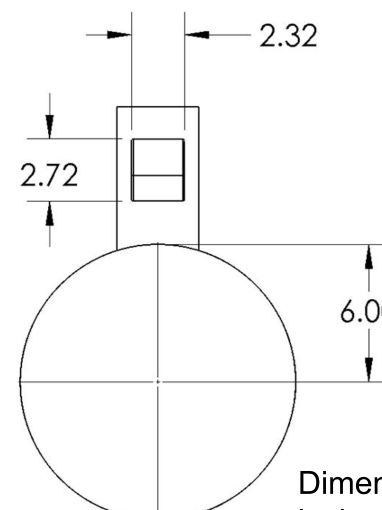
- +3” Larger Pylon

Aerodynamic Design: Pylon/Duct

- Pylon design drivers
  - Risk: Interference drag due to wing and fuselage interaction
  - Opportunity: Cooling drag reduction compared to “mickey mouse ear” configuration

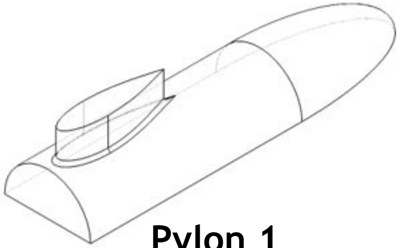




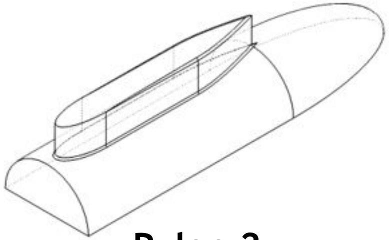


Dimensions: inches

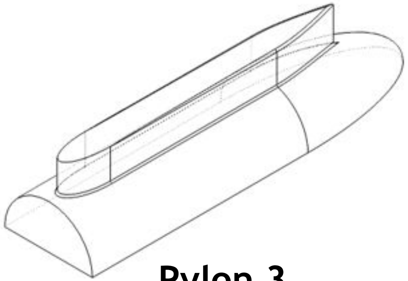
Aerodynamic Design: Pylon/Duct



Pylon 1



Pylon 2



Pylon 3

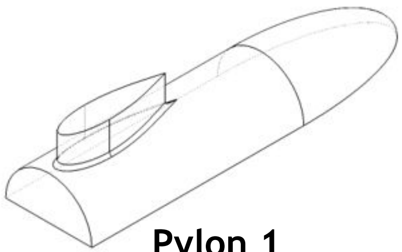
- Wind tunnel testing to determine pylon/duct configuration
- Skin friction drag / separation vs. fuselage volume

Pylon Design Comparison

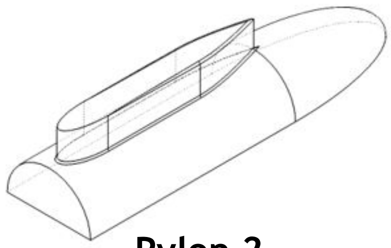
Drag Comparison to Pylon 3

	Pylon 1	Pylon 2
50 mph	-2.03%	-0.92%
60 mph	2.90%	0.87%
75 mph*	0.24%	0.06%

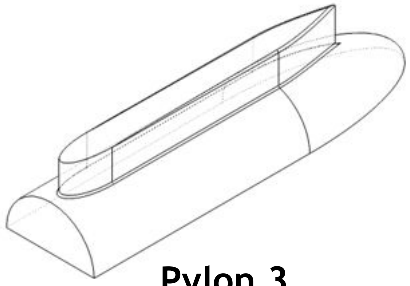
*matching cruise Re



Pylon 1



Pylon 2



Pylon 3

- No significant difference between drag values of pylon configurations compared to ambient noise
- We are moving forward with Pylon 3 since it is the simplest to manufacture

Aero - Sizing Model Verification

The aerodynamic model used for sizing (in GPKit) was simplified by necessity

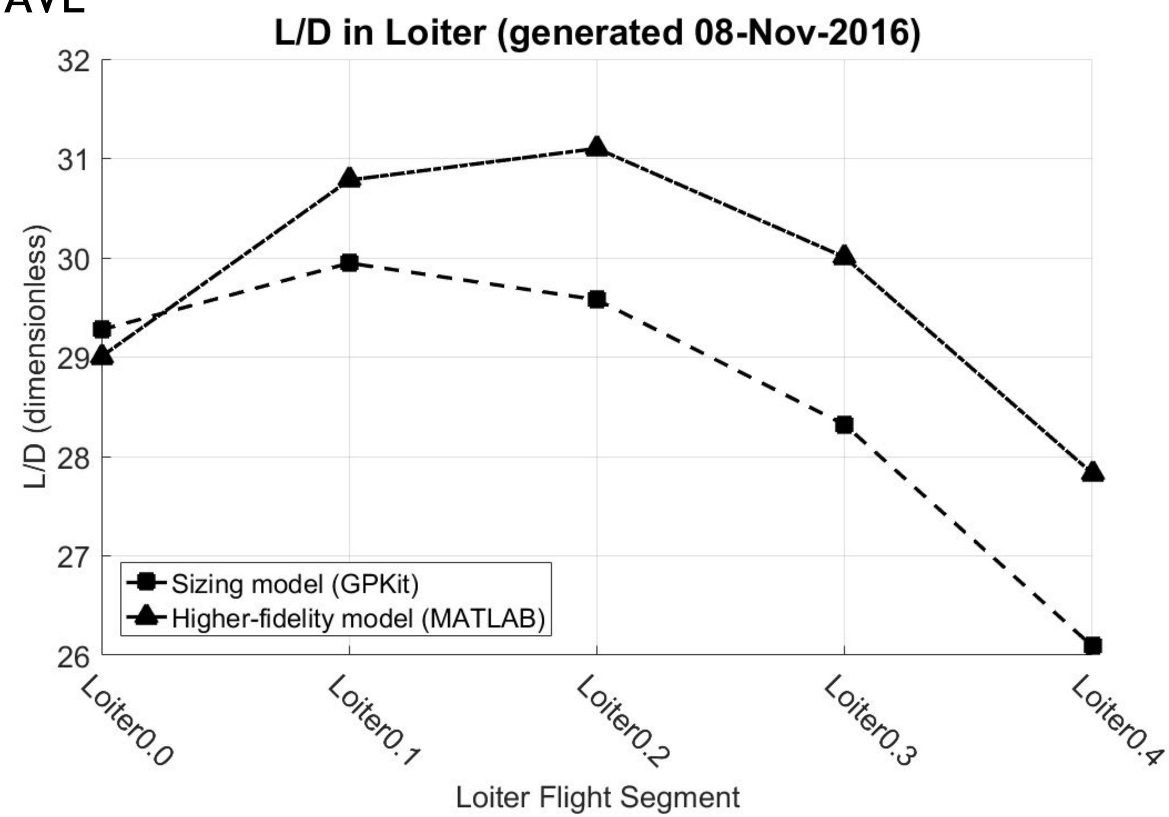
An aerodynamic model was constructed in MATLAB, using higher-fidelity methods

- Fuselage, boom, and cooling-duct drag from semi-empirical methods
- Wing and tail profile drag from XFoil
- Induced drag from AVL

Models agree to within ~7%

Sizing model is conservative

All performance estimates use the sizing model



Aero - Laminar Flow

L/D ratio is affected by achievable wing laminar-flow percentages

To a first approximation, endurance is proportional to L/D (Breguet range equation)

Laminar flow affected by:

- Build quality
- Insect accumulation
- Dew

Effect analyzed by fixing transition in XFoil

Worst case represents a bad build; builds to this point have been better

JHO will use a mold for wing construction, which mitigates the risk

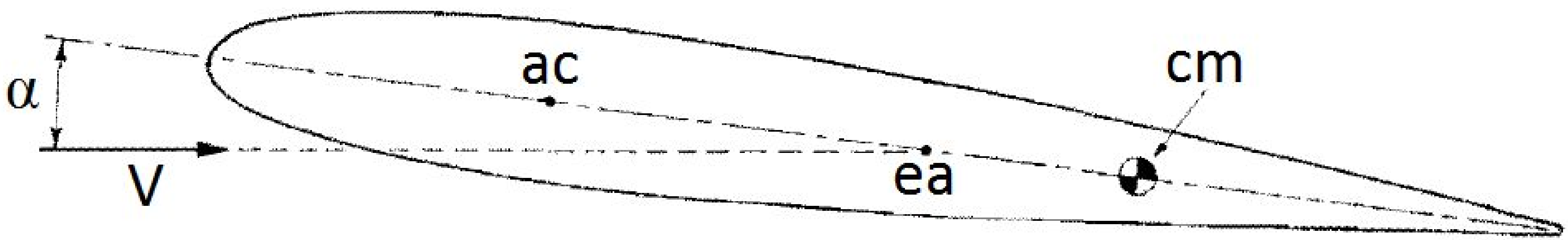
Cases	L/D (averaged)	Endurance (days)
Sizing model (GPKit)	28.6	5.5
Best case	29.7	5.7
Transition fixed at spar (top of wing only)	27.8	5.3
Transition fixed at spar (top and bottom of wing)	26.5	5.1
Transition fixed at 10% (top and bottom of wing)	24.2	4.6

Aero - Aeroelastic Analysis

Simplified 2D sectional method used to analyze tail flutter

3 points on an airfoil section affect its aeroelastic properties:

- Aerodynamic center (AC)
- Elastic axis (elastic center, shear center, EA)
- Center of mass (CM)



If the CM is ahead of the EA, flutter is impossible

To a first approximation, this is true for JHO

More detailed analyses will be conducted using ASWING by CDR

Design Overview and Performance

Aerodynamics

Structures

Propulsion

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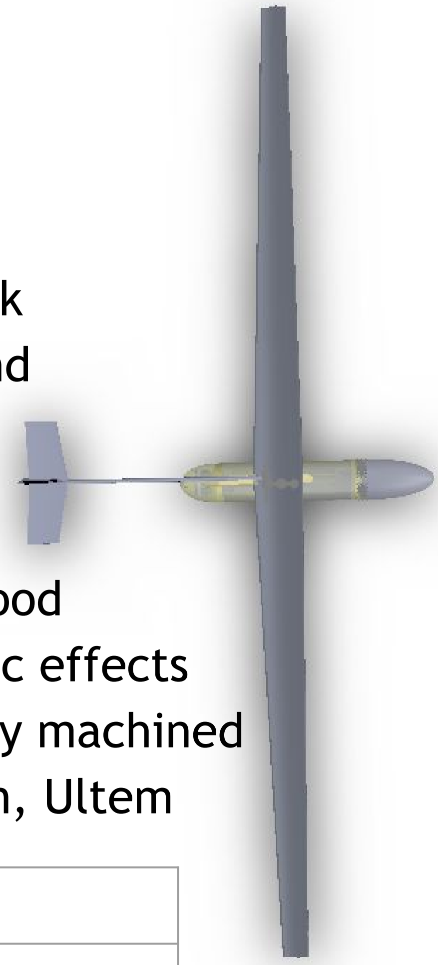
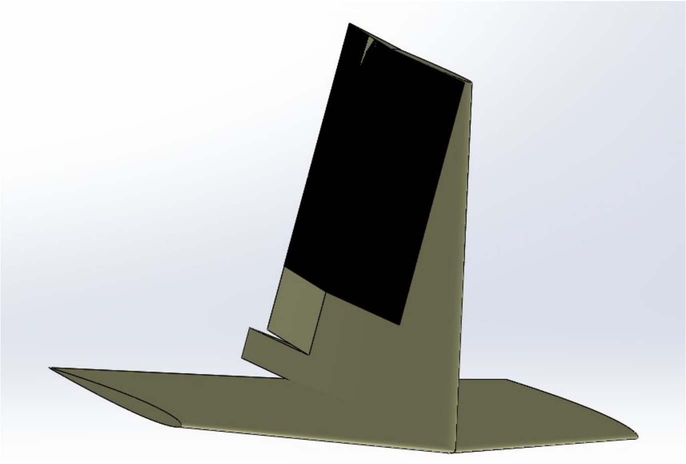
Development Plan

Tail



Manufacturing:
- 0.01 in. Kevlar Layup
- Solid Foam Interior
- Estimated tail weight: 1.55 Lbs
- Estimated boom weight: 0.75 Lbs
- Horizontal Volume Coefficient: 0.67



Testing:
- Practice Kevlar Layups
- Cutting molds this week
- First layup this weekend

Tail-Boom Joint:
- Currently looking at wood
  - No electromagnetic effects
  - Strong, light, easily machined
- Other possibility: Nylon, Ultem

HTail Foam	.35 Lbs
HTail Kevlar	.5 Lbs
VTail Foam	.2 Lbs
VTail Kevlar	.25 Lbs
Connection (Wood)	.25 Lbs
Boom	.75 Lbs

Tail Cont.

Antenna Placement:

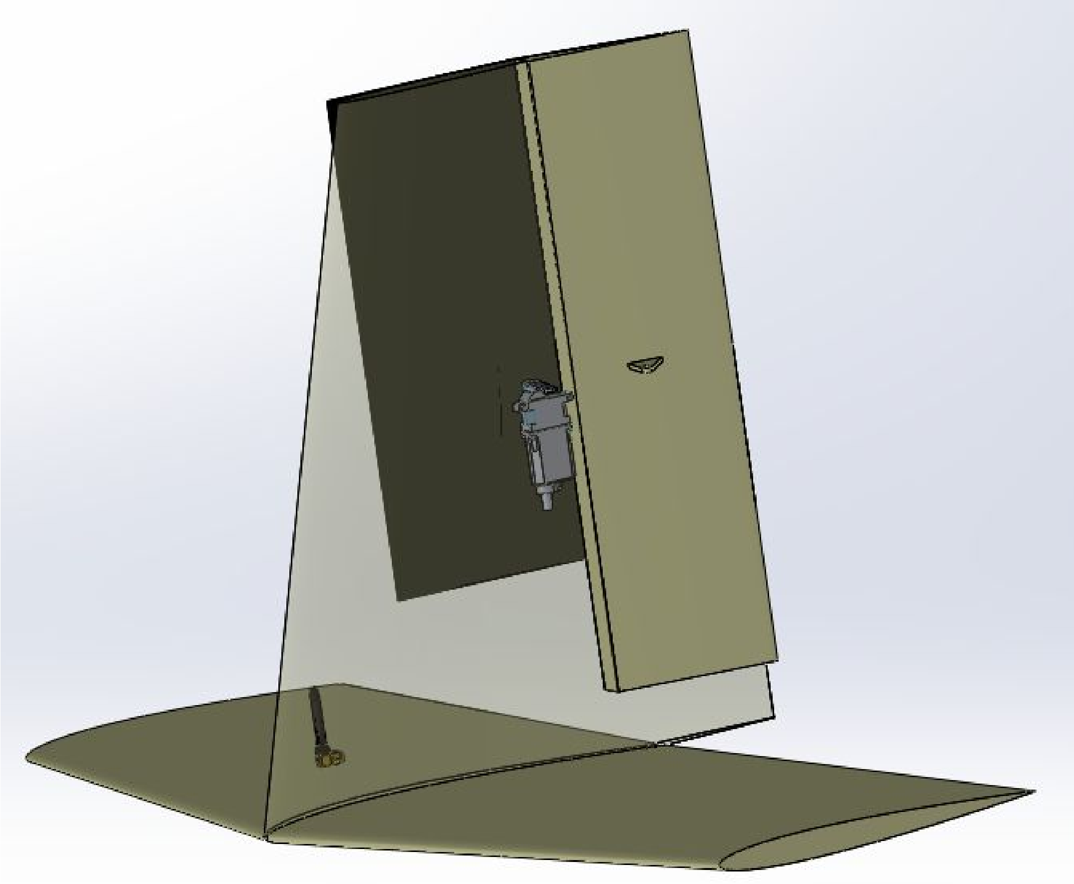
- Peel and Stick positioned on vertical tail
- Flexibility allows for control surface mounting
- Interference shouldn't be issue with carbon boom

Tail-Boom Joint:

- Currently looking at wood
  - No electromagnetic effects
  - Strong, light, easily machined
- Other possibility: Nylon, Ultem

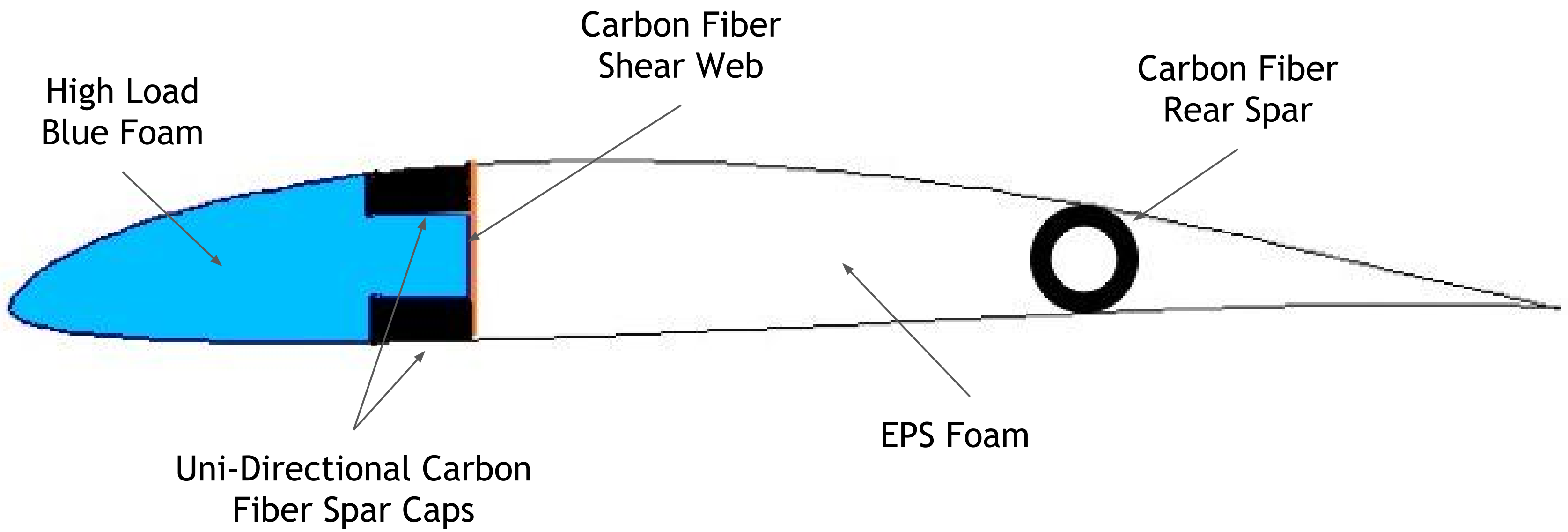
Control Surfaces:

- 2 Elevators (0.4 ft^2 each)
- 1 Rudder (0.4 sq ft)
- Deflections of 15 degrees
- Driven by 3 Pegasus actuators
- In the process of ordering actuators
  - Most testing will be structural in the next weeks

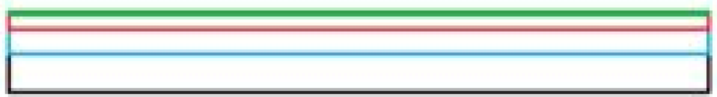


Wing

- Carbon Fiber skin
- Spar Caps are 2 inches wide centered at maximum thickness (34% of chord)
- Composite lay up with a mold for manufacturing



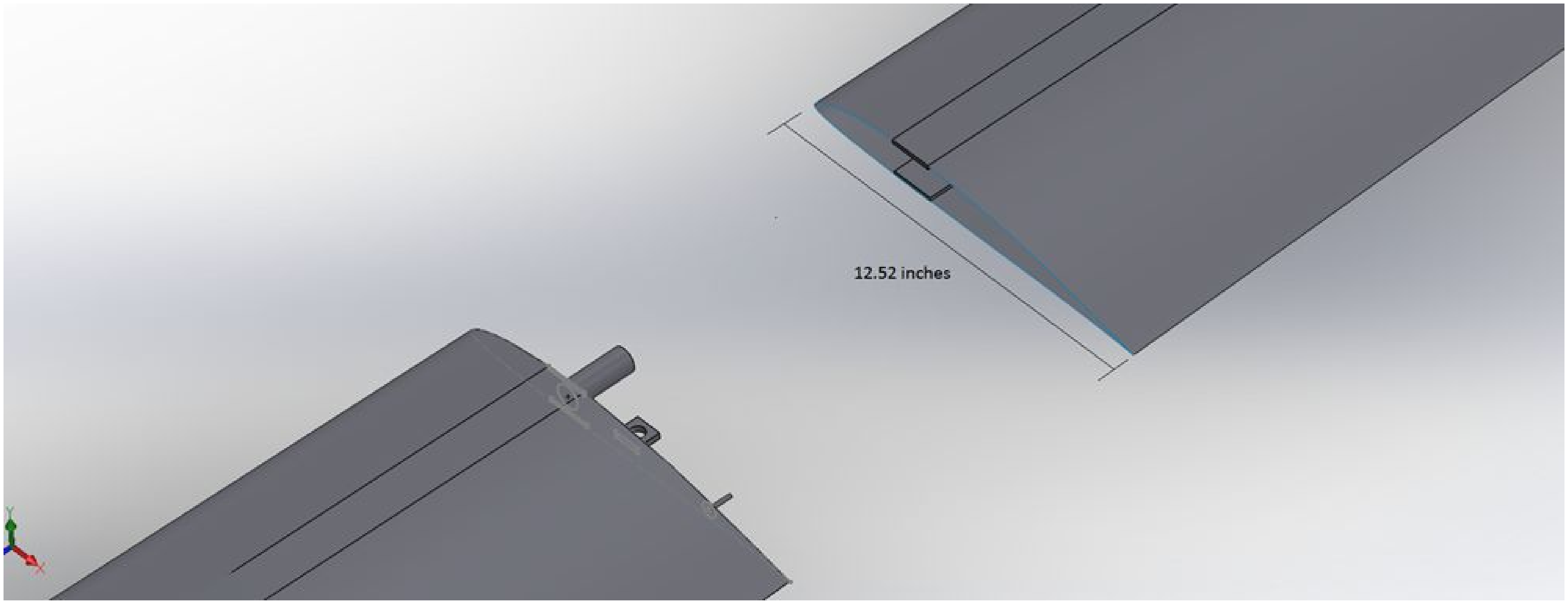
Spar size



Currently the carbon fiber spar has constant width of 2 inches and varies in thickness level.

Thickness from 0-25% away from root: 0.23 inches
Thickness from 25-50% away from root: 0.13 inches
Thickness from 50-75% away from root: 0.06 inches
Thickness from 75-100% away from root: 0.02 inches

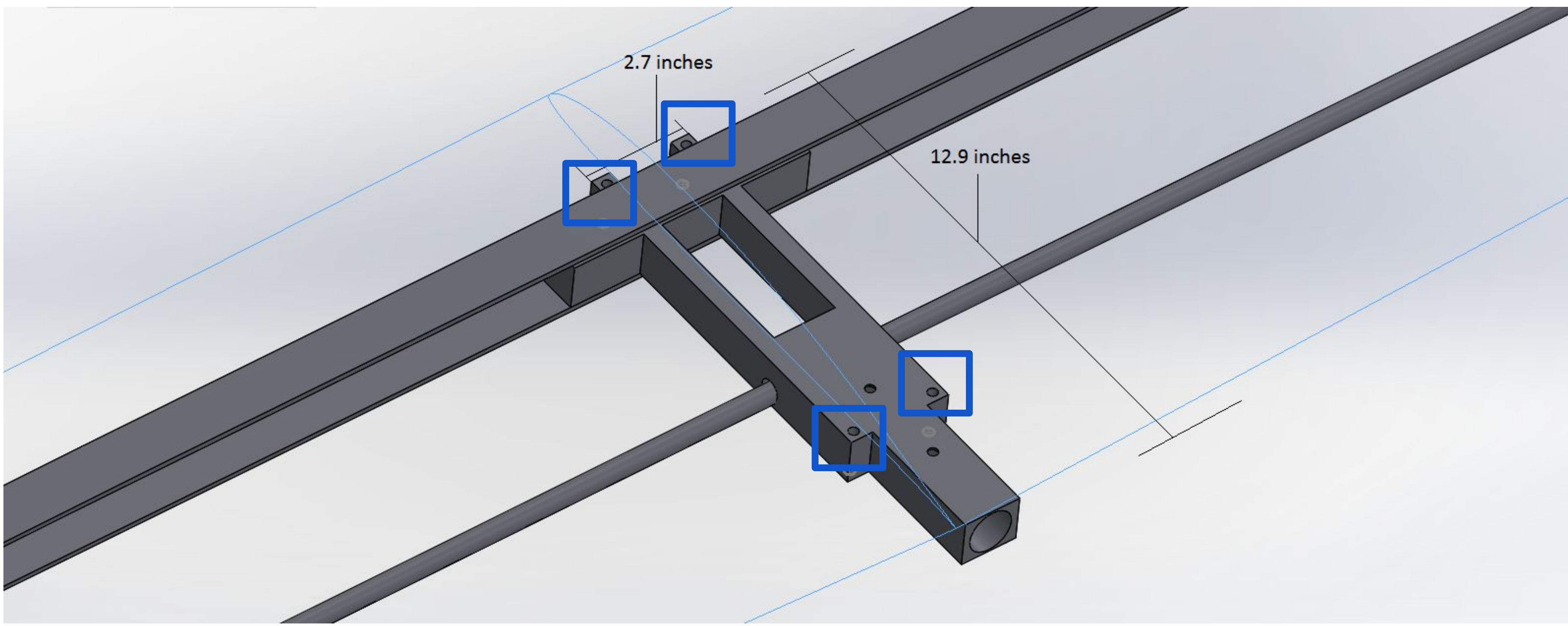
Wing-Wing Connection



- Aluminum rods create a male-female attachment point in between the front spar caps to join wing sections together
  - Handle bending loads
  - Prevent twisting between wing sections
- Connection is held in place with a small pin
  - Prevents wing sections from separating

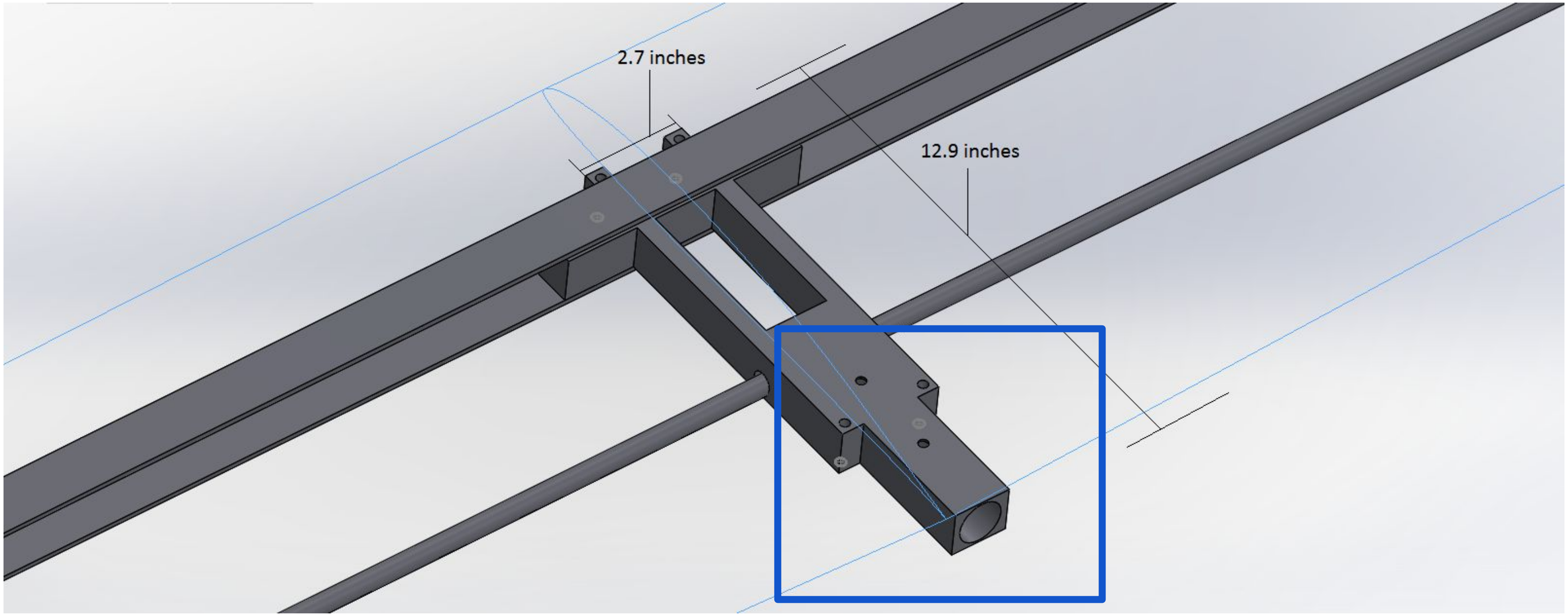
Wing-Pylon

- Aluminum structure allows for wing-to-pylon and wing-to-tail connections
- Bolts connect this aluminum structure to the pylon
  - Distributes loads from wing spars to the connecting bolts

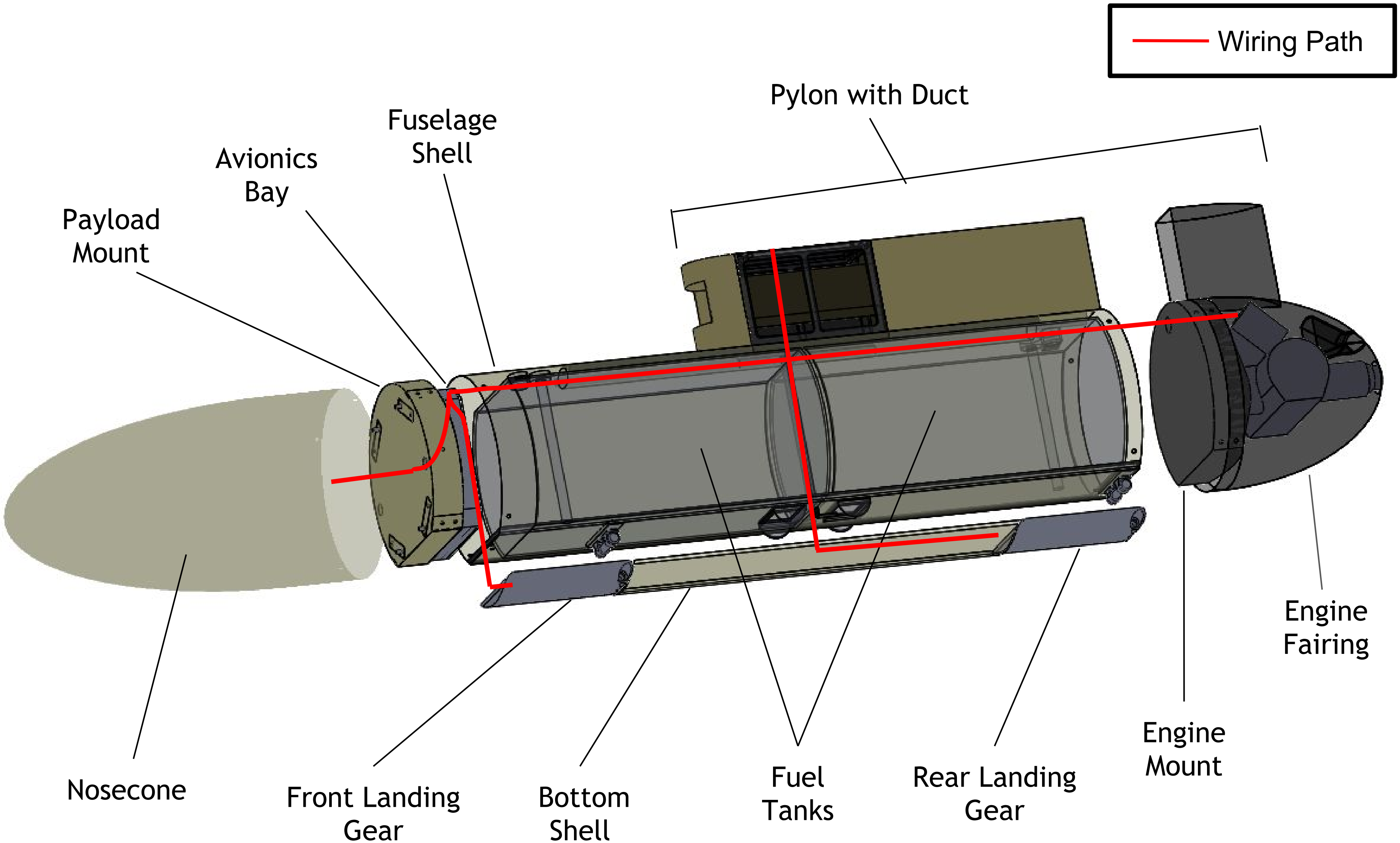


Wing-Tail Connection

- Tail boom can insert into the wing via the aluminum piece
- Requires two bolts for the connection
- Total weight of wing with these connections is 16 pounds



Fuselage Configuration Overview



Fuselage Weight Budget

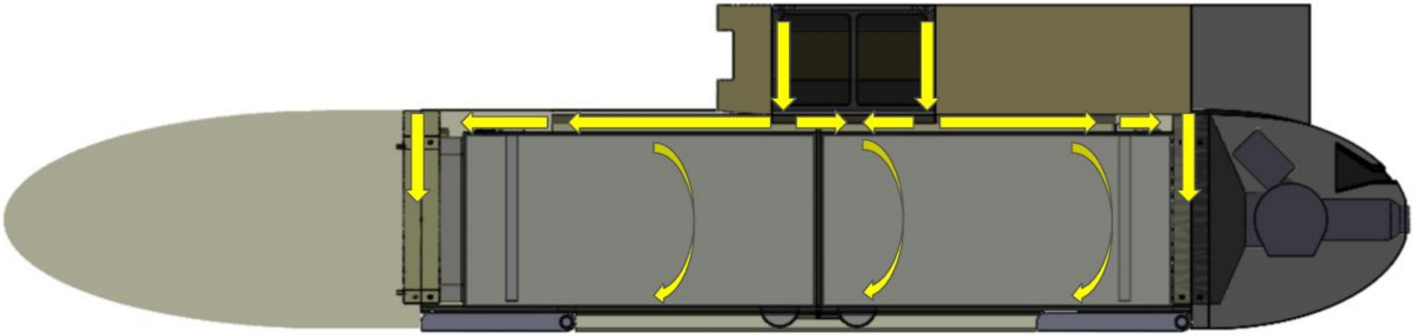
Part Name	Material	Weight (lb)
FUSELAGE		**10.65**
Nosecone Fairing		
Fairing	Kevlar, Epoxy	0.25
Screws to Payload Mount X 4	Screws	0.03
Payload Mount		
Threaded Tabs	Aluminum	0.15
Back Plate Skin - Kevlar	Kevlar	0.13
Back Plate Foam Insertion	Polypropylene (EPP) Foam	0.02
Rim Skin	Kevlar	0.07
Center Fuselage		
Fuselage Shell	Kevlar, Epoxy	2.25
Screws to Payload Mount X 4	Screws	0.03
Screws to Engine Mount X 4	Screws	0.03
Bottom Bulkhead	High Load 60 Foam	0.10
Wood to Mount Light	Balsa Wood	0.00
Oval Wire Channel	Kevlar, Epoxy	0.05
Longeron X 2	Carbon Fiber Tube	0.29

Part Name	Material	Weight (lb)
Fuel Tank Subassembly		3.80
Engine Fairing		
Fairing	Carbon Fiber, Epoxy	0.33
Screws to Engine Mount X 4	Screws	0.03
Pylon		
U Channel	Aluminum	0.87
Wrap	Carbon Fiber, Epoxy	0.16
Inner Duct	Kevlar	0.11
Outer Fairing	Kevlar	0.12
Front Fairing	Kevlar	0.03
Landing Gear		1.35
Engine Mount		
Mount Skin	Carbon Fiber, Epoxy	0.10
Foam Interior	High Load 60 Foam	0.35

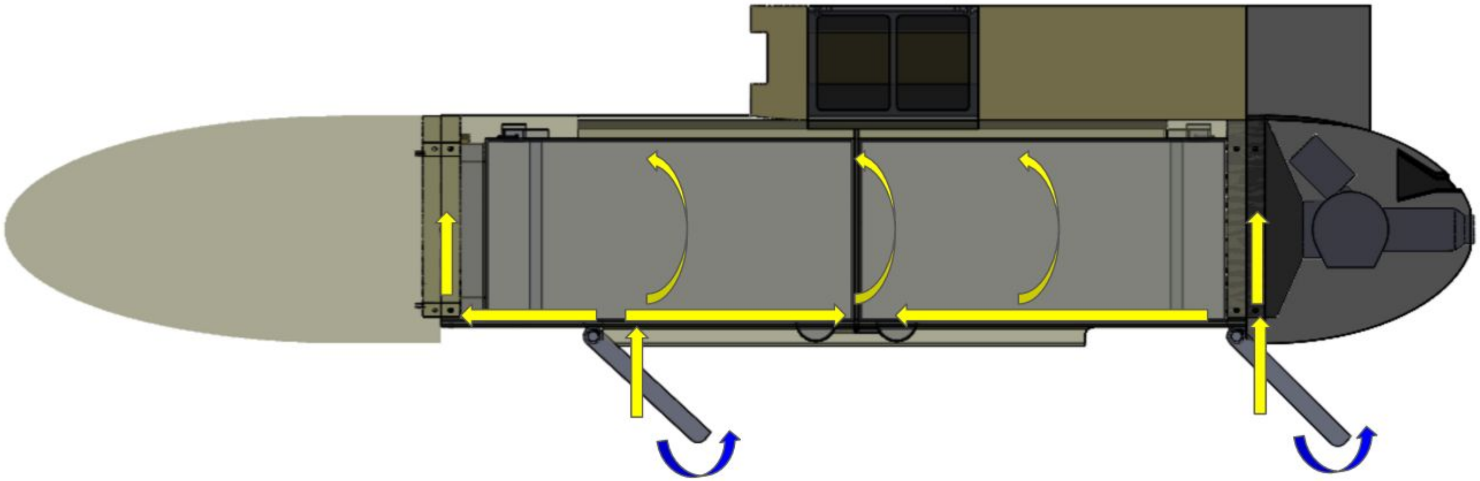
Fuselage Structural Overview

Main Structural Components

- Pylon
- Longerons
- Fuselage Shell
- Payload Mount
- Engine Mount
- Landing Gear
- Bottom Bulkhead

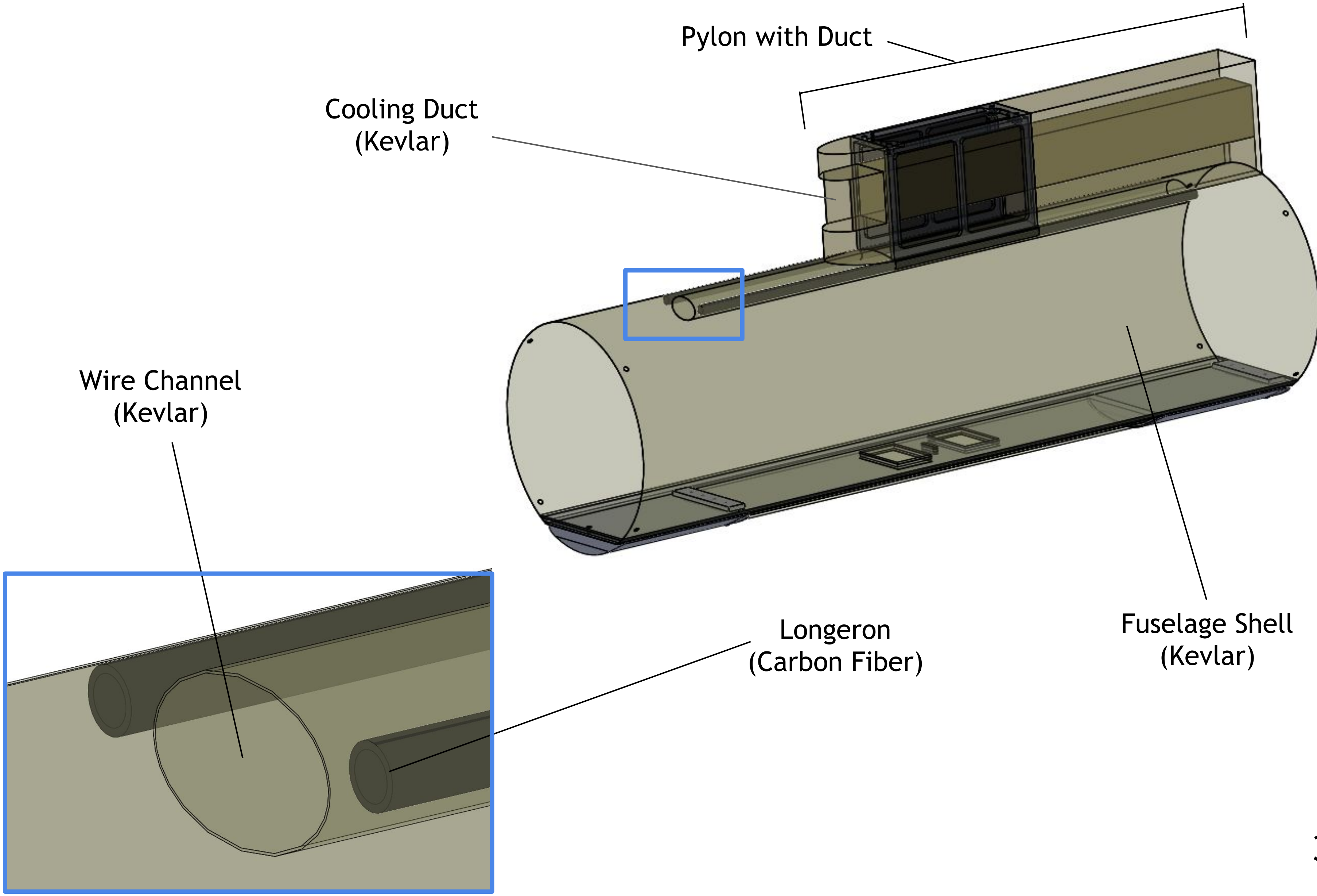


In Flight Load Paths



Landing Load Paths

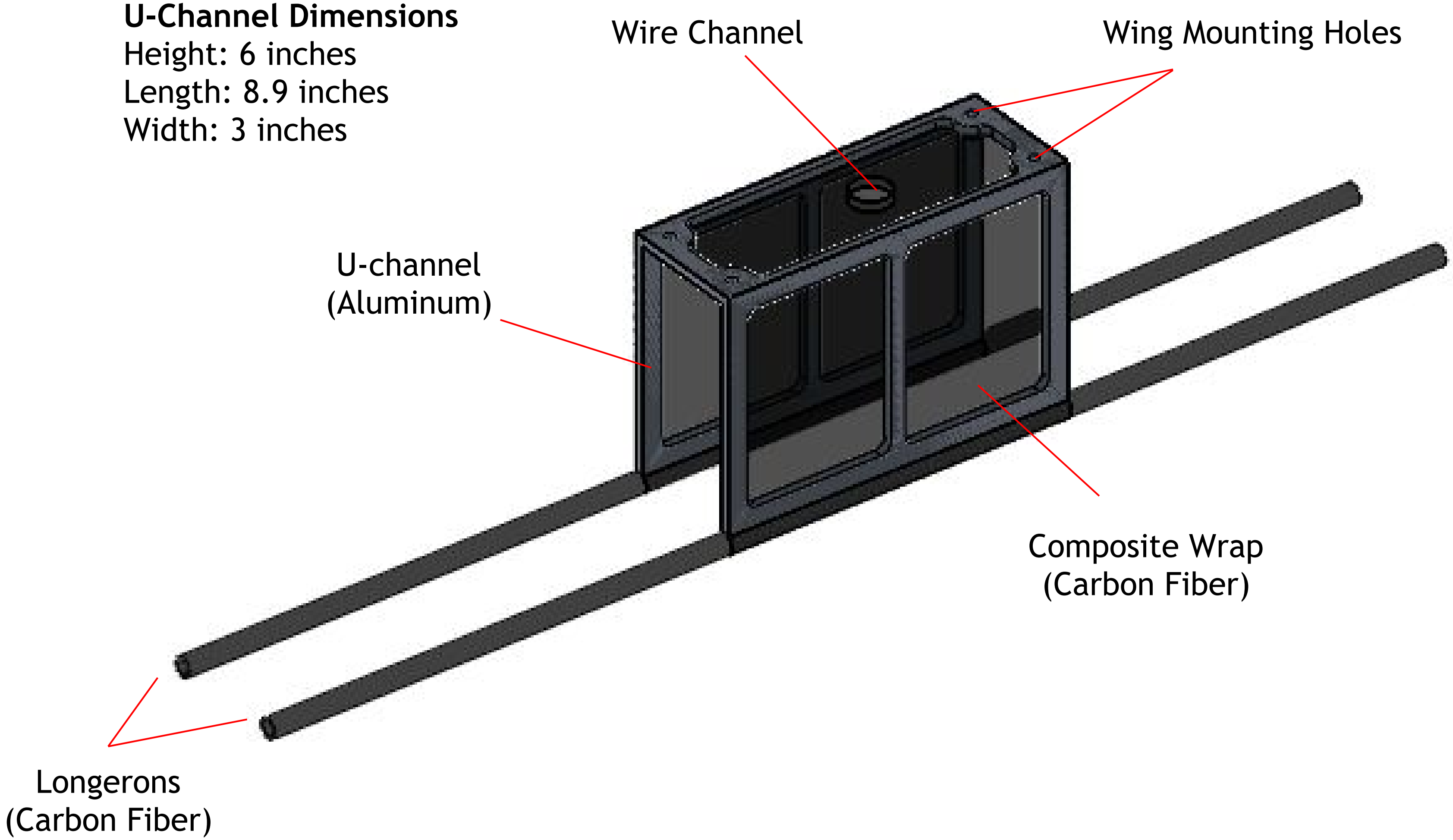
Fuselage Center



Pylon

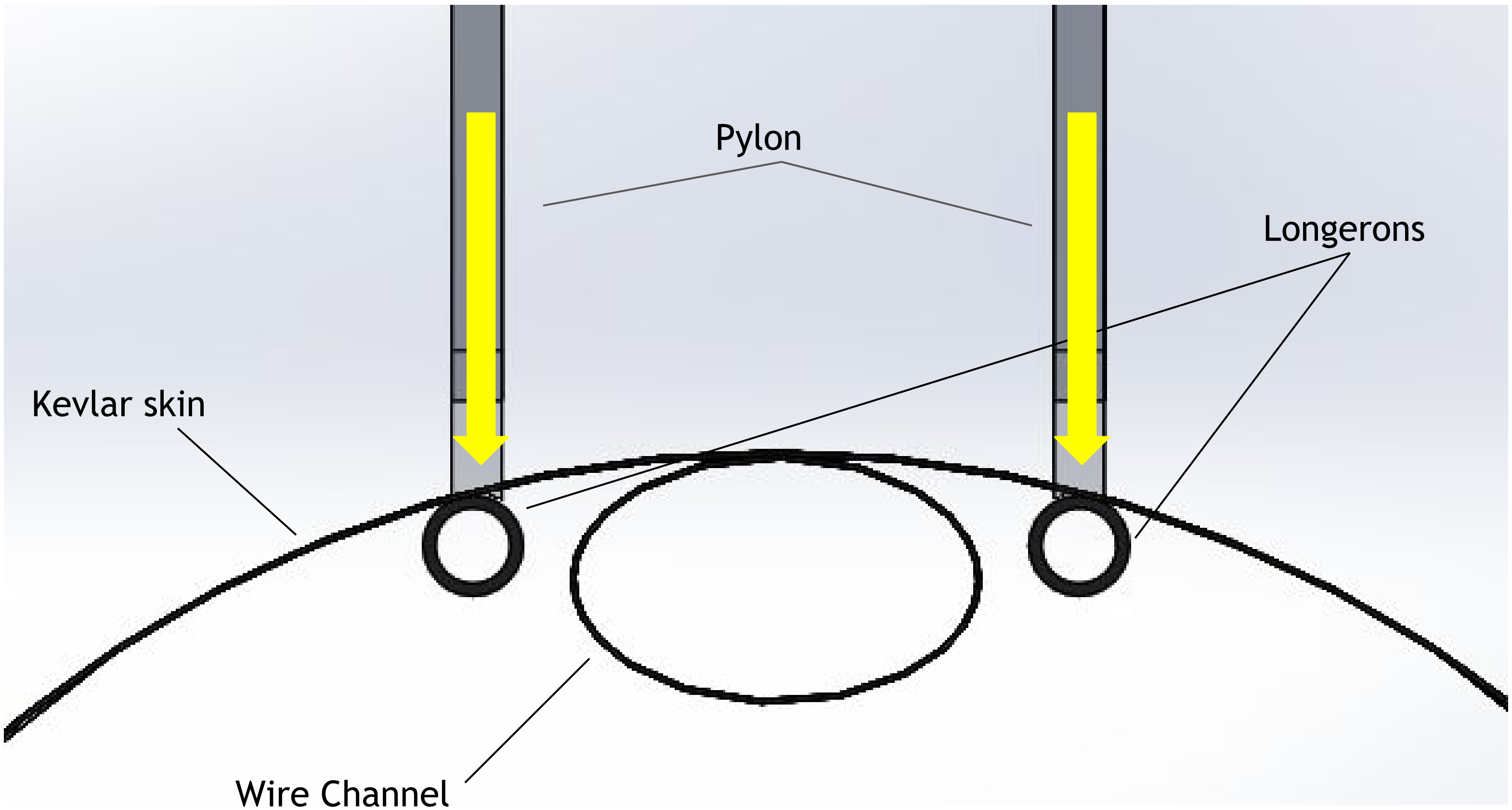
- Aluminum U-Channel creates a connection point with the wing
- Carbon fiber wrap connects longerons to U-channel

U-Channel Dimensions
Height: 6 inches
Length: 8.9 inches
Width: 3 inches



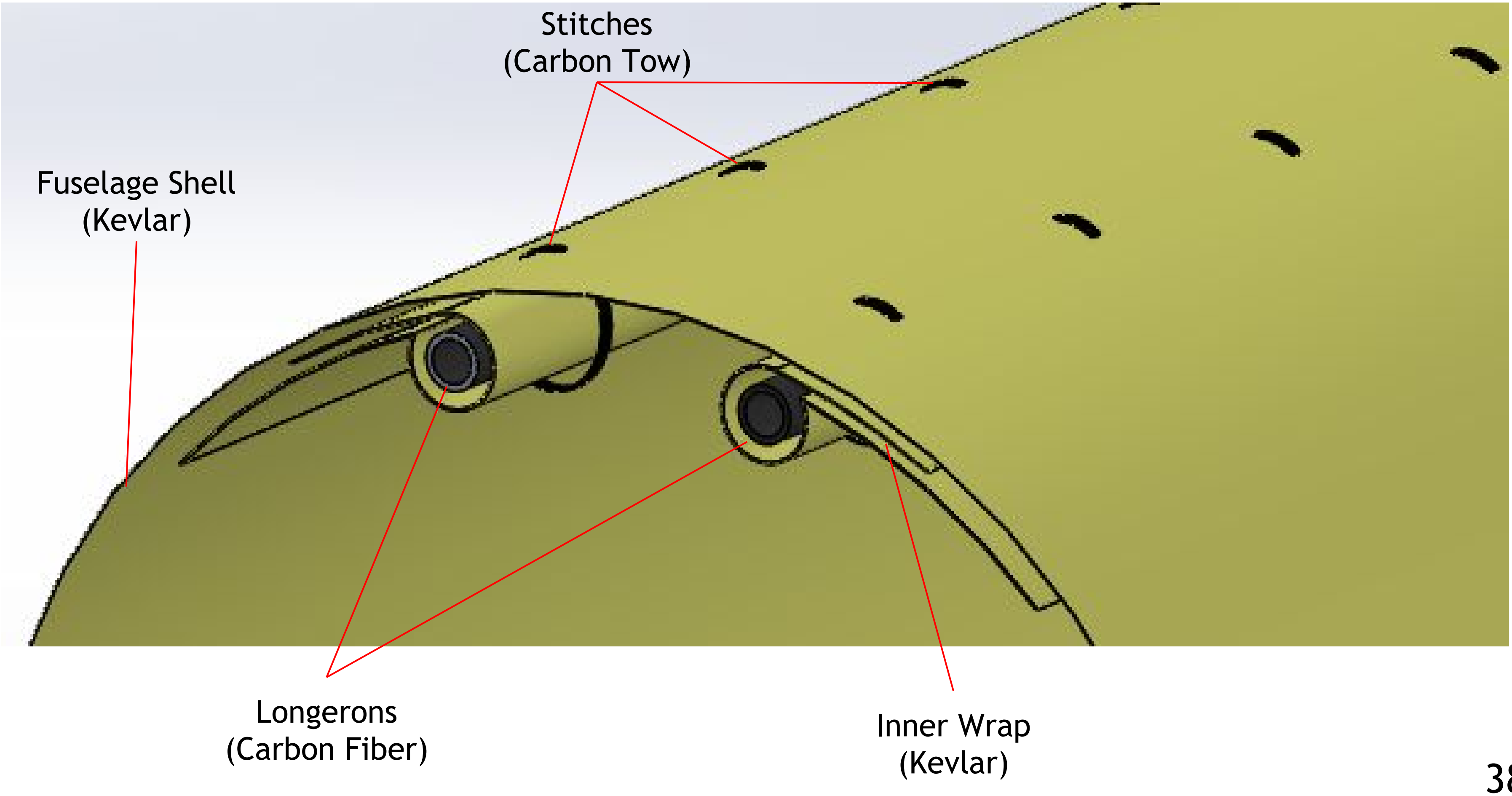
Delamination Risk Area

- Downward force on longerons during landing
- Must prevent delamination with additional internal layup

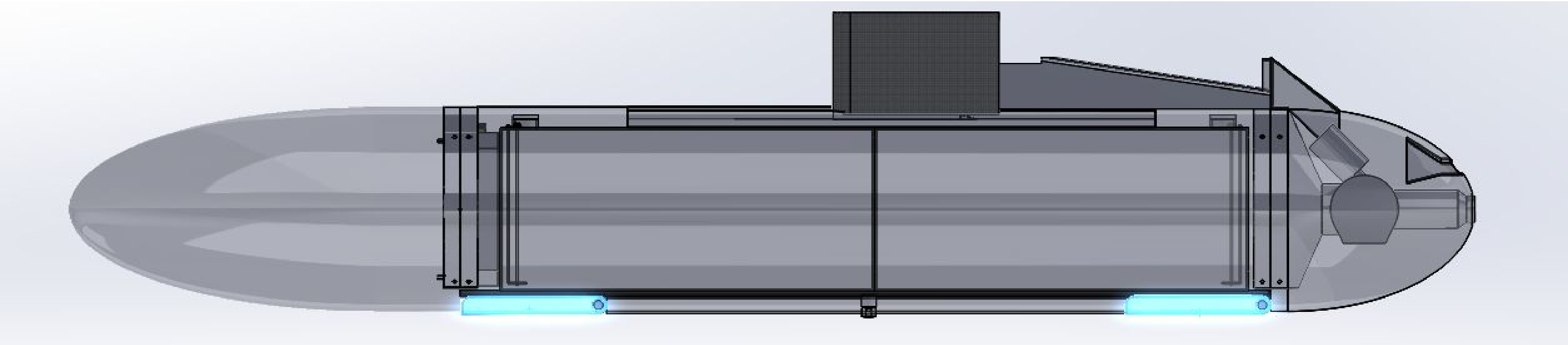


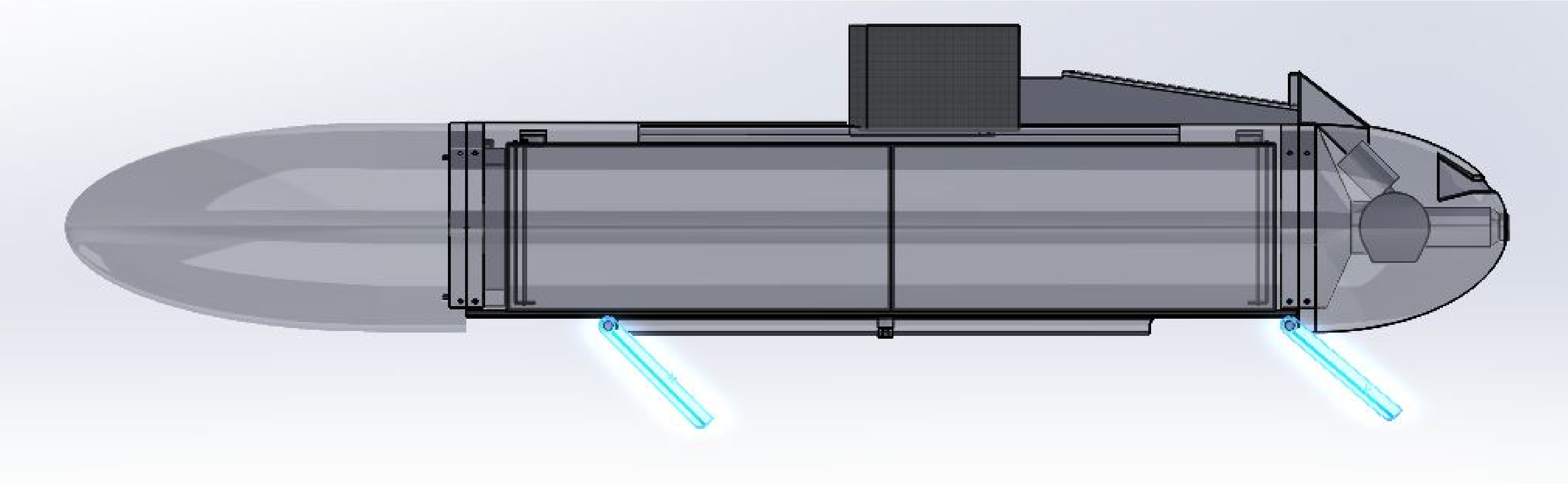
Delamination Mitigation

- Inner Kevlar wrap will reinforce longeron bond to inside of fuselage shell
- Carbon tow stitches will bind longerons to outside of fuselage shell



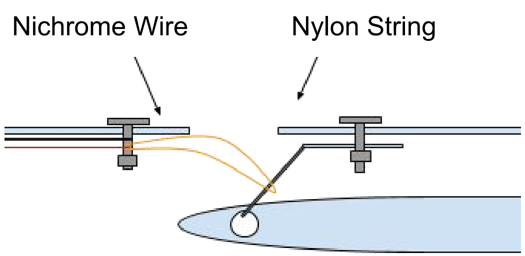
Landing





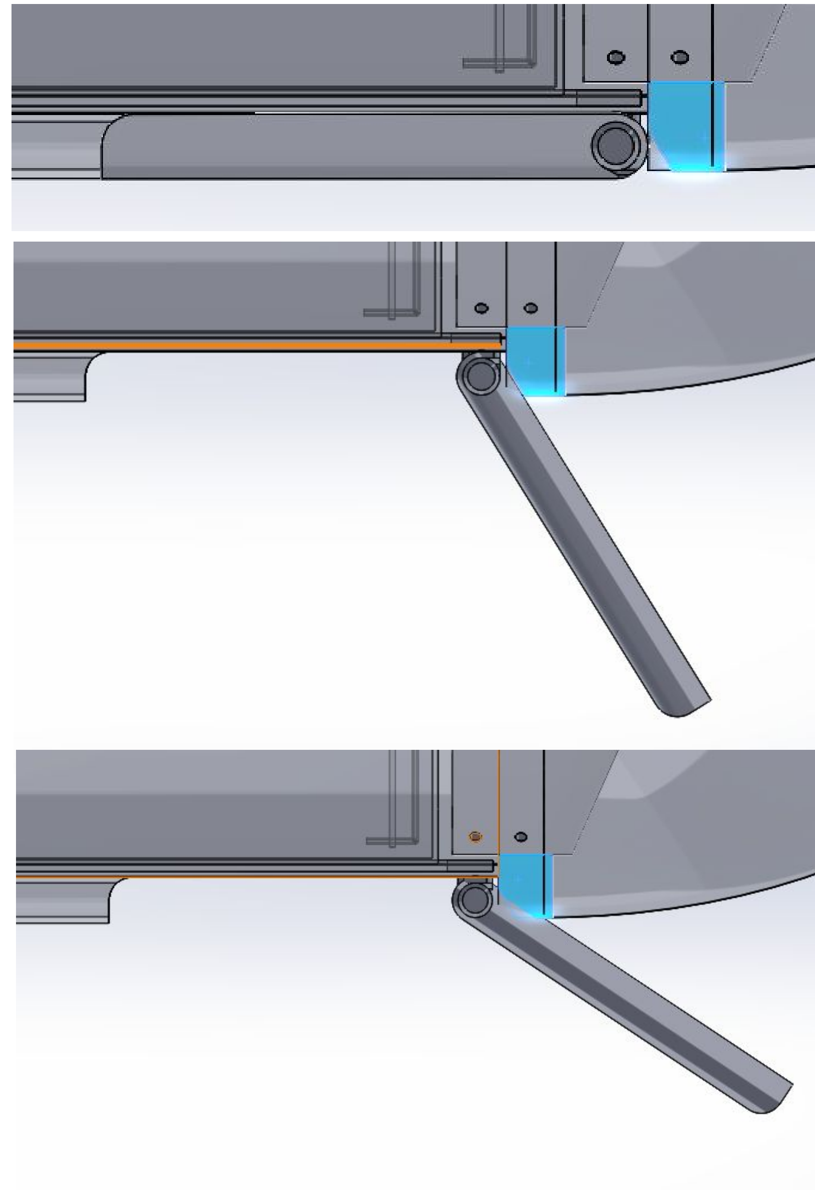
Landing Gear

- Flush with the fuselage in flight
- Deployable via reliable nichrome wire arrangement
- Absorbs energy with rubber stopper
- Weight estimate **1.35lbs**



Potential Risks

- Ease of resetting nichrome wire arrangement
- Shearing during crosswind landing



Center Fuselage Testing

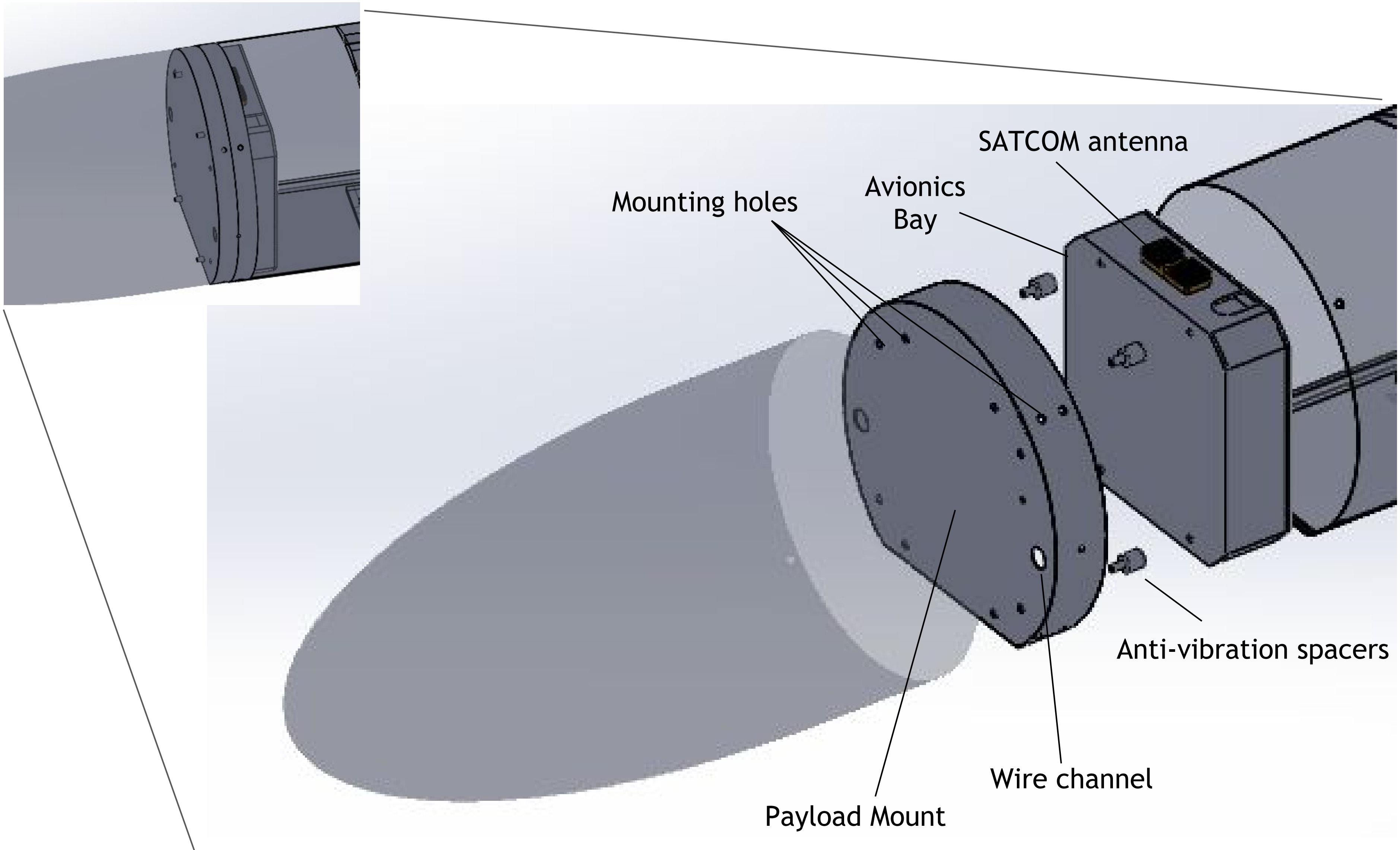
Pylon Attachment Strength Test

- Components:
  - Fuselage center shell
  - Pylon
  - Pylon connection assembly
- Test Objectives:
  - Configuration response to loading
  - Verify the strength of pylon attachment
  - Cracking
  - Delamination
  - Structure deformation

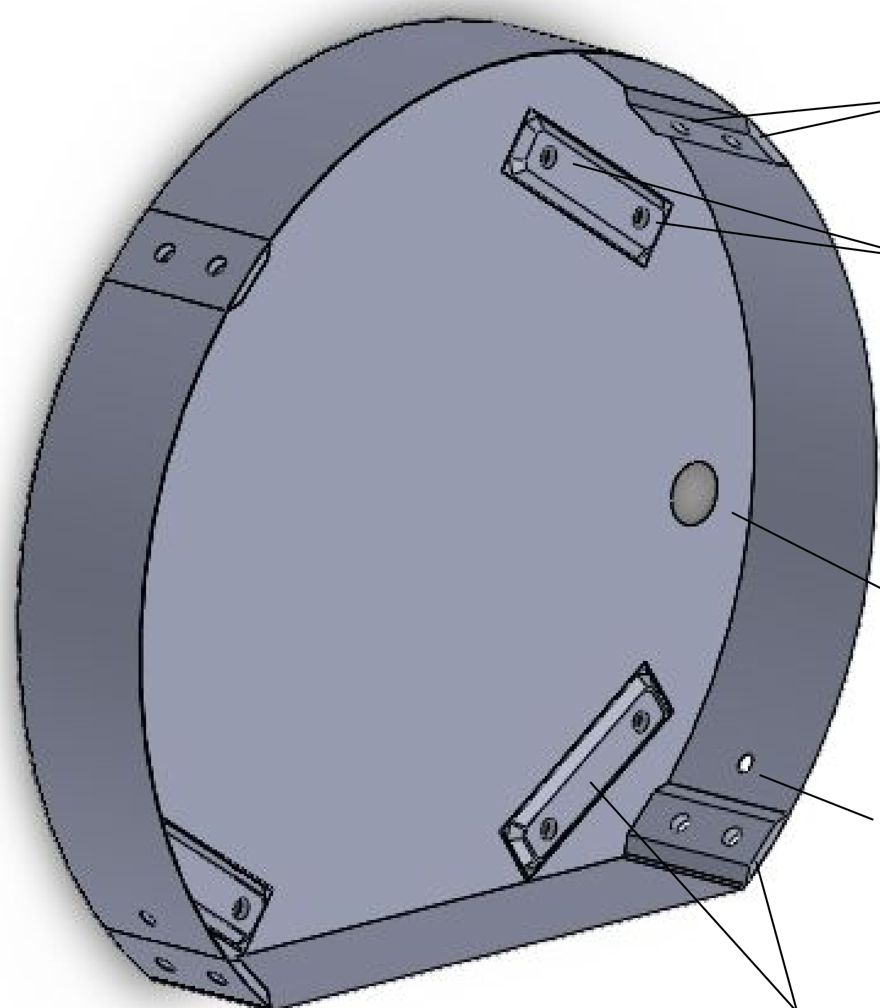
Drop Test

- Components:
  - Fuselage center shell
  - Landing gear
- Test Objectives:
  - Deformation upon impact to ground
  - Delamination
  - Cracking

Payload Mount

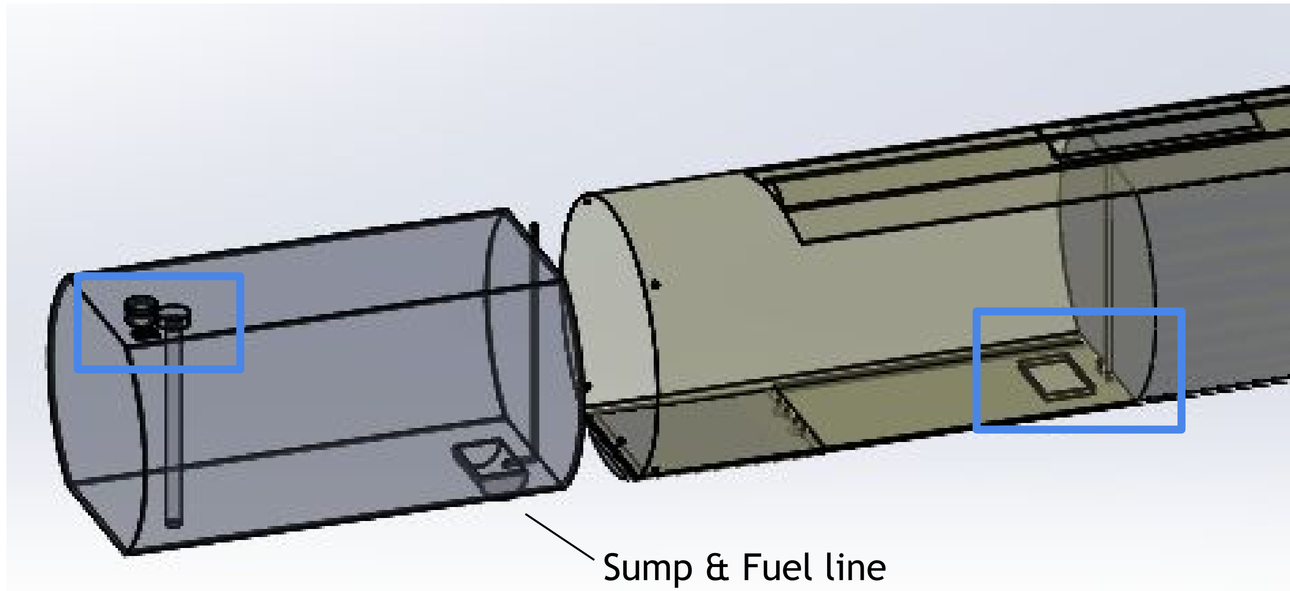


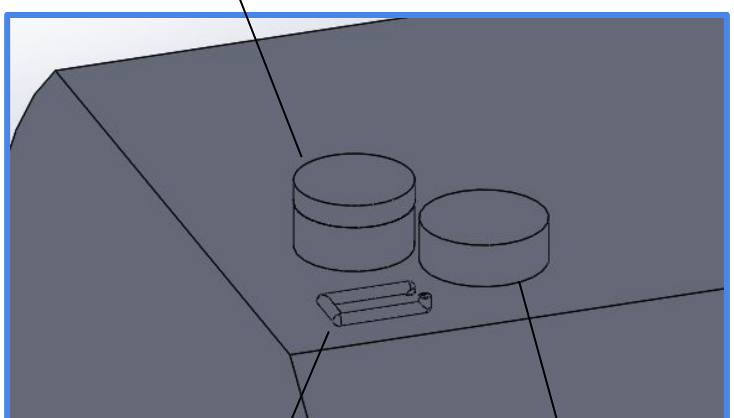
Payload Mount

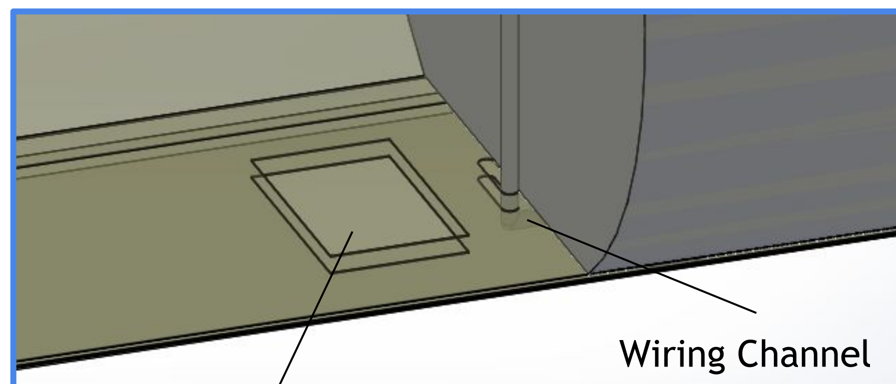


Fuel Tanks

- Semi-rigid
- Internal baffling prevents fuel slosh
- Sumps allow maximum fuel consumption







Design Overview and Performance

Aerodynamics

Structures

<u>Propulsion</u>

Avionics

Flight Operations

Development Plan

Engine Evaluation

Currently carrying RCV DF70 Engine with TorqPro TP70 as alternative:

- Both are 4-stroke, 70cc engines
  - RCV is two-cylinder
  - TorqPro is single cylinder
- DF70 arrives mostly pre-assembled with alternator, ECU, fuel system, and ignition system
  - 10 week lead-time
  - Unable to test this semester
- TP70 requires fitting and configuring 3rd-party EFI system, also does not come pre-assembled with alternator

RCV DF70

TorqPro TP70

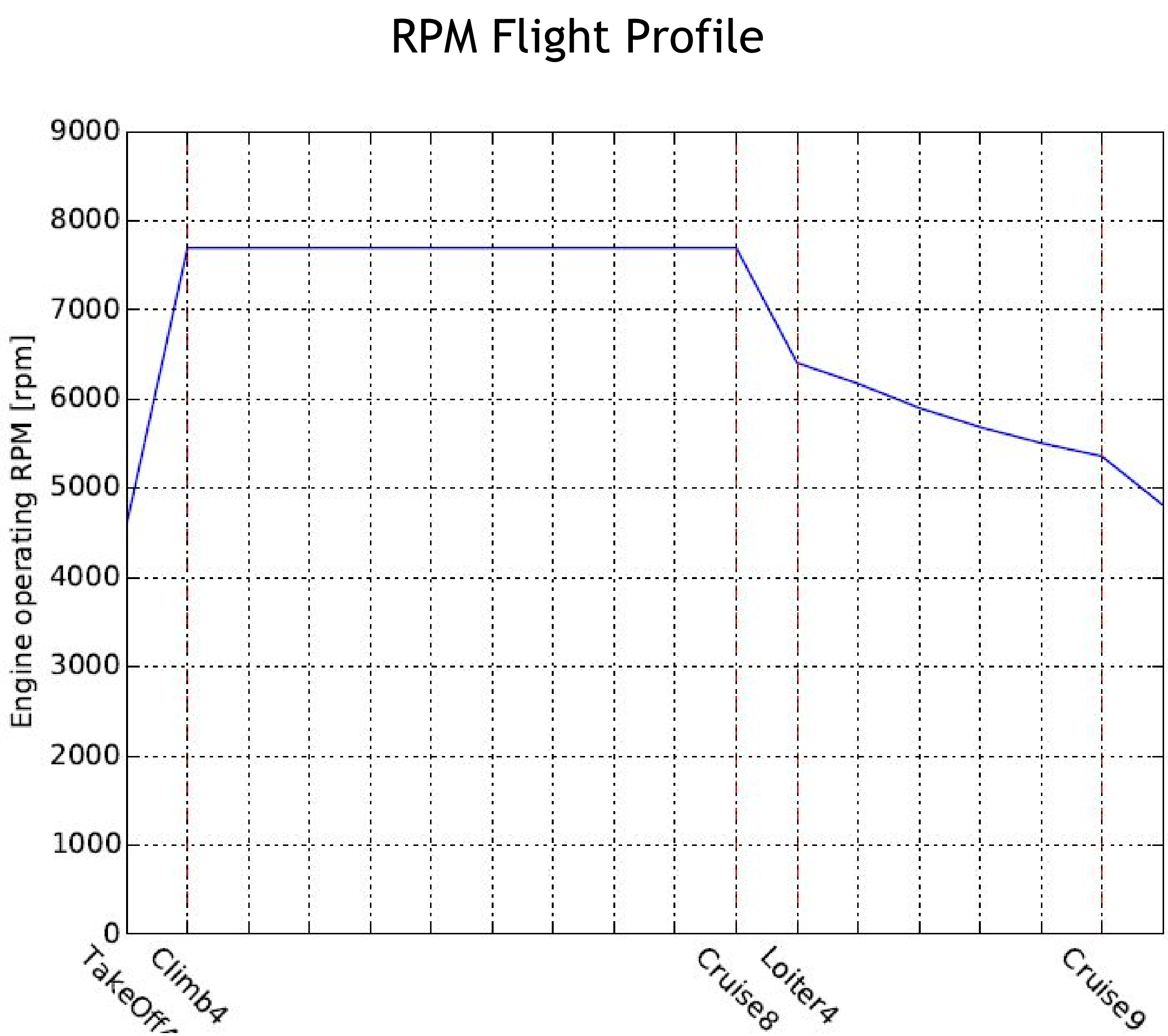
Engine Requirements and Flight Profile

Requirements:

- Provide **230W of AC electrical powe**r to avionics system
  - 100W from Payload at surge power levels
  - 130W from Avionics Bay at surge power levels
- Provide at least **5.12hp of equivalent sea level total power** for climb, maneuvering and steady level flight during all stages of the mission
- Achieve **minimum brake specific fuel consumption** (BSFC) of 0.54 lb/hp hr

	Top of Climb	Cruise	Loiter Start	Loiter End
Altitude [ft]	0 - 15000	15000	15000	15000
Total Power Requirement [hp]	2.47	1.44	1.13	0.69
Equivalent Sea Level Power [hp]	**5.12**	1.77	2.35	1.43

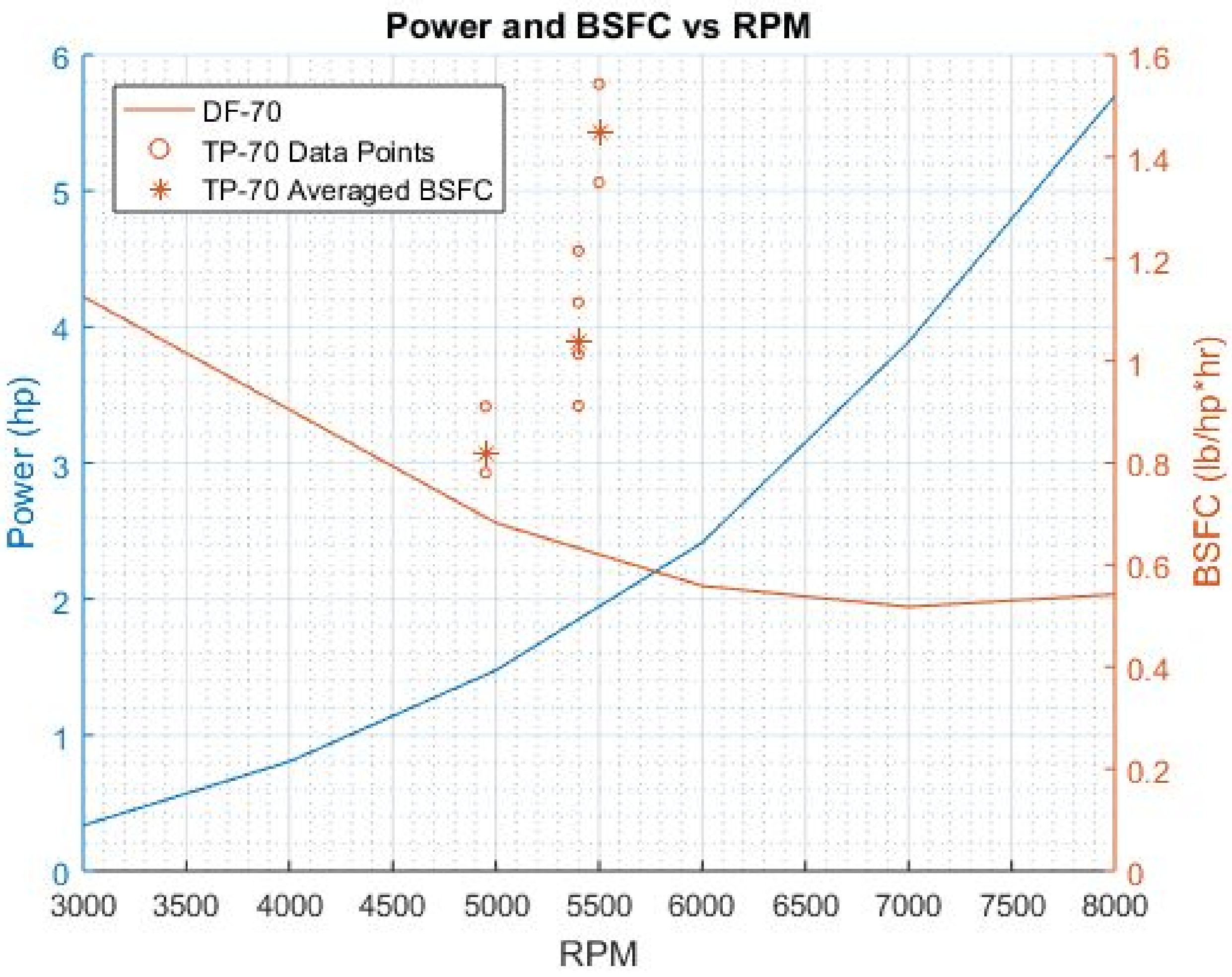
Engine Flight Profile (Continued)



Alternative Engine Testing and Evaluation

- TP-70 meets the previously mentioned requirements
  - Currently evaluating TP-70 BSFC
  - Performing static fuel consumption tests using identical propeller as RCV DF-70 testing (22x8)
  - Preliminary results suggest performance worse than DF-70, however there are a number of reasons why this might improve

RCV DF70 and TorqPro TP-70 Preliminary Data

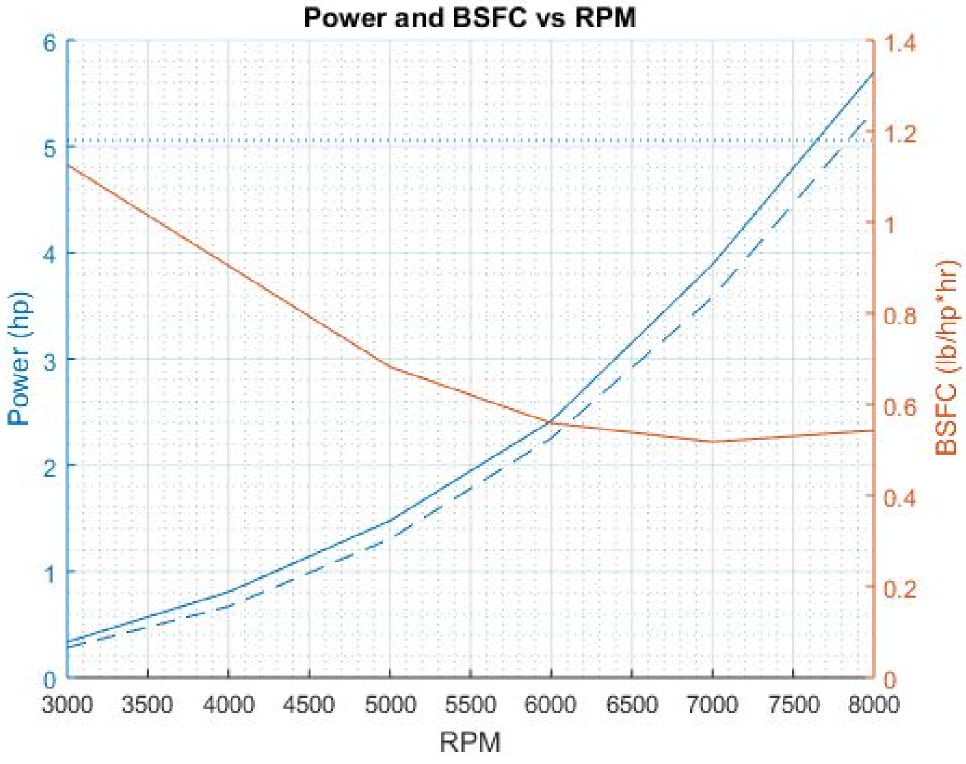


Preliminary Results Analysis

- Preliminary results suggest performance comparable to DF-70 at certain RPM’s and significantly worse at others
- Preliminary results may be unreliable due to:
  - Engine not completely “run in”
  - Poor tuning of carburetor and fuel mixture
  - Poor valve timing adjustment resulting in wasted “backfire” of fuel from intake and poor compression
  - Loss of compression in cylinder due to head gasket failure
- We have reason to believe better understanding of engine and further testing could yield lower BSFC values
- However, we are concerned about the reliability and longevity of the engine

Propeller Choice

- TP-70 more powerful than DF-70 - 6.2hp vs 5.47hp - we already have some power margin during climb
- Propose move to higher pitch, lower diameter propeller for higher propulsive efficiency and potentially better BSFC, at expense of climb performance: test 20x10 propeller, compare to 22x8



Engine Cooling

Minimize cooling drag

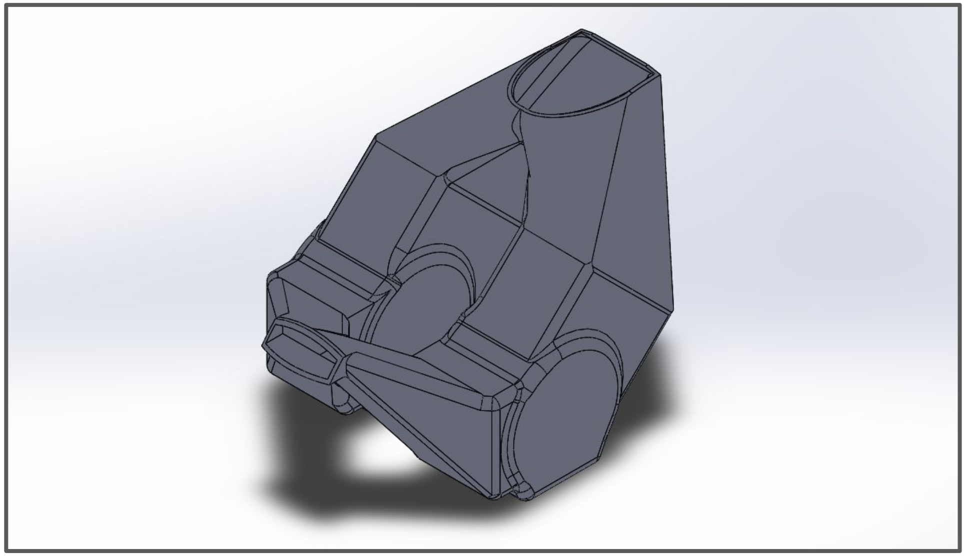
- Reduce intake velocity
- Increase outlet velocity
- Minimize total pressure losses within the duct

Air Intake in the Pylon

Single outlet port

0.008” 2-ply Kevlar

Engine	RCV DF-70	TorqPro TP-70
Inlet Area	9.3 in^2	9.3 in^2
Radiator Frontal Area	19.04 in^2	11.16 in^2
Outlet Area	6.3 in^2	4.65 in^2



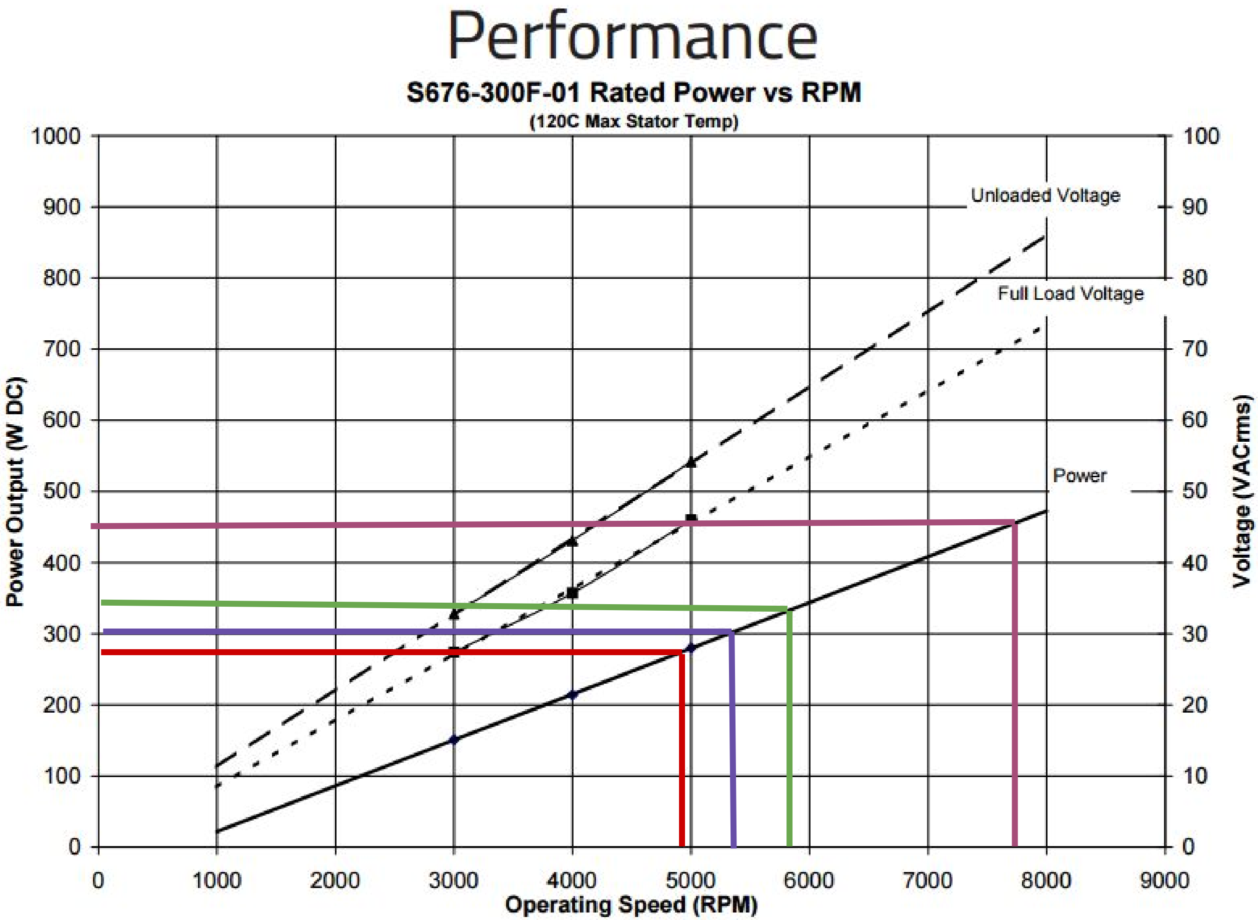
Alternator

Sullivan S676-300F-01

Weight	350g
RPM Range	2500-7500
Power Range	120W-475W

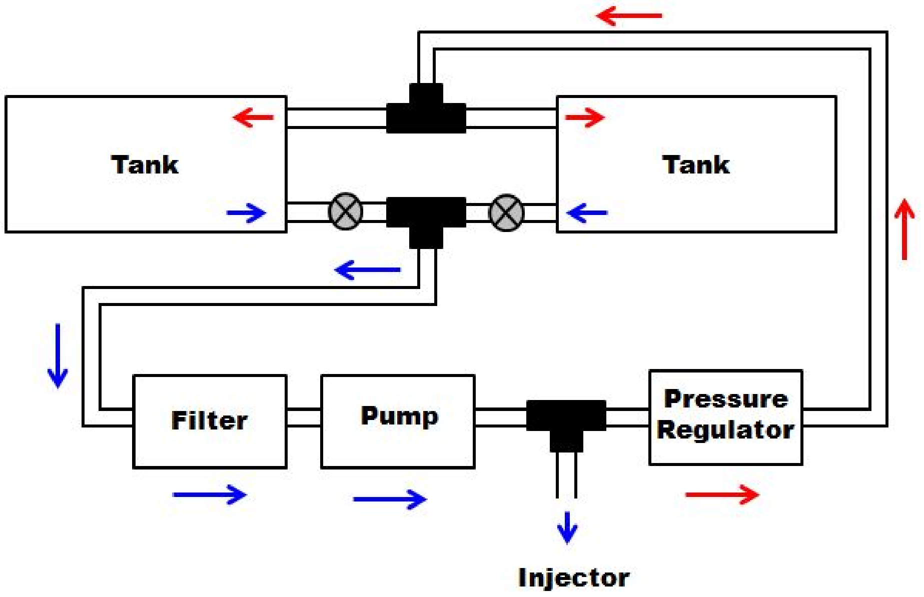
Alternator

Flight Regime	RPM	Power [W]
Climb	7700	450
Cruise	5290	300
Loiter Start	5890	330
Loiter End	4970	280



Fuel System

- Fuel drawn from both fuel tanks
  - Fuel lines merge via T-pipe
- Single filter, fuel pump, and pressure regulator
- Check-valved fuel lines prevent fuel exchange between tanks
- Greater fuel flow rate than fuel consumption rate: provides uniform flow to the injector and eliminates
  - Excess fuel recirculated into the fuel tanks



Risks

- BSFC of DF70 engine worse than quoted
- Current DF70 BSFC data given by RCV:

Performance	Top of Climb	Cruise	Loiter Start	Loiter End
Engine Operating Speed [RPM]	7700	5290	5890	4970
Vehicle Speed [mph]	58	68	56	56
BSFC[lb/hp/hr]	0.532	0.644	0.573	0.687

- Engine inadequately cooled
  - Actively controlled flow rate
- Engine power consumption
  - Engine has ECU, spark plugs and EFI system (fuel pumps, sensors, etc.) that require power in addition to the 230W from Avionics systems

Plan Going Forward

- Continue testing TP70 engine
  - Emulate tests done for DF70
  - Run more tests with 22x8 Zinger propeller to obtain BSFC data
- Test EFI system for power consumption
  - Fuel pump
  - O2 sensor
- Continue communication with EFI manufacturer for TP70
  - Smaller system with less weight
- Obtain power consumption values for DF70
  - Currently in contact with manufacturer

Design Overview and Performance

Aerodynamics

Structures

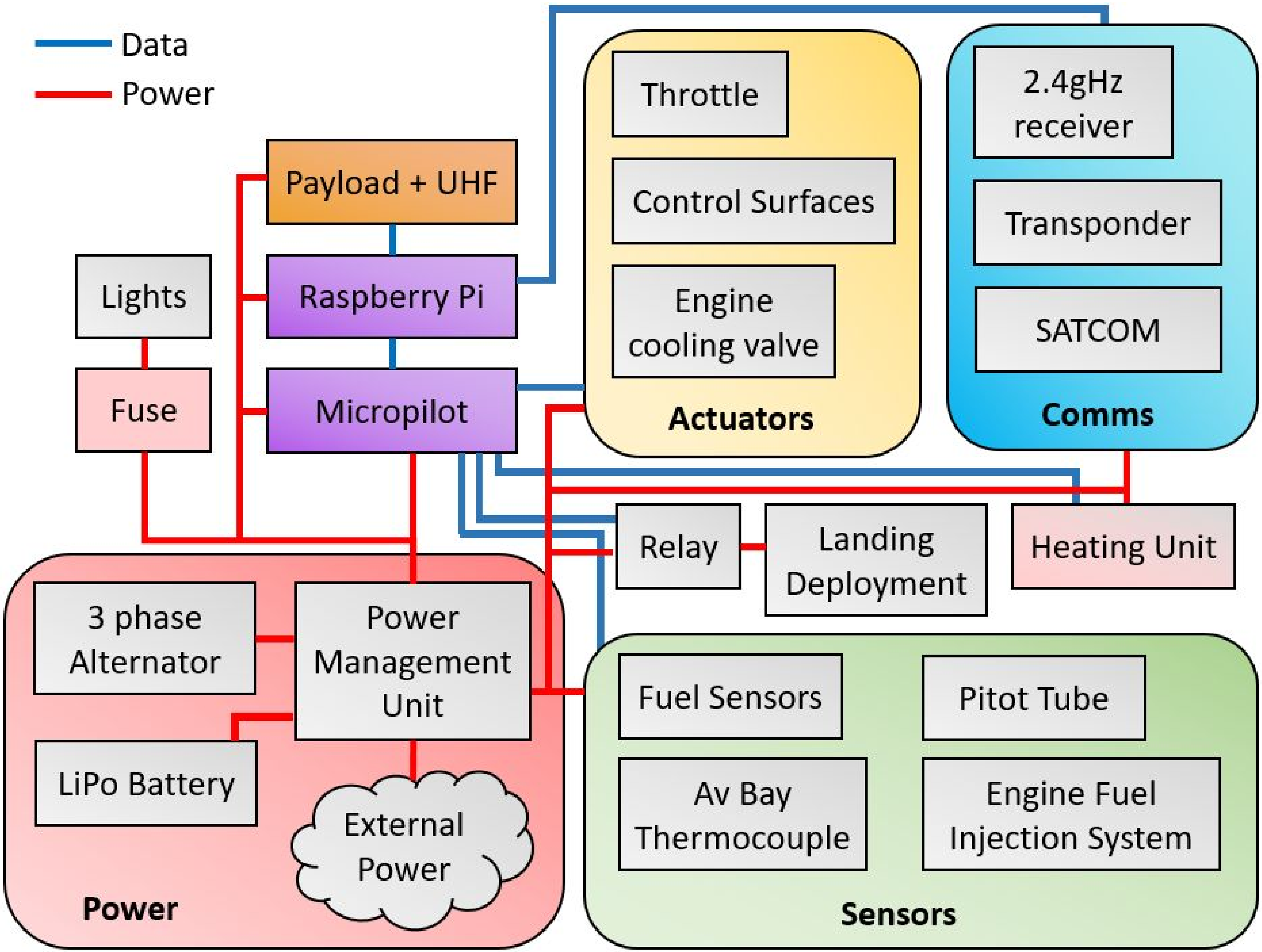
Propulsion

<u>Avionics</u>

Flight Operations

Development Plan

Avionics - System Diagram



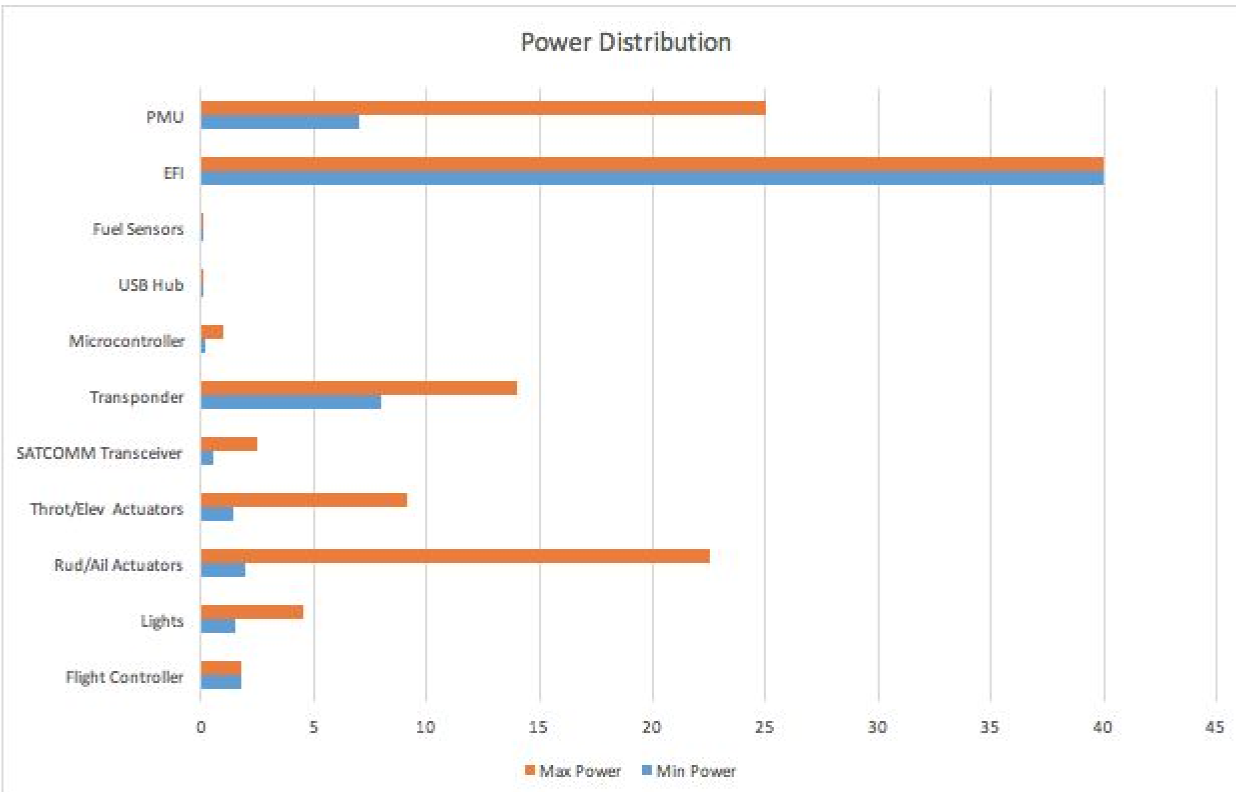
Avionics - Mass Budget

Component	Mass (Total: 5.6 lb)
Flight controller	0.85 oz
Lights	6.1 oz
Actuators	6.9 oz
Pitot Tubing	1.6 oz
SATCOM Antenna	1.6 oz
RockBLOCK	2.7 oz
Transponder + Antenna	4.5 oz
PMU	12.3 oz
Battery	17.2 oz
Fuel Sensors	2.1 oz
Harnessing	21.2 oz
Avionics Bay	12.3 oz
Microcontroller	0.3 oz
USB Hub	1.0 oz

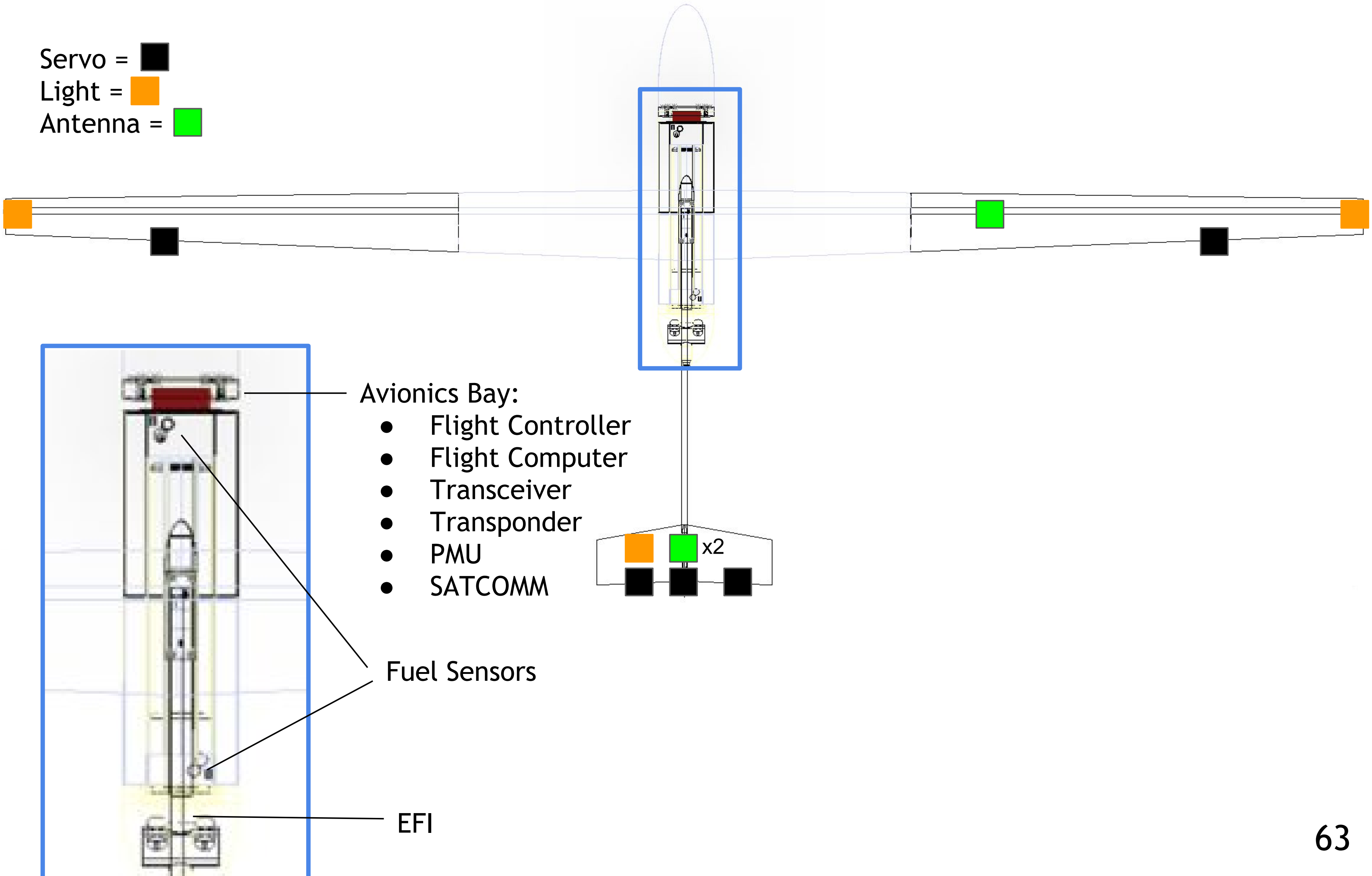
Avionics - Power Budget

Power

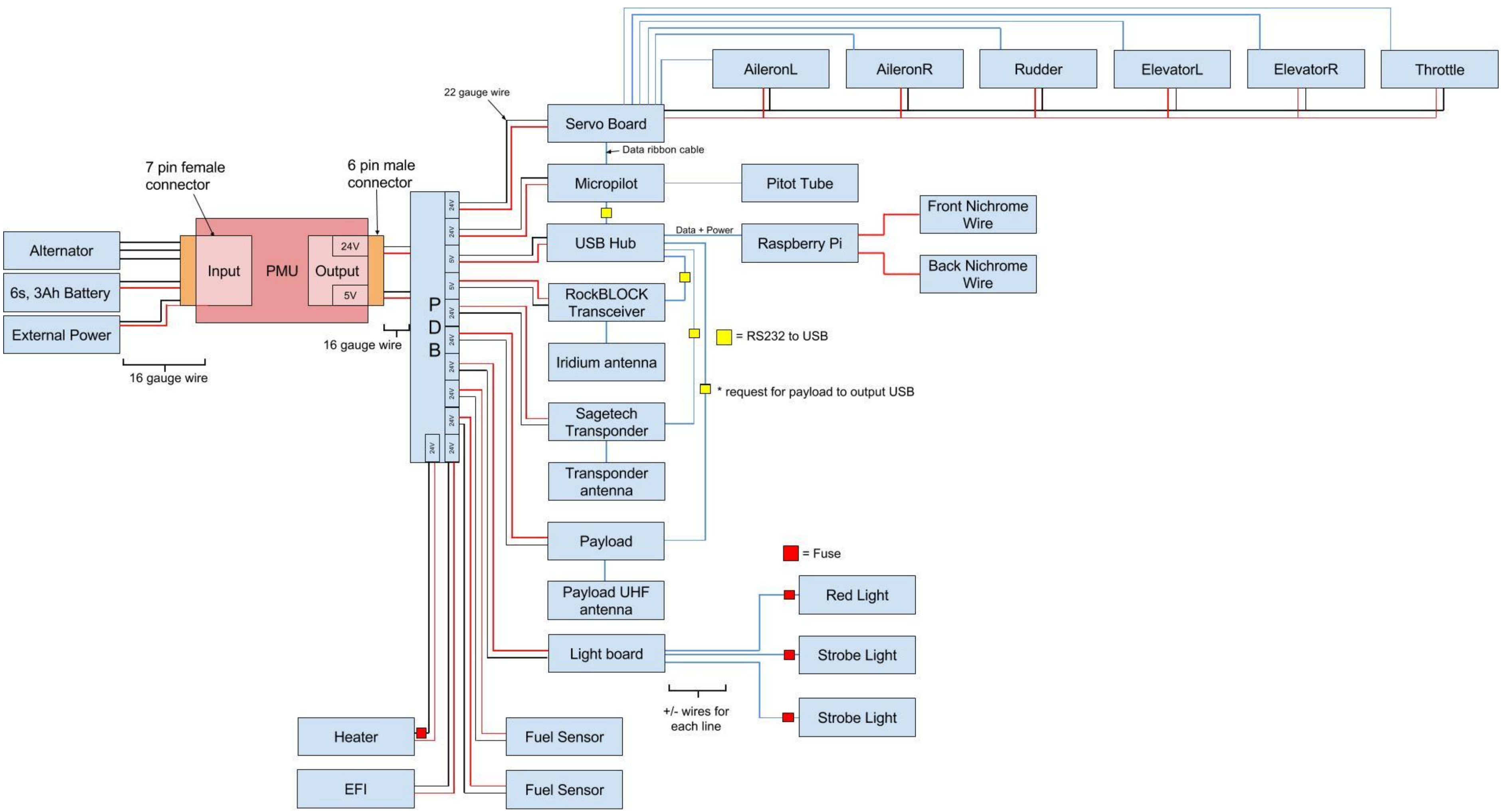
- Alternator power limit: 280 W
- Budgeted mission load: 80 W + 100 W Payload
- Calculated standby load: 63 W + 100 W Payload
- Calculated surge load: 121 W + 100 W Payload



Avionics - Component Layout



Avionics - Wiring Diagram



Avionics - Actuators

- Control surfaces
  - Ailerons & Rudders
    - Operating Temperature: -40 to 158 ℉
    - Case Dimensions: 2.6×2.0×0.8 in
  - Elevators & Throttle
    - Operating Temperature: -40 to 148 ℉
    - Case Dimensions: 2.3×1.4×0.6 in

- Landing Gear
  - Nichrome Wire

Avionics - Avionics bay

- Contains:
    - Flight Controller
    - Flight Computer
    - Transceiver
    - Transponder
    - PMU
    - SATCOMM
    - Battery

- Conductive material construction to reduce electromagnetic interference
- Soft rubber mounts to reduce vibration amplitude
- Insulation to aid in temperature control

Flight Computer

Avionics - Thermal Management

Operating range of temperatures is 0 C (Raspberry Pi) to 60 C (PMU)

Heating:

- Required when: operating at altitude, temperatures below 0 C
- Recommend: use resistive heating unit + insulated avionics box for operating at colder temperatures,
- PMU always radiates 15% of the power sent through it, resistive heater consumes 10W when in use (2% of the time)

Cooling:

- Required when: on ground in extreme temperatures
- Recommend: having a small intake to pass air over the surface of the box when necessary

Avionics - Temperature Analysis

Assumptions: System in equilibrium, heating much easier than cooling, temperature outside equal to the plane temperature, 15% power losses

$$P_{input} = \frac{cA(T_{high} - T_{low})}{L}$$

Cruise

- Temperature in cruise at 15,000ft is within (-58F, 15F)
- 163W used on average ⇒ 24.5W dumped into avionics bay
- L = 0.2in yields inside temperatures in (-11F,106F) ⇒ heater needed 2% of the time

Peak (top of climb):

- 221W used on average ⇒ 33W dumped into avionics bay
- L = 0.2in yields inside temperatures in (10F,122F)

Avionics - Temperature Analysis

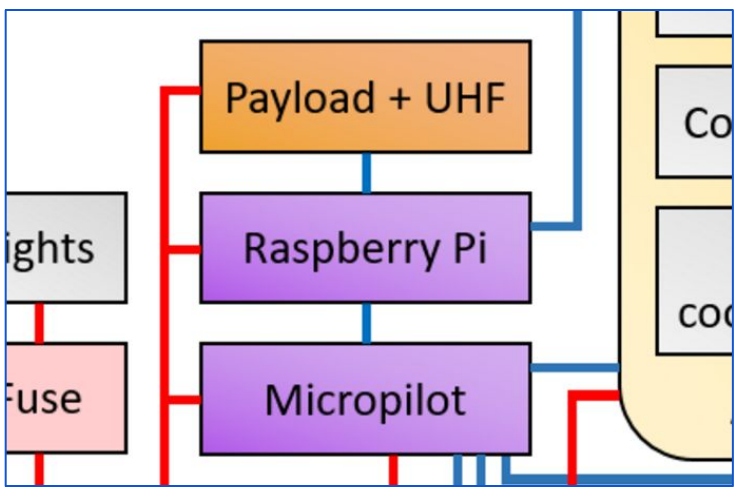
On the ground:

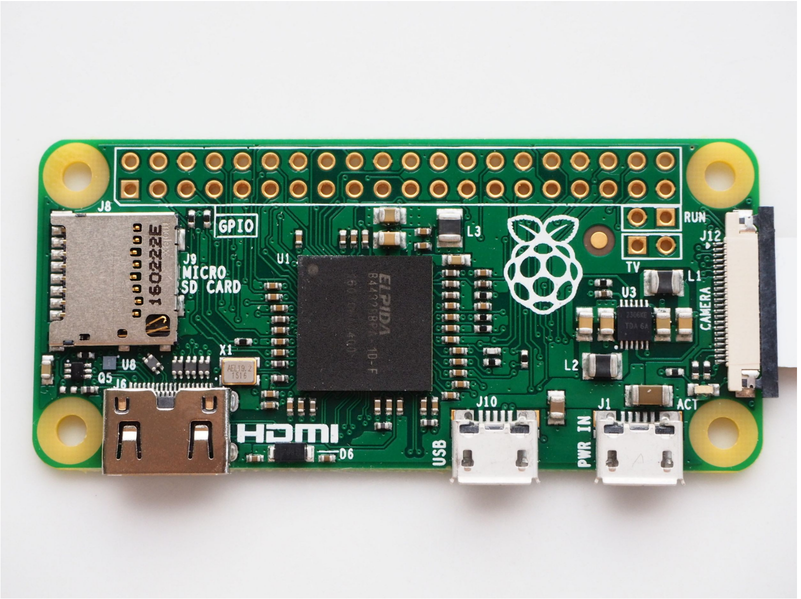
- Much more extreme temperatures (-70F, 115F)
- Focus on the higher end of the temperatures (as heating solves low temperatures)
- Inside temperature of the plane at 115F ⇒ 150F (assumed)
- Payload off, so 63W ⇒ 10W dumped into avionics bay
- Sets the inside of the avionics bay at 170F
- **~20W of cooling necessary!**

Avionics - Key Control Components

Raspberry Pi Zero

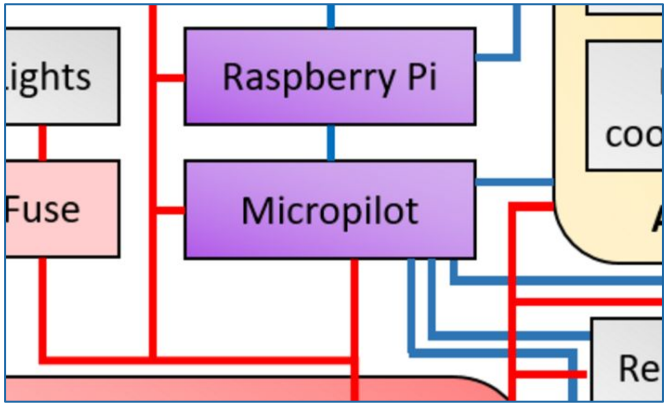
- Avionics hub
- Data handling
- Encryption/decryption using GnuPG
- Payload & Micropilot interfacer
- Avionics bay temperature control





Avionics - Key Control Components

MicroPilot MP 2128 HELI 2

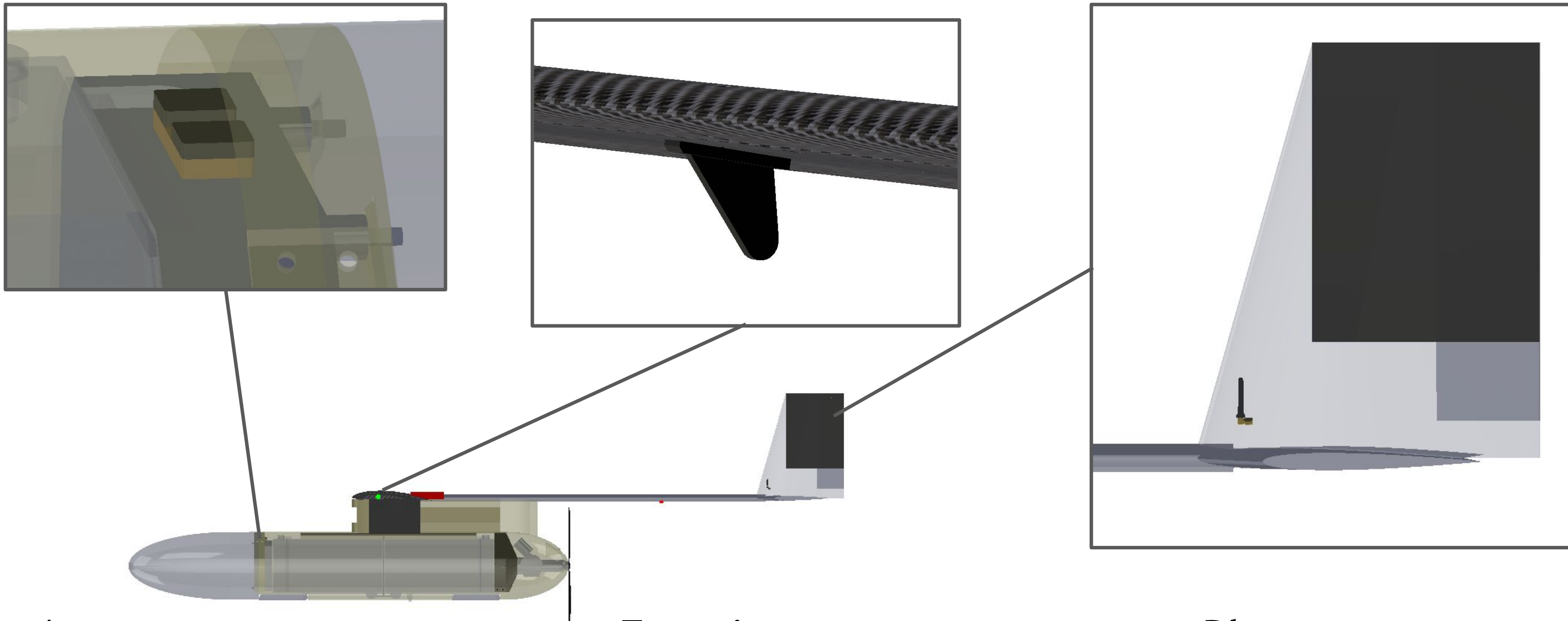


- Fully integrated with 3-axis gyros/ accelerometers, GPS, pressure altimeter, pressure airspeed sensors
- data logging and telemetry
- Software Development Kit for custom mission functionality

Avionics - Ground Control Station

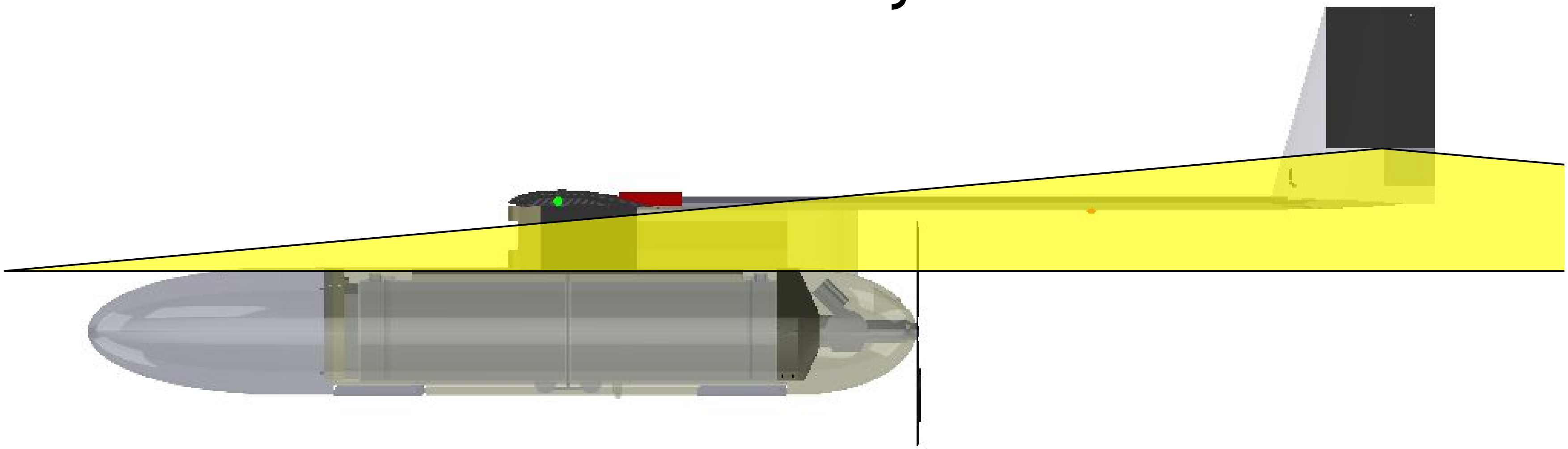
Micropilot HORIZONmp ground control software

Avionics - Communications Overview



Antenna	Function	Placement
1610 - 1626.5 MHz Iridium	BLOS command/control	top of avionics bay
1030 - 1090 MHz blade	Mode S/ADS-B transponder	wing underside
30 - 512 MHz peel-and-stick	payload communications	tail surface
2.4 GHz	LOS command/control	tail interior

Avionics - Communications - Payload ANT



- 5 degree downward-looking angle satisfies 100 km coverage requirement from 15000 ft
- Carbon fiber wing probably OK

RISKS:

- Shadowing from fuselage and engine unavoidable
- Peel-and-stick antenna placed over tail rudder hinge

MITIGATION:

- Subscale test @ Lincoln Lab RF anechoic chamber: Feb/March 2017
- Life-cycle testing of rudder hinge with antenna: ASAP (pending purchase)

Avionics - Testing

Test	Test Objective	Test Description	Required Equipment
Antennas	Verify shadowing effects are acceptable	Antenna coverage test on subscale aircraft model at Lincoln	RF anechoic chamber at LL Subscale model with antenna at scaled frequency
SATCOM	Establish connection with Iridium, send and receive data	Using RockBlock Antenna as a module for RaspberryPi connect to the Iridium System.	RockBlock with Antenna, RaspberryPi
Encryption	Confirm accuracy of encryption and decryption	Receive and decrypt data, encrypt and send data	Rockblock with Antenna, RaspberryPi
Thermal	Validate that components will function within mission bounds	Run components in freezers and heaters to verify they still operate to specification	Every component
Micropilot integration "Ironbird"	Test the functionality of MicroPilot	Bench test using both R/C and SATCOM to show the correct motion of attached servos dependent on the commands used.	Micropilot, wires, servos, Rockblock with Antenna

Design Overview and Performance

Aerodynamics

Structures

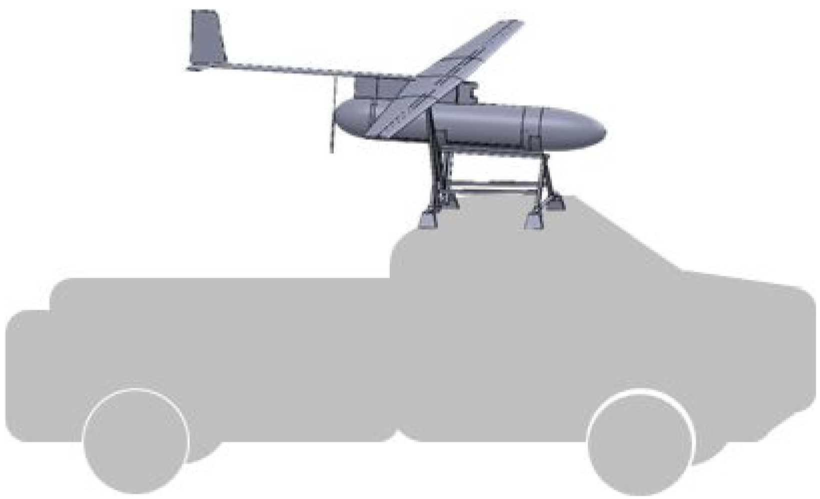
Propulsion

Avionics

Flight Operations

Development Plan

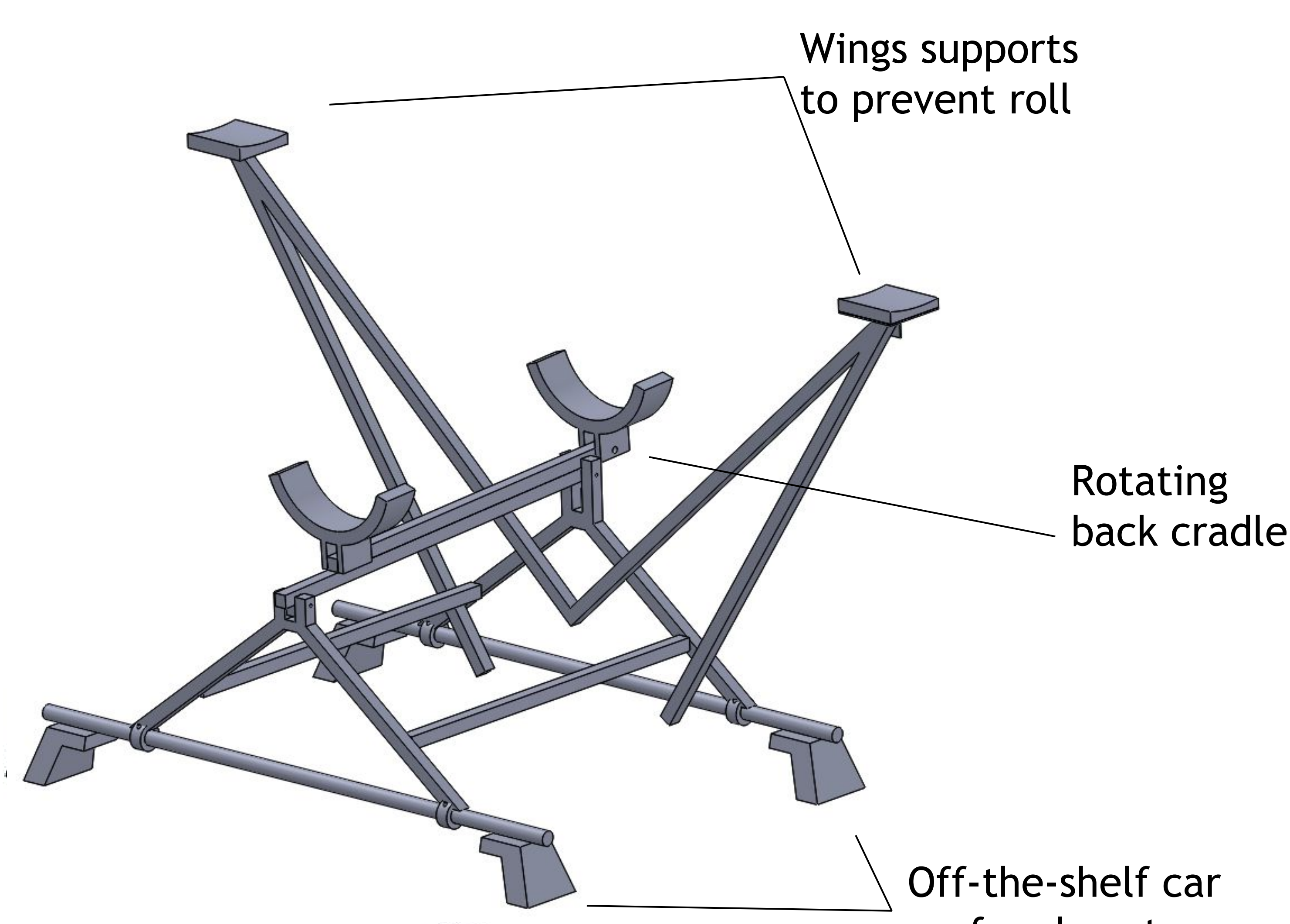
Takeoff Mechanism



Vehicle-assisted launch from any car or truck

Take-Off + Braking Distance < 1200 ft

Takeoff Mechanism



Design Overview and Performance

Aerodynamics

Structures

Propulsion

Avionics

Flight Operations

<u>Development Plan</u>

Development Plan

0. Subsystem testing:

- Propulsion BSFC, fuselage-pylon interference, landing & fuselage structure, manufacturing, avionics bench test

1. Subcale aircraft (V-1):

- Test takeoff structure, avionics, and manufacturing processes

2. Full-scale, lightweight aircraft (V0):

- <55 lbs, FAR 107 allows local flight test
- Gain flight hours of the partially-fueled aircraft

3. Full-scale, full weight (V1):

- V0 brought up to MTOW

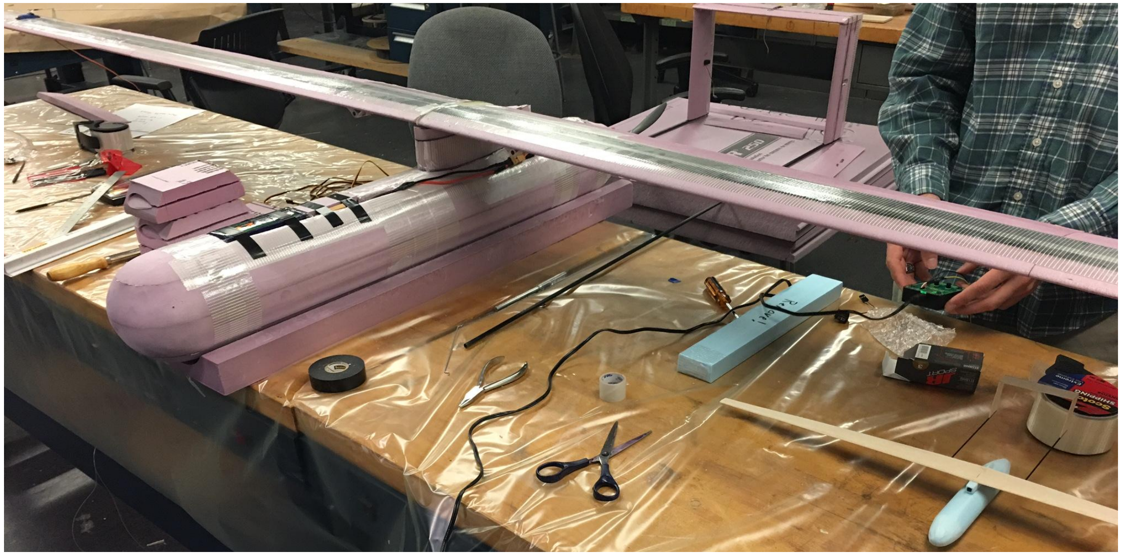
4. Full-scale, long endurance (V2):

- Second full-scale vehicle, equipped for endurance testing

Half-Scale Model Testing

- Primary Test: Evaluation of Takeoff Mechanism
  - Conduct takeoff runs without rotation and separation to measure pitch control authority
  - Conduct takeoff runs with rotation and separation to check separation between aircraft and launch device

- Secondary Test (Optional): Avionics Flying Testbed
  - Install SATCOM command and control equipment on aircraft
  - Demonstrate in-flight handoffs from LOS to BLOS control



V0 Testing

- Configuration #1: Remove one fuel tank, Micropilot, SATCOM antenna and transceiver, transponder unit and antenna
  - Dry Weight: 41.14 lbs
- Configuration #2: Remove one fuel tank, transponder unit and antenna
  - Dry Weight: 41.68 lbs
- Primary Test: Performance
  - Sub-400 ft. AGL flight
  - Extrapolate cruise performance
  - Expend all allowable fuel and extrapolate fuel consumption data
- Other Tests
  - Takeoff Mechanism
  - Landing Gear
  - Handling Qualities
  - Engine Cooling
  - Air Data System Calibration
  - Initial Payload Test*

V1/V2 Testing

- Repeat takeoff, landing, and fuel consumption tests with 100% fuel

- Long Endurance Test
  - Ensure that aircraft is capable of meeting 5-day requirement
  - Will conduct a series of daytime flights at TBD altitude and extrapolate fuel burn data

- Payload Test at Altitude*

Test Location

- Out of the 6 potential sites, eliminated Texas, Alaska, and Nevada
- Evaluation Matrix for sites in North Dakota, New England, and Virginia

Requirement
Site shall provide storage area for the aircraft and program associated equipment
Site shall have at least one runway with a usable length of 1500 ft.
The designated airport shall accommodate the truck-based takeoff mechanism
The designated airport shall accommodate the skid-based aircraft landing mechanism
Site's CoA shall accommodate daylight flight operations to an altitude of up to and including 15,000 ft MSL.
Site shall be in operation for the duration of the vehicle’s endurance test flight. The duration shall not exceed the time between one hour before sunrise and one hour after sunset.
Site's allocated airspace shall have a TBD nm radius over the airport of operations.
Site location shall allocate airspace such that the aircraft can make a forced landing in an unpopulated area in the event of an in-flight emergency

Schedule: Fall 2016

Schedule Item	9/5	9/12	9/19	9/26	**10/3**	10/10	10/17	10/24	10/31	**11/7**	11/14	**11/21**	11/28	**12/5**	12/12	12/19
Risk Reduction & Refinements																
Concept Refinement Review																
TP-70 Engine Test																
Fuselage/Landing Gear Design																
Flight Test Site Evaluation																
Preliminary Design Review																
Fuselage Molds Build																
Fuselage/Landing Gear Build																
Fuselage/Pylon Wind Tunnel Test																
Subscale Model Build																
Subscale Model First Flight																
Subscale Model Flight Test																
Fuselage/Landing Gear Drop Test																
Determine Fuselage Design Failure Points																
Finalize Fuselage Design																
Wing Lay-up Construction																
Critical Design Review																
V0 Build																

Schedule: Spring 2017

Schedule Item	1/9	1/16	1/23	1/30	2/6	2/13	2/20	2/27	3/6	3/13	3/20	3/27	4/3	4/10	4/17	4/24	5/1	5/8	5/15	5/22
V0 Build and Systems Test																				
RFAC Model Build and Test																				
V0 Flight Test																				
V0-V1 conversion																				
V2 Build																				