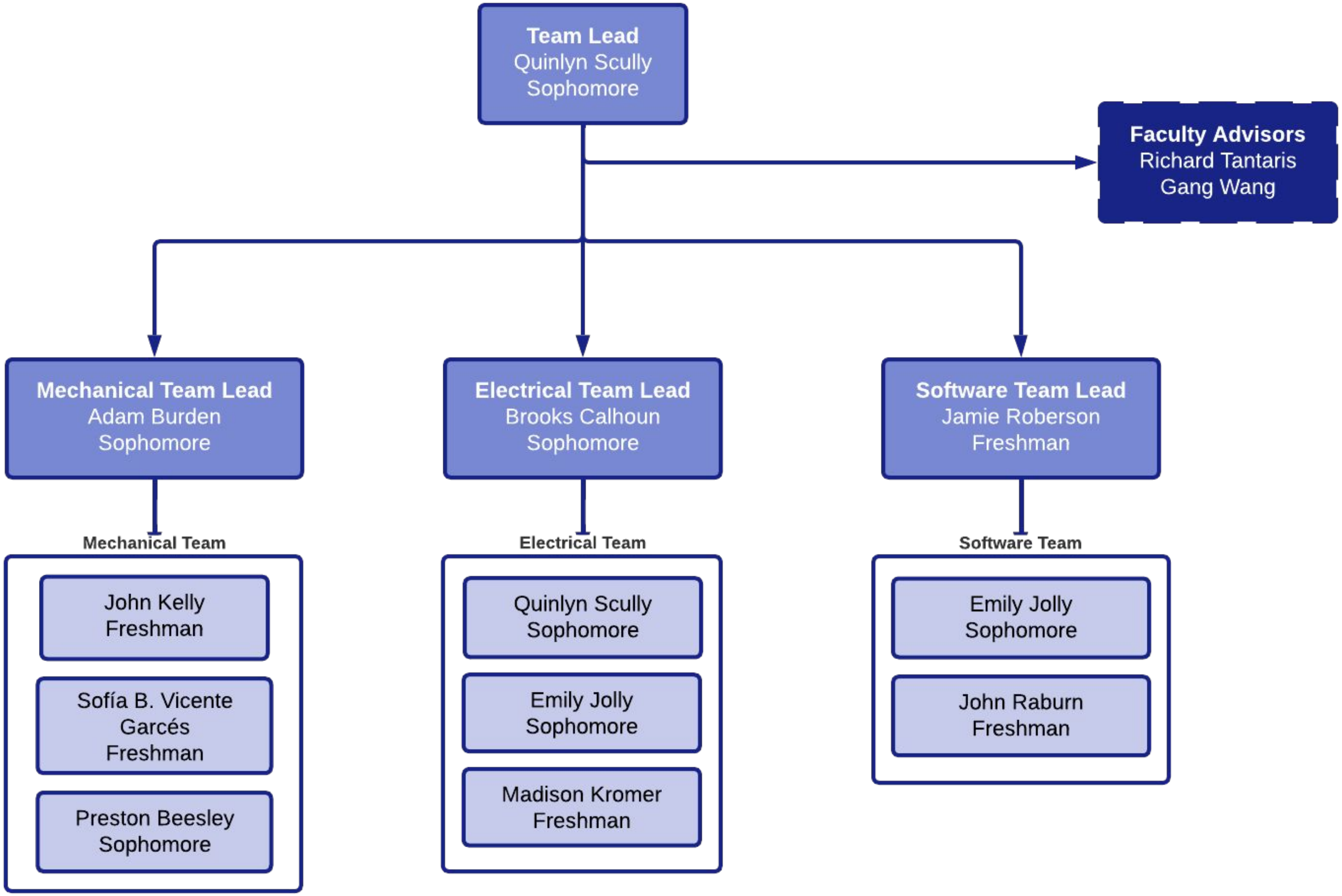
CanSat 2023
Preliminary Design Review (PDR)
Version 1.0

Team # 1070
Obsidian

Team Organization



Team Lead
Quinlyn Scully
Sophomore

Faculty Advisors
Richard Tantaris
Gang Wang

Mechanical Team Lead
Adam Burden
Sophomore

Electrical Team Lead
Brooks Calhoun
Sophomore

Software Team Lead
Jamie Roberson
Freshman

Mechanical Team

- John Kelly, Freshman
- Sofía B. Vicente Garcés, Freshman
- Preston Beesley, Sophomore

Electrical Team

- Quinlyn Scully, Sophomore
- Emily Jolly, Sophomore
- Madison Kromer, Freshman

Software Team

- Emily Jolly, Sophomore
- John Raburn, Freshman

Presentation Outline

Acronyms (1/2)

Acronyms	Definition
3D	3-Dimensional
ADC	Analog-to-Digital Conversion
CDH	Communication Data Handling
CDR	Critical Design Review
CONOPS	Concept of Operations
CSV	Comma Separated Values
DS	Datasheet
EPS	Electrical Power Subsystem
FSA	Flight State - Ascent
FSD	Flight State - Descent

Acronyms	Definition
FSH	Flight State - Heat Shield
FSI	Flight State - Idle
FSL	Flight State - Landed
FSP	Flight State - Parachute
FSR	Flight State - Ready
FSW	Flight Software
GCS	Ground Control Station
GPIO	General-Purpose Input/Output
GPS	Global Positioning System
GPS	Global Positioning System

Acronyms (2/2)

Acronyms	Definition
HAR	Hardware Acceptance Review
I2C	Inter-Integrated Circuit
ID	Identity
IDE	Integrated Development Environment
LED	Light Emitting Diode
MCR	Mission Concept Review
NETID	Network Identity
PCB	Printed Circuit Board

Acronyms	Definition
PDR	Preliminary Design Review
PETG	Polyethylene Terephthalate Glycol
PFR	Post Flight Review
PWM	Pulse Width Modulation
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
UART	Universal Asynchronous Receiver-Transmitter
UTC	Coordinated Universal Time

Systems Overview

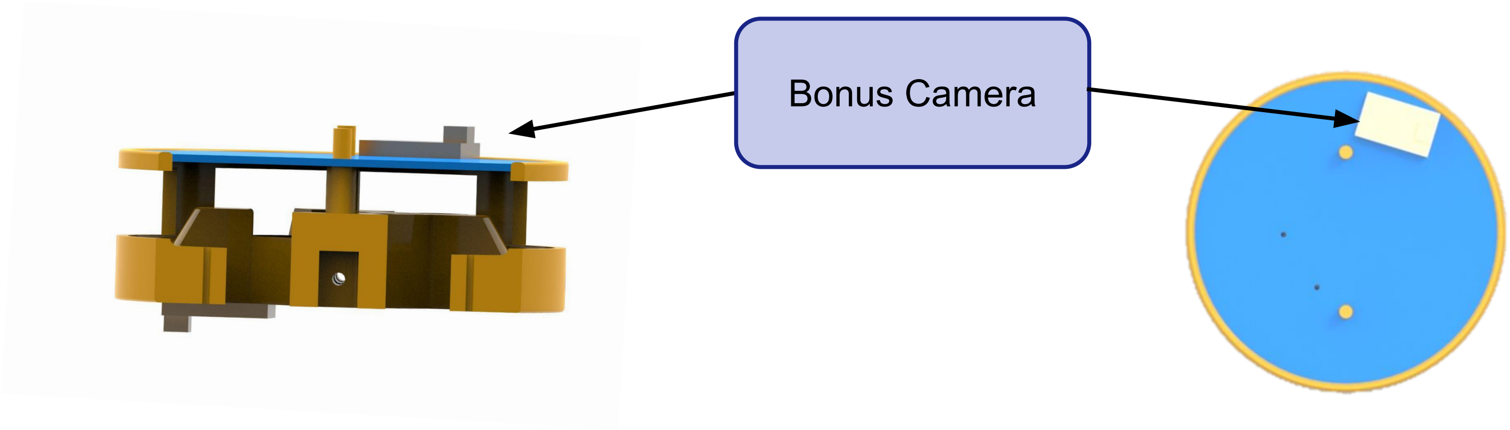
Preston Beesley and Adam Burden

Mission Summary (1/2)

	Mission Objectives
1	Design a CanSat that shall consist of a container and a probe simulating the landing sequence of a planetary probe.
2	The CanSat shall be launched to an altitude ranging from 670 meters to 725 meters above the launch site and deployed near apogee (peak altitude).
3	Orientation of deployment is not controlled during descent.
4	The CanSat shall survive the forces incurred at launch and deployment.
5	Once the CanSat is deployed from the rocket, the CanSat shall descend using a parachute at a rate of 15 m/s.
6	At 500 meters, the CanSat shall release a probe that shall open a heat shield that will also be used as an aerobraking device with a descent rate of 20 meters/second or less
7	A parachute, streamer, parafoil or similar device shall not be used with the heat shield.
8	When the probe reaches 200 meters, the probe shall deploy a parachute and slow the descent rate to 5 meters/second.
9	Once the probe has landed, it shall attempt to upright itself.
10	The CanSat must raise a flag 500 mm above the base of the probe when the probe is in the upright position.
11	A video camera shall be included and point toward the ground during descent.

Mission Summary (2/2)

Bonus Objective
A video camera shall be integrated into the container and point toward the probe. The camera shall record the event when the probe is released from the container. Video shall be in color with a minimum resolution of 640x480 pixels and a minimum of 30 frames per second. The video shall be recorded and retrieved when the container is retrieved.



Bonus Camera

System Requirement Summary (1/2)

Requirement Number	Requirement
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.
7	The rocket airframe shall not be used as part of the CanSat operations.
10	The descent rate of the CanSat (container and science probe) shall be 15 meters/second ± 5 m/s.
12	All structures shall be built to survive 15 Gs of launch acceleration.
13	All structures shall be built to survive 30 Gs of shock.
14	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.

System Requirement Summary (2/2)

Requirement Number	Requirement
15	All mechanisms shall be capable of maintaining their configuration or states under all forces.
32	The probe shall be released from the container when the CanSat reaches 500 meters.
33	The probe shall deploy a heat shield after leaving the container.
34	The heat shield shall be used as an aerobrake and limit the descent rate to 20 m/s or less.
35	At 200 meters, the probe shall release a parachute to reduce the descent rate to 5 m/s +/- 1 m/sec.
36	Once landed, the probe shall upright itself.
37	After uprighting, the probe shall deploy a flag 500 mm above the base of the probe when the probe is in the upright position.

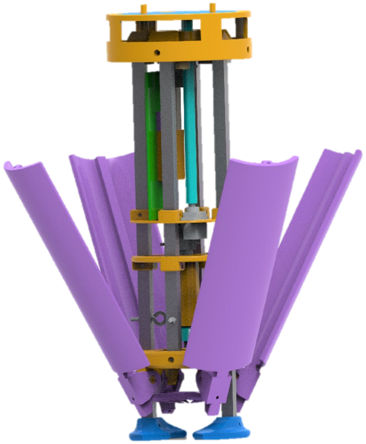
System Level CanSat Configuration Trade & Selection (1/10)

DESIGN 1

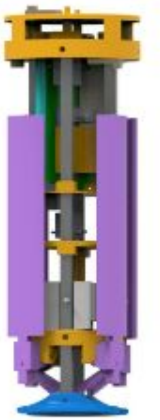
The release mechanism contains an arm and servo with string threaded through two holes. The heat shield includes four 3D printed panels that pivot from the bottom of the CanSat. These segments are used as the self-righting mechanism. The flag Mechanism consists of a threaded rod and a flag stem nut.

Pre-Deployment

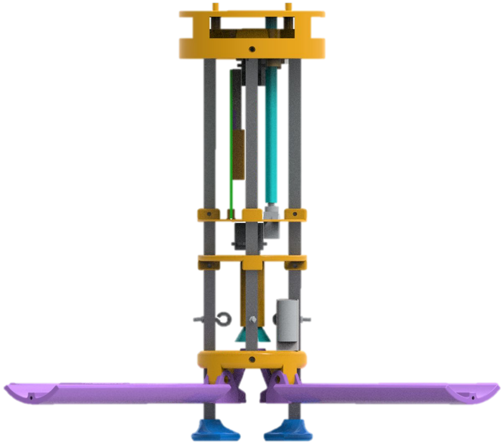
Heat Shield



Payload Parachute Deployment



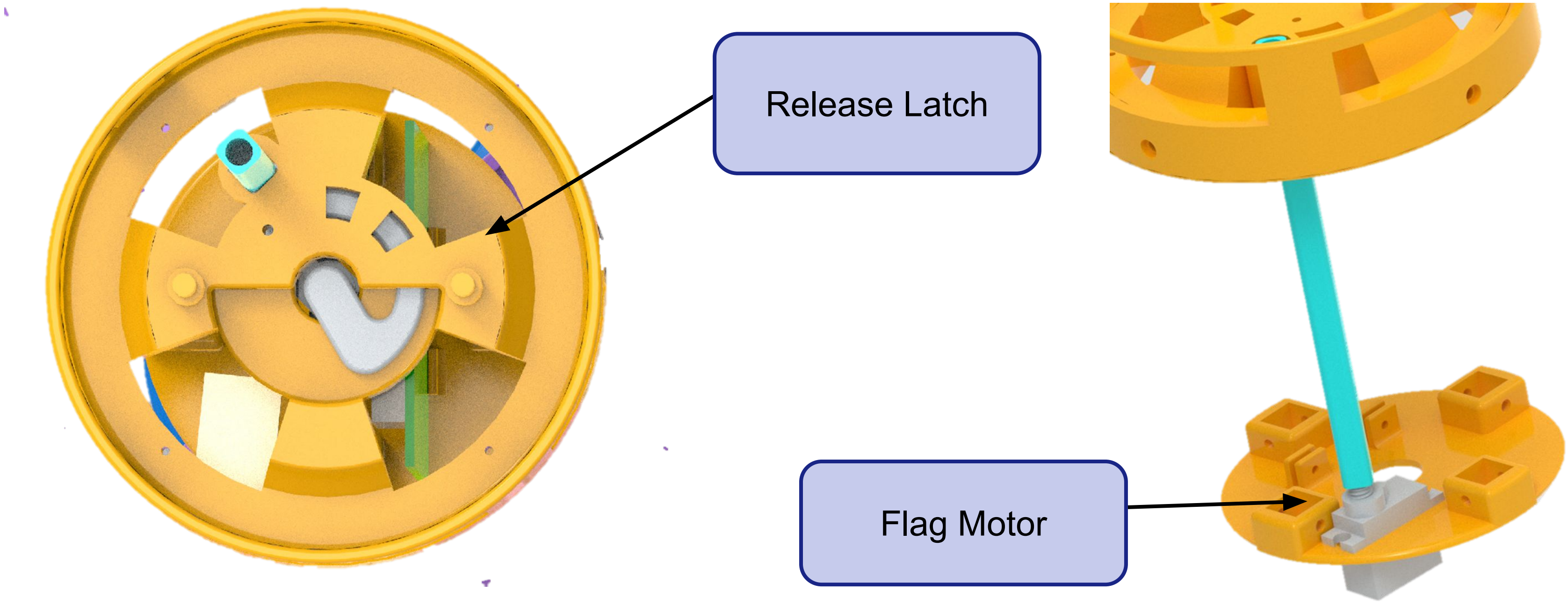
Landed and Upright



System Level CanSat Configuration Trade & Selection (2/10)

DESIGN 1

- The released latch will release the probe from the container and will deploy the payload parachute
- The flag motor will control the flagpole



Release Latch

Flag Motor

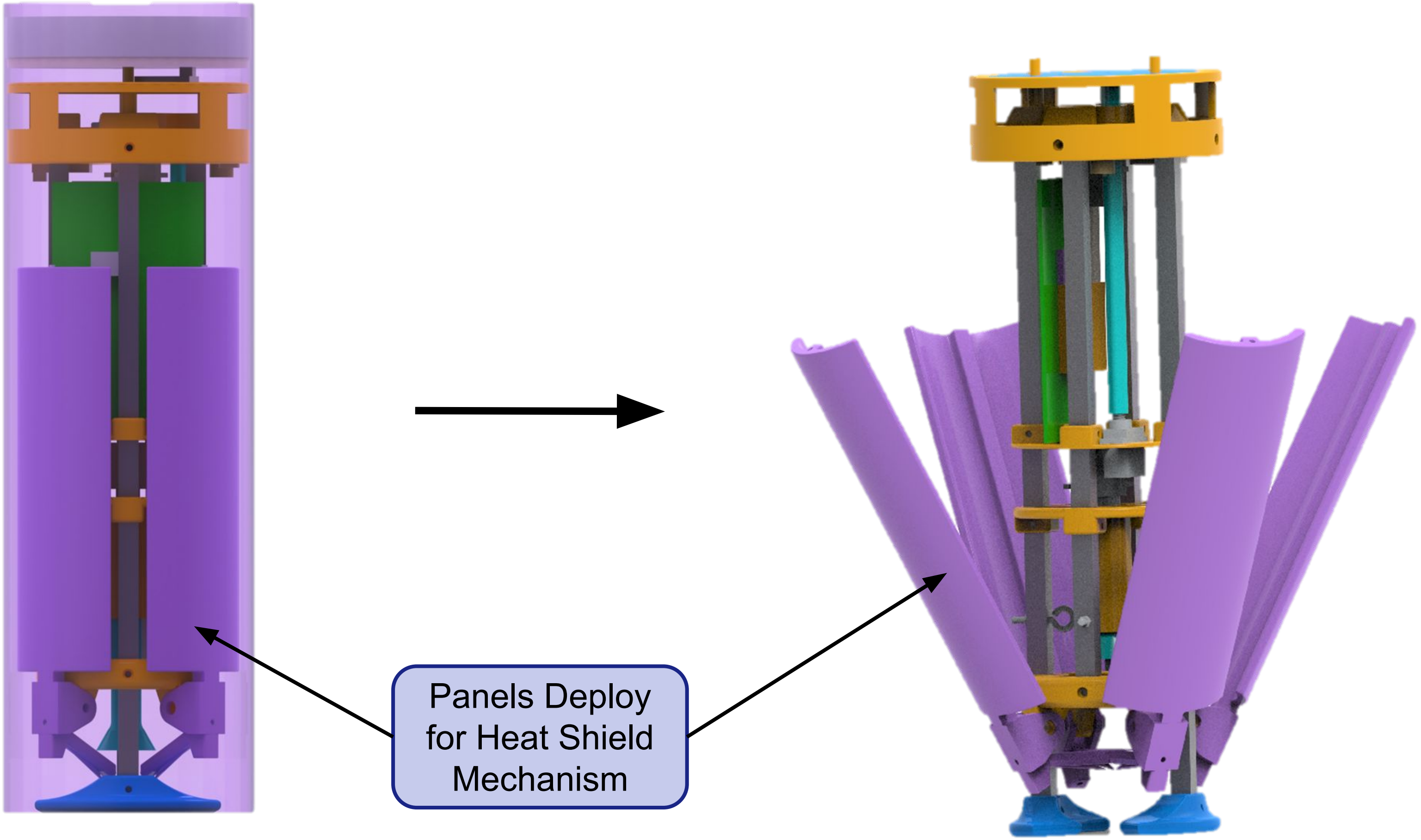
System Level CanSat Configuration Trade & Selection (3/10)

DESIGN 1

Heat Shield Mechanism

UNDEPLOYED

DEPLOYED

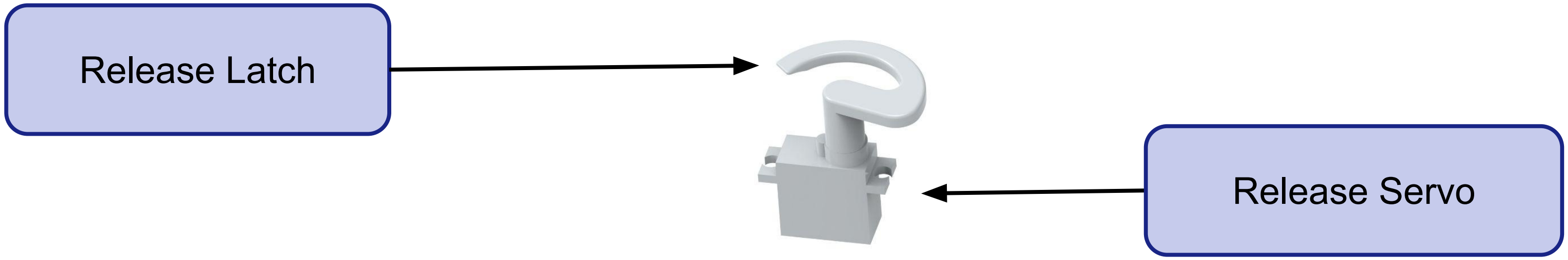


Panels Deploy for Heat Shield Mechanism

System Level CanSat Configuration Trade & Selection (4/10)

DESIGN 1

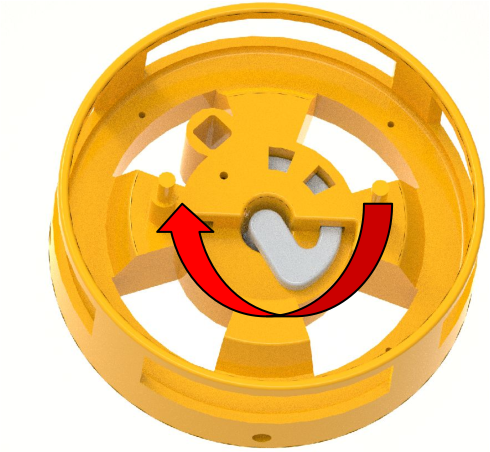
Container and Parachute Release Mechanism



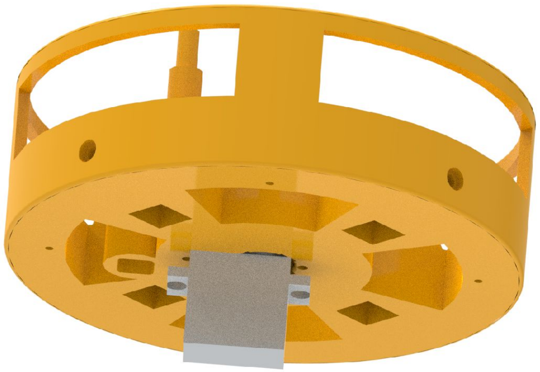
Release Latch

Release Servo

Closed View



Bottom View



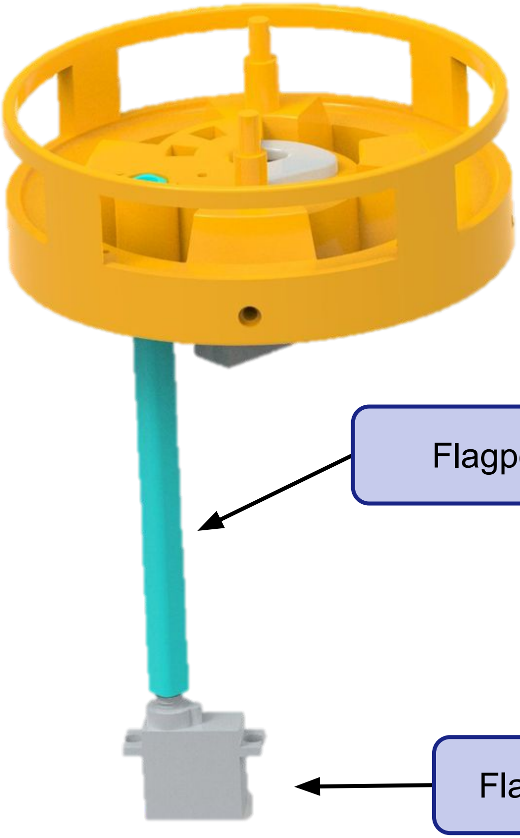
Open View

System Level CanSat Configuration Trade & Selection (5/10)

DESIGN 1

Flag Mechanism

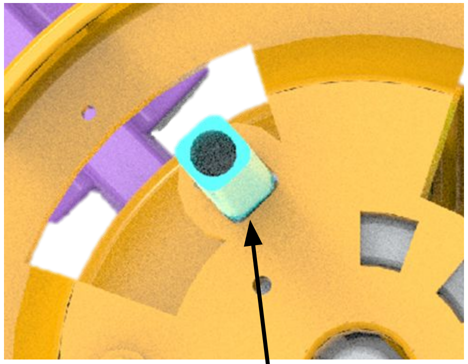
UNDEPLOYED



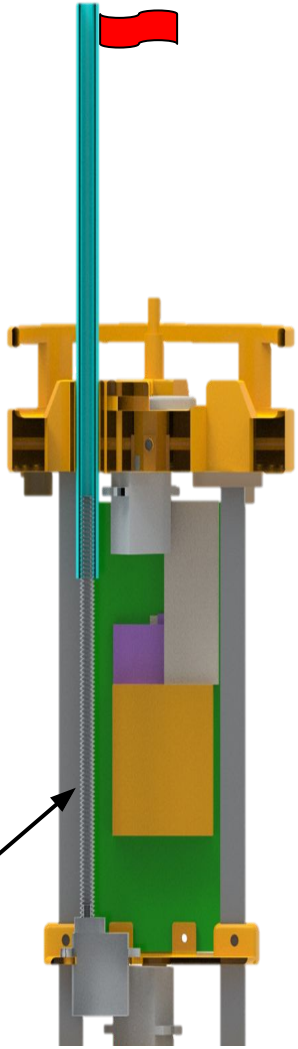
Flagpole

Flag Servo

DEPLOYED



Square hole to stop flagpole from spinning uncontrollably while rising.



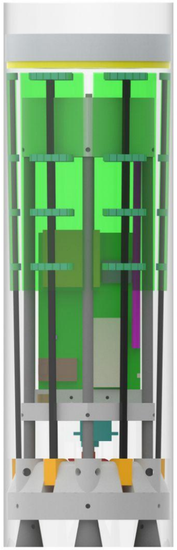
Threaded nylon rod attached to the servo inside the flagpole

System Level CanSat Configuration Trade & Selection (6/10)

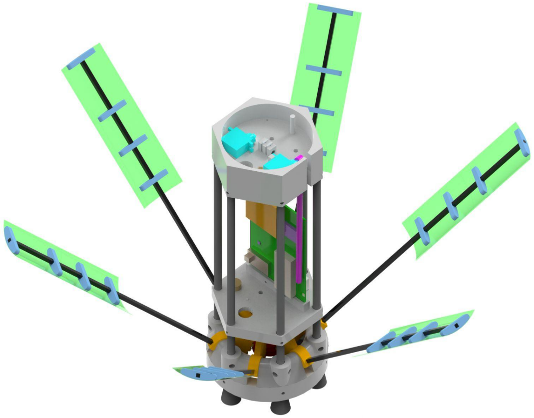
DESIGN 2

This heat shield design consists of six panels that pivot from the bottom of the CanSat and serve as the self righting mechanism. A flagpole hangs from the top of the CanSat and rotates 180 degrees to deploy. The release from the Container and deployment of the parachute are both controlled by a sliding pin mechanism.

Pre-Deployment

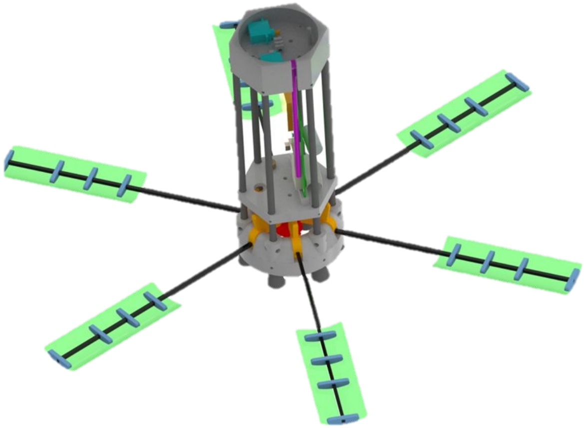


Heat Shield



Probe Parachute Deployed

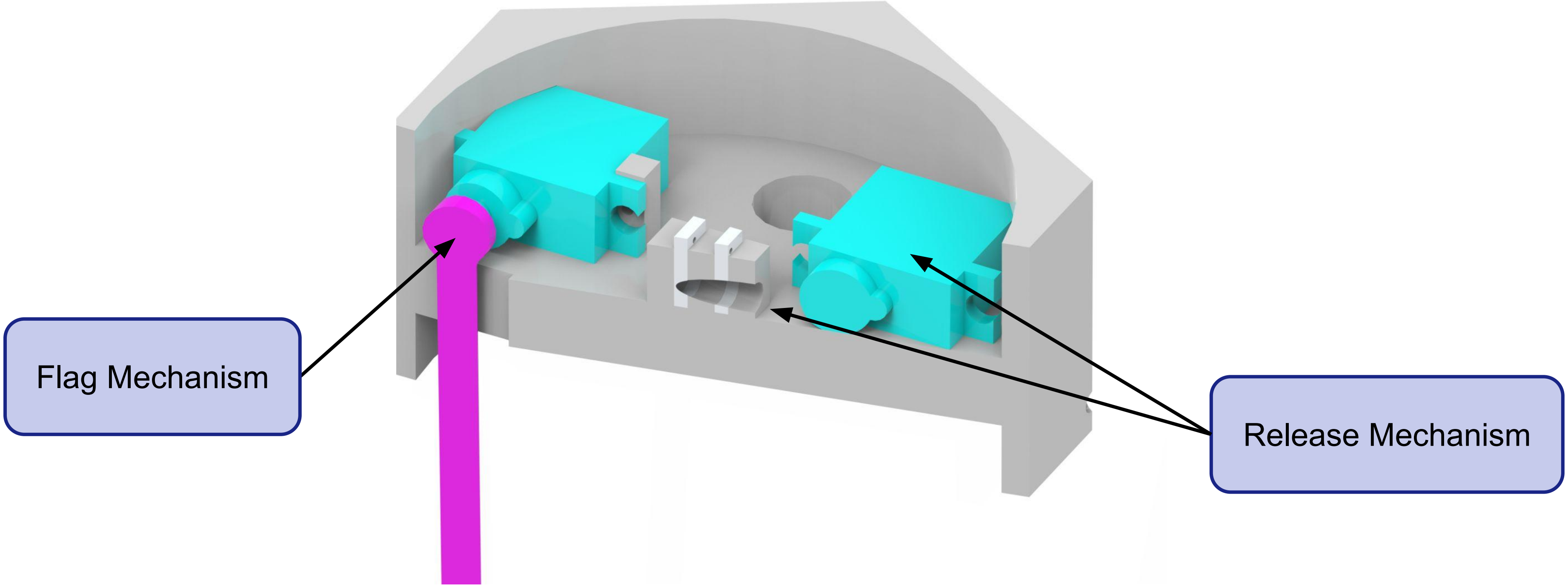
Landed and Upright



System Level CanSat Configuration Trade & Selection (7/10)

DESIGN 2

- The release mechanism will use a motor to control the release of the probe, and the deployment of the payload parachute.
- The flag mechanism uses another servo to release the flagpole



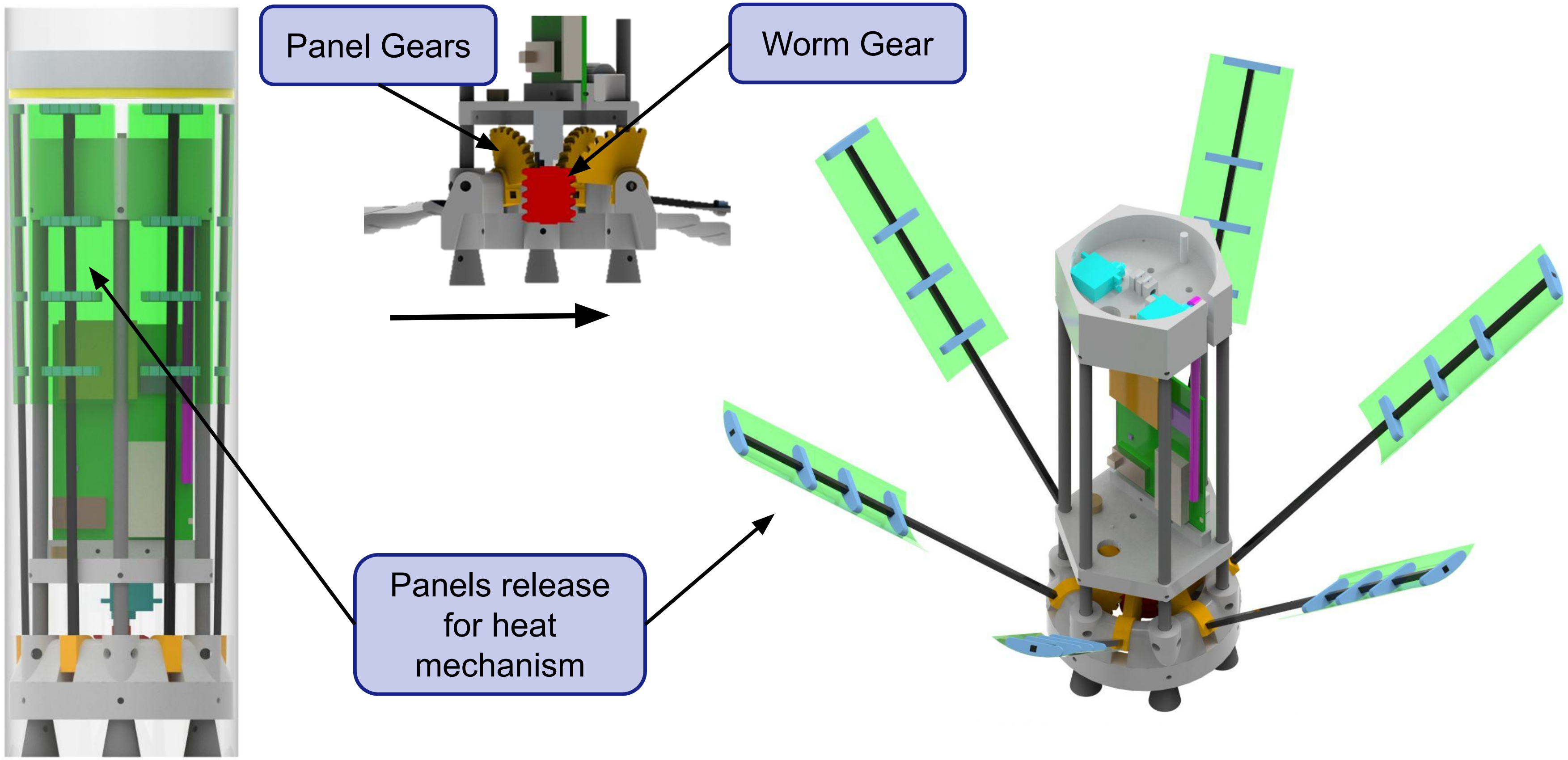
System Level CanSat Configuration Trade & Selection (8/10)

DESIGN 2

Heat Shield Mechanism

UNDEPLOYED IN CONTAINER

DEPLOYED FOR DESCENT



Panel Gears

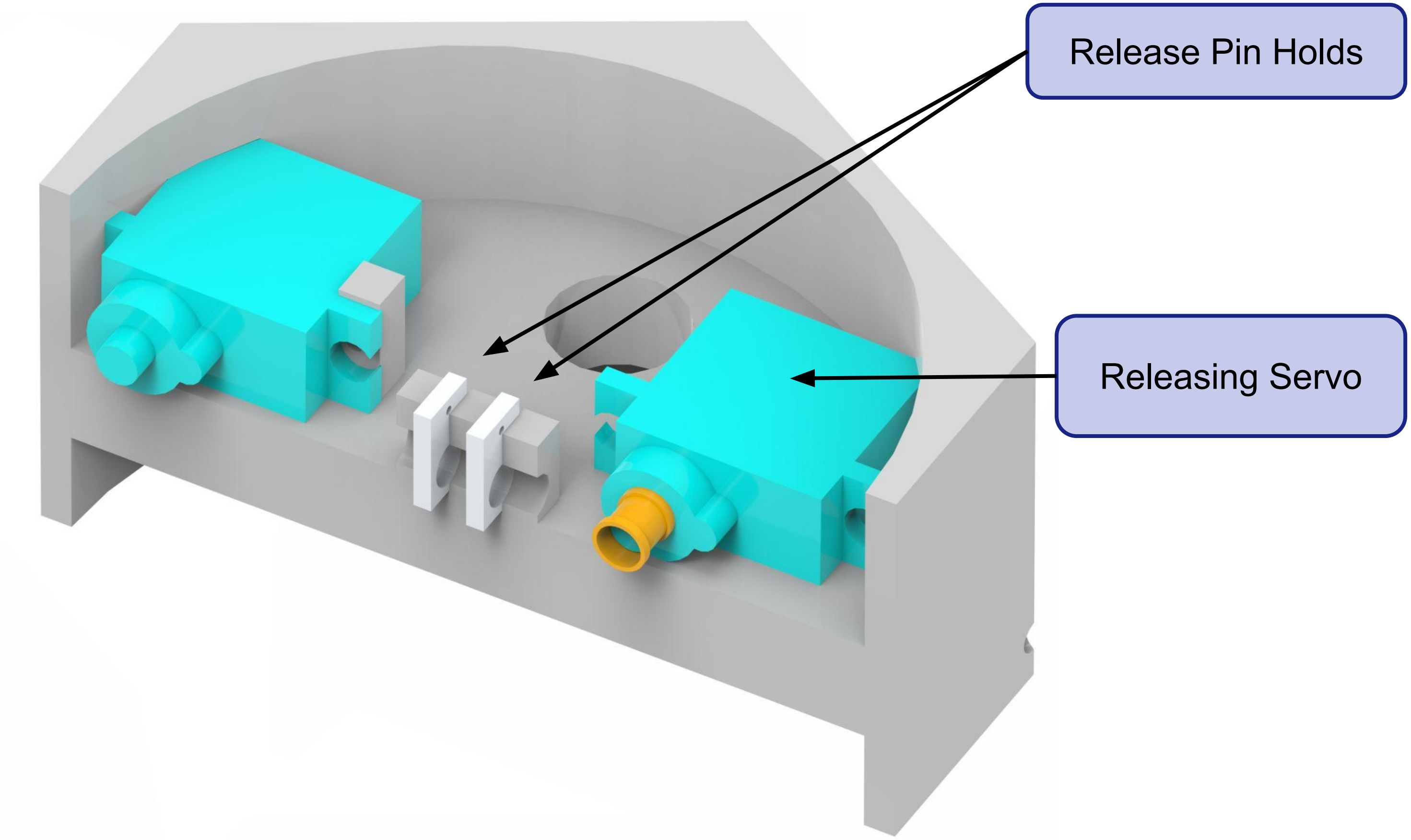
Worm Gear

Panels release for heat mechanism

System Level CanSat Configuration Trade & Selection (9/10)

DESIGN 2

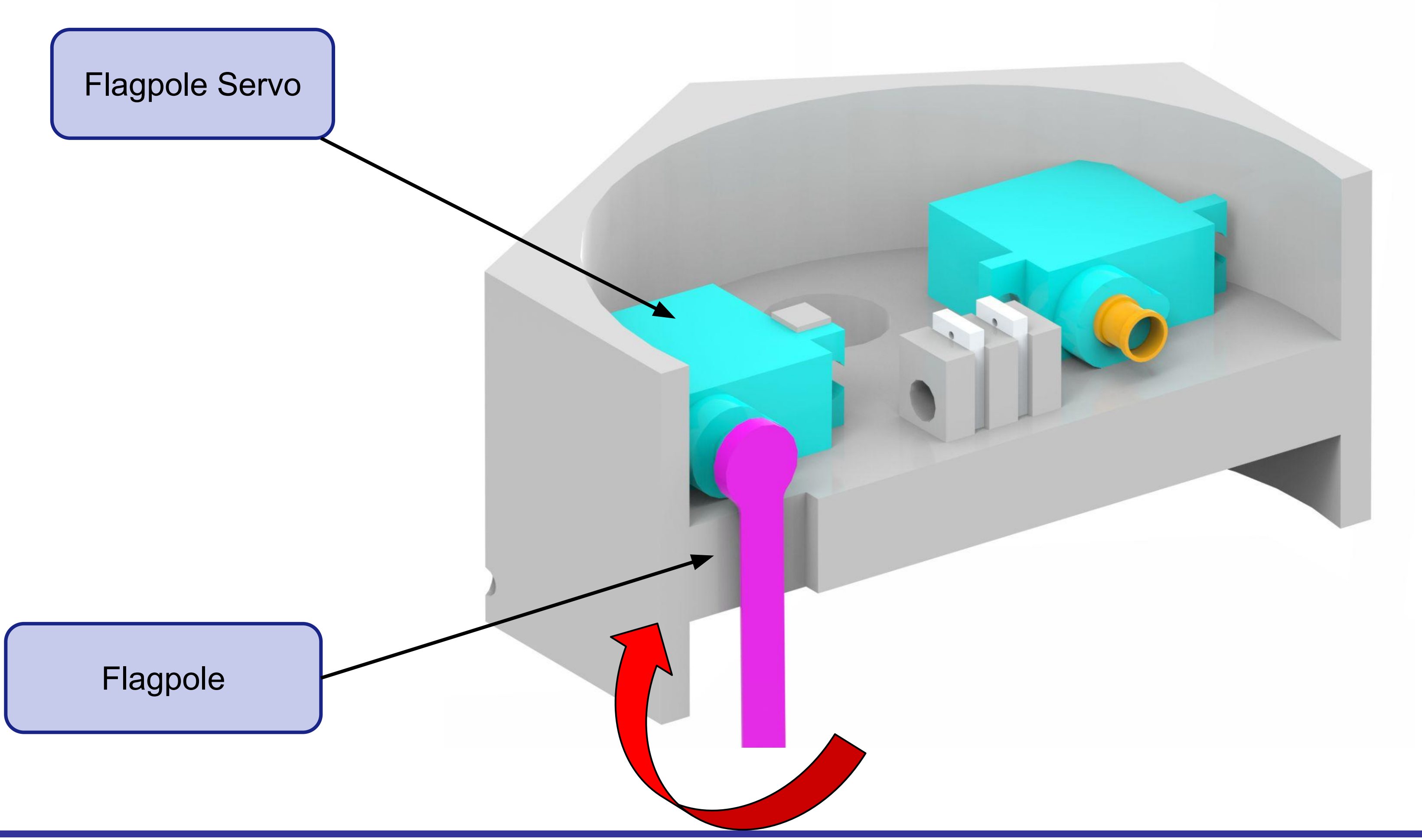
Container and Parachute Release Mechanism



System Level CanSat Configuration Trade & Selection (10/10)

DESIGN 2

Flag Mechanism

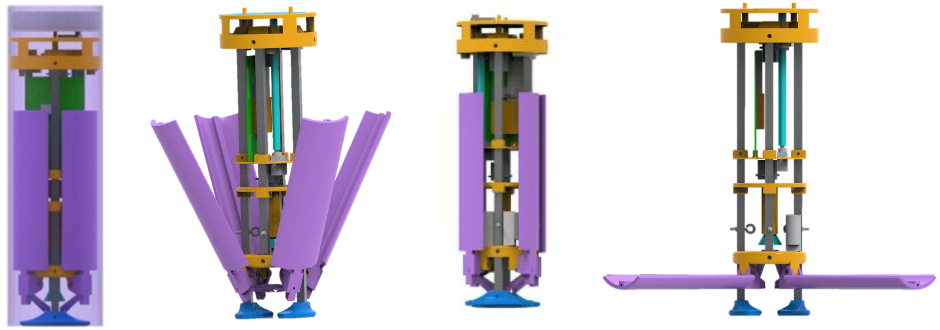


System Level Configuration Selection

Design Number	Pros	Cons
1	● 4 square carbon fiber rods make structure robust and modular ● 4 panel Heat Shield design means decreased failure points ● Low center of mass	● Overweight by 25 g ● Having fewer panels could cause difficulty in self-righting activity ● Requires additional structural plate
2	● More efficient panel mechanism; moves twice as fast. ● High center of force to center of gravity ● Simpler flag mechanism deploys 6 times faster.	● Release mechanism is more likely to fall apart during ascent ● Panel hinge points too high ● 6 supporting carbon fiber rods result in low accessibility for modifications

Selection: DESIGN 1

- Heat Shield mechanism has less moving pieces and therefore is less likely to fail.
- Less carbon fiber rods means more access to make alterations to the CanSat
- Decreased modes of failure due to the 4 panels
- Prototyping of this system will be easier



Physical Layout (1/7)

1st Parachute

Switch, Buzzer, and LEDs

PCB

Heat Shield/
Self-Uprighting System
(Panels)

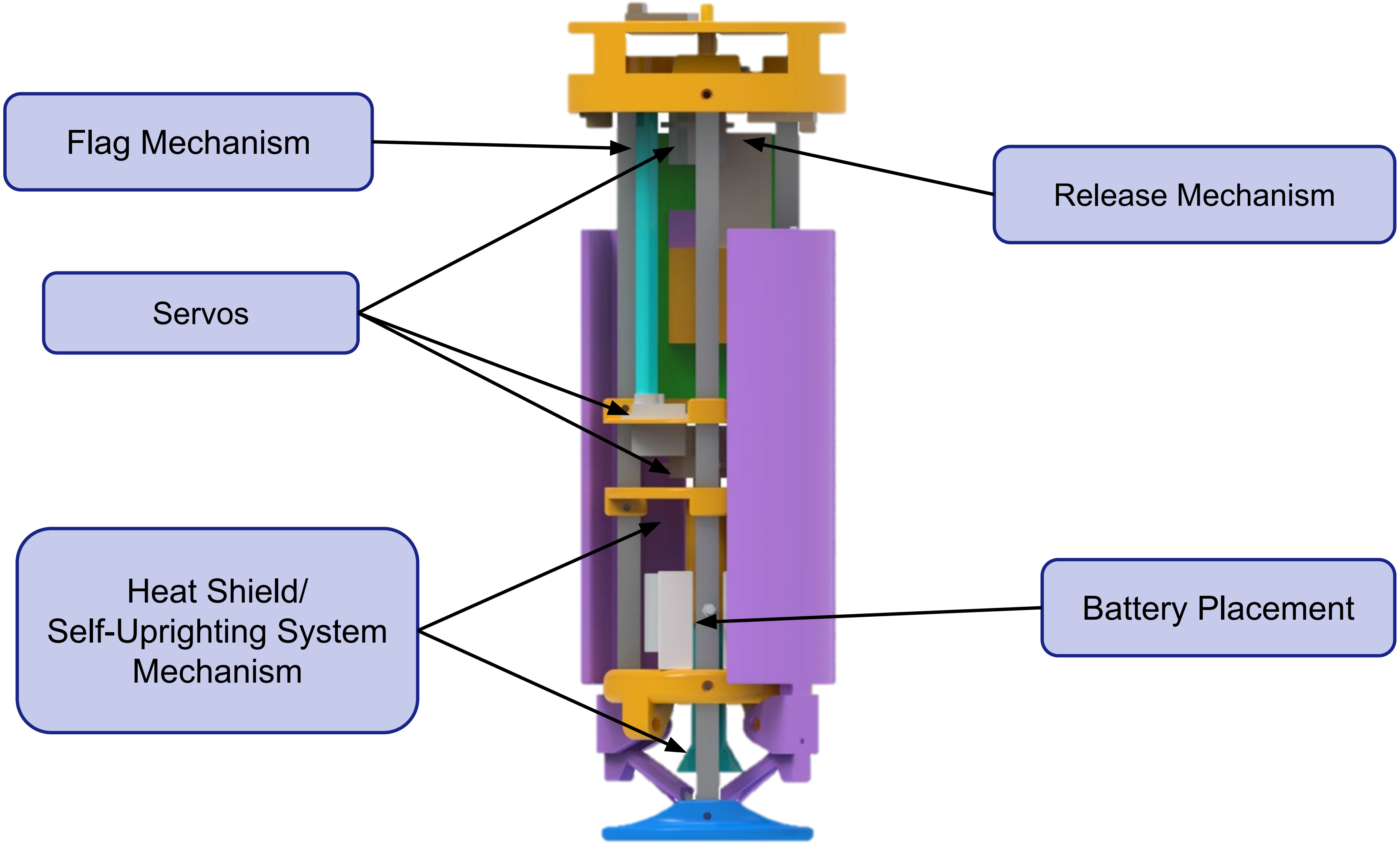
Space to Store 2nd
Parachute

Camera and
Bonus Camera

Fiberglass Container

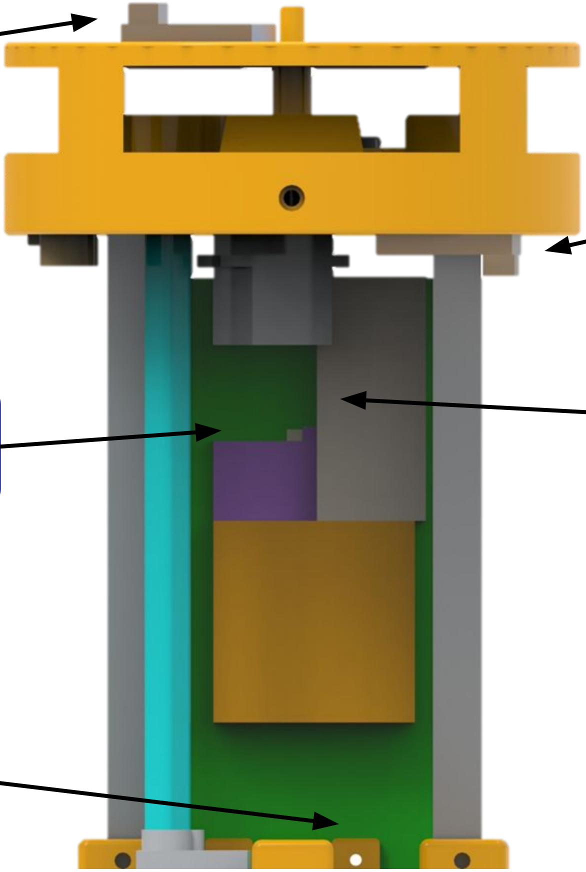
Silicone Landing Legs

Physical Layout (2/7)



Physical Layout (3/7)

Electronics



Bonus Camera

Camera

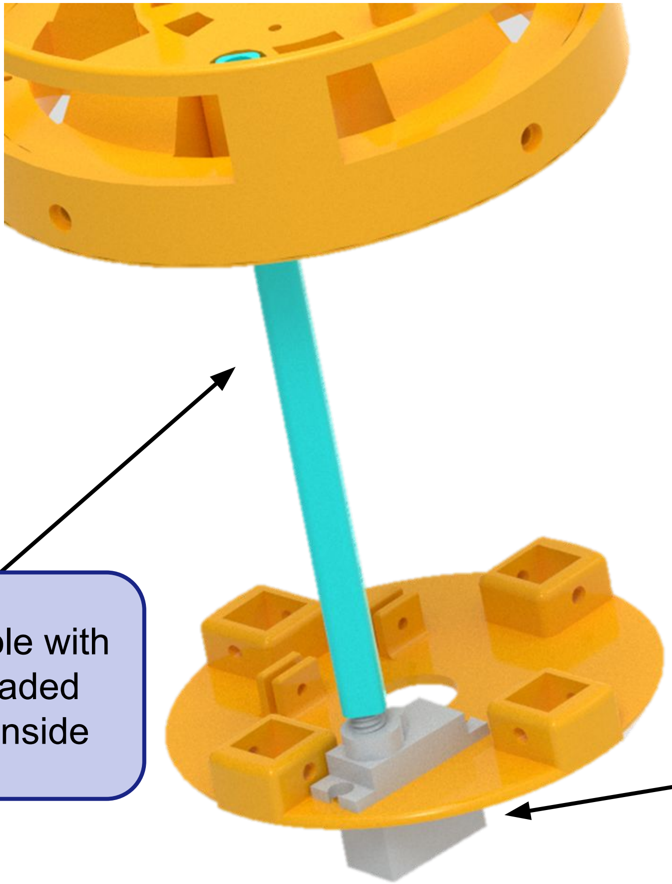
Antenna (Integrated with Xbee)

Electronics Mounted in Place

PCB Mounted with Screws

Physical Layout (4/7)

Flag Mechanism

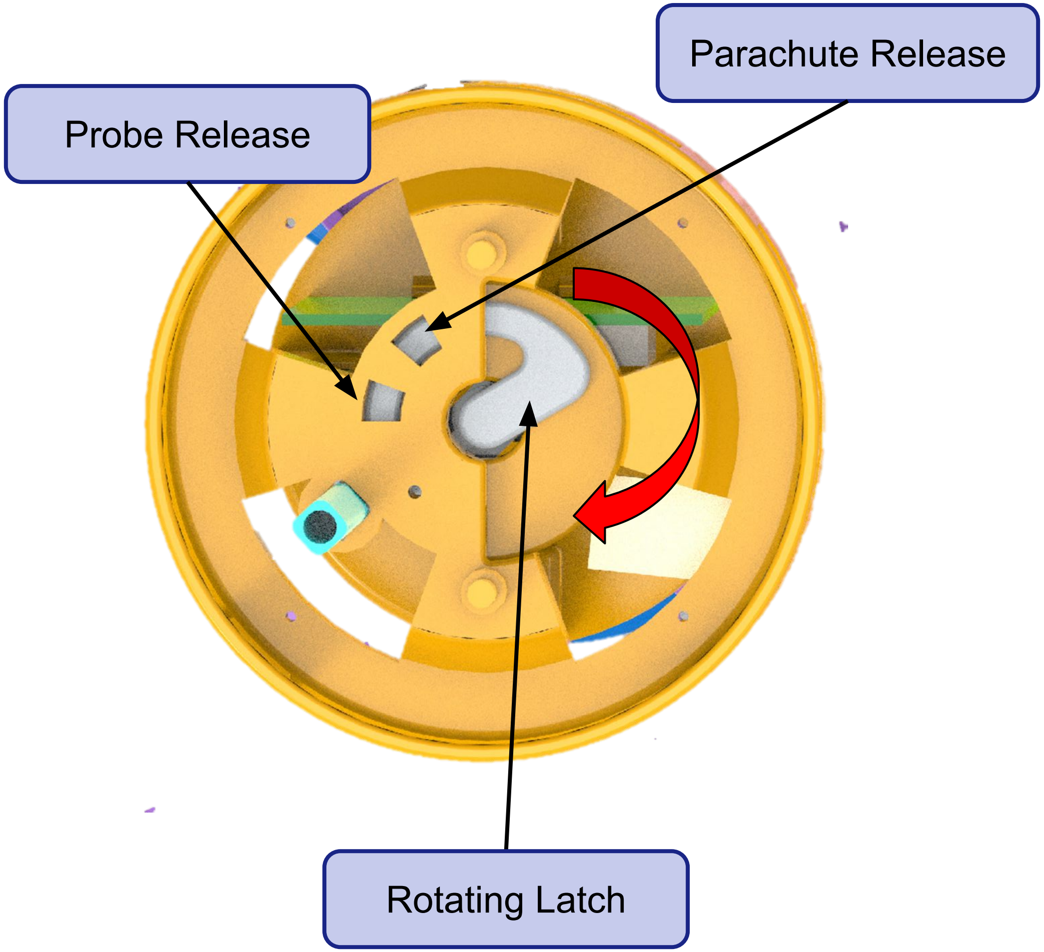


Flagpole with Threaded Rod Inside

Flag Servo

The servo is connected to a threaded nylon rod. When it rotates, the blue piece screwed to the flagpole will rise through a hole in the top plate until it reaches the required height.

Release Mechanism



Parachute Release

Probe Release

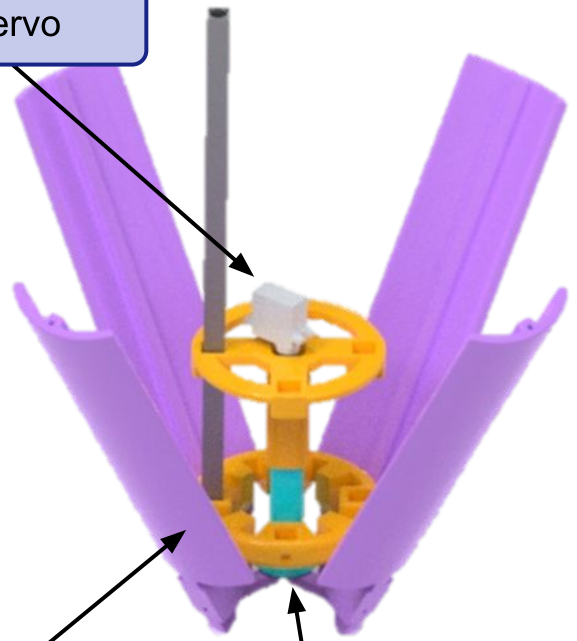
Rotating Latch

As the Latch Rotates the probe and parachute releases are activated. The probe release frees the probe from the container. The parachute release frees the lid, which releases the 2nd parachute.

Physical Layout (6/7)

Heat Shield/ Uprighting Mechanism

ISO VIEW

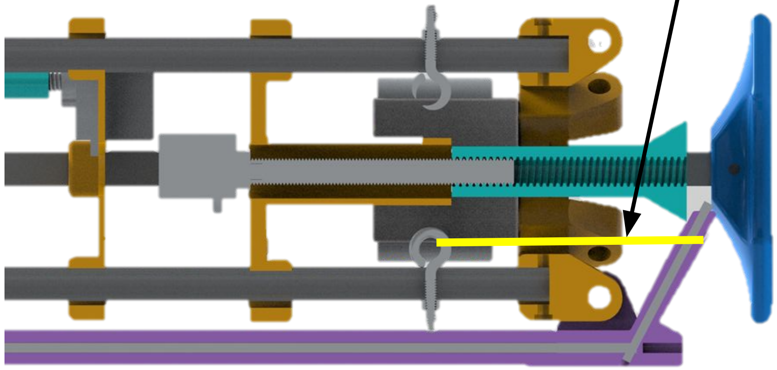


Servo

Panel Protrusion

Pusher Plate

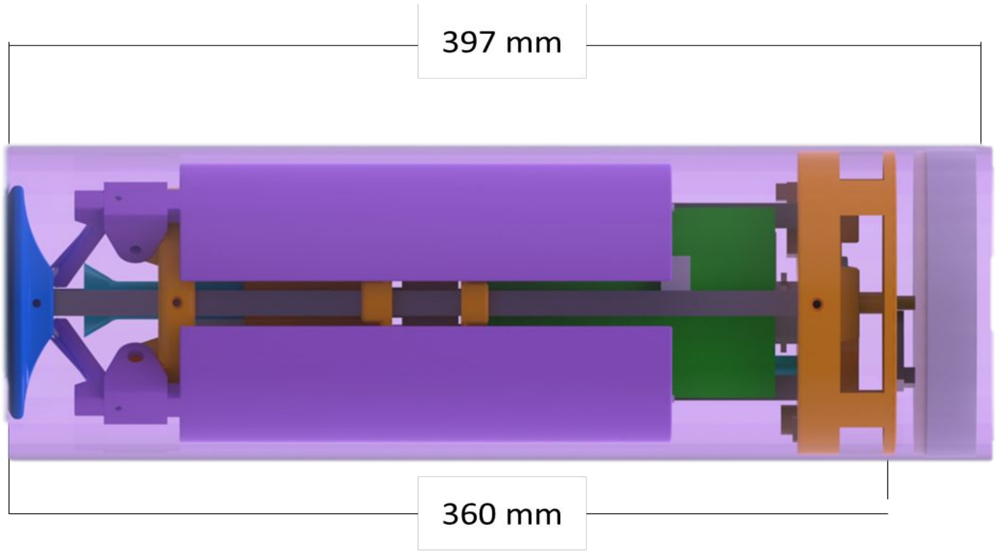
CROSS-SECTION VIEW

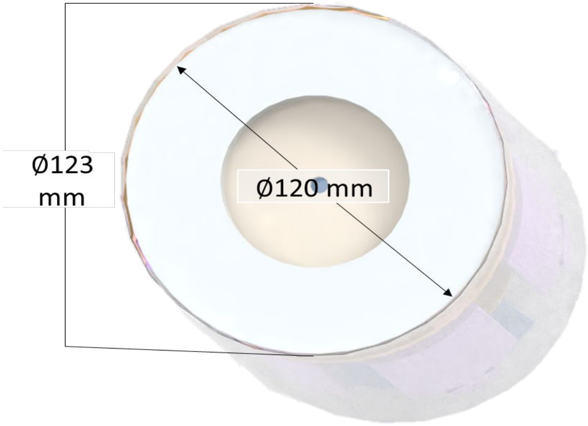


Silicon Rubber Band

The servo rotates a threaded rod inside the pusher plate, pushing down/up on the panel protrusion, causing it to fold/deploy.

Physical Layout (7/7)

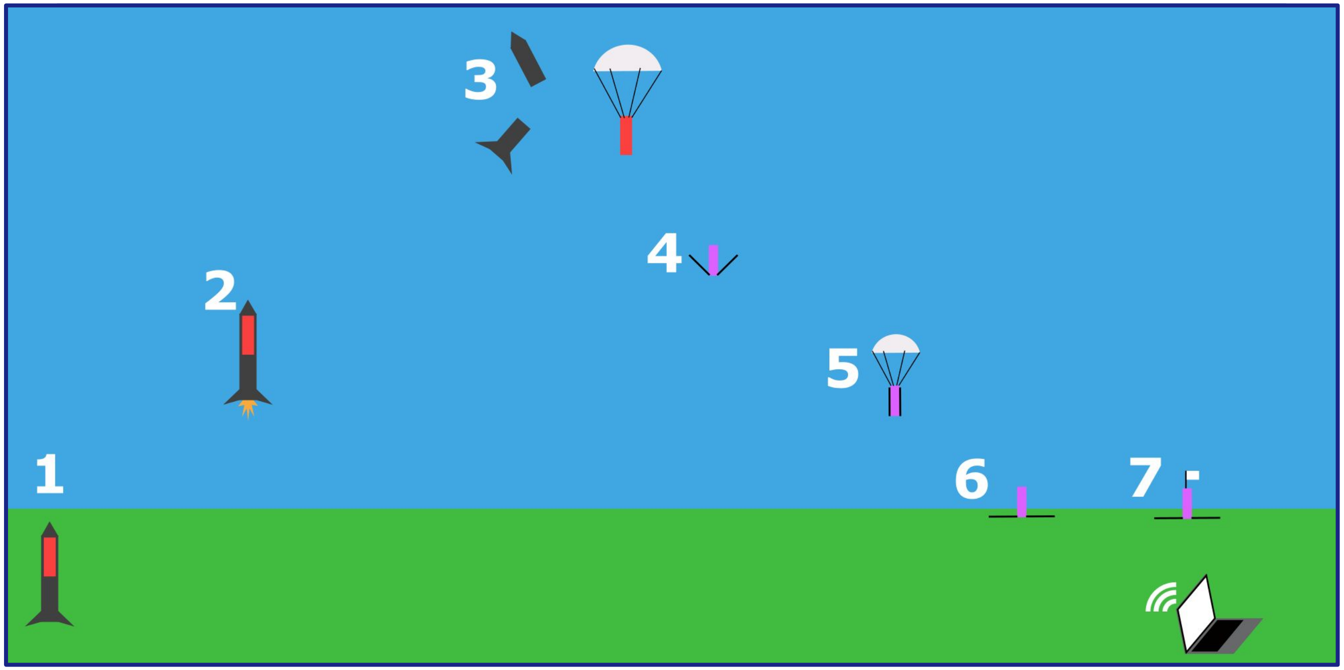




The design's length has a clearance of 37 mm (not including the container's parachute) and its diameter has a clearance of 3 mm within its container.

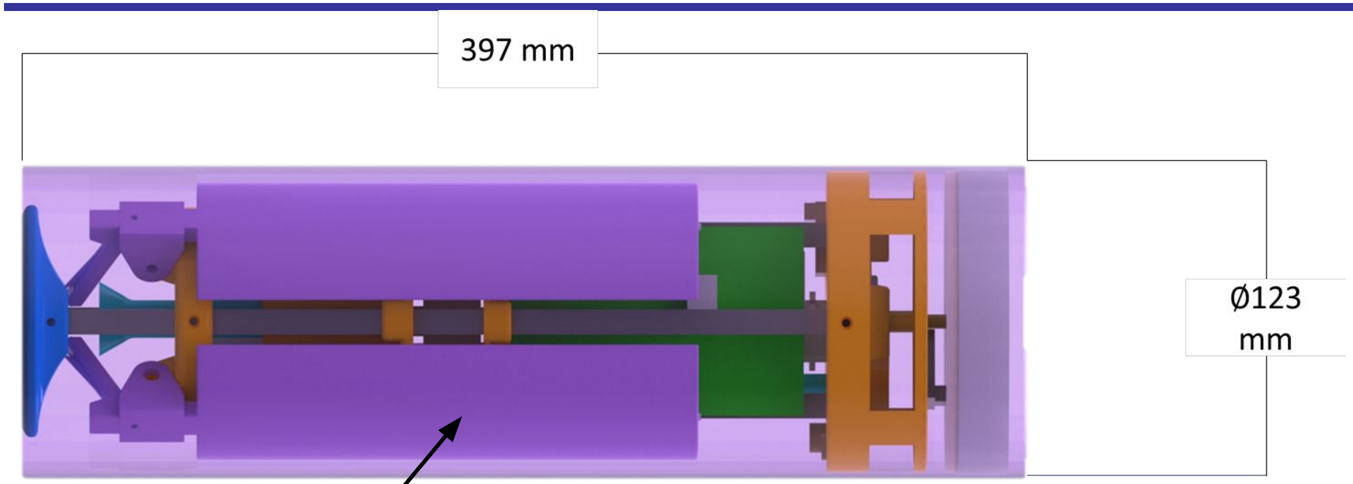
	Payload	Container	Clearance
Diameter	120 mm	123mm	3 mm
Height	360 mm	397mm	37 mm

System Concept of Operations

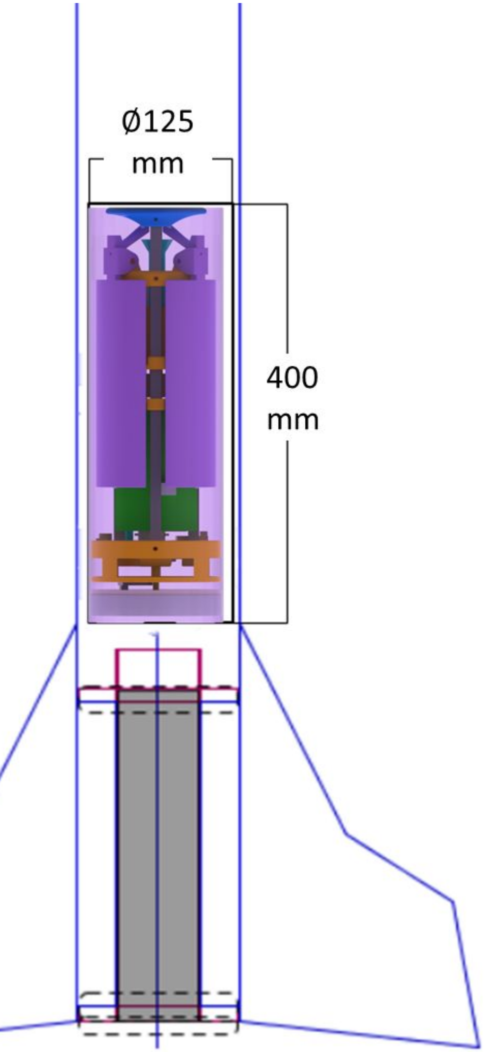


Step	Description
1	The CanSat is powered on and waiting inside the rocket on the ground.
2	The CanSat ascends in the rocket to 700m.
3	At 700m the CanSat is released from the rocket and descends with a parachute at 15m/s to 500m.
4	At 500m the probe is released from the container and descends with the heat shield deployed at 20m/s to 200m.
5	At 200m the probe deploys a parachute, retracts the heat shield, and lands at 5m/s
6	When the probe is lying on the ground, the heat shield opens 90 degrees, lifting the probe upright.
7	The probe extends the flagpole from the top. GPS and altitude data will help the recovery team find the probe. Data transmission is reduced.

Launch Vehicle Compatibility



No sharp protrusions



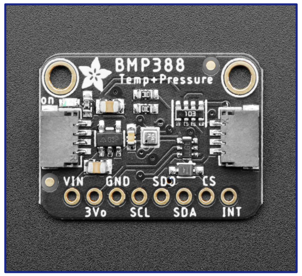
	Vehicle dimensions	CanSat container	Clearance
Height	400 mm	397 mm	3 mm
Diameter	125 mm	123 mm	2 mm

Sensor Subsystem Design

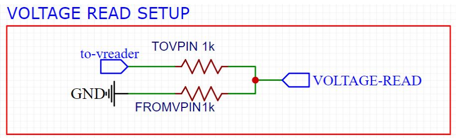
Brooks Calhoun

Sensor Subsystem Overview

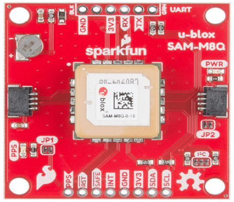
Component	Model/Type	Intended Purpose
Air Pressure	BMP388	Measure the Pressure of the Payload
Air Temperature	BMP388	Measure the Temperature of the Payload
Battery Voltage	Onboard Pin	Measure the Battery Voltage of the Payload
Tilt	BNO055	Measure the Orientation and Tilt of the Payload
GPS	SAM-M8Q	Track the Location of the Payload
Camera	Mini Spy Camera	Record Video of Payload
Bonus Camera	Mini Spy Camera	Camera for Bonus Objective



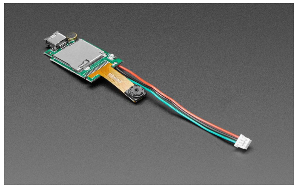
Source: Adafruit



Source: Adafruit



Source: Sparkfun



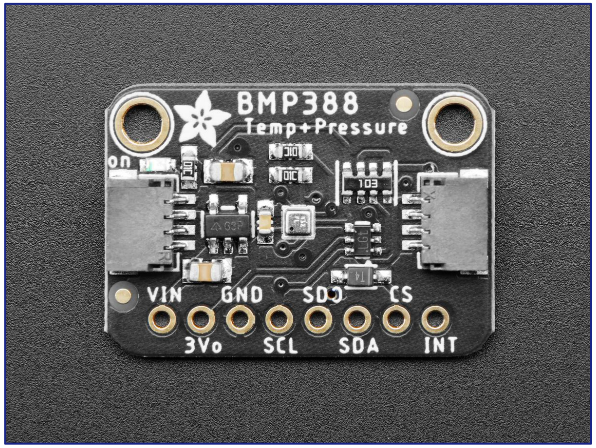
Source: Sparkfun

Payload Air Pressure Sensor Trade & Selection

Model	Interface	Pressure Accuracy (Pa)	Resolution (m)	Size (mm)	Weight (g)	Cost
BMP388	I²C/SPI	8	0.66	21.6 x 16.6 x 3.0	1.2	$9.95
BMP390	I²C/SPI	3	0.25	~21.6 x 16.6 x 3.0	~1.2	$10.95
BMP280	I²C/SPI	12	1	19.2 x 17.9 x 2.9	1.3	$14.95

Selection: BMP388 Breakout

- High resolution
- High pressure accuracy
- Previous usage/familiarity
- Small mass



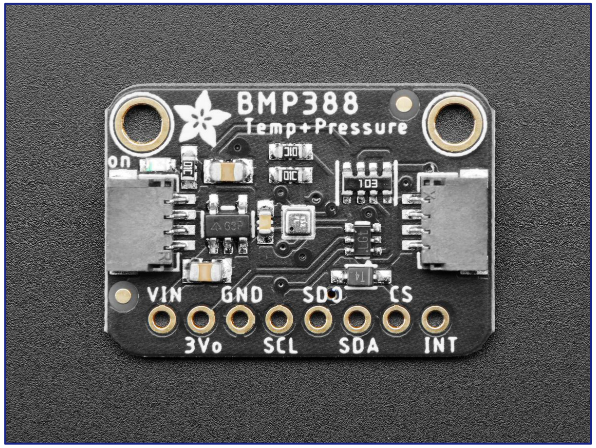
Source: Adafruit

Payload Air Temperature Sensor Trade & Selection

Model	Interface	Resolution (°C)	Size (mm)	Weight (g)	Cost
BMP388	I²C/SPI	0.0050	21.6 x 16.6 x 3.0	1.2	$9.95
BMP390	I²C/SPI	0.0050	~21.6 x 16.6 x 3.0	~1.2	$10.95
MCP9808	I²C	0.0625	21 x 13 x 2	0.9	$4.95

Selection: BMP388 Breakout

- High resolution
- Previous usage/familiarity
- Keeping consistency with choice for air pressure
- Reduces number of sensors needed



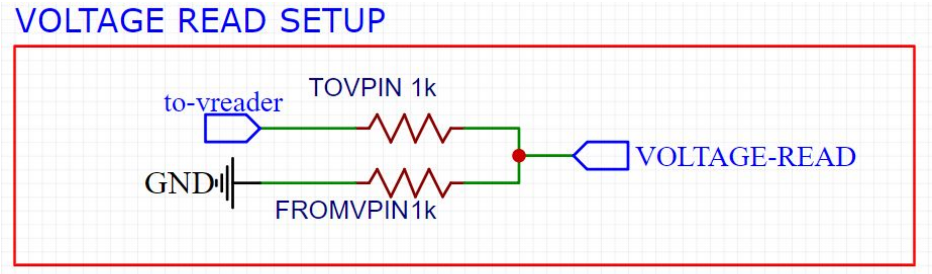
Source: Adafruit

Payload Battery Voltage Sensor Trade & Selection

Model	Interface	Precision	Size (mm)	Weight (g)	Cost
ADC Pin	ADC	< 1/10th V	1 x 1	1.00	$0.10
LM4040	ADC	1/10th V	16 x 12.5 x 2.5	0.70	$7.50
INA260	ADC	1/10th V	22.9 X 22.8X 2.7	2.00	$9.95

Selection: ADC Pin

- Small Mass
- Cost Efficient
- Easy Integration



Payload Tilt Sensor Trade & Selection

Model	Interface	Voltage Input (V)	Current Consumption (mA)	Gyroscope Range	Size (mm)	Weight (g)	Cost
BNO055	I²C	3.3	12.3	±125°/s to ±2000°/s	20 x 27 x 4	3.0	$34.95
LSM6DSOX + LIS3MDL	SPI/I²C	3.6	4	±125/±250/±500/ ±1000/±2000 dps	25.6 x 17.8 x 4.6	1.7	$19.95

Selection: BNO055

- Lower logic level
- Higher accuracy
- Calculates tilt automatically

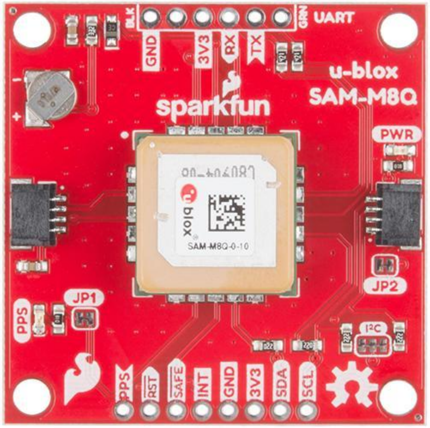
Source: Adafruit

Payload GPS Sensor Trade & Selection

Model	Interface	Position Accuracy	Velocity Accuracy	Antenna	Size (mm)	Weight (g)	Cost
SAM-M8Q	UART, I²C	2.5 m	0.05 m/s	Internal	42.0 x 42.0 x 10.0	13	$42.95
ZOE-M8Q	UART, I²C, SPI	2.5 m	0.05 m/s	External	25.4 x 25.4	8	$49.95
FGPMMOPA6B	UART	3 m	1 m/s	External	16 x 16 x 6	6	$29.95

Selection: SAM-M8Q

- High position resolution
- High velocity resolution
- Arduino libraries available for easier communication



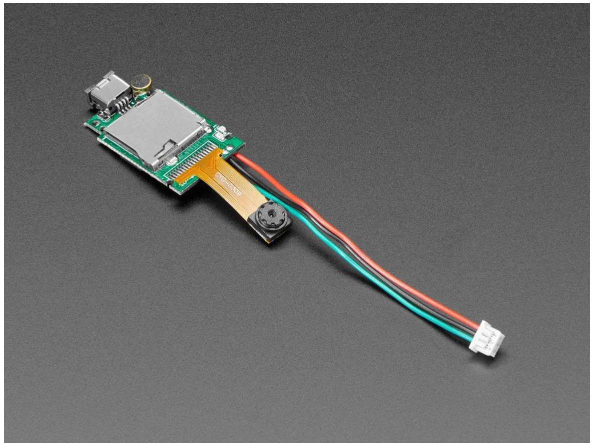
Source: Sparkfun

Payload Camera Trade & Selection

Model	Interface	Resolution (Pixels)	Size (mm)	Weight (g)	Cost
Mini Spy Camera	PWM/GPIO	640 x 480	28.5 x 17 x 4.2	2.8	$12.50
TTL Serial JPEG Camera	PWM/GPIO	640 x 480	32 x 32 x 6.35	3.0	$39.95
uCAM-III	UART	640 x 480	32 x 32 x 21	6.0	$14.95

Selection: Mini Spy Camera

- Cost efficient
- Most flexible, the camera moves and does not have to be attached to the processor.
- Space for a SD card
- 30 Frames per second



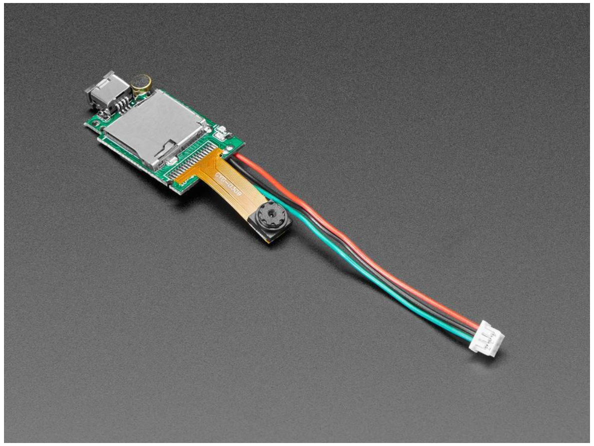
Source: Adafruit

Bonus Camera Trade & Selection

Model	Interface	Resolution (Pixels)	Size (mm)	Weight (g)	Cost
Mini Spy Camera	PWM/GPIO	640 x 480	28.5 x 17 x 4.2	2.8	$12.50
TTL Serial JPEG Camera	PWM/GPIO	640 x 480	32 x 32 x 6.35	3.0	$39.95
uCAM-III	UART	640 x 480	32 x 32 x 21	6.0	$14.95

Selection: Mini Spy Camera

- Small mass
- Flexible
- Using same camera as for payload allows for easier integration
- 30 Frames per second



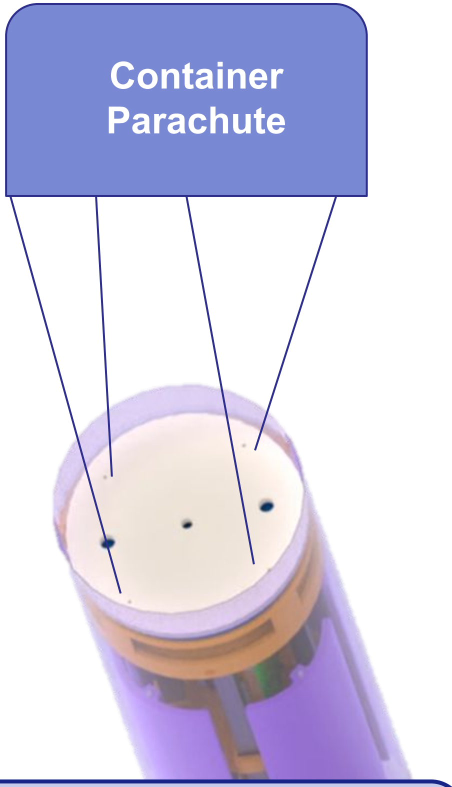
Source: Adafruit

Descent Control Design

Adam Burden

Descent Control Overview

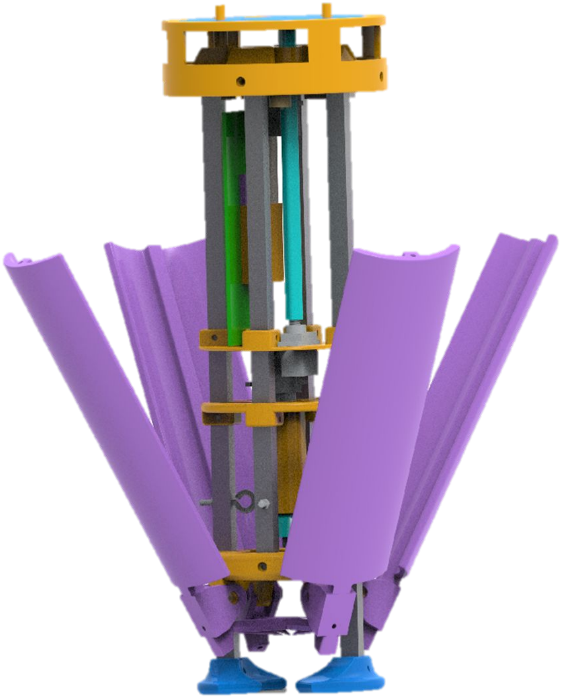
700 m → 500 m



Container Parachute

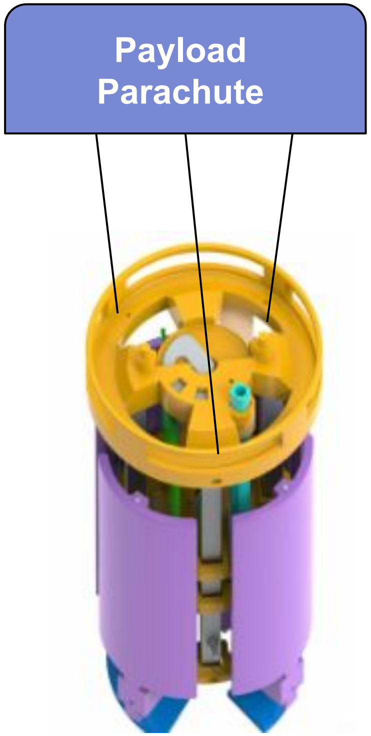
Parachute will deploy to slow CanSat down to 15 m/s

500 m → 200 m



Heat Shield will open panels to 60 degrees to slow descent rate to 20 m/s

200 m → 0 m



Payload Parachute

Payload will use a second parachute to slow the descent rate to 5m/s

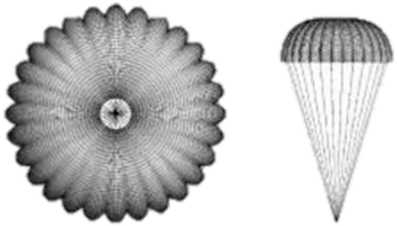
Container Descent Control Strategy Selection and Trade

Design Number	Pros	Cons
Hemispherical Parachute	● Less material = less weight (25 g) ● More stable	● Requires spill holes for stability ● Oscillates while descending
Cross Parachute	● Easily handmade	● Prone to rotational motion ● More material = more weight (35 g) ● Not suited for air-based vehicles

Selection: Hemispherical Parachute

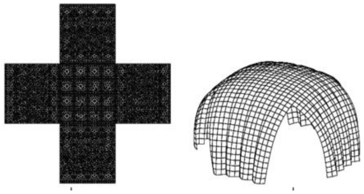
- Requires less material
- Accounts for less weight
- More stable

Hemispherical-Parachute

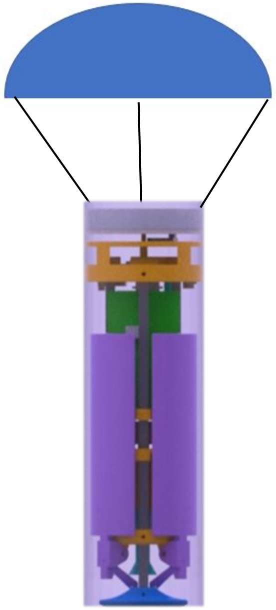


Source: Fan, Yuxin & Xia, Jian. (2014).

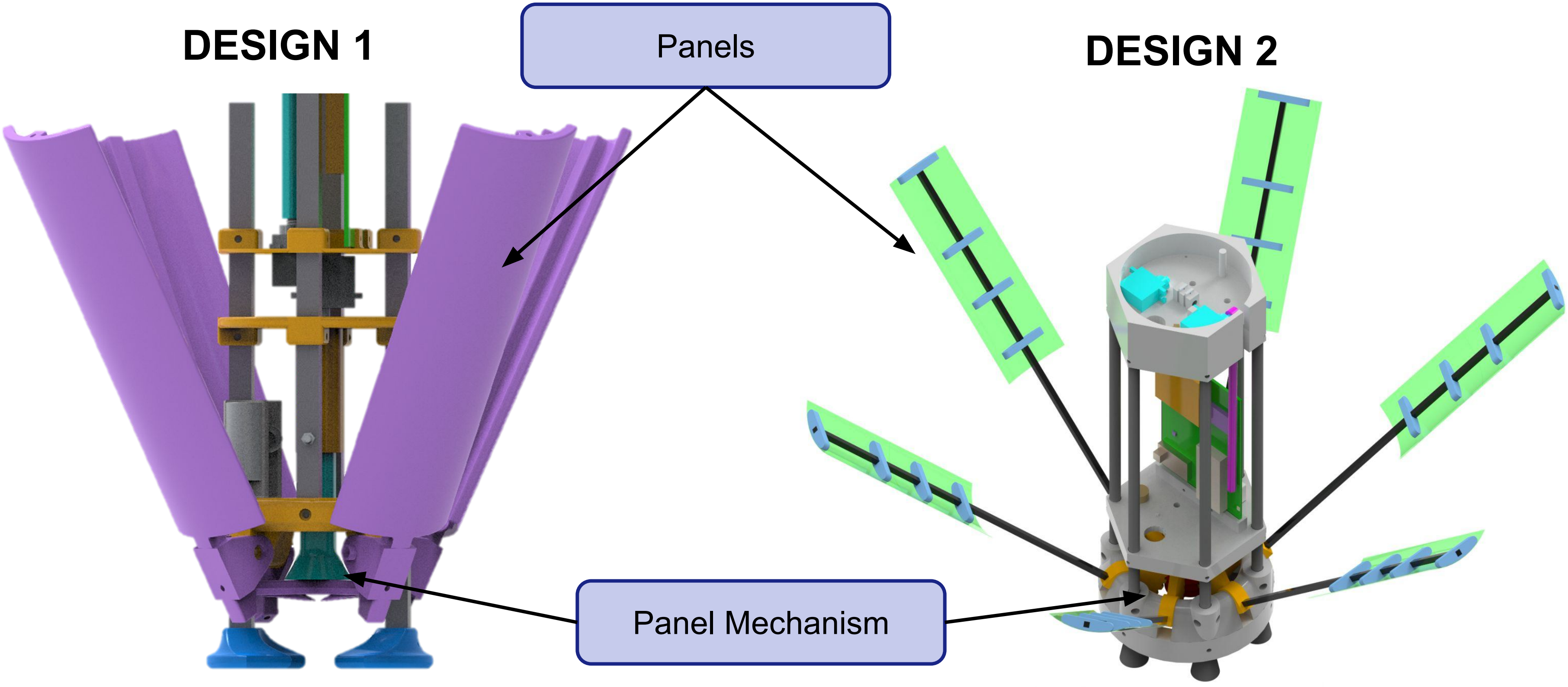
Cross-Parachute



Source: Stein, K. & Benney, Richard & Tezduyar, Tayfun & Potvin, Jean. (2001)



Payload Aerobraking Descent Control Strategy Selection and Trade (1/2)



DESIGN 1

DESIGN 2

Panels

Panel Mechanism

Material Per Panel
- 3D Printed PETG
- 2X Circular Carbon Fiber Rods

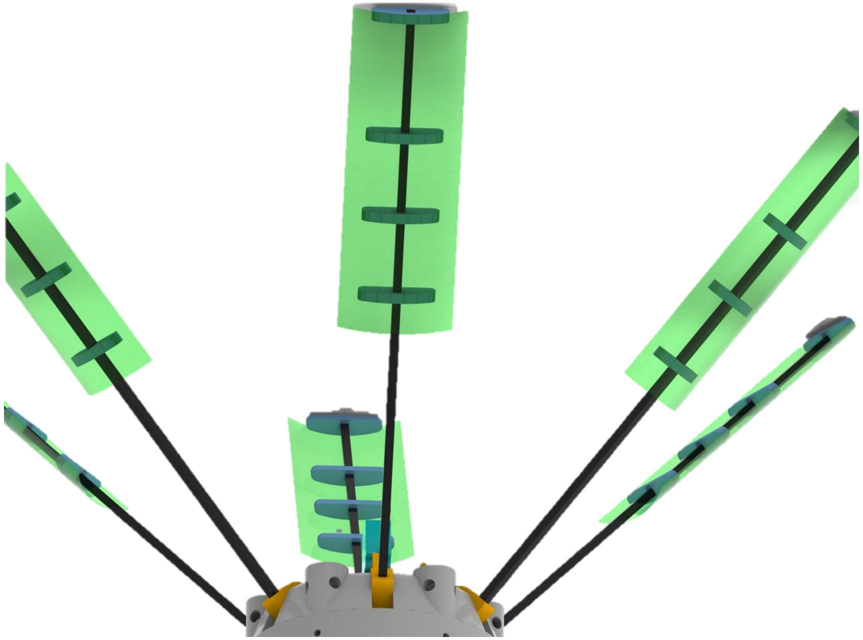
Material Per Panel
- Soda Bottle Cutouts
- Square Carbon Fiber Rods
- PETG Supports

Payload Aerobraking Descent Control Strategy Selection and Trade (2/2)

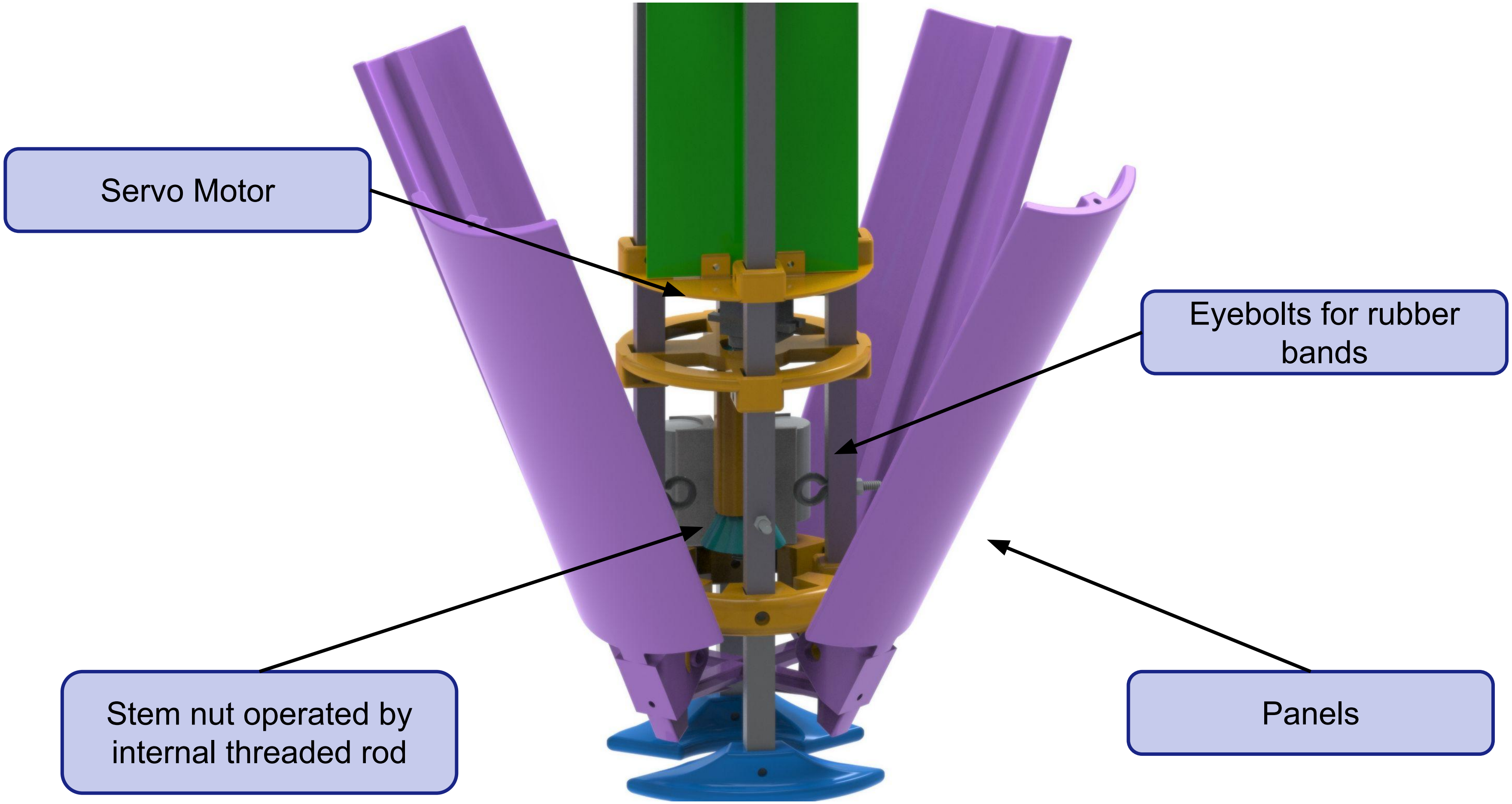
Design Number	Pros	Cons
1	- Unlikely to break - 3D printed with PETG	- Heavy (40 g) - Requires eye bolts for function
2	- Lightweight (22 g) - Cheap ($13 per panel) - Surface area is located at the end of the panels; subsequent high center of force	- Needs to rotate more than 90 degrees because high hinge points. - Needs less ordered parts than design 1

Selection: DESIGN 2

- Longer Panels mean more leverage when self-righting
- High center of force means higher stability during descent



Payload Aerobraking Descent Stability Control Strategy Selection and Trade (1/3)



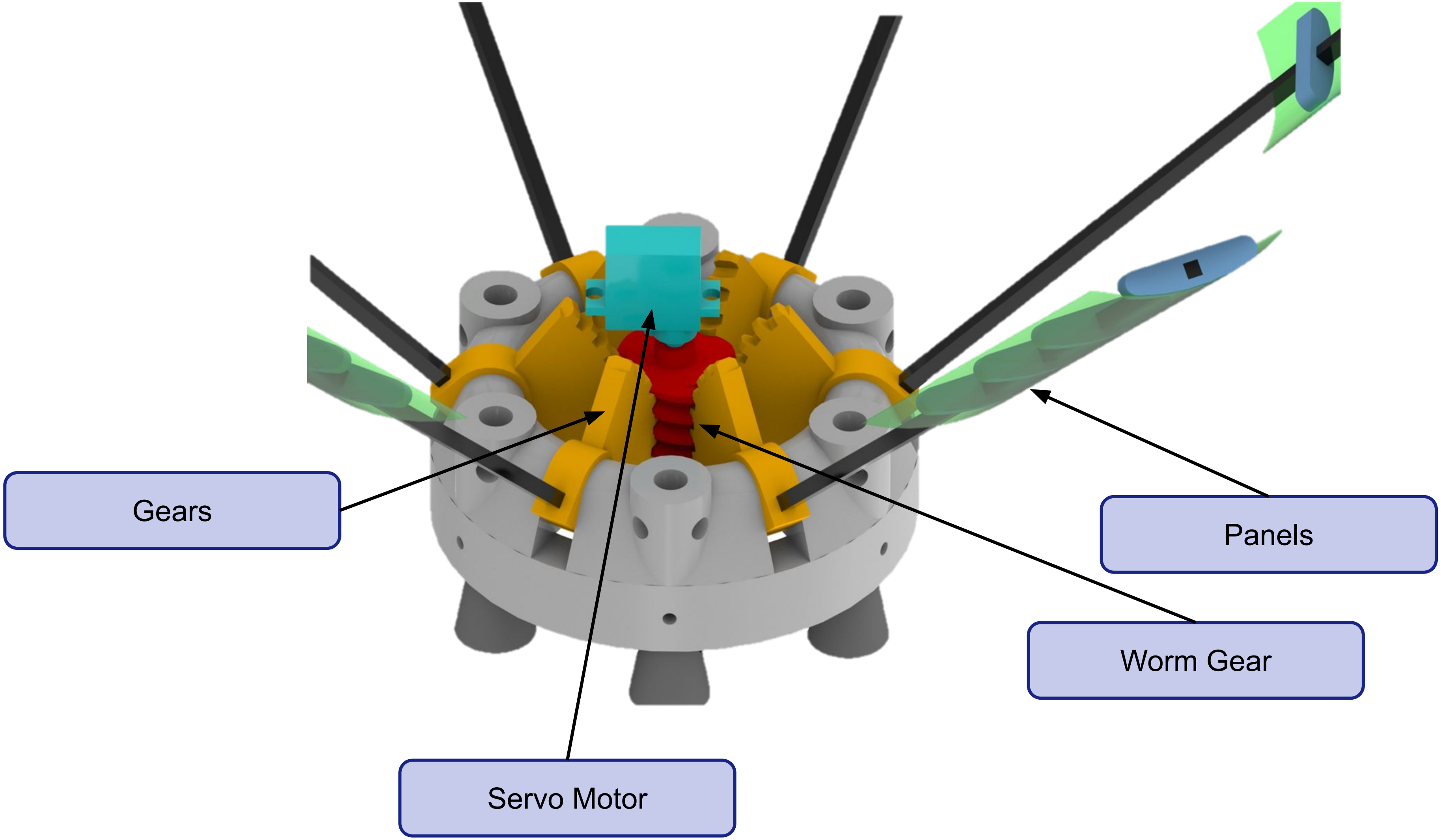
Servo Motor

Eyebolts for rubber bands

Stem nut operated by internal threaded rod

Panels

Payload Aerobraking Descent Stability Control Strategy Selection and Trade (2/3)

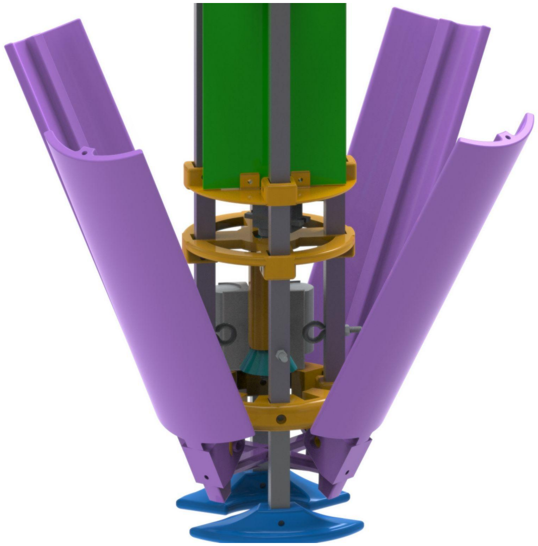


Payload Aerobraking Descent Stability Control Strategy Selection and Trade (3/3)

Design Number	Pros	Cons
1	● Threads provide increased shock protection ● Twice the gear ratio of Design 2 ● Rubber bands provide opening torque during operation	● More friction between threaded rod and stem nut. ● Requires an ordered threaded rod ● Takes twice as long to open.
2	● 3D printed in PETG ● Opens 2 times faster than Design 1 ● 24 g lighter than Design 1	● Complex Tolerancing ● Limited range of motion due to placement of hinges

Selection: DESIGN 1

- Increased shock protection
- Relatively no opening torque required due to rubber bands



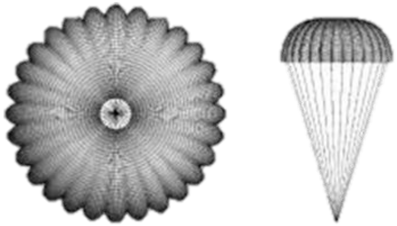
Payload Parachute Descent Control Strategy Selection and Trade

Design Number	Pros	Cons
Hemispherical Parachute	● Less material = less weight (30g) ● More efficient, it has a higher slowing rate for the same surface area	● Might need spill holes
Cross Parachute	● Easier to manufacture ● Less oscillation of the payload	● Prone to rotate ● More material = more weight (45g) ● More unstable

Selection: Hemispherical Parachute

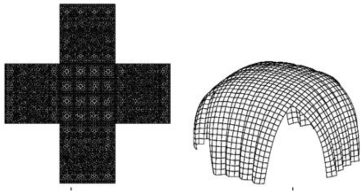
- Accounts for less weight
- More stable
- More efficient for the speed required (5 m/s)

Hemispherical-Parachute

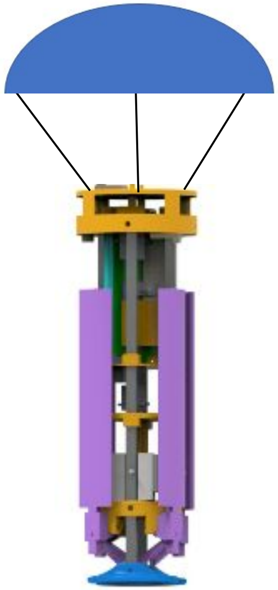


Source: Fan, Yuxin & Xia, Jian. (2014).

Cross-Parachute



Source: Stein, K. & Benney, Richard & Tezduyar, Tayfun & Potvin, Jean. (2001)



Descent Rate Estimates (1/4)

Parachute 700m → 500m:

Magnitude	Symbol	Value
Force Drag Parachute	F_{Dp}	6.131 N
Parachute Drag Coefficient	C_{Dp}	1.42
Area of Parachute	A_p	0.03162 m^2
Air Density	ρ	1.22
Force Drag Payload	F_{Dl}	0.141 N
Payload Drag Coefficient	C_{Dl}	0.82
Area of Payload	A_l	$60^2\pi \cdot 10^{-6}$ m^2
Radius of Parachute	r_1	100.3 mm
Force Drag Total	F_{DT}	6.272 N

$$F_{Dp} = \frac{1}{2} C_{Dp} \cdot A_p \cdot \rho \cdot v^2$$

$$F_{Dl} = \frac{1}{2} C_{Dl} \cdot A_l \cdot \rho \cdot v^2$$

$$F_{DT} = F_{Dp} + F_{Dl} = 6.272\, N$$

$$v = 15 \frac{m}{s}$$

$$\frac{1}{2} C_{Dp} \cdot A_p \cdot \rho \cdot v^2 + \frac{1}{2} C_{Dl} \cdot A_l \cdot \rho \cdot v^2 = 6.272\, N$$

$$A_p = \frac{\frac{2 \cdot F_{DT}}{\rho \cdot v^2} - C_{Dl} \cdot A_l}{C_{Dp}}$$

$$\boxed{\begin{array}{c} A_p = \dfrac{\frac{2 \cdot 6.72}{1.22 \cdot 20^2} - .82 \cdot 60^2 \cdot \pi \cdot 10^{-6}}{.5} = 0.0316\, m^2 \\ r = \sqrt{\dfrac{A_p}{\pi}} = \sqrt{\dfrac{0.03162}{\pi}} = 100.3\, mm \end{array}}$$

Descent Rate Estimates (2/4)

Heat Shield 500m → 200m:

Magnitude	Symbol	Value
Force Drag Heat Shield	F_H	6.131 N
Heat Shield Drag Coefficient	C_{Dp}	0.5
Area of Heat Shield	A_p	0.0505 m^2
Air Density	ρ	1.22
Force Drag Payload	F_{Dl}	0.141 N
Payload Drag Coefficient	C_{Dl}	0.82
Area of Payload	A_l	$60^2\pi \cdot 10^{-6}$ m^2
Descent Rate	v	20 m/s
Force Drag Total	F_{DT}	6.272 N

$$F_{Dp} = \frac{1}{2} C_{Dp} \cdot A_p \cdot \rho \cdot v^2$$

$$F_{Dl} = \frac{1}{2} C_{Dl} \cdot A_l \cdot \rho \cdot v^2$$

$$F_{DT} = F_{Dp} + F_{Dl} = 6.272\,N$$

$$v = 20\frac{m}{s}$$

$$\frac{1}{2} C_{Dp} \cdot A_p \cdot \rho \cdot v^2 + \frac{1}{2} C_{Dl} \cdot A_l \cdot \rho \cdot v^2 = 6.272\,N$$

$$A_p = \frac{\frac{2 \cdot F_{DT}}{\rho \cdot v^2} - C_{Dl} \cdot A_l}{C_{Dp}}$$

$$\boxed{A_p = \frac{\frac{2 \cdot 6.72}{1.22 \cdot 20^2} - .82 \cdot 60^2 \cdot \pi \cdot 10^{-6}}{.5} = 0.0505\,m^2}$$

Descent Rate Estimates (3/4)

Parachute Descent 200m → 0m:

Magnitude	Symbol	Value
Force Drag Parachute	F_{Dp}	6.131 N
Parachute Drag Coefficient	C_{Dp}	1.42
Area of Parachute	A_p	0.2846 m^2
Air Density	ρ	1.22 Kg/m^3
Force Drag Payload	F_{Dl}	0.141 N
Payload Drag Coefficient	C_{Dl}	0.82
Area of Payload	A_l	$60^2 \pi \cdot 10^{-6}$ m^2
Radius of Parachute	r_2	300.9 mm
Force Drag Total	F_{DT}	6.272 N

$$F_{Dp} = \frac{1}{2} C_{Dp} \cdot A_p \cdot \rho \cdot v^2$$

$$F_{Dl} = \frac{1}{2} C_{Dl} \cdot A_l \cdot \rho \cdot v^2$$

$$F_{DT} = F_{Dp} + F_{Dl} = 6.272\, N$$

$$v = 20 \frac{m}{s}$$

$$\frac{1}{2} C_{Dp} \cdot A_p \cdot \rho \cdot v^2 + \frac{1}{2} C_{Dl} \cdot A_l \cdot \rho \cdot v^2 = 6.272\, N$$

$$A_p = \frac{\frac{2 \cdot F_{DT}}{\rho \cdot v^2} - C_{Dl} \cdot A_l}{C_{Dp}}$$

$$\boxed{\begin{gathered} A_p = \frac{\frac{2 \cdot 6.72}{1.22 \cdot 20^2} - .82 \cdot 60^2 \cdot \pi \cdot 10^{-6}}{.5} = 0.284 m^2 \\ r = \sqrt{\frac{A_p}{\pi}} = \sqrt{\frac{0.284}{\pi}} = 301\, mm \end{gathered}}$$

Descent Rate Estimates (4/4)

Descent Rate Estimates Summary

Summary		
Component	**Desired Velocity (m/s)**	**Arean (m^2)**
Container Parachute	15	0.0316
Heat Shield	20	0.0505
Payload Parachute	5	0.2850

With these areas we can solve for the radiu for both parachutes and the total area required on the surface per panel.

Container Parachute

$$r = \sqrt{\frac{A_p}{\pi}} = \sqrt{\frac{0.03162}{\pi}} = 100.3\ mm$$

Payload Parachute

$$r = \sqrt{\frac{A_p}{\pi}} = \sqrt{\frac{0.2846}{\pi}} = 300.9\ mm$$

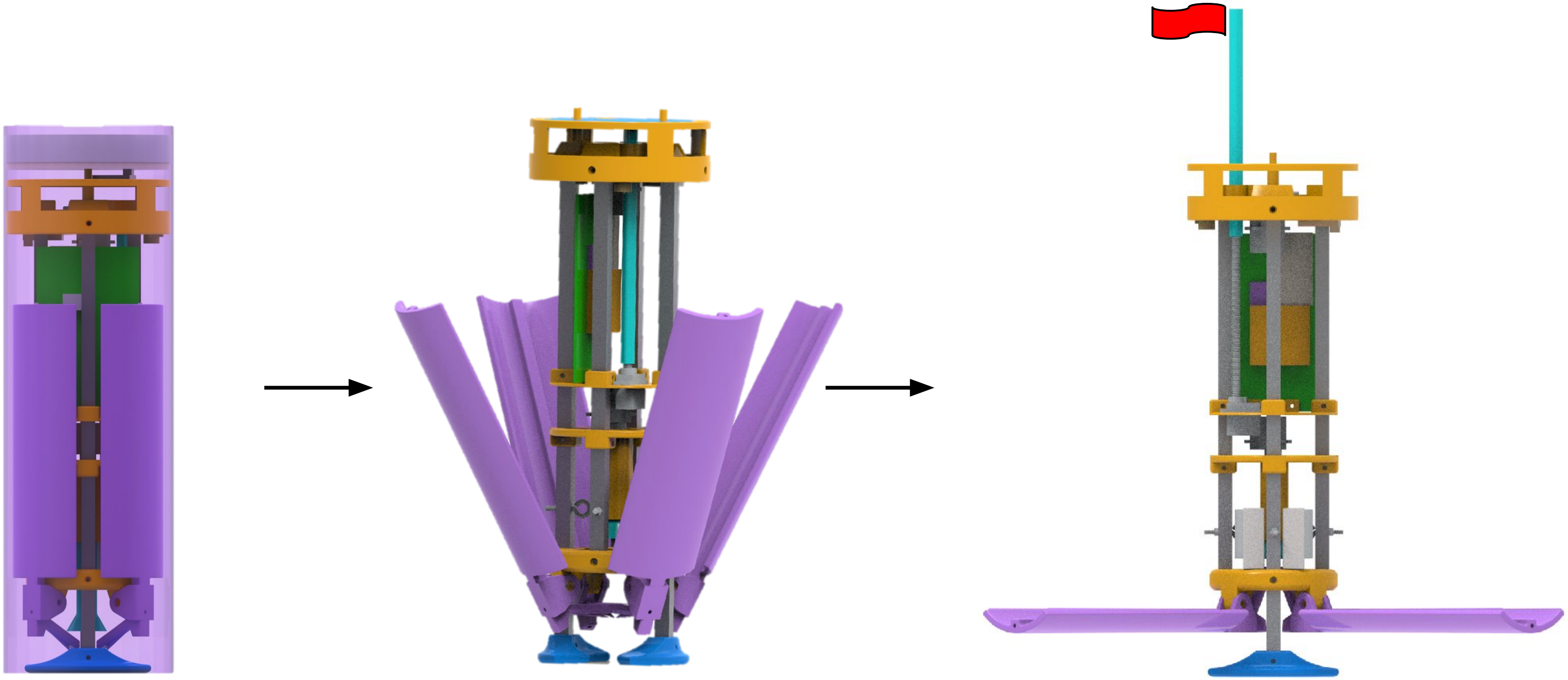
Area of Heat Shield per Panel

$$Area\ per\ Panel = \frac{Total\ Area}{Number\ of\ Panels} = \frac{.0505}{4} = 0.0126\ m^2$$

Mechanical Subsystem Design

John Kelly and Sofia Vicente

Mechanical Subsystem Overview



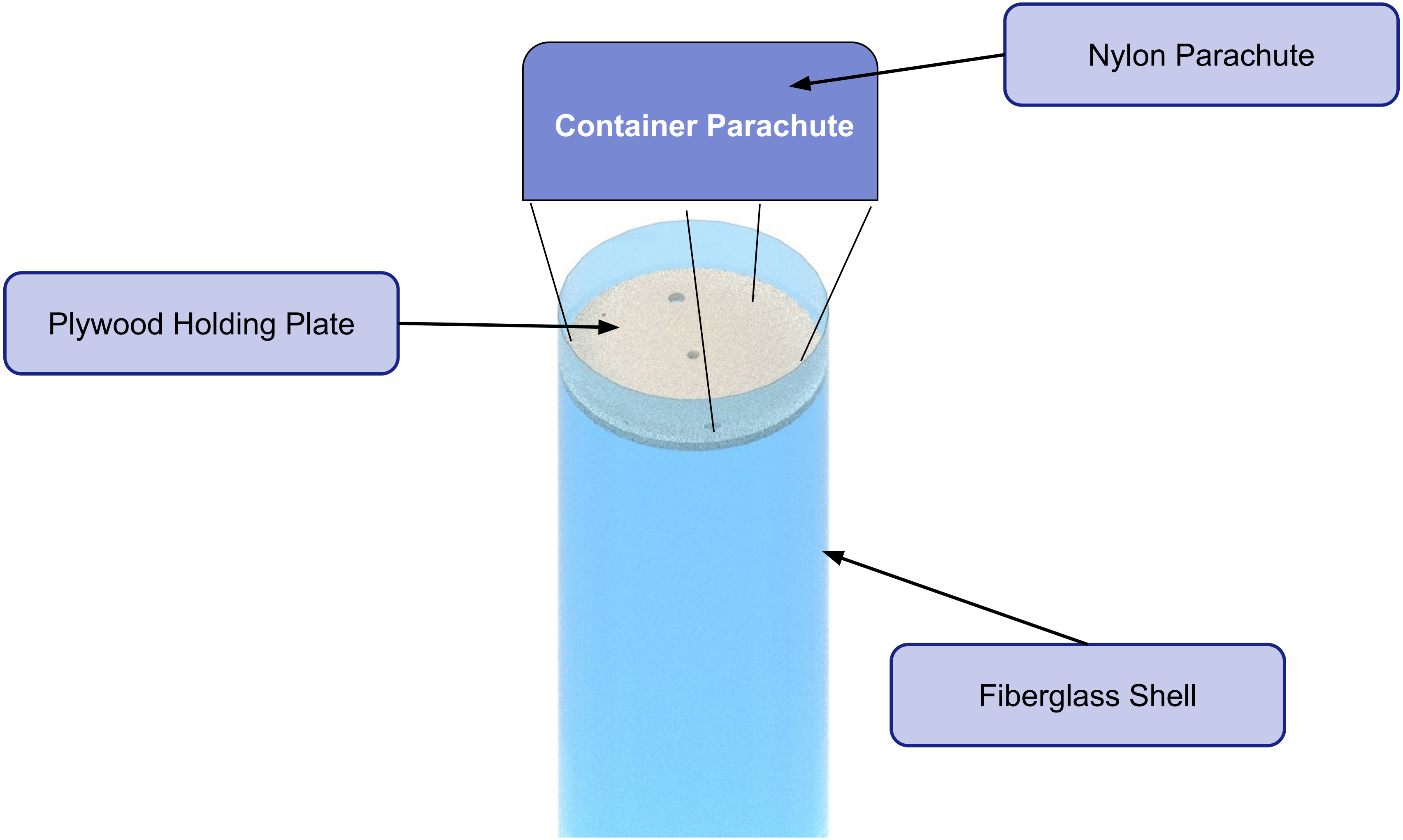
After leaving the Rocket, the Parachute will deploy.

At 500m the release mechanism servo will release the container from the payload via a tied string.

After landing, the panels for the heat shield will extend to 100 degrees to upright the cansat. Flag servo will rotate until flag is fully extended.

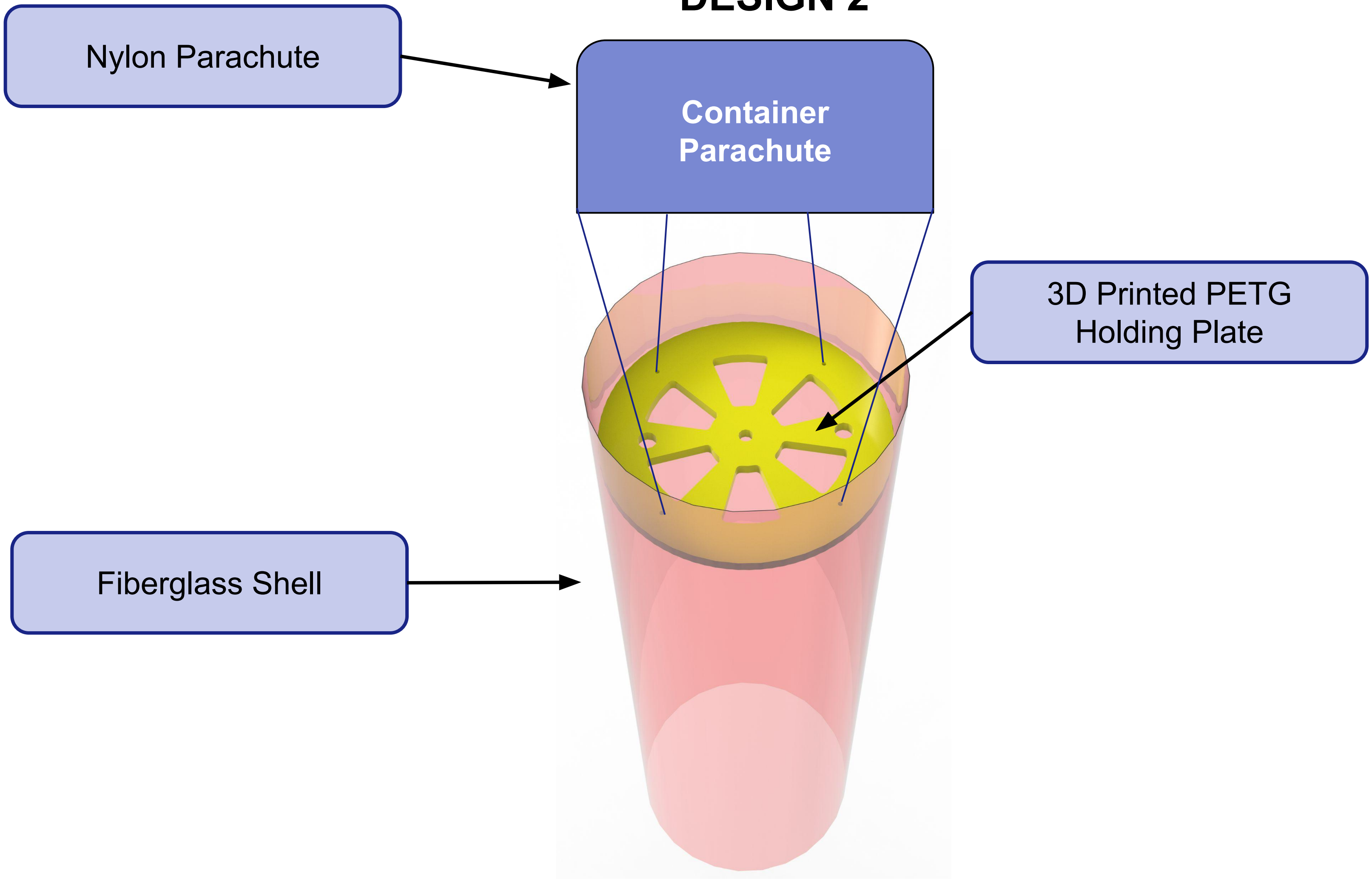
Container Mechanical Layout of Components Trade & Selection (1/3)

DESIGN 1



Container Mechanical Layout of Components Trade & Selection (2/3)

DESIGN 2



Nylon Parachute

Container Parachute

3D Printed PETG Holding Plate

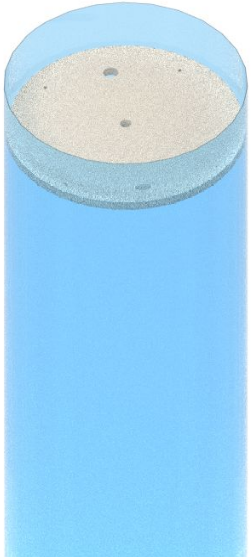
Fiberglass Shell

Container Mechanical Layout of Components Trade & Selection (3/3)

Design Number	Pros	Cons
1	- Plywood holding plate is lighter than PETG holding plate.	- Manufacturing Holding plate requires precise hand cutting of plywood.
2	- Holding plate has more gaps for tying fishing line	- Gaps in holding plate reduce strength.

Selection: DESIGN 1

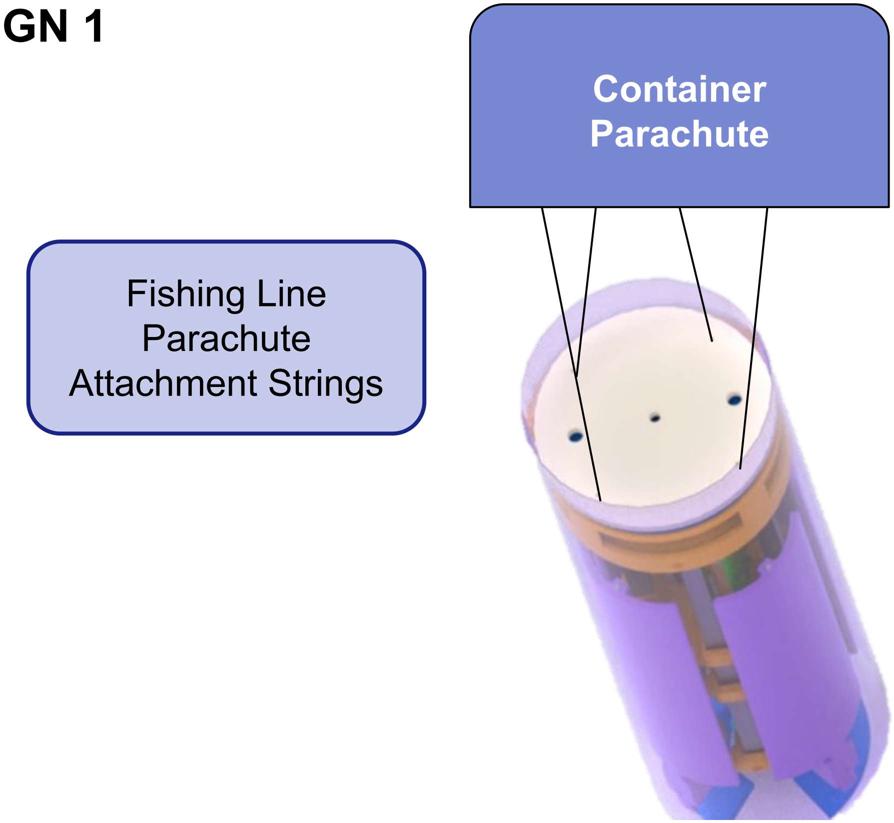
- The overall structure of the Container is stronger and lighter.



Container Parachute Attachment Mechanism (1/2)

DESIGN 1

- The Design 1 parachute will be attached to the plywood holding by four strings.
- Once the rocket drops the Cansat the parachute will open up.



Container Parachute

Fishing Line Parachute Attachment Strings

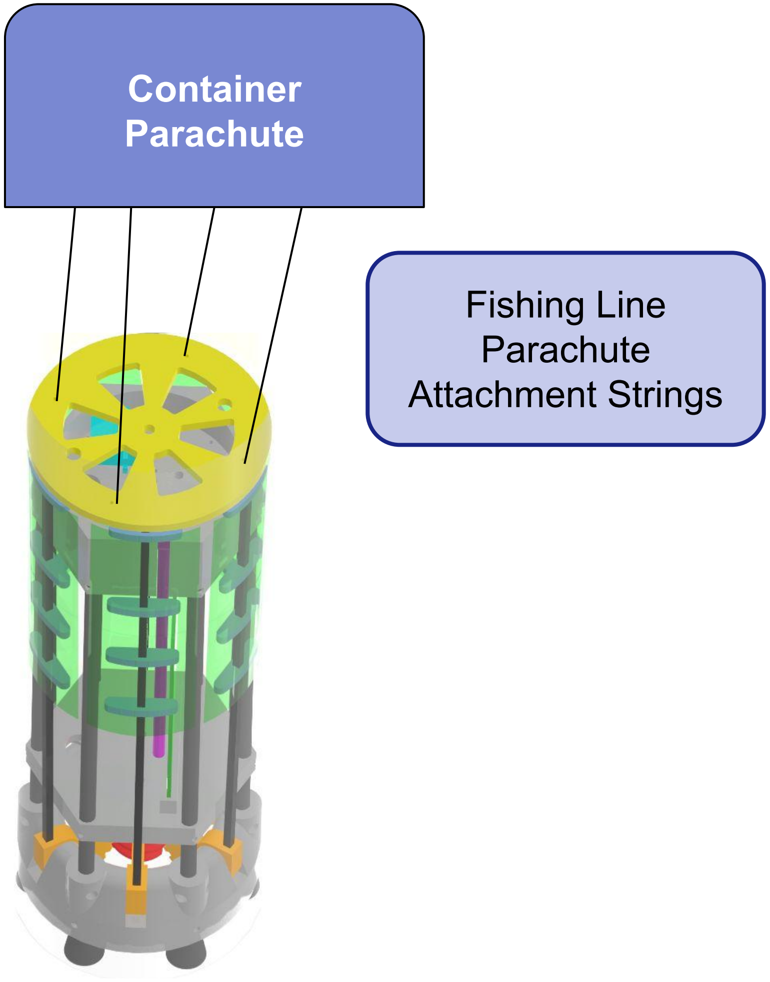
- The container parachute will be made of nylon chord.
- The attachment string will be made of 500 pound fishing line.

Container Parachute Attachment Mechanism (2/2)

DESIGN 2

- The Container parachute for Design 2 will have 4 strings of fishing line attached to a 3D printed holding plate
- When the Cansat drops out of the rocket the parachute should open up.

- The strings used to attach the parachute will be made of fishing line that can hold 500 pounds.
- The parachute holding the container will be made of nylon

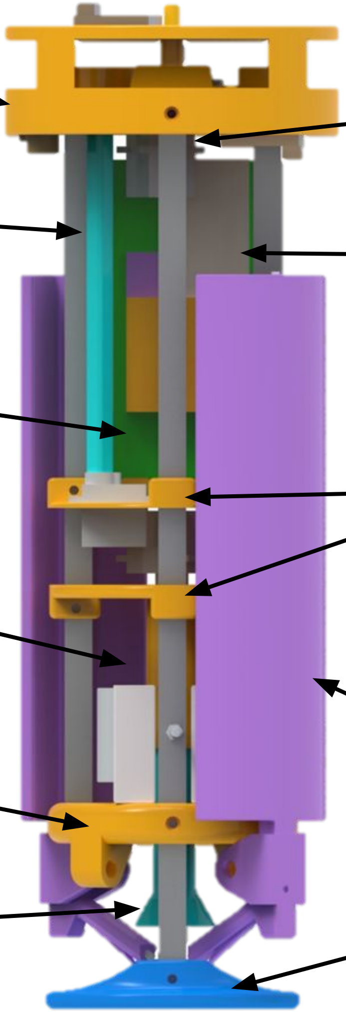


Container Parachute

Fishing Line Parachute Attachment Strings

Payload Mechanical Layout of Components Trade & Selection (1/3)

DESIGN 1



Top plate

Flag Mechanism uses a threaded rod

PCB

Structure uses 4 carbon fiber rods

Base Plate

Uses Mechanism with threaded rod to control panels

Release Mechanism

Electronics

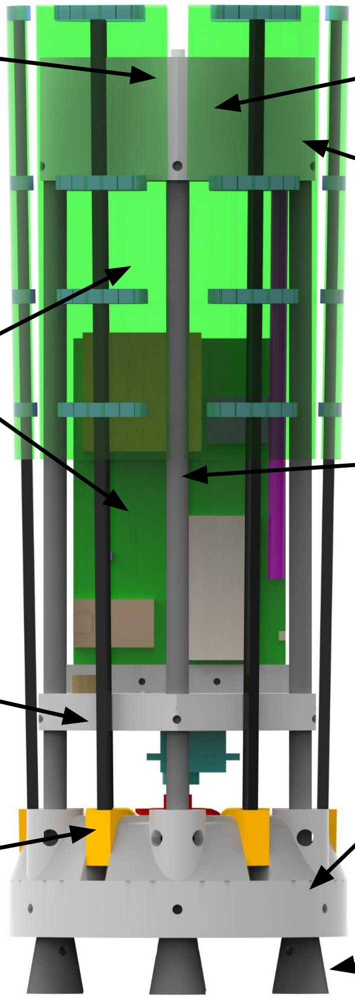
Holding Plates

4 Panels (Heat Shield Uprighting Mechanism)

Silicone Landing Legs

Payload Mechanical Layout of Components Trade & Selection (2/3)

DESIGN 2



Release Mechanism

PCB

6 Panels (Heat Shield Uprighting Mechanism)

Middle Plate

Worm gear mechanism to control the panels

Upper Plate

Flag Mechanism uses a servo

Structure uses 6 carbon fiber rods

Lower Plate

6 Landing Legs

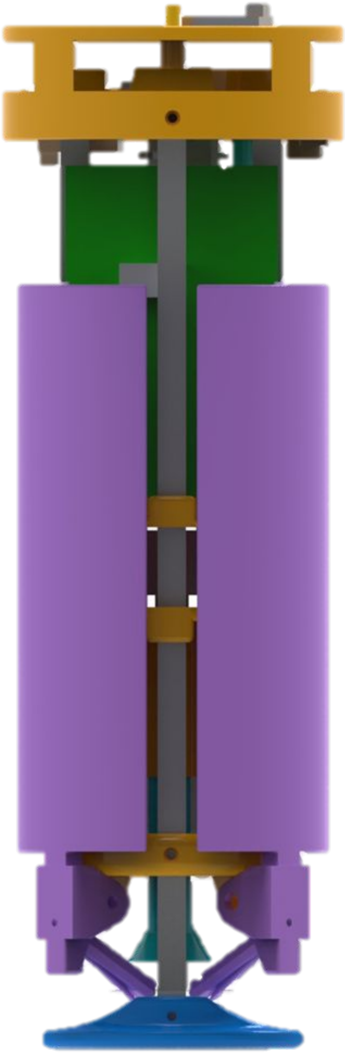
Payload Mechanical Layout of Components Trade & Selection (3/3)

Design Number	Pros	Cons
1	• Less panels = less parts that can malfunction • Square carbon fiber rods = easier to mount and secure to the structure	• Weight (725.9 g) • Requires an additional holding plate
2	• 6 legs = more stability for landing • Can hold a larger PCB	• Less space for surface mounted electrical components • Weight (727.2 g) • Custom gears required are difficult to manufacture

Selection: DESIGN 1

- The mechanical layout is easier to manufacture and more reliable
- More space to place required electrical components
- Lighter so it will need less adjustments to meet the mass requirement

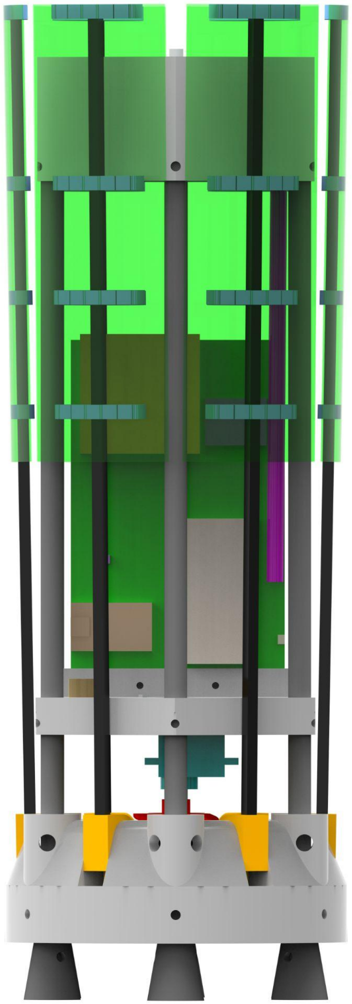
Payload Aerobraking Pre Deployment Configuration Trade & Selection (1/3)



DESIGN 1

Panels will be stored in the upright position before deployment after leaving the container. They will be held in place using the stem nut mechanism and the rubber bands.

Payload Aerobraking Pre Deployment Configuration Trade & Selection (2/3)



DESIGN 2

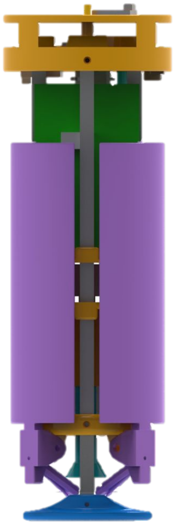
Panels will be stored in the upright position before deployment after leaving the container. They will be held in place using a gear mechanism.

Payload Aerobraking Pre Deployment Configuration Trade & Selection (3/3)

Design Number	Pros	Cons
1	Mechanism is easier to manufacture (bought or 3D printed) 4 wings = less parts that can break or malfunction Easier to control the angle of the panels	Weight (198.95 g) Rubber bands might be damaged after being exposed to the heat
2	Cheaper Lighter (weight = 178 g)	Material of the panels is not as rigid The custom gears needed are difficult to manufacture

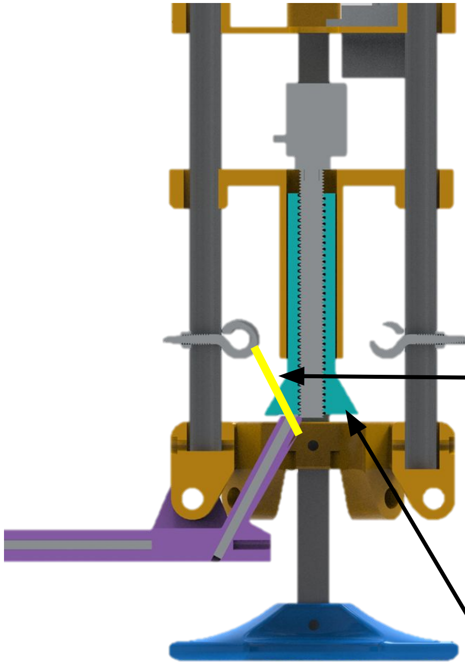
Selection: DESIGN 1

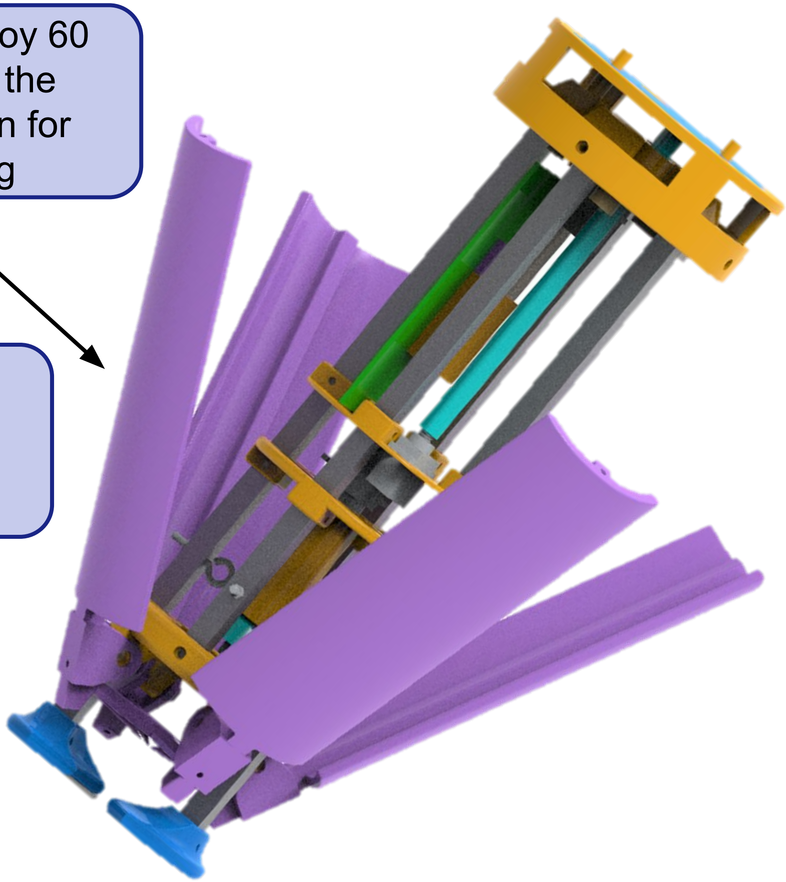
- More reliable and easier to control
- The material of the panels (PETG) is more rigid
- Easier to manufacture
- Changes will be made to lower weight of panels and we will test the effects of heat on the rubber bands



Payload Aerobraking Deployment Configuration Trade & Selection (1/3)

DESIGN 1





Panels will deploy 60 degrees from the stowed position for Aerobraking

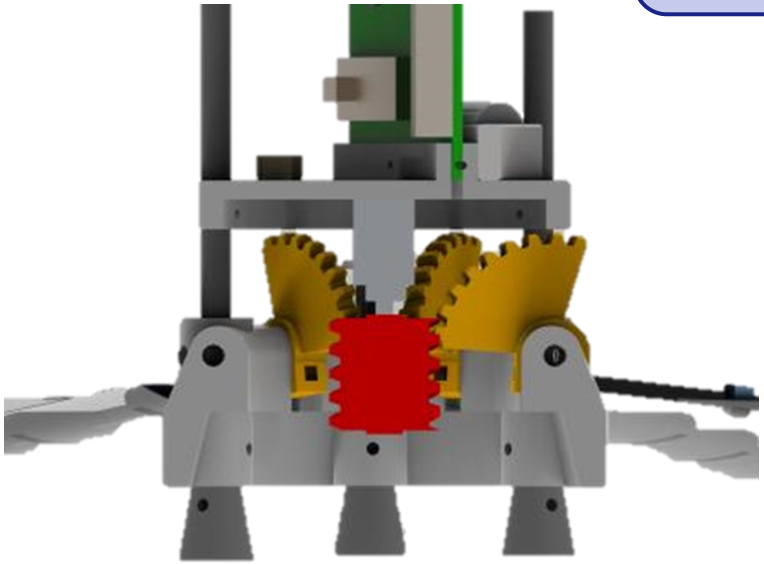
Rubber Bands provide opening torque

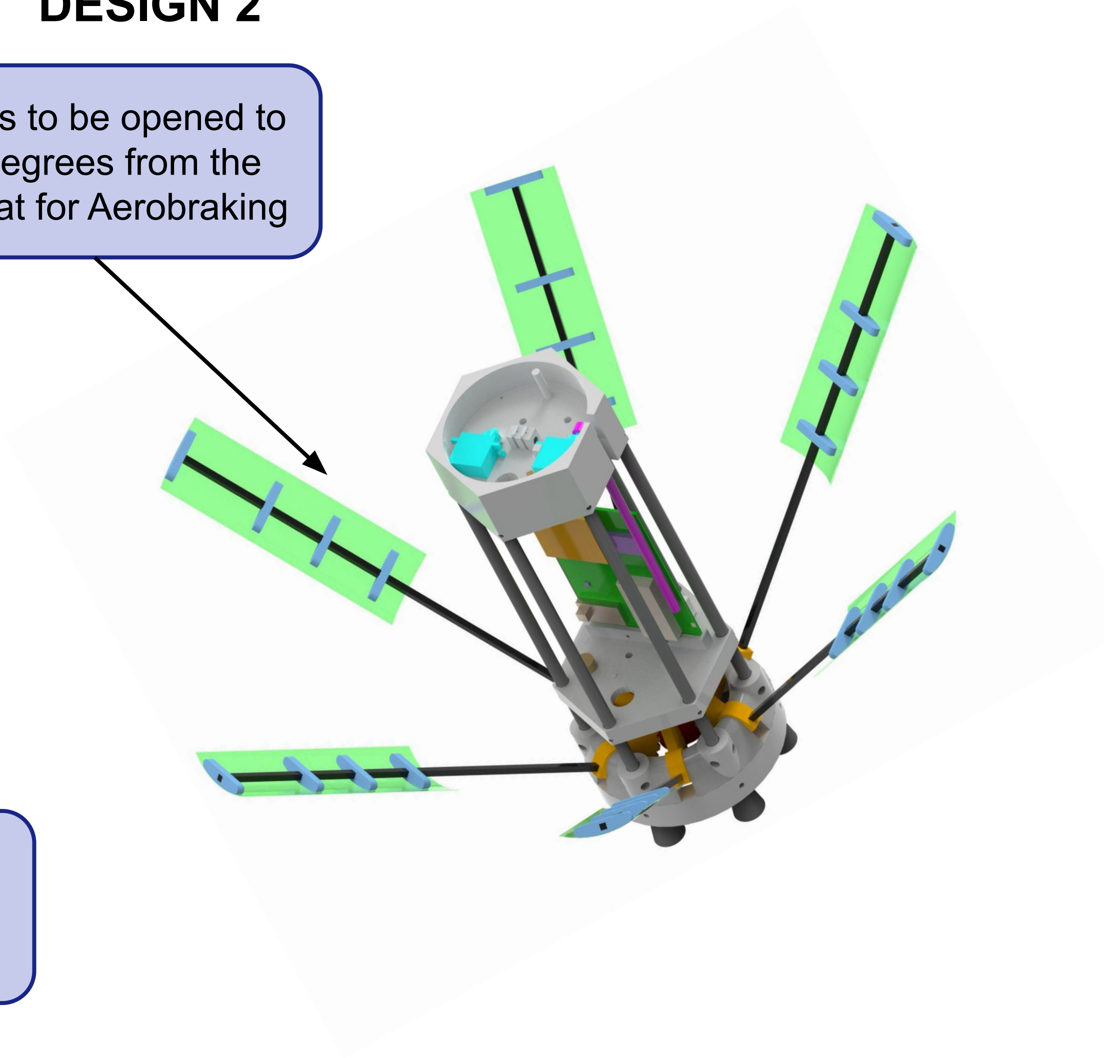
Stemnut moved to desired position that obtains an angle of 60 degrees

Payload Aerobraking Deployment Configuration Trade & Selection (2/3)

DESIGN 2

Panels to be opened to 60 degrees from the CanSat for Aerobraking





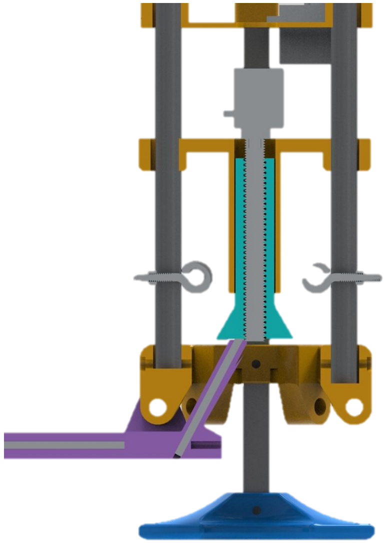
Rotation of worm results in the actuation of the panel gears

Payload Aerobraking Deployment Configuration Trade & Selection (3/3)

Design Number	Pros	Cons
1	• The aerobraking panels have a thicker, sturdier structure. • The control system is stronger against vertical shock.	• Rubber bands in constant tension puts stress on probe frame
2	• The aerobraking system is lighter. • All gear components are 3D printed, allowing timely adjustments to dimensions throughout testing.	• Further out panels experience increased torque with same drag force

Selection: DESIGN 1

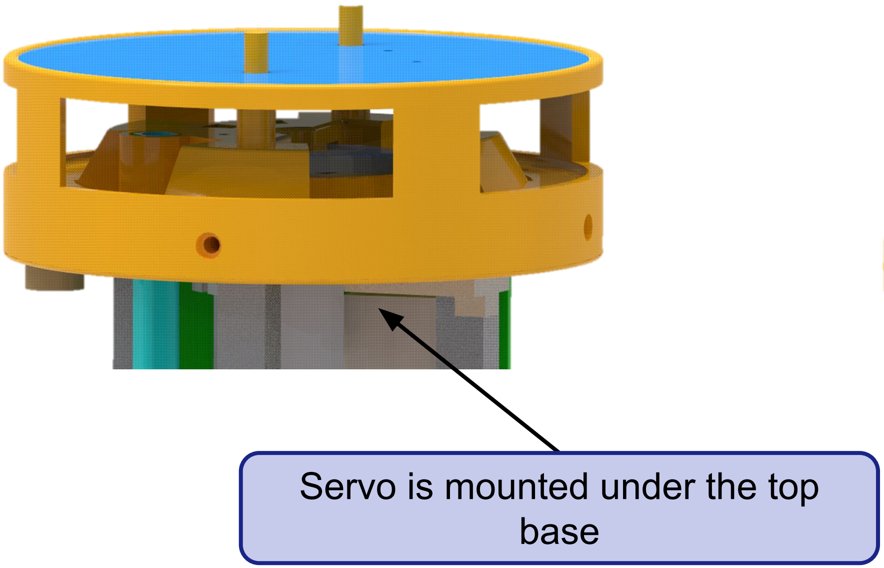
- Aerobraking system is sturdier and harder to break
- Aerobraking mechanisms will both be tested for better empirical data.



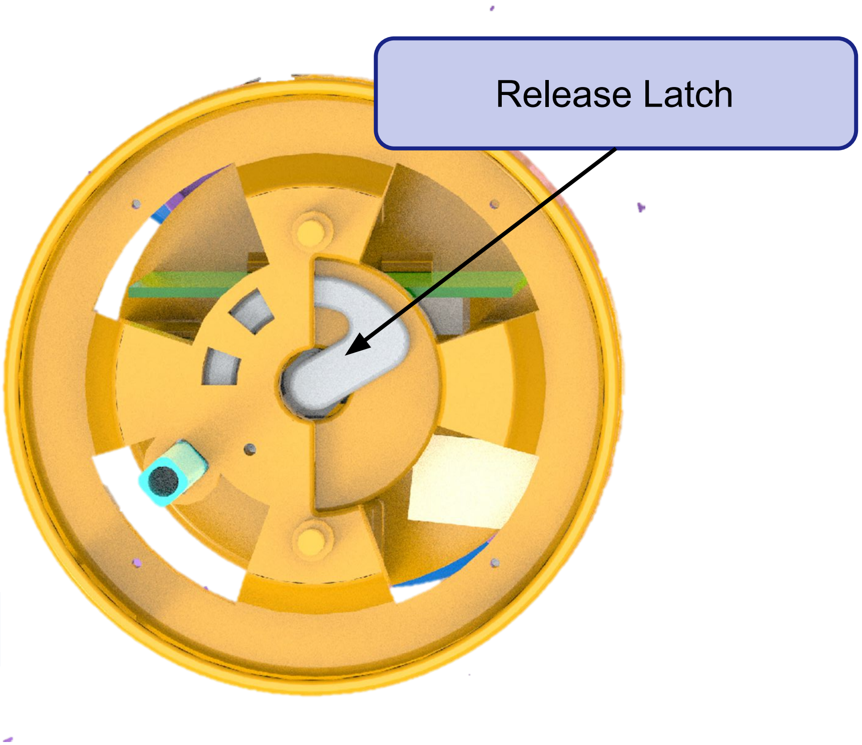
Payload Parachute Deployment Configuration Trade & Selection (1/3)

Design 1

- The parachute will be attached to a release latch.
- The release latch will be 3D printed in PETG.



Servo is mounted under the top base

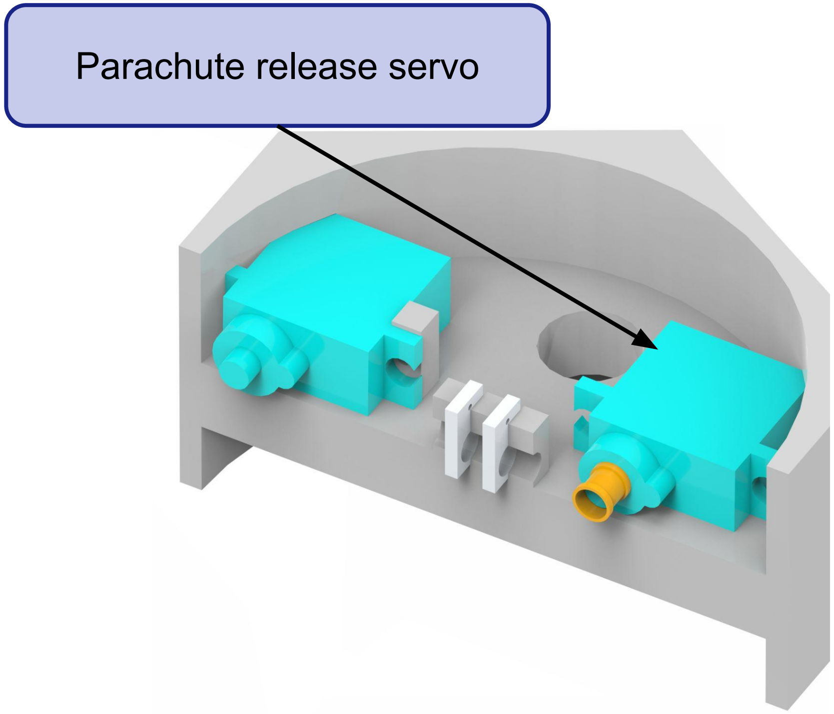


Release Latch

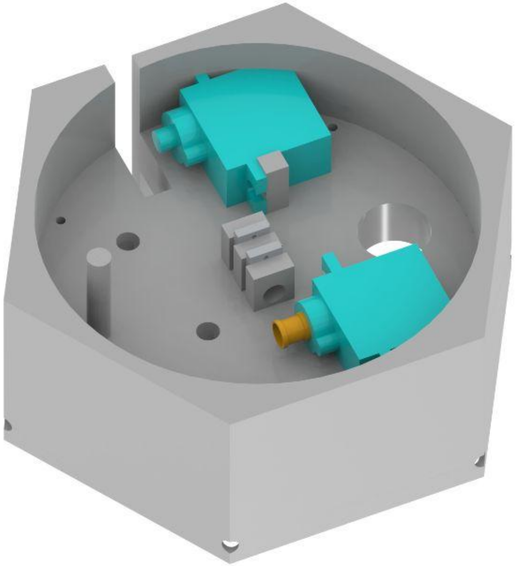
Payload Parachute Deployment Configuration Trade & Selection (2/3)

Design 2

- The parachute will be released by a servo with a spindle head.
- Spindle servo head is 3D printed out of PETG



Parachute release servo

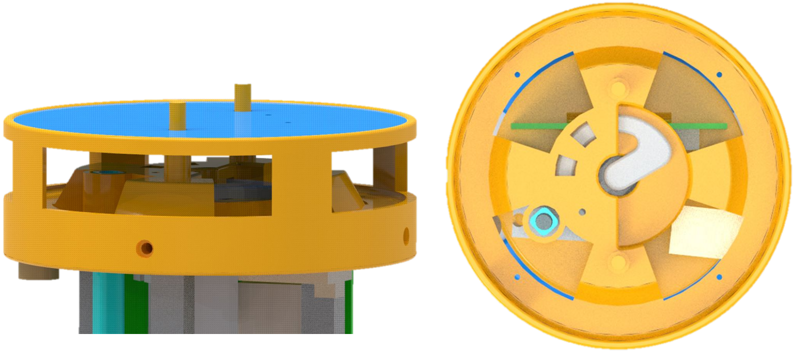


Payload Parachute Deployment Configuration Trade & Selection (3/3)

Design Number	Pros	Cons
1	● Release mechanism is thicker/sturdier ● More space for fishing line to be strung through mechanism. ● Latch displacement can be held by servo against forces in either direction.	● Small amounts of over rotation could release parachute early.
2	● Lighter release mechanism	● The release mechanism must be reset by hand each time for testing ● Servo can only pull on the pin and can't correct for the pin sliding too far due to vibrations

Selection: DESIGN 1

- It is physically stronger
- Better servo control increases reliability

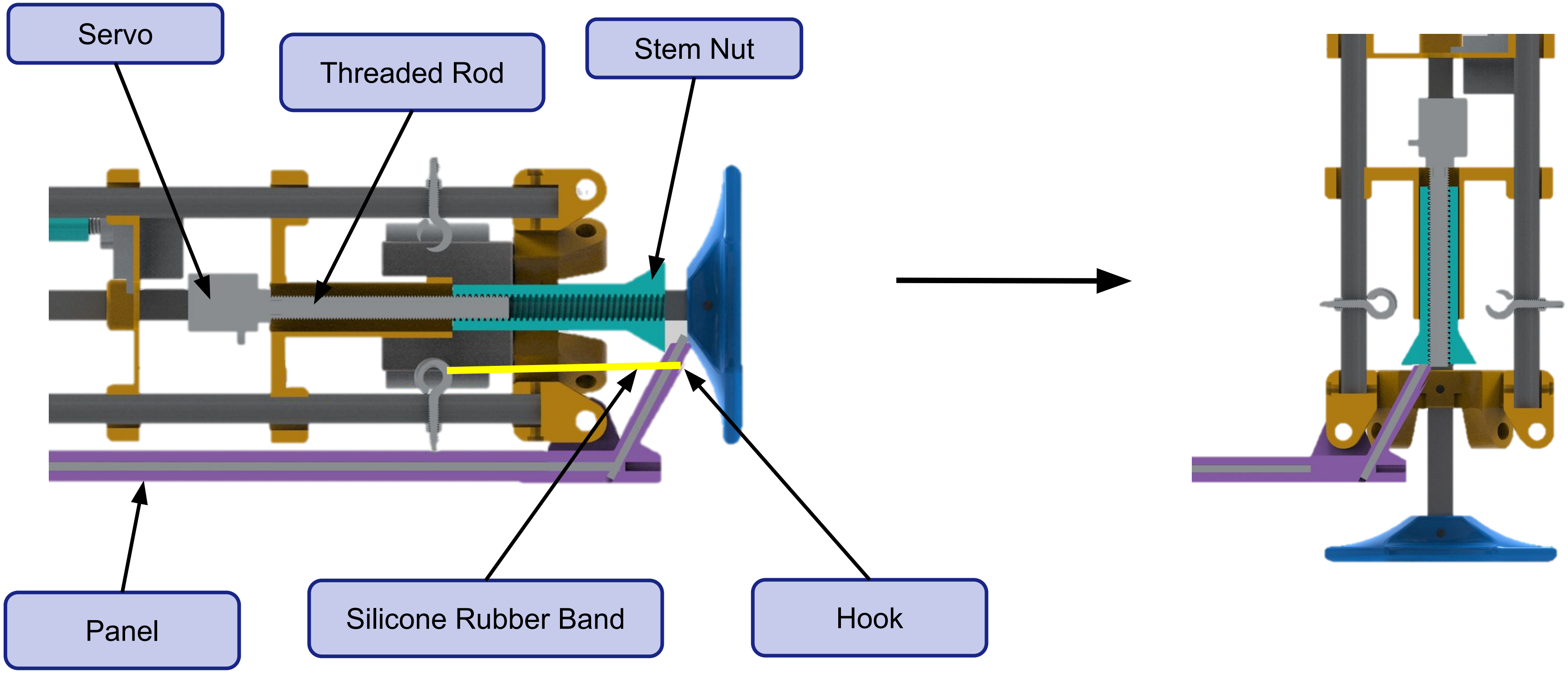


Payload Uprighting Configuration Trade & Selection (1/3)

DESIGN 1

ORIENTATION AFTER LANDING

ORIENTATION AFTER PANELS OPEN



Servo

Threaded Rod

Stem Nut

Panel

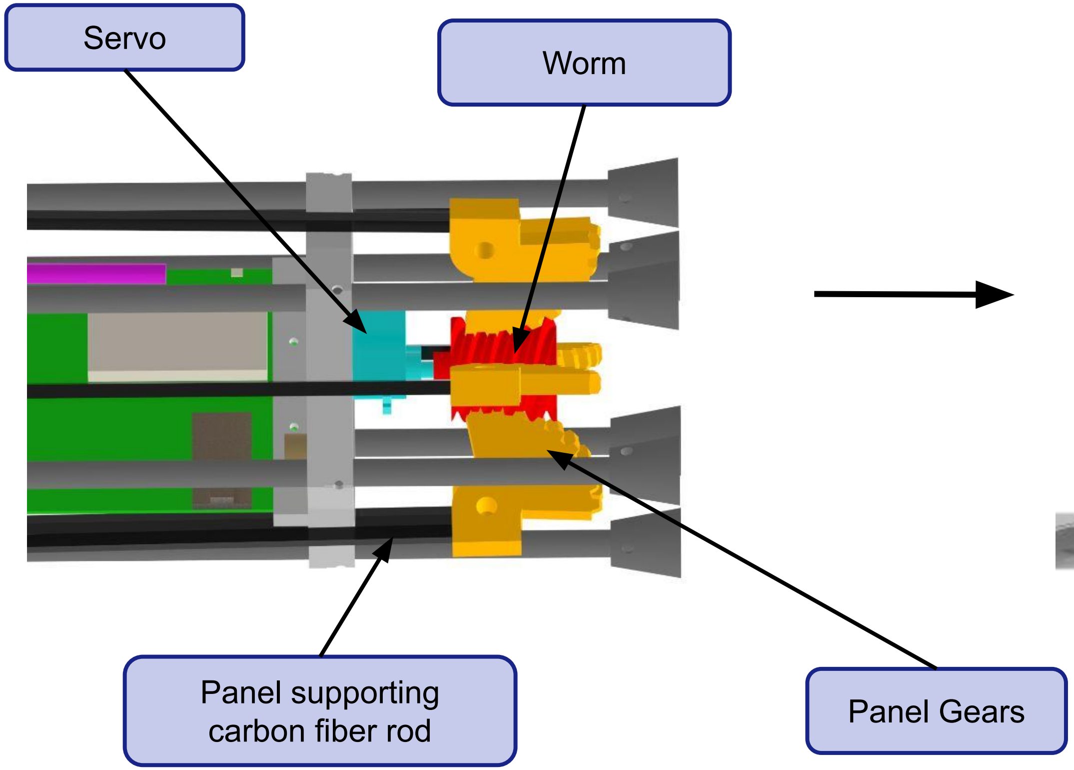
Silicone Rubber Band

Hook

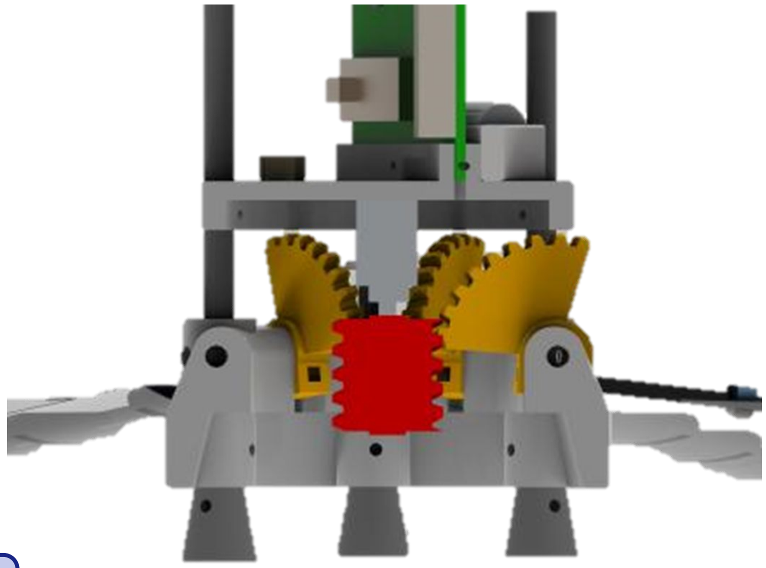
Payload Uprighting Configuration Trade & Selection (2/3)

DESIGN 2

ORIENTATION AFTER LANDING



ORIENTATION AFTER PANELS OPEN

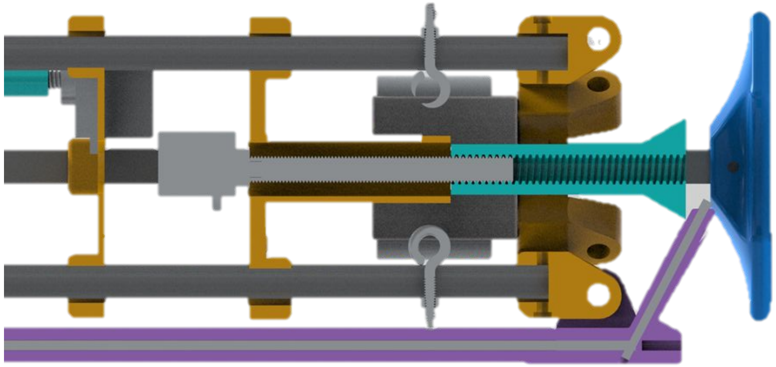


Payload Uprighting Configuration Trade & Selection (3/3)

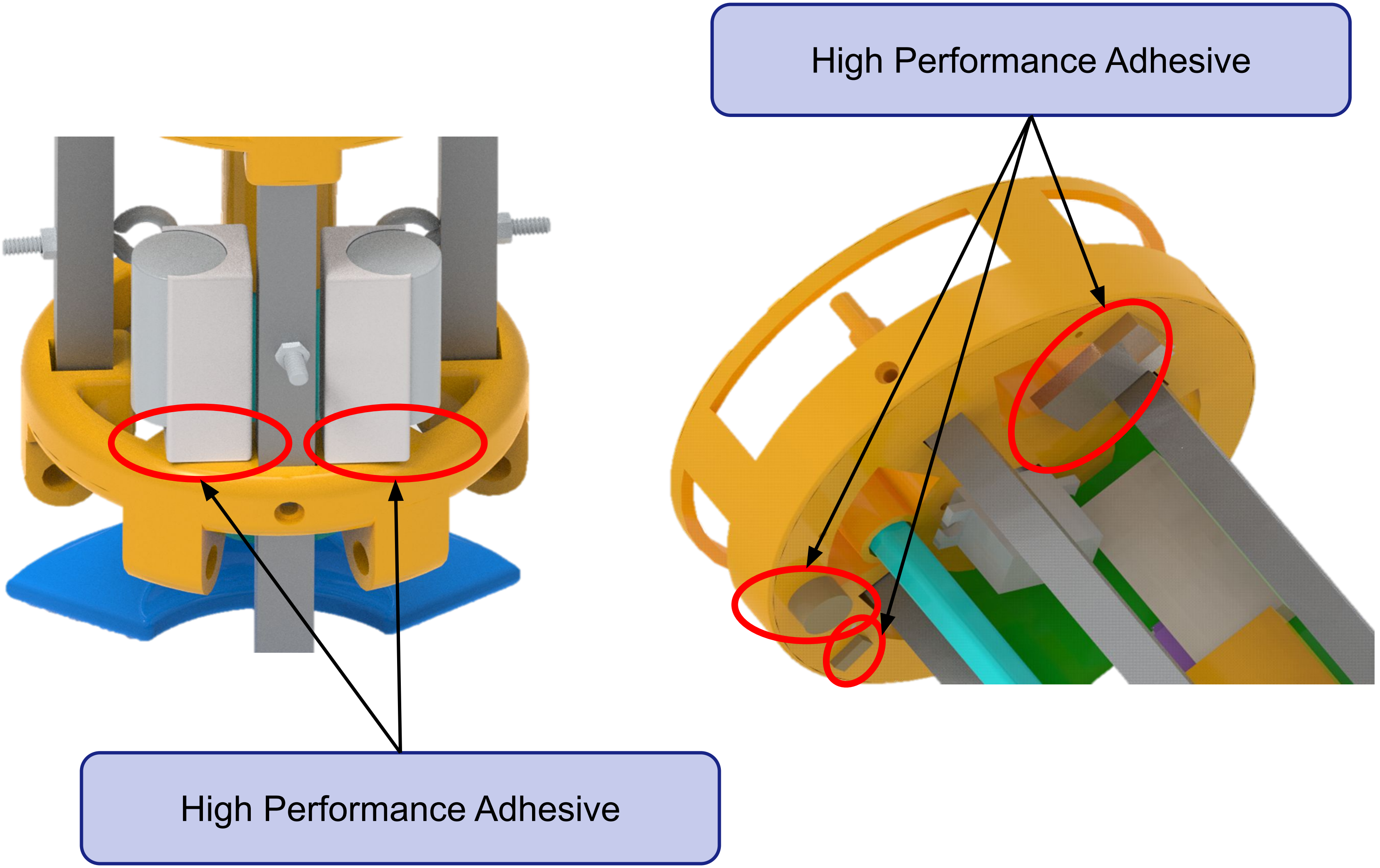
Design Number	Pros	Cons
1	● Thickness of panels increases strength ● Rubber bands provide uprighting torque instead of servo	● Thread tolerancing for smaller threads requires more precise manufacturing ● Larger angles between panels increase sliding friction during uprighting
2	● Lower mass	● Some losses of uprighting torque due to worm gear friction

Selection: DESIGN 1

- Less reliant on high servo torque
- Sturdier panels



Electronics Structural Integrity



High Performance Adhesive

High Performance Adhesive

Mass Budget (1/3)

Component	Source	Quantity	Mass/unit (g)	Mass summary (g)
SAM-M8Q (GPS)	Data sheet	1	13.00	13.00
BNO055	Data sheet	1	3.00	3.00
XBP9B-DMWT-002 (XBee)	Data sheet	1	8.00	8.00
Feather Huzzah32 (Microcontroller)	Data sheet	1	6.80	6.80
LEDs	Estimated	1	1.00	1.00
Buzzer	Data sheet	1	0.70	0.70
Continuous Rotation Micro Servo - FS90R	Data sheet	3	10.00	30.00
Mini Spy Camera	Data sheet	2	2.80	5.60
Payload Processor & Memory (DEV-13712)	Data sheet	1	1.80	1.80
Onboard reader	Data sheet	1	1.00	1.00
Battery holder	Data sheet	2	1.75	3.50
Adafruit BMP388	Data sheet	1	1.20	1.20
Battery	Data sheet	2	17.00	34.00

Mass Budget (2/3)

Component	Source	Quantity	Mass/unit (g)	Mass summary (g)
Panel	Calculated	4	22.00	88.00
Fiberglass shell	Calculated	1	60.00	60.00
Parachute (container)	Calculated	1	30.00	30.00
Parachute (payload)	Calculated	1	25.00	25.00
Leg	Calculated	2	25.00	50.00
Nylon rod	Calculated	1	3.24	3.24
Rod (Heat shield)	Calculated	1	6.39	6.39
Carbon fiber rod	Calculated	4	30.00	120.00
Lid	Calculated	1	17.24	17.24
Holding plate 1	Calculated	1	19.56	19.56
Holding plate 2	Calculated	1	17.14	17.14
Top plate	Calculated	1	84.73	84.73
Bottom plate	Calculated	1	28.45	28.45
Stem Nut	Calculated	1	8.31	8.31

Mass Budget (3/3)

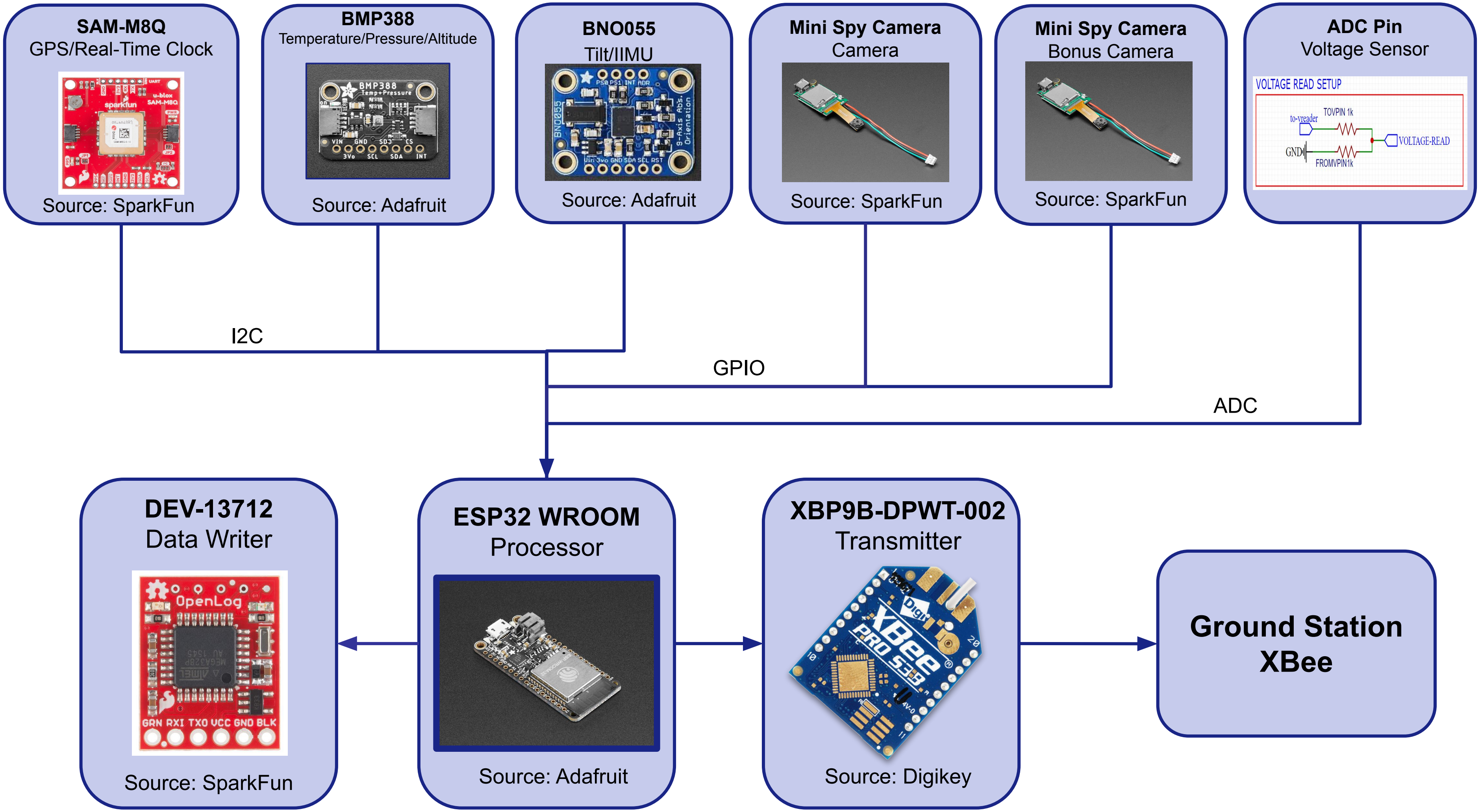
Component	Source	Quantity	Mass/unit (g)	Mass summary (g)
Stem Nut 2	Calculated	1	4.38	4.38
Panel rod 1	Calculated	4	0.75	3.00
Panel rod 2	Calculated	4	3.30	13.20
PCB	Calculated	1	17.00	17.00
			TOTAL	**705.94**
			MASS MARGIN	**-5.94**

Note:
Mass requirement is 700 +/- 10g. Our design is 5.94 g over 700g, meaning we meet the mass requirement.

Communication and Data Handling (CDH) Subsystem Design

Emily Jolly, Jamie Roberson

Payload Command Data Handler (CDH) Overview



SAM-M8Q
GPS/Real-Time Clock
Source: SparkFun

BMP388
Temperature/Pressure/Altitude
Source: Adafruit

BNO055
Tilt/IIMU
Source: Adafruit

Mini Spy Camera
Camera
Source: SparkFun

Mini Spy Camera
Bonus Camera
Source: SparkFun

ADC Pin
Voltage Sensor

I2C

GPIO

ADC

DEV-13712
Data Writer
Source: SparkFun

ESP32 WROOM
Processor
Source: Adafruit

XBP9B-DPWT-002
Transmitter
Source: Digikey

Ground Station XBee

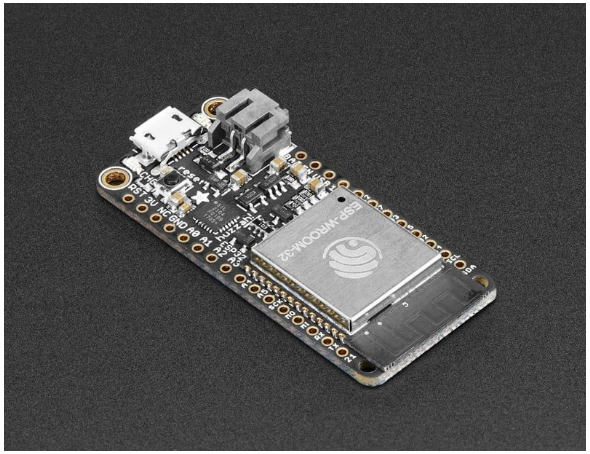
Payload Processor & Memory Trade & Selection (1/2)

Processor

Model	Flash Memory	Boot Time	Processor Speed	UART Pin(s)	ADC Pin(s)	GPIO Pin(s)	Weight (g)	Cost
Feather HUZZAH	4 MB	200-300 ms	240 MHz	2 pairs	13	20	6.8	$19.95
Trinket Pro	28 KB	2-3 sec	200 MHz	1 pair	7	18	2.6	$9.95
Raspberry Pi Pico	2 MB	1.5sec	133 MHz	5 pairs	4	25	6	$5.00

Selection: Feather ESP32 HUZZAH

- Speed
- Expansive memory
- Best SRAM



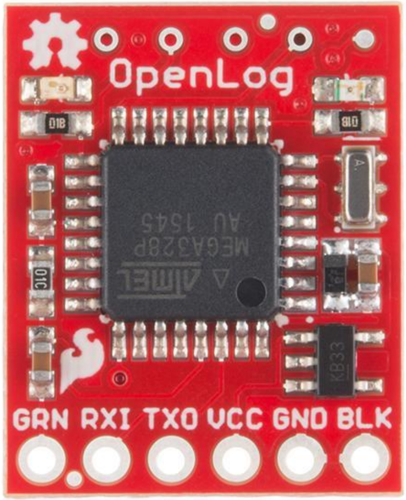
Source: Adafruit

Payload Processor & Memory Trade & Selection (2/2)

Memory

Model	Interface	Capacity (GB)	Weight (g)	Cost
DEV-13712	UART, SPI	32	1.8	$16.95
DEV-15164	I²C	64	14.3	$18.50

Selection: DEV-13712
- Previous usage/familiarity
- Sufficient capacity
- Smaller mass



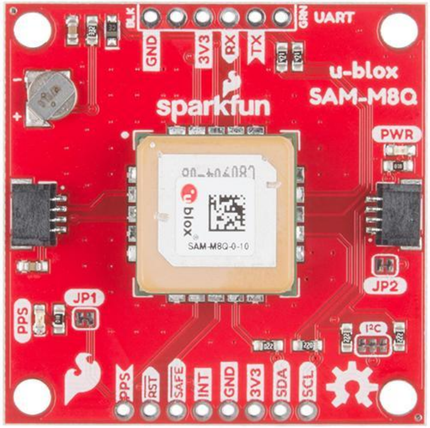
Source: SparkFun

Payload Real-Time Clock

Model	Interface	Battery Backup	Oscillator (kHz)	Input Voltage (V)	Weight (g)	Cost
SAM-M8Q	I²C	Coin Battery	32	3.3	13	$42.95
PCF8523	I²C	Coin Battery	32.8	3.3 or 5	1.2	$7.90
DS1307	I²C	Coin Battery	32.8	5	2.3	$8.45

Selection: SAM-M8Q

- Already using, so no extra cost or weight
- Plan to attach coin battery for independent power source
- For reset tolerance, will check for internal backup data storage and set internal variables to whatever backup



Source: Sparkfun

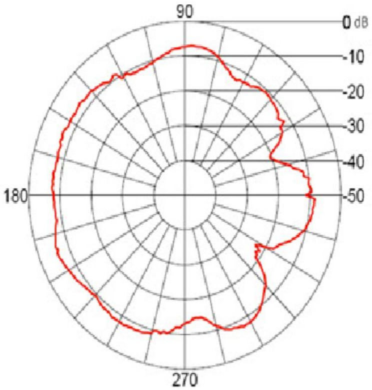
Payload Antenna Trade and Selection

Model	Range (km)	Gain (dBi)	Pattern	Mounting Type	Cost
XBP9B-DPWT-002	9.6	2.1	Omnidirectional	Integrated	Negligible
A09-HASM-675	10	2.15	Omnidirectional	Connector Mount	$34.05

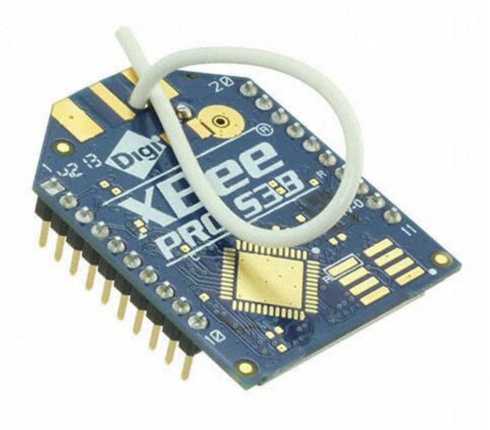
Selection: XB9B-DPWT-002

- Integrated antenna for no extra cost
- Appropriate range
- Lower mass implications

Radiation Pattern



Source: researchgate



Source: Digikey

Payload Radio Configuration

IDLE, READY:

- Only debug/simulation & telemetry commands on
- CXON

ASCENT, DESCENT, HEATSHIELD, PARACHUTE:

- Manual release (rocket, heat shield, parachute) commands active

LANDED:

- Locator & telemetry commands on

Testing via XCTU

- Short range (within a few meters), same computer testing
- Short range, different computer testing
- Medium (20 meters) range testing
- High range (100 meters) with antennae
- Practice launch testing

Source: Digikey

XBee Node Identifier	Location	Model	NET ID	Destination High	Destination Low	Baud Rate
Obsidian	CanSat	XBP9B-DPWT-002	1070	13A200	SL of Decepticon	9600
Decepticon	GCS	XBP9B-DMST-002	1070	13A200	SL of Obsidian	9600

Payload Telemetry Format (1/3)

Telemetry	
Format	TEAM_ID, MISSION_TIME, PACKET_COUNT, MODE, STATE, ALTITUDE, HS_DEPLOYED, PC_DEPLOYED, MAST_RAISED, TEMPERATURE, PRESSURE, VOLTAGE, GPS_TIME, GPS_ALTITUDE, GPS_LATITUDE, GPS_LONGITUDE, GPS_SATS, TILT_X, TILT_Y, CMD_ECHO
Example	1070,13:14:02.22,178,F,HEATSHIELD,398.2,P,N,N,24.9,5.2,13:14:02,401.8,34.7252,-86.6405,1,5.21,7.45,CXON

Payload Telemetry Format (2/3)

Telemetry	Description	Units
TEAM_ID	Assigned four digit team identification number (1070)	N/A
MISSION_TIME	Mission Time in UTC with 1 second or better resolution	hh:mm:ss.ss
PACKET_COUNT	Total count of transmitted packets	N/A
MODE	‘F’ for flight mode and ‘S’ for simulation mode	N/A
STATE	Operating state of the software	N/A
ALTITUDE	Altitude in units of meters and relative to ground level at the launch site. Resolution of 0.1 m	Meters (m)
HS_DEPLOYED	‘P’ indicates the Probe with heat shield is deployed, ‘N’ otherwise	N/A
PC_DEPLOYED	‘C’ indicates the Probe parachute is deployed (at 200 m), ‘N’ otherwise	N/A
MAST_RAISED	‘M’ indicates the flag mast has been raised after landing, ‘N’ otherwise	N/A
TEMPERATURE	Temperature in degrees Celsius. Resolution of 0.1 degrees	Celsius (°C)
VOLTAGE	Voltage of the CanSat power bus. Resolution of 0.1 volts	Volts (V)
PRESSURE	Air pressure of the sensor used. Value must be in kPa with a resolution of 0.1 kPa.	Kilopascals (kPa)

Payload Telemetry Format (3/3)

Telemetry	Description	Units
GPS_TIME	Time from the GPS receiver. The time must be reported in UTC. Resolution of 1 sec	Seconds (s)
GPS_ALTITUDE	Altitude from the GPS receiver in meters above mean sea level. Resolution of 0.1 meters	Meters (m)
GPS_LATITUDE	Latitude from the GPS receiver in decimal degrees. Resolution of 0.0001 degrees North	Degrees (°)
GPS_LONGITUDE	Longitude from the GPS receiver in decimal degrees. Resolution of 0.0001 degrees West	Degrees (°)
GPS_SATS	Number of GPS satellites being tracked by the GPS receiver	N/A
TILT_X	Angle of CanSat X axis in degrees. Resolution of 0.01 degrees	Degrees (°)
TILT_Y	Angle of CanSat Y axis in degrees. Resolution of 0.01 degrees	Degrees (°)
CMD_ECHO	Text of the last command received and processed by the CanSat	N/A

Payload Command Formats (1/2)

General Format - “CMD,1070,<COMMAND>,<ARGUMENT>”

Command	Argument	Argument Type	Description	Echo
CX	ON	String	Turns the telemetry on.	CXON
	OFF	String	Turns the telemetry off.	CXOFF
ST	GPS	String	Sets the internal time to the GPS’s internal time.	STGPS
	[Custom]	String (HH:MM:SS.ss)	Sets the internal time to the custom time	STCUS
SIM	ENABLE	String	Enables but does not run the simulation mode.	SIME
	DISABLE	String	Disables and stops the simulation mode.	SIMD
	ACTIVATE	String	Runs the simulation mode.	SIMA

Payload Command Formats (2/2)

General Format - “CMD,1070,<COMMAND>,<ARGUMENT>”

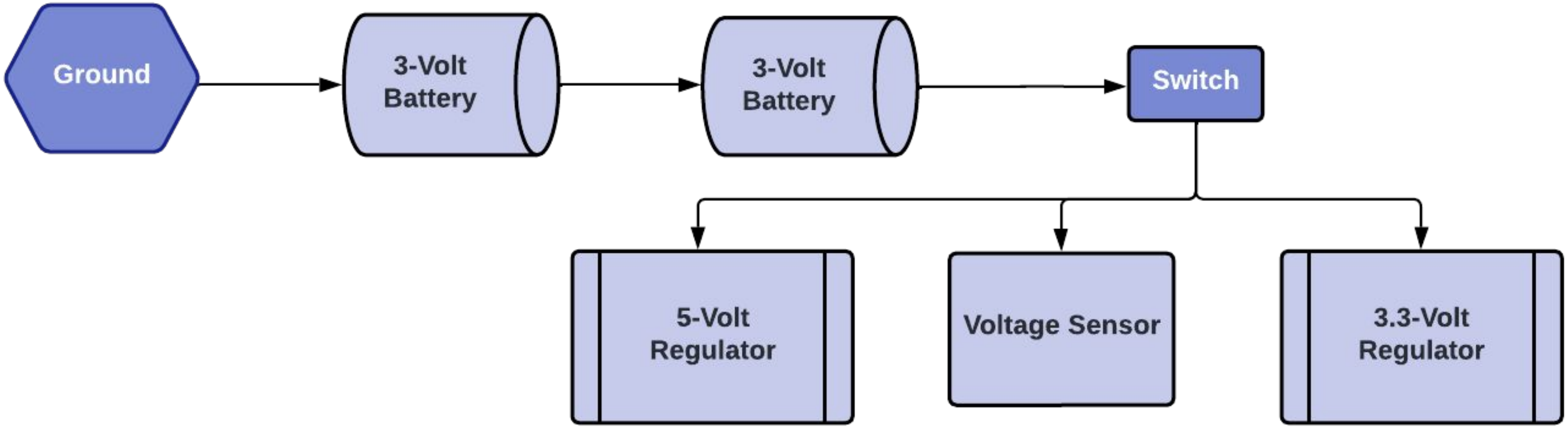
Command	Argument	Argument Type	Description	Echo
SIMP	[Custom]	Float	Sends a fake pressure value to the container.	SIMP
CAL	–	–	Calibrates the altitude of the container to 0 at its current height.	CAL
ACT	MR	String	Activates the release mechanism.	ACTMR
	HS	String	Activates the heat shield deployment.	ACTHS
	PC	String	Activates the parachute.	ACTPC
	AB	String	Toggles the audio beacon.	ACTAB
	LED	String	Toggles the LED.	ACTLED

Electrical Power Subsystem (EPS) Design

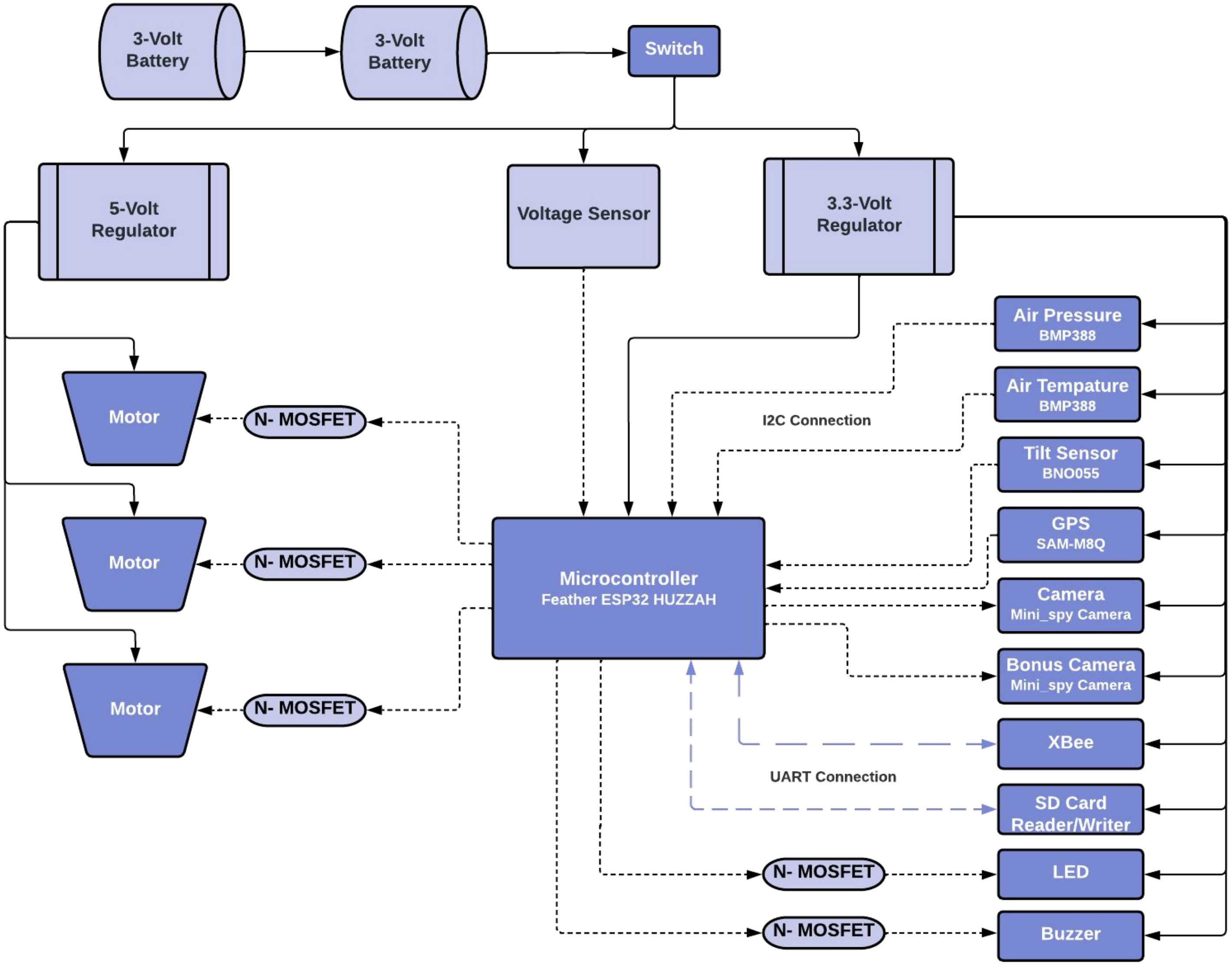
Madison Kromer

EPS Overview

Two Battery System at 6 Volts Feeding a 5 Volt and 3.3 Volt Regulator



Payload Electrical Block Diagram



Payload Power Trade & Selection

Model	Quantity	Nominal Voltage (V)	Nominal Capacity (mAh)	Nominal Energy (Wh)	Size (mm)	Weight (g)	Cost
SureFire-123A	2 in Series	6.0	1550	9.3	34.5 x 17	34	1.48
Energizer Max AA	3 in series	4.5	1540	6.93	50.5 x 14.5	69	0.44

Selection: SureFire-123A

- Provides a longer life for high drain devices and can be up to ⅓ lighter than alkaline batteries.
- Provides a steady voltage curve, which is ideal.
- Energy Density (Wh/kg): 273.5

Source: theshorelinemarket

Mounting Device/
Battery Holder:
BH123A

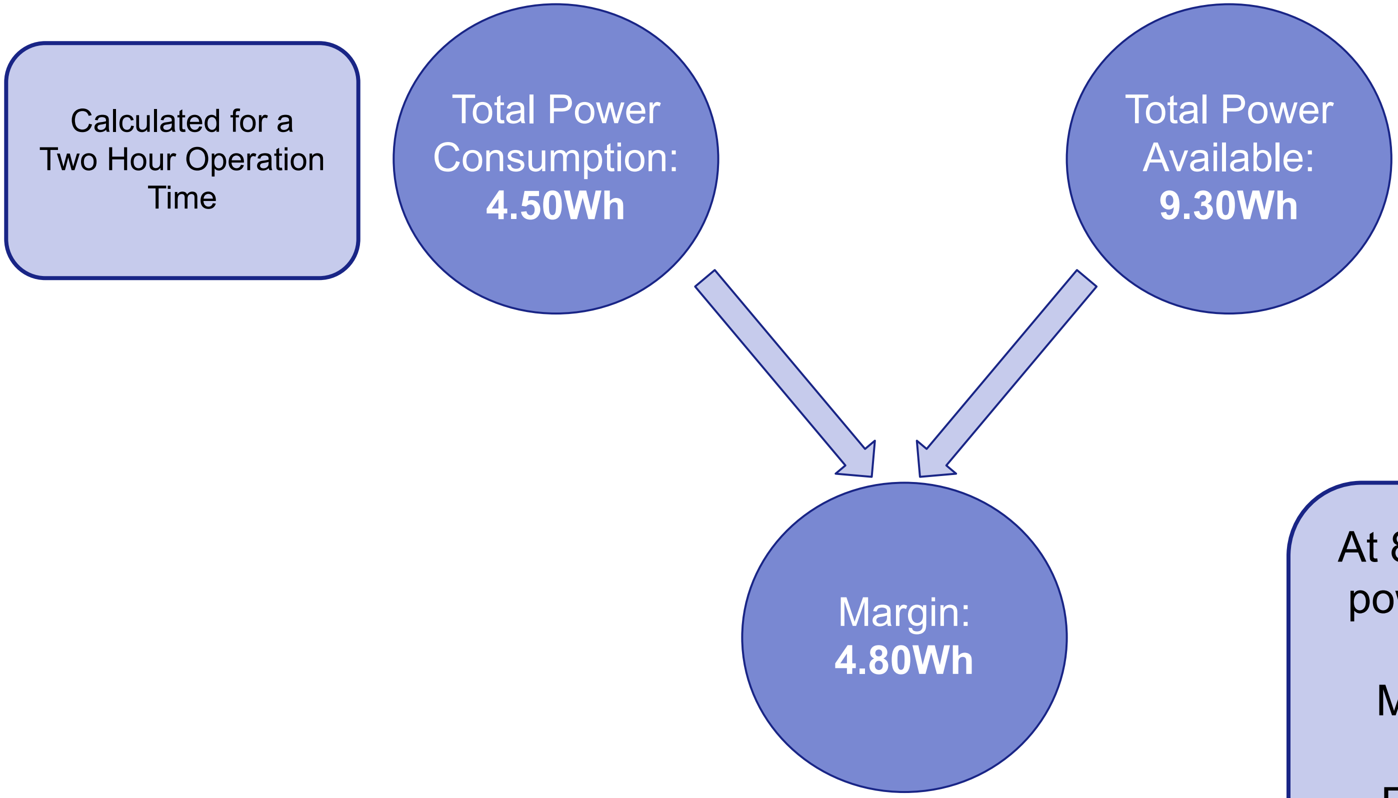
Source: Digikey

Payload Power Budget (1/2)

Component	Input Voltage (V)	Max Active Current (mA)	Idle Current (mA)	Active Power (W)	Idle Power (W)	Duty Cycle	Power Consumption (Wh)	Source
SAM-M8Q (GPS)	3.3	29	23	0.1044	0.0759	100%	0.2088	DS
BMP 388	3.3	0.7	0.1	0.0023	0.0003	100%	0.00462	DS
LSM6DSOX	3.3	3	1	0.0099	0.0033	100%	0.0198	DS
CanSat Camera	3.3	110	85	0.3630	0.2810	100%	0.726	DS
Probe Camera	3.3	110	85	0.3630	0.2810	100%	0.726	DS
LED	5	100	0	0.5000	0.0000	20%	0.200	DS
XBP9B-DMST-002	3.3	215	29	0.7100	0.145	50%	1.00	DS
Servo #1	5	550	100	2.7500	0.5000	0.50%	0.00275	DS
Servo #2	5	550	100	2.7500	0.5000	0.50%	0.00275	DS
Servo #3	5	550	100	2.7500	0.5000	0.50%	0.00275	DS
Feather HUZZAH	3.3	240	20	0.7920	0.0660	100%	1.58	DS
SparkFun OpenLog	3.3	6	2	0.0198	0.0066	50%	0.0264	DS
				Total Power Consumption			**4.50Wh**	

Calculated using max current while components are active.

Payload Power Budget (2/2)



Calculated for a Two Hour Operation Time

Total Power Consumption: **4.50Wh**

Total Power Available: **9.30Wh**

Calculated Using Two 3V Surefire 123A Batteries

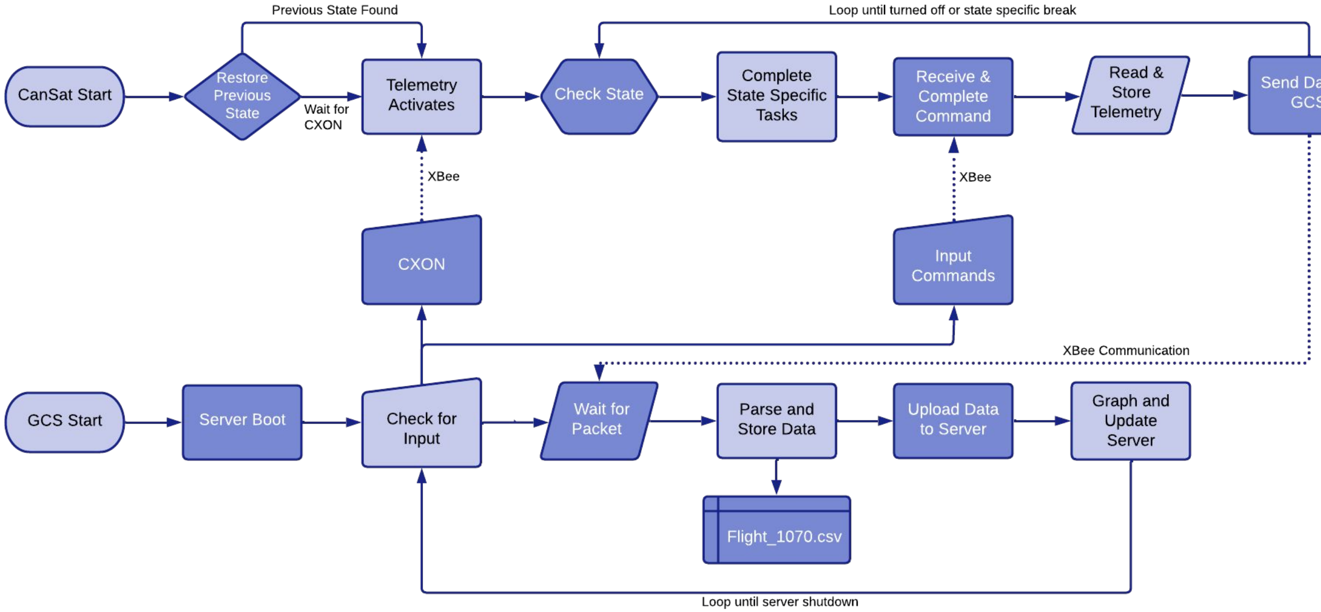
Margin: **4.80Wh**

At 80% Efficiency, total power consumption is **5.40Wh**
Margin will then be **3.90Wh**
Remaining battery percentage: **42%**

Flight Software (FSW) Design

Jamie Roberson

FSW Overview



GCS

- Written in Golang
- Visual Studio Code

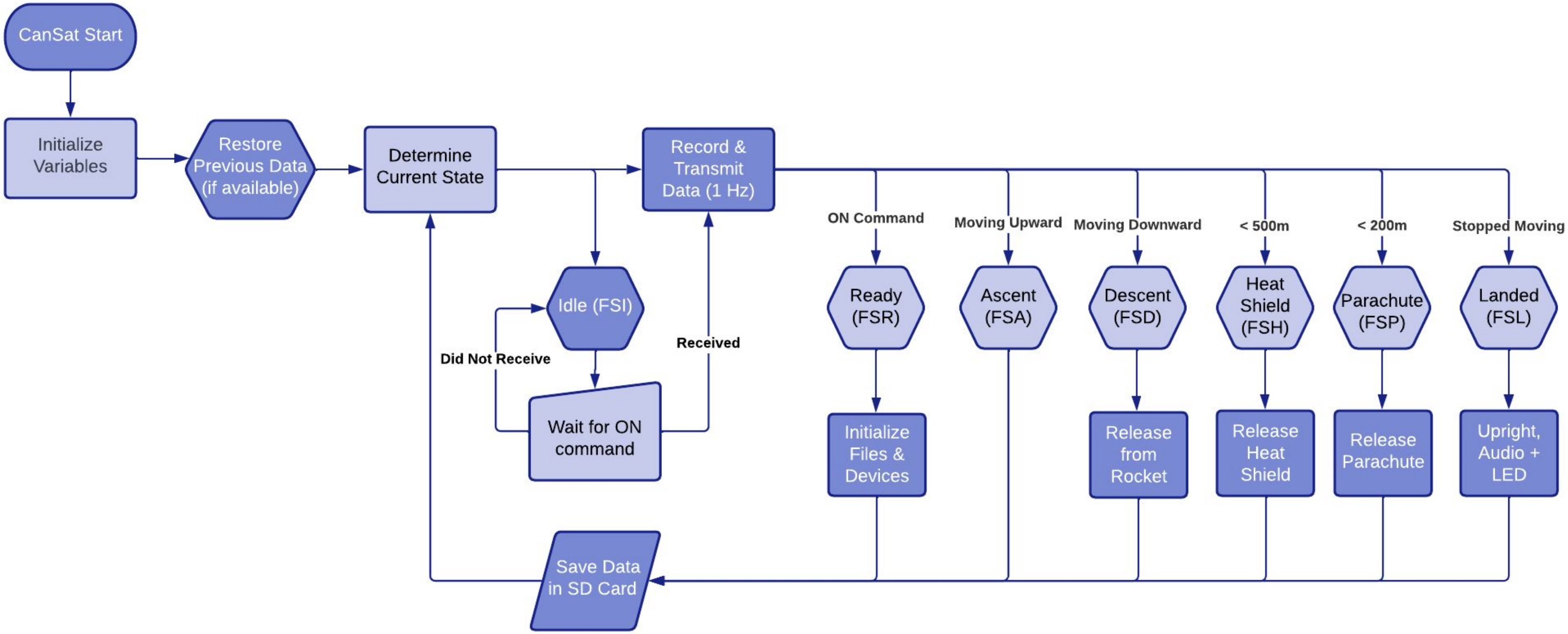
Embedded Software

- Written in C++
- Arduino IDE

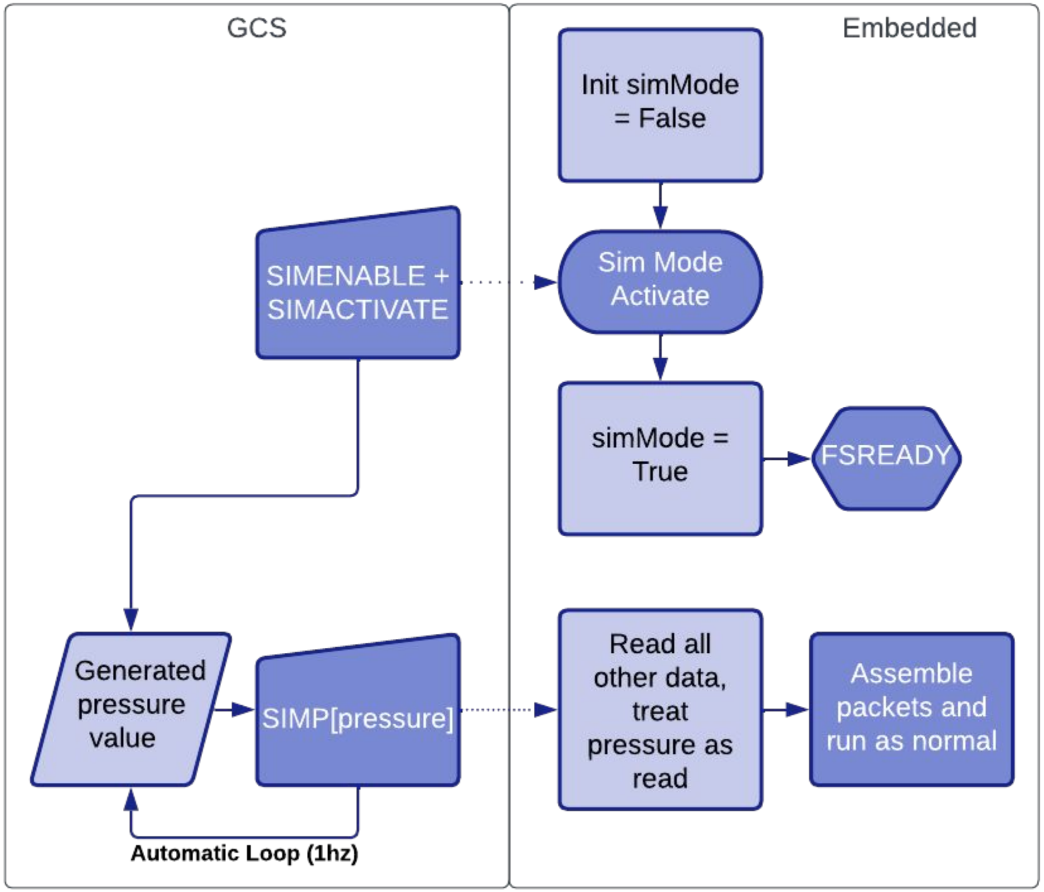
All code uploaded to GitHub repository

Embedded Software Tasks	Ground Control Station Tasks
Generate and store needed telemetry	Send and confirm commands
Receive and process commands	Receive and store needed telemetry
Communicate effectively with GCS	Create visualization of data for users

Payload FSW State Diagram



Simulation Mode Software



Simulation Commands

SIME - Enables Simulation Mode
SIMD - Disables and Stops Simulation Mode
SIMA - Activates Simulation Mode
SIMP - Generated pressure value packet

- Internal variable simMode used to keep track of simulation
- Pressure data is made from a Go generator on GCS, used to determine the altitude of the container
- 1 Hz rate of transmission
- All other data is measured exactly the same, just with generated pressure data

Software Development Plan

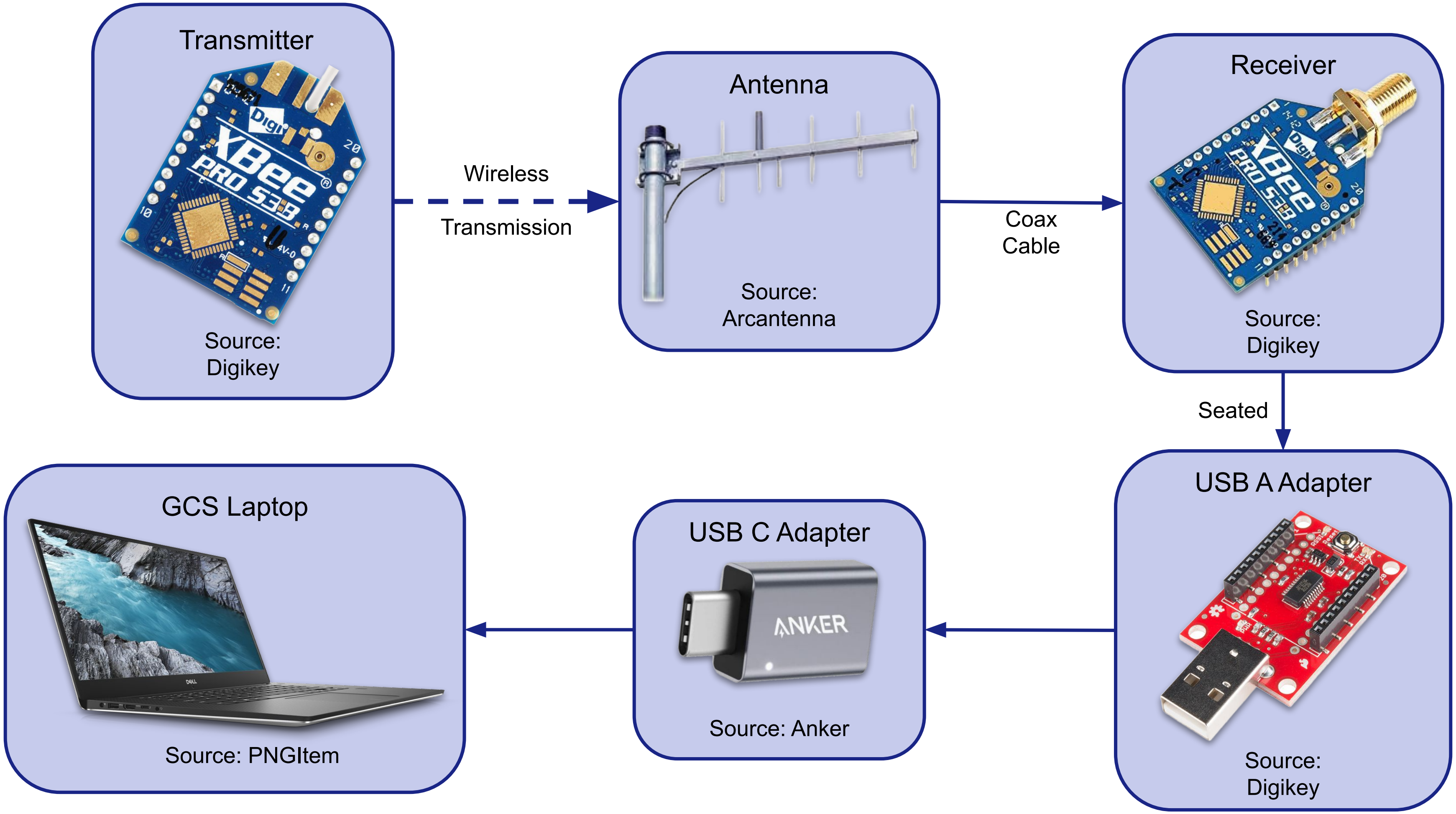
Team Member	Main Responsibilities
Jamie Roberson	Front-end development, embedded software development, server creation, website design, UI/UX, live server updating, command handler, inter-software integration, project management
Emily Jolly	Embedded software development, telemetry reader, packet creation, command receiver & executer, integration with electrical & mechanical
John Raburn	Back-end development, packet receiver, CSV generator, self-created data generator, data parser, performance

- Designated team responsibilities
- Detailed and well-spaced Gantt chart with deadlines and progress bars to make sure team is staying on time
- Other team members can assist if one section gets behind
- Data Generator to test GCS without needing embedded software

Ground Control System (GCS) Design

John Raburn

GCS Overview



Transmitter

Source:
Digikey

Wireless
Transmission

Antenna

Source:
Arcantenna

Coax
Cable

Receiver

Source:
Digikey

Seated

USB A Adapter

Source:
Digikey

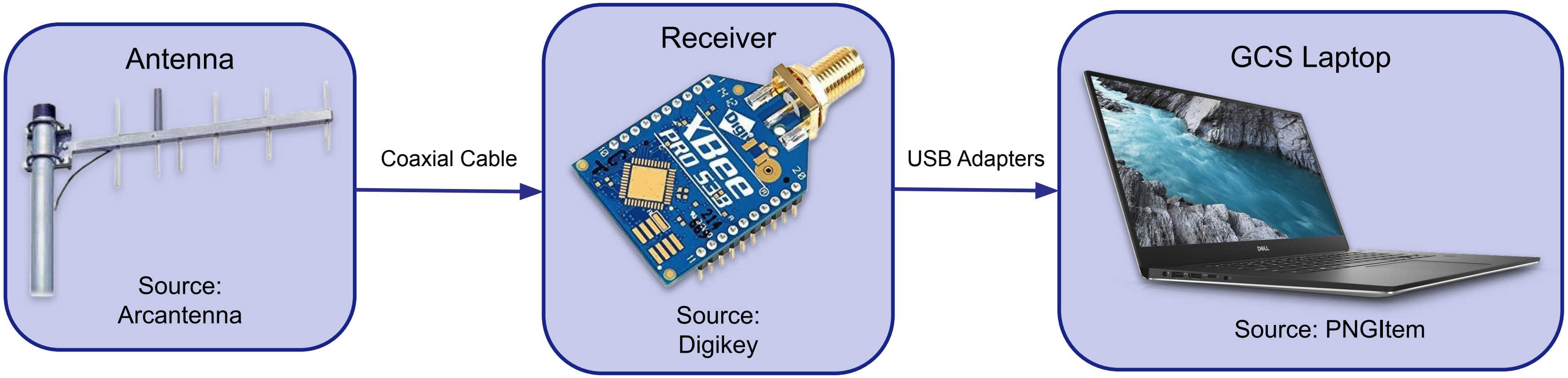
USB C Adapter

Source: Anker

GCS Laptop

Source: PNGItem

GCS Design



Antenna

Source: Arcantenna

Coaxial Cable

Receiver

Source: Digikey

USB Adapters

GCS Laptop

Source: PNGItem

Computer Specifications:

- Battery Life
  - 5 hrs w/o charger
- Overheating Mitigation
  - An umbrella will provide shade
  - Fans will be on performance
  - Any computer can be used
- Auto-update Mitigation
  - Auto-update will be off

Connections Used:

- USB
  - XBee to USB A
  - USB A to C (For computer ports)
- Coaxial
  - Antenna to XBee (Male to Male RP-SMA cord)
- Wireless
  - Container to Ground

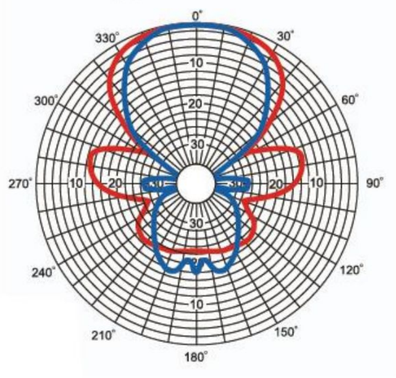
GCS Antenna Trade & Selection

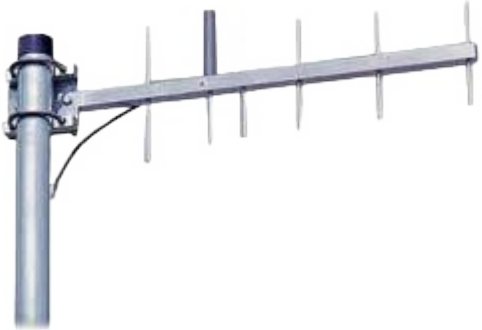
Model	Frequency Range	Gain	Pattern	Mounting Type	Cost
PC960N Yagi	896-940 MHz	11.1 dBi	Directional	Handheld (N-Female Connector)	$65.68
Bingfu Dual Band Male Antenna	5000-5800 MHz	3 dBi	Omnidirectional	Internal (RP-SMA Male Connector)	$17.64

Selection: PC960N Yagi

- Reliability
- High gain
- Adequate frequency range
- Handheld; pointed in direction of CanSat for best signal

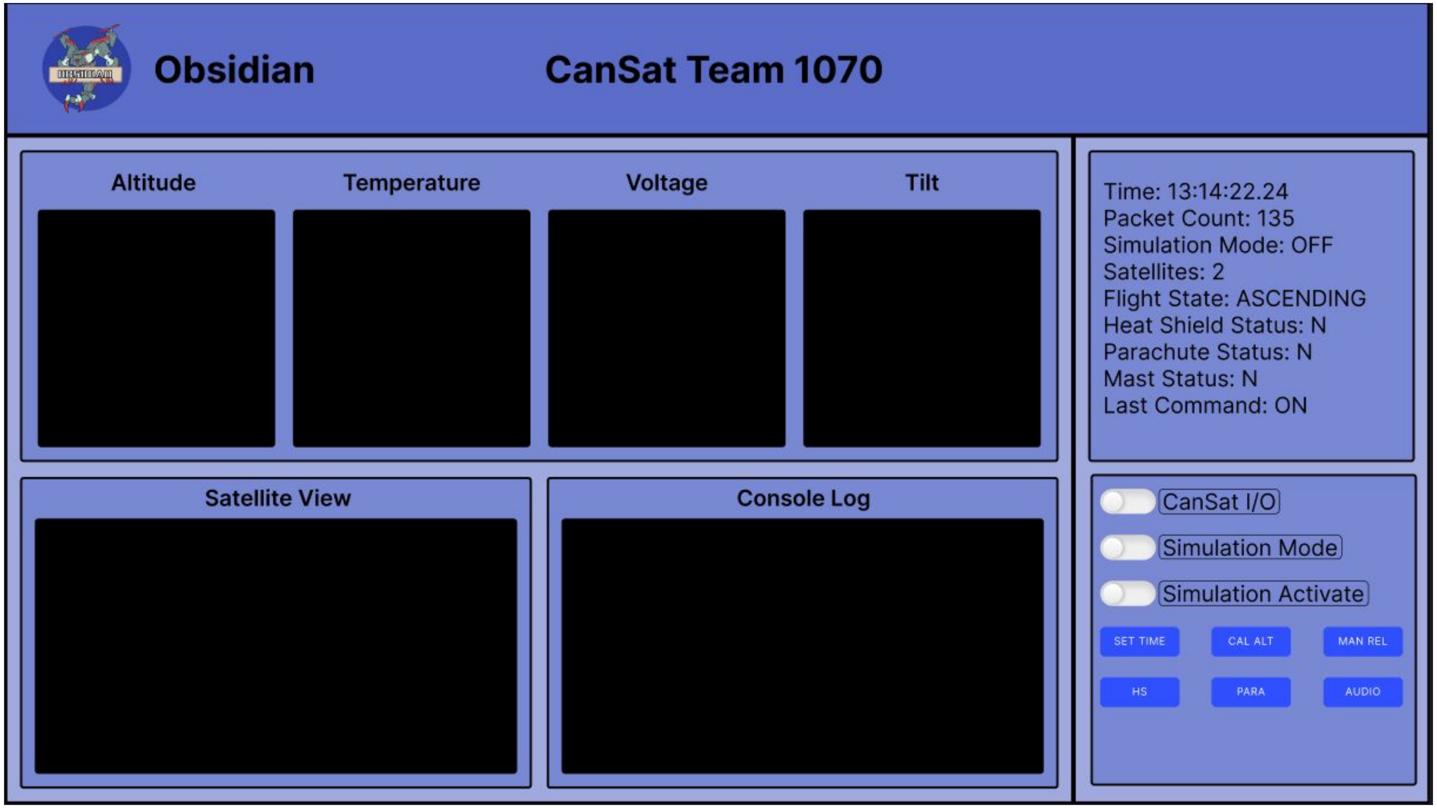
Radiation Pattern





Source: Arcantenna

GCS Software



Time: 13:14:22.24
Packet Count: 135
Simulation Mode: OFF
Satellites: 2
Flight State: ASCENDING
Heat Shield Status: N
Parachute Status: N
Mast Status: N
Last Command: ON

Prototype Design for GCS

Software:

- Backend - Go
- Organized on GitHub

Telemetry Data:

- Formatted to CSV and then sorted by packet number.
- Parsed internally, then sent to frontend.

Simulation Mode:

- Activated via command prompt on the web server.
- Can be loaded with different profiles.

CanSat Integration and Test

Quinlyn Scully

CanSat Integration and Test Overview

Integration and Testing Stages		
Subsystem Level Test Plan	In this testing stage, each subteam will be responsible for testing individual components of the CanSat. This stage allows us to test our individual components to reduce the number of integration errors.	Sensors, CDH, EPS, Radio communications, FSW, Mechanical, Descent Control
Integrated Level Function Test Plan	In this testing stage, the subteams will integrate the individual components. We will use this stage to test and adjust components if needed.	Decent Testing, Communications, Mechanisms, Deployment
Environmental Test Plan	In this testing stage, the CanSat will be tested using the guidelines listed in the CanSat Competition Guide. This test is used to test our CanSat's durability for the mission.	Drop test, Thermal test, Vibration test, Fit Check, VACUUM test
Simulation Test Plan	In this testing stage, software subteam will make a code that will test our release mechanisms. The code will read in simulated data for pressure.	Simulated Pressure Data test

Subsystem Level Testing Plan (1/3)

Subsystem	Test	Component(s)	Test Description	Requirement to Pass
Sensors	Air Pressure	BMP388	We will place the sensor into our vacuum chamber where we compare the barometer pressure.	The recorded pressure and the barometer pressure are approximately the same.
Sensors	Air Temperature	BMP388	We will place the sensor in two places with known temperatures.	The recorded temperatures of both locations are approximately the same as known temperature.
Sensors	Tilt	LSM6DSOX	We will tilt the sensor next to a protractor.	The recorded angle and the protractor angle are approximately the same.
Sensors	GPS	SAM-M8Q	We will take our sensor to three locations along with google maps.	The recorded coordinates are approximately the same latitude and longitude as the phone coordinates.
Sensors	Camera(s)	Mini-Spy Camera	We will film with both cameras for an extended time.	The footage is clear and records for the entire time it is turned.
Sensors	Real Time Clock	SAM-M8Q	We will run the sensor along side a computer clock.	The recorded time and the computer time are the same.

Subsystem Level Testing Plan (2/3)

Subsystem	Test	Test Description	Requirement to Pass
CDH	Command Input	Send a command from the Ground Station to the container and Payload.	The CanSat and GCS will communicate effectively and be able to parse the sent packets.
EPS	Battery Voltage	We will test the battery voltage and the voltage output of both linear regulators with a voltmeter.	The record voltage from the voltmeter will be the same for batteries and linear regulators as the expected voltage.
EPS	Electrical Consistency	Turn on electronics then use a multimeter to test voltage input for all electrical components.	The multimeter measures the proper amount of voltage input as necessary.
Radio Communication	XBee Communication	The Ground Station sends commands to the payload at three different distances.	The payload will respond to the command at all three distances.
FSW	Reset Test	We perform a manual reset for the electronics.	The microcontroller will record data from the last sent packet.
FSW	Packet Test	We will collect data from the sensors and compile it into the required telemetry format.	The telemetry will display in the required format and display accurate values.
FSW	Server Test	We will generate data from the ground station and send it to the server.	The server will display the information that we generate correctly.

Subsystem Level Testing Plan (3/3)

Subsystem	Test	Test Description	Requirement to Pass
Mechanical	Payload Release	We will use our manual release command to allow our payload to release from the shell without obstacles.	When our manual release command release our payload from our shell without getting caught on the shell.
Mechanical	Uprighting Mechanism	We will have our place our CanSat at different angles on the ground and have the servos turn and upright the payload.	When the panels upright itself completely.
Mechanical	Flag Raising	We will turn on our servo and have the flag raise.	When the servo turns the flag will raise.
Descent Control	First Deployment	We will turn our threaded rod where the release mechanism and the first parachute are attached.	When the CanSat properly deploys from the container and the parachute deploys correctly.
Descent Control	Second Deployment	We will turn our servo until the heat shield is open.	When our servos turn, our heat shield deploys to the correct angle.
Descent Control	Third Deployment	We will test our lid containing our second parachute opens when the servo turns.	When our lid opens without external influences.

Integrated Level Functional Test Plan

Integrated Test	Test Description	Requirements to Pass
Decent Testing	We will take our completed CanSat and drop it off of multiple different heights. We will test the first parachute, the heat shield, and the second parachute.	The CanSat will fall at 15m/s with the first parachute, 20m/s with the heat shield, and then fall at 5m/s with the second parachute.
Communication	We will turn on our completed CanSat to begin recording data. All the sensors will record data to the SD card and send the data to the Ground Station.	Our telemetry will be properly transmitted and formatted in the server.
Mechanisms	We will take our mechanical components and integrate with electrical components.	Our electrical components are securely in the CanSat with the switch easily accessed.
Deployment	We will put our completed CanSat in our vacuum chamber to simulate different altitudes. As we change the altitude in the vacuum chamber, the releases mechanisms will deploy our parachutes and our heat shield.	When our CanSat deploys our parachutes and heat shield at the correct altitude given by the vacuum chamber.

Environmental Test Plan (1/2)

Test	Method	Test Description	Requirement to Pass
Drop Test	Fixed Point Drop	The parachute on the CanSat will be attached to a 61 cm cord that is attached to a fixed room with enough space and height that the CanSat does not hit anything. The CanSat will be dropped from the height of the fixed point.	The CanSat did not lose power, telemetry is still retrieved, and there are no detached parts or damage
Thermal Test	Thermal Chamber	A thermal chamber will be assembled using and insulating cooler, hair dryer, and thermometer. The hair dryer will circulate and heat the air inside the cooler to 60℃, which will be maintained for 2 hours.	The integrity of all mechanisms has not been compromised and the epoxy joints and composite materials maintain their strength
Vibration Test	Random Orbital Sander	The CanSat will be placed on a random orbital sander that exposes the CanSat to vibrations from 0 Hz to 233 Hz and generates around 20 to 29 Gs for one minute.	The CanSat has no structural damage, functions correctly, and accelerometer data is still received
Fit Check	Mock Rocket Test	The CanSat will be slid into a tube that has the same dimensions as the rocket used during the competition	The CanSat slides in and out of the tube easily with no impediments

Environmental Test Plan (2/2)

Test	Method	Test Description	Requirement to Pass
Vacuum Test	Vacuum Chamber	The fully configured and powered CanSat will be placed in a vacuum chamber in which the system will be pulled to a vacuum. Throughout the test the telemetry will be monitored, and when the maximum altitude is reached the vacuum will be stopped	The CanSat must transmit and record telemetry during the test, and the telemetry must be provided to judges

Simulation Test Plan

Component	Description	Requirement
Ground	Send activate and enable simulation commands then send generated pressure data to the CanSat using the SIMP command.	The Ground Station should provide data to the CanSat with the simulated pressure data every second.
CanSat	When the activate and enable commands are received, calculate altitude from given pressure. Record all other data as normal.	CanSat enters the Simulation Mode commanded from the GCS. The CanSat should receive the simulated pressure data and respond to the corresponding altitude.

Mission Operations & Analysis

Emily Jolly

Overview of Mission Sequence of Events

Stage	Task	Team
Arrival	Arrive at Launch Site	Everyone
Pre-Launch	Ground Station Set Up	Ground Station Crew
	CanSat Final Preparation (Assembly and Test)	CanSat Crew
	CanSat Check in	CanSat Crew
Launch	Turn CanSat on	CanSat Crew
	Integrate CanSat with Rocket	CanSat Crew
	Monitor Ground Station	Ground Station Crew
	Move to Launch Control Table and Execute Launch Procedures	MIssion Control Officer
Descent	Monitor Ground Station	Ground Station Crew
Recovery	Recover the CanSat	Recovery Crew
Data Analysis	Analyze Data and Turn in Thumb Drive	Ground Station Crew
	Post Flight Review (PFR)	Everyone
	Return to Check in	Recovery Crew

Team Assignments	
Mission Control Officer	Emily Jolly
Ground Station Crew	Jamie Roberson, John Raburn
Recovery Crew	Adam Burden, Preston Beesley
CanSat Cew	John Raburn, Adam Burden, Madison Kromer

Mission Operations Manual Development Plan

Section	Content
Team Roles	Will provide an overview of the roles assigned to team members and the responsibilities for each role
Ground Station Overview	Overview of the ground station and all of its components
Ground Station Procedure	Procedures for setting up the ground station, including a list of all interactions possible with the ground station.
Pre-Launch Checklist	Overall checklist of all components of the CanSat that need to be reviewed before launch
Preparation Procedures for Launch	Procedures and responsibilities for each team role during launch preparation
Launch Procedure	Procedure for all team role responsibilities during launch
Recovery Procedure	Procedure for all team role responsibilities during recovery of the CanSat

CanSat Location and Recovery

CanSat Recovery Options

- GPS will provide an estimated location of the CanSat
- Buzzer will sound when CanSat lands
- Flashing LED
- Flag will raise after CanSat lands and uprights itself
- Container and Payload will have label with contact information and return address
- Coloring visible components
  - Container will be fluorescent pink
  - Parachute will be fluorescent pink

CanSat Team #1070
Obsidian

601 John Wright Drive
Huntsville, AL 35805

Team Lead: Emily Jolly
erj0009@uah.edu
256 - 572 - 6949

Address Label Example

Requirements Compliance

Quinlyn Scully

Requirements Compliance Overview

Full Compliance
We comply to 55 of the 61 requirements
Partial Compliance
We partially comply to requirements 12, 13, 15, 30, and 31 due to lack of testing.
No Compliance
We have full/partial compliance with all requirements
Omitted Requirements
We omit requirements number 43 due to being skipped on the mission guide.

Requirements Compliance (1/7)

Rqmnt Num	Requirement	Comply/ No Comply/ Partial	Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
1	Total mass of the CanSat (science probe and container) shall be 700 grams +/- 10 grams.	Comply	78	
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Comply	28	
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Comply	30	
4	The container shall be a fluorescent color; pink, red or orange.	Comply	119	
5	The container shall be solid and fully enclose the science probes. Small holes to allow access to turn on the science probes are allowed. The end of the container where the probe deploys may be open.	Comply	28	
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Comply	30	
7	The rocket airframe shall not be used as part of the CanSat operations.	Comply	30	
8	The container's parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Comply	12	
9	The Parachute shall be fluorescent Pink or Orange	Comply	119	
10	The descent rate of the CanSat (container and science probe) shall be 15 meters/second +/- 5 m/s.	Comply	49-52	

Requirements Compliance (2/7)

Rqmnt Num	Requirement	Comply/ No Comply/ Partial	Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
11	0 altitude reference shall be at the launch pad.	Comply	89	Under initialize variables
12	All structures shall be built to survive 15 Gs of launch acceleration.	**Partial**	**113**	Needs testing
13	All structures shall be built to survive 30 Gs of shock.	**Partial**	**113**	Needs testing
14	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	75	
15	All mechanisms shall be capable of maintaining their configuration or states under all forces.	**Partial**	**111**	Needs testing
16	Mechanisms shall not use pyrotechnics or chemicals.	Comply	11-30	
17	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Comply	11-30	
18	Both the container and probe shall be labeled with team contact information including email address.	Comply	119	
19	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost. Equipment from previous years shall be included in this cost, based on current market value.	Comply	132-133	
20	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Comply	103-105	

Requirements Compliance (3/7)

Rqmnt Num	Requirement	Comply/ No Comply/ Partial	Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
21	XBEE radios shall have their NETID/PANID set to their team number.	Comply	103-105	
22	XBEE radios shall not use broadcast mode.	Comply	103-105	
23	The container and probe shall include an easily accessible power switch that can be accessed without disassembling the CanSat and science probes and in the stowed configuration.	Comply	22,75	
24	The probe shall include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the CanSat and in the stowed state.	Comply	22	
25	An audio beacon is required for the probe. It shall be powered after landing.	Comply	22	
26	The audio beacon shall have a minimum sound pressure level of 92 dB, unobstructed.	Comply	130-133	Budget
27	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	Comply	94	
28	An easily accessible battery compartment shall be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Comply	75	
29	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	75,94	

Requirements Compliance (4/7)

Rqmnt Num	Requirement	Comply/ No Comply/ Partial	Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
30	The CanSat shall operate during the environmental tests laid out in Section 3.5.	**Partial**	**113-114**	Testing needed
31	The CanSat shall operate for a minimum of two hours when integrated into the rocket.	**Partial**	**112**	Testing needed
32	The probe shall be released from the container when the CanSat reaches 500 meters.	**Comply**	**29**	
33	The probe shall deploy a heat shield after leaving the container.	**Comply**	**29**	
34	The heat shield shall be used as an aerobrake and limit the descent rate to 20 m/s or less.	**Comply**	**29, 50**	
35	At 200 meters, the probe shall release a parachute to reduce the descent rate to 5 m/s +/- 1 m/sec.	**Comply**	**29,51**	
36	Once landed, the probe shall upright itself.	**Comply**	**29,72**	
37	After uprighting, the probe shall deploy a flag 500 mm above the base of the probe when the probe is in the upright position.	**Comply**	**15,29**	
38	The probe shall transmit telemetry once per second.	**Comply**	**85, 98-104**	
39	The probe telemetry shall include altitude, air pressure, temperature, battery voltage, probe tilt angles, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	**Comply**	**85-90**	
40	The probe shall include a video camera pointing down to the ground.	**Comply**	**60**	

Requirements Compliance (5/7)

Rqmnt Num	Requirement	Comply/ No Comply/ Partial	Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
41	The video camera shall record the flight of the probe from release to landing.	Comply	60	
42	The video camera shall record video in color and with a minimum resolution of 640x480.	Comply	38	
44	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Comply	98-99	
45	The probe shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	Comply	98-99	
46	The probe shall have its time set to within one second UTC time prior to launch.	Comply	98-99	
47	The probe flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	Comply	100	
48	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.	Comply	98-101	
49	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Comply	85-90	
50	The ground station shall command the CanSat to start calibrating the altitude to zero when the CanSat is on the launch pad prior to launch.	Comply	85	

Requirements Compliance (6/7)

Rqmnt Num	Requirement	Comply/ No Comply/ Partial	Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
51	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	98	
52	Telemetry shall include mission time with 1 second or better resolution.	Comply	87	
53	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	Comply	83, 110	
54	Each team shall develop their own ground station.	Comply	106	
55	All telemetry shall be displayed in real time during descent on the ground station.	Comply	106	
56	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Comply	87-88	
57	Teams shall plot each telemetry data field in real time during flight.	Comply	106	
58	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Comply	103-104	
59	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Comply	103-104	

Requirements Compliance (7/7)

Rqmnt Num	Requirement	Comply/ No Comply/ Partial	Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
60	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	Comply	89	
61	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the CanSat.	Comply	100	

Management

Quinlyn Scully

CanSat Budget – Hardware (1/3)

Component	Model	Quantity	Reusing	Unit Price	Total	Actual/Estimates /Budgeted	Source
Microcontroller	Feather HUZZAH32	1	No	$19.95	$19.95	Actual	Adafruit
Air Pressure and Temperature	BMP388	1	No	$9.95	$9.95	Actual	Adafruit
IMU	LSM6DSOX + LIS3MDL	1	No	$19.95	$19.95	Actual	Adafruit
GPS and Real-Time Clock	SAM-M8Q	1	No	$42.95	$42.95	Actual	SparkFun
SD Card Writer	DEV-13712	1	No	$16.95	$16.95	Actual	SparkFun
Camera	Mini Spy Camera Adafruit ID: 3202	2	No	$12.50	$25.00	Actual	Adafruit
Buzzer	PS1240	1	No	$1.50	$1.50	Actual	Adafruit
Servo	FS90R	3	No	$7.50	$22.50	Actual	Adafruit
Subtotal				**$158.75**			

CanSat Budget – Hardware (2/3)

Component	Model	Quantity	Reusing	Unit Price	Total	Actual/Estimates /Budgeted	Source
CanSat XBee	XBP9B-DMWT-002	1	No	$62.08	$62.08	Actual	Digikey
Ground Station Xbee	XBP9B-DMST-002	1	No	$62.08	$62.08	Actual	Digikey
Mosfet	N-CHANNEL MOSFET	4	No	$2.25	$9.00	Actual	Adafruit
5V Regulator	5V 1.5A Linear Voltage Regulator	1	No	$0.75	$0.75	Actual	Adafruit
3.3V Regulator	3.3V 800mA Linear Voltage Regulator	1	No	$1.25	$1.25	Actual	Adafruit
LED	LED Sequins	1	No	$3.95	$3.95	Actual	Adafruit
SD Card	SD/MicroSD Memory Card (8 GB SDHC)	3	No	$9.95	$29.85	Actual	Adafruit
Nylon Threaded Rod	98831A360	1	No	$6.35	$6.35	Actual	McMaster-Carr
Subtotal				**$175.31**			

CanSat Budget – Hardware (3/3)

Component	Model	Quantity	Reusing	Unit Price	Total	Actual/Estimates /Budgeted	Source
Routing Eyebolt with Nut	9489T52	4	No	$7.88	$31.52	Actual	McMaster-Carr
Urethane Casting Compound	8644K53	1	No	$40.12	$40.12	Actual	McMaster-Carr
Carbon Fiber Rod	2153T15	6	No	$9.98	$59.88	Actual	McMaster-Carr
Carbon Fiber Square Tube	B09935SJZN	1	No	$13.99	$13.99	Actual	McMaster-Carr
Batteries	Surefire SF123A	24	No	$39.21	$39.21	Actual	Amazon
Battery Holder	BH123a	2	Yes	$1.23	$2.46	Actual	Digikey
Total				**$521.24**			

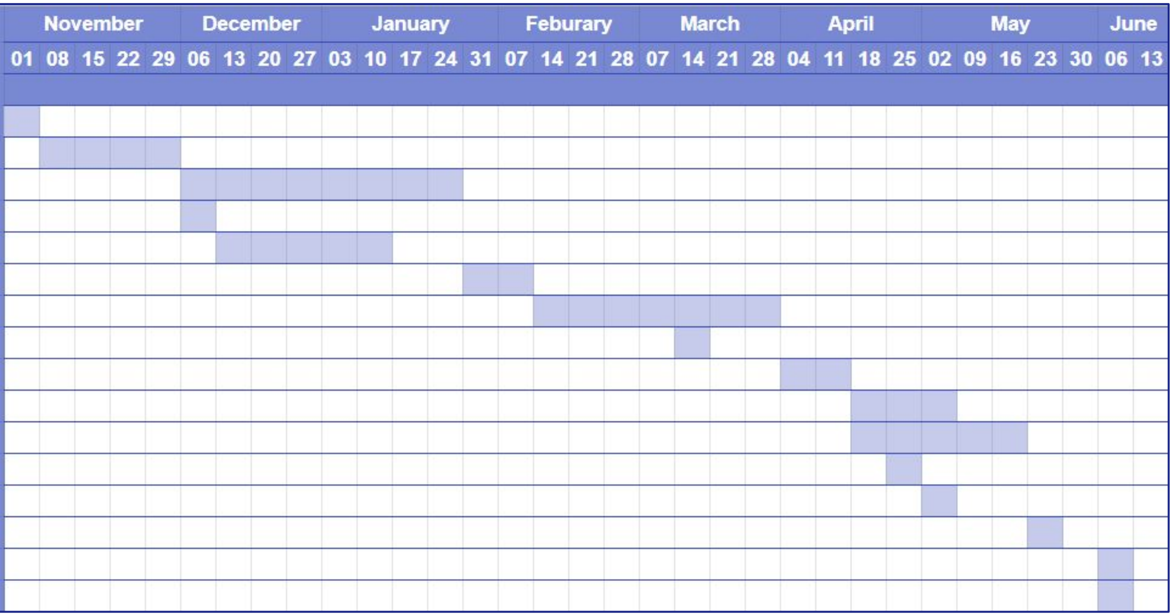
CanSat Budget – Other Costs

Component	Cost	Quantity	Actual/Estimates /Budgeted	Cost	Reuse
Travel (per person)	$116.69	9	Estimate	$1,050.21	
Lodging (per person)	$250.00	9	Estimate	$2,250.00	
Food (per person)	$166.69	9	Estimate	$1,500.21	
XBee Pro 900HP	$62.08	1	Estimate	$62.08	Yes
Prototyping Mechanical	$50.00	1	Estimate	$50.00	
Prototyping Electronics	$20.00	1	Estimate	$20.00	
Ground Station Laptop	$2,200.00	1	Estimate	$2,200.00	
Yagi Antenna	$43.39	1	Actual	$43.39	Yes
CanSat Total Cost	$521.24	2	Actual	$1,042.48	
			Total:	**$8,218.37**	

Program Schedule Overview

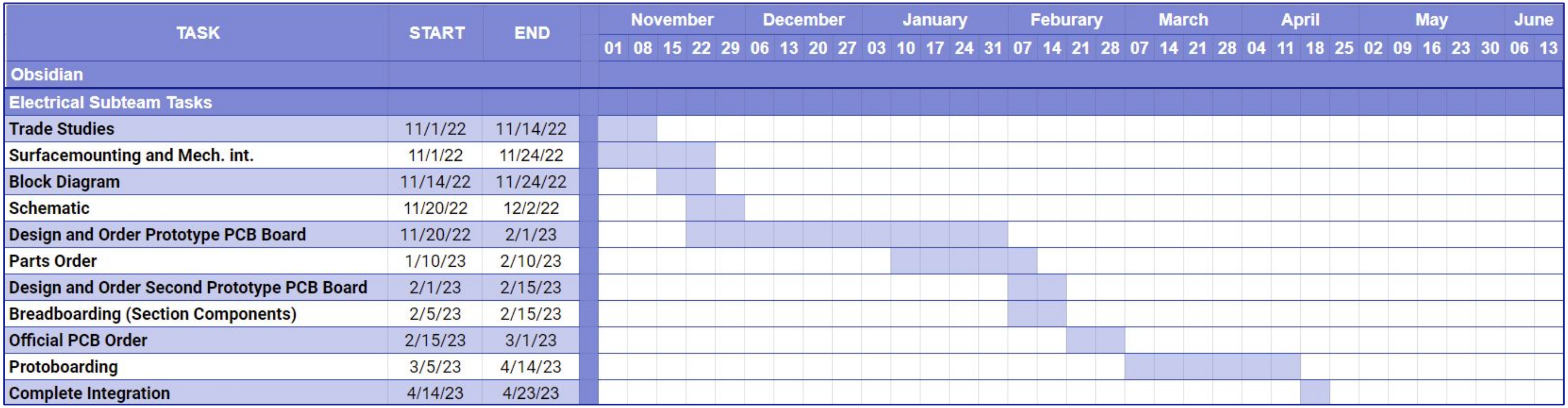
Obsidian Full Team Schedule

TASK	START	END
Obsidian		
Team Application	11/1/22	11/4/22
MCR	11/2/22	12/2/22
PDR Preparation	12/2/22	1/27/23
Finals	12/5/22	12/9/22
Winter Break	12/9/22	1/9/22
PDR Presentation	1/27/23	2/10/23
CDR Preperation	2/10/23	4/1/23
Spring Break	3/13/23	3/17/23
CDR Presentation	4/1/23	4/14/23
Test Launch Phase	4/14/23	5/7/23
Environmental Test Review	4/15/23	5/19/23
Finals	4/24/23	4/28/23
Test Launch	5/1/23	5/7/23
Environmental Test Submission	5/19/23	5/26/23
FRR (Competition)	6/9/23	6/10/23
Post Flight Review (PFR)	6/11/23	6/11/23



Detailed Program Schedule (1/3)

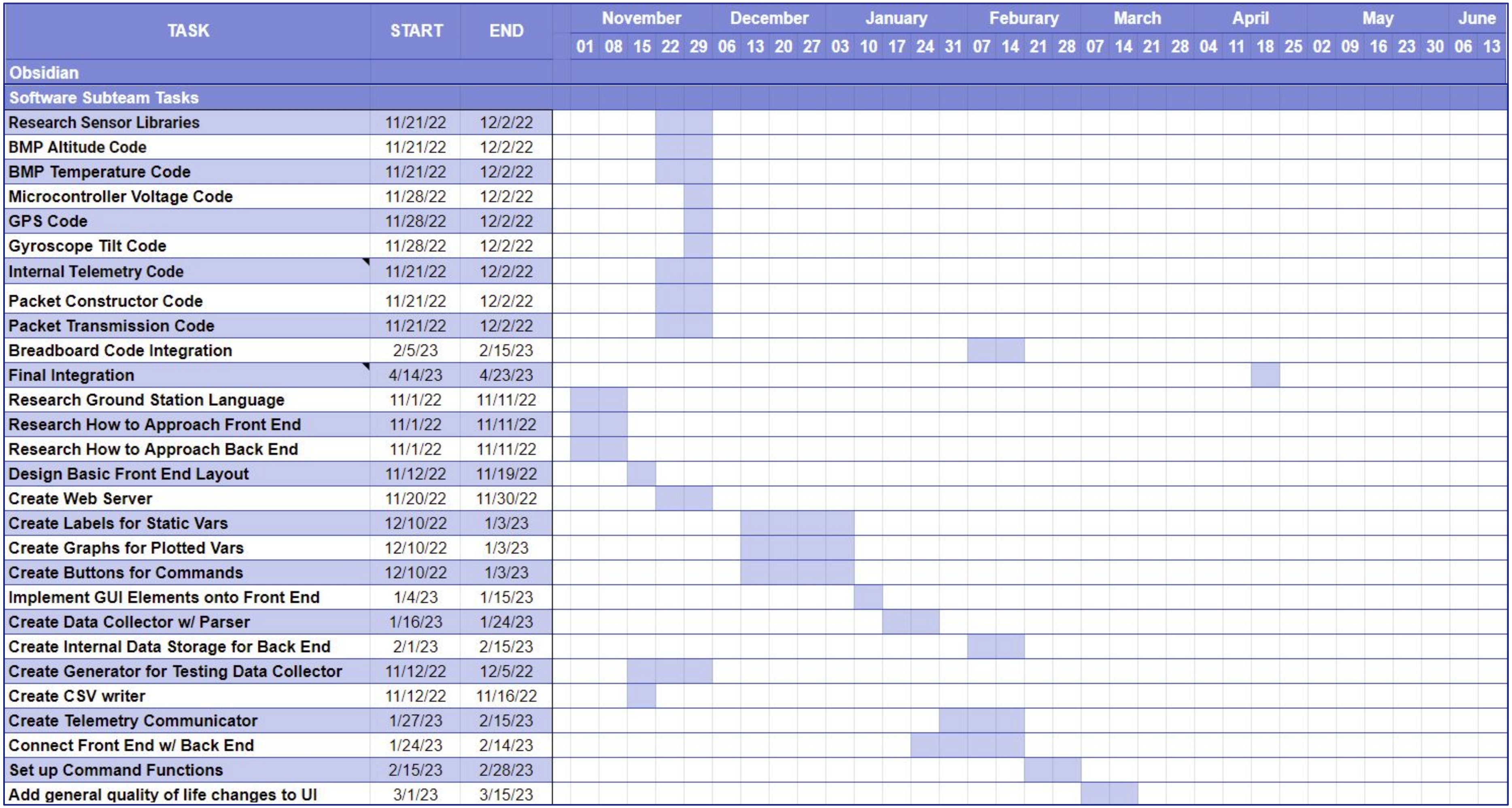
Electrical Subteam Schedule



TASK	START	END	November					December				January					Feburary				March				April				May					June	
			01	08	15	22	29	06	13	20	27	03	10	17	24	31	07	14	21	28	07	14	21	28	04	11	18	25	02	09	16	23	30	06	13
Obsidian																																			
Electrical Subteam Tasks																																			
Trade Studies	11/1/22	11/14/22	▨	▨																															
Surfacemounting and Mech. int.	11/1/22	11/24/22	▨	▨	▨	▨																													
Block Diagram	11/14/22	11/24/22			▨	▨																													
Schematic	11/20/22	12/2/22				▨	▨																												
Design and Order Prototype PCB Board	11/20/22	2/1/23				▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨																			
Parts Order	1/10/23	2/10/23											▨	▨	▨	▨	▨																		
Design and Order Second Prototype PCB Board	2/1/23	2/15/23															▨	▨																	
Breadboarding (Section Components)	2/5/23	2/15/23															▨	▨																	
Official PCB Order	2/15/23	3/1/23																	▨	▨															
Protoboarding	3/5/23	4/14/23																			▨	▨	▨	▨	▨	▨									
Complete Integration	4/14/23	4/23/23																									▨								

Detailed Program Schedule (2/3)

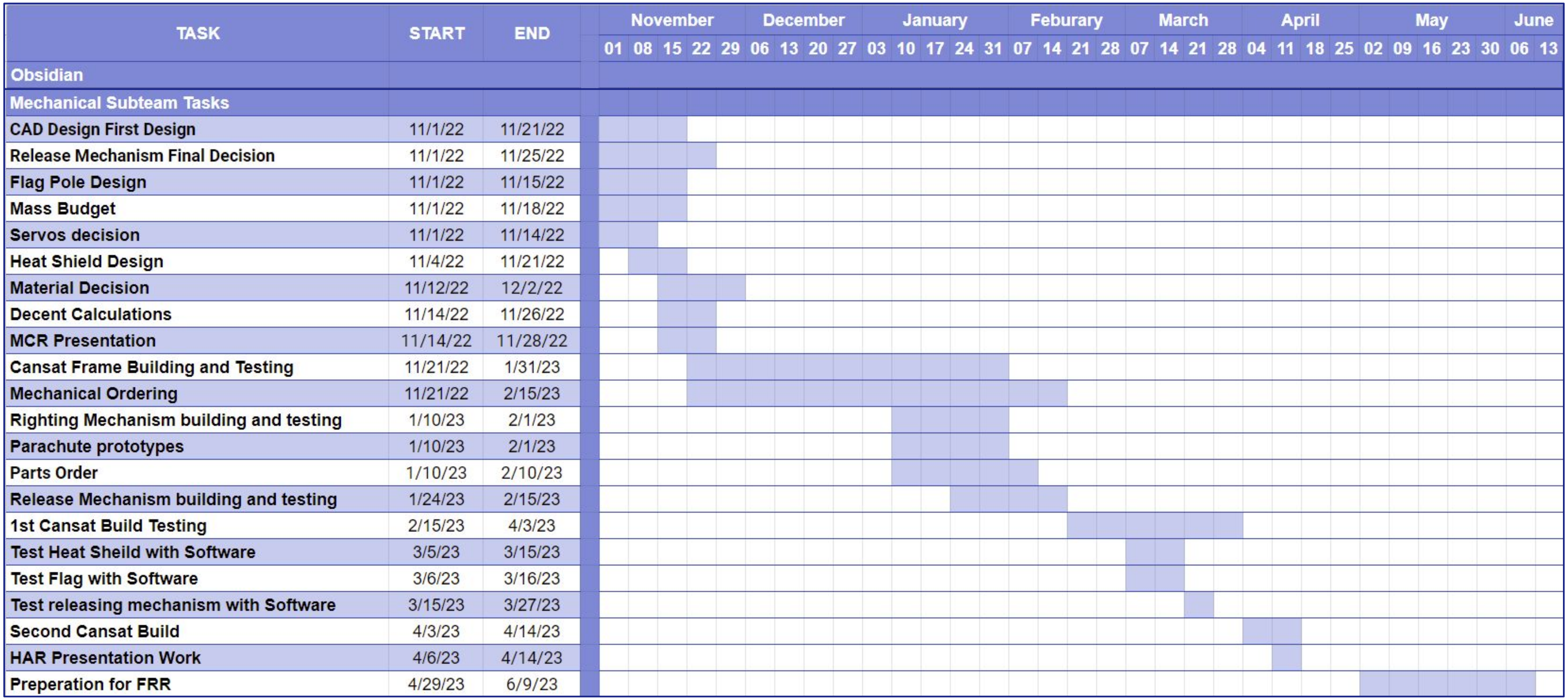
Software Subteam Schedule



TASK	START	END	November					December				January					Feburary				March				April				May					June	
			01	08	15	22	29	06	13	20	27	03	10	17	24	31	07	14	21	28	07	14	21	28	04	11	18	25	02	09	16	23	30	06	13
Obsidian																																			
Software Subteam Tasks																																			
Research Sensor Libraries	11/21/22	12/2/22				▨	▨																												
BMP Altitude Code	11/21/22	12/2/22				▨	▨																												
BMP Temperature Code	11/21/22	12/2/22				▨	▨																												
Microcontroller Voltage Code	11/28/22	12/2/22					▨																												
GPS Code	11/28/22	12/2/22					▨																												
Gyroscope Tilt Code	11/28/22	12/2/22					▨																												
Internal Telemetry Code	11/21/22	12/2/22				▨	▨																												
Packet Constructor Code	11/21/22	12/2/22				▨	▨																												
Packet Transmission Code	11/21/22	12/2/22				▨	▨																												
Breadboard Code Integration	2/5/23	2/15/23															▨	▨																	
Final Integration	4/14/23	4/23/23																									▨								
Research Ground Station Language	11/1/22	11/11/22	▨	▨																															
Research How to Approach Front End	11/1/22	11/11/22	▨	▨																															
Research How to Approach Back End	11/1/22	11/11/22	▨	▨																															
Design Basic Front End Layout	11/12/22	11/19/22			▨																														
Create Web Server	11/20/22	11/30/22				▨	▨																												
Create Labels for Static Vars	12/10/22	1/3/23							▨	▨	▨	▨																							
Create Graphs for Plotted Vars	12/10/22	1/3/23							▨	▨	▨	▨																							
Create Buttons for Commands	12/10/22	1/3/23							▨	▨	▨	▨																							
Implement GUI Elements onto Front End	1/4/23	1/15/23											▨																						
Create Data Collector w/ Parser	1/16/23	1/24/23												▨	▨																				
Create Internal Data Storage for Back End	2/1/23	2/15/23															▨	▨																	
Create Generator for Testing Data Collector	11/12/22	12/5/22			▨	▨	▨																												
Create CSV writer	11/12/22	11/16/22			▨																														
Create Telemetry Communicator	1/27/23	2/15/23														▨	▨	▨																	
Connect Front End w/ Back End	1/24/23	2/14/23													▨	▨	▨	▨																	
Set up Command Functions	2/15/23	2/28/23																	▨	▨															
Add general quality of life changes to UI	3/1/23	3/15/23																			▨	▨													

Detailed Program Schedule (3/3)

Mechanical Subteam Schedule



TASK	START	END	November					December				January					Feburary				March				April				May					June	
			01	08	15	22	29	06	13	20	27	03	10	17	24	31	07	14	21	28	07	14	21	28	04	11	18	25	02	09	16	23	30	06	13
Obsidian																																			
Mechanical Subteam Tasks																																			
CAD Design First Design	11/1/22	11/21/22	▨	▨	▨																														
Release Mechanism Final Decision	11/1/22	11/25/22	▨	▨	▨	▨																													
Flag Pole Design	11/1/22	11/15/22	▨	▨	▨																														
Mass Budget	11/1/22	11/18/22	▨	▨	▨																														
Servos decision	11/1/22	11/14/22	▨	▨																															
Heat Shield Design	11/4/22	11/21/22		▨	▨																														
Material Decision	11/12/22	12/2/22			▨	▨	▨																												
Decent Calculations	11/14/22	11/26/22			▨	▨																													
MCR Presentation	11/14/22	11/28/22			▨	▨																													
Cansat Frame Building and Testing	11/21/22	1/31/23				▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨																			
Mechanical Ordering	11/21/22	2/15/23				▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨																	
Righting Mechanism building and testing	1/10/23	2/1/23											▨	▨	▨	▨																			
Parachute prototypes	1/10/23	2/1/23											▨	▨	▨	▨																			
Parts Order	1/10/23	2/10/23											▨	▨	▨	▨	▨																		
Release Mechanism building and testing	1/24/23	2/15/23													▨	▨	▨	▨																	
1st Cansat Build Testing	2/15/23	4/3/23																	▨	▨	▨	▨	▨	▨											
Test Heat Sheild with Software	3/5/23	3/15/23																			▨	▨													
Test Flag with Software	3/6/23	3/16/23																			▨	▨													
Test releasing mechanism with Software	3/15/23	3/27/23																					▨												
Second Cansat Build	4/3/23	4/14/23																							▨	▨									
HAR Presentation Work	4/6/23	4/14/23																								▨									
Preperation for FRR	4/29/23	6/9/23																											▨	▨	▨	▨	▨	▨	

Conclusions

Major Accomplishments
Electrical Subteam: Completed trade studies, made a block diagram, made schematics, 3 PCB designs created.
Mechanical Subteam: Designed two CanSats using CAD and calculated decent rates. Began 3D printing prototype uprighting mechanisms.
Software Subteam: Designed a server, website, and CSV writer. Began working on the backend code, simulation mode, and receiver code. Began embedded software and electronic basics.
Major Unfinished Work
Electrical Subteam: Test and Design new PCB boards, breadboard telemetry devices
Mechanical Subteam: Complete two manufactured probe prototypes.
Software Subteam: Complete the code for the backend, frontend, and embedded.
Why are we Ready to Proceed to the Next Stage of Development
We are ready to continue to the testing phase as we have researched and designed two CanSats and their inner mechanisms. Electrical components have been chosen and designed onto test PCBs. Software has skeletal and base coding for all faces. Mechanical has designed two CanSat designs ready to be constructed and tested.