



CanSat 2026

Critical Design Review (CDR)

Version 2.0

#1094
MetalHawk



Presentation Outline (1/2)



Section	Presenters	Slide Number
Introduction	Tyler Ebner	1-9
System Overview	Tyler Ebner, Brodie Kirkpatrick and Alex McKinnon	10-31
Sensor Subsystem Design	Rudra Patel	32-42
Descent Control	Nora Brady and Clark Peterson	43-56
Mechanical Subsystem Design	Alex McKinnon, Evan Jeanneret and Jackson Stidham	57-88
Communication and Data Handling Subsystem Design	Tyler Ebner	89-103
Electrical Power Subsystem Design	Rudra Patel	104-112



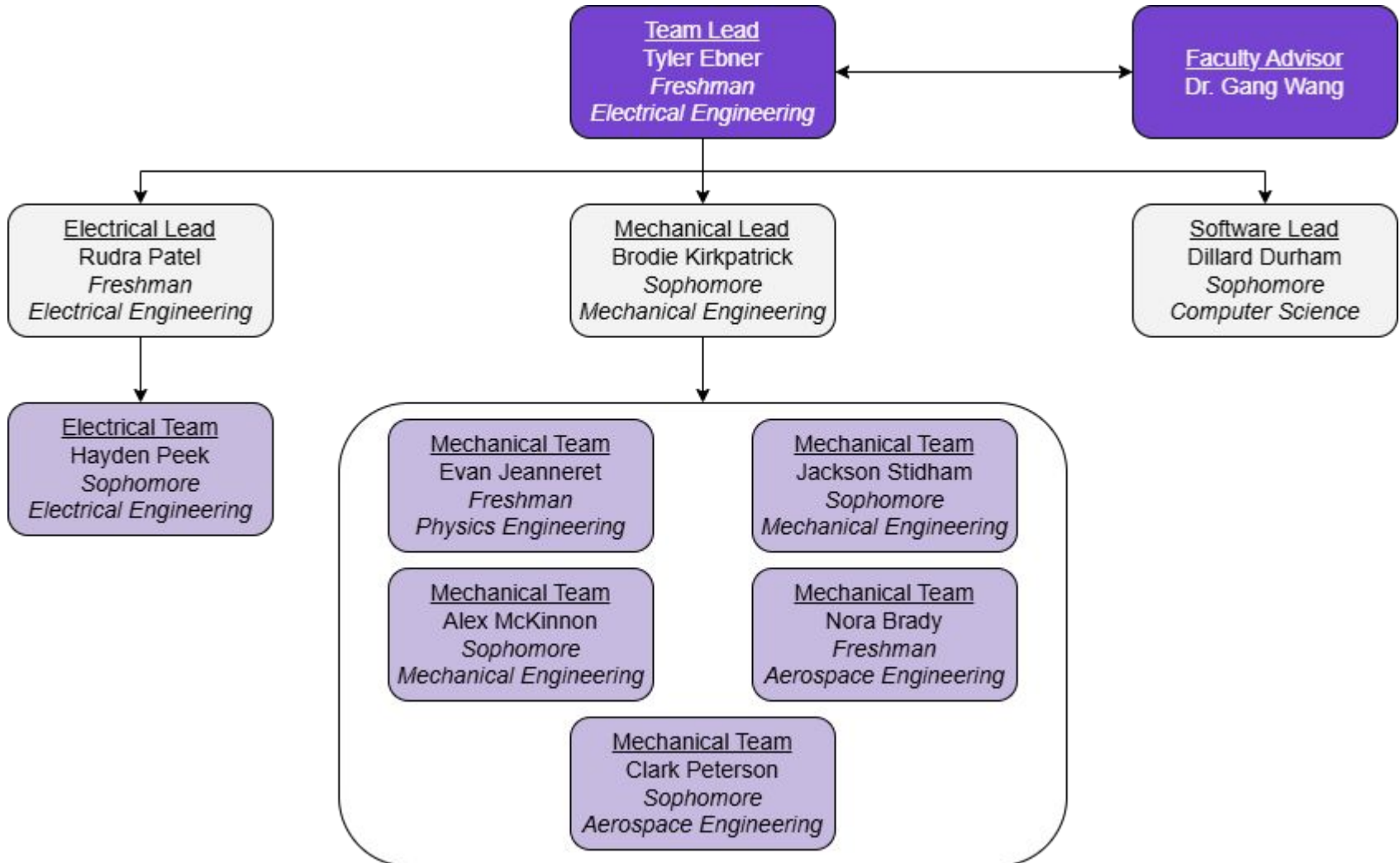
Presentation Outline (2/2)



Section	Presenters	Slide Number
Flight Software (FSW) Design	Dillard Durham	113-120
Ground Control System (GCS) Design	Dillard Durham	121-128
CanSat Integration and Test	Tyler Ebner	129-146
Mission Operations & Analytics	Tyler Ebner	147-159
Requirement Compliance	Tyler Ebner	160-173
Management	Tyler Ebner	174-199



Team Organization





Acronyms (1/5)



Acronym	Meaning	Acronym	Meaning
#	Number	CAD	Computer aided design
%	Percentage	Cd	Coefficient of drag
°/min	Degrees per minute	CDH	Command Data Handling
°/s	Degrees per second	CDR	Critical Design Review
\$	Dollars (USD)	cm	Centimeters
3D	Three Dimensional	Com.	Communication line
A	Amperes	combo	Combination
AC	Alternating current	Comm.	Communications
bd	Baud	COTS	Commercially off the Shelf
c	Degree	csv	Comma-Separated Values
C	Celsius	dB	Decibels



Acronyms (2/5)



Acronym	Meaning	Acronym	Meaning
dBi	Decibels relative to isotropic	G	G-force (accel. due to Earth's gravity)
DC	Direct current	GB	Gigabytes
DCS	Decent control system	GCS	Ground Control Software
DOF	Degrees of freedom	GHz	Gigahertz
EEPROM	Electrically Erasable Programmable Read-only Memory	GPS	Global Positioning System
Elec	Electrical	GUI	Graphical User Interface
EPS	Electrical Power System	h	Hours
Etc.	Excetera	Hz	Hertz
FSW	Flight Software	I2C	Inter-Integrated Circuit
ft	feet	ID	Identification
g	grams	IDE	Integrated Development Environment



Acronyms (3/5)



Acronym	Meaning	Acronym	Meaning
in	Inch	m	Meters
JST	Japan Solderless Terminal	m/s	Meters per second
KB	Kilobyte	mA	MilliAmps
kg	Kilograms	Mag	Magnetometer
kg/cm	Kilogram per centimeter	mAh	MilliAmp hours
kJ/m	Kilojoules per meter	MB	MegaBytes
km	kilometers	Mec.	Mechanism
kPa	Kilopascals	Mech.	Mechanical
lbs	Pounds	MHz	MegaHertz
LED	Light Emitting Diode	Min	Minimum
LLC	Limited Liability Corporation	mm	Millimeters



Acronyms (4/5)



Acronym	Meaning	Acronym	Meaning
MOSFET	Metal Oxide Semiconductor Field Effect Transistor	PDR	Preliminary Design Review
MPa	Megapascals	PE foam	Polyethylene Foam
ms	Milliseconds	PETG	Polyethylene Terephthalate Glycol
NETID	Network Identification	PLA	Polylactic Acid
NMOS	N-Channel MOSFET	PMOS	P-Channel MOSFET
ns	Nanoseconds	PPM	Parts Per Million
Num	Number	RAM	Random Access Memory
Omni	Omnidirectional	Rel.	Relative
Pa	Pascals	RMS	Root Mean Square
PA6-CF	PolyAmide 6 Carbon-Fiber Reinforced	Rqmt	Requirement
PCB	Printed Circuit Board	s	Second



Acronyms (5/5)



Acronym	Meaning	Acronym	Meaning
SD	Secure Digital	UART	Universal Asynchronous Receiver Transmitter
sec	Second	USB	Universal Serial Bus
SI	Système international	USD	United States Dollar
SIM	Subscriber Identity Module	UTC	Coordinated Universal Time
SPI	Serial Peripheral Interface	V	Voltage
TB	Terabyte	VS	Virtual Studio
TPU	Thermoplastic Polyurethane	Wh	Watt Hours



System Overview

**Tyler Ebner, Brodie Kirkpatrick and Alex
McKinnon**



Mission Summary



Mission Objectives	
1	Design a functioning CanSat containing a large hen's egg that releases at a designated elevation.
2	CanSat will operate as the nose cone of a rocket.
3	The CanSat will be launched to a maximum designated height and release from the rocket, deploying an autonomous chute to steer to a designated location.
4	At 2 meters the CanSat will release the egg which must remain intact.
5	CanSat will land in the required landing zone.
6	CanSat will deliver telemetry data to a ground station during flight and stop delivering data once landed.
7	CanSat will activate an audio beacon upon landing.



Summary of Changes Since PDR (1/5)



Section	System	PDR	CDR	Rationale
Mechanical	Nose Cone Parachute	Small Parachute Seated in Nose Cone that Passively Deploys	Small Parachute with Attached Drogue Chute to Aid in Deployment	Reliability
	Structure - Plates	PA6-CF 3D Printed Plates	Composite Plates	Less Mass
	Structure - Rods	M3 Steel Threaded Rods	M3 Steel Threaded Rods with M5 Carbon Fiber Rods	Modularity
	Release Mechanism	14g Servo	20g Servo	More Strength
	Egg Support	Inner TPU Shell with PA6-CF Outer Brace	Inner TPU Shell with Denser TPU Brace with Nylon Insert	Better Shock Absorption and Ease of Assembly



Summary of Changes Since PDR (2/5)



Section	System	PDR	CDR	Rationale
Mechanical	Nose Cone	Fiberglass Nose Cone	Fiberglass Nose Cone with Parachute and Drogue Chute	Required in Mission Guide
	Structure - Mounts	Large PA6-CF Camera Mount and Horizontal Steer Servo Mount	Small PA6-CF Camera Mount and Vertical Steer Servo Mount	Saves Space and Mass
Electrical	Microcontroller	Teensy 4.1	Raspberry Pi Pico 2	It is cheaper, smaller, dual-core processing, easier to work with, programmable I/O pins



Summary of Changes Since PDR (3/5)



Section	System	PDR	CDR	Rationale
Electrical	Batteries	Surefire CR123A	18350 LIION Wholesale	Provides a higher continuous current discharge, convenience to recharge
	Error from where we are facing to target	VECTOR_PRODUCT	STEERING_ERROR	The new name represents the data better
Software	Angle of the left servo	PORT_ANGLE	Removed	Was only useful for testing
	Angle of the right servo	STRB_ANGLE	Removed	Was only useful for testing
	Sets the left servo angle	PORT	Removed	Was only useful for testing
	Sets the right servo angle	STRB	Removed	Was only useful for testing



Summary of Changes Since PDR (4/5)



Section	System	PDR	CDR	Rationale
Software	Processor restart	The variables we store for processor restart are stored in EEPROM	The variables we store for processor restart are stored in the SD card	Storing variables in EEPROM is hard and would wear down its usability
	PID	N/A	We have started developing a PID controller	PID's help autonomous steering systems maintain stability and precise trajectory tracking
	USB connection error handling and reconnection logic	No error handling	Automatic detection of usb device removal and reconnection	Accidental disconnect could disrupt continuation of communications.



Summary of Changes Since PDR (5/5)



Section	System	PDR	CDR	Rationale
Software	Button Section Layout	Static button positioning	Flow layout	The dynamic allocation of rows of buttons allows for maximum graph size while maintaining button visibility



System Requirement Summary (1/3)



Requirement Number	Requirement
C1	The CanSat payload shall function as a nose cone during the rocket ascent portion of the flight.
C4	After deployment, the CanSat payload and container shall descend at 15 meters/second using a parachute that automatically deploys. Error is +/- 3 meters/sec.
C5	At 80% flight peak altitude, the payload shall be released from the container.
C6	At 80% peak altitude, the payload shall deploy a para-glider descent control system.
C7	The payload shall descend at 5 meters/sec averaged over the entire descent within +/- 3 meters/sec with the paraglider descent control system.
C8	The payload shall steer toward a target location.
C12	The payload shall release a protected hens egg when the payload is 2 meters +/- 0.5 m above the ground without breaking the egg.



System Requirement Summary (2/3)



Requirement Number	Requirement
C14	Cost of the CanSat shall be under \$1000. Ground support and analysis tools are not included in the cost of the CanSat. Equipment from previous years shall be included in this cost, based on current market value.
S1	The CanSat and container mass shall be 1000 grams +/- 10 grams.
S2	The nose cone shall be symmetrical along the thrust axis.
S5	The nose cone shall be made as a single piece. Segments are not allowed.
S8	CanSat structure must survive 15 Gs vibration.
S9	CanSat shall survive 30 G shock.
S17	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.



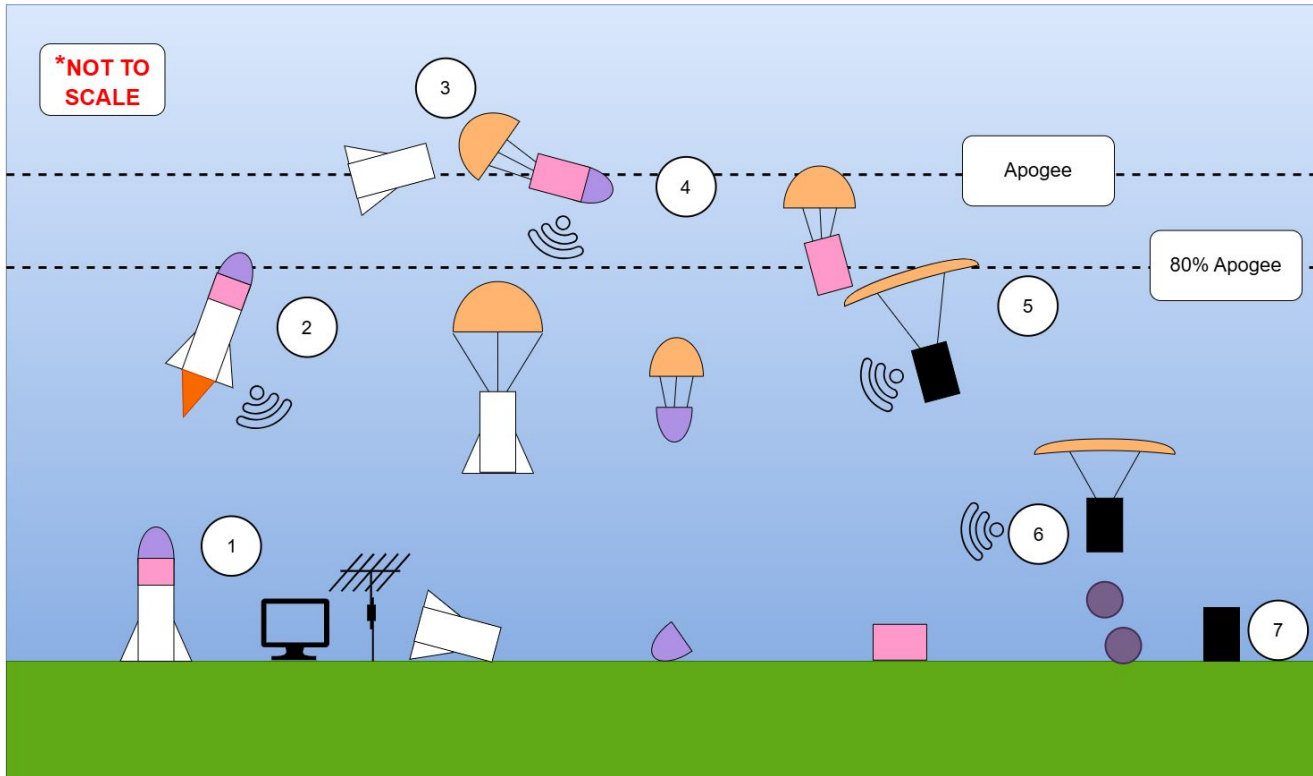
System Requirement Summary (3/3)



Requirement Number	Requirement
S20	If the nose cone is to separate from the payload after payload deployment, the nose cone shall descend at no more than 5 meters/sec.
E3	An easily accessible power switch through the container is required.
E4	The container shall have small access holes for power switches of no more than 10 mm.
E5	Power indicator is required.
E6	The CanSat shall operate for a minimum of two hours when integrated into the rocket.
G4	Each team shall develop their own ground station.
G17	The ground station shall be able to activate all mechanisms on command.



System Concept of Operations (CONOPS) (1/3)



Telemetry data is being transmitted for the extent of the mission

- 1) LAUNCH_PAD: CanSat is on the launchpad and is ready for launch and begins transmitting telemetry data
- 2) ASCENT: CanSat launches
- 3) APOGEE: CanSat releases from the rocket and starts descending
- 4) DESCENT: Payload descends at 5 m/s and Nose cone is dropped
- 5) PROBE_RELEASE: Probe is released from the Can at 80% Apogee
- 6) PAYLOAD_RELEASE: Payload is released from the Probe at 2 meters
- 7) LANDED: CanSat lands and stops transmitting telemetry data



System Concept of Operations (CONOPS) (2/3)



Team Member(s)	Assigned Role	Description
Tyler Ebner	Mission Control Officer	Ensures the team follows the proper procedures outlined in the Missions Operations Manual
Brodie Kirkpatrick, Jackson Stidham, Evan Jeanneret, Alex McKinnon, Hayden Peek	CanSat Crew	Prepares the CanSat for launch and integrates it with the rocket
Nora Brady, Clark Peterson	Recovery Crew	Recovers the CanSat after launch and returns it for judging
Dillard Durham, Rudra Patel	Ground Station Operators	Checks the ground station, ensuring it runs properly, as well as handling the antenna connection



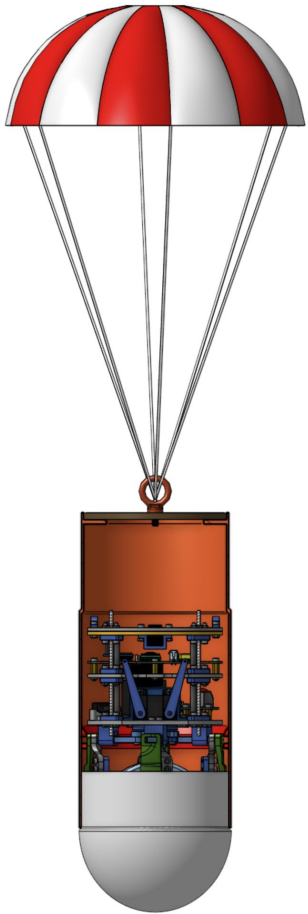
System Concept of Operations (CONOPS) (3/3)



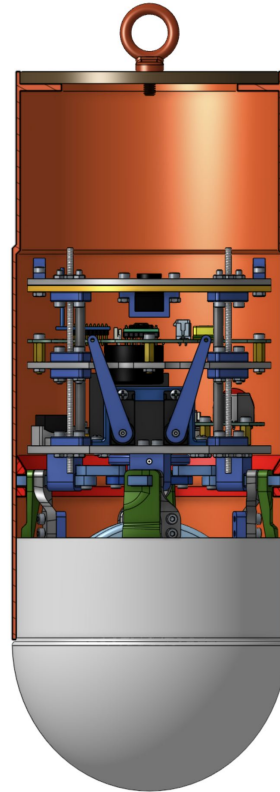
Event	Team Member(s)
Arrival	Full Team
Check-in of CanSat	Full Team
Ground Station preparation	Ground Station Operators
Pre-Launch Checklist	Full Team
Launch Checklist	CanSat Crew, Ground Station Operators
Data Analysis	Ground Station Operators
Recovery, Return CanSat to Judges	Recovery Crew
Completion of PFR presentation	Full Team



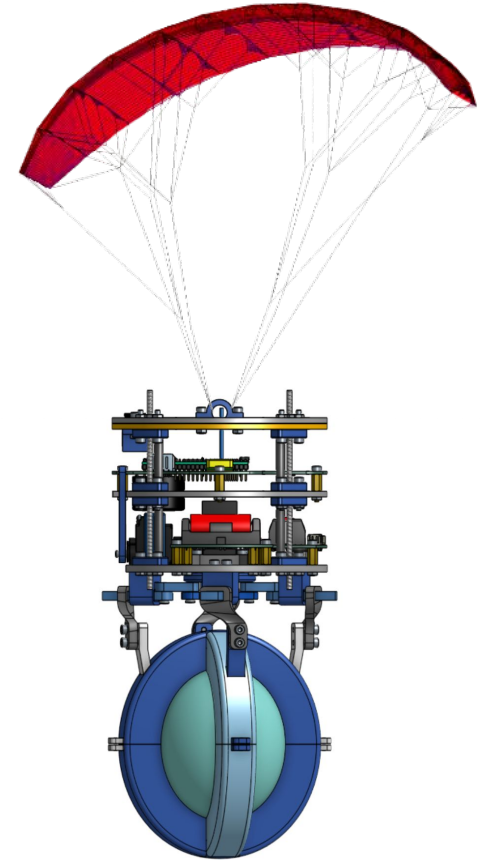
CanSat Physical Layout (1/7)



Stowed Configuration



Launch Configuration



Deployed Configuration



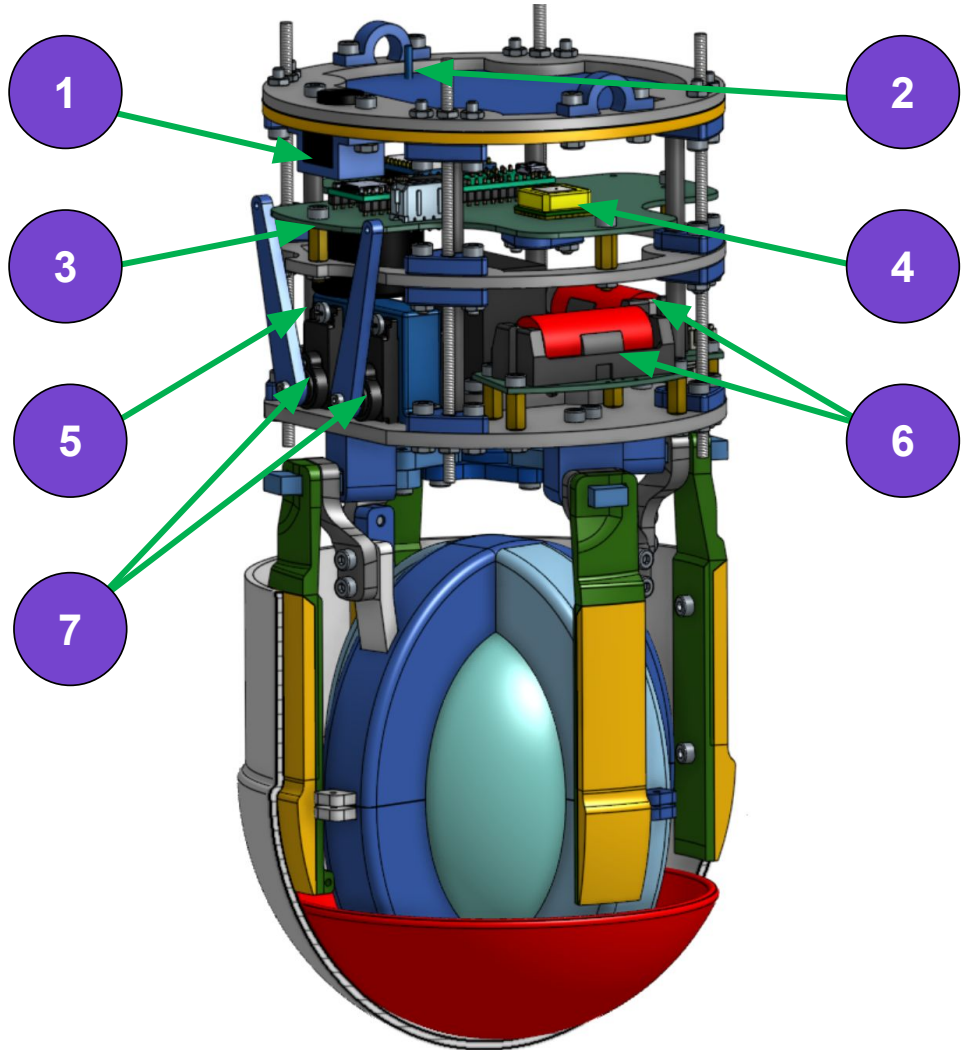
CanSat Physical Layout (2/7)



Electronics

#	Component
1	Descent Control Camera
2	Radio Antenna
3	CDH Board
4	GPS Antenna (Internal)
5	Ground-Facing Camera
6	Power PCB & Batteries
7	Servos

*Various Parts Sectioned for Visibility



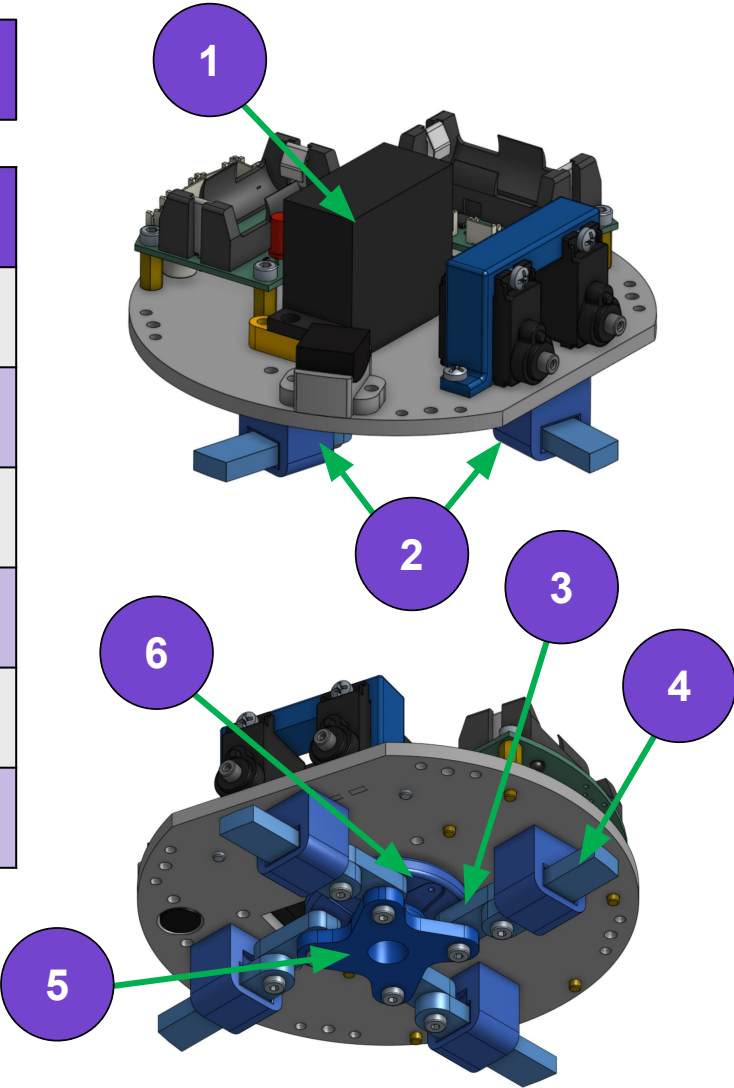


CanSat Physical Layout (3/7)

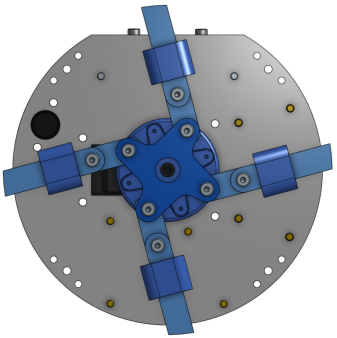


Release Mechanism

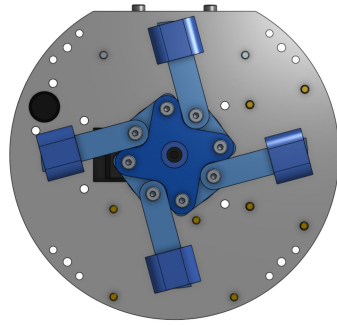
#	Component
1	Center Servo (20g)
2	Guide Slots
3	Center Arms
4	Outer Arms
5	Arm Spacer
6	Servo Mount Disk



Undeployed State



Fully Deployed





CanSat Physical Layout (4/7)



Release States

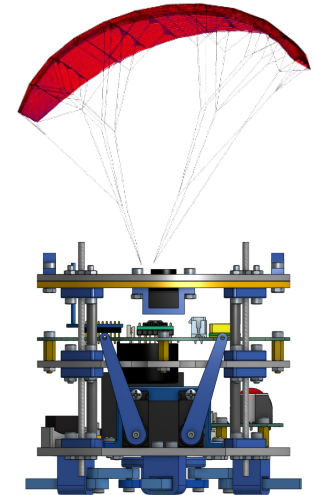
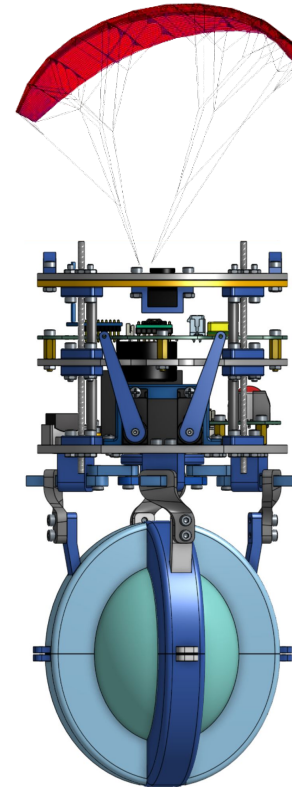
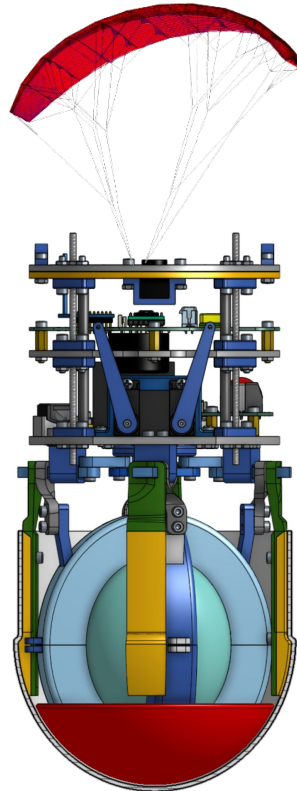
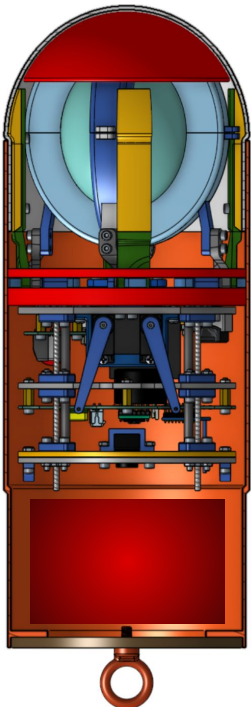
*Various Parts Sectioned & Para-glider Not to Scale

Launch Configuration

Released from Container

Released Nose Cone

Dropped Egg at 2m





CanSat Physical Layout (5/7)



Control System

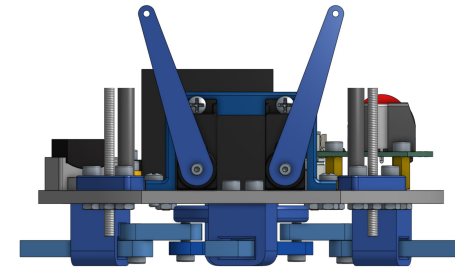
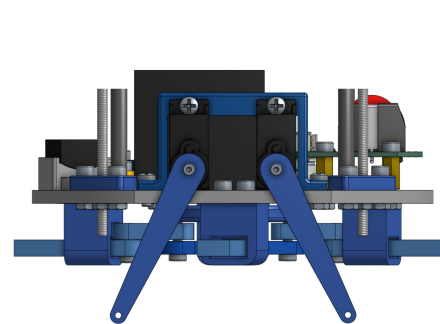
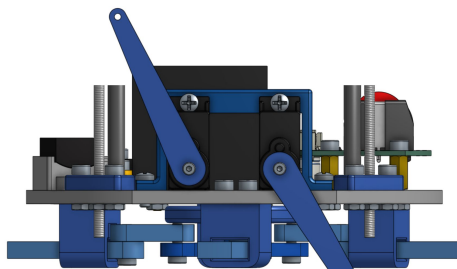
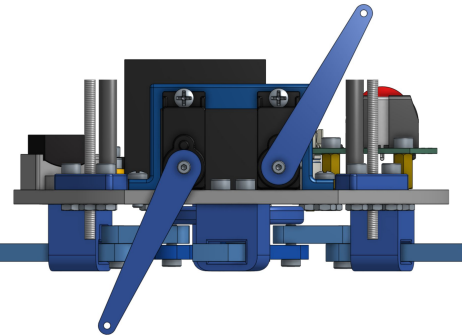
*Various Parts Hidden for Visibility

Turn Left

Turn Right

Brake

Speed Up



Servo Pulls Left Brake Line Down Increasing Camber of the Left Side Steering CanSat Left

Servo Pulls Right Brake Line Down Increasing Camber of the Right Side Steering CanSat Right

Both Brake Lines are Pulled Increasing the Camber of the Airfoil Increasing Lift and Drag

Servos Ease on the Brake Line Decreasing Camber of the Airfoil Decreasing Lift & Drag

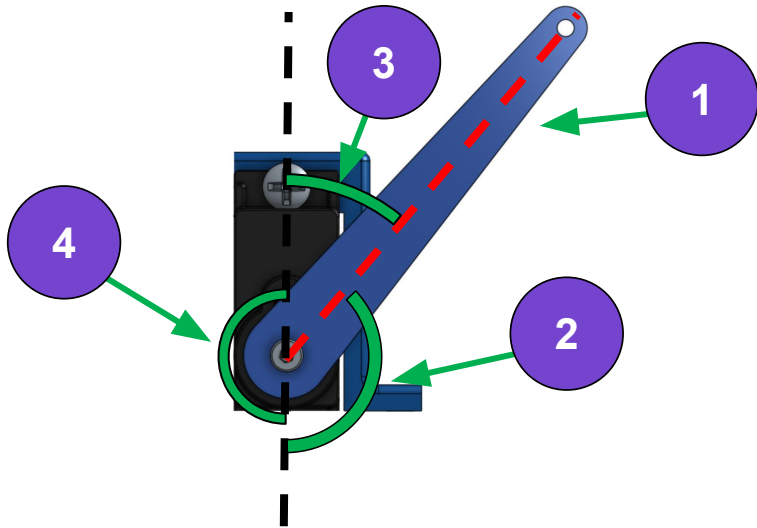


CanSat Physical Layout (6/7)



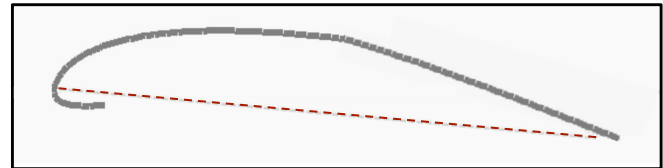
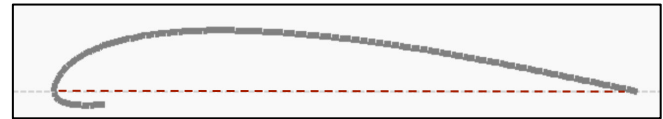
Control System

Available Steering Angle Vs Slack Angle



#	Section
1	Angle with No Slack or Tension in Brake Line
2	Allocated Available Angle for Braking/Turning(135°)
3	Allocated Available Angle for Slack (45°)
4	Total Available Range of Servo (180°)

Normal Vs Cambered Airfoil Profile



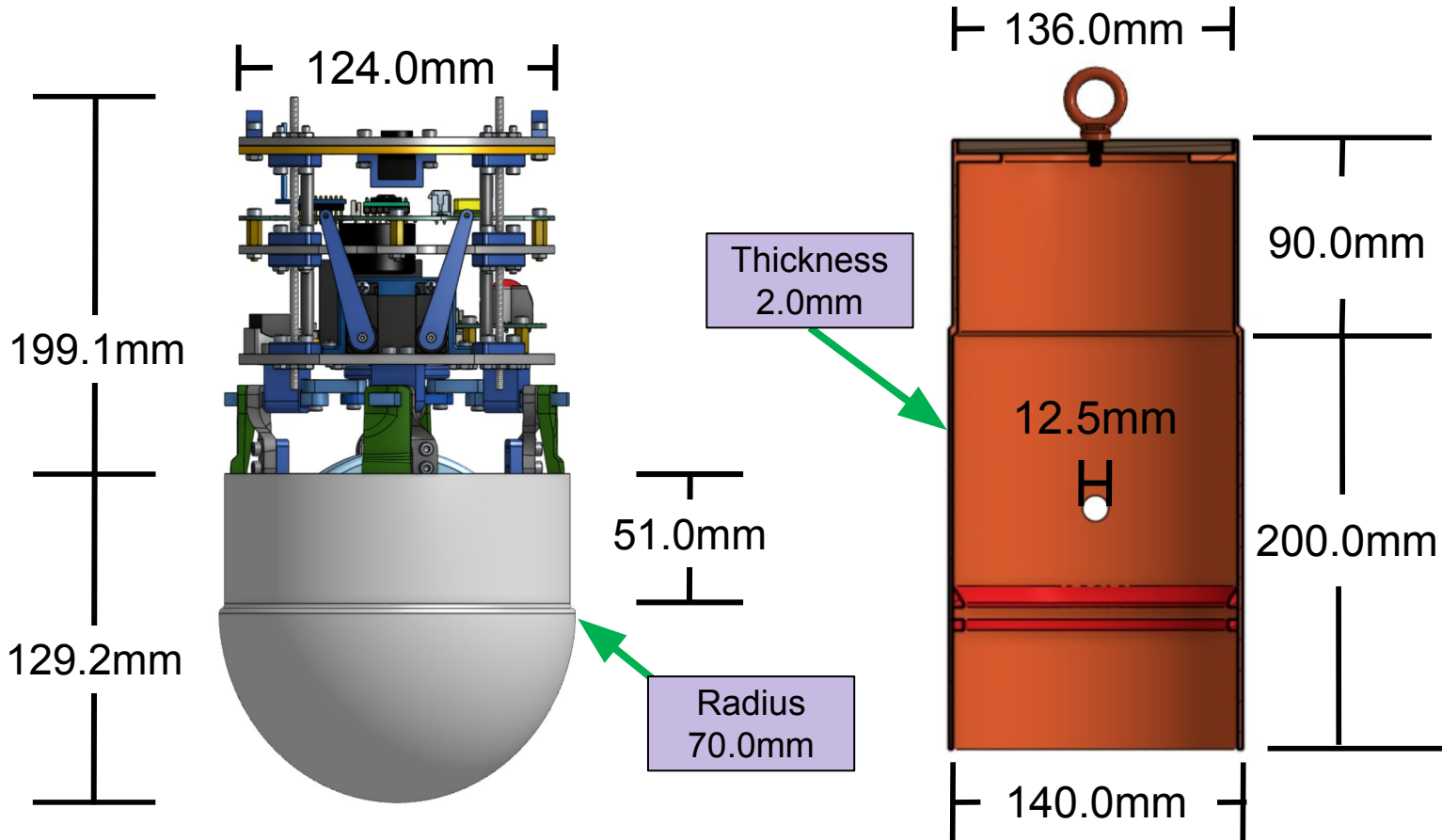
As the Servo Pulls on the Brake Lines, The Camber of the Airfoil Increases Also Increasing Lift and Drag



CanSat Physical Layout (7/7)

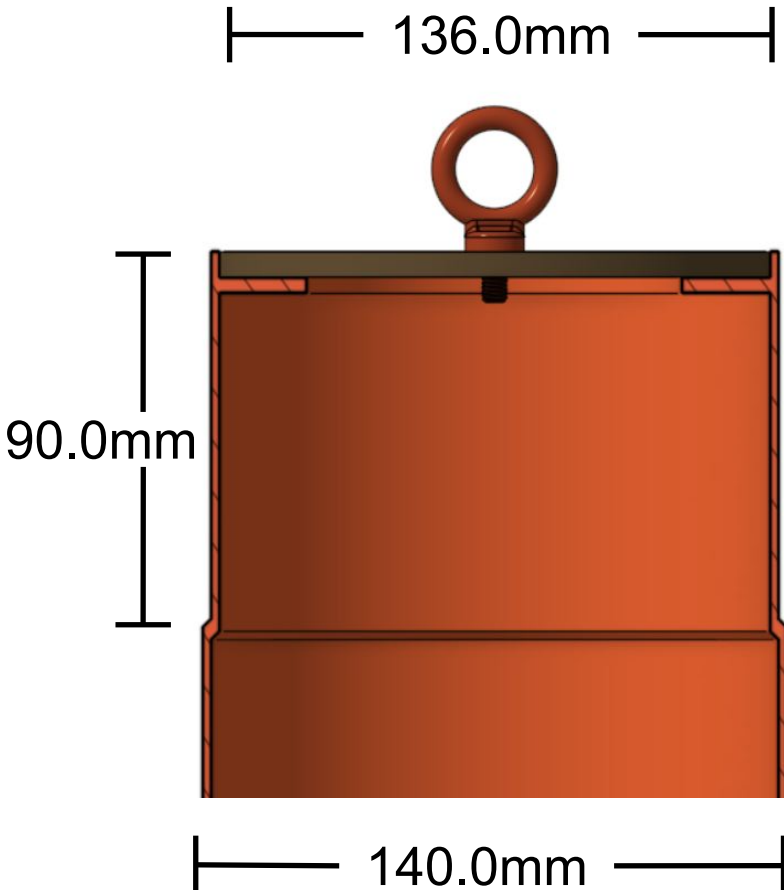


Dimensions





Launch Vehicle Compatibility (1/2)



Container

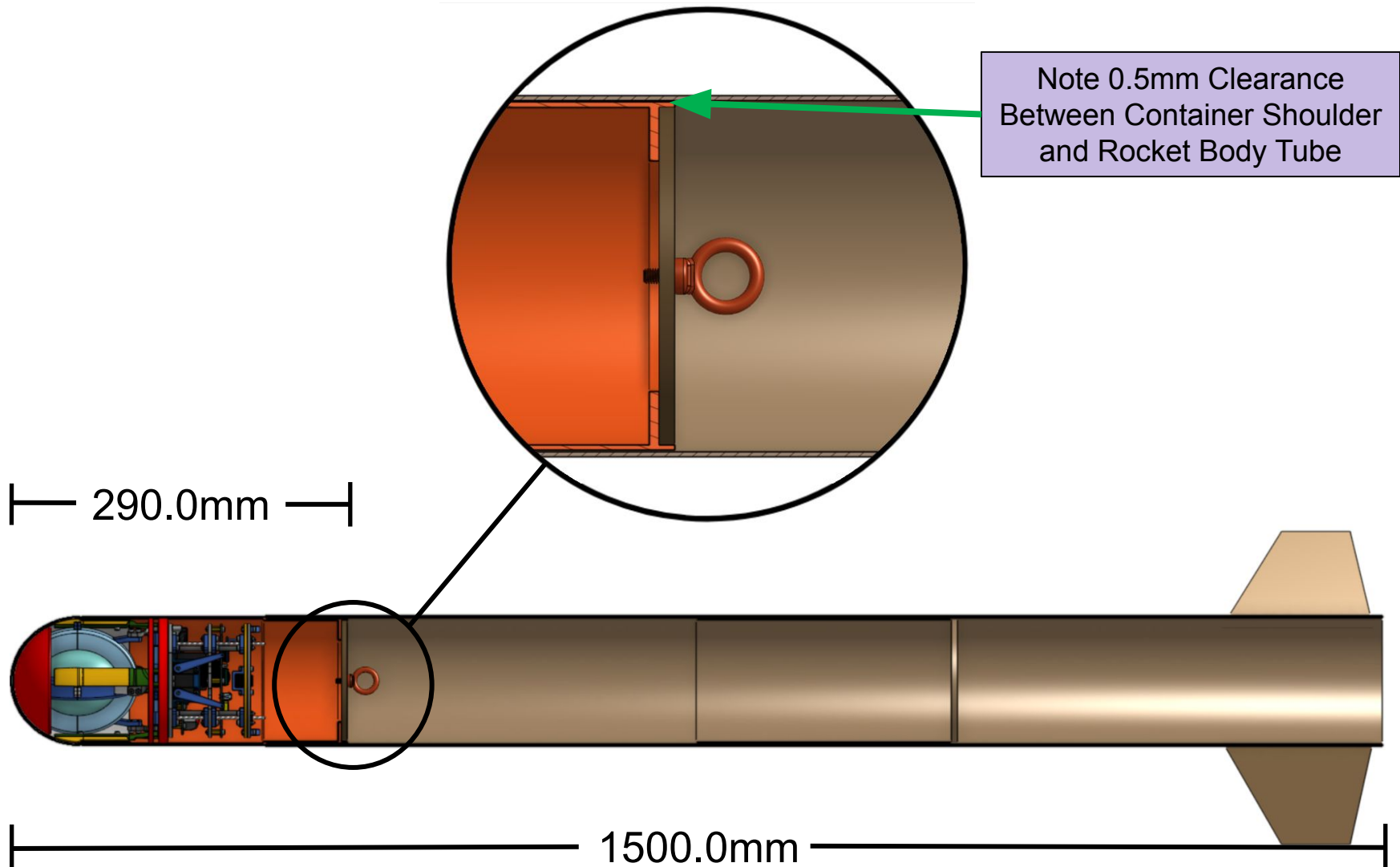
- The container shoulder diameter shall be 136 mm.
- The container shoulder length shall be 90 to 120 mm.
- Above the shoulder, the container diameter shall be 140 mm
- 0.5mm of clearance from each side of the container



Rocket Body Tube



Launch Vehicle Compatibility (2/2)





Sensor Subsystem Design

Rudra Patel



Sensor Subsystem Overview



System	Sensor	Description	Slide Number
Pressure	BMP581	Measures Pressure and Calculates Altitude	35
Temperature	BMP581	Monitors Air Temperature	36
Voltage & Current	INA260	Measures Battery Voltage and Current	37
GPS	SAM-M10Q	Tracks Longitude and Latitude of the CanSat	38
Orientation/ Acceleration	BNO085	Measures CanSat Orientation w/ 9 DOF	39
Descent Camera	Runcam Split v4	Records Parachute Release	40
Ground Camera	Runcam Split v4	Records Single View from the CanSat	41



Sensor Changes Since PDR



There are no changes to the sensor subsystem.



Payload Air Pressure Sensor Summary



Name	Voltage (V)	Interface	Range (hPa)	Mass (g)	Sensitivity (hPa)	Current (µA)	Cost (\$)
BMP581	3.3	I2C	300-1250	2	0.06	1.3	2.92

Variable Type	Telemetry	Data
float	PRESSURE	0.1 kPa

Pressure is used to calculate altitude



Example Code

```
float PRESSURE = 0.0;
sensor_event_t pressure_event;
bmp_pressure->getEvent(&pressure_event);
raw_hPa = pressure_event.pressure;
PRESSURE = raw_hPa/10;
```



Payload Air Temperature Sensor Summary



Name	Voltage (V)	Interface	Range (°C)	Mass (g)	Sensitivity (°C)	Current (µA)	Cost (\$)
BMP581	3.3	I2C	-40~85	2	±0.5	1.3	2.92

Variable Type	Telemetry	Data
float	TEMPERATURE	0.1 °C

Example Code

```
float TEMPERATURE = 0.0;  
sensors_event_t temp_event;  
bmp_temp->getEvent(&temp_event);  
TEMPERATURE = temp_event.temperature;
```

BMP581
Source: Adafruit





Payload GNSS Sensor Summary

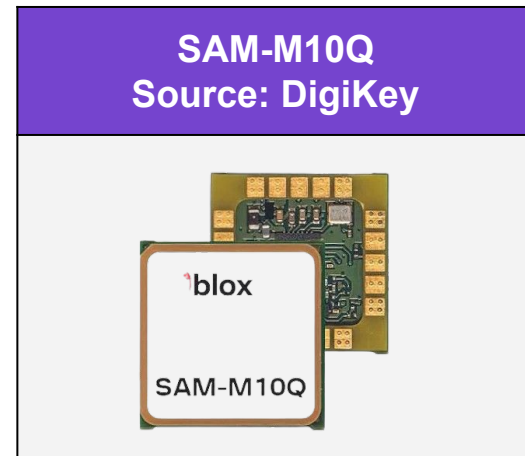


Name	Voltage (V)	Interface	Cold Start (s)	Sensitivity (dBm)	Mass (g)	Accuracy/Range (m)	Current (mA)	Cost (\$)
SAM-M10Q	3.3	UART	23-59	~165	2	1.5	13	14.56

Variable Type	Telemetry	Data
float	GPS_TIME	hh:mm:ss
float	GPS_ALLTITUDE	0.1 meters
float	GPS_LATITUDE GPS_LONGITUDE	0.0001°
float	GPS_SATS	0

Example Code

```
GPS_LATITUDE = sam_m10q.getLatitude() / 10000000.0;
GPS_LONGITUDE = sam_m10q.getLongitude() / 10000000.0;
GPS_ALTITUDE = sam_m10q.getAltitudeMSL() / 1000.0;
GPS_SATS = sam_m10q.getSIV();
sprintf(GPS_TIME, "%02d:%02d:%02d", sam_m10q.getHour(),
sam_m10q.getMinute(), sam_m10q.getSecond());
```





Payload Voltage and Current Sensor Summary



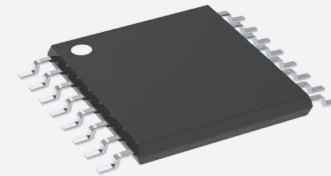
Name	Voltage (V)	Interface	Current Range (A)	Mass (g)	Sensitivity (mA)	Current (μ A)	Cost (\$)
INA260	3.3	I2C	15	2	1.5	310	5.52

Variable Type	Telemetry	Data
float	VOLTAGE	0.1 Volts
float	CURRENT	0.01 Amperes

Example Code

```
float VOLTAGE = 0.0, TEMPERATURE = 0.0;  
CURRENT = (ina260.readCurrent() / 1000.0);  
VOLTAGE = (ina260.readBusVoltage() / 1000.0);
```

INA260
Source: DigiKey





Rotation Rotation Rate Sensor Summary



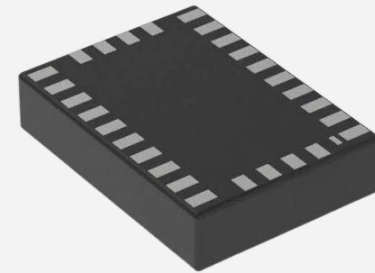
Name	Voltage (V)	Interface	Rotation Rate Range (°/s)	Sensitivity (LSB/°/s)	Mass (g)	Current (mA)	Cost (\$)
BNO085	3.3	I2C	±2000	131	2	7.5	13.05

Variable Type	Telemetry	Data
float	GYRO_R, GYRO_P, GYRO_Y	0.0001 °/s

Example Code

```
float GYRO_P = 0.0, GYRO_R = 0.0, GYRO_Y = 0.0;
GYRO_P = sensorValue.un.gyroscope.x * 57.2958;
GYRO_R = sensorValue.un.gyroscope.y * 57.2958;
GYRO_Y = sensorValue.un.gyroscope.z * 57.2958;
```

BNO085
Source: DigiKey





Payload Acceleration Sensor Summary



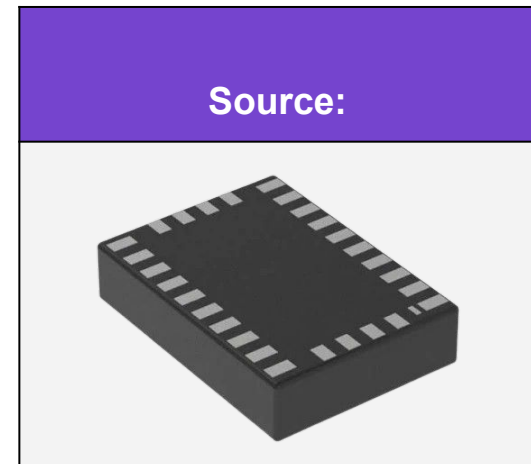
Name	Voltage (V)	Interface	Sensitivity/Range (g)	Linear Accuracy (m/s ²)	Mass (g)	Current (mA)	Cost (\$)
BNO085	3.3	I2C	±8	0.3	2	7.5	13.05

Variable Type	Telemetry	Data
float	ACCELERATION	0.1 m/s ²

```

Example Code

float x = sensorValue.un.linearAcceleration.x;
float y = sensorValue.un.linearAcceleration.y;
float z = sensorValue.un.linearAcceleration.z;
float ACCELERATION = sqrt(pow(x, 2) + pow(y, 2) + pow(z, 2));
    
```





Payload Ground Camera Sensor



Name	Voltage (V)	Interface	Resolution	Range/Field of View (°)	Mass (g)	Current (mA)	Cost (\$)
Runcam Split 4 v2	5	UART	720x480	140	10.2	450	82.99

Example Code

```
cameraSerial.write(turnOnCommand, sizeof(turnOnCommand));
```

Resolution fits requirements.

Runcam Split 4 v2 Source: Adafruit





Payload Release Camera Sensor



Name	Voltage (V)	Interface	Resolution	Range/Field of View (°)	Mass (g)	Current (mA)	Cost (\$)
Runcam Split 4 v2	5	UART	720x480	140	10.2	450	82.99

Example Code

```
cameraSerial.write(turnOnCommand, sizeof(turnOnCommand));
```

Resolution fits requirements.

Runcam Split 4 v2 Source: Adafruit





Descent Control Design

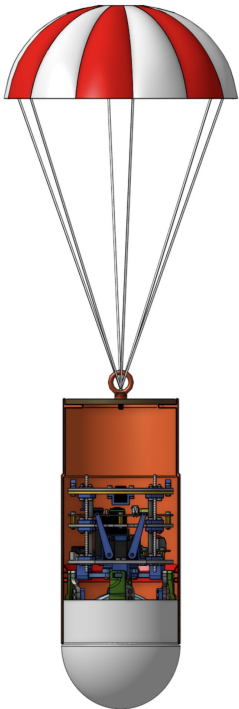
Nora Brady and Clark Peterson



Descent Control Overview



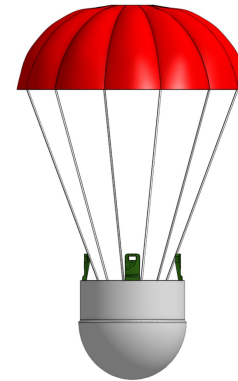
Released from Rocket



Released from Container



Nose Cone Subsystem Released



*Para-Glider not to scale

Descent Mechanism	Area	Descent Rate
Parachute #1	0.055m ²	14.05m/s
Para-glider	1.000m ²	2.02m/s
Parachute #2	0.063m ²	5.00m/s



Descent Control Changes Since PDR



System	PDR	CDR	Rationale
Nose Cone Parachute	Small Parachute Seated in Nose Cone that Passively Deploys	Small Parachute with Attached Drogue Chute to Aid in Deployment	Drogue Chute Makes Proper Deployment 50% More Likely

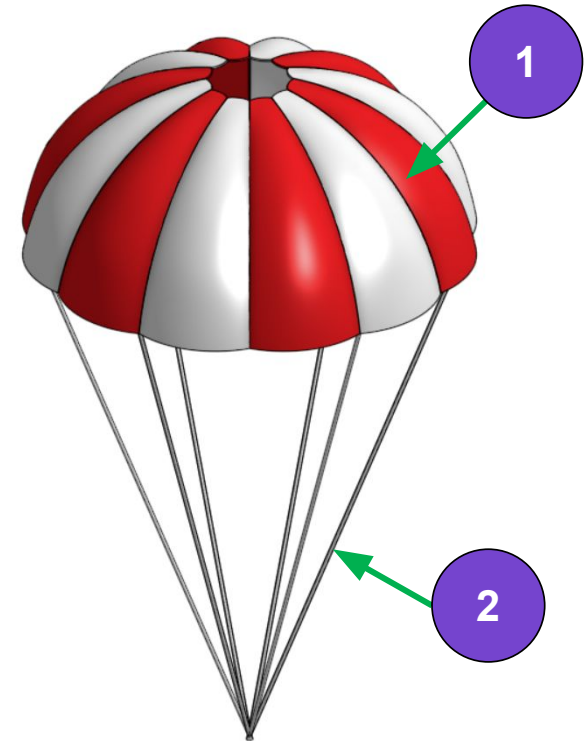


Container Parachute Descent Control Summary



Container Parachute Overview

#	Subsystem	Description
1	Panel	Red and White Single Skin HyperD Ripstop Nylon
2	Bridal Lines	Kevlar Parachute Cord, Tied Together Using an Overhand Loop Knot and a Larks Head Knot
3	Dimensions	70.0mm Outer Radius 25.0mm Spill Hole Radius



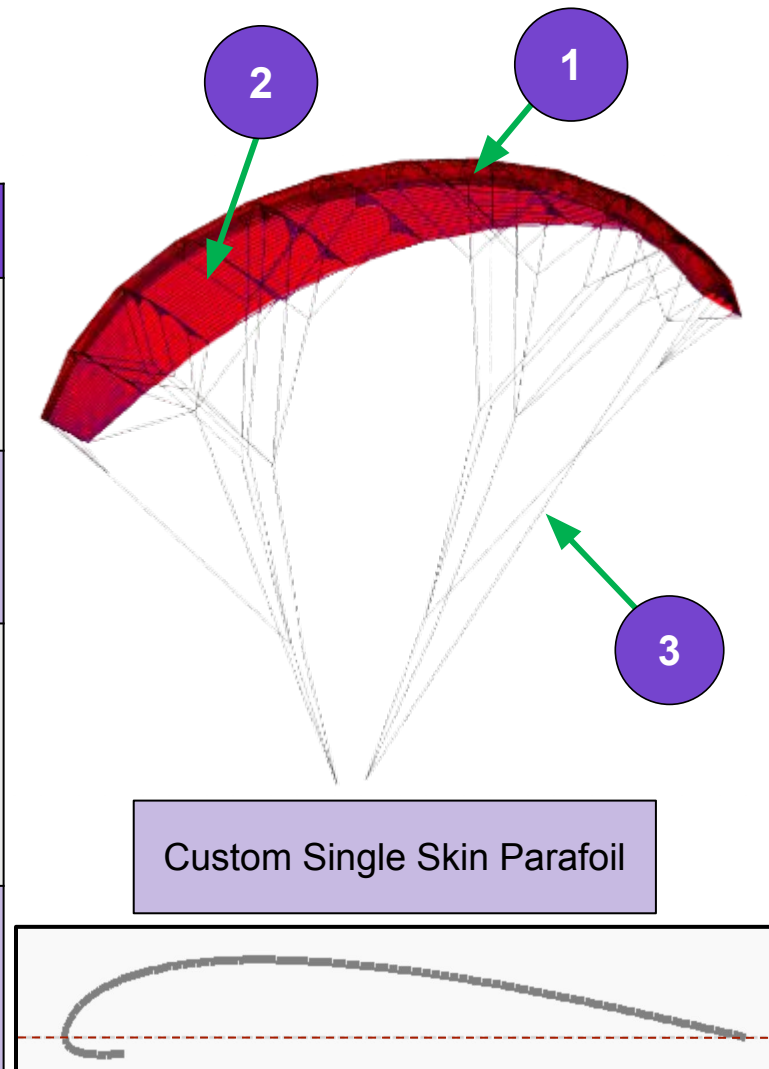


Para-Glider Descent Control Summary



Para-glider Overview

#	Component	Description
1	Panel	Red Single Skin HyperD Ripstop Nylon
2	Ribs	Red Single Skin HyperD Ripstop Nylon
3	Bridal Lines	Kevlar Parachute Cord, Tied Together Using an Overhand Loop Knot and a Larks Head Knot
4	Dimensions	2.17m Wingspan with Varying Chord Length from 0.57m to 0.2m





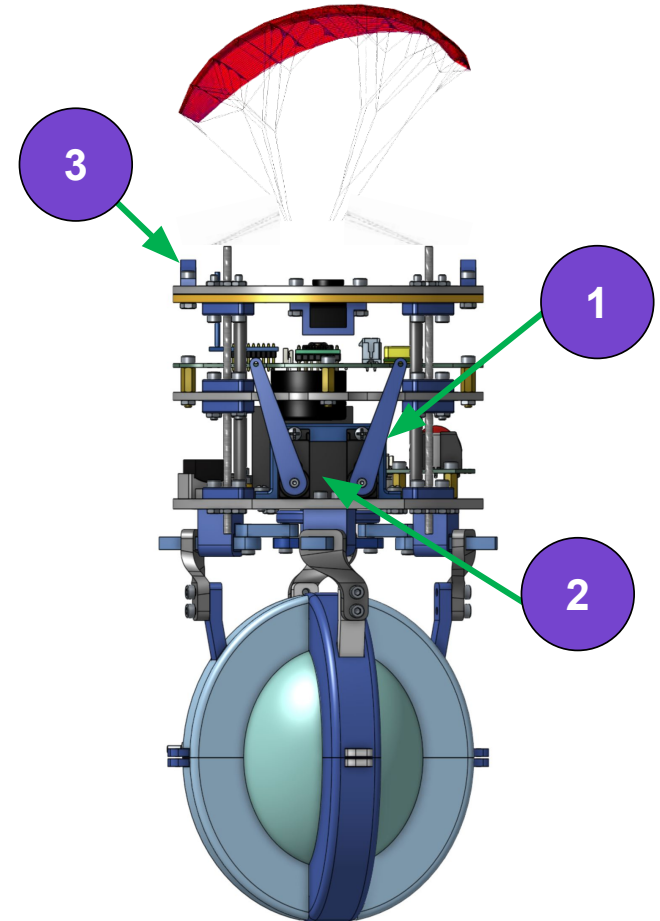
Para-Glider Descent Speed Control Design



Stowed Overview

*Para-glider not to scale

#	Subsystem	Description
1	Arms	3D Printed PA6-CF with a Hole Connecting to the Brake Lines that use Active Control
2	Servo	Attached to the Arms and Adjusts Angle to Steer
3	Attachment Point	A Half Circle made of 3D Printed PA6-CF that Connects the Bridal Lines to the Rest of the CanSat





Descent Rate Estimates (1/8)



Parachute Descent Rates

Variables	Substituted Values
Mass – m	1 kg
Acceleration due to Gravity – g	9.81m/s^2
Area of Parachute – A	0.065 m^2
Coefficient of Drag – C_d	1.5
Air Density – ρ	1.02 kg/m^3



Descent Rate Estimates (2/8)



Equation	Substituted Values
$V_t = \sqrt{\frac{2mg}{\rho AC_d}}$	$V_t = \sqrt{\frac{2(1kg)(9.81\frac{m}{s^2})}{(1.02\frac{kg}{m^3})(0.055m^2)(1.5)}}$
Final Estimated Descent Rate = 14.05 m/s	

Estimates are based of the following assumptions

- Constant Density
- Steady Uniform Flow
- Coefficient of Drag of 1.5



Descent Rate Estimates (3/8)



Para-glider Descent Rates

Variables	Substituted Values
Mass – m	0.7kg
Acceleration due to Gravity – g	9.81m/s ²
Area of Parachute – A	0.80925 m ²
Coefficient of Drag – C_d	1.5
Coefficient of Lift – C_L	0.21
Air Density – ρ	1.02 kg/m ³
Effective Angle	0.75°
Alpha Angle	3.2567°
Angle of Incidence	2.5067°



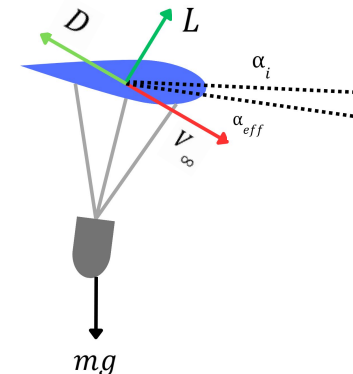
Descent Rate Estimates (4/8)



Equation	Substituted Values
$V = \sqrt{\frac{2mg}{(C_d \sin(\alpha) + C_l \cos(\alpha))(\rho S)}}$	$V = \sqrt{\frac{2(0.7kg)(9.81 \frac{m}{s^2})}{(1.5 \sin(3.25^\circ) + 0.21 \cos(3.25^\circ))(0.80925 m^2 \cdot 1.02 \frac{kg}{m^3})}}$
$V_x = V \cos(\alpha_{eff} + \alpha_i)$	$V_x = 36 \frac{m}{s} \cos(0.75^\circ + 2.5^\circ)$
$V_y = V \sin(\alpha_{eff} + \alpha_i)$	$V_y = 36 \frac{m}{s} \sin(0.75^\circ + 2.5^\circ)$
Final Estimated Descent Rate = 2.04 m/s	

Estimates are based of the following assumptions

- Constant Density
- Steady Uniform Flow
- CanSat Drag is Equal to Airflow Drag
- Flies at Best Glide Ratio
- Lift is Greater than 0
- Angle of Incidence is Greater than 0
- Effective Angle is Greater than 0





Descent Rate Estimates (5/8)



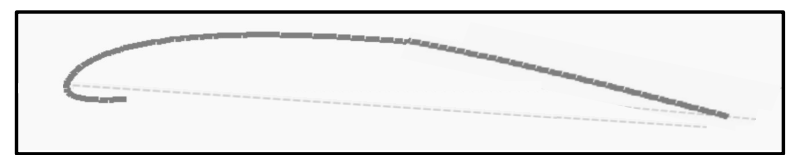
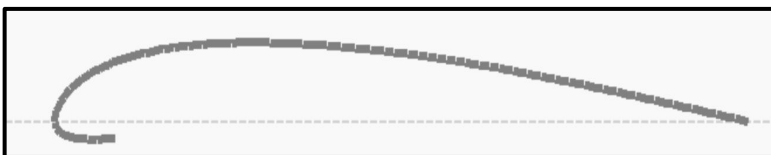
Cl Vs Cd



Cl Vs Effective Angle



Normal Vs Cambered Airfoil Profile





Descent Rate Estimates (6/8)



C_l Vs C_d

Effective Angle	Coefficient of Lift	Coefficient of Drag	Cl by Cd	Angle of Incidence	Alpha	Velocity (m/s)	Velocity X (m/s)	Velocity Y (m/s)
0	0.11	0.011	10.24	5.57	5.57	36.4	36.29	3.54
0.25	0.14	0.011	12.66	4.26	4.51	36.4	36.31	2.86
0.5	0.17	0.011	15.11	3.28	3.78	36.2	36.17	2.39
0.75	0.21	0.012	17.57	2.50	3.25	36.0	35.95	2.04
1	0.24	0.012	20.06	1.85	2.85	35.7	35.71	1.78
1.25	0.28	0.012	22.53	1.29	2.54	35.4	35.44	1.57
1.5	0.32	0.013	25.40	0.75	2.25	35.1	35.13	1.38
1.75	0.36	0.013	27.86	0.30	2.05	34.8	34.83	1.24

Source: MatLab Program



Descent Rate Estimates (7/8)



Descent Rate Summary

Descent Method	Estimated Vertical Descent Rate
Payload & Container – Parachute	14.05 m/s
Payload – Para-glider	2.04 m/s

Both Values Meet Mission Requirements



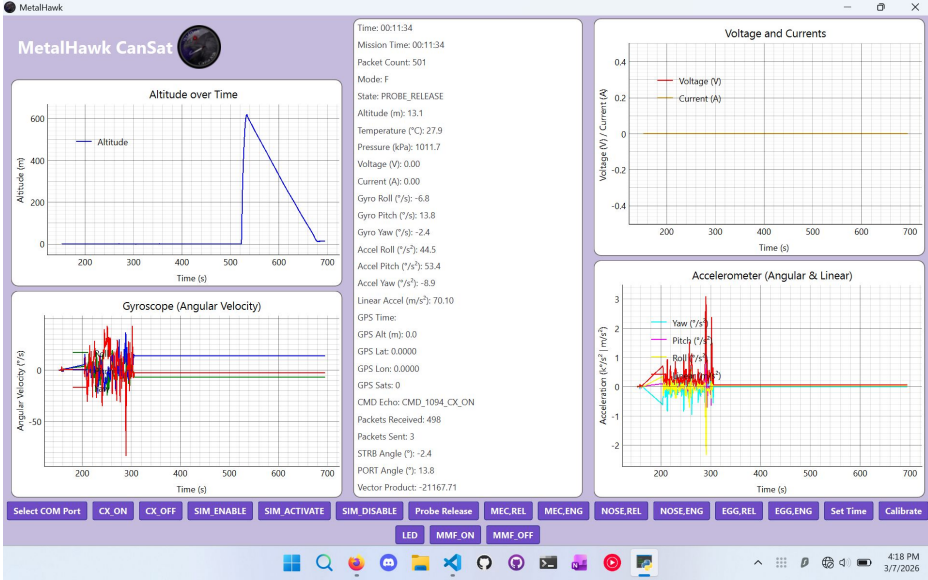
Descent Rate Estimates (8/8)



Tested Decent Rate

Average Descent Rate During Test Launch

4.17 m/s





Mechanical Subsystem Design

**Alex McKinnon, Evan Jeanneret and
Jackson Stidham**



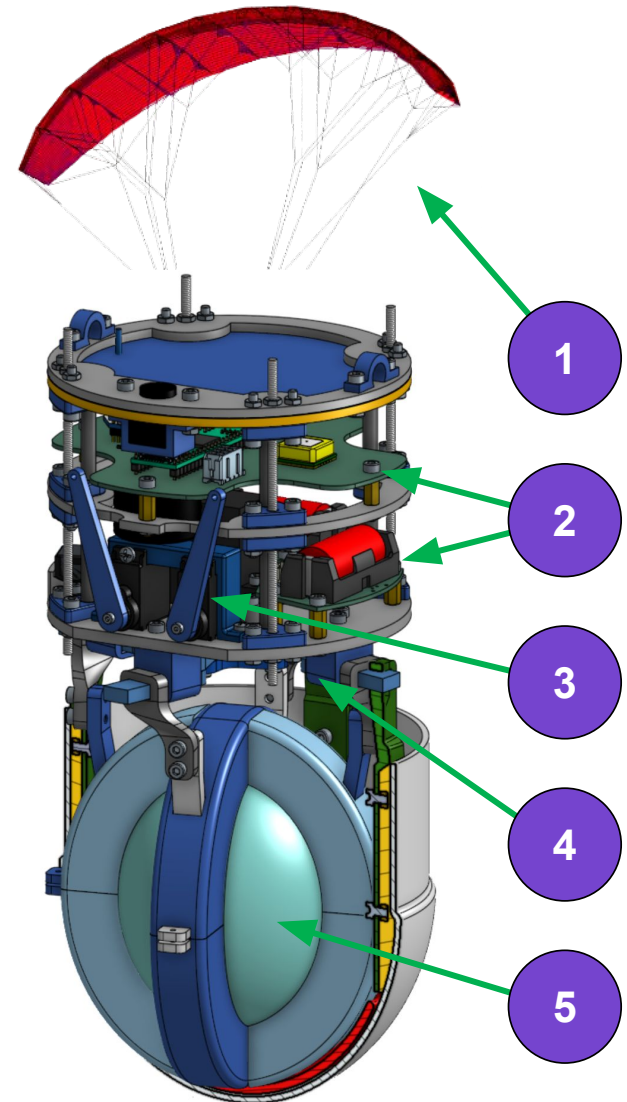
Mechanical Subsystem Overview (1/2)



Payload Overview

*Para-glider not to scale

#	Subsystem	Description
1	Para-glider	Red Single Skin HyperD Ripstop Nylon
2	Electronics	PCBs, Batteries, and Sensors
3	Steering Mechanism	PA6-CF Lever Steer Arms
4	Release Mechanism	3 Stage Release for Payload, Nosecone, and Egg
5	Egg	Soft TPU Shell with Denser TPU Outer Brace



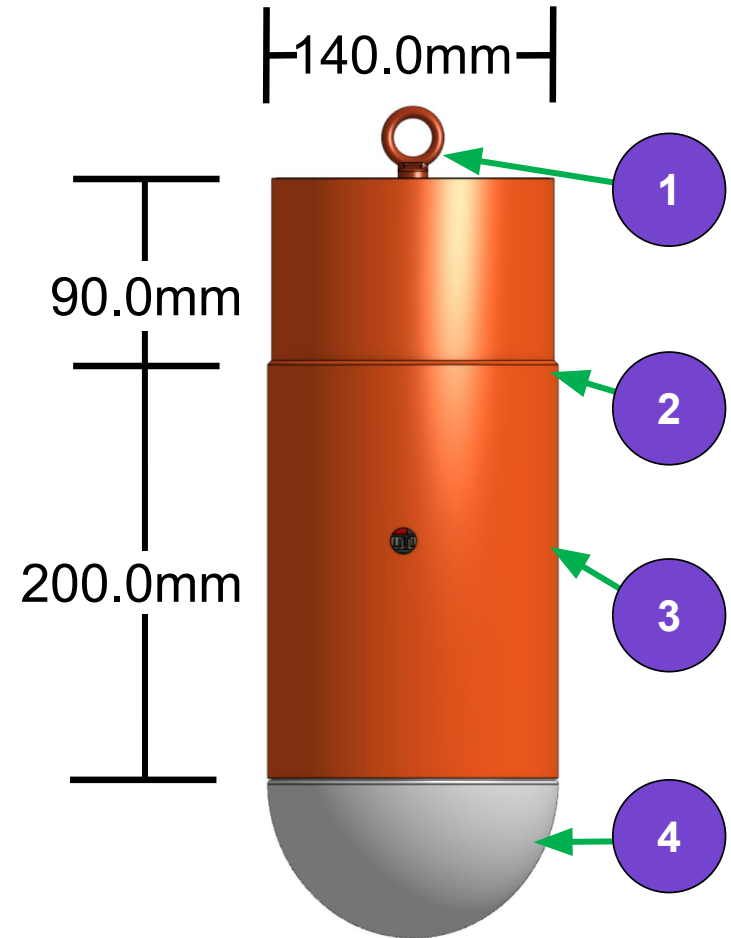


Mechanical Subsystem Overview (2/2)



Container Overview

#	Subsystem	Description
1	¼ Inch Eye Bolt	Attachment for Parachute
2	Container	Woven Fiberglass/Epoxy Resin Composite Container
3	Breather Hole	Hole to Stabilize Pressure for Altimeter and Power on the CanSat
4	Nose Cone	Carbon Fiber/Fiberglass/Epoxy Resin Composite Nose Cone





Mechanical Subsystem Changes Since PDR



System	PDR	CDR	Rationale
Structure - Plates	PA6-CF 3D Printed Plates	Composite Plates	Composited Plates Offer a 50% Mass Reduction
Structure - Rods	M3 Steel Threaded Rods	M3 Steel Threaded Rods with M5 Carbon Fiber Rods	Carbon Rods Decrease Assembly/Disassembly Time by 60%
Release Mechanism	14g Servo	20g Servo	Increased Torque from 3.8 kg/cm ³ to 45 kg/cm ³
Egg Support	Inner TPU Shell with PA6-CF Outer Brace	Inner TPU Shell with Denser TPU Brace with Nylon Insert	Increased Survival Drop Speeds from 20 mph to 45 mph
Nose Cone	Fiberglass Nose Cone with Parachute	Fiberglass Nose Cone with Parachute and Drogue Chute	Drogue Chute Makes Proper Deployment 50% More Likely
Structure - Mounts	Large PA6-CF Camera Mount and Horizontal Steer Servo Mount	Small PA6-CF Camera Mount and Vertical Steer Servo Mount	Saves 1000mm ² of Area on Bottom Plate

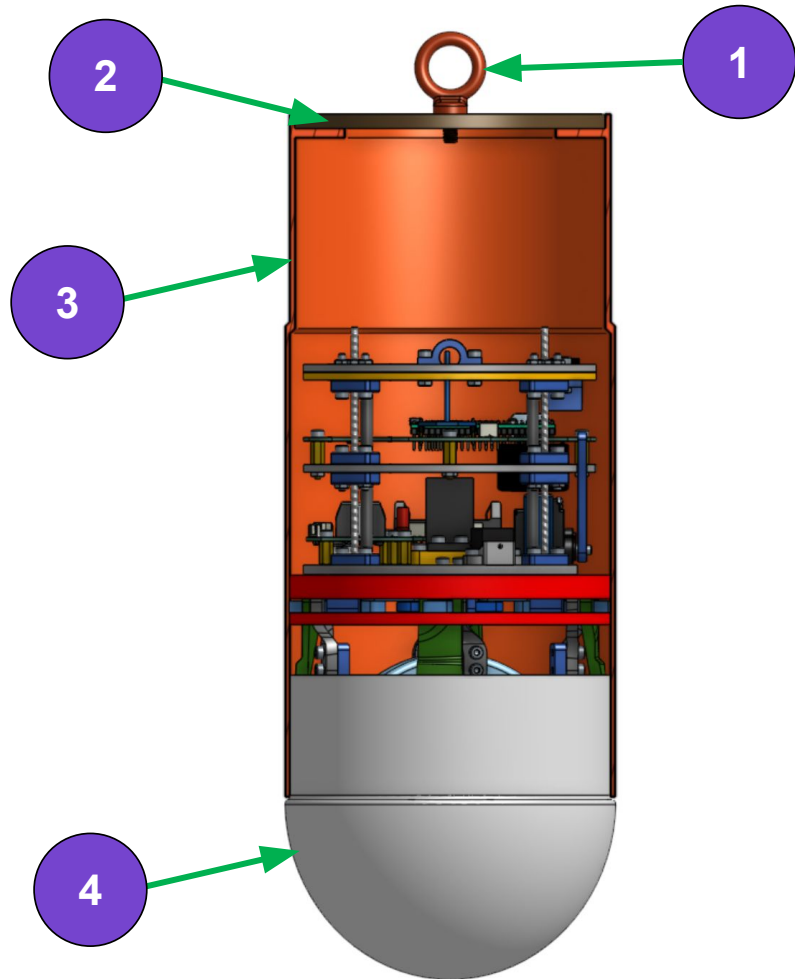


CanSat Mechanical Layout of Components (1/7)



Container

#	Component
1	¼ Inch Eye Bolt
2	Plywood Plate
3	Fiberglass/Epoxy Resin Composite Container
4	Carbon Fiber/Fiberglass/Epoxy Resin Composite Nose Cone



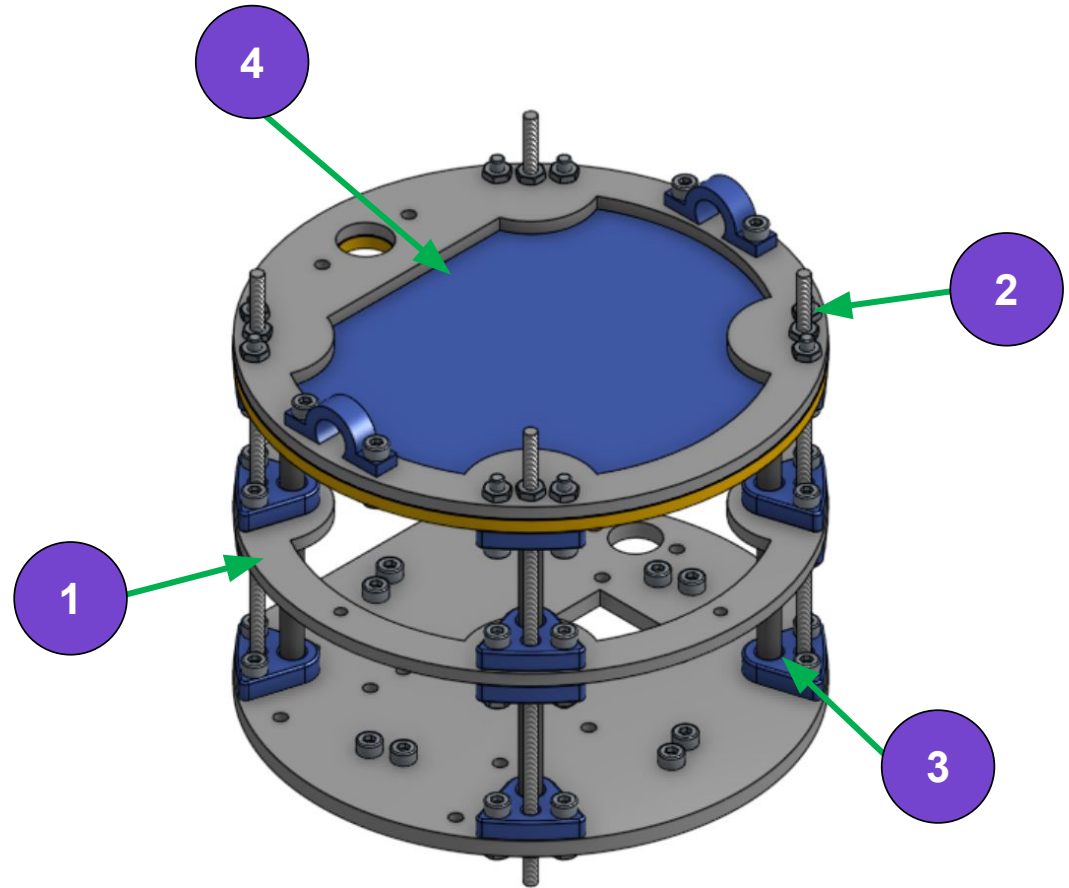


Cansat Mechanical Layout of Components (2/7)



Structure

#	Component
1	M3 Threaded Structure Rods
2	Composite Structure Plates
3	Carbon Fiber Rods
4	Nylon Sheet



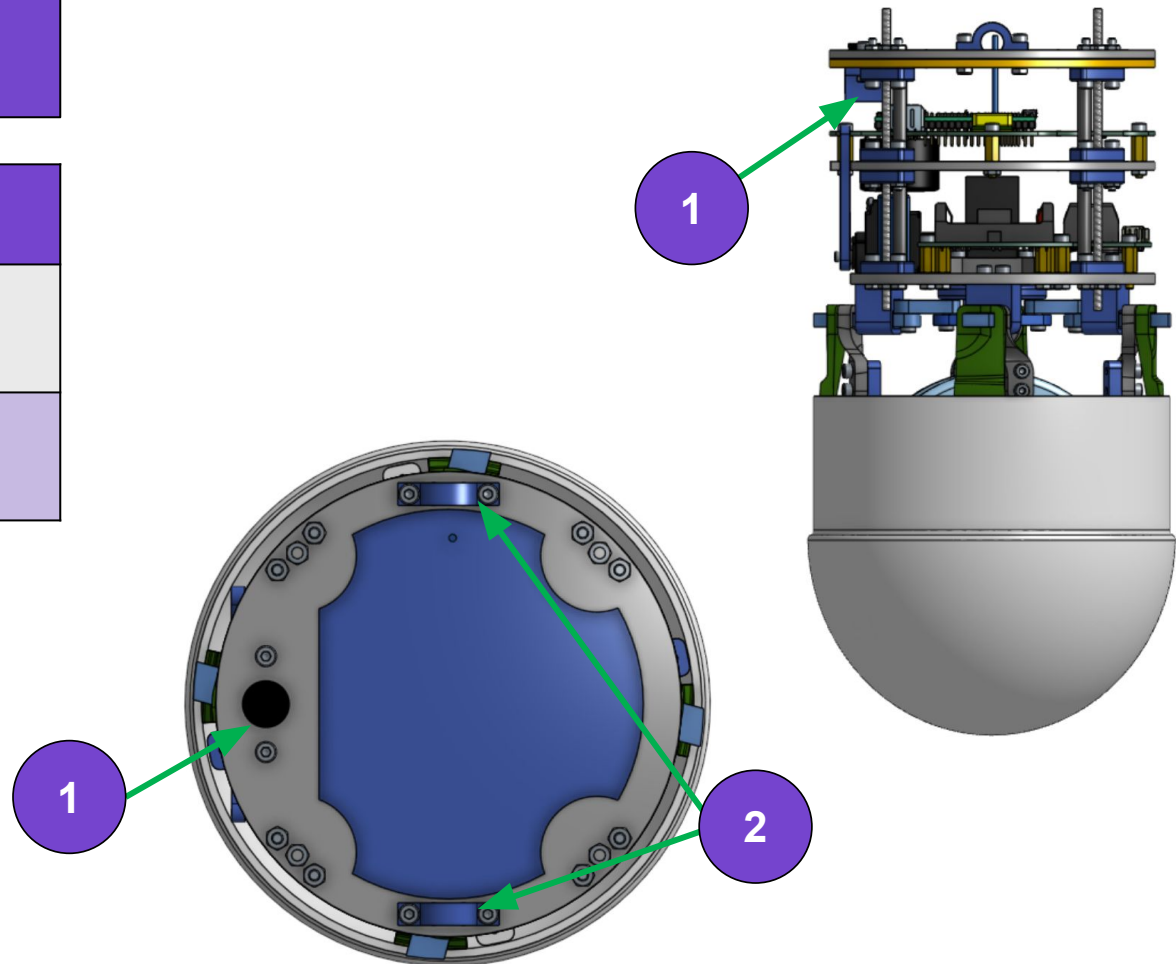


Cansat Mechanical Layout of Components (3/7)



Descent Control Camera

#	Component
1	Descent Control Pointing Camera
2	PA6-CF Bridal Line Attachment Points



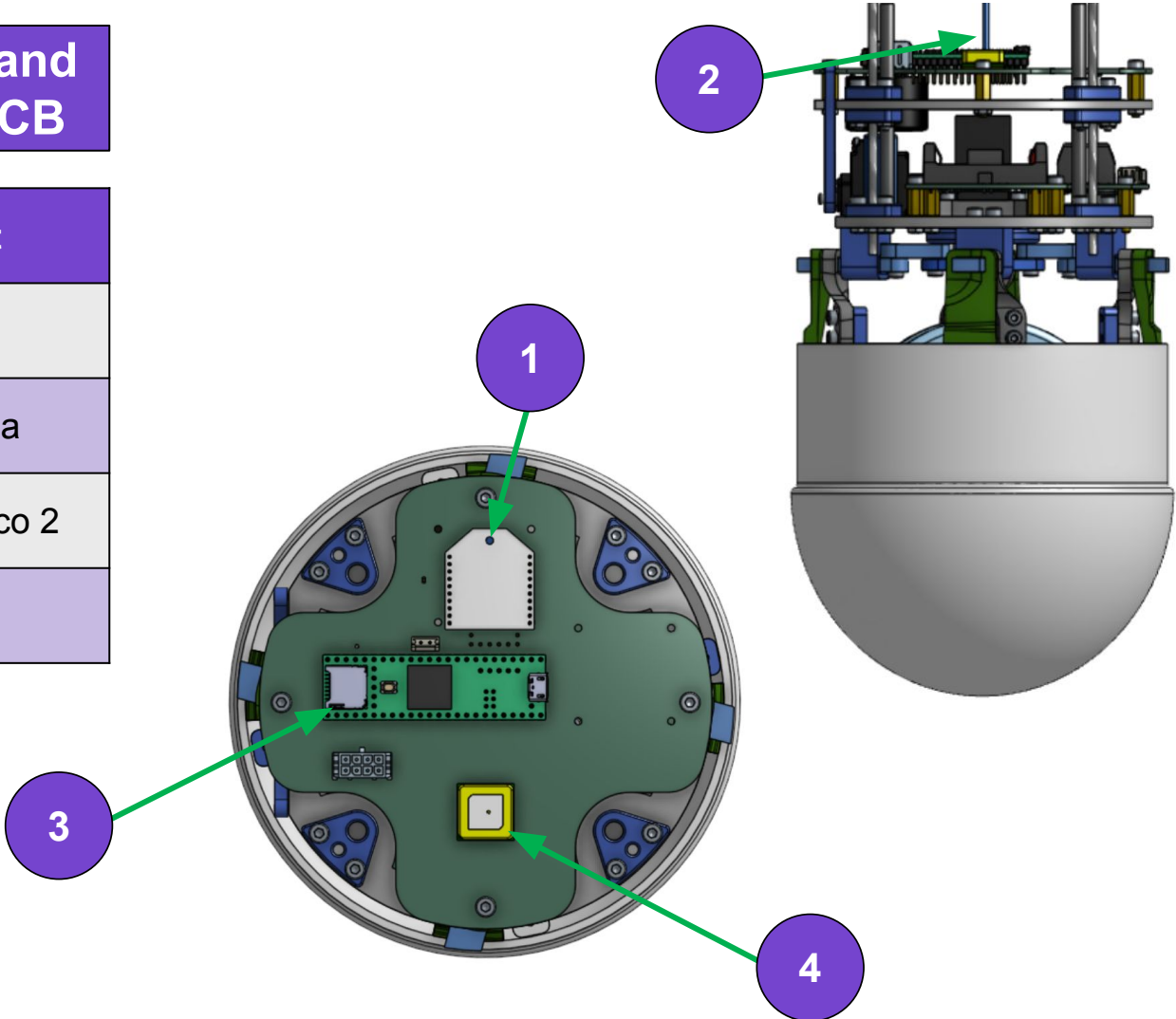


Cansat Mechanical Layout of Components (4/7)



Communication and Data Handling PCB

#	Component
1	XBEE
2	XBEE Antenna
3	Raspberry Pi Pico 2
4	SAM-M10Q



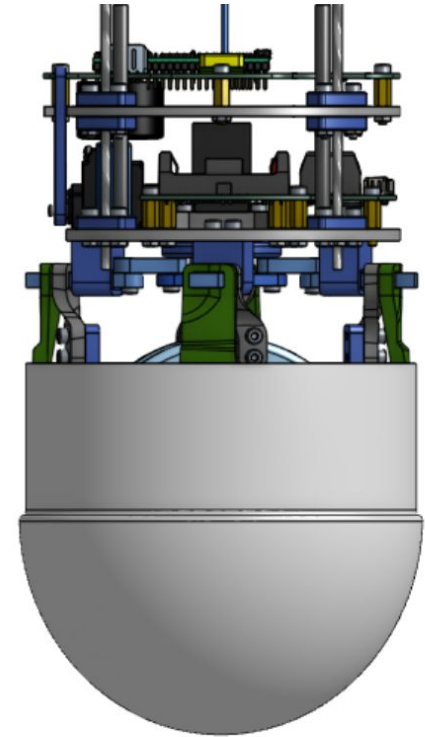
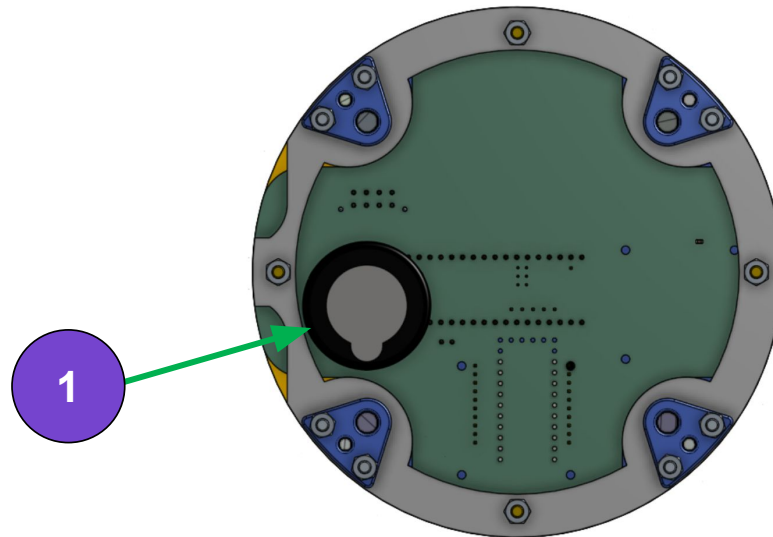


Cansat Mechanical Layout of Components (5/7)



Communication and Data Handling PCB

#	Component
1	Buzzer



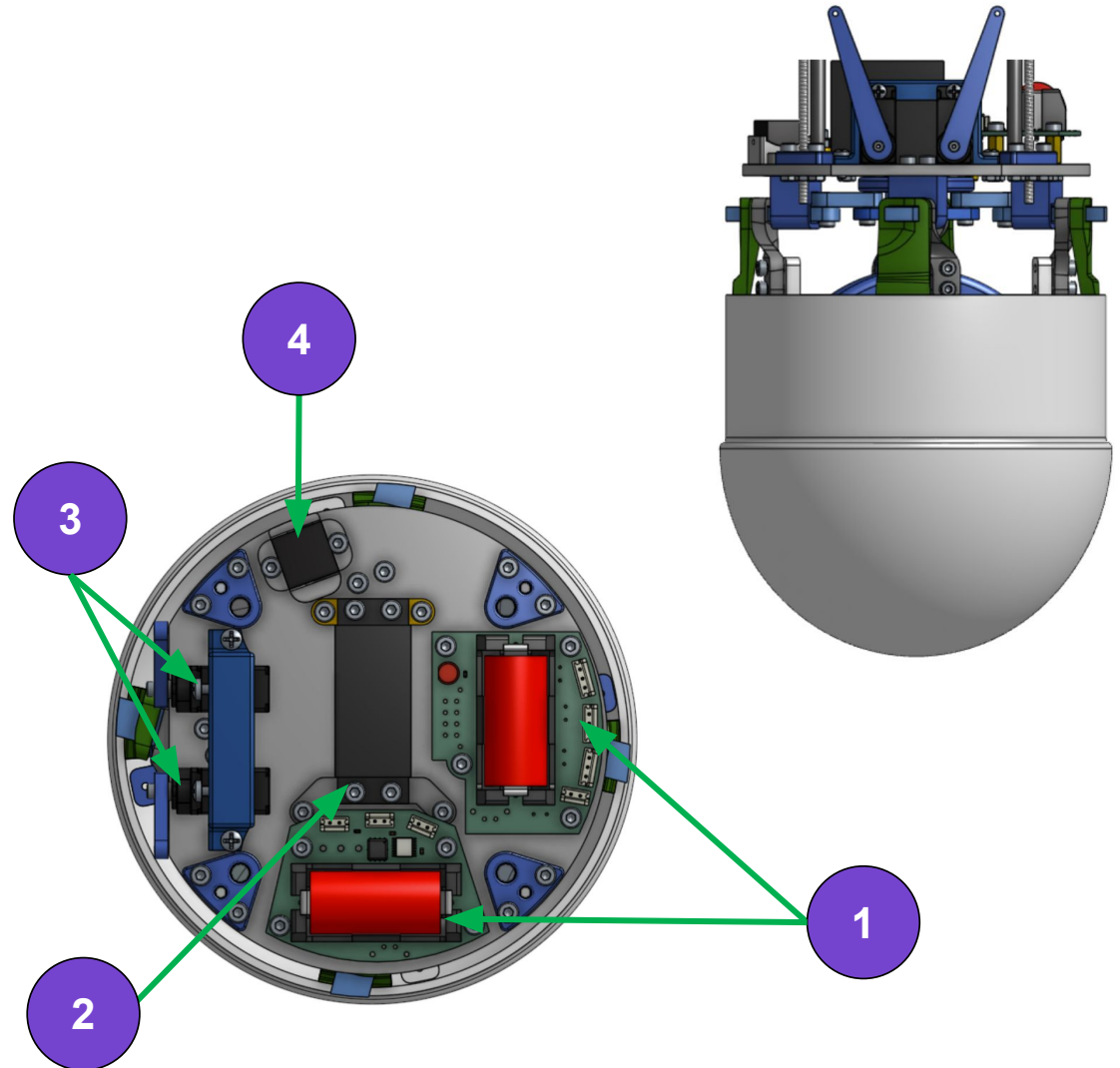


Cansat Mechanical Layout of Components (6/7)



Power and Steering

#	Component
1	Batteries
2	Release Servo
3	Steering Servos
4	Ground Pointing Camera



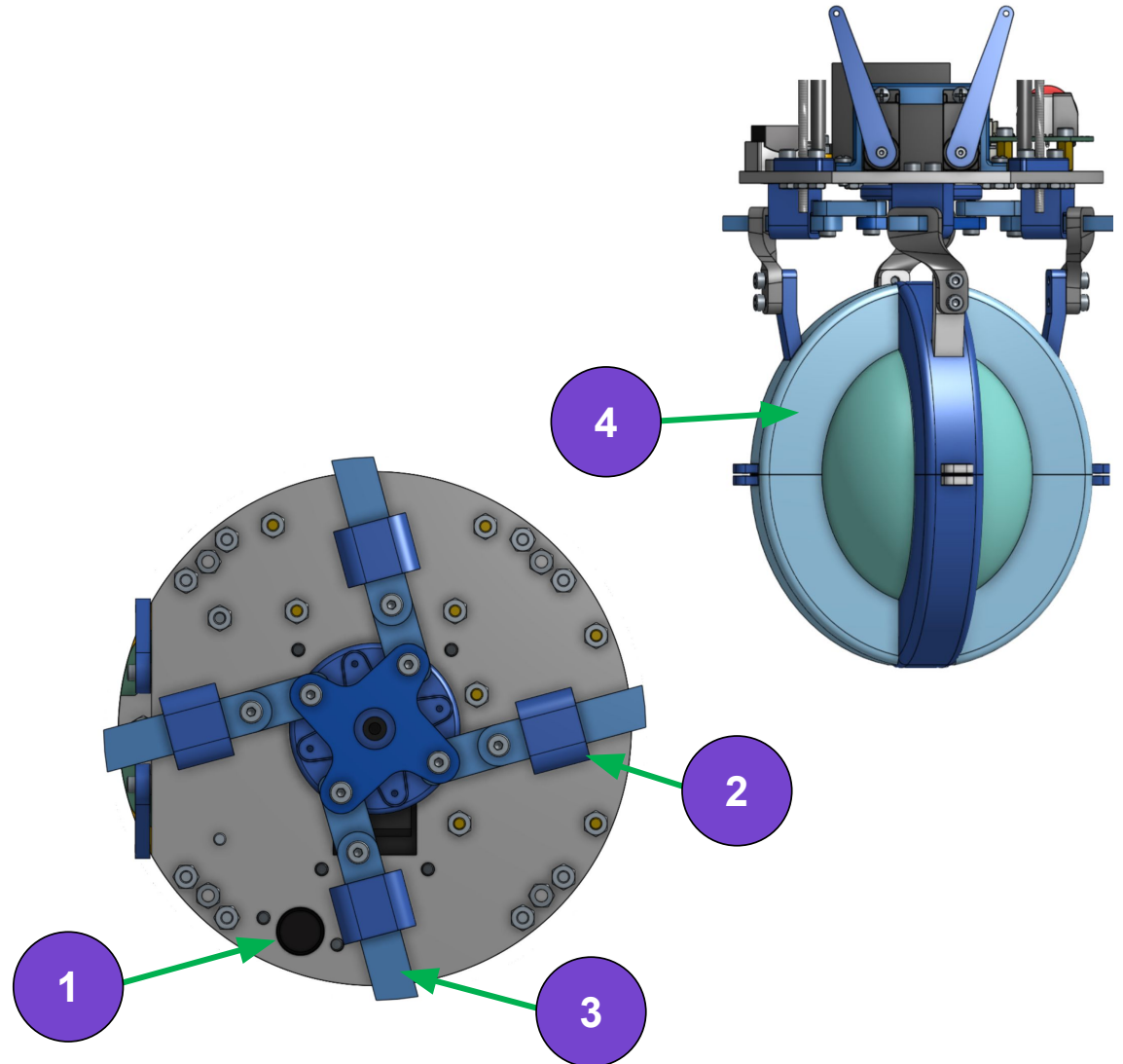


Cansat Mechanical Layout of Components (7/7)



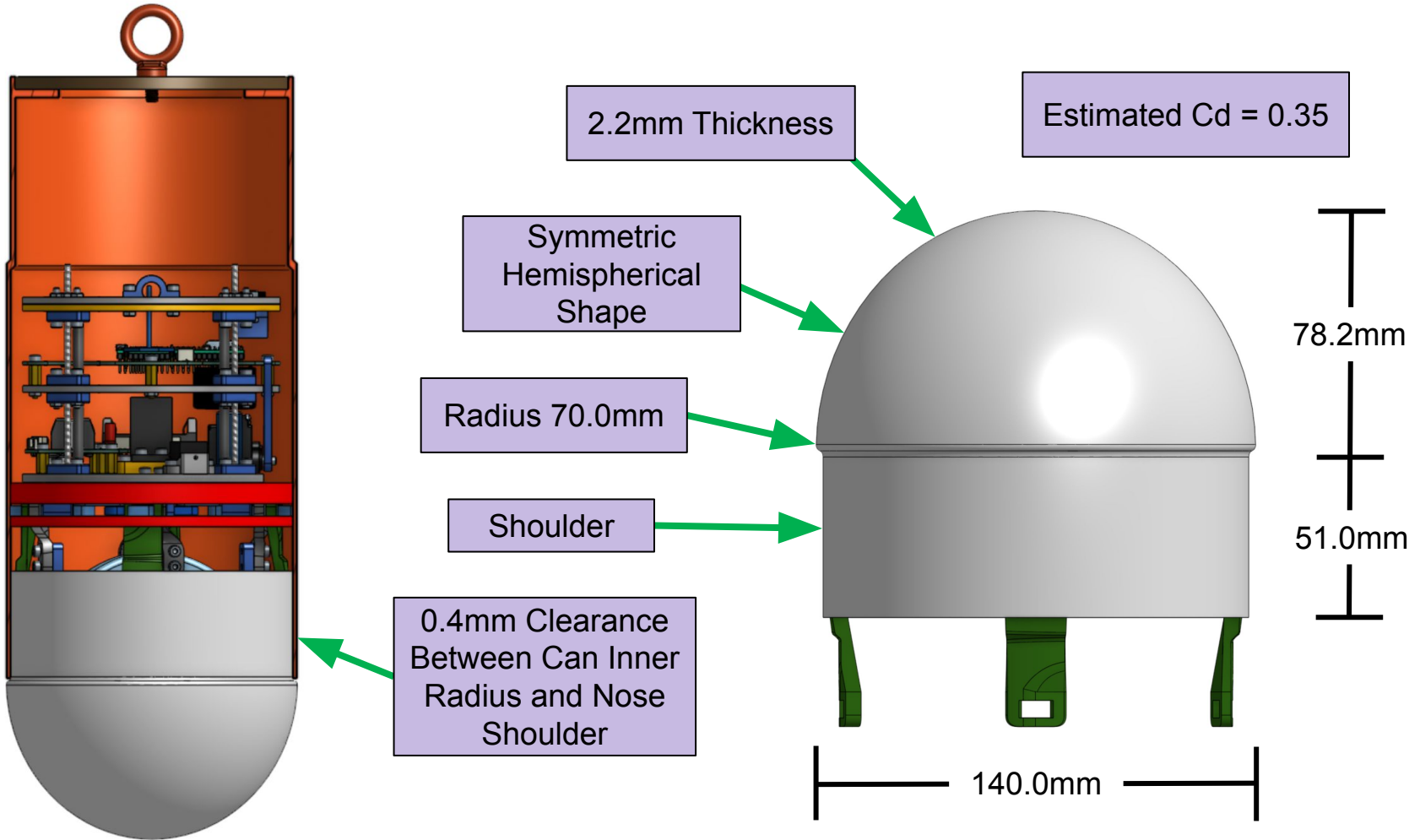
Release and Egg Structure

#	Component
1	Release Arms
2	Guide Blocks
3	Ground Pointing Camera
4	Egg Structure





Nose Cone Design (1/2)





Nose Cone Design (2/2)

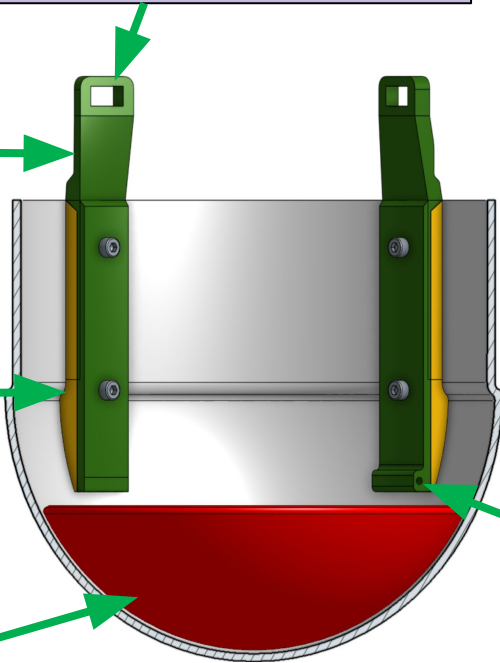
Nose Cone is Attached to the Payload Via Holes That Attach to Release Mechanism

Nose Release Arm

Nose Release Arm Attachment Point

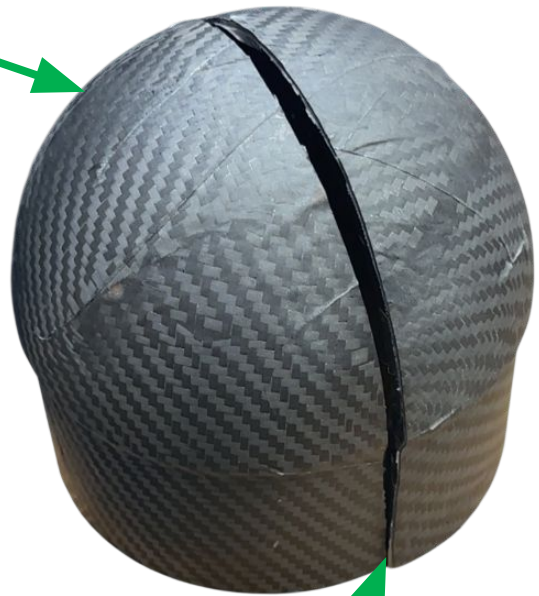
Nose Parachute and Drogue Chute

*Various Parts Hidden for Visibility



Carbon Fiber/Fiberglass/Epoxy Resin Composite

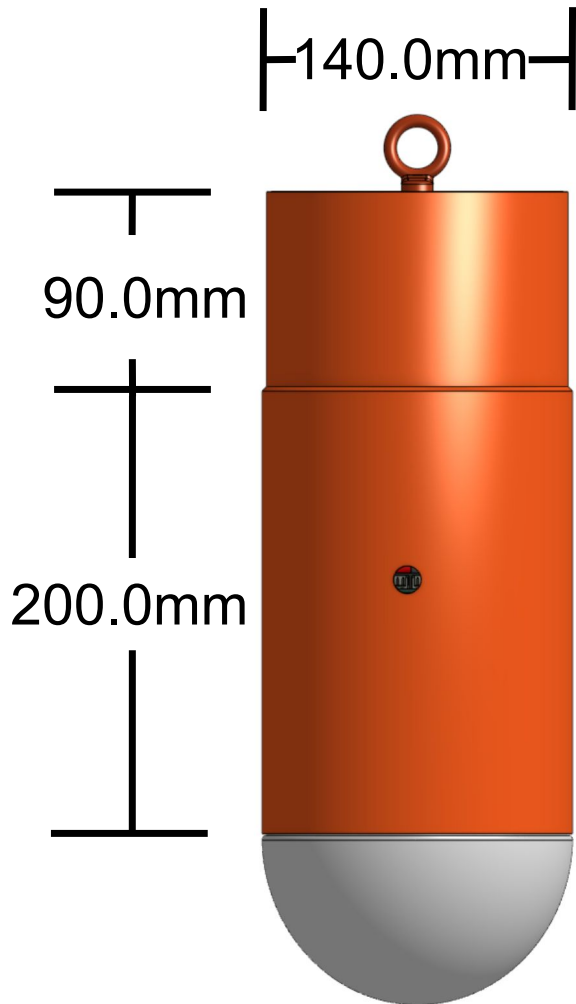
Nose Parachute Attachment Point



*Halves Were Later Joined Using a Strip of Fiberglass Along the Seam



Container Design



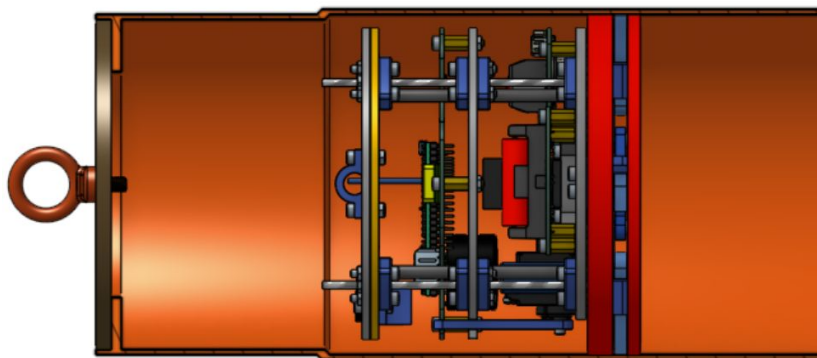
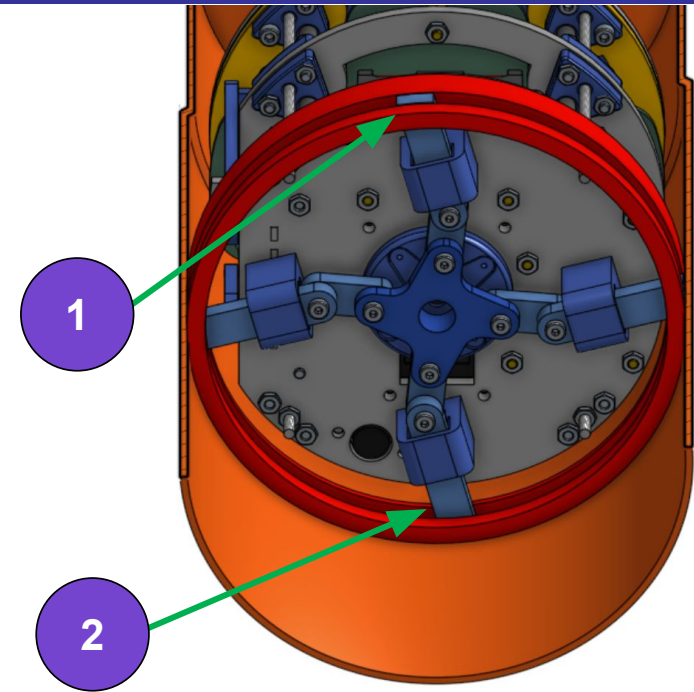
There have been zero changes to the Container since PDR





Payload Pre-Deployment Configuration

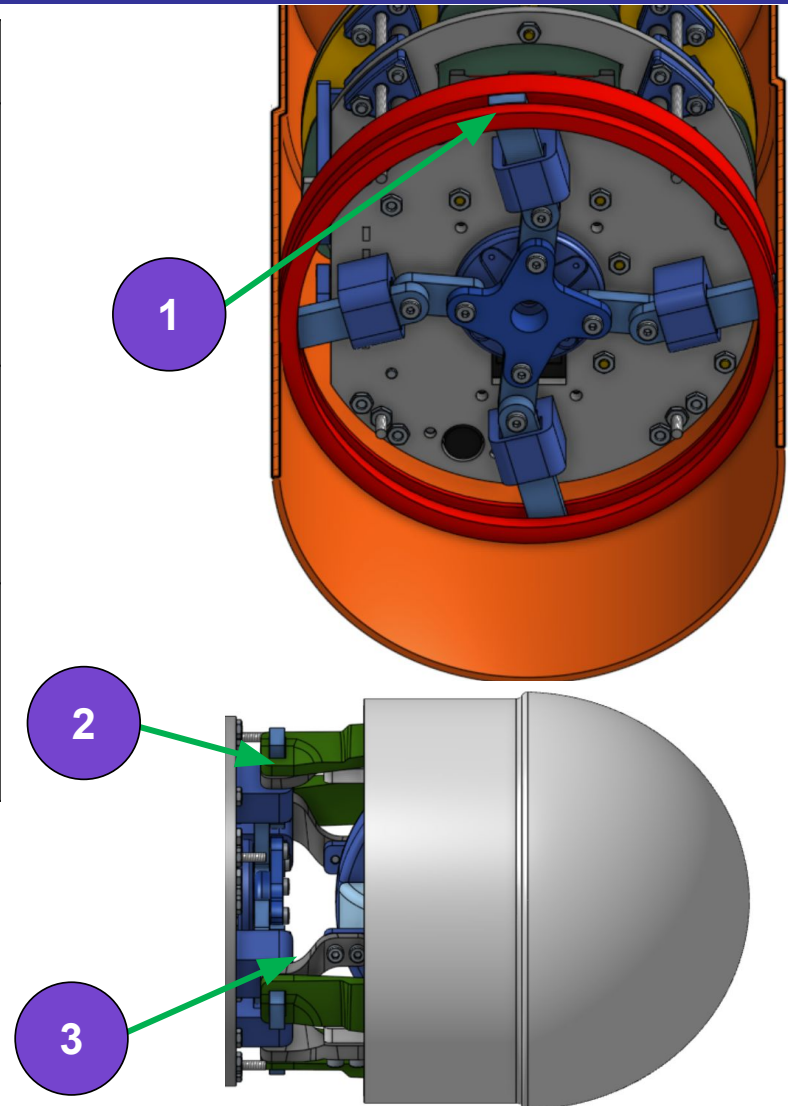
#	Subsystem	Description
1	Epoxied Ring	Release Arms Slide Into to the Ring to Keep the Payload Inside
2	Release Arms	Servo Controls the Release Arms and Controls the State of Payload Release





Payload Release

#	Subsystem	Description
1	Release Arms	Once Payload Release is Triggered the Servo Retracts, Letting the Payload Fall Out
2	Nose Cone	The Servo Retracts and Releases the Nose Cone at the Specified Time
3	Egg Structure	The Servo Retracts Releasing the Egg at the Specified Location

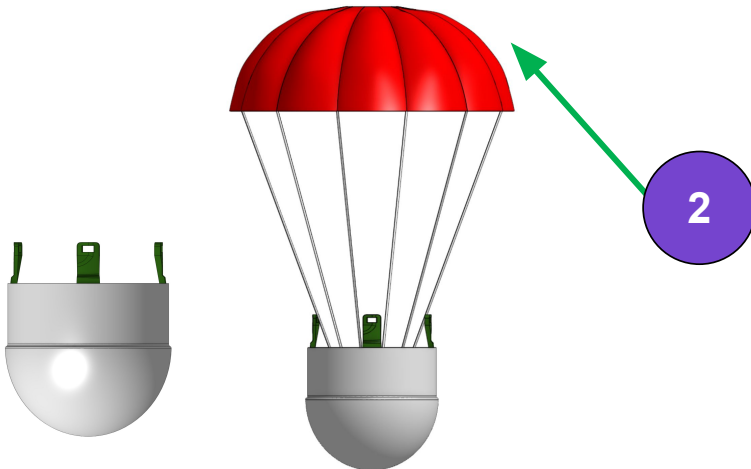
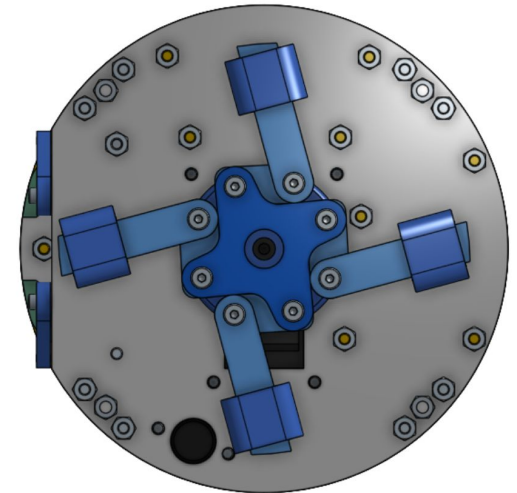
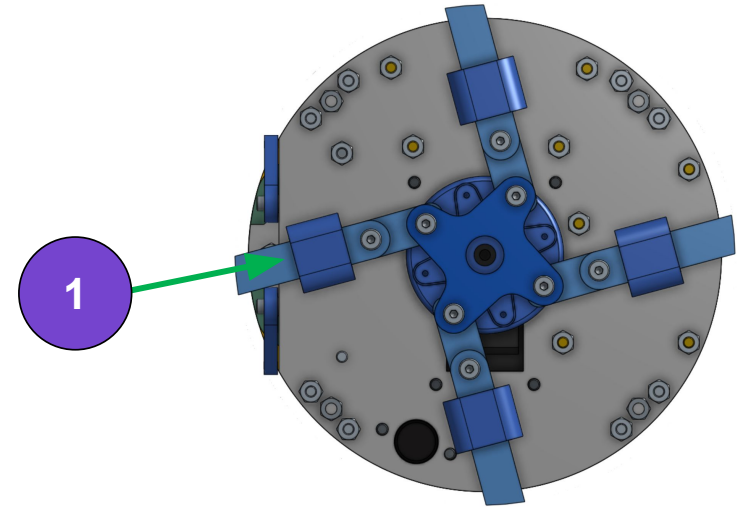




Payload Deployment Configuration



#	Subsystem	Description
1	Release Arms	The Release Mechanism Retracts, Dropping the Payload Out of the Container
2	Nose Cone Parachute	The Nose Cone Parachute Becomes Unfurled Once The Nose Cone is Released

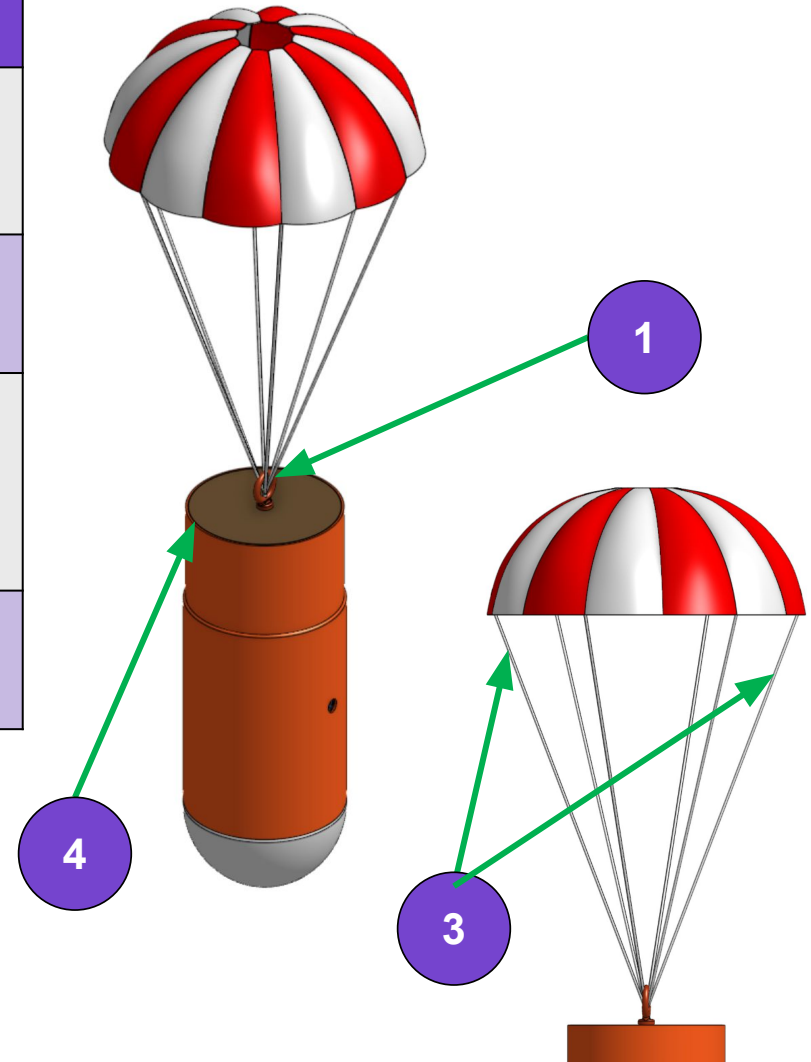
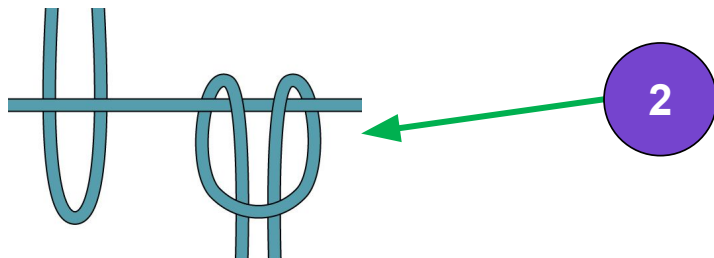




Parachute Attachment to Container



#	Subsystem	Description
1	1/4in Eyebolt	Connected to the Parachute System
2	Lark's Head Knot	Attached to the Eyebolt
3	Kevlar Paracord	Individual Paracord are Attached to the Outer Edges of Para-glider
4	1/4in Thick Plywood Plate	Provides Strength and Rigidity





Para-Glider Deployment



#	Subsystem	Description
1	Bridal Line Attachment Points	Connected to the Parachute Holding it While Deployed
2	Brake Lines	Attached to the Brake Paracord, Controlling the Shape of the Para-glider
3	Passive Deployment, Z-Folded Parachute	The Z-Fold Becomes Undone Once Released

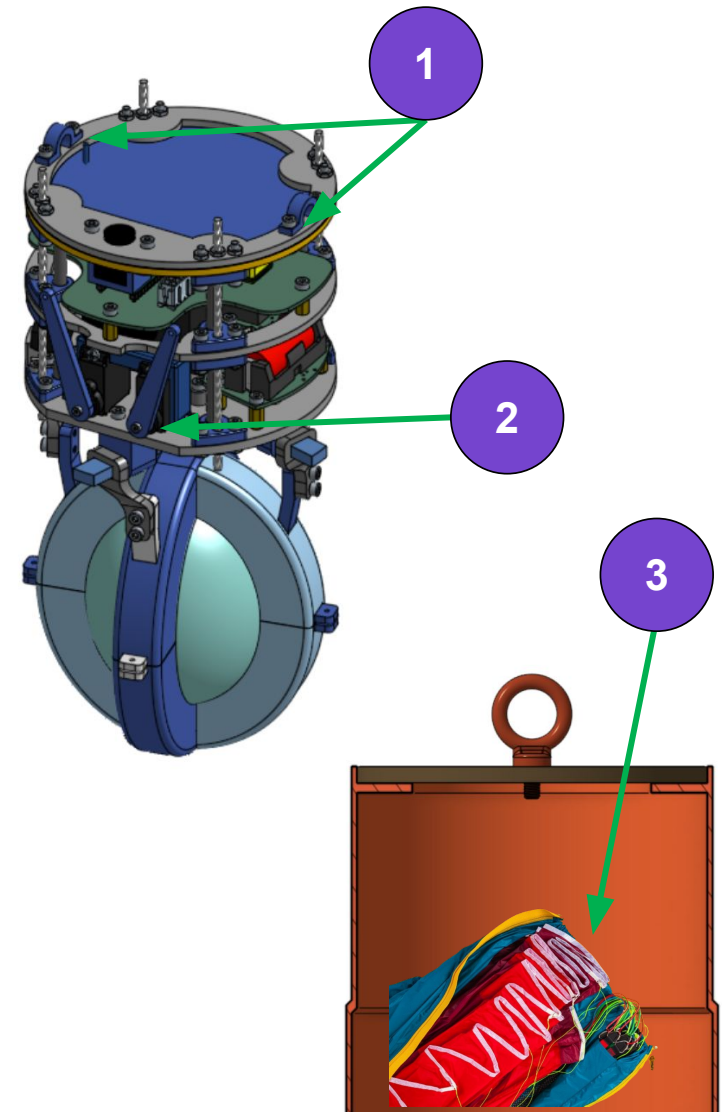


Image Credit:
icaro-paragliders.com

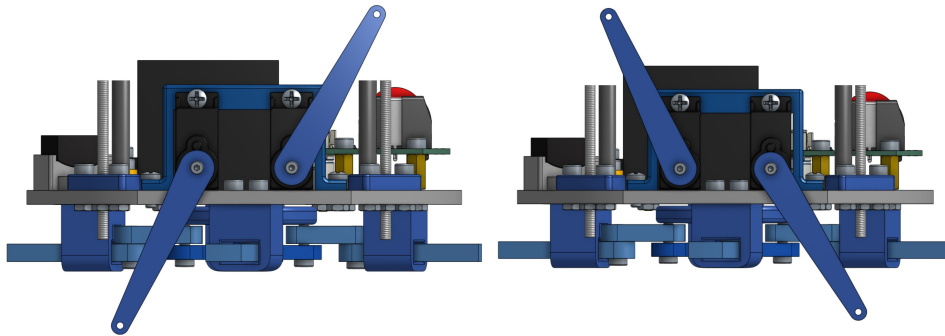
*Various Parts Hidden for Visibility



Payload Steering



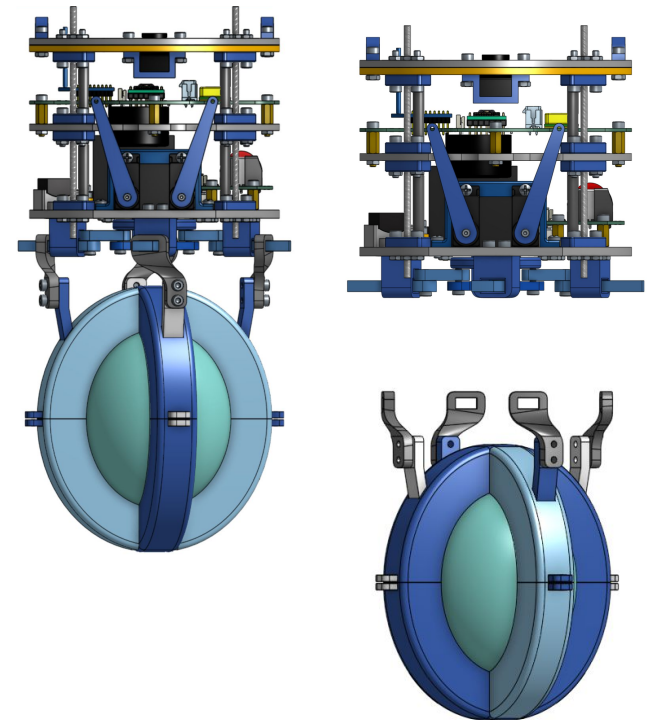
Control System



Turn Left

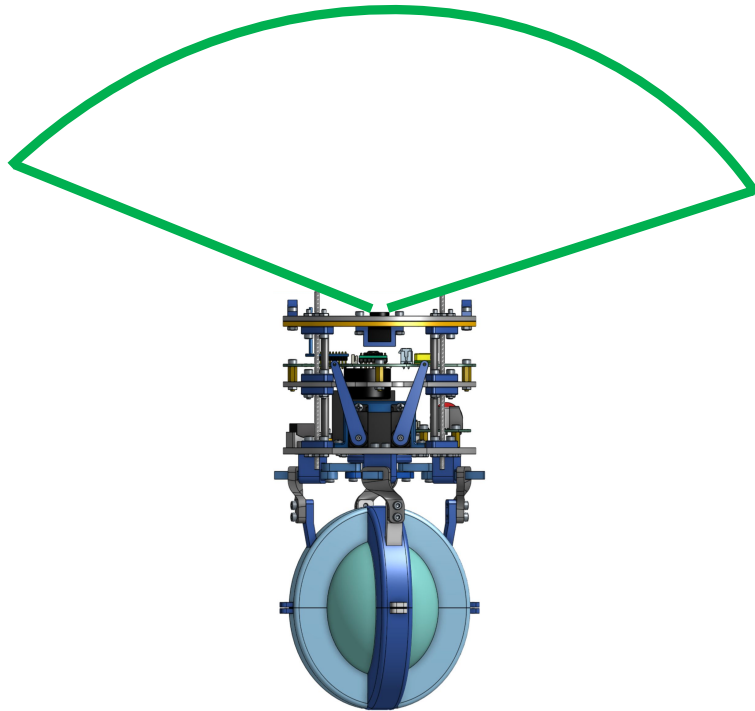
Turn Right

Release



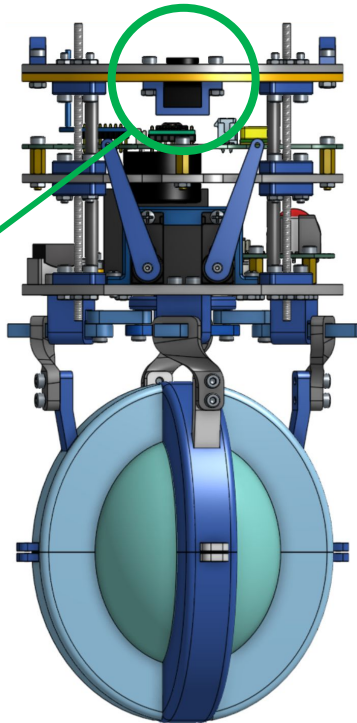
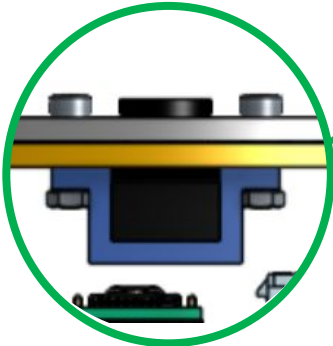


Release Camera Pointing



270° Field of View

Unobstructed View of Para-glider Deployment

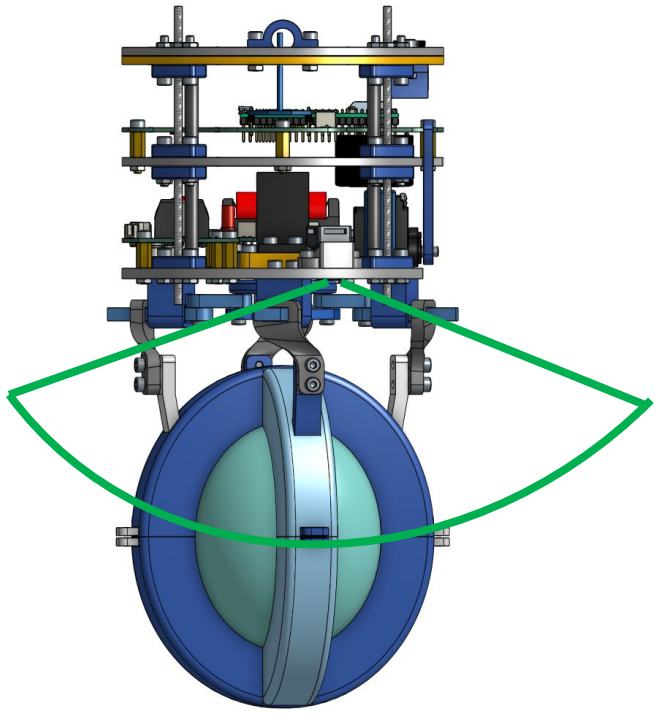


*Various Parts Hidden for Visibility

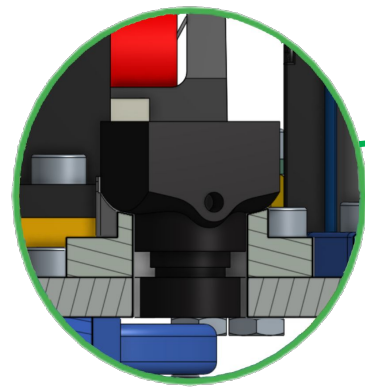


Ground Camera Pointing

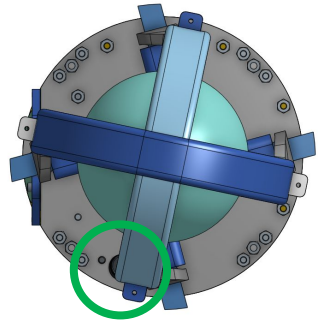
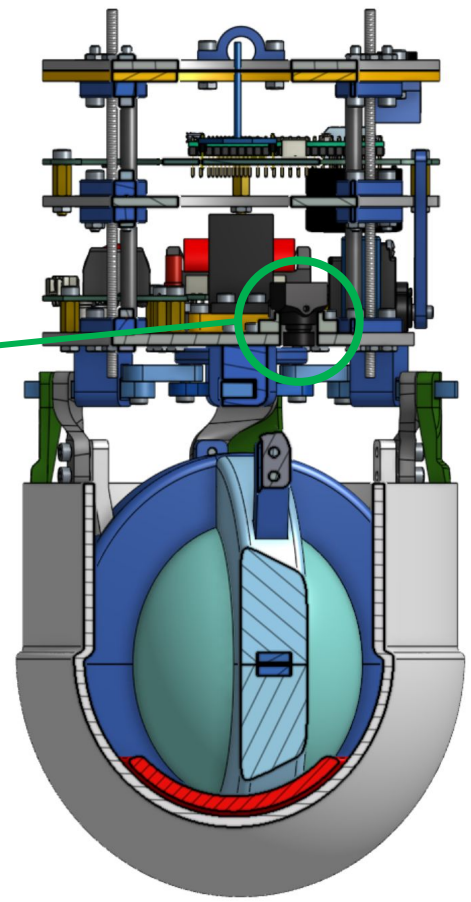
270° Field of View



Unobstructed View of Egg Release

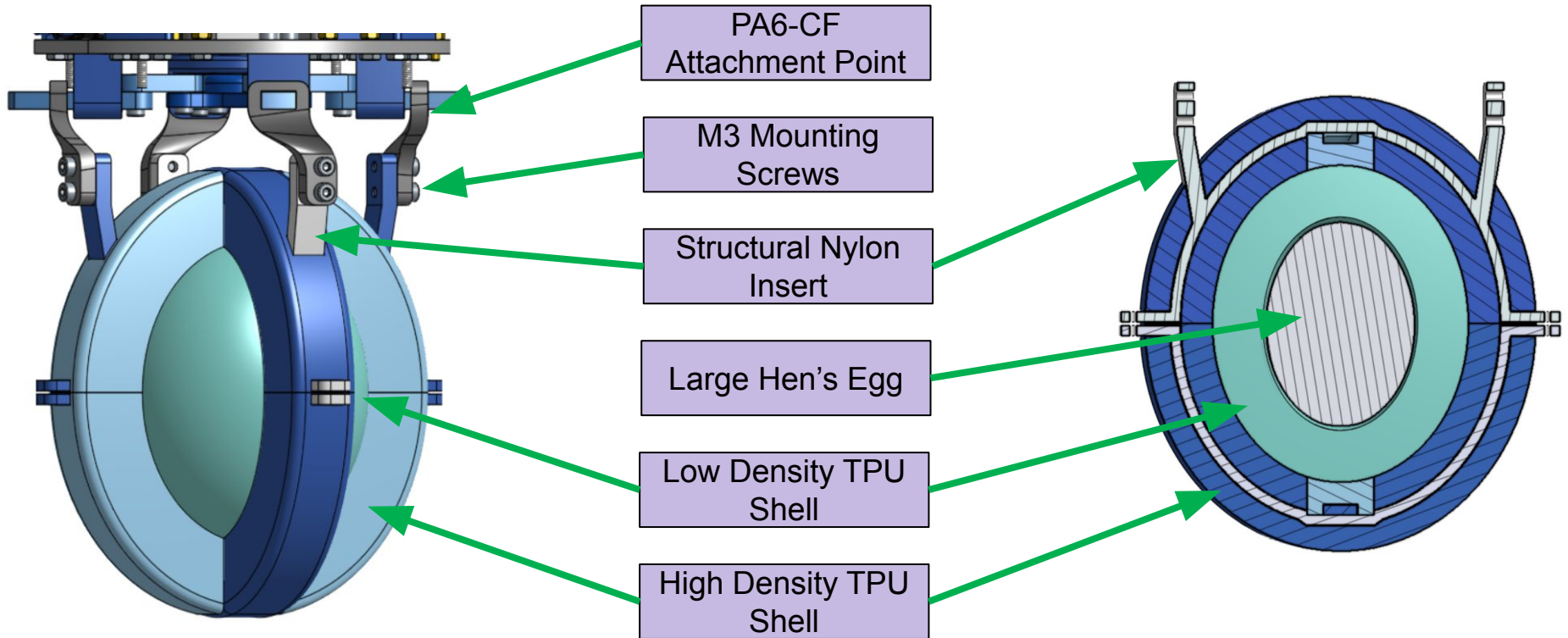


*Various Parts Hidden for Visibility



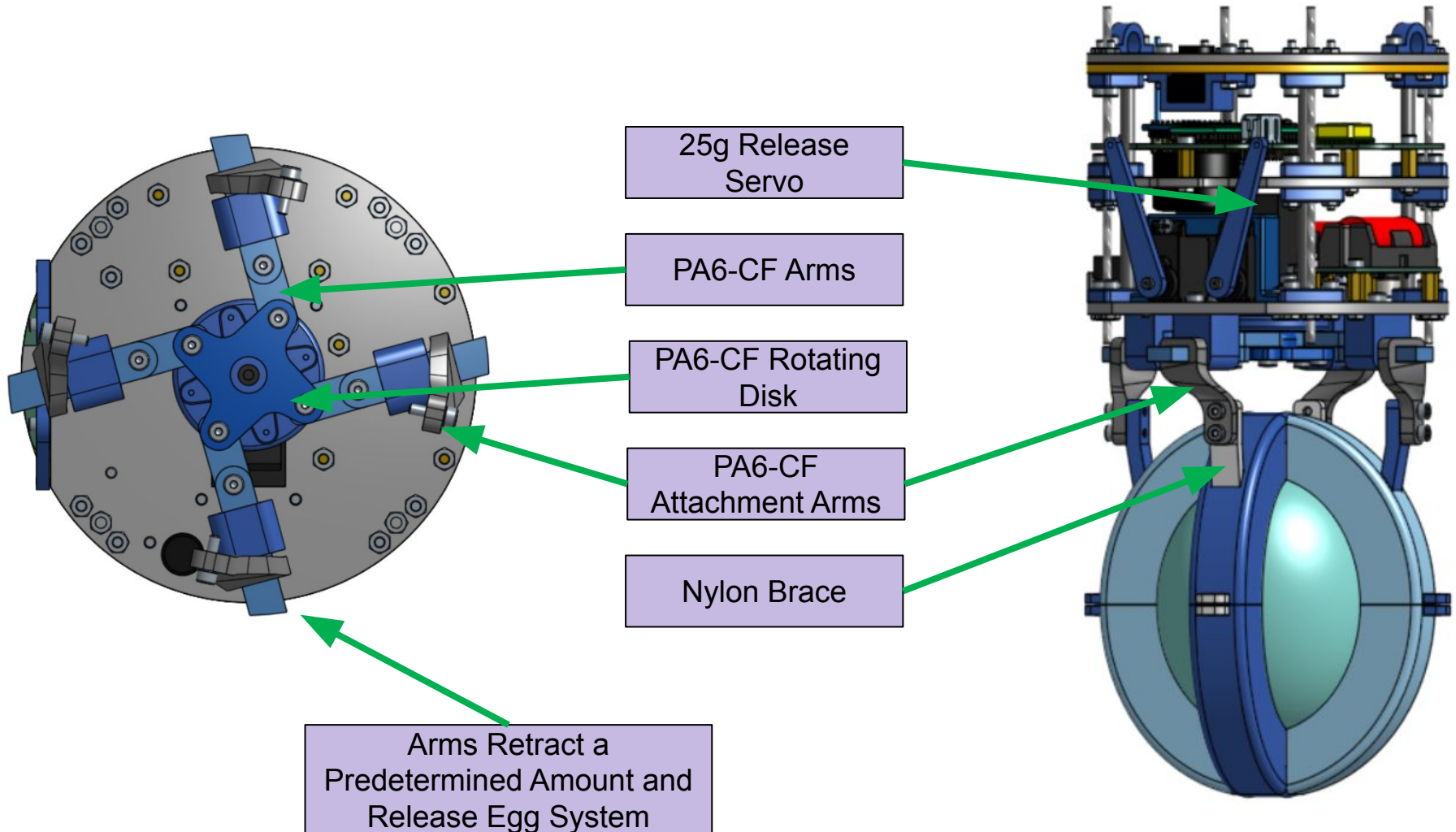


Egg Container Design





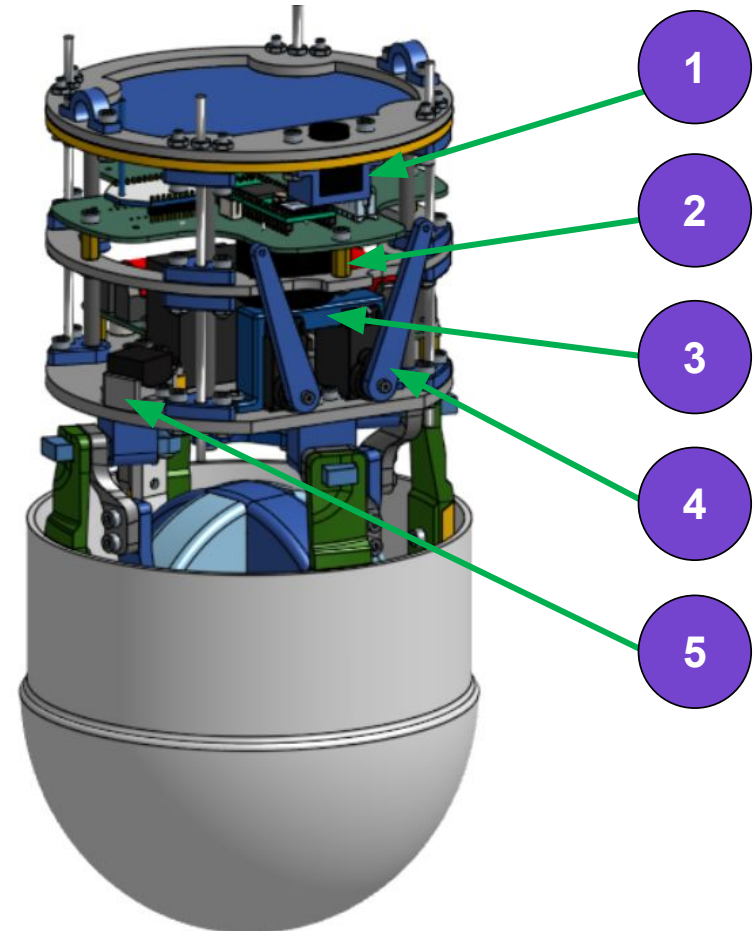
Egg Container Release Design





Structure Survivability

#	Component	Description
1	PA6-CF Top Camera Mount	Custom Mount that Fits Around Camera and Screws Into Top Ring
2	10mm Brass Standoffs	10mm Standoffs with M3 Screws Secure PCBs to Plates
3	PA6-CF Steer Servo Mount	M3 Screws Secure Servos to Mount That is Screwed Into the Bottom Plate
4	PA6-CF Descent Control Arms	Screws Fasten the Control Arms to the Servos and Horn
5	PA6-CF Bottom Camera Mount	The Camera Fits Partially Through Mount and is Secured with Two M3 Screws



Batteries Will be Secured by Zip Ties



Mass Budget (1/7)



Component	SubTeam	Mass(g)	Amount	Total Mass(g)	Uncertainty (g)	Source
Telemetry PCB	Electrical	42.0	1	42	±1	Measured
18350 Li-ion	Electrical	23.0	2	46.0	±0.0	Datasheet
Pico 2	Electrical	6.5	1	6.5	±0.0	Datasheet
XBEE 900HP PRO	Electrical	6.4	1	6.4	±0.0	Datasheet
RunCam Split 4 v2	Electrical	10.2	2	20.4	±0.0	Datasheet
XBEE BREAKOUT	Electrical	4.7	1	4.7	±0.0	Datasheet



Mass Budget (2/7)



Component	SubTeam	Mass(g)	Amount	Total Mass(g)	Uncertainty (g)	Source
DS3245sg 45kg servo	Electrical	60.0	1	60.0	±0	Datasheet
HD0521MG servo	Electrical	12.0	2	24	±.5	Datasheet
Container	Structural	223.0	1	223.0	±22.3	Estimation
Nose Cone	Structural	71.7	1	71.7	±7.2	Estimation
Parachute	Structural	23.5	2	47.0	±2	Measured
Egg	Structural	60.0	1	60.0	±5.0	Estimation
Para-glider	Structural	100.0	1	100.0	±10	Estimation



Mass Budget (3/7)



Component	SubTeam	Mass(g)	Amount	Total Mass(g)	Uncertainty (g)	Source
Release Mec. Parts	Structural	22.1	1	22.1	±2.2	Estimation
Various Screws	Structural	26.8	1	26.8	±2.7	Estimation
Bottom Runcam Mount	Structural	3.2	1	3.2	±0.3	Estimation
Top Runcam Mount	Structural	1.5	1	1.5	±0.2	Estimation
Various Nuts	Structural	9.1	1	9.1	±0.9	Estimation
3mm Eyebolt	Structural	5.1	2	10.2	±1.0	Estimation
Para-glider Mount	Structural	14.5	1	14.5	±1.5	Estimation



Mass Budget (4/7)



Component	SubTeam	Mass(g)	Amount	Total Mass(g)	Uncertainty (g)	Source
¼ in Eyebolt	Structural	22.9	1	22.9	±2.3	Estimation
Release Plate	Structural	25	1	25	±2.5	Estimation
PCB Ring	Structural	8.2	1	8.2	±0.8	Estimation
M3 Steel Rods	Structural	3.8	4	15.5	±1.6	Estimation
Steer Arms	Structural	1.2	2	2.4	±0.2	Estimation
M3 Standoffs	Structural	1.7	8	13.5	±1.4	Estimation
Steer Servo Mounts	Structural	1.8	1	1.8	±0.2	Estimation



Mass Budget (5/7)



Component	SubTeam	Mass(g)	Amount	Total Mass(g)	Uncertainty (g)	Source
Release Ring	Structural	17.5	1	17.5	±1.8	Estimation
M2 Standoffs	Structural	0.7	8	5.4	±0.5	Estimation
Ripstop Nylon (Top Plate)	Structural	1.8	1	1.8	±0.2	Estimation
Egg Inner Ring	Structural	24.0	1	24.0	±2.4	Estimation
Egg Outer Ring	Structural	23.7	1	23.7	±2.4	Estimation
Egg Bottom Cap	Structural	4.9	1	4.9	±0.5	Estimation
Egg Core	Structural	23.1	1	23.1	±2.3	Estimation



Mass Budget (6/7)



Component	SubTeam	Mass(g)	Amount	Total Mass(g)	Uncertainty (g)	Source
Nose Connection Arms	Structural	21.3	1	21.3	±2.0	Estimation

Structural Components Mass
778.8g ±72g

Electrical Components Mass
210.0g ±1.5g

Total Components Mass
988.8g ±73.5g



Mass Budget (7/7)



Mass Budget Overview

Mass Overview	Plans to Correct Mass	Margin of Error
<p>Our margin for the mass budget can be defined by the equation $1000g - 988.8g = 11.2g$</p>	<p>To correct mass, we will increase the number of walls in the 3D printed parts to increase the strength of said parts.</p>	<p>Margin of error sourced from datasheets or slicing software, component's margins of error unable to be found used 10% of mass to calculate.</p>



Communication and Data Handling (CDH) Subsystem Design

Tyler Ebner



CDH Overview



#	Component	Role	Com.
1	Raspberry Pi Pico 2	Microcontroller, holds and runs flight code	N/A
2	BMP581	Pressure, Altitude and Temperature Sensors	I2C
3	SAM-M10Q	GPS Sensors	I2C
4	BNO085	Measures orientation with 9 DOF	I2C
5	INA260AIPWR	Measures Battery Current and Voltage	I2C
6	XBEE 900HP Pro	Transmits Telemetry Data	UART
7	RunCam Split 4 v2	Records view of the payload and one records the parachute release	UART

1



Source:
Adafruit

2



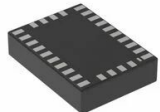
Source:
DigiKey

3



Source:
DigiKey

4



Source:
DigiKey

5



Source:
DigiKey

6



Source:
digi.com

7



Source:
Runcam



CDH Changes Since PDR (1/2)



	Component	PDR	CDR	Rationale
Components	Microcontroller	Teensy 4.1	Raspberry Pi Pico 2	Smaller, cheaper, dual-core processing, programmable I/O

	Data	PDR	CDR	Rationale
Telemetry	Error from where we are facing to target	VECTOR_PRODUCT	STEERING_ERROR	The new name represents the data better
	Angle of the left servo	PORT_ANGLE	Removed	Was only useful for testing
	Angle of the right servo	STRB_ANGLE	Removed	Was only useful for testing



CDH Changes Since PDR (2/2)



	Command	PDR	CDR	Rationale
Commands	Sets the left servo angle	PORT	Removed	Was only useful for testing
	Sets the right servo angle	STRB	Removed	Was only useful for testing

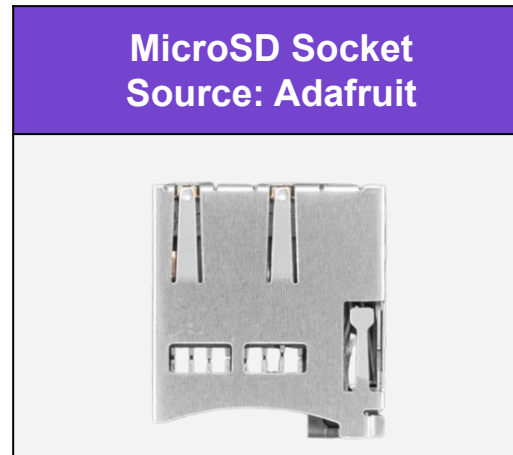


Payload Processor & Memory Selection



Name	Boot Time (ms)	Processor Speed (MHz)	Data Interfaces and Amount	RAM (MB)	Flash Memory (MB)	Data bus width	Power Consumption (Wh)
Raspberry Pi Pico 2	16	133	2 x UART 2 x I2C 2 x SPI 4 x ADC 24 x PWM	0.52	2	32	0.55

Name	Data Interface	Storage Type	Storage amount
MicroSD Socket	UART	microSD Card	32GB



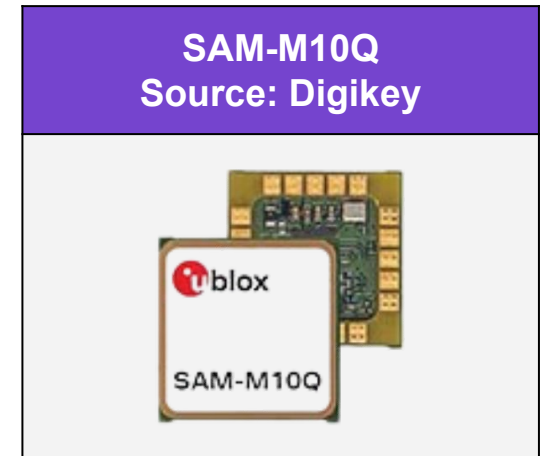


Payload Real-Time Clock



Name	Accuracy (PPM)	Interface	Power Source	Accuracy	Reset Tolerance (V)	Cost (\$)
SAM-M10Q	±0.01	UART	Battery & Coin Cell	30 ns RMS	~1.5	14.56

Name	Voltage	Capacity (mAh)
MS412FE-FL26E	3	1



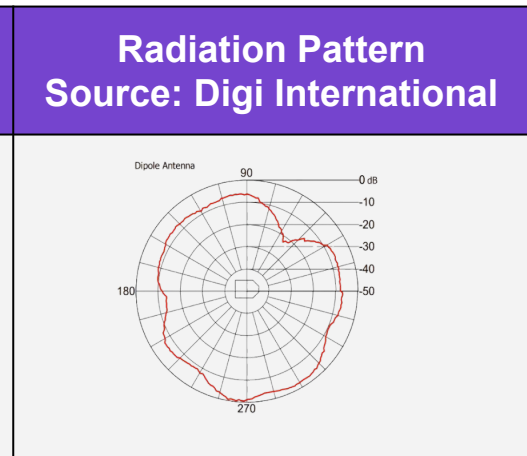
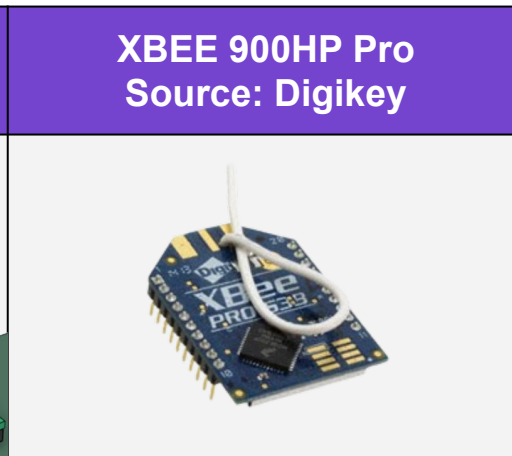
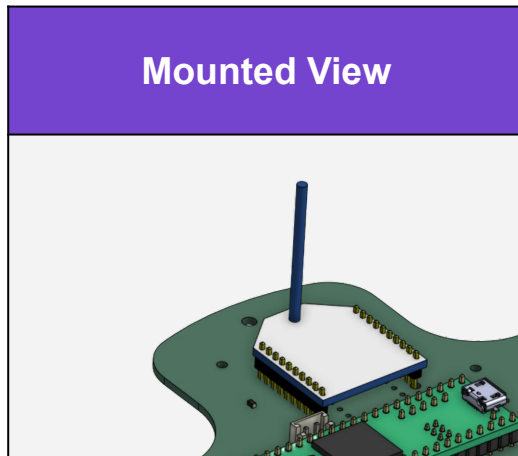


Payload Antenna Selection



XBEE 900HP Pro	
Range	1600 meters
Communication	UART
Max Frequency	928 mHz

Integrated Wire	
Radiation Pattern	OmniDirectional
Gain	1.9 dBm
Connection	Integrated





Payload Radio Configuration



Configuration	
Radio	XBEE 900HP PRO
NETID	1094
Transmission Rate	1 Hzpac
Baud Rate	9600
Frequency	928 MHz
Transmit Power	24 dBm

Transmission controls	
CX_ON	Turns on the transmission of Telemetry data
CX_OFF	Turns off the transmission of Telemetry data
SIM	Will not affect Transmission and is handled separately

XBEE 900HP Pro
Source: Digikey



XBEE will not be in Broadcast mode

Test Launch Radio Performance	
Total packers Sent	501
Total Packets Receivedcom	498
Packet success Percentage	99.4%

End of Transmission
Automatically ends transmission when reaching landed state



Payload Telemetry Format (1/5)



Telemetry Format

```
TEAM_ID,MISSION_TIME,PACKET_COUNT,MODE,STATE,ALTITUDE,TEMPERATURE,PRESSURE  
,VOLTAGE,CURRENT,GYRO_R,GYRO_P,GYRO_Y,ACCEL_R,ACCEL_P,ACCEL_Y,GPS_TIME,GP  
S_ALLTITUDE,GPS_LATITUDE,GPS_LONGITUDE,GPS_SATS,CMD_ECHO,,STRB_ANGLE,PORT_  
ANGLE,VECTOR_PRODUCT
```

Example Packet (As string)

```
1094,10:46:07,576,F,ASCENT,68.0,34.3,96.4,5.7,11.87,-1,2,5,2,-1,0,10:46:07,67.4,36.3405,-82.3241,4  
,CXON,,70,145,1
```

All Telemetry is Transmitted at 1 hz



Payload Telemetry Format (2/5)



Telemetry Requirement	Description	Units and Resolution
TEAM_ID	Four Digit Team Identification Number	1094
MISSION_TIME	Time Since Mission	hh:mm:ss 1 second resolution
PACKET_COUNT	Amount of packets sent by the probe since turned on (Resets by command when put on rocket)	Number of Packets
MODE	Flight Mode and Simulation Mode for Software	'F' or 'S'
STATE	Operating State of the Software	'LAUNCH_PAD', 'ASCENT', 'APOGEE', 'DESCENT', 'PROBE_RELEASE', 'PAYLOAD_RELEASE', 'LANDED'
ALTITUDE	Altitude Relative to the Ground Level of Launch Site (Determined by Pressure)	0.1 meters



Payload Telemetry Format (3/5)



Telemetry Requirement	Description	Units and Resolution
TEMPERATURE	Internal Temperature of the CanSat	0.1 degrees Celsius
PRESSURE	Air Pressure of the Sensor Used	0.1 kPa
VOLTAGE	Voltage of CanSat Power Bus	0.1 volts
CURRENT	Current from the battery	0.01 amperes
GYRO_R	Gyroscopic Reading of the CanSat from its original position in terms of roll	degrees/seconds
GYRO_P	Gyroscopic reading of the CanSat from its original position in terms of pitch	degrees/seconds



Payload Telemetry Format (4/5)



Telemetry Requirement	Description	Units and Resolution
GYRO_Y	Gyroscopic reading of the CanSat from its original position in terms of yaw	degrees/seconds
ACCEL_R	Accelerometer reading of CanSat in terms of roll	degrees/seconds ²
ACCEL_P	Accelerometer reading of CanSat in terms of pitch	degrees/seconds ²
ACCEL_Y	Accelerometer reading of CanSat in terms of yaw	degrees/seconds ²
GPS_TIME	Time from the GPS receiver	hh:mm:ss
GPS_ALLTITUDE	Altitude from the GPS receiver above average sea level	0.1 meters
GPS_LATITUDE	Latitude from GPS receiver	0.0001 degrees North



Payload Telemetry Format (5/5)



Telemetry Requirement	Description	Units and Resolution
GPS_LONGITUDE	Longitude from GPS receiver	0.0001 degrees West
GPS_SATS	Number of GPS satellites being tracked by GPS receiver	N/A
CMD_ECHO	Last command received and processed	N/A
STEERING_ERROR	Vector product of heading and target vectors which is the sin of the error angle	N/A

All Telemetry is in International System of Units



Payload Command Formats (1/2)



Command	Description	Argument	Example
CX	Starts or ends telemetry	ON OFF	CMD,1094,CX,ON CMD,1094,CX,OFF
ST	Sets Payload time to given time or GPS time in UTC within 1 second	<INPUT> GPS	CMD,1094,ST,##,##,## CMD,1094,ST,GPS
SIM	Starts simulation mode with ENABLE and ACTIVATE, then ends it with DISABLE	ENABLE ACTIVATE DISABLE	CMD,1094,SIM,ENABLE CMD,1094,SIM,ACTIVATE CMD,1094,SIM,DISABLE
SIMP	Simulates the pressure with the given pressure in pascals (*Only used while in simulation mode*)	<PRESSURE>	CMD,1094,SIMP,#####
CAL	Makes the flight software set the telemetered altitude to 0 meters	N/A	CMD,1094,CAL
MEC	Releases the probe from the CanSat or engages it	REL ENG	CMD,1094,MEC,REL CMD,1094,MEC,ENG



Payload Command Formats (2/2)



Command	Description	Argument	Example
NOSE	Releases the nose cone (*Only used after MEC command*)	REL ENG	CMD,1094,NOSE,REL CMD,1094,NOSE,ENG
EGG	Releases the payload (*Only used after NOSE command*)	REL ENG	CMD,1094,EGG,REL CMD,1094,EGG,ENG
LED	Blinks the LED	N/A	CMD,1094,LED
MMF	Manually sets the mid mission flag to True (In mission) or False (not in mission)	<TRUE> <FALSE>	CMD,1094,MMF,TRUE CMD1094,MMF,FALSE

All Commands on this slide are of our own design



Electrical Power Subsystem Design

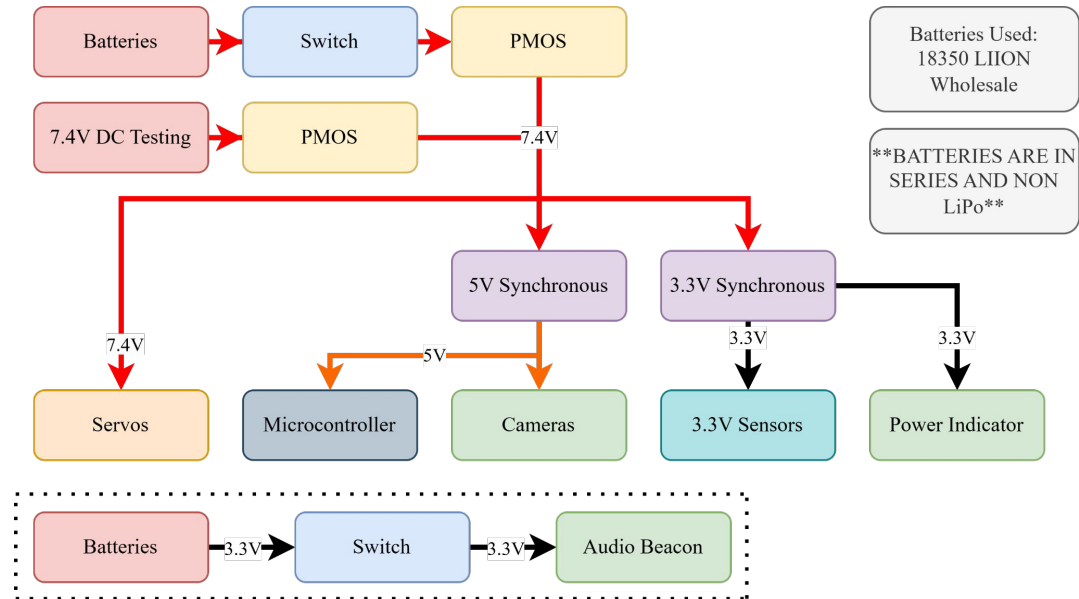
Rudra Patel



EPS Overview



Component	Description
Batteries	Two 3.7V batteries in series for the main subsystem and a 3V coin cell for the buzzer
Slide Switch	Controls power
Synchronous Converters	Buck converters to convert 7.4V and step it down to 5V and 3.3V
PMOS	Using a P-Channel MOSFET as reverse polarity protection.



Batteries Used:
18350 LIION
Wholesale

****BATTERIES ARE IN SERIES AND NON LiPo****

Note

**Audio Beacon is a separate subsystem
All Batteries are non-LiPo**



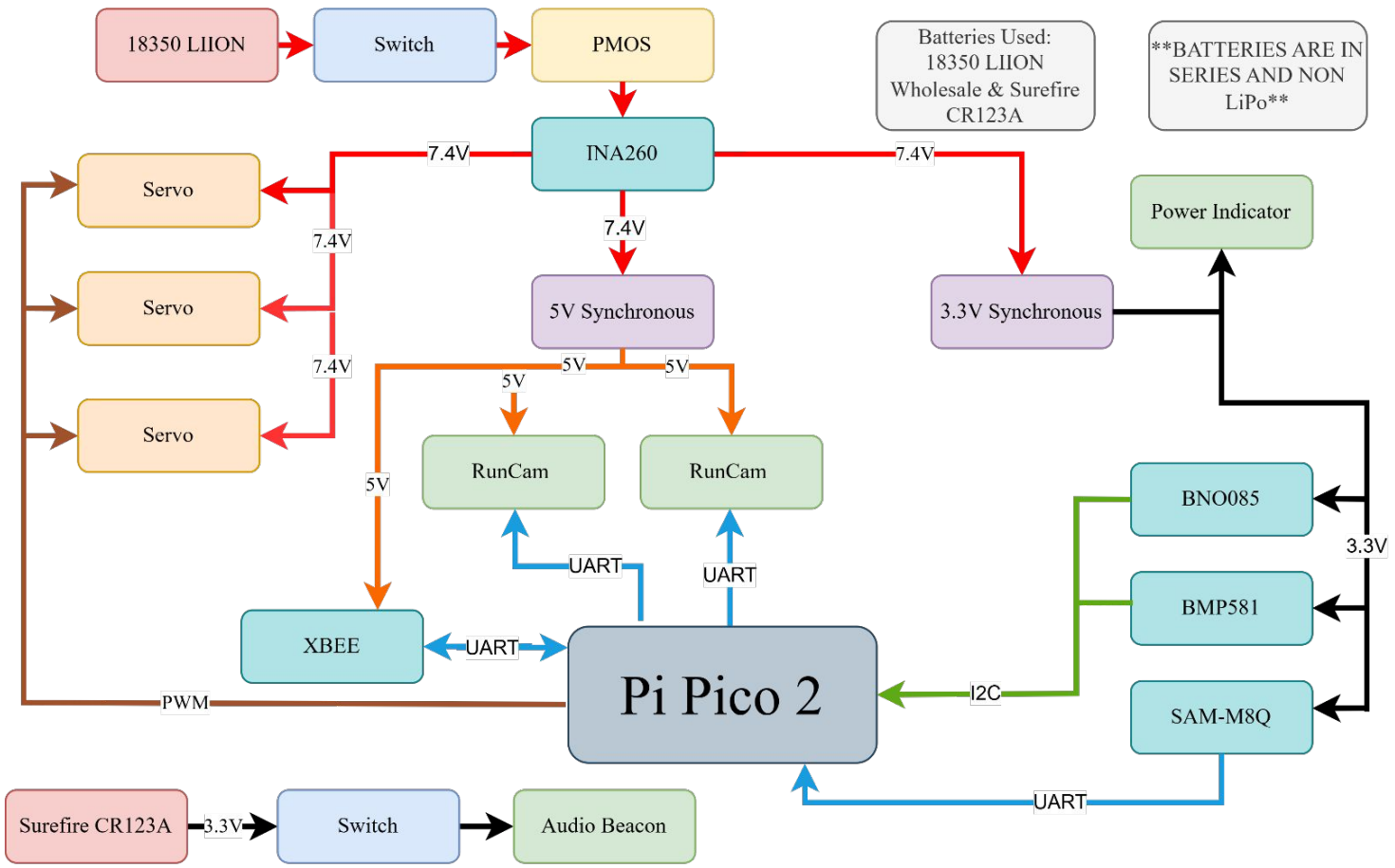
EPS Changes Since PDR



Component	PDR	CDR	Rationale
Microcontroller	Teensy 4.1	Raspberry Pi Pico 2	It is cheaper, smaller, dual-core processing, easier to work with, programmable I/O pins
Batteries	Surefire CR123A	18350 LIION Wholesale	Provides a higher continuous current discharge, convenience to recharge



Payload Electrical Block Diagram



Batteries Used:
18350 LIION
Wholesale & Surefire
CR123A

**BATTERIES ARE IN
SERIES AND NON
LiPo**

Component Legend	
	Power
	Polarity
	Switch
	Buck
	Peripheral
	Motor
	MCU
	Sensors

Arrow Legend	
	7.4V
	5V
	3.3V
	UART
	PWM
	I2C



Payload Power Source



Name	Voltage (V)	Current Capacity (mAh)	Power Capacity (Wh)	Conn.	Max Supply Current (A)	Energy Density (Wh/kg)	Number of Cells	Cost (\$)
18350 LIION Wholesale	3.7	1100	4.07	Series	10	169.58	2	\$6.49

18350 LIION Wholesale

- 2 batteries total
- 2 will be connected in series for CanSat power
- Not a Lithium-ion Polymer

Source: LIION Wholesale





Buzzer Power Source



Name	Voltage (V)	Current Capacity (mAh)	Power Capacity (Wh)	Conn.	Max Supply Current (A)	Energy Density (Wh/kg)	Number of Cells	Cost (\$)
Surefire CR123A	3	1550	4.65	Series	2	273.53	1	\$3.12

Surefire CR123A

- 1 batteries total
- Not a Lithium-ion Polymer

Source: Surefire





Payload Power Budget (1/3)



Components	Quantity	Voltage (V)	Active Current (mA)	Active Duration (h)	Idle Current (mA)	Idle Duration (h)	Energy (Wh)	Source
Pi Pico 2	1	5	55	2	0	0	0.55	Datasheet
Runcam Split 4 v2	2	5	450	0.167	0	1.833	0.75	Datasheet
XBee-PRO 900HP	1	5	215	0.4558	0	1.54	0.49	Datasheet
SER0011	2	7.4	450	0.01667	10	1.9833	0.32	Estimated
CYS-S3019 MG	1	7.4	700	0.00055	20	1.9994	0.24	Estimated
SAM-M10Q	1	3.3	13	2	0	0	0.08	Datasheet
BNO085	1	3.3	15	2	0	0	0.09	Datasheet
BMP581	1	3.3	0.26	2	0	0	0.001	Datasheet
INA260	1	3.3	0.31	2	0	0	0.002	Datasheet
LED	1	3.3	4	2	0	0	0.03	Calculated
*Assumed 2 Hour Flight Time and Maximum Current Draw XBEE calculation done with actual Duty Cycle using example packet				Energy Subtotal (Wh)			2.58	Calculated

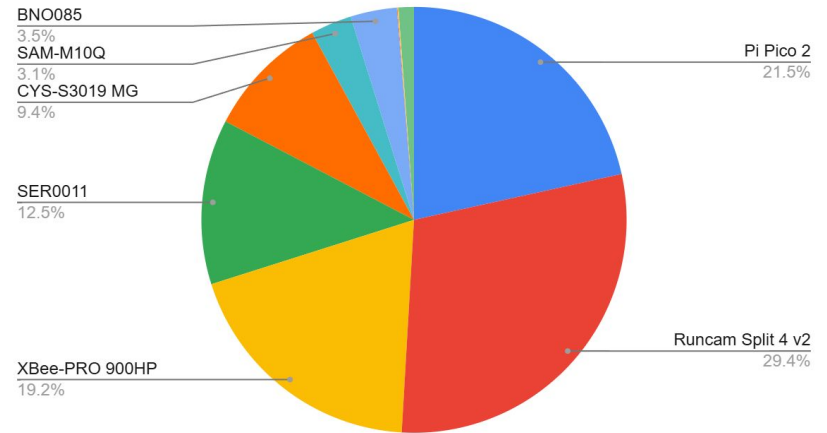


Payload Power Budget (2/3)

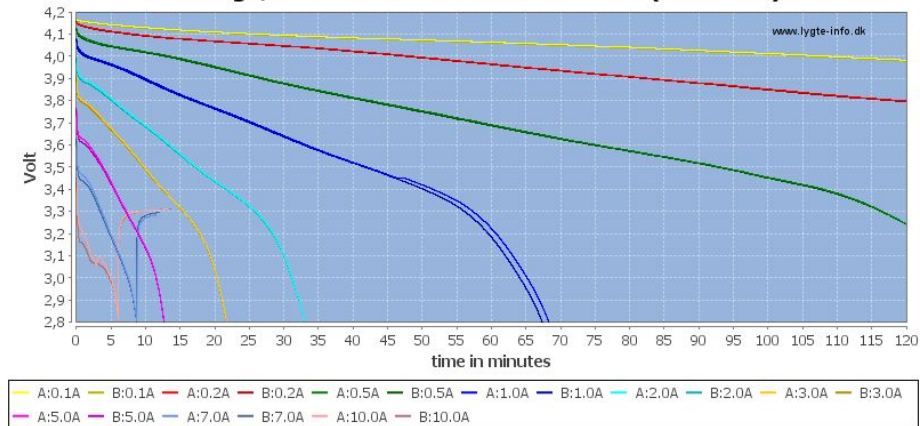


Energy Consumption Subtotal:	2.58 Wh
Power Supply Efficiency:	90%
Total Energy Consumption:	2.83 Wh
Available Battery Energy:	8.14
Energy Margin:	5.31 Wh
Remaining Battery Percentage:	65.2%

Energy (Wh)



Discharge, time: UltraFire 18350 1100mAh (Black-red)



Credit: Lygte-Info



Payload Power Budget (3/3)



Buzzer Subsystem	
Voltage (V)	3
Active Current (mA)	9
Idle Current (mA)	0
Active Duration (hrs)	1
Idle Duration (hrs)	1
Energy (Wh)	0.027
Source	Datasheet

Power Totals	
Energy Consumption Subtotal (Wh):	0.027
Power Supply Efficiency (%):	90.0
Total Energy Consumption (Wh):	0.03
Available Battery Energy (Wh):	4.65
Energy Margin (Wh):	4.62
Remaining Battery Percentage (%):	99.35%



Flight Software (FSW) Design

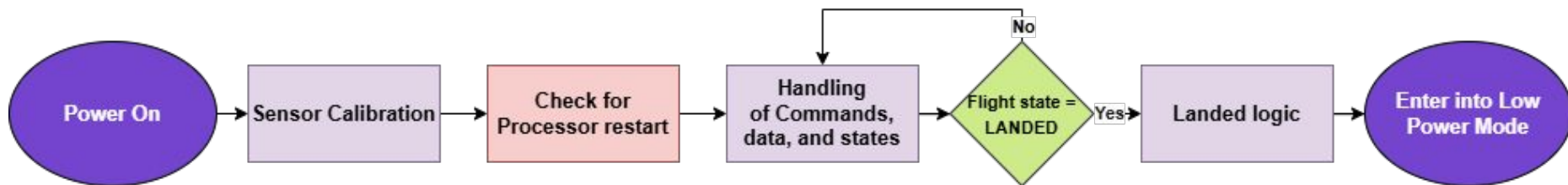
Dillard Durham



FSW Overview



Start Up	Flight Process	Landing
<ul style="list-style-type: none">• Power on All Systems• Boot up Sensors• Check for Processor Restart• Zero Altitude• Await CXON to Begin Telemetry• Turn on LED	<ul style="list-style-type: none">• Determine Flight State• Log and Transmit Telemetry Data• Update EEPROM• Release Probe at 80% Apogee	<ul style="list-style-type: none">• Activate Recovery Beacon (LED/Buzzer)• Secure Camera Footage and Shutdown• Enter into Low Power Mode



Flight Software is done in Arduino IDE using C++



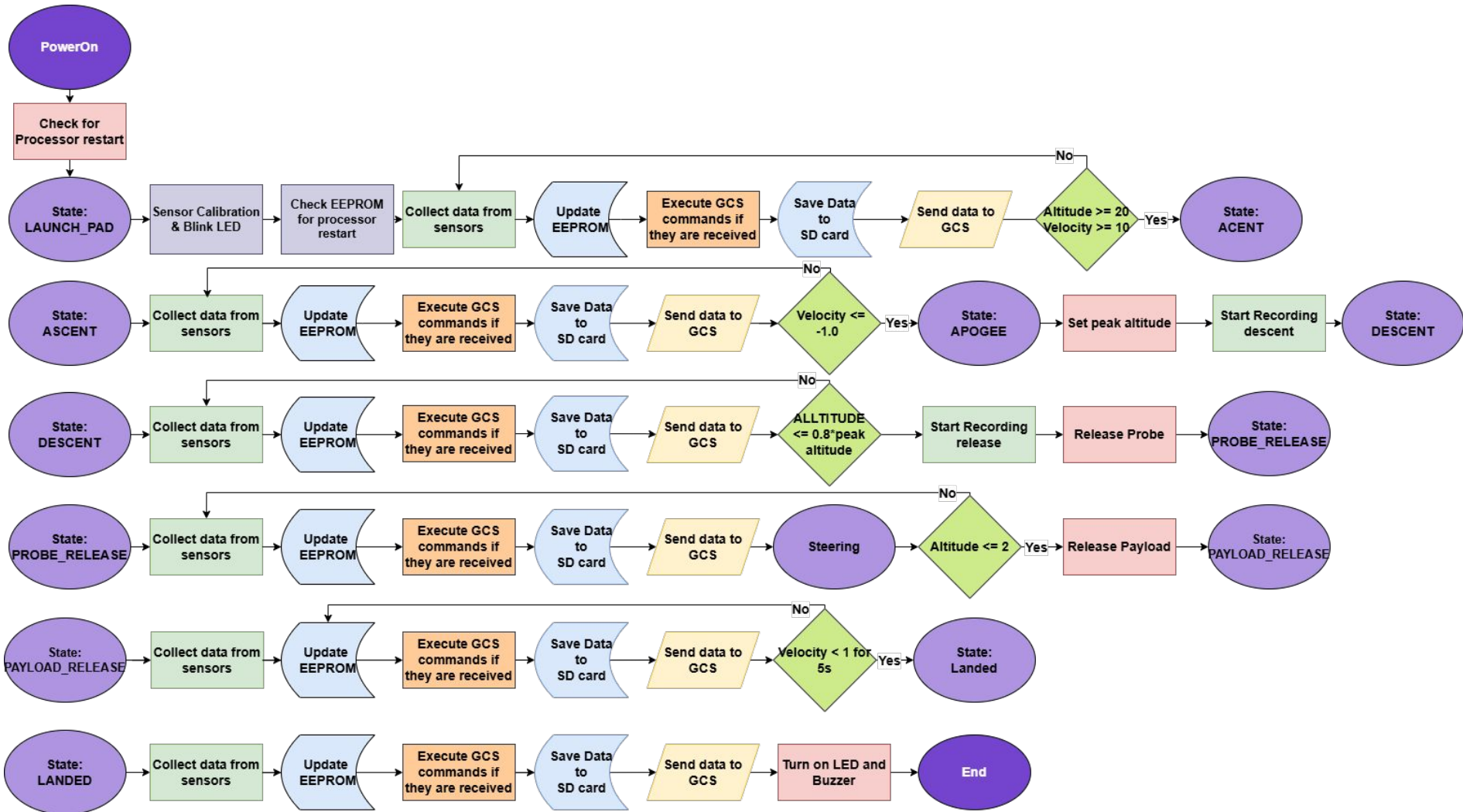
FSW Changes Since PDR



System	PDR	CDR	Rationale
Processor restart	The variables we store for processor restart are stored in EEPROM	The variables we store for processor restart are stored in the SD card	Storing variables in EEPROM is hard and would wear down its usability
PID	N/A	We have started developing a PID controller	PID's help autonomous steering systems maintain stability and precise trajectory tracking

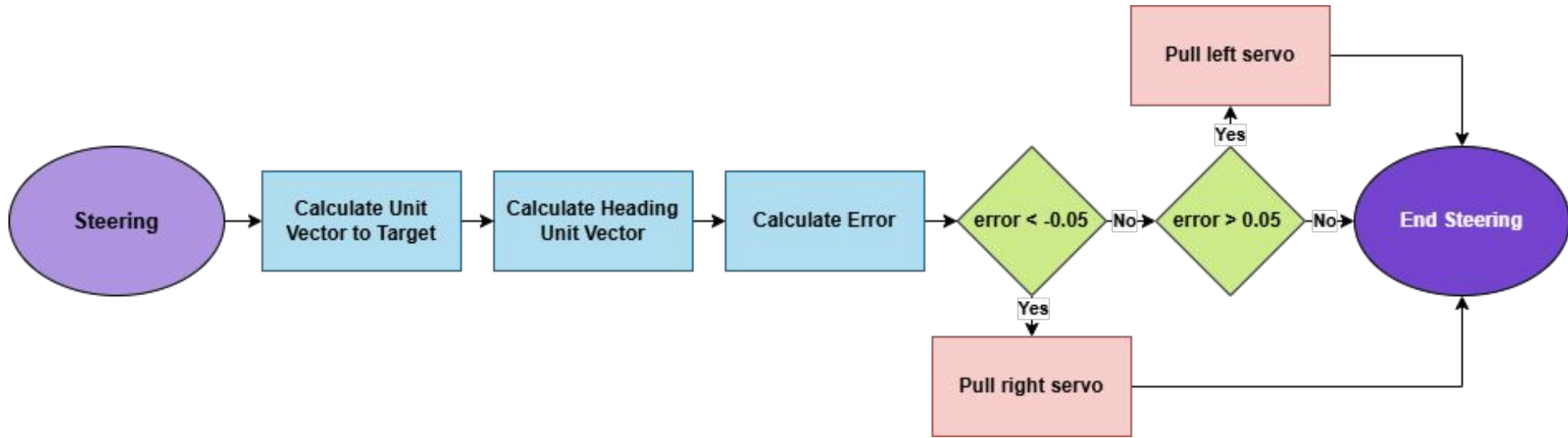


Payload CanSat FSW State Diagram (1/3)





Payload CanSat FSW State Diagram (2/3)



If the Cross Product of these equations is negative the CanSat will turn right, and if it is positive the CanSat will turn left.

VECTOR_PRODUCT Calculations

$$\hat{H} = \sin(\text{heading}) \hat{i} + \cos(\text{heading}) \hat{j} + 0\hat{k}$$

$$\hat{T} = T_x \hat{i} + T_y \hat{j} + T_z \hat{k}$$

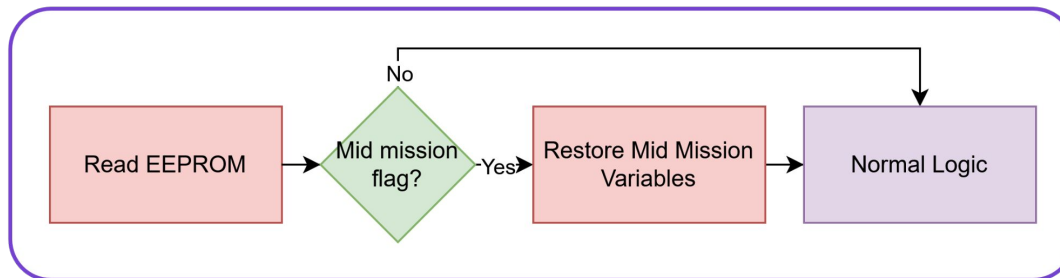
$$\hat{H} \times \hat{T} = (H_x T_y - H_y T_x)$$



Payload CanSat FSW State Diagram (3/3)



Processor restart	Mid Mission Variables	Data Transmission
<ul style="list-style-type: none">• MMF is set to true in EEPROM once entered into Flight state• Save MMV to an SD card• Check EEPROM for Mid Mission Flag on startup• If MMF is detected restore them via reading from SD card• MMF is set to false in EEPROM once entered into Landed state	<ul style="list-style-type: none">• Flight State• Zero Altitude• Altitude• Apogee• Packet Count• Mission Time• Mode• Steering Error	<ul style="list-style-type: none">• Sensor data is pulled at 1 Hz• Telemetry data is transmitted every 1 Hz• Telemetry is saved at 1Hz to the onboard SD card• Mid Mission Variables are saved to a different file on the SD card every 1Hz





Simulation Mode Software



Simulation Mode Commands

CMD,1094,SIM,DISABLE

CMD,1094,SIM,ACTIVATE

CMD,1094,SIM,ENABLE

CMD,1094,SIMP,#####

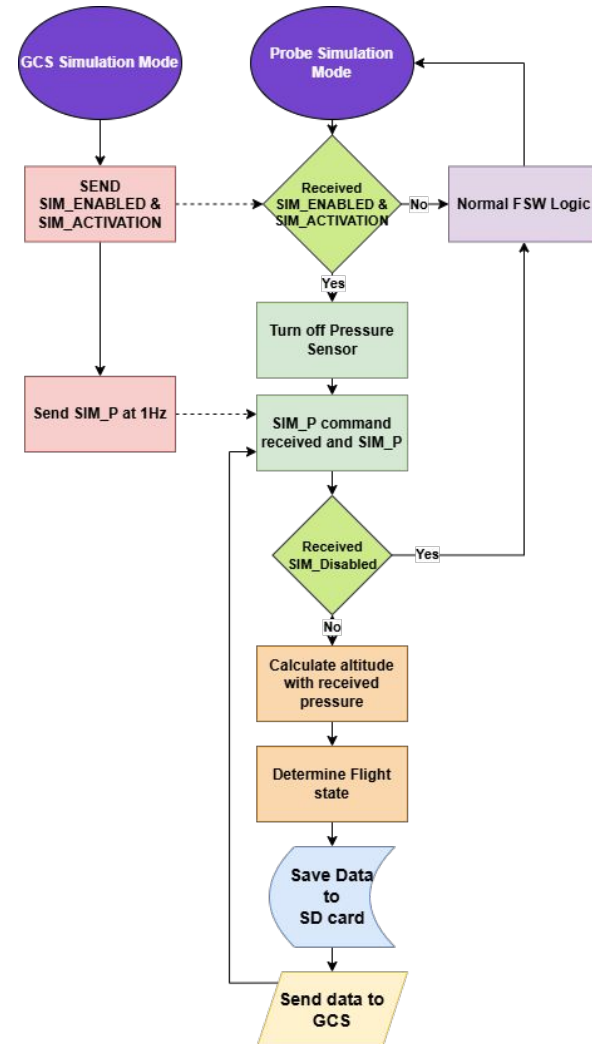
SIMP commands will be sent at a rate of 1 Hz

To activate simulation mode, the SIM_ENABLE and SIM_ACTIVATE commands must both be sent and received

To disable simulation mode, the SIM_DISABLE command must be sent and received

The probe collects all other telemetry besides pressure which will be supplemented with SIMP commands from the ground station

Telemetry data will continue to transmit throughout the duration of simulation mode at 1Hz



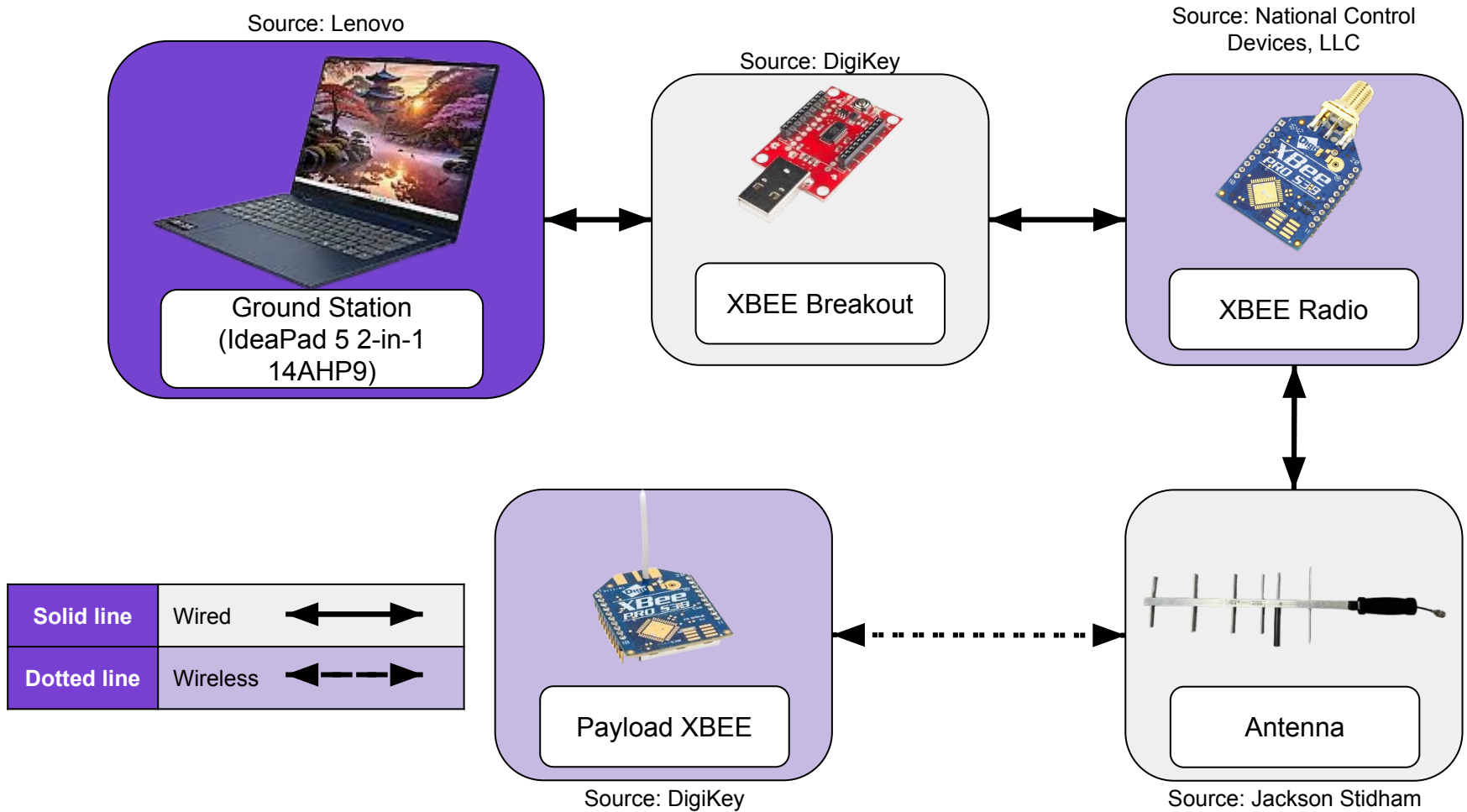


Ground Control System (GCS) Design

Dillard Durham



GCS Overview





GCS Changes Since PDR



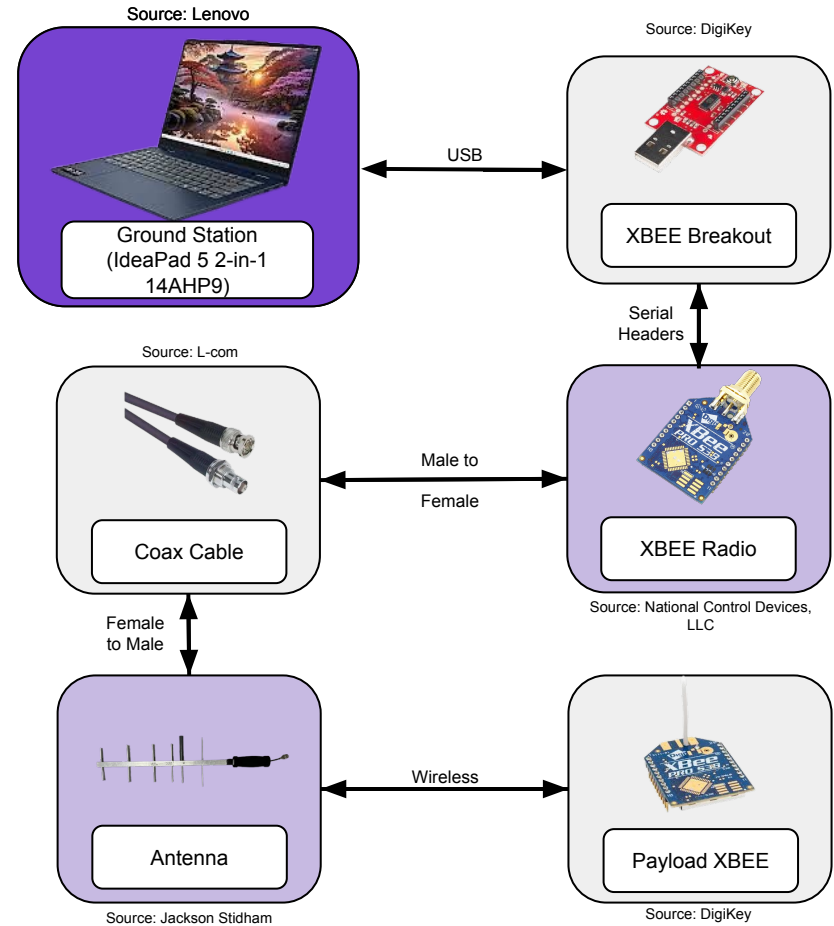
System	PDR	CDR	Rationale
USB connection error handling and reconnection logic	No error handling	Automatic detection of usb device removal and reconnection	Accidental disconnect could disrupt continuation of communications.
Button Section Layout	Static button positioning	Flow layout	The dynamic allocation of rows of buttons allows for maximum graph size while maintaining button visibility



GCS Design



Possible Failure	Prevention Method
Battery Duration	Battery duration 6 Hours (Observed)
Overheating	An umbrella will be brought to keep the laptop out of direct sunlight
Auto Update	The laptop will be checked for updates the day before launch and auto updates will be turned off


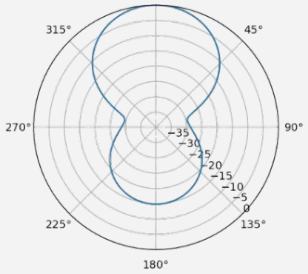




GCS Antenna



Name	Front-to-Back Ratio (dB)	Radiation Pattern	Gain (dBi)	Frequency Range (MHz)	Horizontal Beamwidth (°)	Vertical Beamwidth (°)	Cost (\$)
PC906N	18	Unidirectional	8.5	896-940	65	65	\$3.12

PC906N	Radiation Pattern	Handheld/Tabletop
	<p>HG909P Approx Elevation Pattern (HPBW 50°, F/B 15 dB)</p> 	Handheld



GCS Software (1/3)



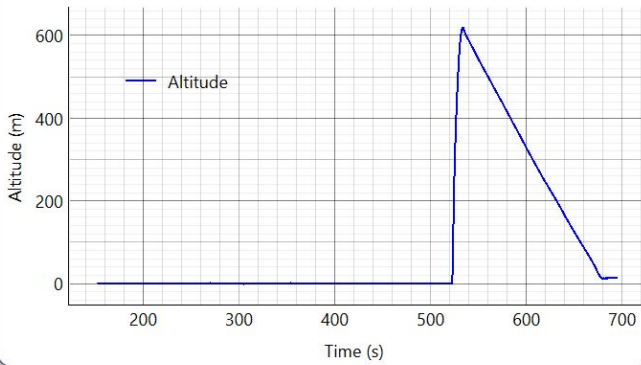
MetalHawk

MetalHawk CanSat

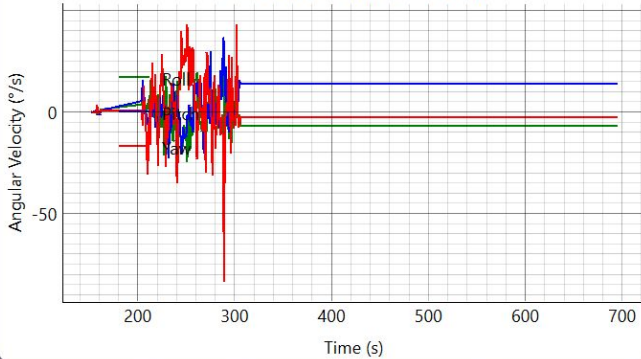


Time: 00:11:34
 Mission Time: 00:11:34
 Packet Count: 501
 Mode: F
 State: PROBE_RELEASE
 Altitude (m): 13.1
 Temperature (°C): 27.9
 Pressure (kPa): 1011.7
 Voltage (V): 0.00
 Current (A): 0.00
 Gyro Roll (°/s): -6.8
 Gyro Pitch (°/s): 13.8
 Gyro Yaw (°/s): -2.4
 Accel Roll (°/s²): 44.5
 Accel Pitch (°/s²): 53.4
 Accel Yaw (°/s²): -8.9
 Linear Accel (m/s²): 70.10
 GPS Time:
 GPS Alt (m): 0.0
 GPS Lat: 0.0000
 GPS Lon: 0.0000
 GPS Sats: 0
 CMD Echo: CMD_1094_CX_ON
 Packets Received: 498
 Packets Sent: 3
 STRB Angle (°): -2.4
 PORT Angle (°): 13.8
 Vector Product: -21167.71

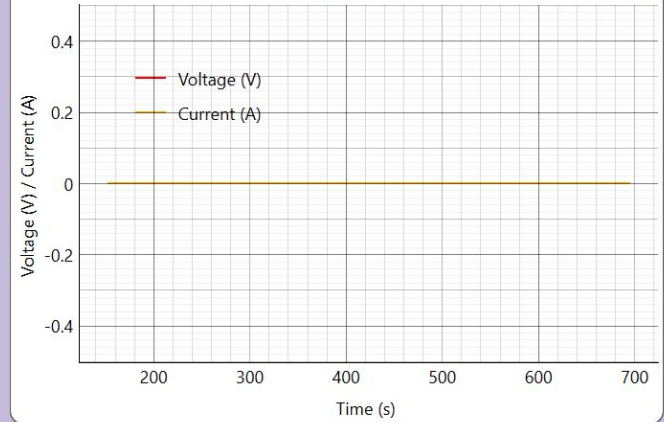
Altitude over Time



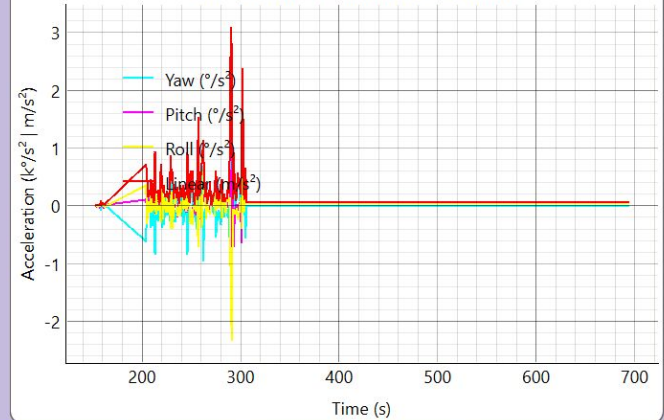
Gyroscope (Angular Velocity)



Voltage and Currents



Accelerometer (Angular & Linear)



- Select COM Port
- CX_ON
- CX_OFF
- SIM_ENABLE
- SIM_ACTIVATE
- SIM_DISABLE
- Probe Release
- MEC.REL
- MEC.ENG
- NOSE.REL
- NOSE.ENG
- EGG.REL
- EGG.ENG
- Set Time
- Calibrate
- LED
- MMF_ON
- MMF_OFF



GCS Software (2/3)



GCS Software Choices

Front End Languages and Libraries

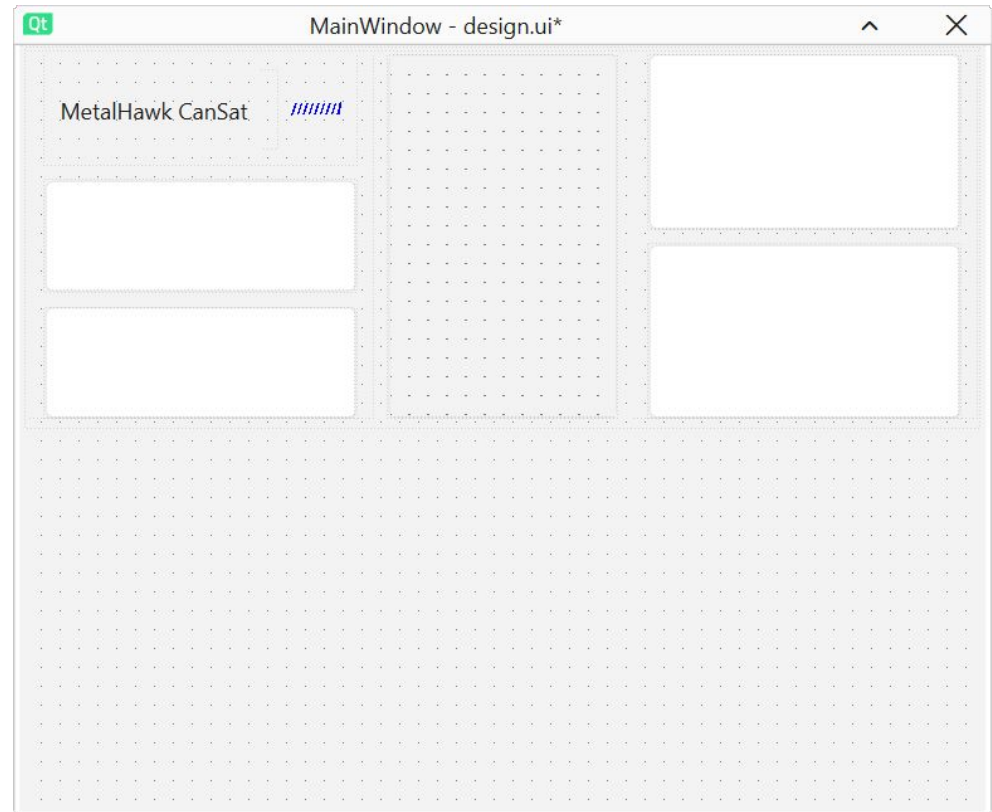
- Python (language)
- pyside6 (library)
- pyqtgraph (library)

Real-time Plotting Design

- Bold traces on graphs for visibility
- Altitude, Battery Voltage, Battery Current, Acceleration and Rotation Rates will be plotted

Development Environment

- Windows (Operating System)
- Visual Studio Code (code editor)
- QT Widgets Designer (UI designer)



QT Widgets Designer view



GCS Software (3/3)



Communications and Simulation

Telemetry and Recordings

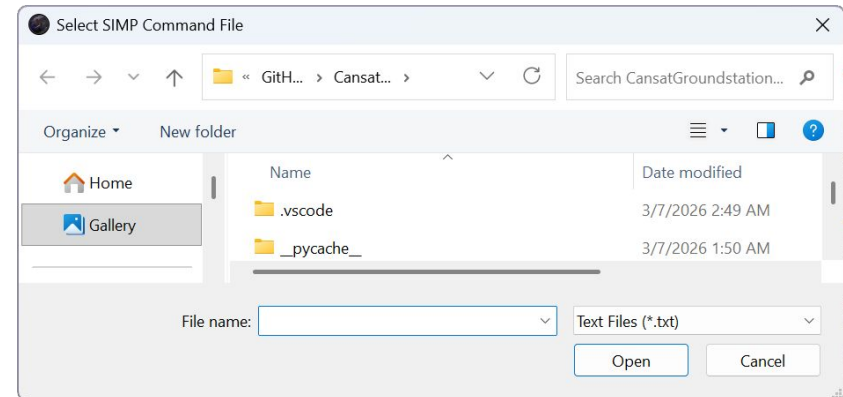
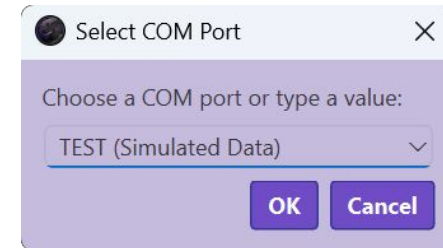
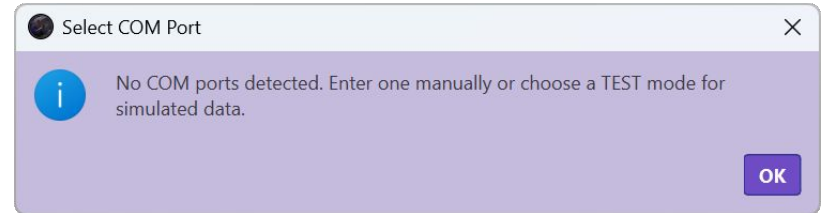
- Telemetry will be sent at 1Hz in SI units which will then be saved into a csv file
- Packet count and losses will be saved and displayed
- Telemetry will be transferred over to a USB drive for the judges
- Telemetry will be saved on onboard SD card in case of radio failure

Commands

- Each command will have its own unique button on the GUI

Simulation Mode

- SIM mode is activated using the SIM_ENABLE and SIM_ACTIVATE commands
- When entered into SIM mode the ground station will prompt for SIMP file
- SIMP csv file data will be sent at 1Hz



Simulated Data is randomly generated data for testing, it is not the same as simulation mode.



CanSat Integration and Test

Tyler Ebner



CanSat Integration and Test Overview



Test	Testing Plan	Pass Requirement
Subsystem Level Test	The individual subsystems within the CanSat will be tested to make sure that they can operate	Each subsystem works properly
Integrated level Functional Test	The CanSat will be fully assembled and each part will be tested to ensure that they fit within the the full CanSat	All parts properly fit within the CanSat and can serve their specific function
Environmental Test	CanSat will be put through various tests that simulate the environmental conditions that will be present on launch day	CanSat passes each individual test without major failure
Simulation Test	CanSat will have SIM ENABLE and SIM ACTIVATE commands sent and then a simulation packet will be uploaded	CanSat operates in simulation mode as if it where in normal flight



Subsystem Level Testing Plan (1/2)



Subsystem	Testing Plan	Pass Requirement
Sensors	Run the sensors with software to see if they measure and record data	Sensors measure and record data as expected
CDH	Send commands from the ground station to the CanSat to see if servos move	Command packets need to be sent successfully
EPS	Test power connections with batteries and DC Check specific sections using multimeters and oscilloscope	Batteries need to be able to power the entire CanSat including servos without brownouts, etc
Radio communications	Make sure XBEE's are able to communicate from distance from each other	Ground station and CanSat must communicate packets to each other flawlessly
FSW	Use simulation mode to test if data is being transmitted and collected on the SD card	Telemetry data is collected on the ground station and recorded on the SD card



Subsystem Level Testing Plan (2/2)



Subsystem	Testing Plan	Pass Requirement
Mechanisms	All mechanical components will be tested by repeated usage	Components work without failing
Descent Control	The CanSat is tested to verify that it descends properly within the guidelines set out by the mission guide	The CanSat descends properly without failure and is stable



Integrated Level Functional Test Plan (1/2)



Subsystem	Payload Release from Container Testing Plan	Pass Requirement(s)
<p>Release trigger</p>	<ul style="list-style-type: none"> We will power on the CanSat within its container and insert it into a cylindrical vacuum chamber with a tether linked between the lid of the chamber and the container's eye bolt the chamber will then be pressurized to the expected pressure seen at the release altitude of 450m 	<ul style="list-style-type: none"> Release mechanism triggers at the correct simulated altitude and payload slides out of container
<p>Mechanisms</p>	<ul style="list-style-type: none"> Drop tests of the assembled CanSat and nose cone from heights that will simulate forces of 30Gs of shock for the CanSat and 15Gs of acceleration for the nose cone Vibration tests will be performed via attaching the payload to a orbital sander to simulate 15Gs of vibration Test release under simulated load using weights hung from release arms 	<ul style="list-style-type: none"> Mechanisms remain intact Release functions without stalling/breaking
<p>Payload Release</p>	<ul style="list-style-type: none"> CanSat will be inserted into an equivalent size and power rocket as the one used for competition and ejected using a black powder charge 	<ul style="list-style-type: none"> Container ejects from rocket body Container parachute remains attached



Integrated Level Functional Test Plan (2/2)



Subsystem	Communication Test Plan	Pass Requirement
Ground station software	The Ground station will send every command to the CanSat.	The CanSat sends an echo for every command while also performing how it should for each command.
Ground station Simulation software	The ground station will send ACTIVATE_SIM, ENABLE_SIM and SIMP commands to test the process of simulation mode.	The CanSat correctly send telemetry and runs off of the simulated pressure.
Telemetry	A test flight will be performed in which the telemetry the telemetry will be monitored.	Telemetry is properly sent and received over the course of the mission.
Antennas	Pair the CanSat Xbee and ground station Xbee. Ensure they stay connected and continue transmitting through the process of the vibration and shock test.	For all listed test communication between antennas remains connected and strong.



Environmental Test Plan (1/2)



Test	Method	Description	Requirements
Drop Test	Attached Point Drop	Verifies structural integrity and function by securing the CanSat with a cord to a rigid structure. After powering on and confirming telemetry, the CanSat is raised to height and released	CanSat must not lose power, must continue delivering telemetry, and must not lose any parts/components
Thermal Test	Thermal Chamber	Verifies the CanSat's ability to operate in high-temperature environments. This test is specifically conducted at an elevated 60 degrees Celsius for two hours to ensure no materials warp, weaken, or fail to function	CanSat must stay operational, no materials may be warped or damaged by heat, structural integrity must stay secure
Vibration Test	Orbital Sander	Verifies the mounting integrity of all components, connections, and overall structural strength under significant mechanical stress, simulating launch vibrations	CanSat must not be damaged, all components and parts must remain structurally sound, CanSat data must continue to be transmitted



Environmental Test Plan (2/2)



Test	Method	Description	Requirements
Fit Check	Rocket Model	The CanSat is integrated with a model that has the same dimensions as the rocket used on flight day	The CanSat can fit inside the model and slide back out without difficulty
Vacuum Test	Vacuum Chamber	Verifies the deployment operation of the payload based on simulated altitude changes	All mechanisms must activate correctly, CanSat must deliver and save telemetry data, cameras must be operational
Simulation Test	Ground Control System	Verifies the deployment operation of the payload based on simulated pressure data received from the ground station	All mechanisms must activate correctly, CanSat must deliver and save telemetry data, cameras must be operational



Test Procedures Descriptions (1/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
1	The CanSat is inserted properly into the rocket where the payload functions as a nose cone.	C1, C2, S15, S16	The payload is inserted and does not fall out or become loose while inserted.
2	A test launch is performed where the CanSat and rocket separate at the proper time.	C3	The CanSat payload deploys when the ejection charge fires.
3	CanSat and container are drop tested and the descent rate is measured.	C4	The payload descends at 15 meters/second with an error of 3 meters/seconds.
4	The CanSat is placed in a vacuum chamber that simulates the conditions of flight and the release mechanism is activated.	C5, C6	The CanSat releases at 80% apogee and para-glider is released.
5	A test launch is performed where the CanSat deploys it's para-glider.	C7	The CanSat descends at 5 meters/second averaged over the flight with an error of 3 meters/second.



Test Procedures Descriptions (2/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
6	A test launch is to be performed in which we will have a landing site.	C8	The CanSat correctly steers towards the landing site.
7	Packets are sent from the CanSat to the ground station. Tested in flight and SIM mode.	C9, X4	Telemetry data is seen in the CSV file to of been sent every 1Hz.
8	Both cameras are connected to the telemetry electrical system and turned on.	C10, C11	Cameras properly record video that is stored for later use.
9	A test launch is completed where the egg system is released at 2 meters with a 0.5 meter error.	C12	The egg is released at the proper height is not broken.
10	A test will be performed where we start the CanSat and audible beacon then disconnect the main battery.	C13	The audible beacon correctly plays and audible sound.
11	The total cost all parts of the CanSat are procured.	C14	The total cost is under \$1000.



Test Procedures Descriptions (3/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
12	The CanSat and container are weighed.	S1	The CanSat and container weigh 1000 grams with an error of 10 grams.
13	The nose cone is inspected for proper measurements and manufacturing methods.	S2,S3, S4,S5, S6,S7	The nose cone meets all measurements and manufacturing methods.
14	CanSat is placed onto an orbital sander with the 15Gs vibration setting.	S8	The CanSat structure survives the 15Gs vibration.
15	The CanSat is drop tested to simulate 30G shock.	S9	The CanSat structure survives 30G shock.
16	The container's dimensions are measured, including diameter, length and shoulder dimensions. The materials are also surveyed.	S10, S11, S12, S13, S14, S18, S19	The container meets the mission guide requirements for dimensions and materials.



Test Procedures Descriptions (4/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
17	All mounts are checked for standoffs, screws, or adhesives.	S17	All mounts are using proper methods outlined in the mission guide.
18	During a test launch the nose cone will be separated from the payload and tested for the conditions of the rocket launch.	S20, S21	The nose cone releases at the proper time and descends at no more than 5 meters/second.
19	The CanSat payload is surveyed to check for any pyrotechnical, chemical actuators or heat hazards.	M1, M2	No pyrotechnical, chemical actuators or heat hazards are used.
20	During a test launch, all mechanisms will be checked for any stresses caused by various forces.	M3	All mechanisms are able to maintain their configuration.
21	Electrical components are checked for spring contacts or battery connections.	M4	No spring contacts are used.



Test Procedures Descriptions (5/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
22	The CanSat is checked for lithium polymer batteries and package type.	E1, E2	The batteries must be allowed by the mission guide.
23	The CanSat is checked for an easily accessible power switch through the container.	E3	The CanSat has a power switch that meet mission requirements.
24	Container is checked for small holes for power switches	E4	The small holes meet the mission guide requirement of no more than 10mm
25	Check the CanSat for a power indicator	E5	Turn on CanSat and see if LED indicators turn on
26	Check CanSat for battery duration.	E6	CanSat must operate for a minimum of 2 hours.
27	Check CanSat buzzer subsystem for power.	E7	The buzzer subsystem must operate with an independent power source



Test Procedures Descriptions (6/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
28	Check buzzer subsystem for switch.	E8	CanSat must have accessible power switch for buzzer.
29	Set the XBEE 900HP PRO to have the NETID/PANID to 1094, and have broadcast mode turned off.	X1, X2, X3	XBEE is properly set to the mission guide criteria.
30	Check the groundstation CSV file for received altitude, air pressure, temperature, battery voltage, command echo, and GPS coordinates that include latitude, longitude, altitude, and number of satellites tracked.	X5	All of previously mentioned telemetry is properly in the CSV file.
31	Hook up only the air pressure and temperature sensor (BMP581) and look to see altitude and temperature change.	SN1, SN2	Altitude and temperature are properly measured.
32	Hook up battery current and voltage sensor (INA260) and look to see if current and voltage change.	SN2, SN10	Current and voltage are properly measure.



Test Procedures Descriptions (7/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
33	Hook up GPS sensor (SAM-M10Q) and look to see if GPS data changes.	SN4	GPS data is properly measured.
34	Hook up acceleration and rotation rate sensor (BNO085) and look to see if they change.	SN5	Acceleration and rotate rate is properly measured.
35	A test launch shall be performed in which afterwards we will look to see if the CanSat release, descent and instrument release where each recorded by their respective cameras.	SN6, SN7, SN8, SN9	The release, descent and instrument release is properly recorded by their respective camera in 640x490 resolution.
36	Turn on groundstation and CanSat, send calibrate command and set time command when on the launch pad, while also monitoring the plots in real time with proper units.	G1, G2, G3, G4, G5, G6, F3	Check the CSV file and ground station to see if the CanSat was zerod and time was set, was sending every 1 second and echos the command while also matching the real time plots.



Test Procedures Descriptions (8/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
37	Turn on groundstation and CanSat and check for plots of altitude, battery voltage, battery current, accelerometer value and rotation rates in real time. While also displaying mission time, temperature, GPS position, received packet count, lost packet count, and flight software state in real time.	G7, G8, G14, G15, G16	All of previously mentioned graphs, data and packets revived are properly displayed simultaneously in bold font, plot traces, axes and dark text on a light background.
38	Pick up the ground station and carry it to other locations without power. Set it up in various locations to verify the ground station and antenna are mobile.	G9, G10, G13	The Groundstation is mobile and not powered by AC power. The antenna is handheld.
39	Send the SIMULATION ENABLE, SIMULATION ACTIVATE, and SIMP commands.	G11, G12, F4, F5, F6	Check the ground station and CSV file to verify that the simulated pressure is sent at 1Hz and that it activated at the correct time while also turning off the Pressure sensor.



Test Procedures Descriptions (9/9)



Test Proc	Description	Rqmts	Pass Fail Criteria
40	Send all commands individually and watch the groundstation and servos.	G17, F7	Every command does exactly what it is supposed to and documented in the mission manual
41	Turn on CanSat and ground station and start transmitting data, turn power off and on again.	F1, F2, F8	Packet count, mission time and zeroed altitude are kept through processor restart



Simulation Test Plan



Test	Description	Requirements
CanSat Mechanism	While running through simulation mode check that all mechanisms release as expected at correct heights	All mechanisms release at the correct time and as expected
Ground Station Display	During simulation mode check if ground station receives and displays all graphs and telemetry data	All graphs display correctly and telemetry data with the CanSat's SD card
Ground Station Commands	Check if commands can be sent to activate simulation mode, run during simulation mode and end simulation mode	Commands send to the CanSat and are working as expected



Mission Operations & Analysis

Tyler Ebner



Overview of Mission Sequence of Events (1/4)



Chronological Order of Events in Descending Order

*Starting at launch day

Event	Team Member(s)
Arrival	Full Team
Check-in of CanSat	Full Team
Ground Station preparation	Ground Station Operators
Pre-Launch Checklist	Full Team
Launch Checklist	CanSat Crew, Ground Station Operators
Data Analysis	Ground Station Operators
Recovery, Return CanSat to Judges	Recovery Crew
Completion of PFR presentation	Full Team



Overview of Mission Sequence of Events (2/4)



Team Member(s)	Assigned Role	Description
Tyler Ebner	Mission Control Officer	Ensures the team follows the proper procedures outlined in the Missions Operations Manual
Brodie Kirkpatrick, Jackson Stidham, Clark Peterson, Alex McKinnon, Hayden Peek	CanSat Crew	Prepares the CanSat for launch and integrates it with the rocket
Nora Brady, Evan Jeanneret	Recovery Crew	Recovers the CanSat after launch and returns it for judging
Dillard Durham, Rudra Patel	Ground Station Operators	Checks the ground station, ensuring it runs properly, as well as handling the antenna connection



Overview of Mission Sequence of Events (3/4)



Antenna and Ground Station Setup

1	Get the Umbrella in place to block Glare and reduce heat
2	Connect the XBEE via the USB port and attach cable to antenna
3	Open the Ground Station application
4	Connect the XBEE via the USB port and attach cable to antenna
5	Select the COM port via the selection menu
6	Use the CXON command to start communication
7	Monitor the telemetry after CX command is sent



Overview of Mission Sequence of Events (4/4)



CanSat Assembly and Test

1	Put in new batteries into the holders
2	Test electrical parts to make sure they work
3	Secure all, screws plates, and any other loose parts like wires and batteries.
4	Test radio communication with built-in test
5	Prepare rocket on launch pad



Field Safety Rules Compliance



Mission Operation Manual (MOM) Overview

Section	Description	Progress
Team Organization	A list of all team members with names, roles and majors	Complete
Packing List	A comprehensive list of all things needed for flight day	In Progress
CanSat Preparation	A checklist for all subteams to ensure they are ready for launch	In Progress
Subteam Inspections	An inspection of every subsystem to ensure it will properly function	In Progress
Cansat Construction	A comprehensive guide on how to construct the CanSat piece by piece	In Progress
Launch Steps	A guide to how to launch the CanSat for safety and function	In Progress



CanSat Location and Recovery



Component	Visibility
Container	Fluorescent Orange and MetalHawk logo
Visible Beacon	Bright Blue LED
Audio Beacon	100 dB Single Tone Audio
GPS	Real Time Position (Longitude & Latitude)
Team Contact	Phone Number of both team lead and recovery lead, return label address, and email address of team lead. Both on the CanSat and Nose Cone
<p>Team Contact Info: Tyler Ebner tde0010@uah.edu (678)-719-5875; Evan Jeanneret edj0015@uah.edu (202)-770-5012; Dr. Gang Wang gang.wang@uah.edu (256)-824-6595 601 John Wright Dr Huntsville AL 35805</p>	



Mission Rehearsal Activities (1/6)



We have rehearsed ground system radio link check procedures ensuring successful telemetry transmission at various ranges



We have successfully rehearsed powering on/off the CanSat and buzzer systems



Mission Rehearsal Activities (2/6)



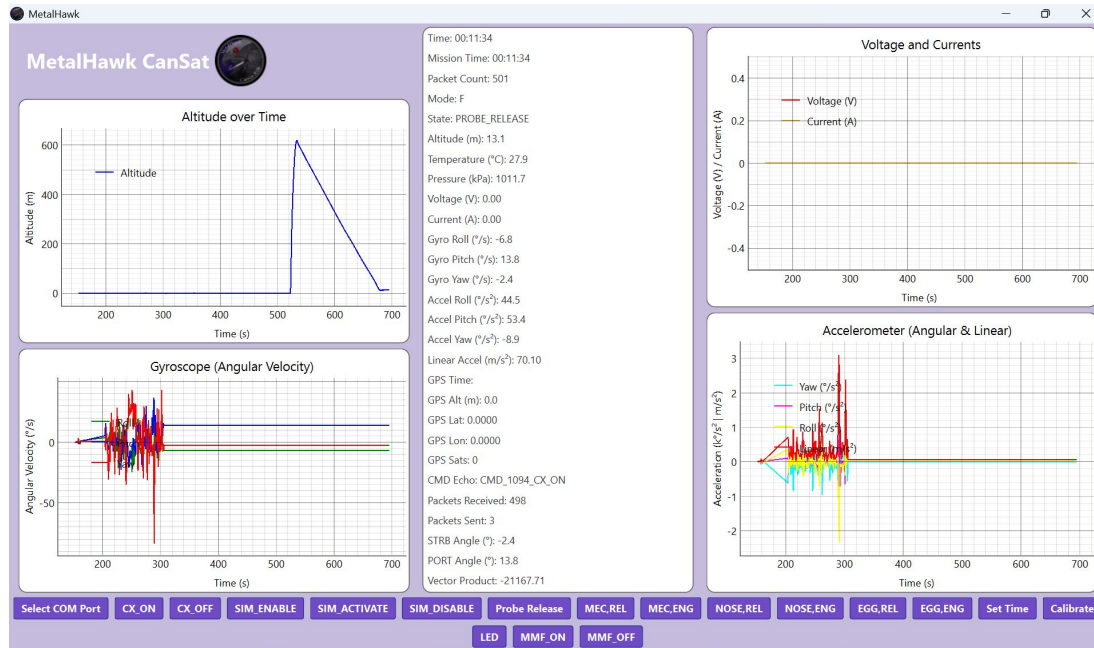
Launch configuration preparations such as a complete payload assembly and the stowing of parachute/para-glider have been completed



We have rehearsed our procedure for loading the CanSat into the launch vehicle using an rocket with equivalent size/power to the competition rocket



Mission Rehearsal Activities (3/6)



We successfully processed, archived, and performed analysis on data received during test launch



Mission Rehearsal Activities (4/6)



Mission Operation Rehearsal Activities	Procedure
Ground system radio link check procedures	<ul style="list-style-type: none">● Test radio transmission from a distance of 600m● Test command transmission and confirm through command echo
Powering on/off the CanSat	<ul style="list-style-type: none">● Power on/off the CanSat● Power on/off the buzzer system
Launch configuration preparations	<ul style="list-style-type: none">● Assemble Cansat structure● Stow nose cone parachute● Stow para-glider● Power on all systems● Load CanSat into the container
Loading the CanSat in the launch vehicle	<ul style="list-style-type: none">● Load the full CanSat into an equivalent size rocket as the one that will be used for competition



Mission Rehearsal Activities (5/6)



Mission Operation Rehearsal Activities	Procedure
Telemetry processing, archiving, and analysis	<ul style="list-style-type: none">● Upload flight log to Google Drive● Manually clean data of errors and missing values
Recovery	<ul style="list-style-type: none">● Visually track the descent of payload and container● Use buzzer and led along with any GPS data to locate and recover payload



Mission Rehearsal Activities (6/6)



We successfully rehearsed all activities at our first test launch on March 7th with plans to rehearse them again at a second launch on May 2d





Requirements Compliance

Tyler Ebner



Requirements Compliance Overview



Compliance of mission guide requirements out of total

Compliance	Partial Compliance	No Compliance
87 out of 87	0 out of 87	0 out of 87

Of all 87 requirement we meet all 87, we were able to test as such at our test launch.



Requirements Compliance (1/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
C1	The CanSat payload shall function as a nose cone during the rocket ascent portion of the flight.	Comply	31	
C2	The CanSat container shall be mounted on top of the rocket with the shoulder section inserted into the airframe.	Comply	31	
C3	The CanSat payload and container shall be deployed from the rocket when the rocket motor ejection charge fires.	Comply	20	
C4	After deployment, the CanSat payload and container shall descend at 15 meters/second using a parachute that automatically deployed. Error is +/- 3m/s.	Comply	44	
C5	At 80% flight peak altitude, the payload shall be released from the container.	Comply	20	
C6	At 80% peak altitude, the payload shall deploy a para-glider descent control system.	Comply	20	
C7	The payload shall descend at 5 meters/second averaged over the entire descent within +/- 3 meters/sec with the para-glider descent control system.	Comply	44, 56	
C8	The payload shall steer toward a target location.	Comply	117	



Requirements Compliance (2/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
C9	The sensor telemetry shall be transmitted at a 1 Hz rate.	Comply	118, 119, 128	
C10	The payload shall record video of the release of the payload from the container and the deployment of the para-glider descent control system.	Comply	33, 90, 116	
C11	A second video camera shall point at the ground.	Comply	33, 90, 116	
C12	The payload shall release a protected hens egg when the payload is 2 meters +/- 0.5 m above the ground without breaking the egg.	Comply	116	
C13	The CanSat payload shall include an audible beacon that is turned on separately and is independent of the CanSat battery and electronics.	Comply	105, 107, 109	
C14	Cost of the CanSat shall be under \$1000. Ground support and analysis tools are not included in the cost of the CanSat. Equipment from previous years shall be included in the cost, based on current market value.	Comply	187	



Requirements Compliance (3/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
S1	The CanSat and container mass shall be 1000 grams +/- 10 grams.	Comply	88	
S2	The nose cone shall be symmetrical along the thrust axis.	Comply	68	
S3	Nose cone radius shall be exactly 70 mm.	Comply	68	
S4	Nose cone shoulder length shall be a minimum of 50 mm.	Comply	68	
S5	The nose cone shall be made as a single piece. Segments are not allowed.	Comply	68	
S6	The nose cone shall not have any openings allowing air flow to enter.	Comply	68	
S7	The nose cone height shall be a minimum of 76mm	Comply	68	
S8	CanSat structure must survive 15 Gs vibration.	Comply	133	
S9	CanSat shall survive 30 G shock.	Comply	133	
S10	The container shoulder length shall be 90 to 120 mm	Comply	29, 30, 59, 70	
S11	The container shoulder diameter shall be 136mm	Comply	29, 30	



Requirements Compliance (4/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
S12	Above the shoulder, the container diameter shall be 140 mm.	Comply	29, 30, 59, 70	
S13	The container wall thickness shall be at least 2 mm when 3D printed and must not flex or be deformed when under pressure.	Comply	29	
S14	The container length above the shoulder shall be 200mm +/-5%.	Comply	29, 59, 70	
S15	The CanSat shall perform the function of the nose cone during rocket ascent.	Comply	31	
S16	The CanSat container can be used to restrain any deployable part of the CanSat payload but shall allow the CanSat to slide out of the payload section freely.	Comply	29	
S17	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	81	
S18	The CanSat container shall meet all dimensions in section F.	Comply	29	
S19	The CanSat container materials shall meet all requirements in section F.	Comply	61	



Requirements Compliance (5/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
S20	If the nose cone is to separate from the payload after payload deployment, the nose cone shall descent at no more than 5 meters/sec	Comply	44	
S21	If the nose cone is to separate from the payload after payload deployment, the nose cone shall be secured to the payload until payload deployment with a pull force to survive at least 15Gs acceleration.	Comply	133	
M1	No pyrotechnical or chemical actuators are allowed.	Comply	72	
M2	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting the vegetation on fire.	Comply	NA	No mechanisms use heat
M3	All mechanisms shall be capable of maintaining their configuration or states under all forces	Comply	133	
M4	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	66	
E1	Lithium polymer batteries are not allowed.	Comply	105, 107, 108 ,109	



Requirements Compliance (6/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
E2	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with metal package similar to 18650 cells. Coin cells are allowed.	Comply	105, 107, 108, 109	
E3	An easily accessible power switch through the container is required.	Comply	29, 59	
E4	The container shall have small access holes for power switches of no more than 10mm.	Comply	29, 59	
E5	Power indicator is required.	Comply	105	
E6	The CanSat shall operate for a minimum of two hours when integrated into the rocket.	Comply	110, 111	
E7	The audio beacon shall operate on a separate battery.	Comply	107, 109, 112	
E8	The audio beacon shall have an easily accessible power switch through the container.	Comply	29, 59	
X1	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Comply	95, 96	



Requirements Compliance (7/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
X2	Xbee radios shall have their NETID/PANID set to their team number.	Comply	96	
X3	Xbee radios shall not use broadcast mode.	Comply	96	
X4	The CanSat shall transmit telemetry once per second.	Comply	96	
X5	The CanSat telemetry shall include altitude, air pressure, temperature, battery voltage, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	Comply	97	
SN1	CanSat payload shall measure its altitude using air pressure.	Comply	35	
SN2	CanSat payload shall measure its internal temperature.	Comply	36	
SN3	CanSat payload shall measure its battery voltage.	Comply	38	
SN4	CanSat payload shall track its position using GPS.	Comply	37	
SN5	CanSat payload shall measure its acceleration and rotation rates.	Comply	39, 40	



Requirements Compliance (8/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
SN6	CanSat payload shall video record the deployment of the para-glider at 80% peak altitude.	Comply	33, 90, 116	
SN7	CanSat payload shall video record the ground during descent.	Comply	33, 90, 116	
SN8	The ground pointing camera shall capture video of the instrument(egg) being released and reaching the ground.	Comply	33, 90, 116	
SN9	The video cameras shall record video in color and with a minimum resolution of 640x480.	Comply	41, 42	
SN10	CanSat payload shall measure its battery current.	Comply	38	
G1	The ground station shall command the CanSat to calibrate the altitude to zero when the CanSat is on the launch pad prior to launch.	Comply	142	
G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	128, 141, 142	
G3	Telemetry shall include mission time with 1 second resolution.	Comply	96, 97, 118, 119	
G4	Each team shall develop their own ground station.	Comply	122, 123, 124, 126, 127, 128	



Requirements Compliance (9/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
G5	All Telemetry shall be displayed in real time in text format during ascent and descent on the ground station.	Comply	114, 118, 119, 128	
G6	All telemetry shall be displayed in International System of Units (SI) and the units shall be indicated on the displays.	Comply	128	
G7	Teams shall plot altitude, battery voltage, battery current, accelerometer value and rotation rates in real time.	Comply	126, 127	
G8	Teams shall display mission time, temperature, GPS position, received packet count, lost packet count, and flight software state in real time.	Comply	126, 127	
G9	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and an antenna.	Comply	122, 124	
G10	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	120, 122, 124	



Requirements Compliance (10/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
G11	The ground station software shall be able to command the payload to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVE.	Comply	143	
G12	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	96, 97, 118, 119	
G13	The ground station shall use a table top or handheld antenna.	Comply	124	
G14	Because the ground station must be viewed in bright sunlight, the displays shall be designed with that in mind, including using larger fonts (14 point minimum), bold plot traces and axes, and a dark text on light background theme.	Comply	126, 127, 128	
G15	All data shall be shown simultaneously in the ground station GUI. Tabs are not allowed.	Cogmply	126, 127, 128	
G16	The ground system shall count the number of received packets. Note that this number is not equivalent to the transmitted packet counter, but it is the count of packets successfully received at the ground station for the duration of the flight.	Comply	96, 120, 126, 127, 128	
G17	The ground station shall be able to activate all mechanisms on command.	Comply	126, 127, 128	



Requirements Compliance (11/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
F1	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	118, 126	
F2	The CanSat shall maintain mission time throughout the entire mission even in the event of a processor resets or momentary power loss.	Comply	118, 126	
F3	The CanSat shall have its time set by ground command to within one second UTC time prior to launch.	Comply	102	
F4	The 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 file.	Comply	102, 119, 128	
F5	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the payload altitude.	Comply	119	
F6	The flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Comply	102, 119, 128	



Requirements Compliance (12/12)



Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
F7	The flight shall include commands to activate all mechanisms. These commands shall be documented in the mission manual.	Comply	102, 103, 128	
F8	Configuration states such as zero altitude calibration software state shall be maintained in the event of a processor reset during launch and mission.	Comply	118	



Management

Tyler Ebner



Status of Procurements (1/8)



Component	Quantity	Ordered	Received	Status
Stainless Steel Threaded Rod	4	2/27/26	Pending	Pending
Kevlar Cord - 300ft	1	2/27/26	Pending	Pending
Assorted M3 Screw Set	1	2/27/26	Pending	Pending
Assorted Threaded Insert Set	1	2/27/26	Pending	Pending
18350 Battery	4	2/27/26	Pending	Pending
Battery Holder Pin	2	2/27/26	Pending	Pending
Assorted M6 Screw Set	1	3/11/26	Pending	Pending



Status of Procurements (2/8)



Component	Quantity	Ordered	Received	Status
Steel Servo Horns	1	3/11/26	Pending	Pending
Raspberry Pi Pico 2	2	3/11/26	Pending	Pending
BNO085	1	3/11/26	Pending	Pending
BMP581	2	3/11/26	Pending	Pending
SAM-M10Q	2	3/11/26	Pending	Pending
Pressure Sensor	2	1/2/26	2/4/26	Received
Current Monitor Regulator	2	1/2/26	2/4/26	Received



Status of Procurements (3/8)



Component	Quantity	Ordered	Received	Status
IMU I2C 32BIT	1	1/2/26	2/4/26	Received
SAM-M10Q	1	1/2/26	2/4/26	Received
Buzzer	1	1/2/26	2/4/26	Received
Switching Voltage Regulators	2	1/2/26	2/4/26	Received
CONN HEADER	4	1/2/26	2/4/26	Received
MOSFET P-30V	2	1/2/26	2/4/26	Received
Diode	5	1/2/26	2/4/26	Received



Status of Procurements (4/8)



Component	Quantity	Ordered	Received	Status
Battery Holder	3	1/2/26	2/4/26	Received
Battery Holder Retainer	5	1/2/26	2/4/26	Received
Mg14 Servo	2	1/2/26	2/4/26	Received
Switch Slide	2	1/2/26	2/4/26	Received
IND	3	1/2/26	2/4/26	Received
Drum Core	4	1/2/26	2/4/26	Received
PCB	2	1/2/26	2/4/26	Received



Status of Procurements (5/8)



Component	Quantity	Ordered	Received	Status
Lithium Battery	1	1/2/26	2/4/26	Received
Diode	4	1/2/26	2/4/26	Received
MOSFET	2	1/2/26	2/4/26	Received
RES	10	1/2/26	2/4/26	Received
CAP CER 4.7UF	15	1/2/26	2/4/26	Received
CAP CER 0.1UF	15	1/2/26	2/4/26	Received
CAP CER 10UF	15	1/2/26	2/4/26	Received



Status of Procurements (6/8)



Component	Quantity	Ordered	Received	Status
8 Rectangular Connectors	4	1/2/26	2/4/26	Received
Socket Contact Tin	50	1/2/26	2/4/26	Received
Regulator	4	1/2/26	2/4/26	Received
Raspberry Pi Pico 2	2	1/2/26	2/4/26	Received
Runcam Split 4	2	1/2/26	2/4/26	Received
12 pack of 123A Batteries	1	1/2/26	2/4/26	Received
Hook Up Wire, 22 AWG	1	1/2/26	2/4/26	Received



Status of Procurements (7/8)



Component	Quantity	Ordered	Received	Status
Hook Up Wire, 20 AWG	1	1/2/26	2/4/26	Received
TPU	1	1/2/26	2/4/26	Received
Carbon Fiber Nylon Filament	1	1/2/26	2/4/26	Received
Mg17 Servo	1	1/2/26	2/4/26	Received
Steel Threaded Rod	2	1/2/26	2/4/26	Received
Steel Eyebolt 1/4in	1	1/2/26	2/4/26	Received
Steel Eyebolt	2	1/2/26	2/4/26	Received



Status of Procurements (8/8)



Component	Quantity	Ordered	Received	Status
Aluminum Standoffs	8	1/2/26	2/4/26	Received
M2 Hex Screw Set	1	1/2/26	2/4/26	Received
M3 Hex Screw Set	1	1/2/26	2/4/26	Received
Kevlar Cord	1	1/2/26	2/4/26	Received
1.0 oz HyperD Ripstop Nylon	3	1/2/26	2/4/26	Received



CanSat Budget – Hardware (1/6)



Name	Team	Price (\$)	Quantity	Total (\$)	Source	Reuse
828-BMP581CT-ND - Pressure Sensor	Electrical	2.92	2	5.84	Digikey	
296-47777-1-ND - Current Monitor Regulator	Electrical	5.52	2	11.04	Digikey	
1888-1006-1-ND - IMU I2C 32BIT	Electrical	13.05	1	13.05	Digikey	
672-SAM-M10Q-00BCT-ND	Electrical	31.50	1	31.50	Digikey	
668-1204-ND - Buzzer	Electrical	3.38	1	3.38	Digikey	X
296-LMR51430XDDCRCT-ND - Switching Voltage Regulators	Electrical	1.58	2	3.16	Digikey	
WM1798-ND - CONN HEADER	Electrical	1.74	4	6.96	Digikey	
785-1421-1-ND - MOSFET P-30V	Electrical	1.50	2	3.00	Digikey	
MMSZ5242B-FDICT-ND - Diode	Electrical	0.12	5	0.60	Digikey	
36-1051-ND - Battery Holder	Electrical	2.14	3	6.42	Digikey	
36-1018C-ND - Battery Holder Retainer	Electrical	0.85	5	4.25	Digikey	
1738-1232-ND - Mg14 Servo	Electrical	8.62	2	17.24	Digikey	



CanSat Budget – Hardware (2/6)



Name	Team	Price (\$)	Quantity	Total (\$)	Source	Reuse
679-1877-ND - Switch Slide	Electrical	6.60	2	13.20	Digikey	
SRR1260A-5R6YCT-ND - IND	Electrical	1.23	3	3.69	Digikey	
490-18407-1-ND - Drum Core	Electrical	0.71	4	2.84	Digikey	
732-10955-ND - PCB	Electrical	0.36	2	0.72	Digikey	
728-1053-ND - Lithium Battery	Electrical	2.20	1	4.40	Digikey	
4878-BAT54CT-ND - Diode	Electrical	0.14	4	0.56	Digikey	
448-IRLB8748PBF-ND - MOSFET	Electrical	1.40	2	2.80	Digikey	
311-4.7KJRCT-ND - RES	Electrical	0.10	10	1.00	Digikey	
1276-1044-1-ND - CAP CER 4.7UF	Electrical	0.08	15	1.20	Digikey	
1276-1043-1-ND - CAP CER 0.1UF	Electrical	0.02	15	0.30	Digikey	
1276-1450-1-ND - CAP CER 10UF	Electrical	0.08	15	1.20	Digikey	
WM26387-ND - 8 Rectangular Connectors	Electrical	0.44	4	1.76	Digikey	
WM1837-ND - Socket Contact Tin	Electrical	0.18	50	9.00	Digikey	



CanSat Budget – Hardware (3/6)



Name	Team	Price (\$)	Quantity	Total (\$)	Source	Reuse
AP63205WU-7DICT-ND - Regulator	Electrical	0.71	4	2.84	Digikey	
Raspberry Pi Pico 2	Electrical	5.00	2	5.00	Adafruit	
B08BWWXK49 - Runcam Split 4	Electrical	119.99	2	239.98	Amazon	
SF12-BB - 12 pack of 123A Batteries	Electrical	37.49	1	37.49	Surefire	
22UL1007KITS - Hook Up Wire, 22 AWG	Electrical	21.58	1	21.58	Remington Industries	
20UL1007KITS - Hook Up Wire, 20 AWG	Electrical	25.91	1	25.91	Remington Industries	
B0DZCD4Z9M - TPU	Mechanical	49.99	1	49.99	Amazon	
PA6-CF - Carbon Fiber Nylon Filament	Mechanical	34.39	1	34.39	Bambu Lab	
9396750002 - Mg17 Servo	Mechanical	14.39	1	14.39	Hobbyking	
90024A218 - Steel Threaded Rod	Mechanical	4.80	2	9.60	McMaster-Carr	
3014T45 - Steel Eyebolt 1/4in	Mechanical	3.82	1	3.82	McMaster-Carr	
3040T11- Steel Eyebolt	Mechanical	7.00	2	14.00	McMaster-Carr	
98952A108 - Aluminum Standoffs	Mechanical	0.81	8	6.48	McMaster-Carr	



CanSat Budget – Hardware (4/6)



Name	Team	Price (\$)	Quantity	Total (\$)	Source	Reuse
B0FGV5K8BT - M2 Hex Screw Set	Mechanical	9.99	1	9.99	Amazon	
B0FGV5FCBN - M3 Hex Screw Set	Mechanical	9.99	1	9.99	Amazon	
B07X7Q55MZ - Kevlar Cord	Mechanical	24.99	1	24.99	Amazon	
1.0 oz HyperD Ripstop Nylon	Mechanical	6.60	3	19.80	RipstopByThe Roll	
Stainless Steel Threaded Rod	Mechanical	4.80	4	19.20	McMaster-Carr	
Kevlar Cord - 300ft	Mechanical	34.99	1	34.99	Amazon	
Assorted M3 Screw Set	Mechanical	9.99	1	9.99	Amazon	
Assorted Threaded Insert Set	Mechanical	16.97	1	16.97	Amazon	
18350 Battery	Electrical	6.49	4	25.96	Liion Wholesale	
Battery Holder Pin	Electrical	3.53	2	7.06	Liion Wholesale	
Assorted M6 Screw Set	Electrical	9.89	1	9.89	Amazon	



CanSat Budget – Hardware (5/6)



Name	Team	Price (\$)	Quantity	Total (\$)	Source	Reuse
Steel Servo Horns	Mechanical	8.99	1	8.99	Amazon	
Raspberry Pi Pico 2	Electrical	6.25	2	12.50	Adafruit	
BNO085	Electrical	13.05	1	13.05	Digikey	
BMP581	Electrical	2.92	2	5.84	Digikey	
SAM-M10Q	Electrical	13.33	2	26.66	Digikey	



CanSat Budget – Hardware (6/6)



Cost Total	
Mechanical Parts Subtotal	\$287.58
Electrical Parts Subtotal	\$582.87
Total Hardware Cost	\$870.45



CanSat Budget – Other Costs



Name	Team	Price (\$)	Quantity	Total (\$)	Source	Reuse
Ground Station Laptop	Software	869.00	1	869.00	Amazon	X
PC906N Antenna	Software	84.68	1	84.68	Digikey	X
Travel	All	100.00	10	1000.00	N/A	
Food	All	100.00	10	1000.00	N/A	
Housing	All	114.00	10	1140.00	N/A	
Prototyping Materials	All	150	1	150	N/A	

Cost Total	
Other Costs Subtotal	\$4,243.68
Total Mission Cost	\$5,144.13

Thank you to our Sponsors



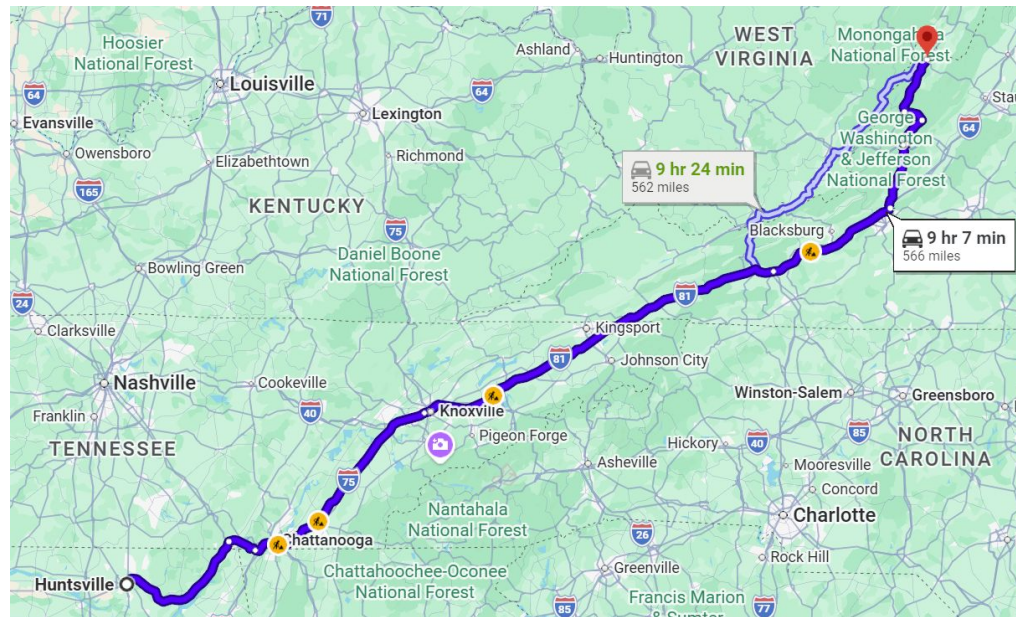


Shipping and Transportation



Transportation Plan

We will be transporting the CanSat and ourselves by driving Vans that will be provided by The University of Alabama in Huntsville. This will include things such as our CanSat, extra parts, tools, and ground station



Source: Google



Conclusions (1/4)



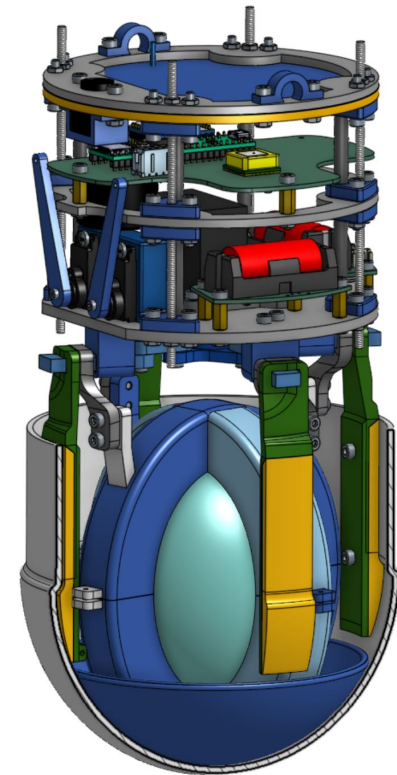
Mechanical Conclusions

Accomplishments

- Created a prototype that accomplishes much of the functionality required for the mission.
- Successfully designed a para-glider that achieved the desired descent rate.

Work to be Done

- Integrate control arms
- Test the release mechanism further
- Redesign to accommodate electrical design changes
- Rebuild full CanSat payload





Conclusions (3/4)



Software Conclusions

Accomplishments

- Successfully created a ground station that communicates with embedded
- Working SIM and SIMP for ground station and embedded
- Processor restart code written
- Autonomous code written

Work to be Done

- Test embedded with all sensors
- Rework embedded for new microcontroller
- Test processor restart code
- Integrate and test the autonomous code



Flight Software Status

- On competition schedule pace
- Sensors and flight states work
- Data is properly transferred and received
- Flight control is written
- Brown out protection is written



Conclusions (4/4)



General Conclusions

Accomplishments

- Had a test launch where every subsystem learned
- Payload was able to glide and transmit data for the duration of the flight

Work to be Done

- Remake our payload
- Design and order a new PCB
- Rework Software and integrate new system

