CanSat 2023
Critical Design Review (CDR)
Outline
Version 1.1

Team 1032

Yes we CANSAT

Presentation Outline

Team Organization

- **Faculty Advisor**: Ting Dong
- **Team Lead**: Savari Datta, Junior
  - Container Subsystem
    - **Container**: Christian Roque, Freshman
  - Payload & Aerodynamics
    - **Payload Lead**: Jordi Rey, Junior
    - Daniel Horton, Junior
    - Melissa Gonzalez Grospe, Sophomore
  - Payload Deployment
    - **Aerodynamics Lead**: Jovana Markovic, Junior
  - Avionics Subsystem
    - **Avionics Lead**: Dylan Falzone, Junior
    - Yashas Shivaram, Junior
    - Paolo D'Alessandro, Junior
  - Flight Software
    - **Flight Software**: Max Epstein, Sophomore

Acronyms

Acronym	Meaning
ABS	Acrylonitrile Butadiene Styrene
CD	Drag Coefficient
CDH	Communication and Data Handling
CSV	Comma-Separated Values
DAC	Digital-to-Analog Converter
EPS	Electrical Power Subsystem
FSW	Flight Software
GCS	Ground Control System
GPS	Global Positioning System
IDE	Integrated Development Environment
LED	Light-Emitting Diode
MAE	Mechanical & Aerospace Engineering

Acronym	Meaning
MQTT	MQ Telemetry Transport
OTS	Off-the-shelf
PDR	Preliminary Design Review
PID	Proportional-Integral-Derivative
PWM	Pulse-Width Modulation
RPM	Revolutions per Minute
SMA	Subminiature Version A
SPI	Serial Peripheral Interface
SSDC	Space Systems Design Club
STEM	Science, Technology, Engineering, and Mathematics
UF	University of Florida

System Overview

Savari Datta, Jordi Rey, Daniel Horton

Main Objectives:

Design a CanSat that shall consist of a container and a payload. The probe shall simulate the sequence of a planetary probe

- The CanSat shall be launched to an altitude ranging from 670 meters to 725 meters above the launch site and deployed near apogee (peak altitude).
- The CanSat must survive the forces incurred at launch and deployment.
- Once the CanSat is deployed from the rocket, the CanSat shall descend using a parachute at a rate of 15 m/s.
- At 500 meters, the CanSat shall deploy a probe that shall open a heat shield.
- The heat shield will be used as an aerobraking device with a descent rate of 20 meters/second or less.
- When the probe reaches 200 meters, the probe shall deploy a parachute and slow the descent rate to 5 meters/second.
- Once the probe has landed, it shall attempt to upright itself and raise a flag 500 mm above the base of the probe.
- The video camera shall be pointed towards the ground during descent.

Mission Summary (2/2)

Bonus Objectives:

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

- Will not be attempting bonus objective

External Objectives:

- To promote STEM engagement at the university level
- To provide team members with valuable hands-on engineering project experience that includes designing, manufacturing and testing of an aerospace system
- To challenge students with unique projects that require critical thinking
- To inspire underclassmen to continue participating in the annual CanSat competition at UF

Summary of Changes Since PDR

Changes	Reason
Shape of the can was completely redesigned	We redesigned the can to withstand more G's during shock. Additionally, the previous can configuration was found to not be very compatible with the probe design and the new configuration would allow the can to be sealed
One platform was removed from the probe	This will allow more room to fit the electronics
Platforms on the probe will be secured using both nuts and superglue instead of a double nut configuration	This will be more secure and save some mass budget
A method to seal the can from outside elements was developed	Secure the can from outside elements
Flag deployment mechanism moved to the bottom of the probe	Allowed for more stability for both the flag and the probe as a whole

System Requirement Summary (1/6)

Requirement Number	Description
1	Total mass of the CanSat (science payloads and container) shall be 700 grams +/- 10 grams.
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.
4	The container shall be a fluorescent color; pink, red or orange.
5	The container shall be solid and fully enclose the science probes. Small holes to allow access to turn on the science probes are allowed. The end of the container where the probe deploys may be open.
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.
7	The rocket airframe shall not be used as part of the CanSat operations.
8	The container's parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.
9	The Parachutes shall be fluorescent Pink or Orange
10	The descent rate of the CanSat (container and science probe) shall be 15 meters/second +/- 5m/s.
11	0 altitude reference shall be at the launch pad.

System Requirement Summary (2/6)

Requirement Number	Description
12	All structures shall be built to survive 15 Gs of launch acceleration.
13	All structures shall be built to survive 30 Gs of shock
14	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high-performance adhesives.
15	All mechanisms shall be capable of maintaining their configuration or states under all forces.
16	Mechanisms shall not use pyrotechnics or chemicals.
17	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.
18	Both the container and payload shall be labeled with team contact information including email address.
19	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost. Equipment from previous years should be included in this cost, based on current market value.
20	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.
21	XBEE radios shall have their NETID/PANID set to their team number.
22	XBEE radios shall not use broadcast mode.
23	The container and probe shall include an easily accessible power switch that can be accessed without disassembling the CanSat and science probes and in the stowed configuration.

System Requirement Summary (3/6)

Requirement Number	Description
24	The probe shall include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the CanSat and in the stowed state.
25	An audio beacon is required for the probe. It shall be powered after landing.
26	The audio beacon shall have a minimum sound pressure level of 92 dB, unobstructed.
27	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.
28	An easily accessible battery compartment shall be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.
29	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.
30	The CanSat shall operate during the environmental tests laid out in Section 3.5.
31	The CanSat shall operate for a minimum of two hours when integrated into the rocket.
32	The probe shall be released from the container when the CanSat reaches 500 meters.
33	The probe shall deploy a heat shield after leaving the container.
34	The heat shield shall be used as an aerobrake and limit the descent rate to 20 m/s or less.
35	At 200 meters, the probe shall release a parachute to reduce the descent rate to 5 m/s +/- 1m/sec.

System Requirement Summary (4/6)

Requirement Number	Description
36	Once landed, the probe shall upright itself.
37	After uprighting, the probe shall deploy a flag 500 mm above the base of the probe when the probe is in the upright position.
38	The probe shall transmit telemetry once per second.
39	The probe telemetry shall include altitude, air pressure, temperature, battery voltage, probe tilt angles, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.
40	The probe shall include a video camera pointing down to the ground.
41	The video camera shall record the flight of the probe from release to landing.
42	The video camera shall record video in color and with a minimum resolution of 640x480.
44	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets
45	The probe shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.
46	The probe shall have its time set to within one second UTC time prior to launch.
47	The probe flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.
48	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.

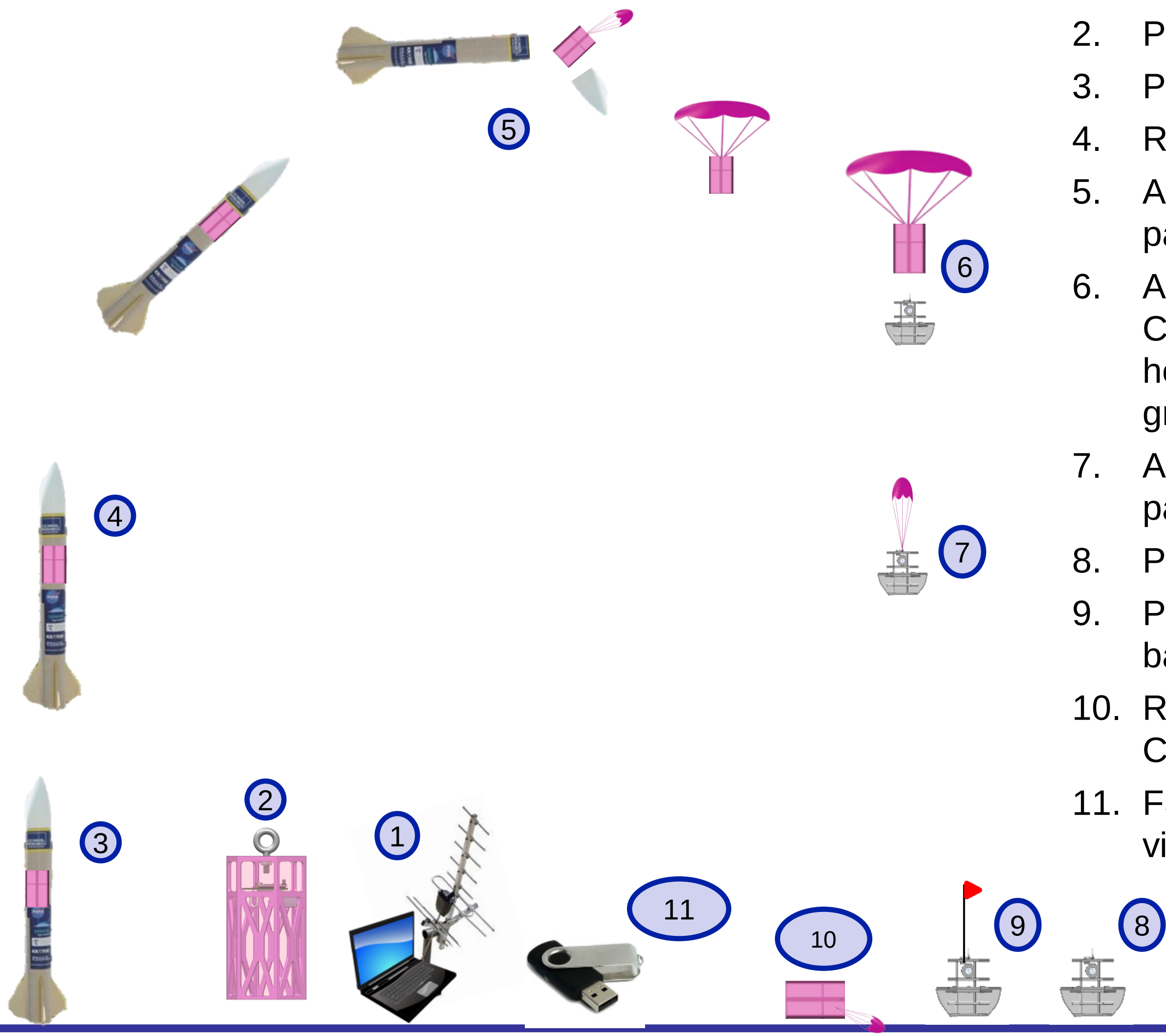
System Requirement Summary (5/6)

Requirement Number	Description
49	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.
50	The ground station shall command the CanSat to start calibrating the altitude to zero when the CanSat is on the launch pad prior to launch.
51	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.
52	Telemetry shall include mission time with 0.01 second or better resolution.
53	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.
54	Each team shall develop their own ground station.
55	All telemetry shall be displayed in real time during descent on the ground station.
56	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)
57	Teams shall plot each telemetry data field in real time during flight.
58	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.
59	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site
60	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.

System Requirement Summary (6/6)

Requirement Number	Description
61	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the CanSat.

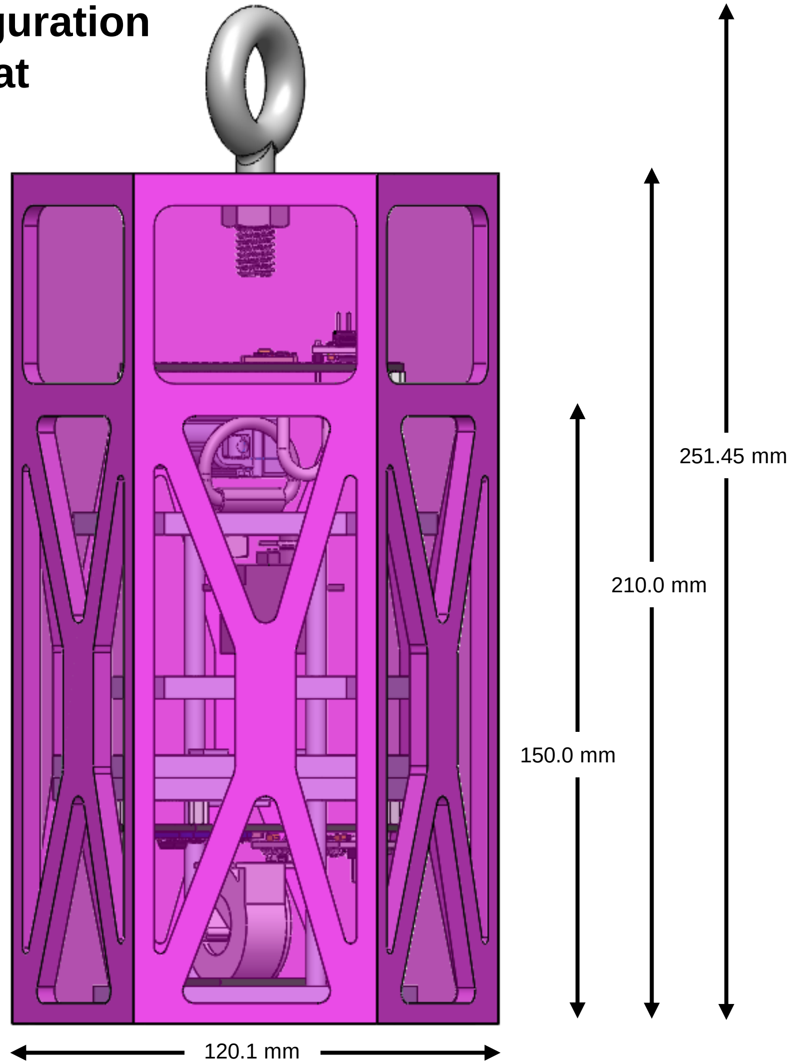
System Concept of Operations (CONOPS)



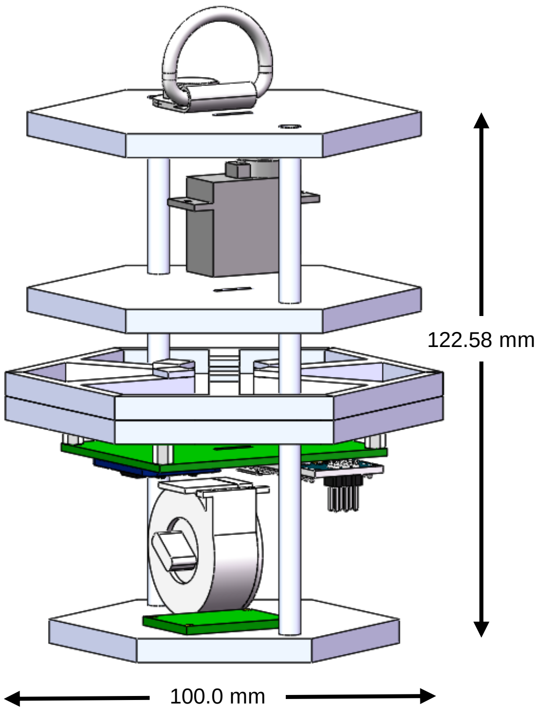
1. Set up ground station
2. Power on CanSat
3. Place CanSat into rocket
4. Rocket is launched
5. At 670-725m the CanSat separates and parachute opens
6. At 500m a probe will be released from the CanSat, which will deploy an aerobraking heat shield, with a camera facing the ground at all times
7. At 200m the probe will deploy a parachute too reduce descent rate
8. Probe will land upright
9. Probe will deploy a flag 500mm above the base of the probe
10. Recovery crew tracks and collects CanSat
11. FSW obtains and saves flight data & video recording to thumb drive

CanSat Physical Layout (1/2)

Launch Configuration of CanSat

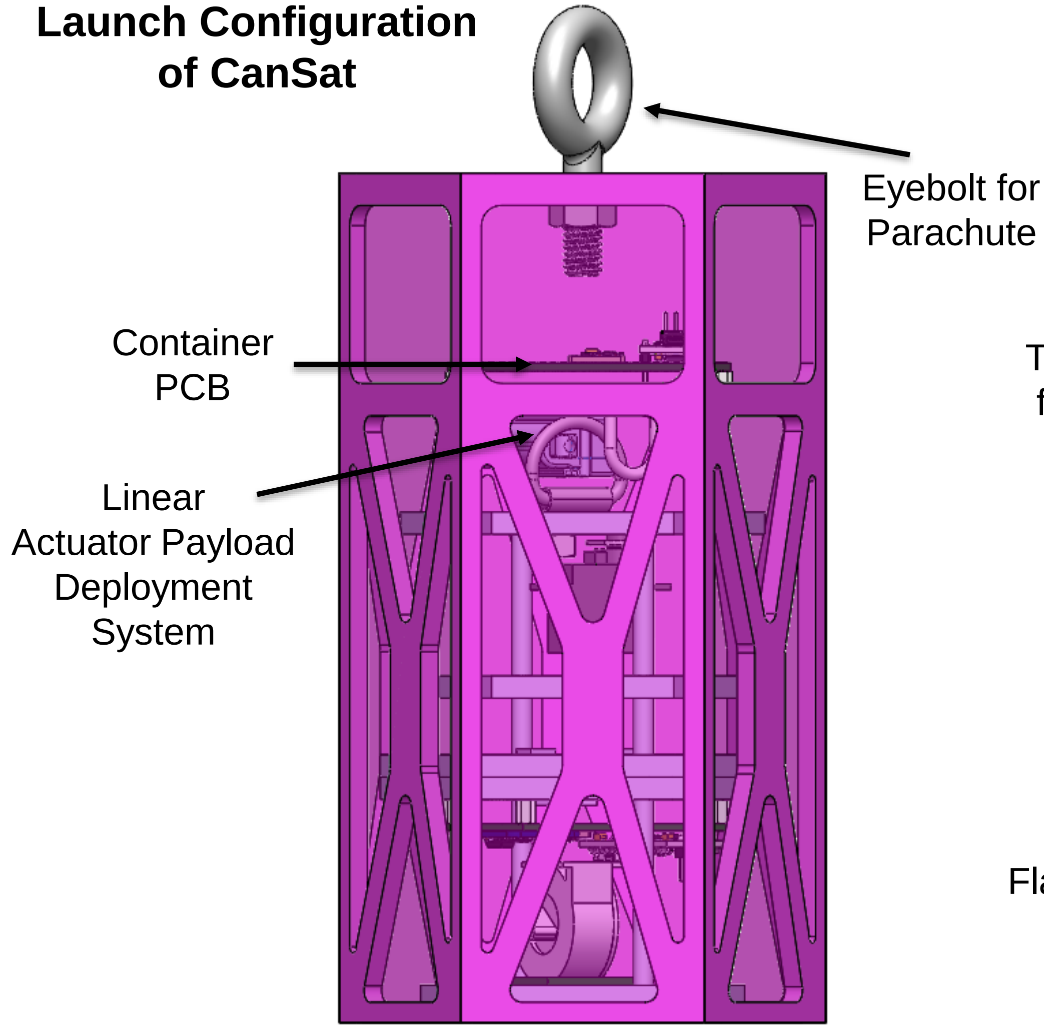


Launch Configuration of Payload

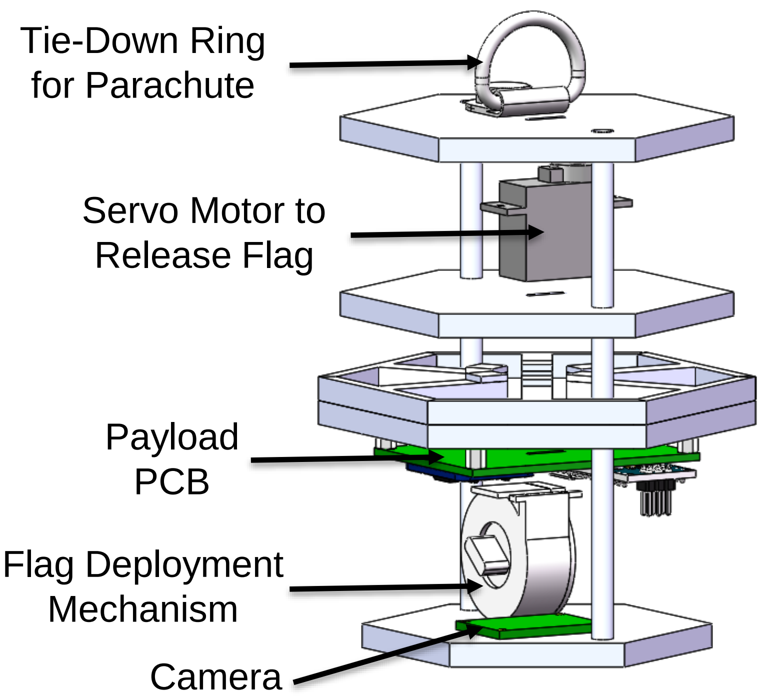


CanSat Physical Layout (2/2)

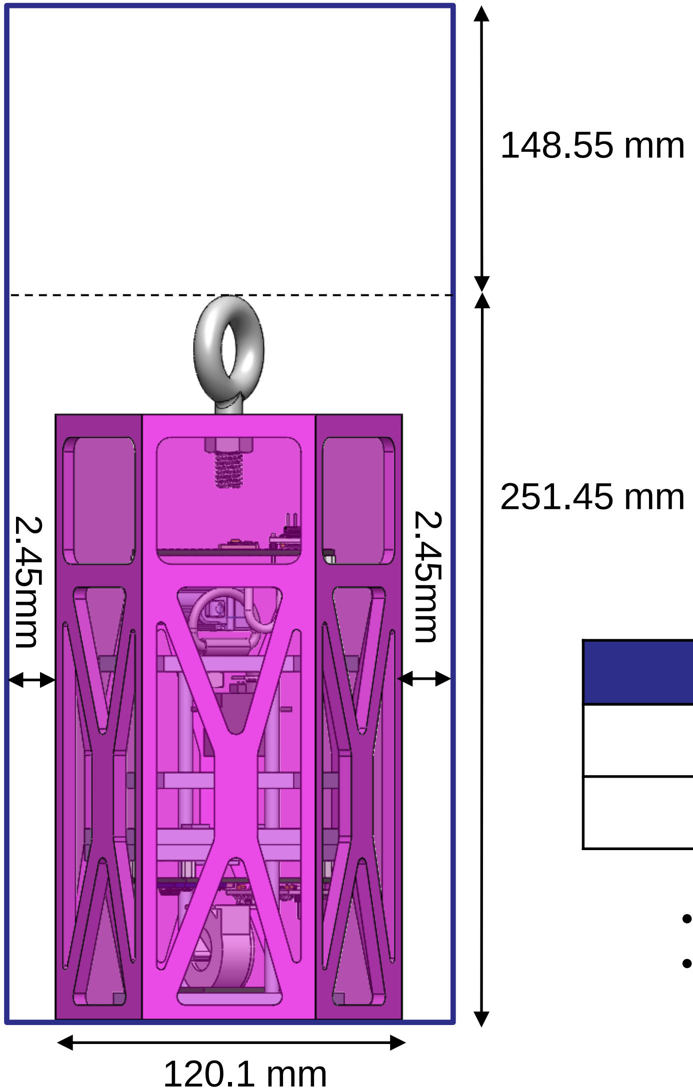
Launch Configuration of CanSat



Launch Configuration of Payload



Launch Vehicle Compatibility (1/2)



Mission Constrains	Dimension (mm)
Height	400
Diameter	125

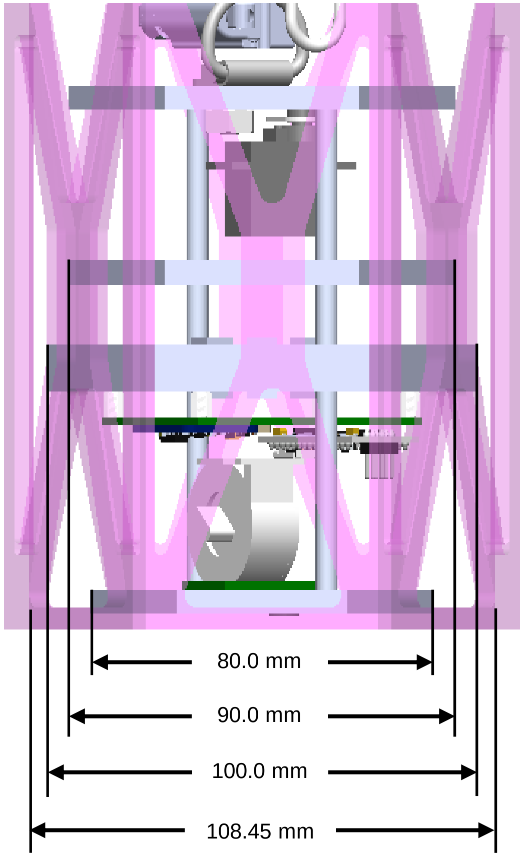
Property	Dimension (mm)	Clearance (mm)
Height	251.45	148.55
Width	120.1	2.45

- ALL sharp edges will be sanded down.
- Limited vertical protrusions (testing will be conducted to ensure no interference)

Launch Vehicle Compatibility (2/2)

Payload Clearance

ALL sharp edges will be sanded down.



Total clearance between payload and wall of container is 8.45 mm, 4.225 mm on each side.

Sensor Subsystem Design

Dylan Falzone

Sensor Subsystem Overview

Sensor Type	Model	Purpose	CanSat Location
GPS module	Adafruit Ultimate	Determine location coordinates (X,Y,Z) & exact time	Payload
Pressure Sensor	Adafruit BMP280	Measure altitude of Container & Payload	Container, Payload
Rotational Sensor	BNO055	Measure gyro readings in degrees per second, angular acceleration, and magnetometer readings in gauss	Payload
Temperature Sensor	BNO055	Measure temperature readings	Payload
Camera	Arducam Mini 2MP Plus	View and record Earth's terrain during descendent	Payload

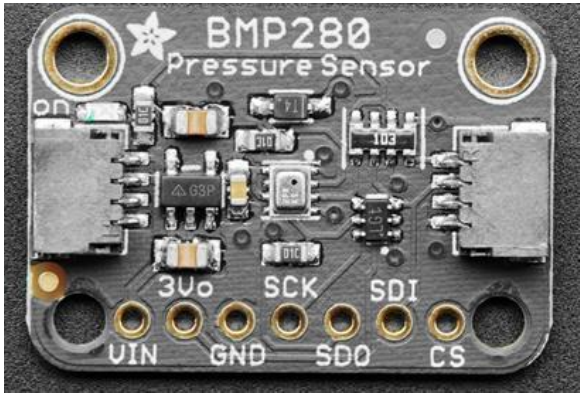
Sensor Changes Since PDR

- **No changes have been made since the PDR**

Payload Air Pressure Sensor Summary

Sensors	Current (at 1Hz) (µA)	Temperature Range (°C)	Interfaces	Resolution (hPa)	Voltage Usage (V)	Size (mm) L x W x H	Weight (g)	Price ($)
Adafruit BMP280	2.7	-40 to 85	I2C, SPI	.0016	1.71 ~ 3.6	19.2 x 17.9 x 2.9	1.3	9.95

Selection	Reasoning for the selection
Adafruit BMP280	- Lower current draw in comparison to other inspected sensors - Greater resolution in comparison to other inspected sensors



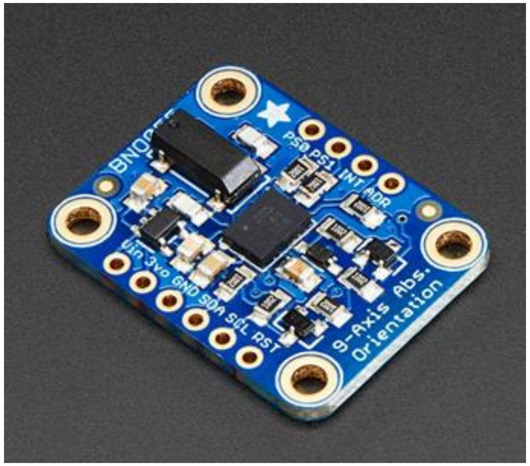
Data Processing
See Next Slide

Data Processing

```
double altittudeCalc(float P){
    double sLP = 101325; //sea level pressures
    double x = pow((P/sLP),(1/5.255));
    double h = 44330 *(1-x);
     return h;
   //h = calculated altitude[m]
   //P = sensed pressure[Pa]
   //Po= sea level preasure[Pa]
}
  Serial.print("Pressure: ");Serial.println(pres/3389.39 ); //inHg
  Serial.print("Altitude: ");;Serial.println(altittudeCalc(pres)); //m
```

Payload Air Temperature Sensor Summary

Selection	Reasoning for the selection
BNO 055	- Familiarity with sensor - Also meets our requirements for the payload's rotational sensor - Availability



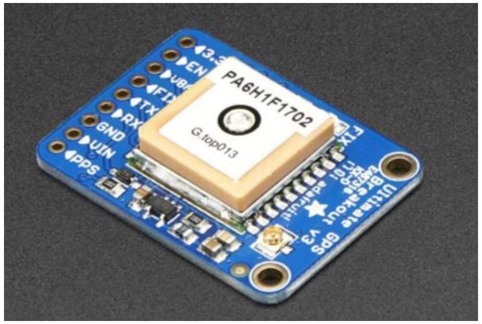
Sensors	Temperature Range (°C)	Interfaces	Voltage Usage (V)	Size (mm) L x W x H	Weight (g)	Price ($)
BNO055	-40 to 85	I2C or UART	1.7 – 3.6	20 x 27 x 4	3	34.95

Data Processing

```
bno.getEvent(&orientation_events);
  Serial.println();
  Serial.print(F("Temperature = "));
  Serial.print(temp_event.temperature);
  Serial.println(" *C");
```

Payload GPS Sensor Summary

Selection	Reasoning for the selection
Adafruit Ultimate	- Lower current draw during tracking in comparison to other inspected sensors - Previous experience with sensor and familiarity with Arduino - Availability



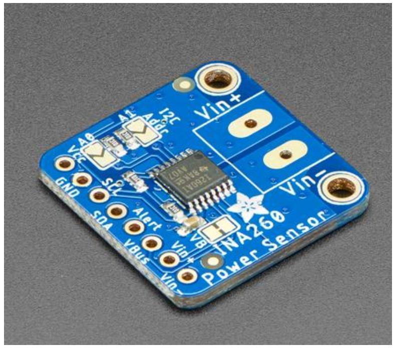
Sensors	Update Rate (Hz)	Operating Voltage (V)	Current (Tracking) (mA)	Interfaces	Size (mm) L x W x H	Weight (g)	Price ($)
Adafruit Ultimate Breakout v3	10	3.0 – 5.0	20	I2C, SPI, UART	25.5 x 35 x 6.5	8.5	29.95

Data Processing

```
Serial.print("Location: ");
Serial.print(GPS.latitude, 4); Serial.print(GPS.lat);
Serial.print(", ");
Serial.print(GPS.longitude, 4); Serial.println(GPS.lon);
Serial.print("Satellites: "); Serial.println((int)GPS.satellites);
```

Payload Voltage Sensor Summary

Selection	Reasoning for the selection
Adafruit INA260	- Greater resolution bit compared to other sensors - Previous experience and familiarity with sensor - Availability



Sensors	Resolution	Interfaces	Size (mm) L x W x H	Weight (g)	Price ($)
Adafruit INA260	16 bit	I2C	22.9 x 22.8 x 2.7	2	9.95

Data Processing

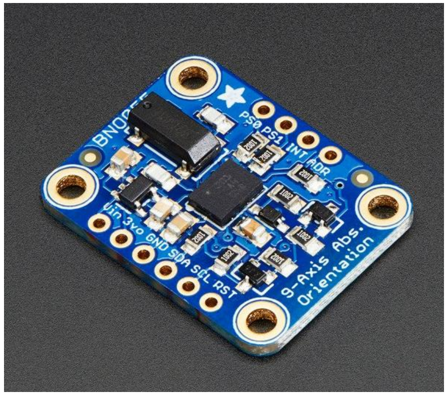
```
Serial.print("Current: ");
Serial.print(ina260.readCurrent());
Serial.println(" mA");

Serial.print("Bus Voltage: ");
Serial.print(ina260.readBusVoltage());
Serial.println(" mV");

Serial.print("Power: ");
Serial.print(ina260.readPower());
Serial.println(" mW");
```

Payload Tilt Sensor Summary

Selection	Reasoning for the selection
BNO055	- Familiarity with sensor - Also meets our requirements for the payload's Temperature sensor - Availability



Sensors	Temperature Range (°C)	Interfaces	Voltage Usage (V)	Size (mm) L x W x H	Weight (g)	Price ($)
BNO055	-40 to 85	I2C or UART	1.7 – 3.6	20 x 27 x 4	3	34.95

Data Processing

```
Serial.print((float)orientation_events.orientation.x);
Serial.print(F(" "));
Serial.print((float)orientation_events.orientation.y);
Serial.print(F(" "));
Serial.print((float)orientation_events.orientation.z);
Serial.println(F(""));
```

Camera Summary

Selection	Reasoning for the selection
Arducam Mini 2MP Plus	- Compatibility with microprocessor - Lower current draw in comparison to other inspected sensors

Name	Price ($)	Weight (g)	Size (mm)	Operating Voltage (V)	Current Draw (mA)	Framerate (fps)
Arducam Mini 2MP Plus	25.99	20	24 x 34	3.3 - 5.0	20	30

Data Processing

```
myCAM.start_capture();
Serial.println(F("start capture."));
total_time = millis();
while ( !myCAM.get_bit(ARDUCHIP_TRIG,
CAP_DONE_MASK));
Serial.println(F("CAM Capture Done."));
```

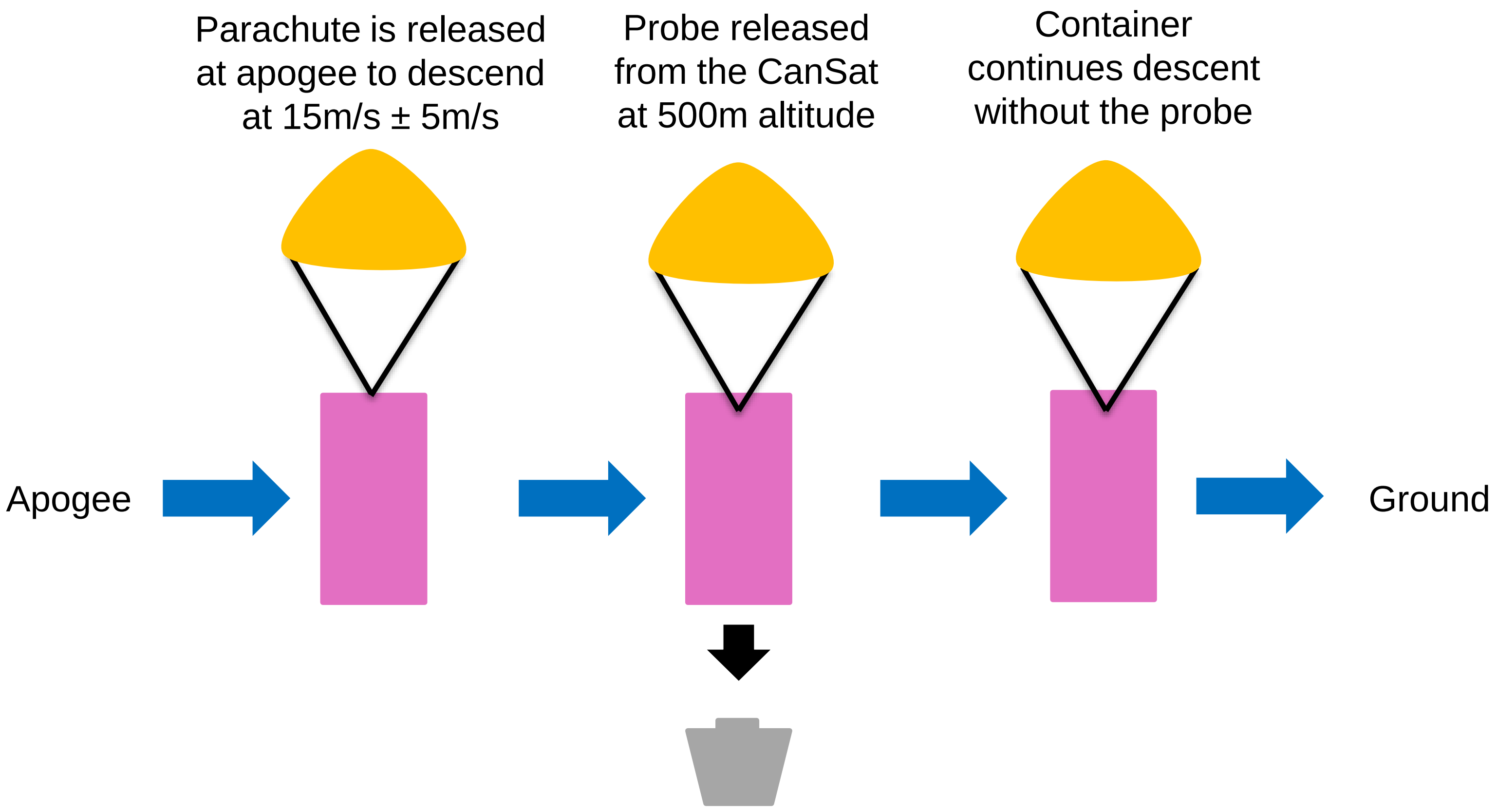
Bonus Camera Summary

- **N/A**

Descent Control Design

Jovana Markovic, Melissa Gonzalez Grospe

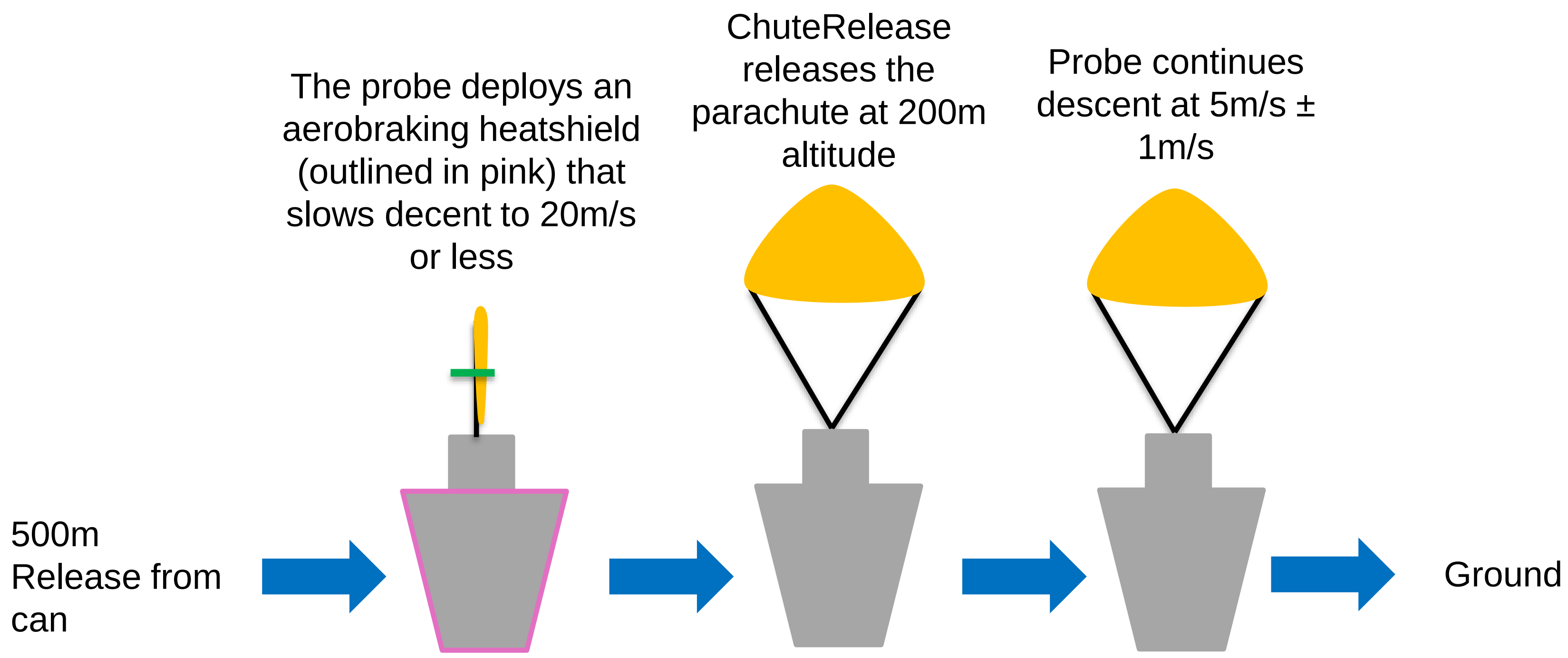
Can Descent:



- The parachute will be laid flat against the top of the can within the rocket
- Parachute will be secured to the can using a fiberglass eyebolt and a double nut

Descent Control Overview (2/2)

Payload Descent:



- The parachute will be held shut until 200m by a ChuteRelease (seen in green above), which will then pop open and allow the parachute to expand
- The Chute release will be secured to the base of the parachute so that it is not lost after opening

Descent Control Changes Since PDR

- **No changes have been made since the PDR**

Container Descent Control Hardware Summary

Container Descent Control	
System	Parachute
System Components	Hexagonal Parachute
	Parachute Chords
	Eyebolt
Parachute sizing	0.3048m in diameter
Parachute color	Orange
Eyebolt Screw sizing	6.6675 cm long shank
Key design considerations	Weight, Simplicity, Stability
Testing	Parachute sizes tested

Payload Aerobraking Descent Control Hardware Summary

Aerobraking	
System	Hexagonal Prism Payload Shape
System Components	Hexagonal Plates
	Extendable arms which serve to enlarge one of the plates
	Spring system which releases the arms into place
	Mylar fabric for the heatshield
System overview	The spring system compresses arm attachments during payload storage. Upon deployment, the arms extend to enlarge the central hexagonal plate, forming a truncated hexagonal pyramid using the mylar fabric that increases drag
Key design considerations	Effortless ejection from can
Testing	Payload shape tested

Payload Descent Stability Control Design

Payload Descent Stability Control	
System	Bottom heavy payload design
System Components	Hexagonal plates
	Poles for vertical alignment
	Electronics
	Other mechanisms
Passive or Active	Passive
System overview	Contents of the payload are placed between the bottom plates to create a bottom-heavy design
Key design considerations	Ability to land upright Prevent tumbling
Testing	Ability to land upright tested

Payload Parachute Descent Control Hardware Summary

Payload Descent Control	
System	Parachute
System Components	Hexagonal Parachute
	Parachute Chords
	Altimeter Chute Release
	Tie-down ring
Parachute sizing	0.53 m in diameter
Parachute color	Orange
System Overview	The parachute is fastened to a tie-down ring that's screwed onto the payload. It stays in place with the help of the device until the desired altitude is attained. Once reached, the device releases and the parachute deploys naturally.
Key design considerations	Components can easily fit within the can Effortless parachute deployment
Testing	Parachute size tested

Descent Rate Estimates (1/2)

Decent Rate Estimates for the following Configurations

Configuration	Device	Desired Rate	Decent Rate Estimate	Method of Calculation
CanSat with payload	Parachute	15 ± 5 m/s	15.3 m/s	Parachute calculations
Payload aerobraking	Umbrella Device	less than 20 m/s	11.3 ± 3.1 m/s	Drop Testing
Payload parachute released	Parachute	5 ± 1 m/s	5.89 ± 1.1 m/s	Drop Testing

Assumptions

- ~2.7 m/s winds
- Total weight is 700 grams
- Payload weight is 300 grams
- 0.53m Hexagon Parachute for Payload

Descent Rate Estimates (2/2)

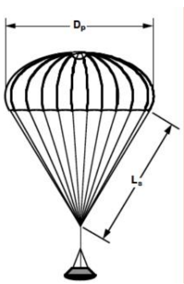
Testing Information

- 3D Printed Model of Container and Aerobraking device
- Brass weights were used to simulate the weight of the interior components (700 grams & 300 grams)
- Parachutes used were those selected from the Trade Study
- Prototype was abruptly thrown in an attempt to mimic shock forces incurred at apogee
- Each protype was tested 10 times and outliers were removed from each data set

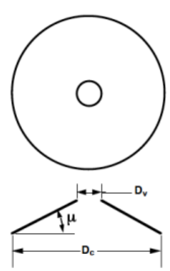
Formulas Used

$$\bar{v} = \frac{\Delta x}{\Delta t} \qquad \Delta x = v_0 t + \frac{1}{2} a t^2 \qquad \sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{N}}$$

$$V^2_{\text{terminal}} = \frac{2 M_{vehicle} \cdot g / \rho}{\left(C_D \cdot S\right)_0^{parachute} + \left(C_D \cdot S\right)_{ref}^{vehicle}}$$



$$D_P = \sqrt{\frac{4S_P}{\pi}}$$



$$S_0 = \lambda \frac{D_c^2}{4} \sqrt{1 + \tan^2 \mu}$$

$$D_0 = \sqrt{\frac{4S_0}{\lambda}}$$

$$S_v = \lambda \frac{D_v^2}{4} \sqrt{1 + \tan^2 \mu}$$

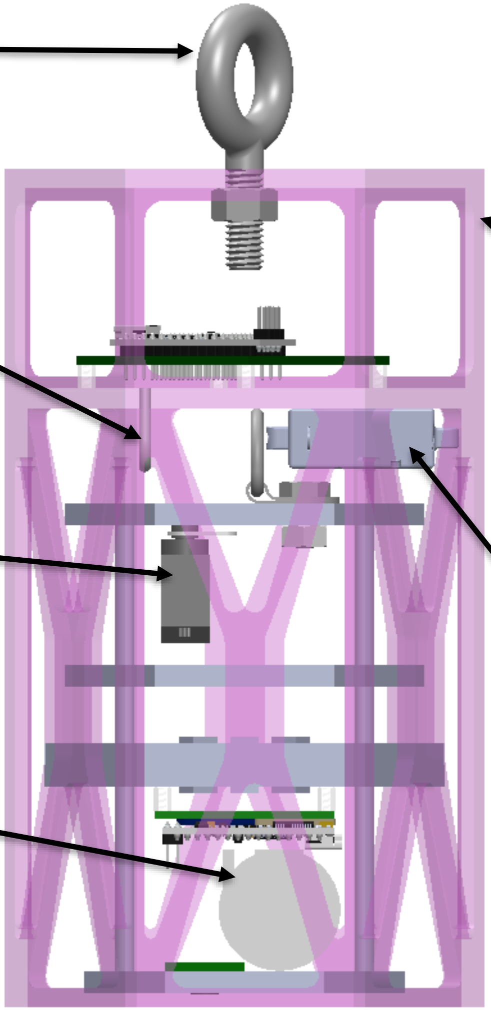
$$\lambda_g = \frac{S_v}{S_0}$$

Formulas Retrieved from:
Section 3.5 Recovery Systems: Parachutes 101 - Utah State University. http://mae-nas.eng.usu.edu/MAE_6530_Web/New_Course/launch_design/Section7.5.pdf.

Mechanical Subsystem Design

Daniel Horton, Christian Roque, Savari Datta, Melissa Gonzalez Grospe

Mechanical Subsystem Overview



Parachute Attachment -
Lightweight fiberglass eyebolt providing mechanical connection between parachute and can.

Payload Securement Ring -
Used to stop payload from sliding off linear actuator arm pre-deployment.

Flag Deployment Servo -
Holds flag inside of the payload until landing. When moved out of the way, the flag will deploy from the payload.

Flag Spring Deployment -
a container will house a clock spring that will be used in reverse to simulate a tape measure that pushes outwards rather than inwards, raising the flag

ABS Hexagonal Canister -
3D-printed six-sided canister structure with separate compartments for containing the payload and avionics. Bottom is hollow to facilitate payload deployment. Wrapped in plastic wrap to enclose sides.

Linear Actuator -
Holds the payload inside the container through parachute ring when deployed. Can be retracted to release payload at the desired altitude.

Mechanical Subsystem Changes Since PDR

- The shape and structure of the can has been redesigned to withstand more force and allow for the can to be sealed
- A platform has been removed from the probe design to have more room for electronics
- Flag deployment mechanism moved to the bottom platform on the probe
- Exit hole for the flag widened to fit the flag

Container Mechanical Layout of Components

Parachute Attachment -
Lightweight fiberglass eyebolt providing mechanical connection between parachute and can.

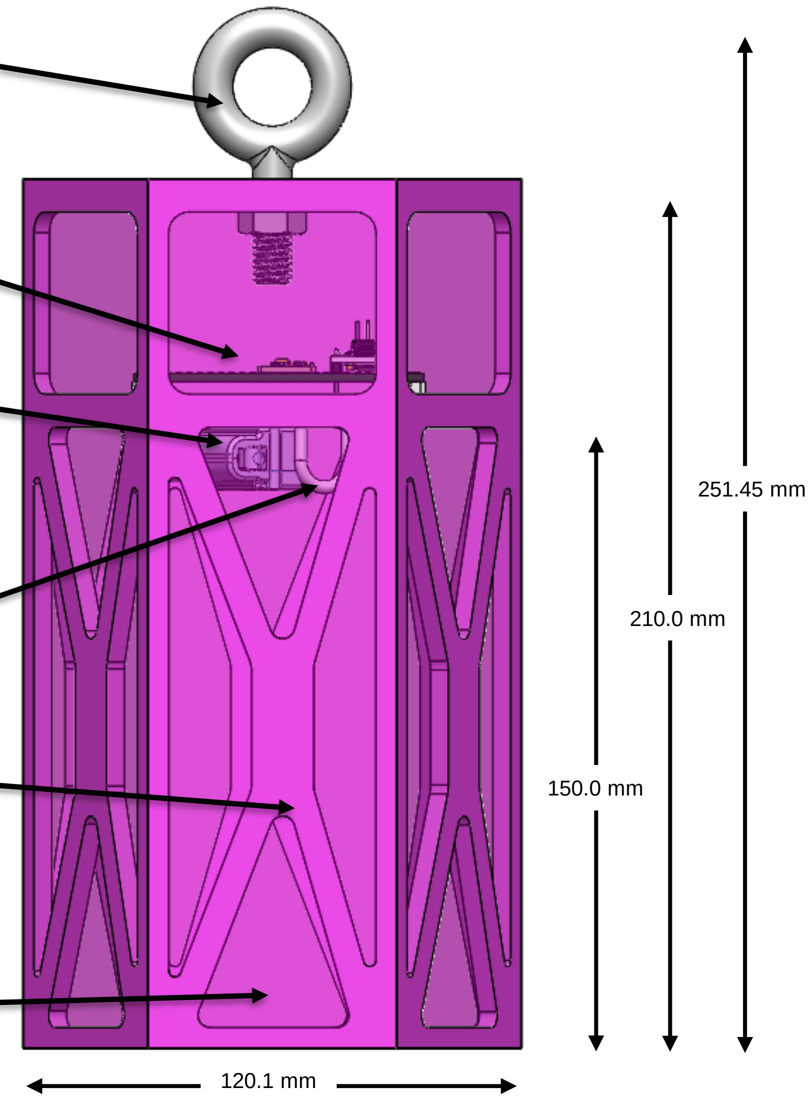
Container PCB -
Mounted in container avionics bay and holds electrical components used to control various subsystems.

Linear Actuator -
Holds the payload inside the container when deployed. Can be retracted to release payload at desired altitude.

Payload Securement Ring -
Used to stop payload from sliding off linear actuator arm pre-deployment.

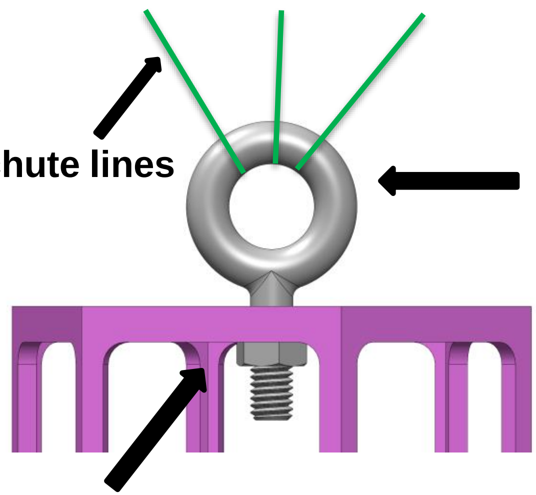
ABS Structure –
Container is hexagonal shaped made of ABS plastic and colored pink.

Plastic Wrap –
Container is wrapped in plastic wrap, which will be heated to create a tight casing.



Container Parachute Attachment Mechanism

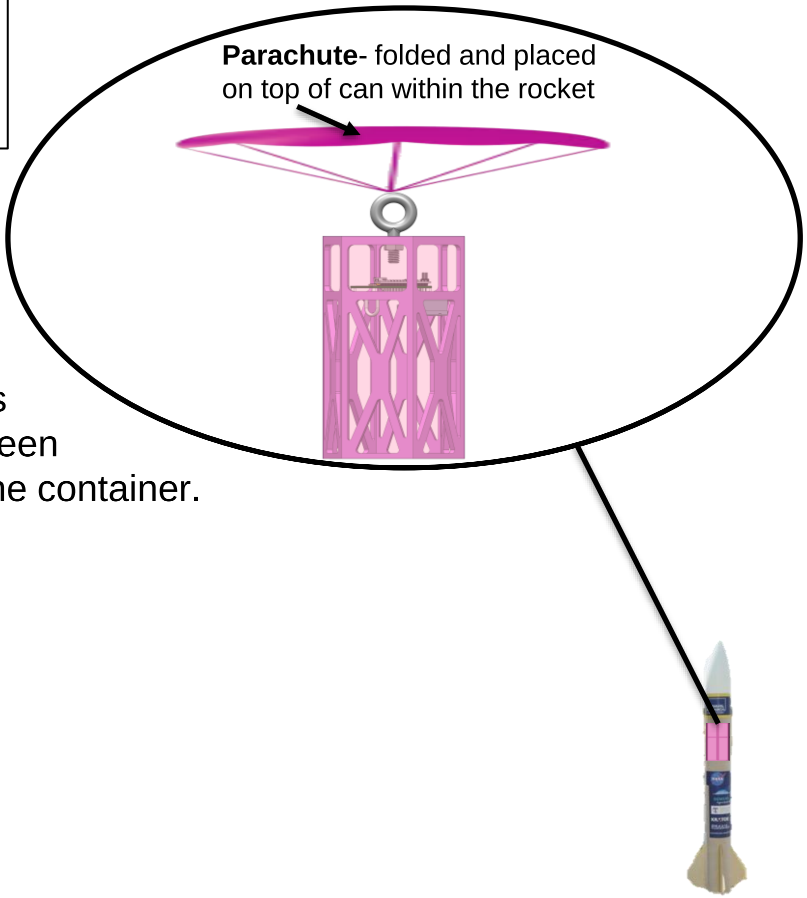
The parachute for the container will be connected via a fiberglass routing eyebolt that is attached to the top of the container using a nut.



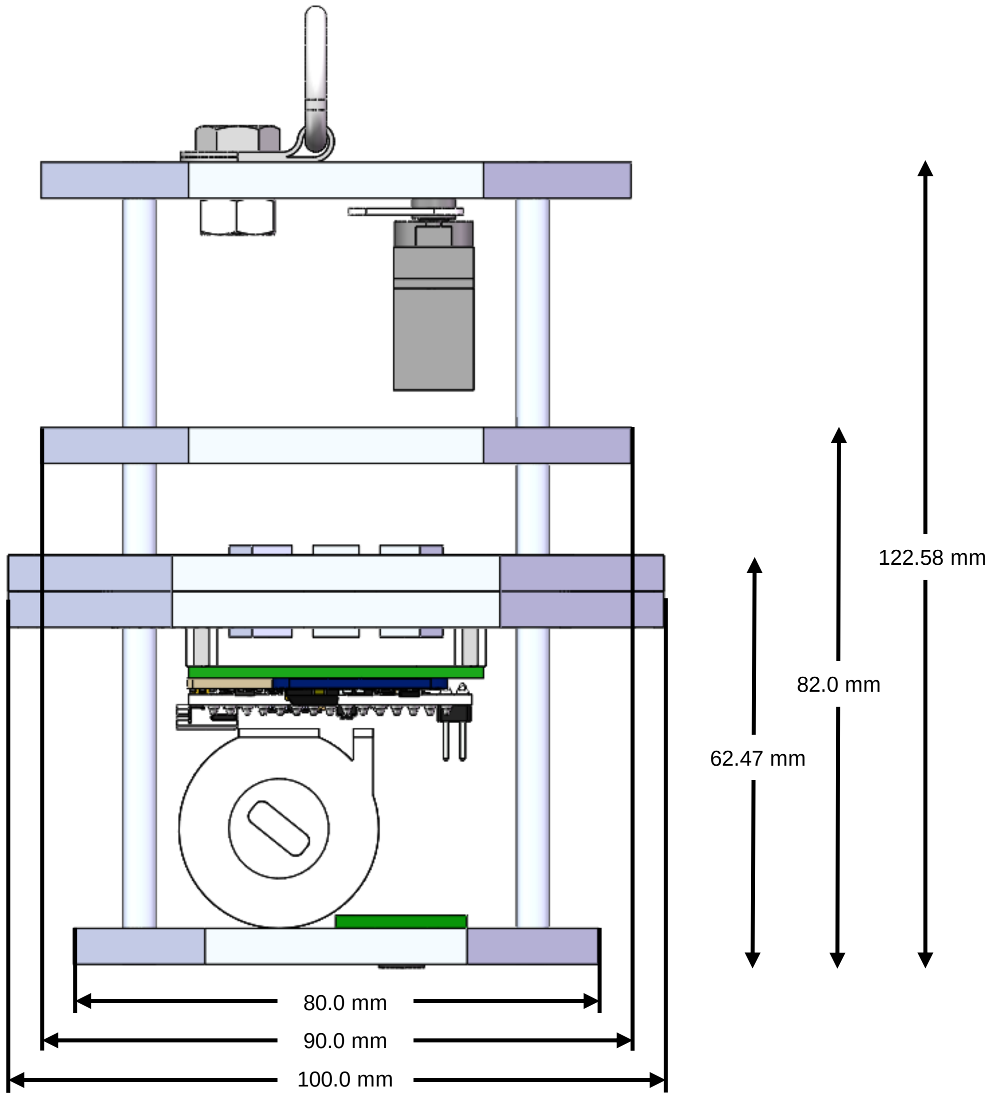
Parachute lines

Eyebolt – Serves as
the connection between
the parachute and the container.

Nut – Tightly secures the Eyebolt
to the container.



Payload Mechanical Layout of Components (1/2)



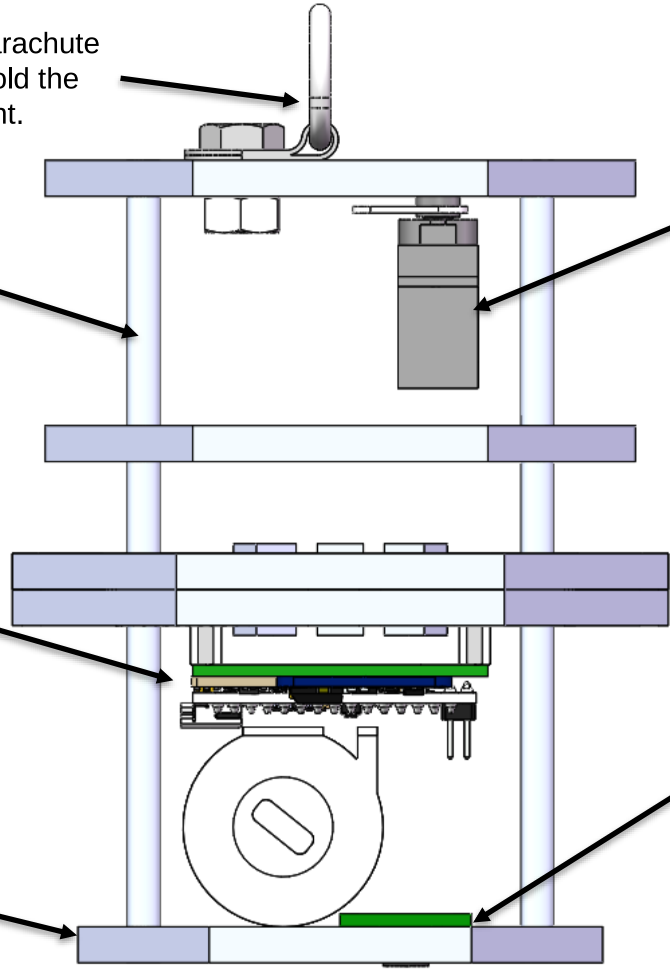
Payload Mechanical Layout of Components (2/2)

Tie-Down Ring – Used to connect parachute to the payload. Additionally used to hold the payload inside the can pre-deployment.

10-32 Aluminum Rods – Used to provide a rigid support structure to the payload design and connect the ABS plates.

Payload PCB – Mounted upside down, holds necessary avionics. Hole in center allows the flag deployment mechanism to run through it.

ABS Plates – Plates provide mounting points for electronic and mechanical components. Flat-bottomed design provides level surface for landing.



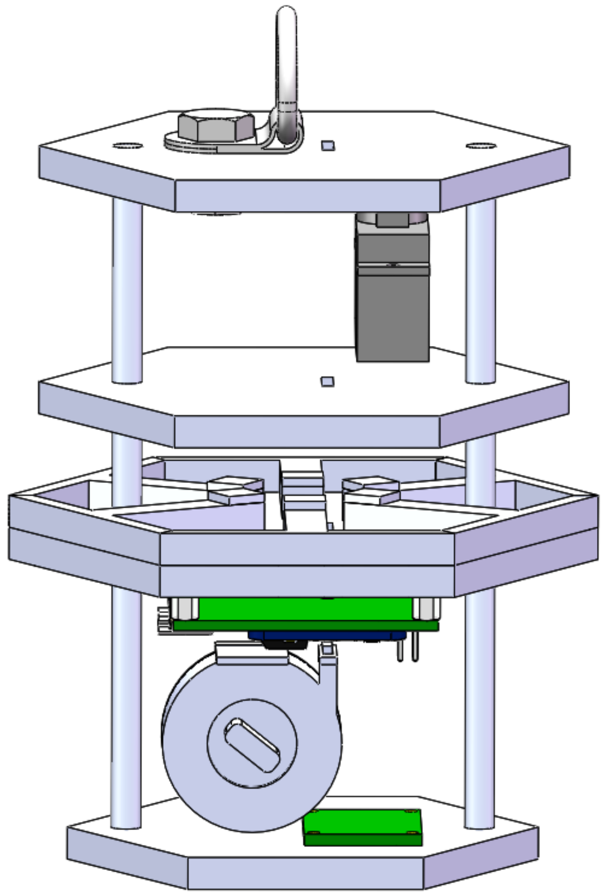
Servo Motor – Used to release the flag out of the top of the payload.

Heatshield mechanism – 6 ABS arms that will be deployed using springs once the payload leaves the can to open the heatshield and increase its aerobraking effect.

Camera – Hole cut in bottom plate to point lens at the ground.

Payload Pre Deployment Configuration

Tie-down Ring is used to keep the payload inside the container until deployment.

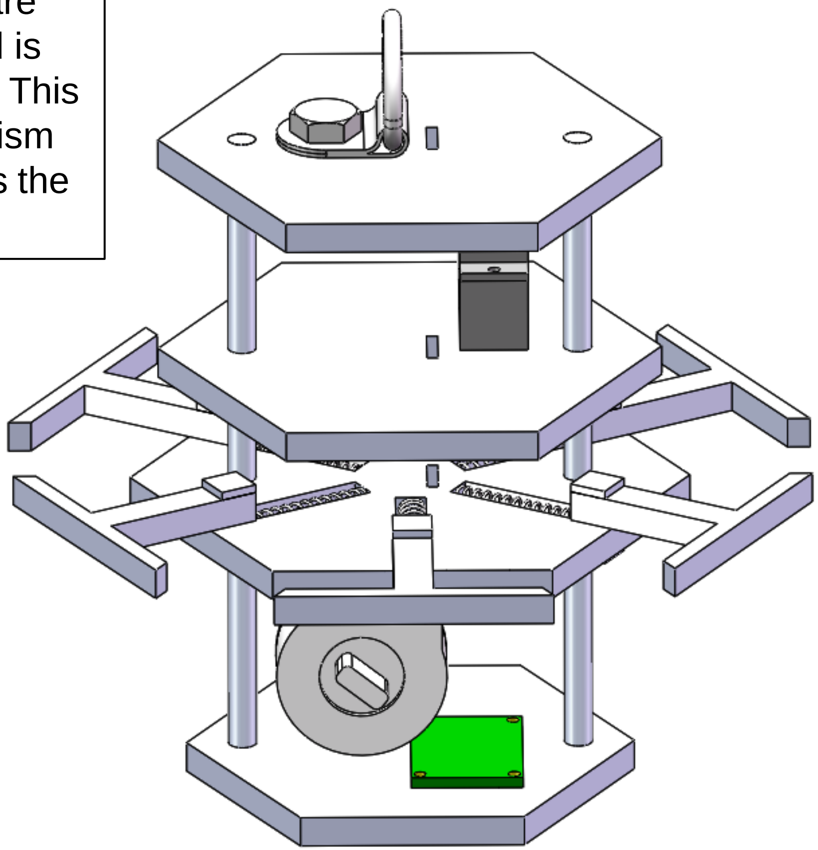


PCB, Flag Deployment, Camera, Servo Motor are mounted to the payload to be secured in place. The Tie-down Ring is secured through a hex-nut and screw.

Spring Loaded Arms are kept in pre deployment positioning by pushing on the inside walls of the container.

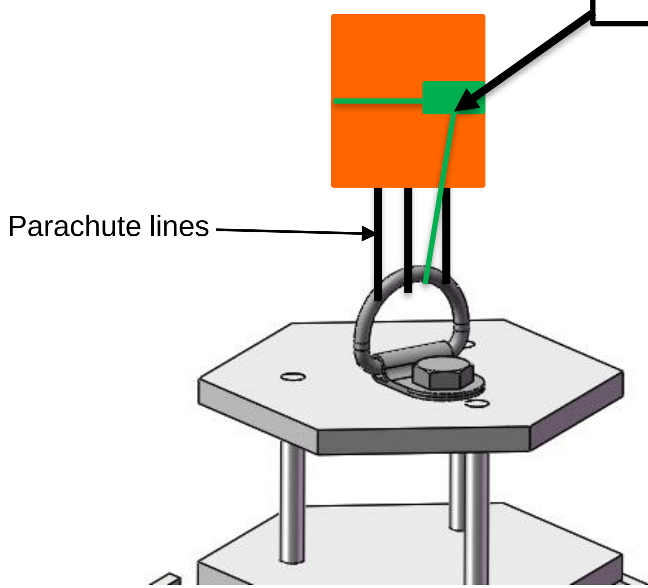
Payload Aerobraking Deployment Configuration

Spring Loaded Arms are released once payload is deployed from container. This creates a hexagonal prism shape which implements the heat shield.

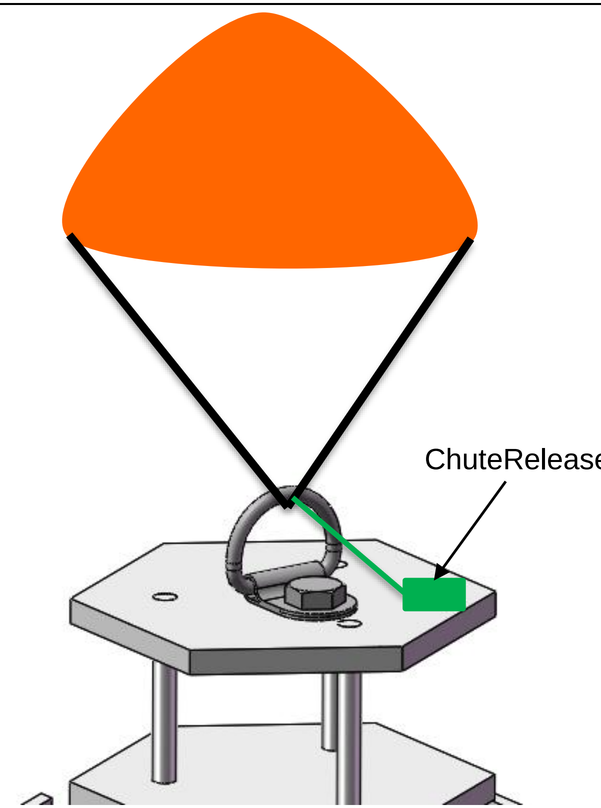


Payload Parachute Deployment Configuration

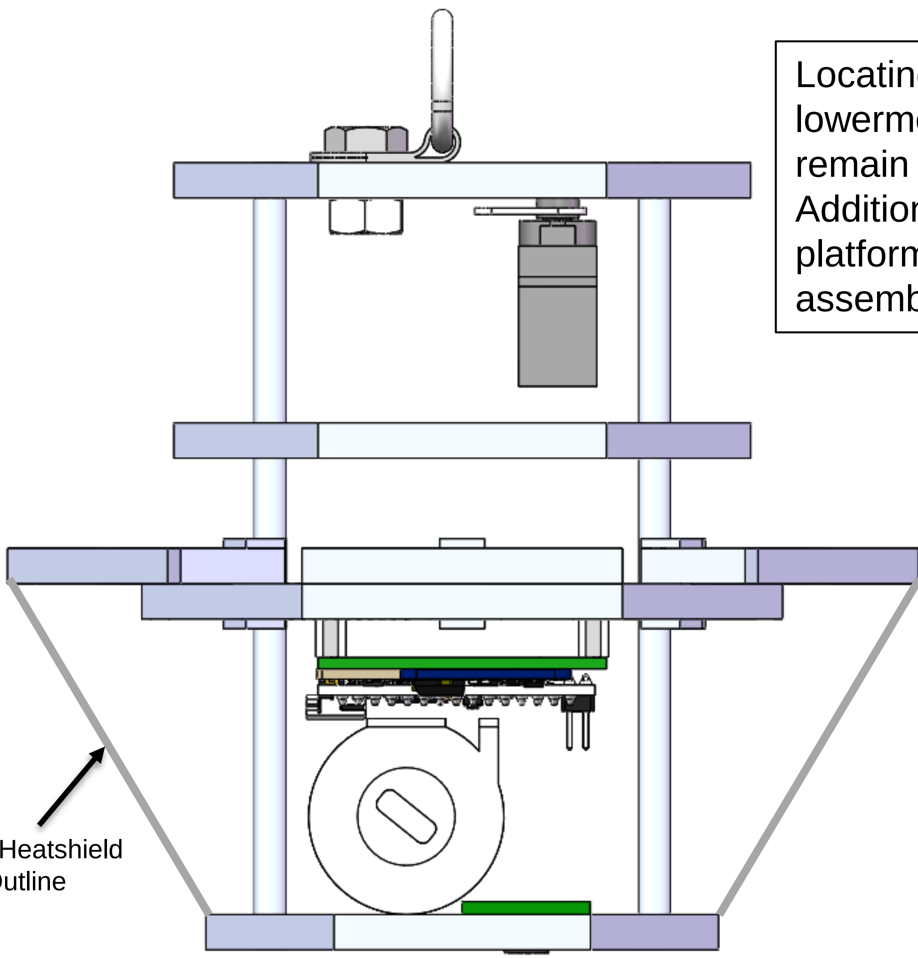
The parachute will originally be held shut by the ChuteRelease device, as seen in the first configuration



At 200m altitude, the Chute release will open and deploy the parachute. The ChuteRelease device will remain attached to the probe through a line (shown in green).



Payload Uprighting Description



Locating the majority of the payload's mass in its lowermost section ensures that the bottom will remain pointed towards the ground.
Additional weights will be added to the bottom platform depending on remaining mass budget after assembly

The umbrella-shaped heatshield is designed such that the payload will maintain a stable orientation during free-fall and landing.

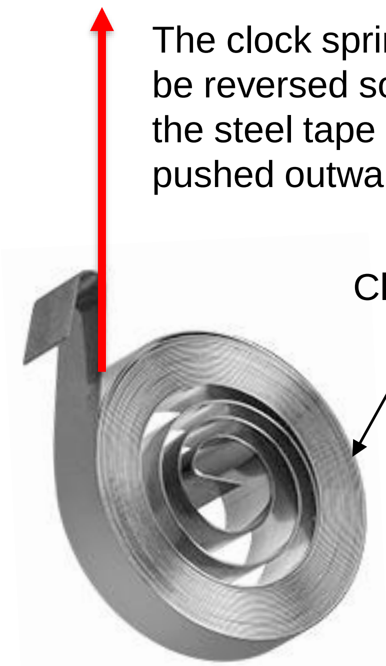
The wide, flat bottom provides a stable and level surface for the payload when landing, ensuring that it will not tip over.

Payload consistently landed with correct orientation during drop testing of a representative model.

Payload Flag Deployment Configuration

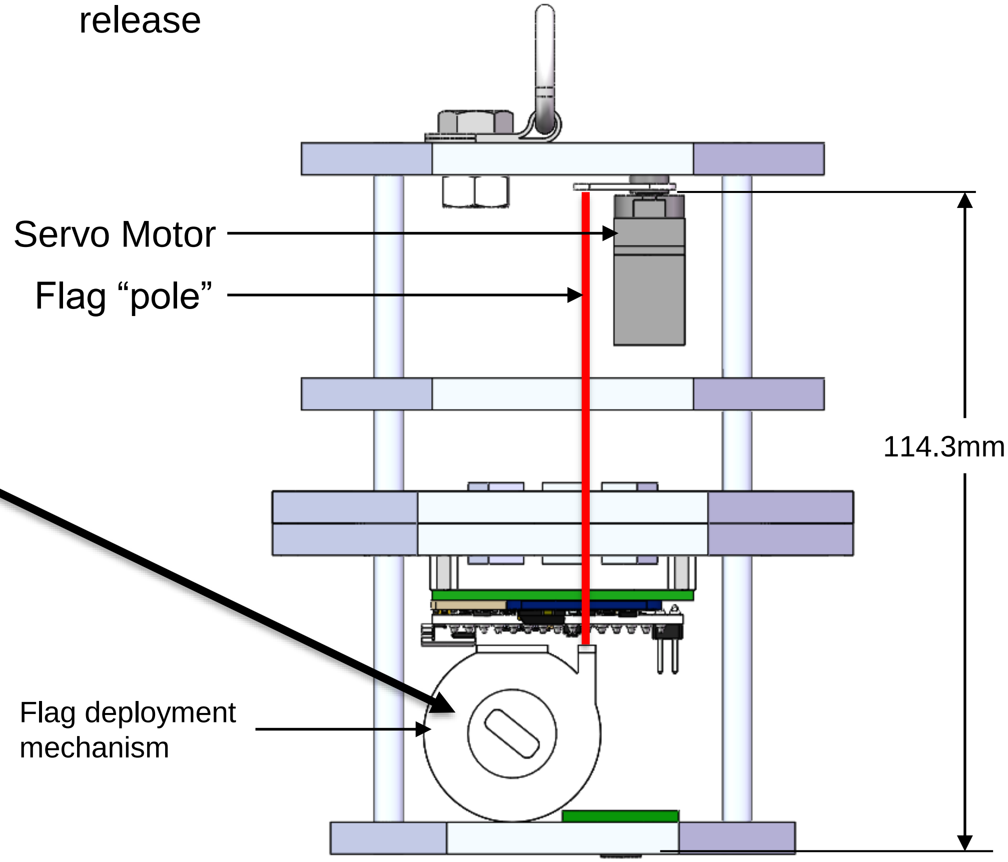
Inside the Flag Deployment Mechanism

The clock spring will be reversed so that the steel tape is pushed outward

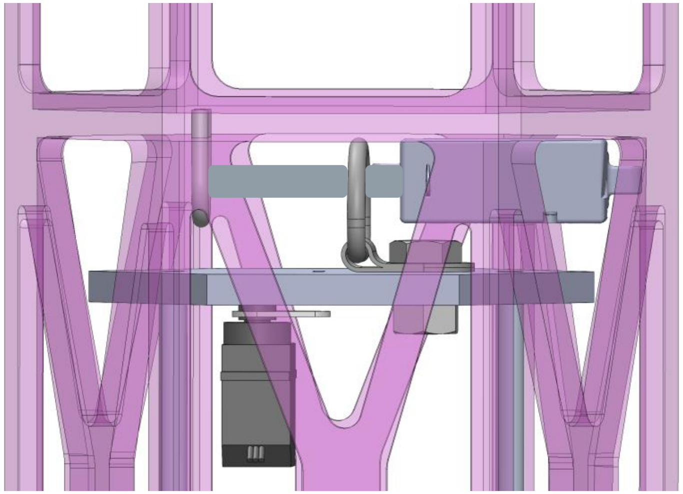


Note: the flag will be attached using super glue. The material will be ripstop nylon and the flag will be triangular.

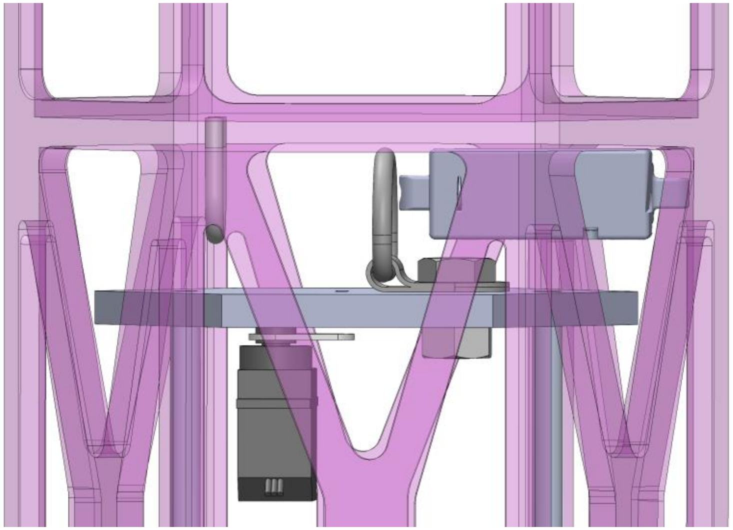
- The flag will be partially expanded within the probe
- The flag will be held down from full expansion by a servo motor, which will move out of the way when time for release



Container Payload Mount



Pre-Release Configuration:
To hold the payload inside the can, the linear actuator is deployed through the tie-down ring of the payload and into the payload securement, mounted opposite of it, which stops the payload from sliding off during descent.



Released Configuration:
At 500 m, the linear actuator is retracted, allowing for the payload to drop through the bottom of the can.

Structure Survivability

- The PCBs for the container and the payload are mounted to the plates using standoffs which are screwed into the plastic
- The various electrical connections/components will be soldered to the PCB, securing them in place
- The eyebolt (container) and the tie down ring (payload) are used for parachute attachment deployed during descent
- The canister and payload were designed with adequate thickness and strength to survive 15 g's of acceleration without buckling or yielding.
- The canister and payload will both be tested for shock force resistance according to the environmental test plan.

Container Mass Budget

Part Name	Mass (g)	Source	Uncertainty (±g)
Fiber Glass Routing Eyebolt	2.40	Datasheet	-
¼- 20 Aluminum Hex Nut	0.50	Datasheet	-
ABS Can Structure	206.00	Estimate	4.65
Payload Securement Ring	0.30	Estimate	0.02
1ft Ultra-Light Parabolic Parachute	9.07	Datasheet	-
Plastic Wrap	3.00	Estimate	0.34

Total Mass: 221.27 grams

Electronics Mass Budget (Container)

Part Name	Mass (g)	Source	Uncertainty (±g)
Adafruit BMP280	1.30	Datasheet	-
Arduino Nano	7.00	Datasheet	-
2032 Cell Batteries	6.20	Datasheet	-
Linear Actuator	15.00	Datasheet	-
Linear Actuator Ring	0.20	Datasheet	-
Plastic Coupling Nuts	0.40	Datasheet	-
PCB Screws	0.10	Datasheet	-

Total Mass: 30.20 grams

Payload Mass Budget (1/2)

Part Name	Mass (g)	Source	Uncertainty (±g)
Springs	0.30	Datasheet	-
Heat Shield Arms	14.10	Measured	0.01
ABS Platforms	138.30	Estimate	3.46
Flag Release	6.84	Estimate	0.18
Steel Tape	1.00	Measured	0.01
Super Lube	1.00	Measured	0.01
Clock Spring	7.80	Datasheet	-
¼-20 Aluminum Screw	0.70	Datasheet	-
¼ - 20 Aluminum Hex Nut	8.50	Datasheet	-
Tie Down Ring	9.00	Datasheet	-
JB Weld Plastic Bonder	2.00	Estimate	0.27

Payload Mass Budget (2/2)

Part Name	Mass (g)	Source	Uncertainty (±g)
2ft Ultra- Light Parabolic Parachute	17.00	Datasheet	-
Aluminum threaded rods	9.80	Datasheet	-
Mylar Reflective Material	112.10	Estimate	3.36
Ripstop Nylon	5.50	Estimate	0.02
Additional Weights	30.00	Datasheet	-

Total Mass: 363.94 grams

Electronics Mass Budget (Payload)

Part Name	Mass (g)	Source	Uncertainty (±g)
Adafruit BMP280	1.30	Datasheet	-
BNO-055	3.00	Datasheet	-
Adafruit Ultimate	8.50	Datasheet	-
Raspberry Pi Pico	3.00	Datasheet	-
ANT-900-RP-2-A	5.00	Measured	0.05
Arducam Mini	20.00	Datasheet	-
Micro SD Cards	1.00	Datasheet	-
Micro SD Readers	3.40	Datasheet	-
XBEE Pro 900 Mhz Radio	5.00	Datasheet	-
2032 Cell Batteries	6.20	Datasheet	-
Servo Motor	9.00	Measured	0.09
Jolly Logic Chute Release	17.20	Datasheet	-

Total Mass: 82.60 grams

Total Mass Budget

Component of the CanSat	Total Mass (g)
Container	221.27
Electronics for Container	30.20
Payload	363.94
Electronics for Payload	82.60

Mass Totals		
Mass (g)	Margin [+, -] (g)	Requirement Total (g)
698.01	±12.47	700 ± 10

Current mass of the CanSat is 698.01 grams

- After can assembly is finished, mass will be reevaluated
- If mass comes out below 690 grams, extra mass will be used to reinforce the can structure and payload
- If mass comes out over 710 grams, measures will be taken to reduce the mass such as decreasing the in-fill of 3D-printed material or reducing the extra weight added to the payload

Communication and Data Handling (CDH) Subsystem Design

Max Epstein, Yashas Shivaram

CDH Overview

Device Type	Model	Purpose
Processor & Memory	Raspberry Pi Pico	Facilitate data storage, sensing, communication
Real-Time Clock	Adafruit Ultimate Breakout v3 GPS Module	Keep track of times for data & calculation purposes
Antenna	ANT-900-RP-2-A	Transmit/receive data from radio/processor configuration
Radio	XBEE-PRO 900HP	Communicate between antennae & processors

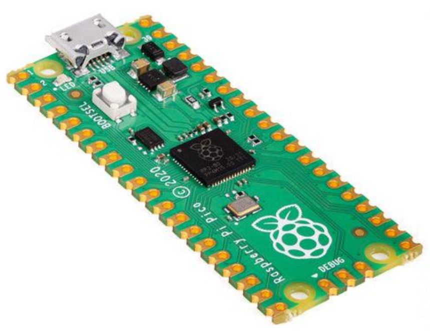
CDH Changes Since PDR

- **No changes have been made since the PDR**

Payload Processor & Memory Selection

Processor	Boot time(s)	Speed (Mhz)	Memory (KB)	Weight (g)	Dimension (mm)	Voltage Input (V)	Ports
Raspberry pi Pico	0.5	125	264	3	51.3x21	1.8 – 5.5	Analog Input - 4 PWM Output - 8 I2C I/O – 1 SPI – 1 DAC Output - 1

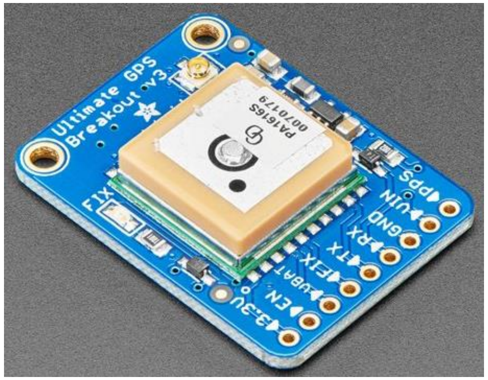
Selection	Reasoning for selection
Raspberry Pi Pico	- Compact size - Compatibility with camera/Familiarity - Availability



Payload Real-Time Clock

Real-Time Clock Keeper	Tolerance Reset	Interface	Cost ($)
Arduino Ultimate Breakout v3	Real-Time clock continues keeping time in the event of a reset	Internal to GPS	0.00

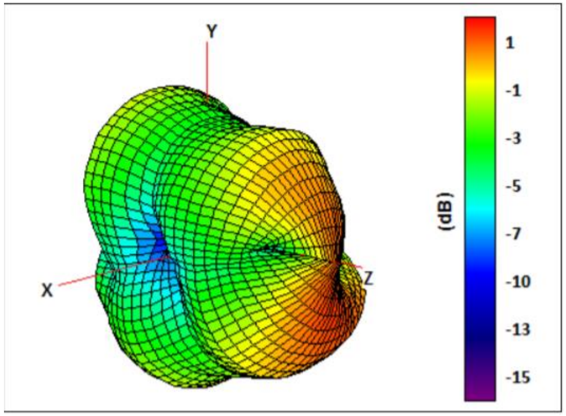
Selection	Reasoning for selection
Adafruit Ultimate GPS Breakout	- Already part of the board - GPS Module will have an independent battery backup - No additional weight, size, or circuitry required

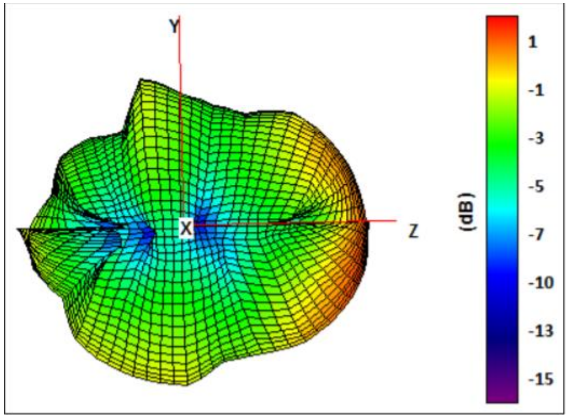


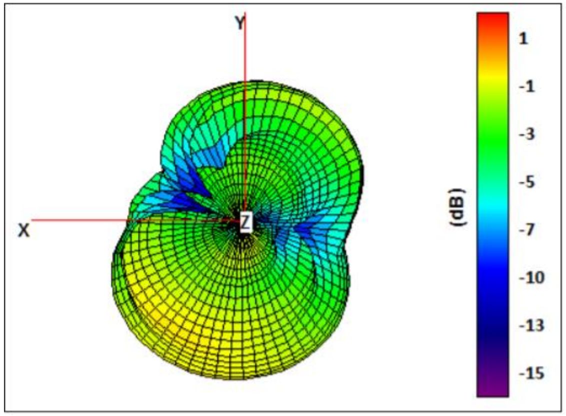
Payload Antenna Selection

Name	Frequency Range (GHz)	Length of Antenna (mm)	Gain (dBi)	Polarization	Connection Type	Weight (g)
ANT-900-RP-2-A	.880-.960	115	2.1	(Linear) Vertical	SMA	11

Selection	Reasoning for selection
ANT-900-RP-2-A	- In accepted frequency range - Compatible with selected radio - Relatively small size







Payload Radio Configuration

Name	Frequency Range (GHz)	Outside Range (km)	Antenna Type	Weight (g)	Cost ($)
XBEE-PRO 900HP	.902 - .928	6.5	RPSMSA	6.9	68

Selection	Reasoning for selection
XBEE-PRO 900HP	- Operates on accepted frequency - Excellent outside range

NETID/PANID – 1032

Transmission Control
- Data will be continuously sent at 1 Hz during all stages of flight - Transmission will be handled by FSW, starting on power on and ending once the container and payload have landed

Payload Telemetry Format

- **Transmitted Data will be saved to a .csv file on ground station.**
- **Data Transmitted:**
- To GCS at 1 Hz packet transmission rate:

    Payload sensor readings (Air pressure/temperature, mission time, GPS time, coordinates, power supply voltage, tilt, altitude, and various states)

How is the data formatted?

-Payload-to-GCS:

-<TEAM_ID>,< MISSION_TIME>, <PACKET_COUNT>, <MODE>, <STATE>, <ALTITUDE>,<HS_DEPLOYED>,<PC_DEPLOYED>,<MAST_RASIED> <TEMP>, <VOLTAGE>, <PRESSURE>,< GPS_TIME>, <GPS_ALTITUDE>, <GPS_LATITUDE>, <GPS_LONGITUDE>, <GPS_SATS>, <TILT_X>,<TILT_Y>, <CMD_ECHO>

- **Example:**
- 1063,13:35:59,25,F,LAUNCH_WAIT,N,N,N,25.3,8.3,230,13:35:35,25,150.0258,168.6765,58,5.02,3.05,CXON

Payload Telemetry Format

Telemetry Field	Purpose	Relayed From:
<TEAM_ID>	Team ID number (1063)	Payload
<MISSION_TIME>	UTC time from RST=0 in 1st software state (hh:mm:ss)	
<PACKET_COUNT>	# of packets transmitted across all devices	
<MODE>	'F' = Flight (default) mode, 'S' = Simulation mode	
<STATE>	Software State (STARTUP, DESCENT, etc.)	
<ALTITUDE>	Altitude in meters relative to ground level (+/- 0.1 m)	
<HS_DEPLOAYED>	‘P’ if the probe has been deployed, ‘N’ if not	
<PC_DEPLOAYED>	‘C’ if the probe parachute has been deployed, ‘N’ if not	
<MAST_RAISED>	‘M’ if the flag has been raised, ‘N’ if not	
<TEMP>	The temperature in degrees Celsius (+/- 0.1C)	

Payload Telemetry Format

Telemetry Field	Purpose	Relayed From:
<PRESSURE>	The air pressure in kPa (+/- 0.1 kPa)	Payload
<VOLTAGE>	Voltage reading of Container power bus (+/- 0.1 V)	
<GPS_TIME>	UTC time generated from GPS (hh:mm:ss) (+/- 1 sec)	
<GPS_LATITUDE>	GPS latitude coordinate in decimal degrees (+/- 0.0001 degrees North)	
<GPS_LONGITUDE>	GPS longitude coordinate in decimal degrees (+/- 0.0001 degrees West)	
<GPS_ALTITUDE>	GPS altitude coordinate in decimal degrees (+/- 0.1 m from sea level)	
<GPS_SATS>	# of satellites being tracked by GPS	
<TILT_X>	The angle of the payload in the x direction in degrees (+/- 0.01)	
<TILT_Y>	The angle of the payload in the y direction in degrees (+/- 0.01)	
<CMD_ECHO>	The last command received and processed by the payload	

Payload Command Formats

CX - Container Telemetry On/Off Command	
CMD,<TEAM_ID>, CX, <ON_OFF>	
CMD & CX	Static Text
<TEAM_ID>	Assigned Team Identification
<ON_OFF>	ON-activates Container transmissions OFF- turns off transmissions
Example: CMD,1032,CX,ON	

SIM - Simulation Mode Control Command	
CMD,<TEAM_ID>, SIM, <MODE>	
CMD & SIM	Static Text
<TEAM_ID>	Assigned Team Identification
<MODE>	'ENABLE' to enable - 'ACTIVATE' to activate- 'DISABLE' both disables and deactivates -> simulation mode.
Example: CMD,1032,SIM,ACTIVATE	

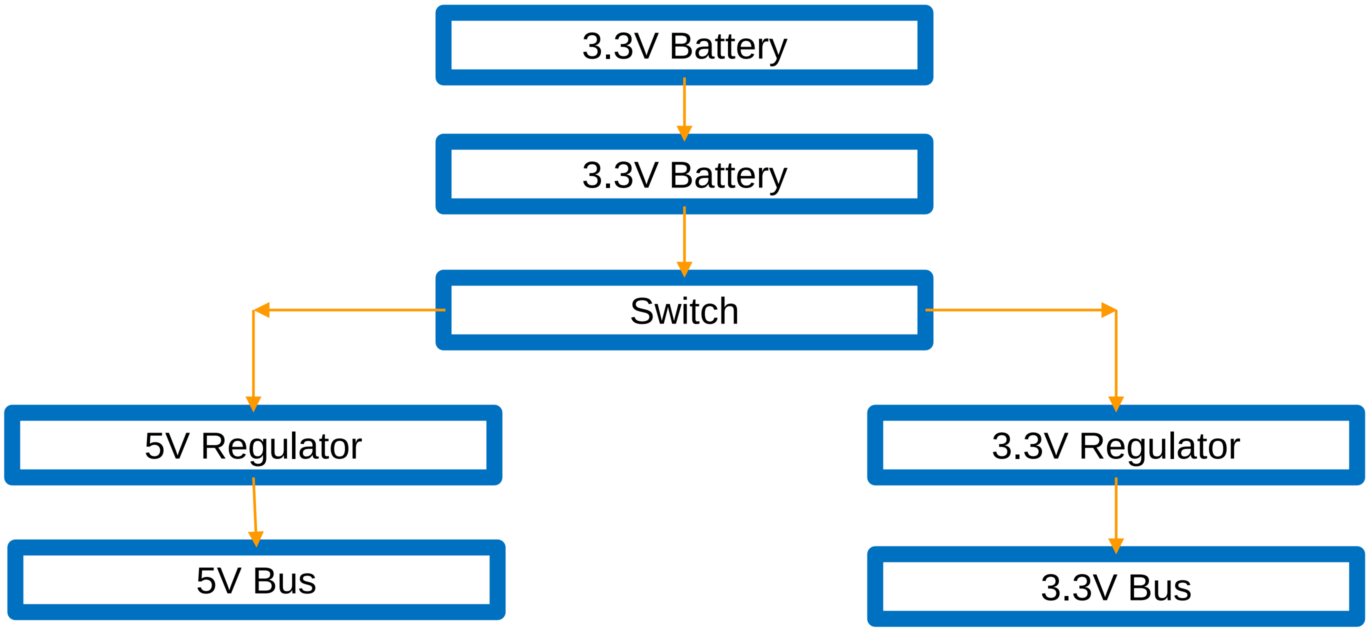
ST - Set Time	
CMD,<TEAM_ID>, ST, <UTC_TIME>	
CMD & ST	Static Text
<TEAM_ID>	Assigned Team Identification
<UTC_TIME>	UTC time in the format hh:mm:ss
Example: CMD,1032,ST,13:35:59	

SIMP - Simulated Pressure Data	
CMD,<TEAM_ID>, SIMP, <PRESSURE>	
CMD & SIMP	Static Text
<TEAM_ID>	Assigned Team Identification
<PRESSURE>	simulated atmospheric pressure data in units of pascals with a resolution of one Pascal.
Example: CMD,1032,SIMP,101325	

Electrical Power Subsystem Design

Paolo D'Alessandro

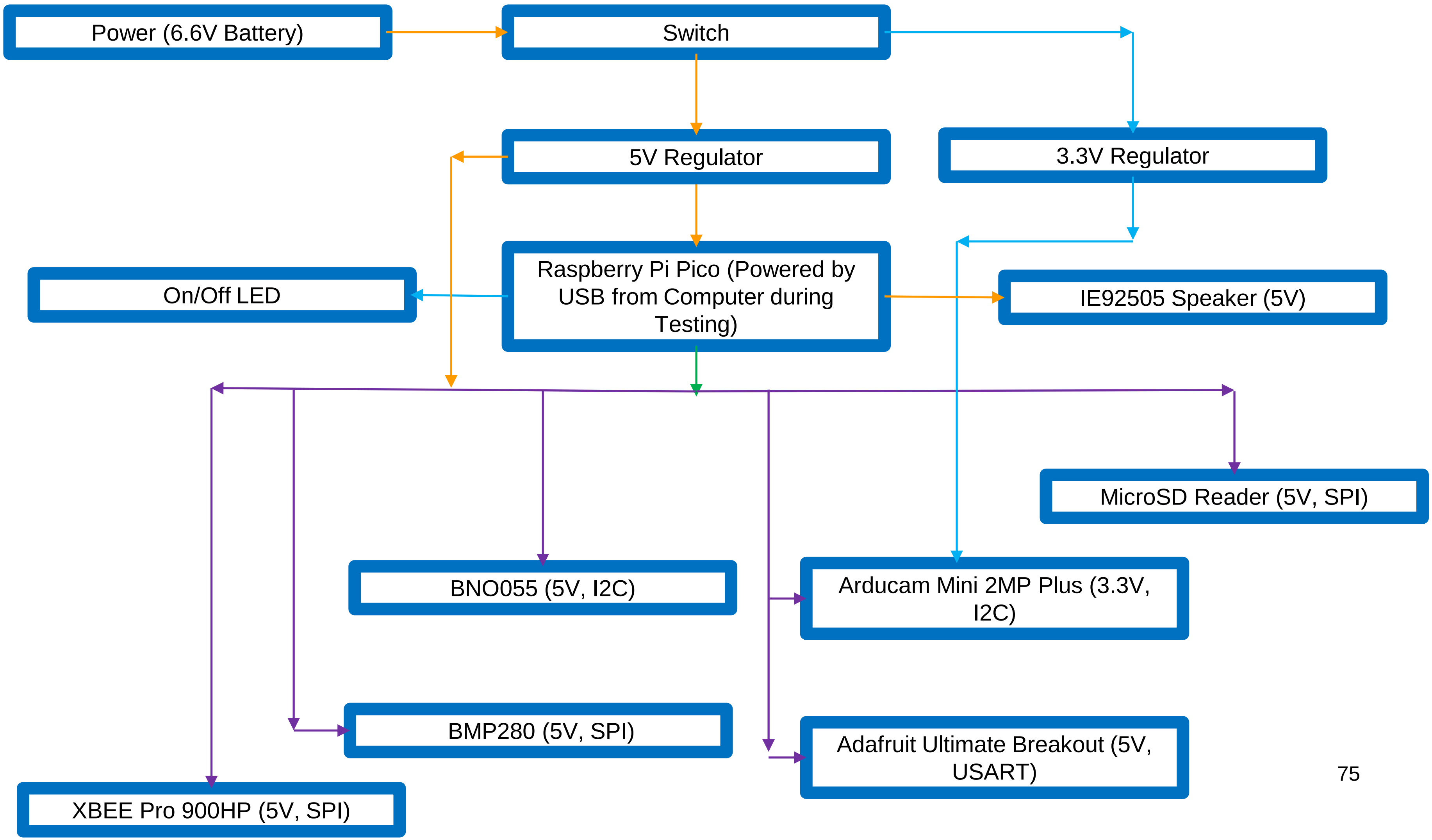
EPS Overview



EPS Changes Since PDR

- **No changes have been made since the PDR**

Payload Electrical Block Diagram



Payload Power Source

Type	Battery	Voltage	Capacity	Weight	Qty. Needed	Total Voltage	Total Weight
Lithium LiCB	CR2032	3.3V	236mAh	3.1g	2	6.6V	6.2g

Selection	Reason for Selection
Lithium LiCB CR2032	- Smaller weight and easily scalable for more power

Battery Configuration
Two CR2032 in series to provide ~6V

Payload Power Budget

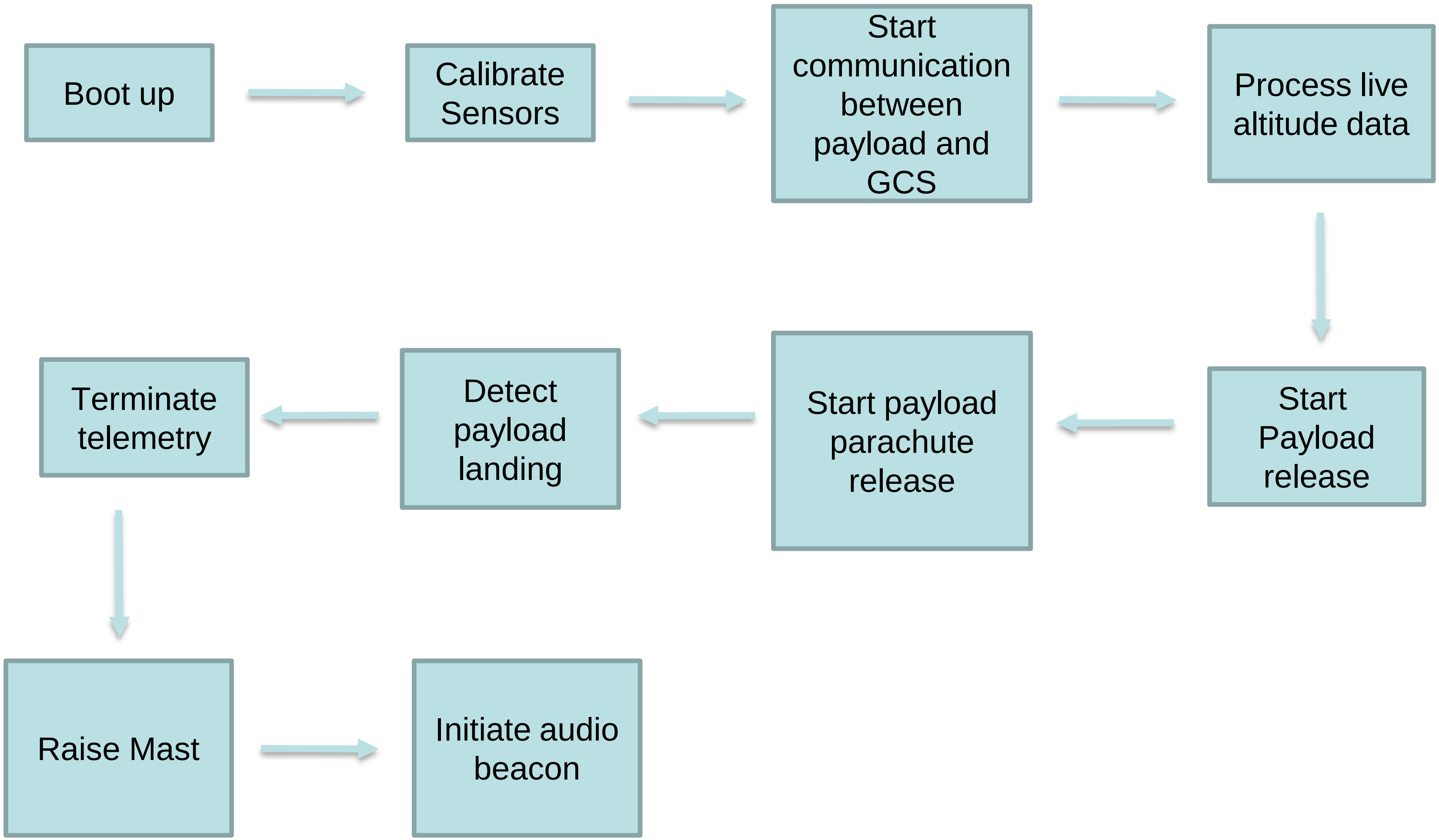
Component	Voltage (V)	Power per Unit (W)	Duty Cycle (%)	Power Consumption (Wh)	Source
Raspberry Pi Pico (Microcontroller)	9V	.1406	100	0.1406	Datasheet
Adafruit Ultimate Breakout (GPS)	5V	.1	100	.1	Datasheet
BMP280 (Air Temperature/Pressure)	5V	0.00025	100	0.000025	Datasheet
IE092505-1 (Sound Alert)	5V	.03	100	50m	Datasheet
Xbee Pro 900 HP (Radio Module)	5V	.0.95	100	.95	Datasheet
LED Light (Lighting Alert)	2.2V	0.044	100	0.044	Datasheet
BNO 055 (Temp/Rotational Sensor)	1.7-3.6V	0.0123	100	0.00155	Datasheet

Flight Software (FSW) Design

Max Epstein

FSW Overview (1/2)

Flowchart



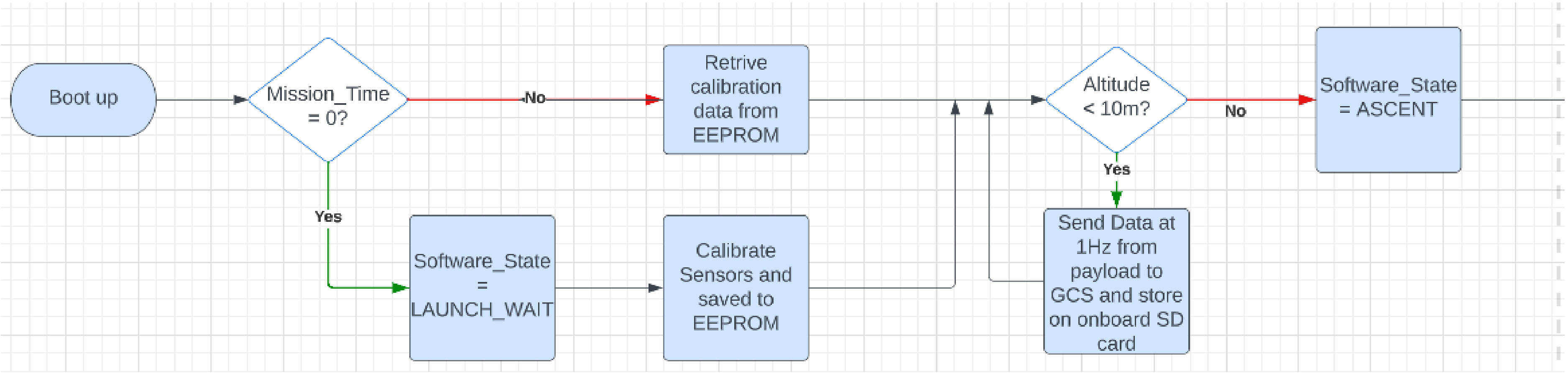
FSW Overview (2/2)

Programming Languages	Python
Development Environments	Visual Studio Code
FSW Tasks	- Boot up and collect sensor data in the correct units required by CanSat. - Communicate telemetry from the payload and container to the GCS to store data. - Keep track of altitude and release the payload and parachute when needed. - Trigger audio beacon after landing.
Payload FSW	- Payload communication - In charge of collecting data with sensors - Contains temperature sensor, pressure sensor, rotational sensor, camera

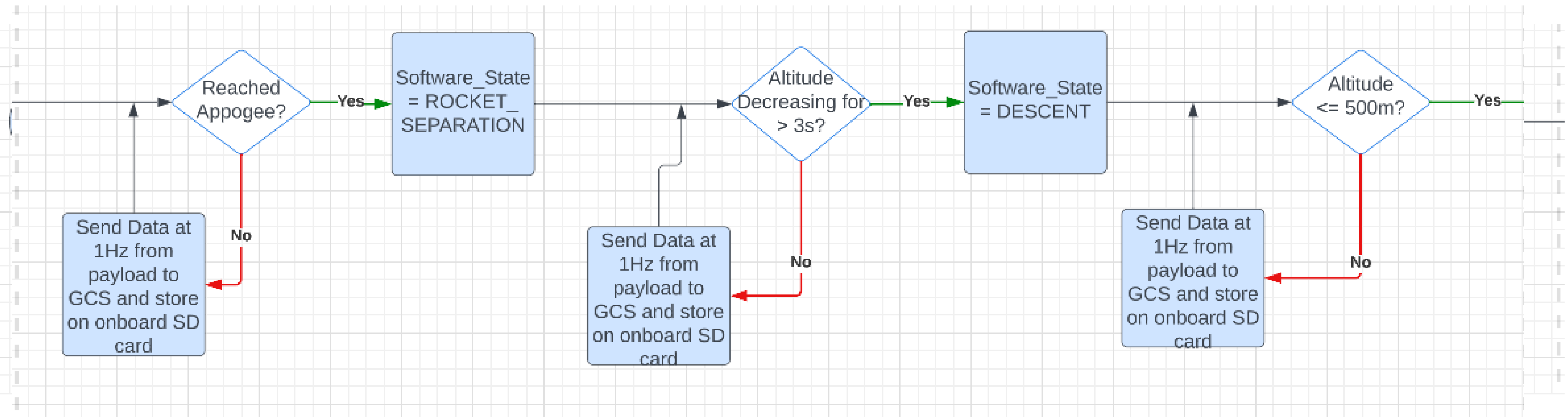
FSW Changes Since PDR

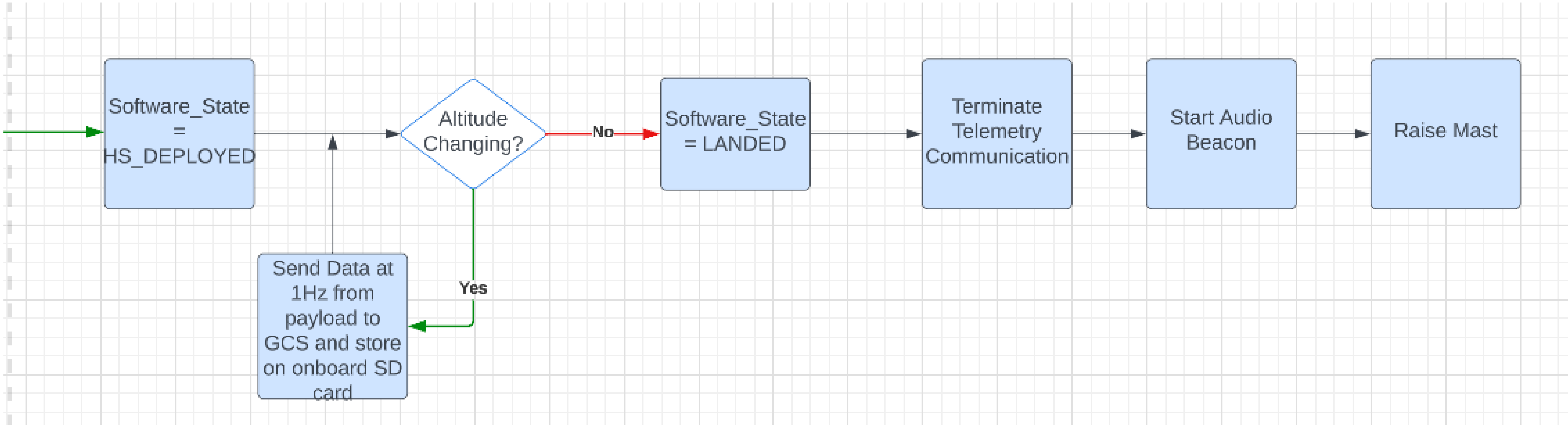
- **No Changes have been made since the PDR**

Payload CanSat FSW State Diagram (1/3)



Payload CanSat FSW State Diagram (2/3)





Software_State = HS_DEPLOYED
Altitude Changing?
No
Yes
Send Data at 1Hz from payload to GCS and store on onboard SD card
Software_State = LANDED
Terminate Telemetry Communication
Start Audio Beacon
Raise Mast

Payload CanSat FSW State Diagram

FSW Recovery from Reset

What is used to recover:

- Mission Time
- GPS Time
- Software State
- Altitude

Causes that call for reset:

- Power loss (power supply)
- Physical damage
- Processor failure

Simulation Mode Software

- **Sensor changes**
  - All air pressure sensors disabled

- **Simulation mode commands**
  - <MODE> switches from 'F' (Flight) to 'S' (Simulation)

- **How is simulated sensor data substituted with real data?**
  - External data from text file fed into certain fields instead of air pressure sensor readings
    - <ALTITUDE>, <PRESSURE>
  - All other sensor readings & telemetry remain the same

Software Development Plan (1/2)

Prototyping and Prototyping Environments

- Environment in Visual Studio Code and Arduino IDE
- Modular code parts

Development Team

- Max Epstein
- Dylan Falzone
- Yashas Shivaram
- Paolo D'Alessandro

Test Methodology

- Simulation mode with varying datasets.
- Freefall sensor testing

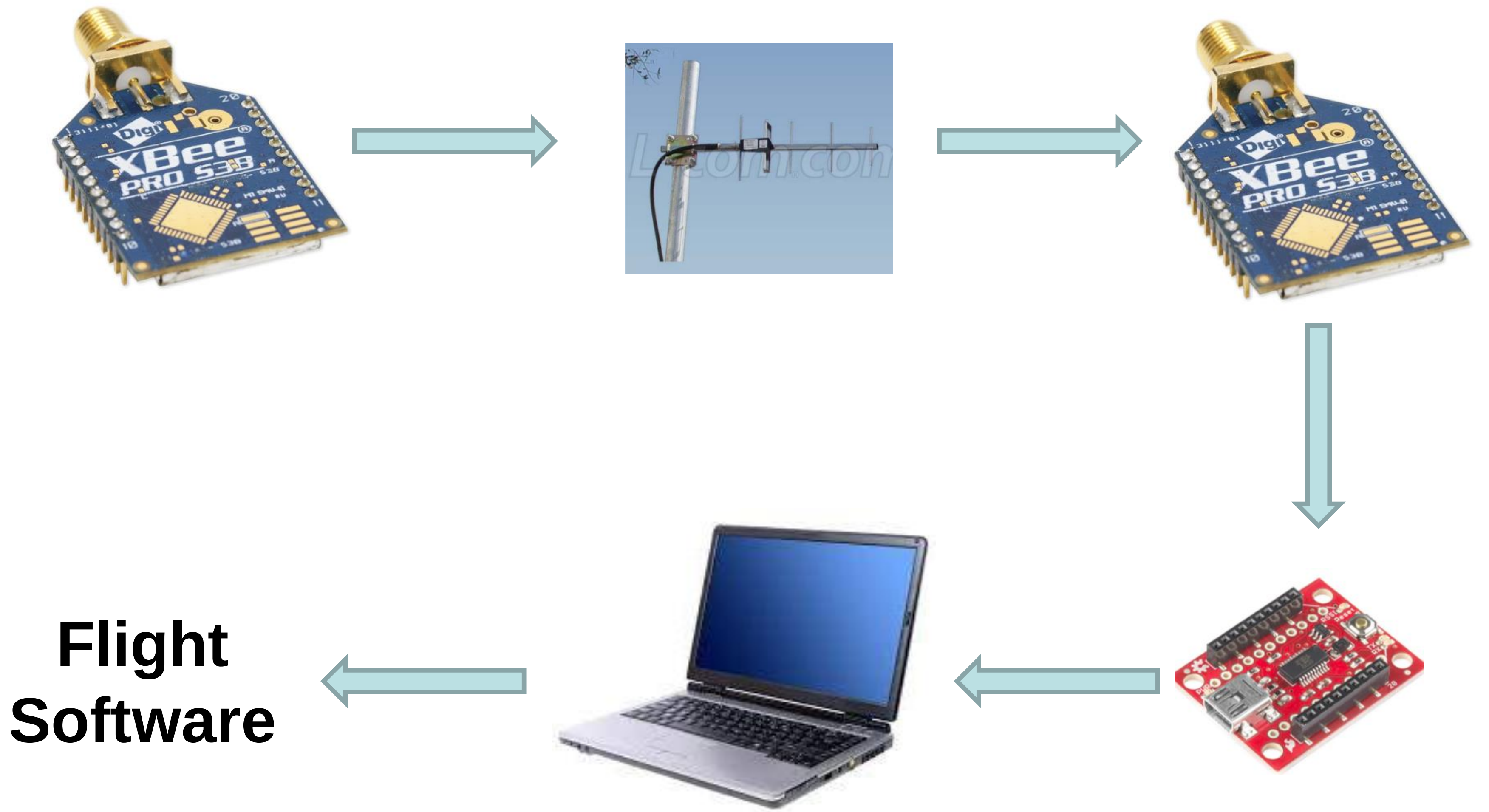
Software Development Plan (2/2)

Subsystem	Development Sequence
Sensors	i. Sensor trade and selection compare and select the best ii. Program each individual sensor in Arduino iii. Integrate and conglomerate all programs, make sure it still functions
Xbee Radio	i. Configure and test point to point communication for the radio (controller and GCS port) ii. Integrate sensors with Xbee for data transmission
Flight Control	i. Program feedback system with servos connected to flight mechanisms
Release Mechanisms	i. Program release mechanisms such as linear actuators
Software State	i. Use the data from sensors to change the states
Audio Beacon	i. Program locator audio beacon
Integration	i. Integrate all software subsystem and ensure 1Hz data transmission from payload. Also, to make sure the software states match up with what is occurring.

Ground Control System (GCS) Design

Dylan Falzone, Max Epstein

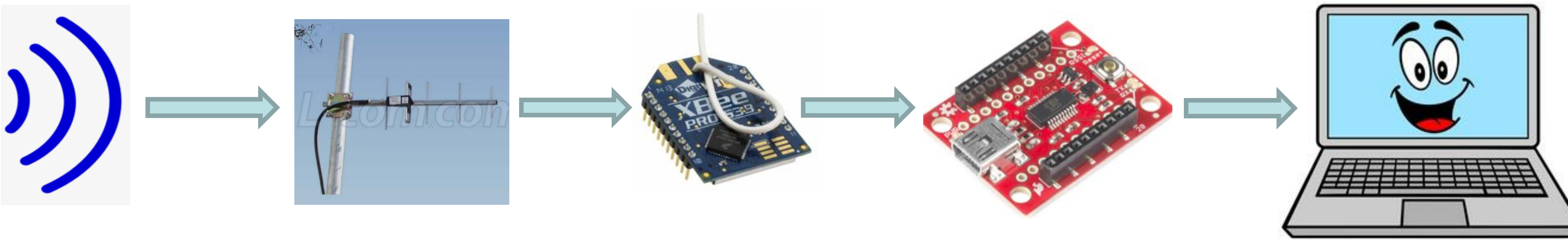
GCS Overview



GCS Changes Since PDR

- **No changes have been made since the PDR**

GCS Design

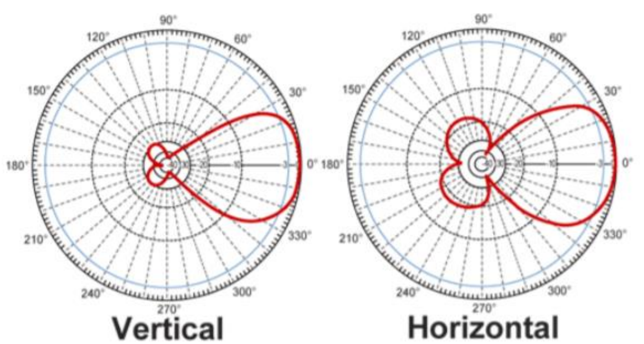


Specifications	
Laptop Battery	4 Hours
Overheating Mitigation	Umbrella & Laptop Cooler
Auto update Mitigation	Disable Auto-Update

GCS Antenna

Name	Frequency Range (GHz)	Length of Antenna (mm)	Gain (dBi)	Polarization	Connection Type	Weight (g)	Cost ($)
900 MHz 14 dBi Al Yagi Antenna	.90-.928	1422	14	Linear	N-Female	680	72.32

Selection	Reasoning for selection
Yagi Antenna	- Gain strength immensely stronger than the other antennas - Larger antenna - Ideal frequency range - Handheld, easy to maneuver



GCS Software (1/3)

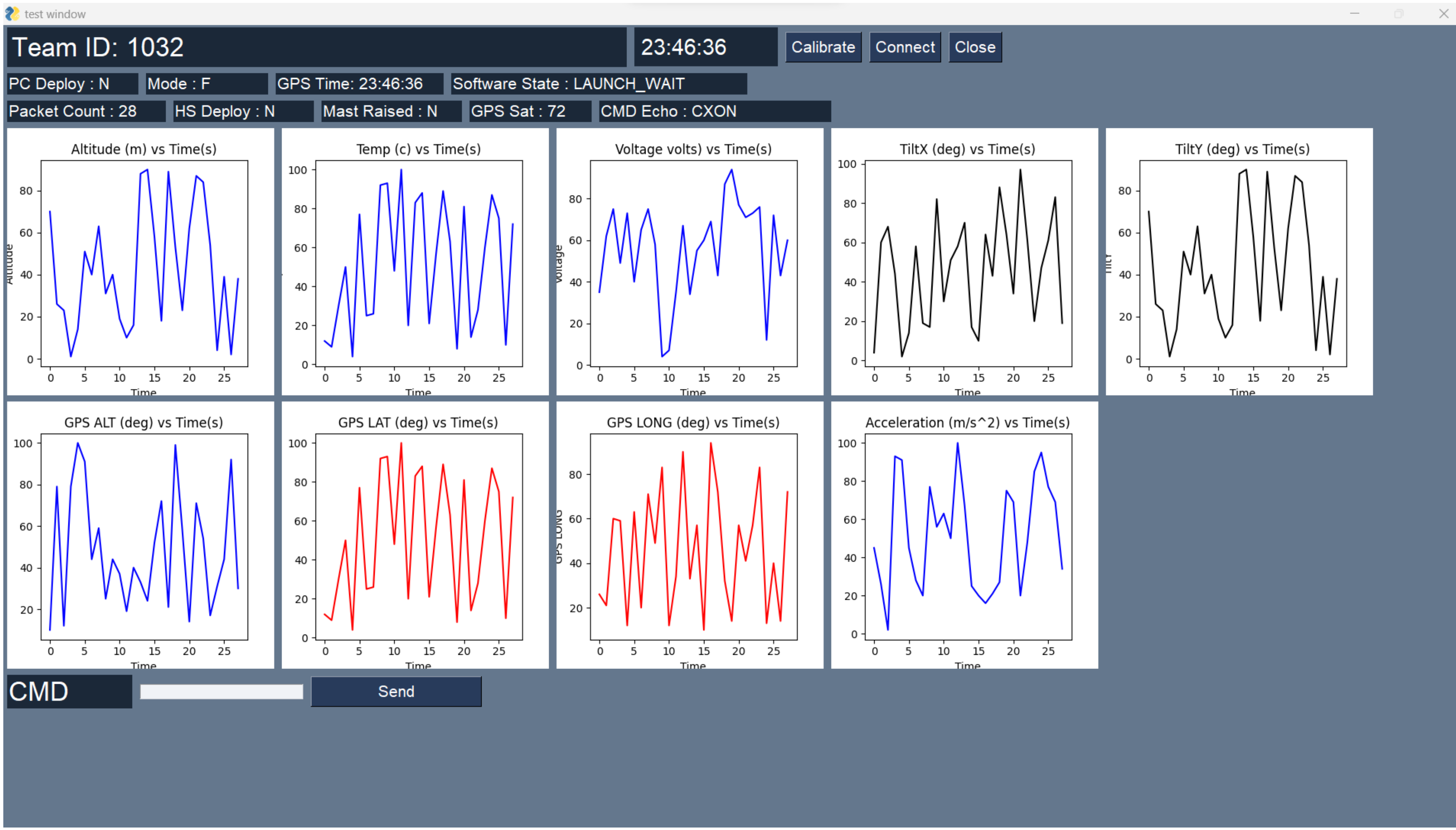
Software Packages:
- Python 3.9.7 - Computational environment of choice
- XCTU – XBee Program Software
- XBEE Python Library – real time access to XBEE via USB interface
- Matplotlib Python Library – real time plotting and data manipulation
- PySimpleGUI Python Library – visual design layout and manipulation
- Pandas Python Library – real time data collection and .csv file status

Command Software and Interface:
- Commands can be sent from the Ground Control Station to the CanSat via command.
- The GCS uses the XBEE Python Library to access the XBEE receiver through the USB interface.

Telemetry Data Recording:
- Telemetry will be saved in a .csv file without manipulation after being read via USB interface.
- .csv data will be analyzed in python and presented via GUI and saved in file.

CSV File Generation:
- .csv file will be generated in GCS Python software for payload and data will be continuously added to the created file as it arrives in packets to GCS.

GCS Software (2/3)



GCS Software (3/3)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	TEAM_ID	MISSION_	PACKET_C	MODE	STATE	ALTITUDE	HS_DEPLO	PC_DEPLO	MAST_RAI	TEMPERAT	VOLTAGE	GPS_TIME	GPS_ALTIT	GPS_LATIT	GPS_LONG	GPS_SATS	TILT_X	TILT_Y	CMD_ECH	T+ Time	Accelerati
2	1032	13:18:34	1	F	LAUNCH_\	70	N	N	N	12	35	13:18:34	10	12	26	12	4	70	CXON	0	45
3	1032	13:18:35	2	F	LAUNCH_\	26	N	N	N	9	62	13:18:35	79	9	21	9	60	26	CXON	1	26
4	1032	13:18:36	3	F	LAUNCH_\	23	N	N	N	30	75	13:18:36	12	30	60	30	68	23	CXON	2	2
5	1032	13:18:37	4	F	LAUNCH_\	1	N	N	N	50	49	13:18:37	79	50	59	50	44	1	CXON	3	93
6	1032	13:18:38	5	F	LAUNCH_\	14	N	N	N	4	73	13:18:38	100	4	12	4	2	14	CXON	4	91
7	1032	13:18:39	6	F	LAUNCH_\	51	N	N	N	77	40	13:18:39	91	77	63	77	14	51	CXON	5	45
8	1032	13:18:40	7	F	LAUNCH_\	40	N	N	N	25	65	13:18:40	44	25	20	25	58	40	CXON	6	28
9	1032	13:18:41	8	F	LAUNCH_\	63	N	N	N	26	75	13:18:41	59	26	71	26	19	63	CXON	7	20
10	1032	13:18:42	9	F	LAUNCH_\	31	N	N	N	92	58	13:18:42	25	92	49	92	17	31	CXON	8	77
11	1032	13:18:43	10	F	LAUNCH_\	40	N	N	N	93	4	13:18:43	44	93	83	93	82	40	CXON	9	56
12	1032	13:18:44	11	F	LAUNCH_\	19	N	N	N	48	7	13:18:44	37	48	12	48	30	19	CXON	10	63
13	1032	13:18:45	12	F	LAUNCH_\	10	N	N	N	100	35	13:18:45	19	100	34	100	51	10	CXON	11	50
14	1032	13:18:46	13	F	LAUNCH_\	16	N	N	N	20	67	13:18:46	40	20	90	20	58	16	CXON	12	100
15	1032	13:18:47	14	F	LAUNCH_\	88	N	N	N	83	34	13:18:47	33	83	33	83	70	88	CXON	13	67
16	1032	13:18:48	15	F	LAUNCH_\	90	N	N	N	88	55	13:18:48	24	88	57	88	17	90	CXON	14	25
17	1032	13:18:49	16	F	LAUNCH_\	58	N	N	N	21	60	13:18:49	52	21	10	21	10	58	CXON	15	20
18	1032	13:18:50	17	F	LAUNCH_\	18	N	N	N	57	69	13:18:50	72	57	94	57	64	18	CXON	16	16
19	1032	13:18:51	18	F	LAUNCH_\	89	N	N	N	89	43	13:18:51	21	89	72	89	43	89	CXON	17	21
20	1032	13:18:52	19	F	LAUNCH_\	53	N	N	N	63	87	13:18:52	99	63	32	63	88	53	CXON	18	27
21	1032	13:18:53	20	F	LAUNCH_\	23	N	N	N	8	94	13:18:53	58	8	14	8	64	23	CXON	19	75
22	1032	13:18:54	21	F	LAUNCH_\	62	N	N	N	81	77	13:18:54	14	81	57	81	34	62	CXON	20	69
23	1032	13:18:55	22	F	LAUNCH_\	87	N	N	N	14	71	13:18:55	71	14	41	14	97	87	CXON	21	20
24	1032	13:18:56	23	F	LAUNCH_\	84	N	N	N	28	73	13:18:56	54	28	57	28	61	84	CXON	22	48
25	1032	13:18:57	24	F	LAUNCH_\	54	N	N	N	60	76	13:18:57	17	60	83	60	20	54	CXON	23	85
26	1032	13:18:58	25	F	LAUNCH_\	4	N	N	N	87	12	13:18:58	31	87	13	87	47	4	CXON	24	95
27	1032	13:18:59	26	F	LAUNCH_\	39	N	N	N	75	72	13:18:59	44	75	40	75	61	39	CXON	25	77
28	1032	13:19:00	27	F	LAUNCH_\	2	N	N	N	10	43	13:19:00	92	10	14	10	83	2	CXON	26	69

CanSat Integration and Test

Jordi Rey

CanSat Integration and Test Overview

Subsystem Level

- Sensors
- CDH
- EPS
- Radio communications
- FSW
- Mechanical
- Descent Control

Integrated Level

- Descent testing
- Communications
- Mechanisms
- Deployment
- Simulation

Environmental

- Drop test
- Thermal test
- Vibration test
- Fit Check
- Vacuum test

Test Plan	
Subsystem Level	Each subsystem listed in this page will be performed
Integrated Level	Integrated tests will be performed after payload and container are built
Environmental	Fit check will be performed on the container and the other tests will be performed on the assembled CanSat

Subsystem Level Testing Plan (1/2)

Subsystem Level Testing	
Sensors	• Pressure sensor tests • Temperature sensor tests • GPS location & time tests • Camera recording and saving video tests • Altimeter tests
CDH	• Processor clock speed tests • EEPROM storage size tests • EEPROM read/write speed tests
EPS	• Battery voltage readings • Impedance tests on each component • Battery power output & tolerance tests
Radio Communications	• XBEE radio receiver/sender tests • Antenna signal quality tests • Packet receival and transmission tests

Subsystem Level Testing Plan (2/2)

Subsystem Level Testing	
FSW	• Data live graph generation tests • Simulation mode tests • CSV data saving & handling • Software states testing
Mechanical	• Container & probe structural tests • Probe deployment tests • Probe upright testing • Avionics bay structural integrity tests • Parachute deployment and release tests • Probe stability control tests • Flag raising test
Descent Control	• Parachute deployment tests • Aerobraking device testing • Descent stability testing

Integrated Level Functional Test Plan

Testing Plan	
Decent Testing	• PID Controller payload descent rate tests
Communications	• Telemetry transmission and retrieval tests • Communication between GCS and Payload
Mechanisms	• Payload release mechanism tests • Payload stability control tests • Aerobrake release mechanism tests • Flag deployment mechanism tests • Payload parachute release mechanism tests
Deployment	• Payload deployment tests at various altitudes • Payload parachute deployments tests at various altitudes • Aerobrake deployments tests at various altitudes • Linear actuator integration with altitude sensor readings
Simulation	• Software state tests • Activation command testing • Sensor readings and telemetry remain unchanged • Text file reading and overriding

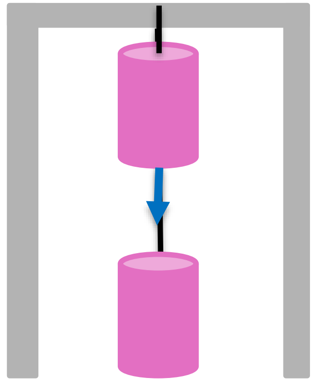
Environmental Test Plan (1/3)

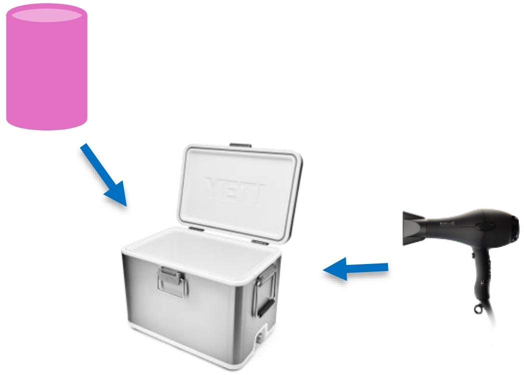
Drop Test

- The CanSat will be tied to a 61 cm 1/8 inch thick kevlar rope to an 80/20 aluminum high surface structure with a height of at least 1 meter
- The CanSat will be powered on and verified that telemetry is being received
- The CanSat will be raised so the attachment point on the parachute is at the same height as the structure's ceiling and released
- It will be checked if the CanSat is still operational and receiving telemetry

Thermal Test

- The CanSat will be turned on and then placed in an insulating cooler
- The cooler will be sealed and set to 60 degrees Celsius using a hairdryer
- The thermal test will run for two hours maintaining a temperature between 55 and 60 degrees Celsius
- Visual inspection and functional tests will be conducted to verify the CanSat survived and can still operate





Environmental Test Plan (2/3)

Vibration Test

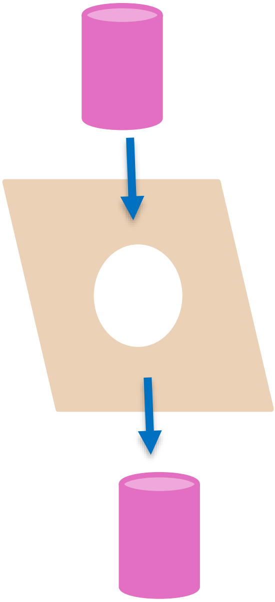
- The CanSat will be placed in a wooden support structure to hold the CanSat
- The sander will be turned on and then powered off to a full stop 5 seconds after reaching full speed
- The previous step will be repeated four more times
- The CanSat will be visually inspected for damage and functionality
- It will be verified that the accelerometer data is being collected

Vacuum Test

- The CanSat will be turned on and suspended in a 5-gallon bucket
- A lid made of 6 mm thick polycarbonate sheet will be placed on top of the bucket
- A vacuum cleaner will be turned on to pull a vacuum inside the bucket
- The telemetry will be collected, and the vacuum turned off at peak altitude

Fit Check

- A 125 mm diameter hole will be cut from a piece of cardboard
- The width of the CanSat will be tested using the 125 mm diameter hole to see if anything is touching



Test Procedures Descriptions (1/5)

Drop Test			
Test Proc	**Test Description**	**Requirements**	**Pass Fail Criteria**
1	Power on the CanSat	23, 24	Pass if CanSat powers on. Otherwise fail.
2	Verify telemetry is being received.	38, 39, 40	Pass if data is received. Otherwise fail.
3	Raise CanSat by the attached cord, so that the two attachment points of the cord are at the same height.		N/A
4	Release the CanSat.		N/A
5	Verify the CanSat did not lose power.	38, 44, 45	Pass if CanSat doesn't lose power. Otherwise fail.
6	Inspect for any damage, or detached parts.	12, 13, 15	Pass if there is no damage. Otherwise fail.
7	Verify telemetry is still being received.	30	Pass if data is still receiving. Otherwise fail.
8	Power down CanSat.	23, 24	Pass if CanSat turns off. Otherwise fail.

Test Procedures Descriptions (2/5)

Thermal Test			
Test Proc	**Test Description**	**Requirements**	**Pass Fail Criteria**
1	Place CanSat into a thermal chamber.		N/A
2	Power on the CanSat.	23, 24	Pass if CanSat powers on. Otherwise fail.
3	Close and seal the thermal chamber and turn on the heat source.		N/A
4	Monitor the temperature and turn off the heat source when the internal temperature reaches 60C and turn on the heat source when the temperature drops to 55C, while maintaining the test conditions for two hours.		N/A
5	Turn off the heat source and perform visual inspection and any functional tests to verify the CanSat survived the thermal exposure and can operate as expected.	38, 39, 40 44, 45	Pass if CanSat operates as expected. Otherwise fail.
6	With the CanSat still hot, test any mechanisms and structures to make sure the integrity has not been compromised. Take precautions to avoid injury. Verify epoxy joints and composite materials still maintain their strengths.	15, 30, 31	Pass if everything is intact. Otherwise fail.
7	Verify that CanSat is still sending data to GCS 47	38, 39	Pass if data is being sent. Otherwise fail.
8	Power down CanSat.	23, 24	Pass if CanSat can turn off. Otherwise fail.

Test Procedures Descriptions (3/5)

Vibration Test			
Test Proc	**Test Description**	**Requirements**	**Pass Fail Criteria**
1	Power on the CanSat.	23, 24	Pass if CanSat powers on. Otherwise fail.
2	Verify accelerometer data is being collected.	38, 39	Pass if accelerometer data is received on the Ground Control Station. Otherwise fail.
3	Power up the sander.		N/A
4	Once the sander is up to full speed, wait 5 seconds.		N/A
5	Power down the sander to a full stop.		N/A
6	Repeat steps 3 to 5 four more times.		N/A
7	Inspect the CanSat for damage and functionality.	12, 13, 15	Pass if CanSat maintains function and structural integrity with no damage to mounting or connections. Otherwise fail.
8	Verify accelerometer data is still being collected.	15	Pass if accelerometer data is received on the Ground Control Station. Otherwise fail.
9	Power down CanSat.	23, 24	Pass if CanSat can turn off. Otherwise fail.

Test Procedures Descriptions (4/5)

Vacuum Test			
Test Proc	**Test Description**	**Requirements**	**Pass Fail Criteria**
1	Suspend the fully configured and powered CanSat in the vacuum chamber.	23, 24	Pass if CanSat powers on. Otherwise fail.
2	Turn on the vacuum to start pulling a vacuum.		N/A
3	Monitor the telemetry and stop the vacuum when the peak altitude has been reached.	38, 39	N/A
4	Let the air enter the vacuum chamber slowly and monitor the operation of the CanSat.	15	Pass if CanSat operates as expected. Otherwise fail.
5	Collect and save telemetry.	44, 45, 51	Pass if data is received. Otherwise fail.
6	Make the saved telemetry available for the judges to review.	56, 57	Pass if data is saved. Otherwise fail.
7	Power down CanSat.	23, 24	Pass if CanSat can turn off. Otherwise fail.

Test Procedures Descriptions (5/5)

Fit Check			
Test Proc	**Test Description**	**Requirements**	**Pass Fail Criteria**
1	Cut 125 mm diameter circle in cardboard		N/A
2	Place CanSat through the hole in the cardboard		Pass if CanSat diameter is < 125mm. Otherwise fail.
3	Inspect CanSat for sharp edges that prevent it from smoothly deploying from the rocket	2,3	Pass if no sharp edges. Otherwise fail.

Simulation Test Plan

How simulation works

- After configuration, once the SIM ENABLE and SIM ACTIVATE commands are ran, simulation mode will run.
- The ground station will transmit pressure data from a csv file at 1Hz intervals to the payload.
- The flight software will determine altitude using radio linked values instead of live sensor data.
- The flight software will detect the launch and release payload and parachute at respective altitudes.
- Lastly, the mast will be raised and the audio beacon will begin once landing is detected

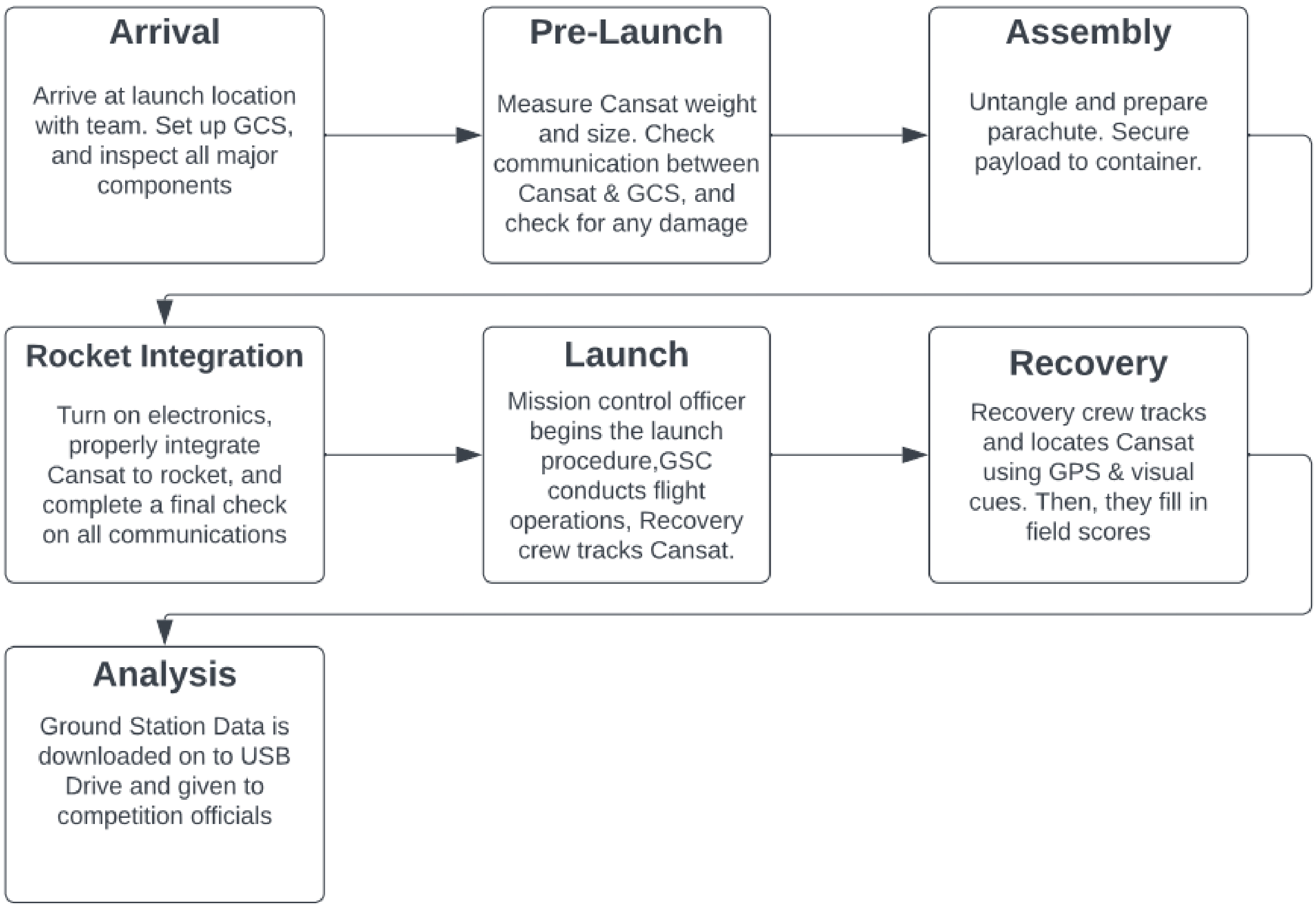
What parts are tested

- The configuration and echoing of commands.
- The calculation of altitude with fed data from the CSV.
- The deployment of payload parachute, mast raise, and trigger of audio beacon.
- Payload video is saved

Mission Operations & Analysis

Melissa Gonzalez Grospe

Flowchart



Arrival
Arrive at launch location with team. Set up GCS, and inspect all major components
Pre-Launch
Measure Cansat weight and size. Check communication between Cansat & GCS, and check for any damage
Assembly
Untangle and prepare parachute. Secure payload to container.
Rocket Integration
Turn on electronics, properly integrate Cansat to rocket, and complete a final check on all communications
Launch
Mission control officer begins the launch procedure,GSC conducts flight operations, Recovery crew tracks Cansat.
Recovery
Recovery crew tracks and locates Cansat using GPS & visual cues. Then, they fill in field scores
Analysis
Ground Station Data is downloaded on to USB Drive and given to competition officials

Overview of Mission Sequence of Events (2/2)

Roles & Responsibilities

- **Mission Control Officer – Savari Datta**
- **Ground Station Crew – Christian Roque, Max Epstein, and Yashas Shivaram**
- **Recovery Crew – Jordi Rey and Daniel Horton**
- **CanSat Crew – Paolo D'Alessandro, Jovana Markovic, Melissa Gonzalez Grospe, Dylan Falzone, Savari Datta, Jordi Rey**

Launch-Day		
Pre-Launch	**Launch**	**Post-Launch**
• Arrive at launch site • Inspect CanSat damage • Fit check CanSat • Inspect Payload damage • Secure payload within container • Construct handheld antenna and setup ground control station • Check telemetry between CanSat and GCS • Properly integrate CanSat to rocket	• Conduct launch procedure • Monitor telemetry data transmission • Perform flight operations • Track container	• Locate container using GPS and visual cues • Ensure all field scores are filled in • GCS data is reduced and downloaded onto thumb drive • Thumb drive is given to competition officials • Prepare for PFR

Field Safety Rules Compliance

Mission Operations Manual		
	GCS Configuration	I. Ground Station Setup Procedure II. Communication Tests III. Antenna Tests
	CanSat Preparation	I. CanSat Assembly Procedure II. Payload to CanSat Integration III. Damage and System Inspection
	CanSat-Rocket Integration	I. Fit Check II. CanSat Parachute Preparation
	Launch Preparation and Procedure	I. Provided by Competition
	Removal Procedure	I. Provided by Competition

Development Status of Mission Operations Manual:

- CanSat Assembly Procedure in progress
- Other sections yet to be started

CanSat Location and Recovery

Container Recovery:

- Container will be a bright pink to aid in the recovery effort
- Parachute will be a bright orange to help visually track the container and probe as they descend
- Container audio beacon will activate once landed
- Last logged GPS position will be used to locate the container

Container Return Address
Yes we CANSAT, University of Florida Team 1032, savaridatta@ufl.edu Mechanical and Aerospace Engineering Building A, University of Florida, 313 Florida, United States of America

Mission Rehearsal Activities

Activities	Rehearsal	Description
Ground System Radio Link Procedures	No	• XBee settings check • Antenna and XBee communication check • Data transmission check
Powering on/off the CanSat	No	• Switch is flicked to turn on CanSat and flicked to turn off
Launch Configuration Preparations	No	• Fit check • Payload is integrated into container • Parachute folding procedure
Loading the CanSat in Launch Vehicle	No	• CanSat to rocket integration
Telemetry processing, archiving, and analysis	No	• Ground station receives all telemetry data • Data is transferred onto CSV file • Data is processed and displayed in real time • Data transfer is ended once container lands
Recovery	No	• Fluorescent container will be tracked during flight • Container buzzer will be listened to and followed • Video data from payload and container transferred to thumb drive

Requirements Compliance

Yashas Shivaram

Requirements Compliance Overview

- *Yes we CANSAT*'s project complies with the requirements of the CanSat 2023 mission
- The requirement compliance was measure using three conditions which are detailed below: Full Compliance, Partial Compliance, and No Compliance.

Full Compliance	The CanSat project complies 53/61 mission requirements
Partial Compliance	There are 8 requirements partially satisfied by our CanSat. This means that the requirement is technically met but will require further analysis and testing for finalization.
No Compliance	There are 0 requirements our current build does not comply to

Requirements Compliance

Req #	Description	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or notes
1	Total mass of the CanSat (science payloads and container) shall be 700 grams +/- 10 grams.	Comply	17	
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Comply	17	
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Comply	19	Sides will be sanded
4	The container shall be a fluorescent color; pink, red or orange.	Comply	44, 99	
5	The container shall be solid and fully enclose the science probes. Small holes to allow access to turn on the science probes are allowed. The end of the container where the probe deploys may be open.	Comply		Added since the PDR
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Comply	41	
7	The rocket airframe shall not be used as part of the CanSat operations.	Comply	41	
8	The container's parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Comply	44	
9	The Parachutes shall be fluorescent Pink or Orange	Comply	99	
10	The descent rate of the CanSat (container and science probe) shall be 15 meters/second +/- 5m/s.	Comply	38	

Requirements Compliance

Req #	Description	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or notes
11	0 altitude reference shall be at the launch pad.	Comply	85	
12	All structures shall be built to survive 15 Gs of launch acceleration.	Partial	39	Needs Testing
13	All structures shall be built to survive 30 Gs of shock	Partial	39	Needs Testing
14	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high-performance adhesives.	Comply	41-46	
15	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Partial	39	Needs Testing
16	Mechanisms shall not use pyrotechnics or chemicals.	Comply	41	
17	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Comply	41	
18	Both the container and payload shall be labeled with team contact information including email address.	Comply	99	
19	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost. Equipment from previous years should be included in this cost, based on current market value.	Comply	51-55	
20	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Comply	60	
21	XBEE radios shall have their NETID/PANID set to their team number.	Comply	60	

Requirements Compliance

Req #	Description	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or notes
22	XBEE radios shall not use broadcast mode.	Comply	60	
23	The container and probe shall include an easily accessible power switch that can be accessed without disassembling the CanSat and science probes and in the stowed configuration.	Partial	67,68	
24	The probe shall include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the CanSat and in the stowed state.	Comply	67	
25	An audio beacon is required for the probe. It shall be powered after landing.	Comply	67, 75	
26	The audio beacon shall have a minimum sound pressure level of 92 dB, unobstructed.	Partial	28	Needs Testing
27	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	Comply	68	
28	An easily accessible battery compartment shall be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Comply	17	
29	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	81-89	
30	The Cansat shall operate during the environmental tests laid out in Section 3.5.	Comply	93	
31	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	Comply	58	
32	The probe shall be released from the container when the CanSat reaches 500 meters.	Comply	45	

Requirements Compliance

Req #	Description	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or notes
33	The probe shall deploy a heat shield after leaving the container.	Comply	47-48	
34	The heat shield shall be used as an aerobrake and limit the descent rate to 20 m/s or less.	Comply	31, 35-34	
35	At 200 meters, the probe shall release a parachute to reduce the descent rate to 5 m/s +/- 1m/sec.	Comply	49, 38	
36	Once landed, the probe shall upright itself.	Partial	50	No active uprighting, more testing
37	After uprighting, the probe shall deploy a flag 500 mm above the base of the probe when the probe is in the upright position.	Comply	41	
38	The probe shall transmit telemetry once per second.	Comply	60, 75, 92	
39	The probe telemetry shall include altitude, air pressure, temperature, battery voltage, probe tilt angles, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	Comply	61	
40	The probe shall include a video camera pointing down to the ground.	Comply	28	
41	The video camera shall record the flight of the probe from release to landing.	Comply	28	
42	The video camera shall record video in color and with a minimum resolution of 640x480.	Comply	28	
44	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets	Comply	61	
45	The probe shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	Comply	61	

Requirements Compliance

Req #	Description	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or notes
46	The probe shall have its time set to within one second UTC time prior to launch.	Comply	64	
47	The probe flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	Partial		Needs testing
48	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.	Partial		Needs testing
49	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Comply	63, 65, 94	
50	The ground station shall command the CanSat to start calibrating the altitude to zero when the CanSat is on the launch pad prior to launch.	Comply	64	
51	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	86	
52	Telemetry shall include mission time with 0.01 second or better resolution.	Comply	61	
53	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	Comply	73	
54	Each team shall develop their own ground station.	Comply	81	
55	All telemetry shall be displayed in real time during descent on the ground station.	Comply	85	
56	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Comply	85	

Requirements Compliance

Req #	Description	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or notes
57	Teams shall plot each telemetry data field in real time during flight.	Comply	85	
58	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Comply	81	
59	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site	Comply	81	
60	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	Comply	84, 94	
61	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the cansat.	Comply	84, 94	

Management

Savari Datta

Status of Procurements

- All components and electronics to be used in the final design of the CanSat and the Ground Control Station have been bought prior to the submission of the CDR.

- <u>Parachutes are currently ordered but not delivered</u>

- In terms of electronics, several backup units were bought in order to account for damage during testing and travel.

- All CanSat structural components also have several backup units to account for damage during testing and travel.

- Procurement of our CanSat’s components is partially completed

CanSat Budget – Hardware

Component	Quantity	Unit Price ($)	Total Price ($)	Value Type
Adafruit BMP280	2	9.95	19.90	Actual
BNO-055	1	34.95	34.95	Actual
Adafruit Ultimate	1	29.95	29.95	Actual
Raspberry Pi Pico	1	4.50	4.50	Actual
ANT-900-RP-2-A	1	3.99	3.99	Actual
Arducam Mini	1	25.99	25.99	Actual
Mirco SD cards	1	4.20	4.20	Actual
Micro SD Readers	1	8.00	8.00	Actual
XBEE Pro 900 Mhz Radio	1	68.25	68.25	Actual
2032 Cell Batteries	4	1.20	4.80	Actual
Arduino Nano	1	20.70	20.70	Actual
ABS Filament 1.75mm ABS, 1 kg	1	22.99	22.99	Actual
Springs	6	1.08	6.48	Actual
Tie Down Ring	1	1.24	1.24	Actual

CanSat Budget – Hardware

Component	Quantity	Unit Price ($)	Total Price ($)	Value Type
Linear Actuator	1	65.00	65.00	Actual
Servo Motor	1	8.84	8.84	Actual
¼-20 Hex Nut	2	9.81	9.81	Actual
Steel Tape	1	14.99	14.99	Actual
Super Lube	1	7.39	7.39	Actual
Clock Spring	1	8.38	8.38	Estimate
JB Weld Plastic Bonder	1	15.74	15.74	Actual
Fiberglass Eyebolt	1	5.66	5.66	Actual
Aluminum threaded rods	2	4.37	8.74	Actual
¼ -20 Screw	1	13.84	13.84	Actual
Mylar Reflective Material	1	6.69	6.69	Actual
1ft Ultra-Light Parabolic Parachute	1	46.00	46.00	Actual
2ft Ultra-Light Parabolic Parachute	1	56.00	56.00	Actual
Plastic Coupling Nuts	4	5.55	22.20	Actual
PCB Screws	4	1.25	5.00	Actual

CanSat Budget – Hardware

Component	Quantity	Unit Price ($)	Total Price ($)	Value Type
ChuteRelease	1	139.95	139.95	Actual
93181A411 Nut – Spool Mount (x100)	1	5.95	5.95	Actual
93070A064 M3 3mm Screws (x50)	1	12.50	12.50	Actual
90592A085 M3-0.5 hew nuts (x100)	1	2.62	2.26	Actual
Ripstop nylon	1	0	0	Actual

CanSat Budget – Other Costs

Component	Quantity	Unit Price ($)	Total Price ($)	Value Type
Ground Station	-	-	-	-
Xbee USB Shield	1	26.00	26.00	Actual
900 MHz 14 dBi Al Yagi Antenna	1	72.32	72.32	Actual
900 MHz XBEE Radio	1	68.25	68.25	Actual
Laptop	1	1	0	Provided by Team Member
Prototyping	1	1	150.00	Estimate
Test Supplies	1	1	150.00	Estimate
Test Facilities/ Manufacturing Equipment	1	1	0	Covered by University

CanSat Budget – Other Costs

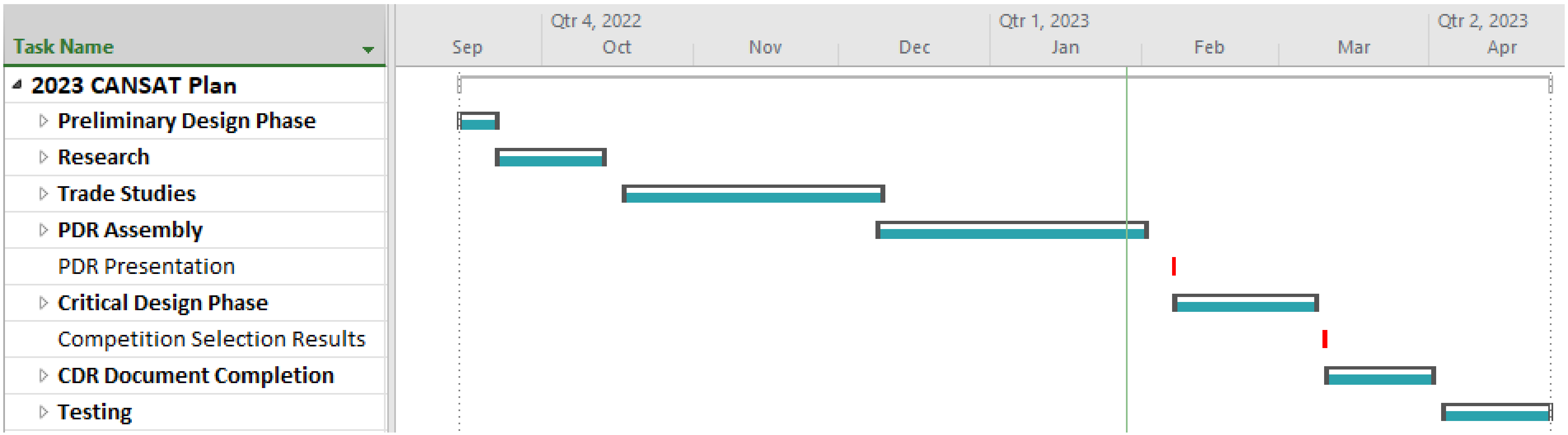
Source of Income:	Funds Provided ($):
UF MAE Department	4000.00

Hardware Costs:	$650.44
Other Costs:	$466.57
Competition Fees:	$200.00
Total Costs:	**$1317.01**

A total cost of $1057.09 for the testing and building of our CanSat as well as CanSat related fees leaves us with a total of **$2682.99** for travel, housing, and food expense. This is expected to be more than sufficient for our 10 members.

Program Schedule Overview

- The schedule below is a broad overlook of the 2022-2023 completion schedule for our team
- The key below defines symbols for the more detailed schedule
- Meetings in the Spring took place on Tuesdays and Wednesdays

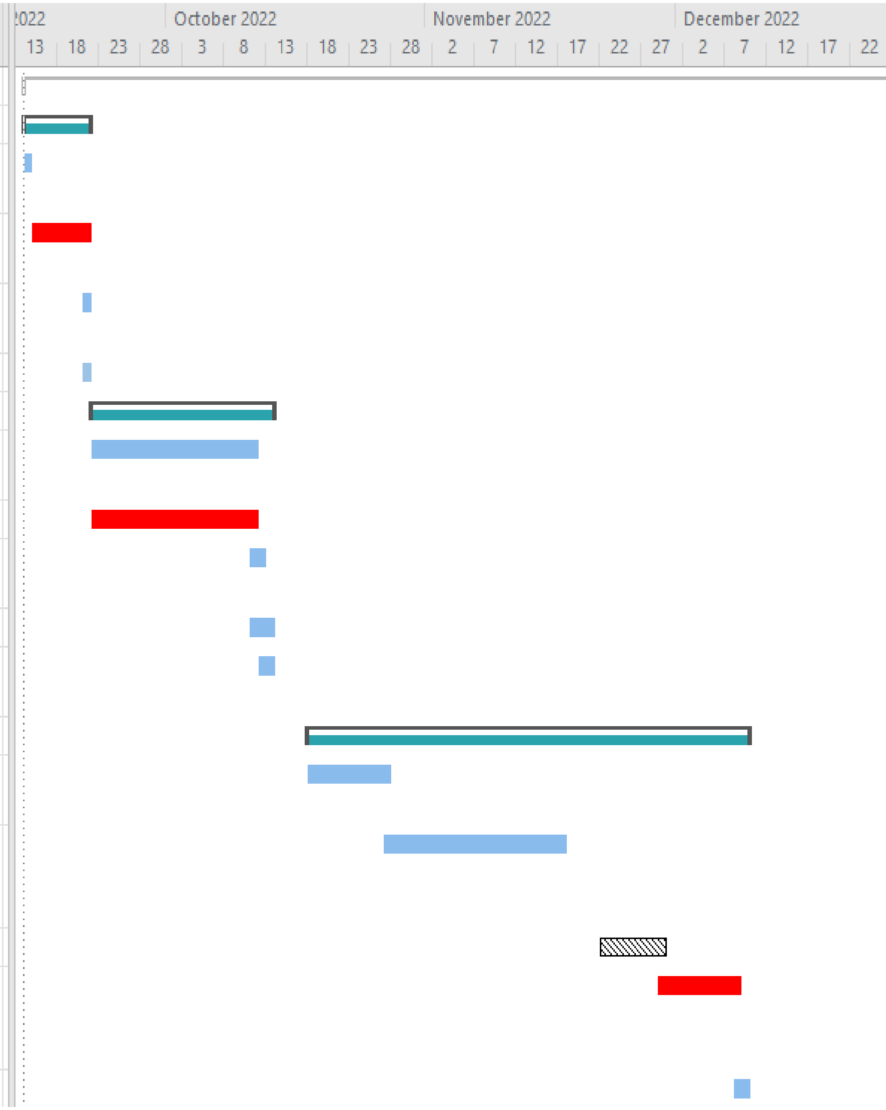


KEY

Design Phase Overview		Important Action	
Task		Holiday/Vacation	

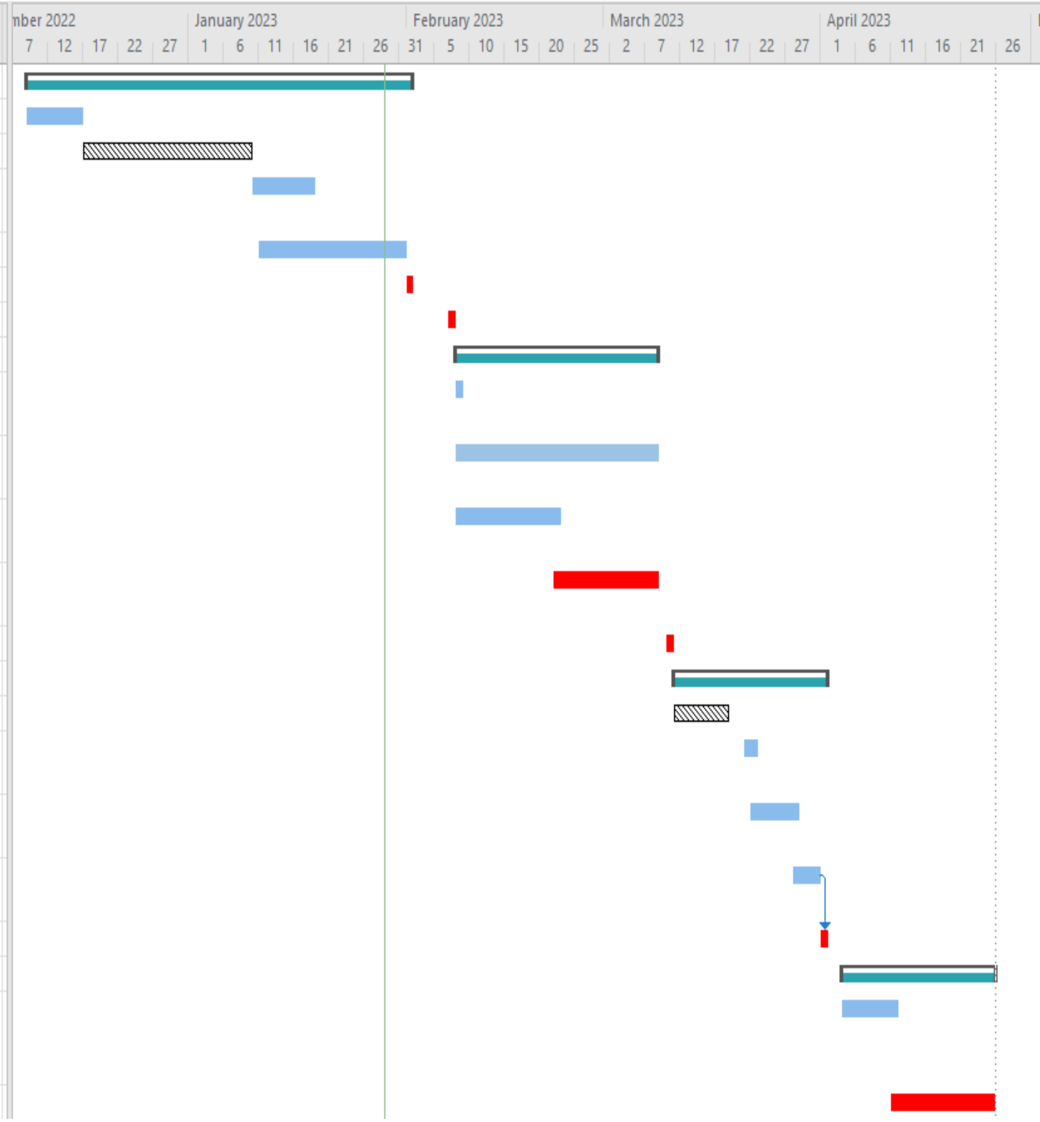
Detailed Program Schedule (1/2)

	Task Name	Duration	Start	Finish	Subteam
0	**2023 CANSAT Plan**	**164 days?**	**Wed 9/14/22**	**Tue 4/25/23**	
1	**Preliminary Design Phase**	**6 days?**	**Wed 9/14/22**	**Wed 9/21/22**	**All**
2	Present Mission Guide and Objective of competition	1 day	Wed 9/14/22	Wed 9/14/22	Management
3	Organize and divide team and responsibilities	5 days	Thu 9/15/22	Wed 9/21/22	Management
4	Document and organize competition requirements	1 day	Wed 9/21/22	Wed 9/21/22	Management
5	Finalize meeting schedule	1 day	Wed 9/21/22	Wed 9/21/22	Management
6	**Research**	**16 days**	**Thu 9/22/22**	**Thu 10/13/22**	**All**
7	Sensors and Electronic research	14 days	Thu 9/22/22	Tue 10/11/22	Avionics and FSW
8	Design Conceptualization	14 days	Thu 9/22/22	Tue 10/11/22	Payload and Container
9	Subsystem design discussions	2 days	Tue 10/11/22	Wed 10/12/22	All
10	Prototyping Designs	3 days	Tue 10/11/22	Thu 10/13/22	Payload and Container
11	Document pros and cons of each design proposal	2 days	Wed 10/12/22	Thu 10/13/22	Payload and Container
12	**Trade Studies**	**39 days**	**Tue 10/18/22**	**Fri 12/9/22**	**All**
13	Prototype testing and quantitative data collection	8 days	Tue 10/18/22	Thu 10/27/22	Payload and Container
14	Verify requirements are met by each subsystem and make according edits	16 days	Thu 10/27/22	Thu 11/17/22	All
15	Thanksgiving Break	6 days	Tue 11/22/22	Tue 11/29/22	All
16	Conduct trade study on various designs for each subsytem	8 days	Tue 11/29/22	Thu 12/8/22	Payload and Container
17	Order materials	2 days	Thu 12/8/22	Fri 12/9/22	Management



Detailed Program Schedule (2/2)

	Task Name	Duration	Start	Finish	Subteam
18	PDR Assembly	40 days	Fri 12/9/22	Wed 2/1/23	All
19	Finals Prep	6 days	Fri 12/9/22	Fri 12/16/22	All
20	Winter Break	17 days	Sat 12/17/22	Mon 1/9/23	All
21	Assign slides and start formatting	7 days	Tue 1/10/23	Wed 1/18/23	All
22	Fill in Tables and Slides	15 days	Wed 1/11/23	Tue 1/31/23	All
23	PDR Due	1 day	Wed 2/1/23	Wed 2/1/23	All
24	PDR Presentation	1 day	Tue 2/7/23	Tue 2/7/23	All
25	Critical Design Phase	21 days	Wed 2/8/23	Wed 3/8/23	All
26	Review Requirements for CDR and mission	1 day	Wed 2/8/23	Wed 2/8/23	All
27	Begin Manufacturing of Finalized Subsystems	21 days	Wed 2/8/23	Wed 3/8/23	Payload and Container
28	Test Flight Software and Avionics	11 days	Wed 2/8/23	Wed 2/22/23	Avionics and Flight Software
29	Conduct the integration of subsystems	11 days	Wed 2/22/23	Wed 3/8/23	All
30	Competition Selection Results	1 day?	Fri 3/10/23	Fri 3/10/23	All
31	CDR Document Completion	18 days?	Sat 3/11/23	Sat 4/1/23	All
32	Spring Break	7 days?	Sat 3/11/23	Sat 3/18/23	All
33	Document Final Design and Analysis for all Subteams	2 days	Tue 3/21/23	Wed 3/22/23	All
34	Fill in Slides and Verify Completion	5 days	Wed 3/22/23	Tue 3/28/23	All
35	Format and Make final Adjustments	4 days	Tue 3/28/23	Fri 3/31/23	All
36	CDR due	1 day	Sat 4/1/23	Sat 4/1/23	Management
37	Testing	16 days?	Tue 4/4/23	Tue 4/25/23	All
38	Verify Sytem Integration meets Competition Requirements	6 days?	Tue 4/4/23	Tue 4/11/23	All
39	Conduct Tests on full system	11 days	Tue 4/11/23	Tue 4/25/23	All



Shipping and Transportation

- Entire CanSat project hardware will be carefully packed and transported to Virginia by car from Gainesville, Florida
- Additional CanSat project supplies and tools will also be transported to Virginia from Gainesville.
- Supplies are to be placed in boxes split by structure, electronics, and tools
- Everything will be shipped a few days before the competition and stored in team member's house (located in Virginia)

Conclusions

Major Accomplishments

- All materials ordered
- CanSat container prototyped
- Prototype of Payload
- Basic telemetry in progress
- Parachute descent control methods developed

Flight Software Status

- Radio Testing started
- Final software versions almost complete

Major Unfinished Work

- Prototype of full CanSat
- Full telemetry communication tests
- Testing of heatshield deployment mechanism

Testing to Complete

- Vibration Test
- Thermal Test
- Drop Test
- Fit Check
- Vacuum Test