CanSat 2024
Preliminary Design Review (PDR)
Outline
Version 1.1

Team 2031

Eggsplorer 1

Presentation Outline

Team Organization

- **Faculty Advisor** – Norman Fitz-Coy
- **Team Lead** – Melissa Gonzalez, Junior
- **Team Lead** – Max Epstein, Junior
  - **Descent Control Subsystem**
    - Christian Roque, Sophomore
    - Melanie Miguel, Sophomore
  - **Mechanical Subsystem**
    - Zachary DeFabrizio, Sophomore
    - Samuel Taylor, Freshman
    - Jake Edwards, Freshman
  - **Avionics Subsystem**
    - Jonathan (Yoni) Gutmann, Junior
    - Sanat Konda, Sophomore
  - **Flight Software Subsystem**
    - Evan (Steele) Elliott, Junior

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

Acronym	Meaning
MAE	Mechanical & Aerospace Engineering
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

Systems Overview

Zachary DeFabrizio, Jake Edwards, Max Epstein, Melissa Gonzalez, Samuel Taylor

Mission Summary (1/2)

Main Objectives:

Design a CanSat that shall simulate a space probe entering a planetary atmosphere while carrying a delicate instrument.

- The CanSat shall act and operate as the nosecone during ascent
- The CanSat must survive the forces at launch and deployment
- The CanSat shall be launched to a maximum altitude of 725 meters above the launch site and deployed near apogee (peak altitude)
- The CanSat shall measure the speed of the rocket during both ascent and descent with a pitot tube
- The CanSat shall open an aerobraking heatshield which should have a descent rate of between 10 to 30 meters per second and not tumble
- At 100 meters, the CanSat shall detach the aerobraking heatshield and simultaneously release a parachute, reducing the descent to 5 meters per second or less
- The CanSat shall land with the egg intact
- The camera shall point in one direction and maintain that direction through the descent

Mission Summary (2/2)

Bonus Objective:

A video camera shall be integrated into the CanSat and point aft of the CanSat. The camera shall capture the CanSat being deployed from the rocket and the release of the parachute. Video shall be in color with a minimum resolution of 640x480 pixels and a minimum of 30 frames per second. The video shall be recorded and retrieved when the CanSat is retrieved.

- We will not be attempting the 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

System Requirement Summary (1/7)

Requirement Number	Description
C1	The CanSat will act as the nose cone during the rocket's ascent portion of the flight.
C2	The CanSat shall be deployed when the ejection charge fires.
C3	After deployment, the CanSat shall deploy its heat shield/aerobraking mechanism.
C4	A silver or gold mylar streamer of 50 mm width and 1.5 meters in length shall be connected to the CanSat and released at deployment, used to locate and identify the CanSat.
C5	At 100 meters, the CanSat shall deploy a parachute and release the heat shield.
C6	Upon landing, the CanSat shall stop transmitting data.
C7	Upon landing, the CanSat shall activate and audio beacon.
C8	The CanSat shall carry a provided large hen's egg with a weight between 51 and 65 grams.
C9	0 altitude reference shall be at the launch pad
C10	During descent with the heat shield deployed, the descent rate shall be between 10 and 30 m/s.
C11	At 100 meters, the CanSat shall have a descent rate of less than 5 m/s.
C12	Total cost of the CanSat shall be below $1000. Ground support and analysis equipment are not included in this cost. Equipment from previous years shall be included at current market price.

System Requirement Summary (2/7)

Requirement Number	Description
S1	The CanSat mass shall be 900 grams +/- 10 grams without the egg.
S2	The nose cone shall be symmetrical along the thrust axis.
S3	The nose cone radius shall be exactly 71 mm.
S4	The nose cone shoulder radius shall be exactly 68 mm.
S5	The nose cone shoulder length shall be a minimum of 50 mm.
S6	CanSat structure must be able to survive 15 Gs vibration.
S7	CanSat shall must survive 30 Gs shock.
S8	The CanSat shall perform the function of the nose cone during rocket ascent.
S9	The rocket airframe can be used to restrain any deployable parts of the CanSat, but shall allow the CanSat to slide out of the payload section freely.
S10	The rocket airframe can be used as part of the CanSat operations.
S11	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.

System Requirement Summary (3/7)

Requirement Number	Description
M1	No pyrotechnical or chemical actuators are allowed.
M2	Mechanisms that use heat shall not be exposed to the outside environment to reduce risk of setting the vegetation on fire.
M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.
M4	Spring contacts shall not be used for making electrical connections to batteries as shock forces can case momentary disconnects.
M5	The CanSat shall deploy a heat shield after deploying from the rocket.
M6	The heat shield shall be used as an aerobrake and limit the descent rate to 10 to 30 m/s.
M7	At 100 meters, the CanSat shall release a parachute to reduce the descent rate to less than 5 m/s.
M8	The CanSat shall protect a hen’s egg from damage during all portions of the flight.
M9	If the nose cone is to be considered part of the heat shield, the documentation shall identify the configuration.
M10	After the CanSat has separated from the rocket, and if the nose cone portion of the CanSat is to be separated from the rest of the CanSat, the nose cone portion shall descent at less than 10 m/s using any type of descent control device.

System Requirement Summary (4/7)

Requirement Number	Description
E1	Lithium polymer batteries are not allowed.
E2	Battery source may be alkaline, Ni-Cad, NiMH or Lithium. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.
E3	The power switch must be easily accessible.
E4	There must be a power indicator.
E5	The CanSat shall operate for a minimum of two hours when integrated into the rocket.
X1	XBEE radios shall be used for telemetry. 2.4 GHz Series in addition to 900 MHz Series are allowed.
X2	XBEE radios shall have their NETID/PANID set to their team number.
X3	XBEE radios shall not use broadcast mode.
X4	The CanSat shall transmit telemetry once per second.
X5	The CanSat telemetry shall include altitude, air pressure, temperature, battery voltage, tilt angles, air speed, command echo, and GPS coordinates which include latitude, longitude, altitude, and number of satellites.

System Requirement Summary (5/7)

Requirement Number	Description
SN1	CanSat shall measure its speed with a pitot tube during both ascent and descent.
SN1	CanSat shall measure its altitude using air pressure.
SN3	CanSat shall measure its internal temperature.
SN4	CanSat shall measure its angle stability with the aerobraking mechanism deployed.
SN5	CanSat shall measure its rotation rate during descent.
SN6	CanSat shall measure its battery voltage.
SN7	The CanSat shall include a video camera pointing horizontally.
SN8	The video camera shall record the flight of the CanSat from launch to landing.
SN9	The video camera shall record video in color and with a minimum resolution of 640x480.

System Requirement Summary (6/7)

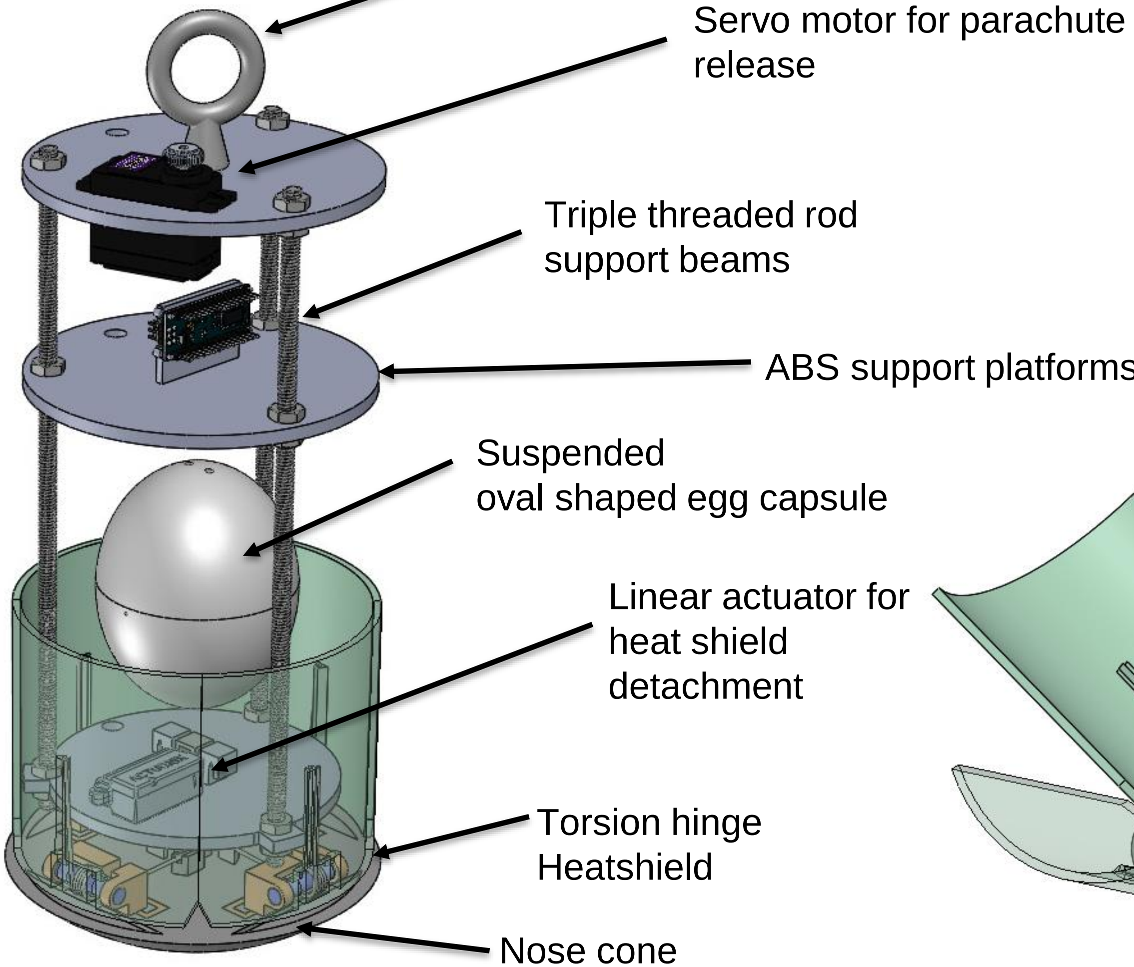
Requirement Number	Description
G1	The ground station shall command the CanSat to calibrate the altitude to zero when the CanSat is on the launch pad prior to launch.
G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.
G3	Telemetry shall include mission time with 1 second or better resolution.
G4	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.
G5	Each team shall develop their own ground station.
G6	All telemetry shall be displayed in real time during descent on the ground station.
G7	All telemetry shall be displayed in engineering units and the units shall be indicated on the displays.
G8	Teams shall plot each telemetry data field in real time.
G9	The ground station shall include one laptop computer with a minimum of two hours battery operation, XBEE radio, and an antenna.
G10	The ground station must be portable so that the team can be positioned at the ground station operation site along the flight line. AC power will be not available.
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 ACTIVATE.

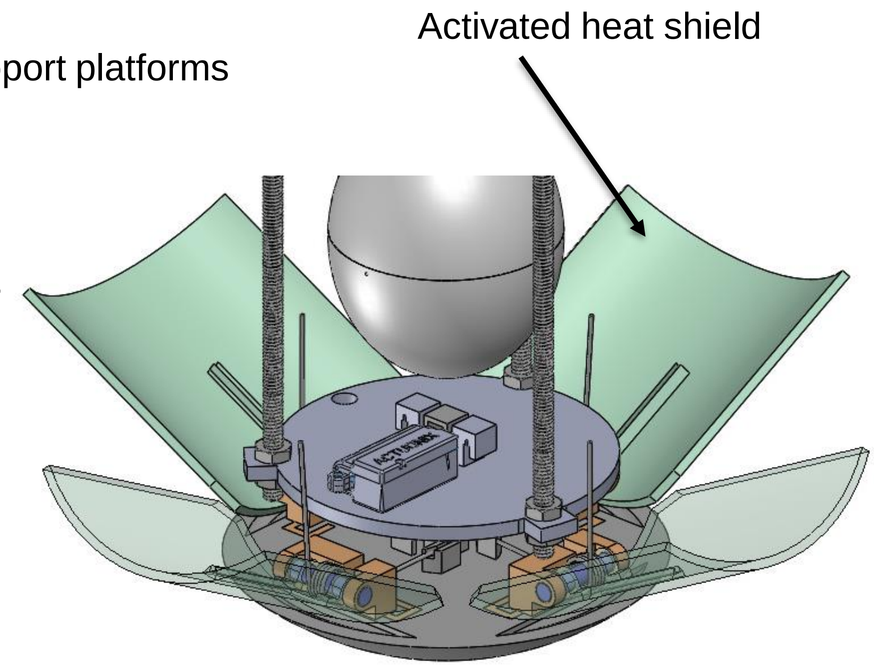
System Requirement Summary (7/7)

Requirement Number	Description
G12	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at 1 Hz interval to the CanSat.
G13	The ground station shall use a table top or handheld antenna.
G14	The displays on the ground station shall be designed with larger fonts (14pt minimum), bold plot traces and axes, and dark text on a light background since the ground station will be viewed in bright sundlight.
G15	The ground system shall count the number of received packets. This is not the number of transmitted packets but the number of packets successfully received at the ground station.
F1	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission through the mission. This value shall be maintained through processor resets.
F2	The CanSat shall maintain mission time throughout the whole mission regardless of processor resets or power loss.
F3	The CanSat shall have its time set to within one second UTC time prior to launch.
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 csv file.
F5	In simulation mode, the flight software shall use the radio uplink pressure values I place of the pressure sensor for determining the payload altitude.
F6	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVE commands.

System Level CanSat Configuration Trade & Selection (1/2)

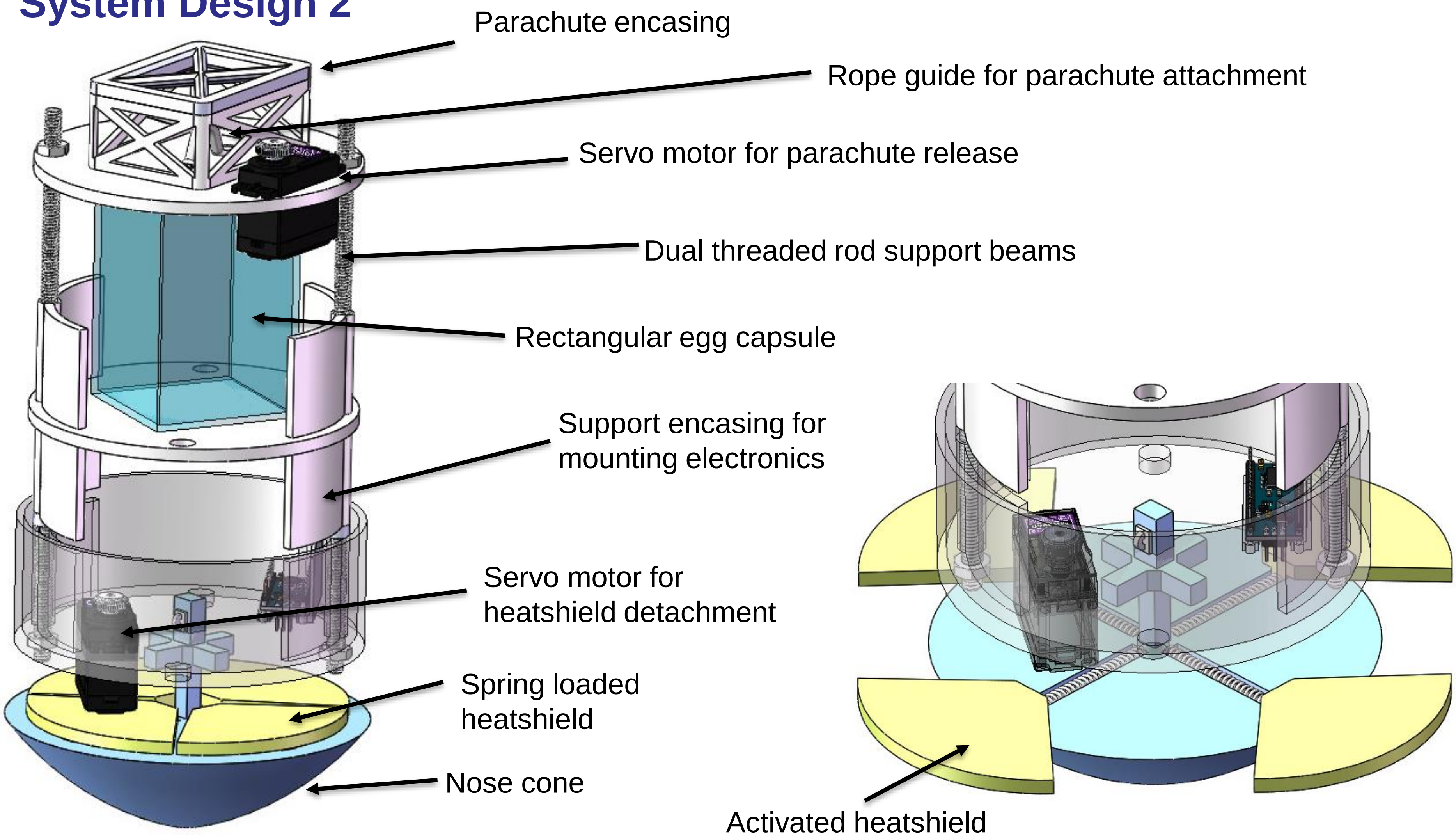
System Design 1





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

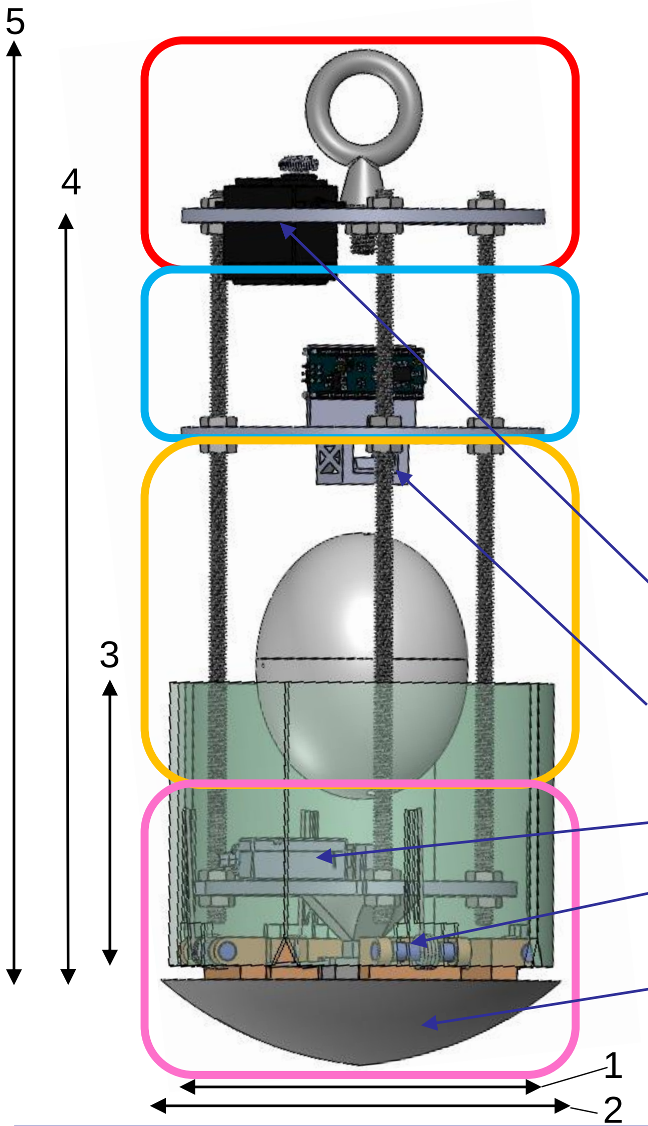
System Design 2



System Level Configuration Selection

Chosen Design: System 1	
Configuration	**Reasoning**
Rotating heatshield	Provides consistent and powerful deployment. In addition, the outward rotation creates an aerodynamic shape that will benefit stability on the decent. The combination of heat shield and nose cone allow for a simple detachment.
Suspended oval shaped egg capsule	The oval shape minimizes the material being used while protecting the egg in the places that matter. The suspension allows for some shock resistance from unexpected forces, thus providing better all-around protection.
Linear actuator for heatshield detachment	Keeps detachment simple without weakening the structural integrity of the CanSat. Due to the mechanism being active we can confirm the heatshield will detach.

Physical Layout



Red: Parachute Deployment
Blue: Avionics Bay
Yellow: Egg Protection Bay
Pink: Heat Shield and Deployment

Basic Dimensions
1: Shoulder Width - 136 mm
2: Nose Cone Diameter - 142 mm
3: Shoulder Length - 100 mm
4: 267.4 mm
5: 300 mm

Servo Motor for parachute deployment

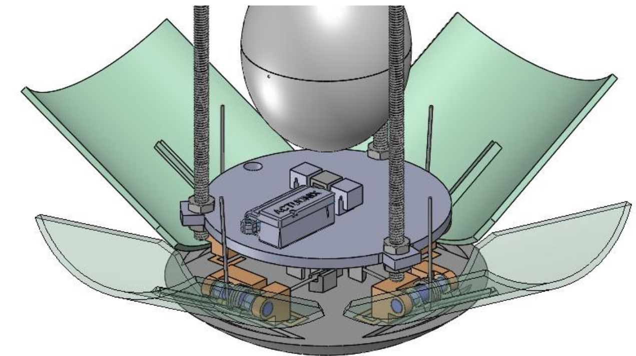
Rubber band attachment

Linear actuator for heat shield detachment

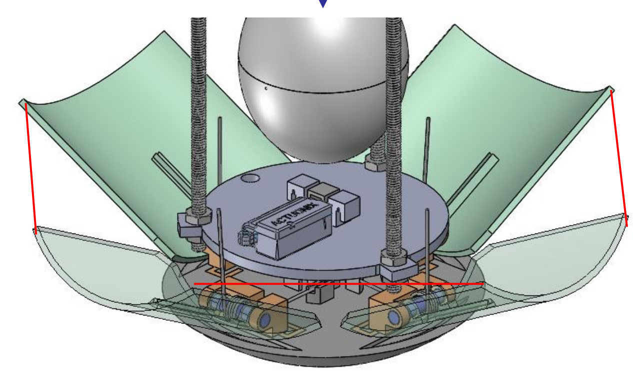
Hinge for heat shield

Nose Cone

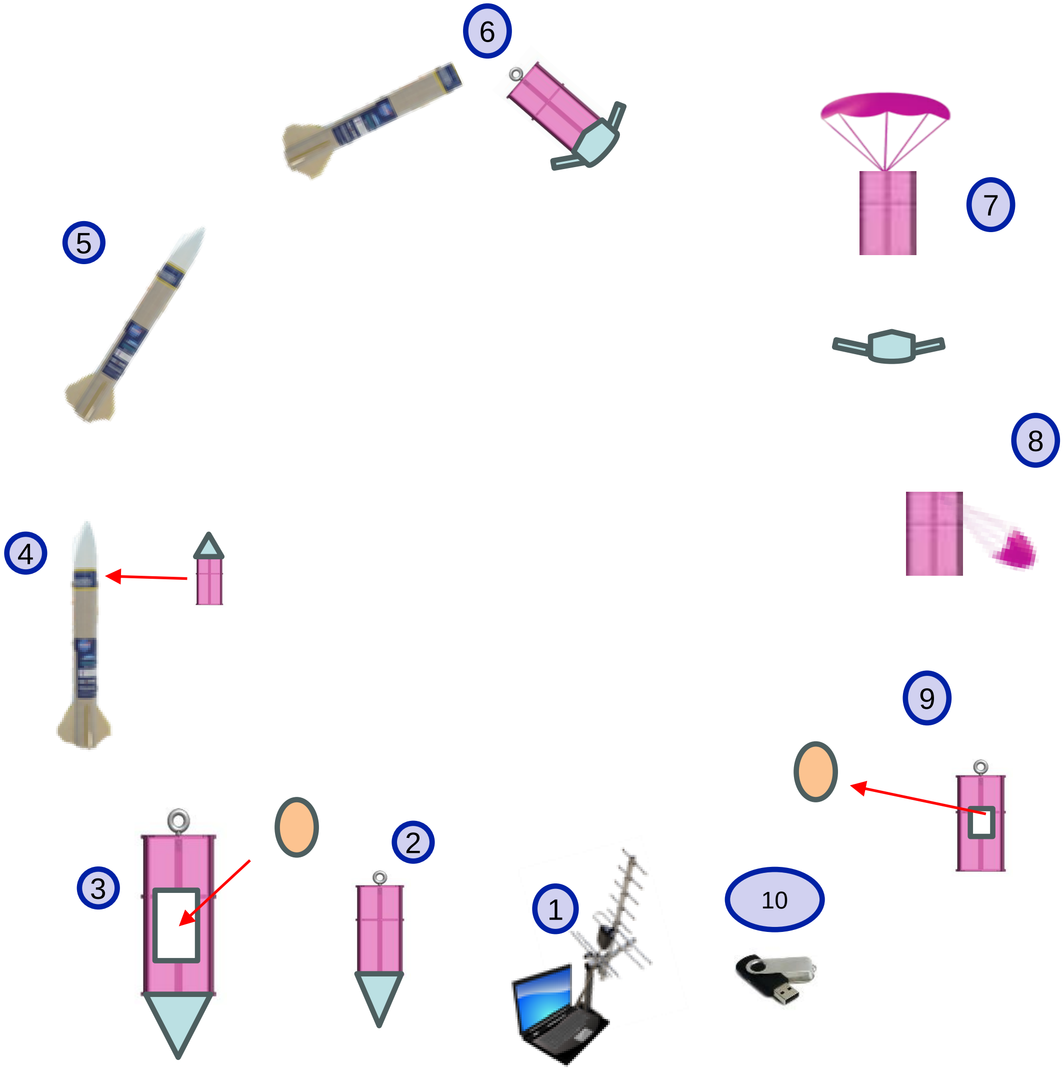
Total Mass 895.73 g



Heat shield deployed configuration. Red lines represent where mylar fabric will be. Section in the back is omitted for simplicity.



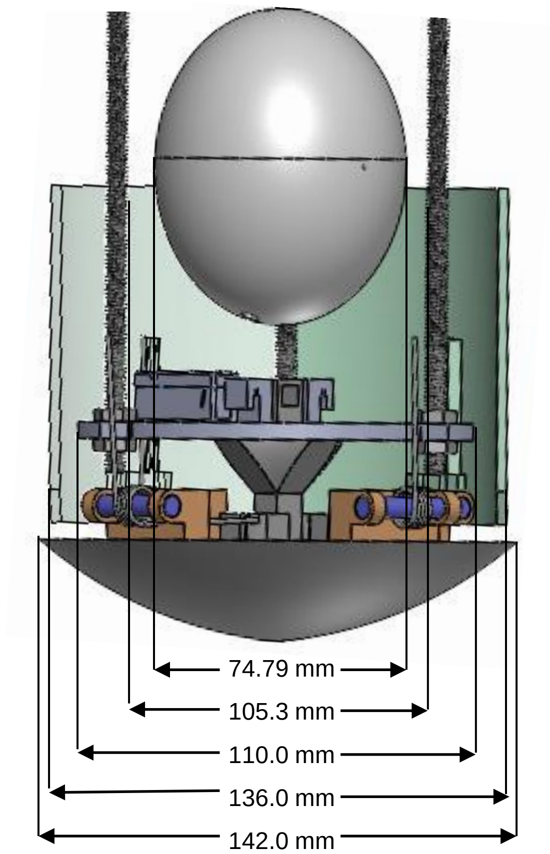
System Concept of Operations



1. Set up ground station.
2. Power on CanSat.
3. Egg is placed inside compartment and loaded into CanSat.
4. Place CanSat into rocket.
5. Rocket is launched.
6. At maximum altitude of 725 m, CanSat is ejected from the rocket the heat shield is immediately deployed and aerobraking starts. Descent is slowed to 10-30 m/s.
7. At 100 m heat shield/aerobrake is detached and the parachute is deployed decreasing the descent to <5 m/s.
8. CanSat will land upright.
9. Recovery crew tracks and collects CanSat and intact egg.
10. FSW obtains and saves flight data & video recording thumb drive.

Launch Vehicle Compatibility

Sharp protrusions and corners will be sanded down.



Sensor Subsystem Design

Jonathan (Yoni) Gutmann

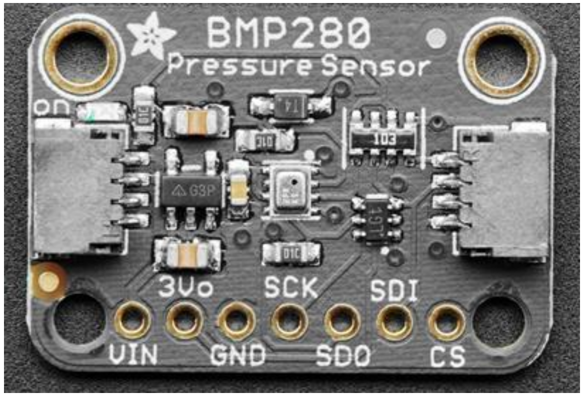
Sensor Subsystem Overview

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	Payload
Rotational Sensor	BNO055	Measure gyro readings in degrees per second, angular acceleration, and magnetometer readings in gauss	Payload
Temperature Sensor	Adafruit BMP280	Measure temperature readings	Payload
Camera	ESP-32	View and record Earth's terrain during descendent	Payload
Wind Speed Sensor	PX4	Measure air speed differential	Payload

Payload Air Pressure Sensor Trade & Selection

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 MPRLS	3.6	-40 to 85	I2C, SPI	.30	1.65 ~ 3.6	17.8 x 16.7 x 7.5	1.1	14.95
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
MPL3115A2	8.5	-40 to 85	I2C	.015	1.95~ 3.6	18 x 19 x 2	1.2	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 - Previous familiarity with the sensor - Also satisfies as our temperature sensor



Payload Air Temperature Sensor Trade & Selection

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 MPRLS	3.6	-40 to 85	I2C, SPI	.30	1.65 ~ 3.6	17.8 x 16.7 x 7.5	1.1	14.95
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
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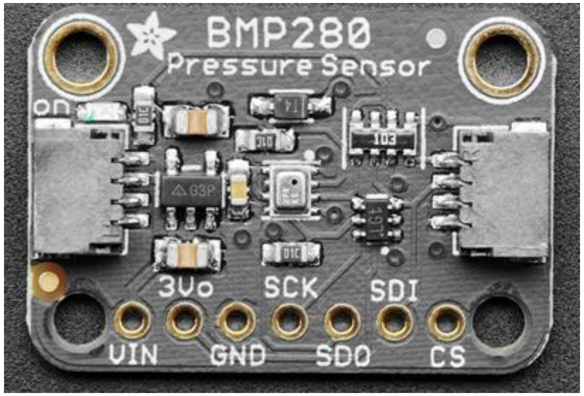
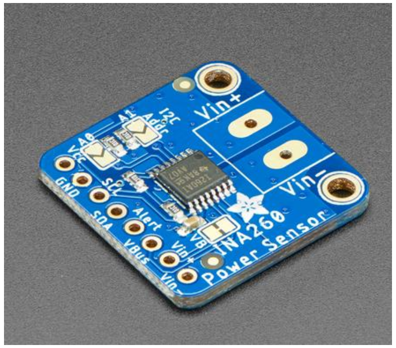
Selection	Reasoning for the selection
Adafruit BMP280	- Lower current draw in comparison to other inspected sensors - Greater resolution in comparison to other inspected sensors - Previous familiarity with the sensor - Also satisfies as our pressure sensor



Payload Battery Voltage Sensor Trade & Selection

Sensors	Resolution	Interfaces	Size (mm) L x W x H	Weight (g)	Price ($)
Adafruit INA219	12 bit	I2C	25.6 x 20.4 x 4.7	4.6	9.95
Adafruit INA260	16 bit	I2C	22.9 x 22.8 x 2.7	2	9.95
Precision LM4040	12 bit	I2C	16 x 12.5 x 2.5	0.7	7.50

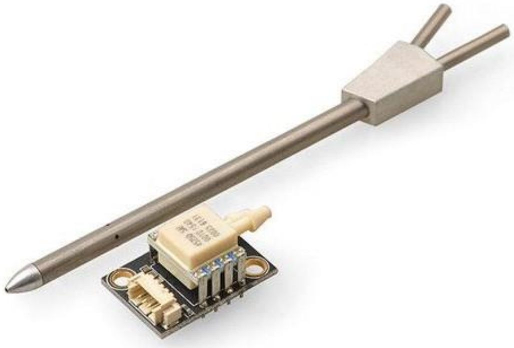
Selection	Reasoning for the selection
Adafruit INA260	- Greater resolution bit compared to other sensors - Previous experience and familiarity with sensor - Availability



Payload Speed Sensor Trade & Selection

Sensors	Resolution	Interfaces	Size (mm) L x W x H	Weight (g)	Price ($)
PX4 Differential Air Speed	12 bit	I2C	100x15	16	55.88
PT60	12 bit	I2C	110 x 9.8	14.1	48.99

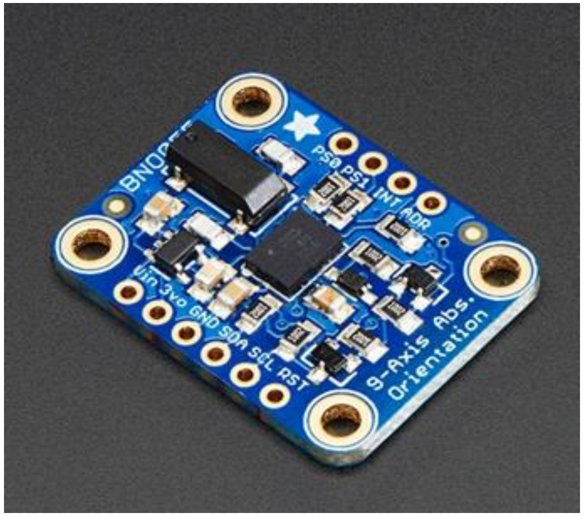
Selection	Reasoning for the selection
PX4 Differential Air Speed	- More advantageous regarding budget - Microcontroller friendly - Speedy shipping



Payload Tilt Sensor Trade & Selection

Sensors	Temperature Range (°C)	Interfaces	Voltage Usage (V)	Size (mm) L x W x H	Weight (g)	Price ($)
HTU31 Temperature & Humidity Sensor	-40 to 125	I2C	3.3 – 5.5	25.5 x 17.7 x 4.6	1.6	6.95
BNO055	-40 to 85	I2C or UART	1.7 – 3.6	20 x 27 x 4	3	34.95
Sensirion SHT31-D	-40 to 125	I2C	2.4 – 5.5	12.7 x 18 x 2.6	0.8	13.95

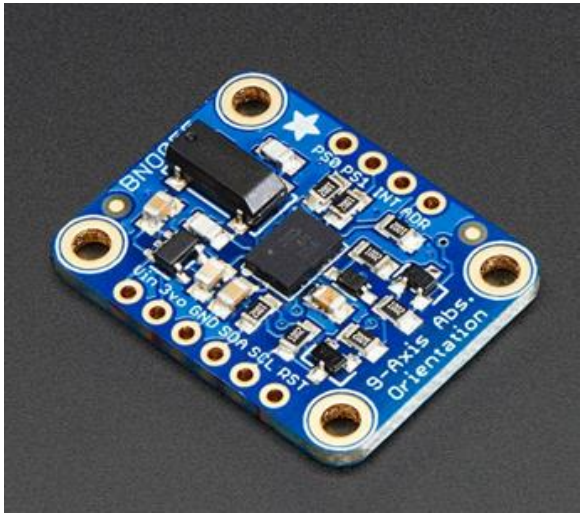
Selection	Reasoning for the selection
BNO 055	- Familiarity with sensor - Compatibility with microcontroller - Availability



Rotation Sensor Trade & Selection

Sensors	Temperature Range (°C)	Interfaces	Voltage Usage (V)	Size (mm) L x W x H	Weight (g)	Price ($)
HTU31 Temperature & Humidity Sensor	-40 to 125	I2C	3.3 – 5.5	25.5 x 17.7 x 4.6	1.6	6.95
BNO055	-40 to 85	I2C or UART	1.7 – 3.6	20 x 27 x 4	3	34.95
Sensirion SHT31-D	-40 to 125	I2C	2.4 – 5.5	12.7 x 18 x 2.6	0.8	13.95

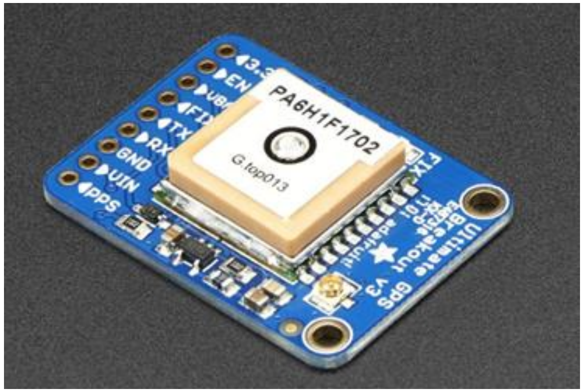
Selection	Reasoning for the selection
BNO 055	- Familiarity with sensor - Compatibility with microcontroller - Availability - Also used as tilt sensor



Payload GPS Sensor Trade & Selection

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
uBlox NEO M8N	10	2.7 – 3.6	23	I2C, SPI, UART	27.6 x 26.6 x 2.4	9.8	11.59
Titan X1	10	3.0 – 4.3	25	I2C, SPI, UART	12.5 x 12.5 6.5	4	69.84

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



Payload Camera Trade & Selection

Name	Price ($)	Weight (g)	Size (mm)	Operating Voltage (V)	Current Draw (mA)	Framerate (fps)
Miniature TTL Serial JPEG Camera	34.95	3	20 x 28	3.3 - 5.0	75	30
Arducam Mini 2MP Plus	25.99	20	24 x 34	3.3 - 5.0	20	15
ESP-32	18.49	28	90 x 55 x 37	4.75V-5.25V	310	30

Selection	Reasoning for the selection
ESP-32	- Meets recording specifications - Readily available - SD card slot is built-in and video storage is easily configurable

Bonus Camera Trade and Selection

- **The bonus is not being attempted**

Descent Control Design

Melanie Miguel, Jake Edwards, Samuel Taylor, Zachary DeFabrizio, Christian Roque

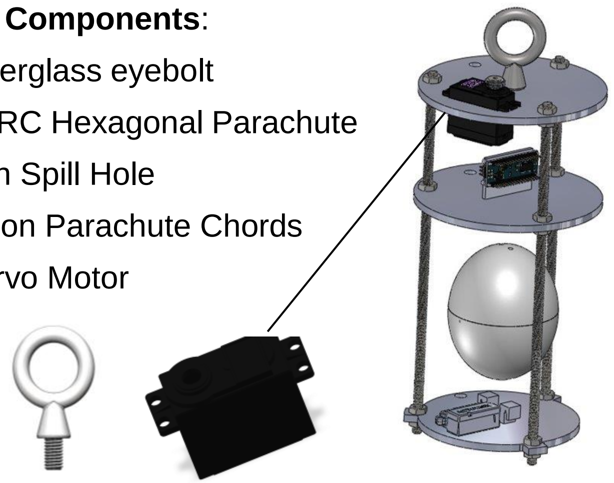
Descent Control Overview

Container Descent Control System:

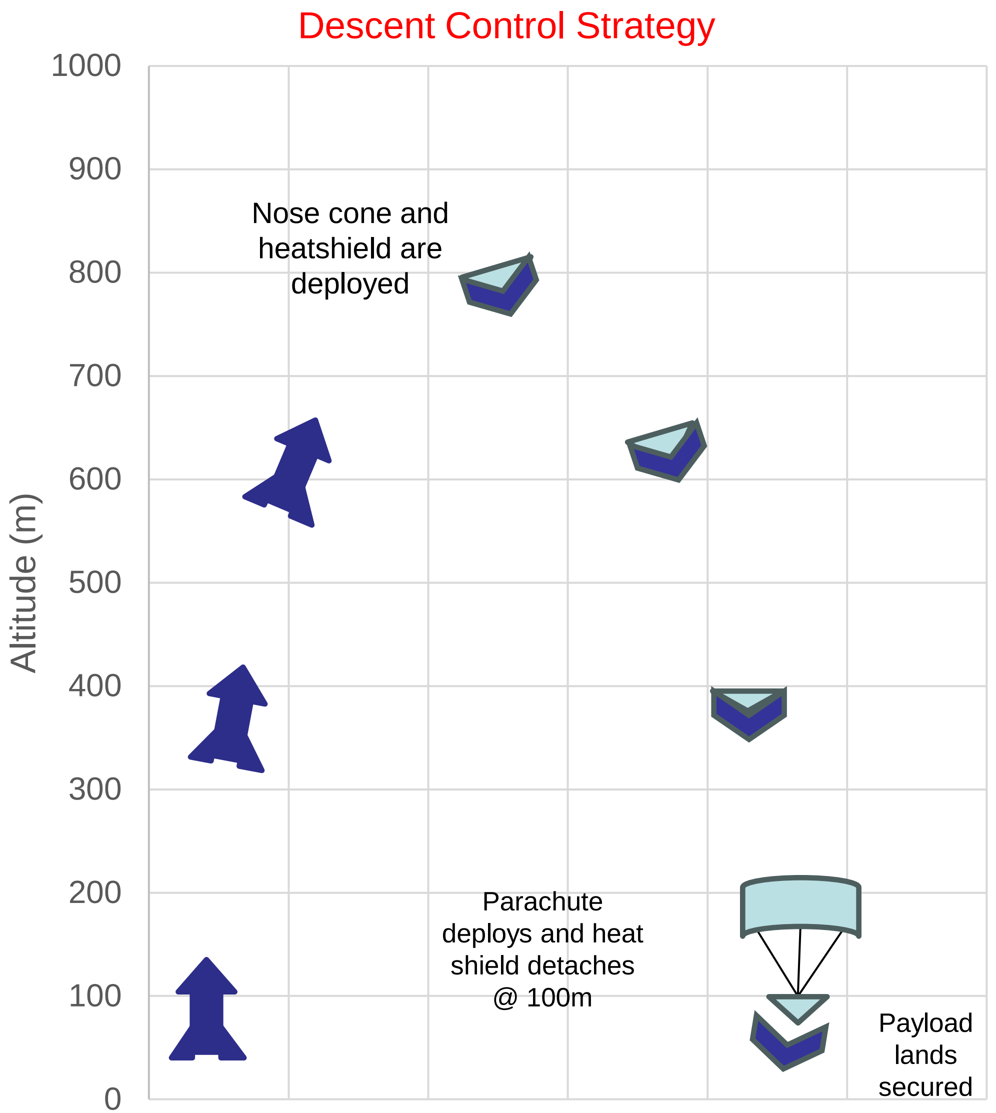
System: Aerobraking Heat Shield, Parachute

System Components:

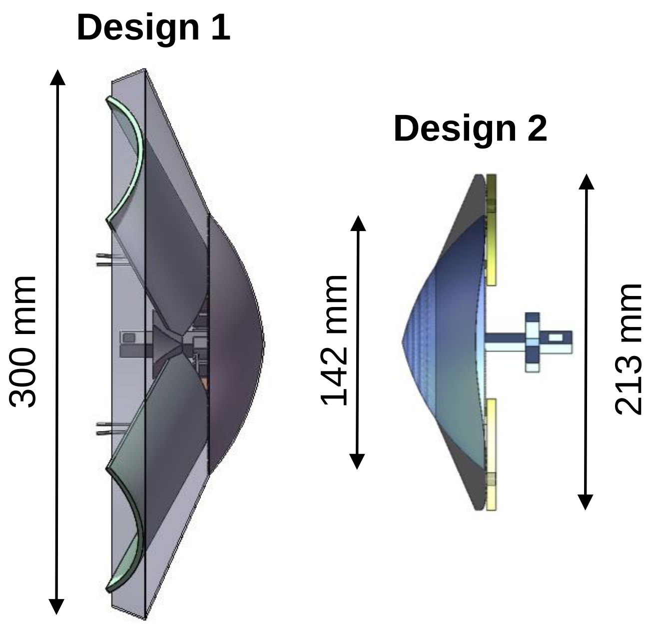
- Fiberglass eyebolt
- TARC Hexagonal Parachute with Spill Hole
- Nylon Parachute Chords
- Servo Motor



System Overview: An eyebolt is attached to the base of the nose cone on a section separating the parachute system from the other nosecone components. The parachute will stay on top of the plate tied tightly to the eyebolt. A string holds the parachute together, against the plate and is looped off the side to the end of the servo motor. The servo is attached to the opposite side of the plate. When the desired altitude is achieved, the servo will retract forcing the string to release along with the parachute.



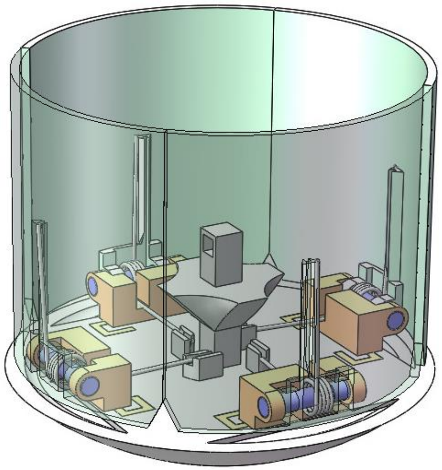
Payload Aerobraking Descent Control Strategy Selection and Trade (1/2)



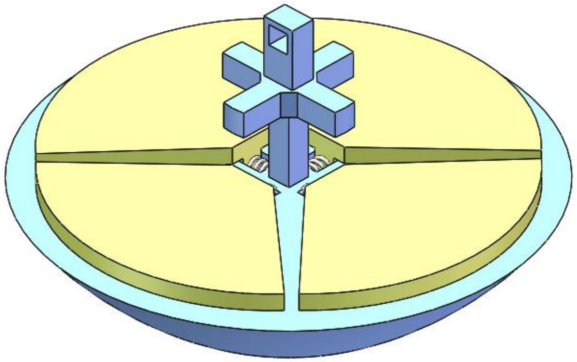
	Design 1	Design 2
Encasing	Mylar	Mylar
Shape	Rounded Cone Circular Cross-Sectional Shape	Pointed Cone Circular Cross-Sectional Shape
Size	Base Diameter of 300 mm Area: ~ 18,250mm^2	Base Diameter of 213 mm Area: ~ 6350mm^2
Angles	~ 25°	~ 25°
Cost	$7.72 for springs $15.77 for ABS	$5.55 for springs $15 for ABS

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

Design	Description	Identified Issues	Evaluation
Torsion Hinge Shield	Following deployment from the can, torsion springs will rotate the shield toward the nose creating a larger cone shaped nose. The increased surface area of the nose cone will slow descent.	Design is heavier then preferred. Assembly and repairs are difficult.	Selected, allows for necessary deceleration while minimizing the size of the nose cone.
Spring Loaded Shield	Following deployment from the can, linear springs extend semi-circular plates that increase the noses area. The increased surface area will slow descent.	Design requires a larger then preferred nose cone. Smooth extension proved difficult to be inconsistent.	Discarded



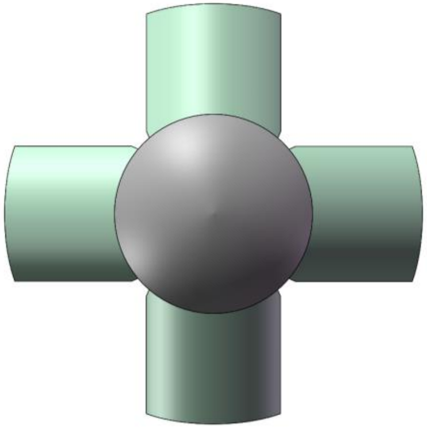
Configuration A:
Torsion Hinge Shield



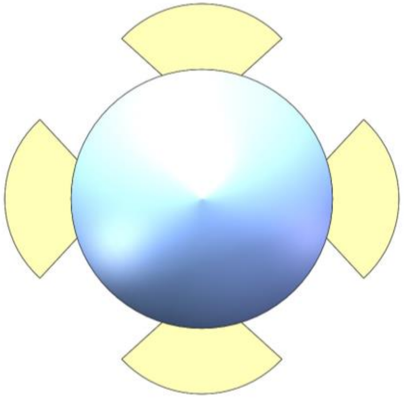
Configuration B:
Spring Loaded Shield

Payload Aerobraking Descent Stability Control Strategy Selection and Trade

Method	Description	Identified Issues	Evaluation
Torsion Hinge Shield	The hinged shields will open creating an elongated rounded cone shape. The shields can adjust their angle in accordance with wind patterns increasing decent stability	When air resistance is very strong, the shields may not be able to open to their full potential. May take a few seconds to get to full potential.	Selected, the variable angle of the heatshield allows for more stability throughout descent.
Spring Loaded Shield	The linear shields will open creating a small pointed cone shape. The larger aerodynamic shape will increase stability.	The stiff position of the open shield is vulnerable to uneven air currents.	Discarded

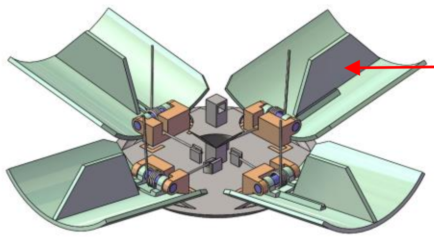


Configuration A:
Torsion Hinge Shield

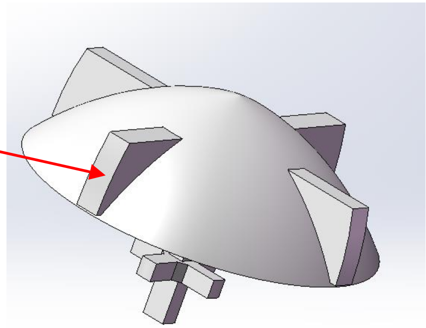


Configuration B:
Spring Loaded Shield

Payload Rotation Control Strategy Selection and Trade



Fins



Configuration A:
Hinge Spring Fins

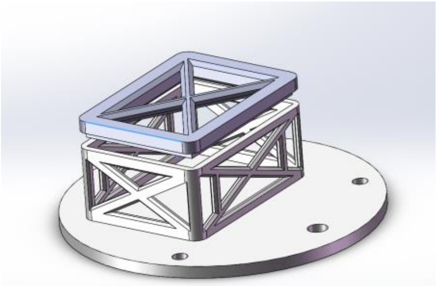
Configuration B:
Nose Cone Control

Design	Description	Identified Issues	Evaluation
Hinge spring fins	Interior fins on spring-loaded flaps deploy with the heat shield, ensuring Z-axis stability during CanSat’s descent	Reduces interior space Increased weight of the overall design	Selected, allows for necessary control of Z-axis rotation
Nose cone control	Fins on the nose cone ensure Z-axis stability during the CanSat’s ascent and descent not allowing for a large range of rotation around the z axis	Increase the complexity of the print Reduces size of egg container	Discarded

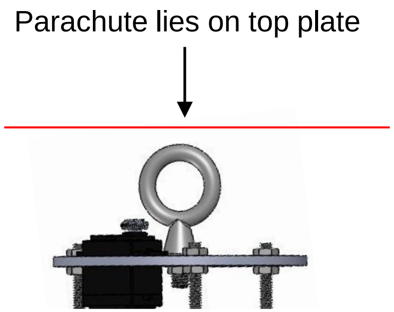
Payload Parachute Descent Control Strategy Selection and Trade

Method	Description	Identified Issues	Evaluation
Separate Container with Hatch System	A container attached to the beams of the nosecone would hold the parachute and allow for its release	The addition of a container adds weight in addition with a battery needed which increases costs. Manufacturing and implementation is more complicated.	Discarded
Resting of base of nosecone	The parachute will rest on top of a plate separate from the rest of the nosecone components and will be tied down. Attached on the opposite side will be a servo motor that hold the string. When the desired altitude of 100 meters is reached, the rotational device will spin to release the string allowing the parachute to be released.	Relying on string to hold the parachute, some weight added with servo motor	Selected, can be secured and implemented correctly and servo motors are easily obtainable

Option A:

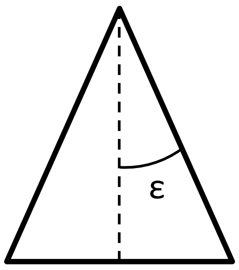


Option B:



- **Discussion**
  - Drag coefficient of parachute based on information provided by the vendor and heatshield drag coefficient determined through research
  - According to calculations, once the heatshield is at terminal velocity, it's arms should form no less than a 45˚ half-vertex angle
  - Weight of the nosecone may vary if further drop testing shows that a lower center of mass is required.
  - All parameters used are to simulate maximum and harshest conditions

ε = half-vertex angle



Formulas Used:

$$v_t = \sqrt{\frac{2mg}{\rho A C_d}}$$

$$\Delta x = v_0 t + \frac{1}{2} a t^2$$

$$T = 518.67 - 0.003567h\,^\circ\mathrm{R}$$

$$\bar{v} = \frac{\Delta x}{\Delta t}$$

$$\rho = \rho_0 \left(\frac{T}{T_0}\right)^{-\frac{g}{a_0 R}-1}$$

Descent Rate Estimates (2/2)

Decent Rate Estimates for the following Configurations

Configuration	Device	Desired Rate	Decent Rate Estimate	Method of Calculation
Payload with heatshield	Aerobraking	10 m/s - 30 m/s	< 17.432 m/s	Terminal velocity calculations
Payload without heatshield	Parachute	Less than 5 m/s	< 4.129 m/s	Parachute calculations
Heatshield only	Aerobraking	Less than 10 m/s	< 9.760 m/s	Terminal velocity calculations

Assumptions

- **Heatshield weight is 377.2 grams**
- **Total weight is 975 grams or less**
- **Cd ≈ 0.75 of a 3D cone with 45° half vertex**
- **Standard atmospheric model used**
- **Estimated altitude range: 634m – 1359m**
- **Estimated air density range: 1.03588kg/m^3 - 1.11308 kg/m^3**
- **Estimated air density @ 100m above ground = 1.10219 kg/m^3**

Mechanical Subsystem Design

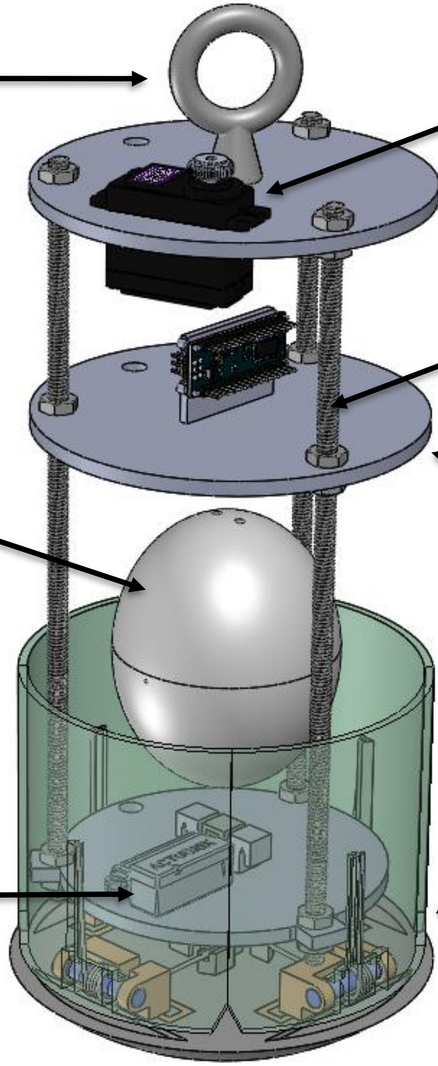
Zachary DeFabrizio, Jake Edwards, Melissa Gonzalez, Jonathan (Yoni) Gutmann, Melanie Miguel, Christian Roque, Samuel Taylor

Mechanical Subsystem Overview

Parachute Attachment:
A threaded fiberglass eyebolt that provides a physical attachment from the CanSat to the parachute.

Oval shaped egg capsule:
An ABS container that encapsulates the egg. Suspended from the bottom and middle platform with elastic bands as shock resistance.

Linear Actuator:
Attaches the Heatshield to the rest of the CanSat when deployed. Can be retracted to release heatshield at desired altitude.



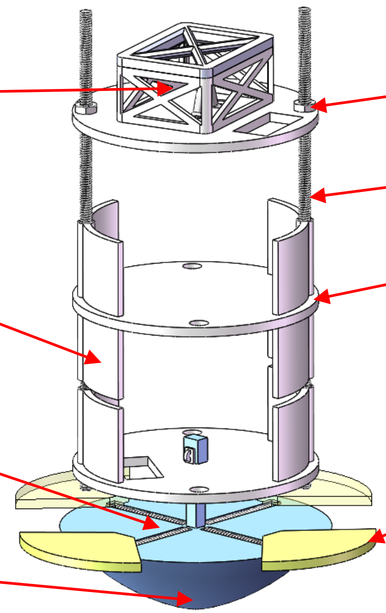
Servo Motor:
Attached to a nylon cord that holds the parachute to the CanSat. Can be activated to release the parachute.

Aluminum threaded rod:
Threaded rods that provide structural integrity along with layer adjustments.

ABS platforms:
Circular ABS platforms that allow for placement of electronics and the mounting of the egg capsule.

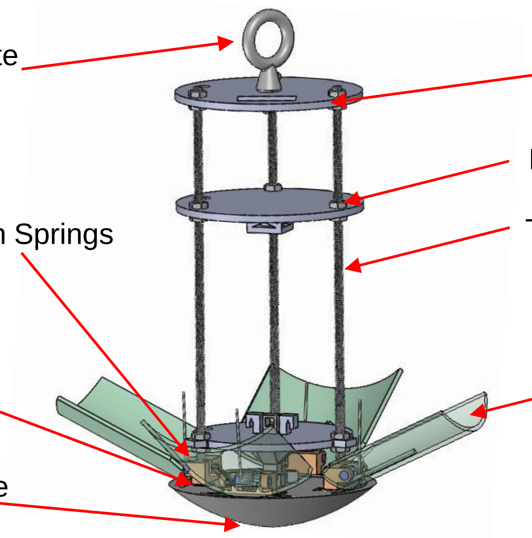
Torsion Hinged Heatshield:
Four ABS shields rest inside the shoulder of the rocket before separation. After separation, torsion springs open rotating the shields outward increasing the drag force on the CanSat.

Payload Mechanical Layout of Components Trade & Selection (1/2)

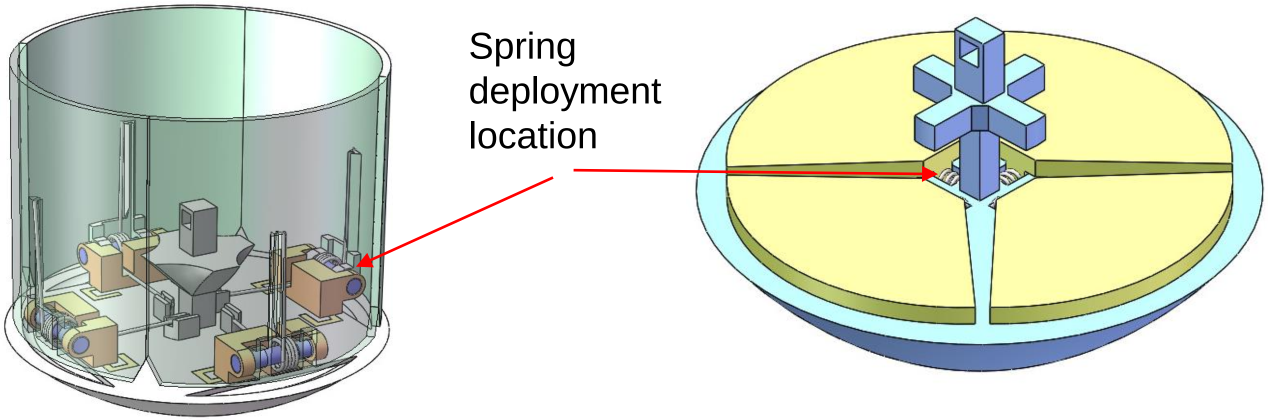


Design	Description	Materials	Evaluation
Spring Loaded Shield	Compressed cylindrical shape. Heat shield spring loaded by horizontal springs. When released the heat shield deploys horizontally to its lengthened position. Heat shield held in place by plastic rod. A series of plastic sections structured by threaded aluminum rods. First there is a section for the electronics, followed by a section for the egg and parachute.	Plates – ABS Plastic Threaded Poles – Aluminum Nuts – Aluminum Heat Shield – ABS Plastic Horizontal Springs –Aluminum Parachute Attachment – Steel Nose Cone – ABS Plastic Electronic Mounts – ABS Plastic	Discarded

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



Design	Description	Materials	Evaluation
Torsion Hinge Shield	Compressed cylindrical shape. Heat shield is spring loaded with torsion springs to 90 degrees when inside of the rocket. When released the springs move to their relaxed position of 180 degrees deploying the heat shield, guided by hinges. The heat shield is held to the payload by plastic rod. There are is then a section divided by circular plastic plates reserved for the egg protection followed by a section reserved for electronics and parachute. Sections structured by threaded aluminum rods.	Plates – ABS Plastic Threaded Poles – Aluminum Nuts - Aluminum Heat Shield Flaps– ABS Plastic Torsion Springs –Aluminum Parachute Eye Bolt – Steel Hinges – ABS Plastic Nose Cone – ABS Plastic	Selected, more structurally sound, more stable heat shield, more efficient aerobraking

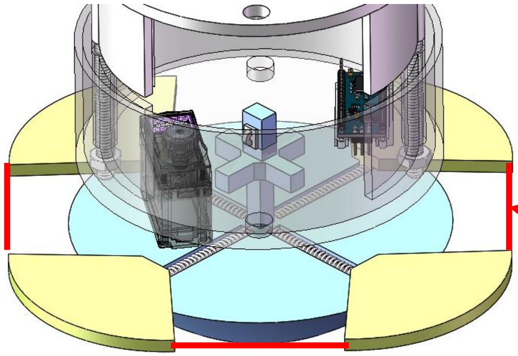


Configuration	Advantages	Disadvantages	Evaluation
Umbrella loaded Spring Deploy	Interchangeable parts Larger spring load to hold the load in place Acts as an additional layer of containment for the egg	Heavier Increased in complexity, meaning a higher chance of failure Higher cost because of springs	Selected, Sturdier, while also providing additional protection to egg
Horizontal loaded Spring	Easier to manufacture Occupies smaller section of the CanSat Lighter weight Cost efficient	Not able to hold the CanSat in place as effectively Not as sturdy and able to resist force create by drag Does not add more protection to the egg on lift-off	Discarded

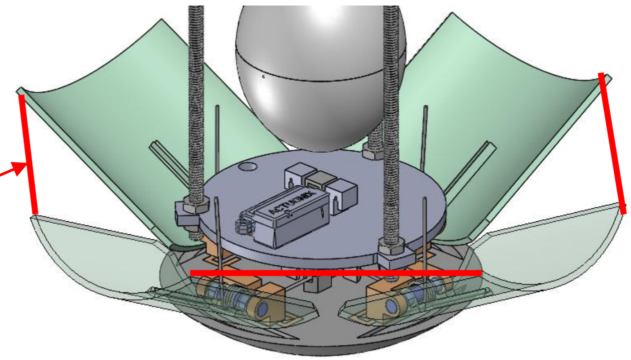
Payload Aerobraking Deployment Configuration Trade & Selection

Nose cone is considered a part of the heat shield and aerobraking

Mylar heat shield fabric attachment shown in red



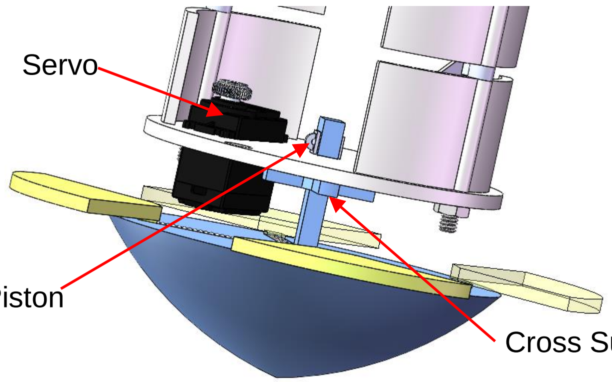
Horizontal Spring Deploy



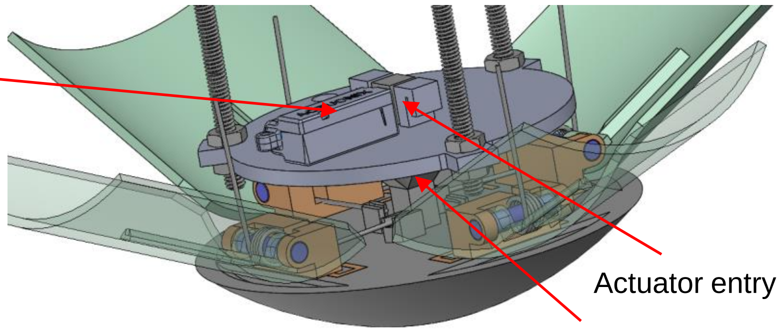
Umbrella Spring Deploy

Configuration	Method	Identified Issues	Evaluation
Spring Loaded Shield	Upon release from can, the spring-loaded arms will be expanded horizontally, causing the implementation of the heat shield which acts as the aerobraking device.	Inefficient aerobraking. Unstable heatshield due to the small diameter. Uses more internal space.	Discarded
Torsion Hinge Shield	Upon release from can, loaded torsion springs will extend to their relaxed 180-degree position, pivoting though the hinges. With the connected mylar fabric this causes the implementation of the heat shield which acts as the aerobraking device.	Harder to manufacture. More spring strength needed because of the angular motion.	Selected, design allows for a larger heat shield and efficient aerobraking. Designing shield down the rocket saves space inside.

Payload Aerobraking Release Trade & Selection



Horizontal Spring Deploy



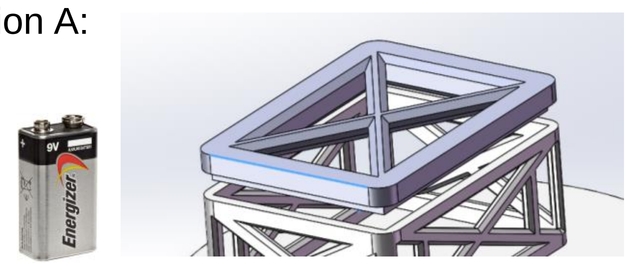
Umbrella Spring Deploy

Configuration	Method	Identified Issues	Evaluation
Servo Motor Release	There is a piston through the square rod in the payload. When prompted the servo motor rotates and pulls a cord that pulls the piston freeing the heat shield module. The cross supports take weight off piston.	Latency in the deployment time. String would allow for unwanted rotation. Added mass.	Discarded
Linear Actuator Release	The square rod through the payload contains a hole for a linear actuator rod. When prompted the linear actuator retracts and the heat shield is released. The square rod and linear actuator restrict rotation and vertical motion. The cross supports take weight off linear actuator.	Linear actuator cannot take a great load. Rotation could lead to actuator stress.	Selected, provides further stability and control over time of release.

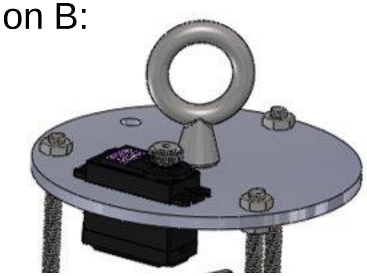
Payload Parachute Deployment Configuration Trade & Selection

Method	Description	Identified Issues	Evaluation
Latch top and hatch	A latched container would hold the parachute and released when a battery powered a latch to release.	Adds significant weight and costs increased with additional section of nosecone. Battery necessary also increases both factors significantly.	Discarded
Servo Motor release	A servo motor is hooked onto a string that wrapped around the extended portion. This string also ties the parachute together. Once retracted at desired altitude, the string is released along with the parachute.	Additional cost for servo motor and structure to ensure string is not released too early.	Selected, costs are reduced, and mechanism is fairly easy to implement

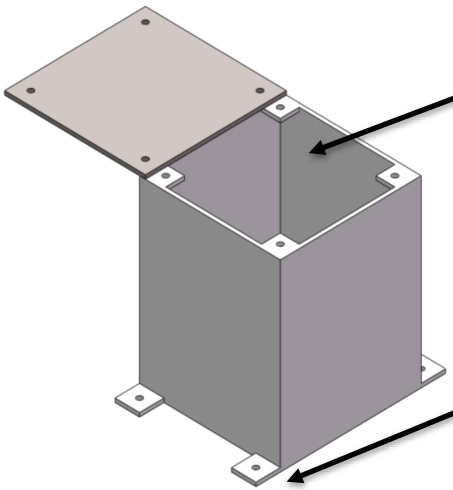
Option A:



Option B:



Payload Egg Containment Configuration Trade & Selection

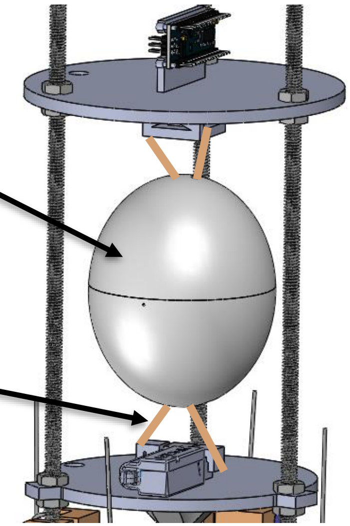


Box stuffed with foam

Screw holes threaded to CanSat frame

Easter Egg stuffed with foam encapsulates egg

Elastic bands stretched between egg and frame



Configuration	Method	Identified Issues	Evaluation
Simple box with foam	Simple rectangular box is stuffed with shock absorbent foam, egg is placed in box and then screwed to CanSat frame.	Far too rigid and provides un-even protection from shock. Long installation time required for inserting screws.	Discarded
"Easter egg" shape container with foam	The container is stuffed with memory foam, egg is placed inside, contraption is closed with screws, and then suspended using stretched elastic bands between the egg and frame of CanSat.	Elastic bands could be difficult to attach quickly and evenly to frame.	Selected, provides omnidirectionality and reliability against uncertain flight paths

Electronics Structural Integrity

- Electronic component mounting methods:
  - Standoffs and screws, high-performance adhesive.
- Electronic component enclosures:
  - All components will be within the payload.
- Securing electrical connections:
  - All components will be soldered, with heat shrink tubing used at wire junctions.
  - Wires will be kept from moving by tape or glue if necessary.
- Descent control attachments
  - Motors/actuators will be mounted similarly to electronic components with screws and high-performance adhesive.

Mass Budget (1/3)

Component	Quantity	Weight (g)	Source
Eyebolt	1	2.4 g	Estimate
Nut	18	1 g (18 g total)	Estimate
Aluminum Rod	3	16.78 g (50.34 g total)	Actual from Datasheet
Egg Container	1	42.5 g	Actual from Datasheet
ABS Platforms	3	185.09 g total	Estimate
Hinge	4	10 g (40 g total)	Actual from Datasheet
Hinge Pin	4	1 g (4 g total)	Actual from Datasheet
Torsion Spring	4	4 g (16 g total)	Actual from Datasheet
Nose Cone	1	140 g	Estimate
Heat Shield Plate	4	54.3 g (217.2 g total)	Actual from Datasheet
Parachute	1	34 g	Actual from Datasheet

Mass Budget (2/3)

Component	Quantity	Weight (g)	Source
Standoffs	4	0.5 g (2 g total)	Actual from Datasheet
High Performance Adhesive	1	1 g	Estimate
Mylar	1	2 g	Estimate
PCB Screws	4	0.1 g (0.4 g total)	Actual from Datasheet
Elastic Bands	2	1.5 g (3 g total)	Actual from Datasheet
Memory Foam	1	5 g	Actual from Datasheet

Mass Budget (3/3)

Component	Quantity	Weight (g)	Source
Adafruit BMP280	1	1.3 g	Actual from Datasheet
Arduino Nano	1	7 g	Actual from Datasheet
BNO-055	1	3 g	Actual from Datasheet
Adafruit Ultimate	1	8.5 g	Actual from Datasheet
ANT-900-RP-2-A	1	5 g	Estimate
XBEE Pro 900 Mhz Radio	1	5 g	Actual from Datasheet
9 Volt Battery	1	45 g	Actual from Datasheet
PX4 Pitot Tube	1	16 g	Estimate
ESP-32	1	18 g	Actual from Datasheet
INA260	1	2 g	Actual from Datasheet
Servo Motor	1	9 g	Actual from Datasheet
Linear Actuator	1	15 g	Actual from Datasheet

Total Mass 895.73 g

Communication and Data Handling (CDH) Subsystem Design

Sanat Konda, Evan (Steele) Elliott

Payload Command Data Handler (CDH) Overview

Device Type	Model	Purpose
Processor & Memory	Arduino Nano	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

Payload Processor & Memory Trade & Selection

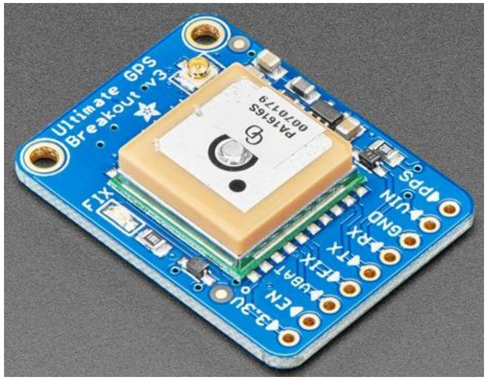
Processor	Boot time (s)	Speed (Mhz)	Memory (KB)	Weight (g)	Dimension (mm)	Voltage Input (V)	Ports
Arduino Nano	8 - 10	16	32	7	18 x 45	7 - 12	Analog Input - 8 PWM Output - 6 I2C I/O - 1 SPI - 1 DAC Output - 0
Raspberry pi Pico	0.5	125	264	3	21 x 51.3	1.8 – 5.5	Analog Input - 4 PWM Output - 8 I2C I/O – 1 SPI – 1 DAC Output - 1
Teensy 3.2	5	16	256	4.8	18 x 36	5	Analog Input - 25 PWM Output - 22 I2C I/O - 4 SPI - 3 DAC Output - 2

Selection	Reasoning for selection
Arduino Nano	- Compact size - Ease of use and familiarity - Availability

Payload Real-Time Clock

Real-Time Clock Keeper	Tolerance Reset	Interface	Cost ($)
Microchip MCP7940M-I/P	Real-Time clock continues keeping time in the event of a reset	I2C	0.75
Arduino Ultimate Breakout v3	Real-Time clock continues keeping time in the event of a reset	Internal to GPS	0.00

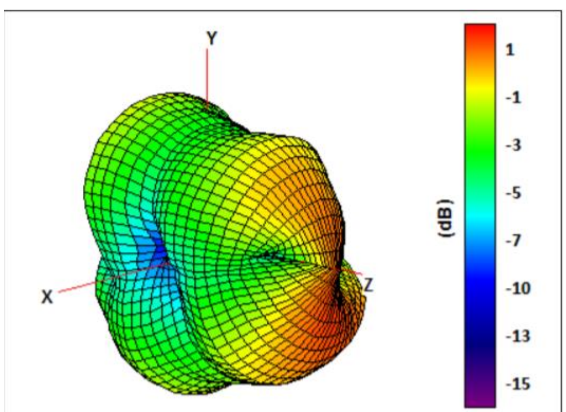
Selection	Reasoning for selection
Adafruit Ultimate GPS Breakout	- Already part of the telemetry communications - Has an independent, onboard battery - No additional weight, size, or circuitry required

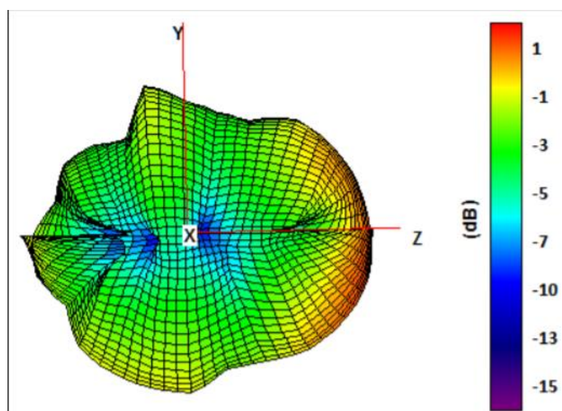


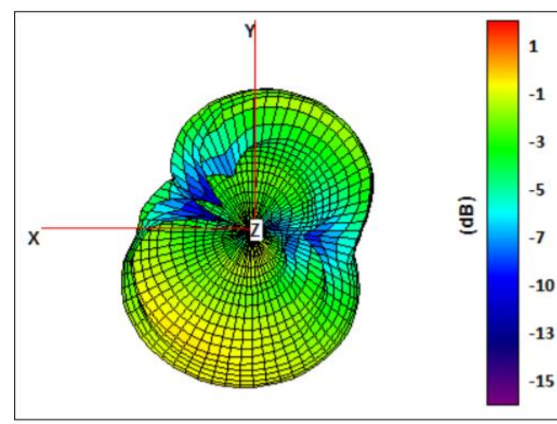
Payload Antenna Trade & Selection

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
Taoglas FXP290 915 MHz	.902-.928	100	1.5	Linear	U.FL	1.5

Selection	Reasoning for selection
ANT-900-RP-2-A	- In accepted frequency range - Compatible with selected radio - Compact 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
XBee S2C 802.15.4	2.4	1.2	Wire	5	30

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

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

NETID/PANID – 2031

Payload Telemetry Format (1/3)

- **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 data formatted?**
  - -Payload-to-GCS:

    TEAM_ID, MISSION_TIME, PACKET_COUNT, MODE, STATE, ALTITUDE, AIR_SPEED, HS_DEPLOYED, PC_DEPLOYED, TEMPERATURE, VOLTAGE, PRESSURE, GPS_TIME, GPS_ALTITUDE, GPS_LATITUDE, GPS_LONGITUDE, GPS_SATS, TILT_X, TILT_Y, ROT_Z, CMD_ECHO
- **Example:**

2031, 23:35:59, 25, F, LAUNCH_WAIT, 150.2, 15.76, N, N, 25.3, 8.3,230, 13:35:35, 25, 150.0258, 168.6765, 58, 5.02, 3.05, 2.63, CXON

Payload Telemetry Format (2/3)

Telemetry Field	Purpose	Relayed From:
<TEAM_ID>	Team ID number (2031)	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_DEPLOYED>	‘P’ if the heat shield has been deployed, ‘N’ if not	
<PC_DEPLOYED>	‘C’ if the probe parachute has been deployed, ‘N’ if not	
<AIR_SPEED>	Airspeed in meters per second measured with the pitot tube during both ascent and descent.	
<TEMP>	The temperature in degrees Celsius (+/- 0.1C)	

Payload Telemetry Format (3/3)

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	
<ROT_Z>	The rotation rate of the CanSat in degrees per second (+/- 0.1)	

Payload Command Formats (1/2)

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,2031,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,2031,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,2031,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,2031,SIMP,101325	

Payload Command Formats (2/2)

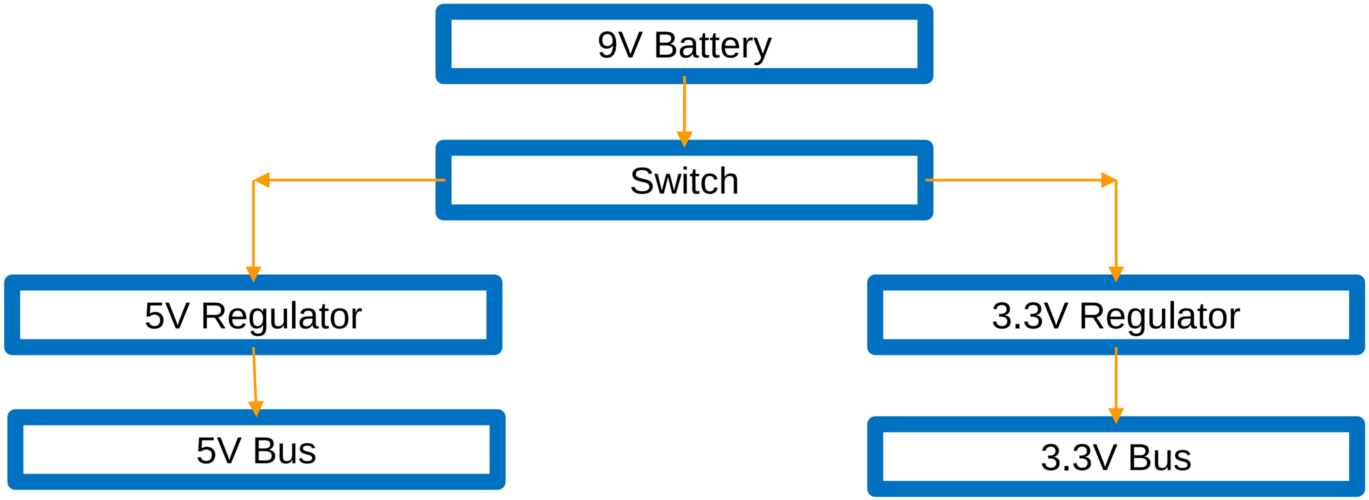
CAL – Calibrate Altitude to Zero	
CMD,<TEAM_ID>, CAL	
CMD & CAL	Static Text
<TEAM_ID>	Assigned Team Identification
Example: CMD,2031,CAL	

BCN – Control Audio Beacon	
CMD,<TEAM_ID>,BCN,ON|OFF	
CMD & BCN	Static Text
<TEAM_ID>	Assigned Team Identification
ON|OFF	ON- turns on audio beacon OFF- turns off audio beacon
Example: CMD,2031,BCN,ON	

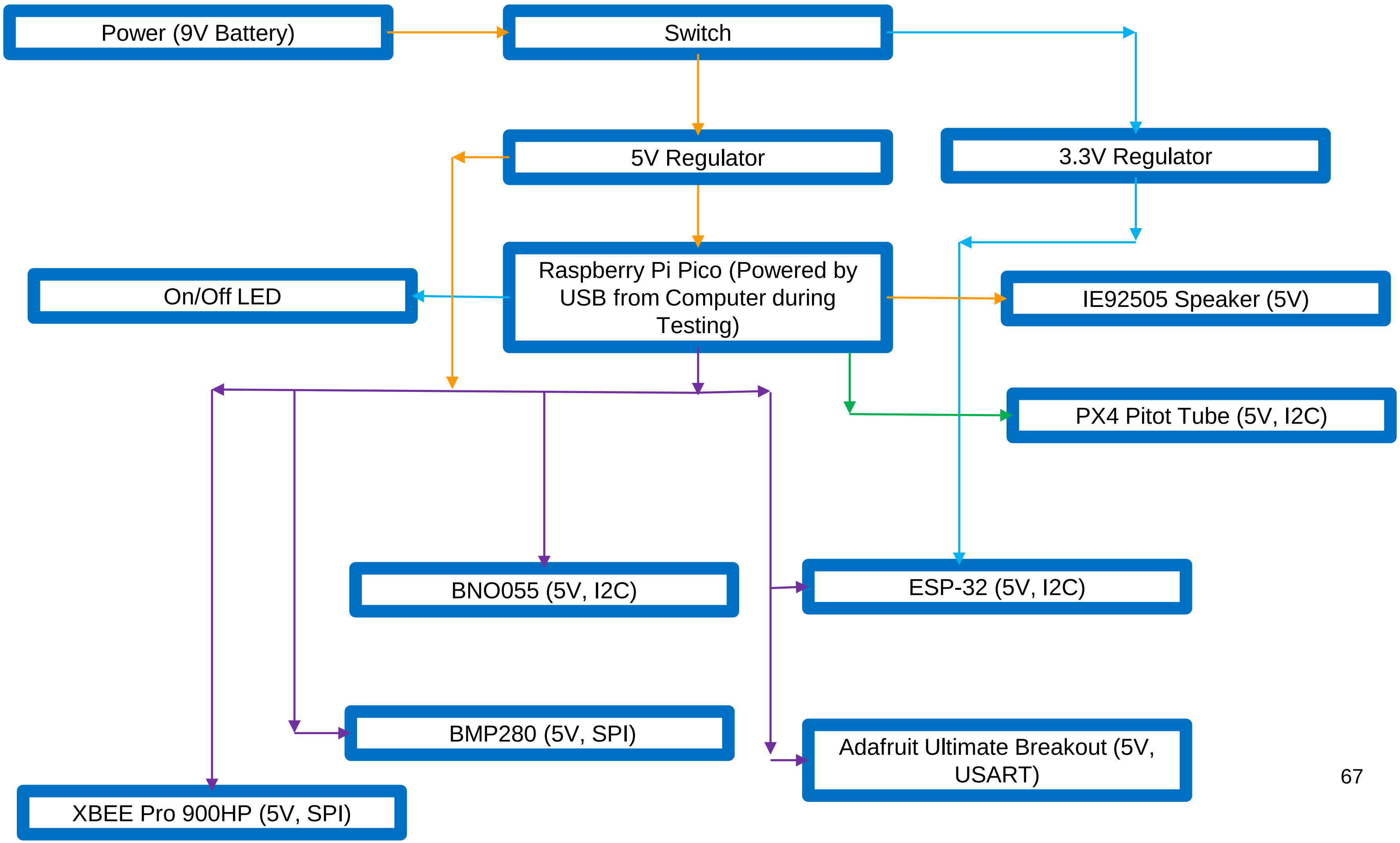
Electrical Power Subsystem (EPS) Design

Jonathan (Yoni) Gutmann

EPS Overview



Payload Electrical Block Diagram



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Payload Power Budget

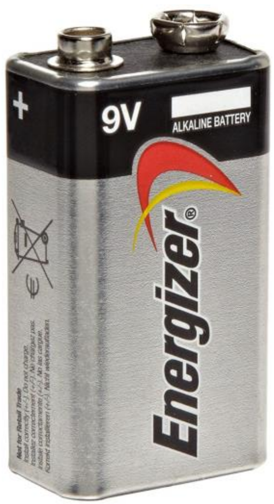
Component	Voltage (V)	Power per Unit (W)	Duty Cycle (%)	Power Consumption (Wh)	Source
Raspberry Pi Pico (Microcontroller)	9V	.1406	100	0.1406	Datasheet
Adafruit Ultimate Breakout (GPS)	5V	.1	100	.1	Datasheet
BMP280 (Air Temperature/Pressure)	5V	0.00025	100	0.000025	Datasheet
PX4 Differential Air Speed	5V	3.6	100	3.6	Datasheet
Xbee Pro 900 HP (Radio Module)	5V	.0.95	100	.95	Datasheet
ESP32	3.3V	1.65	100	1.65	Datasheet
BNO 055 (Temp/Rotational Sensor)	1.7-3.6V	0.0123	100	0.00155	Datasheet

Payload Power Trade & Selection

Type	Battery	Voltage	Capacity	Weight	Qty. Needed	Total Voltage	Total Weight
Lithium LiCB	CR2032	3.3V	236mAh	3.1g	2	6.6V	6.2g
Alkaline Industrial Battery	9V	9V	3.6mAh	46g	1	9V	46g

Selection	Reason for Selection
Alkaline Industrial Battery	- Provides enough current to power the entire system.

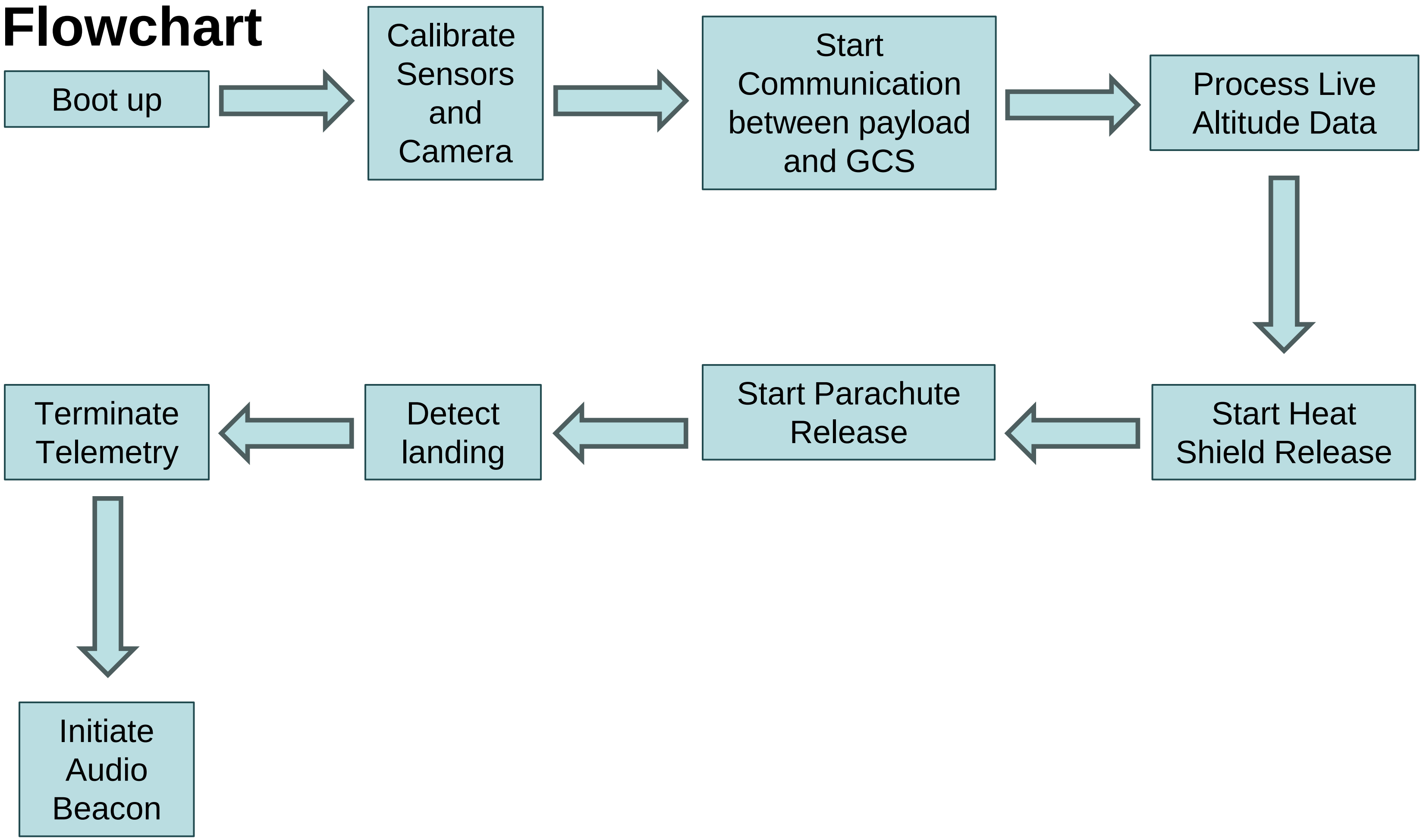
Battery Configuration
Single 9V Battery



Flight Software (FSW) Design

Evan (Steele) Elliott

Flowchart

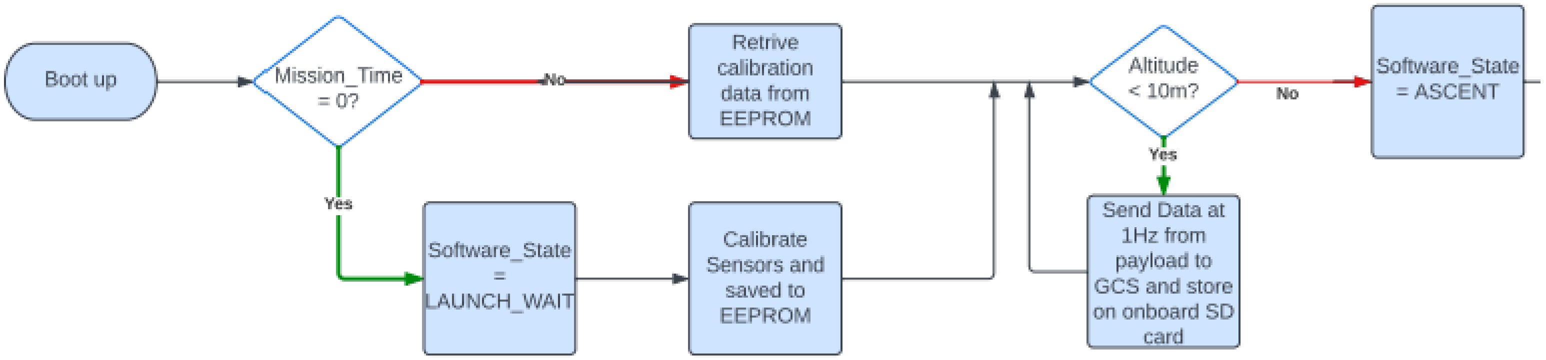


Boot up
Calibrate Sensors and Camera
Start Communication between payload and GCS
Process Live Altitude Data
Start Heat Shield Release
Start Parachute Release
Detect landing
Terminate Telemetry
Initiate Audio Beacon

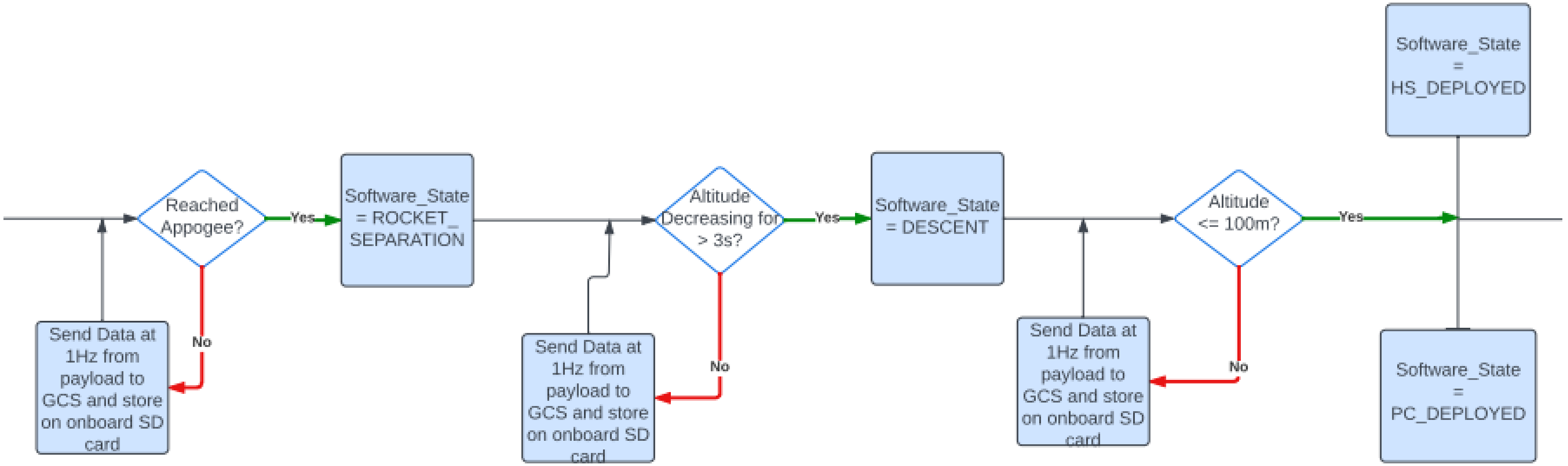
FSW Overview (2/2)

Programming Languages	Python / C
Development Environments	Visual Studio Code & Arduino IDE
FSW Tasks	- Boot up and collect sensor data in the correct units required by CanSat. - Communicate telemetry from the payload to the GCS to store data. - Keep track of altitude and release the heat shield 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

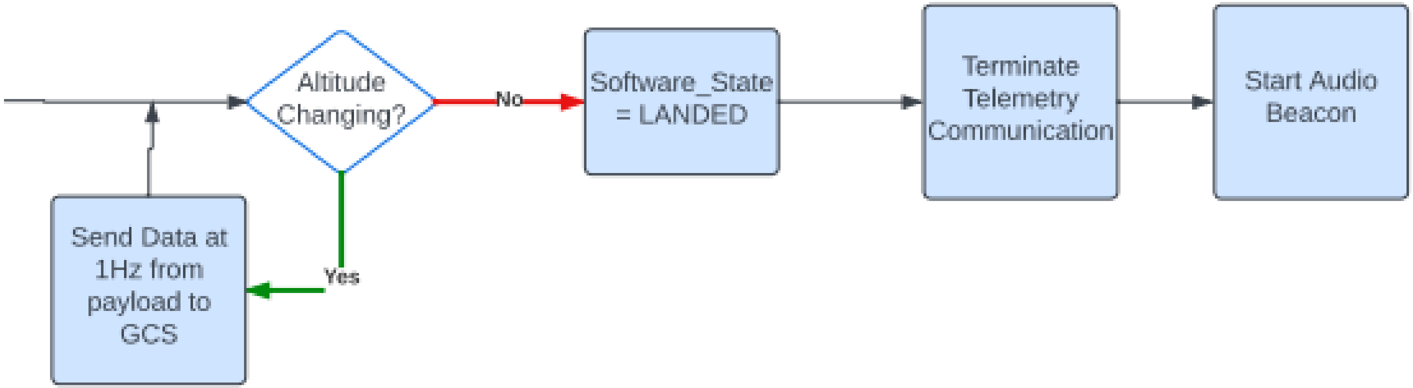
Payload FSW State Diagram (1/4)



Payload FSW State Diagram (2/4)



Payload FSW State Diagram (3/4)



Payload FSW State Diagram (4/4)

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

- Steele Elliott
- Max Epstein

Test Methodology

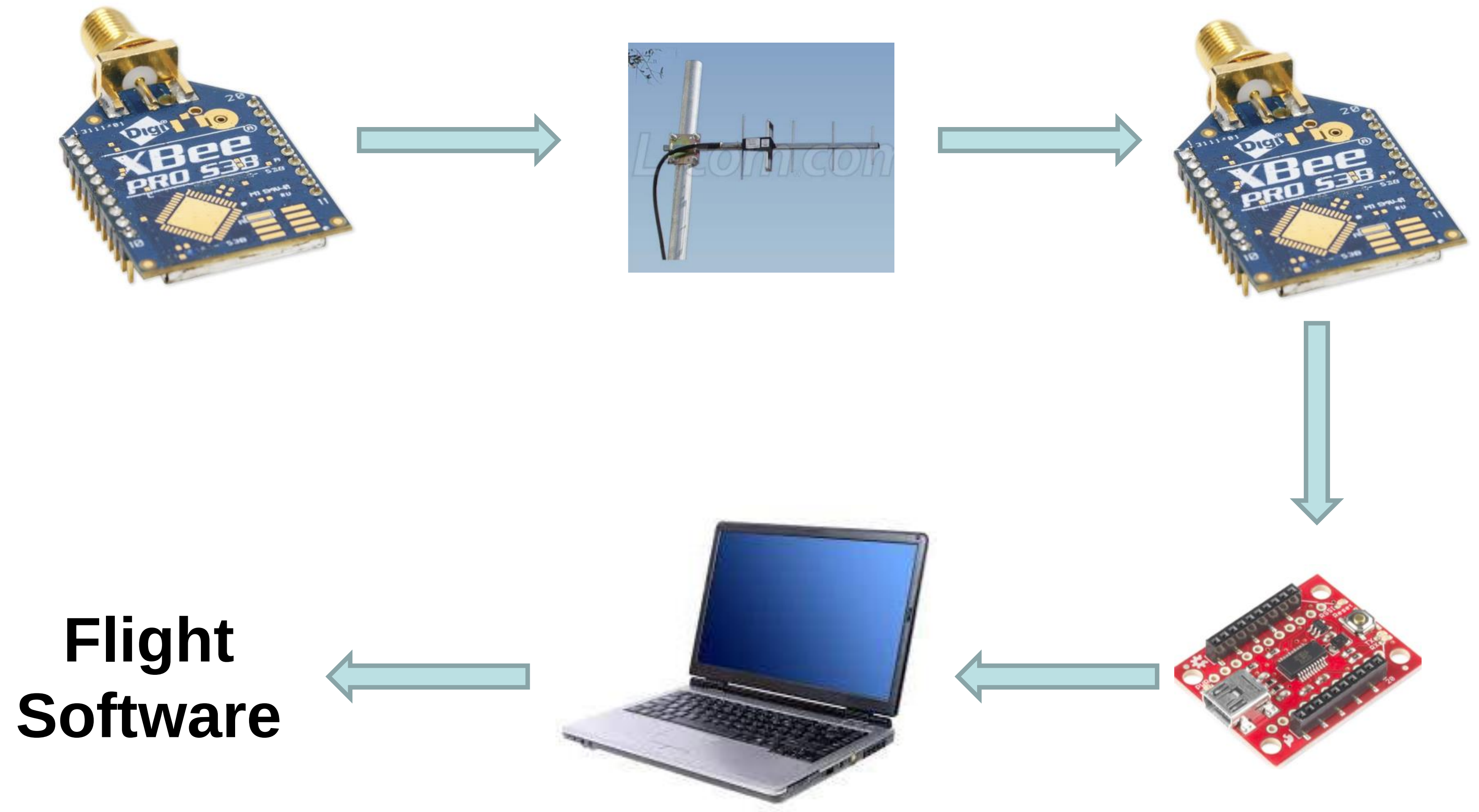
- Simulation mode with varying datasets
- Freefall sensor testing

Software Development Plan (2/2)

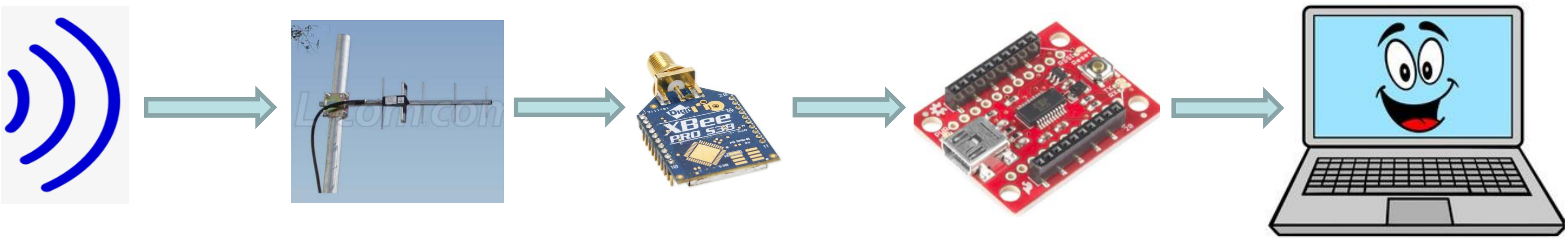
Subsystem	Development Sequence
Sensors	1. Sensor trade and selection compare and select the best 2. Program each individual sensor in Arduino 3. Integrate and conglomerate all programs, make sure it still functions
Xbee Radio	1. Configure and test point to point communication for the radio (controller and GCS port) 2. Integrate sensors with Xbee for data transmission
Flight Control	1. Program feedback system with servos connected to flight mechanisms
Release Mechanisms	1. Program release mechanisms such as linear actuators and servos
Software State	1. Use the data from sensors to change the states
Audio Beacon	1. Program locator audio beacon
Integration	1. 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

Evan (Steele) Elliott, Sanat Konda


Flight
Software

GCS Design

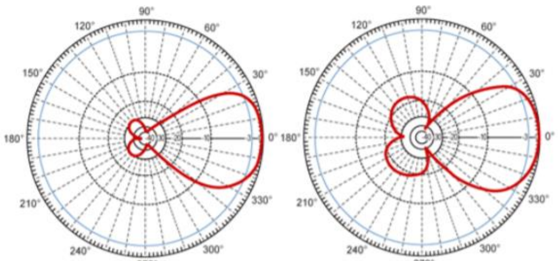


Specifications	
Laptop Battery	4 Hours
Overheating Mitigation	Umbrella, Laptop Cooler, and Jacket
Auto update Mitigation	Disable Auto-Update

GCS Antenna Trade & Selection

Name	Frequency Range (GHz)	Length of Antenna (mm)	Gain (dBi)	Polarization	Connection Type	Weight (g)	Cost ($)
Right-Angle Mini GSM	.85-2.1	57	2	(Linear) Vertical	Right Angle SMA	8	4.95
TL-Dipole Swivel Antenna	2.4	200	5	(Linear) Vertical	RP-SMA	30	8.95
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 - Previous use and accessibility



Vertical Horizontal

GCS Software (1/3)

Software Packages:
- Python 3.11.5 - 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

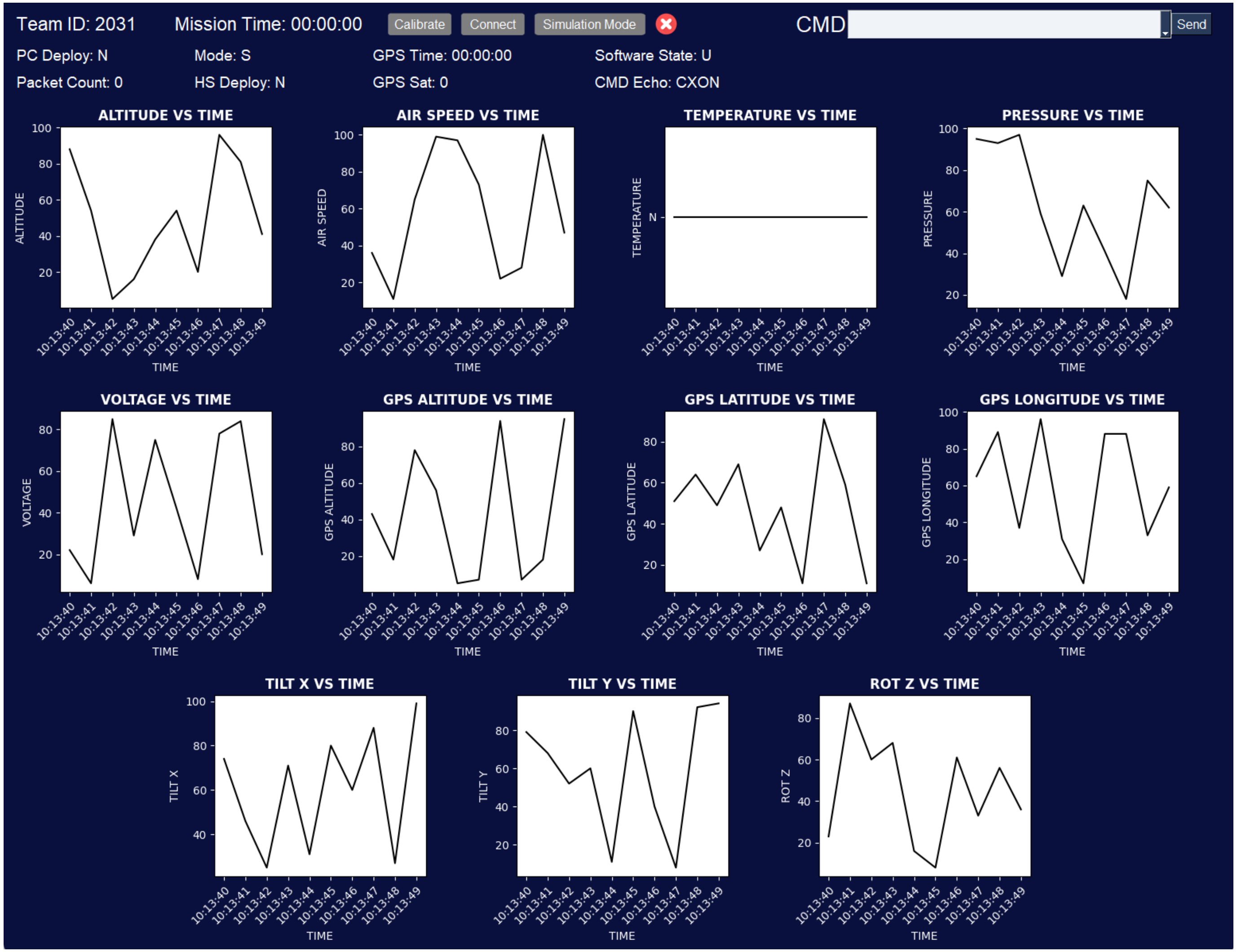
Command Software and Interface:
- Commands can be sent from the Ground Control Station to the CanSat via command.
- The GCS uses the XBEE Python Library to access the XBEE receiver through the USB interface.

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.

Simulation Mode:
- Opens simulation data .csv file and simulates reading commands at frequency of 1 Hz,

GCS Software (2/3)



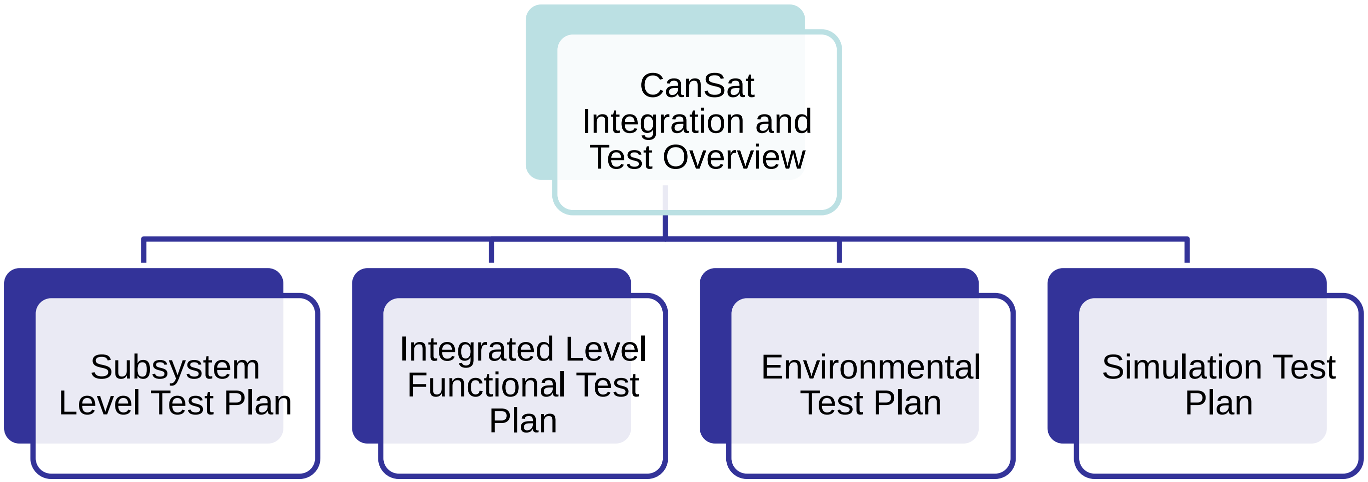
GCS Software (3/3)

TEAM_ID	MISSION_T	PACKET_C	MODE	STATE	ALTITUDE	AIR_SPEED	HS_DEPLO	PC_DEPLO	TEMPERAT	PRESSURE	VOLTAGE	GPS_TIME	GPS_ALTIT	GPS_LATIT	GPS_LONG	GPS_SATS	TILT_X	TILT_Y	TILT_Z	ROT_Z	CMD_ECHO
2031	10:13:00	1	S	LAUNCH_\	39	79	N	N	N	59	45	10:13:00	24	12	19	35	40	100	37	67	CXON
2031	10:13:01	2	S	LAUNCH_\	12	92	N	N	N	95	92	10:13:01	71	48	20	91	20	53	36	100	CXON
2031	10:13:02	3	S	LAUNCH_\	78	53	N	N	N	4	24	10:13:02	46	90	64	87	45	22	74	19	CXON
2031	10:13:03	4	S	LAUNCH_\	89	39	N	N	N	79	5	10:13:03	8	12	38	6	62	23	80	84	CXON
2031	10:13:04	5	S	LAUNCH_\	50	24	N	N	N	2	22	10:13:04	33	80	9	88	1	23	46	10	CXON
2031	10:13:05	6	S	LAUNCH_\	83	10	N	N	N	74	35	10:13:05	12	42	83	50	86	60	27	18	CXON
2031	10:13:06	7	S	LAUNCH_\	24	89	N	N	N	56	27	10:13:06	8	55	60	99	74	39	56	80	CXON
2031	10:13:07	8	S	LAUNCH_\	95	8	N	N	N	75	27	10:13:07	13	56	42	71	8	24	24	63	CXON
2031	10:13:08	9	S	LAUNCH_\	55	30	N	N	N	37	4	10:13:08	85	80	6	57	77	47	22	53	CXON
2031	10:13:09	10	S	LAUNCH_\	63	5	N	N	N	25	11	10:13:09	5	59	32	88	49	30	37	33	CXON
2031	10:13:10	11	S	LAUNCH_\	99	7	N	N	N	78	22	10:13:10	5	16	48	93	71	24	68	87	CXON
2031	10:13:11	12	S	LAUNCH_\	12	17	N	N	N	1	15	10:13:11	98	64	20	90	53	10	26	61	CXON
2031	10:13:12	13	S	LAUNCH_\	32	83	N	N	N	37	48	10:13:12	32	48	58	14	35	9	86	57	CXON
2031	10:13:13	14	S	LAUNCH_\	52	26	N	N	N	49	2	10:13:13	52	25	76	1	6	49	74	59	CXON
2031	10:13:14	15	S	LAUNCH_\	26	39	N	N	N	53	13	10:13:14	13	100	13	98	15	35	3	7	CXON
2031	10:13:15	16	S	LAUNCH_\	93	33	N	N	N	62	30	10:13:15	99	84	30	72	15	8	28	25	CXON
2031	10:13:16	17	S	LAUNCH_\	33	93	N	N	N	81	37	10:13:16	19	33	78	12	86	65	21	2	CXON
2031	10:13:17	18	S	LAUNCH_\	48	55	N	N	N	43	44	10:13:17	27	2	18	43	70	18	25	95	CXON
2031	10:13:18	19	S	LAUNCH_\	70	31	N	N	N	9	16	10:13:18	95	37	95	38	58	32	81	57	CXON
2031	10:13:19	20	S	LAUNCH_\	30	80	N	N	N	72	69	10:13:19	53	93	58	6	72	4	4	75	CXON
2031	10:13:20	21	S	LAUNCH_\	25	24	N	N	N	55	58	10:13:20	59	35	25	1	28	91	47	83	CXON
2031	10:13:21	22	S	LAUNCH_\	30	9	N	N	N	31	90	10:13:21	4	82	19	3	65	70	2	11	CXON
2031	10:13:22	23	S	LAUNCH_\	14	87	N	N	N	79	3	10:13:22	90	17	57	24	34	95	93	23	CXON
2031	10:13:23	24	S	LAUNCH_\	70	17	N	N	N	48	76	10:13:23	78	95	79	55	77	25	89	46	CXON
2031	10:13:24	25	S	LAUNCH_\	80	49	N	N	N	49	71	10:13:24	96	49	87	76	21	69	27	16	CXON
2031	10:13:25	26	S	LAUNCH_\	33	40	N	N	N	21	48	10:13:25	84	44	85	15	35	55	24	22	CXON

CanSat Integration and Test

Evan (Steele) Elliott, Max Epstein, Melissa Gonzalez

CanSat Integration and Test Overview



Subsystem Level Testing Plan (1/2)

Subsystem Level Testing	
Sensors	- Pressure sensor tests - Temperature sensor tests - GPS location & time tests - Rotational Sensors tests - Camera recording and saving video 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 release tests - Probe stability control tests - Flag raising test
Descent Control	- Parachute Drogue tests - Parachute reefing tests - Parachute deployment tests - Aerobraking device 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 are various altitudes - Payload parachute deployments tests at various altitudes - Aerobrake deployments tests are various altitudes - Linear actuator integration with altitude sensor readings

Environmental Test Plan (1/2)

Drop Test

- Verify that all structures can survive 15 Gs of launch acceleration and 30 Gs of shock
- Verify that the container can survive deployment from rocket
- Verify that payload remains in stowed state
- Verify that component and battery mounts can withstand applied forces

Thermal Test

- Verify the CanSat can operate in a hot environment without materials and/or components becoming functionally compromised

Vibration Test

- Verify the structural integrity of all mounts and connections within the CanSat
- Verify that payload remains in stowed state

Fit Check

- Verify that the CanSat and container fits within rocket to minimize deployment failure

Vacuum Test

- Verify deployment operations of the payload

Environmental Test Plan (2/2)

Drop Test

- Plan: Secure the CanSat to testing rig with non-stretch cord, release the CanSat from 61 cm and allow it to freefall, inspect CanSat for damage, if there was no damage then run a functional test.

Thermal Test

- Plan: Place the CanSat in an insulating cooler with a hair dryer, use a remote thermometer to monitor temperature, turn on the CanSat, turn off the heat source once internal temperatures reach 60C and turn on heat sources when temperature reaches 55C. Main this for 2 hours. With heat source off, visually inspect and functionally test CanSat to verify operational integrity survived thermal exposure.

Vibration Test

- Plan: Attach the CanSat to a random orbital sander and power it up to full speed, wait 5 seconds after the sander is at full speed then power it off, repeat the process 5 more times. Remove CanSat from fixture and visually inspect and functionally test CanSat to verify operation integrity. Verify accelerometer data is still being collected.

Fit Check

- Plan: Construct a prototype of the rocket cylinder wall, place the CanSat inside of the prototype and check for proper fit as well as the ability to securely deploy.

Vacuum Test

- Plan: Construct a vacuum chamber using a bucket and a vacuum cleaner. Suspend fully configured and powered CanSat within the vacuum chamber and turn on the vacuum. Monitor telemetry and stop the vacuum once peak altitude has been reached. Let air enter vacuum chamber slowly and monitor operation of CanSat. Collect and save telemetry. Save telemetry for judge reviewal.

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

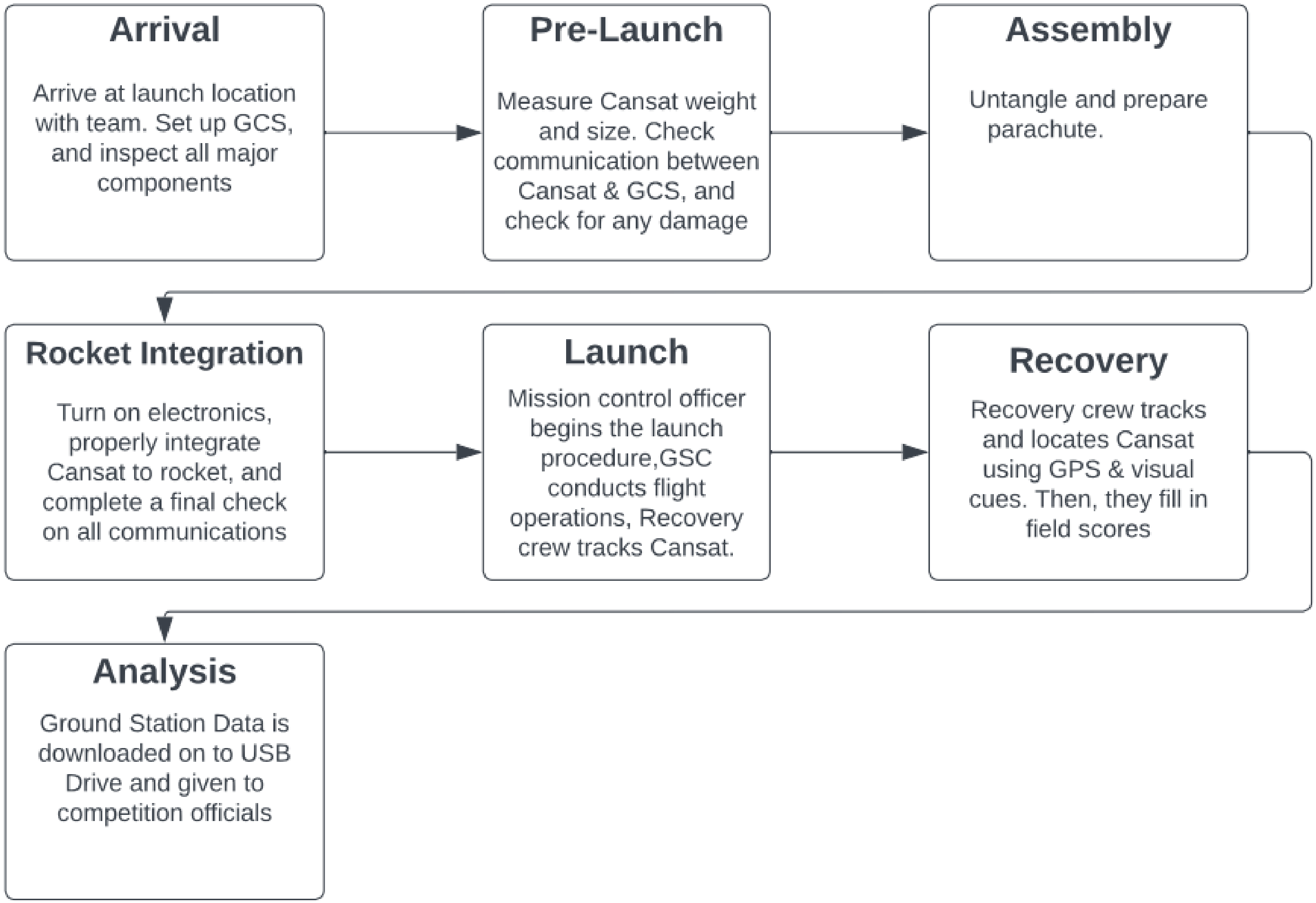
- The configuration and echoing of commands.
- The calculation of altitude with fed data from the CSV.
- The deployment of payload parachute, mast raise, and trigger of audio beacon.
- Payload video is saved and pointing in the correct direction.

Mission Operations & Analysis

Max Epstein, Melissa Gonzalez

Overview of Mission Sequence of Events (1/2)

Flowchart



Overview of Mission Sequence of Events (2/2)

Roles & Responsibilities

- **Mission Control Officer – Melissa Gonzalez**
- **Ground Station Crew – Evan (Steele) Elliott, Max Epstein, Jonathan (Yoni) Gutmann**
- **Recovery Crew – Sanat Konda, Christian Roque**
- **CanSat Crew – Zachary DeFabrizio, Jake Edwards, Samuel Taylor, Melanie Miguel**

Antenna Construction & Ground System Setup

- **Handheld ground station antenna will be mounted to a wood plank to be easily handled and aimed before competition date**
- **Ground system will be setup by Ground Station Crew, this includes the adapters necessary for the ground station antenna and XBEE radio**

Mission Operations Manual Development Plan

<u>Mission Operations Manual Outline:</u>

CGS Configuration:

- Indicates the status of the GCS, antennas, and flight software for final pre-flight checks.

CanSat Preparation and Assembly:

- Indicates the assembly of the CanSat, damage inspection, and assembly of components

CanSat-Rocket Integration:

- Indicates a final checklist and procedure for rocket clearances and assembly inspections.

Launch Preparation:

- Provided by CanSat competition.

Launch Procedure:

- Provided by CanSat competition.

Removal Procedure:

- Provided by CanSat competition.

Recovery Crew will be responsible for container and payload recovery

- **Container & Parachute will be a bright pink color making them easier to identify and locate.**
- **Most recently logged position on GPS will be used to more accurately locate the payload**
- **Contact information and return address labels will be on both the container and the payload**

Requirements Compliance

Max Epstein

Requirements Compliance Overview

- *Eggsplorer 1* complies with the requirements of the CanSat 2024 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 68/73 mission requirements
Partial Compliance	There are 5 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 (1/7)

Req #	Description	Comply / No Comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or notes
C1	The CanSat will act as the nose cone during the rocket's ascent portion of the flight.	Comply	15, 18	
C2	The CanSat shall be deployed when the ejection charge fires.	Comply	20	
C3	After deployment, the CanSat shall deploy its heat shield/aerobraking mechanism.	Comply	45, 46	
C4	A silver or gold mylar streamer of 50mm and 1.5 meters in length shall be connected to the CanSat and released at deployment, used to locate and identify the CanSat.	Partial		Not shown, but is planned for
C5	At 100 meters, the CanSat shall deploy a parachute and release the heat shield.	Comply	47, 48	
C6	Upon landing, the CanSat shall stop transmitting data.	Comply	71	
C7	Upon landing, the CanSat shall activate and audio beacon.	Partial	67	To be added
C8	The CanSat shall carry a provided large hen's egg with a weight between 51 and 65 grams.	Comply	15	
C9	0 altitude reference shall be at the launch pad.	Comply	71	
C10	During descent with the heat shield deployed, the descent rate shall be between 10 and 30 m/s.	Comply	40	
C11	At 100 meters, the CanSat shall have a descent rate of less than 5 m/s.	Comply	40	
C12	Total cost of the CanSat shall be below $1000. Ground support and analysis equipment are not included in this cost. Equipment from previous years shall be included at current market price.	Comply	113	

Requirements Compliance (2/7)

Req #	Description	Comply / No Comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or notes
S1	The CanSat mass shall be 900 grams +/- 10 grams without the egg.	Comply	51, 52, 53	
S2	The nose cone shall be symmetrical along the thrust axis.	Comply	36	
S3	The nose cone radius shall be exactly 71 mm.	Comply	20	
S4	The nose cone shoulder radius shall be exactly 68 mm.	Comply	20	
S5	The nose cone shoulder length shall be a minimum of 50 mm.	Comply	20	
S6	CanSat structure must be able to survive 15 Gs vibration.	Partial		Needs testing (Vibration Test)
S7	CanSat shall must survive 30 Gs shock.	Partial		Needs testing (Drop Test)
S8	The CanSat shall perform the function of the nose cone during rocket ascent.	Comply	18	
S9	The rocket airframe can be used to restrain any deployable parts of the CanSat, but shall allow the CanSat to slide out of the payload section freely.	Comply	20	
S10	The rocket airframe can be used as part of the CanSat operations.	Comply	20, 44, 46	
S11	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	50	

Requirements Compliance (3/7)

Req #	Description	Comply / No Comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or notes
M1	No pyrotechnical or chemical actuators are allowed.	Comply	42	
M2	Mechanisms that use heat shall not be exposed to the outside environment to reduce risk of setting the vegetation on fire.	Comply	42	
M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Partial		Needs testing (Drop Test)
M4	Spring contacts shall not be used for making electrical connections to batteries as shock forces can case momentary disconnects.	Comply	65	
M5	The CanSat shall deploy a heat shield after deploying from the rocket.	Comply	46	
M6	The heat shield shall be used as an aerobrake and limit the descent rate to 10 to 30 m/s.	Comply	40	
M7	At 100 meters, the CanSat shall release a parachute to reduce the descent rate to less than 5 m/s.	Comply	33, 40	
M8	The CanSat shall protect a hen's egg from damage during all portions of the flight.	Comply	49	
M9	If the nose cone is to be considered part of the heat shield, the documentation shall identify the configuration.	Comply	32	
M10	After the CanSat has separated from the rocket, and if the nose cone portion of the CanSat is to be separated from the rest of the CanSat, the nose cone portion shall descent at less than 10 m/s using any type of descent control device.	Comply	40	

Requirements Compliance (4/7)

Req #	Description	Comply / No Comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or notes
E1	Lithium polymer batteries are not allowed.	Comply	68	
E2	Battery source may be alkaline, Ni-Cad, NiMH or Lithium. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	Comply	68	
E3	The power switch must be easily accessible.	Comply	66	
E4	There must be a power indicator.	Comply	67	
E5	The CanSat shall operate for a minimum of two hours when integrated into the rocket	Comply	69	
X1	XBEE radios shall be used for telemetry. 2.4 GHz Series in addition to 900 MHz Series are allowed.	Comply	81	
X2	XBEE radios shall have their NETID/PANID set to their team number.	Comply	81	
X3	XBEE radios shall not use broadcast mode.	Comply	81	
X4	The CanSat shall transmit telemetry once per second.	Comply	60	
X5	The CanSat telemetry shall include altitude, air pressure, temperature, battery voltage, tilt angles, air speed, command echo, and GPS coordinates which include latitude, longitude, altitude, and number of satellites.	Comply	22	

Requirements Compliance (5/7)

Req #	Description	Comply / No Comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or notes
SN1	CanSat shall measure its speed with a pitot tube during both ascent and descent.	Comply	26	
SN1	CanSat shall measure its altitude using air pressure.	Comply	23	
SN3	CanSat shall measure its internal temperature.	Comply	24	
SN4	CanSat shall measure its angle stability with the aerobraking mechanism deployed.	Comply	27	
SN5	CanSat shall measure its rotation rate during descent.	Comply	28	
SN6	CanSat shall measure its battery voltage.	Comply	25	
SN7	The CanSat shall include a video camera pointing horizontally.	Comply	30	
SN8	The video camera shall record the flight of the CanSat from launch to landing.	Comply	30	
SN9	The video camera shall record video in color and with a minimum resolution of 640x480.	Comply	30	

Requirements Compliance (6/7)

Req #	Description	Comply / No Comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or notes
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	73	
G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	84	
G3	Telemetry shall include mission time with 1 second or better resolution.	Comply	57	
G4	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	Comply	73	
G5	Each team shall develop their own ground station.	Comply	81	
G6	All telemetry shall be displayed in real time during descent on the ground station.	Comply	85	
G7	All telemetry shall be displayed in engineering units and the units shall be indicated on the displays.	Comply	85	
G8	Teams shall plot each telemetry data field in real time.	Comply	85	
G9	The ground station shall include one laptop computer with a minimum of two hours battery operation, XBEE radio, and an antenna.	Comply	82	
G10	The ground station must be portable so that the team can be positioned at the ground station operation site along the flight line. AC power will be not available.	Comply	82	
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 ACTIVATE.	Comply	77	

Requirements Compliance (7/7)

Req #	Description	Comply / No Comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or notes
G12	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at 1 Hz interval to the CanSat.	Comply	60	
G13	The ground station shall use a tabletop or handheld antenna.	Comply	83	
G14	The displays on the ground station shall be designed with larger fonts (14pt minimum), bold plot traces and axes, and dark text on a light background since the ground station will be viewed in bright sunlight.	Comply	85	
G15	The ground system shall count the number of received packets. This is not the number of transmitted packets, but the number of packets successfully received at the ground station.	Comply	85	
F1	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission through the mission. This value shall be maintained through processor resets.	Comply	85	
F2	The CanSat shall maintain mission time throughout the whole mission regardless of processor resets or power loss.	Comply	85	
F3	The CanSat shall have its time set to within one second UTC time prior to launch.	Comply	57	
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 csv file.	Comply	77	
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	77	
F6	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVE commands.	Comply	77	

Management

Max Epstein, Melissa Gonzalez

CanSat Budget – Hardware

Component	Quantity	Unit Price ($)	Total Price ($)	Value Type
Adafruit BMP280	1	9.95	9.95	Actual
BNO-055	1	34.95	34.95	Actual
Adafruit Ultimate	1	29.95	29.95	Actual
Arduino Nano	1	25.00	25.00	Actual
ANT-900-RP-2-A	1	3.99	3.99	Actual
ESP 32	1	9.99	9.99	Actual
Mirco SD cards	1	4.20	4.20	Actual
PX4 Pitot Tube	1	55.88	55.88	Actual
XBEE Pro 900 Mhz Radio	1	68.25	68.25	Actual
9 Volt Battery	1	1.62	1.62	Actual
INA 260	1	6.38	6.38	Actual
Linear Actuator	1	65.00	65.00	Actual
Servo Motor	1	8.84	8.84	Actual

CanSat Budget – Hardware

Component	Quantity	Unit Price ($)	Total Price ($)	Value Type
Threaded Aluminum Rod	3	3.67	11.01	Actual
Nut	18	2.09	37.58	Actual
Fiberglass Eyebolt	1	8.12	8.12	Actual
Torsion Spring	4	1.63	6.51	Actual
Parachute	1	36.50	36.50	Actual
Mylar Fabric	1	26.00	26.00	Actual
Elastic Bands	2	0.85	1.70	Actual
High Performance Adhesive	1	3.88	3.88	Actual
Memory Foam	1	10.00	10.00	Actual

CanSat Budget – Other Costs (1/2)

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 - reuse	1	72.32	72.32	Actual
900 MHz XBEE Radio - reuse	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 (2/2)

Source of Income:	Funds Provided ($):
UF MAE Department	$2,700

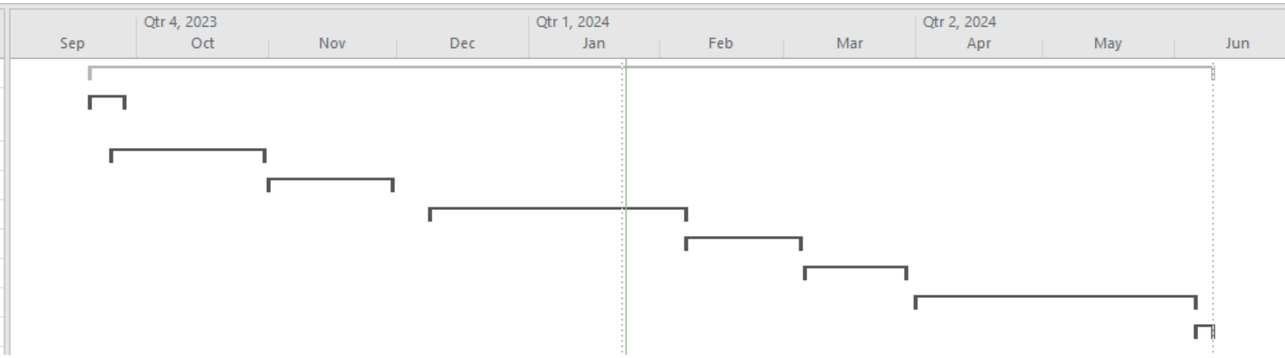
Hardware Costs:	$465.30
Other Costs:	$466.57
Competition Fees:	$200
Total Costs:	**$1,131.87**

A total cost of $1131.87 for the testing and building of our CanSat as well as CanSat related fees leaves us with a total of **$1568.13** for travel, housing, and food expense. This is expected to be more than sufficient for our 10 members. We also have various travel related sponsorships from the university.

Program Schedule Overview

An overview of the competition schedule is shown below, along with a key defining the symbols used in the following detailed schedule.

Task Name	Start	Finish
2024 CANSAT Plan	Wed 9/20/23	Sun 6/9/24
Preliminary Design Phase	Wed 9/20/23	Wed 9/27/23
Research	Mon 9/25/23	Mon 10/30/23
Trade Studies	Wed 11/1/23	Wed 11/29/23
PDR Completion	Sat 12/9/23	Tue 2/6/24
Critical Design Phase	Wed 2/7/24	Mon 3/4/24
CDR Completion	Wed 3/6/24	Fri 3/29/24
Testing	Mon 4/1/24	Wed 6/5/24
Competition	Thu 6/6/24	Sun 6/9/24

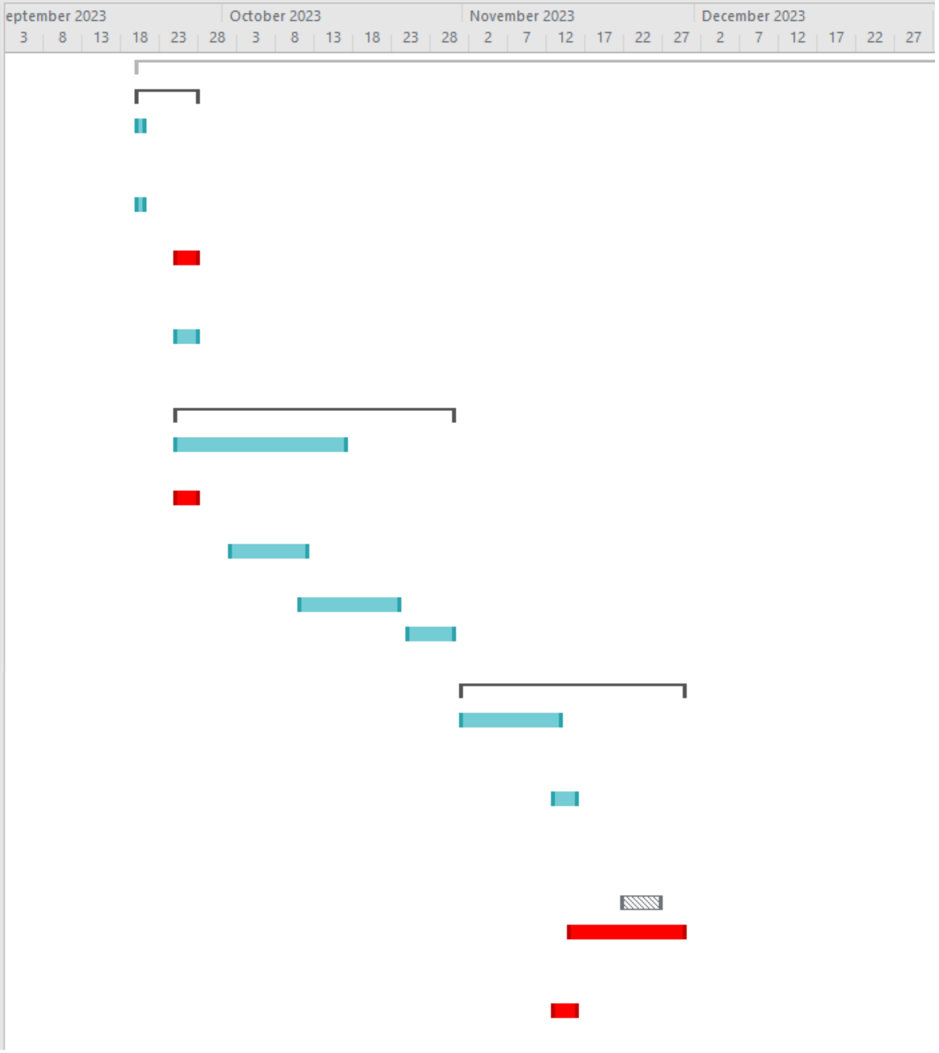


Key

Design Phase Overview	Task
Important Action	Holiday/Vacation

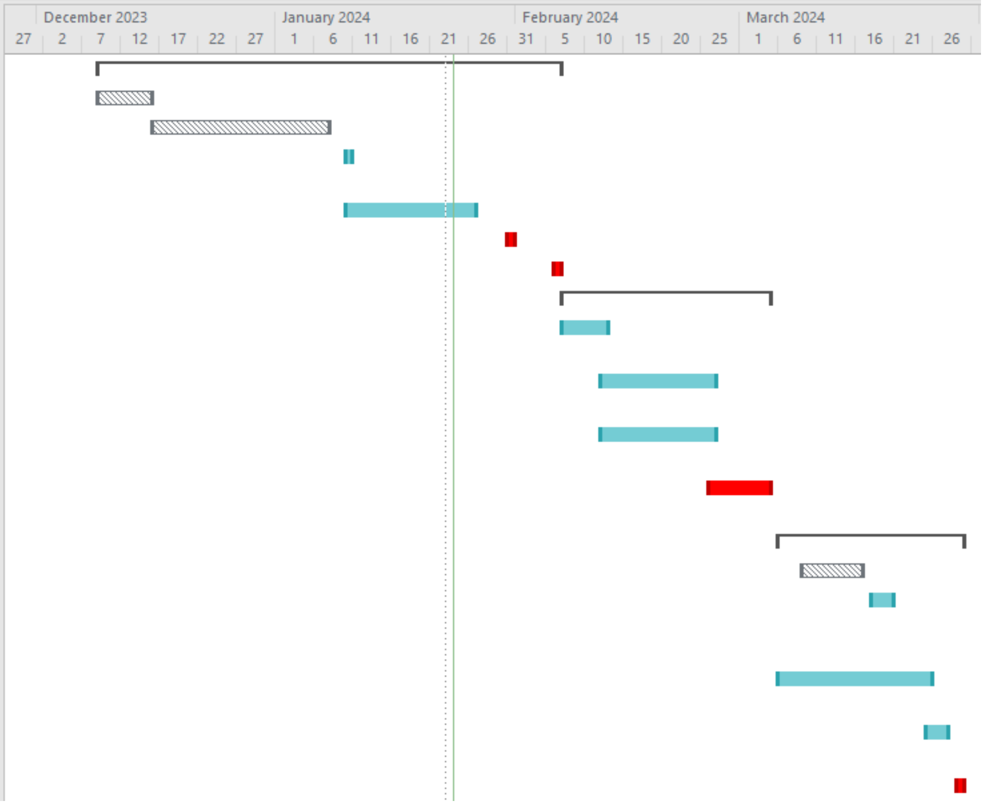
Detailed Program Schedule (1/3)

Task Name	Duration	Start	Finish	Subteam
2024 CANSAT Plan	**188 days?**	**Wed 9/20/23**	**Sun 6/9/24**	**All**
Preliminary Design Phase	**6 days?**	**Wed 9/20/23**	**Wed 9/27/23**	**Management**
Present Mission Guide and Competition Objectives	1 day	Wed 9/20/23	Wed 9/20/23	Management
Finalize Meeting Schedule	1 day	Wed 9/20/23	Wed 9/20/23	Management
Organize and Divide Team and Responsibilities	3 days	Mon 9/25/23	Wed 9/27/23	Management
Document and Organize Competition Requirements	3 days	Mon 9/25/23	Wed 9/27/23	Management
Research	**26 days**	**Mon 9/25/23**	**Mon 10/30/23**	**All**
Sensors/Electronics Research	16 days	Mon 9/25/23	Mon 10/16/23	Electrical Team
Design Conceptualization	3 days	Mon 9/25/23	Wed 9/27/23	Mechanical Team
Subsystem Design Discussions	8 days	Mon 10/2/23	Wed 10/11/23	All
Prototyping Designs	9 days	Wed 10/11/23	Mon 10/23/23	Mechanical Team
Document Pros and Cons of Each Design Proposal	4 days	Wed 10/25/23	Mon 10/30/23	Mechanical Team
Trade Studies	**21 days**	**Wed 11/1/23**	**Wed 11/29/23**	**All**
Prototype Testing and Quantative Data Collection	9 days	Wed 11/1/23	Mon 11/13/23	Mechanical Team
Verify Requirements are Met by Each Subsystem and Make According Edits	3 days	Mon 11/13/23	Wed 11/15/23	All
Thanksgiving Break	4 days	Wed 11/22/23	Sun 11/26/23	All
Conduct Trade Studies on Various Designs for each Subsystem	11 days	Wed 11/15/23	Wed 11/29/23	All
Order Electronics and Parts	3 days	Mon 11/13/23	Wed 11/15/23	Electrical Team



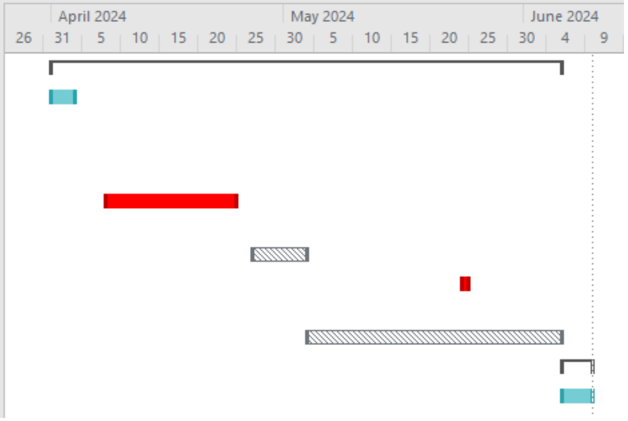
Detailed Program Schedule (2/3)

Task Name	Duration	Start	Finish	Subteam
PDR Completion	**42 days**	**Sat 12/9/23**	**Tue 2/6/24**	**All**
Fall Final Exams	6 days	Sat 12/9/23	Fri 12/15/23	All
Winter Break	17 days	Sat 12/16/23	Sun 1/7/24	All
Assign Slides and Start Formatting	1 day	Wed 1/10/24	Wed 1/10/24	Management
Fill Out Slides	13 days	Wed 1/10/24	Fri 1/26/24	All
PDR Due	1 day	Wed 1/31/24	Wed 1/31/24	All
Present PDR	1 day	Tue 2/6/24	Tue 2/6/24	All
Critical Design Phase	**19 days**	**Wed 2/7/24**	**Mon 3/4/24**	**All**
Review Requirements for CDR	4 days	Wed 2/7/24	Mon 2/12/24	All
Manufacture Finalized Subsystems	11 days	Mon 2/12/24	Mon 2/26/24	Mechanical Team
Test Flight Software and Electronics	11 days	Mon 2/12/24	Mon 2/26/24	Electrical Team
Conduct the Integration of Subsystems	6 days	Mon 2/26/24	Mon 3/4/24	All
CDR Completion	**18 days**	**Wed 3/6/24**	**Fri 3/29/24**	**All**
Spring Break	7 days	Sat 3/9/24	Sat 3/16/24	All
Document Final Design and Analysis for all Subsystems	3 days	Mon 3/18/24	Wed 3/20/24	All
Fill Out Slides and Verify Completion	14 days	Wed 3/6/24	Mon 3/25/24	All
Format and Make Final Adjustments	3 days	Mon 3/25/24	Wed 3/27/24	All
CDR Due	1 day	Fri 3/29/24	Fri 3/29/24	All



Detailed Program Schedule (3/3)

Task Name	Duration	Start	Finish	Subteam
Testing	**48 days**	**Mon 4/1/24**	**Wed 6/5/24**	**All**
Verify System Intergration Meets Competition Requirements	3 days	Mon 4/1/24	Wed 4/3/24	All
Conduct Tests on Full System	13 days	Mon 4/8/24	Wed 4/24/24	All
Spring Final Exams	6 days	Sat 4/27/24	Fri 5/3/24	All
Environmental Test Document Due	1 day	Fri 5/24/24	Fri 5/24/24	All
Summer Break	24 days	Sat 5/4/24	Wed 6/5/24	All
Competition	**2 days**	**Thu 6/6/24**	**Sun 6/9/24**	**All**
Competition Weekend	3 days	Thu 6/6/24	Sun 6/9/24	All



Conclusions

Major Accomplishments
• All electronics have been purchased and ordered • Majority of telemetry components programmed • Avionics communication and data handling in progress • Significant funding secured • Started prototyping CanSat components

Major Unfinished Work
• Telemetry communication tests between CanSat and Ground Station • Full manufactured prototype of CanSat • Some mechanical parts have not been ordered • Egg container has not been tested