CanSat 2026 Preliminary Design Review (PDR) Outline *Version 1.0*

#1064

Bamantara EEPISAT

Presentation Outline

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Team Organization

Acronyms (1/2)

Acronyms	Definition
3D	Three Dimensional
ABS	Acrylonitrile Butadiene Styrene
ADC	Analog to Digital Converter
ASCII	American Standard Code for Information Interchange
BUS	Binary Unit System
CAD	Computer Aided Design
CDH	Communication and Data Handling
COTS	Commercial Of-the-Shelf
CSV	Comma Separated Value
dB	Decibel
dBi	Decibel Isotropic
dBm	Decibel-Milliwatt
DC	Direct Current
DoF	Degree of Freedom
DVR	Digital Video Recorder
EEPROM	Electrically Erasable Programmable Read Only Memory
EPS	Electrical Power Subsystem
FSW	Flight Software
GB	GigaByte
GCS	Ground Control Station
GND	Ground
GNSS	Global Navigation Satellite System
GPIO	General Purpose Input Output
GPS	Global Positioning System
HDPE	High-Density Polyethylene
I/O	Input/Output
I2C	Inter-Integrated Circuit
IDE	Integrated Development Environment
IMU	Inertial Measurement Unit
LED	Light Emitting Diode
MB	MegaByte

Acronyms (2/2)

MCU	Microcontroller Unit
NGL	Negligible
OS	Operating System
PCB	Printed Circuit Board
PETG	Polyethylene Terephthalate Glycol
PFR	Post Flight Review
PG	Para-glider
PLA	Polylactic Acid
POV	Point of View
PWM	Pulse Width Modulation
RAM	Random Access Memory
RBF	Remove Before Flight
RP-SMA	Reverse Polarity SubMiniature version A
RTC	Real-Time Clock
SATS	Satellites
SD	Secure Digital
SDIO	Secure Digital Input Output
SMD	Surface Mount Device
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
UTC	Universal Time Coordinated
XCTU	XBee Configuration and Test Utility

System Requirement Verification	
Acronyms	**Definition**
A	Analysis
I	Inspection
T	Test
D	Demonstration

Systems Overview

Lintang Arum Sari

Mission Summary

Main Objectives

The mission simulates Para-glider Instrument Delivery

1. Design a CanSat that shall consist of a payload and a container that mounts on top of the rocket.
2. The container with the payload shall deploy from the rocket when the rocket reaches peak altitude, and the rocket motor ejection forces a separation.
3. The container with the payload shall descend at a rate of no more than 15 m/s using a parachute.
4. At 80% peak altitude, the payload shall separate from the container and descend using a para-glider descent control system until landing. The descent rate shall be an average of 5 m/s.
5. The payload shall steer toward a specified position to deposit an egg instrument.
6. At 2 meters above the ground, the instrument shall be released and land intact.
7. A release camera shall show the separation of the payload from the container and the para-glider descent control system functioning.
8. A ground video camera shall be pointing downwards and show the ground during descent and the egg instrument being released.
9. The CanSat shall collect sensor data during ascent and descent and transmit the data to a ground station @1 Hz.
10. The sensor data shall include interior temperature, battery voltage, battery current, tilt angle, rotation rate, and GPS position.

External Objectives

1. We have the intention to acquire the first place in the CanSat Competition 2026.
2. To increase experience through any engineering project, adapt to the teamwork environment, project implementation, and time management.

System Requirement Summary (1/4)

RN	Requirement	Subsystem	Priority	Verification			
				A	I	T	D
C1	The CanSat payload shall function as a nose cone during the rocket ascent portion of the flight.	Operational	High	✓	✓	✓	✓
C2	The CanSat container shall be mounted on top of the rocket with the shoulder section inserted into the airframe	Operational	High	✓	✓		
C3	The CanSat payload and container shall be deployed from the rocket when the rocket motor ejection charge fires.	Operational	High	✓			
C4	After deployment, the CanSat payload and container shall descend at 15 m/s using a parachute that automatically deploys. Error is +/- 3 m/s.	Operational	High	✓			
C5	At 80% flight peak altitude, the payload shall be released from the container.	Operational	High	✓			
C6	At 80% peak altitude, the payload shall deploy a para-glider descent control system.	Operational	High	✓			
C7	The payload shall descend at 5 m/s averaged over the entire descent within +/- 3 m/s with the para-glider descent control system.	Operational	High	✓	✓	✓	✓
C8	The payload shall steer toward a target location.	Operational	High	✓	✓		
C9	The sensor telemetry shall be transmitted at a 1 Hz rate	Operational	High	✓	✓	✓	✓
C10	The payload shall record video of the release of the payload from the container and the deployment of the para-glider descent control system	Operational	High	✓	✓		

System Requirement Summary (2/4)

RN	Requirement	Subsystem	Priority	Verification			
				A	I	T	D
C11	A second video camera shall point at the ground.	Operational	High	✓	✓		
C12	The payload shall release a protected hens egg when the payload is 2 meters +/- 0.5 m above the ground without breaking the egg.	Operational	High	✓	✓	✓	
C13	The CanSat payload shall include an audible beacon that is turned on separately and is independent of the CanSat battery and electronics.	Operational	High	✓	✓	✓	✓
C14	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost of the CanSat. Equipment from previous years shall be included in this cost, based on current market value.	Operational	High	✓	✓	✓	✓
S1	The CanSat and container mass shall be 1000 grams +/- 10 grams.	Structural	High	✓	✓	✓	
S8	CanSat structure must survive 15 Gs vibration.	Structural	High	✓			
S9	CanSat shall survive 30 G shock.	Structural	High	✓			
S17	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Structural	High	✓	✓	✓	
M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Mechanical	High	✓			

System Requirement Summary (3/4)

RN	Requirement	Subsystem	Priority	Verification			
				A	I	T	D
E3	An easily accessible power switch through the container is required	Electrical	High	✓	✓	✓	
E6	The CanSat shall operate for a minimum of two hours when integrated into the rocket.	Electrical	High	✓	✓		
E8	The audio beacon shall have an easily accessible power switch through the container	Electrical	High	✓	✓		
X4	The CanSat shall transmit telemetry once per second.	Communications	High	✓	✓	✓	✓
X5	The CanSat telemetry shall include altitude, air pressure, temperature, battery voltage, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	Communications	High	✓	✓	✓	✓
SN6	CanSat payload shall video record the deployment of the para-glider at 80% peak altitude.	Sensor	High	✓	✓		
SN7	CanSat payload shall video record the ground during descent.	Sensor	High	✓	✓		
SN8	The ground pointing camera shall capture video of the instrument (egg) being released and reaching the ground.	Sensor	High	✓	✓		
SN10	CanSat payload shall measure its battery current.	Sensor	High	✓	✓	✓	
G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Ground Station	High	✓	✓	✓	✓

System Requirement Summary (4/4)

RN	Requirement	Subsystem	Priority	Verification			
				A	I	T	D
G3	Telemetry shall include mission time with 1 second resolution	Ground Station	High	✓	✓	✓	✓
G4	Each team shall develop their own ground station.	Ground Station	High	✓	✓	✓	✓
G7	Teams shall plot altitude, battery voltage, battery current, accelerometer value and rotation rates in real time.	Ground Station	High	✓	✓	✓	✓
G8	Teams shall display mission time, temperature, GPS position, received packet count, lost packet count, and flight software state in real time.	Ground Station	High	✓	✓	✓	✓
G9	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBee radio and an antenna.	Ground Station	High	✓	✓		
G12	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the CanSat.	Ground Station	High	✓	✓	✓	✓
G17	The ground station shall be able to activate all mechanisms on command.	Ground Station	High	✓	✓	✓	✓
F1	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Flight Software	High	✓	✓	✓	✓
F2	The CanSat shall maintain mission time throughout the entire mission even in the event of a processor resets or momentary power loss.	Flight Software	High	✓	✓	✓	✓
F7	The flight shall include commands to activate all mechanisms. These commands shall be documented in the mission manual.	Flight Software	High	✓	✓	✓	✓

System Level CanSat Configuration Trade & Selection (1/4)

Configuration A

- The system will provide passive and active descent control.
- The descent control pointing camera will be directed upwards at a 25° angle from the vertical axis.
- The ground pointing camera will be directed downwards at a 25° angle from the vertical axis.
- The para-glider will deploy supported by the drogue-chute.
- The para-glider control mechanism using 2 servos to steer payload direction.
- Payload release mechanism using active control with spring push system.
- Instrument release mechanism using active control with slingshot.

PROS

- Low drag coefficient
- The use of drogue-chute increase the probability to deploy the para-glider
- Easy for maintenance

CONS

- Hard to manufacture
- High cost

System Level CanSat Configuration Trade & Selection (2/4)

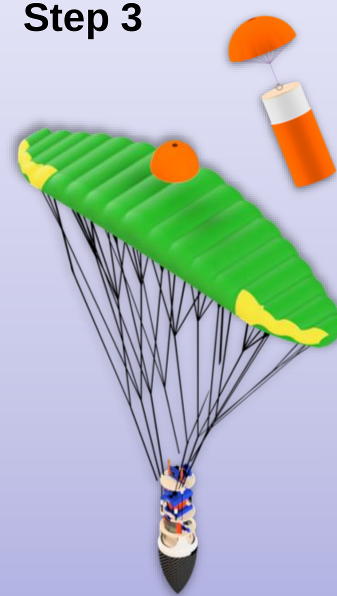
Step 1

The CanSat will be inserted into the rocket body and the para-glider will be stowed inside the container, the para-glider is directly connected to the payload. The CanSat will be detached from the rocket body when the rocket ejection chute fires.

Step 2

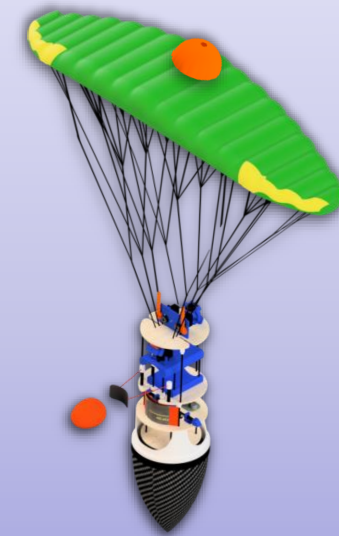
Once the CanSat separates from the rocket, the parachute will be deployed. Upon reaching 80% peak altitude, the payload release mechanism will be active to separate the payload from the container.

Step 3



After the payload separated from the container, the para-glider will be deployed supported by the drogue-chute and wind pressure.

Step 4

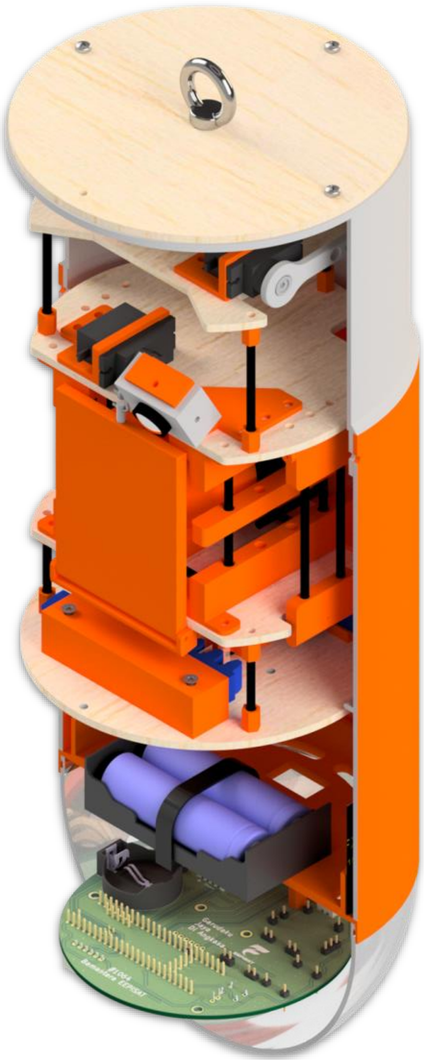


After reaching 2 meters above the ground, the payload will release the egg instrument safely and landed into the target location.

System Level CanSat Configuration Trade & Selection (3/4)

Configuration B

- The system will provide passive and active descent control.
- The descent control pointing camera will be directed upwards.
- The ground pointing camera will be directed downward at a 30° angle from the vertical axis.
- The para-glider will deploy passively using wind pressure.
- Payload release mechanism using active control with a rack gear system.
- Instrument release mechanism using active control with a spring push.



PROS

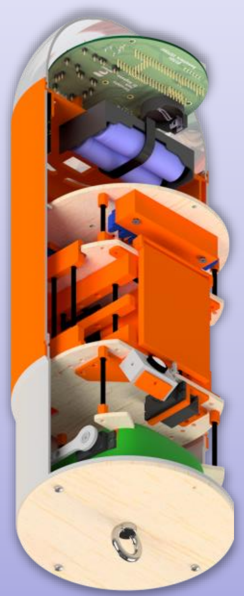
- Easier to manufacture
- Cheaper

CONS

- Higher drag coefficient
- Higher risk of para-glider deployment failure
- More complex mechanism

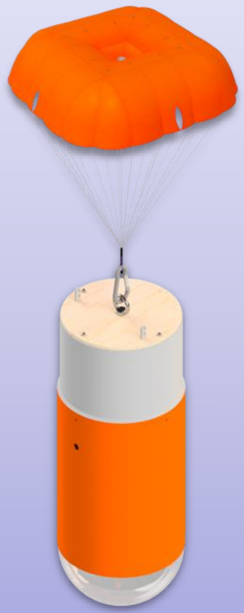
System Level CanSat Configuration Trade & Selection (4/4)

Step 1



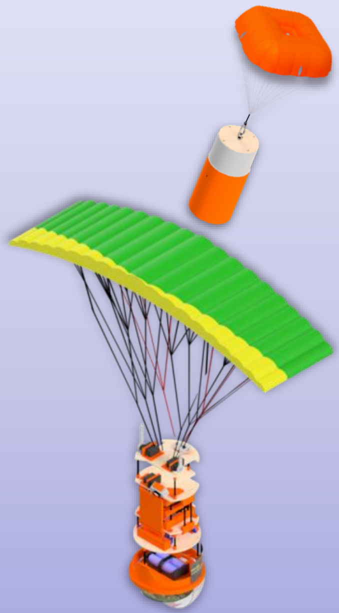
The CanSat will be inserted into the rocket body and the para-glider will be stowed inside the container, the para-glider is directly connected to the payload. The CanSat will be detached from the rocket body when the rocket ejection chute fires.

Step 2



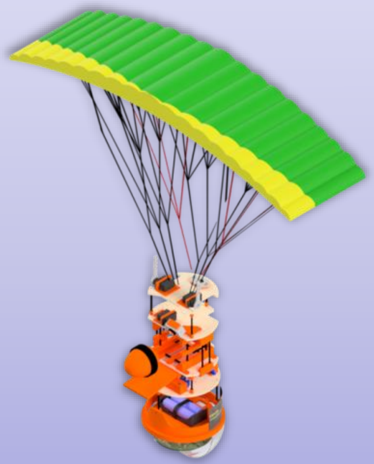
Once the CanSat separates from the rocket, the parachute will be deployed. Upon reaching 80% peak altitude, the payload release mechanism will be active to separate the payload from the container.

Step 3



After the payload separated from the container at 80% peak altitude, the para-glider will be deployed using force from wind pressure.

Step 4



After reaching 2 meters above the ground, the payload will release the egg instrument safely and landed into the target location.

System Level Configuration Selection (1/2)

Configuration A		Configuration B	
PROS	**CONS**	**PROS**	**CONS**
High durability	Hard to manufacture	Easy to manufacture	Fragile
Low drag coefficient			
Low moisture absorbency	Expensive	Affordable	High drag coefficient
Robust			
High strength			
Easy to maintain		Precise	Hard to maintain

Configuration A ✓

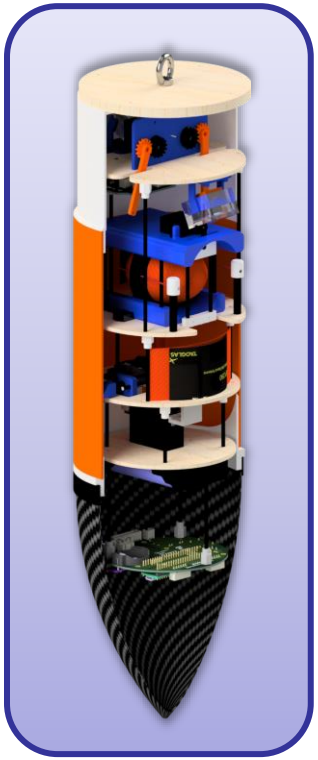
Selected: **Configuration A**

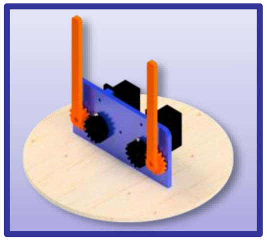
Reasons

- ❑ Both designs comply with the requirements
- ❑ Configuration A is more ideal for achieving the mission
- ❑ Configuration A has a greater possibility of obtaining a specified descent speed
- ❑ Configuration A gives lower drag coefficient

System Level Configuration Selection (2/2)

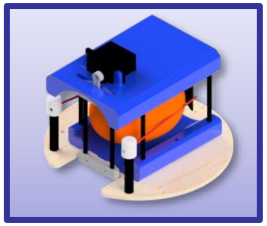
Selected: Configuration A





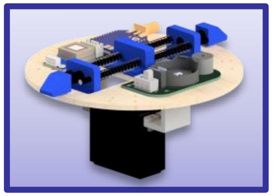
Para-Glider Control Mechanism

The para-glider uses two servos to steer its glide to the left and right. A dual-gear mechanism is implemented to amplify torque on each arm, enabling more effective directional movement.



Release Instrument Mechanism

The servo that attaches to the upper side of the instrument site will move upward in certain angle to retract the horn that kept instrument from pressure by a band, therefore the instrument will release.



Payload Release Mechanism

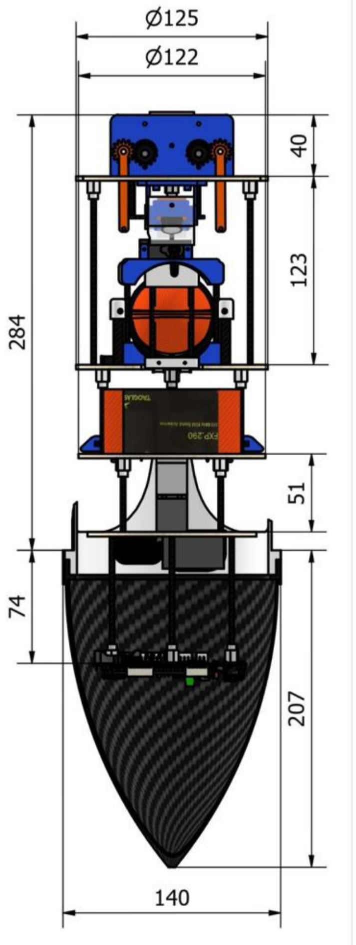
The CanSat will release its payload automatically when it reaches 80% of apogee. This happens when a servo motor moves a slider spring system.

Reasons

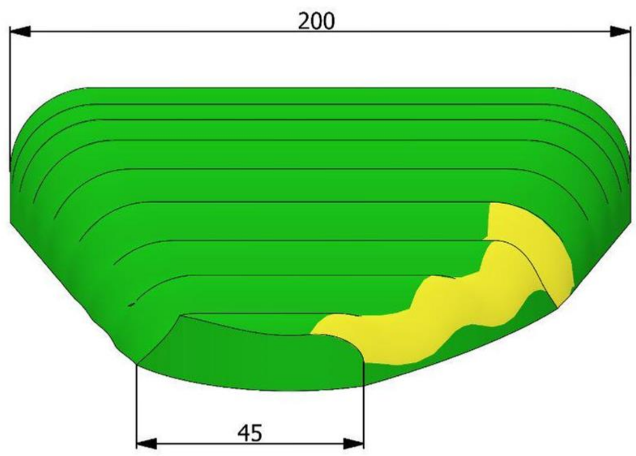
- ❑ More reliable to support the deployment of the para-glider
- ❑ Payload release is most likely to succeed.
- ❑ Easy for maintenance

Physical Layout (1/4)

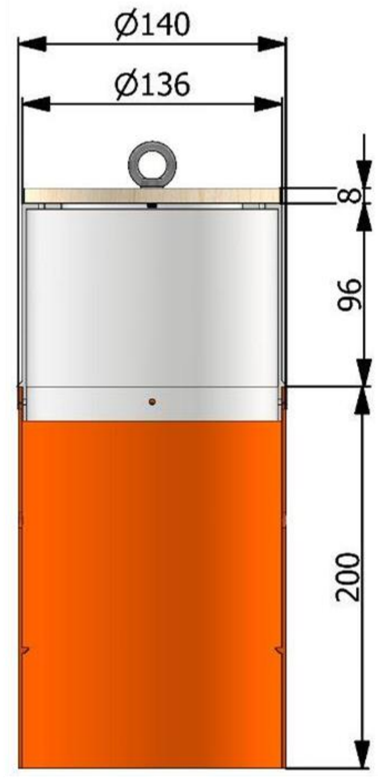
Payload Physical Layout



Chord Length



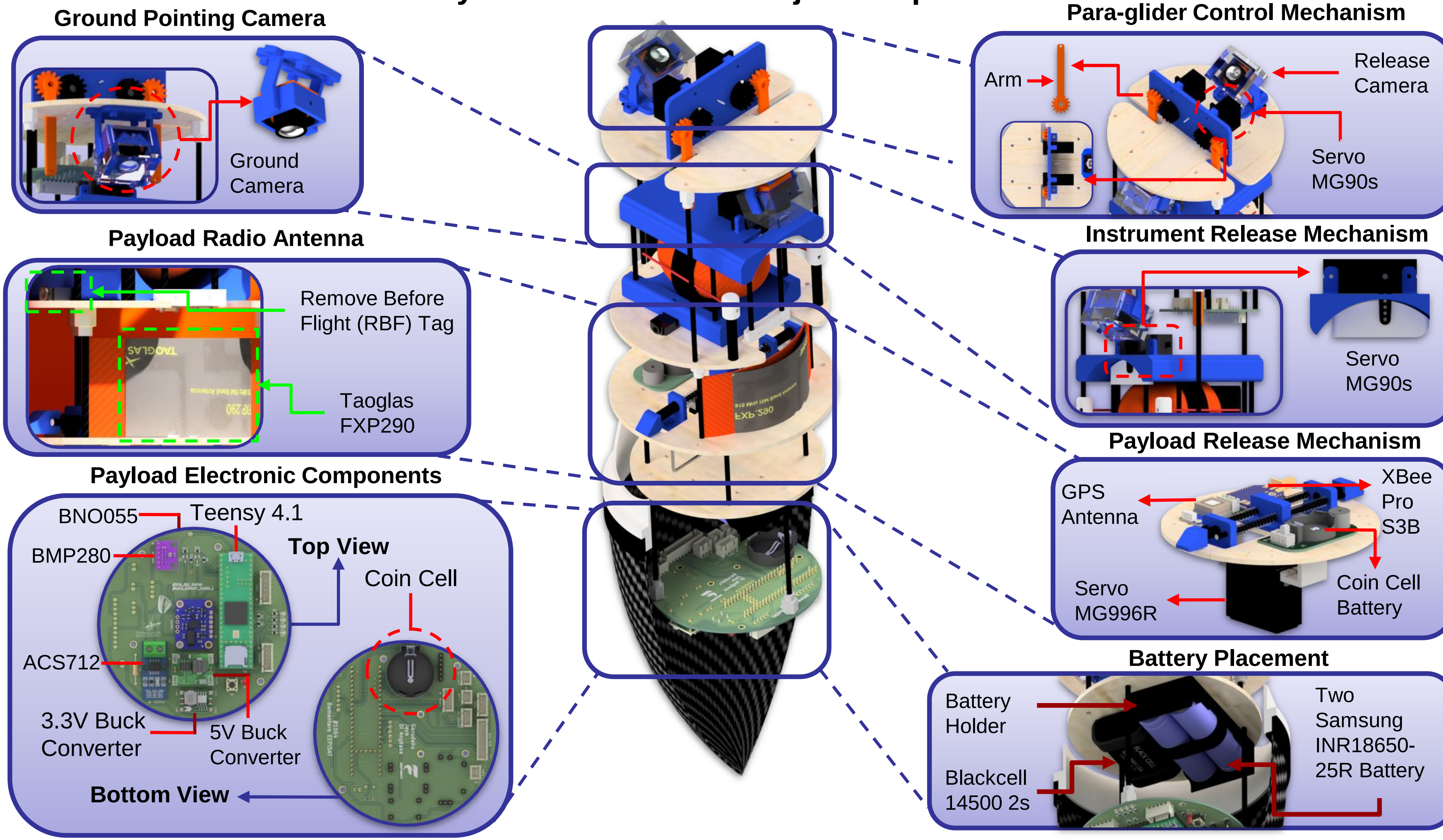
Container Physical Layout



- The dimension of container and payload using technical drawing in **CAD software.**
- All measurement units are in **mm.**

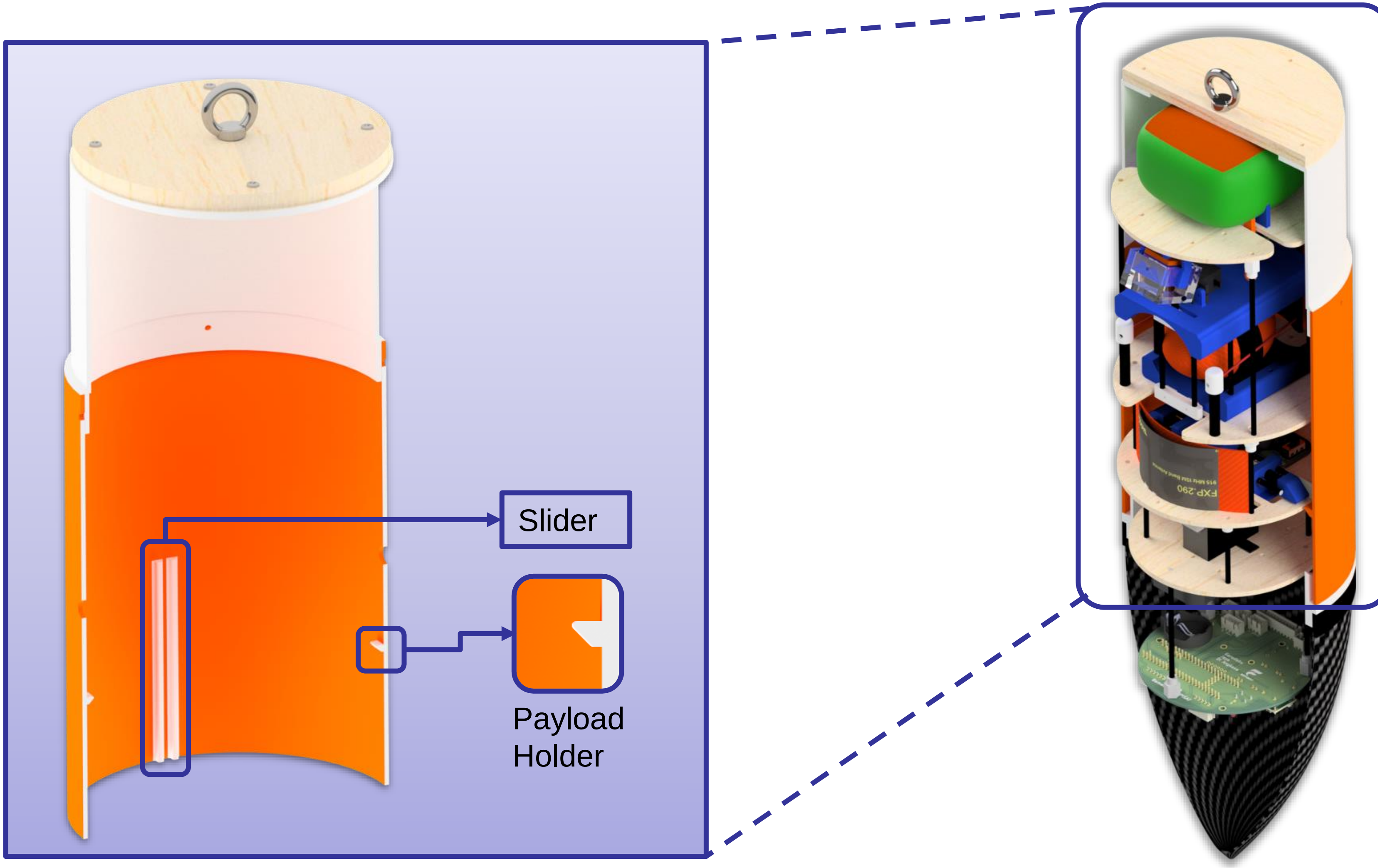
Physical Layout (2/4)

Payload Placement of Major Component



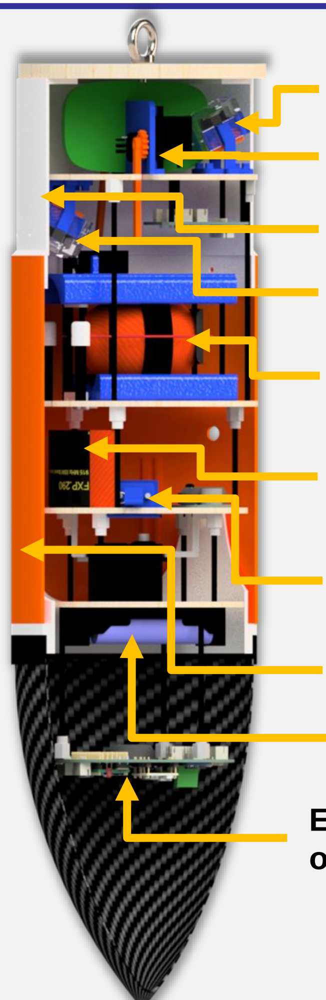
Physical Layout (3/4)

Container Placement of Major Component



Physical Layout (4/4)

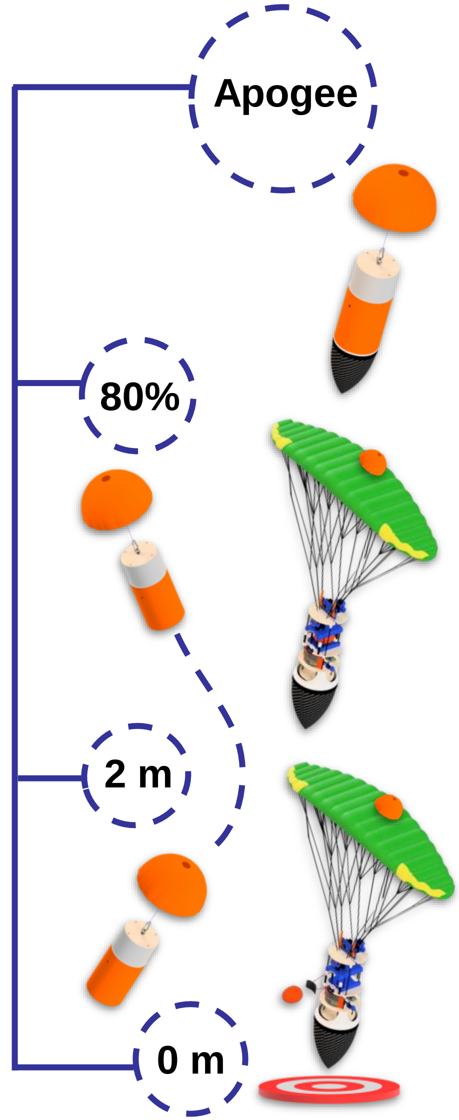
Payload Launch and Deployment Configuration



The CanSat will be inserted into the rocket body and the para-glider will be stowed inside the container, the para-glider is directly connected to the payload. The CanSat will be detached from the rocket body when the rocket ejection chute fires.

Once the CanSat separates from the rocket, the parachute will be deployed. Upon reaching 80% peak altitude, the payload release mechanism will be active to separate the payload from the container.

After the payload is separated from the container, the para-glider will be deployed using the force from the drogue-chute. After reaching 2 meters from ground, the payload will release the egg instrument safely.



System Concept of Operations (1/2)

Pre-Launch

- Arrive at the launch site.
- GCS and antenna setup.
- Sensor system calibration and communication with the GCS command.
- Final CanSat check completed.
- Activate and load the CanSat into a rocket.

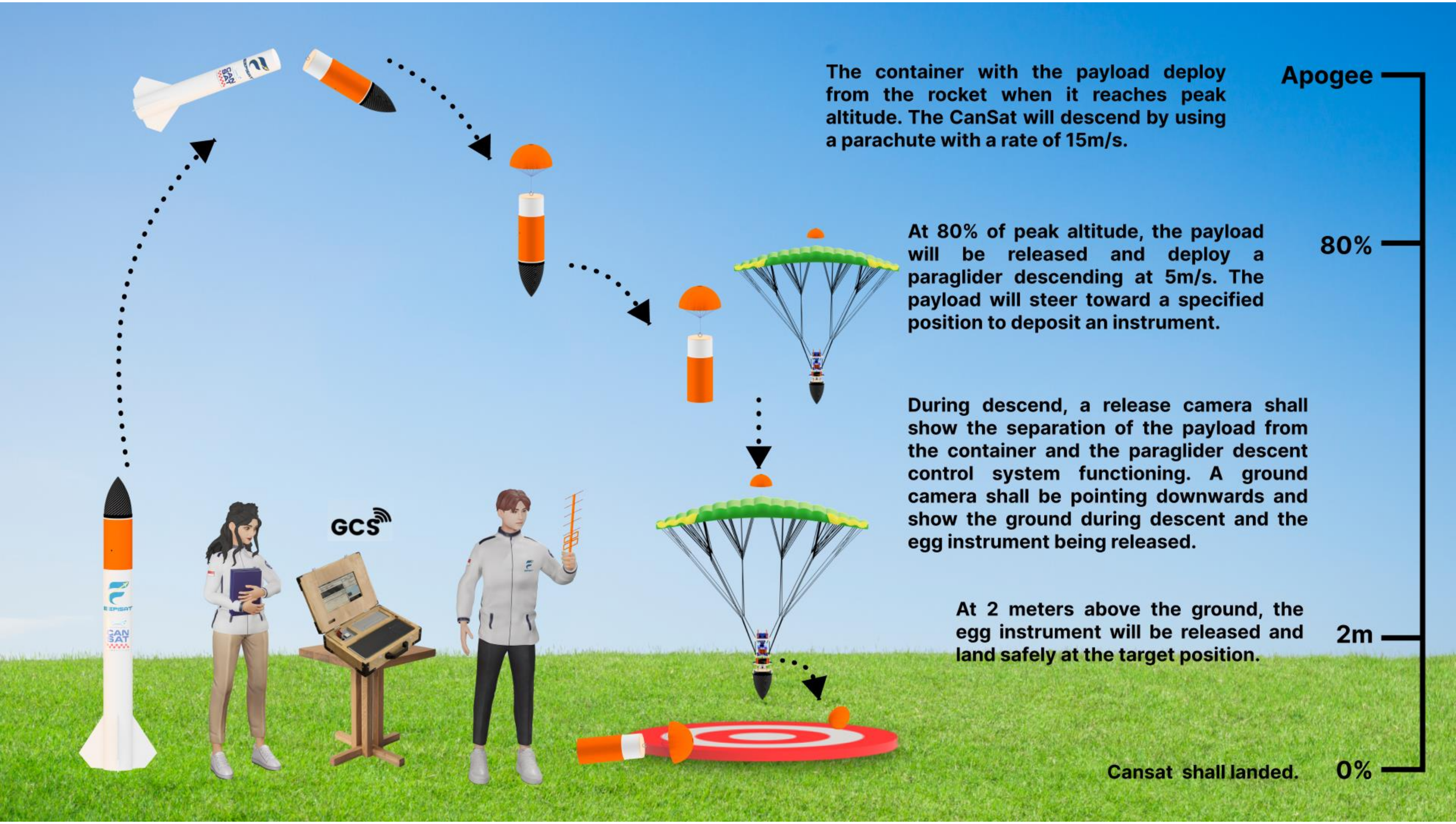
Launch

- The CanSat is mounted in a rocket.
- The CanSat is launched to a peak altitude.
- The container with the payload is deployed from the rocket using a parachute, with a descent rate of no more than 15 m/s.
- The release camera starts recording the separation of the payload from the container and the functioning of the para-glider control system.
- At 80% of peak altitude, the payload separates from the container and descends using a para-glider descent control system with a descent rate of 5 m/s.
- The ground video camera starts recording, pointing downward during descent to capture the release of the egg instrument.
- At 2 meters above the ground, the payload releases the egg instrument, which lands safely at the target location.
- The CanSat lands safely.

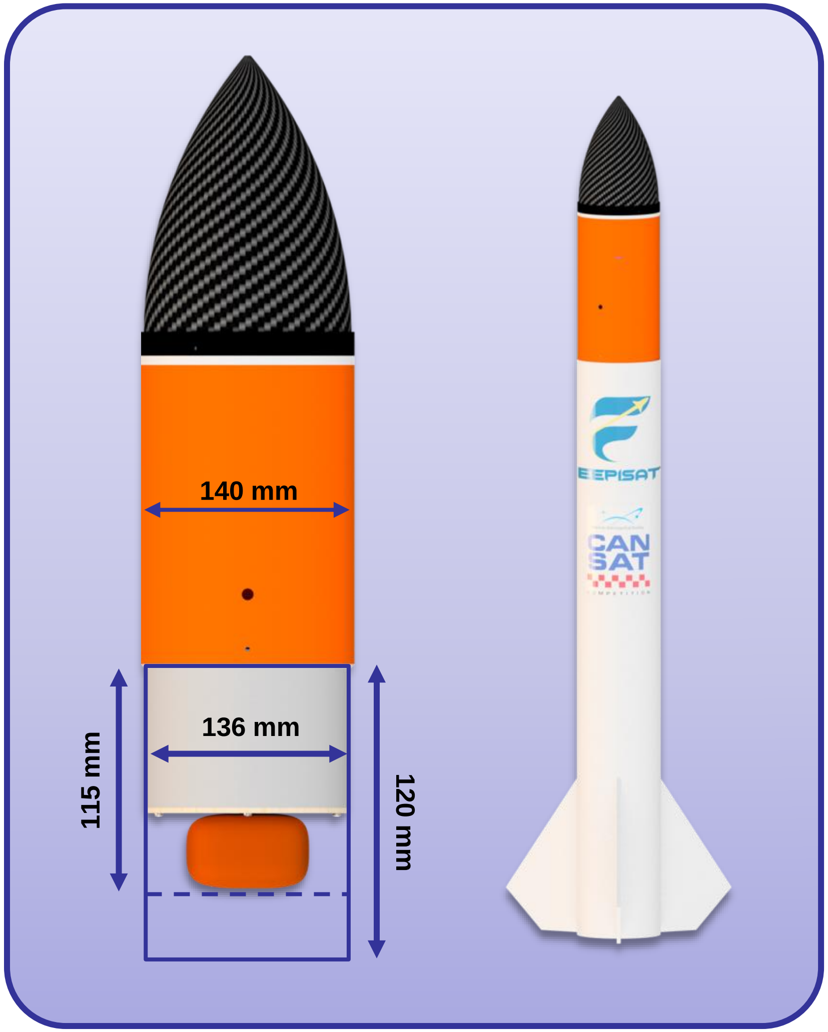
Post-Launch

- CanSat recovery by location from the last telemetry and buzzer.
- Inspection of CanSat damage.
- Take the SD card from the CanSat.
- Analyze data received.
- PFR preparation.

System Concept of Operations (2/2)



Launch Vehicle Compatibility



Dimension (Section)	Height (mm)	Diameter (mm)
Rocket (Requirement Dimensions)	120	136
CanSat	115	136

Information

1. The CanSat design was created in purpose to fit with the rocket.
2. The sharp part of CanSat was built to strengthen the durability
3. The rocket will not be used as a part of CanSat missions.

Sensor Subsystem Design

Ax’l Nurrahim

Sensor Subsystem Overview

Sensor Type	Selected Model	Function	Located In
Air Pressure	BMP280	Measuring air pressure of the CanSat	Payload
Air Temperature	BMP280	Measuring air temperature of the CanSat	Payload
Battery Voltage	ADC Voltage Divider	Measuring battery voltage of the CanSat	Payload
Current Battery	ACS712	Measuring current of the CanSat battery	Payload
GNSS	SAM-M10Q	Determining the position of the CanSat	Payload
Acceleration	BNO055	Tracking the acceleration of the CanSat	Payload
Rotation Rate	BNO055	Measuring the rotation rate of the CanSat	Payload
Release Camera	RunCam Split 2	Recording the separation of the payload from the container and the para-glider descent control system functioning.	Payload
Ground Camera	RunCam Split 2	Record the ground during descent and the instrument being released	Payload
Instrument Release	BMP280	Measuring the distance from the payload to the ground	Payload

Payload Air Pressure Sensor Trade & Selection

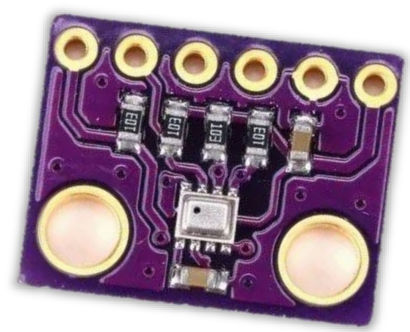
Model	Interface	Pressure Resolution [hPa]	Operating Voltage [V]	Consumption Current [µA]	Pressure Range [hPa]	Mass [g]	Size[1] [mm]	Price[2] [USD]
BMP280	I2C/SPI	0.016	1.71 ~ 3.6	2.7	300 ~ 1100	4.8	15.5 x 12.1 x 2.5	0.42
BMP085	I2C	0.01	1.8 ~ 3.6	3	300 ~ 1100	1	15.7 x 20.3 x 2	11.87
MPL115A2	I2C	1.5	2.5 ~ 5.5	6	500 ~ 1500	0.61	19.2 x 17.9 x 2.9	7.95

Selected Air Pressure Sensor : **BMP280** ✓

BOSCH

Reasons:

- **Low power consumption**
- **Low cost**
- Compact form factor
- High relative accuracy



1. Size of our sensor is in the form of a module.
2. Price references are obtained from local stores.

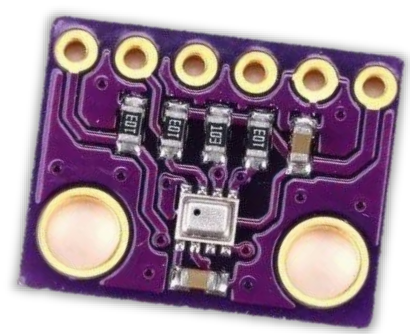
Payload Air Temperature Sensor Trade & Selection

Model	Interface	Temperature Resolution [C]	Operating Voltage [V]	Operating Current [μA]	Temperature Range [°C]	Mass [g]	Size[1] [mm]	Price[2] [USD]
BMP280	I2C/SPI	0.01	1.71 ~ 3.6	2.7	-40 ~ 85	4.8	15.5 x 12.1 x 2.5	0.42
BMP085	I2C	0.1	1.8 ~ 3.6	3	-40 ~ 85	1	15.7 x 20.3 x 2	11.87
MPL115A2	I2C	0.15	2.3 ~ 5.5	6	-40 ~ 105	0.61	19.2 x 17.9 x 2.9	7.95

Selected Air Temperature Sensor : **BMP280** ✓

BOSCH

Reasons:
- **Lightweight**
- **Highest data resolution**
- Wide temperature range data



1. Size of our sensor is in the form of a module.
2. Price references are obtained from local stores.

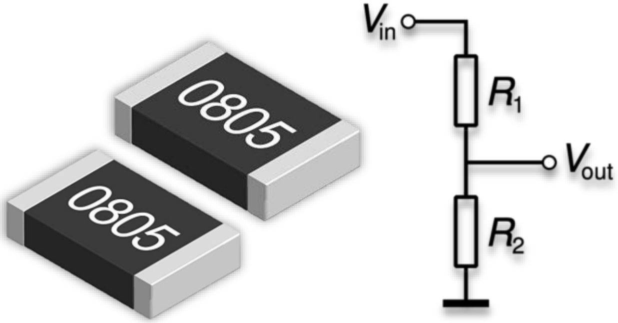
Payload Battery Voltage and Current Sensor Trade & Selection (1/2)

Model	Interface	Resolution [bits]	Operating Voltage [V]	Voltage Range [V]	Mass[1] [g]	Size [mm]	Price[2] [USD]
ADC Pin + Voltage Divider	ADC	12	3.3	0 ~ 9.9	NGL	2 x 2 x 1	0.012
Adafruit INA260	I2C	16	3 ~ 5	0 ~ 36	2	21.9 x 18 x 2.7	15.77
INA219	I2C	12	3 ~ 5	0 ~ 26	2	22.5 x 22.3 x 2	0.95

Selected Battery Voltage Sensor : **ADC Pin + Voltage Divider** (20kΩ + 10kΩ) ✓

Reasons:

- **Simple and cheap (*SMD resistor*)**
- **Minimize board size and design**
- Can use various combination of resistor
- Low Cost



1. Mass is negligible because it is below the fraction of a single gram
2. Price references are obtained from local stores.

Payload Battery Voltage and Current Sensor Trade & Selection (2/2)

Model	Interface	Measurement Methode[1]	Resolution	Operating Voltage [V]	Maximum Current Measure [A]	Mass [g]	Size[2] [mm]	Price[3] [USD]
ACS712	ADC	Hall effect current sensing	Depends on ADC	4.5 ~ 5.5	5	4	31 x 13 x 2	0.69
INA169	ADC	High-side current sensing	Depends on ADC	2.7 ~ 60	±5	5	25.4 x 25.4 x 2	3.19
INA219	I2C	High-side current sensing	12 Bits	3 ~ 5.5	±3.2	5	22.5 x 22.3 x 2	0.95

Selected Current Battery Sensor : **ACS712** ✓

Reasons:

- **Highest maximum current measure**
- Compact design
- Lightweight
- Low cost

1. The INA169 and INA219 modules require a 0.1 Ω shunt resistor.
2. Size of our sensor is in the form of a module.
3. Price references are obtained from local stores.

Payload GNSS Sensor Trade & Selection

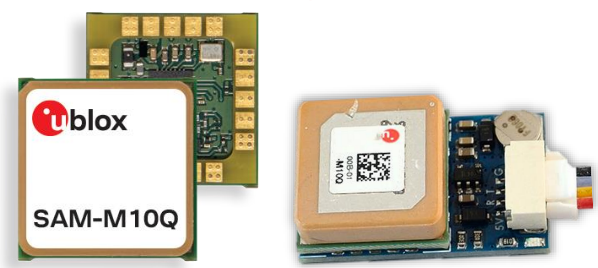
Model	Interface	Rate [Hz]	Resolution Accuracy [m]	Operating Voltage [V]	Operating Current [mA]	Mass [g]	Size [mm]	Price[1] [USD]
SAM – M10Q	UART	1 ~ 25	1.5	3.3 ~ 5	12	10	26 x 16 x 8	28.25
Ublox Neo-M8M	UART	1 ~ 10	2.5	3 ~ 5.5	17	6	18 x 18 x 6	10.82
Ublox Neo-M6	UART	1 ~ 5	2.5	3 ~ 5.5	45	8	22 x 20 x 7	3.23

Selected GNSS Sensor : **SAM – M10Q** ✓

Reasons:

- **Highest update rate**
- **Quad-constellation GNSS tracking**
- **High accuracy**
- Compact form factor

ublox



1. Price references are obtained from local stores.

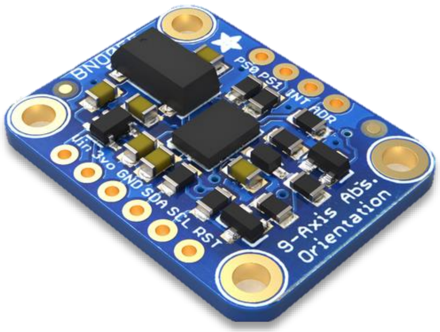
Payload Acceleration Sensor Trade & Selection

Model	Interface	Resolution [bits]	Operating Voltage [V]	Operating Current [mA]	DoF [Axis]	Mass [g]	Size[1] [mm]	Price[2] [USD]
BNO055	I2C	16	3.3 ~ 5	12.3	9	3	26.8 x 20.3 x 2.7	48.77
BNO080	I2C	16	2.4 ~ 3.6	7.5	9	2	26 x 15 x 2	20.91
MPU9250	I2C	16	3.3 ~ 5	10	9	3.5	20 x 15 x 2.8	11.12

Selected Acceleration Sensor : **BNO055** ✓

Reasons:

- **Direct absolute orientation output**
- **Onboard hardware sensor fusion**
- Provide comprehensive data
- High data resolution



1. Size of our sensor is in the form of a module.
2. Price references are obtained from local stores.

Payload Rotation Rate Sensor Trade & Selection

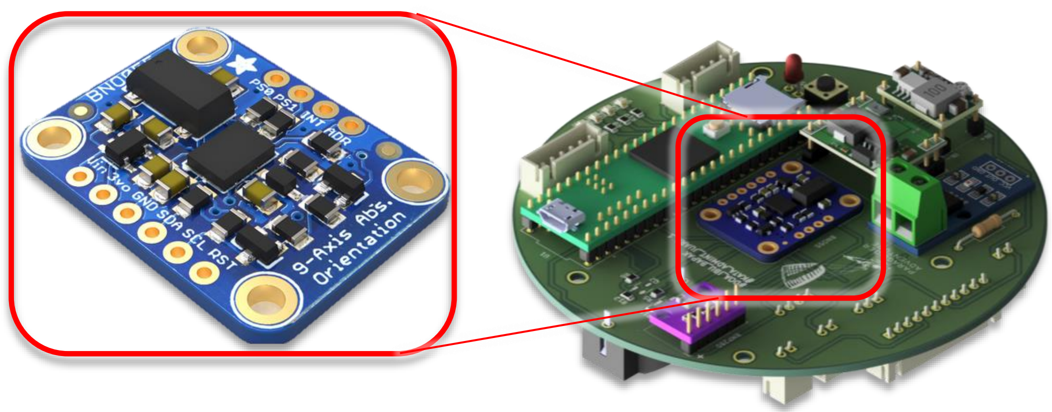
Model	Interface	Resolution [bits]	Operating Voltage [V]	Operating Current [mA]	DoF [Axis]	Mass [g]	Size[1] [mm]	Price[2] [USD]
BNO055	I2C	16	3.3 ~ 5	12.3	9	3	26.8 x 20.3 x 2.7	48.77
BNO080	I2C	16	2.4 ~ 3.6	7.5	9	2	26 x 15 x 2	20.91
MPU9250	I2C	16	3.3 ~ 5	10	9	3.5	20 x 15 x 2.8	11.12

Selected Rotation Rate Sensor : **BNO055** ✓

adafruit

Reasons:

- **Low operating current**
- Lightweight
- Experienced using this sensor



1. Size of our sensor is in the form of a module.
2. Price references are obtained from local stores.

Payload Release Camera Trade & Selection

Model	Interface	Resolution [Pixels]	Operating Voltage [V]	Frame Rate [Hz]	Mass [g]	Size[1] [mm]	Price[2] [USD]
RunCam Split 2	UART/Digital	1920 x 1080	5 ~ 15	60	18	36 x 38 x 27.4	69.90
EYD A10	Digital	1920 x 1080	3.3 ~ 5	30	4.1	10 x 6 x4	20.12
Quelima SQ11	Digital	1280 x 720	3.3 ~ 5	30	15	23 x 23 x 23	15.03

Selected Payload Release Camera : **RunCam Split 2** ✓

Reasons:

- **Critical power-loss protection**
- **High video resolution**
- Integrated DVR System

1. Size of our camera is measured from the entire module.
2. Price references are obtained from local stores.

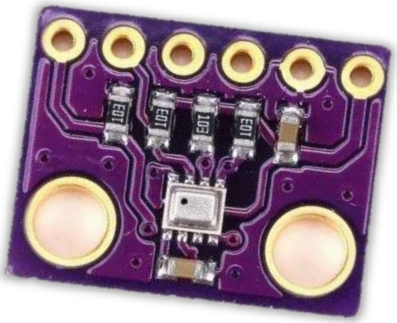
Instrument Release Sensor Trade & Selection

Model	Interface	Measurement Method	Resolution	Operating Voltage [V]	Current Consumption [mA]	Mass [g]	Size[1] [mm]	Price[2] [USD]
BMP280	I2C/SPI	Convert from pressure	0.016 hPa	1.71 ~ 3.6	0.0027	4.8	15.5 x 12.1 x 2.5	0.42
VL53L1X	I2C	Infrared laser	1 mm	2.5 ~ 3.5	18	2.2	20 x 15 x 4	5.33
HC-SR04	GPIO	Ultrasonic frequency	3 mm	3.3 ~ 5	15	9	45 x 20 x 15	1.01

Selected Instrument Release Sensor : **BMP280** ✓ BOSCH

Reasons:

- **More stable and minimally affected by external environmental interference.**
- **Same as temperature and pressure so no need extra module**
- Lowest current consumption



1. Size of our sensor is in the form of a module.
2. Price references are obtained from local stores.

Ground Camera Trade & Selection

Model	Interface	Resolution [Pixels]	Operating Voltage [V]	Frame Rate [Hz]	Mass [g]	Size[1] [mm]	Price[2] [USD]
RunCam Split 2	UART/Digital	1920 x 1080	5 ~ 15	60	18	36 x 38 x 27.4	69.90
EYD A10	Digital	1920 x 1080	3.3 ~ 5	30	4.1	10 x 6 x4	20.12
Quelima SQ11	Digital	1280 x 720	3.3 ~ 5	30	15	23 x 23 x 23	15.03

Selected Ground Camera : **RunCam Split 2** ✓

Reasons:

- **Auto record and auto save video feature**
- **High frame rate video**
- Support access video record using cable

1. Size of our camera is measured from the entire module.
2. Price references are obtained from local stores.

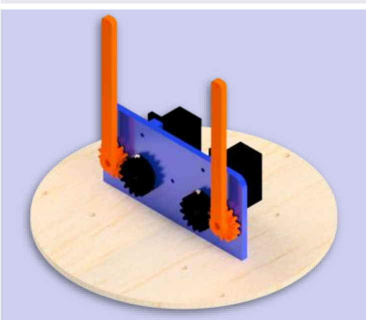
Descent Control Design

Muhammad Rizky

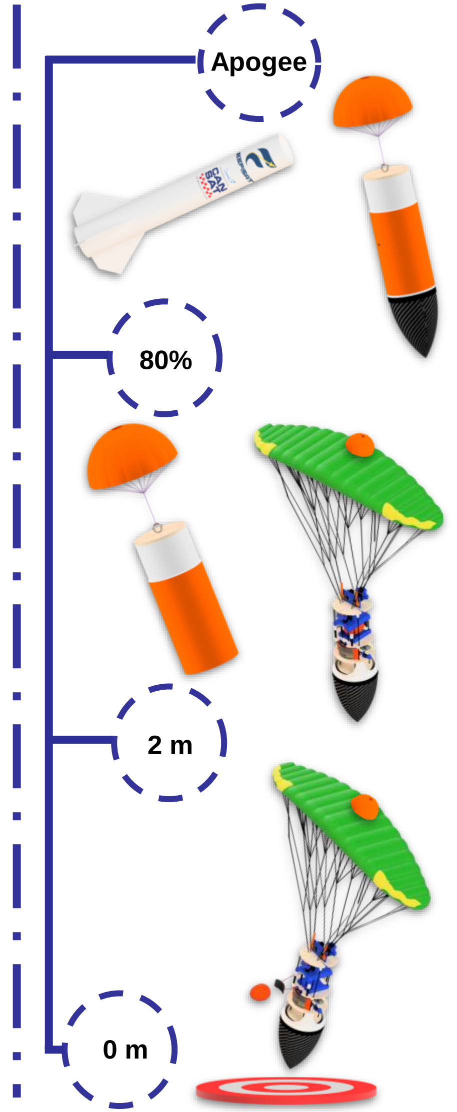
Descent Control Overview

The container has a cylindrical shape with a size of 200 mm and a width of 140 mm. The container is made of Easy ABS and balsa composite. The container consists of two parts, the shoulder and the container's body.

The selected type of the CanSat parachute is a round parachute. The diameter of the CanSat parachute is 265 mm. The parachute is made of ripstop nylon. It has one spill hole as stabilizer with diameter 26.5 mm.



The para-glider uses active control for the maneuver system with 2 servos which will control the movement to the right or left.



The container with the payload shall deploy from the rocket when the rocket reaches apogee and the rocket motor ejection forces a separation. The container with the payload shall descend at a rate of 15 m/s using a parachute that automatically deploys at separation.

At 80% of apogee, the payload shall separate from the container and descend using a para-glider descent control system and make the descent rate of 5 m/s until landing.

The payload must head for the landing pad. At a height of 2 meters from the ground, the payload must safely release the instrument containing the eggs.

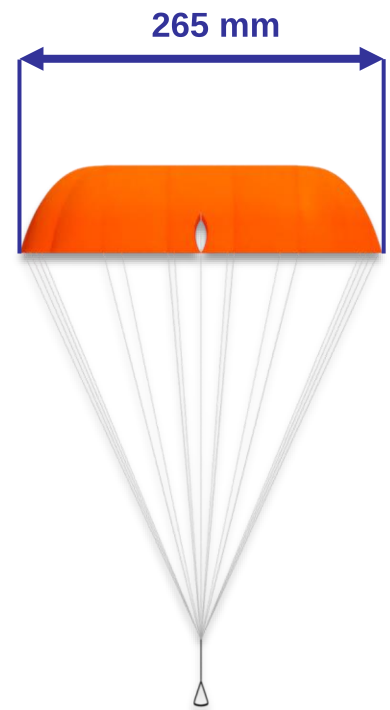
Strategy A

Information

The rounded design of the parachute ensures smoother deployment, minimizing the risk of operational failure. The round parachute is equipped with a spill hole to enhance stability and maintain a downward trajectory towards the nadir point. The integration of these features makes the parachute system provide excellent reliability and performance.

Container Parachute Descent Control Strategy Selection and Trade (2/4)

Strategy B



Information

Square parachute can descend smoothly with high stability and minimal oscillation, achieved through a well-engineered parachute design that prevents swaying after full inflation, while the integrated sleeve system reduces opening shock and enhances overall reliability and consistent performance.

Container Parachute Descent Control Strategy Selection and Trade (3/4)

Selection

Strategy A ✓

Round Parachute with Spill Hole

Strategy B

Square Parachute

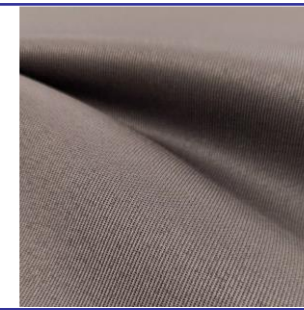
Selected : Strategy A

Reasons
It allows for easy modification of the descent rate. The attachment of the parachute to the container will add a carabiner, this makes the process of attaching the parachute easier. The spill hole serves to prevent excessive spinning of the parachute during descent.

Selection

Selected: Ripstop Nylon ✓



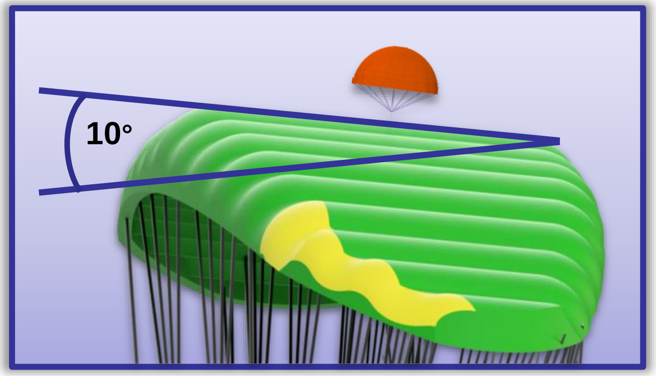


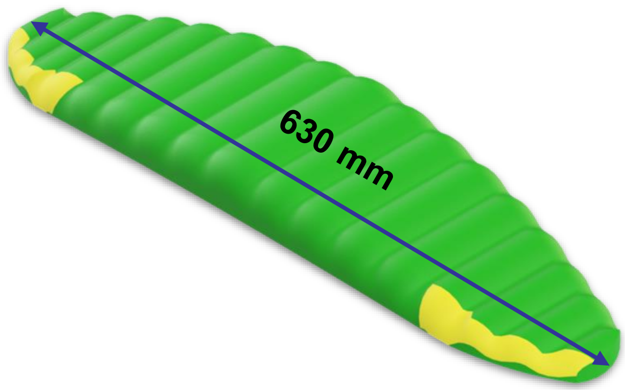
Ripstop Nylon		Cordura		Polyurethane-Coated Polyester	
PROS	**CONS**	**PROS**	**CONS**	**PROS**	**CONS**
More durable	Expensive	Higher tensile strength	Expensive	Cost effective	Heavier
Affordable					Lower breathability
Low moisture absorbency	Difficult to stitch	Abrasion resistant	Heavier	Water resistant	
Lightweight					Lower tensile strength
High strength					

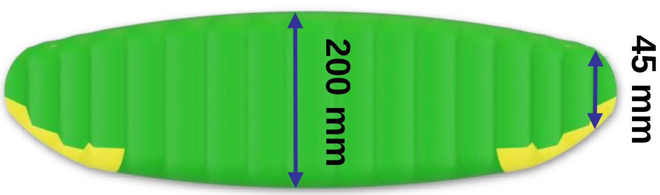
Payload Steering Control Strategy Selection and Trade (1/3)

Strategy A

Folded Position







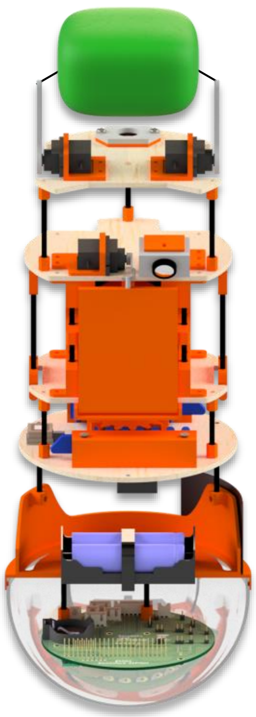
Information

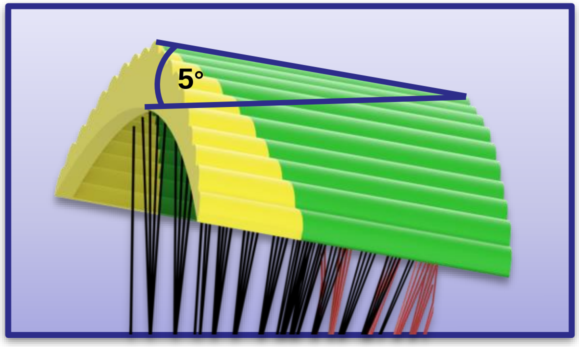
- The stowing position uses the inner body of container
- Low–mid aspect ratio semi-elliptical ram-air para-glider with 10° AoA
- The para-glider will be deployed using a drogue-chute

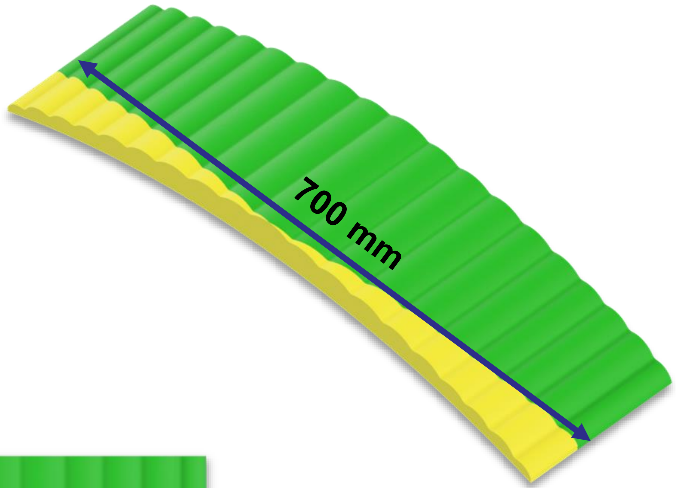
Payload Steering Control Strategy Selection and Trade (2/3)

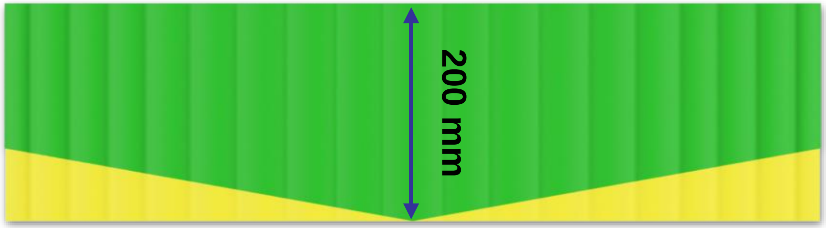
Strategy B

Folded Position









Information

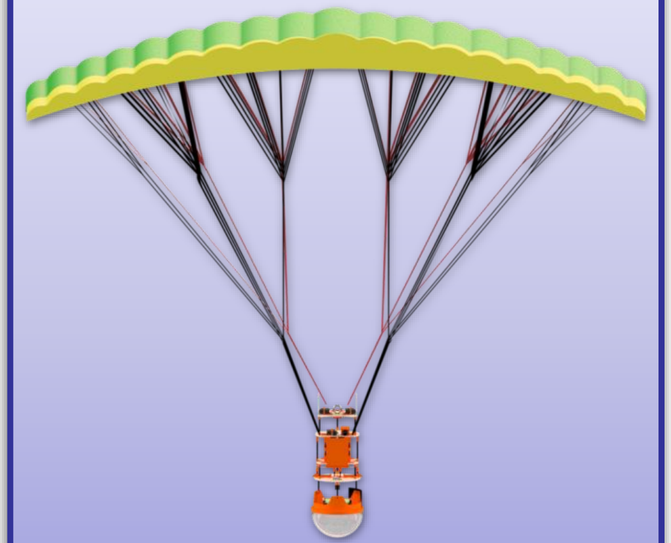
- The stowing position uses the inner body of container
- Low aspect ratio rectangular para-glider 5° AoA
- The para-glider will be passively deployed

Payload Steering Control Strategy Selection and Trade (3/3)

Selection

Strategy A ✓

Strategy B



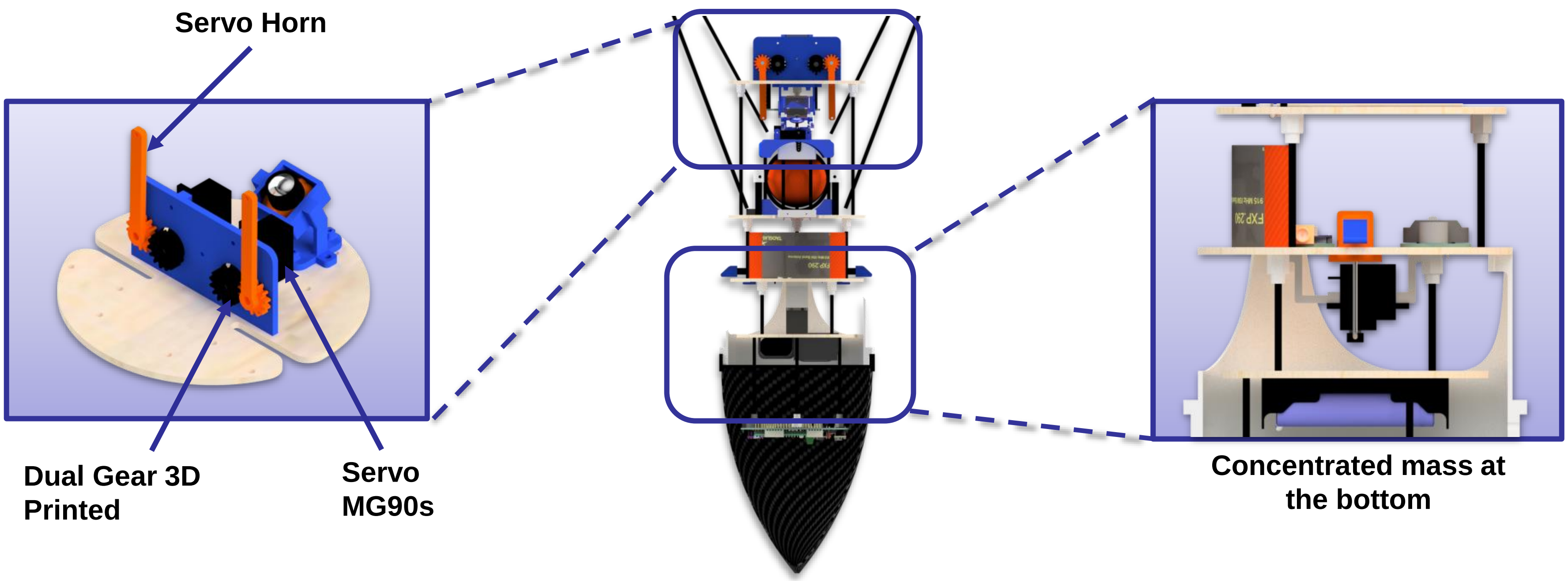
Selected: Strategy A

Reason

1. Easy to manufacture
2. Rapid inflation
3. High stability

Para-Glider Descent Speed Control Strategy Selection and Trade (1/3)

Strategy A



Information

Type of Stability: Passive Control

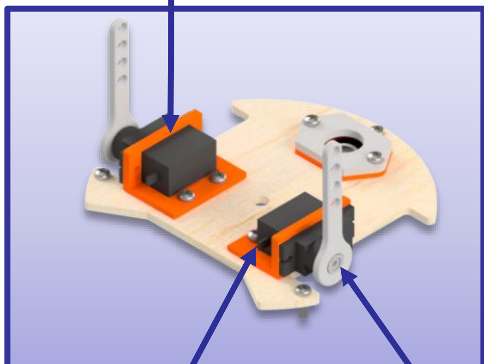
Description:

The para-glider will use a drogue-chute as a passive mechanism to support the deployment of para-glider. The para-glider design to get high stability and high coefficient lift. The payload will maintain the nadir and prevent it from swaying by the focused mass at the bottom.

Para-Glider Descent Speed Control Strategy Selection and Trade (2/3)

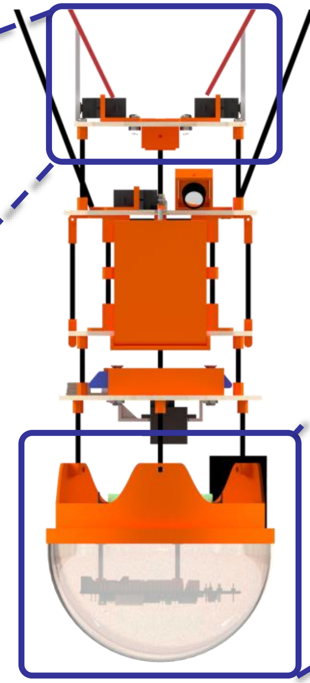
Strategy B

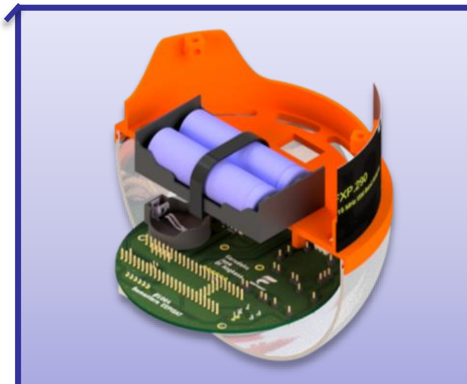
Servo MG90s



Servo 3D Printed Bracket

Servo Horn





Concentrated mass at the bottom

Information

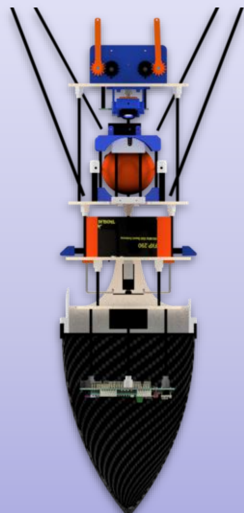
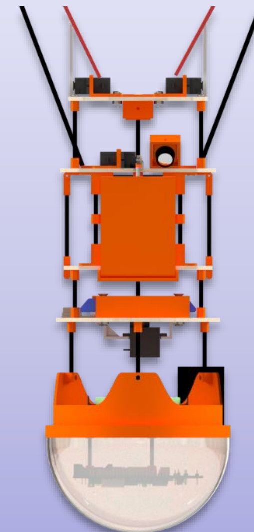
Type of Stability: Passive Control

Description:

The para-glider will use wind pressure as a passive mechanism to deploy the para-glider. The para-glider design to get high lift to drag ratio. The payload will maintain the nadir and prevent it from swaying by the focused mass at the bottom.

Para-Glider Descent Speed Control Strategy Selection and Trade (3/3)

Selection

Strategy A ✓	Strategy B
	

Selected: Strategy A

Reasons
1. More stable descent 2. Higher lift coefficient 3. Smooth maneuver

Descent Rate Estimates (1/5)

The descent rate of each descent phase will be estimated using different parameters	
	
CanSat Parachute	**Payload Para-glider**
Parameters: • Diameter of Parachute *(Dp)* • Diameter of spill hole *(Dsh)*	Parameters: • Span Area (*S*) • Angle of Attack (*AoA*) • Chord Length Average (*cavg*)
Requirement: Descent rate shall be 15 m/s ($\pm$ 3 m/s)	Requirement: Descent rate 5 m/s ($\pm$ 3 m/s)

Descent Rate Estimates (2/5)

CanSat Parachute

We will use the descent velocity with range between minimum [V min = 12 m/s] and maximum [V max = 18 m/s] to determine the parachute radius.

$$\sqrt{\frac{8 \times m \times g}{\rho \times (v_{min})^2 \times \pi \times Cd}} \leq Dp \leq \sqrt{\frac{8 \times m \times g}{\rho \times (v_{max})^2 \times \pi \times Cd}}$$

$$\sqrt{\frac{8 \times 1 \times 9.8}{1.225 \times (12)^2 \times 3.14 \times 1.28}} \leq Dp \leq \sqrt{\frac{8 \times 1 \times 9.8}{1.225 \times (18)^2 \times 3.14 \times 1.28}}$$

$$0.33 \leq Dp \leq 0.22$$

Information:

$Dp = The\ diameter\ of\ the\ parachute\ \ (m)$

$v = Descent\ speed\ (m/s)$

$\pi = 3.14$

$g = gravitational\ acceleration\ (9.8\ m/s^2)$

$Dsh = Spill\ hole\ and\ side\ holes\ diameter\ (m)$

***Assumption**

$* Cd = 1.28\ (Drag\ coefficient\ of\ parachute)$

$* m = 1\ kg\ (CanSat)$

$* \rho = air\ density\ (1.225\ kg/m^3)$

Chosen Diameter	Chosen Radius
0.265 m	**0.132 m**

Diameter of the spill hole and side holes is chosen to be 10% of the diameter of parachute

Diameter of spill hole = $Dsh = Dp \times 10\%$ = **0.0265 m**

Spill hole radius = $\frac{Dsh}{2}$ = **0.0132 m**

Payload Para-glider

We will use the descent velocity at 5.78 m/s to determine the descent speed.

$$V = \sqrt{\frac{2W}{\rho S \times CL} \times \arctan\frac{1}{G}}$$

$$V = \sqrt{\frac{2\times 6.867}{1.225\times 0.077175\times 0.45} \times \arctan\frac{1}{3}}$$

$$V = 5.78\ m/s$$

$$G = \frac{CL}{CD} = \frac{0.45}{0.15}$$

$$S = b \times cavg$$

$$S = 0.63 \times 0.115$$

$$S = 0.077175$$

Information:

G = Lift to Drag Ratio

CD = Coefficient Drag

W = Weight

V = Descent Speed $\left(\frac{m}{s}\right)$

S = Span Area (m^2)

***Assumption**

* $CL = 0.45$ (Coefficient lift para-glider with 10° AoA)
* $m = 0.7\ kg$ (payload)
* ρ = air density $(1.225\ kg/m^3)$

Descent Rate Estimates (4/5)

Information
Container mass : **299.6 g** Payload mass : **700.6 g** **Total CanSat mass: 1,000.2 g**

Payload Para-glider Descent Rate	Container Parachute Descent Rate
$v = \sqrt{\frac{2W}{\rho S \times CL}} \times \arctan\frac{1}{G}$	$v = \sqrt{\frac{8 \times m \times g}{\rho \times (Dp)^2 \times \pi \times Cd}}$
$v = \sqrt{\frac{2 \times 6.867}{1.225 \times 0.077175 \times 0.45}} \times \arctan\frac{1}{3}$	$v = \sqrt{\frac{8 \times (1) \times (9.8)}{1.225 \times (0.265)^2 \times (3.14) \times (1.28)}}$
$v = 5.78\ m/s$	$v = 15.05\ m/s$
	

Descent Rate Estimates (5/5)

Final Result

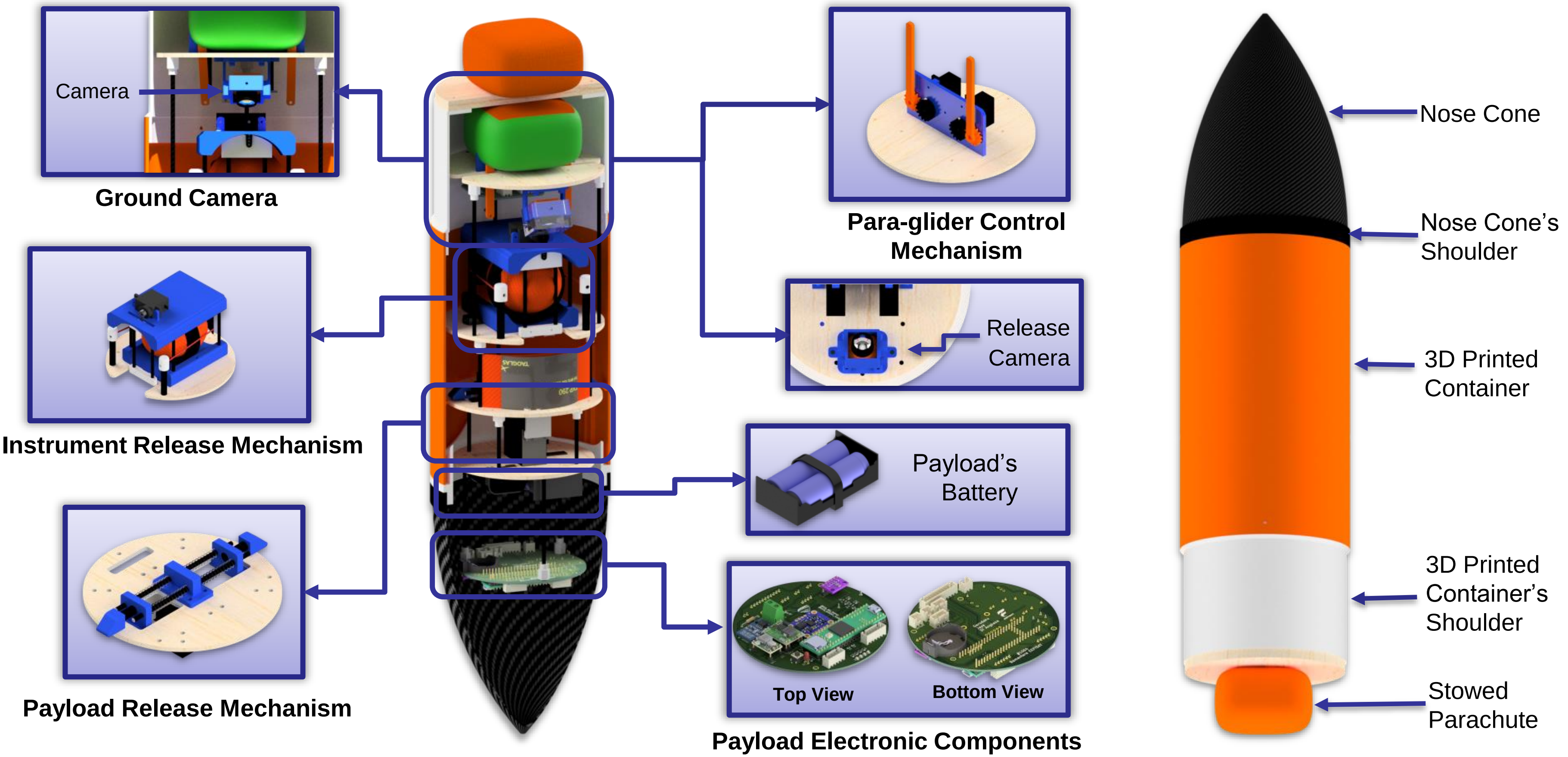
Parachute and Para-glider Summary	
Altitude	**The descent rate each descent phase will be estimated using parameters**
Peak Altitude	Type parachute: **Round parachute** The diameter of parachute: **0.265 m** The descent speed: $\mathbf{15.05\ m/s}$
80%	Type parachute: **Para-glider** The wing span of parachute: **0.63 m** The descent speed: $\mathbf{5.78\ m/s}$

CanSat Summary
The CanSat para-glider uses active control of two servos. The focus of mass is in the bottom of the CanSat to keep the stability and prevent from swaying.

Mechanical Subsystem Design

Muhammad Rizky

Mechanical Subsystem Overview

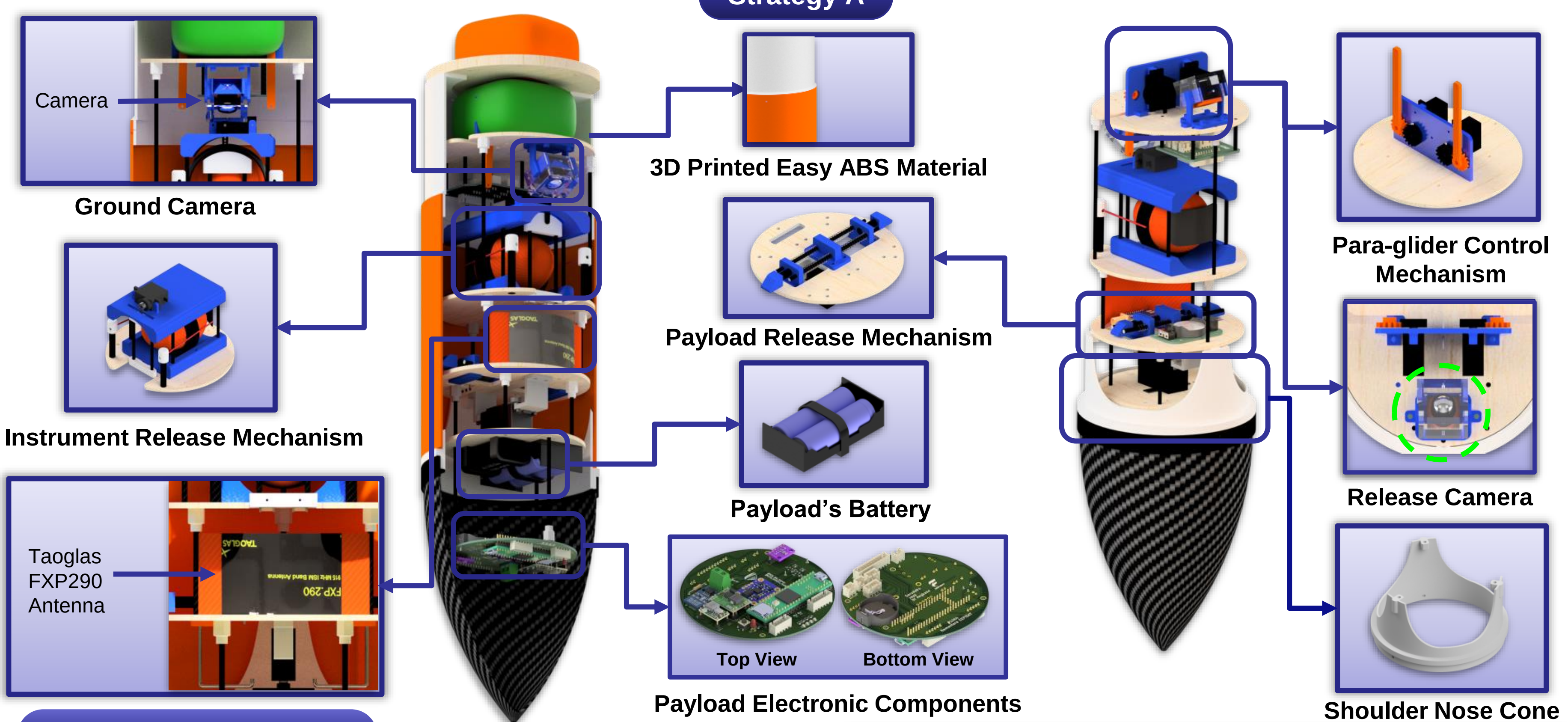


Information

Material: Easy ABS, Balsa Composite, Carbon Fiber
Parachute: Ripstop Nylon
Note: The para-glider will be deployed by a passive mechanism.

CanSat Mechanical Layout of Components Trade & Selection (1/4)

Strategy A



Pros

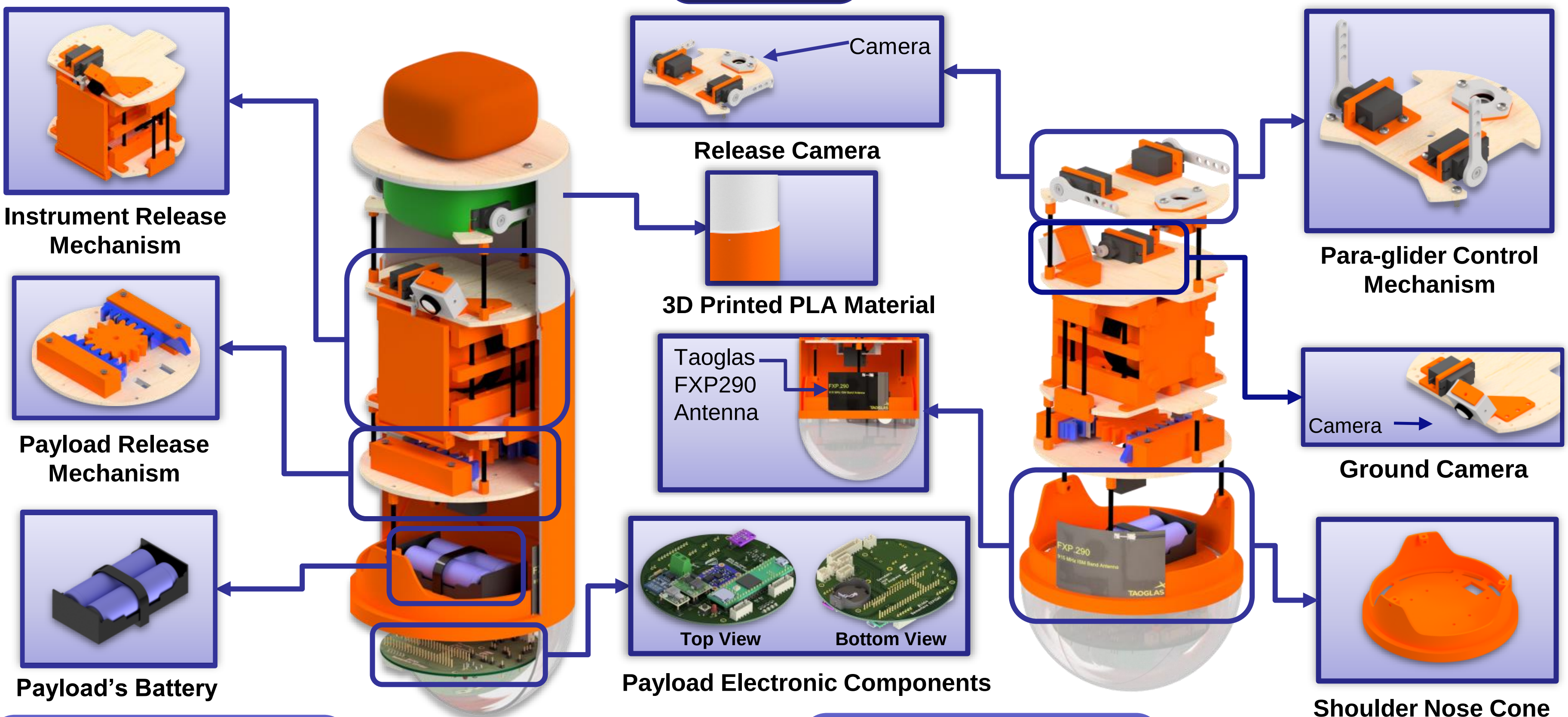
1. Easy to assembly
2. Low drag coefficient
3. Easy to maintenance

Cons

1. Hard to manufacture
2. More expensive

CanSat Mechanical Layout of Components Trade & Selection (2/4)

Strategy B



Pros

1. Easy to manufacture
2. Affordable

Cons

1. High drag coefficient
2. Fragile
3. More complex mechanism

Selection

Strategy A ✓

Strategy B

Selected: **Strategy A**

Reasons

1. Easy to assemble
2. Low drag coefficient
3. Easy to maintain

CanSat Mechanical Layout of Components Trade & Selection (4/4)

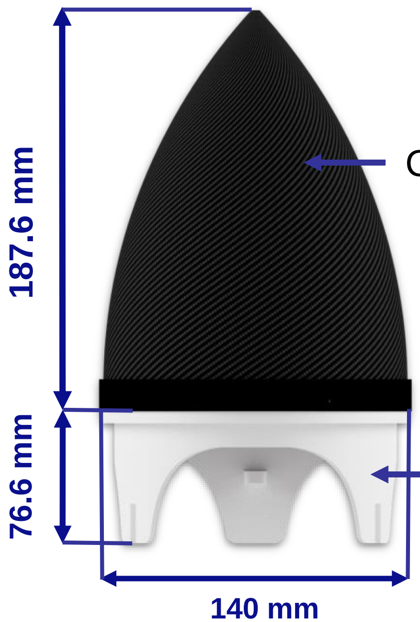
CanSat Material Trade Selection

Part	Material	Density (kg/m^3)	Durability (MPa)	Cost ($)
CanSat Frame	Balsa Composite	410.2	5.4	2.30
	Polycarbonate	1200	75	2.45
Para-glider	Ripstop Nylon	1140	126.72	1.39
	Aramid Fiber	1440	53.01	1.11
Nose Cone	Carbon Composite	1550	470	11.20
	Acrylic	1180	65	4.20
Parachute	Cordura	1440	53.01	1.11
	Ripstop Nylon	1140	126.72	1.39
	Polyurethane-Coated Polyester	970	50	0.98
Container	PETG	1270	52.2	11.65
	Easy ABS	1040	48	13.10

Selected Material	CanSat Frame: **Balsa Composite**	Para-glider: **Ripstop Nylon**	Nose Cone: **Carbon Fiber**	Parachute: **Ripstop Nylon**	Container: **Easy ABS**
Reasons	• Lightweight • Cheap	• Affordable • Lightweight	• High durability • Lightweight	• High strength • Affordable	• Lightweight • High resistance

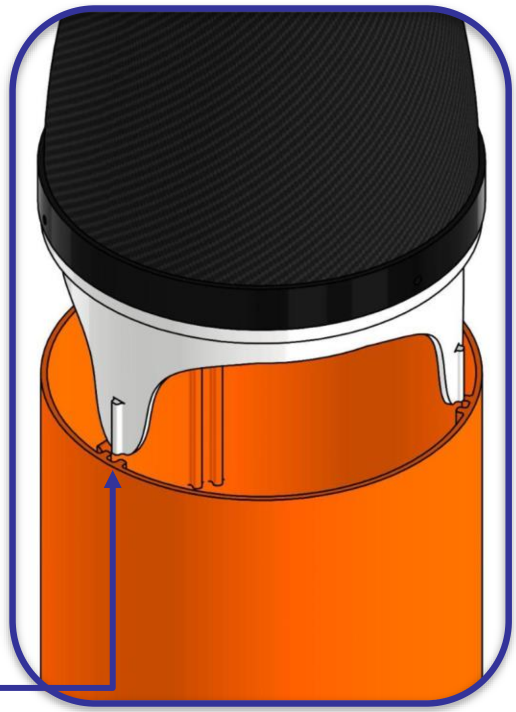
Nose Cone Design Trade & Selection (1/3)

Strategy A - Tangent Ogive Nose Cone

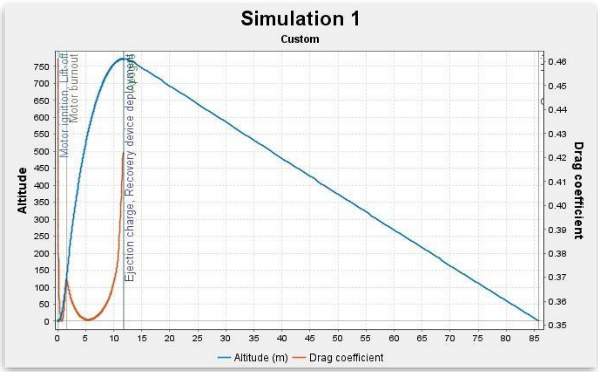


Carbon Material

3D Printed Shoulder Nose Cone



Support Slider



Average Coefficient Drag = 0.3646

Source : openrocket simulation

Pros

1. Lightweight
2. Easy to maintenance
3. Low drag coefficient

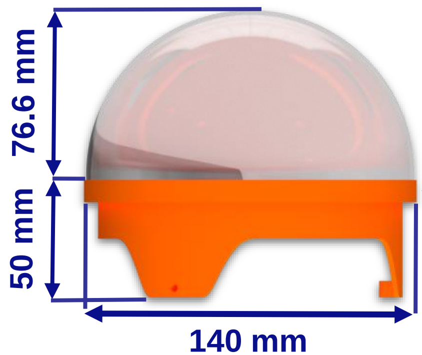
Cons

1. High cost
2. Hard to manufacture

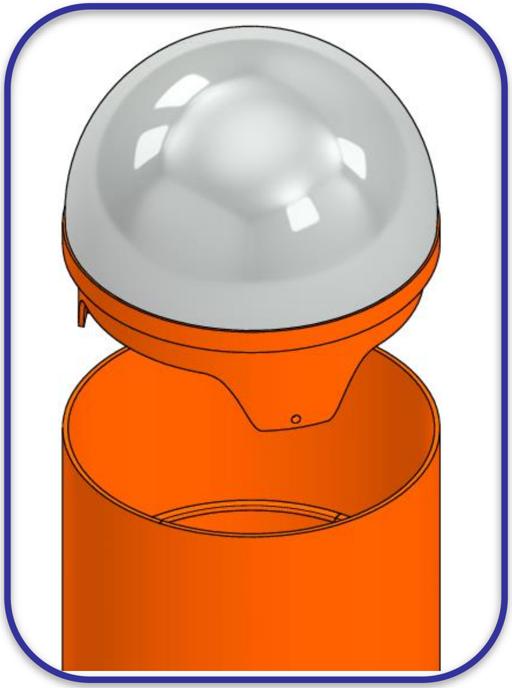
Nose Cone Design Trade & Selection (2/3)

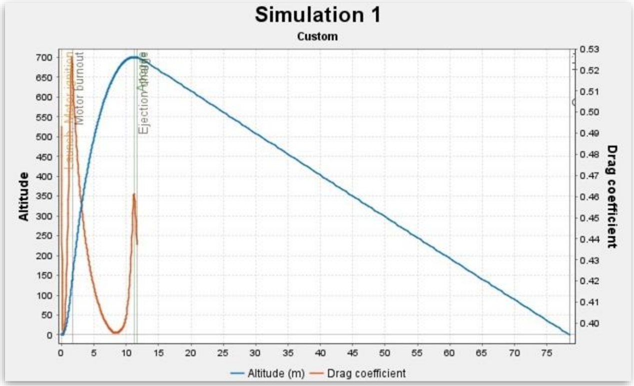
Strategy B – Ellipsoid Nose Cone

Acrylic Material



3D Printed Shoulder Nose Cone





Average Coefficient Drag = 0.3833
Source : openrocket simulation

Pros

1. Easy to manufacture
2. More precise

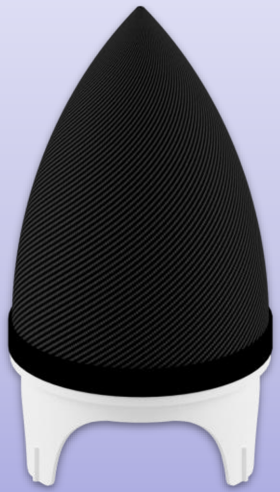
Cons

1. High drag coefficient
2. Hard to maintenance
3. Fragile

Nose Cone Design Trade & Selection (3/3)

Selection

Strategy A ✓



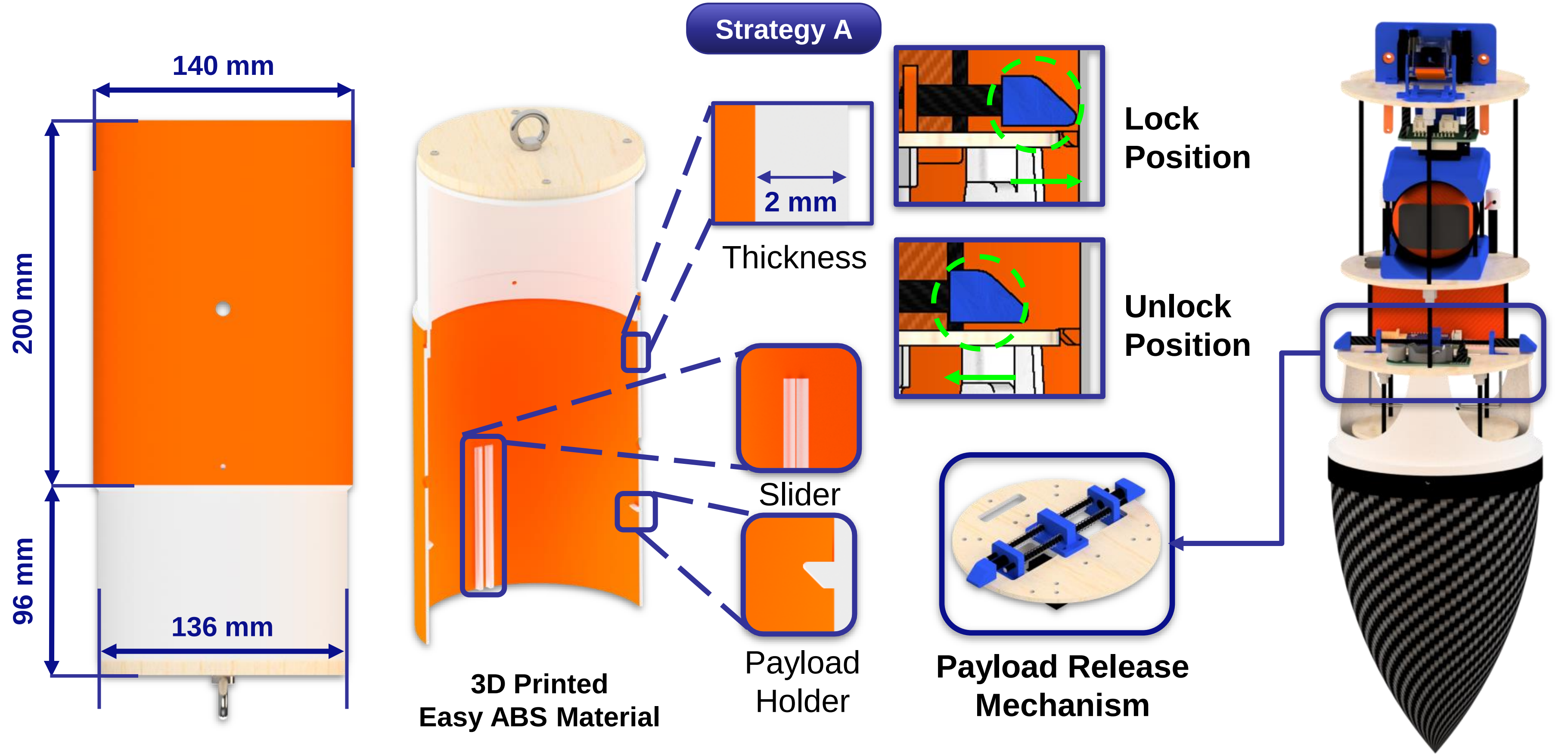
Strategy B

Selected: **Strategy A**

Reasons

1. Low drag coefficient
2. High durability
3. Easy to maintenance

Container Design and Configuration Trade & Selection (1/3)



Pros

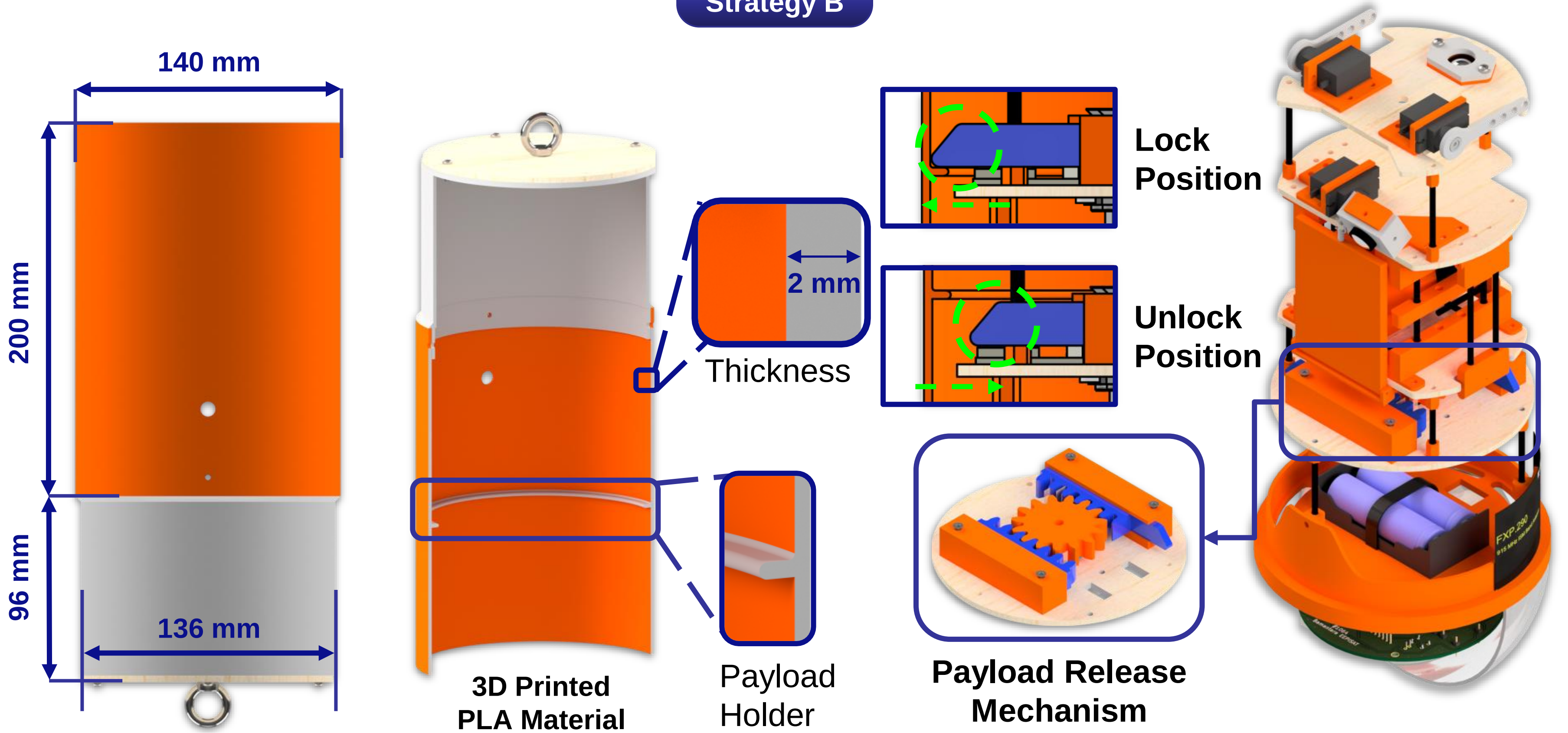
1. High durability
2. Easier to maintain payload position
3. High temperature resistance

Cons

1. Difficult to manufacture
2. Expensive

Container Design and Configuration Trade & Selection (2/3)

Strategy B



Pros

1. Easy to manufacture
2. Cheap

Cons

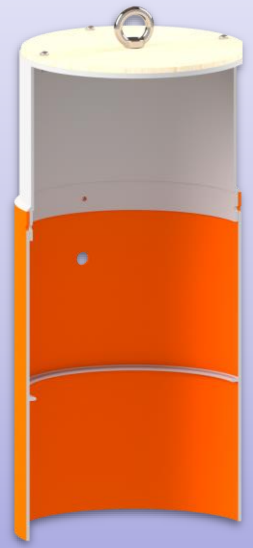
1. Low pressure resistance
2. Fragile
3. Low temperature resistance

Container Design and Configuration Trade & Selection (3/3)

Selection

Strategy A ✓

Strategy B



Selected: Strategy A

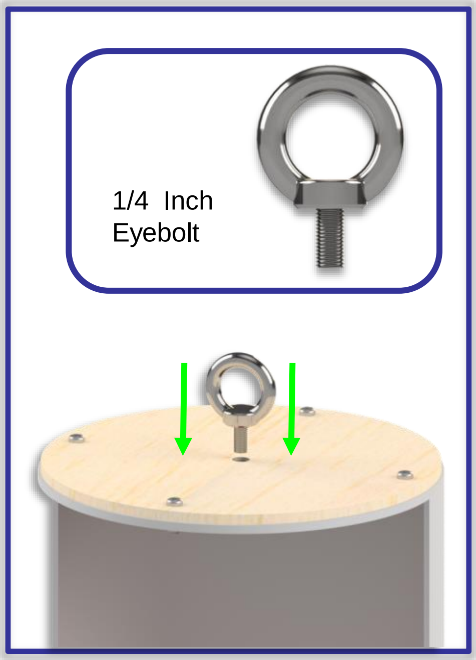
Reasons

1. High durability
2. Easier to maintain payload position
3. High temperature resistance

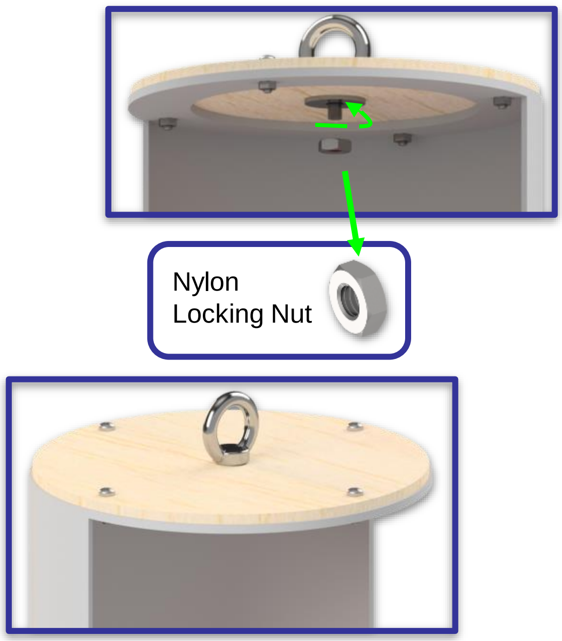
Container Parachute Attachment

Parachute Attachment

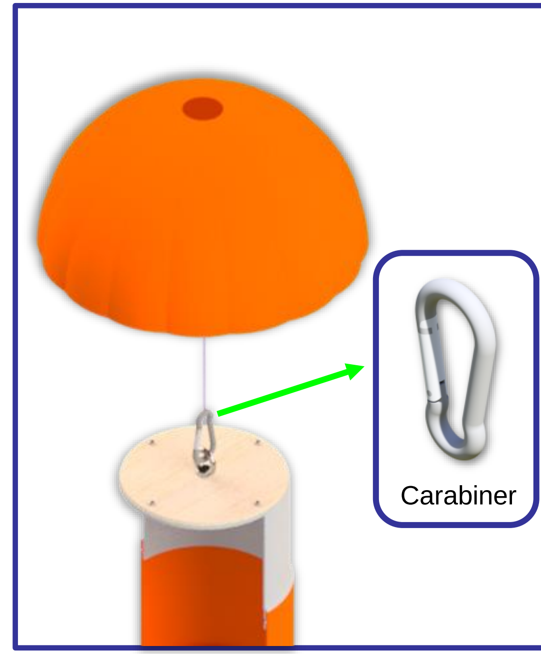
Step 1



Step 2



Step 3



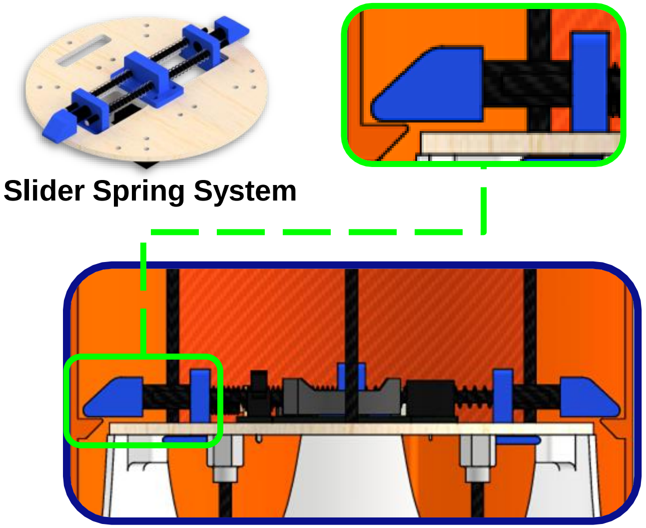
Information	
Step 1	1/4 inch eye bolt is installed on 8 mm balsa composite using a washer
Step 2	The eyebolt is secured to the balsa composite using a washer and a nylon locking nut on the other side
Step 3	The parachute that is connected to the carabiner can be attached to the eyebolt

Payload Release Trade & Selection (1/3)

Strategy A

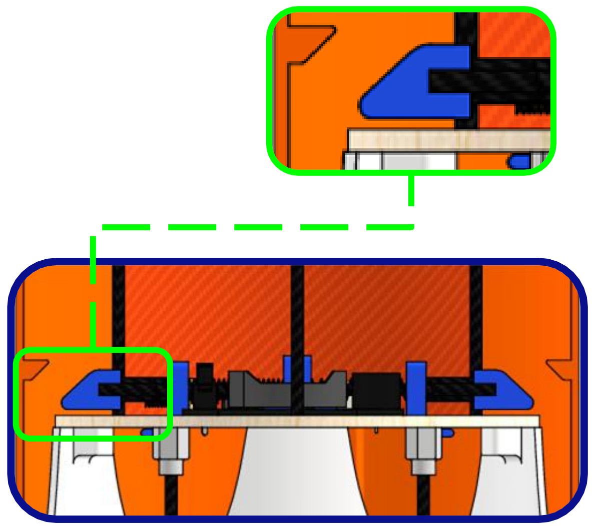
Step 1

Payload Release Mechanism Locking Position

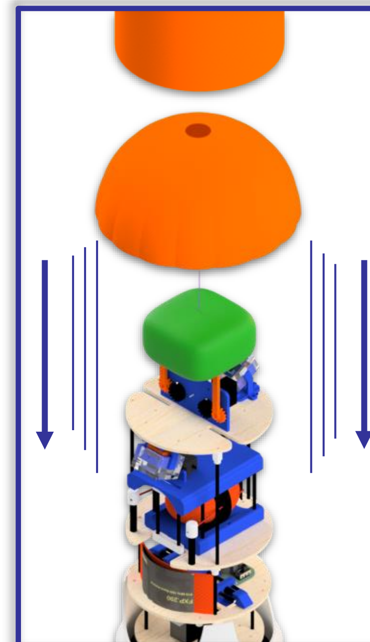


Step 2

Payload Release Mechanism Unlocking Position



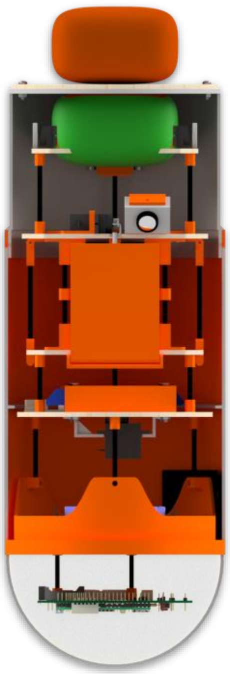
Step 3



Information	
Step 1	The payload is placed inside the container in a steady position. The payload is held by a servo motor connected to a slider spring system as a payload release mechanism. This allows the payload to be stored and locked properly in the container.
Step 2	The payload release mechanism activates when the rocket reaches 80% of peak altitude. At this point, a servo motor drives the slider spring system to unlock the payload from the container.
Step 3	Then the payload will be separated properly from the container by passively.

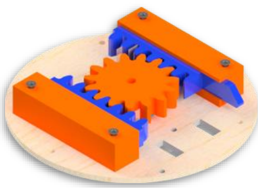
Payload Release Trade & Selection (2/3)

Strategy B

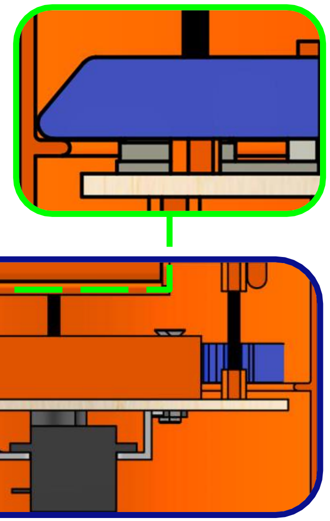


Step 1

Payload Release Mechanism Locking Position

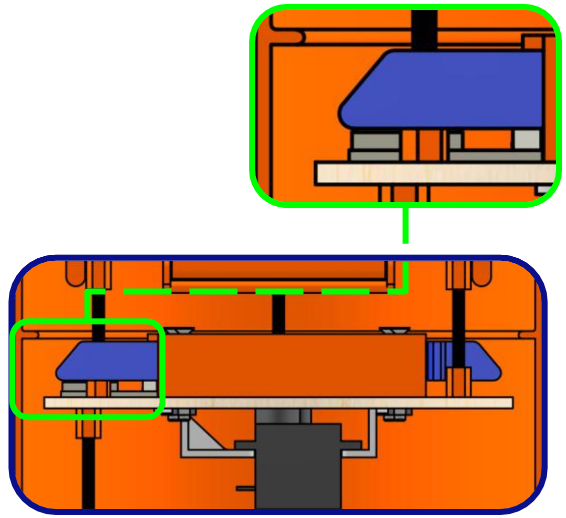


Rack Gear System

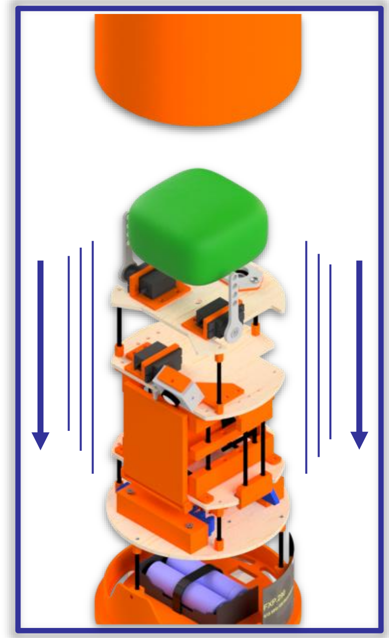


Step 2

Payload Release Mechanism Unlocking Position



Step 3

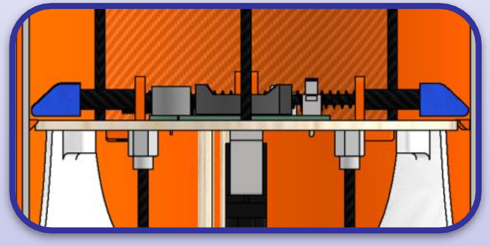


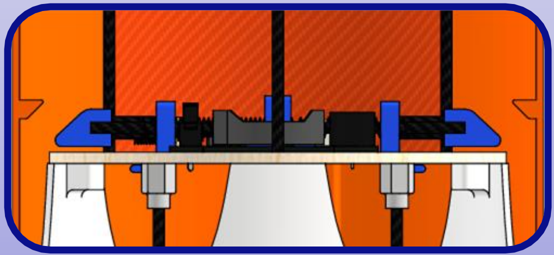
Information	
Step 1	The payload is placed inside the container in a steady position. The payload is held by a servo motor connected to a rack gear system as a payload release mechanism. This allows the payload to be stored and locked properly in the container.
Step 2	The payload release mechanism will activate as the servo rotate the rack gear system at 80% of the peak altitude and the payload starting to separate from the container.
Step 3	Finally, when the rack gear system retracted, the payload will separated from the container by passively.

Payload Release Trade & Selection (3/3)

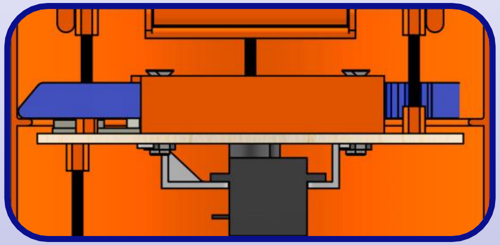
Selection

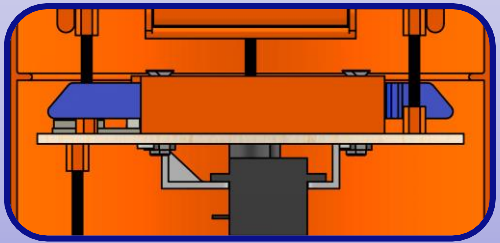
Strategy A ✓





Strategy B





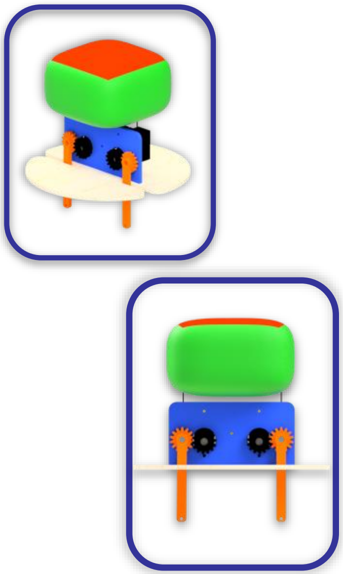
Selected: Strategy A

Reasons

1. Robust
2. Simple mechanism
3. Reliable to complete the requirements

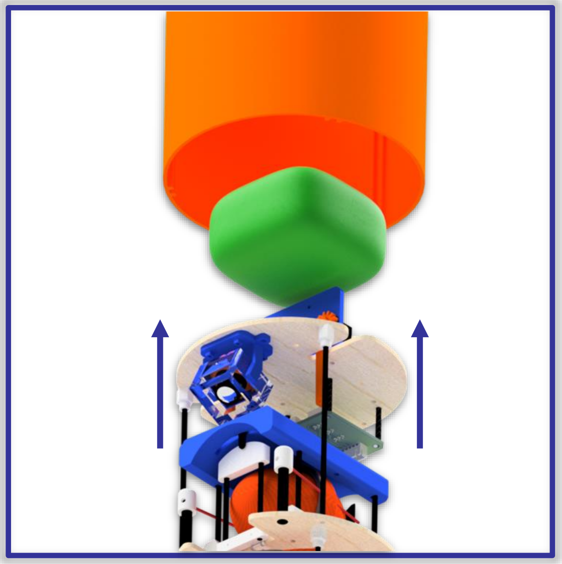
Strategy A

Step 1



Para-glider Stowed Position

Step 2



Para-glider Folds Into The Container

Step 3

Para-glider Inside The Container Body

Information	
Step 1	The para-glider and drogue-chute in default position will be folded into stowed position
Step 2	The stowed para-glider will attached to the top of payload and connected to para-glider control mechanism
Step 3	The payload will be placed inside the container

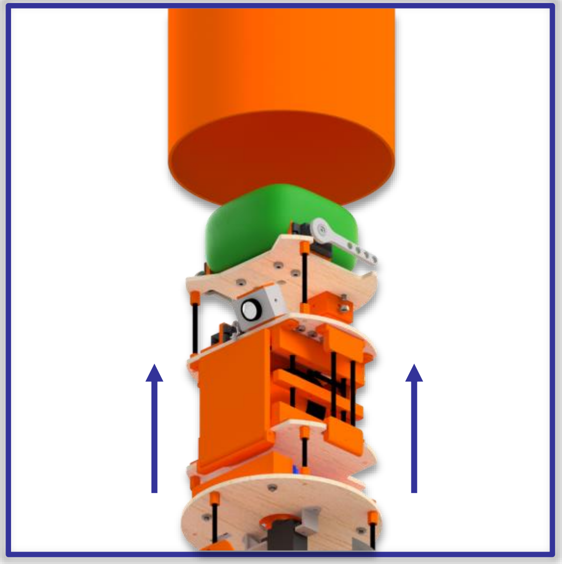
Para-Glider Stow Configuration Trade & Selection (2/3)

Strategy B

Step 1

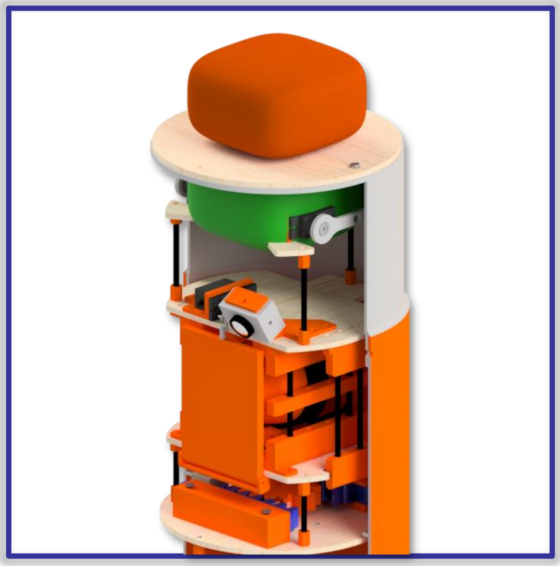
Para-glider Stowed Position

Step 2



Para-glider Folds Into The Container

Step 3



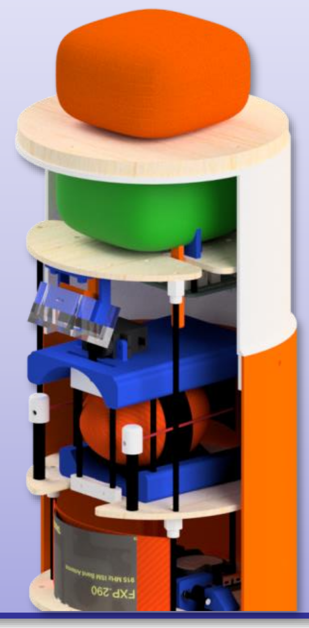
Para-glider Inside The Container Body

Information	
Step 1	The para-glider system attached to the top of payload and connected to para-glider control mechanism
Step 2	The para-glider system attached to the top of payload and connected to para-glider control mechanism.
Step 3	The payload will be place inside the container

Para-Glider Stow Configuration Trade & Selection (3/3)

Selection

Strategy A ✓



Strategy B

Selected: **Strategy A**

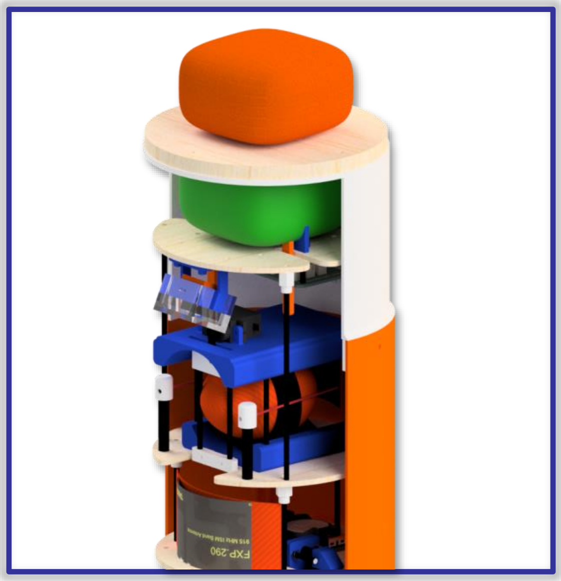
Reasons

1. More reliable
2. Reduce inflation shock
3. More Stable

Para-Glider Deployment Configuration Trade & Selection (1/3)

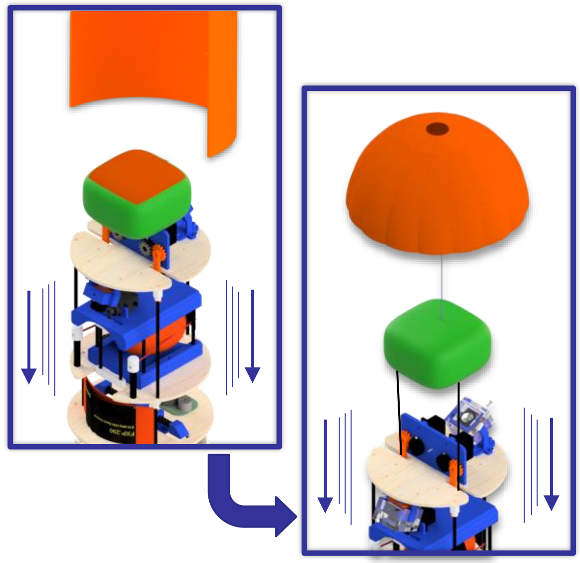
Strategy A

Step 1



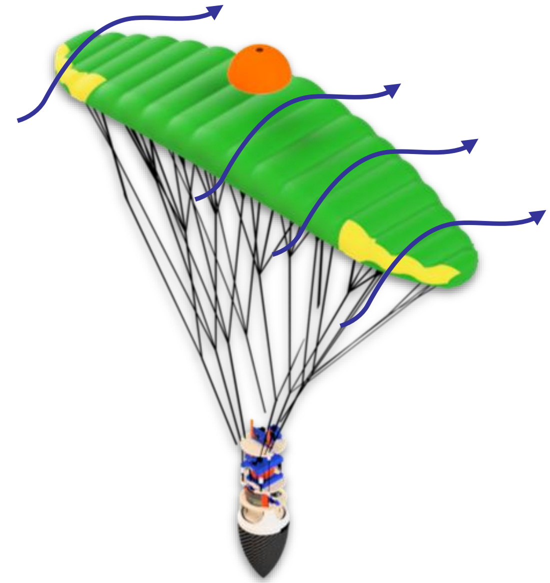
Para-Glider Stowed Position

Step 2



Payload Transition From Para-Glider Stowed Position

Step 3



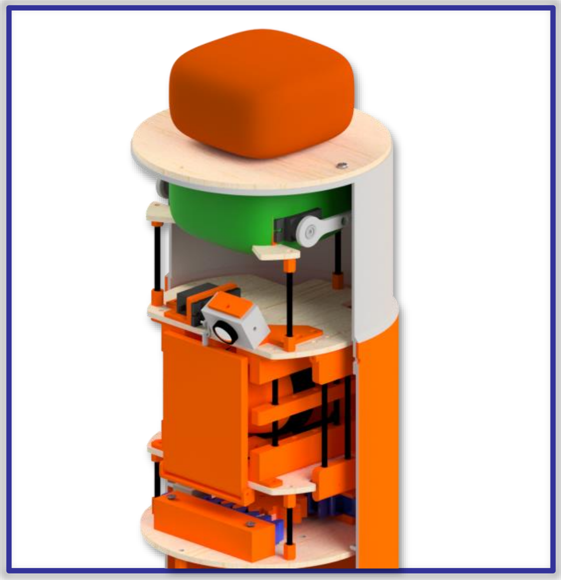
Para-glider Deployment

Information	
Step 1	The para-glider is placed inside the container in the stowed position. The payload is held by a payload release mechanism. This allows the para-glider to be stored and the payload to be securely locked in the container.
Step 2	The payload release mechanism will be activated at 80% of the apogee. After the payload separates from the container, the drogue-chute will deploy and attract the stowed para-glider
Step 3	Then, the para-glider will deploy and carry the payload to the drop zone.

Para-Glider Deployment Configuration Trade & Selection (2/3)

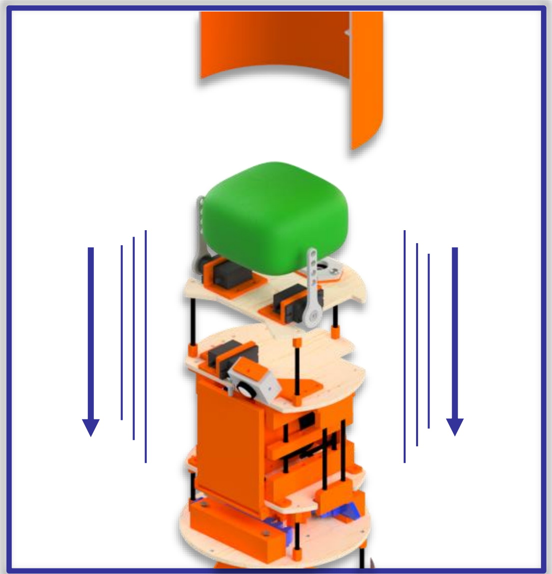
Strategy B

Step 1



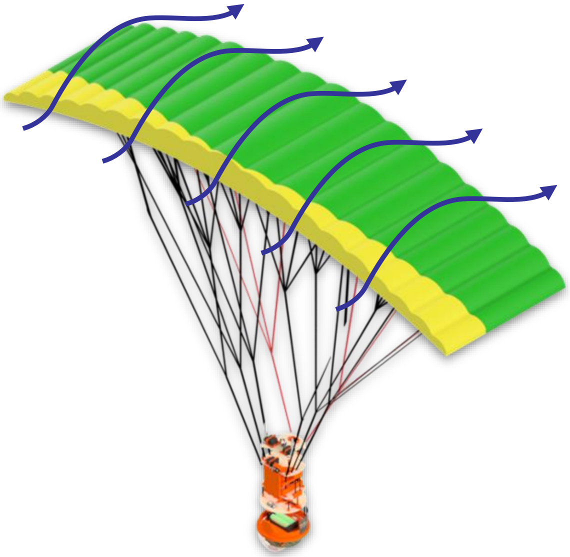
Para-Glider Stowed Position

Step 2



Payload Transition From Para-Glider Stowed Position

Step 3

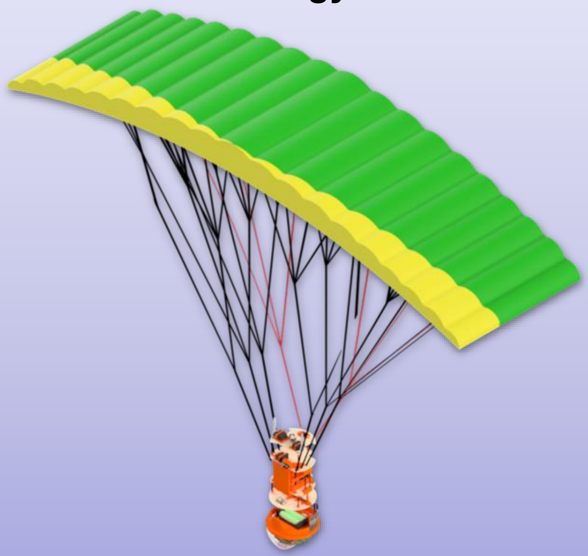


Para-glider Deployment

Information	
Step 1	The para-glider is placed inside the container in the stowed position. The payload is held by a payload release mechanism. This allows the para-glider to be stored and the payload to be securely locked in the container.
Step 2	The payload release mechanism will activate at 80% of the apogee, the payload will separate from the container. Then the stowed para-glider will deploy passively by wind force.
Step 3	Then, the para-glider will deploy and carry the payload to the drop zone.

Para-Glider Deployment Configuration Trade & Selection (3/3)

Selection

Strategy A ✓	Strategy B
	

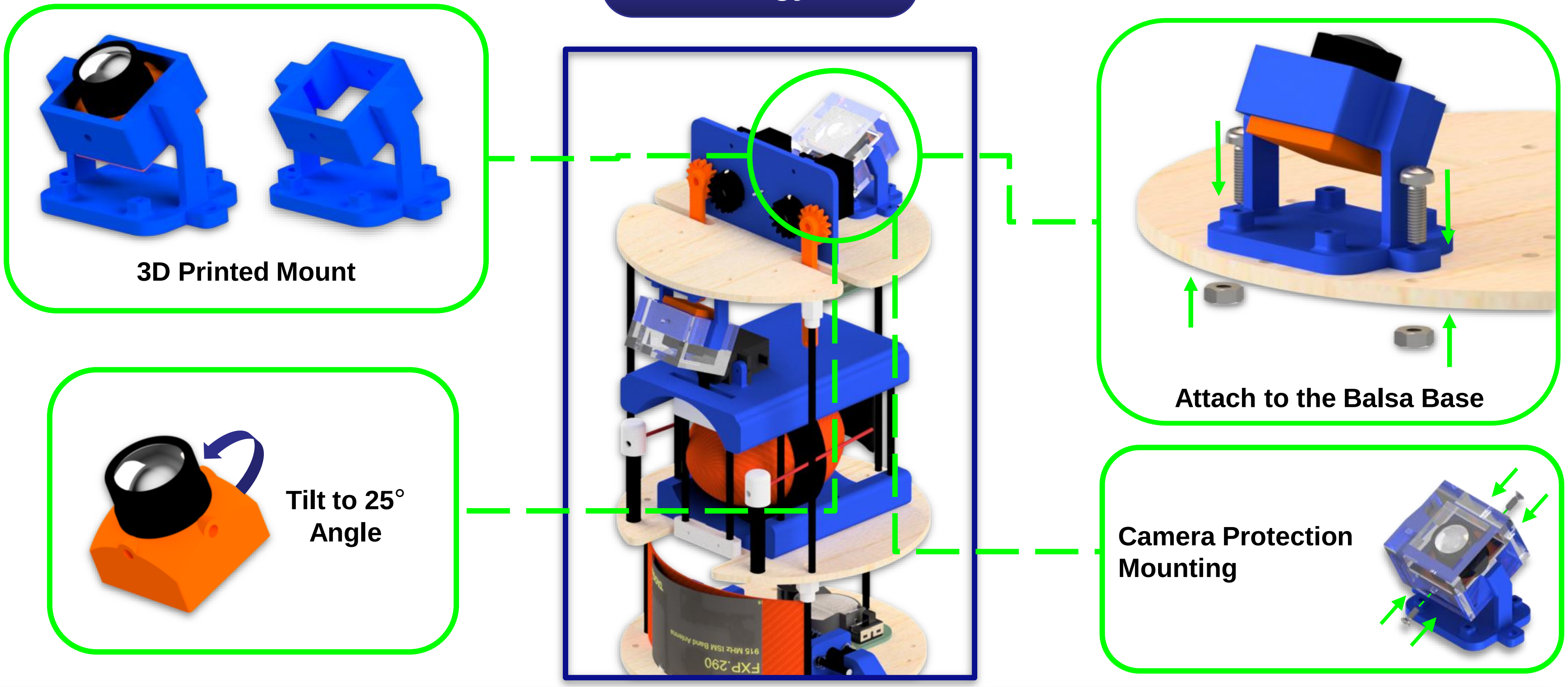
Selected: Strategy A

Reason

1. Lower risk of para-glider deployment failure
2. More reliable
3. Rapid inflation

Descent Control Pointing Camera Mount Trade & Selection (1/3)

Strategy A

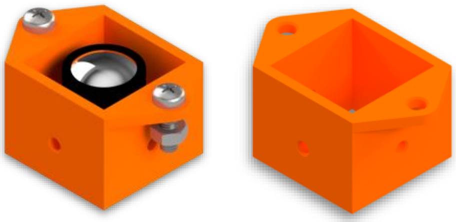


Information

The bracket holds the camera at a passive tilt of up to 25° to get a better view of the para-glider control mechanism and is attached to the top of payload with bolts and nuts. The camera is placed inside the bracket.

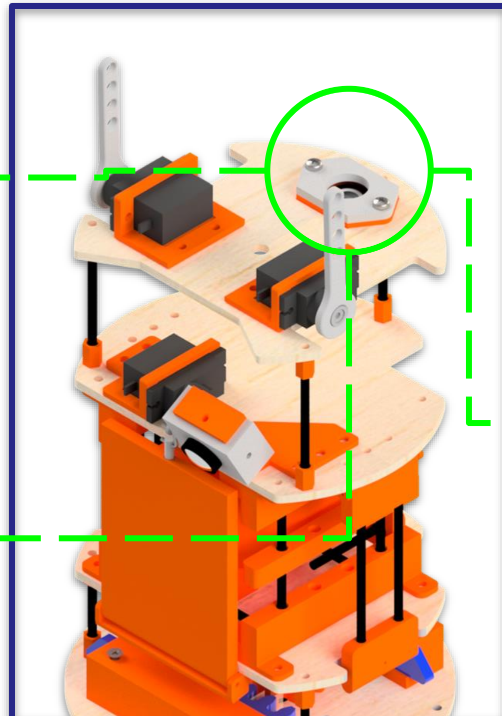
Descent Control Pointing Camera Mount Trade & Selection (2/3)

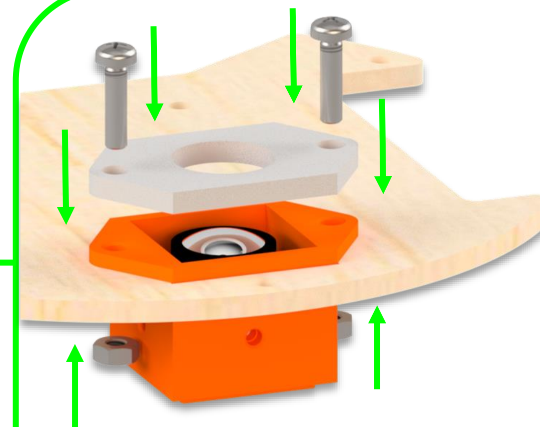
Strategy B



3D Printed Mount

Upward Camera Direction





Camera Mounting and Protection Method

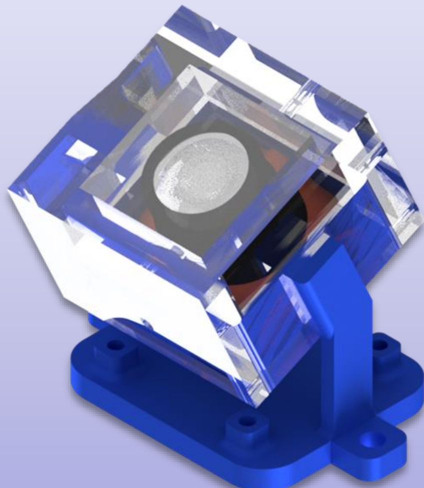
Information

The camera mechanism are passive that attached directly to the upper balsa base. Using bolt and nut to attach the camera bracket through the side of its bracket. The first camera place on top alongside with the para-glider mechanism facing upward.

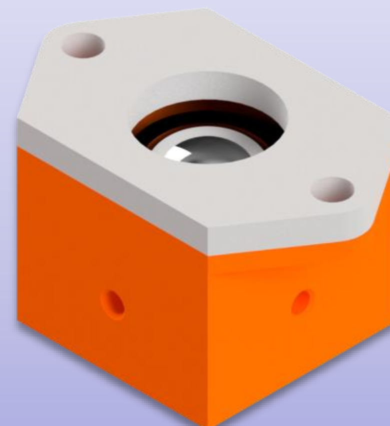
Descent Control Pointing Camera Mount Trade & Selection (3/3)

Selection

Strategy A ✓



Strategy B



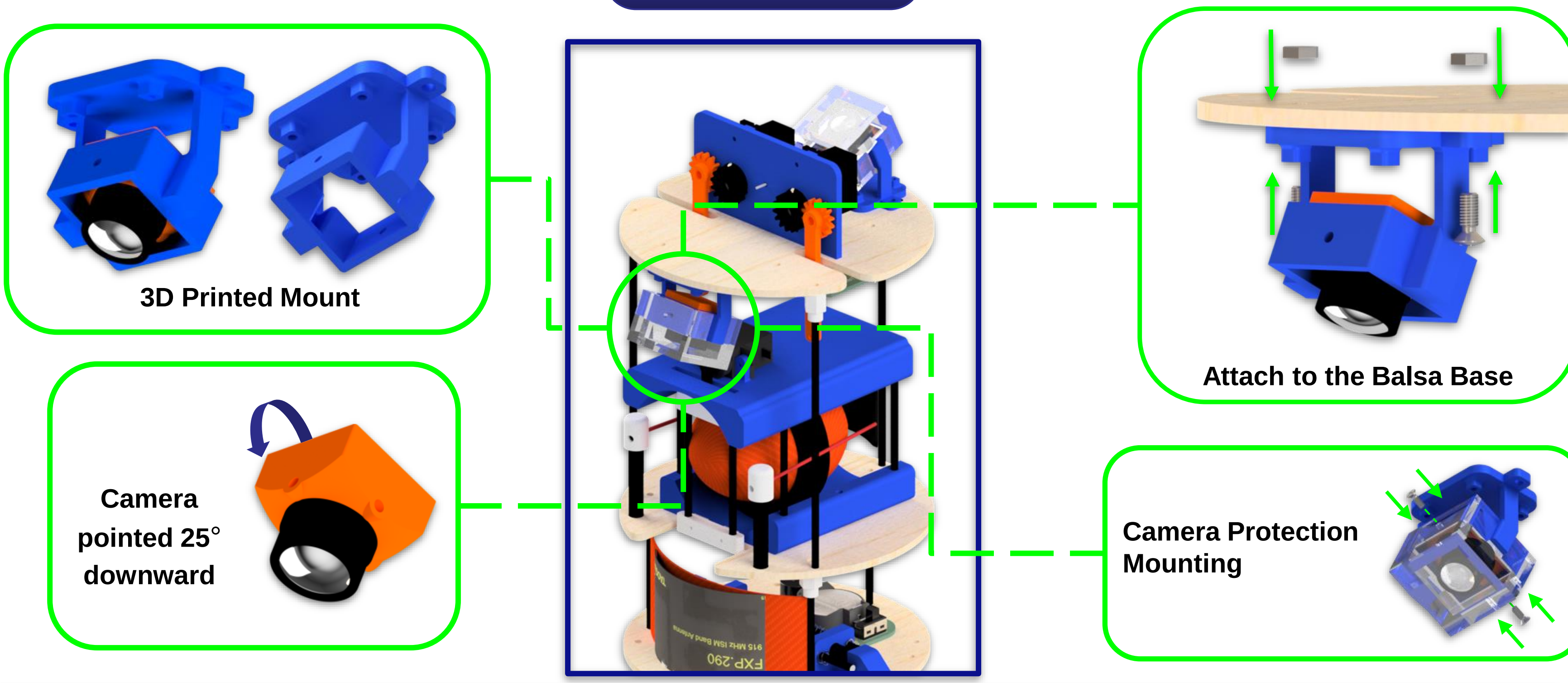
Selected: Strategy A

Reason

1. Better field of view
2. Better camera's PCB protection
3. Accessible design and ease during maintenance

Ground Pointing Camera Mount Trade & Selection (1/3)

Strategy A

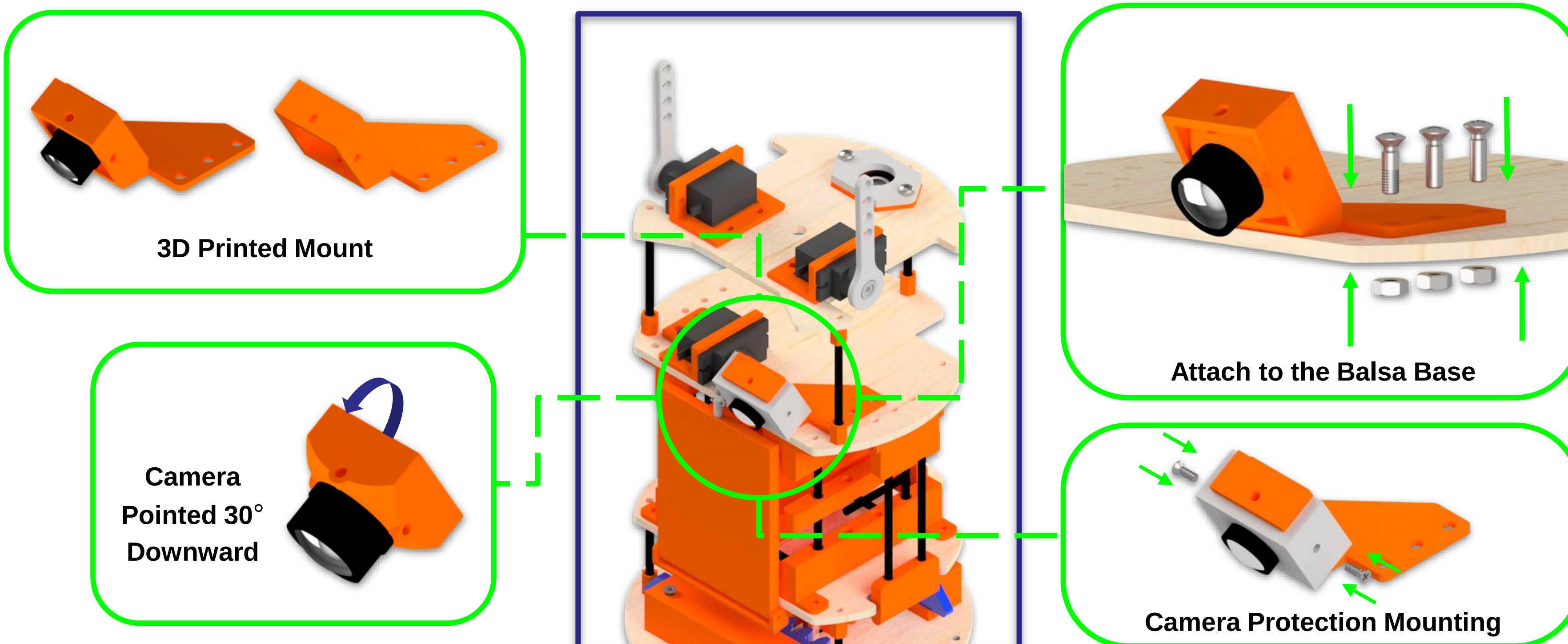


Information

The camera descent control facing the ground are include in a bracket that attach into a balsa base, its tilt 25° refer to the bottom of the payload, therefore it will get a better view of the egg instrument release. Bolts and threaded fasteners are used to act as nuts, ensuring that the bracket is sufficiently strong to securely hold the camera.

Ground Pointing Camera Mount Trade & Selection (2/3)

Strategy B

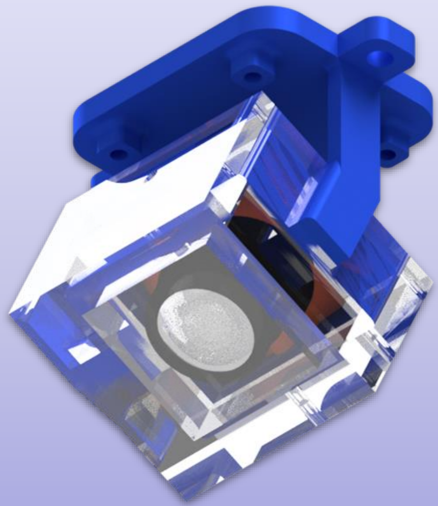
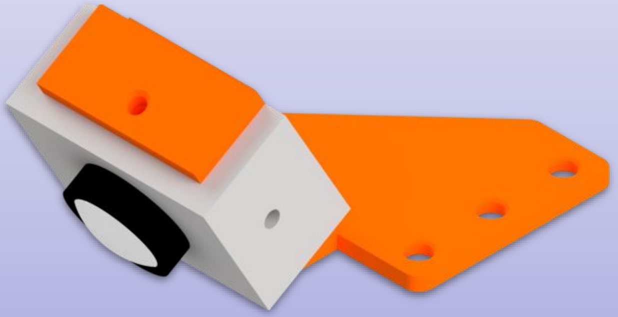


Information

The 3D printed bracket used to hold the camera facing down act as a descent camera that also tilt into 30° angle, attach to the middle base using bolt and thread to make sure its attach strongly.

Ground Pointing Camera Mount Trade & Selection (3/3)

Selection

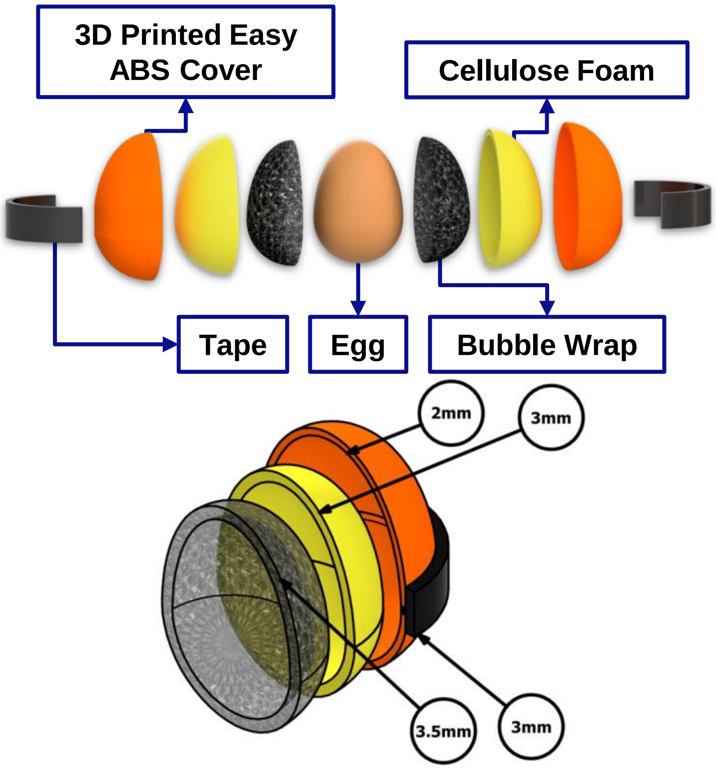
Strategy A ✓	Strategy B
	

Selected: **Strategy A**

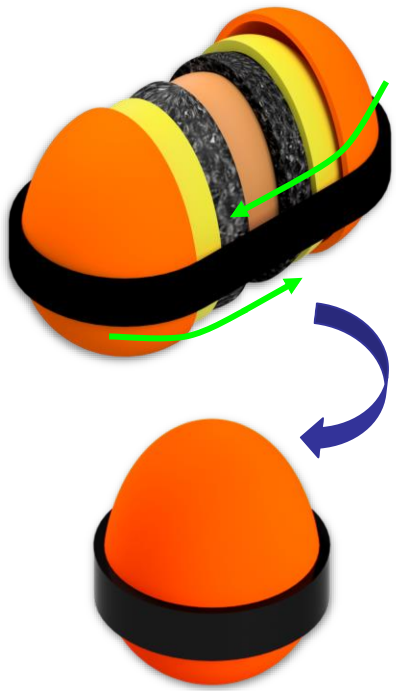
Reason

1. Better camera's PCB protection
2. Accessible design and ease during maintenance
3. Better field of view

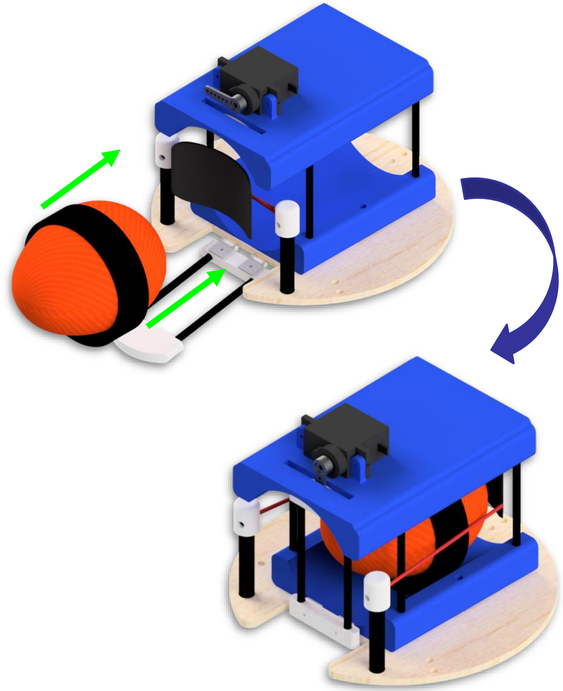
Strategy A



Egg Protection Structure



Egg Protection is Installed



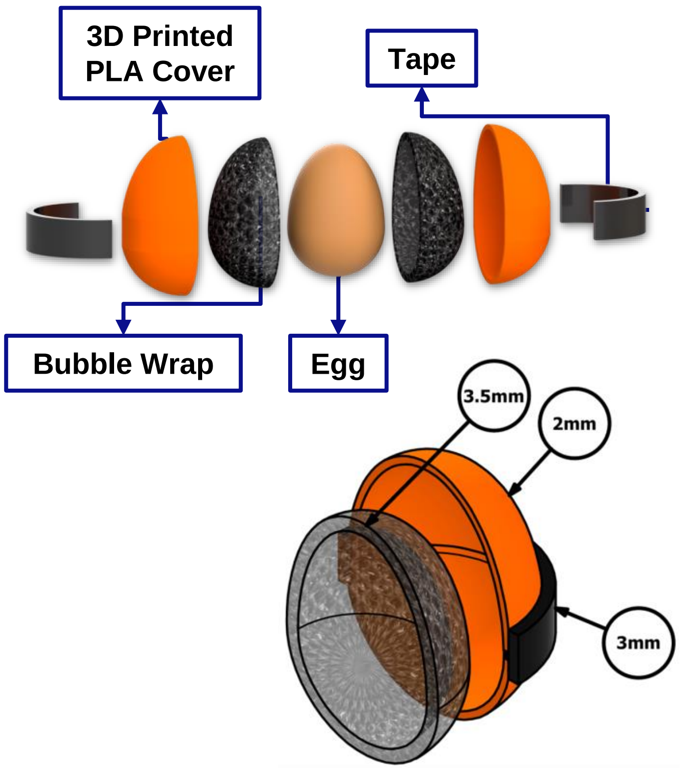
Egg Instrument Have Been Inserted

Information

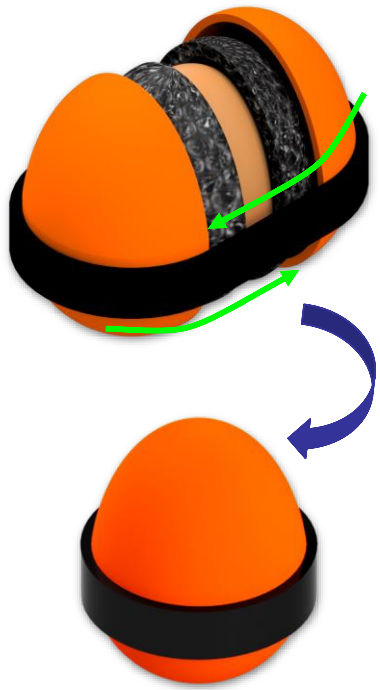
The instrument is covered with multiple layers of protection secured with tape. Each protective layer has different thicknesses and material compositions. The instrument is properly positioned inside the release mechanism.

Egg Instrument Design Trade & Selection (2/3)

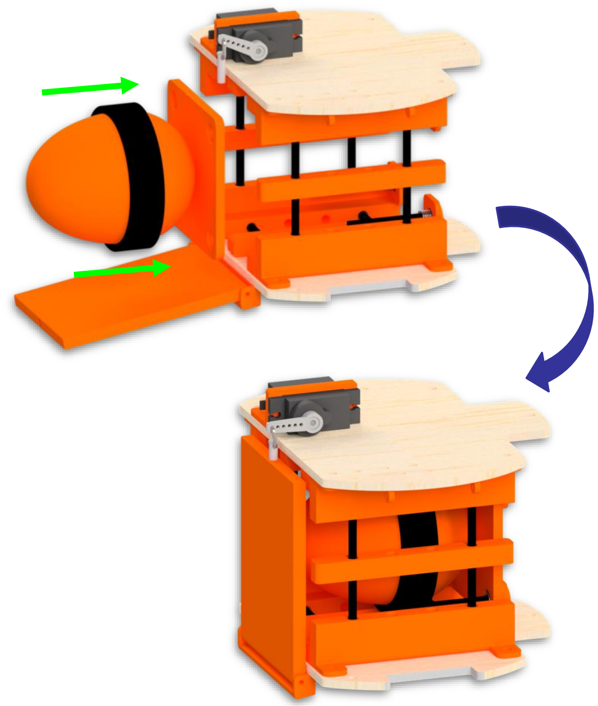
Strategy B



Egg Protection Structure



Egg Protection is Installed



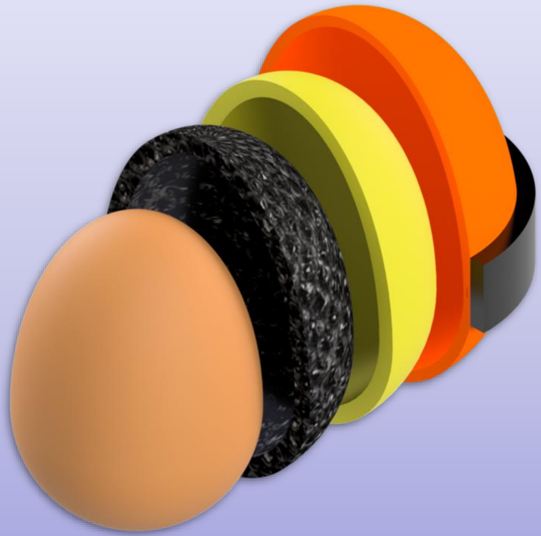
Egg Instrument Have Been Inserted

Information

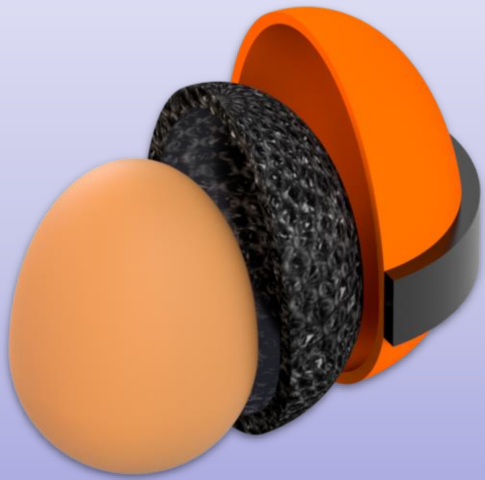
The instrument is covered by bubble wrap and 3D-printed PLA cover, which are secured with tape on the outside of the cover. The instrument is inserted and positioned inside the instrument release mechanism.

Selection

Strategy A ✓



Strategy B



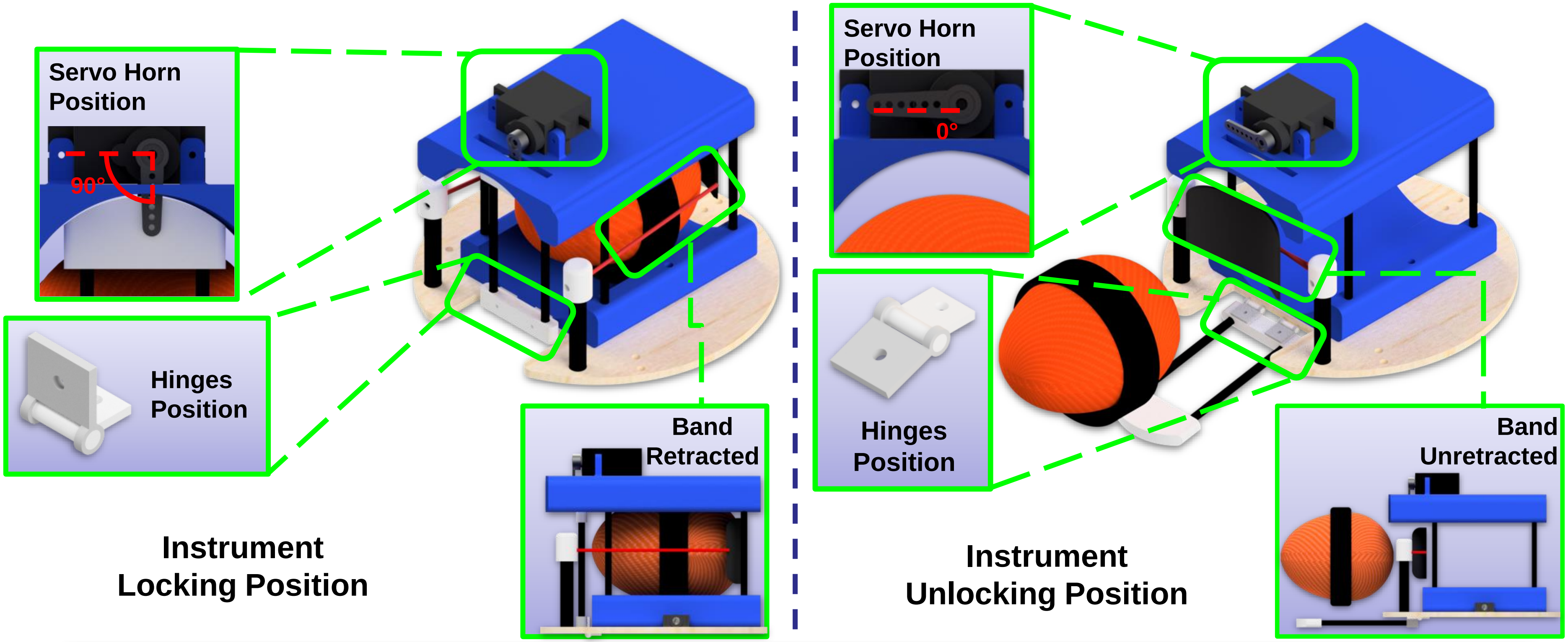
Selected: Strategy A

Reason

1. More durable
2. More compact
3. Advanced protection

Strategy A

Slingshot - Instrument Release Mechanism



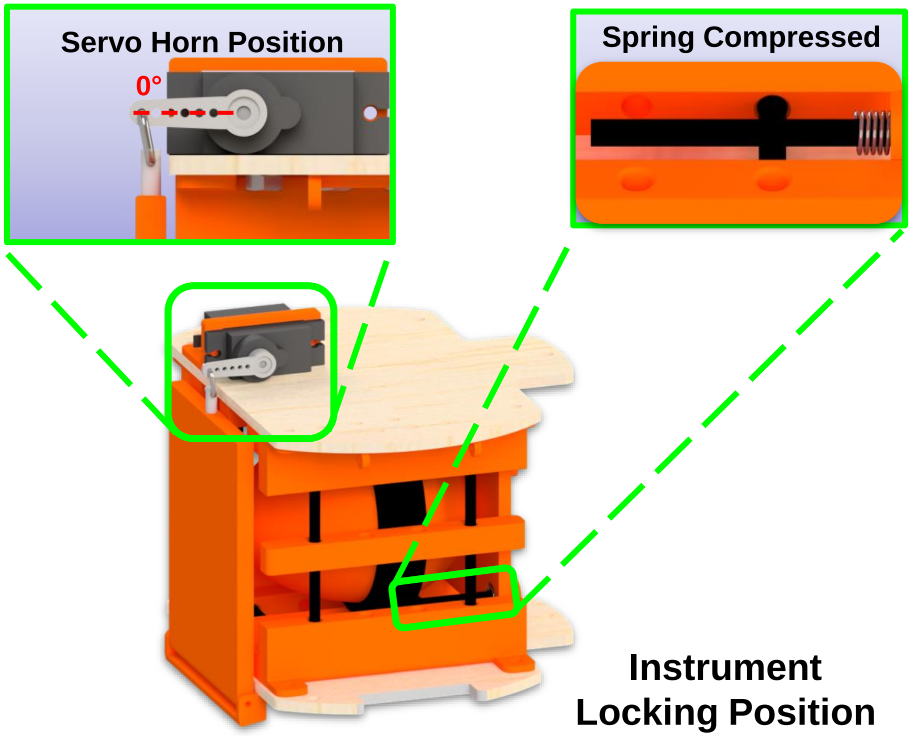
Information

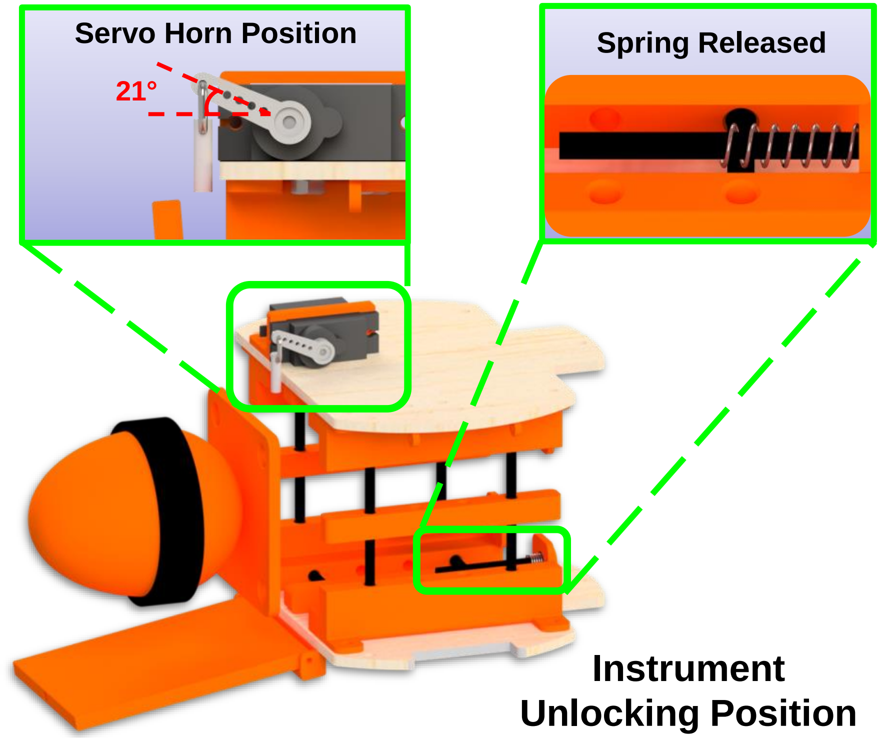
The servo horn will hold the door that connected to the hinge, therefore the egg instrument will not release. When the payload reaches 2 meters above the ground, the horn rises to a 90° angle, then the door will open and the egg instrument which pressed by a band will release.

Egg Instrument Release Trade & Selection (2/3)

Strategy B

Spring Push - Instrument Release Mechanism





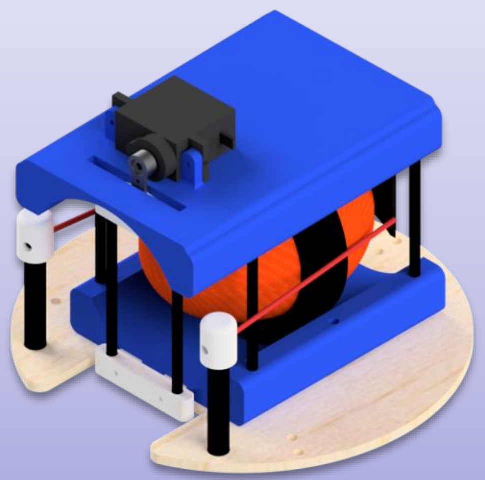
Information

The pin that connected to servo horn will hold the door. It will hold the instrument from being release because the compression of the spring. When the payload reaches 2 meters above the ground, the servo will create 21° angle and the pin will retract upward then release the instrument.

Egg Instrument Release Trade & Selection (3/3)

Selection

Strategy A ✓



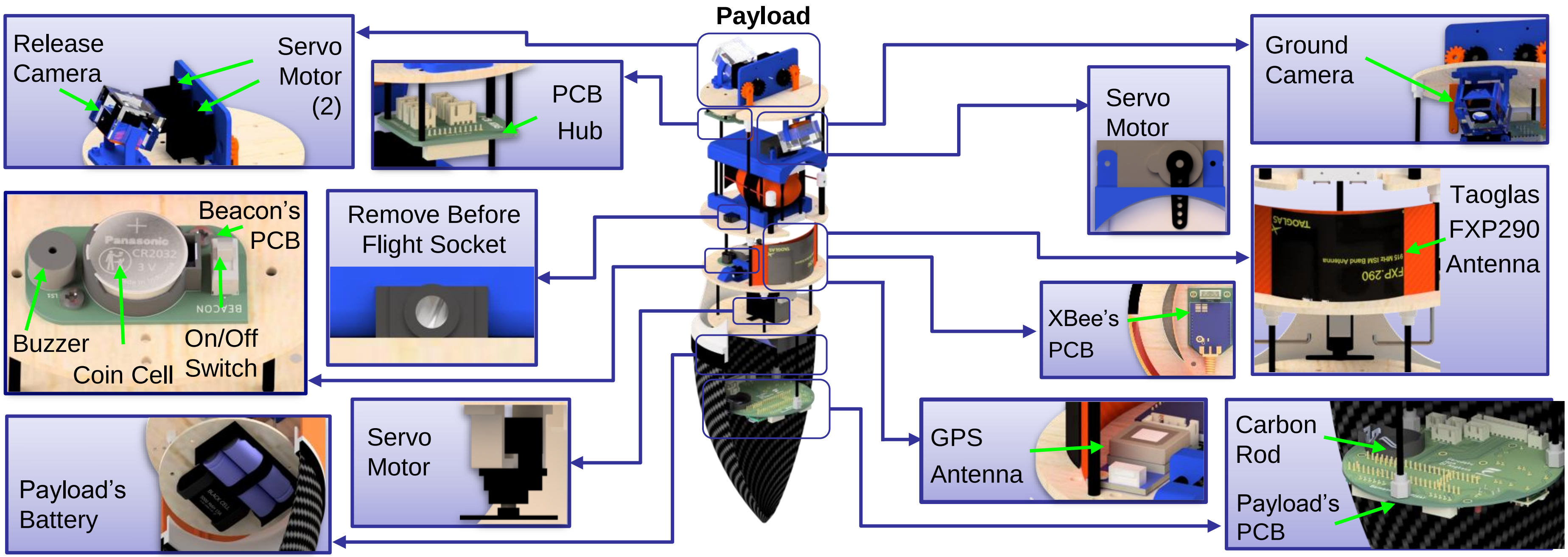
Strategy B

Selected: Strategy A

Reason

1. Easy for assembly
2. Easy to maintain because using slingshot
3. Simpler mechanism

Electronics Structural Integrity



Mounting Method

1. Payload's PCB is placed under the shoulder nose cone, secured by the carbon rod and screw, as well as protected by a carbon nose cone.
2. Beacon's PCB, PCB Hub, and XBee's PCB are secured by the carbon rod and screw.

Enclosures

1. Payload's PCB will be fully enclosed inside its structural body and will be covered by a carbon fiber nose cone.
2. The battery payload will be secured by a holder and held in place by a strap that keeps the battery safe inside the nose cone.

Connection

1. Connectors of electronic components will be soldered and hot-glued to the PCB.
2. Payload batteries, camera, RBF tag, Taoglas FXP290 antenna, and servo motor will be jumpered and secured to the electronic components and modules.

Descent Control Attachment

1. The descent of the payload will be done by the passive mechanism of the para-glider which used two servo to control the direction.
2. To release the payload, motor servo will be used.

Mass Budget (1/3)

Payload-Electrical Component					
Component	**Quantity**	**Determination**	**Mass Unit (g)**	**Mass (g)**	**Margins (g)**
Samsung INR18650-25R Battery	2	Measured	49.5	99	
Teensy 4.1	1	Measured	9	9	
MG90s Servo Motor	3	Measured	12.2	36.6	
Blackcell 14500 2s Battery	1	Measured	45	45	
XBee Pro S3B	1	Measured	6.3	6.3	
BMP280	1	Measured	4.8	4.8	
BNO055	1	Estimated	3	3	0.6
Taoglas FXP290 Antenna	1	Estimated	1.5	1.5	0.3
Buzzer	1	Measured	5	5	
On/Off Switch	1	Measured	1.6	1.6	
MG996R	1	Measured	49	49	
PCB (Payload, PCB Hub, XBee)	1	Measured	39	39	
JST Connector	1	Measured	1.5	1.5	
3 mm LED	1	Estimated	0.4	0.4	0.08
Coin Cell Battery	2	Measured	4	8	
U-blox SAM M10Q	1	Measured	10	10	
ACS712	1	Measured	4	4	
3.3V Buck Converter	1	Measured	0.5	0.5	
5V Buck Converter	1	Measured	2	2	
RunCam Split 2	2	Measured	18	36	
Remove Before Flight Tag	1	Measured	1	1	
Total Mass Electrical Component of CanSat				**363.2**	**0.98**

Note: Due to the complexity of overall system, mass estimation is derived from the 20% of its estimated value.

Mass Budget (2/3)

Payload Structural Component					
Component	**Quantity**	**Determination**	**Mass Unit (g)**	**Mass (g)**	**Margins (g)**
Nose Cone	1	Measured	100.5	100.5	
Instrument Release Mechanism	1	Measured	40.3	40.3	
Payload Release Mechanism	1	Measured	34.6	34.6	
Battery Holder	1	Measured	10.5	10.5	
Battery Holder Frame	1	Measured	8.4	8.4	
Para-glider	1	Measured	108	108	
Camera Bracket	2	Measured	5	10	2
Carbon Rod M3 x 40 mm	4	Measured	0.4	1.6	
Carbon Rod M3 x 50 mm	3	Measured	0.5	1.5	
Carbon Rod M3 x 77 mm	3	Measured	0.8	2.4	
Carbon Rod M3 x 115 mm	3	Measured	1.1	3.3	
Bolt	16	Estimated	0.35	5.6	1.12
Payload Antenna Bracket	1	Measured	10.7	10.7	
Total Mass Structural Component of Payload				**337.4**	**3.12**

Container Structural Component					
Component	**Quantity**	**Determination**	**Mass Unit (g)**	**Mass (g)**	**Margins (g)**
Container	1	Measured	190.6	190.6	
Container’s Shoulder	1	Measured	91.9	91.9	
Parachute	1	Estimated	17.1	17.1	3.42
Total Mass Structural Component of Container				**299.6**	**3.42**

Note: Due to the complexity of overall system, mass estimation is derived from the 20% of its estimated value.

Mass Budget (3/3)

S1: Total mass of the CanSat shall be 1000 grams ±10 grams being installed

Total Mass	
Container	299.6 g
Payload	700.6 g
Total Mass of All System	**1,000.2 g ± 7.52 g**

Margin

Mass Competition Requirement – Total Mass of All System = Margin

1,000 – 1,000.2 = -0.2 g (Fulfill Mass Tolerance)

Uncertainties = ± 7.52 g

Correction Method (Margin Competition ± 10 g)	
If total mass system < 990 grams	We will increase the mass of materials using higher infill density of 3D printed material for the CanSat.
If total mass system > 1,010 grams	We will change the material with lighter material such as composite that has lower density for the CanSat

Communication and Data Handling (CDH) Subsystem Design

Ax'l Nurrahim

Payload Command Data Handler (CDH) Overview

GNSS (SAM-M10Q): To obtain position or location

Servo (MG90s): Actuator of para-glider control and release instrument

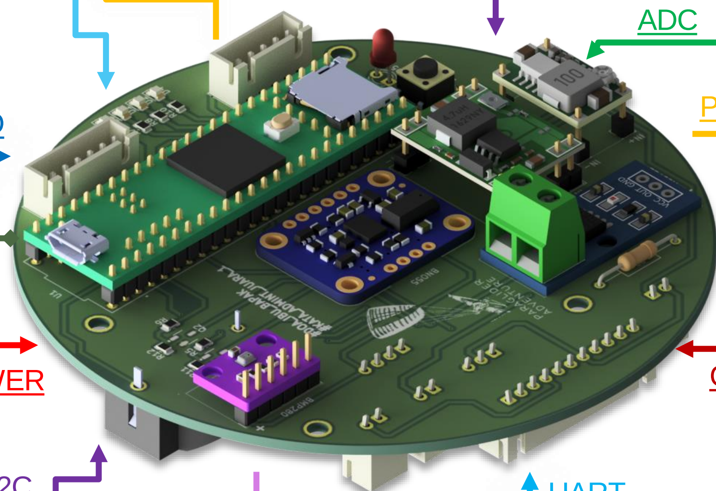
BMP280: Measure pressure and altitude

Voltage Divider: To measure battery voltage power

Micro SD Card: Storage data of the CanSat

Servo (MG996R): Actuator of payload release

Teensy 4.1: Main controller for the CanSat system



LED: As power Indicator

Coin Cell: Supply RTC for the Teensy 4.1

ACS712: Measure battery current power

IMU (BNO055): Inertial Measurement Unit (IMU)

Camera (RunCam Split 2): Record video during mission

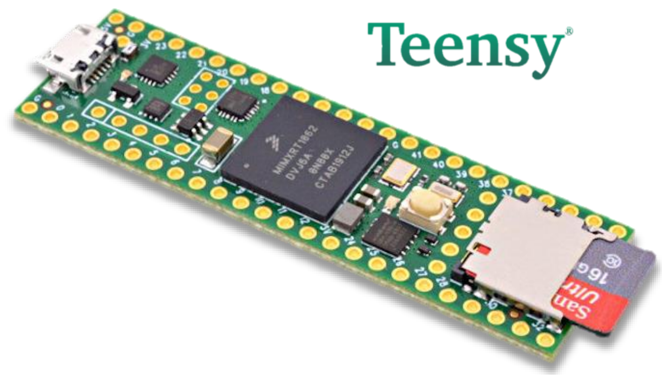
XBee Pro S3B: CanSat to GCS telemetry link

Taoglas FXP290: High gain antenna for XBee

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

Model	Processor				Interfaces						Size[1] [mm]	Mass [g]	Supply Voltage [V]	Price[2] [USD]
	Clock Speed [MHz]	Flash [kB]	RAM [kB]	Boot Time [ms]	I/O Pins	ADC Pins	PWM Pins	UART	SPI	I2C				
Teensy 4.1	600	8192	1024	500	55	18	35	8	3	3	61 x 17.8 x1.57	9	5	56.97
Teensy 4.0	600	2048	1024	500	40	14	31	7	3	3	35.5 x 17.7 x 1.57	5	5	48.13
Raspberry Pi Pico	133	2048	264	2000	26	3	16	2	2	2	21 x 51 x 1.43	6	5	9.56

Selected Payload Processor : **Teensy 4.1 ✓**



Reasons:

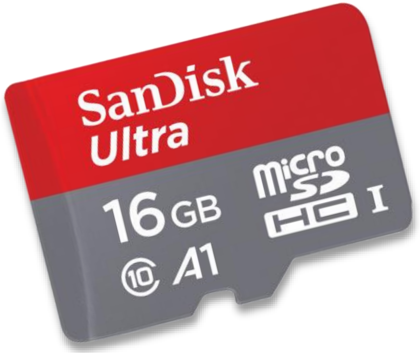
- **High speed processor**
- **Has more pins than other microcontrollers**
- **Larger memory capacity**
- Fast boot time

1. Size of our sensor is in the form of a module.
2. Price references are obtained from local stores.

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

Model	Interface	Memory [GB]	Data Transfer Rate		Price[1] [USD]
			Read (MB/s)	Write (MB/s)	
SanDisk Ultra Micro SD	SD Card Interface	16	98	Minimum speed 10	11.32
Olike TF16G	SD Card Interface	16	90	10	2.88
Toshiba Micro SD	SD Card Interface	8	30	6	1.2

Selected Memory : **SanDisk Ultra Micro SD** ✓



Reasons:

- **Stable data transfer rate**
- **High reliability**
- High speed data transfer

1. Price references are obtained from local stores.

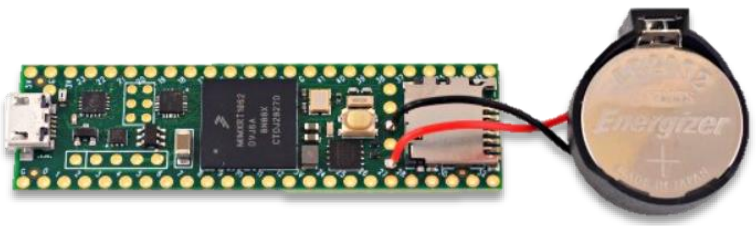
Payload Real-Time Clock

Model	Operating Voltage [V]	Operating Current [μA]	Reset Tolerance	Accuracy [ppm]	Price[1] [USD]
Teensy 4.1 Internal RTC	3	30	Under reset conditions, the software retrieves the recent data stored in the RTC registers.	±20	0
DS3231	2.3 ~ 5.5	3	In reset conditions external clock continues to keep time	±3.5	1.5
DS1302	2 ~ 5	0.3	In reset conditions external clock continues to keep time	±20	0.5

Selected Real Time Clock : **Teensy 4.1 Internal RTC** ✓

Reasons:

- **Included in our microcontroller board (COTS)**
- Simplifies our PCB (no need to route extra modules)
- 3V compatible power supply



1. Price references are obtained from local stores.

Payload Antenna Trade & Selection (1/2)

Model	Range[1] [Km]	Frequency [MHz]	Gain [dBi]	Connector	Size [mm]	Weight[2] [g]	Price [USD]
Taoglas FXP290	11.67	915	1.5	Micro FL	75.4 x 45	1.5	17.05
ANT-900MR Flex ¼ Wave RPSMA	10	915	3	RP-SMA	105 x 18	11	18.83
Noyito Antenna	14.48	915	5	SMA	204 x 13	<1	9.50

Selected Payload Antenna : **Taoglas FXP290** ✓

Reasons:

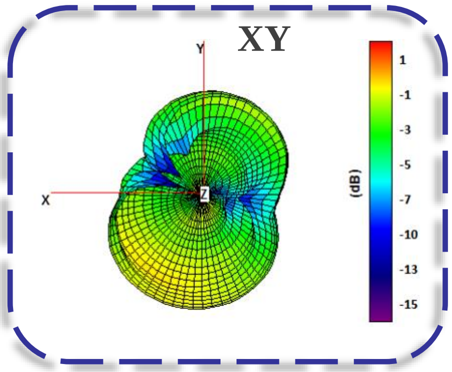
- **Compact & flexible form factor**
- **Small board-level connector**
- Lightweight
- Long effective working range

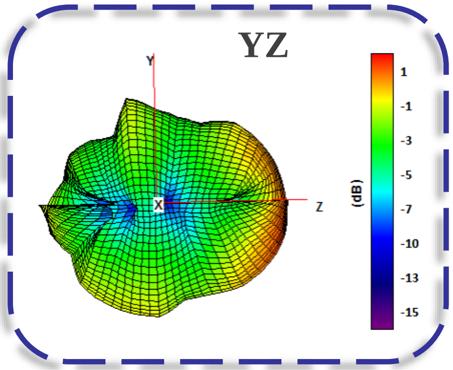
1. The range data is based on information provided in the datasheet
2. Measured weight less than 1 gram

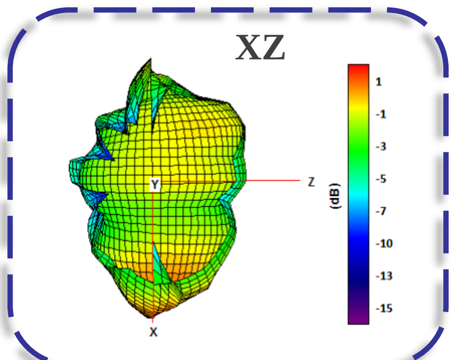
Payload Antenna Trade & Selection (2/2)

Pattern and Placement of Taoglas FXP290 Antenna

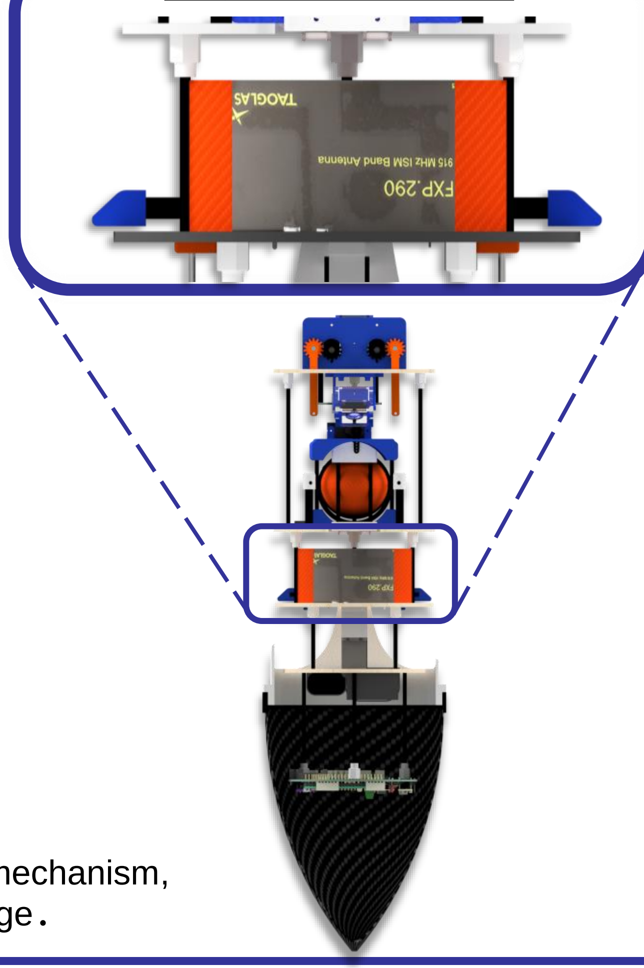
Radiation Patterns of Taoglas FXP290 Antenna







Taoglas FXP290 Antenna



The location of the antenna FXP290 is under the instrument release mechanism, and it is positioned facing outward to achieve maximum signal coverage.

Payload Radio Configuration (1/2)

Model	Range[1] [Km]	Frequency	Receive Current [mA]	Transmit Current [mA]	Operating Voltage [V]	Sensivity [dBm]	Antenna Connector	RF Data Rate [Kb/s]	Price [USD]
XBee PRO S3B	6.5	915 MHz	26	215	3 ~ 3.6	-107	Micro FL	200	55.66
XBee PRO S2B	1.2	2.4 GHz	31	215	2.7 ~ 3.6	-101	Micro FL	250	35
XBee PRO S1	1.6	2.4 GHz	55	215	2.8 ~ 3.4	-100	RPSMA	250	58.40

Selected Payload Radio : **XBee PRO S3B** ✓

DIGI XBee

Reasons:

- **Longest range connection**
- **High sensitivity**
- Low receive and transmit current
- Meets the required specifications

1. The range data is based on information provided in the datasheet

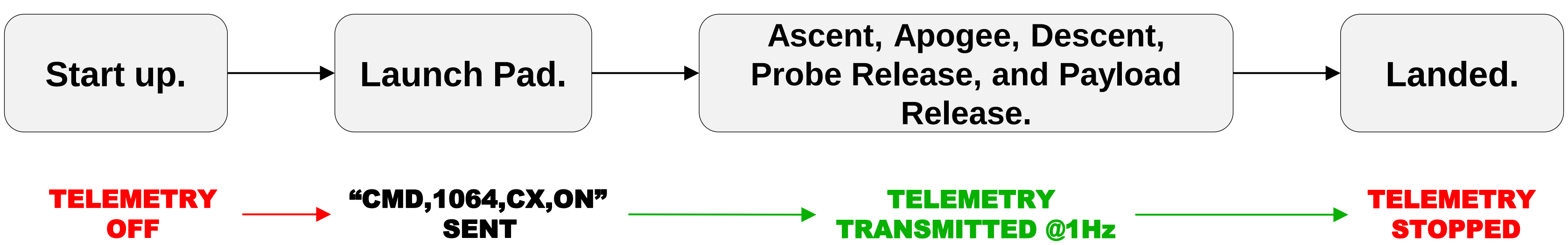
Payload Radio Configuration (2/2)

Overview of Radio Configuration

- As shown in the slide above, we use an **XBee Pro S3B** as the radio communication device between the CanSat and the GCS.
- **We are using NETID 1064 because our team ID is <u>1064.</u>**
- XBee will not be set to Broadcast mode.

Transmission Control

1. The CanSat **telemetry** data will be **transmitted** to the GCS **@1Hz.**
2. The CanSat will start sending data when commanded by GCS using command “CMD,1064,CX,ON”.
3. The transmission of CanSat packet data will commence at the CanSat’s **LAUNCH_PAD** state. Before **LAUNCH_PAD** state the CanSat remains idle.
4. If somehow the Teensy 4.1 runs into reset, it will recover the last packet count from SD Card, so the packet counting doesn’t reset.



Payload Telemetry Format (1/4)

CanSat Telemetry Data		
Data Format	**Sample Data**	**Description**
<TEAM_ID>	1064	The assigned four digit team identification number. Our team ID is 1064
<MISSION_TIME>	13:14:02	UTC time in format hh:mm:ss, where hh is hours, mm is minutes, and ss is seconds. E.g., '13:14:02' indicates 1:14:02 PM.
<PACKET_COUNT>	11	The total count of transmitted packets since turned on, which is to be reset to zero by command when the CanSat is installed in the rocket on the launch pad at the beginning of the mission and maintained through processor reset
<MODE>	F	The ASCII character 'F' for flight mode and 'S' for simulation mode
<STATE>	LAUNCH_PAD	The operating state of the software
<ALTITUDE>	1.1	The altitude in units of meters and must be relative to ground level at the launch site. The resolution must be 0.1 meters
<TEMPERATURE>	33.3	The temperature in degrees Celsius with a resolution of 0.1 degrees.
<PRESSURE>	101.6	The air pressure of the sensor used. Value must be in kPa with a resolution of 0.1 kPa.

Payload Telemetry Format (2/4)

CanSat Telemetry Data		
Data Format	**Sample Data**	**Description**
<VOLTAGE>	7.1	The voltage of the CanSat power bus with a resolution of 0.1 volts.
<CURRENT>	1.0	The current from the battery with a resolution of .01 amperes.
<GYRO_R, GYRO_P, GYRO_Y>	-1,2,1	The gyro readings in degrees per second for the roll, pitch, and yaw axes.
<ACCEL_R, ACCEL_P, ACCEL_Y>	0,-1,2	The accelerometer readings in degrees per second squared for the roll, pitch and yaw axes.
<GPS_TIME>	13:14:02	The time from the GPS receiver. The time must be reported in UTC and have a resolution of one second.
<GPS_ALTITUDE>	24.0	The altitude from the GPS receiver in meters above mean sea level with a resolution of 0.1 meters.
<GPS_LATITUDE>	-7.2758	The latitude from the GPS receiver in decimal degrees with a resolution of 0.0001 degrees North.
<GPS_LONGITUDE>	-112.7942	The longitude from the GPS receiver in decimal degrees with a resolution of 0.0001 degrees West.

Payload Telemetry Format (3/4)

CanSat Telemetry Data		
Data Format	**Sample Data**	**Description**
<GPS_SATS>	4	The number of GPS satellites being tracked by the GPS receiver. This must be an integer number
<CMD_ECHO>	CXON	The fixed text command id and argument of the last received command with no commas
Optional Data Separator	,,	Zero or more additional fields the team considers important following two commas, which indicates a blank field
<CHECKSUM>	124	To verify and validate the quantity of valid and invalid data transmitted or received through telemetry.
<HEADING_ERROR>	90	To evaluate the angular deviation between the CanSat heading and the landing target direction, the data will be formatted in degrees
<PG_STATE>	PG_LOITER	To observe the real-time status of the para-glider control mechanisms.
<DISTANCE_TO _TARGET>	1.2	To measure the current distance of the CanSat from the landing zone, the data will be formatted in meters.
<GROUND_DETECTION _ALTITUDE>	5	To measure the distance from the CanSat to the ground.

Payload Telemetry Format (4/4)

- **Telemetry Format:**

```
TEAM_ID,MISSION_TIME,PACKET_COUNT,MODE,STATE,ALTITUDE,TEMPERATURE,PRESSURE,VOLTAGE,
CURRENT,GYRO_R,GYRO_P,GYRO_Y,ACCEL_R,ACCEL_P,ACCEL_Y,GPS_TIME,GPS_ALTITUDE,GPS_LATITUDE,
GPS_LONGITUDE,GPS_SATS,CMD_ECHO,,CHECKSUM,HEADING_ERROR,PG_STATE,DISTANCE_TO_TARGET,
GROUND_DETECTION_ALTITUDE
```

- **Example:**

```
1064,13:14:02,11,F,LAUNCH_PAD,1.1,33.3,101.6,7.1,1.0,-1,2,1,0,-1,2,13:14:02,24.0,
-7.2758,-112.7942,4,CXON,,124,90,PG_LOITER,1.2,5
```

Payload Command Formats (1/2)

Type of Command	Command Format	Description	Example Data
CX: Payload Telemetry On/Off Command	CMD, <TEAM_ID>, CX, <ON_OFF>	1. CMD and CX are static text 2. <TEAM_ID> is the assigned team identification 3. <ON_OFF> is the string 'ON' to activate the CanSat transmissions. and 'OFF' to turn off the transmissions	The command CMD,1064,CX,ON activates payload telemetry transmission, CMD,1064,CX,OFF will stop payload telemetry transmission
ST: Set Time	CMD, <TEAM_ID>, ST, <UTC_TIME>|GPS	1. CMD and ST are static text 2. <TEAM ID> is the assigned team identification 3. <UTC_TIME>|GPS is UTC time in the format hh:mm:ss or 'GPS' which sets the flight software time to the current time read from the GPS module	The command CMD,1064,ST, 13:35:59 sets the mission time to the value given and the command CMD,1064,ST,GPS sets the time to the current GPS time.
SIM: Simulation Mode Control Command	CMD, <TEAM_ID>, SIM, <MODE>	1. CMD and SIM are static text 2. <TEAM_ID> is the assigned team identification 3. <MODE> is the string 'ENABLE' to enable the simulation mode, 'ACTIVATE' to activate the simulation mode, or 'DISABLE' which both disables and deactivates the simulation mode	Both the CMD,1064,SIM,ENABLE and CMD,1064,SIM,ACTIVATE commands are required to begin simulation mode

Payload Command Formats (2/2)

Type of Command	Command Format	Description	Example Data
SIMP: Simulated Pressure Data (to be used in Simulation Mode only)	CMD, <TEAM_ID> , SIMP, <PRESSURE>	1. CMD and SIMP are static text 2. <TEAM ID> is the assigned team identification 3. <PRESSURE> is the simulated atmospheric pressure data in units of pascals with a resolution of one Pascal	CMD,1064,SIMP,101325 provides a simulated pressure reading to the payload (101325 Pascals = approximately sea level). **Note:** this command is to be used only in simulation mode
CAL: Calibrate Altitude to Zero	CMD, <TEAM_ID> , CAL	1. CMD and CAL are static text 2. <TEAM ID> is the assigned team identification	The command CMD,1064,CAL will calibrate the telemetered altitude to 0 meters
MEC: Mechanism actuation command	CMD,<TEAM ID>,MEC,<DEVICE> , <ON_OFF>	1. CMD and MEC are static text 2. <TEAM_ID> is the assigned team identification 3. <DEVICE> is defined by the team to identify the specific mechanism 4. <ON_OFF> is the string 'ON' to activate the mechanism and 'OFF' to turn off the mechanism	The MEC command is to be sent to activate a specific mechanism DEVICE is defined by the team to identify the specific mechanism

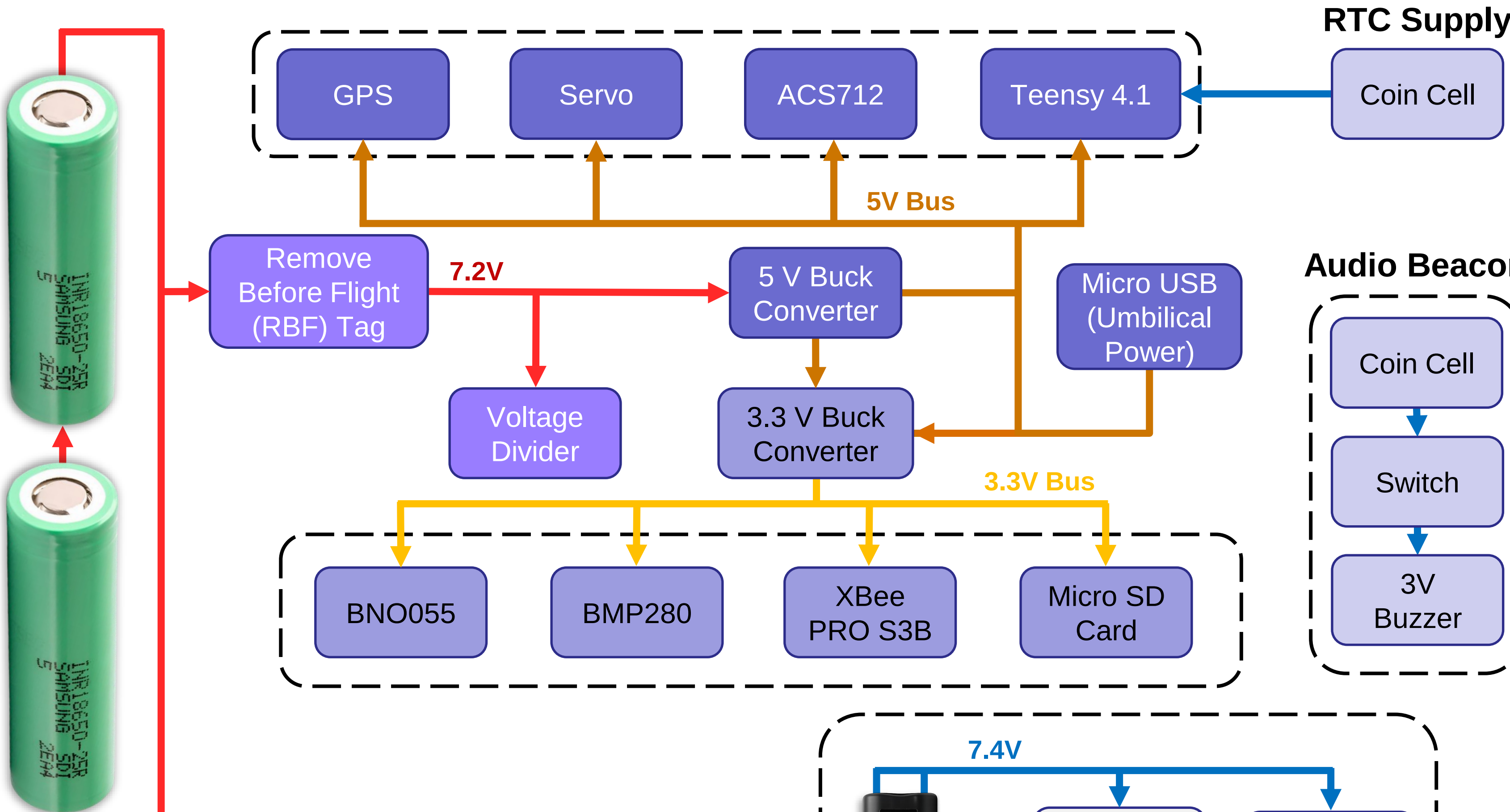
Electrical Power Subsystem (EPS) Design

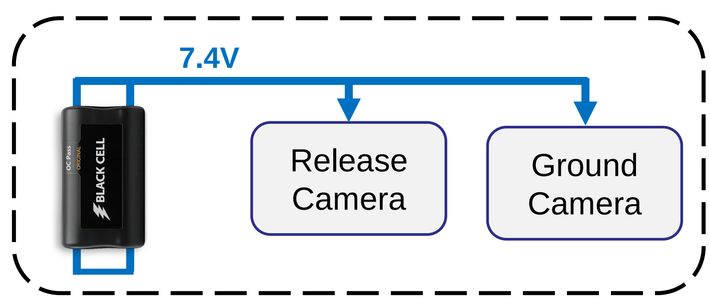
Ax'l Nurrahim

EPS Overview (1/2)

Component	Purpose
Power	• Two Samsung INR18650-25R 3.6V batteries connected in series as main supply of the payload. • 3V coin cell battery is used to supply the internal RTC of the MCU. • The 3.5 mm jack SJ1-3525N acts as a Remove Before Flight (RBF) main supply switch. • 5V buck converter will step down the main supply to 5V for the MCU, sensors, and actuators. • 3.3V buck converter will step down the main supply to 3.3V for the sensors, and radio module. • A 3 mm LED indicates the main power and is supplied from the 5V bus with a resistor. • Micro USB as an umbilical power source for use in testing and safety inspection.
MCU	• Teensy 4.1 will operate all actuators and collect all sensor data. It will be connected to 5V bus. • Micro SD Card will save all sensor data.
Sensors	• BMP280 will collect air pressure, temperature data, and measure the distance from payload to the ground. It will be connected to 3.3V bus. • BNO055 will collect orientation data. It will be connected to 3.3V bus. • U-blox SAM-M10Q to obtain CanSat location. It will be connected to 5V bus. • ACS712 will measure current battery data. It will be connected to 5V bus. • The voltage divider measures battery voltage and is connected to the 7.2V main supply.
Actuators	• Two servos MG90s control the para-glider swing and are connected to the 5V bus. • One servo MG90s operates the instrument release mechanism and is connected to the 5V bus. • One servo MG996R releases the payload from the container and is connected to the 5V bus. • Release camera will record payload release and para-glider control and the ground camera will record ground and instrument release. It will be connected to 7.4V from Blackcell batteries. • A buzzer is used as an audio beacon to help find the payload after landing. It will be connected to a 3V coin cell separated from the CanSat system.
Communications	Data will be sent and received by XBee Pro S3B. The 3.3V buck converter will provide 3.3V to power it.

EPS Overview (2/2)

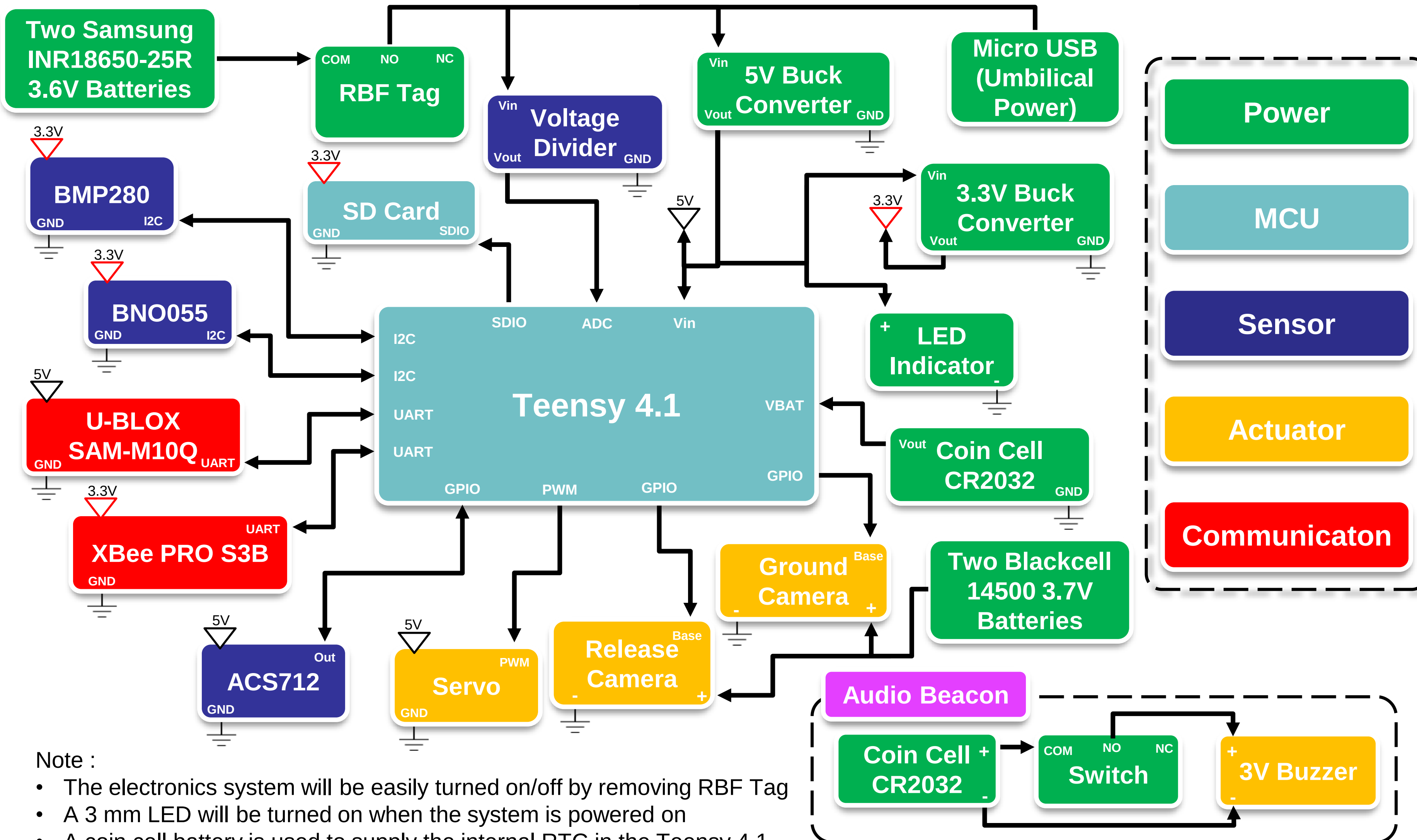




Note :

- Two Samsung INR18650-25R 3.6V batteries connected in series
- Two Blackcell14500 2s 3.7V batteries connected in series

Payload Electrical Block Diagram



Note :

- The electronics system will be easily turned on/off by removing RBF Tag
- A 3 mm LED will be turned on when the system is powered on
- A coin cell battery is used to supply the internal RTC in the Teensy 4.1

Payload Power Trade & Selection (1/3)

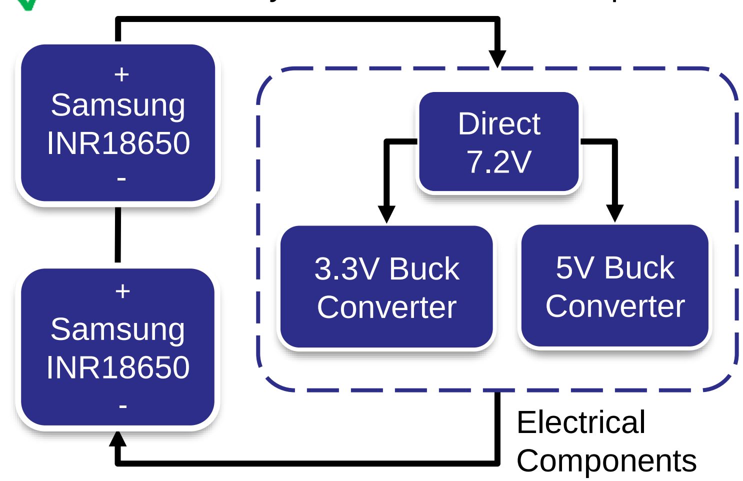
Model	Battery Type	Voltage [V]	Weight [g]	Battery Capacity [mAh]	Maximum Discharge Current [A]	Dimension [mm]		Price [USD]
						Height	Diameter	
Samsung INR18650-25	Lithium Ion	3.6	49.5	2500	20	64.9	18.3	3.68
OLIGHT 18650	Lithium Ion	3.6	48.27	3500	10	69.8	18.5	25.84
Energizer CR123A	Lithium Ion	3.0	16.5	1500	3.5	34.5	17.0	3.06

Selected Payload Battery : **Samsung INR18650-25R** ✓

Reasons:

- Provide the payload with enough power to run for 2 hours
- **Highest maximum discharge**
- High capacity

Two battery will in series to all component



Payload Power Trade & Selection (2/3)

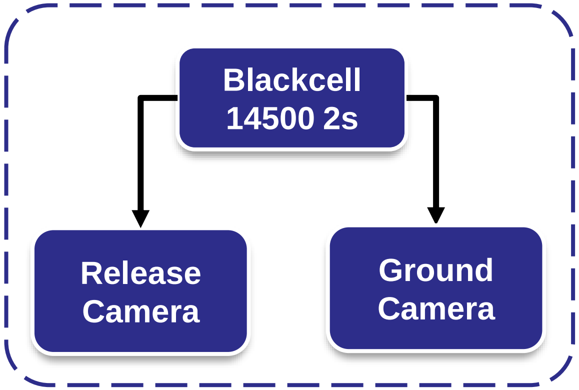
Model	Battery Type	Voltage [V]	Weight [g]	Battery Capacity [mAh]	Maximum Discharge Current [A]	Dimension [mm]		Price [USD]
						Height	Diameter[1]	
Blackcell 14500 2s	Lithium Ion	7.4	45	5000	3	53.3	29.3	5.67
Vapcell F15 14500 2s	Lithium Ion	7.4	52	1500	3	49.3	14.2	8.84

Selected Camera Battery : **Blackcell 14500 2s** ✓

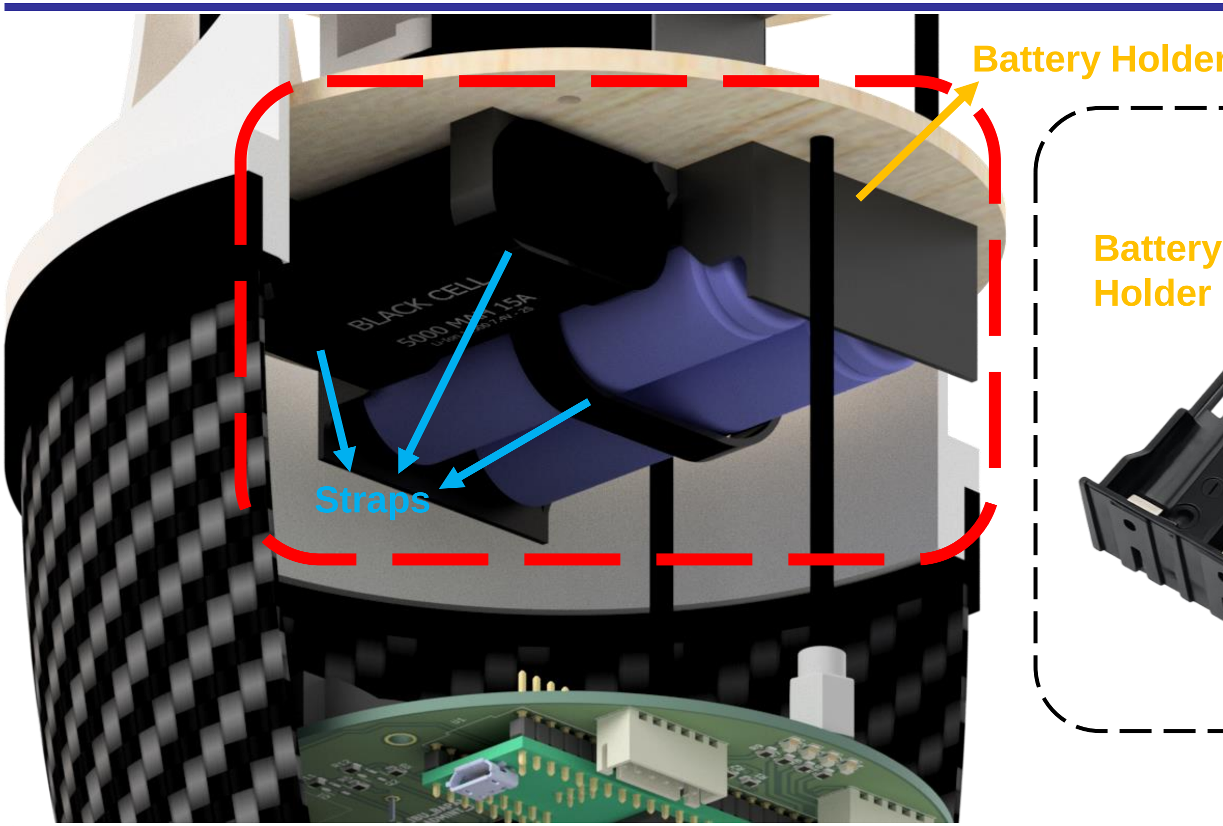
Blackcell 14500 2s that connected in series, will supply the ground camera and release camera

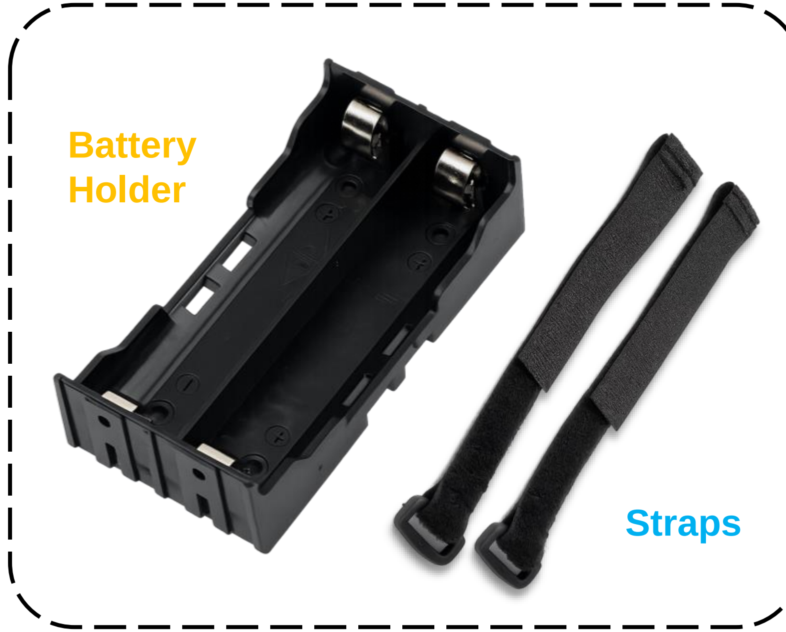
Reasons:

- **Can supply two camera for 2 hours**
- Lightweight
- High capacity



1. The diameter of the Blackcell is measured from the packaging Blackcell 14500 2s (2 battery in series).





Battery Mounting

The battery will be installed in the battery holder inside the nose cone to match the target Center of Mass. The terminals on the battery holder will connect the batteries in series. Straps will be used to make the battery mounting more secure and impact resistant.

Payload Power Budget (1/2)

Main Power Supply : Samsung INR18650-25R

Component	Quantity	Source	Current (mA)	Voltage (V)	Duty Cyles in 1 Hour (%)	Power Consumption (Wh)
Teensy 4.1 (include RTC)	1	Datasheet	100	5	100	0.5
XBee Pro S3B	1	Datasheet	215	3.3	100	0.7095
BMP280	1	Datasheet	0.0027	3.3	100	0.00000891
BNO055	1	Datasheet	12.3	3.3	100	0.04059
Servo MG90s	3	Measured	250	5	50	1.875
SD Card	1	Datasheet	20	3.3	100	0.066
3mm LED	1	Estimated	3	5	100	0.015
Voltage Divider	1	Estimated	0.24	7.2	100	0.001728
U-blox SAM-M10Q	1	Datasheet	12	5	100	0.06
ACS712	1	Datasheet	13	5	100	0.065
Servo MG996R	1	Datasheet	500	5	50	1.25
Total						**4.58282691**
Consumption for 2 Hours						**9.16565382**

Separate Power Supply

Battery	Component	Quantity	Source	Current (mA)	Voltage (V)	Duty Cyles in 1 Hour (%)	Power Consumption (Wh)	Total Consumption for 2 Hours (Wh)
Blackcell 14500 2s	RunCam Split 2	2	Datasheet	440	7.4	100	6.512	**13.024**
Coin Cell CR2032	3V Buzzer	1	Datasheet	30	3	100	0.09	**0.18**

Payload Power Budget (2/2)

Power Supply : Two Samsung INR18650-25R	Energy
Available Power	18 Wh
Power Consumption (2 hours)	9.16565382 Wh
Margins	8.83434618 Wh

Power Supply : Blackcell 14500 2s	Energy
Available Power	37 Wh
Power Consumption (2 hours)	13.024 Wh
Margins	23.976 Wh

Power Supply : Coin Cell CR2032	Energy
Available Power	0.66 Wh
Power Consumption (2 hours)	0.18 Wh
Margins	0.48 Wh

Flight Software (FSW) Design

Adam Kandias

FSW Overview (1/3)

CanSat FSW Tasks

CanSat will collect data from sensors and transmit the data to GCS from launch pad until landed. When the rocket reaches peak altitude, the container with the payload will deploy from the rocket and deploy a parachute at separation. At 80% of peak altitude, the payload will release from the container and descend using a para-glider descent control system until landing.

The payload will steer toward a specified position to drop an egg instrument at 2 meters above the ground, ensuring it lands safely.

There are two main cameras in the payload. The release camera will capture the payload separation and the para-glider control mechanism. The ground camera pointed at 25° downward and showed the ground view during descent and the instrument release.

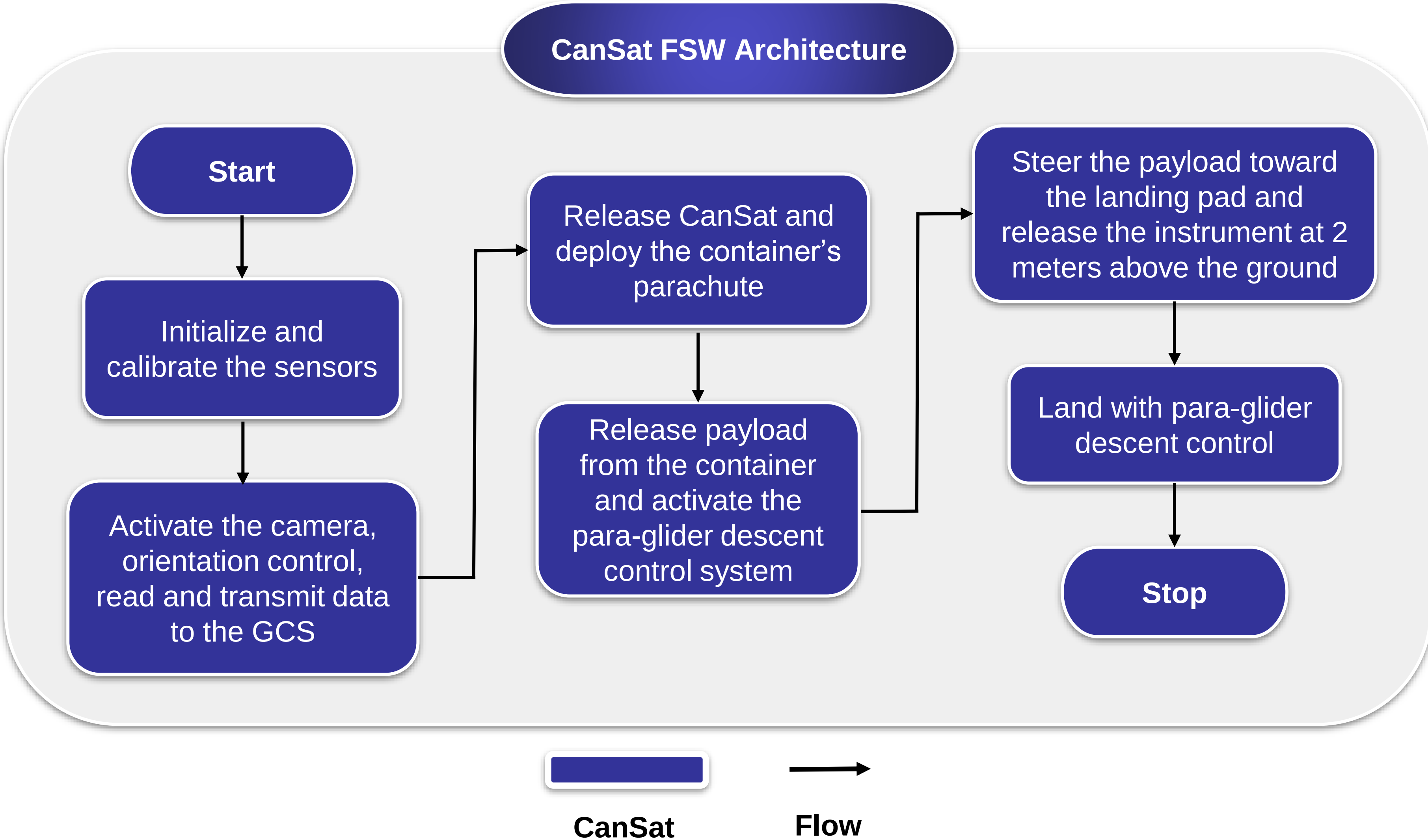
Programming Languages

C/C++

Development Environments

- Visual Studio Code
- PlatformIO
- XCTU
- hTerm

FSW Overview (2/3)

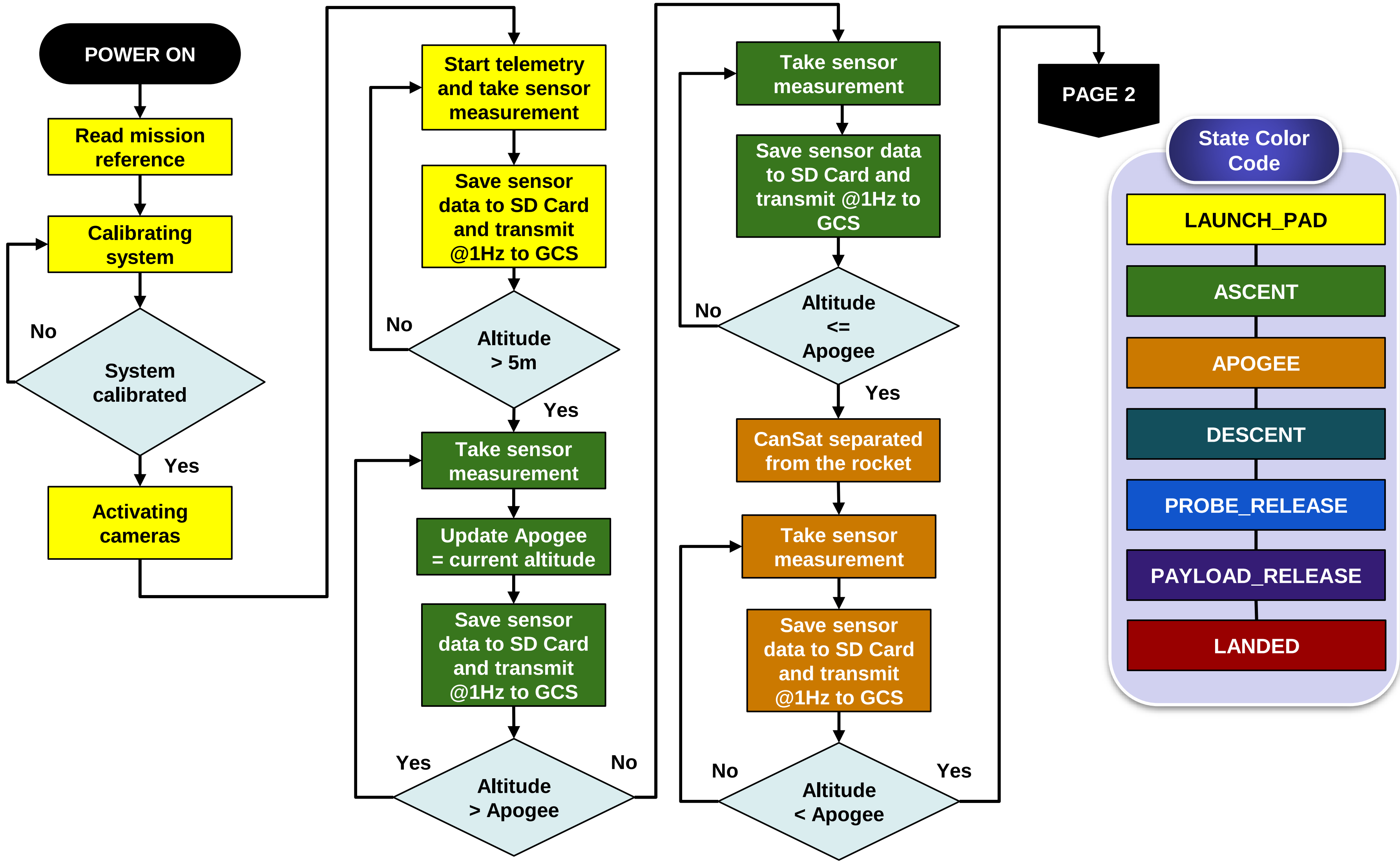


FSW Overview (3/3)

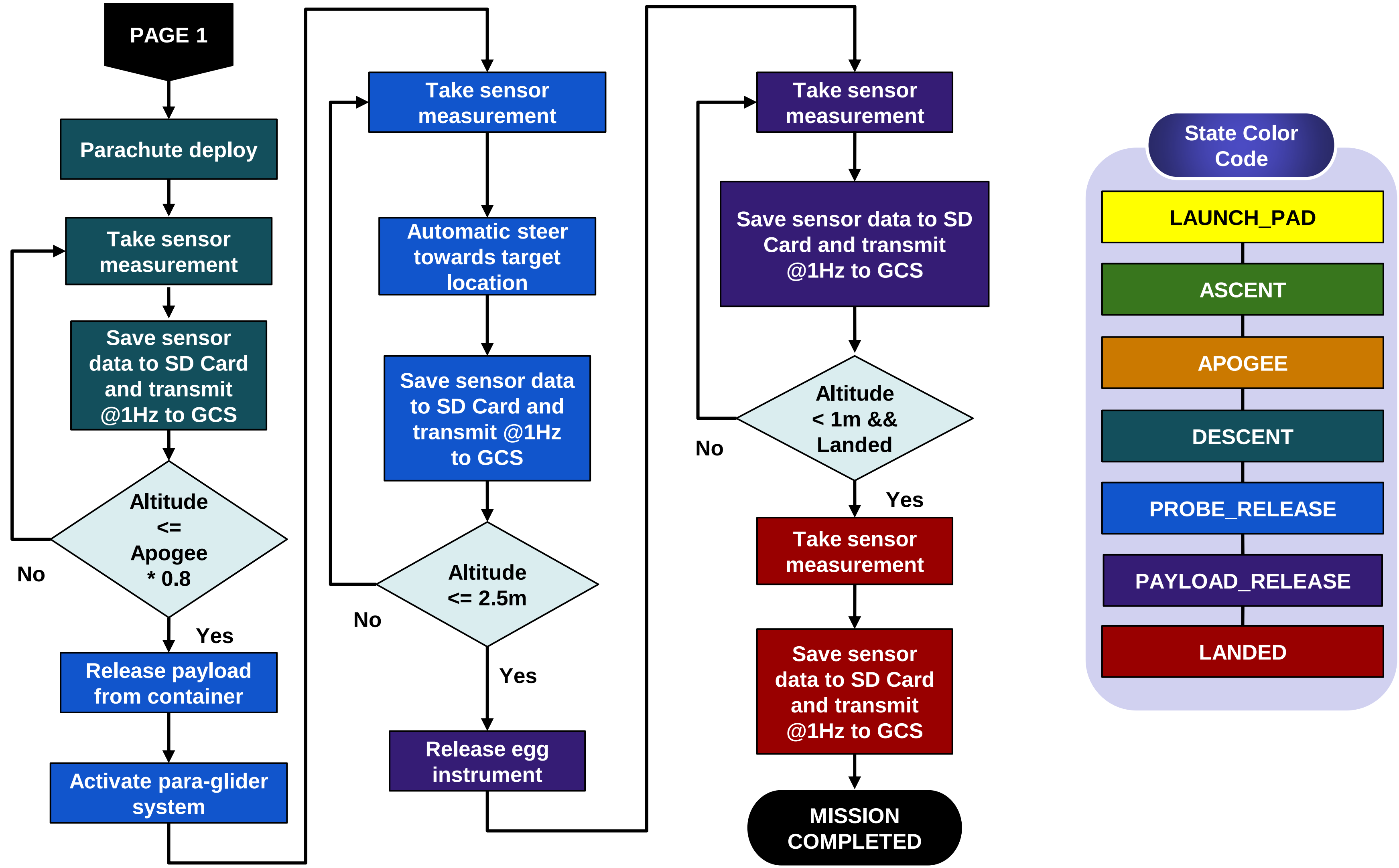
CanSat FSW Tasks

1. The CanSat will set the new mission reference when receiving **CAL** from the GCS and save the calibration data to the SD Card.
2. The CanSat FSW mode will read from the SD Card on the Teensy 4.1. The GCS default mode is flight mode, and when the CanSat receives commands **SIM ENABLE** and **SIM ACTIVATE** from the GCS, the CanSat will enter the simulation mode.
3. When the CanSat enters the **LAUNCH_PAD** state, it will wait for launch and continue transmitting telemetry to the GCS.
4. When the CanSat enters the **ASCENT** state, it will collect sensor data packets and save them to the SD Card, then transmit them @1Hz to the GCS via XBee Pro S3B.
5. When the CanSat reaches peak altitude, the state will change to **APOGEE**, and the container with the payload will separate from the rocket and deploy a parachute. Then the system changes into the **DESCENT** state.
6. At 80% of peak altitude, the payload will release from the container and the state will change to **PROBE_RELEASE**. Then, the payload will activate the para-glider descent control system and steer toward the target position.
7. At 2 meters above the ground, the payload will release the instrument, and the state will change to **PAYLOAD_RELEASE**. After touchdown, the CanSat will enter the **LANDED** state.
8. The Mission will be completed

Payload FSW State Diagram (1/4)



Payload FSW State Diagram (2/4)



Payload FSW State Diagram (3/4)

Mechanism Activation

At launch pad, Teensy 4.1 will activate:

- The release camera to record the payload release and para-glider descent control mechanism.
- The ground camera will be pointing 25° downward to record the descent view and instrument release.

At 80% of peak altitude, the servo system will activate:

- Payload release mechanism for separating the payload from the container.
- Para-glider descent control system, allowing steering toward the landing pad.

At 2 meters above ground:

- The instrument release mechanism will activate to release the egg.

Major Decision Points in The Logic

The altitude will be the major decision parameter among other parameters used as consideration.

Data Storage

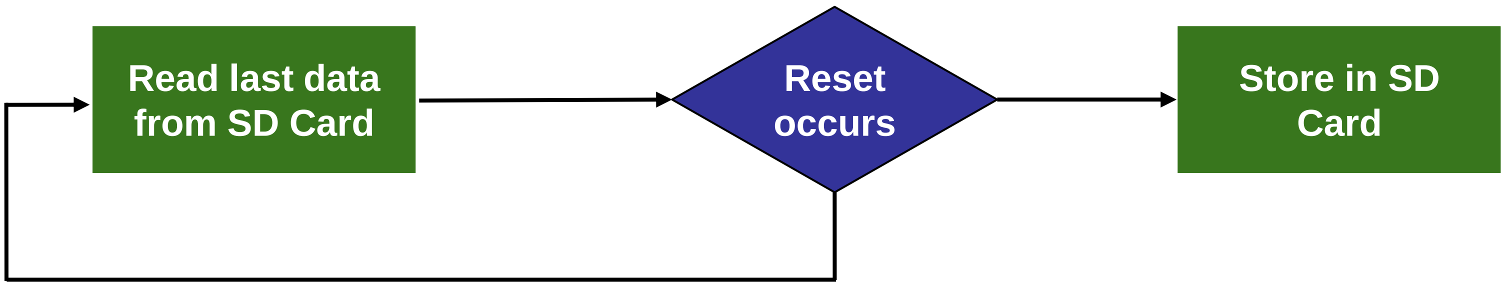
- Video and backup telemetry data will be stored on the SD card.
- SD card is used for recovery after reset.

Sampling of Sensors

The data sensor will be sampled @1 Hz (1000ms).

Communications

- Communicates using the Taoglas FXP290 Antenna and transmits data to the ground station.
- All commands will be included in CDH.



Payload Data Recovery

Teensy 4.1 will recover (stored in SD Card):

- Packet count
- Last state
- Command echo
- Reference altitude

Reason for reset:
Temporary power loss occurs.

Power Management:
The payload system is powered by two Samsung INR18650 25R 2500mAh batteries, capable of sustaining the system for over two hours of operation including telemetry and para-glider control system.

Simulation Mode Software (1/2)

SIMULATION MODE

- ➢ Simulation mode is used for testing, pre-flight demonstration, and contingency conditions, when launch operations are not possible. The telemetered pressure sensor data shall reflect the commanded simulation values, not the actual sensor readings.
- ➢ To activate the simulation mode, the GCS must send **SIM ENABLE** followed by **SIM ACTIVATE** to the CanSat.
- ➢ The values other than pressure and altitude (calculated from the pressure values) will remain actual sensor readings. The relayed CanSat telemetry will contain actual sensor values.
- ➢ The barometric pressure data will be read from a .csv file in the GCS and transmitted to the CanSat at a rate of 1 data per second (1 Hz).
- ➢ After simulation mode is active, the flight software will receive barometric pressure sensor commands (**SIMP**) from the GCS and use the received values as if they were actual barometric pressure readings. These simulated values will be used in the altitude calculation and determination of software states.
- ➢ After the GCS sends **SIM DISABLE**, the flight software will switch back to flight mode.

Simulation Mode Software (2/2)

SIMULATION MODE COMMAND

CMD,<TEAM_ID>,SIM,<MODE>

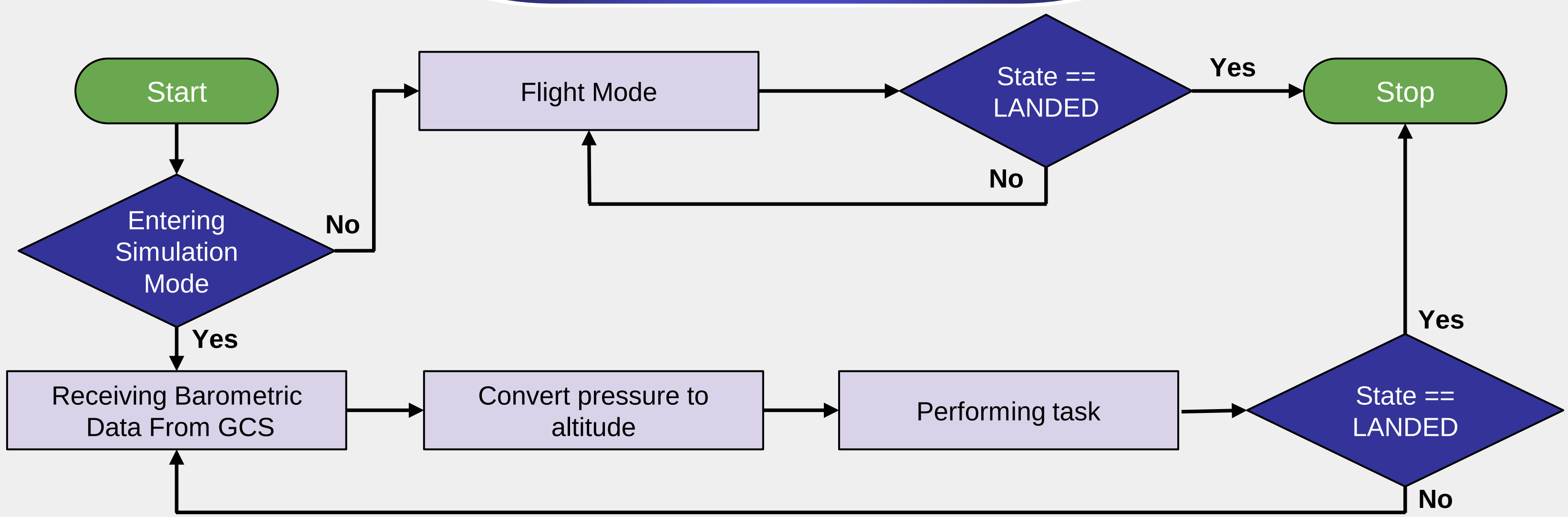
<MODE> consists of :

- **‘ENABLE’** to enable simulation mode;
- **‘ACTIVATE’** to activate simulation mode; or
- **‘DISABLE’** to disable and deactivate simulation mode.

CMD,<TEAM_ID>,SIMP,<PRESSURE>

- This command provides a simulated pressure reading to the CanSat.
- <PRESSURE> is the simulated atmospheric pressure data in units of pascals with a resolution of one Pascal.

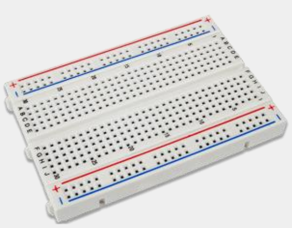
SIMULATION MODE FLOWCHART



Software Development Plan (1/4)

PROTOTYPING PROCEDURE AND PROTOTYPING ENVIRONMENT

Subject	Prototyping Environment	Prototyping Procedure
Teensy 4.1	PlatformIO	Programming and debugging are done in Platform IO and the data will be monitored in hTerm
Sensors	Breadboard and PCB	Each sensor is tested on the breadboard separately



Software Development Plan (2/4)

SOFTWARE SUBSYSTEM DEVELOPMENT SEQUENCE

Subsystem	Development Sequence
Sensors	● **Sensor trade and selection** - select the best sensors for our application. ● **Individual sensor programming** - program CanSat sensor with PlatformIO.
State Mechanism	Integrate all sensors and test it in the state mechanism.
XBee Telemetry	**Testing GCS and CanSat communication** - configure and test all CanSat sensors to ensure telemetry data is transmitted successfully to the GCS.
Para-glider Control Mechanism	Program and test the para-glider descent control system, including steering control to ensure payload toward the landing pad.
Instrument Release Mechanism	Program and test the instrument release mechanism, ensuring accurate release at 2 meters above ground level.
Integrate all	Integrate all software subsystems to ensure proper functionality and seamless operation of the entire system

Development Team	
1. Ax'l Nurrahim	2. Adam Kandias

Software Development Plan (3/4)

TEST METHODOLOGY

1. Necessary software is installed such as Visual Studio Code and PlatformIO to help the software development
2. Telemetry software tests are simulated using XCTU
3. Sensors and hardware were tested separately
4. Test the state mechanism for the CanSat
5. Test the system recovery for the CanSat
6. Test the telemetry data and communication commands using hardware
7. Test the flight mode software using GCS
8. Test the simulation mode software using GCS
9. Check whether the FSW meets the competition requirements
10. Test integrated sensors and hardware according to the mission

Software Development Plan (4/4)

PLANS TO REDUCE THE RISK OF LATE SOFTWARE DEVELOPMENT

- Apply sprint-based development for each subsystem and test software as soon as possible.
- Weekly meeting to review and check progress also identify and fix issues quickly.
- Using collaboration tools for easy collaboration and tracking progress.

USED TOOLS

GITHUB

Centralized code repository, version control, and issue tracking.

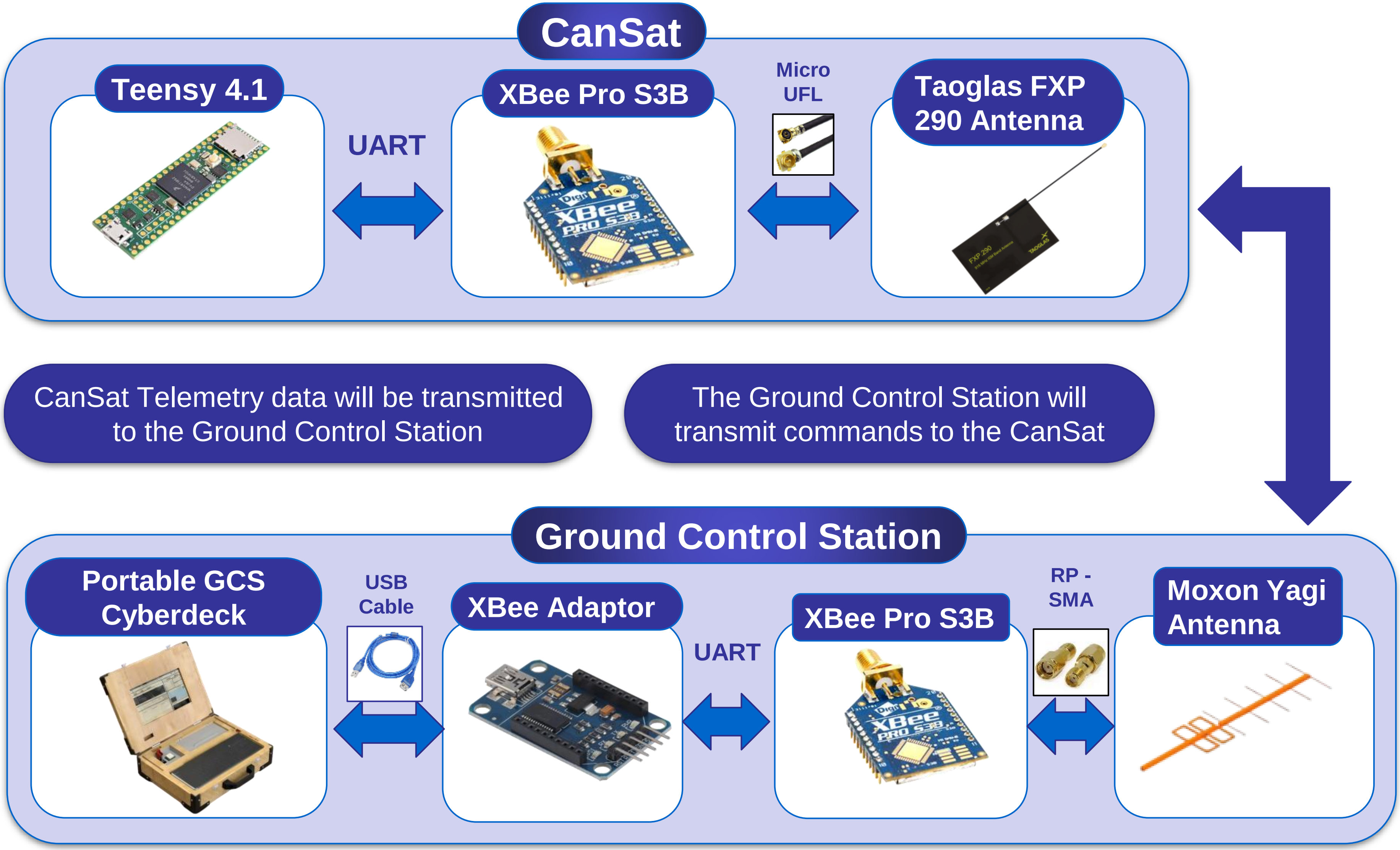
NOTION

Kanban board for task management, documentation, and milestone tracking.

Ground Control System (GCS) Design

Adam Kandias

GCS Overview



GCS Design

Connected Components

Portable GCS Cyberdeck

USB Cable

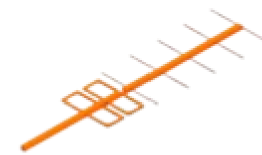
XBee Adaptor

UART

XBee Pro S3B

RP - SMA

Moxon Yagi Antenna



Specifications

Battery

The Portable GCS Cyberdeck can run for 2 hours on battery when fully charged.

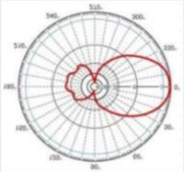
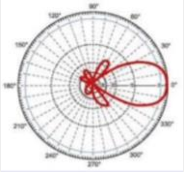
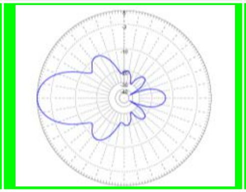
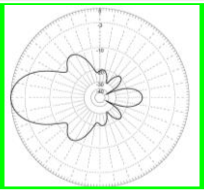
Overheating Mitigation

To prevent overheating, a cover enclosure will be attached to shield the Portable GCS from direct sunlight. Additionally, added internal fan to make sure the air circulation work properly.

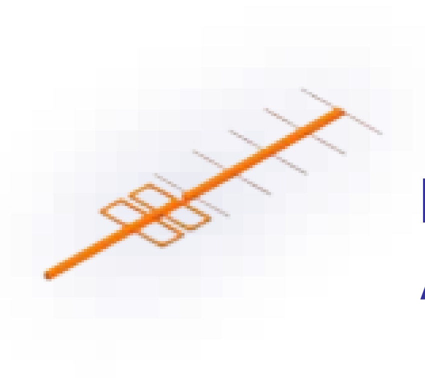
Auto Update Mitigation

Use Raspberry Pi OS, especially Debian Linux-based, so there's no auto update feature.

GCS Antenna Trade & Selection (1/2)

Model	Frequency Rate (MHz)	Gain (dBi)	Beamwidth (Horizontal/ Vertical)	Direction	Range (km)	Cost ($)	Antenna Pattern	
							Horizontal	Vertical
Yagi-22/0 Antenna	915	9	36°/35°	Directional	~2.5	15.70		
Moxon Yagi Antenna	915	10.5	40°/45°	Directional	~3.5	5.88		

Selected Antenna



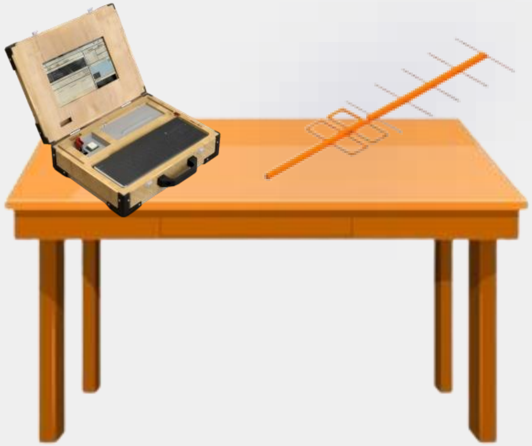
Moxon Yagi Antenna ✓

Reasons

- Offers more directional beamwidth range
- Easy to carry and handle
- More affordable and easy to hold
- More proven performance in previous competitions

Handheld Antenna ✓

Table Top Antenna



Selected Mounting Antenna Design

Handheld Antenna ✓

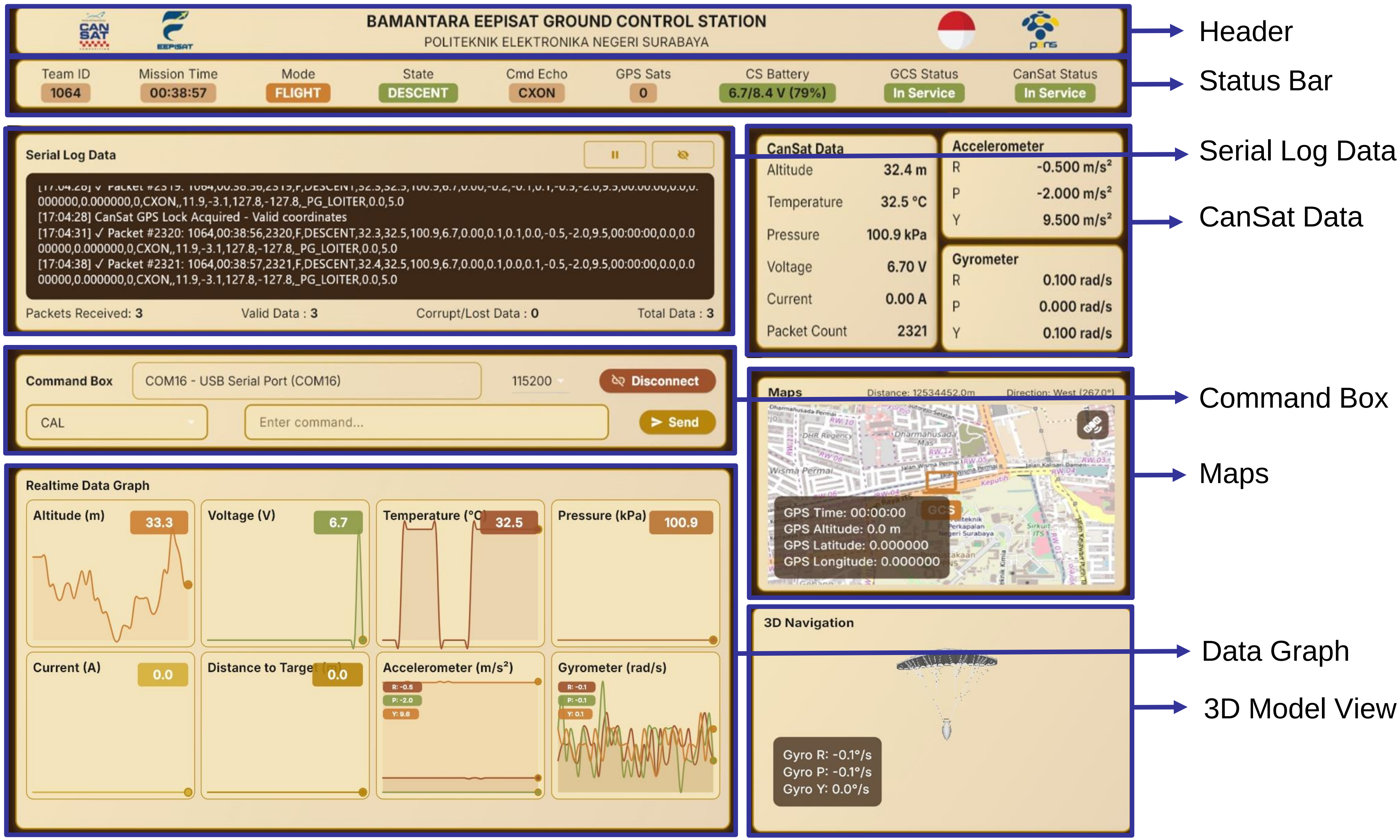
Reasons

The antenna will be handheld to aid targeting and minimize data loss, as the payload height will be constantly dynamic and varying.

GCS Software (1/4)

Telemetry Display Prototypes	The Ground Station will display real time telemetry data from CanSat through labels, chart, 3D models, and a map.
Commercial Off The Self (COTS) Software Packages Used	● Visual Studio Code ● Flutter ● XCTU
Real-Time Plotting Software Design	Telemetry data from serial port will be transferred to the Portable GCS Cyberdeck through USB port, processed in Flutter with libserialport library and fl_chart for display the telemetry data in charts.
Command Software and Interface	There will be a command text box that will allow to send commands to start telemetry communication, calibrate all telemetry data, and a dropdown that contains command header.
Telemetry Data Recording and Media Presentation	The judges will be given media data recorded from the CanSat using the camera along with screenshots of the interface, and CanSat telemetry data in the form of a .csv file via a USB memory storage device.
Describe .csv Telemetry File Creation	● All telemetry data will be saved as .csv (Comma Separated Value) files, where data is separated by comma. ● CSV file name will be Flight_<TEAM_ID>.csv
Simulation Mode Description	The GCS will control the CanSat using SIM ENABLE and SIM ACTIVATE commands, then read the barometric pressure data from the csv file and communicate it to the flight software with interval of one second via the Simulated Pressure data Command

GCS Software (2/4)



GCS Software (3/4)

Mission Progress

LAUNCH PAD | ASCENT | APOGEE | DESCENT | PROBE RELEASE | PAYLOAD RELEASE | LANDED

→ Mission Progress

Data Table

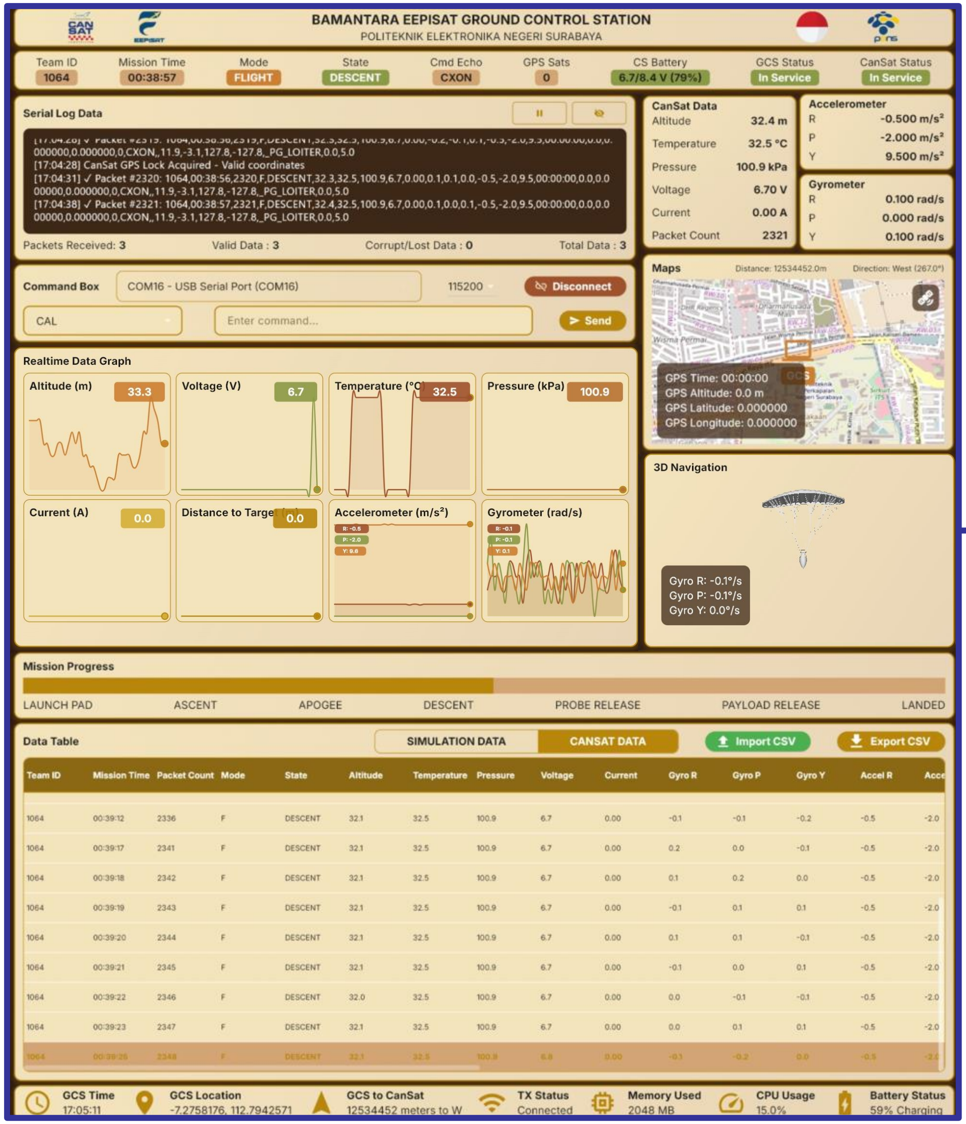
SIMULATION DATA | CANSAT DATA | Import CSV | Export CSV

Team ID	Mission Time	Packet Count	Mode	State	Altitude	Temperature	Pressure	Voltage	Current	Gyro R	Gyro P	Gyro Y	Accel R	Acce
1064	00:39:12	2336	F	DESCENT	32.1	32.5	100.9	6.7	0.00	-0.1	-0.1	-0.2	-0.5	-2.0
1064	00:39:17	2341	F	DESCENT	32.1	32.5	100.9	6.7	0.00	0.2	0.0	-0.1	-0.5	-2.0
1064	00:39:18	2342	F	DESCENT	32.1	32.5	100.9	6.7	0.00	0.1	0.2	0.0	-0.5	-2.0
1064	00:39:19	2343	F	DESCENT	32.1	32.5	100.9	6.7	0.00	-0.1	0.1	0.1	-0.5	-2.0
1064	00:39:20	2344	F	DESCENT	32.1	32.5	100.9	6.7	0.00	0.1	0.1	-0.1	-0.5	-2.0
1064	00:39:21	2345	F	DESCENT	32.1	32.5	100.9	6.7	0.00	-0.1	0.0	0.1	-0.5	-2.0
1064	00:39:22	2346	F	DESCENT	32.0	32.5	100.9	6.7	0.00	0.0	-0.1	-0.1	-0.5	-2.0
1064	00:39:23	2347	F	DESCENT	32.1	32.5	100.9	6.7	0.00	0.0	0.1	0.1	-0.5	-2.0
1064	00:39:25	2348	F	DESCENT	32.1	32.5	100.9	6.8	0.00	-0.1	-0.2	0.0	-0.5	-2.0

→ Data Table

GCS Time 17:05:11 | **GCS Location** -7.2758176, 112.7942571 | **GCS to CanSat** 12534452 meters to W | **TX Status** Connected | **Memory Used** 2048 MB | **CPU Usage** 15.0% | **Battery Status** 59% Charging

→ Footer



GCS Software
Full Screen View

CanSat Integration and Test

Lintang Arum Sari

CanSat Integration and Test Overview

Subsystem Level	Integrated Level Functional	Environmental	Simulation
❑ Sensors ❑ CDH ❑ EPS ❑ Radio communications ❑ FSW ❑ Mechanical ❑ Descent Control	❑ Descent testing ❑ Communications ❑ Mechanisms ❑ Deployment	❑ Drop test ❑ Thermal test ❑ Vibration test ❑ Fit Check ❑ Vacuum test	❑ GCS ❑ Flight Software

Preparing of Required Test Condition → Component Testing of Each Subsystem → Subsystem Level Testing → Integrated Level Functional Testing → Environmental Testing

Subsystem Level Testing Plan

Sensors	▪ Functional tests of the sensors on the breadboard. ▪ High-accuracy sensor calibration.
CDH	▪ XBee data transfer range and configuration. ▪ Verify the data's accuracy and speed of transmission to the ground station. ▪ Ensure that the data format follows the mission guide.
EPS	▪ Testing each component to ensure proper operation. ▪ Testing that power can fulfill the demand for electronic components. ▪ Inspect electronics for damage such as short circuits.
Radio Communications	▪ Antenna range test. ▪ Beam and stability of communication testing.
FSW	▪ Accuracy of the data received from sensors and camera. ▪ Maintain recovery data in case of a microcontroller resets. ▪ Flight Algorithm test. ▪ State testing.
Mechanical	▪ CanSat release mechanism test. ▪ Ensure the component of CanSat can survive when it's launched. ▪ Ensure the CanSat structure survived when it's landed. ▪ Ensure the CanSat protect an egg instrument from damage during all portions of the flight. ▪ Servo will be inspected carefully to ensure freedom of operation.
Descent Control	▪ CanSat stability drop test. ▪ Parachute system test. ▪ CanSat aerobraking test.

Integrated Level Functional Test Plan

Descent Testing	▪ The purpose of this test is to ensure that CanSat descends at the speed defined in the mission guide. The egg must survive without breaking through all portions of flight and the payload must land in the target position. ▪ We will drop a 1000 g of CanSat +/- 10 g without the egg from the top of the buildings using a parachute to test its descent rate.
Communications	▪ The purpose of this test is to ensure that the communication system is functional. ▪ We will use flight software to communicate with the XBee at 1Hz for the CanSat at various ranges. The data must be shown in the GCS monitor. ▪ This test will be performed in a crowded area to ensure that the signal is not disturbed.
Mechanisms	▪ The purpose of this test is to ensure that the CanSat can be released from the rocket and the para-glider mechanism operates correctly. ▪ Verify that the CanSat's para-glider mechanism is succeed. ▪ Ensure the CanSat deploys a heat shield after leaving the rocket and land with the egg intact.
Deployment	• Parachute deployment will be tested at various altitude. • CanSat deployment at various altitude. • Check for any sharp edges or obstacles that could prohibit CanSat from being deployed.

Drop Test

This test is designed to verify that the CanSat parachute and attachment point will survive the deployment from the rocket section which can be very violent.

I. Power on CanSat.
II. Verify telemetry is being received.
III. Raise CanSat by the attached cord, so that the attachment points of the cord, on the eye bolt and the parachute, are at the same height.
IV. Release the CanSat.
V. Verify the CanSat did not lose power.
VI. Inspect for any damage, or detached parts.
VII. Verify telemetry is still being received.

(CanSat mission guide)

Drop Test Frame

Environmental Test Plan (2/5)

Thermal Test

This test is to verify the CanSat can operate in a hot environment. The heat source will be provided by a thermal chamber and a hot air gun.

I. Place CanSat into a thermal chamber.
II. Turn on the CanSat.
III. Close and seal the thermal chamber.
IV. Turn on the heat source.
V. Monitor the temperature and turn off the heat source when the internal temperature reaches 60 °C and turn on the heat source when the temperature drops to 55 °C.
VI. Maintain the test conditions for two hours.
VII. 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.
VIII. With the CanSat still hot, test any mechanisms and structures to make sure the integrity has not been compromised. Take precautions to avoid injury.
IX. Verify epoxy joints and composite materials still maintain their strengths.

(CanSat mission guide)

EEPISAT's Thermal Chamber

Vibration Test

This test is designed to verify the mounting integrity of all components, mounting connections, structural integrity, and battery connections. The vibration will be tested with a RK3000 Vertical Vibration Meter.

I. Power on the CanSat.
II. Verify accelerometer data is being collected.
III. Power up the vibration machine.
IV. Once the vibration machine is up to full speed, wait 5 seconds.
V. Power down the vibration machine to a full stop.
VI. Repeat steps iii to v four more times.
VII. Inspect the CanSat for damage and functionality.
VIII. Verify accelerometer data is still being collected.
IX. Power down CanSat.

(CanSat mission guide)

RK3000 Vertical Vibration Meter

Environmental Test Plan (4/5)

Fit Check

This test is designed to verify if the CanSat is able to fit in the rocket. To ensure that CanSat fits in the rocket and reduces the possibility of deployment failure, we use vernier caliper to control the accuracy of CanSat's diameter with a margin of error.

(CanSat mission guide)

Vernier Caliper

Environmental Test Plan (5/5)

Vacuum Test

This test is designed to verify deployment operation of the CanSat.

I. Suspend the fully configured and powered CanSat in the vacuum chamber.
II. Turn on the vacuum to start pulling a vacuum.
III. Monitor the telemetry and stop the vacuum when the peak altitude has been reached.
IV. Let the air enter the vacuum chamber slowly and monitor the operation of the CanSat.
V. Collect and save telemetry.
VI. Make the saved telemetry available for the judges to review.

(CanSat mission guide)

EEPISAT's Vacuum Chamber

Simulation Test Plan

GCS

This test is designed to verify if the Ground Station is capable of reading a .csv file of barometric pressure data that simulates the mission profile and transmitting the values to the CanSat at a rate of one data per second (1 Hz) via commands. We will put it to the test by preparing barometric data in .csv file. The **Simulated Pressure Data** command will read data containing a barometric pressure value and transmit it to the flight software at one second interval (1 Hz) to start simulating altitude. GCS will receive the converted altitude value from the flight software.

Flight Software

This test is designed to verify that the GCS barometric pressure data will converted in altitude. We will enable simulation mode with **ENABLE** command from GCS. After that, we begin the simulation mode with **ACTIVATE** command to stop reading pressure from the sensor system. Substituting the data of the sensor with .csv file from the committee and make sure it transmitted to GCS in altitude data. At 101325 Pascals (approximately sea level) barometric data will be saved to SD Card as an altitude ground level reference.

Mission Operations & Analysis

Lintang Arum Sari

Overview of Mission Sequence of Events (1/4)

1. Arrival

- Team arrival at the launch site.
- GCS and antenna setup.
- Check for any damages that may occur during travel.

2. Pre-Launch

- Communication inspection.
- Mechanism inspection.
- Assembly of the CanSat.
- Check the CanSat dimension and weight.

3. Rocket Integration

- Final CanSat inspection completed before launch.
- Turn on the CanSat, integrate it into the rocket, and ensure communication with GCS.

Overview of Mission Sequence of Events (2/4)

4. Mission	▪ CanSat in a rocket launch. ▪ Flight monitoring. ▪ Display GCS to the judges and collect telemetry data during the mission. ▪ Recovery crew preparation.
5. Recovery	▪ CanSat recovery by location from last telemetry and buzzer. ▪ Inspection of CanSat damage. ▪ Retrieve data from SD Card in the CanSat.
6. Data Analysis	▪ GCS data analysis and acquisition. ▪ Deliver SD Card and telemetry data to judges for scoring. ▪ Evaluation team for launch day. ▪ PFR preparation.

Overview of Mission Sequence of Events (3/4)

Mission Control Officer	**Personnel:** **Lintang Arum Sari** *(Responsible for informing the Flight Coordinator when the team and their CanSat is ready to be launched)*
Ground Station Crew	**Personnel :** **Adam Kandias** *(Responsible for monitoring the ground station for telemetry reception and issuing commands to the CanSat)*
Recovery Crew	**Personnel :** **Rafida Azis Al Habib, Muhammad Tsaqif Mukhayyar** *(Responsible for tracking the CanSat and going out into the field for recovery and interacting with the field judges)*
CanSat Crew	**Personnel :** **Muhammad Rizky, Ax'l Nurrahim** *(Responsible for preparing the CanSat, integrating it into the rocket, and Verifying its status)*

Overview of Mission Sequence of Events (4/4)

Antenna Construction and Ground System Setup

The Ground Control Station will use the Moxon Yagi antenna and the XBee Pro S3B via an USB adapter for quickly execute the communication with CanSat on the launch day. We will use a laptop cover for overheat mitigation and prevent the screen from sun glare.

CanSat Assembly and Test

Right before the CanSat turn in, we will perform the sensor and communication testing, mechanism testing, and simulation testing at the launch site to ensure the system working properly.

Mission Operations Manual Development Plan

Mission Operational Manual	Description
Ground Station Configuration	System setup and communication test, antenna communication test.
CanSat Preparation	CanSat general inspection, fit check and major mechanism inspection.
CanSat Integration into Rocket	CanSat final inspection and clearance before integration into rocket.
Launch Preparation Procedure	Document is provided by CanSat competition.
Launch Procedure	Document is provided by CanSat competition.
Removal Procedure	Recovery and data acquisition.

CanSat Location and Recovery

CanSat Recovery

- ❖ Recovery crew will maintain visual contact with the CanSat to aid recovery.
- ❖ We will provide team details on CanSat's outside construction.
- ❖ We also use GPS to track the CanSat.
- ❖ The color of the CanSat and parachute is orange.
- ❖ CanSat has a buzzer that will continuously buzz when it lands.

CanSat COMPETITION 2026
Team #1064 BAMANTARA EEPISAT
eepisatindonesia@gmail.com
+62 858-0670-8945
PENS Campus, Surabaya,
East Java, Indonesia

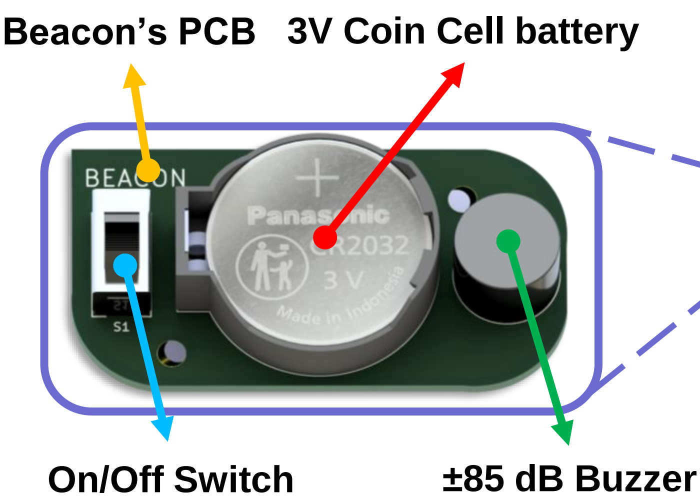
*This address labeling will be placed on our CanSat's body

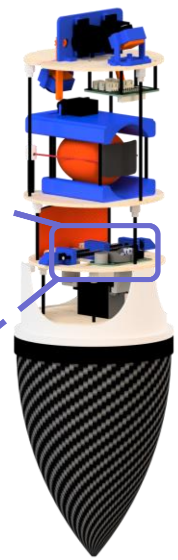
Audio Beacon Information

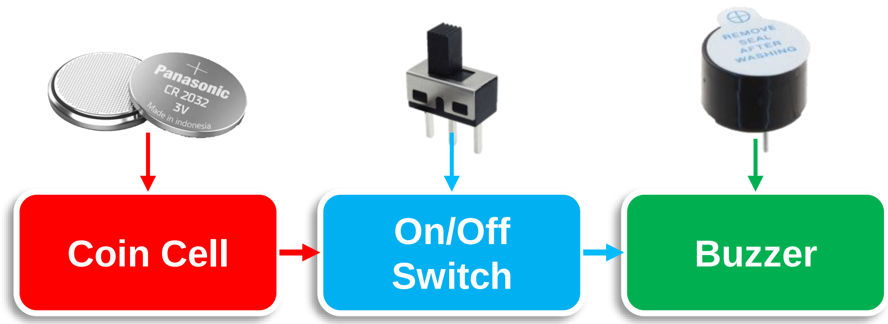
- Audio beacon using separated battery such as 3V coin cell battery to power the buzzer
- Audio beacon has an easy accessible on/off switch.
- Audio beacon is totally separated from main electronics CanSat system.
- ±85 dB buzzer is selected so that we can easily hear it even at further distances.

Audio Beacon Power Budget

Model	Quantity	Operating Voltage	Duty Cycle	Available Power	Power Consumption	Margin	Source
Audio Beacon	1	3V	100%	0.66 Wh	0.18 Wh (2 Hours)	0.48 Wh	Datasheet







- Last up to 7 hours
- Custom PCB Beacon for better quality and protection
- Audio beacon placed next to payload release mechanism

Requirements Compliance

Fatma Aliea Wibowo

Requirements Compliance Overview

We designed and created CanSat by analyzing and identifying the CanSat Mission Guide 2026. The system will be tested in compliance with the CanSat Integration and Test section.

- We have complied with 82 requirements based on the CanSat Mission Guide 2026.
- There are 5 partial compliances that will require further testing. We need to build some prototypes in order to fully comply with these requirements that were only partially met.
- There are not any requirements that don't comply with our design.

(Comply)

(Partial)

(No Comply)

Requirements Compliance (1/13)

Operation Requirements				
RN	**Requirement**	**Compliance**	**Ref Slides**	**Notes**
C1	The CanSat payload shall function as a nose cone during the rocket ascent portion of the flight.	Comply	23	
C2	The CanSat container shall be mounted on top of the rocket with the shoulder section inserted into the airframe	Comply	24	
C3	The CanSat payload and container shall be deployed from the rocket when the rocket motor ejection charge fires.	Comply	23	
C4	After deployment, the CanSat payload and container shall descend at 15 m/s using a parachute that automatically deploys. Error is +/- 3 m/s.	Comply	52	
C5	At 80% flight peak altitude, the payload shall be released from the container.	Comply	23	
C6	At 80% peak altitude, the payload shall deploy a para-glider descent control system.	Comply	23	
C7	The payload shall descend at 5 m/s averaged over the entire descent within +/- 3 m/s with the para-glider descent control system.	Comply	52	
C8	The payload shall steer toward a target location.	Comply	23	
C9	The sensor telemetry shall be transmitted at a 1 Hz rate	Comply	100	

Requirements Compliance (2/13)

Operation Requirements				
RN	**Requirement**	**Compliance**	**Ref Slides**	**Notes**
C10	The payload shall record video of the release of the payload from the container and the deployment of the para-glider descent control system	Comply	76 - 78	
C11	A second video camera shall point at the ground.	Comply	79 - 81	
C12	The payload shall release a protected hens egg when the payload is 2 meters +/- 0.5 m above the ground without breaking the egg.	Comply	85	
C13	The CanSat payload shall include an audible beacon that is turned on separately and is independent of the CanSat battery and electronics.	Comply	88	
C14	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost of the CanSat. Equipment from previous years shall be included in this cost, based on current market value.	Comply	176	

Requirements Compliance (3/13)

Structural Requirements				
RN	Requirement	Compliance	Ref Slides	Notes
S1	The CanSat and container mass shall be 1000 grams +/- 10 grams.	Comply	91	
S2	The nose cone shall be symmetrical along the thrust axis.	Comply	60 - 62	
S3	Nose cone radius shall be exactly 70 mm	Comply	60 – 62	
S4	Nose cone shoulder length shall be a minimum of 50 mm	Comply	60 – 62	
S5	The nose cone shall be made as a single piece. Segments are not allowed.	Comply	60 – 62	
S6	The nose cone shall not have any openings allowing air flow to enter	Comply	60 – 62	
S7	The nose cone height shall be a minimum of 76 mm.	Comply	60 – 62	
S8	CanSat structure must survive 15 Gs vibration.	Partial	145	We have not integrated our CanSat
S9	CanSat shall survive 30 G shock.	Partial	143	We have not integrated our CanSat

Requirements Compliance (4/13)

Structural Requirements				
RN	Requirement	Compliance	Ref Pages	Notes
S10	The container shoulder length shall be 90 to 120 mm.	Comply	63 – 65	
S11	The container shoulder diameter shall be 136 mm.	Comply	63 – 65	
S12	Above the shoulder, the container diameter shall be 140 mm	Comply	63 – 65	
S13	The container wall thickness shall be at least 2 mm when 3D printed and must not flex or be deformed when under stress.	Comply	63 – 65	
S14	The container length above the shoulder shall be 200 mm +/- 5%.	Comply	63 – 65	
S15	The CanSat shall perform the function of the nose cone during rocket ascent.	Comply	23	
S16	The CanSat container can be used to restrain any deployable parts of the CanSat payload but shall allow the CanSat to slide out of the payload section freely	Comply	24	
S17	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	88	
S18	The CanSat container shall meet all dimensions in section F	Comply	18	

Requirements Compliance (5/13)

Structural Requirements				
RN	**Requirement**	**Compliance**	**Ref Pages**	**Notes**
S19	The CanSat container materials shall meet all requirements in section F.	**Comply**	59	
S20	If the nose cone is to separate from the payload after payload deployment, the nose cone shall descend at no more than 5 m/s.	**Comply**	23	
S21	If the nose cone is to separate from the payload after payload deployment, the nose cone shall be secured to the payload until payload deployment with a pull force to survive at least 15 Gs acceleration.	**Partial**	60	Theoretically complies

Requirements Compliance (6/13)

Mechanism Requirements				
RN	**Requirement**	**Compliance**	**Ref Pages**	**Notes**
M1	No pyrotechnical or chemical actuators are allowed.	**Comply**	19	
M2	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting the vegetation on fire.	**Comply**	19	
M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.	**Partial**	142 – 146	Theoretically Complies
M4	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	**Comply**	88	

Requirements Compliance (7/13)

Electrical Requirements				
RN	**Requirement**	**Compliance**	**Ref Pages**	**Notes**
E1	Lithium polymer batteries are not allowed.	Comply	111	
E2	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	111	
E3	An easily accessible power switch through the container is required	Comply	88	
E4	The container shall have small access holes for power switches of no more than 10 mm.	Comply	20	
E5	Power indicator is required.	Comply	93	
E6	The CanSat shall operate for a minimum of two hours when integrated into the rocket.	Partial	111	Theoretically complies
E7	The audio beacon shall operate on a separate battery.	Comply	88	
E8	The audio beacon shall have an easily accessible power switch through the container	Comply	88	

Requirements Compliance (8/13)

Communication Requirements				
RN	Requirement	Compliance	Ref Pages	Notes
X1	XBee radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBee radios are also allowed.	Comply	99	
X2	XBee radios shall have their NETID/PANID set to their team number	Comply	100	
X3	XBee radios shall not use broadcast mode	Comply	100	
X4	The CanSat shall transmit telemetry once per second.	Comply	100	
X5	The CanSat telemetry shall include altitude, air pressure, temperature, battery voltage, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	Comply	101 – 104	

Requirements Compliance (9/13)

Sensor Requirements				
RN	**Requirement**	**Complinace**	**Ref Pages**	**Notes**
SN1	CanSat payload shall measure its altitude using air pressure.	Comply	27	
SN2	CanSat payload shall measure its internal temperature.	Comply	28	
SN3	CanSat payload shall measure its battery voltage.	Comply	29	
SN4	CanSat payload shall track its position using GPS.	Comply	31	
SN5	CanSat payload shall measure its acceleration and rotation rates.	Comply	32	
SN6	CanSat payload shall video record the deployment of the para-glider at 80% peak altitude.	Comply	34	
SN7	CanSat payload shall video record the ground during descent.	Comply	36	
SN8	The ground pointing camera shall capture video of the instrument (egg) being released and reaching the ground.	Comply	34	
SN9	The video cameras shall record video in color and with a minimum resolution of 640x480.	Comply	36	

Requirements Compliance (10/13)

Sensor Requirements				
RN	**Requirement**	**Compliance**	**Ref Pages**	**Notes**
SN10	CanSat payload shall measure its battery current.	**Comply**	29	

Requirements Compliance (11/13)

Ground Station Requirements				
RN	**Requirement**	**Compliance**	**Ref Pages**	**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	106	
G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	134	
G3	Telemetry shall include mission time with 1 second resolution	Comply	118	
G4	Each team shall develop their own ground station.	Comply	130 – 137	
G5	All telemetry shall be displayed in real time in text format during ascent and descent on the ground station.	Comply	135 – 136	
G6	All telemetry shall be displayed in the International System of Units (SI) and the units shall be indicated on the displays.	Comply	135 – 136	
G7	Teams shall plot altitude, battery voltage, battery current, accelerometer value and rotation rates in real time.	Comply	135 – 136	
G8	Teams shall display mission time, temperature, GPS position, received packet count, lost packet count, and flight software state in real time.	Comply	135 – 136	
G9	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBee radio and an antenna.	Comply	131	

Requirements Compliance (12/13)

Ground Station Requirements				
RN	**Requirement**	**Compliance**	**Ref Pages**	**Notes**
G10	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Comply	133	
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	123 – 124	
G12	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the CanSat.	Comply	123	
G13	The ground station shall use a table top or handheld antenna.	Comply	133	
G14	Because the ground station must be viewed in bright sunlight, the displays shall be designed with that in mind, including using larger fonts (14 point minimum), bold plot traces and axes, and a dark text on light background theme.	Comply	135 – 137	
G15	All data shall be shown simultaneously in the ground station GUI. Tabs are not allowed.	Comply	135 – 136	
G16	The ground system shall count the number of received packets. Note that this number is not equivalent to the transmitted packet counter, but it is the count of packets successfully received at the ground station for the duration of the flight.	Comply	100	
G17	The ground station shall be able to activate all mechanisms on command.	Comply	105 – 106	

Requirements Compliance (13/13)

Flight Software Requirements				
RN	**Requirement**	**Compliance**	**Ref Pages**	**Notes**
F1	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Comply	122	
F2	The CanSat shall maintain mission time throughout the entire mission even in the event of a processor resets or momentary power loss.	Comply	122	
F3	The CanSat shall have its time set by ground command to within one second UTC time prior to launch.	Comply	105	
F4	The flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile file.	Comply	123 – 124	
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	123 – 124	
F6	The flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Comply	123 – 124	
F7	The flight shall include commands to activate all mechanisms. These commands shall be documented in the mission manual.	Comply	105 – 106	
F8	Configuration states such as zero altitude calibration software state shall be maintained in the event of a processor reset during launch and mission	Comply	122	

Management

Fatma Aliea Wibowo

CanSat Budget – Hardware (1/3)

Electrical Components

Component	Quantity	Considerations	Unit Cost ($)	Total Cost ($)
BMP280	1	Actual	0.42	0.42
ACS712	1	Actual	0.69	0.69
U-blox SAM-M10Q	1	Actual	28.25	28.25
BNO055	1	Actual	48.77	48.77
RunCam Split 2	2	Actual	69.90	139.80
Teensy 4.1	1	Actual	56.97	56.97
SanDisk Ultra microSD	3	Actual	11.32	33.96
Taoglas FXP290	1	Actual	17.05	17.05
XBee Pro S3B	1	Actual	55.66	55.66
Samsung INR18650-25R	2	Actual	3.68	7.36
Servo MG90s	3	Actual	1.90	5.7
Servo MG996R	1	Actual	2.98	2.98
PCB (Payload, PCB Hub, XBee)	1	Actual	29.91	29.91
3mm LED	1	Actual	0.03	0.03
3.3V Buck Converter	1	Actual	0.39	0.39
Coin Cell CR2032	2	Actual	0.31	0.62
5V Buck Converter	1	Actual	0.48	0.48
3V Buzzer	1	Actual	0.12	0.12
ON/OFF Switch	1	Actual	0.03	0.03
Black Cell 14500 2s	1	Actual	5.67	5.67
Total Cost Electrical Components ($)				**434.86**

CanSat Budget – Hardware (2/3)

Mechanical Components

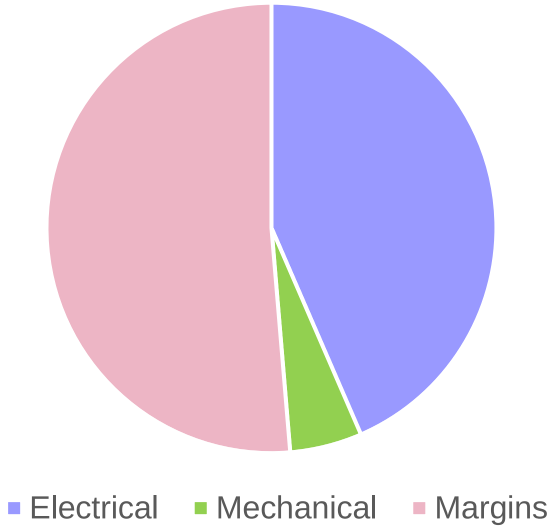
Component	Quantity	Considerations	Unit Cost ($)	Total Cost ($)
Carbon Rod Solid 3mm	10	Actual	0.81	8.10
Easy ABS	1	Actual	9.71	9.71
Ripstop Nylon (1 x 1.5 m)	1	Actual	1.40	1.40
Slingshot Rubber	1	Actual	0.89	0.89
Balsa 3mm	8	Actual	0.89	7.12
Carbon Fiber Sheet	1	Actual	13.11	13.11
Torsion Spring	4	Actual	0.18	0.72
Resin Epoxy	1	Actual	5.07	5.07
Fiberglass	1	Actual	0.89	0.89
Carbon Tube 5mm	1	Actual	1.10	1.10
Acrylic	1	Actual	1.79	1.79
RBF Tag	1	Actual	0.36	0.36
Battery Holder	1	Actual	0.6	0.6
Straps Battery	4	Actual	0.24	0.96
Total Cost Mechanical Components ($)				**51.82**

CanSat Budget – Hardware (3/3)

Component	Total Cost ($)
Total Cost Electrical Components	434.86
Total Cost Mechanical Components	51.82
Total Hardware Budget ($)	**486.68**

CanSat Requirement Cost – Hardware Budget = **Margins**

$1000 - $486.68 = **$ 513.32**



Ground Control Station Cost

Component	Quantity	Considerations	Unit Cost ($)	Total Cost ($)
Moxon Yagi Antenna	1	Actual	8.06	8.06
XBee Pro S3B	1	Actual	55.66	55.66
XBee Adapter	1	Actual	3.87	3.87
USB Cable	1	Actual	1.27	1.27
RP-SMA Connector	1	Actual	1.14	1.14
Raspberry Pi 4	1	Actual	148.99	148.99
Keyboard	1	Actual	5.96	5.96
LED Monitor	1	Actual	71.52	71.52
SanDisk Ultra microSD	1	Actual	11.32	11.32
GPS GEOX – M10	1	Actual	11.36	11.36
Powerbank 20.000 mAh 20W	1	Actual	15.45	15.45
DS2331 RTC Module	1	Actual	1.47	1.47
INA219 Current Module	1	Actual	1.38	1.38
Pilot Switch	1	Actual	0.96	0.96
Plywood	6	Actual	1.24	7.44
Total Ground Control Station Cost ($)				**345.85**

CanSat Budget – Other Costs (2/2)

Others Cost

Component	Quantity	Considerations	Unit Cost ($)	Total Cost ($)
Registration	1	Actual	200	200
Prototyping	1	Estimated	100	100
Round Trip CGK-IAD Ticket	8 people	Estimated	1,352	10,816
Round Trip Train Ticket	8 people	Estimated	23.85	190.8
Visa	8 people	Estimated	160	1,280
Uniform	8 people	Actual	16.10	128.8
Mobile Wi-Fi	1	Actual	56.37	56.37
Hotel	7 nights	Estimated	196	1,372
Round Trip Bus Ticket	8 people	Estimated	84.64	677.12
Ground Control Station Cost	1	Actual	345.85	345.85
Total Other Costs ($)				**15,116.94**

Sources of Income

Sources of Income	Total Cost ($)
PENS Funding	4,469.98
Sponsorship	11,000.00
Total Income ($)	**15,469.98**

Program Schedule Overview

Cansat 2026

Project Start Date: 19-Sept-25
Project Leader: Rafida Azis Al Habib

PM=Project Manager
AD=Administration
SS=Sponsorship
MC=Mechanical
HW=Hardware
SW=Software
RnD=Research and Development
BT=Branding

Task	Assign	Start	End	Days	Status	% Complete	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Summary																
Team Member Recruitment	ALL	1-Sep-25	19-Sep-25	18	Completed	100%										
Internal Funding	AD	19-Sep-25	19-Sep-25	1	Completed	100%										
Middle 1st Semester Exam	ALL	29-Sep-25	3-Oct-25	4	Exam	100%										
PDR Preparation	ALL	6-Oct-25	26-Jan-26	112	Completed	100%										
Procurement of Components & Materials	HW, MC,SW	10-Oct-25	30-Mar-26	171	On-going	65%										
Sponsorship	AD, SS, BT	14-Oct-25	22-May-26	220	On-going	49%										
EEPISAT's Website Developing	RnD	14-Oct-25	2-Jun-26	231	On-going	47%										
Registration	PM	16-Nov-25	16-Nov-25	1	Completed	100%										
Final 1st Semester Exam	ALL	17-Nov-25	21-Nov-25	4	Exam	100%										
Team Member Vacation	ALL	25-Dec-25	4-Jan-26	10	Completed	100%										
PDR Submission	PM	26-Jan-26	26-Jan-26	1	Completed	100%										
CDR Preparation	ALL	1-Feb-26	27-Mar-26	54	Upcoming	0%										
System Integration	ALL	1-Mar-26	22-May-26	82	Upcoming	0%										
CDR Submission	PM	27-Mar-26	27-Mar-26	1	Upcoming	0%										
Mid 2nd Semester Exam	ALL	13-Apr-26	17-Apr-26	4	Exam	0%										
System Improvement	ALL	17-Apr-26	22-May-26	35	Upcoming	0%										
Final 2nd Semester Exam	ALL	2-June-26	6-June-26	4	Exam	0%										
Enviromental Test Submission	ALL	22-May-26	22-May-26	1	Upcoming	0%										
CanSat Shipping	ALL	2-June-26	2-June-26	1	Upcoming	0%										
FRR	ALL	5-Jun-26	5-Jun-26	1	Upcoming	0%										
Competition	ALL	4-Jun-26	7-Jun-26	4	Upcoming	0%										
PFR	PM	7-Jun-26	7-Jun-26	1	Upcoming	0%										

(Completed)
(On-going)
(Exam)
(Upcoming)

Overall accomplishment: 43%

Detailed Program Schedule (1/3)

Task	Assign	Start	End	Days	Status	% Complete	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Mechanical																
Mission Guide Study	MC	19-Aug-25	19-Sep-25	31	Completed	100%										
Middle 1st Semester Exam	ALL	29-Sep-25	3-Oct-25	4	Exam	100%										
Prototype Manufacturing	MC	19-Sep-25	1-Nov-25	43	Completed	100%										
Material Trade	MC	19-Sep-25	31-Oct-25	42	Completed	100%										
Cansat 1st Design	MC	6-Oct-25	5-Dec-25	60	Completed	100%										
Procurement of Materials	MC	6-Oct-25	27-Mar-26	172	On-going	65%										
Prototype Testing	MC	20-Oct-25	5-Dec-25	46	Completed	100%										
Cansat 2nd Design	MC	3-Nov-25	25-Dec-25	52	Completed	100%										
Final 1st Semester Exam	ALL	17-Nov-25	21-Nov-25	4	Exam	100%										
Team Member Vacation	ALL	25-Dec-25	4-Jan-26	10	Completed	100%										
Mass Budget Calculate	MC	5-Jan-26	10-Jan-26	5	Completed	100%										
System Integrating	MC	18-Feb-26	23-May-26	94	Upcoming	0%										
Mid 2nd Semester Exam	ALL	13-Apr-26	17-Apr-26	4	Exam	0%										
System Improvement	MC	3-Apr-26	23-May-26	50	Upcoming	0%										
System Testing	MC	15-Apr-26	29-Apr-26	14	Upcoming	0%										
Final 2nd Semester Exam	ALL	2-June-26	6-June-26	4	Exam	0%										

Assign to: Muhammad Rizky

Overall accomplishment: 67%

(Completed)

(On-going)

(Exam)

(Upcoming)

Detailed Program Schedule (2/3)

Task	Assign	Start	End	Days	Status	% Complete	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Hardware																
Mission Guide Study	HW	19-Aug-25	19-Sep-25	31	Completed	100%										
Middle 1st Semester Exam	ALL	29-Sep-25	3-Oct-25	4	Exam	100%										
Component Trade	HW	19-Sep-25	1-Nov-25	43	Completed	100%										
Procurement of Components	MC	6-Oct-25	27-Mar-26	172	On-going	67%										
Payload PCB Design	HW	6-Oct-25	5-Dec-25	60	Completed	100%										
XBEE Communication Test	HW	20-Oct-25	3-Nov-25	14	Completed	100%										
Electrical Prototype Test	HW	3-Nov-25	25-Dec-25	52	Completed	100%										
Component Testing	HW	12-Nov-25	25-Nov-25	13	Completed	100%										
Final 1st Semester Exam	ALL	17-Nov-25	21-Nov-25	4	Exam	100%										
Flight Algorithm	HW	24-Nov-25	24-Dec-25	30	Completed	100%										
Team Member Vacation	ALL	25-Dec-25	4-Jan-26	10	Completed	100%										
Camera Tracking Test	HW	17-Feb-26	1-Mar-26	12	Upcoming	0%										
System Integrating	HW	1-Mar-26	23-May-26	83	Upcoming	0%										
Mid 2nd Semester Exam	ALL	13-Apr-26	17-Apr-26	4	Exam	0%										
System Improvement	HW	3-Apr-26	23-May-26	50	Upcoming	0%										
System Testing	HW	15-Apr-26	29-Apr-26	14	Upcoming	0%										
Final 2st Semester Exam	ALL	2-June-26	6-June-26	4	Exam	0%										

Assign to: Ax'l Nurrahim

Overall accomplishment: 63%

(Completed) (On-going)

(Exam) (Upcoming)

Detailed Program Schedule (3/3)

Task	Assign	Start	End	Days	Status	% Complete	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Software																
Mission Guide Study	SW	19-Aug-25	19-Sep-25	31	Completed	100%										
GCS Design	SW	19-Sep-25	17-Nov-25	59	Completed	100%										
Middle 1st Semester Exam	ALL	29-Sep-25	3-Oct-25	4	Exam	100%										
Antenna Trade	SW	19-Sep-25	15-Nov-25	57	Completed	100%										
Improve Antenna Design	SW	17-Nov-25	12-Dec-25	25	Completed	100%										
Final 1st Semester Exam	ALL	17-Nov-25	21-Nov-25	4	Exam	100%										
Team Member Vacation	ALL	25-Dec-25	4-Jan-26	10	Completed	100%										
Antenna Manufacturing	SW	17-Feb-26	1-Mar-26	12	Upcoming	0%										
System Integrating	SW	1-Mar-26	23-May-26	83	Upcoming	0%										
Antenna Range Test	SW	1-Apr-26	30-Apr-26	29	Upcoming	0%										
Mid 2nd Semester Exam	ALL	13-Apr-26	17-Apr-26	4	Exam	0%										
System Improvement	SW	3-Apr-26	23-May-26	50	Upcoming	0%										
System Testing	SW	15-Apr-26	29-Apr-26	14	Upcoming	0%										
Final 2st Semester Exam	ALL	2-June-26	6-June-26	4	Exam	0%										

Assign to: Adam Kandias

Overall accomplishment: 50%

(Completed) (On-going)

(Exam) (Upcoming)

Conclusions (1/3)

Division	Major Accomplishments	Major Unfinished Work	Testing to Complete
Mechanical	• Major mechanism has been tested • Several environmental test has been completed	• Overall system integration	• Environmental test
Hardware	• All sensors have been tested • XBee Communication test completed	• Overall system integration	-
Software	• GUI Design Completed • Antenna has been built and tested • Flight software status has been developed and tested	• Overall system integration	-
Administration & Sponsorship	• Sponsorship and partnership contracted • Travel and shipment plans have been established	• Waiting for other sponsors	-
Branding Team & RnD	• Official social media still active • New generation website development	• Developing the social media and website promotion	-

Conclusions (2/3)

Partnership

The official team has already partnership with several companies to support our development and travel for CanSat Competition 2026.

Conclusions (3/3)

Bamantara EEPISAT Are Ready to Proceed to The Next Stage of Development

- Preliminary Design Phase is finished for mechanical, software, and electronic systems and is ready for implementation.
- The official team has already improved the team’s social media and entered a sponsorship agreement.