CanSat 2023
Preliminary Design Review (PDR)
Outline
Version 1.0

#1085

Bamantara EEPISAT

Presentation Outline

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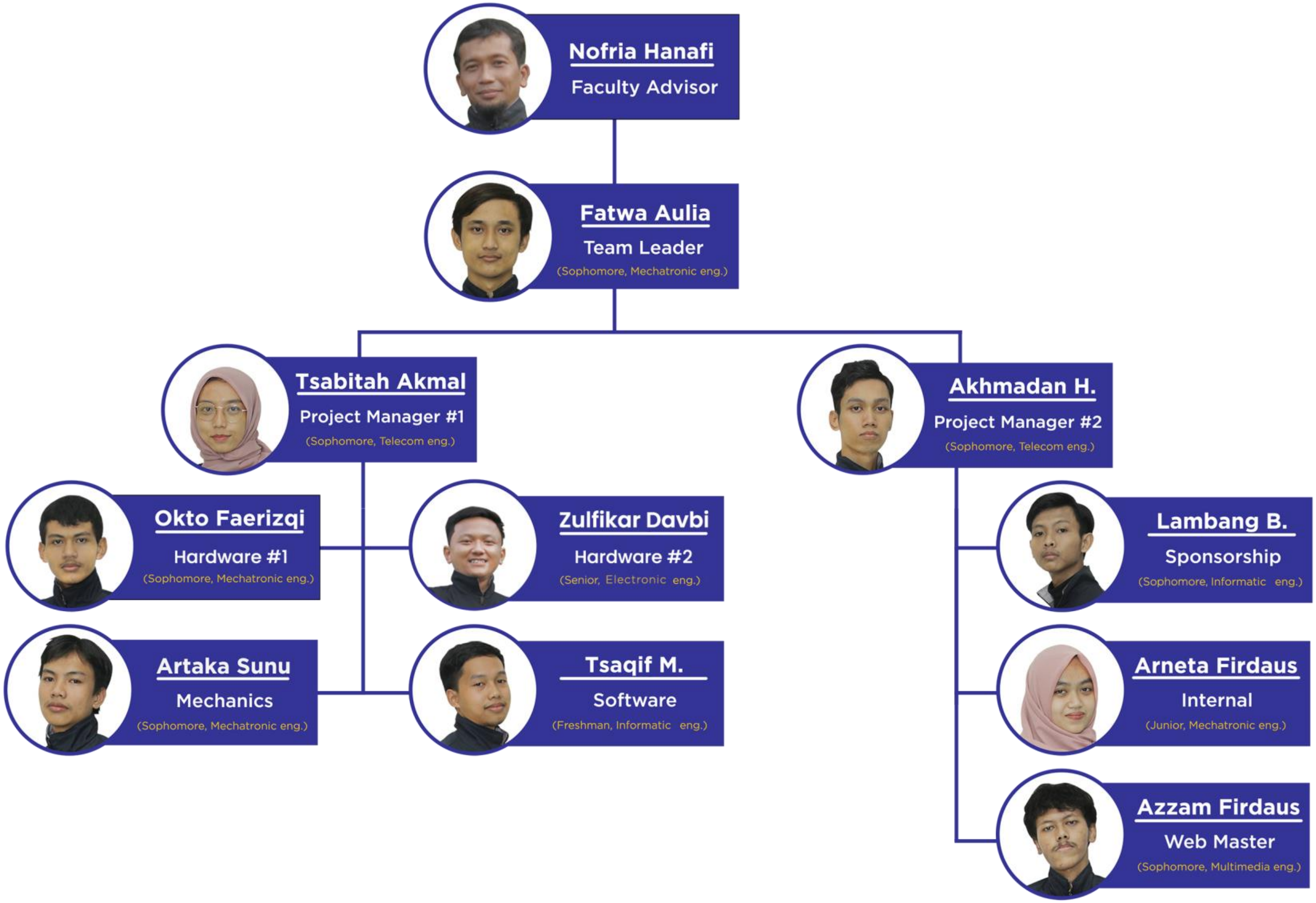
Team Organization



Acronyms

Acronyms	Definition
3D	Three Dimensional
ABS	Acrylonitrile Butadiene Styrene
AC	Alternating Current
ADC	Analog to Digital Converter
BM	Bonus Mission
CAD	Computer Aided Design
CDH	Communication Data Handling
CONOPS	Concept of Operation
CSV	Comma Separated Value
dB	Decibel
dBi	Decibel Isotropic
DC	Direct Current
DoF	Degree of Freedom
EPS	Electrical Power System
FSW	Flight Software
GCS	Ground Control Station
GND	Ground
GPIO	General Peripheral Input Output
GPS	Global Positioning System
HDPE	High Density Polyethylene
I/O	Input/Output
I2C	Inter-Integrated Circuit
IDE	Integrated Development Environment
MCU	Microcontroller Unit
PCB	Printed Circuit Board
PFR	Post Flight Review
PLA	Polylactic Acid
PWM	Pulse Width Modulation
RAM	Random Access Memory
RN	Requirement Number
RP-SMA	Reverse Polarity SMA
RTC	Real Time Clock
SD	Secure Digital
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver/Transmitter(Serial)
UTC	Universal Time Coordinated
XCTU	Next Generation Configuration Platform for XBEE/RF Solution

Acronyms	Verification Methods
A	Analysis
I	Inspection
T	Test
D	Demonstration

Systems Overview

Tsabitah Akmal Al Mumtazah

Mission Summary

Main Objectives	Bonus Objectives
The mission is to simulate the landing sequence of a planetary probe • Design a CanSat that shall consist of a container and a payload • The CanSat shall be launched to an altitude ranging from 670 meters to 725 meters above the launch site and deployed near apogee • After CanSat is deployed from the rocket, the CanSat shall descent using a parachute at a rate of 15 m/s • At 500 meters, the CanSat shall release a payload that shall open a heat shield that will also be used as an aerobraking device with a descent rate of 20 m/s or less • After the payload reaches 200 meters, the payload shall deploy a parachute and slow the descent rate to 5 m/s • Once the payload has landed, it shall attempt to upright itself and raise a flag 500 mm above the base of the payload • A video camera shall be included and point toward the ground during descent	A video camera shall be integrated into the container and point toward the payload • The camera shall record the event when the payload is released from the container • Video shall be in color with a minimum resolution of 640x480 pixels and a minimum of 30 frames per second • The video shall be recorded and retrieved when the container is retrieved

External Objectives

- We have the intention to acquire first place in CanSat Competition 2023
- To increase experience through any engineering project, adapt to the teamwork environment, and implement project and time management

System Requirement Summary (1/6)

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

System Requirement Summary (2/6)

RN	Requirement	Reasons	Priority	Verification			
				A	I	T	D
10	All structures shall be built to survive 15 Gs of launch acceleration.	Competition Requirement	High		✓	✓	✓
11	All structures shall be built to survive 30 Gs of shock.	Competition Requirement	High		✓	✓	✓
12	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Competition Requirement	High		✓	✓	
13	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Competition Requirement	High			✓	
14	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Competition Requirement	High		✓		
15	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Competition Requirement	High	✓	✓	✓	
16	XBEE radios shall have their NETID/PANID set to their team number.	Competition Requirement	High		✓	✓	
17	XBEE radios shall not use broadcast mode.	Competition Requirement	High		✓	✓	
18	The container (if needed) and probe shall include an easily accessible power switch that can be accessed without disassembling the cansat and science probes and in the stowed configuration.	Competition Requirement	High		✓		✓

System Requirement Summary (3/6)

RN	Requirement	Reasons	Priority	Verification			
				A	I	T	D
19	The probe shall include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the cansat and in the stowed state.	Competition Requirement	High		✓		✓
20	An audio beacon is required for the probe. It shall be powered after landing.	Competition Requirement	High				✓
21	The audio beacon shall have a minimum sound pressure level of 92 dB, unobstructed.	Competition Requirement	High		✓	✓	
22	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.	Competition Requirement	High		✓		
23	An easily accessible battery compartment shall be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Competition Requirement	High		✓	✓	
24	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Competition Requirement	High		✓	✓	
25	The CanSat shall operate during the environmental tests laid out in Section 3.5.	Competition Requirement	High	✓	✓	✓	✓
26	The CanSat shall operate for a minimum of two hours when integrated into the rocket.	Competition Requirement	High	✓	✓	✓	✓
27	The probe shall be released from the container when the CanSat reaches 500 meters.	Competition Requirement	High	✓		✓	

System Requirement Summary (4/6)

RN	Requirement	Reasons	Priority	Verification			
				A	I	T	D
28	The probe shall deploy a heat shield after leaving the container.	Competition Requirement	High	✓		✓	
29	The heat shield shall be used as an aerobrake and limit the descent rate to 20 m/s or less.	Competition Requirement	High	✓		✓	
30	At 200 meters, the probe shall release a parachute to reduce the descent rate to 5 m/s +/- 1m/sec.	Competition Requirement	High	✓		✓	
31	Once landed, the probe shall upright itself.	Competition Requirement	High	✓		✓	
32	After uprighting, the probe shall deploy a flag 500 mm above the base of the probe when the probe is in the upright position.	Competition Requirement	High	✓		✓	
33	The probe shall transmit telemetry once per second.	Competition Requirement	High		✓	✓	
34	The probe telemetry shall include altitude, air pressure, temperature, battery voltage, probe tilt angles, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	Competition Requirement	High	✓	✓	✓	✓
35	The probe shall include a video camera pointing down to the ground.	Competition Requirement	High	✓	✓	✓	
36	The video camera shall record the flight of the probe from release to landing.	Competition Requirement	High	✓	✓	✓	✓

System Requirement Summary (5/6)

RN	Requirement	Reasons	Priority	Verification			
				A	I	T	D
37	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.	Competition Requirement	High	✓		✓	✓
38	The probe shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	Competition Requirement	High	✓		✓	✓
39	The probe shall have its time set to within one second UTC time prior to launch.	Competition Requirement	High		✓	✓	
40	The probe flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	Competition Requirement	High	✓	✓	✓	✓
41	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the payload altitude.	Competition Requirement	High			✓	✓
42	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Competition Requirement	High		✓	✓	✓
43	The ground station shall command the CanSat to start calibrating the altitude to zero when the CanSat is on the launch pad prior to launch.	Competition Requirement	High			✓	
44	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Competition Requirement	High		✓	✓	✓
45	Telemetry shall include mission time with 0.01 second or better resolution.	Competition Requirement	High			✓	

System Requirement Summary (6/6)

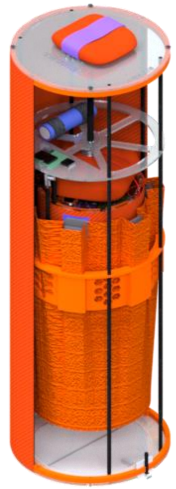
RN	Requirement	Reasons	Priority	Verification			
				A	I	T	D
46	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	Competition Requirement	High		✓	✓	
47	Each team shall develop their own ground station.	Competition Requirement	High	✓	✓	✓	
48	All telemetry shall be displayed in real time during descent on the ground station.	Competition Requirement	High	✓	✓	✓	✓
49	Teams shall plot each telemetry data field in real time during flight.	Competition Requirement	High		✓	✓	
50	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Competition Requirement	High		✓	✓	
51	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.	Competition Requirement	High		✓		
52	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.	Competition Requirement	High		✓	✓	
53	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.	Competition Requirement	High	✓	✓	✓	✓
BM	A video camera shall be integrated into the container and point toward the payload. The camera shall record the event when the payload is released from the container.	Mission Guide	High	✓	✓	✓	✓

System Level CanSat Configuration Trade & Selection (1/5)

Configuration A
• The system will provide both passive and active descent control • The electronic components will be fully enclosed within its structural body • The payload is using leadscrew mechanism with DC motor to maintain its heat shield angle • The 3D printed holder will be used to prevent shock and vibration of the payload • A servo and two rubbers will be used to deploy the payload's parachute and flag mechanism

PROS	CONS
• The payload is more stable as its descent • The bottom lids that aren't locked when releasing the payload make the container still rigid	• The 3D printed holder increases the mass significantly

System Level CanSat Configuration Trade & Selection (2/5)



Step 1

The payload will be stowed in the container with 3D printed holder to prevent shock and vibration. The payload will be separated from the container using a leadscrew attached to the DC motor as a control.

Step 2

At the separation phase, the payload will be released if the heat shield ribs unhooked from the 3D printed holder with leadscrew and DC motor mechanism. After the ribs are detached from the holder, the spring in the container will push the payload out from the container.

Step 3

The payload will be released at 500 m. The descent rate of payload aerobraking is maintained by DC motor and leadscrew mechanism.

Step 4

At 200 m, the payload's parachute will be deployed and maintain the descent rate.

System Level CanSat Configuration Trade & Selection (3/5)

Configuration B	

- The system will provide passive descent control
- The electronic components will be fully enclosed within its structural body
- The payload is using servo mechanism and fixed stopper to maintain its heat shield angle
- The cork will be used to prevent shock and vibration of the payload
- Fixed stopper and cord will be used to deploy the payload's parachute and flag mechanism

PROS	CONS
• The container cover that opens to the side offers enough room for releasing the payload • The system has passive descent control so it doesn't require any power	• The hinges of the container are easily broken

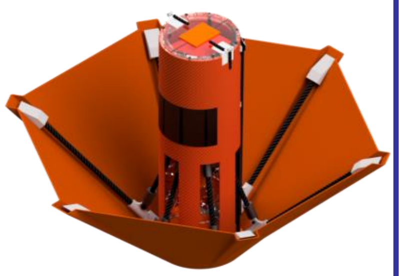
System Level CanSat Configuration Trade & Selection (4/5)

Step 1

The payload will be stowed in the container with cork to prevent shock and vibration. The payload will be separated from the container using a rubber attached to servo as a control.

Step 2

At the separation phase, the container's body will open if the servo is unlocked, the spring pulls the body covers, and airflow pushes the body covers to the top. After the container's body is opened, the payload's heat shield ribs will be deployed by torsion springs to open a heat shield.



Step 3

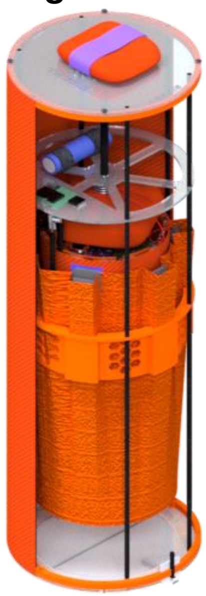
The payload will be released at 500 m. The descent rate of payload aerobraking is maintained by servo and fixed stopper mechanism.

Step 4

At 200 m, the payload's parachute will be deployed and maintain the descent rate.

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

Configuration Selection

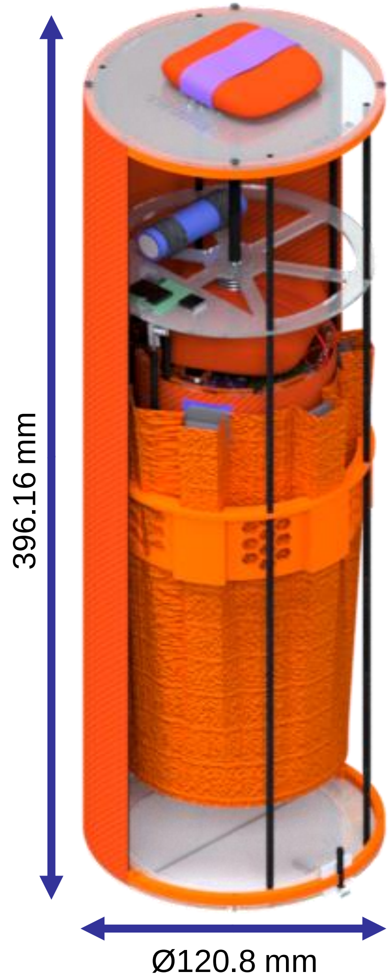
Configuration A ✓	Configuration B
	

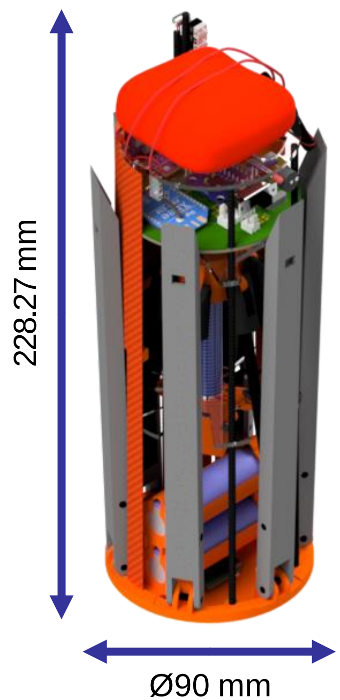
Selected: Configuration A

Reasons
• Both designs comply the requirements • Configuration A is most likely to be succeed • Configuration A provides more stable descent • Configuration A has better vibration reduction material for stowing the payload in the container

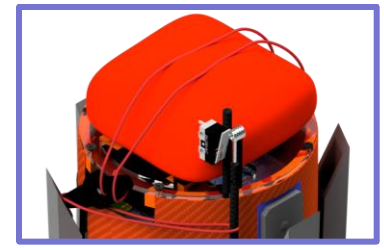
System Level Configuration Selection

Selected: Configuration A

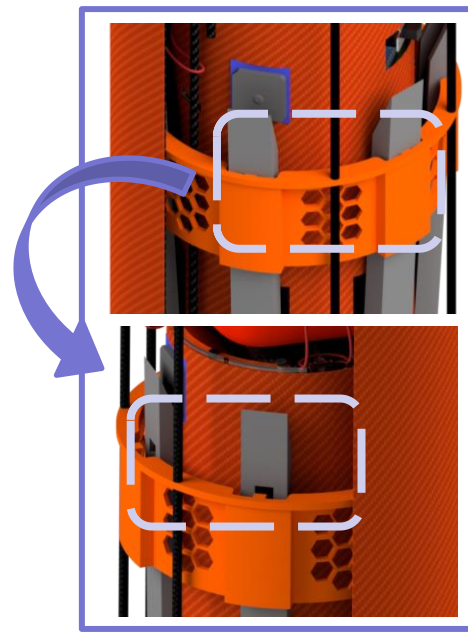




The rubber unlocking system will deploy the payload's parachute and raise a flag.



The payload will be released by leadscrew mechanism when heat shield ribs are unhooked from the 3D printed holder.

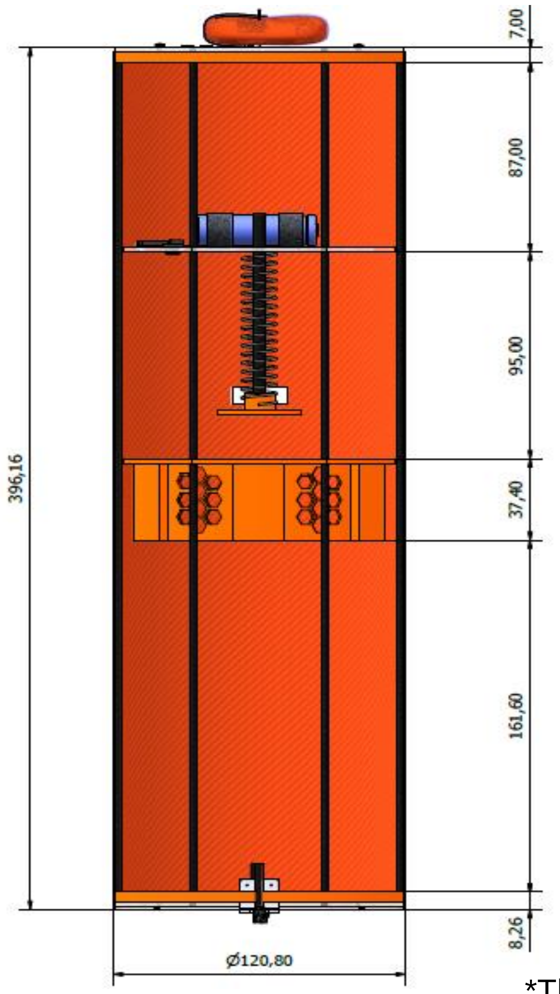


Reasons

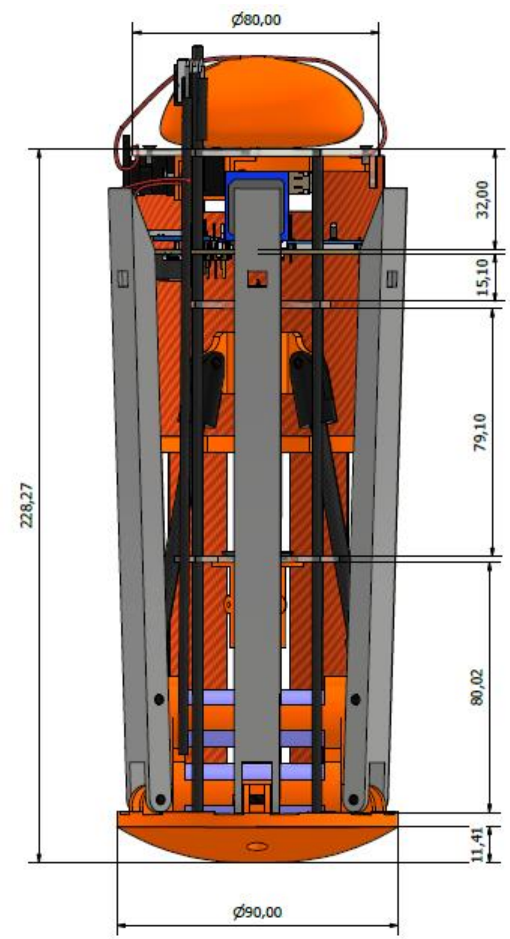
- More reliable stow system using 3D printed material
- Easy to build

Physical Layout (1/4)

Container Dimension



Payload Dimension

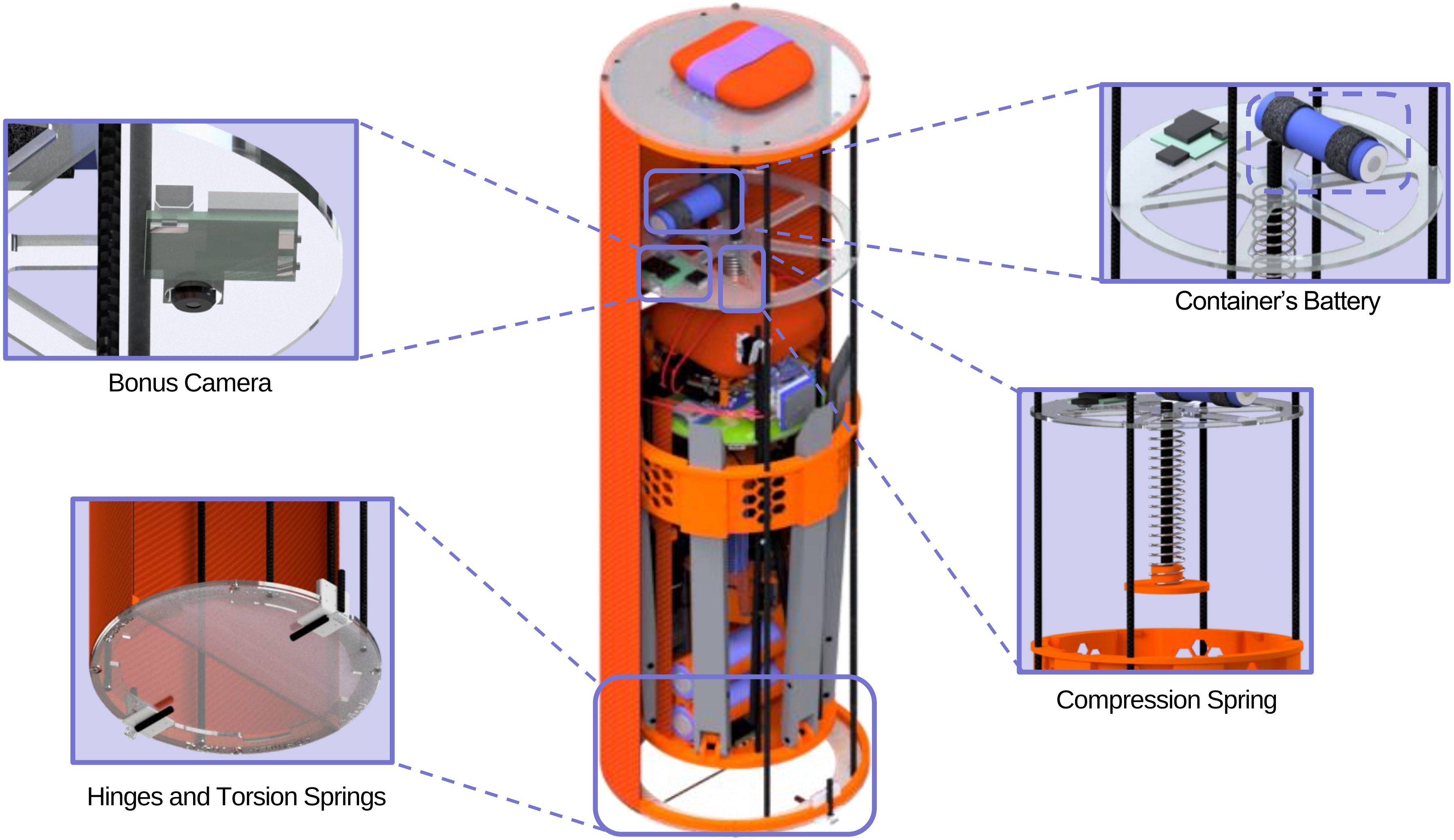


*The dimension of container and payload using technical drawing in CAD software

*All measurement units are in mm

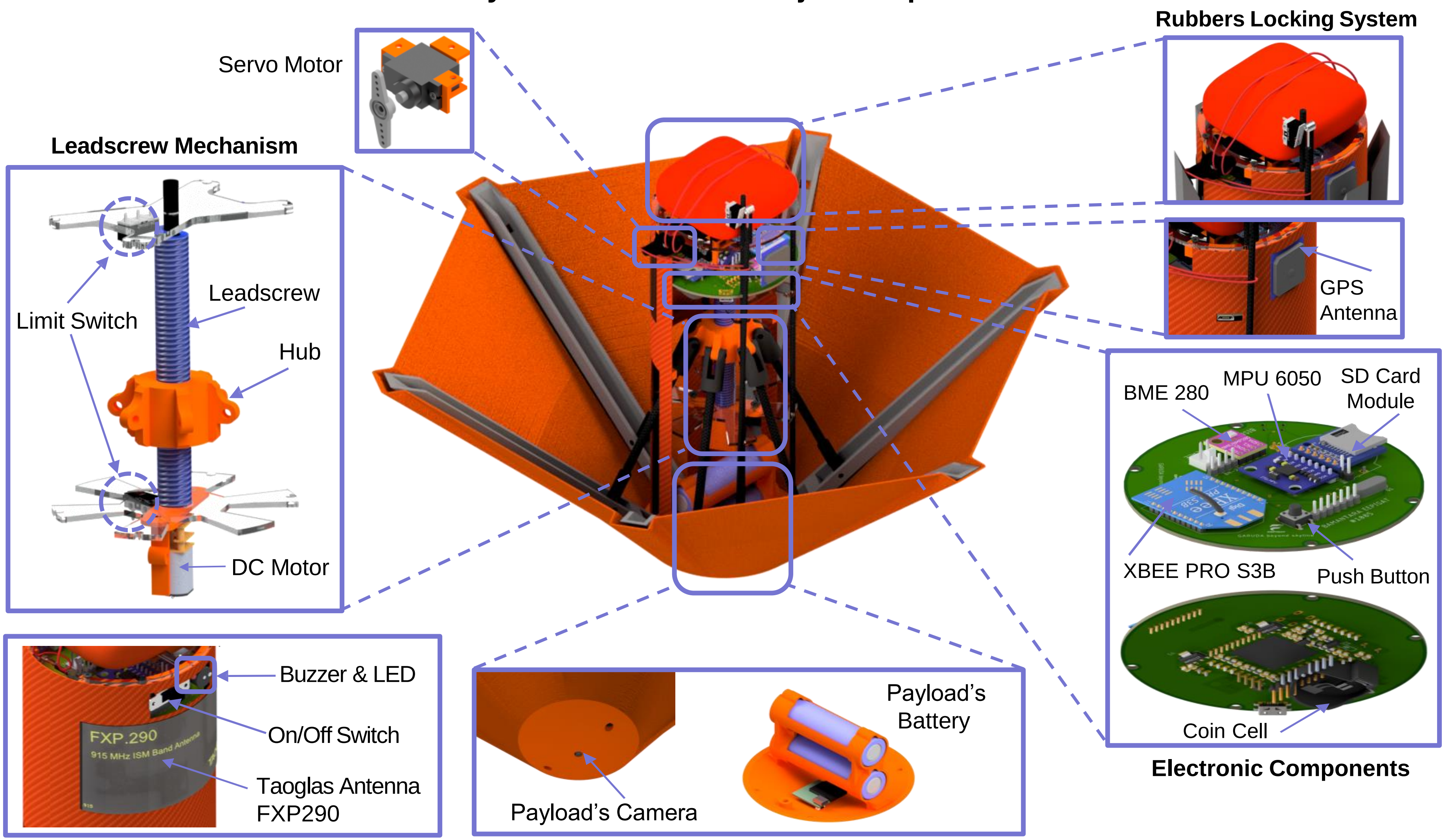
Physical Layout (2/4)

Container Placement of Major Component



Physical Layout (3/4)

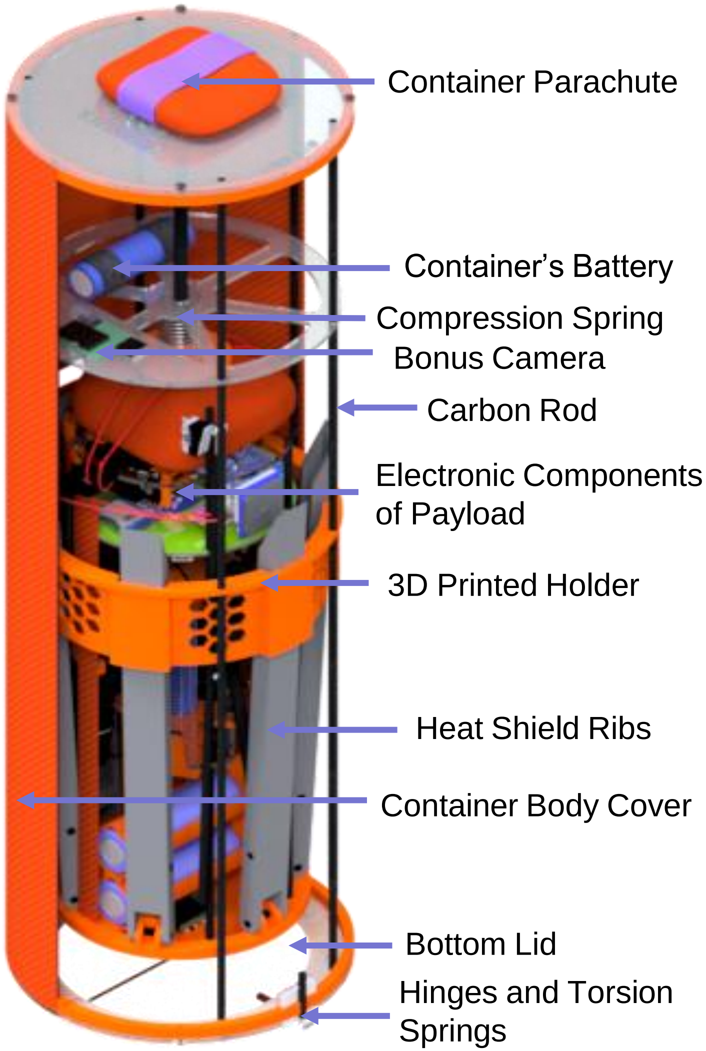
Payload Placement of Major Component



Electronic Components

Physical Layout (4/4)

Payload Launch and Deployed Configuration

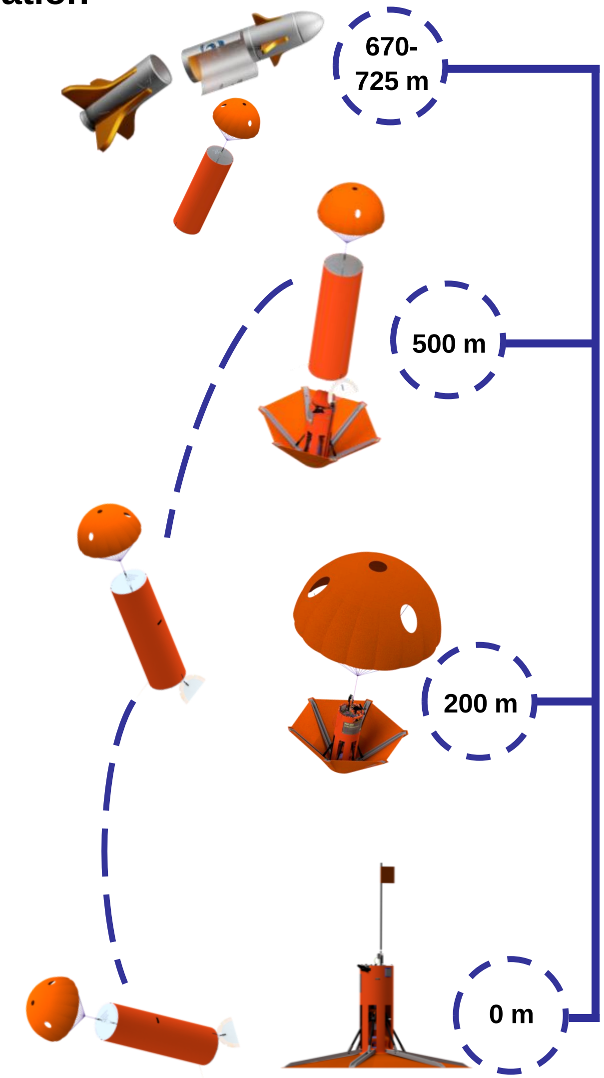


The container separates from the rocket at an altitude of 670-725 meters. The container will descend at a rate of 15 m/s using a parachute above the container.

At an altitude of 500 meters, the payload will be released from the container and open a heat shield that will also be used as an aerobraking device, with a descent rate of 20 m/s or less.

At an altitude of 200 meters, the parachute will be released from the payload. It will make the descent at a rate of 5 m/s.

The payload lands and after upright itself the payload raises a flag 500 mm above the base of the payload.



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 CanSat into a rocket

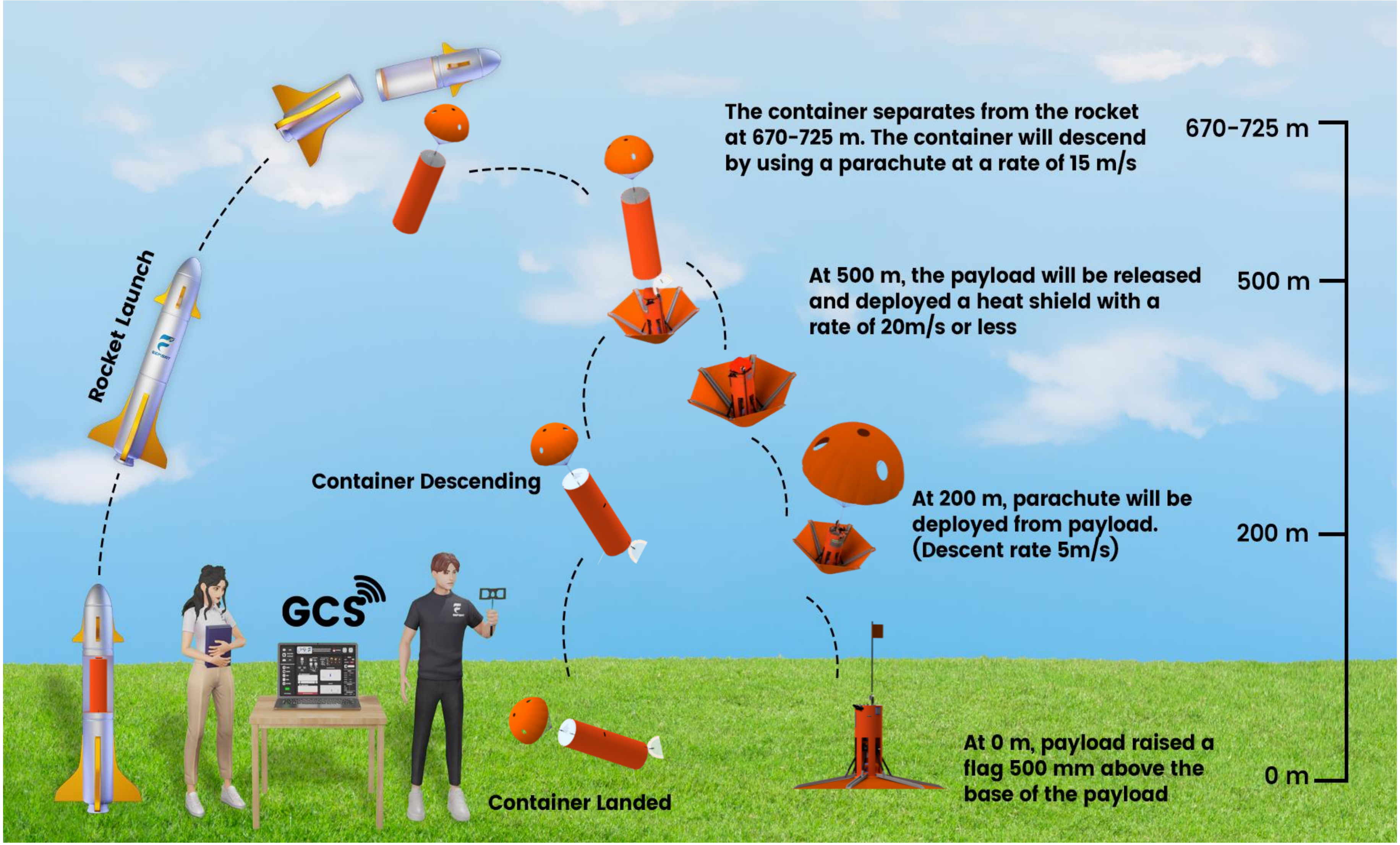
Launch

- CanSat in a rocket launch
- CanSat is released from the rocket (670–725 m)
- Container parachute deployment with a rate of 15 m/s
- The video camera started to record the separation of the payload then the payload open a heat shield at 500 m with a rate of 20 m/s or less
- Payload parachute deployment at 200 m with a rate of 5 m/s
- Payload landed in the upright position and raised a flag 500 mm above the base of the payload. Therefore video camera stopped recording
- Payload shall stop transmitting data to GCS

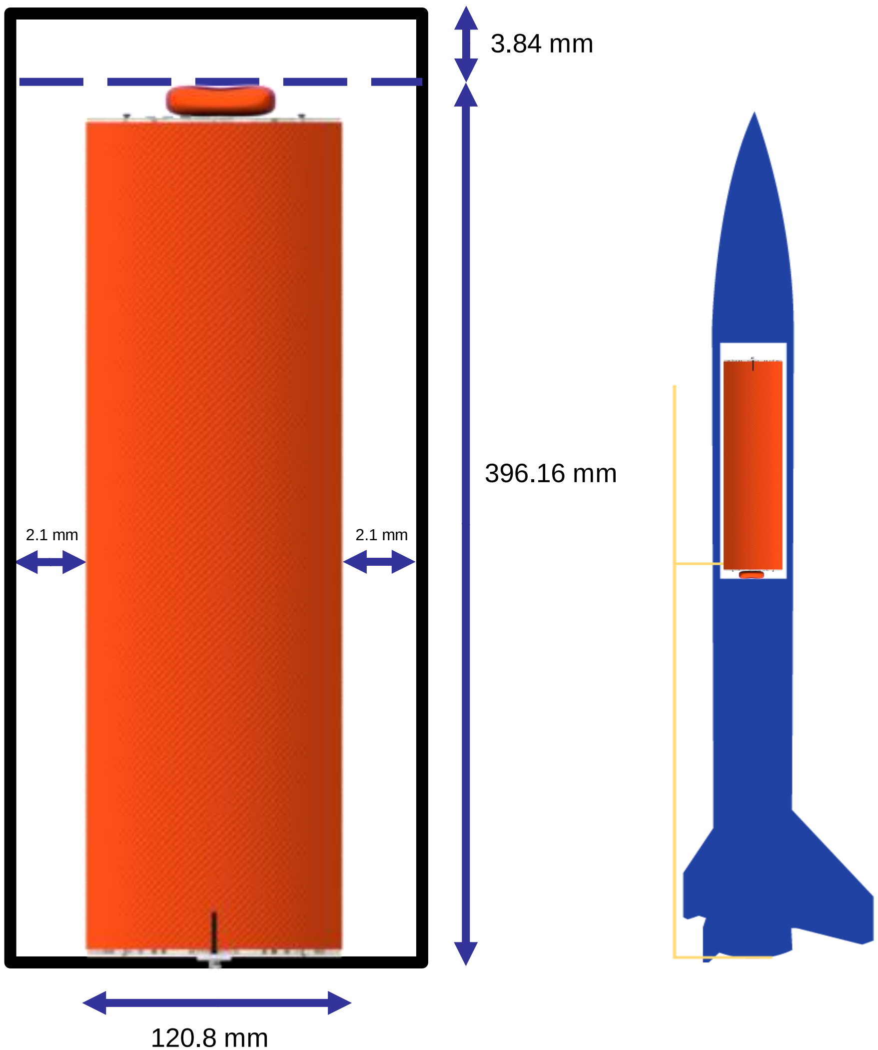
Post-Launch

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

System Concept of Operations (2/2)



Launch Vehicle Compatibility



Dimension (Section)	Height (mm)	Diameter (mm)
Rocket (Requirement Dimensions)	400	125
Container	396.16	120.8
Payload	228.27	90

Information:

1. CanSat consists of two parts: container and payload
2. No sharp protrusions
3. The dimension of CanSat is designed to prevent shaking in the rocket and provide a gap to release
4. Rocket will not be used as part of CanSat operations

Sensor Subsystem Design

Achmad Bagus Okto Faerizqi

Sensor Subsystem Overview

Sensor Type	Selected Model	Function	Located In
Air Pressure	BME280	To measure air pressure in order to calculate altitude	Payload
Air Temperature	BME280	To measure air temperature inside of the payload	Payload
Battery Voltage	ADC Voltage Divider	To measure battery voltage of the payload	Payload
Tilt Sensor	MPU6050	To detect orientation or inclination	Payload
GPS	BN-220	To obtain position or location	Payload
Camera	Quelima SQ11	To record video during the mission process	Payload

Payload Air Pressure Sensor Trade & Selection

Model	Interface	Resolution (hPa)	Supply Current (µA)	Range (hPa)	Mass (g)	Size (mm)	Cost ($)
BME 280	I2C	0.0018	2.8	300 – 1100	1.0	13.5 x 10.5 x 2	9.05
BMP 388	I2C/SPI	0.3	3.4	300 – 1250	1.2	21.6 x 16.6 x 3	9.95
MPL115A2	I2C	1.5	6	500 – 1500	0.61	19.2 x 17.9 x 2.9	7.95

Selected Sensor		Reasons
	**BME280 ✓**	• Low supply current • Can be used for multiple measurements • We have experience working with this sensor

Payload Air Temperature Sensor Trade & Selection

Model	Interface	Resolution (°C)	Supply Current (µA)	Range (°C)	Accuracy (°C)	Mass (g)	Size (mm)	Cost ($)
BME 280	I2C	0.01	2.8	-40 ~ 85	±1	1.0	13.5 x 10.5 x 2	9.05
BMP 388	I2C/SPI	0.00016	3.4	-40 ~ 85	±2	0.1	21.6 x 16.6 x 3	9.95
MPL115 A2	I2C	0.18	6	-40 ~ 85	±1	0.61	19.2 x 17.9 x 2.9	7.95

Selected Sensor	Reasons
 **BME280 ✓**	• Can be used for multiple measurements • Smaller size than the others • Low supply current

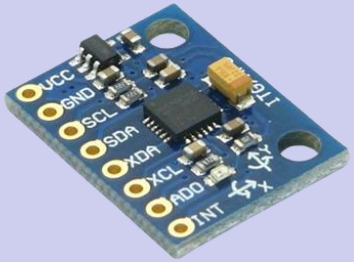
Payload Battery Voltage Sensor Trade & Selection

Model	Interface	Resolution (bits)	Voltage (V)	Mass (g)	Size (mm)	Cost ($)
ADC STM32F407VGT6	Analog	12	3.3	Embedded	Embedded	0
Teensy 4.0	I2C/SPI	12	3.3 - 5	Embedded	Embedded	32.13
INA 260	I2C	16	3.6	0.61	19.2 x 17.9 x 2.9	1.77

Selected Sensor	Reasons
 **ADC STM32F407VGT6 ✓**	• Minimize board size because included in the microprocessor • More precise • No cost (included in STM32F407VGT6)

Payload Tilt Sensor Trade & Selection

Model	Interface	Resolution (bits)	Voltage (V)	DoF	Mass (g)	Size (mm)	Cost ($)
MPU6050	I2C	12	3.3	3 axis	2.1	14 x 12 x 2	1.5
BNO055	I2C	16	3.3	3 axis	2	5.2 x 3.8 x 1.1	40.80
Adafruit 4485	I2C	16	2.3	3 axis	5	25.6 x 17.8 x 4.6	1.77

Selected Sensor		Reasons
	**MPU6050 ✓**	• Affordable • Lightweight • High accuracy based on the tolerance

Payload GPS Sensor Trade & Selection

Model	Interface	Resolution (m)	Supply Current (mA)	Rate (Hz)	Mass (g)	Size (mm)	Cost ($)
BN-220	UART	± 2.5	67	1	5.3	22 x 20 x 6	14
MTK MT3339	UART	± 3.0	85	16	4	16 x 16 x 5	42
UBLOX NEO-6M	UART	± 2.5	67	5	1.0	16 x 12.2 x 2.4	5.49

Selected Sensor		Reasons
	**BN-220 ✓**	• Lightweight • Low energy • Good sensitivity

Payload Camera Trade & Selection

Model	Interface	Resolution (Pixels)	Voltage (V)	Frame Rate (Hz)	Mass (g)	Size (mm)	Cost ($)
Quelima SQ11	Digital	1280 x 720	5	30	5.2	23 x 23 x 23	4.53
Adafruit Mini Spy Camera	SPI	640 x 480	5	30	2.8	28.5 x 17 x 4.2	12.5
TTL Serial Camera	SPI	640 x 480	5	30	3	32 x 32 x 32	45

Selected Camera	Reasons
 **Quelima SQ11 ✓**	• Affordable with good quality • Wide angle lens • SD Card slot available

Bonus Camera Trade & Selection

Model	Interface	Resolution (Pixels)	Voltage (V)	Frame Rate (Hz)	Mass (g)	Size (mm)	Cost ($)
Quelima SQ11	Digital	1280 x 720	5	30	5.2	23 x 23 x 23	4.53
Adafruit Mini Spy Camera	SPI	640 x 480	5	30	2.8	28.5 x 17 x 4.2	12.5
TTL Serial Camera	SPI	640 x 480	5	30	3	32 x 32 x 32	45

Selected Camera		Reasons
	**Quelima SQ11 ✓**	• Affordable with good quality • Wide angle lens • SD Card slot available

Descent Control Design

Artaka Sunu Adhi Prasetya

Descent Control Overview

Container

The container's shape is cylinder. The size of the container is 396.16 mm in height and 120.8 mm in diameter. It will be made of ABS, acrylic, fiberglass, and balsa composite.

The container has an openable bottom lids. The mass of the container is focused at the bottom of the container to maintain the stability of the container.

Payload

The payload is shaped like an upside-down umbrella. The payload is using DC motor and leadscrew mechanism to maintain descent stability.

The mass of the payload is focused at the bottom of the payload to maintain nadir direction and prevent the payload from swaying

Parachute

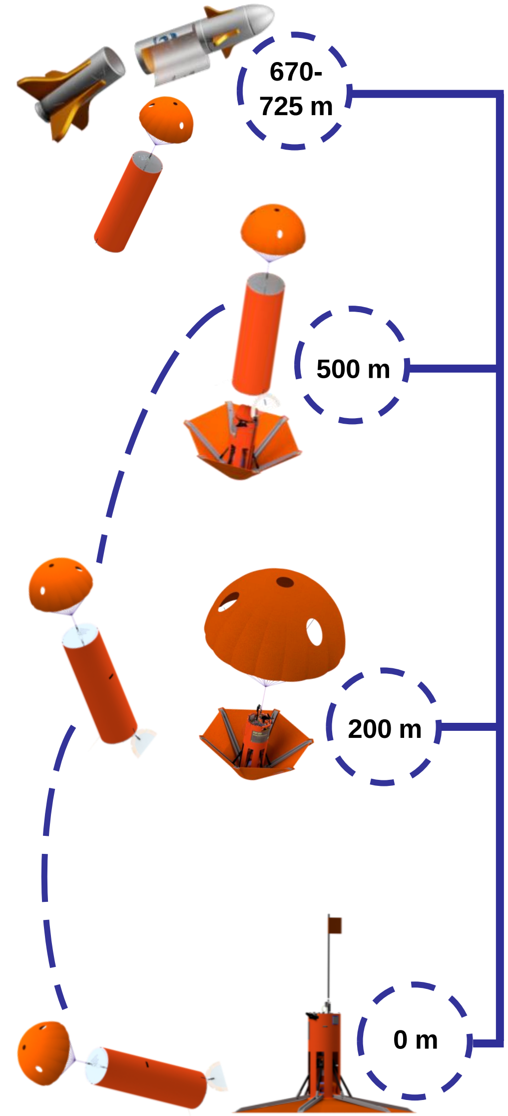
The selected type of the container parachute and payload parachute is a round parachute. The diameter of the container parachute is 222 mm and the payload parachute is 547 mm. The parachute is made of orange ripstop nylon. It has three side holes and one spill hole as stabilizer with diameter 22 mm for container parachute and 54.7 mm for payload parachute.

The container separates from the rocket at an altitude of 670-725 meters. The container will descent at a rate of 15 m/s using a parachute above the container.

At an altitude of 500 meters, the payload will be released from the container and open a heat shield that will also be used as an aerobraking device, with a descent rate of 20 m/s or less.

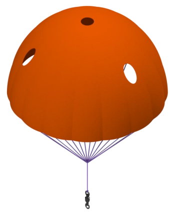
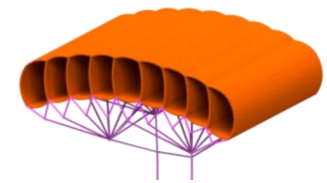
At an altitude of 200 meters, the parachute will be released from the payload. It will make the descent at a rate of 5 m/s

The payload lands and after upright itself the payload raises a flag 500 mm above the base of the payload.



Container Descent Control Strategy Selection and Trade (1/2)

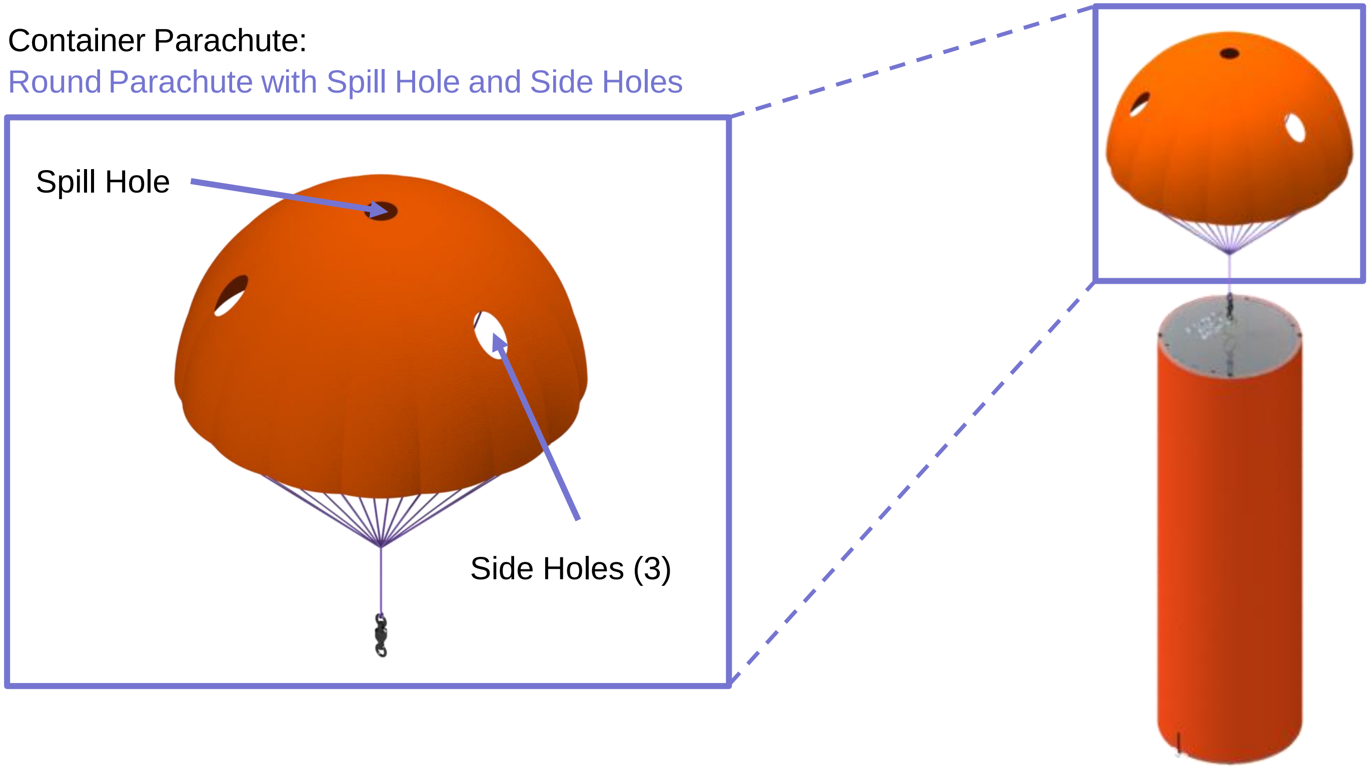
Parachutes selection helps to set up container descent design and operation. The parachute manages the descent of the container.

					
Round Parachute with spill hole and side holes		da Vinci's Parachute		Ram-air Parachute	
PROS	CONS	PROS	CONS	PROS	CONS
High drag coefficient	Difficult to fabricate	The pyramid shape allows for a gradual descent	Not providing enough drag	Ram-air parafoils are steerable	Less drag force
High durability while opening		Smoother ride	The corner and edges easy to damage	Open quickly	Faster landing
Open quickly					
Stable with spill hole and side holes					
Lightweight					

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

Selection:

Container Parachute:
Round Parachute with Spill Hole and Side Holes



Selected: Round Parachute with Spill Hole and Side Holes

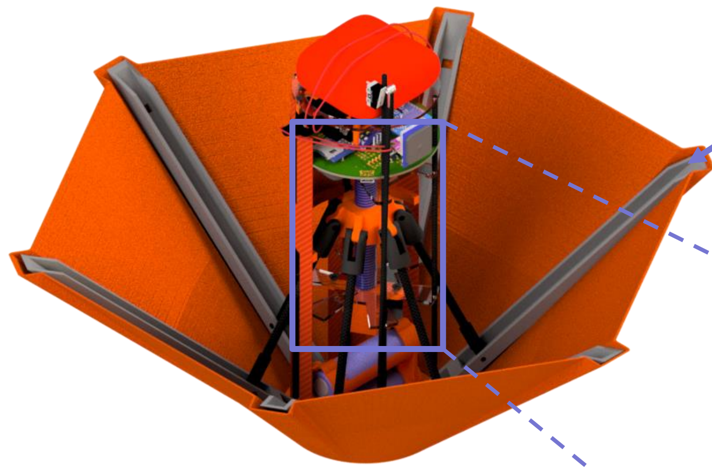
Reasons
• Descent rate can be easily modified • Lightweight • The parachute’s spill hole and side holes can improve stability

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

Payload Aerobraking Descent Control

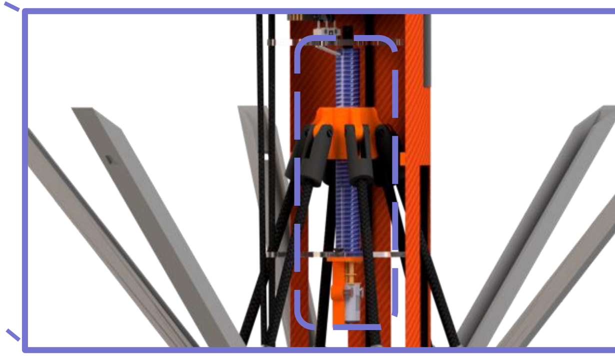
“Strategy A”

Stowed Position



Deployed Position

DC Motor and Leadscrew Mechanism



Information

- The payload is shaped like an upside-down umbrella
- A cone-shaped nose is designed to reduce drag caused by air resistance
- Using DC motor and leadscrew mechanism to deploy a heat shield
- Six ribs connected to the hub

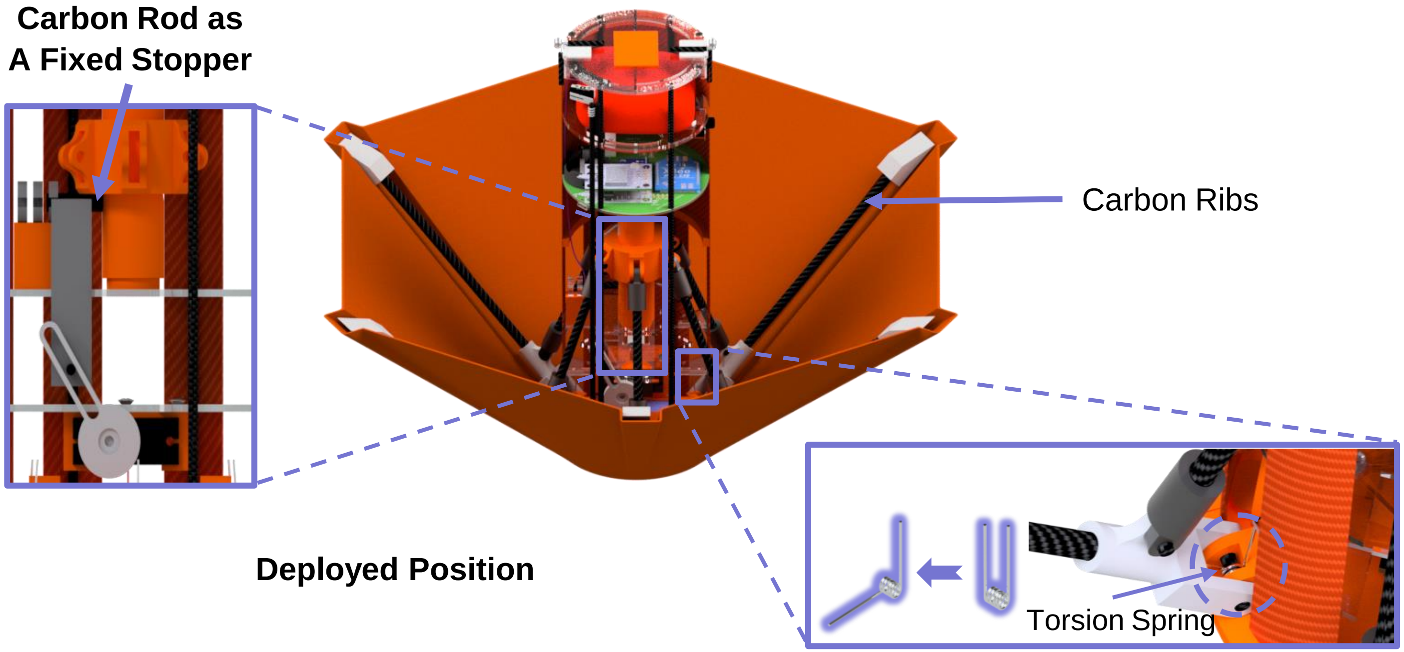
Payload Aerobraking Descent Control Strategy Selection and Trade (2/3)

Payload Aerobraking Descent Control

"Strategy B"

Stowed Position

Cone-shaped nose



Deployed Position

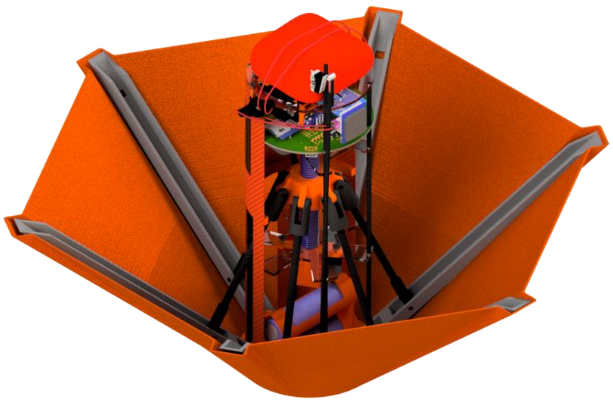
Information

- The payload is shaped like an upside-down umbrella
- Using torsion springs to deploy a heat shield
- Carbon rod as a fixed stopper
- Torsion springs are located and attached to the ribs

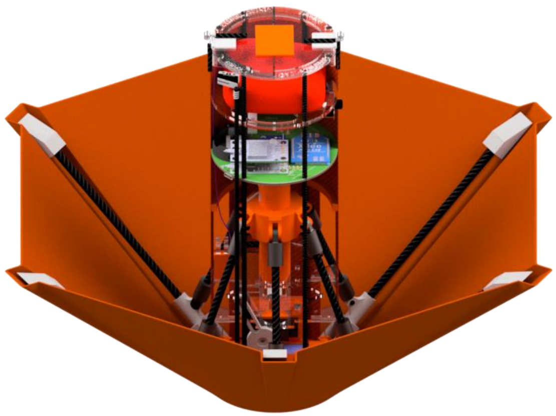
Payload Aerobraking Descent Control

“Selection”

Strategy A ✓



Strategy B



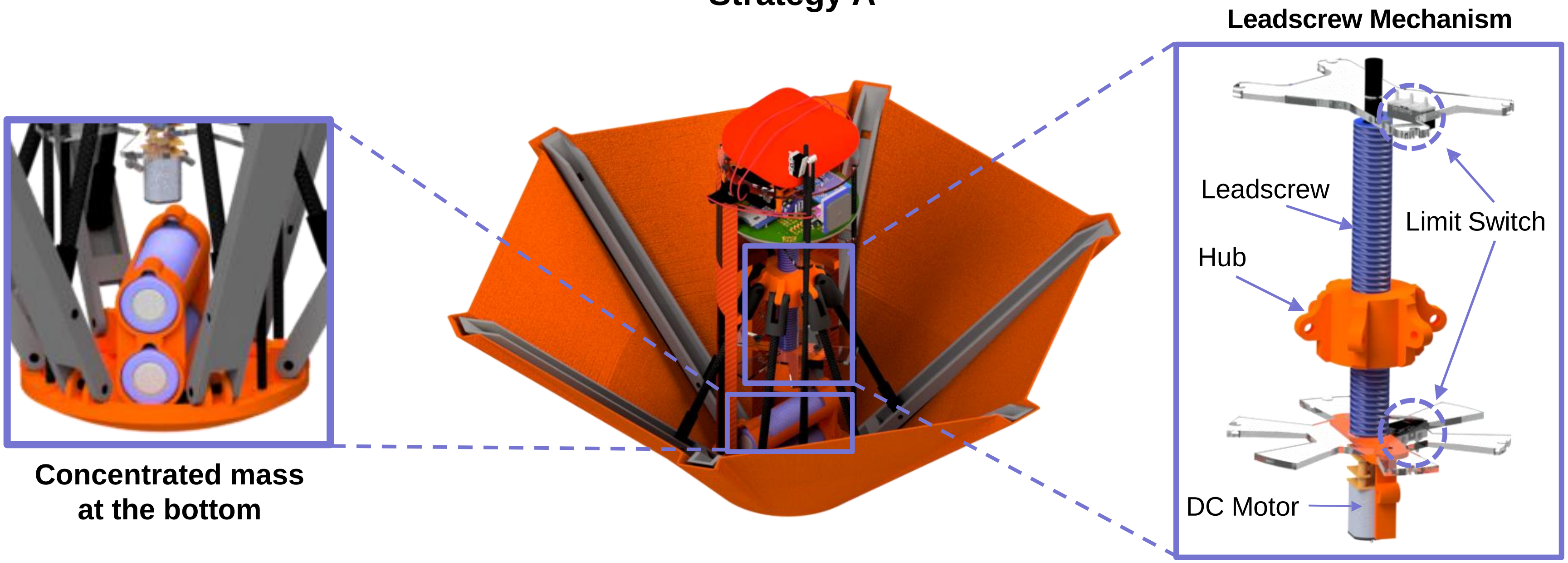
Selected: Strategy A

Reasons
We choose strategy A because the mechanism control is more flexible and the descent rate is easily adjustable, whereas strategy B offers less control. Furthermore, the DC motor and leadscrew mechanism provides precise control over the descent rate.

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

Payload Aerobraking Descent Stability

“Strategy A”



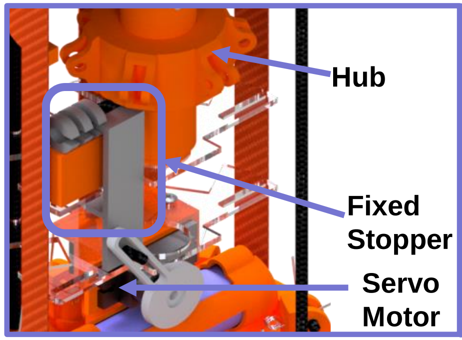
Information

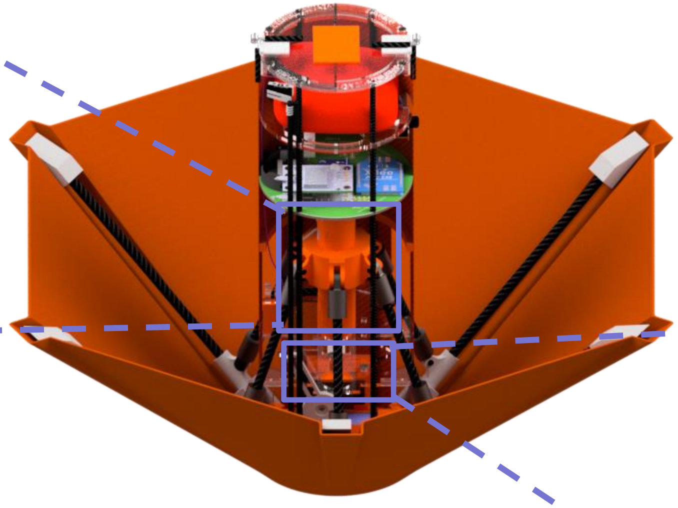
Type of Stability: Active Control
Description:
The payload is using leadscrew and DC motor to maintain descent stability. Other stability is maintained by placing major components at the bottom of the payload, so that the mass is focused at the bottom. This configuration helps to maintain the nadir direction and prevents the payload from swaying.

Payload Aerobraking Descent Stability

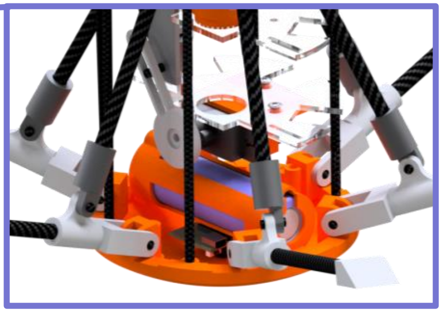
"Strategy B"

Fixed Stopper Mechanism





Concentrated mass at the bottom



Information

Type of Stability: Passive Control

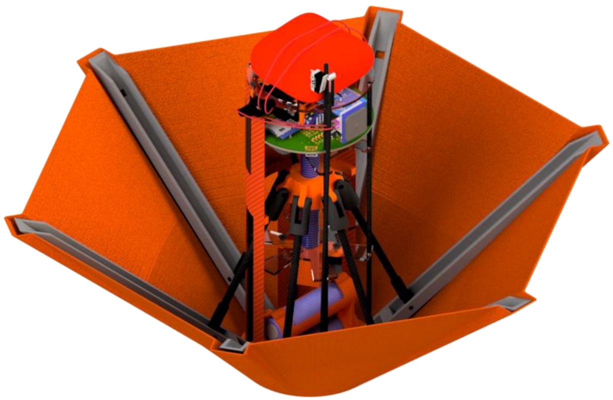
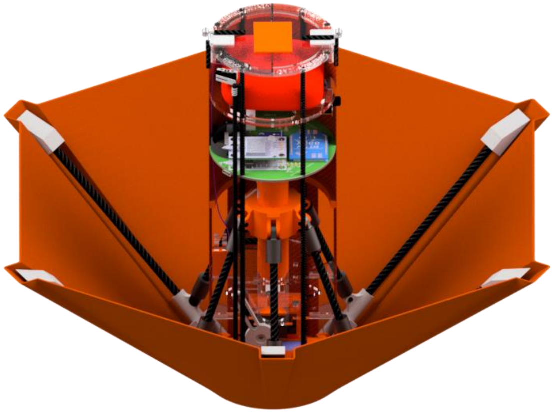
Description:

The payload is using servo and fixed stopper mechanism to maintain descent stability. The servo mechanism can be used to control the locker position of the fixed stopper, which limits the angle of the heat shield ribs. By controlling the position of the locker, the payload can maintain the nadir direction and prevents the payload from swaying. The mass is also focused at the bottom to maintain stability.

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

Payload Aerobraking Descent Stability

“Selection”

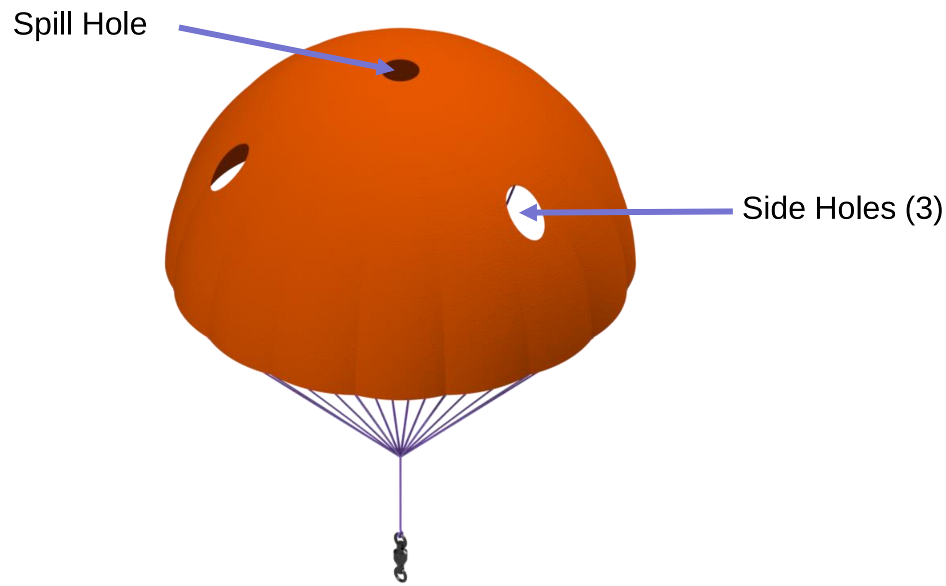
Strategy A ✓	Strategy B
	

Selected: Strategy A

Reasons
• Increase the precision and reliability of the aerobraking process • More stable descent • Ensuring a safe and controlled landing

Payload Parachute Descent Control

"Strategy A" – Round Parachute with Spill Hole and Side Holes

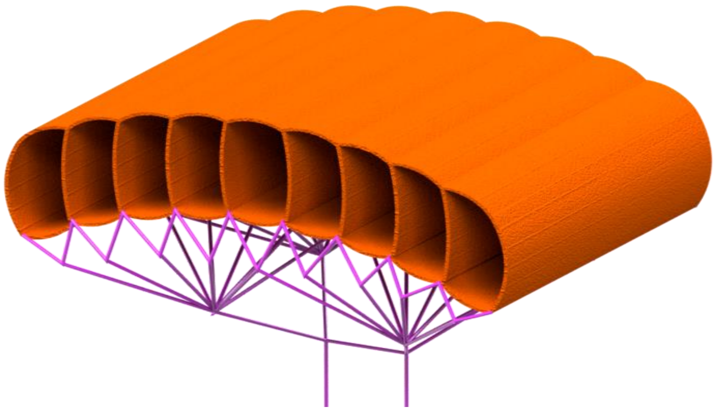


Information

Round parachutes are relatively simple to fold and pack, making them easy to stow and transport. The round shape makes the parachute easy to open, which reduces the risk of a malfunction. Round parachute with spill hole and side holes are used to stabilize the parachute so the nadir direction can be maintained.

Payload Parachute Descent Control

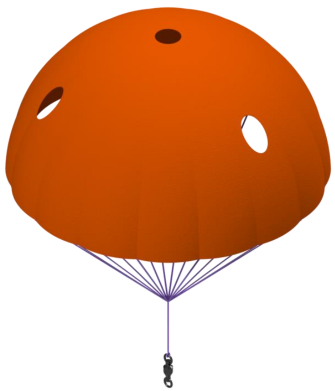
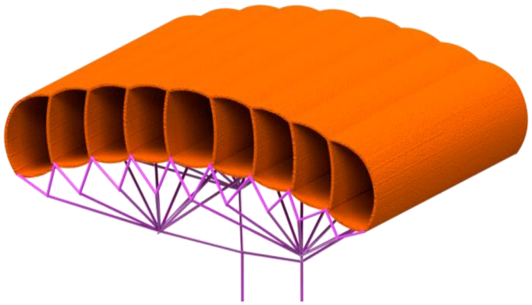
“Strategy B” – Ram-air Parachute



Information
Ram-air parachute systems have a greater glide ratio, which can increase the distance that can be covered during descent. Ram-air parachute systems are better able to handle high winds and turbulent conditions. Ram-air parachutes can be used in a variety of applications, making them suitable for a wide range of payloads and descent scenarios.

Payload Parachute Descent Control

“Selection”

Strategy A ✓	Strategy B
	
Round Parachute with Spill Hole and Side Holes	**Ram-air Parachute**

Selected: Strategy A

Reasons
We choose the round parachute with spill hole and side holes for the payload because descent rate of the round parachute with spill hole can be easily modified. Parachute is more stable if it has a spill hole and side holes. Spill hole helps to prevent the parachute from spinning excessively in the air while the side holes help to prevent the parachute from drifting too much in one direction.

Payload Parachute Descent Control Strategy Selection and Trade (4/4)

Payload Parachute Descent Control

“Parachute Material”

Selected: Ripstop Nylon ✓

Ripstop Nylon		Plastic HDPE		Kevlar	
PROS	CONS	PROS	CONS	PROS	CONS
More durable	Expensive	Cheap	Flammable	Heat resistant	Absorbs moisture
Affordable					Low compressive strength
Low moisture absorbency	Difficult to stitch	Lightweight	Less durable		
Lightweight					Expensive
High strength					

Descent Rate Estimates (1/6)

The descent rate of each descent phase will be estimated using different parameters		
		
Container Parachute	**Payload Parachute**	**Payload Aerobraking**
Parameters: • Diameter of Parachute *(Dp)* • Diameter of spill hole and side holes *(Dsh)*	Parameters: • Diameter of Parachute *(Dp)* • Diameter of spill hole and side holes *(Dsh)*	Parameters: • Radius of heat shield *(Rhs)*
Requirement: Descent rate of 15 m/s (± 5 m/s)	Requirement: Descent rate of 5 m/s (± 1 m/s)	Requirement: Descent rate of 20 m/s or less

Descent Rate Estimates (2/6)

Container Parachute

We use the range of descent velocity between minimum [V min = 10 m/s] and maximum [Vmax = 20 m/s] to determine diameter of parachute

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

$$\sqrt{\frac{8\times 0.7\times 9.8}{1.225\times(20)^2\times 3.14\times 1.28}} \leq Dp \leq \sqrt{\frac{8\times 0.7\times 9.8}{1.225\times(10)^2\times 3.14\times 1.28}}$$

$$\mathbf{0.166 \leq Dp \leq 0.333}$$

Information:

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

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

$\pi = 3.14$

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

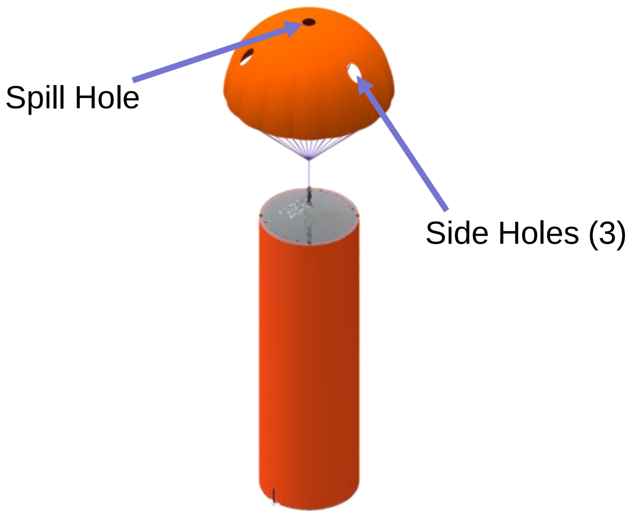
$Dsh =$ *Spill hole and side holes diameter* (m)

***Assumption**

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

$*\ m = 0.7\ kg$ (*container + payload*)

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



Chosen Diameter	Chosen Radius
0.222 m	**0.111 m**

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

Diameter of spill hole and side holes = $Dsh = Dp \times 10\%$ = **0.0222 m**

Spill hole and side holes radius = $\frac{Dsh}{2}$ = **0.0111 m**

Descent Rate Estimates (3/6)

Payload Parachute

We use the range of descent velocity between minimum [V min = 4 m/s] and maximum [Vmax = 6 m/s] to determine diameter of parachute

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

$$\sqrt{\frac{8\times0.5\times9.8}{1.225\times(6)^2\times3.14\times1.28}} \leq Dp \leq \sqrt{\frac{8\times0.5\times9.8}{1.225\times(4)^2\times3.14\times1.28}}$$

$$\mathbf{0.47 \leq Dp \leq 0.70}$$

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*)

$* \ m = 0.5\ kg$ (*payload*)

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

Chosen Diameter	Chosen Radius
0.547 m	**0.273 m**

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

Diameter of spill hole and side holes = $Dsh = Dp \times 10\%$ = **0.0547 m**

Spill hole and side holes radius = $\frac{Dsh}{2}$ = **0.0273 m**

Descent Rate Estimates (4/6)

Payload Heat Shield

We use the range of descent velocity between minimum [V min = 10 m/s] and maximum [Vmax = 20 m/s] to determine the radius of heat shield

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

$$\sqrt{\frac{2\times 0.5\times 9.8}{1.225\times(20)^2\times 3.14\times 0.47}} \leq Rhs \leq \sqrt{\frac{2\times 0.5\times 9.8}{1.225\times(10)^2\times 3.14\times 0.47}}$$

$$\mathbf{0.116 \leq \mathit{Rhs} \leq 0.232}$$

Information:

$Rhs = The\ Radius\ of\ the\ heat\ shield\ (m)$

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

$\pi = 3.14$

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

***Assumption**

$*\ Cd\ =\ 0.47\ (when\ heat\ shield\ deploy\ 45^0)$

$(Drag\ coefficient\ of\ heat\ shield)$

$*\ m = 0.5\ kg\ (payload)$

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

Chosen Radius	Chosen Diameter
0.155 m	**0.310 m**

Descent Rate Estimates (5/6)

Information

Container mass : 228.1 g
Payload mass : 473.37 g
Total mass : 701.47 g

CanSat (Container + Payload) Descent Rate

$$v = \sqrt{\frac{8 \times m \times g}{\rho \times (Dp)^2 \times \pi \times Cd}}$$

$$v = \sqrt{\frac{8 \times (0.7) \times (9.8)}{1.225 \times (0.222)^2 \times (3.14) \times (1.28)}}$$

$$\boldsymbol{v = 15.03\ m/s}$$

Payload Aerobraking Descent Rate

$$v = \sqrt{\frac{2 \times m \times g}{\rho \times (Rhs)^2 \times \pi \times Cd}}$$

$$v = \sqrt{\frac{2 \times (0.47) \times (9.8)}{1.225 \times (0.155)^2 \times (3.14) \times (0.47)}}$$

$$\boldsymbol{v = 14.56\ m/s}$$

Payload Parachute Descent Rate

$$v = \sqrt{\frac{8 \times m \times g}{\rho \times (Dp)^2 \times \pi \times Cd}}$$

$$v = \sqrt{\frac{8 \times (0.47) \times (9.8)}{1.225 \times (0.547)^2 \times (3.14) \times (1.28)}}$$

$$\boldsymbol{v = 5.00\ m/s}$$

Descent Rate Estimates (6/6)

Final Result

Parachute and Heat Shield Summary	
Altitude	**The descent rate each descent phase will be estimated using parameters**
725-500 m	Type parachute: Round parachute The diameter of container parachute: **0.222 m** Spill hole diameter: **0.0222 m** The descent speed: **15.03 m/s**
500-200 m	The radius of heat shield: **0.155 m** The descent speed: **14.56 m/s**
200-0 m	Type parachute: Round parachute The diameter of payload parachute: **0.547 m** Spill hole diameter: **0.0547 m** The descent speed: **5.00 m/s**

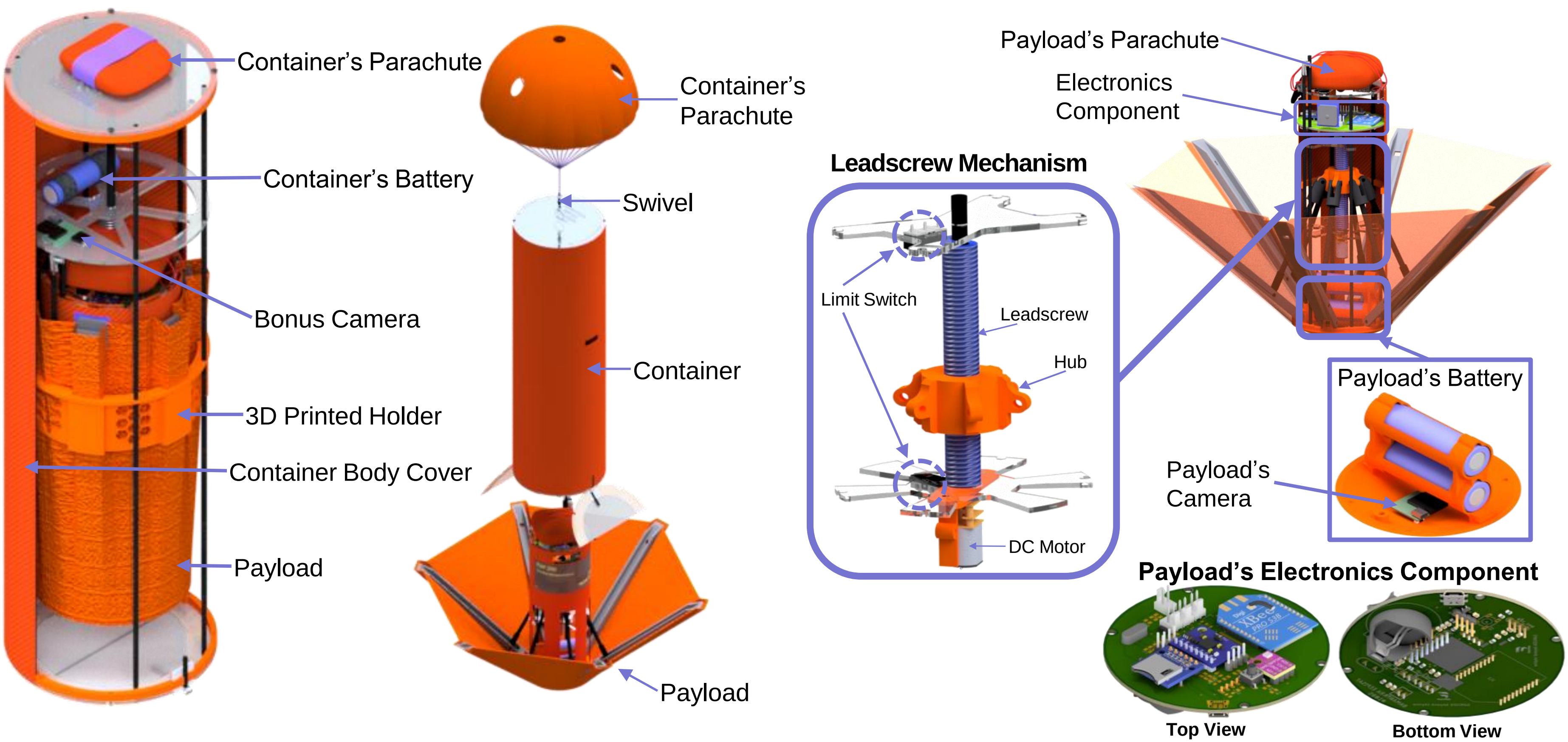
Container Summary
The container has a parachute to manage descent control. The parachute has spill hole and sides holes to improve stability and maintain nadir direction.

Payload Summary
The payload is using active control. DC motor and leadscrew mechanism are used to maintain the heat shield angle. The focus of mass is in the bottom of the payload to keep the stability and prevent from swaying.

Mechanical Subsystem Design

Artaka Sunu Adhi Prasetya

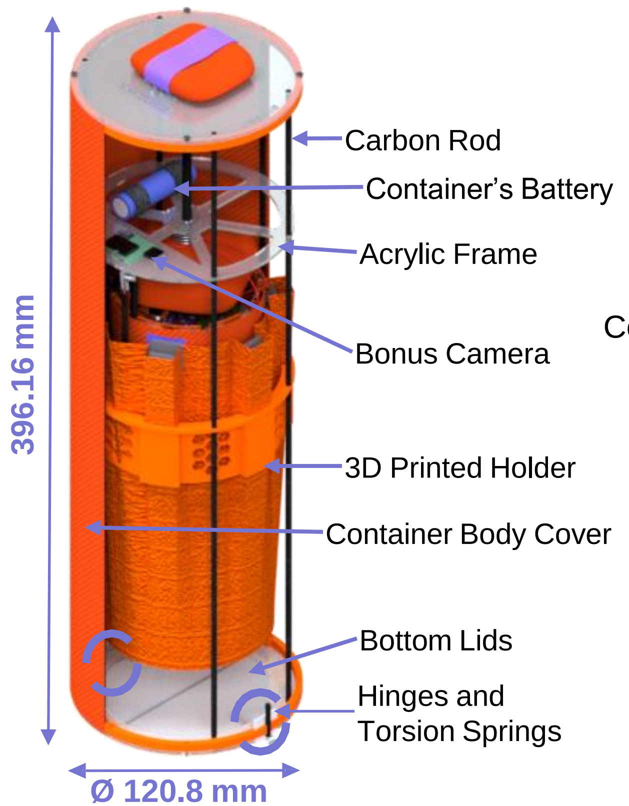
Mechanical Subsystem Overview



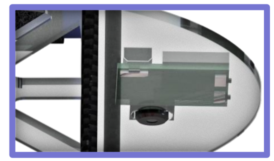
Container	Payload
Material: Acrylic, ABS+, Fiberglass **Parachute**: Ripstop Nylon **Note:** The container has a parachute	**Material**: ABS+, Acrylic, Fiberglass **Parachute**: Ripstop Nylon **Note:** The payload will be actively controlled by DC motor and leadscrew mechanism. The payload has a parachute

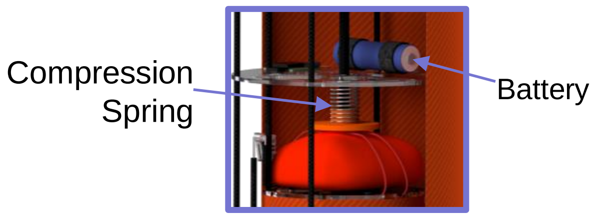
Container Mechanical Layout of Components Trade & Selection (1/5)

Container Strategy A – Mechanical Layout

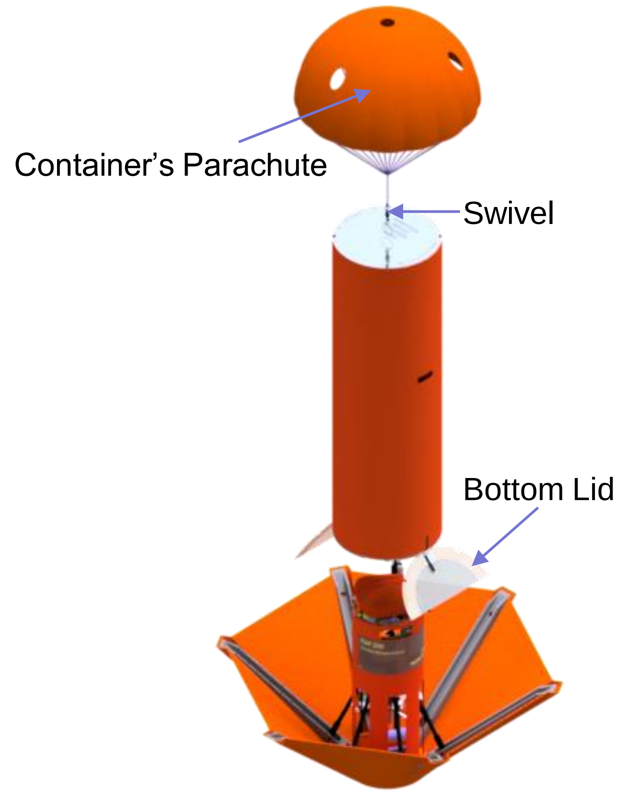


Bonus Camera





3D Printed Holder

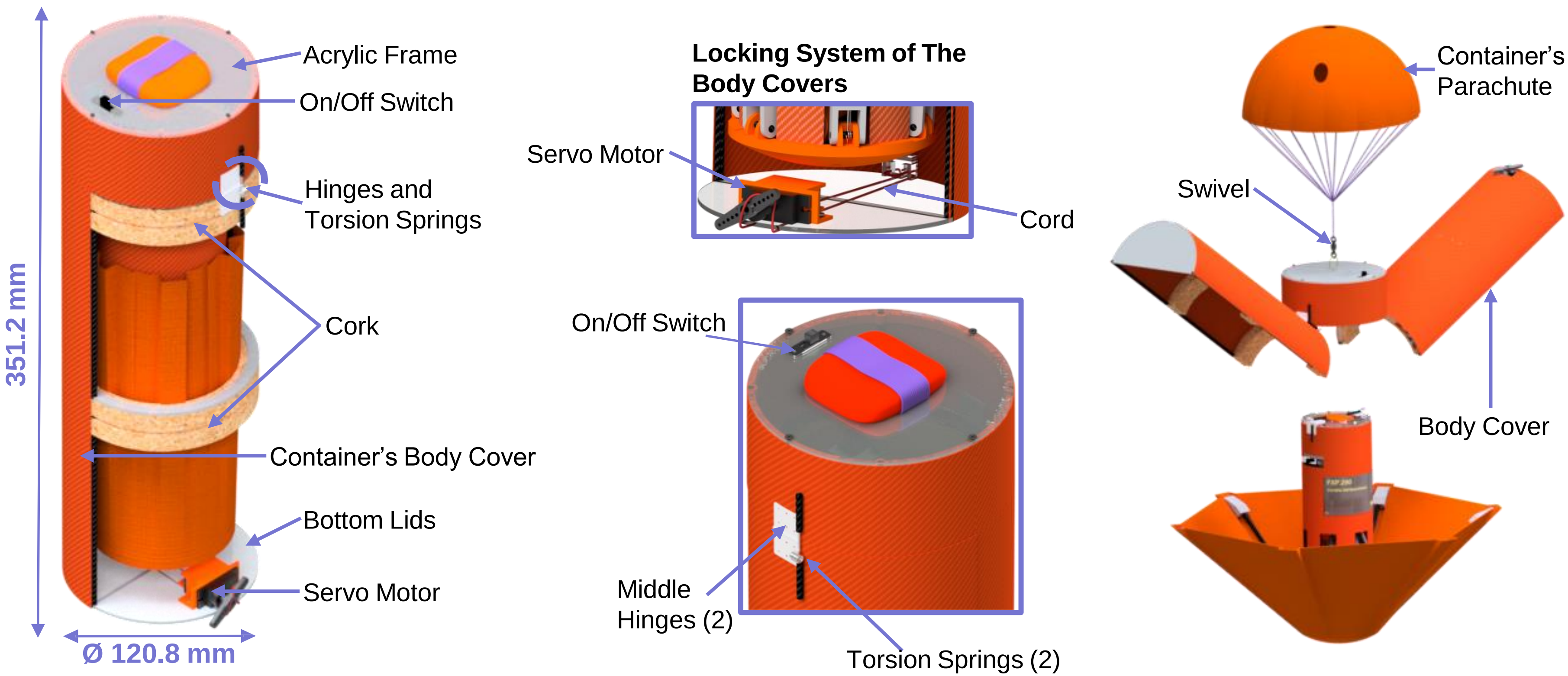


Information

1. The container has two hinges combined with spring located at bottom of the container
2. The bottom lids are openable
3. After the ribs of the heat shield are unhooked from the 3D printed holder using the DC motor and leadscrew mechanism, the spring inside the container pushes it downward until it hits the bottom lids. This caused the payload to be released

Container Mechanical Layout of Components Trade & Selection (2/5)

Container Strategy B – Mechanical Layout



Information

1. The container has two hinges located at the middle of the container
2. The container has two springs located beside the middle hinges
3. The body covers are openable
4. The spring will pull the body covers when its opened. At the same time, airflow will push the body covers up

Container Mechanical Layout of Components Trade & Selection (3/5)

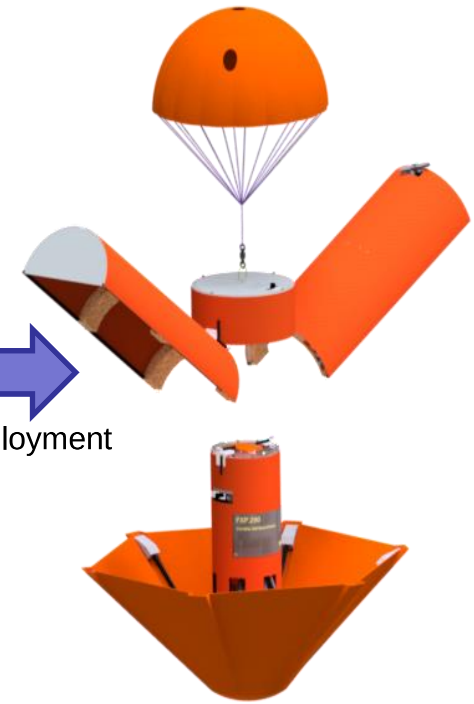
Container Strategy Trade Selection

Strategy A √

After Deployment

Strategy B

After Deployment



Selected: Strategy A

Reasons
1. There is no need for a door locker 2. It has better durability 3. Feasible

Container Mechanical Layout of Components Trade & Selection (4/5)

Container Material Trade Selection (1/2)

Container Body Cover

Selected: Fiberglass

Reasons: lightweight, high durability, sturdy, affordable

Material	Density (g/cm³)	Durability (MPa)	Cost ($)
Fiberglass	2.53	300	10.0
PLA+	1.23	57.8	15.22

Container Frame

Selected: ABS+ and Acrylic

Reasons: lightweight, heat resistant, sturdy, good combination

Material	Density (g/cm³)	Durability (MPa)	Cost ($)
ABS+	1.04	48.0	12.09
PLA+	1.23	57.8	15.22
Acrylic	1.18	65	1.39

Container Lids

Selected: Acrylic

Reasons: high durability and cheap

Material	Density (g/cm³)	Durability (MPa)	Cost ($)
ABS+	1.04	48.0	12.09
PLA+	1.23	57.8	15.22
Acrylic	1.18	65	1.39

Container Material Trade Selection (2/2)

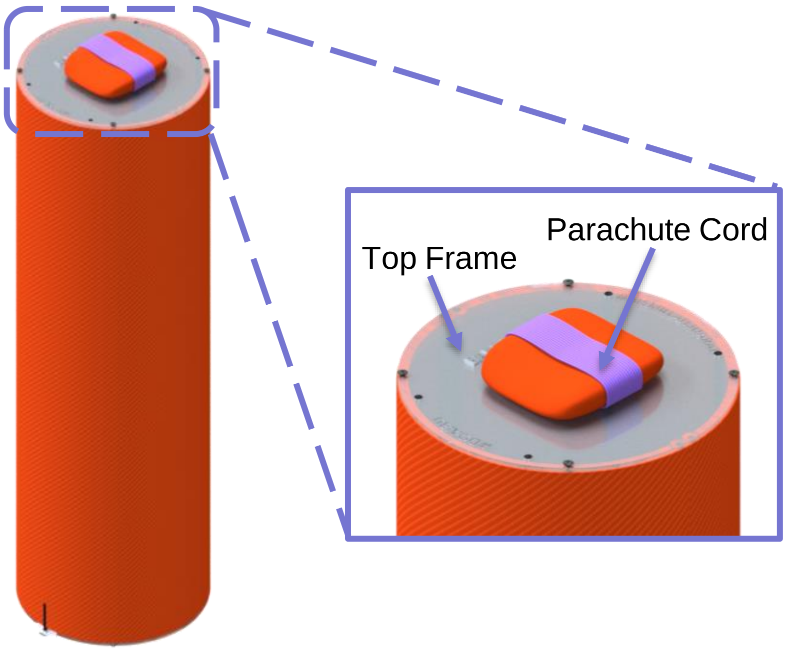
Parachute Material

Material	Density (kg/m^3)	Durability (MPa)	Strength	Permeability (cc/cm^2/sec)	Cost ($)
Ripstop Nylon	1140	126.72	High	0.02	1.39
Plastic HDPE	961	38.0	Medium	1.741	0.99
Polyester	1200	129	High	175	9.33

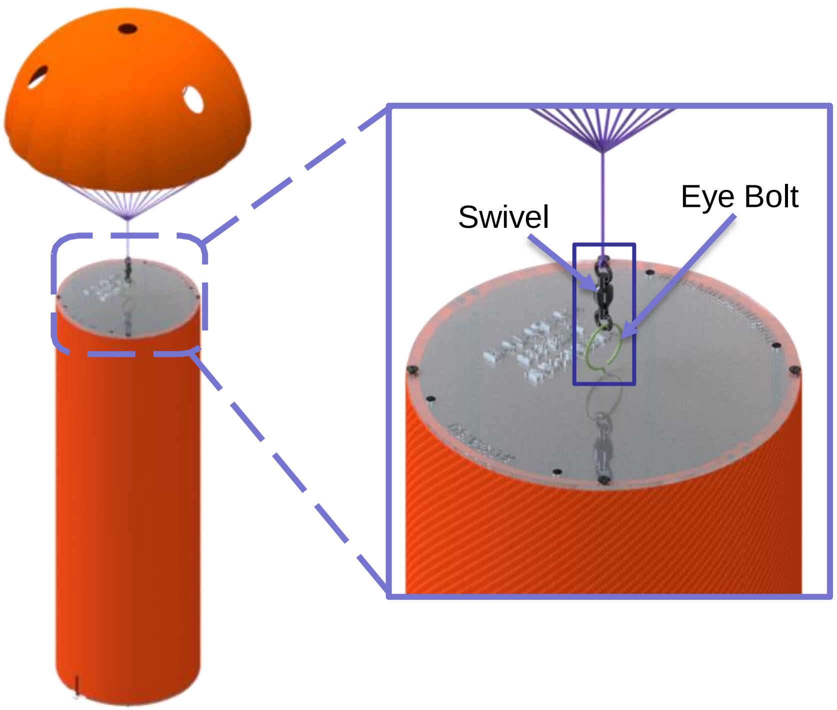
Selected Material	Reasons
 **Ripstop Nylon ✓**	• Light material • High strength • More durable • Low moisture absorbency • Affordable

Container Parachute Attachment Mechanism

Before Deployment Container Parachute



After Deployment Container Parachute

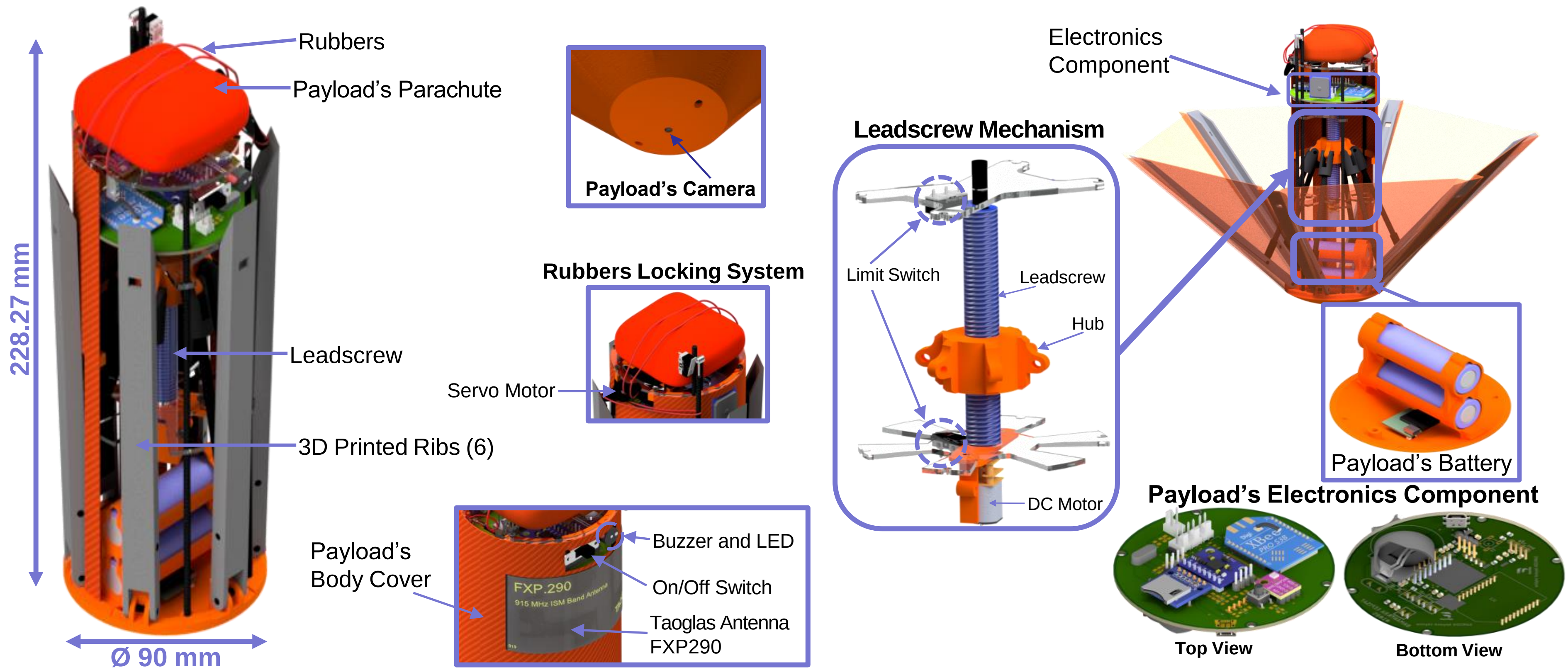


Information

1. The container's parachute is placed on the top of container at folded position
2. The cord of parachute keeps the parachute to maintain its folded position before release
3. The parachute will be opened by the air-resistance assist
4. The container's parachute will be attached by a swivel and eye bolt

Payload Mechanical Layout of Components Trade & Selection (1/6)

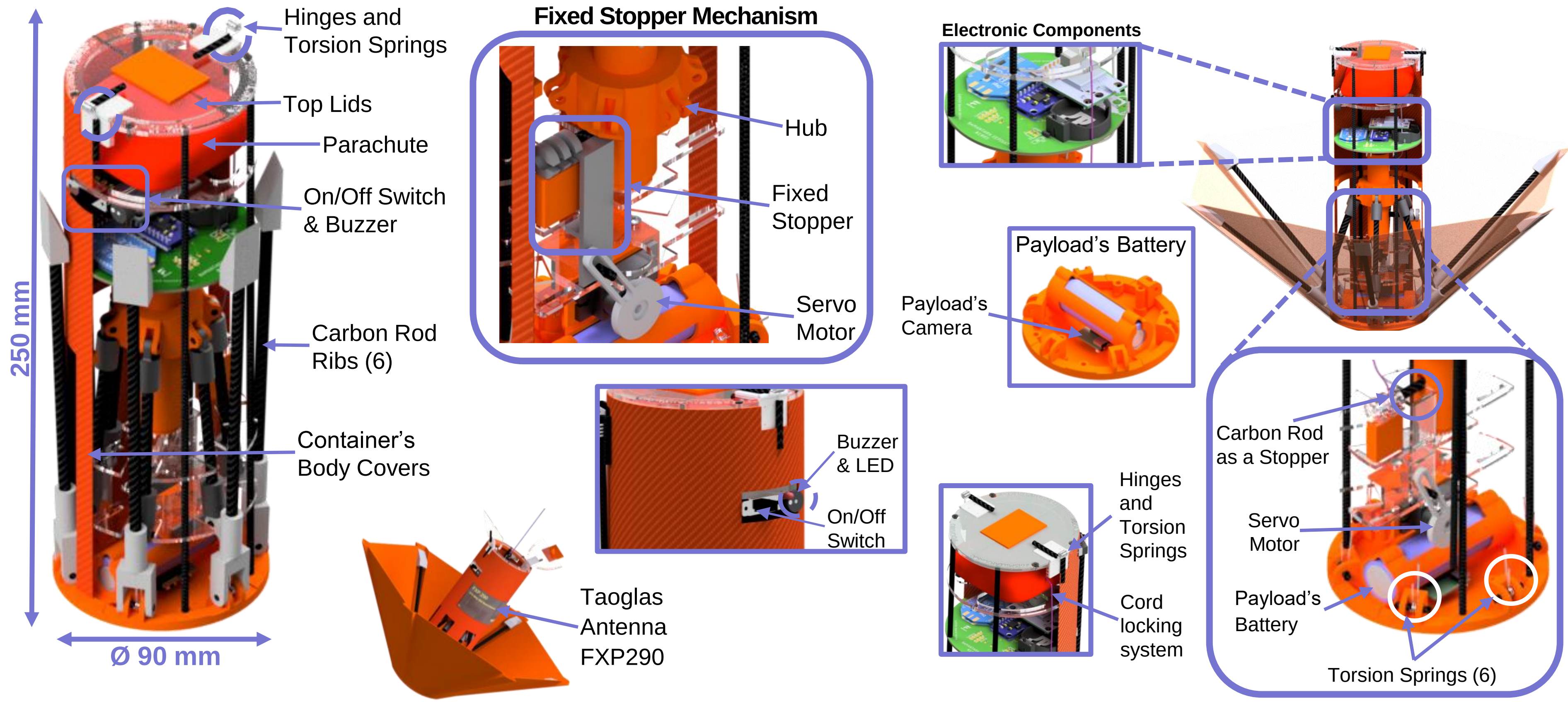
Payload Strategy A – Mechanical Layout



PROS	CONS
1. Adjusting the opening of the heat shield more accurately 2. More stable in high airflow 3. Can provide fast and smooth linear motion	1. High electrical current demand

Payload Mechanical Layout of Components Trade & Selection (2/6)

Payload Strategy B – Mechanical Layout

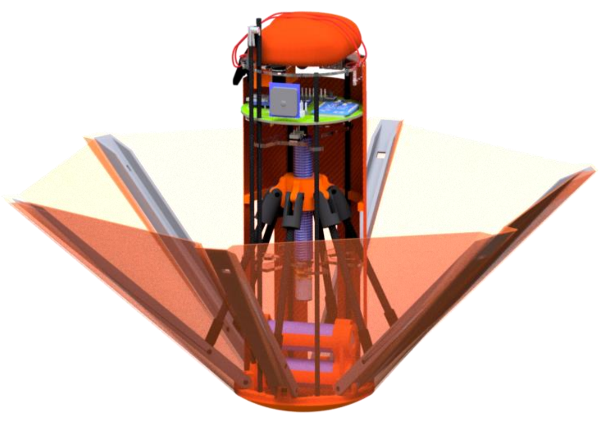


PROS	CONS
1. Simple to deploy with torsion spring	1. High risk to failure
2. Low power consumption	2. Not suitable for a high-speed descent

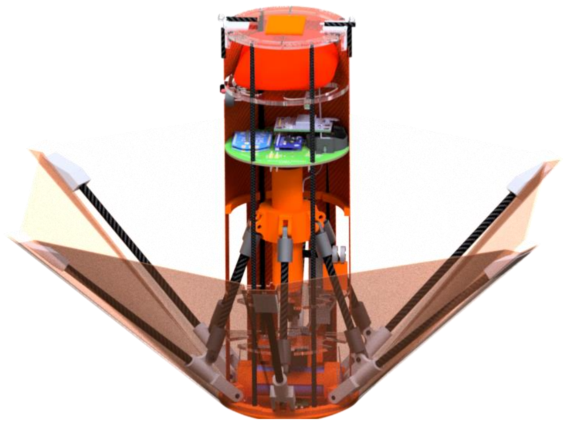
Payload Mechanical Layout of Components Trade & Selection (3/6)

Payload Mechanical Selection
“Selection”

Strategy A ✓



Strategy B



Selected: Strategy A

Reasons
1. Higher stability
2. Easy to adjust the heat shield angle
3. Simpler mechanism

Payload Mechanical Layout of Components Trade & Selection (4/6)

Payload Material Trade Selection (1/3)

Payload Body Cover

Selected: Fiberglass
Reasons: lightweight, high durability, sturdy

Material	Density (g/cm^3)	Durability (MPa)	Cost ($)
Fiberglass	2.53	300	10.00
PLA+	1.23	57.8	15.22
Crepe Paper Composite	0.56	87.5	1.18

Parachute Material

Selected: Ripstop Nylon
Reasons: more durable, affordable, lightweight, high strength

Material	Density (kg/m^3)	Durability (MPa)	Strength	Permeability ($cc/cm^2/sec$)	Cost ($)
Ripstop Nylon	1140	126.72	High	0.02	1.39
Plastic HDPE	970	38.0	Medium	1.741	0.99
Polyester	1200	129	High	175	9.33

Payload Mechanical Layout of Components Trade & Selection (5/6)

Payload Material Trade Selection (2/3)

Heat Shield Coating Surfaces Material

Material	Density (kg/m^3)	Durability (MPa)	Cost ($)
Ripstop Nylon	1140	126.72	1.39
Plastic HDPE	970	38.0	0.99
Polyester	1200	129	9.33

Selected Material	Reasons
 **Ripstop Nylon ✓**	• Light material • High strength • More durable • Low moisture absorbency • Affordable

Payload Mechanical Layout of Components Trade & Selection (6/6)

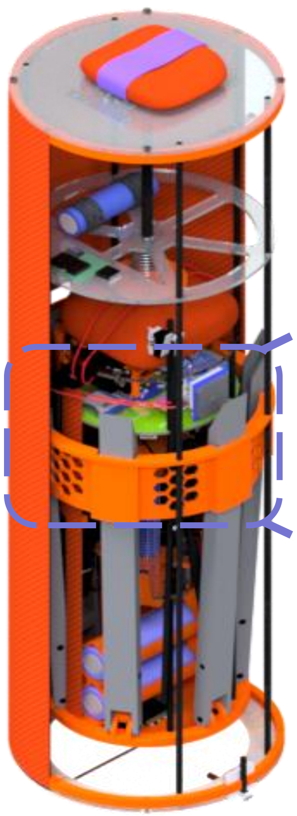
Payload Material Trade Selection (3/3)

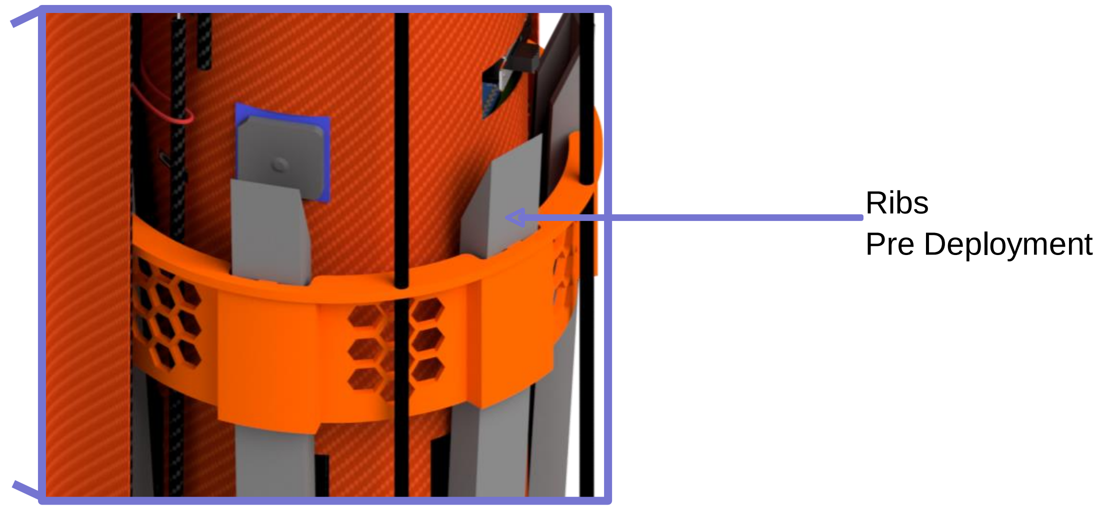
Part	Material	Density (kg/m^3)	Durability (MPa)	Cost ($)
Payload Frame	Acrylic	1.18	65.0	1.39
	PLA+	1.23	57.8	15.22
Payload Nose	ABS+	1.04	48.0	12.09
	PLA+	1.23	57.8	15.22
Heat Shield Ribs	ABS+	1.04	48.0	12.09
	Carbon Rod	1.5	300.0	6.0
Leadscrew	PLA+	1.23	57.8	15.22
	Teflon	2.2	20.0	10.0
	ABS+	1.04	48.0	12.09
DC Motor Brackets	PLA+	1.23	57.8	15.22
	ABS+	1.04	48.0	12.09

Selected Material	Payload Frame: **Acrylic**	Payload Nose: **ABS+**	Heat Shield Ribs: **ABS+**	Leadscrew: **Teflon**	DC Motor Brackets **ABS+**
Reason	• Higher durability • Cheapest	• Strong material • Easy to shape • Cheapest	• Easy to shape • Lighter	• Smoother surface • Cheapest	• Strong material • Heat resistant • Cheapest

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

Strategy A





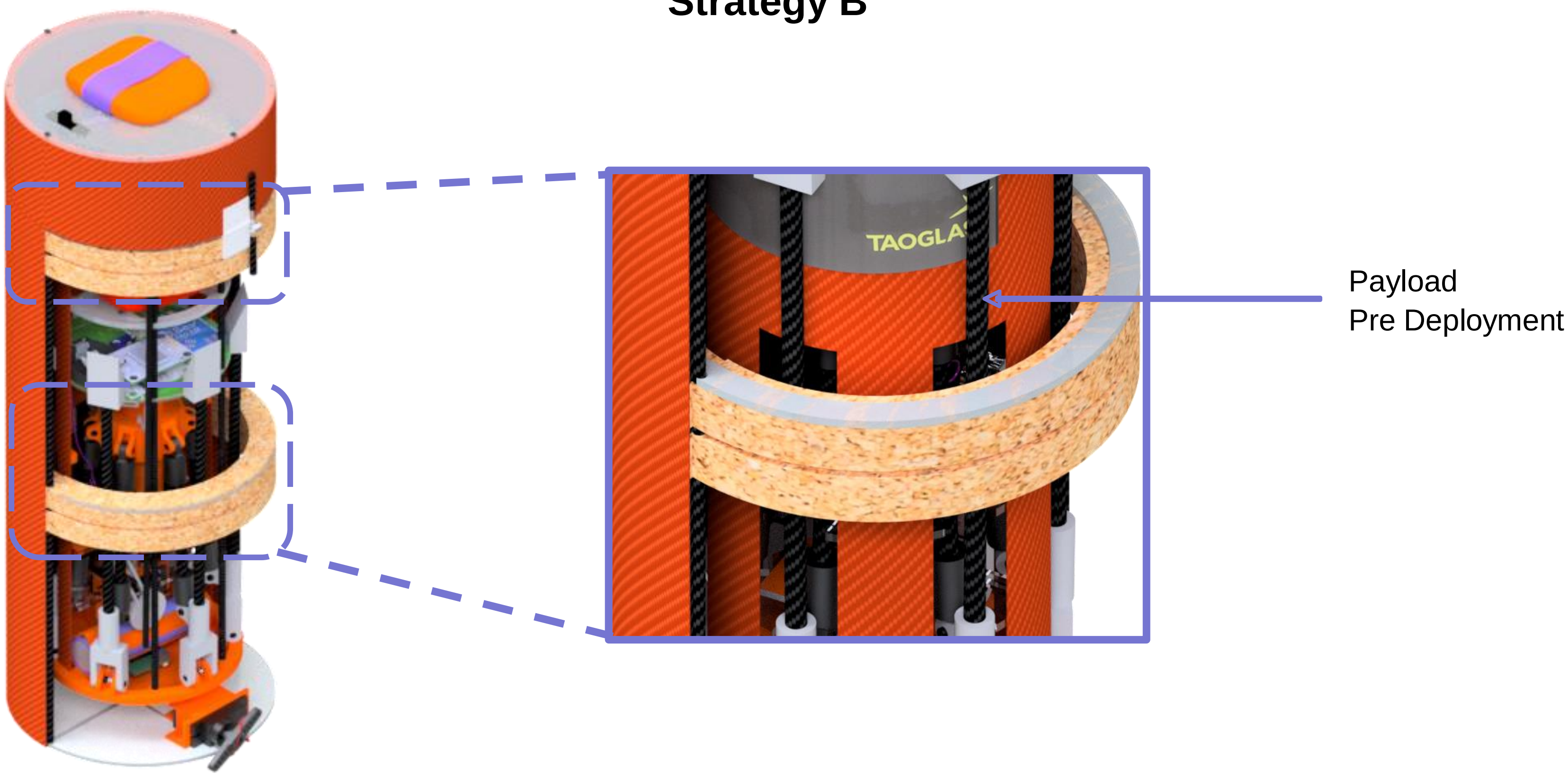
3D Printed Holder

Information

1. The 3D printed holder will be made of ABS+
2. Holder is used to reduce the shock and prevent shifting while the payload is stowed
3. The holder has a shape that matches with the payload shape
4. In the pre-payload deployment condition, the ribs will hook onto the holder to lock the payload into position

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

Strategy B



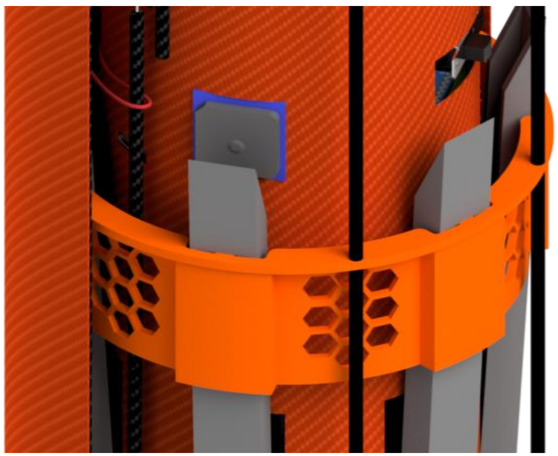
Information

1. This strategy is using corks as protective material for the payload during stowed in the container
2. The corks are not flammable and not crumbled easily
3. Corks has a fairly lightweight

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

Payload Aerobraking Pre Deployment
“Selection”

Strategy A ✓



Strategy B

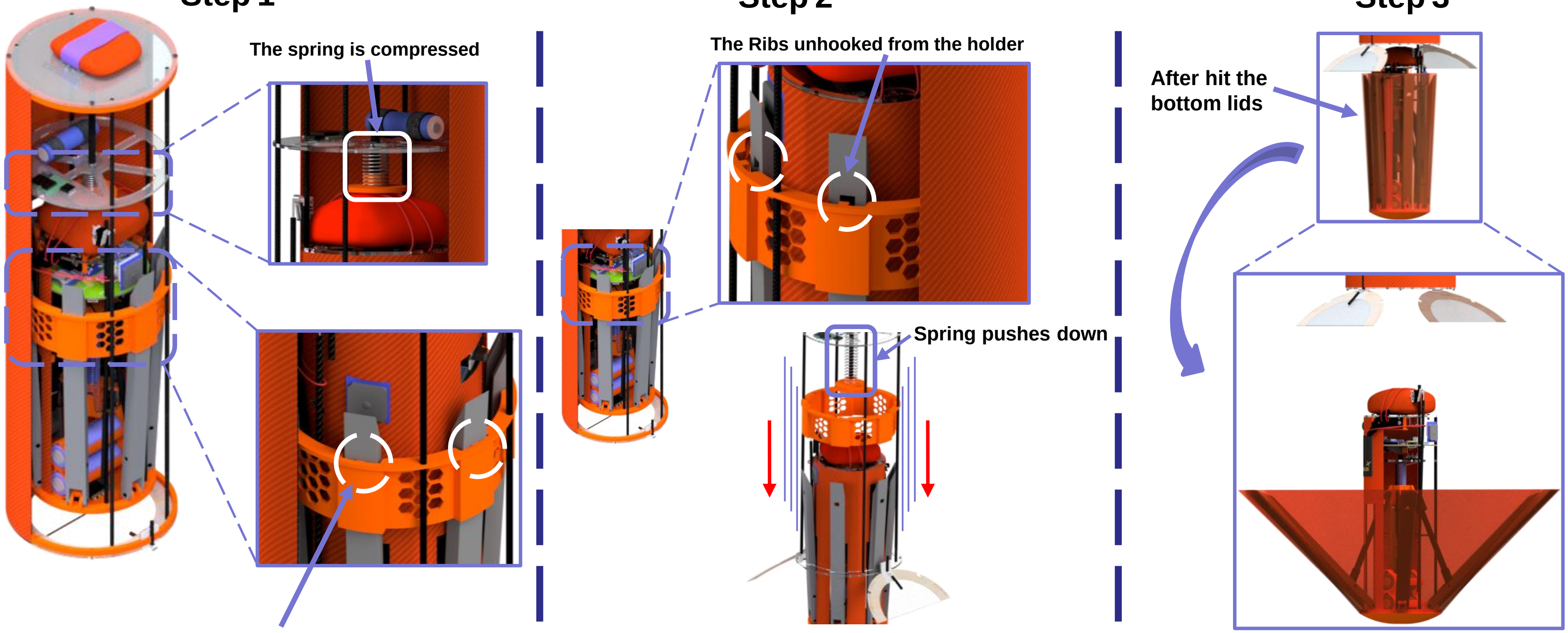
Selected: Strategy A

Reasons
1. The 3D printed holder can keep the heat shield is stowed while in the container
2. Cork is more difficult to attach inside the container
3. Easy to manufacture advanced shape

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

Strategy A

Step 1 | Step 2 | Step 3



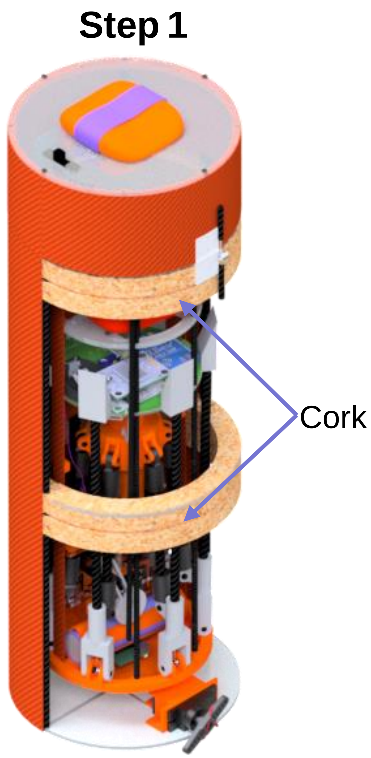
Payload Ribs Stowed Position | Payload Ribs Transition From Stowed Position | Payload Deployment Position

Information

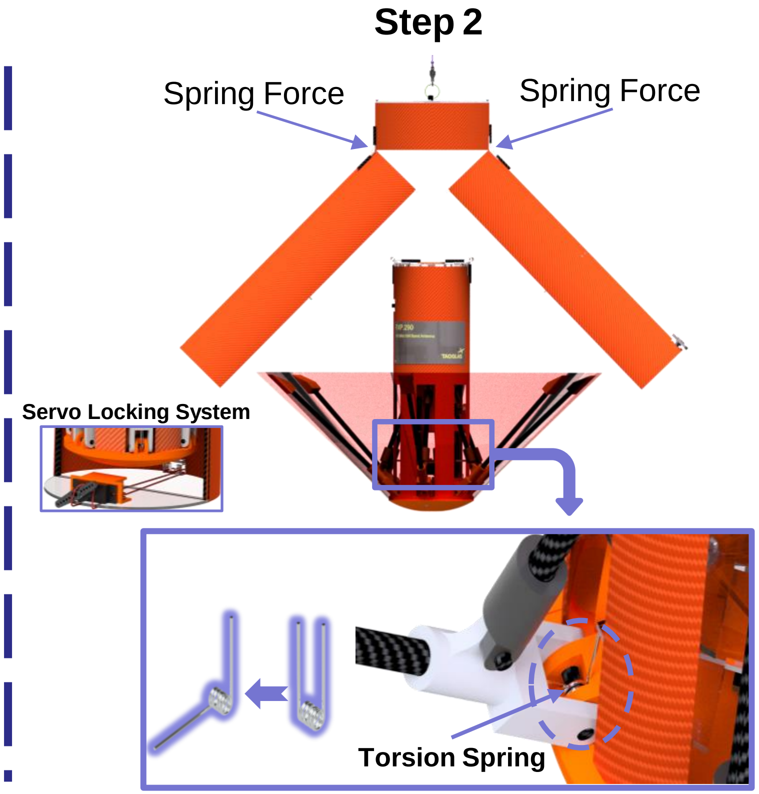
The payload will be released when the heat shield ribs unhooks from the 3D printed holder with DC motor and leadscrew mechanism. After the ribs is unhooked from the holder, the spring in the container will push the payload out from the container.

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

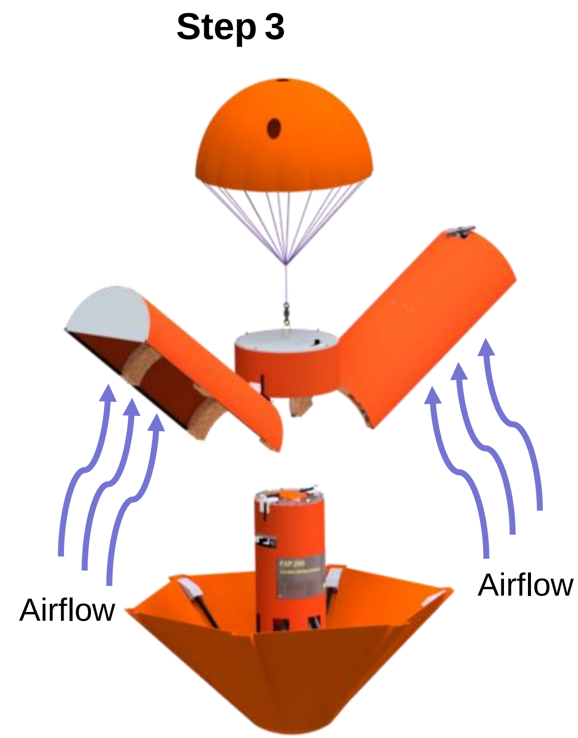
Strategy B



Payload Ribs Stowed Position



Payload Ribs Transition From Stowed Position



Payload Deployment Position

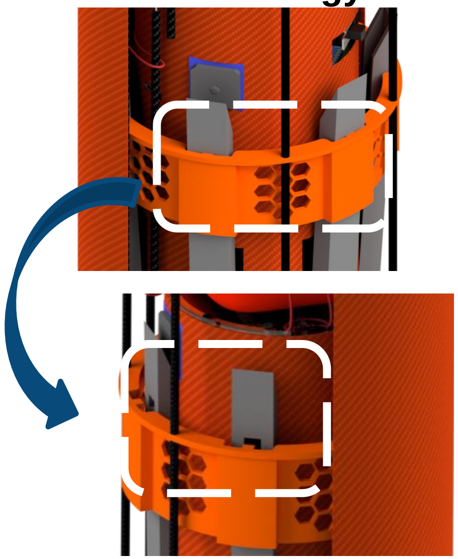
Information

The container's body will open if the servo is unlocked, the spring pulls the body covers, and airflow pushes the body covers to the top. After the container's body is opened, the payload's heat shield ribs will be deployed by torsion springs to open a heat shield.

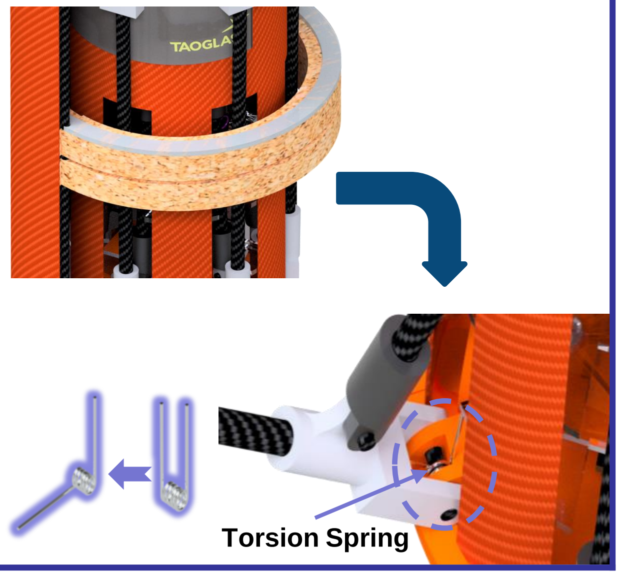
Payload Aerobraking Deployment Configuration Trade & Selection (3/3)

Payload Aerobraking Deployment "Selection"

Strategy A ✓



Strategy B

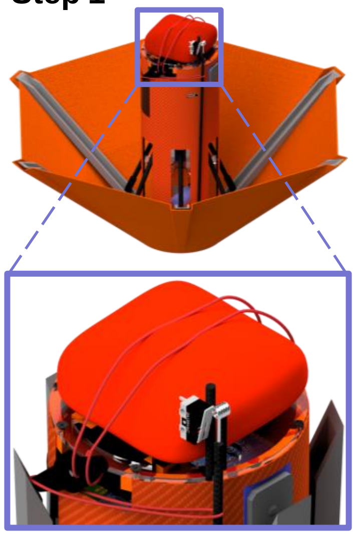


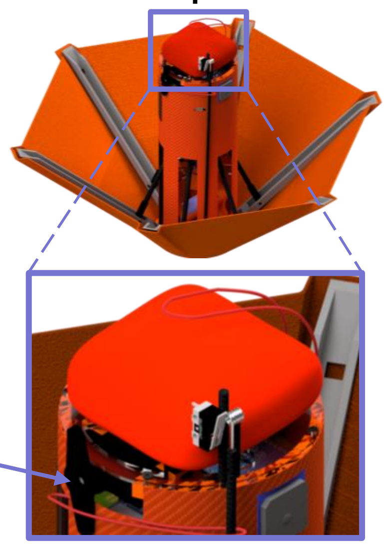
Selected: Strategy A

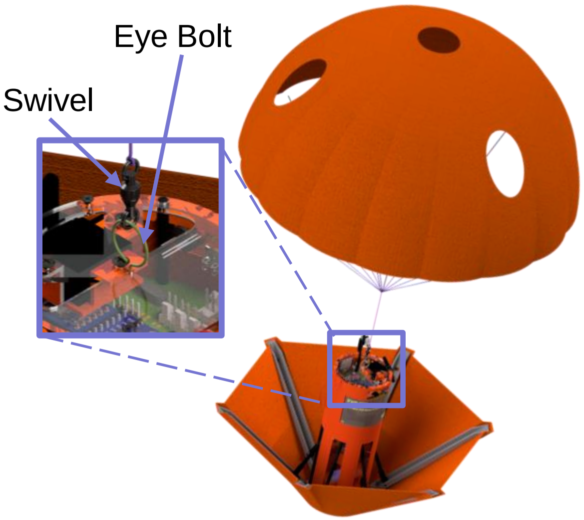
Information
1. The 3D printed holder can keep the body of the container rigid and stable 2. Repulsion from the torsion springs have a risk to stuck in the container's body

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

Strategy A

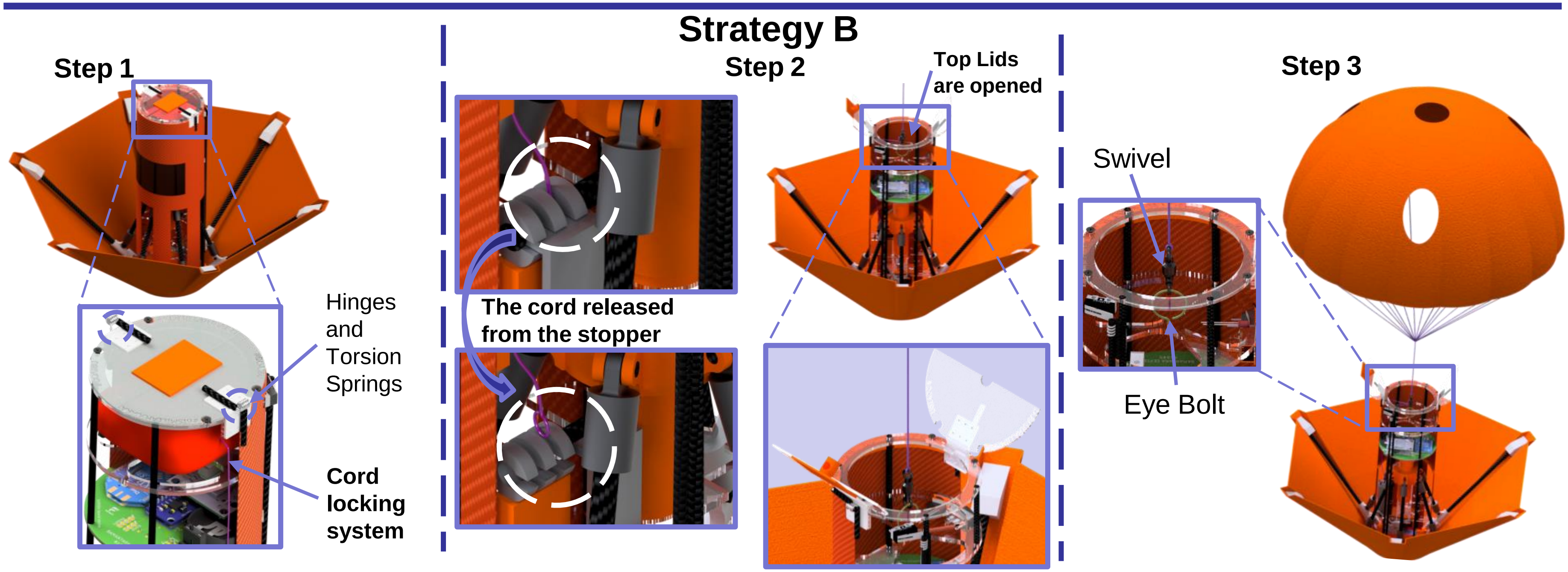






Information	
Step 1	The payload parachute is placed on the top frame of the payload in a folded position and is attached by an eye bolt to the payload. The eye bolt is attached to the parachute frame and hard-glued. The rubber keeps the payload parachute on the top frame before release. The payload parachute is connected to the eye bolt with a swivel as a connector
Step 2	At 200 m, servo actives and the rubber will be released
Step 3	After the rubber is released, the payload parachute deployed from the payload

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

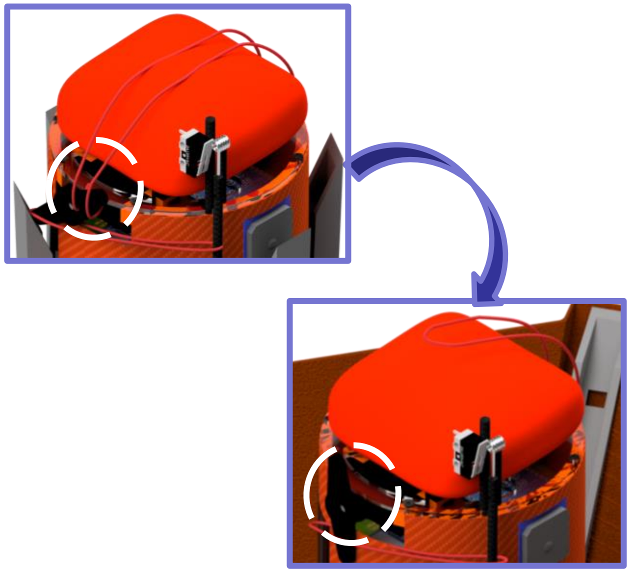


Information	
Step 1	The payload parachute is placed between top lid and parachute frame of the payload in folded position and attached by an eye bolt to payload. The eye bolt is attached to parachute frame and hard-glued. The top lid kept the payload parachute inside of the payload before release because it is held by cord connected with the slider. The payload parachute is connected to the eye bolt with swivel as a connector
Step 2	At 200 m, servo actives to move the stopper to remove the strap from the slider that opens the top lid
Step 3	After the top lid is opened, the payload parachute deployed from the payload

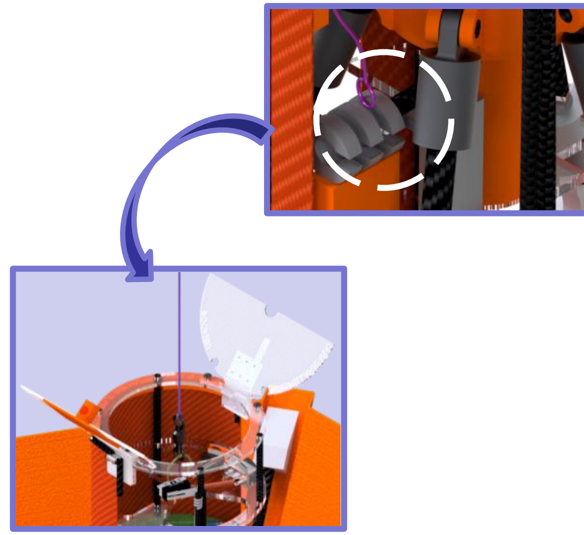
Payload Parachute Deployment Configuration Trade & Selection (3/3)

Payload Parachute Deployment
“Selection”

Strategy A ✓



Strategy B



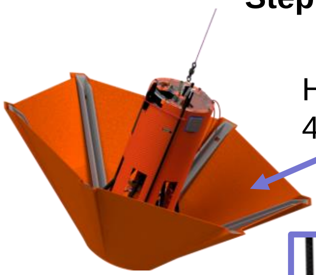
Selected: Strategy A

Reasons
1. Simpler deployment mechanism 2. Feasible 3. Easy to build

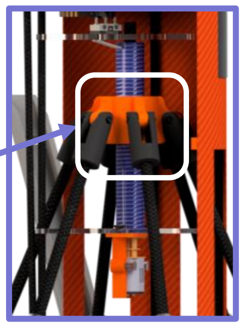
Payload Uprighting Configuration Trade & Selection (1/3)

Strategy A

Step 1



Heat shield at a 45-degree angle

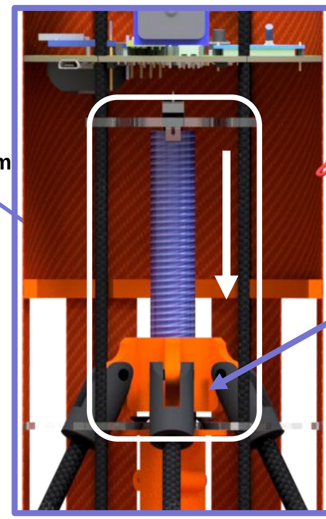


Leadscrew Mechanism Before Uprighting

Payload Landing Position

Step 2

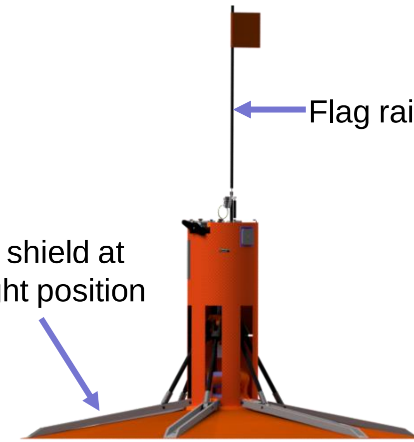
Leadscrew Mechanism After Uprighting



Hub Moves Down

Payload Transition From Landing Position

Step 3



Flag raised

Heat shield at upright position

Payload Upright Position

Information	
Step 1	The payload, which landed on the ground, uses a leadscrew mechanism to upright itself
Step 2	The leadscrew rotates to move the hub downward to adjust the heat shield ribs to upright position
Step 3	After the hub is moved downward, the payload is in an upright position. Then, the servo is activated to release a cord that raises the flag

Payload Uprighting Configuration Trade & Selection (2/3)

Strategy B

Step 1

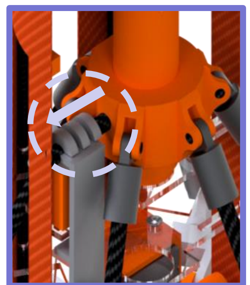
Heat shield at a 45-degree angle

Stopper Mechanism Before Uprighting

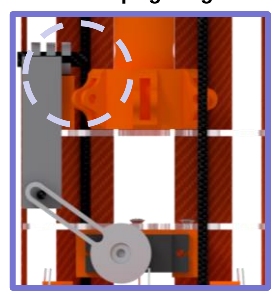
Payload Landing Position

Step 2

Stopper move to left



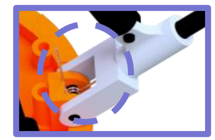
Stopper Mechanism After Uprighting

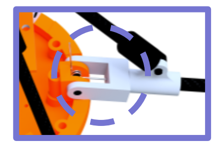


Payload Transition From Landing Position

Step 3

Ribs pulled by torsion spring





Flag raised

Heat shield at upright position

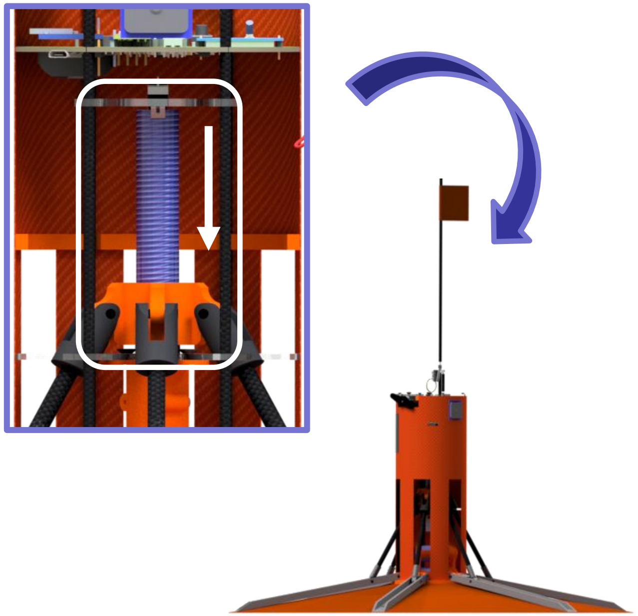
Payload Upright Position

Information	
Step 1	The payload, which landed on the ground, uses a stopper mechanism to upright itself
Step 2	The stopper moves to the left, which is driven by the servo. After that, the hub moves down, pulled by the torsion springs
Step 3	The torsion springs pull the hub downward, and then the payload is in an upright position. Then, the stopper move to left to release a cord and the flag raises

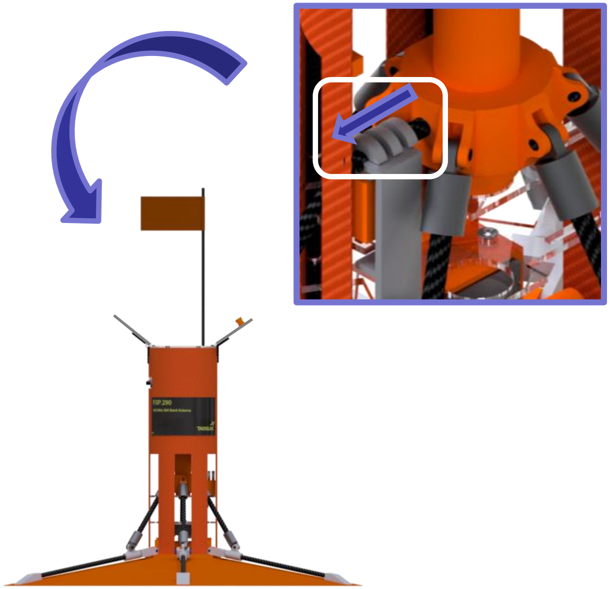
Payload Uprighting Configuration Trade & Selection (3/3)

Payload Upright Strategy "Selection"

Strategy A ✓



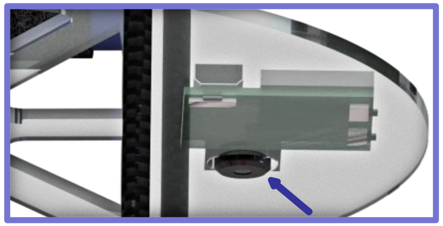
Strategy B



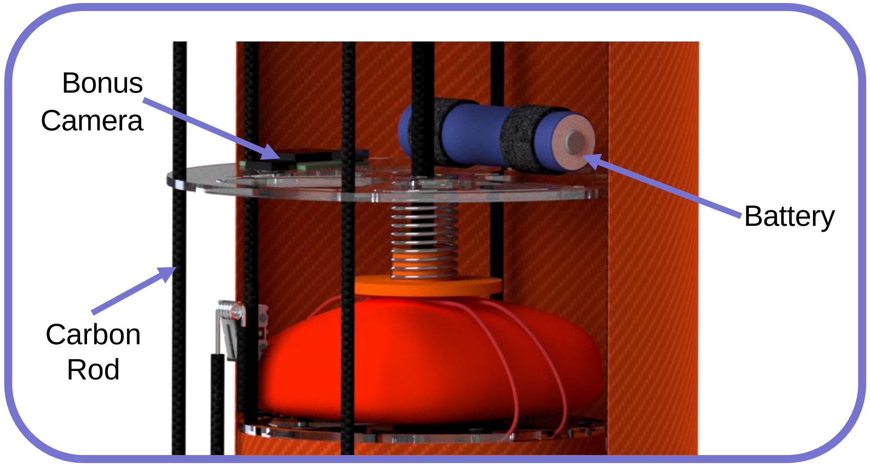
Selected: Strategy A

Reasons
1. Most likely to be succeed
2. This strategy is simpler to upright the payload

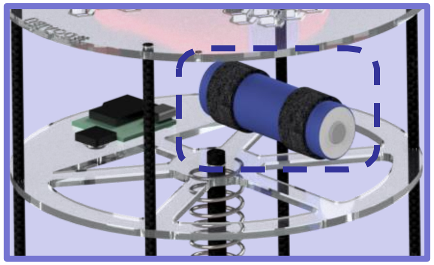
Container



Bonus Camera

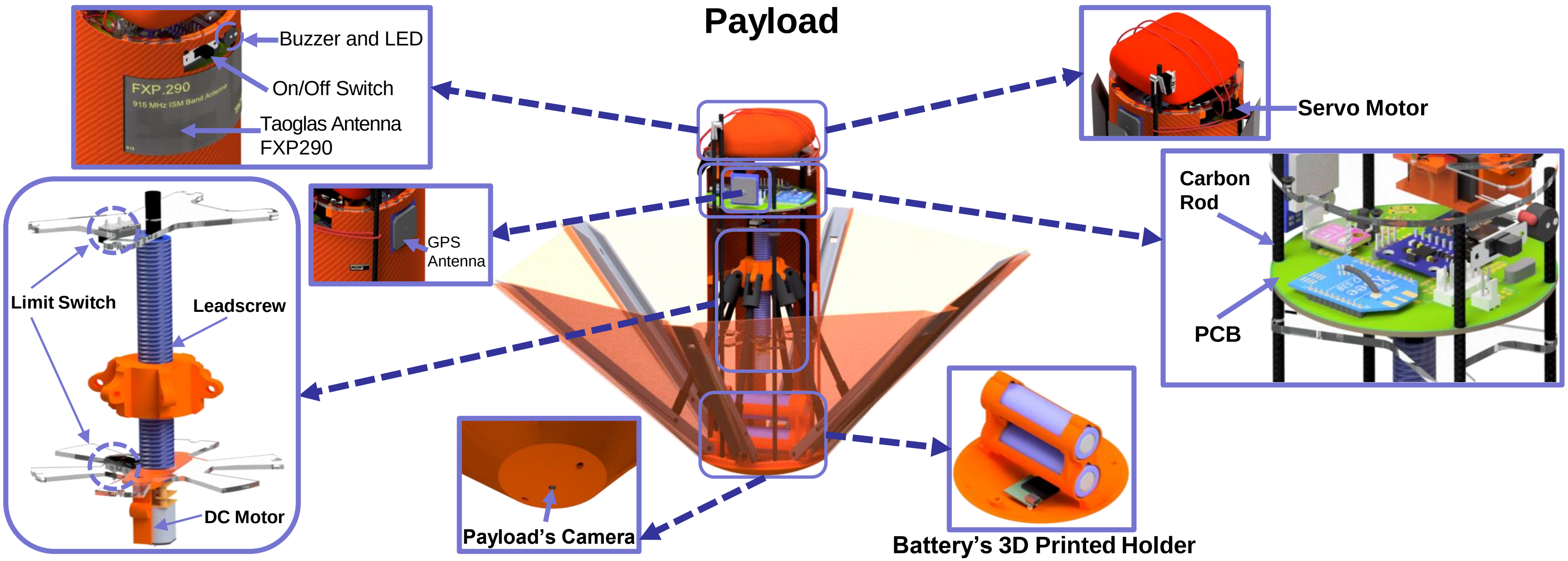


Electronics Component



Container's Battery

Mounting Method	Enclosures	Connection	Descent Control Attachment
1. Container's battery is mounted using battery strap	1. The battery of the container and bonus camera is fully enclosed inside its structural body	1. Bonus camera will be jumpered and secured to the battery	1. The descent rate of the container will be provided by the parachute connected to the swivel



Mounting Method	Enclosures	Connection	Descent Control Attachment
1. Payload's PCB is secured by carbon rod as standoffs	1. Payload's PCB will be fully enclosed inside its structural body 2. The battery of the payload will be kept by 3D printed holder to ease battery access	1. Connectors of electronic components will be soldered and hot glued to the PCB 2. Payload batteries, camera, On/Off Switch, Taoglas Antenna FXP290, DC motor, and servo motor will be jumpered and secured to the electronic components	1. The payload's descent will be provided due to the payload mechanism using DC motor and leadscrew 2. To open the rubber and flag mechanism, a servo will be used

Mass Budget (1/4)

Container-Electrical Component					
Component	**Quantity**	**Determination**	**Mass Unit (g)**	**Mass (g)**	**Margins (g)**
Soshine 14500 Battery	1	Measured	21	21	
Quelima SQ11	1	Estimated	15	15	3
Total Mass Electrical Component of Container				**36**	**3**

Container-Structural Component					
Component	**Quantity**	**Determination**	**Mass Unit (g)**	**Mass (g)**	**Margins (g)**
Top Frame	1	Measured	27.2	27.2	
Bottom Lid Frame	1	Measured	7.5	7.5	
Bottom Lid	2	Measured	13.6	27.2	
Spring Holder Frame	1	Measured	10	10	
Carbon Rod 396 mm	8	Measured	4.2	33.6	
Hinges	2	Measured	0.6	1.2	
Parachute	1	Measured	6	6	
Container's Body Cover	2	Estimated	23.87	47.74	9.54
3D Printed Holder	1	Measured	22.6	22.6	
Torsion Spring	2	Measured	0.3	0.6	
Compression Spring	1	Estimated	3.7	3.7	0.74
Bolt	8	Estimated	0.1	0.8	0.16
Spring Shoe	1	Measured	3.96	3.96	
Total Mass Structural Component of Container				**192.1**	**10.44**

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

Mass Budget (2/4)

Payload-Electrical Component					
Component	**Quantity**	**Determination**	**Mass Unit (g)**	**Mass (g)**	**Margins (g)**
Olight 18650 Battery	2	Measured	50.0	100.0	
STM32F407VGT6	1	Estimated	2.0	2.0	0.4
MG90 Servo Motor	1	Measured	14.6	14.6	
MPU 6050	1	Measured	1.6	1.6	
XBEE Pro S3B	1	Measured	6.4	6.4	
BN-220	1	Measured	5.6	5.6	
BME280	1	Measured	1.0	1.0	
Taoglas Antenna FXP290	1	Measured	1.5	1.5	
Buzzer	1	Measured	5.0	5.0	
DC Motor	1	Datasheet	10.0	10.0	
On/Off Switch	1	Measured	1.6	1.6	
Limit Switch	3	Measured	0.5	1.5	
Quelima SQ11	1	Estimated	15.0	15.0	3
PCB	1	Estimated	8.1	8.1	1.62
SD Card Module	1	Measured	1.5	1.5	
3 mm LED	1	Measured	0.4	0.4	
Driver Motor MX1508	1	Datasheet	2.2	2.2	
Coin Cell Battery	1	Measured	4	4	
Total Mass Electrical Component of Payload				**182**	**5.02**

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

Mass Budget (3/4)

Payload-Structural Component					
Component	**Quantity**	**Determination**	**Mass Unit (g)**	**Mass (g)**	**Margins (g)**
Payload's Body Cover	2	Estimated	12.85	25.7	5.14
Carbon Rod 228 mm	4	Measured	2.41	9.64	
Parachute Frame	1	Measured	5.6	5.6	
Rubber	2	Estimated	6.3	12.6	2.52
Payload Middle-top frame	1	Measured	4	4	
Payload Middle-bottom frame	1	Measured	5	5	
Payload's Nose	1	Measured	27	27	
Leadscrew	1	Estimated	20	20	4
Hub	1	Measured	7.1	7.1	
Parachute	1	Measured	37	37	
Ribs Assembly	6	Measured	16.28	97.68	
Heat Shield	1	Estimated	20	20	4
DC Motor Bracket	1	Estimated	3	3	0.6
Torsion Spring	1	Measured	0.3	0.3	
Carbon Rod 250 mm (Flagpole)	1	Measured	2.65	2.65	
Flag	1	Estimated	3	3	0.6
Battery Holder	1	Measured	7	7	
Bolt	11	Estimated	0.1	1.1	0.22
Servo Holder	1	Measured	3	3	
Total Mass Structural Component of Payload				**291.37**	**17.08**

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

Mass Budget (4/4)

RN 1: Total mass of the CanSat (science payload and container) shall be 700 grams ±10 grams

Total Mass	
Container	228.1 ± 13.44 g
Payload	473.37 ± 22.10 g
Total Mass of All System	**701.47 ± 35.54 g**

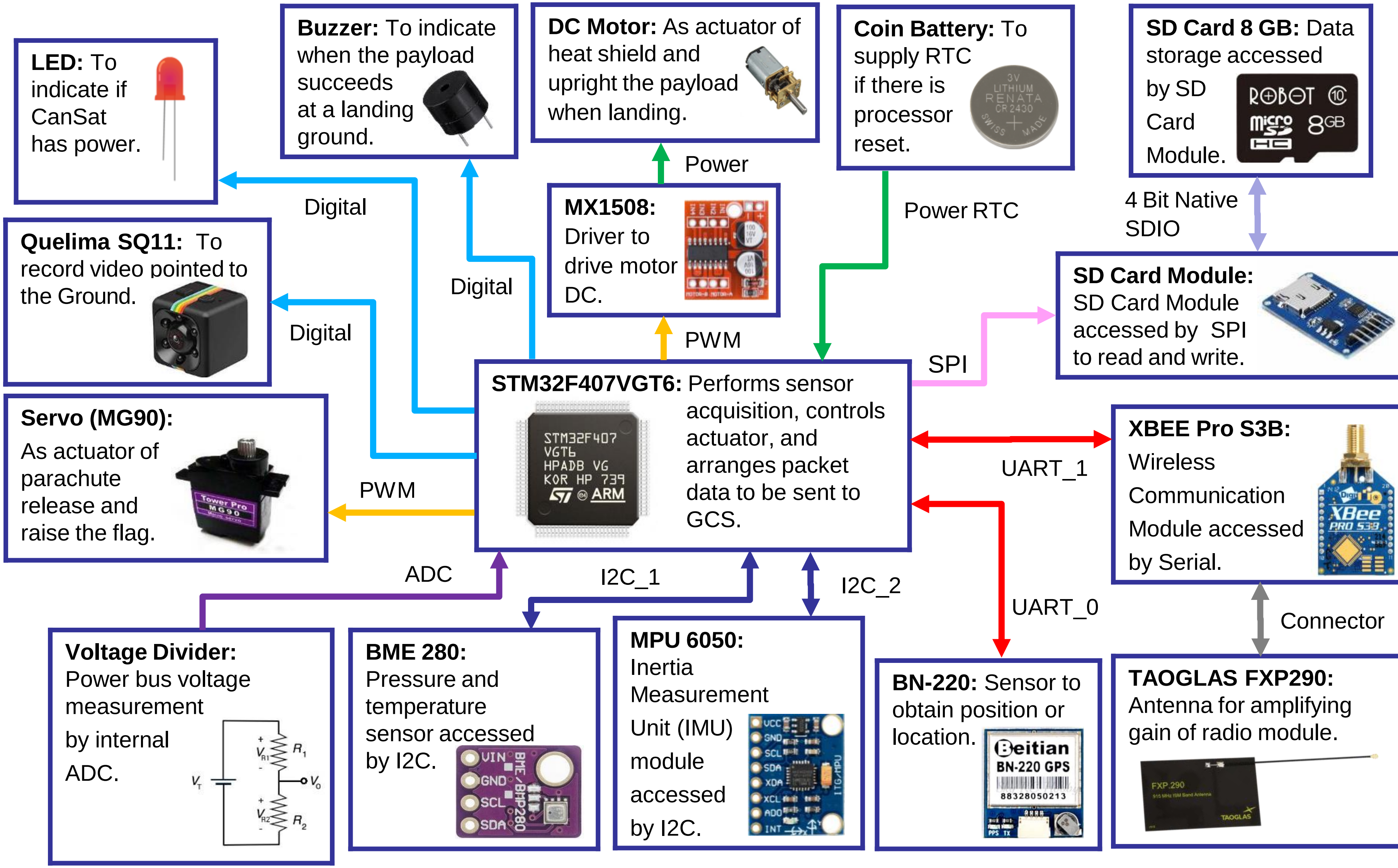
Margin
Mass Competition Requirement – Total Mass of All System = Margin **700 – 701.47 = -1.47 g (Fulfill Mass Tolerance)** Uncertainties = ± 35.54 g

Correction Method (Margin Competition ± 10 g)	
If total mass system < 690 grams	We will increase the mass of materials using higher infill density of 3D printed material for container or payload.
If total mass system > 710 grams	We will change the material with lighter material such as composite that has lower density for container and payload.

Communication and Data Handling (CDH) Subsystem Design

Achmad Bagus Okto Faerizqi

Payload Command Data Handler (CDH) Overview



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

Model	Boot Time (s)	Processor Speed (MHz)	Operating Voltage (V)	Data Interfaces (Types & Numbers)		Memory Storage	Cost ($)
STM32F407VGT6 Minimum System	0.001	164	3.3 – 5	Digital Pin (82) PWM Pin (12)	Serial Pin (6) SPI Pin (3) I2C Pin (3)	EEPROM 4Kb Flash 8Mb RAM 1024Kb	15.00
Teensy 4.0	0.005	600	3.3 – 5	Digital Pin (40) PWM Pin (31)	Serial Pin (7) SPI Pin (3) I2C Pin (3)	EEPROM 1Kb Flash 2Mb RAM 1024Kb	19.95
Teensy 3.6	0.005	180	3.3 – 5	Digital Pin (62) PWM Pin (22)	Serial Pin (6) SPI Pin (3) I2C Pin (4)	EEPROM 4Kb Flash 1Mb RAM 256Kb	29.25

Selected Processor	Reasons
Weight: 1.4 g 14 mm 14 mm **STM32F407VGT6 Minimum System ✓**	• Fast boot time • Cheapest • It's a powerful microcontroller with many GPIOs • It's smaller and can be assembled to a customized minimum system

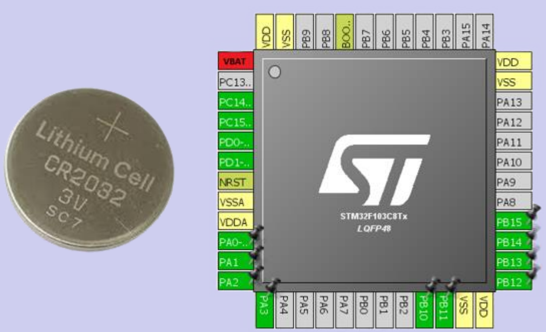
Payload Processor & Memory Trade & Selection (2/2)

Model	Memory (GB)	Interface	Data Transfer Rate		Cost ($)
			Write (MB/s)	Read (MB/s)	
Samsung EVO	16	SD Card Interface	20	80	6.95
ROBOT Micro SD	8	SD Card Interface	45	45	3.22
VGEN SD Card Hyper	16	SD Card Interface	90	100	6.79

Selected Memory	Reasons
 **ROBOT Micro SD ✓**	• Stable data transfer rate • More reliable and easy to use • It has a great performance • Cheapest

Payload Real-Time Clock

Model	Operating Voltage (V)	Operating Current	Reset Tolerance	Accuracy (ppm)	Cost ($)
Built-in STM32F407VGT6	3.3	Built-in	In reset conditions, the software reads the last data from the RTC register value	± 20	0
DS-1307	3.3	1.5 mA	In reset conditions external clock continues to keep time	± 23	1.2
DS-3231	3.3	300 µA	In reset conditions external clock continues to keep time	± 3.5	1.56

Selected RTC		Reasons
	**Built-in STM32F407VGT6 ✓**	• Minimize board size because it's included in STM32F407VGT6 • No cost (included in STM32F407VGT6) • Easy to use

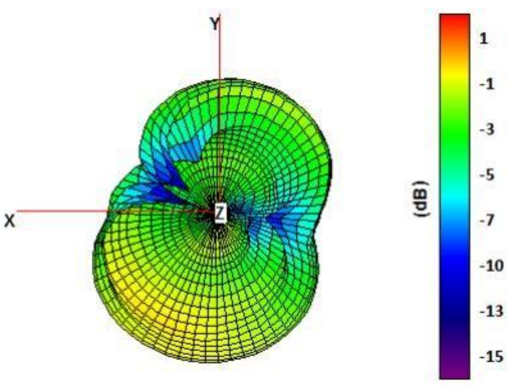
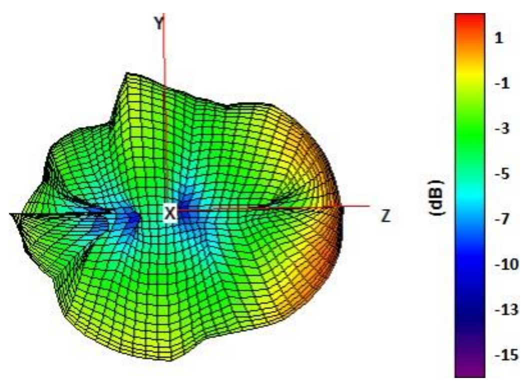
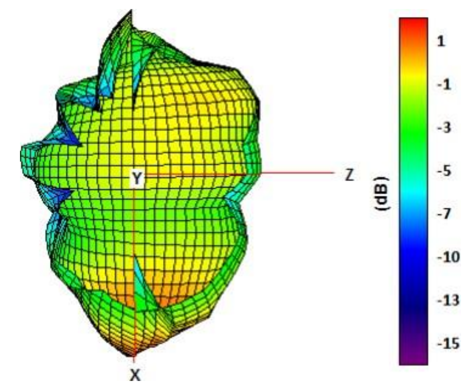
Payload Antenna Trade & Selection (1/2)

Payload-to-Ground link

Model	Range (km)	Frequency (MHz)	Gain (dBi)	Connector	Size (mm)	Cost ($)
Taoglas FXP290	11.67	915	1.5	Micro FL	75.4 x 45.4	17.05
Digi A09-HASM-675	12.85	915	2.1	RP-SMA	175 x 10	31.03
Noyito Antenna	14.48	915	5	SMA	204 x 13	36.19

Selected Antenna	Reasons
 **Taoglas FXP290 ✓**	• Can be placed to XBEE using a small micro FL • Lightweight and small • Affordable

Payload Antenna Trade & Selection (2/2)

Radiation Patterns of Taoglas FXP290		
XY	**YZ**	**XZ**
		

Taoglas Antenna FXP290

* The antenna is located at payload's body

Payload Radio Configuration (1/2)

Payload-to-Ground XBEE Radio Selection

Model	Range (km)	Sensitivity (dBm)	Receive Current (mA)	Transmit Current (mA)	Supply Voltage (V)	Frequency	Cost ($)
XBEE Pro S3B	14	-107	26	215	3.0 – 3.6	915 MHz	57.52
XBEE Pro S2C	3.2	-101	31	120	2.1 – 3.6	2.4 GHz	50.02
XBEE Pro S1	1.6	-100	55	215	2.8 – 3.4	2.4 GHz	58.40

Selected Radio	Reasons
 **XBEE Pro S3B ✓**	• Highest sensitivity • Better range than other XBEE • We have experience working with this radio module

Payload Radio Configuration (2/2)

Overview of Radio Configuration

- As presented in the slide above we are using one “XBEE Pro S3B” for radio communication device from payload to GCS
- We are using NETID 1085 because our team ID is 1085

Transmission Control

1. The payload telemetry data will be transmitted to the GCS @1Hz
2. The payload will start sending data when commanded by GCS using command “CMD,1085,CX,ON”
3. The transmission of payload packet data will commence at the payload’s **LAUNCH_WAIT** state. Before **LAUNCH_WAIT** state, the payload remains idle
4. When the CanSat landed, the payload will stop sending data to the GCS
5. If somehow the STM32F407VGT6 runs into reset, it will recover the last packet count from SD Card, so the packet counting doesn’t reset

Payload Telemetry Format (1/2)

Payload Telemetry Data		
Data Format	**Sample Data**	**Description**
<TEAM_ID>	1085	The assigned team identification number. Our team ID is 1085
<MISSION_TIME>	00:09:02.22	UTC time in format hh:mm:ss.ss, where hh is hours, mm is minutes, and ss.ss is seconds (including hundredth of second)
<PACKET_COUNT>	12	The total count of transmitted packets since turn 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 (the default mode upon system start) and 'S' for simulation
<STATE>	LAUNCH_WAIT	The operating state of the payload
<ALTITUDE>	100.1	The payload altitude in units of meters and must be relative to ground level. The resolution must be 0.1 meters
<HS_DEPLOYED>	P	The ASCII character 'P' indicates the payload with heat shield deployed, 'N' otherwise
<PC_DELPLOYED>	C	The ASCII character 'C' indicates the payload parachute is deployed (at 200m), 'N' otherwise
<MAST_RAISED>	M	The ASCII character 'M' indicates the flag mast has been raised after landing, 'N' otherwise
<TEMPERATURE>	28.9	The payload temperature in units degrees Celsius. The resolution must be 0.1 degrees C
<VOLTAGE>	3.1	The payload power bus voltage in units volts. The resolution must be 0.1 V

Payload Telemetry Format (2/2)

Payload Telemetry Data		
Data Format	**Sample Data**	**Description**
<PRESSURE>	100.1	The payload air pressure of the sensor used in units kPa. The resolution must be 0.1 kPa
<GPS_TIME>	00:09:02	The time generated by the GPS receiver. The time must be reported in UTC and have a resolution of a second
<GPS_ALTITUDE>	100.2	The altitude generated by the GPS receiver in meters above mean sea level with a resolution of 0.1 meters
<GPS_LATITUDE>	17.0199	The latitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees North
<GPS_LONGITUDE>	189.0077	The longitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees West
<GPS_SATS>	5	The number of GPS satellites being tracked by the GPS receiver. This must be an integer number
<TILT_X, TILT_Y>	1.12, 2.12	The angle of the CanSat X and Y axes in degrees, with a resolution of 0.01 degrees, where zero degrees is defined as when the axes are perpendicular to the Z axis which is defined as towards the center of gravity of the Earth
<CMD_ECHO>	CXON	The fixed text command id and argument of the last received command with no commas
<CHECKSUM>	“,”	Commas are used to ensure that data sent to GCS is valid, if there is a data error then GCS will know about it

Payload Data Format will be transmitted @1 Hz to the GCS
1085,15:00:10.01,100,F,LAUNCH_WAIT,100.1,P,C,M,30.0,100.1,3.1,00:09:02,100.2,17.0199,189.0077,7,1.12,2.12,CXON,

Payload Command Formats (1/2)

Type of Command	Command Format	Description	Example Data
ST: Set Time	CMD, <TEAM_ID>, ST, <UTC_TIME>	• CMD and ST are static text • <TEAM ID> is the assigned team identification • <UTC_TIME> is UTC time in the format hh:mm:ss	The command CMD,1085, ST,13:50:02 sets the mission time to the value given
SIM: Simulation Mode Control Command	CMD, <TEAM_ID>, SIM, <MODE>	• CMD and SIM are static text • <TEAM_ID> is the assigned team identification • <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,1085,SIM,ENABLE and CMD,1085,SIM,ACTIVATE commands are required to begin simulation mode
CX: Payload Transmission On/Off	CMD, <TEAM_ID>, CX, <ON_OFF>	• CMD is static text • CX are static text indicating to control telemetry for payload • <TEAM ID> is the assigned team identification • <ON_OFF> is the string 'ON' to activate the science payload transmissions and 'OFF' to turn off the transmissions	CMD,1085,CX,ON will trigger the payload to begin telemetry transmissions. CMD,1085,CX,OFF will trigger the payload to stop telemetry transmissions

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>	• For testing purpose only • CMD and SIMP are static text • <TEAM ID> is the assigned team identification • <PRESSURE> is the simulated atmospheric pressure data in units of pascals with a resolution of one pascal	CMD,1085,SIMP,101325 provides a simulated pressure reading to the payload (101325 Pascals = approximately sea level) **Note**: only in simulation mode
CAL: Payload reset and calibration	CMD, <TEAM_ID>, CAL	• CMD and CAL are static text • <TEAM ID> is the assigned team identification	CMD,1085,CAL will reset the microcontroller on payload to set new mission reference

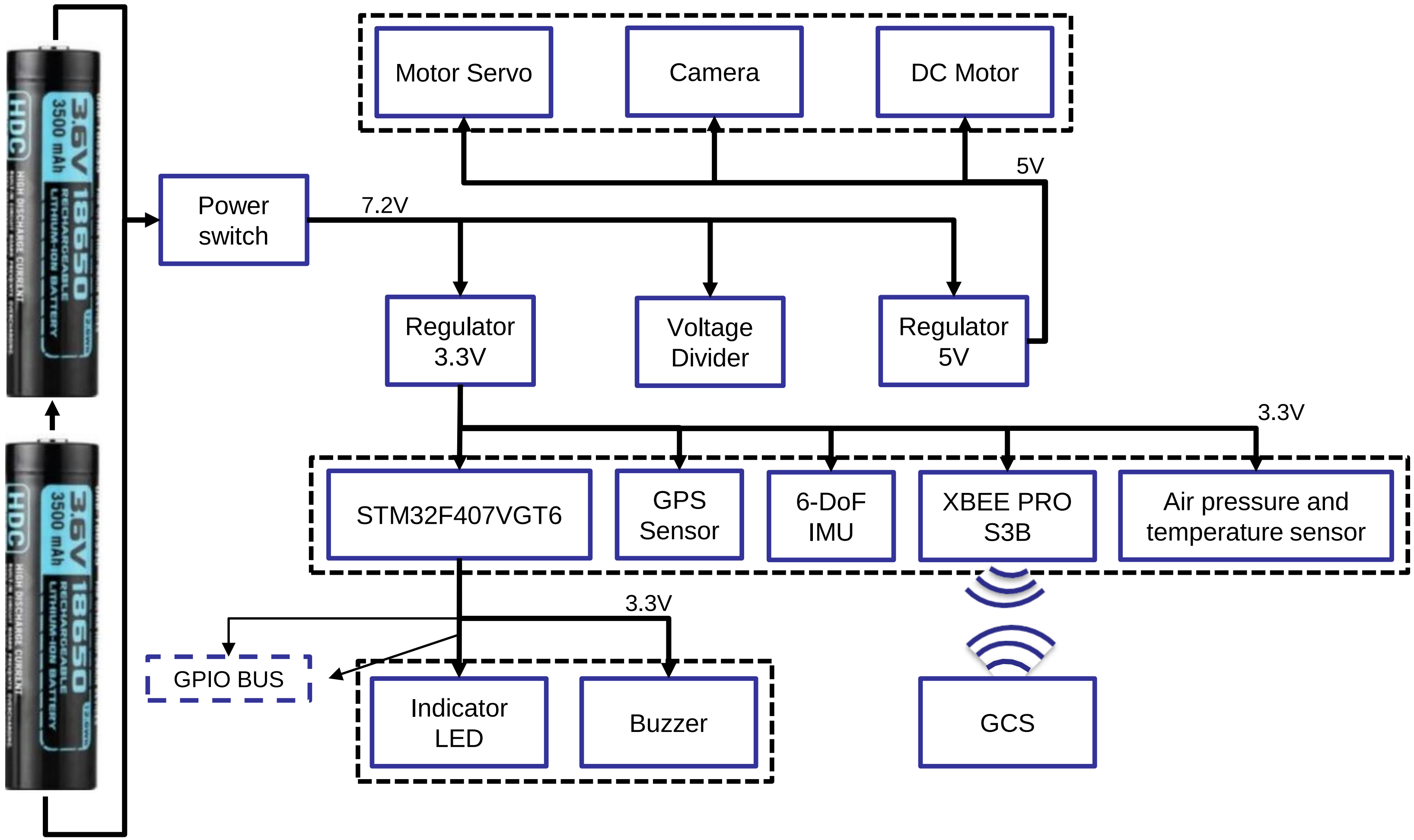
Electrical Power Subsystem (EPS) Design

Achmad Bagus Okto Faerizqi

EPS Overview (1/2)

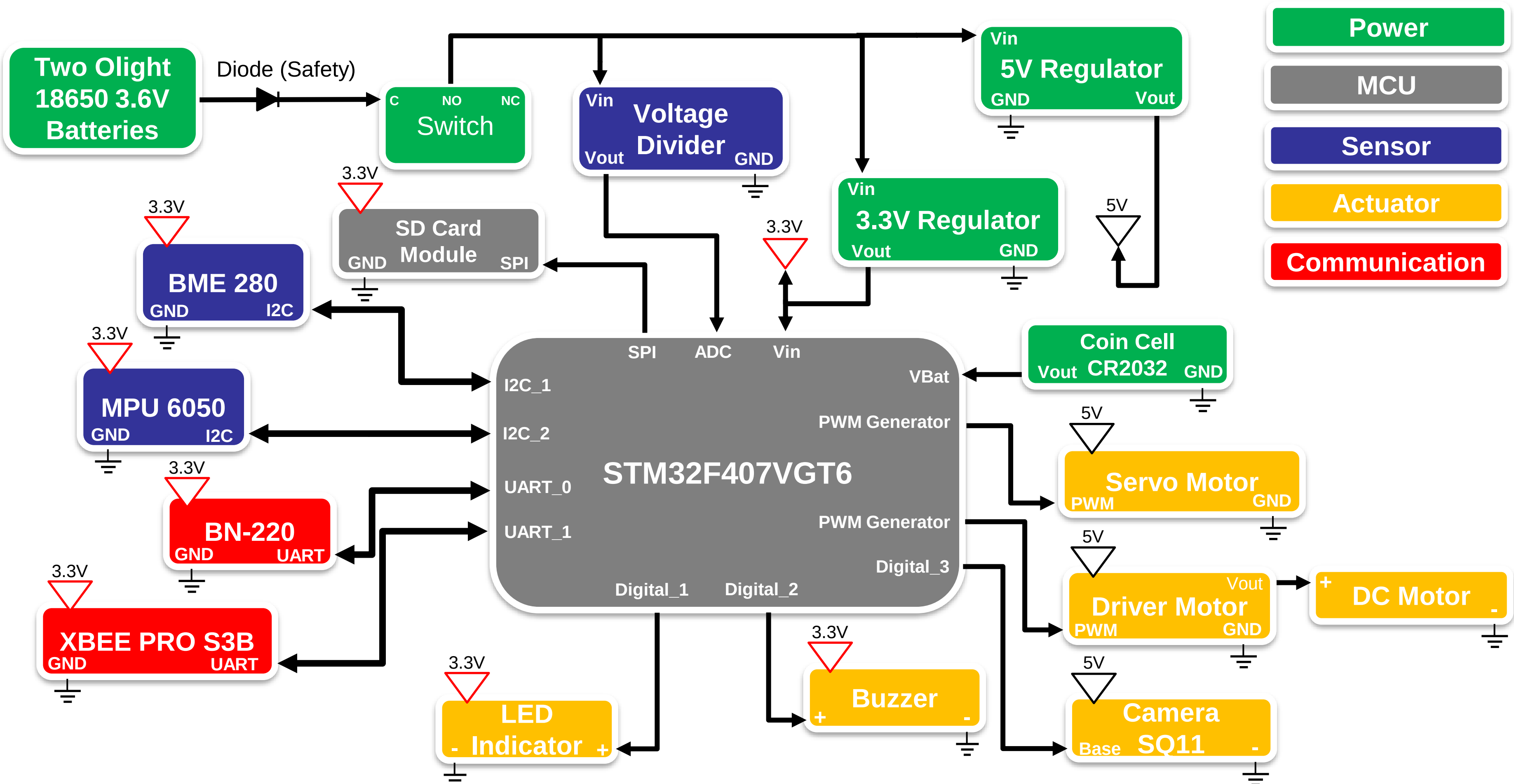
Component	Purpose
Power	• All components in the payload are powered by two Olight 18650 3.6V batteries connected series The total voltage is 7.2V • Real-Time Clock (RTC) power is provided by a 3V coin battery • The payload will be reset and power connected and disconnected using an external on/off switch • All of the sensors and the XBEE in the payload are powered by the 3.3V regulator
MCU	• STM32F407VGT6 will operate all actuators and collect all sensor data. It will be supplied by 3.3V output from the regulator • SD Card will save all sensor data • RTC will keep mission time in case of a sudden reset
Sensors	• BME280 will collect temperature and pressure data. It will be supplied by 3.3V from the voltage regulator • The MPU6050 will collect orientation data. It will be supplied by 3.3V from the voltage regulator • The voltage divider will take battery voltage data. It will be connected to 7.2V from the batteries
Actuators	• The heat shield will be opened using a DC motor. It will receive 5V as power from the voltage regulator • The camera will be used to record terrain. It will be supplied by 5V from the voltage regulator • The LED indicator will turn on to show that the system is active. It will receive 3.3V from a GPIO pin as power • The servo will be used to deploy the parachute and the flag. It will be supplied by 5V from the voltage regulator
Communications	Data will be sent and received from the GCS by XBEE Pro S3B. The voltage regulator will provide 3.3V to power it

EPS Overview (2/2)



- Two Olight 18650 3.6V batteries connected series

Payload Electrical Block Diagram



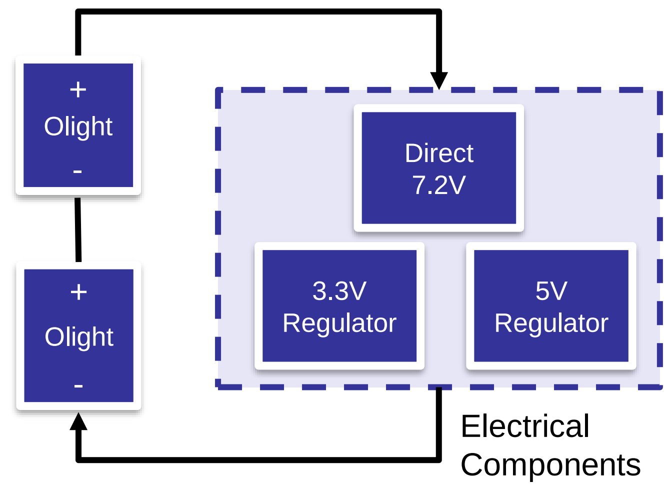
- The electronics system will be easily turned on/off by a switch
- The buzzer beeps and the LED blinks when the system is powered on
- A cell coin battery is used to supply the internal RTC in the MCU

Payload Power Trade & Selection

Model	Battery Type	Voltage (V)	Weight (g)	Nominal Capacity (mAh)	Maximum Discharge Current	Dimension (mm)		Cost ($)
						Height	Diameter	
OLIGHT 18650	Lithium Ion	3.6	48.27	3500	10.000	69.8	18.5	25.13
Toshiba ER6V	$SOCl_2$	3.6	48.5	2000	3500	65.3	18.5	6
Samsung INR18650-25R	Lithium Ion	3.6	45	2500	4000	65	18	4.99

Selected Battery	Reasons
 **OLIGHT 18650 ✓**	• Provide the payload with enough power to run for 2 hours • High discharge current • High capacity

Two battery will in series to all components



Payload Power Budget (1/2)

Component	Quantity	Source	Current (mA)	Voltage (V)	Duty Cycles in 1 Hour (%)	Power Consumption (Wh)
STM32F407VGT6 (include RTC)	1	Datasheet	50	3.3	100	0.165
XBEE Pro S3B	1	Datasheet	215	3.3	100	0.7095
BME280	1	Estimated	1.064	3.3	100	0.0035112
MPU6050	1	Datasheet	12.3	3.3	50	0.020295
Servo MG90	1	Measured	250	5	50	0.625
DC Motor	1	Measured	180	5	50	0.45
SD Card Module	1	Datasheet	20	3.3	50	0.033
SQ11 – Camera	1	Measured	80	5	50	0.2
LED	1	Estimated	30	3.3	100	0.099
Buzzer 95 dB	1	Datasheet	80	3.3	100	0.264
Voltage Divider	1	Estimated	0.878	7.2	100	0.0063216
BN-220	1	Measured	67	3.3	100	0.2211
Total						**2.796728**
Consumption for 2 Hours						**5.593456**

Payload Power Budget (2/2)

Selected Container Power: Olight 18650 ✓

Available power	= Voltage x Capacity = 7.2 V x 3.5 Ah = **25.2 Wh**
Power consumption (Wh)	= **5.593456 Wh**
Margins	= Available power – Power consumption = 25.2 Wh – 5.593456 Wh = **19.60654 Wh**

Flight Software (FSW) Design

Muhammad Tsaqif Mukhayyar

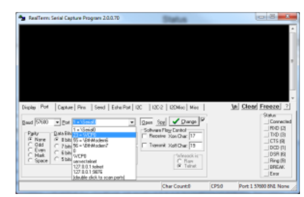
FSW Overview (1/3)

CanSat FSW Tasks

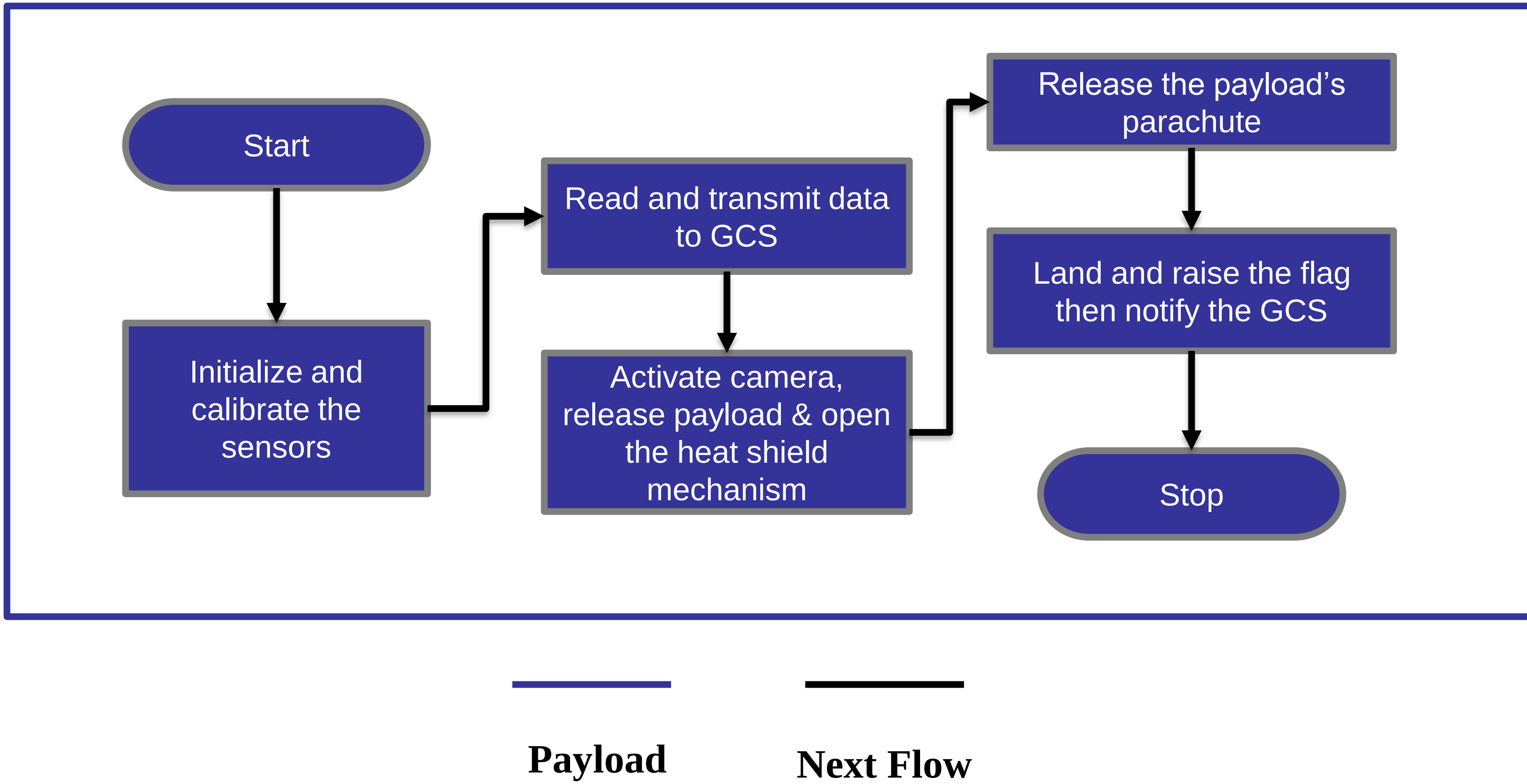
CanSat will collect data from sensors and transmit the data to GCS during ascent until it land. At 500 m, the CanSat will release a payload and then activate the heat shield mechanism in the payload. When the payload reaches 200 m, the payload will deploy a parachute. Once the payload has landed, it will raise a flag using the servo mechanism. The SD Card is used to back up the data and store the video on the container and payload.

A video camera will be added to the payload and pointed toward the ground. The bonus video camera will be added to the container to record and show the separation of the payload.

Programming Languages	Development Environments
• C/C++	• Arduino IDE • STM32CubeIDE • XCTU • RealTerm



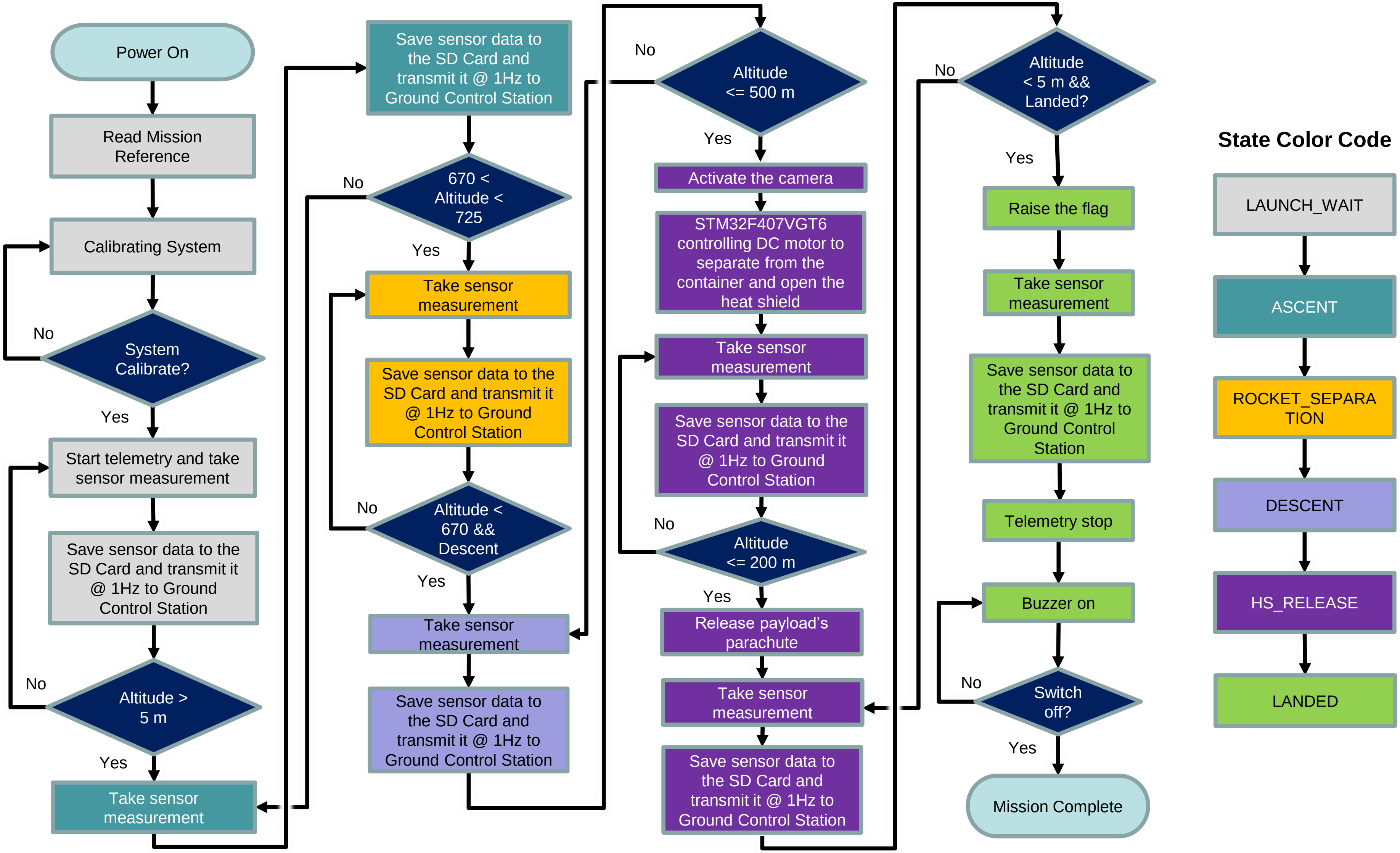
CanSat FSW Architecture



FSW Overview (3/3)

Payload FSW Tasks
1. The payload will set the new mission reference when receiving **CAL** from the GCS and save calibration data to the SD Card 2. The payload FSW mode will read from SD Card on the STM32F407VGT6, the default mode is Flight mode, and when the payload receives commands **SIM ENABLE** and **SIM ACTIVATE** from the GCS, the payload will enter the simulation mode 3. When the payload enters the **ASCENT** state, the payload will collect the packet data and then save it to the SD Card, the payload packet data will be transmitted @1Hz to the ground station via XBEE Pro S3B 4. In 500 m the payload will deploy the heat shield and the **HS_DEPLOYED** indicator change into **P** from **N** 5. In 200 m the payload will deploy its parachute and the **PC_DEPLOYED** indicator change into **C** from **N** 6. When the state is **LANDED** the payload will raise a flag and **MAST_RAISED** indicator changed to **M** from **N**, and all telemetry data transmission will be stopped 7. The mission will be completed

Payload FSW State Diagram (1/3)



Payload FSW State Diagram (2/3)

Mechanism Activations

At 500 m, STM32F407VGT6 will activate :

- The DC motor to control the payload to separate from container
- The DC motor to control the payload ribs to open heat shield
- The camera to record terrain

At 200 m, STM32F407VGT6 will activate :

- The servo to open rubber locking system to deploy payload's parachute.

At Landed, STM32F407VGT6 will activate :

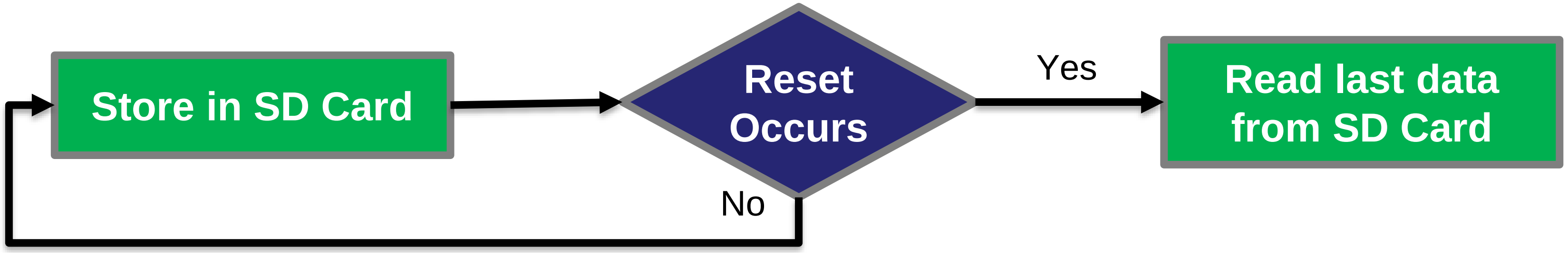
- The servo to control the flag to raise
- The DC motor to control the payload to upright position

Major Decision Points in The Logic

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

Data Storage	Sampling of Sensors	Communications
• Video and backup telemetry data will be stored on the SD Card • SD Card is used for recovery after reset	The data sensor will be sampled at 1 Hz (1000ms).	Payload communicates using Taoglas FXP 290 and transmits data to the ground station. All commands will be included in CDH.

Payload FSW State Diagram (3/3)



Payload Data Recovery

STM32F407VGT6 will recover (stored in SD Card):

- Packet Count
- Last State
- Command Echo
- Reference Altitude

Reason for Reset

Temporary power loss occurs

Power Management

For two hours flight is enough with (2x) 3.6V OLIGHT 18650 3500 mAh batteries

Simulation Mode Software (1/2)

Simulation Mode

- Simulation mode is for testing, pre-flight demonstration, and contingency, where launch operations are not possible. The telemetered pressure sensor data should reflect the commanded simulation values, not the actual sensor readings
- To activate the simulation mode, GCS must send **SIM ENABLE** followed by **SIM ACTIVATE** to the payload
- The values other than the pressure and altitude (calculated from the pressure values) will be actual sensor readings. The relayed payload telemetry will contain actual sensor values
- The barometric pressure data will be read by a .txt file in the GCS and transmitted value by the command to the payload at a rate of one data per second
- After the simulation mode is active, flight software will receive barometric pressure sensor command (**SIMP**) from GCS and use the received values as if they were actual barometric pressure readings in the calculation of altitude, and determination software state
- After GCS sends the **SIM DISABLE**, the flight software will switch to flight mode

Simulation Mode Software (2/2)

Simulation Mode Commands

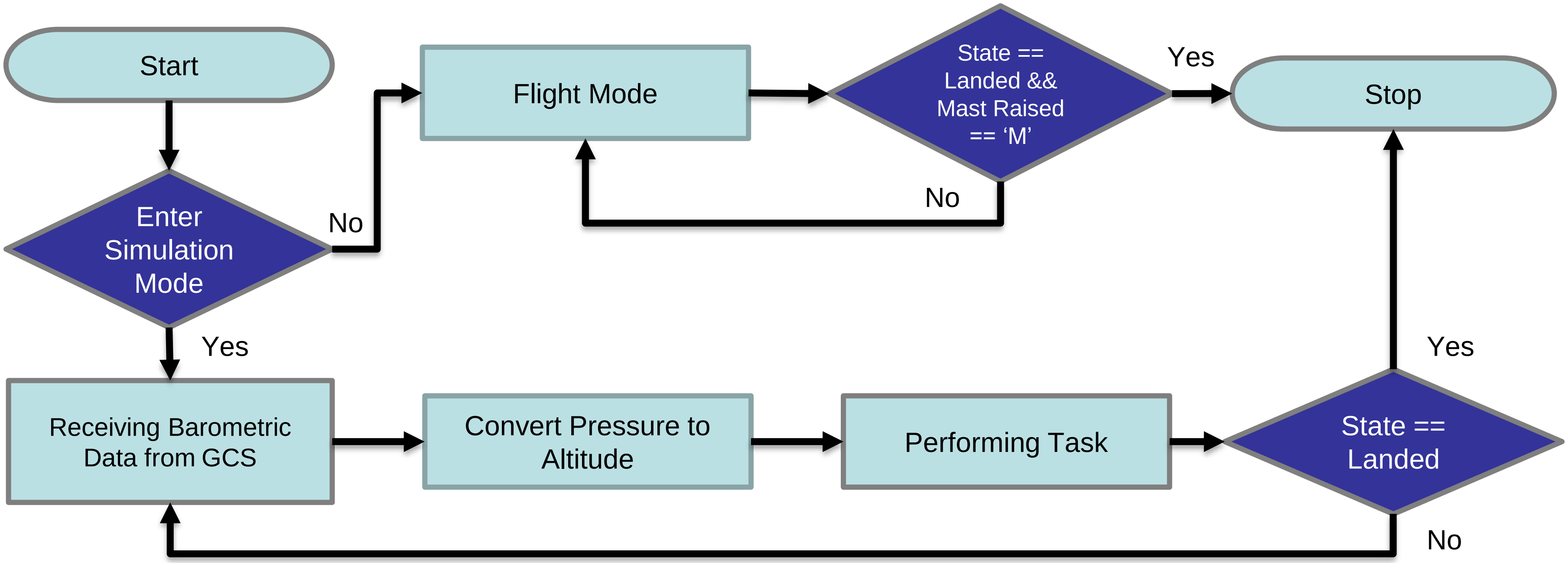
CMD,<TEAM_ID>,SIM,<MODE>

<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 payload

Simulation Mode Flowchart



Software Development Plan (1/3)

Prototyping procedure and prototyping environment		
Subject	**Prototyping Environment**	**Prototyping Procedure**
STM32F407VGT6	STM32CubeIDE	Programming and debugging are done in STM32CubeIDE and the data will be monitored in **RealTerm**
Sensors	Breadboard and PCB	Each sensor is tested on the breadboard separately

Software Development Plan (2/3)

Test Methodology	
Subsystem	**Development Sequence**
Sensors	• **Sensor trade and selection -** select the best sensors for our application • **Individual sensor programming** - program payload sensor with STM32CubeIDE
State Mechanism	Integrate all sensors and test it in state mechanism
XBee Telemetry	**Testing GCS and payload communication** – Configure and test all payload sensors data that will be transmitted to GCS
Heat Shield Mechanism	Program the payload mechanism with DC motor to control the heat shield ribs
Parachute Mechanism	Program the payload mechanism with servo to deploy the parachute
Flag Mechanism	Program the payload mechanism with servo to raise the flag
Integrate all	Integrate all software subsystem to ensure all system works well

Development Team

1. Achmad Bagus Okto Faerizqi
2. Muhammad Tsaqif Mukhayyar

Software Development Plan (3/3)

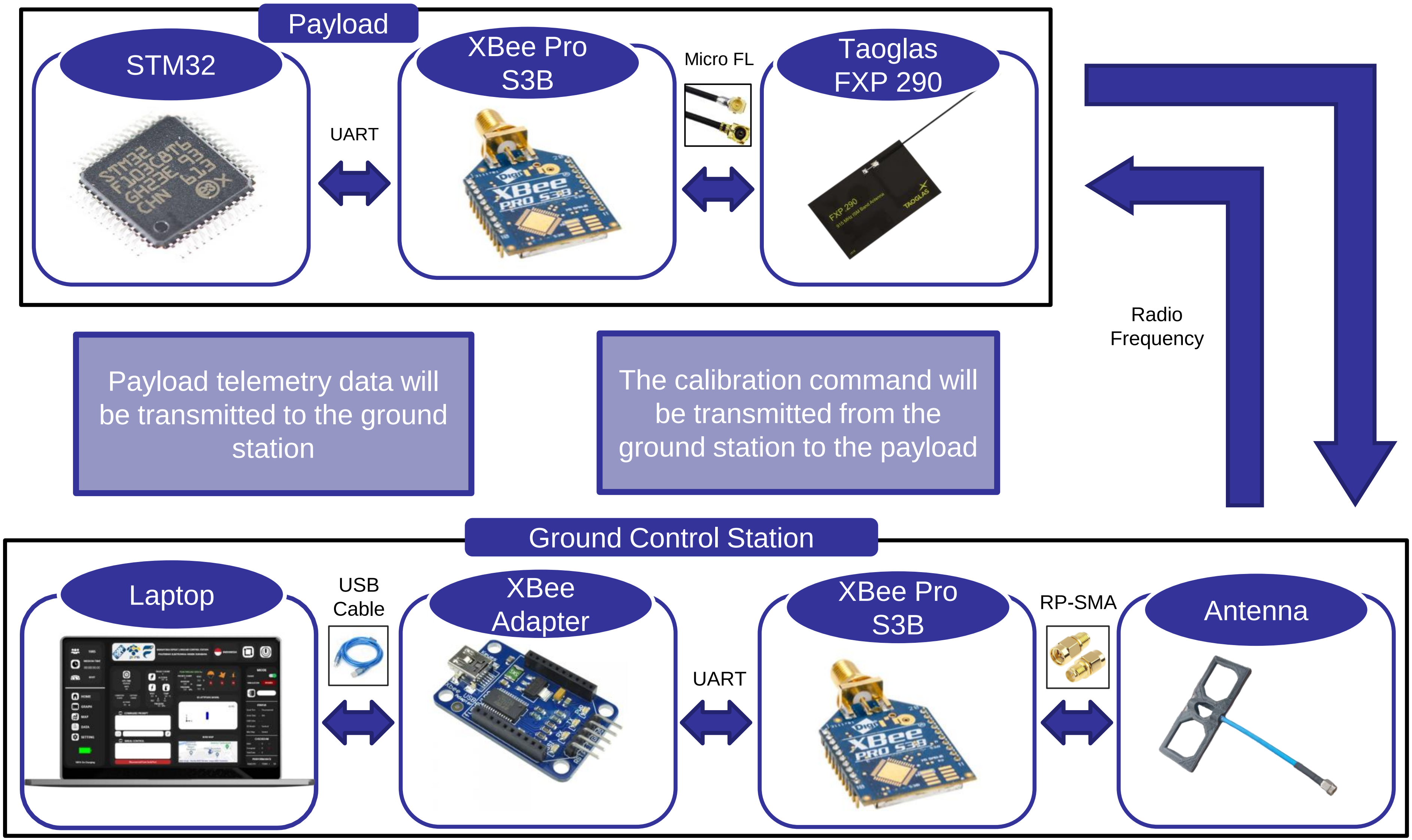
Test Methodology

- Necessary software is installed such as Arduino IDE and STM32Cube IDE to help the software development
- Telemetry software tests are simulated using XCTU
- Sensors and hardware were tested separately
- Test the state mechanism for the payload
- Test the system recovery for the payload
- Test the telemetry data and communication commands using hardware
- Test the flight mode software using GCS
- Test the simulation mode software using GCS
- Check whether the FSW meets the competition requirements
- Test integrated sensors and hardware according to the mission

Ground Control System (GCS) Design

Muhammad Tsaqif Mukhayyar

GCS Overview



GCS Design

Antenna

RP-SMA

XBee Pro S3B

UART

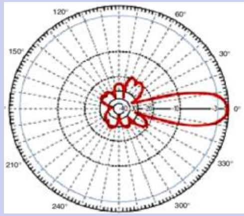
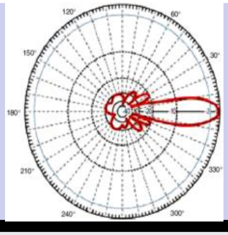
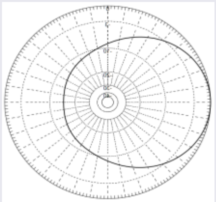
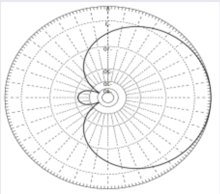
XBee Adapter

USB Cable

Laptop

Specifications	
Battery	GCS Laptop can operate 2.5 hours on battery from fully charged
Overheating Mitigation	There will be an external laptop cooling fan with power source from power bank and also an umbrella
Auto Update Mitigation	Auto update and internet connection will be disabled before the launch

GCS Antenna Trade & Selection (1/2)

Model	Frequency Rate (MHz)	Gain (dBi)	Beamwidth (Horizontal/ Vertical)	Direction	Range (km)	Cost ($)	Antenna Pattern	
							Horizontal	Vertical
ZIISOR LoRa DIRECTIONAL YAGI ANTENNA	915 MHz	12	32°/30°	Directional	~20	25.50		
Moxon Antenna	915 MHz	6.56	70°/85°	Directional	~11	10		

Selected Antenna		Reasons
	**Moxon Antenna ✓**	• It can be brought easily • Easy to hold and cheaper than Yagi Antenna • Wide range of beamwidth • We have experience working with this antenna

GCS Antenna Trade & Selection (2/2)

Handheld Antenna (SELECTED)

Table Top Antenna

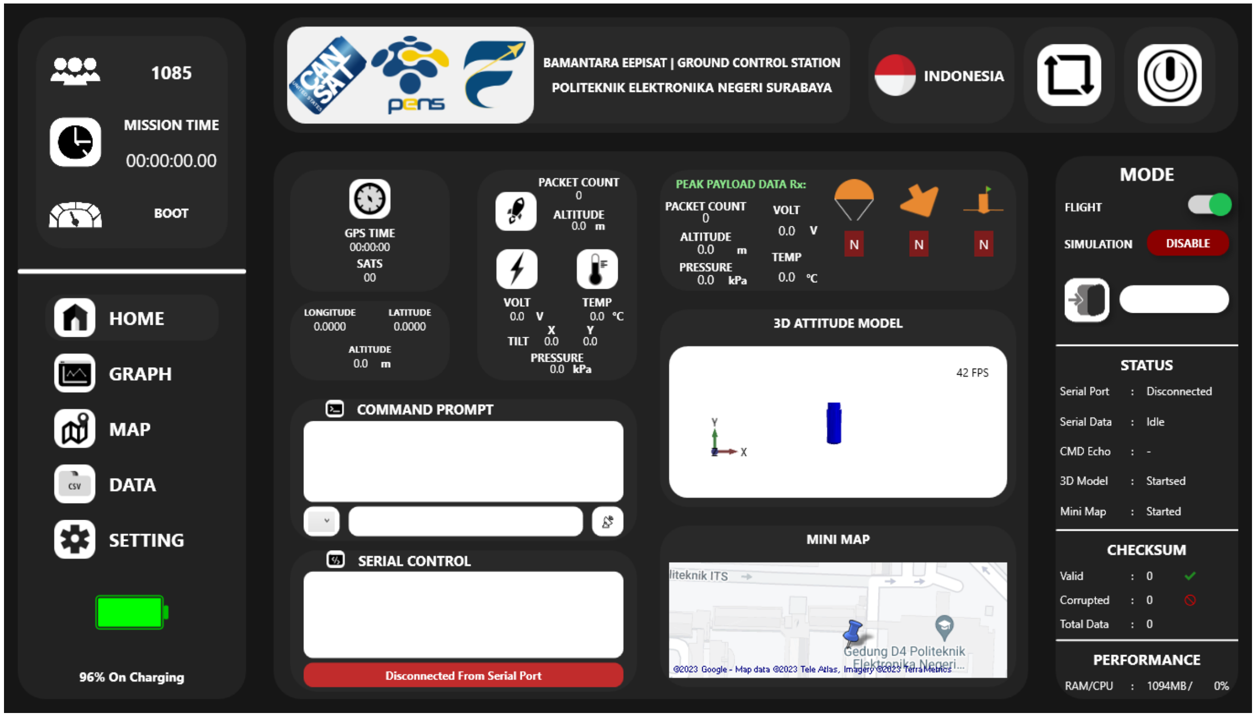
Selected Mounting Antenna Design: Handheld Antenna

Reasons
The antenna will be held in the hand to facilitate targeting and reduce data loss because the payload's altitude will fluctuate.

GCS Software (1/4)

Telemetry Display Prototypes	The ground control station will get real-time graphs, labels, map, 3D model and charts displaying the telemetry data collected from the payload
Commercial Off The Shelf (COTS) Software Packages Used	• Visual Studio 2022 Community Edition • XCTU (XBee Program Software)
Real-Time Plotting Software Design	The telemetry data received from the serial port will be transferred to the PC by USB connector, and processed with C# using LiveCharts2.net and C# WPF library to display the telemetry in real-time and finally data will be saved in a .csv file
Command Software And Interface	There will be a command text box to command the payload to begin communicating the telemetry data as well as to calibrate all of the telemetry data
Telemetry Data Recording And Media Presentation To Judges For Inspection	The judges will be given media data recorded from the payload and container using the camera, the interface screenshot, and payload telemetry data in the form of a .csv file via a USB memory storage device
Description of .csv Telemetry File Creation For Judges	• All received telemetry data will be saved as .csv (Comma Separated Value) file. In CSV format, data is separated by a comma • CSV file name will be “Flight_<TEAM_ID>.csv”
Simulation Mode Description	GCS will command the payload using SIM ENABLE and SIM ACTIVATE. After that, GCS will read the lines of the .txt file containing the barometric pressure data and communicate it to the flight software at intervals of one second using the Simulated Pressure Data Command

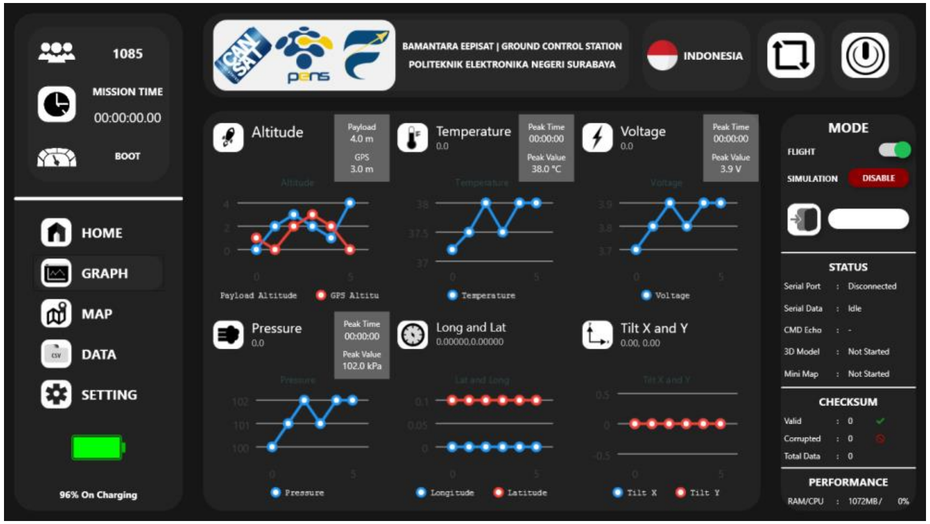
GCS Software (2/4)

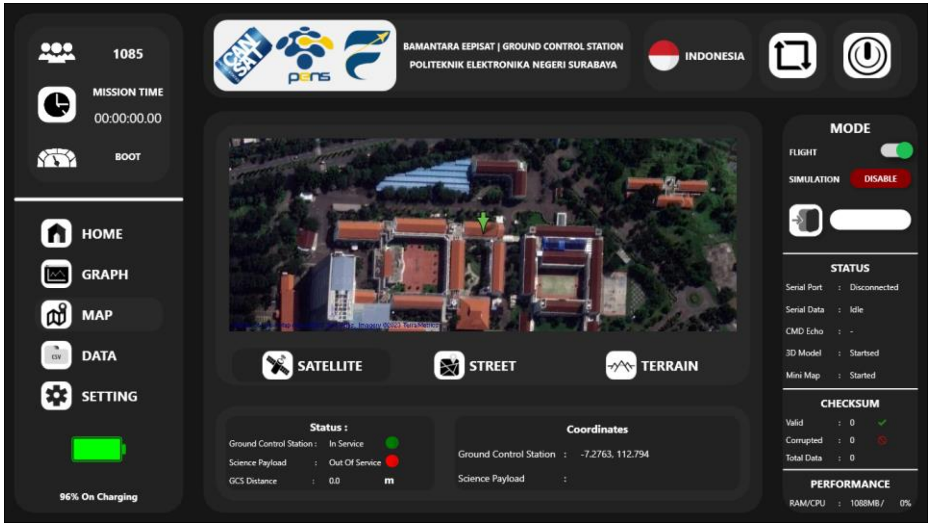


Dashboard View

GCS Software (3/4)

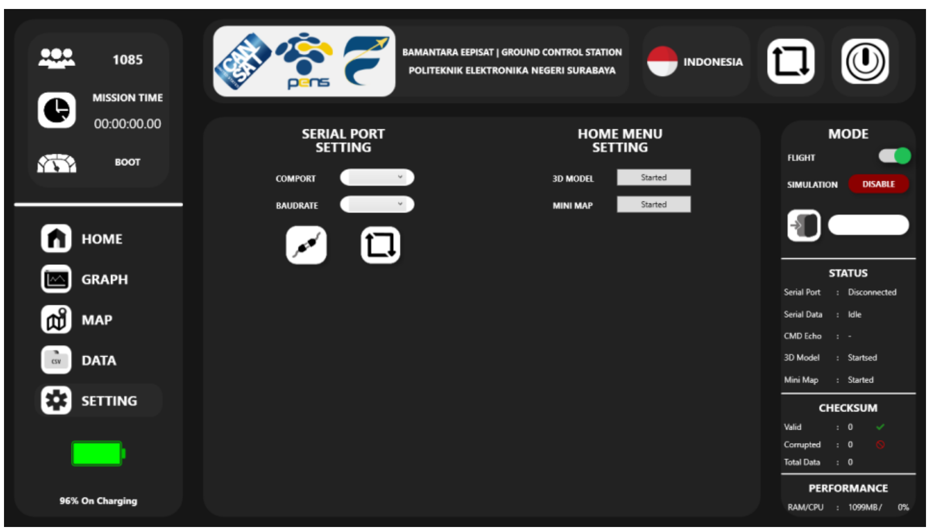
Graph View





Map View

Data CSV View



Setting View

CanSat Integration and Test

Tsabitah Akmal Al Mumtazah

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

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	• Payload release mechanism test • Ensure the component of CanSat can survive when it's launched • Ensure the payload is uprighted after landing • Servo and DC motor will be inspected carefully to ensure freedom of operation
Descent Control	• CanSat stability drop test • Parachute system test • Payload aerobraking test

Integrated Level Functional Test Plan

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 • We will drop a 700 g container 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 payload 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 payload can be released from the container and the parachute mechanism operates correctly • Verify that the payload parachute mechanism is succeed • Ensure the payload deploys a heat shield after leaving the container
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

Environmental Test Plan (1/5)

Drop Test

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

- Power on CanSat
- Verify telemetry is being received
- Raise CanSat by the a 61 cm non-stretching cord
- Release the CanSat
- Verify the CanSat did not lose power
- Inspect for any damage, or detached parts
- 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 and container can operate in a hot environment. The heat source will be provided by a thermal chamber and a hot air gun.

- Place CanSat into a thermal chamber, turn on the CanSat, close and seal the thermal chamber, turn on the heat source
- 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
- Maintain the test conditions for two hours
- 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
- With the CanSat still hot, test any mechanisms and structures to make sure the integrity has not been compromised. Take precautions to avoid injury
- Verify epoxy joints and composite materials still maintain their strengths

(CanSat mission guide)

EEPISAT's Thermal Chamber

Environmental Test Plan (3/5)

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 an orbital sander.

- Power on the CanSat
- Verify accelerometer data is being collected
- Power up the sander. Once the sander is up to full speed, wait 5 seconds
- Power down the sander to a full stop. Repeat it four more times
- Inspect the CanSat for damage and functionality
- Verify accelerometer data is still being collected
- Power down CanSat

(CanSat mission guide)

RK3000 Vertical Vibration Meter

Fit Test

This test is designed to verify if the CanSat is able to fit in 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
Source: https://www.aliexpress.us

Environmental Test Plan (5/5)

Vacuum Test

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

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

(CanSat mission guide)

Vacuum Chamber
Source: https://ubuy.co.id

Simulation Test Plan

GCS

This test is designed to verify if the Ground Station is capable of reading a .txt file of barometric pressure data that simulates the mission profile and transmitting the values to the payload at a rate of one data per second (1 Hz) via commands. We will put it to the test by preparing barometric data in .txt 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 was generated 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. Substituted the data of the sensor with .txt 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

Tsabitah Akmal Al Mumtazah

Overview of Mission Sequence of Events (1/3)

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 container and payload
- 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 (2/3)

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 payload

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 (3/3)

Roles	Member Name
Mission Control Officer *(Responsible for informing the Flight Coordinator when the team and their CanSat is ready to be launched)*	• Fatwa Aulia Al-Haq
Ground Station Crew *(Responsible for monitoring the ground station for telemetry reception and issuing commands to the CanSat)*	• Muhammad Tsaqif Mukhayyar
Recovery Crew *(Responsible for tracking the CanSat and going out into the field for recovery and interacting with the field judges)*	• Tsabitah Akmal Al Mumtazah • Akhmadan Habibullah
CanSat Crew *(Responsible for preparing the CanSat, integrating it into the rocket, and verifying its status)*	• Artaka Sunu Adhi Prasetya • Achmad Bagus Okto Faerizqi

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 container and payload to aid recovery
- We will provide team details on CanSat's outside construction
- We also use GPS to track the payload
- The color of the container, payload, and parachute is orange
- Payload has a buzzer that will continuously buzz when it lands

CanSat COMPETITION 2023
Team #1085 BAMANTARA EEPISAT
eepisatindonesia@gmail.com
+62 896-6425-0927
PENS Campus, Surabaya,
East Java, Indonesia

This address labeling will be placed on our container and payload’s body

Requirements Compliance

Tsabitah Akmal Al Mumtazah

Requirements Compliance Overview

We designed and created CanSat by analyzing and identifying the CanSat Mission Guide 2023. The system will be tested in compliance with the CanSat Integration and Test section.

- We have complied with 56 requirements based on the CanSat Mission Guide 2023.
- 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 s were only partially met.
- There are not any requirements that don’t comply with our design.

(Comply)

(Partial)

(No Comply)

Requirements Compliance (1/7)

RN	Requirement	Compliance	Ref Slides	Notes
1	Total mass of the CanSat (science probe and container) shall be 700 grams +/- 10 grams.	**Comply**	83-86	
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	**Comply**	25	
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	**Comply**	25	
4	The container shall be a fluorescent color; pink, red or orange.	**Comply**	143	
5	The container shall be solid and fully enclose the science probes. Small holes to allow access to turn on the science probes are allowed. The end of the container where the probe deploys may be open.	**Comply**	13	
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	**Comply**	25	
7	The rocket airframe shall not be used as part of the CanSat operations.	**Comply**	25	
8	The container's parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	**Comply**	62	
9	The Parachute shall be fluorescent Pink or Orange.	**Comply**	36	
10	The descent rate of the CanSat (container and science probe) shall be 15 meters/second +/- 5 m/s.	**Comply**	53-54	
11	0 altitude reference shall be at the launch pad.	**Comply**	124	

Requirements Compliance (2/7)

RN	Requirement	Compliance	Ref Slides	Notes
12	All structures shall be built to survive 15 Gs of launch acceleration.	**Partial**	132	We have not integrated our CanSat yet
13	All structures shall be built to survive 30 Gs of shock.	**Partial**	134	We have not integrated our CanSat yet
14	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	**Comply**	81-82	
15	All mechanisms shall be capable of maintaining their configuration or states under all forces.	**Partial**	132-136	Theoretically complies
16	Mechanisms shall not use pyrotechnics or chemicals.	**Comply**	56-80	
17	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	**Comply**	56-80	
18	Both the container and probe shall be labeled with team contact information including email address.	**Comply**	143	
19	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost. Equipment from previous years shall be included in this cost, based on current market value.	**Comply**	154-158	
20	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	**Comply**	94	

Requirements Compliance (3/7)

RN	Requirement	Compliance	Ref Slides	Notes
21	XBEE radios shall have their NETID/PANID set to their team number.	**Comply**	95	
22	XBEE radios shall not use broadcast mode.	**Comply**	95	
23	The container (if needed) and probe shall include an easily accessible power switch that can be accessed without disassembling the cansat and science probes and in the stowed configuration.	**Comply**	21	
24	The probe shall include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the cansat and in the stowed state.	**Comply**	101-102	
25	An audio beacon is required for the probe. It shall be powered after landing.	**Comply**	101-102	
26	The audio beacon shall have a minimum sound pressure level of 92 dB, unobstructed.	**Comply**	101	
27	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	**Comply**	104	
28	An easily accessible battery compartment shall be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	**Comply**	19-21, 81-82	
29	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	**Comply**	81-82	

Requirements Compliance (4/7)

RN	Requirement	Compliance	Ref Slides	Notes
30	The CanSat shall operate during the environmental tests laid out in Section 3.5.	**Partial**	132-136	We have not integrated our CanSat yet
31	The CanSat shall operate for a minimum of two hours when integrated into the rocket.	**Partial**	104	Theoretically complies
32	The probe shall be released from the container when the CanSat reaches 500 meters.	**Comply**	22-24	
33	The probe shall deploy a heat shield after leaving the container.	**Comply**	22-24	
34	The heat shield shall be used as an aerobrake and limit the descent rate to 20 m/s or less.	**Comply**	52-54	
35	At 200 meters, the probe shall release a parachute to reduce the descent rate to 5 m/s +/- 1m/sec.	**Comply**	51, 53-54	
36	Once landed, the probe shall upright itself.	**Comply**	78-80	
37	After uprighting, the probe shall deploy a flag 500 mm above the base of the probe when the probe is in the upright position.	**Comply**	78-80	
38	The probe shall transmit telemetry once per second.	**Comply**	95	
39	The probe telemetry shall include altitude, air pressure, temperature, battery voltage, probe tilt angles, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	**Comply**	96-97	
40	The probe shall include a video camera pointing down to the ground.	**Comply**	33	

Requirements Compliance (5/7)

RN	Requirement	Compliance	Ref Slides	Notes
41	The video camera shall record the flight of the probe from release to landing.	**Comply**	27	
42	The video camera shall record video in color and with a minimum resolution of 640x480.	**Comply**	33-34	
44	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	**Comply**	113	
45	The probe shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	**Comply**	113	
46	The probe shall have its time set to within one second UTC time prior to launch.	**Comply**	95-97	
47	The probe flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	**Comply**	114-115	
48	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**	114-115	
49	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	**Comply**	114-115	
50	The ground station shall command the CanSat to start calibrating the altitude to zero when the CanSat is on the launch pad prior to launch.	**Comply**	124	

Requirements Compliance (6/7)

RN	Requirement	Compliance	Ref Slides	Notes
51	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	**Comply**	124	
52	Telemetry shall include mission time with 0.01 second or better resolution.	**Comply**	113	
53	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	**Comply**	113	
54	Each team shall develop their own ground station.	**Comply**	120-127	
55	All telemetry shall be displayed in real time during descent on the ground station.	**Comply**	124	
56	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	**Comply**	124	
57	Teams shall plot each telemetry data field in real time during flight.	**Comply**	96-97	
58	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	**Comply**	120-123	
59	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	**Comply**	120-127	
60	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	**Comply**	124	

Requirements Compliance (7/7)

RN	Requirement	Compliance	Ref Slides	Notes
61	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the CanSat.	**Comply**	114-115	
BM	A video camera shall be integrated into the container and point toward the payload. The camera shall record the event when the payload is released from the container. Video shall be in color with a minimum resolution of 640x480 pixels and a minimum of 30 frames per second. The video shall be recorded and retrieved when the container is retrieved.	**Comply**	34	

Management

Arneta Firdaus

CanSat Budget – Hardware (1/4)

Electronics Components

Component	Quantity	Considerations	Unit Cost ($)	Total Cost ($)
STM32F407VGT6	1	Actual	25.0	25.0
MPU6050	1	Actual	1.34	1.34
BME280	1	Actual	10.02	10.02
BN-220	1	Actual	13.35	13.35
Servo MG90	1	Actual	1.74	1.74
MX 1508 Driver Motor	1	Actual	0.47	0.47
DC Motor GA-N20	1	Actual	3.0	3.0
SD Card Module	1	Actual	0.60	0.60
Xbee Pro S3B	1	Actual	57.52	57.52
Limit Switch	3	Actual	0.05	0.15
Taoglas Antenna FXP290	1	Actual	17.05	17.05
Camera SQ11	2	Actual	4.01	8.02
SD Card Robot 8GB	2	Actual	3.34	6.68
ON/OFF Switch	2	Actual	0.14	0.28
Micro USB Type B	1	Actual	0.05	0.05
Buzzer 5V	1	Actual	0.10	0.10
LED 3mm	2	Actual	0.03	0.06
Voltage Regulator	2	Actual	0.067	0.134
Olight 18650	2	Actual	25.13	50.26
Battery Charger 18650 (2 Slots)	1	Actual	2.81	2.81
CR2032 Coin Cell	1	Actual	0.17	0.17
PCB	2	Actual	1.05	2.10
Total Cost Electronics Components ($)				**200.904**

CanSat Budget – Hardware (2/4)

Mechanics Components

Component	Quantity	Considerations	Unit Cost ($)	Total Cost ($)
Carbon Fiber Rod Solid 3mm	16	Actual	0.83	13.28
Carbon Fiber Rod Tube 5mm	1	Actual	2.65	2.65
Carbon Fiber Rod Tube 3mm	1	Actual	0.83	0.83
ABS+	1	Actual	12.09	12.09
Resin Epoxy	1	Actual	15.83	15.83
Ripstop Nylon	1	Actual	1.39	1.39
Chinese Knotting Cord	1	Actual	1.42	1.42
Acrylic 600 x 400 x 2 mm	1	Actual	3	3
Fiberglass Woven Cloth 0,17 x 1200 x 1000mm	1	Actual	1.42	1.42
Torsion Spring	4	Actual	0.32	1.28
Compression Spring	1	Actual	0.65	0.65
Teflon	1	Actual	10.0	10.0
Total Cost Mechanics Components ($)				**63.84**

Ground Station Components

Component	Quantity	Considerations	Unit Cost ($)	Total Cost ($)
Moxon Antenna	1	Actual	10	10
XBee Pro S3B	1	Actual	57.52	57.52
XBee Adapter	1	Actual	5.27	5.27
USB Cable	1	Actual	1.29	1.29
RP SMA	1	Actual	2.59	2.59
Total Cost Ground Station Components ($)				**76.67**

CanSat Budget – Hardware (4/4)

Component	Total Cost ($)
Total Cost Electronics Components	200.904
Total Cost Mechanics Components	63.84
Total Cost Ground Station Components	76.67
Total Hardware Budget ($)	**341.414**

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

$ 1000 - $ 341.414 = **$ 658.586**

CanSat Budget – Other Costs

Others Cost

Component	Quantity	Considerations	Unit Cost ($)	Total Cost ($)
Registration	1	Actual	200	200
Prototyping	1	Estimated	100	100
Round Trip CGK-IAD Ticket	10 people	Estimated	1,745	17,450
Round Trip Train Ticket	10 people	Estimated	51.04	510.4
Visa	10 people	Estimated	160	1,600
Uniform	15 people	Actual	19.65	294.75
SIM Card	1 people	Actual	30	30
Guest House	7 nights	Estimated	100	700
Bus	10 people	Estimated	86	860
Total Cost Ground Station Components ($)				**21,745.15**

Sources of Income

Sources of Income	Total Cost ($)
PENS Funding	3,272.36
Sponsorship	19,000
Total Income ($)	**22,272.36**

Program Schedule Overview

CANSAT PROJECT SCHEDULE

Cansat 2023

Project Start Date: 01-Oct-22
Project Leader: Fatwa Aulia

PM=Project Manager **MC=Mechanical** **WM=Web Master**
AD=Administration **HW=Hardware** **BT=Brand**
SS=Sponsorship **SW=Software**

Task	Assign	Start	End	Days	Status	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Summary															
Team Member Recruitment	ALL	1-Sep-22	27-Sep-22	26	Completed										
Internal Funding	AD	27-Sep-22	27-Sep-22	1	Completed										
Middle 1st Semester Exam	ALL	3-Oct-22	7-Oct-22	4	Exam										
PDR Preparation	ALL	10-Oct-22	27-Jan-23	109	Completed										
Procurement of Components & Materials	HW, MC,SW	10-Oct-22	30-Mar-23	171	On-going										
Sponsorship	AD, SS, BT	14-Oct-22	25-May-23	223	On-going										
EEPISAT's Website Developing	WM	14-Oct-22	18-Jun-23	247	On-going										
Registration	PM	4-Nov-22	4-Nov-22	1	Completed										
Final 1st Semester Exam	ALL	21-Nov-22	25-Nov-22	4	Exam										
Team Member Vacation	ALL	25-Dec-22	19-Feb-23	56	On-going										
PDR Submission	PM	1-Feb-23	1-Feb-23	1	Upcoming										
CDR Preparation	ALL	1-Feb-23	1-Apr-23	59	Upcoming										
System Integration	ALL	1-Mar-23	25-May-23	85	Upcoming										
CDR Submission	PM	1-Apr-23	1-Apr-23	1	Upcoming										
Mid 2nd Semester Exam	ALL	3-Apr-23	6-Apr-23	3	Exam										
System Improvement	ALL	3-Apr-23	25-May-23	52	Upcoming										
Final 2nd Semester Exam	ALL	22-May-23	26-May-23	4	Exam										
Enviromental Test Submission	ALL	26-May-23	26-May-23	1	Upcoming										
CanSat Shipping	ALL	29-May-23	29-May-23	1	Upcoming										
FRR (Flight Readiness Review)	ALL	9-Jun-23	9-Jun-23	1	Upcoming										
Competition	ALL	8-Jun-23	11-Jun-23	3	Upcoming										
PFR	PM	11-Jun-23	11-Jun-23	1	Upcoming										

(Completed) (On-going)

(Exam) (Upcoming)

Detailed Program Schedule (1/3)

Task	Assign	Start	End	Days	Status	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Mechanical															
Mission Guide Study	MC	1-Oct-22	8-Oct-22	7	Completed										
Middle 1st Semester Exam	ALL	3-Oct-22	7-Oct-22	4	Exam										
Prototype Manufacturing	MC	4-Oct-22	1-Nov-22	28	Completed										
Material Trade	MC	9-Oct-22	31-Oct-22	22	Completed										
Cansat 1st Design	MC	9-Oct-22	5-Dec-22	57	Completed										
Procurement of Materials	MC	10-Oct-22	30-Mar-23	171	On-going										
Prototype Testing	MC	29-Oct-22	2-Dec-22	34	Completed										
Cansat 2nd Design	MC	10-Nov-22	27-Dec-22	47	Completed										
Final 1st Semester Exam	ALL	21-Nov-22	25-Nov-22	4	Exam										
Team Member Vacation	ALL	25-Dec-22	19-Feb-23	56	On-going										
Mass Budget Calculate	MC	4-Jan-23	10-Jan-23	6	Completed										
System Integrating	MC	1-Mar-23	25-May-23	85	Upcoming										
Mid 2nd Semester Exam	ALL	03-Apr-23	6-Apr-23	3	Exam										
System Improvement	MC	3-Apr-23	25-May-23	52	Upcoming										
System Testing	MC	15-Apr-23	29-Apr-23	14	Upcoming										
Final 2nd Semester Exam	ALL	22-May-23	26-May-23	4	Exam										

Assign to: Artaka Sunu Adhi Prasetya (MC)

(Completed) (On-going) (Mechanical)

(Exam) (Upcoming)

Detailed Program Schedule (2/3)

Task	Assign	Start	End	Days	Status	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Hardware															
Mission Guide Study	HW	1-Oct-22	8-Oct-22	7	Completed										
Middle 1st Semester Exam	ALL	3-Oct-22	7-Oct-22	4	Exam										
Component Trade	HW	9-Oct-22	12-Nov-22	34	Completed										
Procurement of Components	MC	10-Oct-22	30-Mar-23	171	On-going										
Payload PCB Design	HW	20-Oct-22	30-Nov-22	41	Completed										
XBEE Communication Test	HW	21-Oct-22	1-Nov-22	11	Completed										
Electrical Prototype Test	HW	10-Nov-22	1-Dec-22	21	Completed										
Component Testing	HW	12-Nov-22	1-Dec-22	19	Completed										
Final 1st Semester Exam	ALL	21-Nov-22	25-Nov-22	4	Exam										
Flight Algorithm	HW	1-Dec-22	4-Jan-23	34	Completed										
Team Member Vacation	ALL	25-Dec-22	19-Feb-23	56	On-going										
Camera Tracking Test	HW	15-Feb-23	16-Mar-23	29	Upcoming										
System Integrating	HW	1-Mar-23	25-May-23	85	Upcoming										
Mid 2nd Semester Exam	ALL	3-Apr-23	6-Apr-23	3	Exam										
System Improvement	HW	3-Apr-23	25-May-23	52	Upcoming										
System Testing	HW	15-Apr-23	29-Apr-23	14	Upcoming										
Final 2nd Semester Exam	ALL	22-May-23	26-May-23	4	Exam										

Assign to: Achmad Bagus Okto Faerizqi (HW)

(Completed) (On-going) (Hardware)

(Exam) (Upcoming)

Detailed Program Schedule (3/3)

Task	Assign	Start	End	Days	Status	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Software															
Mission Guide Study	SW	1-Oct-22	8-Oct-22	7	Completed										
Middle 1st Semester Exam	ALL	3-Oct-22	7-Oct-22	4	Exam										
GCS Design	SW	9-Oct-22	27-Dec-22	79	Completed										
Antenna Trade	SW	17-Oct-22	28-Oct-22	11	Completed										
Improve Antenna Design	SW	31-Oct-22	27-Dec-22	57	Completed										
Final 1st Semester Exam	ALL	21-Nov-22	25-Nov-22	4	Exam										
Team Member Vacation	ALL	25-Dec-22	19-Feb-23	56	On-going										
System Integrating	SW	1-Mar-23	25-May-23	85	Upcoming										
Antenna Manufacturing	SW	10-Mar-23	20-Mar-23	10	Upcoming										
Antenna Range Test	SW	1-Apr-23	30-Apr-23	29	Upcoming										
Mid 2nd Semester Exam	ALL	3-Apr-23	6-Apr-23	3	Exam										
System Improvement	SW	3-Apr-23	25-May-23	52	Upcoming										
System Testing	SW	15-Apr-23	29-Apr-23	14	Upcoming										
Final 2nd Semester Exam	ALL	22-May-23	26-May-23	4	Exam										

Assign to: Muhammad Tsaqif Mukhayyar (SW)

(Completed) (On-going) (Software)

(Exam) (Upcoming)

Conclusions (1/2)

Division	Major Accomplishments	Major Unfinished Work
Mechanical	• Major mechanism has been tested	• Enviromental testing of integrated CanSat • CanSat design improvement based on testing and evaluation results
Hardware	• All sensors have been tested • XBEE Communication test completed	• CanSat PCB boards are still in improvement phase • Integration with software and mechanic
Software	• GUI design and testing completed	• Antenna design improvement based on testing and evaluation results
Administration & Sponsorship	• Sponsorship and partnership contracted	• Waiting for other sponsors
Brand Team & Web Master	• Official social media still active	• Developing the social media • Website is still on developing

Conclusions (2/2)

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

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