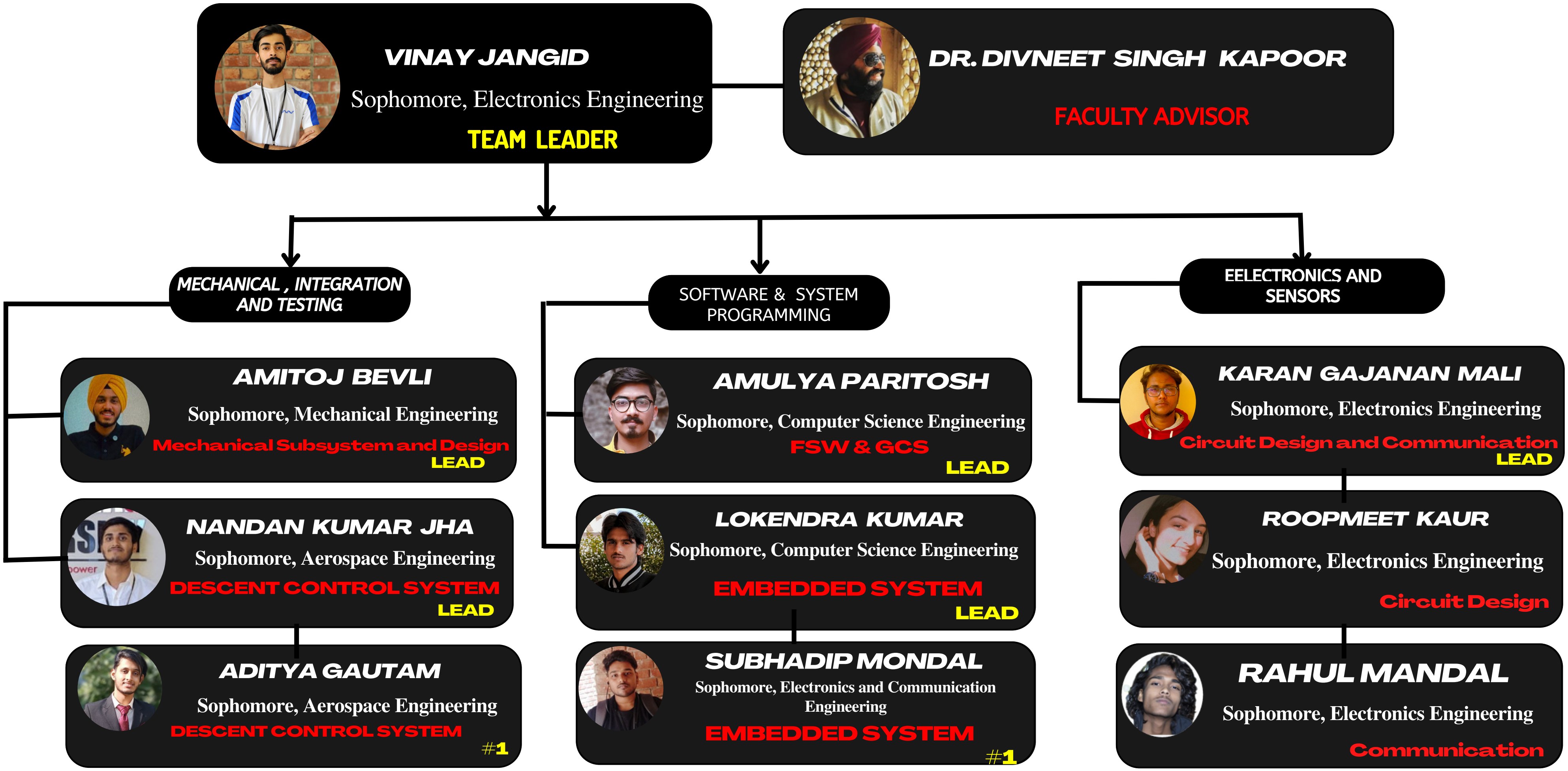
CanSat 2023
Preliminary Design Review (PDR) Outline
Version 1.1

 # 1087

VANDE

Presentation Outline

Team Organization



Acronyms (1/2)

Acronyms	Meaning
FRR	Flight Readiness Review
MCO	Mission Control Officer
DTC	Data Transport Case
PFR	Post Flight Review
CDR	Critical Design Review
PCB	Printed Circuit Board
S2C	Source to Contract
ABS	Acrylonitrile Butadiene Styrene
COMM	Communication

Acronyms	Meaning
PETG	Polyethylene Terephthalate Glycol
MJF	Multi Jet Fusion
RTC	Real Time Clock
GPS	Global Positioning System
GCS	Global Control Station
CAM	Camera
SP	Serial Port
I2C	Inter Integrated Circuit
MCU	Microcontroller Unit

Acronyms (1/2)

Acronyms	Meaning
PAN	Personal Area Network
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver Transmitter
EEPROM	Electronically Erasable Programmable Read Only Memory
SRAM	Static Random Access Memory
GPIO	General Purpose Input Output
SMA	Sub Miniature Version A
NETID	Network Resuscitation Program

Acronyms	Meaning
FSW	Flight Software
NRP	Neonatal Resuscitation Program
ASCII	American Standard Code for Information Interchange
CVS	Comma Separated Values
CX	Container Telemetry ON/OFF
SIM	Simulation Mode Control Command
DC	Direct Current
ES	Estimated

Systems Overview

Rahul Mandal

Mission Summary (1/2)

MAIN OBJECTIVES

The mission is to design a CanSat consisting of a container and a probe . The Cansat shall be launched to an altitude ranging from 670 meters to 725 meters above the launch site and deployed near the peak altitude .

After Deploying from the Rocket

- ***The CanSat shall descend with the use of a parachute at a rate of 15 m/s .***
- ***At 500 meters , the CanSat shall release a probe which opens a heat shield and can be used as an aerobraking device with a descent rate of 20 meters/second .***
- ***When the probe reaches 200 meters , the probe shall deploy a parachute and bring down the descent rate to 5 meters / second .***
- ***Once the probe has landed , it shall attempt to upright itself and raise a flag 500 mm above the base of the probe when the probe is in the upright position.***
- ***A video camera shall be included that will be pointing towards the ground during descent.***

VANDE

Mission Summary (1/2)

BONUS OBJECTIVE

- ***A video camera shall be integrated into the container which should point towards the probe.***
- ***The camera should be able to record the event when the probe is released from the container.***
- ***Video shall be in color with a minimum resolution of 640 x 480 pixels and a minimum of 30 frames per second.***
- ***The video shall be recorded and retrieved when the container is retrieved .***

Note for heatshield : A parachute, streamer, parafoilor similar device shall not be used with the heat shield.

System Requirement Summary (1/12)

S.No	Requirement	Priority	Verfication			
			A	I	D	T
1.	Total mass of the CanSat (science probe and container) shall be 700 grams (+/- 10 grams) .	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.	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.	High		✓		
4.	The container shall be a fluorescent color; pink, red or orange.	Medium		✓		
5.	The container shall be solid and fully enclose the science probes. Small holes to allowaccess to turn on the science probesare allowed. The end of the container where the probe deploys may be open.	High		✓		✓

System Requirement Summary (2/12)

S.No	Requirement	Priority	Verfication A	Verfication I	Verfication D	Verfication T
6.	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	High		✓		
7.	The rocket airframe shall not be used as part of the CanSat operations.	High		✓		
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.	High		✓	✓	✓
9.	The Parachute shall be fluorescent Pink or Orange	Medium		✓		
10.	The descent rate of the CanSat (container and science probe) shall be 15 meters/second (+/- 5m/s) .	High	✓			✓

System Requirement Summary (3/12)

S.No	Requirement	Priority	Verfication			
			A	I	D	T
11.	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	High	✓			✓
12.	0 altitude reference shall be at the launch pad.	High				✓
13.	All structures shall be built to survive 15 Gs of launch acceleration.	High		✓	✓	✓
14.	All structures shall be built to survive 30 Gs of shock.	High		✓	✓	✓
15.	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws , or high performance adhesives.	High		✓		✓

System Requirement Summary (4/12)

S.No	Requirement	Priority	Verfication			
			A	I	D	T
16.	**Mechanisms shall not use pyrotechnics or chemicals.**	High				✓
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.**	High		✓		
18.	**Both the container and probe shall be labeled with team contact information including email address.**	High		✓		
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.**	High		✓		
20.	**XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed**	High	✓	✓		

System Requirement Summary (5/12)

S.No	Requirement	Priority	Verfication A	I	D	T
21.	**XBEE radios shall have their NETID/PANID set to their team number.**	High	✓	✓		✓
22.	**XBEE radios shall not use broadcast mode.**	High		✓		✓
23.	**The container and probe shall include an easily accessible power switch that can be accessed without disassembling the cansat and science probes and in the stowed configuration.**	High		✓		✓
24.	**The container and 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.**	High		✓		✓
25.	**An audio beacon is required for the probe. It shall be powered after landing.**	High		✓		✓

System Requirement Summary (6/12)

S.No	Requirement	Priority	Verfication			
			A	I	D	T
26.	The audio beacon shall have a minimum sound pressure level of 92 dB, unobstructed.	High		✓		✓
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.	High	✓	✓		✓
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.	High		✓		✓
29.	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	High				✓
30.	The Cansat shall operate during the environmental tests	High				✓

System Requirement Summary (7/12)

S.No	Requirement	Priority	Verfication A	I	D	T
31.	**The Cansat shall operate for a minimum of two hours when integrated into the rocket.**	High		✓		✓
32.	**The probe shall be released from the container when the CanSat reaches 500 meters.**	High		✓		✓
33.	**The probe shall deploy a heat shield after leaving the container.**	High		✓		✓
34.	**The heat shield shall be used as an aerobrake and limit the descent rate to 20 m/s or less.**	High				✓
35.	**At 200 meters, the probe shall release a parachute to reduce the descent rate to 5 m/s +/- 1m/sec.**	High		✓		✓

System Requirement Summary (8/12)

S.No	Requirement	Priority	Verfication			
			A	I	D	T
36.	Once landed, the probe shall upright itself.	High		✓		
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.	High		✓		✓
38.	The probe shall transmit telemetry once per second.	High		✓		✓
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.	High	✓	✓	✓	✓
40.	The probe shall include a video camera pointing down to the ground.	High	✓	✓	✓	✓

System Requirement Summary (9/12)

S.No	Requirement	Priority	Verfication A	Verfication I	Verfication D	Verfication T
41.	The video camera shall record the flight of the probe from release to landing.	High		✓		
42.	The video camera shall record video in color and with a minimum resolution of 640x480.	High	✓	✓		✓
43.	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.	High	✓	✓	✓	✓
44.	The probe shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	High	✓	✓	✓	✓
45.	The video camera shall record the flight of the probe from release to landing.	High		✓		

System Requirement Summary (10/12)

S.No	Requirement	Priority	Verfication			
			A	I	D	T
46.	The probe shall have its time set to within one second UTC time prior to launch.	High	✓	✓		✓
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.	High	✓			✓
48.	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.	High	✓			✓
49.	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	High	✓		✓	✓
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.	High	✓		✓	✓

System Requirement Summary (11/12)

S.No	Requirement	Priority	Verfication			
			A	I	D	T
51.	**The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.**	High		✓		✓
52.	**Telemetry shall include mission time with 0.01 second or better resolution.**	High	✓	✓	✓	✓
53.	**Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.**	High			✓	✓
54.	**Each team shall develop their own ground station.**	High		✓	✓	✓
55.	**All telemetry shall be displayed in real time during descent on the ground station .**	High		✓		✓

System Requirement Summary (12/12)

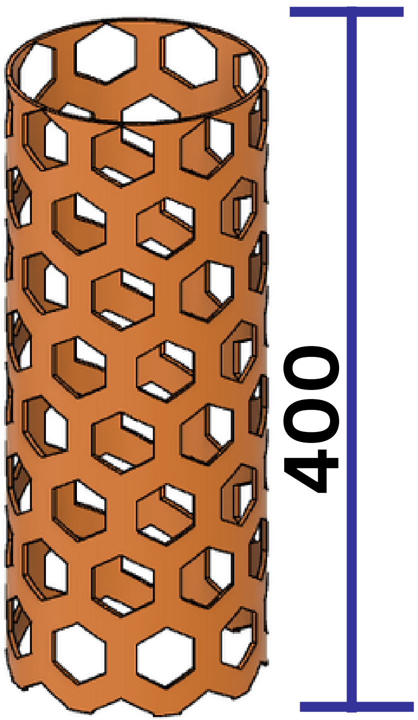
S.No	Requirement	Priority	Verfication			
			A	I	D	T
56.	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	High		✓	✓	✓
57.	Teams shall plot each telemetry data field in real time during flight.	High	✓	✓	✓	✓
58.	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	High		✓		✓
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.	High	✓	✓		✓
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.	High	✓	✓	✓	✓
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	High	✓	✓		✓

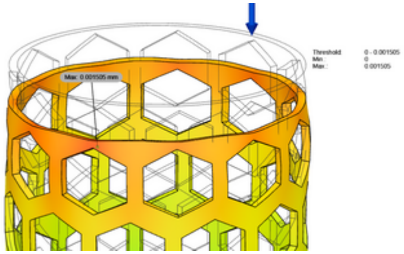
System Level CanSat Configuration Trade & Selection (1/2)

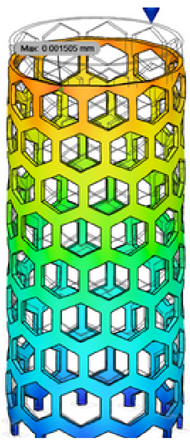
Configuration 1

Not Selected

Chassis structure of Container







- Made up of Nylon PA-11 material .
- Height = 400 mm
- Diameter = 122 mm.
- PCBs are hinged vertically with the walls of the container as shown in figure.
- Can carry the payload.
- Aligned Centre of Mass.
- Complies with almost all requirements.
- High Material Volume

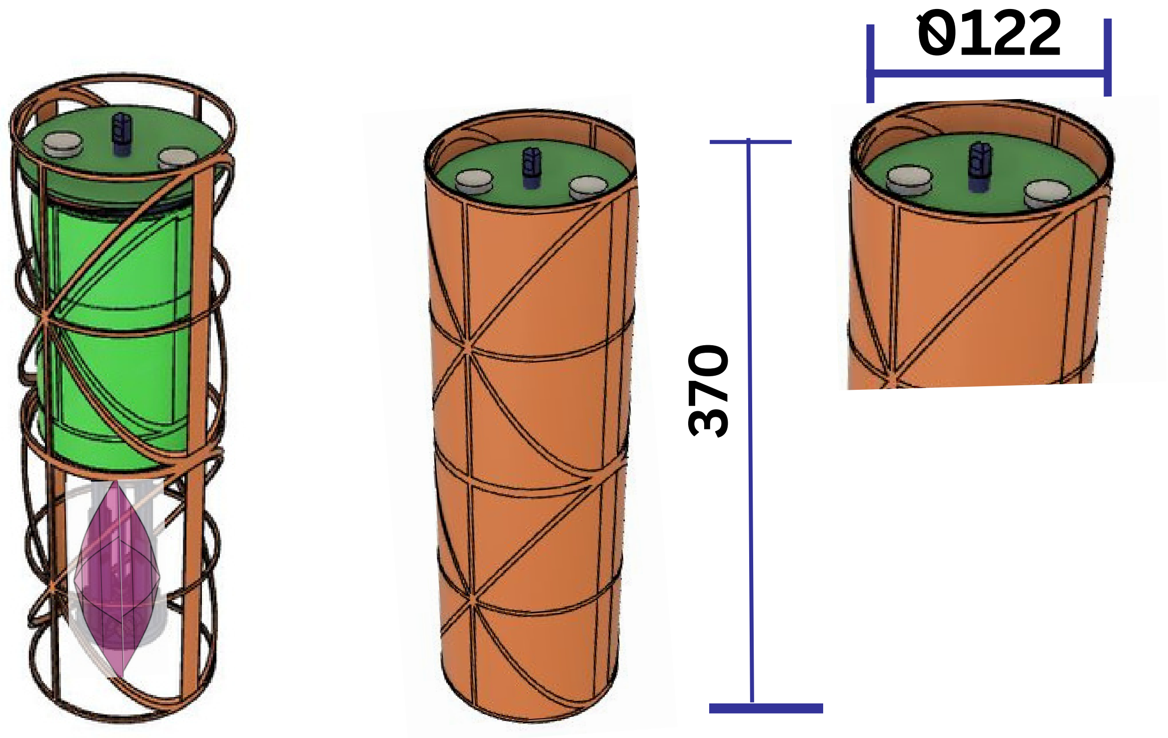
- ***Consumes more mass.***
- ***Hinge can't be made on side walls.***
- ***Less stability in air***

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

Configuration 2

Designed Chassis Inspired by Spider Web Design

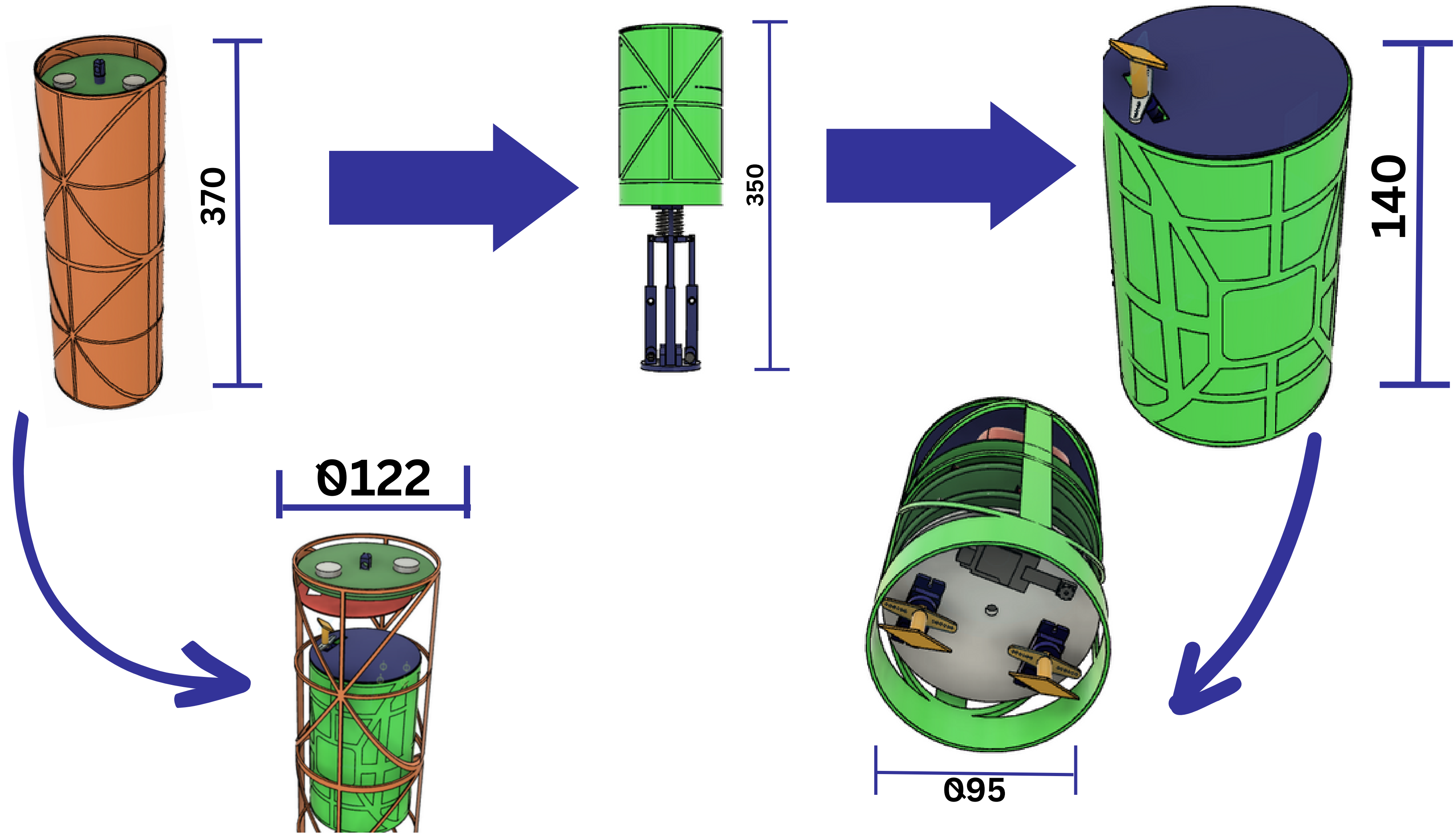
Selected



- ***More stable.***
- ***Requires less mass.***
- ***CG is balanced.***
- ***layering provides more stability***

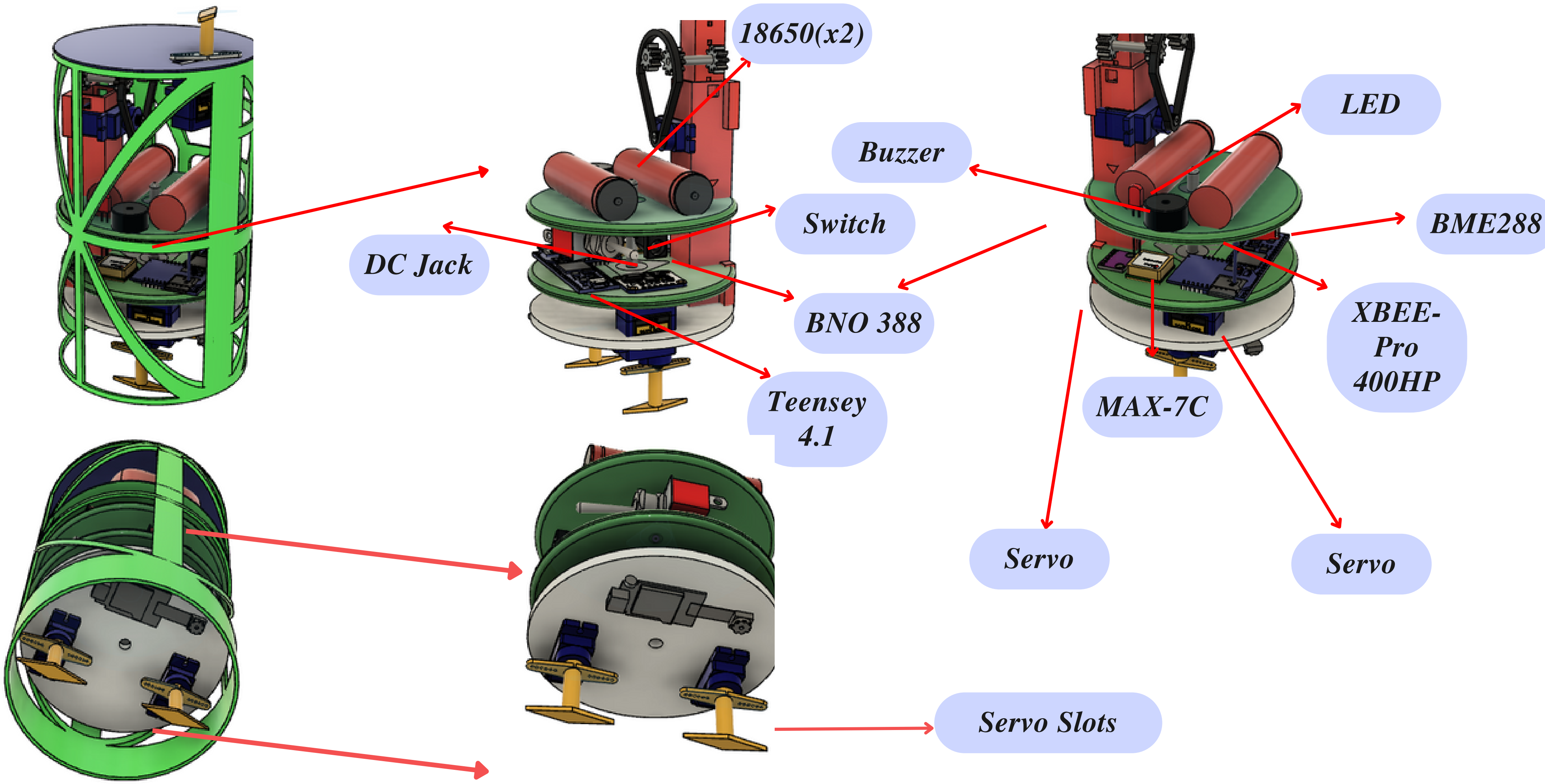
- Made up of PLA+ thermoplastic material.
- Height = 370 mm
- Diameter = 122 mm.
- PCBs are fixed horizontally with the walls of the container as shown in figure.
- Equipped team details
- Estimated mass of CANSAT is 709 g.
- Aligned centre of mass.
- Complies with almost all the requirements.
- Low Material Volume.

Physical Layout (1/2)

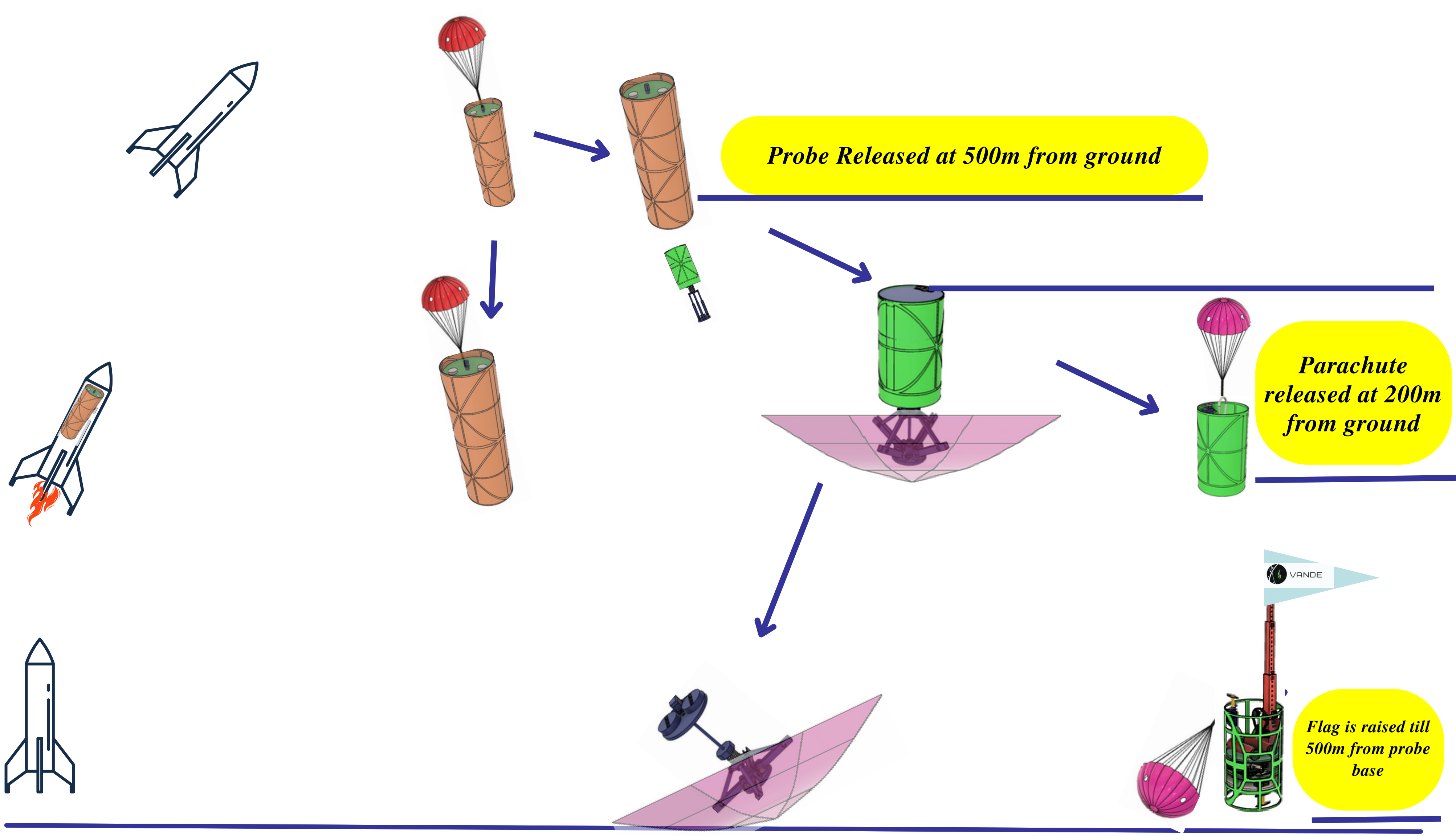


Physical Layout (2/2)

Probe Electrical Layout



System Concept of Operations



Sensor Subsystem Design

Vinay Jangid

Sensor Subsystem Overview

SENSOR	MODEL	ROLE	LOCATION
GPS	MAX-M8Q	Determining the position	PAYLOAD
BATTERY VOLTAGE	TENSY 4.1 ANALOG	Measurement of the battery voltage	PAYLOAD
BONUS CAMERA	ADAFRUIT MINI SPY CAM	Capturing the video of the payload	CONTAINER AND PAYLOAD
AIR TEMPERATURE	BME-280	Measurement of air temperature and pressure	PAYLOAD
ROTATION CONTROL	BNO-085	Obtaining orientation of the payload	PAYLOAD
AIR PRESSURE	BME-388	Measurement of air temperature and pressure	PAYLOAD

Payload Air Pressure Sensor Trade & Selection

Name of the Sensor	SIZE [mm]	Mass [g]	Operating voltage [V]	Operating current [mA]	Range [hPa]	Interfaces	COST [$]
BMP 388	2.5 , 2.5 , 0.93	1.2	3.0	3.6	300.00~1100.00	I2C.SPI	3.47
MS5611	19 , 13 , 2	9	1.8 ~ 3.6	1.5	10~1200	I2C, SPI	6.25
MPL3115A2	18 , 19 , 2.5	1.2	1.95 ~ 3.6	4.2	500~1150	I2C	8.00

SELECTED SENSOR	REASONS
BMP 388	• Highly accessible Library • High accuracy • Low current consumption • Familiarity with the sensor

Payload Air Temperature Sensor Trade & Selection

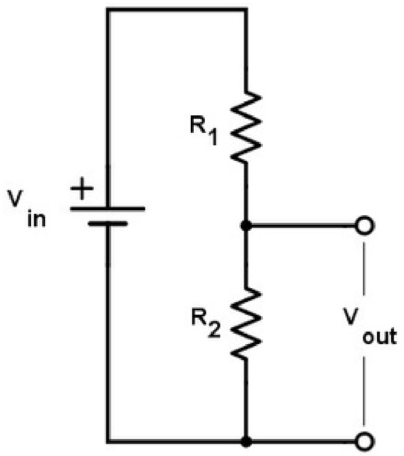
Name of the Sensor	SIZE [mm]	WEIGHT [g]	Operating voltage [V]	Operating current [mA]	Range [°C]	Accuracy [°C]	Interfaces	COST [$]
BME 280	2.5 , 2.5 , 0.93	1.2	3.0	3.6	-40~+85	±1	I2C	9.95
DHT22	27 , 59 , 14	2.4	3.3~6	0.2	-40~+80	±0.5	Single Bus	6.5

SELECTED SENSOR	REASONS
BME 280	• lower power consumption • higher accuracy in measurement • measures both temperature and pressure

Payload Battery Voltage Sensor Trade & Selection

Name of the Sensor	CI(s)	MASS [g]	Sensitivity Or Resolution	Range [V]	Accuracy (V)	COST [$]
Teensy 4.1 Analog Pin	Analog	<1	0.05 V	0.00~3.30	±0.1%	0
Arduino Voltage Sensor	Analog	20	4.8 v	0.00~5.00	±0.1%	0.22

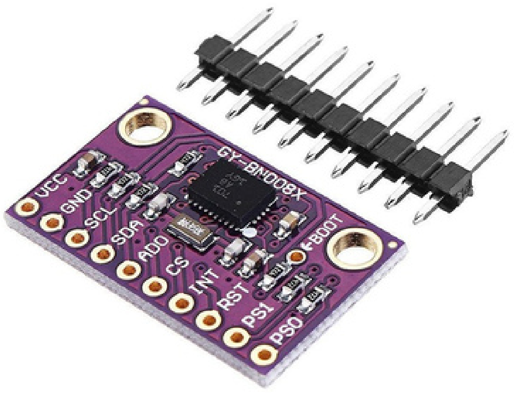
SELECTED SENSOR	REASONS
Teensy 4.1 Analog Pin	• Included with Teensy • No external area occupation needed • No extra cost • No I2C, SPI or UART interfaces needed • Easy to calculate



Payload Tilt Sensor Trade & Selection

Name of the Sensor	SIZE [mm]	WEIGHT [g]	Operating voltage [V]	Operating current [mA]	Resolution [degree]	Interfaces	COST [$]
BNO 055	5.2 x 3.8 x 1.1	3.0	3.3V ~ 5V	12.3	40	I2C	25
BNO 085	5.2 x 3.8 x 1.1	1.2	3.3V	3.3V	-40°C ~ 85°C.	I2C,SPI	38.90

SELECTED SENSOR	REASONS
BNO 085	• has a higher resolution • 9-axis sensor



Payload GPS Sensor Trade & Selection

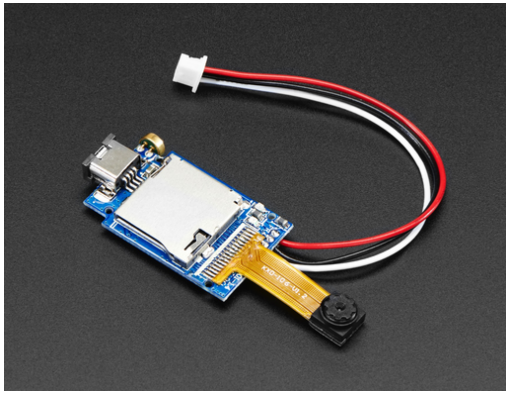
Name of the Sensor	SIZE [mm]	WEIGHT [g]	Operating voltage [V]	Operating current [mA]	Accuracy (m)	Interfaces	
NEO-M8N	25 x 35 x 3	17	1.65V ~ 3.6V	21	±2.0	UART	
SAM-M8Q	22 x 22 x 1.6	8.5	2.7V ~ 3.6V	23	±2.0	UART	

SELECTED SENSOR	REASONS
SAM-M8Q	• High accuracy for ±2.0 m • Lower price • Smaller size compared to NEO-M8N • Less weight • Highly accessible library

Payload Camera Trade & Selection

Name	Mass [g]	Operating voltage [V]	microSD card	Resolution [pixels]	Interfaces	Price [$]
Eachine 2503	6	3.8~5.0	Yes	1920x1080 1280x720	Analog	30
ADAFRUIT MINI SPY CAM	2.8	3.7 - 5	yes	640*480	Digital I/O	12.50
RunCam Split 3 Micro	14	5~20	Yes	1920x1080	165	60

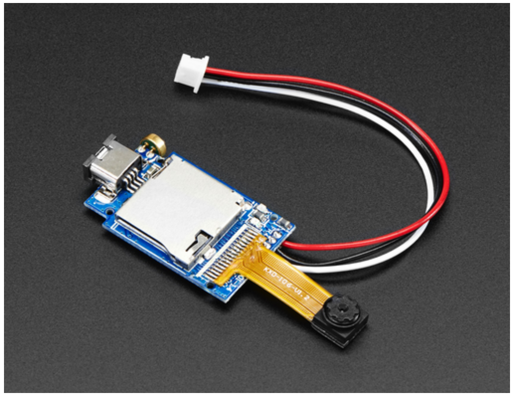
Selected sensor	Reason
ADAFRUIT MINI SPY CAM	• small size • in-build sd card unit



Bonus Camera Trade and Selection

Name	Mass [g]	Operating voltage [V]	microSD card	Resolution [pixels]	Interfaces	Price [$]
Eachine 2503	6	3.8~5.0	Yes	1920x1080 1280x720	Analog	30
ADAFRUIT MINI SPY CAM	2.8	3.7 - 5	yes	640*480	Digital I/O	12.50
RunCam Split 3 Micro	14	5~20	Yes	1920x1080	165	60

Selected sensor	Reason
ADAFRUIT MINI SPY CAM	• small size • in-build sd card unit

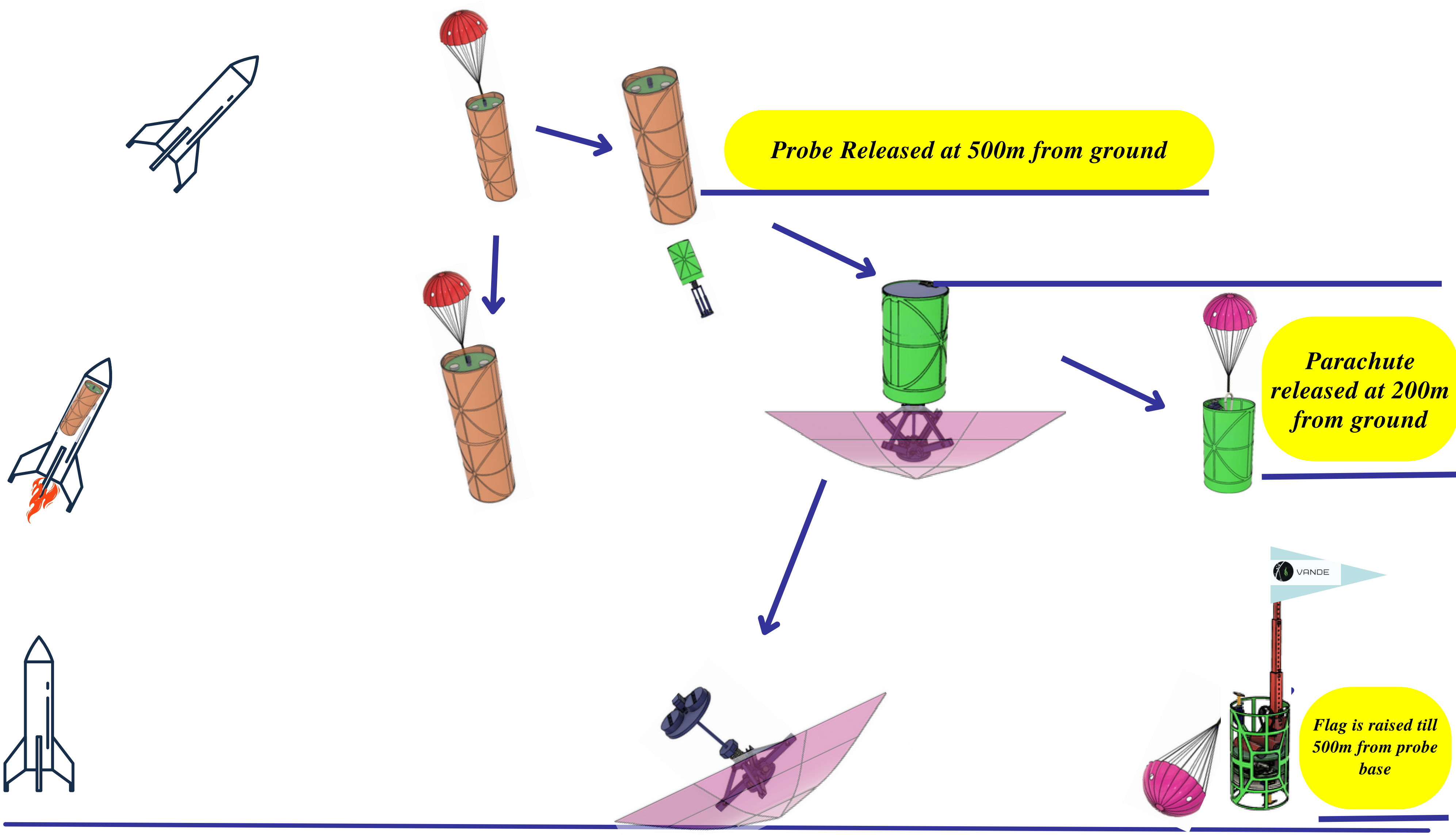


Descent Control Design

NANDAN KUMAR JHA

ADITYA GAUTAM

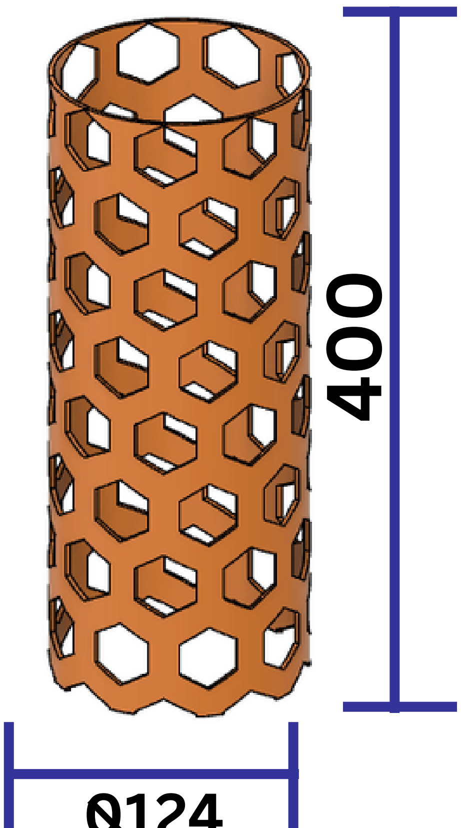
Descent Control Overview 1/1



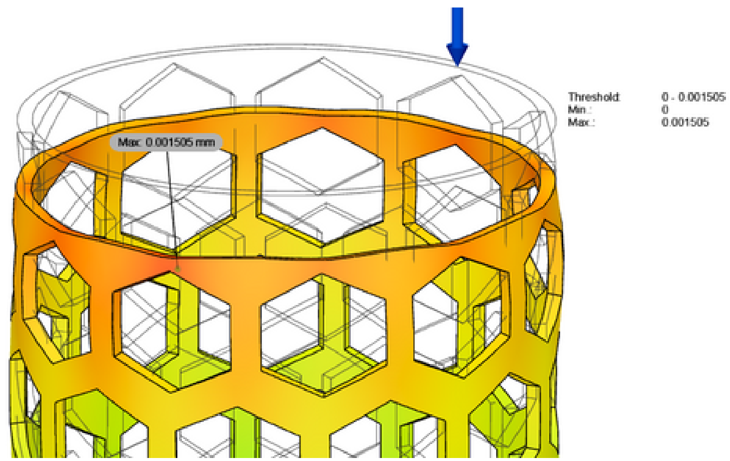
Container Descent Control Strategy Selection and Trade 1/10

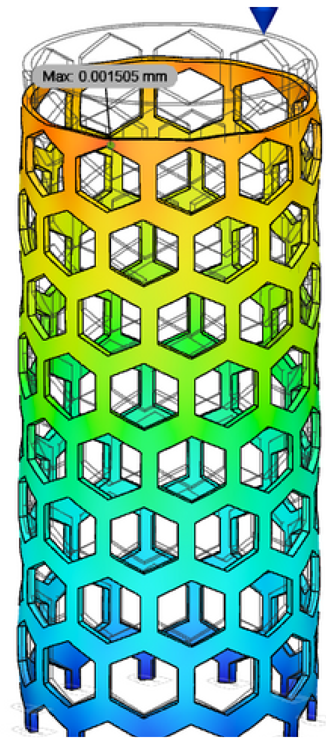
Configuration 1

Not Selected



Chassis structure of Container





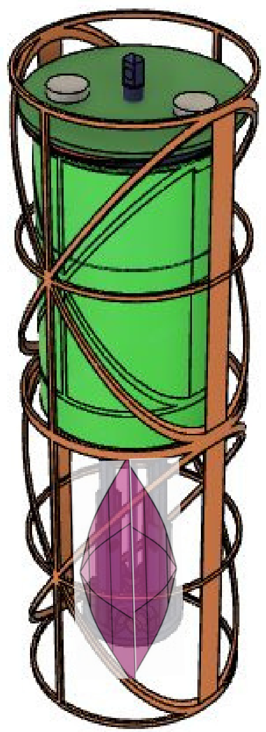
- *Consumes more mass.*
- *Hinge can't be made on side walls.*
- *Less stability in air*

Container Descent Control Strategy Selection and Trade 2/10

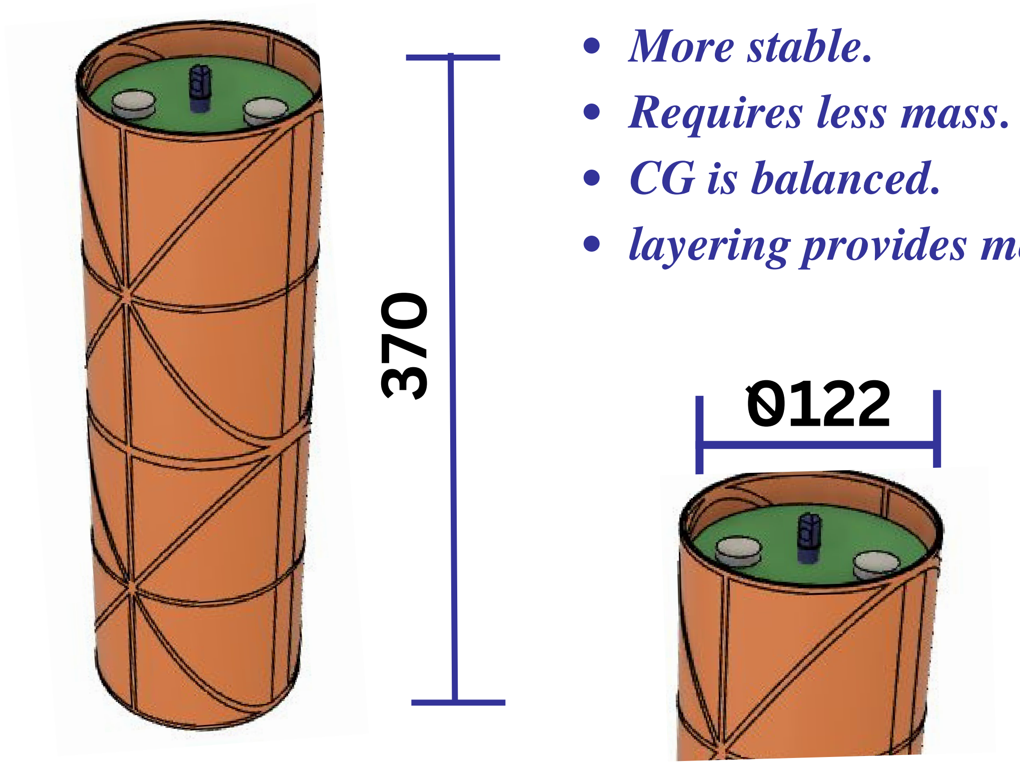
Configuration 2

Selected

Designed Chassis Inspired by Spider Web Design



(chassis structure)



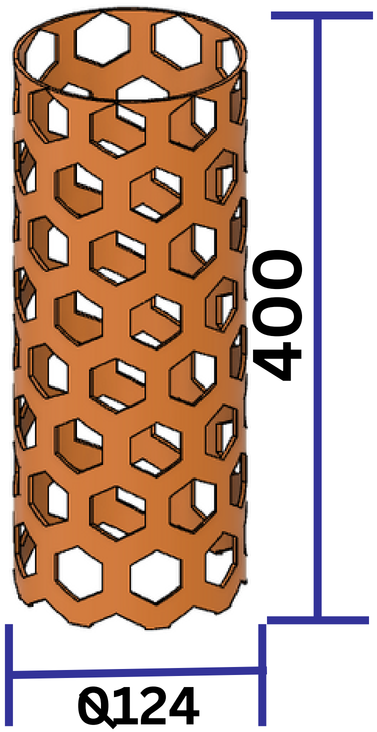
(Covered CanSat)

- *More stable.*
- *Requires less mass.*
- *CG is balanced.*
- *layering provides more stability*

Container Descent Control Strategy Selection and Trade 3/10

Configuration 1

Not Selected

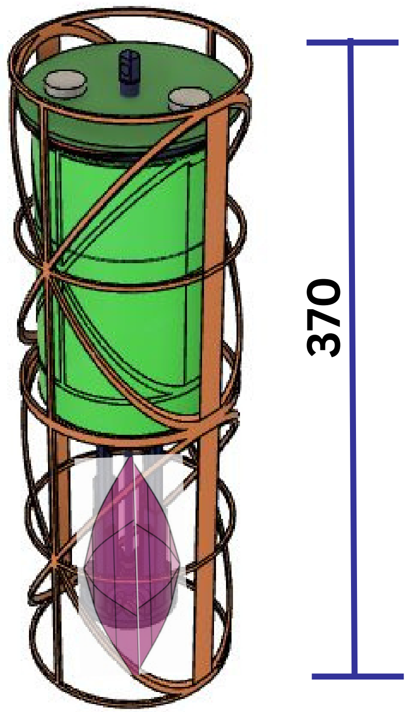


Configuration 2

Selected

Rationale for selection

- *More stable as compared to configuration 1.*
- *provide greater stability after layering.*
- *Under estimated mass Budget of CANSAT.*
- *Aligned Center of mass.*
- *Low material volume.*
- *made up of PLA+ Thermoplastic material.*



(chassis structure)

- **CANSAT Drogue Parachute Deployment**

Configuration 1

Octagonal Parachutes

Not Selected

image source:Google

- ***Less stable as compared to Configuration 2***
- ***Complex Deployment Mechanism.***
- ***Not Suitable with Required Descent Velocity.***
- ***Dimension is not exact compared to required descent rate***
- ***Required More space.***

Selected material	***COLOUR***	***Rationale***
Nylon	Fluorescent Red	Easily Available

Container Descent Control Strategy Selection and Trade 5/10

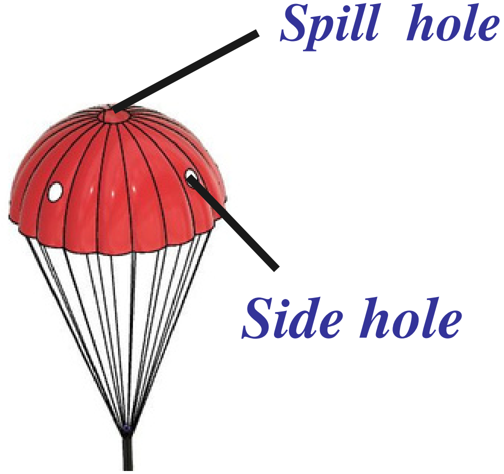
- **CANSAT Drogue Parachute Deployment**

Configuration 2

Round parachute with spill hole

Selected

- *More stable as compared to configuration 1*
- *Greater stability with spill holes and sides holes.*
- *Easy to deploy.*
- *Opening Time is short.*
- *Good for low drop altitude.*
- *Dimension is exact for required Descent rate.*
- *Easily Available in the Market.*



Selected material	*Color*	*Rationale*
Ripstop Nylon	Fluorescent Red	Easier to cut and manufacture.

- **Selection and Trade of Parachutes**

Octagonal Parachutes

Not Selected

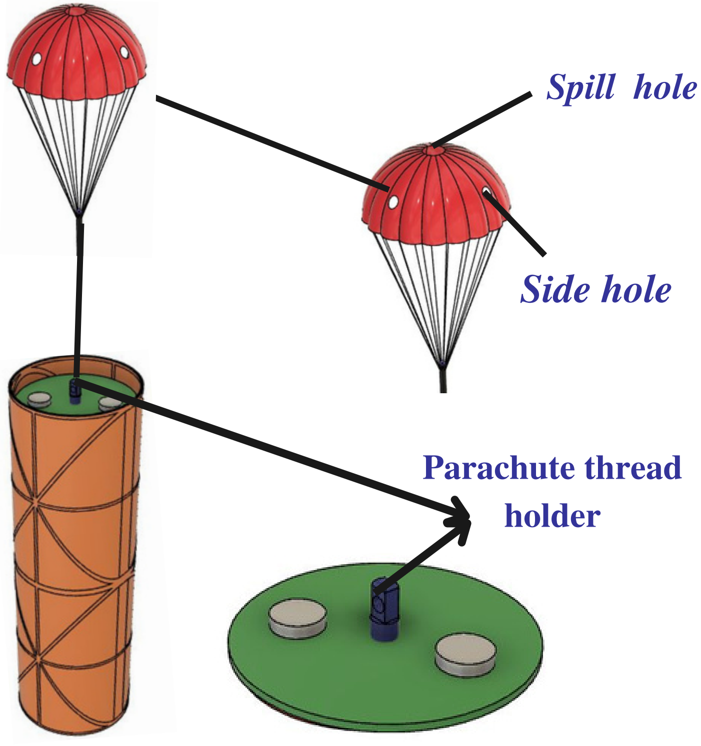
image source:Google

Rationale for selection

- *More stable as compared to configuration 1*
- *Greater stability with spill holes and sides holes.*
- *Easy to deploy.*
- *Opening Time is short.*
- *Good for low drop altitude.*
- *Dimension is exact for required Descent rate.*
- *Easily Available in the Market.*

Round parachute with spill hole

Selected

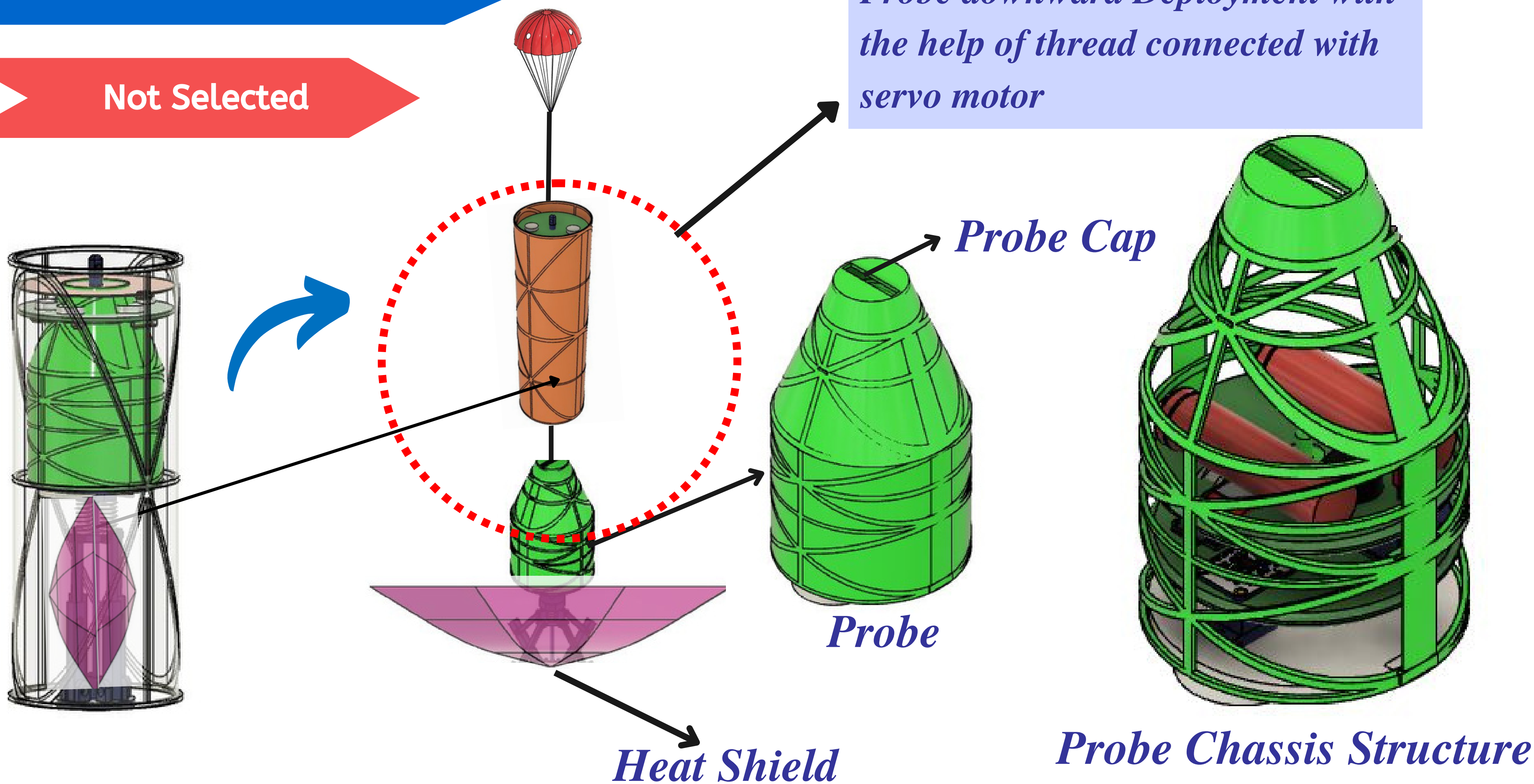


- **Probe Deployment from CANSAT**

Configuration 1

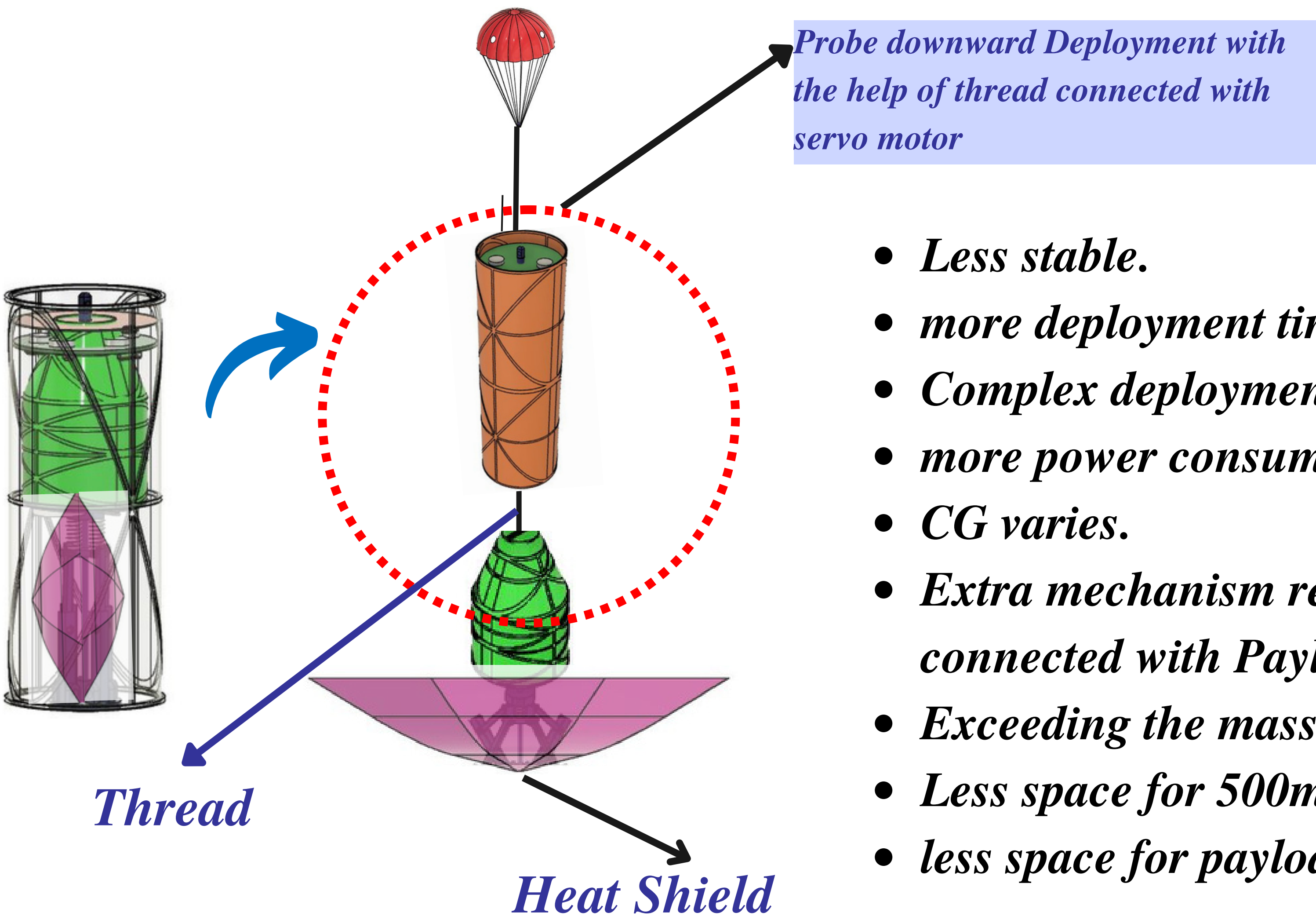
Not Selected

Probe downward Deployment with the help of thread connected with servo motor



Container Descent Control Strategy Selection and Trade 8/10

- **Probe Deployment from CANSAT**



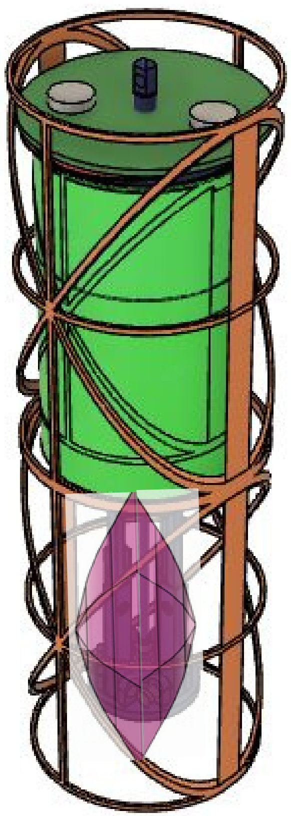
- *Less stable.*
- *more deployment time.*
- *Complex deployment mechanism.*
- *more power consumption due to servo*
- *CG varies.*
- *Extra mechanism required for thread connected with Payload.*
- *Exceeding the mass Budget*
- *Less space for 500mm flag opening.*
- *less space for payload parachute.*

Container Descent Control Strategy Selection and Trade 9/10

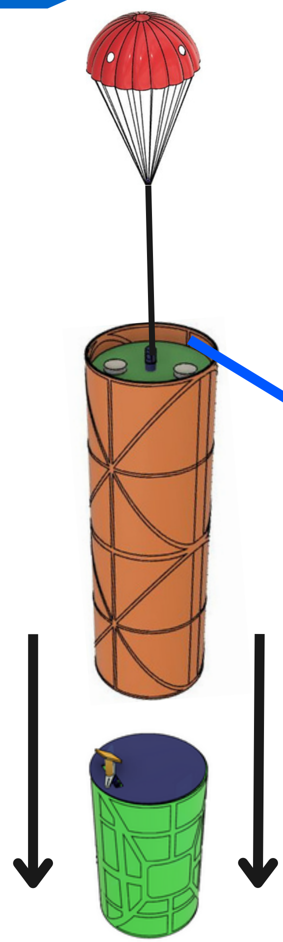
- **Probe Deployment from CANSAT**

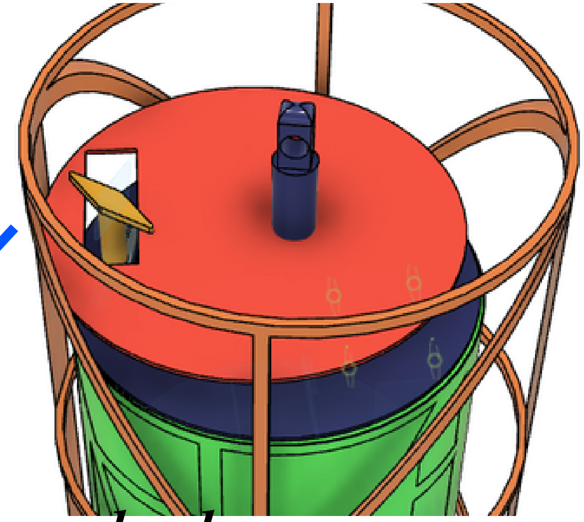
Configuration 2

Selected



(chassis structure)





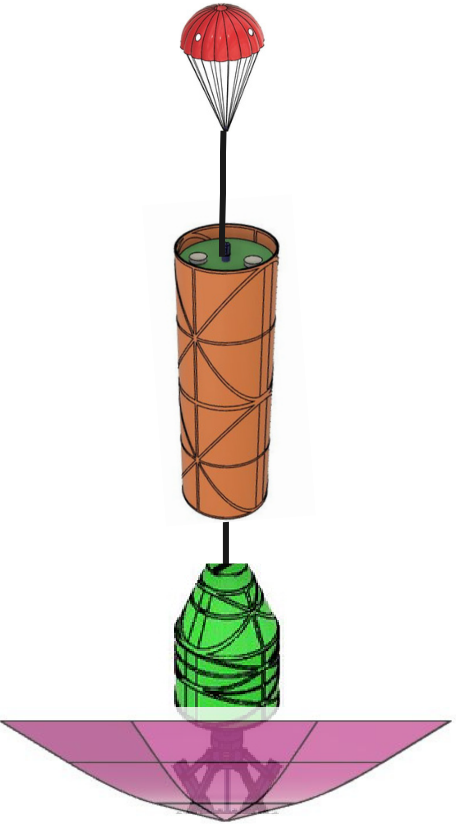
Servo holds the payload

- *The servo is responsible for holding Probe and CANSAT*
- *The servo rotates at 30 degrees.*
- *The probe is free to fall from the CANSAT.*

Container Descent Control Strategy Selection and Trade 10/10

Configuration 1

Not Selected

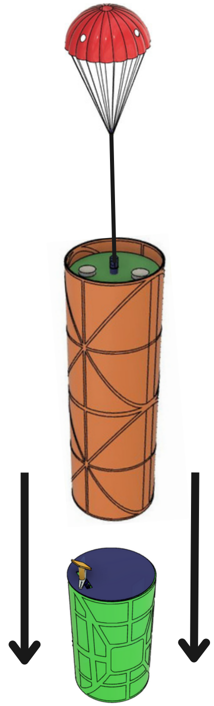


Rationale for selection

- *Short Opening Time.*
- *Maintain stability during descent.*
- *Easily deployed with the help of servo.*
- *No extra mechanism is required.*
- *Low risk of toppling.*
- *deployment mechanism is suitable as per selected design.*
- *All the Mechanism are under mass budget.*
- *Less power consumption with servo motor.*

Configuration 2

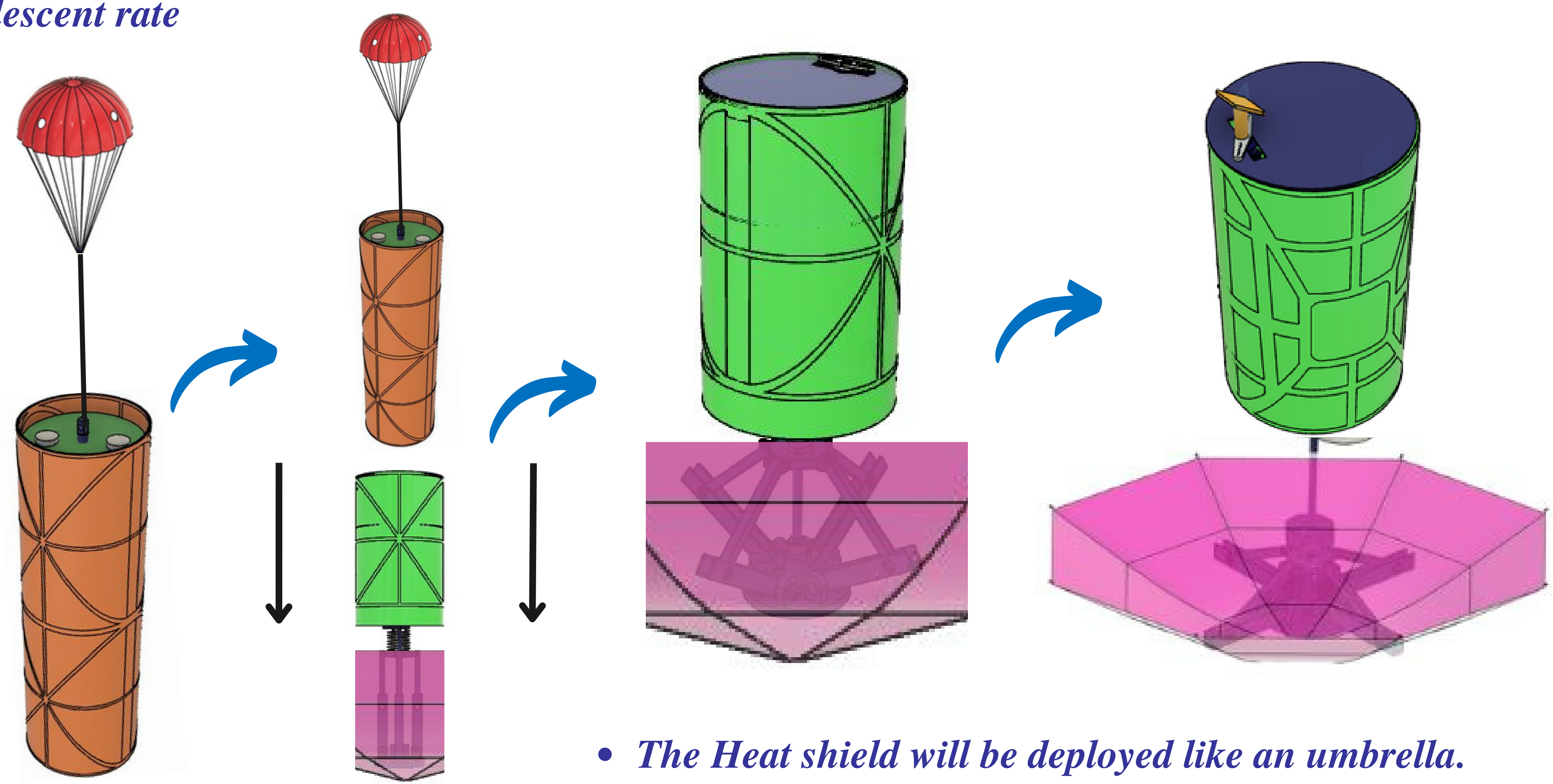
Selected



Payload Aerobraking Descent Stability Control Strategy Selection and Trade 1/6

Heat Shield Deployment Overview

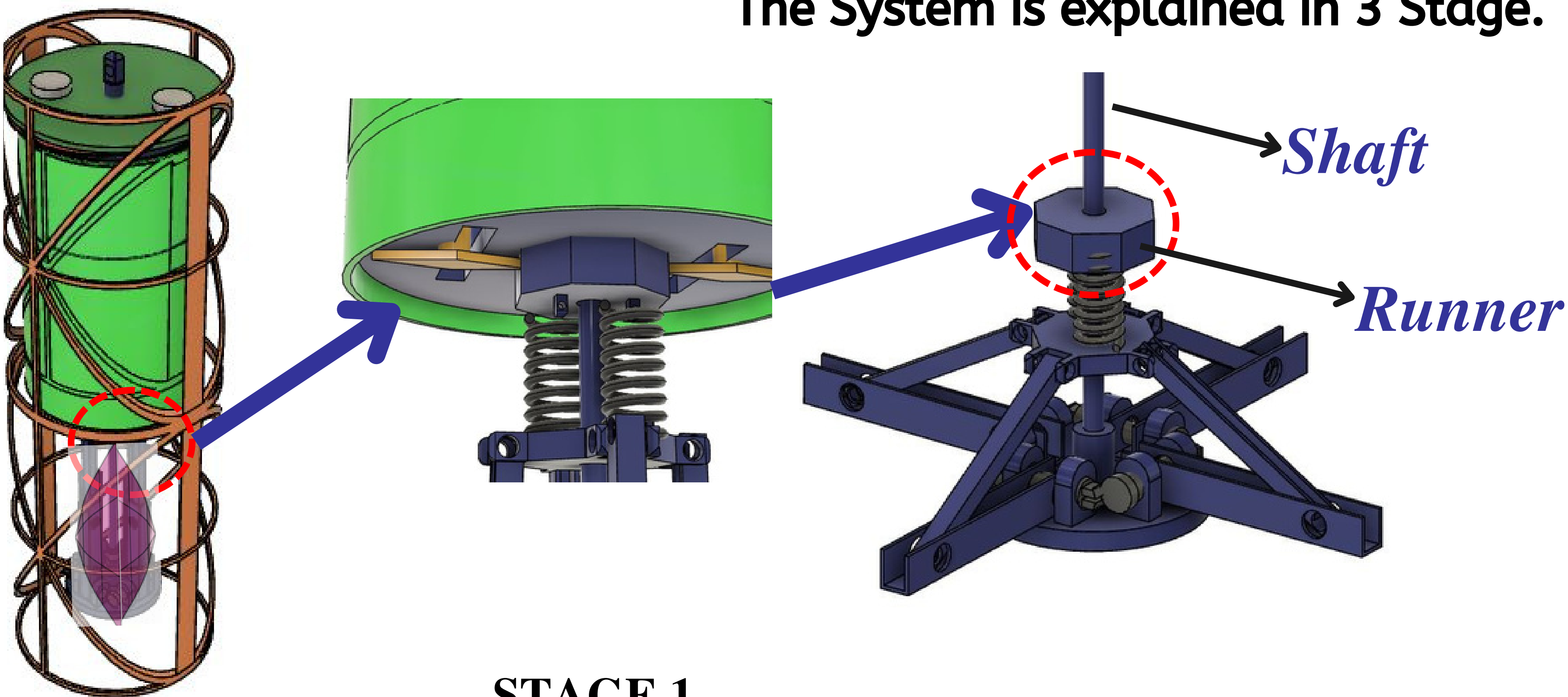
- *At an apogee of 500m heat shield will open which will act as an aerobraking to reduce the descent rate*



- *The Heat shield will be deployed like an umbrella.*

Heat Shield Deployment Mechanism

The System is explained in 3 Stage.

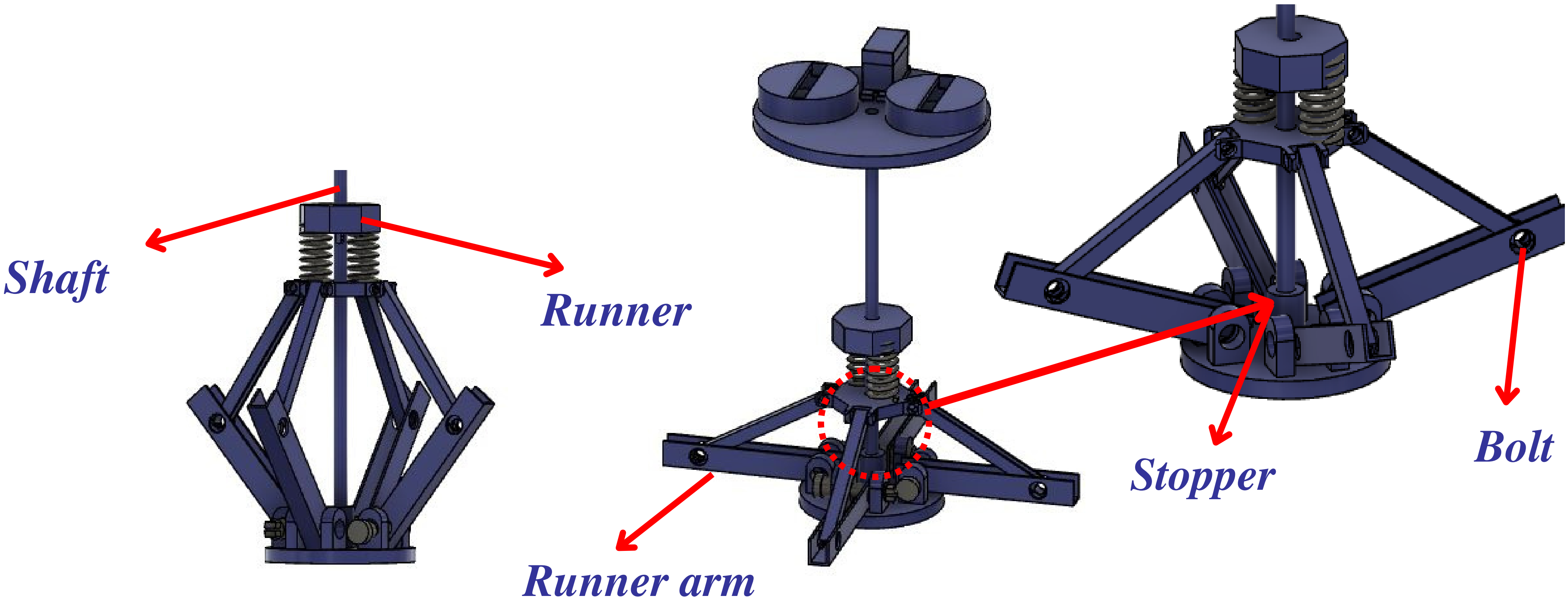


STAGE 1

- *The servo is rotated, and the runner is released.*

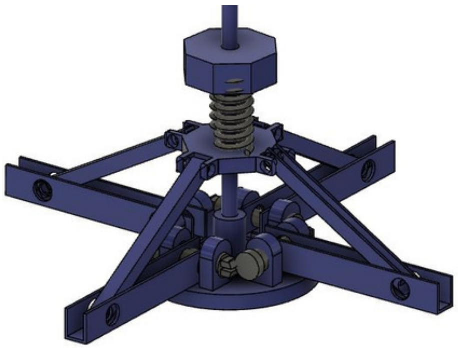
Heat Shield Deployment Mechanism

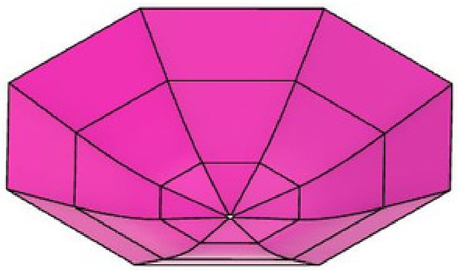
Stage 2 *The runner travels through shaft and reaches to stopper.*

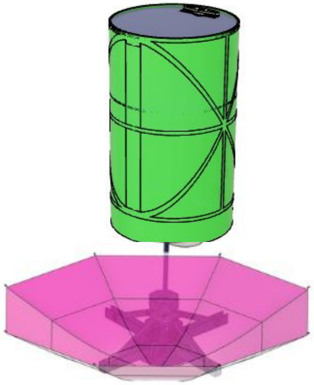


Heat Shield Deployment Mechanism

STAGE 3 *The heat Shield is opened successfully.*

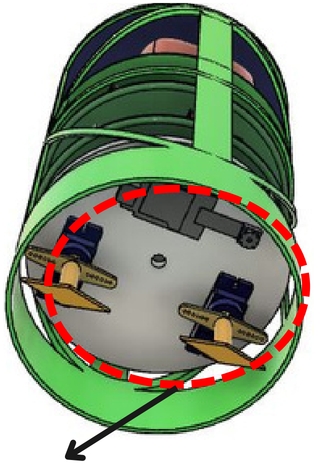






Heat Shield Removal mechanism

- *The system of heat shield is connected to the Probe.*
- *When the servo is rotated the heat shield will completely detached from probe.*



Heat Shield

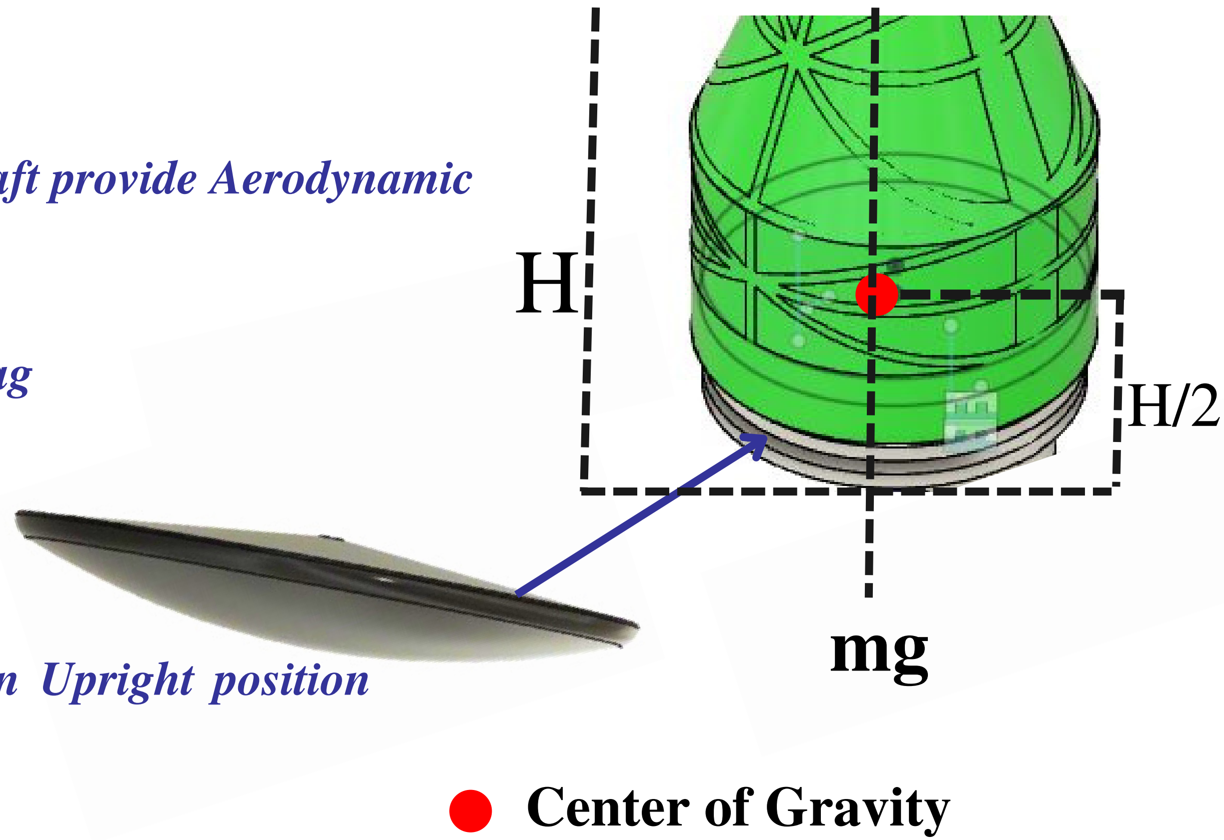
Not Selected

Configuration 1

Passive Stability

Description of Rejection

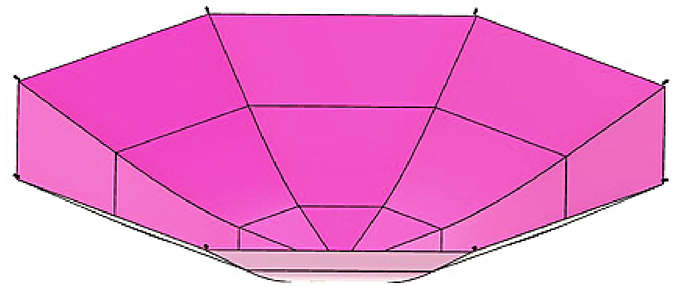
- *Convex Heat shield of spacecraft provide Aerodynamic stability during Descent.*
- *Counter less Aerodynamic Drag*
- *CG differs due to extra weight of Heat shield*
- *Difficult to bring the probe in Upright position after landing*



Heat Shield

Active Stability

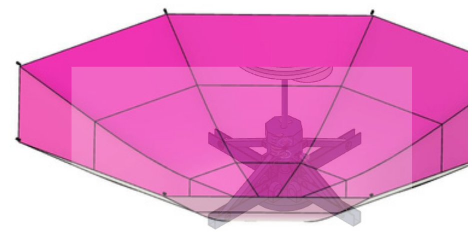
Configuration 2

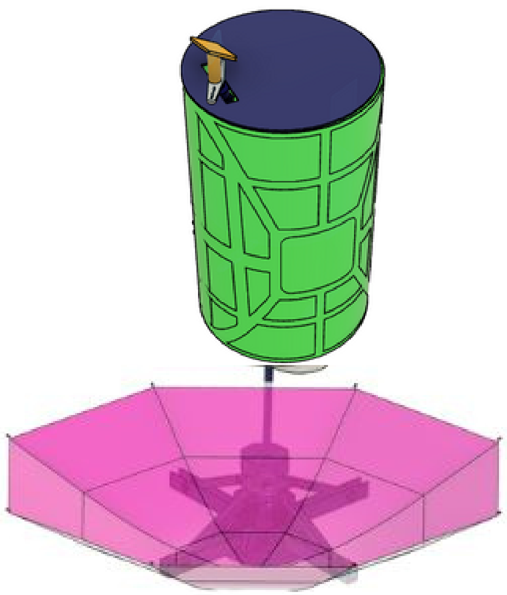


Selected

Rationale for selection

- *Light weight.*
- *Easier Opening Mechanism.*
- *Under Mass Budget as per Design.*
- *Provide more Stability.*
- *CG is balanced*
- *Provide sufficient drag to maintain Descent rate.*
- *Works at 100C-150C temperature.*





Selected material	Rationale
Aerogels Fabric	Light weight as per mass Budget

Payload Configuration Parachute

Configuration 1

Octagonal Parachutes — **Not Selected**

image source:Google

- ***Less stable as compared to Configuration 2***
- ***Complex Deployment Mechanism.***
- ***Not Suitable with Required Descent Velocity.***
- ***Dimension is not exact compared to required descent rate***
- ***Required More space.***

Selected material	Rationale
Nylon	Easily Available

Payload Parachute Descent Control Strategy Selection and Trade 2/3

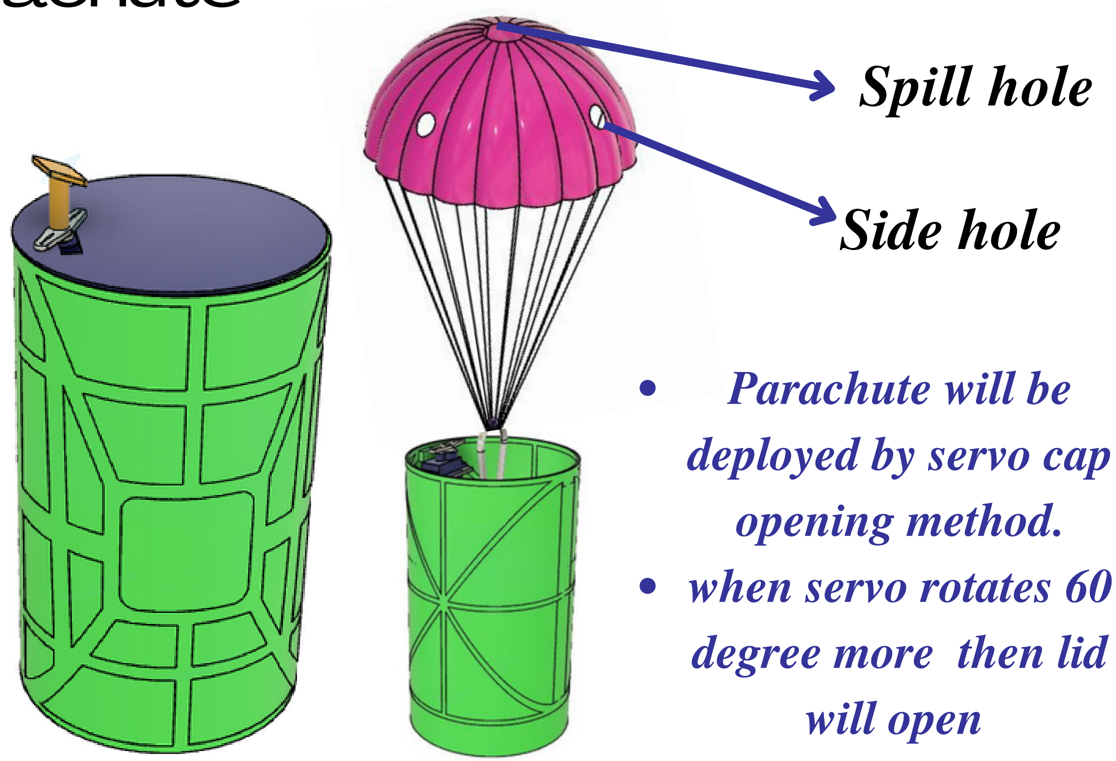
Payload Configuration Parachute

Configuration 2

Selected

Round parachute with spill hole

- *More stable as compared to configuration 1*
- *Greater stability with spill holes and sides holes.*
- *Easy to deploy.*
- *Opening Time is short.*
- *Good for low drop altitude.*
- *Dimension is exact for required Descent rate.*
- *Easily Available in the Market.*



- *Parachute will be deployed by servo cap opening method.*
- *when servo rotates 60 degree more then lid will open*

Selected material	Rationale
Ripstop Nylon	Easier to cut and manufacture.

- **Selection and Trade of Parachutes**

Octagonal Parachutes

Not Selected

image source:Google

Rationale for selection

- *More stable as compared to configuration 1*
- *Greater stability with spill holes and sides holes.*
- *Easy to deploy.*
- *Opening Time is short.*
- *Good for low drop altitude.*
- *Dimension is exact for required Descent rate.*
- *Easily Available in the Market.*

Round parachute with spill hole

Selected

Descent Rate Estimates 1/12

Assumptions made for Descent Control:

- Drag is equal to weight (at terminal velocity)

$$F_D = \frac{1}{2}\rho C_D A v^2 \qquad (1)$$

$$W = mg \qquad (2)$$

$$F_D = mg$$

From (1) and (2)

$$mg = \frac{1}{2}\rho C_D A v^2$$

$$A = \frac{2mg}{\rho C_D v^2} \qquad (3)$$

F_D = Drag Force
C_D = Drag Coefficient
m = Mass of the body
g = Acceleration due to gravity
A = Area of parachute
ρ = Density of air
v = Descent Velocity

Descent Rate Estimates 2/12

Assumptions made for Descent Control:

- Drag coefficient depends on the shape of the parachute

Now, the chute area, in terms of chute diameter

Diameter (D) = 2(Radius)

D = 2r

r = D/2

So, $A = \pi r^2 = \pi(^d/_2)^2 = \frac{\pi D^2}{4}$

$$A = \frac{\pi D^2}{4} \qquad (4)$$

D = Diameter

R = Radius

A = Area

For calculating the diameter of the chute

$$A = \frac{\pi D^2}{4}$$

$$D = \sqrt{\frac{4A}{\pi}} \qquad (5)$$

Descent Rate Estimates 3/12

Combining (3) and (4), we get

$$\frac{\pi D^2}{4} = \frac{2mg}{\rho C_D v^2}$$

$$D = \sqrt{\frac{8mg}{\pi \rho C_D v^2}}$$

This is the final form of the chute equation.

For calculating the descent velocity of the chute

$$v = \sqrt{\frac{8mg}{\rho D^2 \pi C_D}}$$

D = Diameter

m = Mass of the body

g = Acceleration due to gravity

ρ = Density of air

C_D = Drag Coefficient

v = Descent Velocity

Descent Rate Estimates 4/12

- **CANSAT with Payload Parachutes Calculation**

The diameter of the parachute (Dp) will be calculated by taking the maximum and minimum value of velocity i.e. (V max = 20 m/s) and (V min = 10 m/s).

$$\sqrt{\frac{8mg}{\rho(v_{\max})^2\pi C_D}} \leq Dp \leq \sqrt{\frac{8mg}{\rho(v_{\min})^2\pi C_D}}$$

$$\sqrt{\frac{8\times(0.7)\times(9.8)}{1.225\times(20)^2\times 3.14\times 1.42}} \leq Dp \leq \sqrt{\frac{8\times(0.7)\times(9.8)}{1.225\times(10)^2\times 3.14\times 1.4}}$$

$0.15 \text{ m} \leqslant Dp \leqslant 0.31 \text{ m}$

Therefore, Diameter = 0.20 m

Radius = Diameter/2 = 0.10 m

Diameter of spill hole is 4% of the diameter of the parachute.

Dsh = 0.20 x 4/100 = 0.008 m

Rsh= Dsh/2 = 0.004 m

Dp = Diameter
m = Mass of CANSAT with Payload
g = Acceleration due to gravity
ρ = Density of air
CD= Drag Coefficient
V= Descent Velocity

Constants:

g = 9.81 m/s^2
Cd = 1.42
ρ = 1.225 kg/m^3
m = 0.7 kg (±0.01 kg)

Descent Rate Estimates of CANSAT with Payload

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

$$V = \sqrt{\frac{8 \times (0.7) \times (9.8)}{1.225 \times (0.20)^2 \times (3.14) \times (1.42)}}$$

V = 15.86 m/s

m* = *Mass of Payload Aerobraking
g* = *Acceleration due to gravity
ϱ* = *Density of air
Dp* = *Diameter of Parachute
π* = *Mathematical Constant
Cd* = *Drag Coefficient
V= Descent Velocity

Constants:

g = 9.81 m/s^2
CD= 1.42
ϱ = 1.225 kg/m^3
m = 0.7 kg (±0.01 kg)

Descent Rate Estimates 6/12

Heat Shield as an Aerobraking Dimension Estimation

Mass of Payload with Heat Shield = 550g= 0.55Kg

The diameter of the Heat shield (DH) will be calculated by taking the maximum and minimum value of velocity i.e. (Vmax = 20 m/s) and (Vmin = 10 m/s).

$$\sqrt{\frac{8mg}{\rho(v_{\max})^2\pi C_D}} \leq D_H \leq \sqrt{\frac{8mg}{\rho(v_{\min})^2\pi C_D}}$$

$$\sqrt{\frac{8\times(0.55)\times(9.8)}{1.225\times(20)^2\times3.14\times1.42}} \leq D_H \leq \sqrt{\frac{8\times(0.55)\times(9.8)}{1.225\times(10)^2\times3.14\times1.42}}$$

m = *Mass of Payload Aerobraking*
g = *Acceleration due to gravity*
ϱ = *Density of air*
Dh =*Diameter of Heat Shield*
v = *Descent velocity*
π = *Mathematical Constant*
Cd = *Drag Coefficient*

0.13m ≤ DH ≤ 0.27 m

Therefore , Diameter=0.25 m

Constants:

g = 9.81 m/s^2
Cd = 1.42
ϱ = 1.225 kg/m^3
m = 0.55 Kg

Descent Rate Estimates of Payload Aerobraking

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

$$V = \sqrt{\frac{8 \times (0.55) \times (9.8)}{1.225 \times (0.25)^2 \times (3.14) \times (1.42)}}$$

$V = 11.26$ m/s

m = Mass of Payload Aerobraking
g = Acceleration due to gravity
ϱ = Density of air
Dh = Diameter of Heat Shield
π = Mathematical Constant
Cd = Drag Coefficient
v = Descent Velocity

Constants:

g = 9.81 m/s^2
CD= 1.42
ϱ = 1.225 k g/m^3
m = 0.55 Kg

Payload Parachutes Dimension Estimation

Mass of Payload with Parachute = 390g= 0.39Kg

The diameter of the parachute (Dp) will be calculated by taking the maximum and minimum value of velocity i.e. (Vmax = 15 m/s) and (Vmin = 5 m/s).

$$\sqrt{\frac{8mg}{\rho(v_{\max})^2\pi C_D}} \leq Dp \leq \sqrt{\frac{8mg}{\rho(v_{\min})^2\pi C_D}}$$

Dp = Diameter
m = Mass CANSAT with Payload
g = Acceleration due to gravity
ρ = Density of air
CD= Drag Coefficient
v = Descent Velocity

$$\sqrt{\frac{8\times(0.39)\times(9.8)}{1.225\times(15)^2\times 3.14\times 1.42}} \leq D_p \leq \sqrt{\frac{8\times(0.39)\times(9.8)}{1.225\times(5)^2\times 3.14\times 1.42}}$$

0.14m ≤ Dp ≤ 0.46 m

Descent Rate Estimates 9/12

$0.14m \leq Dp \leq 0.46$ m

Therefore , Diameter=0.45 m

Constants:

g = 9.81 m/s^2
CD= 1.42
ϱ = 1.225 k g/m^3
m = 0.39 Kg

Radius = Diameter/2 = 0.225m

Diameter of spill hole is 4% of the diameter of the parachute.

Dsh = 0.45 x 4/100 = 0.018 m

Rsh= Dsh/2 = 0.009 m

Descent Rate Estimates of Payload Parachute

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

$$V = \sqrt{\frac{8 \times (0.39) \times (9.8)}{1.225 \text{ x } (0.45)^2 \times (3.14) \times (1.42)}}$$

V = 5.27 m/s

***m* = Mass of Payload Aerobraking**
***g* = Acceleration due to gravity**
***ϱ* = Density of air**
***Dp* = Diameter of Parachute**
***π* = Mathematical Constant**
***Cd* = Drag Coefficient**
***v* = Descent Velocity**

Constants:

***g* = 9.81 m/s^2**
***Cd* = 1.42**
***ϱ* = 1.225 kg/m^3**
***m* = 0.39 Kg**

Descent Rate Estimates 11/12

Descent Rate Estimates of Payload Parachute

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

$$V = \sqrt{\frac{8 \times (0.39) \times (9.8)}{1.225 \times (0.45)^2 \times (3.14) \times (1.42)}}$$

V = 5.27 m/s

m = Mass of Payload Aerobraking
g = Acceleration due to gravity
ϱ = Density of air
Dp = Diameter of Parachute
π = Mathematical Constant
Cd = Drag Coefficient
v = Descent Velocity

Constants:

g = 9.81 m/s^2
Cd = 1.42
ϱ = 1.225 kg/m^3
m = 0.39 Kg

Descent Rate Estimates Summary

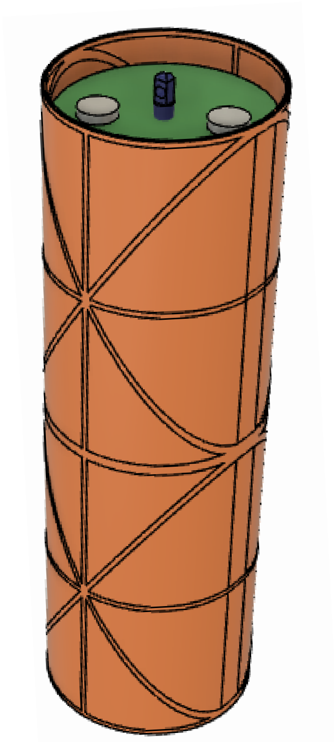
Stage	Descent Velocity	Diameter	Colour	Material selection
Drogue parachute	v=15.86 m/s	0.20 m	Fluorescent Red	Nylon
Heat shield	V=11.26 m/s	0.25 m	Fluorescent Pink	Aerogel fabric
Payload Parachute	V = 5.27 m/s	0.45 m	Fluorescent Pink	Ripstop Nylon

Mechanical Subsystem Design

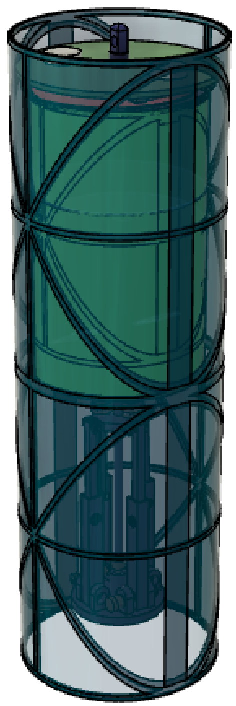
Amitoj Singh Bevli

Mechanical Subsystem Overview(1/3)

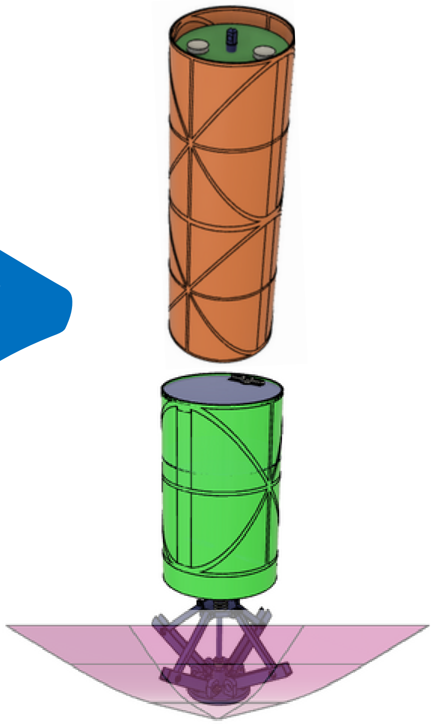
Designed Chassis Inspired by Spider Web Design



Isometric View
(Covered CanSat)

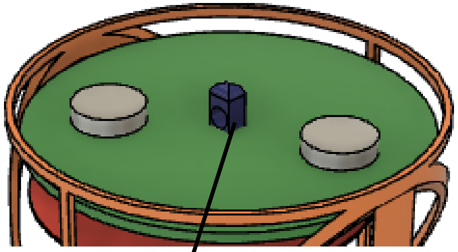


Isometric View
(Components& Probe View)

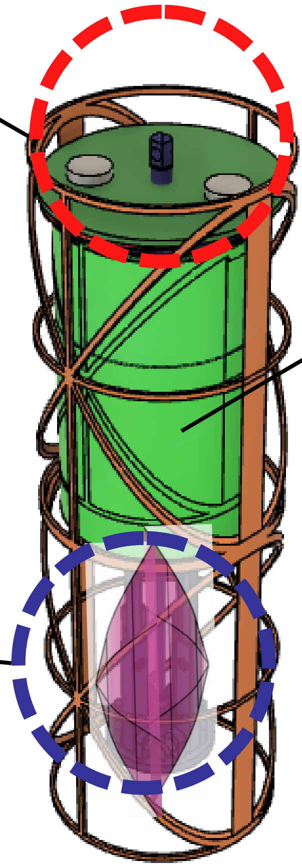


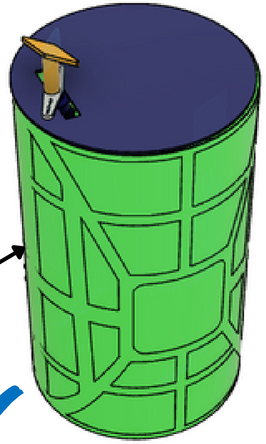
Isometric View
(Deployed Probe)

Different Sections of CANSAT

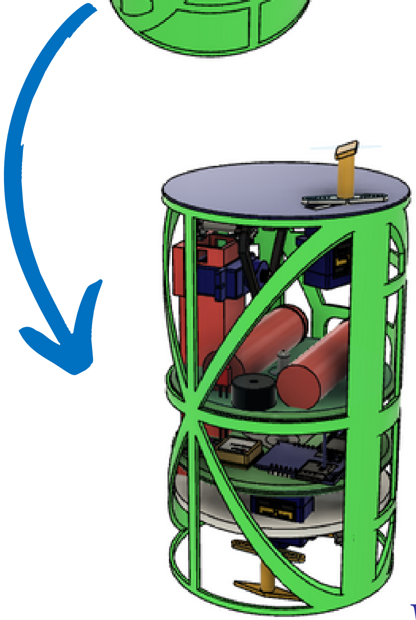


Eye Bolt for parachute connection

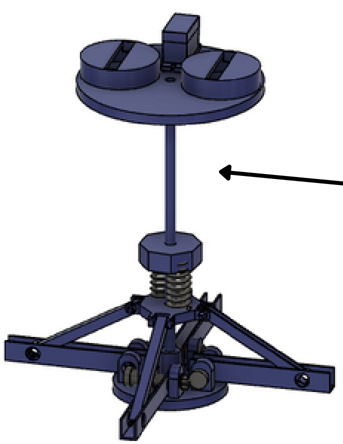




Probe designed with servo slot at the top (to hold it with CAN)



Chassis and Components View of Probe



Heat Shield opening mechanism.

Material Selection for Manufacturing

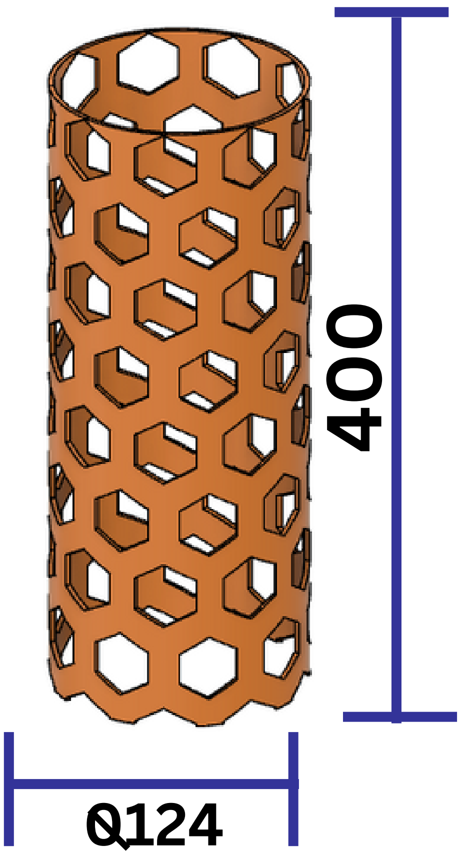
S.No.	Material	Manufacturing	Advantages	Disadvantages
1.	ABS	3D Printing	Strong	Brittle
2.	Nylon PA-11	3D Printing	Very Strong	Very Expensive
3.	PLA Plus	3D Printing	Easy to Print	Comparatively weak
4.	Carbon Fibre	3D Printing	Strongest	Extremely Expensive

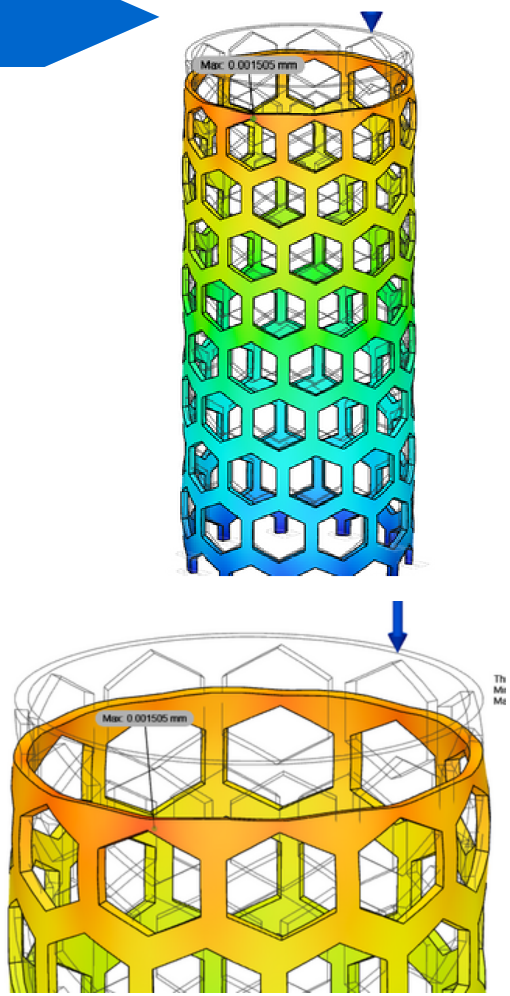
Selected Material	Rationale
PLA Plus 	▪ Easy to print ▪ Cost Effective ▪ It is biodegradable

Container Mechanical Layout of Component Trade & Selection (1/4)

Configuration 1

Not Selected





- *Consumes more mass(133gm)*
- *Hinge can't be made on side walls.*
- *Less stability in air*

- *Made Up of Nylon PA-11 Material.*
- *Height = 400 mm.*
- *Diameter = 124 mm*
- *CAN carry the Payload.*
- *Equipped with a hatch door for easily accessing the components inside the container.*
- *Aligned center of mass.*
- *Complies with almost all requirements.*
- *High material volume.*

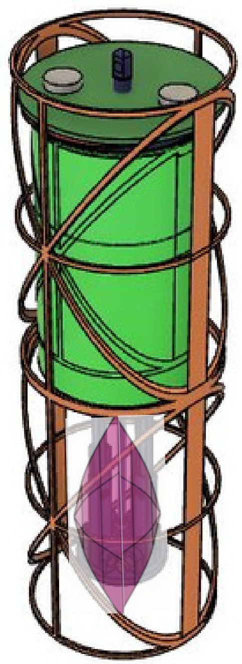
Chassis structure of Container

Container Mechanical Layout of Component Trade & Selection (2/4)

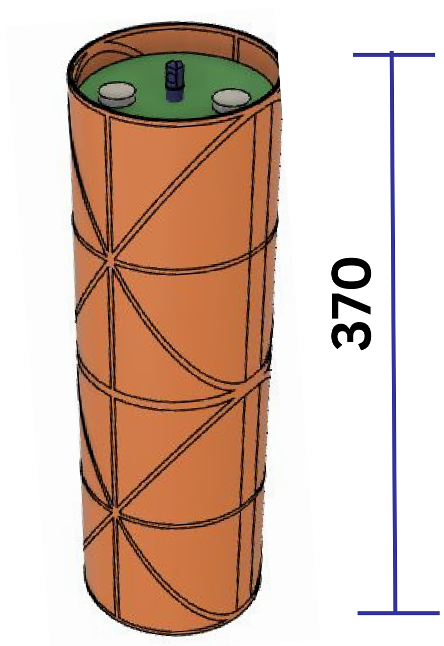
Configuration 2

Designed Chassis Inspired by Spider Web Design

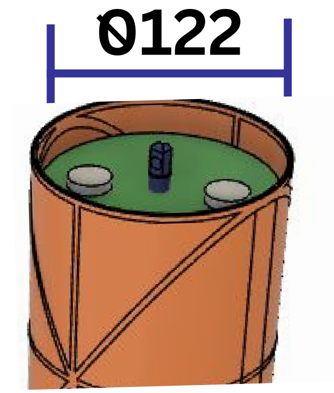
Selected



(chassis structure)



(Covered CanSat)

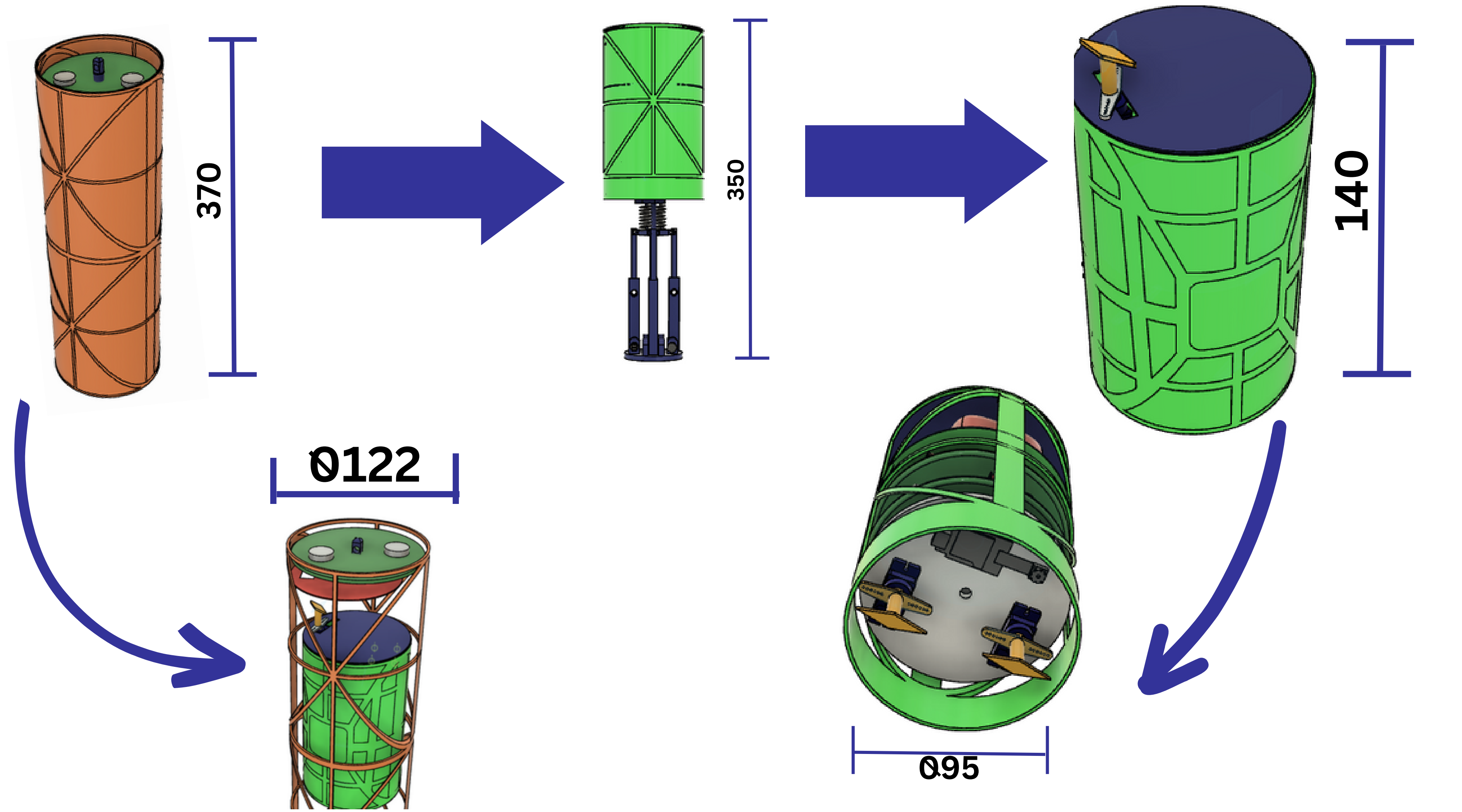


- *More stable.*
- *Requires less mass(97gm)*
- *CG is balanced.*
- *layering provides more stability*

- Made up of PLA+ thermoplastic material.
- Height = 370 mm
- Diameter = 122 mm.
- PCBs are fixed horizontally with the walls of the container as shown in figure.
- Equipped team details
- Estimated mass of CANSAT is 709 g.
- Aligned centre of mass.
- Complies with almost all the requirements.
- Low Material Volume.

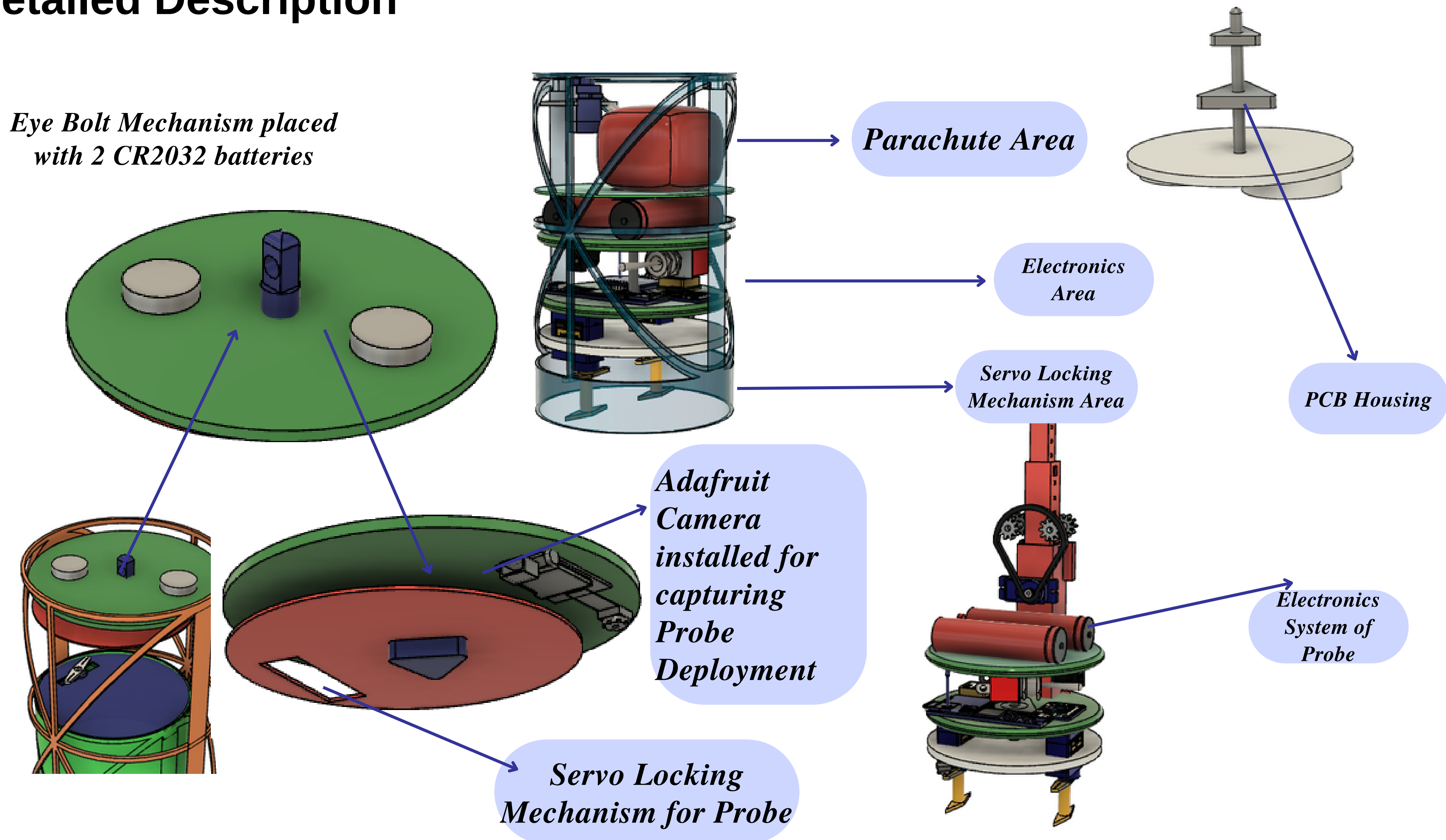
Container Mechanical Layout of Component Trade & Selection (3/4)

Dimensions of CANSAT & Probe



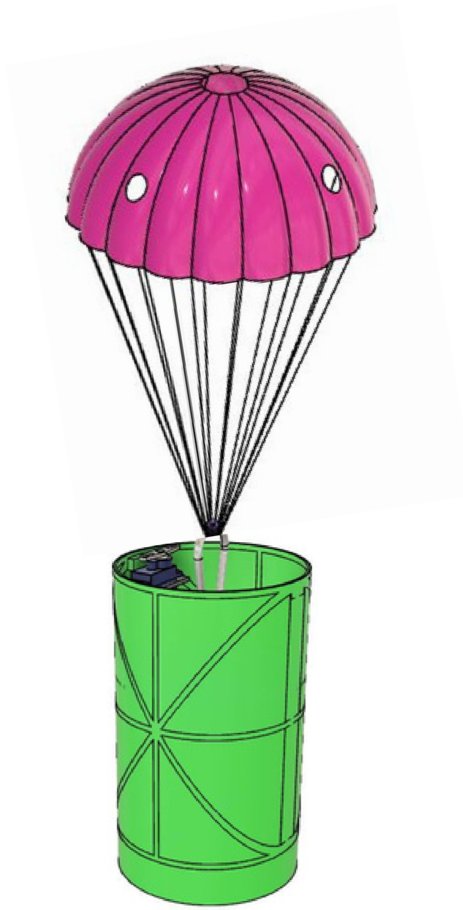
Container Mechanical Layout of Component Trade & Selection (4/4)

Detailed Description

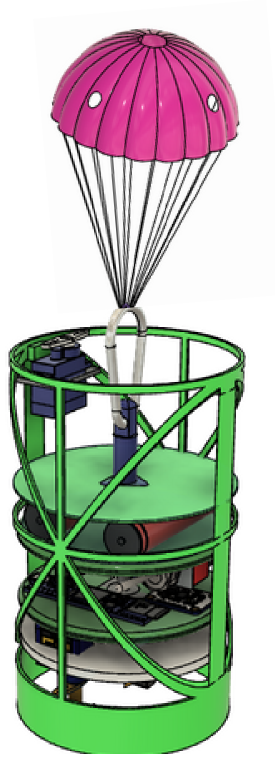


Container Parachute Attachment Mechanism

CanSat Parachute Deployment (Mirror View)

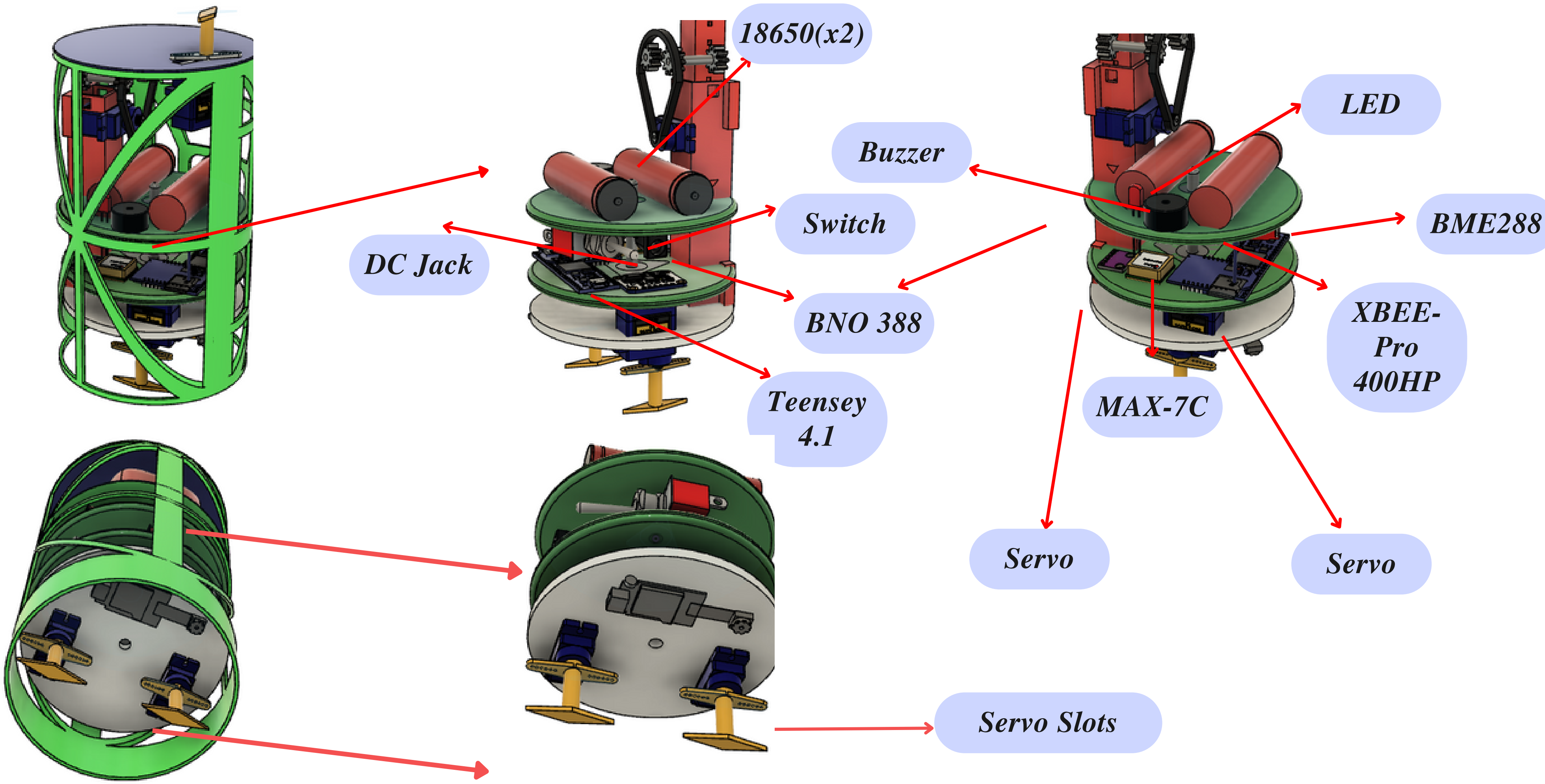


Probe Parachute Deployment



Through Eyebolt and Carabiner , the parachute is attached

Probe Electrical Layout

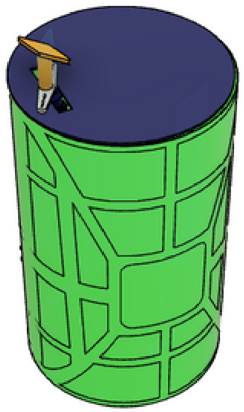


Probe Mechanical Overview

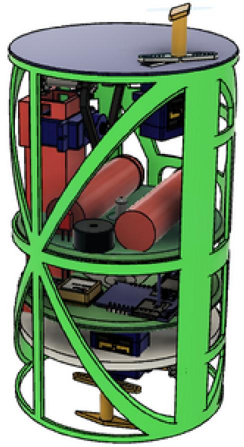
Configuration 1: Accepted

Reasons:

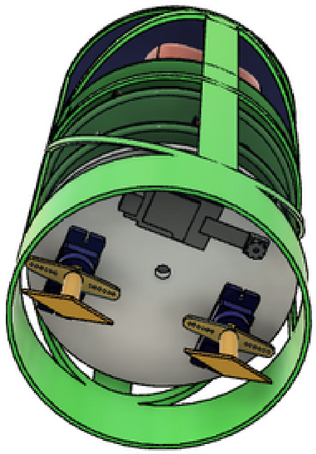
- *Lid opening mechanism allows parachute to deploy as per requirements*
- *This model was stable under air drag*
- *Less weight/material was required to make this*



Isometric View (Layered Probe)



Isometric View (Components Visible)

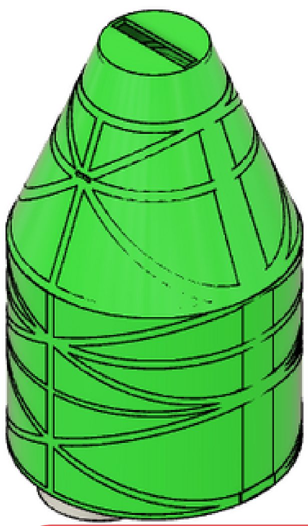


Bottom View (Servo Locking)

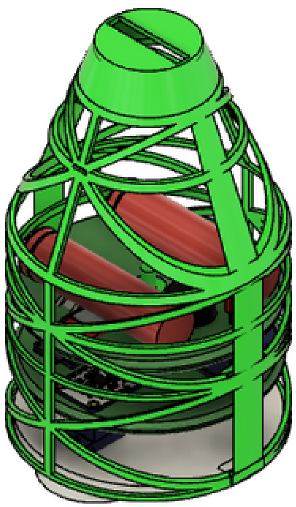
Configuration 2: Rejected

Reasons:

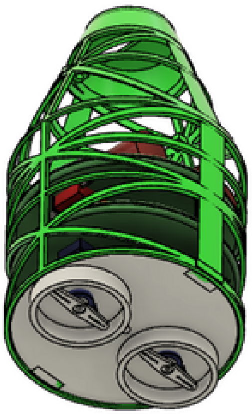
- ***Lid opening mechanism was impossible due to less dimentions on top***
- ***This model was vulnerable to topple in atmosphere***
- ***More weight/material was required to make this***



Isometric View (Layered Probe)



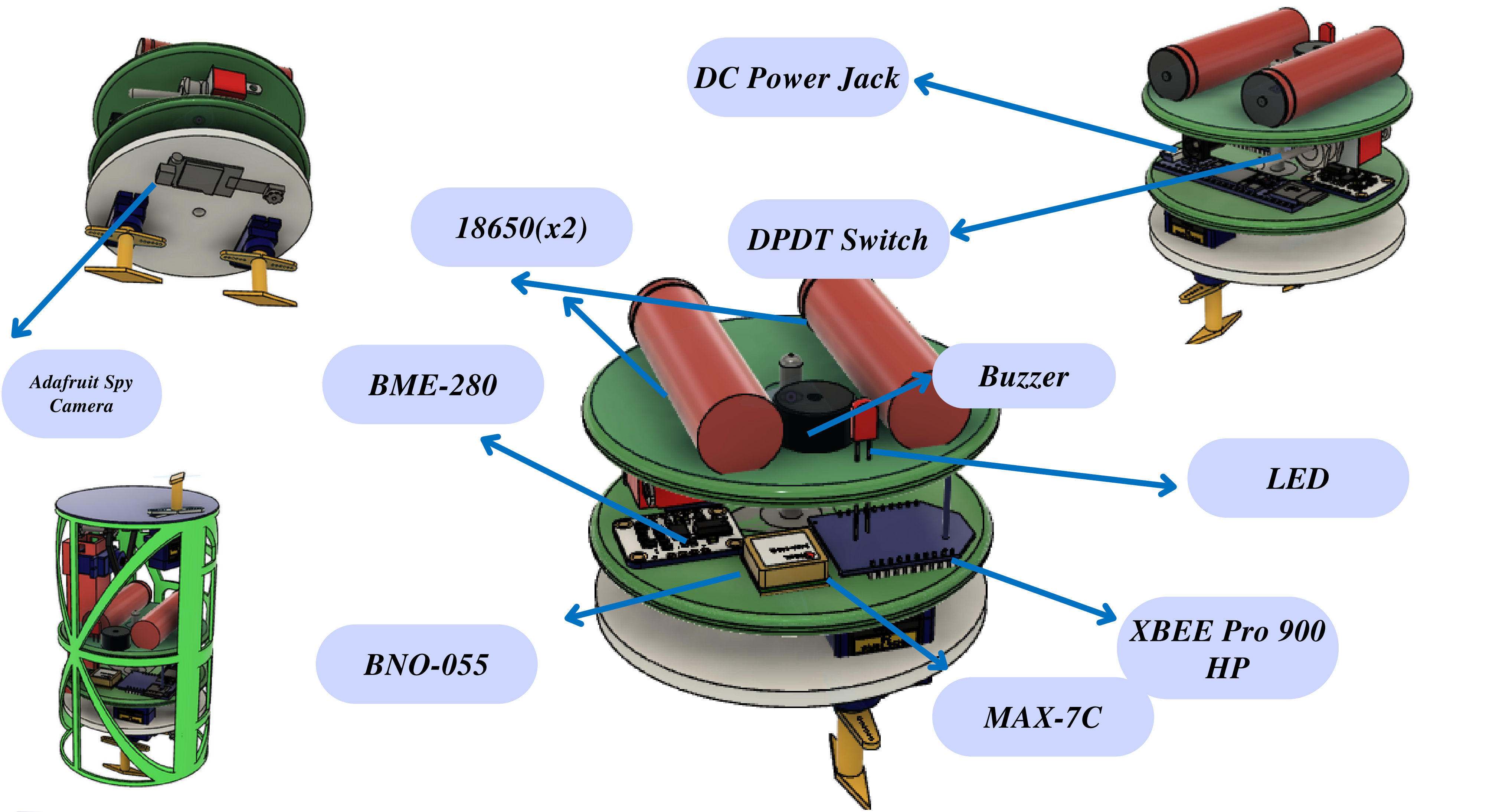
Isometric View (Components Visible)



Bottom View (Servo Locking)

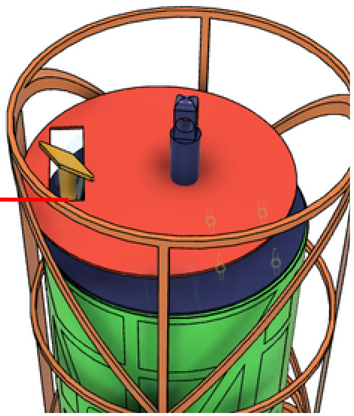
Payload System (3/11)

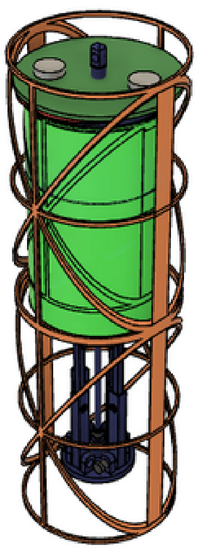
Electronic Sub-System of Probe

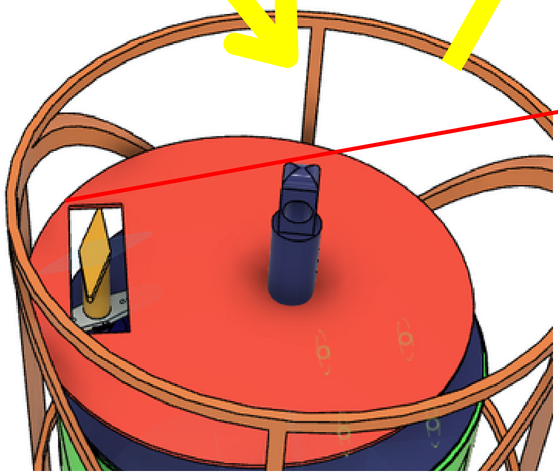


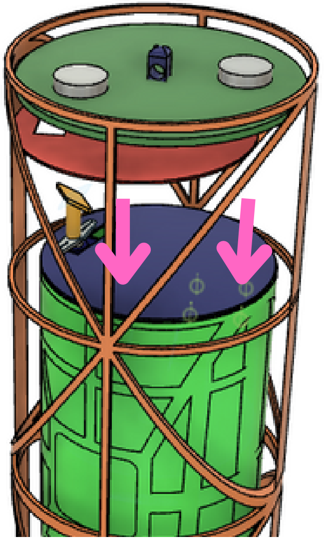
Probe Deployment Mechanism

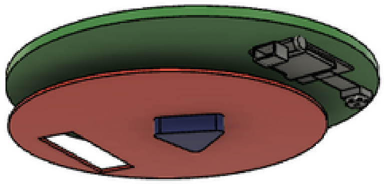
Servo Mechanism for Probe Attachment with Can







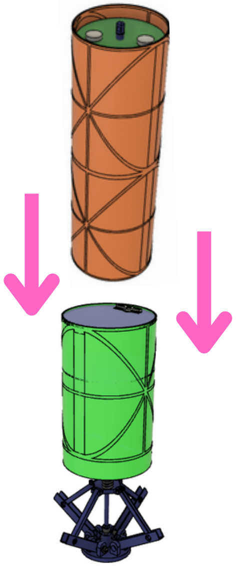




The descent is captured with spy cam(attached at cansat pcb)

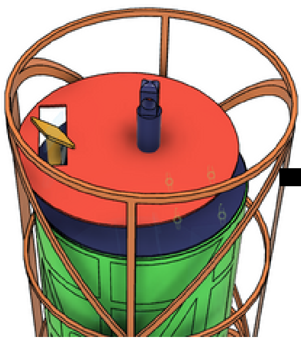
The servo rotates30 deg and it gets detached from can

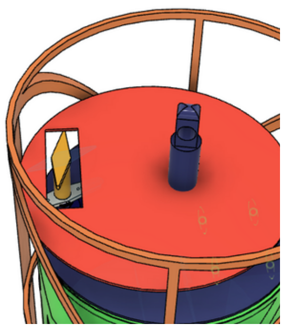
- *The Probe will free fall freely when the servo arm passes through the slot on probe's cover*



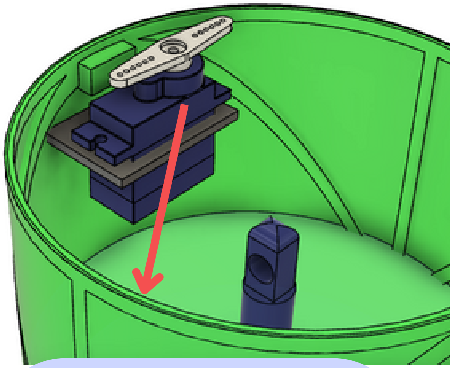
Payload System (5/11)

Probe Deployment Mechanism

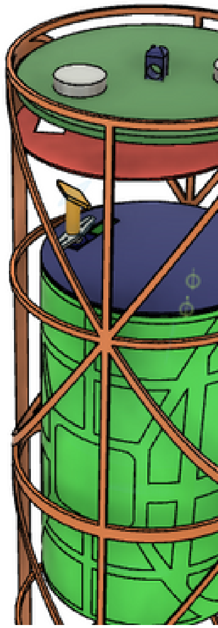




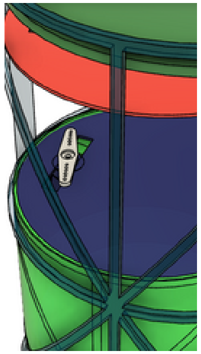
Servo rotates at 30 deg



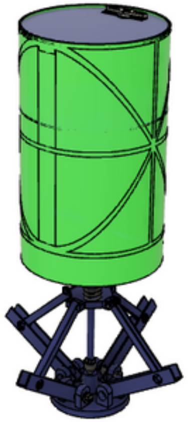
The servo is responsible for holding probe and CanSat



Probe is free to fall from CanSat

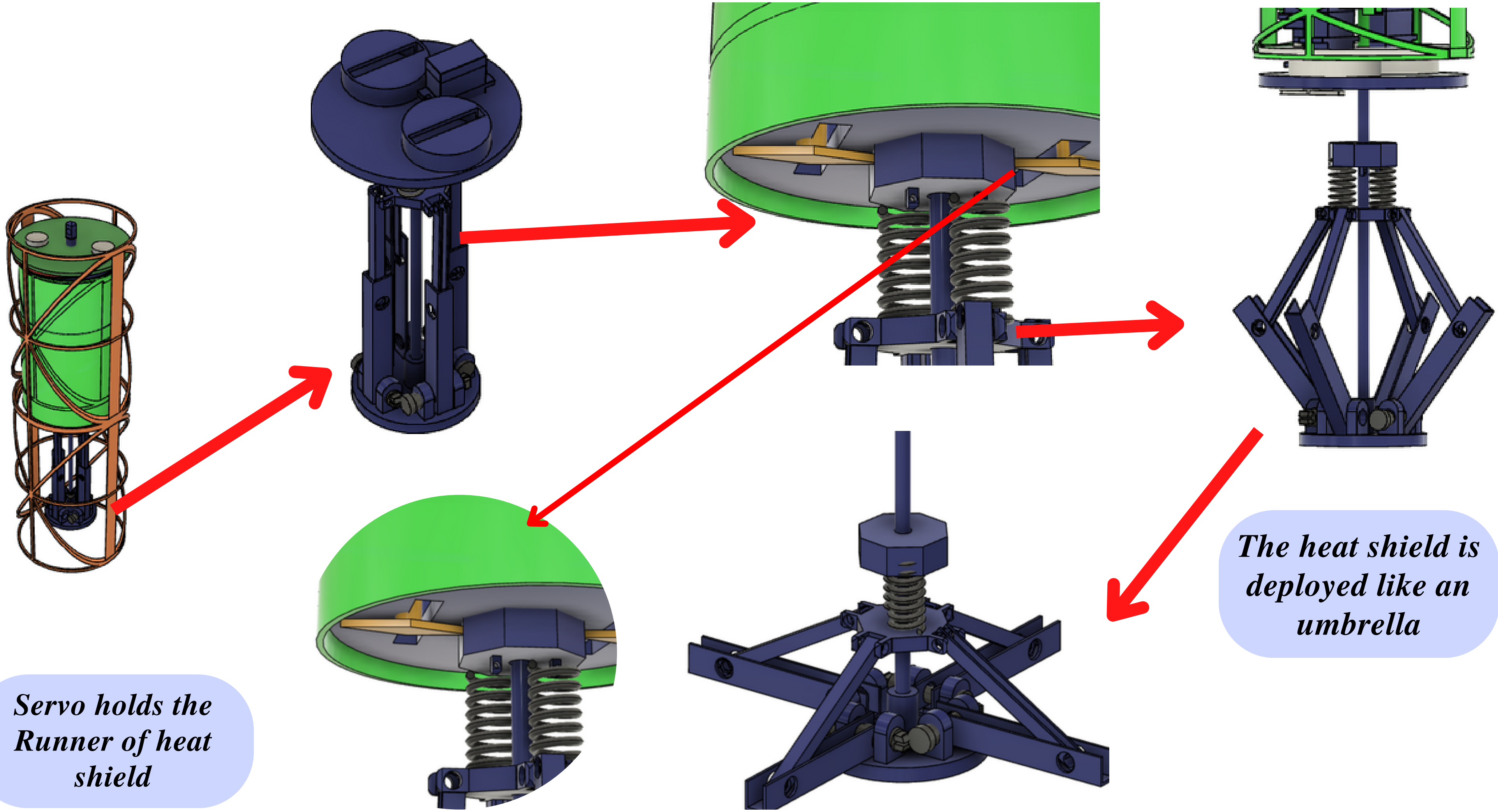


Servo holds parachute deployment at 60 deg



Simultaneously the heat shield is opened

Heat Shield Deployment Mechanism

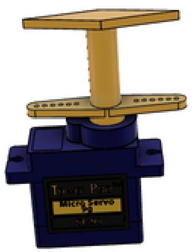


Servo holds the Runner of heat shield

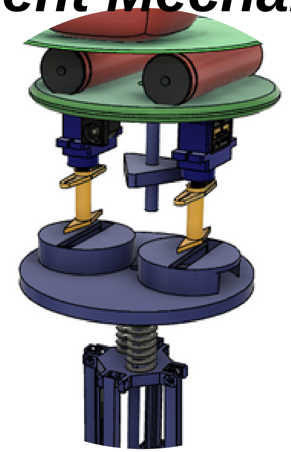
The heat shield is deployed like an umbrella

Payload System (7/11)

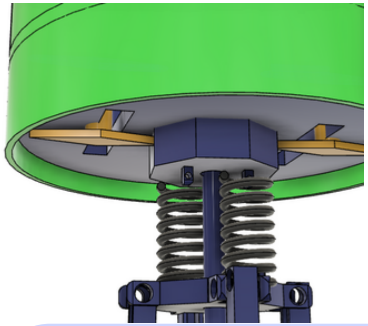
Heat Shield Deployment Mechanism



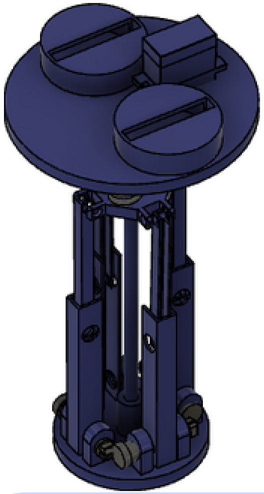
SG90 Servo Motor with custom extend arm



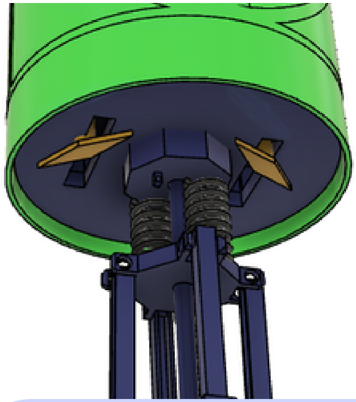
Servo slot mechanism



Two servo's are holding the runner at 30 deg

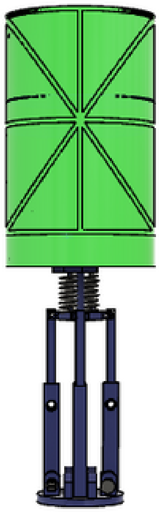


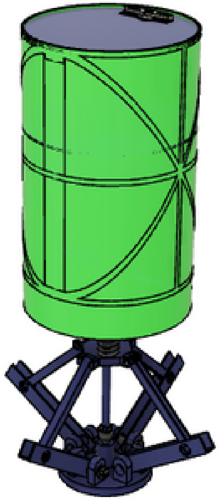
Heat Shield Mechanism

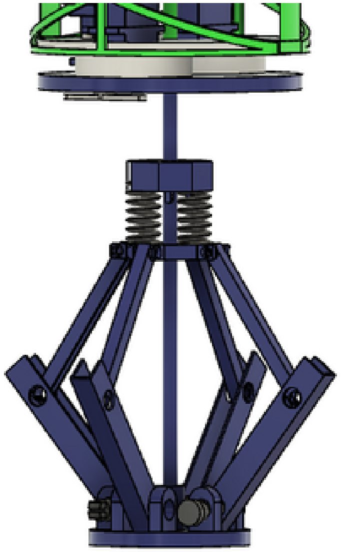


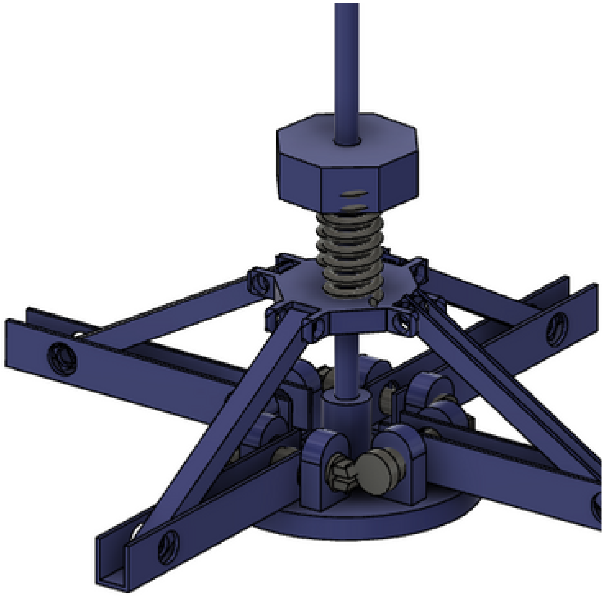
Two servo's will rotate 30 deg wrt each other & runner will slide through shaft of heat shield

Heat Shield Deployment Mechanism

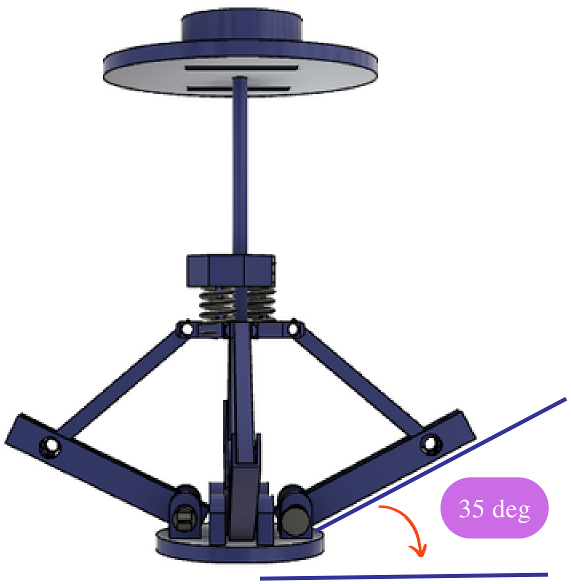




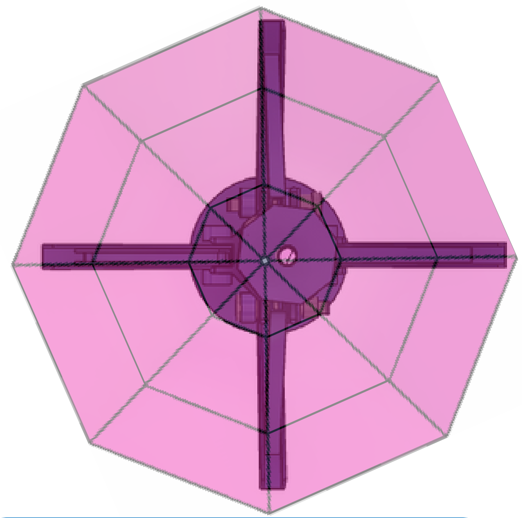




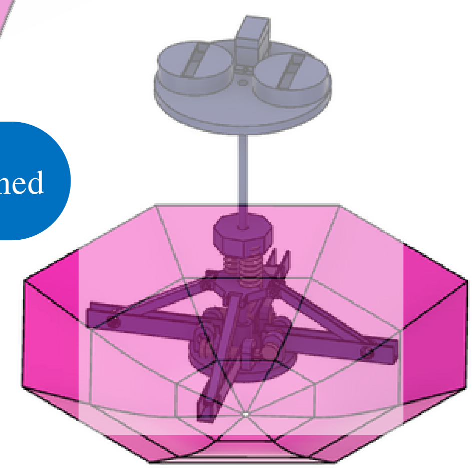
Heat Shield Mecahnism



The Finial is placed at a specific height to block the heat shield at 35 deg from ground



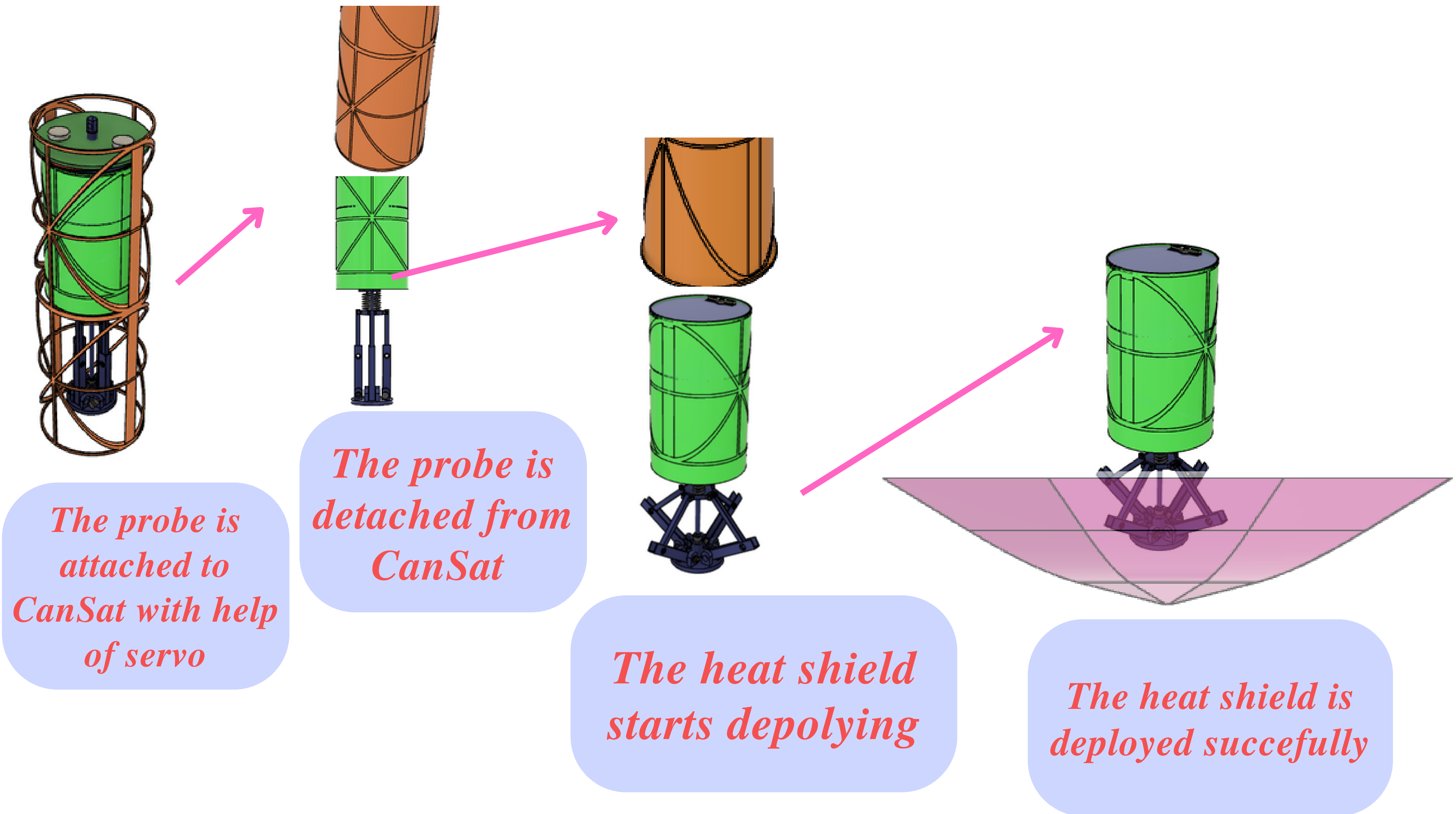
Top View of heat shield fully opened



Isometric View

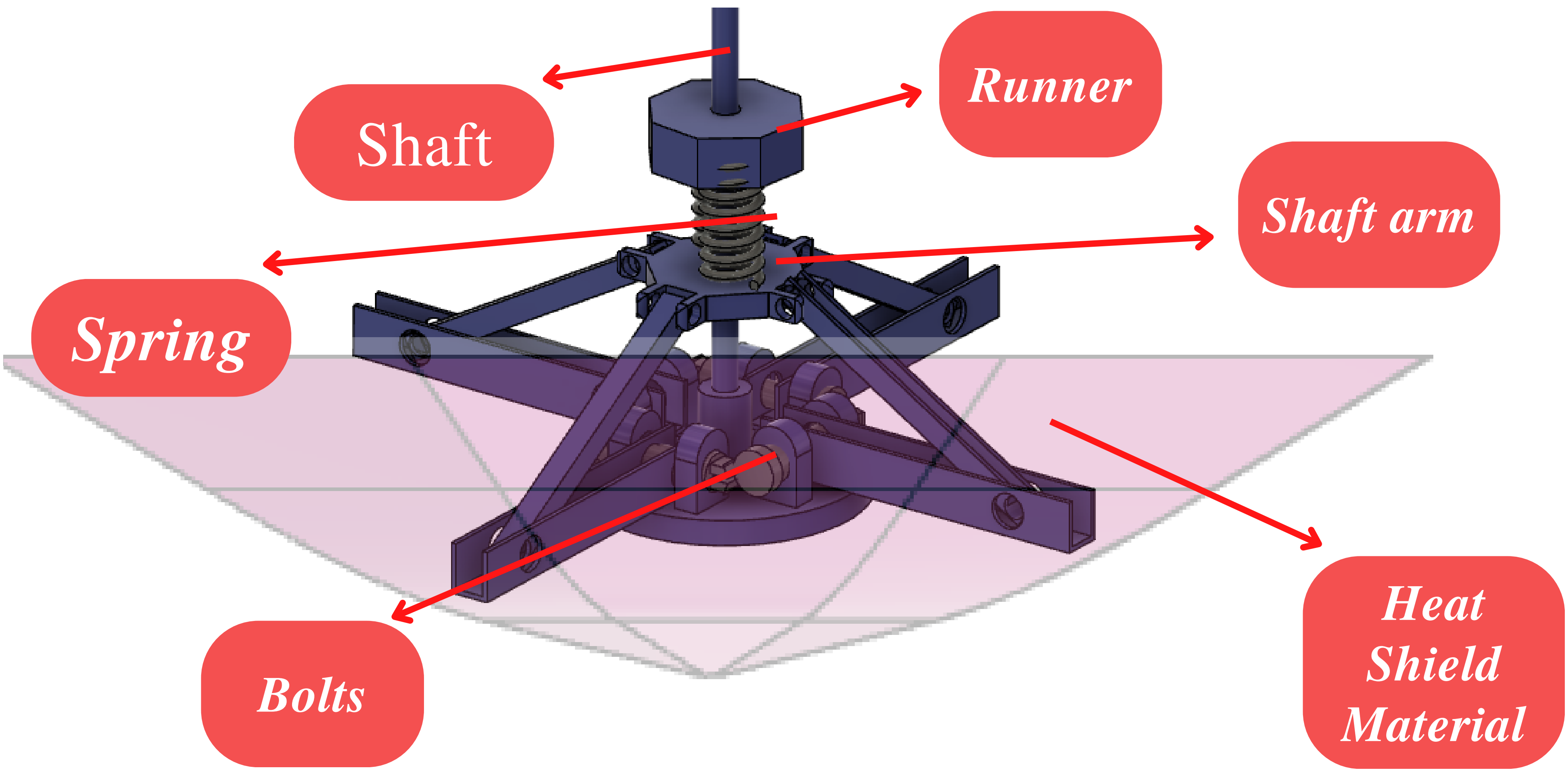
Payload System (9/11)

Heat Shield Deployment Mechanism



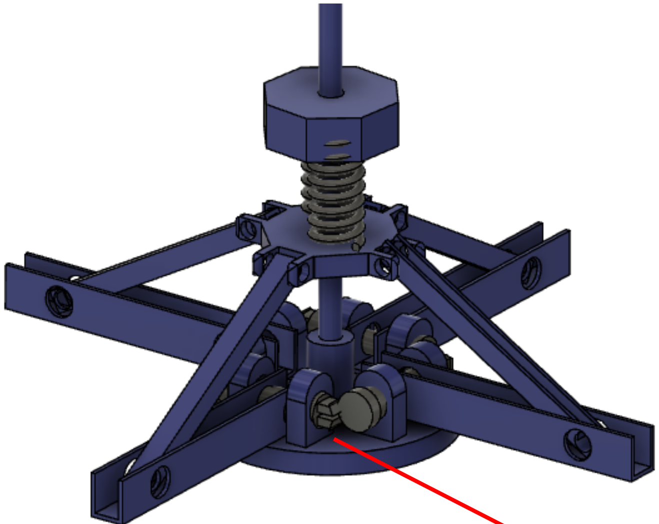
Payload System (10/11)

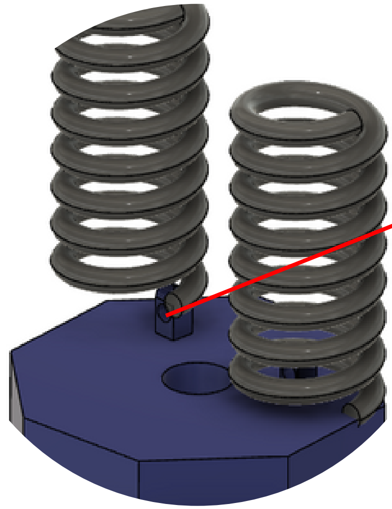
Heat Shield Deployment Mechanism



Payload System (11/11)

Heat Shield Deployment Mechanism

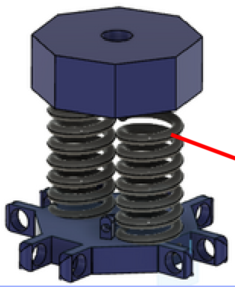




The springs are attached through hinges on runner

Completely deployed mechanism of heat shield

The arms of heat shield are attached with help of pla + made locks(allows the free rotatry moment of arms)

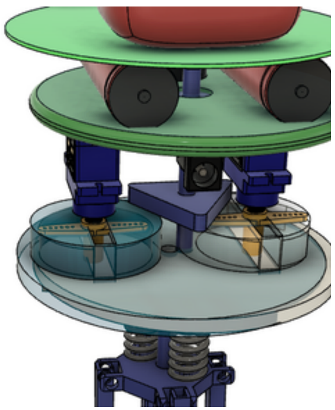


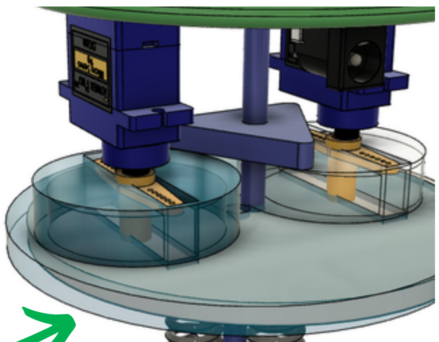
Runner, springs and shaft arm are connected to each other

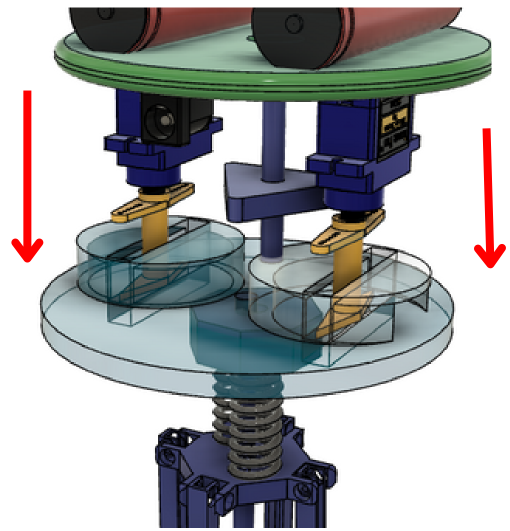
Spring

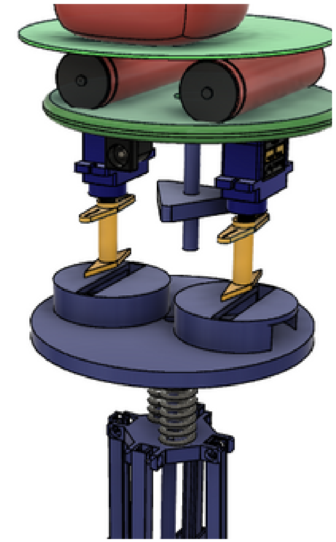
Heat Shield Removal System

Heat Shield is held with help of 2 servo's









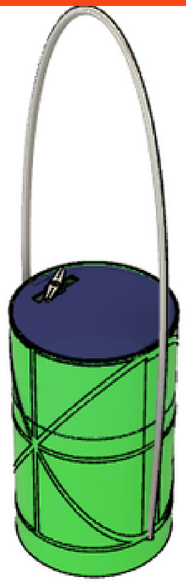
SG90 Servo's locking heat shield at 180 deg

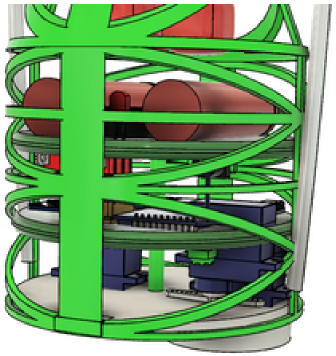
SG90 Servo's rotating at 90 deg to release heat shield

Heat shield releasing through slots

Flag Raising System

Configuration 1: Rejected





Rubber band will be destroyed with help of servo having blade

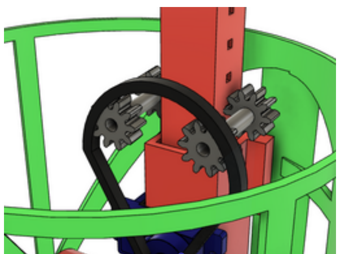
The flag will be raised at height of 500m from base of probe

The steel wire is stopped with help of rubber band

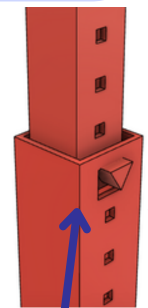
Flag Raising System inspired from Radio Antenna

Configuration 2: Accepted

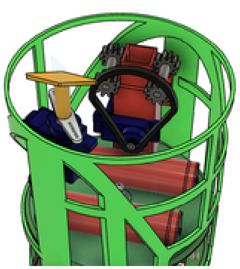
This mechanism consists of SG90 servo, 2 spurgears, rubber pulley which altogether comprises of the actuator



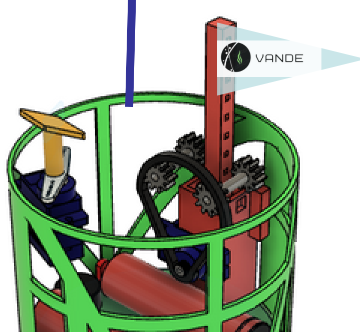
Spur Gear's being rotated



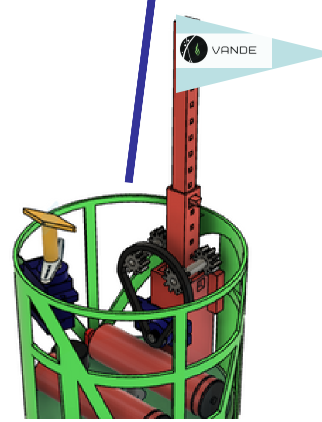
Actuator Locking Mechanism



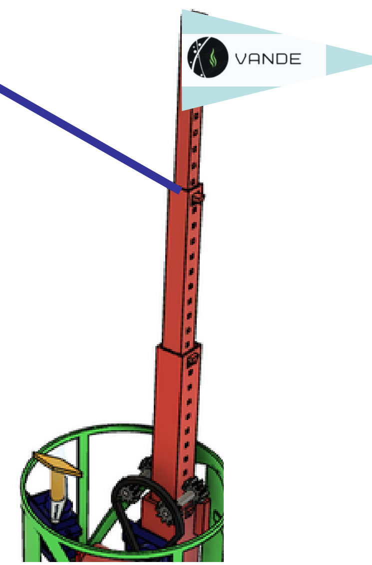
Ground Level View



Flag started to upright



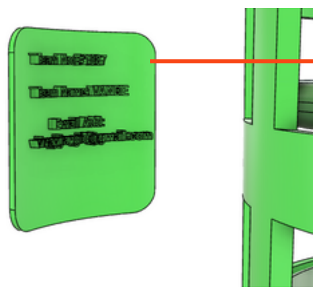
Actuator Rod being half upright



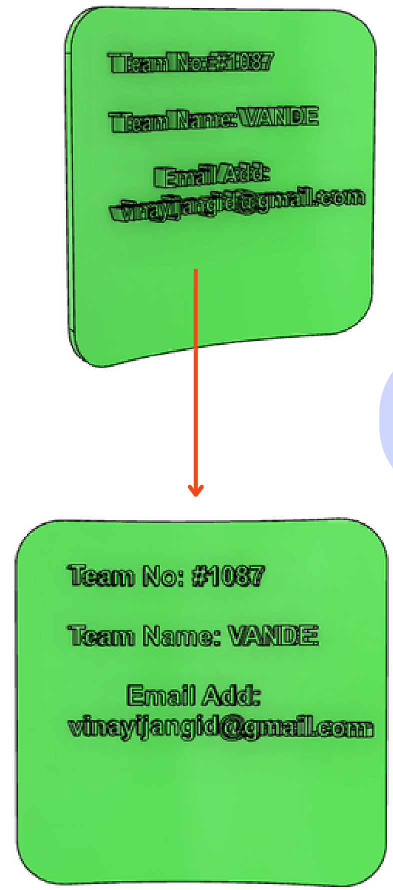
Flag completely raised 500mm from base of probe

Hatch Door for Accessing required components easily without disassembling the probe

Hatch Door is made for easy access to SPDT switch, DC Jack, Tensy 4.1; usb slot



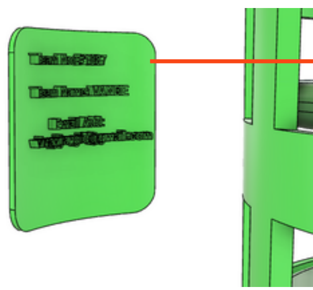
Back of Hatch Door; team details are embossed



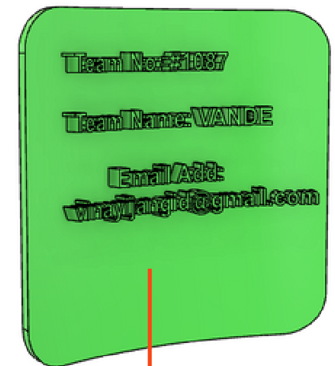
Team Details: Team Number
Team Name
Email Address

Hatch Door for Accessing required components easily without disassembling the probe

Hatch Door is made for easy access to SPDT switch, DC Jack, Tensy 4.1; usb slot



Back of Hatch Door; team details are embossed



Team Details: Team Number
Team Name
Email Address

VANDE

Mass Budget

Component	Mass (g)	Source
Body Frame (Container + Probe+ Heat Shield mechanism)	210	Estimate
PCB	176	Estimate
Battery	45 x 2 + 5*2.92 = 104.6	Estimate
Servo Motor	11 x 4 = 44	Estimate
Descent mechanism (parachute + +paracord)	172	Estimate
Screws	0.5 x 6 = 3	Estimate
Total =	709.6	

Communication and Data Handling (CDH) Subsystem Design

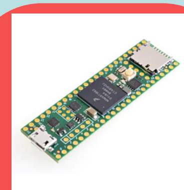
Karan Gajanan Mali and Rahul Mandal

Payload Command Data Handler (CDH) Overview

MCU and Communication Link with GCS


GSM Antenna connected using RP-SMA to XBEE

Probe XBEE for data telemetry to GCS communicating via UART


Teensy 4.1 , Our MCU

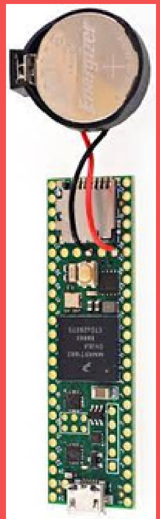
Connected to OnBoard PCB

Sensors In Probe


BMP388 communicating with I2C Protocol


BME280 communicating with I2C Protocol

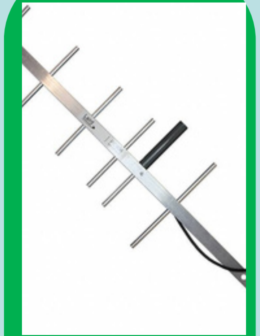

BNO085 communicating with UART Protocol


Inbuilt RTC in Teensy 4.1

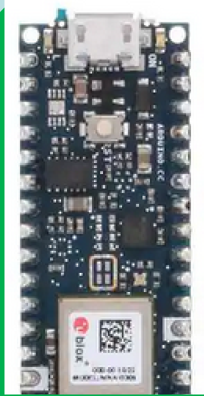

SAM M8Q GPS communicating with I2C protocol

RF-Link

GCS


Yagi Antenna for Boosting the RF signal

XBEE GCS for communicatin g with Probe XBEE


GCS MCU , Arduino Nano BLE 33

GCS Software Communicating with GCS MCU using Serial Communication

Payload Processor & Memory Trade & Selection (1/3)

Container processor	**Clock Speed(MHz)**	**Supply Voltage(V)**	**GPIO pins**	Interface	**Flash Memory(KB)**	**RAM (KB)**	**EEPROM (KB)**	**Boot Time(s)**	**Cost**
Teensy 4.1	600	3.3 - 5.0	42	UART 8 SPI 3 I2C 3	8092	1024	4	1.4	31.5
Arduino Nano	16	5.0	22	UART 1 SPI 1 I2C 1	32	2	1	8-10	25

Selected Processor		Rational
Teensy 4.1		• Fast Boot Time • Enough Interfaces for MIssion • Fast Clock Speed • Enough Memory Storage • HIgher Memory , GPIO , EEPROM

Payload Processor & Memory Trade & Selection (2/3)

Memory Read and Write Module	**Supply Voltage(V)**	**Interface**	**Size (mm)**	Cost
Teensy 4.1 in-Built MicroSD card Slot	Embedded	Embedded	_	0
Mini MicroSD cardReader	4.5 - 5.5	SPI	18 x 25 x 3	6

Selected Processor		Rational
Teensy 4.1		• No extra consumption of space • Already built in with MCU • No added weight cost • Extra cost is zero

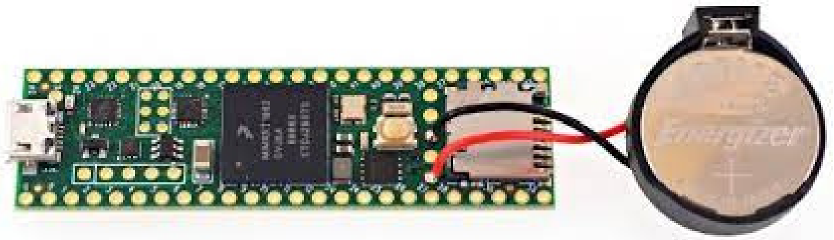
Payload Processor & Memory Trade & Selection (3/3)

Selected Payload Memory	Memory Storage (GB)	Interface	Speed (Mb/s) Read	Speed (Mb/s) Write	Cost
Kingston	8	SPI and SDIO	60	50	30
SanDisk Ultra	16	SPI and SDIO	100	60	26

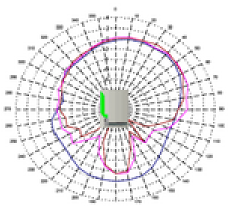
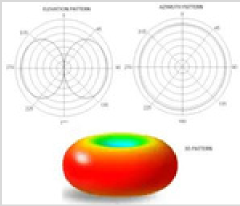
Selected Processor		Rational
SanDisk Ultra	 	• Cheaper , Faster Read/Write Speed than Kingston • Sufficient storage for the mission

Payload Real-Time Clock

RTC Module	**Power** Source (V)	**Reset Tolerance**	Interface	**Operating (V)**	**Weight (g)**	Size (mm)	**Cost**
PCF8523	External	Maintains Accurate Time keeping	I2C	1.0 V to 5.0 V	2.3 g	25.8x 21.8 x 5	5
Teensy 4.1 Built-in RTC	External	Maintains Accurate Time Keeping	-	-	-	-	0

Selected	Rational
Teensy Built in RTC 	• No Extra Cost • Use of No extra Space and Weight • with Hardware and Software , time VAlue will be precise

Payload Antenna Trade & Selection

Antenna	Gain (dB)	Frequency	Radio Pattern	Efficiency [%] / [dB]	Connect or Type	Weight (g)	Size (mm)	Cost
Stubby Antenna	1.0(peak) -0.5(min)	824MHz-2.17GHz		65 / -1.8 (peak) 50 / -3.0 (min)	RP-SMA	11.1	18.4 x 8.0 x 49.5	9
ANT-900-RP-2-A	2.1	880-960		70	RP-SMA	13	8x95	4

Selected	Rational
ANT-900-RP-2-A 	• Suitable for selected radio module • Versatile, Cost effective

Payload Radio Configuration (1/3)

Radio Module	Sensitivity (dBm)	Transmit Current (mA)	Transmit Power (mW)	Operating Voltage (V)	Operating Frequency (MHz)	Range (m)	Weight (g)	Size (mm)	Cost
XBee 802.15.4	-103	135	8	2.1-3.6	2400	1200	6	13x19	37
XBee Zigbee	-103	40	6.3	2.1-3.6	2400	1200	5	13x19	28
XBee Pro 900 HP	-101	215	250	2.1-3.6	902-928	3500	5	13x19	97.50

Selected	Rational
XBee Pro 900 HP 	• Suitable Range • Less weight • Suitable Frequency Range

Payload Radio Configuration (2/3)

Payload GCS Antenna Link

ANT-900-RP-2-A

RP-SMA connector antenna with a Gain of 2.1 dB

Payload Radio Configuration (3/3)

Probe Data Transmission Control

Transmission Start	Transmission End
Transmission starts as soon as CanSat is switched ON at Pre-Launch Stage	Transmission ends by Container FSW when it lands according to Software States
Container Radio transmits at 1HZ	Recovery Crew finds the Container and switches it off

Payload Telemetry Format (1/2)

DATA FORMAT	*SAMPLE*	*DISCRIPTION*
TEAM_ID	1087	The assigned team identification number
MISSION_TIME	13:14:02	UTC time in format hh:mm:ss, where hh is hours, mm is minutes, and ss is seconds
PACKET_COUNT	10	The total count of transmitted packets since turn on, which is to be reset
MODE	F	'F' for flight mode and 'S' for simulation mode.
STATE	ASCENT	The Operating state of software
ALTITUDE	248.9	The altitude in units of meters
HS_DEPLOYED	N	Indication of Probe with heat shield is deployed, "P" for yes "N" for otherwise
PC_DEPLOYED	C	Indication of Probe parachute deployment "C" for yes "N" for otherwise
MAST_RAISED	M	Indication of flag mast has been raised after landing "M" for yes "N" for otherwise
TEMPERATURE	30°	The temperature in degrees Celsius

Payload Telemetry Format (2/2)

DATA FORMAT	SAMPLE	DISCRIPTION
PRESSURE	101.3	The air pressure of the sensor used in kPa.
VOLTAGE	5	The voltage of the CanSat power bus
GPS_TIME	13:22:23	The time from the GPS receiver in UTC
GPS_ALTITUDE	50	The altitude from the GPS receiver in meters
GPS_LATITUDE	37.7863 N	The latitude from the GPS receiver in decimal 0.0001 degrees North.
GPS_LONGITUDE	122.4149 W	The Longitude form the GPS receiver in decimal 0.0001 degrees West
GPS_SATS	3	The number of GPS satellites being tracked by the GPS receiver
TILT_X, TILT_Y	-32.65, 36.68	The angles of the CanSat X and Y axes in degrees
CMD_ECHO	SIMP<PRESSURE>	The last command received and processed by the CanSat.

Payload Command Formats

DATA FORMAT	SAMPLE	DISCRIPTION
CX	ON	Activate the payload telemetry transmissions
ST	UTC	Set the current time read from the GPS module, In UTC
SIM	ENABLE	Enable the simulation mode,
SIMP	101325	The simulated atmospheric pressure data in units of pascals
CAL	SET_NIL	To calibrate altitude to zero

Electrical Power Subsystem (EPS) Design

Vinay Jangid

EPS Overview (1/2)

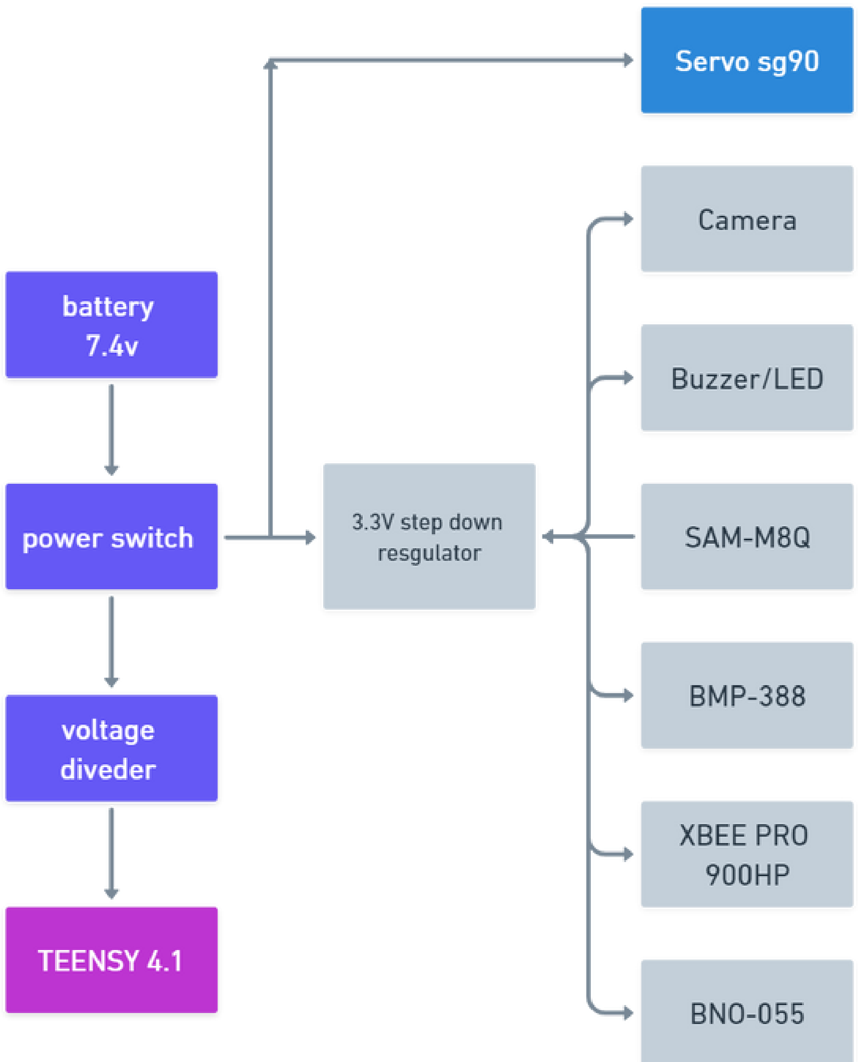
Container Components

CONTAINER COMPONENTS	***FUNCTION***	***USE***
ADAFRUIT SPY CAM	CAMERA	TO RECORD THE FOOTAGE
ESP C3	MCU	CONTROL UNIT FOR CAMERA
98DB BUZZER	AUDIO SOURCE	FOR RECOVERY PURPOSE
LED	-	POWER INDICATOR
CR 2032	POWER SOURCE	POWERING CAMERA

Payload Components

Components	*FUNCTION*	*USE*
TEENSY 4.1	MCU	Controlling All The Sensors
SAM-m8q	GPS	For Location
XBEE PRO 900 HP	Radio Comm.	for data transmission to gcs
Adafruit SPY CAM	camera	to record the footage
3.67x2 CELL	Power source	powering the whole container
BMP388	Pressure and Temp	To Measure Temp And Pressure
BNO085	Rotation Sensor	To Find Orientation Of Can
SERVO (G90)		
98DB BUZZER	Audio Source	For Recovery Purpose
LED	-	Power Indicator

Payload Electrical Block Diagram (1/2)



Payload Electrical Block Diagram (2/2)

DPDT Switch

We have used a DPDT Switch for switchng power supplies , on one Side we have connected it from internal power source and on the other side it will be powered from external power source

DC Female Jack

This is used for external power source using a 9V battery and a DC Male jack to 9V Battery Snapper.

This is done for Testing and demonstration Purposes

Payload Power Trade & Selection

S.NO	Model Name	Type	Normal voltage(V)	Capacity (mAh)	Weight (g)	Size (mm)	Cost
1.	Panasonic 18650	Lithium Ion	3.3	65 / -1.8 (peak) 50 / -3.0 (min)	11.1	18.65 x 65.08	$9.99
2.	Duracell Ultra	Alkaline	9	70	13	16.5 x 46.5 x 12.9	$2.95

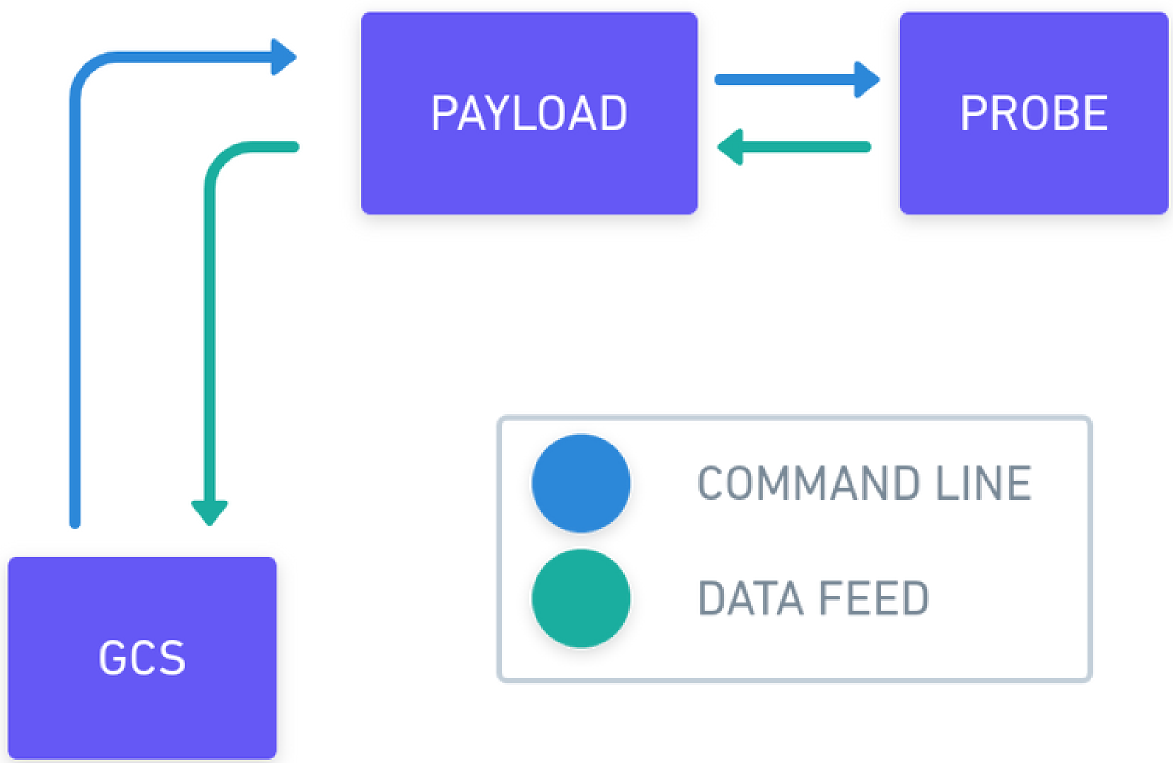
Selected Processor		Rational
18650		●*Higher Capacity* ●*Meets the power requirements and gives adequate backup* ●*Constant undisturbed supply of power*

Flight Software (FSW) Design

Amulya Paritosh and Lokendra Kumar

FSW Overview (1/6)

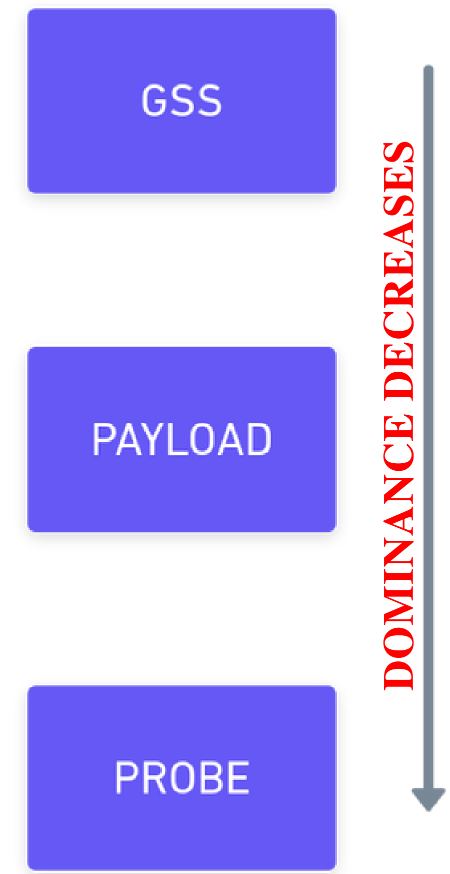
Command Dominance Principle



NOTE :: All arrows are wireless flow

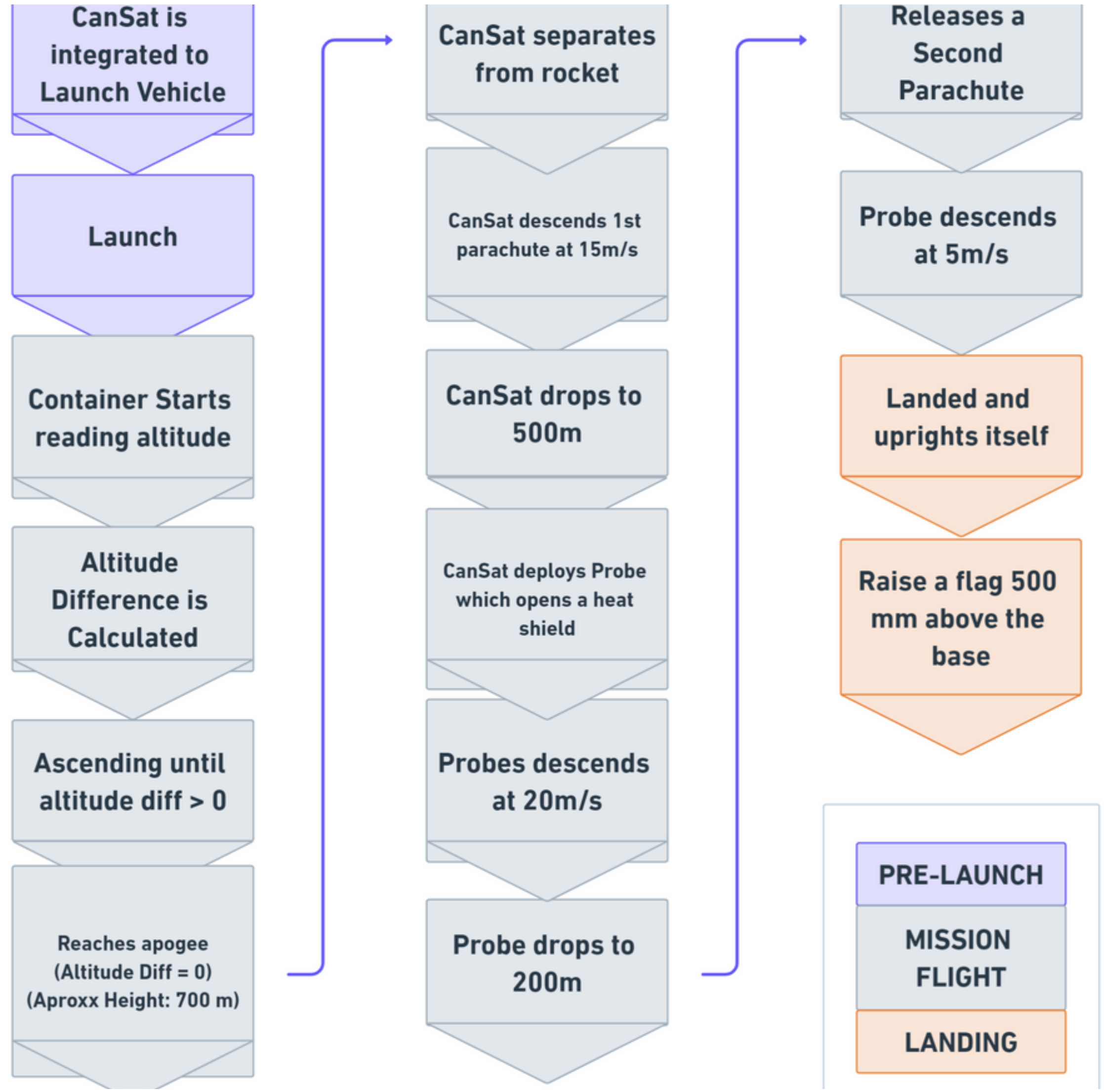
Hierarchy

Lower Controllers cannot override dominance



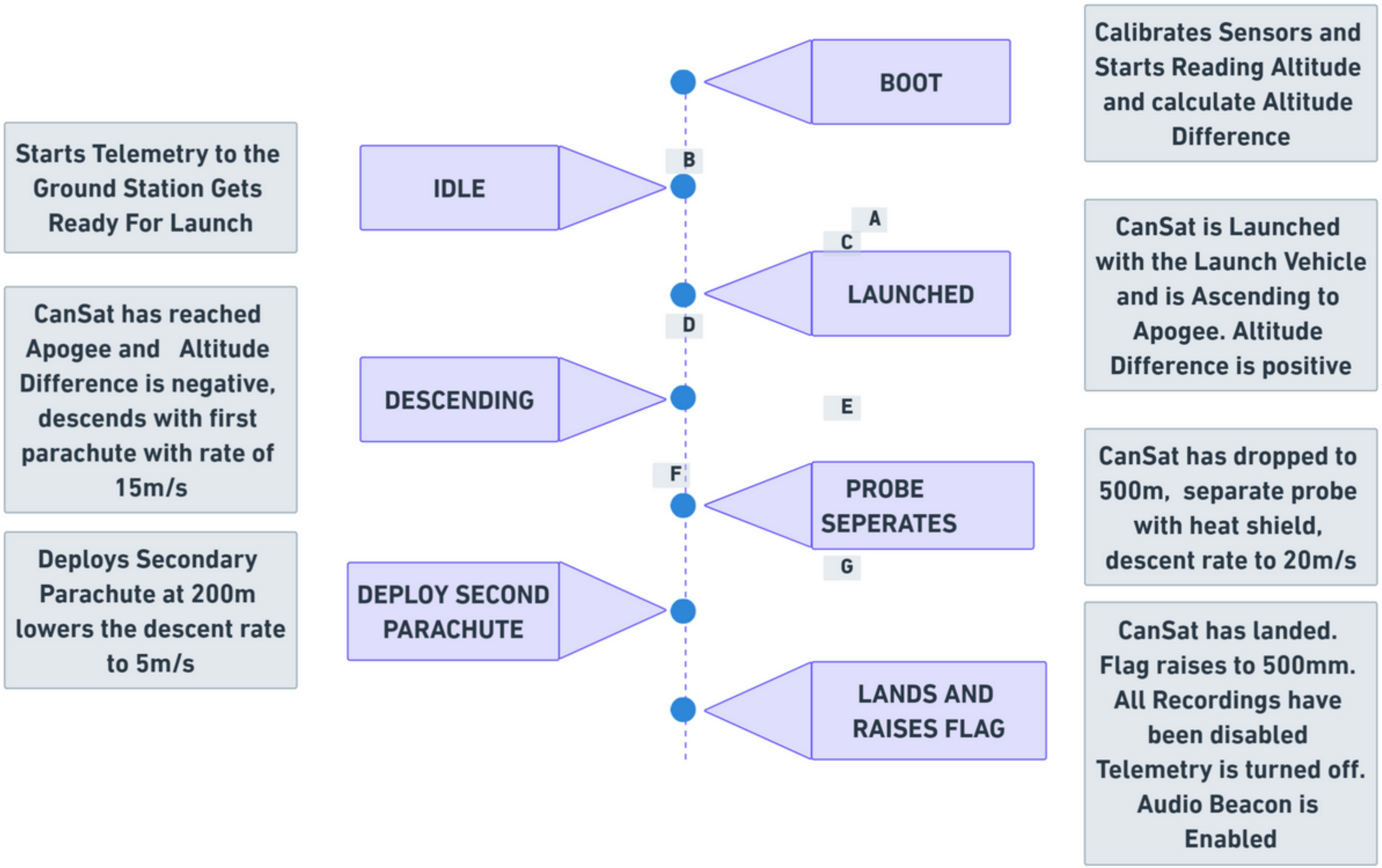
FSW Overview (2/6)

Basic FSW Architecture



FSW Overview (3/6)

Software States



FSW Overview (4/6)

Tasks of Container FSW

- **Calibrate Connected Sensors**
- **Switches between Flight Mode**
- **Switches it's state according to Altitude**
- **Triggers various Actuators and Bonus Camera**
- **Collects and Organizes Sensors Data**
- **Stores Data Onboard**
- **Feeds Data to GCS through Radio Link**
- **Keeps the Packet Count**
- **Communicates between GCS & Tethered Payload**
- **Receives Real Time Commands from GCS**
- **Commands the Tethered Payload to poll**
- **Deploys Tethered Payload at 0.5m/s at 300m**

FSW Overview (5/6)

Tasks of Payload FSW

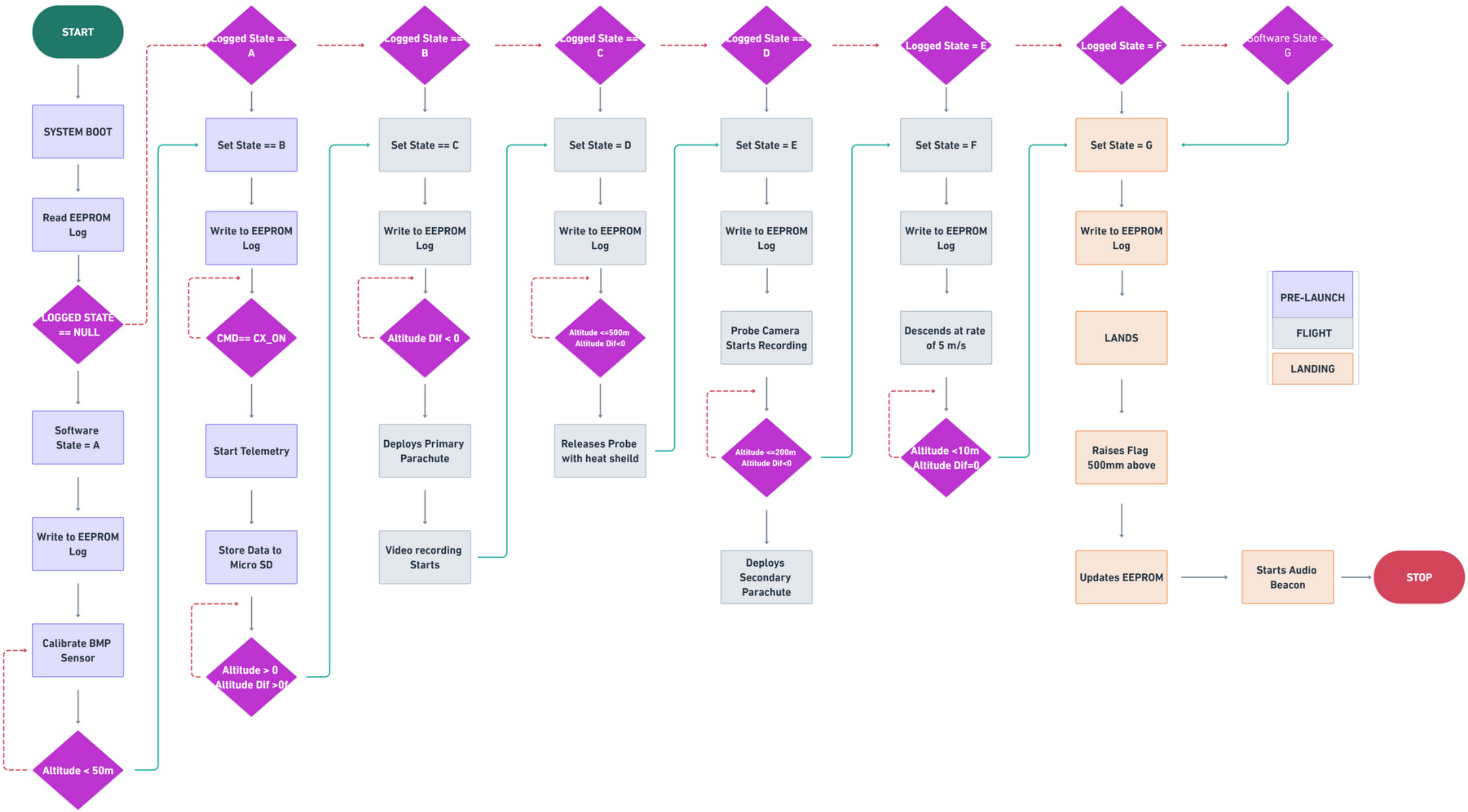
- **Receives Commands from Container**
- **Collects and Organizes Sensor Data**
- **Keeps the Packet Count**
- **Stabilizes the Payload to South Direction**
- **Uploads the organized data to Container at 4Hz**
- **Triggers the Mission Camera to Start Recording**
- **Start and Stop of Payload Telemetry**

FSW Overview (6/6)

Differences Between Container and Payload FSW

CONTAINER FSW	*PAYLOAD FSW*
Container FSW can command the Payload FSW	*Vice-Versa is not possible*
The Container receives Data from the payload.	*Payload doesn't receive any data, but only commands from the container.*
The Container starts telemetry as CanSat is in Pre-launch Idle State.	*Payload starts telemetry only after receiving CXON command*
The Container is directly linked with GCS	*Payload is not directly linked with GCS*

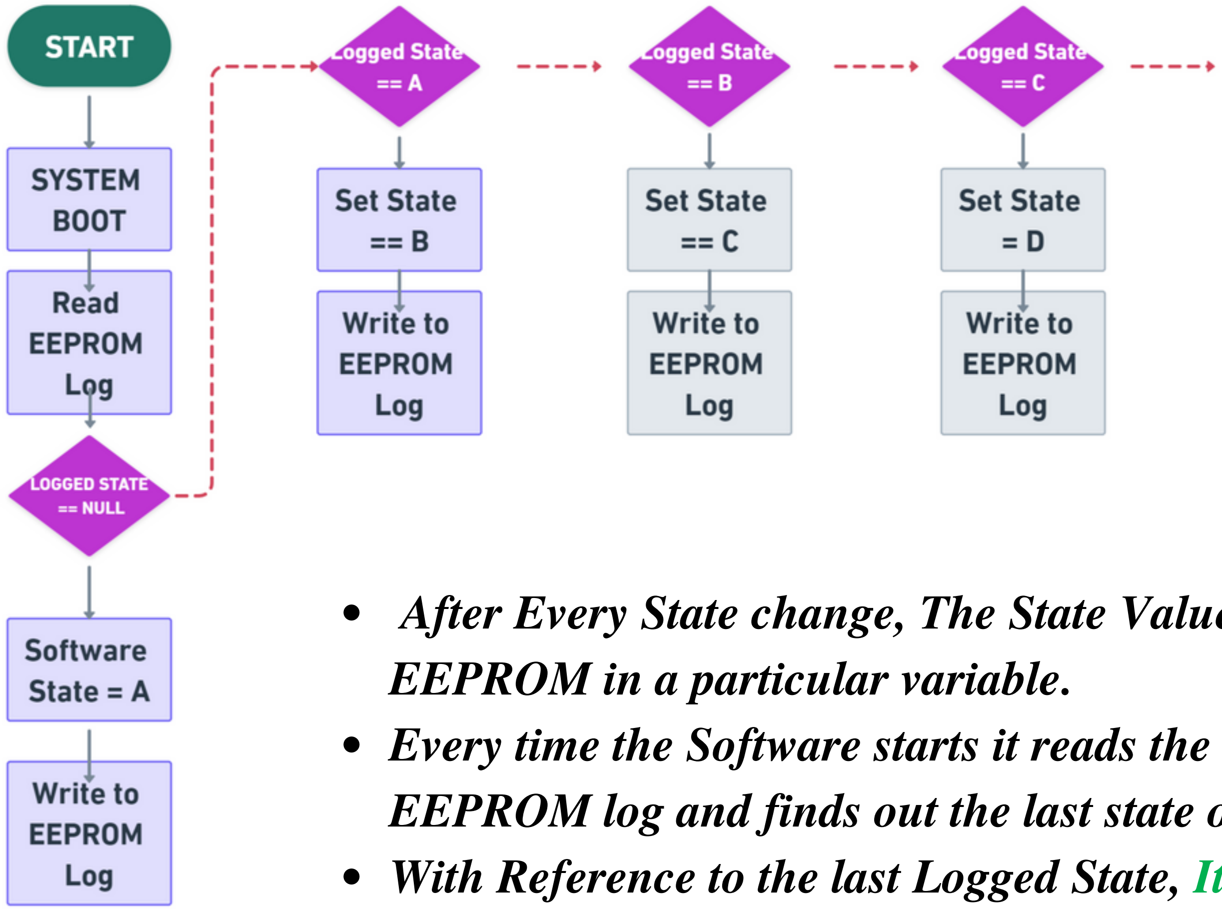
Payload FSW State Diagram (1/6)



Payload FSW State Diagram (2/6)

State Recovery Mechanism in case of Processor Reset

State Logging Method



- *After Every State change, The State Value is Logged into EEPROM in a particular variable.*
- *Every time the Software starts it reads the variable from the EEPROM log and finds out the last state of the mission.*
- *With Reference to the last Logged State, It Directly Jumps to the Next Adjacent State and Recovers to the Mission*

Payload FSW State Diagram (3/6)

Possible Reasons of Processor Reset

- Power Discontinuity due to shocks during Launch
- Exceptional Program Crash

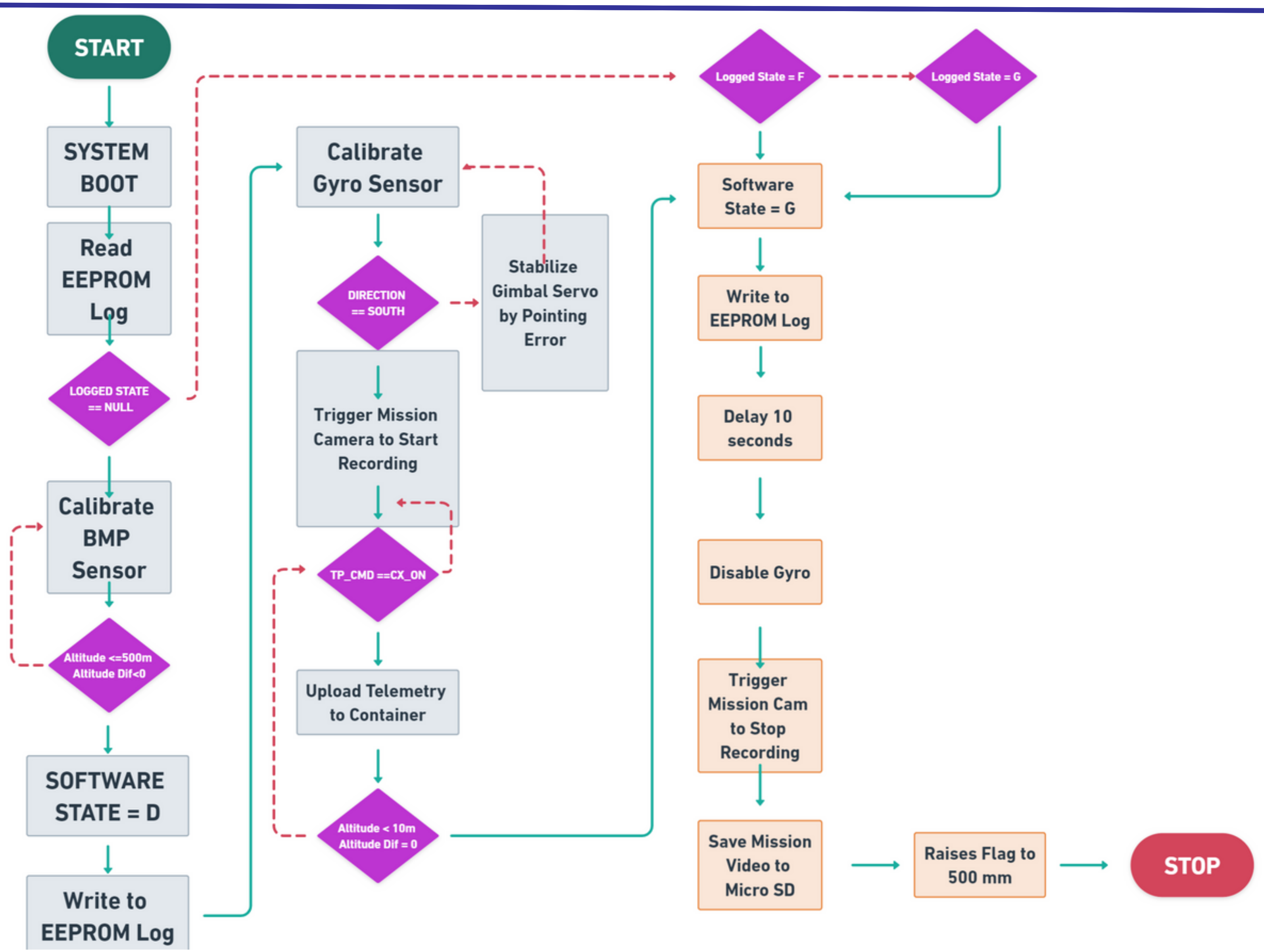
Data Used to Recover The State

- Last State Data
- Last Altitude Data

Method Used For Software Recovery

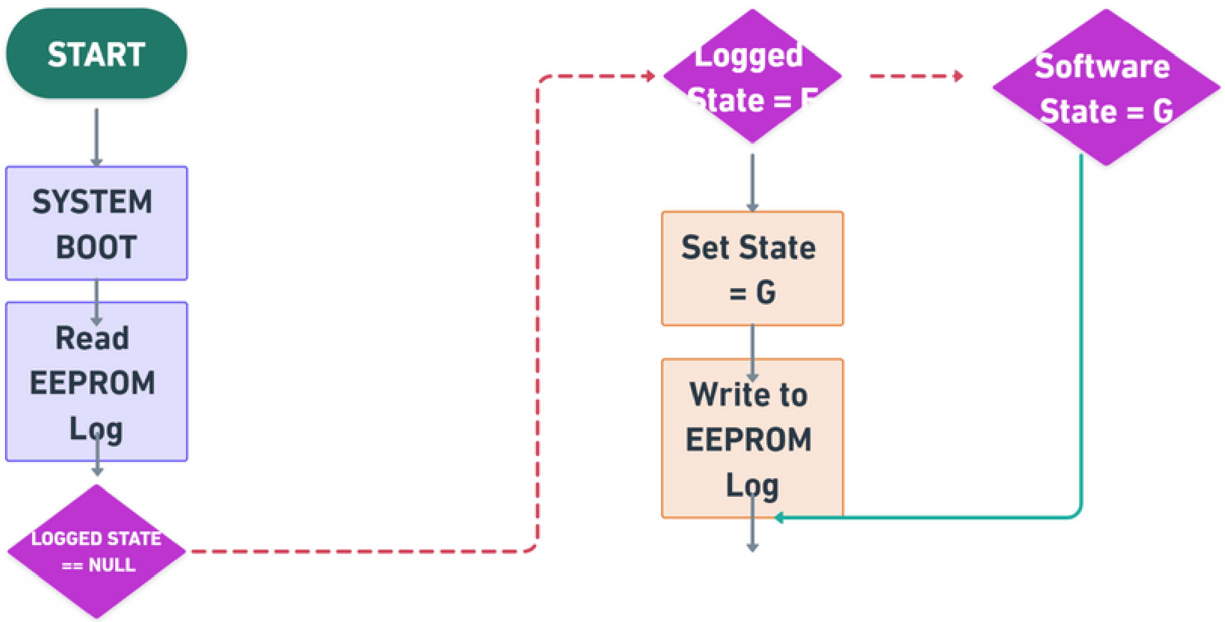
- State Logging Method

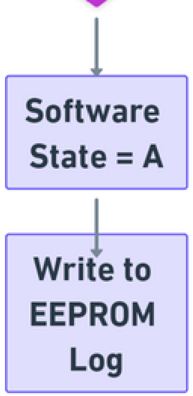
Payload FSW State Diagram (4/6)



Payload FSW State Diagram (5/6)

State Recovery Mechanism in case of Processor Reset | State Logging Method





- After Every State change, The State Value is Logged into EEPROM in a particular variable.
- Every time the Software starts it reads the variable from the EEPROM log and finds out the last state of the mission.
- With Reference to the last Logged State, It Directly Jumps to the Next Adjacent State and Recovers to the Mission

Payload FSW State Diagram (6/6)

Possible Reasons of Processor Reset

- **Power Discontinuity due to Shock in Tether**
- **Power Discontinuity due to shocks during Launch**
- **Exceptional Program Crash**

Data Used to Recover The State

- **Last State Data**
- **Last Altitude Data**

Method Used For Software Recovery

- **State Logging Method**

Simulation Mode Software (1/5)

Simulation Mode is an additional Flight Mode supported in Ground Control Software to Upload Simulated Pressure Data to Container to substitute readymade data in place of Real Sensor Data.

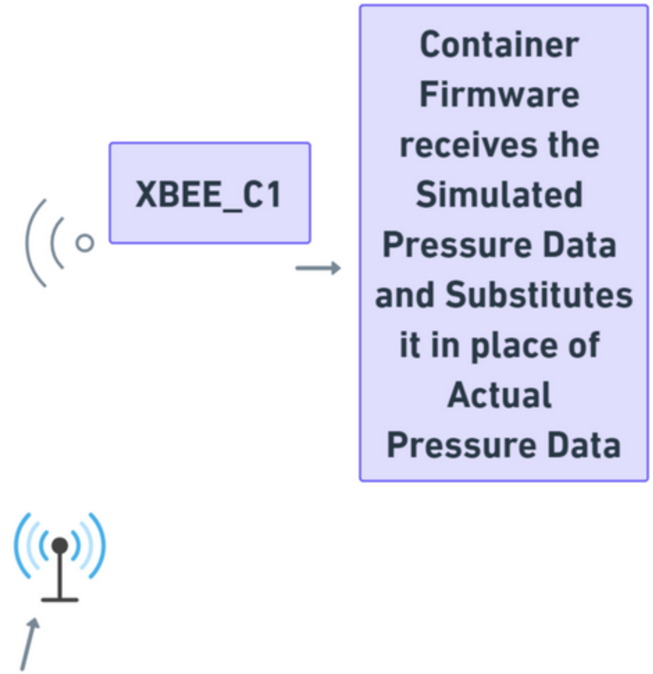
Requirement Of Simulation Flight Mode

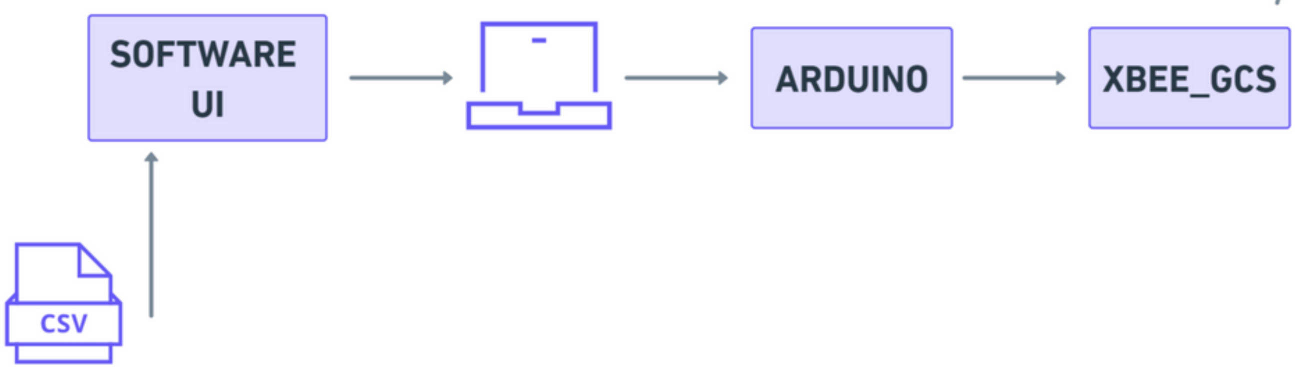
- **No Rocket Flight is Identical .**
- **Varying Temperature, Pressure Conditions can vary result in different team's**
- **Post Flight data, thus inputs can help in fair Evaluation .**
- **In case of Demonstration of Mission due to Rain On Launch Day.**
- **For Testing after Integration.**
- **Uncertainty in Weather and Humidity.**

Simulation Mode Software (2/5)

Systematic Transmission Of Simulated Pressure Data From Software

- ***Ground Station Software has the Ability to Read a CSV File that Contains Simulated Pressure Data (SIMP)***
- ***The SIMP is then Uploaded through the Radio Uplink to the Container.***
- ***GCS uploads Simulated Pressure Data at the rate of 1Hz.***
- ***Container Firmware receives the Simulated Pressure Data and Substitutes it in place of Actual Pressure Data.***





Simulation Mode Software (3/5)

3 Variable Concept for Substitution of Simulated Data

pa_read

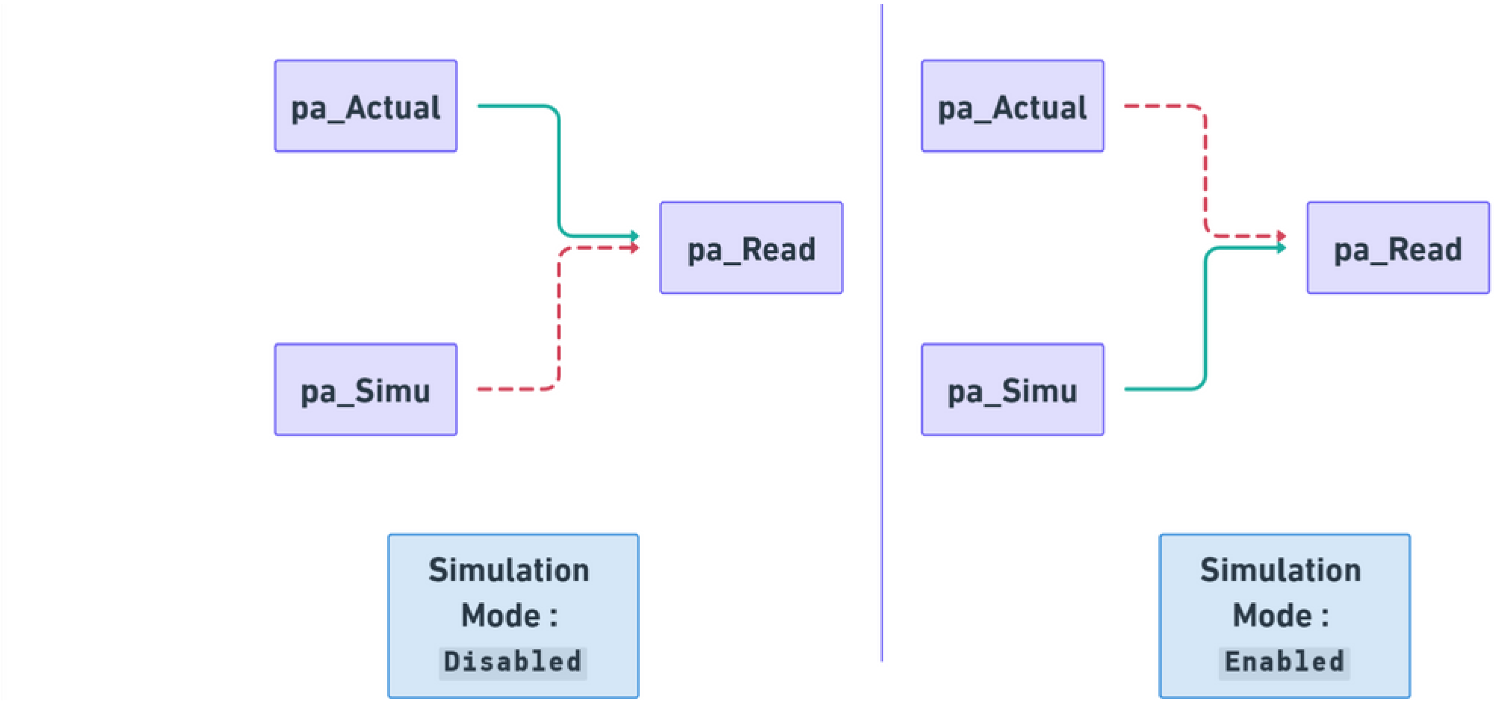
An Integer Variable in container firmware that is used to calculate Altitude with Pressure Data

pa_Actual

An Integer Variable in container firmware that contains Actual Pressure Data From MPL-3115A2 Sensor

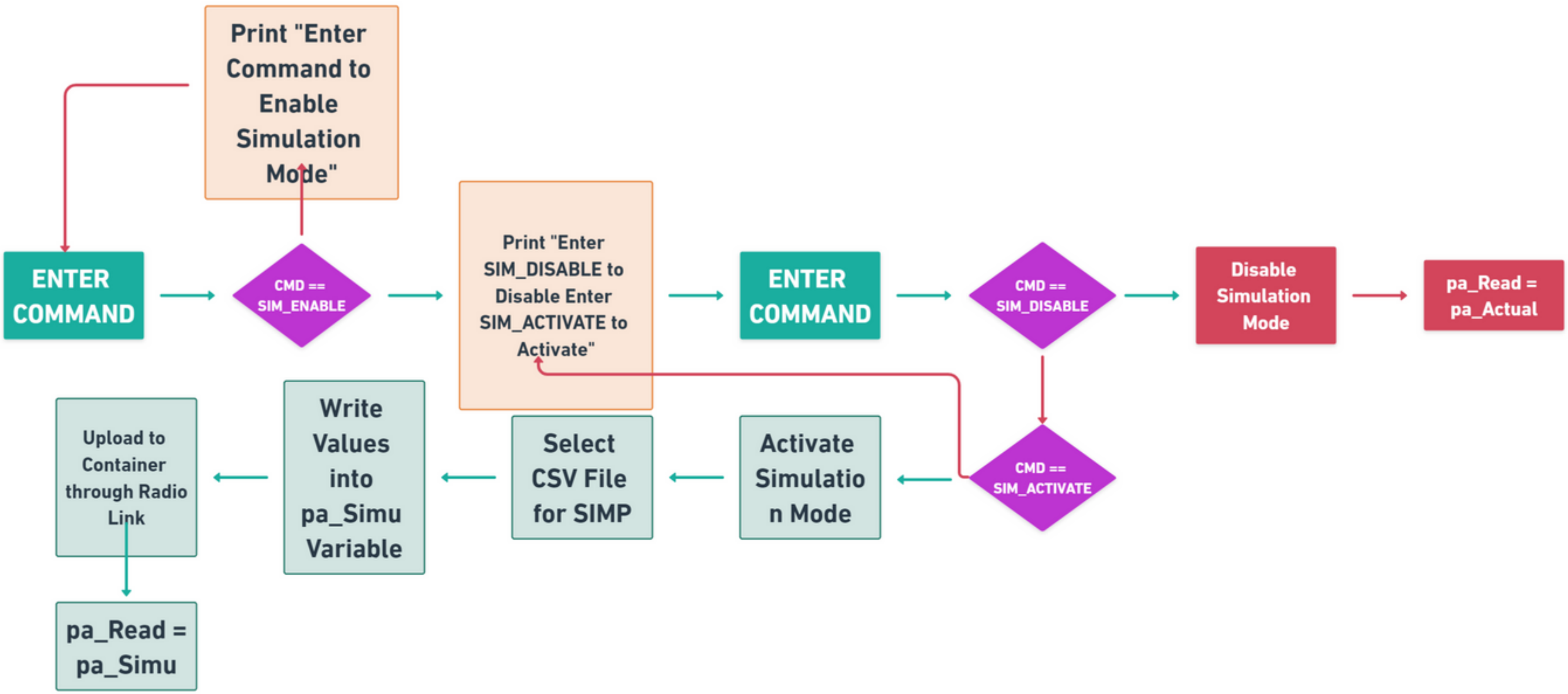
pa_Simu

An Integer Variable in GCS firmware that contains Simulated Pressure Data From CSV File Provided



Simulation Mode Software (4/5)

Software Architecture Of Simulation Mode



Simulation Mode Software (5/5)

Commands used in Simulation Mode

CMD,1070,SIM,ENABLE : Enables Simulation Mode

CMD,1070,SIM,ACTIVATE: Activates Simulation Mode

CMD,1070,SIM,DISABLE: Both Disable and Deactivate Simulation Mode

Where

- **CMD and SIM are Static Text**
- **1087 is our Assigned Team ID**
- **ENABLE, DISABLE, ACTIVATE are Strings**

Format of Simulation Mode Pressure Data

CMD,1070,SIMP,<PRESSURE>

Where

- **CMD and SIM are Static Text**
- **1087 is our Assigned Team ID**
- **<PRESSURE> is Simulated Pressure data in Pascal**

Ground Control System (GCS) Design

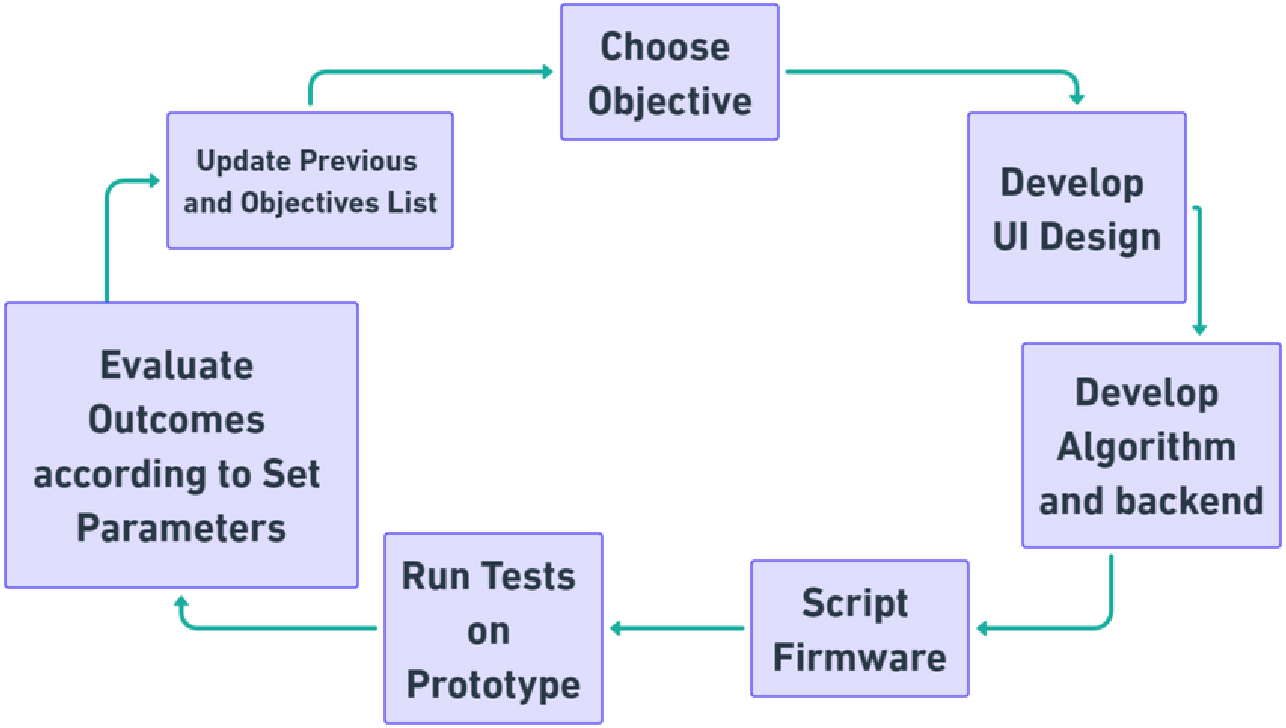
Amulya Paritosh and Shubhadip Mondal

Software Development Plan (1/2)

Software Development Team

Amulya Paritosh
Lokendra Kumar
Shubhdeep Mondal

Methodology Involved - Agile Methodology

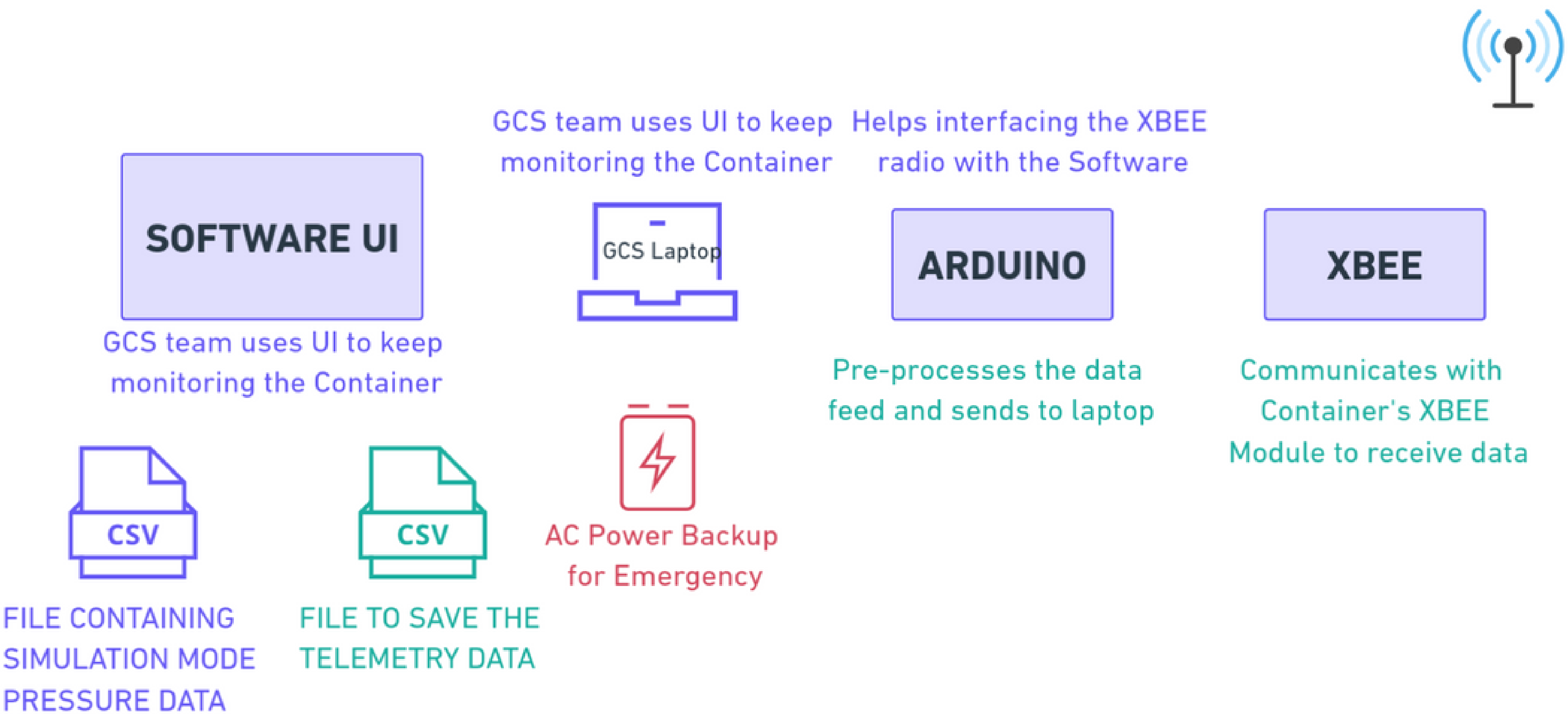


Software Development Plan (2/2)

Prototyping Sectors And their Environment

Sectors	Environment	Description
Hardware and Sensors	Breadboard and Jumper Wires	Connect according to Sketch and Start Test on the Sensors used throughout
Firmware	Teensyduino	Scripting the Firmware for different sensors and testing functionality
UI/UX	Figma, Qt Designer	Prototyping the most user-friendly UI/UX for Software
GCS Software	Visual Studio 2019	Using PyQt5 and python with Qt Designer to develop cross platform application.
PCB Simulations	Circuito.io	To make connections and E-simulations of PCB Circuit

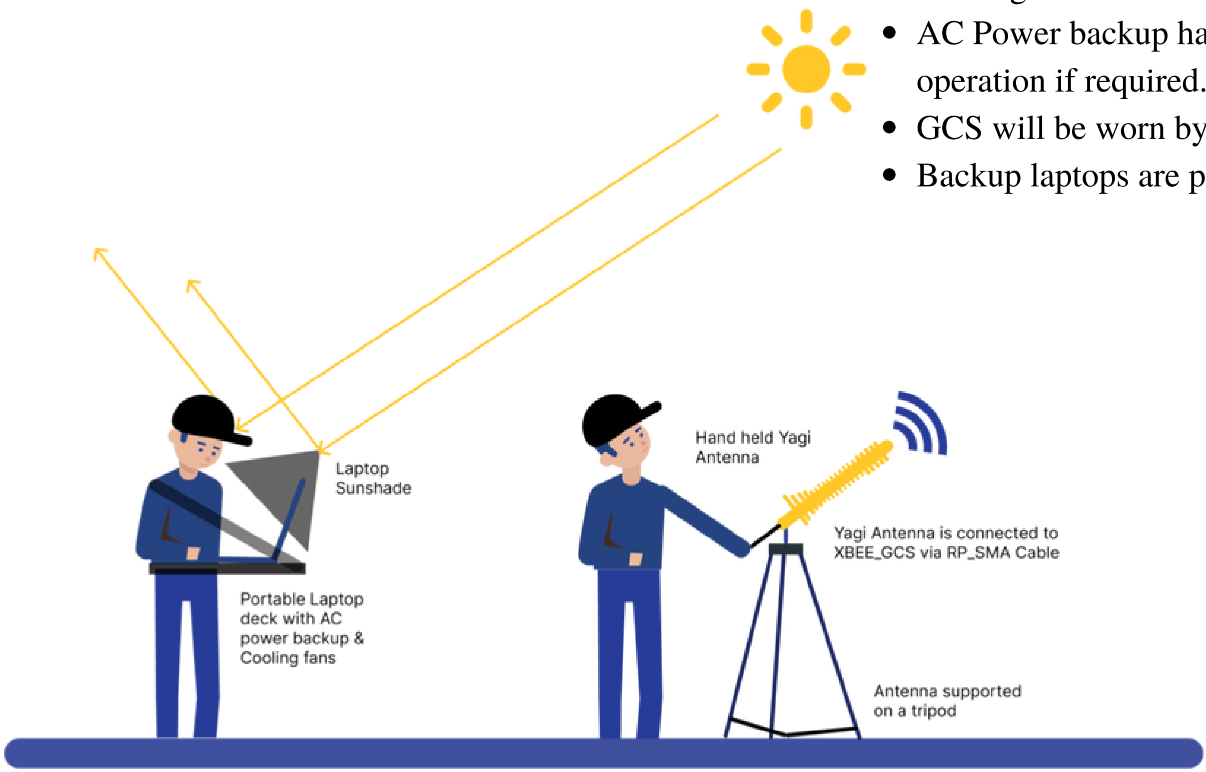
GCS Overview



GCS Design

Specifications

- GCS can operate independently for at-least of 4 hours.
- Cooling fans are used at the bottom docking for laptop ventilation.
- AC Power backup has been added for the additional duration of operation if required.
- GCS will be worn by a member using a harness and ply deck.
- Backup laptops are pre-installed with software.



GROUND CONTROL TEAM (Concept)

GCS Software (1/6)

Commercial Of The Shelf Software Packages (COTS)

- XCTU for calibrating XBEE Modules and setting them to desired PANID/NETID
- Arduino Hardware package for interfacing Arduino with the backend of Ground Station Software

Telemetry display prototypes and Plotting data

- Qt Designer and PyQt5 architecture to design and organize Real-time Telemetry from Container.
- Arduino Hardware package for interfacing Arduino board with the backend of Ground Station Software and interfacing between XBees and GCS Laptop.
- GUI inbuilt Chart packages for creating Temperature and Altitude Charts.

Command Software and Interface

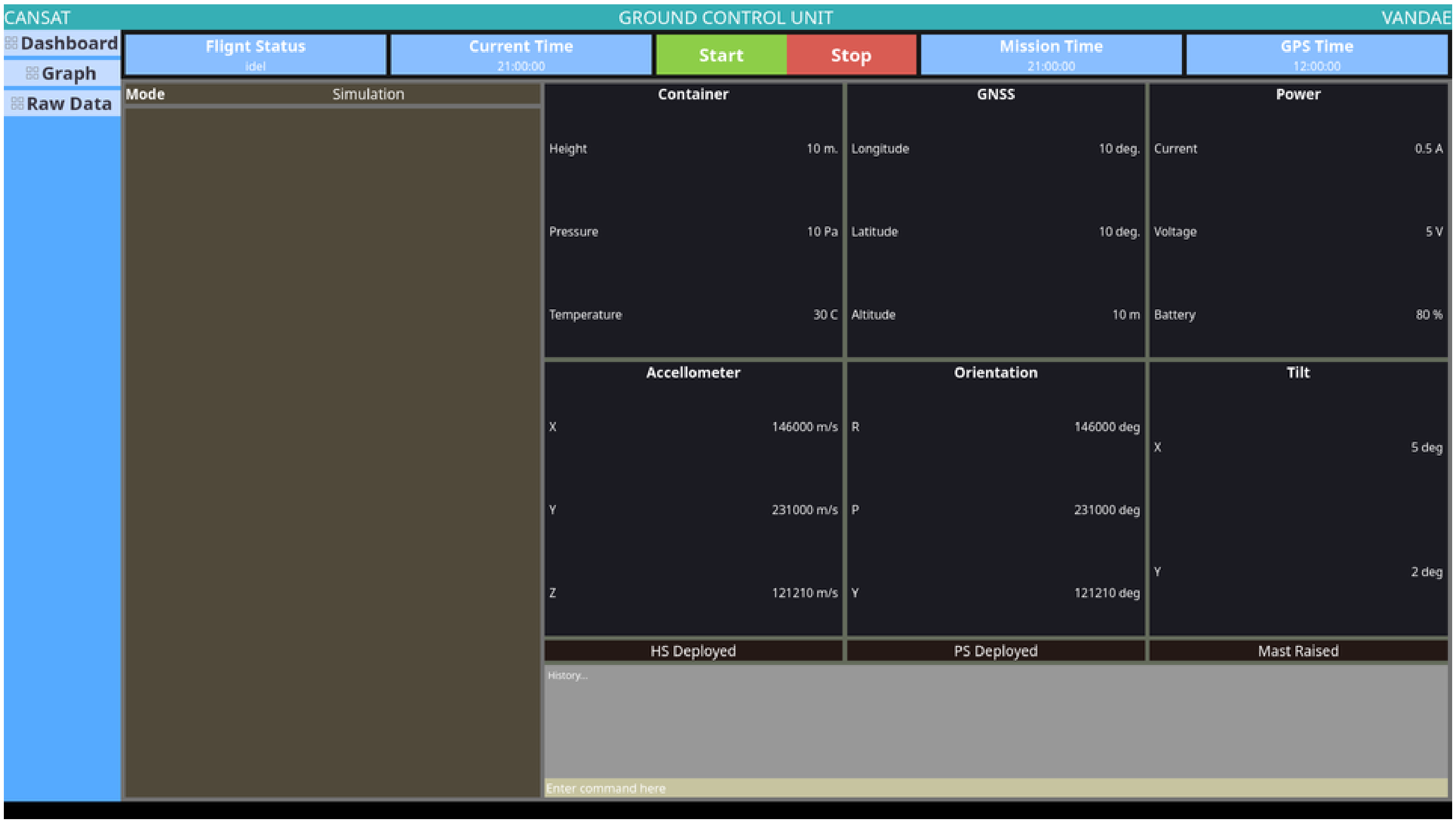
- Independent Space for input text option, which is rather checked by Compiler with switch case structure script.
- If the entered command matches with any case the software switches to the functionality of that particular command.

.CSV file creation for Judges

- Standard CSV Python 3.10.1 library to periodically save telemetry files in the mentioned format as of Mission Guide i.e. [Flight_1070_C.csv] for Container Telemetry and [Flight_1070_T.csv] for Tethered Payload Telemetry.

GCS Software (2/6)

Telemetry Display Prototype (QtApplication)

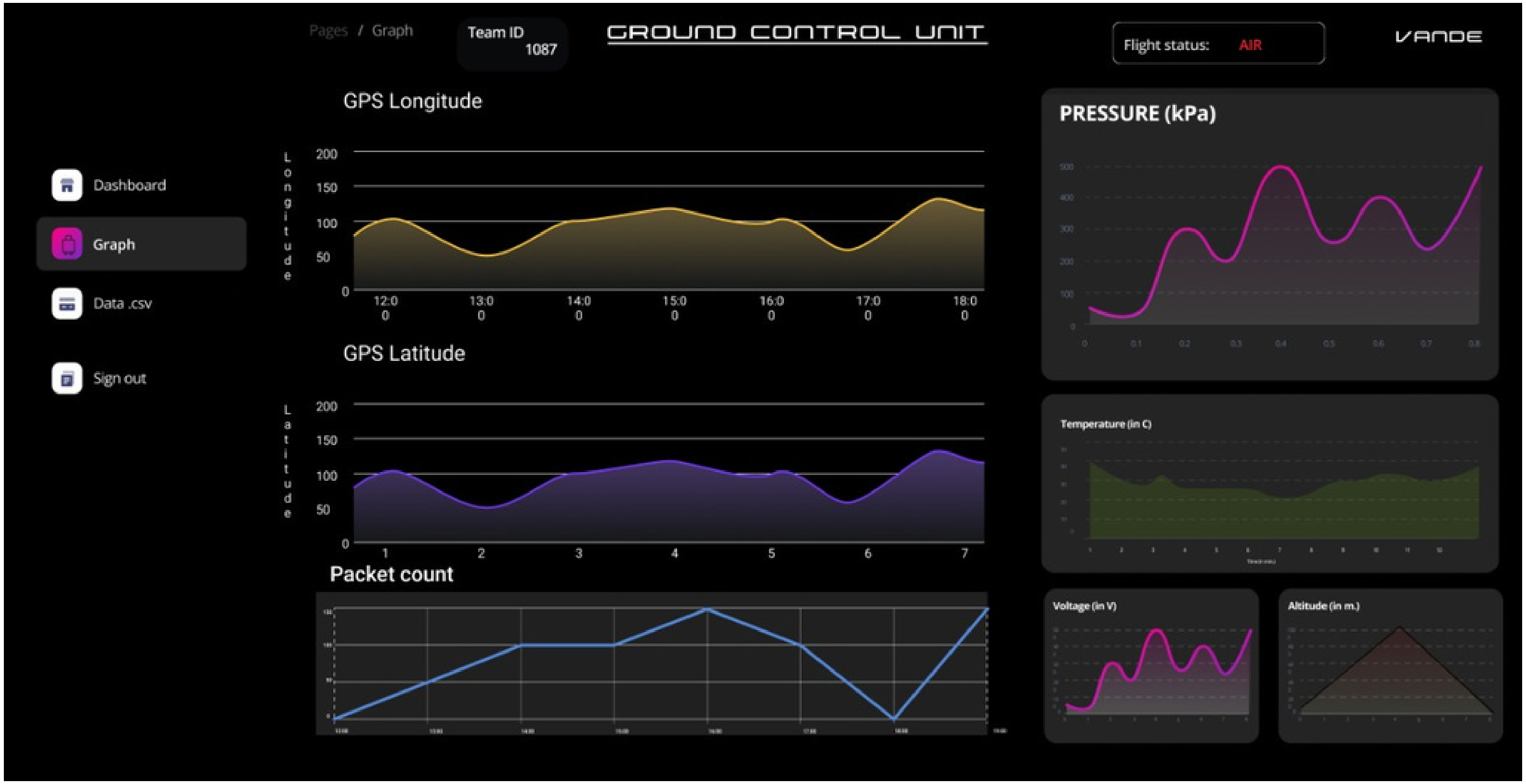


This Prototype has ability to display the telemetry of both Container and Payload

I is designed to render a real time 2d animation of the cansat from the telemetry data

GCS Software (3/6)

Real-time Plotting Prototype (Figma Concept)



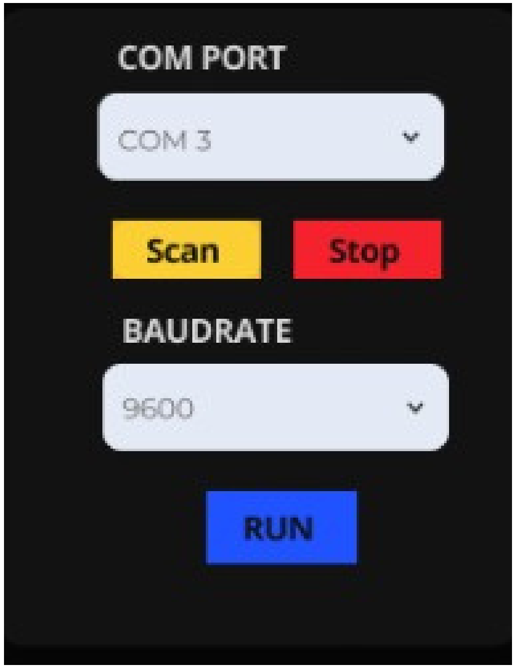
GCS Software (4/6)

Command Software and Interface

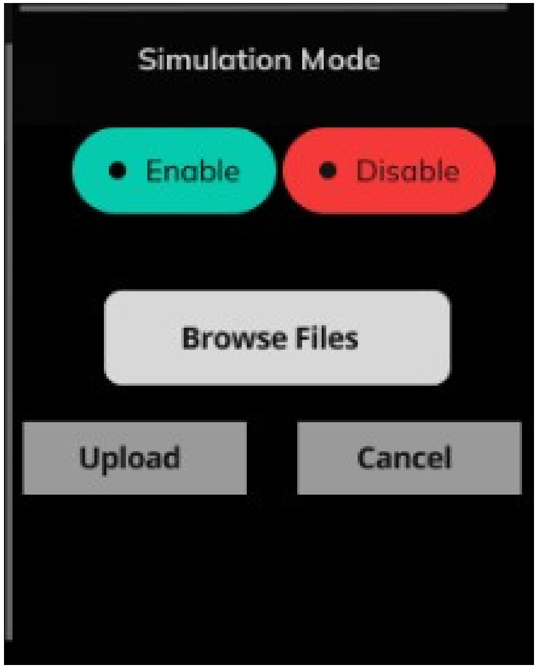
There is dropdown for commands from where every command can be selected. Also the Command dialog supports writing the command manually.

A History scroll area will show all the commands executed or failed with the time stamp for logging and refference.

Easy Access Settings (Figma Prototype)

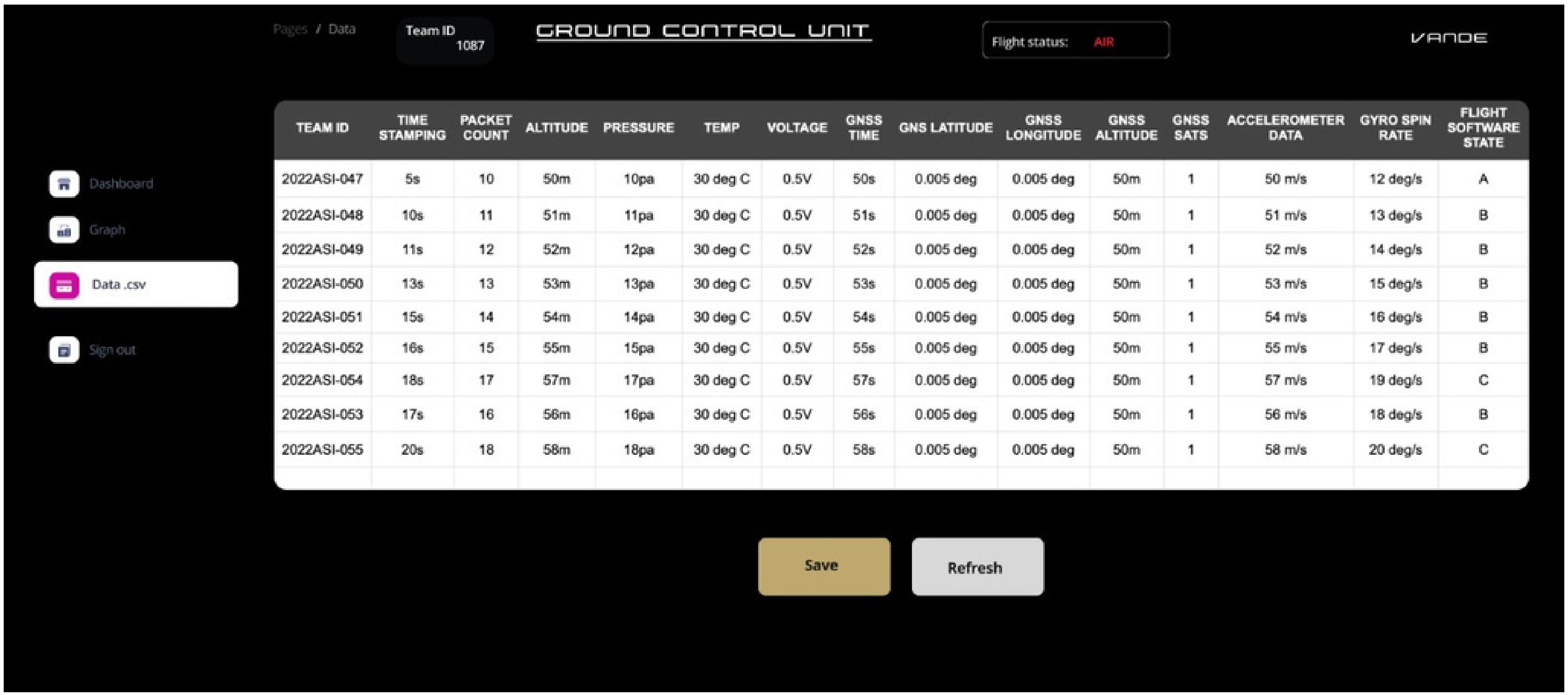


COM port for getting data can easily be changed from the menu



Enabling and Disabling of the simulation mode and the simulation data file can also be accessed through menu

Telemetry Data Recording and CSV File Creation (Figma Prototype)



TEAM ID	TIME STAMPING	PACKET COUNT	ALTITUDE	PRESSURE	TEMP	VOLTAGE	GNSS TIME	GNS LATITUDE	GNSS LONGITUDE	GNSS ALTITUDE	GNSS SATS	ACCELEROMETER DATA	GYRO SPIN RATE	FLIGHT SOFTWARE STATE
2022ASI-047	5s	10	50m	10pa	30 deg C	0.5V	50s	0.005 deg	0.005 deg	50m	1	50 m/s	12 deg/s	A
2022ASI-048	10s	11	51m	11pa	30 deg C	0.5V	51s	0.005 deg	0.005 deg	50m	1	51 m/s	13 deg/s	B
2022ASI-049	11s	12	52m	12pa	30 deg C	0.5V	52s	0.005 deg	0.005 deg	50m	1	52 m/s	14 deg/s	B
2022ASI-050	13s	13	53m	13pa	30 deg C	0.5V	53s	0.005 deg	0.005 deg	50m	1	53 m/s	15 deg/s	B
2022ASI-051	15s	14	54m	14pa	30 deg C	0.5V	54s	0.005 deg	0.005 deg	50m	1	54 m/s	16 deg/s	B
2022ASI-052	16s	15	55m	15pa	30 deg C	0.5V	55s	0.005 deg	0.005 deg	50m	1	55 m/s	17 deg/s	B
2022ASI-054	18s	17	57m	17pa	30 deg C	0.5V	57s	0.005 deg	0.005 deg	50m	1	57 m/s	19 deg/s	C
2022ASI-053	17s	16	56m	16pa	30 deg C	0.5V	56s	0.005 deg	0.005 deg	50m	1	56 m/s	18 deg/s	B
2022ASI-055	20s	18	58m	18pa	30 deg C	0.5V	58s	0.005 deg	0.005 deg	50m	1	58 m/s	20 deg/s	C

Our GSC periodically saves the telemetry data in a defined location which can be changed through settings. But we can also save the data from the save button to out desired location

CANSAT Integration and Test

Rahul Mandal

Environmental Test Plan (1/4)

Drop Test

- Switch ON the CANSAT.
- Verify the transmission of telemetry.
- Lift CANSAT using a non-stretching cable.
- Release the CANSAT.
- Ensure that the CANSAT didn't experience a power loss. Verify to see if any parts are damaged or detached, and confirm that telemetry is still being received.

Environmental Test Plan (2/4)

Thermal Test

- Put CANSAT in a thermal chamber with a hot air gun as the heat source.
- Switch ON the CANSAT.
- Seal the thermal chamber by closing it.
- Power ON the heat source.
- Turn the heat source on when the temperature dips to 55°C for two hours and turn off when the interior temperature reaches 60°C.
- To ensure the CANSAT survived the temperature exposure, do visual inspections and any necessary functional tests.

Environmental Test Plan (3/4)

Vibrational Test

- Turn on the CANSAT and make sure the accelerometer is collecting data.
- Install a CANSAT over the orbital sander and turn it on.
- After the sander reaches its maximum speed, wait five seconds.
- Completely shut off the sander's power.
- Do it a further four times.
- Check for damage and functioning issues with the CANSAT. Check to see if accelerometer data is still being captured.

Environmental Test Plan (4/4)

Vaccum Test

- Hang the powered-up and fully configured CANSAT in the vacuum chamber.
- Start creating a vacuum by turning on the vacuum chamber.
- Keep an eye on the telemetry.
- Slowly allow air to enter the vacuum chamber while keeping an eye on the CANSAT performance.
- Gather and record telemetry.

Mission Operations & Analysis

Roopmeet Kaur

Overview of Mission Sequence of Events

Sequence Of Events

1

ARRIVAL

1. Team arrival at the launch site
2. CanSat state look-over
3. Integrate CanSat with Parachutes
4. Set-Up Ground Control Station and Antenna

2

Pre-Launch

1. Check CanSat configuration
2. Inspect Communications, Descent, & Deployment part
3. Ensure all the connections of Payload & Container
4. Recall safety instructions according to Manual

3

Flight Preparation

1. Inspect Assembled CanSat
2. Check Mechanisms and Power supplies
3. Perform Drop Test according to Manual
4. Flight Readiness Review before launch

Overview of Mission Sequence of Events

Sequence Of Events

4

Launch

1. Turns ON the CanSat & integrate it into the rocket
2. After integration, data is transmitted & stored at Onboard Storage Modules
3. Monitor GCS and publish telemetry into MQTT
4. Recovery Crew gets active

5

Recovery

1. CanSat recovery initiates
2. Locating CanSat by its audio beacon and GPS
3. Recover all on-board data modules and seal it in DTC
4. Handover DTC to MCO

6

Data Analysis

1. Retrieve flight data from Micro-sd cards
2. Retrieve Video files of both Container & Payload
3. Analyze telemetry data
4. Preparation of Post Flight Review
5. Presentation of Post Flight Review

Requirements Compliance

Roopmeet Kaur

Requirements Compliance Overview

Our Designs and Concepts are based on the Mission Guide 2023 and have been developed for meeting the requirements of Mission.

Compliance	Number of requirement	Comment for resolving
Comply	58	All concepts are designed and ready to go for manufacture

Compliance	Number of requirements	Comment for resolving
Partial	03	Applies to some extent , may vary while or after getting manufactured

Compliance	Number of requirements	Comment for resolving
No Comply	0	Will be re-analyzed and work on

Compliance	No. of requirements	Comments
Comply	58	
Partial	3	
No Comply	0	
Total	61	

Requirements Compliance (1/12)

S.No	Requirement	Comply/Partial/No Comply	Slide No.	Comments
1.	Total mass of the CanSat (science probe and container) shall be 700 grams (+/- 10 grams) .			
2.	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.			
3.	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.			
4.	The container shall be a fluorescent color; pink, red or orange.			
5.	The container shall be solid and fully enclose the science probes. Small holes to allowaccess to turn on the science probesare allowed. The end of the container where the probe deploys may be open.			

Requirements Compliance (2/12)

S.No	Requirement	Comply/Partial/No Comply	Slide No.	Comments
6.	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.			
7.	The rocket airframe shall not be used as part of the CanSat operations.			
8.	The container's parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.			
9.	The Parachute shall be fluorescent Pink or Orange			
10.	The descent rate of the CanSat (container and science probe) shall be 15 meters/second (+/- 5m/s) .			

Requirements Compliance (3/12)

S.No	Requirement	Comply/Partial/No Comply	Slide No.	Comments
11.	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.			
12.	0 altitude reference shall be at the launch pad.			
13.	All structures shall be built to survive 15 Gs of launch acceleration.			
14.	All structures shall be built to survive 30 Gs of shock.			
15.	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws , or high performance adhesives.			

Requirements Compliance (4/12)

S.No	Requirement	Comply/Partial/ No Comply	Slide No.	Comments
16.	Mechanisms shall not use pyrotechnics or chemicals.			
17.	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.			
18.	Both the container and probe shall be labeled with team contact information including email address.			
19.	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost. Equipment from previous years shall be included in this cost based on current market value.			
20.	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed			

Requirements Compliance (5/12)

S.No	Requirement	Comply/Partial /No Comply	Slide No.	Comments
21.	XBEE radios shall have their NETID/PANID set to their team number.			
22.	XBEE radios shall not use broadcast mode.			
23.	The container and probe shall include an easily accessible power switch that can be accessed without disassembling the cansat and science probes and in the stowed configuration.			
24.	The container and probe shall include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the cansat and in the stowed state.			
25.	An audio beacon is required for the probe. It shall be powered after landing.			

Requirements Compliance (6/12)

S.No	Requirement	Comply/Partial/ No Comply	Slide No.	Comments
26.	The audio beacon shall have a minimum sound pressure level of 92 dB, unobstructed.			
27.	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.			
28.	An easily accessible battery compartment shall be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.			
29.	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.			
30.	The Cansat shall operate during the environmental tests			

Requirements Compliance (7/12)

S.No	Requirement	Comply/Partial/ No Comply	Slide No.	Comments
31.	The Cansat shall operate for a minimum of two hours when integrated into the rocket.			
32.	The probe shall be released from the container when the CanSat reaches 500 meters.			
33.	The probe shall deploy a heat shield after leaving the container.			
34.	The heat shield shall be used as an aerobrake and limit the descent rate to 20 m/s or less.			
35.	At 200 meters, the probe shall release a parachute to reduce the descent rate to 5 m/s +/- 1m/sec.			

Requirements Compliance (8/12)

S.No	Requirement	Comply/Partial/ No Comply	Slide No.	Comments
36.	Once landed, the probe shall upright itself.			
37.	After uprighting, the probe shall deploy a flag 500 mm above the base of the probe when the probe is in the upright position.			
38.	The probe shall transmit telemetry once per second.			
39.	The probe telemetry shall include altitude, air pressure, temperature, battery voltage, probe tilt angles, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.			
40.	The probe shall include a video camera pointing down to the ground.			

Requirements Compliance (9/12)

S.No	Requirement	Comply/Partial/ No Comply	Slide No.	Comments
41.	The video camera shall record the flight of the probe from release to landing.			
42.	The video camera shall record video in color and with a minimum resolution of 640x480.			
43.	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.			
44.	The probe shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.			
45.	The video camera shall record the flight of the probe from release to landing.			

Requirements Compliance (10/12)

S.No	Requirement	Comply/Partial/ No Comply	Slide No.	Comments
46.	The probe shall have its time set to within one second UTC time prior to launch.			
47.	The probe flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.			
48.	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.			
49.	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.			
50.	The ground station shall command the Cansat to start calibrating the altitude to zero when the Cansat is on the launch pad prior to launch.			

Requirements Compliance (11/12)

S.No	Requirement	Comply/Partial/ No Comply	Slide No.	Comments
51.	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.			
52.	Telemetry shall include mission time with 0.01 second or better resolution.			
53.	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.			
54.	Each team shall develop their own ground station.			
55.	All telemetry shall be displayed in real time during descent on the ground station .			

Requirements Compliance (12/12)

S.No	Requirement	Comply/Partial/ No Comply	Slide No.	Comments
56.	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)			
57.	Teams shall plot each telemetry data field in real time during flight.			
58.	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.			
59.	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.			
60.	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.			
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			

Management

Roopmeet Kaur

CanSat Budget – Hardware

Electric Components					
	Component	**Quantity**	**Unit Price**	**Total price**	**Indication**
CONTAINER	**Adafruit mini spy cam**	**1**	$12.50	**$12.50**	Actual
	CR 2032	2	**$2.98**	**$5.96**	Actual
	sd card	**1**	**$29**	**$29**	Actual
	Buzzer	**1**	**$3.03**	$3.03	Actual
	LED	**1**	**$.023**	**$.023**	Actual
	ESP-C3	**1**	**$5**	**$5**	Actual
	Push button	**1**	$1.50	**$1.50**	Actual
			SUBTOTAL	$57.22	

CanSat Budget – Hardware

Electric Components					
	Component	**Quantity**	**Unit Price**	**Total price**	**Indication**
PAYLOAD	**TEENSY 4.1**	**1**	**$31.50**	$31.50	**Actual**
	BNO085	**1**	**$24.95**	**$24.95**	**Actual**
	18650	**2**	**$4.99**	**$9.98**	**Actual**
	BMP388	**1**	**$15.77**	$15.77	**Actual**
	SAP-M8Q	**1**	$31.5	**$31.5**	**Actual**
	PCB	**2**	**$3.06**	**$6.12**	**Estimate**
	XBEE-PRO 900MHZ	**1**	**$48.96**	$48.96	**Estimate**
	Adafruite Spy Cam	**1**	**$12.50**	**$12.50**	**Actual**
	SD Card	**1**	**$29**	$29	**Actual**
	Resistors	**3**	**$30**	**$60**	**Estimate**
			SUBTOTAL	$270.28	

CanSat Budget – Hardware

Electric Components

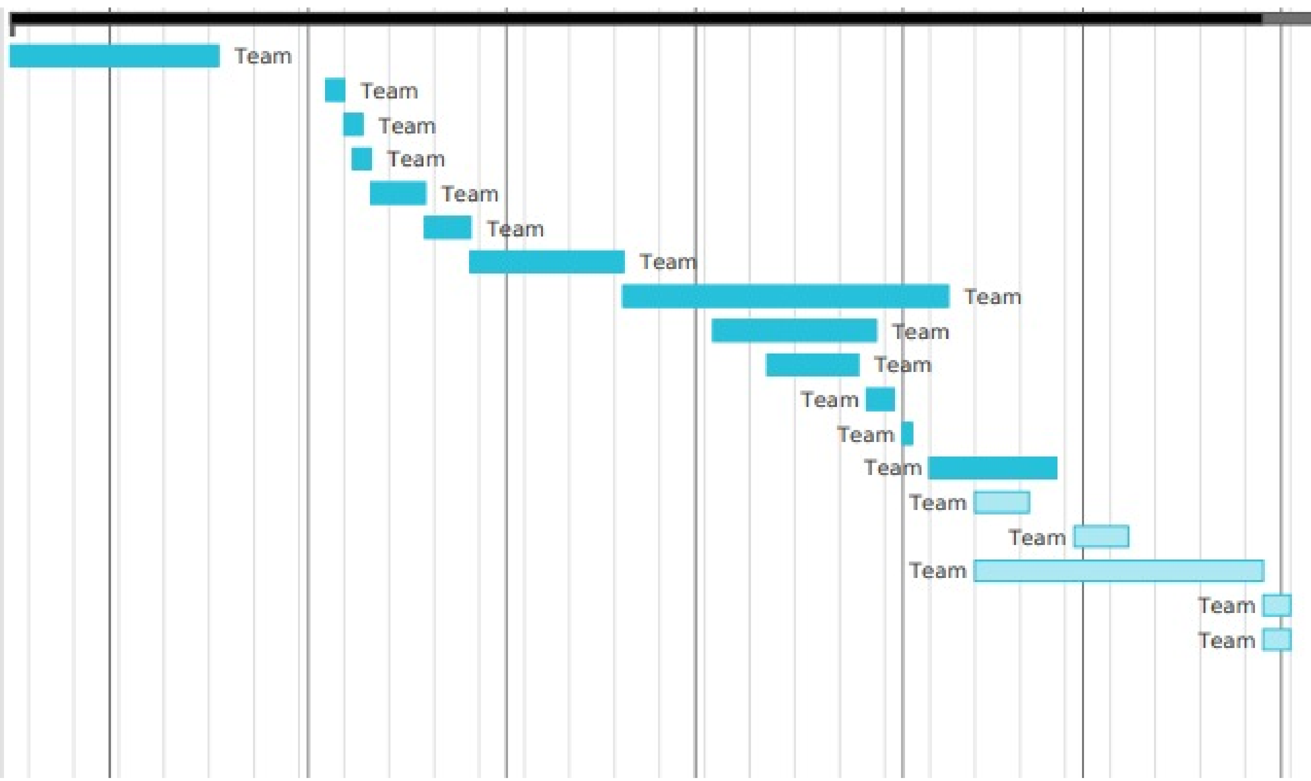
	Component	Quantity	Unit Price	Total price	Indication
PAYLOAD	Antenna	1	$2	$2	Actual
	CR2032	1	$2.98	$2.98	Estimate
	Buzzer	1	$3.03	$3.03	Actual
	LED	1	$0.23	$0.23	Actual
	Push Button	1	$1.50	$1.50	Estimate
	Servo motor G90	3	$7.63	$22.89	Actual
	Pin Header Connectors	4	$0.5	$2	Estimate
	Wires	15	$0.66	$9.9	Estimate
	Capacitor	3	$0.34	$1.02	Estimate
			SUBTOTAL	$45.55	

CanSat Budget

Components					
	Component	Quantity	Unit Price	Total price	Indication
Mechanical Design	PLA Plus	250gm	$0.4	$4	Estimate
	Nylon Cloth	180x180mm	$2	$4	Estimate
	Steel Wire	400mm	$4.59	$18	Estimate
	3-D Printing	-	-	$25	Estimate
			SUBTOTAL	$51	

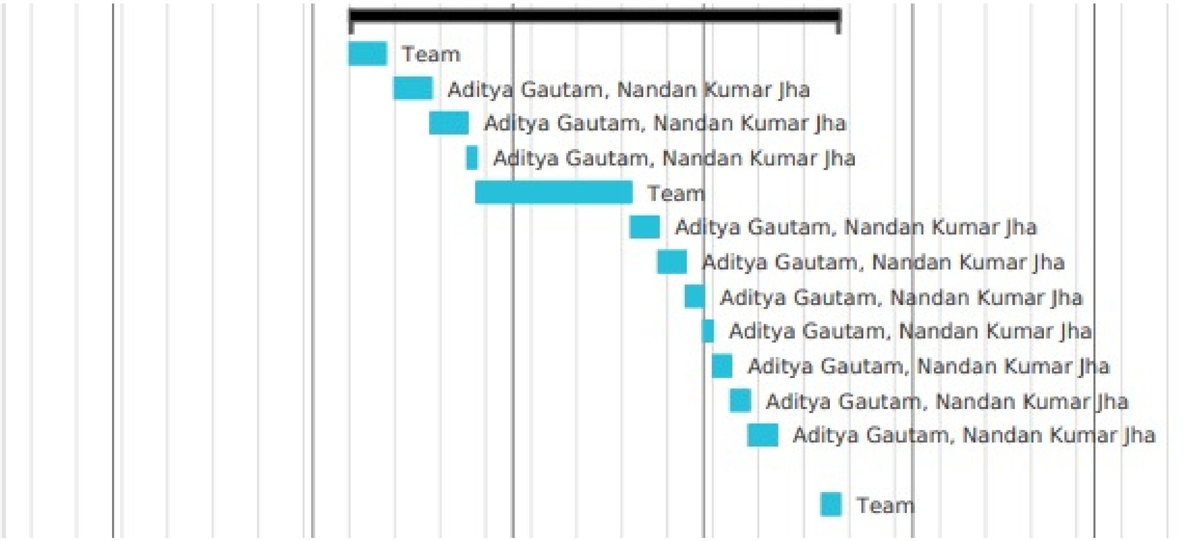
Program Schedule Overview

Overall project milestones and Ad...	0h	72%
Team formation	0	100%
Registration for the competition	0	100%
Mission Discussion	0	100%
Subsystem Division	0	100%
Analysis of elementary designs and i...	0	100%
Finalization of ideas and designs	0	100%
End Term Examinations	0	100%
Winter Break	0	100%
Initiation of PDR document	0	100%
Initiation for gathering sponsorships	0	100%
Finalisation of PDR document	0	100%
PDR submission	0	100%
PDR presentation	0	100%
Prototyping of Designs	0	0%
Mid Semester Test-1	0	0%
Preparation of CDR document	0	0%
Submission of CDR	0	0%
CDR presentation	0	0%
Flight Readiness Review	0	0%
Launch date	0	0%
PFR and Awards	0	0%

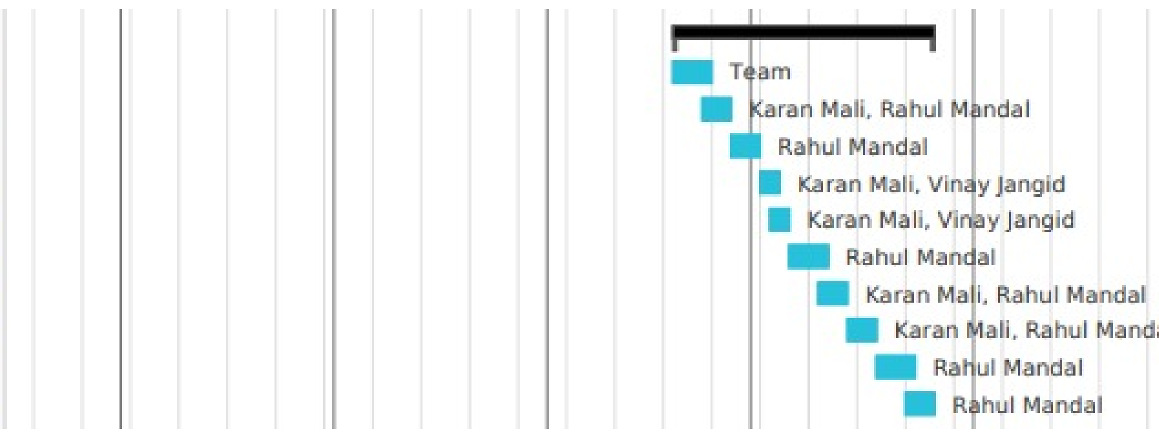


Detailed Program Schedule (1/3)

Descent Control System	0h	100%
Study Mission Guide	0	100%
3D CAD Modelling of Drogue Parachu...	0	100%
Material Selection for Drogue Parach...	0	100%
Finalisation of Drogue Parachute	0	100%
End Term Examinations	0	100%
Descent Estimation of Drogue Parac...	0	100%
3D CAD modelling of Heat shield with...	0	100%
Material selection for heat shield	0	100%
Finalisation of heat shield	0	100%
Descent Estimation of heat shield	0	100%
3D CAD modelling of Payload Parach...	0	100%
Material selection for Payload parac...	0	100%
Descent Estimation of Payload Parac...	0	100%
Dummy Testing of Drogue, Payload ...	0	100%



Communication and Data Handling	0h	100%
Study Mission guide	0	100%
Research on Modules	0	100%
Selection of Xbee for GCS to contain...	0	100%
Research on GCS antenna	0	100%
Trade and selection of antenna	0	100%
Calibrating Xbee with XCTU software	0	100%
Testing of Xbee with antennas	0	100%
Interlinking Xbee with MCU and other...	0	100%
Synchronization of Telemetry data	0	100%
Testing the final communication	0	100%



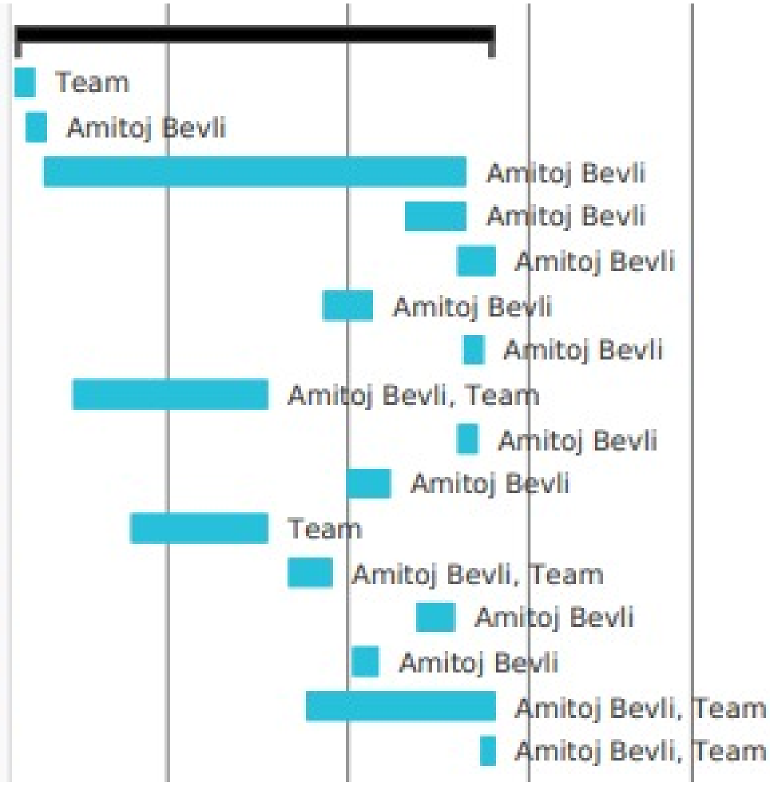
Detailed Program Schedule (2/3)

Electronics	**0h**	**100%**	
Study Mission guide	0	100%	Team
Research on sensors required	0	100%	Roopmeet Kaur, Vinay Jangid
Necessary sensors trade and selecti...	0	100%	Roopmeet Kaur, Vinay Jangid
GPS selection	0	100%	Vinay Jangid
End Term Examinations	0	100%	Team
Camera trade and selection	0	100%	Vinay Jangid
Payload sensors trade and selection	0	100%	Vinay Jangid
Research and selection of microcont...	0	100%	Roopmeet Kaur, Vinay Jangid
Memory card selection	0	100%	Vinay Jangid
Battery trade and selection	0	100%	Vinay Jangid
Testing and calibration of sensors	0	100%	Roopmeet Kaur, Vinay Jangid
Interlinking firmware	0	100%	Karan Mali, Vinay Jangid
Preparation of algorithms for schema...	0	100%	Roopmeet Kaur
Design schematics for container and...	0	100%	Karan Mali
Calculation of Power budget	0	100%	Roopmeet Kaur

FSW/GCS	**23/12/22**	**24/01/23**	**62%**	
Reading and Studying Software Requ...	23/12	24/12	100%	Team
Analysis of Software Layout	25/12	27/12	100%	Amulya Paritosh
Wire Framing the overall Architecture	28/12	29/12	100%	Amulya Paritosh, Shubhadip Mondal
Testing Microcontroller with Software	30/12	01/01	50%	Lokendra Kumar, Shubhadip Mondal
Selecting Suitable Development envi...	02/01	02/01	100%	Amulya Paritosh, Lokendra Kumar
UI/UX Requirement	03/01	03/01	100%	Amulya Paritosh, Lokendra Kumar
UI/UX design in Figma	05/01	07/01	100%	Amulya Paritosh, Shubhadip Mondal
Developing first Prototype of GCS	08/01	10/01	33%	Amulya Paritosh
Testing First Prototype with Radio C...	12/01	13/01	0%	Lokendra Kumar
Upgrading and Troubleshooting proto...	15/01	17/01	0%	Amulya Paritosh, Shubhadip Mondal
Testing COTS Libraries Efficiency	24/01	24/01	40%	Lokendra Kumar, Shubhadip Mondal

Detailed Program Schedule (3/3)

Mechanical Subsystem	**05/11/22**	**25/01/23**	**100%**
Brief analysis of Mission Guide	05/11	07/11	100%
Listing of requirement as per MIssion	07/11	09/11	100%
Preliminary design	10/11	20/01	100%
Evaluation And Analysis of Prelimina...	11/01	20/01	100%
Modified Design	20/01	25/01	100%
Stress Analysis	28/12	04/01	100%
Evaluation and analysis of Modified ...	21/01	23/01	100%
Trade and selection of material used ...	15/11	17/12	100%
Upgraded design after Analysis and ...	20/01	22/01	100%
Design of parachute Deployment Me...	01/01	07/01	100%
End Term Examinations	25/11	17/12	100%
Design of Gyroscope to stabilise Con...	22/12	28/12	100%
Integration of payload into container	13/01	18/01	100%
Bottom Lid Lock Design	02/01	05/01	100%
Evaluation of complete design	25/12	25/01	100%
List of mass budget	24/01	25/01	100%



Conclusions

Major Accomplishments

- Selection of all sensors/components.
- UI of software and architecture of FSW is ready.
- Mechanical conceptual design completed prototyping started.
- Sponsorship granted.

Major Unfinished Work

- Prototype Manufacturing of CanSat Chassis(s).
- Environmental testing of CANSAT

- Why you are ready to proceed to next stage of development ?

"We feel that we maintain a complete understanding of the mission requirements while taking into account our designed concepts in PDR."

As a result, with the support of the institute, we are prepared for the next stage of development.

We hope to meet you in the next stage....

Team VANDE