CanSat 2020
Preliminary Design Review (PDR)
Outline
Version 1.0a

Team # 3720

Gizmo AVASKR

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Presentation Outline

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- **Systems Overview –** Adya Singh
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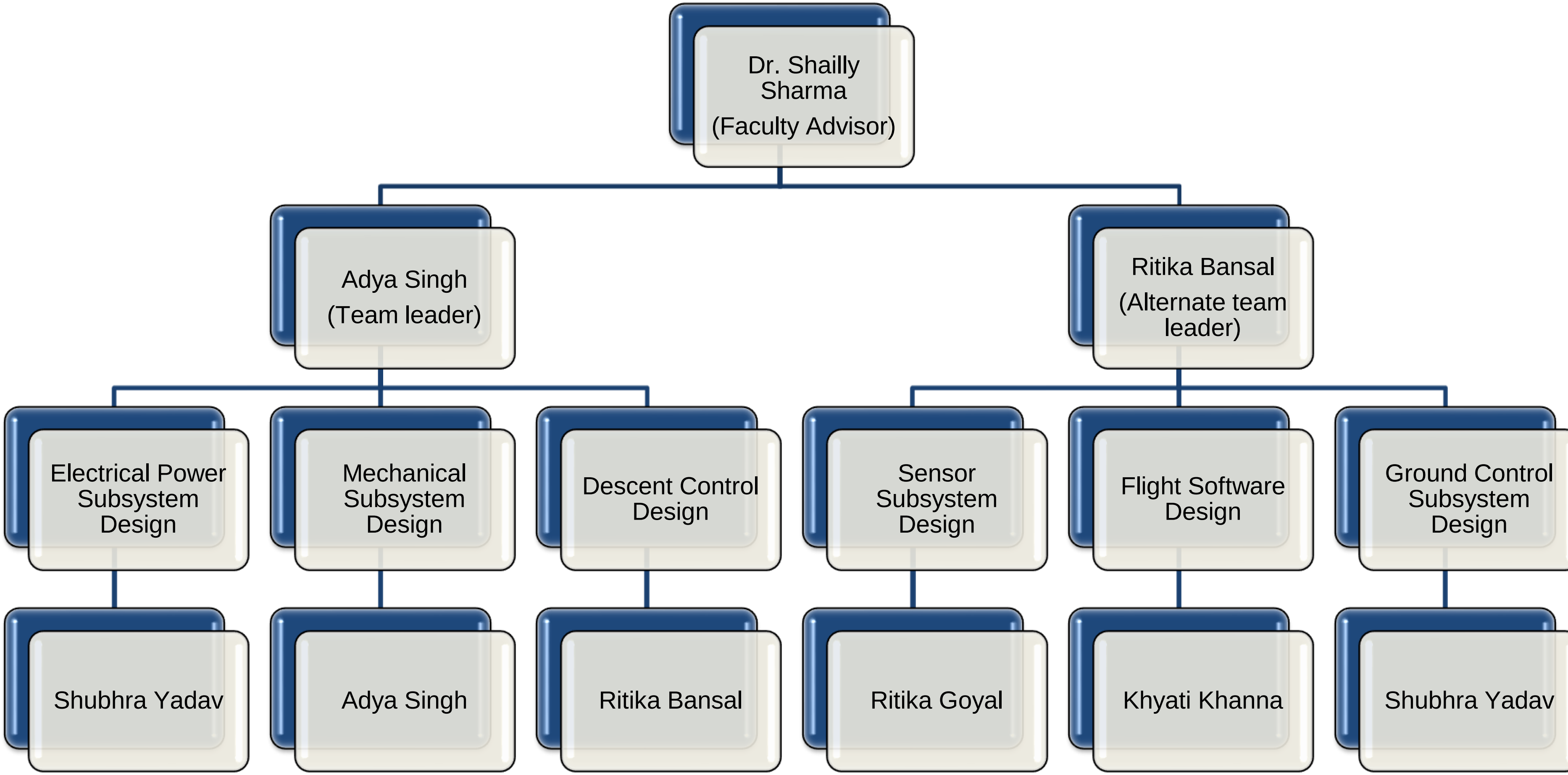
- **Descent Control Design –** Ritika Bansal
- **Mechanical Subsystem Design –** Adya Singh
- **CDH Subsystem Design –** Shubhra Yadav
- **Electrical Power Subsystem Design –** Ritika Bansal
- **Flight Software Design –** Khyati Khanna
- **Ground Control System Design –** Shubhra Yadav
- **CanSat Integration and Test –** Khyati Khanna
- **Mission Operations and Analysis –** Ritika Goyal
- **Requirements Compliance –** Aditi Kulshrestha
- **Management –** Aditi Kulshrestha

Team Organisation

Name	Year	Subject of Study
Aditi Kulshrestha	3	Mechatronics
Adya Singh	3	Electrical and Electronics
Khyati Khanna	2	Electronics and Instrumentation
Ritika Bansal	3	Mechatronics
Ritika Goyal	3	Electronics and Instrumentation
Shubhra Yadav	3	Electronics and Instrumentation

FACULTY ADVISOR	Dr. Shailly Sharma	Department of Automation, Banasthali University

Team Organisation



Acronyms

- **.CSV** -Comma Separated Value
- **A**-Analysis
- **ABS –**Acrylonitrile Butadiene
- **A/D –**Analog or Digital
- **API -**Application Program Interface
- **AC -**Alternating Current
- **CDH** –Communication & Data Handling
- **CR**–Competition Requirement
- **COG**-Center of Gravity
- **D**-Demonstration
- **DCS** -Descent Control System
- **EEPROM** -Electrically Erasable Programmable Read Only Memory
- **FSW**-Flight Software
- **GCS**-Ground Control System
- **GPS**-Global Positioning System
- **GUI**-Graphical User Interface
- **I**-Inspection

Acronyms

- **IDE**-Integrated Development Environment
- **I2C**-Inter -Integrated Circuit
- **I.E**–That is
- **LED**–Light Emitting Diode
- **Li -ion**–Lithium Ion
- **MCU**–Micro controller
- **MSD**–Mechanical Subsystem Design
- **NI-CAD**–Nickel Cadmium
- **NI-MH**-Nickel Metal Hydride
- **NO –**Normally Open
- **PCB**–Printed Circuit Board
- **RTC**–Real Time Clock
- **RF Communication** –Radio Frequency Communication
- **RP-SMA**–Reverse Polarity Subminiature Version A

Acronyms

- **RPM –**Revolution per minute
- **RX**–Receiver
- **SD** Card -Secure Digital Card
- **SPI**–Serial Peripheral Interface
- **SSR**–Sensor Subsystem Requirements
- **Sync –**Synchronization
- **T**-Testing
- **TTL**–Transistor Transistor Logic
- **TX** –Transmitter
- **UART**–Universal Asynchronous Receiver –Transmitter
- **USB**–Universal Serial Port
- **VM**–Verification Method

System Overview

Adya Singh

MISSION OBJECTIVE

Design a CanSat that will consist of a container and a science payload. The science payload shall be a delta wing glider that will glide in a circular pattern, once released.

- The CanSat shall be launched to an altitude ranging 670 meters to 725 meters above the launch site and deployed near apogee (peak altitude).
- Once the CanSat is deployed from the rocket, the CanSat shall descend using a parachute at a descent rate of 20 m/s.
- At 450 meters, the container shall release the science payload. The science payload shall glide in a circular pattern with a radius of 250 meters collecting sensor data for one minute and remain above 100 meters after being released. Afterwards, the glider shall deploy a parachute to cause the glider to stop gliding and drop to the ground at a rate of 10 meters/second.
- The science payload shall monitor altitude, air speed and the science payload shall be a particulate matter/dust sensor to detect particulates in the air while gliding.

MISSION BONUS OBJECTIVE

- A video camera shall be integrated into the science payload and point toward the coordinates provided for the duration of the glide time.
- Video shall be in color with a minimum resolution of 640x480 pixels and 30 frames per second. The video shall be recorded and retrieved when the science payload is retrieved.
- Points will be awarded only if the camera can maintain pointing at the provided coordinates for 30 seconds uninterrupted.

EXTERNAL OBJECTIVE

- Show the track of CanSat location on the map.
- Funding for project’s hardware and logistic.
- Grant Real Time Testing environment
- Seek for sponsorship for the CanSat cost and travel fare for all the team members.

System Requirement Summary

ID	Requirements	Rationale	Priority	VM
SOR-01	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	CR	HIGH	A,I
SOR-02	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	CR	HIGH	A,I,D
SOR-03	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Easy deployment	HIGH	A,D
SOR-04	The container shall be a fluorescent color; pink, red or orange	Increase visibility	HIGH	D
SOR-05	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	CR	HIGH	A,D

System Requirement Summary

ID	Requirements	Rationale	Priority	VM
SOR-06	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	CR	HIGH	A,I,D
SOR-07	The rocket airframe shall not be used as part of the CanSat operations.	CR	HIGH	A,I,D
SOR-08	The container 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.	CR	HIGH	A
SOR-09	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	CR	HIGH	A,I
SOR-10	The container shall release the payload at 450 meters +/- 10 meters.	CR	HIGH	A,I
SOR-11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	CR	HIGH	A,I

System Requirement Summary

ID	Requirements	Rationale	Priority	VM
SOR-12	The science payload shall be a delta wing glider.	CR	HIGH	A
SOR-13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s.	CR	HIGH	A,I
SOR-14	All descent control device attachment components shall survive 30 Gs of shock.	Survival ability	HIGH	A,I
SOR-15	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Environmental protection	HIGH	A,I
SOR-16	All structures shall be built to survive 15 Gs of launch acceleration.	Survival ability	HIGH	A,I
SOR-17	All structures shall be built to survive 30 Gs of shock.	Survival ability	HIGH	A,I

System Requirement Summary

ID	Requirements	Rationale	Priority	VM
SOR-18	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Survival ability	HIGH	A,I,D
SOR-19	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Survival ability	HIGH	A,I
SOR-20	Mechanisms shall not use pyrotechnics or chemicals.	No unwanted reaction	HIGH	D
SOR-21	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.	Fire safety	HIGH	D
SOR-22	The science payload shall measure altitude using an air pressure sensor.	CR	HIGH	A,I,T
SOR-23	The science payload shall provide position using GPS.	CR	HIGH	A,I,T

System Requirement Summary

ID	Requirements	Rationale	Priority	VM
SOR-24	The science payload shall measure its battery voltage.	CR	HIGH	A,I,T
SOR-25	The science payload shall measure outside temperature.	CR	HIGH	A,I,T
SOR-26	The science payload shall measure particulates in the air as it glides.	CR	HIGH	A,I,T
SOR-27	The science payload shall measure air speed.	CR	HIGH	A,I,T
SOR-28	The science payload shall transmit all sensor data in the telemetry.	CR	HIGH	A,I
SOR-29	The science payload shall transmit all sensor data in the telemetry.	CR	HIGH	A,D
SOR-30	The Parachutes shall be fluorescent Pink or Orange	Increase visibility	HIGH	D
SOR-31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	CR	HIGH	A,I,T

System Requirement Summary

ID	Requirements	Rationale	Priority	VM
SOR-32	The ground station shall generate a .csv file of all sensor data as specified in the telemetry section.	CR	HIGH	A,I,T
SOR-33	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	CR	HIGH	A,I,T
SOR-34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	CR	HIGH	A,I,T
SOR-35	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	CR	HIGH	A,I,D
SOR-36	XBEE radios shall have their NETID/PANID set to their team number.	CR	HIGH	A,I,D

System Requirement Summary

ID	Requirements	Rationale	Priority	VM
SOR-37	XBEE radios shall not use broadcast mode.	CR	HIGH	A,I,D
SOR-38	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	CR	HIGH	A
SOR-39	Each team shall develop their own ground station.	CR	HIGH	D
SOR-40	All telemetry shall be displayed in real time during descent.	CR	HIGH	A,T
SOR-41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	CR	HIGH	A,T,D
SOR-42	Teams shall plot each telemetry data field in real time during flight.	CR	HIGH	A
SOR-43	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	CR	HIGH	A,D

System Requirement Summary

ID	Requirements	Rationale	Priority	VM
SOR-44	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.	CR	HIGH	A,T,D
SOR-45	Both the container and probe shall be labeled with team contact information including email address.	CR	HIGH	D
SOR-46	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.	CR	HIGH	A,T,D
SOR-47	No lasers allowed.	CR	HIGH	A,D
SOR-48	The probe must include an easily accessible power switch that can be accessed without disassembling the CanSat and in the stowed configuration.	CR	HIGH	A,D

System Requirement Summary

ID	Requirements	Rational	Priority	VM
SOR-49	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the CanSat and in the stowed state.	CR	HIGH	A,D
SOR-50	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	CR	HIGH	A.T
SOR-51	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	CR	HIGH	D
SOR-52	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.	CR	HIGH	A,D
SOR-53	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	CR	HIGH	A,I

System Requirement Summary

ID	Requirements	Rational	Priority	VM
SOR-54	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	CR	HIGH	A,D
SOR-55	The CANSAT must operate during the environmental tests laid out in Section 3.5.	CR	HIGH	D
SOR-56	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	CR	HIGH	A,I,T
SOR-57	A video camera shall be integrated into the science payload and point toward the coordinates provided for the duration of the glide time. Video shall be in color with a minimum resolution of 640x480 pixels and 30 frames per second. The video shall be recorded and retrieved when the science payload is retrieved. Points will be awarded only if the camera can maintain pointing at the provided coordinates for 30 seconds uninterrupted.	Bonus Requirement	MEDIUM	A,I,T

CONFIGURATION 1: TOKYO FAN FOLDING BASED

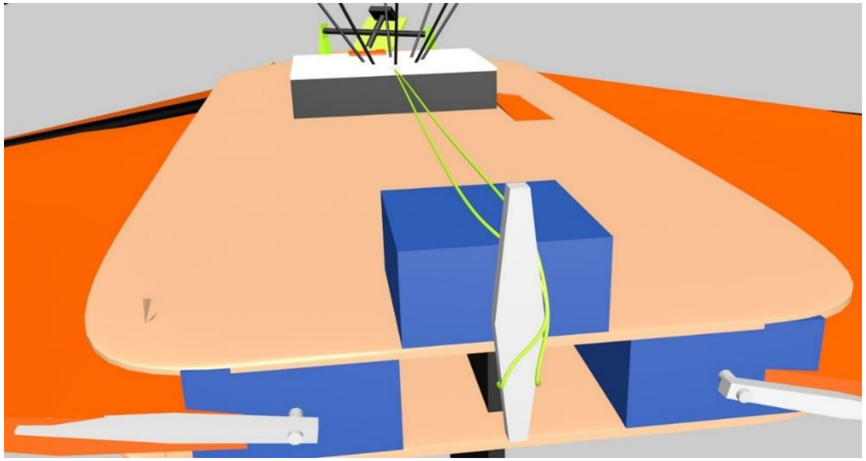
Science Payload

- The science payload is a delta wing glider.
- The fuselage houses the electronics, placed at the centre of gravity (centroid) of the delta wing glider.
- Foldable wings (Tokyo fan foldings) fit inside the cavities made by separating two carbon plates in the fuselage while inside the Can and are held together in fan foldings.
- Carbon rods at the edges of the wings provide strength and stability to the structure.
- The fuselage is more convex at the top with a very slight curvature at the bottom so as to minimize the drag and maximize the lift.

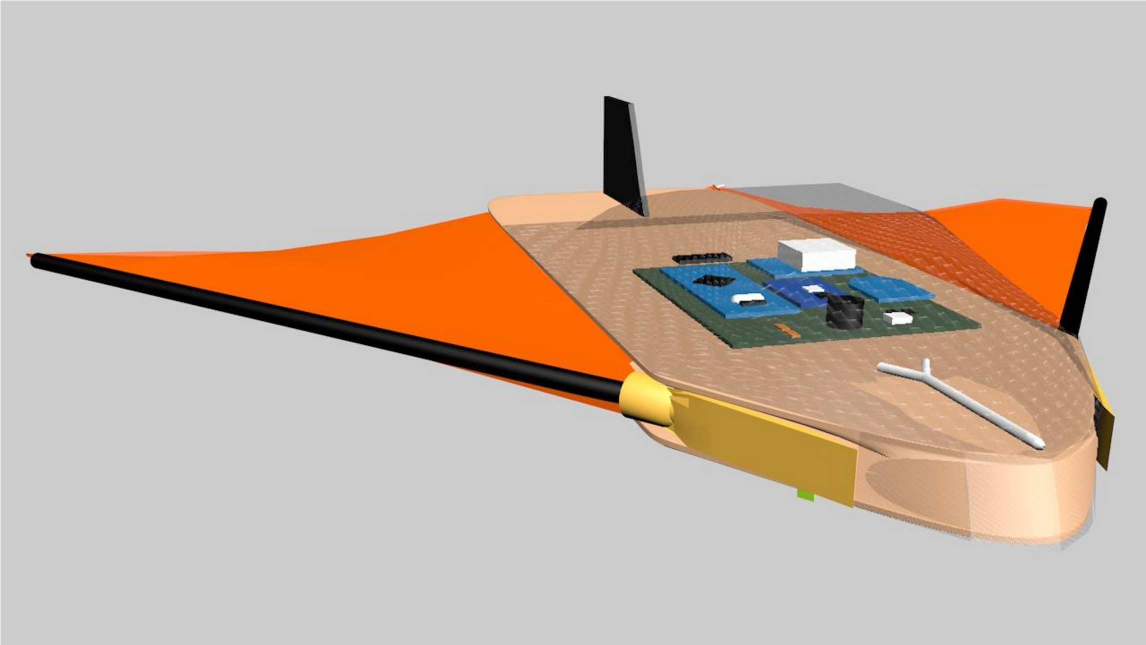
CONFIGURATION 1: TOKYO FAN FOLDING BASED (CONTINUED…)

Science Payload

- The wings are made up of nylon fabric so as to minimize the weight of the science payload.
- Ailerons are to be controlled by two servo motors.
- The fuselage has a base plate and a top plate in between which the cavity is made to house the folded wings and the carbon rod while the payload is in the stowed condition.
- Autopilot mechanism is used to control the trajectory of our glider.



CONFIGURATION 1: TOKYO FAN FOLDING BASED (CONTINUED…)



CONFIGURATION 1: TOKYO FAN FOLDING BASED (CONTINUED…)

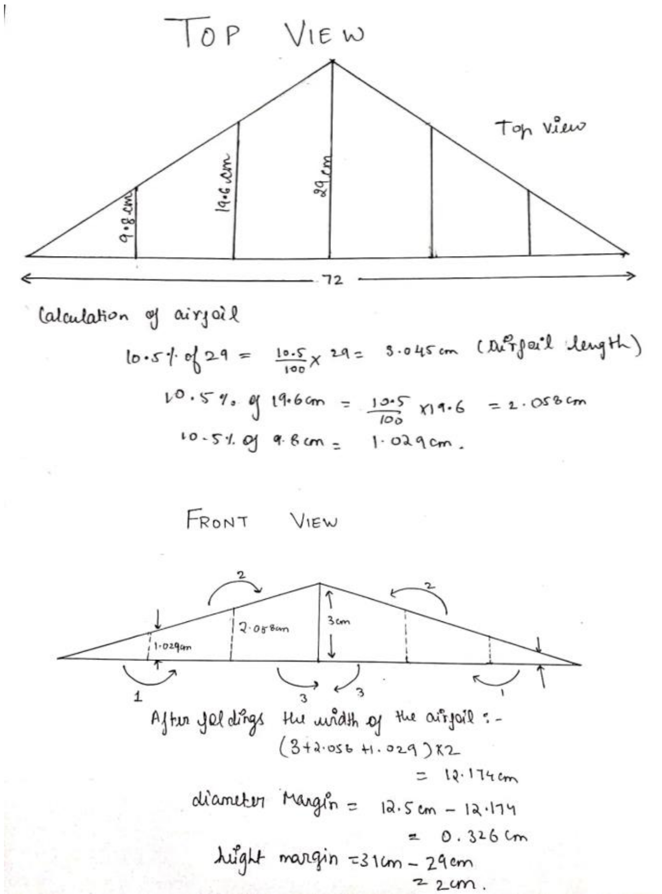
Container

- The cylindrical container structure includes four carbon rods an ABS ring with a lamination sheet that is transparent to reduce the printing weight, covering it from outside.
- No electronics is associated with the container.
- Passively openable side exit door.
- Compartment at the top for parachute storage.
- Parachute is attached to the container by a eyebolt hook.
- Parachute deploys passively.

CONFIGURATION 2: MULTIPLE FOLDINGS BASED

Science Payload

- The Science Payload is simple structure made up of Balsa wood.
- Consists of cambered airfoil.
- It consists of two foldings on one side similarly on the other side of the fuselage(from their edge as axis of rotation).
- The Fuselage compartment will mount all the electronics part placed at the center of the gravity.
- Auto pilot mechanism is used to control the trajectory of our glider.



CONFIGURATION 2:

Container

- Simple ABS printed cylindrical structure.
- A servo with a centre spring is used for releasing the science payload from the container.
- No electronics is associated with the container.
- Exit door is passively openable.
- Parachute compartment is present at the top of the container.
- Parachute attached with a fish hook.
- Parachute deploys passively.

PROS AND CONS

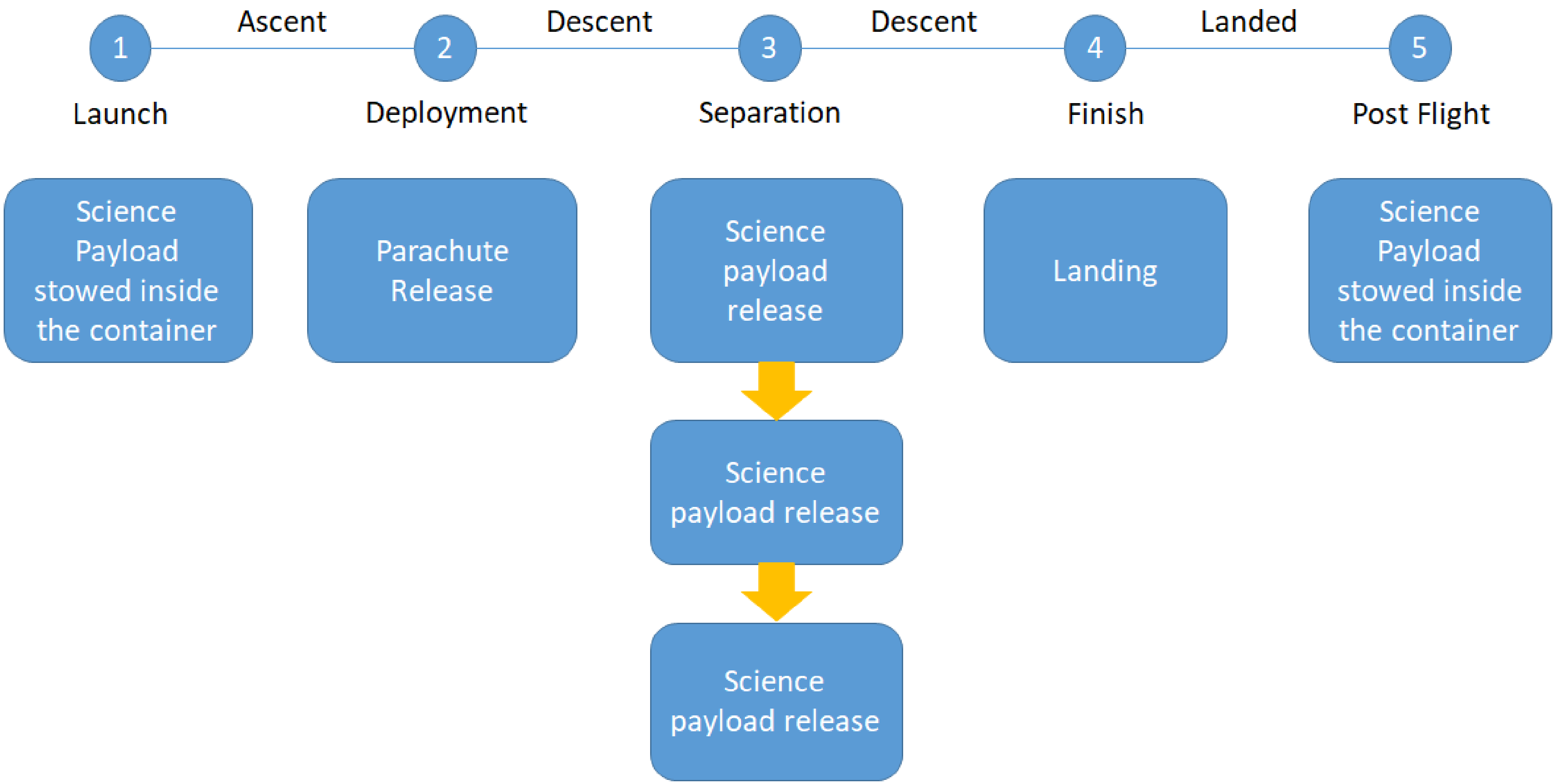
S.No	Tokyo Fan Folding Based	Multiple folds (Balsa Wood) based
1.	Wings are easy to fold and fit inside the container.	Wings are difficult to fold and fit inside the container.
2.	Rods are easily being connected to two hinges and rivets at head of the fuselage.	Multiple hinges in the carbon rod increasing the weight of Science Payload.
3.	Makes an aerodynamically stable structure.	Makes a structure having low aerodynamic stability.
4.	Simple structure.	Complex structure.
5.	Ailerons and elevators can be made out of existing nylon fiber wing , so no need of extra material .	Extra material is required for vertical stabilizer mechanism.
6.	Wings are easy to stretch open up during deployment.	Wings are complex to stretch open during deployment.

Selected Configuration: Tokyo Fan Folding Based

REASONS

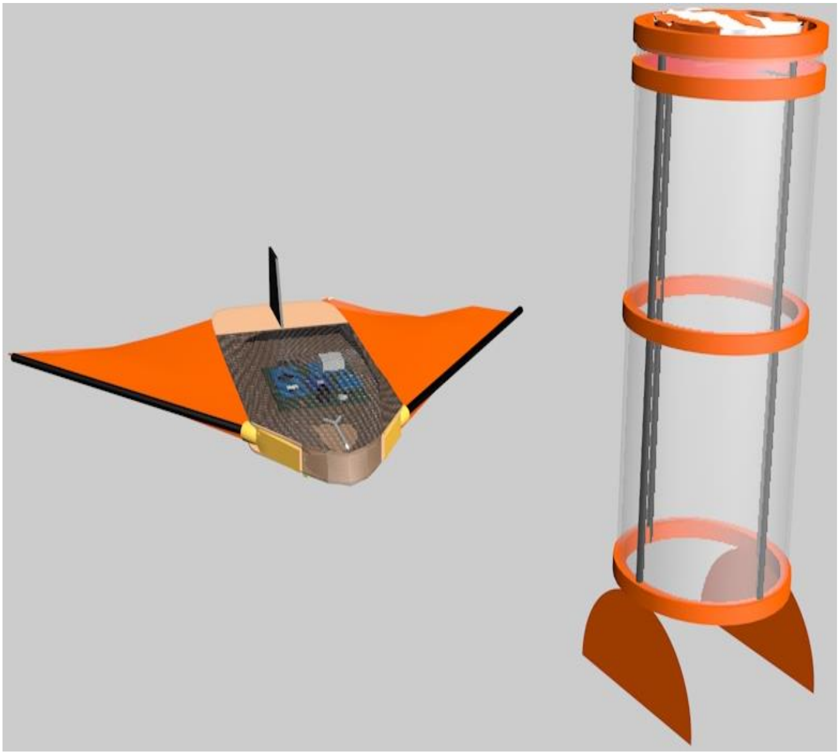
- Aerodynamic stability
- Simple structure
- Easy deployment

System Level CanSat Configuration Trade & Selection

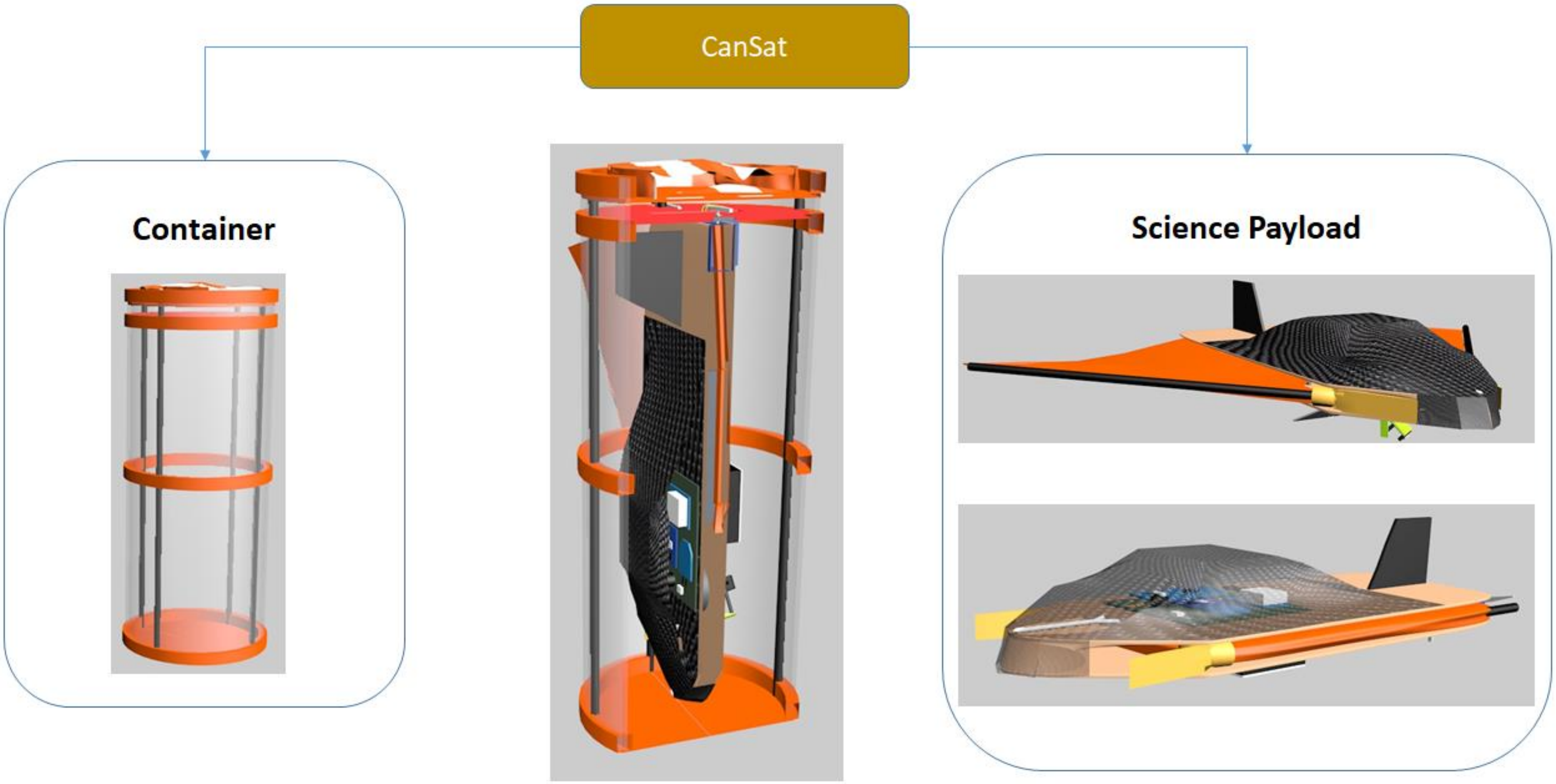


CONFIGURATION 1: TOKYO FAN FOLDING BASED (selected)

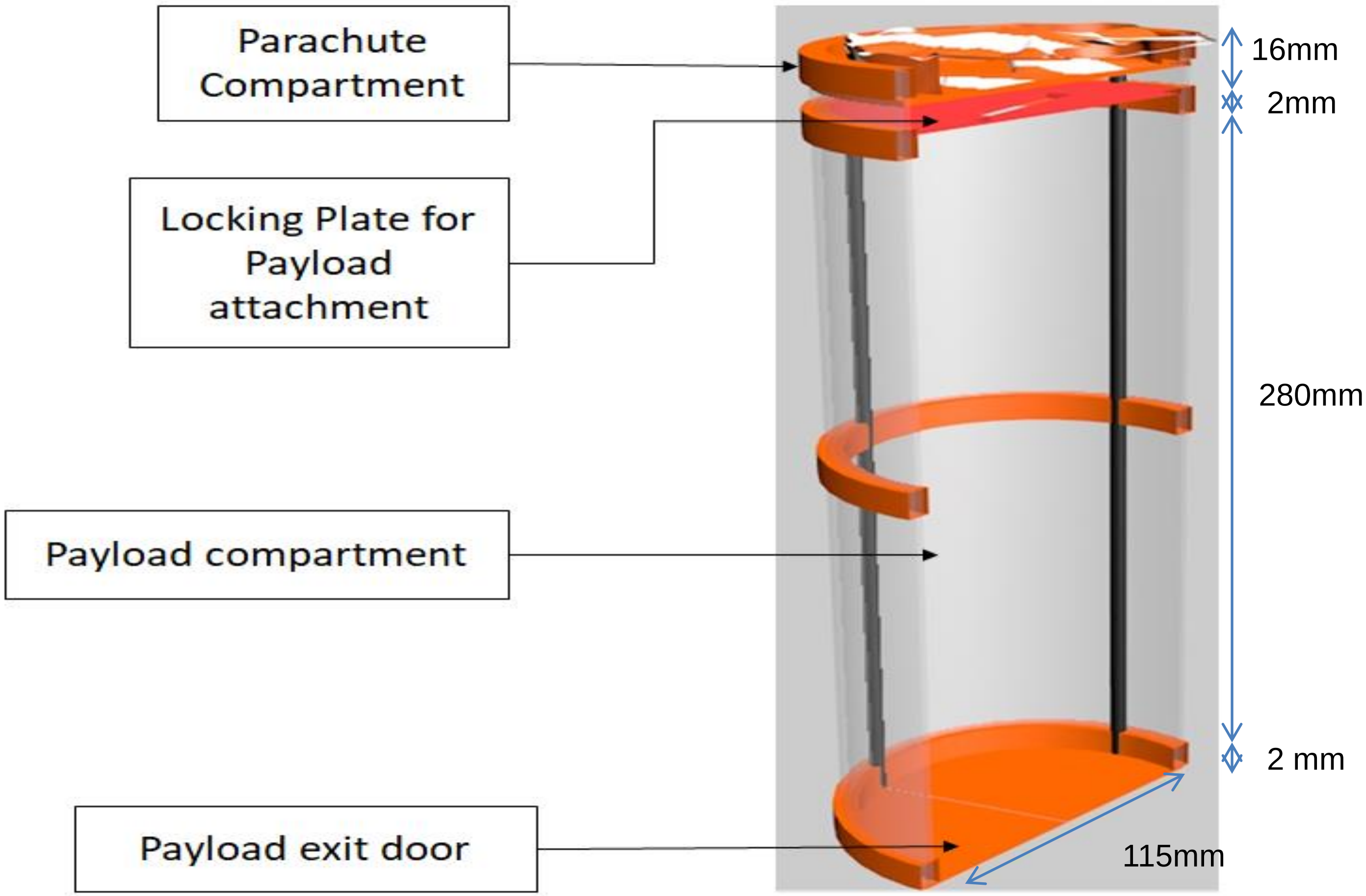
- Simple sliding mechanism for carbon rods used inside the container.
- Cambered airfoil on the fuselage
- making the structure aerodynamically stable.
- No electronics mounted on the container. PCB is housed inside the science payload.
- Weight is distributed so as to allow maximum lift.
- Vertical stabilizer is used.
- Easy to fold and fit inside the container.
- Wings are easy to open on deployment of payload.
- Transparent lamination sheet to check LED indication.



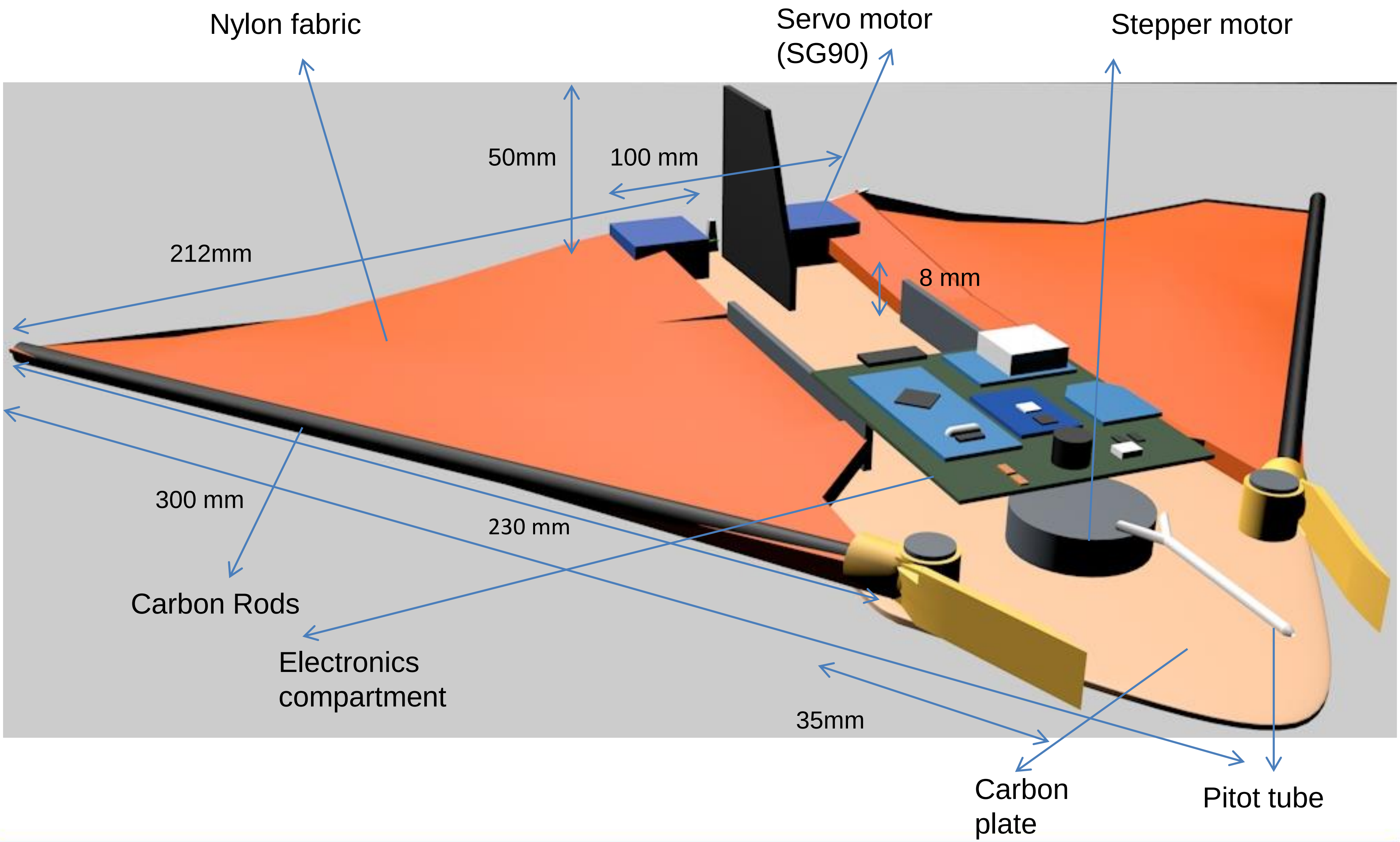
Physical Layout



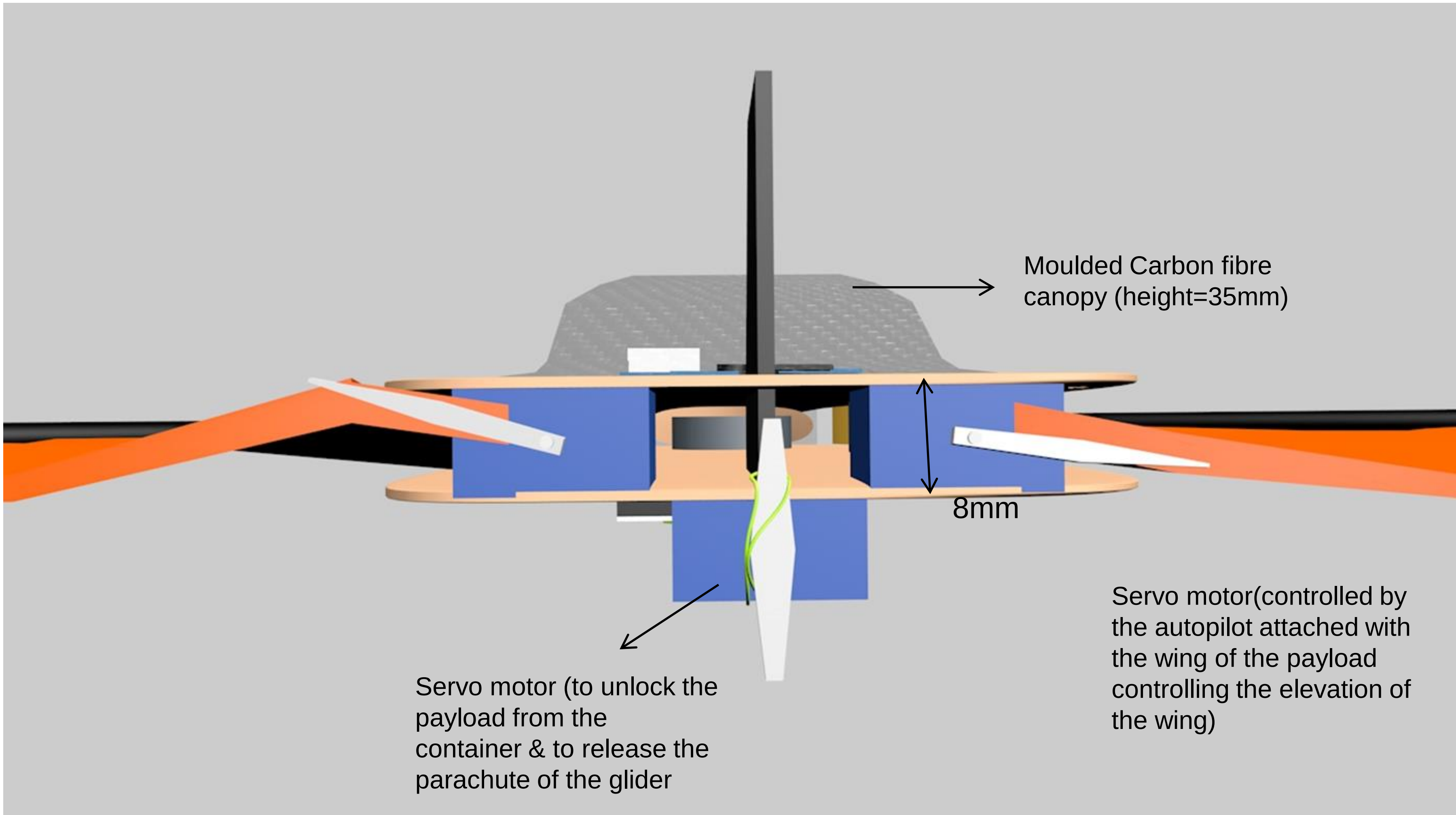
CONTAINER


Parachute Compartment
Locking Plate for Payload attachment
Payload compartment
Payload exit door
16mm
2mm
280mm
2 mm
115mm

Physical Layout

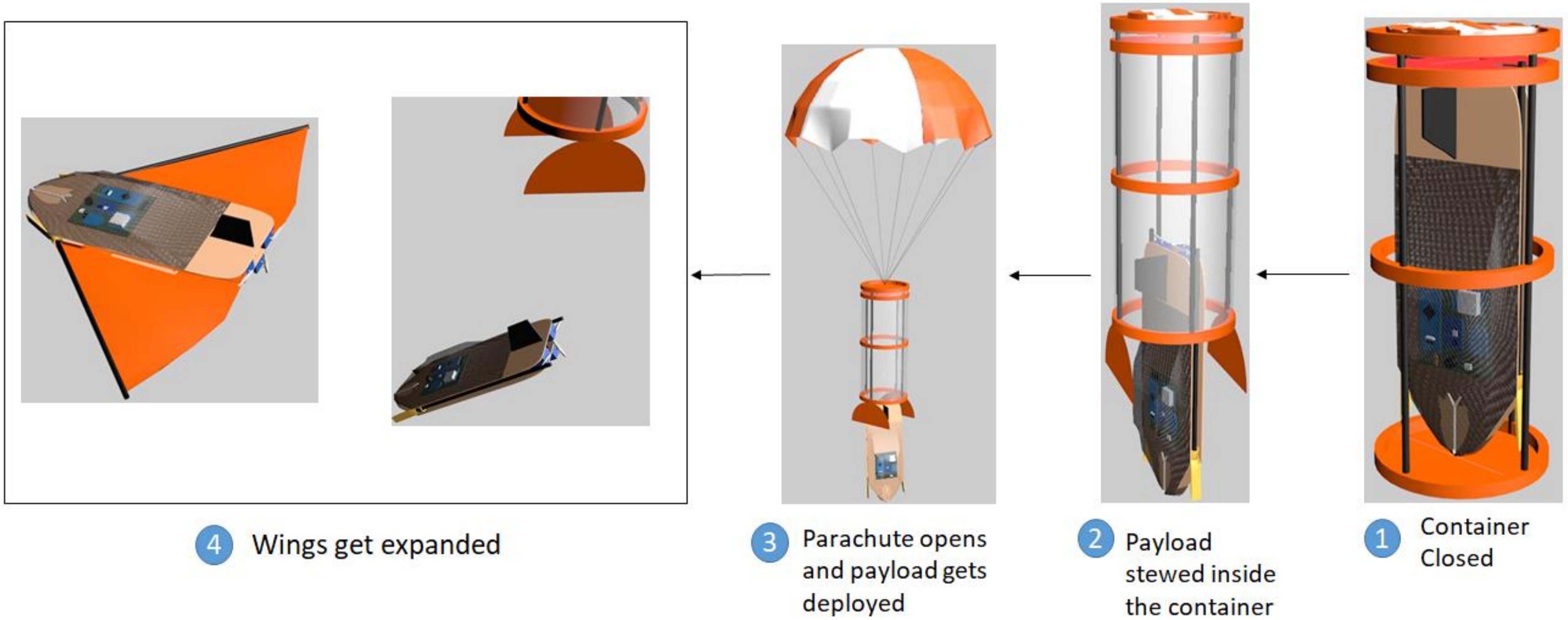


Physical Layout



CanSat Assembly

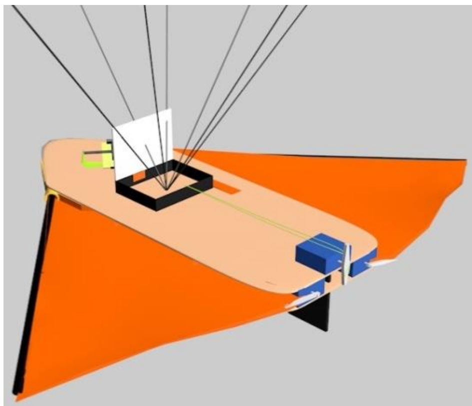
Operation 1: From apogee to 450m

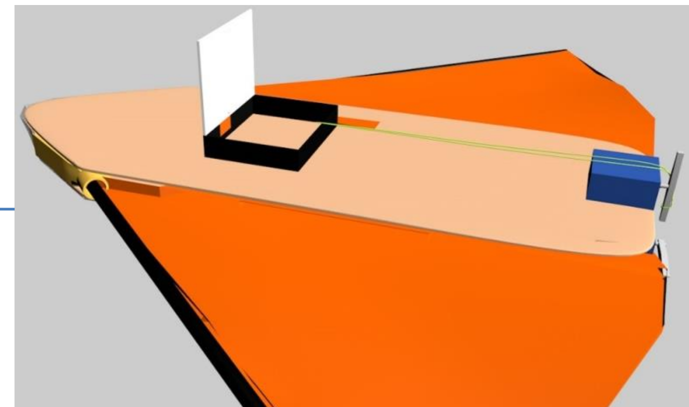


CanSat Assembly

Operation 2: From 100m to ground

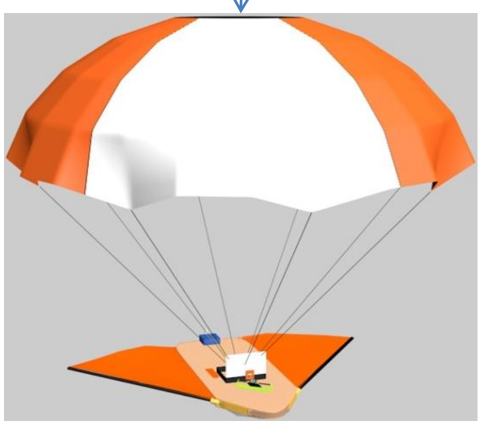
Parachute is deployed

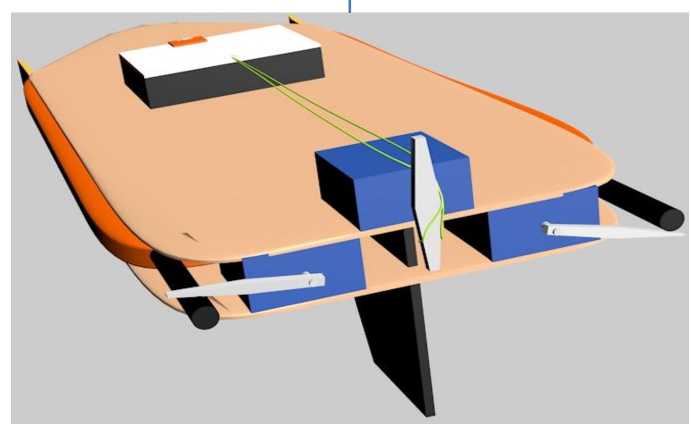




Motor after receiving command opens the compartment of the parachute

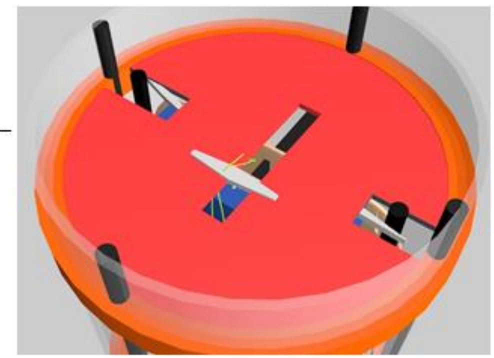
Payload descents at the rate of 10m/s



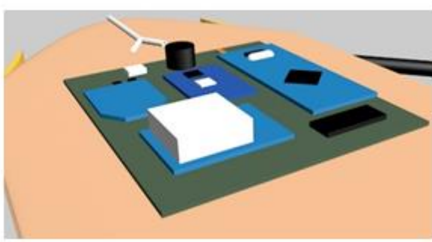


PLACEMENT OF MAJOR COMPONENTS

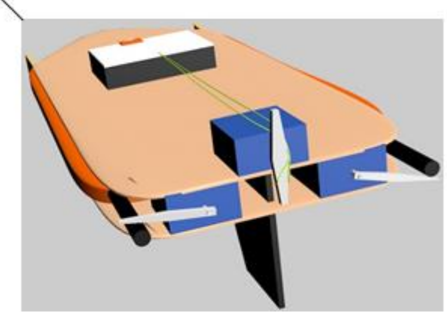
parachute



Container lock

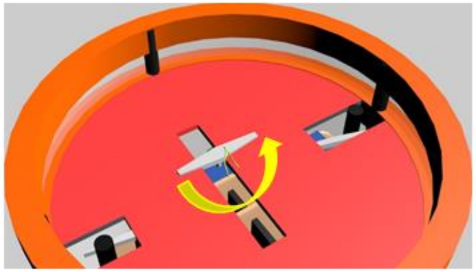


Electronics compartment

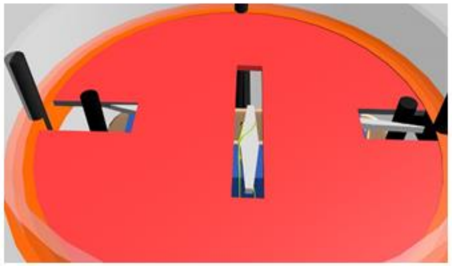


Delta glider rod lock

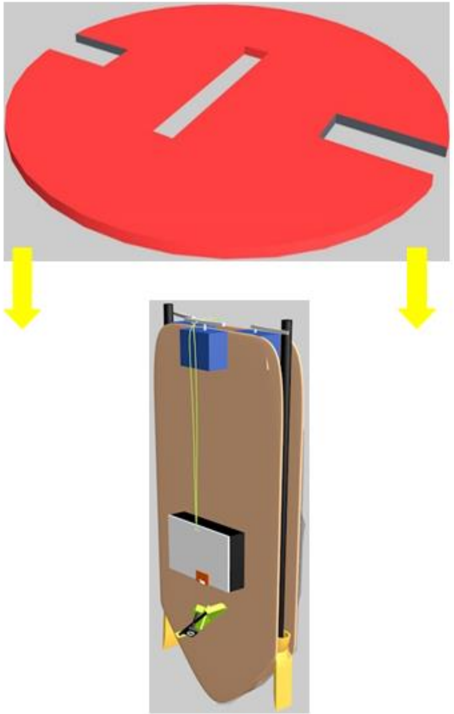
CONTAINER RELEASE MECHANISM



1. Container locked



2. Container unlocked



3. Container Separated

The lock key will rotate to unlock the container from the Science Payload

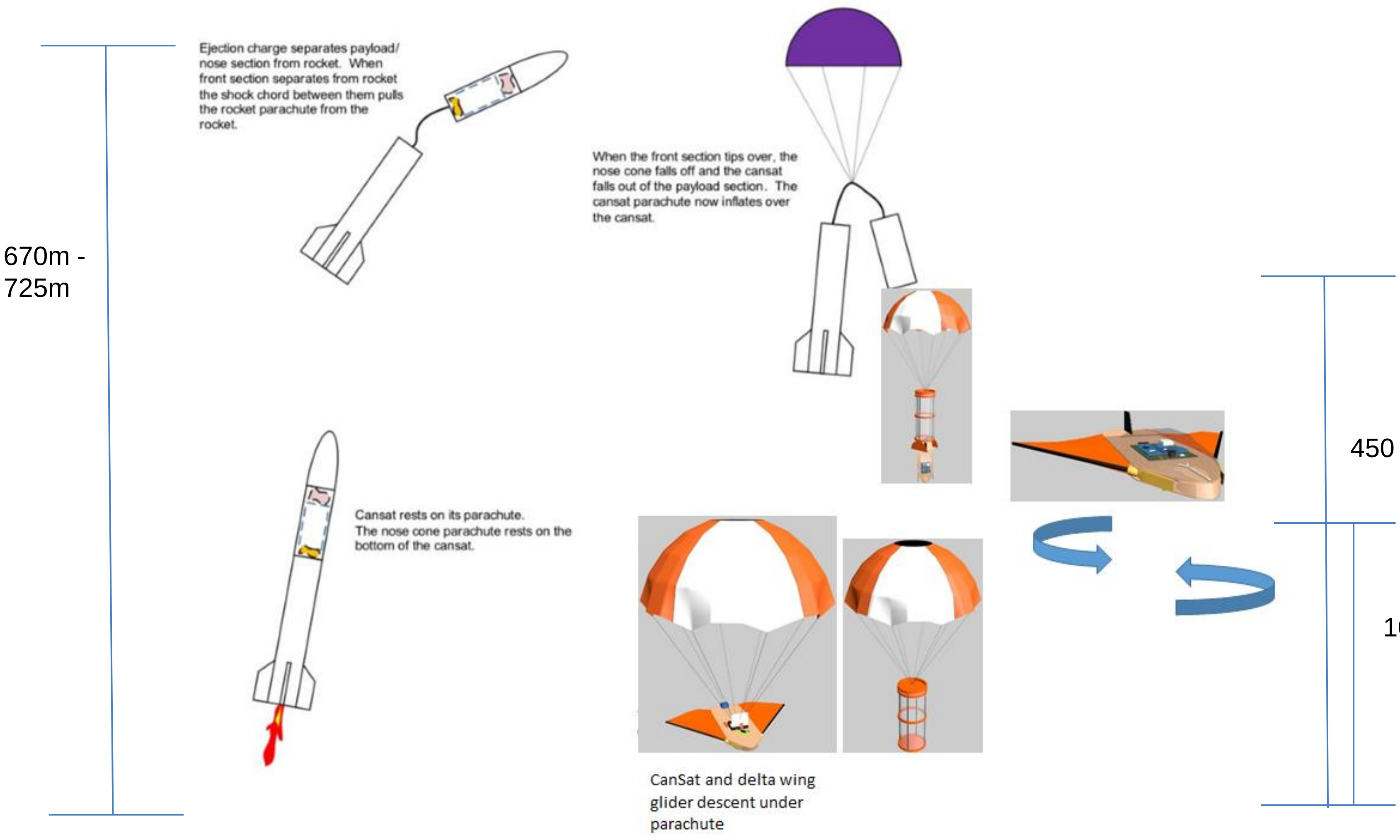
DELTA GLIDER DEPLOYMENT MECHANISM

1. Carbon rods locked

2. Carbon rods unlocked

On the release of delta glider, the leading tip of the carbon rods will align with the leading tip of the fuselage, hence opening the wings to their full span

System Concept of Operations



System Concept of Operations

1. Pre Flight
- ✓ System Checks
- ✓ Communication Establishment

2. Launch Pad
- ✓ CanSat integration to rocket
- ✓ Sensor calibration and Xbee configuration.

3. Ascent
- ✓ Data transmission through telemetry
- ✓ Launch (670 to 725m)

4. CanSat Deployment
- ✓ Parachute deployment
- ✓ Descent @20m/s from apogee to 450m above launch site

5. Deployment of Payload
- ✓ Science payload released at 450m.
- ✓ Camera is ON
- ✓ Delta wing glider revolves in circular pattern of radius 250m using autopilot mechanism

6. At 100m
- ✓ Descent @10m/s

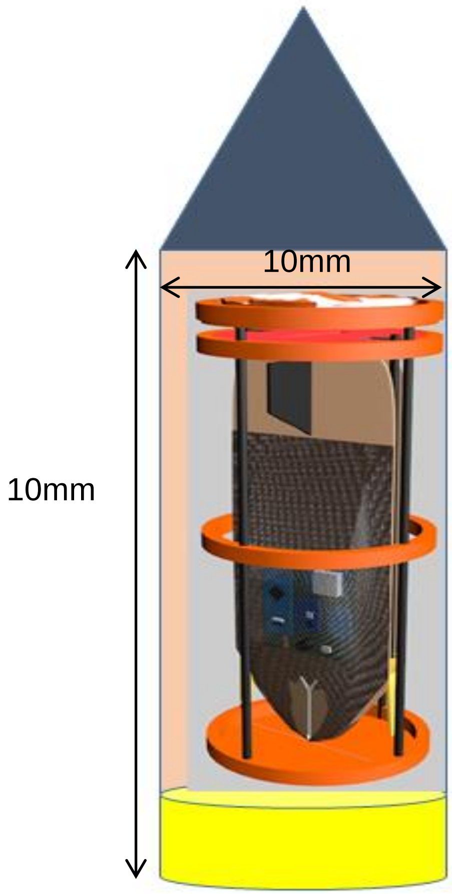
7. Ground
- ✓ Landing
- ✓ Audio beacon trigger
- ✓ Recovery

8. Post Flight
- ✓ Video and telemetry inspection by judges
- ✓ PRF preparation and presentation

Launch Vehicle Compatibility

Section	Width (mm)	Height (mm)
Rocket Payload Section	125	310
CanSat	115	300
Margin	10	10

- No sharp edges on the CanSat surface.
- Science Payload is placed inverted inside the container and the CanSat is placed straight inside the rocket for easy deployment.
- The CanSat is designed with provided parameters as in mission guide 2020, with safe tolerance.



Sensor Subsystem Design

Ritika Goyal

Sensor Subsystem Overview

S.NO	TYPE	MODEL	PURPOSE
1.	Pressure sensor	BMP 388	To measure the outside pressure and altitude
2.	Temperature sensor	BMP 388	To measure the outside temperature
3.	GPS	Ublox neo 6M	To get GPS information
4.	Voltage sensor	Voltage divider	To know the battery voltage
5.	Air speed sensor	mRo-MS5525V2	To know the air speed
6.	Air particulates sensor	PM 2.5 GP2Y1010AUOF	To know the amount of dust in air
7.	Camera	Y2000	To capture descend video

Sensor Subsystem Requirements

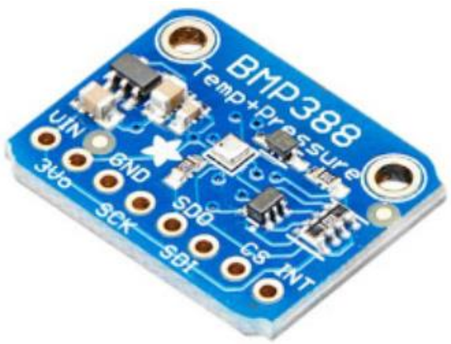
ID	REQUIREMENTS	RATIONALE	PRIORITY	VM
SSD-1	The science payload shall measure altitude using an air pressure sensor	CR	HIGH	A,I,T
SSD-2	The science payload shall provide position using GPS	CR	HIGH	A,I,T
SSD-3	The science payload shall measure its battery voltage	CR	HIGH	A,I,T
SSD-4	The science payload shall measure outside temperature	CR	HIGH	A,I,T
SSD-5	The science payload shall measure particulates in the air as it glides	CR	HIGH	A,I,T
SSD-6	The science payload shall measure air speed	CR	HIGH	A,I,T
SSD-7	A video camera shall be integrated into the science payload and point toward the coordinates provided for the duration of the glide time. Video shall be in color with a minimum resolution of 640x480 pixels and 30 frames per second. The video shall be recorded and retrieved when the science payload is retrieved. Points will be awarded only if the camera can maintain pointing at the provided coordinates for 30 seconds uninterrupted.	Bonus Requirement	MEDIUM	A,I,T

Payload Air Pressure Sensor Trade & Selection

Payload Air Pressure Sensor	Size (mm)	Weight (g)	Pressure Range (hpa)	Operating Voltage(V)	Relative Accuracy (Pa)	Interfacing	
BMP280	2x2x0.9	1.3	300-1100	3-5	12	I2C, SPI	
BMP388	2x2x0.75	1.2	300-1250	3-5	8	I2C,SPI	

CHOSEN DEVICE : BMP 388

REASONS:
- Low power consumption
- High accuracy
- High measurement rate
- Acts as temperature sensor also at the same time



Payload Air Temperature Sensor Trade & Selection

Payload Air Pressure Sensor	Size (mm)	Weight (g)	Pressure Range (hpa)	Operating Voltage(V)	Relative Accuracy(Pa)	Interfacing	Cost
BMP280	2x2x0.9	1.3	300-1100	3-5	12	I2C, SPI	$3.15
BMP388	2x2x0.75	1.2	300-1250	3-5	8	I2C,SPI	$2.10

<u>CHOSEN DEVICE : BMP 388</u>

REASONS:

- Low power consumption
- High accuracy
- High measurement rate
- Acts as pressure sensor also at the same time

GPS Sensor Trade & Selection

GPS Module	Interface	Operating Voltage	Accuracy	Size	Weight	Price
Ublox NEO 6m	UART, SPI, I2C	3.3V-5V	2m	25mmx35mm	12g	$11.33
GPS GLONASS Dual GNSS Module	TTL, UART	5V	2m	40mmx40mm	16g	$7.81

CHOSEN MODULE: UBLOX NEO 6M

- Low operating voltage
- Boot time 27 sec
- Low weight
- High accuracy
- Navigation update rate: 5 Hz
- Sensitivity: -161dBm

✓ GPS will use the message format: NMEA 0183

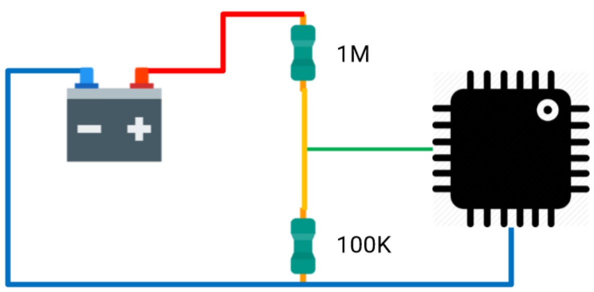
Payload Power Voltage Sensor Trade & Selection

GPS Module	Interface	Operating Voltage	Resolution	Size	Weight	Price
Voltage divider circuit	Analog	0.02- 25V	0.00489	5mmx5mm	1g	$0.014
TC54	Analog	1.1-6.0V	0.6	40mmx40mm	2g	$1

CHOSEN MODULE: VOLTAGE DIVIDER CIRCUIT

REASONS:

- Small in size
- Easy implementation
- No extra power consumption
- Wide voltage detection range
- High accuracy



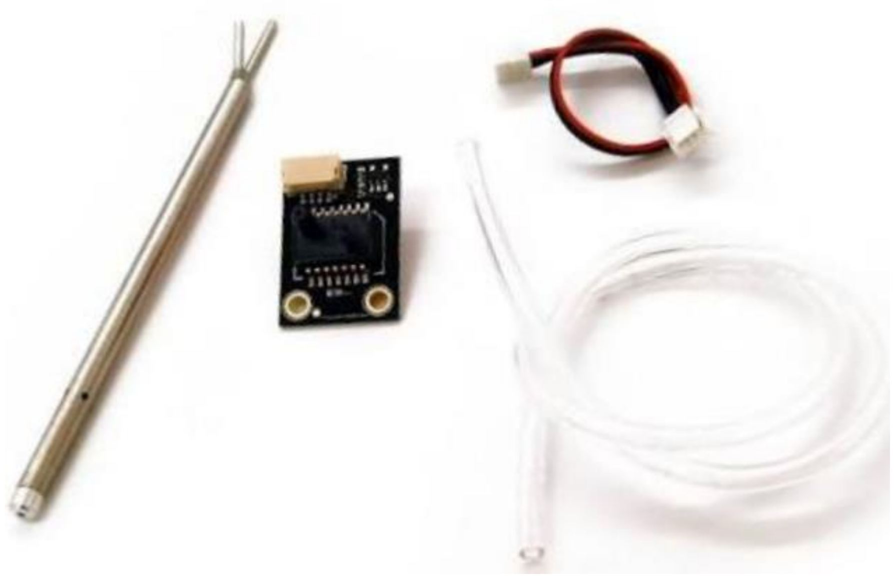
Air Speed Sensor Trade & Selection

Payload Air Pressure Sensor	Weight (g)	Maximum Pressure (hpa)	Operating Voltage(V)	Relative Accuracy (Pa)	Interfacing	Min. Operating Temperature (degree Celcius)
MPXV7002DP	10.34	700	5	2.5	I2C	-10
mRo-MS5525V2	8.94	1380	5	2.5	I2C, SPI	-40

<u>CHOSEN DEVICE : mRo-MS5525V2</u>

REASONS:

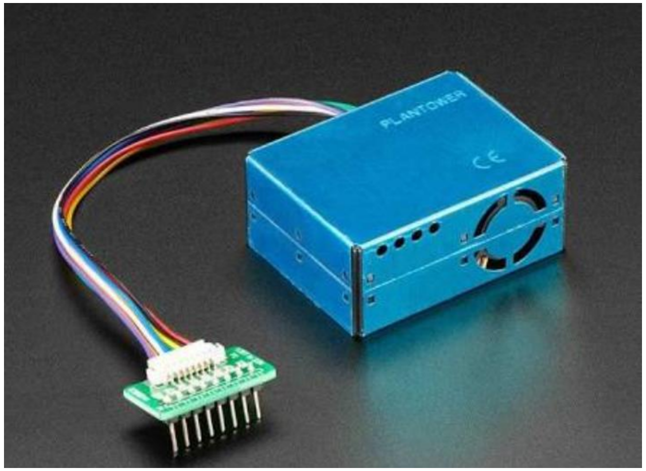
- Low power consumption
- High accuracy
- Low weight



Particulates/Dust Sensor Trade & Selection

Payload Air Pressure Sensor	Size (mm)	Power Supply	Weight (g)	Temperature Range	Operating Voltage (V)	Relative Accuracy	Interfacing	Minimum detection level (micrrom)
PM 2.5 GP2Y1010AUOF	46*34*18	DC 3V	16	-10 - 60	3-5	10	I2C	0.8
SPS30	40.6*40.6*12	4.5-5.5 V	26	-10 -60	3-5	10	I2C	0.3

CHOSEN DEVICE : PM 2.5GP2Y1010AUOF



REASONS:

- Low power consumption
- High accuracy
- High measurement rate
- Low weight

Bonus Camera Trade & Selection

Device Name	Interface	Operating Voltage (V)	Megapixels	Resolution	Weight (g)	Price (₹)
Y2000	Digital	5V	0.3	640×480	10	₹1099
OV7670	12C	5V	0.3	640×480	12	₹700

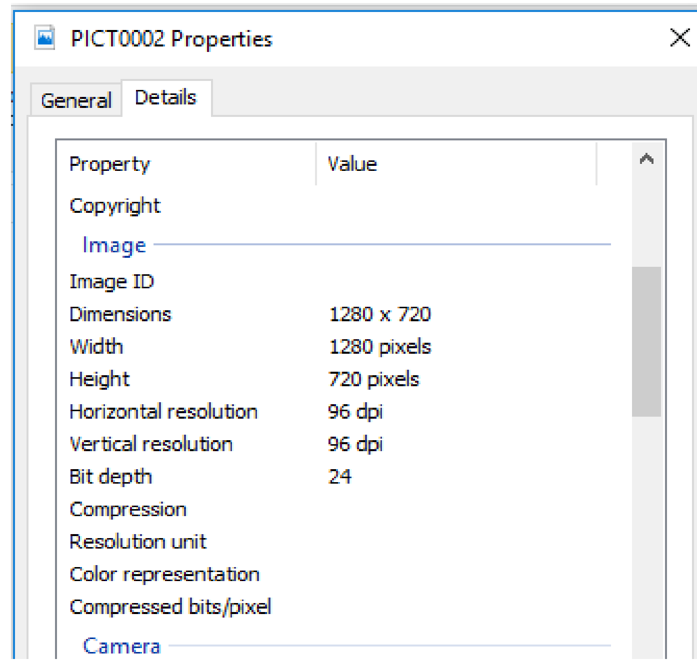
Selected Device: **Y2000**

Reasons:

- High sensitivity in low light
- Image support :JPG
- 30 FPS video capture capability
- Easy to communicate with MCU

RESOLUTION INFORMATION OF CAMERA

Image taken from Y2000



Container Air Pressure Sensor Trade & Selection

Container will not contain any sensors. Pressure will be sensed by the pressure sensor installed in payload.

Descent Control Design

Ritika Bansal

Descent Control Overview

CONTAINER :

• Container made of carbon rods of 5mm diameter and PET plastic of 1.50 mm of dimensions 125 mm diameter and 310 mm height.
• Uses passive descent methods after separation from rocket (parachute)
•Round parachute made of nylon fabric with spill hole used to reduce cupping with a radius of approx.

GLIDER :

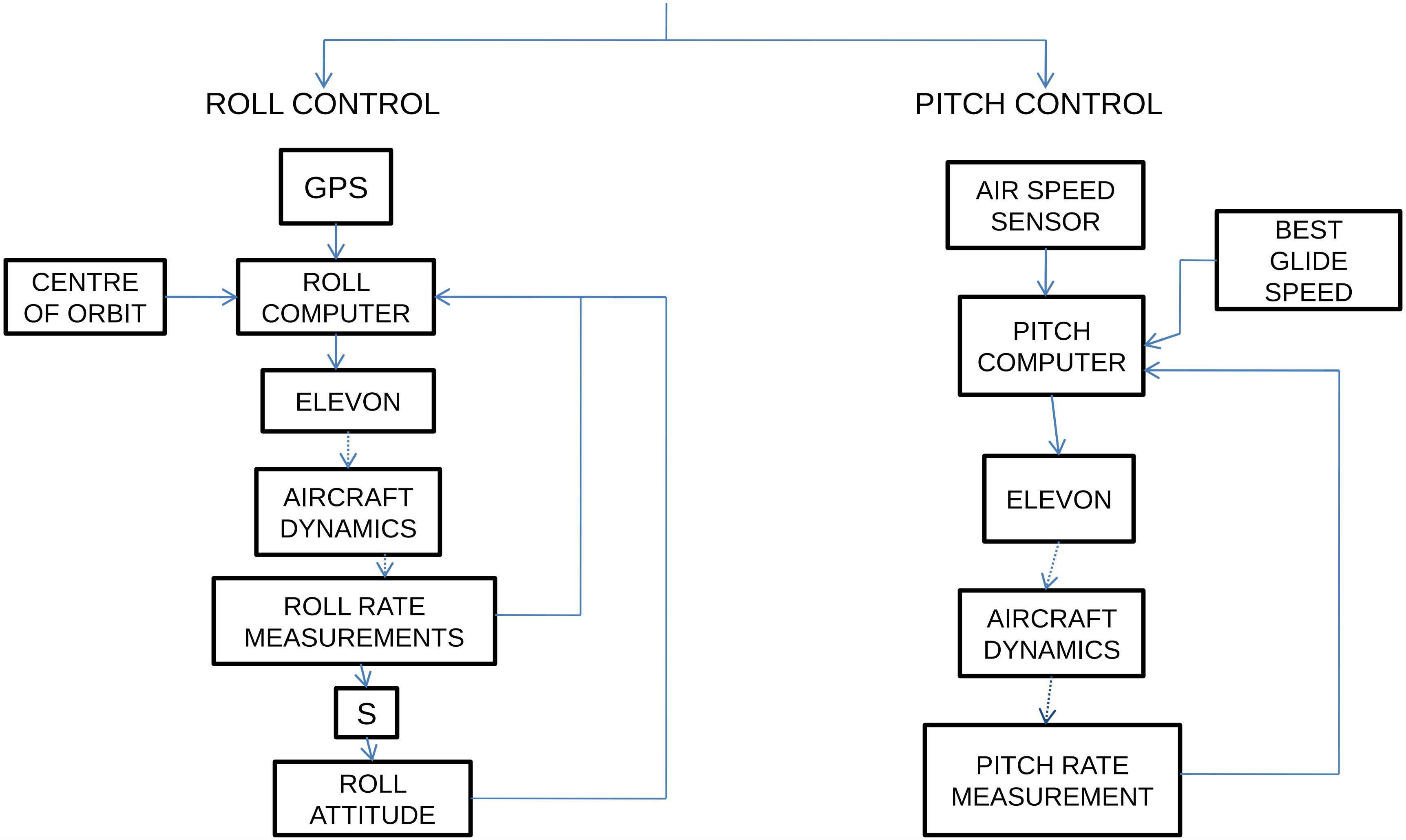
• Fuselage , vertical stabilizer made of carbon fibre.
• Wing, horizontal stabilizer made of nylon fibre (umbrella material)
• Released at 450 meters from the container using separation mechanism
• Follows a circular path of radius 250 m during descent for at least 1 minute.
• Uses a folding mechanism for the wings

DESCENT CONTROL PREPARATORY STEPS :

- Mathematical model development
- Parameter estimation by Flight Testing
- Development of Drag Polar
- Estimation of best glide speed

Descent Control Overview

EXECUTION ALGORITHM : **AUTOPILOT**



Descent Control Requirements

ID	REQUIREMENTS	RATIONALE	PRIORITY	VM
DCD-1	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	CR	HIGH	A,I
DCD-2	The container shall release the payload at 450 meters +/- 10 meters	CR	HIGH	A,I
DCD-3	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container	CR	HIGH	A,I
DCD-4	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s	CR	HIGH	A,I
DCD-5	All structures shall be built to survive 15 Gs of launch acceleration.	CR	HIGH	A,I
DCD-6	All structures shall be built to survive 30 Gs of shock.	CR	HIGH	A,I

Descent Control Requirements

ID	REQUIREMENTS	RATIONALE	PRIORITY	VM
DCD-7	All mechanisms shall be capable of maintaining their configuration or states under all forces.	CR	HIGH	A,I

Payload Descent Control Strategy Selection and Trade

TOPIC	OPTIONS	CHOSEN	REASON
Container materials	1) PET Plastic & Carbon fibre 2) Styrofoam 3) Balsa Wood	PET Plastic & Carbon fibre	Strong, cost efficient & light
Colour	1) Fluorescent Pink 2) Fluorescent Orange	Fluorescent Orange	Group decision
Shock force survival for – a) Fuselage b) Wings	a) 1) Balsa , 2)Carbon fibre b) 1) Nylon Cloth , 2) Balsa	a) Carbon fibre b) Nylon cloth	Shock absorbent, has no chance of falling
DCS Connections	1) Servo motor 2) Screw 3) Kevlar	Servo motor	Easiest to separate with latch mechanism
Parachute	1) Conical w/o spill hole 2) Round with spill hole	Round with spill hole	Best at increasing drag, spill hole to reduce cupping

Payload Descent Control Strategy Selection and Trade

TOPIC	OPTIONS	CHOSEN	REASON
Preflight Review Testability	1) Yes 2) No	Yes	All parts will be rigorously tested to specification given the competition guide

Payload Descent Control Strategy Selection and Trade

Payload Configuration 1	Properties	Pros	Cons
Carbon fibre deign	➢ Fuselage type= Carbon fibre ➢ Fuselage length= 21.2 cm ➢ Wing Type : Nylon Tafetta (190 threads per inch) with carbon rods at the end ➢ Wing area(both wings)= 262.44 cm^2 ➢ Wing span (both wings + fuselage)= 42.4 cm ➢ Weight of glider with electronics= 350 g(approx) ➢ Wing connected with extra piece of wing to the fuselage	➢ Carbon fibre is light weight , cheap, aerodynamic, easy to manufacture and durable ➢ Easily testable ➢ Nylon wings are easy to fabricate and easier to fit in container	➢ Difficulty in mounting wing

Payload Descent Control Strategy Selection and Trade

Payload Configuration 2	Properties	Pros	Cons
Balsa Design	➢ Fuselage type= Balsa ➢ Fuselage length= 28 cm ➢ Wing Type : Balsa airfoils with spars and covered with Mylar ➢ Wing area(both wings)= 470.4 cm^2 ➢ Wing span (both wings + fuselage)= 72 cm ➢ Weight of glider with electronics= 400 g(approx) ➢ Wing connected with axel to the fuselage	➢ Easy to mount electronics	➢ Not so aerodynamic ➢Heavy fuselage ➢Hard to fabricate ➢Difficult to meet container dimensions

Payload Descent Control Strategy Selection and Trade

Payload Configuration Chosen	Rationale
Carbon fibre Design	➢ Better materials for shock absorbency ➢ Complies with dimensioning constraints ➢ Easier to manufacture ➢ Generates more lift ➢ More aerodynamic

Payload Descent Control Strategy Selection and Trade

S.NO	Design	Ease of fabrication	Non-Tumbling	Stability
1.	Hemispherical Shape with Spill hole	9	9	8
2.	Para-foils	5	8	9

Hemispherical Parachute

OR

Para – foils

SELECTED DESIGN : HEMISPHERICAL SHAPE WITH SPILL HOLE

Reasons :

Easy to fold and place inside Cansat
Easy to fabricate
Need less time to inflate
Small in size

Payload Descent Stability Control Strategy Selection and Trade

S.NO	Design	Ease of fabrication	Non-Tumbling	Stability
1.	Spill- Hole	9	9	8
2.	Ring-Slot	5	9	9

<u>CHOSEN DEVICE : SPILL-HOLE DESIGN</u>

Reasons:

- Ease of fabrication
- Easy deployment, No tangling of ring slots
- It increases the stability
- Spill holes let air slip through and avoid unwanted oscillations

DESCENT RATE ESTIMATES CALCULATED USING TERMINAL VELOCITY EQUATION

Eq. (1) $$S = \frac{\pi d^2}{4}$$

Eq. (2) $$S = \frac{2W}{\rho C_D v^2}$$

Eq .(3) $$L = \frac{C_L \rho v^2 A}{2}$$

S = Surface Area
ρ = Air Density at Deployment Altitude (1.205 kg/m3)
g = Acceleration due to Gravity (9.81 m/s^2)
v = Desired Descent Velocity
d = Diameter of the Parachute
CD = Coefficient of Drag (assumed 1.5)
W = Weight of the CANSAT
A = Wing Area
L = Lift Force
CL = Coefficient of Lift

CONTAINER + PAYLOAD (PHASE I : APOGEE TO 450M)

Drag Equation

$$D = Cd\ v^2 \rho A / 2$$

So, area comes out to be:

$$A = 2D / Cd \rho v^2$$

A = 2 *0.6 *9.81/(1.225* 20*20*1.6)

A = 0.0150153 m^2 = 150.1530 cm^2

(this is 97% area of the canopy)

3% of the canopy area is contributed to spill hole

∴ **Total canopy area** = 154.7969 cm^2

∴ Area of spill hole = 4.64 cm^2

So, radius of the parachute comes out to be **7 cm**

T = Distance / velocity = 220/20 = **11 sec**

Assumptions:

This Drag(D) Equation is to find out the area required for parachute to travel Phase 1 with speed 20 m/sec (±5 m/ sec).

Cd(Drag Coefficient)=1.6

ρ(Density of air)=1.225 Kg/ m^3

v = Desired velocity

A = Ref. Area D = Mass x Gravity

g = 9.81 m/ sec^2

CONTAINER (PHASE II : 450M TO GROUND)

Mass of the container = 150gms
Ref. area = 0.0150153 m^2

v^2 = 2mg/ ρCdA
=2 * 0.15 *9.81/(1.225 *1.6 * 0.0150153)
v^2 = 100
v= 10m/sec

Time taken by the container to reach ground=
Distance / Velocity = 450/10.00
= 45.00 sec

SCIENCE PAYLOAD (PHASE II : 450M TO GROUND)

Drag Equation

$$D = Cd\ v\text{^}2\rho A\ /2$$

So, area comes out to be:

$$A = 2D\ /Cd\rho v\text{^}2$$

A = 2 × 0.35 × 9.81 /1.1 × 1.225 *10*10

A = 0.05096 m^2

=509.610 cm^2

Using A = πr^2 :

r = (509.6/ π)^0.5 = 12.739 cm

So, radius comes out to be **12.7 cm**

Time = Distance / velocity

= 450/10

= 45 sec

Assumptions:
This Drag(D) Equation is to find out the area required for disc to travel Phase 2 with speed 10m/s

Cd(Drag Coefficient.)= 1.11
ρ(Density of air)=1.225 Kg/ m^3
v = velocity
A = Ref. Area
D = Mass x Gravity
g = 9.81 T m /sec^2

Descent Rate Estimates

Shape	Mass (g)	Coefficient of Lift/ Drag	Surface area (cm^2)	Radius (cm)	Time taken (sec)	Descent velocity (m/s)
Container + Payload	600	1.5	150.15	7	11	20
Container	150	1.5	150.15	7	45	10
Payload	350	1.11	509.6	12.7	45	10

Mechanical Subsystem Design

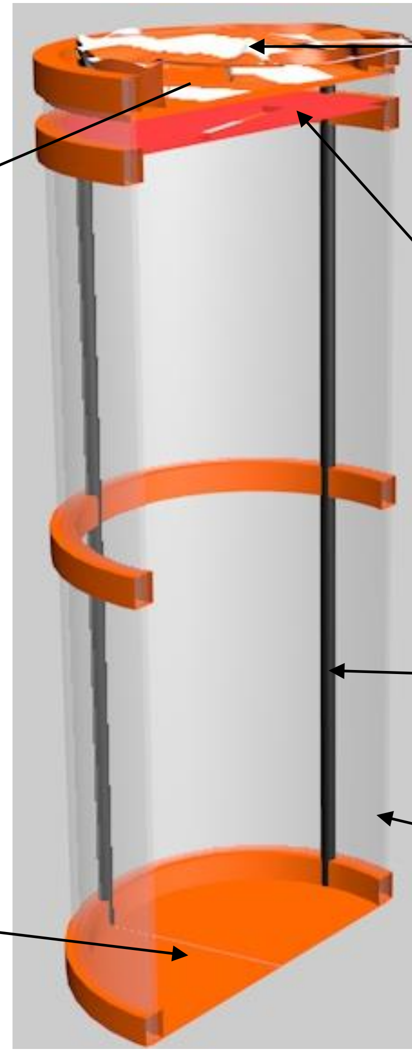
Adya Singh

Mechanical Subsystem Overview

CONTAINER OVERVIEW

Eyebolt hook (steel) to hold the parachute

Exit Gate (ABS) Container opening to release science payload



Parachute (Nylon 66-20D ripstop) TO control the descent of the container to 20m/s

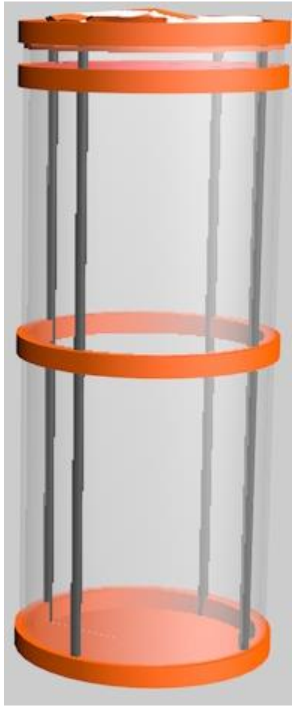
Locking Plate (ABS) to lock the science payload

Carbon fiber rod

Lamination Sheet

Mechanical Subsystem Overview

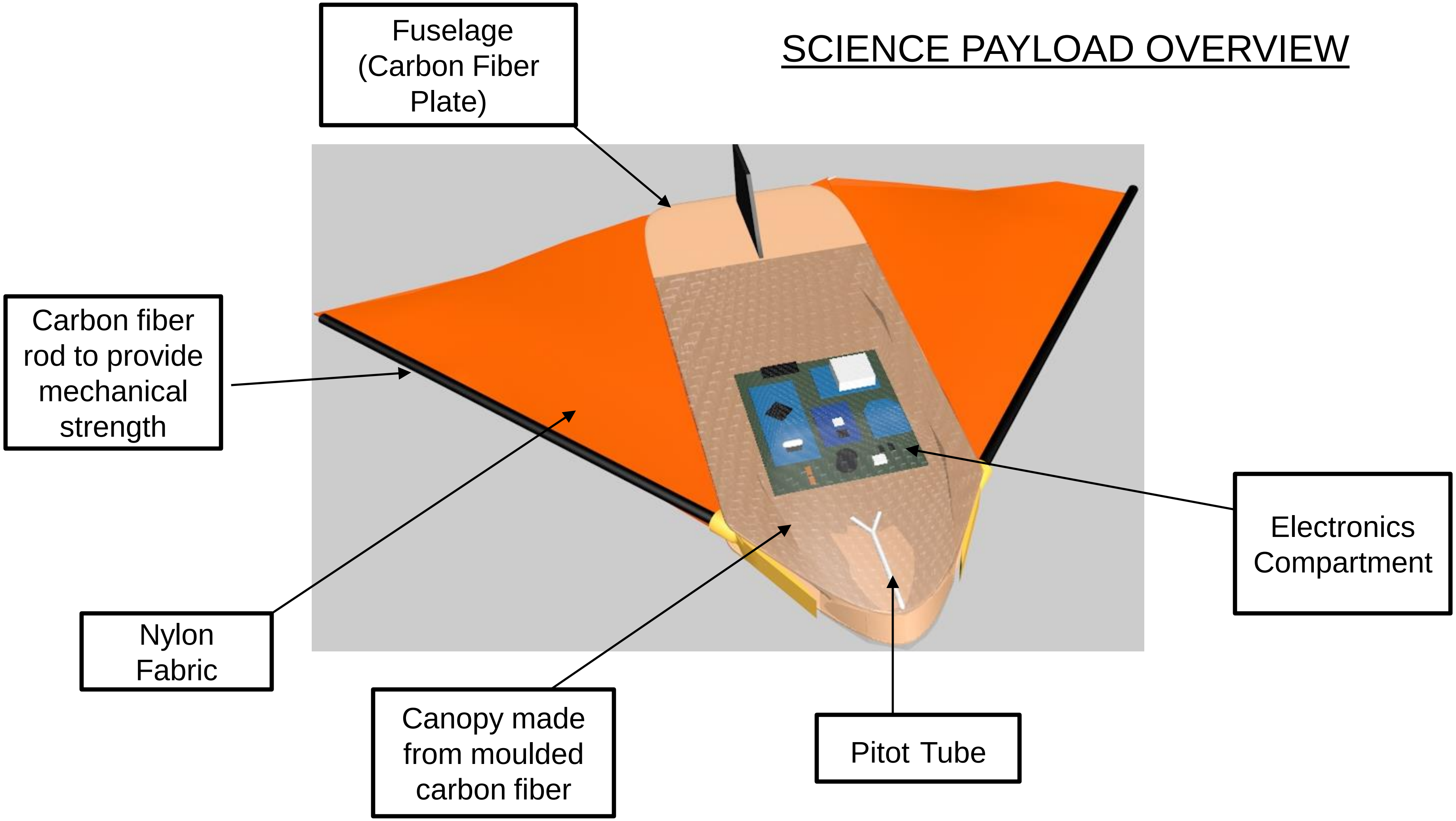
CONTAINER CONFIGURATIONS:



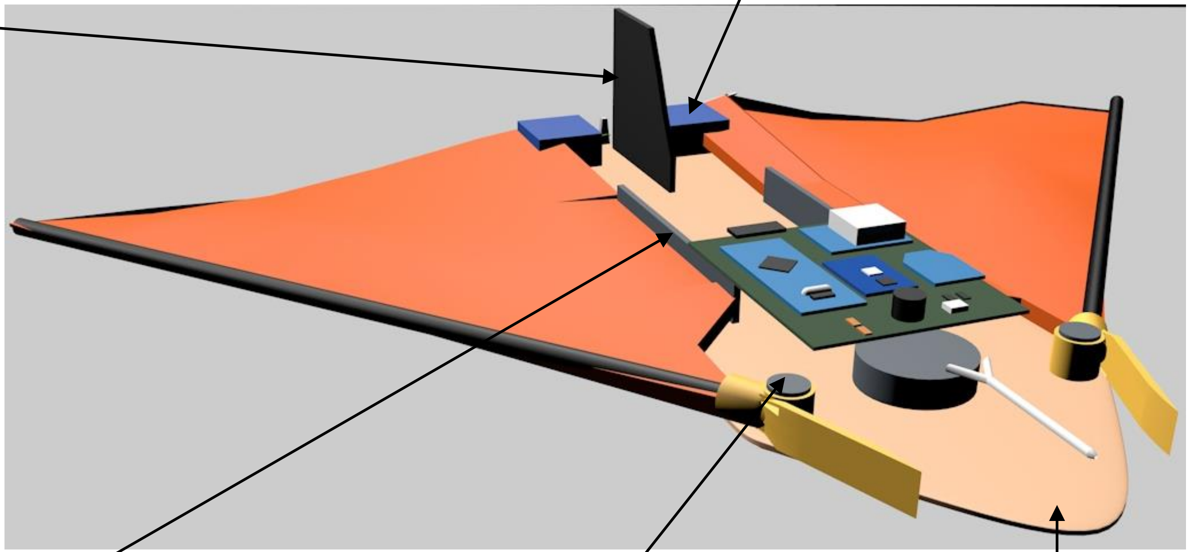
Parachute Closed

Parachute Open

Mechanical Subsystem Overview



Science Payload Overview



Servo Motor (for elevating the fabric)

Vertical Stabilizer (Carbon Plate)

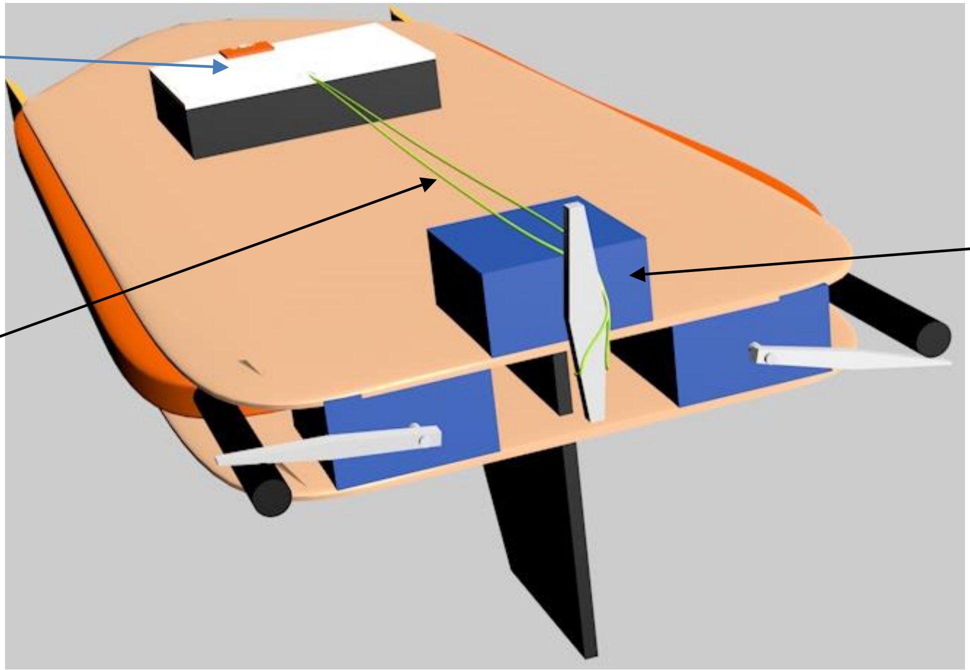
Vertical slab to separate top and base pate for wing compartment and attachment

Rivet (for inward and outward movement of the rods)

Base Plate (Carbon Fiber)

Science Payload Overview

Parachute Compartment for payload

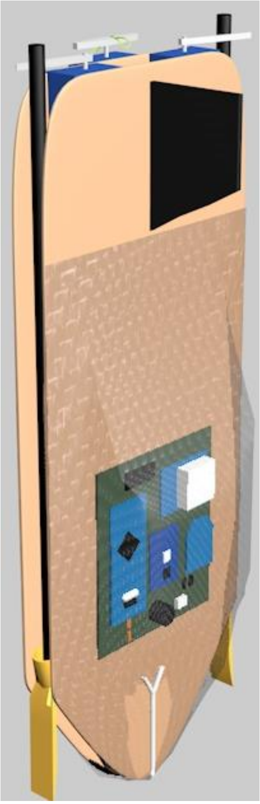


Servo Motor for opening the parachute

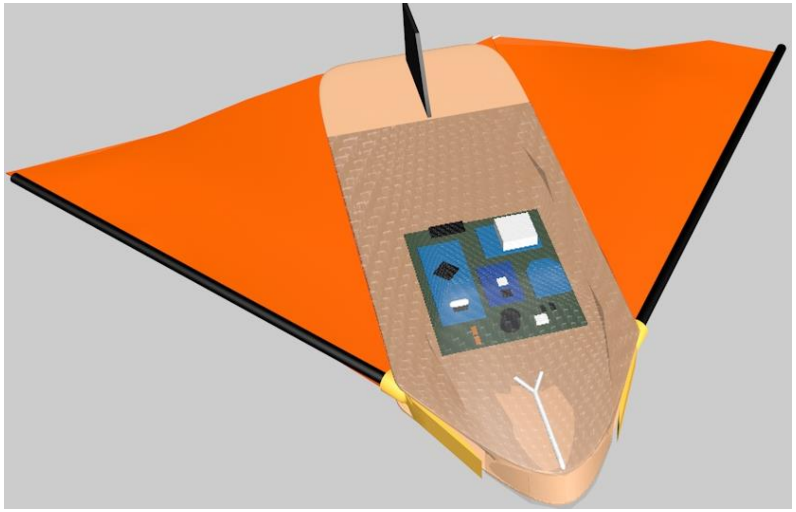
Elastic for pulling open the lid

Mechanical Subsystem Overview

Science Payload Configuration Overview:

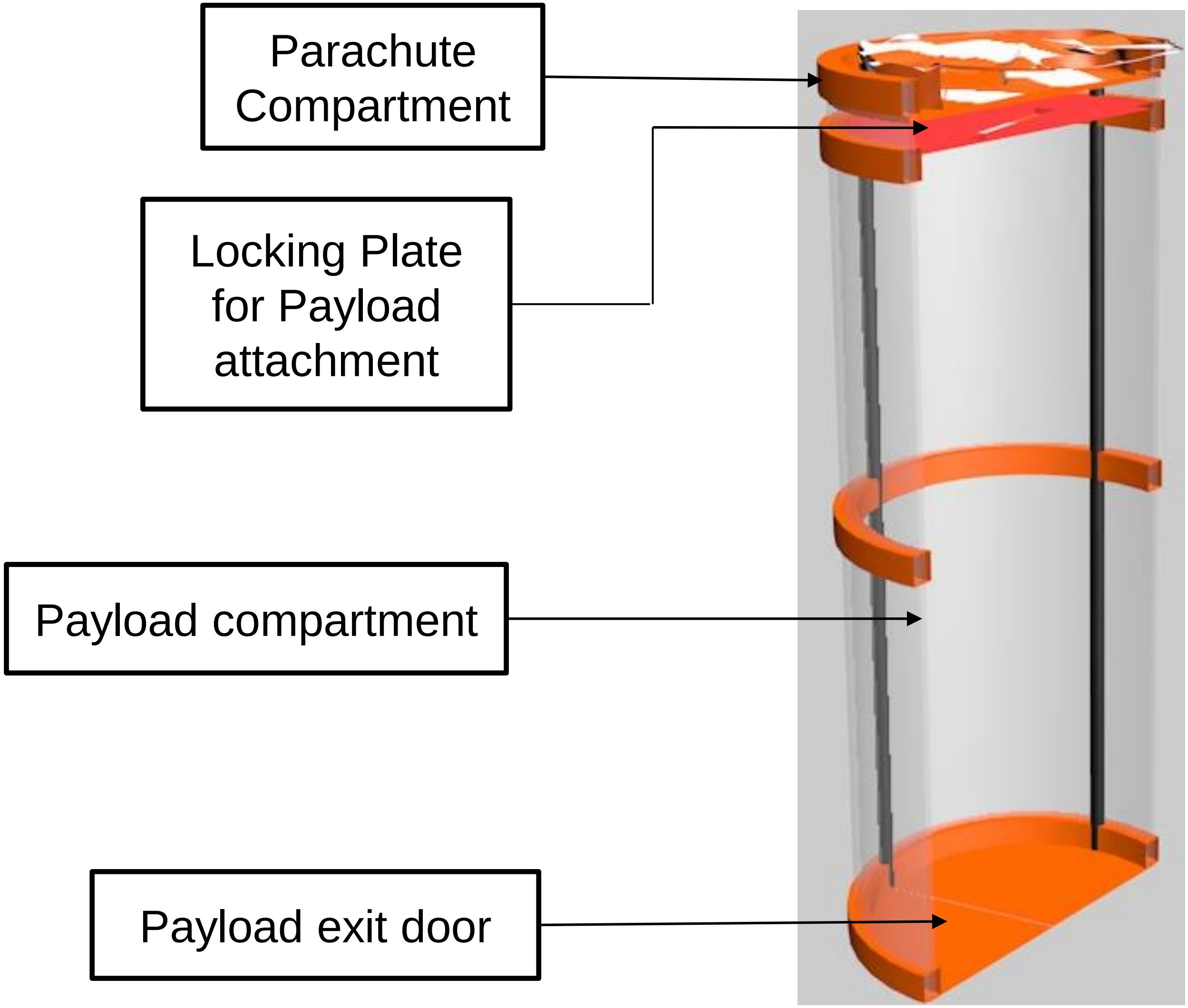


Delta Wing Glider
(Stowed Condition)



Delta Wing Glider (Deployed Condition)

Mechanical Subsystem Overview



Mechanical Sub-System Requirements

ID	Requirements	Rationale	Priority	VM
MSD-1	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	CR	High	A,I
MSD-2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Launch Vehicle Compatibility	High	A,I,D
MSD-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.	Safe Deployment	High	A,D
MSD-4	The container shall be a fluorescent color; pink, red or orange.	Easily visible from height	High	D
MSD-5	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	CR	High	A,I,D
MSD-6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	CR	High	A,I

Mechanical Sub-System Requirements

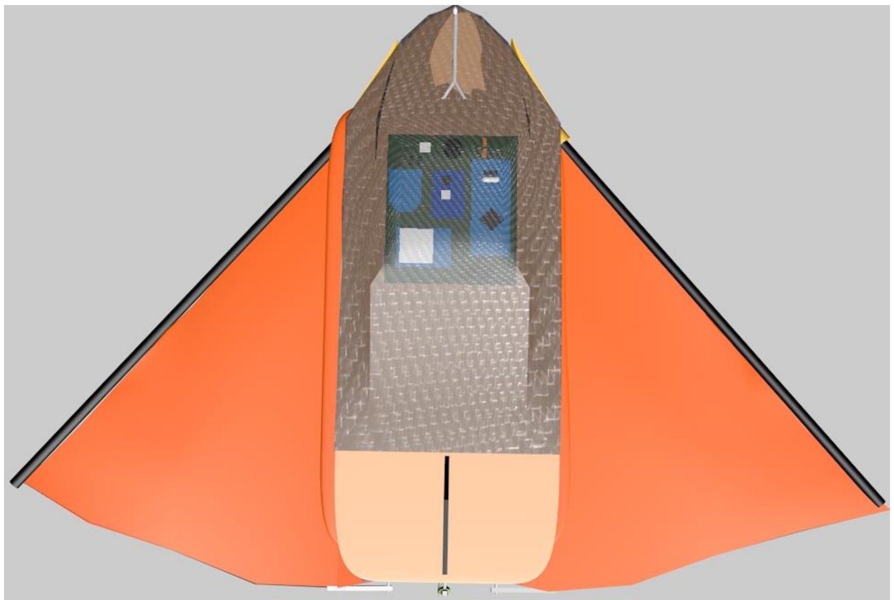
ID	Requirements	Rationale	Priority	VM
MSD-7	The rocket airframe shall not be used as part of the CanSat operations.	CR	High	A,I,D
MSD-8	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	CR	High	A,I
MSD-9	All structures shall be built to survive 15 Gs of launch acceleration.	CR	High	A,I
MSD-10	All structures shall be built to survive 30 Gs of shock.	CR	High	A,I
MSD-11	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	CR	High	A,I
MSD-12	All mechanisms shall be capable of maintaining their configuration or states under all forces.	CR	High	A,I
MSD-13	Mechanisms shall not use pyrotechnics or chemicals.	CR	High	D

Mechanical Sub-System Requirements

ID	Requirements	Rationale	Priority	VM
MSD-14	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	CR	High	D
MSD-15	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	CR	High	A,I
MSD-16	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	CR	High	A,I,D
MSD-17	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	CR	High	A,I,D

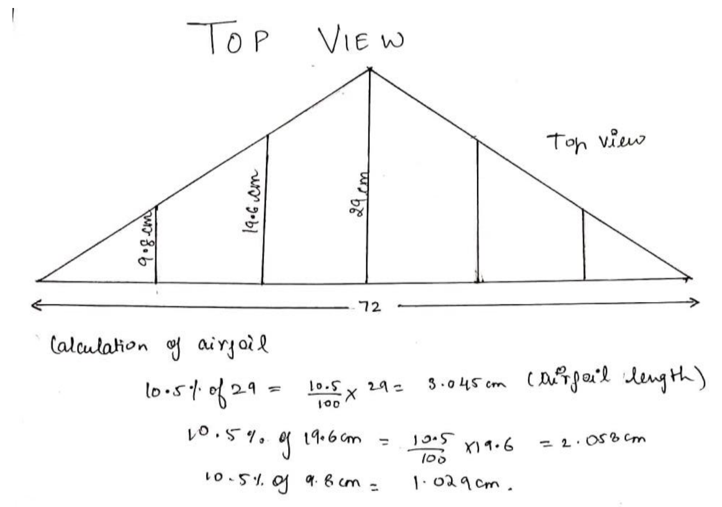
Payload Mechanical Layout of Components Trade & Selection

Payload Mechanical Layout 1:



Tokyo Fan Folding Based Structure

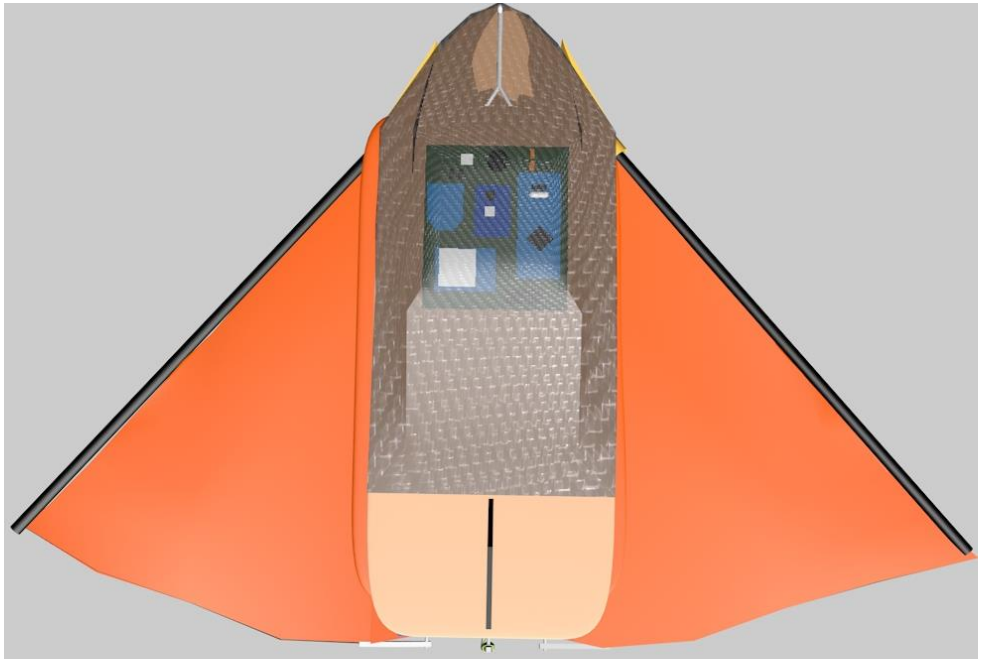
Payload Mechanical Layout 2:



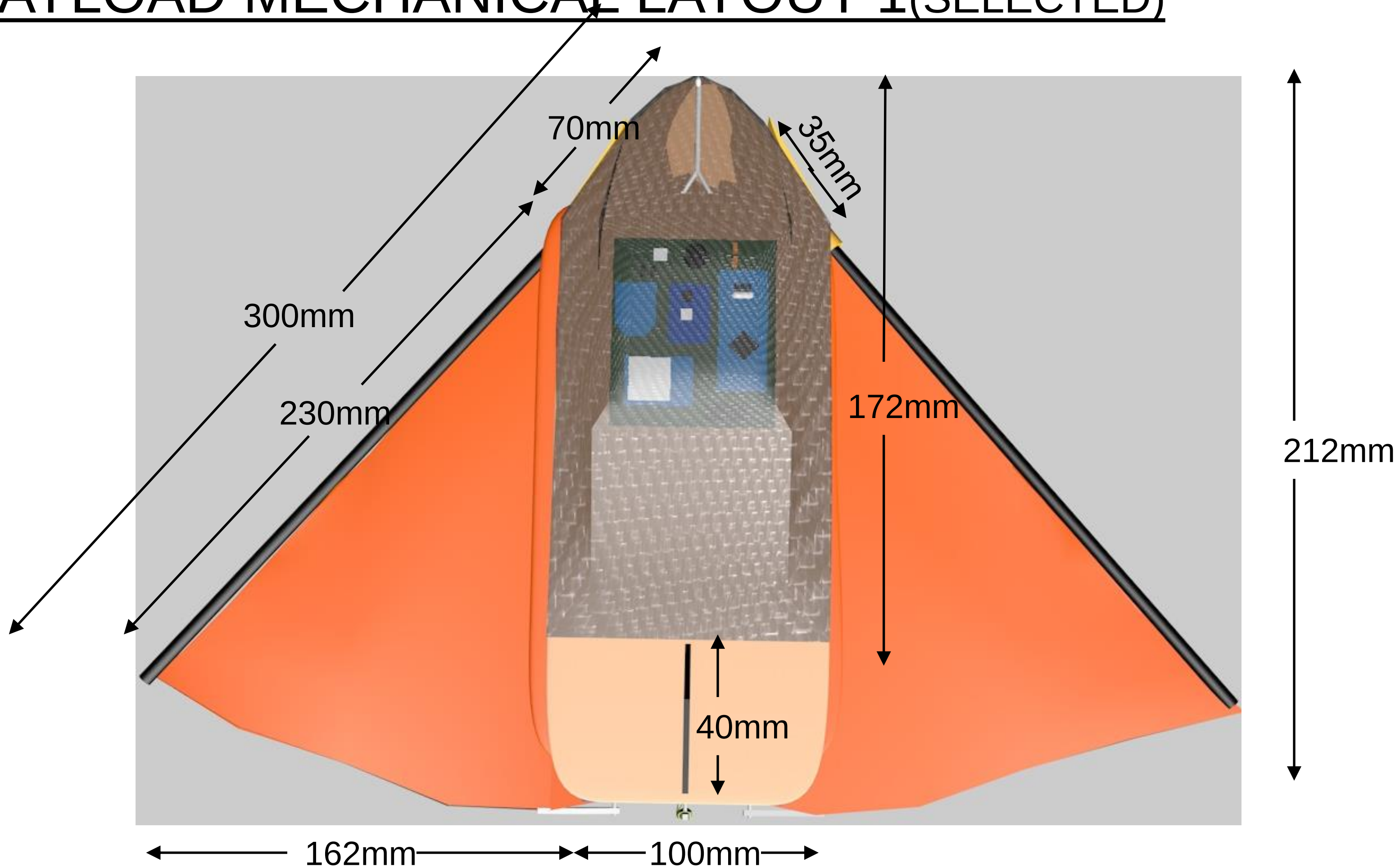
Multiple Folds Based Structure

PAYLOAD MECHANICAL LAYOUT 1(selected)

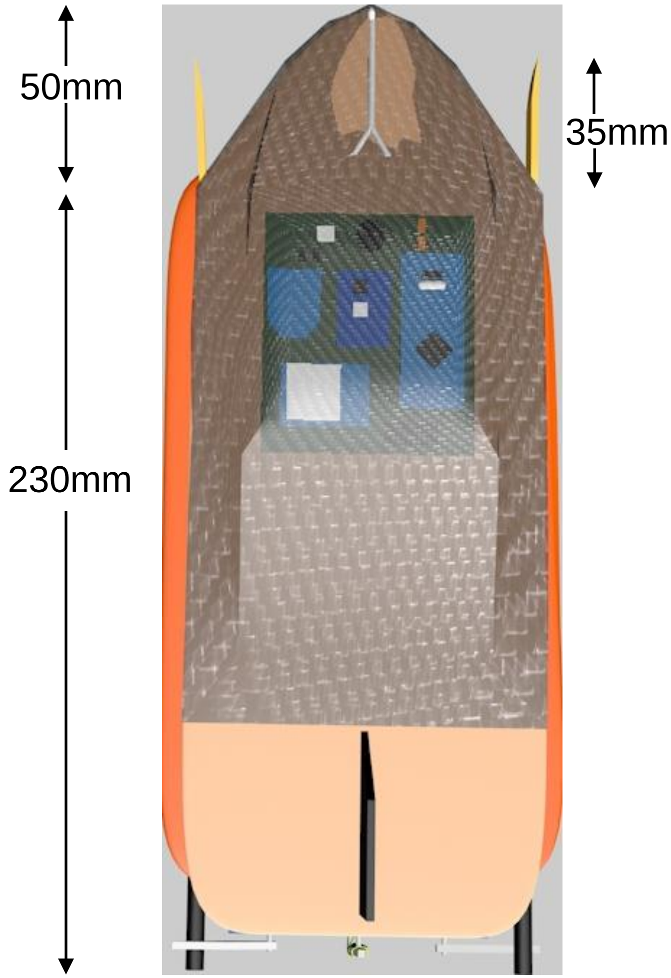
- Canopy is aerodynamically more stable.
- Easy to fit inside the container.
- Easy to implement air speed sensor and parachute.
- Easy locking and unlocking mechanism.
- Cavity for folded wings in stowed condition.
- Autopilot system controls the motor to elevate the wings.

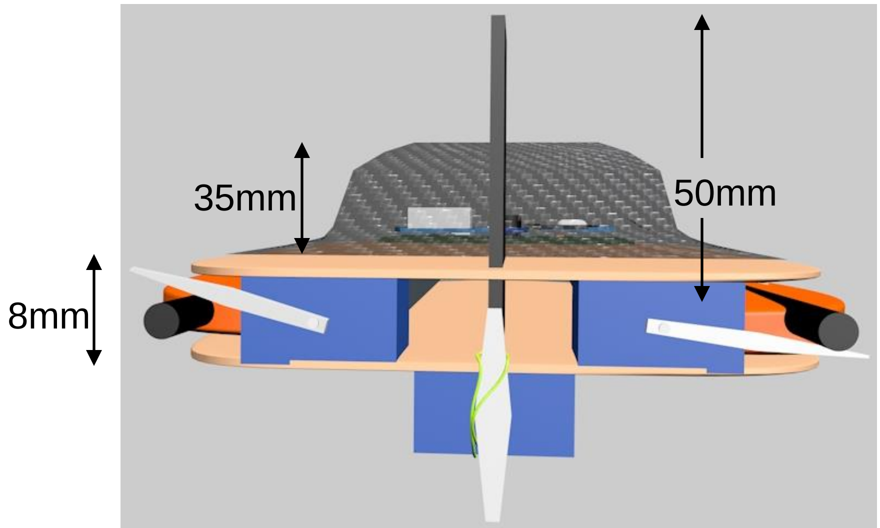


PAYLOAD MECHANICAL LAYOUT 1(SELECTED)

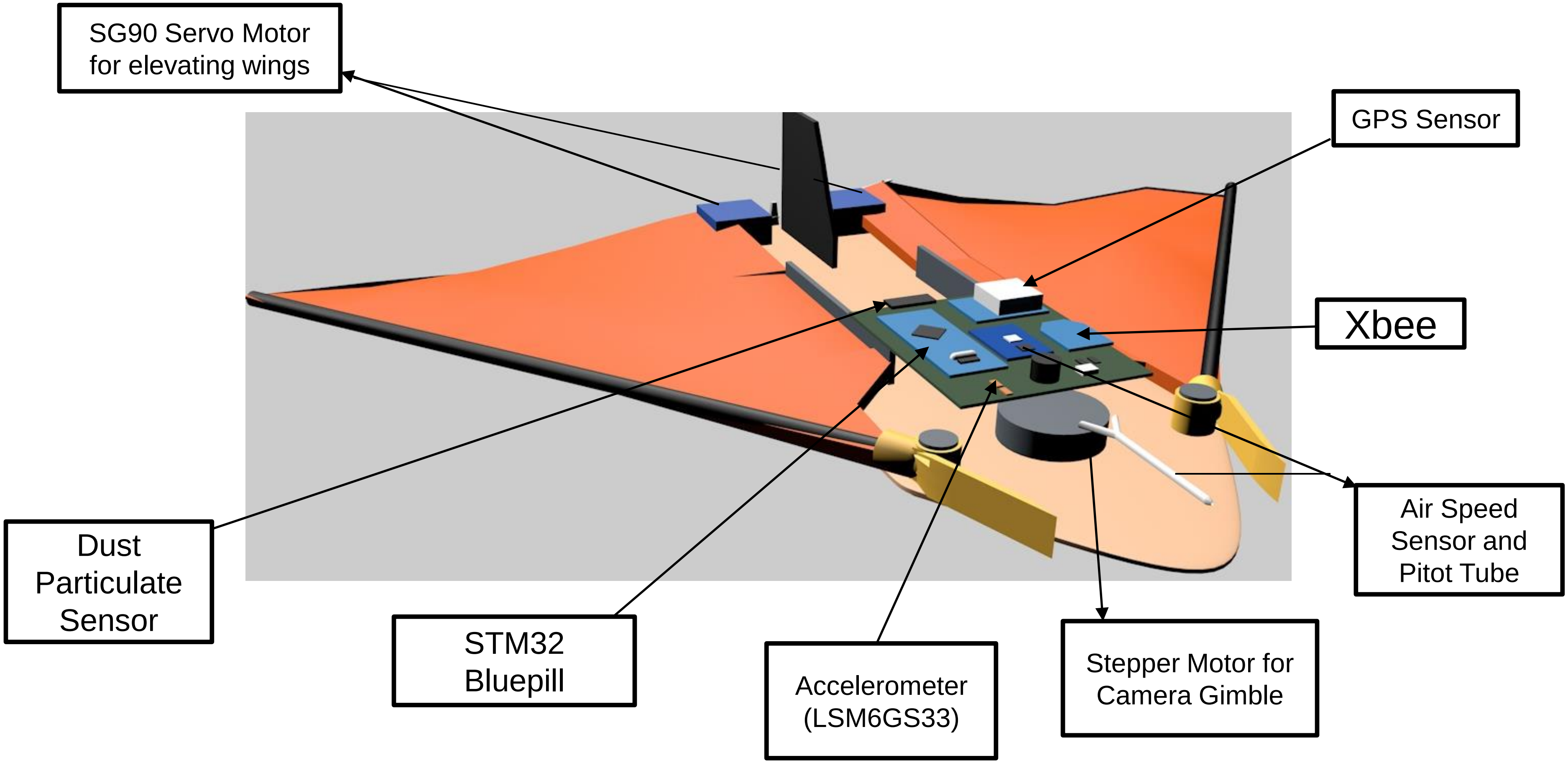


Payload Mechanical Layout of Components Trade & Selection

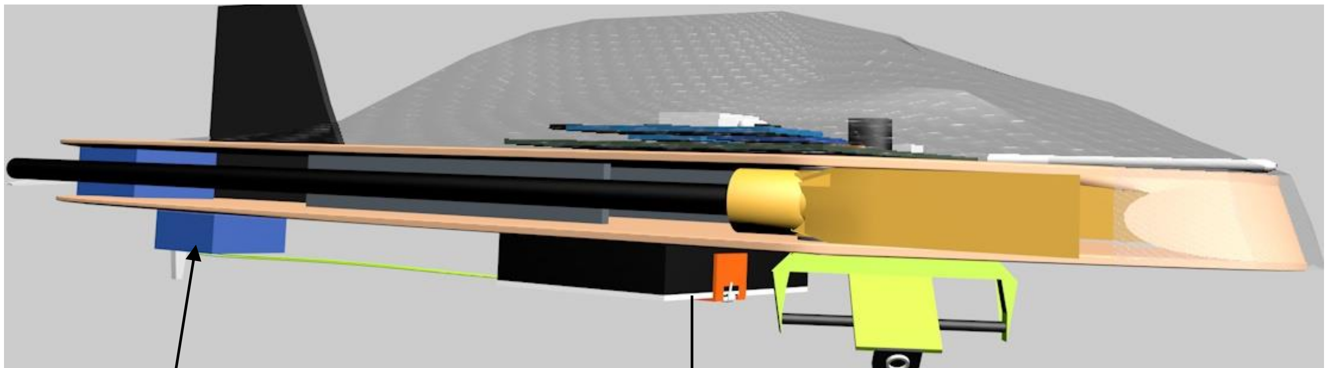




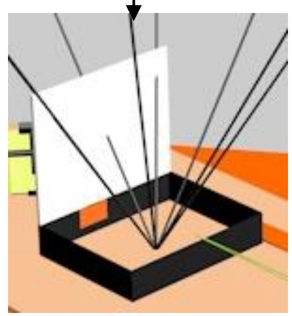
LOCATION OF ELECTRICAL AND MECHANICAL COMPONENTS



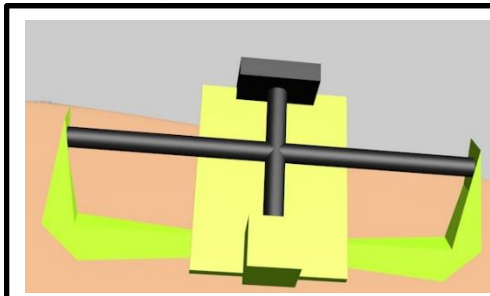
LOCATION OF ELECTRICAL AND MECHANICAL COMPONENTS



SG90 Servo Motor for opening the lid of parachute compartment and locking the payload to locking plate



Eyebolt hook and parachute

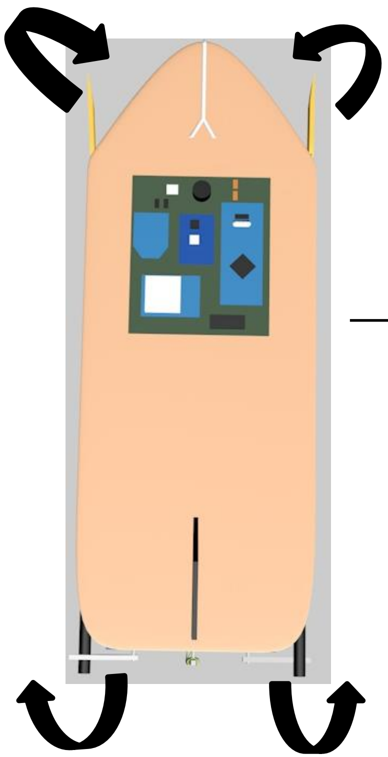


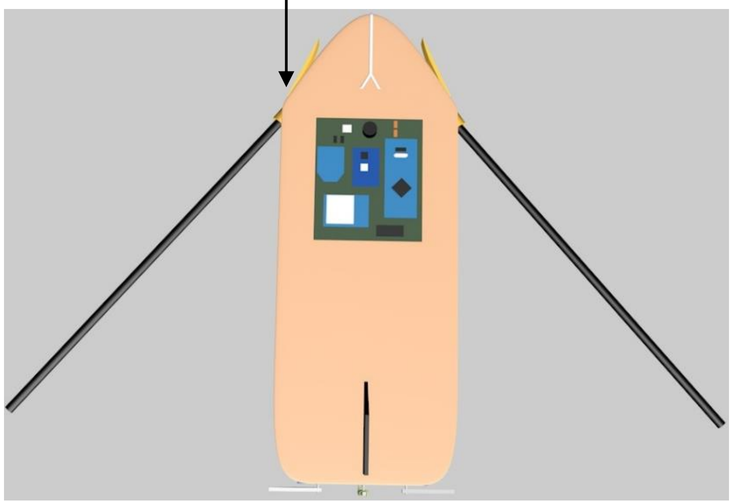
Camera Gimble

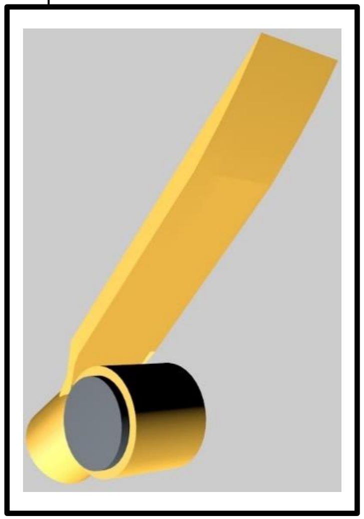
Payload Mechanical Layout of Components Trade & Selection

DELTA WING GLIDER ATTACHMENT POINTS

Carbon rod movement





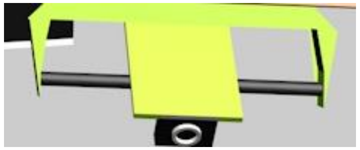


Rivet (Steel)

Payload Mechanical Layout of Components Trade & Selection

Major Mechanical Parts (Container and Payload)

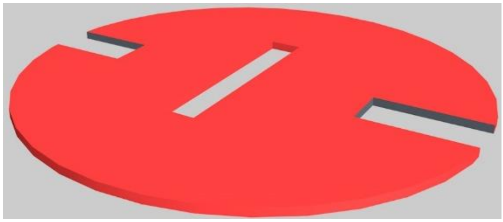
Carbon Rod



Camera Gimble

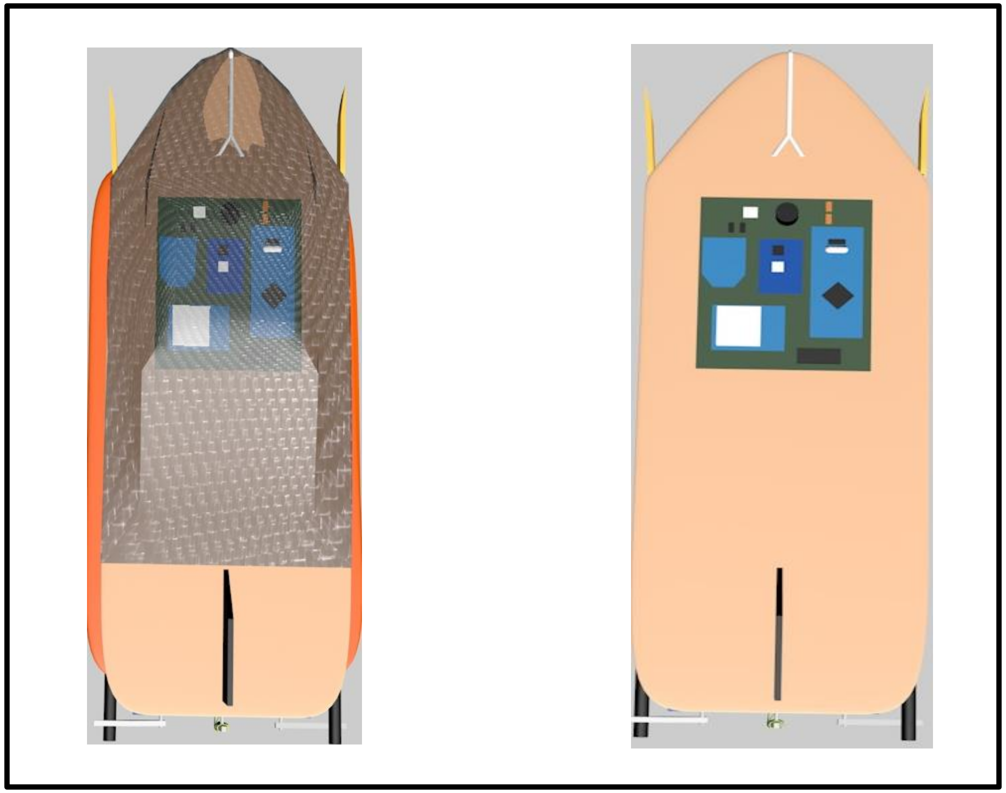
Eyebolt Hook

Steel Rivet



Locking Plate for Science Payload

Issues related to stowed configuration of Science Payload

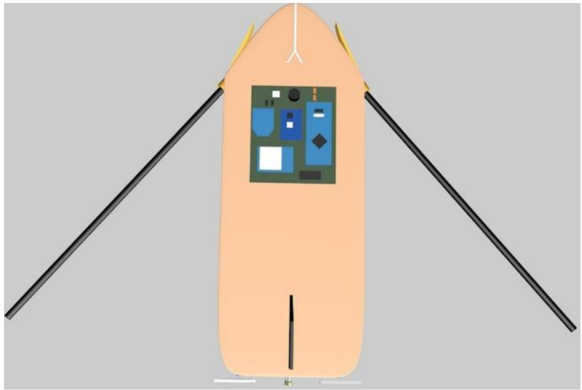


Science Payload in
stowed condition

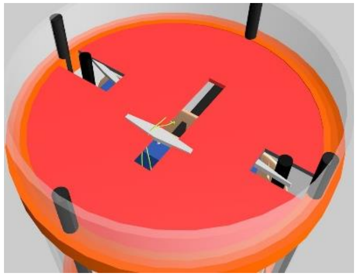
- Container can house a payload with a diameter of at most 105mm (margin left = 5mm)
- Length of the glider is 280mm (margin left after considering the bottom lid and locking plate is 16mm for parachute compartment)

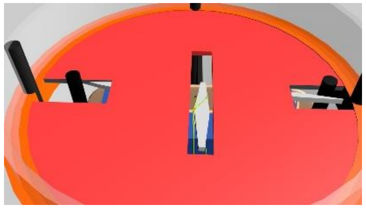
Mechanism Used To Keep The Payload In Stowed Configuration

- Locking mechanism for wings’ rod inside the container.



When servo gets the command to open at 450m, the carbon rods get unlocked from the container as the servo rotates 90 degrees, the rods get detached and fall due to it’s own weight.

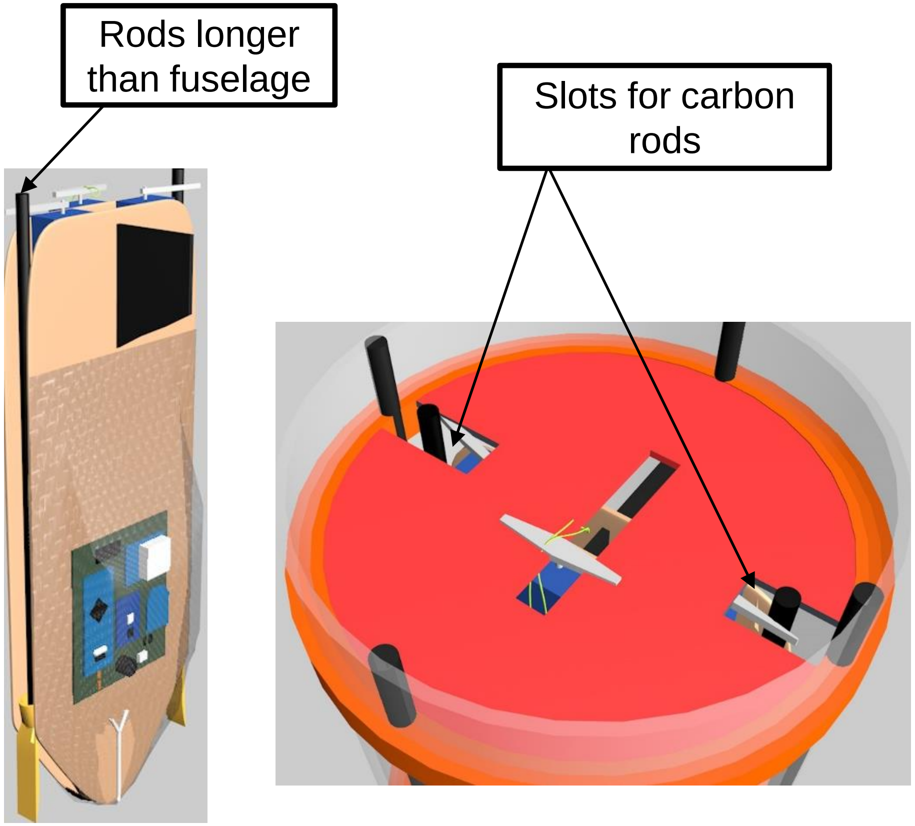




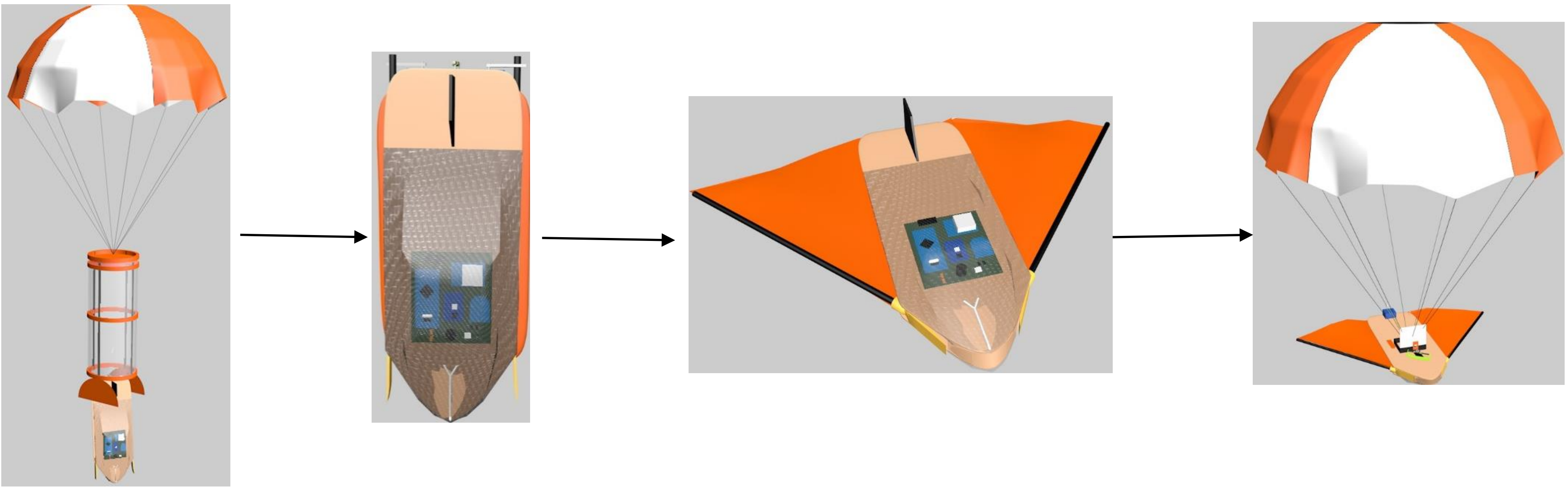
Payload Pre Deployment Configuration Trade & Selection

Issues related to the Payload Transition from stowed to deployed configuration

- As the length of the rods are exceeding the length of the fuselage in stowed condition, the slots were made in the locking plate for the rods to fit in.
- After the deployment from the container, the rods open with a jerk, so a damper is used to avoid the jerk and slow down the movement of rods.



Science Payload Delta Wing Glider Deployment Mechanism Transition



After the servo gets detached from the locking plate, at 100m from the ground it will rotate to release the parachute from the column. On the deployment of the glider, the carbon rods will expand and the nylon fabric will stretch to its full span, the two servos will operate the nylon fabric to elevate it.

Container Mechanical Layout of Components Trade & Selection

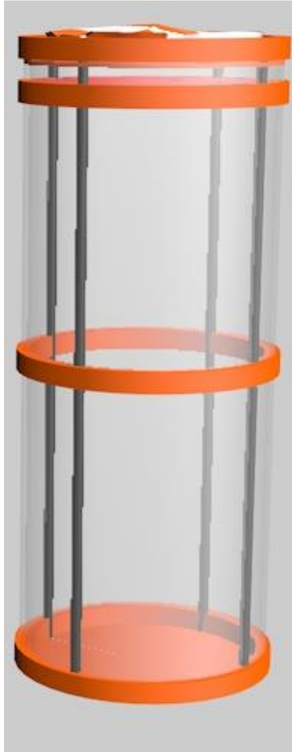
Container Mechanical Layout 1

Container Mechanical Layout 2

Container Mechanical Layout of Components Trade & Selection

Container Mechanical Layout 1 (Selected)

- Simple and easy to design
- Rods provide stability and strength to the structure.
- Inbuilt parachute compartment.
- Lesser number of rods and rings to support the structure, so lesser weight.
- Stable design.



Container Mechanical Layout of Components Trade & Selection

Material Selection (Rods):

Material	Density	Strength	Ease of machining	Mass of Rods	Cost
Carbon fibre 3K	1.9g/cm^3	600 MPa	6	34.8 (6 rods)	$13.5
Aluminium 6061	2.7g/cm^3	290 Mpa	9	50.4 (6 rods)	$6

<u>SELECTED DEVICE: CARBON FIBRE</u>

REASONS:

- Low Density
- Enough strength
- Light weight
- Can absorb high shock
- Easily available

Container Mechanical Layout of Components Trade & Selection

Material Selection (Container lids and lock plates):

Material	Density	Strength	Ease of machining	Mass of Rods	Cost
Polycarbonate Sheet	1.2g/cm^3	70 MPa	7	8g	$2
ABS	0.9g/cm^3	76 Mpa	9	7g	$4

<u>SELECTED DEVICE: ABS</u>

REASONS:

- Low Density
- Appreciable strength
- Light weight
- High Accuracy

Container Mechanical Layout of Components Trade & Selection

Material Selection (Rivet):

Material	Rotation smoothness	Ease of Making	Mass (g)	Cost
ABS	5	8	8 (2 pcs)	$4
Metal	9.5	9.5	24 (2 pcs)	$1.3

<u>SELECTED DEVICE: METAL</u>

REASONS:

- Appreciable Weight
- More smoothness in Rotation
- Ease of assembly
- Less friction

Material Selection (Wing):

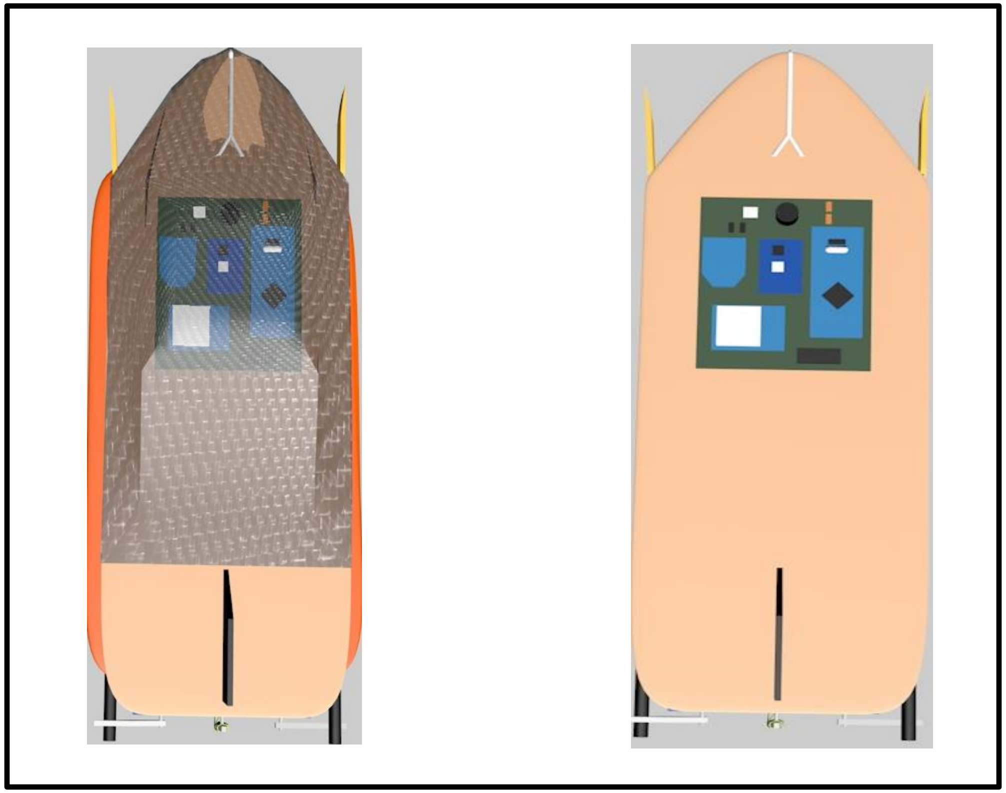
Material	Density	Strength	Cost
Nylon(190T)	1.15g/cm^3	6500psi	$2.01
Silk	1.25g/cm^3	5gm/den	$1.40

SELECTED DEVICE: NYLON FABRIC

REASONS:

- Low Density
- Enough strength
- Light weight
- Can absorb high shock
- Easily available

Issues related to stowed configuration of Science Payload



Science Payload in stowed condition

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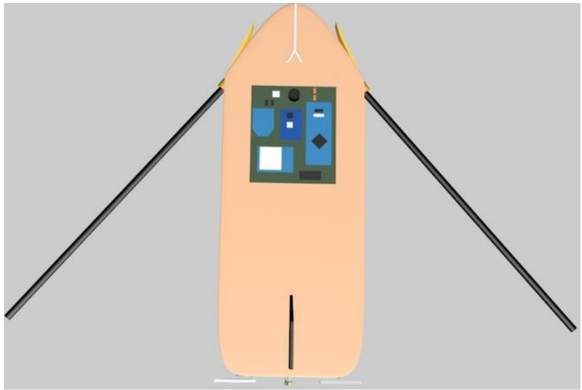
- Length of the glider is 280mm (margin left after considering the bottom lid and locking plate is 16mm for parachute compartment)

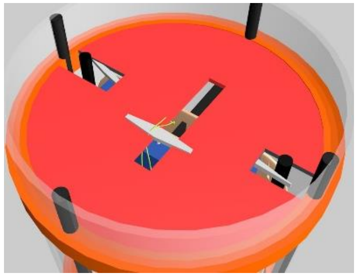
Payload Pre Deployment Configuration Trade & Selection

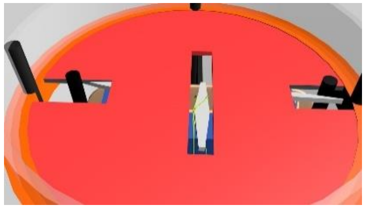
Mechanism used to keep the payload in stowed configuration

- Locking mechanism for wings' rod inside the container.



When servo gets the command to open at 450m, the carbon rods get unlocked from the container as the servo rotates 90 degrees, the rods get detached and fall due to it's own weight.





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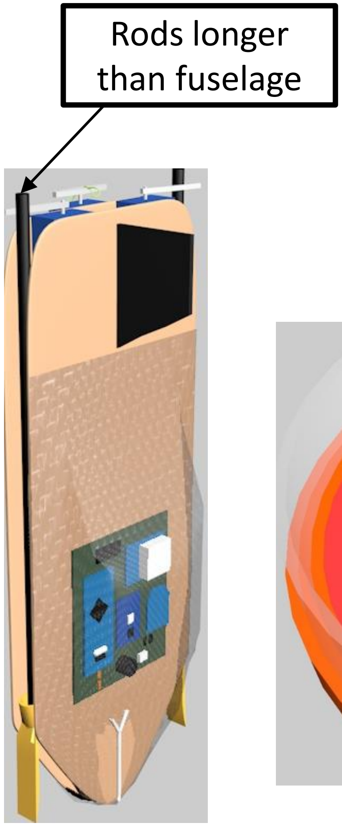
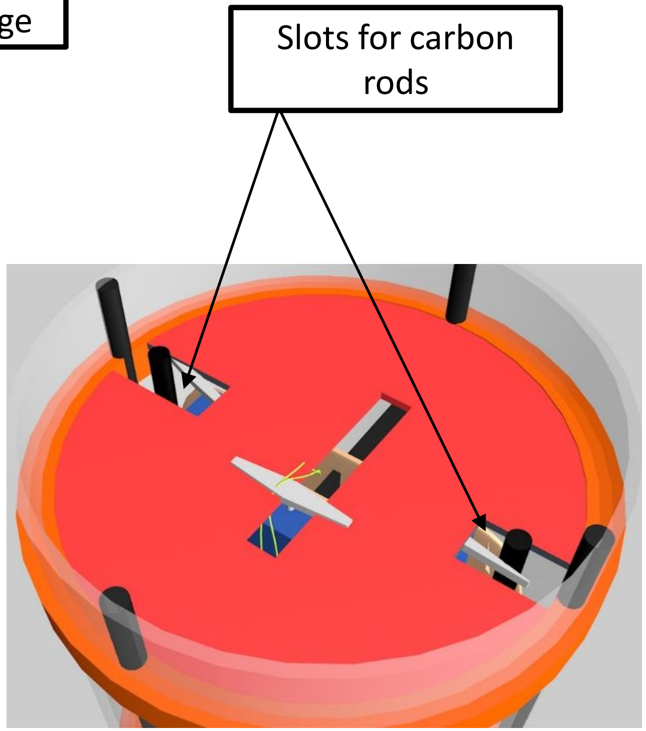
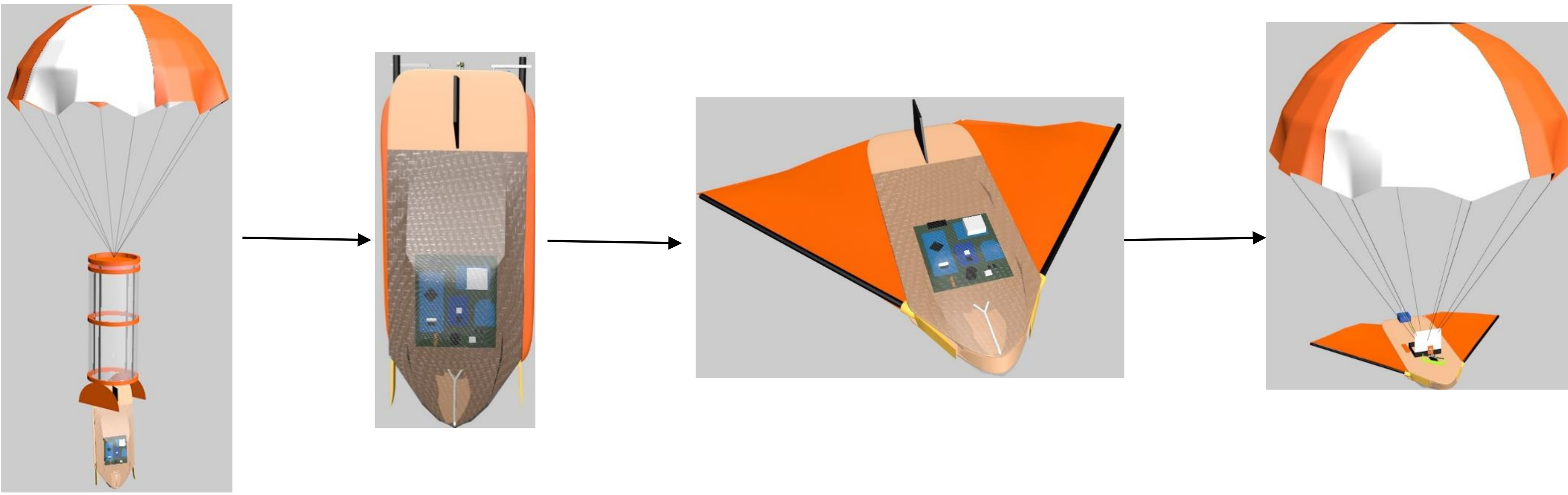




Payload Deployment Configuration Trade & Selection

Science Payload Delta Wing Glider Deployment Mechanism Transition



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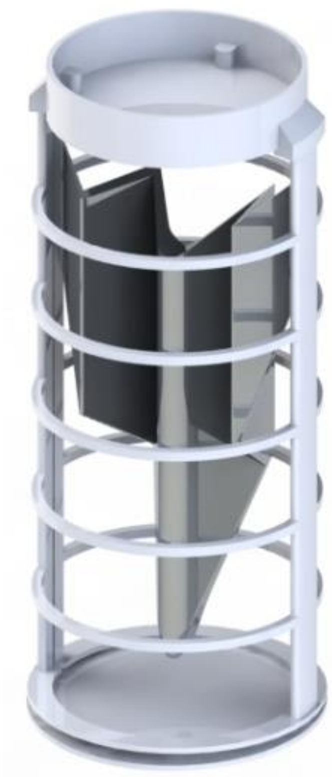
Container Mechanical Layout of Components Trade & Selection

Container Mechanical Layout 1

Container Mechanical Layout 2



Container Mechanical Layout 1 (Selected)

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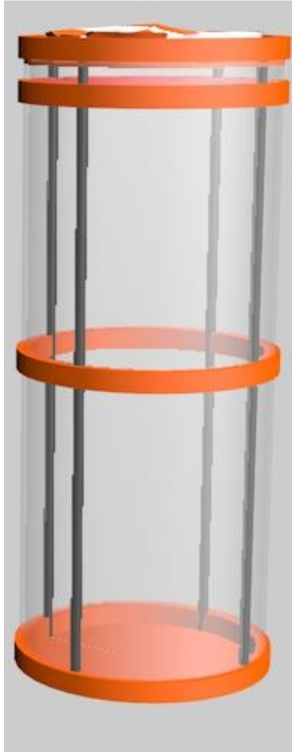
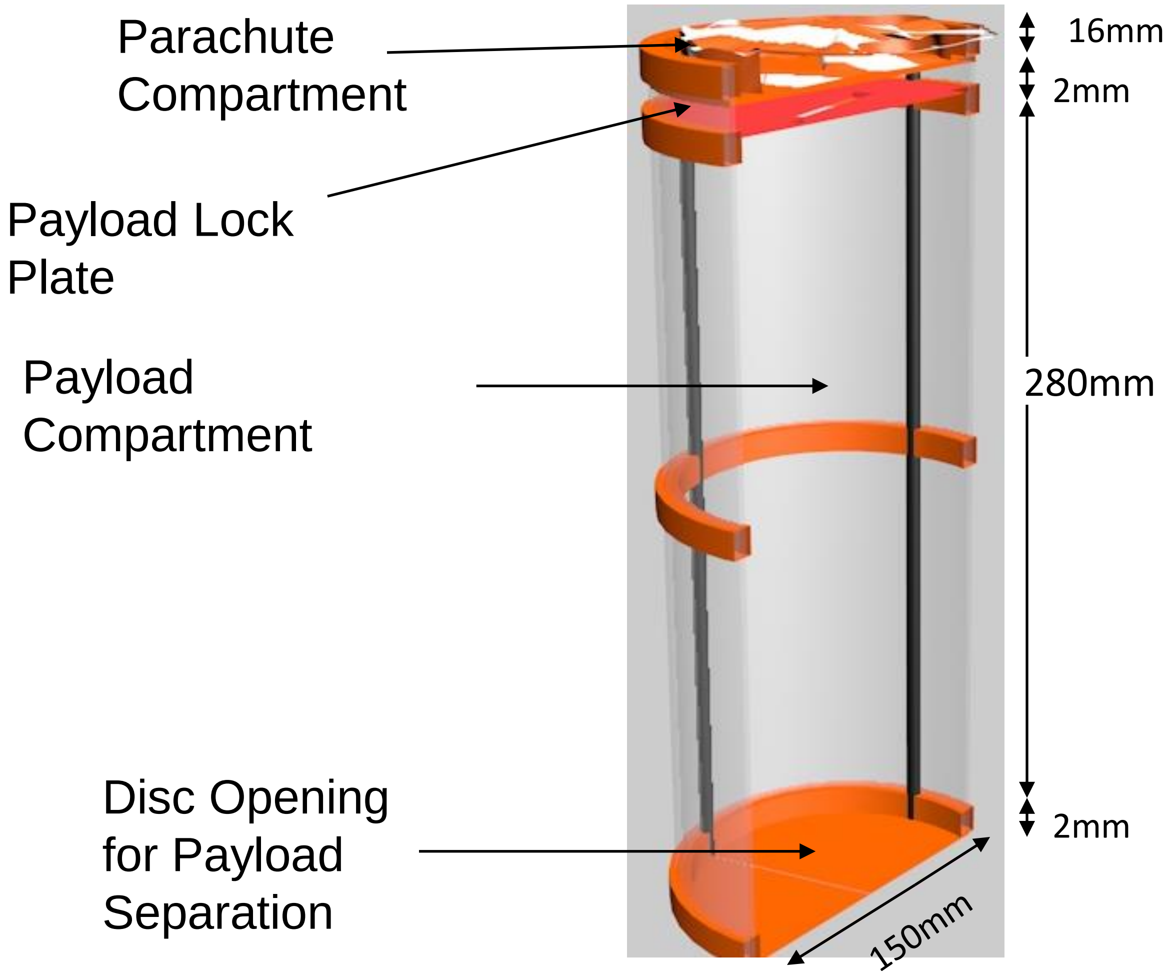
- Inbuilt parachute compartment.
- Lesser number of rods and rings to support the structure, so lesser weight.
- Stable design.

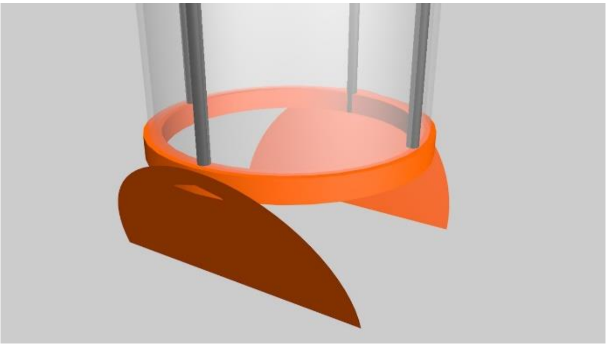


Container Mechanical Layout of Components Trade & Selection

Container Mechanical Layout 1(Selected)

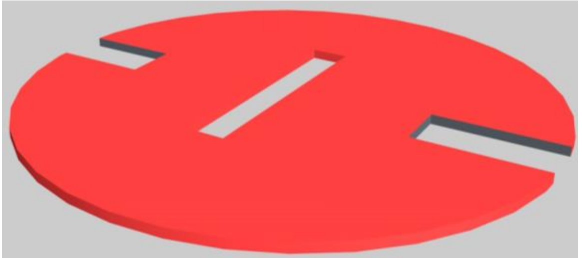


Major Mechanical Parts



Exit disc for Payload

Eyebolt Hook



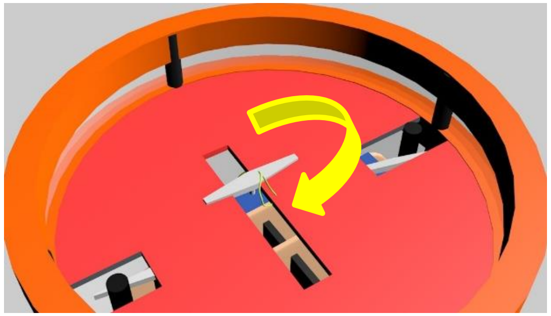
Locking Plate for Payload

Rivets

Hinges

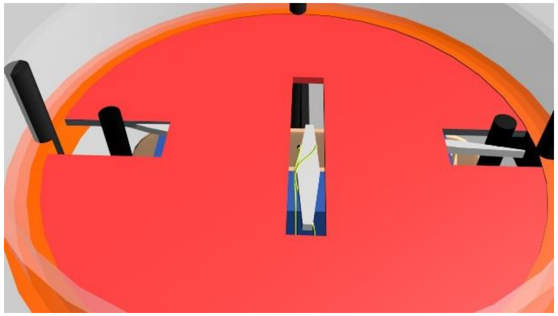
Payload Release Mechanism

Container Locked



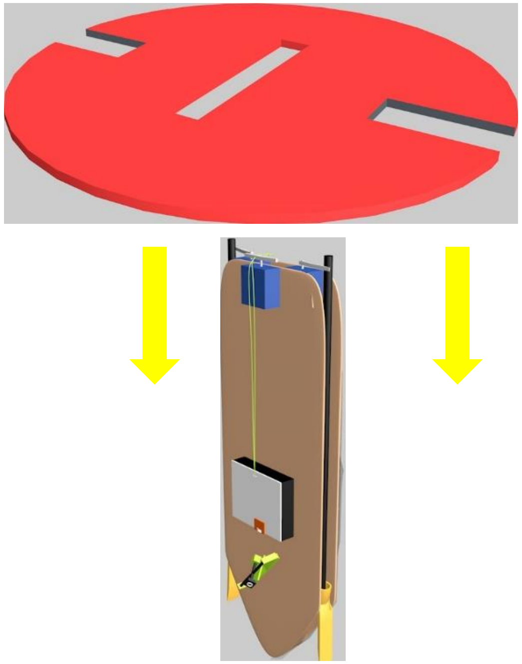
The key will keep the container and the payload in this locked position

Container Unlocked



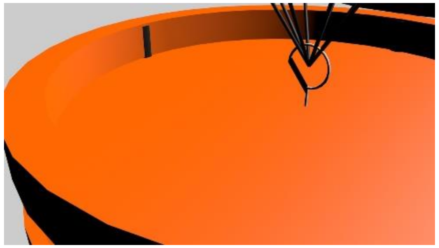
When command is given to the motor, it will rotate to unlock the Payload

Payload Released



Container Parachute Attachment Mechanism

Parachute Attachment



Eyebolt hook is used for attachment of parachute

Stowed Parachute

The parachute is kept folded inside the parachute compartment At the time of deployment, air will pass and the parachute will inflate

Parachute Released

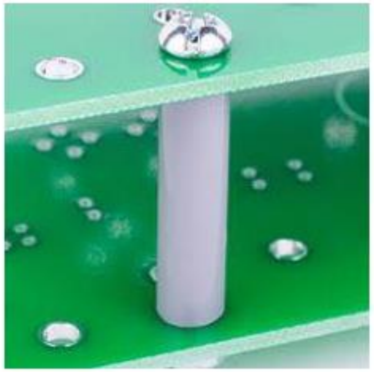
As the air goes inside the parachute, it inflates and controls the descent rate of CanSat

Electronics Structural Integrity

Electronics Compartment Mounting Methods :

- All electronics is soldered on the PCB except antenna, camera, switch and battery.
- The PCB will be mounted on the top plate of the fuselage, inside the electronics compartment.

Electronics Compartment Enclosures :



- All the electronics will be enclosed in the electronics compartment and will be mounted on PCB using standoffs and screws.
- Dust Particulate sensor is mounted on the base plate of the fuselage.

Securing Electrical Connections

- A custom PCB is used to prevent tangling of wires
- All sensitive connections are soldered and secured with silicon glue.
- A drop test will be performed to check the strength of electrical connections.
- Wired connections are used only for battery and switch.

Mass Budget

Container

Component Name	Mass (g)	Source
Lock Plate	20	Estimated
Parachute	11	Estimated(slicer)
Carbon rods ,rings,hinges ,plates	8+20+10+18+20	Estimated
Miscellaneous	15	
Total	113	

Science Payload

Component Name	Mass (g)	Source
Electronics	183.94	Data Sheet
3D printed parts	20	Estimated (slicr)
Carbon 3k rods,plates,nylon	10+55+25+10	Estimated
Miscellaneous	10	
Total	313.94	

TOTAL CANSAT

Structure Name	Mass (g)
Science Payload	313.94
Container	113
Total	426.94
Requirement	600
Margin	173.06

Communication and Data Handling (CDH) Subsystem Design

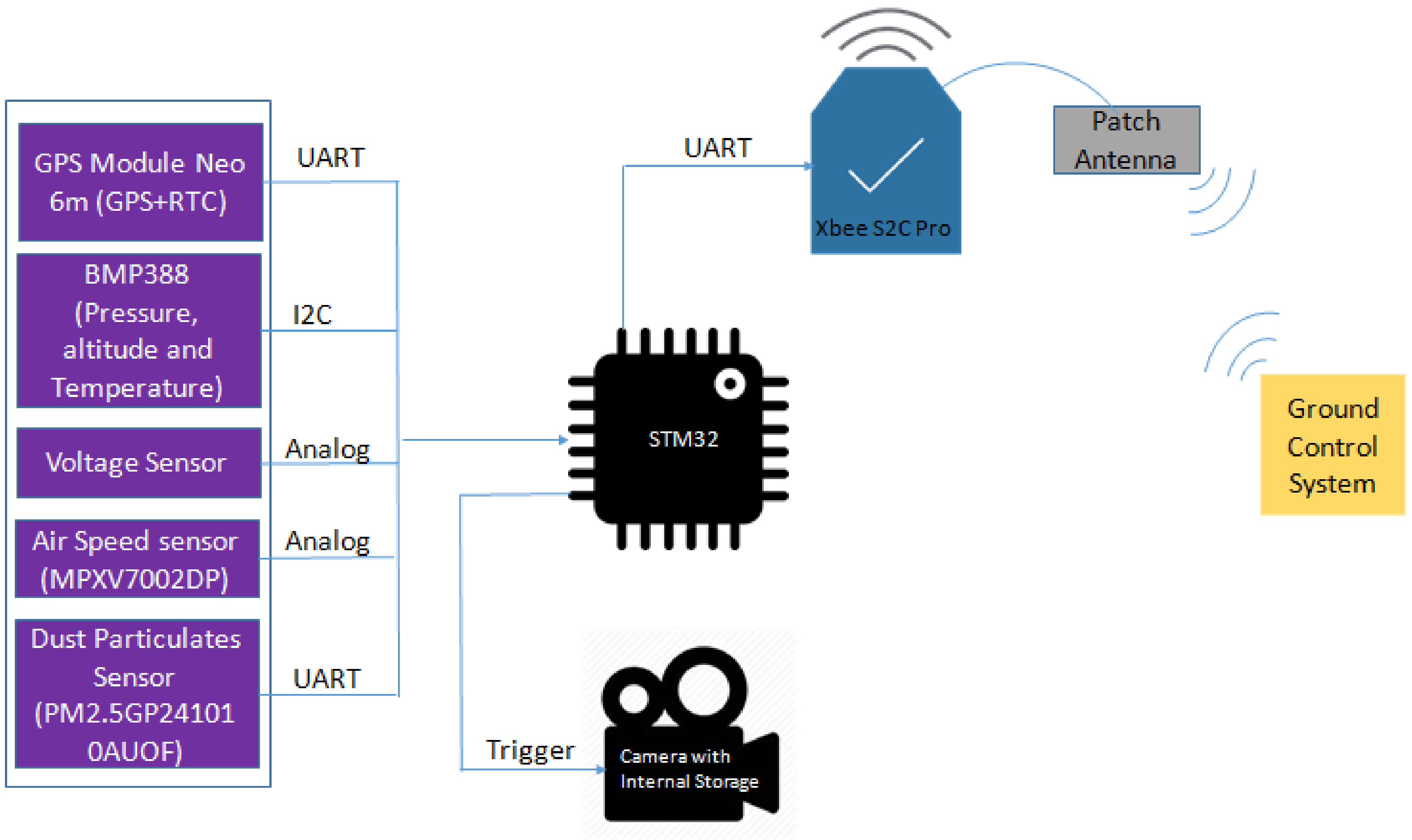
Shubhra Yadav

Payload CDH Overview

S.No	Component	Rationale
1.	Xbee Pro S2C	**Radio transreceiver:** For telemetry transmission, establishing communication between Cansat and GCS
2.	STM32F103C8 Blue Pill	**MCU:** To process the Cansat sensor data
3.	Patch Antenna	**Antenna:** For boosting Radio signal strength
4.	Inbuilt real time clock (RTC)	To provide the mission time

Payload CDH Overview

SENSOR SUB SYSTEM



Payload CDH Requirements

ID	Requirements	Rationale	Priority	VM
CDH-1	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	CR	High	A,I,D
CDH-2	The ground station shall generate a CSV file of all the sensor data as specified in the telemetry section.	CR	High	A,I,T
CDH-3	Telemetry shall include mission time with a resolution of one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	CR	High	A,I,T
CDH-4	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	CR	High	A,I
CDH-5	XBEE radios shall be used for telemetry. 2.4 GHz series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	CR	High	A,I,D
CDH-6	XBEE Radios shall have their NETID/PANID set to their team numbers.	CR	High	A,I,D
CDH-7	XBEE radios shall not use broadcast mode.	CR	High	A,I,D

Payload CDH Requirements

ID	Requirements	Rationale	Priority	VM
CDH-8	Each team shall develop their own ground station.	CR	High	D
CDH-9	All telemetry shall be displayed in real time during descent	CR	High	A,D
CDH-10	All telemetry shall be displayed in engineering units (meters, meters per second, celsius, etc)	CR	High	D
CDH-11	Teams shall plot each telemetry data field in real time during flight.	CR	High	D

Payload Processor & Memory Trade & Selection

Controller Board	Size (mm)	Mass (g)	Operating voltage	Clock frequency	Data Interfaces	Memory
Arduino Nano ATmega328p	43.18x18.54	7g	5V	16MHz	1-SPI, 1-I2C, 1-UART, 14 GPIO, 8 Analog Input	SRAM: 2KB EEPROM: 1KB
STM32F103 C8 Blue Pill	60x22	8g	3.3V	72MHz	2-SPI, 2-I2C, 3-UART, 37 GPIO, 10 Analog Inputs	SRAM: 20KB EEPROM: 2KB
Arduino UNO	68.6x53.3	25g	5V	16MGz	1-SPI, 1-I2C, 1-UART, 14 GPIO, 6 Analog Input	SRAM: 2KB EEPROM: 1KB

CHOSEN CONTROLLER: STM32F103C8 Blue Pill

- High Clock Frequency (72MHz)
- Inbuilt RTC
- Fast Boot
- Low operating voltage
- Sufficient number of GPIO pins
- Low weight, Low cost, Small size
- Upto 128KB flash memory, 2KB EEPROM, 20KB SRAM

RTC Module	Dimensions (mm)	Mass (g)	Operating Voltage	Battery Backup	Interfaces
STM32F103C8 Blue Pill Inbuilt RTC	60x22	8g	3.3V	Yes	Upto 2-I2C
DS1307	46x24	5g	3.3V-5V	Yes	I2C
DS1302	50x25	8g	3.3-5V	Yes	I2C

CHOSEN MODULE: STM32F103C8 Blue Pill Inbuilt RTC

- No extra component required
- No extra weight required
- No extra cost required
- No extra space required
- Backup Battery is provided is provided on Vbat terminal of controller, making RTC independent of Processor Reset.

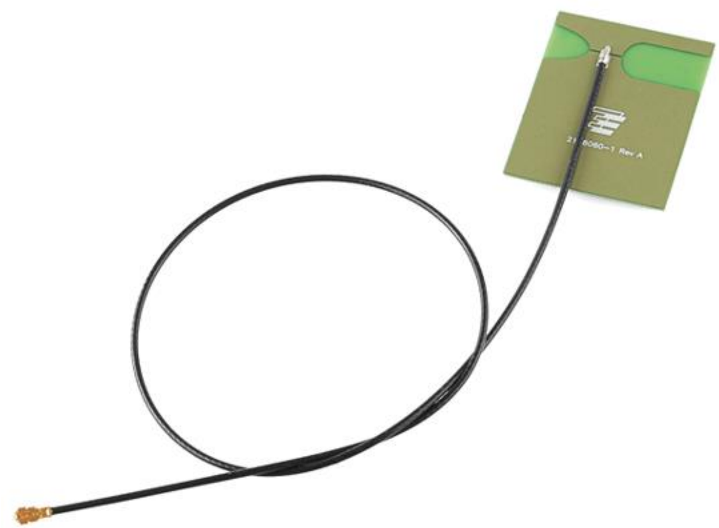
Inbuilt RTC

Payload Antenna Trade & Selection

Antenna	Polarization	Gain	Frequency Range(GHz)	Connector Type	Mass(g)
SparkFun 2.4GHz Patch Antenna	Linear & Vertical	2DBI	2.3-3.8; 5.15-5.875	U.FL	3.3
Rubber Duck Antenna	Linear & Vertical	20DBI	2.4-2.5	RP-SMA	10

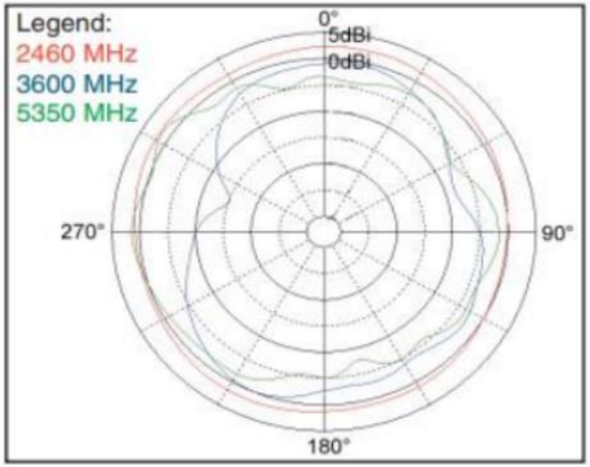
ANTENNA CHOSEN: SparkFun 2.4 GHz Antenna

•High Gain Antenna
•Work under Required frequency:2.4GHz
•Low Weight under 3.3g
•Easily Mountable
•Connector plug compatible with selected Radio (XBEE PRO S2C)U.FL

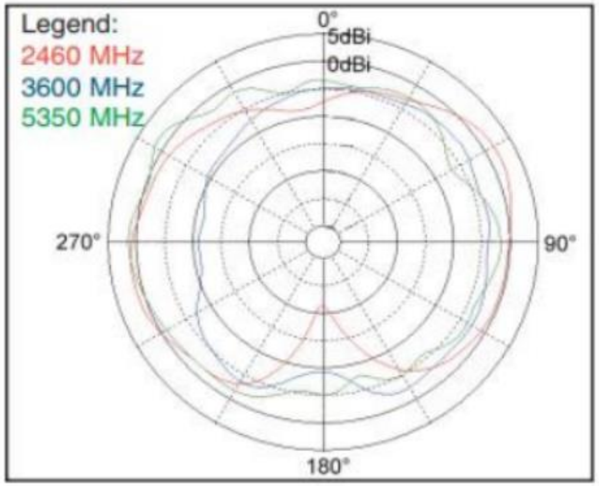


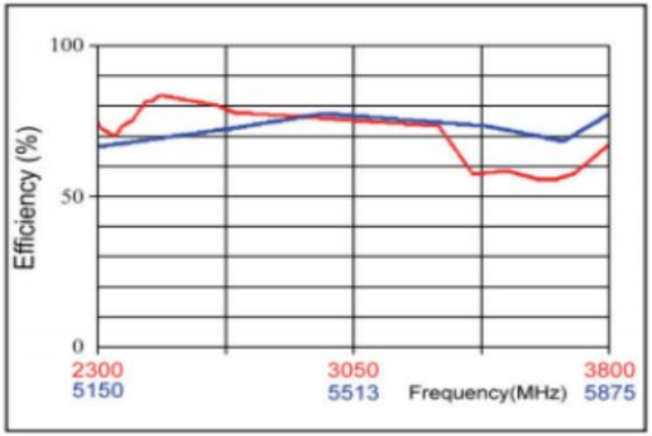
Sparkfun 2.4 GHz Patch Antenna Radiation Pattern:

Azimuth



Elevation





Payload Radio Configuration

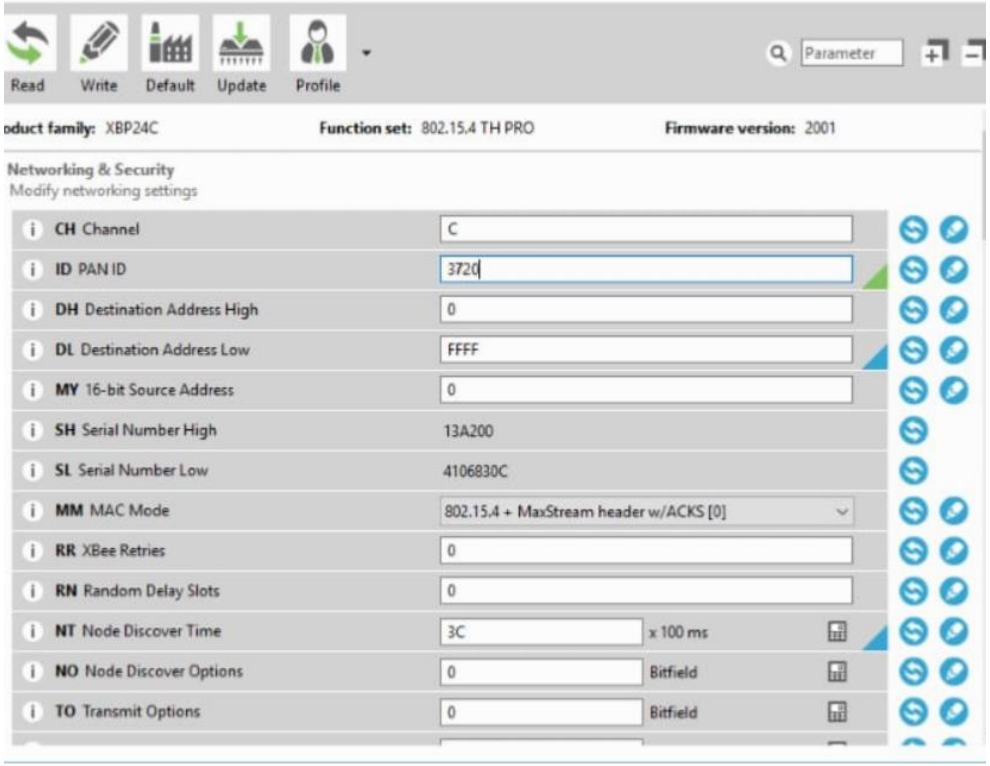
Specifications	Xbee S2C Pro	Digi Xbee 3
Operating Voltage	2.7V-3.6V	2.1V-3.6V
Dimensions	13mmx19mm	13mmx19mm
Max Data Rate	250Kbps	250Kbps
Weight	4g	4g
Interface	UART, I2C, SPI	UART, I2C, SPI
Frequency	2.4GHz	2.4GHz
Distance Range	1600m	1200m
Cost	₹1664.53	₹ 2280

Chosen Payload Radio Configuration: Xbee S2C Pro

- Sufficient range of 1 mile (1600m)
- Operating current:
  - ✓ 31mA on receiver end
  - ✓ 120mA on transmitter end
- Low power consumption
- Low weight

Payload Radio Configuration

- Software used for Xbee Configuration: **X-CTU**
- NETID/PAN-IP: **Team No. (3720)**
- Xbee Configuration: **AT MODE**
- Probe Xbee Radio Mode: **ROUTER-AT**
- Ground Station Xbee Radio Mode: **Coordinator AT**
- Xbee Broadcast Mode: **OFF**
- Communication Protocol: **802.15.4**
- Xbee Radio Operating Frequency: **2.4GHz**
- Antenna Direction: **Downward**



Payload Radio Configuration

- Xbee Pro S2C PAN-ID shall be set as Team no.(3720).
- The Xbee Radio is used at a frequency of 2.4GHz.
- The Xbee Pro S2C Radio is configured using AT-Mode.
- The Probe radio is configured as Router AT and the Ground Station as coordinator AT.
- Both Xbee Radio settings are configured using X-CTU software.
- Minimum 1Hz of frequency is set as the transmission rate for probe’s Xbee.
- The Router Xbee is set to transmit telemetry to the coordinator Xbee.
- The Xbee will not be configured in Broadcast Mode.
- A formatted string of data from payload will be sent to Ground Station.
- The Patch antenna will face downward to transmit data with least obstacles in path.
- The RF communication between Router and coordinator Xbee will follow

TELEMETRY CONFIGURATION :

- Data Transmission Baud Rate: **9600**.
- Data Transmission Mode: **Continuous**
- Data Packets Transmission rate: **Greater than 1Hz**
- Sensor reading units: **Standard Engineering units**
- Data Packets Format: **ASCII comma separated value**.
- Telemetry Data File Name: **Flight_3720.csv**

TELEMETRY FORMAT :

<TEAM_ID>,<MISSION_TIME>,<PACKET_COUNT>,<ALTITUDE>,<PRESSURE>,<TEMP>,<VOLTAGE>,<GPS_TIME>,<GPS_LATITUDE>,<GPS_LONGITUDE>,<GPS_ALTITUDE>,<GPS_SATS>,<AIR_SPEED>,<SOFTWARE_STATE>,<PARTICLE_COUNT>

Payload Telemetry Format

<u>TELEMETRY EXAMPLE :</u>

3720,36s,23,280m,320Pa,24.5C,7.4v,12:35:26,30.7690448,76.575
7943,601m,5,35m/s,SCIENCE_PAYLOAD_ACTIVE,2500-5000

<u>TELEMETRY DATA :</u>

- **TEAM_ID>:** Assigned team identification. i. e(3720).
- **<MISSION_TIME>:** Time since initial power up*(units=seconds).*
- **< PACKET_COUNT>:** Count of transmitted packets since initial power up.
- **<ALTITUDE >:** Altitude relative to ground level(*units =meters ,Resolution=0.1).*
- **< PRESSURE>**: Measurement of atmospheric pressure*(units= Pascal, Resolution=1Pa).*
- **< TEMP>:** Surrounding temperature *(units=degree Celsius, Resolution=0.1 degree c)*
- **< VOLTAGE>:** Voltage of CanSat power bus*(units=volts, Resolution=0.01 v).*
- **< GPS_TIME>:** Time generated by the GPS receiver(*Zone=UTC, Resolution=1 second).*

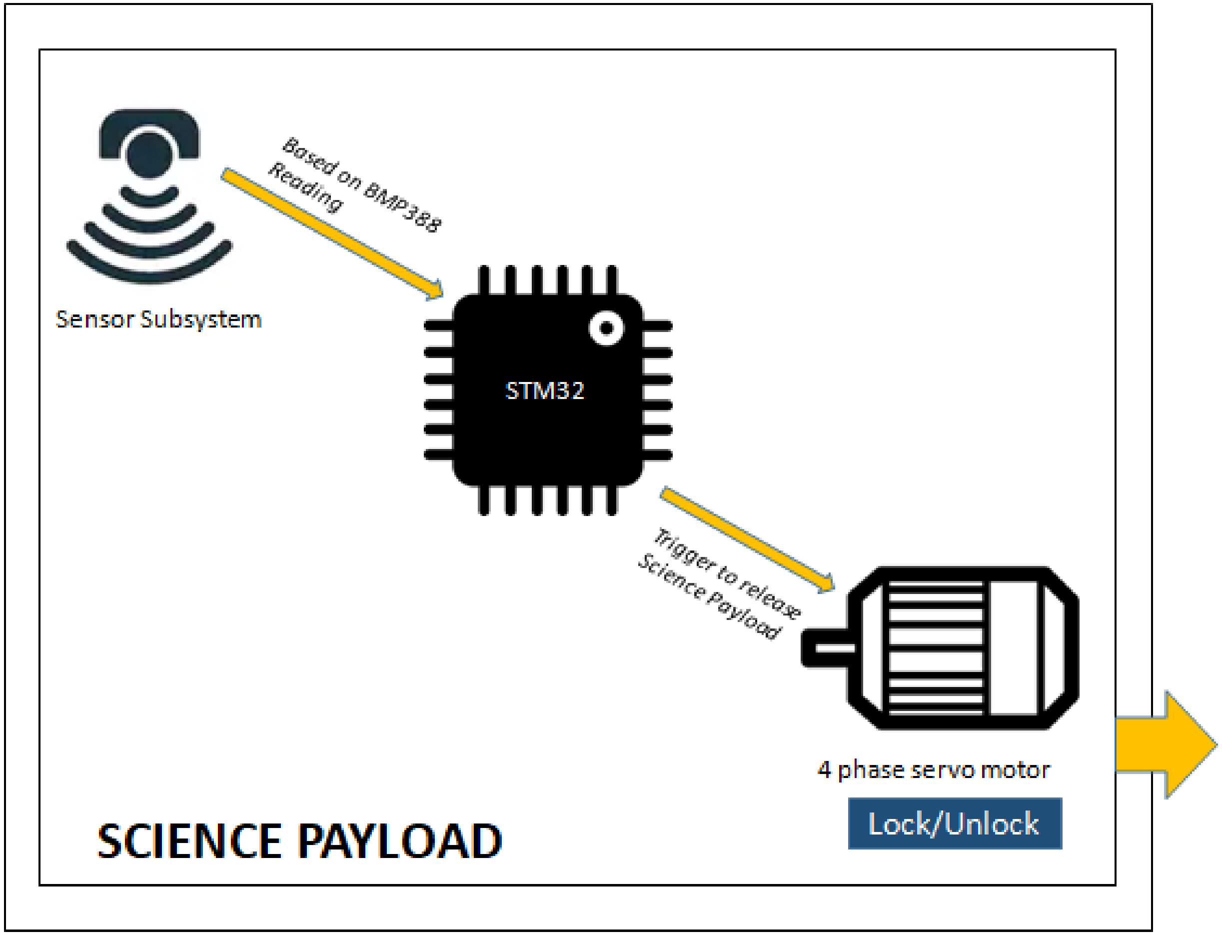
Payload Telemetry Format

TELEMETRY DATA CONTINUES..

- **<GPS_LATTITUDE>:**Latitude generated by the GPS receiver *(Resolution=0.0001 Degrees).*
- **<GPS_LONGITUDE>:**Longitude generated by the GPS receiver *(Resolution=0.0001 Degrees).*
- **<GPS_ALTITUDE>:**Altitude generated by the GPS receiver in meters above mean sea level*(Resolution=0.1meters).*
- **<GPS_SATS>:**Number of GPS satellites being tracked by the GPS receiver*(Integer).*
- **<AIR_SPEED>:**Air speed relative to the payload*(units=meters/second).*
- **<SOFTWARE_STATE>:**Operating state of the software.*(boot, idle,launch detect, deploy,etc).*
- **<PARTICLE_COUNT>:**Measured particle count in mg/m^3*(Decimal).*

- Video recorded will be saved in internal storage.
- The example telemetry and telemetry format fulfills the requirements of competition guidelines.

CONTAINER



Since all measurements and data transmission process is carried out by the Science Payload, no electronics are mounted on the container

Container CDH Requirements

ID	Requirements	Rationale	Priority	VM
Cdh-1	The container 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	CR	High	A,I,T
Cdh-2	The container shall release the payload at 450 meters +/- 10 meters.	CR	High	A,I,T

All Mechanisms, measurements and data transmission process will be carried out from Science Payload. So, we will use the same processor from the science payload to initiate mechanism based on BMP388 sensor altitude readings.

<u>CHOSEN CONTROLLER: STM32F103C8 Blue Pill</u>

- High Clock Frequency (72MHz)
- Inbuilt RTC
- Fast Boot
- Low operating voltage
- Sufficient number of GPIO pins
- Low weight, Low cost, Small size
- Upto 128KB flash memory, 2KB EEPROM, 20KB SRAM

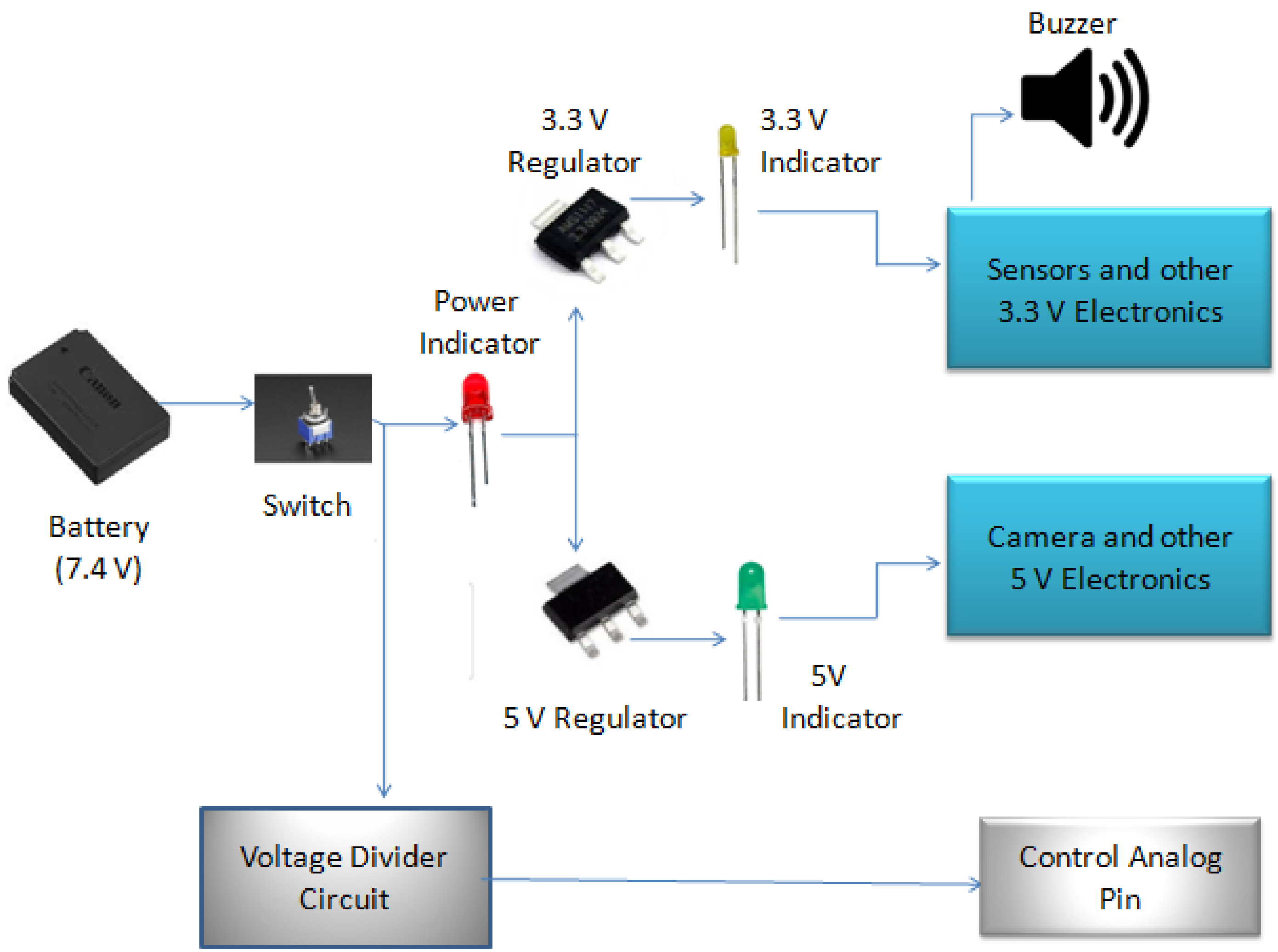
Electrical Power Subsystem (EPS) Design

Ritika Bansal

EPS Overview

COMPONENT	PURPOSE
DTSE LP-E12 Battery	To provide power to the electronic circuit
Switch	To control power supply
Voltage Regulator (AMS1117 3.3 V)	To regulate voltage output to 3.3 V
Voltage Regulator (LM805 5V)	To regulate voltage output to 5 V
LEDs	Supply indicator
Voltage Divider Circuit	To know the battery voltage
Buzzer	To mark the landing of the glider

EPS Overview



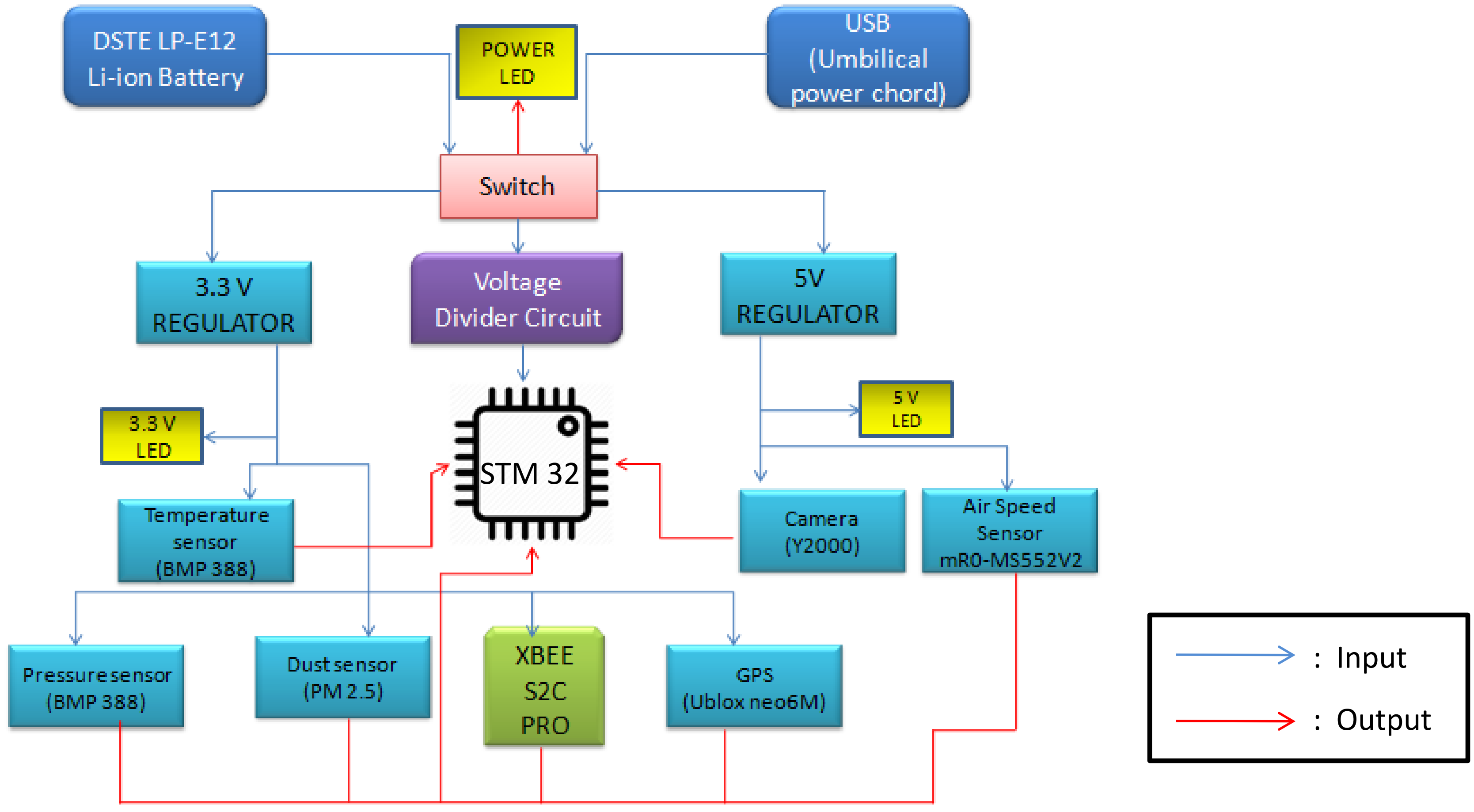
EPS Requirements

ID	Requirements	Rationale	Priority	VM
EPS-1	The probe must include an easily accessible power switch that can be accessed without disassembling the Cansat and in the stowed configuration.	For easy power access	HIGH	A,D
EPS-2	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the Cansat and in the stowed state.	Power verification	HIGH	A,D
EPS-3	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Fast Recovery	HIGH	A,T
EPS-4	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	Audible	HIGH	D
EPS-5	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.	Cansat requirements and safety	HIGH	A,D

EPS Requirements

ID	Requirements	Rationale	Priority	VM
EPS-6	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Easy battery access	HIGH	A,I,D
EPS-7	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Safety from power disconnection	HIGH	A,I,D
EPS-8	The CANSAT must operate during the environmental tests	Cansat requirements	HIGH	A,I,T
EPS-9	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Cansat requirements	HIGH	A,I,T

Payload Electrical Block Diagram



Payload Power Trade & Selection

Battery	Chemical	Nominal Voltage	Nominal Capacity(mAh)	Weight (g)	Dimensions (mm)
CR2	Lithium Manganese Dioxide	3.0 V	800	10	15.3 x 26.5
DSTE LP-E12 Li-ion	Lithium ion	7.2 V	2300	9.07	4.7x3.6x1.6

Chosen battery : DSTE LP- E12 Li –ion

Specifications:

- Enough voltage and current capacity
- Can be used for 3-4trials
- Less Weight
- Consists of 2*3.6V Li cells of 2300mAH connected in series to get 7.2V output.

Payload Power Budget

Component Name	Voltage (V)	Current (mA)	Power Consumption (mW)	Duty Cycle (%)	Source
STM 32	2.7-3.3	33.5	0.126	100	Datasheet
Camera	5	110	11	100	Datasheet
Pressure Sensor **BMP 388**	3	0.1	0.72	100	Datasheet
Air Speed Sensor **MPXV 7002DP**	3	10	0.7	100	Datasheet
Air Particulates Sensor **PM2.5GP2Y1010AUOF**	3	15	0.5	100	Datasheet
GPS Ublox neo 6M	3-3.5	45	0.225	100	Datasheet
Xbee Radios(2.4GHz)	3.6	31	111.6	100	Datasheet
Voltage Divider	3.6	0.2	0.72	100	Datasheet
Servo motor	5	250	1.25	5	Estimated

Container Electrical Block Diagram

All the Mechanisms , measurement sensors and electronics are installed in Science payload .
All the data transmission process will also be carried out from Science Payload. So, there will be no electric circuit installed in the container

Container Power Trade & Selection

No electric circuit in the container

Container Power Budget

There is no power consumption inside the container

Flight Software (FSW) Design

Khyati Khanna

FSW Overview

Overview of the FSW design

–Data from the sensors is read first

–Necessary calculations are done

–Send data through Xbee

Flight summary

–Glider from the container has to be released at 450meters (+/-10m)

–Initialize the sensors

–Collect data

–Transmit the processed data once per second to ground station

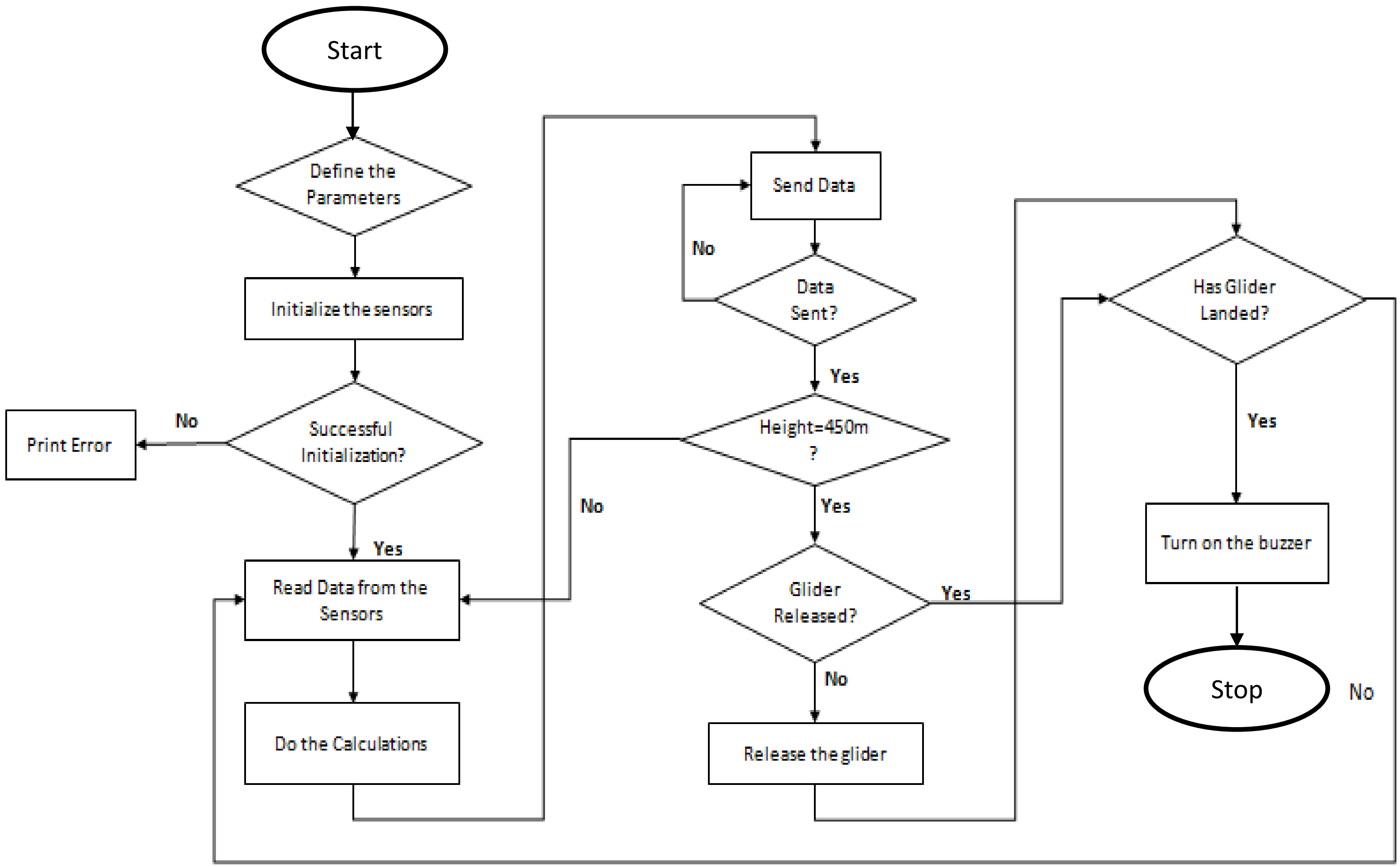
–On landing, turn in the buzzer

Programming language used: C++

FSW Requirements

ID	Requirements	Rationale	Priority	VM
FSW-01	At 450 meters (+/-10 meters)the container shall release the payload	CR	HIGH	A,I,D
FSW-02	Flight software will maintain a count of packets transmit	CR	HIGH	A,I,D
FSW-03	The science payload shall measure altitude using an air pressure sensor ,outside temperature, battery voltage, position using GPS, spin rate of the auto-gyro blades relative to the science vehicle, pitch and roll	CR	HIGH	A,I,D
FSW-04	The probe shall transmit all sensor data in the telemetry at the rate of 1Hz	CR	HIGH	A,I,D
FSW-05	The Science Payload shall be able to follow the GCS commands to calibrate barometric altitude, and roll and pitch angles to zero	CR	HIGH	A,I,D
FSW-06	Teams will collect and plot data in real time	CR	HIGH	A,I,D
FSW-08	Transmission ends once glider lands	CR	HIGH	A,I,D
FSW-09	Audio beacon will turn on after glider lands	BR	MEDIUM	A,I,D

Payload FSW State Diagram



No Software Design for Container

All the mechanisms are carried out in the payload

PSEUDO CODE

- Launch detection
- Starts collecting data and transmitting data
- if altitude = 450m release glider from the can
- continue collecting and transmitting data
- Stop sending data if glider lands and turn on the buzzer

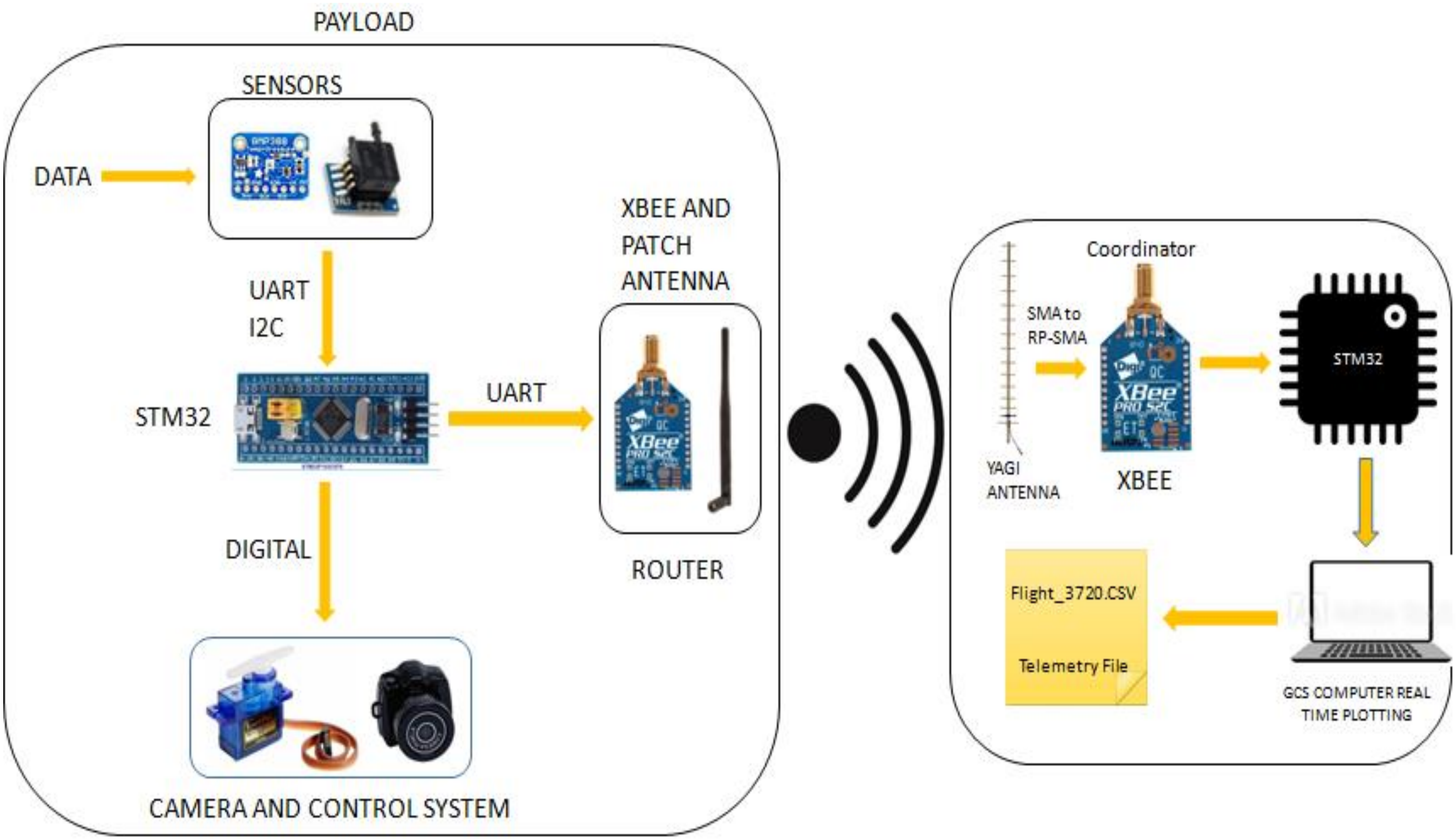
Software Development Plan

- Regular meetings for weekly work allotment
- Regular work to accomplish software development task set till the next meeting
- Dividing up the tasks according to the specialization
- Testing the sensors and telemetry

Ground Control System (GCS) Design

Shubhra Yadav

GCS Overview



GCS Requirements

ID	Requirements	Rationale	Priority	VM
GCS-1	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	CR	High	A, I, T
GCS-2	The ground station shall generate a CSV file of all the sensor data as specified in the telemetry section.	CR	High	A, I, D
GCS-3	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	CR	Medium	A, I
GCS-4	Each team shall develop their own ground station.	CR	High	D
GCS-5	All telemetry shall be displayed in real time during descent.	CR	High	D
GCS-6	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	CR	High	A, D
GCS-7	Teams shall plot each telemetry data field in real time during flight.	CR	High	A, I, D

GCS Requirements

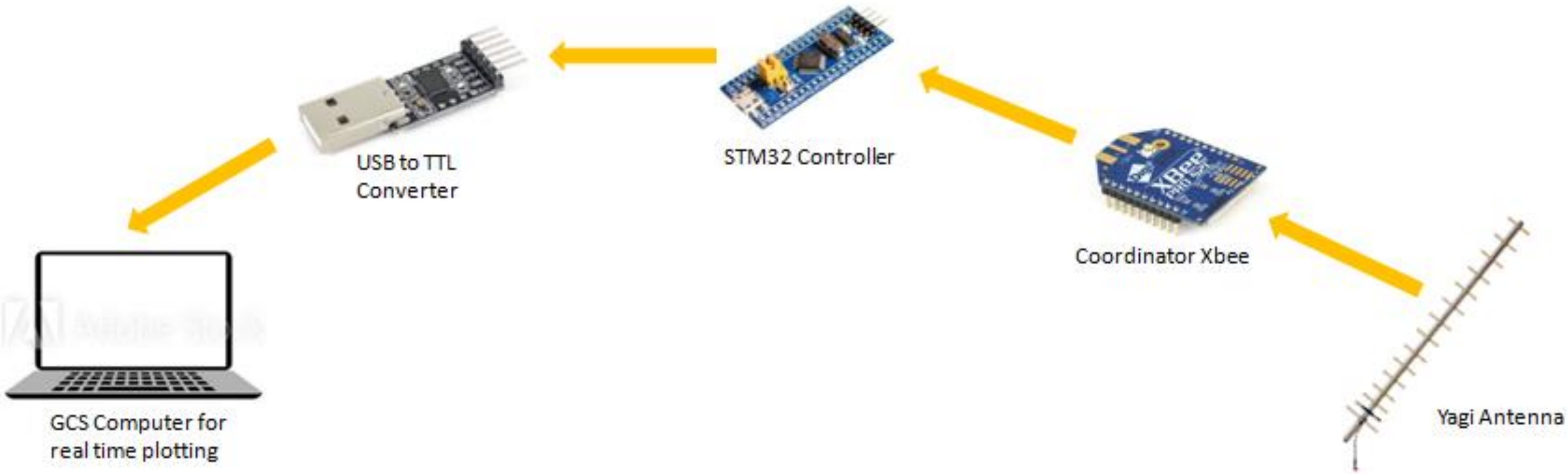
ID	Requirements	Rationale	Priority	VM
GCS-8	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	CR	HIGH	A, D
GCS-9	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	CR	HGH	D
GCS-10	Both the container and probe shall be labeled with team contact information including email address.	CR	HIGH	D

GCS Design

- GCS will at least have 3 hours of battery life with laptop cooling pad to prevent overheating and umbrella to prevent irradiance.
- Updated Window version will be brought into use and auto update will be turned off.
- All unwanted running apps will be disabled during the competition.
- The antenna will be pointed towards the Cansat to prevent data losses.

COMPONENTS:

- Yagi Antenna
- Xbee Pro S2C (RP-SMA port)
- STM32 Blue Pill Controller
- USB to TTL Converter
- Laptop



GCS Antenna Trade & Selection

Antenna	Gain	Direction	Frequency	Impedance	Price
Yagi Antenna	16dBi	Omni-Directional	2.4GHz	50Ω	$11.6
Duck Antenna	6dBi	Omni-Directional	2.4GHz	50Ω	$2.48

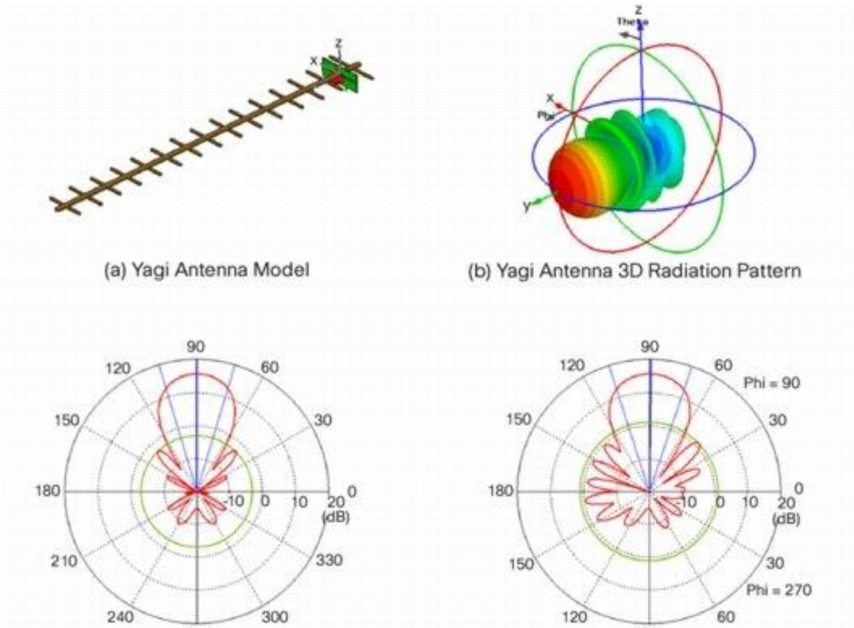
CHOSEN DEVICE : YAGI ANTENNA

- RP-SMA Connector
- High power gain antenna(16dBi)
- Works with 2.4GHzISM band IEEE802.11b,802.11g,IEEE802.11n
- Better Radiation pattern
- Less weight
- Easy to hold in hand

NOTE: As long as the Yagi is pointed directly at cansat with margin of 10 degrees ,range of operation is around 900m.

YAGI ANTENNA RADIATION PATTERNS

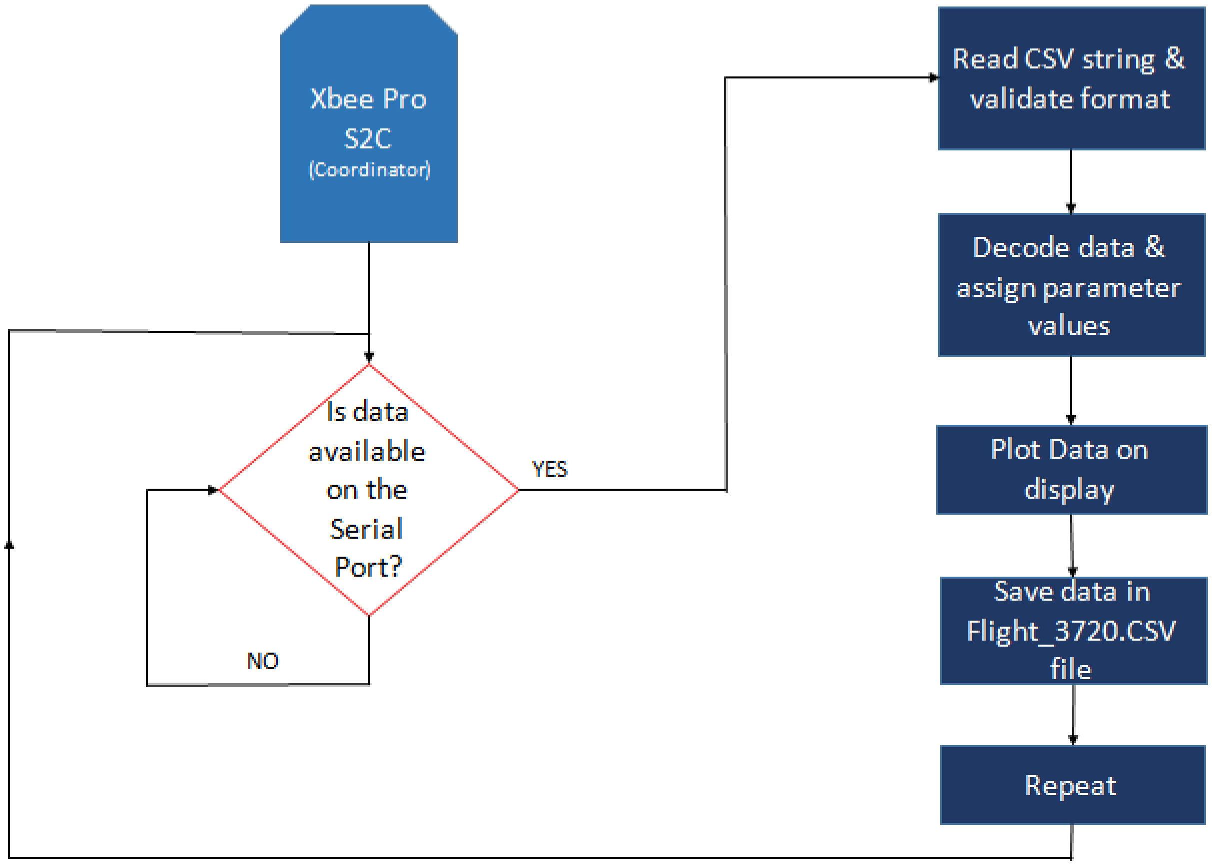
- Azimuthal , Vertical and Horizonal polarization
- Azimuthal Beam:
  1. Cursor az: 0.0º
  2. Elevation angle:17.0º
- Horizontal Beam: 38º
- Vertical Beam:30 º



(a) Yagi Antenna Model
(b) Yagi Antenna 3D Radiation Pattern
(c) Yagi Antenna Azimuth Plane Pattern
(d) Yagi Antenna Elevation Plane Pattern

GCS Software

- **Language:** Python
- **IDE:** PyCharm
- **Libraries:** PySerial, Matplotlib, MicroPython (GRPL-uPython)



GCS Software

Commands:

- ✓ When Cansat system is ON, CanSat is software looped to receive commands from Xbee via GCS radios.
- ✓ Three kinds of commands will be there:

S.No.	Calibration Command	Testing Command	Launching Command
1.	This command will be used to calibrate the sensors.	This command is used to test all the sensors, i.e. CanSat functionality.	This command is used to initiate telemetry transmission.
2.	The GCS will transmit the Calibration Command to flight software.	The GCS can make query to the flight software by sending a testing command for an individual module.	The GCS will transmit Launch Command to flight software, which breaks the command loop and start a new telemetry transmission loop.
3.	On setting the offset, the flight software will return offset values to GCS as confirmation.	Based on query, the flight software will execute tasks and respond to GCS.	Calibration and testing commands will be disabled after launch command.
4.	Can be executed several times.	This can be executed several times.	This can only be used once per session.

GCS Software

TELEMETRY DATA DISPLAY

- ✓ Telemetry data will be displayed using custom Python GUI
- ✓ Telemetry data will be displayed in the form of graph/map/custom views along with the numerical value.

SOFTWARE PACKAGES

- ✓ Using a software PyCharm IDE for Python, a Python program will read the serial data from STM32 controller (receiving from the Xbee and the Yagi antenna) on the selected port and plotting all the data on one frame, including multiple graphs & tables using Matplotlib, PySerial

TELEMETRY MEDIA AND PRESENTATION

- ✓ The received data will be written to a plain text file with .csv extension (Comma separated values) in a background thread along with plotting the same data on main GUI frame.
- ✓ Data will contain all telemetry information with data separated by comma (,).

GCS Software

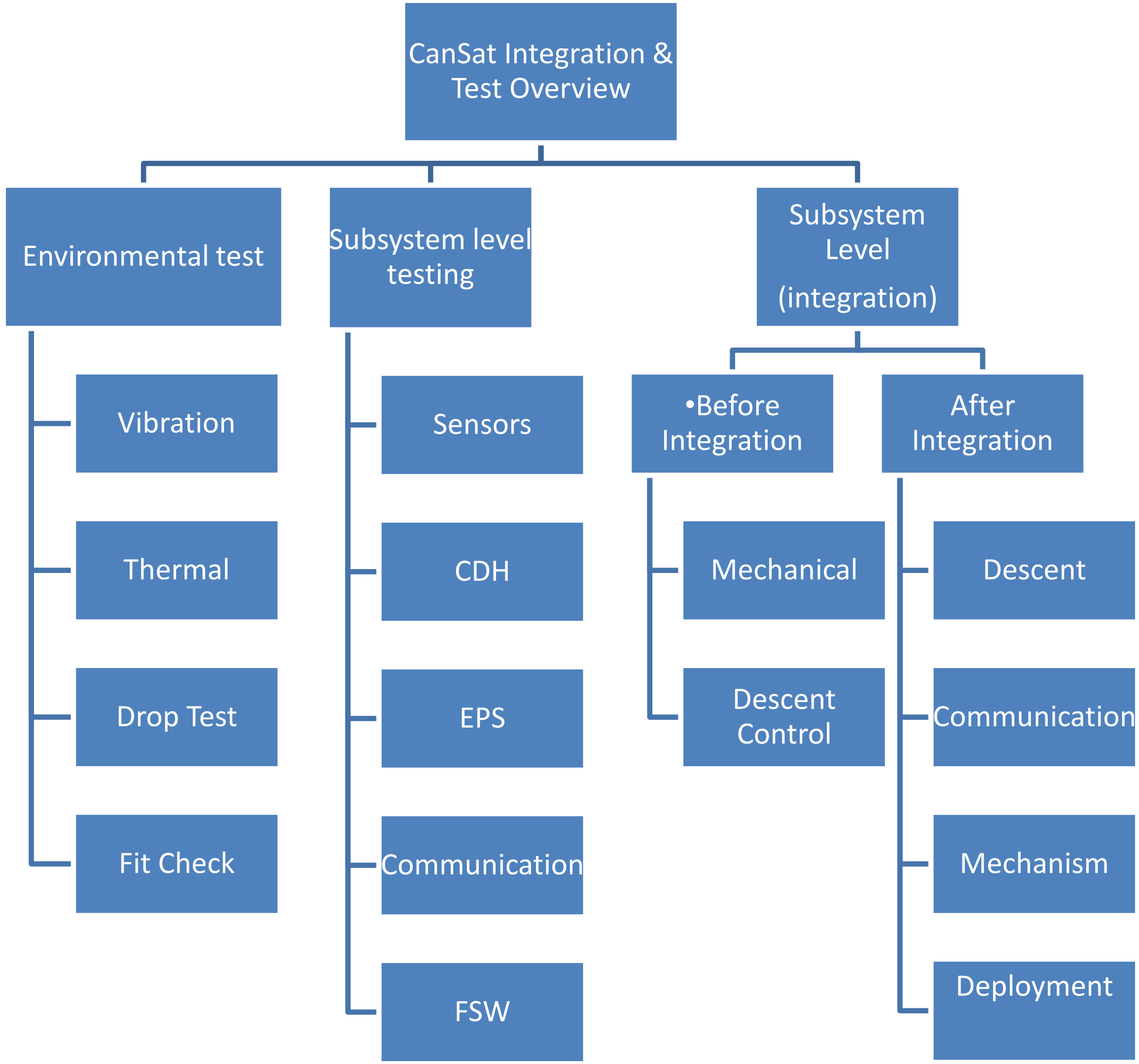
COMMAND SOFTWARE AND INTERFACE

- ✓ Using connect command in GCS software, connections shall be established.

CanSat Integration and Test

Khyati Khanna

CanSat Integration and Test Overview



Subsystem Level Testing Plan

Sensors	Sensors will be checked and will be separately calibrated before mounting them into Cansat.
CDH	Sample data send via radio modules will be checked if they can be properly handled by the ground station software. Time of sending and receiving data will also be checked
EPS	Battery used?
Radio Communication	Verification of radio modules parameters and communication quality on ground has to be checked
FSW	All the software designs are checked if they are working properly according to the task

Subsystem Level Testing Plan

Mechanical	Mechanical elements of the CanSat are to be checked separately so as to ensure if they are made properly. CanSat will be tested to ensure that it successfully survives structure survivability tests. When all electrical subsystems are integrated, then the CanSat will be checked again.
Descent Control	To check if with a sample of mass attached, if the parachute descent is stable or not.

Integrated Level Functional Test Plan

Descent Testing	We check the descent rate by deploying the CanSat from high building of known height. From camera the test will be recorded which lets us calculate the descent rate of rotor and parachute
Communications	On ground the communication between CanSat and ground station is checked
Mechanisms	Opening and separation mechanisms are being tested of the CanSat
Deployment	To check if the probe can be deployed from the container without any trouble

Environmental Test Plan

Vibration	The CanSat will be place on a vibrator to check if there is any damage
Thermal	CanSat will be tested by putting it on high temperature to check it is causing any damage to the CanSat (e.g. electronics). The system will be tested for 2 hours and the temperature resistance will be checked
Drop Test	Cansat will be manually dropped from a height and the damage and deterioration from the original structures will be checked
Fit Check	Fit check will be performed using a cylindrical envelop to check if canSat can be easily deployed from the rocket.

Mission Operations & Analysis

Ritika Goyal

Overview of Mission Sequence of Events

PRE- LAUNCH

Arrival	▪ CanSat Assembly ▪ Devices connected for the communication ▪ All modules are checked
GCS Setup	▪ Antenna setup is done ▪ Software setup for real time plotting is done
Integration	▪ Payload is wrapped into the container ▪ CanSat is placed in the launcher

LAUNCH

Rocket Launch	▪ FSW is initiated ▪ Sensors are calibrated
Separation	▪ At 450m CanSat is separated from the container ▪ Camera turned on to shoot ▪ Data is being collected and transmitted to GCS
Landing	▪ As the glider lands the audio beacon is turned on ▪ Data transmission will be stopped

Overview of Mission Sequence of Events

POST- LAUNCH

Recovery	▪ Any damage to the container after the landing will be examined ▪ Safe landing will be judged by the field judges
Analysis	▪ Data is taken from the glider ▪ Judges will check the telemetry data
Post Flight Reporting (PFR)	▪ Begin writing the PFR from the data obtained ▪ On the scheduled date the presentation will be presented

Overview of Mission Sequence of Events

TEAM MEMBERS ROLE AND RESPONSIBILITIES

S.No.	Name	Crew	Roles and Responsibilities
1	Khyati Khanna	Mission Control Officer	Informs Flight Coordinator when team and CanSat are ready for the launch
2	Adya Singh	CanSat Crew	Prepares the CanSat, integrates it into the rocket and verifies the status
3	Shubhra Yadav		
4	Ritika Bansal	GCS Crew	Monitors the ground station for telemetry reception and issuing commands to the CanSat
5	Aditi Kulshrestha	Recovery Crew	tracks the CanSat and goes out into the field for recovery and interacting with the field judges. Makes sure, all field scores are filled in
6	Ritika Goyal		

Mission Operations Manual Development Plan

MANUAL DEVELOPMENT PLAN INCLUDES :

- Electronics Test (e.g. electrical connections, radio communication, sensor working etc)
- Recovery Check(e.g. container recovery, payload recovery etc)
- Mechanical Test(e.g. electronic mounting, Parachute mounting etc)
- Integration Test(e.g. radio communication to ground station, power to CanSat etc)

CanSat Location and Recovery

- Container will be traced when it will be released from the payload
- Fluorescent orange colour of payload will help in locating the payload
- Audio beacon will also help in locating the payload after landing
- GPS location of payload will be used in recovery of the payload
- Team logo on the payload will be used for identification

Requirements Compliance

Aditi Kulshrestha

Requirements Compliance Overview

- **Majority of requirements are complied.**

- Complied Subsystem
  - ✓ Sensor Subsystem
  - ✓ Descent Control subsystem
  - ✓ Mechanical Subsystem
  - ✓ Communication & Data handling subsystem
  - ✓ Flight software
  - ✓ Electrical & Power Subsystem
  - ✓ Ground Control Station Subsystem
- All subsystem shall be tested to check whether the design meets competition requirement.
- The designs & methods may be changed till CDR, based on their test results.
- Delta Wing glider descent calculations for phase II will be justified till CDR.

Requirements Compliance

RN	Requirements	Comply/ No Comply Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
01	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	Comply	88	
02	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Comply	88	
03	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Comply	88	
04	The container shall be a fluorescent color; pink, red or orange	Comply	88	
05	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	Comply	88	

Requirements Compliance

RN	Requirements	Comply/ No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
06	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Comply	89	
07	The rocket airframe shall not be used as part of the CanSat operations.	Comply	89	
08	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Comply	65	
09	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Comply	65	
10	The container shall release the payload at 450 meters +/- 10 meters.	Comply	65	

Requirements Compliance

RN	Requirements	Comply/ No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	Comply	65	
12	The science payload shall be a delta wing glider.	Comply	21	
13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s.	Comply	21	
14	All descent control device attachment components shall survive 30 Gs of shock.	Comply	21	
15	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Comply	21	

Requirements Compliance

RN	Requirements	Comply/ No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
16	All structures shall be built to survive 15 Gs of launch acceleration.	Comply	21	
17	All structures shall be built to survive 30 Gs of shock.	Comply	21	
18	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	22	
19	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Comply	22	
20	Mechanisms shall not use pyrotechnics or chemicals.	Comply	22	
21	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Comply	22	

Requirements Compliance

RN	Requirements	Comply/No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
22	The science payload shall measure altitude using an air pressure sensor.	Comply	51	
23	The science payload shall provide position using GPS.	Comply	51	
24	The science payload shall measure its battery voltage.	Comply	51	
25	The science payload shall measure outside temperature.	Comply	51	
26	The science payload shall measure particulates in the air as it glides.	Comply	51	
27	The science payload shall measure air speed.	Comply	51	
28	The science payload shall transmit all sensor data in the telemetry.	Comply	21	
29	The science payload shall transmit all sensor data in the telemetry.	Comply	21	

Requirements Compliance

RN	Requirements	Comply/ No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
30	The Parachutes shall be fluorescent Pink or Orange	Comply	21	
31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	Comply	126	
32	The ground station shall generate a .csv file of all sensor data as specified in the telemetry section.	Comply	126	
33	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Comply	126	

Requirements Compliance

RN	Requirements	Comply/No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	Comply	126	
35	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Comply	126	
36	XBEE radios shall have their NETID/PANID set to their team number.	Comply	126	
37	XBEE radios shall not use broadcast mode.	Comply	126	
38	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Comply	21	
39	Each team shall develop their own ground station.	Comply	161	

Requirements Compliance

RN	Requirements	Comply/ No comply /Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
40	All telemetry shall be displayed in real time during descent.	Comply	161	
41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Comply	161	
42	Teams shall plot each telemetry data field in real time during flight.	Comply	161	
43	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Comply	162	
44	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Comply	162	
45	Both the container and probe shall be labeled with team contact information including email address.	Comply	162	

Requirements Compliance

RN	Requirements	Comply/ No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
46	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Comply	154	
47	No lasers allowed.	Comply	21	
48	The probe must include an easily accessible power switch that can be accessed without disassembling the CanSat and in the stowed configuration.	Comply	144	
49	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the CanSat and in the stowed state.	Comply	144	
50	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Comply	144	

Requirements Compliance

RN	Requirements	Comply/ No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
51	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	Comply	144	
52	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.	Comply	144	
53	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Comply	145	
54	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	145	
55	The CANSAT must operate during the environmental tests	Comply	145	

System Requirement Summary

RN	Requirements	Comply/ No comply/ Partial	X-Ref Slide(s) Demonstrating Compliance	Team comments or note
56	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Comply	145	

Management

Aditi Kulshrestha

CanSat Budget – Hardware

Electronics				
Component	**Model**	**Quantity**	**Unit Price($)**	**Total Price($)**
Barometer	Adafruit BMP388	1	9.95 (total)	9.95 (total)
GPS	Ublox Neo-6M GPS	1	16.24(total)	16.24(total)
Camera	Y2000	1	41.98(total)	41.98(total)
XBEE	XBEE Pro S2C	1	30.11(total)	30.11(total)
Microcontroller	STM32F103C8 Blue Pill	1	4.55(total)	4.55(total)
Voltage Measurement	Voltage Divider Circuit	1	0.1(total)	0.1(total)
Air Particle Sensor	PM 2.5 GP2Y1010AUOF	1	39.72 (total)	39.72 (total)
Air Speed Sensor	MPXV7002DP	1	27.74 (total)	27.74 (total)
Gyroscope	LSM6DS33	1	9.95(total)	9.95(total)

CanSat Budget – Hardware

Electronics				
Component	**Model**	**Quantity**	**Unit Price($)**	**Total Price($)**
Antenna (CanSat)	Patch Antenna	1	5.32(total)	5.32(total)
Antenna (GS)	Yagi Antenna	1	11.62(total)	11.62(total)
Battery	DTSE LP-E12	1	64.41(total)	64.41(total)
Buzzer	-	1	0.58(total)	0.58(total)
Voltage Regulator(3.3 V)	AMS1117 3.3 V	1	0.21(total)	0.21(total)
Voltage Regulator (5 V)	LM805 5V	1	2.80(total)	2.80(total)
Servo Motor	Servo Motor SG90	2	4.20(total)	8.40(total)
Stepper Motor	BI0006255	1	1.72(total)	1.72(total)
XBEE Adaptor	XBEE Adaptor explorer	1	4.06(total)	4.06(total)

CanSat Budget – Hardware

Electronics				
Component	**Model**	**Quantity**	**Unit Price($)**	**Total Price($)**
Stepper Motor Driver	A4988	1	1.33(total)	1.33(total)

Sub Total :-	**$279.07(total)**

CanSat Budget – Hardware

Mechanical				
Component	**Model**	**Quantity**	**Unit Price($)**	**Total Price($)**
Carbon Rods	-	6x 300mm	0.21(total)	1.26(total)
Rivet	Stainless steel	2	0.031(total)	0.062(total)
Carbon Fiber	-	$0.5m^2$	$2.94(total)	$2.94(total)
Nylon	Nylon 190T	$0.5m^2$	$2.10(total)	$2.10(total)
Damper	M3 Anti vibration Rubber damper ball	1	1.14(total)	1.14(total)

Sub total:-	$7.502

CanSat Budget – Other Costs

Ground Station				
Component	**Model**	**Quantity**	**Unit Price($)**	**Total Price($)**
Laptop	HP 15-**DA0330TU**	1	633.03(total)	633.03(total)
Microcontroller	STM32F103C8 Blue Pill	1	9.80(total)	9.80(total)
XBEE	XBEE Pro S2C	1	30.11(total)	30.11(total)
XBEE Adaptor	XBEE Adaptor explorer	1	4.06(total)	4.06(total)
Antenna (GS)	Yagi Antenna	1	11.62(total)	11.62(total)

Sub Total :-	**$687.9(total)**

CanSat Budget – Other Costs

Travel Cost:

Other Cost	Quantity	Unit Price($)	Total Price($)	Cost Determination
Flight	6 seats	1250	7500	Estimated
Travel	6	150	900	Estimated
Hotel	4(days)x2(rooms)	255	1020	Budgeted
Food	5 days	55	330	Budgeted
Sub Total:-		**$1710**	**$9750**	**Estimated**

CanSat Budget – Other Costs

Categories	Cost
Electrical and Mechanical	$286.572
Ground Station	$687.9
Other Costs	$785

Program Schedule Overview

	Sep	Oct	Nov	Dec	Jan	Feb	March	April	May	June
Competition preparation										
Final fabrication										
CDR teleconference preparation										
CDR submit										
CanSat Fabrication										
Prepare CDR										
PDR teleconference preparation										
PDR submission										
Compilation of PDR										
Prepared PDR										
Finalised Design										
Finalised Sensors										
Working on Prototypes										
Analysing Mission Guide										
Selection of member										
Beginning of CanSat										

Detailed Program Schedule

Objective	Week1	week2	week3	week4	Week5	Week6	Week7	Week8	Week9	Week10
Management										
Recruit										
Look for Sponsors										
Budget										
Start										
Register Team										

Detailed Program Schedule

Objective	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9	Week10
Mechanical										
Research /Design										
Glider Dimensioning										
Material Selection										
Objective	**Week1**	**Week2**	**Week3**	**Week4**	**Week5**	**Week6**	**Week7**	**Week8**	**Week9**	**Week 10**
Electrical										
Purchased Sensors										
Set up SFW										
Communication Test										

Detailed Program Schedule

February 1- March 31

Objective	Week1	week2	week3	week4	Week5	Week6	Week7	Week8
Management								
PDR Due(Jan31)								
Begin CDR								
PDR teleconference								

Objective	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8
Mechanical								
Design Folding Mechanism								
Fabricate folding								
Test Folding								
Design Tuning Mechanism								
Test Tuning								
Integrate with Sensors								
Environmental tests								

Detailed Program Schedule

Objective	Week1	week2	week3	week4	Week5	Week6	Week7	Week8
Electrical								
GPS parsing								
Test pitot tube								
Data logging to SD card								
Communication error detection								

Detailed Program Schedule

April 1-June 15

Objective	**Week1**	**week2**	**week3**	**week4**	**Week5**	**Week6**	**Week7**	**Week8**	**Week9**
CDR due									
CDR Teleconference									
Budget for travel									
Begin PFR									

Objective	**Week1**	**Week2**	**Week3**	**Week4**	**Week5**	**Week6**	**Week7**	**Week8**	**Week9**
Mechanical									
Design release									
Prototype testing									
Test release									
Test entire Cansat									
Test Launch									

Detailed Program Schedule

Objective	Week1	week2	week3	week4	Week5	Week6	Week7	Week8	Week 9
Electrical									
Battery integration									
Power System									
Packaging									
Final Testing									

Conclusions

CanSat problem was analysed and solved using different strategies and by performing various experiments to find the best possible solutions.

ACCOMPLISHMENTS :

- Glider Design are completed.
- Electric Designs are completed.
- Communications tests in work.

UNFINISHED :

- Integration
- Environmental tests