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# CanSat 2026 Preliminary Design Review (PDR) Outline

**Team 1081  
SEDs ITBA**



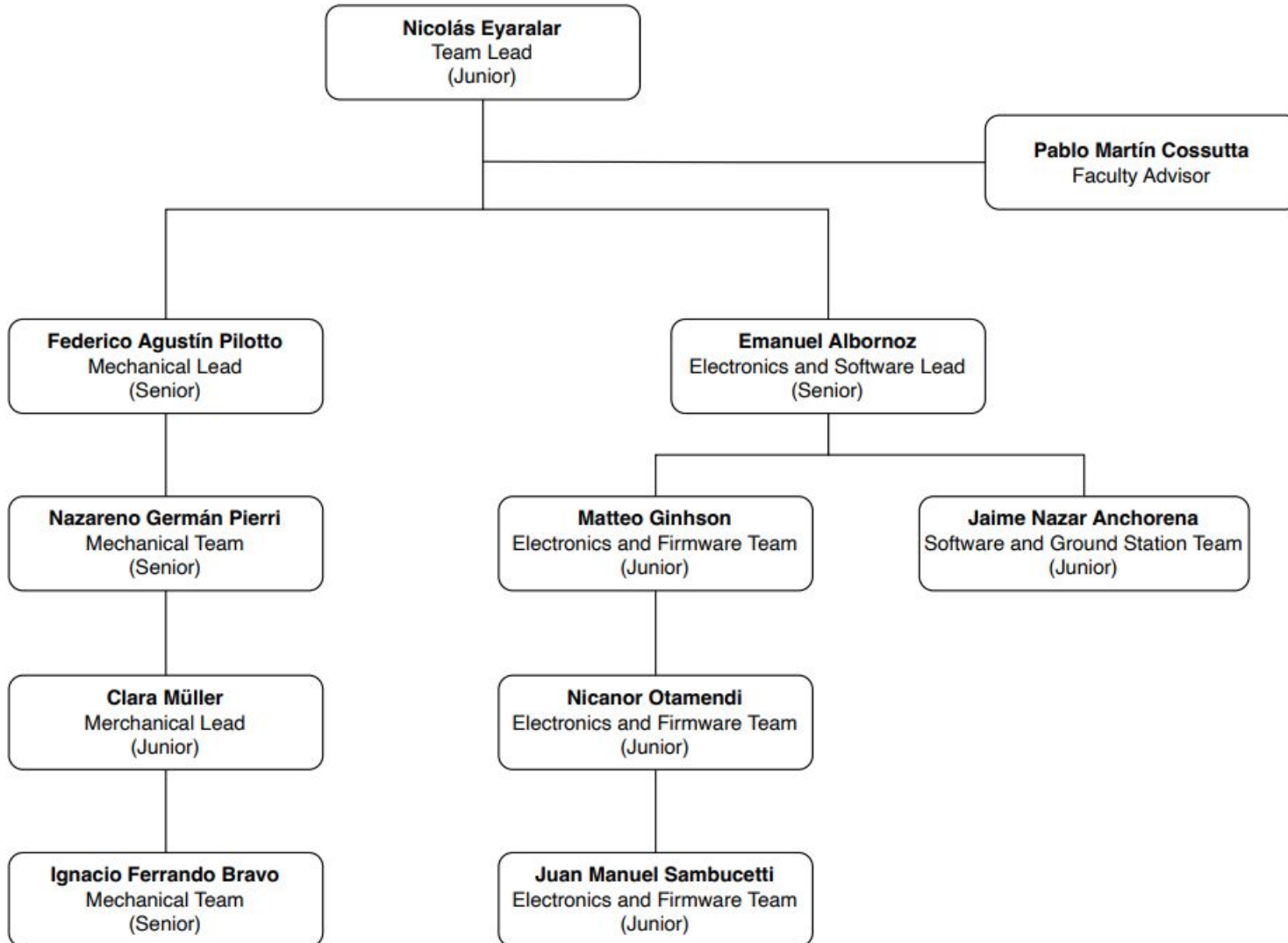
# Presentation Outline



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# Team Organization





# Acronyms



Acronym	Explanation
FSW	Flight Software
$m$	Mass
$g$	Gravitational Acceleration
$\rho$	Density of the Air
$v$	Terminal Velocity
$Cd$	Drag Coefficient
$A$	Area
GCS	Ground Control System
MCU	Micro Controller Unit
RTC	Real Time Clock

Acronym	Explanation
ADC	Analog-Digital Converter
PCB	Printed Circuit Board
SMD	Surface Mount Device
T&S	Trade & Selection
GPS	Global Positioning System
ODR	Output Data Rate
LED	Light Emitting Diode
COTS	Commercial Off-The-Shelf
NEGL	Negligible
FOV	Field of View
LSB	Least Significant Bit



# Systems Overview

**Nicolás Eyaralar**  
**Federico Agustín Pilotto**  
**Ignacio Ferrando Bravo**



# Mission Summary



Design a Cansat that consists of a payload and a container that mounts on top of the rocket. The payload rests inside the container at launch and includes the nose cone as part of the payload. The container with the payload shall deploy from the rocket when the rocket reaches peak altitude and the rocket motor ejection forces a separation. The container with the payload shall descend at a rate of no more than 15 meters/second using a parachute that automatically deploys at separation. At 80% peak altitude, the payload shall separate from the container and descend using a para-glider descent control system until landing. The descent rate shall be an average of 5 meters/second. The payload shall steer toward a specified position to deposit an instrument. At 2 meters above the ground, the instrument shall be released and land intact. A video camera shall show the separation of the payload from the container and the para-glider descent control system functioning. A second video camera shall be pointing downwards and show the ground during descent and the instrument being released. The instrument will be simulated using a large hens egg with a mass ranging from 54 grams to 64 grams. The Cansat shall collect sensor data during ascent and descent and transmit the data to a ground station at a 1 Hz rate. The sensor data shall include interior temperature, battery voltage, battery current, altitude, tilt angle, rotation rate, and GPS position.

## External objectives:

- Apply class concepts to real practice and gain more experience on the aerospace field
- Contribute to the recognition and prestige of our university
- Motivate students from different careers and ages to join SEDS-ITBA



# System Requirement Summary (1/3)



#	code	Requirement Description	Subsystem
1	C1	The Cansat payload shall function as a nose cone during the rocket ascent portion of the flight.	Operational
2	C2	The Cansat container shall be mounted on top of the rocket with the shoulder section inserted into the airframe.	Operational
3	C4	After deployment, the Cansat payload and container shall descend at 15 meters/second using a parachute that automatically deploys. Error is +/- 3 m/s.	Operational
4	C5	At 80% flight peak altitude, the payload shall be released from the container.	Operational
5	C6	At 80% peak altitude, the payload shall deploy a para-glider descent control system.	Operational
6	C7	The payload shall descend at 5 meters/second averaged over the entire descent within +/- 3 meters/sec with the para-glider descent control system.	Operational
7	C8	The payload shall steer toward a target location.	Operational
8	C9	The sensor telemetry shall be transmitted at a 1 Hz rate.	Operational
9	C10	The payload shall record video of the release of the payload from the container and the deployment of the para-glider descent control system.	Operational
10	C11	A second video camera shall point at the ground.	Operational
11	C12	The payload shall release a protected hens egg when the payload is 2 meters +/- 0.5 m above the ground without breaking the egg.	Operational



# System Requirement Summary (2/3)



#	code	Requirement Description	Subsystem
12	C13	The Cansat payload shall include an audible beacon that is turned on separately and is independent of the Cansat battery and electronics.	Operational
13	S1	The Cansat and container mass shall be 1000 grams +/- 10 grams.	Structural
14	S2	The nose cone shall be symmetrical along the thrust axis.	Structural
15	S8	Cansat structure must survive 15 Gs vibration	Structural
16	S9	Cansat shall survive 30 G shock.	Structural
17	S17	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Structural
18	S20	If the nose cone is to separate from the payload after payload deployment, the nose cone shall descend at no more than 5 meters/sec.	Operational
19	S21	If the nose cone is to separate from the payload after payload deployment, the nose cone shall be secured to the payload until payload deployment with a pull force to survive at least 15 Gs acceleration.	Operational
20	E3	An easily accessible power switch through the container is required.	Electrical
21	E5	Power indicator is required.	Electrical
22	X4	The Cansat shall transmit telemetry once per second.	Communications



# System Requirement Summary (3/3)



#	code	Requirement Description	Subsystem
23	X5	The Cansat telemetry shall include altitude, air pressure, temperature, battery voltage, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	Communications
24	SN6	Cansat payload shall video record the deployment of the para-glider at 80% peak altitude.	Sensors
25	G4	Each team shall develop their own ground station.	Ground Station
26	G17	The ground station shall be able to activate al mechanisms on command.	Ground Station

## Design A



**Container fitted configuration**

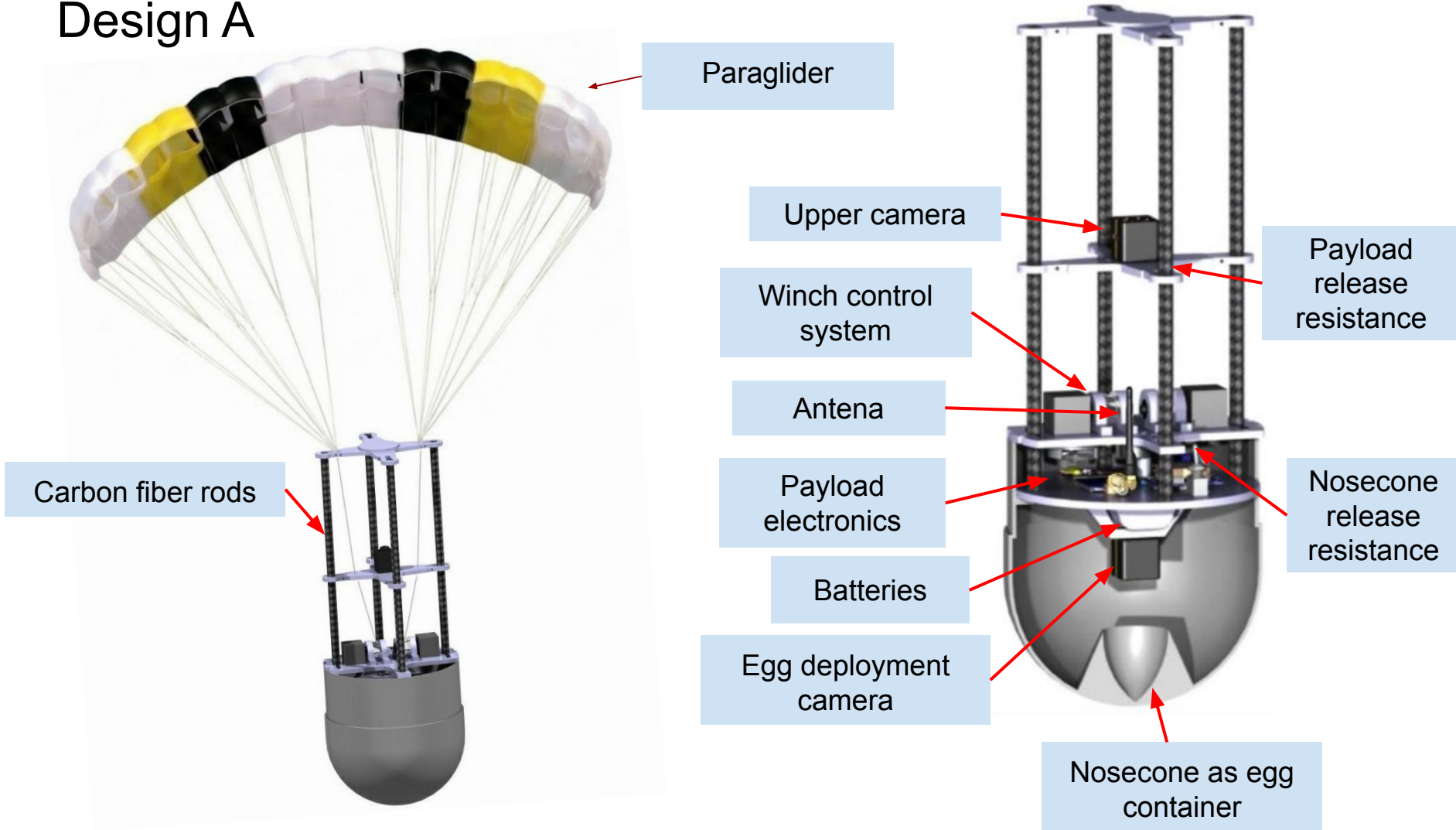


**Deployed configuration**



**Post nosecone (egg container) deployment configuration**

## Design A



## Design B



Container fitted configuration

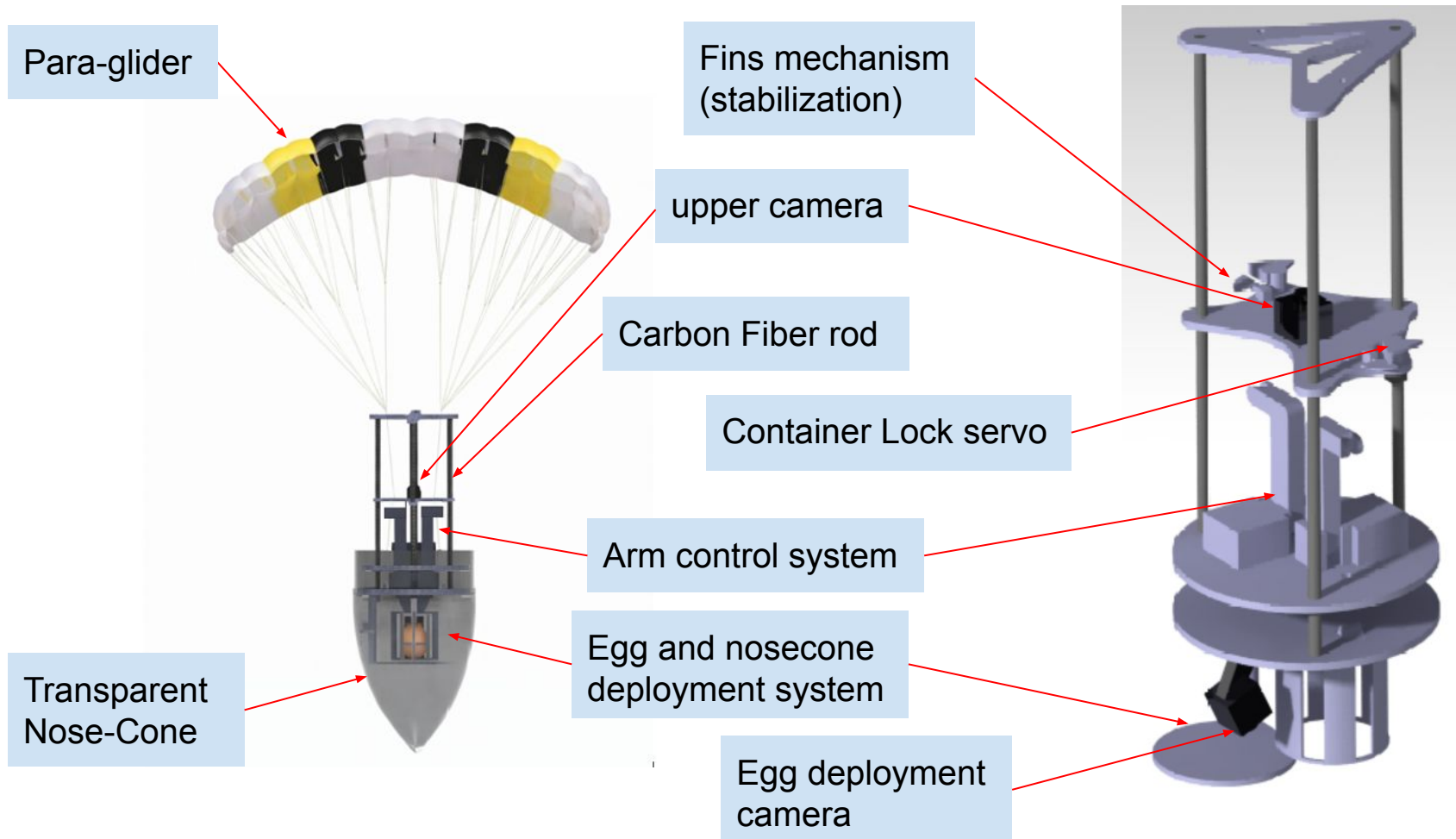


Pre nose-cone deployment configuration



Post nose-cone and egg deployment configuration

## Design B



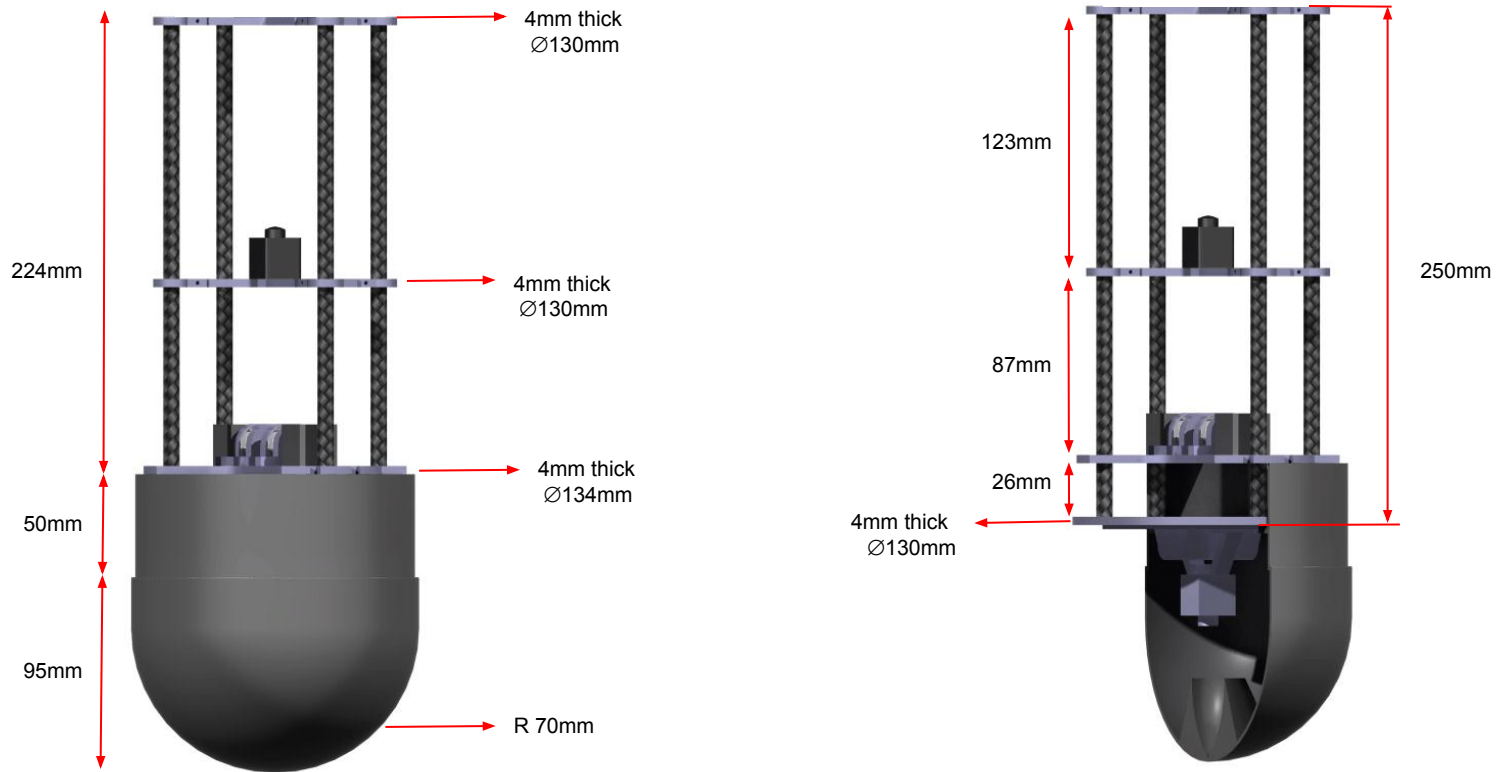


# System Level Configuration Selection

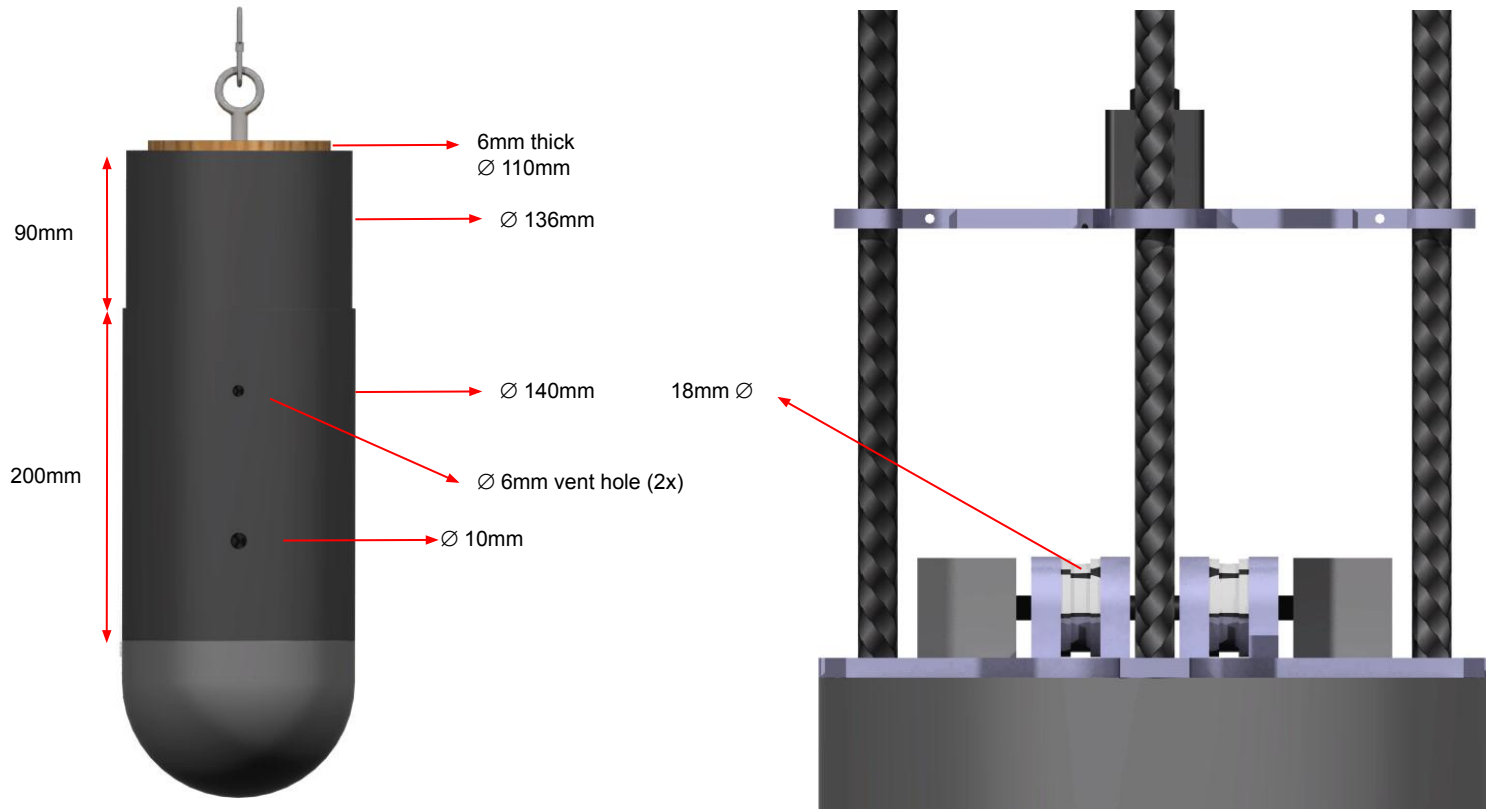


Design	Design A	Design B
Advantages	<ul style="list-style-type: none"><li>● Resistant</li><li>● Rigid</li><li>● Lighter</li><li>● Cheaper</li><li>● Less components</li><li>● Great response range</li><li>● Centered mass center</li><li>● Lesser mechanisms</li></ul>	<ul style="list-style-type: none"><li>● Resistant</li><li>● Rigid</li><li>● Simpler control system</li></ul>
Disadvantages	<ul style="list-style-type: none"><li>● Complex control system</li><li>● Heavy servos</li><li>● Harder manufacture</li></ul>	<ul style="list-style-type: none"><li>● Expensive</li><li>● Heavier</li><li>● More components</li><li>● Harder to assemble</li><li>● Descentered mass center</li><li>● More mechanisms</li><li>● Limited response range</li></ul>
<b>Conclusion and Rationale</b>	Design A is chosen <ul style="list-style-type: none"><li>● It's lighter, more robust, rigid and reliable</li></ul>	

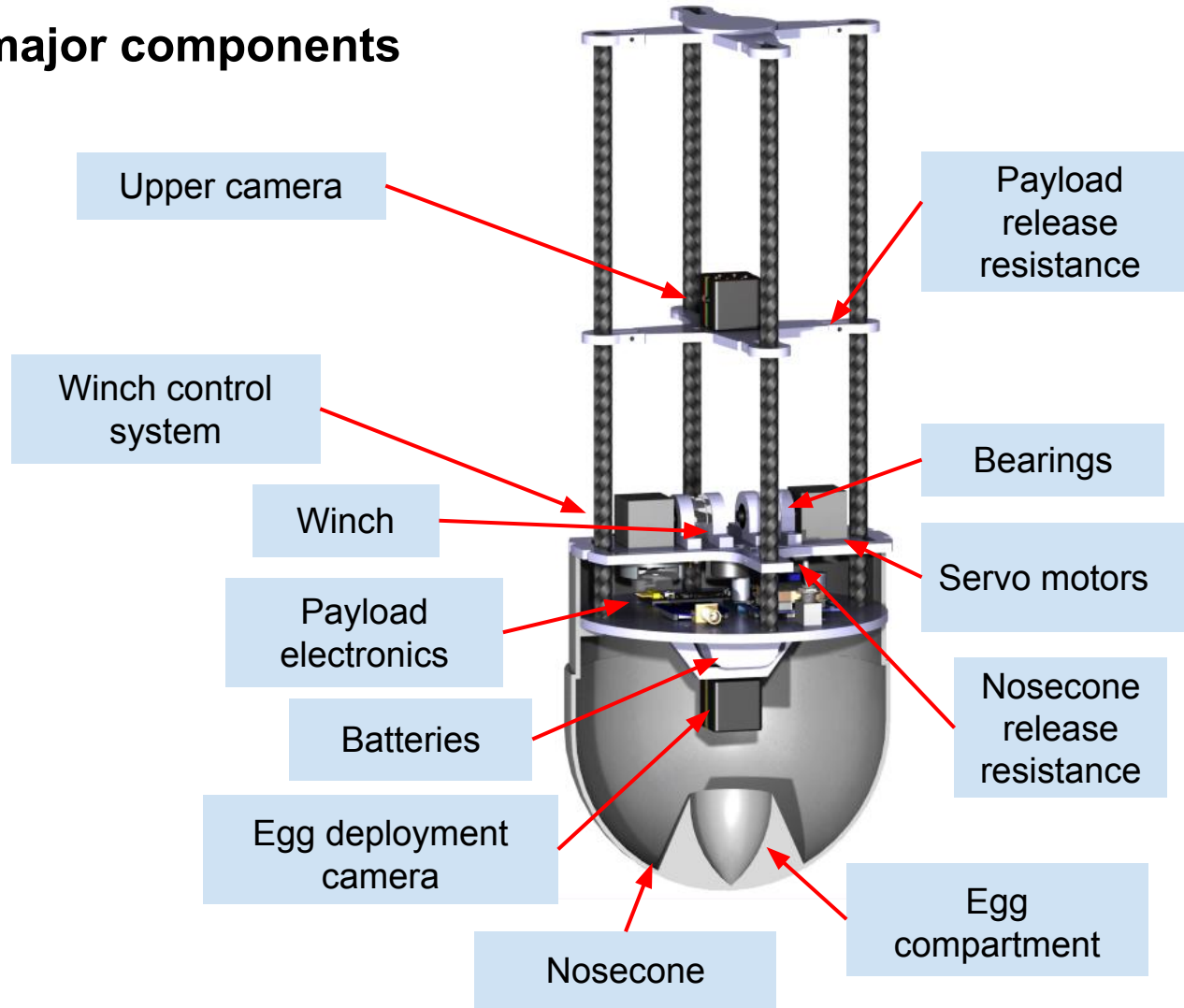
## Payload dimensions



## Winch and container dimensions



## Placement of major components



## Launch Configuration (as mounted in the rocket)

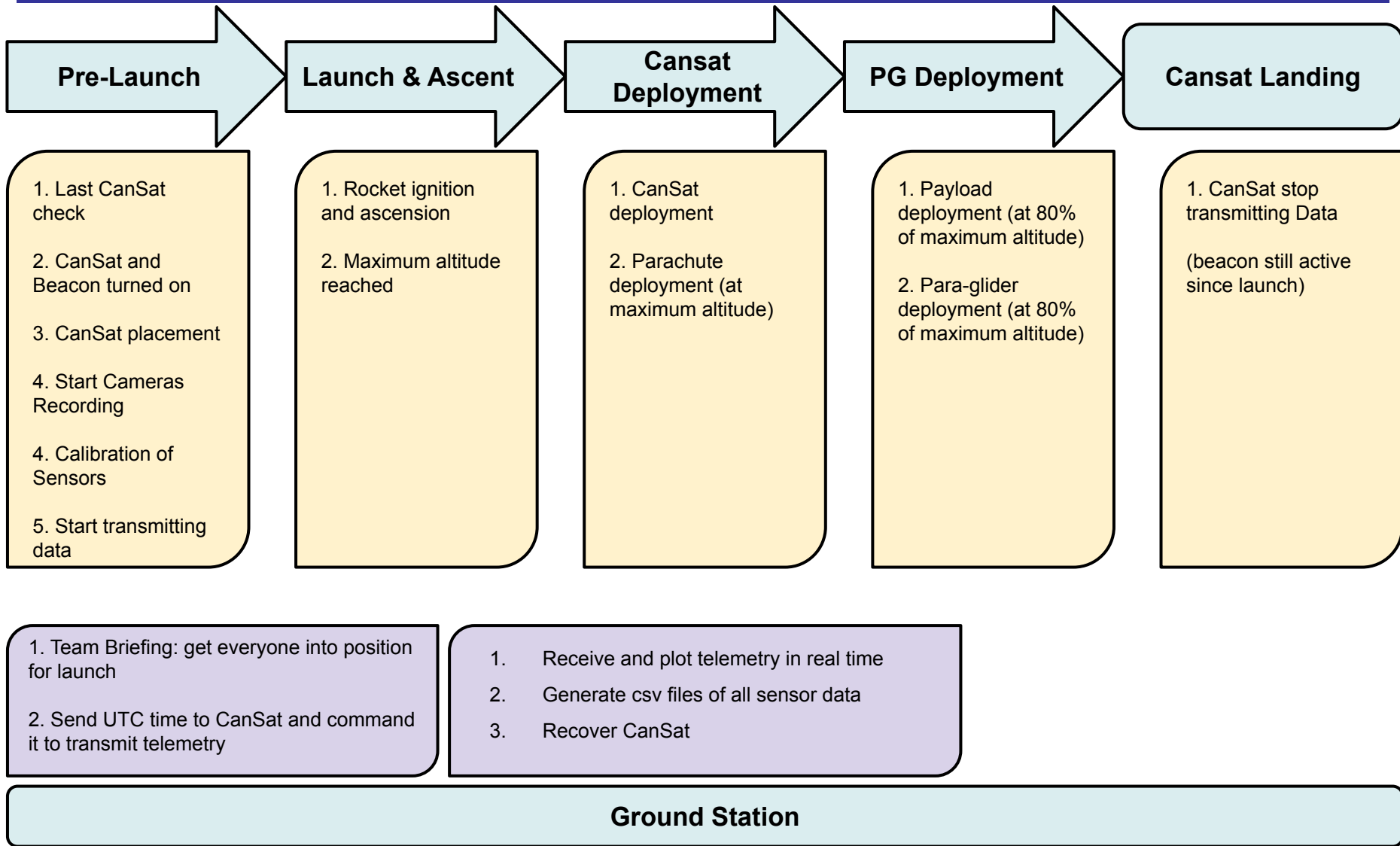


## Deployed Configuration





# System Concept of Operations

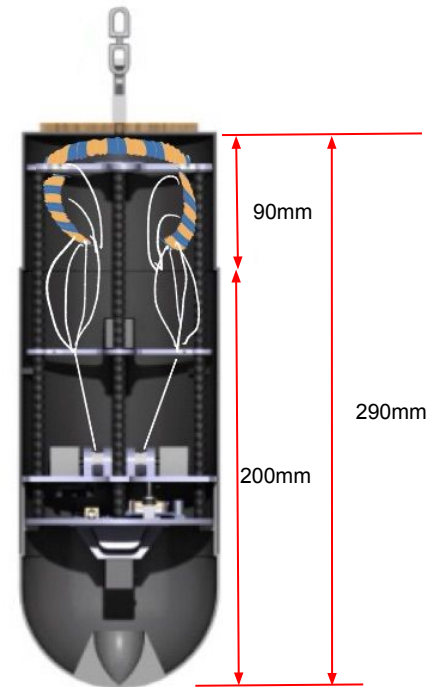
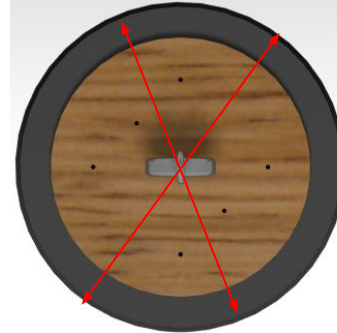


- **Container and nose cone dimensions and its clearance with the payload**

Floors	Container/Nosecone internal diameter	Floor diameter	Clearance
Top	132mm	130mm	2mm
Camera	136mm	130mm	6mm
Winch	136mm	134mm	2mm
Electronics	131mm	130mm	1mm

Internal Container diameter	External shoulder nose cone diameter	Clearance
136mm	135mm	1mm
Container height	Payload height from nosecone shoulder	Clearance
288mm	270mm	18mm

Container Shoulder Diameter  $\varnothing$ 136mm      Container Diameter  $\varnothing$ 140mm



Container diameter  $\varnothing$ 136mm into

Dimensions required for launch vehicle compatibility	container shoulder length 90 to 120 mm.
	container shoulder diameter 136 mm.
	Above the shoulder, container diameter 140 mm



# Sensor Subsystem Design

**Emanuel Albornoz**  
**Matteo Ginhson**

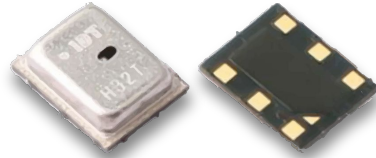
## BNO055

Acceleration and rotation rate (IMU)



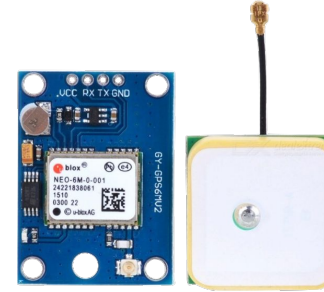
## HS3003

Air temperature



## Ublox Neo-6M

GNSS receiver



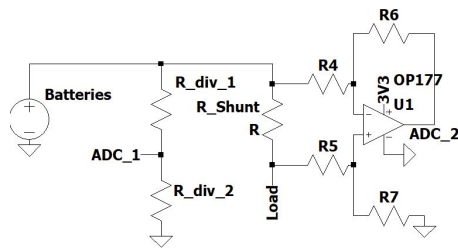
## TFS20-L

LiDar Sensor (Floor detection)



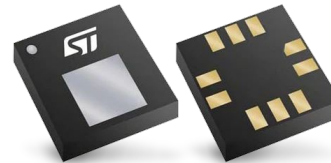
## Resistor divider + Shunt + ADC

Battery voltage and current



## LPS22HB

Air pressure



## Quelima SQ11

Cameras



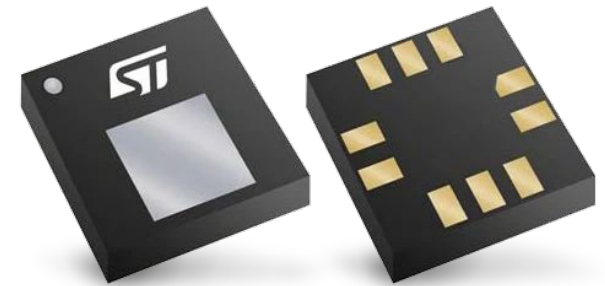
Name	Relative Accuracy [hPa]	Resolution [LSB/hPa]	Footprint [mm]	Sensing Range [hPa]	Interfaces	Mass <sup>1</sup> [g]	Operating Current [μA]	Operating Voltage [V]	Price <sup>2</sup> [USD]
LPS22HB	±0.10	4096	2 × 2	260 - 1260	I2C/SPI	NEGL	3	1.7 ~ 3.6	3.28
BMP280	±0.12	625	2 × 2.5	300 - 1100	I2C/SPI	NEGL	2.8	1.7 ~ 3.6	2.36
HP206C	±0.5	100	3 × 5	300 - 1200	I2C	NEGL	85.2	1.8 ~ 3.6	2.78



## Selected Sensor: LPS22HB

### Reasons:

- Previous experience
- Wide sensing range
- 3.3V operation, same as our MCU.
- Excellent resolution



### Notes:

1. mass is negligible because it is below the fraction of a single gram
2. price reference was obtained from the supplier [Mouser Electronics](#)

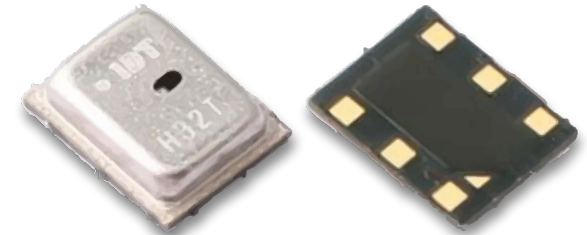
Name	Footprint [mm]	Mass <sup>1</sup> [g]	Operating current [μA]	Operating voltage [V]	Range [°C]	Resolution [°C]	Interface	Price <sup>2</sup> [USD]
HS3003	3.0 × 2.4	NEGL	24.4	2.3-5.5	-40 ~ +125	0.015	I2C	3.45
DS18B20	4 × 5	NEGL	2.8	3-5.5	-50 - 125	0.0625	1-Wire Interface	10
BMP280	4 × 2.5	NEGL	2.8	1.7-3.6	-40 - 85	0.01	I2C/SPI	3.15

## Selected Sensor: **HS3003**



### Reasons:

- Previous experience
- Available code libraries for guidance
- Excellent range and resolution



#### Notes:

1. mass is negligible because it is below the fraction of a single gram
2. price reference was obtained from the Mouser Electronics website

Name	Weight [g]	Size [mm]	Operating current [mA]	Input Range <sup>3</sup> [V]	Input Range [A]	Resolution [mV/LSB]	Resolution [mA/LSB]	Interface	Price <sup>2</sup> [USD]
2 ADC Channels+ Voltage divider + Shunt + Opamp	NEGL	10 x 6	0.015	0 ~ 8.25	6A	2	~1	12-bit ADC (0 ~ 3.3V)	0.2
INA219	NEGL	3 x 3	1	0 ~ 26	6A	40	~	I2C	4.43

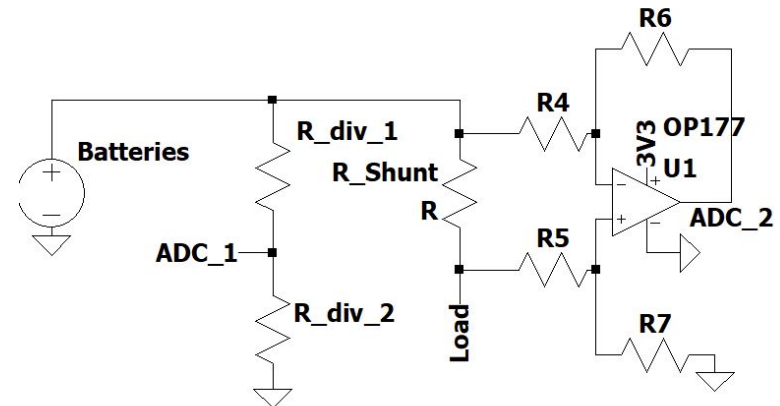
## Selected Sensor: **ADC (2 channels) + Voltage divider + Shunt Resistor + Opamp**

### Reasons:

- Lowest current consumption
- Easy interface (ADC inputs)
- Close to negligible cost
- Reliable, and easy to test

### Notes:

1. mass is negligible because it is below the fraction of a single gram
2. price reference was obtained from the Mouser Electronics website
3. to specify the range the voltage divider was taken into account



Name	GNSS System	Accuracy [m]	Update Rate [Hz]	Interface	Current [mA]	Size / Mass	Voltage [V]	Price <sup>1</sup> [USD]
<b>Ublox NEO-6M</b>	GPS	2.5	1-5	UART/SPI/D DC/USB	40	16×12.2×2.4 mm / 16g	2.7 ~ 3.6	10.9
<b>VK2828U7G5 LF</b>	GPS, GLONASS, Galileo, and more	2.5	1	UART (TTL or RS232)	50	25x25x4 mm / 16g	3.3 ~ 5	5.3
<b>Quectel L80</b>	GPS, GLONASS	2.5	1	UART	20	16×16×6.45 mm / 20.4g	3.0 ~ 4.3	4.5
<b>Ublox NEO-M8N</b>	GPS, GLONASS, Galileo	2.5	1-10	UART/SPI/D DC/USB	20	16×12.2×2.4 mm / 16g	2.7 ~ 3.6	31

## Selected Sensor: **Ublox NEO-6M**

### Reasons:

- Previous Experience
- Wide availability of code libraries for guidance
- Low weight and low current
- Optimal price-performance relationship

### Notes:

1. price reference was obtained from the supplier [Mouser Electronics](#) and [Digikey](#)



Name	Footprint [mm]	Mass <sup>1</sup> [g]	Supply Current [mA]	Supply Voltage [V]	ODR [Hz]	Resolution [LSB/g]	Interface	Price <sup>2</sup> [USD]
BNO055	3.8 x 5.2	NEGL	12.3	1.7-3.6	100	1000	I2C/UART	12.34
BMI323	2.5 x 3	NEGL	0.69	1.71-3.63	6400	16380	I2C/SPI	3.27
MPU6050	20 x 16	NEGL	2.8	1.7-3.6	4 ~ 1000	16384	I2C/SPI	8.5

## Selected Sensor: **BNO055**

### Reasons:

- **Integrated 32-bit Cortex M0+ running Bosch Sensortec sensor fusion software**, for calibrated and accurate output data using their proprietary algorithms.
- Full Inertial Measurement Unit, also including a Magnetometer.
- **Will also be used to track the Rotation Rate.**
- Easier UART integration.
- Extensive code integration library provided by Bosch.



### Notes:

1. Mass is negligible when it is below the fraction of a single gram.
2. Price reference was obtained from the supplier [Digikey](https://www.digikey.com).

Name	Footprint [mm]	Mass <sup>1</sup> [g]	Supply Current [mA]	Supply Voltage [V]	ODR [Hz]	Resolution [LSB/dps]	Interface	Price <sup>2</sup> [USD]
BNO055	3.8 x 5.2	NEGL	12.3	1.7-3.6	100	16	I2C/UART	12.34
I3G4250D	4 x 4	NEGL	6.1	2.4-3.6	840	~57	I2C/SPI	8.89
BMI323	2.5 x 3	NEGL	0.69	1.71-3.63	6400	~65	I2C/SPI	3.27

## Selected Sensor: **BNO055**

### Reasons:

- **Integrated 32-bit Cortex M0+ running Bosch Sensortec sensor fusion software**, for calibrated and accurate output data using their proprietary algorithms.
- Full Inertial Measurement Unit, also including a Magnetometer.
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Name	Size [mm]	Weight [g]	Operating current [mA]	Operating voltage [V]	Resolution [px]	FPS	Included Memory [GB]	Interface	Price (\$)
Adafruit 3202	28.5x17x4.2	2.8	110	5	640 x 480	30	32	Digital	12.5
SQ11	23x23x23	15	120	3.3	1280 x 720	30	64	Digital	12
OV7670	35x34 x25	10	15	3.3	640 x 480	30	0	SCCB+I2C	5.5



## Selected Sensor: **Quelima SQ11**

### Reasons:

- High resolution (color) and FOV
- Previous Experience
- Optimal power consumption
- SD card connection already integrated
- Easy customization and control
- Already tested.

Name	Footprint [mm]	Mass <sup>1</sup> [g]	Supply Current [mA]	Supply Voltage [V]	ODR [Hz]	Resolution [cm]	Scope [m]	Ambient light resistance [Klux]	Interface	Price <sup>2</sup> [USD]
TFS20-L	15 x21x7.8	1.35	130	3.3	250	1	0.2-9	100	I2C/UART	24.16
TFmini-S LiDAR	42x15x22	5	200	5	1000	1	0.1-7	70	I2C/SPI	70
HC-SR04	45 × 20 × 15	9	15	5	20hz	0.3	0.02-4	-	GPIO	4

## Selected Sensor: TFS20-L (LiDar)

### Reasons:

- High measurement rate for fast dynamic tracking
- Reliable distance measurement using **ToF technology**
- Works under **strong ambient light conditions**
- Lightweight and compact form factor
- Low power consumption
- Easy integration via **I2C/UART**
- Reduces processing load on main MCU

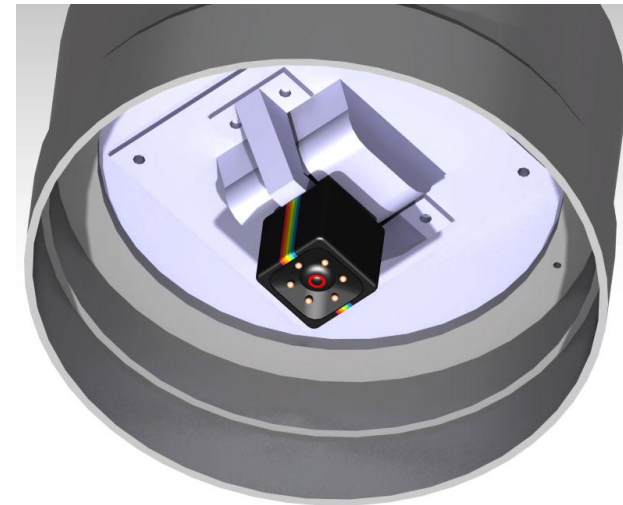


Name	Size [mm]	Weight [g]	Operating current [mA]	Operating voltage [V]	Resolution [px]	FPS	Included Memory [GB]	Interface	Price (\$)
Adafruit 3202	28.5x17x4.2	2.8	110	5	640 x 480	30	32	Digital	12.5
SQ11	23x23x23	15	120	3.3	1280 x 720	30	64	Digital	12
OV7670	35x34 x25	10	15	3.3	640 x 480	30	0	SCCB+I2C	5.5

Selected Sensor: **Quelima SQ11**

**Reasons:**

- High resolution (color) and FOV
- Previous Experience
- Optimal power consumption
- SD card connection already integrated
- Easy customization and control
- Already tested.





# Descent Control Design

**Nazareno German Pierri**  
**Clara Müller**

# Descent Control Subsystem Overview (1/2)

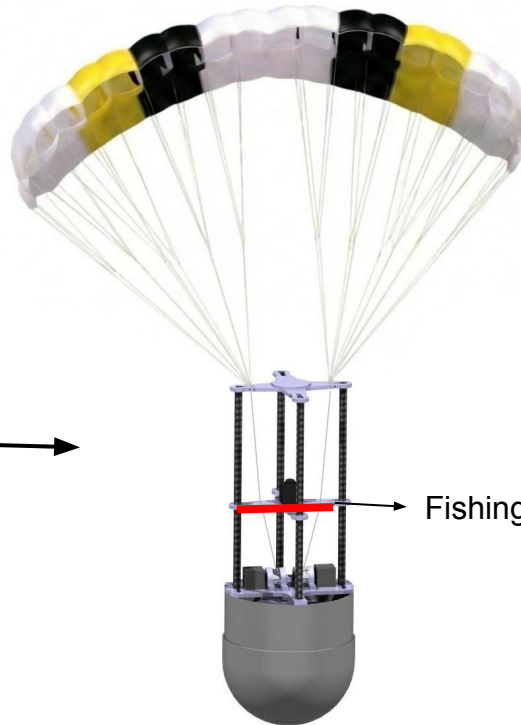
**Deployment mechanism:**  
Fishing line attachment

**Parts:**

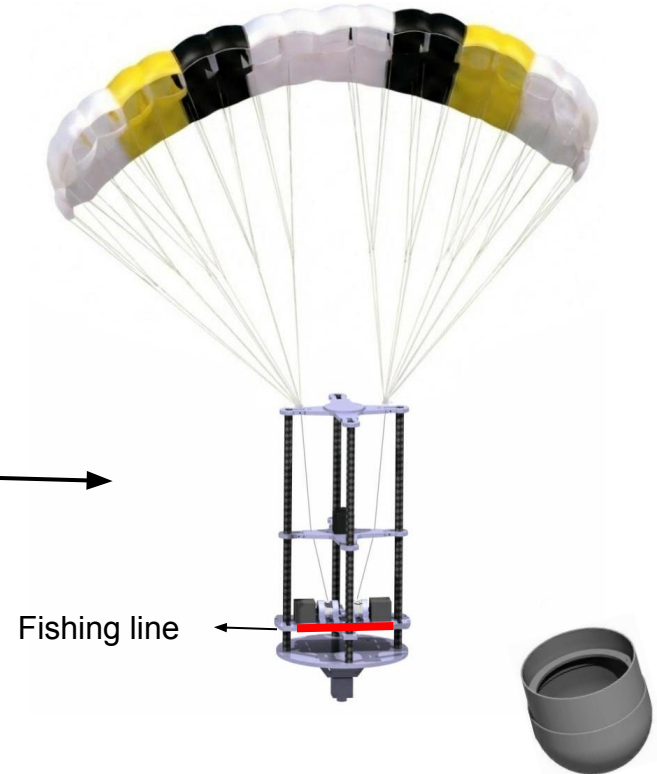
- Parachute
- Paraglider
- Fishing line



**Container fitted configuration**



**Deployed configuration**



**Post nosecone (egg container) deployment configuration**




# Descent Control Subsystem Overview (2/2)



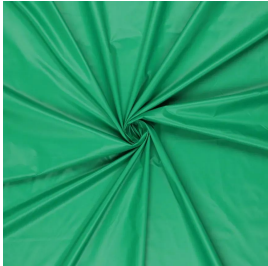
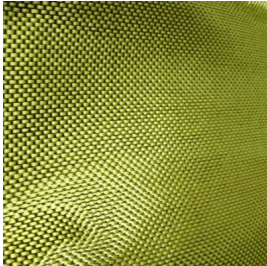

◆  
CanSat will communicate with the ground station for the entire mission

1	2	3	4	5	6
CanSat is loaded into launch vehicle	CanSat deploys at peak altitude.	Container with payload descend with a parachute	At 80% peak altitude payload is released from container and paraglider is deployed	Payload glides to the landing area	Both payload and container drop to the ground without breaking.

# Parachute Descent Control Strategy Selection and Trade (1/2)

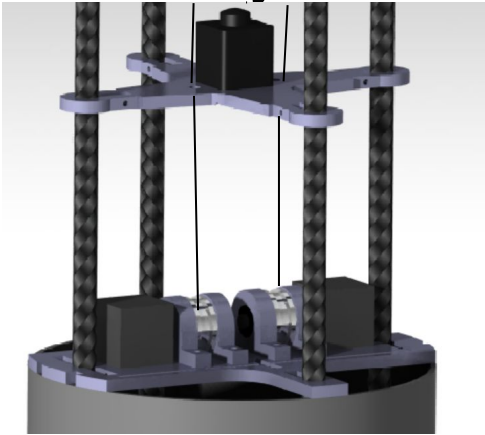
Parachute Type	Hemispherical	Hexagonal	Cross-Parachute
Reference			
Advantages	<ul style="list-style-type: none"> <li>• Stable with spill hole</li> <li>• High coefficient of drag</li> </ul>	<ul style="list-style-type: none"> <li>• Ease of manufacturing</li> <li>• Lightweight</li> <li>• Compact</li> <li>• Reduced oscillation during freefall</li> </ul>	<ul style="list-style-type: none"> <li>• Ease of manufacturing</li> <li>• Stable</li> <li>• Easy to fold</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>• Hard to manufacture</li> </ul>	<ul style="list-style-type: none"> <li>• Low coefficient of drag</li> </ul>	<ul style="list-style-type: none"> <li>• Deployment is challenging</li> <li>• Low coefficient of drag</li> </ul>
<b>Conclusion</b>	Hexagonal design is chosen because <ul style="list-style-type: none"> <li>• Ease of manufacture</li> </ul>		

# Parachute Descent Control Strategy Selection and Trade (2/2)

Parachute Material	Nylon	Kevlar	Silk
Reference			
Advantages	<ul style="list-style-type: none"> <li>• Common</li> <li>• Elastic</li> <li>• Low porosity</li> <li>• Wind resistant</li> <li>• Inexpensive</li> </ul>	<ul style="list-style-type: none"> <li>• High tensile strength</li> <li>• Heat resistant</li> </ul>	<ul style="list-style-type: none"> <li>• Lightweight</li> <li>• Wind resistant</li> <li>• Easy to fold</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>• Heat sensitive</li> <li>• Non Biodegradable</li> </ul>	<ul style="list-style-type: none"> <li>• Expensive</li> </ul>	<ul style="list-style-type: none"> <li>• Expensive</li> </ul>
Conclusions	Nylon is chosen because <ul style="list-style-type: none"> <li>• It is cheaper</li> </ul>		

## Design A

### Winch system

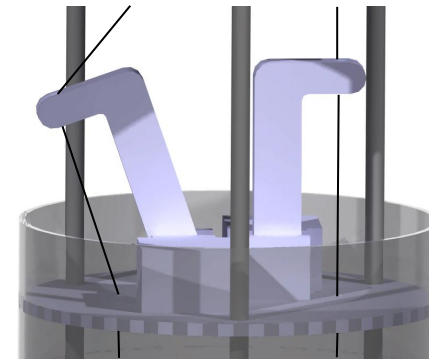


- The servo motors allow winch to roll up the line within itself to pull on one line or the other making the shape of the paraglider to lean to that side, making it turn to the side pulled.
- This design allows a linear control on the steering of the paraglider.
- Lines pass through a hole in the drum, and are knotted on the other side.

## Descent Steering

## Design B

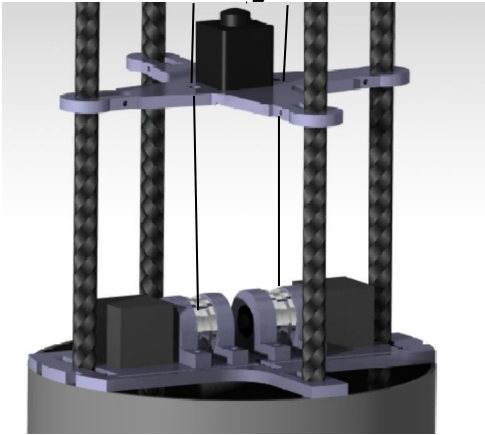
### Arm Control System



- Arms are moved by servos to pull on one line or the other, just as in the first case, making it turn to that side.
- The arms allow to manage how much to incline the arms to vary the turning speed.
- Line runs through guiding vanes on the tip of the arm.

## Design A

### Winch system

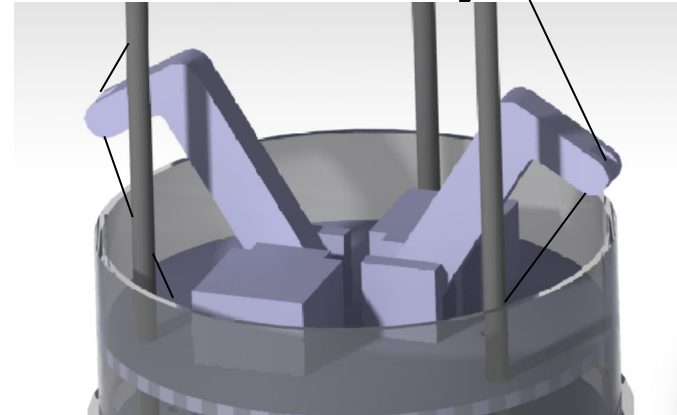


- Electronic control allow drums to roll up the line within itself to pull on both lines, pulling the glider up, increasing it's angle of attack.
- Design allows to have a step by step control of how much line is rolled.

## Descent Speed Control

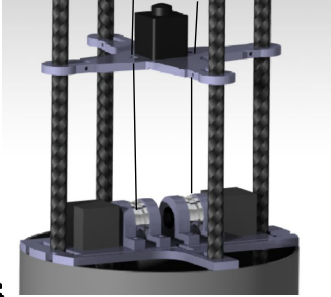
## Design B

### Arm Control System



- Arms are moved by servos to pull on both lines, just as in the first case.
- Electronic control allows to manage how much to incline the arms depending on speed rate.

## Design A



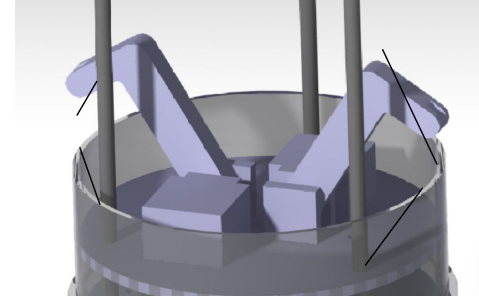
### Advantages

- High range of motion allowing flexibility in amount of line travel necessary for an effective turn.
- Since the line is always reeled at the same radius there is constant torque.

### Disadvantages

- Risk of tangling
- More complex

## Design B



### Advantages

- Simpler design

### Disadvantages

- Limited line travel
- As the arm reaches its full extension, the torque required by the servo increases significantly

Selection	Rationale
A	It provides extensive line travel and constant torque, ensuring precise and reliable control over the glider's angle of attack throughout the descent.

## Design A

Low center of mass (Passive control)

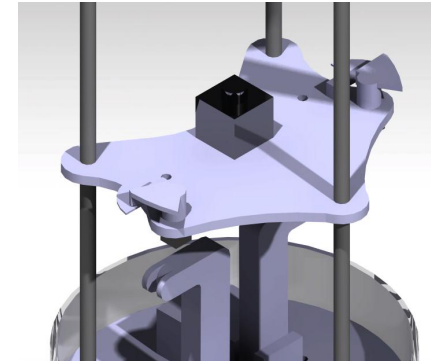


### Advantages:

- Low and symmetrical center of mass makes the descent stable
- It doesn't need complex electronics

## Design B

Servo-controlled fins for stability (Active control)



### Advantages:

- High accuracy active stability control

### Disadvantages:

- Complex control system
- Complex stowing for the fins
- More weight, accounting for the servos and fins

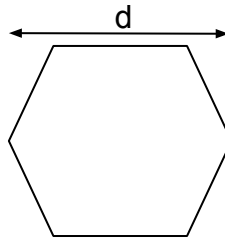
Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>• Having the center of mass far below the center of pressure ensures the payload won't tumble</li> <li>• Being it a passive control design, it does not need complex electronics to work</li> </ul>

## Assumptions

- Steady state descent
- $g = 9,81 \text{ m/s}^2$
- No wind
- Drag = Weight at terminal velocity
- Peak altitude = 700 m

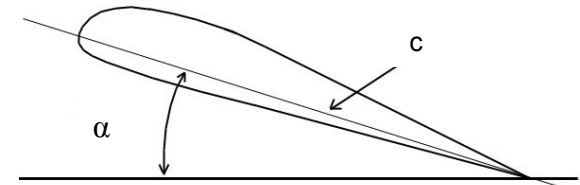
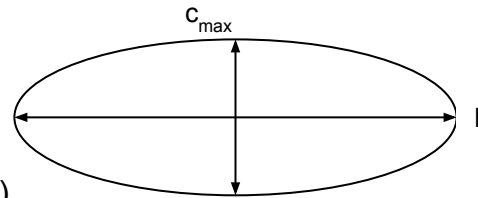
### Container parachute

- $m_1 = 1 \text{ kg}$
- $\rho_1 = 1.15 \text{ kg/m}^3$  (at 700m)
- $A_1 = 3\sqrt{3}/8 d^2 = 0,6495 d^2$
- $Cd_1 = 0.8$  (should be experimentally verified)



### Payload paraglider

- $m_2 = 0.70 \text{ kg}$
- $\rho_2 = 1.225 \text{ kg/m}^3$
- $A_{Planar} = \frac{\pi}{4} b c_{max}$  (Area of paraglider seen from below)
- $A_{Ef} = A_{Planar} \cos(\alpha)$  (Effective area after taking into account  $\alpha$ )
- $Cd_2 = 1.5$  (should be experimentally verified)



Variables
$m$ : Mass
$g$ : Acceleration of the Earth
$\rho$ : Density of the Air
$v$ : Terminal Velocity
$Cd$ : Drag Coefficient
$C_L$ = Lift Coefficient
$A$ : Area
$b$ = para-glider wingspan
$c$ = para-glider chord
$d$ = length of the diagonal of the hexagon
$\alpha$ = angle of attack

## Equations

Container parachute

$$F_{\text{gravity}} = F_{\text{drag}} + F_{\text{lift}} \quad mg = \frac{1}{2} \rho v^2 C_d A + 0$$

$$v = \sqrt{\frac{2mg}{\rho C_d 0.6495 d^2}}$$

$$d = \sqrt{\frac{2mg}{\rho C_d 0.6495 v^2}}$$

Payload paraglider

$$F_{\text{gravity}} = F_{\text{drag}} + F_{\text{lift}}$$

$$mg = \frac{1}{2} \rho C_d A v^2 + \frac{1}{2} \rho C_L A v^2$$

$$C_L = \frac{2mg}{\rho A v_{\text{target}}^2} - C_d$$

### Variables

$m$  : Mass

$g$  : Acceleration of the Earth

$\rho$  : Density of the Air

$v$  : Terminal Velocity

$C_d$  : Drag Coefficient

$A$  : Area

$b$  = para-glider wingspan

$c$  = para-glider chord

$d$  = length of the diagonal of the hexagon

$\alpha$  = angle of attack

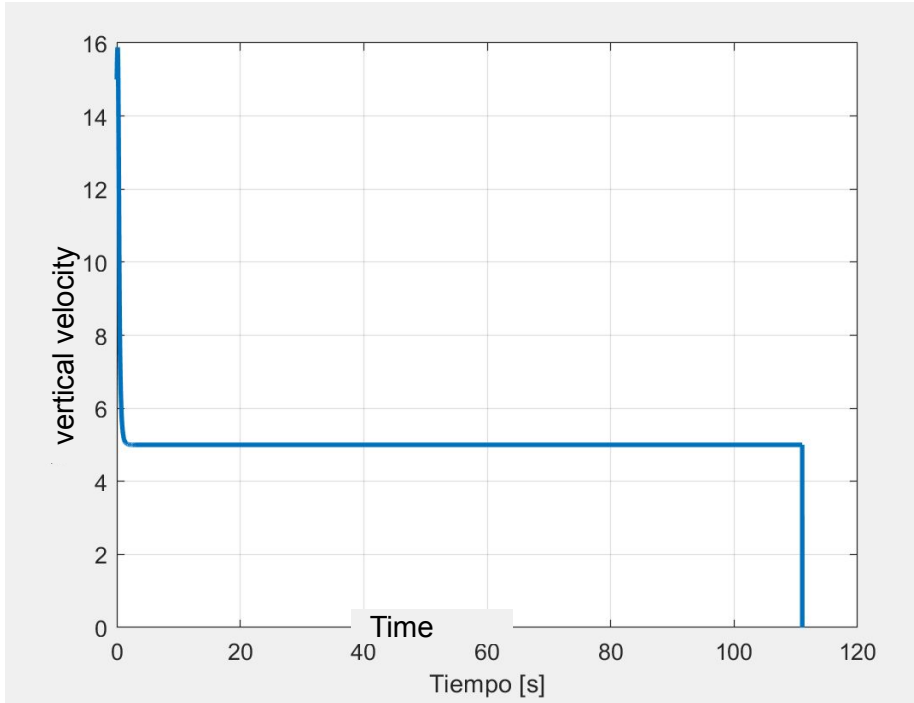


# Descent Rate Estimates (3/4)

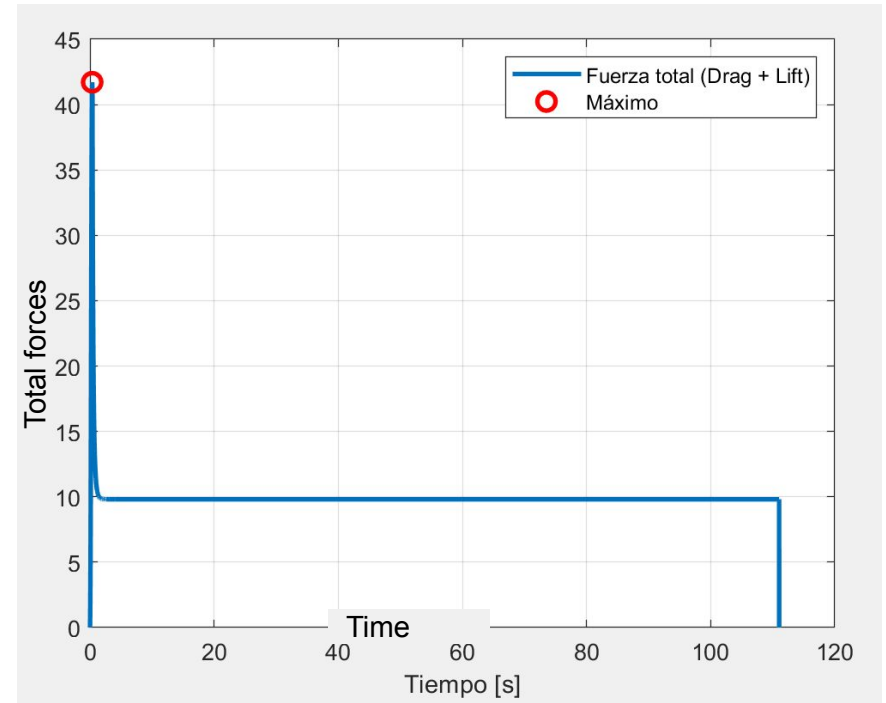


Parachute	Para-glider
<p>The descent rate should be 15 m/s <math>\pm</math> 3 m/s Dimensioning for 12 m/s to have a margin: <b>d = 0.4775 m</b></p> <p>We choose d = 0,47 m for ease of assembly</p> <p><b>v = 12.19163 m/s</b></p>	<p>A simulation was performed including gravity, aerodynamic drag and lift, and a parachute inflation time of 0.4 s. The paraglider geometry was adjusted to ensure the descent velocity converges to the target value after inflation.</p> <p><b>b = 1.0 m</b> <b>c<sub>max</sub> = 0.3 m</b> <b><math>\alpha = 15^\circ</math></b></p> <p>The lift coefficient was adjusted to meet the target descent velocity:</p> <p><b>C<sub>L</sub> = 1.31</b></p> <p>These values provide sufficient aerodynamic area to reach the target descent velocity while keeping the system compact and easy to assemble.</p> <p>Final descent velocity:</p> <p><b>v = 4.6 m/s</b></p>

The forces and velocity variations were evaluated on a series of iterations of 0.1s to see the different points of interest during the descent.  
This also provides a continuous analysis of the variables.



Vertical velocity throughout the descent



Total forces throughout the descent

Name	Weight [g]	Size [mm]	Stall Current [A]	Input Range [V]	Input Range [A]	Max. Torque [kg.cm]	Max rotation angle	Interface	Price [USD]
Wishiot TD-9512MG	60	40.8*20.2*28.5	2.7 (7.2v)	4.8 ~ 7.2	0.006- 2.7	14.5	270°	PWD	14.32
Feetech FT-3329-C001	28.3	30*10*35.7	2.5 (7.4V)	6 ~ 8.4	0.006 -2.5	10	250°	PWD	28.43
INJORA 25KG	60	40.5*20*40.5	9.0 (7.4V)	6 ~ 8.4	0.02 ~10	35	270°	PWD	14.99

## Selected Motor: **Wishiot TD-9512MG**

### Reasons:

1. Small Size.
2. Optimal torque-to-volume efficiency.
3. Lowest price.



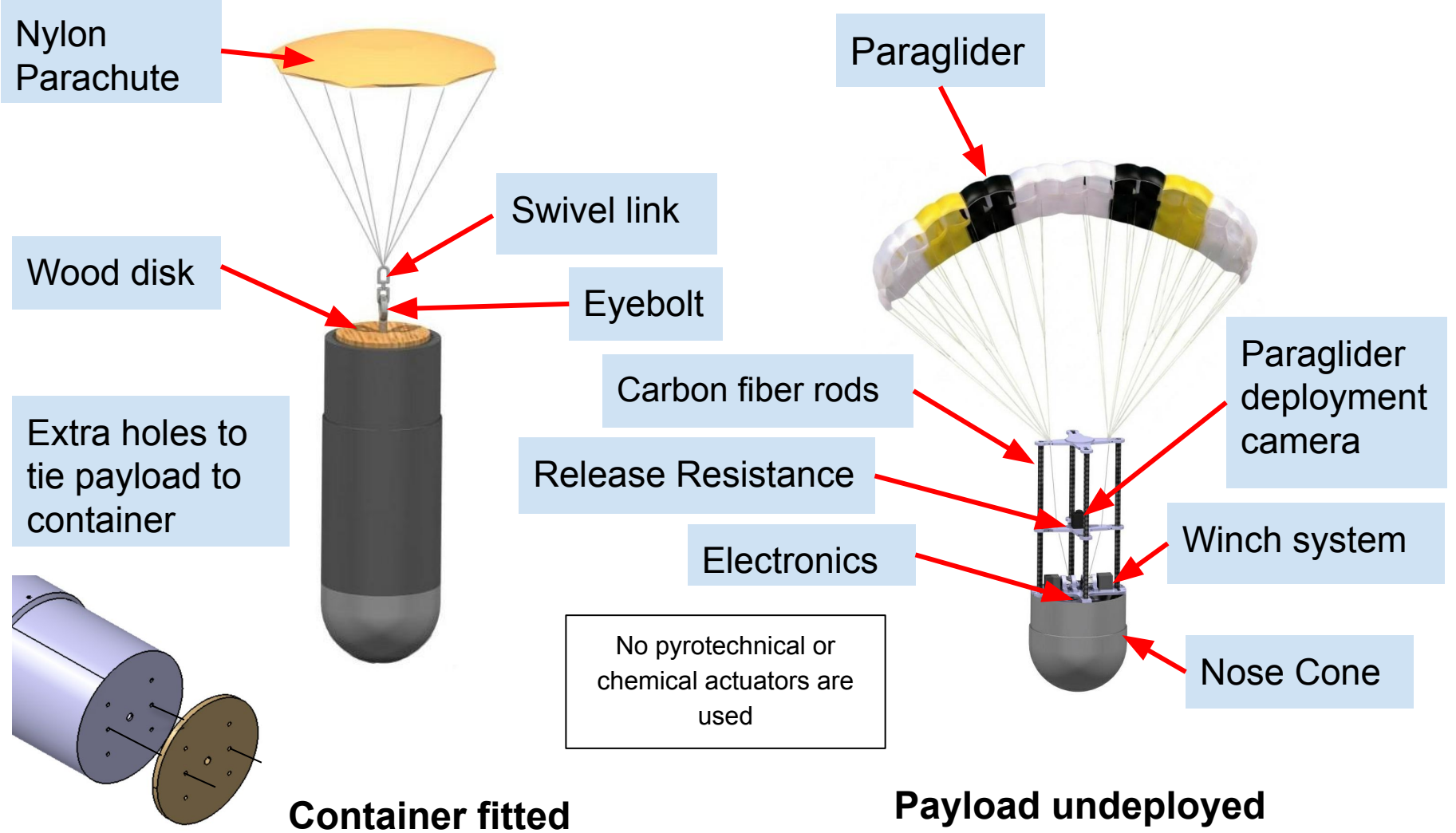
**This is the motor that will control the drums to roll up the line in order to control the paraglider and the Cansat's trajectory.**



# Mechanical Subsystem Design

**Federico Agustín Pilotto**  
**Ignacio Ferrando Bravo**  
**Nazareno German Pierri**  
**Clara Müller**  
**Juan Sambucetti**

# Mechanical Subsystem Overview (1/2)





# Mechanical Subsystem Overview (2/2)

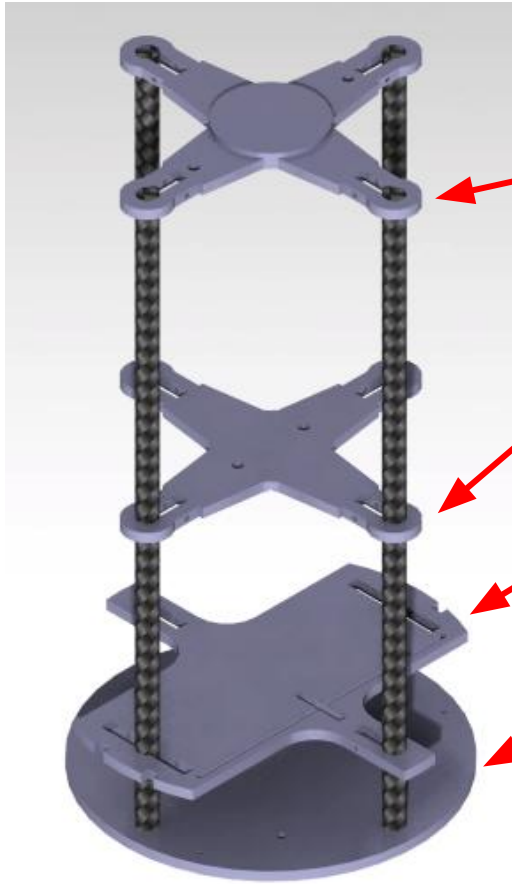


## Materials

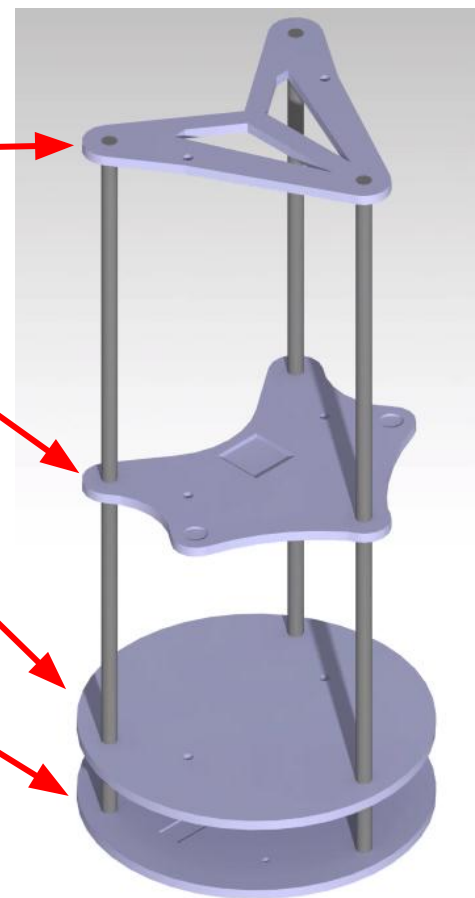
Part	Material
Container, Floors, Nosecone, camera and bearing supports	ABS
Eyebolt support disk	Plywood
Structural rods	Carbon fiber
Paraglider	210T plaid Cloth
Parachute	Nylon
Bolts and nuts, eye bolt, swivel link, bearings	Steel
Winches and shafts	Aluminium

## Structure of payload

**Design A**  
(4 structural rods)



**Design B**  
(3 structural rods)



1st Floor

2nd Floor

3rd Floor

4th Floor



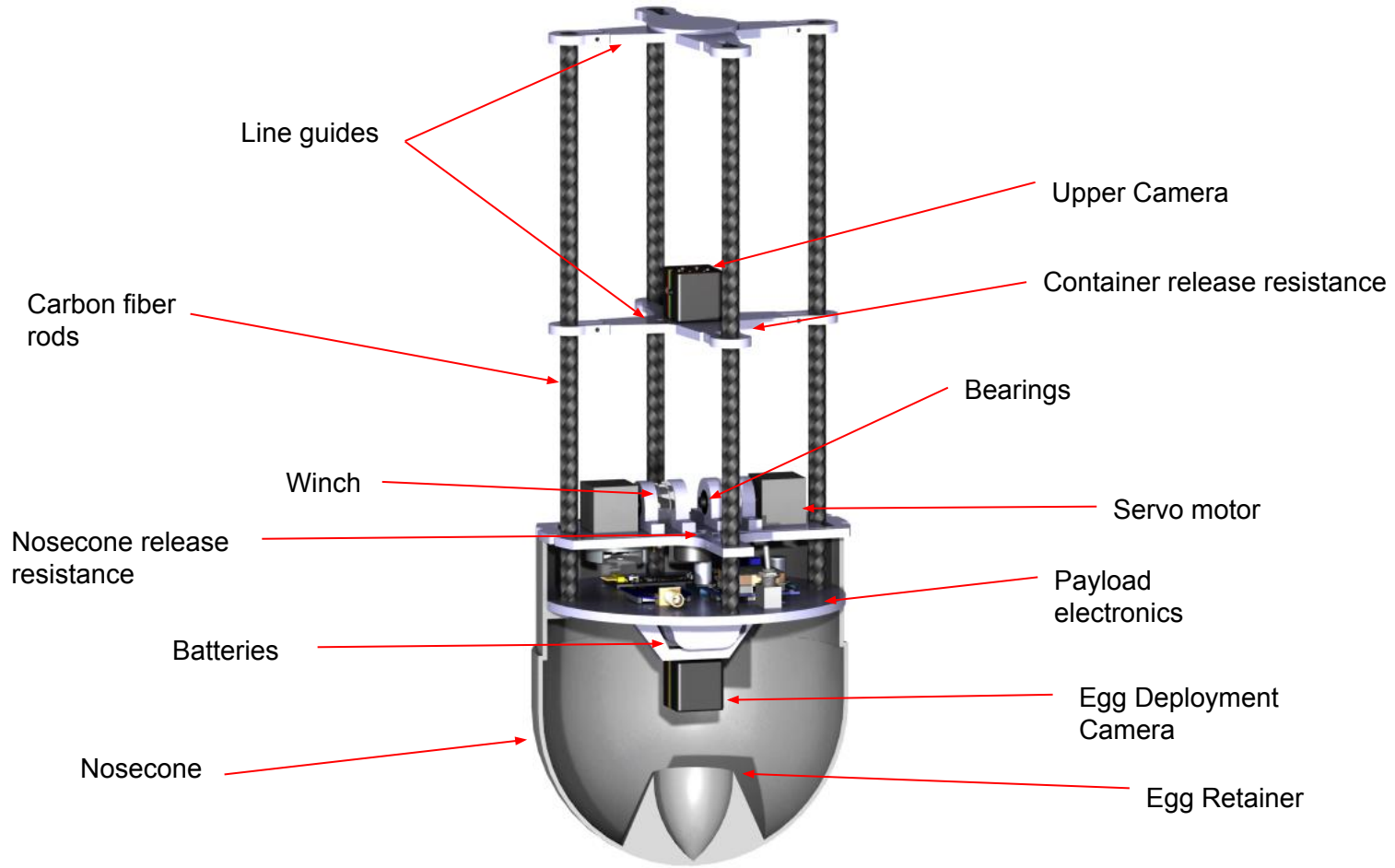
# Cansat Mechanical Layout of Components Trade & Selection (2/7)



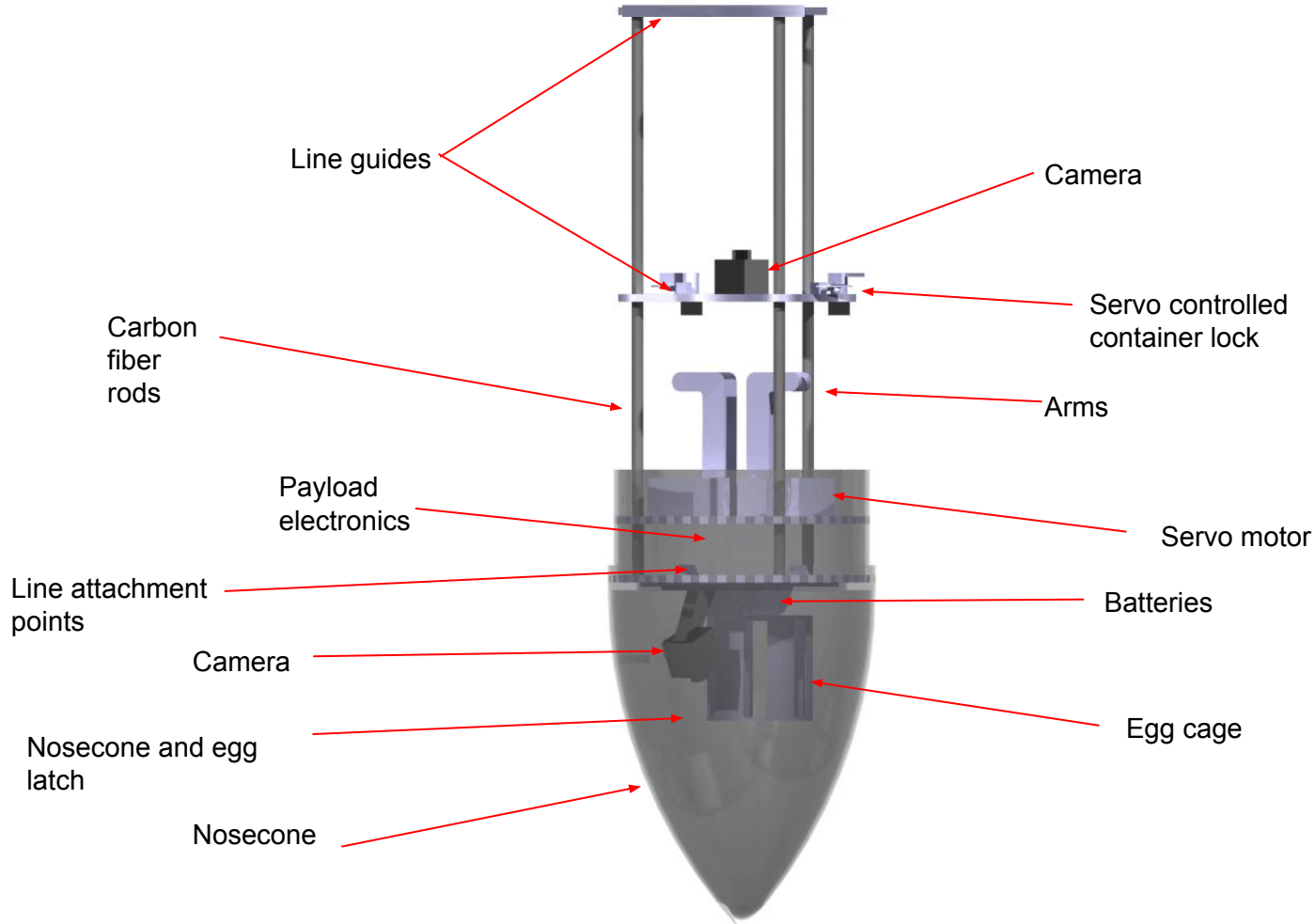
## Structure of payload

	Components	
	Design A	Design B
1st Floor	Paraglider	Paraglider
2nd Floor	Upper Camera and container release resistance	Upper Camera, container lock servo and stability control system
3rd Floor	Winch control system and nosecone release resistance, beacon	Arm control system, kill switch, beacon
4th Floor	Electronic components, batteries and egg deployment camera, kill switch	Electronic components, kill switch, batteries, egg and nosecone deployment system and egg deployment camera

## Design A



## Design B



## Container Design

### General Dimensions (Same for Both)

1/4" Eye Bolt Hole

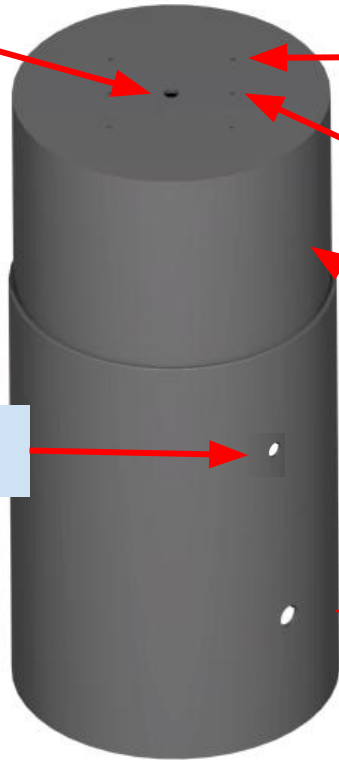
M3 Screw Holes

Fishing line Holes

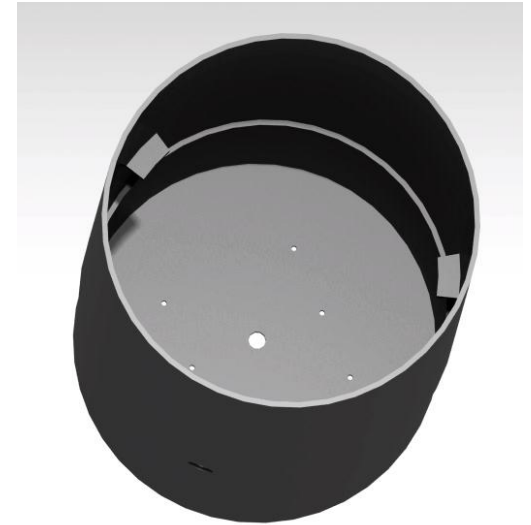
Vent Holes

90 mm length rocket shoulder

Kill switch hole



### Detail: Lock Shoulders (Design B)



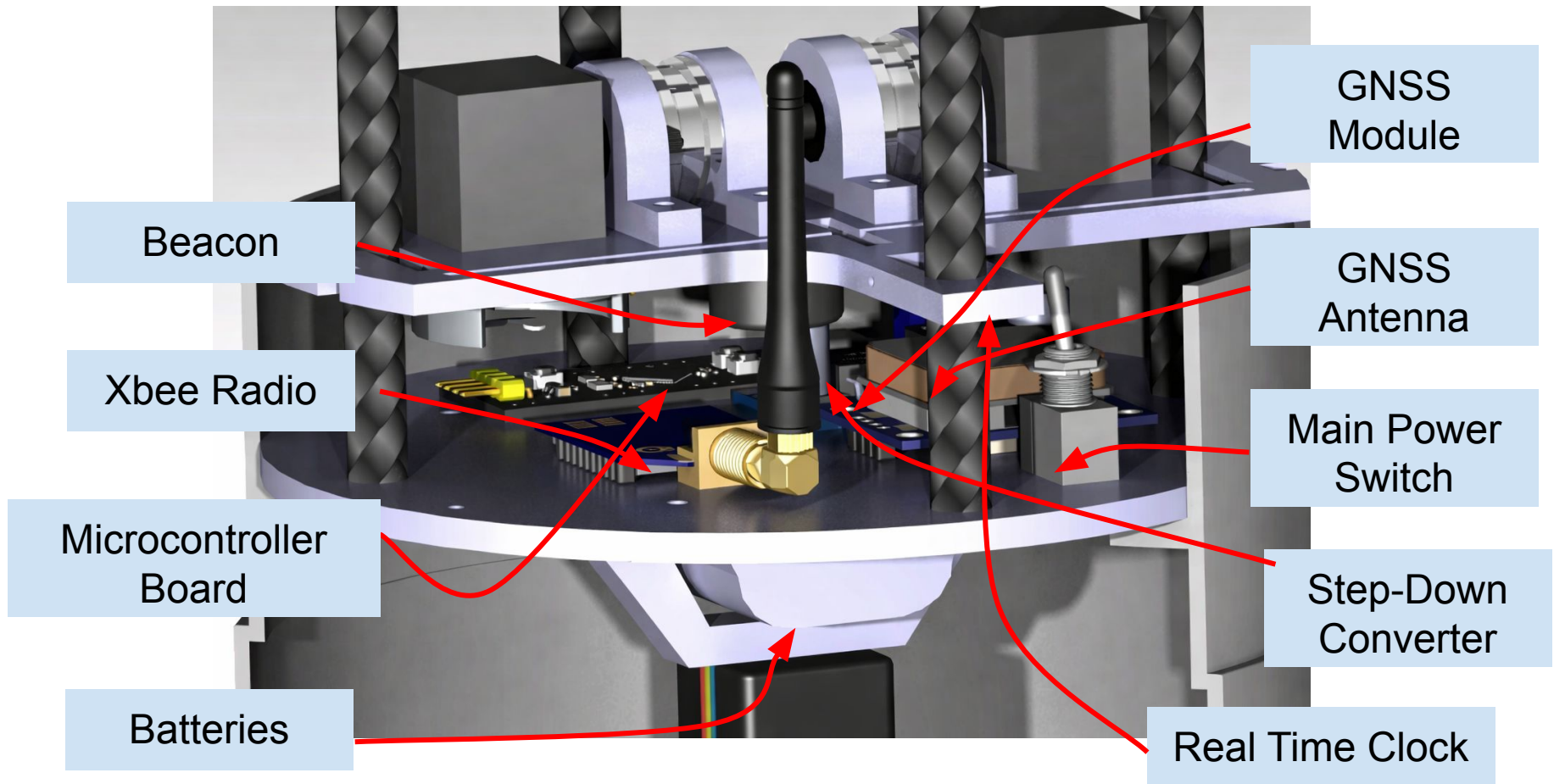


# Cansat Mechanical Layout of Components Trade & Selection (6/7)



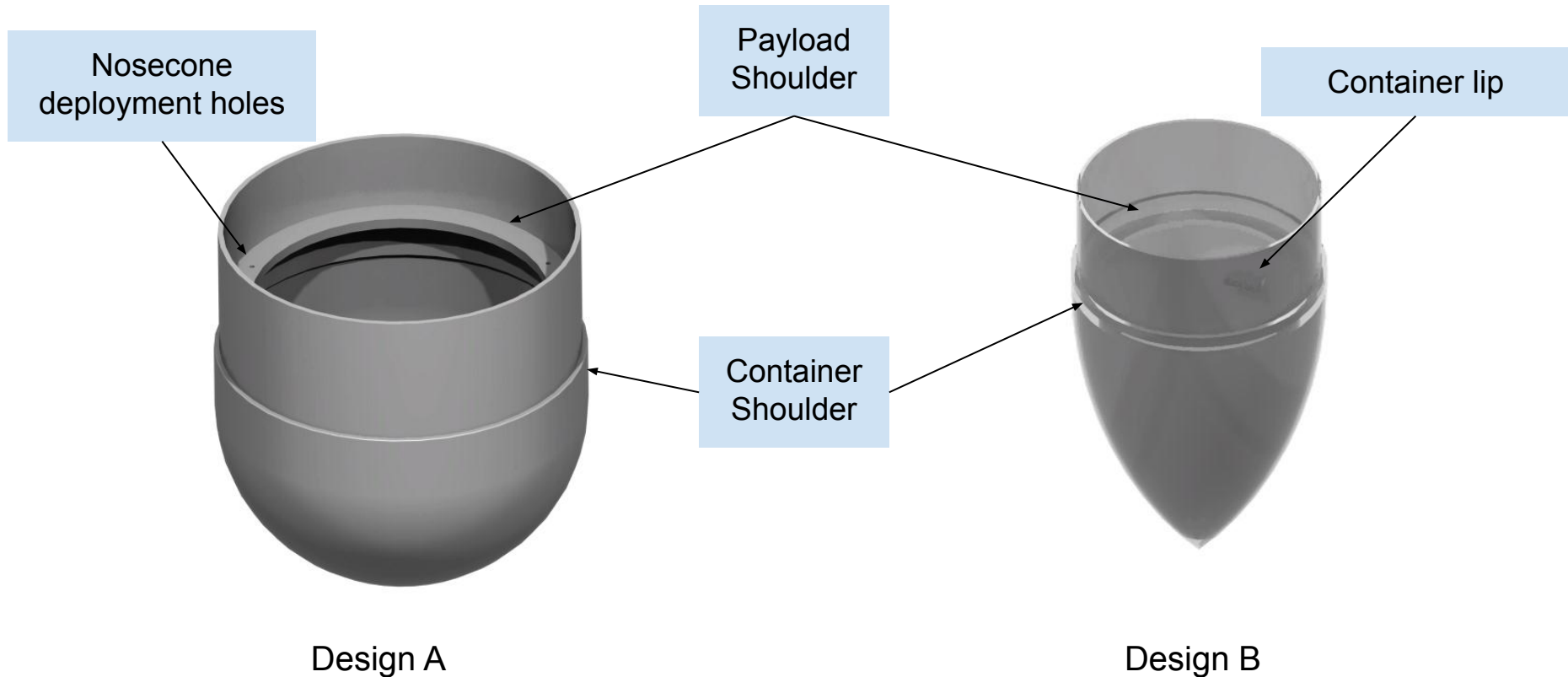
Design	Design A	Design B
Advantages	<ul style="list-style-type: none"><li>• Symmetric</li><li>• Robust</li><li>• Reliable</li><li>• Cheaper</li></ul>	<ul style="list-style-type: none"><li>• More space on floors</li><li>• Larger, simpler parts</li></ul>
Disadvantages	<ul style="list-style-type: none"><li>• Smaller parts to assemble</li><li>• Less space on floors</li></ul>	<ul style="list-style-type: none"><li>• Expensive</li><li>• Asymmetric</li><li>• Less robust</li></ul>
Conclusion	Design A is chosen for its Reliability and Symmetry	

Electronic Components Layout (Same placement & position in both designs)

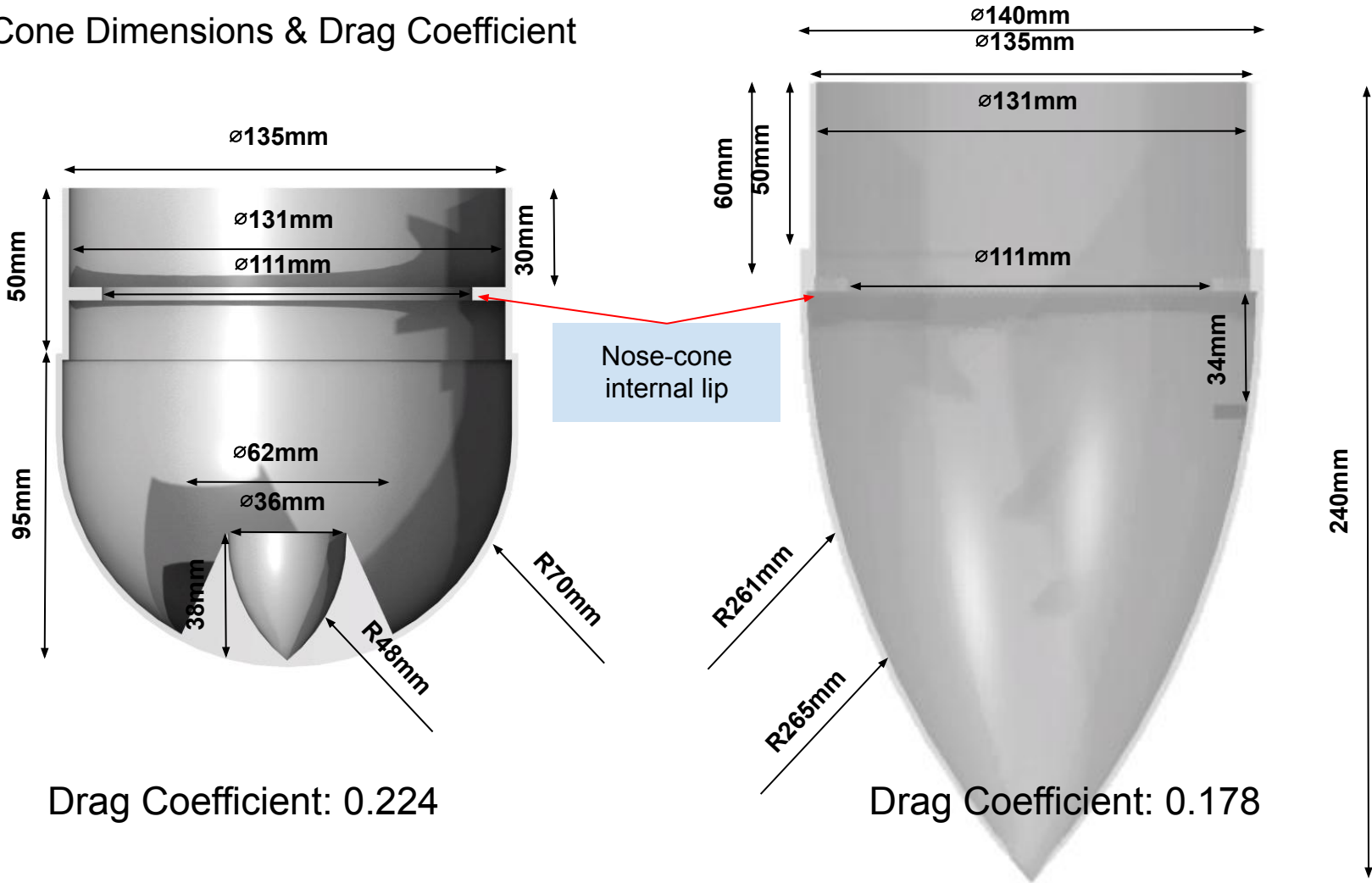


## NoseCone shoulder & Container fitting

- Both designs of the nose cone include a 50 mm shoulder where the container fits leaving a small gap between the two parts (1mm).



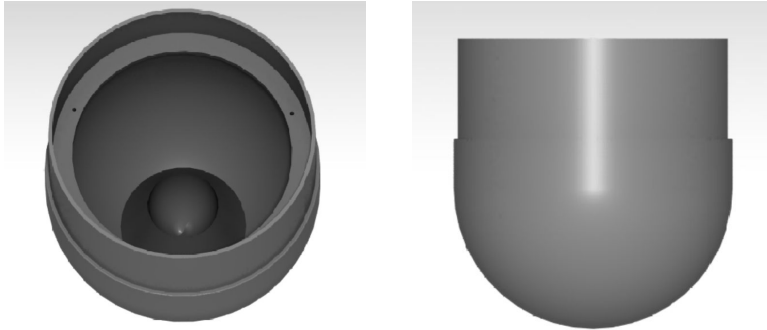
## NoseCone Dimensions & Drag Coefficient



**Both nose cones are symmetrical along the thrust axis.**

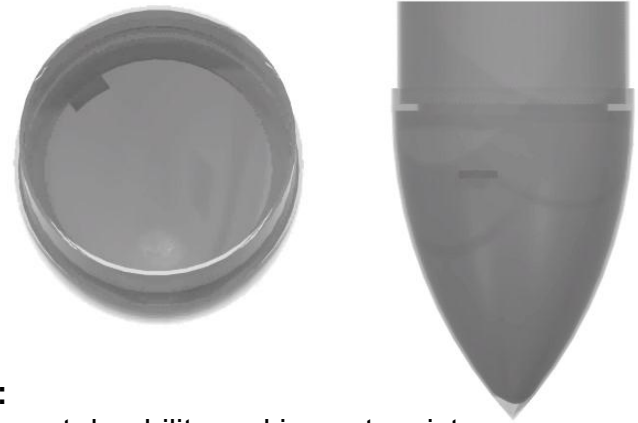
## Design A

Abs Material nose cone (Non-Pointy end)



## Design B

PC Material nose cone (Pointier end)



### Advantages:

- It has decent durability and impact resistance
- Easy to manufacture, low cost.
- Simpler design, more robust.
- It's non pointy end, helps not reaching a higher speed rate during descent.

### Disadvantages:

- Though it's better for descent, the shape of the nose cone produces higher drag during ascent.

### Advantages:

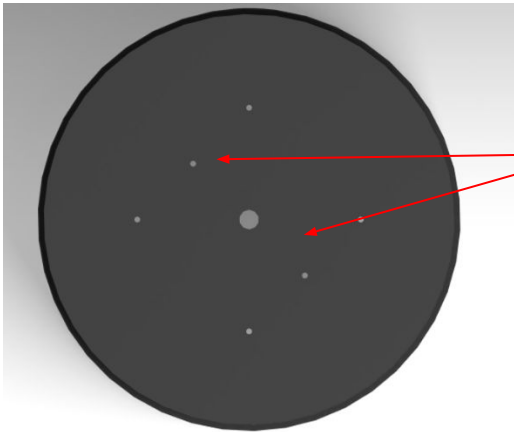
- It has great durability and impact resistance
- It's pointy end, helps reaching a higher altitude during ascent.
- Transparent material enables the recording of the hole flight.

### Disadvantages:

- Pointy end doesn't help reducing descent speed.
- Higher cost, and higher weight.

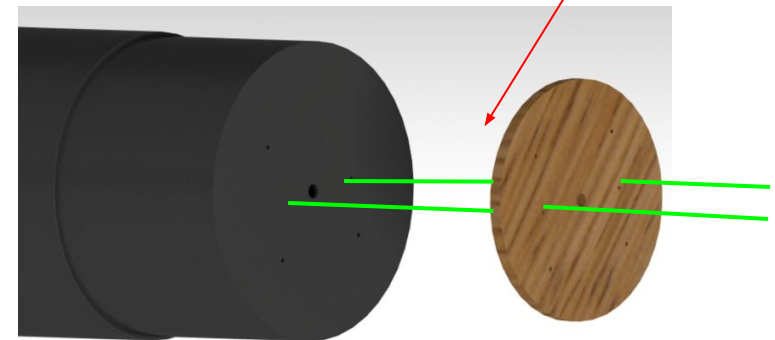
Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>• Having a lower weight and cost, with reasonable values of resistance, ensures a higher profitable option.</li> </ul>

## Design A



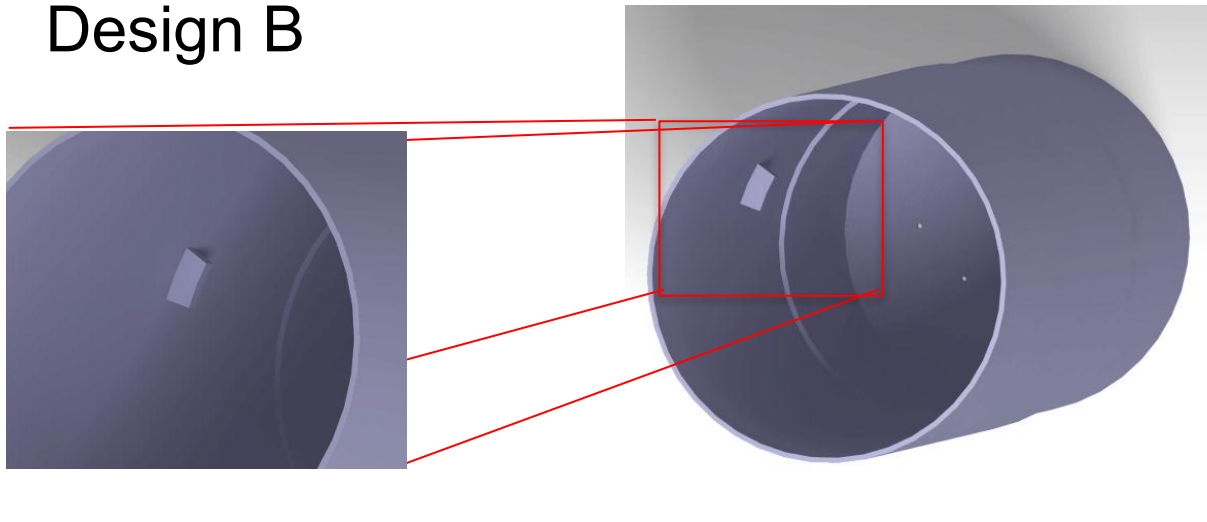
Container and wood disk have 2 extra holes to pass a fishing line through them and tie payload to the container

When CanSat reaches 80% of peak altitude, a resistance burns the fishing line letting the cansat separate from the container (Full description of the mechanism in Payload Release T&S)



Fishing lines are shown in green to contrast colours

## Design B

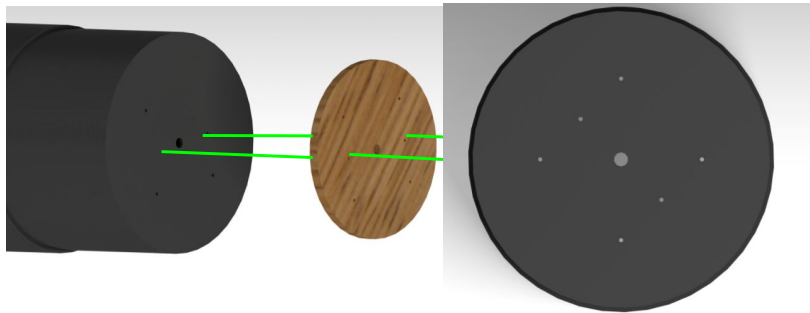


detailed view

The internal wall of the container has stoppers to keep the payload inside the container with a servo-controlled lock

When CanSat reaches 80% of peak altitude, the servos rotate letting the cansat separate from the container (Full description of the mechanism in Payload Release T&S)

## Design A



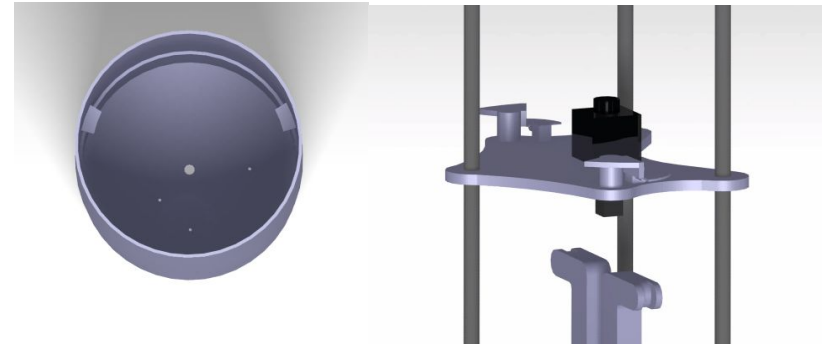
### Advantages:

- Ease of manufacturing
- Small change from reference design

### Disadvantages:

- The stowing mechanism has to be tested to ensure it can resist until payload release
- Not easy to assemble the hole ride of the fishing line through all the holes.

## Design B



### Advantages:

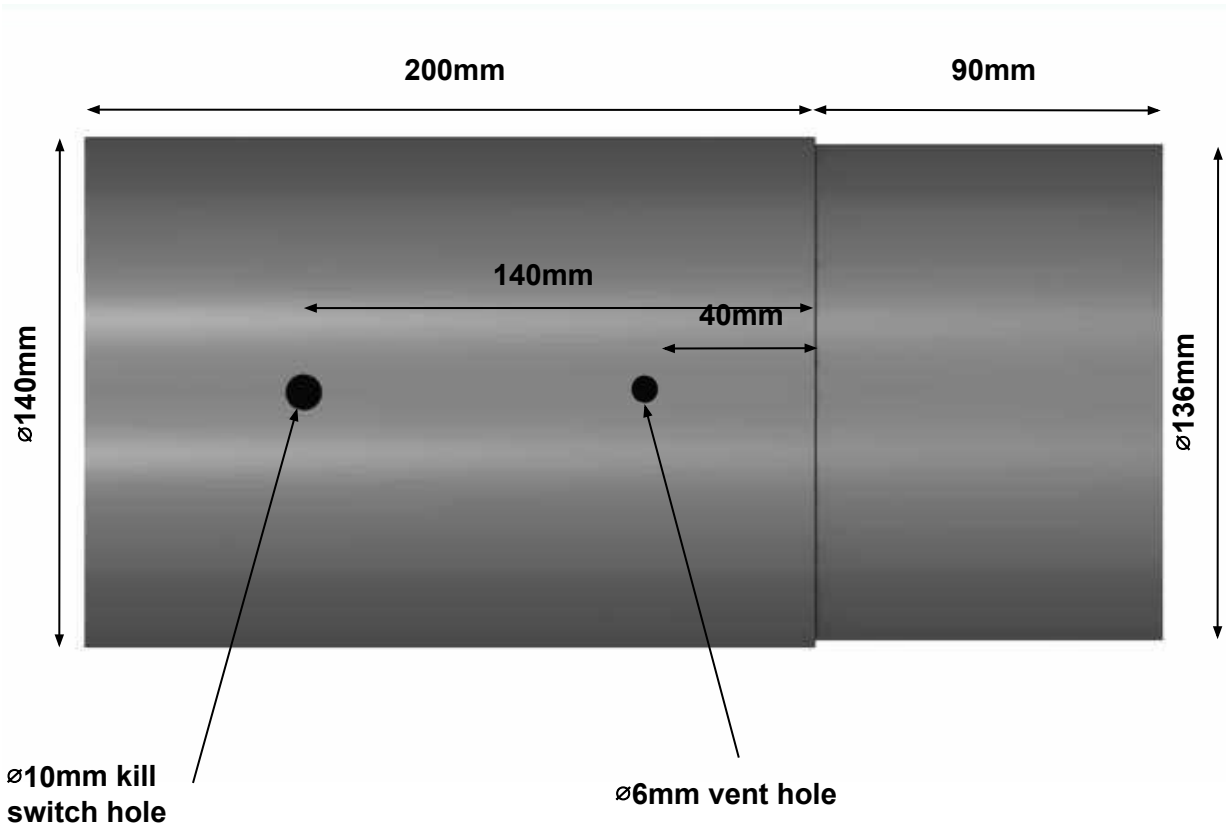
- Stowing mechanism more reliable than design A
- Small change from reference design

### Disadvantages:

- High chance of payload hitting stoppers, which may cause damage to it
- Might be difficult to 3D print, high quantity of support material.

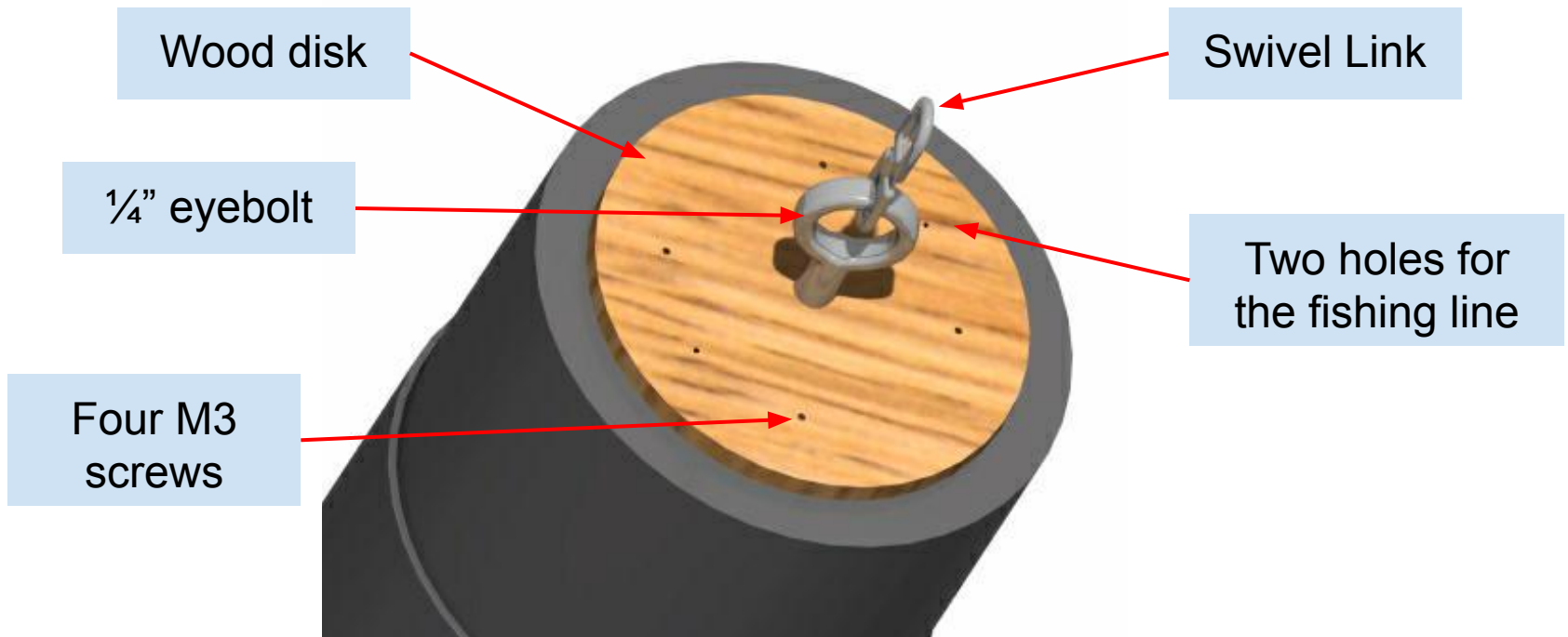
Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>• Chance of payload hitting stoppers is unacceptable.</li> </ul>

## Container Dimensions



Dimensions are the same for both designs. Wall thickness is 2mm through the whole container

The parachute is attached to the Cansat through the eyebolt. A swivel link is also used to avoid its entanglement when the Cansat rotates. Four M3 screws are used to attach the wood disc to the container. This disc has two additional holes to pass the fishing line through.



## Design A (fishing line attachment)

Different colours of the same components are shown to provide a better understanding of the mechanism

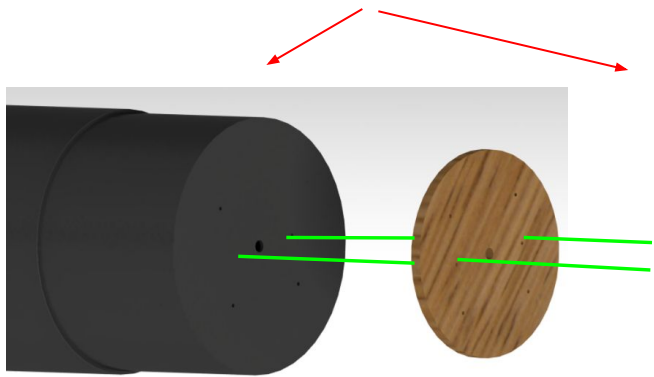


Image shows only the lower part of the container

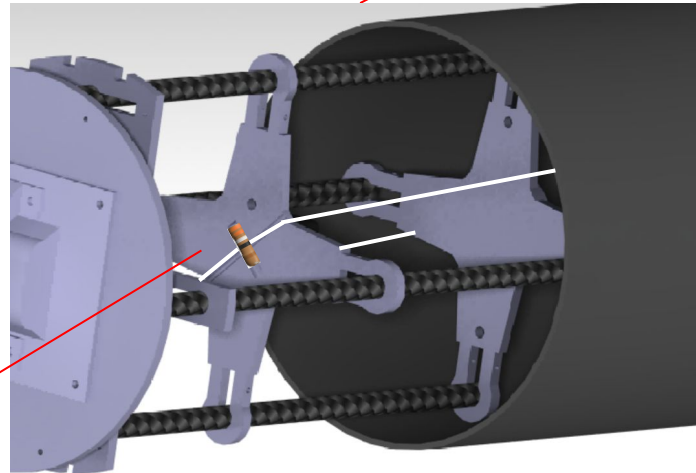
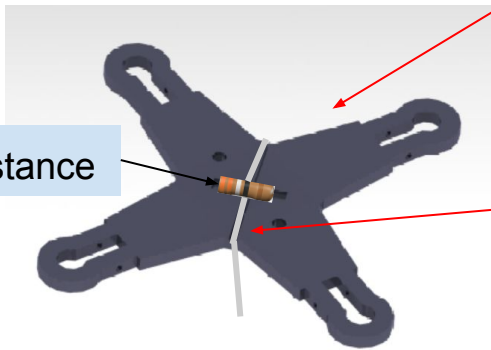


Image shows how the fishing line gets from the container top to the release resistance



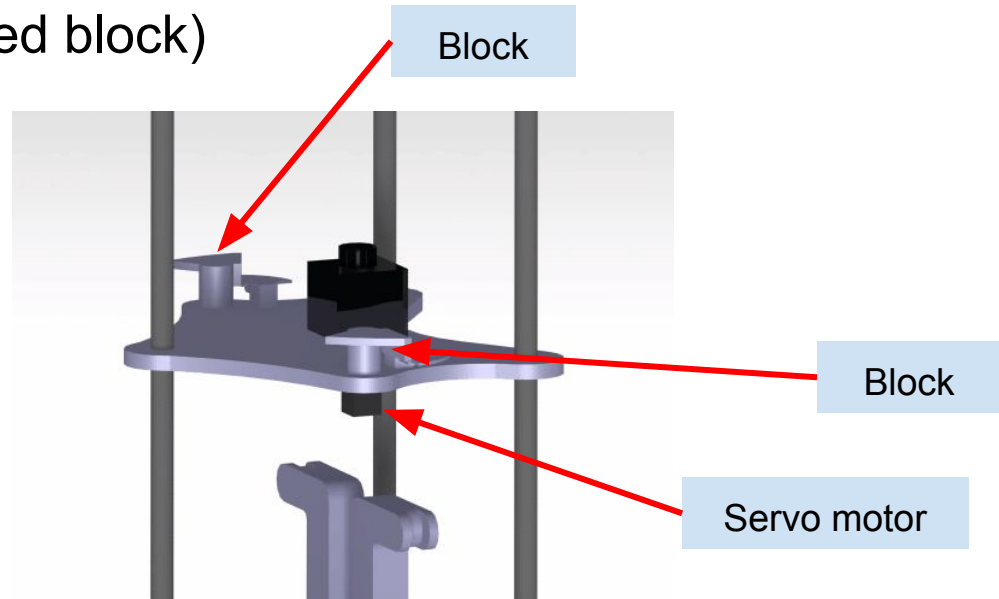
The base of the design, is to make the fishing line the only part attaching the payload from the container

## Design B (servo controlled block)



Stoppers

Once it's time to deploy, the servos rotate, unblocking the stoppers. Container lifted by parachute slides through payload.



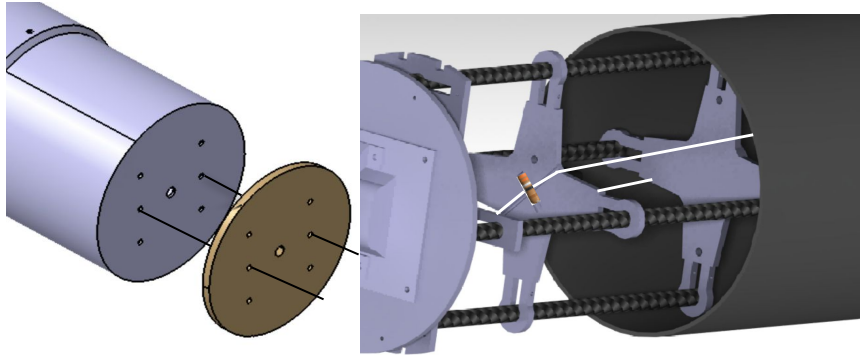
Block

Block

Servo motor

Design is based on a servo that blocks the container from sliding upwards (once the payload is deployed from rocket). Two servos 120° from one another ensure that rotation of the container does not permit release from block.

## Design A



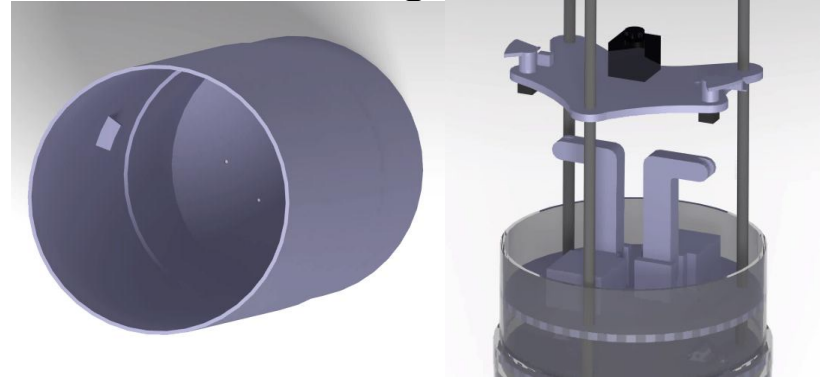
### Advantages:

- Lower weight
- Lower cost
- Moderate reliability
- Does not need too much electronics to run.

### Disadvantages:

- Moderate reliability
- Could get tangled
- Not easy to assemble the hole side of the fishing line through all the holes.

## Design B



### Advantages:

- Highly reliable
- Easy to place and assemble.

### Disadvantages:

- The weight that is added to the payload is not coordinate with the use its given.
- Costly
- Not easy to make pieces of that size and to fit perfectly.

Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>• Having a lower weight and cost, with reasonable values of reliability, ensures the most cost effective option.</li> </ul>

## Design A (passive attachment)

Stowing like this allows not to be so tight in the clearance volume

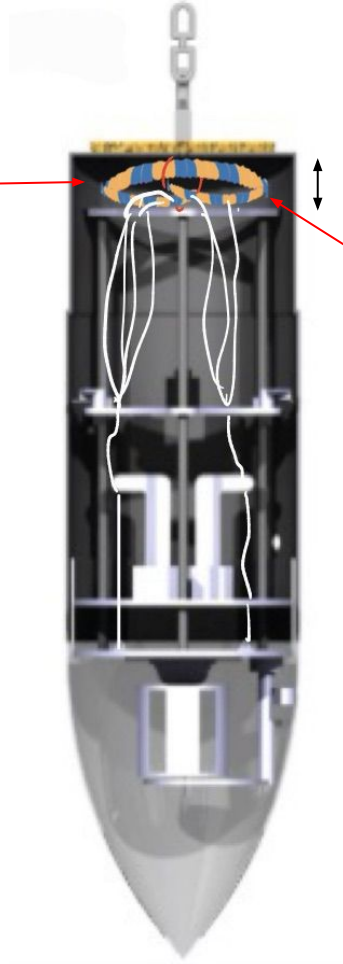


A 20 mm gap to store paraglider while container is on

Paraglider lays on the upper floor, without any special stowing shape.

## Design B (fishing line assistance)

Glider is completely stowed inside clearance volume



A 30 mm gap to store paraglider while container is on

Glider has to be carefully stowed to avoid faulty deployment

## Design A



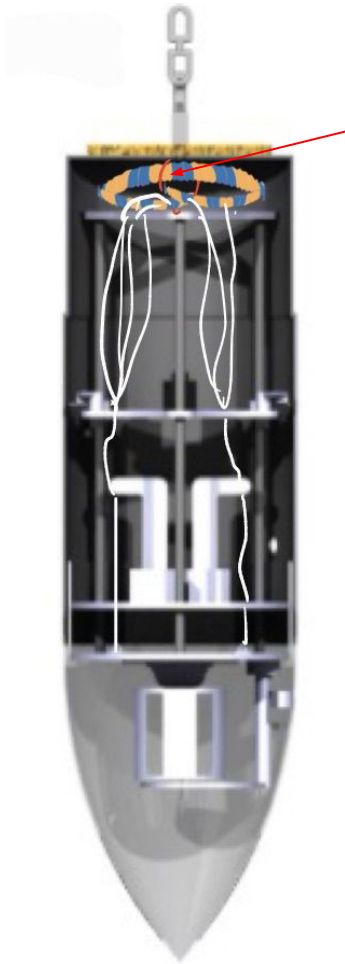
Mechanism relies on the shock wave of entering air to deploy automatically the glider

Transient

This passive mechanism ensures avoiding any type of entanglement



## Design B (fishing line assistance)



Line attached to the container rounds the stowed glider, not knotted.

Upon deployment, container's upward movement makes line to drag at least for a short time the stowed glider

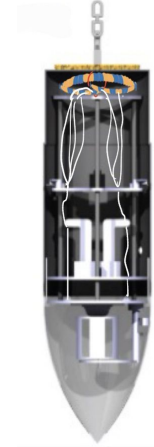


The idea is to assist the deployment of the glider with a pseudo active mechanism

## Design A



## Design B



### Advantages:

- Moderate reliability
- Simpler
- Easy deployment (passive)
- Easy to assemble

### Disadvantages:

- Moderate reliability

### Advantages:

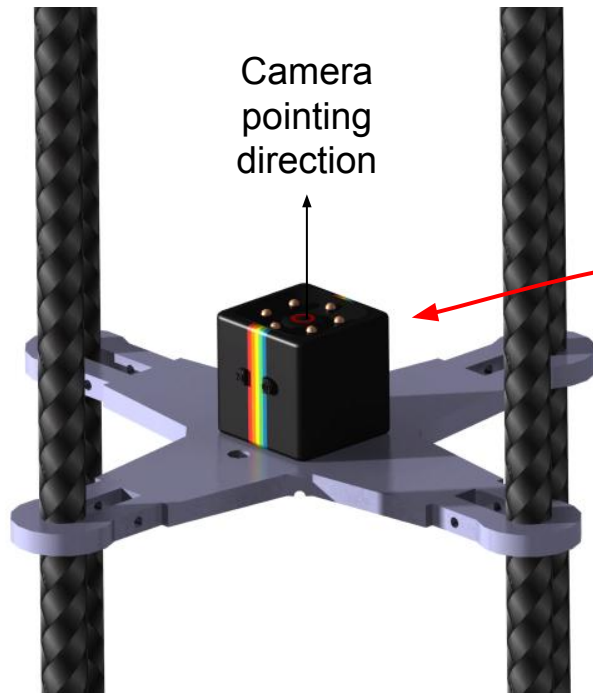
- Reduces deployment time
- Easy to place

### Disadvantages:

- Difficult to assemble
- An additional fishing line is required to stow and deploy

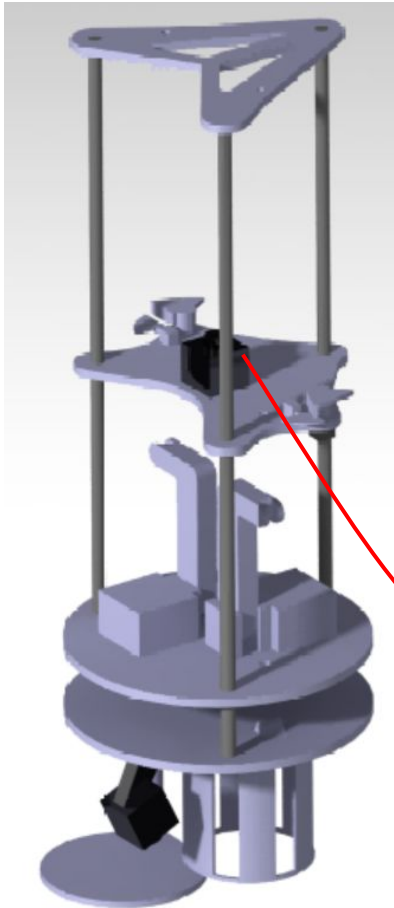
Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>● It is a simpler and easier solution with no risks of failure in both stowage or deployment.</li> </ul>

## Design A



Centered camera allows a central view of the paraglider during descent

For mounting the camera is glued to the floor

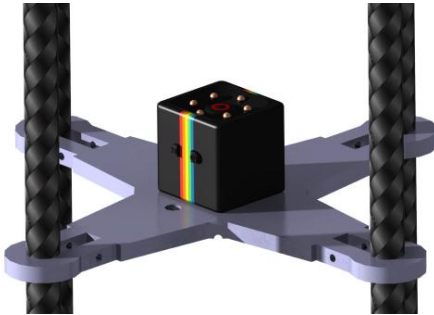


Given the higher placement of the camera floor because of the length of the arms, a fisheye camera is used providing a full view of the paraglider during descent



For mounting the camera is glued to the floor

## Design A



### Advantages:

- Simpler design
- Cheaper
- Safe mounting
- Cheaper

### Disadvantages:

- Smaller field of vision

## Design B



### Advantages:

- Wider field of vision
- Safe mounting

### Disadvantages:

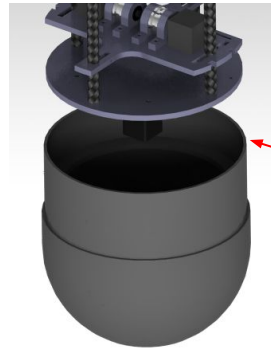
- Expensive
- More complex

Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>• It is a simpler and cheaper design that still allows a good view of paraglider during descent</li> </ul>

## Design A



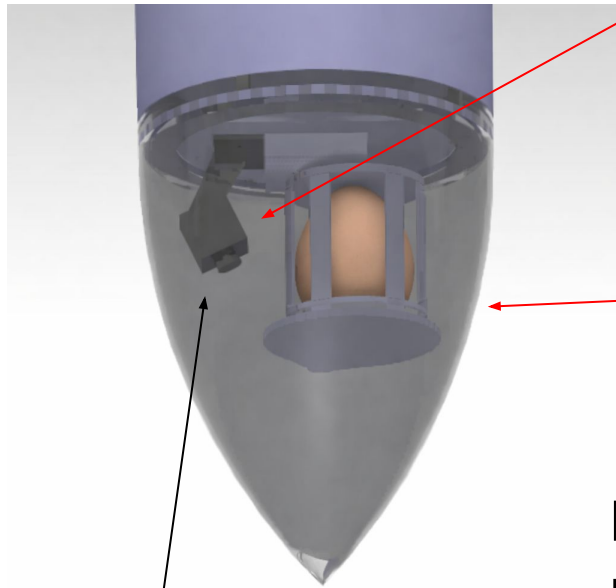
Centered camera allows for a central view of the deployment of the nose cone with the egg instrument



Nose cone material does not allow the recording of the whole flight. Only allows to see the deployment moment and afterwards.

Camera is fixed to the support using glue

## Design B

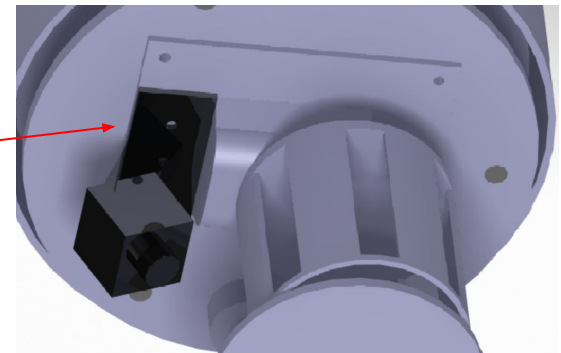


Camera is positioned decentered to film both the descent and the egg instrument at the same time

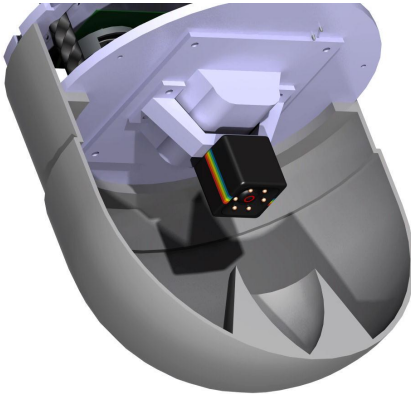
Transparent nose cone allows recording of the whole flight



M3 screws are used to fix the camera support to the lower floor. Camera is glued to the support.



## Design A



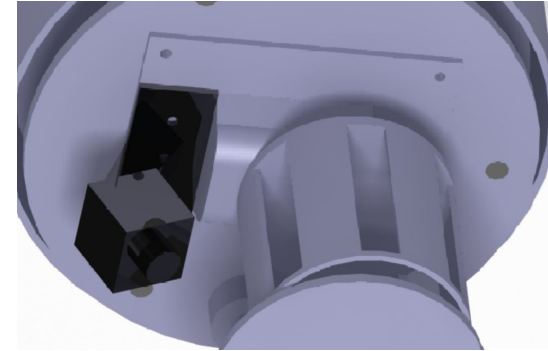
### Advantages:

- Simpler design
- Easy to assemble and fix
- Central view of the deployment
- Keeps the mass center centered

### Disadvantages:

- Only allows to see the deployment moment and afterwards.
- Lengthens nose-cone height

## Design B



### Advantages:

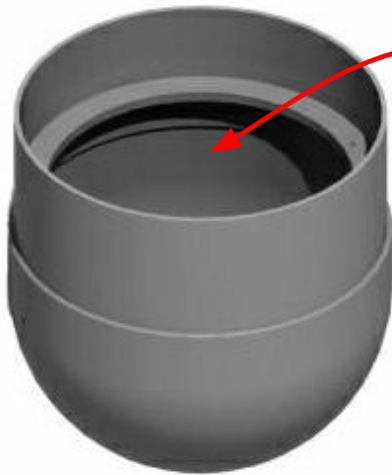
- Better camera position for both egg deployment and descent filming

### Disadvantages:

- Decentralizes payload mass center
- Non-vertical filming
- Requires more components
- Hard to assemble and fix the recording angle

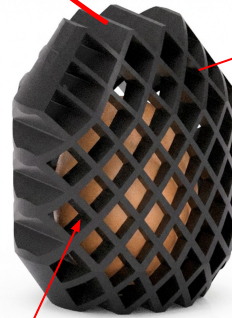
Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>• It is a simpler, more robust and more suitable solution for its task (filming the instrument deployment).</li> </ul>

## Design A

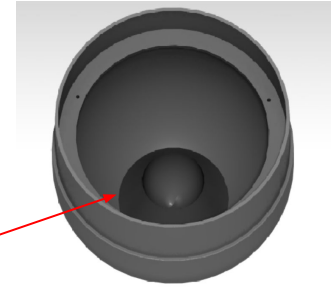


3D printed TPU protection

Nose-cone egg instrument container

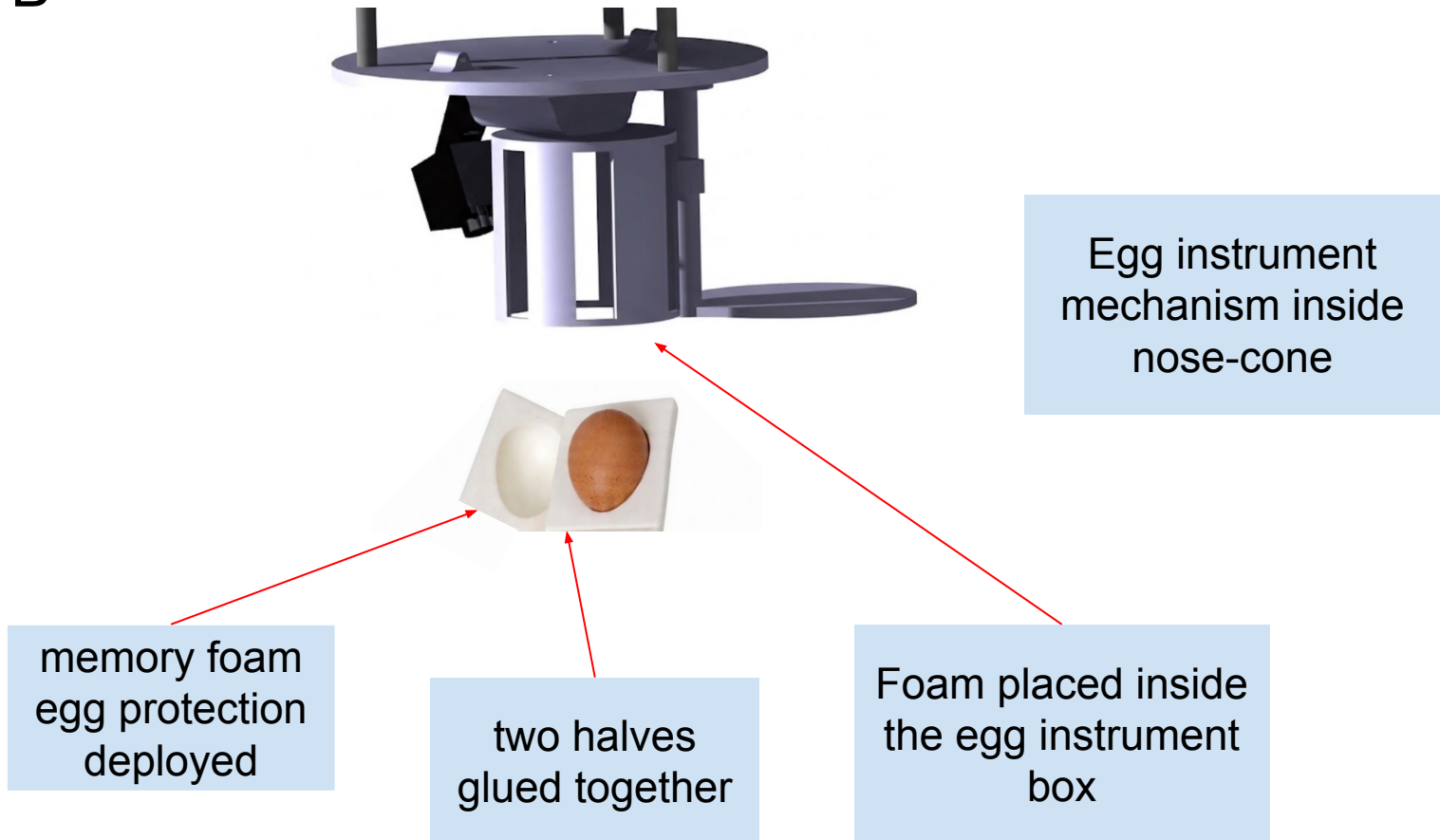


Protection is made of two half parts, glued together when egg is placed



Protection fits tight in the instrument support, and is reinforced with glue

## Design B



Egg instrument mechanism inside nose-cone

memory foam egg protection deployed

two halves glued together

Foam placed inside the egg instrument box

## Design A



## Design B



### Advantages:

- Easier to assemble
- Lower cost
- Moderate reliability
- Does not need too much electronics to run
- Lower weight

### Disadvantages:

- Could, although improbable, get separated from nosecone upon impact
- More costly material

### Advantages:

- Easy to place and assemble
- Cheap material

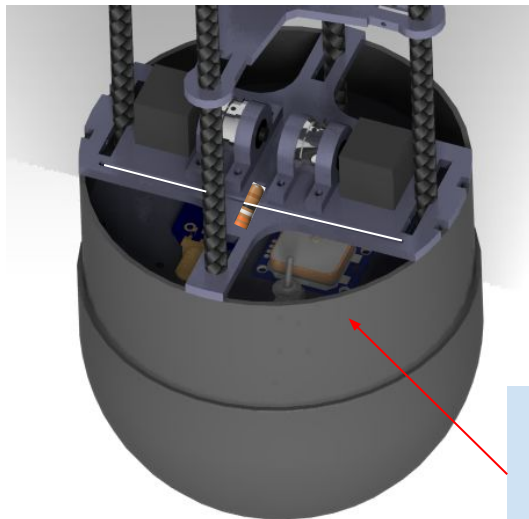
### Disadvantages:

- Higher weight
- Lower resistance to impact
- Lower elasticity would direct more forces to the egg
- Need for a egg shaped material to increase its temperature and impregnate the shape in the foam

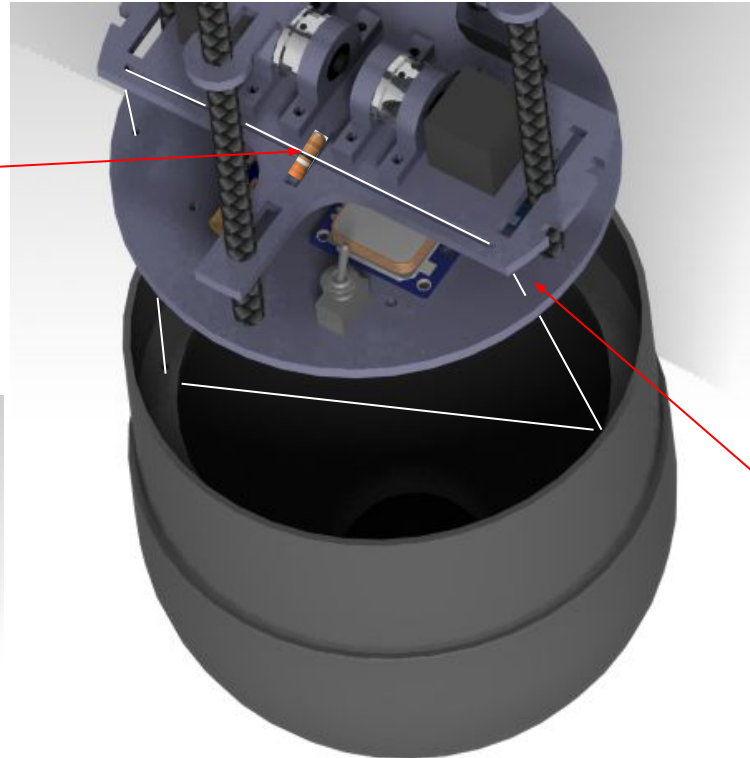
Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>• Although costly, the elasticity of the material, together with its easy assembly characteristics, gives us more confidence on a correct functioning upon impact.</li> </ul>

## Design A

Fishing line will pass through a resistance, to be burned when at 2 meters from the ground



Attached position



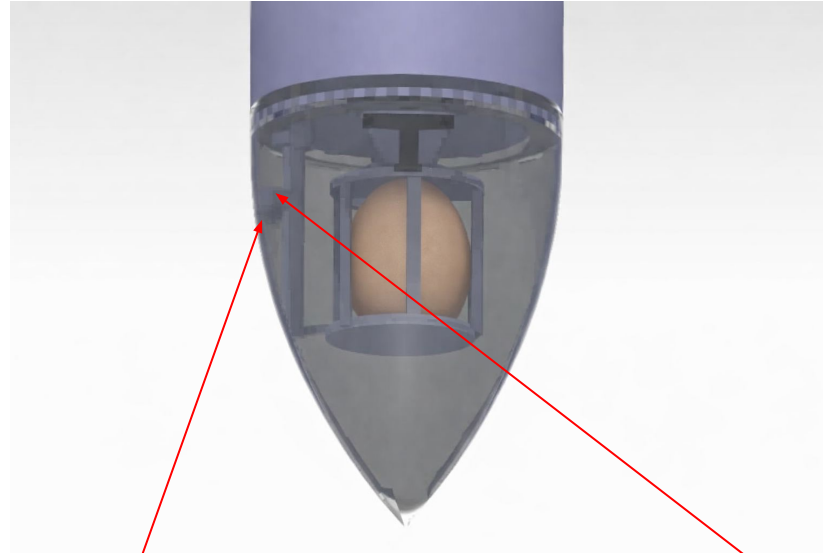
Before nose-cone deployment, system will slow down descent, to enable nose-cone to fall at no more than 5 m/s.

Same as container deployment, a fishing line will maintain the nose-cone attached to the payload

Fishing line will be knotted here

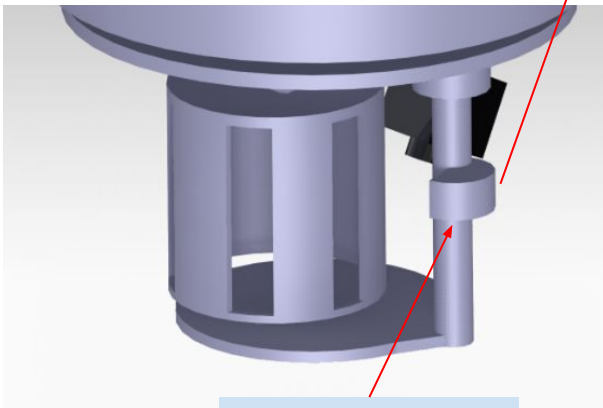
## Design B

Servo motor will both deploy the nose-cone, and the later the egg instrument at 2 meters height.



Before nose-cone deployment, system will slow down descent, to enable nose-cone to fall at no more than 5 m/s.

Container lip

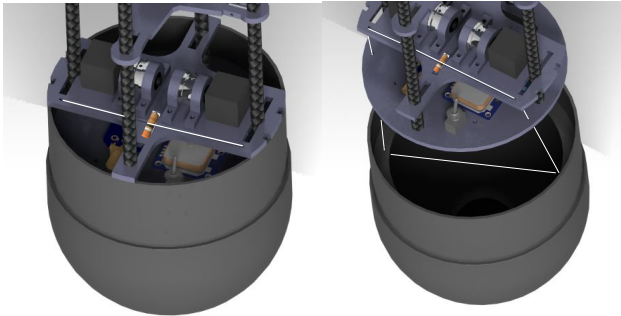


Servo Lock

Servo rotates, and container lip stops being retained by servo lock



## Design A



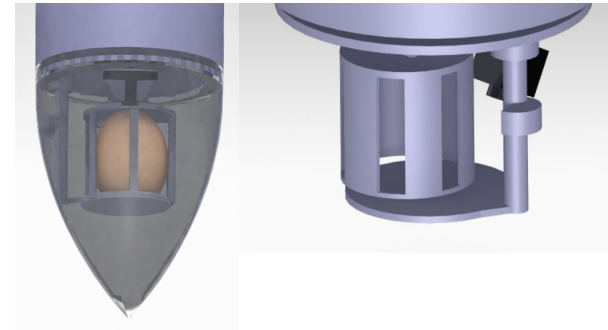
### Advantages:

- Lower cost
- High reliability
- Does not need too much electronics to run
- Cheaper system

### Disadvantages:

- More uncomfortable to assemble
- Could get tangled
- Would need stock of resistors in case of malfunction.

## Design B



### Advantages:

- Easy to assemble
- Allows stepped deployments

### Disadvantages:

- Higher weight
- Complex electronics
- Nose-cone could rotate and decouple from payload when not intended

Selection	Rationale
Design A	<ul style="list-style-type: none"> <li>• Having a lower weight and cost, with less electronic burden, ensures a higher profitable option.</li> </ul>



# Electronics Structural Integrity (1/4)



## Mounting Methods

Method	Description
Screws and Standoffs	<ul style="list-style-type: none"><li>• Some components and breakout boards are through-hole modules with screw holes.</li><li>• Secures components in a robust manner facilitating airflow and heat dissipation.</li></ul>
High Performance Hot melt silicone	<ul style="list-style-type: none"><li>• Thermoplastic material with a melting point around 100 °C</li><li>• High-G vibration resistant</li><li>• Can be easily applied using a hot glue gun</li></ul>
High Performance Adhesives (Epoxy)	<ul style="list-style-type: none"><li>• Adheres components permanently to the payload framework.</li><li>• Mass efficient: lightweight compared to metallic mounting parts.</li><li>• Does not require pre drilled holes or any specific geometry.</li></ul>
Surface Mount Technology (SMT)	<ul style="list-style-type: none"><li>• Facilitates the integration of lightweight components and modules with castellated holes by soldering them directly to the main PCB.</li><li>• Minimizes the overall footprint and vertical profile by eliminating the need for bulky headers or connectors.</li></ul>



# Electronics Structural Integrity (2/4)



## Electronic component enclosures

Name	Description
Nose Cone walls	<ul style="list-style-type: none"><li>• Electronics are enclosed with a 3D printed sleeve (ABS material).</li></ul>
Nylon wire burning resistor housing	<ul style="list-style-type: none"><li>• The burning resistor is placed on its own 3D printed structure to prevent other components from burning or receiving any damage from the heat.</li></ul>

## Securing Electrical Connections

Method	Description
Soldering electrical connections	<ul style="list-style-type: none"> <li>● Solder is applied to all connections or cables that require a permanent and resistant mechanical attachment improving durability and signal quality.</li> <li>● Applies only to those components that do not need to be periodically serviced or removed.</li> </ul>
<i>Micro-Lock</i> Connectors	<ul style="list-style-type: none"> <li>● <i>Micro-Lock</i> connectors are high-performance reduced size connectors used in automotive industry.</li> <li>● Electrical connections (power, digital, sensor, etc) will use <i>Micro-Lock</i> connectors.</li> <li>● Provides a strong connection lock and a reliable metal contact that ensures signal integrity. AEC-Q100 certified</li> </ul>

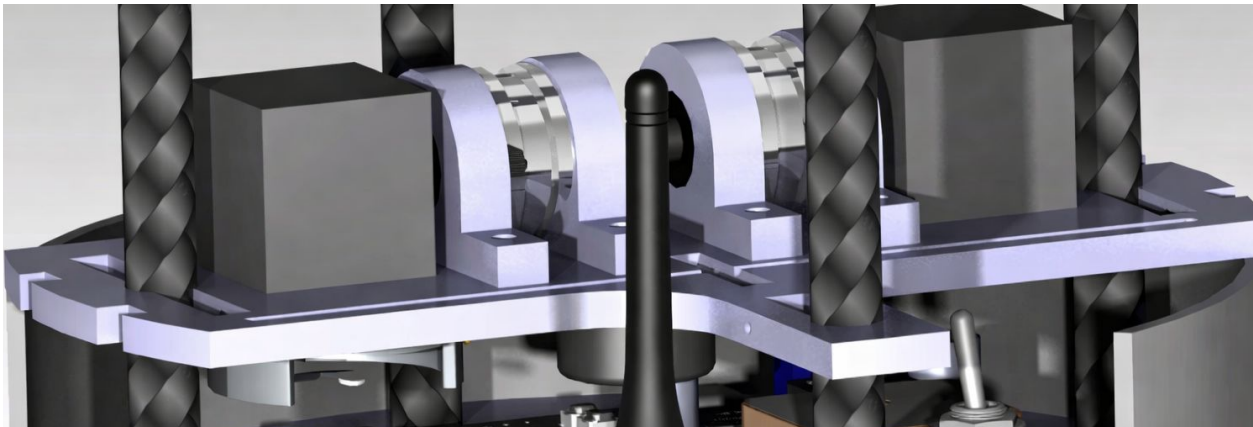
*Micro-Lock* Connectors

**molex**



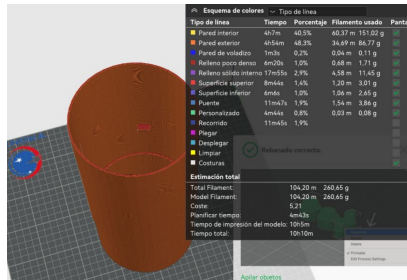
## Descent Control Attachments

Method	Description
Recessive Adhesive Mounting	<ul style="list-style-type: none"> <li>• Utilizes high-performance adhesive within custom-fit mounting pockets to ensure the servos are permanently fixed.</li> <li>• Distributes mechanical stress across the bond surface, enhancing resistance to high-G deployment shocks.</li> <li>• Allows the structure to absorb part of the forces exerted by the paraglider.</li> </ul>



## Sources of Uncertainties:

- CAD Estimate
  - Pieces like the eyebolt, bolts and swivel link, as they are standardized, they have fixed dimensions. Density added to the CAD software provides an accurate approximation of the real value.
- Slicer
  - ABS material pieces have their weight measured by the slicer software. The program used was BambuStudio. The uncertainty was measured by scaling the parts taking into account the 3D printer's dimensional accuracy.





## Mass Budget (2/6)



### Sources of Uncertainties:

- Estimates
  - Parachute weight estimation was done using the material's density and the geometry given. Uncertainties rely on small variations in dimensions, given the manufacturing process related to it.
  - Para-glider weight estimation was performed searching for real RC gliders in the internet, and making approximations based on our dimensions compared to them. Uncertainties rely on difference in model assimilation, and attachment points.
  - Electronic modules weight's uncertainty comes from the manufacturer's datasheet.



# Mass Budget (3/6)



- **Mass of each structural element (1/2):**

Component	Material	Infill	Corrected mass [g]	Uncertainty[g]	Source
Nosecone	ABS	20%	110	±2	Slicing Estimate
Container	ABS	20%	250	±2	Slicing Estimate
Upper floor	ABS	10%	6	±0,3	Slicing Estimate
Guide floor	ABS	20%	7	±0,3	Slicing Estimate
Winch floor	ABS	20%	15	±0,3	Slicing Estimate
Electronics floor	ABS	20%	19	±0,5	Slicing Estimate
Bearing supports (4x)	ABS	20%	6	±0,2	Slicing Estimate
Camera support	ABS	20%	2	±0,1	Slicing Estimate
Egg capsule	TPU	20%	10	±0,2	Slicing Estimate

- Mass of each structural element (2/2):

Component	Material	Mass [g]	Uncertainty[g]	Source
Parachute	Nylon	13	±2	Estimate
Paraglider	210T plaid cloth	80	±10	Estimate
Eyebolt	steel	20	±2	CAD Estimate
Swivel link	steel	5	±1	CAD Estimate
Wooden disc	wood	19	±3	CAD Estimate
Bolts and Nuts	steel	21	±1	CAD Estimate
Fishing line	Nylon	5	±0,5	Estimate
Winch (2x)	aluminium	12	±2	CAD Estimate
Bearing (4x)	steel	5	±0,5	CAD Estimate
Rod (4x)	carbon fiber	38	±3	CAD Estimate
Egg	Egg	59	±5	Mission guide
<b>Total Structure Mass = 702 ± 35,9 [g]</b>				



# Mass Budget (5/6)



- Mass of each component of Cansat:**

Component	Mass [g]	Uncertainty [g]	Source
MCU: STM32F4	5,00	±0,50	Datasheet
GPS: Ublox Neo-6M + Antenna	16,00	-	Datasheet
Cameras: Quelim SQ11 (x2)	23,00	±0,50	Measured
Communication: XBee module + Antenna	15,00	±0,50	Measured
Servos (x2)	120,00	±6,00	Datasheet
TFS20-L (x2)	2,70	-	Datasheet
RTC module: DS3231 + Battery	6,00	-	Datasheet
PCB + Cables + Connectors	25,00	±2,00	Estimated
Payload Battery + Holder	50,00	±2,00	Datasheet
Beacon Board	5,00	±1,00	Estimated
Beacon Battery	21,00	-	Datasheet
Buzzer	7,80	-	Datasheet
<b>Total Hardware Mass = 296.5 ± 12.5 [g]</b>			

- **Total mass of all components and structural elements:**

Total Mass Budget	
System	Mass[g]
Structure/Mechanic	702 ± 35,9
Hardware/Electronic	296.5 ± 12,5
<b>Total Mass = 998,5 ± 48,4</b>	

This approach provides a reliable and consistent basis for the mass data of each component, whether it's from datasheets, direct measurements, or estimates based on prior experience.

$$\text{Margin} = 1000\text{g} - 998,5\text{g} = +1,5\text{g}$$

## Methods for correction:

- **3D Printer Parts Infill:** We will adjust the **infill** configuration of our 3D printed parts to get closer to the desired total mass (for increasing or decreasing mass)
- **Solder Wire:** Soldering wire (Tin-Lead Alloy) will be used to **fine tune** the total mass within the 1000±10g range, adding more material to specific sections of the PCB board designed for this
- **Removing material:** Extreme measure of mass reducing, only if needed at launch site, would be removing material on several parts of the payload (only on the ones that this is allowed)

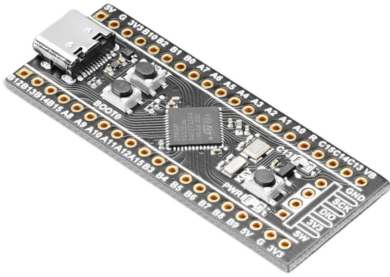


# Communication and Data Handling (CDH) Subsystem Design

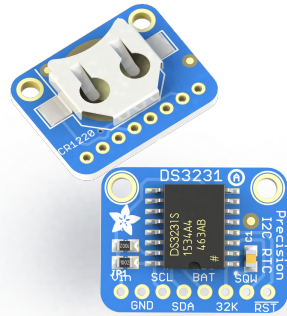
**Jaime Nazar Anchorena**  
**Emanuel Albornoz**  
**Matteo Ginhson**

## STM32F411 "BlackPill" Development Board

Microcontroller Board



## DS3231 mini Real Time Clock



## ANT-900MR Flex ¼ Wave RPSMA Payload Antennash

Estimated Range > 10000 m  
(at Line Of Sight)



## Xbee Pro S3B Radio



NETID/PANID: 1081

XBees will not be set to Broadcast mode.

Telemetry rate: 1Hz

## SanDisk Ultra memory

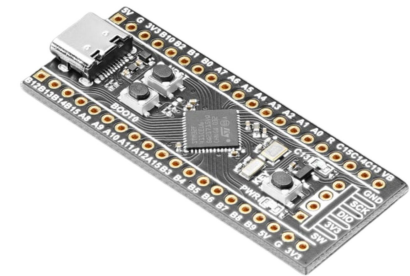


Name	Processor					Interfaces						Size WxL [mm]	Mass [g]	Price [USD]	Onboard Sensors?	Supply Voltage [V]
	Chip Name	Clock Speed [MHz]	Flash Mem [kB]	RAM Mem [kB]	Boot Time [ms]	I/O Pins	ADC Pins	PWM Pins	UART	SPI	I2C					
STM32F4	STM32F411CEU6	100	512	256	200	25	10	12	3	3	2	20x53	5	12	No	3v3
NodeMCU ESP32	Tensilica LX6	240	4096	520	200	25	15	21	3	3	2	26x48	10	12,00	Temp	3v3
Raspberry Pi Pico	RP2040	133	2048	264	2000	26	3	16	2	2	2	21x51	4	4,00	Temp	5V
Arduino Nano	Atmega 328p	16	32	2	500	20	8	6	1	1	1	18x44	7	10,00	No	5V (USB) 7-15V (pin 30)

## Selected Board: **STM32F411 “BlackPill”** develop board

### Reasons:

1. **Tiny form factor** (very compact board size)
2. **Powerful and reliable microcontroller core** (*Arm Cortex-M4F @ 100 MHz*)
3. **Can be directly surface mounted** (*castellated holes*)
4. **Programming flexibility:** supports both **low-level programming** (register-level / HAL / LL) or **high-level programming** through frameworks such as **STM32duino (Arduino core)**
5. **STM software ecosystem:** compatible with the official **STM32Cube IDE** development environment (ST toolchain), allowing professional debugging/programming workflows (e.g., via **ST-Link**) and access to STM32Cube libraries.



Series name	Interface	Read Speed [MB/s]	Write Speed [MB/s]	Price [USD]
SanDisk Ultra	SPI and SDIO	98	18	2.43
Verbatim HC	SPI and SDIO	90	10	6.41
Hikivision L2	SPI and SDIO	92	20	7.3

## Selected: SanDisk Ultra

- Sufficient read and write speeds while being cheap
- Previous experience
- 1 x 32GB for Data Logging, interfacing with the MCU.
- 2 x 64GB, one for each camera.



## Camera Memory

64 GB memory  
*(independent from the main circuit)*



## Program Memory

512kb Built In Flash  
256kb Built In RAM

### Notes:

1. The BlackPill development board also comes with an 8MB external SPI Flash.

Name	W×L×H Size [mm]	Mass [g]	Operating voltage [V]	Operating Current [μA]	Interface	Temp Compensated	Reset Tolerance	Extra NVRAM Memory	Price [USD]
DS3231	23×38×13	9	2.3 ~ 5.5	200	I2C	Yes	Yes	no	20.99
<b>DS3231 mini</b>	<b>14x14x12</b>	<b>3</b>	<b>2.3 ~ 5.5</b>	<b>200</b>	<b>I2C</b>	<b>Yes</b>	<b>Yes</b>	<b>no</b>	<b>17.5</b>
DS1307 (TinyRTC)	28×27×10	7	4.5 ~ 5.5	1500	I2C	No	Yes	56 bytes	7.5
DS1302	23×43×12	9	4.5 ~ 5.5	1500	I2C	No	Yes	no	2.6

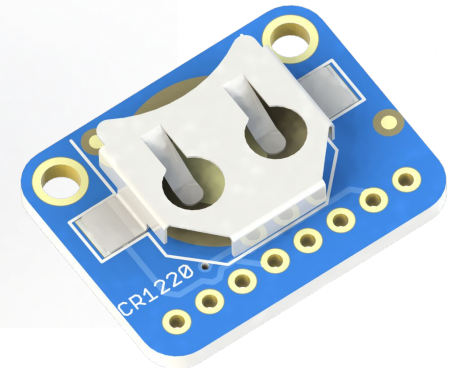
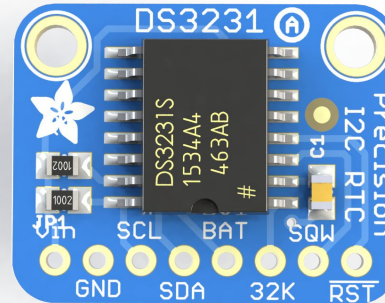
## Selected Module: **DS3231 mini**

### Reasons:

1. Small Size
2. Lightweight
3. 3.3V compatible
4. Temperature compensated

#### Notes:

1. Price reference was obtained from the supplier [Adafruit](#), [Amazon](#)
2. Consumes 0,6mWh



Name	Dimensions [mm]	Gain [dBi]	Range [m]	Weight [g]	Polarization	Connector	Price [USD]
ANT-900MR Flex ¼ Wave RPSMA	105x18x11	2.15	>10000 Estimated	15	Vertical	RP-SMA	7
<b>Xbee</b> Whip Antenna (Wire)	Length: 25	2	1200	< 1	Linear	Protrudes from Xbee	Included with XBee
<b>FXP70 Freedom</b> <b>2.4 GHz</b>	Cable: 52, Ø1.13 Antenna 27x25x0.1	1.5	1200	2	Linear	U.fl	3.35

## Selected Antenna: **ANT-900MR Flex ¼ Wave RPSMA**

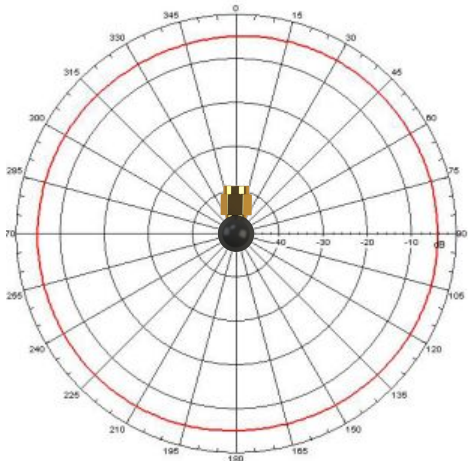
### Reasons:

1. High Gain and long range
2. Previous experience
3. Strong connection attachment (RP-SMA)

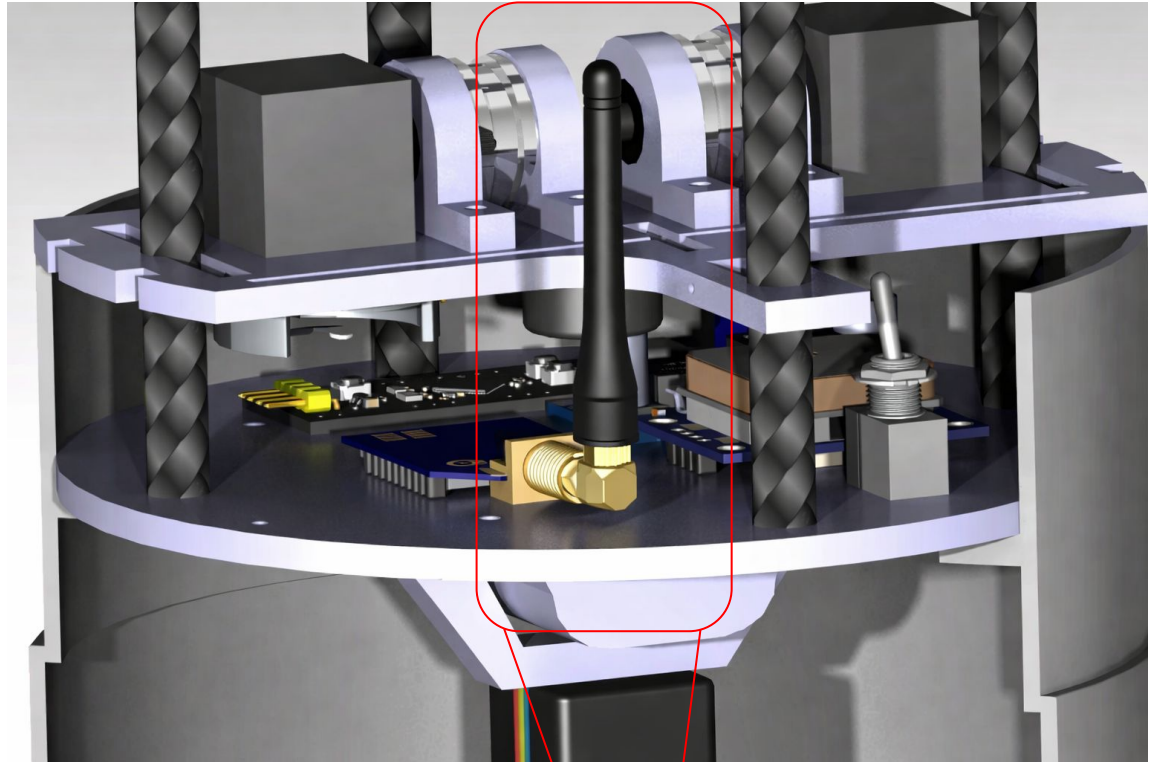
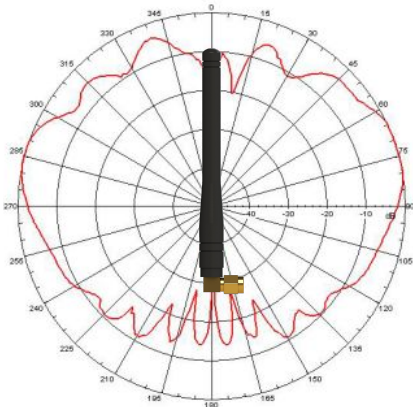


## Antenna Location, Range & Radiation Patterns

H-PLANE



E-PLANE



Antenna Location

Name	Frequency [GHz]	Antenna Connector	Transmit current [mA]	Receive current [mA]	Operating Voltage [V]	Range [m]	Sensitivity [dBm]	RF Data Rate [Kbps]	Price
XBee PRO S3B 915MHz	0.9-0.928	Whip wire - RP-SMA	215	29	2.4-3.6	6500	-101	200	58.08
XBee S2B (XB24CAUIT-001)	2.4	Whip wir - RP-SMA	120	31	2.7-3.6	3200	-101	200	35

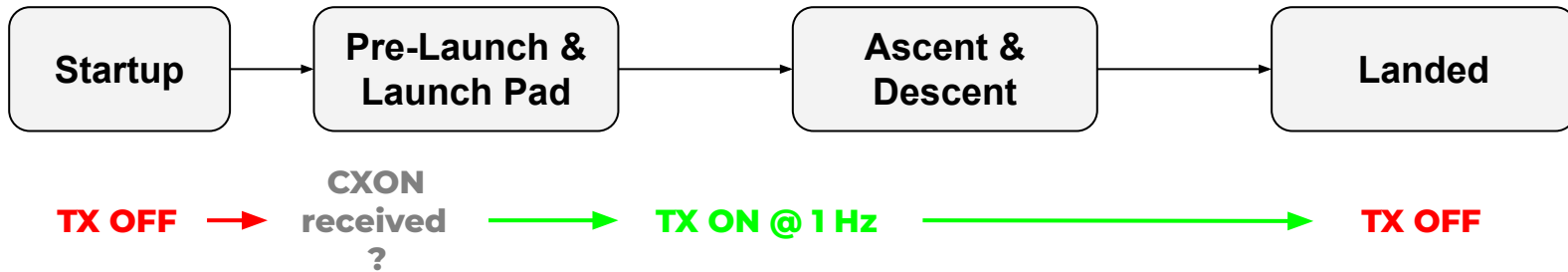
- **NETID/PANID will be set to: 1081**, using XCTU software
- XBees will **not** be set to Broadcast mode.
- This XBee will be used to send payload **telemetry** at a **rate of 1 Hz** to the ground station.
- Large range XBee provides larger distance coverage, thus, mitigating possible sources of error provided by unexpected rocket displacement.



## Transmission Control

The transmission control for the payload will follow the next steps:

- 1) **Startup:** Payload turned on but not transmitting telemetry.
- 2) **Pre-Launch and Launch Pad:** Payload On, waiting for CXON command to begin transmitting telemetry.
- 3) **Ascent, Apogee and Descent:** Payload is transmitting telemetry to GS with a frequency of 1Hz.
- 4) **Landing:** The Container shall stop transmitting telemetry when it lands.





# Payload Telemetry Format(1/4)



Data Format	Example	Description
TEAM_ID	1081	Assigned team identification
MISSION_TIME	01:22:10	UTC time in format hh:mm:ss
PACKET_COUNT	50	Total count of transmitted packets
MODE	F	'F' for flight mode and 'S' for simulation mode
STATE	ASCENT	Operating state of the software
ALTITUDE	500.3	Altitude in units of meters relative to ground level
TEMPERATURE	25.7	Temperature in Celsius
PRESSURE	101.2	Air pressure measured in kPa



# Payload Telemetry Format(2/4)



Data Format	Example	Description
VOLTAGE	8.3	Voltage of the payload battery
CURRENT	2.48	Payload battery current in Amperes
GYRO_P, GYRO_Y, GYRO_R	18, 21, 20	Gyroscope readings in degrees per second for the roll, pitch, and yaw axes
ACCEL_R, ACCEL_P, ACCEL_Y	30, 35, 33	Accelerometer readings for the roll, pitch and yaw axes
MAG_R, MAG_P, MAG_Y	0.22, 0.03, 0.09	Magnetometer readings in the roll, pitch and yaw axes in gauss
GPS_TIME	13:14:02	Time from GPS receiver in UTC



# Payload Telemetry Format(3/4)



Data Format	Example	Description
GPS_ALTITUDE	200.8	Altitude readings from the GPS in meters
GPS_LATITUDE , GPS_LONGITUDE	3.8793 , 18.3672	Coordinate readings from the GPS in degrees
GPS_SATS	5	Number of GPS satellites being tracked by the receiver
CMD_ECHO	CXON	Text of the last command received and processed by the Cansat.
MOTOR_L , MOTOR_R	23 , 31	Para-glider control motors position readings in degrees



# Payload Telemetry Format(4/4)



- **The Cansat telemetry packet will be transmitted at a rate of 1Hz with the following format\*:**

TEAM\_ID, MISSION\_TIME, PACKET\_COUNT, MODE, STATE, ALTITUDE, TEMPERATURE, PRESSURE, VOLTAGE, CURRENT, GYRO\_R, GYRO\_P, GYRO\_Y, ACCEL\_R, ACCEL\_P, ACCEL\_Y, GPS\_TIME, GPS\_ALTITUDE, GPS\_LATITUDE, GPS\_LONGITUDE, GPS\_SATS, CMD\_ECHO, **MOTOR\_L, MOTOR\_R**

- **Example:** 1081, 01:22:10, 50, F, ASCENT, 500.3, 25.7, 101.2, 8.3, 2.4, 1.2, 18, 21, 20, 30, 35, 33, 13:14:02, 200.8, 3.8793, 18.3672, 5, **CX0N, 23, 31**

\*Data in bold indicates it isn't part of the required telemetry



# Payload Command Formats



Command	Format	Command Description	Example	Example Description
CX	CMD , <TEAM_ID> , CX , <ON_OFF>	Payload telemetry On/Off command	CMD , 1081 , CX , ON	Activates payload telemetry transmission
ST	CMD , <TEAM_ID> , ST , <UTC_TIME>   GPS	Set time	CMD , 1081 , ST , 13 : 35 : 59	Sets the mission time to 13:35:59
SIM	CMD , <TEAM_ID> , SIM , <MODE>	Simulation Mode Control Command	CMD , 1081 , SIM , ENABLE	Enables simulation mode
SIMP	CMD , <TEAM_ID> , SIMP , <MODE>	Simulated Pressure Data	CMD , 1081 , SIMP , 101325	Provides a simulated pressure reading of 101325 Pascals
CAL	CMD , <TEAM_ID> , CAL	Calibrate Altitude to Zero	CMD , 1081 , CAL	Sets altitude to 0
MEC	CMD , <TEAM_ID> , MEC , <DEVICE> , <ON_OFF>	Activate a specific mechanism. 0 for autopilot, 1 for egg drop and 2 for probe release.	CMD , 1081 , MEC , 1 , ON	Turn mechanism 1 on
CAL_PRY	CMD , <TEAM_ID> , CAL_PRY	Calibrate Pitch, Roll and Yaw angles	CMD , 1081 , CAL_PRY	Set Pitch, Roll and Yaw angles to 0



---

# Electrical Power Subsystem (EPS) Design

**Nicanor Otamendi**  
**Juan Sambucetti**

## Beacon Battery

2x CR2477 (1Ah)



## Coin Battery

RTC Battery  
CR2032 (225mAh)



## Payload Batteries

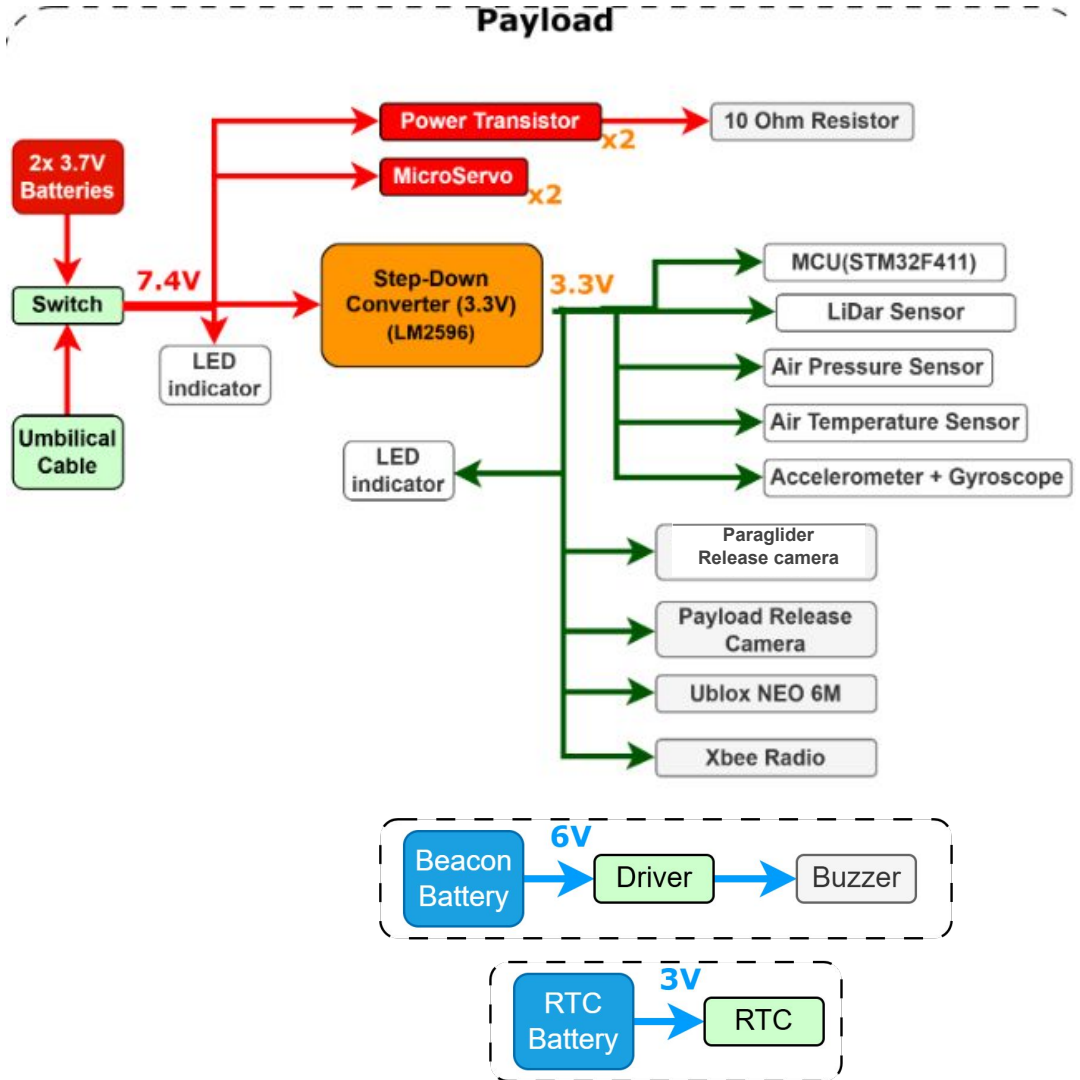
2x Vapcell INR14500 H10

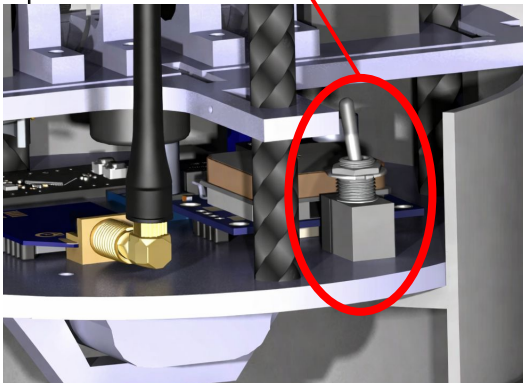
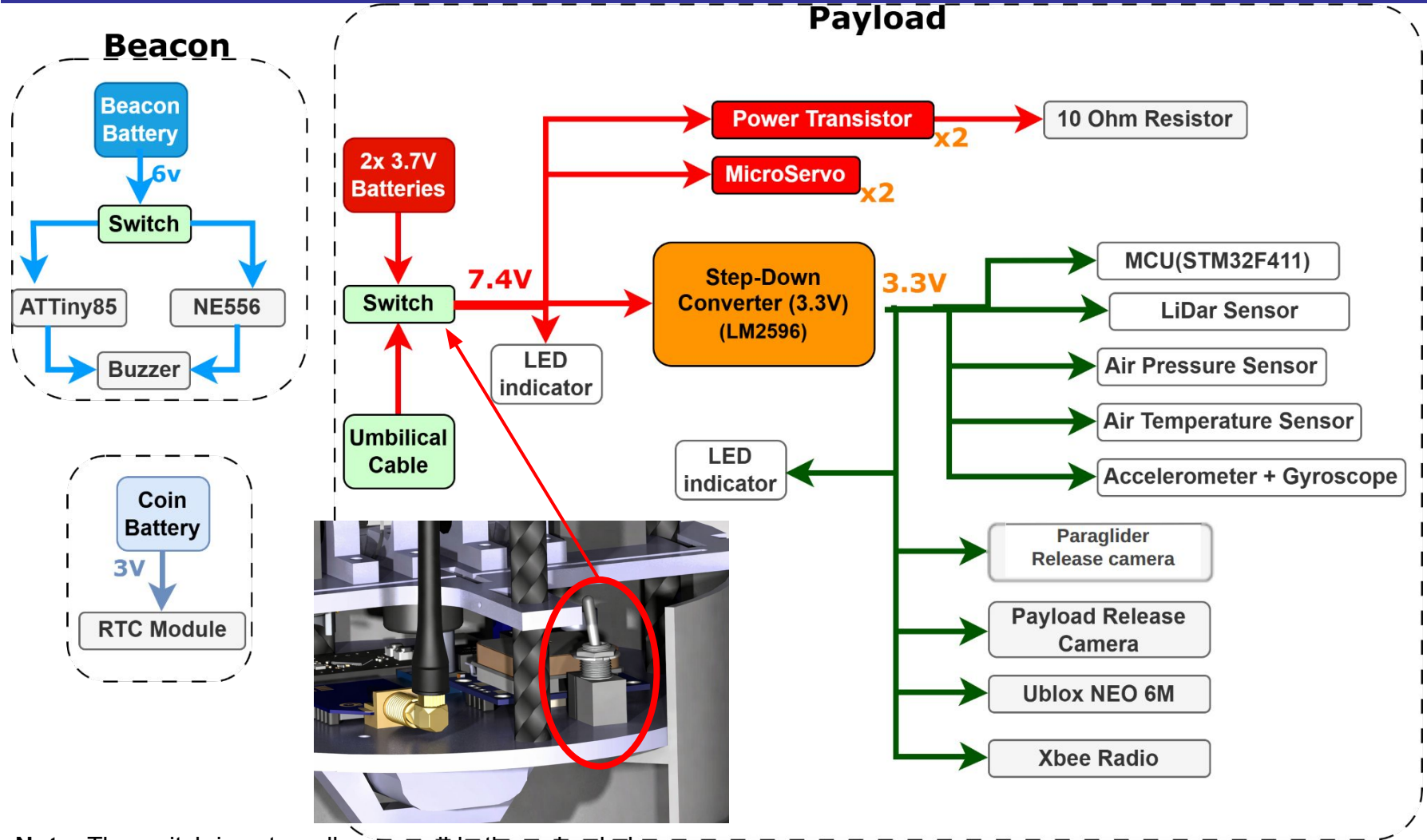


## Step-Down 3.3V Converter LM2596



10 Ohm Resistor and Power Transistor are used to burn the fishing line





**Note:** The switch is externally accessible through a hole.

**Note:** LED's are power indicators and are visible through the same hole as the switch.

Name	Technology	Weight [gr]	Voltage [V]	Battery Capacity [mAh]	Battery Capacity [Wh]	Max. Current [A]	Rechargeable	Price [USD]
<b>Samsung INR18650</b>	Lithium ion	46.5	3.7	2500	9.25	20	Yes	4.99
<b>Energizer 522</b>	Alkaline	45	9	600	5.4	0.6	No	2.1
<b>Vapcell INR14500 H10</b>	Lithium ion	22	3.7	1000	3.7	10	Yes	3.6

**Model Selected:** Vapcell INR14500 H10

**Reasons:**

- Lowest weight
- Great price-to-capacity relationship
- High nominal current
- Enough capacity
- Rechargeable

**Connection:** *Superseal* Connector

The battery will have cables soldered to its pads and electrically connected to the Container through a pair of *Superseal* connectors



**Max Discharge  
Continuous Current:** 10A (single cell)



# Payload Power Trade & Selection (2/3)



## Battery configuration selection

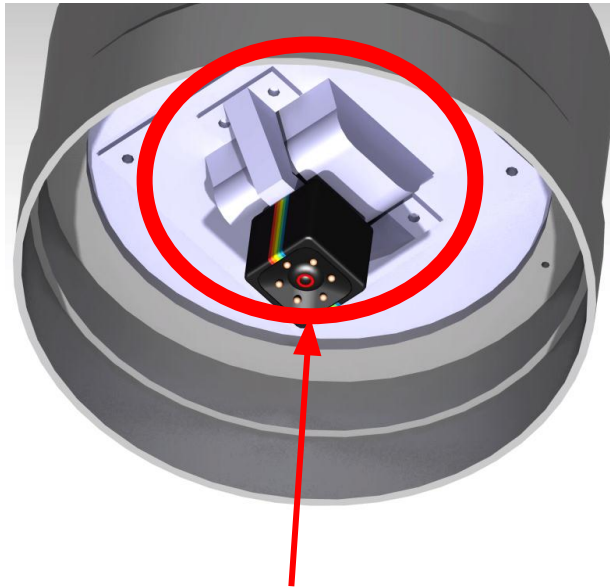
Battery Configuration	Max Discharge Current	Voltage	Max Discharge Power
Single Cell (1S)	10 A	3,7 V	37 W
<b>Two cells in series (2S)</b>	10 A	<b>7,4 V</b>	<b>74W</b>
Two cells in parallel (2P)	20 A	3,7 V	74W

**Selected configuration: Two cells in series (2S)**

### Reasons

- There are major components which require 7,2 V or more (heating resistors and servomotors) for optimal operation.
- We prefer to feed these components directly from the batteries instead of using 1S or 2P and a Step-Up (Boost) converter due to efficiency concerns of these kind of converters and their current limits.
- Step-Down converters perform more efficiently for low current consumption (from 7.4V to 3.3V)

## Battery Mounting and Connection



**Batteries and Battery Holder**

### Battery Mounting

The spot welded cells will be physically placed inside a removable battery case inside the nose cone, enhancing the low vertical position of the *Center of Mass* and allowing the external recharge of the batteries.

### Battery Connection

The cells will spot welded to nickel strips, then a cable is welded to the strip (battery pack still removable).

## Technologies

### Alkaline:

- High discharge current
- Not rechargeable, low voltage

### Li-Ion (selected):

- Higher voltage, high energy density, rechargeable, High discharge current
- More expensive

### Battery charging

We charged the battery taking it out on a charging station with an estimated charging time of 2 hours

### Ni-Mh:

- Rechargeable, cheaper
- Higher self-discharge, low voltage

### Selected: Li-Ion:

- **Highest** energy density (lower weight)
- Rechargeable
- High discharge current



# Payload Power Budget (1/2)



Type	Component	Qty.	Duty Cycle [min]	Duty Cycle [%]	Peak Current [mA]	Voltage [v]	Energy [Wh]	Source
Sensor	LPS22HB	1	120	100.00%	0.012	3.3	0,00010	Datasheet
Sensor	HS3003	1	120	100.00%	0.0244	3.3	0,00020	Datasheet
Sensor	Resistor Divider + ADC Shunt	1	120	100.00%	0.02	3.3	0,00017	Estimated
GPS	Ublox Neo-6M	1	120	100.00%	40	3.3	0,33000	Datasheet
Sensor	BNO055	1	120	100.00%	12.3	3.3	0,10148	Datasheet
Sensor	TFS20-L	2	5	4.17%	130	3.3	0,00012	Datasheet
Clock	DS3231 mini	1	120	100.00%	0.015	3.3	0,08257	Datasheet
Camera	Quelima SQ11	2	5	4.17%	120	3.3	0,31350	Datasheet
MCU	STM32F411	1	120	100.00%	38	3.3	1,94400	Datasheet
Motor	SERVOS	2	3	2.50%	2700	7.2	0,14775	Datasheet
Radio	XBee Transmitting	1	10	8.33%	215	3.3	0,01632	Datasheet
Radio	XBee Idle	1	110	91.67%	2	3.3	0,08938	Datasheet
Heating Resistor	10 Ohm Resistor 1/4W	2	0.042	0.03%	740	7.4	0,00657	Estimated
<b>TOTAL</b>					<b>6947.37</b>		<b>3,03214</b>	

**Note:** the power consumption was calculated **considering 80% efficiency** of the DC/DC buck converter.

**Note:** Stall current was assumed to estimate the servo's consumption.

**Note:** Wh consumption is associated to the total consumption divided by two. Real consumption of the mission equals to Energy [Wh] \* 2h



# Payload Power Budget (2/2)



Power Source: Payload Battery	Energy [Wh]
Total Energy Consumption	3.03
Battery Energy (100% discharge depth)	7.4
Energy Margin	4.37

Discharge Depth	Operating Time [h]
100%	4.88
60%	2.93

Power Source: Beacon Battery	Energy[Wh]
Total Energy Consumption	0.476
Battery Energy (100% discharge depth)	6
Energy Margin	5.524

Discharge Depth	Operating Time [h]
100%	25.21
60%	15.12

Power Source: RTC Battery	Energy[Wh]
Total Energy Consumption (RTC)	0.0012
Battery Energy (100% discharge depth)	0.675
Energy Margin	0.6738

Discharge Depth	Operating Time [h]
100%	1125
60%	675



---

# Flight Software (FSW) Design

**Jaime Nazar Anchorena**



# FSW Overview(1/3)



## • State Overview

**STARTUP**  
Retrieve stored data from memory. If a processor reset took place, skip to the state found in memory.

**LAUNCH PAD**  
Wait for CXON command. When received, take measurements, send telemetry, calibrate altitude, start radio transmission, set UTC time, receive commands from ground, activate GPS and wait for ascent.

**ASCENT**  
Send telemetry, determine flight state based on altitude and receive commands from the ground.

**APOGEE**  
Send telemetry, save maximum altitude, set para-glider and ground cameras to record and receive commands from the ground.

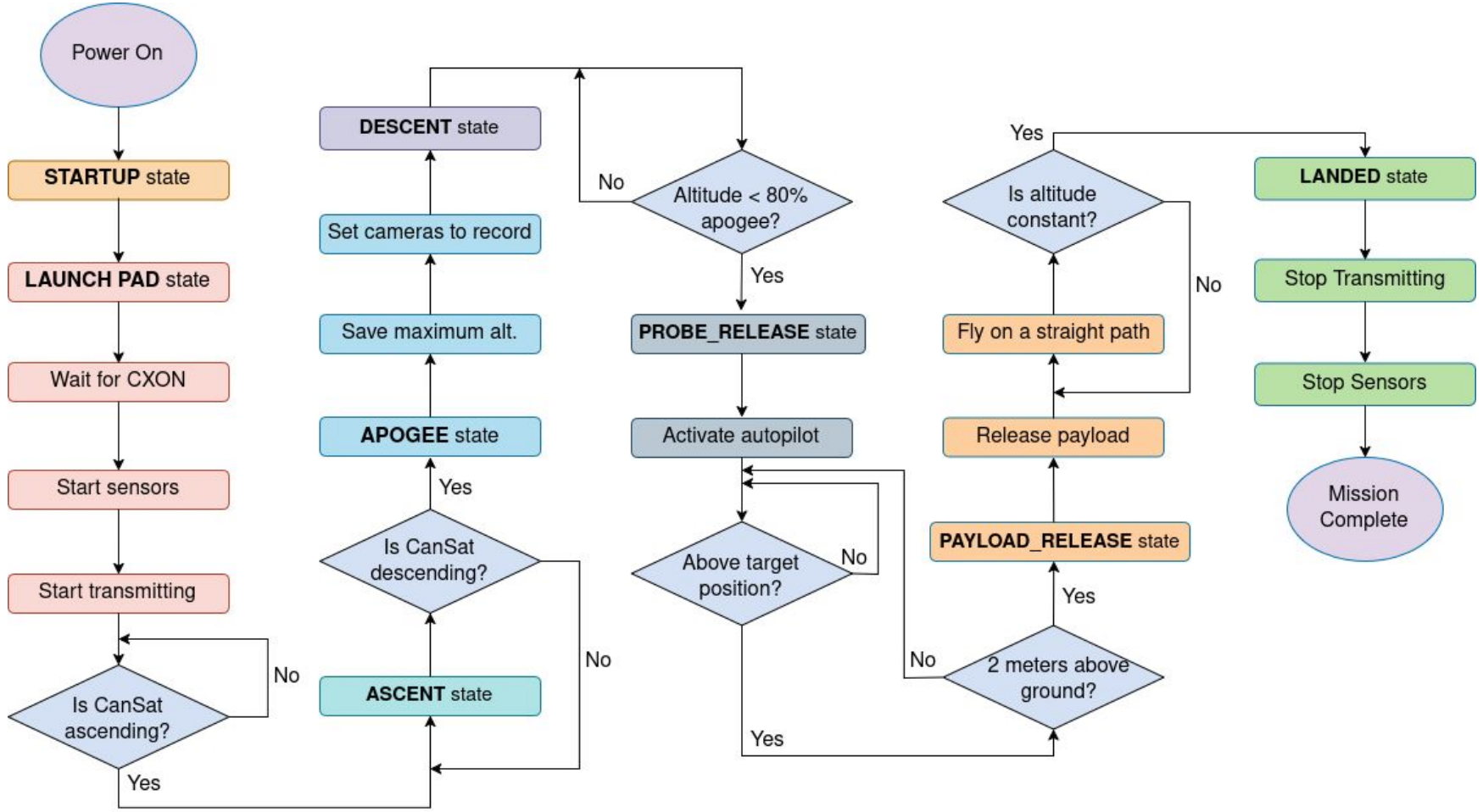
**DESCENT**  
Take measurements and send telemetry, determine flight state based on altitude, receive commands from the ground, wait to reach 80% altitude.

**PROBE\_RELEASE**  
Release probe, take measurements and send telemetry, determine flight state based on altitude, receive commands from the ground, activate the autopilot, wait to be 2 meters above the target location.

**PAYLOAD\_RELEASE**  
Release payload, take measurements and send telemetry, determine flight state based on altitude, receive commands from the ground, continue flight on a straight path.

**LANDED**  
Stop camera recording and deactivate payload telemetry.

## • Basic FSW Architecture





# FSW Overview(3/3)

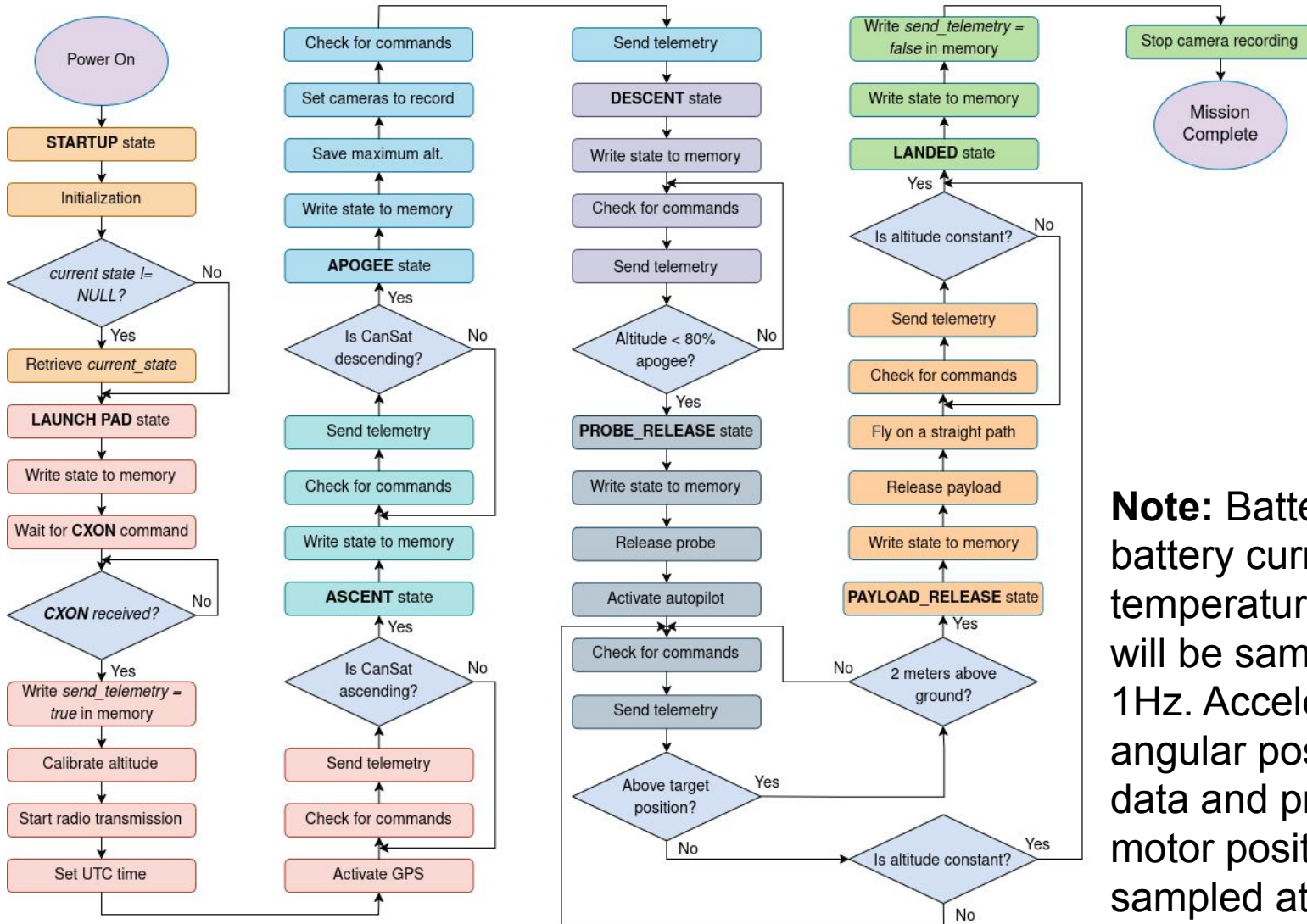


- **FSW Tasks**

- Transmit sensor measurements once per second to the Ground Station
  - Send, receive and process packets via XBEE radios
  - Keep track of mission state (based on altitude data) in case the processor resets
  - Steer CanSat towards the required position
  - Control deployment mechanisms
  - Keep track of mission time through processor resets
  - Operate in simulated flight mode
- 
- Programming language: **C**
  - Development environments: **STM32CubeIDE**

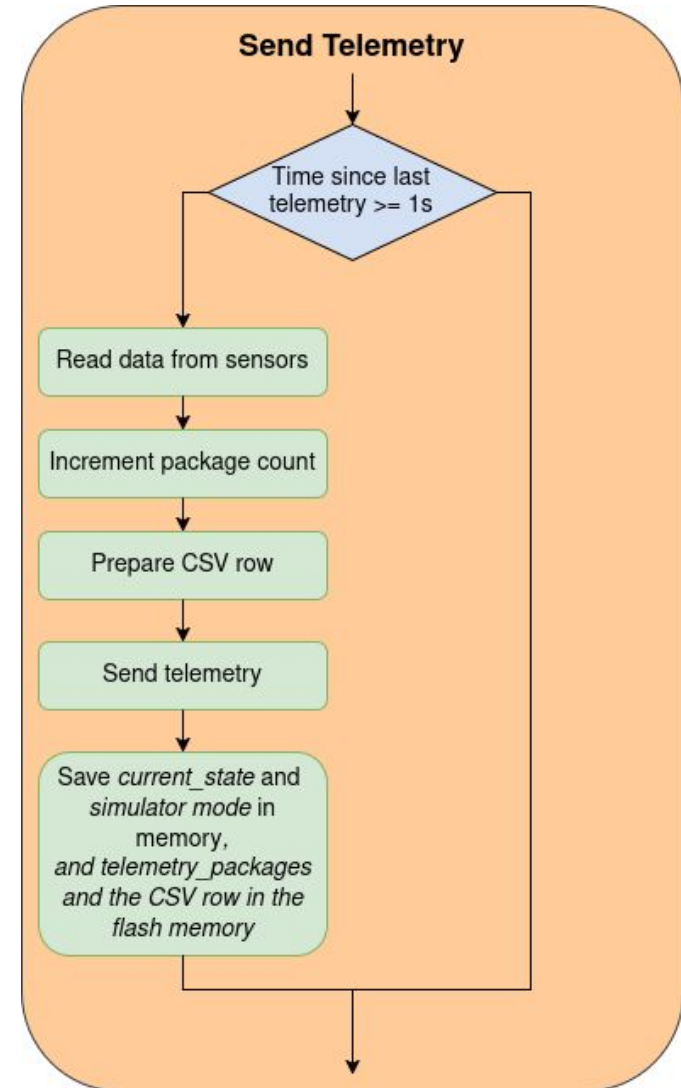
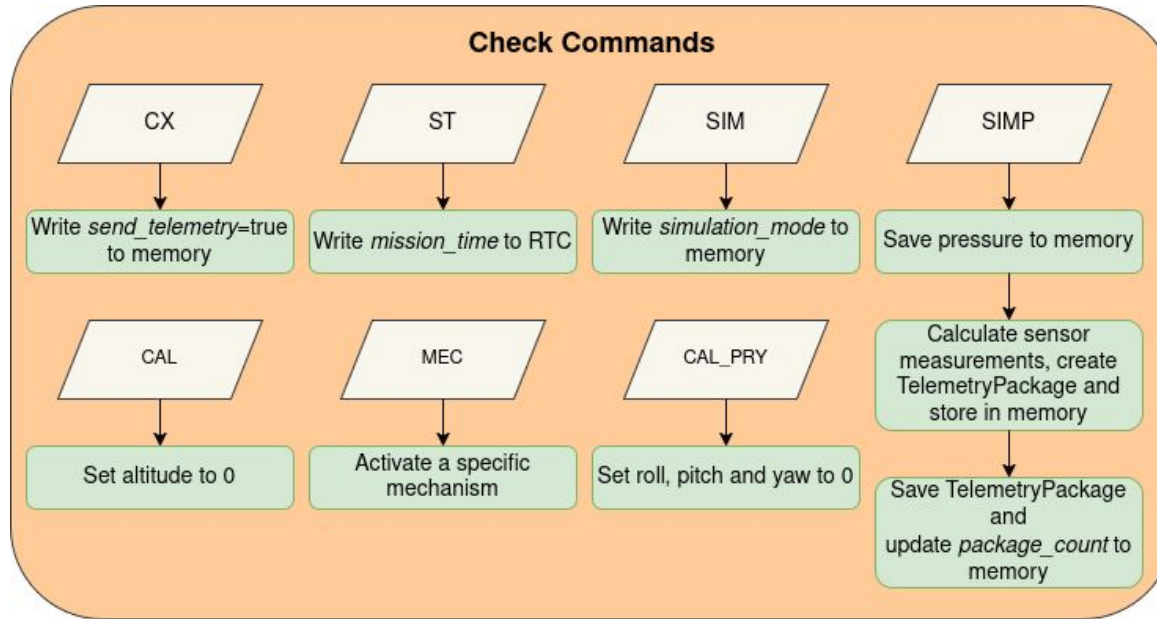


# Payload FSW State Diagram(1/2)



**Note:** Battery voltage, battery current, temperature and time will be sampled at 1Hz. Acceleration, angular position, GPS data and pressure, motor position will be sampled at 100Hz.

# Payload FSW State Diagram(2/2)



In the event of a power loss, the processor would reset. We will store the current state, *send\_telemetry*(boolean), *simulation\_mode*(boolean), the telemetry packages on the memory of the system, and the zero altitude calibration reference, to be retrieved on startup.

We also store in memory the content of each *TelemetryPackage* in case it needs to be sent again.



# Simulation Mode Software(1/2)



- **Simulation Mode**

The Ground Station reads simulated barometric pressure values once per second from a .csv provided by the competition and transmits them via commands to the Cansat. Then, the values are used for calculations of altitude and flight software logic instead of the actual pressure sensor readings.

- **Commands**

- **SIM (Simulation Mode Control):** Sets the current operation mode:
  - **ENABLE:** Enable the simulation mode.
  - **ACTIVATE:** Activates the simulation mode.
  - **DISABLE:** Disables and deactivates the simulation mode.
- **SIMP (Simulated Pressure Data):** Sends simulated barometric pressure values.



## Simulation Mode Software(2/2)



- **Simulated sensor data**
- Flight software activates the simulation mode after receiving SIM ENABLE and SIM ACTIVATE commands
- Once activated, the flight software monitors the radio link for barometric pressure sensor commands (SIMP) sent from the Ground Station
- Received values are used as if they were actual barometric pressure readings in the calculation of altitude, determination software state, and when to release the CanSat.
- Values other than the pressure and altitude (calculated from the pressure values) will be actual sensor readings (e.g., actual battery, temperature, and GPS).



# Software Development Plan(1/4)



- **Prototyping and prototyping environments**
  - All sensors will be tested individually as development progresses.
  - Breadboards and homemade PCB's will be used to create prototype circuits to test software modules. Data obtained will be monitored and evaluated.
- **Test methodology**
  - Pre-existing libraries will be used for unit testing of individual components, as well as integrated tests.



# Software Development Plan(2/4)



- **Naming conventions**

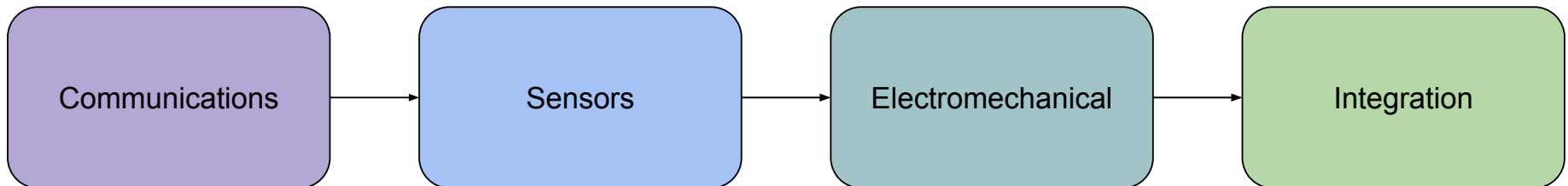
- Snake case for naming files, functions and variables
- Pascal case for naming data structures

- **Constraints**

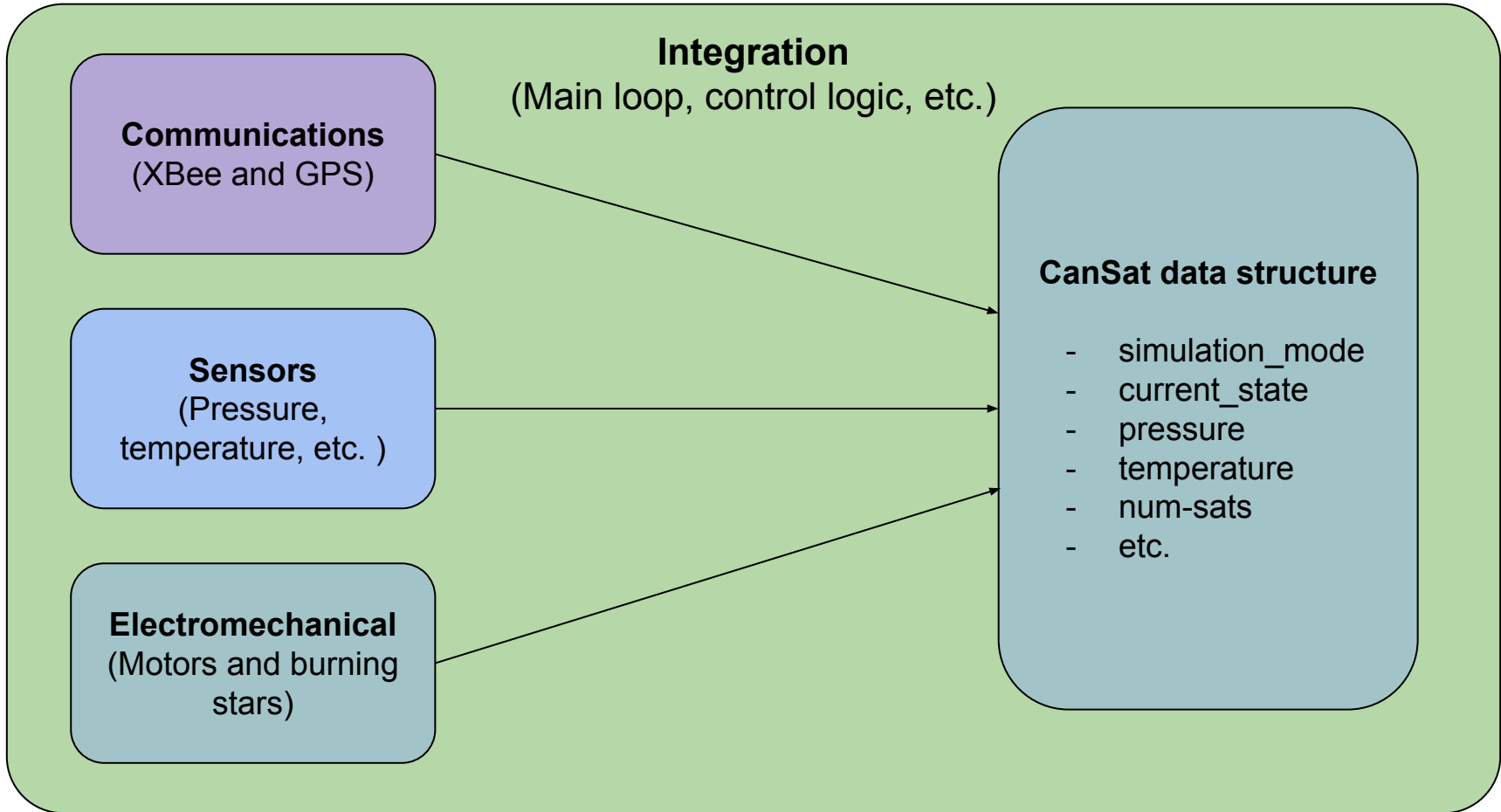
- 512KB of flash memory available for instructions
- Limited to imperative programming
- STM32 not as widely supported compared to Arduino

- **Software subsystem development sequence**

The software will be developed in different modules, to be able to test each module individually and to prioritize reusability.



- **Module structure**





# Software Development Plan(3/4)



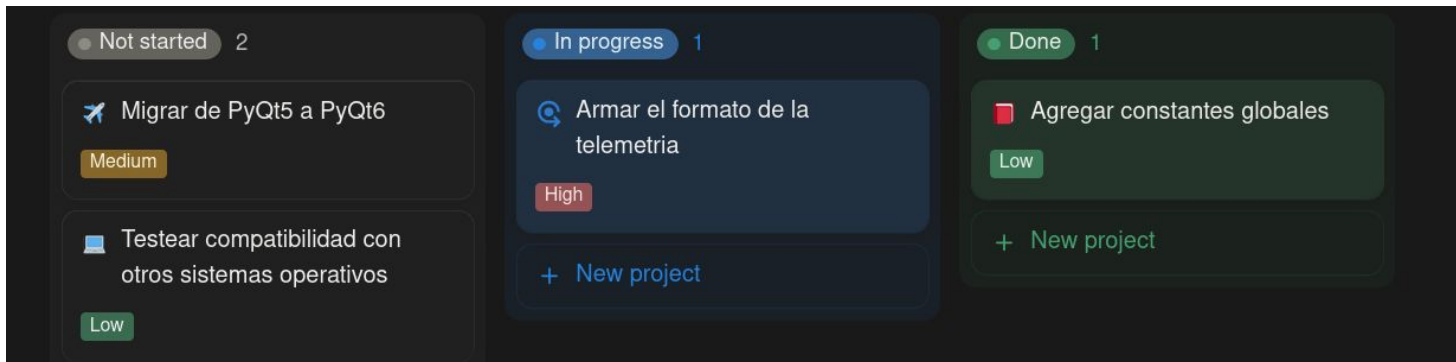
- **Development and testing team**
  - Matteo Ginhson
  - Jaime Nazar Anchorena
  - Nicanor Otamendi
  - Emanuel Agustín Albornoz
  - Juan Manuel Sambucetti
- **Plans to reduce the risk of late software development**
  - Agile methodologies to develop and test software as soon as possible
  - Weekly meetings to track progress and possible problems
  - Use of Github and Notion to organize and set tasks

- **Github**

- We will use Github to be able to collaborate and track changes
- Code can be easily revised and reverted in case of errors.

- **Notion**

- Similar to Jira and Trello, allows collaborators to set and organize tasks, as well as track progress
- We'll use Kanban Boards to visualize the progress





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# Ground Control System (GCS) Design

**Jaime Nazar Anchorena**



Laptop with **GCS**

USB



XBee USB Adapter  
**FT232RL**

Through-Hole  
Mount



XBee  
**PRO S3B**

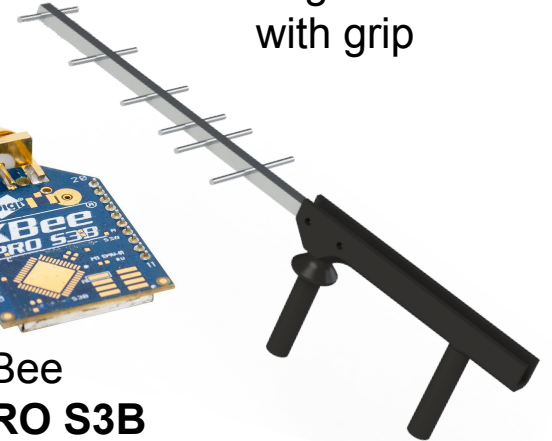
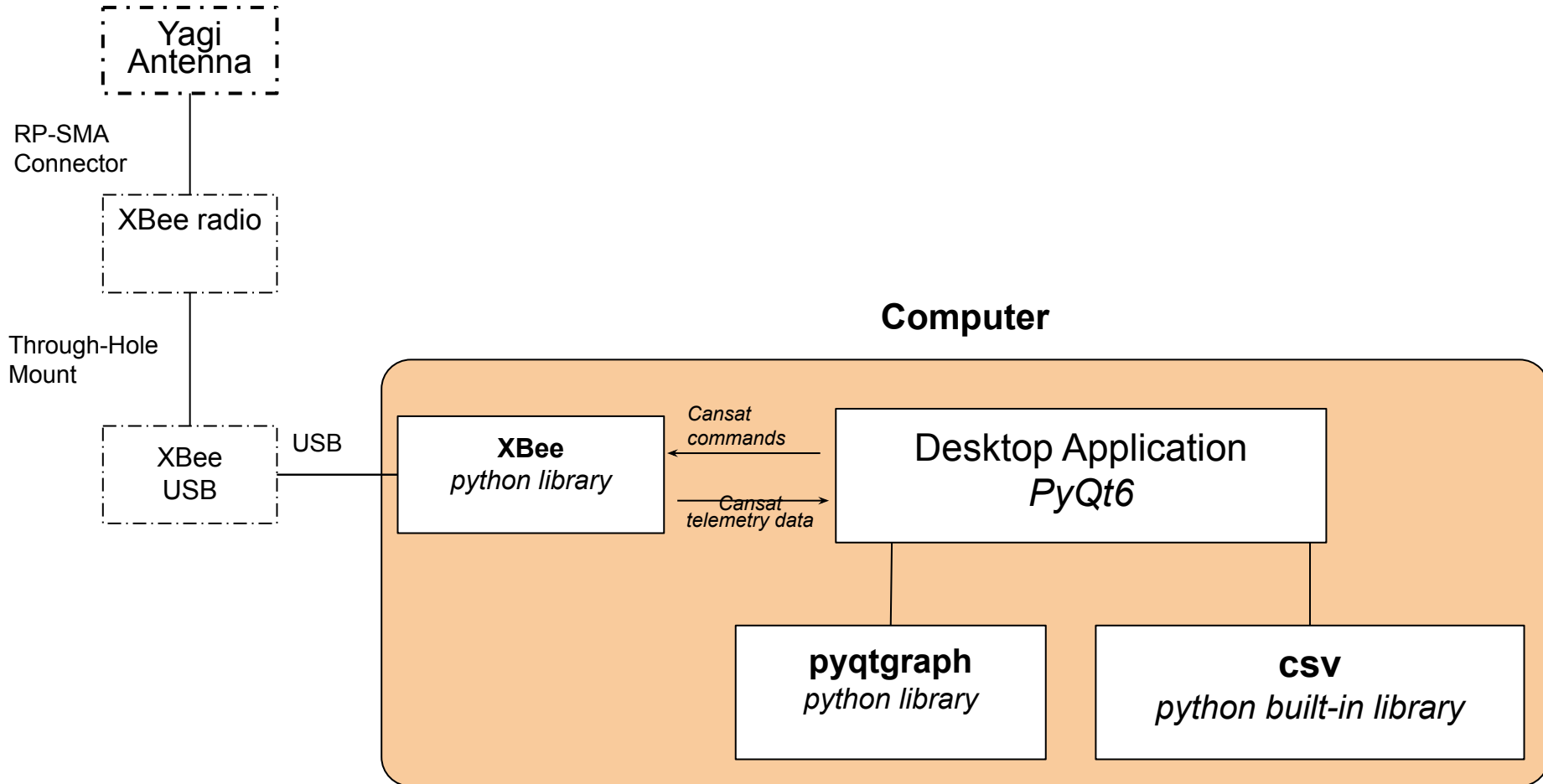


Table-Top  
Yagi Antenna  
with grip

## • Ground Station Diagram





- **Specifications**

- **Battery life**

- The GCS will run on a laptop with an average battery life of 6 hours

- **Overheating mitigation**

- The laptop will be kept in the shade, using a sunshade if necessary

- **Auto update mitigation**

- If running Windows, Windows Updates will be disabled on the laptop

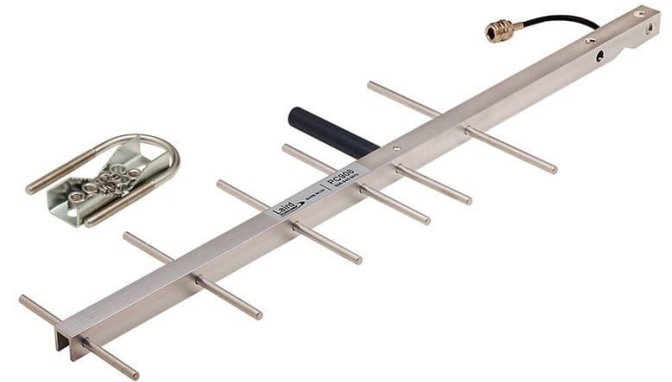
Name	Range [m]	Dimensions [mm]	Gain [dBi]	Weight [gr]	Polarization	Connector type	Price (\$)
YA6900W	30000 Estimated	445x185 (LxW)	8.8	452	Linear	RPSMA	168
<b>A09-Y11NF</b>	<b>&gt;46000 Estimated</b>	<b>635x150 (LxW)</b>	<b>11.1</b>	<b>837</b>	<b>Linear</b>	<b>RPSMA</b>	<b>155</b>

Antenna used for Ground Station to Cansat link

Selected : **A09-Y11NF**

Pros:

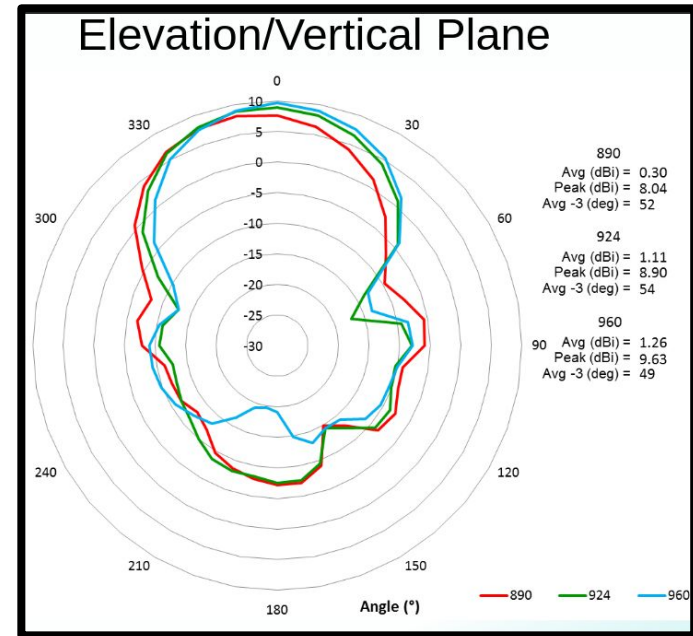
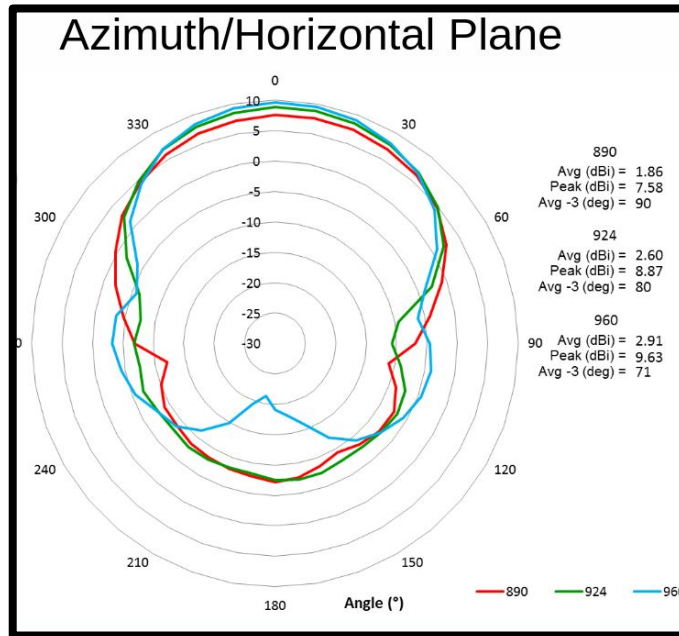
- Large Gain [dBi]
- Long Range: >46000 m (est.)
- Connector type allows us to aim the antenna correctly.
- Robust and Reliable



Mounting:

- Antenna will be aimed to the CanSat.
- The antenna will be mounted into a custom chassis for better aim and handling, directly connected to the XBee and aimed actively aimed towards the CANSAT.

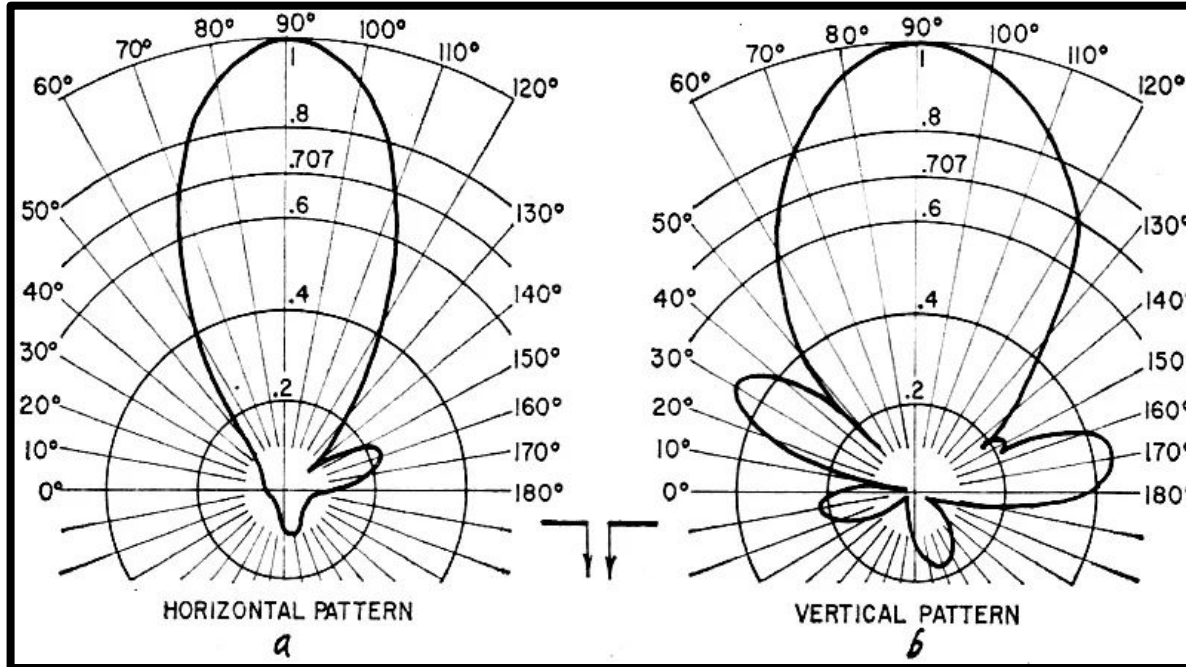
## YA6900W Radiation Patterns



— 890 — 924 — 960

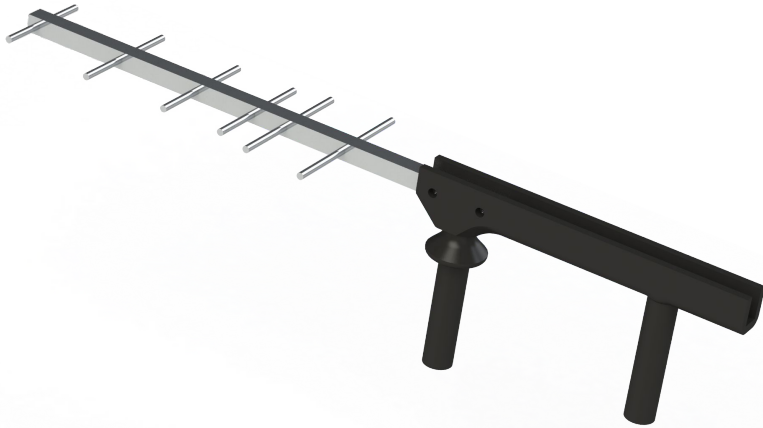
- The patterns shown here can be interpreted as the 2D projection of the whole radiation pattern across all panes.
- H-Plane co-polarization radiation pattern is omnidirectional.

## A09-Y11NF Radiation Patterns



- Long antenna allows for extended range if radio supports it
- The patterns shown here can be interpreted as the 2D projection of the whole radiation pattern across all panes.
- Both H-plane and V-Plane are highly directional with a suitable radial range associated. Highly applicable for CANSAT competition.

## Design A (*Hand-held*)



### Pros & Cons

- Lighter, easy to carry and is less likely to break apart.
- Less comfortable, could lead to fatigue

## Design B (*Table Top*)



### Pros & Cons

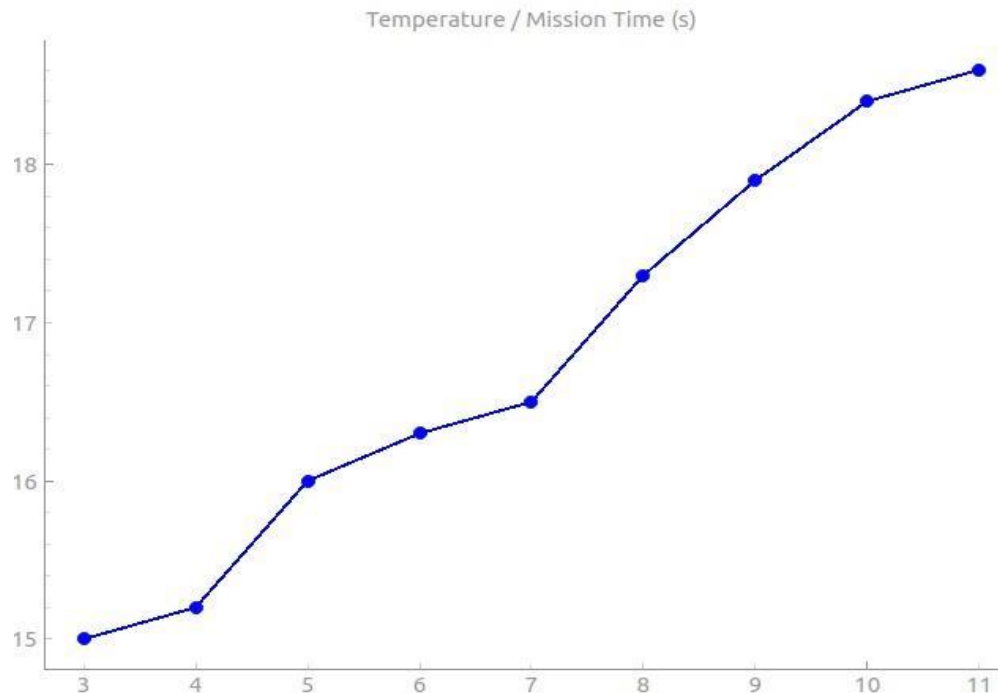
- Robust tripod base, comfortable aim and holding method
- Lower range of mobility

Selection	Rationale
<b>Design A</b> (hand-held)	<ul style="list-style-type: none"> <li>• A customized hand-held mounting for the antenna allows for robust, stable and reliable aiming at the CANSAT. Allows for more precise aiming and faster response times.</li> </ul>

- **Telemetry display prototypes**

Plot using PyQtGraph

The graph will expand as more data is received





# GCS Software(2/8)



- **Commercial off the shelf (COTS) software packages used**
  - **Python3 Desktop Application**
    - Allows for efficient, cross-platform development, and it takes advantage of the team's familiarity with the language.
  - **Python libraries used**
    - **PyQt6**
    - **pyqtgraph**: high performance real-time plots
    - **CSV**: built-in module for file reading and writing
    - **XBee**: Python library for communication with the antenna



# GCS Software(3/8)



- Real-time plotting software design





# GCS Software(4/8)



- **Command software and interface**

Buttons for frequently used commands and command prompt  
Positioned in the top-right corner

The screenshot displays the GCS software interface. On the left, the ITBA logo is shown above flight data: Team: 1234, Time: 00:00:00, Packet Count: 0, Lost Packet Count: 0, Mode: FLIGHT, State: DESCENT, Altitude: 0.0 m, Temperature: 0.0 °C, Pressure: 0.0 Pa, Battery Voltage: 0.0 V, and GPS Position: Alt.: 0.0 m Lat.: 0.000 ° Lon.: 0.000 °. The main panel features a 'Commands' section with buttons for 'Start Telemetry', 'End Telemetry', 'Clear Plot Data', 'Set Time', 'Cal. Altitude', 'Cal. PRY', 'Enable SIM', 'Activate SIM', and 'Deactivate SIM'. Below these is a 'Send Command' input field containing 'CMD,1234, SIM,ENABLE' and a 'Send' button. At the bottom, four data plots are visible: 'Altitude' (0-700), 'Temperature' (0-56), 'Battery voltage' (0-12), and 'Acceleration' (X, Y, Z axes, -9 to 9).

- **Calibration command description**

Before rocket integration, the payload will be kept in a horizontal position using a table and a bubble level meter.

Then, using a black marking in the nose cone and a compass, the payload will be set to point north.



Bubble level

After this preparation, a team member will send the CAL\_PRY command in the GCS software, setting the current position to north and pitch, yaw, and roll to 0.

When the cansat is prepared for launch, a team member will send a CAL command in the GCS software, assigning the current pressure reading from the pressure sensor to altitude 0.



- **Telemetry data recording and media presentation to judges for inspection**

The module `csv` in Python allows us to write content to a CSV file on the system

```
1 import csv
2
3 header = ['TEAM_ID', 'MISSION_TIME', ..., 'CMD_ECHO']
4 csv_file_path = 'Flight_1234.csv'
5 with open(csv_file_path, 'w', newline='') as csv_file: # Creates new CSV file
6     writer = csv.writer(csv_file)
7
8 telemetry = ['2099', '00:01:30', ..., "CXON"]
9 with open(csv_file_path, 'w', newline='') as csv_file:
10     writer = csv.writer(csv_file)
11     writer.writerow(telemetry) # Saves telemetry data to the csv file
12
13 print(f'Telemetry data saved to {csv_file_path}')
```

The file can be transferred to an USB if necessary or used to create more user friendly formats such as graphs



# GCS Software(7/8)



- **Telemetry format\***

TEAM\_ID, MISSION\_TIME, PACKET\_COUNT, MODE, STATE, ALTITUDE, TEMPERATURE, PRESSURE, VOLTAGE, CURRENT, GYRO\_R, GYRO\_P, GYRO\_Y, ACCEL\_R, ACCEL\_P, ACCEL\_Y, GPS\_TIME, GPS\_ALTITUDE, GPS\_LATITUDE, GPS\_LONGITUDE, GPS\_SATS, CMD\_ECHO, **MOTOR\_L**, **MOTOR\_R**

\*Data in bold indicates it isn't part of the required telemetry



- **Simulation mode description**

The user can command the software to send **ACTIVATE**, **ENABLE** and **DISABLE** commands to the container to set the simulation state.

When the commands **SIM ENABLE** and **SIM ACTIVATE** are sent, the ground station will read the provided csv file and send them once per second to the Cansat

The python built-in library `csv` will be used to read the csv file.



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# CanSat Integration and Test

**Nicolás Eyaralar**



# CanSat Integration and Test Overview (1/2)



Subsystem	Test Description
<b>Sensor</b>	<ul style="list-style-type: none"><li>• Individual test of each sensor (Hardware &amp; Software)</li><li>• Integrated sensor subsystem test</li></ul>
<b>CDH</b>	<ul style="list-style-type: none"><li>• Individual test of each component (Hardware &amp; Software)</li><li>• Integrated CDH subsystem test</li></ul>
<b>Mechanical</b>	<ul style="list-style-type: none"><li>• Structural integrity test</li><li>• Mass budget test</li></ul>
<b>EPS</b>	<ul style="list-style-type: none"><li>• Measurement of real energy consumption</li><li>• Measurement of batteries real capacity</li><li>• Integrated EP subsystem test</li></ul>
<b>Radio Communications</b>	<ul style="list-style-type: none"><li>• Individual test of each receiver/emitter (Hardware &amp; Software)</li><li>• Range test (Antenna + XBee)</li></ul>
<b>FSW</b>	<ul style="list-style-type: none"><li>• Ensure data saving</li><li>• Verification of subsystems</li><li>• Verification of all software states</li><li>• Testing of simulation mode</li></ul>
<b>Descent Control</b>	<ul style="list-style-type: none"><li>• Opening forces on the glider's line attachment</li><li>• Integrated Descent Control subsystem test</li><li>• Rotation stability test</li></ul>



# CanSat Integration and Test Overview (2/2)



Test Plan	Test Description
<b>Integrated Level Functional Test Plans</b>	<ul style="list-style-type: none"><li>• Descent test</li><li>• Communications test</li><li>• Mechanisms test</li><li>• Deployment test</li></ul>
<b>Environmental Test Plans</b>	<ul style="list-style-type: none"><li>• Drop test</li><li>• Thermal test</li><li>• Vibration test</li><li>• Fit check</li><li>• Vacuum test</li></ul>
<b>Simulation Test Plans</b>	<ul style="list-style-type: none"><li>• Simulation mode sensors test</li><li>• Simulation mode communications test</li><li>• Simulation mode software test</li></ul>



# Subsystem Level Testing Plan (1/2)



Test Plan	Test Description
<b>Sensors</b>	<ul style="list-style-type: none"><li>• Testing environments will be developed in order to simulate real scenarios and check each sensor functionality</li><li>• All sensor will be connected to a development board via breadboard to check connections and simultaneous functionality</li><li>• Readings will be checked with standards for further calibration</li></ul>
<b>CDH</b>	<ul style="list-style-type: none"><li>• Communication will be tested individually for every XBee module and antenna used, in order to check connections, different scenarios and adapter module functionality</li></ul>
<b>Mechanical</b>	<ul style="list-style-type: none"><li>• Mass Budget Test</li><li>• Cansat Structural integrity, verify the Subsystems resist the forces required</li><li>• Verify the Release resistance mechanism reliability</li><li>• Verify all subsystem functions separately: Parachute deployment, Payload release, egg instrument release.</li></ul>
<b>Descent Control</b>	<ul style="list-style-type: none"><li>• The electric part of the descent control subsystem will be tested before integration with the Container</li><li>• The capability of the payload to stabilize itself and the camera will be tested by inducing external rotation.</li></ul>



# Subsystem Level Testing Plan (2/2)



Test Plan	Test Description
<b>EPS</b>	<ul style="list-style-type: none"><li>• The real energy consumption of the Cansat will be measured with a multimeter in different controlled environments and load conditions</li><li>• Batteries real capacity will be tested in different controlled environments with a battery capacity indicator</li><li>• The system will be tested when already integrated in the Cansat by checking Cansat's battery life</li><li>• Max current drain will be tested in a simulated flight</li><li>• Max temperature of component's package will be measured</li></ul>
<b>Radio Communications</b>	<ul style="list-style-type: none"><li>• Every XBee will be connected to a development board to ensure correct functionality.</li><li>• Cansat-GS communication will be tested in an open field in a 2 Km range</li></ul>
<b>FSW</b>	<ul style="list-style-type: none"><li>• Ensure saving data in case of processor reset</li><li>• Verification of subsystems such as release mechanisms and communications</li><li>• Verification of all software states</li><li>• Testing of simulation mode</li></ul>



# Integrated Level Functional Test Plan



Test Plan	Test Description
<b>Descent</b>	<ul style="list-style-type: none"><li>• A container and payload equivalent will be dropped from a drone to verify descent rate with the parachute and then will do the same with the para-glider.</li></ul>
<b>Communications</b>	<ul style="list-style-type: none"><li>• Communication range will be tested using a testing mode on the FSW Communication Module.</li><li>• Signal blocking will be tested using different materials to cover the radios.</li><li>• Different orientations and moving conditions of the payload will be tested to ensure a robust communication in any kind of situation or context scenario</li></ul>
<b>Mechanisms</b>	<ul style="list-style-type: none"><li>• Simultaneous TX Comms and release resistances activation will be tested to ensure the battery can provide sufficient power with all mechanisms working as expected</li></ul>
<b>Deployment</b>	<ul style="list-style-type: none"><li>• Parachute and para-glider deployment will be tested using simulation mode with the cansat stationary.</li><li>• Parachute and para-glider deployment will be tested using simulation mode in conjunction with a descent test.</li></ul>



# Environmental Test Plan (1/2)



Test Plan	Test Description
<b>Drop Test</b>	<ul style="list-style-type: none"><li>• 61 cm non-stretching cord is attached to a fixed point in the ceiling and to the parachute</li><li>• CanSat is raised to the ceiling and released</li><li>• A mattress is placed under the CanSat in case of a structural damage on the joints.</li></ul>
<b>Thermal Test</b>	<ul style="list-style-type: none"><li>• An electric oven (thermal chamber) with the CanSat inside will be heated up to around 60 degrees Celsius for 2 hours to test if temperature affects the proper working of the CanSat with ongoing communications.</li></ul>
<b>Vibration Test</b>	<ul style="list-style-type: none"><li>• A orbital sander provided by the university is used to simulate vibration on the CanSat for 5s five times.</li><li>• The purpose of this vibration is to check that all components and structural joints stay fixed and working.</li><li>• Telemetry and proper working of the sensors are to be controlled during the test.</li></ul>



# Environmental Test Plan (2/2)



Test Plan	Test Description
<b>Fit Check</b>	<ul style="list-style-type: none"><li>• The CanSat is inserted in the open section of the payload to make sure all components fit inside the way they are supposed to.</li></ul>
<b>Vacuum Test</b>	<ul style="list-style-type: none"><li>• The CanSat is placed in a closed box with a hole prepared to insert the hose of a vacuum cleaner to remove the air.</li><li>• Once a vacuum starts forming the pressure sensor is used to measure the simulated altitude.</li><li>• When peak altitude is reached the hose will be removed and the air will be let back in slowly.</li></ul>



# Simulation Test Plan



Test Plan	Test Description
<b>What parts of the CanSat get tested during simulation?</b>	The simulation validates the performance of all software components and the communication link with the Ground Station. Furthermore, every onboard sensor is tested during this phase, with the specific exclusion of the LiDar.
<b>How is the simulation implemented?</b>	When simulation mode is active, the CanSat software behaves precisely as it does during normal operations. The only deviation is that physical barometer data is bypassed; instead, the system processes pressure values received directly from the ground via radio communication (FSW Simulation Mode set by the GCS).



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# Mission Operations & Analysis

**Nicolás Eyaralar**



# Overview of Mission Sequence of Events (1/2)



## Arrival to Launch Site

### PHASE 1

#### Basic Configuration

#### Check In

#### Pre Launch Preparations

- Prepare Cansat for turn-in
- Final CanSat tests
- Teams present fully integrated CanSat at the check-in station.

- Prepare antennas and set up the ground station
- Verify CanSat is communicating with the ground station
- Power on CanSat and place it in the rocket
- Transport launch vehicle to the pad and await rail integration.

### PHASE 2

#### Flight

#### Launch

#### Recovery and Post-Flight

- CanSats must be flight-ready, only power switch actuation is allowed
- The mission control officer executes launch procedures at the control table, overseen by the flight coordinator
- Ground station crew performs all required flight operations
- Once the flight is complete, the team recovery crew will wait until cleared to enter the field

- Following the launch of all CanSats, the recovery crew will proceed to retrieve the payload and verify the structural integrity of the Egg.
- Ground station crew clears the area and submits a thumb drive with data to the ground station judge
- The recovery crew will return to check-in for any final judgment requirements



# Overview of Mission Sequence of Events (2/2)



Position	Tasks	Members
<b>Mission Control Officer</b>	<ul style="list-style-type: none"><li>● Manages the Team Launch</li><li>● Verifies that everything is ready with The Ground Station Crew</li><li>● Executes the launch procedure with flight coordinator oversight</li></ul>	<ul style="list-style-type: none"><li>● Nicolás Eyaralar</li></ul>
<b>Ground Station Crew</b>	<ul style="list-style-type: none"><li>● Monitor the ground station for telemetry reception</li><li>● Issue commands to the CanSat.</li><li>● Performs all required flight operations</li></ul>	<ul style="list-style-type: none"><li>● Matteo Ginhson</li><li>● Emanuel Agustin Albornoz</li><li>● Jaime Nazar Anchorena</li></ul>
<b>Recovery Crew</b>	<ul style="list-style-type: none"><li>● Track and recover the CanSat</li><li>● Interact with field judges</li><li>● Make sure all field scores are filled in</li></ul>	<ul style="list-style-type: none"><li>● Federico Agustín Pilotto</li><li>● Ignacio Ferrando Bravo</li><li>● Nicanor Otamendi</li></ul>
<b>CanSat Crew</b>	<ul style="list-style-type: none"><li>● Prepare the CanSat and integrate it into the rocket</li><li>● Verifying status before launching</li></ul>	<ul style="list-style-type: none"><li>● Clara Müller</li><li>● Nazareno German Pierri</li><li>● Juan Manuel Sambucetti</li></ul>



# Mission Operations Manual Development Plan



Mission Operation Manual	Content
<b>Configuration of The Ground Station</b>	<ul style="list-style-type: none"><li>● Ground Station assembly</li><li>● Antenna assembly</li><li>● Monitor the ground station for telemetry reception</li><li>● Issue commands to the CanSat.</li></ul>
<b>CanSat Preparation</b>	<ul style="list-style-type: none"><li>● Check status of all mechanism</li><li>● CanSat General Inspection</li></ul>
<b>CanSat Integration into Rocket</b>	<ul style="list-style-type: none"><li>● Final clearance Inspection</li><li>● Mounting CanSat into Rocket</li></ul>
<b>Launch Preparation and Launch Procedure</b>	<ul style="list-style-type: none"><li>● Documents are provided by CanSat Competition</li></ul>
<b>Recovery procedure</b>	<ul style="list-style-type: none"><li>● Document is provided by CanSat Competition</li><li>● Finding the CanSat</li></ul>



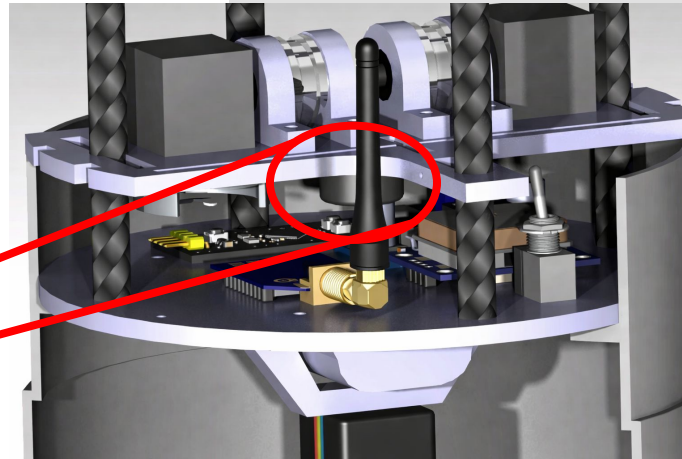
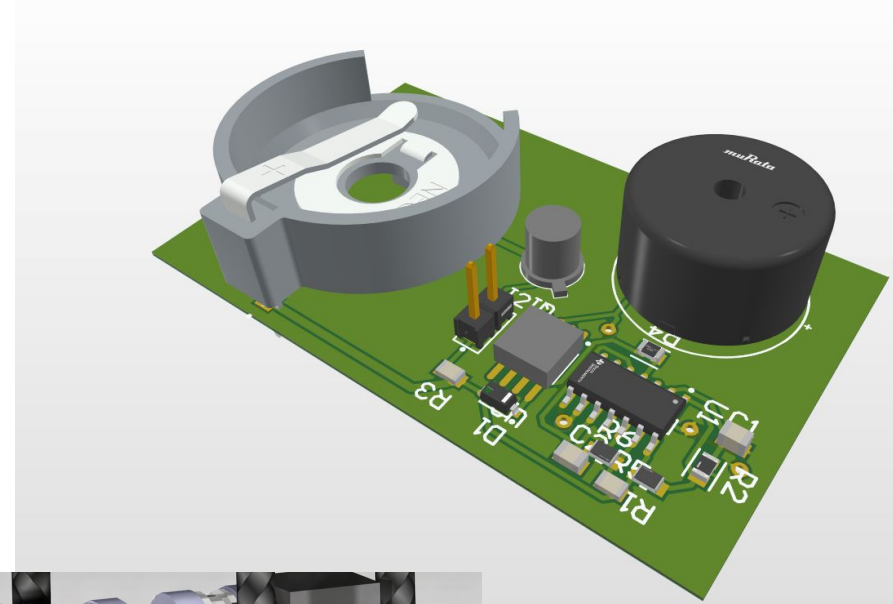
# CanSat Location and Recovery



## CanSat Recovery

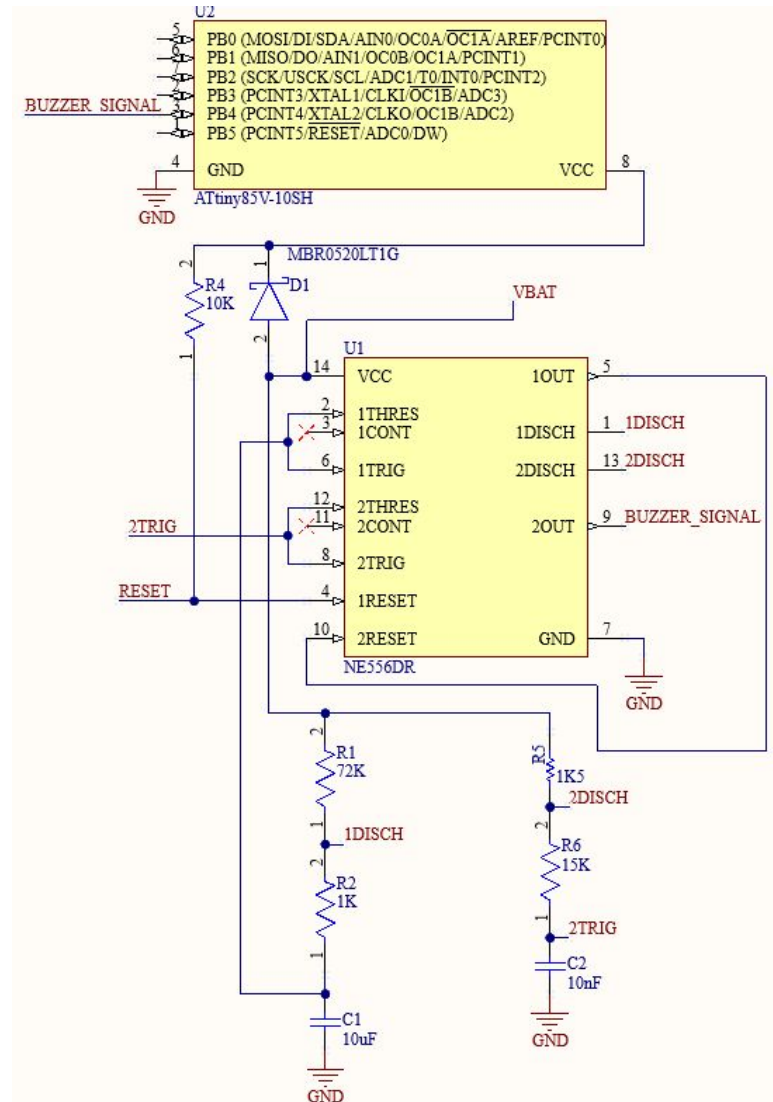
- GPS location will be used to assist CanSat recovery
- Cansat will have a loud audio beacon
- Cansat will have contact and return information printed on the exterior
- Payload will have distinctive colours to make it easy to recognise in the drop zone
- Container will have reflective adhesive to make it easy to find

- The design provides two ways to drive the buzzer (main through ATTiny85, failsafe using a 556 dual timer)
- The beacon signal is enabled by default as long as the battery is connected, but can be disabled through a one way DIP switch for transport.
- Two CR2477 coin cells feed this circuit.
- The board will be installed where the red circle indicates.



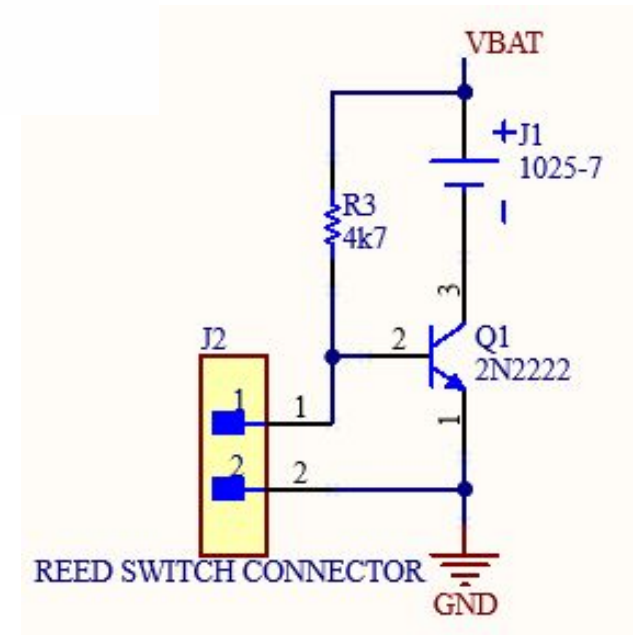
The main way to drive the buzzer is through an ATTiny85, which in normal operation will also hold the master timer in RESET state.

In case of a software crash or freeze, the ATTiny's internal watchdog works together with a software lock to pull the RESET pin high through R4. This sends a 50% D.C. 1Hz modulated signal to the buzzer.



The beacon is activated by installing the battery, and is only disabled by bridging pins 1 and 2 in J2, as shown in the schematic. A DIP switch will be installed remotely, near the body of the CanSat, so that the beacon can be silenced through a hole in the container.

The intention with this design is to make sure that the beacon will fail ON in as many scenarios as possible, as the device will still function if the DIP switch fails or physically breaks from impact.



Two CR2477 batteries will be used in series, to provide a nominal 6V to the circuit.

The combination of the two cells gives an approximate capacity of 6Wh, well over the energy demands that the beacon has.

The expected worst-case scenario is for a runtime of a full hour.





# CanSat Beacon Design (5/5) (Battery)



## Estimated energy consumption (120 minute runtime)

The voltage used for all calculations was 5.5V DC.

Component	Expected power draw (mW)	Expected energy consumption (mWh)
NE555 timer IC	22	44
ATTiny85	66	132
Piezo buzzer (PKM22EPPH4012-B0) (50% Duty Cycle)	6	12
Misc. circuitry resistors	25	50
<b>TOTAL</b>	<b>119</b>	<b>238</b>

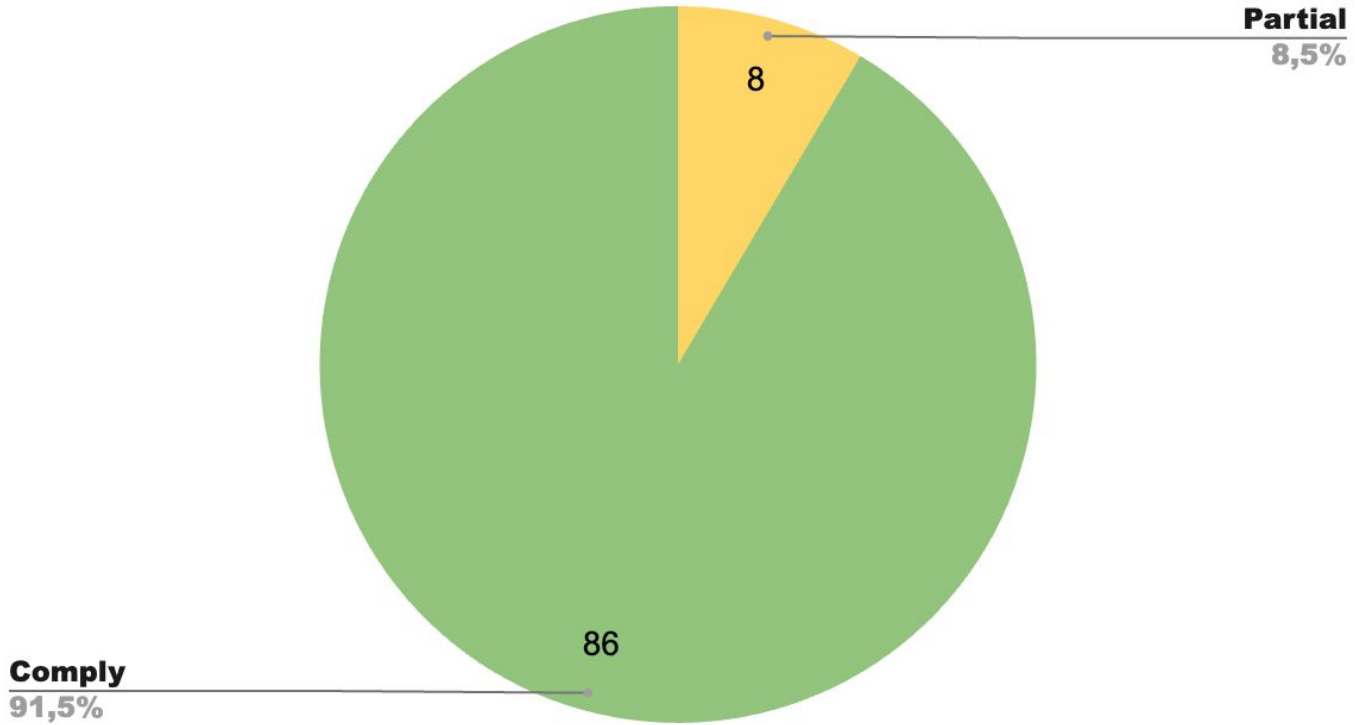
Runtime: Including a 2x safety factor, the calculated runtime of the beacon is over 25 hours (6Wh/0.238W).



# Requirements Compliance

**Nicolás Eyaralar**

## Requirements Compliance of PDR





# Requirements Compliance (1/10)



#	Code	Requirement	Status	Slide Ref.	Comments
1	C1	The Cansat payload shall function as a nose cone during the rocket ascent portion of the flight.	<b>Comply</b>	<a href="#">16</a> , <a href="#">20</a> , <a href="#">34</a>	
2	C2	The Cansat container shall be mounted on top of the rocket with the shoulder section inserted into the airframe.	<b>Comply</b>	<a href="#">16</a> , <a href="#">20</a> , <a href="#">34</a>	
3	C3	The Cansat payload and container shall be deployed from the rocket when the rocket motor ejection charge fires.	<b>Comply</b>	<a href="#">34</a>	
4	C4	After deployment, the Cansat payload and container shall descend at 15 meters/second using a parachute that automatically deploys. Error is +/- 3 m/s.	<b>Partial</b>	<a href="#">41</a> , <a href="#">42</a> , <a href="#">43</a>	Theoretically complies, further testing needed.
5	C5	At 80% flight peak altitude, the payload shall be released from the container.	<b>Comply</b>	<a href="#">33</a> , <a href="#">34</a> , <a href="#">59</a> , <a href="#">64</a>	
6	C6	At 80% peak altitude, the payload shall deploy a para-glider descent control system.	<b>Comply</b>	<a href="#">33</a> , <a href="#">34</a> , <a href="#">61</a>	
7	C7	The payload shall descend at 5 meters/second averaged over the entire descent within +/- 3 meters/sec with the para-glider descent control system.	<b>Partial</b>	<a href="#">41</a> , <a href="#">42</a> , <a href="#">43</a>	Theoretically complies, further testing needed.
8	C8	The payload shall steer toward a target location.	<b>Partial</b>	<a href="#">34</a> , <a href="#">37</a>	Theoretically complies, further testing needed.
9	C9	The sensor telemetry shall be transmitted at a 1 Hz rate.	<b>Comply</b>	<a href="#">95</a> , <a href="#">101</a> , <a href="#">102</a>	



# Requirements Compliance (2/10)



#	Code	Requirement	Status	Slide Ref.	Comments
10	C10	The payload shall record video of the release of the payload from the container and the deployment of the para-glider descent control system.	<b>Comply</b>	<a href="#">72</a>	
11	C11	A second video camera shall point at the ground.	<b>Comply</b>	<a href="#">75</a>	
12	C12	The payload shall release a protected hens egg when the payload is 2 meters +/- 0.5 m above the ground without breaking the egg.	<b>Partial</b>	<a href="#">33,34</a> , <a href="#">78,81</a>	Theoretically complies, further testing needed.
13	C13	The Cansat payload shall include an audible beacon that is turned on separately and is independent of the Cansat battery and electronics.	<b>Comply</b>	<a href="#">160</a> , <a href="#">161</a> , <a href="#">162</a>	
14	C14	Cost of the Cansat shall be under \$1000. Ground support and analysis tools are not included in the cost of the Cansat. Equipment from previous years shall be included in this cost, based on current market value.	<b>Comply</b>		
16	S1	The Cansat and container mass shall be 1000 grams +/- 10 grams.	<b>Comply</b>	<a href="#">93</a>	
17	S2	The nose cone shall be symmetrical along the thrust axis.	<b>Comply</b>	<a href="#">56,57</a>	
18	S3	Nose cone radius shall be exactly 70 mm	<b>Comply</b>	<a href="#">57</a>	
19	S4	Nose cone shoulder length shall be a minimum of 50 mm	<b>Comply</b>	<a href="#">15</a> , <a href="#">57</a>	



# Requirements Compliance (3/10)



#	Code	Requirement	Status	Slide Ref.	Comments
20	S5	The nose cone shall be made as a single piece. Segments are not allowed.	Comply	<a href="#">10</a> , <a href="#">15</a> , <a href="#">18</a> , <a href="#">51</a> , <a href="#">56</a>	
21	S6	The nose cone shall not have any openings allowing air flow to enter.	Comply	<a href="#">10</a> , <a href="#">15</a> , <a href="#">18</a> , <a href="#">51</a> , <a href="#">56</a>	
22	S7	The nose cone height shall be a minimum of 76 mm.	Comply	<a href="#">15</a> , <a href="#">57</a>	
23	S8	Cansat structure must survive 15 Gs vibration	Partial	<a href="#">151</a>	Theoretically complies, further testing needed.
24	S9	Cansat shall survive 30 G shock.	Partial	<a href="#">151</a>	Theoretically complies, further testing needed.
25	S10	The container shoulder length shall be 90 to 120 mm.	Comply	<a href="#">62</a>	
26	S11	The container shoulder diameter shall be 136 mm.	Comply	<a href="#">16</a> , <a href="#">20</a> , <a href="#">62</a>	
27	S12	Above the shoulder, the container diameter shall be 140 mm	Comply	<a href="#">16</a> , <a href="#">20</a> , <a href="#">62</a>	
28	S13	The container wall thickness shall be at least 2 mm when 3D printed and must not flex or be deformed when under stress.	Comply	<a href="#">62</a>	
29	S14	The container length above the shoulder shall be 200 mm +/- 5%.	Comply	<a href="#">16</a> , <a href="#">20</a> , <a href="#">62</a>	
30	S15	The Cansat shall perform the function of the nose cone during rocket ascent.	Comply	<a href="#">20</a> , <a href="#">34</a>	



# Requirements Compliance (4/10)



#	Code	Requirement	Status	Slide Ref.	Comments
31	S16	The Cansat container can be used to restrain any deployable parts of the Cansat payload but shall allow the Cansat to slide out of the payload section freely.	Comply	<a href="#">20</a> , <a href="#">67</a> , <a href="#">69</a>	
32	S17	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	<a href="#">84</a>	
33	S18	The Cansat container shall meet all dimensions in section F.	Comply	<a href="#">20</a> , <a href="#">16</a> , <a href="#">62</a>	
34	S19	The Cansat container materials shall meet all requirements in section F.	Comply	<a href="#">48</a>	
35	S20	If the nose cone is to separate from the payload after payload deployment, the nose cone shall descend at no more than 5 meters/sec.	Comply	<a href="#">81</a>	
36	S21	If the nose cone is to separate from the payload after payload deployment, the nose cone shall be secured to the payload until payload deployment with a pull force to survive at least 15 Gs acceleration.	Partial	<a href="#">81</a> , <a href="#">151</a>	Theoretically complies, further testing needed.
38	M1	No pyrotechnical or chemical actuators are allowed.	Comply	<a href="#">47</a>	
39	M2	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting the vegetation on fire.	Comply	<a href="#">85</a>	



# Requirements Compliance (5/10)



#	Code	Requirement	Status	Slide Ref.	Comments
40	M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Partial	<a href="#">37,64,78,81</a>	Theoretically complies, further testing needed.
41	M4	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	<a href="#">86</a>	No connection will be made using connectors other than the ones shown in this slide
43	E1	Lithium polymer batteries are not allowed.	Comply	<a href="#">111, 113</a>	
44	E2	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	Comply	<a href="#">111, 113</a>	
45	E3	An easily accessible power switch through the container is required.	Comply	<a href="#">110</a>	
46	E4	The container shall have small access holes for power switches of no more than 10 mm.	Comply	<a href="#">110</a>	
47	E5	Power indicator is required.	Comply	<a href="#">110</a>	
48	E6	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	Comply	<a href="#">114, 115</a>	
49	E7	The audio beacon shall operate on a separate battery.	Comply	<a href="#">162</a>	



# Requirements Compliance (6/10)



#	Code	Requirement	Status	Slide Ref.	Comments
50	E8	The audio beacon shall have an easily accessible power switch through the container.	<b>Comply</b>	<a href="#">161</a>	
52	X1	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	<b>Comply</b>	<a href="#">101</a>	
53	X2	XBEE radios shall have their NETID/PANID set to their team number.	<b>Comply</b>	<a href="#">95,101</a>	
54	X3	XBEE radios shall not use broadcast mode.	<b>Comply</b>	<a href="#">95,101</a>	
55	X4	The Cansat shall transmit telemetry once per second.	<b>Comply</b>	<a href="#">95,101,102</a>	
56	X5	The Cansat telemetry shall include altitude, air pressure, temperature, battery voltage, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	<b>Comply</b>	<a href="#">103,104,105,106</a>	
58	SN1	Cansat payload shall measure its altitude using air pressure.	<b>Comply</b>	<a href="#">22, 23</a>	
59	SN2	Cansat payload shall measure its internal temperature.	<b>Comply</b>	<a href="#">22, 24</a>	
60	SN3	Cansat payload shall measure its battery voltage.	<b>Comply</b>	<a href="#">22, 25</a>	
61	SN4	Cansat payload shall track its position using GPS.	<b>Comply</b>	<a href="#">22, 26</a>	



# Requirements Compliance (7/10)



#	Code	Requirement	Status	Slide Ref.	Comments
62	SN5	Cansat payload shall measure its acceleration and rotation rates.	<b>Comply</b>	<a href="#">22</a> , <a href="#">27</a> , <a href="#">28</a>	
63	SN6	Cansat payload shall video record the deployment of the para-glider at 80% peak altitude.	<b>Comply</b>	<a href="#">117</a> , <a href="#">118</a> , <a href="#">120</a>	
64	SN7	Cansat payload shall video record the ground during descent.	<b>Comply</b>	<a href="#">75</a>	
65	SN8	The ground pointing camera shall capture video of the instrument (egg) being released and reaching the ground.	<b>Comply</b>	<a href="#">75</a>	
66	SN9	The video cameras shall record video in color and with a minimum resolution of 640x480.	<b>Comply</b>	<a href="#">29</a> , <a href="#">31</a>	
67	SN10	Cansat payload shall measure its battery current.	<b>Comply</b>	<a href="#">22</a> , <a href="#">25</a>	
69	G1	The ground station shall command the Cansat to calibrate the altitude to zero when the Cansat is on the launch pad prior to launch.	<b>Comply</b>	<a href="#">107</a> , <a href="#">121</a> , <a href="#">140</a> , <a href="#">141</a>	
70	G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	<b>Comply</b>	<a href="#">131</a> , <a href="#">142</a>	
71	G3	Telemetry shall include mission time with 1 second resolution.	<b>Comply</b>	<a href="#">102</a> , <a href="#">120</a>	
72	G4	Each team shall develop their own ground station.	<b>Comply</b>	<a href="#">139</a>	



# Requirements Compliance (8/10)



#	Code	Requirement	Status	Slide Ref.	Comments
73	G5	All telemetry shall be displayed in real time in text format during ascent and descent on the ground station.	<b>Comply</b>	<a href="#">139</a>	
74	G6	All telemetry shall be displayed in the International System of Units (SI) and the units shall be indicated on the displays.	<b>Comply</b>	<a href="#">103</a> , <a href="#">104</a> , <a href="#">105</a> , <a href="#">139</a>	
75	G7	Teams shall plot altitude, battery voltage, battery current, accelerometer value and rotation rates in real time.	<b>Comply</b>	<a href="#">138</a> , <a href="#">139</a>	
76	G8	Teams shall display mission time, temperature, GPS position, received packet count, lost packet count, and flight software state in real time.	<b>Comply</b>	<a href="#">139</a>	
77	G9	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and an antenna.	<b>Comply</b>	<a href="#">130</a> , <a href="#">132</a>	
78	G10	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	<b>Comply</b>	<a href="#">130</a> , <a href="#">132</a>	
79	G11	The ground station software shall be able to command the payload to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	<b>Comply</b>	<a href="#">140</a> , <a href="#">144</a>	



# Requirements Compliance (9/10)



#	Code	Requirement	Status	Slide Ref.	Comments
80	G12	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the Cansat.	<b>Comply</b>	<a href="#">144</a>	
81	G13	The ground station shall use a table top or handheld antenna.	<b>Comply</b>	<a href="#">130</a> , <a href="#">133</a> , <a href="#">134</a> , <a href="#">135</a> , <a href="#">136</a>	
82	G14	Because the ground station must be viewed in bright sunlight, the displays shall be designed with that in mind, including using larger fonts (14 point minimum), bold plot traces and axes, and a dark text on light background theme.	<b>Comply</b>	<a href="#">132</a>	
83	G15	All data shall be shown simultaneously in the ground station GUI. Tabs are not allowed.	<b>Comply</b>	<a href="#">139</a>	
84	G16	The ground system shall count the number of received packets. Note that this number is not equivalent to the transmitted packet counter, but it is the count of packets successfully received at the ground station for the duration of the flight.	<b>Comply</b>	<a href="#">139</a>	
85	G17	The ground station shall be able to activate all mechanisms on command.	<b>Comply</b>	<a href="#">140</a>	
87	F1	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	<b>Comply</b>	<a href="#">121</a>	



# Requirements Compliance (10/10)



#	Code	Requirement	Status	Slide Ref.	Comments
88	F2	The Cansat shall maintain mission time throughout the entire mission even in the event of a processor resets or momentary power loss.	<b>Comply</b>	<a href="#">121</a>	
89	F3	The Cansat shall have its time set by ground command to within one second UTC time prior to launch.	<b>Comply</b>	<a href="#">121</a> , <a href="#">140</a> , <a href="#">107</a>	
90	F4	The flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile file.	<b>Comply</b>	<a href="#">122</a>	
91	F5	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the payload altitude.	<b>Comply</b>	<a href="#">123</a>	
92	F6	The flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	<b>Comply</b>	<a href="#">122</a> , <a href="#">123</a>	
93	F7	The flight shall include commands to activate all mechanisms. These commands shall be documented in the mission manual.	<b>Comply</b>	<a href="#">107</a>	
94	F8	Configuration states such as zero altitude calibration software state shall be maintained in the event of a processor reset during launch and mission.	<b>Comply</b>	<a href="#">121</a>	



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# Management

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# CanSat Budget – Hardware (1/4)



Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual/Free
Electronics-Payload				
LPS22HB	Yes	1	3.28	Actual
HS3003	Yes	1	3.45	Actual
ADC (2 channels) + Voltage divider + Shunt Resistor	No	1	0.2	Estimated
Ublox NEO-6M	Yes	1	10.9	Actual
BNO055	No	1	12.34	Actual
Quelima SQ11	Yes	2	12	Actual
TFS20-L	No	2	24.16	Actual
STM32F4	No	1	12	Actual



# CanSat Budget – Hardware (2/4)



Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual/Free
Electronics-Payload				
DS3231 mini	Yes	1	17.5	Actual
ANT-900MR Flex ¼ Wave RPSMA	Yes	1	7	Actual
XBee PRO S3B 915MHz	Yes	2	58.08	Actual
Vapcell INR14500	No	2	3.6	Actual
A09-Y11NF	Yes	1	155	Actual
Wishiot TD-9512MG	No	2	14.3	Actual
PKM22EPP-40	Yes	1	0.87	Actual
ATTiny85	No	1	1.30	Estimated
CR2477	Yes	2	5.3	Actual
<b>TOTAL (Electronics Payload) = 458.72 USD</b>				



# CanSat Budget – Hardware (3/4)



Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual
Mechanics				
Nylon Ripstop	YES	900 cm <sup>2</sup>	0.001 per cm <sup>2</sup>	Estimated
Carbon Fibre Rods (4x350mm)	YES	4	59/1m	Actual (MercadoLibre)
Braid fishing line	NO	1	6.5 per 100m	Actual (MercadoLibre)
ABS	NO	1 kg	20/kg	Actual (MercadoLibre)
Aluminum	NO	0.1kg	2.59/kg	Actual
Torsion Spring	NO	4	4	Estimated
Screws, washers and nuts	NO	10	5	Estimated
Bearings	NO	2	5	Estimated
Eyebolt + Swivel link	YES	1	5	Estimated

**TOTAL (Mechanics) = 191.26 USD**



# CanSat Budget – Hardware (4/4)



Subsystem	Cost (USD)
Electrical	<b>458.72 USD</b>
Mechanical	<b>191.26 USD</b>
<b>TOTAL = 649.98 USD</b>	



# CanSat Budget – Other Costs (1/2)



Ground Station				
Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual
Yagi Antenna	YES	1	155	Actual
Yagi Antenna Mounting (Hand-held)	YES	1	25	Estimated
XBee USB Adapter FT232RL	YES	1	14.2	Actual
Laptop Computer	YES	1	500	Estimated
Umbrella	YES	1	9	Actual
<b>TOTAL (Ground Station) = 703.2 USD</b>				



# CanSat Budget – Other Costs (2/2)



Travel Costs					
	Description	Quantity	Cost [USD]	Total Cost [USD]	Source
Airline	Round Trip	10	1350	13500	Estimated
Visa	Application Fee	6	185	1110	Actual
Hotel		10 (4 Nights)	65 (per night, per person)	2600	Estimated
Food	15 meals	10 (5 Days)	45 (per day)	2250	Estimated
Transport	Rental Van + Gas	2	310	620	Estimated
<b>PER PERSON = 2082 USD if Visa is needed / 1897 USD if Visa NOT needed</b>					
<b>TOTAL = 20080 USD</b>					

Competition Fee was paid by **Instituto Tecnológico de Buenos Aires**.

CanSat build cost financing is yet to be determined.

We are still in the process of looking for sponsors for the travel expenses.

*\*All costs are estimates and may vary depending on availability and exchange rates. (Except for Visa's Fee)*





# Detailed Program Schedule (1/2)



## LEGEND

**TABLE COLORS:**

	Table 1: Project Management & Logistics
	Table 2: Mechanical & Descent Subsystem
	Table 3: Electronics & Flight Software
	Table 4: Ground Station Subsystem
	Exam Periods

**ASSIGNEE CODES:**

<b>TL</b>	Team Leads (Mechanical, Electronics & PM)
<b>MT</b>	Mechanical Team
<b>EF</b>	Electronics & Firmware Team
<b>SGS</b>	Software & Ground Station Team
<b>ALL</b>	All Teams

### TABLE 1: PROJECT MANAGEMENT & LOGISTICS

ID	Task Name	Assignee	Start Date	Finish Date	Duration
1.1	Team Recruiting	TL	15/09/2025	30/09/2025	16 days
1.2	Team Selection	TL	30/09/2025	10/10/2025	11 days
1.3	Research Phase	ALL	07/10/2025	30/12/2025	85 days
1.4	Summarize and Analyze Mission Guide	TL	16/10/2025	22/10/2025	7 days
1.5	Contact University and Sponsors for Funding	TL	17/10/2025	02/06/2026	229 days
1.6	System Design Phase	ALL	20/11/2025	20/01/2026	62 days
1.7	December Exam Period	ALL	03/12/2025	23/12/2025	21 days
1.8	Ordering Components	ALL	15/01/2026	24/02/2026	41 days
1.9	PDR Completion	ALL	15/01/2026	30/01/2026	16 days
1.10	PDR Deadline	ALL	30/01/2026	30/01/2026	MILESTONE
1.11	February Exam Period	ALL	02/02/2026	21/02/2026	20 days
1.12	PDR Presentations	ALL	02/02/2026	20/02/2026	19 days
1.13	CDR Completion	ALL	01/03/2026	27/03/2026	27 days
1.14	CDR Deadline	ALL	27/03/2026	27/03/2026	MILESTONE
1.15	CDR Presentations	ALL	06/04/2026	24/04/2026	19 days
1.16	ETD Completion	ALL	01/05/2026	22/05/2026	22 days
1.17	ETD Deadline	ALL	22/05/2026	22/05/2026	MILESTONE
1.18	Flight Day	ALL	06/06/2026	06/06/2026	MILESTONE
1.19	PFR	ALL	07/06/2026	07/06/2026	MILESTONE



# Detailed Program Schedule (2/2)



**TABLE 2: MECHANICAL & DESCENT SUBSYSTEM**

ID	Task Name	Assignee	Start Date	Finish Date	Duration
2.1	Design and Analyze Different Mechanical Layout Prototypes	MT	22/12/2025	10/01/2026	20 days
2.2	Descent System Research and Selection	EF & MT	10/01/2026	20/01/2026	11 days
2.3	Define Mechanical Electronics Requirements	EF & MT	14/01/2026	27/01/2026	14 days
2.4	Integrate Descent Design with Electronic Components	EF & MT	18/01/2026	27/01/2026	10 days
2.5	ETD Planning and Completion	MT	20/01/2026	28/01/2026	9 days
2.6	Prototype Assembly	ALL	24/02/2026	21/03/2026	26 days
2.7	Prototype Testing	ALL	28/03/2026	15/04/2026	19 days
2.8	Prototype Iteration	ALL	15/04/2026	28/04/2026	14 days
2.9	Final Prototype Testing	ALL	05/05/2026	20/05/2026	16 days

**TABLE 3: ELECTRONICS & FLIGHT SOFTWARE**

ID	Task Name	Assignee	Start Date	Finish Date	Duration
3.1	Define Software Requirements for Payload, Container and GS	EF	30/11/2025	18/12/2025	19 days
3.2	Design Architecture for Container Software	EF & MT	19/12/2025	25/12/2025	7 days
3.3	Electronic System Research and Selection	EF	19/12/2025	07/01/2026	20 days
3.4	Create Container State Diagram	EF	03/01/2026	21/01/2026	19 days
3.5	Define Electronics Based on Research	EF	08/01/2026	14/01/2026	7 days
3.6	Integrate Design with Electronic Components	EF	17/01/2026	30/01/2026	14 days
3.7	Integrate Designs with Electronic Component Definitions	EF	15/01/2026	01/02/2026	18 days
3.8	Determine Software Development Process	EF	22/01/2026	27/01/2026	6 days
3.9	Develop and Test Flight Software	EF	28/01/2026	01/02/2026	5 days

**TABLE 4: GROUND STATION SUBSYSTEM**

ID	Task Name	Assignee	Start Date	Finish Date	Duration
4.1	Design Architecture for Ground Station Software	SGS	26/12/2025	05/01/2026	11 days
4.2	Research Antenna Technology	SGS	03/01/2026	20/01/2026	18 days
4.3	Design and Prototype GCS Software	SGS	15/01/2026	26/01/2026	12 days
4.4	Determine or Design Antenna	SGS	25/01/2026	02/02/2026	9 days



# Conclusions (1/2)



## Major Accomplishments

- Completed comprehensive mechanical design validation via CAD modeling, ensuring precise component fit and readiness for structural simulations
- All electronic components have been chosen and meet mission requirements.
- Turning all the software requirements into a detailed description of the software and all of its states while finding similarities in the components to simplify implementation.
- Established a clear organizational structure with defined technical roles and work packages for all team members.

## Major Unfinished Work

- CanSat's prototype yet to be 3D printed.
- Major set of electronic components yet to be ordered.
- Main PCB yet to be designed.
- Funding sourced yet to be determined.
- Test Plans defined and ready for execution.



## Conclusions (2/2)



All in all, the team has met most preliminary design requirements and is ready to proceed to the next stage of development as all major goals and milestones are complete. Having won the last CanSat Competition, team SEDS-ITBA, which is made up of students from multiple areas in engineering ready to confront the challenge of designing and building a space-type system, takes on the challenge to put up with the previous form, and reach for the top again. Having analysed the requirements of the mission, carried out a rigorous study of different ways we can meet them and defined optimal solutions to all encountered problems, we are ready to advance to the next stage, where we will put to test all our conclusions and iterate where necessary.

