CanSat 2024
Preliminary Design Review (PDR) Outline
Version 1.0

Your Team # 2099
SEDS ITBA

Presentation Outline

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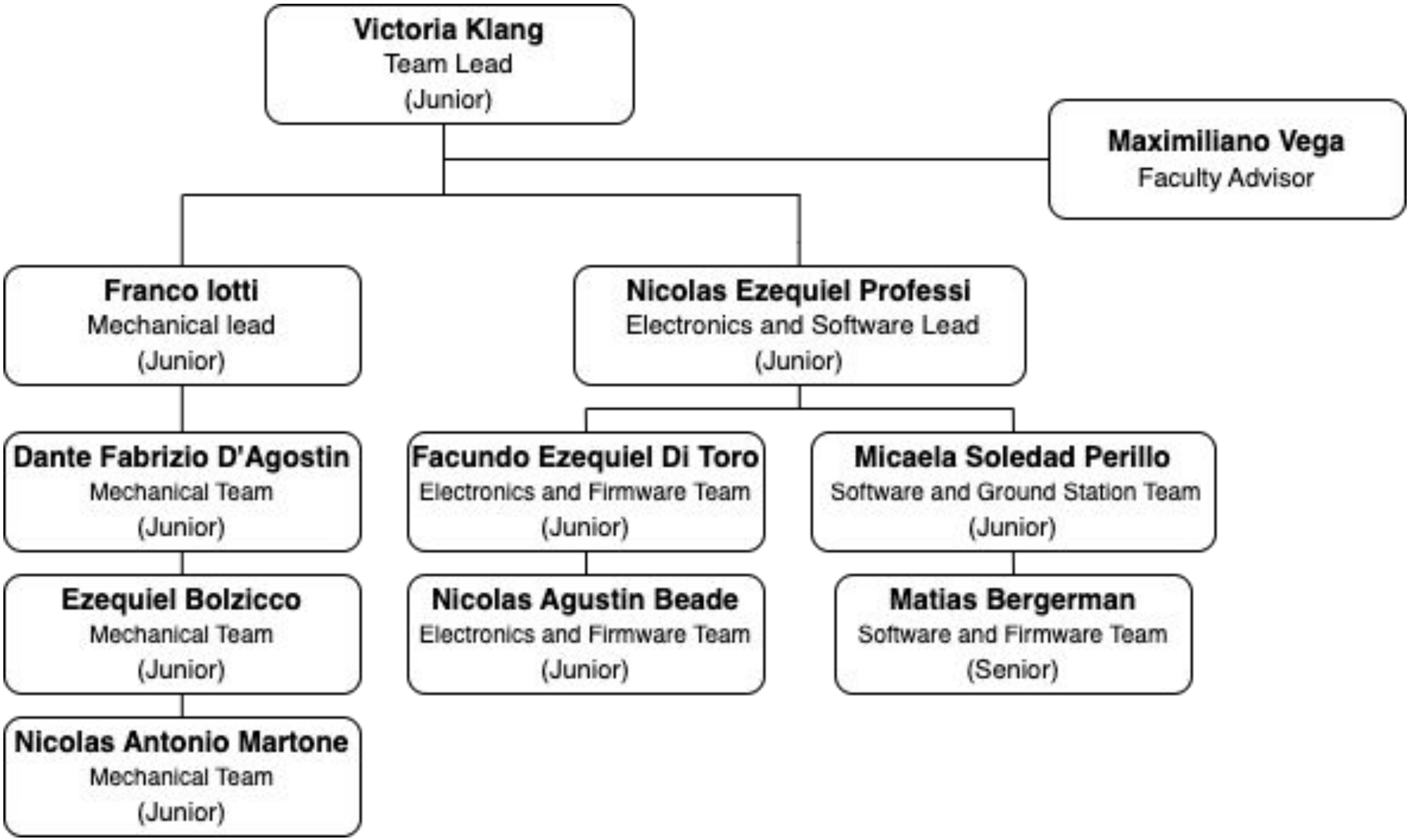
Team Organization



Acronyms (1/2)

Acronym	Explanation
MECH	Mechanical Subsystems
ES	Electrical Systems
FSW	Flight Software
m	Mass
g	Acceleration of the Earth
ρ	Density of the Air
v	Terminal Velocity
Cd	Drag Coefficient
A	Area
GCS	Ground Control System
HS	Aerobraking Heat Shield
MCU	Microcontroller Unit

Acronyms (2/2)

Acronym	Explanation
RTC	Real time clock
GPS	Global Positioning System
NiCr	Nichrome
Li-Ion	Lithium Ion
Ni-Mh	Nickel–metal hydride
LED	Light emitting diode

Systems Overview

Victoria Klang

Mission Summary

The mission embarks on a journey that focuses on two critical aspects: safeguarding the payload and effectively managing descent speed. The Cansat, initially simulating the role of the nose cone, is launched with the rocket to a maximum altitude of 725 meters. During this ascent, it assumes control of both the rocket's speed and the cargo's orientation, a task challenged by the potentially violent conditions.

Upon reaching the maximum altitude, the ejection charge fires, separating the Cansat from the main structure. At 725 meters, the Cansat opens a heat shield, aiming to reduce speed to 15m/s while maintaining stability and control. At 100 meters, a pivotal phase begins as the Cansat releases the heat shield and simultaneously, a parachute deploys to further slow the descent, aiming for a final speed of 5m/s. The ultimate mission goal is to achieve a successful landing with the egg intact, simulating the careful handling of a delicate cargo.

Bonus objective: The team has chosen to follow the bonus objective because we are confident that, drawing from our past CanSat experience, adding a static camera will not compromise the CanSat in terms of mass or complexity.

External objectives:

- Apply class concepts to real practice and gain more experience on the aerospacial 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)

Requirement Number	Requirement	Subsystem
1	The Cansat mass shall be 900 grams +/- 10 grams without the egg being installed.	MECH
2	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	MECH, ELECTRICAL
3	The Cansat shall perform the function of the nose cone during rocket ascent.	MECH
4	All mechanisms shall be capable of maintaining their configuration or states under all forces.	MECH
5	The Cansat shall deploy a heat shield after deploying from the rocket.	MECH
6	At 100 meters, the Cansat shall deploy a parachute and release the heat shield.	MECH

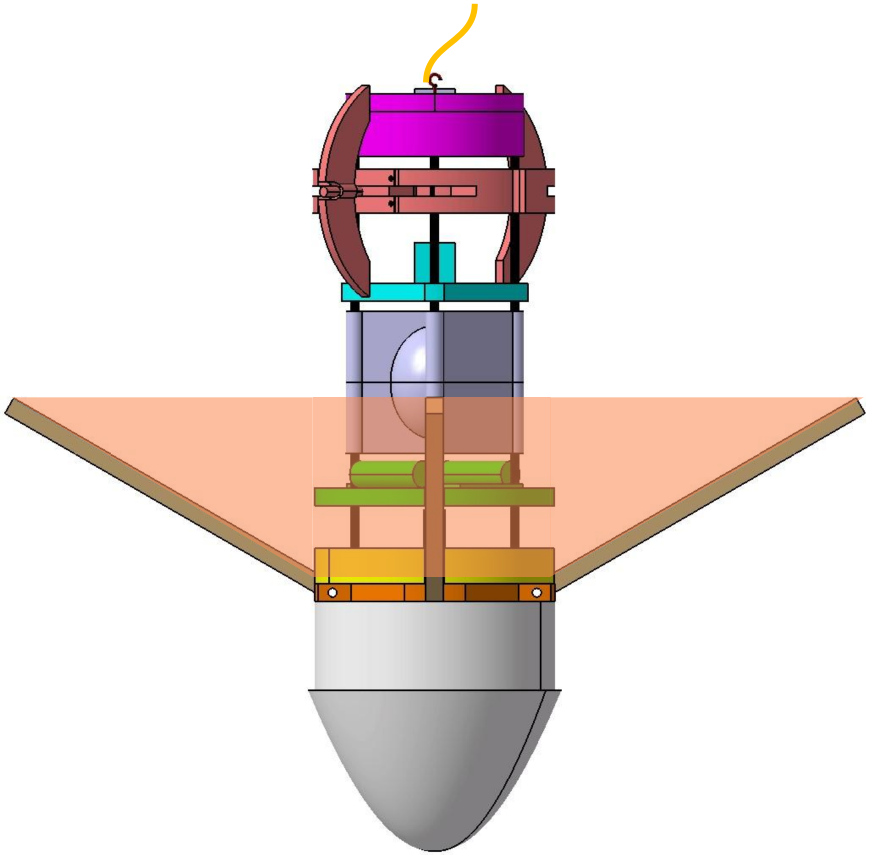
System Requirement Summary (2/3)

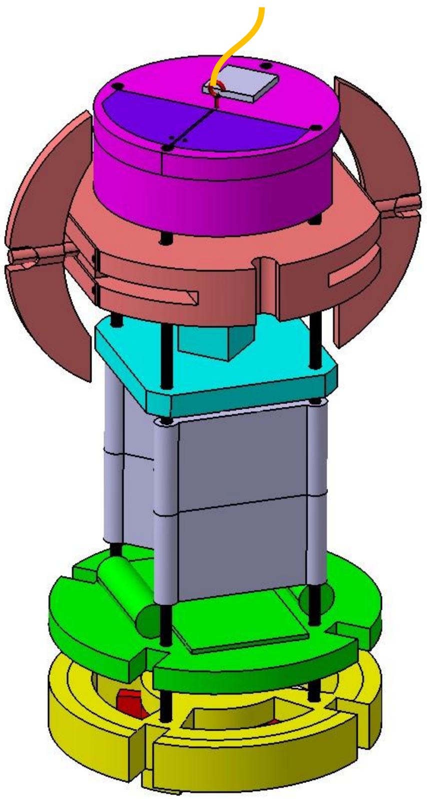
Requirement Number	Requirement	Subsystem
7	"The Cansat shall protect a hens egg from damage during all portions of the flight.	MECH
8	During descent with the heat shield deployed, the descent rate shall be between 10 to 30 m/s.	MECH
9	At 100 meters, the Cansat shall have a descent rate of less than 5 m/s.	MECH
10	Cansat shall survive 30 G shock.	MECH
11	Cansat structure must survive 15 Gs vibration	MECH
12	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	ELECTRICAL

System Requirement Summary (3/3)

Requirement Number	Requirement	Subsystem
13	Easily accessible power switch is required	ELECTRICAL
14	Power indicator is required for each voltage domain	ELECTRICAL
15	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	ELECTRICAL
16	The maximum current of the cansat cannot exceed the maximum discharge current of the battery.	ELECTRICAL
17	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."	BUDGET

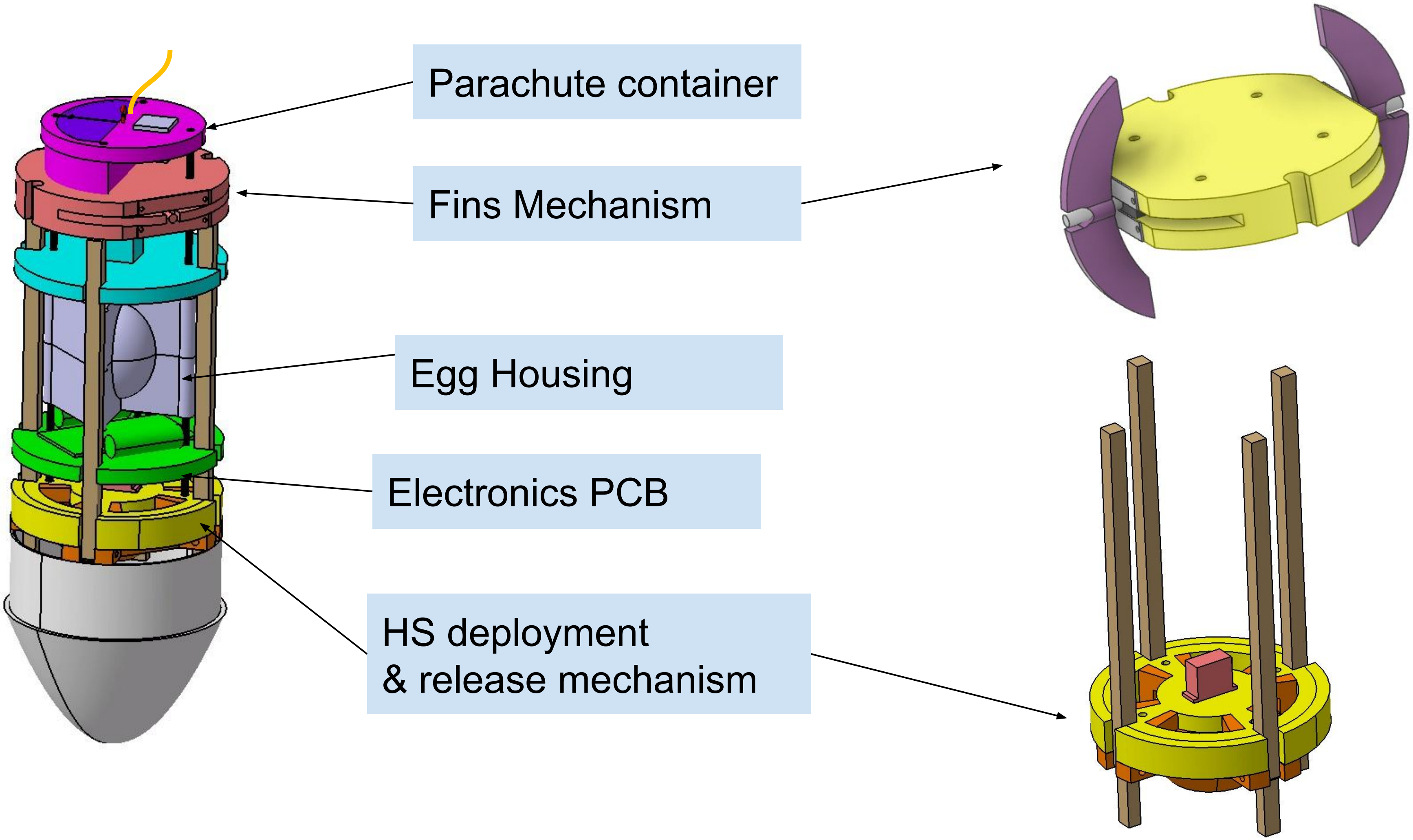
Design 1





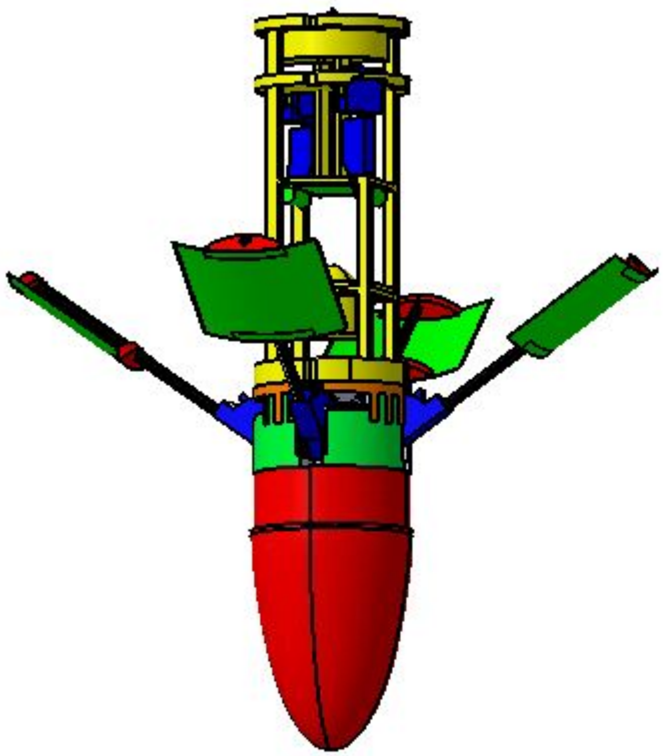
Stowed Configuration **Deployed Configuration** **HS release Configuration**

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



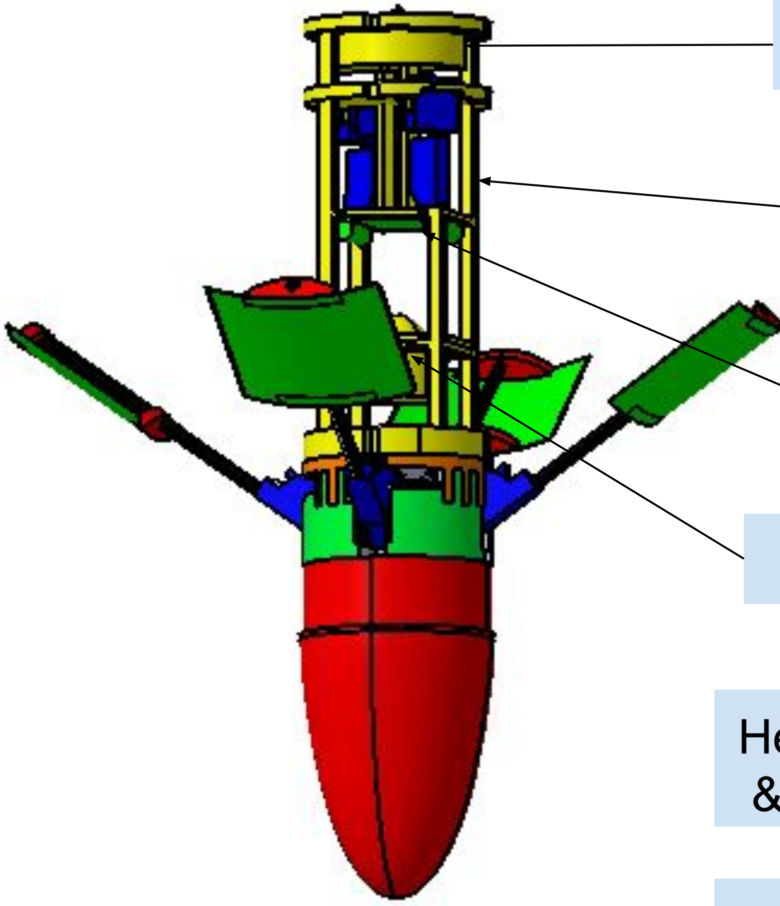
System Level CanSat Configuration Trade & Selection(3/4)

Design 2



Stowed Configuration **Deployed Configuration**

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



Parachute container

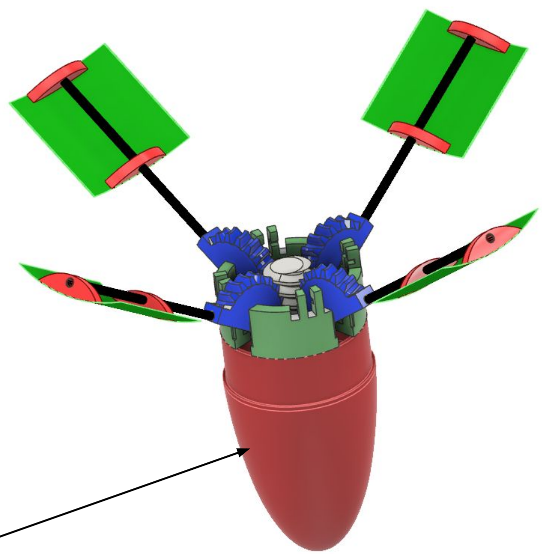
Fins

Electronics PCB and batteries

Egg Housing

Heatshield deployment & release mechanism

3D printed structure

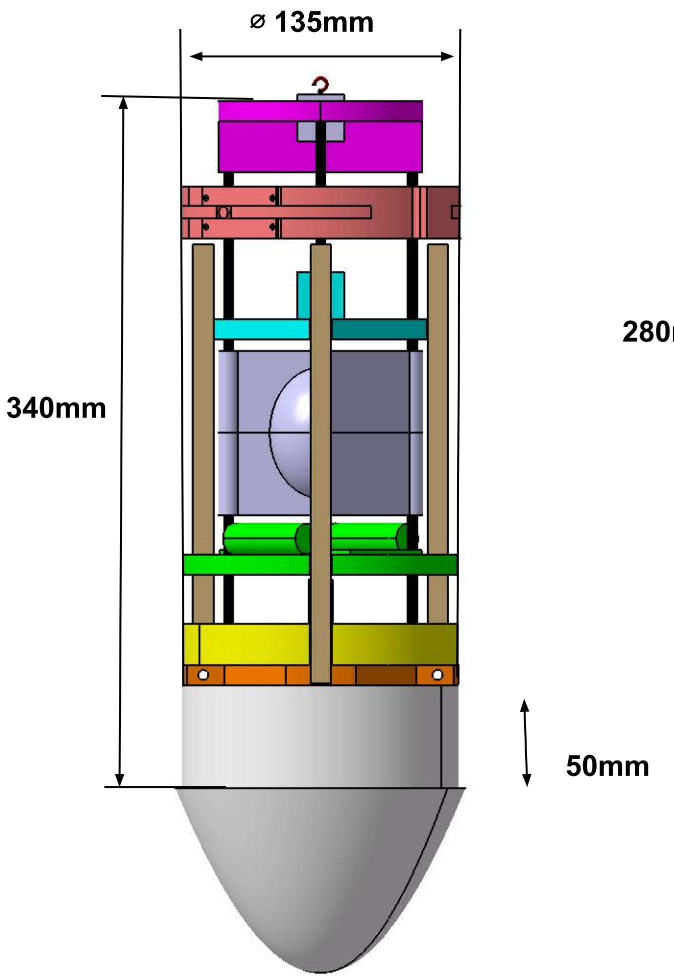


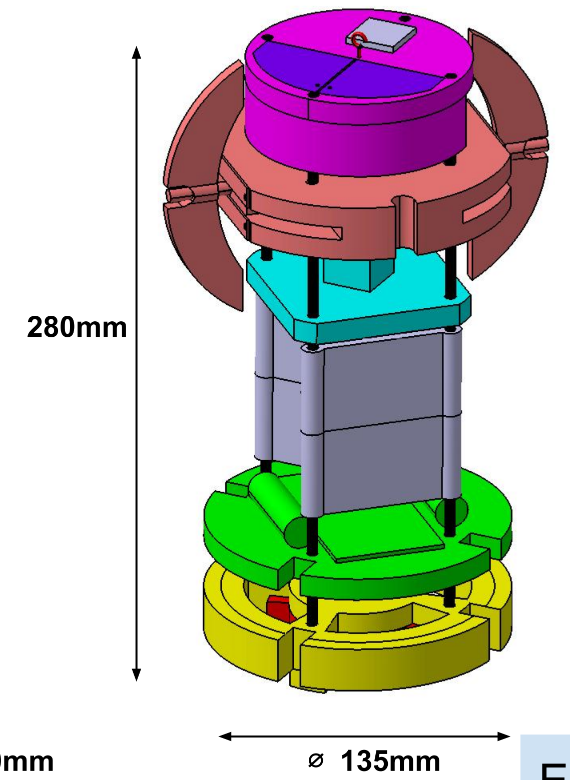
System Level Configuration Selection

Design	Design 1	Design 2
Advantages	• resistant • modular • lighter	• structure only needs to be printed • cheap
Disadvantages	• expensive • the shelves need to be attached to the rods	• less resistant • if the structure is damaged, everything needs to be printed again • needs more material to be resistant • heavier
Conclusion	Design 1 is chosen • it's lighter and modular	

Physical Layout (1/3)

Selected: Design 1



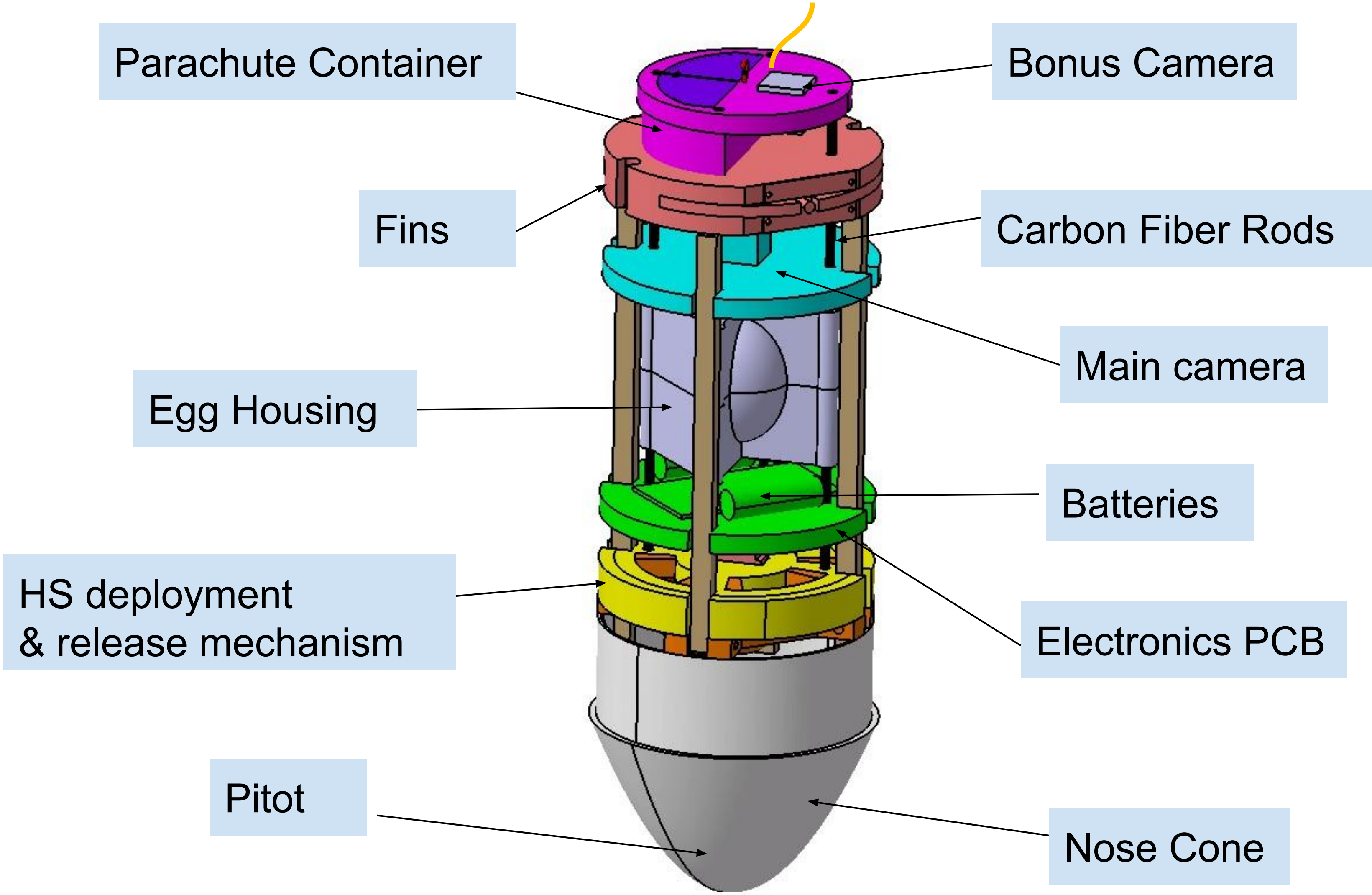


Burning fishing line-controlled systems will open the spring-loaded HS and parachute.

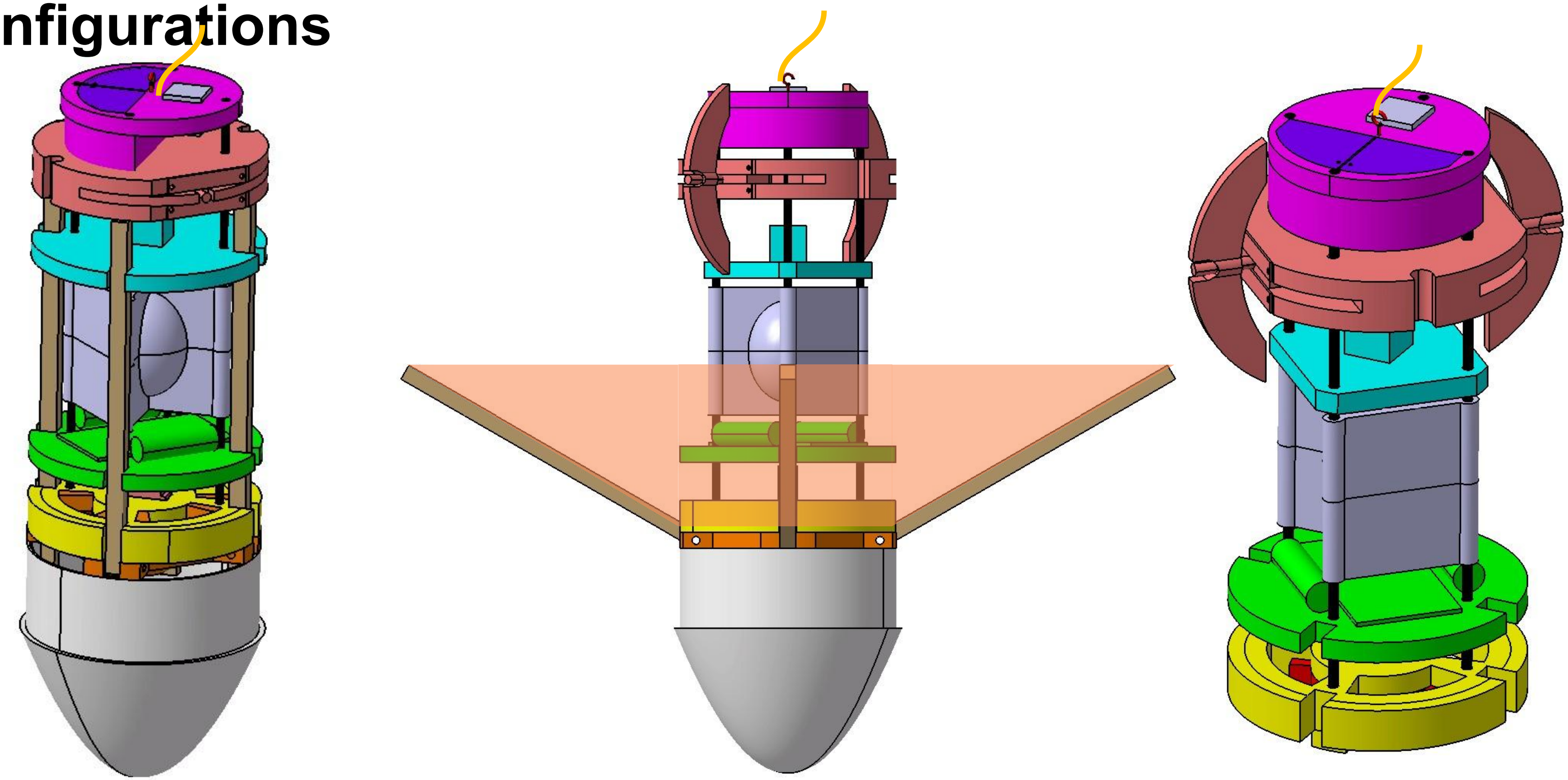
Rotation control and HS separation are to be commanded by Servo motors.

Egg will be encapsulated in a spring suspended container.

Physical Layout (2/3)



Configurations



Stowed Configuration | **Deployed Configuration** | **HS release Configuration**

System Concept of Operations

Pre-Launch → **Launch** → **HS Deployment** → **Parachute Deployment** → **Cansat Landing**

Pre-Launch

1. Last CanSat check
2. CanSat placement
3. CanSat turned on
4. Start Cameras Recording
4. Calibration of Telemetry
5. Start transmitting data

Launch

1. Rocket ignition and ascension
2. Maximum altitude reached (725m)
3. CanSat deployment

HS Deployment

1. HS deployment (at maximum altitude)

2, Fins deployment

Parachute Deployment

1. HS released (at 100 m)
2. Parachute deployment (at 100 m)

Cansat Landing

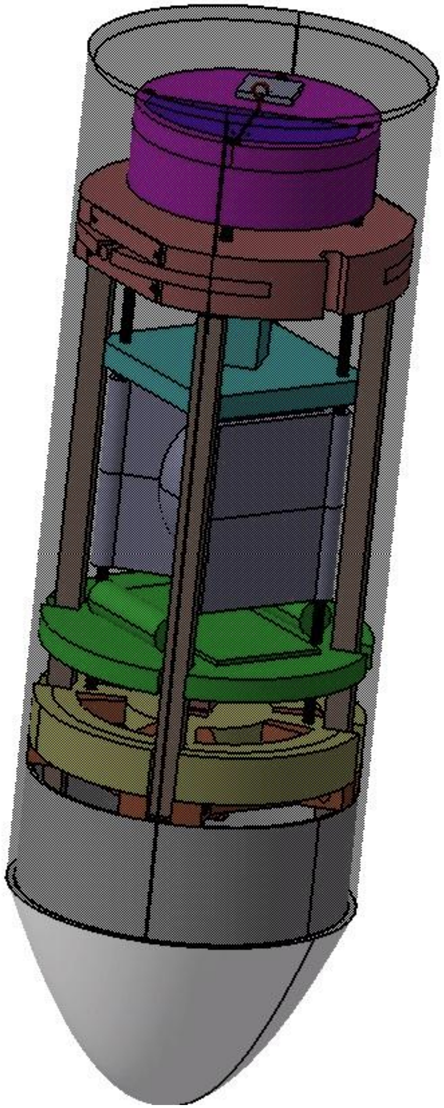
1. CanSat stop transmitting Data
2. Beacon is activated

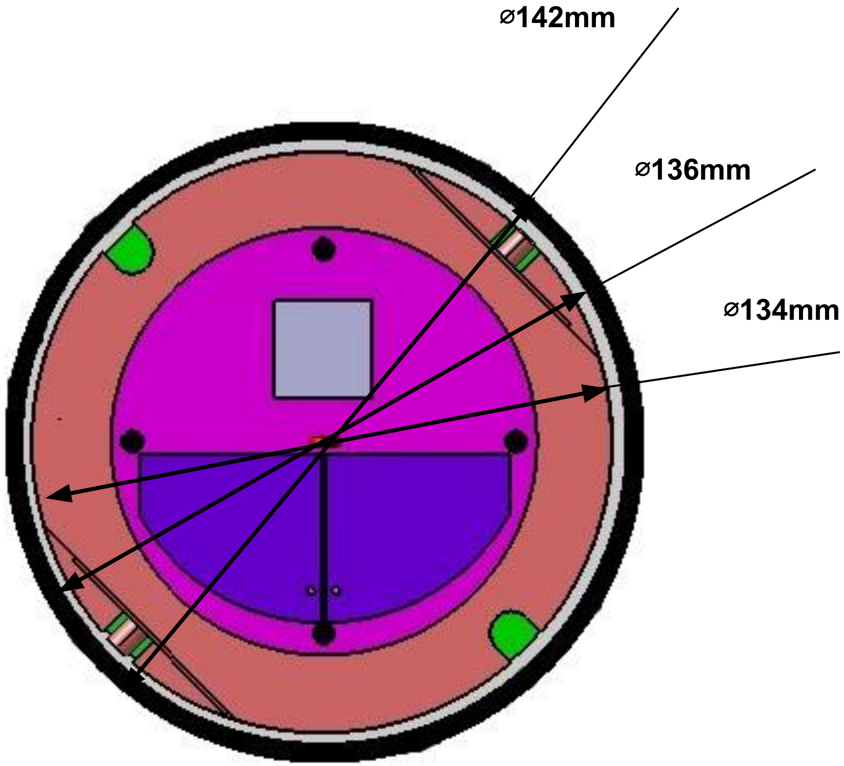
Ground Station

1. Team Briefing: get everyone into position for launch
2. Send UTC time to CanSat and command it to transmit telemetry

1. Receive and plot telemetry in real time
2. Generate csv files of all sensor data
3. Sens information to the MQTT server

Launch Vehicle Compatibility (1/2)





Launch Vehicle Compatibility (2/2)

	Payload section dimensions (mm)	CanSat dimensions (mm)	Clearance (mm)
Diameter	136	134	2
Height	350	340	10

Sensor Subsystem Design

Facundo Di Toro

Sensor Subsystem Overview

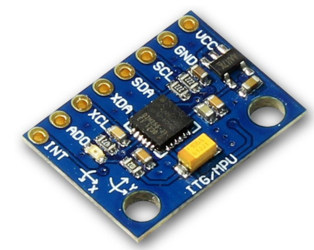
- Position
- Rotation
- Airspeed
- Temperature
- Battery

mpxv7002dp

Airspeed sensor (makes use of pitot)

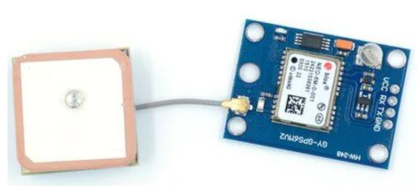
Bmp280

Pressure and Temperature sensor



Mpu6050

Rotation rate and orientation sensor

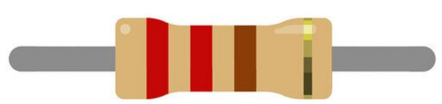


Ublox NEO-6M

GPS module

Sq11

Low-size spy camera



Resistor divider

Battery sensor using MCU's ADC

Payload Air Pressure Sensor Trade & Selection

Name	Size [mm]	Mass [gr]	Operating current [μA]	Operating voltage [V]	Range [Pa]	Resolution [Pa]	Interface	Price ($)
BME280	PKG: 21.6x16.6x3.0	1.2	3.4	1.65 - 3.6	300 - 1100h	30	I2C/SPI	9.95
BMP280	PKG: 13.5x10.5x2	1	2.8	1.7-3.6	300 - 1100h	0.18	I2C/SPI	9.05
MPL3115 A2	PKG: 18 x 11 x 2	1.4	40	-0.3 - 3.6	200 - 1100h	1.5	I2C	13.77

Selected Sensor: BMP280

Reasons:

- High resolution.
- Low power consumption.
- Low PCB weight
- Wide range
- Previous experience
- Availability in Argentina

Notes: Air pressure sensor will be use to measure altitude

Payload Air Temperature Sensor Trade & Selection

Name	Size [mm]	PCB Weight [gr]	Operating current [µA]	Range [ºC]	Operating voltage [V]	Resolution [°C]	Interface	Price ($)
BMP280	PKG: 13.5x10.5x2	1	2.8	-40 - 85	1.7-3.6	0.1	I2C/SPI	9.05
DTH22	PKG: 27x59x14	2.4	20	-55 - 125	3.3 - 6	0.5	1-Wire	6.5
MS5611	PKG: 19x13x2	1.5	1.5	-50 - 160	1.8 - 3.6	0.1	I2C	1.6

Selected Sensor: BMP280

Reasons:

- High resolution
- Low power consumption
- Low PCB weight
- Wide range
- Contains multiple sensors for other uses, such as pressure
- Availability in Argentina

Notes: Air temperature sensor will be use to measure cansat internal temperature

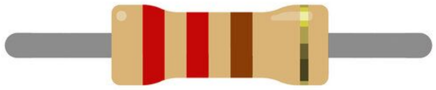
Payload Battery Voltage Sensor Trade & Selection

Name	Size [mm]	Weight [gr]	Operating current [mA]	Operating voltage [V]	Resolution [mV]	Interface	Price ($)
ADC Pin + Voltage divider	Negligible	Negligible	0.2	0-3.3	0.001	Analog	Negligible
LM4040	16x12.5 x2.5	0.7	15	0-5	0.1	ADC	7.5
INA219	1.5x3	0.3	1	0-26	0.125	I2C	5

Selected Sensor: ADC Pin + Voltage divider

Reasons:

- No additional cost, weight or space needed
- Simple method
- Reliable



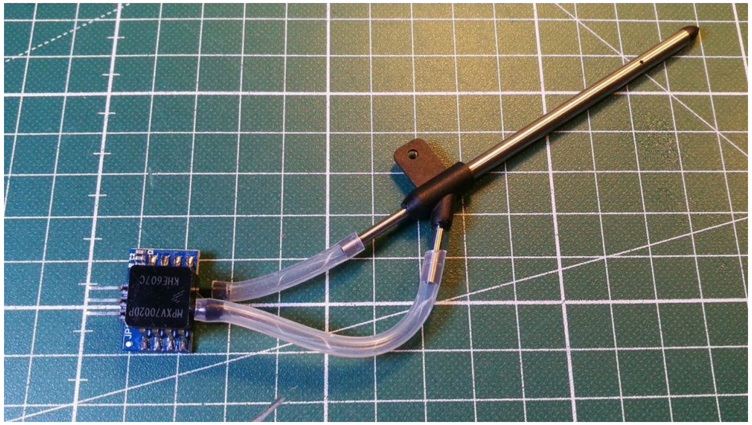
Payload Speed Sensor Trade & Selection

Name	Size [mm]	Weight [gr]	Operating current [mA]	Operating voltage [V]	Resolution [bits]	Interface	Price ($)
MPXV7002 + Pitot Tube	11x11x13	3	10	4.75 - 5V	12	I2C/SPI	20
LM4040	16x12.5 x2.5	0.7	3	0-5	14	I2C/SPI	51

Selected Sensor: MPXV7002 + Pitot Tube

Reasons:

- It is cheaper, the only problem is the high consumption
- Easier to acquire in Argentina
- Works appropiately in temperatures the Cansat will find itself exposed to



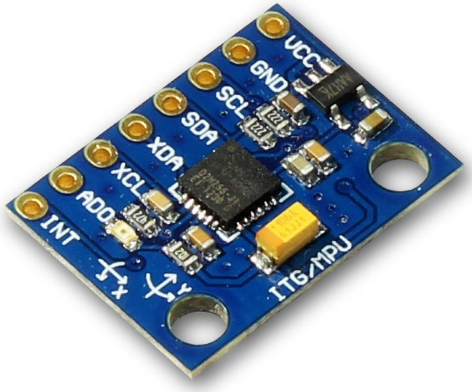
Payload Tilt Sensor Trade & Selection

Name	Size [mm]	PCB Weight [gr]	Operating current [mA]	Operating voltage [V]	Resolution [º/s]	Interface	Price ($)
MPU-9250	25x15x3	3	0.4	2.4 - 3.6	0.004	I2C/SPI	11
MPU-6050	20x16x3	3.2	0.4	2.9 - 3.6	0.018	I2C/SPI	3.15
OKY3231	15x12x3	4.3	4	2.7 - 5	0.11	I2C/SPI	9.15

Selected Sensor: MPU-6050

Reasons:

- Low power consumption.
- Small board size.
- Software simplicity and reliability
- Previous use
- Inexpensive



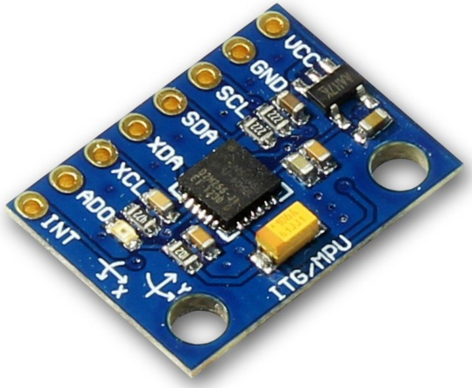
Rotation Sensor Trade & Selection

Name	Size [mm]	PCB Weight [gr]	Operating current [mA]	Operating voltage [V]	Resolution [bits]	Interface	Price ($)
MPU-9250	25x15x3	3	0.4	2.4 - 3.6	16	I2C/SPI	11
MPU-6050	20x16x3	3.2	0.4	2.9 - 3.6	16	I2C/SPI	3.15
L3G4200D	21.6x21x3	1.5	10	2.4 - 3.6	16	I2C/SPI	9.15

Selected Sensor: MPU-6050

Reasons:

- Low power consumption.
- Small board size.
- Software simplicity and reliability
- Previous use
- Inexpensive
- It can also be used as Tilt sensor



Notes: Rotation sensor will be use to measure angle stability during aerobraking and rotation during descent

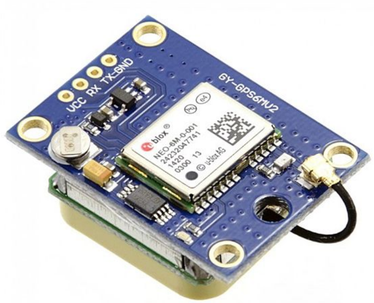
Payload GPS Sensor Trade & Selection

Name	Size [mm]	Weight [gr]	Operating current [mA]	Operating voltage [V]	Navigation update rate [Hz]	Horizontal accuracy [m]	Interface	Price ($)
SAM-M8Q	26x16x7.5	7	67	2.7-3.6	2.5	2.5	UART//DDC	39.95
Ublox NEO-6M	16x12.2x2.4	12	67	2.7-3.6	2.5	2.5	UART/SPI/DDC/USB	16.07
MTK3339	16x12.2x2.4	17	67	2.7-3.6	2.5	2.5	UART/SPI/DDC/USB	27.66

Selected Sensor: Ublox NEO-6M

Reasons:

- Great horizontal accuracy
- Optimal power consumption
- Low price
- Availability in Argentina
- Previous experience



Payload Camera Trade & Selection

Name	Size [mm]	Weight [gr]	Operating current [mA]	Operating voltage [V]	Resolution [px]	FPS	Included Memory [GB]	Interface	Price ($)
Adafruit 3202	29x17x 5	2.8	110	5	640x480	30	32	Digital	12.5
OV7670	35x34 x25	10	10	3.3	640 x 480	30	0	SCCB+I2C	5
SQ11	23x23x23	5.2	120	5	1280 x 720	30	64	Digital	6

Selected Sensor: SQ11

Reasons:

- High resolution (color) and viewing angle
- Optimal power consumption
- SD card connection already integrated
- Easy customization and control

Bonus Camera Trade and Selection

Name	Size [mm]	Weight [gr]	Operating current [mA]	Operating voltage [V]	Resolution [px]	FPS	Included Memory [GB]	Interface	Price ($)
Adafruit 3202	29x17x 5	2.8	110	5	640x480	30	32	Digital	12.5
OV7670	35x34 x25	10	10	3.3	640 x 480	30	0	SCCB+I2C	5
SQ11	23x23x23	5.2	120	5	1280 x 720	30	64	Digital	6

Selected Sensor: SQ11

Reasons:

- High resolution (color) and viewing angle
- Optimal power consumption
- SD card connection already integrated
- Easy customization and control

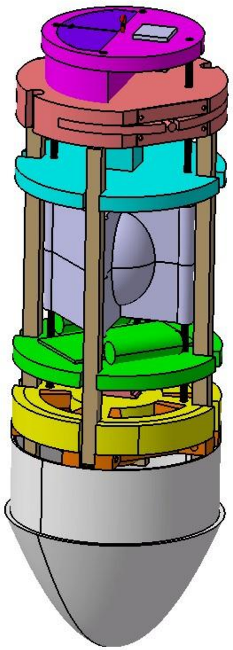
Descent Control Design

Dante F. D’Agostin & Franco Iotti

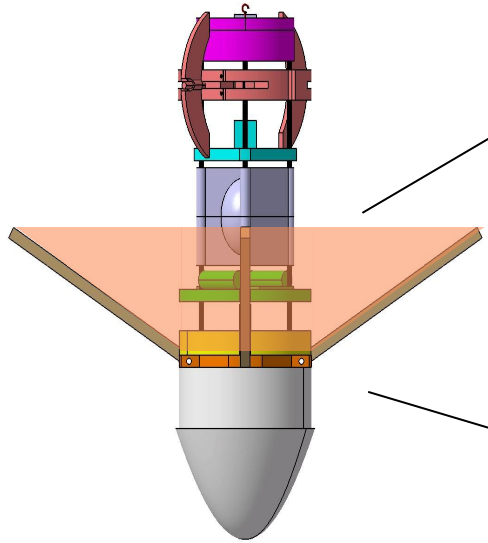
Descent Control Overview (1/2)

- Nose Cone is part of the Heat Shield
- Hexagonal Nylon Parachute

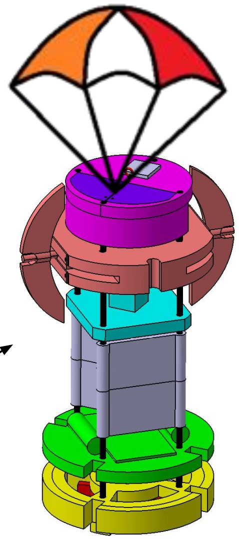
Parts:
- HS
- Fins
- Parachute



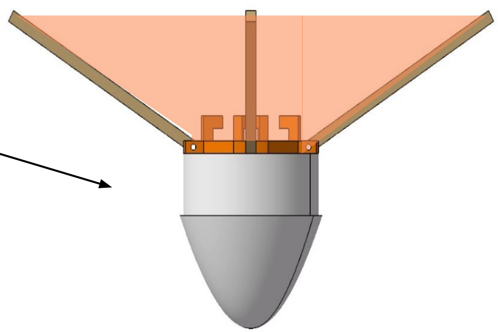
Stowed Configuration



Deployed HS Configuration

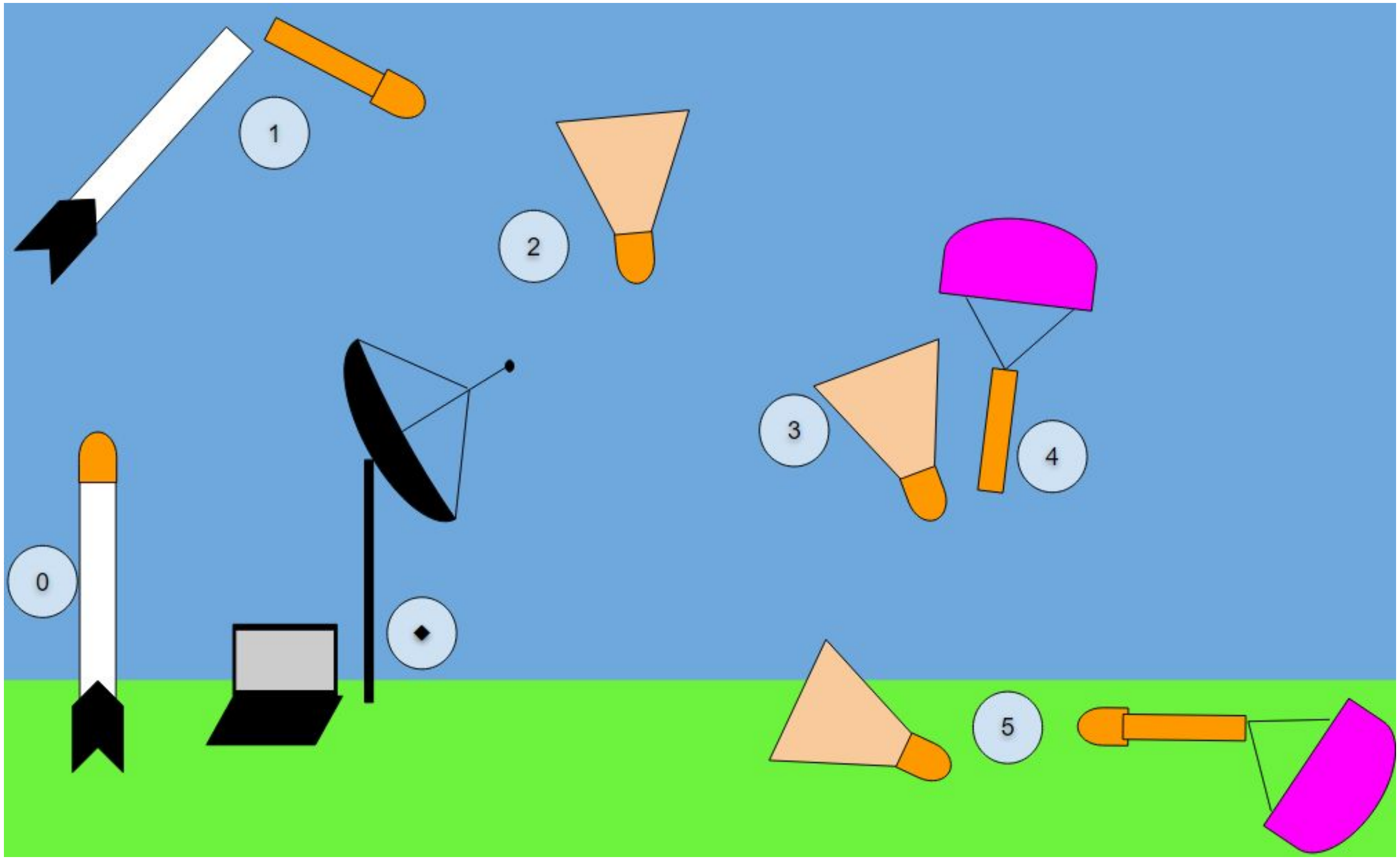


Parachute Deployed Configuration



Nosecone and HS detached

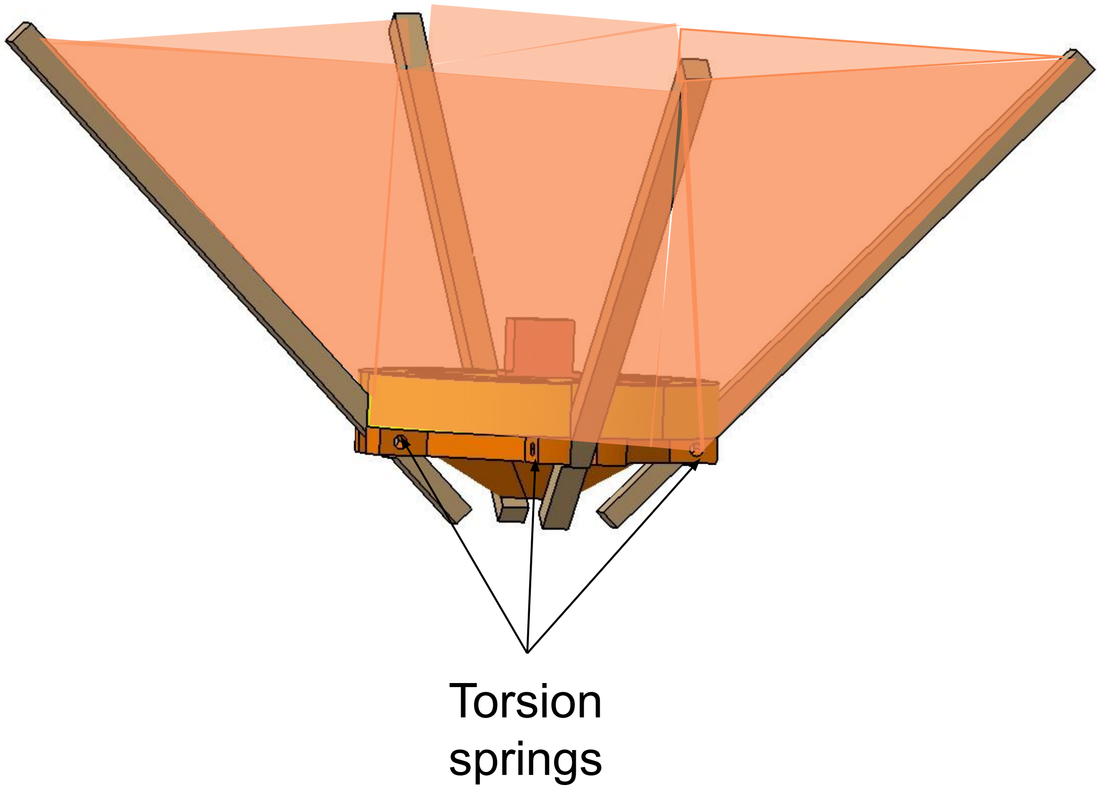
Descent Control Overview (2/2)



◆
CanSat will communicate with the ground station for entire mission

0	1	2	3	4	5
CanSat is loaded into launch vehicle	CanSat deploys at a maximum altitude of 725m	Heat shield opens and it descends at 10-30 m/s	At 100m heat shield is released and parachute is deployed	CanSat descends at less than 5 m/s	Cansat shall land with the egg intact

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

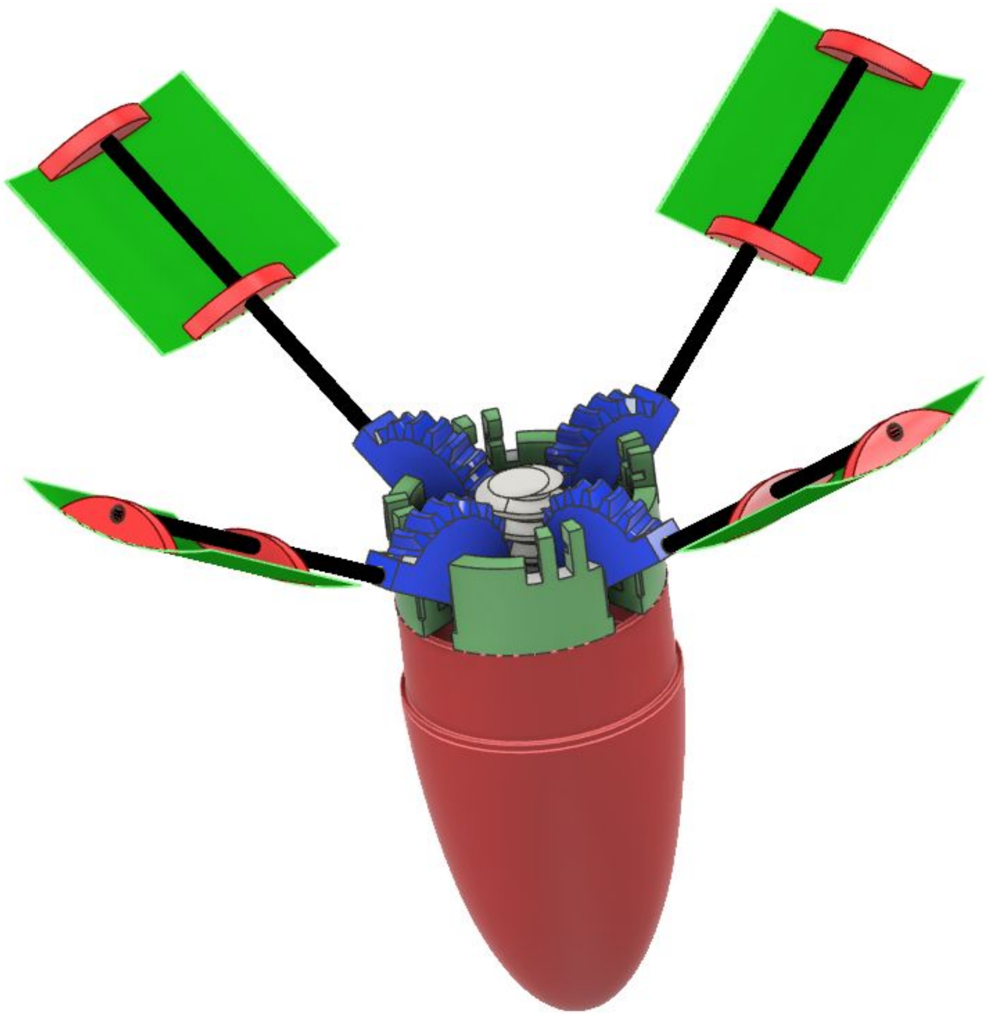


4-Arms Nylon String Attached

Ripstop Nylon Aerobraking Heat Shield

No Servos required, Springs and magnets deployment

Conic Shape



4-Arms PET 1 Servo Design

Rigid PET Aerobraking Heat Shield

Single Servo deployment

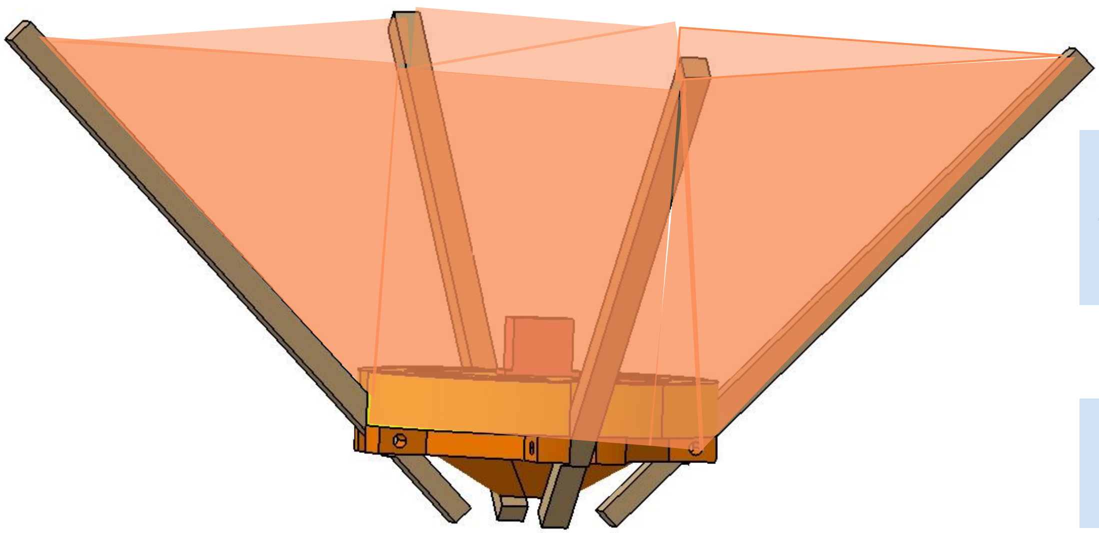
4 Rectangles

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

Design	**Design 1**	**Design 2**
Advantages	• Low power consumption (burning the fishing line) • Lighter • Easy to separate from Cansat • Stable	• Control of descent with the angle of the heat Shield
Disadvantages	• No control of descent, angle is fixed	• More power consumption (1 servo) • Heavier • Difficult to separate • Difficult to manufacture • Less efficient to slow down the Cansat
Conclusion	4-Arms Nylon String Attached is chosen • Easier assembly • Needs 1 servo less	

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

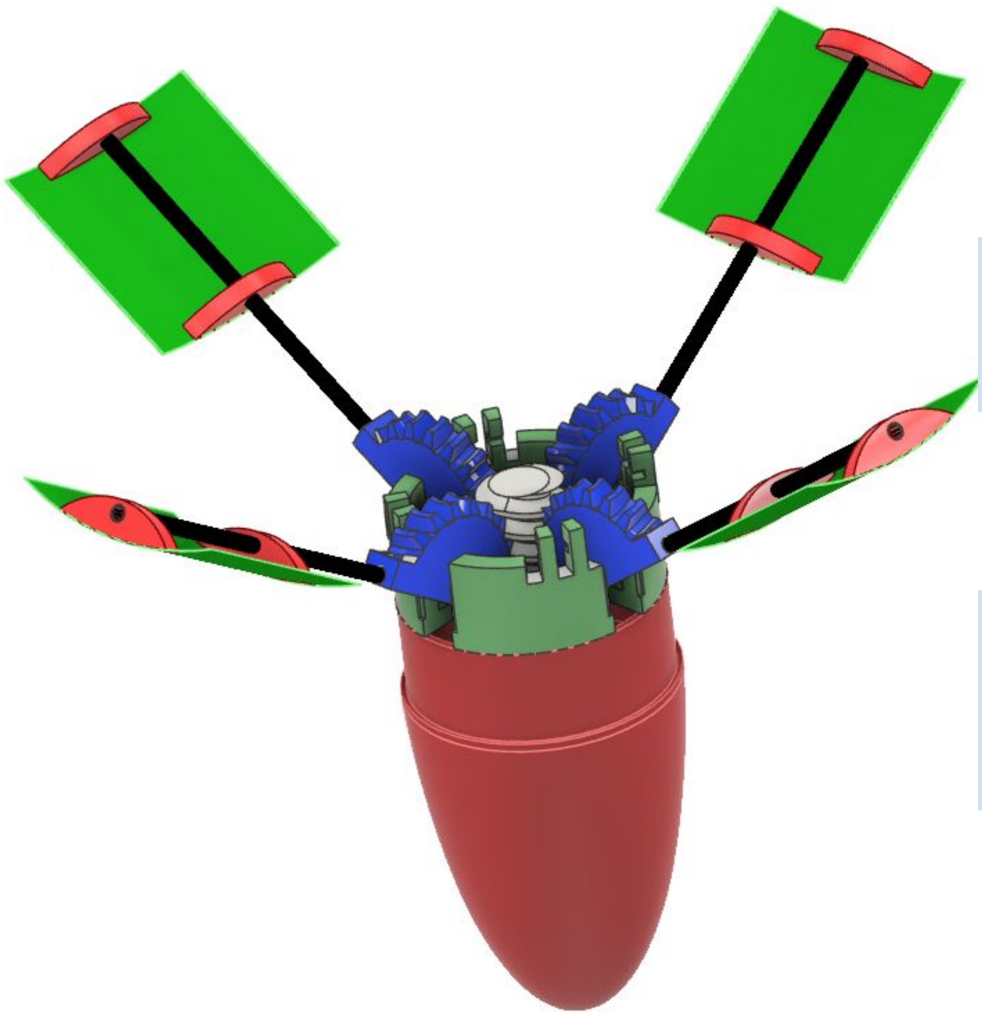
Passive Nadir Stabilization



Stability is controlled passively, the center of pressure sits higher than the center of mass

Center of pressure will be fixed, leaving us with no control over stabilization.

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



Passive Nadir Stabilization

Stability is controlled passively, the center of pressure sits higher than the center of mass

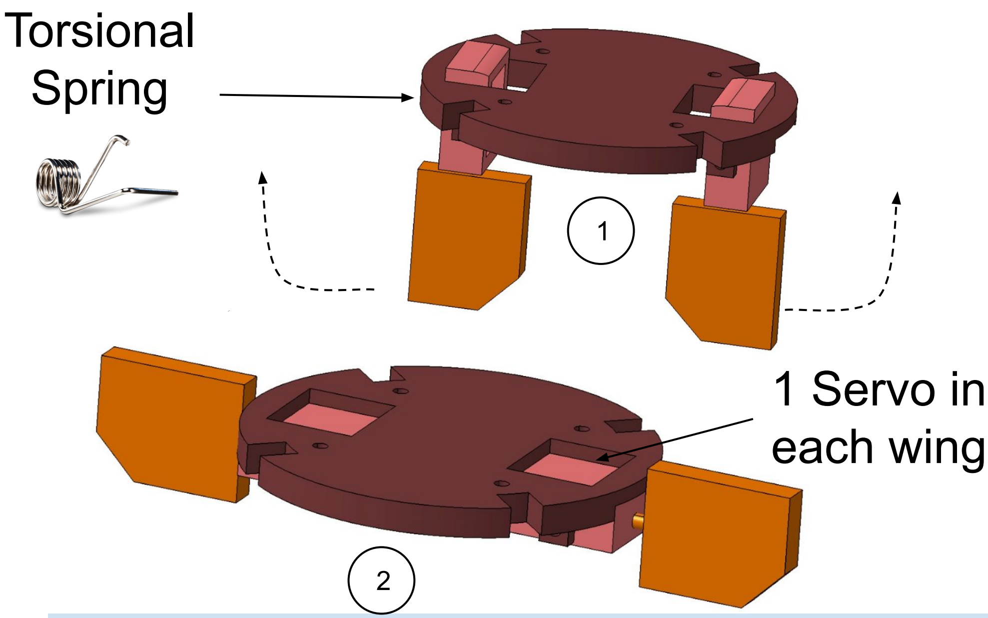
Changing the angles with the servo, we can change terminal velocity and position of the center of pressure, giving us some control over stabilization.

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

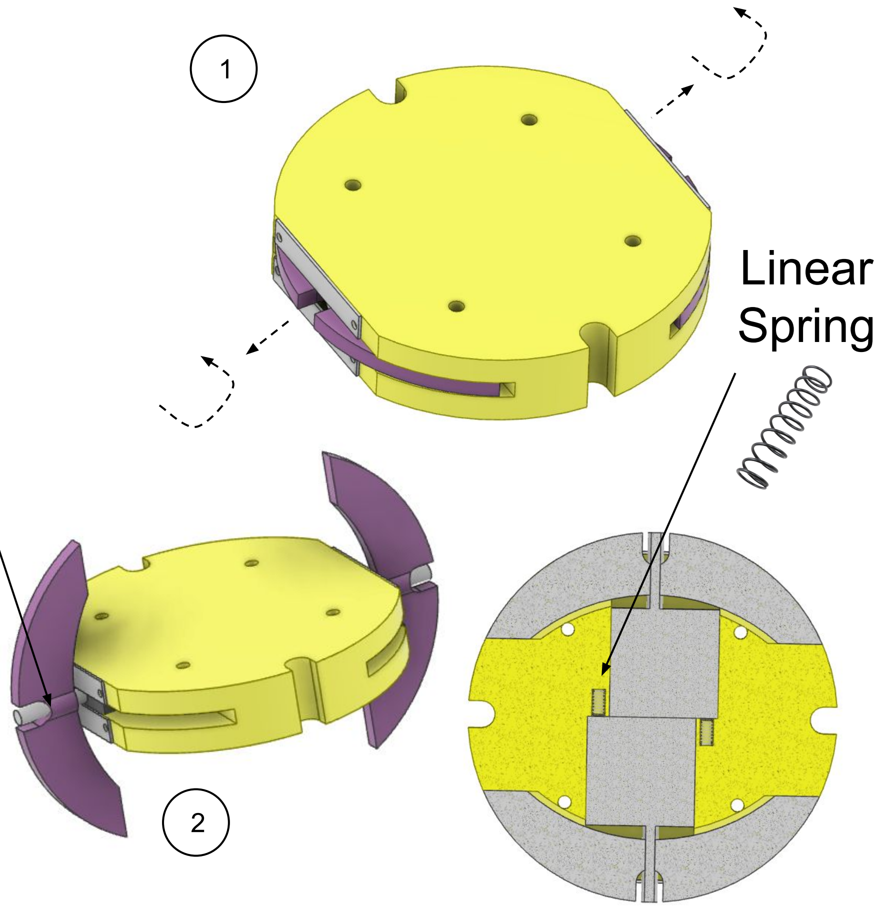
Conclusion	Design 1 is chosen because ● As there is a safe difference between the 2 Center, it is very stable ● Needs 1 less servo The fins that control the rotation stability can also help for maintaining the nadir direction

Payload Rotation Control Strategy Selection and Trade (1/2)

Design 1



Design 2



Both designs open the fins at deployment of the Cansat burning with nichrome wire a fishing line that maintains them in place.
The fins can rotate separately and by tilting in opposite directions it can control the rotation of the Cansat. This way the camera always points the same direction

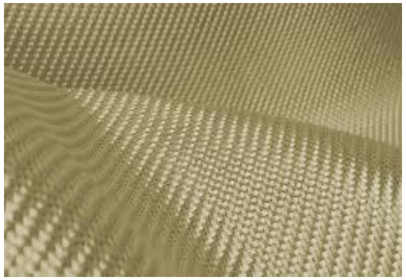
Payload Rotation Control Strategy Selection and Trade (2/2)

Design	**Design 1**	**Design 2**
Advantages	• Active rotation stabilization • Deployment movement is helped with the wind	• Active rotation stabilization • Less Space
Disadvantages	• Takes more space	• Wings have limited length because of diameter restrictions • More time needed to reach operating position
Conclusion	Design 2 is chosen because • less vertical space needed	

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

Parachute Type	**Hexagonal**	**Hemisferical**	**Cross-Parachute**
Reference			
Advantages	• Ease of manufacturing • Lightweight • Compact • Reduced oscillation during freefall	• Stable with spill hole • High coefficent of drag • Good for low drop altitude	• Ease of manufacturing • Stable • Easy to fold
Disadvantages	• Low coefficent of drag	• Hard to make	• Deployment is challenging • Low coefficent of drag
Conclusion	Hexagonal design is chosen because ● Ease of manufacture		

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

Parachute Material	Nylon	Kevlar	Silk
Reference			
Advantages	• Common • Elastic • Low porosity • Wind resistant • Inexpensive	• High tensile strenght • Heat resistant	• Lightweight • Wind resistant • Easy to fold
Disadvantages	• Heat sensitive • Non Biodegradable	• Expensive	• Expensive
Conclusions	Nylon is chosen because ● it is cheaper		

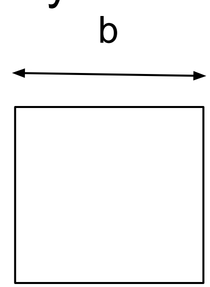
Descent Rate Estimates (1/3)

Assumptions

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

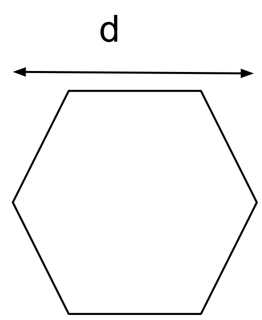
Heat Shield

- $m_1 = 0{,}9 \ kg$
- $\rho_1 = 1{,}15 \ kg/m^3$ (at 725 m)
- $A_1 = b^2$
- $Cd_1 = 0{,}5$ (should be experimentally verified)



Parachute

- $\mathrm{m}_2 = 0{,}7 \ \mathrm{kg}$
- $\rho_2 = 1{,}2 \ kg/m^3$ (at 100m)
- $A_2 = 3\sqrt{3}/8 \ d^2 = 0{,}6495 \ \mathrm{d}^2$
- $Cd_2 = 0{,}8$ (should be experimentally verified)



Variables
m : Mass
g : Acceleration of the Earth
ρ : Density of the Air
v : Terminal Velocity
Cd : Drag Coefficient
A : Area
d : length of the diagonal of the hexagon
b : length of the side of the square

Descent Rate Estimates (2/3)

Equations

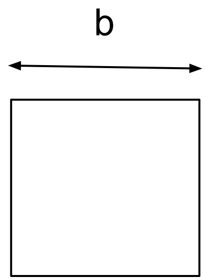
$$F_{gravity} = F_{drag}$$

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

Heat Shield

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

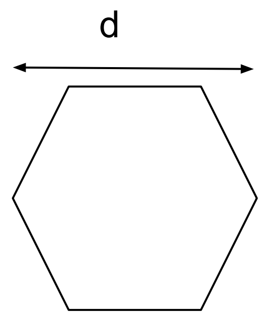
$$b = \sqrt{\frac{2mg}{\rho C_d v^2}}$$



Parachute

$$v = \sqrt{\frac{2mg}{\rho C_d 0{,}6495 d^2}}$$

$$d = \sqrt{\frac{2mg}{\rho C_d 0{,}6495 v^2}}$$



Variables
m : Mass
g : Acceleration of the Earth
ρ : Density of the Air
v : Terminal Velocity
Cd : Drag Coefficient
A : Area
d : length of the diagonal of the hexagon
b : length of the side of the square

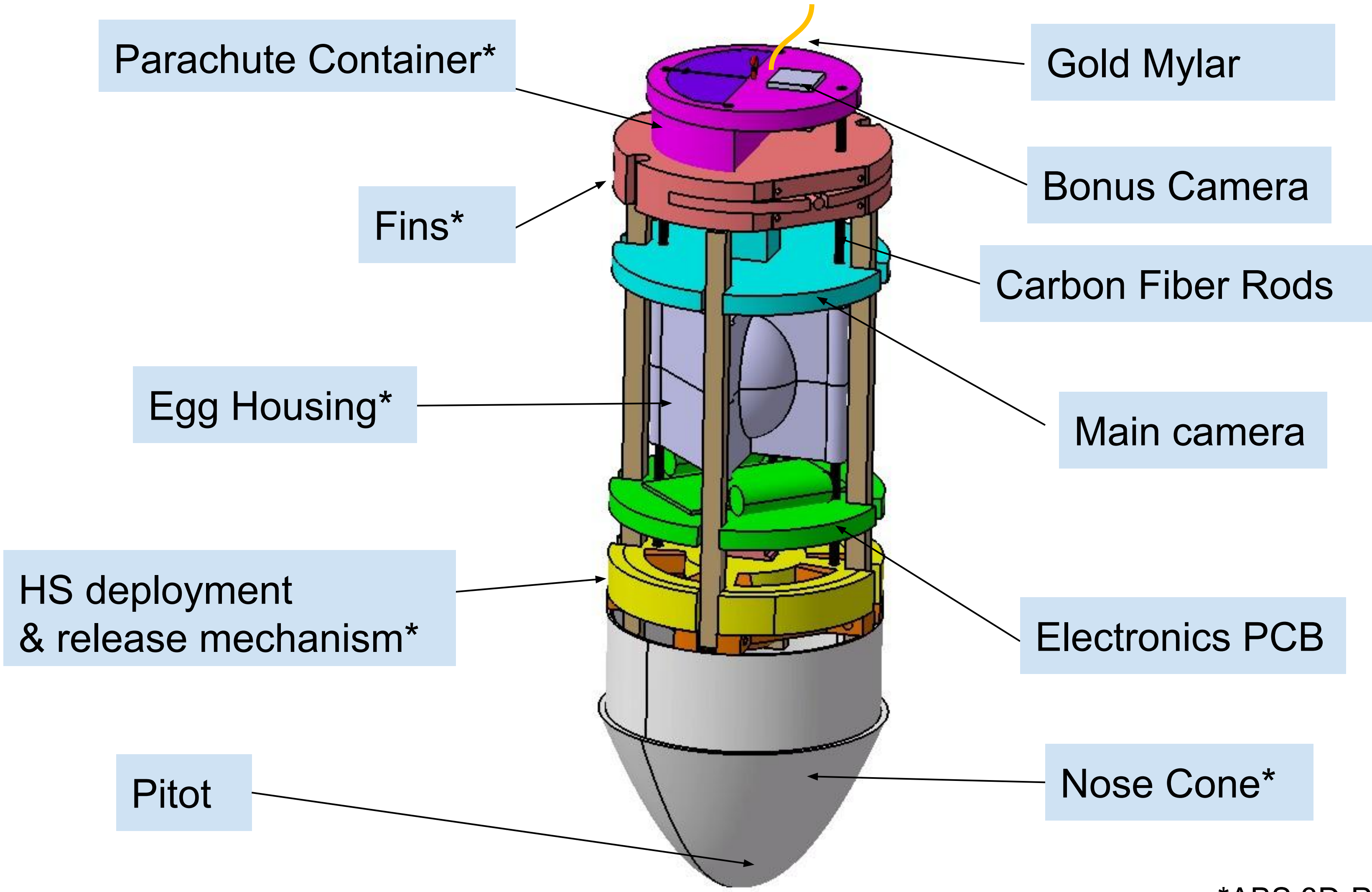
Descent Rate Estimates (3/3)

Heat Shield	Parachute
The descent rate should be 10-30 m/s We decide v = 15 m/s to have margin b = 0,369 m We choose b = 0,37 m for ease of assembly v = 14,977m/s	The descent rate should be les than 5 m/s We decide v = 3 m/s to have margin d = 1,56439 m We choose d = 1,56 m for ease of assembly v = 3,008 m/s

Mechanical Subsystem Design

Nicolas Martone & Ezequiel Bolzico

Mechanical Subsystem Overview



*ABS 3D-Printed

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

Selection of material for the rods

	Aluminium Rods	Carbon Fibre Rod	Threaded Rods
Density g/cc	2.70	1.8	7.8
Strength	Medium to High	Very high	High
Corrosion Resistance	Good	Non-corrosive	High
Price	Medium	More expensive	Cheapest
Modulus of elasticity (E) Gpa	68.9	228	210
Tensile strength (σ) Mpa	450	1035	240
Specific stiffness (E/ρ)	25.6	43.8	26,9
Specific tensile strength (σ /ρ)	166	647	30,7
Advantages	-	Very easy to handle as well as lightweight.	Easier positioning of each floor

Despite being more expensive, Carbon fibre rods are chosen since they are lighter and stronger than other options

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

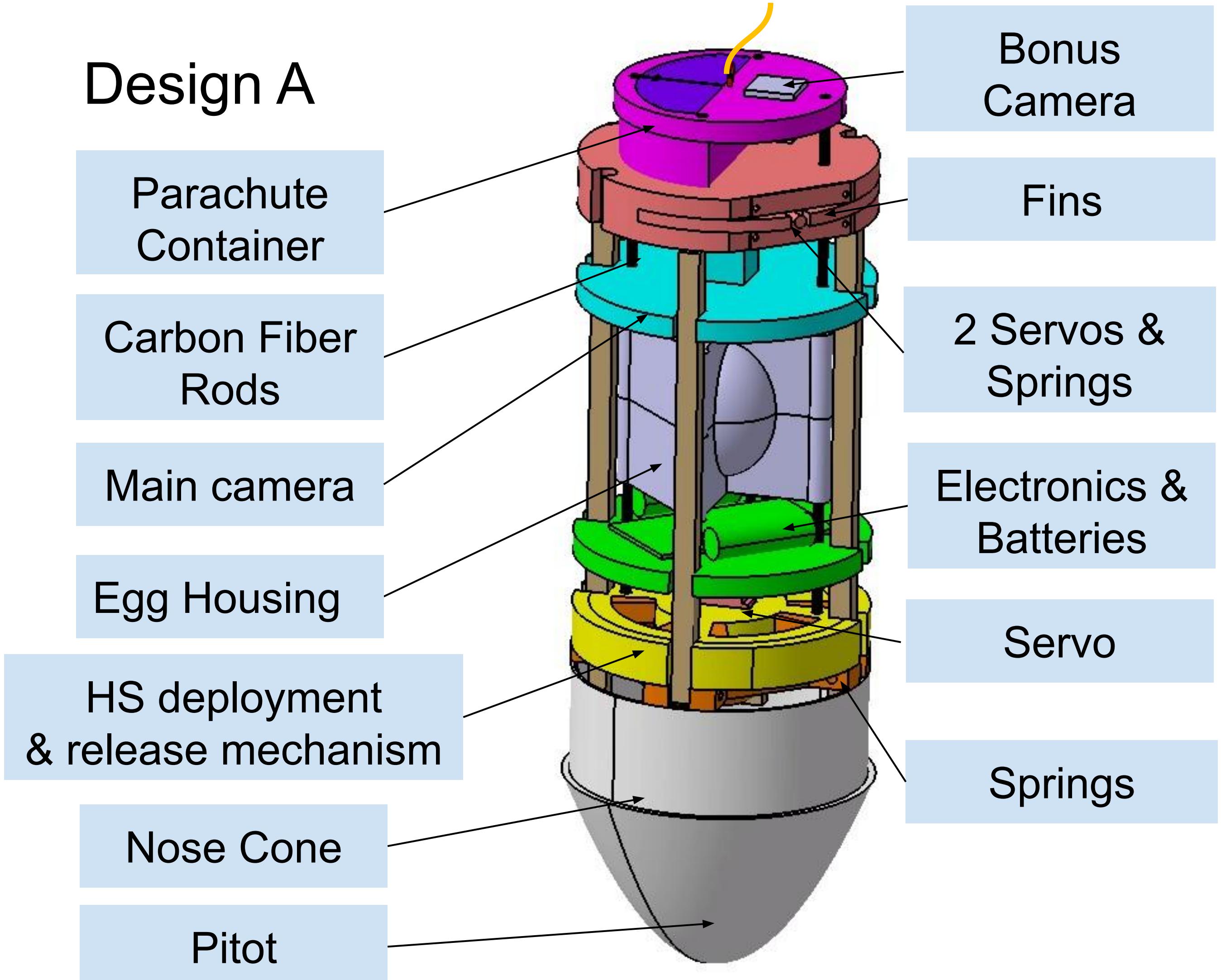
Selection of material for 3D printing

	PETG	ABS	PLA
Support Structure	Breakaway	Breakaway	Breakaway
Density	1.29 g/cm^3	1.05 g/cm^3	1.24 g/cm^3
Tensile Strength	XZ:45.8 MPa	XZ:41 MPa	XZ: 48 MPa
Flexural Stress	XZ:68 MPa	XZ:74 MPa	84 MPa
IZOD Impact, notched	XZ: 80 J/m	XZ: 205 J/m	XZ: 27 J/m
Heat Deflection Temperature	73 °C	82 °C	51 °C
Tg	~=80 °C	~=110 °C	~=62 °C
Advantages	High-impact mechanical parts that may be exposed to moderate heat loads are ideal for this material.	Strong (impact)	Low cost Fast printing

ABS is chosen since its Heat Distortion Temperature and Tg are higher than PLA's and PETG's.

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

Design A

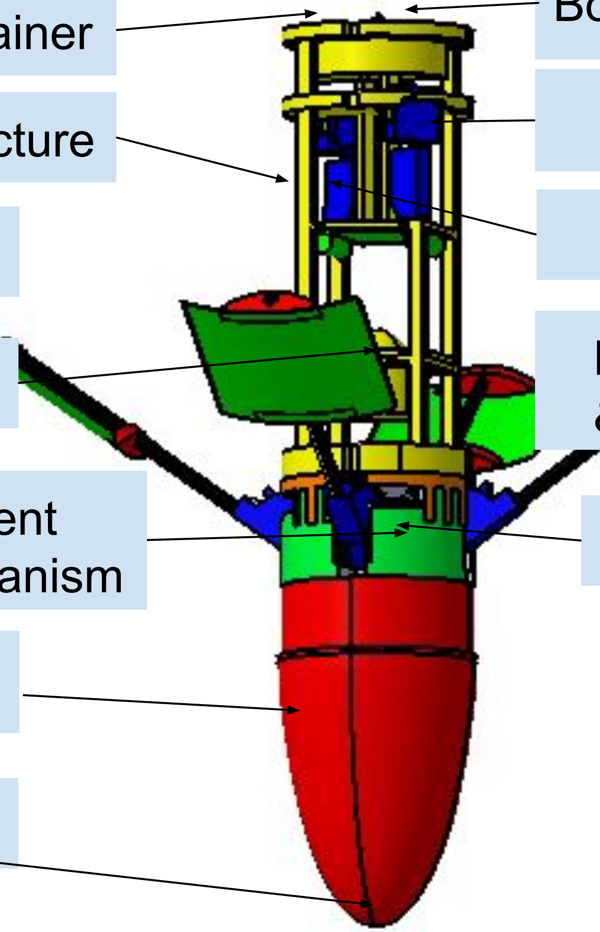


Electronics:

- XBee
- Antenna
- Microcontroller
- Sensors
- etc.

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

Design B



Electronics:

- XBee
- Antenna
- Microcontroller
- Sensors
- etc.

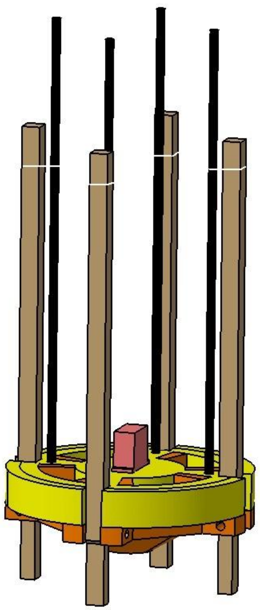
Payload Mechanical Layout of Components Trade & Selection (5/5)

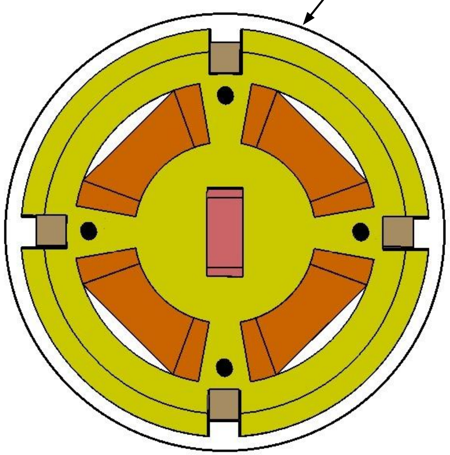
Design	Design 1	Design 2
Advantages	• resistant • modular • lighter	• structure only needs to be printed • cheap
Disadvantages	• expensive • the shelves need to be attached to the rods	• less resistant • if the structure is damaged, everything needs to be printed again • needs more material to be resistant • heavier
Conclusion	Design A is chosen • it's lighter and modular	

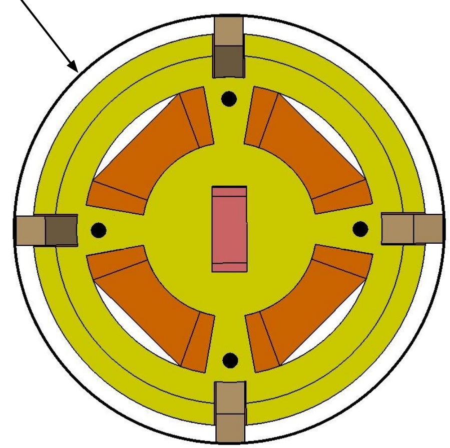
Design 1

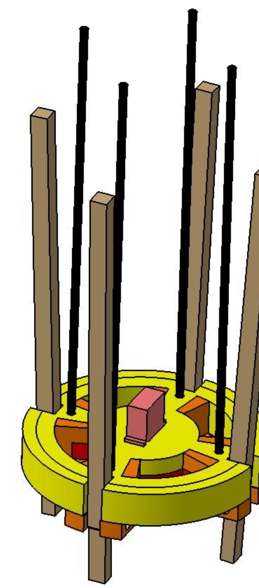
Design 2

Payload section









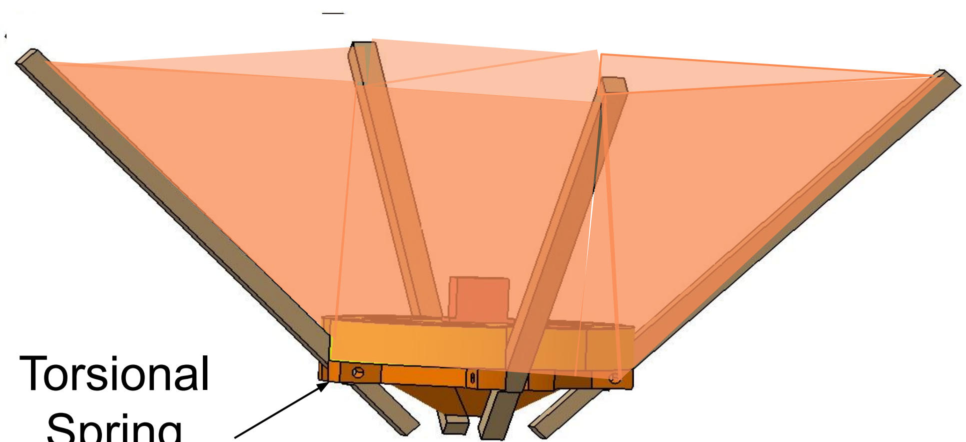
Design 1: The heat shield is kept inside the cansat with a fishing line.
For deployment, the fishing line is burned with a nichrome wire

Design 2: The heat shield rests on the payload section's wall.
Ready for deployment when the cansat separates from the rocket

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

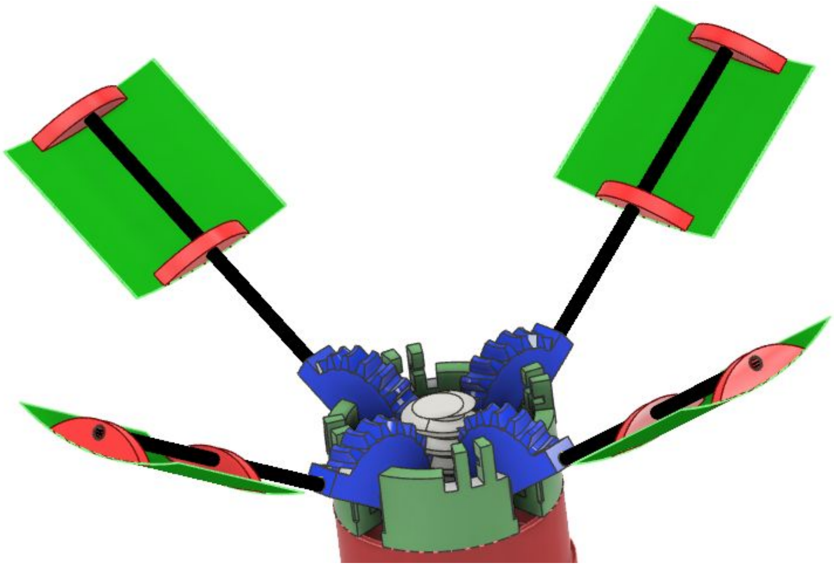
Design	Design 1	Design 2
Advantages	• Easier to introduce in the payload section	• Doesn’t need a mechanism to transition from stowed to deployed configuration
Disadvantages	• Load on the electric system	• Friction between heat shield and payload section’s wall
Conclusion	Design 1 is chosen since it’s more reliable and there isn’t a chance the Cansat gets struck in payload area.	

Design 1



Each leg has a torsion spring at the pivot.
Heat Shield auto deploys.

Design 2



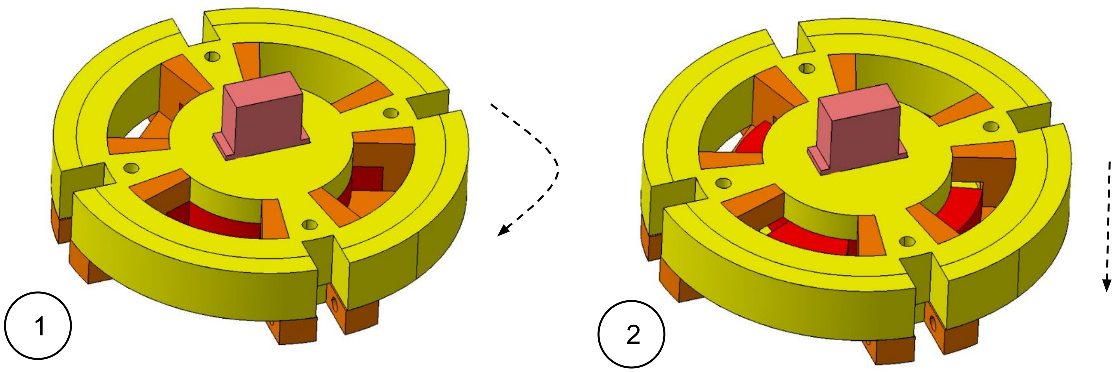
Each leg has a half gear meshed with a central screw.
Deployment is controlled with a servo.

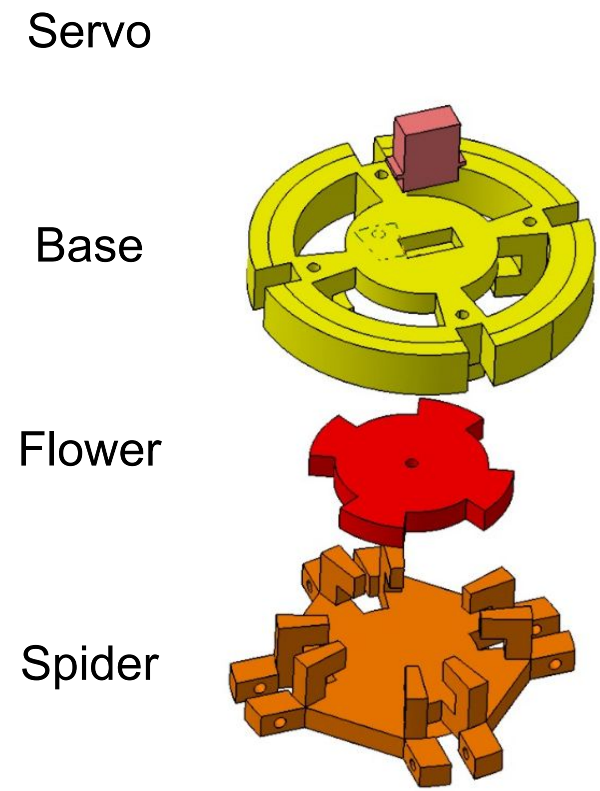
Payload Aerobraking Deployment Configuration Trade & Selection (2/2)

Design	**Design 1**	**Design 2**
Advantages	• Less weight • No servos required	• Can control center of pressure & air speed with servo
Disadvantages	• Does not have a locked position	• Need for another servo
Conclusion	• Design 1 is chosen because it is more simple and lighter	

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

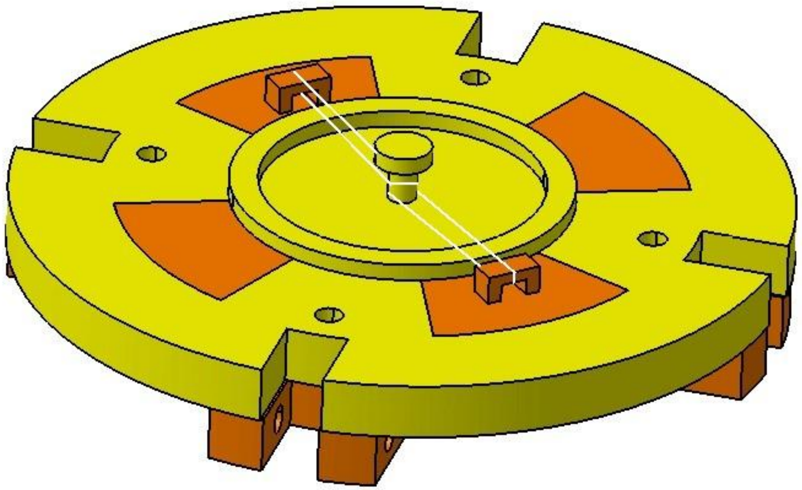
Design 1

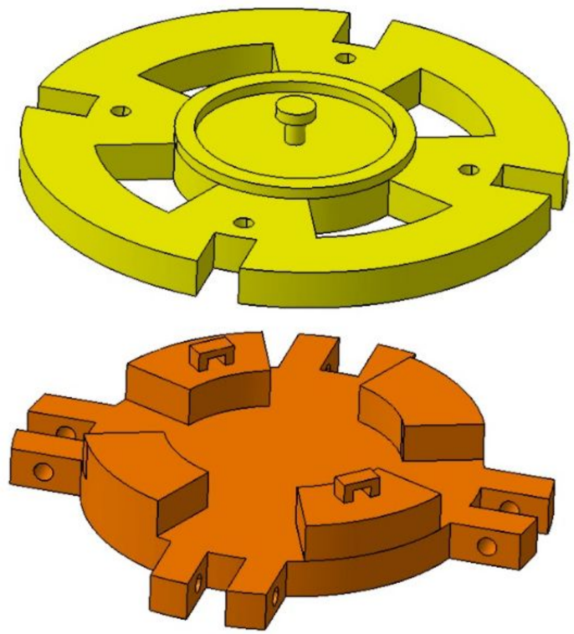




Base is connected to the rest of the Cansat.
Spider is connected to the HS and Nose Cone. Flower holds together both elements.
With the help of the Servo the Flower rotates and the Spider can be released from the Base.

Design 2





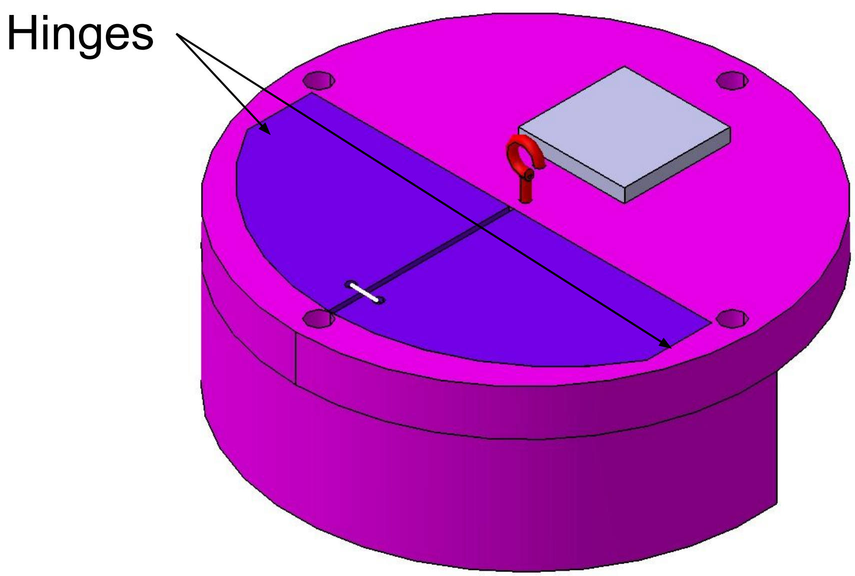
Base is connected to the rest of the Cansat
Spider is connected to HS and Nosecone.
They interlock due to their form and detach from each other by burning the fishing line that holds them.

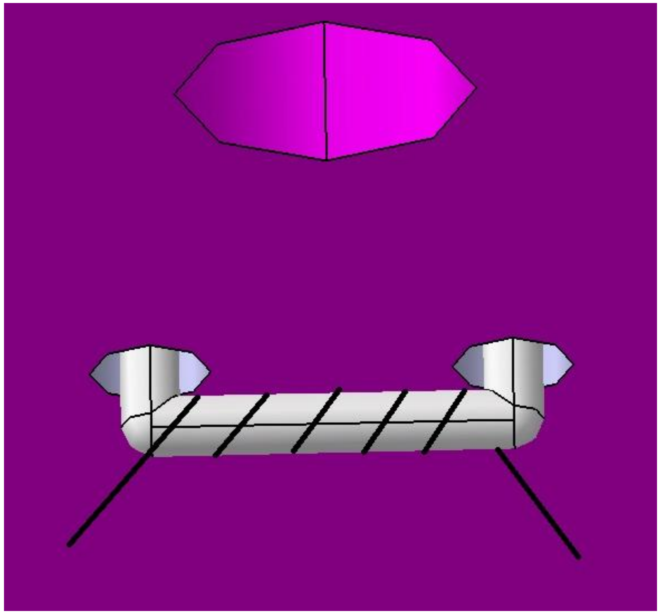
Payload Aerobraking Release Configuration Trade & Selection (3/3)

Design	Design 1	Design 2
Advantages	• More robust • More Reliable	• Lighter • Doesn´t require actuators
Disadvantages	• Requires a servo • More complex/heavier	• High chances of unwanted release
Conclusion	• Design 1 is chosen because it is more reliable	

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

Design A: Line

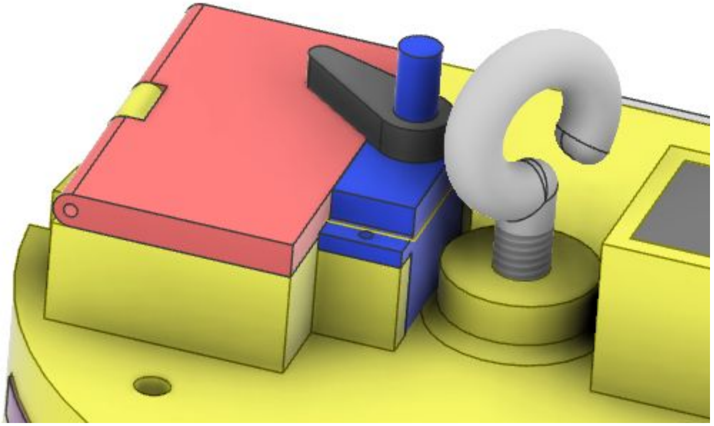




- The parachute wires attach to an eye bolt
- Parachute is folded inside the Parachute housing
- Parachute is held by 2 doors and a fishing line
- For deployment a nichrome wire cuts the line and the doors pivot on hinges

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

Design B: Servo



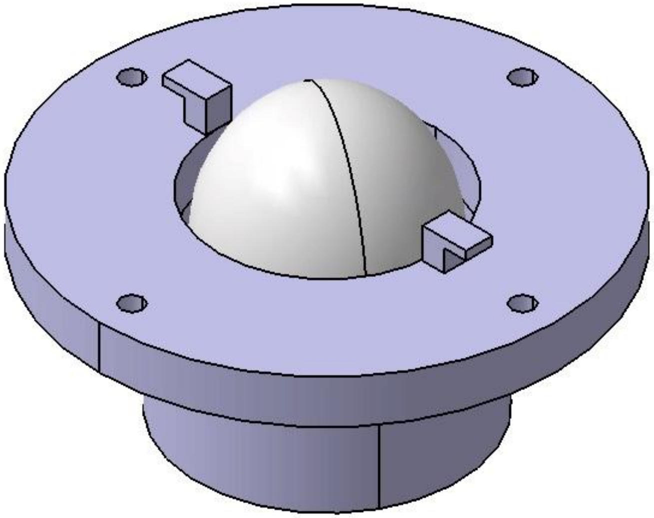
- The parachute wires attach to an eye bolt
- Parachute is folded inside the Parachute housing
- Parachute is held by a lid with a lock
- For deployment a servo makes the lock rotate and allows the lid to open

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

Design	Design A	Design B
Advantages	• Lighter • Easiest release method • Cheaper	• More Reliable • More Robust
Disadvantages	• Parachute has to push the door	• More power consumption (servo) • Heavier
Conclusion	Design A is chosen because • it is cheaper, lighter and more simpler.	

Payload Egg Containment Configuration Trade & Selection (1/3)

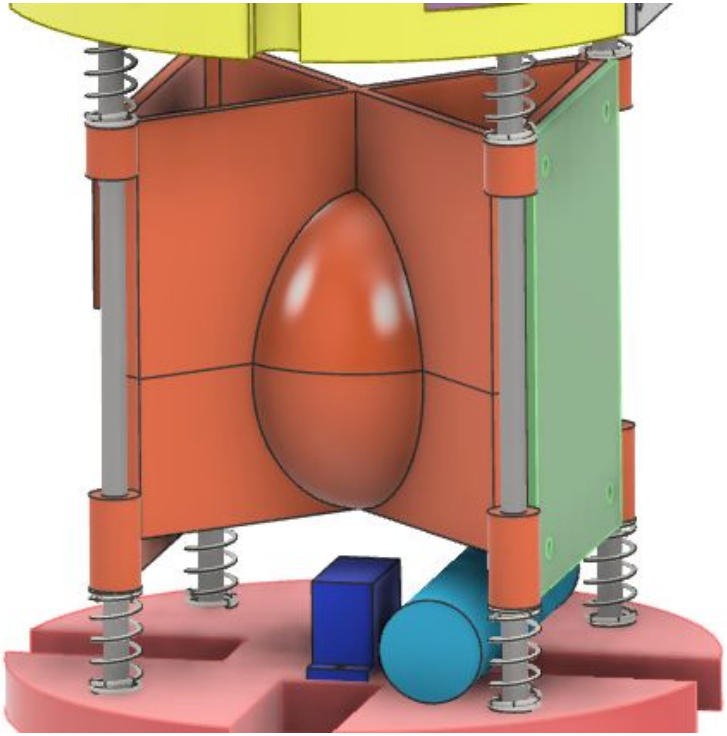
Design 1



- The egg is inserted in a cylinder
- The cylinder has cloth or fabric for shock absorption
- The egg is held down by a leather strap

Payload Egg Containment Configuration Trade & Selection (2/3)

Design 2



- The egg is inserted in a two-part capsule.
- The capsule is lined with a sponge to absorb variations in the eggs shape.
- The capsule is suspended by springs to absorb shocks.

Payload Egg Containment Configuration Trade & Selection (3/3)

Design	**Design 1**	**Design 2**
Advantages	• Less space used	• Absorbs vibrations
Disadvantages	• Can't absorb vibrations	• Egglike shape for the Egg holder is difficult to manufacture
Conclusion	Design B is chosen because • springs cushion better the vibrations and shocks.	

Electronics Structural Integrity

Electronic Mounting	
Material	**Properties**
Hot melt silicone	● It has a melting point of roughly 100 degrees Celsius. ● It's simple to use. ● It's a thermoplastic glue that can be implemented using a hot glue gun.
Mounting slot	● A component of the payload's structure as components are fitted to the Payload framework.
High Performance Adhesive	● Components are firmly adhered to the payload framework. ● Permanent. ● Lightweight. ● Surface-applicable.
Screws and Standoffs	● The majority of components are through-hole modules with screw holes. ● Secures components in a robust manner. ● Sizes can vary
Payload Enclosure Method	
Payload’s walls	● The payload’s electronics are enclosed with a 3d printed sleeve

Mass Budget (1/5)

Electronics Mass Breakdown		
Component	**Mass[g]**	**Source (Estimate/Manufacturer/Datasheet)**
MCU: ESP32	10	Manufacturer
Camera: Quelima SQ11 x 2	30	Manufacturer
Battery: Samsung INR18650	46.5	Datasheet
PCB + Resistors + Capacitors + Power Switches	40	Estimate
Sensor: BMP280 module	1	Manufacturer
RTC module + battery	11	Datasheet
GPS Ublox NEO-6M + Antenna	16	Datasheet
XBEE S2C PRO + Radio Antenna	4.2	Manufacturer
MPXV7002 + Pitot Tube	10	Estimate

Mass Budget (2/5)

Electronics Mass Breakdown		
Component	**Mass[g]**	**Source**
Cables & Connectors	10	Estimate
Mechanical Switch	1	Estimate
Buzzer	1	Datasheet
DC/DC Boost Converter Xl6009 Module	12	Manufacturer
LDO	0.5	Estimate
Servo Tower Pro Mg90 x3	40.2	Manufacturer
Sensor MPU-6050	5	Manufacturer
NiCr Wire x3	1	Estimate
TOTAL = 239,4 g		

Mass Budget (3/5)

Mechanics Mass Breakdown (1/2)		
Component	**Mass[g]**	**Source**
Carbon Fiber Rods x 4	44,1	Estimate
Fins x 2	9.3	Slicer estimate
Fins floor	40.5	Slicer estimate
Egg holder	39,3	Slicer estimate
Nose cone	171.8	Slicer estimate
Parachute Housing	60.9	Slicer estimate
Parachute door	2,8	Slicer estimate
Heat shield legs x 4	43,6	Slicer estimate
Heat shield deployment mechanism (Spider)	65.1	Slicer estimate
Heat shield deployment mechanism (Base)	68.6	Slicer estimate

Mass Budget (4/5)

Mechanics Mass Breakdown (2/2)		
Component	**Mass[g]**	**Source**
Heat shield deployment mechanism (Flower)	18.5	Estimate
Nylon	16	Estimate
Parachute	56.3	Estimate
Torsion Spring x 4	10	Estimate
Linear Spring x 10	20	Estimate
TOTAL = 666.8 g		

Mass Budget (5/5)

Total Budget	
System	**Mass[g]**
Electronics	239.4
Mechanics	666,8
Total	906,2

We estimate a margin of error in the mass calculation due to uncertainties in each component and the added mass of assembly materials (Glues, wires length, screws, etc)

Our calculated mass falls in the tolerance range.

We may need to raise infill if some parts don't fulfill strength requirements. If we go over the mass limit further analysis is needed to determine where weight saving is possible

Communication and Data Handling (CDH) Subsystem Design

Matías Bergerman

Payload Command Data Handler (CDH) Overview

Payload		
Model	Type	Description
NodeMCU ESP32	Microcontroller + memory	• Runs all the software for the payload. • Handles data from all sensors. • Coordinates actuators
XBee S2C + Whip wire antenna	RF Module + Antenna	• Sends telemetry to the Container at a rate of 4 packets per second. • Data can be stored, prepared and relayed to Ground Station.

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

Name	Outline Size [mm]	Weight [gr]	Flash Memory [KB]	SRAM [KB]	Boot Time	Clock Speed [MHz]	Microcontroller	Interfaces	Price($)
Arduino Nano	45x18	7	32	2	1.5 s	16	ATmega328	SPI: 1 I2C: 1 UART: 1	20.7
NodeMCU ESP32	48x26	9.3	4000	520	200 ms	240	Xtensa® 32-bit LX6	SPI: 4 I2C: 2 UART: 3	11.5
NodeMCU ESP8266	58×31	10	4000	32 instruction + 96 user	300 ms	160	Xtensa® 32-bit LX3	SPI: 2 I2C: 0 UART: 2	6.6
BluePill STM32	53x23	9	64	20	150 ms	72	STM32F103C8T6	SPI: 2 I2C: 2 UART: 3	8.85
Raspberry Pi Pico	52.3x21	9	2000	264	2 s	240	RP2040	SPI: 2 I2C: 2 UART: 1	7

Selected Processor: NodeMCU ESP32

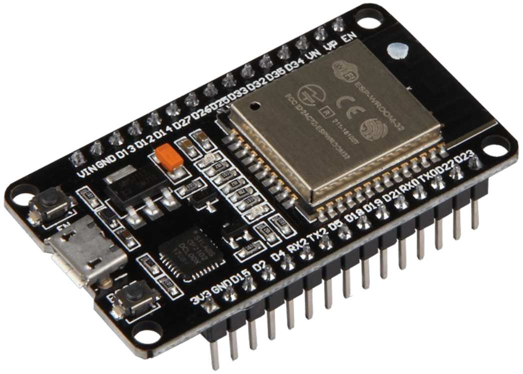
Payload Processor & Memory Trade & Selection (2/3)

Name	Outline Size [mm]	Weight [gr]	Flash Memory [KB]	SRAM [KB]	Clock Speed [MHz]	Microcontroller	Interfaces	Price ($)
NodeMCU ESP32	48x26	9.3	4000	520	240	Xtensa® 32-bit LX6	SPI: 4 I2C: 2 UART: 3	11.5

Selected Processor: NodeMCU ESP32

Reasons:

- There are MicroPython implementations for the ESP32, as well as C compilers, which is suitable for firmware development.
- Complies with the number of interfaces needed (1 x I2C + 2 x UART).
- Flash memory and SRAM are significantly higher than similarly priced alternatives.
- Low boot time allowing fast recovery from power reset.



Note:
Available online information regarding boot times is not completely reliable, and will be dominated by the firmware implementation and bootloader choice. This parameter will be measured experimentally when prototyping starts.

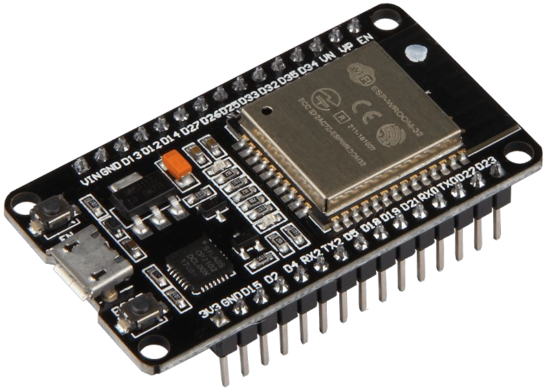
Payload Processor & Memory Trade & Selection (3/3)

Name	Size [mm]	Weight [g]	Type	Max size	Interface	Price ($)
Micro SD card Module	42x24x3.5	10	Read/Write	32GB	SPI	0.86
NodeMCU ESP32 internal Flash Memory	Integrated	Negligible	Read/Write	4MB	Integrated	No additional cost

Selected memory: NodeMCU ESP32 internal Flash

Reasons:

- Considering 2024 CanSat code to be close in size as last year's (roughly 32 KB), 4MB is more than enough to store the code as well as telemetry backup information.
- Does not require additional space, cost or weight.



Payload Real-Time Clock (1/2)

A real-time clock with independent power supply can be implemented with a coin cell battery and an external RTC IC. This IC usually needs a 32.768 kHz crystal oscillator which may be external or internal.

RTC IC	Package	Battery voltage range (V)	Oscillator	Interface	Vbat Current consumption (nA)	IC Price($)	Crystal Price ($)
DS3231	8-SOIC	2.5 - 5.5	Internal Crystal	I2C	840	9.3	0 (integrated)
DS1307	8-SOIC	2 - 3.5	External Crystal	I2C	300	4.27	0.15

Selected RTC: DS1307

Reasons:

- Lower price
- Lower current consumption allows for smaller battery
- Interface compatible with selected MCU
- Voltage range compatible with coin-cell batteries
- Addition of an external crystal oscillator does not significantly increase cost or weight.

Payload Real-Time Clock (2/2)

A real-time clock with independent power supply can be implemented with a coin cell battery and an external RTC IC. This IC usually needs a 32.768 kHz crystal oscillator which may be external or internal.

Battery	Voltage (V)	Size (mm)	Weight (gr)	Capacity (mAh)	Price($)
CR2032	3	20 diameter x 3.2 height	3.1	210	0.5
CR1225	3	12.5 diameter x 2.5 height	0.9	47	1.45

Selected RTC Battery: CR1225

Reasons:

- Lower footprint and weight.
- Battery capacity can supply the RTC for multiple years.

Payload Antenna Trade & Selection (1/2)

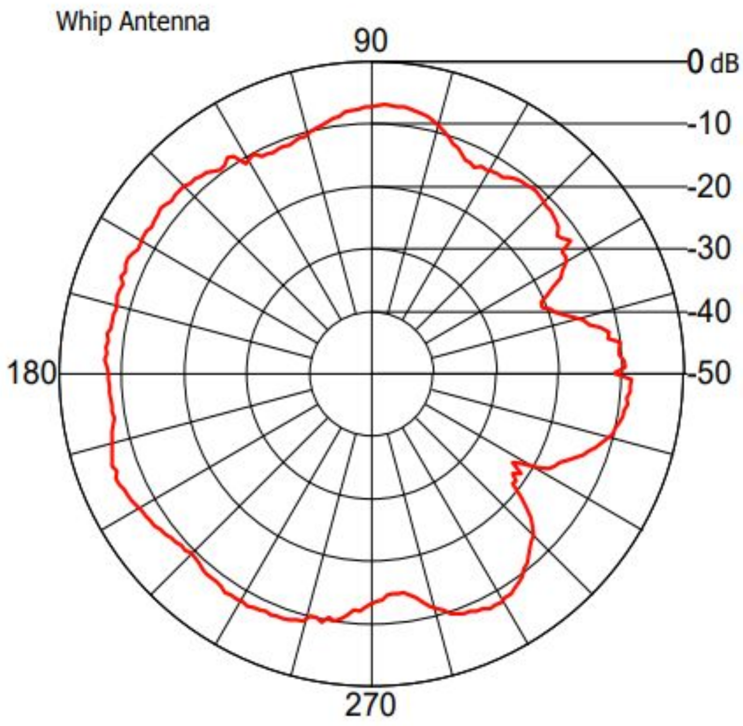
Name	Range [m]	Radiation Pattern	Dimensions [mm]	Gain [dBi]	Weight [gr]	Polarization	Connector type	Price ($)
Whip wire Antenna	1200	(1)	Length: 25	2	0 - 70	Linear	Protrudes from Xbee	Included with XBee
FXP70 Freedom 2.4 GHz	1200	(2)	Cable: 52, Ø1.13 Antenna: 27x25x0.1	1.5	0 -70	Linear	U.fl	3.35

Selected Antenna: Whip wire

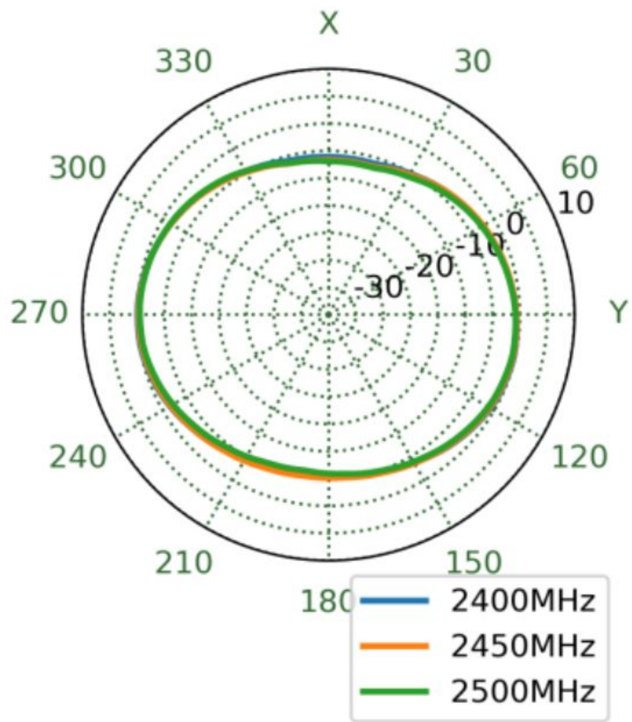
Reasons:

- Occupies little to no extra space
- Already attached to the XBee
- Distance from container to payload does not justify the extra space for a more robust antenna.
- No actual need to displace the antenna from the payload

Payload Antenna Trade & Selection (2/2)



(1)

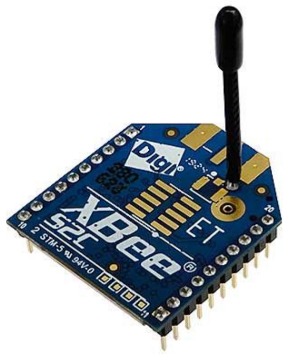


(2)

- Whip wire antenna radiation pattern was determine experimentally according to *"XBee & XBee-PRO OEM RF Module Antenna Considerations"*, this pattern was compared to the typical dipole radiation pattern (doughnut shaped).
- Where as the radiation pattern of the Taoglas antenna is omnidirectional or sphere like.
- The patterns shown here can be interpreted as the 2D projection of the whole radiation pattern over the horizontal plane (XY).

Payload Radio Configuration

Name	Frequency [GHz]	Antenna Connector	Transmit current [mA]	Receive current [mA]	Operating Voltage [V]	Range [m]	Sensitivity [dBm]	RF Data Rate [Kbps]
XBee S2C (XB24CAUIT-001)	2.4	Whip wire	45	31	2.7-3.6	3200	-101	250



- **NETID/PANID will be set to: <u>2099</u>, using XCTU software**
- XBees will **<u>not</u>** be set to broadcast mode.
- This XBee will be used to send payload telemetry at a rate of 4Hz to the container.
- Lowest range and thus lower consumption makes it a great application for short range communication.

- **The transmission control for the payload will follow the next steps:**
  - **Pre- Launch/Launch:** Payload On, not transmitting telemetry.
  - **Release of the CanSat:** Payload On, not transmitting telemetry.
  - **Release of the payload:** Container commands payload to begin telemetry. Container starts polling and relaying payload telemetry to GS with a frequency of 4Hz.
  - **Landing:** The Container shall stop polling payload telemetry and stop all transmissions when it lands.

Payload Telemetry Format (1/4)

Data Format	Example	Description
TEAM_ID	5000	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
AIR_SPEED	2	Air speed in meters per second
HS_DEPLOYED	C	‘C’ for deployed heat shield, ‘N’ otherwise

Payload Telemetry Format (1/4)

Data Format	Example	Description
PC_DEPLOYED	P	‘P’ for deployed parachute, ‘N’ otherwise
TEMPERATURE	29.4	Measured temperature in degrees Celsius
VOLTAGE	4.3	Voltage of the Cansat power bus
PRESSURE	101.2	Measured air pressure in kPa
GPS_TIME	13:14:02	Time from GPS receiver in UTC
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

Payload Telemetry Format (3/4)

Data Format	Example	Description
TILT_X, TILT_Y	75.01, 3.12	X and Y Cansat angles
ROT_Z	13.4	Rotation rate in degrees per second
CMD_ECHO	CXON	Last command received and processed
GYRO_P, GYRO_Y	18, 21	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
POINTING_ERROR	0	Yaw pointing error in degrees
WIRE_FIN, WIRE_HS, WIRE_PC	1, 1, 1	State of fins, heat shield and parachute wires. 1 for burnt wire, 0 otherwise

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, AIR_SPEED, HS_DEPLOYED, PC_DEPLOYED, TEMPERATURE, VOLTAGE, PRESSURE, GPS_TIME, GPS_ALTITUDE, GPS_LATITUDE, GPS_LONGITUDE, GPS_SATS, TILT_X, TILT_Y, ROT_Z, CMD_ECHO,, GYRO_P, GYRO_Y, ACCEL_R, ACCEL_P, ACCEL_Y, POINTING_ERROR, WIRE_FIN, WIRE_HS, WIRE_PC

- **Each telemetry field is delimited by a comma, and each packet is concluded by a single return character. Fields following the double comma in the telemetry format constitute optional data.**
- **Example:**

  1000,01:22:10,50,S,ASCENT,500.3,10,P,C,29.3,4.31,100.3,15:25:09,300.4,10.0543,20.1078,20,18.03,21.56,30.5,CXON,,18,21,30,35,33,0,1,1,1

Payload Command Formats

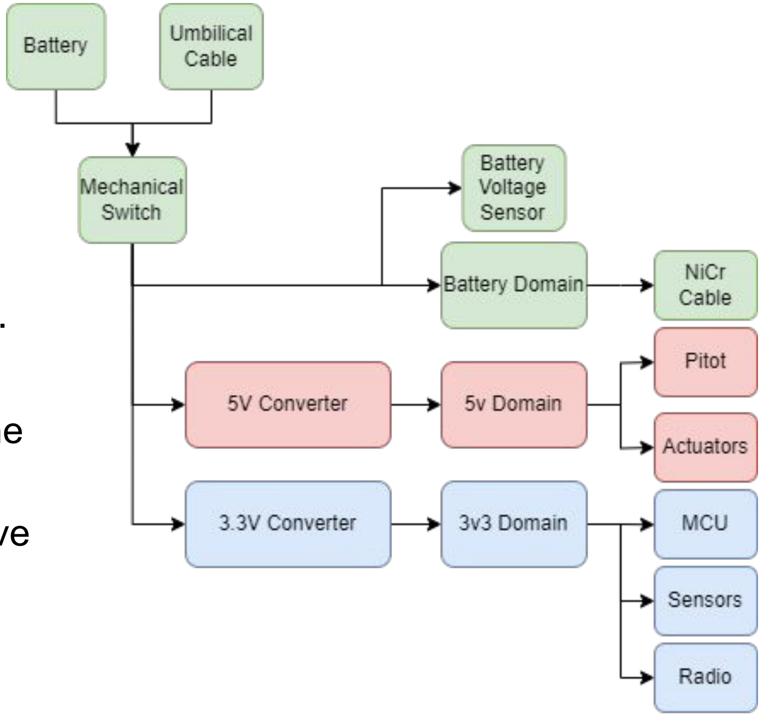
Command	Format	Command Description	Example	Example Description
CX	CMD,<TEAM_ID>,CX,<ON_OFF>	Payload telemetry On/Off command	CMD,1000,CX,ON	Activates payload telemetry transmission
ST	CMD,<TEAM_ID>,ST,<UTC_TIME>|GPS	Set time	CMD,1000,ST,13:35:59	Sets the mission time to 13:35:59
SIM	CMD,<TEAM_ID>,SIM,<MODE>	Simulation Mode Control Command	CMD,2099,SIM,ENABLE	Enables simulation mode
SIMP	CMD,<TEAM_ID>,SIMP,<MODE>	Simulated Pressure Data	CMD,2099,SIMP,101325	Provides a simulated pressure reading of 101325 Pascals
CAL	CMD,<TEAM_ID>,CAL	Calibrate Altitude to Zero	CMD,2099,CAL	Sets altitude to 0
CAL_PITCHROLL	CMD,<TEAM_ID>,CAL_PITCHROLL	Calibrate Pitch, Yaw and Roll to Zero	CMD,2099,CAL_PITCHROLL	Sets Pitch, Yaw and Roll to Zero
BCN	CMD,<TEAM_ID>,BCN,<ON_OFF>	Audio bacon On/Off command	CMD,2099,BCN,OFF	Deactivates the audio bacon

Electrical Power Subsystem (EPS) Design

Nicolas Ezequiel Professi

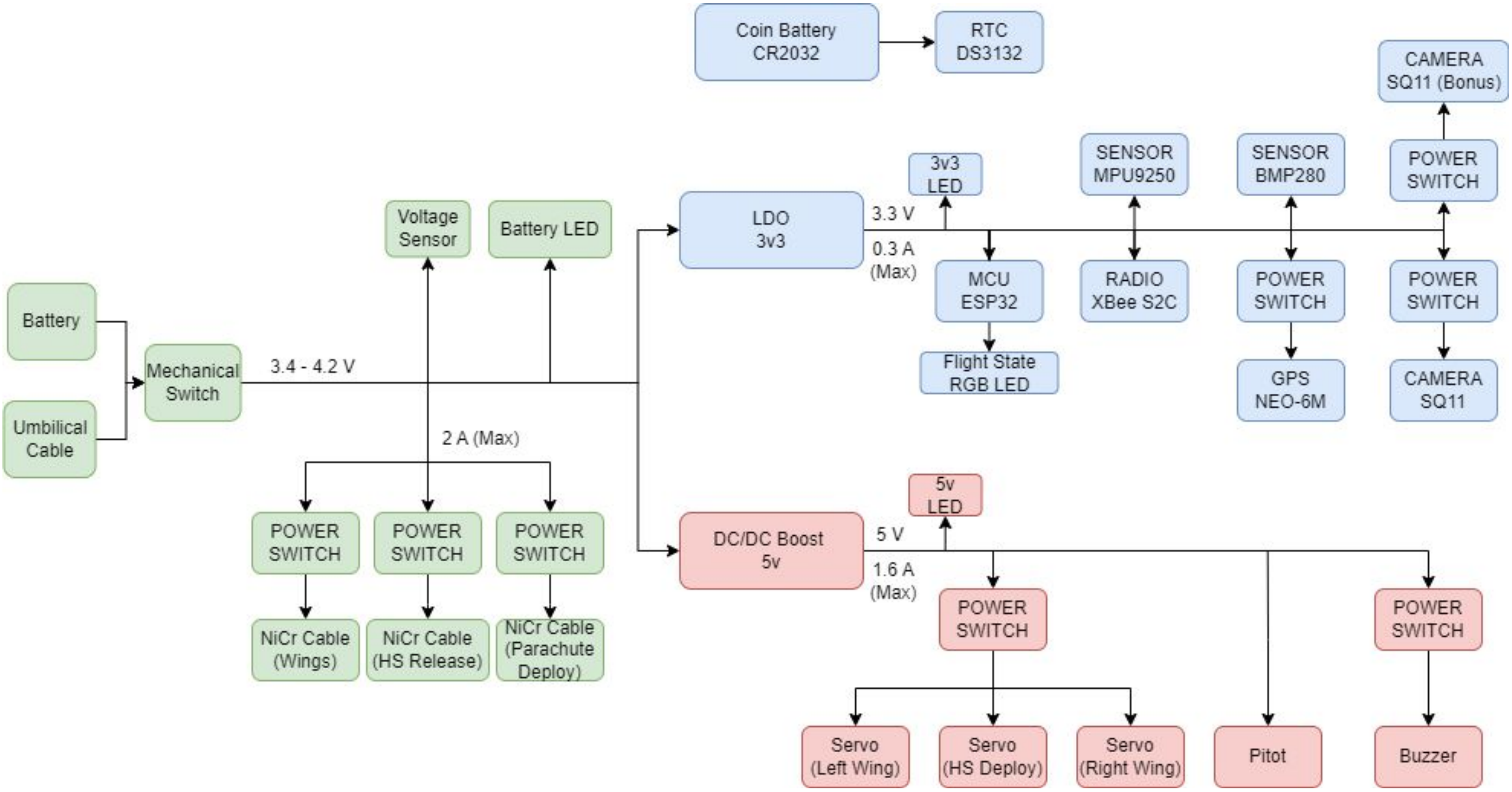
EPS Overview

- **Battery**: Used as power source for components.
- **Umbilical Cable:** Power source for testing.
- **Mechanical Switch**: To turn on and off the system.
- **Battery Voltage Sensor:** To gather battery voltage.
- **NiCr Cable**: Used to deploy spring mechanism inside the cansat.
- **5V Converter**: Elevates battery voltage using a DC/DC boost converter to 5v for the actuators and the pitot tube sensor.
- **3.3V Converter**: Decreases battery voltage using a LDO to 3.3v for the microcontroller, the sensors and the radio module.
- **Sensors**: Used for information gathering throughout flight.
- **Radio**: To provide communication between the CanSat and the Ground Station.
- **Actuators**: Used for movement control (servos), and to retrieve module after landing with a sound alarm.
- **Pitot:** Pitot tube sensor for air speed.
- **Power Switches:** To turn on and off high power components during flight.
- **LED:** Visual indication of correct voltage in every domain.
- **RTC:** Real time clock, uses a coin battery.



Simplified power distribution diagram

Payload Electrical Block Diagram



Payload Power Trade & Selection (1/3)

Name	Technology	Weight [gr]	Voltage [V]	Capacity [mAh]	Energy Density [Wh/gr]	Nominal Current [mA]	Rechargable	Price ($)
Energizer 522	Alkaline	45	9	600	0.12	150	No	2.1
Samsung INR18650	Lithium ion	46.5	3.7	2550	0.203	2750	Yes	2.6
Energizer CR123A	Lithium ion	16.5	3	1000	0.182	1500	Yes	3

Selected: Samsung 18650 (1 unit)

Reasons:

- Low weight
- Good energy density
- High nominal current
- Optimal capacity
- Rechargable

Conection: JST Connector

The battery will be electrically connected to the Container through a pair of JST connectors

Battery Connection

The battery will spot welded to nickel strips, then a cable is welded to the strip

Battery Mounting

The battery will be physically placed inside a sealed battery cavity

Payload Power Trade & Selection (2/3)

Battery configuration selection

Because all configurations exceed the minimum amount of energy required, the decision criteria are based on the maximum current during flight.

Domain	Condition	Max Current	Max Current at Battery Domain
Battery Domain	NiCr wire power on	2 A	2 A
5v Domain	Wing Servos Stalling	1,4 A	2,1 A (90% efficiency of boost converter)
3v3 Domain	MCU at full capacity + XBEE sending telemetry	0,3 A	0,3 A
TOTAL			**4,5 A**

Battery Configuration	Max Current	Voltage	Max Dischage Power
Single Cell (1S)	2,5 A (1C)	3,7 V	9,25 W
Two cells in series (2S)	2,5 A (1C)	7,4 V	18,5 W
Two cells in parallel (2P)	5 A (2C)	3,7 V	18,5 W

Selected: Single Cell (1S) configuration

Reasons:

- Although it doesn't comply with the current requirement, flight software can shut down servos while NiCr wires are powered on. In this configuration, the maximum current will be 2.4 A.
- Half weight

Alkaline:

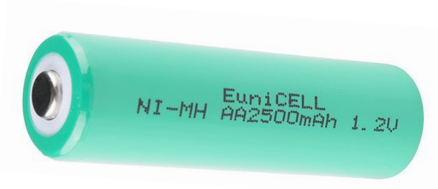
- Advantages: High discharge current
- Disadvantages: Not rechargeable, low voltage

Li-Ion:

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

Ni-Mh:

- Advantages: Rechargeable, cheaper
- Disadvantages: Higher self-discharge, low voltage



Selected: Li-Ion

Reasons:

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

Payload Power Budget (1/2)

Type	Component	Quantity	Voltage [v]	Current [mA]	Duty Cycle [s]	Duty Cycle [%]	Energy [Wh]	Source
MCU	ESP32	1	3,3	68	7200	100,00%	0,503	Datasheet
Sensor	BMP280	1	3,3	1,12	7200	100,00%	0,008	Datasheet
Sensor	ADC Pin + Voltage divider	1	3,3	0,2	7200	100,00%	0,001	Estimated
Sensor	MPU-6050	1	3,3	0,4	7200	100,00%	0,003	Datasheet
Sensor	MPXV7002 + Pitot Tube	1	5	10	7200	100,00%	0,111	Datasheet
Camera	Quelima SQ11	2	3,3	90	80	1,11%	0,015	Measured
GPS	Ublox NEO-6M	1	3,3	67	7200	100,00%	0,496	Datasheet
Actuator (Wings)	Tower Pro Mg90	2	5	300	80	1,11%	0,074	Estimated
Actuator (HS)	Tower Pro Mg90	1	5	300	80	1,11%	0,037	Estimated
Actuator	NiCr Wire	3	3,7	2000	2	0,03%	0,012	Estimated
Actuator	Led	4	3,3	5	7200	100,00%	0,148	Estimated
Actuator	Buzzer CMT-8540S	1	5	150	1800	25,00%	0,417	Datasheet
Radio	XBee XBP24CAWIT Trasmiting	1	3,3	120	80	1,11%	0,010	Datasheet
Radio	XBee XBP24CAWITI Idle	1	3,3	31	7140	99,17%	0,227	Datasheet
Total							2,063	

Payload Power Budget (2/2)

Note:

- 5V component`s power consumption was calculated considering the 90% efficiency of the DC/DC boost converter.
- 3.3V component`s power consumption was calculated using 3.7V times the component current.

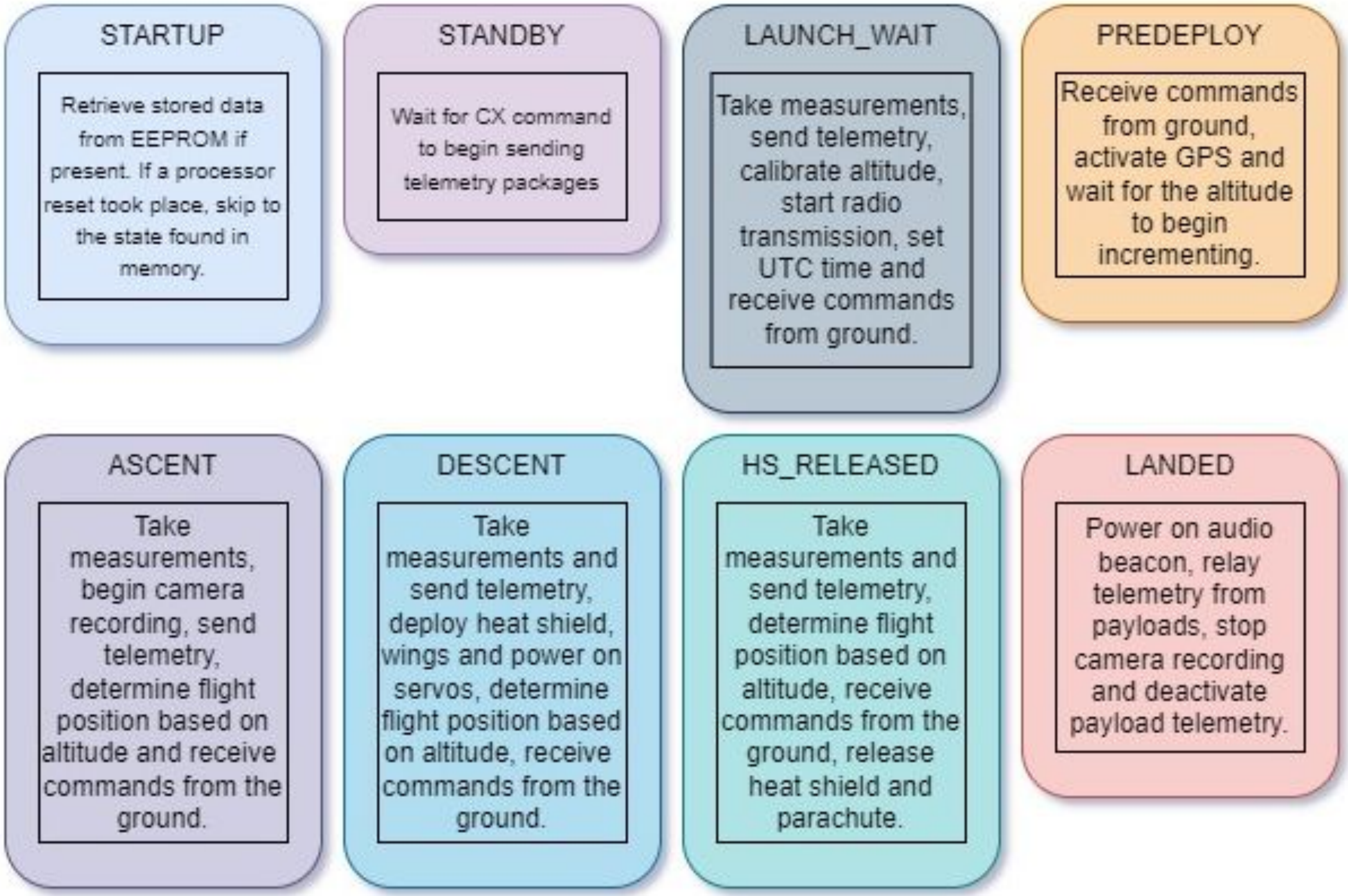
Power Source: Payload Battery	Energy [Wh]
Total Energy Consumption	2,063
Battery Energy (100% discharge depth)	9,25
Energy Margin	7,187
Operating Time (60% discharge depth)	5 Hour, 25 Min

Power Source: RTC Battery	Energy
Total Energy Consumption (RTC)	0,2 mWh
Battery Energy (100% discharge depth)	0,675 Wh
Operating Time (100% discharge depth)	20 Months

Flight Software (FSW) Design

Micaela Perillo

- **State Overview**

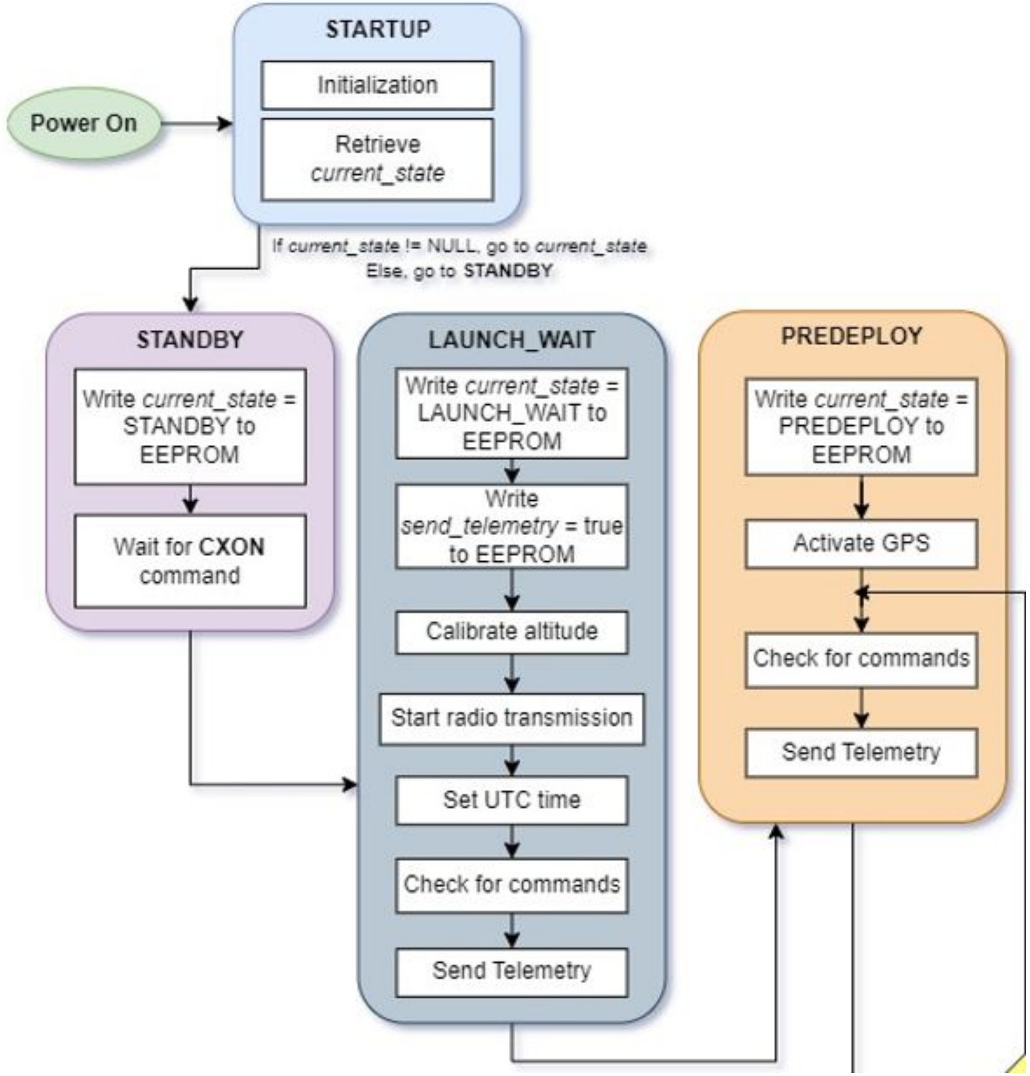


FSW Overview (2/2)

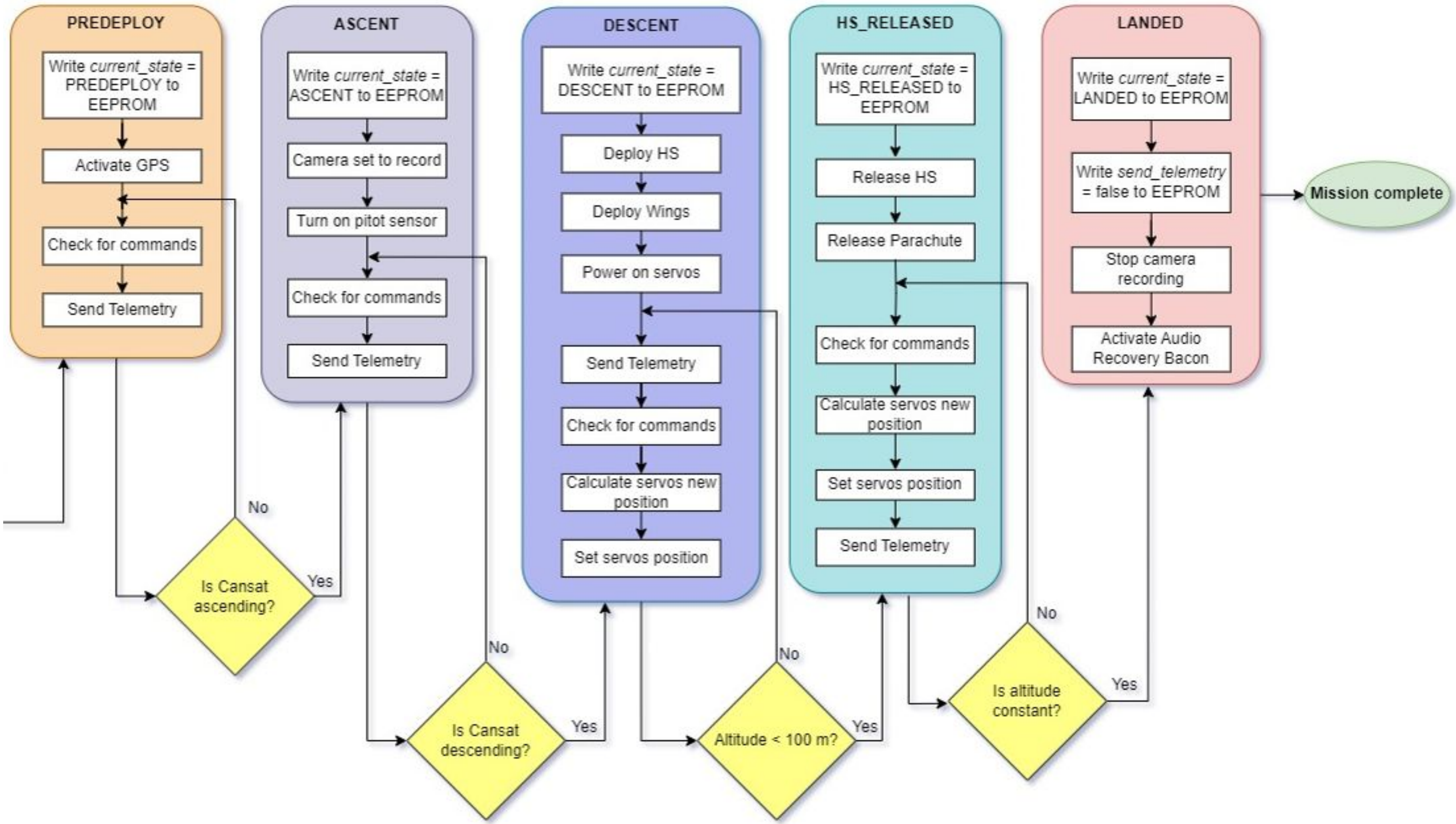
- **FSW Tasks**
  - Transmit sensor measurements once per second to the Ground Station
  - Send, receive and process commands via XBEE radios
  - Keep track of mission state (based on altitude data) in case the processor resets
  - Control deployment mechanisms
  - Power up Audio Beacon for recovery after landing
  - Keep track of mission time through processor resets
  - Operate in simulated flight mode

- Programming language: **C++**
- Development environment: **VSCode**

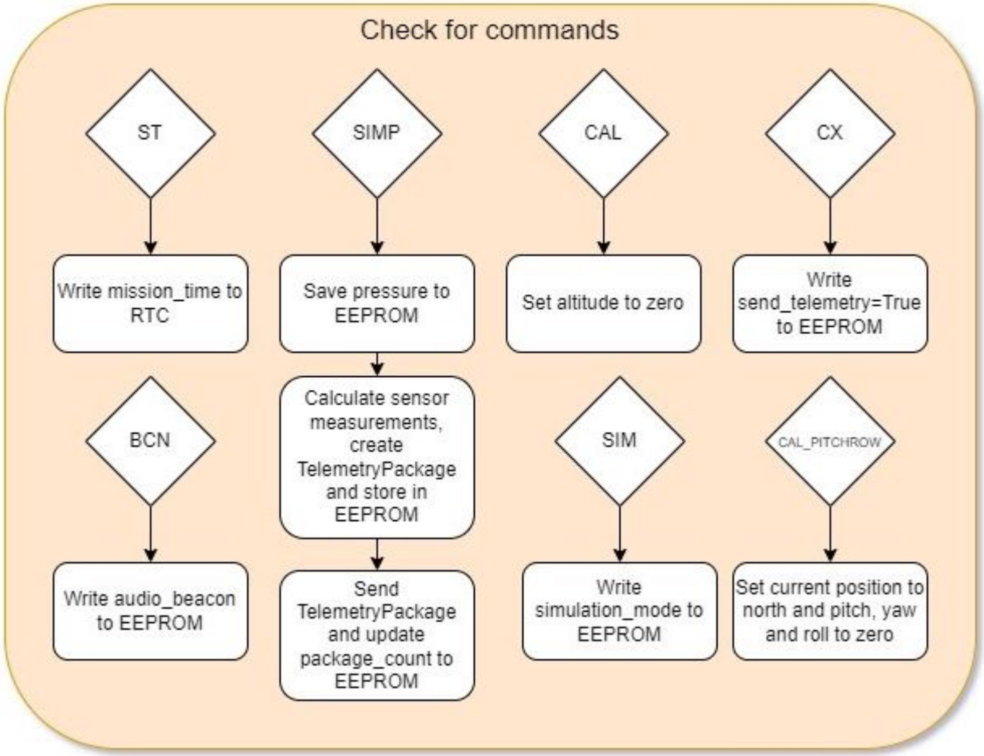
Payload FSW State Diagram (1/3)

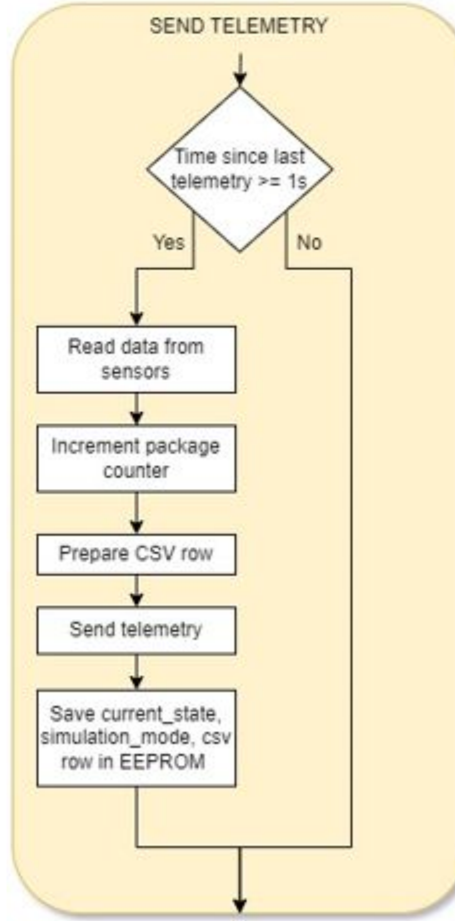


Payload FSW State Diagram (2/3)



Payload FSW State Diagram (3/3)





In the event of a power loss, the processor would reset. We will store the current state, send_telemetry (boolean), simulation_mode (boolean) and the telemetry packages on the EEPROM memory of the system, to be retrieved on startup

We also store in EEPROM 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 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)

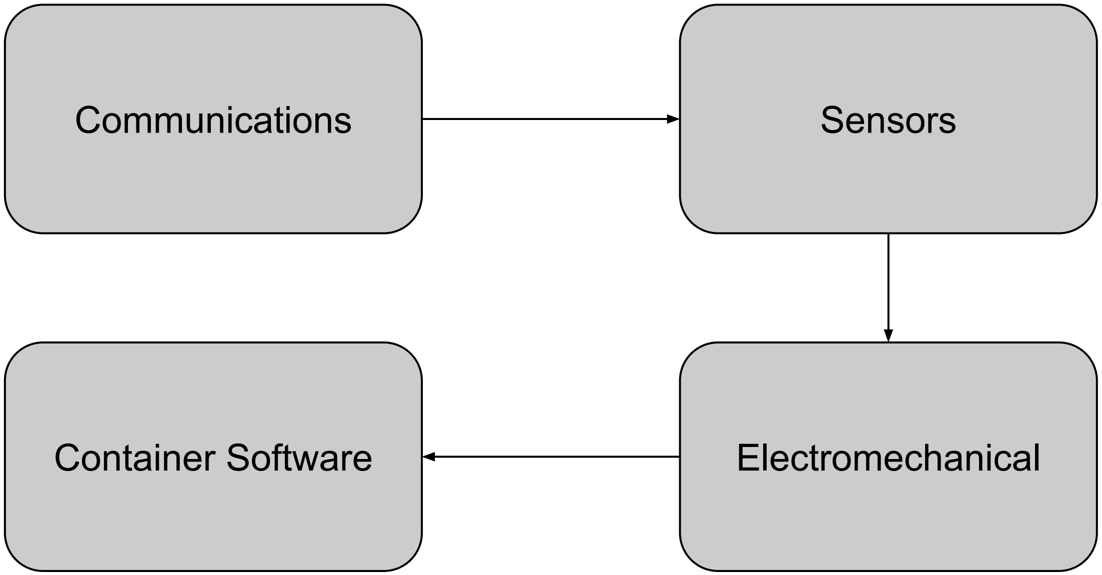
- **Prototyping and prototyping environments**
  - All sensors will be tested individually as development progresses.
  - Breadboards will be used to create a prototype circuit. Data obtained will be monitored and evaluated.

- **Test methodology**
  - Pre-existing libraries will be used for unit testing of individual components, as well as integrated tests.

Software Development Plan (2/4)

- **Software subsystem development sequence**

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



Software Development Plan (3/4)

- **Development team**
  - Nicolas Professi
  - Micaela Perillo
  - Matias Bergerman

- **Plans to reduce the risk of late software development**
  - Agile methodologies to develop and test software
  - Weekly meetings to track progress and possible problems
  - Use of Github and Notion to organize and set tasks

Software Development Plan (4/4)

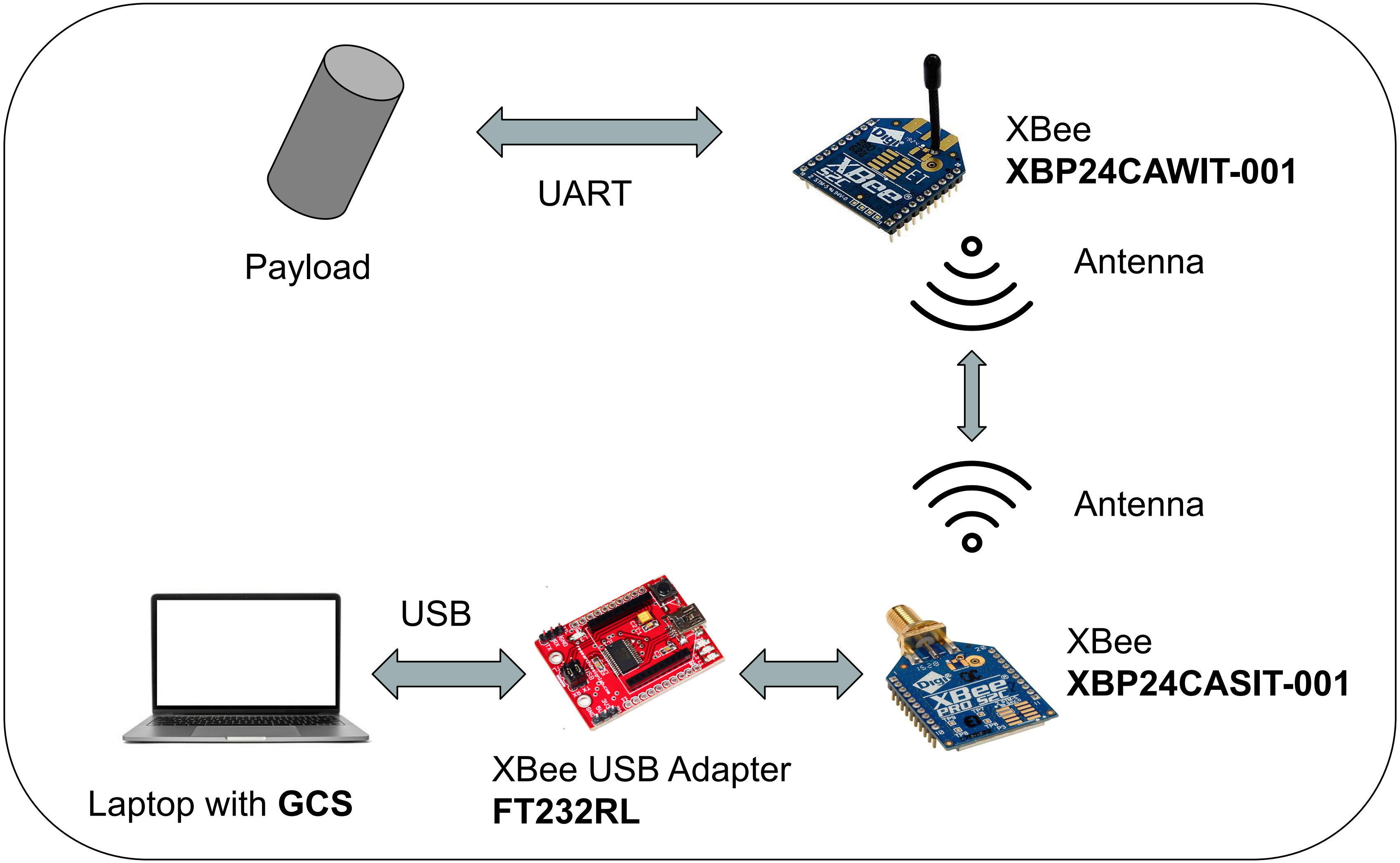
- **Github**
  - We will use Github to be able to collaborate and track changes
  - Code can be easily revised and reverted in case of errors.

- **Notion**
  - Similar to Jira and Trello, allows collaborators to set and organize tasks, as well as track progress
  - We use a Kanban Board to visualize the progress

Ground Control System (GCS) Design

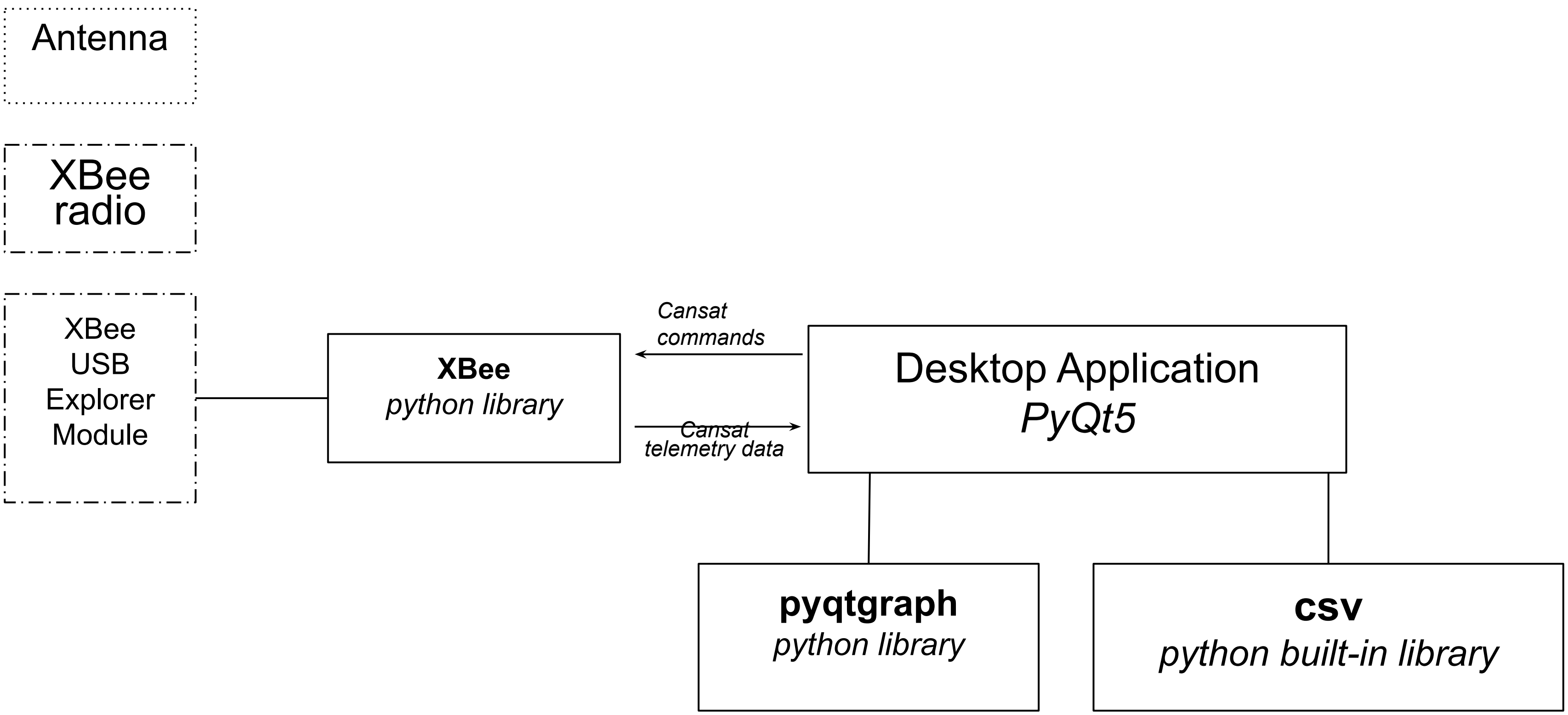
Micaela Perillo

GCS Overview



GCS Design (1/2)

- **Ground Station Diagram**



GCS Design (2/2)

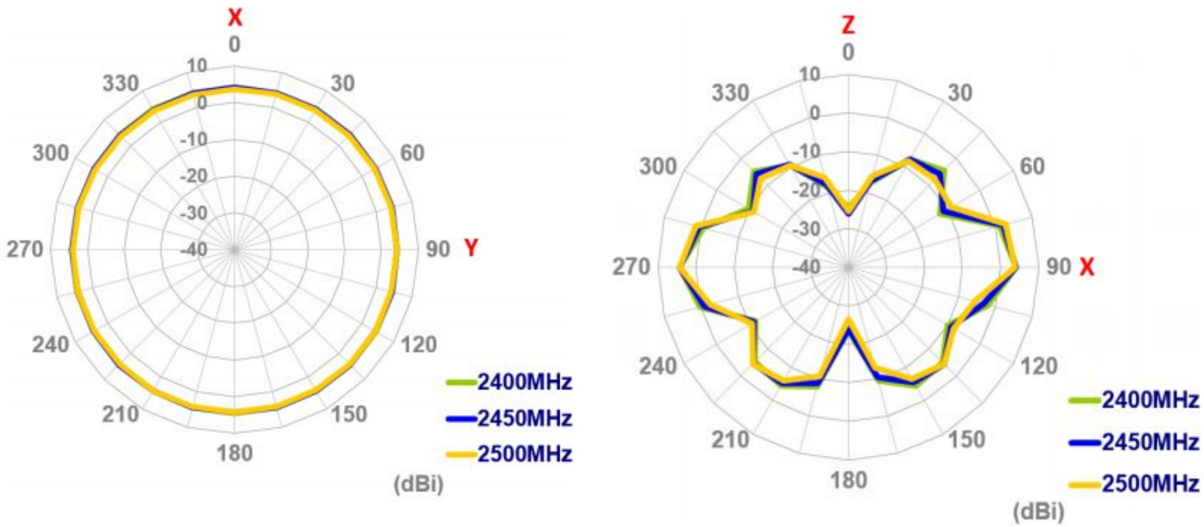
- **Battery life**
  - The GCS will run on a laptop with an average battery life of 6 hours
- **Overheating mitigation**
  - The laptop will be kept in the shade, using a sunshade if necessary
- **Auto update mitigation**
  - If running windows, Windows Updates will be disabled on the laptop

GCS Antenna Trade & Selection (1/4)

Name	Range (m)	Gain (dBi)	Polarization	Radiation Pattern	Dimensions (mm)	Connector	Price (U$S)
Taoglas GW.22.5153	~3200	5	Linear	**(1)*** Omnidirectional	ANT: - Length: 235 - Diameter: 13	RP-SMA	11,64
Tp-link Tl-ANT 2408CL	~3200	8	Linear, Vertical	**(2)*** Omnidirectional	ANT: - Length: 294 mm - Diameter: 13	RP-SMA	11,27

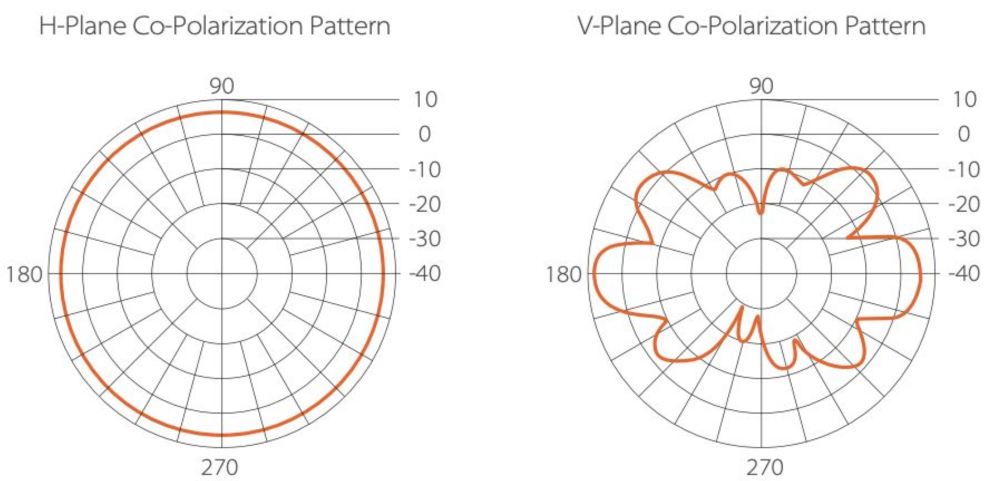
*Next page

1*



X
0
10
0
-10
-20
-30
-40
330
30
300
60
270
90
Y
240
120
210
150
180
2400MHz
2450MHz
2500MHz
(dBi)
Z
0
330
30
300
60
270
90
X
240
120
210
150
180
2400MHz
2450MHz
2500MHz
(dBi)

2*

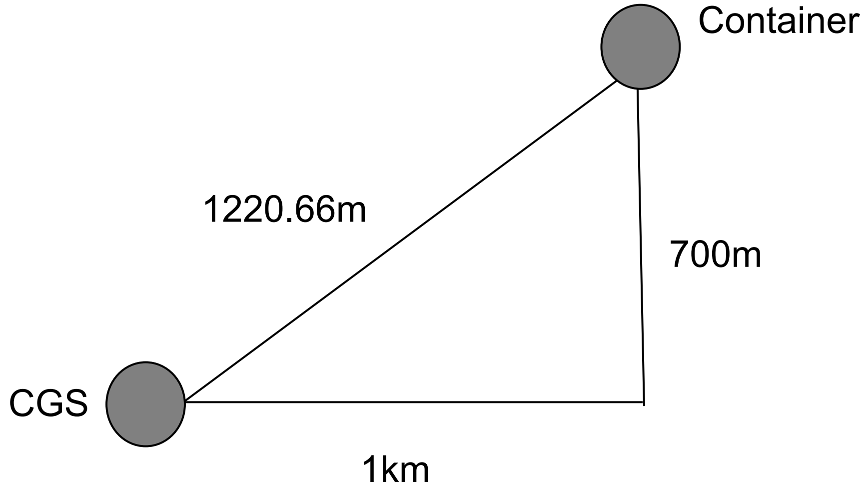


H-Plane Co-Polarization Pattern
V-Plane Co-Polarization Pattern
90
10
0
-10
-20
-30
-40
180
270

Selected Antenna: Tp-link Tl-ANT2408CL

- Allows for directional adjustment
- Better gain radiation (8dBi).
- Easier to buy.
- Familiarity

Assuming that the CanSat container has a maximum horizontal displacement of 1km at the highest point of its trajectory the distance between the CGS to the container results in a total of 1220.66 m. Thus, the selected antenna meets the distance requirements.



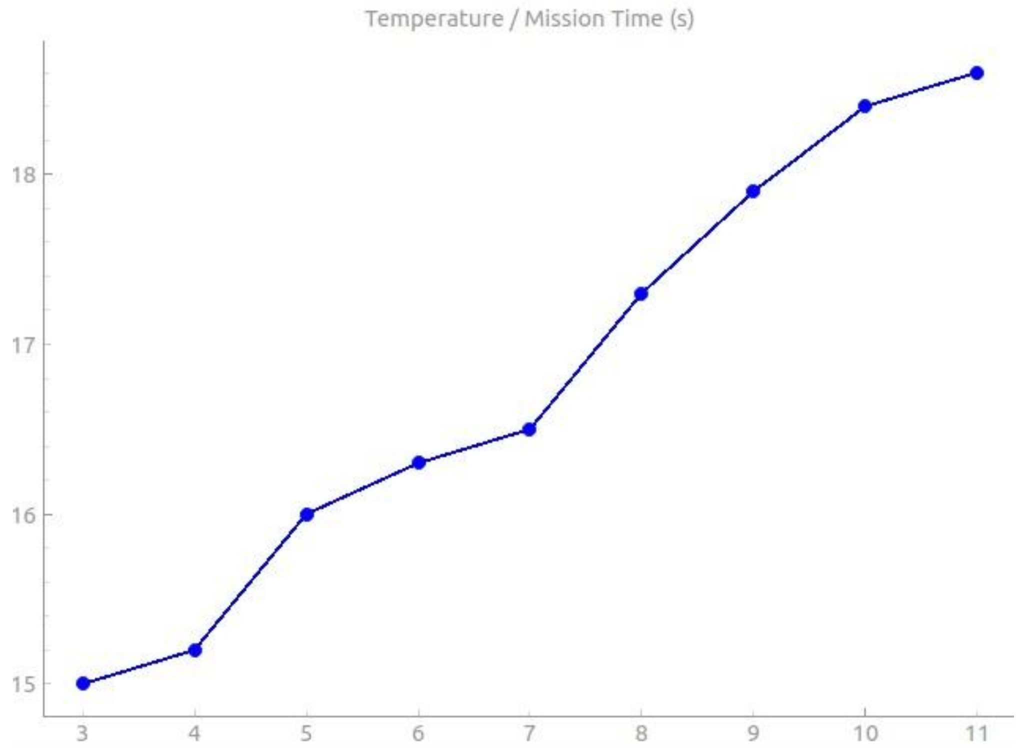
Antenna Mounting Design

Configuration	Handheld	Table Top
Advantages	• More range	• More reliable • Long time applications
Disadvantages	• Short time applications • Less reliable • Requires a team member to operate it	• Less range
Conclusion	Handheld configuration is chosen because the range is extended and the antenna is prepared for directional adjustment	

GCS Software (1/7)

Telemetry display prototypes

Plot using *PyQtGraph*
The graph will expand as more data is received

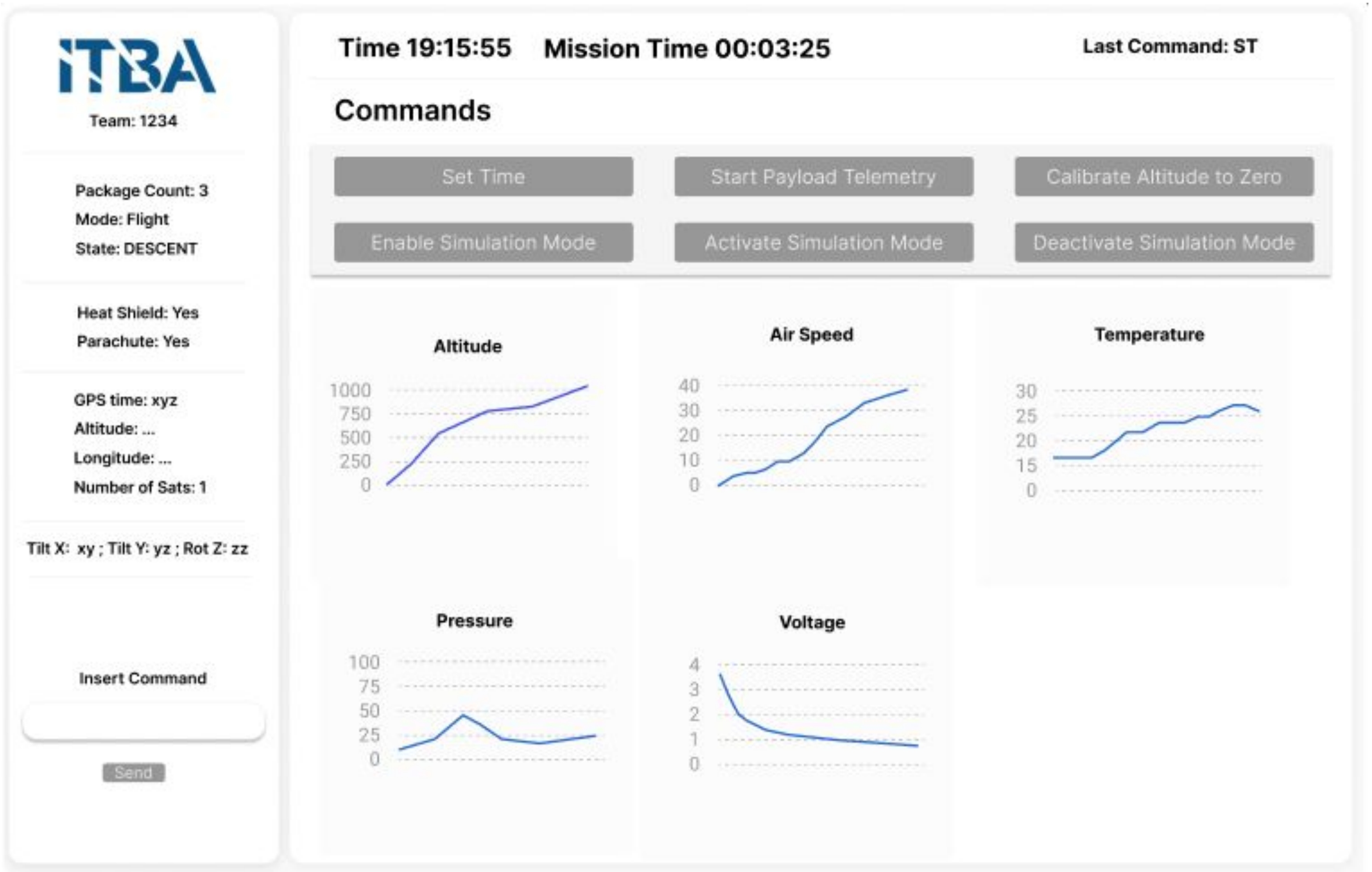


GCS Software (2/7)

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**
  - PyQt5
  - CSV: built-in module for file reading and writing
  - XBee: Python library for communication with the antenna

Real-time plotting and command software



GCS Software (4/7)

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

```python
import csv

header = ['TEAM_ID', 'MISSION_TIME', ..., 'CMD_ECHO']
csv_file_path = 'Flight_2099.csv'
with open(csv_file_path, 'w', newline='') as csv_file: # Creates new CSV file
    writer = csv.writer(csv_file)

telemetry = ['2099', '00:01:30', ..., "CXON"]
with open(csv_file_path, 'w', newline='') as csv_file:
    writer = csv.writer(csv_file)
    writer.writerow(telemetry) # Saves telemetry data to the csv file

print(f'Telemetry data saved to {csv_file_path}')
```

- The files can be transferred to an USB/uploaded if necessary

GCS Software (5/7)

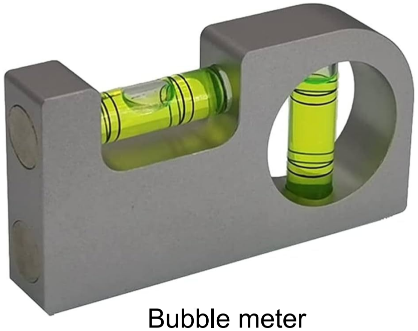
- **Telemetry format:**

TEAM_ID, MISSION_TIME, PACKET_COUNT, MODE, STATE, ALTITUDE, AIR_SPEED, HS_DEPLOYED, PC_DEPLOYED, TEMPERATURE, VOLTAGE, PRESSURE, GPS_TIME, PS_ALTITUDE, GPS_LATITUDE, GPS_LONGITUDE, GPS_SATS, TILT_X, TILT_Y, ROT_Z, CMD_ECHO

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.

Calibration command description


Bubble meter

- Before rocket integration, the payload will be kept in a horizontal position using a table and a bubble meter. Then, using a black marking in the nose cone and a compass, the payload will be set to point north.
  After this preparation, a team member will send the CAL_PITCHROLL 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, setting the current altitude to 0.

CanSat Integration and Test

Facundo Di Toro

CanSat Integration and Test Overview (1/2)

Subsystem level test plans

Sensor
- Individual test of each sensor (Hardware & Software)
- Integrated sensor subsystem test

CDH
- Individual test of each component (Hardware & Software)
- Integrated CDH subsystem test

Mechanical
- Structural integrity test
- Mass budget test

EPS
- Measurement of real energy consumption
- Measurement of batteries real capacity
- Integrated EP subsystem test

Radio Communications
- Individual test of each receiver/emitter (Hardware & Software)
- Range test (Antenna + XBee)

FSW
- Ensure data saving
- Verification of subsystems
- Verification of all software states
- Testing of simulation mode

Descent Control
- Opening forces of the HS and wings test
- Integrated Descent Control subsystem test
- Rotation stability test

CanSat Integration and Test Overview (2/2)

Integrated Level Functional Test Plans

- Descent test
- Communications test
- Mechanisms test
- Deployment test

Environmental Test Plans

- Drop test
- Thermal test
- Vibration test
- Fit check
- Vacuum test

Simulation Test Plans

- Simulation mode sensors test
- Simulation mode communications test
- Simulation mode software test

Subsystem Level Testing Plan (1/2)

Sensors
- Testing environments will we developed in order to simulate real scenarios and check each sensor functionality
- All sensor will be connected to an ESP32 development board via breadboard to check connections and simultaneous functionality
- Readings will be checked with standards for further calibration

Mechanical
- Mass Budget Test
- Cansat Structural integrity, verify the Subsystems resist the forces required
- Verify the spring-NiCr mechanism reliability
- Verify all subsystem functions separately: Movement of the wings, Egg Containment function, HS deployment, HS release & Parachute deployment,

CDH

ESP32 - XBee communication will we tested individually for every XBee module used, in order to check connections and adapter module functionality

Descent control
- The electric part of the descent control subsystem will be tested before integration with the Container
- The opening forces of the HS and wings to overcome air resistance will be verified.
- The capability of the payload to stabilize itself and the camera will be tested by inducing external rotation.

Subsystem Level Testing Plan (2/2)

EPS
- The real energy consumption of the Cansat will be measured with a multimeter in different controlled environments
- Batteries' real capacity will be tested in different controlled environments with a battery capacity indicator
- The system will be tested when already integrated in the Cansat by checking Cansat's battery life
- Max current drain will be tested in a simulated flight
- Max temperature of component´s package will be measure

Radio Communications
- Every XBee will we connected to a ESP32 to ensure correct functionality.
- Cansat-GS communication will be tested in an open field in a 1 Km range

FSW
- Ensure saving data in case of processor reset
- Verification of subsystems such as release mechanisms and communications
- Verification of all software states
- Testing of simulation mode

Integrated Level Functional Test Plan

Descent

- A container equivalent will be dropped from a drone to verify descent velocity with the HS and then with the parachute.

Communications

- Communication range will be tested using a testing mode on the FSW Communication Module.
- Handling of lost radio messages (and automatic resending) will be tested using a testing mode on the FSW Communication Module.
- Signal blocking will be tested using different materials to cover the radios.

Mechanisms

- Simultaneous communication and servo / nichrome wire activation will be tested to ensure sufficient power.

Deployment

- HS & parachute & Finss deployment will be tested using simulation mode with the cansat stationary.
- HS & parachute &Fins deployment will be tested using simulation mode in conjunction with a descent test.

Environmental Test Plan (1/2)

Drop Test:
- 61 cm cord is attached to a fixed point in the ceiling and to the parachute
- CanSat is raised to the ceiling and released
- A mattress is placed under the CanSat in case of a structural damage on the joints.

Thermal Test:
- 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.

Vibration Test:
- A orbital sander provided by the university is used to simulate vibration on the CanSat for 5s four times.
- The purpose of this vibration is to check that all components and structural joints stay fixed and working.
- Telemetry and proper working of the sensors are to be controlled during the test.

Environmental Test Plan (2/2)

Vacuum Test:
- The CanSat is placed in a closed box with a hole prepared to insert the hose of a vacuum cleaner to remove the air.
- Once a vacuum starts forming the pressure sensor is used to measure the simulated altitude.
- When pak altitude is reached the hose will be removed and the air will be let back in slowly.

Fit Check:
- The CanSat is inserted in the open section of the payload to make sure all components fit inside the way they are supposed to.

Simulation Test Plan

What parts of the CanSat get tested during simulation?
- During the simulation, every sensor except for the barometer and pitot tube is tested, the communication between ground, container, and payload are also tested, and the behaviour of all software components is tested as well.

How is the simulation implemented?
- Once in simulation mode, the container software will act exactly as in normal mode, except that the readings from the barometer will not be taken and, instead, the air pressure values will be processed once they are received as communication from the ground. The payload software does not include a simulation mode, and will therefore act exactly as in normal mode.

Mission Operations & Analysis

Overview of Mission Sequence of Events (1/2)

Arrival to launch site

Basic Configuration

Check in

- Prepare Cansat for turn-in
- Final CanSat tests
- Teams submit fully assembled CanSats to the check-in line

Pre Launch Preparations

- 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
- Take rocket to launch pad and wait for it to be installed

Flight

Launch

- CanSats must be flight-ready, only power switch manipulation 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

Recovery and Post-Flight

- After all CanSats have launched, the team recovery crew will head out to recover
- 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
Mission Control Officer	• Manages the Team Launch • Verifies that everything is ready with The Ground Station Crew • Executes the launch procedure with flight coordinator oversight	• Victoria Klang
Ground Station Crew	• Monitor the ground station for telemetry reception • Issue commands to the CanSat. • Performs all required flight operations	• Micaela Perillo • Facundo Di Toro • Nicolas Beade • Matias Bergerman
Recovery Crew	• Track and recover the CanSat • Interact with field judges • Make sure all field scores are filled in	• Franco Iotti • Nicolas Professi
CanSat Crew	• Prepare the CanSat and integrate it into the rocket • Verifying status before launching	• Nicolas Antonio Martone • Ezequiel Bolzicco • Dante D'Agostin

Mission Operations Manual Development Plan

MIssion Operation Manual	Content
Configuration of The Ground Station	• Ground Station assembly • Antenna assembly • Monitor the ground station for telemetry reception • Issue commands to the CanSat.
CanSat Preparation	• Check status of all mechanism • CanSat General Inspection
CanSat Integration into Rocket	• Final clearance Inspection • Mounting CanSat into Rocket
Launch Preparation and Launch Procedure	• Documents are provided by CanSat Competition
Recovery procedure	• Document is provided by CanSat Competition • Finding the CanSat

CanSat Location and Recovery

Recovery Strategy
Brightly Colored:
Mylar Streamer: A gold mylar streamer be connected to the Cansat and released at deployment. This will be used to locate and identify the Cansat.
GPS: GPS location will be used to assist CanSat recovery
Audio: Upon landing, the Cansat shall activate an audio beacon.
Team Contact: Container and Payload will have label with team contact information

Requirements Compliance

Facundo Di Toro

Requirements Compliance Overview

The design complies with most requirements according to the 2024 CanSat Mission Guide. The majority of the present design meets the standards, as those requirements that do not are still to be empirically tested.

A table showing the requirement states is shown on the slides below with each requirement taken from the Competition Guide is labelled according to 3 categories:

Comply	**Partial**	**Insufficient**

Changes might occur during the Critical Design Review and testing.

Requirements Compliance (1/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
1	The Cansat mass shall be 900 grams +/- 10 grams without the egg being installed.	Comply	Mass Budget (70-74)	
2	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	Electronics structural integrity (69)	
3	The Cansat shall perform the function of the nose cone during rocket ascent.	Comply	Mechanical Subsystem Overview (50)	
4	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Partial		Test required
5	The Cansat shall deploy a heat shield after deploying from the rocket.	Comply	Payload Aerobraking Deployment (58-59)	
6	At 100 meters, the Cansat shall deploy a parachute and release the heat shield.	Comply	Payload Aerobraking Release/ Parachute Deployment (60-62)	

Requirements Compliance (2/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
7	The Cansat shall carry a provided large hens egg with a mass range of 51 to 65 grams	Comply	Payload Egg Containment (66-68)	
8	During descent with the heat shield deployed, the descent rate shall be between 10 to 30 m/s.	Partial	Descent Rate Estimate (46-48)	Test required
9	At 100 meters, the Cansat shall have a descent rate of less than 5 m/s.	Partial	Descent Rate Estimate (46-48)	Test required
10	Cansat shall survive 30 G shock.	Partial		Test required
11	Cansat structure must survive 15 Gs vibration	Partial		Test required
12	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	Payload Power (93-95)	

Requirements Compliance (3/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
13	Easily accessible power switch is required	Partial		Switch positions yet to be defined
14	Power indicator is required for each voltage domain	Comply	Payload Electrical Block Diagram (92)	
15	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	Comply	Payload Power Budget (96-97)	
16	XBEE radios shall not use broadcast mode.	Comply	Payload Radio Configuration (84)	
17	XBEE radios shall have their NETID/PANID set to their team number.	Comply	Payload Radio Configuration (84)	
18	The Cansat shall transmit telemetry once per second.	Comply	Payload FSW State Diagram (101-103)	

Requirements Compliance (4/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comment
19	The Cansat telemetry shall include altitude, air pressure, temperature, battery voltage, Cansat tilt angles, air speed, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	Comply	Payload Telemetry Format (85-88)	
20	The Cansat shall function as a nose cone during the rocket ascent portion of the flight	Comply	Mechanical Subsystem Overview (50)	
21	The Cansat shall be deployed from the rocket when the rocket motor ejection charge fires.	Comply	Payload Aerobraking Deployment (58-59)	
22	After deployment from the rocket, the Cansat shall deploy its heat shield/aerobraking mechanism.	Comply	Payload Aerobraking Deployment (58-59)	
23	A silver or gold mylar streamer of 50 mm width and 1.5 meters length shall be connected to the Cansat and released at deployment.	Comply	Mechanical Subsystem Overview(50)	
24	Upon landing, the Cansat shall stop transmitting data.	Comply	Payload FSW State Diagram (101-103)	

Requirements Compliance (5/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
25	Upon landing, the Cansat shall activate an audio beacon.	Comply	Payload FSW State Diagram (101-103)	
26	0 altitude reference shall be at the launch pad.	Comply	GCS Software (124)	
27	Cost of the Cansat shall be under $1000. Ground support and analysis tools are not included in the cost of the Cansat. Equipment from previous years shall be included in this cost, based on current market value.	Comply	CanSat Budget – Hardware (155-158)	
28	Nose cone shall be symmetrical along the thrust axis.	Comply	Physical Layout (16-18)	
29	Nose cone radius shall be exactly 71 mm	Comply	Launch Vehicle Compatibility (20-21)	
30	Nose cone shoulder radius shall be exactly 68 mm	Comply	Launch Vehicle Compatibility (20-21)	

Requirements Compliance (6/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
31	Nose cone shoulder length shall be a minimum of 50 mm	Comply	Physical Layout (16-18)	
32	The rocket airframe can be used to restrain any deployable parts of the Cansat but shall allow the Cansat to slide out of the payload section freely.	Comply	Launch Vehicle Compatibility (20-21)	
33	The rocket airframe can be used as part of the Cansat operations.	Comply	Payload Aerobraking Pre Deployment (56-57)	We do not use it
34	No pyrotechnical or chemical actuators are allowed.	Comply	EPS Overview (91)	
35	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.	Partial		Ubication of nichrome wires not defined yet
36	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	Payload Power (93)	

Requirements Compliance (7/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
37	The heat shield shall be used as an aerobrake and limit the descent rate to 10 to 30 m/s.	Comply	Descent rate estimate (46-48)	
38	At 100 meters, the Cansat shall release a parachute to reduce the descent rate to less than 5 m/s.	Comply	Descent rate estimate (46-48)	
39	The Cansat shall protect a hens egg from damage during all portions of the flight.	Comply	Payload Egg Containment (66-68)	
40	If the nose cone is to be considered as part of the heat shield, the documentation shall identify the configuration.	Comply	Descent Control Overview (34-35)	
41	After the Cansat has separated from the rocket and if the nose cone portion of the Cansatis to be separated from the rest of the Cansat, the nose cone portion shall descend at less than 10 meters/second using any type of descent control device.	Comply	Payload Aerobraking Release (60-62)	
42	Lithium polymer batteries are not allowed.	Comply	Payload Power Trade & Selection (93)	

Requirements Compliance (8/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
43	The maximum current of the cansat cannot exceed the maximum discharge current of the battery.	Partial		Test required
44	The total energy required shall be less than 60% of the energy in the battery.	Partial		Test required
45	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Comply	Payload Radio Configuration (84)	
46	Cansat shall measure its speed with a pitot tube during ascent and descent.	Partial		Position is to be defined
47	Cansat shall measure its altitude using air pressure.	Comply	Payload Air Pressure Sensor Trade & Selection (24)	
48	Cansat shall measure its internal temperature.	Comply	Payload Air Temperature Sensor Trade & Selection (25)	

Requirements Compliance (9/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
49	Cansat shall measure its angle stability with the aerobraking mechanism deployed.	Comply	Rotation Sensor Trade & Selection (29)	
50	Cansat shall measure its rotation rate during descent.	Comply	Rotation Sensor Trade & Selection (29)	
51	Cansat shall measure its battery voltage.	Comply	Payload Battery Voltage Sensor (26)	
52	The Cansat shall include a video camera pointing horizontally.	Comply	Mechanical Subsystem Overview (50)	
53	The video camera shall record the flight of the Cansat from launch to landing.	Comply	Payload FSW State Diagram (101-103)	
54	The video camera shall record video in color and with a minimum resolution of 640x480.	Comply	Payload Camera Trade & Selection (31)	

Requirements Compliance (10/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
55	The ground station shall command the Cansat to calibrate the altitude to zero when the Cansat is on the launch pad prior to launch.	Comply	GCS Software (118-124)	
56	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	GCS Software (118-124)	
57	Telemetry shall include mission time with 1 second or better resolution.	Comply	Payload FSW State Diagram (101-103)	
58	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	Comply	Payload FSW State Diagram (101-103)	
59	Each team shall develop their own ground station.	Comply	Ground Control System (GCS) Design (112-113)	
60	All telemetry shall be displayed in real time during descent on the ground station.	Comply	GCS Software (118-124)	

Requirements Compliance (11/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
61	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.) and the units shall be indicated on the displays.	Comply	GCS Software (118-124)	
62	Teams shall plot each telemetry data field in real time during flight.	Comply	GCS Software (118-124)	
63	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and an antenna.	Comply	GCS Overview (111)	
64	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Comply	GCS Overview (111)	
65	The ground station software shall be able to command the payload to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	Comply	GCS Software (118-124)	

Requirements Compliance (12/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
66	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the Cansat.	Comply	GCS Software (118-124)	
67	The ground station shall use a table top or handheld antenna.	Comply	GCS Design (112-113)	
68	Because the ground station must be viewed in bright sunlight, the displays shall be designed with that in mind, including using larger fonts (14 point minimum), bold plot traces and axes, and a dark text on light background theme.	Comply	GCS Design (112-113)	
69	The ground system shall count the number of received packets. Note that this number is not equivalent to the transmitted packet counter, but it is the count of packets successfully received at the ground station for the duration of the flight.	Comply	GCS Design (112-113)	
70	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Comply	GCS Design (112-113)	

Requirements Compliance (13/13)

#	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments
71	The Cansat shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	Comply	Payload FSW State Diagram (101-103)	
72	The Cansat shall have its time set to within one second UTC time prior to launch.	Comply	Payload FSW State Diagram (101-103)	
73	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 csv file.	Comply	Simulation Mode Software (104-105)	
74	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the payload altitude.	Comply	Simulation Mode Software (104-105)	
75	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Comply	Simulation Mode Software (104-105)	

Management

Victoria Klang

CanSat Budget – Hardware (1/4)

Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual/ Free
Electronics-Payload				
BMP280	NO	1	4.9	Actual (MercadoLibre)
MPU9250	NO	1	12.54	Actual (MercadoLibre)
XBEE S2C + Radio Antenna	YES	1	179.32	Actual (MercadoLibre)
XBEE S2C PRO + Radio Antenna	NO	1	200	Estimated (EBay)
XBEE Adapter Module	YES	1	24.36	Actual (MercadoLibre)
Voltage Regulator (3-5v)	NO	2	4.34	Actual (MercadoLibre)
CR123A Battery	NO	1	5.9	Actual (MercadoLibre)
Switch	NO	1	1	Actual (MercadoLibre)
ESP32	NO	1	16.9	Actual (MercadoLibre)
SQ11 Camera	NO	2	20	Actual (MercadoLibre)

CanSat Budget – Hardware (2/4)

Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual/ Free
Electronics Container				
GPS Sensor Ublox NEO-6M + Antenna	YES	1	25.45	Actual (MercadoLibre)
RTC (w/ Battery)	YES	1	4	Actual (MercadoLibre)
Samsung 18650 Battery	NO	1	11.18	Actual (MercadoLibre)
Nichrome wire	NO	3	5	Estimated
Sound Beacon: Buzzer	NO	1	4.54	Actual (MercadoLibre)
MPXV7002 + Pitot Tube	NO	1	20	Estimated (Ebay)
PCB & SMT Electronics	NO	1	45	Estimated
Servo Tower Pro Mg90	NO	3	9	Actual (MercadoLibre)
LED	NO	2	0.1	Actual (MercadoLibre)
Cables + Conectors	NO	1	2	Actual (MercadoLibre)
TOTAL = 698.87 USD				

CanSat Budget – Hardware(3/4)

Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual
Mechanics				
Nylon Ripstop 1369 cm^2	NO	1	0.001 per cm^2	Estimated
Nylon Ripstop 15800 cm^2	NO	1	0.001 per cm^2	Estimated
Carbon Fibre Rods	NO	4	33/1m	Actual (MercadoLibre)
Braid fishing line	NO	1	5 per 100m	Actual (MercadoLibre)
ABS	NO	1 kg	21/kg	Actual (MercadoLibre)
Torsion Spring		4	2	Estimated
Linear Spring		10	1,6	Estimated
TOTAL= 120 USD				

CanSat Budget – Hardware(4/4)

Subsystem	Cost (USD)
Electrical	698.87
Mechanical	120
TOTAL = 818.87	

CanSat Budget – Other Costs

Travel (per person)		
	Price (USD)	Price (ARS)
Airline	1400	1.645.00
Visa	185	217.375
Hotel	300	352.500
Food	50	58750
Other travel fees	50	58750
TOTAL= 1885 USD per person		
TOTAL=18850 USD		

Competition inscription was paid by ***Instituto Tecnologico 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.

CanSat Budget – Other Costs

Ground Control Station		
	Price (USD)	Price (ARS)
Computers	1000	-
Umbrella	10	10000
Others	70	-
TOTAL = 1080 USD		

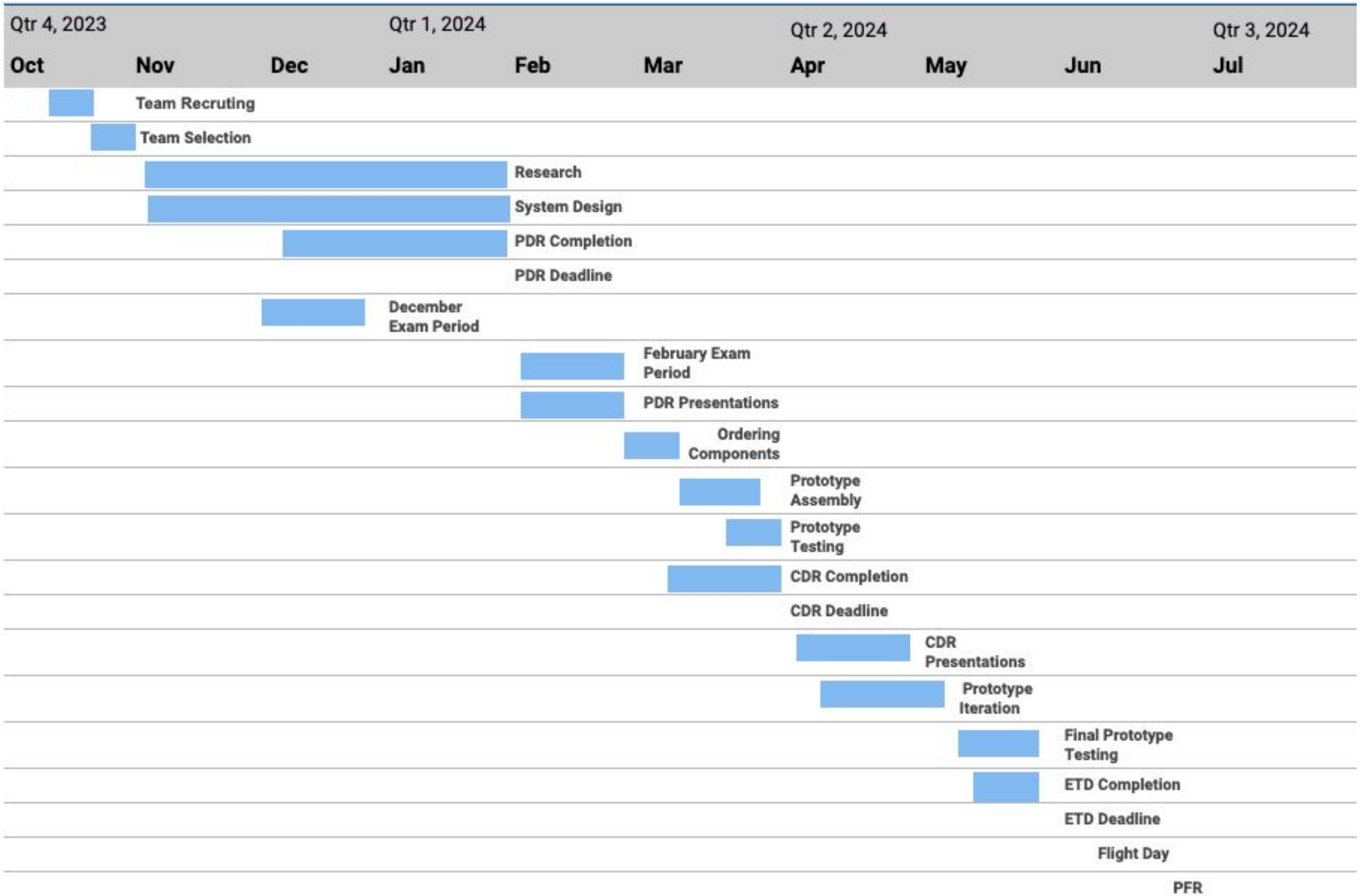
We will use a team member's computer, so its cost is an estimate.

CanSat Budget – Other Costs

Overall Mission Cost		
	Price (USD)	Price (ARS)
Hardware	819	-
Ground Station	1080	-
Team Travel	18850	-
Contingencies	200	-
TOTAL = 20949 USD		

This cost is an estimate, and may fluctuate.

Program Schedule Overview



Detailed Program Schedule (1/3)

1	**Competition Overview**				
1.1	Team Recruting	All	15/10/23	21/10/23	6
1.2	Team Selection	All	21/10/23	31/10/23	10
1.3	Research	All	01/11/23	19/11/23	18
1.4	System Design	All	20/11/23	14/01/24	54
1.5	PDR Completion	All	15/01/24	02/02/24	17
1.6	PDR Deadline	All	02/02/24	02/02/24	0
1.7	December Exam Period	All	05/12/23	23/12/23	18
1.8	February Exam Period	All	06/02/24	24/02/24	18
1.9	PDR Presentations	All	05/02/24	23/02/24	18
1.10	Ordering Components	All	05/02/24	24/02/24	19
1.11	Prototype Assembly	All	20/02/24	02/03/24	12
1.12	Prototype Testing	All	03/03/24	17/03/24	14
1.13	CDR Completion	All	07/03/24	29/03/24	22
1.14	CDR Deadline	All	29/03/24	29/03/24	0
1.15	CDR Presentations	All	08/04/24	26/04/24	18
1.16	Prototype Assembly	All	26/04/24	04/05/24	8
1.17	Prototype Iteration	All	05/05/24	12/05/24	7
1.18	Final Prototype Testing	All	13/05/24	18/05/24	5
1.19	ETD Completion	All	07/05/24	24/05/24	17
1.20	ETD Deadline	All	24/05/24	24/05/24	0
1.21	Flight day	All	08/06/24	08/06/24	0
1.22	PFR	All	09/06/24	09/06/24	0

Detailed Program Schedule (2/3)

2	**Management**				
2.1	Recruit Interested Team Members	Team Lead	15/10/23	21/10/23	6
2.2	Summarize and Analyze Mission Guide	Team Lead	16/10/23	22/10/23	6
2.3	Contact University and Sponsors for Funding	Team Lead	17/10/23	01/06/24	224
3	**Flight Software**				
3.1	Define Software Requirements for Playload, Container and Ground Station	Software and Firmware Team	30/11/23	18/12/23	18
3.2	Design Architecture for Container Software	Software and Firmware Team	19/12/23	25/12/23	6
3.4	Design Architecture for Ground Station Software	Software and Firmware Team	26/12/23	02/01/24	6
3.5	Integrate Design with Electronic Components	Software and Firmware Team	03/01/24	21/01/24	18
3.6	Create Container State Diagram	Software and Firmware Team	22/01/24	27/01/24	5
3.7	Determine Software Development Process	Software and Firmware Team	28/01/24	01/02/24	3
3.8	Develop and Test Software	Software and Firmware Team	03/02/24	01/06/24	118
4	**Container and Playload Design**				
4.1	Design and Analyze different Mechanical Layout Prototypes	Mechanical Team	19/12/23	06/01/24	17
4.2	EDT Planning and Completition	Mechanical Team	07/01/24	21/01/24	14
4.3	Define Electronics to be used based on Research	Mechanical Team	22/01/24	01/02/24	9
5	**Descent Control Design**				
5.1	System Research and Selection	Electronics and Firmware Team	03/01/24	21/01/24	18
5.2	Integrate Design with Electronic Components Definitions	Electronics and Firmware Team	22/01/24	01/02/24	9

Detailed Program Schedule (3/3)

6	**Electronic Systems**				
6.1	System Research and Selection	Electronics and Firmware Team	19/12/23	07/01/24	18
6.2	Define Electronics to be used based on Research	Electronics and Firmware Team	08/01/24	14/01/24	6
6.3	Integrate Designs with Electronic Component Definitions	Electronics and Firmware Team	15/01/24	01/02/24	16
7	**Ground Station**				
7.1	Research Antena Technology	Software and Ground Station Team	03/01/24	21/01/24	18
7.2	Design and Prototype GCS Software	Software and Ground Station Team	22/01/24	26/01/24	4
7.3	Determine or Design Antena	Software and Ground Station Team	27/01/24	01/02/24	4

Conclusions (1/2)

Major accomplishments
• Responsibilities between team members were assigned successfully. • CanSat's mechanical prototyping has been developed using CAD software to ensure all components will fit when assembled as well as for simulation testing. • 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. • All electronic components have been chosen and meet most requirements.

• Major unfinished work as for 2/2/2024
• Waiting for confirmation from possible sponsors. • The electronic components are not ordered yet. • CanSat's prototype has not been 3d printed yet. • Not all software components were prototyped ahead of the development start date.

Conclusions (2/2)

We are ready to move to the CDR phase!

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. Team SEDS-ITBA is made up of students from multiple areas in engineering, who are ready to confront the challenge of designing and building a space-type system. 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.