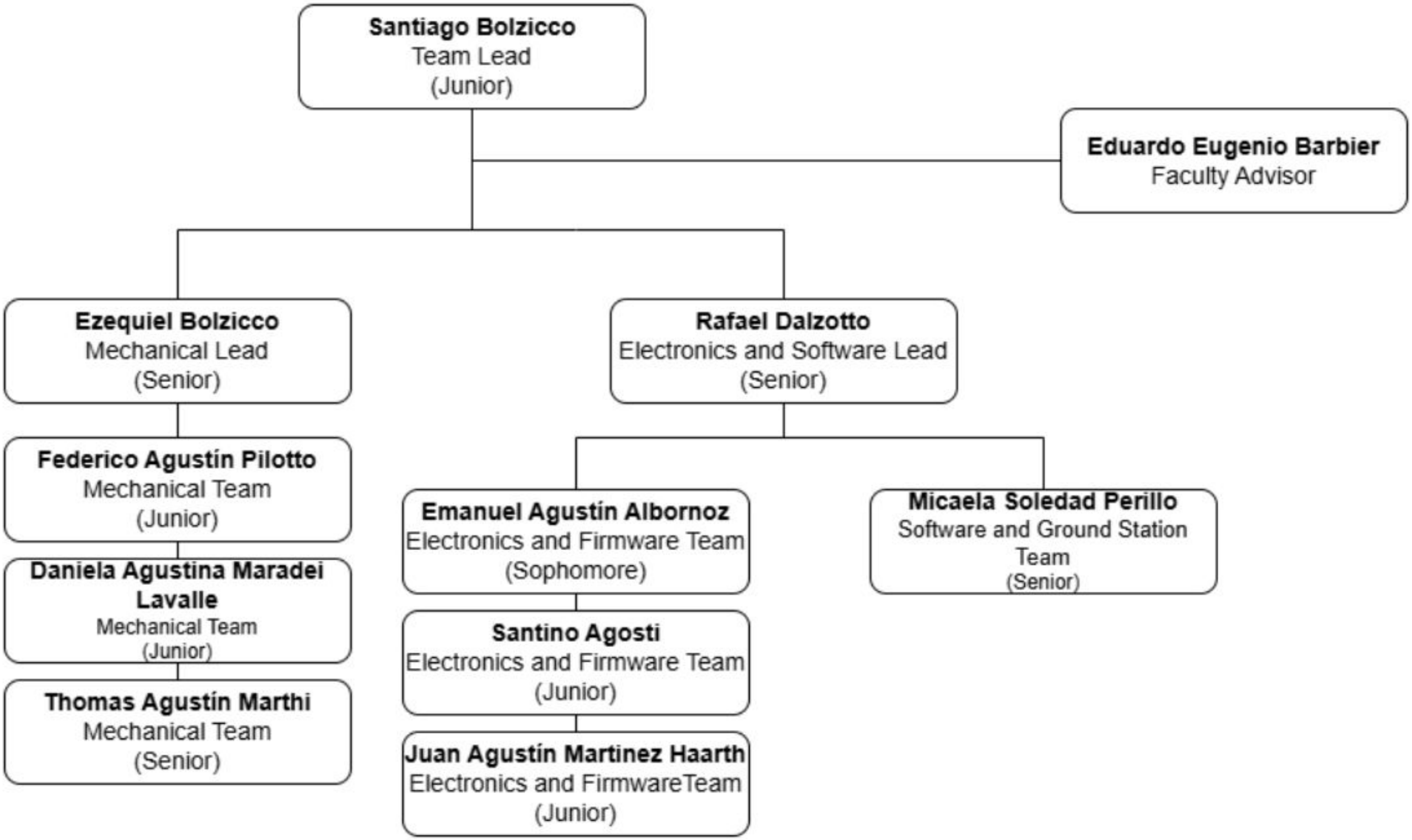
CanSat 2025
Preliminary Design Review (PDR)

Team 3165

SEDS ITBA

Presentation Outline

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
AG	Auto-Gyro
MCU	Microcontroller Unit

Acronyms (2/2)

Acronym	Explanation
RTC	Real time clock
GPS	Global Positioning System
ODR	Output Data Rate
LED	Light Emitting Diode
COTS	Commercial Off-The-Shelf
NEGL	Negligible
FOV	Field of View
PID	Proportional, Integrative and Derivative
ADC	Analog-Digital Converter
PCB	Printed Circuit Board
SMD	Surface Mount Device
T&S	Trade & Selection

Systems Overview

Santiago Bolzicco
Ezequiel Bolzicco
Thomas Marthi
Federico Agustin Pilotto

Mission Summary

Mission overview: Design a Cansat that consists of a payload and a container that mounts on top of the rocket. The payload rests inside the container at launch and includes the nose cone as part of the payload. The container with the payload shall deploy from the rocket when the rocket reaches peak altitude and the rocket motor ejection forces a separation. The container with the payload shall descend at a rate of no more than 20 meters/second using a parachute that automatically deploys at separation. At 75% peak altitude, the payload shall separate from the container and descend using an autogyro descent control system until landing. The descent rate shall be 5 meters/second. A video camera shall show the separation of the payload from the container and the auto-gyro functioning. A second video camera shall be pointing downward at 45 degrees from nadir and oriented north during descent and be spin stabilized so that the view of the earth is not rotating. The Cansat shall collect sensor data during ascent and descent and transmit the data to a ground station at a 1 Hz rate. The sensor data shall include interior temperature, battery voltage, altitude, auto-gyro rotation rate, acceleration rate, magnetic field, and GPS position.

External objectives:

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

System Requirement Summary (1/3)

#	code	Requirement Description	Subsystem
1	C1	The Cansat payload shall function as a nose cone during the rocket ascent portion of the flight	Operational
2	C2	The Cansat container shall be mounted on top of the rocket with the shoulder section inserted into the airframe.	Operational
3	C4	After deployment, the Cansat payload and container shall descend at 20 meters/second using a parachute that automatically deploys. Error is +/- 3 m/s.	Operational
4	C5	At 75% flight peak altitude, the payload shall be released from the container.	Operational
5	C6	At 75% peak altitude, the payload shall deploy an auto-gyro descent control system.	Operational
6	C7	The payload shall descend at 5 meters/second with the auto-gyro descent control system.	Operational
7	C8	The sensor telemetry shall be transmitted at a 1 Hz rate.	Operational
8	C9	The payload shall record video of the release of the payload from the container and the operation of the auto-gyro descent control system.	Operational
9	C10	A second video camera shall point in the north direction during descent.	Operational
10	C11	The second camera shall be pointed 45 degrees from the Cansat nadir direction during descent.	Operational
11	C12	The second video camera shall be spin stabilized so the ground view is not rotating in the video.	Operational

System Requirement Summary (2/3)

#	code	Requirement Description	Subsystem
12	C13	The Cansat payload shall include an audible beacon that is turned on separately and is independent of the Cansat electronics.	Operational
13	C14	Cost of the Cansat shall be under $1000. Ground support and analysis tools are not included in the cost of the Cansat. Equipment from previous years shall be included in this cost, based on current market value.	Operational
14	S1	The Cansat and container mass shall be 1400 grams +/- 10 grams.	Structural
15	S8	Cansat structure must survive 15 Gs vibration	Structural
16	S9	Cansat shall survive 30 G shock.	Structural
17	S17	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Structural
18	E3	Easily accessible power switch is required	Electrical
19	E5	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	Electrical
20	X5	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.	Communications

System Requirement Summary (3/3)

#	code	Requirement Description	Subsystem
21	SN6	Cansat payload shall measure auto-gyro rotation rate.	Sensor
22	G5	Each team shall develop their own ground station.	Ground Station

System Level CanSat Configuration Trade & Selection (1/4)

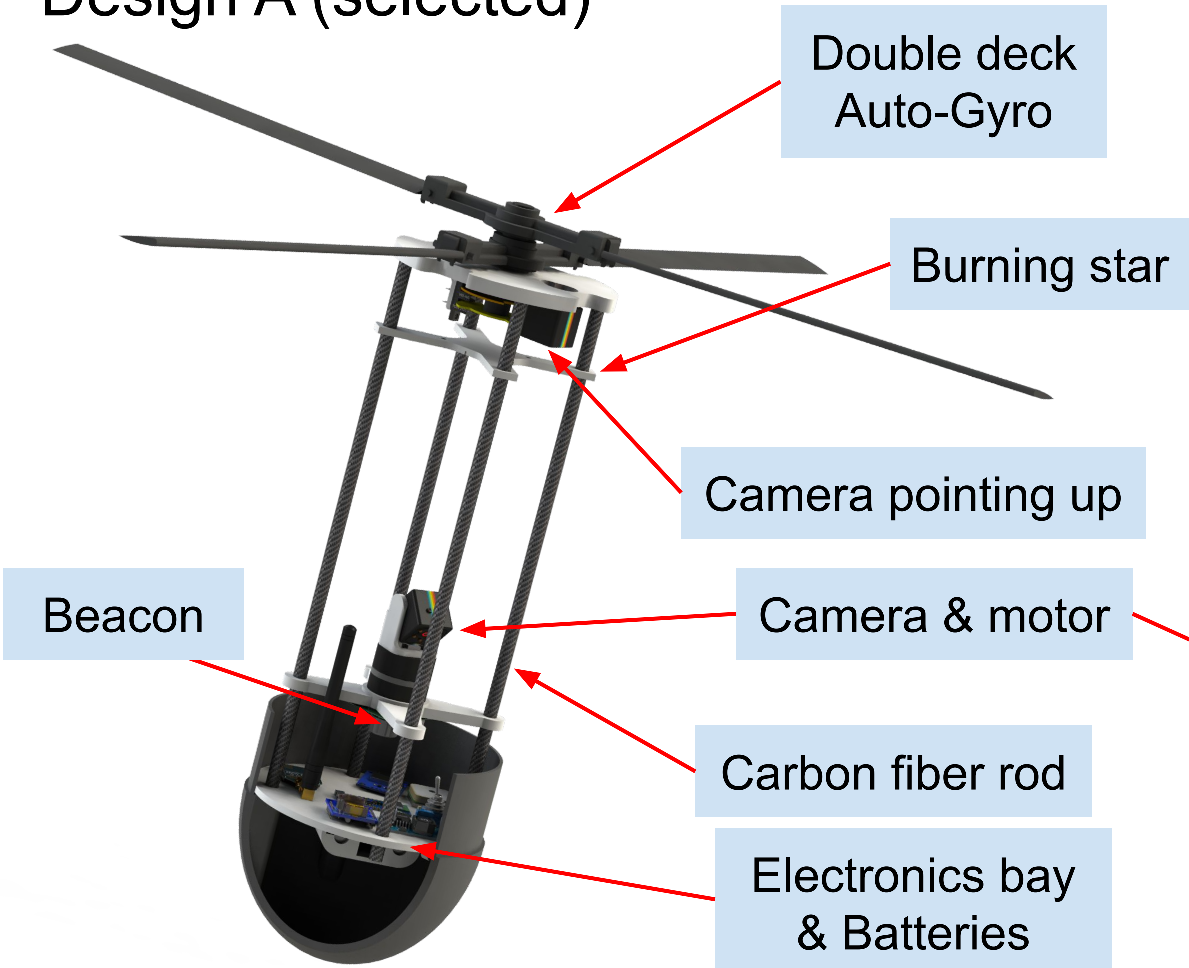
Design A (selected)

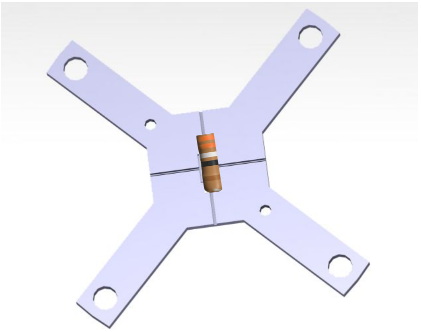
Container fitted configuration

Stowed Configuration

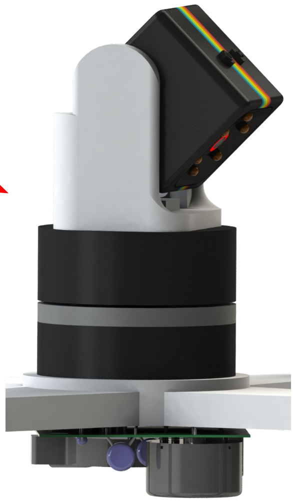
Deployed Configuration

Design A (selected)





We named "Burning Star" the mechanism in charge of cutting loose the fishing line



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

Design B

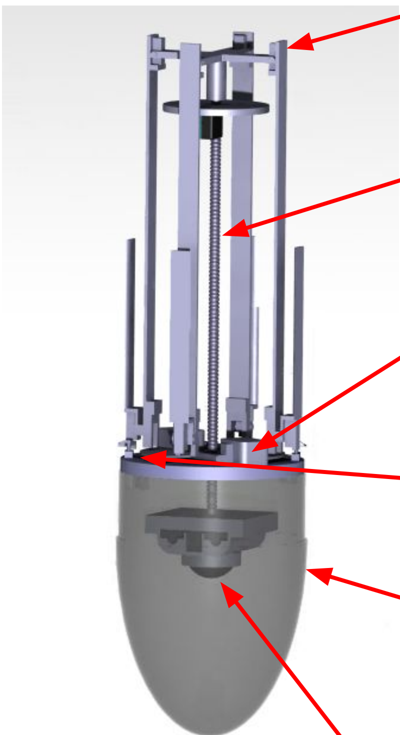
Container fitted configuration

Stowed Configuration

Deployed Configuration

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

Design B



Auto-Gyro

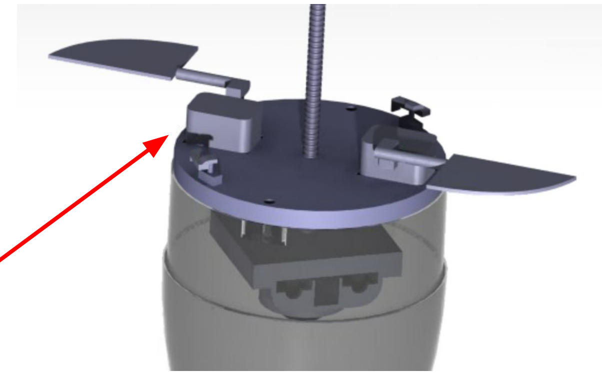
Threaded-rod

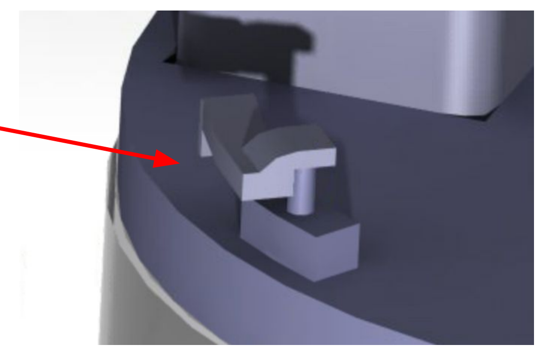
Fins-Mechanism (stabilization)

Container lock servo

Transparent Nose-Cone

360° camera



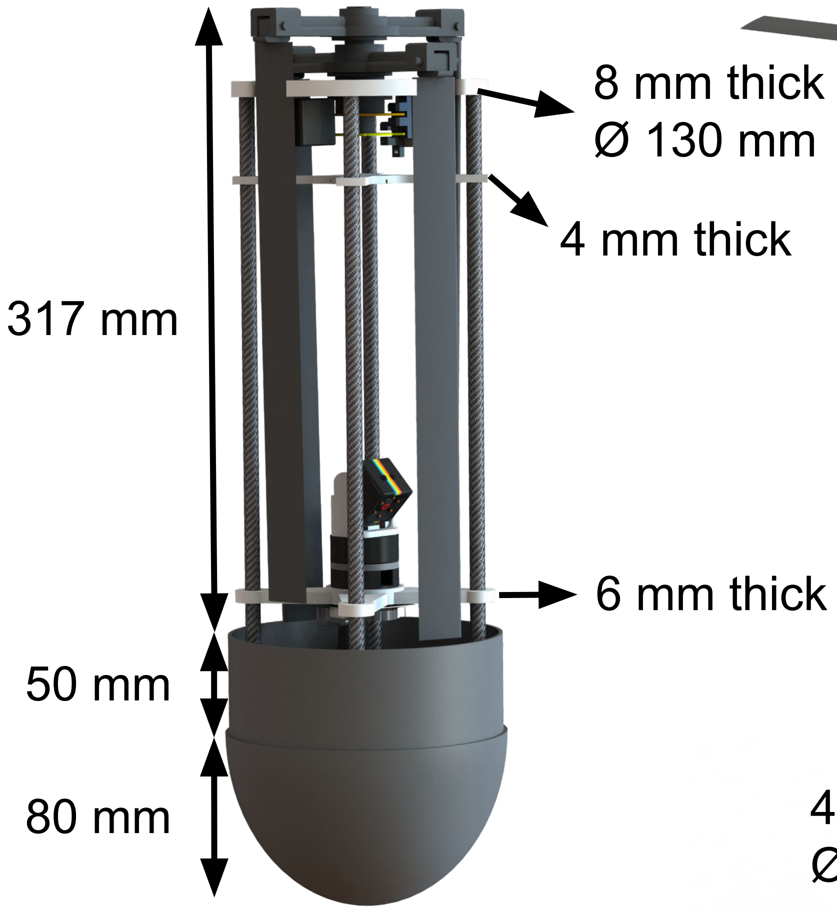


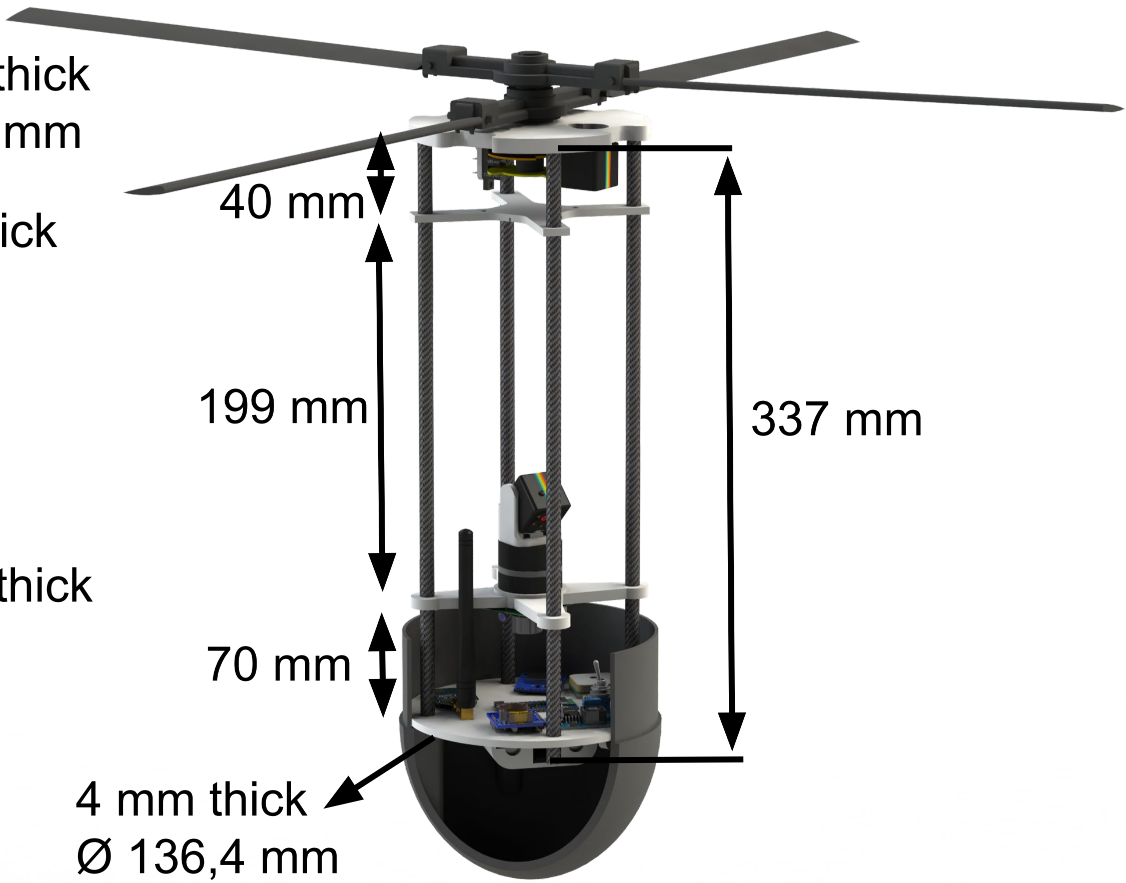
System Level Configuration Selection

Design	Design A	Design B
Advantages	● Resistant ● Rigid ● Lighter ● Cheaper ● Less moving parts	● Resistant ● Only one structural rod ● Simple deck Auto-Gyro ● Easier to assemble
Disadvantages	● Complex double deck Auto-Gyro ● Rods are force-fitted into Nose-Cone ● Harder to assemble	● Expensive ● Rod needs to be mechanized ● Heavier ● Higher number of moving parts
Conclusion and Rationale	Design A is chosen ● It's lighter, more robust, rigid and reliable	

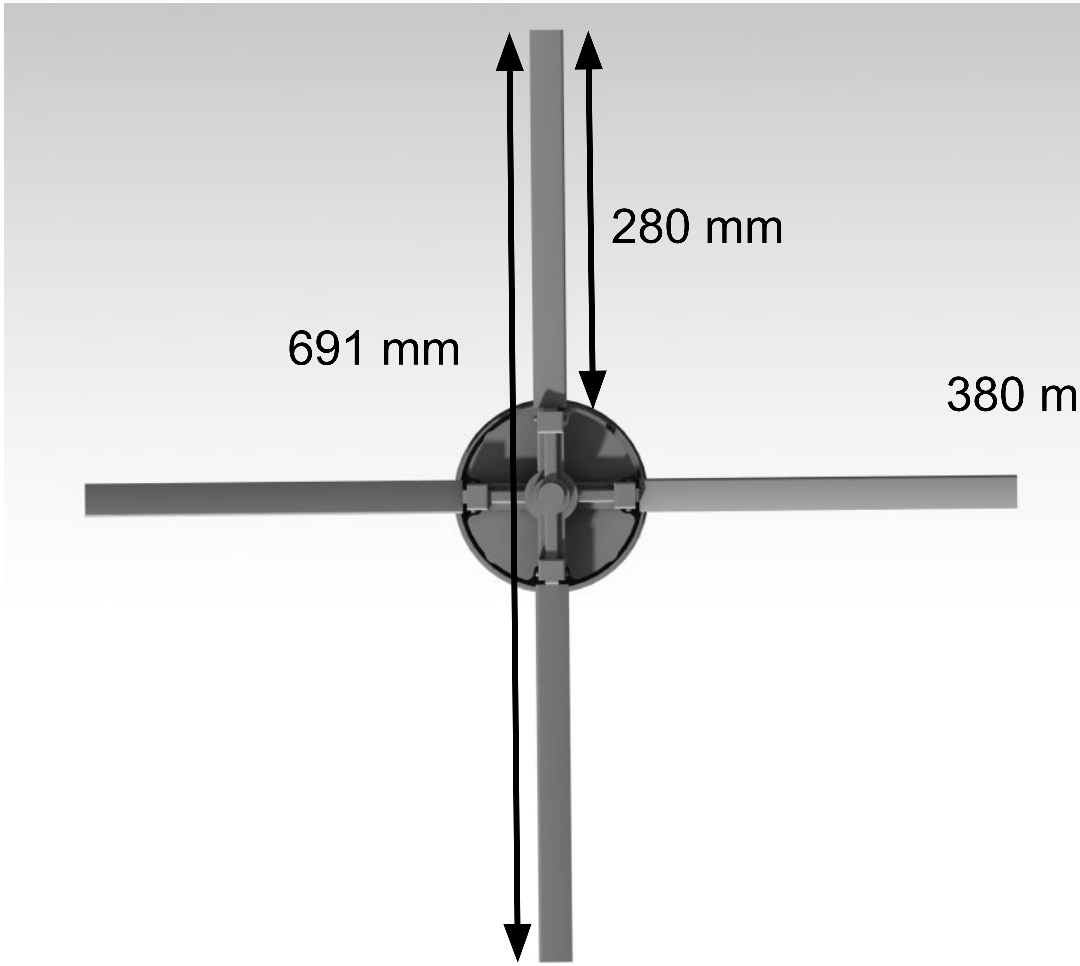
Physical Layout (1/4)

Payload dimensions



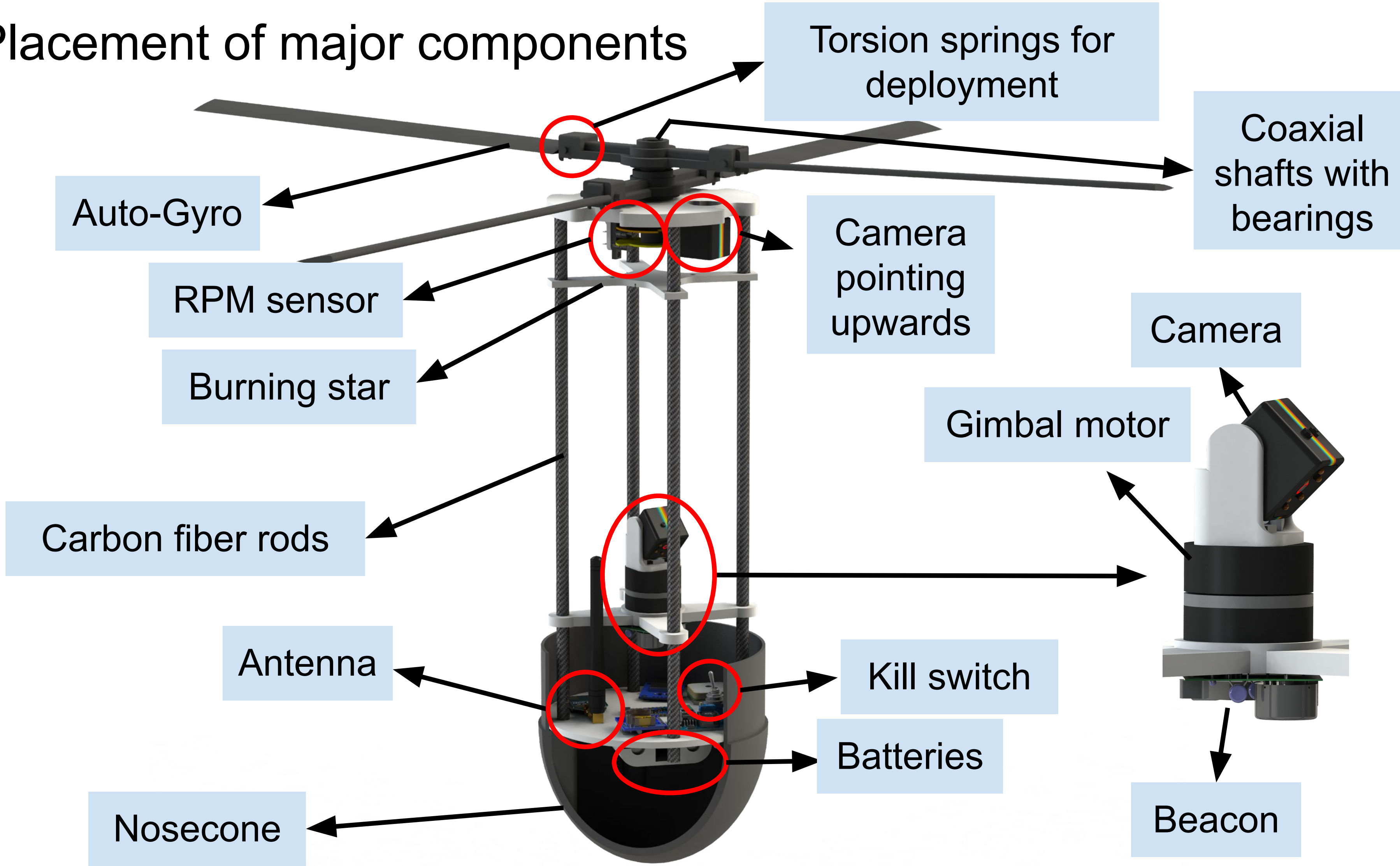


Auto-gyro and container dimensions

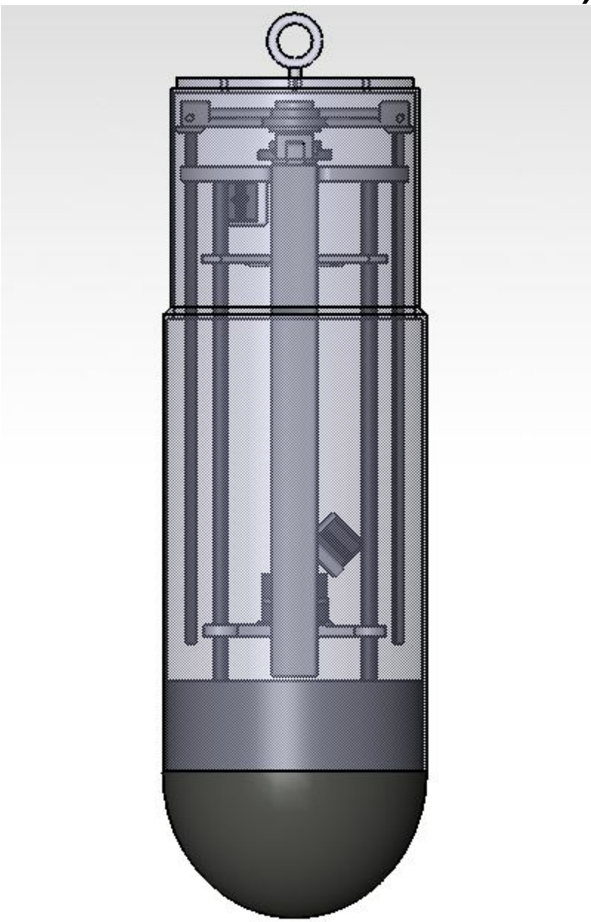


Physical Layout (3/4)

Placement of major components



Launch configuration
(as mounted in rocket)



Deployed configuration

System Concept of Operations

Pre-Launch	Launch & Ascent	Cansat Deployment	AG Deployment	Cansat Landing
1. Last CanSat check 2. CanSat and Beacon turned on 3. CanSat placement 4. Start Cameras Recording 4. Calibration of Sensors 5. Start transmitting data	1. Rocket ignition and ascension 2. Maximum altitude reached	1. CanSat deployment 2. Parachute deployment (at maximum altitude)	1. Payload deployment (at 75% of maximum altitude) 2. Auto-gyro deployment (at 75% of maximum altitude)	1. CanSat stop transmitting Data (beacon still active since launch)

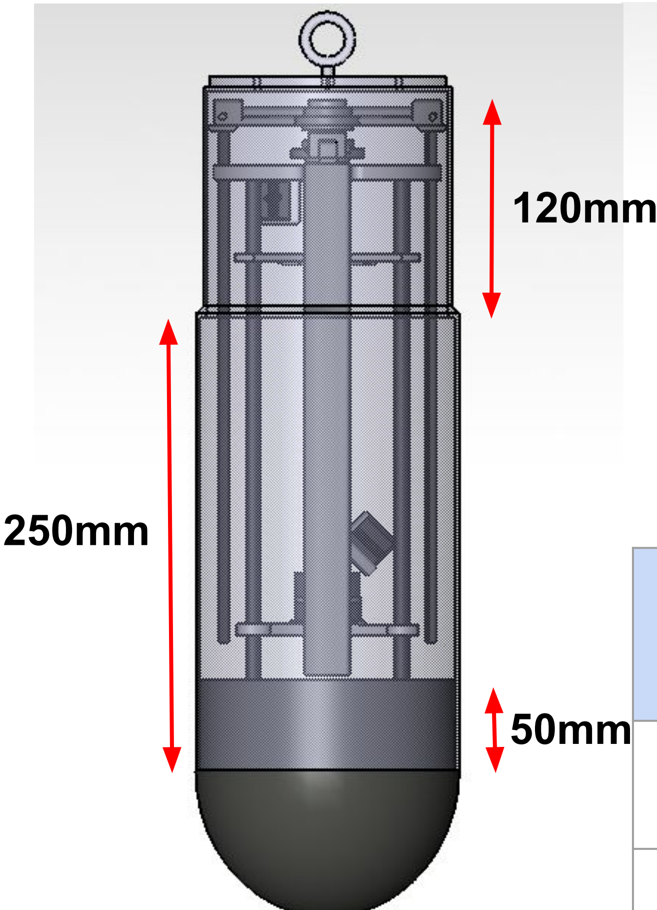
Ground Station

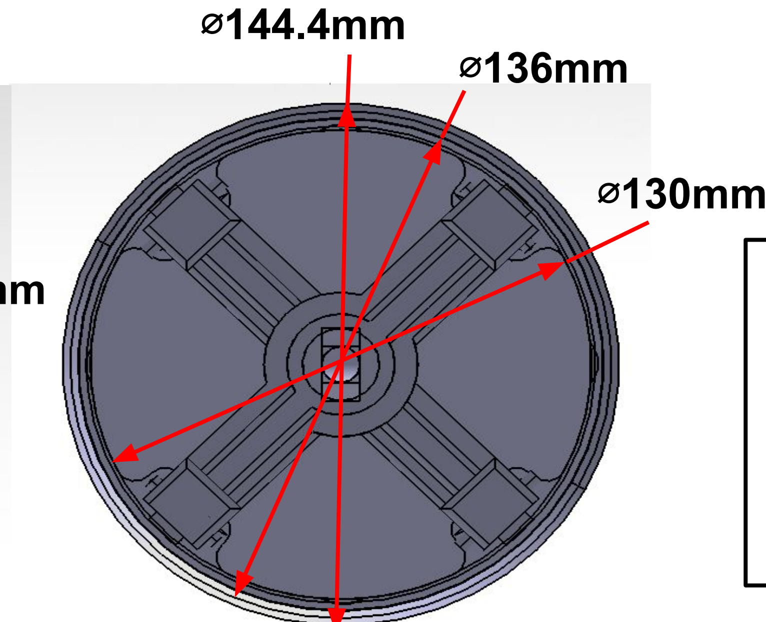
1. Team Briefing: get everyone into position for launch

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. Recover CanSat

Launch Vehicle Compatibility





Container shoulder is, as required, ⌀136 mm, enabling to place itself inside launch vehicle

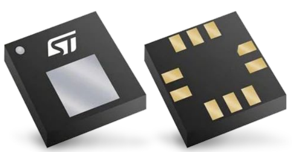
	Container section dimensions (mm)	Payload dimensions (mm)	Clearance (mm)
Diameter	132	131	1
Height	372	367	5
Nosecone	140,4	139	1,4

Sensor Subsystem Design

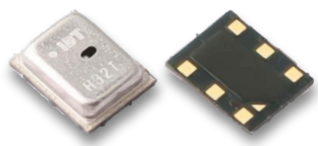
Emanuel Albornoz
Rafael Dalzotto

Sensor Subsystem Overview

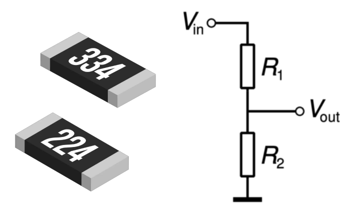
LPS22HB
Air pressure



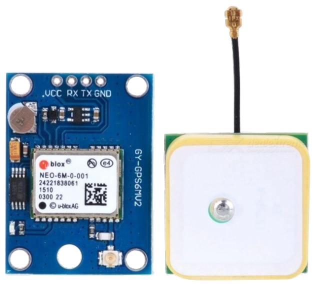
HS3003
Air temperature



Resistor divider + ADC
Battery voltage



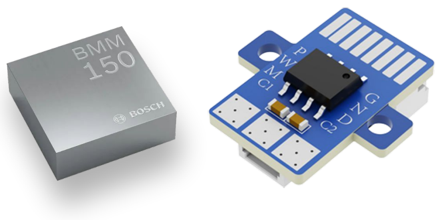
Ublox Neo-6M
GNSS receiver



TCST2103
Autogyro RPM Sensors
(Infrared switch)

BMI 270
Tilt Sensor
(Accelerometer)

BMM150 + AS5048A
Ground Cam Orientation
(Magnetometer + Angular Pos Encoder)



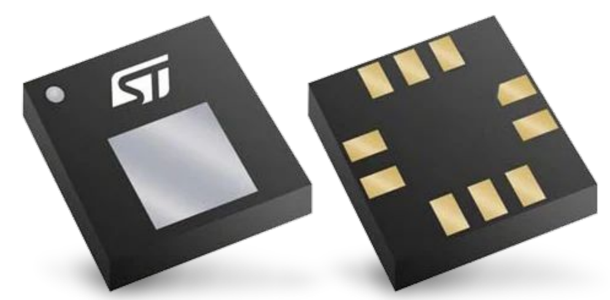
Quelima SQ11
Cameras

Payload Air Pressure Sensor Trade & Selection

Name	Relative Accuracy [hPa]	Footprint [mm]	Sensing Range [hPa]	Interfaces	Mass[1] [g]	Operating Current [µA]	Operating Voltage [V]	Price[2] [USD]
LPS22HB	±0.10	2 × 2	260 - 1260	I2C/SPI	NEGL	3	1.7 ~ 3.6	3.54
BMP280	±0.12	2 × 2.5	300 - 1100	I2C/SPI	NEGL	2.8	1.7 ~ 3.6	2.36
MPL3115A2	±0.5	3 × 5	200 - 1100	I2C	NEGL	40	-0.3 ~ 3.6	5.46

Selected Sensor: **LPS22HB**

STMicroelectronics



Reasons:

- **Included in our microcontroller board (COTS)**
- Simplifies our PCB (no need to route extra modules)
- High relative accuracy
- Wide sensing range
- Low Operating Current

Notes:

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

Payload Air Temperature Sensor Trade & Selection

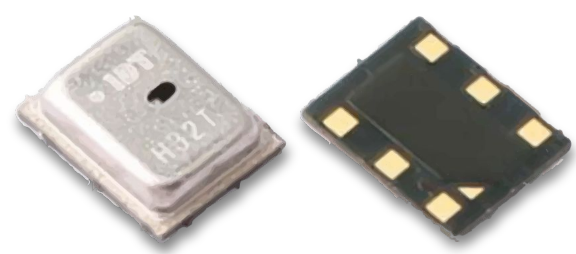
Name	Footprint [mm]	Mass[1] [g]	Operating current [µA]	Operating voltage [V]	Range [°C]	Relative Accuracy [°C]	Interface	Price[2] [USD]
HS3003	3.0 × 2.4	NEGL	24.4	2.3-5.5	-40 ~ +125	0.035	I2C	2.66
BMP280	2 × 2.5	NEGL	2.8	1.7-3.6	-40 - 85	0.01	I2C/SPI	9.05
TMP117	2 × 2	NEGL	3.4	1.8-5.5	-55 - 150	0.0078	I2C	5

Selected Sensor: **HS3003**

RENESAS

Reasons:

- **Included in our microcontroller board (COTS)**
- Simplifies our PCB (no need to route extra modules)
- Low Price
- Wide Temperature range



Notes:

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2. price reference was obtained from the Mouser Electronics website

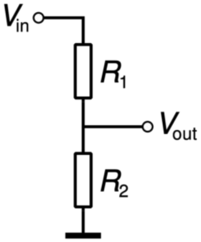
Payload Battery Voltage Sensor Trade & Selection

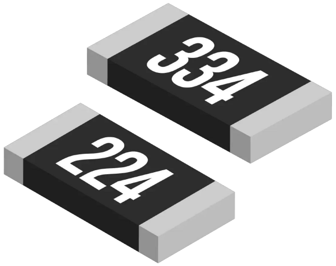
Name	Room Size [mm]	Mass[1] [g]	Operating current [mA]	Input Range[3] [V]	Resolution [mV/LSB]	Interface	Price[2] [USD]
ADC Pin + Voltage divider	2 x 2	NEGL	0.015	0 ~ 8.25	2	12-bit Analog Input (0 ~ 3.3V)	0.2
ADS1115 + Voltage Divider	5 x 3	NEGL	0.200	0 ~ 8.25	0.125	I2C	6.27
INA219	1.5 x 3	NEGL	1	0 ~ 26	40	I2C	4.43

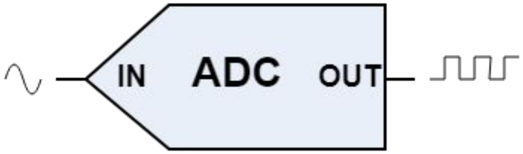
Selected Sensor: **ADC Pin + Voltage divider** (330k + 220k)

Reasons:

- Simple and cheap *(SMD resistors)*
- Lowest current consumption
- Easy interface (ADC pin)
- No additional cost, weight or space needed
- Reliable







Notes:

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

Payload GNSS Sensor Trade & Selection

Name	GNSS System	Accuracy [m]	Update Rate [Hz]	Interface	Current [mA]	Size / Mass	Voltage [V]	Price[1] [USD]
Ublox NEO-6M	GPS	2.5	1-5	UART/SPI/DDC/USB	40	16×12.2×2.4 mm / ~1g	2.7 ~ 3.6	10.9
Ublox NEO-M8N	GPS, GLONASS, Galileo	2.5	1-10	UART/SPI/DDC/USB	20	16×12.2×2.4 mm / ~1g	2.7 ~ 3.6	20
Quectel L80	GPS, GLONASS	2.5	1	UART	20	16×16×6.45 mm / 4.3g	3.0 ~ 4.3	4.5
MTK3339	GPS	2.5	1-5	UART/SPI/DDC/USB	67	16x12.2x2.4 mm / 17g	2.7 ~ 3.6	27

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

Reasons:

- Previous Experience
- Availability in Argentina
- Low weight and low current
- Optimal price-performance relationship

Notes:

1. price reference was obtained from the Mouser Electronics website

Payload Auto-Gyro Rotation Rate Sensor Trade & Selection

Name	Sensor Type	WxLxH Size [mm]	Mass[1] [g]	Operating current [mA]	Operating voltage [V]	Switching Time [us]	Output	Price[2] [USD]
GP2Y0A21YK0F	IR	13 x 29.5 x 13.5	3	30	4.5 ~ 5.5	38000	Analog	15
TCRT5000	IR	5.8 x 10.2 x 7	NEGL	60	1.25 ~ 5.5	25	Analog	1
SS40F	Hall	4 x 4 x 1.5	NEGL	5	4.5 ~ 24	1,5	Digital	1.79
A1104	Hall	4 x 4 x 1.5	NEGL	7.5	3.8 ~ 24	0.4	Digital	2.1
TCST2103	IR Slot	6 x 25 x 11	1	64	1.6 ~ 18	10	Digital	1.13

Selected Sensor: **TCST2103**

Reasons:
- Previous experience
- 3.3V and 5V compatible.
- Available in our university
- Simpler implementation than Hall Sensors
- Max RPM ≥ 100000 RPM

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

Payload Tilt Sensor Trade & Selection

Name	Footprint [mm]	Mass[1] [g]	Supply Current [μA]	Supply Voltage [V]	ODR [Hz]	Resolution [LSB/g]	Interface	Price[2] [USD]
BMI 270	3.0 × 2.4	NEGL	970	1.7- 3.6	12.5 ~ 1600	16384	I2C/SPI	4.9
MPU6050	20 × 16	NEGL	2.8	1.7-3.6	4 ~ 1000	16384	I2C/SPI	8.5
BNO055	3.8 × 5.2	NEGL	3.4	2.4-3.6	7.81 ~ 1000	1000	I2C/UART	10.9

Selected Sensor: **BMI 270**

BOSCH

Reasons:

- **Included in our microcontroller board (COTS)**
- High Output Data Rate (ODR)
- Low Price
- Small footprint
- High resolution

Notes:

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

Payload Ground Camera Orientation Sensor Trade & Selection (1/3)

Sensors Used	Approach	Total Current Consumption [mA]	ODR [Hz]	Operating Voltage [V]	Interfaces	Total Price [USD]
ICM-20948	**Direct** measurement (magnetic compass on camera)	3.11	100	3.3	I2C	18.5
AS5048A + BMM150	**Indirect** measurement (magnetic compass on payload, measurement of camera position with encoder)	20	> 300 in forced mode	3.3	I2C + SPI	24

Selected Sensor: **BMM150 + AS5048A**

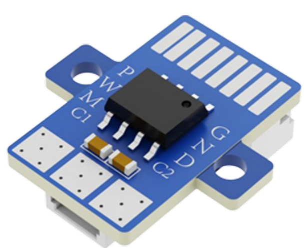
BOSCH

ams OSRAM

Reasons:

- Higher Output Data Rate (ODR)
- BMM150 is already included in our microcontroller board
- No need to perform a digital communication over the rotary slip ring connection
- More reliable digital communication

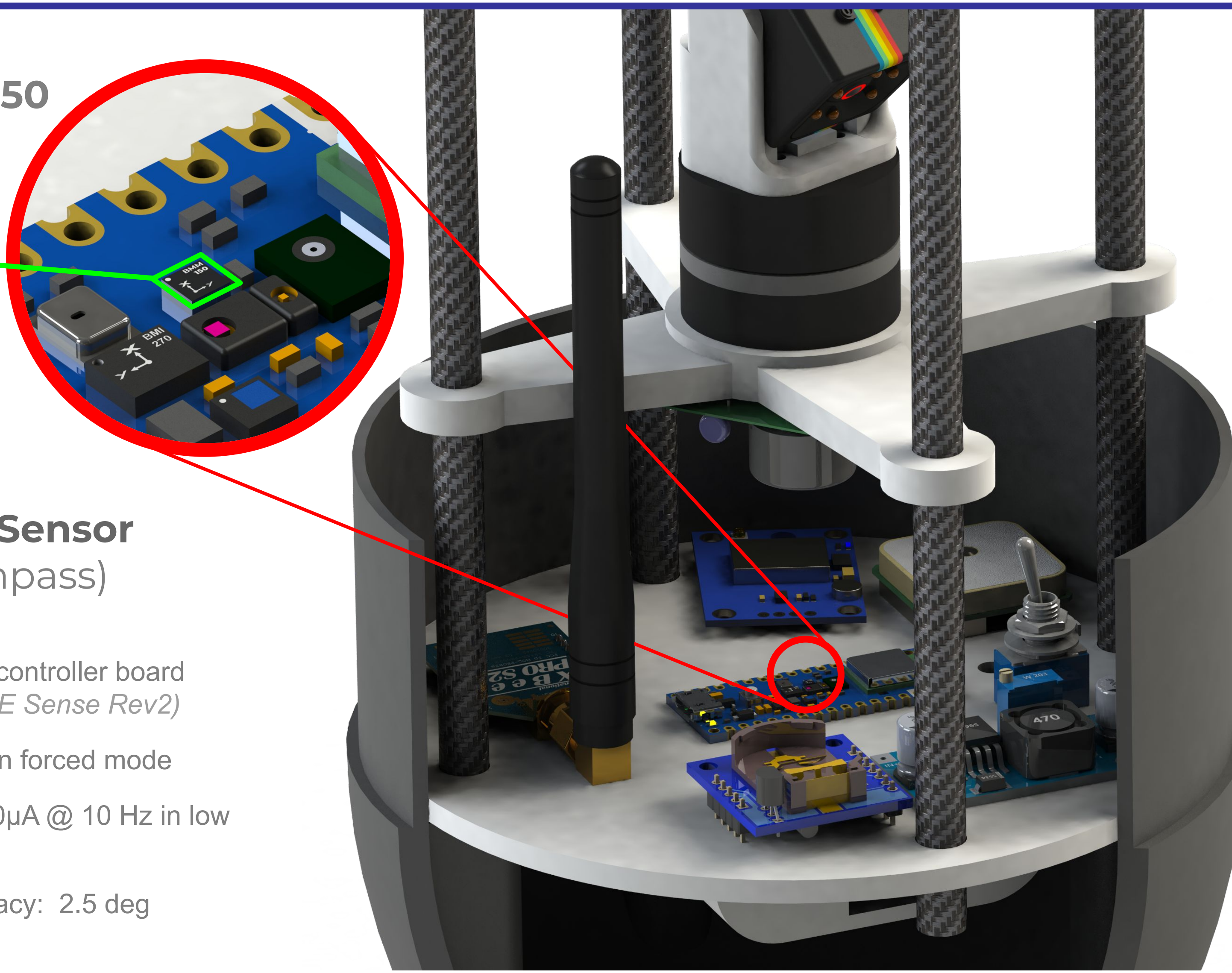
BMM150



AS5048A

Payload Ground Camera Orientation Sensor Trade & Selection (2/3)

BOSCH **BMM150**

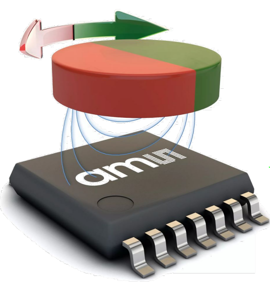


Three-Axis Geomagnetic Sensor
(Magnetic Compass)

- Included in our microcontroller board *(Arduino Nano 33 BLE Sense Rev2)*
- High ODR: >300 Hz in forced mode
- Ultra-Low Power (170μA @ 10 Hz in low power mode)
- Good Heading Accuracy: 2.5 deg

Payload Ground Camera Orientation Sensor Trade & Selection (3/3)

Encoder
Magnet



amu OSRAM AS5048A

Magnetic Rotary Encoder
(14-Bit Angular Position Sensor)

- High resolution (0.0219°/LSB)
- 3.3V / 5V compliant
- Easy to use vía SPI or I2C
- High sensing speed: 12.4 kHz ODR

Parachute Release Camera Trade & Selection

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

Selected Sensor: **Quelima SQ11**

Reasons:

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

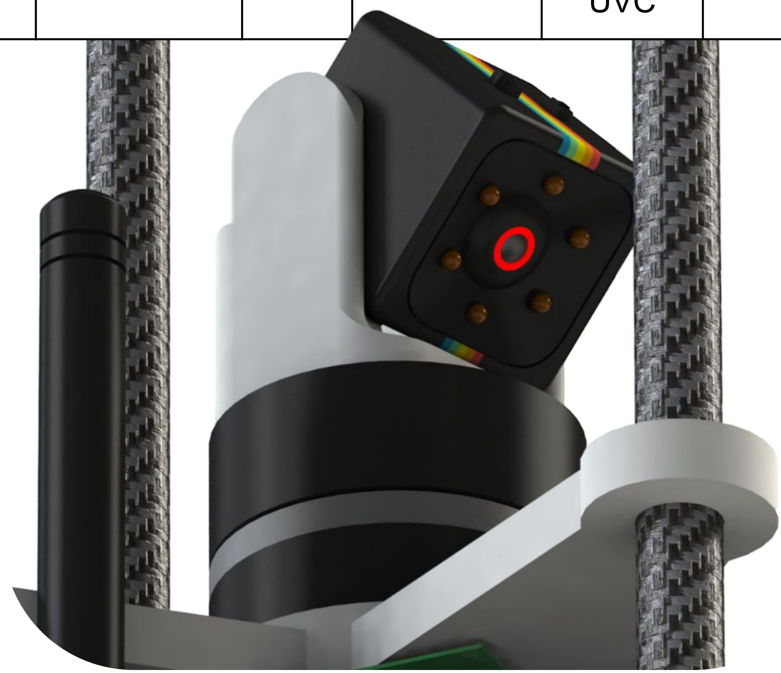
Ground Camera Trade and Selection

Name	Size [mm]	Weight [g]	Operating current [mA]	Operating voltage [V]	Resolution [px]	FPS	Included Memory [GB]	Interface	Price [USD]
Adafruit 3202	28.5x17x4.2	2.8	110	5	640 x 480	30	32	Digital	12.5
SQ11	23x23x23	15	120	3.3	1280 x 720	30	64	Digital	8.4
BT-568 360° cam	35x35x29	40	220	5	3264x2448	30	0	UART, UVC	167

Selected Sensor: **Quelima SQ11**

Reasons:

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



Descent Control Design

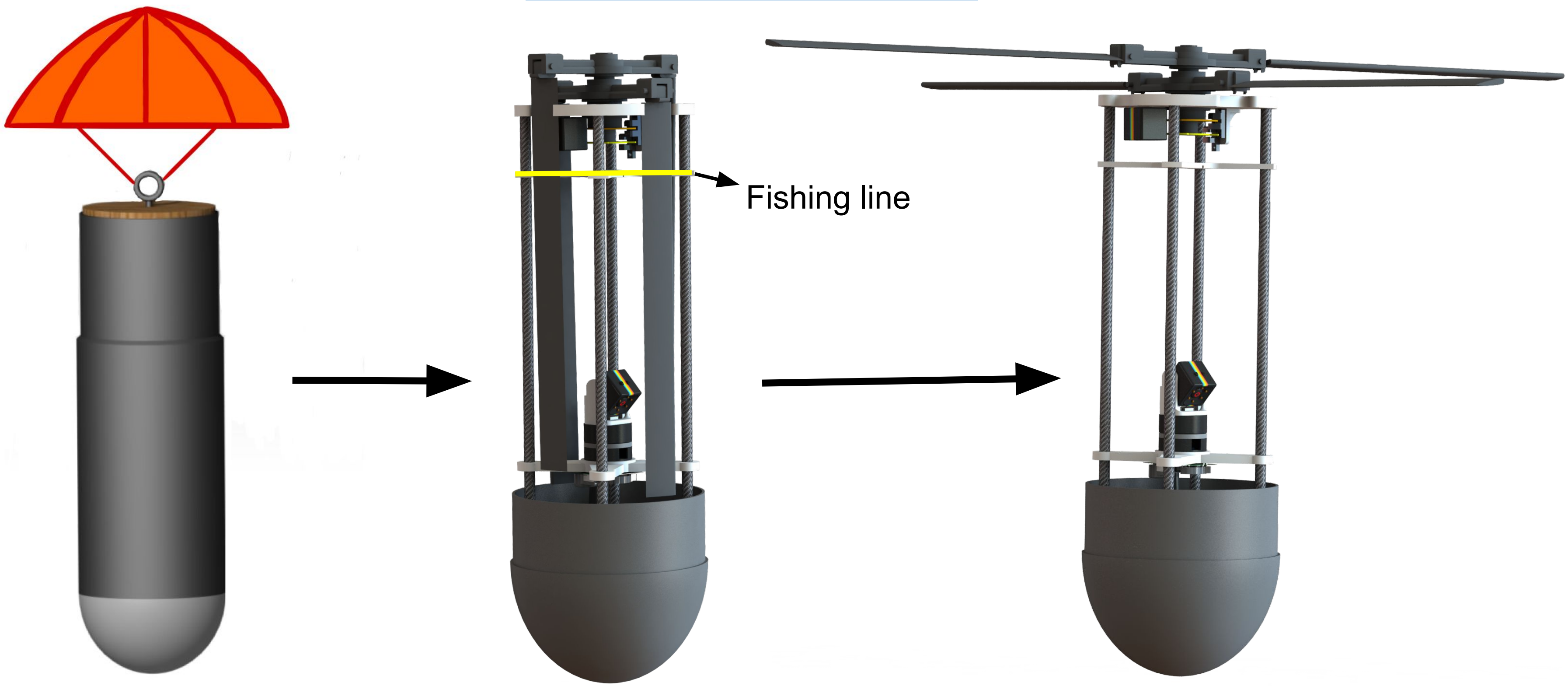
Thomas Marthi
Federico Agustin Pilotto

Descent Control Overview (1/2)

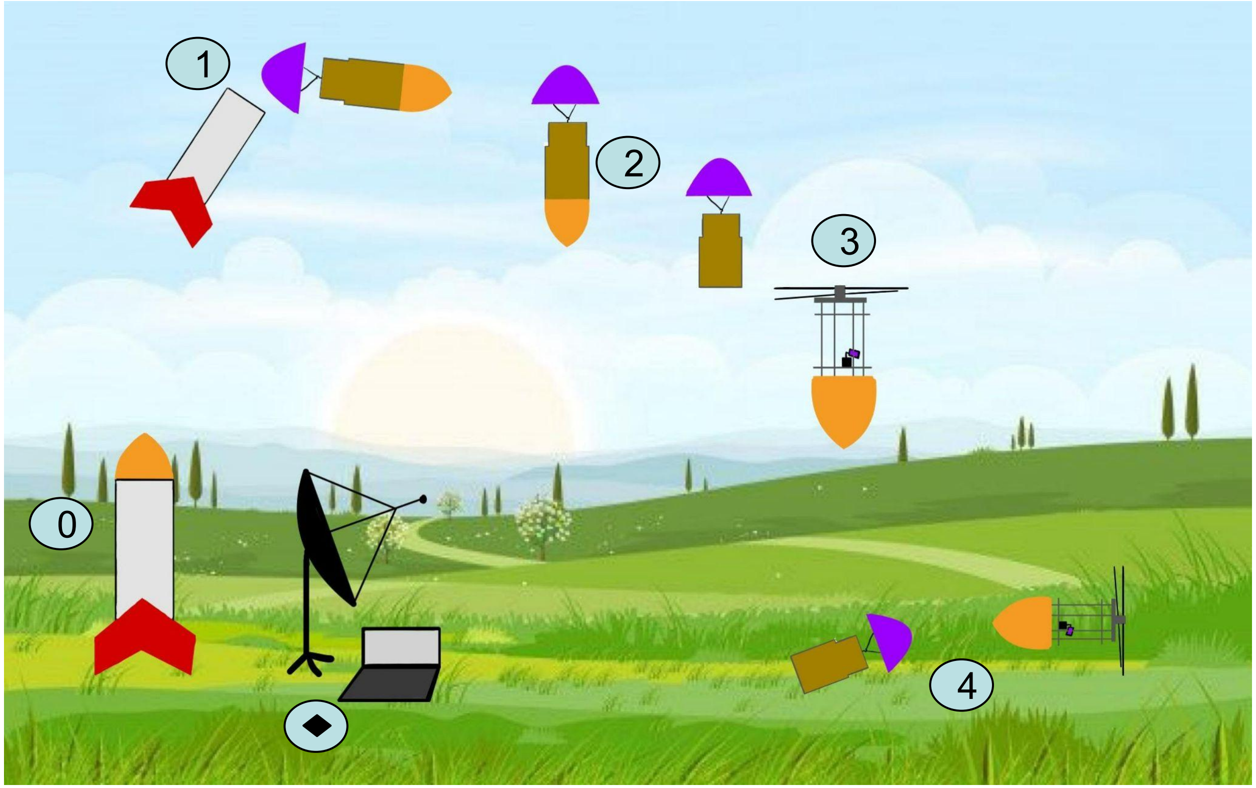
- Double deck Auto-Gyro
- Fishing line attachment

Parts:
- Fishing line
- Auto-Gyro
- Hexagonal Parachute

Nose cone does not separate from payload



Container fitted **Stowed Configuration** **Deployed Configuration**



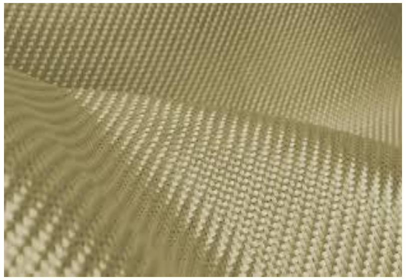
◆
CanSat will communicate with the ground station for entire mission

0	1	2	3	4
CanSat is loaded into launch vehicle	CanSat deploys at peak altitude.	Payload with container drops with parachute the first 25% of descent at a speed rate of 20 m/s.	Payload is released from container and autogyro deploys. Descent rate of 5 m/s.	Both payload and container drop to the ground without breaking.

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

Parachute Type	Hexagonal	Hemispherical	Cross-Parachute
Reference			
Advantages	• Ease of manufacturing • Lightweight • Compact • Reduced oscillation during freefall	• Stable with spill hole • High coefficient of drag	• Ease of manufacturing • Stable • Easy to fold
Disadvantages	• Low coefficient of drag	• Hard to make	• Deployment is challenging • Low coefficient of drag
Conclusion	Hexagonal design is chosen because ● Ease of manufacture		

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 strength • Heat resistant	• Lightweight • Wind resistant • Easy to fold
Disadvantages	• Heat sensitive • Non Biodegradable	• Expensive	• Expensive
Conclusions	Nylon is chosen because ● It is cheaper		

Design A
2 rotors with 2 blades each

Advantages:
- Produces sufficient lift without needing long blades (Should be experimentally verified)
- Counter rotating rotors torques cancel each other out
- Easy to stow

Disadvantages:
- Needs a complex shaft
- If one blade breaks, there isn't a backup blade

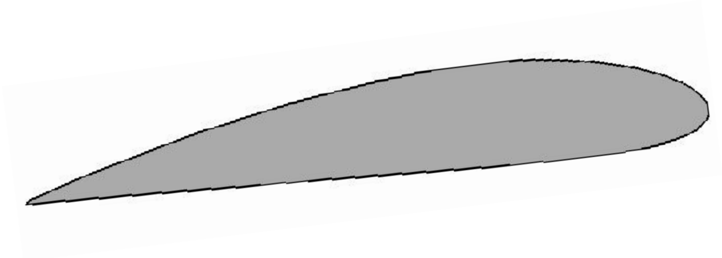
Design B
1 rotor with 4 blades

Advantages:
- Only needs one simple shaft
- Being 4 blades there is backup if one of them breaks

Disadvantages:
- Needs long blades two reach the necessary lift
- Hard to stow the long blades
- Blades are more likely to bend and break
- Produces a torque on the payload

Selection	Rationale
Design A	• Shorter blades are less likely to break and easier to stow

Design A
NACA airfoil with 8º angle of attack



Design B
Flat blade without angle of attack

Advantages:
- Produces better lift with shorter blades
- High stall angle

Disadvantages:
- Hard to produce
- Hard to stow

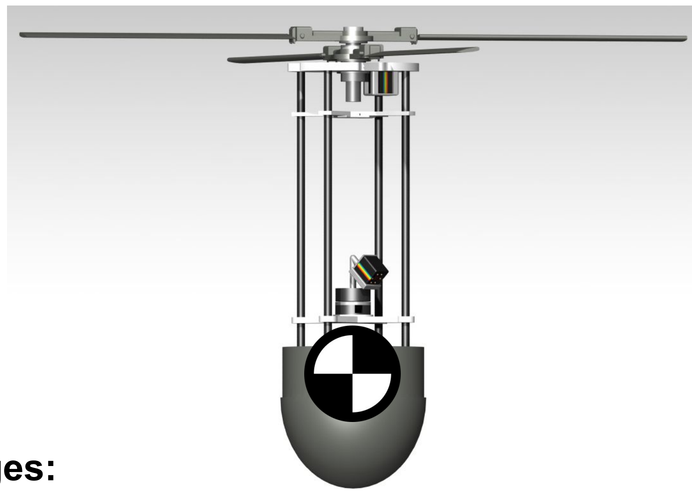
Advantages:
- Easy to make
- Easy to stow

Disadvantages:
- Produces low lift with a low angle of attack
- May produce stall

Selection	Rationale
Design A	• Its capable of getting the 5 m/s decent rate without using large blades

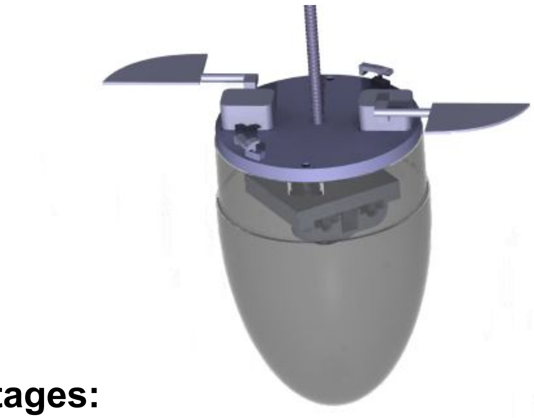
Auto-Gyro Descent Stability Control Strategy Selection and Trade

Design A
Low center of mass (Passive control)



Advantages:
- Low and symmetrical center of mass makes the descent stable
- It doesn't need complex electronics
- Counter rotating blades avoids unnecessary rotation in the main axis

Design B
Servo-controlled fins for stability (Active control)



Advantages:
- High accuracy active stability control

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

Selection	Rationale
Design A	• Having the center of mass far below the center of pressure ensures the payload won't tumble • Being it a passive control design, it does not need complex electronics to work

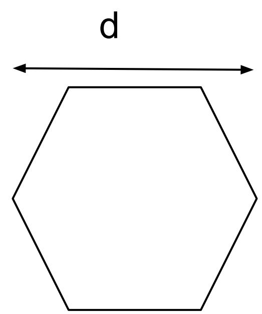
Descent Rate Estimates (1/3)

Assumptions

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

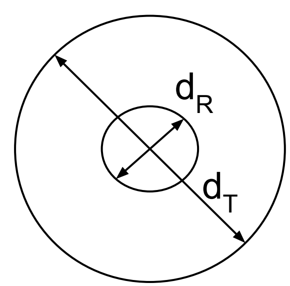
Container parachute

- $m_1 = 1{,}4\ kg$
- $\rho_1 = 1{,}15\ kg/m^3$ (at 700 m)
- $A_1 = 3\sqrt{3}/8\ d^2 = 0{,}6495\ \mathrm{d}^2$
- $Cd_1 = 0{,}8$ (should be experimentally verified)



Auto-gyro

- $\mathrm{m}_2 = 1\ \mathrm{kg}$
- $\rho_2 = 1{,}17\ kg/m^3$ (at 500 m)
- $A_2 = 2\pi(\mathrm{d_T}^2 - \mathrm{d_R}^2)/4$ (Accounting for both rotors and neglecting the internal rotor)
- $Cd_2 = 1{,}1$ (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
d_R: Diameter of the internal rotor
d_T: Total diameter, accounting for the blades

Descent Rate Estimates (2/3)

Equations

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

Parachute

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

Auto-gyro

$$L = \sqrt{\left[\left(\frac{m\,g}{\pi\,\rho\,v^2\,C_d}\right) + R_R^2\right]} - R_R$$

$$v = \sqrt{\frac{m\,g}{\pi\,\rho\,C_d\left[(L+R_R)^2 - R_R^2\right]}}$$

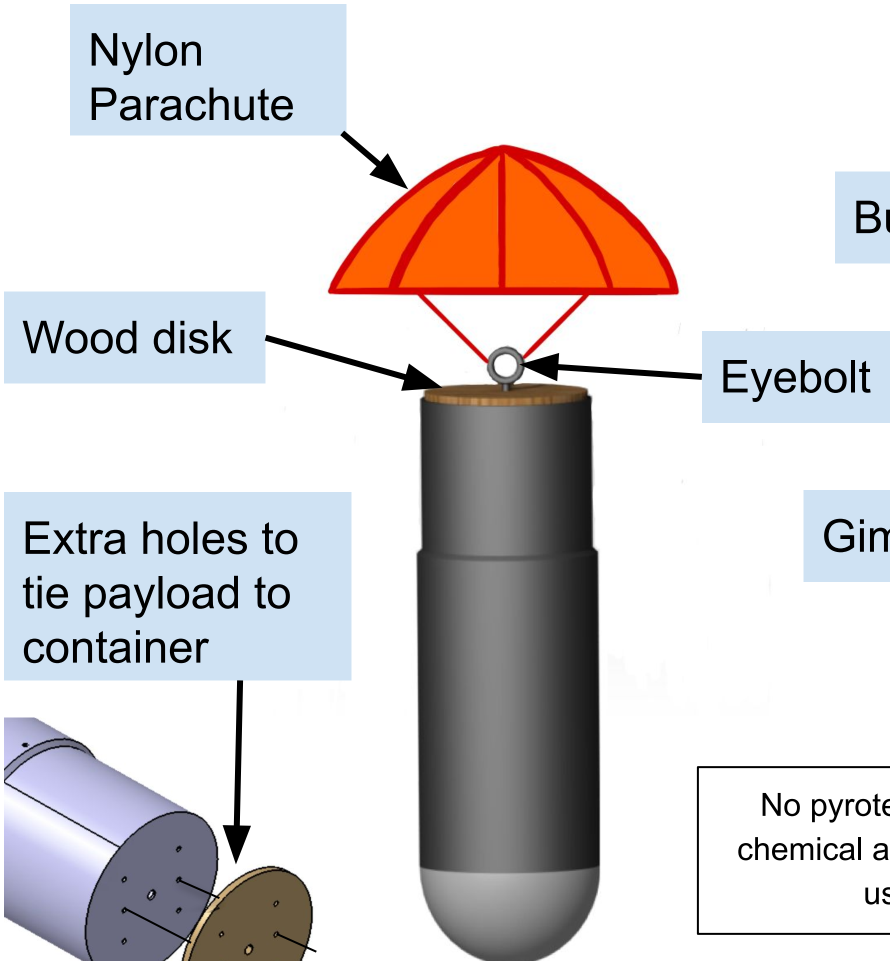
Variables
m : Mass
g : Acceleration of the Earth
ρ : Density of the Air
v : Terminal Velocity
Cd : Drag Coefficient
A : Area
d : Length of the diagonal of the hexagon
R_R: Radius of the central rotor
R_T: Total radius
L: Longitud of the blade

Descent Rate Estimates (3/3)

Parachute	Auto-gyro
The descent rate should be 20 m/s ± 3 m/s Dimensioning for 18 m/s to have a margin: **d = 0,3766 m** We choose d = 0,37 m for ease of assembly **v = 18,324 m/s**	The descent rate should be 5 m/s ± 3 m/s. Dimensioning for a target speed of 4,6 m/s to have a margin: **L = 281,84 mm** We choose L = 280 mm for ease of assembly, and still being in the target range **v = 4,63 m/s**

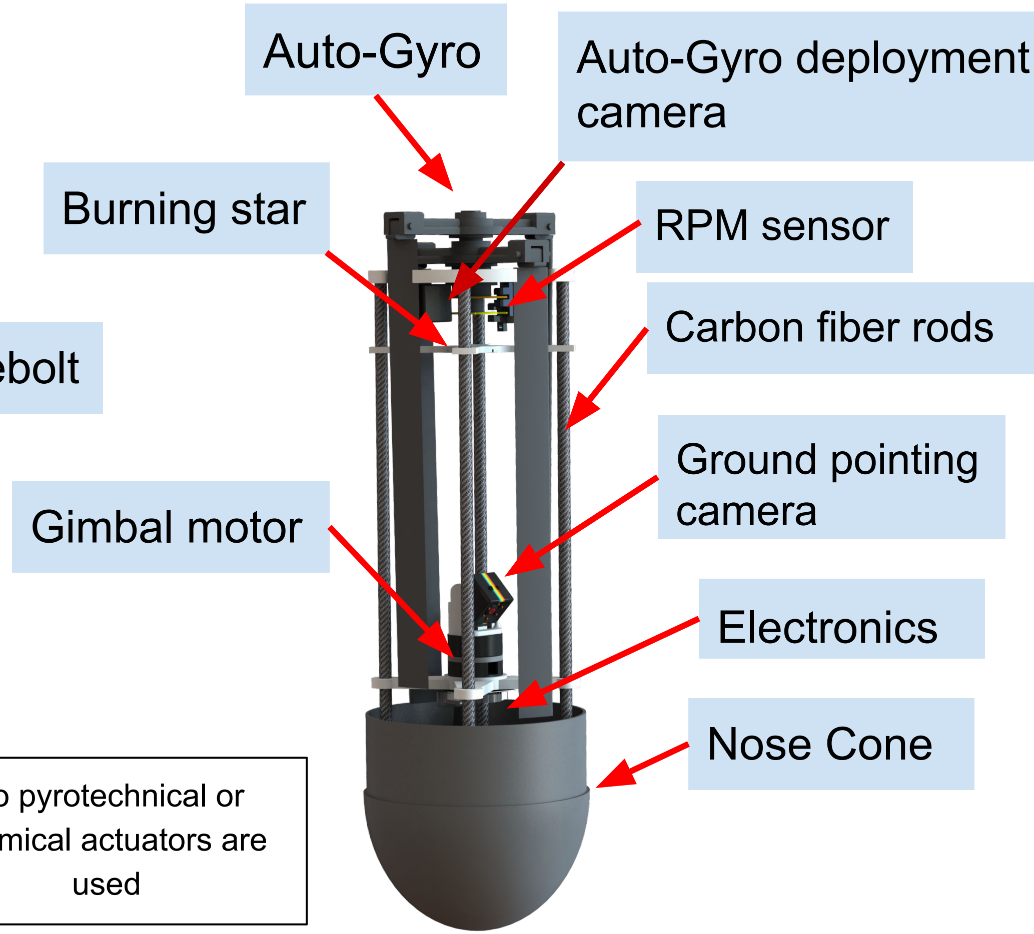
Mechanical Subsystem Design

Daniela Maradei
Ezequiel Bolzicco
Thomas Marthi
Federico Agustin Pilotto
Agustin Martinez



Container fitted

No pyrotechnical or chemical actuators are used



Payload undeployed

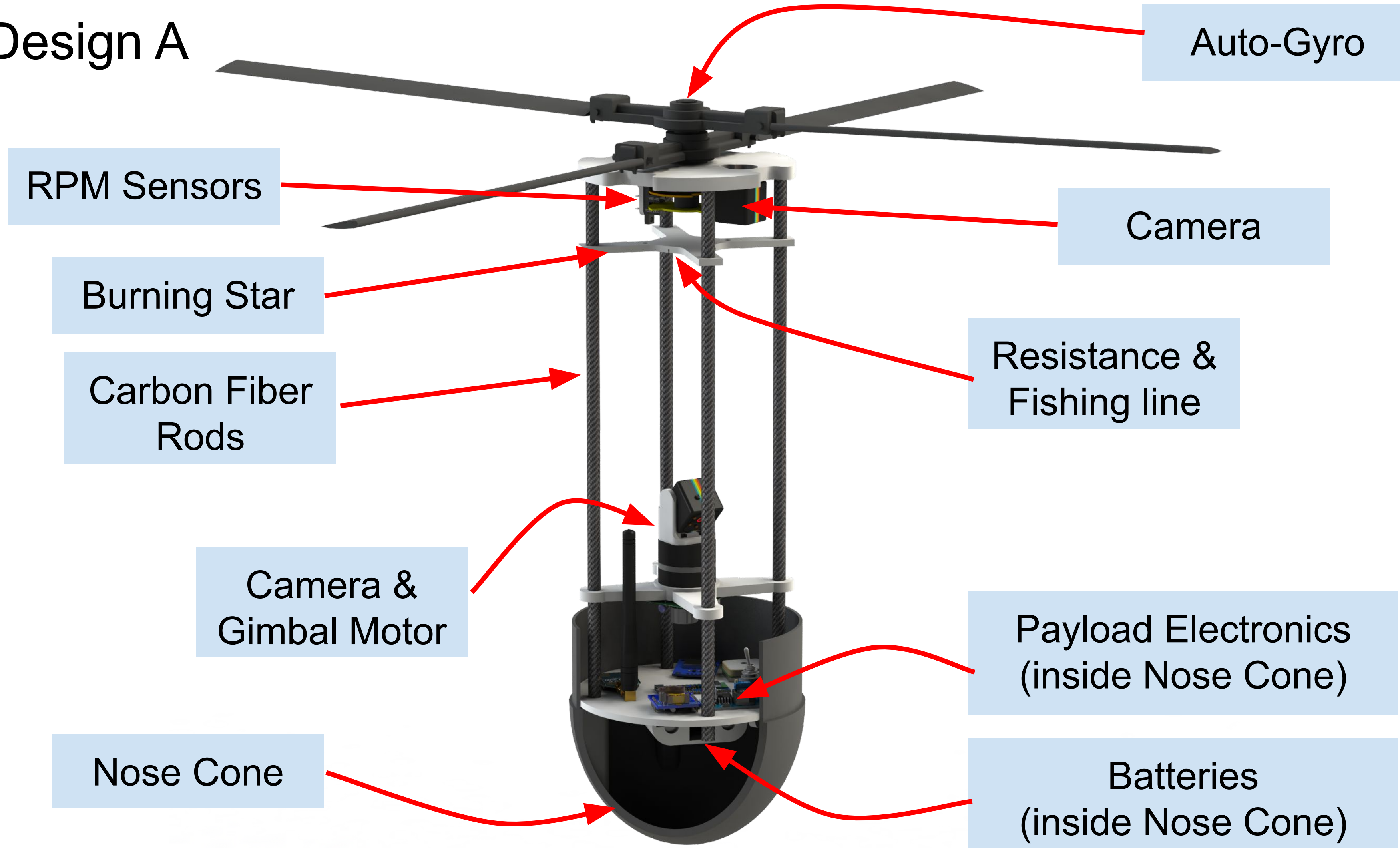
Mechanical Subsystem Overview (2/2)

Materials

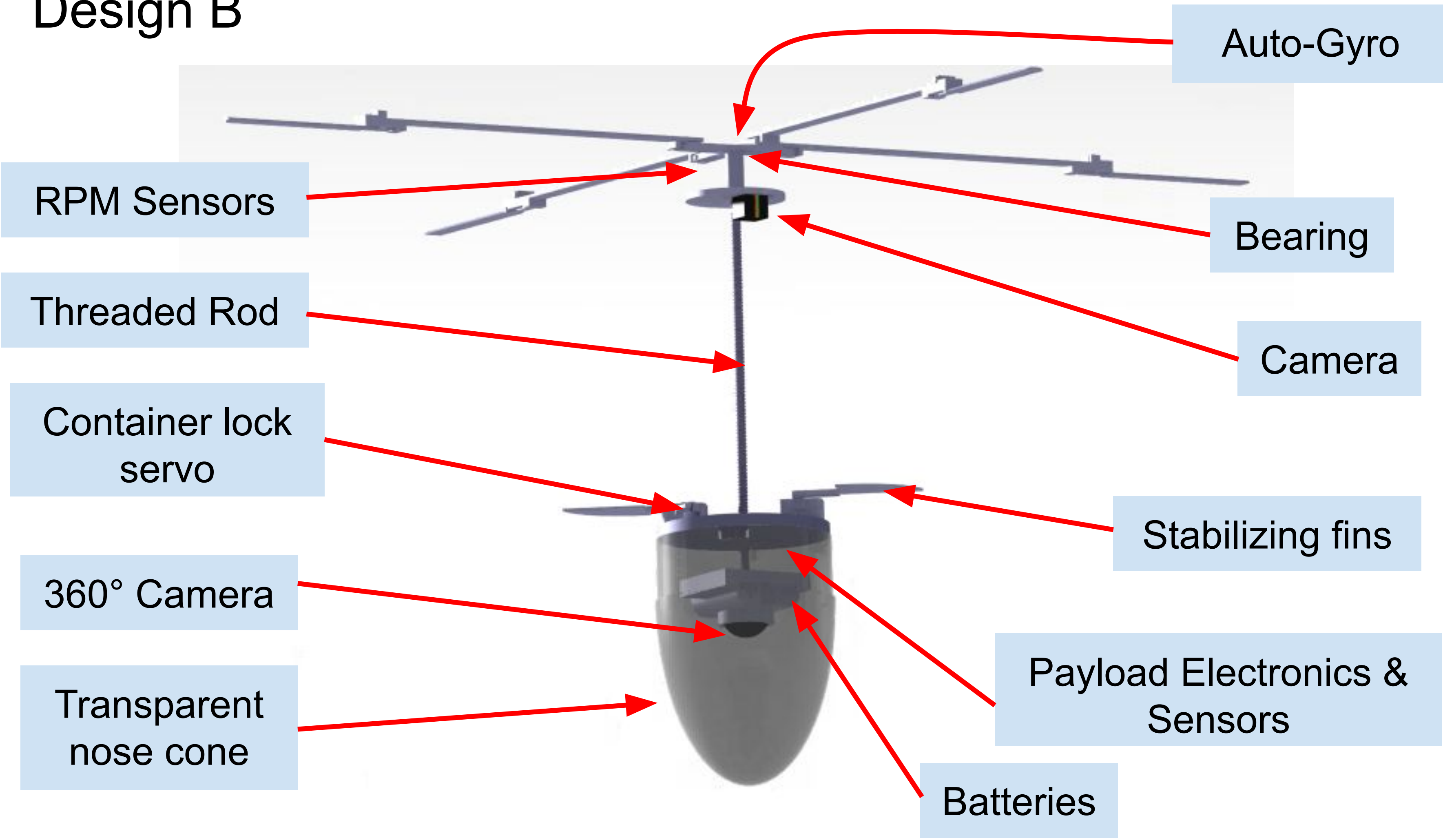
Part	Material
Container	ABS
Eyebolt support disk	Wood
Structural rods	Carbon fiber
Auto-Gyro blades and rotors	ABS
Auto-gyro shaft	Aluminum
Components floor, Burning star, Camera bracket, Nosecone	ABS
Parachute	Nylon

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

Design A



Design B



Auto-Gyro
RPM Sensors
Bearing
Threaded Rod
Camera
Container lock servo
Stabilizing fins
360° Camera
Payload Electronics & Sensors
Transparent nose cone
Batteries

Selection of material for the rods

	Aluminium Rods	Carbon Fibre Rods	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

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.

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

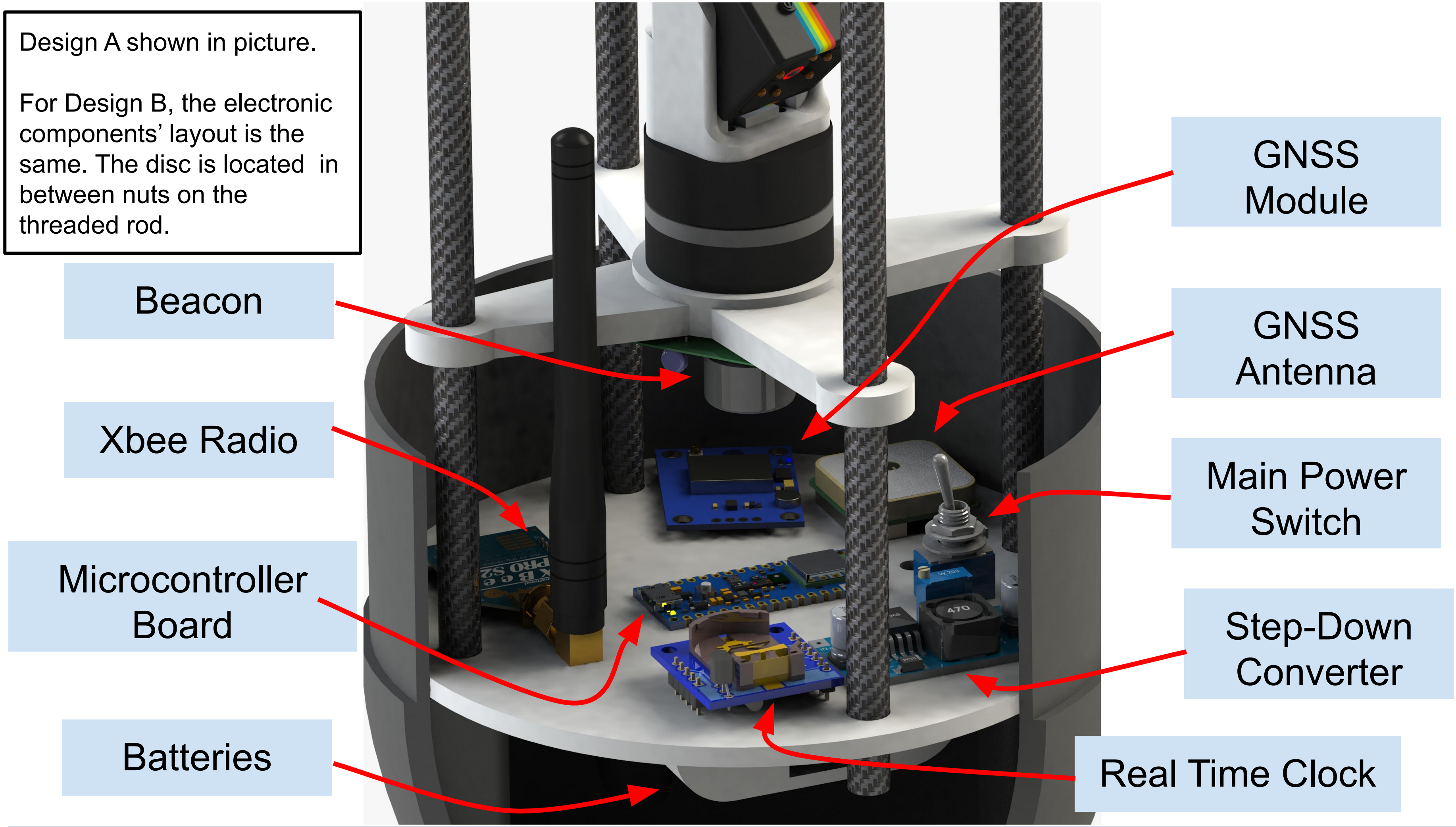
Design	Design A	Design B
Advantages	• Resistant • Rigid • Lighter • Cheaper • Less moving parts	• Resistant • Only one structural rod • Simple deck Auto-Gyro • Easier to assemble
Disadvantages	• Complex double deck Auto-Gyro • Rods are force-fitted into Nose-Cone • Harder to assemble	• Expensive • Rod needs to be mechanized • Heavier • Higher number of moving parts
Conclusion	Design A is chosen • It's lighter, more robust and reliable	

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

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

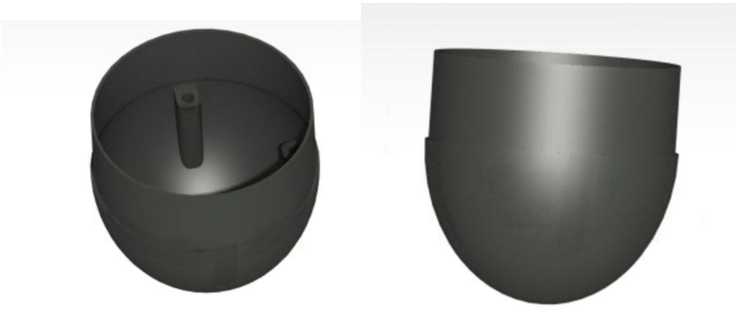
Design A shown in picture.

For Design B, the electronic components' layout is the same. The disc is located in between nuts on the threaded rod.



Nose Cone Design Trade & Selection (1/4)

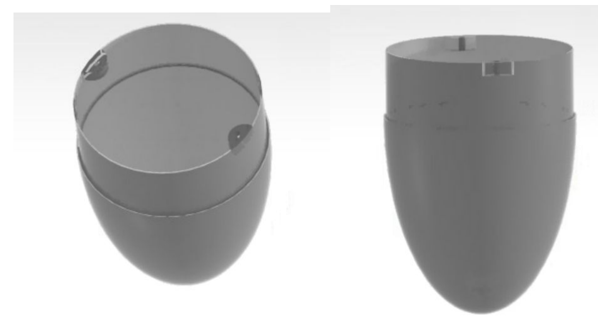
Design A
Abs Material nose cone (Non-Pointy end)



Advantages:
- It has decent durability and impact resistance
- Easy to manufacture, low cost.
- Lower weight
- It's non pointy end, helps not reaching a higher speed rate during descent.

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

Design B
PC Material nose cone (Pointier end)



Advantages:
- It has great durability and impact resistance
- It's pointy end, helps reaching a higher altitude during ascent.
- Transparent material enables the use of a 360 camera.

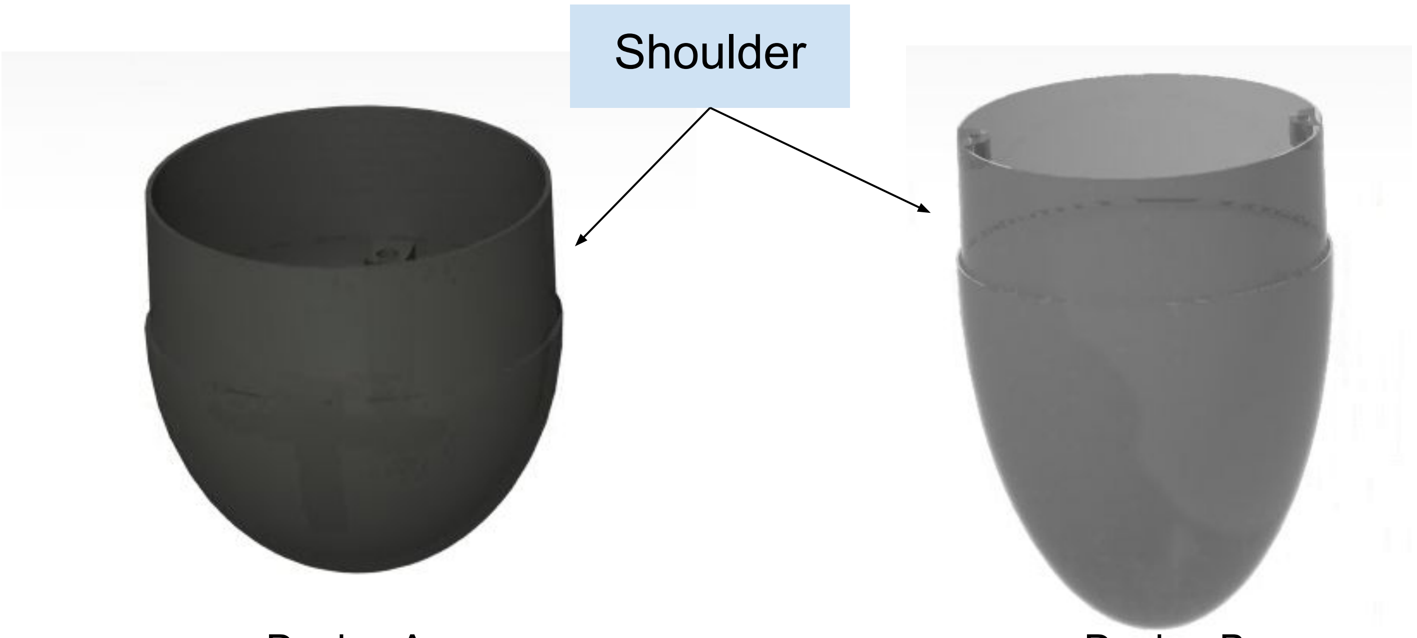
Disadvantages:
- Pointy end doesn't help reducing descent speed.
- Higher cost, and higher weight.

Selection	Rationale
Design A	• Having a lower weight and cost, with reasonable values of resistance, ensures a higher profitable option.

Nose Cone Design Trade & Selection (2/4)

Nose Cone shoulder & Container fitting

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

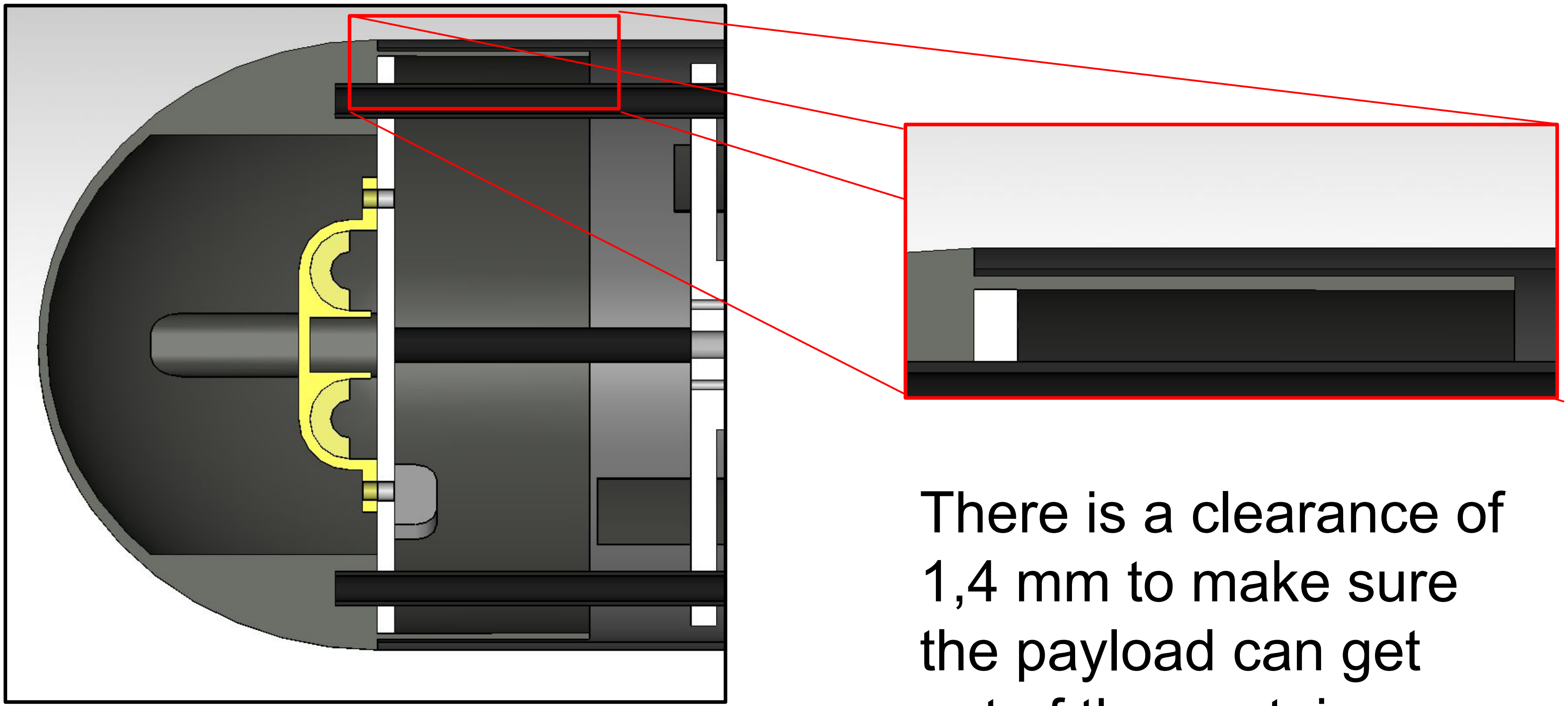


Design A

Design B

Nose Cone Design Trade & Selection (3/4)

Nose Cone shoulder & Container fitting

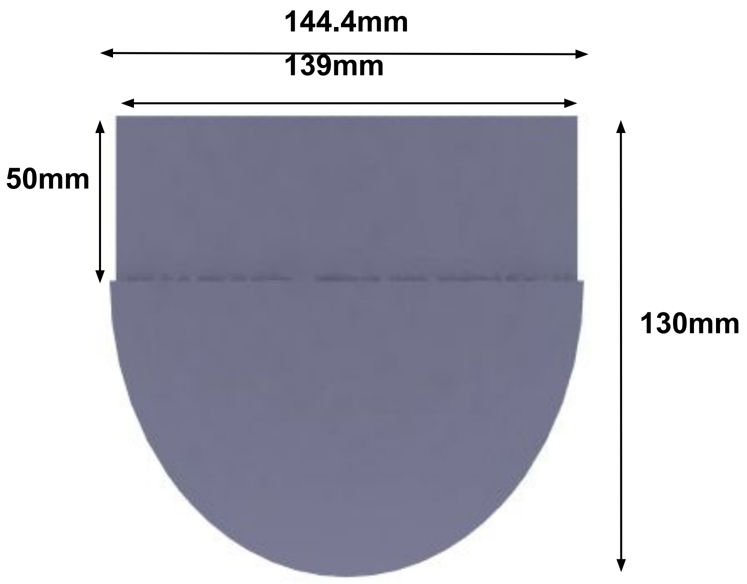


There is a clearance of 1,4 mm to make sure the payload can get out of the container

Nose Cone Design Trade & Selection (4/4)

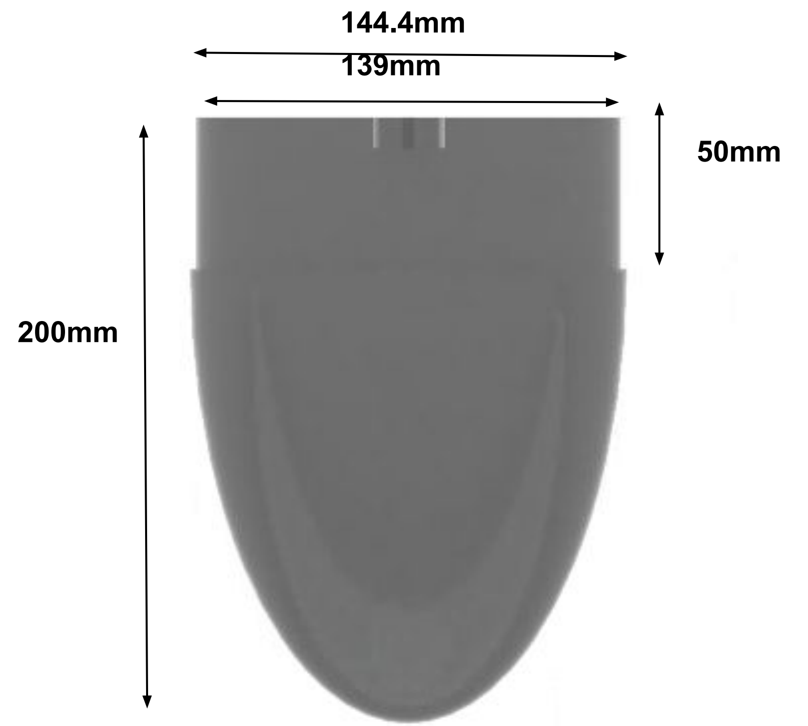
Nose Cone Dimensions & Drag Coefficient

Design A



Drag Coefficient: 0.224

Design B

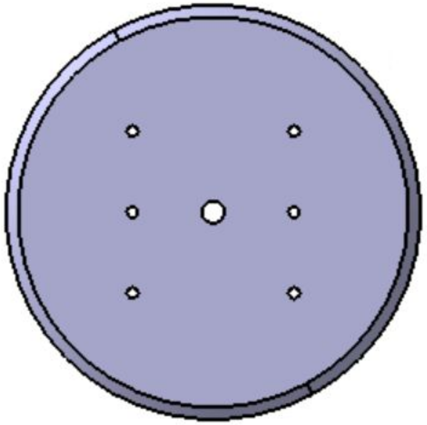


Drag Coefficient: 0.178

Both nose cones are symmetrical along the thrust axis.

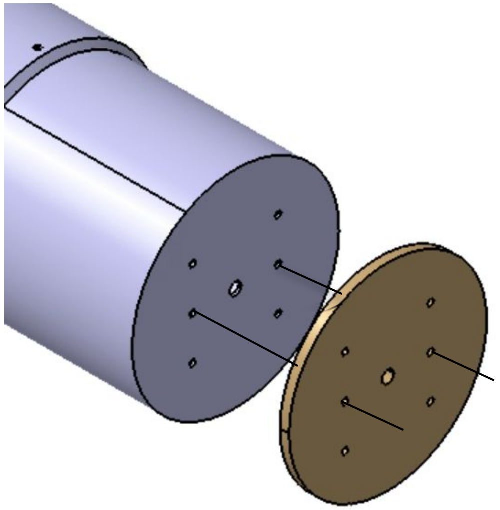
Container Design and Configuration Trade & Selection (1/4)

Design A

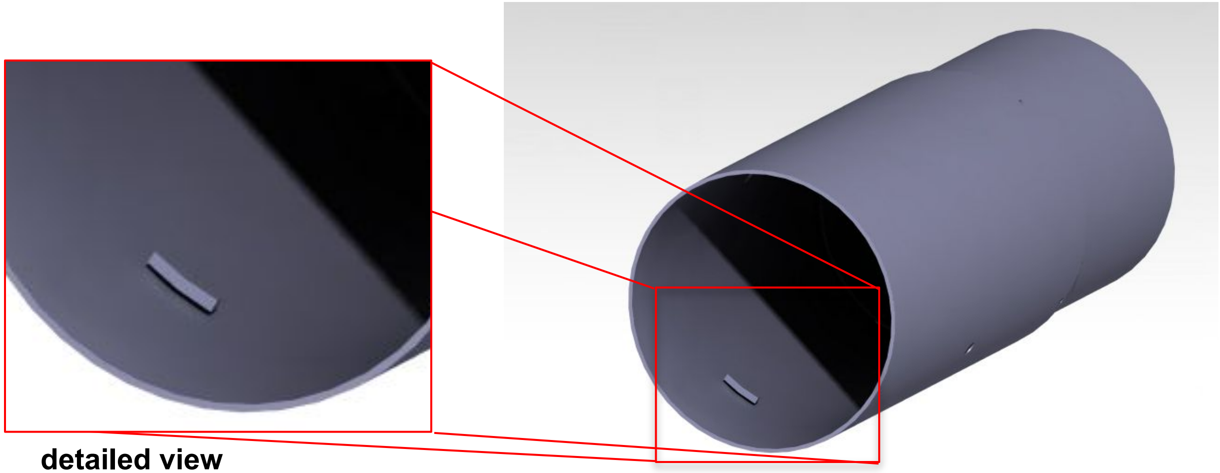


Container and wood disk have 2 extra holes to pass a fishing line through them and tie payload to the container

When CanSat reaches 75% of peak altitude, a resistance burns the fishing line letting the cansat separate from the container (Full description of the mechanism in Payload Release T&S)



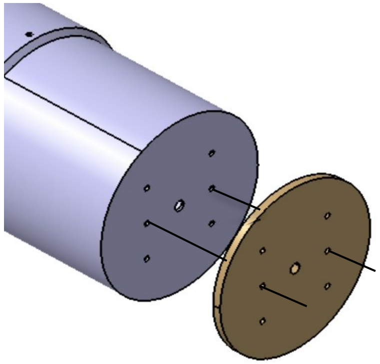
Design B

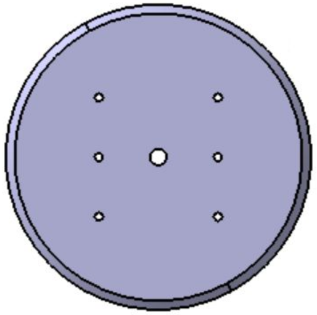


The internal wall of the container has stoppers to keep the payload inside the container with a servo-controlled lock

When CanSat reaches 75% of peak altitude, the servos rotate letting the cansat separate from the container (Full description of the mechanism in Payload Release T&S)

Design A





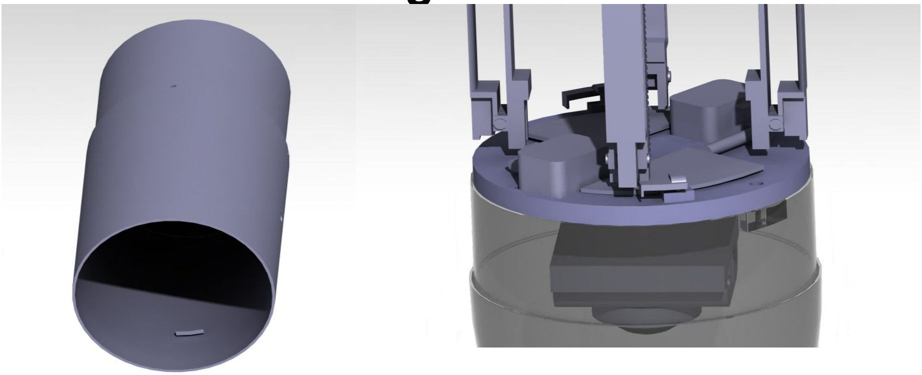
Advantages:

- Ease of manufacturing
- Small change from reference design

Disadvantages:

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

Design B



Advantages:

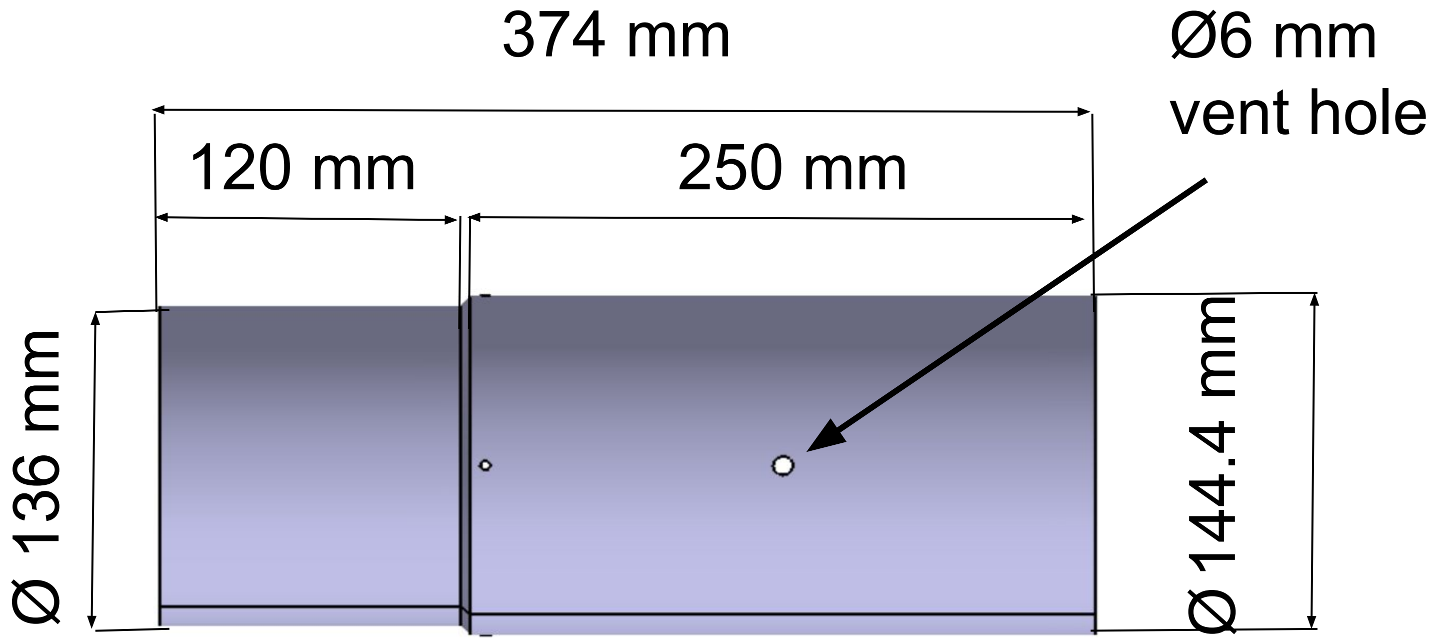
- Stowing mechanism more reliable than design A
- Small change from reference design

Disadvantages:

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

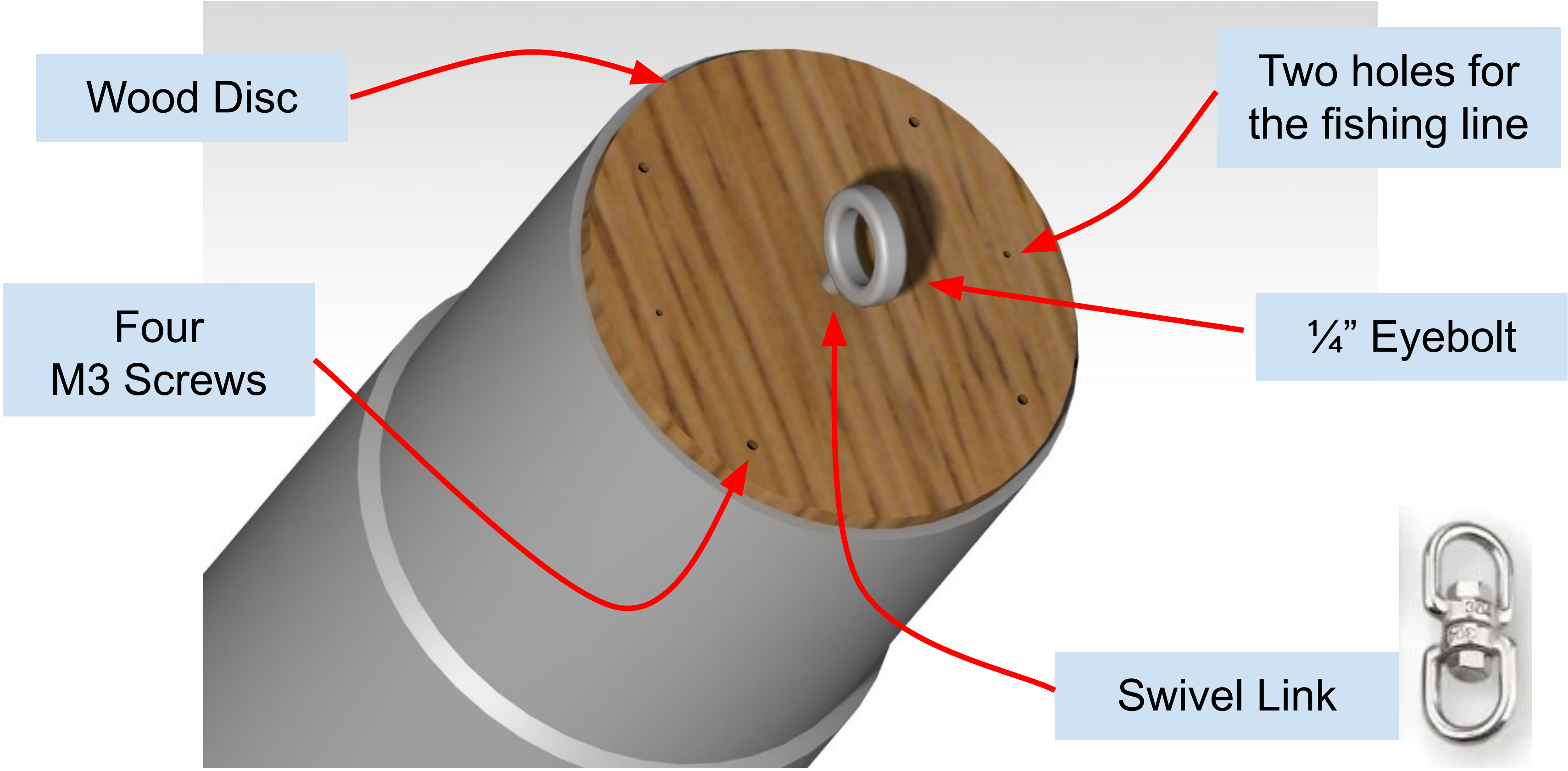
Selection	Rationale
Design A	• Chance of payload hitting stoppers is unacceptable.

Container Design and Configuration Trade & Selection (4/4)



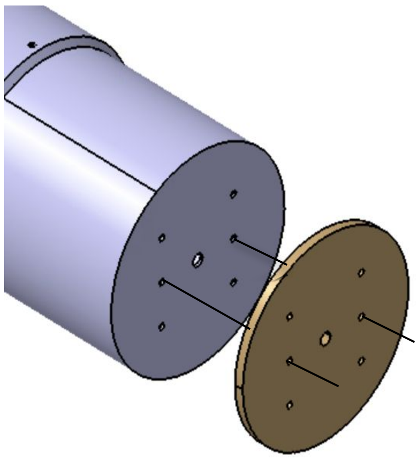
Dimensions are the same for both designs. Wall thickness is 2mm through the whole container

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



Payload Release Trade & Selection (1/3)

Design A (fishing line attachment)



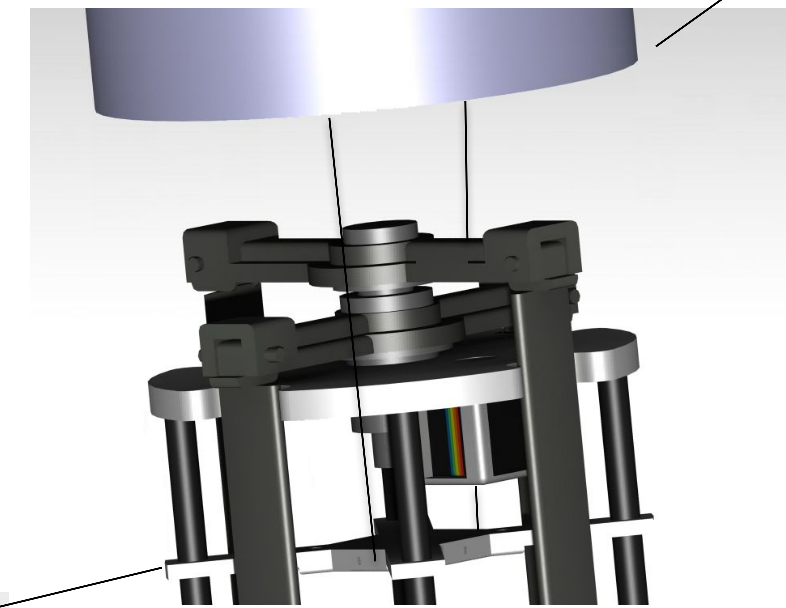
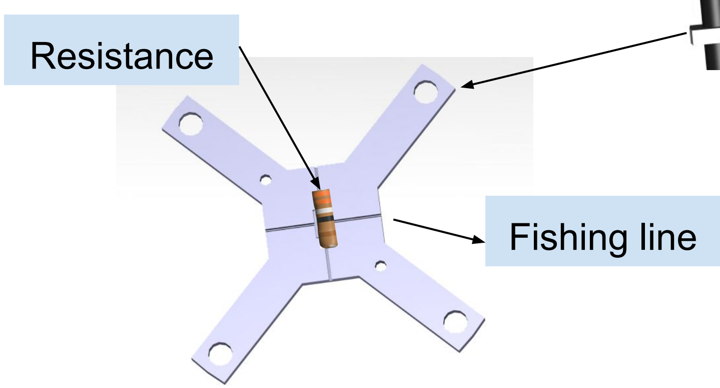


Image shows only the upper part of the container

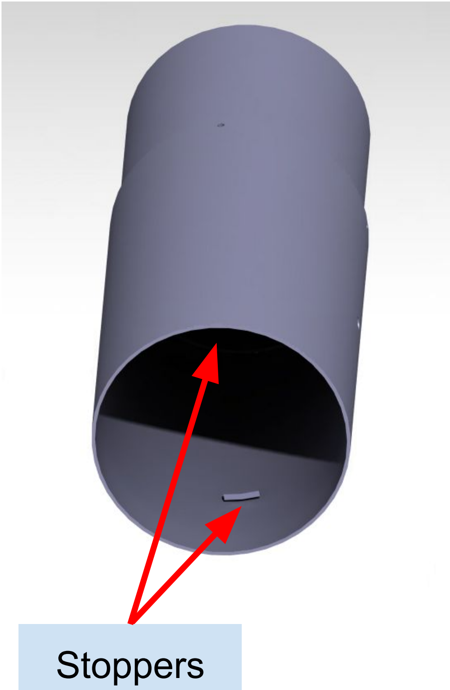
Image shows how the fishing line gets from the container top to the burning star

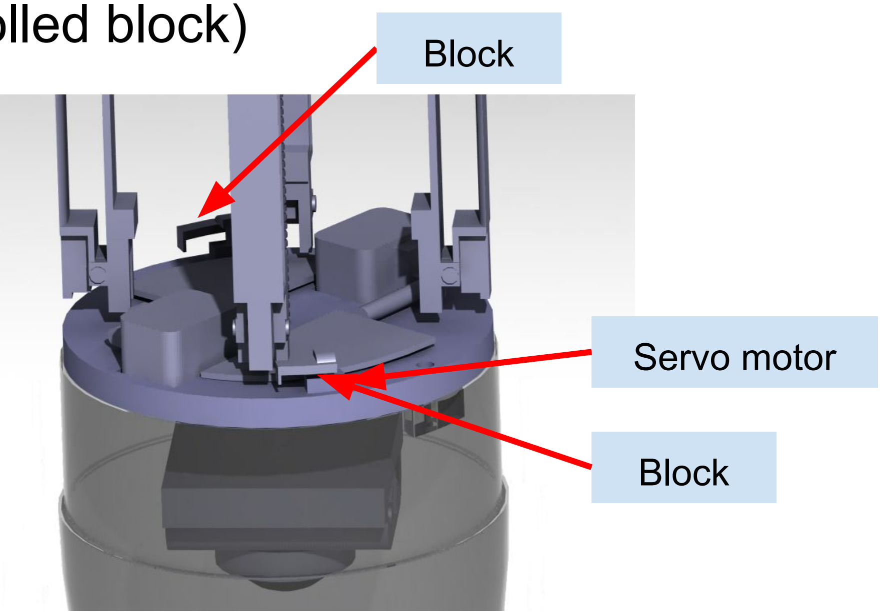


The base of the design, is to make the fishing line the only part attaching the payload from the container

Payload Release Trade & Selection (2/3)

Design B (servo controlled block)

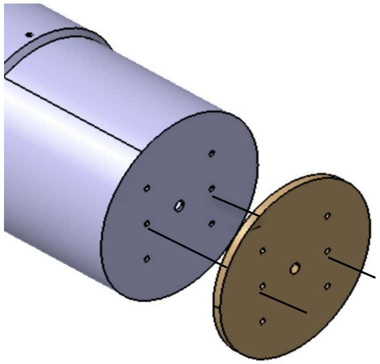


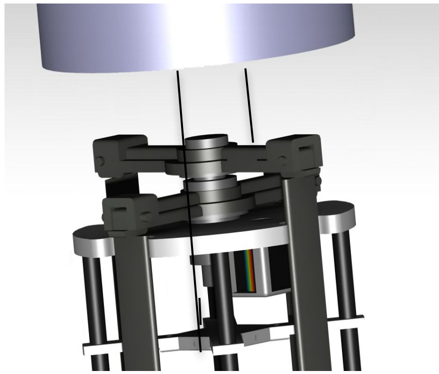


Once it's time to deploy, the servos rotate, unblocking the stoppers. Container lifted by parachute slides through payload.

Design is based on a servo that blocks the container from sliding upwards (once the payload is deployed from rocket). Two servos 180° from one another ensure that rotation of the container does not permit release from block.

Design A





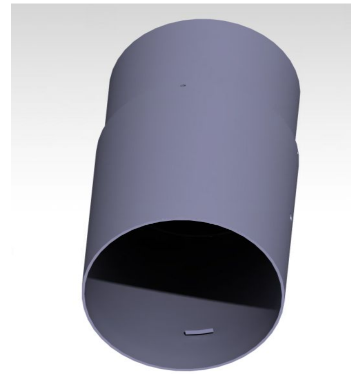
Advantages:

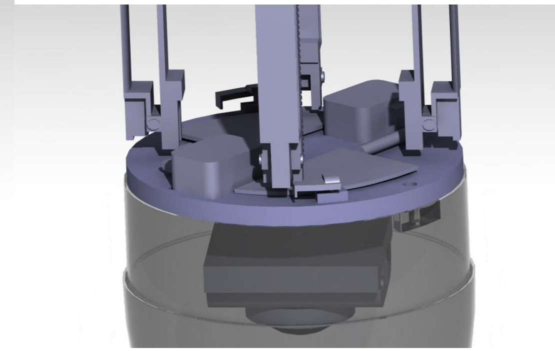
- Lower weight
- Lower cost
- Moderate reliability
- Does not need too much electronics to run.

Disadvantages:

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

Design B





Advantages:

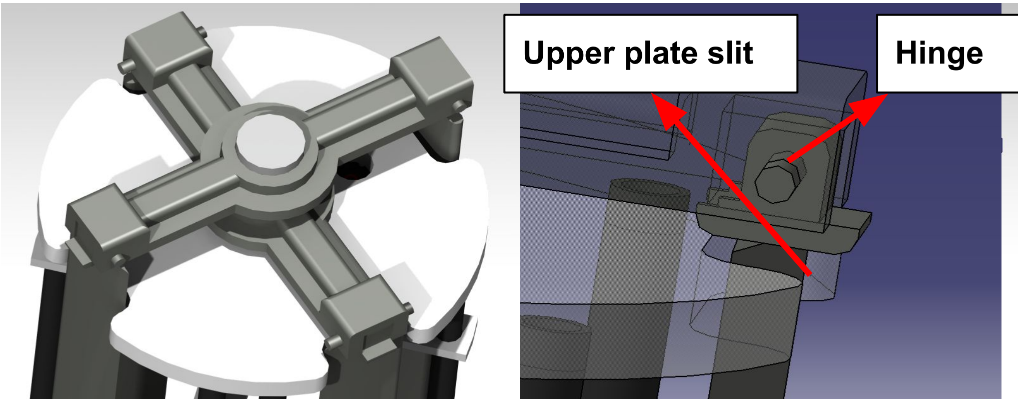
- Highly reliable
- Easy to place and assemble.

Disadvantages:

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

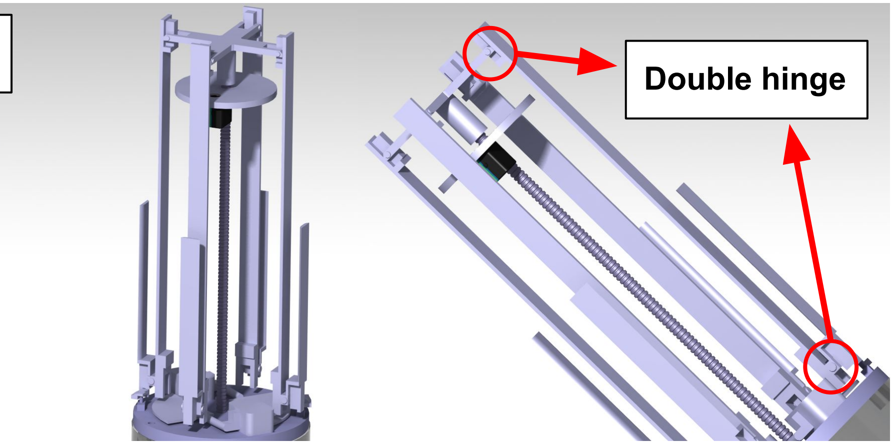
Selection	Rationale
Design A	• Having a lower weight and cost, with reasonable values of reliability, ensures a higher profitable option.

Design A



Blades are stowed via a hinge mechanism and are kept in place by the geometry of the upper plate, which keeps the rotor from rotating and makes the blades close to the body avoiding possible damages in deployment. Also a fishing line keeps the blades closed.

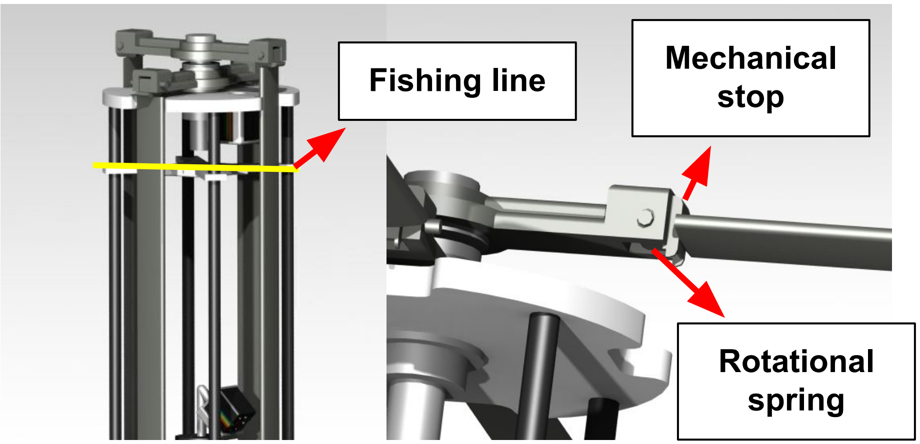
Design B



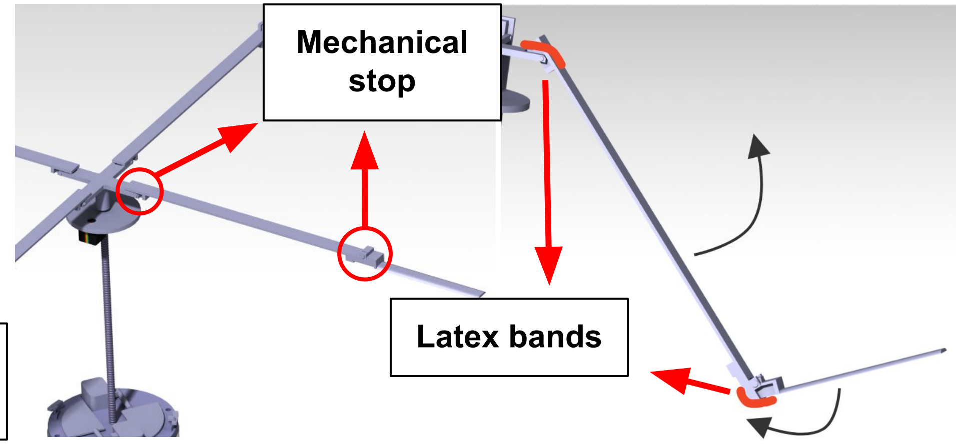
Blades are stowed by a double hinge mechanism, accounting for longer blades. The blades are kept close just by the the inner walls of the container, thus not relying in the fishing line.

Selection	Rationale
Design A	• Having the blades close to the body and longitudinally with the main axes of the payload makes for a reliable and easy to stow configuration

Design A



Design B



The deployment of the auto-gyro consist in 3 stages:

1. As soon as the payload is separated from the container, the fishing line keeping the blades closed is burned

2. Free to open the blades with the help of the spring unfold

3. Fully open the blades are kept in position by a mechanical stop

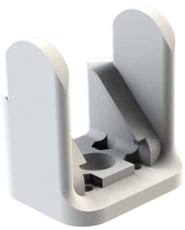
Deployment follows the same steps as Design A, but instead of using rotational springs it uses Latex bands that pull the blades to the desire position. Instead of one hinge mechanism per blade, there are two that open in opposite directions.

Selection	Rationale
Design A	• Simple and reliable with fewer moving parts • Easy to assemble

Design A deployment demonstration

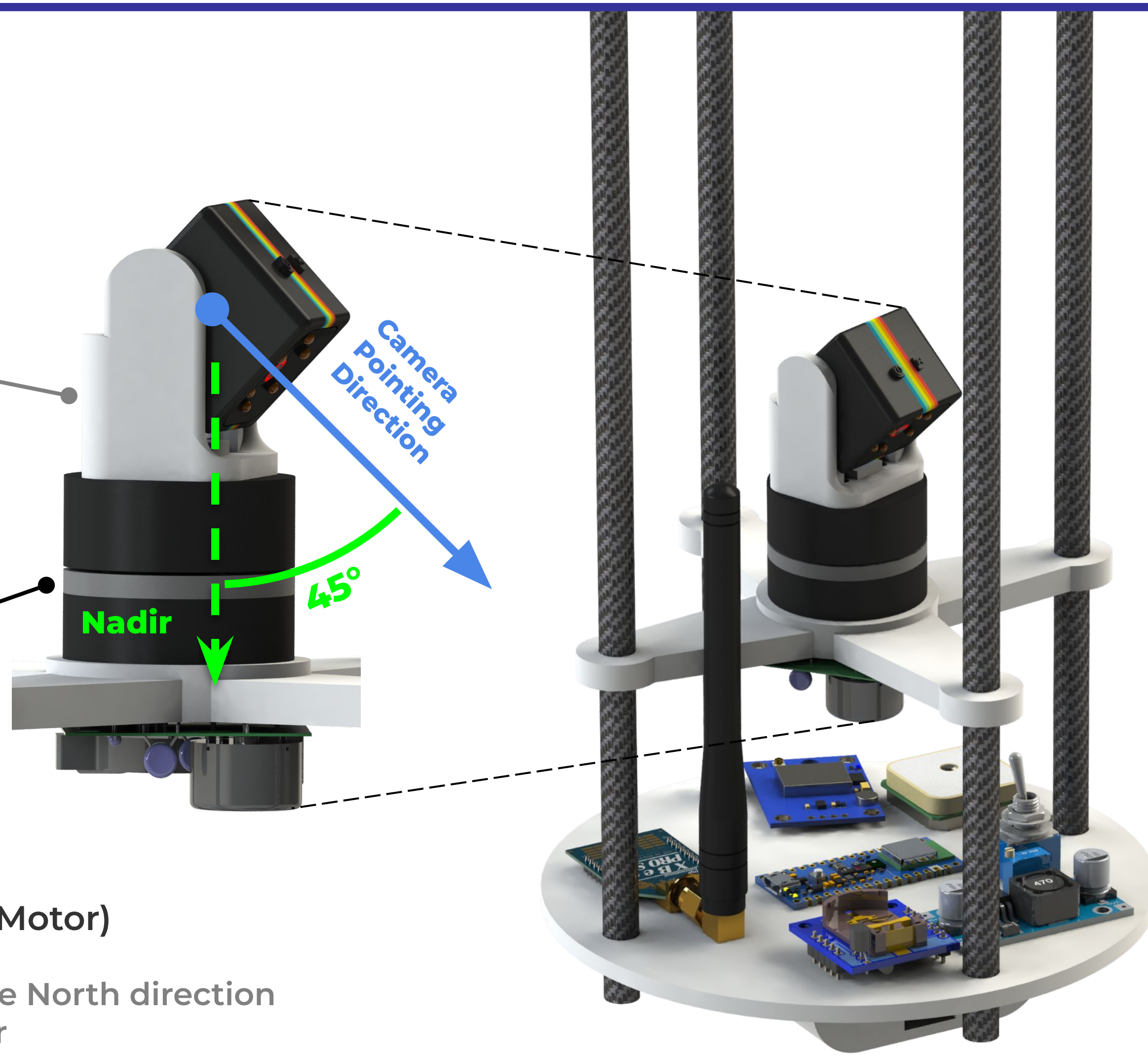
Ground Pointing and Orientation Trade & Selection (1/3)

Design A (Selected)



Passive 45° Nadir Camera Holder

CANSAT has been designed to descend within valid angular deviation range on its longitudinal axis, thus, the passive 45° Nadir Camera Holder.



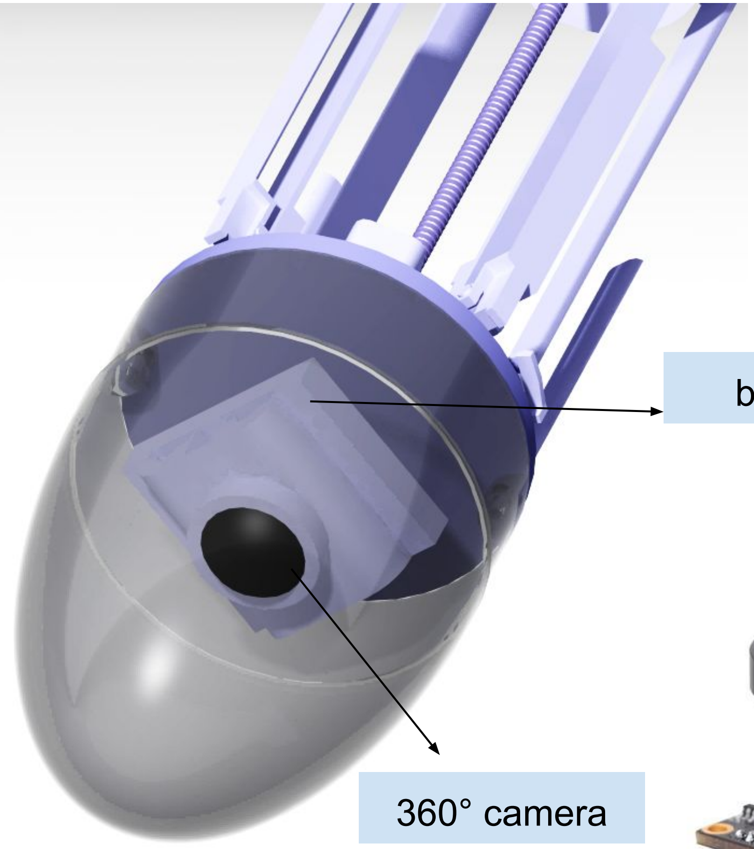
GM2804 Gimbal Motor with Encoder

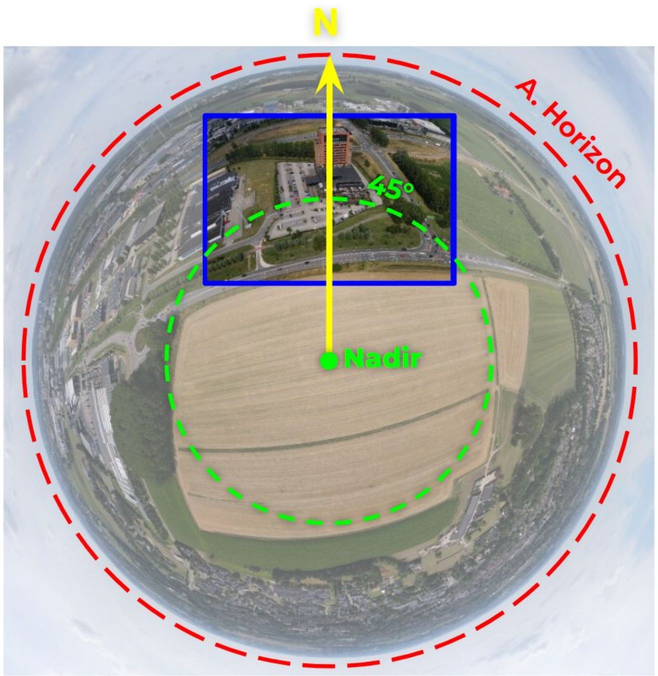
(Three-phase 12N/14P Brushless DC Motor)

Used to actively point the camera to the North direction (heading control) using a PID controller

Design B

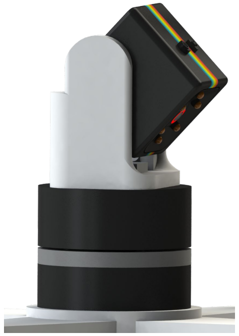
Using Payload's tilt, orientation and geomagnetic compass sensor data, 360° camera crops the image to generate a **frame** pointing **north**, and **45° from nadir**





Ground Pointing and Orientation Trade & Selection (3/3)

Design A



Advantages:
- No need real time image processing
- Reliable and simple software available
- Cheap

Disadvantages:
- Complex mechanism and technology
- Overall Design consists of moving parts
- Higher Power Consumption

Design B

Advantages:
- Easy Assemblance
- Lighter weight and low power consumption
- No moving or complex mechanical parts

Disadvantages:
- Needs real-time image processing
- Requires highly complex algorithms
- Higher cost

Selection	Rationale
Design A	• Although Design B is easier to assemble, simpler software and lower cost and previous experience makes Design A the chosen design.

Electronics Structural Integrity (1/3)

Mounting Methods

Method	Description
Screws and Standoffs	• Some components and breakout boards are through-hole modules with screw holes. • Secures components in a robust manner.
High Performance Hot melt silicone	• It has a melting point of roughly 100 Celsius degrees. • High-G vibration resistant • It's simple to use. • It's a thermoplastic glue that can be implemented using a hot glue gun.
High Performance Adhesive	• Components are firmly adhered to the payload framework. • Permanent. • Lightweight. • Surface-applicable.
Surface Mount Technology (SMT)	• Lightweight components and boards with castellated holes are soldered directly to our main PCB.

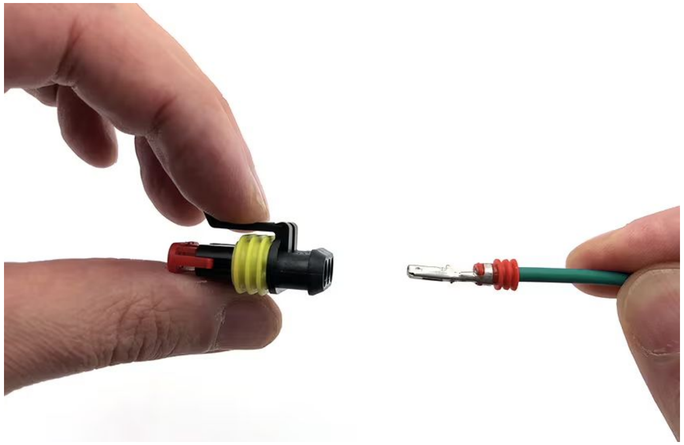
Electronic component enclosures

Name	Description
Nose Cone walls	The payload electronics are enclosed with a 3d printed sleeve (ABS material)
Nylon wire burning resistor housing	The resistor which burns the fishing line to release the payload is covered by a 3D printed structure in order to protect any other object or material from burning

Securing Electrical Connections

Method	Description
Soldering electrical connections	All connections and cables which don't require to be removed, disassembled or disconnected, will be soldered in order to ensure a strong connection and signal integrity
Superseal Connectors	● All electrical connections (power, digital, sensor, etc) will use *Superseal* connectors ● These are high performance connectors used in the automotive industry. ● Comes with a connection lock and a long metal contact to prevent any kind of inconvenient with the connection and signal integrity

Superseal Connectors



Mass Budget (1/4)

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

Component	Solid Mass [g]	Infill	Corrected mass [g]	Uncertainty[g]	Source
Nose cone	203	1	203	±2	Slicing Estimate
Upper Flow	99	0,6	59,4	±0.5	Slicing Estimate
Floor 1	62	0,6	37,2	±0.5	Slicing Estimate
Battery Cover	26	0,8	20,8	±0.5	Slicing Estimate
Rod x 4	-	-	52	±0.5	CAD Estimate
Camera Axis	7	0,5	3,5	±0.1	Slicing Estimate
Rotor x 2	22	0,5	22	±0.5	Slicing Estimate
Axis 1	-	-	36	±0.5	CAD Estimate
Axis 2	-	-	15	±0.5	CAD Estimate

Mass Budget (2/4)

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

Component	Mass [g]	Infill	Corrected mass [g]	Uncertainty[g]	Source
Ground Camera Bracket	31	0.6	18.6	±0.5	Slicing Estimate
Resistor mount	15	0.6	9	±0.5	Slicing Estimate
Resistor mount cover	3	0.6	1.8	±0.25	Slicing Estimate
Blade x4	23	0.8	73.6	±1	Slicing Estimate
Container	440	1	440	±2	Slicing Estimate
Parachute	-	-	13.35	±5	Estimate
Fishing Line	-	-	5	±0.5	Estimate
Torsion Spring x 4	-	-	10	±1	Manufacturer
Total Structure Mass = 1020 ± 17 [g]					

Mass Budget (3/4)

- **Mass of each component of Cansat:**

Component	Mass[g]	Uncertainty[g]	Source
MCU: Nano 33 BLE Sense R2	5	±0.5	Measured
Camera: Quelima SQ11 x 2	23	±0.5	Measured
Battery: Samsung INR18650 x2 + Battery holder	125	±1	Measured
PCB	30	±10	Estimate
TCST2103	1	±0.1	Measured
RTC module: DS3231 mini + Battery	6	±0.5	Measured
GPS Ublox NEO-6M + Antenna	16	±1	Measured
XBEE S3B PRO + Radio Antenna	15	±1	Measured
Cables & Connectors	30	±10	Estimate
Mechanical Switch	8	±0.5	Estimate
Buzzer	1	±0.5	Datasheet
Beacon Battery: CR2477 x2	21	±0.5	Datasheet
Step-Down 3.3V Converter LM2596	6	±0.5	Manufacturer
Gimbal Motor GM2804 w/ Encoder	51	±0.2g	Manufacturer
Total Component Mass = 338 ± 27 g			

Mass Budget (4/4)

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

Total Mass Budget	
System	**Mass[g]**
Structure/Mechanic	1020
Hardware/Electronic	338
Total Mass = 1358 ± 44	

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

Margin = 1400 g - 1358 **= +42 g**

Methods for correction:

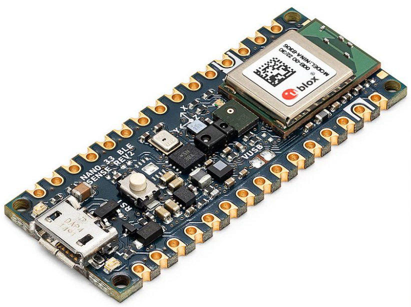
- **3D Printer Parts Infill:** We will adjust the **infill** configuration of our 3D printed parts to get closer to the desired total mass (for increasing or decreasing mass)
- **Solder Wire:** Soldering wire (Tin-Lead Alloy) will be used to **fine tune** the total mass within the 1400±10g range, adding more material to specific sections of the PCB board designed for this
- **Removing material:** Extreme measure of mass reducing, only if needed at launch site, would be removing material on several parts of the payload (only on the ones that this is allowed)

Communication and Data Handling (CDH) Subsystem Design

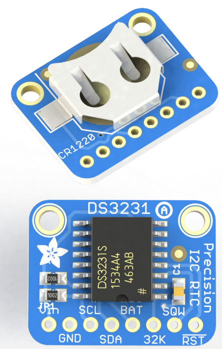
Santino Agosti
Rafael Dalzotto
Agustin Martinez

Payload Command Data Handler (CDH) Overview

Arduino Nano 33 BLE Sense Rev2
Microcontroller Board



DS3231 mini
Real Time Clock



ANT-900MR Flex ¼ Wave RPSMA
Payload Antenna

Estimated Range > 10000 m
(at Line Of Sight)

Xbee Pro S3B
Radio

NETID/PANID: **3165**

XBees will <u>**not**</u> be set to Broadcast mode.

Telemetry rate: **1Hz**

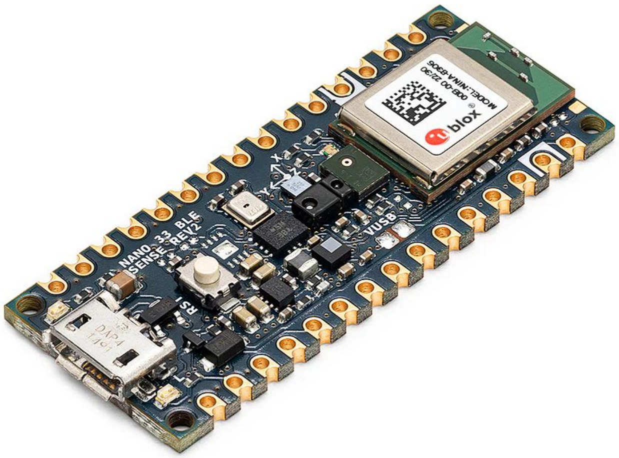
Payload Processor & Memory Trade & Selection

Name	Processor					Interfaces						Size WxL [mm]	Mass [g]	Price [USD]	Onboard Sensors?	Supply Voltage [V]
	Chip Name	Clock Speed [MHz]	Flash Mem [kB]	RAM Mem [kB]	Boot Time [ms]	I/O Pins	ADC Pins	PWM Pins	UART	SPI	I2C					
Nano 33 BLE Sense R2	**nRF52840**	64	1024	256	1000	14	8	12	1	1	1	18x45	5	40,50	Accel, Gyro, Mag, Temp, Pressure	3v3
NodeMCU ESP32	Tensilica LX6	240	4096	520	200	25	15	21	3	3	2	26x48	10	12,00	Temp	3v3
Raspberry Pi Pico	RP2040	133	2048	264	2000	26	3	16	2	2	2	21x51	4	4,00	Temp	5V
Arduino Nano	Atmega 328p	16	32	2	500	20	8	6	1	1	1	18x44	7	10,00	*No*	5V (USB) 7-15V (pin 30)

Selected Board: **Arduino Nano 33 BLE Sense Rev2**

Reasons:

1. Comes with high quality onboard sensors (Accelerometer, Gyroscope, Magnetometer, Temperature, Pressure)
2. Tiny form factor
3. Powerful and reliable microcontroller core (Arm Cortex-M4F @ 64 MHz)
4. Can be directly surface mounted (castellated holes)



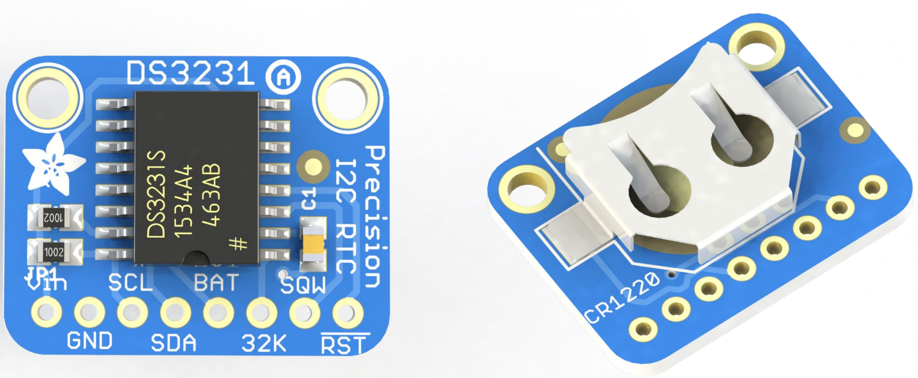
Payload Real-Time Clock

Name	W×L×H Size [mm]	Mass [g]	Operating voltage [V]	Interface	Temp Comp	Reset Tolerant?	Extra NVRAM Memory	Price [USD]
DS3231	23×38×13	9	2.3 ~ 5.5	I2C	yes	yes	no	7.5
DS3231 mini	14x14x12	3	2.3 ~ 5.5	I2C	yes	yes	no	14.95
DS1307 (TinyRTC)	28×27×10	7	4.5 ~ 5.5	I2C	no	yes	56 bytes	4.16
DS1302	23×43×12	9	4.5 ~ 5.5	I2C	no	yes	no	7

Selected Module: **DS3231 mini**

Reasons:

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



Payload Antenna Trade & Selection (1/2)

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

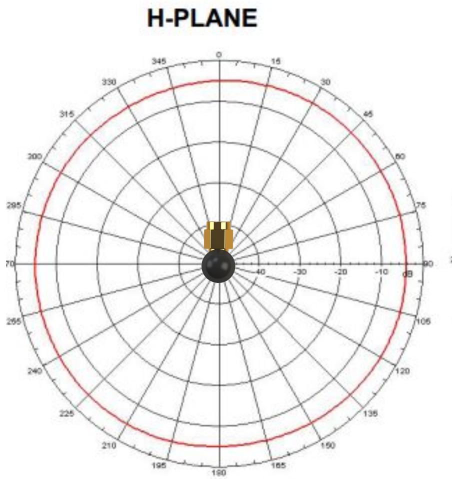
Selected Antenna: **ANT-900MR Flex ¼ Wave RPSMA**

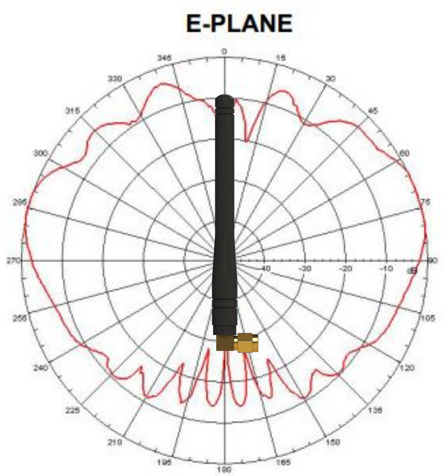
Reasons:

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

Payload Antenna Trade & Selection (2/2)

Antenna Location, Range & Radiation Patterns





Estimated
Range > 10000m
(at Line Of Sight)

Payload Radio Configuration (1/2)

Name	Frequency [GHz]	Antenna Connector	Transmit current [mA]	Receive current [mA]	Operating Voltage [V]	Range [m]	Sensitivity [dBm]	RF Data Rate [Kbps]	Price
XBee PRO S3B 915MHz	0.9-0.928	Whip wire - RP-SMA	215	29	2.4-3.6	6500	-101	200	88.5
XBee S2B (XB24CAUIT-001)	2.4	Whip wir - RP-SMA	120	31	2.7-3.6	3200	-101	200	35

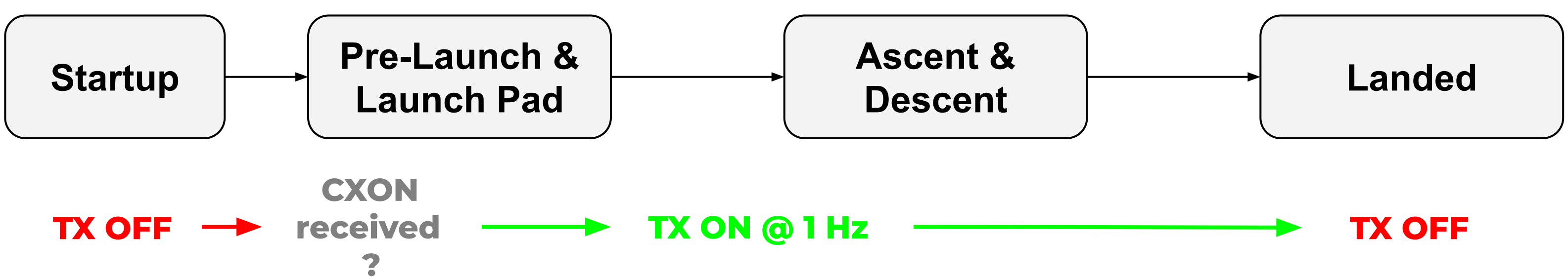
- **NETID/PANID will be set to: <u>3165</u>, using XCTU software**
- XBees will **<u>not</u>** be set to Broadcast mode.
- This XBee will be used to send payload **telemetry** at a **rate** of **1 Hz** to the ground station.
- Large range XBee provides larger distance coverage, thus, mitigating possible sources of error provided by unexpected rocket displacement.

Payload Radio Configuration (2/2)

Transmission Control

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

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



Payload Telemetry Format (1/4)

Data Format	Example	Description
TEAM_ID	3165	Assigned team identification
MISSION_TIME	01:22:10	UTC time in format hh:mm:ss
PACKET_COUNT	50	Total count of transmitted packets
MODE	F	‘F’ for flight mode and ‘S’ for simulation mode
STATE	ASCENT	Operating state of the software
ALTITUDE	500.3	Altitude in units of meters relative to ground level
TEMPERATURE	25.7	Temperature in Celsius
PRESSURE	101.2	Air pressure measured in kPa

Payload Telemetry Format (2/4)

Data Format	Example	Description
VOLTAGE	8.3	Voltage of the payload battery
GYRO_P, GYRO_Y, GYRO_R	18, 21, 20	Gyroscope readings in degrees per second for the roll, pitch, and yaw axes
ACCEL_R, ACCEL_P, ACCEL_Y	30, 35, 33	Accelerometer readings for the roll, pitch and yaw axes
MAG_R, MAG_P, MAG_Y	0.22, 0.03, 0.09	Magnetometer readings in the roll, pitch and yaw axes in gauss
AUTO_GYRO_ROTATION_RATE	2165	Rotation rate of the auto-gyro relative to the Cansat structure in degrees per second
GPS_TIME	13:14:02	Time from GPS receiver in UTC

Payload Telemetry Format (3/4)

Data Format	Example	Description
GPS_ALTITUDE	200.8	Altitude readings from the GPS in meters
GPS_LATITUDE, GPS_LONGITUDE	3.8793, 18.3672	Coordinate readings from the GPS in degrees
GPS_SATS	5	Number of GPS satellites being tracked by the receiver
CMD_ECHO	CXON	Text of the last command received and processed by the Cansat.

Payload Telemetry Format (4/4)

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

  TEAM_ID, MISSION_TIME, PACKET_COUNT, MODE, STATE, ALTITUDE, TEMPERATURE, PRESSURE, VOLTAGE, GYRO_R, GYRO_P, GYRO_Y, ACCEL_R, ACCEL_P, ACCEL_Y, MAG_R, MAG_P, MAG_Y, AUTO_GYRO_ROTATION_RATE, GPS_TIME, GPS_ALTITUDE, GPS_LATITUDE, GPS_LONGITUDE, GPS_SATS, CMD_ECHO,

- **Example:** `3165,01:22:10,50,F,ASCENT,500.3,25.7,101.2,8.3,18,21,20,30,35,33,0.22,0.03,0.09,2165,13:14:02,200.8,3.8793,18.3672,5,CXON,`

Payload Command Formats

Command	Format	Command Description	Example	Example Description
CX	CMD,<TEAM_ID>,CX,<ON_OFF>	Payload telemetry On/Off command	CMD,3165,CX,ON	Activates payload telemetry transmission
ST	CMD,<TEAM_ID>,ST,<UTC_TIME>|GPS	Set time	CMD,3165,ST,13:35:59	Sets the mission time to 13:35:59
SIM	CMD,<TEAM_ID>,SIM,<MODE>	Simulation Mode Control Command	CMD,3165,SIM,ENABLE	Enables simulation mode
SIMP	CMD,<TEAM_ID>,SIMP,<MODE>	Simulated Pressure Data	CMD,3165,SIMP,101325	Provides a simulated pressure reading of 101325 Pascals
CAL	CMD,<TEAM_ID>,CAL	Calibrate Altitude to Zero	CMD,3165,CAL	Sets altitude to 0
MEC	CMD,<TEAM ID>,MEC,<DEVICE>,<ON_OFF>	Activate a specific mechanism.	CMD,3165,MEC,1,ON	Turn mechanism 1 on
CAL_PR	CMD,<TEAM_ID>,CAL_PR	Calibrate Pitch and Roll angles	CMD,3165,CAL_PR	Set Pitch and Roll angles to 0

Electrical Power Subsystem (EPS) Design

Santino Agosti
Rafael Dalzotto
Emanuel Albornoz

EPS Overview

Beacon Battery
CR2477 (1Ah)

Coin Battery
RTC Battery
CR2023 (225mAh)

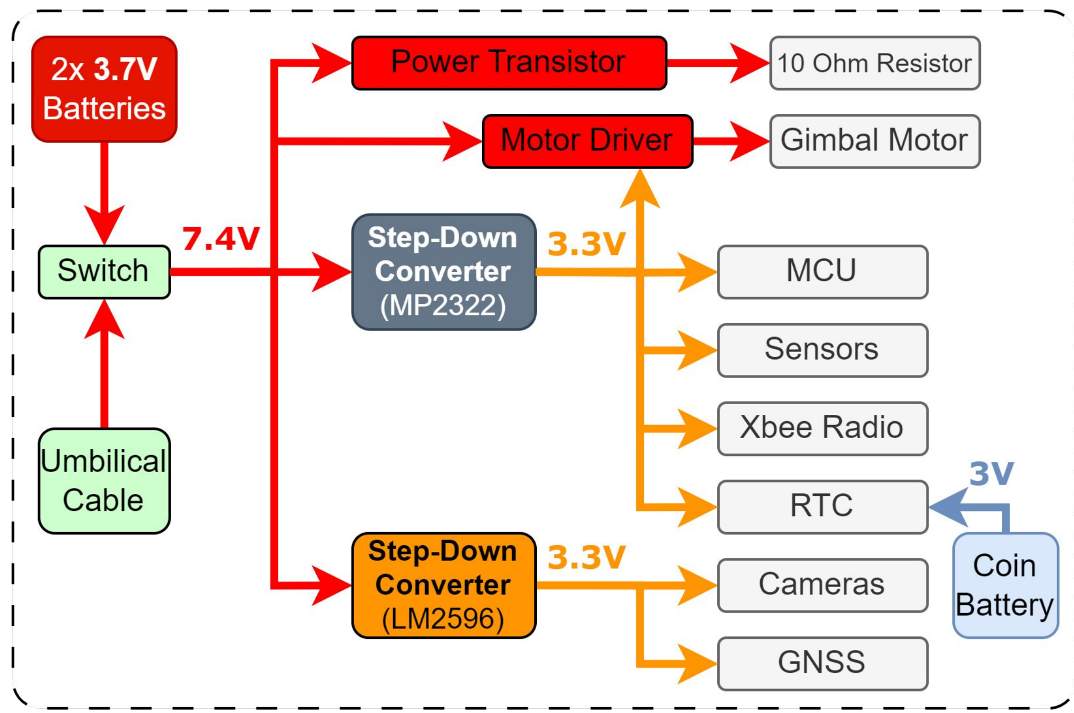
Payload Batteries
2x INR18650 (2550mAh)

Step-Down 3.3V Converter LM2596

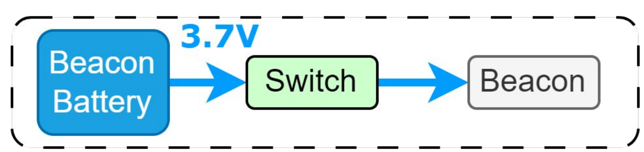
Step-Down 3.3V Converter
MP2322 (Monolithic Power Systems)

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

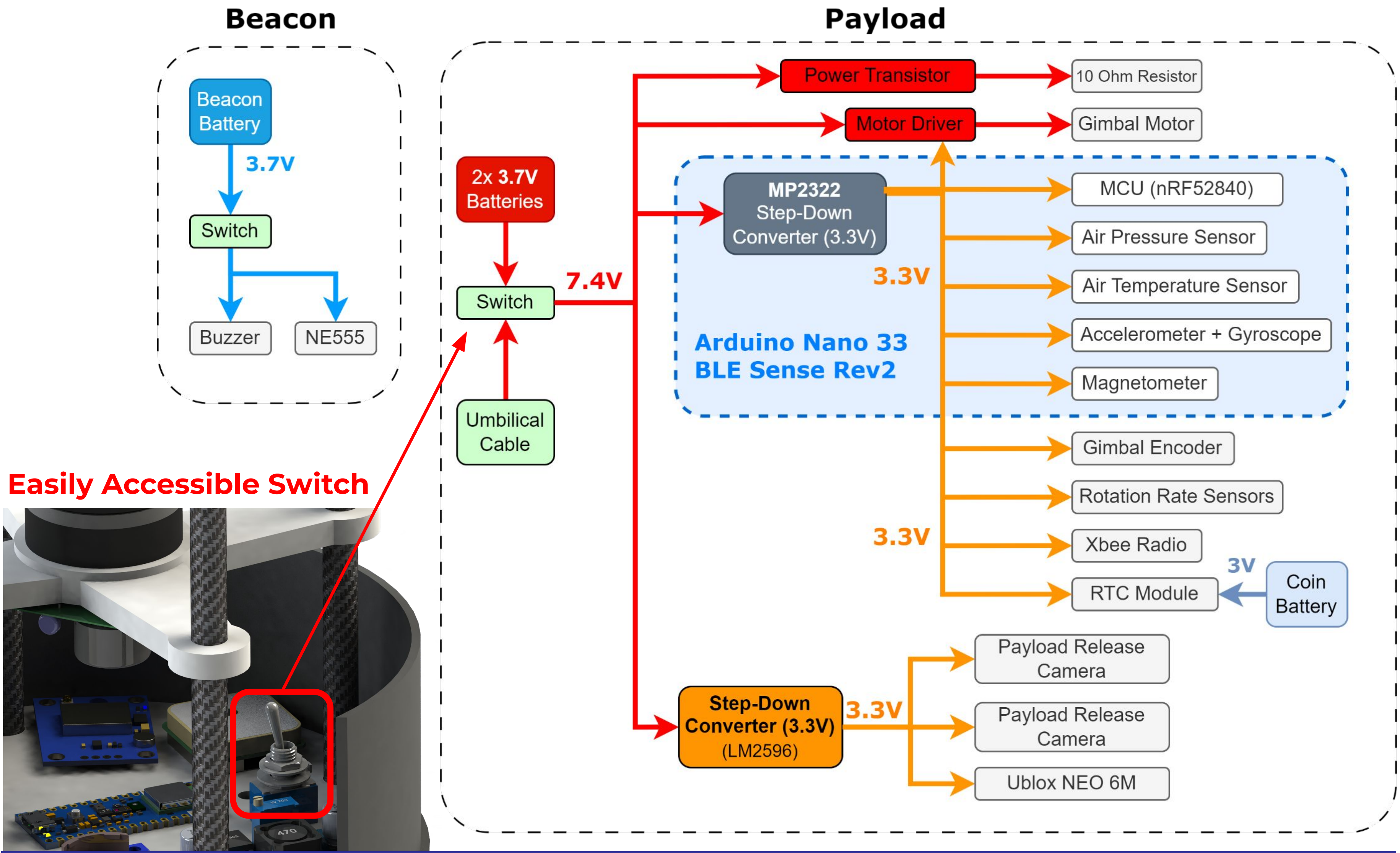
Payload



Beacon



Payload Electrical Block Diagram



Payload Power Trade & Selection (1/3)

Name	Technology	Weight [gr]	Voltage [V]	Battery Capacity [mAh]	Energy Density [Wh/gr]	Nominal Current [mA]	Rechargable	Price [USD]
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

Model Selected: Samsung INR18650

Reasons:

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

Connection: *Superseal* Connector

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

Max Discharge Continuous Current: 20A (single cell)

Battery configuration selection

Battery Configuration	Nominal Discharge Current	Voltage	Max Discharge 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 configuration: Two cells in series (2S)

Reasons

- We have two major components which require 7,4V or more (heating resistor and gimbal motor) for proper operation.
- We prefer to feed these components directly from the batteries instead of using 1S or 2P and a Step-Up (Boost) converter due to efficiency concerns of these kind of converters and their current limits.
- Step-Down converters perform more efficiently for low current consumption (from 7.4V to 3.3V)

Payload Power Trade & Selection (3/3)

Battery Mounting and Connection

Battery Mounting

The battery will be physically placed inside a sealed battery cavity inside the nose cone, enhancing the low vertical position of the *Center of Mass*.

Battery Connection

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

Technologies

Alkaline:

- High discharge current
- Not rechargeable, low voltage

Li-Ion (selected):

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

Ni-Mh:

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

Selected: *Li-Ion:*

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

Payload Power Budget (1/2)

Type	Component	Qty.	Duty Cycle [min]	Duty Cycle [%]	Current [mA]	Voltage [v]	Energy [Wh]	Source
Sensor	LPS22HB	1	120,0000	100,00%	0,003	3,3	0,00002	Datasheet
Sensor	HS3003	1	120,0000	100,00%	0,024	3,3	0,00018	Datasheet
Sensor	Resistor divider + ADC	1	120,0000	100,00%	0,015	3,3	0,00011	Estimated
GPS	Ublox Neo-6M	1	120,0000	100,00%	40,000	3,3	0,29333	Datasheet
Sensor	TCST2103	2	2,0000	1,67%	128,000	3,3	0,01564	Datasheet
Sensor	BMI 270	1	120,0000	100,00%	0,970	3,3	0,00711	Datasheet
Sensor	BMM150 + AS5048A	1	120,0000	100,00%	20,000	3,3	0,14667	Datasheet
Camara	Quelima SQ11	2	2,0000	1,67%	240,000	3,3	0,02933	Datasheet
MCU	Arduino 33 Sense Rev2	1	120,0000	100,00%	40,000	3,3	0,29333	Datasheet
Motor	GM2804 Gimbal Motor	1	2,0000	1,67%	200,000	7,4	0,06222	Datasheet
Radio	XBee Transmitting	1	1,3300	1,11%	215,000	3,3	0,01747	Datasheet
Radio	XBee Idle	1	118,6600	98,88%	2,000	3,3	0,01450	Datasheet
Heating Resistor	10 Ohm Resistor 1/4W	1	0,0833	0,07%	215,000	7,4	0,00279	Estimated
TOTAL:					**1101,012**		**0,86543**	

Payload Power Budget (2/2)

Note:

- 3.3V component's power consumption was calculated considering the 90% efficiency of the DC/DC boost converter.

Power Source: Beacon Battery	Energy
Total Average Power	1,203W
Battery Energy (100% discharge depth)	3.7 Wh
Operating Time (100% discharge depth)	3 hours

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

Power Source: Payload Battery	Energy [Wh]
Total Energy Consumption	0,85802
Battery Energy (100% discharge depth)	18,5
Energy Margin	17,64198
Operating Time (60% discharge depth)	25 hour

Flight Software (FSW) Design

Micaela Perillo

FSW Overview (1/2)

- **State Overview & Basic FSW architecture**

STARTUP

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

LAUNCH_PAD

Wait for CXON command. When received, take measurements, send telemetry, calibrate altitude, start radio transmission, set UTC time, receive commands from ground activate GPS and wait for the altitude to begin incrementing.

ASCENT

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

APOGEE

Send telemetry, save maximum altitude, set parachute camera to record and receive commands from the ground.

DESCENT

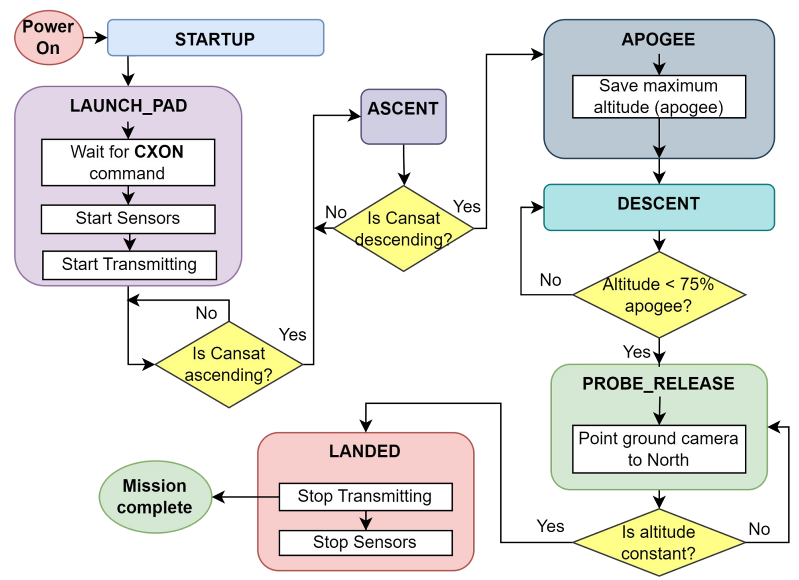
Take measurements and send telemetry, determine flight state based on altitude, receive commands from the ground, wait to reach 75% altitude.

PROBE_RELEASE

Release probe, take measurements and send telemetry, point camera to North, activate ground camera and gimbal motor determine flight state based on altitude, receive commands from the ground.

LANDED

Stop camera recording and deactivate payload telemetry.

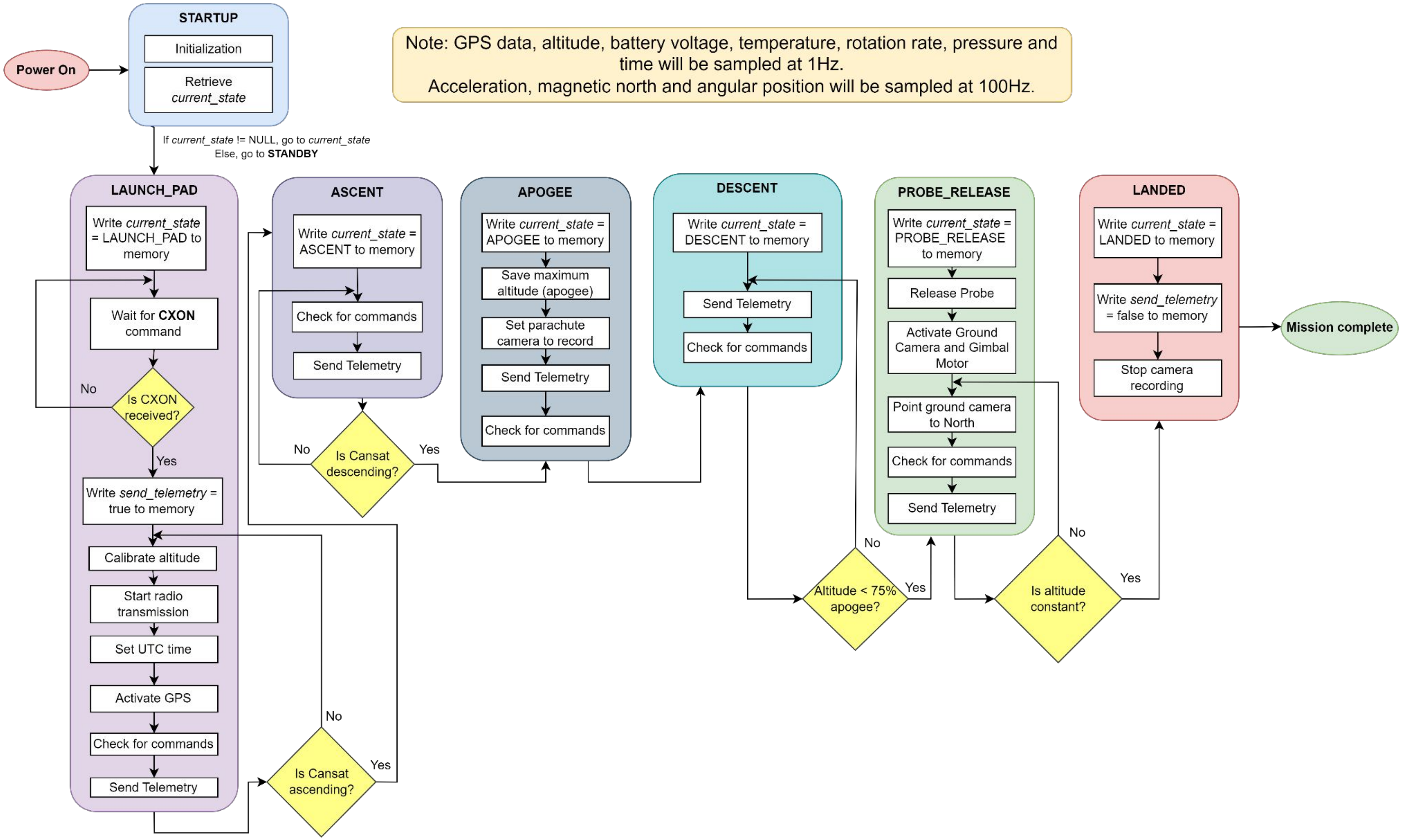


FSW Overview (2/2)

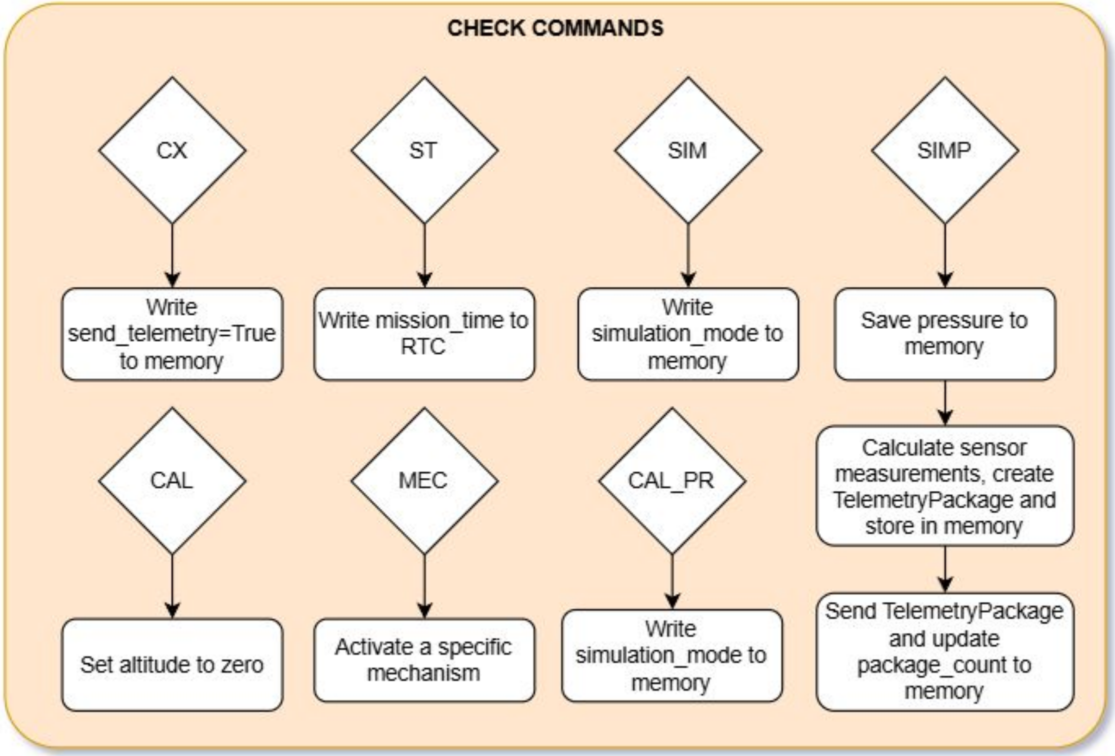
- **FSW Tasks**
  - Transmit sensor measurements once per second to the Ground Station
  - Send, receive and process packets via XBEE radios
  - Keep track of mission state (based on altitude data) in case the processor resets
  - Control deployment mechanisms
  - Keep track of mission time through processor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

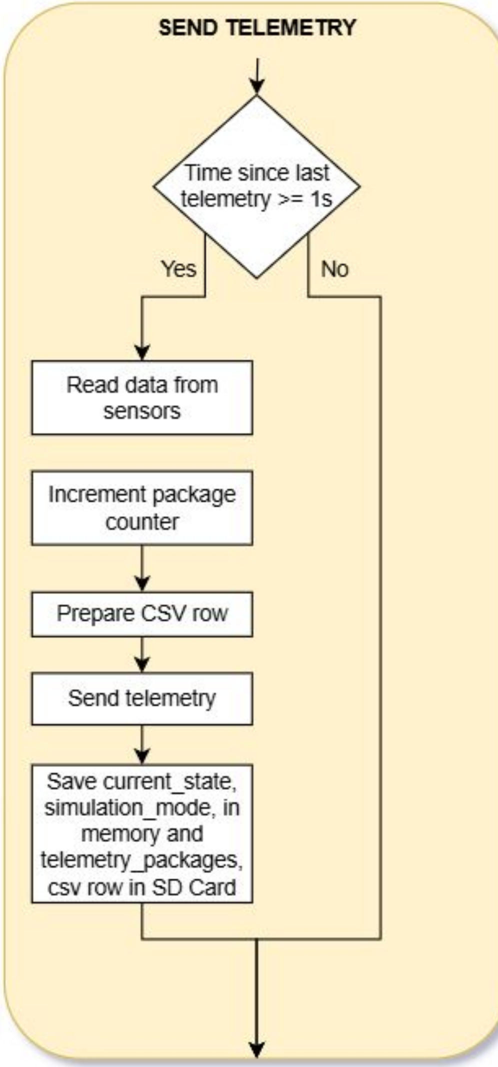
- Programming language: **C++**
- Development environments: **VSCode + PlatformIO**

Payload FSW State Diagram (1/2)



Payload FSW State Diagram (2/2)





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

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

Simulation Mode Software (1/2)

- **Simulation Mode**

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

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

Simulation Mode Software (2/2)

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

Software Development Plan (1/4)

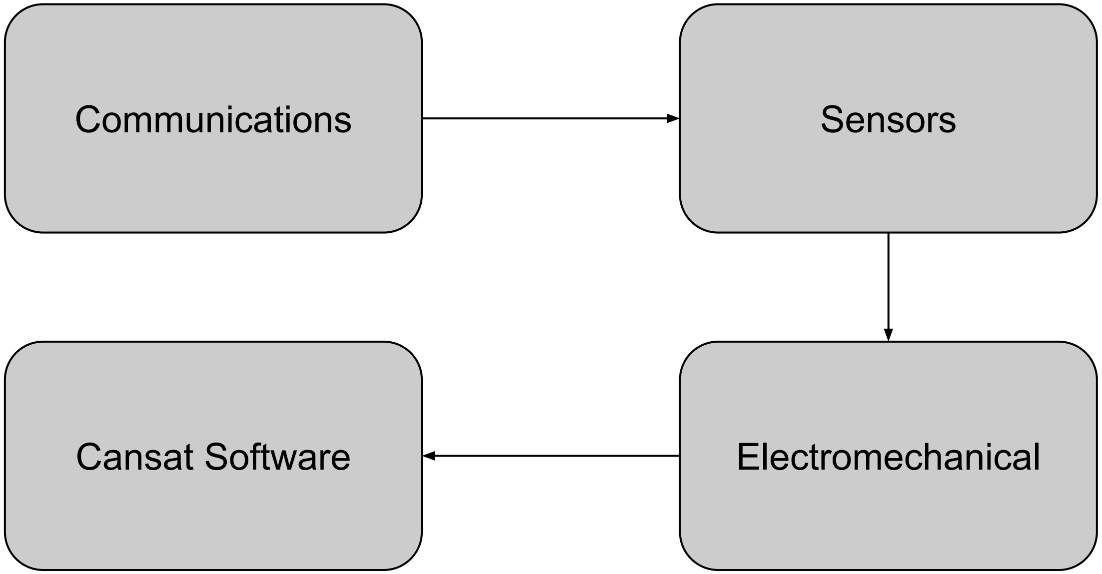
- **Prototyping and prototyping environments**
  - All sensors will be tested individually as development progresses.
  - Breadboards and homemade PCB's will be used to create prototype circuits to test software modules. Data obtained will be monitored and evaluated.

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

Software Development Plan (2/4)

- **Software subsystem development sequence**

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



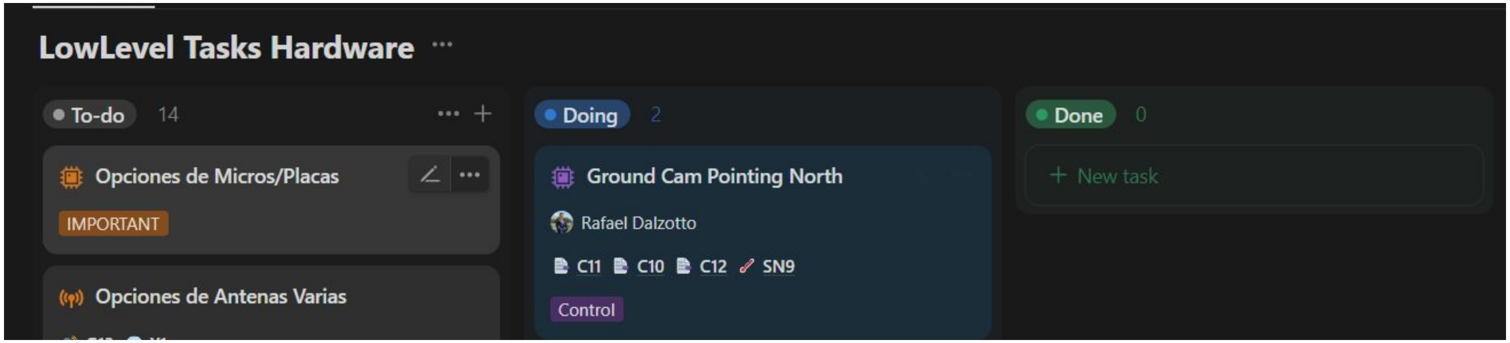
Software Development Plan (3/4)

- **Development and testing team**
  - Rafael Dalzotto
  - Micaela Perillo
  - Santino Agosti
  - Emanuel Agustín Albornoz

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

Software Development Plan (4/4)

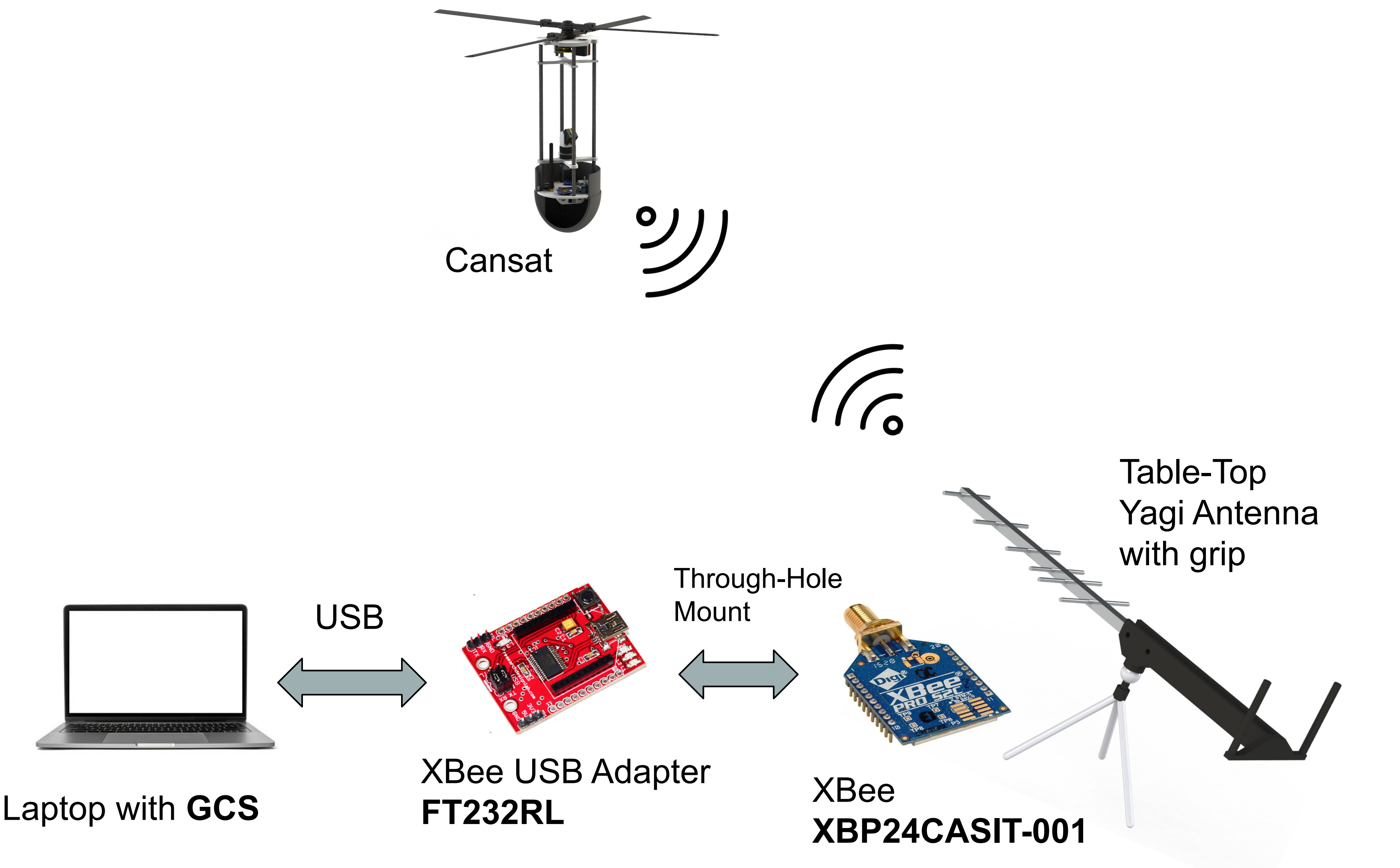
- **Github**
  - We will use Github to be able to collaborate and track changes
  - Code can be easily revised and reverted in case of errors.
- **Notion**
  - Similar to Jira and Trello, allows collaborators to set and organize tasks, as well as track progress
  - We'll use Kanban Boards to visualize the progress



Ground Control System (GCS) Design

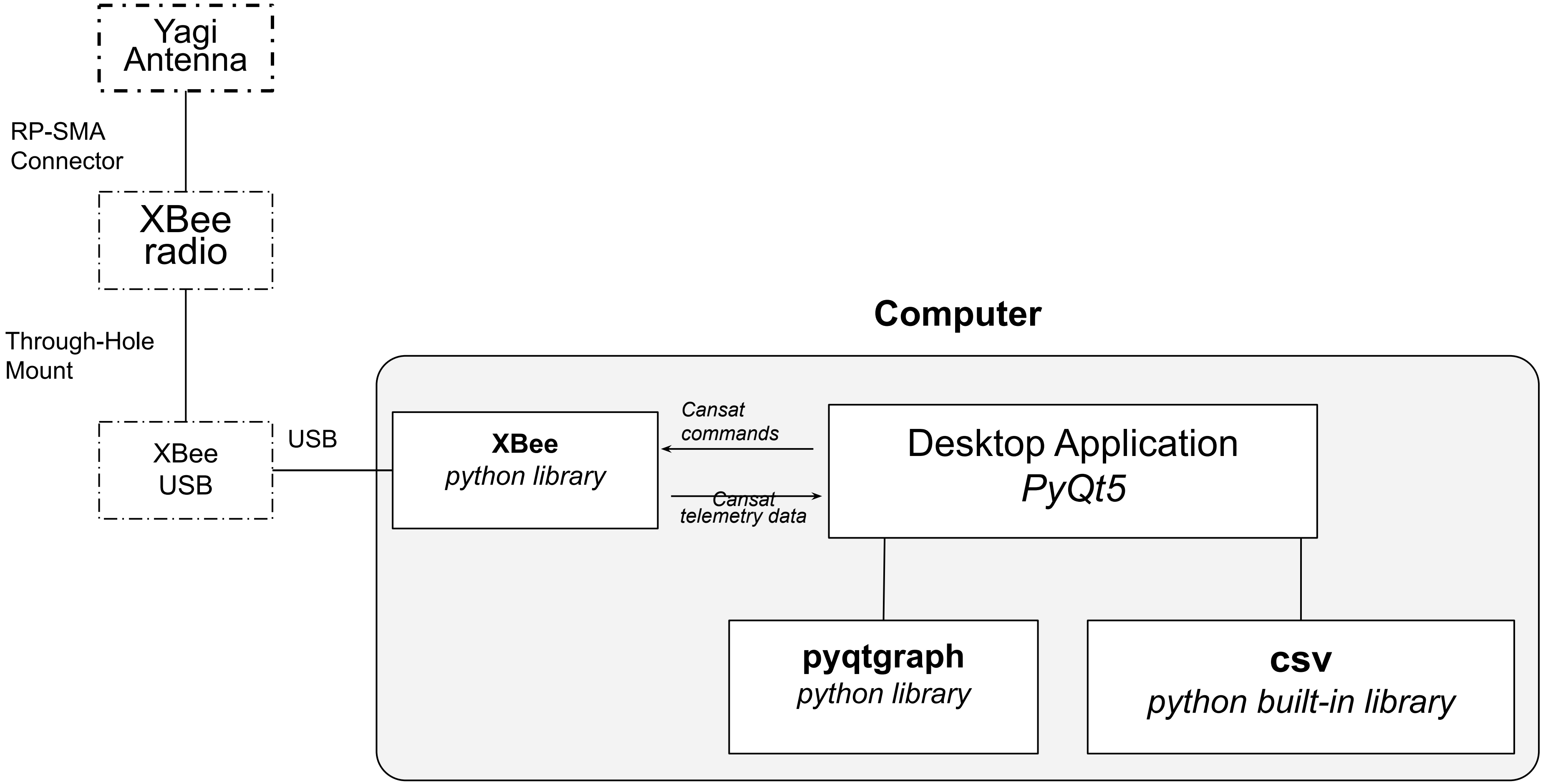
Agustin Martinez
Micaela Perillo

GCS Overview



GCS Design (1/2)

- **Ground Station Diagram**



GCS Design (2/2)

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

Name	Range [m]	Dimensions [mm]	Gain [dBi]	Weight [gr]	Polarization	Connector type	Price ($)
HP-915-JW-3 800N	10000 Estimated	80x13x13	2	10	Linear	RPSMA	7
A09-Y11NF	>46000 Estimated	635x150 (LxW)	11.1	837	Linear	RPSMA	150

Antenna used for Ground Station to Cansat link

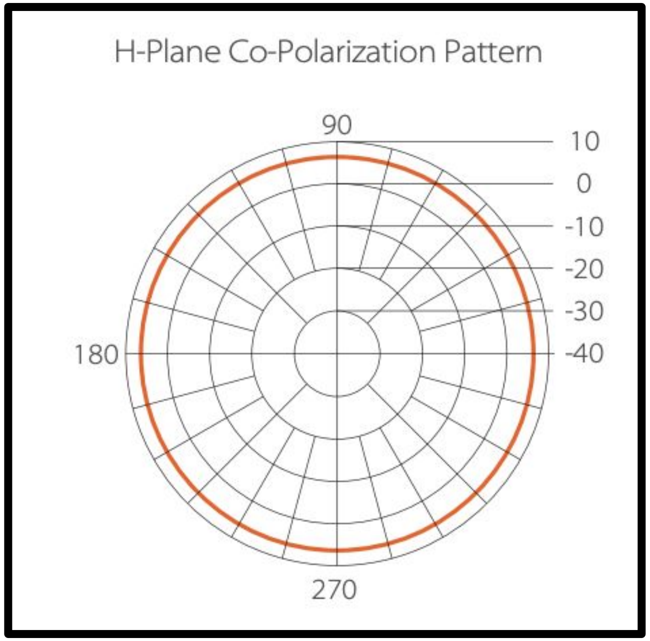
Pros:

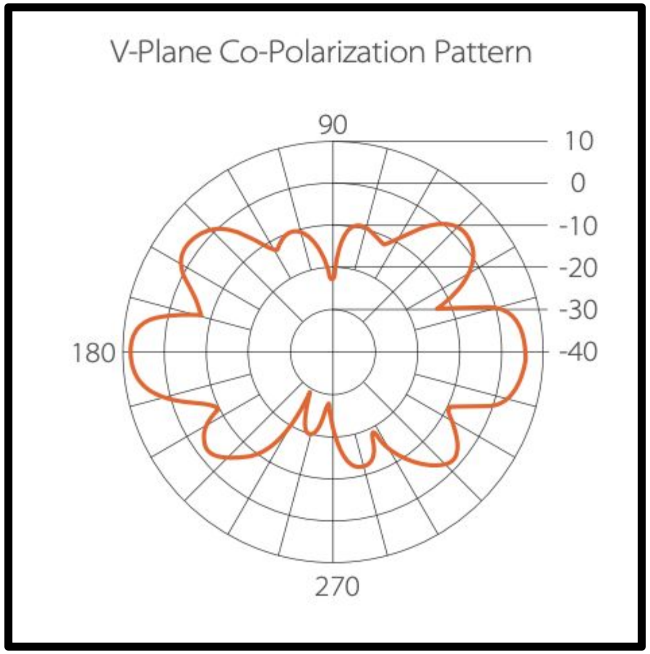
- Large Gain [dBi]
- Long Range: >46000 m (est.)
- Connector type allows us to aim the antenna correctly.
- Robust and Reliable

Mounting:

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

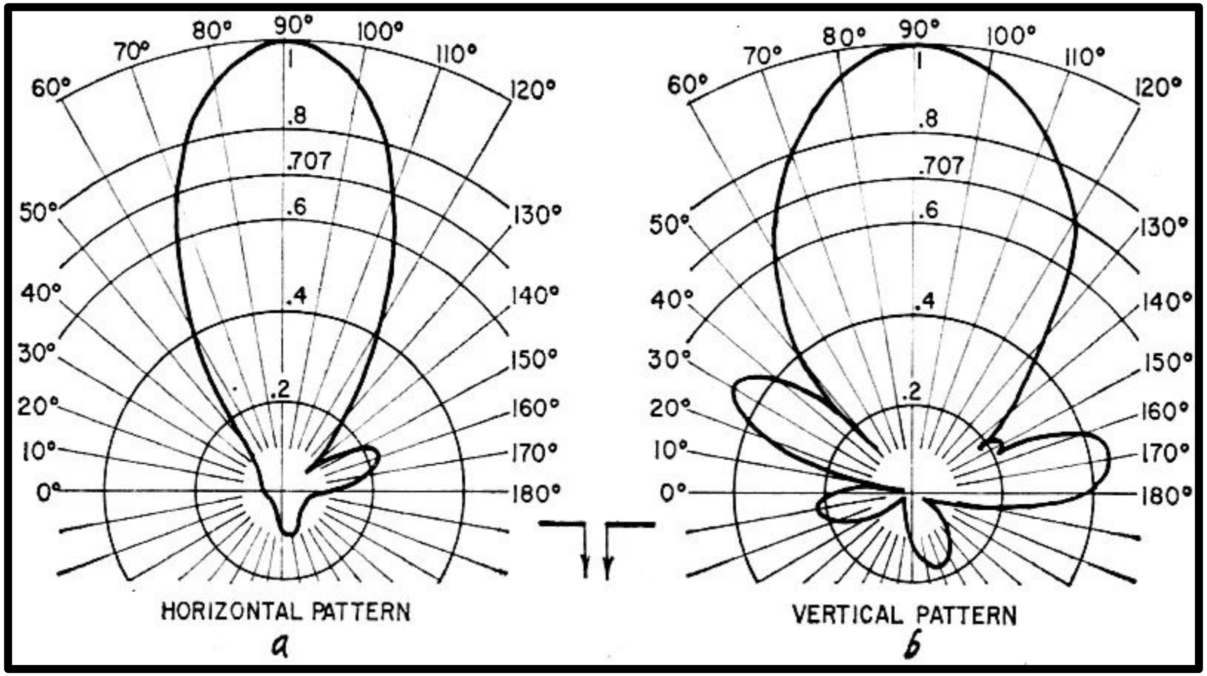
HP-915-JW-3800N Radiation Patterns





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

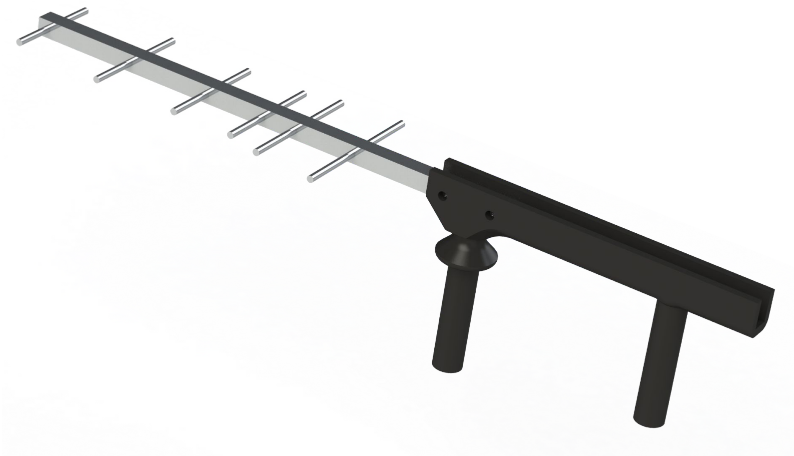
A09-Y11NF Radiation Patterns



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

GCS Antenna Trade & Selection (4/4)

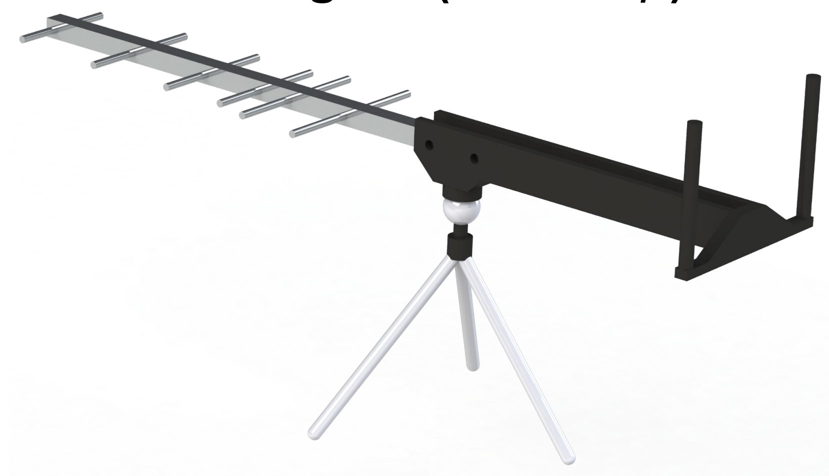
Design A (*Hand-Held*)



Pros & Cons

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

Design B (*Table Top*)



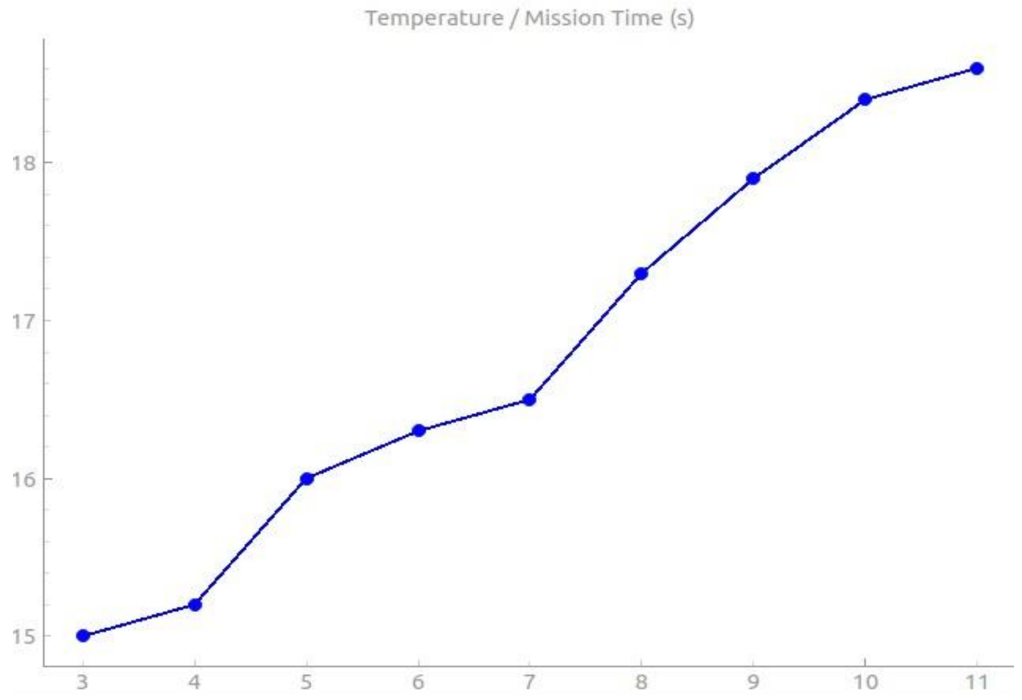
Pros & Cons

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

Selection	Rationale
Design B (table top)	• A customized table top mounting for the antenna allows for robust, stable and reliable aiming at the CANSAT. Reduces possible human error at aiming due to fatigue through an extensive hold time period.

- **Telemetry display prototypes**

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



GCS Software (2/7)

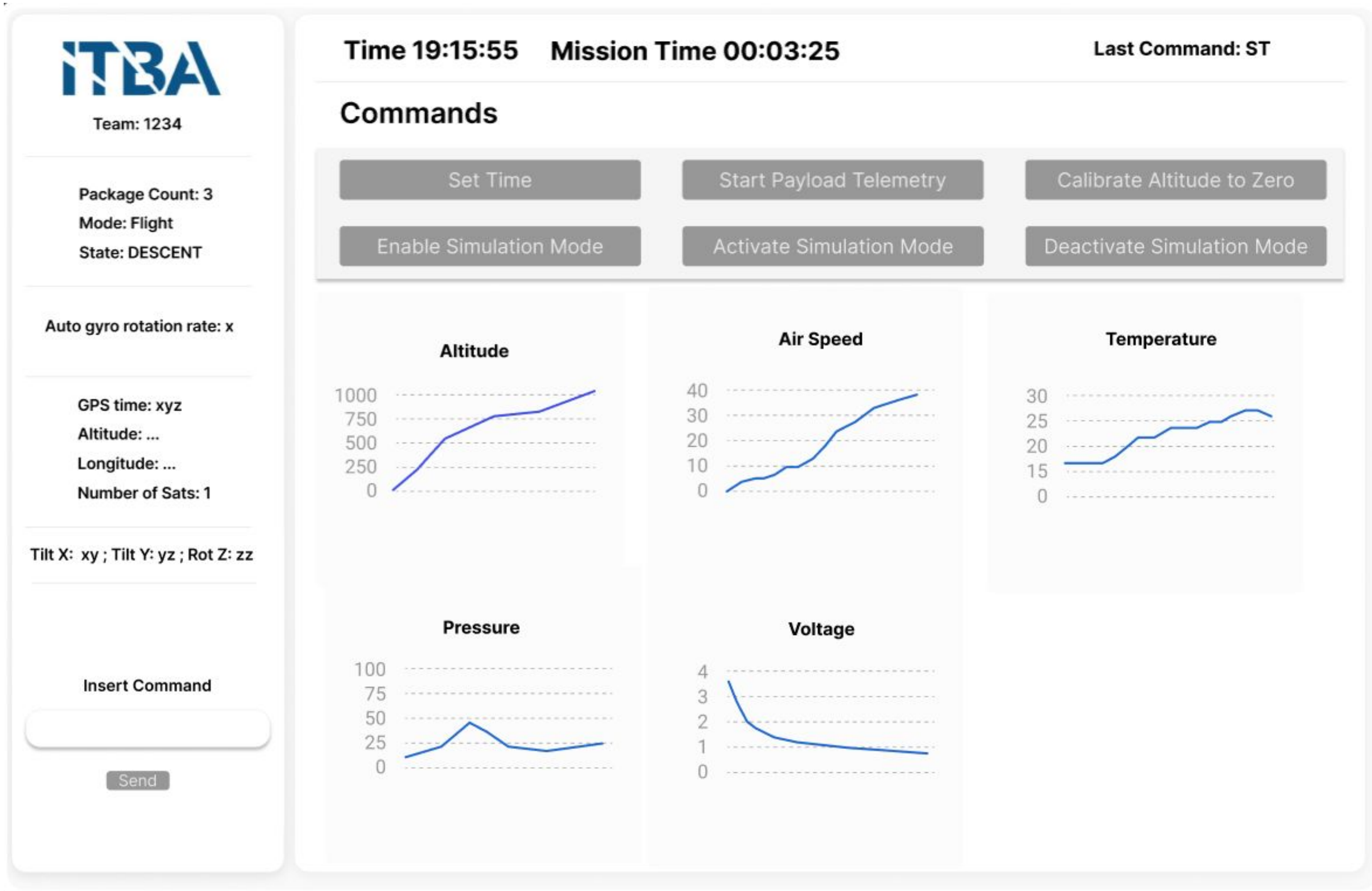
- **Commercial off the shelf (COTS) software packages used**

  - **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**
    - **pyqtgraph:** high performance real-time plots
    - **CSV:** built-in module for file reading and writing
    - **XBee:** Python library for communication with the antenna

GCS Software (3/7)

- **Real-time plotting and command software**



Calibration command description

Bubble level

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

GCS Software (5/7)

- **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_1234.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 file can be transferred to an USB if necessary

GCS Software (6/7)

- **Telemetry format**

TEAM_ID, MISSION_TIME, PACKET_COUNT, MODE, STATE, ALTITUDE, TEMPERATURE, PRESSURE, VOLTAGE, GYRO_R, GYRO_P, GYRO_Y, ACCEL_R, ACCEL_P, ACCEL_Y, MAG_R, MAG_P, MAG_Y, AUTO_GYRO_ROTATION_RATE, GPS_TIME, GPS_ALTITUDE, GPS_LATITUDE, GPS_LONGITUDE, GPS_SATS, CMD_ECHO [,,OPTIONAL_DATA]

GCS Software (7/7)

- **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.

CanSat Integration and Test

Santino Agosti

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 AG blades
- 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 be developed in order to simulate real scenarios and check each sensor functionality
- All sensor will be connected to a 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 Burning Star mechanism reliability
- Verify all subsystem functions separately: Movement of blades, Parachute deployment, Payload release & AG deployment

CDH

Communication will be tested individually for every XBee module and antenna used, in order to check connections, different scenarios 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 AG and blades 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 and load conditions
- 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 measured

Radio Communications
- Every XBee will we connected to a development board to ensure correct functionality.
- Cansat-GS communication will be tested in an open field in a 2 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 and payload equivalent will be dropped from a drone to verify descent rate with the parachute and then will do the same with the auto-gyro.

Communications

- Communication range will be tested using a testing mode on the FSW Communication Module.
- Signal blocking will be tested using different materials to cover the radios.
- Different orientations and moving conditions of the payload will be tested to ensure a robust communication in any kind of situation or context scenario

Mechanisms

- Simultaneous TX Comms, Gimbal Motor and Burning Star activation will be tested to ensure the battery can provide sufficient power with all mechanisms working as expected.

Deployment

- Parachute and auto-gyro deployment will be tested using simulation mode with the cansat stationary.
- Parachute and auto-gyro deployment will be tested using simulation mode in conjunction with a descent test.

Environmental Test Plan (1/2)

Drop Test:
- 61 cm non-stretching 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 with ongoing communications.

Vibration Test:
- A orbital sander provided by the university is used to simulate vibration on the CanSat for 5s five 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)

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.

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 peak altitude is reached the hose will be removed and the air will be let back in slowly.

Simulation Test Plan

What parts of the CanSat get tested during simulation?
- During the simulation, every sensor except for the barometer is tested, the communication between the Ground Station and Cansat are also tested, and the behaviour of all software components is tested as well.

How is the simulation implemented?
- Once in simulation mode, the Cansat 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.

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	● Santiago Bolzicco
Ground Station Crew	● Monitor the ground station for telemetry reception ● Issue commands to the CanSat. ● Performs all required flight operations	● Micaela Perillo ● Rafael Dalzotto ● Emanuel Albornoz ● Santino Agosti
Recovery Crew	● Track and recover the CanSat ● Interact with field judges ● Make sure all field scores are filled in	● Agustín Martinez Haarth ● Daniela Maradei Lavalle
CanSat Crew	● Prepare the CanSat and integrate it into the rocket ● Verifying status before launching	● Ezequiel Bolzicco ● Federico Agustín Pilotto ● Thomas Agustín Marthi

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

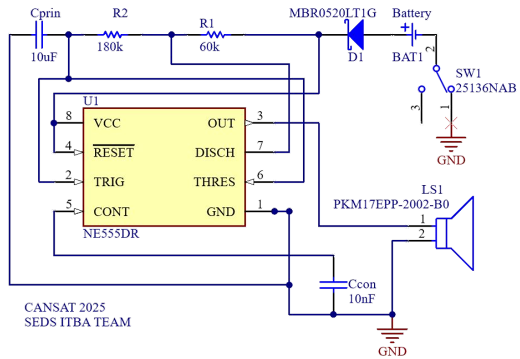
CanSat Recovery

- GPS location will be used to assist CanSat recovery
- Cansat will be colored bright pink for easy identification
- Payload will be colored bright orange for easy identification
- Cansat will have a loud audio beacon
- Cansat will have contact and return information printed on the exterior

CanSat Beacon Design (1/5)

Beacon Overview

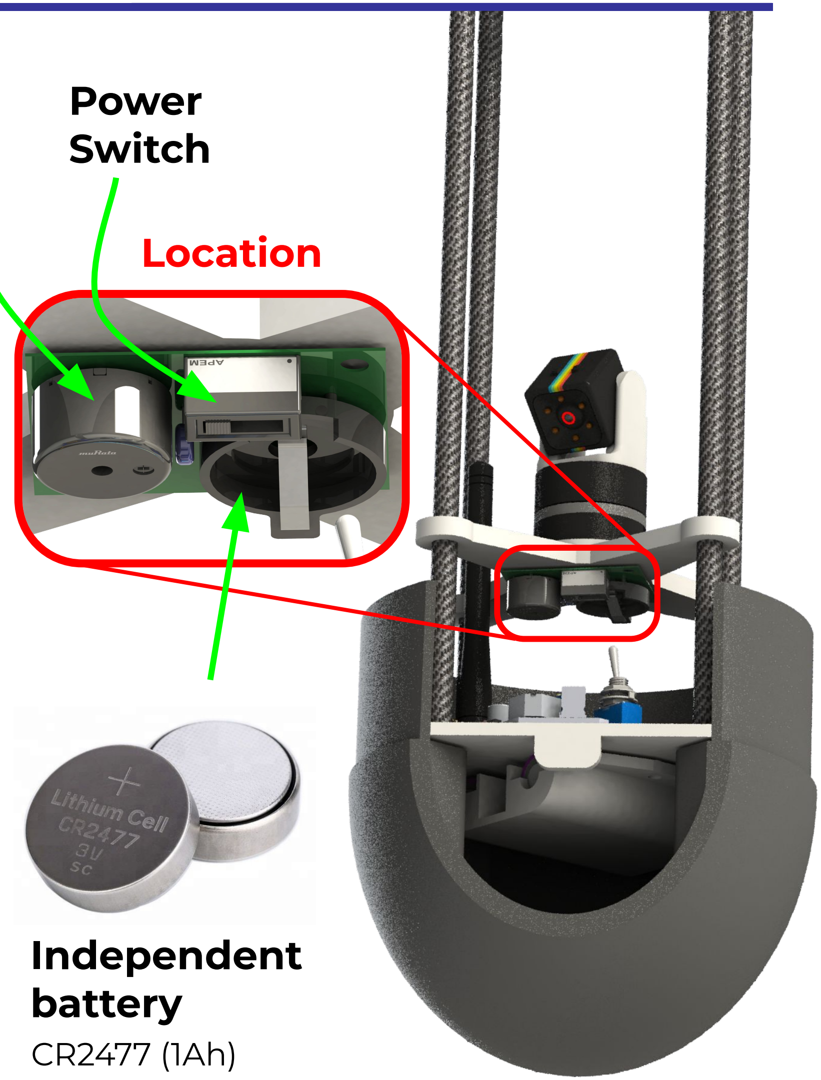
- Beeps for 250 ms every 1 second
- Safe Power Switch to prevent beacon from turning off
- Lasts up to 39 hours



Active Buzzer

Power Switch

Location



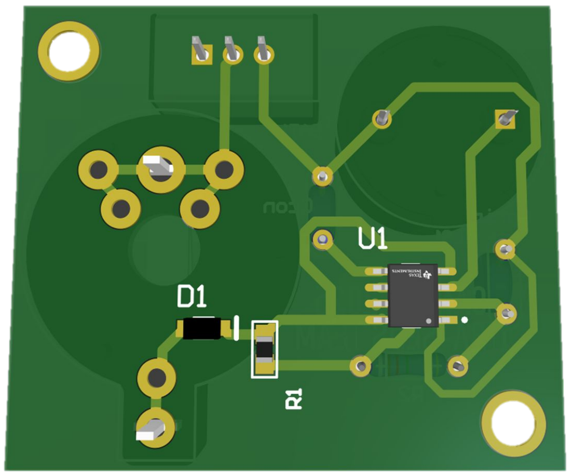
Independent battery

CR2477 (1Ah)

CanSat Beacon Design (2/5)

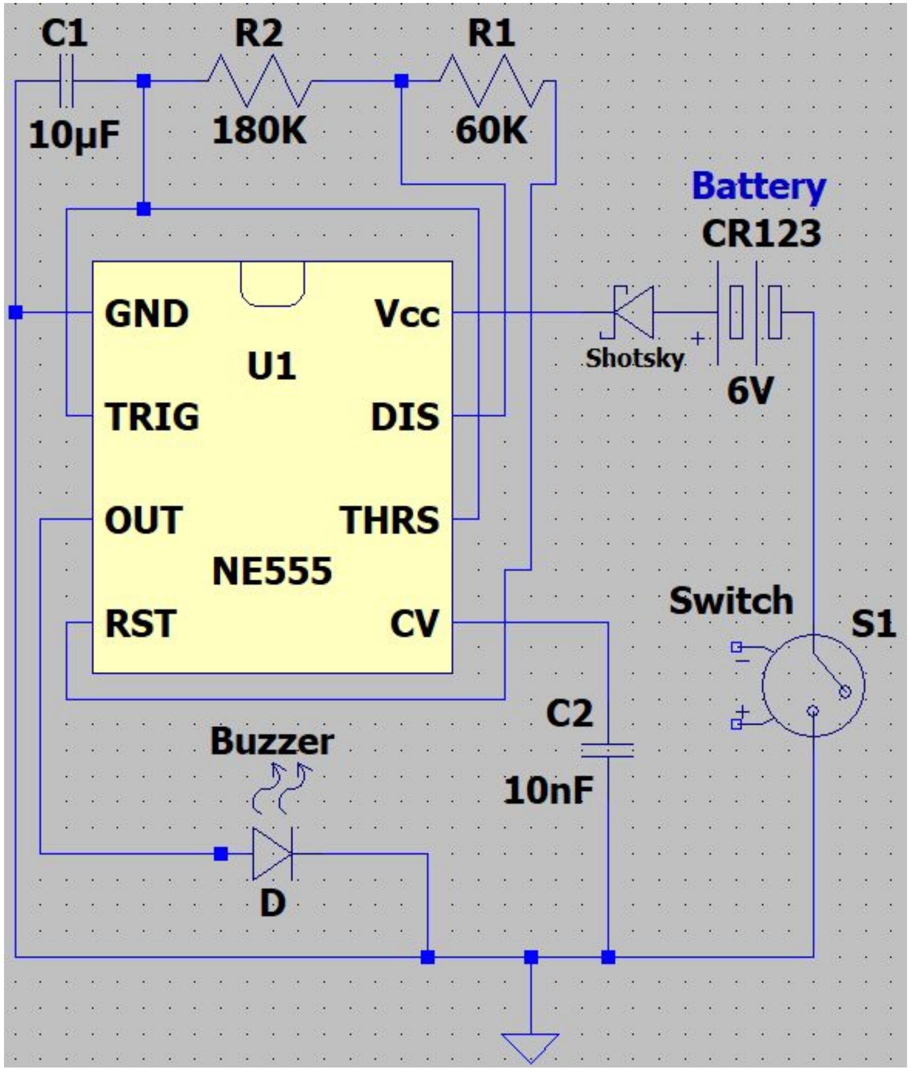
- **Introduction:**

The beacon is a fully **independent tracking circuit** for post-flight payload recovery. It operates on a dedicated Lithium Cell **power source** (CR2477) and emits **250 ms pulses every one second** using a **555 timer**, optimizing energy consumption. A **safety switch** prevents unintended turn-off due to high-g vibrations or crash at landing.



CanSat Beacon Design (3/5)

- **Beacon LTSpice diagram:**



- **Benefits:**
  - Independent Power Source
  - Energy Efficiency
  - Minimized Interference
  - Modular Design

- **Operating Values:**
  -Beacon frequency: 1Hz
  -Duty Cycle (Timer555): 25%
  -Operating Voltage: 3.3V-5V
  -Temperature Range: -40°C to 85°C
  -Total Weight: ~ 40g
  -Total Price: ~ $25

CanSat Beacon Design (4/5)

Component	Name	Characteristics
Timer 555	NE555DR	SMD version, low power, SOIC-8 / Operating voltage: 4.5V - 15V / Quiescent current: ~200 µA (astable mode)
Capacitor 1	Multilayer Ceramic Capacitor	$10\mu F$
Capacitor 2		10nF
Resistor 1	SMD 0805	$180k\Omega$
Resistor 2	Carbon Film Resistor	$60k\Omega$
Buzzer	Murata PKM22EPP-20	Resonant frequency: 2.0 kHz / Operating voltage: 3 - 20V
Switch	SPDT	Slide Type
Battery	CR2477	Capacity: 1000 mAh / Nominal voltage: 3V / Maximum current: 1.5A
Diode	Schottky	Maximum reverse voltage: 20V

CanSat Beacon Design (5/5)

- **Power control**

Power Calculations

1. Timer 555 Power Consumption (Active):

$$P_{\text{Timer555}} = 0.3\,\text{mA} \times 3\,\text{V} = 0.9\,\text{mW}$$

2. Beacon Power Consumption (Active):

$$P_{\text{Beacon}} = 100\,\text{mA} \times 3\,\text{V} = 300\,\text{mW}$$

Total Average Power (Considering Beacon Duty Cycle at

$$P_{Total} = P_{Timer\ 555} + (P_{Beacon} \times Duty\ Cycle)$$

$$P_{\text{Total}} = 0.9\,\text{mW} + (300\,\text{mW} \times 0.25) = 75.9\,\text{mW}$$

Battery Operation Time

The total available energy from the batteries is:

$$E_{\text{Battery}} = 1000\,\text{mAh} \times 3\,\text{V} = 3\,\text{Wh}$$

To calculate the estimated operation time:

$$T = \frac{E}{P} = \frac{3\,\text{Wh}}{0.0759\,\text{W}} \approx 39.53\,\text{h}$$

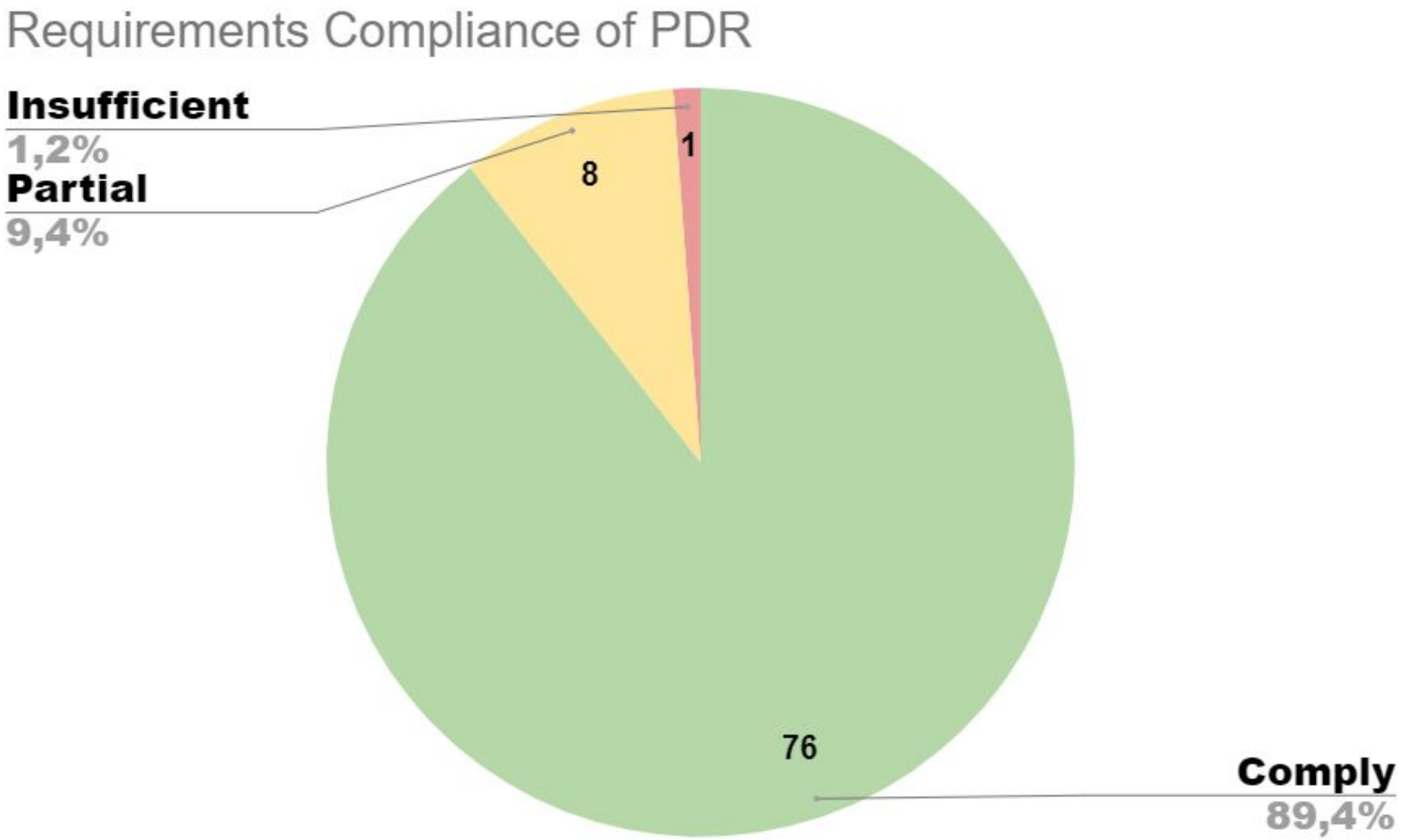
Conclusion:

- The **total power consumption** is **75.9mW.**
- With **one 3V, 1000 mAh battery** the estimated operation time is approximately **39.53 hours**.

Requirements Compliance

Ezequiel Bolzicco

Requirements Compliance Overview



Comply	Partial	Insufficient

Requirements Compliance (1/15)

#	Code	Description	Status	Slide Ref.	Comments
1	C1	The Cansat payload shall function as a nose cone during the rocket ascent portion of the flight	Comply	19, 37	
2	C2	The Cansat container shall be mounted on top of the rocket with the shoulder section inserted into the airframe.	Comply	19, 37	
3	C3	The Cansat payload and container shall be deployed from the rocket when the rocket motor ejection charge fires.	Comply	37	
4	C4	After deployment, the Cansat payload and container shall descend at 20 meters/second using a parachute that automatically deploys. Error is +/- 3 m/s.	Partial	37, 45	Theoretically complies, but further testing is needed
5	C5	At 75% flight peak altitude, the payload shall be released from the container.	Comply	37	
6	C6	At 75% peak altitude, the payload shall deploy an auto-gyro descent control system.	Comply	37, 40, 45	

Requirements Compliance (2/15)

#	Code	Description	Status	Slide Ref.	Comments
7	C7	The payload shall descend at 5 meters/second with the Auto-Gyro descent control system.	Partial	45	Theoretically complies, but further testing is needed
8	C8	The sensor telemetry shall be transmitted at a 1 Hz rate.	Comply	81, 86, 87	
9	C9	The payload shall record video of the release of the payload from the container and the operation of the Auto-Gyro descent control system.	Comply	33	
10	C10	A second video camera shall point in the north direction during descent.	Comply	31, 32, 70, 72	
11	C11	The second camera shall be pointed 45 degrees from the Cansat nadir direction during descent.	Comply	70	
12	C12	The second video camera shall be spin stabilized so the ground view is not rotating in the video.	Comply	31, 32, 70, 72	

Requirements Compliance (3/15)

#	Code	Description	Status	Slide Ref.	Comments
13	C13	The Cansat payload shall include an audible beacon that is turned on separately and is independent of the Cansat electronics.	Comply	141, 143	
14	C14	Cost of the Cansat shall be under $1000. Ground support and analysis tools are not included in the cost of the Cansat. Equipment from previous years shall be included in this cost, based on current market value.	Comply	164, 165, 166, 167	
15	S1	The Cansat and container mass shall be 1400 grams +/- 10 grams.	Comply	79	
16	S2	Nose cone shall be symmetrical along the thrust axis.	Comply	58	
17	S3	Nose cone radius shall be exactly 72.2 mm	Comply	58	
18	S4	Nose cone shoulder length shall be a minimum of 50 mm	Comply	58	

Requirements Compliance (4/15)

#	Code	Description	Status	Slide Ref.	Comments
19	S5	The nose cone shall be made as a single piece. Segments are not allowed.	Comply	55, 58	
20	S6	The nose cone shall not have any openings allowing air flow to enter.	Comply	55, 58	
21	S7	The nose cone height shall be a minimum of 76 mm.	Comply	58	
22	S8	Cansat structure must survive 15 Gs vibration	Partial	133	Theoretically complies, but further testing is needed
23	S9	Cansat shall survive 30 G shock.	Partial	133	Theoretically complies, but further testing is needed
24	S10	The container shoulder length shall be 90 to 120 mm.	Comply	62	

Requirements Compliance (5/15)

#	Code	Description	Status	Slide Ref.	Comments
25	S11	The container shoulder diameter shall be 136 mm.	Comply	62	
26	S12	Above the shoulder, the container diameter shall be 144.4 mm	Comply	62	
27	S13	The container wall thickness shall be at least 2 mm.	Comply	62	
28	S14	The container length above the shoulder shall be 250 mm +/- 5%.	Comply	62	
29	S15	The Cansat shall perform the function of the nose cone during rocket ascent.	Comply	19, 37	
30	S16	The Cansat container can be used to restrain any deployable parts of the Cansat payload but shall allow the Cansat to slide out of the payload section freely.	Comply	21	

Requirements Compliance (6/15)

#	Code	Description	Status	Slide Ref.	Comments
31	S17	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Partial	73	Mechanical mounts need further specification
32	S18	The CanSat container shall meet all dimensions in section F	Comply	62	
33	S19	The Cansat container materials shall meet all requirements in section F.	Comply	48	
34	S20	If the nose cone is to separate from the payload after payload deployment, the nose cone shall descend at no more than 5 meters/sec.	Comply	36	Nose cone does not separate from payload
35	S21	If the nose cone is to separate from the payload after payload deployment, the nose cone shall be secured to the payload until payload deployment with a pull force to survive at least 15 Gs acceleration.	Comply	36	Nose cone does not separate from payload
36	M1	No pyrotechnical or chemical actuators are allowed.	Comply	47	No pyrotechnical or chemical actuators are used.

Requirements Compliance (7/15)

#	Code	Description	Status	Slide Ref.	Comments
37	M2	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting the vegetation on fire.	Comply	74	
38	M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Partial	47, 48, 49, 51, 52, 53	Theoretically complies, but further testing is needed
39	M4	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	75	
40	E1	Lithium polymer batteries are not allowed.	Comply	94	No LiPo battery were used
41	E2	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	Comply	94, 96	
42	E3	Easily accessible power switch is required	Comply	95	

Requirements Compliance (8/15)

#	Code	Description	Status	Slide Ref.	Comments
43	E4	Power indicator is required for each voltage domain	Insufficient	-	Full schematic not designed yet
44	E5	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	Comply	100	
45	E6	The audio beacon shall operate on a separate battery.	Comply	141	
46	E7	The audio beacon shall have an easily accessible power switch.	Comply	141	
47	X1	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Comply	86	
48	X2	XBEE radios shall have their NETID/PANID set to their team number.	Comply	81, 86	

Requirements Compliance (9/15)

#	Code	Description	Status	Slide Ref.	Comments
49	X3	XBEE radios shall not use broadcast mode.	Comply	81, 86	
50	X4	The Cansat shall transmit telemetry once per second.	Comply	81, 86, 87	
51	X5	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	88, 89, 90, 91	
52	SN1	Cansat payload shall measure its altitude using air pressure.	Comply	24	This sensor is used as a pressure altimeter
53	SN2	Cansat payload shall measure its internal temperature.	Comply	25	
54	SN3	Cansat payload shall measure its battery voltage.	Comply	26	

Requirements Compliance (10/15)

#	Code	Description	Status	Slide Ref.	Comments
55	SN4	Cansat payload shall track its position using GPS.	Comply	27	
56	SN5	Cansat payload shall measure its acceleration and rotation rates.	Comply	29	
57	SN6	Cansat payload shall measure auto-gyro rotation rate.	Comply	28	
58	SN7	Cansat payload shall video record the release of the parachute and deployment of the auto-gyro at 75% peak altitude.	Comply	33	
59	SN8	Cansat payload shall video record the ground at 45 degrees from nadir direction during descent.	Comply	34	
60	SN9	The camera video shall be spin stabilized and oriented in the north direction so the view of the ground is not rotating more than 10 degrees in either direction.	Comply	30, 31, 32	

Requirements Compliance (11/15)

#	Code	Description	Status	Slide Ref.	Comments
61	SN10	The video cameras shall record video in color and with a minimum resolution of 640x480	Comply	33, 34	
62	SN11	The CanSat shall measure the magnetic field.	Comply	30	BMM150 is a geomagnetic sensor (3-axis)
63	G1	The ground station shall command the Cansat to calibrate the altitude to zero when the Cansat is on the launch pad prior to launch.	Comply	123	
64	G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	124, 125	
65	G3	Telemetry shall include mission time with 1 second or better resolution.	Comply	104,105	
66	G4	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	Comply	104,105	

Requirements Compliance (12/15)

#	Code	Description	Status	Slide Ref.	Comments
67	G5	Each team shall develop their own ground station.	Comply	122	
68	G6	All telemetry shall be displayed in real time during descent on the ground station.	Comply	122	
69	G7	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.) and the units shall be indicated on the displays.	Comply	122	
70	G8	Teams shall plot each telemetry data field in real time during flight.	Comply	122	
71	G9	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and an antenna.	Comply	113	
72	G10	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Comply	113	

Requirements Compliance (13/15)

#	Code	Description	Status	Slide Ref.	Comments
73	G11	The ground station software shall be able to command the payload to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	Comply	126	
74	G12	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the Cansat.	Comply	126	
75	G13	The ground station shall use a table top or handheld antenna.	Comply	113	
76	G14	Because the ground station must be viewed in bright sunlight, the displays shall be designed with that in mind, including using larger fonts (14 point minimum), bold plot traces and axes, and a dark text on light background theme.	Comply	122	
77	G15	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	122	

Requirements Compliance (14/15)

#	Code	Description	Status	Slide Ref.	Comments
78	G16	The ground station shall be able to activate all mechanisms on command.	Comply	122	
79	F1	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Comply	104, 105	
80	F2	The Cansat shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	Comply	104, 105	
81	F3	The Cansat shall have its time set by ground command to within one second UTC time prior to launch.	Comply	92	
82	F4	The flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile file.	Comply	106, 107	

Requirements Compliance (15/15)

#	Code	Description	Status	Slide Ref.	Comments
83	F5	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the payload altitude.	Comply	106, 107	
84	F6	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Comply	106, 107	
85	F7	The flight shall include commands to activate all mechanisms. These commands shall be documented in the mission manual.	Comply	92	

Management

Santiago Bolzicco
Rafael Dalzotto

CanSat Budget – Hardware (1/4)

Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual/ Free
Electronics-Payload				
330k SMD 0805 Resistor (tol 1%)	NO	1	0,1	Estimated
220k SMD 0805 Resistor (tol 1%)	NO	1	0,1	Estimated
Ublox NEO-6M + Patch Antenna	YES	1	10,9	Actual
TCST2103	NO	2	1,13	Actual
Quelima SQ11	YES	2	12	Actual
Superseal Connectors Pair (M+F)	NO	8	4,66	Actual
Arduino Nano 33 BLE Sense Rev2	NO	1	42	Actual
DS3231 mini RTC + battery	NO	1	14,95	Actual
Xbee Pro S3B	YES	1	88,5	Actual
ANT-900MR Flex ¼ Wave RPSMA	YES	1	7	Actual

CanSat Budget – Hardware (2/4)

Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual/ Free
Electronics-Payload				
Samsung INR18650 Li-Ion Battery	YES	2	2,6	Actual
Switch	YES	1	1,3	Actual
Step-Down Converter	NO	1	6,78	Actual
10 Ohm Resistor 1/4W	NO	1	0,1	Actual
Safe Toggle Switch	NO	1	0,8	Actual
+90dB Active Buzzer	NO	1	5,8	Actual
PCB	NO	2	15	Estimated
GM2804 Gimbal Motor w/Encoder	NO	1	39	Actual
Other Electrical & Electronics	NO	1	50	Estimated
TOTAL (Electronics Payload) = 366,07 USD				

CanSat Budget – Hardware (3/4)

Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual
Mechanics				
Nylon Ripstop	YES	900 cm^2	0.001 per cm^2	Estimated
Carbon Fibre Rods (4x350mm)	YES	4	59/1m	Actual (MercadoLibre)
Braid fishing line	NO	1	6.5 per 100m	Actual (MercadoLibre)
ABS	NO	1 kg	20/kg	Actual (MercadoLibre)
Aluminum	NO	0.1kg	2.59/kg	Actual
Torsion Spring	NO	4	4	Estimated
Screws, washers and nuts	NO	10	5	Estimated
Bearings	NO	2	5	Estimated
Eyebolt + Swivel link	YES	1	5	Estimated
TOTAL (Mechanics) = 191 USD				

CanSat Budget – Hardware(4/4)

Subsystem	Cost (USD)
Electrical	366,07
Mechanical	191
TOTAL = 557,07 USD	

CanSat Budget – Other Costs (1/2)

Ground Station				
Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual
Yagi Antenna	NO	1	150	Actual
Yagi Antenna Mounting (Table Top)	NO	1	25	Estimated
XBee USB Adapter FT232RL	YES	1	88,5	Actual
Laptop Computer	YES	1	1000	Estimated
Umbrella	YES	1	9	Actual
TOTAL (Ground Station) = 1272,5 USD				

CanSat Budget – Other Costs (2/2)

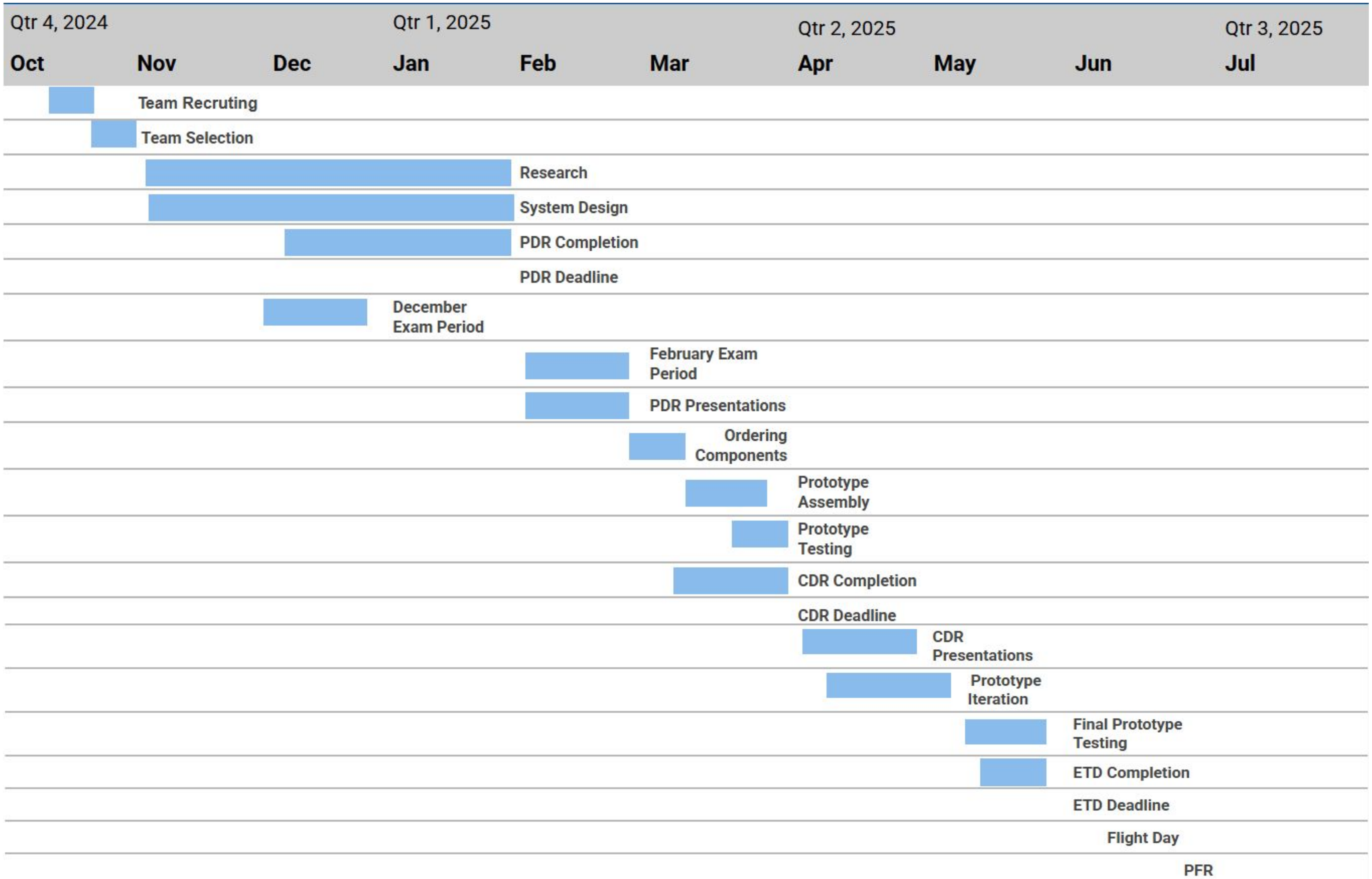
Travel (per person)	
	Price (USD)
Airline	1400
Visa	185
Hotel	300
Food	50
Other travel fees	50
PER PERSON = 1885 USD	
TOTAL = 18850 USD	

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 – Total Costs

CANSAT 2025	
	Real Cost (USD)
Electrical Hardware	366,07
Mechanical Hardware	191
Ground Station	1272,5
Travelling	18850
TOTAL	**20679,57**

Program Schedule Overview



Detailed Program Schedule (1/3)

	Task Name	Assignee	Start	Finish	Duration
1	**Competition Overview**				
1.1	Team Recruting	All	15/10/24	21/10/24	6
1.2	Team Selection	All	21/10/24	31/10/24	10
1.3	Research	All	01/11/24	19/11/24	18
1.4	System Design	All	20/11/24	14/01/25	54
1.5	PDR Completion	All	15/01/25	31/01/25	16
1.6	PDR Deadline	All	31/01/25	31/01/25	0
1.7	December Exam Period	All	05/12/24	23/12/24	18
1.8	February Exam Period	All	06/02/25	24/02/25	18
1.9	PDR Presentations	All	03/02/25	21/02/25	18
1.10	Ordering Components	All	05/02/25	24/02/25	19
1.11	Prototype Assembly	All	20/02/25	02/03/25	12
1.12	Prototype Testing	All	03/03/25	17/03/25	14
1.13	CDR Completion	All	06/03/25	28/03/25	22
1.14	CDR Deadline	All	28/03/25	28/03/25	0
1.15	CDR Presentations	All	07/04/25	25/04/25	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	06/05/25	23/05/25	17

Detailed Program Schedule (2/3)

1.20	ETD Deadline	All	23/05/25	23/05/25	0
1.21	Flight day	All	07/06/25	07/06/25	0
1.22	PFR	All	08/06/25	08/06/25	0
2	**Management**				
2.1	Recruit Interested Team Members	Team Lead	15/10/24	21/10/24	6
2.2	Summarize and Analyze Mission Guide	Team Lead	16/10/24	22/10/24	6
2.3	Contact University and Sponsors for Funding	Team Lead	17/10/24	01/06/25	224
3	**Flight Software**				
3.1	Define Software Requirements for Playload, Container and Ground Station	Software and Firmware Team	30/11/24	18/12/24	18
3.2	Design Architecture for Container Software	Software and Firmware Team	19/12/24	25/12/24	6
3.4	Design Architecture for Ground Station Software	Software and Firmware Team	26/12/24	02/01/25	6
3.5	Integrate Design with Electronic Components	Software and Firmware Team	03/01/25	21/01/25	18
3.6	Create Container State Diagram	Software and Firmware Team	22/01/25	27/01/25	5
3.7	Determine Software Development Process	Software and Firmware Team	28/01/25	01/02/25	3
3.8	Develop and Test Software	Software and Firmware Team	03/02/25	01/06/25	118
4	**Container and Playload Design**				
4.1	Design and Analyze different Mechanical Layout Prototypes	Mechanical Team	19/12/24	06/01/25	17
4.2	EDT Planning and Completition	Mechanical Team	07/01/25	21/01/25	14
4.3	Define Electronics to be used based on Research	Mechanical Team	22/01/25	01/02/25	9

Detailed Program Schedule (3/3)

5	**Descent Control Design**				
5.1	System Research and Selection	Electronics and Firmware Team	03/01/25	21/01/25	18
5.2	Integrate Design with Electronic Components Definitions	Electronics and Firmware Team	22/01/25	01/02/25	9
6	**Electronic Systems**				
6.1	System Research and Selection	Electronics and Firmware Team	19/12/24	07/01/25	18
6.2	Define Electronics to be used based on Research	Electronics and Firmware Team	08/01/25	14/01/25	6
6.3	Integrate Designs with Electronic Component Definitions	Electronics and Firmware Team	15/01/25	01/02/25	16
7	**Ground Station**				
7.1	Research Antena Technology	Software and Ground Station Team	03/01/25	21/01/25	18
7.2	Design and Prototype GCS Software	Software and Ground Station Team	22/01/25	26/01/25	4
7.3	Determine or Design Antena	Software and Ground Station Team	27/01/25	01/02/25	4

Conclusions (1/2)

Major accomplishments
● CanSat's mechanical prototyping has been developed using CAD software to ensure all components will fit when assembled as well as for simulation testing. ● All electronic components have been chosen and meet mission requirements. ● Turning all the software requirements into a detailed description of the software and all of its states while finding similarities in the components to simplify implementation. ● Roles and tasks between team members have been assigned.

Major unfinished work
● CanSat's prototype yet to be 3D printed. ● Major set of electronic components yet to be ordered. ● Main PCB yet to be designed. ● Funding sourced yet to be determined.

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.