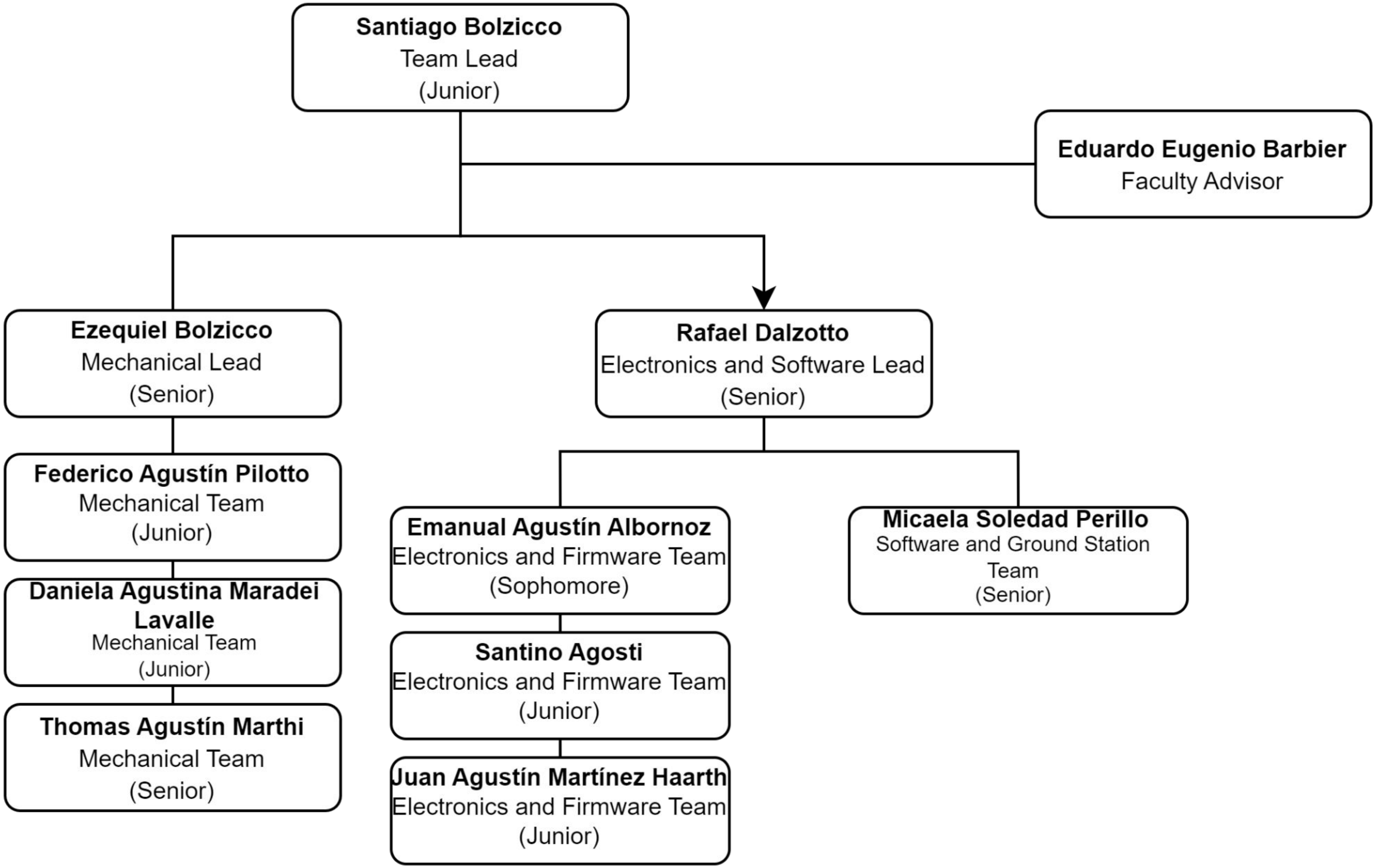
CanSat 2025
Critical Design Review (CDR)
Version 1.2

Team 3165

SEDS ITBA

Presentation Outline

Team Organization



Acronyms (1/3)

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 (2/3)

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

Acronyms (3/3)

Acronym	Explanation
FEA	Finite Element Analysis
CEP	Circular Error Probable
GNSS	Global Navigation Satellite System
SBAS	Satellite Based Augmentation System
VSWR	Voltage Standing Wave Ratio
NCCS	North Centralized Coordinate System
PGC	Payload Ground Camera

System Overview

Santiago Bolzicco, Thomas Marthi

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

Summary of Changes Since PDR (1/2)

Subsystem	Element	Changes	Rationale
Sensor	Autogyro RPM sensor	A1104 hall-effect sensor will be used instead of IR	Size
Descent Control	Autogyro shaft	One shaft will be used instead of two coaxial shafts	Manufacturability
Descent Control	Blade stoppers	Blades stoppers were made wider and thicker	Robustness
Descent Control	Rotor's diameter	The rotor's diameter was reduced by 5 mm.	Size optimization
Descent Control	Descent rates	Descent rates have been recalculated	Performance accuracy
Descent Control	Rotor design	Rotors were redesigned to fit a bearing inside	Design needs
Descent Control	Autogyro blades	Autogyro blades were widened	Stability and robustness
MECH	Electrical connectors	Micro-Lock connectors will be used	Lower weight and size
MECH	Floor attachment	Screws replaced by cable glands	Assembly efficiency
MECH	AG deploy camera location	Upper camera now is attached to the burning star floor	FOV improvement
MECH	Nose Cone lock method	A slide and lock mechanism with two screws will be used instead	Assembly efficiency

Summary of Changes Since PDR (2/2)

Subsystem	Element	Changes	Rationale
CDH	Payload Processor Memory Selection	An extra 4 Mb Flash SPI memory was added	Need for permanent memory storage accessible from FSW
EPS	3.3V Step-Down Converter	MP1584 will be used instead of the LM2596	Smaller size and lower weight
FSW	No changes	No changes	No changes
GCS	GCS Antenna Design	A Hand-Held antenna configuration will be used instead of a table-top one	Better mobility and simpler design

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 Concept of Operations (CONOPS) (1/2)

Pre-Launch

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

Launch & Ascent

1. Rocket ignition and ascension

2. Maximum altitude reached

Cansat Deployment

1. CanSat deployment

2. Parachute deployment (at maximum altitude)

AG Deployment

1. Payload deployment (at 75% of maximum altitude)

2. Auto-gyro deployment (at 75% of maximum altitude)

Cansat Landing

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

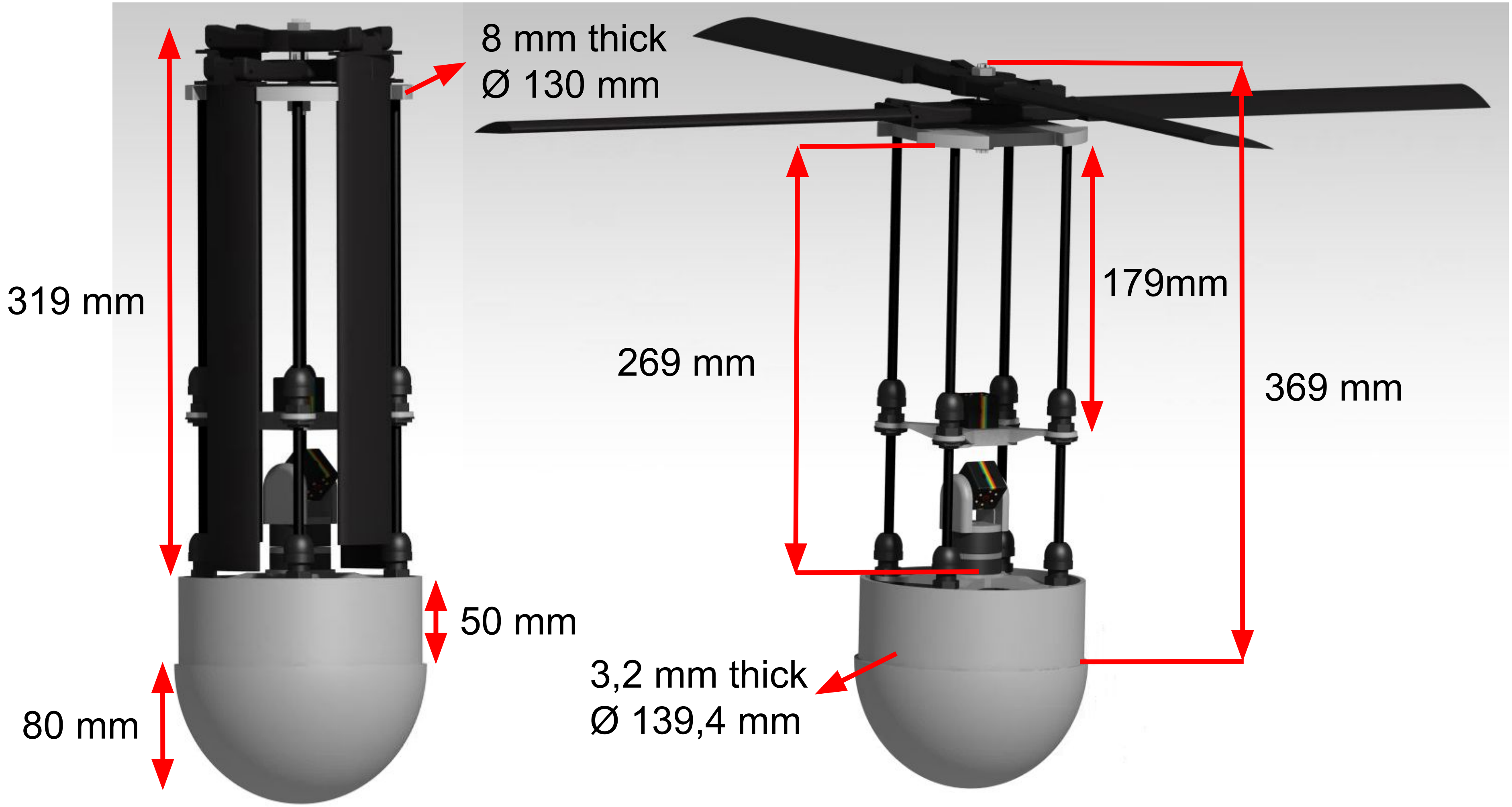
1. Receive and plot telemetry in real time
2. Generate csv files of all sensor data
3. Recover CanSat

System Concept of Operations (CONOPS) (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 • Agustín Martinez Haarth
Recovery Crew	• Track and recover the CanSat • Interact with field judges • Make sure all field scores are filled in	• Ezequiel Bolzicco • Emanuel Albornoz • Daniela Maradei Lavalle
CanSat Crew	• Prepare the CanSat and integrate it into the rocket • Verifying status before launching	• Federico Agustín Pilotto • Thomas Agustín Marthi • Santino Agosti

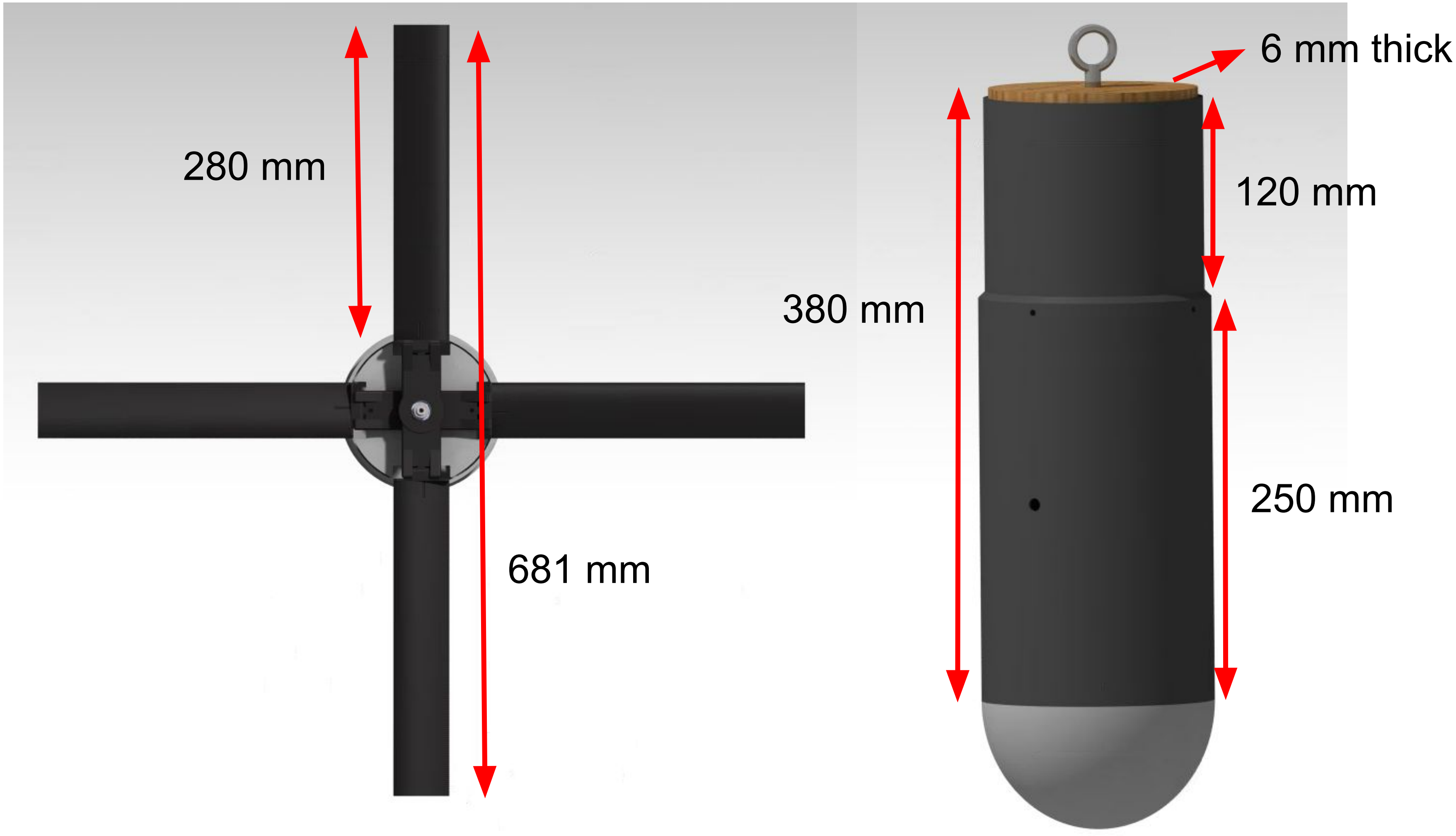
CanSat Physical Layout (1/4)

Payload dimensions



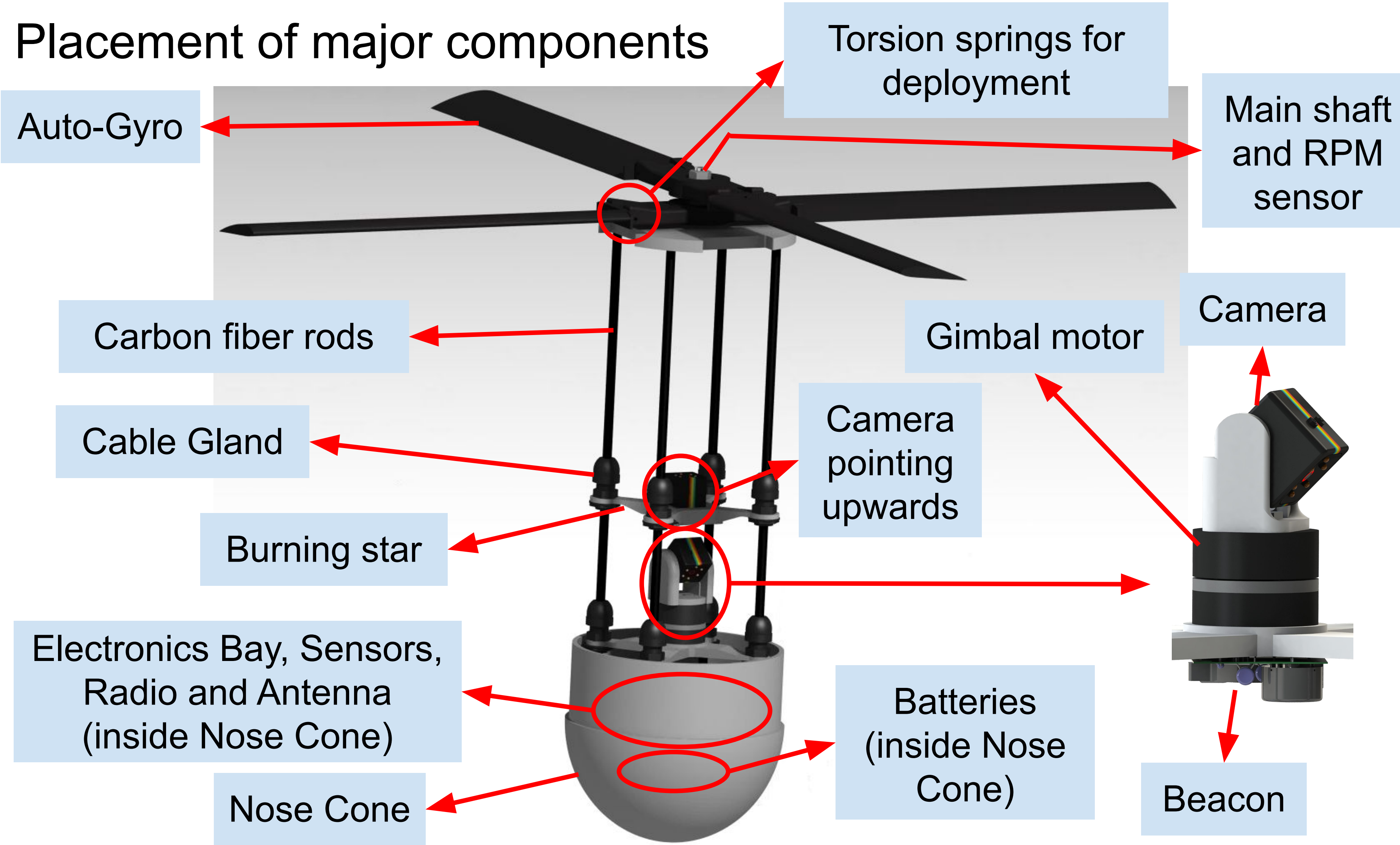
CanSat Physical Layout (2/4)

Auto-gyro and Container dimensions



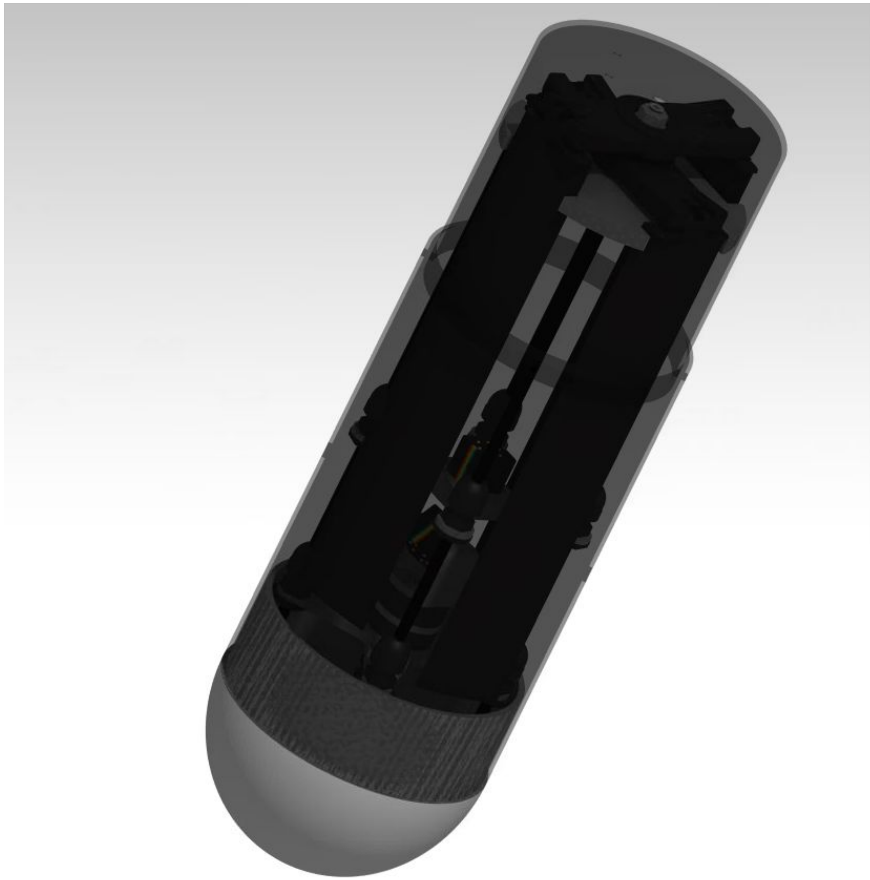
CanSat Physical Layout (3/4)

Placement of major components



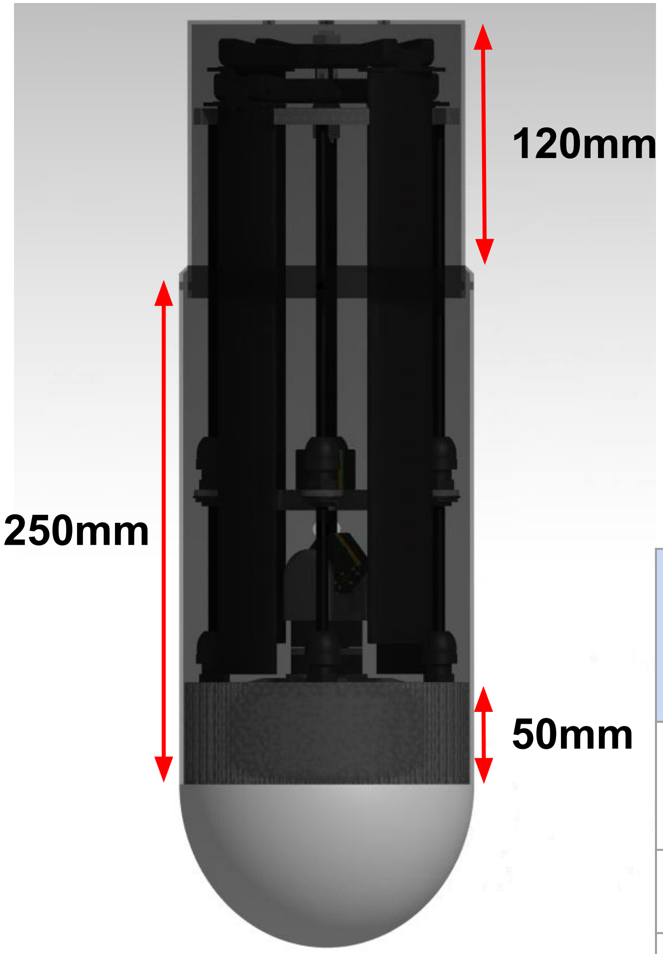
CanSat Physical Layout (4/4)

Launch configuration
(as mounted in rocket)



Deployed configuration

Launch Vehicle Compatibility



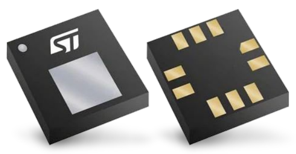
Container shoulder is, as required, ⌀136 mm, enabling to place itself inside launch vehicle

	Container section dimensions (mm)	Payload dimensions (mm)	Clearance (mm)
Diameter	132	130	2
Height	372	369	3
Nosecone	140,4	139,4	1

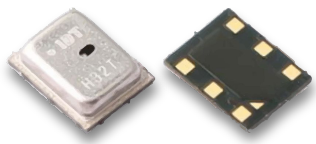
Sensor Subsystem Design

Rafael Dalzotto
Emanuel Albornoz
Santino Agosti

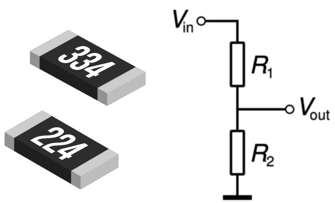
LPS22HB
Air pressure



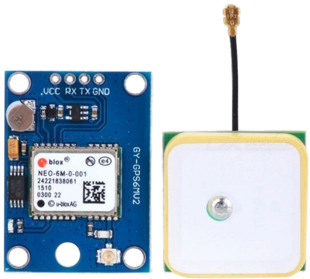
HS3003
Air temperature



Resistor divider + ADC
Battery voltage



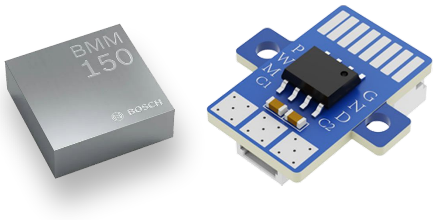
Ublox Neo-6M
GNSS receiver



A1104
Autogyro RPM Sensors
(Hall effect sensor)

BMI 270
Tilt Sensor
(Accelerometer)

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



Quelima SQ11
Cameras

Sensor Changes Since PDR

Changes	Rationale
A1104 hall effect sensor will be used for the Auto-gyro Rotation Rate Sensors instead of the **TCST2103** infrared switch	The overall sensing system is **significantly smaller** in comparison. Additionally, the main axis of the autogyro will be fixed, so the outer blade rotation rate must be measured from the top external side of the axis in order to access the moving parts. Therefore, a miniature sensor is more convenient

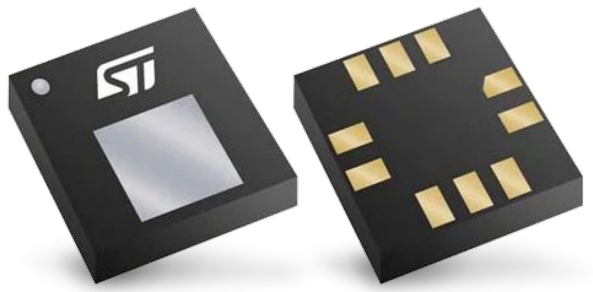
TCST2103
Autogyro RPM Sensors
(Infrared switch)

A1104
Autogyro RPM Sensors
(Hall effect sensor)

Payload Air Pressure Sensor Summary

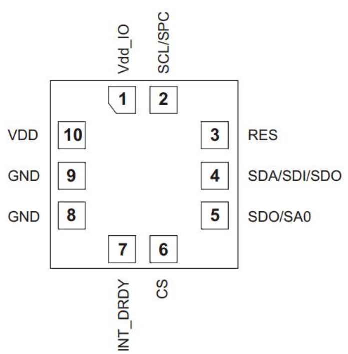
LPS22HB STMicroelectronics

MEMS nano pressure sensor: 260-1260 hPa absolute digital output barometer



2mm × 2mm Footprint datasheet

- 260 to 1260 hPa absolute **pressure range**
- ±0.10 hPa **relative accuracy**
- **Current consumption** down to 3 μA
- 4096 LSB/hPa **pressure sensitivity**
- 24-bit pressure **data output format** (in hPa)
- **Supply voltage**: 1.7 to 3.6 V
- SPI and I2C **interfaces**
- Negligible **mass**
- High overpressure capability: 20x full-scale
- Embedded temperature compensation
- Output Data Rate up to 75 Hz
- High **shock survivability**: 22,000 g
- Negligible **mass**



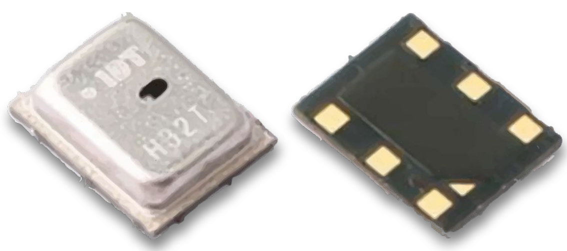
$$H = 44330 \cdot \left[1 - \left(\frac{P}{p_0}\right)^{\frac{1}{5.25588}}\right]$$

Where, "H" stands for altitude (m), "P" the measured pressure (kPa) from the sensor and "p0" is the reference pressure at sea level (101.325 kPa).

Payload Air Temperature Sensor Summary

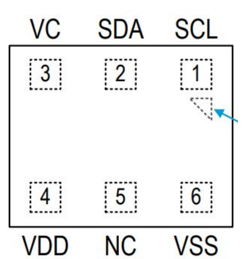
HS3003 RENESAS

High Performance Relative
Humidity and Temperature Sensor



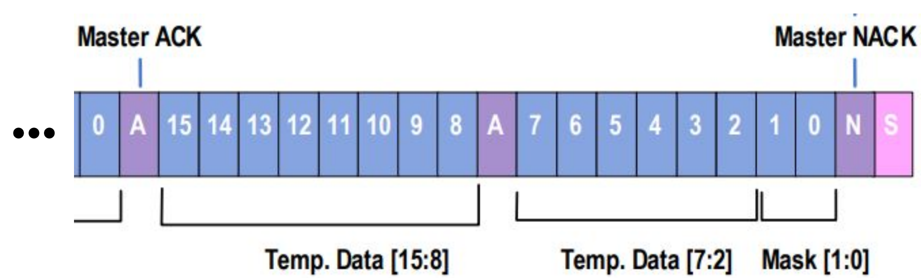
datasheet

3mm × 2.41mm Footprint



- -40 to +125 °C **temperature range**
- ±0.25 °C **relative accuracy**
- Average **current consumption** of 24.4 µA
- ±0.015 °C **temperature sensitivity**
- 14-bit temperature **data output format** (in °C)
- **Supply voltage**: 3.3 to 5.5 V
- I2C **interface**
- Negligible **mass**
- Response time[1] constant: 2 sec
- Highly robust protection from harsh environmental conditions and mechanical shock

$$Temperature\,[^{\circ}C] = \left(\frac{Temperature\,[15:2]}{2^{14}-1}\right) * 165 - 40$$

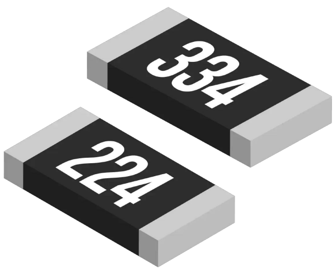


Notes:

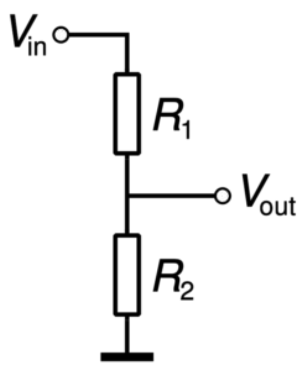
1. Response time depends on system thermal mass and air flow
2. Formula retrieved from datasheet

ADC Pin + Resistor Voltage Divider

390k and 220k resistor in series



- 0V to +9.15V **voltage range**
- Operating **current** of 15 µA
- ±0.22 mV **sensitivity**
- 12-bit **data output format**
- ADC microcontroller pin **interface**
- **Supply voltage**: 3.3V (microcontroller board)
- Negligible **mass**



$$V = 9.15 \cdot \left(\frac{\text{adc\_output}}{4095} \right)$$

Payload GNSS Sensor Summary

NEO-6M

Versatile u-blox 6 GPS modules

16mm × 12.2mm Footprint

- UART, USB, DDC (I2C compliant) and SPI **interfaces**
- Based on GPS chips qualified according to AEC-Q100
- Position **accuracy:** 2.5 m CEP and 2 m SBAS
- Average **current consumption** of 37 mA
- **Sensitivity** up to -161 dBm (tracking mode)
- NMEA, UBX binary and RTCM **data output format**
- **Supply voltage**: 2.7 V to 3.6 V
- Navigation **update rate** up to 5 Hz
- Total **weight** 16g (module + antenna)

No data processing is needed on our side:

- We use an NMEA parsing tool called TinyGPSPlus.
- The data is already obtained in the desired format.

NEO-6 Product Summary

NEO-6 u-blox 6 GPS Module Datasheet

Auto-gyro Rotation Rate Sensor Summary

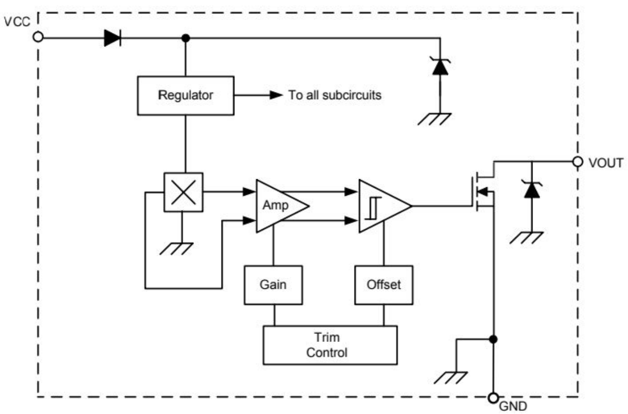
A1104

ALLEGRO microsystems

Continuous-Time Hall-Effect Switch

[A110x datasheet]

- 400 ns **switching time** (up to 1 GHz switching freq.)
- AEC-Q100 automotive qualified
- Average **current** consumption of 4.1 mA
- Digital **output interface**
- Supply **voltage**: 3.8 to 24 V
- Integrated **schmitt trigger** and NMOS output
- **Mass**: ~1g



Functional Block Diagram

Approach: Rotation time measurement

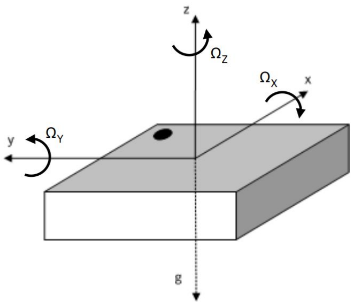
```
1/period = frequency [Hz]
rate = frequency * 60 [RPM]
```

- +100000 RPM limited by microcontroller time measurement capabilities
- These limitations do not compromise our requirements in the slightest.

Payload Tilt Sensor Summary

BMI 270 BOSCH

6-axis Inertial Measurement Unit for high-performance applications



3mm × 2.4mm Footprint

BMI270 Datasheet

Example of reading

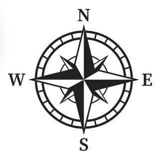
```
float x, y, z;
if (IMU.accelerationAvailable()) {
      IMU.readAcceleration(x, y, z);
      Serial.print(x);
      Serial.print('\t');
      Serial.print(y);
      Serial.print('\t');
      Serial.println(z);
}
```

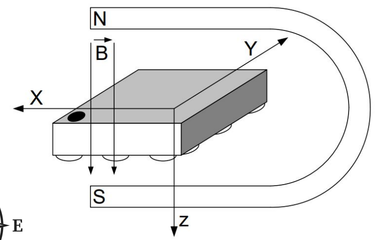
- **16-bit triaxial** accelerometer and gyroscope sensor
- From ±2g to ±16g **accelerometer range**
- Up to 1600 Hz accel **output data rate**
- From 2048 to 16384 LSB/g accel **resolution**
- From ±125 to ±2000 dps **gyroscope range**
- From 16384 to 262144 LSB/dps gyro **sensitivity**
- Up to 6400 Hz gyro **output data rate**
- Average **current consumption** of 970 μA (max)
- **Supply voltage**: 1.71 to 3.6 V
- SPI and I2C **interfaces**
- Negligible **mass**
- Ease of use by **library,** no complex data processing is needed on our side

Payload Ground Camera Orientation Sensor (1/3)

BMM150 BOSCH

Three-Axis Geomagnetic Sensor
(magnetic compass)





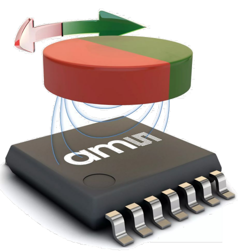
- High **ODR**: >300 Hz in forced mode, 100 Hz in regular preset
- Ultra-Low Power (170μA @ 10 Hz in low power mode)
- **Average current** of 4.9 mA in high performance mode
- Good Heading **Accuracy**: ±2.5 deg
- Magnetic field **range:** up to ±2500 μT
- Magnetic field **resolution:** 0.3 μT
- **Operating voltage:** 1.62V to 3.6V
- SPI and I2C **interfaces**
- Negligible **mass**

BMM150 datasheet

+

AS5048A ams OSRAM

Magnetic Rotary Encoder
(14-Bit Angular Position Sensor)



- High **resolution** (0.0219°/LSB)
- From 0° to 360° **range,** 14-bit output
- Operating **voltage:** 3.3V or 5V
- SPI, I2C and PWM **interfaces**
- High sensing speed: Up to 12.4 kHz **ODR**
- 15 mA **supply current**

AS5048A datasheet

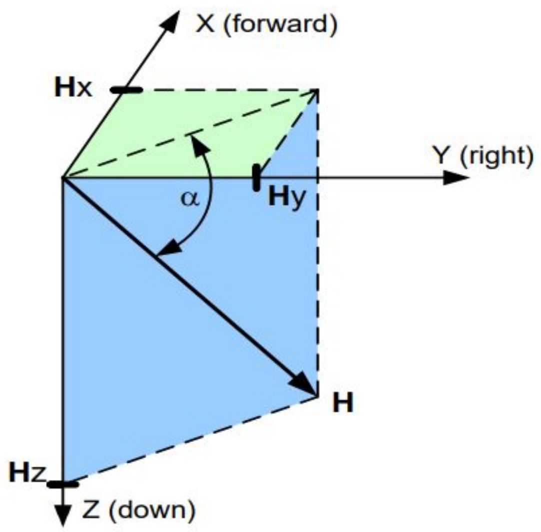
Tilt Compensated Magnetometer

Motivation: It is crucial to implement a tilt compensation software for the Earth's Magnetic Field Measurement. The inclination angle of Earth's magnetic field in Virginia (α) is around 65°. Therefore, a small tilt over the sensor can induce a large error over the measurement of the ***Azimuth angle***:

Initial Approximation: When no tilt is present, a common approach used to estimate the heading is to measure two orthogonal components of the magnetic vector (Hx and Hy) and calculate the heading as the arctangent of their ratio.
Heading = Arctan(Hx/Hy)

If some tilt is present, the measured values Hx and Hy change and the resultant heading has a considerable associated error.

Figure 2. Magnetic Field Inclination Angle



Tilt Compensation

The Pitch and Roll can be estimated by taking in consideration the projections of the gravitational field sensed by the **BMI 270 6-axis IMU** from the Arduino Nano 32 BLE. Knowing the tilt and the magnetic inclination angle in Virginia, a 3-dimensional inverse rotational matrix can be used to correctly transform the measured magnetic field orthogonal component values, to their tilt compensated ones.

Payload Ground Camera Orientation Sensor (3/3)

The Pitch Rotation Matrix is:

$$C_p = \begin{pmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\phi & 0 & \cos\phi \end{pmatrix}$$

The Roll rotation matrix is:

$$C_r = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & \sin\theta \\ 0 & -\sin\theta & \cos\theta \end{pmatrix}$$

$$\vec{H}' = (H_x^{'}, H_y^{'}, H_z^{'})$$

Is the IMU measured Magnetic FIeld Vector

$$\vec{H} = (H_x, H_y, H_z)$$

Is the Tilt Corrected Magnetic Field Vector

$$\begin{pmatrix} Hx' \\ Hy' \\ Hz' \end{pmatrix} = \begin{pmatrix} \cos\phi & 0 & -\sin\phi \\ \sin\theta\sin\phi & \cos\theta & \sin\theta\cos\phi \\ \cos\theta\sin\phi & -\sin\theta & \cos\theta\cos\phi \end{pmatrix} \cdot \begin{pmatrix} Hx \\ Hy \\ Hz \end{pmatrix}$$

Applying the inverse rotational matrix

$$\vec{H} = \begin{pmatrix} \cos\phi & \sin\theta\sin\phi & \cos\theta\sin\phi \\ 0 & \cos\theta & -\sin\theta \\ -\sin\phi & \sin\theta\cos\phi & \cos\theta\cos\phi \end{pmatrix} \cdot \vec{H}'$$

Vector from which the magnetic orientation can be calculated with more precision given its tilt compensation as:

$$\text{Tilt Compensated Heading} = Arctan(\frac{H_x}{H_y})$$

Quelima SQ11

Mini spy camera

- **Supply voltage:** 3.3V
- **Current consumption:** 120 mA (average)
- **Output format:** MP4 video file
- **Storage:** Internal, 64 GB (SD card)
- **Resolution:** 1280 x 720p
- **Field of View:** 140°
- **Framerate:** 60 FPS
- **Control interface:** Digital (pulses sent from microcontroller)
- **Weight:** 15 g
- **Size:** 23 x 23 x 23 mm
- **Video:** Color

No data processing is needed on our side.

Quelima SQ11

Mini spy camera

- **Supply voltage:** 3.3V
- **Current consumption:** 120 mA (average)
- **Output format:** MP4 video file
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No data processing is needed on our side.

Descent Control Design

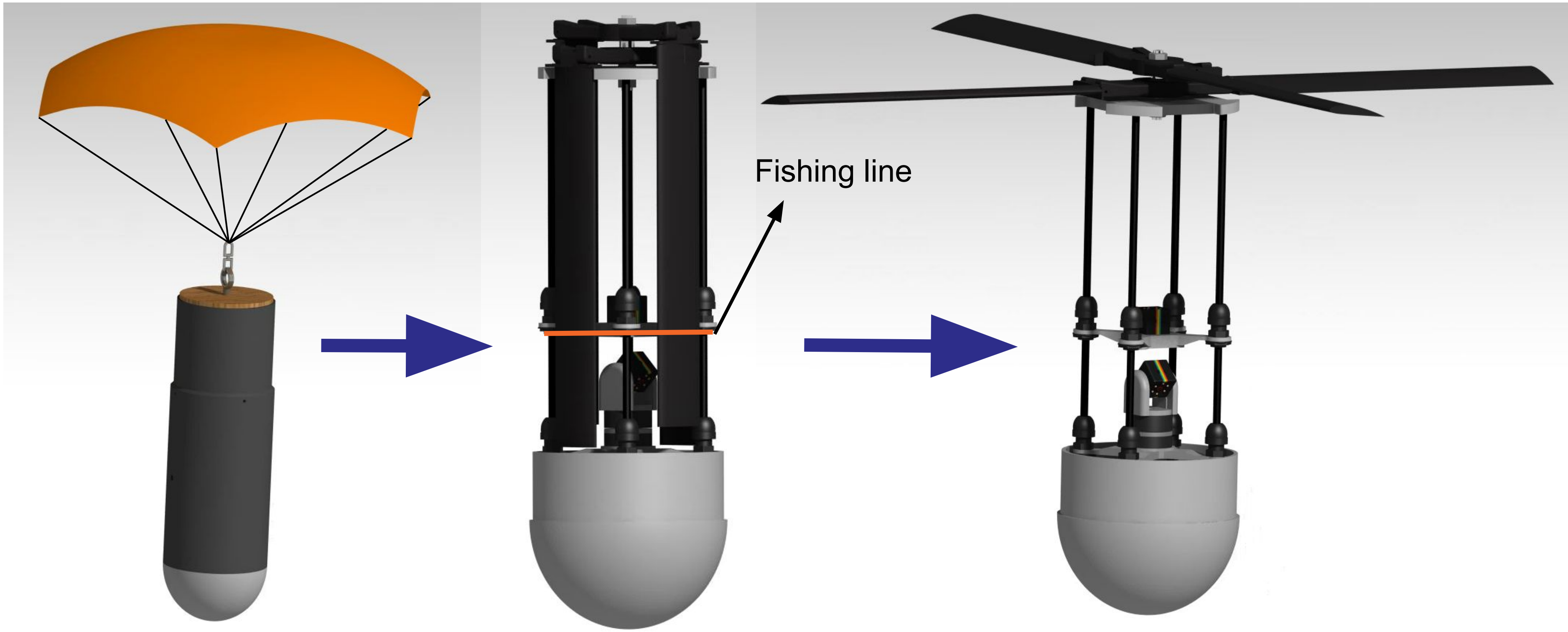
Ezequiel Bolzicco
Thomas Marthi
Federico Pilotto

Descent Control Overview (1/2)

- Double deck Auto-Gyro
- Fishing line attachment

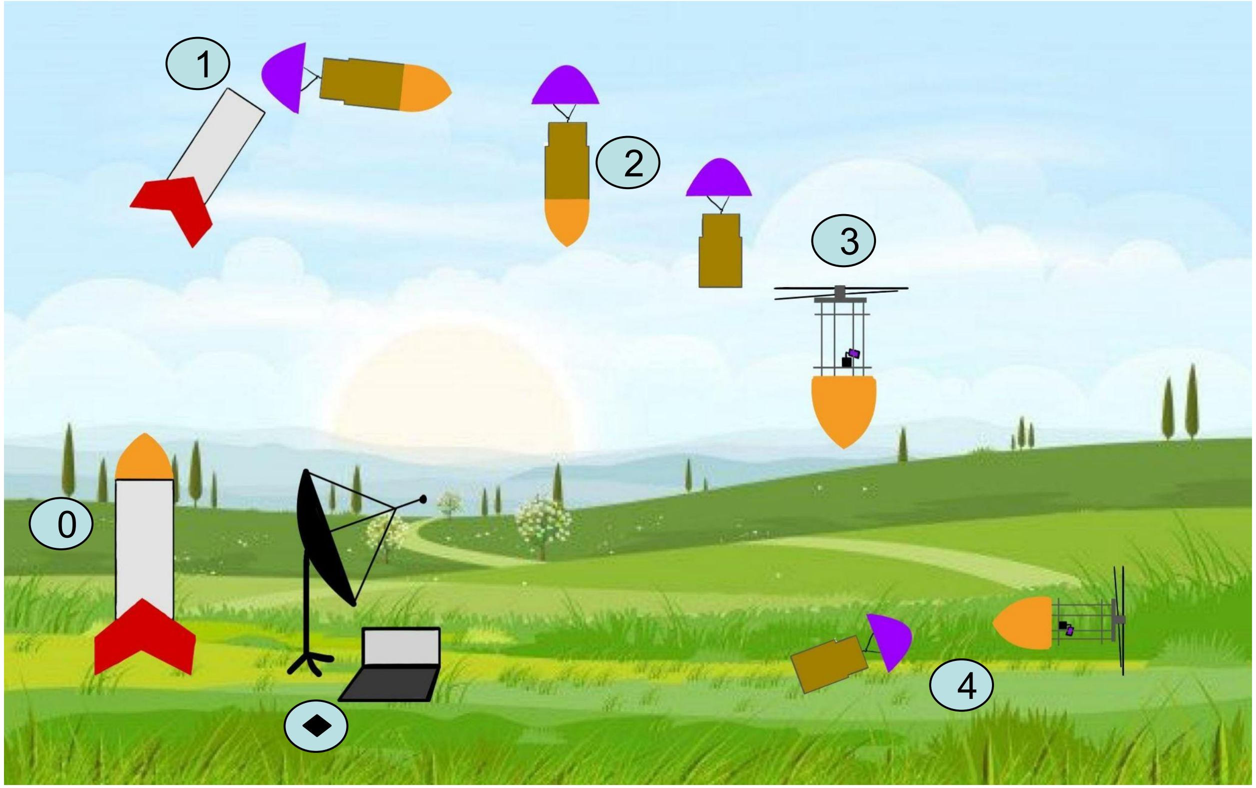
Parts:
- Fishing line
- Auto-Gyro
- Hexagonal Parachute

Nose cone does not separate from payload



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

Descent Control Overview (2/2)



◆
CanSat will communicate with the ground station for entire mission

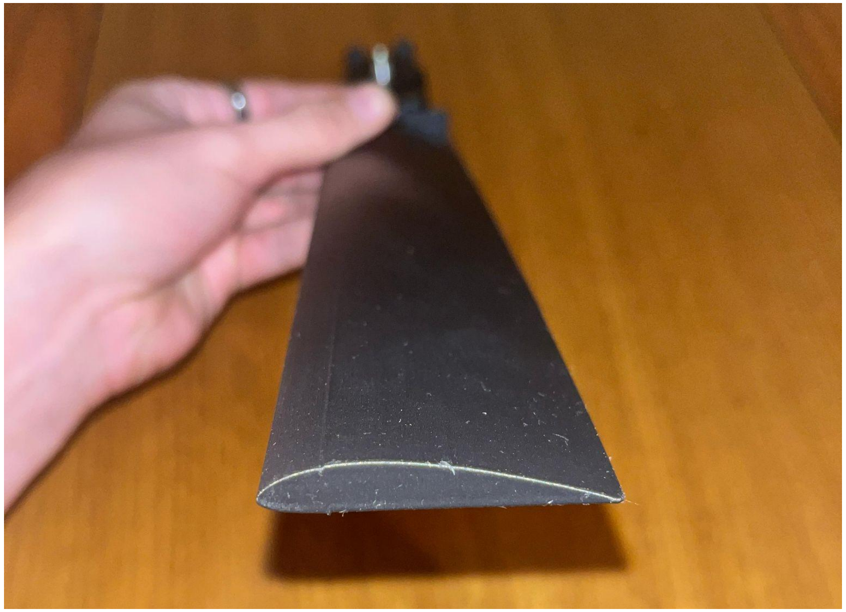
0	1	2	3	4
CanSat is loaded into launch vehicle	CanSat deploys at peak altitude.	Payload with container drops with parachute the first 25% of descent at a speed rate of 20 m/s.	Payload is released from container and autogyro deploys. Descent rate of 5 m/s.	Both payload and container drop to the ground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

Descent Control Changes Since PDR (1/2)

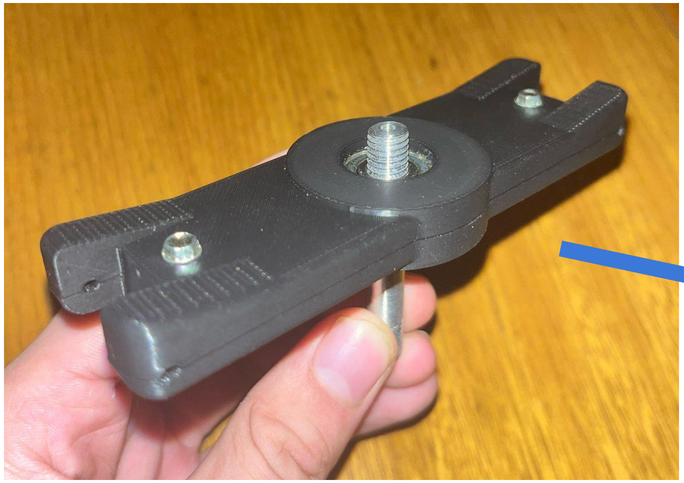
Change	Rationale
Autogyro will have one shaft instead of two coaxial shafts	Easier to manufacture and to assemble.
Blades stoppers were made wider and thicker	To make them more robust
Rotor’s diameter was reduced by 5 mm	To fit comfortably inside the container
Descent rates have been recalculated	Rotor dimensions were changed
Rotors were redesigned to fit a bearing inside	A way to encase the rotor bearing was needed
Autogyro blades were widened	For better stability and robustness

Descent Control Changes Since PDR (2/2)

Autogyro shaft



Autogyro blades

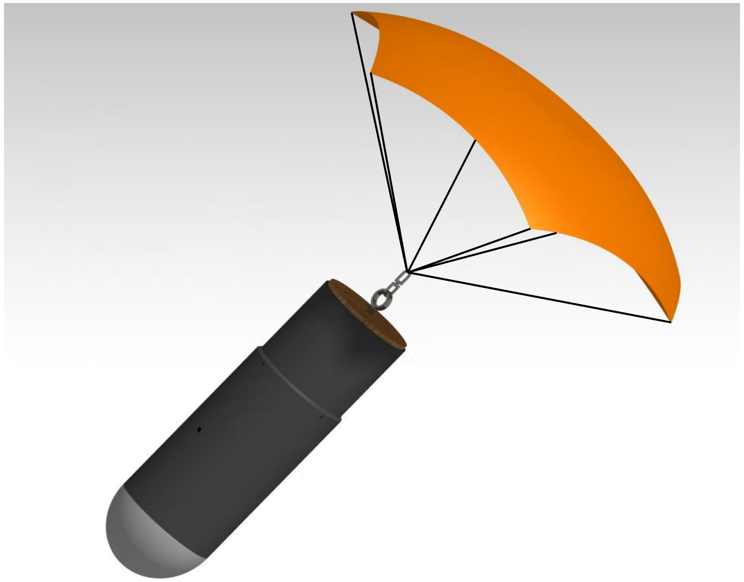


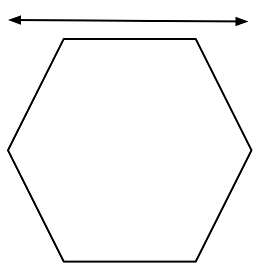
Rotor

Bearing inside rotor

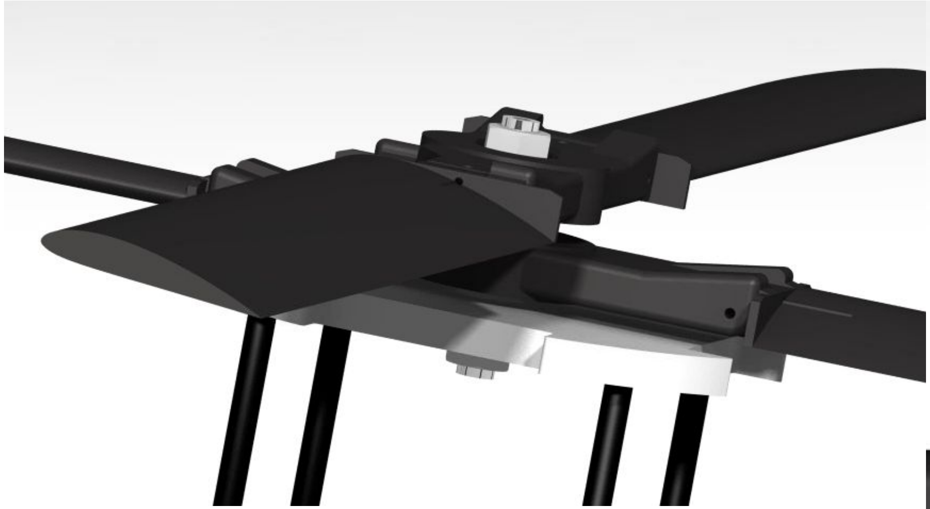
Parachute design characteristics

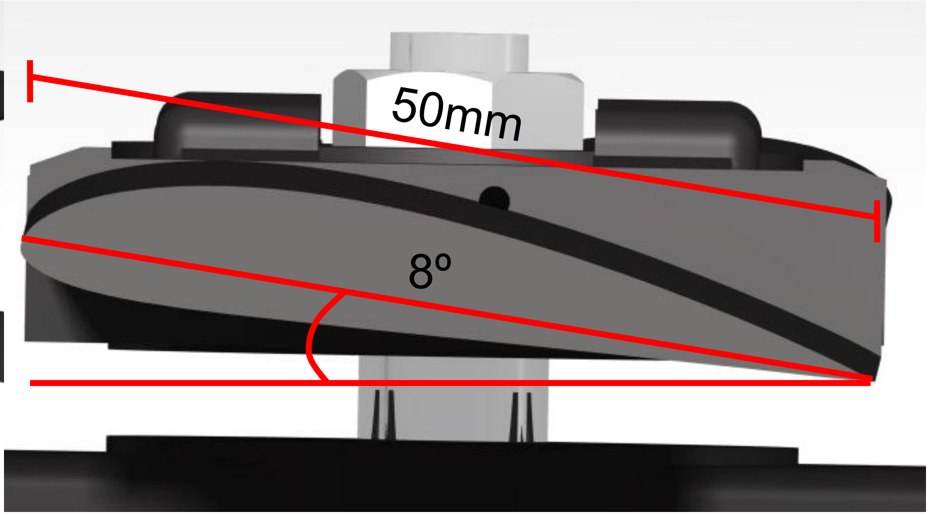
Decisions	Rationale
Hexagonal shape	- Reduces oscillation during freefall - Lightweight & compact - Easy to manufacture
Diameter of 0,37 m	To comply with the required descent rate, according to calculations
Bright orange	Easily recognizable in long distances
Use of a swivel link	To avoid entanglement
Fishing line	To attach the parachute to the container
Passive nadir stabilisation	Enough to guarantee a stable descent





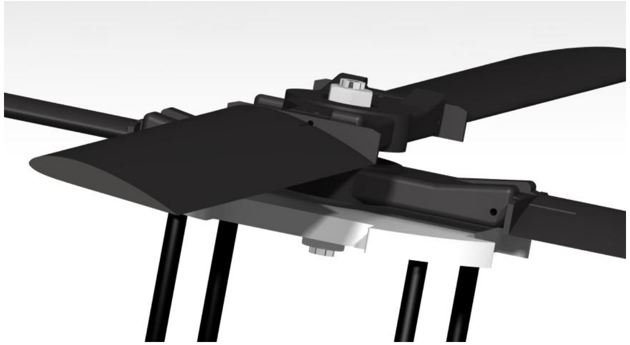
Autogyro design characteristics





- Two counter rotating rotors with 2 blades each
- Airfoil used is a NACA 4415
- Airfoil´s chord is 50mm
- Blade length is 280mm with a rotor´s diameter of 115mm
- Angle of attack is 8º
- The expected rotation rate is 49,38 rad/s

Rotation rate calculation



- Blade length: L = 280 mm.
- Rotor´s radius: $R_R = 57{,}5mm$.
- Blades per floor: 2
- Weight to support: approximately 1kg
- Airfoil: NACA 4415
  - C_d (Drag Coefficient) = 1.1
- Angle of attack 8°
- Airfoil's chord: 50 mm
- $\rho\ (air\ density) = 1.225\ \frac{kg}{m^3}$

For an autogyro in free fall state, force equilibrium at stationary state is expressed by:

$$W = D$$

Where:

- W being the weight of the autogyro.
- D is the aerodynamic drag force.

Drag force is expressed by the equation:

$$D = \frac{1}{2}\, C_d\, \rho\, A\, V^2$$

Where:

- C_d is the drag coefficient.
- ρ is the value for air density.
- A is the area of the rotor´s disk, that considering that the rotor doesn't produce lift, is: $A = 2\,\pi\,(r_e^2 - r_i^2)$
  - $r_e = L +$
- V is terminal velocity.

Equalizing both equations, and clearing terminal velocity:

$$V = \sqrt{\frac{W}{C_d\,\rho\,\pi[(L + R_R)^2 - R_R^2]}}$$

Advance ratio is defined by the formula:

$$\mu = \frac{V}{\omega\,(L + R_R)}$$

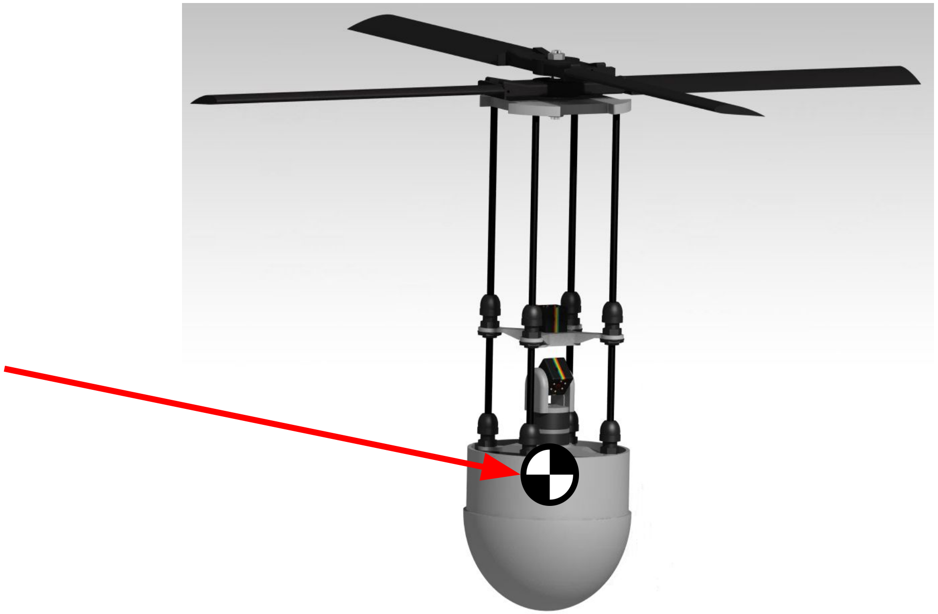
- Average advance ratio $\mu = 0.3$.

Thus $\boldsymbol{\omega} = \mathbf{49.38}\frac{\boldsymbol{rad}}{\boldsymbol{s}}$, equal to 471 RPM.

Auto-gyro Descent Stability Control Design

- CanSat is kept stable using the passive mechanism of lowering the center of mass
- Rotation is kept controlled using the counter torques of the blades
- The center of mass is lower than the center of pressure to maintain Nadir direction

Approximated center of mass



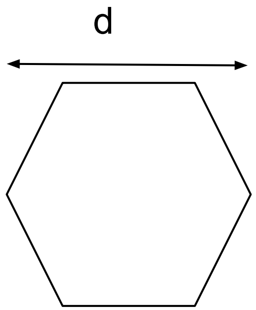
Descent Rate Estimates (1/3)

Assumptions

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

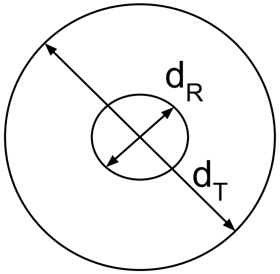
Container parachute

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



Auto-gyro

- $m_2 = 1$ kg
- $\rho_2 = 1{,}17\ kg/m^3$ (at 500 m)
- $A_2 = 2\pi(d_T^2 - d_R^2)/4$ (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

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

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

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

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

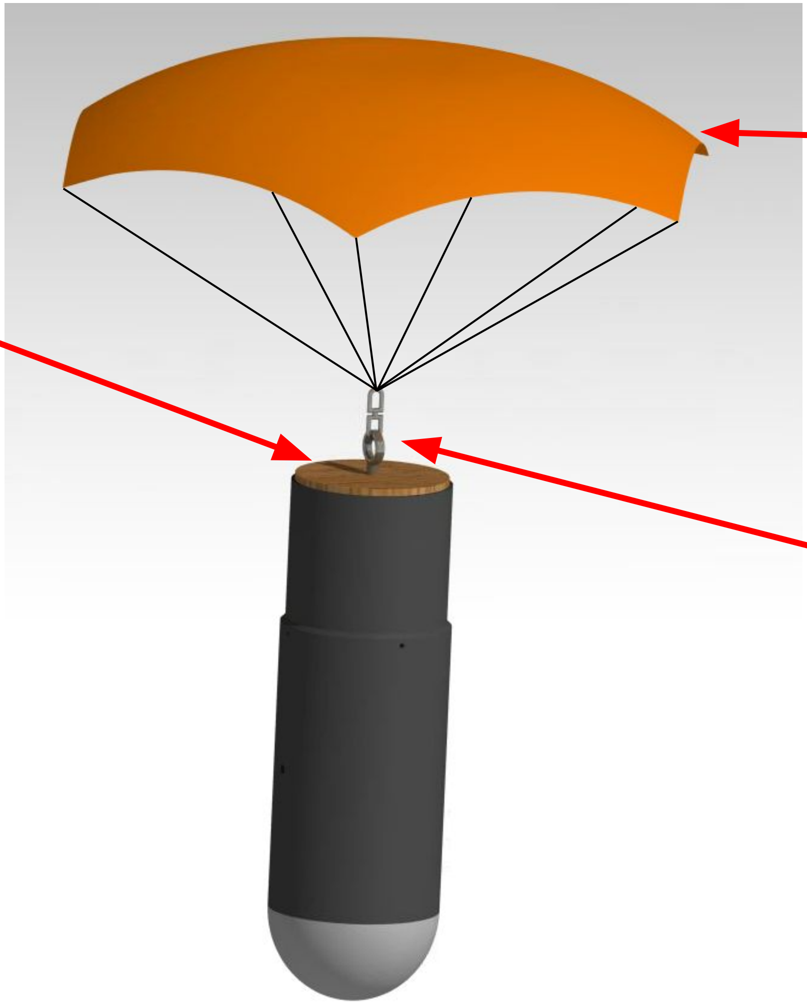
Descent Rate Estimates (3/3)

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 = 285,97 mm** We choose L = 280 mm so it can fit within payload's maximum height, and still being in the target range **v = 4,68 m/s**

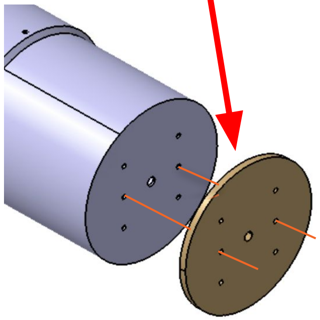
Mechanical Subsystem Design

Daniela Maradei
Federico Pilotto
Ezequiel Bolzicco
Agustin Martinez

Container fitted



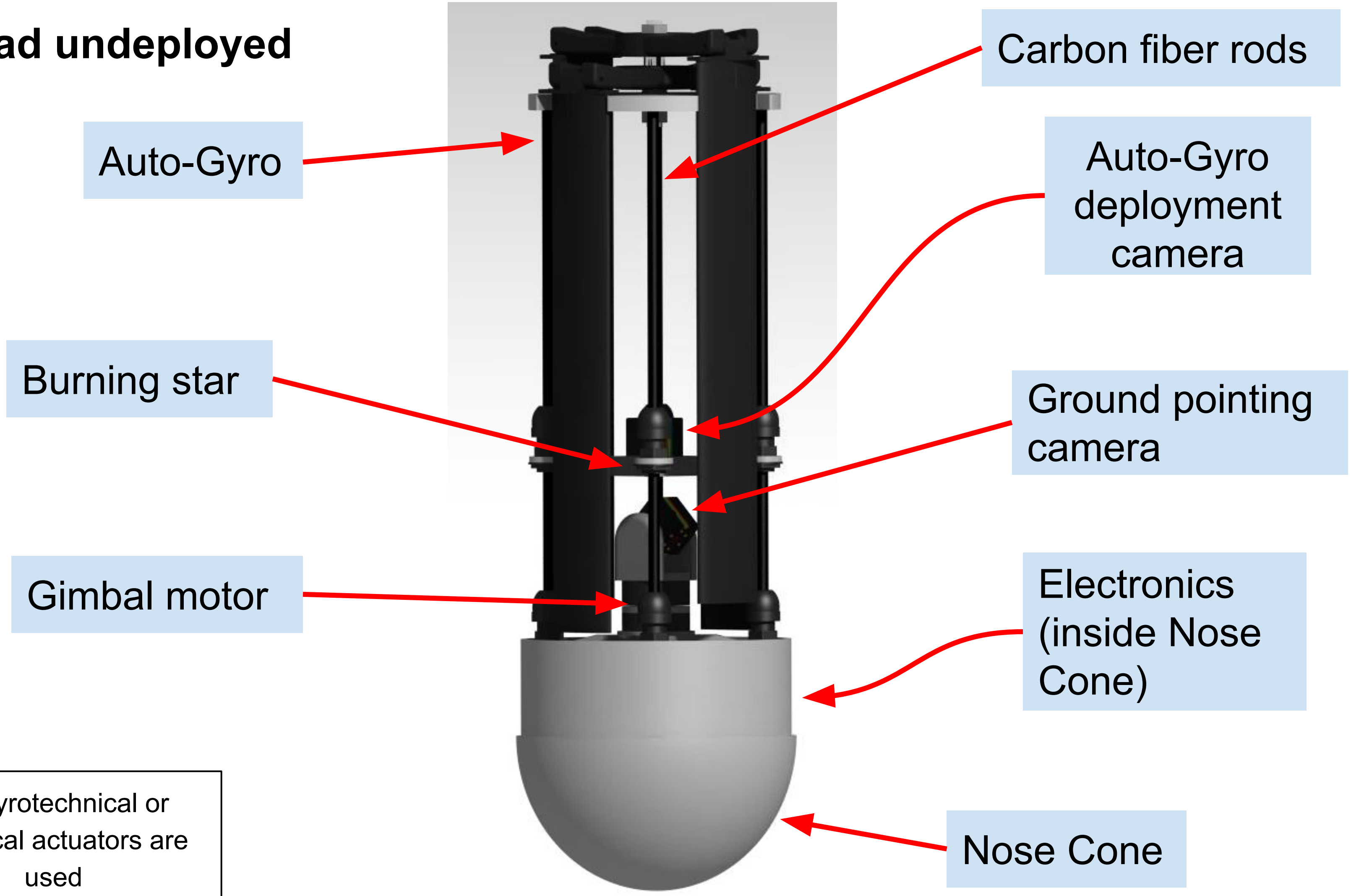
Extra holes to tie payload to container



No pyrotechnical or chemical actuators are used

Mechanical Subsystem Overview (2/3)

Payload undeployed



No pyrotechnical or chemical actuators are used

Mechanical Subsystem Overview (3/3)

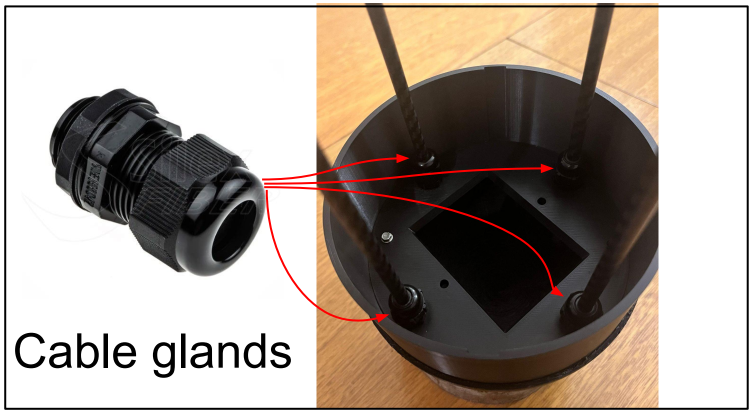
Materials

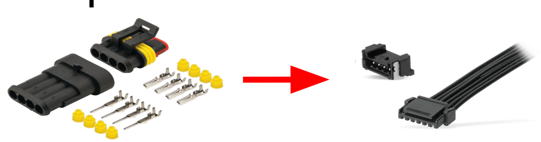
Part	Material
Container	ABS
Eyebolt support disk	Wood
Structural rods	Carbon fiber
Auto-Gyro blades and rotors	ABS
Auto-gyro shaft	Aluminum
Components floor, Burning star, Camera bracket, Nosecone	ABS
Parachute	Nylon

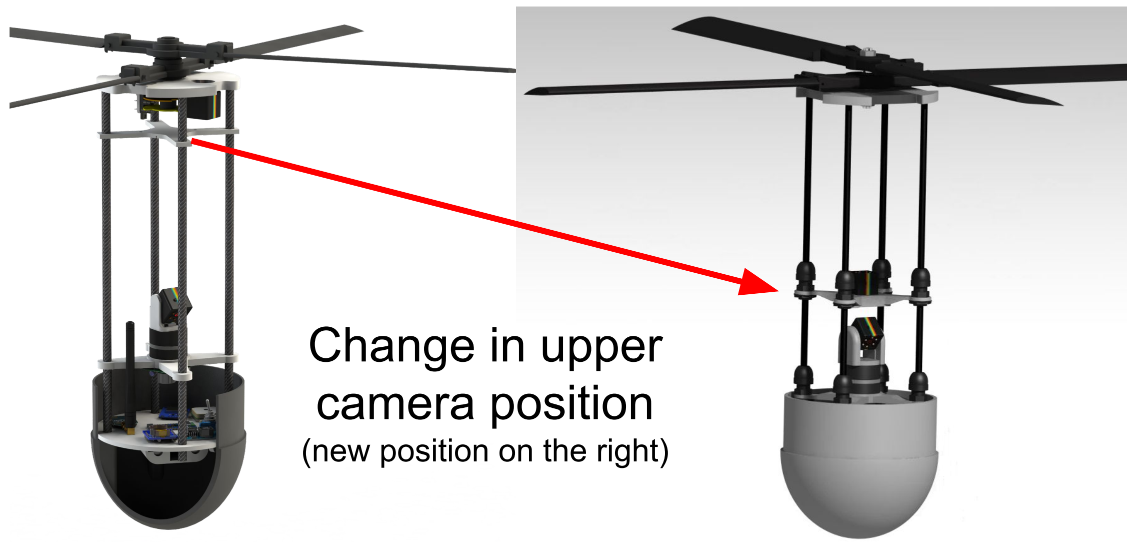
Mechanical Subsystem Changes Since PDR (1/2)

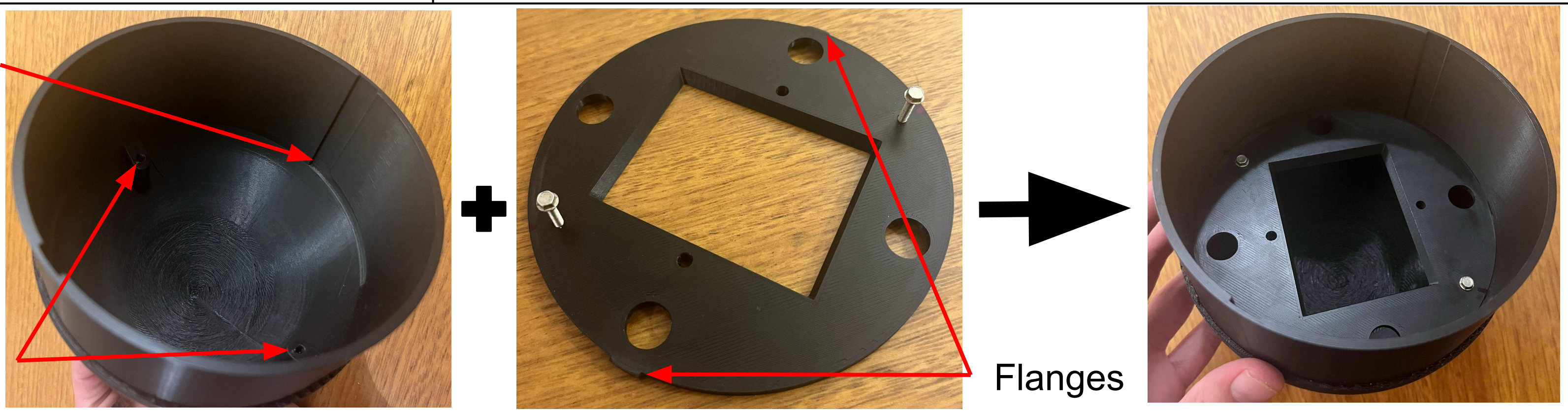
Change	Rationale
Micro-Lock Connectors will be used instead of Superseal Connectors	Smaller size and lower weight than the Superseal connectors and still AEC-Q100 qualified
Screws replaced by cable glands for floor positioning	Easier and faster to assemble
Upper camera moved downwards	Better field of view and overall lower center of mass
Upper camera now is attached to the burning star floor	Better field of view and overall lower center of mass
Nose Cone is now fitted to the lower flor via a slide and lock mechanism and two small screws	Easier and faster assemble

Mechanical Subsystem Changes Since PDR (2/2)



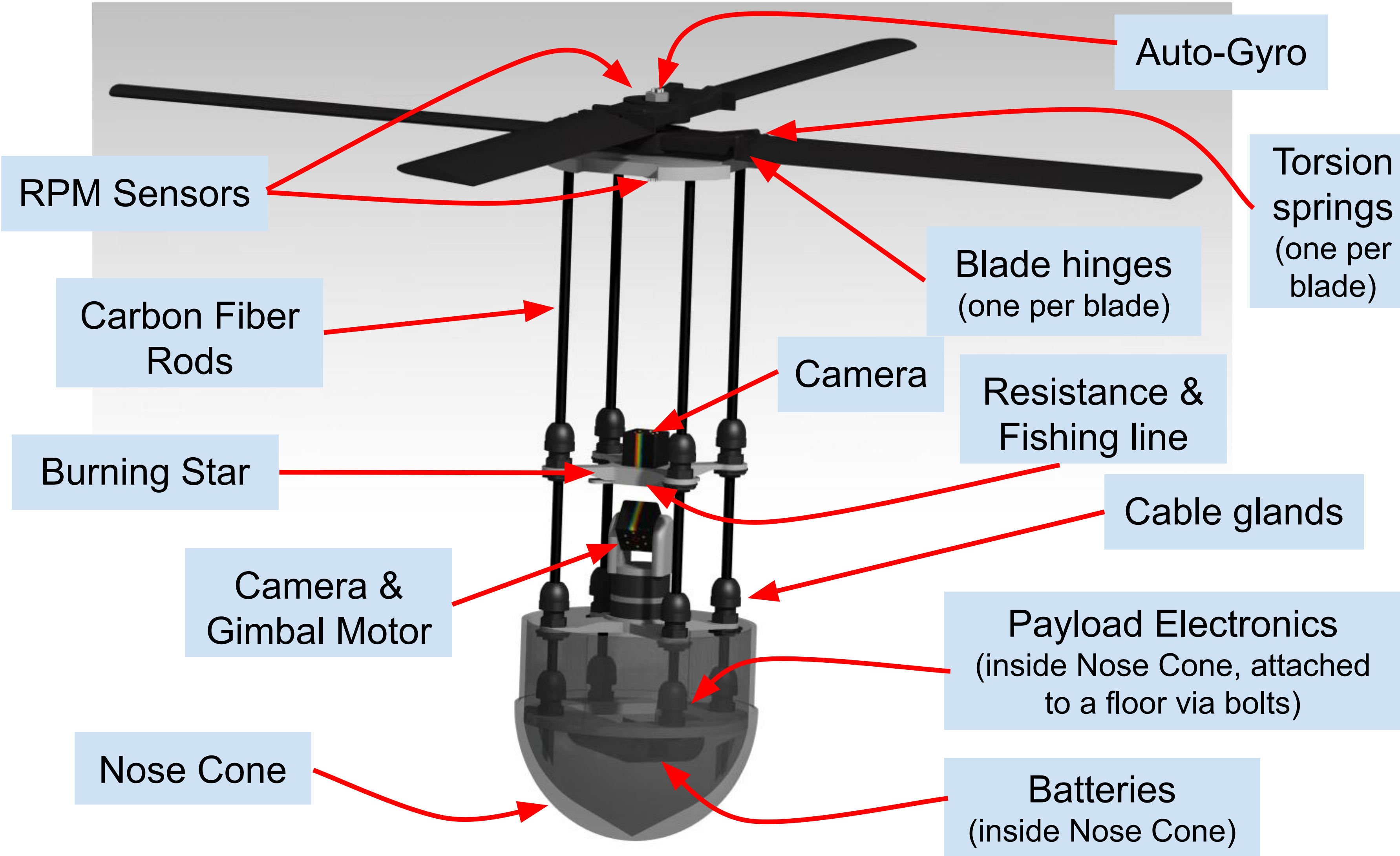






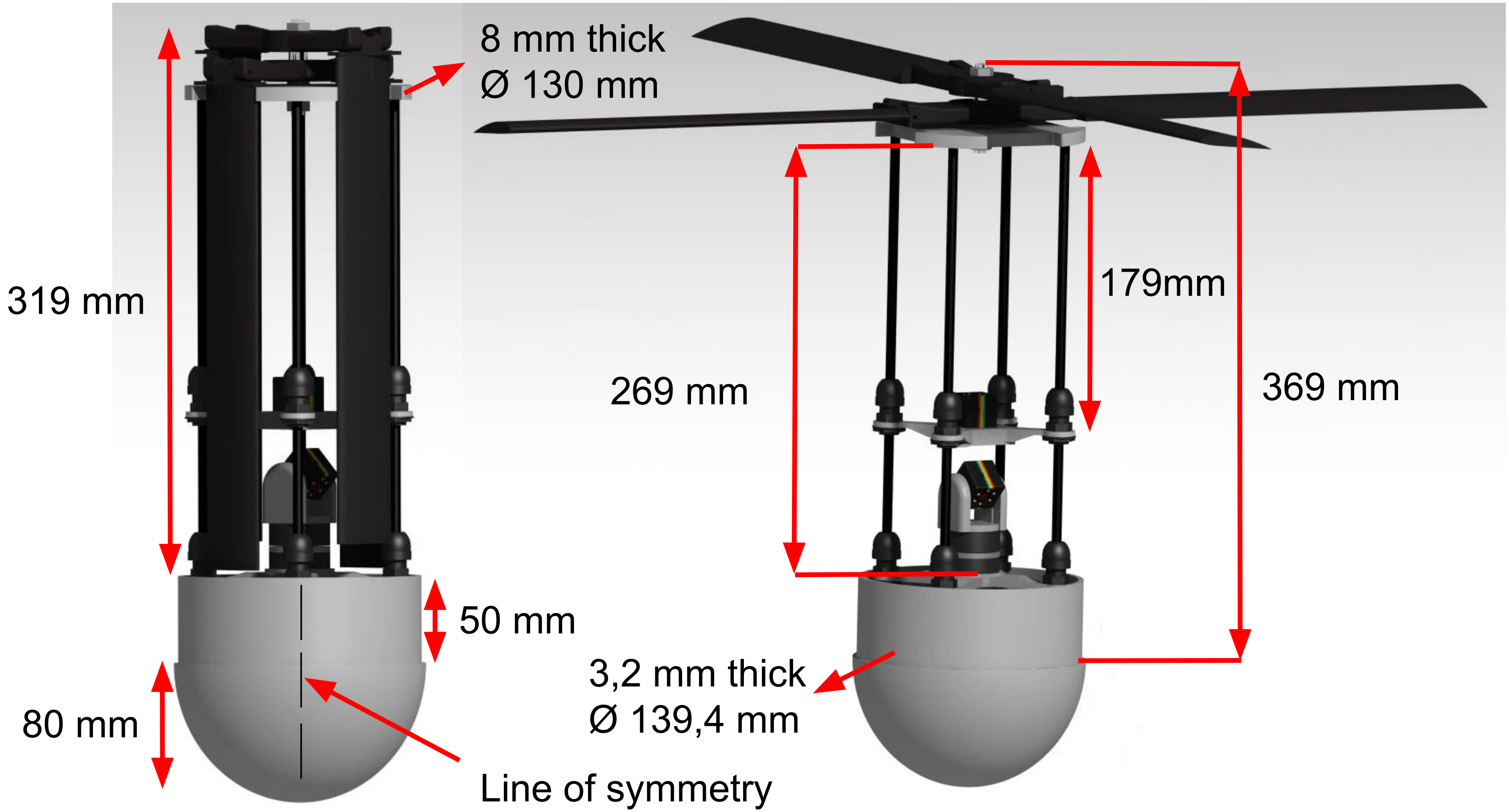
Slide & Lock mechanism for Nose Cone

Cansat Mechanical Layout of Components (1/4)



Cansat Mechanical Layout of Components (2/4)

Payload dimensions

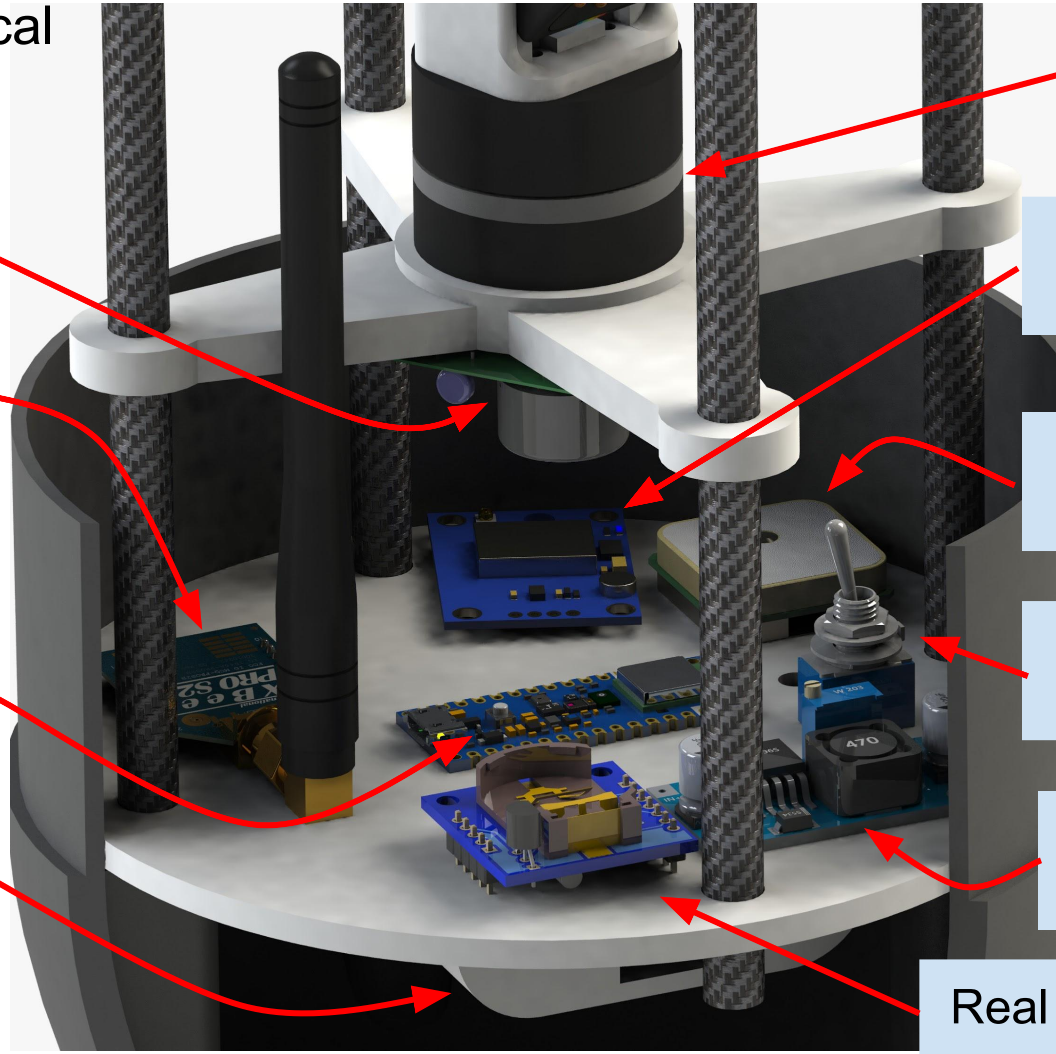


Cansat Mechanical Layout of Components (3/4)

Structural materials

Part	Material
Structural rods	Carbon fiber
Auto-Gyro blades and rotors	ABS
Auto-gyro shaft	Aluminum
Components floor, Burning star, Camera bracket, Nosecone	ABS

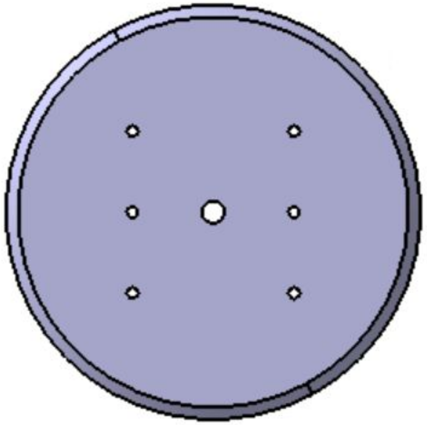
Location of electrical components



Notes:

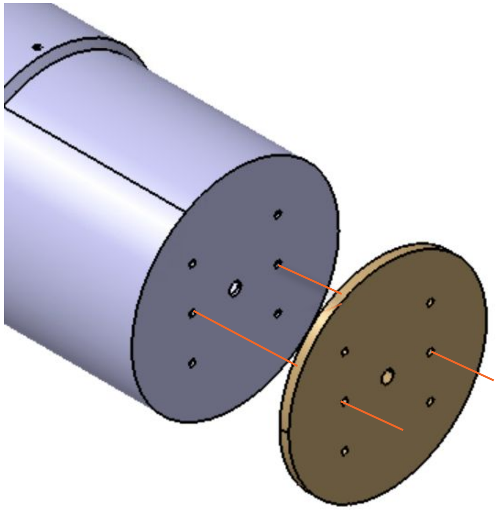
1. These images are for illustrative purposes only and do not reflect the final appearance of the electronic components, only their placement and distribution.

Container Design (1/3)

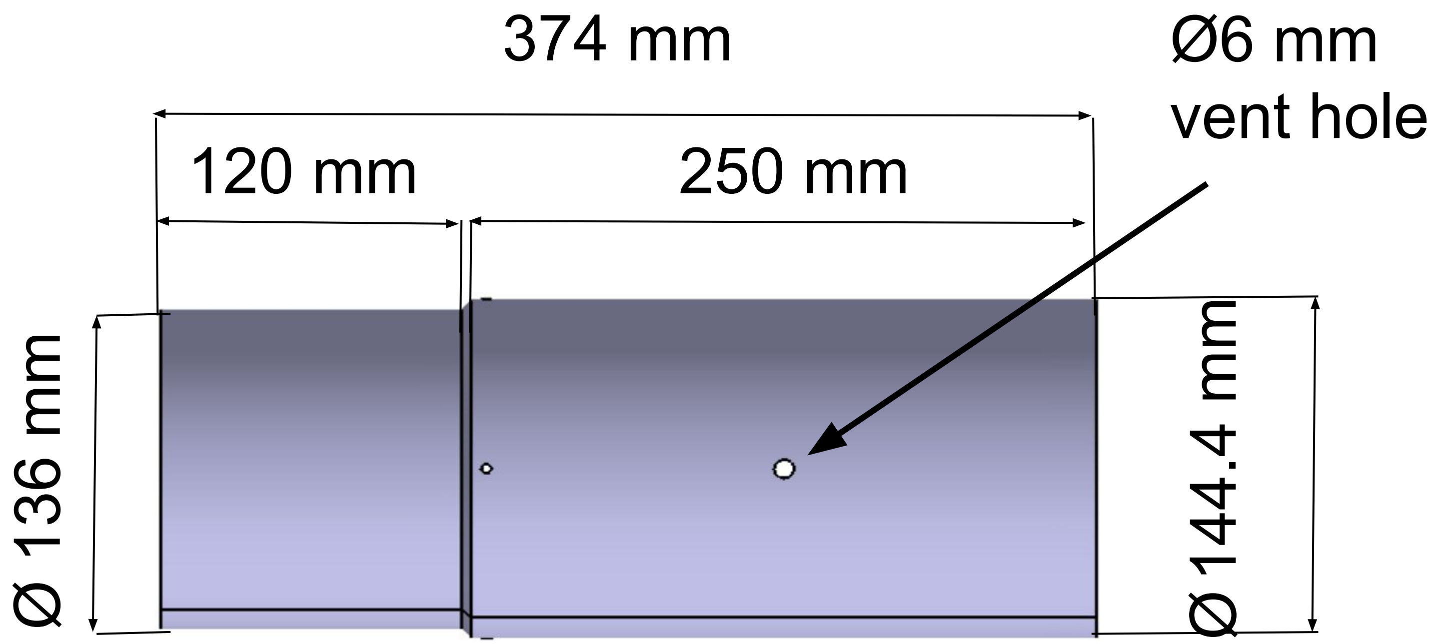


The container and wood disk have 2 extra holes to pass a fishing line through them and tie the payload to the container

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)



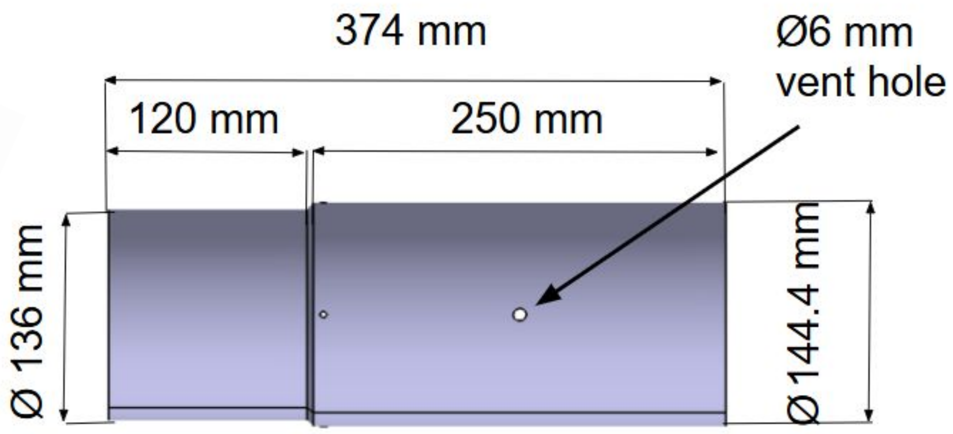
Container Design (2/3)



Wall thickness is 2mm through the whole container

Container Design (3/3)

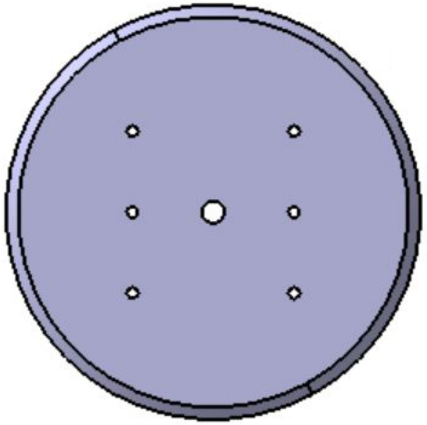
Dimensions will be carefully measured using highly precise tools to ensure a proper fit in the launch vehicle

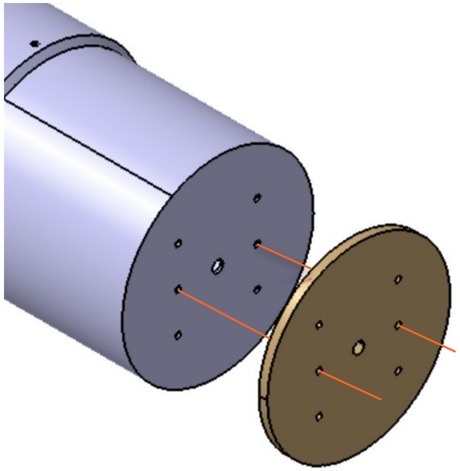


Wall thickness is 2mm through the whole container

Payload Pre-Deployment Configuration (1/2)

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

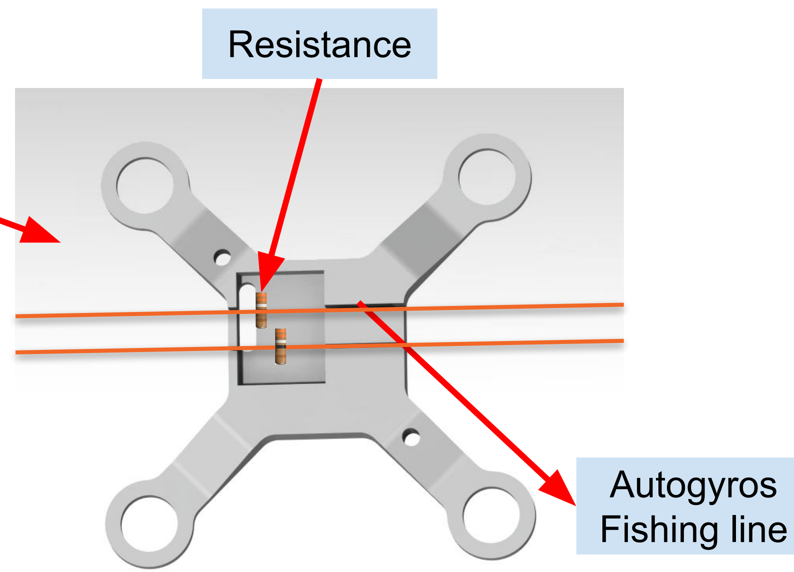




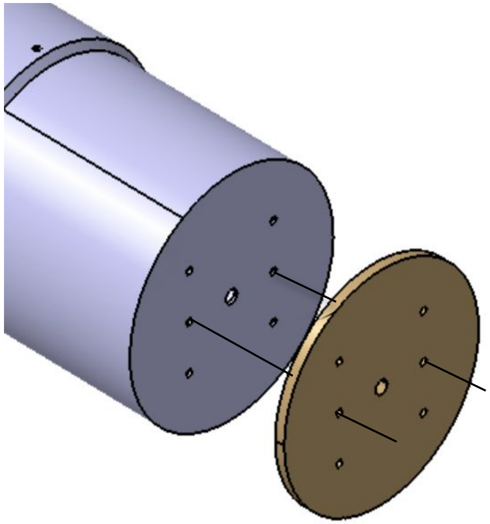
Payload Pre-Deployment Configuration (2/2)

Payload is kept in stowed configuration with a fishing line. When the payload is released from the container, this fishing line is burned with a resistance, deploying the autogyro

Stowed Configuration



Payload Release (1/2)



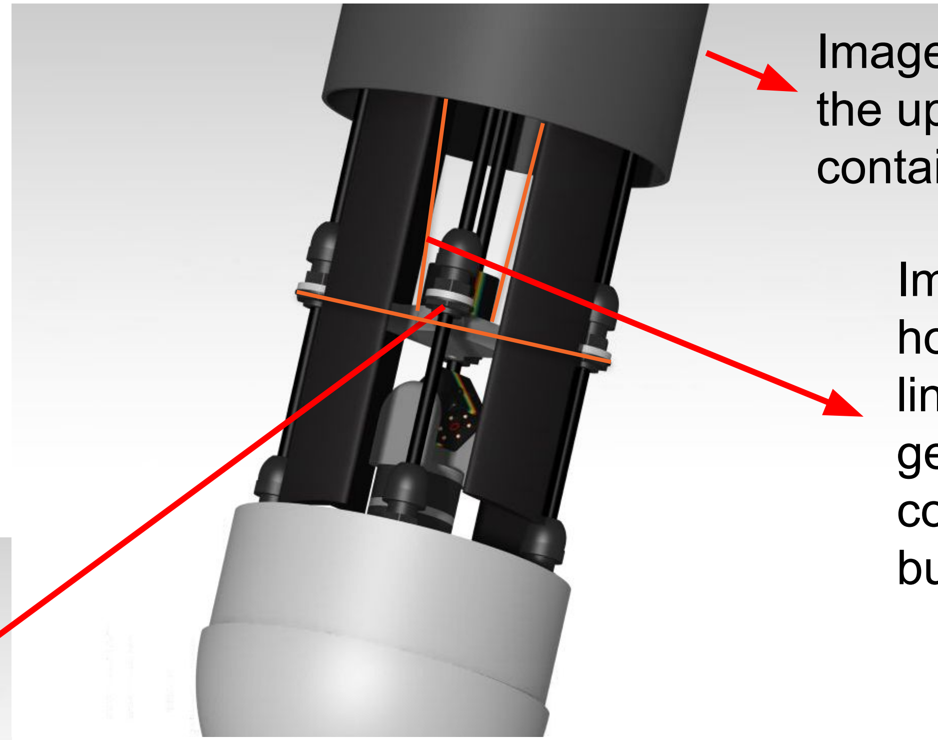
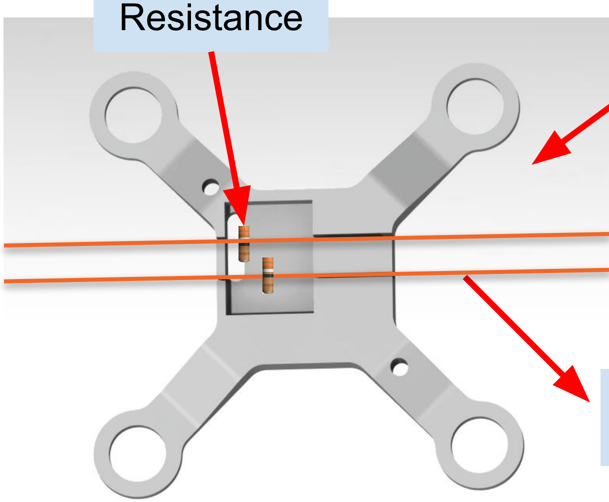


Image shows only the upper part of the container

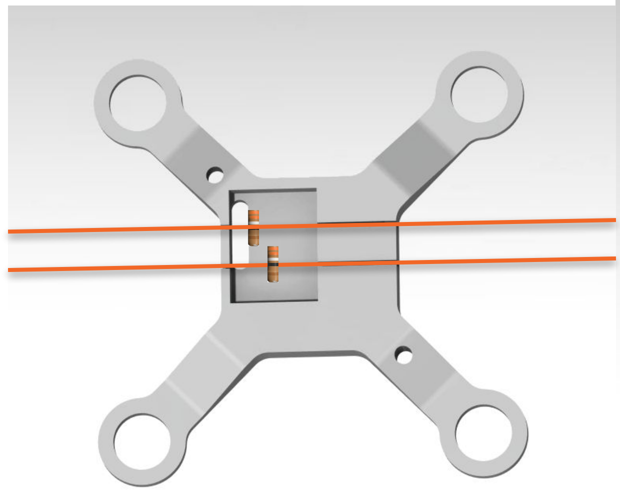
Image shows how the fishing line (orange) gets from the container to the burning star



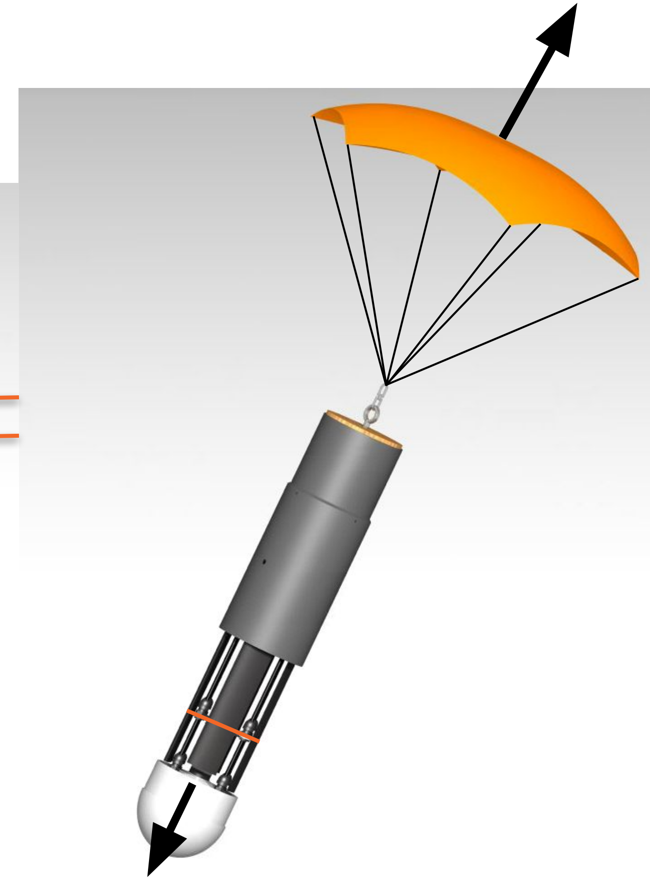
The base of the design, is to make the fishing line the only part attaching the payload from the container

Sequence of operation for release

Payload and container are held together by a fishing line



When CanSat reaches 75% of peak altitude, the burning star is triggered and the fishing line is burned



Payload separates from container

Payload Deployment Configuration

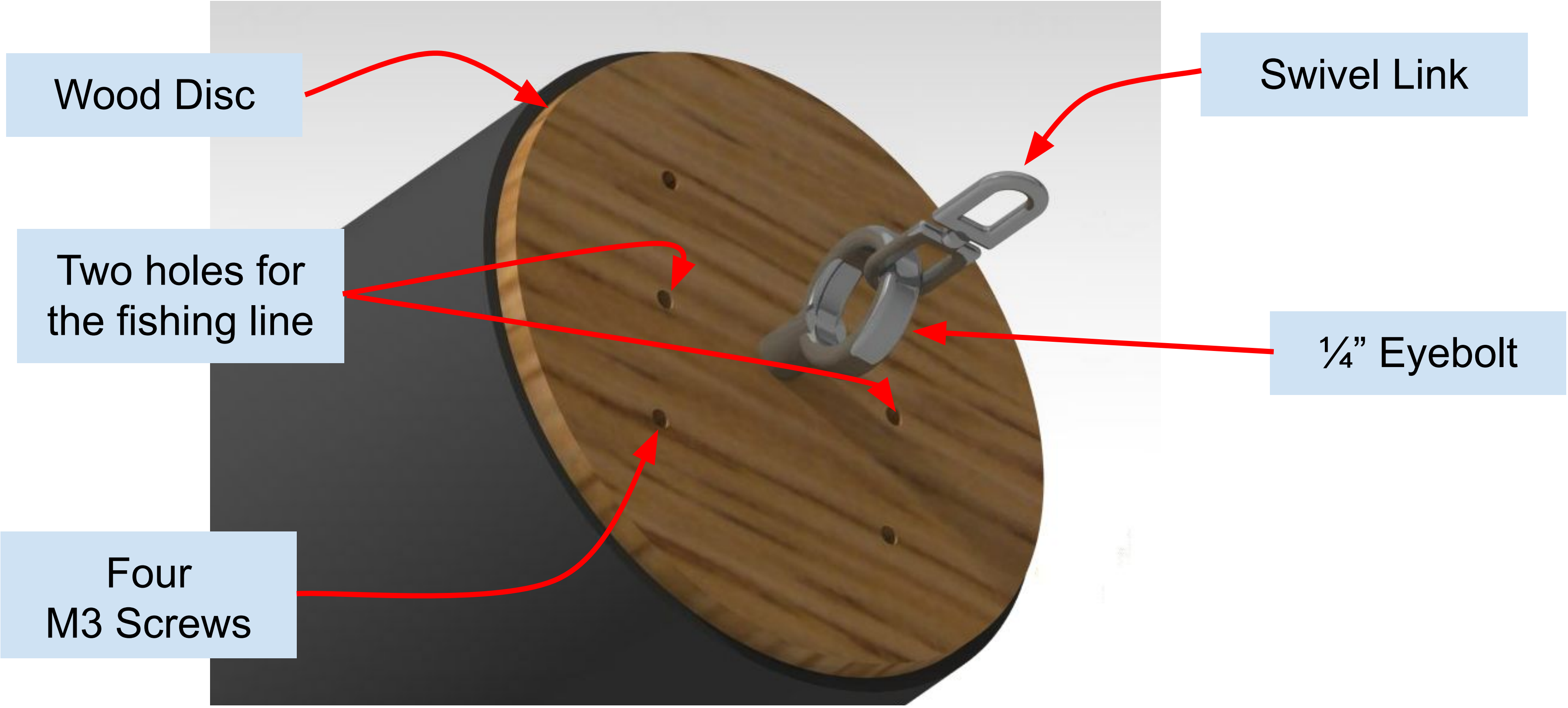
There's no change in payload structure besides the opening of the autogyro.

Stowed Configuration

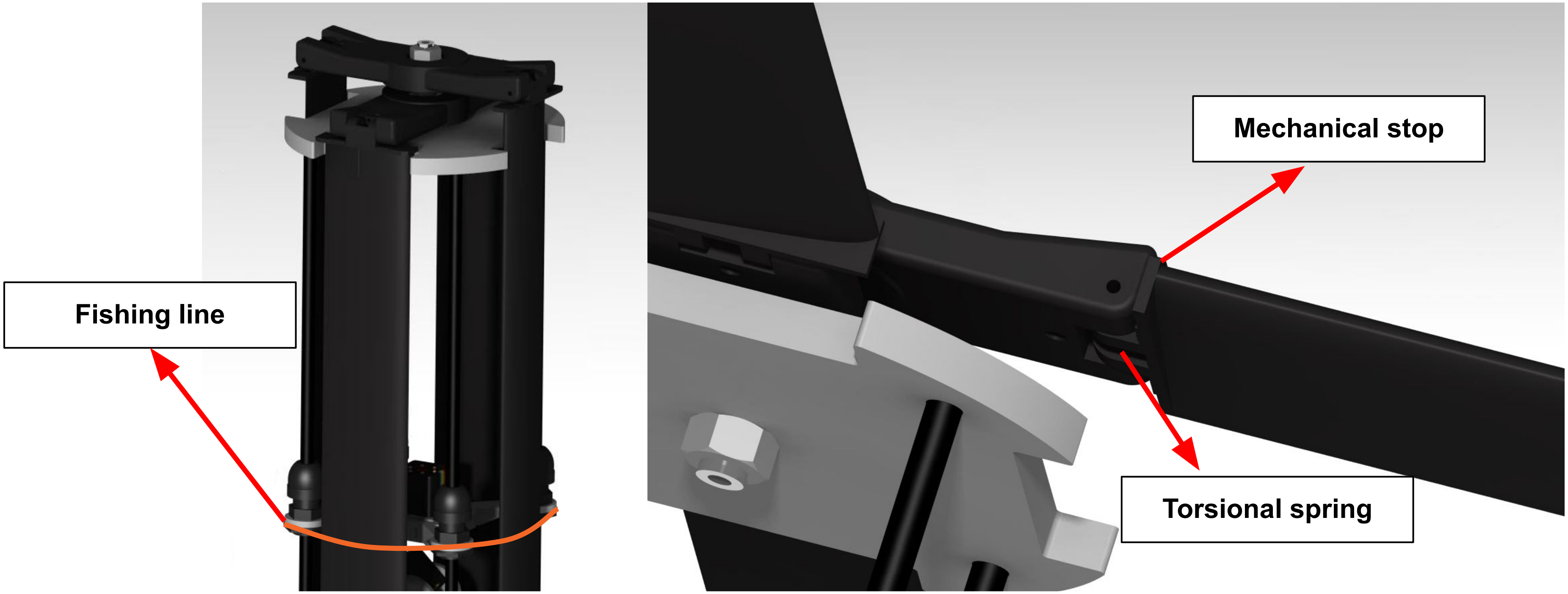
Deployed Configuration

Parachute Attachment to 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.



Auto-gyro deployment (1/2)



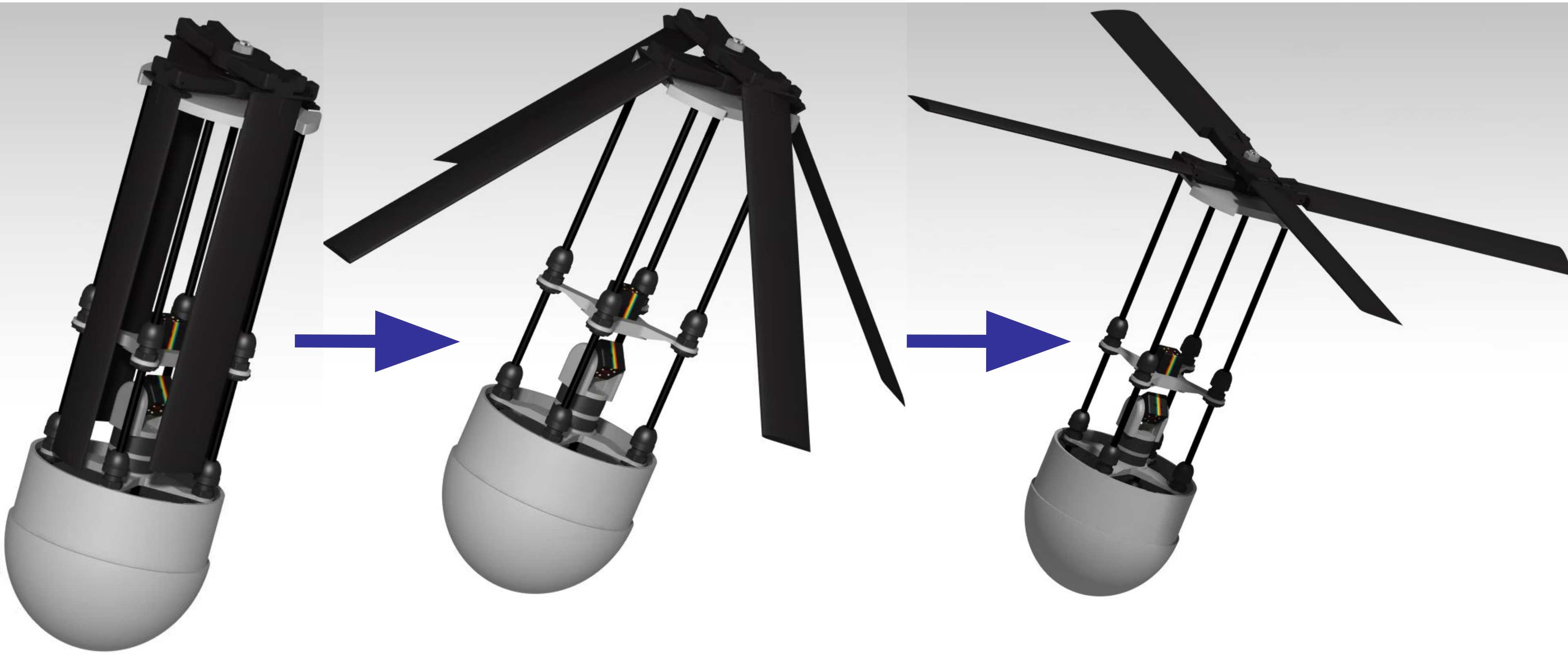
The deployment of the auto-gyro consists of 3 stages:

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

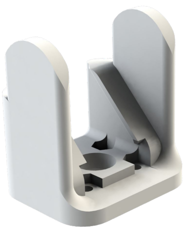
2. Free to open, the blades with the help of the springs unfold

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

Deployment demonstration

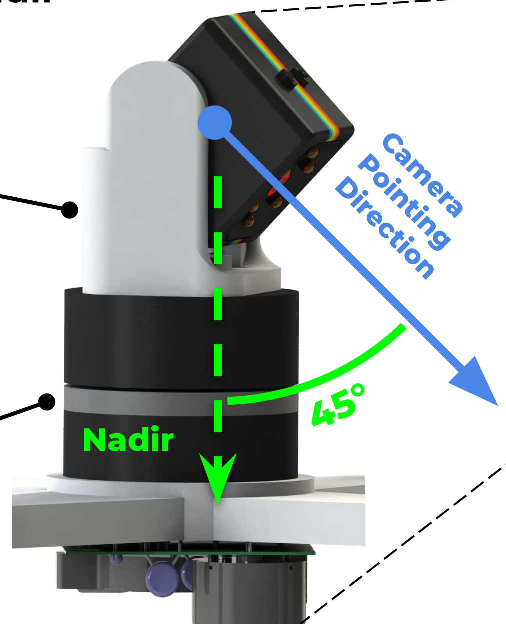


Ground Camera Pointing (1/5)



Passive (Fixed) 45° Nadir Camera Holder

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

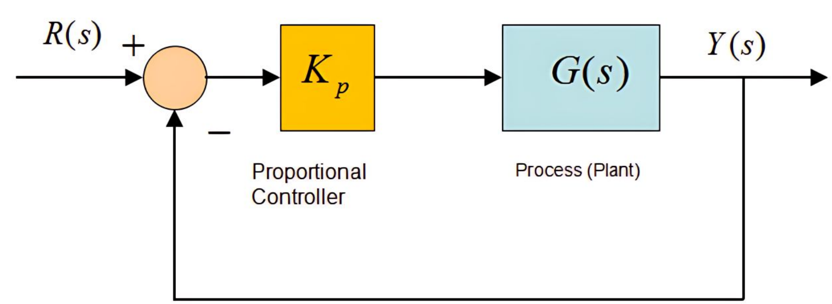


GM2804 Gimbal Motor with Encoder

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

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

Algorithm Used: **PI Controller**



Ground Camera Pointing (2/5)

Control System Design Using the North Centralized Coordinate System (NCCS)

The CANSAT orientation is described using a **North Centralized Coordinate System (NCCS)**. The system follows a clockwise-positive convention for angular measurements, where:

- **North = 0°**
- **West = 90°**
- **South = 180°**
- **East = 270°**

Idea and Motivation
Initial conditions: **Prior to Launch,** the camera orientation and CANSAT orientation are set to be equal.

The **objective** is to implement a negative feedback loop that continuously adjusts the Payload Ground Camera's orientation to maintain a steady northward view.

- The system receives the CANSAT's current orientation (in NCCS format) from the BMM150 magnetometer.
- A Magnetic Rotary Encoder (NAME) measures the gimbal motor's angular position.
- The control system adjusts the gimbal motor to rotate in counterclockwise direction such that its final orientation, with respect to the CANSAT orientation, is the negative orientation of the CANSAT in NCCS, therefore, ensuring that the ground camera remains fixed towards North (0°).

This approach is fundamentally based on the explicit use of the **North Centralized Coordinate System (NCCS)** to maintain precise orientation control.

Ground Camera Pointing (3/5)

Let **CS, PGC** be the orientations of the **C**AN**S**AT and **P**ayload **G**round **C**amera in NCCS.

Initially **PGC =** A° & **CS =** B°

Let **PGC’** be the camera orientation with respect to the CANSAT orientation (clockwise positive).

Initially **PGC’ = PGC - CS = (**A - B)° **(1)**

The Control System objective is to ensure that the relative orientation of the Payload Ground Camera with respect to the Payload orientation **(PGC’)** is set to be the negative CANSAT orientation value in NCSS.

That is, ensure that at any given moment:

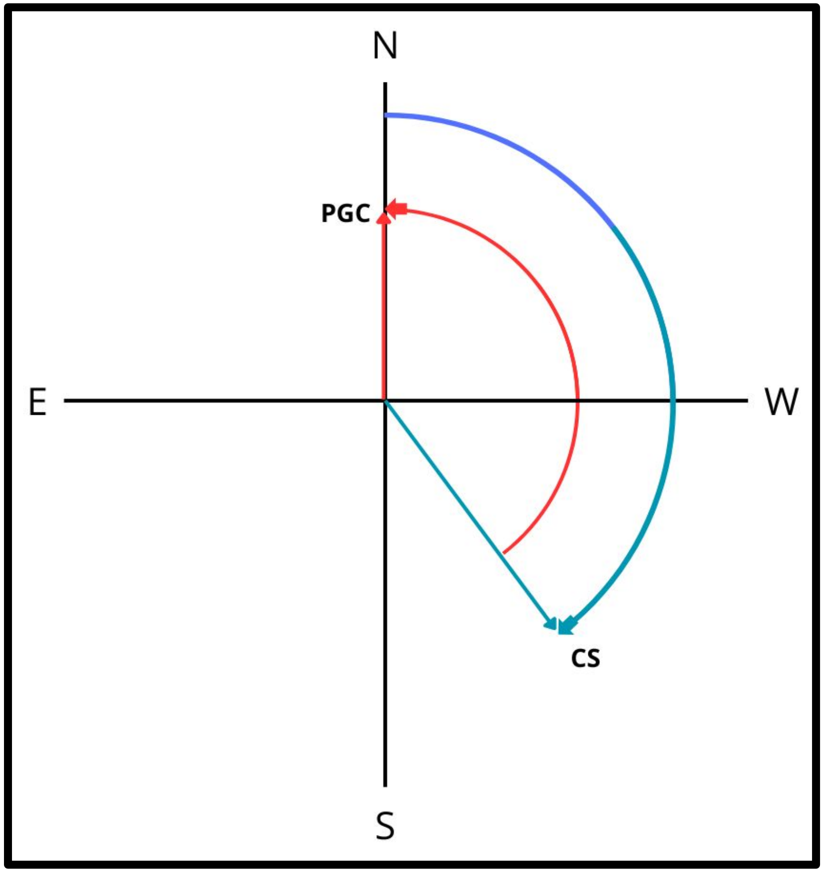
PGC’ = -B°

Taking into account **(1):**

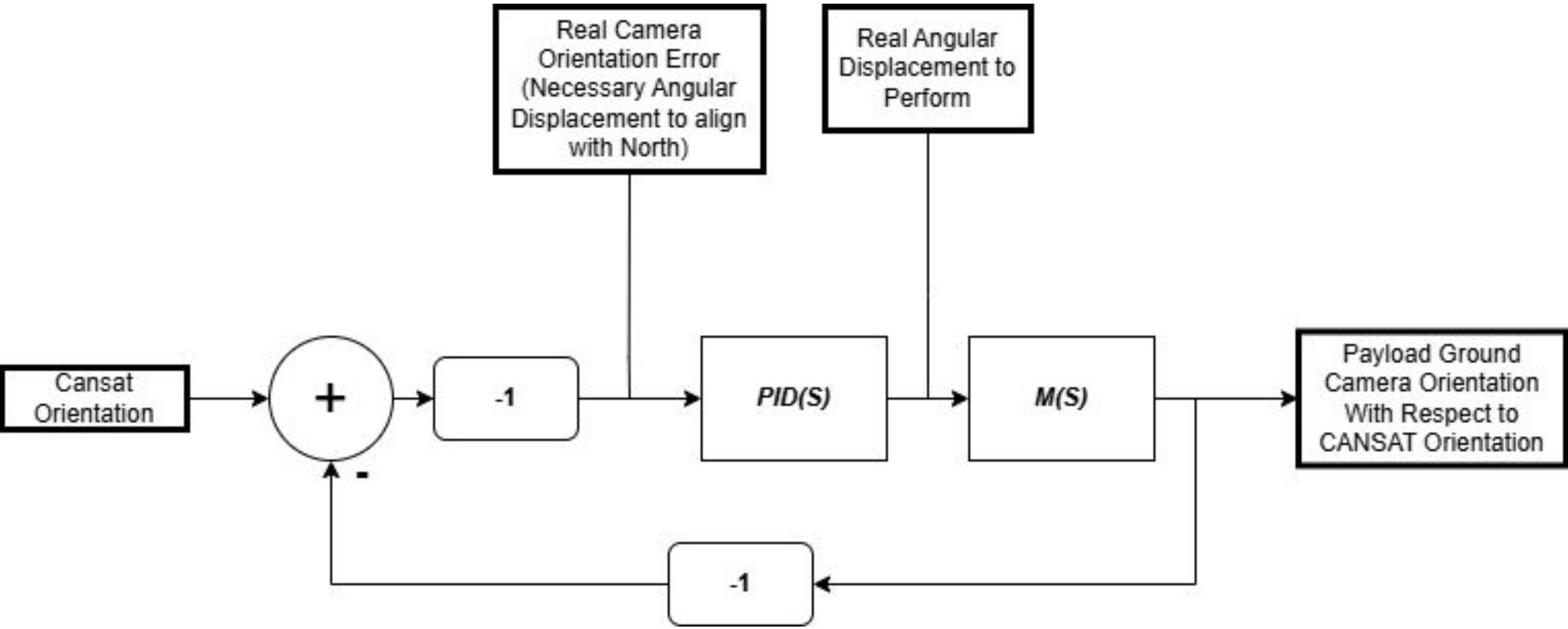
PGC’ = PGC - CS

-B° = **PGC -** B°

If and only if: **PGC =** 0°

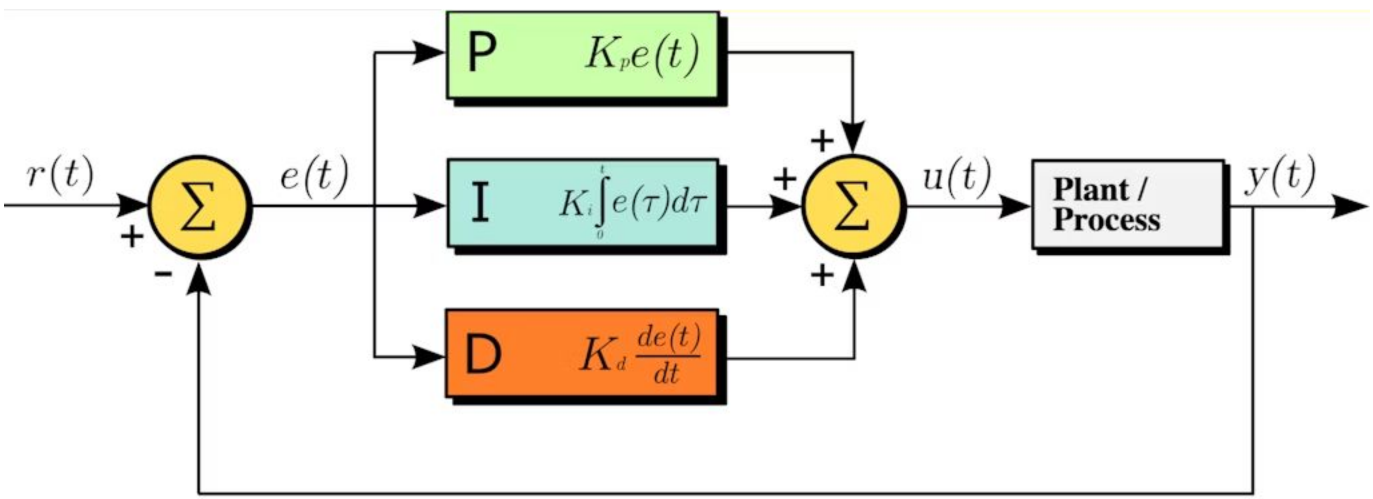


Payload Ground Camera Orientation Sensor (4/5)



Ground Camera Pointing (5/5)

PID Controller: The application of a PID controller is a reasonable control option for the gimbal motor given the dynamic environment. The PID approach offers potential benefits by delivering adaptive corrections to counteract the unpredictable motion inherent in free fall, utilizing orientation errors to guide motor adjustments against base tumbling or aerodynamic influences. It is also theoretically capable of addressing cumulative deviations that might emerge from sustained disturbances, such as turbulence, while moderating rapid shifts to limit oscillations in the gimbal's response. Compared to simpler control strategies, which may struggle with the erratic conditions of descent, the PID's combined corrective mechanisms suggest a promising framework for achieving stable orientation. However, its suitability remains provisional; further testing is required to validate its effectiveness under the specific physical constraints and variability of this scenario, ensuring it meets the system's precision and reliability demands.



Structure Survivability (1/4)

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.

Structure Survivability (2/4)

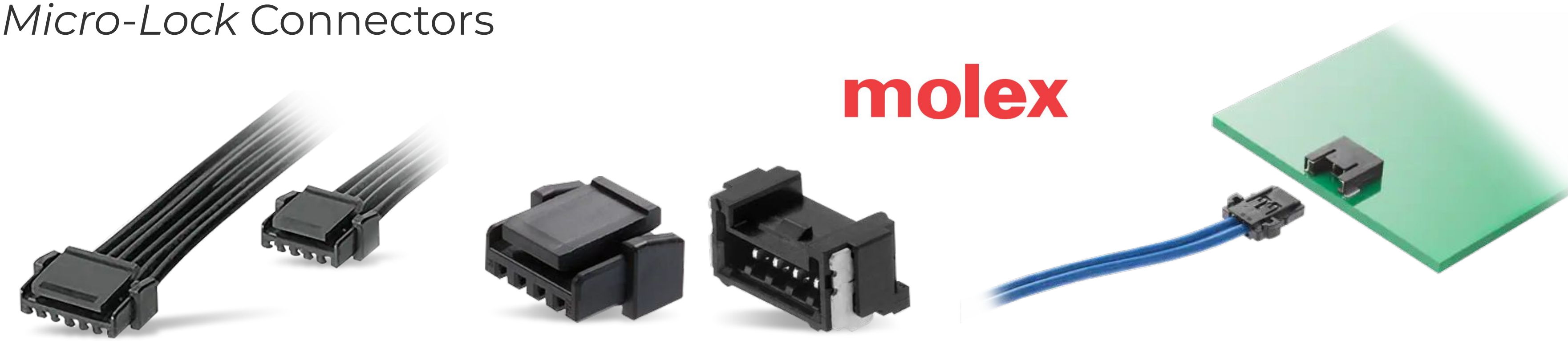
Electronic component enclosures

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
Micro-Lock Connectors	• All electrical connections (power, digital, sensor, etc) will use *Micro-Lock* connectors • These are high-performance small-sized connectors used in the automotive industry. • Comes with a strong connection lock and a reliable metal contact to prevent any kind of inconvenient with the connection and signal integrity. AEC-Q100 certified

Micro-Lock Connectors



Structure Survivability (4/4)

Acceleration and shock force requirements and testing

- Critical structural parts were tested for 15g acceleration and 30g shock with FEA
- Non critical parts were simplified and checked with hand calculations
- No real world tests have been conducted yet
- CanSat shock survivability will be tested with a 30g drop test

Mass Budget (1/3)

- **Mass of each structural element:**

Component	Mass [g]	Uncertainty [g]	Source
Nose Cone	129	0,5	Measured
Upper floor	40	2	Estimate
First floor	26	0,5	Measured
4x Carbon fibre rods	52	0,5	Measured
Camera motor floor	15	0,75	Estimate
Camera holder	9	0,45	Estimate
2x Rotors with bearings included	60	0,5	Measured
Autogyro shaft	7	0,5	Measured
Burning Star	15	0,75	Estimate
4x Blades	164	0,5	Measured
Container	334	16,7	Estimate
4x Torsional spring	6,5	0,5	Measured
Bolts and nuts	90	0,5	Measured
Cable Gland	54	0,5	Measured
TOTAL STRUCTURE MASS =	**1001,5**	**25,15**	

Mass Budget (2/3)

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

Component	Mass [g]	Uncertainty [g]	Source
Nano 33 BLE Sense R2	5	0,5	Measured
Camera: Quelima SQ11 x 2	23	0,5	Measured
Payload Batteries + Battery holder	125	0,5	Measured
PCB	30	1,5	Estimate
RTC module: DS3231 mini + Battery	6	-	Datasheet
GPS Ublox NEO-6M + Antenna	16	-	Datasheet
XBEE S3B PRO + Radio Antenna	15	0,5	Measured
Cables & Connectors	20	2	Estimate
Mechanical Switch	8	0,5	Measured
Buzzer	7,8	0	Datasheet
Beacon Battery: CR2477 x4	42	-	Datasheet
Step-Down 3.3V Converter MP1584	2	-	Datasheet
Gimbal Motor GM2804 w/ Encoder	55	0,5	Measured
TOTAL HARDWARE MASS =	**354,8**	**6,5**	

Mass Budget (3/3)

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

Total Mass Budget		
System	**Mass[g]**	**Uncertainty [g]**
Structure/Mechanic	1001.5	25.15
Hardware/Electronic	354.8	6.5
Total Mass = 1356.3 ± 31.65		

Negative Margin = 1400 g - 1356.3 g - 31.65g **= 12.05 g**
Positive Margin = 1400 g - 1356.3 g + 31.65g = **75.35 g**
Mass Margin = 43.7 ± 31.65 g

Methods for correction:

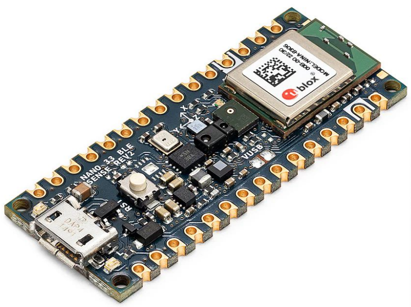
- **3D Printer Parts Infill:** We will adjust the **infill** configuration of our 3D printed parts to get closer to the desired total mass (for increasing or decreasing mass)
- **Solder Wire:** Soldering wire (Tin-Lead Alloy) will be used to **fine tune** the total mass within the 1400±10g range, adding 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

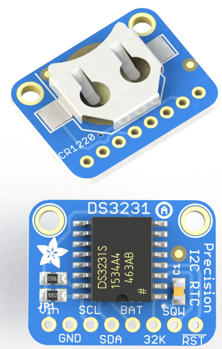
Rafael Dalzotto
Agustín Martinez Haarth

CDH Overview

Arduino Nano 33 BLE Sense Rev2
Microcontroller Board



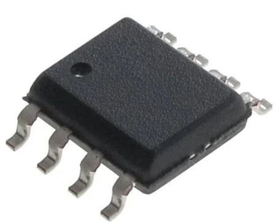
DS3231 mini
Real Time Clock



ANT-900MR Flex ¼ Wave RPSMA
Payload Antenna

Estimated Range > 10000 m
(at Line Of Sight)

4Mb Flash SPI Memory
Permanent memory storage for data recovery



Xbee Pro S3B
Radio

NETID/PANID: **3165**

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

Telemetry rate: **1Hz**

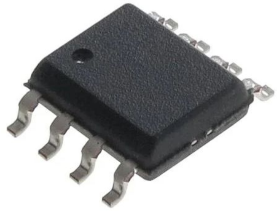
CDH Changes Since PDR

Change	Rationale
Added 4Mb Flash SPI Memory for permanent storage and for data recovery	Arduino Nano 33 BLE Sense Rev2 doesn't have a permanent storage memory accessible from the flight software

AT25SF041B RENESAS

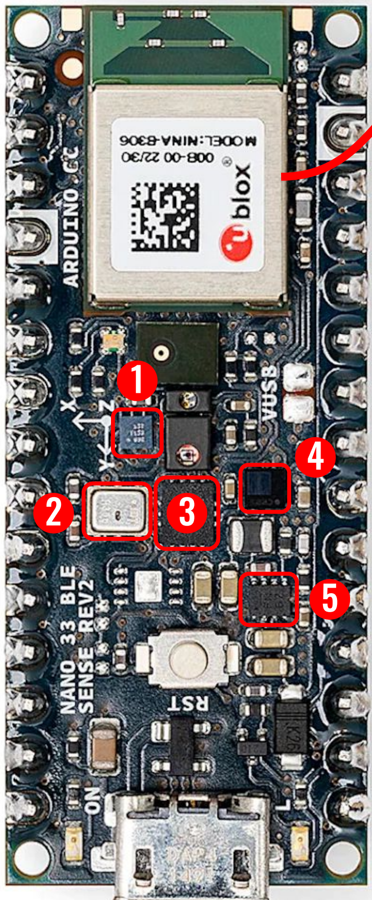
4Mb Flash SPI Memory

Permanent memory storage for data recovery



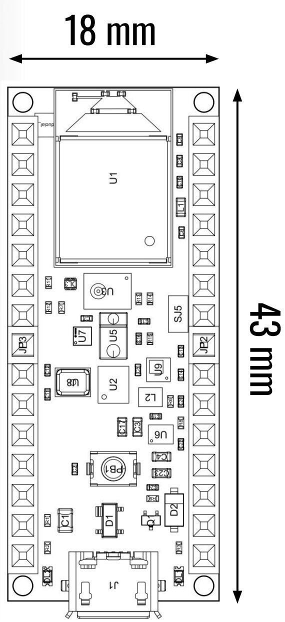
Payload Processor & Memory Selection (1/3)

Arduino Nano 33 BLE Sense Rev2



NINA-B306 Core Module with **nRF52840 microcontroller**

- Arm® Cortex®-M4 32-bit **processor** with FPU
- Processor **speed**: 64 MHz
- 1 MB Flash and 256 kB RAM **memory**
- ~200ms **boot time** (measured bare metal)
- Supply **current:** 15mA at 3.3V supply **voltage**
- **Data bus:** 3x AMBA 3 AHB-Lite interface



Board Weight: 5g

Memory requirements for flight software code are largely covered with this board (1 MB Flash)

Additional features

This board comes with high quality onboard sensors

1  **BMM150** Magnetic Compass

2  **HS3003** Air Temp Sensor

3  **BMI270** Tilt Sensor

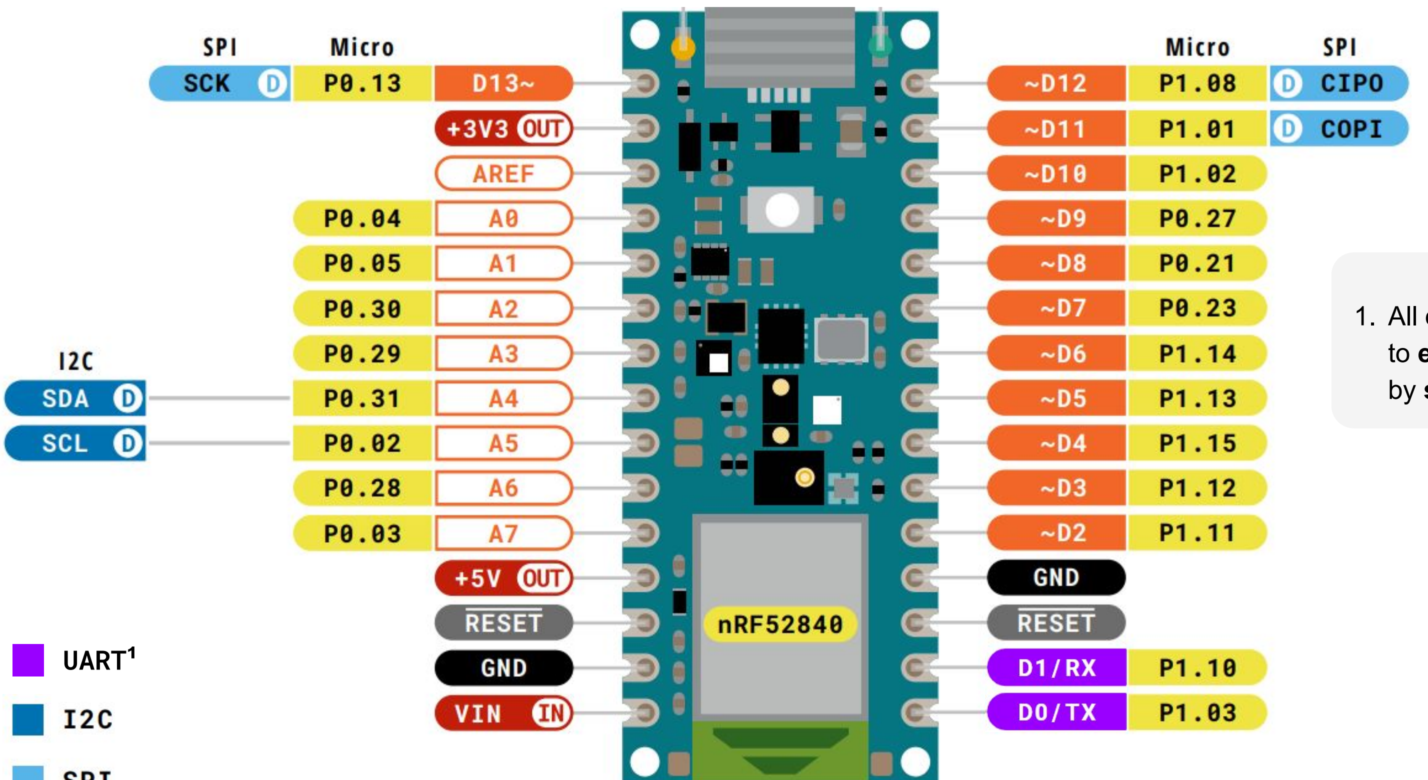
4  **LPS22HB** Air Pressure Sensor

5  **MP2322** 3.3V Step-Down Converter Ultra-small footprint

Arduino datasheet   NINA-B3 datasheet   nRF52840 datasheet

Payload Processor & Memory Selection (2/3)

Payload Processor Data Interfaces



NOTES

1. All digital pins can be configured to **emulate** an **UART** peripheral by **software**

- UART[1]
- I2C
- SPI
- GPIO Digital External
- Analog External

I/O Pins	ADC Pins	~PWM Pins	UART[1]	SPI	I2C
14	8	12	1	1	1

Payload Processor Memory Selection

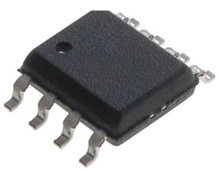
(1) Program Memory

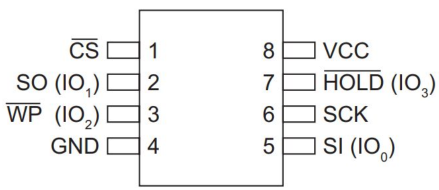
1 MB Flash + 256 kB RAM
Included in microcontroller kit

(2) Camera Memory

64 GB memory included
(independent)

(3) Permanent Memory Storage





For **maintaining** program state data and **configuration states** after power outages or processor resets during launch and mission.

RENESAS

AT25SF041B

4 Mb Flash SPI Memory

datasheet

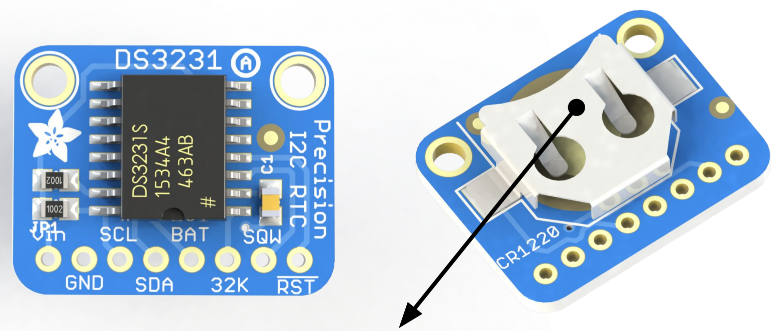
- SPI **clock speed**: Up to 108 MHz
- Stand-by **current** up to 30 μA
- Supply **voltage** from 2.5V to 3.6V
- Operating **temperature** from -40 °C to 85 °C

Payload Real-Time Clock

DS3231 mini

ANALOG DEVICES

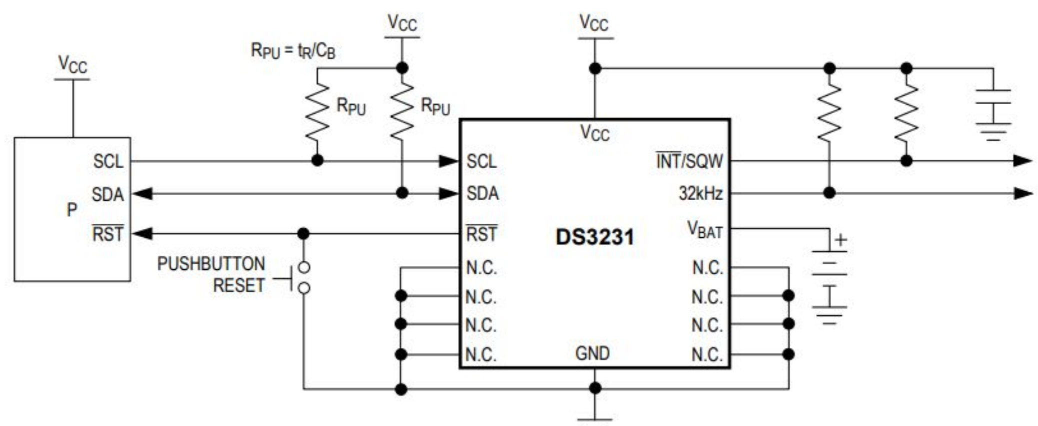
Extremely Accurate I2C Real Time Clock
with temperature compensation



Independent power supply
At least 10 days of battery life
with CR1220 (~37mAh)

- Supply **Voltage:** From 2.3V to 5.5V
- Average Supply **Current:** Up to 300 μA
- Battery **leakage current:** Up to 100 nA
- Active **battery current:** Up to 150 μA
- The device is **reset tolerant**
- 16 × 12 mm **footprint**
- I2C **interface**
- **Accuracy** ±3.5ppm from -40°C to +85°C
- (Time Resolution is higher than 1 second)

Typical Operating Circuit



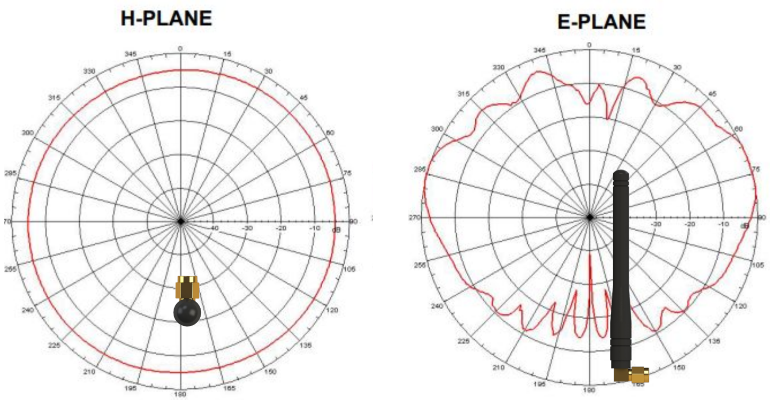
DS3231 datasheet

ANT-900MR Flex ¼ Wave RPSMA

Wireless External Antenna for 900 MHz Applications

- 2.15dBi **Gain**
- >10000m estimated **range** (LoS)
- 15g **weight** (measured)
- 105×18×11 mm **sized**
- **Nominal impedance:** 50 Ω.
- **Frequency range:** 868-915 MHz
- **VSWR:** ≤ 1.5.
- **Operating temperature:** -40ºC to 85ºC

Antenna Radiation Pattern



Payload Radio Configuration (1/2)

Radio used: **XBee PRO S3B 915MHz**

- **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

Used configuration:

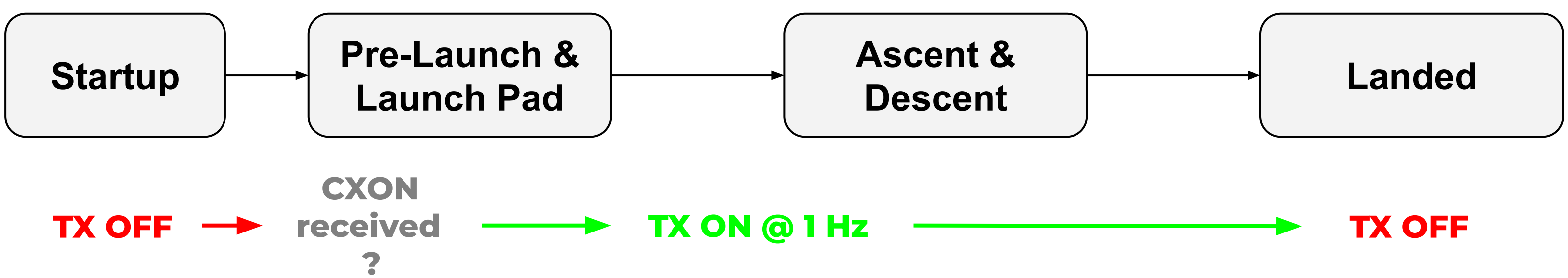
- Radio **frequency**: 915 MHz
- Transmit **power**: 24 dBm (250mW)
- Receiver **sensitivity**: -101dB
- Range: >6500 m (dipole antennas)

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)

Parameter	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)

Parameter	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)

Parameter	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 Formats (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,
8.3,18,21,20,30,35,33,0.22,0.03,0.09,2165,13:14:02,200.8,3.879
3,18.3672,5,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 Design

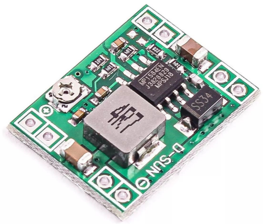
Rafael Dalzotto
Emanuel Albornoz

Beacon Battery
CR2477 (1Ah)

Coin Battery
RTC Battery
CR2023 (225mAh)

Payload Batteries
2x INR18650 (2550mAh)

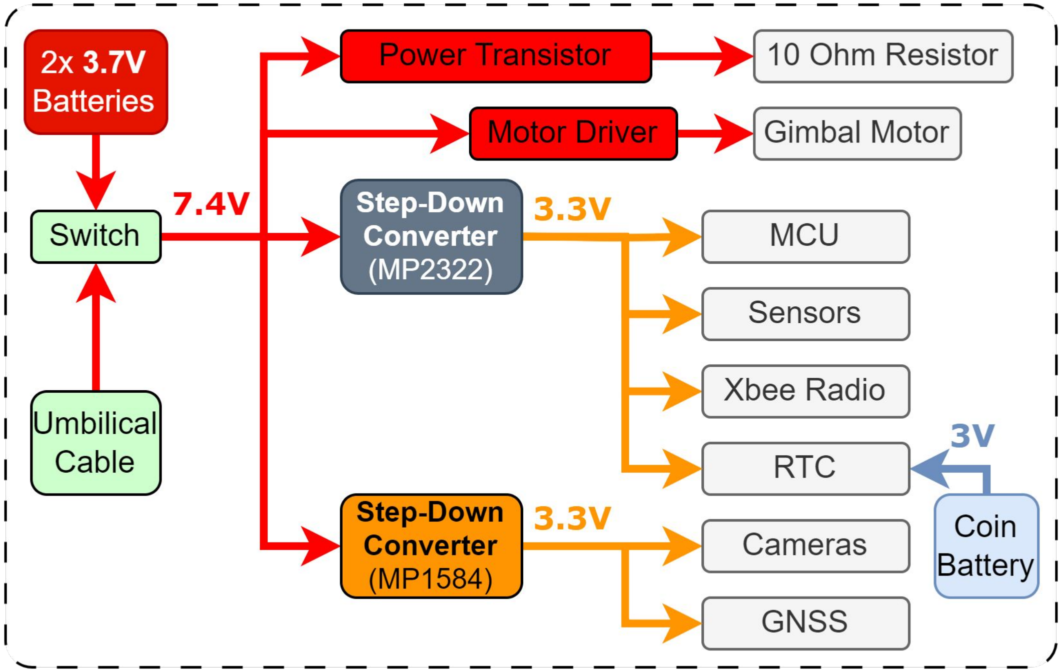
Step-Down 3.3V Converter MP1584



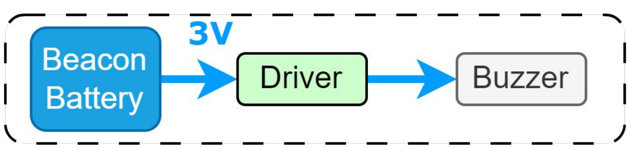
Step-Down 3.3V Converter
MP2322 (Monolithic Power Systems)

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

Payload



Beacon

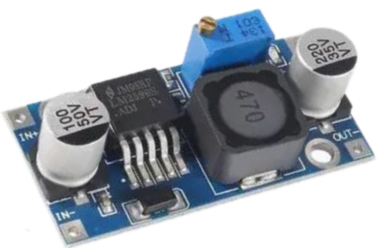


EPS Changes Since PDR

Change	Rationale
MP1584 step-down converter will be used instead of the **LM2596**	MP1584 is much smaller because it has a higher switching frequency than the LM2596

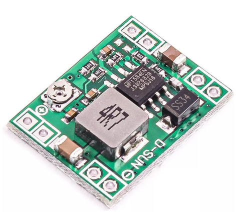
Texas Instruments

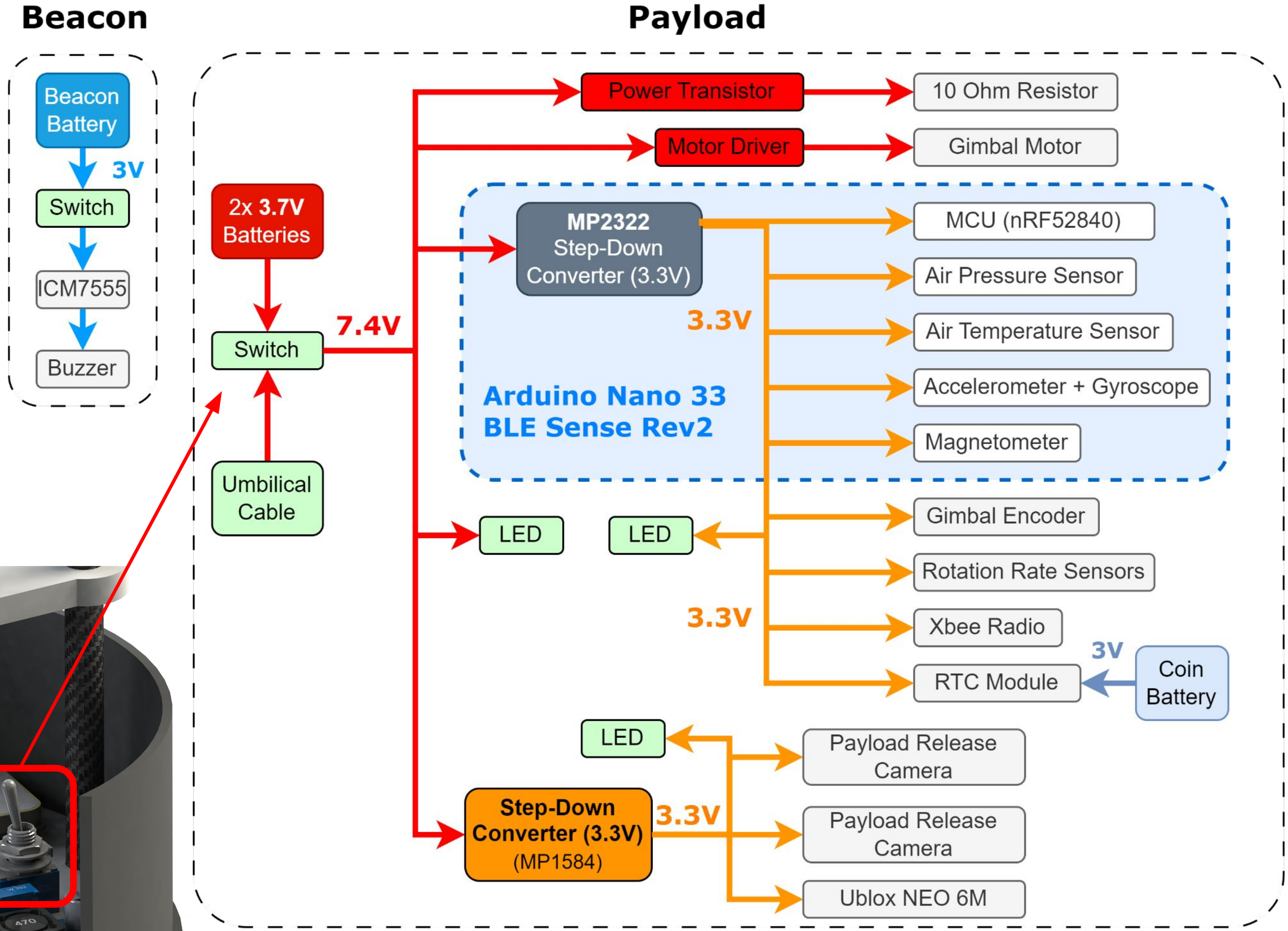
Step-Down 3.3V Converter LM2596



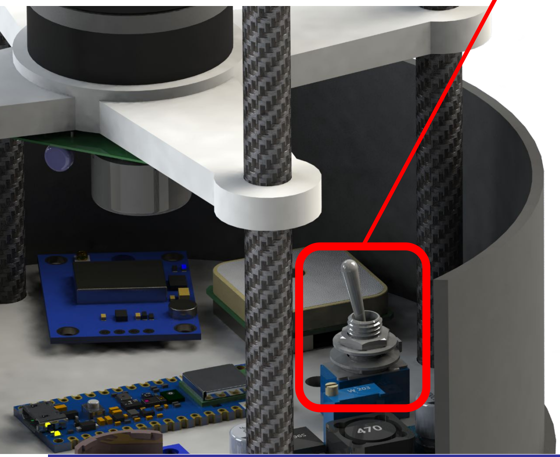
MPS Monolithic Power Systems

Step-Down 3.3V Converter MP1584





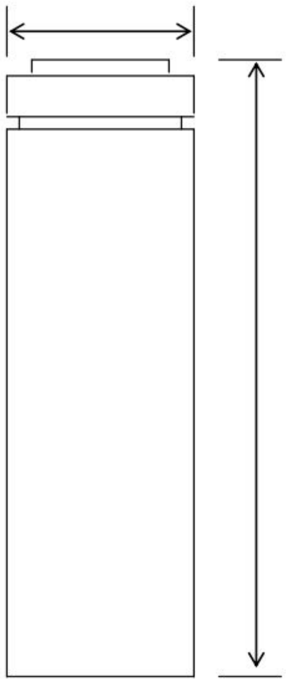
Easily Accessible Switch



Samsung INR18650

Lithium ion technology

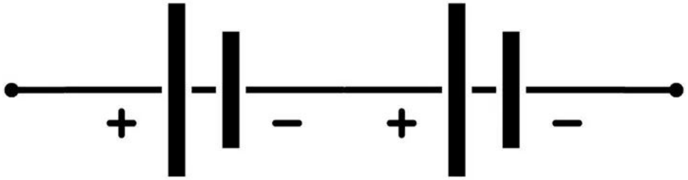
- **Cell voltage:** 3.7V
- **Weight:** 46.5g
- **Density energy:** 0.203 Wh/g
- **Nominal current:** 2750 mA
- **Nominal capacity:** 2550 mAh
- **Max. discharge current:** 20A (continuous)
- **Dimensions:** 18.4 mm (diameter) x 65 mm



Selected configuration: Two cells in series (2S)

➔ **Total Energy:** 18.5 Wh

➔ **Nominal Voltage:** 7.4V



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	0,00003	Datasheet
Sensor	HS3003	1	120,0000	100,00%	0,024	3,3	0,00023	Datasheet
Sensor	Resistor divider + ADC	1	120,0000	100,00%	0,015	3,3	0,00014	Estimated
GPS	Ublox Neo-6M	1	120,0000	100,00%	60	3,3	0,56571	Datasheet
Sensor	A1104	2	120,0000	100,00%	4,1	3,3	0,07731	Datasheet
Sensor	BMI 270	1	120,0000	100,00%	0,97	3,3	0,00915	Datasheet
Sensor	BMM150 + AS5048A	1	120,0000	100,00%	20	3,3	0,18857	Datasheet
Camera	Quelima SQ11	2	5,0000	4,17%	240	3,3	0,18857	Datasheet
MCU	Arduino 33 Sense Rev2	1	120,0000	100,00%	45	3,3	0,42429	Datasheet
Motor	GM 2804 Gimbal Motor	1	3,0000	2,50%	500	7,4	0,26429	Datasheet
Radio	XBee Transmitting	1	10,0000	8,33%	215	3,3	0,16893	Datasheet
Radio	XBee Idle	1	118,6600	98,88%	2	3,3	0,01865	Datasheet
Burn Resistor	10 Ohm Resistor 1/4W	2	0,0417	0,03%	740	7,4	0,00316	Estimated
TOTAL [Wh] =							**1,909**	

Note: the power consumption was calculated **considering 70% efficiency** of the DC/DC buck converter.

Payload Power Budget (2/2)

Power Source: Payload Battery	Energy [Wh]
Total Energy Consumption	1,909
Total Battery Energy	18,500
Energy Margin	16,591

Discharge Depth	Operating Time [h]
100%	9,7
60%	5,8

Power Source: RTC Battery	Energy [Wh]
Total Energy Consumption (RTC)	0,00045
Battery Energy (100% discharge depth)	0,11100
Energy Margin	0,11055

Discharge Depth	Operating Time [h]
100%	246
60%	148

Power Source: Beacon Battery	Energy [Wh]
Total Average Power	0,075
Battery Energy (100% discharge depth)	3,700
Energy Margin	3,625

Discharge Depth	Operating Time [h]
100%	49,3
60%	29,6

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

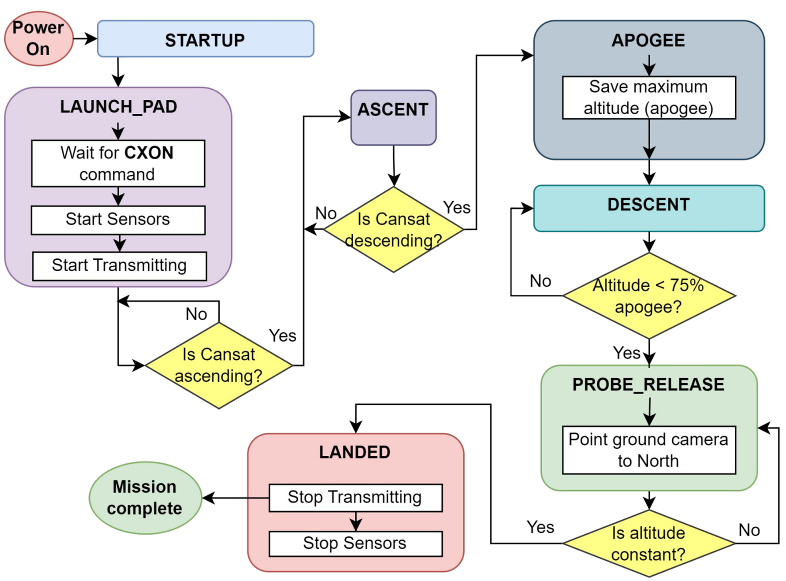
Take measurements and send telemetry, determine flight state based on altitude, receive commands from the ground, wait to reach 75% altitude.

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)

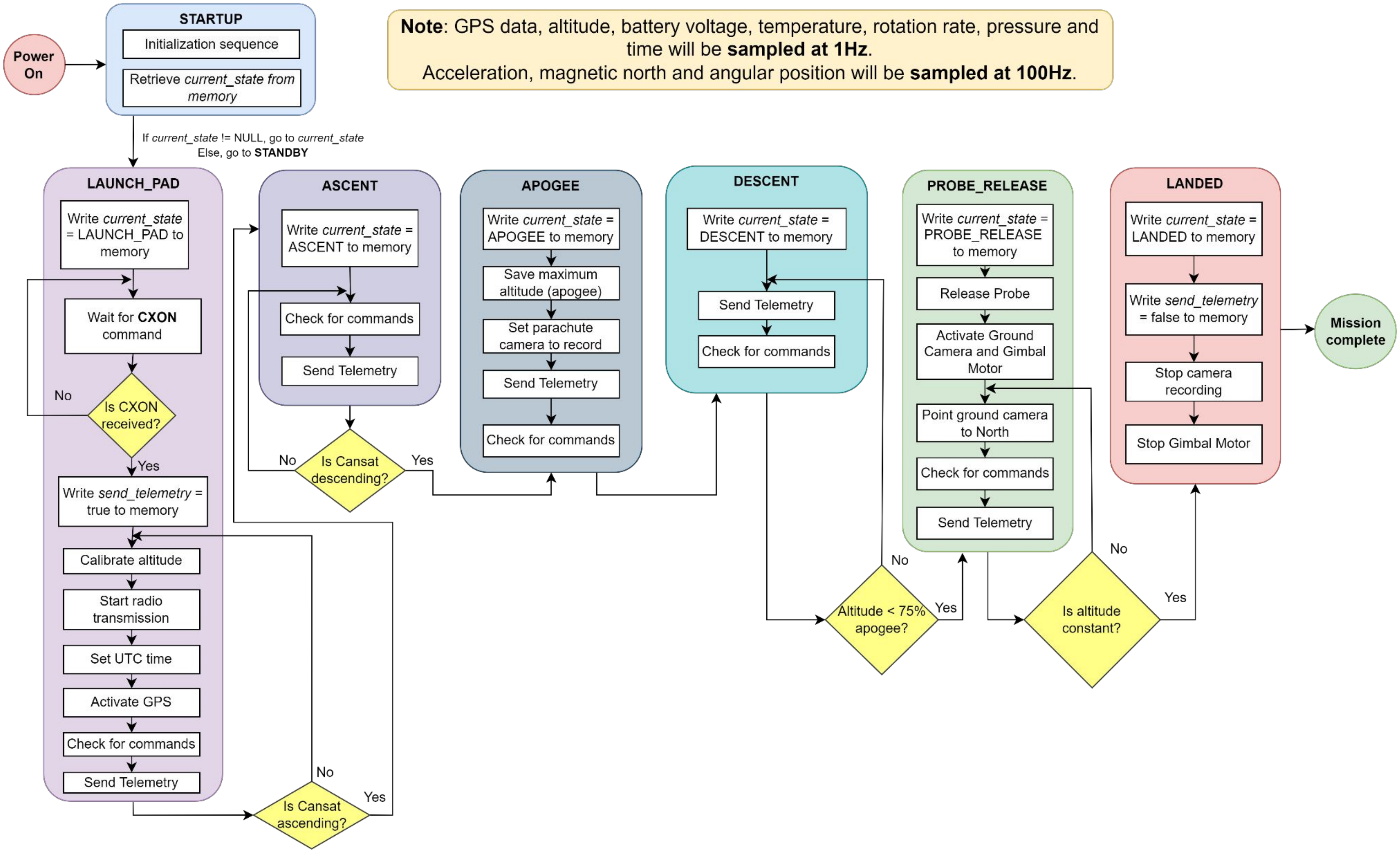
- **FSW Tasks Summary**
  - Transmit sensor measurements once per second to the Ground Station
  - Send, receive and process packets via XBEE radios
  - Keep track of mission state (based on altitude data) in case the processor resets
  - Control deployment mechanisms
  - Keep track of mission time through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

- Programming **languages**: **C/C++**
- Development **environment**: **VSCode + PlatformIO**

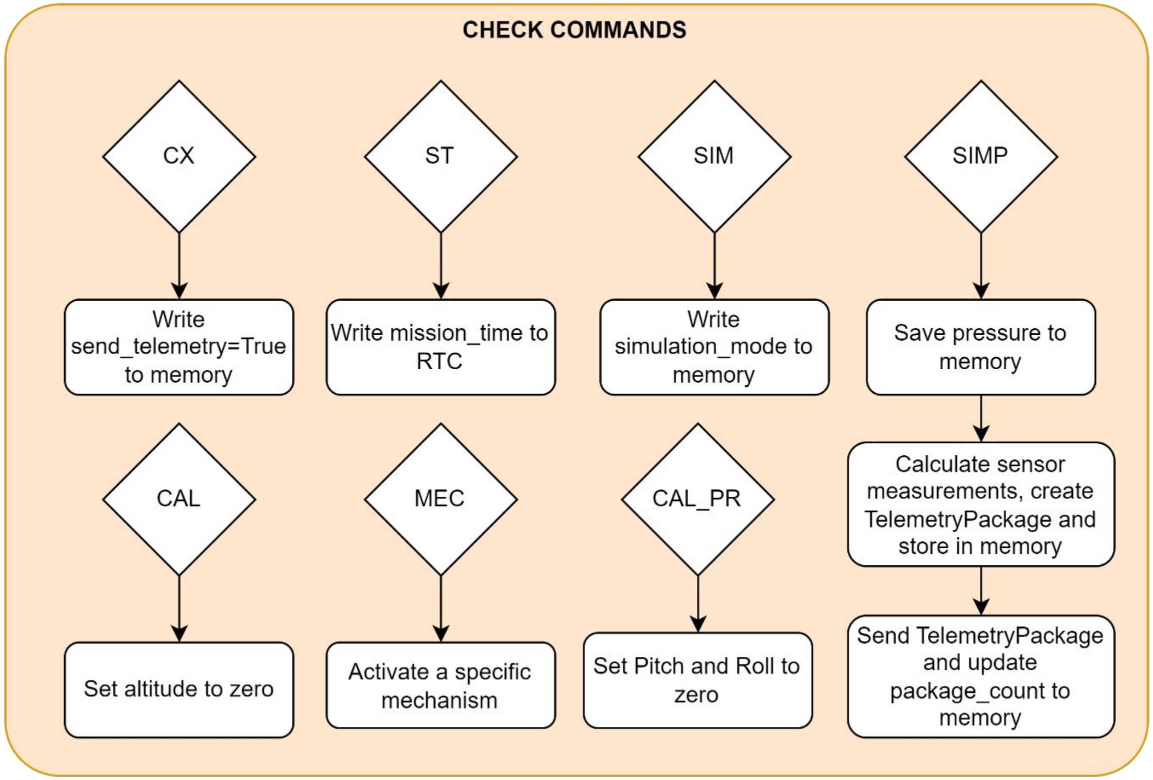
FSW Changes Since PDR

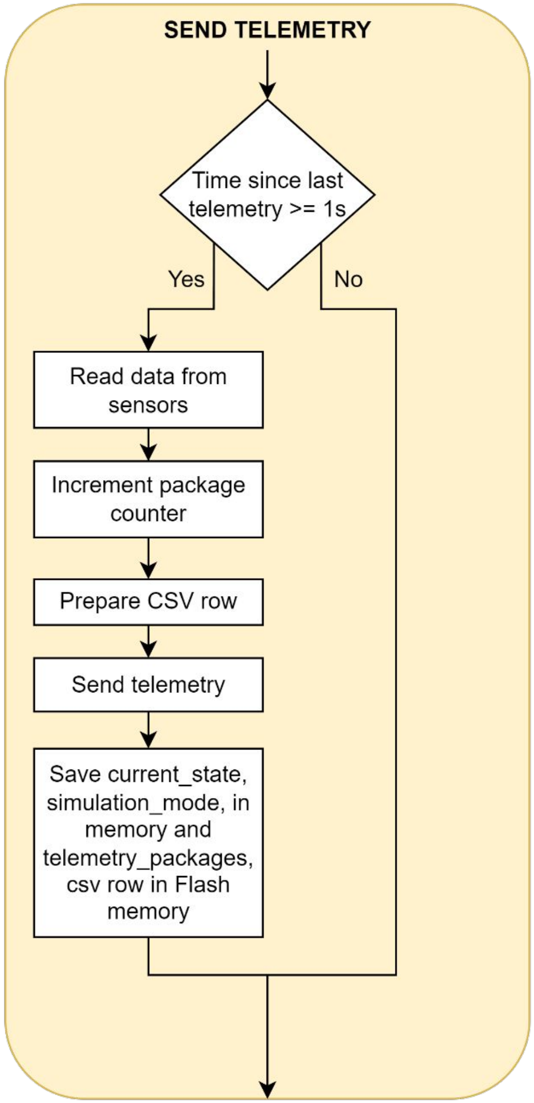
No changes have been made to the Flight Software design since the PDR

Payload CanSat FSW State Diagram (1/2)



Payload CanSat 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 (4Mb Flash), 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**

The Ground Station reads simulated barometric pressure values from a .csv provided by the competition and transmits them via **SIMP** 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 continuously monitors the radio link for barometric pressure sensor commands (SIMP) sent from the Ground Station.
  - **The received values are treated as actual barometric pressure readings** for altitude calculations, software state determination, and the CanSat Probe release decision
  - 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 (1/5)

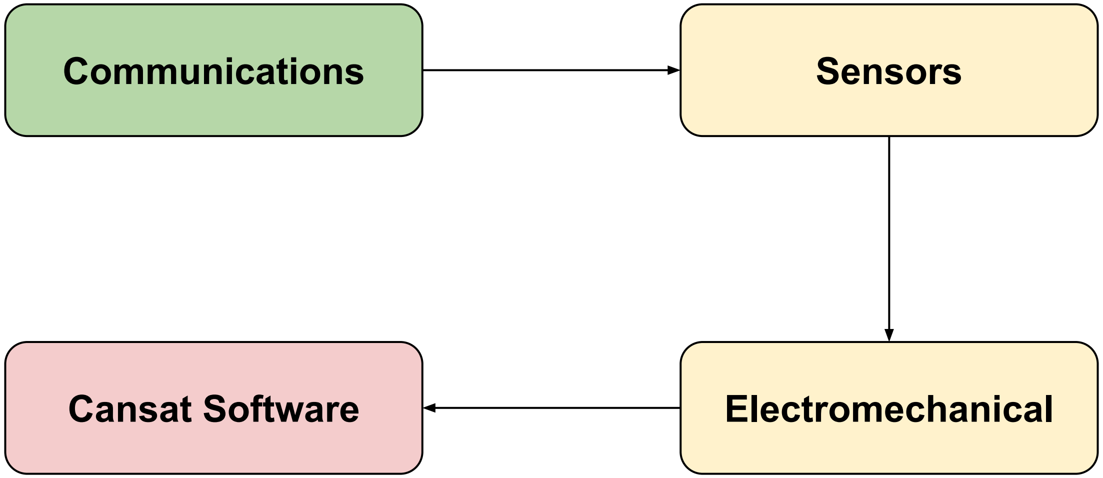
- **Prototyping and prototyping environments**
  - All sensors are being tested individually as development progresses.
  - A PCB prototype has been developed, and we are collecting and evaluating data from it to make adjustments.

- **Test methodology**
  - Pre-existing libraries are being used for unit testing of individual components, as well as for integration testing.
  - Exhaustive individual tests are made in the electronics laboratory of our university (for software-controlled sensors and radios)

Software Development Plan (2/5)

- **Software subsystem development sequence**

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



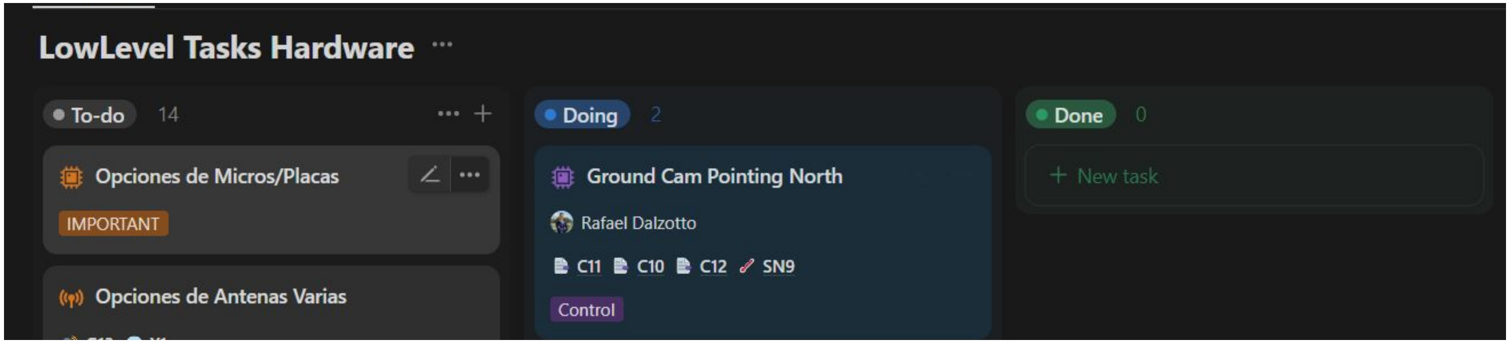
Software Development Plan (3/5)

- **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

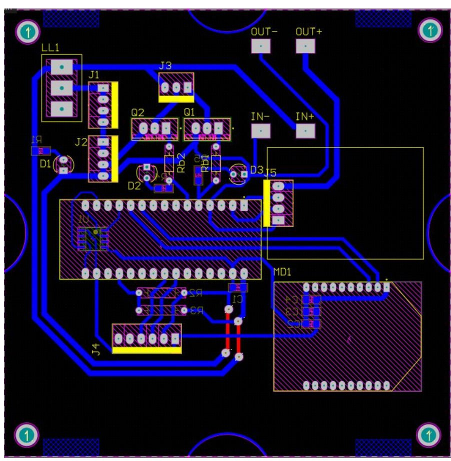
Software Development Plan (4/5)

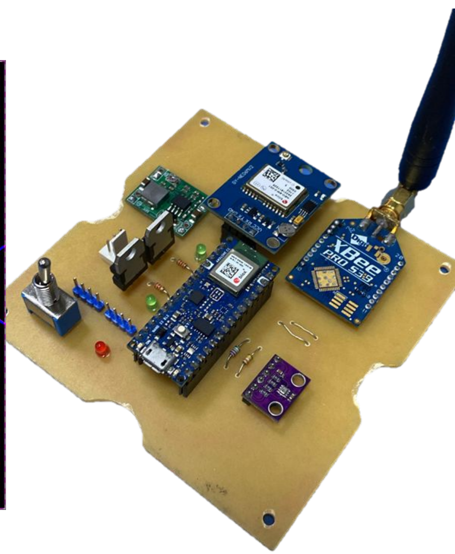
- **Github**
  - We will use Github to be able to collaborate and track changes
  - Code can be easily revised and reverted in case of errors.
- **Notion**
  - Similar to Jira and Trello, allows collaborators to set and organize tasks, as well as track progress
  - We'll use Kanban Boards to visualize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

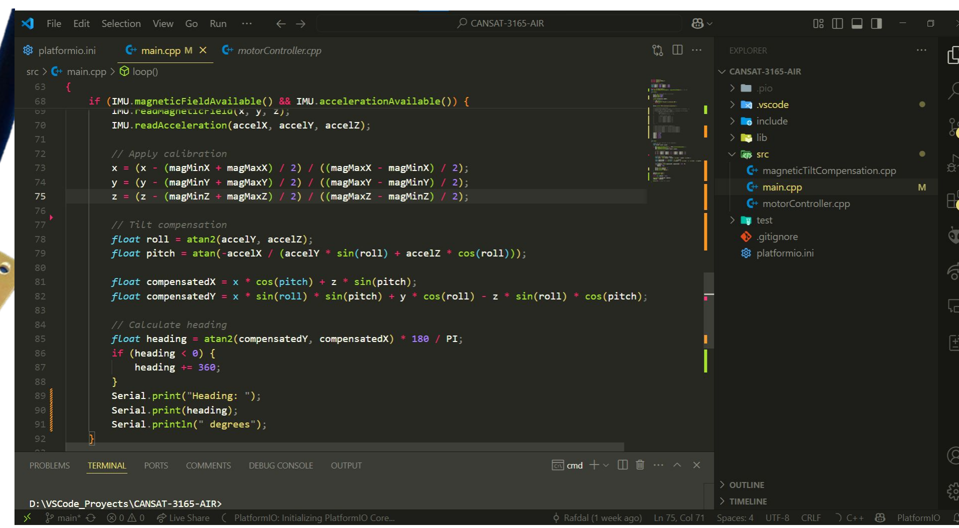


Software Development Plan (5/5)

- **Progress since PDR**
  - A basic prototype of the main PCB has been developed to test radio communications and sensor driver modules.



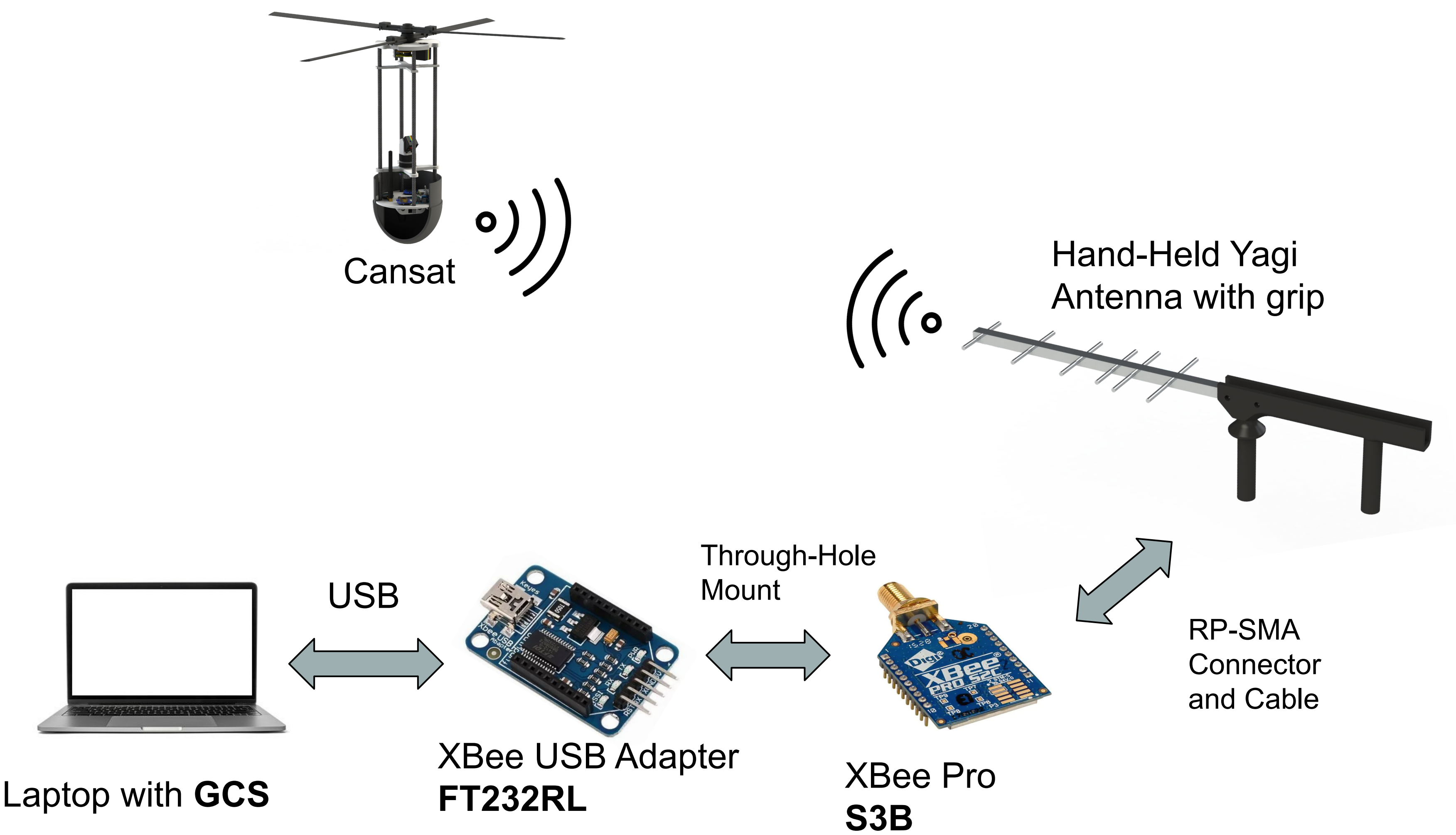




Ground Control System (GCS) Design

Santino Agosti
Micaela Perillo

GCS Overview

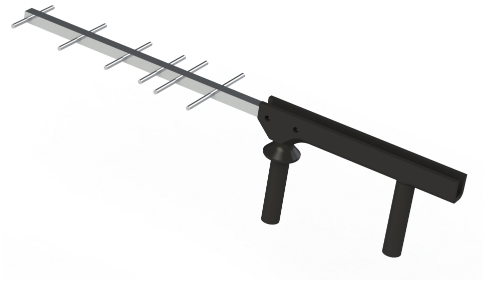


GCS Changes Since PDR

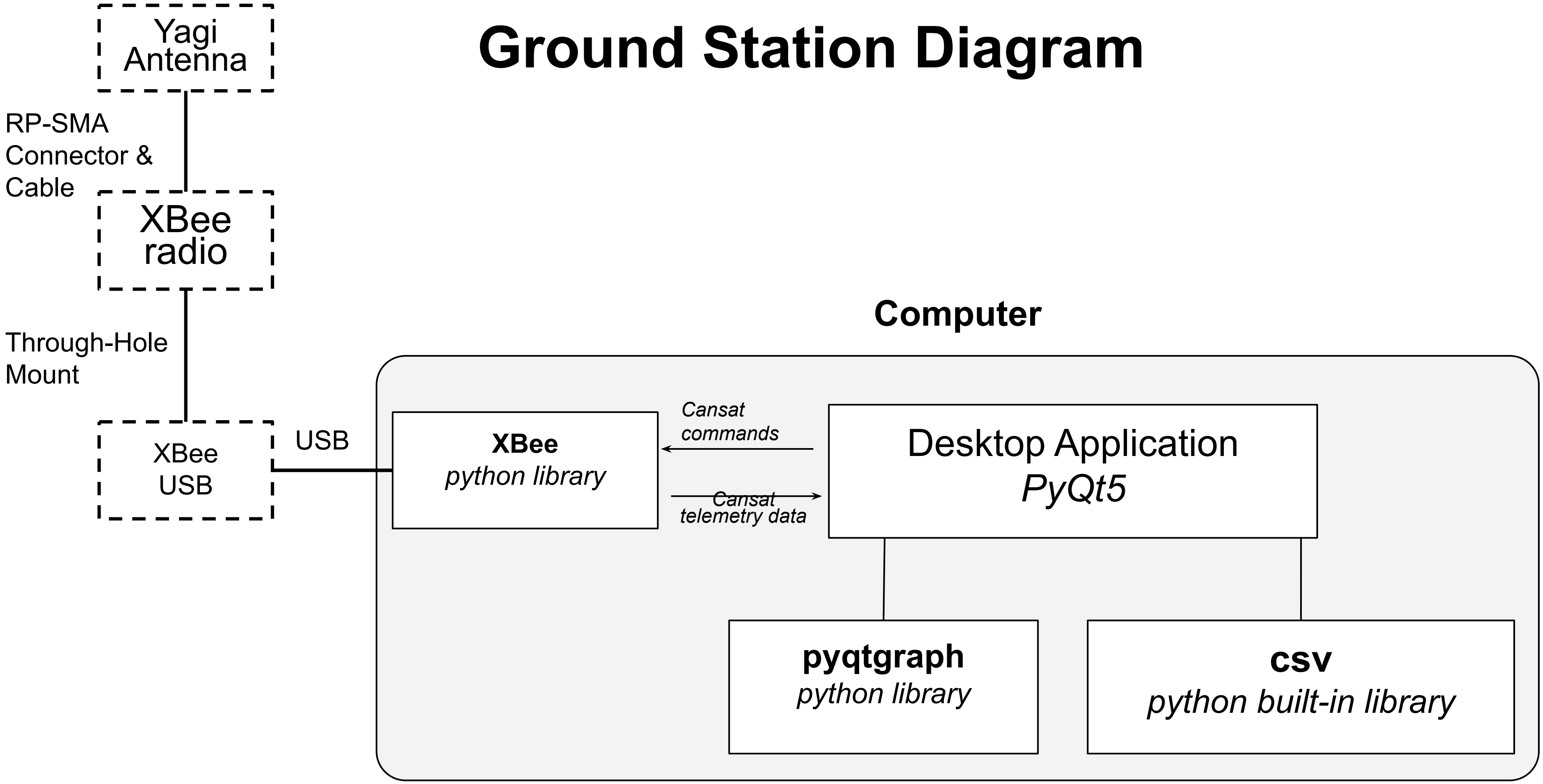
Change	Rationale
Hand-held Yagi antenna with grip will be used instead of a table top one	Better mobility and simpler system

Table-Top Yagi Antenna

Hand-Held Yagi Antenna with grip



Ground Station Diagram



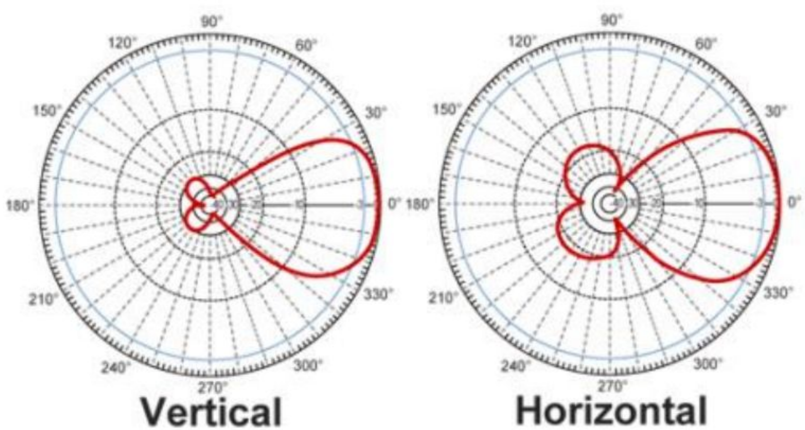
GCS Design (2/2)

- **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
  - Portability:
    - No AC power is needed for GCS operation. GCS is fully portable. The team can be positioned at the ground station operation site along the flight line

A09-Y11NF

880 MHz to 960 MHz, Heavy-Duty Yagi Antenna, 11dBi, RP-SMA Connector

Typical Radiation Pattern

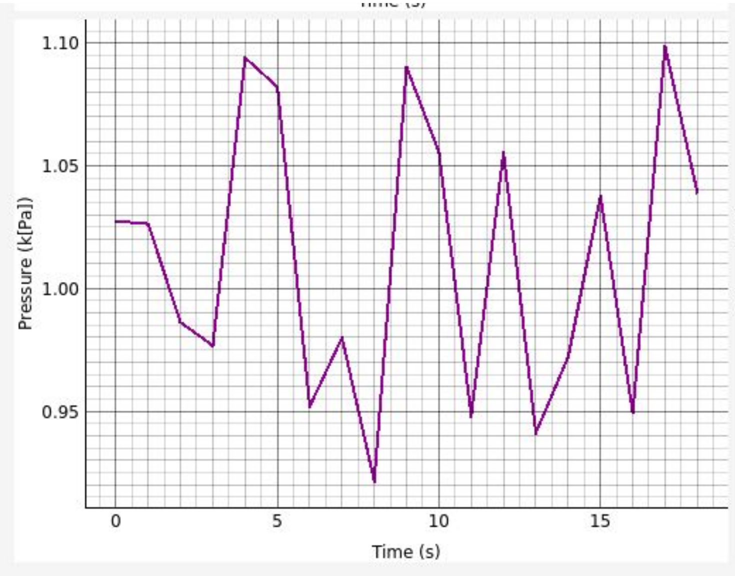


Gain:	11 dBi
Horizontal Beam Width:	54 Degrees
Vertical Beam Width:	48 Degrees
Maximum Input Power:	100 Watts
Impedance:	50 Ω
Range:	890 - 960 MHz
Polarization:	Linear
Radiation Pattern:	Directional
Typical VSWR:	1.3:1
Maximum VSWR:	1.5:1
Dimensions (L x W):	635 x 150 mm
Weight:	837 g
Range (LoS):	> 46000 m

GCS Software (1/7)

- **Telemetry display screen shots**
  - Telemetry will be displayed in **real-time** in the Ground Station using the ***pyqtgraph* library**
  - Telemetry will be recorded in a **.csv** file using the csv library from Python.

Graph display example (beta)



- **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

```
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

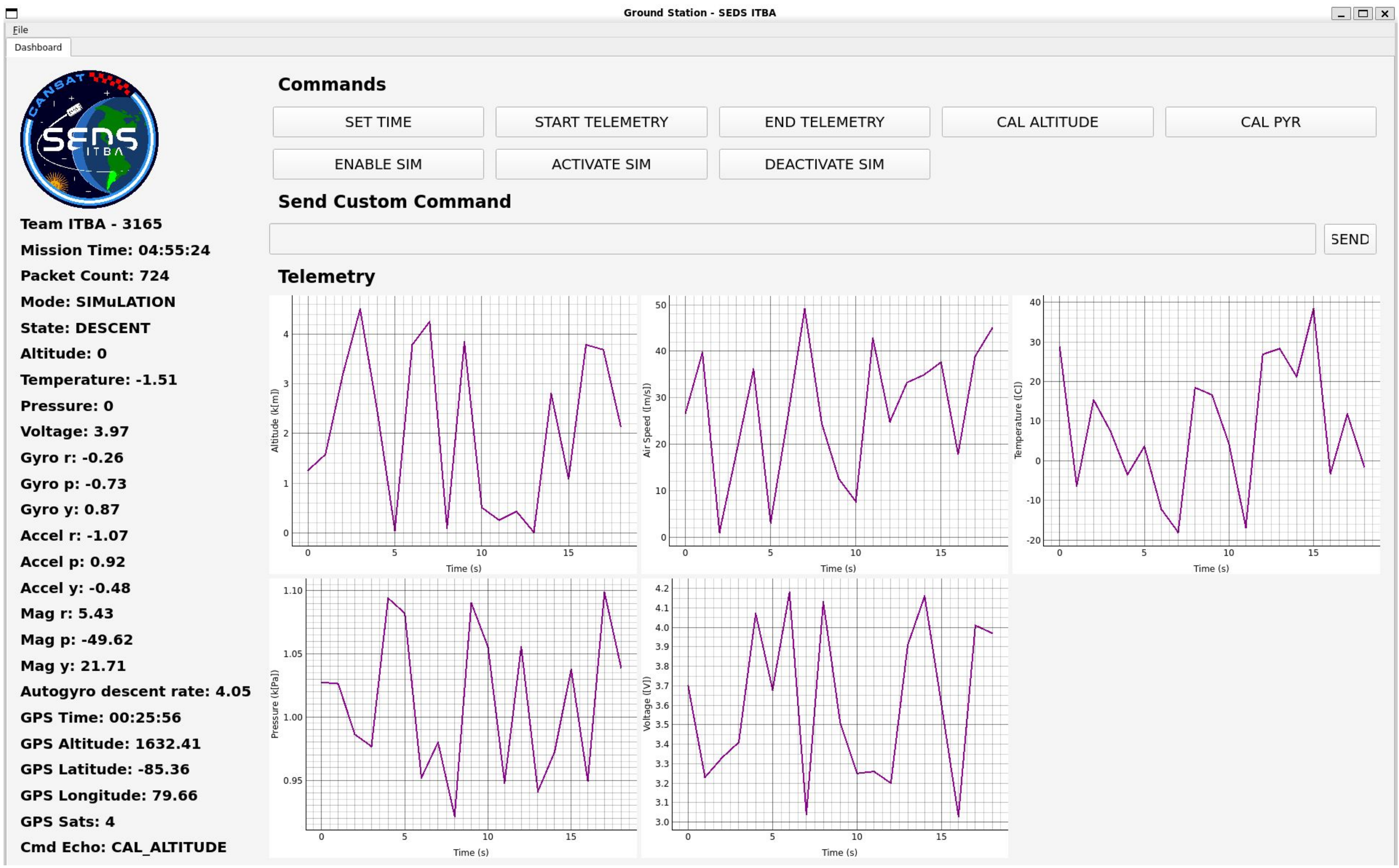
GCS Software (3/7)

- **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

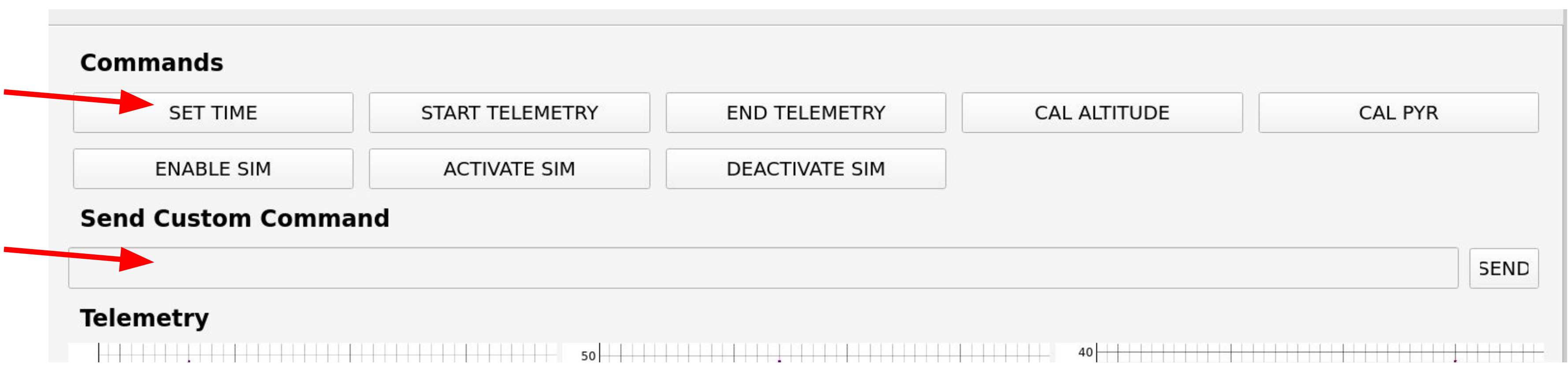
Real-time plotting and command software interface (beta)



GCS Software (5/7)

Commanding

1. The operator can send the commands via **buttons** on the interface or by typing commands on the command line.
2. Then the commands are sent in plain text vía the Xbee Radio to the Cansat



- **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 **(at 1 Hz)** to the Cansat

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

GCS Software (7/7)

- **Progress since PDR**

    - A beta version of the Ground Station software is fully developed.
    - Next, we must test the antennas alongside the Flight Software.

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
- Each sensors will be connected to a test bench to check connections and individual functionality
- Simultaneous functionality will be tested
- Readings and data output format will be checked to meet requirements and expected physical behaviour

CDH

- Testing environments will simulate real conditions to verify functionality in harsh conditions.
- Communication, data integrity, and memory performance will be validated.
- Boot time, power consumption, and real-time clock accuracy and reset tolerance will be checked.
- Command formats and execution will be tested for proper functionality.
- Verify that telemetry data is correctly stored and retrieved.
- Processor power loss and data recovery will be tested.

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.

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

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

- Each 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 (1/4)

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.

Mechanisms

- Critical parts will be tested both in the laboratory using real scale forces, and also on the field doing drop tests. To **ensure they survive the required force limits**.
- Expected theoretical values will be compared to real experimental ones enabling us to change elements in case of unsuccessful results.

Deployment

- Payload **release trigger** will be tested using simulation mode to ensure its correct release from the container at 450m.
- Auto-gyro deployment trigger will be tested using simulation mode with the cansat stationary to ensure it activates at 450m, after the payload is released.
- Auto-gyro deployment will be tested using simulation mode in conjunction with a descent test.
- Fishing line's resistance will be tested to **ensure parachute keeps attached** to the container during deployment.
- Prototype will be dropped from progressively higher altitudes to test the payload release mechanism and the auto-gyro deployment mechanism, to ensure the triggering of both mechanisms works correctly

Communication Test Plan

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

Ground station software

- Storing the received sensor data in a CSV file and real time data plotting will be tested using an Xbee connected to the computer.

- To find bugs, each button will be pressed multiple times.

Communication Test Plan

Telemetry

- Telemetry format will be checked to comply with the format requirements
- Time between packets will be checked
- Data will be checked.

Antennas

- Communication range will be tested using a testing mode on the FSW Communication Module.
- Radios will be placed at least 2 km away in an open field.
- Antennas will be set in the horizontal axis, pointing at the same direction
- Handling of lost radio messages (and automatic resending) will be tested using a testing mode on the FSW Communication Module.
- Signal blocking will be tested using different materials to cover the radios.

Environmental Test Plan (1/3)

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 (2/3)

Fit Check:
- The CanSat is inserted in the container 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.

Environmental Test Plan (3/3)

Dimensions Verification:

To ensure the CanSat meets mission requirements, precise measurements will be conducted using calibrated tools. A digital caliper will be used to verify critical dimensions such as the outer casing, payload compartment, and clearance between components. A micrometer will check the thickness of structural parts and small tolerances to ensure proper assembly. A high precision ruler will confirm overall height and width, ensuring the CanSat fits within the required envelope.

To validate accuracy, physical measurements will be cross-checked against the CAD model, and a fit test will be performed in a mock launch container to ensure there are no obstructions. The verification is considered successful if all dimensions remain within tolerances and the system integrates seamlessly.

Simulation Test (1/2)

Simulation Test Process:

To verify the correct functionality of the CanSat's simulation mode, the following test procedure will be carried out: First, the SIM ENABLE and SIM ACTIVATE commands will be sent to the CanSat to activate the simulation mode. Once the mode is activated, the Ground Station should begin transmitting simulated barometric pressure data by reading a .csv file and sending one SIMP command every second to the CanSat. This will be checked.

It will be verified that the CanSat correctly receives each SIMP command and processes the simulated pressure data as real sensor readings for altitude calculations and flight software state determination. It will also be verified that the CanSat Probe release mechanism is correctly triggered based on the altitude calculations derived from the simulated pressure data.

It will be confirmed that telemetry data such as battery, temperature, and GPS readings come from the actual sensors, with only the pressure readings being simulated.

The procedure will be repeated with various simulated scenarios to verify that the CanSat consistently and reliably responds to the simulated data. Any discrepancies or failures in the system's behavior will be identified, and adjustments will be made to the software or hardware as necessary to ensure proper operation under all test conditions.

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.

Test Procedures Descriptions (1/7)

Test Proc	Test Description	Rqmts	Pass Fail Criteria	
1	**Drop Test:** The CanSat is attached at 3m height, raised 61cm and dropped. A mattress is placed under the CanSat in case of structural damage on the joints.	S9, S17, M3	Payload and container are expected to have the lowest damage.	Not tested yet
2	**Mass Requirement Test:** Verify that the mass is 1400 g ± 10 g weighing it on a scale.	S1	The weight should be within margin	Not tested yet
3	**Simulated Mission Test:** Payload release and autogyro deployment will be tested using simulation mode. It will be verified that mechanism activations are correctly triggered by altitude.	C5, C6, SN7	All mechanism activation must deploy correctly at 75% of peak altitude	Not tested yet
4	**Descent Rate Test:** An equivalent CanSat will be dropped from a drone to verify descent velocity with only the parachute and then with the Auto-Gyro system	C4, C7	The velocity, descent rates and rotation should be within margin	Not tested yet

Test Procedures Descriptions (2/7)

Test Proc	Test Description	Rqmts	Pass Fail Criteria	
5	**Thermal Endurance 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 and using battery.	S17, M3, E5	All systems and communications must function properly throughout the entire 2-hour test.	Not yet tested
6	A orbital sander provided by the university is used to simulate vibration on the CanSat	S8, S17, M3	All systems should work correctly and structural integrity not be compromised	Not yet tested
7	The CanSat will be placed in a vacuum chamber	C5, C6, S17, M3	All deployment should work	Not yet tested
8	The Container will be placed inside a correctly sized tube to make sure it fits inside the way it should. Payload will be placed inside the container to make sure it fits the way it should. Dimensions will me checked to make sure they meet the requirements	C3, S3, S4, S7, S10, S11, S12, S13, S14, S18	The container should pass fit through the tube without difficulties. Payload should fit correctly inside the container. Dimensions should meet the requirements	✓

Test Procedures Descriptions (3/7)

Test Proc	Test Description	Rqmts	Pass Fail Criteria	
9	**Camera Orientation Control Test:** Camera Orientation response will be tested against step, linear, noise, and other rotation functions on a flat rotating base. Procedure will be repeated with different magnetometer tilt.	C10, C12,SN8, SN9	The camera should face to a specific direction within +/- 10 degrees for the duration of the test.	Not yet tested
10	**Cameras Recording Test** Ground pointing camera's direction will be checked. AG camera´s field of view will be checked	C9, C11	Ground camera should be pointing 45 +/- 3 degrees from CanSat nadir direction. AG camera should be able to record payload release and operation of AG clearly.	Not yet tested
11	Storing data to the Flash Memory and recovering after a processor reset and a power loss, in different scenarios	F1, F2, G4	Data and program status should persist correctly	Not yet tested
12	The FSW Communication Module is used in conjunction with an XBee connected to the Arduino Nano 33 BLE Sense Rev2	X1, X4	The Arduino must send and receive packages	Not yet tested

Test Procedures Descriptions (4/7)

Test Proc	Test Description	Rqmts	Pass Fail Criteria	
13	The GCS Software sends commands to enable simulation, reads simulation values from a CSV file and sends them the CDH running the FSW.	G11, G12, G16, F4, F5, F6	The FSW should react to the pressure values, sending adequate telemetry and activating mechanisms at the right moment	Not yet tested
14	A CSV file is read using the csv Python library running on an PyQt5 app	G12, F4	The file should be read and transmitted with the correct data	✓
15	A CSV file is written using the csv Python library running on an PyQt5 app	G2	The software should be able to send and receive packets and parse their content.	✓
16	The GCS Software Communication Module is used running an PyQt5 app	E5	The battery chosen should be able to last at least 2 hours working with all components connected	✓

Test Procedures Descriptions (5/7)

Test Proc	Test Description	Rqmts	Pass Fail Criteria	
17	Simulating landing state, we will check cansat telemetry state The audio bacon range will be tested in an open field	C13	The FSW should stop transmitting data. Cansat audio bacon must be audible from 20 meters	Not yet tested
18	Cansat power on test: We will connect the batteries to the cansat using a 0.1ohm resitor in series to retrieve current drain at 10Hz. Then, we will turn it on using the mechanical switch. After two hours, we will disconnect the battery and check the remaining capacity.	E3	Current cannot exceed 8A in any moment, and cannot exceed 2.75A for more than 10 seconds. Battery remain capacity must be 60% at least. Switch should be easily accessible.	Not yet tested
19	Xbee transmition test: Cansat and Ground Station will be set in an open field 2km away. CXON command is sent. Then we will check the data received in the GCS	C8, G15, F1, X2, X4	GCS should not miss any packet. Telemetry time between packets must be 1s +- 50ms. We will check NETID setted to our team number and the telemetry format.	Not yet tested

Test Procedures Descriptions (6/7)

Test Proc	Test Description	Rqmts	Pass Fail Criteria	
20	**Sensor Test:** Altitude, temperature, battery voltage, position, acceleration, rotation, AG rotation rate and magnetic field sensors will be tested to ensure they work properly. CanSat telemetry will be checked to include all this measurements	X5, SN1, SN2, SN3, SN4, SN5, SN6, SN11	Sensor data must fulfill precision and format criteria. Telemetry format and frequency must fulfill mission requirements	Not yet tested
21	**Hardware and Software Design Requirements Compliance Test:** These requirements don’t require an experimental / empirical test, we will review them using a checklist.	E7, X3, G1, G3, G6, G7, G8, G9, G14, F3, F7	Hardware and Software Design Requirements must be met.	Not yet tested

Test Procedures Descriptions (7/7)

NOTE

All Requirements that aren't mentioned in the previous slices, don't need an empirical test. They either don't correspond to our design or they were thought in the design and will be checked with a checklist.

Mission Operations & Analysis

Santiago Bolzicco

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 manipulaton 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 untill 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 judgement 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 • Agustín Martinez Haarth
Recovery Crew	• Track and recover the CanSat • Interact with field judges • Make sure all field scores are filled in	• Ezequiel Bolzicco • Emanuel Albornoz • Daniela Maradei Lavalle
CanSat Crew	• Prepare the CanSat and integrate it into the rocket • Verifying status before launching	• Federico Agustín Pilotto • Thomas Agustín Marthi • Santino Agosti

Field Safety Rules Compliance

The Mission Operations Manual will be divided into the following sections:

- GCS Configuration and Command Reference
- CanSat Preparation
- CanSat Integration
- Launch Preparation
- Launch Procedure
- Removal Procedure

Development status: The Mission Operational Manual will be ready and assembled in a 3 ringed binder by the end of May before beginning flight rehearsals.

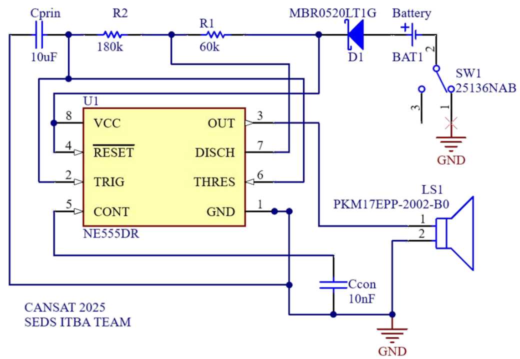
CanSat Location and Recovery (1/6)

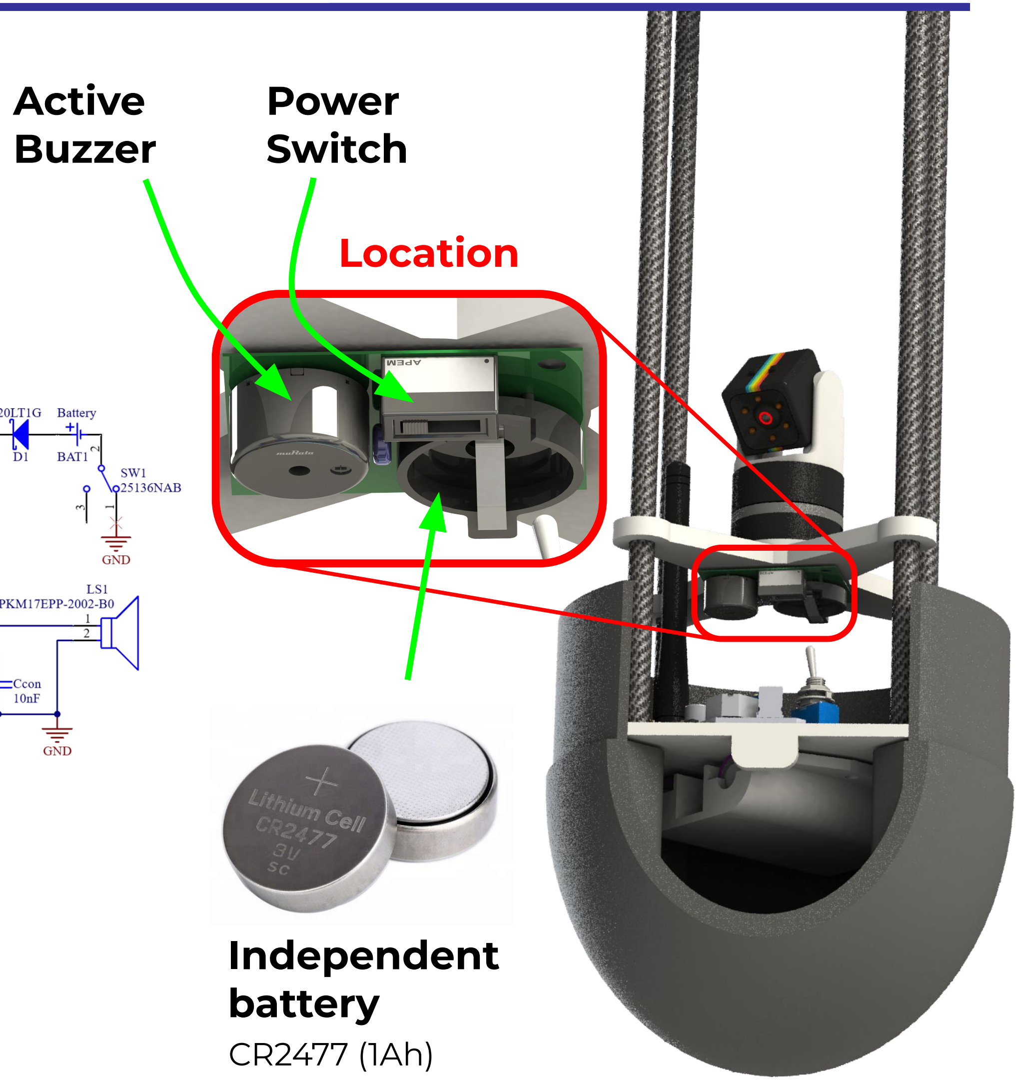
CanSat Recovery

- GPS location will be used to assist CanSat recovery
- Cansat container 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

Beacon Overview

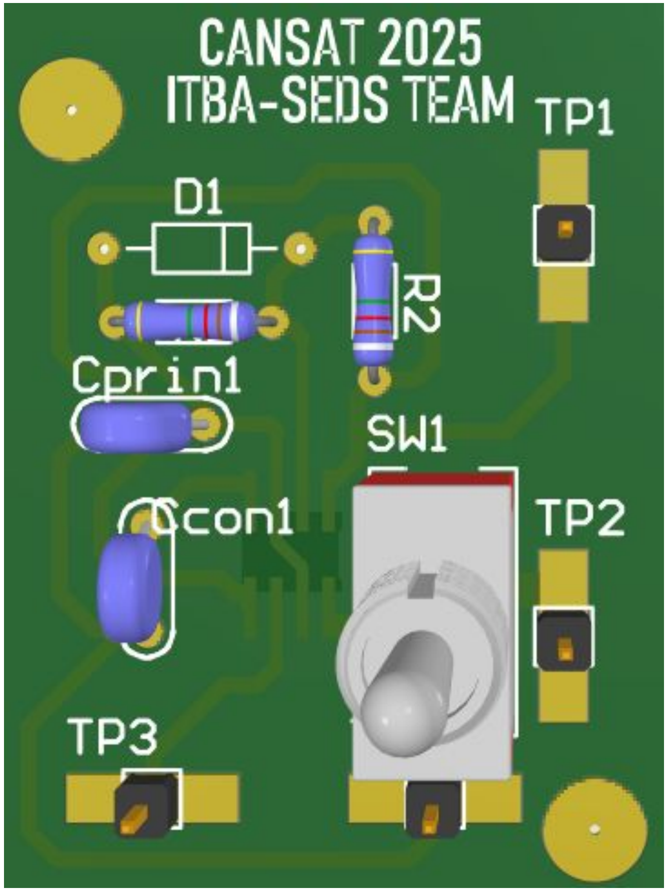
- Beeps for 250 ms every 1 second
- Safe Power Switch to prevent beacon from turning off
- Lasts up to 39 hours

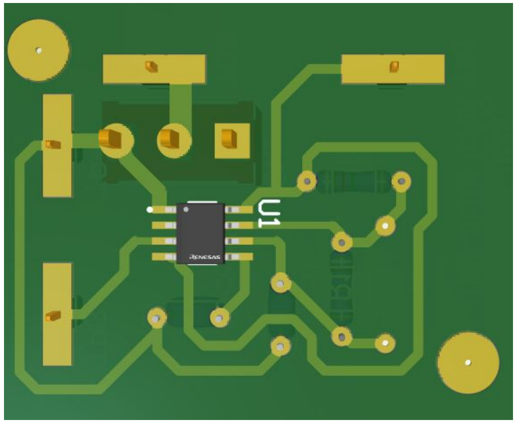




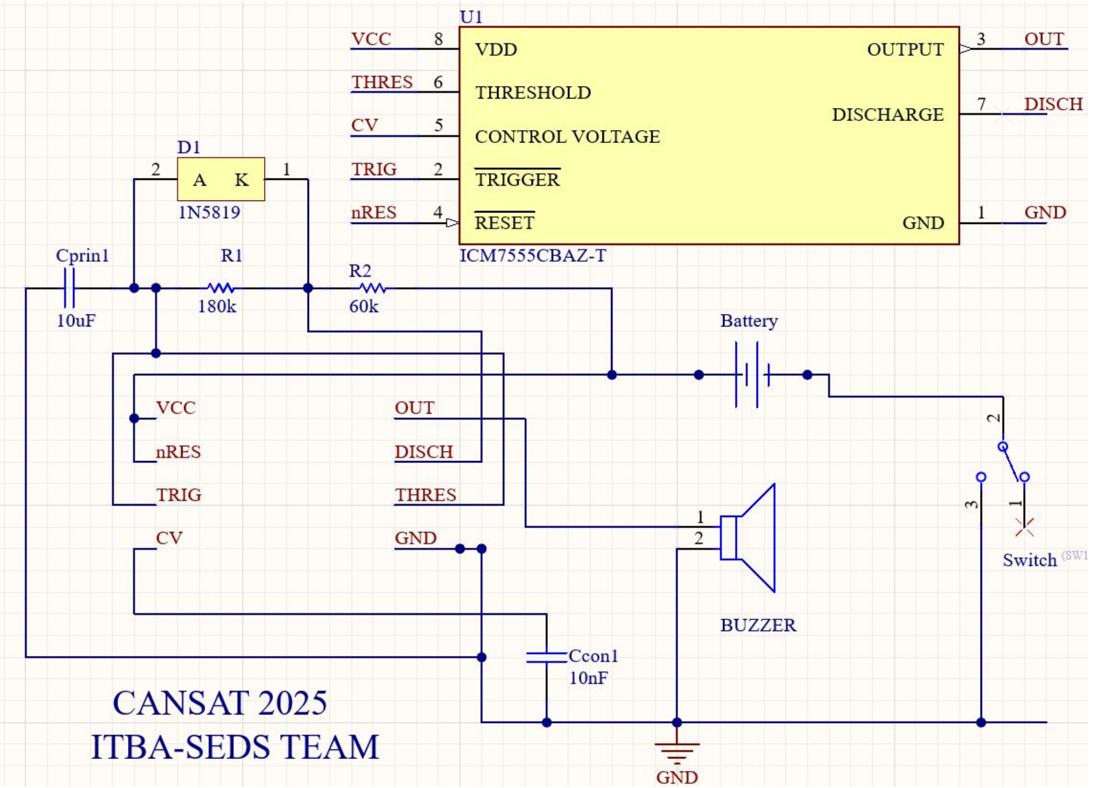
- **Introduction:**

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.





- **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 Location and Recovery (5/6)

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	10μF
Capacitor 2		10nF
Resistor 1	Carbon Film Resistor	180kΩ
Resistor 2	Carbon Film Resistor	60kΩ
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

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**.

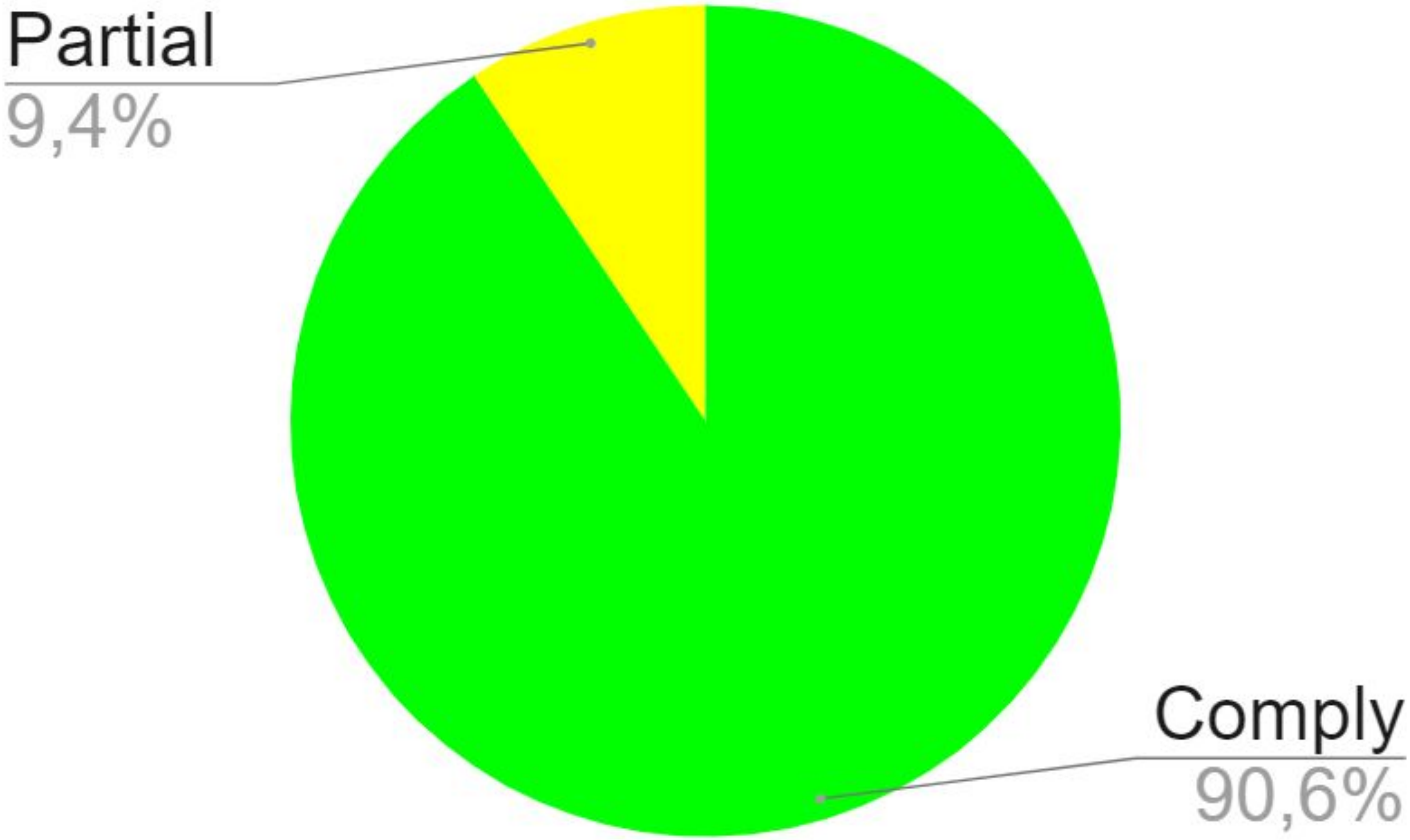
Activities rehearsed as of March 28

- **Ground system radio link check procedures:**
  - Two Xbees will be used for a short range transmission test, following the test procedures detailed in the previous sections
- **Testing sensors**
  - We have manufactured a PCB for testing all sensors. Not yet tested
- **Launch configuration preparations (e.g., final assembly and stowing appendages)**
  - We haven´t tested the payload stowing mechanism nor the stowage configuration of the AG
  - Final assembly is yet to be done
- **Loading the CanSat in the launch vehicle**
  - We have not done any loading rehearsal yet
- **Telemetry processing, archiving, and analysis**
  - CSV files were plotted correctly using the GCS.
  - No radio communication test were performed
- **Recovery**
  - We have yet to test the buzzer.
  - We have yet to test the GPS positioning.
- **Electrical Power Subsystem basic functionality:**
  - Correct battery and voltage converters behaviour were tested while **switching on and off** our basic PCB board for testing purposes

Requirements Compliance

Daniela Maradei

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, 36, 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, 46	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, 46, 62	

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	46	Theoretically complies, but further testing is needed
8	C8	The sensor telemetry shall be transmitted at a 1 Hz rate.	Comply	88	
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	34	
10	C10	A second video camera shall point in the north direction during descent.	Comply	33, 68, 69, 70	
11	C11	The second camera shall be pointed 45 degrees from the Cansat nadir direction during descent.	Comply	33, 68, 69, 70	
12	C12	The second video camera shall be spin stabilized so the ground view is not rotating in the video.	Comply	33, 68, 69, 70	

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	153,154,155, 156,157,158	
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	181,182,183	
15	S1	The Cansat and container mass shall be 1400 grams +/- 10 grams.	Comply	77,78,79	
16	S2	Nose cone shall be symmetrical along the thrust axis.	Comply	54	
17	S3	Nose cone radius shall be exactly 72.2 mm	Comply	20	
18	S4	Nose cone shoulder length shall be a minimum of 50 mm	Comply	20,54	

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	54	
20	S6	The nose cone shall not have any openings allowing air flow to enter.	Comply	54	
21	S7	The nose cone height shall be a minimum of 76 mm.	Comply	16, 54	
22	S8	Cansat structure must survive 15 Gs vibration	Partial	133, 137	Theoretically complies, but further testing is needed
23	S9	Cansat shall survive 30 G shock.	Partial	133, 137	Theoretically complies, but further testing is needed
24	S10	The container shoulder length shall be 90 to 120 mm.	Comply	58, 59	

Requirements Compliance (5/15)

#	Code	Description	Status	Slide Ref.	Comments
25	S11	The container shoulder diameter shall be 136 mm.	Comply	20, 58, 59	
26	S12	Above the shoulder, the container diameter shall be 144.4 mm	Comply	20, 58, 59	
27	S13	The container wall thickness shall be at least 2 mm.	Comply	58, 59	
28	S14	The container length above the shoulder shall be 250 mm +/- 5%.	Comply	20, 58, 59	
29	S15	The Cansat shall perform the function of the nose cone during rocket ascent.	Comply	19, 36, 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	20, 62, 63	

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, 74, 75	Mechanical mounts need further specification
32	S18	The CanSat container shall meet all dimensions in section F	Comply	20, 58, 59	
33	S19	The Cansat container materials shall meet all requirements in section F.	Comply	20, 58, 59	
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	48, 49	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	62,63,74	
38	M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Partial	76,133	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	56,75	
40	E1	Lithium polymer batteries are not allowed.	Comply	98, 99	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	98, 99, 101	
42	E3	Easily accessible power switch is required	Comply	98	

Requirements Compliance (8/15)

#	Code	Description	Status	Slide Ref.	Comments
43	E4	Power indicator is required for each voltage domain	Comply	98	LEDs are used
44	E5	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	Comply	101	Estimated operating time is over two hours
45	E6	The audio beacon shall operate on a separate battery.	Comply	101, 153	
46	E7	The audio beacon shall have an easily accessible power switch.	Comply	153	
47	X1	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Comply	88, 116	
48	X2	XBEE radios shall have their NETID/PANID set to their team number.	Comply	88	

Requirements Compliance (9/15)

#	Code	Description	Status	Slide Ref.	Comments
49	X3	XBEE radios shall not use broadcast mode.	Comply	88	
50	X4	The Cansat shall transmit telemetry once per second.	Comply	89	
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	90, 91, 92, 93	
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	34, 53	
59	SN8	Cansat payload shall video record the ground at 45 degrees from nadir direction during descent.	Comply	68	
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	68, 69, 70, 71, 72	

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	94, 125	CAL ALTITUDE button is in the GUI
64	G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	122	
65	G3	Telemetry shall include mission time with 1 second or better resolution.	Comply	86, 90	
66	G4	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	Comply	85	Flash memory is used for this purpose

Requirements Compliance (12/15)

#	Code	Description	Status	Slide Ref.	Comments
67	G5	Each team shall develop their own ground station.	Comply	116	
68	G6	All telemetry shall be displayed in real time during descent on the ground station.	Comply	121, 124	
69	G7	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.) and the units shall be indicated on the displays.	Partial	124	Just the plots have units
70	G8	Teams shall plot each telemetry data field in real time during flight.	Comply	124	
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	116, 117, 119	
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	116, 117, 119	

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	125, 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	116, 117	
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.	Partial	124	Graph Texts need to be adjusted
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	124	

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	125	
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	107	
80	F2	The Cansat shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	Comply	85, 107	
81	F3	The Cansat shall have its time set by ground command to within one second UTC time prior to launch.	Comply	107	ST command
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	108, 109	

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	109	
84	F6	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Comply	109	
85	F7	The flight shall include commands to activate all mechanisms. These commands shall be documented in the mission manual.	Comply	107, 125, 151	

Management

Santiago Bolzicco

Status of Procurements (1/3)

Component	Quantity	Status	Expected Arrival
390k SMD 0805 Resistor (tol 1%)	10	ARRIVED	
220k SMD 0805 Resistor (tol 1%)	10	ARRIVED	
Ublox NEO-6M + Patch Antenna	1	PENDING	April 16
A1104 Hall-Effect Sensor	2	PENDING	March 31
Quelima SQ11	2	PENDING	April 24
Micro-Lock Connectors Pair (M+F)	8	PENDING	April 16
Arduino Nano 33 BLE Sense Rev2	1	PENDING	March 31
DS3231 mini RTC + battery	1	PENDING	April 16
Yagi		PENDING	April 24
Motor Gimbal Driver DRV8313PWP	1	PENDING	March 31
4 Mb Flash SPI Memory	2	ARRIVED	

Status of Procurements (2/3)

Component	Quantity	Status	Expected Arrival
Samsung INR18650 Li-Ion Battery	2	PENDING	April 24
Switch	3	ARRIVED	
Step-Down Converter	1	PENDING	April 16
10 Ohm Resistor 1/4W	2	ARRIVED	
Safe Toggle Switch	1	ARRIVED	
97 dB Active Buzzer (CPI-3116-3-100T)	2	PENDING	March 31
PCB	2	ARRIVED	
GM2804 Gimbal Motor w/Encoder	1	ARRIVED	
Other Electrical & Electronics	1		End of April

Status of Procurements (3/3)

Component	Quantity	Status	Expected Arrival
Carbon Fibre Rods (4x350mm)	4	ARRIVED	
Braid fishing line	1	ARRIVED	
ABS 1 kg	1	ARRIVED	
Aluminum 0.1kg	1	ARRIVED	
Torsion Spring	4	PENDING	April 14
Screws, washers and nuts as needed	1	ARRIVED	
Bearings	2	ARRIVED	
Eyebolt + Swivel link	1	ARRIVED	

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
A1104	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)	NO	4	47/1m	Actual (TiendaMia)
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	6 per 10 units	Actual (MercadoLibre)
Screws, washers and nuts, as needed	NO	1	15	Actual
Bearings	NO	2	5 per unit	Estimated
Eyebolt + Swivel link	NO	1	5	Actual
TOTAL (Mechanics) = 154 USD				

CanSat Budget – Hardware (4/4)

Subsystem	Cost (USD)
Electrical	366,07
Mechanical	154
TOTAL = 520,07 USD	

CanSat Budget – Other Costs (1/2)

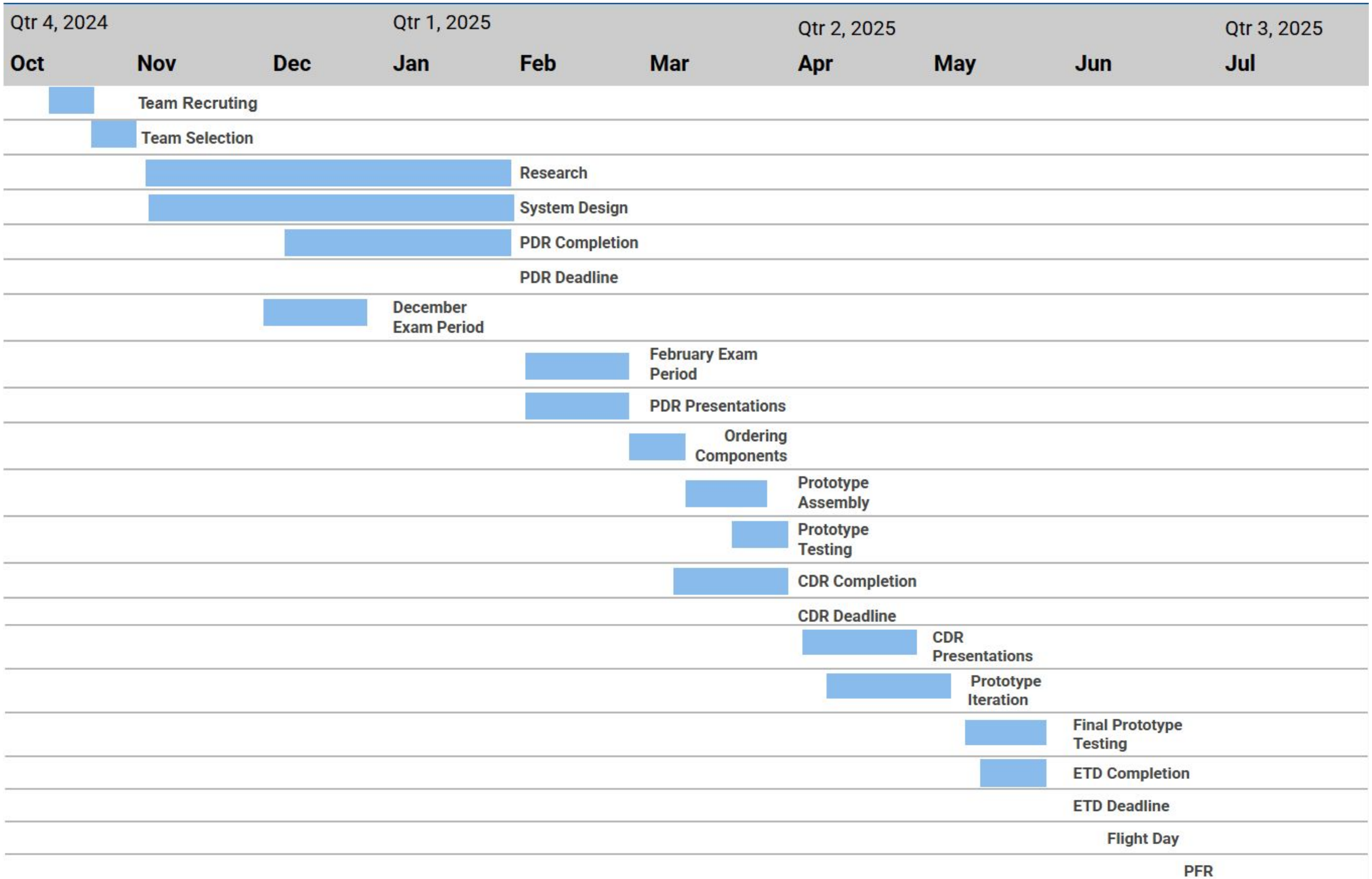
Ground Station				
Component/Hardware	Reuse?	Quantity	Cost per Unit (USD)	Estimated/Actual
Yagi Antenna	NO	1	150	Actual
Yagi Antenna Mounting (Table Top)	NO	1	25	Estimated
XBee USB Adapter FT232RL	YES	1	88,5	Actual
Laptop Computer	YES	1	1000	Estimated
Umbrella	YES	1	9	Actual
TOTAL (Ground Station) = 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 and CanSat build cost was paid by ***Instituto Tecnologico de Buenos Aires***.
We are still in the process of looking for sponsors for the travel expenses.

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

- At this time 70% of the work is done
- The pending work includes prototype assembling and testing, besides of the competition phase

Shipping and Transportation

Taking into account airline restrictions, and that we are flying by plane from Buenos Aires, Argentina to Virginia, which is not a direct flight, and in where we will take transportation to Virginia Tech we have decided that:

Carry on Baggage	Checked Baggage
• Computer • Batteries	• Various tools (such as screwdriver, hammers, etc) • Extra 3d printed parts, if CanSat is broken during travel • CanSat padded with bubble wrap or foam

Conclusions (1/3)

Major accomplishments
• Most of the components have been ordered and will be arriving in the coming weeks. • The sensors proposed in the PDR function as expected, and we did not need to do any major changes. • We have 3D-printed the firsts prototypes for the nose cone and the autogyro. • Most software components have been tested with the hardware and work as expected.

Conclusions (2/3)

Major unfinished work
- Looking for sponsors for travel expenses - Waiting for electrical components and structural pieces - Testing of mechanisms due to missing pieces

Testing to complete
- The subsystem level test that are left - All System level tests - Environmental Test
Flight software status
- Individual tests have been conducted for certain modules which are currently been developed - We were not capable of performing general tests

Conclusions (3/3)

We are ready to move to the next phase!

All in all, the team has met most critical design requirements and is ready to proceed to the next stage of development as all major goals and milestones are complete. However, there are still several key tests to be conducted to validate critical aspects of the project. As we move forward, we remain committed to ensuring that all functionalities are thoroughly verified before the final implementation.