Nucleo de AeroEspacial

ASTRO

Electronics Report

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1 Electronics Working Volume

- **Dimensions:** 300 mm × 119 mm (inner diameter)

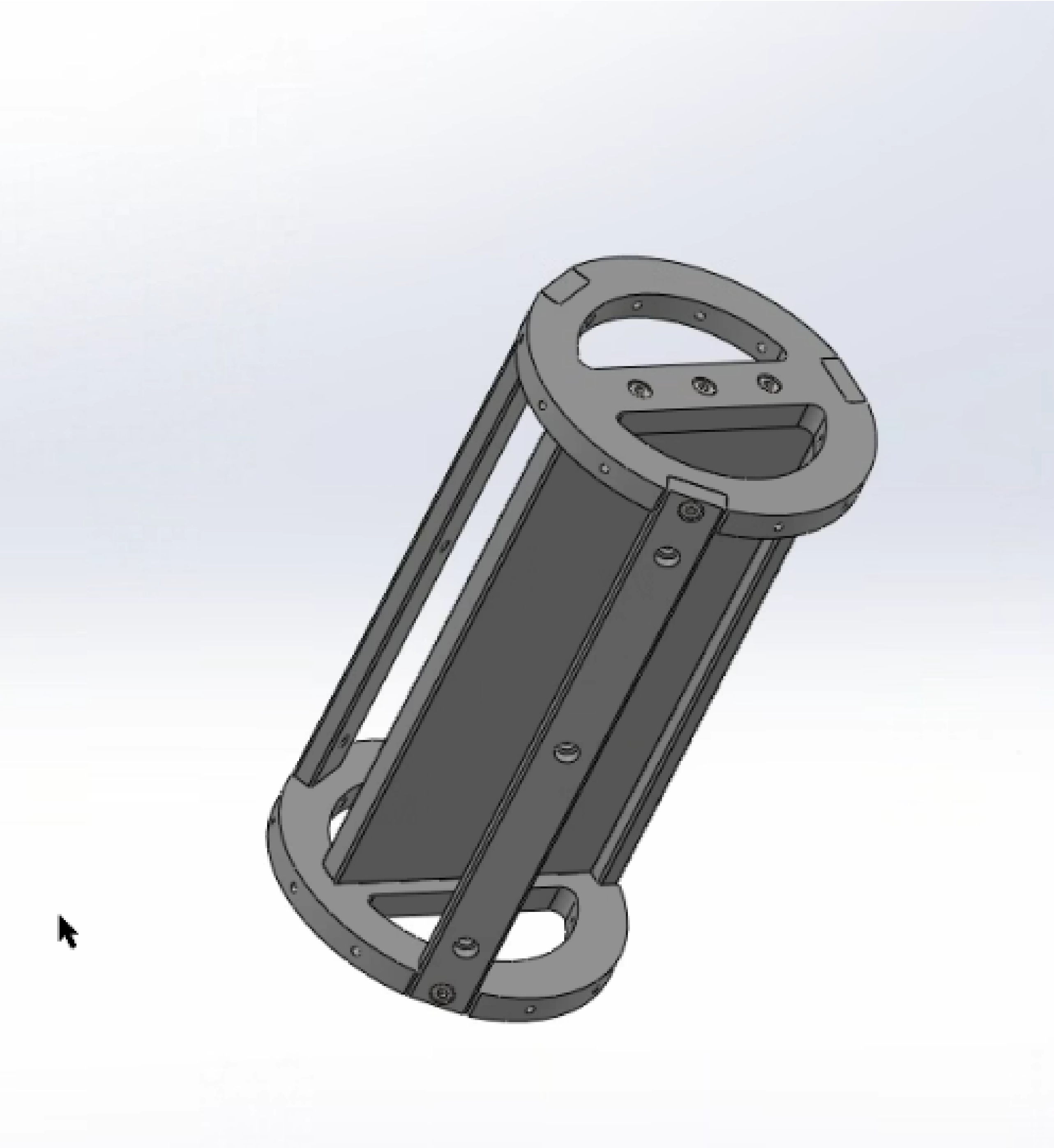


Figure 1: View of future PCB placement

PCB	Designation
PCB 1	SRAD
PCB 2	COTS
PCB 3	PSU

2 Electronic Components

2.1 SRAD

Device	Voltage (V)	Current (mA)	Power (mW)
CPU STM32F411	1.8 – 3.6	?	?
6DOF IMU ICM-45686	3.3	34	?
3DOF accelerometer ADXL375	2.0–3.6	145 µA	?
3DOF magnetometer LIS2MDL	1.71 – 3.6	200 µA	?
Barometer MS5607	1.8–3.6 V	1.4	?
GPS module NEO-M9N	3.6	?	?
LoRa SX1278 Ra-02	1.8 – 3.3	105	?
SparkFun microSD Transflash	3.3	20	?

2.2 COTS

Device	Voltage (V)	Current (mA)	Power (mW)
CATS Vega	7–24	100	321.75

2.3 PSU

- Converts main battery voltage to 5 V, and 3.3 V
- Can be disconnected via an arming pin (to be removed before flight)

Battery System

Electrical power is supplied by two Lithium-Polymer (LiPo) batteries:

- **Main Battery (SRAD):** 7.4 V, 2400 mA·h
- **Redundancy Battery (COTS Flight Computer):** 7.4 V, 2400 mA·h

Gens ace 2400mAh 2S 7.4V RX Lipo Battery Pack with JST-SYP Plug

Parameter	**Value**
Balancer Connector Type	JST-XHR-2P
Brand	Gens Ace
Capacity (mAh)	2400
Configuration	2S1P
Connector Type	JST-SYP
Discharge Rate (C)	/
Height ($\pm$2mm)	17
Is Featured Product	No
Length ($\pm$5mm)	88
Max Burst Discharge Rate (C)	NO
Net Weight ($\pm$20g)	94
Over 300Wh	No
Preorder Config	No
Store No.	M502A
Voltage (V)	7.4
Width ($\pm$2mm)	29
Wire Gauge	AWG20#
Discharge Wire Length (mm)	80
Quantity per Box	42 pcs/box
Capacity Range (mAh)	1000–2999

Table 1: Specifications of Gens Ace 7.4V 2400mAh LiPo Battery

Additionally, external power can be provided via a pad connector to keep the main battery fully charged during pre-flight checks.

3 Programming of the SRAD Computer

The SRAD computer was developed using **STM32CubeIDE**, chosen for its comprehensive toolset, native support for STM32 microcontrollers, and integrated debugging and configuration features. Communication between the SRAD computer and external systems is currently handled via **UART** using the RX/TX interface.

Programming and debugging are performed through the **ST-LINK V2** interface, shown in Fig. 2. This interface provides a stable and reliable connection between the development PC and the STM32 microcontroller.


ST-LINK V2
STM8 & STM32
RST
SWDIO
GND
GND
SWCLK
SWIM
3.3V
3.3V
5.0V
5.0V

The complete hardware setup used during development is illustrated in Fig. 3. The STM32F411 development board itself is shown in Fig. 4.

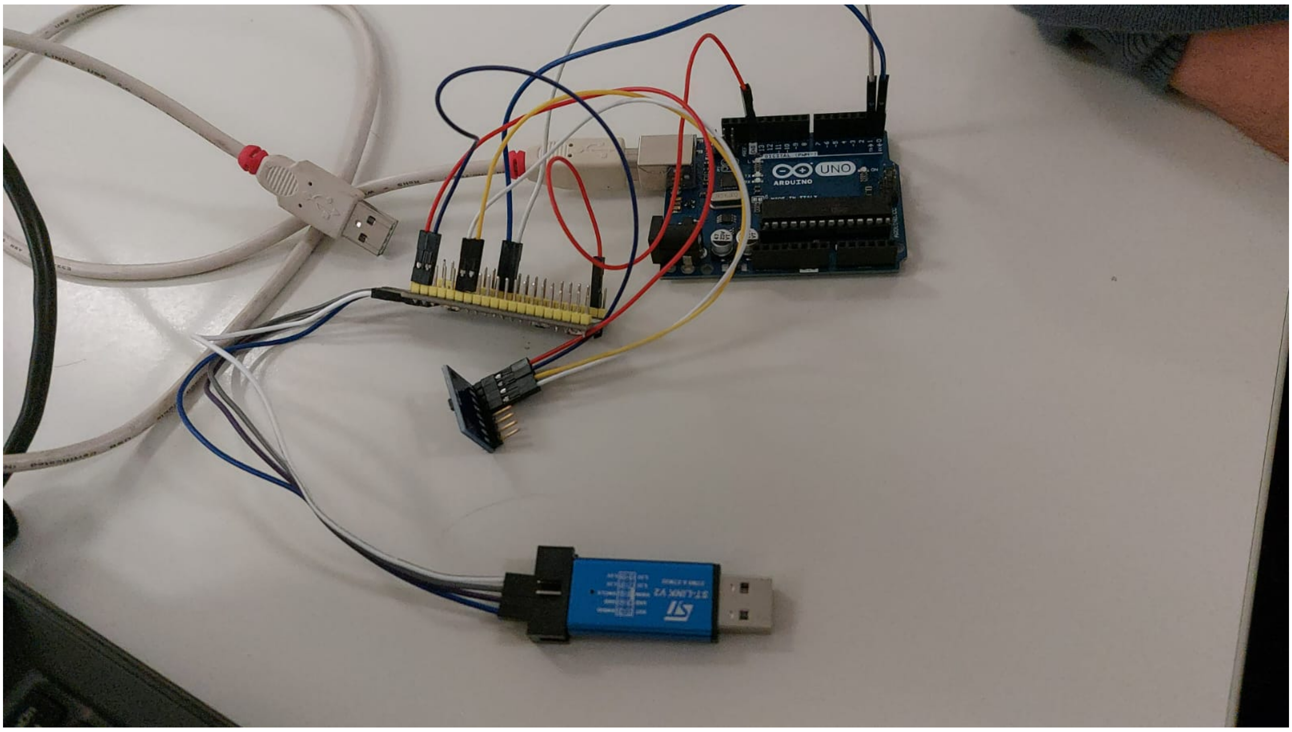
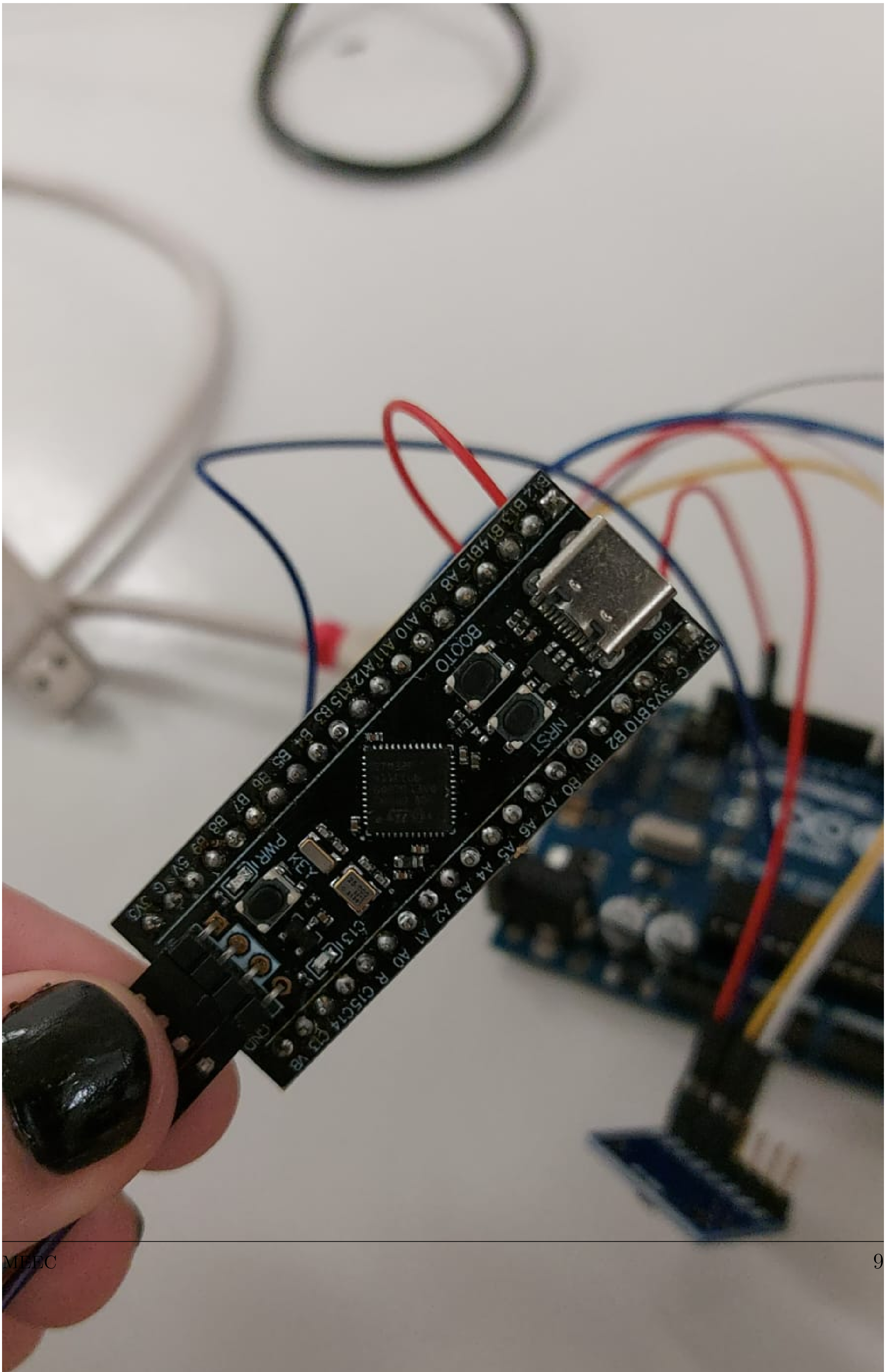


Figure 3: Current development setup


BOOT0
NRST
PWR
KEY

Key design choices and operational rules for the system are summarized below:

- The COTS recovery system will always issue the recovery deployment signal.
- The COTS system takes priority and can overrule any deployment signal generated by the SRAD computer.
- The firmware is built on **FreeRTOS**, providing deterministic task scheduling and modular task management.

4 Control System / Dynamics

4.1 Active control

The active control system of the *ASTRO Rocket* is exclusively dedicated to the deployment of airbrakes, which are used to increase aerodynamic drag and reduce velocity in order to achieve the target apogee. Other forms of active control, such as fin actuation, are prohibited by the European Rocketry Challenge (EuRoC) regulations [1].

The airbrake control is implemented using PID controllers running on one of the onboard microcontrollers. This controller communicates with the servo motor system, which actively deploys the airbrakes by rotating a geared mechanism. The PID controller is designed based on the relationship between the *drag coefficient* and the *Mach number* for each airbrake deployment level. Velocity measurements are used as the primary feedback variable to determine the appropriate control action required to reach the target velocity at each altitude. The altitude is estimated by correlating the pressure measured by the onboard barometer with the International Standard Atmosphere (ISA) pressure model. Further details regarding the experimental implementation and results will be presented in future revisions of this document.

4.2 Sensing System

The sensing and control subsystem features a more sophisticated architecture. All sensors are connected to an onboard microcontroller dedicated to data handling and signal processing. The acquired data are processed through a Multiplicative Extended Kalman Filter (MEKF) to enhance state estimation accuracy and suppress measurement noise. The MEKF is a well-established algorithm widely used in spacecraft attitude determination systems due to its high precision [2].

In the context of apogee estimation, the MEKF contributes by providing accurate attitude quaternion estimates derived from the magnetometer, gyroscope, and accelerometer measurements. When the pitch angle, inferred from the estimated quaternion, approaches zero, the rocket is considered to have reached the apex of its parabolic trajectory, indicating the apogee point.

5 Ground Station

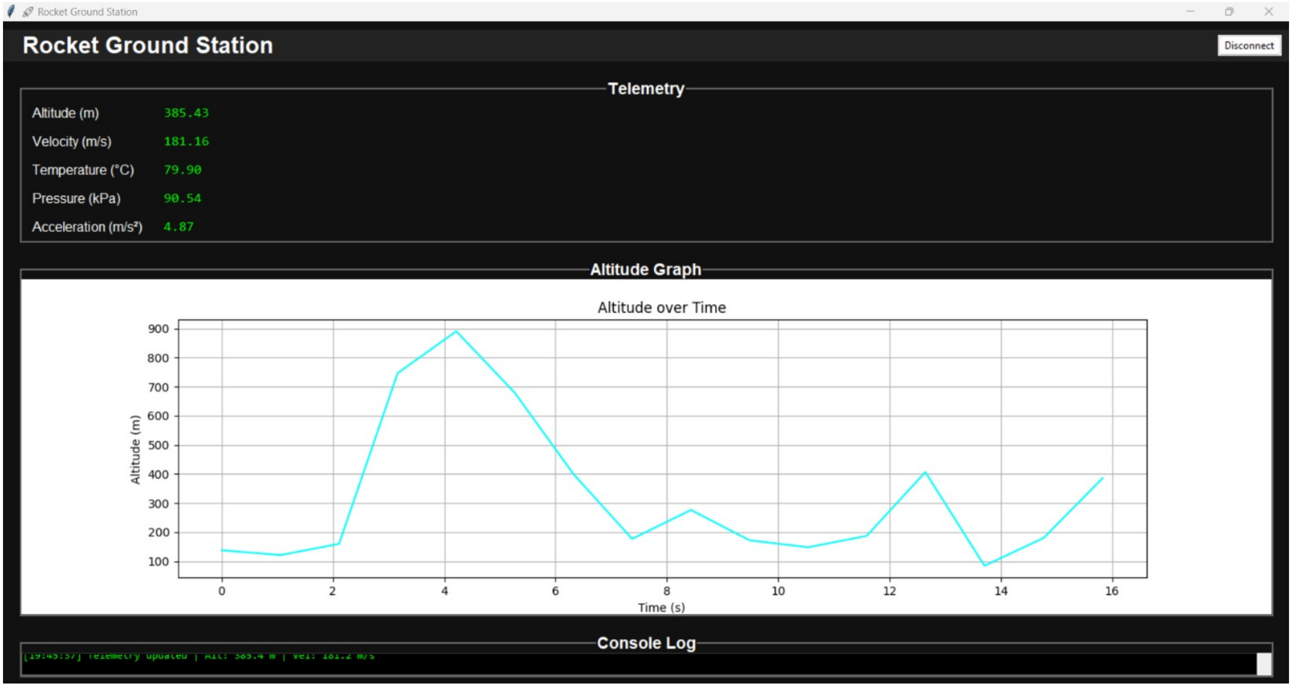


Figure 5: Current Ground Station

TODO:

- Add simulation CSV data input
- Display position in 3D
- Temperature data
- Airbrake percentage
- Gyroscope pressure data
- Parachute trigger (main/rogue)
- Ask for team feedback
- Rocket arming signal
- Time tracking
- Internal pressure measurement

6 Antennas

Communication between the ground station and the rocket will be handled using the LoRa SX1278 Ra-02 module, paired with a Yagi-Uda antenna and a Vertical End Feed.
The LoRa Sx1278 Ra-02 module provides long-range communication and high interference immunity with low power consumption

References

[1] European Rocketry Challenge, *European Rocketry Challenge: Rules & Requirements*, Portuguese Space Agency, 2025, accessed: 11 November 2025. [Online]. Available: https://www.europespaceport.pt/euroc

[2] F. Markley, Y. Cheng, J. Crassidis, and R. G. Reynolds, "Error-covariance reset in the multiplicative extended kalman filter for attitude estimation," *Journal of Guidance, Control, and Dynamics*, 2023.