CanSat 1st Report – Juice

1 Introduction

We are one of the two teams representing Decroly School. Our team is composed of Cassiel Urbanska, Alexandre Itschert, Nathan Bastin, and Louna de Locht. We are all in our final year of high school. Our school has been participating in this competition for several years, which is how we became aware of it.

We chose to take part in the CanSat Belgium programme because it offers a unique opportunity to apply scientific studies in a concrete and practical way. This project allows us to experience how theoretical scientific knowledge can be transformed into real-world experimentation, combining physics, engineering, biology, and data analysis.

Participating in CanSat is also a unique opportunity. It gives us the chance to work as a team on a complete scientific project.

1.1 Primary mission

Regarding the primary mission, we will record atmospheric data: temperature, pressure, and altitude and we will transfer this data in real time to a ground station, so that we can recover the data even if our CanSat is lost.

1.2 SECONDARY MISSION

Our secondary mission aims to collect surrounding particles and dust by aspiration (thanks to a propeller) and analyse samples from the Cansat's immediate environment upon landing, in order to detect and distinguish potential forms of life that may be present.

This mission is distinctive in that it is strongly biology-oriented, whereas CanSat projects typically focus primarily on engineering and physics. The interdisciplinary nature of the approach attracted us and motivated the selection of this secondary mission. It also seeks to address the challenge of controlling contamination in biological samples collected during space missions, while responding to the difficulty of obtaining surface samples with minimal interaction.

The mission will proceed as follows: the CanSat will detect landing using two parameters, acceleration and altitude. Once the accelerometer has recorded two maxima and two minima, and the altitude sensor has detected a peak, the CanSat will determine that it has landed and will initiate the secondary mission.

2 PROJECT DESCRIPTION

2.1 PRIMARY MISSION

During the primary mission, we plan to measure the atmospheric pressure, temperature, and altitude of our CanSat. These measurements will be obtained using a BME280-3V3 sensor. This sensor is well suited to our needs, as it is compact, reliable, and already integrated into our PCB, since it is the same model used during the workshop. Our microcontroller board is a Raspberry Pi Pico.

Regarding radio communications, we will use an RFM69 module for the ground station, connected to a Yagi antenna (composed of a director, a dipole, and a reflector). For the CanSat antenna, we will use a µFL antenna cable combined with a 433 MHz SMA antenna integrated into our PCB. A standard toggle switch will be used to power the system on and off.

Our parachute will have a circular shape, with a diameter of 33 cm, and will be bright orange in colour. It will be equipped with eight metal rings at its edges in order to securely attach the suspension lines without damaging the fabric. It also includes a central vent hole with a diameter of 5.5 cm. We selected the orange colour to ensure that the CanSat remains clearly visible during its descent, making recovery easier.

Since the raspberry pi pico does not have enough storage space we are planning on using a SD card to store all the information.

Figure 1. Our Yagi antenna

2.2 Secondary Mission

To achieve this objective, our CanSat will be equipped with a fan positioned at the bottom of the can. This fan will be isolated from the external environment by a layered assembly of very thin plastic and foam. The purpose of this design is to allow the fan to draw outside air into the CanSat when operating, while preventing air from entering the can when the fan is switched off. Our initial concept to address this issue consisted of a flap that would detach upon impact during landing; however, we concluded that this mechanism presented an excessive risk of malfunction.

The collected sample will then pass through a funnel directing it into a sterile container filled with foam material. We intend to use aquarium-grade filtering foam (open-cell polyurethane), as it is readily available, inexpensive, and suitable for sampling purposes. Any microorganisms present in the air sample are expected to adhere to the foam. Sterility within this compartment will be ensured through an electromagnetic sealing system. At the inlet, an electromagnet will hold a thin magnetic plate in place, thereby preventing any air ingress through the fan opening. A second electromagnet will be installed at the outlet of the culture container, in order to prevent air entry through that conduit as well. When the electromagnets are deactivated, the thin plates can be slightly lifted by the airflow generated by the fan, allowing air to circulate through the system. A key advantage of using electromagnets in this project is that they can be activated remotely: they can remain engaged while the CanSat is in flight, and be deactivated upon landing (a critical element to include in the system diagram).

A second compartment, sterilised using the same method, will be placed adjacent to the first one but will remain completely sealed. Its purpose is to serve as a sterile reference container to validate the sterility of our sampling process. We will refer to it as the “control” container.

After landing, both containers will be recovered, and a sample from each foam insert will be transferred into separate Petri dishes. This will allow us to compare the two environments and draw conclusions regarding possible contamination and biological presence.

The code diagram sits in **1.5 Software design**.

2.2.1 Mechanical design

2.2.1.1 Parachute Design

Our parachute will be circular, with a diameter of 33 cm, and will be bright orange in colour. It will be fitted with eight metal rings at its edges in order to securely attach the suspension lines without damaging the fabric. It also includes a central vent hole with a diameter of 5.5 cm. We selected the orange colour to ensure that the CanSat remains clearly visible during its descent, facilitating tracking and recovery.

Figure 2. Parachute descent test

Regarding the design calculations for the parachute, no theoretical calculations were performed. Instead, we produced an initial prototype (based on previous functional parachutes our school had kept) and progressively refined its dimensions through several test flights. After multiple trials, we reduced the parachute size in order to reach an optimal configuration that effectively slows down the CanSat during descent.

Because we have not yet had the opportunity to properly test our parachute, we calculated the speed of the parachute to see if it meets the requirements (see annexe)

2.2.1.2 Can Design

The can will consist of two parts: two half-cans cut longitudinally. They will overlap along their thickness, and threaded rods running through both sections along their entire length will allow the assembly to be secured, while still enabling straightforward opening when required (see 3D visualisation). The two circular end faces of the cylindrical structure will also interlock, as illustrated bellow

At the bottom of the CanSat, there will be a fan directly connected to a funnel that will channel the air toward the foam. The bottom of the can will be recessed by 5 mm toward the interior of the CanSat in order to protect the fan.

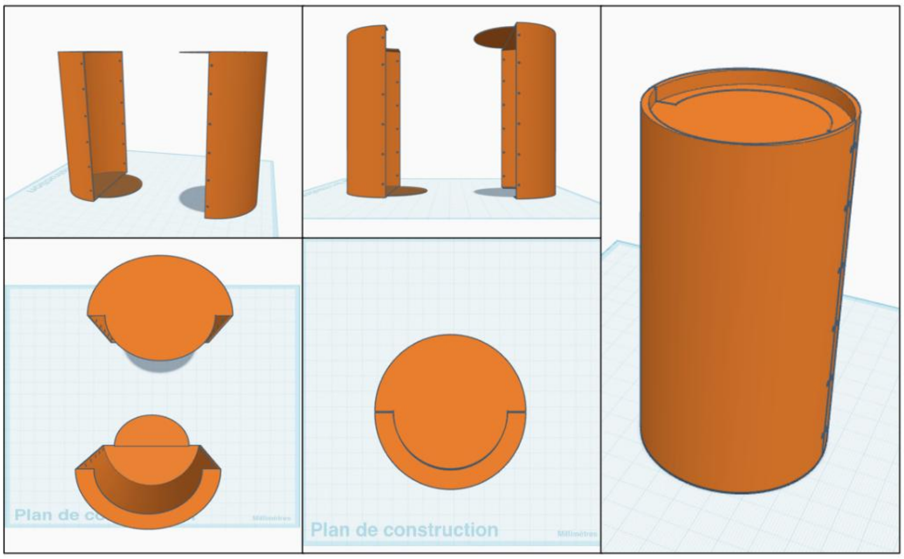


Figure 3. Can 3D design

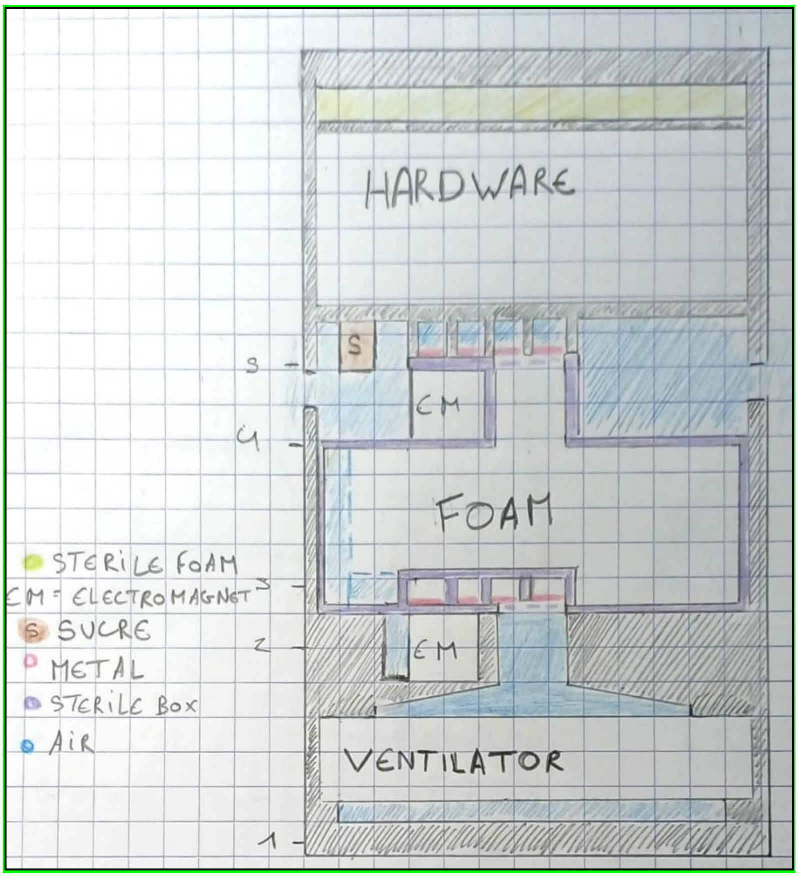


Figure 4. Diagram of our Can

2.2.1.3 Récupération et mise en culture.

After the CanSat landing, we will retrieve the two foam samples (the control foam and the foam that was in contact with the sample) and keep them in their original containers. They will be removed from the containers in a sterile environment, most likely by working near a flame to maintain sterile conditions. Both foams will then either be placed in a liquid nutrient medium (standard nutrient broth) or swabbed and spread onto a Petri dish. The choice of the most practical method is still under consideration, as both options have advantages and disadvantages: the liquid medium does not allow differentiation between the types of microorganisms present, but it enables faster growth and the production of a larger biomass. The solid medium on a Petri dish, on the other hand, allows easier observation, comparison, and identification of the different colonies, at the cost of slower and less abundant growth.

After 24 hours of incubation in the culture medium, we will assess both foam samples using a spectrophotometer (loan or acquisition still under investigation). The results will then be analyzed and compared.

2.2.2 Electronic design

2.2.2.1 System overview

We will use an RFM69 radio module, which was provided to us at the beginning of the project. It is compact, reliable, and sufficiently powerful for our communication requirements.

Regarding environmental sensing, we will use a BME280 3V3 sensor. Its performance is adequate for the parameters we intend to measure and compute, and therefore no additional sensor is required.

We will also integrate an Adafruit Ultimate GPS Breakout module with GLONASS support. This module is compact and provides the level of accuracy and reliability needed for our project.

In addition, we plan to purchase 5V electromagnets in order to implement an effective sealing mechanism that can be controlled remotely, ensuring that the CanSat remains airtight when required

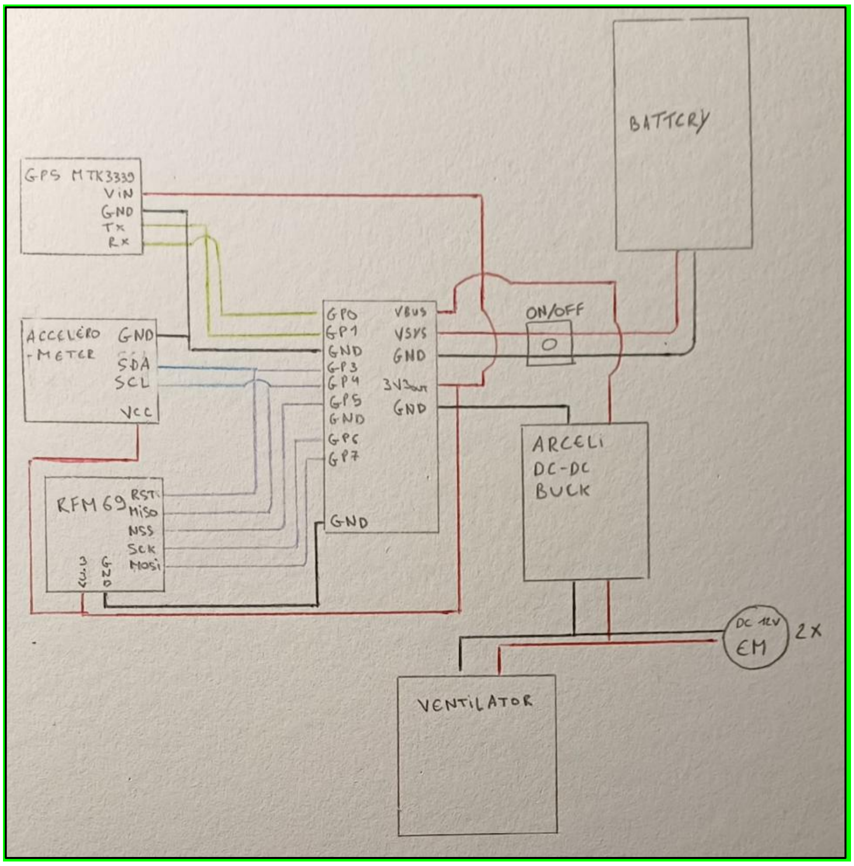


Figure 5. Connection diagram for the Raspberry Pico.

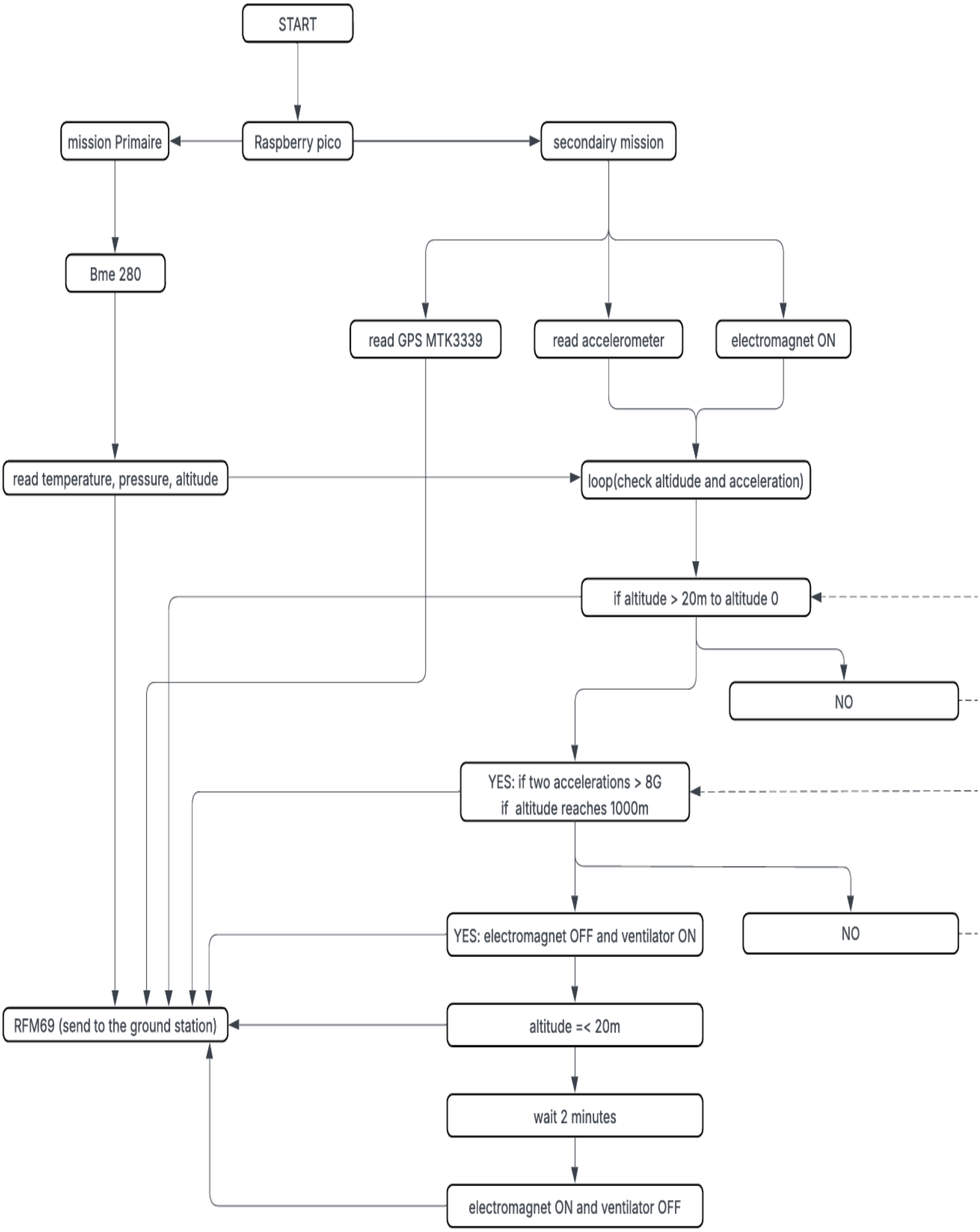
.

2.2.2.2 Power consumption

Module	Expected power draw (mA)
RPi Pico	50
rfm69	120
BME280	0,6
gps Adafruit	20/25
electromagnet	500-1000
fan	100 - 500
TOTAL	**790,6-1695,6**

As shown here, the electromagnets have a significant power draw. We are therefore considering adding an additional battery to compensate for this consumption and ensure sufficient power availability throughout the mission.

2.2.3 Software design



In this software design if there is a 'read' or an 'if' statement, this means that the data is sent to the RFM69 and saved to the SD card.

2.2.4 Ground station design & Data processing

2.2.4.1 Antenna & Data Capturing

We will use the pico and PCB provided in the basic kit, attached to a Yagi antenna.

If we have the time for it we will build our own Yagi antenna and this is what it might look like.

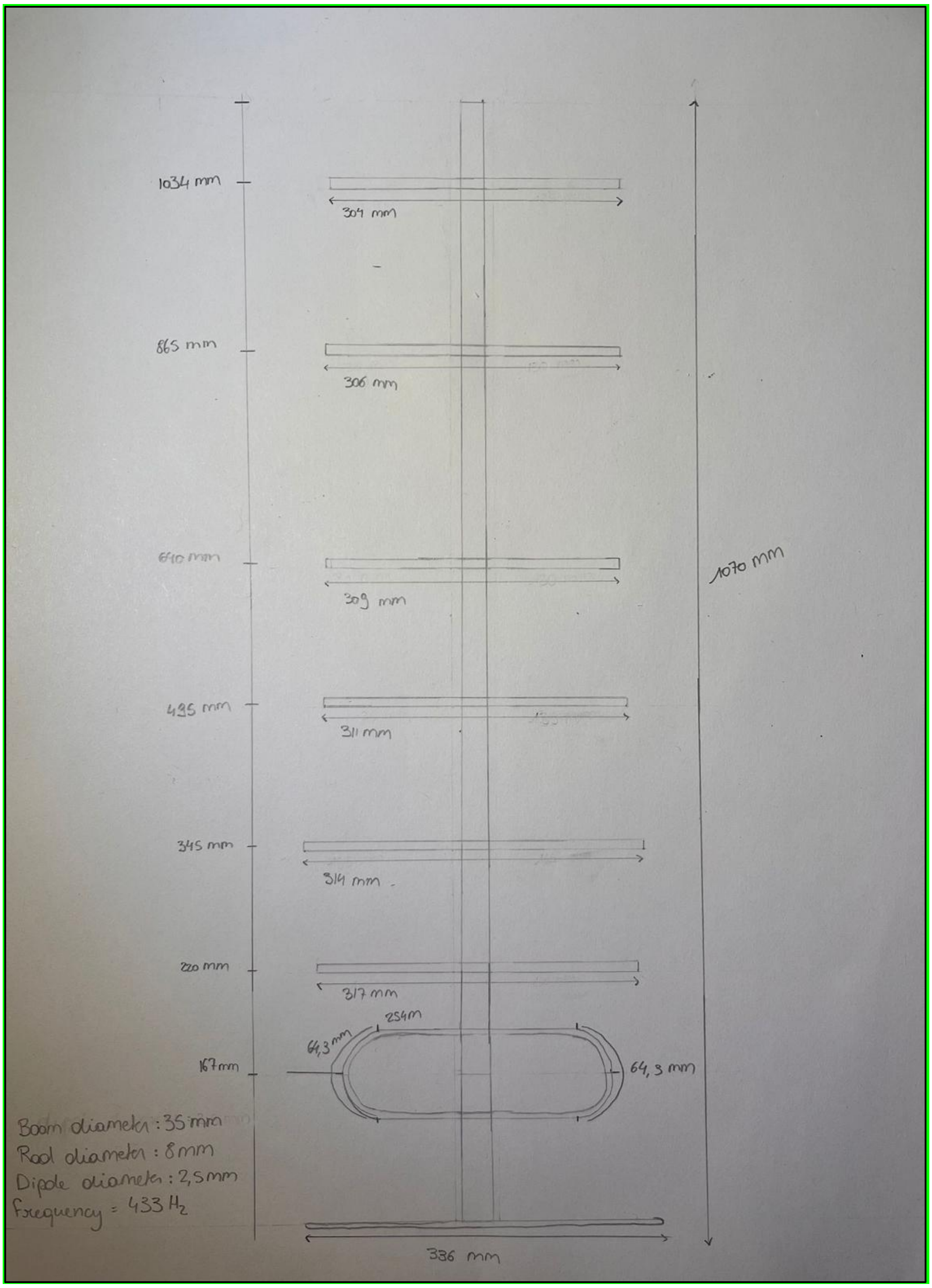


Figure 6. Measurement for the Yagi antenna

2.2.4.2 Data Processing

For our primary mission: thanks to our antenna, we will have live data on our computer, which will allow us to perform the necessary calculations.

For our secondary mission: we plan to collect our can at the end so that we can take it to the laboratory to analyze the bacteria we have collected. We also need to verify if our fan and our electromagnets have worked well and have done what we needed them to do to make sure our foam has been kept safe and neutral until the landing.

2.2.5 Recovery system

Our CanSat parachute is bright orange so that it can be seen and tracked visually; in addition, we plan to integrate a GPS and a buzzer into our CanSat as standard so that we can track our can wherever it is.

3 TESTING

We have already tested our Yagi antenna and the various codes needed for the primary mission, and they are working without any problems. We have started testing our parachute, which seems to be working fine, but we have not been able to test it from a great height. We plan to contact the municipality of Beersel to request access to its water tower, which is much higher, so that we can conduct tests there. We have also made some initial 3D prints, but the plans still need to be improved.

Figure 7. Radio communication distance test

Parachute test distance at Beersel water tower

Height of the water tower: 33 m

Distance from the castle to the field extremity: 1,37 km= 1370 m

Test distance (using Pythagorean theorem) :

$$= \sqrt{33^2 + 1370^2} = 1370{,}4 \text{ meters}$$

<table>
<tr><th></th><th>Status</th><th>Comment</th></tr>
<tr><td>Parachute</td><td>NOT FUNCTIONAL</td><td>We made some first tests and it does not yet withstand a load of 100 N.</td></tr>
<tr><td>Primary mission</td><td>FUNCTIONAL</td><td>Everything has been tested and is functional.</td></tr>
<tr><td>Code for the primary mission</td><td>FUNCTIONAL</td><td>It has been tested and is functional.</td></tr>
<tr><td>Antenna</td><td>FUNCTIONAL</td><td>Has been tested and works.</td></tr>
<tr><td>Secondary mission</td><td>ON HOLD (waiting for delivery)</td><td><table>
<tr><td>Fan</td><td>NOT TESTED</td></tr>
<tr><td>Steril foam</td><td>NOT TESTED</td></tr>
<tr><td>Electromagnets</td><td>NOT TESTED</td></tr>
<tr><td>Aspiration</td><td>NOT TESTED</td></tr>
</table></td></tr>
<tr><td>Hardware</td><td>NOT FUNCTIONAL</td><td>We have a part of the components but not everything yet</td></tr>
<tr><td>Battery</td><td>NOT FUNCTIONAL</td><td>We have all of the components, we just need to integrate them in our system.</td></tr>
<tr><td>Recovery</td><td>FUNCTIONAL</td><td>It has been tested and works well</td></tr>
</table>

Note for the parachute: We tested the parachute by dropping it from the second floor and calculating its final speed. We encountered a minor issue: the measured final speed was too low (3.4 m/s). We believe this result is due to the limited drop height of only two floors, which does not allow the parachute to reach its true terminal velocity.

To obtain more accurate results, we plan to conduct additional tests at a different location with a significantly greater drop height.

4 REQUIREMENTS

No.	Requirement	Status
1	**Size of a standard soda can (115 mm height and 66 mm diameter)**	OK
2	**Antenna and parachute (folded) respect the CanSat diameter (66 mm)**	OK
3	**Weight between 300 g and 350 g**	at this stage of advancement, OK
4	No explosive or flammable material	OK
5	4 hours of power from battery or solar panels	We didn't tested our battery yet
6	The battery can be changed on field	WeThe replacement mechanism is still under consideration.
7	**Have a master switch**	We will do so
8	Have a reusable recovery system, such as a parachute (bright coloured fabric recommended)	OK
9	Parachute attachment should accept 100 N	The first parachute prototype failed due to a problem with the attachment.
10	**Flight time limited to 120 s**	We're waiting for the test at the water tower of Beersel
11	A descent rate between 8 and 11 m/s	We're waiting for the test at the water tower of Beersel
12	**Acceleration 20 g**	we haven't tested that yet
13	**A positioning system can help retrieval (beeper, GPS, radio signal...)**	presence of a GPS. OK
14	Total value under €500	at this stage of advancement, OK
15	Include real market cost of sponsored material	OK
16	**Respect assigned radio frequency**	OK

5 OVERALL PROGRESS

5.1 HUMAN RESOURCES

Cassiel Urbanska Richel: curious about sciences (especially biology),has been playing rugby for ten years, loves music, and has a strong interest in learning.

Alexandre Itschert: huge music enthusiast, fluently speaks French, Dutch and English.

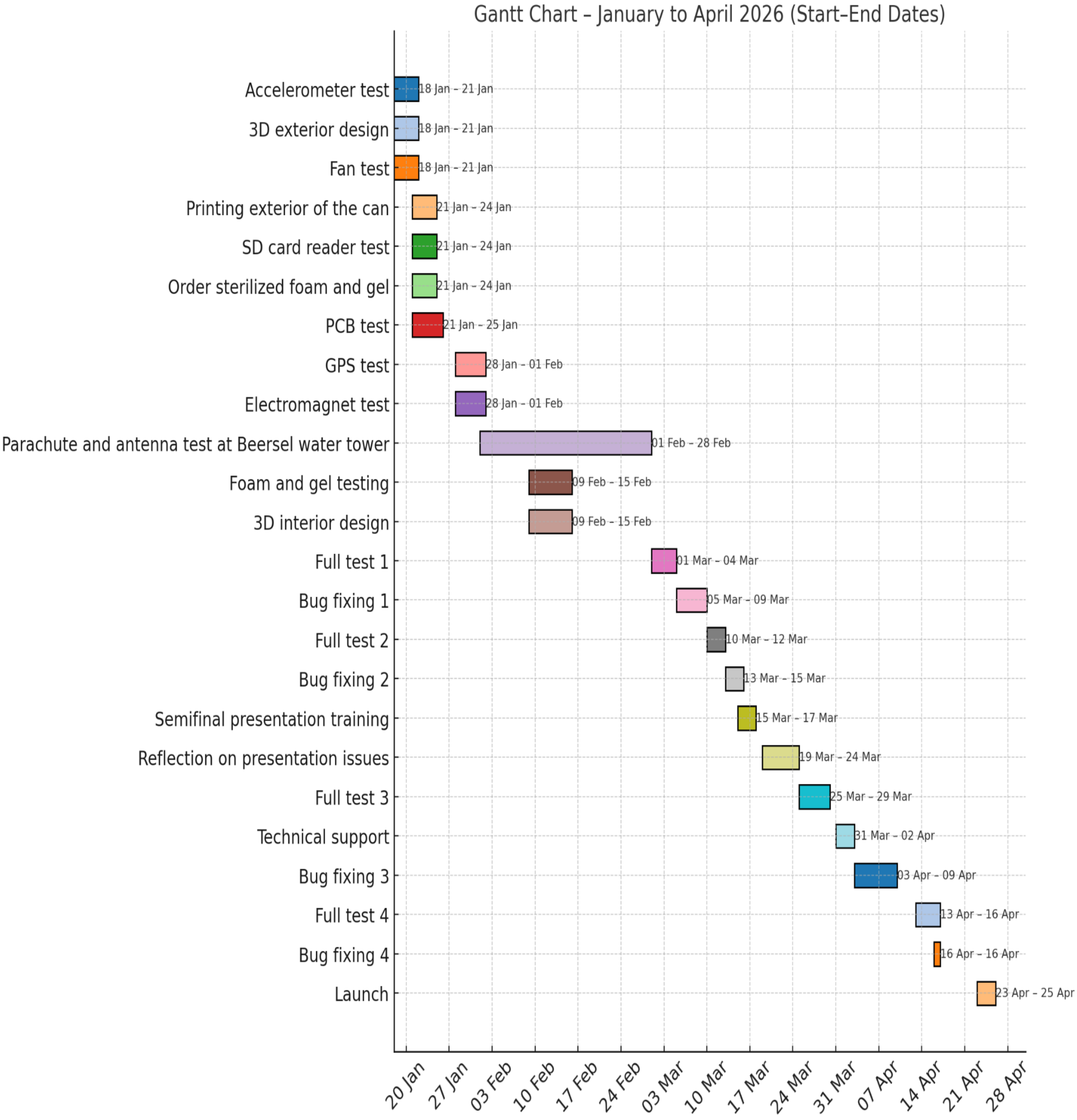
Louna de Locht: really fond of sciences, nature, sports, loves doing projects of all sorts.

Nathan Bastin: passionate about math, biology , sport and drawing.

Figure 8. From left to right : Cassiel, Nathan, Louna & Alexandre

Task	**Louna**	**Cassiel**	**Alexandre**	**Nathan**
Communication	YES		YES	
Hardware			YES	YES
Software			YES	YES
Administration	YES			YES
3D design		YES		
Parachute & Recovery	YES		YES	
Drafting	YES	YES	YES	YES
engineering		YES		
planification	YES			YES
budget	YES			

5.2 Planning



Gantt Chart – January to April 2026 (Start–End Dates)
Accelerometer test
18 Jan – 21 Jan
3D exterior design
18 Jan – 21 Jan
Fan test
18 Jan – 21 Jan
Printing exterior of the can
21 Jan – 24 Jan
SD card reader test
21 Jan – 24 Jan
Order sterilized foam and gel
21 Jan – 24 Jan
PCB test
21 Jan – 25 Jan
GPS test
28 Jan – 01 Feb
Electromagnet test
28 Jan – 01 Feb
Parachute and antenna test at Beersel water tower
01 Feb – 28 Feb
Foam and gel testing
09 Feb – 15 Feb
3D interior design
09 Feb – 15 Feb
Full test 1
01 Mar – 04 Mar
Bug fixing 1
05 Mar – 09 Mar
Full test 2
10 Mar – 12 Mar
Bug fixing 2
13 Mar – 15 Mar
Semifinal presentation training
15 Mar – 17 Mar
Reflection on presentation issues
19 Mar – 24 Mar
Full test 3
25 Mar – 29 Mar
Technical support
31 Mar – 02 Apr
Bug fixing 3
03 Apr – 09 Apr
Full test 4
13 Apr – 16 Apr
Bug fixing 4
16 Apr – 16 Apr
Launch
23 Apr – 25 Apr
20 Jan
27 Jan
03 Feb
10 Feb
17 Feb
24 Feb
03 Mar
10 Mar
17 Mar
24 Mar
31 Mar
07 Apr
14 Apr
21 Apr
28 Apr

Task	Status (in percent)	Noticed
Primary mission	IN PROGRESS (90)	The can is not printed yet
Code primary mission	DONE (100)	
PCB	IN PROGRESS (45)	We have the different plans of the pcb and we ordered it. We need to test it
Secondary mission	IN PROGRESS (50)	
Parachute	IN PROGRESS (90)	waiting for a test at Beersel water tower
Antenna	DONE (100)	We are currently using a commercially available antenna provided by the school. However, if time permits, we plan to build our own Yagi antenna.
Modelling	IN PROGRESS (60)	We already made some first tests but we need to improve the details of our can
Contact	DONE (100)	
Website	DONE (100)	
Logo	DONE (100)	
Website blog	IN PROGRESS (/)	We will update it overtime depending on our progresses
Instagram	IN PROGRESS (/)	We will update it overtime depending on our progresses

Our primary mission is 70% done

Our secondary mission is 60% done

Total: 65% done

5.3 Budget

Part	Price	Shop	Order Date
CanSat Starter kit	€ 100	/	WE HAVE
Antenna	/	/	WE HAVE
Parachute	9,4€	/	WE HAVE
GPS	32,60 €	EBAY	
3 electromagnets	7,26 €	aliexpress	19-27/01/2026
PLA bobine	24,99€/1kg	prusa research	
ARCELI 2 PIÈCES DC-DC BUCK CONVERTISSEUR DE TENSION	9,99 €	amazon.fr	23-25/01/2026
TOTAL	€	/	/

5.4 Outreach

We created an Instagram page where we share content about CanSat, the JUICE mission, and our project's progress, with the goal of reaching as many followers as possible. We post regularly, although we do not follow a strict posting schedule.

We also believe it is important to create a visual and artistic identity that is reflected across our Instagram page, our logo, and our website.

Our website introduces the team, explains the CanSat project, and documents the development and progress of our work.

For each workshop we carried out,whether within the team or together with the team of teachers,we published summaries including our conclusions, the problems we encountered, and the solutions considered.

instagram page: https://www.instagram.com/cansatjuice/

website: https://cansatjuice.wixsite.com/cansat

6 Discussion

At the beginning we initially had little knowledge of electronics but we learned a lot with videos or asking questions to old participants. and then we started loving this project. We are all very motivated. We're eager to reach the final, see our can at 1000 meters in the sky and observe the microorganisms collected during the mission.

7 Conclusion

We all quickly agreed that we wanted a mission centered around biology, and the idea came to us quite quickly. Everything got off to a fast start, and the whole group was very motivated to move forward. The distribution of roles and the allocation of each person's strengths and weaknesses happened naturally. The primary mission went smoothly and was completed very quickly. Where we encountered problems was mainly with 3D printing and the various designs. Since no one in our group had any 3D printing experience, we had to learn this skill from scratch. Because it's a complex process, it took us some time to make our first prints and achieve satisfactory results. Regarding the internal and external design of the can, we had to explore all the different layout possibilities and all the available materials to arrive at our final choice. We originally wanted to use agar plates, but today we opted for foam, which doesn't break under impact. We encountered many difficulties, especially with the electromagnet system and the placement of our foam. We also had to change the positions several times due to the air movement within the can, as it needs to be forced against the foam and then be able to escape from the can. All of these are conclusions we made from our current progression.

8 References

Yagi antenna: https://www.k7mem.com/Ant_Yagi_VHF_Quick.html

Yagi Antenna: https://www.instructables.com/2M-Yagi-Antenna/

code : https://thonny.org

3D: https://www.tinkercad.com/ and https://www.blender.org

Internet website: https://fr.wix.com/

gant diagram: https://chatgpt.com/

diagram code : https://www.lucidchart.com

dashboards: https://excel.cloud.microsoft/fr-fr/

different views for parachute and Yagi antenna: https://www.google.com/maps

Biologie, Campbell, Pearson Education 4ed and 7e edition

Microbiology A laboratory Manual, Cappucino & Welsh, 7e edition, Pearson

Microbiology an introduction, Tortora, Funke & case, 11e edition, Pearson

9 APPENDIX

9.1 ANTENNA & DATA CAPTURING

Here is the code we will use to recept the data from our primary mission:

```
""" Frequency Scanner """
from machine import SPI, Pin
from rfm69 import RFM69
import time
FREQ          = 433
ENCRYPTION_KEY                                                                                    =
b"\x01\x02\x03\x04\x05\x06\x07\x08\x01\x02\x03\x04\x05\x06\x07\x08"
NODE_ID        = 100 # ID of this node (BaseStation)
spi  =  SPI(0,  sck=Pin(6),  mosi=Pin(7),  miso=Pin(4),  baudrate=50000,  polarity=0,
phase=0, firstbit=SPI.MSB)
nss = Pin( 5, Pin.OUT, value=True )
rst = Pin( 3, Pin.OUT, value=False )
led = Pin( 25, Pin.OUT )
rfm = RFM69( spi=spi, nss=nss, reset=rst )
rfm.frequency_mhz = FREQ
rfm.encryption_key = ( ENCRYPTION_KEY )
rfm.node = NODE_ID
print( 'NODE           :', rfm.node )
print("Waiting for packets...")
while True:
  rfm.frequency_mhz = FREQ
  print( 'Freq: ' + str(rfm.frequency_mhz) + "\t", end=" ")

  packet = rfm.receive( timeout=0.5 ) # Without ACK
  if packet is None: # No packet received
    print( "." )
    pass
  else: # Received a packet!
    led.on()
    # And decode from ASCII text (to local utf-8)
    message = str(packet, "ascii") # this is our message
    rssi = str(rfm.last_rssi) # signal strength
    print(message + ", " + rssi) # print message with signal strength
    led.off()
  FREQ += 0.25
  if FREQ == 440:
    FREQ = 433
```

9.2 PARACHUTE CALCULUS

For our calculations we used the formula : $mg = \frac{1}{2}Cd\rho a v^2$

m= mass= 0,3 kg
G= gravity= 9,81m/s^2
Cd= drag coefficient = ?
$\rho =$ Air density= $1,1\ kg/m^3$
$a =$ Surface= $\frac{\pi}{4}m^2$

Calculations:

$mg = \frac{1}{2}Cd\rho a_1 v_1^2$

$mg = \frac{1}{2}Cd\rho a_2 v_2^2$

$\frac{1}{2}Cd\rho a_1 v_1^2 = \frac{1}{2}Cd\rho a_2 v_2^2$

$a_1 v_1^2 = a_2 v_2^2$

$\frac{\pi d_1^2}{4}v_1^2 = \frac{\pi d_2^2}{4}v_2^2$

$d_1^2 v_1^2 = d_2^2 v_2^2$

$d_1 = 1m$ (we have data for a parachute of such a diameter)
$v_1 = 3\ m/s$ (for a 1m diameter parachute)
$d_2 = 0,33\ m$
$v_2 = ?$

We isolate v_2^2

$\frac{d_1^2 v_1^2}{d_2^2} = v_2^2$

We replace with data

$\frac{1^2 3^2}{0,33^2} = v_2^2$

$v_2 = 9\ m/s$

That was the speed we were looking for, we can conclude that the diameter we chose (0,33 m) is accurate